BROADAXE PROJECT –SOILS REPORT

Regulatory Framework

IPNF Forest Plan

The Forest Plan (GR2, IPNF Forest Plan, p. II-32-II-33) directs the following standards for the soil resources on National Forest System lands:

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, or severely burned, as determined in the project analysis.
2. Projects should strive to maintain sufficient large woody debris to maintain site productivity. Large woody debris is essential for maintenance of sufficient microorganism populations.
3. In the event of whole tree logging, provisions for maintenance of sufficient nutrient capital should be made in the project analysis.

Specific standards and guidelines for Management Areas 1, 6 and 9 are presented in the IPNF Forest Plan (GR2, IPNF Forest Plan, p. III-4 and III-30).

Regional Soils Direction

Region 1 manual direction for Soil Detrimental Impacts recommends maintaining 85% of an activity area's soils at an acceptable productivity potential with respect to detrimental impacts (SW1). This recommendation is based on research indicating that a decline in productivity would have to be at least 15% to be detectable (Powers, 1990). The manual definition of activity area excludes system roads.

The Regional manual direction for Organic Matter recommends that management of coarse woody debris (CWD) follow guidelines such as those contained in Graham et al. (1994) to maintain healthy soil physical and biological conditions (SW1).

Analysis Area

To address Regional manual direction for soil impacts, the analysis area is each timber harvest or fuels treatment unit (activity area) and associated temporary roads and landings. At the Regional level, existing classified National Forest system roads and landings are designated lands and, as such, detrimental impacts and the loss of soil productivity due to their construction are irretrievable effects that are not considered in the cumulative effects analysis.

To address the Forest Plan Standard to maintain 80% of the activity area in acceptable productivity, a separate cumulative effects analysis area will include both the activity area as defined by the Regional manual supplement (SW1) and existing forest roads and landings in the project area to be used to accomplish project activities (SW11).

Erosion and sedimentation effects of previous, proposed, and reasonably foreseeable activities are analyzed and discussed in the Watershed Resources section.

Analysis Methods

The existing condition for the soil resource was determined using the IPNF Soil NEPA Analysis Process (Niehoff, 2002). Field data were used to confirm information in the stand management database concerning previous management activities in proposed action stands (SW2). Natural erosion and sediment production hazards were gathered from landtype descriptions in the IPNF Land Systems Inventory (GR19, IPNF Landtype Map Unit Descriptions). The direct and cumulative effects of proposed activities on soil were predicted using the Soil Disturbance Spreadsheet Model (Niehoff, 2002) and the IPNF Updated Soil Guidelines (SW11). Representative foliar nutrient samples were collected according to the IFTNC Foliage Collection Procedure (SW3). Field monitoring of a recent, similar salvage harvest in the project area, the Beetlemania Salvage Project, was conducted in 2002 (SW9).

Throughout the Soils Resource section, areas were calculated using ARCINFO GIS and are rounded off, which may cause slight discrepancies between resource analysis numbers.

Affected Environment

Reference Condition

Natural events and processes historically dictated environmental conditions across the St. Joe River basin. Effects from natural disturbances such as volcanic eruptions (*e.g.* Mt. Mazama and Mt. St. Helens), alpine glaciation, fires, landslides, and flooding interacted with other land-shaping processes like geologic uplift and stream channel down-cutting to form the basic character of watersheds and soil resources. Landscapes and biological communities evolved with these processes to develop functional ecosystems, which possessed an inherent resiliency to effects from natural disturbance regimes representing pulse-type disturbance (Reeves *et al*., 1995). Pulse disturbances influence the natural range of environmental conditions that are expected for ecosystems functioning at broad geographic scales but typically allow systems to begin recovering to pre-disturbance conditions. The reference condition for the Broadaxe Area was determined from review of existing data and field reconnaissance.

Detrimental Soil Impacts

Detrimental impacts are defined as compaction, displacement, puddling, or severe burning of the soil due to management activities. Since there was no known management of the upper and middle St. Joe River basin prior to European settlement, detrimental impacts by definition could not have occurred. The only impacts that could be attributed to natural causes would be displacement due to mass failures or severe burning due to severe wildfire. Mass failure is not a dominant geomorphic process in the Broadaxe area (see *Sensitive Landtypes* below), so displacement should not have been a significant factor in natural soil disturbance. Historic wildfires may have resulted in severely burned soils. Portions of the Broadaxe drainage were burned in 1889 and in the 1910 fire (see Fire/Fuels report). These fires encouraged the regeneration of stands dominated by lodgepole pine in the upper Broadaxe drainage. There are no significant fires recorded after 1910 in the project area.

