PIQUETT FUELS PROJECT

Categorical Exclusion
Soils Specialist Report
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INTRODUCTION

This analysis describes the existing condition of the soil resource within the Piquett Fuels project area and evaluates potential direct, indirect, and cumulative effects of the proposed action.

POTENTIAL RESOURCE EFFECTS RELATED TO SOIL RESOURCES

The suite of potential management activities proposed within the Piquett Fuels project area have the potential to impair soil productivity through compaction, rutting, or displacement of soils through use of mechanized equipment. Additionally, prescribed burning could sustain or adversely affect soil condition. On productive areas with resilient soil conditions, the burning would enhance soil conditions with increased nutrient supply. In areas previously impacted from timber harvest and wildfire, prescribed burning prior to recovery of soil biogeochemical conditions may prolong soil recovery and potentially compromise long-term soil productivity.

While potential soils effects have been itemized in detail below, of note is that design features have been developed through this analysis to ensure that project activities would be in compliance with all relevant regulatory authority. Past monitoring of management activities with similar (if not identical) design features have been successfully implemented without compromising long-term soil productivity (per Bitterroot Forest Plan monitoring reports 2006-2018).

Changes to soil quality

Forest Service Manual (FSM) 2550 defines soil quality as "the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation and ecosystem health." Activities associated with the proposed action have the potential to influence multiple attributes of soil quality, including soil productivity (physical soil characteristics, organic matter and nutrients, soil organisms), soil erosion, and mass wasting / soil stability.

<u>Physical Soil Characteristics</u>

Heavy equipment may compact, displace, or rut soil, thereby reducing pore spaces and impeding root growth.

<u>Organic Matter and Nutrients</u>

Timber harvest has potential to reduce nutrient availability through redistribution and removal of organic matter from the site during harvest operations. Prescribed burning can have mixed effects since much of the area in departed conditions from what is considered natural. The impacts from timber harvest accompanied by heavy slash burning previously depleted soil organic matter. Prescribed burning, though designed to emulate natural processes, can potentially reduce long-term organic matter availability if not implemented at site-appropriate frequencies and under site-appropriate prescriptions. As noted above, implementation of prescribed burning prior to recovery of soil biogeochemical conditions following past management activity may prolong soil recovery and potentially compromise long-term soil productivity.

Soil Organisms

Soil organisms, including fungi and bacteria, drive nutrient cycling through symbiotic relationships where plants provide sugars and microorganisms provide readily available nutrients. Microorganisms also aid in decomposition of organic matter (which releases nutrients for plant growth). Management changes to organic matter from prescribed burning and mechanized harvest activities can affect soil organism activity. Adverse changes to soil condition occur where soil organisms have less air and water within topsoil. The disturbance also advances organism activity by increasing the available organic matter for decomposition.

Soil Erosion

Soil erosion can occur when the surface soil is compacted or when the loose surface soil and its protective layer of organic material are changed by management activities such as those proposed under the Piquett Fuels project. Loss of topsoil from erosion can adversely affect soil productivity by reducing water holding capacity, soil organic matter, nutrients, biota, and depth of soil.

Mass Wasting / Soil Stability

Roads can fail where road surface drainage concentrates and saturates soils. Mass failures triggered by human causes are detrimental soil disturbances if outside road templates. Road templates themselves are dedicated towards infrastructure rather than for growing vegetation.

Resource Indicators and Measures

Per the National Forest Management Act, Multiple Use Sustained Yield Act, and FS Region 1 and Bitterroot Forest Plan Direction, management activities must maintain long-term soil quality and productivity. As such, proposed activities will be evaluated to discern whether they would create a long-term reduction in soil quality. The benchmark by which this evaluated is the Region 1 detrimental soil disturbance guideline (FSM 2500-2014-1). This guideline states that detrimental soil disturbance should be limited to 15% or less of the activity area, not including system roads. If an area would exceed 15% detrimental disturbance as result of a project, then the project must include actions to mitigate cumulative impacts so the total impact is less than 15%. If the existing condition of an activity area already exceeds 15%, then the project must result in a net improvement in soil condition. While detrimental soil disturbances are the basis for the effects analysis, not all soil disturbances have a detrimental effect on soil productivity. Indicators for detrimental soil disturbance (DSD) for individual soil physical property attributes are defined by compaction, rutting, displacement, severely burned soils, surface erosion and mass failure (FSM 2500-2014-1).

The R1 soil guidelines do not account for variable habitat and soil type. In order to account for project-related changes in organic matter as they relate to coarse wood, this analysis will use changes in coarse wood as a secondary indicator of change in soil quality that could result from project implementation. To inform this analysis, information presented in *Soils, Wildlife, and Fire Requirements for Retention of*

Coarse Woody Debris: Assessment for Haacke Claremont Environmental Assessment (Mayn 2007) will be referenced that outlines forest plan direction, updated understanding of ecosystem dynamics related to coarse wood, and provides site-specific coarse wood guidelines. Though this document was edited to cater directly to the Haacke Claremont EA and its associated project area, the analysis conducted therein is relevant for the Piquett Fuels project area.

Table 1: Resource indicators and measures for assessing effects

Resource Element	Resource Indicator	Measure (Quantify if possible)	Used to address: P/N, or key issue?	Source (LRMP S/G; law or policy, BMPs, etc.)?
Soils	Changes in soil quality	Detrimental soil disturbance in excess of 15% on a per area basis	Key Issue	Federal law, FS R1 policy, Bitterroot FP
Soils	Changes in soil organic matter	Forest floor and coarse wood debris	No	FS R1 policy

SPATIAL AND TEMPORAL BOUNDS OF ANALYSIS

The Region 1 Supplement 2500-2014-1 (see project record) defines an activity area as a land area affected by a management activity to which soil quality standards are applied. Examples include timber harvest units, landings and temporary roads; mechanized fuel treatment units; and prescribed burn units. Activities outside of the locations of proposed management are not subject to a cumulative effects analysis because they do not overlap spatially with the lands being proposed for management in the Piquett project area. Soil effects do not extend off of the piece of ground where they occur.

