Trout-West Fuel Reduction Project
Final Watershed and Soils Report

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Introduction

This report describes the existing condition of the Watershed and Soils resources in the Trout-West Fuel Reduction Project area and tiers to the Upper South Platte Watershed Landscape Assessment (Foster Wheeler 1999) in which the historic and current conditions of the Soils and Water resources are well articulated. The Trout-West Project Environmental Impact Statement (EIS) proposes to reduce the risk of damaging wildfire of the magnitude of the recent Buffalo Creek and Hi Meadows fires, and especially the Hayman Fire. To achieve this objective, the Project proposes to reduce timber stand densities, a primary component of wind-driven wildfires. In addition to the Proposed Action and No Action alternatives, five alternatives were developed to address issues. This report discusses the environmental consequences of these alternatives. This report was prepared by James Nelson, TEAMS hydrologist.

Affected Environment

Watershed

Watersheds are areas of land that drain water, sediment, and dissolved materials to a common outlet. They occur at multiple scales and range from large river basins to watersheds of very small streams. The United States Geological Survey (USGS) has devised a hydrological unit code (HUC) that divides the lower contiguous states into 18 regions and numbers them (first field). These, in turn, are further subdivided into smaller and smaller land units, each with their own field, until the fifth field, which are watersheds that can be in the range of hundreds of thousands of acres, and sixth field subwatersheds that are usually in the range of tens of thousands of acres, although they can be smaller. Each is a watershed in that they meet the basic definition stated above. The utility of the numbering system is identifying discrete land units at the various scales.

The Trout-West Project is located in the two sixth field watersheds called Trout Creek (HUC 101900020201) and West Creek (HUC 101900020202). The Trout and West Creek watersheds are about 86,800 acres and 44,200 acres, respectively, and are tributary to Horse Creek and the South Platte River. There are 91 miles of perennial streams and 130 miles of intermittent streams in Trout Creek watershed, and 54 miles of perennial streams and 42 of intermittent streams in West Creek watershed. Not only are these two watersheds important to the residents within them for quality of life but also to downstream users including the city of Denver as part of their municipal water supply.

Each watershed is a mosaic of different terrestrial communities and uses that influence and are influenced by the ecological function/processes within the watershed. The streams contain a variety of aquatic habitats that connect the whole watershed through diverse and complex ecological processes. The ecological health of a watershed is important because, when a disturbance disrupts the ecological process/functions in any part of the watershed, it has a rippling effect in the lower portions of the watershed and especially the streams.

Water on the Pike-San Isabel National Forest is limiting. The Water Erosion Prediction Project (WEPP, v. 2000.05.24) computer model contains a climate generator which adjusts the temperature and precipitation from a nearby site with recorded measurements, in this case Bailey, Colorado, with 45 years of records at 39.40^{o}N by 105.48^{o}W and 7730 feet elevation, to the analysis area at 38.88^{o}N by 105.06^{o}W and 8600 feet elevation. This data is compared to the precipitation records from the Manitou Experimental Station Headquarters (Tapia, unpublished data) taken between 1937 and 2000 (Table 1).

Table 1. Climate parameters for Woodland Park, CO and 45 years of record from the Manitou Experimental Forest Headquarters.

Month	Mean Maximum Temperature (^{o}F)	Mean Minimum Temperature (^{o}F)	Mean Precipitation (in)	Number of wet days	Mean Precipitation (in) from Manitou HQ 64-yr Avg
January	40.1	12.6	0.35	3.5	0.36
February	43.0	13.4	0.50	3.9	0.46
March	46.9	16.6	1.07	6.3	0.95
April	55.2	22.9	1.66	6.6	1.54
May	64.0	30.7	2.08	9.1	1.97
June	75.0	37.5	1.61	8.5	1.84
July	79.6	43.4	2.53	12.7	2.96
August	77.5	41.8	2.37	12.5	2.76
September	71.9	33.7	1.18	6.2	1.17
October	62.1	24.6	1.09	4.4	0.86
November	48.1	16.9	0.72	4.2	0.66
December	41.1	12.8	0.54	3.8	0.38
Annual			15.70	81.6	15.91

The average precipitation at the Woodland Park coordinates is 15.70 inches, which is well distributed during the growing season. July is the wettest month, receiving an average of 2.53 inches, and January is the driest, receiving an average of 0.35 inches. The six wettest months are April through September, reflecting a growing season in which nearly 75% of the annual precipitation occurs.

This compares well with the Mainitou HQ records, which averaged 15.91 over 64 years with a similar pattern. This climate promotes the recovery of vegetation following disturbance that protects the soil from surface erosion and filters out sediment in overland flow, but the intensity of summer thunderstorms causes severe erosion of unprotected soils. Recovery following disturbance would likely occur over a five-year period following disturbance, approximating a sigmoid growth pattern as the lower vegetation develops.

The State of Colorado's Department of Health has designated beneficial uses for the streams in the analysis area as Recreation Class 1, Agriculture, Aquatic Life Cold Water Class 1, and Domestic Water Supply. The Department of Health has identified Trout Creek and its tributaries as having impaired water quality, in this case for sediment, and placed Trout Creek on the 303(d) list. The federal Clean Water Act requires states to compile a list of water bodies, known as the 303(d) list, that are impaired (do not fully or partially support their beneficial uses). Based on temperature monitoring done by Pike's Peak Ranger District personnel, Trout Creek appears to violate water quality standards for temperature as well (Gallagher et al. 1998), though it is not on the 303(d) list for that reason. Excessive nutrient loading was identified in the Upper South Platte Watershed Landscape Assessment (Landscape Assessment) as another issue that affects the water quality of Trout Creek. If there is a concern for a stream and the documentation is not adequate for listing on the 303(d) list, then it may be placed on the Monitoring and Evaluation list. Trail Creek, tributary to West Creek, has been placed on this list for sediment.

The Landscape Assessment described the area's streams in terms of sediment source and transport or response (depositional) reaches. This was a function of Rosgen channel typing. This would provide a good characterization of the natural watershed in the absence of humans and beaver. Roads and their drainage systems extend the stream network beyond the natural system. Wemple (1994), in her study of Oregon Cascade Mountains forested watersheds, determined that nearly 60% of the road system was hydrologically integrated with the fluvial system. This extends the sediment source area beyond the area analyzed in the Landscape Assessment. In addition, some reaches identified as transport reaches have been modified by beaver to function as response reaches.

Beaver are an important biological component of these watersheds for maintaining watershed health and function. Accelerated soil erosion is not subtle in the analysis area and is mostly associated with roads. Sediment in road ditches and ephemeral draws below roads and behind beaver dams are clearly evident. Beaver dams function as grade-control structures built cheaply and effectively with available materials. The continued success of beaver in fulfilling their role in the proper functioning of the watershed depends on the quality of habitat. As available food supplies decline or the ponds become substantially silted in, the beaver move on and no longer maintain the dam. In the absence of maintenance, dams fail, releasing the stored sediment that has not been stabilized by riparian vegetation. Most of the dams in the analysis area appear to be constructed with willow of small diameter and are subject to rapid failure.

One study conducted in south-central Oregon east of the Cascade Mountains indicates that water temperatures in meadow streams below beaver dams had lower daily fluctuations than similar stream reaches without beaver dams (Friedrichsen 1996). Beaver dams tend to reconnect degraded streams with their floodplains; high flows are forced onto the floodplain, dissipating stream energy and depositing sediment. More of the high flows become stored in the banks for later release, attenuating the effects of the flood event. Beavers can be a problem for road management by plugging culverts as part of a dam or by aggrading streams below a culvert, reducing the capacity of the culvert. The Forest uses perforated smaller culverts inside larger culverts to discourage beaver from plugging the culvert.

Water-Road Interaction

There has always been a connection between human transportation corridors and bodies of water. Early trails and paths were often constructed alongside streams for people to meet their daily needs, and new inhabitants to an area tended to settle near lakes, streams, or rivers. Near the water, terrain tends to be gentler and grades are often less steep. Therefore, it has often been desirable and easier to build roads in these areas and desirable to build roads where people are located and to gather needed resources.

Roads within the analysis area provide the benefit of access for management activities and public use, but also have adverse impacts on the function of the watershed, which increases with mileage near streams and road density. These factors can alter physical processes in streams, leading to changes in flow regimes, the movement and storage of sediment, bank stability, and substrate composition. These changes can have important biological consequences, affecting all stream ecosystem components (Furnisset al. 1991). These changes can range from subtle to dramatic, depending on a variety of factors including the resilience of the watershed to disturbance, weather, traffic patterns, road surfacing material, condition of the road surfacing, condition of the road profile (maintenance), and the interconnectedness of the road drainage with the fluvial system.

As a result of usage and in the absence of maintenance, aggregate and natural road surfacing wears out and the profile becomes more rutted. No matter how shallow the ruts, water will flow down the ruts of roads with a grade and gain energy, entraining fine surfacing material. This sediment-laden flow often leaves the road surface where the road flattens out at a stream crossing and contributes directly to stream sediment. Maintenance removes the ruts and shapes the road profile with a crown so that water takes the most direct path to leave the road surface and with much less energy.

There is a total of 560 miles of road of all jurisdictions within the Trout Creek watershed, 329 miles of which are on national forest system lands. West Creek watershed contains 238 miles of road of all jurisdictions, 189 miles of which are on national forest system lands. Just over half of the roads on national forest system lands are “unclassified,” which means that they are not system roads but were developed by illegal off-road usage. These unclassified roads were identified through aerial photo interpretation and verified by site visits. Current Forest policy permits vehicles to drive 200 feet off of system roads.

Although roads are a major contributor of sediment to area streams, given the variables involved, rather than discussing the amount of sediment from roads, the affected environment is described in terms of *potential sources* of sediment. These sources include the type of road surfacing used and the amount of roads within 300 feet of streams.

Table 2 identifies the total road mileage in the project area and the amount that is within 300 feet of a stream and that potentially could contribute sediment. Roads surfaced with bituminous material (blacktop) are less prone to generating erosion, and then only along the shoulders and in the ditch if not adequately vegetated. Aggregate (gravel) roads contribute more sediment than bituminous roads as the surfacing wears under traffic, and varies by the durability of the aggregate. Natural (native) surface roads contribute the most amount of sediment, especially coarse textured soils that do not bind well. To minimize the sediment delivered by natural surface roads, the road prism should be shaped to promote frequent drainage including crowns, ditches, and rolling dips. Relief culverts help move surface water to the downhill side of the road, and when installed frequently, minimize the outflow's energy. Roads constructed by the Forest Service incorporate these principles into their design. However, unclassified roads were never designed and constructed to specification, but developed through usage. There is no consideration of topography, per se, and unclassified roads can be as steep as the vehicle creating it can handle before spinning out. About 52% of all roads within the national forest in Trout Creek watershed are unclassified, and 34% of all roads within the national forest in West Creek watershed are unclassified.

Table 2 displays the road mileage by jurisdiction and surfacing and indicated whether or not roads are within 300 feet of perennial and intermittent streams.

Table 2. Road Mileage by Watershed, Jurisdiction, and Surfacing.

Watershed	*Within 300' of perennial and/or intermittent stream?*	*Forest Service Jurisdiction*				*Other*				*Total*
		BIT	*NAT*	*Uncl/ NAT*	*Total*	*BIT*	*AGG*	*NAT*	*Total*	
Trout Creek	No	1.9	90.0	129.0	220.9	47.2	10.4	143.5	201.1	422.0
	Yes	0.9	37.3	42.9	81.1	11.5	0.2	44.9	55.6	137.7
	Total	2.8	127.3	171.9	302.0	58.7	10.6	188.4	256.7	559.7
West Creek	No	0.0	82.7	52.9	135.6	0.4	0.0	32.0	32.4	168.0
	Yes	0.0	21.8	12.4	34.2	5.8	0.0	29.5	35.3	69.5
	Total	0.0	104.5	65.3	169.8	6.2	0.0	61.5	67.7	237.5

Other: This category includes State, County, municipal, and private roads or roads identified through the cartographic feature file (CFF) coding system in GIS.
BIT: Bituminous. Blacktop paving.
AGG: Aggregate. Crushed rock applied to the road as surfacing.
NAT: Natural. No surfacing is placed on the road.
Uncl: Unclassified roads on national forest system lands. Natural surfacing.

Road density is another measure of road-stream interaction that allows one watershed to be compared to another in relative terms. There are nearly 800 miles of roads of all surface types and ownerships within the analysis area, and an average of 3.9 miles of road per square mile (mi/mi^2). However, it is the road density within 300 feet of streams that indicates the potential effects of roads on streams and it is the Forest Service road network, including both system and unclassified roads, that the action alternatives can influence. Table 3 displays the road density by watershed for all jurisdiction roads, all jurisdiction roads within 300 feet of perennial and intermittent streams, and national forest roads within 300 feet of perennial and intermittent streams within the national forest boundary. It should be noted that the road density increases within the stream corridor in both watersheds but is generally lower on national forest system lands.

Table 3. Road Density (mi/mi^2) by Jurisdiction and Proximity to the Streams System Within The Trout-West Affected Area.

