Soils Specialist Report for

Fallen Bear EA

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I. Regulatory Framework

The regulatory framework providing direction for protecting a site's inherent capacity to grow vegetation comes from the following principle sources:

- *The Multiple Use-Sustained Yield Act of 1960*
- *The National Forest Management Act of 1976 (NFMA)*
- *The Forest Plan and Regional Soil Quality standards (2554.03-R1 Suppl. 2500-99-1)*

The Multiple Use-Sustained Yield Act of 1960 directs the Forest Service to achieve and maintain outputs of various renewable resources in perpetuity without permanent impairment of the land's productivity.

The National Forest Management Act of 1976 (NFMA) charges the Secretary of Agriculture with ensuring research and continuous monitoring of each management system to safeguard the land's productivity. To comply with NFMA, the Chief of the Forest Service has charged each Forest Service Region with developing soil quality standards for detecting soil disturbance and indicating a loss in long-term productive potential. These standards are built into Forest Plans.

The Forest Plan objective for soils (Forest Plan p. II-8) is to manage the soil resource to maintain long-term productivity. The objective is that management activities on forest lands will not significantly impair the long-term productivity of the soil or produce unacceptable levels of sedimentation resulting from soil erosion. Forest Plan standards for soils are listed below.

<u>Forest Plan Soil Standard #1</u>

Soil disturbing management practices will strive to maintain at least 80 percent of the activity area in a condition of acceptable productivity potential for trees and other managed vegetation. Unacceptable productivity potential exists when soil has been detrimentally compacted, displaced, puddled, or severely burned as determined in the project analysis.

<u>Forest Plan Soil Standard #2</u>

Projects should strive to maintain sufficient large woody debris to maintain site productivity. Large woody debris is essential for maintenance of sufficient micro-organism populations.

<u>Forest Plan Soil Standard #3</u>

In the event of whole tree logging, provision for maintenance of sufficient nutrient capital should be made in the project analysis.

The Regional Soil Quality Standards (R-1 Supplement 2500-99-1 - USDA FS 1999c) were revised in November 1999. Manual direction recommends maintaining 85% of an activity area's soil at an acceptable productivity potential with respect to detrimental impacts, including the effects of compaction, displacement, rutting, severe burning, surface erosion, loss of surface organic matter, and soil mass movement.

II. Affected Environment

A. Analysis Methods

1. Analysis Area

The analysis area for direct, indirect, and cumulative effects on soil resources encompasses all land within individual treatment units and landings. Existing classified National Forest system roads and trails are considered dedicated lands for other purposes and, as such, soil quality standards do not apply. System roads are considered, however, when determining if Forest Plan Standard #1 within activity areas would be met and if slope stability is compromised.

Commercial treatment would be conducted on approximately 483 acres for Alternative B and 293 acres for Alternative C that are dominated by dry- and moist site vegetation occurring at an elevation of 4000-5200 feet on generally southern and western slopes ranging from ~20% to greater than 50%. There are 34 units ranging in size from 2 acres to 57 acres for Alternative B and 22 units ranging in size from 1 to 56 acres in Alternative C (Table

Soil-3). Harvest activities would be accomplished using ground-based and skyline logging followed by various fuels treatments (Table Soil-1).

Also proposed are 775 acres of pre-commercial thinning, 777 acres of white pine pruning, and 161 acres of seed tree treatment (girdling) for mistletoe. A large portion of these different treatments overlap and would take place within the same units.

The analysis also considers how much area has been devoted to resources where soil quality standards do not apply, such as system roads on National Forest System lands in the Fallen Bear Project Area. Land outside of the analysis area described above is not considered because direct and indirect effects to soils are site specific and would not occur beyond these areas. Cumulative effects to soils are those effects that overlap in time and space, so there would be no cumulative effect where there are no direct or indirect effects.

Table Soil-1. Comparison of Proposed Activities by Alternative

Proposed Activity	Alternative A	Alternative B	Alternative C
Timber Harvest	**0**	**483**	**293**
Ground-based	0	91	45
Skyline	0	392	248
Road Construction	**0**	**2.8**	**0.8**
System	0	2.8	0.8
Temporary	0	0	0
Road Reconstruction	0	17.9	7.3
Fuels Treatment: *Total is more than timber harvest acres because some units would have more than one type of treatment*			
Yard Tops Near Road	0	34	28
Lop	0	204	153
Grapple Pile & Burn Piles	0	62	36
Underburn	0	202	112
No Treatment	0	15	15
Pre-commercial Thinning*	**0**	**775**	**775**
Mistletoe Treatments*	**0**	**161**	**161**

*Most of the mistletoe girdling would occur on areas also proposed for pre-commercial thinning and white pine pruning.

2. Methods Used

Soil resource existing conditions were determined using TSMRS records, aerial photography, GIS data, and on-the-ground-visits. Landtypes and hazard ratings were gathered from landtype descriptions and characteristics described in the Idaho Panhandle National Forests Land Systems Inventory (S-2 and 3; Soil Appendix A - Maps).

Two different accounting methods were used for roads within activity areas:

(1) The Forest Plan Standard activity areas include proposed new system roads and existing system roads within proposed harvest units.

(2) The Region 1 Soil Quality Standard activity areas include only temporary and non-system roads within proposed harvest units.

No temporary roads are proposed with this project, and all travel ways within activity areas are existing or new system roads. The area that would be affected by system road construction and decommissioning was estimated using an average 37-foot road width that includes a 14-foot wide running surface and cut and fill slopes.

Existing conditions and impacts from past activities (Table Soil-3) were quantified using a combination of on-the-ground soil transects (the "Onsite Assessment Method" outlined in Niehoff (2002)), depth of organic matter, and amount of coarse woody debris (S-1). In addition to field verification, potential disturbance for the soil resource was estimated using Niehoff's (2002) guidelines for soil NEPA analysis and the Soil Disturbance Spreadsheet (S-4). These methods provide data that is used in the analysis to determine if Forest Plan and Regional Soil Quality Standards would be met. The approximate confidence level (±5 percent) for field data gathered during the Onsite Assessment Method is 80 to 90 percent for the units with the exception of Unit 97 that is about 75 percent (Page-Dumroese and others 2006a; S-10). The indicator for the analysis is detrimental soil disturbance measured as a percentage within the activity areas with the desired goal to design new activities that do not result in detrimental soil conditions on more than 15 percent of an activity area as required by the Regional Soil Quality Standard and 20 percent of an activity area as required by the Forest Plan Standard.

3. Assumptions and Limitations

The disturbance spreadsheet evaluates potential detrimental disturbance on proposed harvest units for each harvest method based on empirically derived coefficients that were obtained and averaged from numerous monitored sites throughout the Idaho Panhandle National Forests (Forest Plan Monitoring and Evaluation Reports 1988, 1991, 1993 and 1997).

The model is limited to the harvest and slash disposal methods for which coefficients have been determined, and its coefficients assume that Best Management Practices (BMPs) will be implemented. The model does not account for changes in soil type, the recovery of soils over time, or existing conditions. The coefficients used and the protocol for applying the Soil Disturbance Spreadsheet are included in the "Soil NEPA Analysis Process and Source of Soil Disturbance Model Coefficients" (Niehoff 2002).

4. Scientific Uncertainty and Controversy

The definition of "detrimental disturbance" is tied to existing soil quality standards and guidelines. When the USDA Forest Service soil quality standards were originally put into practice, the threshold for detrimental disturbance was defined as a change in any monitoring variable that would trigger a 15% decline in soil productivity from that of the pre-disturbed condition. At that time, the 15% value was judged to be the smallest change detectable statistically at an operational level of monitoring (Powers and others 1998).

Thus, current practice utilizes this number as a common soil quality standard. Cooperative studies and research, such as the Long Term Soil Productivity Study (LTSP) (Page-Dumroese and others 2006b; Powers 2006; Powers and others 2005) are ongoing to provide the best available information in addition to professional judgment although the repeated challenge from many sectors is ongoing.

5. Soils and Productivity

The practice of timber management can have long-lasting impacts on the soil resource if precautions are not taken. The following three design and management criteria relate to soil productivity.

5.1 Detrimentally Disturbed Soil within Activity Areas (Harvest Units)

Detrimental soil impacts are defined as the proportion of an activity area that may be subjected to displacement, compaction, rutting, erosion, or severe burning due to a particular management activity (such as harvest or fuels treatment), exclusive of dedicated resources (such as system roads). The soils in an activity area are considered detrimentally disturbed when the following soil conditions exist as a result of forest practices:

a. For volcanic ash-influenced surface soils, compaction results in a 15% or more increase in bulk density, or a 50% reduction in water infiltration rates. Soil compaction reduces the supply of air, water, and nutrients to plants. Roads, ground-based yarding, and dozer piling are the major contributors to compaction.

b. Detrimental displacement is the removal of 1 or more inches (in depth) of any surface soil horizon, usually the A horizon, from a continuous area greater than 100 square feet.

c. Surface erosion is indicated by rills, gullies, pedestals, and soil deposition and should be kept within tolerable limits by retaining enough ground cover, depending on site characteristics.

d. Rutting consists of wheel ruts at least 2 inches deep in wet soils.

e. Burns that create very high temperatures at the soils surface when surface soil moisture content is low result in almost complete loss of surface and upper soil horizon organics. Hydrophobic (water-repellent) conditions may also reduce water infiltration, promote overland flow, and increase erosion. Many of the nutrients stored in these organics can also be volatilized and removed from the site in fly-ash (Amaranthus 1989; DeBano 1991; Garrison and Moore 1998).

To verify impacts and extent of past soil disturbing activities in the areas identified for treatment, existing conditions were determined during on-the-ground field observations (Table Soil-3; S-1).

5.2. Low Potassium Sites - Sites Containing Geologic Formations that are Naturally Deficient in Potassium Bearing Minerals

Harvesting results in the removal of nutrients that have been accumulated in the wood and foliage over time. Of concern is the possible loss of potassium in the soil and its effect on forest health, especially the increased susceptibility to insects and disease (Garrison-Johnston and others 2003) and a possible link between potassium deficiency and the lack of tree resistance to root disease (Garrison-Johnston and others 2003). Research (Garrison-Johnston 2003; Garrison-Johnston and others 2004 and 2007; Moore and others 2004a; Shen and

others 2001) suggests a complex balance between underlying geology and the natural deficiency of potassium in northern Idaho. Derived primarily from underlying geologic formations, potassium is a product of slow weathering processes in comparison to soil nitrogen, which can be replenished more rapidly through nitrogen fixation or atmospheric deposition.

Some geological formations of the metasedimentary Precambrian Belt Supergroup have a natural deficiency of potassium (Garrison-Johnston 2003; Garrison-Johnston and others 2007). Foliar analysis was therefore conducted on various geologies, including the lower and middle Wallace Formation, on the St. Joe Ranger District (S-15) to determine nutrient levels.

Whole-tree yarding and removal of treetops can lead to the direct loss of potassium (Morris and Miller 1994). On some sites, ±43 percent of the available potassium is retained in trees, with the remainder being held in subordinate vegetation, forest floor, and soil pools. Within the trees, about 85 percent of the potassium is held in the branches, twigs, and foliage (Garrison and Moore 1998; Moore and others 2004b). It is therefore vital to recycle as many nutrients as possible before removal, which can be done by leaving small-scale debris to leach out potassium (Baker and others 1989; Barber and Van Lear 1984; Edmonds 1987; Garrison and Moore, 1998; Laskowski and others 1995; Palviainen and others 2003).

