APPENDIX A

SIGNIFICANT ISSUE #1 SOILS

Specialist's Report on Soils for the Templeman HFRA Project

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Table of Contents

1. Regulatory Framework for Soils ..... Page SOIL-3

2. Methodology Used in the Soil Productivity Analysis..... Page SOIL-3

3. Affected Environment……...Page SOIL-4

4. Existing Soil Conditions..... Page SOIL-7

A. Land Types and Hazard Ratings .....Page SOIL-7
B. Soils and Productivity .....Page SOIL-9
C. Wildfire and Severely Burned Soils.....Page SOIL-9
D. Existing Site Conditions from Past Activities.....Page SOIL-10

5. Environmental Consequences to Soils..... Page SOIL-11

A. Methodology Used to Analyze Environmental Consequences to SoilsPage SOIL-11
B. Direct and Indirect Effects from Wildfire to All Alternatives ....Page SOIL-13
C. Direct and Indirect Effects to Soils with No-Action.....Page SOIL-13
D. Direct and Indirect Effects under the Proposed Action .....Page SOIL-14
E. Cumulative Effects of Past, Ongoing, and Reasonably Forseeable Activities……..Page SOIL-18

5. Consistency with Forest Policy & Legal Mandates..... Page SOIL-21

6. References Cited in the Soils Analysis..... Page SOIL-22

SOIL Map Appendix…… .....Page SOIL-A1

Soil Map-1: Soil Landtype …….....Page SOIL-26
Soil Map-2: Mass Failure Potential & Landtype Sensitivity ……Page SOIL-27
Soil Map-3: Surface Erosion Potential ……Page SOIL-28
Soil Map-4: Soil Productivity Potentia ……Page SOIL-29
Soil Map-5: Harvest History…… .....Page SOIL-30
Soil Map-6: Proposed Landing Sites…….. .....Page SOIL-31

List of Tables

Table SOIL-1. Summary of Landtype Hazards Associated with Harvest Activities in the Templeman Project Area.....Page SOIL-7

Table SOIL-2. Summary of Existing Conditions and Potential Impacts for the Proposed Action Following Guidelines Niehoff .....Page SOIL-11

Table SOIL-3. Potential Detrimental Disturbance Coefficients Used for Various Logging and Prescribed Fire Scenarios.....Page SOIL-12

Table SOIL-4. Distribution of Harvest Treatments for the Proposed ActionPage SOIL-15

List of Figures

Figure SOIL-1. Distribution of Geology in the Templeman Project Area .Page SOIL-4

Soil Resources

Introduction

Much of the proposed Templeman HFRA project area has been subject to ground disturbing activities primarily within the last three decades. The project area was therefore assessed for previous activities to determine the current level soil disturbance on all proposed harvest units. Landtypes and associated hazards, data collected, observations, and mitigation measures are provided in this document. All field notes and associated background documentation are available in the project file.

Purpose and Need

The purpose and need identified during the scoping process for this project is to reduce excessive forest fuels, including dead, dying, down timber and live ladder fuels. An additional purpose and need identified for the project is to improve forest composition, structure, and diversity of the treated stands by providing for tree species and stocking levels similar to historic levels that better resist insects, diseases, wildfire, and that wildlife are adapted to.

1. 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.

Section 6 of 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 and guidelines are built into Forest Plans.
Forest Plan direction (Forest Plan, p. II-17) 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 are addressed in Section 6 of this report.
The Regional Soil Quality Standards (R-1 Supplement 2500-99-1) 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. This recommendation is based on research indicating that a decline in productivity would have to be at least 15% to be detectable (Powers, 1990). In areas where more than 15 percent detrimental soil conditions exists 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. These standards do not apply to intensively developed sites such as permanent roads/landings, mines, developed recreation and administrative sites.

2. Methodology Used in the Soil Productivity Analysis

Analysis of the soil resource was carried out utilizing aerial photography, geographic information system (GIS) data, the timber stand database (TSMRS), and the roads and other related databases. Hazards from erosion, mass failure, soil productivity, and landtype sensitivity were gathered from landtype descriptions in the Idaho Panhandle National Forests Land Systems Inventory (PF Doc. SOIL-2 and 3; SOIL – Map Appendix, Maps 1 to 4). The proposed action was analyzed to identify those units that would require design modifications to meet Regional and Forest Plan standards. Discrepancies of acres are possible due to rounding.

Proposed ground-based and other harvest units were field reviewed in 2005, 2006, and 2007 by the Forest Soil Scientist to verify existing soil conditions by conducting the "Onsite Assessment Method" outlined in Niehoff (2002). See soil field assessment sheets/data (PF Doc. SOIL-1, 13, 14, and 16).

Data lists were developed for all proposed treatment units and summarize existing conditions that include acres of constructed or designated roads (PF Doc. SOIL-7, and 10). Potential disturbance for the soil resource was determined using Niehoff's (2002) guidelines for soil NEPA analysis, the Soil Disturbance Spreadsheet (PF Doc. SOIL-6), and field verification (PF Doc. SOIL-1). 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 disturbance spreadsheet is limited to the harvest and slash disposal methods for which coefficients have been determined and its coefficients assume that best management pratices (BMPs) have been implemented since 1990. The disturbance spreadsheet does not account for changes in soil types or the recovery of soils over time from existing previous harvest activities.

Analysis Area

The analysis area for soil resources encompasses all land within an individual treatment unit or a compilation of all the individual harvest units and associated temporary roads and landings. Existing classified National Forest system roads are considered designated lands and, as such, the loss of soil productivity due to their construction will not be considered in the cumulative effects analysis.

Treatment will be conducted on approximately 1158 acres dominated by dry- and moist site vegetation including Douglas-fir, grand fir, cedar-hemlock, and ponderosa pine occurring at an elevation of 3100-3300 feet on generally east- and west-facing slopes in the north part of the project area and southwest facing slopes in the southern part of the proposed sale. Slope gradients range from flat to greater than 45 percent. There are 7 units and 2 plantations ranging in size from 26 acres

to 290 acres. Harvest activities will be accomplished using ground-based logging (~1016 acres or 88 percent), skyline systems (~51 acres or 4 percent), and hand-felling in two plantations (~91 acres or 8 percent) (Table SOIL-4).

A total of ~0.4 miles of temporary roads are proposed in Units 4a (0.11 mi.) and Unit 5 (0.24 mi.) to access timber (PF Doc. SOIL-10). The temporary roads will be utilized for the length of the timber sale contract and for fuels treatment and will be decommissioned (by full recontour/obliteration) after completion of the contract, approximately 3-5 years after construction. Otherwise, existing system roads will be utilized for hauling purposes, landing sites, and a location for the skyline equipment to operate.

3. Affected Environment

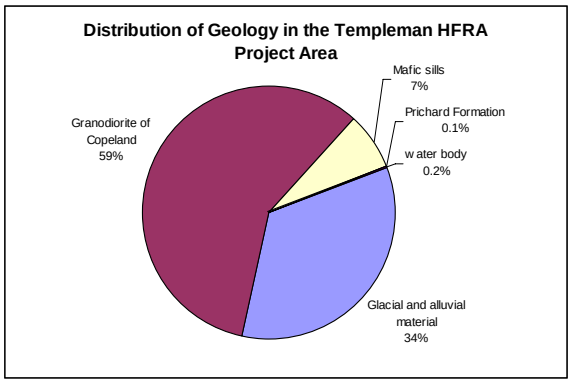

Figure Soil-1: Distribution of geology in the Templeman HFRA project area.

3.A. Geology and Soils

The parent geology ranges from glacial or alluvial deposits to small outcrops of mafic intrusions in the lower elevation southeastern parts (Units 1 and 2) and east facing side slopes (Units 3, 4, 5, and 6) and portions of granodiorite in the higher elevation western units (Units 3, 4, 5, and 6) (PF Doc. SOIL-9 and 17). Throughout the Resource Area, the soil has developed in a mosaic pattern as dictated by topographic relief, vegetation, and aspect. Soils are generally grey to reddish brown to light brown ash-influenced silt loams with rock content of ~0 to 40% that is generally increasing at a depth of 6 to 12 inches below the surface on most slopes. Soils are often not very deep due to bedrock and boulders just below the subsoil, especially in the eastern part of Units 1 and throughout Units 3, 4, 4a, 5, and 6. Soil depth increases on the lower lying parts of Units 1 and 2 where glacial material dominates or were benches allow for a greater accumulation of soil.

Under the predominant timber stands, silt loam textured ash capped soil have developed. 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 6,700 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, while the subsoils are not as fertile.

3.B. Soils and Productivity

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

3.B.1. Detrimentally disturbed soils 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. *Soil displacement results in the loss of either one inch of or half of the humus-enriched surface layer (A-soil horizon), whichever is less. The loss of the litter layer alone could be detrimental on some marginal sites. Displacement removes the most productive part of the soil resource. Roading, ground-based yarding, dozer piling and cable corridors are the major contributors to displacement.*

b. *Soil compaction that results in a 15 percent or more increase in bulk density, or a 50% reduction in water infiltration rates typical for volcanic ash influenced surface soils is considered detrimental. Soil compaction reduces the supply of air, water, and nutrients to plants. Roading, ground based yarding, dozer and grapple piling are the major contributors to compaction.*

c. *Surface erosion is indicated by rills, gullies, pedestals, and localized soil deposition and should be kept within tolerable limits by retaining enough ground cover, depending with onsite conditions.*

d. *Fire consumes most woody debris and the duff and litter layer, often exposing mineral soil. Burn ash that is white or reddish color, indicates that much of the carbon was oxidized by fire (Burned-Area Emergency Rehabilitation Handbook FSH 2509.13). Burns that create very high temperatures at the soil surface when soil moisture content is low result in an almost complete loss of surface and upper soil horizon organics. Many of the nutrients and ectomycorrhizae associated with these organics can be lost to the atmosphere through volatilization and removed from the site in fly-ash (Garrison and Moore 1998) or lost to high ground temperature flux (Harvey et al. 1986 p. 7).*

3.B.2. Low Potassium Sites - Sites containing geologic formations that are naturally deficient in potassium bearing minerals.