Watershed	*All Jurisdiction on All Ownerships*	*All Jurisdiction Within 300', All Ownerships*	*FS Roads Within 300' on NF*
Trout Creek	4.13	5.46	3.48
West Creek	3.45	6.21	3.23
AVERAGE	**3.89**	**5.84**	**3.36**

Soils

The importance of soil erosion is two-fold. First, soil loss reduces the productivity of a site by reducing soil depth and therefore water storage capacity, organic- and nutrient-rich surface soils, and possibly rooting depth where soils are already thin. Secondly, a portion of the eroded soil becomes sediment in area streams, reducing water quality and modifying channel morphology in deposition reaches. This portion may be low or high, depending on a variety of factors discussed below.

The parent material of these watersheds is granite, which weathers to coarse gravel and fine sand in the soil profile. The coarse-textured parent material provides a moderately acidic substrate for soil development that generally tends to be weakly developed and sandy- to gravelly-textured. The soils that develop on these coarse-textured parent materials, in the absence of effective cover such as vegetation, litter and large wood, are all highly susceptible to erosion when subjected to direct impact of wind and water.

Wind and water moving across the soil surface, including raindrop impact, are the key soil-disturbance processes contributing to soil erosion in the analysis area. The degree to which these processes contribute to erosion is a function of local climate, topography, amount and type of disturbance, and time. The influence of humans on the landscape has been extensive in most of the analysis area. Native American communities are known to have used fire to manipulate wildlife habitat and improve hunting success. Most of the Native American impacts likely ended by 1870. In general, fire suppression during the post-Euroamerican settlement period has reduced the frequency of fire-related soil disturbance.

Fire-related soil disturbance has two elements: the natural effects based on fire behavior and the human effects associated with both the suppression effort of wildfire and also the prevention activities in fuels management. The human component of fire-related soil disturbance has likely increased progressively over time, as humans perceive an increasing risk to assets of increasing value and devote more resources to the task of fire and fuels management. A combination of fuel management activities such as machine slash piling and fire suppression activities such as dozer line building compound the effects of uncharacteristically intense wildfire

The Landscape Assessment concluded that these watersheds as a whole are highly susceptible to erosion and that human modifications to the landscape have increased the erosion potential in some areas. Native-surface roads and trails are likely a primary cause of accelerated soil erosion, along with detrimental off-road soil compaction and bare soil exposure from vehicles, ground-based timber harvesting, community and rural development, and farming and livestock grazing, which reduce or eliminate infiltration of surface water and water storage capacity. These land use activities displace or remove nutrient rich organic and mineral layers from the soil. During rain or snowmelt, decreased infiltration capacity increases the amount of sheet erosion, which can lead to rill and gully formation.

The network of roads and trails can focus overland flow, rills, and streamlets into artificial flow networks that move water and soil downslope. The study mentioned earlier (under **Watershed**) in the Oregon Cascade Mountains determined that nearly 60% of roads are hydrologically connected to the stream system (Wemple 1994). Lack of maintenance and poor maintenance practices of road drainage ditches can lead to hypersaturation of road-fill in areas, potentially causing slope failure or road surfacing erosion for certain finer-textured materials. Roads with berms on both sides or below grade roads are effectively stream channels concentrating flow with increasing energy that entrain road surfacing until the water is directed off the road by way of a relief ditch or low point. The cumulative effect of natural and human-caused disturbance may leave soil layers in an unprotected state, much more susceptible to future erosion events and soil loss.

Potential Fire Effects to Soil

The effects of wildfire are well documented in the Landscape Assessment. The Hayman, Buffalo Creek, and Hi Meadows fires are recent, local examples that had negative impacts on soils and exposed soil to the forces of erosion. Lower intensity/severity prescribed fire would have less impact on soils than high intensity and severity wildfires. Soil should be viewed as both a habitat and selective growth medium when analyzing the effect of fire. Soils contain the seeds of prior successional stands. Severe fires tend to kill a very high percentage of these dormant seeds, while lower intensity fires merely scarify seed coats of many fire-adapted species, allowing them to germinate during the next growing season.

Studies cited in the Landscape Assessment indicate that high severity burn areas experience higher rates of soil loss from erosion, increased peak flows of runoff, greater duff reduction, loss in soil nutrients, and soil heating. Water and sediment yields may increase as more of the forest floor is consumed. If the fire consumes the duff and organic layers of the soil and the mineral soil is exposed, soil infiltration and water storage capacities of the soil are reduced. These impacts may last weeks or decades, depending on the fire severity and intensity, any remedial measures, and the rate of vegetative recovery.

The Landscape Assessment discussed the phenomenon of hydrophobicity by which intense surface fires lead to the formation of water-repellant layers in the soil. Hydrophobicity interferes with and reduces the soil's infiltration characteristics and the water repellent layers may be thicker and more intense in coarser soils under coniferous forests. Qualitatively, hydrophobic soils probably increase the net surface erosion of soils by retarding infiltration and thereby increasing sheet wash. Although the condition may be relatively short-lived following fire, hydrophobic soils played a role in the flooding of Buffalo Creek after the 1996 wildfire.

The Landscape Assessment indicates that, in contrast to intense wildfires, low or moderate intensity burns generally do not cause a corresponding increase in runoff and erosion. A reduction in existing fuel loadings by prescribed fire or other treatments should greatly reduce the threat of high-intensity wildfires and the associated risks of flooding, erosion, and downstream sedimentation. However, these treatments do have some impacts to the soil resource, including accelerated soil erosion and downstream sedimentation.

The Disturbed WEPP model was used to estimate the amount of accelerated soil erosion for an average year's precipitation as a result of both wildfire and prescribed fire. Wildfire could generate 6.8 tons per acre of soil erosion moving off site from steeper slopes (50%) and 3.6 tons per acre on more gentle slopes (20%) in the first year following disturbance. Prescribed fire would produce an estimated 2.3 tons per acre of soil erosion moving off site on the steeper slopes and 1.1 tons per acre on the more gentle slopes in the first year following disturbance. The natural annual erosion rate, in the absence of disturbance, is estimated to be 0.06 tons per acre on steeper slopes and 0.01 tons per acre on more gentle slopes.

Soil Descriptions

The soils that could be affected by the proposed actions consist of predominantly two general soil mapping units: the Sphinx-Legault-Rock outcrop and the Boyett-Frenchcreek-Pemdant.

The Sphinx-Legault-Rock outcrop soil map unit covers most of the Project Area. This soil unit occurs on slopes to 80 percent. The **Sphinx** soils are coarse textured, shallow and somewhat excessively drained. They formed in material weathered from Pike's Peak granite on mountainsides.

The surface layer is gravelly coarse sandy loam. Permeability is rapid and the available water capacity is low. Runoff is moderate to rapid and the hazard of water erosion is moderate to severe, depending on slope. This soil supports ponderosa pine and Douglas-fir communities. The **Legault** soil is a dark grayish brown, very gravelly coarse sandy loam that has also formed from weathered Pike's Peak granites. It is found on north-facing aspects and higher elevations of the mountainsides. Permeability is moderately rapid, and the available water capacity is very low. Runoff is rapid and the hazard of erosion is moderate to severe, depending on slope. The dominant vegetation is Douglas-fir (Moore 1992).

The Boyett-Frenchcreek-Pendant soil mapping unit occurs on the lower slopes along the upper reaches of Trout Creek. The **Boyett-Frenchcreek** complex is found on alluvial terraces with slopes up to 40%. The **Boyett** soil is found on ridges and the **Frenchcreek** soil is found in swales. This well-drained, deep sandy loam to gravelly sandy loam soil is formed in alluvium weathered from arkosic sandstone and Pike's Peak granite. Permeability is moderately rapid and the available water capacity is low. Runoff is slow or medium and the hazard of water erosion is slight on slopes less than 15%. Runoff is medium to rapid and the hazard of water erosion is moderate on slopes between 15% and 40%. The soils are susceptible to sheet erosion and gullying in areas where runoff is concentrated or where natural plant cover is disturbed. The **Pendant** soil is found on mountainsides up to 70% slopes. This somewhat excessively well drained, shallow cobbly loam soil is weathered from limestone. Permeability is moderate and the available water is very low. Runoff is rapid and the hazard of water erosion is moderate. (Moore 1992).

Effects Analysis

Forests generally have very low erosion rates (between 0.01 and 0.06 tons/acre/year, depending on slope, as estimated by the Water Erosion Prediction Project model for the analysis area) unless they are disturbed. Common natural and human-caused disturbances include windthrow events, off-road vehicle (ORV) recreational use, prescribed and wild fire, ground-based timber harvest operations, and road building and maintenance. Given the local precipitation pattern and vegetative recovery potential, the impact of these activities to the soil resource lasts a moderate length of time following cessation, and, for the purposes of this analysis, is estimated to be five years. The WEPP model was selected to estimate the effects of the proposed timber harvest on soil erosion as the direct effect and sediment delivery to area streams as the indirect effect. The Disturbed WEPP is one of a series of computer models developed for application to such proposed activities as timber harvest and was selected to estimate the effects of harvesting.

The Disturbed WEPP model is only a model and, as such, approximates the potential accelerated erosion. A portion of the erosion would make its way to the landing and even less may become sediment in the area streams. The model's greatest utility is making comparisons between alternatives.

The values used are the average amount predicted by the model in tons per acre associated with harvest operations, low- or high-intensity fires, or tons per mile associated with temporary road construction; the range is between a return interval of 1.5 years (67% probability) to 30 years (3% probability).

The Disturbed WEPP model requires six input elements from the user: climate, soil texture, local topography, residual plant community, residual surface cover, and percent rock. The WEPP:Roads routine requires climate, road design, soil type and surfacing, road gradient and width, fill and buffer gradients. The local climate is presented in Table 1, above. The six wettest months are April through September, reflecting a growing season where each of the months receives, on average, between one and 2.5 inches of precipitation. This climate promotes the moderate recovery of vegetation, which protects the soil from surface erosion and filters out sediment in overland flow. Based on these characteristics, the anticipated rate of recovery would likely approximate a sigmoid curve over a five-year period following disturbance. That is, 100% of the predicted amount would occur in the first year following treatment, 95% in the second year, 70% in the third year, 30% in the fourth year, 5% in the last year, and zero thereafter.

The soil texture used in running the model is sandy loam because it best represents a coarse-textured soil typical of decomposed granite. The topography of the proposed harvest areas ranges from very gentle (less than 5%) to very steep (over 50%). The natural ground cover is estimated to average about 40%. Three harvesting scenarios were considered and incorporated in models runs for the Proposed Action: 1) feller-buncher harvesting and tractor yarding on slopes less than 20%; 2) hand felling and cable yarding; or 3) hand felling and helicopter yarding on slopes over 20%. A landing and the skidtrails coming into it serves about 20 acres of tractor-yarded harvesting and the upper half's residual plant community of the commercially thinned units would fall into the "20 year old trees" category with 35% ground cover (5% reduction from natural). The lower half of all units would fall into the "skid trail" residual plant community with 30% ground cover because this is the area where landings are located and skidtrails converge and are concentrated. These cover values represent a total of 15% soil disturbance from the harvest operation, meeting the Forest Plan standard for maximum soil impacts. The lower half is also physically connected to the road in most cases.

The model's prediction of erosion leaving an undisturbed area with 20% slope averages 0.01 tons per acre and ranges between zero (67% probability) and 0.32 tons per acre (3% probability). The predicted accelerated soil erosion leaving tractor yarded treatment areas less than 20% slope averages 0.08 tons per acre, and ranges between zero (67% probability) and 1.64 tons per acre (3% probability). One ton per acre of soil loss, given a bulk density of 70 lbs/ft^3, is equal to an average soil depth of erosion of 0.008 inches and when concentrated to 15% of the area would average 0.05 inches of depth.

Two temporary road scenarios were evaluated by the WEPP Roads model: 1) a 4% grade, 13 foot wide road with a 10% side slope; and 2) an 8% grade, 13 foot wide road with a 20% side slope. The model's prediction of road prism erosion for mean annual average precipitation is 1.8 tons/mile for scenario 1 and 2.9 tons/mile for scenario 2.

The average of 2.4 tons/mile will be used for the predicted erosion associated with the roads. As temporary roads, the road would be used for about a year, and perhaps just for a few months to access the treatment area, after which it would be rehabilitated. Once rehabilitated, the recovery would be similar to other disturbed areas following the sigmoid recovery pattern.

Three broadcast burning scenarios were evaluated using Disturbed WEPP as a function of slope: 20% for tractor units; 30% for inclusions within tractor units that were identified by GIS as over 20%; and 50% for helicopter/cable units. The model's predicted values are 1.13 tons/acre leaving slopes of 20%, 1.58 tons/acre leaving slopes of 30%, and 2.31 tons/acre leaving slopes of 50%. These figures should be viewed in the context of average conditions and would vary by such factors as tons/acre of fuel, fuel continuity, soil and fuel moisture at time of burning, and the amount of litter, duff and low vegetation consumed by the fire, which affects the amount of exposed mineral soil. It is anticipated that cool, low intensity broadcast burns would leave a mosaic of unburned islands within the fire perimeter of about 30% on average. The above WEPP model predictions are, therefore, adjusted to 70% (i.e. 0.8, 1.1 and 1.6 tons/acre, respectively). Pile burning affects small, discrete areas that are disconnected from drainage pathways, and, therefore, would have no measurable effect on soil erosion.