Soil Nutrients and Productivity

Soils in the upper Broadaxe area are developed on metasediments of the Proterozoic Belt Supergroup and have relatively low to moderate soil productivities (GR19, IPNF Landtype Map Unit Descriptions; SW4).

Soils in the project area may be naturally deficient in some essential plant nutrients (Garrison and Moore, 1998). Potassium deficiency in particular may increase susceptibility to insects and disease in certain tree species. The lower member of the Wallace Formation underlies 57% of the project area; the Middle Wallace member 18%; and the St. Regis Formation underlies 25% of the Broadaxe drainage (SW5; Lewis *et al.*, 1999). Surface soils are developed on >7 inches of volcanic ash-influenced loess overlying the bedrock (SW7, SW13). Because it is formed primarily from fine glass fragments, the volcanic ash has an excellent water-holding capacity and provides a favorable tree-rooting medium but it does not contribute significantly to soil nutrient content.

Three samples were collected from the Quartz Gold Project Area in the winter of 2002-2003 for foliar nutrient analysis (SW5). These samples consisted of previous season's growth of needles from 5 dominant or co-dominant fir trees in each of three previously untreated stands underlain by the three main rock units in the project area (SW5). Table 1 displays the average proportion of critical levels for nutrients that were found to be deficient (shown in ***bold italics***) in the foliage from the trees sampled. Magnesium, calcium, zinc, manganese, iron, aluminum, and sodium were all found to meet or exceed critical levels for tree health and vigor in all samples collected and analyzed.

Table 1. Foliar Nutrient Analysis Results

Rock Unit	*Tree Species	***Proportion of Critical Level for Tree Species***					
		Nitrogen	Phosphorus	Potassium	Sulfur	Copper	Boron
Middle Wallace Fm.	GF	***0.85***	***0.87***	***0.93***	1.22	***0.67***	***0.61***
Lower Wallace Fm.	DF	***0.76***	***0.85***	***0.81***	***0.67***	2.10	***0.59***
St. Regis Fm.	DF	***0.68***	1.37	***0.81***	***0.73***	1.30	***0.64***

*GF = grand fir (*Abies grandis*), DF = Douglas-fir (*Pseudotsuga menziesii*)

Sensitive Landtypes

Soils in the Broadaxe area are generally formed from volcanic ash deposits and underlying fine to coarse sediments derived from the bedrock parent materials. Quartzite and argillite members of the Proterozoic Belt Supergroup (Wallace and St. Regis Formations) underlie the majority of the area. Soils formed from these parent materials are weakly weathered and have relatively low strength.

High sensitivity landtypes are defined to have a high to moderate mass failure potential with a high or moderate potential to deliver sediment to a stream channel, or have a high

to moderate surface, subsurface, or substratum erosion hazard with a high potential to deliver sediment to a stream channel (SW4, SW6).

High sensitivity landtypes constitute approximately 163 acres or 5% of the Broadaxe project area. They include an avalanche chute (landtype 415) in the upper mainstem of Broadaxe Creek and alpine glaciated basins in two headwater areas. Landtype 415 (47 acres) also has a high mass failure hazard. Complete descriptions and management recommendations for each sensitive landtype are located in the project file document SW7.

Existing Condition

The effects of previous land management activities in the project area on native soil productivity and erosion were assessed to determine the current condition of the soils resource in the Broadaxe area.

The Broadaxe Project Area is a part of the middle St. Joe River Zone, where management-induced surface erosion has been identified as the dominant erosional process. Natural erosional processes have been identified as secondary to management-induced erosion in this zone (SW8).

Detrimental Soil Impacts

Detrimental soil impacts are defined as the proportion of an activity area that may be subjected to compaction, displacement or severe burning due to a particular management activity such as harvest or fuels treatment, exclusive of committed resources such as system roads and landings. Detrimental impacts can have negative effects on both soil productivity and erosion potential (Harvey et al., 1994).

There are no activities listed in the timber stand management database for the proposed action stands (see Management History Report. No stumps, skid trails, severely burned areas, or fireline were observed within the proposed action stands during field visits in summer 2003 and fall 2004 (SW2). Therefore, there are no existing detrimental impacts in any of the proposed salvage units. Monitoring of the 1998 Beetlemania salvage units in the lower Broadaxe drainage showed BMPs were implemented and highly effective in preventing erosion and achieving Regional soils guidelines (GR18, IPNF 2002 Forest Plan Monitoring and Evaluation Report, p.36; SW9).

There are approximately 20 miles of existing system roads in the Broadaxe drainage. Additionally, 4 miles of road decommissioning and storage has previously been completed in the drainage. Most of these road treatments were accomplished as part of the Beetlemania project in 1998 (SW9). Although these treatments included ground-disturbing activities such as recontouring and decompaction; over the long term, these areas will return to their full productivity potential.