Whole-tree yarding and removal of treetops can lead to the direct loss of potassium (Morris and Miller 1994). On some sites, 45 percent of the available potassium is detained 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 et al. 2004b). It is therefore vital to recycle as many nutrients as possible before removal which can be accomplished by overwintering small-scale debris to leach out potassium and other nutirents (Baker et al. 1989; Barber and Van Lear 1984; Edmonds 1987; Garrison and Moore 1998; Laskowski et al. 1995; and Palviainen et al. 2004).

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 Templeman Project Area, include: 58 percent granodiorite, 34 percent glacial and alluvial deposits, 7 percent mafic intrusions, and >1 percent metasedimentary Belt series Prichard formation (Figure SOIL-1; PF Doc. SOIL-9 and 17).

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 et al. 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 Cirteria and Mitigation" (Chapter 2, Section 2.4, EA).

3.B.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 et al. (1994). Retaining

coarse woody debris and organic matter is important to maintaining the soils 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 et al., 1994). It performs many physical, chemical, and biological functions in forest ecosystems and is 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 et al. 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. Soil survey data indicates that the majority of activity areas contain adequate organic matter to support strong ectomycorrhizae populations.

Because CWD is such a valuable part of a functioning ecosystem, a portion of this material must be maintained to ensure that organic matter is recycled for long-term soil productivity. Following recommendations from Graham et al. (1994), approximately 5 to 15 tons/acre should be present to maintain forest productivity on dry sites whereas 17 to 33 tons per acre should remain in moister cedar/hemlock habitats. However, the amount of coarse woody debris will likely be kept at the lower end of the recommendations in several locations near roadsides in order to address the hazardous fuels reduction requirements. Retention of more desirable existing trees in many areas, especially ponderosa pine and larch, will also contribute litter and provide potential CWD in the future.

3.B.4. Biomass removal

Most biological activity in the soil takes place in the surface soil or litter layers. Although this is a potential source of biomass, it is extremely important to maintaining a wide variety of ecosystem functions such as nutrient supply, erosion control, water retention, and rooting medium. and should not be removed without strong overriding silvicultural reasons. This is true for all sites, not just nutrient sensitive locations.

In most cases biomass harvesting may not create additional or increased physical impacts to soil productivity as compared to conventional forest harvesting if guidelines are followed. Where biomass harvesting may create an increased impact compared to conventional forest harvesting is with respect to nutrient removals. Reducing more biomass from a site inevitably removes more nutrients. Some mineral soils have a sufficient nutrient capital to tolerate a larger number of such harvest rotations while others may reflect more deleterious effects. Current management recommendations, based primarily on findings by the IFTNC, are currently used to protect that resource (Garrison and Moore 1998; Garrison-Johnston et al. 2007). These include soils associated with formations of the Precambrian metasedimentary Belt Supergroup and granitics (Garrison-Johnston et al. 2007). However, additional assessment may be required if aggressive biomass removal is proposed over multiple rotations in the future.

4. Existing Conditions

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

4.A Landtypes and hazard ratings of the Idaho Panhandle National Forests;
4.B Soils and productivity;
4.C Wildfire and severely burned soils;
4.D Existing site conditions and past activities.

4.A. Landtypes and Hazard Ratings

Thirteen landtypes have been identified and mapped in the Resource Area out of which eleven are in harvest units identified in the proposed action. Descriptions of each landtype, detailed acreages, and maps displaying landtypes and hazards are contained in the project file and the map appendix (PF Doc. SOIL-2, SOIL-3, SOIL-4, SOIL-12; SOIL – Map Appendix, Maps 1 to 4). Hazard ratings have also been compiled and are listed in subcategories for mass failure, surface erosion, landtype sensitivity, and soil productivity. These are rated as low, moderate, or high for each landtype (Table SOIL-1).

Table SOIL-1. Summary of landtype hazards associated with harvest activities in the Templeman HFRA Project Area.

Harvest	Mass Failure Potential			Surface Erosion Potential			Landtype Sensitivity			Soil Productivity		
	L	M	H	L	M	H	L	M	H	L	M	MH
PA	100%	0%	0%	100%	0%	0%	95%	2%	3%	16%	81%	3%

PA – Proposed Action; L – Low; M – Moderate; H – High; MH – Moderately High

Mass Failure Potential is the relative probability of downslope 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.

Mass failures detrimentally disturb the soils because organic matter, the productive ash layer, and even subsurface layers of the soil can be carried down slope during a failure. All of the landtypes associated with the 1158 acre Proposed Action have a low mass failure potential rating (see Table SOIL-1; SOIL – Map Appendix, Map 3, and PF Doc. SOIL-4) and no active slides or slumps were found during the field assessment.

However, an extensive wetland system stretches from north to south outside of the treatment areas and is believed to be fed through subsurface flow primarily by the adjacent hills to the west. In several locations along FR397D, increased moisture is apparent, especially near the northeast corner of Unit 5 were a small wet area is ponding next to the road (due to absence of a culvert) and a nearby

cutslope is saturated (PF Doc. SOIL-13). Slope failures, especially associated with roads, cannot be ruled out.

Removal of forest canopy and cover from either clearcutting or wildland fire increases landslide occurrence (Gray and Megahan 1981; Megahan et al. 1978). This is primarily due to root decay, soil disturbance, increased snow accumulation and altered melting rates, and soil water increases from reduced interception and transpiration.

Little research has been conducted to determine if partial cutting affects landslide rates. Megahan et al. (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 than tree crown removal.

Surface Erosion Potential is a rating of the relative susceptability of exposed soils to sheet and rill erosion.

All but 1 acre of soil landtypes associated with the Proposed Action (1158 acres) are rated low for surface erosion (Table SOIL-1; SOIL – Map Appendix, Map 2, and PF Doc. SOIL-4). The potential for soil erosion concerns is not so much associated with harvest treatments as with existing roads (Cacek 1998). The dominant processes in roaded portions are surface erosion from bare soil areas of roads, including the cutslope, fillslope, and travelway.

Revegetation of cut slopes and fill slopes is often difficult because of 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 erosion of road cut slopes and fill slopes is generally lower.

Road erosion and sediment yield usually decline after construction (Jones 2000; Switalski et al. 2004) but can provide a chronic, long-term source of sediment to streams. Periodic large pulses of erosion may occur during intense water yield and overland flow events in interaction with road drainage systems. Roads and their associated impacts are analyzed in detail in the Specialist's Report on Hydrology (EA Appendix C).

Landtype Sensitivity is a rating that incorporates mass failure, surface erosion, and sediment delivery potentials to determine a rating of low, moderate, or high sensitivity for a given

Within the 1158 acres of the Proposed Action harvest activity areas, 95 percent (1095 acres) of soils have a low, 2 percent (23 acres) have a moderate, and 3 percent (40 acres) have a high landtype sensitivity rating (Table SOIL-1; SOIL – Map Appendix, Map 3, and PF Doc. SOIL-4).

The landtype that exhibits high sensitivity (MU 103) is associated primarily with proposed pre-commercial thinning Units 29 and 35 situated near the valley bottom and toeslopes. Because drainage courses and riparian zones are buffered and will not be entered by mechanical equipment, a potential increase in sediment delivery from this landtype unit is minimal.

Two acres in Unit 5 are also located on MU 103 and were field checked. The area in question is located on a flat bench with an additional bench and ~250 feet of vegetative buffer located

downslope with no reason to believe that the proposed harvest activities at this site will add an increased sediment load to Templeman Creek. All acres (<0.5 acre each) characterized as high sensitivity in Units 3 and 4 have been moved away from the areas of hydrologic concern around Templeman Lake.

As part of project planning, all drainage courses and riparian zones have an INFISH designated buffer zone that will not be entered by any proposed harvest activities. With established buffer zones, the potential sediment increases from fuel or timber management work is minimal. Roads are considered a potential source for sediment delivery and are analyzed in detail in the Specialist's Report for Hydrology (EA Appendix C).

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.

Within the 1158 acres of the Proposed Action harvest activity areas, 16 percent (185 acres) of soils have a low, 81 percent (933 acres) have a moderate, and 3 percent (39 acres) have a moderately high productivity potential (Table SOIL-1; SOIL – Map Appendix, Map 4, and PF Doc. SOIL-4).

Reduced productivity is mainly due to south aspects and shallow rocky soils and affects portions of Units 1, 3, and 4. Removal of canopy can also affect soil moisture content on these sites in several ways. Precipitation may enter previously intercepted areas and provide existing or establishing vegetation with additional needed moisture and increased decomposition rates. Conversely, rain events may increase erosion on the now exposed soil, especially if the potential is high, and reduce the availability of a growing medium. Furthermore, increased sunlight may also support plant growth or heat up soils to the extent that vegetation is inhibited. Regeneration may also be influenced by competition, especially shrubs.

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; Frandsen and Ryan 1985; Hungerford et al. 1991; McNabb and Cromack 1990). Prescribed underburning and pile burning could potentially remove woody debris that would otherwise provide nutrients to the soil as the decay process occurs (Page-Dumroese et al. 2006). Hence, burning when soil moisture content is high helps to maintain coarse woody debris requirements.

However, on an unpredictable site-specific basis, some drier sites may burn at a severity level that removes all of the protecting 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 reduces the velocity of any overland flow, thereby reducing the erosion potential (Beschta 2004). Project design features, such as increased soil moisture when burning, tree retention, and the least amount of ground disturbance are expected to minimize this effect.

4.B. Soils and Productivity

The soils found in the Templeman Resource Area owe their productivity to excellent nutrient-holding capacities and other favorable characteristics provided by a volcanic ash layer. However, these generally young and poorly developed soils can experience long-term deficiencies when

biologically essential elements, like organic matter and coarse woody debris, are not sufficiently available.

Organic matter content varies throughout the activity areas (PF Doc. SOIL-1, 13, 14, and 16) but is generally low to optimum for most surveyed units, which are primarily east and west facing. Localized variabilities 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.