Under the condition-based analysis framework being used for this project, environmental consequences are analyzed for all acres within the project boundary, subject to the design features and mitigations prescribed within the analysis. Such a framework would suggest that the 15% DSD soil resource indicator should be considered across the entire project area; i.e. so long as less than 15% of soils within the entire 5800 acre project area are detrimentally disturbed, project activities would be in compliance with R1 soil guidelines. Application of this resource indicator across an entire project area, however, could potentially allow for adverse soil effects in both magnitude and extent across nearly 900 acres of the designated project area, which is not in line with law, regulation, and policy. As such, this analysis will apply the 15% DSD soil resource indicator at the same scale as it is traditionally used under "unit-based" NEPA analyses. Typical units sizes range from 10 to 40 acres.

With respect to temporal bounds, soil and vegetation recovery following low severity burning generally occurs rapidly (e.g. Neary et al 2005; Robichaud et al. 2010). Silvicultural prescriptions for this project work are designed with the intent of stand re-entry in approximately 30-35 years. Accordingly, this analysis addresses the potential effects of this project on soil productivity through that same time frame.

METHODS AND DATA SOURCES

The soils analysis is based on the current soil condition as well as analysis of relative site potential and analyzes the effects to soil quality and productivity that may be caused by implementation of the proposed management activities. Road- related erosion and sediment yield is analyzed in the Water Resources analysis and as such as not been further analyzed here.

Soil characterization using mapped data

Bedrock geology was assessed using best available 1:100,000 mapped quad (Berg and Lonn 1996) available through MBMG's seamless server (http://mbmg.mtech.edu/information/geologicmap.asp) and via the Bitterroot N.F.'s geospatial library.

The Soil Survey of the Bitterroot National Forest Area (USDA NRCS 2019) served as the primary data source for describing soil resources in the project area. These data were accessed through the Bitterroot National Forest Geospatial Library, Web Soil Survey (USDA NRCS 2019), and SoilWeb (https://casoilresource.lawr.ucdavis.edu/gmap/). Interpretive queries developed by NRCS provided further soils characterization information and supplemented the assessment of management-related soils limitations.

Detrimental soil disturbance monitoring

Detrimental soil disturbance was evaluated using the Forest Soil Disturbance Monitoring Protocol (FSDMP) (Page-Dumroese et al. 2009). The FSDMP method is designed to provide a statistically valid rapid assessment of soil conditions based on visual indicators to describe surface conditions that affect site sustainability, hydrologic function, and site productivity. The FSDMP is intended to be used nationwide so that monitoring data will be consistent across the country and at the same time, provide room for local interpretation of whether different levels of impact are detrimental within a given ecological condition. The protocol consists of a randomized transect grid sample within a project unit. A minimum of 30 sample points is required to achieve statistically valid estimates (see project file); greater stand variability will require more sample points to provide the same level of statistical confidence. At predetermined frequencies, a suite of visual indicators are assessed and one of four soil disturbance classes are assigned. Class 0 soil disturbance is in effect a natural undisturbed soil condition, while Class 3 disturbance is significantly disturbed through rutting, compaction, burning, topsoil displacement, or some combination of these attributes. See Page-Dumroese et al. 2009 for more detailed discussion of the FSDMP protocol and how soil disturbance classes are defined.

Based on broader regional convention and guidance from FSDMP protocol authors, Class 2 and 3 soil disturbances are generally considered detrimental.

In order to assess existing conditions, past harvest units were selected for monitoring using the FACTS activity database. Units were selected to represent a range of years since last entry and a variety of harvest intensities. Some of these activities were implemented prior to modern NEPA analysis in absence of policy surrounding maintenance of long-term soil productivity and without the range of typical design features used to mitigate adverse soil effects. As such, conditions observed within the Piquett Fuels project boundary may not be wholly representative of conditions that may be observed following implementation of project activities. These monitored units, however, likely represent a complete range of disturbed conditions within the project boundary from no human-caused DSD to a "worst-case" situation where units may still be recovering from past management activities.

Other datasets and databases

The Forest Service's Forest Activities Tracking (FACTS) database provided information on past management activities that have been undertaken within the project area. These data are available within the Bitterroot N.F.'s geospatial library. Other geospatial data was used for both cartographic and geospatial analysis purposes, including but not limited to roads data, hillshading, wildfire history, and aerial imagery.

Climatic water deficit comprised a critical data source for this analysis. This 30 meter grid resolution dataset is an annual representation of the difference between potential evapotranspiration and actual evapotranspiration (PET – AET) (Dobrowski et al 2012; Abatzoglou et al 2014; tertiary data processing by Z Holden, USFS R1 Regional Office). Data are available within the Forest Service's Region 1 corporate GIS library.

EXISTING CONDITION

Geologic/geomorphic context

Approximately 96% of the Piquett Fuels project area is underlain by granite or metamorphosed variants (monzogranite/granodiorite). These parent materials often produce coarse-textured, well-drained soils with high coarse fragment contents, though soils mapped in monzogranite in some cases are clay-enriched. The other approximately four percent of the project area is comprised of felsic intrusive rock underlying an upland hillslope in the Violet Creek Drainage and alluvium within the West Fork Bitterroot River valley bottom.

