BURNED AREA EMERGENCY STABILIZATION PLAN

MURPHY FIRE COMPLEX: WILDHORSE ZONE

SOIL & WATER RESOURCES ASSESSMENT

I. OBJECTIVES

- Assess overall soil and watershed changes caused by the fire, particularly those that pose substantial threats to human life and property, and critical natural and cultural resources. This includes evaluating changes to soil conditions, hydrologic function, and watershed response to precipitation events.

- Develop a map of soil burn severity.

- Identify potential flood and erosion source areas and sediment deposition areas.

- Identify potential threats to life, property, and critical natural and cultural resources in relation to flooding, erosion, and sediment deposition.

- Develop treatment recommendations, if necessary; and

- Identify future monitoring needs, if necessary.

II. ISSUES

A. Human Health & Safety:

- Potential for flash flooding on the upper Bruneau River and Meadow Creek and their tributaries due to increased runoff from the Murphy Fire.

- Potential for damages to roads, culverts and bridges.

- Potential for increase in rocks rolling or falling onto the FS system roads within the burned area due to decrease in surface tension on steep burned slopes.

- Potential threats to residential structures on private property (Keas, Tennel, Scott).

B. Soil/Watershed Stabilization:

- Potential for increased soil erosion, mud / debris flows and sediment delivery to Meadow Creek and Bruneau River due to increased runoff from the Murphy Fire.

- Potential for increase in rolling/falling rocks due to soil erosion and decrease in surface tension on steep burned slopes.

C. T&E Habitat Stabilization and recovery: Potential water quality effects to fish habitat.

D. Cultural Heritage Resources: Potential flood damage to cultural sites including grave sites along Meadow Creek and the Meadow Creek guard station.

E. Invasive Plants: No soil or water resource issues were identified for this category.

III. OBSERVATIONS

A. Background

1. Physiography

The Wildhorse Zone of the Murphy Fire Complex is located approximately 70 miles north of Elko, NV and encompasses a total of 95,163 acres within the Owyhee High Plateau Major Land Resource Area (MLRA). The Owyhee High Plateau MLRA surrounds Elko, Nevada and extends to the northeast corner of the state and into Idaho and Oregon. The fire burned on mountain slopes and in drainages. Elevations within the burned area range from approximately 1494 meters in canyons in the northern portion of the fire to 2880 meters in the mountains in the southern area of the fire.

2. Geology

North part of the burned area: The higher slopes east of the Bruneau River are underlain with granite (along road #751). The geology north of the granite and mid-to-high slopes west of the Bruneau River is mostly ignimbrite and welded tuff with small areas of sedimentary rocks (shale, limestone and conglomerate). Lower slopes along the Bruneau River are sedimentary.

Central part of the burned area is cored by granite which extends east and west from the Bruneau River up to the ridgelines. Small areas of tuff, ignimbrite and rhyolite occur on lower slopes. All of Rattlesnake Canyon just to the north is composed of limestone. The Meadow Creek watershed to the west side is established mostly in rhyolite with granite on the higher east slopes and tuff in the valley bottom near its confluence with the Bruneau River. Tuff, sandstone, conglomerate and quartzite occur in the southwest corner of the burned area.

South part of the burned area: Pine and Rosebud mountains are predominately quartzite with schist, limestone, shale and rhyolite on the lower west slopes above the Bruneau River. Tuff, sandstone, conglomerate and small areas of rhyolite make up the lower slopes of Copper Mountain (quartzite) east of the Bruneau River.

The rhyolitic areas have the most dense drainage network – primarily dendritic to subparallel. The granitic areas contain a lot of disintegrating granite in place (grus) with tors (“stonehenges”) along ridgelines. The granite, tuff and limestone support an intermediary dense drainage network – dendritic to subparallel. The quartzite and clastic sedimentary rocks have the least dense drainage network – also dendritic to subparallel.

A few landslides, colluvial aprons and longitudinal talus/scree slopes exist within the burned area, mostly in the south part where there are large exposures of quartzite and sedimentary rocks.

3. Soils

Soils form the basis of the terrestrial ecosystems that are found in the burned area and are a natural three-dimensional body on the earth’s surface. Soil has properties that result from the integrated effect of climate and living matter acting on earthly parent materials as conditioned by relief over a period of time. Within relatively short distances, the combination of these soil-forming factors can vary, resulting in soils with different physical and chemical characteristics. Soils in the Wildhorse Zone of the Murphy Fire Complex area occur on moderately young steep land surfaces derived primarily from volcanic and granitic parent materials, with small areas of sedimentary materials present. See Table 1 for the general description of the Landtype Associations, associated soils, and the acreage of each that are found in Murphy Fire area. The soils have developed under shrubland and/or grassland vegetation in the vast majority of the burn area. A minor percentage of the area has soils that have developed under forest vegetation for some time. Soils tend to be either in the loamy skeletal or clayey-skeletal textural families. Most soils have an organic enriched surface layer and are typically shallow to moderately deep on the mountain side-slopes or ridges and deep on toe-slopes and valley bottoms.

Table 1: General Landtype Association Descriptions for lands in the Murphy Complex Fire area.