The predicted accelerated soil erosion from the proposed timber harvesting, broadcast burning, temporary road construction, and the predicted wildfire would be the direct effect, and any sediment delivery to area streams would be the indirect effect. The sum of the recent past harvest, the planned harvest, the proposed harvest and road building, the Polhemus prescribed fire, and the Hayman wildfire, over time, constitute the cumulative effects.

The Pike-San Isabel National Forest is considering salvage harvest of the Hayman Fire. It is not known at this time where or how much salvaging would occur but it is a reasonably foreseeable action that would add to the cumulative effects of all action alternatives, though only in a qualitative way.

Existing Condition

The Existing Condition of the analysis area includes those ground-disturbing activities that have been approved or have already occurred whose impacts will be manifested during the analysis period of 2003 to 2013. They include the Polhemus prescribed fire, the Trout Creek Timber Sale, and the Hayman wildfire. Those disturbances will continue to provide some level of soil erosion and sediment delivered to area streams for five years beyond the year of disturbance, until vegetation has become established. The Polhemus prescribed fire was burned in late summer 2001. Of the estimated 7,100 acres in the Trout Creek watershed, about 90% was completed before the fire that was reducing air quality below acceptable standards was put out. The Forest is monitoring the amount of sediment introduced into area streams as a result of this prescribed fire but no information is currently available (Marsh, personal communication).

The Disturbed WEPP model predicts 1.13 tons per acres of soil moving off site as a result of the treatment, and an estimated 60% of that making its way into the fluvial system by way of roads, control lines, and ephemeral draws. The estimated total is 4,330 tons in the first year, diminishing to zero over five years. Based on monitoring being done by Forest personnel, this predicted amount can be verified for accuracy as monitoring results become available.

The Trout Creek Timber Sale is in the Trout Creek watershed and harvesting began in February, 2002; the entire commercial treatment area of 950 acres is expected to be completed in 2002, with residual effects lasting until 2007.

The Hayman Fire (June 2002) burned nearly 6,400 acres in Trout Creek, of which 3,660 acres were moderate- to high-intensity (57%), and over 20,400 acres in West Creek, of which 10,990 acres were moderate- to high-intensity (54%). The Disturbed WEPP model prediction for soil erosion following wildfire on 50% slopes is 6.8 tons/acre and on 20% slopes is 3.6 tons/acre. Assuming a wildfire would cover an area of varying slopes, an average of 5.2 tons/acre in the first year is the estimated amount from moderate-to-high intensity wildfire. This number is further modified by the fact that the Hayman Fire experienced about 55% moderate-to-high fire intensity and 45% low fire intensity (similar to a prescribed underburn), which occurred mostly on slopes less than 20%. The average amount of accelerated soil erosion from Hayman Fire and any future wildfires is estimated to be 3.37 tons per acre for the first year. Each burn area would follow the recovery pattern for other disturbed areas, stated earlier.

On September 23, the Trout-West Interdisciplinary Team (IDT) visited the Hayman Fire within the analysis area and the Sheepnose Timber Sale area just outside the analysis area. I noted very little erosion compared to what I had seen in the same area during field visits in the summer of 2001. The reason for the minimal accelerated soil erosion within the portion of the fire I saw is likely due to low precipitation following the fire. The precipitation recorded at the Manitou Experimental Forest headquarters is a good representative of what was received in the analysis area. The recorded amounts for June totaled 0.70 inches (38% of average); the highest intensity occurred on June 20th between 2100 and 2200 hours, when 0.25 inches fell. The recorded amounts for July totaled 0.55 inches (19% of average); the highest intensity occurred on July 19th between 1200 and 1300 hours, when 0.17 inches fell. The recorded amounts for August totaled 0.35 inches (13% of average); the highest intensity occurred on August 3 between 1300 and 1400 hours, when 0.16 inches fell. Elsewhere on the fire, high intensity rainfall events have occurred, causing severe erosion, and the analysis area remains at risk of severe erosion until adequate ground vegetation is established.

There has been no US Forest Service timber harvest or prescribed fire activities in West Creek watershed in the last five years and none are approved to occur in the next ten years.

Bob Solari, Trout-West Hazard Fuel Reduction Project IDT fuels planner, predicted in May 2002 that there is a 100% probability that a catastrophic wildfire of 10,500 acres will occur within the project area (one third of the area) within the next ten years; the same probability exists outside the project area in the rest of the watersheds. This equates to 42,000 acres burning within the two watersheds over the next 10 years. The Hayman Fire burned about 26,800 acres in the analysis area, leaving a predicted 15,200 acres yet to burn in the next 10 years. There is a 10% probability that a 10,500-acre fire will occur in any given year within the project area and a 4,700-acre fire in the rest of the watersheds. I assume that the probability is distributed equally between the two watersheds, proportional to currently unburned area. Trout Creek watershed, with 74,000 unburned acres, is 76% of the analysis area and West Creek watershed, with 24,000 unburned acres, is 24% of the area. Each year it is predicted that 1,155 acres will burn in Trout Creek watershed and 365 acres will burn in West Creek watershed.

The Colorado State Forest Service does not require private landowners to report the harvest of timber from their lands. The Colorado State Forest Service does not keep official records whenever private timber is harvested and, according to Dennis Will at the Woodland Park office, only about 20 acres have been harvested in the past 10 years between the two watersheds based on an informal survey. There is no expectation that any important level of harvest or hazard fuel thinning will occur in the foreseeable future in either watershed, even with the impacts of the recent wildfires fresh in local landowners' minds. Therefore, the management of private forestlands is expected to have no cumulative impact on the function of either watershed. The effect of no hazard fuel reduction on private land will be viewed in the same context of being at risk for a catastrophic wildfire as on public land. Road densities and condition would remain the same. Table 3 estimates the amount of erosion over time in total tons from known harvests and prescribed fires for an average year for each watershed.

Table 3. Predicted Accelerated Soil Erosion from Recent and Anticipated Land-Disturbing Activities (total tons, rounded to the nearest ton).

Watershed	*Year Treated*	*2002 (existing)*	*2003*	*2004*	*2005*	*2006*	*2007*	*Beyond*
Trout Creek	2001 Polhemus Rx burn	4330	4115	3030	1300	215	0	
	2002 Trout Cr TS 950 ac		75	70	55	25	5	0
	2002 Hayman Fire		21568	20490	15098	6470	1078	0
	Total	**4330**	**25758**	**23590**	**16453**	**6710**	**1083**	**0**
West Creek	2002 Hayman Fire		68748	65311	48124	20624	3437	0
	Total	**0**	**68748**	**65311**	**48124**	**20624**	**3437**	**0**

No Action

Under No Action the proposed fuel reduction would not occur at this time. Those harvested areas recently cut, the prescribed broadcast burn areas and the Hayman fire will continue. The incremental increase in accelerated soil erosion and reduced water quality as the result of No Action is the risk of additional wildfire, which the Proposed Action is intended to reduce. Bob Solari, IDT fuels planner, predicts that a catastrophic wildfire of 10.500 acres will occur within the project area (both watersheds) within the next ten years, and a total of 42,000 acres will burn in the analysis area. Hayman Fire burned 26,800 acres of this predicted amount, leaving 15,200 acres yet to burn in the upcoming decade. The effect of No Action would be a 1,520-acre fire occurring in each year for the next ten years and beyond that a 4,200-acre occurring in the next two decades. I assume that the probability for this decade is distributed equally between the two watersheds, proportional to the unburned area. Trout Creek watershed, with 74,000 unburned acres, is 76% of the analysis area and West Creek watershed, with 24,000 unburned acres, is 24% of the area. Each burn area would follow the recovery pattern for other disturbed areas, stated earlier. Table 4 shows predicted erosion leaving predicted wildfires under the No Action alternative, in total tons.

Table 4. Predicted Erosion leaving Predicted Wildfires (Total Tons)

Water-shed	*Year of Fire*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*
Trout Creek	**2002**	3892	3697	2724	1168	195	0	0	0	0	0
	2003		3892	3697	2724	1168	195	0	0	0	0
	2004			3892	3697	2724	1168	195	0	0	0
	2005				3892	3697	2724	1168	195	0	0
	2006					3892	3697	2724	1168	195	0
	2007 & beyond						3892 +	3697 +	2724 +	1168 +	195 +
	Total	**3892**	**7589**	**10313**	**11481**	**11676**	**11676**	**11676**	**11676**	**11676**	**11676**
West Creek	**2002**	1230	1169	861	369	61	0	0	0	0	0
	2003		1230	1169	861	369	61	0	0	0	0
	2004			1230	1169	861	369	61	0	0	0
	2005				1230	1169	861	369	61	0	0
	2006					1230	1169	861	369	61	0
	2007 & beyond						1230 +	1169 +	861 +	369 +	61 +
	Total	**1230**	**2399**	**3260**	**3629**	**3690**	**3690**	**3690**	**3690**	**3690**	**3690**

The sum of the Existing Condition accelerated soil erosion from disturbed areas and as a result of the risk of wildfire over the next decade is presented in Table 5.

Table 5. Predicted Erosion Leaving Disturbed Areas (Tractor Yarding, Broadcast Burning, and Existing and Predicted Wildfire) in Total Tons: No Action

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013 & beyond*
Trout Creek	27482	24042	17023	12564	11676	11676	11676	11676	11676	11676
West Creek	66541	50523	23884	7066	3690	3690	3690	3690	3690	3690

The portion of the offsite erosion that reaches area streams as a result of No Action would reduce water quality in area streams and affect downstream users. Factors that would influence how much sediment would actually reach the streams include the juxtaposition of the access roads to existing harvest units, road design, temporary storage time in road ditches and ephemeral channels, frequency of relief culverts or rolling dips, filtering vegetation below relief culverts and dips, and road maintenance that includes ditch cleaning. Existing harvest units with an access road with an adverse grade are unlikely to contribute sediment since there would be not road below the landing. Roads with an outslope design, as many spur roads are, tend not to transport sediment far. Relief culverts and rolling dips that direct sediment-laden runoff into vegetated buffers and away from pathways that directly reach the streams, increases storage time in the uplands. Sediment delivered to ephemeral draws and channels would only be temporarily stored, and would move closer to the intermittent and perennials streams with each runoff event. For these reasons, it is not possible to predict with accuracy the amount of sediment reaching the stream system and when. However, based on the concept that 60% of the road system is hydrologically integrated with the stream system, 60% of the predicted erosion leaving burned areas is assumed to become sediment in area streams for purposes of analysis. Table 6 shows predicted erosion entering streams from disturbed areas, in total tons.

Table 6. Predicted Erosion Entering Streams from Disturbed Areas (Tractor Yarding, Broadcast Burning and Wildfire), in Total Tons

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013 & beyond*
Trout Creek	2335	4553	6188	6889	7006	7006	7006	7006	7006	7006
West Creek	738	1439	1956	2177	2214	2214	2214	2214	2214	2214

Soil and Water Mitigation Measures

These Soil and Water Mitigation Measures for Trout-West Hazard Fuel Reduction apply to all action alternatives with the following exceptions: those that apply to Temporary Roads would not apply to Alternatives C and D.

- No new system road construction.
- Restrict temporary road construction to slopes less than 20%; avoid stream crossings.
- Meet or exceed Colorado Forest Stewardship Guidelines to Protect Water Quality.
- Limit detrimental soil compaction and displacement to 15% of each treatment area. To meet this standard, the following methods are recommended:
    - Require ground based skidding over frozen ground or dry soils (less than 20% soil moisture).
    - Require partial suspension of logs for all yarding systems.
    - Monitor unit for detrimental soil conditions following yarding; allow machine piling only if detrimental soil conditions will not exceed 15% detrimental conditions (S&Gs).
    - Limit ground based skidding equipment to slopes less than 20% except steep pitches less than 40% for less than 200 feet.
- Leave maximum amount of biomass possible for soils (given that the amount is acceptable from a fuels standpoint); use low to moderate intensity burn to retain most of the 3" and greater material and some of the fine material.
- Where whole tree yarding occurs, return slash with skidder to the skid trail with each turn to keep landing size down and redistribute slash onto the skid trails to function as organic waterbars to dissipate overland flow energy (up to 2 tons/acre). Fell, lop and scatter vegetation onto reclaimed road for effective ground cover (integrate with down wood requirement).
- Allow slash to cure at least 1 year before underburning so that nutrients will leach out into the soil.
- Subsoil temporary roadbed where original slope was less than 10%; recontour as needed to reclaim road to near natural conditions on steeper slopes. Revegetate for erosion control following Forest native plant policy. Planning assumptions are that ½ the roads would be subsoiled, ½ would be recontoured with an excavator.
- No heavy machinery or tree removal within 100 feet of perennial and intermittent streams.
- Avoid skidding down ephemeral draws (unless approved by a soils scientist or hydrologist). Draws may be crossed at a steep angle (45-90^{o}).
- Hazard trees within the riparian buffer felled for safety should be directionally felled across the stream if the top can reach more than half way across or, if not, felled on the contour, and left in place.
- Maintain a minimum of 40% effective ground cover in slash, coarse wood, grass, forbs and shrubs for filtered sunlight and cooler soil surface temperatures.