Coarse woody debris (CWD) was found to be variable as well (PF Doc. SOIL-1, 13, 14, and 16). Some stands contain higher amounts of down wood, generally on the moister east-facing slopes, pockets that have been excluded from fire and past management, or sites that contain elevated tree mortality. Drier south-facing slopes and ridges have lower CWD levels that often reflect shallower soils and past harvest activities, such as in Units 3 and 4, or past wildfire activities, such as in Unit 7. Decomposition may also be affected due to light and moisture variations under different canopy densities.

4.C. Wildfire and Severely Burned Soils

Records of historic wildfires enforce that the potential for future wildfire remains, especially if a fire ignites in an untreated area under dry weather conditions and with a general climate change suggesting a warming trend in the future. The Templeman area burned in 1889, the 1920s, and last in 1979 with the Templeman Fire.

Severe deteriorating effects that wildfires have on soils usually include loss of organics and nutrients and a reduction of water infiltration (Wells et al. 1979). Burns that create very high soil surface temperatures, particularly when soil moisture content is low, result in an almost complete loss of soil microbial populations, woody debris, and the protective duff and litter layer over mineral soil. Since erosion increases following a fire are often directly proportional to fire intensity (Megahan 1990), the removal of ash-capped surface soils could reduce soil productivity.

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 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 et al. 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 et al. 2001). However, before infiltration improves, increased overland runoff and sediment movement can be expected.

If a severe fire were to occur that caused hydrophobic soils in the project area, the primary risks for erosion and mass failure would be from roads, especially at stream crossings and culvert locations. Following a severe fire, rehabilitation efforts to mitigate the fire's effects on erosion and sediment delivery would likely occur, substantially reducing potential negative effects.

4.D. Existing Site Conditions and Past Activties

Past harvest is evident throughout the project area, generally as tree stumps and skid trails. Results from on-site field assessments within proposed activity areas estimate that the existing soil disturbance totals 127 acres (Table SOIL-2; PF Doc. Soil-1). Impacts are concentrated on skid trails that converge and intersect throughout the units or portions of units (PF Doc. SOIL-1, 13, 14, and 16). Compaction levels vary on trails with many showing less initial impact or increased recovery compared to heavier used trails that still show clear signs of compaction. The presence of large rotten logs in the subsoil of several units may have lessened some of the past equipment impacts which otherwise could have been higher. Burn piles are present, especially in Units 1 and 2, but soils have recovered quite well, showing no hydrophobicity or discoloration, little to no weeds in the disturbed areas, and some apparent tree regeneration.

The majority of impacts occur in Units 1, 2, 3, and 4 which have been treated during several timber sales over the past three decades and most likely during earlier operations in the 1930s for which no record exists (SOIL – Map Appendix, Map 5). Four out of the nine proposed units exceed the Regional Soil Quality Standards (Table SOIL-2).

Moist site species, such as cedar-hemlock, dominate in Units 5 and 6 and have attributed a heavy fuel load consisting of tangled down and partially down debris. Many rotten logs are buried, barely visible, or partially submerged, suggesting that the actual tons per acre calculated are likely higher. Occasional larch and grand fir are also present but little to no regeneration of trees or other vegetation occurs on the forest floor due to the density of canopy.

On drier sites, such as in Units 3, 4, 4a, and portions of Unit 1, Douglas-fir, ponderosa pine, and larch are the predominant tree species. An often thick accumulation of shrubs has established in the understory but organic matter and coarse woody debris is usually much lower on these dry sites compared to moister stands (PF Doc. SOILS-1, 13, 14, and 16). Several grassy openings on the gently sloping ridge line in Unit 4 have been crossed by skid trails in the past or may have also been used as landings. Some of the soils in these areas have slight wetland characteristics and, though not saturated throughout the year, contain indicators (mottles, slight gleying, vegetation) that suggest that these openings are much wetter during the late winter and spring seasons (PF Doc. SOIL-13).

A small wet area with standing water is present at the far northeast corner of Unit 5 just past the bend near the road (PF Doc. SOIL-13). Installation of an appropriately sized culvert (see hydrology report) is proposed to allow for this area to drain since the road fill is presently obstructing flow. Along the same stretch of the northernmost boundary of the unit, a ~50 ft. long saturated cut slope is also present. Though no active seepage is visible during the summer, the sandy soils are gleyed, mottled, and very moist. This area appears to be part of the flow paths to the extensive below lying wetland complex.

A birch grove and the sudden presence of extensive dense ground cover in the central eastern portion of Unit 2 also suggest shallow groundwater though no seepage or puddles were found in the summer months (PF Doc. SOIL-13). During the wetter parts of the season, however, the soils in this area may remain more moist or saturated than the rest of the unit.

The present road system designated as "classified" or "system" (Forest Development Roads) on the National Forest transportation system is considered dedicated land. Roads are categorized as "classified" (dedicated under the area transportation plan) or "unclassified" (non-dedicated roads, which are not considered necessary for long-term forest management objectives). There are a total of ~13 miles of roads within the project area. In both cases, the loss of soil productivity on either category of road is considered detrimental.

Table SOIL-2: Summary of existing conditions and potential impacts for the Proposed Action following guidelines in Niehoff (2002; PF SOIL-44).

						Predicted Impact from Temporary Road Construction		**Potential Detrimental Disturbance**	
Unit	**Activity Area (acres)**	**Proposed Treatment**	**Proposed Logging System**	**Proposed Slash Treatment**	**Existing Condition % ****	**Proposed Temp Road Con-struction (miles)**	**Estimated Road Dis-turbance (acres) +**	**Estimated Acres***	**In Unit Total %**
1	47	CT/SS	GB	GP^	16			8	16
2	44	CT/SS	GB	GP^	17			7	17
3	145	CT/GS	GB	UB	17			25	17
4	266	CT/GS	GB	UB	18			48	18
4a	51	CT/GS	S	UB^	4	0.11	1.3	4	9
5	199	CT/SS	GB	GP^	6	0.24	0.6	21	10
6	26	ST	GB	GP	9			3	10
7	289	Bio/Thin	GB	Biomass removal	8			38	13
29	58	PCT	Hand fell	None	-			0	0
35	33	PCT	Hand fell	None	-			0	0
Total	**1158**				**127**	**0.35**	**1.9**	**153**	

GB – Ground Based
S – Skyline
CT – Commercial Thin
SS – Sanitation Salvage
GS – Group Selection
ST – Shelterwood
PCT – Pre-commercial Thin
GP – Grapple Pile
UB - Underburn

* Refer to Table SOIL-3 and PF SOIL-6 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. Additionally, all ground-based units (except Unit 7) will be winter logged for further resource protection. Rounding errors may occur.
**Existing detrimental disturbance includes impacts from old non-system roads/trails present in some of the units.
^Removal of biomass after overwintering of slash is a purchaser option.
+Assuming an avg. width of 30 ft. The temp roads will be fully obliterated post-harvest.

5. Environmental Consequences to Soils

5.A. Methodology Used to Analyze Environmental Consequences to Soils

Soil quality standards are applied to "activity areas" or individual harvest units (USDA FS 1999). The activity area is considered an appropriate geographic unit for assessing 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 and a second

management activity is planned for that same site, then soil cumulative effects are possible. One exception that calls for evaluation beyond an activity area would be slope stability, which requires a closer look at the adjacent terrain outside of activity areas to determine if cumulative effects from past management activities and roads are adverse.

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 (PF Doc. SOIL-18). 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, burning, and roads and landings constructed for direct and indirect effects. Detrimental disturbance associated with the Templeman Project would be a commitment of the soil resource because the majority of soils are expected to be on a recovering trend over the long-term following detrimental disturbance from proposed vegetation management activities.

Based on past monitoring efforts (Niehoff 2002), tractor logging prior to 1990 has had the most detrimental soil impacts and ranged between 24 and 42 percent. Since 1990, tractor logging methods and recommended protection measures have decreased most detrimental impacts to an average of 13 percent (Niehoff 2002), which is two percent less than the maximum allowable criteria established by the Regional guidelines. Winter logging, as proposed with the majority of units in this project, is estimated to have fewer impacts at ~10 percent for an activity area.

Helicopter and skyline/cable logging systems tend to have between 0 to 2 percent detrimental effects (Niehoff 2002; McIver and Starr 2000). These logging systems have less impact than tractor systems because the equipment stays on the road and the logs are partially suspended, restricting disturbances to times when logs are being dragged over the ground (Krag 1991; Seyedbagheri 1996). There is no helicopter logging proposed for the Templeman Project.

Direct effects on soils from proposed activities were measured 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 and also include areas disturbed due to the construction of temporary roads.

Compaction, erosion, displacement, rutting, 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 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 Proposed Action. Roads and landings that are to remain on the landscape for future use cause irretrievable effects on productivity as those lands become "dedicated" lands. Those roads that are temporarily needed for

project work and are planned for decommissioning have detrimental effects initially, but rehabilitation efforts (ripping, re-contouring) would initiate a long-term recovery sequence. 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 et al. 1985).

Table SOIL-3. Potential detrimental disturbance coefficients used for various logging and prescribed fire scenarios.

Ground-Based Logging	**Detrimental Disturbance Coefficients (%)**
Winter - with grapple piling or underburning	10
Summer – with slash removal	13
Aerial Logging	
Skyline logging with underburning	0 - 2

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-3.

Road calculations used 30-foot widths that take into account a 14-foot wide running surface and the cut and fill slope disturbance; however, on gentle ground, the road width is usually less. Effects to these areas would be considered detrimental and identified as "dedicated" lands.

Indirect effects include the loss of site productivity due to the removal of large woody debris and nutrients. Large woody debris is essential for maintenance of sufficient microorganism populations and long-term site productivity. Research has indicated that potassium (among other nutrients) is an important element for site productivity and may be deficient in certain geological parent material. Design features are incorporated into the activities to meet the management of large woody debris and organic matter as detailed in the research guidelines contained in Graham et al. (1994). These recommendations emphasize tons per acre and are defined as any woody residue larger than three inches in diameter.

5.B. Direct and Indirect Effects from Wildfire to All Alternatives

Given the absence of fire over numerous decades and increased fuel loads in many 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 et al. 2007). The proposed vegetation and fuels 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).