Landtype Association Unit	Overall Slope Range	Dominant Landforms	Parent Material	Dominant Soils	Acres in Burn Area
11	0-15	Stream Terraces Floodplains	Mixed Alluvial Deposits	Typic Argixerolls L-Sk, Fluvaqentic Haloaquolls F-L	505
33	25-65%	Mountain Slopes of Carbonate Sedimentary Rocks	Limestone Colluvium	Calcic Argixerolls L-Sk, Pachic Cryoborolls L-Sk	20,700
34	15-60%	Mountain Slopes of Volcanic Ashy Rocks	Welded Tuff Residuum	Typic Argixerolls F, Aridic Argixerolls F	8,268
37	30-75%	Mountain Slopes of Rhyolite Rocks	Rhyolite Colluvium & Residuum	Typic Argixerolls C-SK, Lithic Argixerolls C-Sk	9,111
38	15-60%	Mountain Slopes of Metamorphic Rocks	Quartzite & Chert Colluvium	Lithic Argixerolls L-SK, Pachic Cryoborolls L-Sk	1,638
39	15-60%	Mountain Slopes of Granitic Rocks	Quartzite Colluvium & Residuum	Typic Argixerolls F Lithic Argixerolls L-Sk	23,479
46	30-70%	Steep Canyon Slopes in Basalt Flows	Basalt Colluvium & Residuum	Typic Argixerolls C-SK, Rock Outcrop	14,884
47	30-70%	Steep Canyon Slopes in Rhyolite Flows	Rhyolite Colluvium & Residuum	Lithic Argixerolls L-SK, Rock Outcrop	1,562
68	15-70%	Sub-alpine Headlands in Quartzite Rock	Quartzite Residuum & Colluvium	Typic Cryoboroll L-Sk, Pachic Cryoborolls L-Sk	1,896
77	5-50%	Structural Basin Lands in Rhyolite Rocks	Welded Tuff Residuum	Typic Argixerolls F Pachic Argixerolls F	2,609
86	3-30%	Snake River Plateau Lands	Basalt Residuum	Typic Argixerolls F Lithic Argixerolls C-Sk	5,277
87	5-40%	Plateau Headlands	Basalt & Welded Tuff Residuum	Pachic Argixerolls L-SK, Argic Pachic Argixerolls F	427
97	45-65%	Strongly Dissected Rock Lands	Rhyolite Colluvium & Residuum	Rock Outcrop , Scree, Lithic Argixerolls L-SK	39
98	30-75%	Rock Mountains & Scree Lands	Quartzite Residuum	Rock Outcrop , Scree	4,271

The soils vary greatly across the high plains and mountainous landscapes in the Wildhorse Zone of the Murphy Fire Area. The primary soil differences are associated with changes in geologic parent materials and the depth to bedrock. The vast majority of soils have an organic enriched surface layer and are classified as mollisols.

The valley bottom soils associated with riparian vegetation on stream terraces and floodplains tend to be deep, and well drained; and are coarse-loamy, skeletal soils in the areas of granitic parent materials. In the areas of volcanic tuff parent materials the soils have a higher silt and clay content and tend to be classified as either fine-loamy or fine textural groups with moderate amounts of gravels and stones.

The rolling foothills, hillslopes, and alluvial fans tend to be moderately sloping 15 to 35% slopes. Again, most of the soils being deep well-drained or moderately well-drained, skeletal mollisolls. The finer soil textures are associated with the volcanic parent materials, and the coarser textures with the granitic parent materials. There are some areas of loamy-textured soils that occur on these landforms, which are derived from meta-sedimentary parent material.

The steeper 35 to 65% mountain slopes tend to have a major component of shallow to bedrock soils and rock-outcrops. The percentage of shallower soils is greatest on the meta-sedimentary and granitic parent materials; and less dominant on the volcanic parent materials areas. Again, most of these soils tend to be mollisols with the relationship of the soil texture being linked to the parent materials as described earlier.

There is a small percentage of the landforms that are structural breaklands with very steep 50 to 75%+ slopes that are dominantly rock-land and rubble-land with a minor percentage of weakly developed skeletal soils that are classified as inceptisols or entisols.

4. Climate

North Central Elko County, in northeastern Nevada, is characterized by an arid climate with low relative humidity, high evaporation and abundant sunshine. Summers are hot with average monthly maximum temperatures 90 to over 100 degrees Fahrenheit. Winters are cold with average temperatures generally between -10 and 40 degrees Fahrenheit. Precipitation patterns and amounts are orographically controlled. Mean annual precipitation for the fire area ranges from about 14 inches, measured at Wildhorse Reservoir (#269072) southwest of the fire, to nearly 18 inches at the Jarbidge 4N climate station (#264038) northeast of the fire. Most of the precipitation comes during the winter in the form of snow and spring rain between March and June.

5. Hydrology and Water Quality

The major drainages within the Wildhorse Zone of the Murphy Fire include upper Bruneau Creek and Meadow Creek. These watersheds drain to the north into the Snake River in Idaho. The USGS operates a real-time stream flow station (# 13161500) on the Bruneau River at Rowland, NV. The long term mean flow for this site is 17 cfs. Annual maximum streamflows between 1998 and 2006 ranged between 230 and 1,600 cfs. Recent spikes in streamflows for this gage site at the end of July 2007, following a rain event over the southeast portion of the fire, were about 20 cfs followed by another at 40 cfs.

There are no water quality limited segments of stream identified within the Wildhorse Zone of the Murphy Fire. However, there is an isolated area of ephemeral drainageways in the upper headwaters along the north and east flank of the fire that drain into the Jarbidge River, which is listed on the Nevada 2004 303(d) impaired water bodies list.

B. Reconnaissance and Assessment Methodologies

The purpose of a burned area assessment is to determine if the fire has caused emergency watershed conditions, if there are values-at-risk, and if emergency stabilization treatments are necessary to mitigate damages to these values. Values-at-risk may include commercial and residential properties, capital improvements, and critical cultural and natural resources located within or downstream of the fire, that may be subject to damage from flooding, ash, mud and debris deposition, and hill slope erosion. If emergency watershed conditions are found, and values-at-risk are identified, then the magnitude and scope of the emergency is mapped and described, values-at-risk and resources to be protected are analyzed, and treatment prescriptions are developed to protect these values. Emergency watershed conditions include assessment of both hydrologic and soil factors. The most significant factor is the loss of soil cover, which can lead to erosion and changes in hill slope hydrologic function in the form of decreased infiltration and increased runoff. Such conditions lead to increased flooding, sedimentation and deterioration of soil condition.

Aerial reconnaissance and field observations conducted August 1 - 3, 2007 were used to modify the BARC in order to produce the final soil burn severity classification.

1. Soil Burn Severity

Natural soil processes essential to the sustainability of healthy terrestrial ecosystems are often altered by wildfires. Depending on the intensity and severity of a wildfire, soil characteristics like organic matter/nutrient status, soil aggregate stability, and hydrologic function can be reduced significantly, impairing the ability of vegetation to reestablish and increasing runoff and soil erosion/sedimentation following rain events. A burned area assessment following a wildfire is necessary to quantify the impacts to the soil resource and potential values at risk within a watershed.