All of the soils in the nearly 5800 acre project area have been mapped as complexes within 29 unique landtypes (the Bitterroot N.F. has a landtype-based soil survey that accounts for geomorphology in tandem with soil properties). Approximately 50% of the project area is comprised of five landtypes spanning dissected mountain slopes. A number of soil families are represented within these five landtypes (see Appendix D). Soils within these families generally display poor development and are often shallow, particularly on south aspects. Soil map unit descriptions suggest that some map units may also have argillic (i.e. clay-enriched) subsurface mineral horizons. This map unit attribute has not been validated in the field to date. Soils with clay enrichment may be more susceptible to compaction from ground-based harvest activities, but the coarseness of the soils may offset this risk to some extent; overall risk related to soil texture is site-specific in nature. Further assessment of overall soil risk to disturbance will be discussed below.

Previous land management pertinent to soils effects analysis

The Piquett Fuels project area has a long history of active management. The FACTS database includes commercial harvest activities dating to the 1960's in the project area. Approximately 2700 acres of management activities have been documented within the project area, with some units have received multiple treatments through the years. Just under half of the managed acres documented in facts were treated with silvicultural prescriptions that removed the majority of standing timber (stand clearcut/shelterwood removal cut/seed tree cut). The majority of this work was completed via ground-based harvest systems in the mid 1960's and mid 1980's.The most recent harvest activities occurred in 1995.

All units clearcut in the 1960's were converted to terrace plantations. While no field reconnaissance has been completed to date on terraces within the Piquett Fuels project area, a number of terraces were evaluated within the Mud Creek project area, which borders the project area to the southwest and has similar physiography and parent geology. When constructed, benches were cut exposing bare mineral soil- often devoid of or having limited organic enrichment - and pushing the surface organic-enriched soils off of the flat bench to the riser slope between terrace benches.

Today, terraces in this area display a range of soil conditions. Some terrace benches support diverse understory vegetation assemblages resembling those seen in undisturbed adjacent stands. Organic litter and duff has accumulated on site. Soils across these sites display limited to no compaction, intact soil aggregates, abundant fine root expression, and the beginnings of organic enrichment at and near the soil surface.

In contrast to these sites, some areas, particularly south aspects with shallow depths to bedrock, display virtually no understory revegetation (invasives can be a concern), only a thick (on the order of half an inch to an inch) bed of ponderosa pine needles. Soils are still compacted and display little to no organic matter recovery.

No past prescribed burning has been documented within the Piquett Fuels project area in the FACTS database.

Past Wildfire Activity

Just over 5300 acres of recorded wildfire (included areas that have re-burned) have been documented within the Piquett Fuels project area. Nearly 3900 acres of the project area was burned or re-burned by wildfires prior to 1940. The remaining 1400 acres was burned during the fires of 2000 and the Rombo fire in 2007. Inevitably, the area burned under a range of fire intensities and severities.

Based on observations in the Mud Creek project area and field assessment within the Piquett Fuels project area, evidence of past fire impacts to soil physical properties were not observed. Since fire effects typically are transient, with most within the first few years, the largest lasting effects may be the reduced amount of forest floor organics and coarse wood. Soil condition as it relates to wildfire and coarse wood will be evaluated during individual project development within the broader Piquett Fuels project area.

Soil Disturbance Monitoring

Seven units covering approximately 357 acres were monitored within the Piquett Fuels project area. Four units covering approximately 221 acres have persistent soil disturbance from past timber management, with only two units having disturbance defined as detrimental. Signs of past disturbance included pockets of understory plants with less diversity and abundance than corresponding undisturbed areas, limited organic matter recovery, and rutting. These areas were generally small and isolated and, as noted above, not deemed detrimental in every instance. Persistent disturbance is likely attributable to past ground-based yarding.

All units where soil disturbance was noted were lumped together for the purposes of this analysis (see Efta 2020, project record)

To better discern what edaphic, physiographic, climatic, and/or management-specific controls may be influencing persistence of detrimental soil disturbance, further analysis was undertaken. Monitored units were overlaid with bedrock geology and soils map units and visually evaluated in ArcGIS to look for correlation. Harvest activity, harvest method, and years since past harvest were reviewed concurrently. Summary statistics were computed for gridded climatic water deficit data using monitored units as zonal boundaries.

While the number of monitored stands is small, analysis suggests that site recovery and resilience to soil disturbance (or lack thereof) may be better predicted by climatic water deficit than by soil map unit, parent geology, harvest type, or time since past stand entry. While more field data is necessary to validate this hypothesis, available data and field observation from adjacent project areas suggests that application of climatic water deficit as a surrogate for soil resilience is a reasonable approach for constructing a soil risk evaluation framework under condition-based soils analysis. A more comprehensive report on these methods is found in Efta (2020) in the project record.

SOIL RISK EVALUATION FRAMEWORK UNDER THE CONDITION-BASED IMPLEMENTATION PROCESS

Applying the above analysis for soil resource management within the Piquett Fuels project area, a soil productivity risk matrix was developed. The matrix consisted of two primary factors – a soil resiliency index and levels of existing soil disturbance that could complicate recovery of proposed forestry treatments (see Appendix A). The soil resiliency index was developed from water deficit data and classified into high and low categories. High resiliency is associated with low water deficit since these areas have greater potential soil water for growth. Low resiliency has higher levels of solar exposure and thus higher summer water deficit such as low elevation south facing slopes. The threshold was based on field data, observed recovery and aerial photo interpretation of reforestation canopy. The second matrix factor spans three levels of soil condition: no sign of soil disturbance, potential soil disturbance from past management, and verified soil disturbance from past management.

For each soil risk category (SRC), a general narrative description was developed to understand and contexualize the risk posed to soil resources should a management activity be proposed at a given location with the project area. Appendix A gives the complete Soil Risk Matrix and SRC narrative descriptions.

Project activities analyzed under a condition-based analysis approach on the Bitterroot National Forest will rely on two key components to ensure compliance with laws, regulations, and policies and that project-related effects remain within the bounds under which they were analyzed.