Proposed Action

The Proposed Action recommends canopy, and therefore fuel, reduction on nearly 7,100 acres in the Trout Creek watershed and about 10,200 acres in West Creek using mechanical removal method such as tractors, helicopters, and cable systems. About 4,900 acres of tractor yarding would occur in the Trout Creek watershed, and 8,500 acres of tractor yarding in the West Creek watershed. In addition, another 1,500 acres in Trout Creek and 400 acres in West Creek would receive light treatment using hand felling and treating in place of the excess stocking. The design of this alternative is intended to minimize the amount of accelerated soil erosion from the project while meeting the objective of reduced risk of catastrophic wildfire. Mechanical harvesters and rubber-tired skidders would likely be used on slopes less than 20% (with minor inclusion of pitches up to 40% not to exceed 200 feet); helicopters would be used on slopes greater than 20%, and in areas where road access is poor or non-existent and a new stream crossing would be necessary to access by road. Cable systems are proposed for areas with a suitable road in place and the topography would permit full suspension (skyline system). Helicopters could be used in lieu of cable systems where the volume treated would not warrant bringing in a cable side. The Proposed Action would use 68 miles of existing system roads and 48 miles of unclassified roads to facilitate excess biomass removal. No new system roads would be built, but 14 miles of temporary roads would be built on slopes less than 20%, 8 miles in Trout Creek and 6 miles in West Creek. The anticipated accelerated erosion rate from temporary road construction is 2.4 tons per mile for the first year. The system roads used in this alternative would receive maintenance to improve road profiles and drainage. Minor reconstruction would occur as necessary to improve alignment and drainage, and to reroute away from sensitive areas where feasible. Of the estimated 48 miles of unclassified roads to be used and rehabilitated, 19 miles are in Trout Creek watershed and 29 miles are in West Creek watershed. Some unclassified roads within tractor treatment areas would likely be used as skidtrails and waterbarred following use but those that are mostly on steeper slopes and not desirable for use may only be blocked to promote natural recovery. Broadcast burning would occur on those treatment areas more than one mile from the urban interface and would total 1,100 acres in Trout Creek watershed and 5500 acres in West Creek watershed.

The Disturbed WEPP model predicts that tractor yarding on slopes less than 20% would generate about 0.08 tons per acre of sediment leaving the treatment area the first year, given an average year's precipitation. The range is between 1.6 tons per acre for a 30-year event (3% probability) and zero tons for a one and a half year event (67% probability). The 950 acres of on-site treatment using feller-bunchers or chainsaws, piling and burning and the 1945 acres of light thinning are not expected to have any measurable affect on the soil resources because of the small area affected, following the above mitigation measures, and the discontinuity of the burn piles from the rest of the area by virtue of residual vegetation.

Hand felling and helicopter yarding is expensive and the value of the material removed from the hillside to the landing will likely not cover the cost of this yarding method, requiring subsidy. However, the impact of this method to the soil resource is negligible and similar to the natural erosion rate. No road building of either temporary or system roads is necessary to accommodate this method. Landings would be located on flat ground adjacent to existing roads. Therefore, no additional sediment is predicted when this yarding method is used. Likewise, skyline yarding with full suspension and no additional road building would have negligible impact to the soil resource and similar to the natural erosion rate.

For the purposes of this analysis, it is assumed that about 17% of the treatment area in each watershed would be treated each year for six years, beginning in 2003; all post-harvest treatments could be completed within 10 years. The 17%-assumption would also apply to the temporary road construction needed to access the tractor treatment areas (in the same year as harvested) and to broadcast burning (delayed by two years to allow for preparation post-harvest and curing time). This incremental treatment scheme also would allow for adaptive management to repeat successes and adjust for failures or undesirable consequences. It would also spread the effects over a long enough period of time to minimize the sediment delivered to area streams. The anticipated rate of recovery would likely approximate a sigmoid curve over a five-year period following disturbance. That is, 100% of the predicted amount would occur in the first year following treatment, 95% in the second year, 70% in the third year, 30% in the fourth year, 5% in the last year, and zero thereafter.

The road densities within the six treatment units would decline following completion of the respective projects through rehabilitation of unclassified roads. There is a high risk that the factors that promoted the development of the 237 miles of unclassified roads in both watersheds would be exacerbated by more open stand conditions and the road density may go up over time without strict enforcement of the off-road use policy. Tables 7, 8, and 9 show predicted soil erosion leaving timber harvest areas, proposed temporary roads, and proposed broadcast burning areas, respectively, in total tons.

Table 7. Predicted Erosion Leaving Proposed Timber Harvest, in Total Tons

Water-shed	***Year of Harvest***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***
Trout Creek	**2003**	67	64	47	20	3						
	2004		67	64	47	20	3					
	2005			67	64	47	20	3				
	2006				67	64	47	20	3			
	2007					67	64	47	20	3		
	2008						67	64	47	20	3	
	Total	**67**	**131**	**178**	**198**	**201**	**201**	**134**	**70**	**23**	**3**	**0**

Water-shed	Year of Harvest	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
West Creek	2003	116	110	81	35	6						
	2004		116	110	81	35	6					
	2005			116	110	81	35	6				
	2006				116	110	81	35	6			
	2007					116	110	81	35	6		
	2008						116	110	81	35	6	
	Total	**116**	**226**	**307**	**342**	**348**	**348**	**232**	**122**	**41**	**6**	**0**

Table 8. Predicted Erosion Leaving Proposed Temporary Roads, in Total Tons

Water-shed	Year of Const	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Trout Creek	2003	3.2	3.0	2.2	1.0	0.2	0	0	0	0	0	0
	2004		3.2	3.0	2.2	1.0	0.2	0	0	0	0	0
	2005			3.2	3.0	2.2	1.0	0.2	0	0	0	0
	2006				3.2	3.0	2.2	1.0	0.2	0	0	0
	2007					3.2	3.0	2.2	1.0	0.2	0	0
	2008						3.2	3.0	2.2	1.0	0.2	0
	Total	**3.2**	**6.2**	**8.4**	**9.4**	**9.6**	**9.6**	**6.4**	**3.4**	**1.2**	**0.2**	**0**
West Creek	2003	2.4	2.3	1.4	1.0	0.1	0	0	0	0	0	0
	2004		2.4	2.3	1.4	1.0	0.1	0	0	0	0	0
	2005			2.4	2.3	1.4	1.0	0.1	0	0	0	0
	2006				2.4	2.3	1.4	1.0	0.1	0	0	0
	2007					2.4	2.3	1.4	1.0	0.1	0	0
	2008						2.4	2.3	1.4	1.0	0.1	0
	Total	**2.4**	**4.7**	**6.1**	**7.1**	**7.2**	**7.2**	**4.8**	**2.5**	**1.1**	**0.1**	**0**

Table 9. Predicted Erosion Leaving Proposed Broadcast Burning, in Total Tons

Water-shed	*Year of Harv*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	**2005**	162	154	113	49	8	0	0	0	0	0	0
	2006		162	154	113	49	8	0	0	0	0	0
	2007			162	154	113	49	8	0	0	0	0
	2008				162	154	113	49	8	0	0	0
	2009					162	154	113	49	8	0	0
	2010						162	154	113	49	8	0
	Total	**162**	**316**	**429**	**478**	**486**	**486**	**324**	**170**	**57**	**8**	**0**
West Creek	**2005**	1210	1150	847	363	60	0	0	0	0	0	0
	2006		1210	1150	847	363	60	0	0	0	0	0
	2007			1210	1150	847	363	60	0	0	0	0
	2008				1210	1150	847	363	60	0	0	0
	2009					1210	1150	847	363	60	0	0
	2010						1210	1150	847	363	60	0
	Total	**1210**	**2360**	**3207**	**3570**	**3630**	**3630**	**2420**	**1270**	**423**	**60**	**0**

Bob Solari, IDT fuels planner, predicts that a catastrophic wildfire of 10,500 acres will occur within the project area (both watersheds) within the next ten years, and a total of 42,000 acres will burn in the analysis area. Hayman Fire burned 26,800 acres of this predicted amount, leaving 15,200 acres yet to burn in the upcoming decade. The Proposed Action would reduce the risk each year as treatment occurs from 1,520 acres the first year to 497 acres the tenth year, declining by 117 acres each year. At the end of the decade the risk would be 20% within the project area and 30% in the rest of the analysis area, for an average risk of 28%. Therefore, I assume that the probability is distributed equally between the two watersheds proportional to the unburned area. Trout Creek watershed, with 74,000 unburned acres, is 76% of the analysis area and West Creek watershed, with 24,000 unburned acres, is 24% of the area. Each burn area would follow the recovery pattern for other disturbed areas, stated earlier. Tables 10a and 10b show tons of predicted erosion leaving predicted wildfires in Trout Creek and West Creek, respectively.

Table 10a. Predicted Erosion Leaving Predicted Wildfires in Trout Creek, in Total Tons

Water - shed	*Year of Fire*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Trout Creek	**2003**	3892	3697	2724	1168	195	0	0	0	0	0	0	0
	2004		3592	3412	2514	1078	180	0	0	0	0	0	0
	2005			3292	3127	2304	988	165	0	0	0	0	0
	2006				2993	2843	2095	898	150	0	0	0	0
	2007					2696	2561	1887	809	135	0	0	0
	2008						2396	2276	1677	719	120	0	0
	2009							2096	1991	1467	629	105	0
	2010								1796	1706	1257	530	90
	2011									1496	1421	1047	449
	2012										1196	1136 +	837 +
	Total	**3892**	**7289**	**9428**	**9802**	**9116**	**8220**	**7322**	**6423**	**5523**	**4623**	**4014**	**3708**

Yr of Fire	**2016**	**2017 & beyond**
2010	75	0
2011	359 +	60 +
Total	**3603**	**3588**

Table 10b. Predicted Erosion Leaving Predicted Wildfires in West Creek, in Total Tons

Water - shed	***Year of Fire***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***
West Creek	**2003**	1230	1169	861	69	61	0	0	0	0	0	0	0
	2004		1136	1079	795	341	57	0	0	0	0	0	0
	2005			1041	989	729	312	52	0	0	0	0	0
	2006				947	900	663	284	47	0	0	0	0
	2007					849	807	594	255	42	0	0	0
	2008						755	717	529	226	38	0	0
	2009							661	628	463	198	33	0
	2010								566	538	396	170	28
	2011									472	448	330	142
	2012										377 +	358 +	264 +
	Total	**1230**	**2305**	**2981**	**2800**	**2880**	**2594**	**2308**	**2025**	**1741**	**1457**	**1268**	**1169**

Yr of Fire	**2016**	**2017 & beyond**
2010	24	
2011	113 +	19 +
Total	**1136**	**1131**

Table 11 shows tons of predicted erosion leaving disturbed areas in both Trout and West Creeks.

Table 11. Predicted Erosion Leaving Disturbed Areas (Tractor Yarding, Temporary Roads, Broadcast Burning, and Wildfire), in Total Tons: Proposed Action

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	3962	7426	9776	10325	9756	8909	7948	6982	5871	4796	4071	3716	3603
West Creek	1348	2536	4504	5589	6442	6519	6175	5780	4203	2733	1691	1229	1136

The **indirect effect** of the Proposed Action would be that portion of the offsite erosion that reaches area streams. Factors that would influence how much sediment would actually reach the streams include the juxtaposition of the access road to the harvest unit, road design, temporary storage time in road ditches and ephemeral channels, frequency of relief culverts or rolling dips, filtering vegetation below relief culverts and dips, and road maintenance that includes ditch cleaning. Harvest units with an access road with an adverse grade are unlikely to contribute sediment since there would be not road below the landing. Roads with an outslope design, as many spur roads are, do not transport sediment far. Relief culverts and rolling dips that direct sediment-laden runoff into vegetated buffers and away from pathways that directly reach the streams increase storage time in the uplands. Sediment delivered to ephemeral draws and channels would only be temporarily stored, and would move closer to the intermittent and perennial streams with each runoff event. For these reasons, it is not possible to predict with accuracy the amount of sediment reaching the stream system and when. However, based on the concept that 60% of the road system is hydrologically integrated with the stream system, 60% of the predicted erosion leaving treatment unit is assumed to become sediment in area streams for purposes of analysis (Table 12).