Two rating methods have been used to describe fire effects: Fire Intensity and Soil Burn Severity. *Fire Intensity* is based on temperature, flame length, heat of combustion, and total amount and size of fuel consumed. It accounts for convective heat rising into the atmosphere and fire effects on the above ground vegetation.

Soil Burn Severity is a relative rating of the degree of change due to fire impacts on soil productivity, erosion rate and potential for vegetation recovery. It is based on temperature, moisture content of duff and other surface fuels, heat of combustion, and total amount of duff and ground vegetation consumed. Soil Burn severity accounts for the amount of conductive and radiant heat that goes down into the soil, affecting soil characteristics. Generally, there is a close correlation between the depth, intensity, and residence time of heat penetrating into a soil and the loss and/or alteration of soil properties. Increased fire intensity promotes the formation of water repellent (hydrophobic) layers at or near the soil surface, and loss of soil structural stability. These changes to the soil environment can dramatically increase the potential for runoff and soil particle detachment by water and transport off-site (erosion) in burned areas. To mitigate the potential for large-scale erosion events, it is important that accurate predictions be made regarding the hydrologic response of post-burn soils. Mapping soil burn severity is the primary analysis used for making these predictions.

To establish the spatial distribution and extent of burn severities occurring across burned areas, aerial reconnaissance and field evaluations were conducted. Soils in all soil burn severity classes were examined in the field to assess for post-fire hydrophobic conditions. This information was then used to classify the Burned Area Reflectance Classification (BARC) satellite imagery (discussed later) into a soil burn severity map. The criteria used to evaluate soil burn severity on the ground included assessments of soil hydrophobicity (water repellency), ash depth and color (fire severity), size of residual fuels/vegetation (fire intensity), soil structure and aggregate stability, post-fire effective ground cover, and subsurface plant root viability. To determine soil hydrophobicity, both the water drop method (qualitative) and a decagon mini-disk infiltrometer (quantitative) - to measure the amount of water that infiltrates in a given time - were used. Based on results from aerial and field evaluations, the Wildhorse Zone of the Murphy Fire Complex area was mapped into four relative soil burn severity classes. These included high, moderate, low, and unburned. Appendix III contains photos showing typical examples of each soil burn severity class found within the fire.

Changes to vegetation are among the primary factors affecting a Burned Area Reflectance Classification (BARC). The BARC is a satellite-derived map of post-fire changes in spectral reflectance. This is used in combination with field observations to develop a map of post-fire soil and watershed condition. Post-fire Landsat imagery was acquired August 1, 2007 and was used in combination with a pre-fire Landsat image acquired July 9, 2007 to produce the BARC map for the fire. A small sliver along the western portion of the fire was not entirely covered by the pre-fire image, so it was supplemented with imagery from July 29, 2006. The BARC map was then evaluated during field visits and helicopter reconnaissance to produce the final soil burn severity map. The soil burn severity classification is determined by changes in soil parameters including duff and litter cover, organic matter and fine roots, soil structure, and infiltration rate. A soil burn severity map is produced by adjusting the BARC map as necessary to reflect field observations of these parameters. Cloud coverage across the eastern part of the fire (Copper Mountain area and north) during the post-fire satellite pass gave anomalous reflectance that indicated a mosaic of moderate, low and unburned areas in the headwaters of Buck Creek. While these soil burn severity classes show up on the final soil burn severity map, actual ground conditions showed that Buck Creek headwaters did not burn. The final soil burn severity map was used to evaluate post-fire erosion rates and watershed response.

2. Erosion Potential

Surface erosion is defined as the movement of individual soil particles by a force, and is initiated by the planar removal of material from the soil surface (sheet erosion) or by concentrated removal of material in a downslope direction (rill erosion). According to Foster (1982) and Megahan (1986), surface soil erosion is a function of four factors:

1. Susceptibility of the soil to detachment,
2. Magnitude of external forces (raindrop impact or overland flow),
3. Amount of protection available by material that reduces the magnitude of the external force (soil cover), and
4. Management of the soil that makes it less susceptible to erosion.

Raindrops striking exposed mineral soil with sufficient force can dislodge soil particles and small aggregates. Once soil particles are detached by splash erosion they are more easily transported in overland flow.

Fires generally consume most of the shielding plant and litter cover, which provide wind protection and soil stability. When soils vulnerable to wind erosion are stripped of vegetation, soil particles become available for transport by the wind through surface creep, saltation or suspension. Wind erosion is generally localized in rolling and mountainous terrain due to natural wind breaks, and as such, nutrients are redistributed across the landscape. Observations of dust devils are often common in the burned areas. The potential risk of blowing dust as a result of fire occurs on roads within and downwind of the fire areas, in which blowing dust and ash can create serious visibility problems. Oftentimes it may take several years before burned areas have reestablished enough vegetation to reduce wind erosion and resulting dust storms, depending on the severity of the fire, the inherent soil susceptibility to wind erosion, and vegetation recovery. It’s generally accepted that fire-induced water repellency can increase post-fire runoff; however there is also recent research indicating that water repellency may also increase potential for wind erosion (S. Ravi, et. al. 2005). Burned areas which exhibit higher soil burn severity and vegetation mortality can serve as a potential source area for fugitive dust and are at risk of topsoil loss.

Fire effects were evaluated in terms of soil condition parameters. These parameters included changes in litter and duff (vegetative ground cover), destruction of fine and very fine roots in the surface horizon, susceptibility to erosion, infiltration of water and development of hydrophobic (water repellent) soil surfaces. Changes in vegetative ground cover as affected by the fire were noted and compared to pre-fire conditions. Strength of surface soil structural aggregates was examined. Water infiltration was normal at most sites tested. Water repellency was evaluated by observing the depth and thickness of a water repellent horizon in surface soils where it existed, and the length of time a water drop remained beaded on the surface.