Vegetation and fuel treatments would reduce the chance that a wildfire could have as severe of an effect on the soils and surrounding private property in treated areas as it could in untreated areas because there would be a reduction in the tons per acre of dead and dying fuels on those treated sites. The occurrence of a high intensity wildfire would have an increased potential for impacts to soils and soil productivity in severely burned areas, especially since the risk of soil erosion increases proportionally with fire intensity (Megahan 1990). Other effects would include the potential loss of organics, loss of nutrients, and a reduction of water infiltration (Wells et al. 1979). Burns that create very high soil surface temperatures, particularly when soil moisture content is low, result in an

almost complete loss of soil microbial populations, woody debris, and the protective duff and litter layer over mineral soil (Hungerford 1991; Neary et al. 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 et. al. 1989).

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 et al. 2001). Though hydrophobicity is a naturally occurring phenomenon that can be found on the mineral soil surface, it is greatly amplified by increased burn severity (Doerr et al. 2000; Huffman et al. 2001; Neary et al. 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 et al. 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 hydrophobic soils result from a severe, high temperature fire, moderate surface erosion could occur but the potential for mass failures would be low to moderate because of the Templeman Project Area's overall landtype characteristics; however, localized slope movement could be possible. The areas of primary risk after a severe burn include some of the steep slopes on the west side and east-facing slopes and drainages above the wetlands in the mid-section of the project area. Following a severe fire, rehabilitation efforts to mitigate the fire's effects on erosion and sediment delivery would be performed as funding became available.

5.C. Direct and Indirect Effects to Soils with No-Action

With No-Action, no new management induced detrimental soil impacts would occur in the Templeman Project Area. Stands currently at high mortality risk would not be treated, which may increase infestation levels and associated risks of stand loss due to wildfire, severe burning, erosion concerns, and loss of soil nutrients. On a landscape scale, the promotion of more fire-resilient species, such as western larch and ponderosa-pine, would not occur, leaving the area susceptible to fires that would be too intense for direct attack with hand-crews. Several timber stands would continue to harbor increased fuel loads and move towards moderate to higher risks of considerable losses.

No direct effects to the soil resource would occur with No Action since there would be no road construction, logging, or fuel treatment activities. There would be no compaction or displacement beyond what currently exists. 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. In moister habitat sites, increase in organic matter has a more beneficial function to overall soil productivity because it fosters formation of ectomycorrhizae that enhances nutrient and water uptake (Graham et al. 1994). In dry habitat types, increases of organic matter may result in a negative response because organic materials are likely too dry for ectomycorrhizal growth and can reduce natural regeneration of dry sites species adapted to a habitat with shorter fire return intervals.

As the fire risk increases over time due to tree mortality and higher fuel loading, the introduction of weeds and unwanted flora following a fire could lead to higher competition between less desirable

and native vegetation (Erickson and White 2007). In the absence of such a hot fire, nutrients would be retained on site. Areas currently populated with weeds would not as likely be treated in the near future with the No Action alternative due to limited available appropriated funding.

5.D. Direct and Indirect Effects to Soils under the Proposed Action

The direct and indirect effects of the Proposed Action on the soil resource were assessed based on their potential to create detrimental impacts and to affect soil productivity. To reduce the impacts to soils and soil productivity, the Proposed Action utilizes Soil and Conservation practices as described in the Soil and Water Conservation Practices (SWCP) Handbook FSH 2509.22 (USDA FS 1988b). This handbook outlines Best Management Practices (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.

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. "Design Criteria and Mitigation" would also be implemented as part of the Proposed Action to ensure that activities are consistent with Forest and Regional guidelines for soil compaction, displacement, and nutrient retention (Chapter 2, Section 2.4, EA).

Direct and Indirect Effects of Harvest Treatments – The Proposed Action proposes commercial thinning/group selection on 462 acres, commercial thinning/sanitation salvage on 290 acres, irregular shelterwood cuts on 25 acres, biomass thinning on 290 acres, and precommercial thinning on 91 acres by utilizing a combination of ground-based harvest (1016 acres or 88 percent), skyline yarding (51 acres or 4 percent), and hand felling (91 acres or 8 percent) (Table SOIL-4; PF Doc. SOIL-6). The post-harvest fuel treatments in activity areas consist of a combination of underburns (462 acres), lop and scatter (380 acres), and grapple piling (316 acres) (Table SOIL-4). Harvest activities would occur in the winter during adequate frozen or snow conditions for all activity areas with the exception of Unit 7 which is scheduled for summer operations.

The proposed vegetation management activities have the potential to cause soil disturbance, such as compaction, by detrimentally affecting an estimated 153 acres from a long-term productive growing state (Table SOIL-2; PF SOIL-6 and 11). The disturbance is predicted to occur primarily in activity locations subjected to ground-based logging. When considering all harvest activities within the 1,158 acres of activity areas, the total disturbance level for the proposed action is ~13 percent. Removal of infrequent roadside hazard trees is not expected to have any short- or long-term detrimental effects on soil productivity. Results of disturbance calculations are included in the Project File (Doc. SOIL-6 and 11).

Table SOIL-4. Distribution of harvest treatments for the Proposed Action.

Treatment	Proposed Action
Skyline	51
Tractor	1016
Hand fell	91
Total	**1158**
Underburn	462
Grapple pile	316
Lop and Scatter	380
Total	**1158**
Commercial Thinning/Group Selection	462
Commercial Thinning/Sanitation Salvage	290
Irregular Shelterwood	25
Pre-commercial Thin	91
Biomass Removal	290
Total	**1158**

Fuels reduction proposed for this project consists primarily of ground-based logging which, based on past monitoring, would result in an overall soil disturbance level of ~10 percent for winter-logging in each activity area, excluding existing disturbances, and ~13 percent for summer logging in Unit 7 (Table SOIL-3). As previously discussed, ground-based logging can have the most detrimental effect to the soil resource. "Design Criteria and Mitigation" in addition to BMPs would be used to decrease the effect of ground-based yarding systems (Chapter 2, Section 2.4, EA).

Table SOIL-2 displays harvest units and their assigned logging prescription for the Proposed Action. Units 1, 2, 3, and 4 exceed the detrimental disturbance limit of 15 percent due to existing roads and trails from previous management activities. Based on these monitored existing conditions and estimated potential impacts, proposed harvest Units 1, 2, 3, and 4 should therefore receive the highest attention levels to ensure that proper design features are adhered to meet required soil quality standards. This would be accomplished by strictly adhering to using some of the numerous existing skid trails, and utilizing slash mats whenever possible in addition to proceeding with harvest operations during the winter season when appropriate frozen and/or snow conditions are present.

The Proposed Action could increase the amount of compaction and displacement of soils in some of the proposed treatment units where ground-based equipment is used for harvest and fuels reduction activities. In addition, underburning can impact soils if proper procedures are not followed, including maintaining adequate levels of soil moisture. Severe burning and ground disturbance could also encourage weed infestation. Protective design features (Chapter 2, Section 2.4, EA) are therefore required in order to lessen compaction and disturbance impacts to the soils in activity areas. These include winter logging in all but one unit and use of slash mats, existing roads, and skid trails whenever possible.

Currently, seventeen proposed landings associated with skyline and ground-based harvest are situated on already existing old landing sites located along Forest Service system roads and at the terminus of the temporary road linked to Units 5 and 7 (SOIL – Map Appendix, Map 6). That disturbance is accounted for in the existing condition. At this time, no new landing sites are currently proposed.

The logging slash from tree limbs, tops, and un-merchantable pieces would stay within all harvest units except Unit 7 and be allowed to remain for one wet season before being underburned or grapple piled. This would allow the foliage and branches to leach and recycle nutrients, primarily potassium, back into the soils' organic layer. Slash in two units (29 and 35) would also be lopped, scattered, and left without additional site preparation. Determination of fire risk where slash is left untreated for prolonged periods of time will be made by the district fire management officer. Where fire risk is considered high, especially near roadsides, flexibility will be given to treat slash more aggressively, which may reduce the amount of recycled nutrients in these localities.

Direct and Indirect Effects of Biomass Removal – Commercial thinning with mandatory biomass removal is proposed on approximately 290 acres in Unit 7. With respect to biomass removal in Unit 7, logging residue that exceeds the 5 to 15 tons per acre requirement of leaving 3"+ diameter material (Graham et al. 1994; Design Features - Chapter 2, Section 2.4, EA) would be removed during harvest with a small-scale harvester and forwarder. The smaller and lighter machinery should result in less compaction compared to equipment typically used for sawtimber-size trees, especially if passes are limited (Johnson et al. 2007). Removal of residue would also eliminate additional subsequent trafficking by biomass collection equipment that may increase physical impacts to the soil. For comparison, "standard-sized" harvesting equipment vary in width between 10-12 feet and weigh between 50-60,000 lbs, whereas the small-scale machines vary in width between 7-10 feet and weigh less than 26,000 lbs. A special contract provision will be developed for restricting the size and type of equipment to be used in Unit 7.

Removal of biomass that is in excess of recommended retention levels will be a contractor option on approximately 341 acres for Units 1, 2, 4a, and 5 on. Slash would be collected after it overwinters for a wet season to allow nutrients to recycle back into the soil. The woody material that remains on-site would primarily be high-nutrient small branches and foliage. On the average, about 25 percent of the above-ground nutrients in the pre-harvest stand would be retained following residue removal, compared to about 40 percent retained following conventional harvest (Minnesota Forest Resources Council, 2007). Existing guidelines, such as having equipment re-use trails and existing infrastructure, and utilization of slash mats would also reduce adverse impacts of harvest and grapple piling operations.

Direct and Indirect Effects of Mitigation Measures - Mitigation measures, such as use of existing skid trails, slash mats, and winter logging would keep proposed harvest impacts under 15% for the units that are currently below this level. Design and mitigation measures to limit harvest impacts are described in Chapter 2.

Four activity areas which currently exceed soil quality standards (Units 1, 2, 3, and 4) would be winter logged to further prevent additional impacts. A combination of seasonal restrictions and strict adherence to making use of existing skid trail corridors and utilizing slash mats whenever possible should provide protection so that current conditions are not increased.