Table 12. Predicted Erosion Entering Streams from Disturbed Areas (Tractor Yarding, Temporary Roads, Broadcast Burning and Wildfire), in Total Tons

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	2377	4456	5866	6195	5854	5345	4769	4189	3523	2878	2443	2230	2162
West Creek	809	1522	2702	3353	3865	3911	3705	3468	2522	1640	1015	737	682

The **cumulative effect** of accelerated soil erosion from the Proposed Action is the sum of the projected amount in the No Action alternative (not including wildfire-induced erosion) plus the projected amount from the Proposed Action (including wildfire-induced erosion, but at lower risk), plus the effects from foreseeable actions including salvage harvest from the Hayman Fire. Based on the Watershed and Soils Specialist Report by Deborah Entwhistle, hydrologist for the Pike/San Isabel National Forest, the rates of soil erosion are the difference between the current levels as a result of the wildfire following BAER (burned area emergency restoration) treatments and the post-salvage erosion rates[1]. The salvage would likely occur this year, with the effects realized starting in 2004. Table 13 shows predicted change in accelerated erosion leaving disturbed areas as a result of Hayman Fire salvage alternatives.

Table 13. Predicted Change in Accelerated Erosion Leaving Disturbed Areas, in Tons

		Alternative 2 (Hayman Salv)				*Alternative 3 (Hayman Salv)*			
Treatment	*Erosion Diff tons/acre*	*Trout Creek*		*West Creek*		*Trout Creek*		*West Creek*	
		(acres treated)	*tons*	*(acres treated)*	*tons*	*(acres treated)*	*tons*	*(acres treated)*	*tons*
No BAER	-0.94	209	-196	626	-588	268	-252	1790	-1683
Air Seed	-0.43					0	0	528	-227
Scarify/seed	0.28					227	64	2150	602
Air Mulch	0.58					137	79	969	562
Total		209	-196	626	-588	632	-109	5437	-746

This analysis indicates that accelerated soil erosion would be reduced as a result of implementing the salvage sale in both Trout and West Creeks for both Hayman Salvage action alternatives. Because this reduction is based on slash that is immediate and would last past the five years needed for the ground vegetation to recover, the amount is considered a constant for those five years. Alternative 3 has been identified as the Preferred Alternative so its results have been incorporated into Table 14a and all such tables for the other alternatives.

Table 14a. Predicted Cumulative Accelerated Erosion Leaving Disturbed Areas, in Total Tons

Water shed	*2004*	*200 5*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	27443	237 70	16377	11299	9756	8909	7948	6982	5871	4796	4071	3716	3603
West Creek	65913	499 14	24382	8280	6442	6519	6175	5780	4203	2733	1691	1229	1136

Alternative A

This alternative is similar to the Proposed Action with the exception that no prescribed burning would occur. The 950 acres of on-site treatment using feller-bunchers or chainsaws, piling, and burning would not occur under this alternative. The predictions of soil erosion from tractor yarding, temporary road construction, and risk of catastrophic wildfire would be the same (Tables 7, 8, and 10). Whole-tree yarding would be used to remove the slash in excess of down wood requirements to the landing for later chipping and hauling off-site. Table 14b shows predicted erosion leaving disturbed areas.

Table 14b. Predicted Erosion leaving Disturbed Areas (Tractor yarding, Temporary Roads, and Wildfire) in Total Tons: Alternative A

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	3962	7426	9614	10009	9327	8431	7462	6496	5547	4626	4014	3708	3603
West Creek	1348	2536	3294	3149	3235	2949	2545	2150	1783	1463	1268	1169	1136

The **indirect effect** of Alternative A would be that portion of the offsite erosion that reaches area streams (Table 15a). Factors that would influence how much sediment would actually reach the streams are those identified in the Proposed Action. Based on the concept that 60% of the road system is hydrologically integrated with the stream system, 60% of the predicted erosion leaving treatment units is assumed to become sediment in area streams for purposes of analysis.

Table 15a. Predicted Erosion Entering Streams from Disturbed Areas (Tractor Yarding, Temporary Roads, and Wildfire), in Total Tons

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	2377	4456	5768	6005	9199	5059	4477	3898	3328	2776	2408	2225	2162
West Creek	809	1522	1976	1889	1941	1769	1527	1290	1070	878	761	701	862

The **cumulative effect** of accelerated soil erosion from the Alternative A is the sum of the projected amount in the No Action alternative (not including wildfire-induced erosion) plus the projected amount from Alternative A (including wildfire-induced erosion, but at lower risk), and the effects of the Hayman Fire salvage (Table 15b).

Table 15b. Predicted Cumulative Accelerated Erosion Leaving Disturbed Areas, in Total Tons

Water shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	27443	23770	16215	10983	9327	8431	7462	6496	5547	4626	4014	3708	3603
West Creek	65913	49914	23172	5840	3235	2949	2545	2150	1783	1463	1268	1169	1136

Alternative B

This alternative would treat only those stands identified in the Proposed Action that are within one mile of the urban interface. The treatment would include about 2,900 acres of helicopter and cable yarding, 9,300 acres of tractor yarding, 1,100 acres of light treatment, and 300 acres of mechanical treatment that is left on-site. The same methods would be employed as in the Proposed Action. No broadcast burning is anticipated since the only treatment would be within one mile of the urban interface; however, pile burning would occur to dispose of excess fuel loading. About 50 miles of system roads, 31 miles of unclassified roads, and 12 miles of temporary roads would be needed to implement this alternative. Tables 16 and 17 estimate the amount of erosion expected to occur from the implementation of this alternative.

Table 16. Predicted Erosion leaving Proposed Timber Harvest in Total Tons

Water-shed	*Year of Harvest*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Trout Creek	**2003**	55	52	39	16	3	0	0	0	0	0	0
	2004		55	52	39	16	3	0	0	0	0	0
	2005			55	52	39	16	3	0	0	0	0
	2006				55	52	39	16	3	0	0	0
	2007					55	52	39	16	3	0	0
	2008						55	52	39	16	3	0
	Total	**55**	**107**	**146**	**162**	**165**	**165**	**110**	**58**	**19**	**3**	**0**
West Creek	**2003**	69	66	48	21	3	0	0	0	0	0	0
	2004		69	66	48	21	3	0	0	0	0	0
	2005			69	66	48	21	3	0	0	0	0
	2006				69	66	48	21	3	0	0	0

Water-shed	*Year of Harvest*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*		*2012*	*2013*	*2014*
	2007					69	66	48	21	3	0	0
	2008						69	66	48	21	3	0
	Total	**69**	**135**	**183**	**204**	**207**	**207**	**138**	**72**	**24**	**3**	**0**

Table 17. Predicted Erosion leaving Proposed Temporary Roads in Total Tons

Water-shed	*Year of Const*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Trout Creek	**2003**	3.2	3.0	2.2	1.0	0.2	0	0	0	0	0	0
	2004		3.2	3.0	2.2	1.0	0.2	0	0	0	0	0
	2005			3.2	3.0	2.2	1.0	0.2	0	0	0	0
	2006				3.2	3.0	2.2	1.0	0.2	0	0	0
	2007					3.2	3.0	2.2	1.0	0.2	0	0
	2008						3.2	3.0	2.2	1.0	0.2	0
	Total	**3.2**	**6.2**	**8.4**	**9.4**	**9.6**	**9.6**	**6.4**	**3.4**	**1.2**	**0.2**	**0**
West Creek	**2003**	1.6	1.5	1.1	0.5	0.1	0	0	0	0	0	0
	2004		1.6	1.5	1.1	0.5	0.1	0	0	0	0	0
	2005			1.6	1.5	1.1	0.5	0.1	0	0	0	0
	2006				1.6	1.5	1.1	0.5	0.1	0	0	0
	2007					1.6	1.5	1.1	0.5	0.1	0	0
	2008						1.6	1.5	1.1	0.5	0.1	0
	Total	**1.6**	**3.1**	**4.2**	**4.7**	**4.8**	**4.8**	**3.2**	**1.7**	**0.6**	**0.1**	**0**

Bob Solari, IDT fuels planner, predicts that a catastrophic wildfire of 10,500 acres will occur within the project area (both watersheds) within the next ten years, and a total of 42,000 acres will burn in the analysis area. Hayman Fire burned 26,800 acres of this predicted amount leaving 15,200 acres yet to burn in the upcoming decade.

Alternative B would reduce the risk each year as treatment occurs, from 1,520 the first year to 782 acres the tenth year, declining by 82 acres each year. At the end of the decade the risk would be 40% within the project area and 60% in the rest of the analysis area, for an average risk of 55%. Therefore, I assume that the probability is distributed equally between the two watersheds proportional to the unburned area. Trout Creek watershed, with 74,000 unburned acres, is 76% of the analysis area and West Creek watershed, with 24,000 unburned acres, is 24% of the area. Each burn area would follow the recovery pattern for other disturbed areas, stated earlier. Tables 18a and 18b show predicted erosion leaving predicted wildfires in Trout and West Creeks, respectively.

Table 18a. Predicted Erosion leaving Predicted Wildfires in Trout Creek, in Total Tons

Water - shed	***Year of Fire***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***
Trout Creek	**2003**	3892	3697	2724	1168	195	0	0	0	0	0	0	0
	2004		3683	3499	2578	1105	184	0	0	0	0	0	0
	2005			3474	3301	2432	1042	174	0	0	0	0	0
	2006				3296	3131	2307	989	165	0	0	0	0
	2007					3053	2900	2137	916	153	0	0	0
	2008						2844	2702	1991	853	142	0	0
	2009							2632	2500	1842	790	132	0
	2010								2423	2302	1696	727	121
	2011									2214	2103	1550	664
	2012										2002 +	1902 +	1401 +
	Total	**3892**	**7380**	**9697**	**10343**	**9916**	**9277**	**8634**	**7995**	**7364**	**6733**	**6313**	**6090**

Yr of Fire	***2016***	***2017 & beyond***
2010	111	0
2011	601 +	100 +
Total	**6017**	**6006**

Table 18b. Predicted Erosion leaving Predicted Wildfires in West Creek, in Total Tons

Water - shed	*Year of Fire*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017 & beyond*
	2003	1230	1169	861	369	61	0	0	0	0	0	0	0		
	2004		1163	1105	814	349	58	0	0	0	0	0	0		
	2005			1095	1040	767	328	55	0	0	0	0	0		
	2006				1031	980	722	309	51	0	0	0	0		
	2007					964	916	675	289	48	0	0	0		
West	**2008**						896	852	627	269	44	0	0		
	2009							832	791	582	250	41	0		
	2010								765	727	536	229	38	35	0
	2011									698	663	489	209	190	32
	2012										634	602	444		
	Total	**1230**	**2332**	**3061**	**3254**	**3121**	**2920**	**2723**	**2523**	**2324**	**2127**	**1995**	**1927**	**1905**	**1902**

Table 19 shows predicted erosion leaving disturbed areas under Alternative B.

Table 19. Predicted Erosion Leaving Disturbed Areas (Tractor Yarding, Temporary Roads, and Wildfire), in Total Tons: Alternative B

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	3950	7493	9851	10514	10091	9452	8750	8056	7384	6746	6313	6090	6017
West Creek	1301	2470	3248	3463	3333	3132	2864	2597	2349	2130	1995	1927	1905

The **indirect effect** of Alternative B would be that portion of the offsite erosion that reaches area streams (Table 20). Factors that would influence how much sediment would actually reach the streams are those identified in the Proposed Action. Based on the concept that 60% of the road system is hydrologically integrated with the stream system, 60% of the predicted erosion leaving treatment units is assumed to become sediment in area streams for purposes of analysis.

Table 20. Predicted Erosion Entering Streams from Disturbed Areas (Tractor Yarding, Temporary Roads, and Wildfire), in Total Tons

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	2370	4496	5911	6308	6055	5671	5250	4834	4430	4048	3788	3654	3610
West Creek	781	1482	1949	2078	2000	1879	1718	1558	1409	1278	1197	1156	1143

The **cumulative effect** of accelerated soil erosion from Alternative B is the sum of the projected amount in the No Action alternative (not including wildfire-induced erosion) plus the projected amount from this alternative (including wildfire-induced erosion, but at lower risk), and the effects of the Hayman Fire salvage (Table 21).

Table 21. Predicted Cumulative Accelerated Erosion Leaving Disturbed Areas, in Total Tons

Water shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	27431	23837	16452	11488	10091	9452	8750	8056	7384	6746	6313	6090	6017
West Creek	65866	49848	23126	6154	3333	3132	2864	2597	2349	2130	1995	1927	1905

Alternative C

This alternative would treat all the stands identified in the Proposed Action but would build no temporary roads for access. Those stands not accessible with the existing system and unclassified road network would be yarded using helicopters. The treatment would include about 6,100 acres of helicopter and cable yarding, 11,280 acres of tractor yarding, 1,945 acres of light treatment, and 950 acres of mechanical treatment that is left on-site. The same methods would be employed as in the Proposed Action. About 6,600 acres of broadcast burning are proposed beyond one mile of the urban interface, and pile burning would occur elsewhere to dispose of excess fuel loading.

About 68 miles of system roads and 48 miles of unclassified roads would be needed to implement this alternative. Tables 22 and 23 estimate the amount of erosion expected to occur from the implementation of this alternative.