3. Watershed Response

The major determining factor influencing runoff and erosion from burned hillslopes is the amount of disturbance to the forest floor that protects the underlying mineral soil (Robichaud 2000). The unburned forest floor consists of a litter layer (leaves, needles, fine twigs, bark flakes, matted dead grass, mosses and lichens, O1 soil horizon) and a duff layer (partially decomposed remnants of the material in the litter layer, O2 soil horizon) (Martin and Moody 2001). These layers absorb most of the rainfall, provide storage of water and obstruct the flow of water on hillslopes. The combustion process converts the forest floor into ash and charcoal. Ash and small soil particles seal soil pores (Morin and Banyamini 1977, Neary et al. 1999), decreasing the infiltration rate (Fuller et al. 1995, Barfield et al. 1981) and increasing potential runoff and erosion.

When the charcoal and ash are removed from the hillslope by post-fire runoff or wind, the soil is left bare and susceptible to rain splash and overland flow.

Overland flow occurs as a result of rainfall that exceeds soil infiltration capacity and the storage capacity of depressions. On the unburned forest floor, overland flow follows a myriad of interlinking flow paths that constantly change as organic material (litter and duff layers) and inorganic material (rock) are encountered (Huggins and Burney 1982). Consumption of the forest floor by fire alters the path of overland flow by reducing the overall length of the flow path, resulting in the concentration of flow into a shorter flow path. This concentration of overland flow increases the hydraulic energy of the flow and can result in rill erosion. At the watershed scale, the reduction of hillslope flow path lengths and the formation of rills that have a high water conveyance capacity reduce the times of concentration or the amount of time for overland flow to reach a defined point within the watershed. Although less litter, duff, and vegetation is present in desert and range lands than in a forested environment, the same processes occur. However, the differences in infiltration and overland flow between pre-fire and post-fire conditions are less in a desert/rangeland environment than in a forest because there is less ground fuel to burn.

Overland flow is also influenced by the fire-induced water repellency (hydrophobicity) of the soils. The reduction of infiltration due to water repellency can increase overland flow (DeBano et al. 1967). Infiltration curves for water repellent soils reflect increasing wettability over time once the soil is placed in contact with water. Water repellency decreases (hence infiltration increases) with time because the hydrophobic substances responsible for hydrophobicity are slightly water soluble and slowly dissolve, thereby increasing wettability. In general, hydrophobicity is broken up or is sufficiently washed away within one to two years after a fire (Robichaud, 2000).

On-the-ground field observations and aerial reconnaissance within and downstream of the burn areas were conducted to determine watershed response. Geologic and Landtype Association maps (based on lithology and geomorphology) were used during field surveys to evaluate post-fire hillslope stability, runoff, and erosion/debris flow potential. Channel morphology related to transport and deposition processes were noted, along with channel crossings and stream outlets. Observations included condition of riparian vegetation and the volume of sediment stored in channels and on slopes that could be mobilized. Burn severity and changes in soil infiltration were also considered.

4. Values-at-risk

The BAER hydrologist, soil scientist and geologist conducted a rapid assessment of life and property within and downstream of the fire and three properties located within the burned area (Keas, Tennel and Scott). Aerial reconnaissance and field tours were conducted to ascertain locations of structures and roads with respect to stream channels and floodplains. Road crossings of streams and drainage ways were inventoried to determine location, size, capacity, and condition. Archeological and historic sites in Meadow Creek (grave site and ranger station) and flume/pipeline ruins in Bruneau Creek were assessed for potential hydrologic impacts. Potential impacts to water quality and fish habitat was evaluated indirectly as soil burn severity, watershed response, and erosion potential.

Additionally, soil burn severity and watershed response was reviewed for the Idaho portion of the Murphy Fire through collaboration with Idaho BLM BAER team members. Issues of concern for the northern portion of the Wildhorse Zone of the Murphy fire included watershed responses in the Columbet and Dorsey watersheds, the recovery and stability of riparian systems, and the potential effects to fish habitat.

C. Findings

1. Soil Burn Severity

The Murphy Fire – Wildhorse Zone burned primarily through sparse juniper, sagebrush, shrub, and grass/forb vegetation. While fire intensity varied throughout the burn area, the rapid rate of fire spread through predominately fine fuels with light fuel loading, produced short fire residence times. The resulting burn severity is low throughout most of the burned area with some small, isolated areas of moderate burn severity. Very small areas of high soil burn severity were observed within the Wildhorse Zone. They were limited to areas where pre-fire vegetation was dense, particularly riparian areas, under which deeper layers of litter and duff had accumulated. These areas showed the effects of longer periods of burning as observed by the complete loss of surface organic materials and a deeper ash layer. Overall, the soil infiltration was not affected in a significant way by the wildfire.

Aerial reconnaissance and field observations conducted within the fire perimeter revealed that most burned area soils fell into a low soil burn severity classification. Viable shrub root crowns and grass roots should allow for natural revegetation of these sites but with somewhat reduced post-fire foliage coverage than pre-fire. Soils with a moderate or high burn severity classification were limited to several relatively small areas and have significantly less viable shrub root crowns. The natural revegetation on these sites is likely to be slower and will have less foliage cover than the low burn severity sites. Total acres burned and percent acres burned for each burn severity class are presented in Table 3 and the Soil Burn Severity map included in Appendix IV.

Table 3. Soil Burn Severity acreage for the Murphy Fire Complex, Wildhorse Zone.

Soil Burn Severity	Acres	Percent
High	41	<.1
Moderate	8,741	9.2
Low	67,088	70.5
Unburned	19,294	20.3
Total	95,164	100

Soils in all soil burn severity classes were examined in the field to assess for post-fire hydrophobic conditions using the field timed water bead test. Field observations indicated that soils on the low soil burn severity sites had very limited post-fire hydrophobic characteristics. Approximately 2% of the low burn severity sites had slightly hydrophobic conditions in the surface soil (1/4 to 1/2 inch depth), this occurred very sporadically in the examined areas. The moderate soil burn severity areas were slightly hydrophobic post-fire on approximately 15 to 20% of their aerial extent. This occurred primarily directly under the sagebrush plants that had been totally consumed by fire. Approximately an 8 to 10 inch circle around the base of the plant was slightly hydrophobic, and that condition reduced significantly a few inches outside of that circle. The soils on high soil burn severity sites were slightly hydrophobic on 50 to 60% of their aerial extent. However, the high soil burn severity class for this fire is only approximately 40 acres. The hydrophobic conditions are expected to improve following the first rainfall on the fire area, and with any additional rainfall events as the soils re-wet several times.