In addition, provision for net improvement on previously impacted activity areas would be achieved through soil restoration activities that would target detrimental disturbance in Units 1 and 2. This would be accomplished through decompaction, addition of organic material, seeding, and weed control. Anticipated results would provide for improvements in hydrologic function and would initiate a recovery process that otherwise may be prolonged as soil compaction persists. Post-harvest monitoring is scheduled to assess if mitigation objectives in these units are met.

Direct and Indirect Effects of Pre-commercial Treatments – Pre-commercial thinning is planned in Units 29 and 35 and and would include 91 acres of hand-thinned fuels reduction. No mechanized

equipment would enter the parcels, therefore, no disturbance from compaction, displacement, or rutting of soils would occur. The potential incidental salvage and removal of hand-thinned Christmas trees and boughs would have little impact on soil productivity since the bulk of trees within the currently overpopulated stand remains.

Direct and Indirect Effects of Prescribed Burning and Slash Pile Disposal - No measurable negative effects on soils are anticipated from post-harvest underburning if soil moisture content is equal to or above 25 percent when the burning occurs (Niehoff 1985 and 2002). On south-facing aspects (mainly portions of Units 3 and 4), the prescribed burns would have no long-term detrimental effects when executed in the spring because organic matter would be retained, continue to protect soils, and contribute to ongoing soil productivity. Burning under controlled conditions at high soil moisture also reduces potential nutrient losses and the chance of creating hydrophobic soils that can lead to increased erosion, sedimentation, and debris flows (Ice 2003; Neary et al. 2005; Robichaud 2000; Swanson 1981).

However, on an unpredictable site-specific basis, some drier areas 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 overland flow, thereby decreasing the erosion potential (Beschta et al. 2004).

When burn piles are large, nutrient losses from heat and volatilization could be considerable. It is recommended that burn piles be small and numerous rather than large and few. 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.
Design features also require piling machinery to utilize existing trails, operate on a slash mat whenever enough material is available, and stay on slopes less than ~40 percent to prevent soil disturbance in excess of guidelines. The units would be entered from existing roads and skid trails. 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.

Direct and Indirect Effects of Temporary Road Construction and Road Reconstruction - The Proposed Action has scheduled a total of ~0.4 miles of temporary road construction associated with Units 4a and 5 to move personnel, logs, and skyline equipment to complete harvest and fuels treatments (PF Doc. SOIL-10). Construction of temporary roads would have an effect to short-term site productivity through compaction and displacement on approximately 1.9 acres (PF SOIL-10). The temporary road would be obliterated upon completion of use, thus helping the recovery of soil productivity, improving infiltration, and reducing hydrologic effects from road surface runoff (Switalski et al. 2004). No new permanent roads will be constructed.

Segments of Forest Roads #397A, #397C, #397D, #940, #940-UA, #940-UB and #941, totaling 9.9 miles, will require minor reconstruction prior to use. The road work includes roadside brushing, blading, ditchline cleaning and shaping, spot graveling, and ditch relief pipe installation and replacement. Effects to soils are usually short-term and limited to sites that are already dedicated system roads. The road work would actually improve current conditions by stabilizing the roadbed that is eroding in several locations.

Refer to the Hydrology Specialist's report for additional information of road effects (EA Appendix C).

A small wet area with standing water is present at the far northeast corner of Unit 5 just past the bend near the road (PF Doc. SOIL-13). Installation of an appropriately sized culvert (see hydrology report) is proposed to allow for this area to drain since the road fill is presently obstructing flow. Along the same stretch of the northernmost boundary of the unit, a ~50 feet long saturated cut slope is also present. Though no extensive seepage is visible in the summer, the sandy soils are partially gleyed, mottled, and very moist. This area appears to be one of the main contributors to the extensive below lying wetland complex. Recommendations include restricting logging above the immediate cut slope to no closer than a chain to retain slope integrity and hydrologic function. No other road related areas of stability concerns were observed in the project area.

Direct and Indirect Effects on Soil Productivity – The Resource Area is underlaid by glacial and alluvial material and granitic bedrock (Figure SOIL-1; PF. Doc. SOIL-9 and 17). These parent materials are not expected to be quite as potassium deficient as some Belt Series rocks, which makes up less than 1 percent of the Templeman Project Area (Garrison-Johnston et al. 2004 and 2007; Moore et al. 2004a and 2004b). Nevertheless, fine residue (foliage and branches) is allowed to remain throughout the winter within each proposed harvest unit. This allows potassium and other nutrients to leach out of the fine residue and back into the soil where it would be available for future uptake (Baker et al. 1989; Barber and Van Lear 1984; Edmonds 1987; Garrison and Moore 1998; Laskowski et al. 1995; and Palviainen et al. 2004).

As a direct effect, harvesting on all sites would remove within each tree bole (and bark) about 22 percent of the potassium that is contained within a tree (Garrison-Johnston et al. 2004). This may have an indirect effect on some plants that remain in the stand. The commercial removal of Douglas-fir, grand fir, western cedar, and hemlock in association with leaving western larch would allow the release of stored foliar potassium as a beneficial nutrient for uptake by western larch (Garrison and Moore 1998). Western larch is a more potassium-efficient species (Garrison-Johnston et al. 2007) and would remain throughout those units where it already is part of the stand component. Measuring the effects of on-site productivity, however, cannot be done with certainty until more research information becomes available. At this time, management recommendations from the IFTNC are used as guidelines for maintaining sufficient potassium on a site.

Approximately 5 to 15 tons per acre of coarse woody debris for dry sites and 17 to 33 tons per acre for moist sites would be left after harvest and site-prep operations are completed. This would provide protection against soil erosion as well as a long-term source of nutrients and organic matter (Brown et al. 2003; Graham et al. 1994). The majority of harvest units currently display satisfactory coarse woody debris levels though Units 3, 4, and 4a are presently on the lower end of material (PF Doc. SOIL-1).

Indirect effects of soil nutrient loss include reduced growth and yield and increased susceptibility to pathogens, such as root disease (Garrison and Moore 1998; Garrison-Johnston 2003) and insect infestation (Garrison-Johnston 2003; Garrison-Johnston et al. 2004). 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.

Effects of soil wood loss include altered processes of forest regeneration and growth, favoring species requiring lower soil moisture and nutrient levels. Additional effects could also include loss

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.

5.E. Cumulative Effects of Past, Ongoing, and Reasonably Foreseeable Activities
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, primarily in regards to slope stability.

Existing roads and landings designated as classified on the National Forest transportation system are considered dedicated lands. The loss of soil productivity on these sites occurred when the roads and landings were constructed and are an irretrievable effect. These lands are not considered part of the cumulative effects because they are now included as a capital investment to the permanent transportation system.

***Spatial Scale* -** the appropriate spatial scale, or geographic bounds, for cumulative effects analysis relates to an area that would be affected by the proposed action. This area is referred to as the cumulative effects analysis area and may vary between resources. The task of selecting the geographical boundaries involves several factors, including the scope of the project considered and the features of the land. Cumulative effects due to physical, chemical, and biological impacts generally increase with the scope of past and proposed activities (Reid and Hilton 1998).
Since direct and indirect effects from soils are measured within "activity areas," the cumulative effects analysis area for the soils resource consists of the unit scale (activity areas where management activities are proposed) and the immediate surrounding area adjacent to the activity area in regards to slope stability.

***Temporal Scale* -** 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.

Generally, detrimental effects on soils are not permanent and depend primarily on soil texture, parent material, aspect, and level of disturbance, i.e. compaction. Recovery time is on the average 30 to 70 years as second growth timber becomes established around disturbed areas (Dykstra and Curran 2002; Froehlich et al. 1983 and 1985). However, soil displacement that mixes or moves the volcanic ash surface layer and reduces soil moisture holding capacity and productivity is essentially irreversible.

Cumulative Effects of Timber Harvest – Units 1 and 2 have had timber sales conducted in the past that include prescriptions and stand treatments under the Surely Temple Timber Sale (1993-1997) and the Templeman Timber Sale (1982-1986). Units 3, 4, and 4a were treated with the Surely Temple Timber Sale (1993-1997), Templeman Timber Sale (1982-1986), and the Huckleberry CT (1990-1992). The Breakout Timber Sale was conducted on Units 5 and 6. Past harvest on the Plantations include the Camp Nine Timber Sale (1981), and for Plantation Unit 29 the Camp Nine Timber Sale (1981), Mini Meadow Timber Sale (1989) and the Little Rock Blow Down (1982).

These sales implemented a combination of single-tree and group selection (uneven-aged), commercial thinning, and sanitation treatments followed by fertilizing, yarding topwood, slashing, bucking and grapple-piling and burning slash concentrations. The Templeman Fire burned Unit 7 in 1979, was then salvage logged in 1980, and re-planted in 1980-81 (SOIL – Map Appendix, Map 5). Past harvest is therefore evident throughout the project area, generally as stumps and the presence of skid trails (PF Doc. SOIL-1, 13, 14, and 16; SOIL – Map Appendix, Map 5).

The proposed vegetation management activities have the potential to cumulatively increase soil disturbance from the current estimate of 11 percent (127 acres) to 13 percent (153 acres) (Table SOIL-2; PF SOIL-6 and 11). The disturbance is predicted to occur primarily in activity locations subjected to ground-based logging.

Table SOIL-2 displays harvest units and their assigned logging prescription for the Proposed Action. Units 1, 2, 3, and 4 exceed the detrimental disturbance limit of 15 percent due to existing roads and trails from previous management activities. Soil Quality Standards (USDA FS 1999) are met if the cumulative detrimental effects from project implementation do not exceed the conditions prior to the planned activity. This would be accomplished by strictly adhering to the existing skid trails and incorporating them into the layout in addition to proceeding with harvest operations during the winter season when appropriate frozen and/or snow conditions are present. Based on monitored existing conditions and estimated potential impacts, proposed harvest Units 1, 2, 3, and 4 should therefore receive the highest attention levels to ensure that proper design features are used to meet required soil quality standards.