Table 22. Predicted Erosion leaving Proposed Timber Harvest in Total Tons

Water-shed	*Year of Harvest*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
	2003	53	50	37	16	3	0	0	0	0	0	o
	2004		53	50	37	16	3	0	0	0	0	0
	2005			53	50	37	16	3	0	0	0	0
Trout Creek	**2006**				53	50	37	16	3	0	0	0
	2007					53	50	37	16	3	0	0
	2008						53	50	37	16	3	0
	Total	**53**	**103**	**140**	**156**	**159**	**159**	**106**	**56**	**19**	**3**	**0**
	2003	97	92	68	29	5	0	0	0	0	0	0
	2004		97	92	68	29	5	0	0	0	0	0
	2005			97	92	68	29	5	0	0	0	0
West Creek	**2006**				97	92	68	29	5	0	0	0
	2007					97	92	68	29	5	0	0
	2008						97	92	68	29	5	0
	Total	**97**	**189**	**257**	**286**	**291**	**291**	**194**	**102**	**34**	**5**	**0**

Table 23. Predicted Erosion Leaving Proposed Broadcast Burning in Total Tons

Water-shed	*Year of Harvest*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	**2005**	162	154	113	49	8	0	0	0	0	0	0
	2006		162	154	113	49	8	0	0	0	0	0
	2007			162	154	113	49	8	0	0	0	0
	2008				162	154	113	49	8	0	0	0
	2009					162	154	113	49	8	0	0

Water-shed	***Year of Harvest***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***
	2010						162	154	113	49	8	0
	Total	**162**	**316**	**429**	**478**	**486**	**486**	**324**	**170**	**57**	**8**	**0**
West Creek	**2005**	1210	1150	847	363	60	0	0	0	0	0	0
	2006		1210	1150	847	363	60	0	0	0	0	0
	2007			1210	1150	847	363	60	0	0	0	0
	2008				1210	1150	847	363	60	0	0	0
	2009					1210	1150	847	363	60	0	0
	2010						1210	1150	847	363	60	0
	Total	**1210**	**2360**	**3207**	**3570**	**3630**	**3630**	**2420**	**1270**	**423**	**60**	**0**

Bob Solari, IDT fuels planner, predicts that a catastrophic wildfire of 10,500 acres will occur within the project area (both watersheds) within the next ten years, and a total of 42,000 acres will burn in the analysis area. Hayman Fire burned 26,800 acres of this predicted amount, leaving 15,200 acres yet to burn in the upcoming decade. Alternative C would reduce the risk each year as treatment occurs, from 1,520 the first year to 467 acres the tenth year, declining by 117 acres each year. At the end of the decade the risk would be 20% within the project area and 30% in the rest of the analysis area, for an average risk of 28%. Therefore, I assume that the probability is distributed equally between the two watersheds proportional to the unburned area. Trout Creek watershed, with 74,000 unburned acres, is 76% of the analysis area and West Creek watershed, with 24,000 unburned acres, is 24% of the area. Each burn area would follow the recovery pattern for other disturbed areas, stated earlier. Table 24a and 24b show predicted erosion leaving predicted wildfires in Trout and West Creeks, respectively.

Table 24a. Predicted Erosion leaving Predicted Wildfires in Trout Creek, in Total Tons

Water - shed	*Year of Fire*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Trout Creek	**2003**	3892	3697	2724	1168	195	0	0	0	0	0	0	0
	2004		3592	3412	2514	1078	180	0	0	0	0	0	0
	2005			3292	3127	2304	988	165	0	0	0	0	0
	2006				2993	2843	2095	898	150	0	0	0	0
	2007					2696	2561	1887	809	135	0	0	0
	2008						2396	2276	1677	719	120	0	0
	2009							2096	1991	1467	629	105	0
	2010								1796	1706	1257	530	90
	2011									1496	1421	1047	449
	2012										1196	1136 +	837 +
	Total	**3892**	**7289**	**9428**	**9802**	**9116**	**8220**	**7322**	**6423**	**5523**	**4623**	**4014**	**3708**

Yr of Fire	*2016*	*2017 & beyond*
2010	75	0
2011	359 +	60 +
Total	**3603**	**3588**

Table 24b. Predicted Erosion leaving Predicted Wildfires in West Creek, in Total Tons

Water - shed	*Year of Fire*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
West Creek	**2003**	1230	1169	861	69	61	0	0	0	0	0	0	0
	2004		1136	1079	795	341	57	0	0	0	0	0	0
	2005			1041	989	729	312	52	0	0	0	0	0
	2006				947	900	663	284	47	0	0	0	0
	2007					849	807	594	255	42	0	0	0
	2008						755	717	529	226	38	0	0
	2009							661	628	463	198	33	0
	2010								566	538	396	170	28
	2011									472	448	330	142
	2012										377 +	358 +	264 +
	Total	**1230**	**2305**	**2981**	**2800**	**2880**	**2594**	**2308**	**2025**	**1741**	**1457**	**1268**	**1169**

Yr of Fire	*2016*	*2017 & beyond*
2010	24	
2011	113 +	19 +
Total	**1136**	**1131**

Table 25 shows predicted erosion leaving disturbed areas under Alternative C.

Table 25. Predicted Erosion Leaving Disturbed Areas (Tractor Yarding, Broadcast Burning and Wildfire) in Total Tons: Alternative C

Water - shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	3955	7892	9730	10274	9588	8857	7914	6965	5866	4796	4071	3716	3603
West Creek	1327	2494	4448	5446	6378	6455	6132	5757	4195	2732	1691	1229	1136

The **indirect effect** of Alternative C would be that portion of the offsite erosion that reaches area streams (Table 26). Factors that would influence how much sediment would actually reach the streams are those identified in the Proposed Action. Based on the concept that 60% of the road system is hydrologically integrated with the stream system, 60% of the predicted erosion leaving treatment units is assumed to become sediment in area streams for purposes of analysis.

Table 26. Predicted Erosion entering Streams from Disturbed Areas (Tractor yarding, Temporary Roads, and Wildfire) in Total Tons

Water - shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	2373	4735	5838	6164	5753	5314	4748	4179	3520	2878	2443	2230	2162
West Creek	796	2841	2669	3268	3827	3873	3679	3454	2517	1639	1015	737	682

The **cumulative effect** of accelerated soil erosion from the Alternative C is the sum of the projected amount in the No Action alternative (not including wildfire-induced erosion) plus the projected amount from this alternative (including wildfire-induced erosion, but at lower risk), and the effects of the Hayman Fire salvage (Table 27).

Table 27. Predicted Cumulative Accelerated Erosion leaving Disturbed Areas in Total Tons

Water shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	27436	24236	16331	11238	9588	8857	7914	6965	5866	4796	4071	3716	3603
West Creek	75480	49872	24326	8137	6378	6455	6132	5757	4195	2732	1691	1229	1136

Alternative D

This alternative would employ the same treatments as in the Proposed Action and apply them to national forest lands within ½ mile of the urban interface. No temporary roads would be constructed. Broadcast burning would be the preferred method of slash-treatment within the zone between 600 feet from the urban interface and the ½-mile perimeter. About 3,130 acres of thinning would be tractor yarded, 3,020 acres of thinning would be helicopter yarded, 600 acres would be lightly thinned and the slash treated in place, and 3,840 acres would be broadcast burned. Of these treatments, tractor yarding and broadcast burning would impact the soil resource.

About 1,840 acres of tractor yarding and 3,200 acres of broadcast burning are proposed in the Trout Creek watershed; about 1,290 acres of tractor yarding and 640 acres of broadcast burning are proposed in the West Creek watershed.

Because of the reduced number of acres, compared to any of the other action alternatives, it is more likely that this alternative would be completed in four years: the first two dedicated to the stand treatments and the second two years to post-harvest treatments such as broad cast burning. Table 28 shows predicted erosion leaving timber harvest and broadcast burning areas under Alternative D.

Table 28. Predicted Erosion Leaving Alternative D Timber Harvest and Broadcast Burning in Total Tons

Water-shed	*Year of Harv*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Trout Creek	**2003**	74	70	52	22	4	0	0	0	0	0	0
	2004		74	70	52	22	4	0	0	0	0	0
	2005			1861	1768	1303	558	93	0	0	0	0
	2006				1861	1768	1303	558	93	0	0	0
	Total	**74**	**144**	**1983**	**3703**	**3097**	**1865**	**651**	**93**	**0**	**0**	**0**
West Creek	**2003**	60	57	42	18	3	0	0	0	0	0	0
	2004		60	57	42	18	3	0	0	0	0	0
	2005			857	814	600	257	43	0	0	0	0
	2006				857	814	600	257	43	0	0	0
	Total	**60**	**117**	**956**	**1731**	**1435**	**960**	**300**	**43**	**0**	**0**	**0**

Bob Solari, IDT fuels planner, predicts that a catastrophic wildfire of 10,500 acres will occur within the project area (both watersheds) within the next ten years, and a total of 42,000 acres will burn in the analysis area. Hayman Fire burned 26,800 acres of this predicted amount leaving 15,200 acres yet to burn in the upcoming decade. Alternative D would reduce the risk each year as treatment occurs, from 1,520 the first year to 1,331 acres the tenth year, declining by 21 acres each year. At the end of the decade the risk would be 80% within the project area and 100% in the rest of the analysis area, for an average risk of 95%. Therefore, I assume that the probability is distributed equally between the two watersheds proportional to the unburned area. Trout Creek watershed, with 74,000 unburned acres, is 76% of the analysis area and West Creek watershed, with 24,000 unburned acres, is 24% of the area. Each burn area would follow the recovery pattern for other disturbed areas, stated earlier. Tables 29a and 29b show predicted erosion leaving predicted wildfires in Trout and West Creeks, respectively.

Table 29a. Predicted Erosion Leaving Predicted Wildfires in Trout Creek, in Total Tons

Water - shed	*Year of Fire*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Trout Creek	**2003**	3892	3697	2724	1168	195	0	0	0	0	0	0	0
	2004		3838	3646	2687	1151	192	0	0	0	0	0	0
	2005			3785	3595	2650	1135	189	0	0	0	0	0
	2006				3731	3544	2612	1119	187	0	0	0	0
	2007					3677	3493	2574	1103	184	0	0	0
	2008						3623	3442	2536	1087	181	0	0
	2009							3569	3391	2498	1071	178	0
	2010								3515	3339	2461	1054	176
	2011									3461	3288	2423	1038
	2012										3407 +	3237 +	2385 +
	Total	**3892**	**7535**	**10155**	**11181**	**11217**	**11055**	**10893**	**10732**	**10569**	**10408**	**10299**	**10243**

Yr of Fire	*2016*	*2017 & beyond*
2010	173	0
2011	1022 +	170 +
Total	**10224**	**10221**

Table 29b. Predicted Erosion Leaving Predicted Wildfires in West Creek, in Total Tons

Water - shed	*Year of Fire*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
West Creek	**2003**	1230	1169	861	69	61	0	0	0	0	0	0	0
	2004		1213	1152	849	364	61	0	0	0	0	0	0
	2005			1196	1136	837	359	60	0	0	0	0	0
	2006				1180	1121	826	354	59	0	0	0	0
	2007					1163	1105	814	349	58	0	0	0
	2008						1146	1089	802	344	57	0	0
	2009							1129	1073	790	339	56	0
	2010								1112	1056	778	334	56
	2011									1095	1040	767	329
	2012										1078	1024	755
	Total	**1230**	**1382**	**3209**	**3234**	**3546**	**3497**	**3446**	**3395**	**3343**	**3292**	**3259**	**3242**

Yr of Fire	*2016*	*2017 & beyond*
2010	55	0
2011	323	54
Total	**3235**	**3234**

Table 30 shows predicted erosion leaving disturbed areas under Alternative D.

Table 30. Predicted Erosion Leaving Disturbed Areas (Tractor Yarding, Broadcast Burning, and Wildfire) in Total Tons: Alternative D

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	3966	7679	12138	14884	14314	12920	11544	10825	10569	10408	10299	10243	10224
West Creek	1290	1499	4165	4965	4981	4457	3746	3438	3343	3292	3259	3242	3235

The **indirect effect** of Alternative D would be that portion of the offsite erosion that reaches area streams (Table 31). Factors that would influence how much sediment would actually reach the streams include the juxtaposition of the access road to the harvest unit, road design, temporary storage time in road ditches and ephemeral channels, frequency of relief culverts or rolling dips, filtering vegetation below relief culverts and dips, and road maintenance that includes ditch cleaning. Harvest units with an access road with an adverse grade are unlikely to contribute sediment since there would be not road below the landing. Roads with an outslope design, as many spur roads are, do not transport sediment far. Relief culverts and rolling dips that direct sediment-laden runoff into vegetated buffers and away from pathways that directly reach the streams increase storage time in the uplands. Sediment delivered to ephemeral draws and channels would only be temporarily stored, and would move closer to the intermittent and perennials streams with each runoff event. For these reasons, it is not possible to predict with accuracy the amount of sediment reaching the stream system and when. However, based on the concept that 60% of the road system is hydrologically integrated with the stream system, 60% of the predicted erosion leaving treatment unit is assumed to become sediment in area streams for purposes of analysis.