Measured soil infiltration rates were done using the Decagon Mini Disk Infiltrometer as a measurement tool, on various soil types and soil burn severities. The measured infiltration rates on the unburned sites ranged from 2-3 ml/minute. The field testing was done at each site for 3 minutes. Most of the burned sites ranged from 2 to 5 ml/minute, with the slowest site being an alluvial terrace with moderate soil burn severity that was very slightly hydrophobic at the surface. The highest measurement was a low soil burn severity on welded tuff soils that had rate of 9 ml/minute. We could not find any major differences between the unburned and the burned sites based upon these measurements.

Field observations of the post-fire soil conditions on the steeper (40+%) mountain slopes revealed that very little organic matter was remaining on the ground surface, only the surface pebbles or other coarse fragments would absorb the raindrop forces and slow down and potential runoff. Based upon the examination of the area in upper Bruneau Canyon where an intense thunderstorm occurred, it is apparent that the post-fire runoff potential on these hillslopes has significantly increased. This is probably due to a reduction in the time of concentration of the overland flow for any given rain event because the organic surface layer and plant canopy that acts as a buffer is now gone. The WEPP modeling discussed in the next section also revealed significant increases in potential post-fire runoff.

The watershed and vegetation BAER team members discussed several potential hillslope treatments and the potential effectiveness of those treatments on the mountain slopes in this burn area. These included seeding, straw mulch and straw wattles. It was determined that these traditional hill slope treatments would not be very effective on the steep hill slopes in the burned area to successfully mitigate the threat to values-at-risk, and/or would not be cost effective for the values at risk.

2. Erosion Potential

The surface erosion potential for each representative Landtype Association hill-slope within the Murphy Fire area was estimated using the Disturbed WEPP module within the Water Erosion Prediction Project (WEPP) computer model (Elliot et. al). The WEPP model calculates the runoff and erosion from a hill-slope and outputs include: inches of precipitation from rain events, number and runoff from rainfall events, number and runoff from snowmelt events, upland erosion rate, and probability of erosion occurring during the time period. The model estimated erosion amount can be plus or minus 50% of the actual erosion event amount, according to the author's documentation.

The data entered into the WEPP computer model includes the following parameters: local climate data, soil texture, treatment to the site (e.g. grassland, low severity burn), slope gradient, slope length, slope area, and percent cover on the site. The climate data from the Mountain City Ranger Station, Nevada was used as the basis to model the precipitation events. The slope characteristics were developed from the topographic maps of the fire area. The percent cover (surface rock/vegetation cover) for a given existing situation or for a future scenario was based upon field observations and the best professional judgment of the soil scientists after discussions with the vegetation specialist. The climatic time period modeled, was for 30 years. The reported soil erosion rate is for an average over a 30-year period, which includes both minor and major storm events. The WEPP erosion modeling was done for pre-fire, immediate post-fire Low/Moderate Soil Burn Severity (non-hydrophobic), and after the first growing season post-fire. See Table 4 for the modeled potential post-fire soil erosion.

Table 4: Disturbed WEPP pre-fire and post-fire potential soil erosion and probability of runoff.

Landtype Association	Percent of Fire Area	Pre-fire Grassland Soil Erosion (tons/acre)	Probability of Pre-fire Runoff from Grassland (%)	Pre-fire Shrubland Soil Erosion (ton/acres)	Probability of Pre-fire Runoff from Shrubland (%)	Potential Post-fire Soil Erosion tons/acre	Probability of Post-fire Runoff (%)	Potential Soil Erosion One Year Following Fire (tons/acre)
33	21.9	.4	23	0	0	7.2	80	3.8
34	8.7	.5	33	0	0	6.9	80	3.9
37	9.6	.6	33	0	0	5.8	80	3.5
38	1.7	.6	33	0	0	5.3	80	2.7
39	24.8	.6	33	0	0	6.7	80	4.4
46	15.7	.3	23	0	0	6.1	77	3.0
47	1.6	.6	33	0	0	5.6	80	3.3
68	2.0	.5	33	0	0	5.0	80	3.3
77	2.8	.2	30	0	0	4.8	93	3.5
86	5.6	2.7	30	0	0	6.9	93	4.1
98	4.5	2.9	43	0	0	4.8	50	3.4

Note – Landtype Association Map units occupying less than 1% of fire area were not modeled.

There is the potential for significant runoff and associated soil erosion to occur on the steeper Landtypes if an intense rainstorm were to impact the fire area. This scenario has already occurred in several locations in the upper Bruneau River drainage following a localized intense thunderstorm on July 31, 2007. The WEPP estimate from high intensity rainstorm occurring prior to the amelioration of the post-fire soil/vegetation conditions on the steeper mountain slopes was in excess of 20 tons per acre of potential soil erosion. Past experience on the Bitterroot and Flathead NF's is that these high post-fire erosion events only take place where localized intense precipitation events occur over the burn area. Typically the precipitation cells are from 100 to 2000 acres in size.

In summary, the majority of the burned area did not have a detrimental affect on vegetation or soils. There was only 1.2% of the burned area classified as having high vegetation mortality, and less than 0.1% of the fire area was determined to have a *high soil burn severity*. Where soils with *high soil burn severity* occurred, they were not associated with critical values at risk. The majority of the fire (70.5%) was determined to have burned with a *low soil burn severity*. In the area burned by the fire, approximately 3.3 percent of the sites tested were slightly hydrophobic. The few sites where hydrophobic conditions were observed were well distributed across the fire area.

The fact that the fire burned with a low severity in most areas does not mean there were not fire effects. Greater potential for soil erosion exists in areas with steeper slopes (>40%), which a high percentage of the fire area is. Because of the steep slopes and moderate permeability rates associated with the majority of the soils in the fire area, the removal of the vegetation and surface organic layer has increased the runoff potential from these sites significantly. The Disturbed WEPP modeling results showed a 47 to 63% increase in probability runoff from the vast majority of the burned lands in the fire area.