Under most natural circumstances, potassium returns to the soil when the tree dies. Unlike many other soil nutrients, potassium is derived primarily from the underlying geology that, for the Fallen Bear Project Area, includes: 70% and 18% metasedimentary Belt series middle and lower Wallace Formations, respectively, and 12% Wishard sills/mafic intrusions (Figure Soil-1; S-7 and 13).

The Intermountain Forest Tree Nutrition Cooperative (IFTNC) continues to research potassium contents within tree species and different rock types in order to establish specific minimum thresholds for retention and effects of potassium on tree growth and resistance to root diseases (Mika 2005; Shaw 2005; Garrison-Johnston and others 2007). Until these minimum thresholds are developed through research, the Idaho Panhandle National Forests are using management recommendations from the IFTNC as a guideline for maintaining sufficient potassium on a site. These measures have been incorporated into the "Design Criteria and Mitigation".

5.3. Maintenance of Large Woody Debris and Organic Matter

The third soil productivity criterion relates to the management of coarse woody debris (CWD) and organic matter and follows the research guidelines contained in Graham and others (1994). Retaining coarse woody debris and organic matter is important to maintaining the soil's most productive layer. Coarse woody debris is defined as material derived from tree limbs, boles, and roots greater than three inches in diameter and in various stages of decay (Graham and others 1994). It performs many physical, chemical, and biological functions in forest ecosystems and is also a key habitat component for many wildlife species and for stream ecology. Because coarse woody debris is such a valuable part of a functioning ecosystem, a portion of the material must be maintained to ensure that organic matter is recycled for long-term productivity. Nevertheless, in natural systems organic matter fluctuates with forest growth, mortality, fire, and decay.

The average optimum level of fine organic matter is 21 to 30 percent (Graham and others 1994), which equates to 1 to 2 inches of surface litter and humus. Optimum levels of fine organic matter relate to ectomycorrhizae fungus, which is a good indicator of healthy forest soil. In moist western hemlock and cedar habitat types, strong levels of ectomycorrhizae exist when organic levels exceed 30 percent.

B. Existing Conditions

1. Geology and Soils

The parent geology within the Fallen Bear Project Area consists primarily of weakly weathered quartzite, siltite, and argillite from Precambrian metasedimentary Belt rocks of the middle and lower Wallace Formation (Figure Soil-1). Medium- to fine-grained grey to black basic sills, also known as the Wishard sills, intruded during the Tertiary and Cretaceous (about 1,073-1,200 Ma and at about 750-830 Ma) into the Wallace Formation and dissect the project area from east to west in a fairly regular pattern (S-7 and 13). Residual and alluvial deposits are dominant along the valley bottoms and drainages.

Landscape morphology is primarily composed of mid- to high-elevation straight to slightly convex moderately sloping to steep mountain side slopes. Ridges and upper sidelopes with frequent rock outcrops and shallow soils are also present at higher elevations. Where straight sideslopes are dissected, they contain drainages with numerous unnamed small streams and narrow riparian zones that feed into Bruin Creek in the eastern portion,

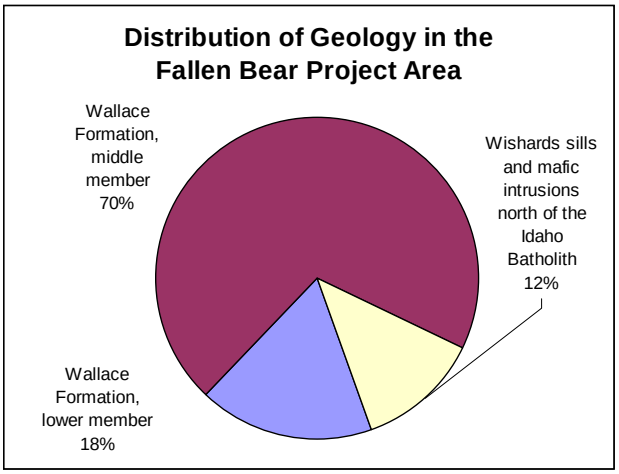

Figure Soil-1. Distribution of geology in the Fallen Bear Project Area.

Tumbledown Creek in the mid-section, and straight into the St. Joe River in the western portion of the project area. These lower elevation main drainages are defined by steep breaklands and lower sideslopes.

Throughout the landscape, the soil has developed in a mosaic pattern as dictated by topographic relief, vegetation, and aspect. Soils are generally light to dark brown to reddish brown ash-influenced silt loams of variable depth with differing amounts of angular or subangular gravels, cobbles, boulders, and bedrock.

Soil depth increases in drainages and on gentler sloping ground were volcanic ash-capped soils have settled to a greater depth. The volcanic material accumulated from several of the Cascade volcanoes eruptions with most of the ash originating from Mt. Mazama (Crater Lake) in Oregon about 6,800 years ago. The uppermost part of the ash is usually enriched with organic matter that is incorporated into this part of the soil and has a high water- and nutrient-holding capacity, both of which are important for soil productivity. The subsoils are not as fertile and generally have a very high gravel and rock fragment content and are much thinner on harsher south-facing aspects where bedrock protrudes, especially along ridges.

2. Soil Resources

Four criteria were used to assess existing conditions for soil resources:

2.1. Landtypes and hazard ratings of the Idaho Panhandle National Forests;
2.2. Soils and productivity;
2.3. Wildfire and severely burned soils;
2.4. Existing site conditions and past activities.

2.1. Landtypes and Hazard Ratings

Ten landtypes have been identified in activity units for Alternative B and six landtypes have been identified for Alternative C. Detailed descriptions and characteristics of each are located in the soils section of the project file (S-2 and 3). Hazard ratings have also been compiled and are broken into subcategories of mass failure, productivity, surface erosion, subsurface erosion, and landtype sensitivity (S-5 and 6; Soil Appendix A - Maps); each is rated as low, moderate, or high for a particular landtype as displayed in the following table.

Table Soil-2. Landtype Characteristics Associated with Proposed Activity Areas for Alternatives B and C*

		Mass Failure Potential			Subsurface Erosion Potential			Surface Erosion Potential		
		Low	Mod	High	Low	Mod	High	Low	Mod	High
Alt B	Acres	430	50	0	470	10	0	480	0	0
	% of Area	90	10	0	98	2	0	100	0	0
Alt C	Acres	245	48	0	282	10	0	293	0	0
	% of Area	84	16	0	96	4	0	100	0	0

		Landtype Sensitivity			Productivity Potential				
		Low	Mod	High	Low	Low-Mod	Mod	Mod-High	High
Alt B	Acres	430	40	10	8	19	415	39	0
	% of Area	90	8	2	2	4	86	8	0
Alt C	Acres	245	38	10	0	0	255	38	0
	% of Area	83	13	3	0	0	87	13	0

L – Low; M – Moderate; H – High; LM- Low to Moderately Low; MH – Moderately High
* Detailed mileage of newly proposed system road construction and associated landtype hazard potentials are available in S-18.

Mass Failure - Mass failures detrimentally disturb soils because organic matter, the productive ash layer, and even subsurface layers of the soil can be carried downslope during a failure. Within proposed activity units in Alternative B, 90 percent of soils have a low and 10 percent have a moderate mass failure potential; for Alternative C, 84 percent of soils have a low and 16 percent have a moderate mass failure potential (Table Soil-2; S-5 and 6; Soil Appendix A - Maps). Harvest treatment and new system road construction is not proposed on any landtypes identified to have high mass failure potential. Landtypes that exhibit moderate mass failure potential are located primarily along lower-to mid-elevation mountain sideslopes and stream breaklands.

> ***Mass Failure Potential*** is the relative probability of down-slope movement of masses of soil material. Besides natural failure, landslides or slumping can be triggered by a number of mechanisms including harvest activities, severe burning, and related road building.

No active slides or slumps were found during the field assessment with the exception of an unstable fill slope on Road 3310UA above Haggerty Creek between Units 97 and 96B (project file W-8 & W-9). Two small shoots containing signs of movement and erosion have developed in association with a failing fill slope and the slope below it. The road is proposed to be decommissioned.

Removal of forest canopy and cover from either clearcutting or wildland fire increases landslide occurrence (Megahan and others 1978; Gray and Megahan 1981). This is primarily due to root decay, soil disturbance, increased snow accumulation, altered melting rates, and soil water increases from reduced interception and transpiration. Megahan and others (1978) found that landslide occurrence increased only slightly when overstory canopy was reduced from 100 percent to 11 percent, but increased dramatically when canopy closure went below 11 percent. They also found that crown cover from shrubs affected landslide occurrence after 80 percent crown removal and indicated that landslide occurrence is more sensitive to shrub removal than tree crown removal.

Surface and Subsurface Erosion - Within the proposed harvest activity areas for Alternatives B and C, 100 percent of soils have a low surface erosion potential. Within proposed activity units in Alternative B, 98 percent of soils have a low and 2 percent have a moderate subsurface erosion potential; for Alternative C, 96 percent of soils have a low and 4 percent have a moderate subsurface erosion potential. None of the activity areas have a high surface or subsurface erosion rating (Table Soil-2; S-5 and S-6; Soil Appendix A - Maps). For system roads built outside of the activity areas, 100 percent of the affected area has a low subsurface erosion potential (S-18).

> ***Surface Erosion Potential*** is a rating of the relative susceptibility of exposed soils to sheet and rill erosion.
> ***Subsurface Erosion*** is a rating of the relative susceptibility of exposed sheet and rill erosion of the subsoils exposed during road construction.

Roads are currently the primary source of erosion and sediment production in the project area. The dominant processes in roaded portions are surface erosion from bare soil areas of roads, including the cutslope, fillslope, and travelway. Revegetation of cutslopes and fillslopes is often difficult due to lack of soil moisture, organic material, low productivity potential, and desiccation of seeds and seedlings, especially on south-facing slopes. On moist slopes, revegetation efforts are more successful since growing conditions are more favorable.

Road erosion and sediment yield usually decline after construction (Jones 2000; Switalski and others 2004) but can provide a chronic, long-term source of sediment to streams within the project area. Periodic large pulses of erosion may occur during intense water yield and overland flow events in interaction with road drainage systems.

Landtype Sensitivity – Within the proposed harvest activity areas for Alternative B, 90 percent of soils have low landtype sensitivity, 8 percent have a moderate landtype sensitivity, and 2 percent have a high landtype sensitivity potential; for Alternative C, 83 percent of soils have low landtype sensitivity, 13 percent have a moderate landtype sensitivity, and 3 percent have a high landtype sensitivity potential (Table Soil-2; S-5 and 6; Soil Appendix A - Maps). The high rating acres are associated with Landtype 479 located in Unit 181 (9 acres) and Unit 159 (1 acre). These landtypes have an increased rating because they occur on stream breaklands associated with steep drainages that are tributaries to major streams and rivers.

> ***Landtype Sensitivity*** is a rating that incorporates mass failure, surface erosion, sediment delivery potentials, and average slope gradient to determine a rating of low, moderate, or high sensitivity for landtypes.

Roads are considered a potential source for sediment delivery and are analyzed in greater detail in the *Water Resource Report*.

Soil Productivity – For Alternative B, soil productivity is generally low to moderately low in 2 to 4 percent, moderate in 86 percent, and moderately high in 8 percent of the activity areas. For Alternative C, soil productivity is moderate in 87 percent, and moderately high in 13 percent of the activity areas (Table Soil-2; S-5 and 6; Soil Appendix A - Maps). Reduced productivity is mainly due to dry south- or southwest aspects and shallow, steep, and rocky soils. Regeneration may also be influenced by competition, especially shrubs.