Regional guidelines suggest that any activity area that exceeds R1 standards should move toward a net improvement in soil quality. Soils in the Templeman Project Area are very light textured silt loams with moderate to little gravel-sized fragment content, making them very susceptible to compaction. Though bedrock, cobbles, and boulders are found at very shallow depths, the overlying layer of soil gains little protection from its presence throughout the majority of the area. Based on several field visits and professional judgement, ripping or subsoiling of skid trails is not recommended in Units 3 and 4 due to commonly shallow soils, widespread presence of bedrock and in-situ boulders, the possibility of mixing less productive subsoils with the generally gravel free very fine textured soils, and the potential spread of weeds.

However, improvements will take place in Units 1 and 2 by decompacting skid trails. Soils in these two units, especially Unit 1 along the valley, are deeper, not as shallow, and differ in bedrock and parent material (glacial alluvium and mafic rocks) compared to the granite outcrops on the west side. Although rehabilitation through decompaction and/or recontouring cannot assume complete reversal to natural conditions, efforts initiate a long-term recovery process. Anticipated results would enhance hydrologic function and would initiate a recovery process that otherwise may be prolonged as soil compaction persists (PF Doc. SOIL-19 and 20).

It was also recommended to switch summer operations to winter harvest to reduce detrimental disturbance from harvest activities with the intent to not exceed present levels. In addition, prescription in the project area was also modified from the initial single-tree selection uneven-aged management with 10-year entry cycles to group selection uneven-aged management with 30-60 year entry cycles to promote a recovery over an extended time while limiting return entry for several decades. Post-harvest monitoring is planned to occur once logging activities are completed. Unit 7 is the only activity area scheduled for summer logging due to concerns of equipment limitations during

the winter season and locating small cut trees during snow pack in this proposed biomass unit. The relatively low existing impact levels, the small-scale equipment to be used, and the amount of slash created should provide protection of soils during summer operations.

The Templeman Project Area is surrounded by non-Forest Service land to the west, north, south, and southwest and also includes one small parcel of private land in the south-central portion around Templeman Lake. Logging activities and development have taken place in these areas and are expected to continue at an unkown rate. Activities on non-Forest Service land that detrimentally disturb soils, impair soil productivity, and increase soil water content are site specific and have no additional effects on the analysis area. There are no other timber sale activities planned by the Forest Service in the surrounding area and the Meadow Creek drainage in the forseeable future.

Cumulative Effects of Roads – All developed roads built in the past have a lasting effect on soil productivity due to compaction and displacement. County, private, and USFS forest roads account for approximately 13 miles of roads in the Templeman Project Area (PF Doc. SOIL-7). Their maintenance for residence access, recreation, and vegetation management calls for ongoing use that result in a considerable amount of compaction and displacement through the project area.

Proposed temp road construction and existing road re-conditioning and maintenance may increase short-term sediment movement from road surface runoff initially but should be minimal, especially at road locations higher on the slope that are at a relatively low gradient and provide for sufficient buffer zones. Road maintenance includes ditch relief pipe installation, blading, and brushing, and typically improves drainage and decreases erosion from water channeling down the road surface in the long run. For a detailed analysis and information on roads and related issues, please see Specialist's Report on Hydrology (EA Appendix C).

Cumulative Effects from Future Salvage - In the event that incidental residual tree mortality occurs after completion of the project as a result of windstorms, ice-damage, fire, insects or disease in Units 1, 2, 3, 4, 4a, 5, 6, 7 and associated roadsides used for hauling, salvage may occur. Existing skid trails and landings would be utilized or areas would be cable yarded from roadsides not requiring off-road equipment, adhering to design criteria established for this project. This activity could occur until superceded by another management decision in the affected area.

Impacts to soils are not expected to exceed past the levels analyzed in Table SOIL-2 if the design features remain identical, including seasonal restrictions, use of slash mats, and other limitations and criteria outlined in Chapter 2. The proposed post-harvest soil monitoring for this project should be reviewed before any future activities are initiated.

Cumulative Effects from Recreation – Disturbance from general motorized use and recreational access has been occuring and will continue throughout the project area indefinitely. No changes in the existing recreation profile are anticipated though the current use of ATVs on the temp road extension for Unit 4a may be restricted after obliteration. Other recreational activities that occur off the developed roads, such as the gathering of miscellaneous forest products and hunting, is generally carried out on foot and has no additional effects on the activity areas.

Cumulative Effects of Fire – Fires that burned in 1889 and the 1920s affected much of the proposed Resource Area. The most recent fire occurred in 1979 and burned close to 400 acres in and around proposed Unit 7. The affected areas are recovering and no observable effects to soils were found.

Cumulative Effects of Fire Suppression – Active fire suppression has protected much of the Resource Area over the past decades but has resulted in increased fuel loading. The proposed harvest would aid future suppression activties by reducing current levels of infected dead and dying trees, thereby reducing the potential for larger scale fires. The benefits of fires with lower intensity and severity would include a reduced potential of excessive soil heating and sterilization as well as hydrophobic conditions that tend to increase sediment movement, flooding, and possible slope instability.

On small fires, disturbance from fire suppression activities is usually limited to hand tools; most hand fire-line construction has only minor (insignificant) impacts to the soil resource. During fire suppression, closed roads may be reopened for access and incorporated as fire line. As part of the post-fire work, the areas of disturbance are rehabilitated and the roads returned to their previous condition in most cases.

Cumulative Effects of Noxious Weeds - Noxious weed monitoring and treatment would occur as needed and would follow guidelines established in the Bonners Ferry Noxious Weeds EIS (USDA 1995). 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.

6. Consistency with Forest Policy and Legal Mandates

The Proposed Action would comply with Forest Plan standards and Regional Soil Quality Standards (USDA 1999) related to detrimentally disturbed soils.

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.

The Proposed Action would comply with this standard; all proposed activity areas are below or at the acceptable productivity potential for trees and other managed vegetation (PF Doc. SOIL-7 and 8). Including system roads, the proposed activities have the potential to disturb a total of 175 acres (PF Doc. SOIL-8).

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.

The Proposed Action would comply with this standard; large woody debris retention would follow the research guidelines of Graham et al. (1994) to ensure the maintenance of site productivity.

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.

There is no whole-tree logging proposed with the Proposed Action.

Region 1 Soil Quality Standards

Detrimental disturbance would not exceed the recommended 15 percent in six activity areas (Table SOIL-2). Existing conditions in four proposed activity areas (Units, 1, 2, 3, and 4) are currently above 15 percent. Mitigation measures, such as winter logging, strict adherence to existing skid trails, and utilization of slash mats are put in place to reduce the cumulative detrimental effects from prior disturbance and proposed project implementation. Based on professional judgement, restoration is not recommended for Units 3 and 4 to commonly shallow soils, widespread presence of bedrock and in-situ boulders, the possibility of mixing less productive subsoils with the generally gravel free very fine textured soils, and the potential spread of weeds. However, decompaction of utilized skid trails is scheduled for Units 1 and 2 since soils are deeper, differ in underlying parent material and rock content, and the reduced likelyhood of mixing with less productive subsoils. The proposed activities have the potential to disturb a total of 153 acres (Table SOIL-2).

By not increasing cumulative detrimental effects and existing conditions in units over 15 percent and through decompaction efforts to provide for net improvement, the proposed project would meet Regional Soil Quality Standards.

Organic matter layer thickness would be retained as appropriate for local conditions.
Large woody debris would be maintained at recommended volumes (Graham et al. 1994) in each proposed activity area.