The increased runoff potential increases to potential for soil erosion to occur. The majority of the soils increased from a pre-fire soil erosion potential of approximately .5 ton/acre/year (grassland site) to a post-fire potential soil erosion of approximately 6 tons/acre/year. With a high intensity rainstorm the potential soil erosion could be in excess of 20 to 30 tons/acre/year if 30-year return interval storm were to occur. Because of the low mortality of the burned vegetation, the short time-frame when the burned area is susceptible to post-fire erosion (approximately 2 years), and the limited decrease in risk associated with seeding grass, the watershed and vegetation specialist did not recommend any grass seeding in the fire area. Other upland watershed treatments to reduce the potential runoff and/or soil erosion were examined but none were deemed appropriate to be used on the burned mountain slopes in this fire area. The most effective post-fire treatments for this area are associated with roads and road drainage situations. The treatments relate to maintaining adequate drainage capacity in the bridges and culverts to accommodate the post-fire potential runoff; and to reduce the effects of the road system to off-site values at risk.

3. Watershed Response

The primary watershed response of this fire is expected to include periodic flushes of ash-laden runoff and sediment, rock, and organic debris, in response to high-intensity rain events, for the first few years following the fire. Thus, the fire was mapped as predominantly moderate and high watershed response, with high erosion potential, due to the inherent characteristics of this steep and rugged terrain. Debris-producing events are expected to be localized, and should be limited to redistribution from steep, upper landscape positions to deposition on toe slopes and debris cones. Coalescing debris flows are not expected to be carried into main channel ways and transported further downstream. Sediment-laden runoff will likely be observed for the first year following the fire, or until vegetation recovers and begins to filter hill slope runoff again. After this period, runoff should start to decline and return towards background levels. Temporary increases in spring flow may occur due to the reduction in interception and evapo-transportation where vegetation was burned adjacent to springs.

Natural recovery of annual grasses and other vegetation, as well as long-term re-establishment of the shrub component, is expected to reduce this value to within allowable limits, within 1 to 2 years following the fire. Vegetation recovery is largely dependant on climatic cycles. If wet winters occur, vegetation recovery could be rapid, with forbs and grasses providing ground cover similar to that observed in the adjacent areas previously burned during the 2006 Charleston fire, located just south of the Murphy Fire. By the second winter season, forbs and grasses should provide sufficient cover to reduce any increase in watershed response to pre-fire levels. Once sprouting vegetation begins to produce brush crowns and a duff/litter layer, watershed response will be reduced further. However, if winters are dry, vegetation recovery will be slow, and thus the establishment of ground cover and shrub communities will be slow, and watershed response will remain slightly elevated over pre-fire conditions.

4. Values-at-risk

Due to burned vegetation and exposed soil on steep mountain slopes, there is a significant potential for increased runoff and soil erosion/sedimentation, which results in five main values at risk. These identified post-fire effects and values at risk shaped the analysis and report:

Threats to Life and Property: There are numerous locations in the fire area that are at increased risk for potential flash floods, rock-fall and debris flows due to steep slopes, geologic materials, and additional post-fire runoff. Structures on Keas, Tennel and Scott private properties were determined to not be at risk.

Fisheries/Aquatics: There is a risk of water quality (turbidity) to streams in the short term. (See Wildlife Resource Assessment.)

Road System: Several road segments, especially along roads #067 and #751, were identified to have potential post-fire road surface drainage problems and/or under-sized culverts unable to handle post-fire stream flows as a result of the anticipated increased runoff.

Soil Productivity: Several areas have a high potential for post-fire soil erosion if a high intensity rainstorm were to occur during the first two years following the fire. The loss of a major portion of the topsoil would reduce the soil productivity of these sites.

Water Quality: The tributary headwaters to the Jarbidge River, including Buck, Columbet and Dorsey Creeks, were mostly unburned with very small areas of low soil burn severity and still have upland and riparian buffers intact. Thus, adverse effects to the water quality and 303(d) status of the Jarbidge River are not anticipated as a result of the Murphy Fire, Wildhorse Zone.

There will be increased sediment yield and associated nutrient yield from the runoff waters of the burned watersheds for the next one to two years. These sediment increases may affect some aquatic habitat in the Bruneau and Jarbidge River systems, as sediment is transported off hill slopes and redistributed throughout channels. Refer to the Wildlife Assessment for further discussion on sedimentation impacts to bull trout, Redband trout, and Columbia spotted frogs.

IV. RECOMMENDATIONS

A. Emergency Stabilization – Fire Suppression Repair: Refer to Operations Assessment.

B. **Emergency Stabilization:** includes treatments to protect public safety, fisheries, roads and water quality.

1. Human Health & Safety

a. Safety Signs

Situation: FS System roads within the burned area are at risk for flash flooding, mud/debris flows and rolling / falling rock.

Recommendation: Install hazard warning signs on FS system roads where they (1) enter the burned area and (2) at forks within the burned area, in order to warn drivers of the elevated hazards when driving the minimally maintained road systems within the burn.

See Part F; Specification 12, Install and Replace Safety Signs, and the Watershed Treatments Map in Appendix IV.

2. Soil/Watershed Stabilization

a. Hicks Ford

Situation: The bridge at Hicks crossing on Meadow Creek was severely damaged during the fire and had to be removed for safety purposes. A ford was quickly installed to keep the road in service during suppression operations. But, the material used was not properly set in the stream bed for long-term service.

Recommendation: Reconstruct the ford in to order to keep the road in service with minimal maintenance at this stream crossing.

See Part F, Specification 2, Hicks Ford Improvement, and the Watershed Treatments Map in Appendix IV.

b. Up-size culverts

Situation: Several culverts within the burned area are now undersized for passing potential storm runoff and therefore present a risk for road damage.

Recommendation: Up-size culverts that do not currently have the capacity to accommodate the anticipated increased post-fire runoff. Replace culverts that due to poor installation have a high risk of failure with the anticipated increased post-fire runoff.