Table 31. Predicted Erosion Entering Streams from Disturbed Areas (Tractor Yarding, Broadcast Burning and Wildfire) in Total Tons

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	2380	4607	7283	8930	8588	7752	6926	6495	6341	6245	6179	6146	6134
West Creek	774	899	2499	2979	2989	2674	2248	2063	2006	1975	1955	1945	1941

The **cumulative effect** of accelerated soil erosion from Alternative D is the sum of the projected amount in the No Action alternative (not including wildfire-induced erosion) plus the projected amount from this alternative (including wildfire-induced erosion, but at lower risk), and the effects of the Hayman Fire salvage (Table 32).

Table 32. Predicted Cumulative Accelerated Erosion Leaving Disturbed Areas in Total Tons

Water shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	27447	24023	18739	15858	14314	12920	11544	10825	10569	10408	10299	10243	10224
West Creek	65855	48877	24043	7656	4981	4457	3746	3438	3343	3292	3259	3242	3235

Alternative E

This alternative would treat about 26,320 acres using the same tools and techniques as the Proposed Action, except that persistent openings would be created in patches averaging 20 acresbut as large as 40 acres, on a total of 7,900 acres distributed across the landscape. About 70% would be in tractor-yarded stands and 30% in helicopter- and cable-yarded stands. Due to the increased intensity of harvest and the focus on south and west aspects for their location where there is less ground vegetation, the risk of accelerated soil erosion from raindrop impact and wind increases. I used a "tall prairie grass" as a surrogate for the residual vegetation in the persistent openings since some shrubs and some short grasses would be present but the model only has shrub or short grass as choices. Regardless, some additional accelerated erosion would occur where tractor yarding is proposed and is estimated to be 0.45 tons/acre. The helicopter yarding method won't mitigate the total loss of tree cover, exposing the soil surface to erosive forces, and the amount of erosion is estimated to be 1.33 tons/acre. Although about half of the openings would be allowed to reforest and the other half would be maintained as long-term openings, they are treated the same in this analysis since their vegetative composition would be similar for the ten years following treatment.

Tables 33, 34, and 35 show predicted erosion leaving proposed timber harvest, proposed temporary roads, and proposed broadcast burning areas, respectively.

Table 33. Predicted Erosion Leaving Proposed Timber Harvest in Total Tons

Water-shed	*Year of Harvest*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Trout Creek	**2003**	371	352	260	111	19	0	0	0	0	0	0
	2004		371	352	260	111	19	0	0	0	0	0
	2005			371	352	260	111	19	0	0	0	0
	2006				371	352	260	111	19	0	0	0
	2007					371	352	260	111	19	0	0
	2008						371	352	260	111	19	0
	Total	**371**	**723**	**983**	**1094**	**1113**	**1113**	**742**	**390**	**130**	**19**	**0**

Water-shed	*Year of Harvest*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
West Creek	**2003**	629	598	440	189	31	0	0	0	0	0	0
	2004		629	598	440	189	31	0	0	0	0	0
	2005			629	598	440	189	31	0	0	0	0
	2006				629	598	440	189	31	0	0	0
	2007					629	598	440	189	31	0	0
	2008						629	598	440	189	31	0
	Total	**629**	**1227**	**1667**	**1856**	**1887**	**1887**	**1258**	**660**	**220**	**31**	**0**

Table 34. Predicted Erosion Leaving Proposed Temporary Roads in Total Tons

Water-shed	*Year of Const*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*
Trout Creek	**2003**	3.2	3.0	2.2	1.0	0.2	0	0	0	0	0	0
	2004		3.2	3.0	2.2	1.0	0.2	0	0	0	0	0
	2005			3.2	3.0	2.2	1.0	0.2	0	0	0	0
	2006				3.2	3.0	2.2	1.0	0.2	0	0	0
	2007					3.2	3.0	2.2	1.0	0.2	0	0
	2008						3.2	3.0	2.2	1.0	0.2	0
	Total	**3.2**	**6.2**	**8.4**	**9.4**	**9.6**	**9.6**	**6.4**	**3.4**	**1.2**	**0.2**	**0**
West Creek	**2003**	2.4	2.3	1.4	1.0	0.1	0	0	0	0	0	0
	2004		2.4	2.3	1.4	1.0	0.1	0	0	0	0	0
	2005			2.4	2.3	1.4	1.0	0.1	0	0	0	0
	2006				2.4	2.3	1.4	1.0	0.1	0	0	0
	2007					2.4	2.3	1.4	1.0	0.1	0	0
	2008						2.4	2.3	1.4	1.0	0.1	0
	Total	**2.4**	**4.7**	**6.1**	**7.1**	**7.2**	**7.2**	**4.8**	**2.5**	**1.1**	**0.1**	**0**

Table 35. Predicted Erosion Leaving Proposed Broadcast Burning in Total Tons

Water-shed	*Year of Harv*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*
Trout Creek	**2005**	232	220	162	70	12	0	0	0	0	0	0
	2006		232	220	162	70	12	0	0	0	0	0
	2007			232	220	162	70	12	0	0	0	0
	2008				232	220	162	70	12	0	0	0
	2009					232	220	162	70	12	0	0
	2010						232	220	162	70	12	0
	Total	**232**	**452**	**614**	**684**	**696**	**696**	**464**	**244**	**82**	**12**	**0**
West Creek	**2005**	1725	1639	1208	517	86	0	0	0	0	0	0
	2006		1725	1639	1208	517	86	0	0	0	0	0
	2007			1725	1639	1208	517	86	0	0	0	0
	2008				1725	1639	1208	517	86	0	0	0
	2009					1725	1639	1208	517	86	0	0
	2010						1725	1639	1208	517	86	0
	Total	**1725**	**3364**	**4572**	**5089**	**5175**	**5175**	**3450**	**1811**	**603**	**86**	**0**

Bob Solari, IDT fuels planner, predicts that a catastrophic wildfire of 10,500 acres will occur within the project area (both watersheds) within the next ten years, and a total of 42,000 acres will burn in the analysis area. Hayman Fire burned 26,800 acres of this predicted amount, leaving 15,200 acres yet to burn in the upcoming decade. Alternative E would reduce the risk each year as treatment occurs, from 1,520 the first year to 467 acres the tenth year, declining by 117 acres each year. At the end of the decade the risk would be 20% within the project area and 30% in the rest of the analysis area, for an average risk of 28%. Therefore, I assume that the probability is distributed equally between the two watersheds proportional to the unburned area.

Trout Creek watershed, with 74,000 unburned acres, is 76% of the analysis area and West Creek watershed, with 24,000 unburned acres, is 24% of the area. Each burn area would follow the recovery pattern for other disturbed areas, stated earlier. Tables 36a and 36b show predicted erosion leaving predicted wildfires in Trout and West Creeks, respectively.

Table 36a. Predicted Erosion leaving Predicted Wildfires in Trout Creek, in Total Tons

Water - shed	*Year of Fire*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Trout Creek	**2003**	3892	3697	2724	1168	195	0	0	0	0	0	0	0
	2004		3592	3412	2514	1078	180	0	0	0	0	0	0
	2005			3292	3127	2304	988	165	0	0	0	0	0
	2006				2993	2843	2095	898	150	0	0	0	0
	2007					2696	2561	1887	809	135	0	0	0
	2008						2396	2276	1677	719	120	0	0
	2009							2096	1991	1467	629	105	0
	2010								1796	1706	1257	530	90
	2011									1496	1421	1047	449
	2012										1196	1136 +	837 +
	Total	**3892**	**7289**	**9428**	**9802**	**9116**	**8220**	**7322**	**6423**	**5523**	**4623**	**4014**	**3708**

Yr of Fire	*2016*	*2017 & beyond*
2010	75	0
2011	359 +	60 +
Total	**3603**	**3588**

Table 36b. Predicted Erosion Leaving Predicted Wildfires in West Creek, in Total Tons

Water - shed	*Year of Fire*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
	2003	1230	1169	861	69	61	0	0	0	0	0	0	0
	2004		1136	1079	795	341	57	0	0	0	0	0	0
	2005			1041	989	729	312	52	0	0	0	0	0
	2006				947	900	663	284	47	0	0	0	0
	2007					849	807	594	255	42	0	0	0
West Creek	**2008**						755	717	529	226	38	0	0
	2009							661	628	463	198	33	0
	2010								566	538	396	170	28
	2011									472	448	330	142
	2012										377 +	358 +	264 +
	Total	**1230**	**2305**	**2981**	**2800**	**2880**	**2594**	**2308**	**2025**	**1741**	**1457**	**1268**	**1169**

Yr of Fire	*2016*	*2017 & beyond*
2010	24	
2011	113 +	19 +
Total	**1136**	**1131**

Table 37 shows predicted erosion leaving disturbed areas under Alternative E.

Table 37. Predicted Erosion Leaving Disturbed Areas (Tractor Yarding, Persistent Openings, Temporary Roads, Broadcast Burning, and Wildfire) in Total Tons: Alternative E

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Trout Creek	4266	8018	10651	11357	10853	10027	8766	7512	6118	4886	4096	3720
West Creek	1861	3537	6379	8027	9346	9577	8746	7863	5412	3299	1871	1255

The **indirect effect** of Alternative E would be that portion of the offsite erosion that reaches area streams (Table 38). Factors that would influence how much sediment would actually reach the streams include the juxtaposition of the access road to the harvest unit, road design, temporary storage time in road ditches and ephemeral channels, frequency of relief culverts or rolling dips, filtering vegetation below relief culverts and dips, and road maintenance that includes ditch cleaning. Harvest units with an access road with an adverse grade are unlikely to contribute sediment since there would be not road below the landing. Roads with an outslope design, as many spur roads are, do not transport sediment far. Relief culverts and rolling dips that direct sediment-laden runoff into vegetated buffers and away from pathways that directly reach the streams increase storage time in the uplands. Sediment delivered to ephemeral draws and channels would only be temporarily stored and would move closer to the intermittent and perennials streams with each runoff event. For these reasons, it is not possible to predict with accuracy the amount of sediment reaching the stream system and when. However, based on the concept that 60% of the road system is hydrologically integrated with the stream system, 60% of the predicted erosion leaving treatment unit is assumed to become sediment in area streams for purposes of analysis.

Table 38. Predicted Erosion Entering Streams from Disturbed Areas (Tractor Yarding, Temporary Roads, Broadcast Burning, and Wildfire) in Total Tons

Water-shed	*2004*	*2005*		*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Trout Creek	2560	4811	6391	6814	6512	6016	5260	4507	3671	2932	2458	2232
West Creek	1117	2122	3827	4816	5608	5746	5248	4718	3247	1979	1123	753

The **cumulative effect** of accelerated soil erosion from Alternative E is the sum of the projected amount in the No Action alternative (not including wildfire-induced erosion) plus the projected amount from this alternative (including wildfire-induced erosion, but at lower risk), and the effects of the Hayman Fire salvage (Table 39).

Table 39. Predicted Cumulative Accelerated Erosion Leaving Disturbed Areas in Total Tons

Water-shed	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*
Trout Creek	27747	24362	17252	12331	10853	10027	8766	7512	6118	4886	4096	3720
West Creek	65682	49500	23705	10718	9346	9577	8746	7863	5412	3299	1871	1255

Comparison of Alternatives and Conclusions

Sediment

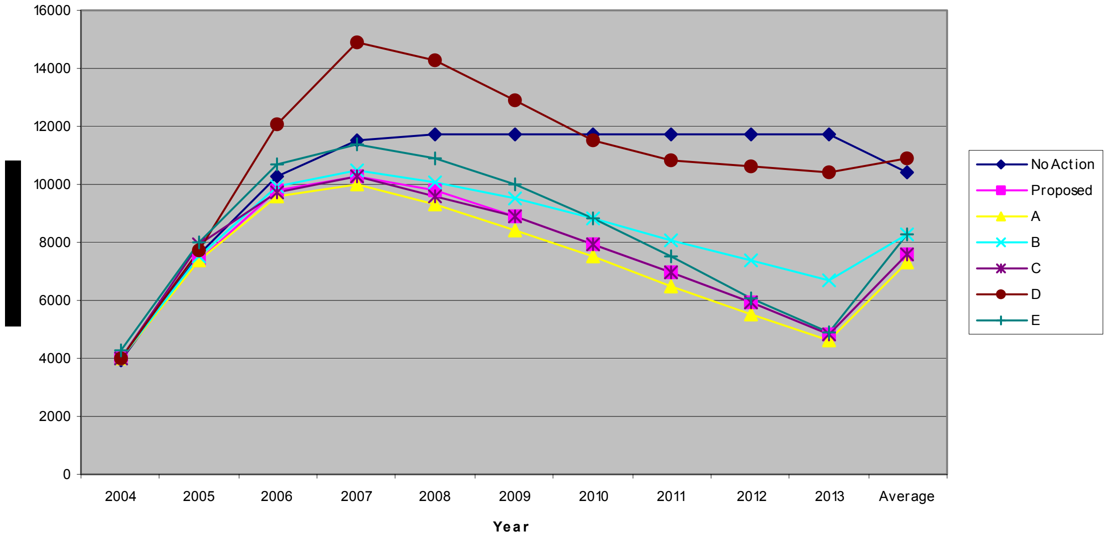
Table 40 is taken from the direct effects tablespresented previously in this report and re-organized for direct comparison for the first decade, by alternative.