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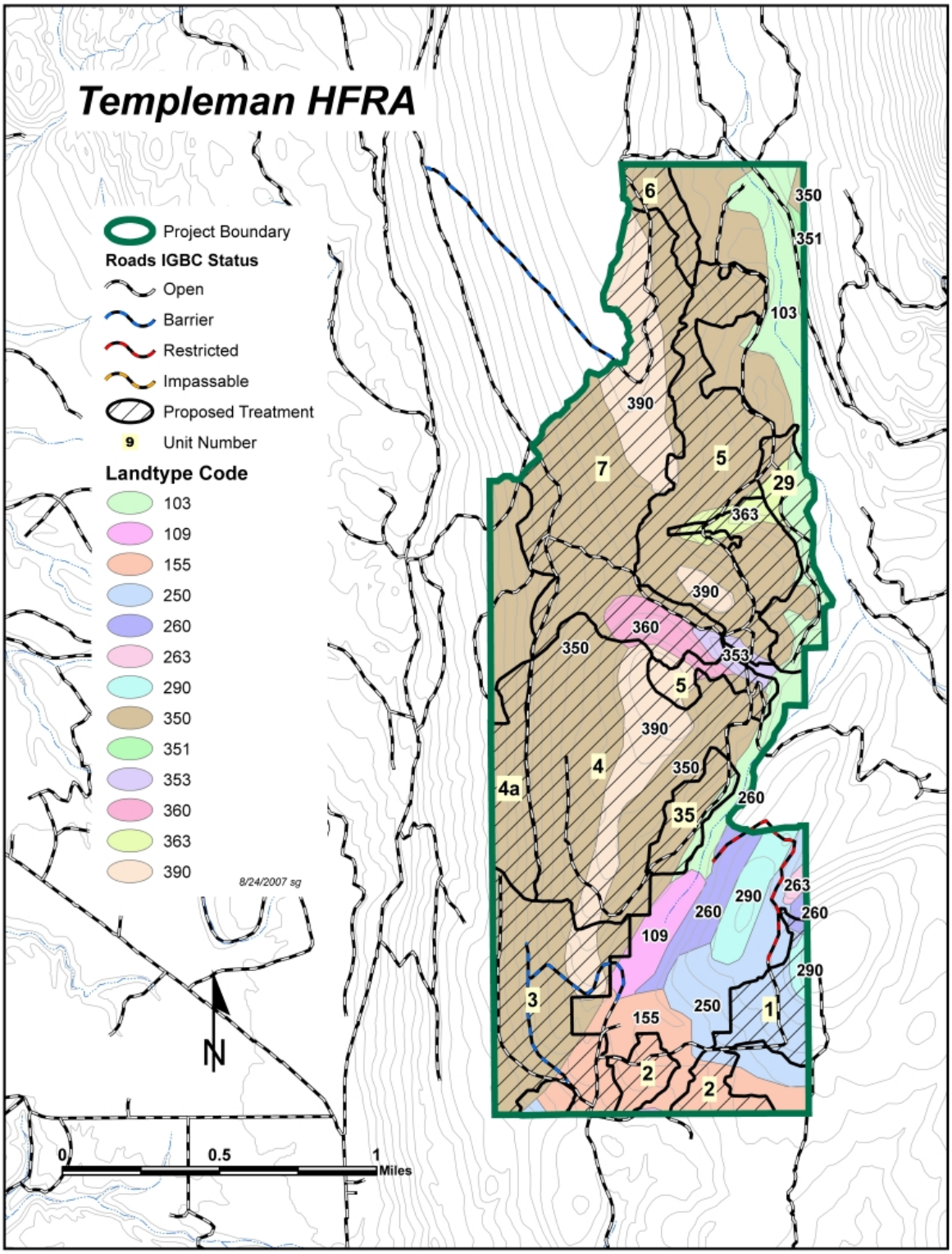
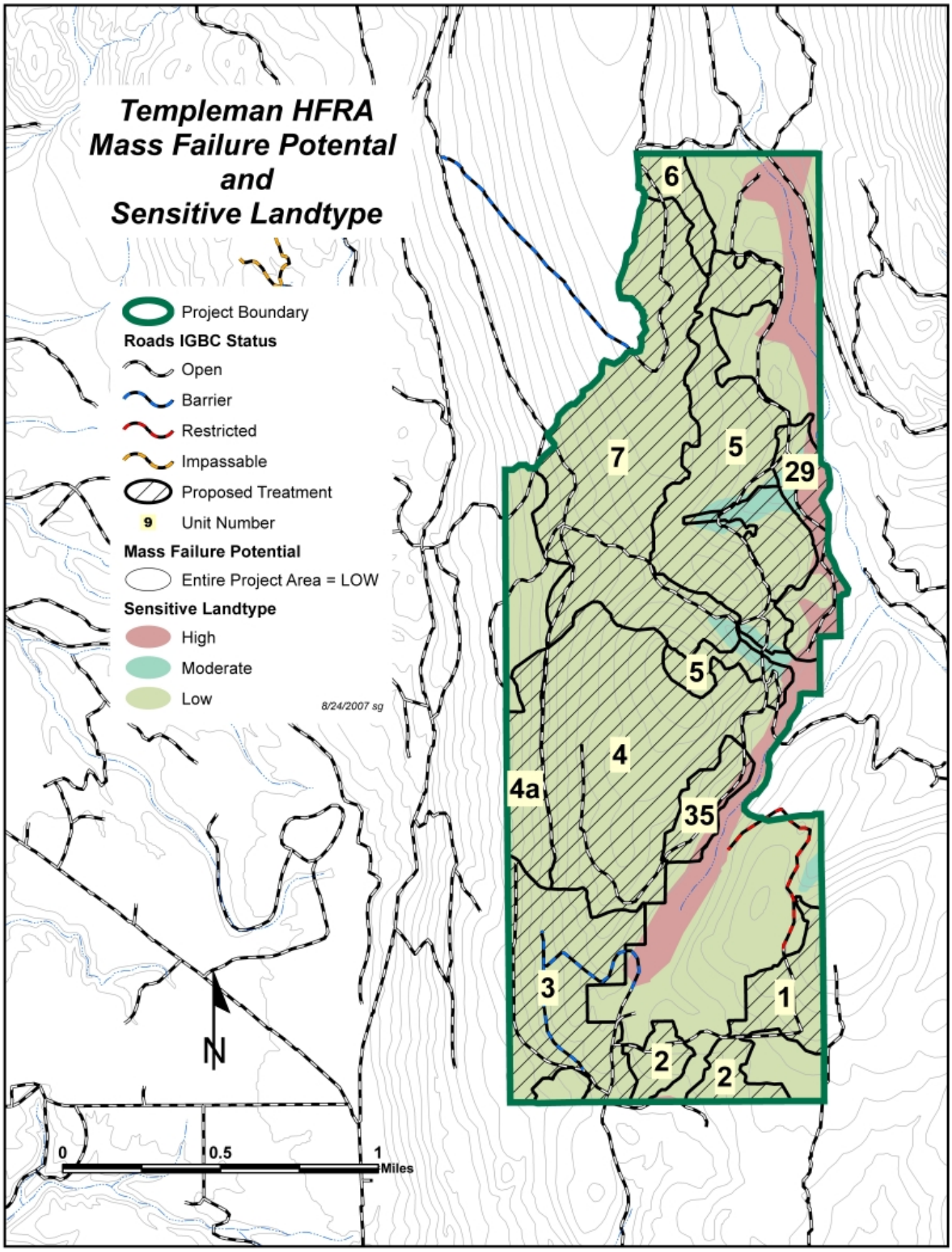
SOILS - Map Appendix

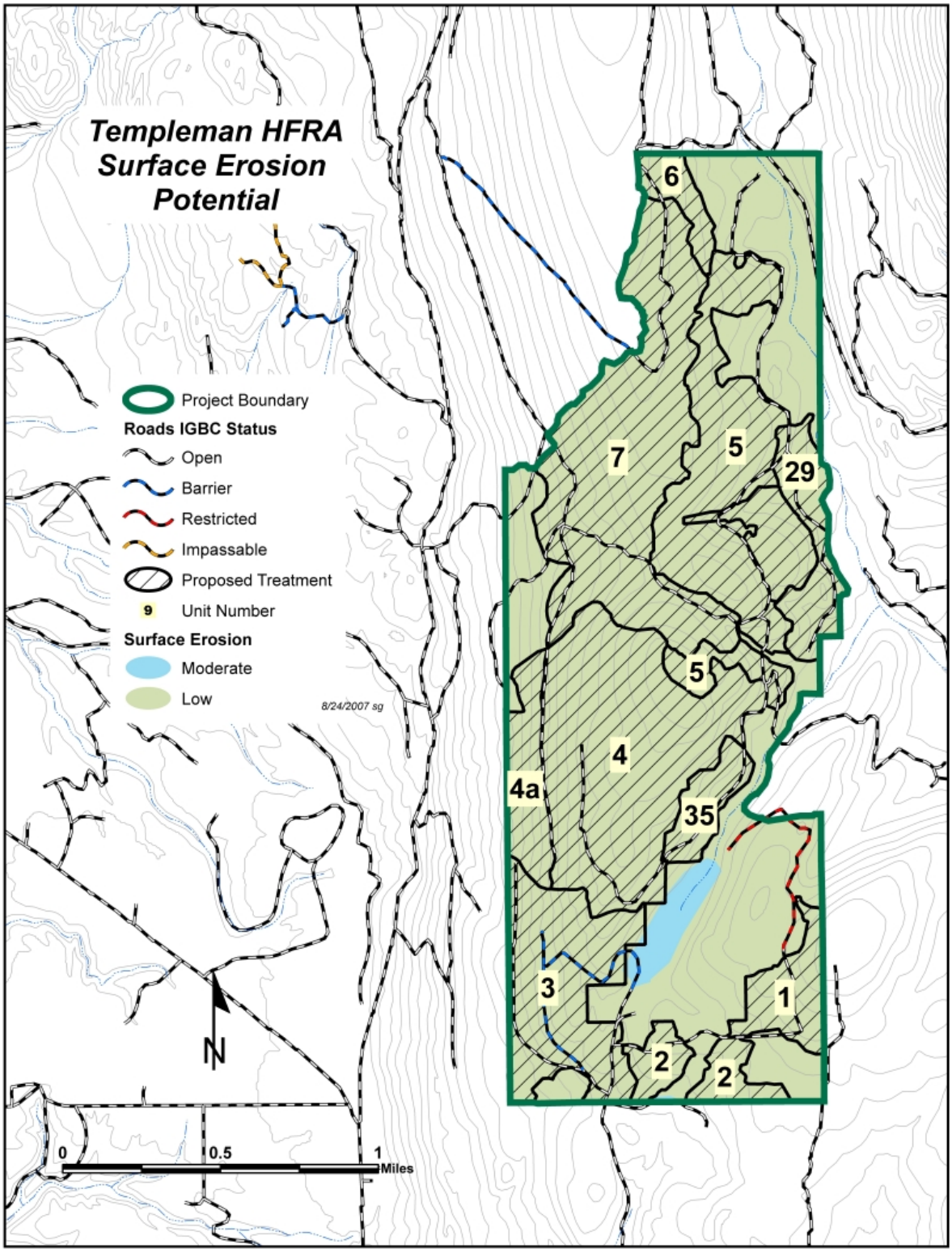
SOIL Map-1: Soil Landtypes. For Detailed Landtype Descriptions Refer to PF Doc. SOIL-2.