> ***Soil Productivity Potential*** is a rating of the relative capacity or ability of a soil to produce and sustain biomass. Low productivity areas a generally associated with shallow, rocky steep slopes on southerly aspects.

Soil productivity can be tied to an important duff and litter layer that protects soil, provides nutrients, reduces erosion potential, and maintains soil moisture. Litter prevents the breakdown of soil aggregates and reduces the velocity of any overland flow, thereby reducing the erosion potential (Beschta and others 2004). When a site is burned, however, some drier sites may burn at a severity level that removes all of the protective duff and litter layers, even under managed fire conditions.

2.2. Soils and Productivity

The most productive part of the soil occurs near the surface at the contact between the forest litter and the mineral soil. This layer is frequently only a few inches thick but it contains most of the soil nitrogen, potassium, additional nutrients, and mycorrhizae that must be present for a site to be productive.

Underneath this organic horizon is volcanic ash that occurs as the surface layer of the mineral soil. The volcanic material accumulated from several Cascade volcano eruptions with most of the ash originating from Mt. Mazama (Crater Lake) in Oregon about 6,800 years ago. The top part of the ash is usually enriched with organic matter that is incorporated into this part of the soil. The ash has a high water- and nutrient-holding capacity, both of which are important for soil productivity, while the lower part of the volcanic ash contains less organic matter and is not as fertile. Below the volcanic ash, the subsoils and substratum tend to be medium to coarse textured and often contain a very high amount of rock fragments.

The generally young and poorly developed soils found in the Fallen Bear Project Area can also experience long-term deficiencies when biologically essential elements, like organic matter and coarse woody debris, are not sufficiently available. Soil wood loss includes altered processes of forest regeneration and growth, favoring species requiring lower soil moisture and lower nutrient levels, and provide for a greater potential for soil erosion. Potential loss or reduction of organic matter can lead to a decline in several key soil and foliar nutrients (Powers 2005). Further effects also include a reduction of habitat for species requiring soil wood as dens or substrate for invertebrates, bacteria and fungi, which affect food availability for small rodents and their predators.

2.3. Wildfire and Severely Burned Soils

Wildfire is a natural component in forests and commonly influences soils and watershed processes. However, as a result of fire suppression during the last century, natural fire regimes do not exist anywhere in northern Idaho today (Smith and Fisher 1997).

Depending on the intensity of the fire and the severity of its effects, wildfire can alter watershed soils by consuming the erosion-limiting litter layer at the top of soils and the binding organics within the soil (Ice 2003). Condensation of volatized organics on soil surfaces often result in water-repellant (hydrophobic) soil conditions (DeBano 1981; Doerr and others 2000; Dyrness 1976) that can contribute to overland flow and increased in-channel failures (Ice 2003).

A wildfire in 1910 burned two patches in the far southwestern portion of the project area. Over the years several lightning strikes have resulted in some small localized burns, but otherwise no larger scale fires have occurred since then. These records of historic burns enforce the potential for future wildfire, especially with a general climate change suggesting a warming trend in the future (Mazza 2008).

Many of the nutrients present in surface organics and large woody debris can also be lost to the atmosphere through volatilization and removed from the site in fly-ash (DeBano 1991; Amaranthus 1989). Burn ashes are usually grey or reddish in color, indicating that much of the carbon is oxidized by fire.

Depending on fire severity and plant characteristics, many plants will survive and re-initiate growth soon after a fire. However, the ability of surviving plants to reestablish, thrive, and reseed in subsequent years will be greatly affected by the presence of invasive plants and weeds (Goodwin and Sheley 2001). Burned areas can contain high initial nutrient levels, exposed ground surfaces, and low shade with high light conditions which all directly favor colonization of new and remaining invasive plants. Survival coupled with disturbances produced by fire can cause

rapid and expanded invasive plant growth. As a result, values such as soil productivity, wildlife habitat, watershed stability, and water quality often deteriorate.

When soils turn hydrophobic, water infiltration is reduced. Though hydrophobicity is a naturally occurring phenomenon that can be found on the mineral soil surface, it is greatly amplified by increased burn severity (Huffman and others 2001). The heat of a fire vaporizes hydrophobic compounds in the organic matter and moves them into the soil layer where they condense and form a water repellant coating on the soil particles. Soil hydrophobicity usually returns to pre-burn conditions in no more than six years (DeBano 1981; Dyrness 1976) and other studies have documented a much more rapid recovery of one to three years (Huffman and others 2001). However, before infiltration improves, increased overland runoff and sediment movement can be expected. No long-term impacts to soils from past fires have been associated with the Fallen Bear Project Area.

2.4. Existing Site Conditions and Past Activities

In 2006 and 2007, the proposed units were field checked and data was recorded to estimate the degree of soil disturbance (S-1). Onsite assessment followed guidelines in Niehoff (2002) and included shovel tests on random transects to determine soil characteristics, compaction, organic matter depth, and coarse-woody debris content of proposed activity areas. Transects were also supplemented by visual observation and photos during the walk-through (S-1).

Soils are generally well drained light to dark or reddish brown silt loams that formed in volcanic ash and the underlying parent material. Gravel and rock fragment content varies between 5-80% and increases in amount and size depending on shallowness or depth to bedrock.

Site visits have been made to all proposed units in order to assess existing conditions and to field check the data records (S-1). More than three quarters of the proposed activity areas have 4 percent or less existing soil detrimental disturbance (Table Soil-3). In general, impacts were found to be localized, are limited to small areas within each unit, and are often associated with disturbance from game trails. Many of the proposed harvest units have not been entered in the past. Where old stumps are present, the ground in proximity is often undisturbed and no visible or physical evidence of logging remains. In areas where roads or skid trails are visible, the soil may be compacted, may also only show slight disturbance, or has recovered. Due to the steepness of the terrain, the most recent past logging activities have primarily utilized skyline systems or ground-lead cable that, in steep terrain, caused little soil disturbance.

A good amount of coarse-woody debris is present in most units with the exception of Units 151, 183A, and 183B. Unit 151 is located on steep shallow soils and contains numerous rock outcrops and a low overall tree count compared to adjacent stands (S-1). Units 183A & B were affected by a fire in 1910 that likely reduced woody debris (S-1). Organic matter content varies throughout the activity areas (S-1) but is generally low to optimum for most surveyed units, which are primarily south- and west facing. Localized variability and depths are natural and usually correlate to habitat type and aspect with excessive needle cast often decreasing the establishment of a more herbaceous ground cover, especially in moister habitats.

Table Soil-3. Summary of existing conditions and potential impacts from proposed management activities for Alternatives B and C following R1 Soils Quality Standards.

Unit	Activity Area Acres* (Alt C in parenthesis)	Proposed Treatment	Proposed Logging System	Proposed Fuels Treatment	Existing Detrimental Disturbance %	Potential Disturbance from Proposed Activities#		Potential Disturbance from proposed Activities#	
						Alt B		Alt C	
						Est. Acres	Unit Total %	Est. Acres	Unit Total %
40	40 (0)	CC/RES	S	UB	4	1.6	4	-	-
96A	6 (0)	CC/RES	T	UB	3	0.8	13	-	-
96B	8 (0)	CC/RES	S	UB	3	0.2	3	-	-
97	15 (14)	CC/RES	S	UB	5	0.8	5	0.8	5
103	2 (2)	CT	S	Lop	2	0.03	2	0.03	2
109	19 (19)	CT	S	Lop, YTR	2	0.4	2	0.4	2
127A	10 (10)	SW	T	UB	2	1.3	13	1.3	13
127B	14 (14)	SW	S	UB	2	0.3	2	0.3	2
132	15 (15)	CT	S	None	5	0.8	5	0.8	5
148	19 (0)	CT	S	YTR, LS, UB	0	0.4	2	-	-
150	15 (0)	SW	S	UB	0	0.3	2	-	-
151	13 (0)	SW	S	UB	0	0.3	2	-	-
159	21 (21)	CC/RES	S	UB	0	0.4	2	0.4	2
165A	4 (0)	CT	T	GP	7	0.5	13	-	-
165B	8 (0)	CT	S	Lop	7	0.6	7	-	-
167	9 (9)	CC/RES	S	UB	0	0.2	2	0.2	2
181	11 (11)	ST	S	UB	0	0.2	2	0.2	2
183A	5 (3)	CT	T	GP	0	0.7	13	0.7	13
183B	8 (8)	CT	S	Lop, YTR	0	0.2	2	0.2	2
189	28 (28)	CT	S	Lop	0	0.6	2	0.6	2
198A	6 (6)	SW	T	UB (Lop, GP)	0	0.8	13	0.8	13
198B	14 (14)	SW	S	UB (Lop)	0	0.3	2	0.3	2
199A	21 (18)	CT	T	GP	2	2.7	13	2.7	13
199B	8 (11)	CT	S	Lop, GP	2	0.6	8	0.6	8
206A	2 (0)	CT	T	Lop	3	0.3	13	-	-
206B	20 (0)	CT	S	Lop	3	0.6	3	-	-
211A	9 (0)	CT	T	GP	0	1.2	13	-	-
211B	14 (0)	CT	S	Lop	0	0.3	2	-	-
226(A)	0 (1)	CT	T	Lop, YTR(GP)	0	-	-	0.1	13
226(B)	57 (56)	CT	S	Lop, YTR	0	1.1	2	1.1	2
227A	9 (6)	ST	T	UB	2	1.2	13	0.8	13
227B	4 (7)	ST	S	UB	2	0.08	2	0.1	2
233(A)	0 (1)	CT	T	Lop, YTR(GP)	0	-	-	0.1	13
233(B)	21 (20)	CT	S	Lop, YTR	0	0.4	2	0.4	2
271A	19 (0)	CT	T	GP	2	2.5	13	-	-
271B	9 (0)	CT	S	Lop	2	0.2	2	-	-
Total acres	**483 (293)**					**22.9**		**12.9**	

CT – Commercial Thin
ST – Seed Tree
SW – Shelterwood
CC/RES – Clearcut w. Reserves
T - Tractor
S-Skyline

UB – Underburn
GP – Grapple Pile
Lop – Lop
YTR – Yard Tops within 200 feet of Road

#Results include existing conditions. Refer to Table Soil-4 for coefficients used to predict potential detrimental disturbance for proposed logging and slash treatment scenarios including burning and piling. The level of disturbance increase also depends on the amount or lack of existing skid trails. Activity units that have had little prior disturbance will show a greater incremental increase in potential detrimental disturbance than those units that already contain a network of existing skid trails. Little to no increase in disturbance is expected there because equipment would re-use existing skid trails and move on slash mats whenever possible.
*****differences in acres due to rounding

III. Environmental Consequences to Soils

A. Analysis Methods

1. Analysis Area

Soil quality standards are applied to "activity areas" or individual harvest units (USDA FS 1999c). The activity area is considered an appropriate geographic unit for assessing direct and indirect soil environmental effects because soil productivity is a site-specific attribute of the land and is not dependent on the productivity of an adjacent area. Similarly, if one acre of land receives soil impacts – i.e. reduced soil porosity, water holding capacity, aeration, long-term productivity etc. – and a second management activity is planned for that same site, then soil cumulative effects are possible. One exception that requires a closer look at the adjacent terrain outside of activity areas would be the evaluation of slope stability to determine if cumulative effects from management activities and roads are adverse.

The task of selecting the geographical boundaries involves several factors, including the scope of the project considered and the features of the land. However, evaluation of cumulative effects to soil productivity does not require an integrated "watershed-type" assessment since that is not considered an appropriate geographic area. This is because assessment of soil quality within too large an area can mask or "dilute" site specific effects (S-16). Cumulative effects due to physical, chemical, and biological impacts often increase with the scope of past and proposed activities (Reid and Hilton1998).