- Prescriptions (activity cards); and
- Implementation Plan

Prescription (activity cards):

The first component is a prescription for a specific activity (e.g. regeneration harvest). This prescription (hereafter referred to as an activity card) will specify the how, what, when, and where a specific activity can (or perhaps cannot) take place as well as resource-specific requirements and/or limitations to that activity. These resource-specific limitations may reference Forest Plan standards, other laws, regulations, and policies, or may be specific to the geographic area (e.g. HUC or stand-scale) for which the activity is being considered.

Implementation Plan:
The second component is an implementation plan which outlines the procedural steps for taking a signed decision and implementing activities on the ground. Both components are documented in appendices and included with the environmental document as part of the signed decision.

The project implementation plan details the steps required to conduct treatment actions that will shift project area existing conditions to desired conditions. Implementation starts by identifying a treatment area (a subset of drainage(s) within the larger analysis area) and set of actions by the line officer. The actions are checked against the environmental document and decision to ensure the activity was analyzed. Public input is requested on the treatment area and actions to be taken. An out-year plan is then developed from which project proponents will develop an initial set of treatment units, temporary road routes, and other location specific implementation details. This out-year plan is cross-referenced with resource-specific guidance and limitations listed in the activity cards to ensure the plan is in compliance with design elements, Forest Plan standards, other regulatory requirements, and spatial and temporal constraints.

Once an initial set of treatment units is developed, resource specialists will review the out-year plan. This review may require on-the-ground surveys to determine resource conditions. Treatment unit boundary adjustments, restrictions on treatment timing, and other mitigations may be required depending on proposed treatment units and resource conditions. The out-year plan is modified and adjusted based on resource specialist input through an interdisciplinary team process. Surveys and mitigations are all documented and become part of the project file. The line officer then approves the revised out-year plan at which point timber sales may be advertised and service contracts developed.

The last component of the implementation plan is monitoring. Monitoring is critical both during project implementation to ensure compliance with criteria listed in the activity cards as well as post-implementation to assess and document design element effectiveness and adapt (if needed) prior to development of the next out-year plan.

Application of the Soil Risk Evaluation Framework

Under the condition-based analysis framework for the Piquett Fuels project, proposed vegetation management activities would be developed collaboratively between the forest soils specialist and other IDT members during the out-year plan development process. While developing individual treatment proposals within the out-year plan (i.e. prescribed burning, commercial harvest, or road work) the forest soil scientist would determine the Soil Risk Category (SRC) or Categories that the proposed activities would fall within (see **Appendix A**) from the map products available in the project record (also see **Appendix C**). The SRC would determine the type and intensity of field reconnaissance necessary to support project implementation. Additionally, SRCs would guide development of additional design features or project modifications if/when deemed necessary.

As an example application of the framework, say that ground-based commercial harvest is proposed in a portion of the Piquett Fuels project area that has been mapped as SRC D. Under this category, past harvest activities have been documented but there is no known occurrence of persisting long-term soil productivity. Determination of existing DSD within these areas would be required. Relative soil resilience is also limited for category SRC D. In this category, ground-based commercial timber harvest constitutes a higher risk to long-term soil productivity than in areas proposed to have higher soil resilience (SRC categories A, C, and E with low water deficit = higher relative resilience). If DSD is found to be persisting on the site, additional design features may be required to ensure that long-term soil productivity would be maintained following project implementation in SRC D category soils.

Following adaptation of proposed project activities to SRCs, monitoring would be necessary to evaluate whether proposed design features and associated mitigation and avoidance strategies were effective at maintaining long-term soil productivity. These data, in turn, can be used to refine thresholds for developing SRCs and for making recommendations as to which activities may be successful or not within a given SRC.

ENVIRONMENTAL CONSEQUENCES

Under this condition-based analysis paradigm, evaluation of resource effects requires assurance that all aspects of the implementation plan (of which the above soil risk evaluation framework is a part) are fully carried out. As noted above, the implementation plan includes steps to ensure that all proposed activities are evaluated and deemed appropriate by interdisciplinary team members. Additionally, the implementation plan ensures that all relevant design features have been applied or are developed so that desired conditions are achieved following implementation.

This comprises a critical assumption necessary for a finding of No Extraordinary Circumstances for soils. Provided that this assumption can be met, the following set of direct and indirect effects is anticipated.

Direct/Indirect Effects:
The following analysis details the project impacts to soil quality and changes to soil organic matter.

Physical Soil Characteristics

Under the proposed action, direct effects on soil physical characteristics would occur only within the boundaries of the treated units. Most detrimental effects would be concentrated on primary skid trails and landings.

The proposed treatment areas would be harvested using designated trails and landings that are laid out to spatially occupy less than 15 percent of the activity unit. To the extent feasible, trails and landings would utilize existing roads and trails. Use of existing roads and trails would reduce the amount of new disturbance, as would operating under low moisture soil conditions or over snow and frozen ground. Coarse textured soils with high coarse fragment contents and ample drainage are less prone to compaction, rutting, and loss of soil structure when driven upon, making them conducive to less DSD than some other soil types. Soils with high coarse fragment contents and limited vegetation cover, however, can be more susceptible to displacement. Implementation of project design features (including, but not limited to: operating within specific soil moisture conditions, adhering to prescribed season of operation, operating exclusively on designated trails and landings) would minimize risk of extensive topsoil displacement.

Reeves and others (2011) collected, collated, and statistically analyzed current and legacy soil monitoring data from 11 National Forests in the Forest Service's Northern Region. Mean detrimental soil disturbance for ground-based harvest on the Bitterroot National Forest was found to be 7.4%. Note that only nine units were analyzed for this study. The one skyline harvest evaluated in the publication was found to have approximately 2% DSD.

The 2018 Bitterroot N.F. Biennial Monitoring Evaluation Report contains a recent compendium of past soils monitoring across the forest (USDA Forest Service 2019). Analysis conveyed within the report shows that harvest activities have displayed consistent downward trends in DSD since the 1990s and over the past five years per-harvest unit DSD has generally fallen below 10%, with minor exception. DSD associated with skyline harvest has been observed to be 4% or less over the past eight years.