Table 40. Predicted Erosion Leaving Disturbed Areas (in Total Tons, Rounded to the Nearest 100 Tons)

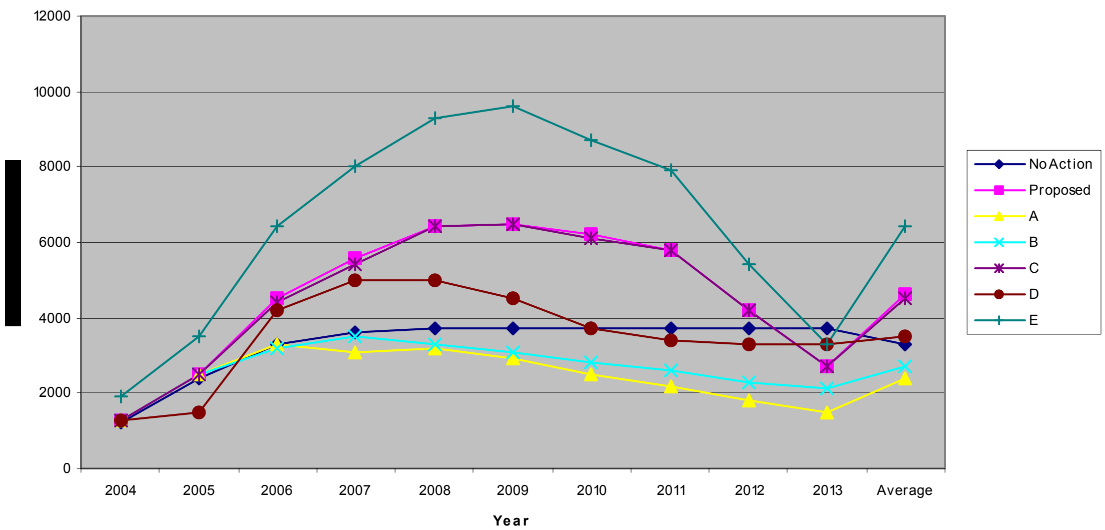
Water-shed	*Alter-native*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*		*2011*	*2012*	*2013*	*Avg*
Trout Creek	**NA**	3.9k	7.6k	10.3k	11.5k	11.7k	11.7k	11.7k	11.7k	11.7k	11.7k	**10.4k**
	PA	4.0k	7.4k	9.8k	10.3k	9.8k	8.9k	7.9k	7.0k	5.9k	4.8k	**7.6k**
	A	4.0k	7.4k	9.6k	10.0k	9.3k	8.4k	7.5k	6.5k	5.5k	4.6k	**7.3k**
	B	4.0k	7.5k	9.9k	10.5k	10.1k	9.5k	8.8k	8.1k	7.4k	6.7k	**8.3k**
	C	4.0k	7.9k	9.7k	10.3k	9.6k	8.9k	7.9k	7.0k	5.9k	4.8k	**7.6k**
	D	4.0k	7.7k	12.1k	14.9k	14.3k	12.9k	11.5k	10.8k	10.6k	10.4k	**10.9k**
	E	4.3k	8.0k	10.7k	11.4k	10.9k	10.0k	8.8k	7.5k	6.1k	4.9k	**8.3k**
West Creek	**NA**	1.2k	2.4k	3.3k	3.6k	3.7k	3.7k	3.7k	3.7k	3.7k	3.7k	**3.3k**
	PA	1.3k	2.5k	4.5k	5.6k	6.4k	6.5k	6.2k	5.8k	4.2k	2.7k	**4.6k**
	A	1.3k	2.5k	3.3k	3.1k	3.2k	2.9k	2.5k	2.2k	1.8k	1.5k	**2.4k**
	B	1.3k	2.5k	3.2k	3.5k	3.3k	3.1k	2.8k	2.6k	2.3k	2.1k	**2.7k**
	C	1.3k	2.5k	4.4k	5.4k	6.4k	6.5k	6.1k	5.8k	4.2k	2.7k	**4.5k**
	D	1.3k	1.5k	4.2k	5.0k	5.0k	4.5k	3.7k	3.4k	3.3k	3.3k	**3.5k**
	E	1.9k	3.5k	6.4k	8.0k	9.3k	9.6k	8.7k	7.9k	5.4k	3.3	**6.4k**

The following charts display the information in Table 40 graphically, the right-most point being the average amount of accelerated erosion.

Predicted Soil Erosion by Alternative
Trout Creek Watershed



Predicted Soil Erosion by Alternative
West Creek Watershed



Alternative A (no broadcast burning) generates the least amount of accelerated soil erosion in both watersheds. There are significant differences in the amount of predicted accelerated soil erosion between some of the alternatives, but the relative ranking of the alternatives in one watershed are not necessarily the same in the other watershed.

The major differences between the alternatives from one watershed to the other is the Hayman Fire having already burned most of the predicted wildfire in West Creek watershed reducing the risk this decade for additional wildfire and the higher amount of broadcast burning occurring in West Creek watershed.

Trout Creek

No Action generates the second highest amount of accelerated soil erosion due to the risk of damaging wildfire occurring in the next decade.

There are minor differences between the Proposed Action and Alternatives A, B, C, and E in the Trout Creek watershed. The differences between the Proposed Action and Alternative A are minor because of the relatively few (1,100) acres broadcast burned under the Proposed Action.

Alternative B has no broadcast burning, but the increased accelerated soil erosion predicted is from the higher risk of damaging wildfire.

The differences between the Proposed Action and Alternative C (no temporary roads) are so minor because the roads were initially located where they would cause minimal erosion, are temporary, and because the amount of tractor ground (<20% slope) that shifts to helicopter yarding is low (about 13% and mostly in West Creek watershed). The two alternatives appear equal because the differences are slight and drop out when rounding to the nearest 100 tons.

Alternative D (1/2-mile treatment) generates more soil erosion than No Action because there are effects from the treatment, including broadcast burning, but the risk of damaging wildfire remains very high.

Alternative E (persistent openings averaging 20 acres) has a somewhat higher predicted soil erosion in the Trout Creek watershed over the Proposed Action due to increased acres treated and the exposed nature of openings, but the amount of openings is relatively low (2,800 acres).

West Creek

No Action generates the third least amount of accelerated soil erosion due to the area already burned by the Hayman Fire reducing the risk of damaging wildfire occurring in the next decade.

The Proposed Action generates more accelerated soil erosion than No Action, primarily because of the amount of broadcast burning.

Alternative A generates the least accelerated soil erosion because it reduces the risk of damaging wildfire without broadcast burning.

Alternative B generates the second least accelerated soil erosion because similar to Alternative A, it reduces the risk of damaging wildfire without broadcast burning but on a lesser scale than Alternative A.

The Proposed Action and Alternative C are nearly equal because they both broadcast burn the same amount of acreage and the temporary roads in the Proposed Action account for very little accelerated soil erosion due to their location. Alternative C is less because of less tractor yarding.

Alternative D generates more accelerated soil erosion than Alternatives A and B and No Action because it has little reduction in the risk of damaging wildfire while relying on broadcast burning, but is less than the Proposed Action and Alternatives C and E because it broadcast burns less acreage.

Alternative E generates the most accelerated soil erosion in the West Creek watershed because it broadcast burns the most acreage and creates 4,700 acres of persistent openings, especially on steeper slopes.

Conclusion: The alternative that reduces the risk of catastrophic wildfire while maintaining protective ground cover the best would have the least accelerated soil erosion. Alternative A would create the least erosion and, therefore, the least sediment entering area streams.

Road Density

The opportunity to rehabilitate unclassified roads and reduce roads density, especially within 300 feet of perennial and intermittent streams, is directly influenced by the amount of land treated and road system used. The Proposed Action and Alternatives A and E use the most unclassified roads, rehabilitate them, and reduce road density within 300 feet of area streams to the least amount. Alternative D uses the least amount of unclassified roads that are then rehabilitated and leaves the highest density of roads within 300 feet area streams of all the action alternatives. Alternatives B and C are intermediate in effectiveness of reducing road density within 300 feet of area streams, as displayed in Table 41.

Table 41. Road Density in Miles/Mile^2 Within 300 Feet of the Streams System of the Trout-West Affected Area.

Watershed	*No Action*	*Prop'd Action*	*Alt A*	*Alt B*	*Alt C*	*Alt D*	*Alt E*
Trout Creek	3.48	3.07	3.07	3.29	3.14	3.32	3.07
West Creek	3.23	2.41	2.41	2.76	2.64	2.95	2.41
AVERAGE	**3.36**	**2.74**	**2.74**	**3.03**	**2.89**	**3.14**	**2.74**

Nutrient Removal and Effects to Site Productivity

All alternatives would reduce site nutrient to some degree but in different ways. Wildfire has the greatest impact on site nutrients by volatilizing nitrogen found in the foliage and fine twigs of trees and shrubs and the above-ground portions of forbs and grasses. Released nutrients such as phosphorus and potassium can be lost by leaching and nutrient-rich surface soil erosion. The action alternatives vary in the mechanism of nutrient loss but would retain sufficient woody debris, ground cover, and above-ground biomass to maintain site nutrients and productivity. The Proposed Action and Alternatives B, C, D, and E rely on pile and/or broadcast burning to reduce the excess slash loading, while Alternative A relies on chipping and hauling off the excess fuel loading to meet desired level of woody debris.

Monitoring

Monitor each phase of the selected alternative for compliance with the Forest Plan Standards and Guidelines and the Mitigation Measures above, and for effectiveness, on a sample basis. Contact the Forest Hydrologist and/or Forest Soil Scientist during layout and during implementation so that timely monitoring can be done.

Install sediment traps at harvest unit landings to validate mitigation measures and calibrate WEPP model predictions, on a sample basis.

Attachments

R-2 Watershed Effects Checklist

This checklist ensures that all required effects are analyzed, gives a snapshot of all effects, and identifies items to dismiss from rigorous analysis. Blanks mean no effect; "x" means minor effect; "xx" means substantial effect.

Project Name: Trout-West Hazard Fuel Reduction Project
Watersheds: Trout Creek and West Creek

		PA	Alt. A	Alt. B	Alt. C	Alt D	Alt E
Aquatic Ecosystems							
Physical:	Sediment	x	x	xx	x	xx	xx
	Bed/Bank Stability						
	Flow Regimes	x	x	x	x	x	x
Chemical:	Temperature/Oxygen						
	Water Purity			x		x	x
Biological:	Aquatic Life			x		x	x
	TES Species						
Soil Productivity							
	Soil Erosion	x	x	xx	xz	xx	xx
	Soil Compaction						
	Nutrient Removal						
	Soil Heating						
	Regeneration Hazard						
Geologic Hazards							
	Landslides						
	Soil Failures						
	Earthquakes						
Special Areas							
	Riparian Ecosystems						
	Wetlands						
	Floodplains						
Cumulative Effects							
	Aquatic Ecosystems			x		x	x
	Soil Productivity			x		x	x
	Riparian Ecosystems						

Special Designations Checklist

This checklist identifies special values that might require increased concern and protection. If the project overlaps with any such area, mark with an "x".

Riparian Management Area	x	Critical Watershed		Jurisdictional Wetlands	
Wild and Scenic River		Impaired/Threatened Stream	x	Rare Ecosystem	
Drinking Water Supply	x	Natural Research Area		Critical Habitat (TES)	

By (name): James Nelson

Discussion

Checked items from the watershed effects checklist are discussed in the water, soils, and fisheries specialist reports and in the NEPA document. The following briefly discusses why unchecked items will have no effect:

Unchecked Item	**Rationale**
Bed/Bank Stability	Riparian buffer, no new stream crossings, minor & temp increase in flow.
Temp/Oxygen	Retention of stream shading and channel stability, increased sediment less than No Action except Alt. D & E (West Cr only)
Water Purity and Aquatic Life (PA, A, C)	Increased sediment less than No Action
TES	None present
Soil Compaction	Meet Forest Plan standards
Nutrient Removal	Hand felling & bole removal only in helo-yarded stands (except within 600' urban interface) and return of slash in tractor-yarded stands
Geologic Hazards (all)	No road construction on slopes over 20%, Helo-yarding on slopes over 20% (with minor exception, see text)
Special Areas (all)	Avoidance
Aquatic Ecosystem	Increased sediment in PA, Alts A & C below No Action
Soil Productivity	Increased erosion in PA, Alts A & C below No Action
Riparian Ecosystem	Mitigation measures protecting riparian areas, no new road crossings

Note: Soils and Water References are listed in the Final Environmental Impact Statement.