Although impacts on soils from system road construction fall outside of the analysis areas, they are discussed and reviewed for potential soil stability concerns.

The pre-commercial and mistletoe treatments would not include the use of mechanical harvesting equipment and are only discussed in the following section. A detailed display of these treatment units are therefore not included in this report but a listing and locations are available in Table Soil-1 and Map 3 in the EA.

2. Analysis Timeframe

The temporal scale is dependent on the specific issue being addressed with no one scale being appropriate for all issues. The analysis may need to evaluate the effects of proposed management over all seasons for several days, years, decades, or perhaps centuries. This is complicated by data constraints that require monitoring to detect change – though data are often insufficient to identify even trends or trajectories of change until the impact is large enough or has been occurring for some time. Furthermore, there is often a lag between some action and its observed effect. This analysis strives toward an integrated approach to soil processes and function to project future trends in response to proposed management options to the best of abilities.

The temporal scales can be defined as long and short-term. For this evaluation, short-term effects are those that occur approximately within the first 10 years following proposed management activities. Long-term effects are those that occur approximately after 10 years or more following proposed management activities.

3. Methods Used

To determine whether proposed activities would detrimentally impact or have cumulative effects on soils, the IPNF Soil NEPA Analysis Process (Niehoff 2002) was used. The potential detrimentally disturbed acres were calculated using coefficients based on past IPNF soil monitoring data. The coefficients were developed as an average soil disturbance level and equated to harvest equipment, fuel treatment methods, and the time of year fuel treatment took place.

This monitoring information is contained in Forest Plan Monitoring and Evaluation Reports and is summarized in the IPNF Soil NEPA Analysis Process (Niehoff 2002). Calculations incorporated the acres and types of proposed logging, fuel treatment, and landings constructed for direct and indirect effects.

No temporary roads are proposed with this project and all roads within activity areas are existing or new system roads. The area that would be affected by system road construction and decommissioning was estimated using an average 37-foot road width that includes a 14-foot wide running surface and cut and fill slopes.

Direct effects on soils from proposed activities were estimated by analyzing the effects of compaction, erosion, burning, rutting, and displacement on the soil surface that is the most productive layer and also the easiest to disturb through activities. Potential impacts are based on the type of logging system and fuel treatments used.

Acres of detrimental disturbance were calculated by multiplying activity area size by the disturbance coefficient derived from monitoring reports. Coefficients used for proposed logging systems are displayed in Table Soil-4.

Table Soil-4. Potential detrimental disturbance coefficients used for various logging and prescribed fire scenarios.

Tractor Harvest	**Detrimental Disturbance Coefficients (%)**
With grapple piling or underburning	13
Aerial Harvest	
Skyline with underburning	0 - 2
Skyline with grapple piling	8

Compaction, rutting, displacement, and severe burning can affect the soils physical, chemical, and biological properties, which indirectly can affect the growth and health of trees and other plants. Compaction and rutting reduces soil permeability and infiltration, which can cause soil erosion. Displacement reduces plant growth where topsoil and organic matter are removed. Severely burned soils can become hydrophobic (water repellent) and lead to increased erosion, runoff, and/or reduced productivity.

Ground-based and skyline/cable logging systems would be utilized under the action alternatives. Roads and landings that are to remain on the landscape for future use can cause detrimental effects on productivity as those lands become "dedicated" lands.

Generally, detrimental effects on soils are not permanent and depend primarily on soil texture, parent material, aspect, and level of disturbance, i.e. compaction. Vegetative recovery time is approximately ±30 to 70 years as the second growth timber becomes established around the disturbed areas and develops enough crown foliage to intercept and evapotranspirate moisture (Dykstra and Curran 2002; and Froehlich and McNabb 1983; Froehlich and others 1983 and 1985).

Indirect effects may include the loss of site productivity due to the removal of vegetation and nutrients. Large woody debris is essential for maintenance of sufficient microorganism populations and long-term site productivity. Research indicates that potassium, among other nutrients, is an important element for site productivity and may be deficient among certain Belt Supergroup formations (Garrison-Johnston and others 2007).

Foliar analysis was conducted on various geologies on the St. Joe Ranger District (S-15) to determine nutrient levels. This information is used for proposed harvest units. Design features are incorporated into the activities to manage large woody debris and organic matter as detailed in the research guidelines contained in Graham and others (1994). These recommendations emphasize tons per acre and are defined as any woody residue larger than three inches in diameter. Conservation of nutrients is also proposed by allowing slash to remain for one wet season where yarding tops is not proposed (Garrison and Moore 1998) before treatment of excessive activity fuels takes place. In most harvest units tree tops, foliage, and branches would be left to over-winter, which allows potassium to leach out of these materials (Baker and others 1989; Barber and Van Lear 1984; Edmonds 1987; Garrison and Moore 1998; Laskowski and others 1995; and Palviainen and others 2004).

Cumulative effects include the combination of direct and indirect effects from past, present, and reasonably foreseeable activities. Direct, indirect, and cumulative effects on soils are measured within each activity area although adjacent land outside of the activity area is considered as well in regards to slope stability. New system roads are discussed to provide extent of impacts but essentially are considered dedicated lands.

4. Assumptions and Limitations

Evaluation of cumulative effects to soil productivity does not require an integrated "watershed-type" assessment since that is not considered an appropriate geographic area. This is because assessment of soil quality within too large an area can mask or "dilute" site specific effects (S-16) and because of the variability in soil texture, the amount of organic matter and ground cover, soil response to past projects, and the intensity of the past project.

5. Scientific Uncertainty and Controversy

Soil productivity is the inherent capacity of a soil to support the growth of specified plants, plant communities, or a sequence of plant communities (USDA 2008 draft). In order to estimate detrimental impacts and their effects to site productivity the distribution, duration, extent, and degree of disturbance is considered. Among numerous other scientific uncertainties, controversy remains in regards to how much disturbance needs to be present to detect a

negative response to management activities (Powers 1990) as well as how long and to what extent site disturbance influences long-term productivity (Miller 2004).

B. Effects of Wildfire with All Alternatives

No remaining evidence of soil damage from previous fires was noted within proposed treatment units.

Given the absence of fire over numerous decades and increased fuel loads in most parts of the project area, the chance of a wildfire occurring could be enhanced if an ignition starts in an untreated area during extreme dry weather conditions (Heyerdahl and others 2007). The proposed vegetation treatment in the project area would not necessarily prevent wildfires from occurring, but would increase the ability to suppress such a fire should ignition occur in treated areas (Maurer 2007).

The probability of a high severity fire is not certain to occur within the project area during a given timeframe. The fact, however, is that when a fire breaks out, the chances for high severity fire effects on soils can be much higher in untreated areas with increased fuel loads compared to those that have successfully completed treatment, including post-harvest logging slash (Certini 2005; Cram and others 2006; Graham and others 2004; Gorman 2003; Keane and others 2002).

Vegetation and fuel treatments would reduce the chance that a wildfire could have as severe of an effect on soils in treated areas as it could in untreated areas because there would be a reduction in the tons per acre of fuels on treated sites.

The continued accumulation of dead and down fuel loads contributes to an increased potential for locally severe fire effects on soil and soil productivity in severely burned areas. High intensity burns that create high soil surface temperatures, particularly when soil moisture content is low, can result in a complete loss of soil microbial populations, woody debris, and the protective duff and litter layer over mineral soil (Erickson and White 2008; Hungerford 1991; Neary and others 2005). Nutrients stored in the organic layer (such as potassium and nitrogen) can also be lost or reduced through volatilization and as fly ash (DeBano 1991; Amaranthus and others 1989).

Additional deteriorating effects of wildfires on soils usually include a reduction of water infiltration (Wells and others 1979) that contributes to the risk of soil erosion which increases proportionally with fire intensity (Megahan 1990). Fire-induced soil hydrophobicity is presumed to be a primary cause of the observed post-fire increases in runoff and erosion from forested watersheds (Huffman and others 2001). Though hydrophobicity is a naturally occurring phenomenon that can be found within the mineral soil surface, it is greatly amplified by increased burn severity (Doerr and others 2000; Huffman and others 2001; Neary and others 2005).

Soil hydrophobicity usually returns to pre-burn conditions in no more than six years (DeBano 1981). Dyrness (1976) and other studies have documented a much more rapid recovery of one to three years (Huffman and others 2001). The persistence of a hydrophobic layer will depend on the strength and extent of hydrophobic chemicals after burning and the many physical and biological factors that can aid in breakdown (DeBano 1981). This variability means that post-fire impacts on watershed conditions are difficult to predict and to quantify.

If a wildfire occurred in the Fallen Bear Project Area, consequent resource damage from mechanized suppression activities and burn severity could range from negligible to severe, depending on location, size, severity of burn, and subsequent administrative activities. Primary risks for erosion and mass failure would be from stream breaklands, steep slopes, and associated roads, especially at stream crossings in the event of debris flows. Loss of soil productivity could be extended depending on burn severity, location, and post-fire climate characteristics. Following a severe fire, rehabilitation efforts to mitigate the fire's effects on erosion and sediment delivery could occur and reduce potential negative effects.

C. Alternative A – No Action

1. Direct and Indirect Effects

No new management-induced detrimental direct and indirect impacts would occur in the Fallen Bear Project Area. There would be no compaction or displacement beyond the currently existing levels. Nutrients would continue to cycle, build up at current rates, and not be subject to removal due to harvest and fuel treatment activities.

With the No-Action alternative, no new management-induced detrimental direct or indirect impacts would occur in the Fallen Bear Project Area. There would be no compaction or displacement beyond the currently existing levels. With current management, including fire suppression, soil potassium, nitrogen, and other nutrients would continue to cycle, build up at current rates, and not be subject to removal due to harvest or fuels reduction. Soil nutrient cycling would continue at low rates from rock weathering, atmospheric deposition (mostly nitrogen), and nitrogen

fixation. Soil nutrients would be bound in organic matter complexes and slowly released through decay. Timber stands would continue to reflect past management practices that selectively harvested seral species. Increases in the representation of less nutrient-demanding species (western larch, western white pine) would be delayed or may only occur as the result of wildfire.

Throughout the silvicultural landscape, tree mortality from pathogens, insects, and weather events would continue as in the past, which has a direct influence on the area's recycling of organic matter and changes in fuel loading. Stands currently at high mortality risk would not be treated, which may increase insect and disease infestation levels and associated risks of stand loss due to wildfire, severe burning, erosion concerns, and loss of soil nutrients. On a landscape scale, ecosystem composition improvement and the promotion of more fire-resilient species, such as western larch, would not occur. Several timber stands would continue to harbor increased fuel loads and move towards moderate to higher risks of losses should a fire occur.

Fuel buildup would continue to contribute to the risk of high-intensity wildfires that may be difficult to suppress and could kill much of the vegetation in both upland and riparian areas. High soil temperatures produced during high-intensity fires create water repellant surface soil conditions that greatly reduce water infiltration and increase overland flow and erosion (Niehoff 1985). Increased runoff combined with a lack of vegetation cover to protect slopes and filter sediments could lead to increased peak stream flows, excessive sediment delivery, and consequent adverse impacts to soil quality.

The introduction of weeds and unwanted flora following a fire could lead to higher competition between less desirable and native vegetation. Weeds can increase erosion, reduce soil moisture, and deplete nutrient levels (DiTomaso 2000). Because the roots of many noxious weeds are deeper than native grasses, they also contribute less organic matter near the soil surface. Refer to the Specialist's Report on Weeds for additional details.