It is explicitly noted within the report that ground-based skidding on slopes at or near 40% gradient pose the greatest concern due to potential for topsoil displacement. This concern would be addressed with implementation of the design feature limiting operations on gradients greater than 35%.

Site recovery would be expedited through reclamation of the temporary road and skid trails. These activities may include, but not be limited to, seeding with native plants and soil aeration/ripping. Dick et al. (1988) found that subsoiling (tilling) restored biological processes that were reduced by soil compaction. In general, tilling or scarifying a compacted soil improves productivity by reducing the resistance of soil to root penetration, and providing improved soil drainage and aeration to enhance seedling establishment and tree growth (Bulmer 1998) and improve the environment for soil organisms. Of note is that the goal of soil restoration is to set the stage for the soil to begin the recovery process; soil restoration is not an immediate result of ripping, planting, or any other activity.

Through application of the soil risk evaluation framework, tools for achieving desired conditions would be informed by site-specific soil resilience, thereby minimizing recovery duration.

Changes to Organic Matter and Nutrients from Commercial Harvest

For all proposed harvest units, coarse wood would be retained on site as outlined within the design features for the project. Maintenance of down coarse wood within the natural range of variability for the project area habitat types and compliance with R1 soil quality guidelines would ensure coarse wood benefits to soil organic matter and microsite would endure in units proposed exclusively for commercial timber harvest.

Through implementation of design features, surface organic matter would not be stripped or displaced off site, thereby preventing reoccurrence of the same soil resource effects persisting on site following the past harvest entry. Implementation of proposed reclamation measures following completion of project activities would further ensure that organic matter is not permanently removed.

Changes to Organic Matter and Nutrients from Prescribed Burning

Prescribed fire burn plans would be designed to achieve low to moderate intensity/severity fire effects across the proposed burn units. Nutrients in litter and organic horizons are readily volatilized during combustion (DeBano 1990). Under burn intensities and severities encountered during prescribed burning, however, a portion of nutrients, cations, and organic material would remain available as a result of incomplete consumption of litter and organic material. Short-lived periodic increases in plant available nitrogen (the most limiting nutrient in these ecosystems) would occur followed by rapid vegetation uptake (Neary et al. 2005).

Plant regrowth would be most rapid in the first years following prescribed burning. Soil and vegetation recovery following low severity burning generally occurs rapidly (e.g Neary et al 2005; Robichaud et al 2010). Sites burned under low intensity/severity have been shown to recover within 1-3 years post-fire.

The most impacted soils from burning would not occur within prescribed fire areas, but at pile burning sites within timber harvest units. Pile burning would result in loss of organic matter across localized areas within treated units. Implementation of site reclamation would ensure site recovery and maintenance of long-term soil productivity.

Construction of fireline using mechanized equipment would entail driving machinery along the unit boundary and scraping surface organic matter from an approximately three foot wide swath to bare mineral soil. Some topsoil displacement would be inevitable. Organic matter and displaced topsoil would be raked back across the fireline following burning operations, thereby ensuring that no long-term organic matter deficit persists.

Soil Organisms

With the symbiotic relationship between soil organisms and soil organic matter, response of soil organisms to proposed management activities is expected to correspond to soil organic matter dynamics. Accordingly, through maintenance of coarse wood and minimizing soil disturbance during operations, the effects to soil microorganisms would be minor. The ability of soil microorganisms to move from undisturbed sites to disturbed sites would minimize losses and facilitate recovery of soil microbiology. A variety of organic matter would remain on all sites, including living trees where available and other forest vegetation. In addition, the existing organic layer on the soil surface would be retained over at least 85 percent of the area, providing habitat and nutrients for soil microorganisms.

Soil Erosion

There is potential for increased soil erosion from mechanized operations (specifically skid trails and landings). This potential can be minimized through maintenance of surface organic matter as discussed above along with successful implementation of proposed design features and standard timber sale contract provisions. Well-drained, coarse textured soils (which pervade much of the project area) are less susceptible to erosion that finer textured soils that drain less readily.

Following project implementation, reclamation of landings and skid trails would minimize post-treatment erosion potential. As vegetation recovers on site, erosion potential is expected to decrease to background levels.

Soil erosion associated with project activities has been discussed in further detail within the Water Resources Report.

Mass Wasting

The potential for project-related mass wasting is low. Recent mass wasting associated with forest roads has coincided with impaired road drainage, such as plugged culverts or ditches that allowed for water to run out onto the road prism and saturate road fill.

Temporary road locations would be informed by the soil risk evaluation process to minimize duration of effects and/or avoid adverse effects to soil productivity. During project implementation, Best Management Practices on the temporary road and haul roads would be maintained at appropriate intervals through contract oversight. In doing so, the potential for project-related mass-wasting is low. Further, temporary road construction associated with project activities would be reclaimed immediately following conclusion of project activities, thereby minimizing risk of failure by minimizing timeframe that the road exists.

RESOURCE SPECIALIST CATEGORICAL EXCLUSION REVIEW

Extraordinary Circumstances:

1. **Are any resource conditions present? ___No____ If yes, address in more detail in part 2 below.**

2. **If resource conditions are present, could the proposed action have any extraordinary environmental effects? ____N/A___**

3. **For your resource area of expertise, is this proposal consistent with Forest Plan standards, guidelines, and Management Area direction? YES, if mitigations listed previously are included and the project implementation plan is adhered to.**

Forest Plan

Under implementation of the Proposed Action, long-term soil quality and/or productivity is not expected to be compromised. Through adherence to the implementation plan, implementation of all design features, applicable BMPs, and standard timber sale contract provisions, soil resources would maintain soil productivity, thereby keeping project work in line with Forest Plan Goals, objectives, and standards.