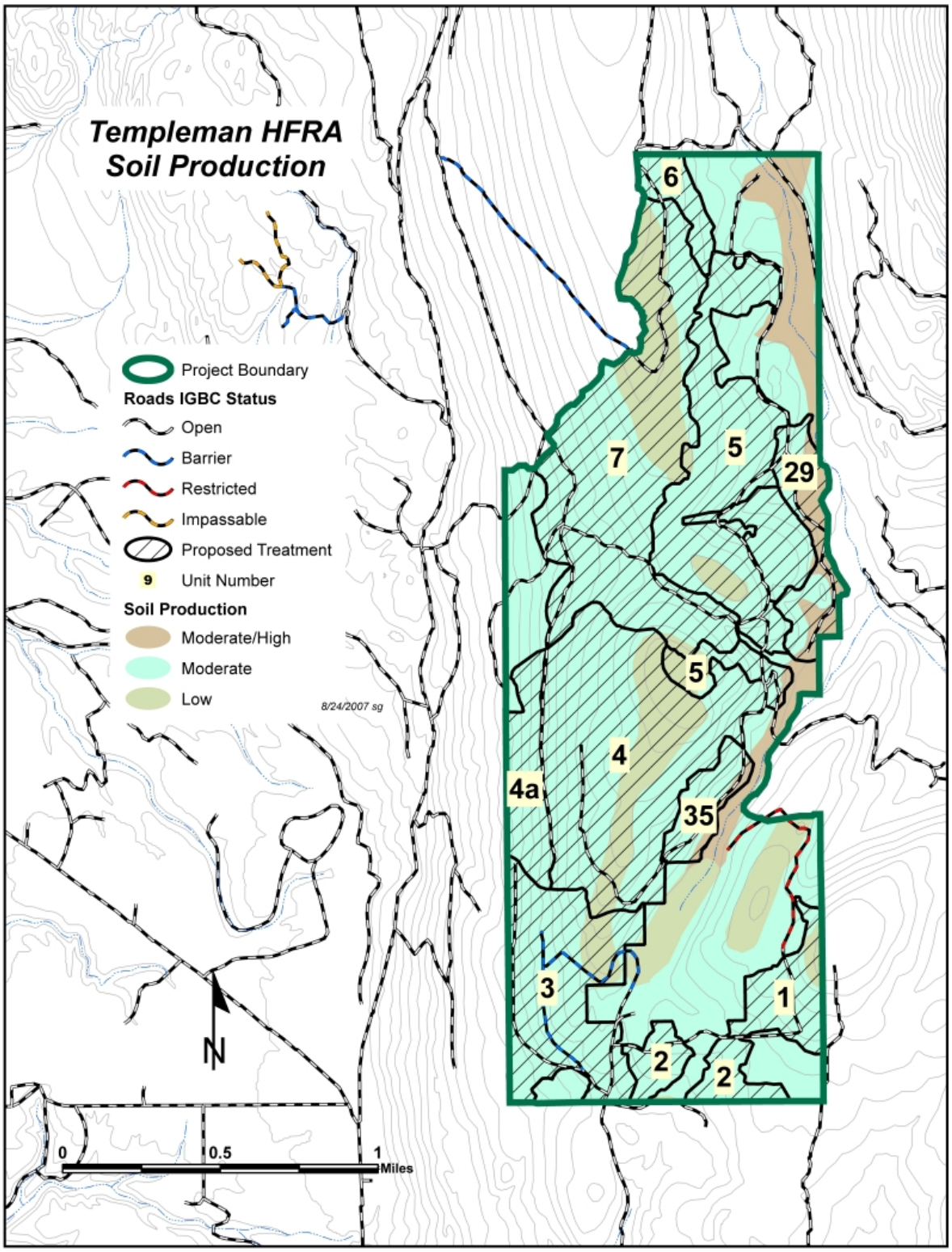
SOIL Map-2: Mass Failure Potential and Sensitive Landtypes.



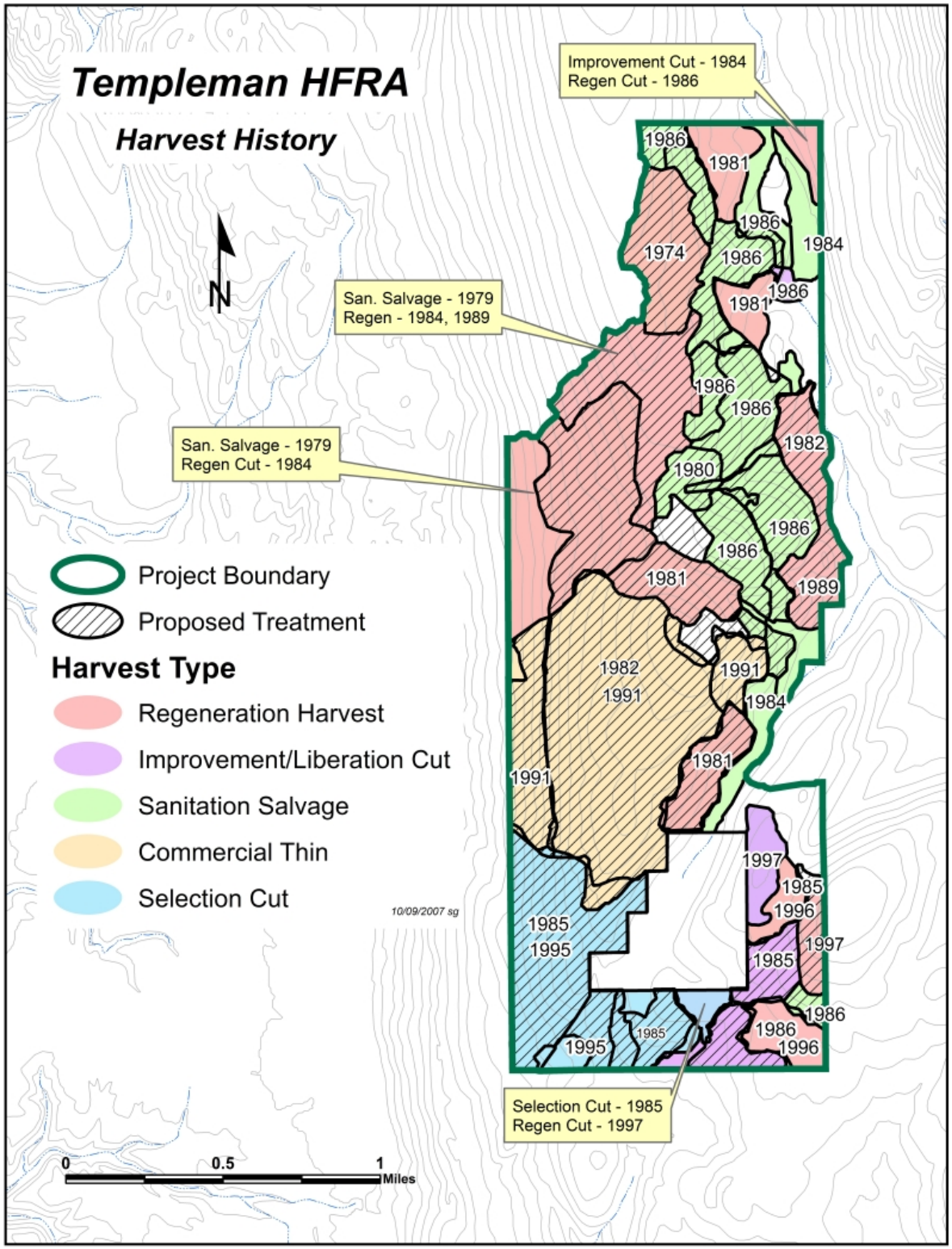
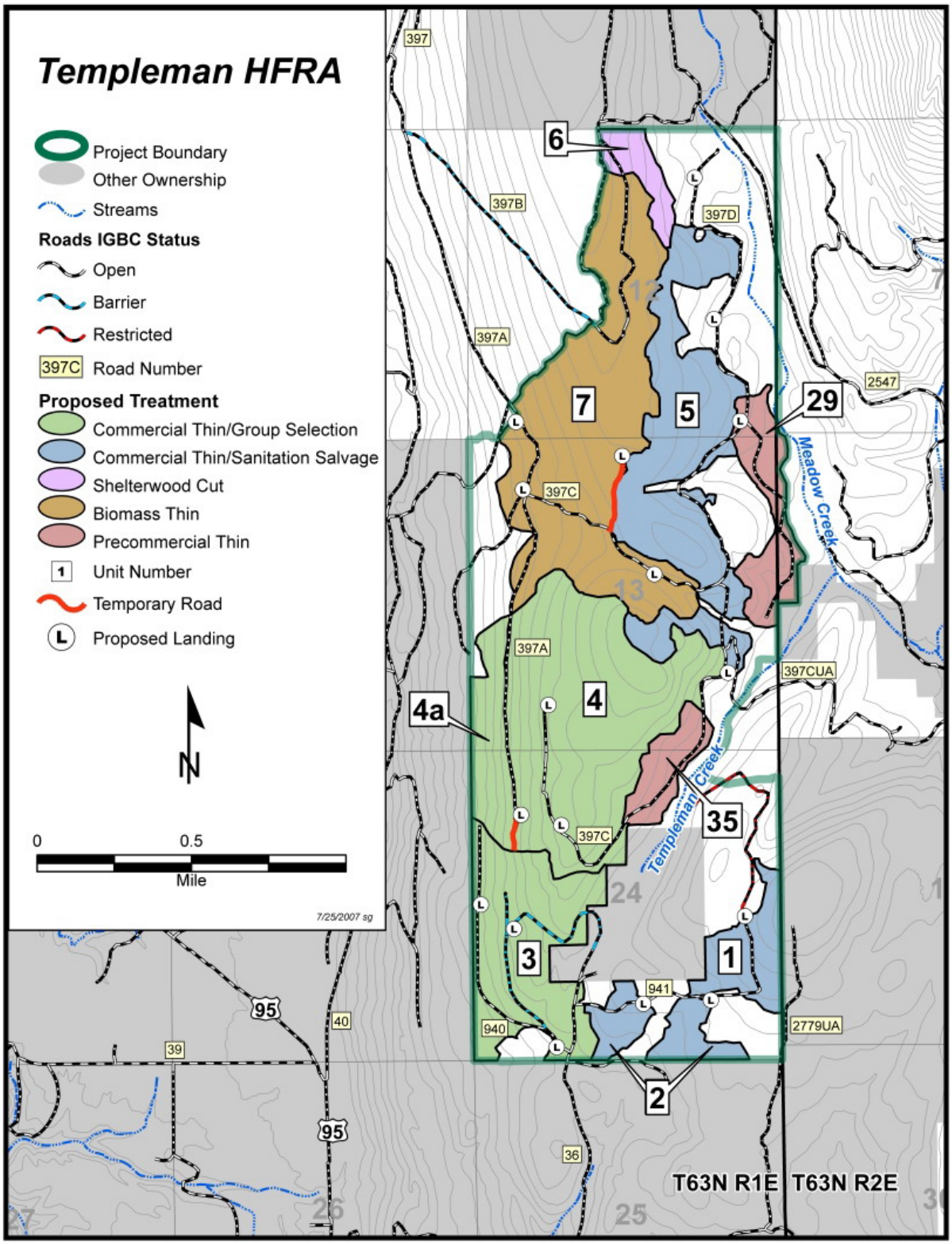
SOIL Map-3: Surface Erosion Potential.



SOIL Map-4: Soil Productivity Potential.



SOIL Map-5: Templeman Harvest History.



SOIL Map-6: Templeman Proposed Landing Sites.