Soil Nutrients and Productivity

The majority of previous activities in the project area occurred on soil developed from rocks of the Belt Group, which may be inherently low in certain soil nutrients. Portions of the proposed activity areas may also have lingering impacts due to wildfires that occurred around the turn of the century. The dominance of lodgepole pine in the project

area and the associated generally low volume of CWD and relatively thin fine organic matter layer in the proposed units are likely results of those fires.

Standards for retention of organic material on harvested units have been in place on the Idaho Panhandle since 1987 (GR2: IPNF Forest Plan, p. II-32-II-33). Manual direction clarified these standards (SW1) based on CWD recommendations in Graham et al. (1994) for maintenance of microorganisms and long-term soil productivity. No harvest activities have occurred in the stands proposed for salvage in the Broadaxe project.

Sensitive Landtypes

Approximately 25 acres on landtypes rated with high sensitivity have been harvested in the Broadaxe area. These two units in the headwater reaches of Broadaxe Creek were likely impacted by at least some ground-based harvesting. However, these stands would not be re-entered for the Broadaxe project and are topographically removed from the proposed salvage units. Stand 280-02-025 was clearcut and burned in 1984. The 12 acres of this stand underlain by landtype 211 may be over-saturated due to the loss of trees and may have limited regeneration due to brush competition. This stand is in a separate sub-drainage from any proposed action stands.

Environmental Consequences

Direct, Indirect & Cumulative Effects

No Action

In the no-action alternative, no new management-induced detrimental impacts would occur in the Broadaxe area. Lodgepole pine stands currently at high risk for mortality would not be treated. This could increase the risk of residual stand loss due to wildfire (Goheen and Hansen, 1993; see Fire/Fuels report), which could cause severe burning, resulting in hydrophobicity and loss of soil nutrients (SW10). In the likely absence of such a hot fire, nutrients would be retained on site. Cumulative effects of no action would only be the lingering detrimental impacts due to previous management activities in other stands in the Broadaxe drainage.

Proposed Action

The effects of the proposed action on the soil resource were assessed based on their potential to create detrimental impacts, as defined by the R1 Soil Management Supplement (SW1), and to ensure compliance with the Forest Plan Standard to maintain 80% productivity in the activity area (SW11). These effects are summarized in the project file document SW40. Potential effects on soil productivity and sensitive landtypes are also discussed (see EA Table 1 for descriptions of vegetative and fuels treatments and Broadaxe EA map for locations of activities).

Coarse woody debris guidelines have been adopted as design criteria to ensure soil nutrient continuity (see Design Features – SOILS). Nutrient management recommendations from the Intermountain Forest Tree Nutrition Cooperative (IFTNC; Garrison and Moore, 1998; Niehoff, 2002) would be implemented as appropriate in this project (see Design Features – SOILS).

Forest Service Handbook 2509.22 (Soil and Water Conservation Practices Handbook) outlines Best Management Practices (BMPs) and other standard mitigations that meet the intent of the soil and water protection elements of the Idaho Forest Practices Act. Through a memorandum of understanding with the State of Idaho (9/19/88), FSH 2509.22 replaces Forest Plan Appendix S - Best Management Practices. BMPs tiered to the Handbook and applicable to the Broadaxe project are included as design criteria (see Watershed Appendix) and would be applied during timber harvest, fuels treatments and roadwork. These techniques and their effectiveness are documented in several publications and Forest Service documents and websites (FSH 2509.22; GR16, 17, 18, IPNF Forest Plan Monitoring and Evaluation Reports 2000, 2001, 2002; USDA 2002a, LNF BMP Effectiveness Monitoring Report; Seyedbagheri, 1996; Lynch and Corbett, 1989 & 1990; Idaho DEQ, 2001).

Detrimental Soil Impacts

Soil impacts due to project activities were predicted using the IPNF Soil Disturbance Spreadsheet Model (Niehoff, 2002), which is tiered to the Regional Soil Manual Supplement (SW1). The model contains Forest-validated coefficients for percent detrimental impacts per activity area for vegetative and fuels treatments, assuming implementation of standard BMPs and soil and water conservation practices (Niehoff, 2002). No cumulative effects are anticipated in the proposed salvage units because these stands have not previously been entered (SW2).

The Spreadsheet Model predicts direct effects of up to 13% detrimental impacts in 6 proposed harvest units where ground-based harvest methods (yarding and/or falling) are proposed or anticipated (SW13). Where prescribed fire is proposed to treat activity fuels and prepare sites for planting, soil moisture requirements would limit the potential to destroy organic matter, create hydrophobic conditions, or induce significant nutrient losses (see Design Features and Watershed Appendix, FSH 2509.22). All potential detrimental disturbances may affect a total of up to 8% of the 509 acres proposed for harvest in the Broadaxe project area (or 1.25% of the drainage). Cumulative effects (as defined by the Regional Soil Manual: SW1) would only include those induced by project activities, as no previous management has occurred within the proposed salvage units.