4. **For your resource area of expertise, is this proposal consistent with all applicable laws and regulations? YES, if mitigations listed previously are included and the project implementation plan is adhered to.**

Forest and Rangeland Renewable Resources Planning Act of 1974 (16 U.S.C. 1600-1614) (as amended by National Forest Management Act (NFMA) of 1976 (16 U.S.C. 472a)

The Forest and Rangeland Renewable Resources Planning Act states that development and administration of the renewable resources of the National Forest System are to be governed by those concepts outlined within the Multiple-Use Sustained Yield Act of 1960. Through this mandate, the act requires maintenance of land productivity as well as conservation and/or restoration where appropriate. Specific excerpts pertinent to soil resources include:

Section 2 (16 USC 1600). Under general findings, the law states that "(3) to serve the national interest, the renewable resource program must be based on a comprehensive assessment of present and anticipated uses, demand for, and supply of renewable resources from the Nation's public and private forests and rangelands, through analysis of environmental and economic impacts, coordination of multiple use and sustained yield opportunities as provided in the Multiple-Use, Sustained-Yield Act of 1960 (74 Stat. 215; 16 U.S.C. 528-531), and public participation in the development of the program;"

Section 4 (16 USC 1602) directs the Secretary of Agriculture to formulate a Renewable Resource Plan. "The Program will include, but not be limited to- "(C) recognize the fundamental need to protect and where appropriate, improve the quality of soil, water, and air resources;"

Section 6 (16 USC 1604). This section directs the creation of forest and land management plans that must "(E) ensure that timber will be harvested from National Forest System lands only where- "(i) soil, slope, or other watershed conditions will not be irreversibly damaged;"

Long-term soil quality and productivity would be maintained through adherence to the implementation plan and implementation of design features and BMPs during project implementation. Irreversible damage to soil resources is not anticipated. As such, this work would be in compliance with the Forest and Rangeland Renewable Resources Planning Act of 1974 (as amended under NFMA 1976).

Multiple Use Sustained Yield Act of 1960

Per the MUSYA of 1960, national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes (16 USC 2 (I); Sec 528). Through implementation of proposed design features and pertinent BMPs, implementation of project work would not preclude "regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land."

Forest Service Region 1 Guidelines

Regional Forest Service guidelines require that National Forest System lands be managed to prevent permanent impairment of land productivity, and maintain or improve soil quality (USDA 2014). Soil quality is maintained when erosion, compaction, displacement, rutting, burning, and loss of organic matter are maintained within defined soil quality standards.

Region 1 guidelines state that detrimental soil disturbance should be limited to 15% or less of the activity area, not including system roads. If an area would exceed 15% detrimental disturbance as result of a project, then the project must include actions to mitigate cumulative impacts so the total impact is less than 15%. If the existing condition of an activity area already exceeds 15%, then the project must result in a net improvement in soil condition. While detrimental soil disturbances are the basis for the effects analysis, not all soil disturbances have a detrimental effect on soil productivity.

Per FSM 2500-2014-1, detrimental soil disturbance (DSD) for individual soil physical property attributes is defined as:

> Compaction. Detrimental compaction is a 15 percent increase in natural bulk density. The cumulative effects of multiple site entries on compaction should also be considered since compacted soils often recover slowly.
>
> Rutting. Wheel ruts at least 2 inches deep in wet soils are detrimental.
>
> Displacement. Detrimental displacement is the removal of 1 or more inches (depth) of any surface soil horizon, usually the A horizon, from a continuous area greater than 100 square feet.
>
> Severely-burned Soil. Physical and biological changes to soil resulting from high-intensity burns of long duration are detrimental. This standard is used when evaluating prescribed fire. Guidelines for assessing burn intensity are contained in the Burned-Area Emergency Rehabilitation Handbook (FSH 2509.13).

Surface Erosion. Rills, gullies, pedestals, and soil deposition are all indicators of detrimental surface erosion. Minimum amounts of ground cover necessary to keep soil loss to within tolerable limits (generally less than 1 to 2 tons per acre per year) should be established locally depending on site characteristics.

Soil Mass Movement. Any soil mass movement caused by management activities is detrimental.

As with the other regulatory authorities mentioned above, implementation of design features and applicable BMPs would ensure that project work would comply with FS Region 1 Soil Quality Guidelines.

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APPENDIX A. SOIL RISK EVALUATION FRAMEWORK

Soil resilience (inverse of climatic water deficit)	Water deficit range	No known past activities	Past activities	Past activities with known DSD
High	371-500	A	C	E
Low	500-589	B	D	F

Soil Risk Category (SRC)	Narrative Description
A	There are no documented past management activities within these areas and relative soil resilience within this area is considered high (i.e. better than the rest of the project area). **Actions:** Proposed project activities are subject to the standard range of design features contained in Appendix B.
B	No known past activities have occurred within these areas, but soil resilience following disturbance will be more limited than in SRC A. Management activities have potential to have more prolonged impacts than in SRC A. **Actions:** Careful selection of management activities may be required to ensure long-term soil productivity and additional design features beyond those contained in Appendix B may be warranted.
C	Past management activities have been documented in these areas, but there are currently no documented instances of persisting short- or long-term soil productivity compromise from past project implementation. Relative soil resilience is considered high. **Actions:** Inventory of persisting detrimental soil disturbance will be required within these project areas. Proposed project activities are subject to the standard range of design features contained in Appendix B. Should persisting DSD from past management activities be found during field reconnaissance, proposed project activities may need to be modified to avoid adverse soil resource effects.
D	Past management activities have been documented in these areas, but there are currently no documented instances of persisting short- or long-term soil productivity compromise from past project implementation, but likelihood of persistence is higher than under SRC C. Relative soil resilience is limited. **Actions:** Careful selection of management activities may be required to ensure long-term soil productivity and additional design features may be warranted. Should persisting DSD from past management activities be found during field reconnaissance, proposed project activities may need to be modified to avoid adverse soil resource effects.
E	Past management activities in these areas has created persisting long-term detrimental soil disturbance. More information is needed to discern the extent to which natural site potential versus differences in past harvest practices may have influenced persisting concerns in these areas. **Actions:** Careful selection of management activities may be required to ensure long-term soil productivity and additional design features may be warranted. Proposed project activities may need to be modified to avoid adverse soil resource effects.
F	Past management activities in these areas has created persisting long-term detrimental soil disturbance. Management activities may have more prolonged impacts than in SRCs A, C, and E. **Actions:** Careful selection of management activities is required to ensure long-term soil productivity and additional design features may be warranted. Avoidance of commercial harvest or prescribed burning in the areas should be considered as well as exploration of potential restoration opportunities. If project activities are deemed necessary and/or appropriate, additional design features may be necessary.