2. Cumulative Effects

No cumulative effects to soils would take place as no harvest and fuel treatments would be added. When combined with the effects of past and ongoing fire suppression, not implementing the proposed action would further increase the risk of severe stand-replacing fires (compared to areas that are proposed for treatment in the other alternatives) that could increase the potential for locally severe fire effects on soils. There are no reasonably foreseeable activities likely to result in substantial adverse effects on soil productivity in these units (S-14).

With no new activities, no new management-induced detrimental cumulative impacts would occur in the Fallen Bear Project Area. No cumulative effects to soils would take place as no harvest and fuel treatments would be added. Conversely, none of the existing roads would be decommissioned.

When combined with the effects of past and ongoing fire suppression, not implementing the proposed action would continue the risk of severe stand-replacing fires in areas that would otherwise be treated with the action alternatives. Should such a fire occur, the continued accumulation of dead and down fuel loads could contribute to an increased potential for locally severe fire effects on soils, including physical alteration of soil structure and development of hydrophobic layers.

D. Alternatives B and C

1. Direct and Indirect Effects

The discussion for Alternatives B and C are combined to avoid repetition because effects described for timber harvest, fuel treatments, organic matter, coarse woody debris, nutrients, yarding tops, and soil movement would be the same or less for Alternative C (Table Soil-3).

Alternatives B and C would meet Region 1 soil quality standards and IPNF Forest Plan Standards (S-8) because long-term detrimental disturbance is not expected to exceed 13% in any proposed activity area (Table Soil-3), so full productivity potential would be maintained on at least 87% in every activity area. Potential detrimental disturbance could affect up to 23 acres of the 483 acres proposed for treatment in Alternative B and 13 acres out of the 293 acres proposed in Alternative C.

Alternative C differs from Alternative B (Table Soil-1) because it has ~2.0 miles less road construction. Consequently, access is reduced and would result in a reduction of 144 acres of skyline and 46 acres of ground-based harvest because Units 40, 96A & B, 148, 150, 151, 165A & B, 206A & B, 211 A & B, and 271A & B are not included in Alternative C. Fuel treatments would also be slightly different in Alternative C and include 6 fewer acres of yarding tops, 26 fewer acres of grapple piling, and 90 fewer acres of underburning. Alternative C has a reduced risk of potential road related mass failure and erosion because it includes less road construction than Alternative B. Table Soil-3 displays the resulting comparison of soil disturbance levels between both alternatives.

Coarse woody debris would be maintained at recommended levels in all units so that preservation of ecosystem function is expected. Using Regional guidance for coarse woody debris retention would adhere to the Forest Plan Standard to maintain sufficient microorganism populations for site productivity. Where yarding of tops is proposed, design features, including nutrient management recommendations, would ensure compliance with the Forest Plan Standard to maintain sufficient nutrient capital.

1.1 Detrimental Soil Disturbance

Design features to protect soil and site productivity (see Design Features above) would be implemented as part of the action alternatives to ensure that activities are consistent with Forest and Regional standards in terms of soil compaction, displacement, and nutrient retention. See EA for details of proposed activities.

The effects of the action alternatives on the soil resource were assessed based on their potential to create detrimental impacts and to affect soil productivity. Table Soil-3 shows soil disturbance levels for Alternatives B and C. Standard and site-specific Best Management Practices (BMPs) and soil and conservation practices as described in the Soil and Water Conservation Practices (SWCP) Handbook FSH 2509.22 are included as design features (Water Report Appendix) and would be applied during timber harvest and road decommissioning, construction, maintenance, and reconstruction to minimize soil erosion and maintain acceptable soil productivity (Seyedbagheri 1996; Lynch and Corbett 1989, 1990; Idaho DEQ 2001; USDA 2002). The Soil and Water Conservation Practices Handbook outlines BMPs that protect the soil and water resources at a higher level than do existing Idaho Forest Practices rules and regulations, thereby incorporating all Idaho State standards.

BMP and post-harvest monitoring is conducted annually by the IPNF to validate the implementation and effectiveness of BMPs and design criteria associated with land management activities (USDA Forest Service IPNF 1997-2006). Monitoring results are used to adapt future management actions where improvements in meeting objectives are indicated and show that acceptable productivity potential is maintained.

The techniques and their effectiveness are documented in several publications (Seyedbagheri 1996; Lynch and Corbett 1989 and 1990; Idaho DEQ 2001). The BMPs would have a high effectiveness in minimizing soil compaction and displacement, address seeding of disturbed areas, limit operations when soil moistures are high, and address conduct of logging.

Timber Harvest - Timber harvest activities that may affect soils include approximately 483 acres for Alternative B and 293 acres for Alternative C using a combination of ground-based logging and skyline yarding (Table Soil-1; S-4). These vegetation management activities have the potential to cause detrimental soil disturbance, such as compaction and displacement, by reducing productivity on an estimated 23 acres (Alternative B) and 13 acres (Alternative C) of the total activity area (Table Soil-3; S-4).

All landings associated with skyline and ground-based harvest would be located along existing or new system roads. There would be no equipment on the high banks above the cut slopes of roads. Table Soil-3 displays harvest units and their assigned logging prescription for Alternatives B and C. All of the proposed harvest units under all alternatives would meet Regional soil quality and Forest Plan standards.

The level of soil disturbance increase depends primarily on the amount or lack of existing skid trails. Activity units that have had little prior disturbance will show a greater incremental increase in potential detrimental disturbance than those units that contain a network of already existing skid trails (Table Soil-3). Proposed skyline units that were previously yarded with the same logging system have little to no additional impacts because existing corridors are generally reused.

Soil compaction effects can last for decades but are irreversible. Recovery processes vary greatly with soil texture, clay content, and their interaction with climatic processes such as cycles of freezing-thawing and wetting-drying (Dykstra and Curran 2002; Landsberg and others 2003). Persistence of compacted soil and, presumably, long-term consequences of compaction for tree growth depend on the severity of the initial compaction, the ability of species to cope with compacted soils, and rates of processes that decompact the soil (Cromack and others 1979; Froehlich and McNabb 1983; Froehlich and others 1985). Soil displacement that mixes or removes the volcanic ash surface layer, however, reduces soil moisture holding capacity and associated productivity.

Timber harvesting would open up tree canopies, and logging slash from tree limbs, tops, and un-merchantable pieces would add to existing short-term fuel loadings. Canopy removal would allow wind and sunlight to penetrate, heat, and dry the debris, which could increase potential fire intensity and severity until the slash is treated or naturally abated. However, the long-term risk for a stand-replacing wildfire would be reduced by creating more

open stand structures that would have lower accumulations of smaller diameter fuels and that would be less likely to support crown fires (see Fallen Bear Fire and Fuels Report).

The proposed action includes post-harvest monitoring of some units where ground-based equipment is proposed to be used for skidding on all or part of the unit. Soils would be monitored after completion of harvest and fuel treatment activities. Proposed activities on units are expected to meet Forest and Regional soil quality standards but monitoring is included to verify expected results.

Road Decommissioning - For Alternative B, approximately 35 miles of system road would be decommissioned (Road Management Rx D). For Alternative C, approximately 35.5 miles of system road would be decommissioned (Road Management Rx D). This would include decompaction and some recontouring with the goal of restoring site productivity. Assuming 4.5 acres per mile of road, approximately 157 acres under Alternative B and 159 acres under Alternative C of National Forest System land would be on the path to recovery towards a productive land base (Table Soil-7).

Road Maintenance - No additional soil impacts would occur from proposed road maintenance activities such as blading, drainage improvements, and surfacing on existing dedicated roads.

Fuel Treatments - Activity-fuel treatments that may affect soils with Alternative B include approximately 34 acres of yarding tops, 202 acres of broadcast burning, and 62 acres of grapple piling followed by pile burning. For Alternative C, treatments include approximately 28 acres of yarding tops, 112 acres of broadcast burning, and 36 acres of grapple piling followed by pile burning. See Table Soil-3 for a list of fuel treatments by unit.

Severely burned soils can become water repellent and lead to increased erosion, runoff, and/or reduced productivity. Prescribed burning would be done when soil moisture in the upper surface inch of mineral soil has a moisture content of 25% or more by weight or 60 to 100 percent duff moisture. Past monitoring has shown that burning under these conditions has minimal to no impacts on soil productivity (Niehoff 1985; Niehoff 2002; USDA Forest Service 2001, 2002, 2003, 2005 and 2006).

Design features also require piling machinery to utilize existing trails and stay on slopes less than 35 percent to prevent soil disturbance in excess of guidelines. Design features for grapple piling require operation of equipment over slash mats whenever enough material is available, preferentially re-using existing skid trails if present. Forest Plan monitoring and research (Eliasson and Wästerlund 2007; Han 2006; Niehoff 2002; USDA Forest Service 2001b, 2002-2004) indicates reduced soil disturbance if equipment is operated on a slash mat.

Only areas that could be reasonably accessed would be treated and none of the trails would be excavated to facilitate access. The residual logging debris that would be lopped and scattered or that could not be grapple piled and burned would increase potential fire intensity and severity for a few years until snow could compress the debris and the fine organics would decompose.

Severe burning and ground disturbance could create bare soils and encourage noxious weed infestation. The above mentioned design features are therefore incorporated to lessen disturbance impacts in activity areas in order to prevent long-term impacts to the soil resource.

Pre-commercial Thinning, White Pine Pruning, and Dwarf Mistletoe Treatments - Pre-commercial thinning is proposed on 775 acres and white pine pruning is proposed on 777 acres under both alternatives (Map 3 - EA). Girdling of trees to treat dwarf mistletoe is proposed on 161 acres mostly overlapping simultaneously with the proposed pre-commercial thin units. All of this work would be done by hand (chainsaws and hand tools), and the cut trees and branches would be left on site with no further treatment. Since there would be no soil compaction and no removal of biomass, there would be no detrimental effect on soil productivity or quality. Nutrients held within the cut trees and branches would be released. These treatments are not discussed further in terms of soils.

Gopher Baiting - No detrimental impacts to the soil resource are expected from gopher baiting. A reduction in gopher activity would actually reduce the mixing and displacement of soils in localized areas. Gopher baiting is not discussed further in terms of soils.

1.2 Organic Matter & Coarse Woody Debris

Timber Harvest - Harvesting the tree bole (and bark) would remove about ±43 percent of the tree's potassium (Garrison-Johnston and others 2004) which may cause, indirect effects to vegetation as nutrient sources are removed from site. However, the logging slash from tree limbs, tops, and un-merchantable pieces would remain

within all harvest units (except tops only would be removed in portions of Units 109, 148 (Alternative B only), 183B, 226B, and 233B) and would be lopped and scattered or be left over at least one wet season before being underburned or grapple piled. This would allow the foliage and branches to leach and recycle some of their nutrients, primarily potassium, back into the soils' organic layer.

Harvest activities are not expected to reduce soil organic matter within the proposed units because existing organic matter would be not be removed from the forest floor. Harvest activities may actually increase material that would contribute to the organic surface layer through limbs and tops left on-site. Existing organic matter would not be diminished by harvest activities, but organic matter recruitment would likely be less in those portions of units identified for yarding tops (Table Soil-3).

No reduction in the current existing CWD levels would occur from harvest activities because there is no removal of material from the forest floor. Design features recommend CWD levels based on Graham and others (1994) and would provide protection against soil erosion as well as a long-term source of nutrients and organic matter (Brown and others 2003). Coarse woody debris recommendations for different sites are displayed in Table Soil-5.

Table Soil-5. Recommended coarse woody debris retention.