See Part F, Specification 3, Upsize Culverts, and the Watershed Treatments Map in Appendix IV.

c. Inspect and clean culverts and one bridge

Situation: Several culverts and their catchments were found to be nearly or completely filled with sediment. One bridge has an accumulation of variable-sized woody debris perched at a high water line just upstream from the bridge. If mobilized by future storm flow, these logs could create a log jam beneath the bridge and possibly cause flood damage to its structural integrity. Sediment-plugged culverts risk diverting flood flows over the roadway and possibly cause undermining of the road prism.

Recommendation: Clean and maintain existing culverts and bridges as soon as possible to ensure maximum flow capacity is available to accommodate anticipated post-fire runoff.

See Part F, Specification 4, Inspect/Clean Culverts and Bridge, and the Watershed Treatments Map in Appendix IV.

d. Post-storm road patrol and maintenance

Situation: Roads in the Wildhorse Zone of the Murphy Fire Complex primarily follow river bottoms, passing through long narrow canyons in several places, and cross long steep slopes in and out of the canyons. There is an immediate and future threat to travelers along the roads within the burned area due to the increased potential for rolling and falling rock from burned slopes above the highway and increased potential for flash floods and mudflows. With the loss of vegetation normal storm frequencies and magnitudes can more easily initiate rill and gully 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 along steep slopes and put the safety of users at risk.

Recommendation: Monitor road drainage structures (bridges & culverts) 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.

See Part F, Specification 5, Post-Storm Road Patrol and Maintenance, and the Watershed Treatments Map in Appendix IV. FS system roads within the burned area

e. Streambank and Road Stabilization (Road #751)

Situation: Road #751 is a key transportation route between the Bruneau River and the Jarbidge River drainages. There is a 1.5 mile portion of the road that is located in an ephemeral draw that drains into the Bruneau River. Currently there are eight ephemeral streams that cross the road prism and are intercepted by a gully in the main ephemeral draw. The gully wall is immediately adjacent to the fill-slope along approximately 650 feet of the road length and threatens to undermine the road prism. In addition, this is a direct sediment source into the Bruneau River. The sediment from this source enters the Bruneau River above resident red-band trout habitat, and probable over-wintering bull trout habitat (T&E species).

Recommendation: Complete streambank and road stabilization on a portion of road #751 that drains into the Bruneau River, to reduce head-cut erosion of the road prism into the gully and reduce potential increases in sediment input into Redband trout and Bull trout habitat.

See Part F, Specification 6, Stream bank and Road Stabilization, and the Watershed Treatments Map in Appendix IV.

3. **T&E Habitat Stabilization/Recovery:** No treatments are recommended for soil and water resources for this issue.

4. **Cultural Heritage:** No treatments are recommended for soil and water resources for this issue.

5. **Invasive Plants:** No treatments are recommended for soil and water resources for this issue.

C. Rehabilitation: None

D. Management Recommendations – Non-Specification Related:

1. Soil/Watershed Stabilization

Issue: Forage for livestock has been reduced by the fire. Many of the remaining green areas are riparian corridors. Recovery of the re-sprouting burned portions and health of the unburned portions of these corridors is extremely important in keeping sediment out of the drainages. Livestock will tend to migrate to the flush of new sprout growth which could adversely impact the vegetation recovery process. This will prolong the exposure of soils to erosion and runoff, and reduce the filtering processes of stream terraces and floodplains. Livestock will also concentrate in and around sensitive riparian areas within the burn, such as seeps and springs.

Recommendation: Defer grazing from the uplands and riparian corridors. The team recommends resting the burned areas from livestock grazing until native or seeded vegetation is reestablished. Long-term management should utilize grazing practices that minimize cattle concentration in riparian and streamside zones during the grazing season. (See also the Vegetation and Range Resource Assessment.)

2. Cultural Heritage:

Issue: The ditch relief culvert located at the Meadow Creek Ranger Station (historic site with structural foundations) is too long. The outlet extends several feet into the channel from the road prism, causing runoff to erode the embankment adjacent to the ruins of the ranger station.

Recommendation: Remove 3-4 excess feet from the outflow end of the pipe with a bevel cut to the pipe. Then harden the outlet apron and outer curve of the channel and embankment by the ruins with Class 2 rip rap. (See Cultural Resource Assessment.)

V. CONSULTATIONS

Ron Hudson, Hydrologist, Humboldt-Toiyabe National Forest, Elko, NV
Kevin Carnes, Civil Engineer, Humboldt-Toiyabe National Forest, Elko, NV
Mike Balen, Engineer, Humboldt-Toiyabe National Forest, Elko, NV

VI. REFERENCES

Coats, Robert R., Geology of Elko County, Nevada, 1987, Nevada Bureau of Mines and Geology, Bulletin 101.

DeBano, L.F., Osborn, J.F., Krammes, J.S., and J. Letey Jr. 1967. Soil Wettability and wetting agents…our current knowledge of the problem. General Technical Report PSW-43. Berkeley, CA. U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 13 p.

Foster, G.R. 1982. Modeling the erosion process. In: Haan, C.T., Johnson, H.P., Brakensiek, D.L., eds. Hydrologic Modeling of Small Watersheds. St. Joseph, MI. American Society of Agricultural Engineers. Chapter 8.

Granger, Arthur E., Mendell M. Bell, George C. Simmons, and Florence Lee, Geology and Mineral Resources of Elko County, Nevada, 1957, Nevada Bureau of Mines, Bulletin 54.

Huggins, L.F. and J.R. Burney. 1982. Surface runoff, storage, and routing. In: Haan, C.T., Johnson, H.P., Brakensiek, D.L., eds. Hydrologic Modeling of Small Watersheds. St. Joseph, MI. American Society of Agricultural Engineers. Chapter 5.

Martin, D.A. and J.A. Moody. 2001. Comparison of soil infiltration rates in burned and unburned mountainous watersheds. Hydrological Processes. 15:2893-2903.

Megahan, W.F., 1986. Recent studies on erosion and its control on forest lands in the United States. In: Richard, F. ed. Range basin sediment delivery: Proceedings, 1986, August. Albuquerque, NM. IAHS Publication 159, Wallingford, Oxon, United Kingdom: 178-189.