APPENDIX B. STANDARD DESIGN FEATURES/MITIGATIONS

Commercial harvest

- To a) ensure maintenance of long-term soil productivity through continued nutrient input and on-site moisture retention and b) meet understory wildlife habitat requirements, coarse woody material would be retained on-site upon completion of project activities per those guidelines outlined in *Soils, Wildlife, and Fire Requirements for Retention of Coarse Woody Debris: Assessment for Haacke Claremont Environmental Assessment* (Mayn 2007- further updates in progress). Larger diameter (15 inches or greater) unmerchantable material, not contained within trees designated to be cut, would not be yarded in units where coarse woody debris tonnages are less than prescribed. At the timber sale pre-work conference, purchaser shall be encouraged to use largest diameter material available to meet this requirement.

- Selected project units that overlap with past harvest activities would be visited in the field prior to implementation of commercial harvest activities. General soil morphologic characterization will be conducted along with detrimental soil disturbance monitoring. These will be done in effort to a) establish a baseline against which to evaluate change in detrimental soil disturbance post implementation and b) determine whether any further design features or mitigations may be required to ensure project activities maintain long-term soil productivity. Selection of units to monitor prior to project implementation would be based upon the soil risk matrix (soil resiliency and soil condition from past timber harvest). Additional factors could include but not limited to:
    - Time since last harvest entry;
    - Past harvest type;
    - Susceptibility to detrimental soil disturbance based on mapped soil, geologic, and geomorphic attributes.

Ground-based yarding

- To minimize extent of project-related detrimental soil disturbance, harvest operations should utilize existing (i.e. previously used) skid trails and/or road beds whenever feasible.
- Ground-based yarding should be generally restricted to slopes 35 percent or less, as directed in the 1999 Bitterroot Forest Plan Monitoring Report and supported by subsequent monitoring. While the Bitterroot Forest Plan allows for ground-based yarding on up to 40 percent slopes, restricting operations to 35 percent slopes or less has been shown to minimize soil displacement and compaction due to rutting.
- To avoid excess soil compaction and/or displacement, ground-based yarding would only occur when soils are sufficiently dry or during appropriate winter conditions. These conditions can be further described as follows:
    - Dry conditions: Sufficiently dry operating conditions exist when the top six inches of mineral soil **does not** form a soft ball when squeezed in the palm of the hand and free water **is not** on the surface of the sample when squeezed or shaken. Contact the Forest Soil Scientist if questions arise.

- Winter conditions: Ground-based operations must maintain the following combination of snow depth and frozen soil conditions under the wheels or tracks/treads of equipment at all times.

Depth of compacted (by equipment) snow under wheels or track/tread*	**Minimum thickness of solidly frozen soil needed below compacted snow layer**
10 or more inches	0 inches
7 to 10 inches	1 inch
4 to 7 inches	2 inches
less than 4 inches	4 inches

* Pre-trailing. Pre-trailing selected skid trails a day or so prior to skidding or other heavy trail use is a way to achieve this objective. If average, pre-compacted snow depth along the proposed trail is more than 15 inches, pre-trailing can be done whether or not the soil is frozen. If pre-compacted snow depth is 8 to 15 inches; pre-trailing should be done only if the soil is solidly frozen in the top one inch or more. Otherwise, pre-trailing should be delayed until more snow falls to accumulate to the 15 inch or more depth. To further aid soil protection, pre-trailing should be done using an “easy-does-it” approach, including slow ground speeds and steady movements. Avoid spinning tires and bouncing equipment around on trails as much as possible. Adequate pre-trailing air temperatures generally are in the low 20’s Fahrenheit or lower. For more information about pre-trailing conditions, consult with the Forest soil scientist.

- To expedite recovery in light of recent soil disturbance incurred during the previous entry, primary skid trails in ground-based harvest units would be slashed, seeded, and fertilized following completion of project activities.

Prescribed burning

Broadcast burning

- To prevent detrimental accelerated erosion and associated loss of soil productivity, prescribed burning would use the soil risk matrix to design burn prescriptions. Burn operations should ensure that at least 70 percent ground cover is maintained within each prescribed fire unit boundary. In cases where ground cover is less than 70 percent prior to burning, consumption and loss of ground cover should not exceed 15 percent. Ground cover includes duff, organic soil horizons, leaf litter and needlecast, ground cover associated with understory vegetation, fine and coarse woody debris, and surface coarse fragments. Prescribed fire prescriptions would be designed to meet these soil protection requirements.
- Coarse wood requirements would be considered when designing burn prescriptions. Coarse wood larger than 15 inches in diameter would not be *intentionally* ignited by crews during hand lighting operations.
- Prior to burning, harvest-related slash would be left for one winter after cutting to allow for initial decomposition and nutrient leaching.
- Fireline construction using mechanized equipment would be required to adhere to the same soil moisture guidelines as those required during ground-based commercial harvest operations; sufficiently dry operating conditions exist when the top six inches of mineral soil **does not** form

a soft ball when squeezed in the palm of the hand and free water **is not** on the surface of the sample when squeezed or shaken.