Site Conditions	Coarse Woody Debris*
Dry sites to dry end of moist sites	7-14 tons/acre
Moist sites	17-33 tons/acre

**(Graham and others 1994)*

The amount of coarse woody debris would likely be kept at the lower end of the recommendations in several locations near main roads in order to reduce fuels reduction requirements. The majority of harvest units currently display a mix of satisfactory coarse woody debris levels though Units 151, 183A, and 183B are presently on the lower end of material.

Fuel Treatment - No long-term measurable negative effects on organic matter and coarse woody debris are anticipated from post-harvest underburning when soil moisture in the upper surface inch of mineral soil has a moisture content of 25% or more by weight or 60 to 100 percent duff moisture (Niehoff 1985 and 2002). When soils have adequate moisture conditions to retain their biological, chemical, and physical integrity, effects from the loss of forest floor can be minimized (Barnett 1989; Erickson and White 2008; Frandsen and Ryan 1985; Hungerford and others 1991; McNabb and Cromack 1990).

In south- and southwest facing units, the prescribed burns would have limited detrimental effects when executed in the spring. Burning under controlled conditions reduces potential soil nutrient losses, decreases the possibility of higher severity impacts from wildfires, and lessens the chance of creating hydrophobic soils that can lead to increased erosion, sedimentation, and debris flows (de Dios Benavides-Soloria and McDonald 2005; Heyerdahl and others 2007; Ice 2003; Maurer 2007; Neary and others 2005; Robichaud 2000; Swanson 1981).

When burn piles are large, nutrient losses from heat and volatilization could be considerable. In some cases, burning of the slash piles may create localized patches of hydrophobic soils for a short period (as much as one to two years) but the areas are generally not large or extensive enough to alter slope hydrologic responses or long-term soil productivity.

However, on an unpredictable site-specific basis, some drier sites may underburn at a severity level that removes all of the protective duff and litter layers, even under managed fire conditions. The duff and litter layer is important in protecting the soil horizons, both as reducing erosion potential and in maintaining soil moisture. Litter prevents the breakdown of soil aggregates and lessens the velocity of any overland flow, thereby decreasing the erosion potential (Beschta and others 2004). Direct effects of prescribed underburning and pile burning could potentially remove woody debris that would otherwise provide long-term nutrients to the soil as the decay process occurs (Page-Dumroese and others 2006a). Burning when soil moisture content is high helps to maintain coarse woody debris and organic matter requirements.

1.3 Nutrient Levels

Timber Harvest - The Fallen Bear Area is underlain primarily by metasedimentary Belt series rocks of the middle and lower Wallace Formation and some intrusive sills (Figure Soil-1; S-11 and 12). These parent materials are expected to be of moderate to good nutrient value though some of the intrusive rocks have a poor nutrient status (Garrison-Johnston and others 2004 and 2007; Moore and others 2004a and 2004b).

One specific nutrient, potassium (K), appears to decrease tree mortality by promoting biochemical defense compounds and plays an important role in forest health (Entry and others 1991; Mika and others 1993; Moore and others 1994). Because underlying rocks are the primary source of K and since some of the local underlying rocks show deficiencies (Garrison-Johnston and others 2007), recycling of vegetation that contains K can potentially counter reductions. Fine residue (foliage and branches) contains over half of a tree's K distribution and would remain throughout at least one wet season within proposed harvest units. This would allow potassium and other nutrients to leach out of the fine residue and back into the soil where they would be available for future uptake by vegetation.

Nutrient levels are not expected to decline sufficiently to irreversibly impair soil productivity because slash would be left over-winter (except where tops would be yarded) or left on site where fuels would be lopped. This would allow for leaching of nutrients from slash into the soil (Garrison and Moore 1998). Lopping is proposed for almost half of the units although in some the material will be piled and burned or grapple piled after over-wintering.

Yarding of tops is proposed to reduce slash below roads in commercial thin Units 109, 148 (Alt. B only), 183B, 226(B), and 233(B) for a total of approximately 34 acres in Alternative B and 28 acres in Alternative C (Table Soil-6; S-11). These treatment areas would be approximately 200 feet wide below roads in the attempt to reduce excess slash piles and post-harvest fuel loading, to lessen the likelihood of fire along travel corridors, and to provide control during underburning.

Table Soil-6. Silvicultural prescription and number of units with some yarding of tops.

Silvicultural Prescription	Clearcut with Reserves	Commercial Thin	Group Shelterwood
# of Units with Some Yarding of Tops	0	7	0

Yarding tops would remove nutrients, but residual timber in the commercially thinned units is estimated to be 60-80%. The unmerchantable tops of all harvested trees would be removed to the landing while still attached to the uppermost portion of the sawlog. Tops would only be yarded from the first 200 feet below the road. Limbs and branches on the remainder of the trees would remain in the unit. Lopping would occur in the remainder of all five units with no additional equipment entering the activity area with the exception of Unit 148 (Alternative B only), which would be underburned. Slash would remain on site over a wet season so that mobile nutrients, such as potassium, can leach from fine materials back into the soil. Broadcast burns would be "light" in nature and would foster the release of tied up nutrients.

Removal of tops would likely result in about twice as much potassium loss as bole-only yarding, so that the five units where tops would be yarded for 200 feet below the road may sustain a greater nutrient loss than the remaining activity areas. However, soil productivity within activity areas is not expected to be irreversibly damaged because limbs and branches not attached to the top and those breaking from the tops during removal would remain on site and contribute to the nutrient pool.

Douglas-fir and grand fir consume and store more potassium than other tree species. Over-wintering slash allows the release and makes available stored potassium, benefiting western larch, ponderosa pine, and western white pine which require less potassium for growth and maintenance (Garrison and Moore 1998; Garrison-Johnston and others 2007). Precipitation (Stark 1979) and weathering of rocks will continue to make additional nutrients available on site. Annual needle, leaf, and twig fall, forbs, and shrub mortality will continue to recycle nutrients as well. At this time, management recommendations from the IFTNC (Garrison and Moore 1998) are used as guidelines for maintaining sufficient potassium on a site.

1.4 Soil Movement (Erosion, Mass Failure)

Timber Harvest - Harvest activities are proposed in landtypes rated with low surface erosion potential on 100% of the proposed activity areas. Soil erosion is not expected because of residual canopy and ground cover, operation of mechanical equipment on a slash mat when available combined with other BMPs, and the overall low risk of surface erosion.

Harvest activities are not proposed on landtypes rated with high mass failure potential because proposed units would be buffered by ½ the height of a site potential tree to exclude such areas and there would be no proposed harvest activities within the buffer. No change in mass failure potential is expected from the proposed harvest activities (Megahan and King 2004 p. 207) because of low and moderate mass failure potential ratings in the activity areas (Table Soil-2; S-5 and 6; Soil Appendix A - Maps) and residual stocking.

As part of project planning, all drainage courses and riparian zones would also have an INFISH designated buffer zone that would not be entered by any proposed harvest activities. With established buffer zones, the potential sediment increases from fuel or timber management work is minimal. The high sensitivity areas within Units 181 and 159 fall within these buffer zones.

Road Construction - New system road construction is proposed for 2.8 miles under Alternative B and 0.8 miles under Alternative C. None of the newly proposed road segments are located on landtypes with high hazard ratings (S-18). Megahan and King (2004 p. 209) attribute roads as having the greatest effect on mass failure of all practices associated with forest management.

2. Cumulative Effects

Few cumulative effects are anticipated in the proposed activity areas because the majority of units have had little to no past disturbance. Combining the existing and predicted detrimental impacts of activities, long-term cumulative soil impacts may affect no more than 13% of the activity areas, therefore meeting Region 1 soil quality standards. When existing and proposed system roads are incorporated, cumulative soil impacts would affect no more than 20% of the activity areas, therefore meeting forest plan standards. There are no current or reasonably foreseeable future activities beyond what is proposed with this project that would affect soils in the proposed treatment units (project file s-14).

2.1 Past Activities **(see project file S-14)**

Timber Harvest and Related Activities - The most recent timber harvest overlapping with any proposed activity areas occurred in Units 132, 159, and 167 that were harvested in the past (Map 8). Existing detrimental disturbance was found in Unit 132 and is at 5%; Units 159 and 167 did not show any detrimental disturbance (S-1). Previous logging in other proposed units occurred prior to the 1960s and no record exists in the data base regarding those activities. The legacy impacts to soils were observed and recorded during field visits and are reflected in the existing conditions (Table Soil-3; S-1). Past impacts to soils are low because of the steep terrain of the area that required primarily skyline logging, which has had little to no impact on long-term soil productivity.

Slope Stability - Proposed harvest activities can elevate the potential for slope instability from increased soil water content, reduced and decomposing root mass, and decreased canopy cover when added to already existing past harvest activities within the same vicinity (Megahan and others 1978; Gray and Megahan 1981).

None of the harvest units in the proposed project area are spatially associated with any past harvest activities (i.e. downslope or upslope) adjacent to potentially unstable slopes. All proposed activity units were identified as presently stable or not relevant to having a cumulative effect.

A high sensitivity potential is associated with Landtype 479 located in Unit 181 (9 acres) and Unit 159 (1 acre). These landtypes have an increased rating because they occur on stream breaklands associated with steep drainages that are tributaries to major streams and rivers. Unit 181 has a vegetated buffer of over 300 feet above the drainage while Unit 159 is almost 500 feet above the stream. Because both units will be skyline yarded with no mechanical equipment entering the stand, no movement of sediment above natural levels is expected.

Fire - Fires occurred in the southwestern portion of the Fallen Bear Project Area in 1910; however, since that last stand-replacing fire, wildfire suppression has reduced human or natural fire spread. No remaining evidence of soil damage from previous fires was noted within proposed treatment units. Reduced coarse woody debris counts, however, can be associated with the northern portion of this past fire which affects proposed Units 183A & B where charcoal was found during on-site monitoring.

Road Construction - Past road construction on National Forest System lands has resulted in the removal of soils from the productive land base. Approximately 290 acres of National Forest System lands within the Fallen Bear Project Area are dedicated to 65 miles of system roads. The area affected by existing system roads was estimated using 4.5-acres per mile (37-foot road width that includes a 14-foot wide running surface and cut and fill slopes).

Grazing - No past, present, or foreseeable cattle grazing occurs on Forest Service land within the activity areas (and project area).

2.2 Present and Reasonably Foreseeable Activities (see project file S-14)

Timber Harvest - No timber activities beyond the Fallen Bear timber sale are proposed or ongoing in the reasonably foreseeable future.

Fire - Wildfires have been common in the past and should not be eliminated as an ecological process. Salvage opportunities would be considered if a wildfire should occur within the project area. However, it is unfeasible at this time to predict if, when, where, or how that would be proposed. Additional analysis and a separate decision would be required.

Successful fire suppression actions would reduce the chance of detrimental effects to soil productivity. Most hand fireline construction would have only minor disturbance to the soil resource. On small wildfires, impacts from fire suppression activities are usually limited to hand tools and most hand fire-line construction has only minor (insignificant) impacts to the soil resource. As needed, closed roads would be reopened for access and be incorporated as part of the fireline construction. As part of post-fire work, the areas of disturbance would be rehabilitated and the roads would be returned to their previous status.

Road Maintenance - Road maintenance includes blading, brushing, typically improves drainage, and decreases erosion from water channeling down the road surface. This management activity is ongoing and will extend into the reasonably foreseeable future. No additional roads are planned to be constructed beyond what is proposed with the Fallen Bear Project. For additional information on roads, please see *Water Resource Report.*

Noxious Weed Treatment - Areas of disturbed soil provide an optimal location for weed establishment and subsequent invasion (Sheley and others 2002). Weeds establish quickly and can increase erosion, deplete soil moisture, and alter nutrient levels (DiTomaso 2000). Because the roots of noxious weeds are deeper than native grasses, they also contribute less organic matter near the soil surface. Refer to the Weeds section for additional details (Sperber and others 2003).