Direct effects due to construction and recontouring of a temporary road are predicted in proposed Units 6 and 8. However, the predicted total disturbance is ≤13% in each activity area (SW13). This level of disturbance is too low to expect measurable negative effects to site productivity (Niehoff, 2002; Powers, 1990). In addition, hydrologic recovery has been documented to occur within 3 to 5 years of decommissioning (Hickenbottom, 2000 and Redente et al., 1994). Therefore, assuming a maximum period of use of 3 years, conditions may be expected to recover within 8 years of initial implementation. Productivity potential may recover somewhat more slowly, however, retention and addition of organic material on reclaimed roadbeds is a standard practice (see Design Features) and would provide nutrients as well as soil stabilization in these areas.

Although existing system roads are not considered to be part of the activity area at the Regional level, an analysis of the total impacts of roads to be used to complete the proposed activities was conducted to ensure compliance with the Forest Plan Standard.

Approximately 7.5 miles of existing system road would be used to move personnel, logs, and/or equipment to complete the harvest and fuels treatments. This could entail opening and/or reconditioning some segments. Combining the predicted detrimental impacts of proposed activities and the total area of existing system roads to be used for project implementation, cumulative soil impacts may affect up to 15% of the project activity area including forest roads to be used in the project area (SW13).

Soil Nutrients and Productivity

The proposed vegetative and activity fuels treatments are located on the St. Regis and Lower Wallace Formations and are expected to remove site nutrients with the removal of trees. Certain nutrients, particularly potassium, are known to be critical for tree resistance to insects and disease, especially root-rotting organisms (Garrison and Moore, 1998). It is also known that the soils in the project area are inherently deficient in some of these nutrients with respect to optimal levels for site vegetation (see Table 1). However, CWD would be retained at recommended levels in all units (see Design Features) by specification in marking plans and through contract administration. In seven proposed units, fuels treatment activities may result in some additional mortality of fire-intolerant species not to be harvested. This would generate additional CWD and organic matter that would cycle more nutrients back to the soil.

Although whole-tree yarding for fuels reduction is specified in 4 units, retention of fine organic material is expected to be relatively high compared to the existing condition in all units. Needles from dead lodgepole pine trees will likely have fallen to the ground prior to any harvest activities; and tops, limbs and needles of dead, dying and high-risk lodgepole pine trees would likely break off during falling and yarding activities. Retention of the majority of site nutrients is expected because approximately 75% of the nutrients taken up by trees are held in the branches, twigs, and foliage (Garrison and Moore, 1998).

Sensitive Landtypes

No ground-based vegetative or fuels treatment activities would occur on highly sensitive landtypes (SW4). Five acres of proposed Unit 9 overlaps landtypes with moderate to high mass failure and sub-soil erosion hazards. This portion of the unit would be hand felled and yarded with full-suspension, so no ground-disturbance or negative effects are expected. Because the harvest would only remove dead and dying trees, the effect on soil water uptake would be the same as no action, therefore, no additional saturation of unstable soils is expected. Skyline yarding would occur on approximately 60 acres of ground with moderate sensitivity due to mass failure potential. Because the logging system would minimally disturb the surface soil horizons and only dead and dying trees would be removed, the moderate mass failure potential would not be exacerbated.

No road construction is proposed on highly sensitive landtypes. Approximately, 0.2 miles of temporary road would be built on a landtype with moderate potential for mass failure. However, road construction is not contraindicated in the landtype map unit description (landtype 411, SW7). Project activities are not expected to exacerbate the potential for mass erosion, therefore there should be no significant individual or cumulative effects on sensitive landtypes due to project activities. The cumulative effects

of project activities on sediment delivery to streams is analyzed and discussed in the Watershed specialist's report.

Consistency with Forest Plan and Other Directives

IPNF Forest Plan Standards

Soil-disturbing management activities would maintain >80% of the activity area in a condition of acceptable productivity, as required by the Forest Plan.

The Regional guidance to follow the coarse woody debris recommendations of Graham et al. (1994) would adhere to the Forest Plan Standard to maintain sufficient microorganism populations for site productivity.

Where whole-tree logging is planned or anticipated, design features of the project, including IFTNC nutrient management recommendations, would ensure compliance with the Forest Plan Standard to maintain sufficient nutrient capital.

Management area direction to implement Best Management Practices would be included in the proposed action.

Regional Manual Recommendations

Detrimental disturbance would not exceed the recommended 15% in any individual activity area (harvest/fuels unit).

Fine 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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