Moran, J. and Y. Benyamini. 1977. Rainfall infiltration into bare soils. Water Resources Research. 13(5):813-817.

Neary, D.G., Klopatek, C.C., DeBano, L.L. and F. Folliot. 1999. Fire effects on below ground sustainability: a review and synthesis. Forest Ecology and Management. 122:51-71.

Robichaud, P.R. 2000. Fire effects on infiltration rates after prescribed fire in Northern Rocky Mountain forests, USA. Journal of Hydrology. 231-232:220-229.

USDA-U.S. Forest Service, 2006. Erosion Prediction Model (WEPP), Erosion Risk Management Tool (ERMiT), and Disturbed WEPP submodules (USDA Forest Service Rocky Mountain Research Station and San Dimas Technology and Development Center; http://forest.moscowfsl.wsu.edu/fswepp/, updated February 8, 2006.

USDA, Forest Service, 2007, Cost Estimating Guide for Road Construction - Intermountain, Southwestern and Rocky Mountain Regions.

USDA, Forest Service, Humboldt National Forest, Bruneau River Watershed Environmental Assessment, Mountain City Ranger District, 1994.

USDA, Forest Service, Humboldt-Toiyabe National Forest, Forest Development Road Cooperative Agreement with Elko County, Nevada, 1962, updated 1967.

USDA, Forest Service, Humboldt National Forest, North Humboldt Planning Unit, USFS Landtype Associations, Landform Section for Soils Report and Resource Document.

USDA - Natural Resource Conservation Service, 1997, Soil Survey of Elko County, Nevada: Central Part, Volume 1, 2, and 3, 1389 pp.

USGS, The National Flood Frequency Program – Methods for Estimating Flood Magnitude and Frequency in Rural Areas in Nevada, 1999, USGS Fact Sheet 123-98.

WRCC Western Regional Climate Center, http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?nv8346.

Marsha Davis, Geologist, NPS Pacific West Region	(206) 220-4262
Jessica Gould, Hydrologist, US Forest Service, Black Hills National Forest	(605) 716-2039
Dean Sirucek, Soil Scientist, US Forest Service, Flathead National Forest	(406) 387-3817

Runoff Model Results - USGS National Flood Frequency Program

National Flood Frequency Program, Version 3.0
Based on Water-Resources Investigations Report 02-4168
Equations from database NFFv3.mdb
Updated by Kries 10/16/2002 at 3:51:06 PM; new equation from WRIR 02-4140
Equations for Nevada developed using English units

Site: Murphy Complex Fires 2007 - Nevada USFS - Humboldt-Toiyabe NF, Nevada
User: Jessica Gould, BAER Hydrologist
Date: Wednesday, August 08, 2007 01:11 PM

Rural Estimate: Upper Bruneau River to confluence with Meadow Creek
  Basin Drainage Area: 317 mi2
  1 Region
  Region: Northwest_Region_2
    Drainage_Area = 317 mi2
    Mean_Basin_Elevation = 6740 ft
  Crippen & Bue Region 15

Rural Estimate: Meadow Creek (tributary to Bruneau River)
  Basin Drainage Area: 58.7 mi2
  1 Region
  Region: Northwest_Region_2
    Drainage_Area = 58.7 mi2
    Mean_Basin_Elevation = 6590 ft
  Crippen & Bue Region 15

Flood Peak Discharges, in cubic feet per second

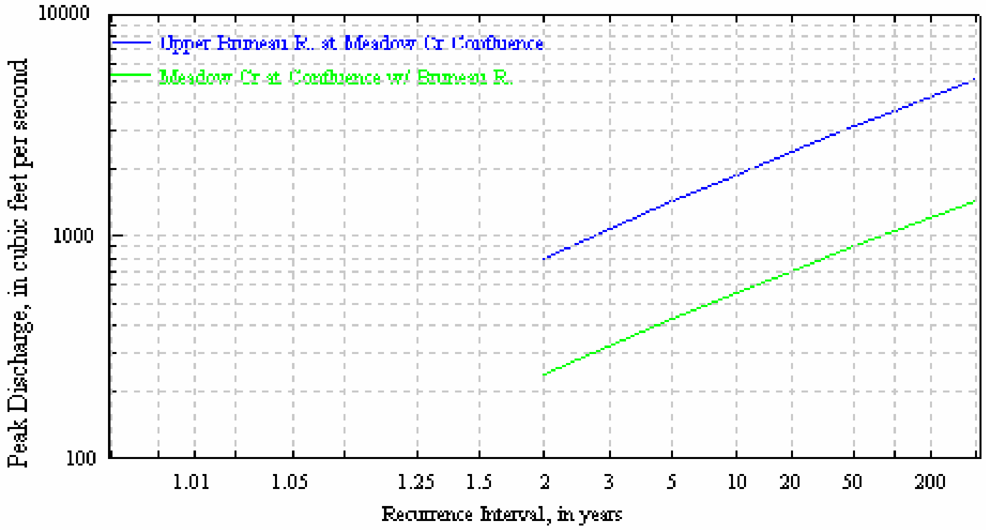
Estimate	Recurrence Interval, yrs	Peak, cfs	Standard Error, %	Equivalent Years	
Upper Bruneau	2	796	72	1	
	5	1440	66	1.8	
	10	1870	61	3.1	*1870 / 317 = 5.9 cfs /sq. mile*
	25	2560	61	4.6	
	50	3130	64	5.5	
	100	3690	68	6.1	
	500	5180			

maximum: 378000 (for C&B region 15)

Flood Peak Discharges, in cubic feet per second

Estimate	Recurrence Interval, yrs	Peak, cfs		Standard Error, %	Equivalent Years
Meadow Creek	2	239	72	1	
	5	426	66	1.8	
	10	553	61	3.1	*553 / 58.7 = 9.4 cfs/ sq. mile*
	25	746	61	4.6	
	50	900	64	5.5	
	100	1050	68	6.1	
	500	1450			

maximum: 160000 (for C&B region 15)



Flood Frequency Plot - Murphy Complex Fire (2007)
USGS National Flood Frequency (NFF) for Nevada, Region 2