Noxious weed monitoring and treatment would therefore occur as needed and would follow guidelines established in the St. Joe Noxious Weeds ROD (USDA 1999). Effects to soil resources were analyzed in the document and its adaptive strategy. No additional effects to soils beyond what was analyzed for and disclosed in the EIS are expected to occur.

Recreation and Other Activities - The project area is open for general motorized use which allows for hunting, fuel wood gathering, collection of miscellaneous forest products, outfitter and guide uses, dispersed camping, and motorized touring. Recreational activities are expected to increase over time and may contribute to localized, small-scale disturbances.

Activities such as berry picking, personal Christmas tree removal, and driving on open roads are not expected to affect the soil resource because these activities do not cause substantial changes to soil conditions.

2.3 Proposed Activities

The proposed activities that would affect soils and would occur where effects from past, present, and reasonably foreseeable activities are still evident include timber harvest, fuels treatment, system road construction, and system road decommissioning.

Timber Harvest and Fuel Treatment - The cumulative result of Alternative B would reduce productivity on approximately 23 acres (Table Soil-3) of National Forest System land in the Fallen Bear Project Area. This is ~5% of the 482 acres of proposed activity area. Under Alternative C, approximately 13 acres (Table Soil-3) of National Forest System land would be affected which amounts to a ~4% loss of productive land base on the 294 acres of proposed activity area.

Under Alternatives B and C, all proposed units are expected to meet Regional and Forest Plan requirements after harvest and site-prep activities are concluded (Table Soil-3; S-8 and 9).

System Road Construction - When existing and proposed system roads are incorporated, cumulative soil impacts would affect no more than 20% of the activity areas, therefore meeting Forest Plan standards (S-8 and 9). R1 Soils Quality Standards do not include system roads

Within the entire Project Area, approximately 2.8 miles of new system road would be constructed under Alternative B (S-18). That equates to approximately 12.5 acres of land dedicated to system roads where soil productivity would not be maintained. For Alternative C, approximately 0.8 miles of new system road would be constructed (S-18). That equates to approximately 3.6 acres of land dedicated to system roads where soil productivity would not be maintained. Roads and landings that are to remain on the landscape for future use cause irretrievable effects on

productivity, as those lands become "dedicated" lands. A detailed analysis of roads and their effects is available in the *Water Resource Report*.

Cumulative Effects on Productive Land Base - The cumulative effects of road construction and system road decommissioning on the productive land base in the project area are shown in Table Soil-7. Approximately 12.5 acres would be removed from the productive land base under Alternative B for the proposed new construction of 2.8 miles of system road; approximately 3.5 acres would be removed from the productive land base under Alternative C for the proposed new construction of 0.8 miles of system road (S-17). Approximately 157 acres under Alternative B and 159 acres for Alternative C would be on the path of recovery towards a productive land base from road decommissioning (Rx D) (S-17).

Table Soil-7. Comparison of Alternative B and C - Summary of land not in productive land base.

Designated Use	Alternative B Acres (miles)	Alternative C Acres (miles)
Existing System Roads	290 (65)	290 (65)
Additional System Roads	12.5 (2.8)	3.5 (0.8)
Recovery Trend towards the Productive Land Base from Road Decommissioning (Road Rx D)*	-157 (35)	-159 (35.5)
Total Land Dedicated to Other Uses (Soil Quality Standards Do Not Apply)	**145.5 (33)**	**134.5 (30)**

**Road decommissioning efforts (ripping, incorporation of woody material etc.) would not instantly rehabilitate all 35 acres but would initiate a long-term recovery sequence for soil productivity.*

IV. Regulatory Consistency

A. Forest Plan

The proposed activities would comply with Forest Plan Standards for maintaining soil productivity.

Forest Plan Soil Standard #1

Soil disturbing management practices will strive to maintain at least 80 percent of the activity area in a condition of acceptable productivity potential for trees and other managed vegetation. Unacceptable productivity potential exists when soil has been detrimentally compacted, displaced, puddled, or severely burned as determined in the project analysis.

Alternatives B & C would comply with this standard because all proposed activity areas would be at or below soil quality limits for disturbance and would maintain the acceptable productivity potential for managed vegetation. Including system roads within harvest units, the proposed activities have the potential to disturb a total of 37 acres with Alternative B and 21 acres with Alternative C (S-8 and 9).

Forest Plan Soil Standard #2

Projects should strive to maintain sufficient large woody debris to maintain site productivity. Large woody debris is essential for maintenance of sufficient micro-organism populations.

Alternatives B & C would comply with this standard because logging slash from tree limbs and un-merchantable pieces would remain within all harvest units that already contain satisfactory CWD levels. Large woody debris retention would follow the research guidelines of Graham and others (1994) to ensure the maintenance of site productivity. Coarse woody debris levels in Units 151, 183A, and 183B that currently contain reduced amounts would be increased by logging residue to meet appropriate levels after harvest activities are completed.

Forest Plan Soil Standard #3

In the event of whole tree logging, provision for maintenance of sufficient nutrient capital should be made in the project analysis.

Alternatives B & C would comply with this standard because provisions to maintain sufficient nutrient capital would include leaving lopped limbs and branches from the remainder of the trees that would be yarded with attached tops.

Nutrients would also be provided from foliage and limbs that break from tops as they are moved to the landing. All yarding of roadside trees along a 200 foot buffer would occur in units proposed for commercial thinning that would retain 60 to 80 percent of the current stand volume.

B. Region 1 Soil Quality Standards

All alternatives would comply with Region 1 soil quality standards.

Design new activities that do not create detrimental soil conditions on more than 15 percent of an activity area. In areas where less than 15 percent detrimental soil conditions exist from prior activities, the cumulative detrimental effect of the current activity following project implementation and restoration must not exceed 15 percent. In areas where more than 15 percent detrimental soil conditions exist from prior activities, the cumulative detrimental effects from project implementation and restoration should not exceed the conditions prior to the planned activity and should move toward a net improvement in soil quality.

The proposed activities would comply with Regional Soil Quality Standards (USDA 1999) related to detrimentally disturbed soils. All alternatives would comply with this standard because none of the proposed units are expected to surpass disturbance limits of 15% and existing detrimental disturbance is below 15% in all proposed activity areas. The proposed activities have the potential to disturb a total of 23 acres with Alternative B and 13 acres with Alternative C (Table Soil-3). The greatest impacts are expected to be ~13% in Units 96A, 127A, 165A, 183A, 198A, 199A, 206A, 211A, 227A, and 271A which means that at least 87% of the activity areas would retain their full productivity potential. The remaining units would maintain more area in conditions with full productivity potential due to fewer impacts from logging with a skyline system.

Organic matter layer thickness would be retained as appropriate for local conditions.

All alternatives would comply with this standard because the currently satisfactory levels of local organic matter would be maintained. Harvest activities may actually increase material that would contribute to the organic surface layer through limbs and tops left on-site. Existing organic matter would not be diminished by harvest activities, but organic matter recruitment would likely be less in those portions of units identified for yarding tops

Large woody debris would be maintained at recommended volumes (Graham and others 1994) in each proposed activity area.

All alternatives would comply with this standard because the coarse woody debris in units with satisfactory levels would be maintained. Coarse woody debris levels in Units 151, 183A, and 183B that currently contain reduced amounts would be increased by logging residue to meet appropriate levels after harvest activities are completed.

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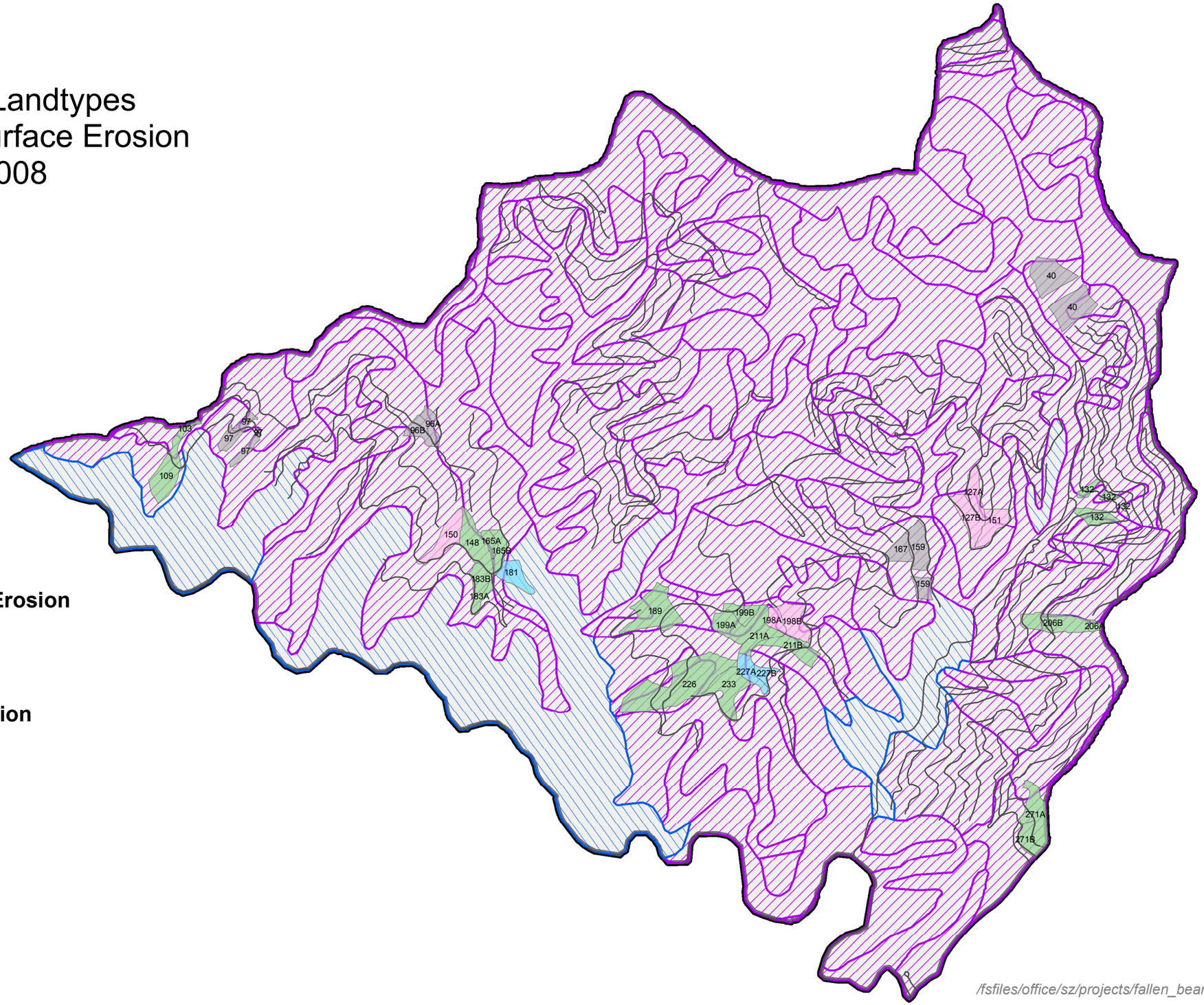
Fallen Bear Soils Report

VI. Soil Appendix A – Maps

Soil Map 1 – Erosion Potential and Landtype Map Units
Soil Map 2 – Potential Landtype Sensitivity
Soil Map 3 – Mass Failure Potential and Soil Productivity

Fallen Bear Landtypes
Subsurface & Surface Erosion
8/28/2008



Landtypes - Subsurface Erosion

- L
- M

Landtypes - Surface Erosion

- L

Proposed Units - Alternative B

- CC/Res
- CT
- ST
- SW

Project Area Boundary

Roads

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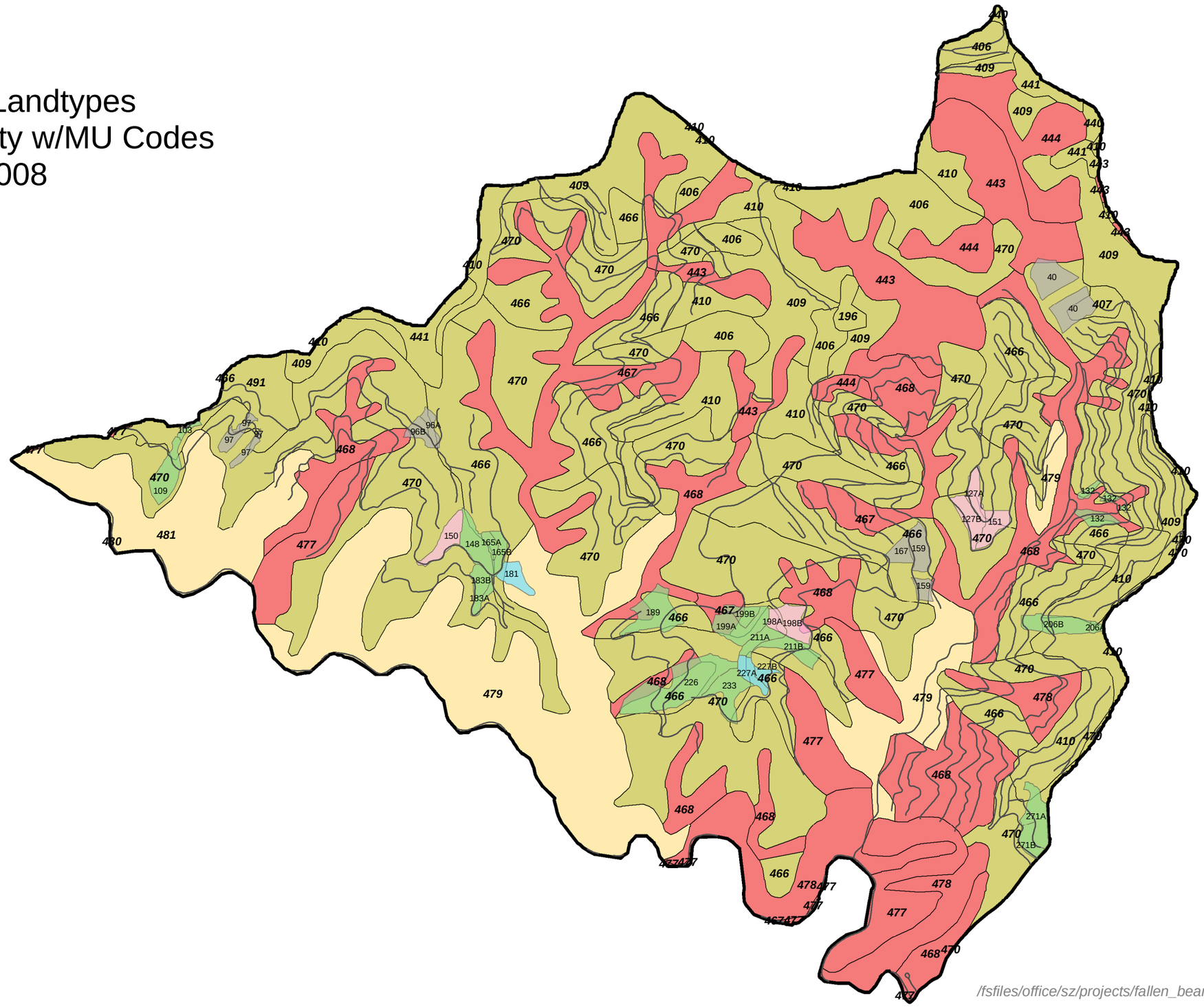
Fallen Bear Landtypes
Landtype Sensitivity w/MU Codes
9/10/2008



Landtype Sensitivity

- H
- L
- M

Proposed Units - Alternative B

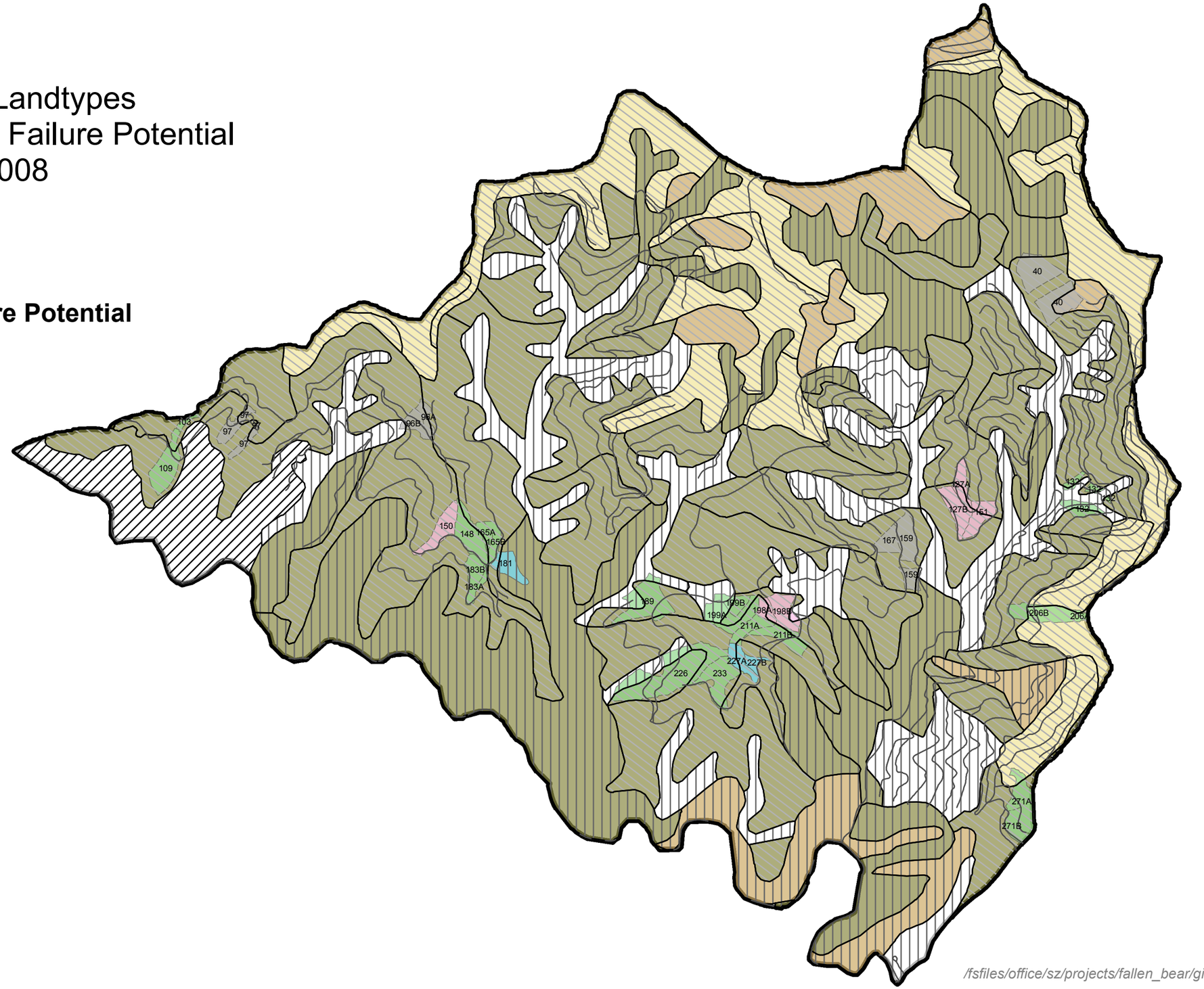
- CC/Res
- CT
- ST
- SW

Project Area Boundary

Roads

/fsfiles/office/sz/projects/fallen_bear/gis/landtypes.mxd

Fallen Bear Landtypes
Productivity & Mass Failure Potential
8/29/2008



Landtypes - Mass Failure Potential

- H
- M
- L

Landtype Productivity

- L
- L-M
- M
- MH

Proposed Units - Alternative B

- CC/Res
- CT
- ST
- SW

- Project Area Boundary
- Roads

/fsfiles/office/sz/projects/fallen_bear/gis/landtypes.mxd

V. Soil Appendix B – Design Features for Soils

1. Ground-based equipment for harvest and site prep activities:
   a. Ground-based operations would be limited to slopes equal to or less than 35%.
   b. Only approved skid trail locations would be allowed.
   c. Where terrain is conducive, trails would be spaced at maximum distance, except where converging at intersections.
   d. Equipment would not be operated under saturated conditions and in moist or wet depression areas.
   e. Only areas that are reasonably accessed by ground-based equipment would be treated, and no trails would be excavated to facilitate access.
   f. To minimize disturbance (soil compaction or displacement), practices such as skidding and mechanical harvesting would occur on existing skid trails and over slash when available. Units would be designed to utilize directional falling.
   g. The leading end of logs would be suspended during skidding.
2. Skyline Yarding: The leading end of logs would be suspended during yarding.
3. The Intermountain Forest Tree Nutrition Cooperative assembled data suggesting that nutrient levels may be conserved in treatment units by allowing logging slash to stay on site through a wet season of 4 to 6 months not including June through September. By leaving sufficient levels of wood on site, long-term soil productivity would be protected.
4. Nutrient sources such as needles and limbs would be maintained on site by allowing slash to remain for one wet season prior to all slash disposal treatments (Intermountain Forest Tree Nutrition Cooperative, Garrison and Moore 1998) except where tops would be yarded.
5. Tops of trees would be removed only along a maximum buffer of 200 feet below roads in Units 109, 148 (Alt B only), 183, 226 and 233 (226B and 233B in Alternative C).
6. Recommendations in *Managing Coarse Woody Debris in Forests of the Rocky Mountains* (Graham and others 1994) would be used to retain sufficient levels of coarse woody debris on site after slash disposal. Special attention to meet coarse woody debris levels would be given to Units 151, 183A, and 183B that are currently low. The following recommendations would be used in prescriptions:

Recommended Coarse Woody Debris Retention*

Site Conditions	Coarse Woody Debris
Drier to dry end of moist sites	7-14 tons/acre
Moist sites	17-33 tons/acre

**(Graham and others 1994)*

7. Prescribed burning would be done when soil moisture in the upper surface inch of mineral soil has a moisture content of 25% or more by weight or 60 to 100 percent duff moisture (IPNF Updated Soil Guidelines 1998). This is particularly important in Units 40, 96A & B, 97, 103, 127A & B, 132, 148, 150, 206A, 206B, and 211A, and 211B where soil productivity on the primarily west- and south-facing slopes is reduced and could be impacted through severe burning of the often shallow soils.
8. Grapple-piling would occur on existing skid trails and over slash when available. See additional design criteria for ground-based equipment above.
9. Silvicultural and burning prescriptions would retain sufficient levels of coarse woody debris on site after slash disposal (Graham and others 1994).