- To expedite site recovery, constructed fireline would be rehabilitated as soon as possible following completion of project activities, preferably within the same calendar year if not the following field season. Fireline rehabilitation would include, but not be limited to, replacement of displaced vegetation to minimize extent of exposed mineral soil and placement of slash across the line.
- To ensure maintenance of long-term soil productivity through continued nutrient input and on-site moisture retention, coarse woody material would be retained on-site upon completion of project activities based on assumed fire groups/vegetation response units within proposed project units (per Mayn 2007).

Hand piling and burning (not associated with landings)

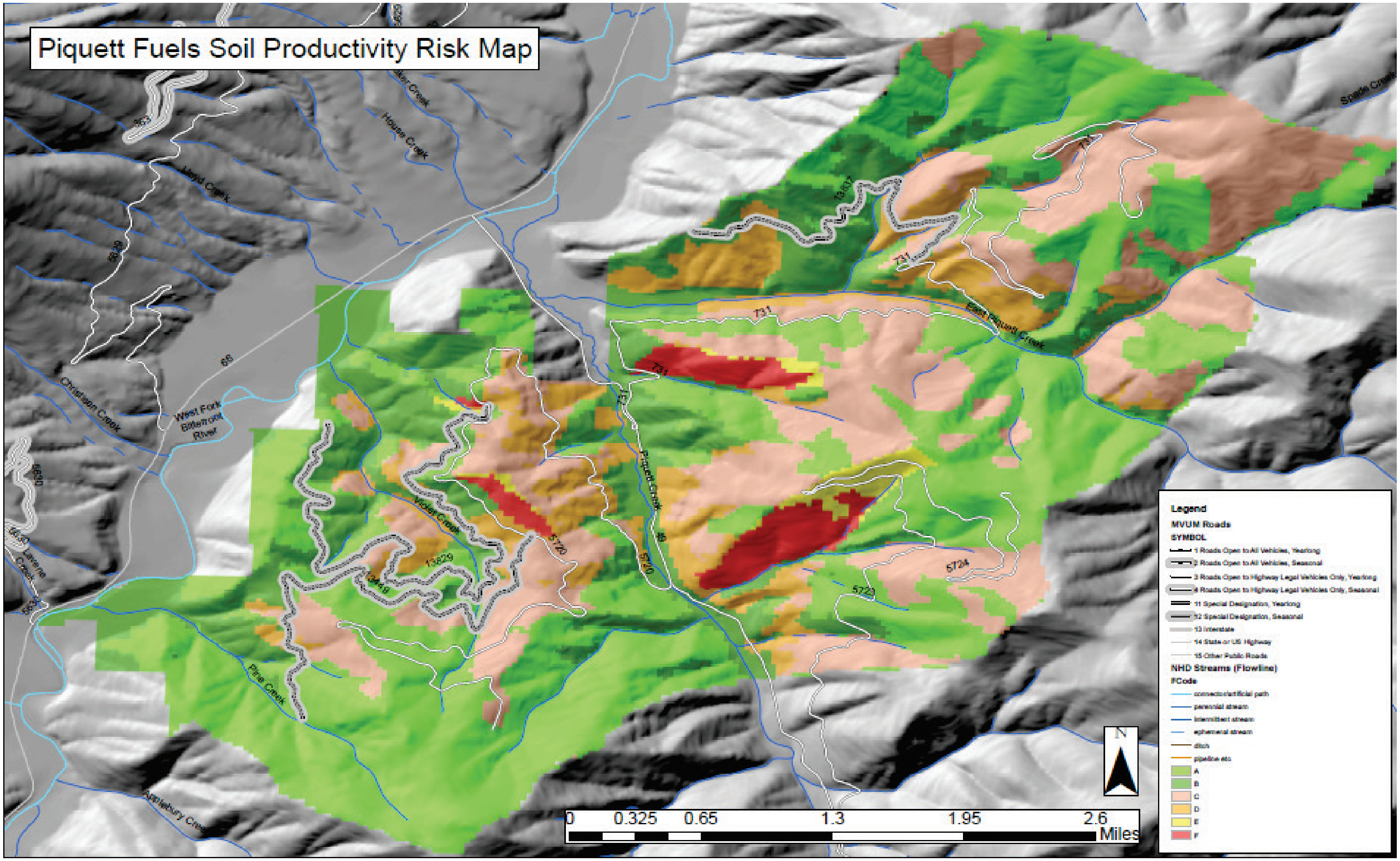
- In order to minimize extent of localized soil disturbance, hand piles would average six to eight feet in diameter; localized soil disturbance associated with each individual pile would be restricted to 50 square feet or less.
- To minimize extent of new detrimental soil disturbance, slash piles should take advantage of pre-disturbed locations wherever feasible, such as (but not limited to) old log landings, skid trails, and roads associated with past harvest units.
- Where feasible and practicable, crews may consider building crib structures to elevate burn piles six to twelve inches off the ground to minimize degree of soil burn severity.

Temporary road and landings

- Rehabilitation activities of temporary road construction and landings would include recontouring, slashing with readily available debris, and application of organic fertilizer and seed.

APPENDIX C. PIQUETT FUELS SOIL PRODUCTIVITY RISK MAP.

Grid format: T:\FS\NFS\Bitterroot\Project\SouthZone\PiquettCreek\GIS\Workspace\Soils\jefta\Piquett_data.gdb\SPR_map1



APPENDIX D. DOMINANT SOIL MAP UNITS AND ACREAGES FALLING WITHIN THE PIQUETT FUELS PROJECT AREA.

Map unit symbol	Map unit name	Polygon count	Total acres within project boundary	Percent of total project area
31B70	Macmeal-Kadygulch-Tolman families, complex, dissected mountain slopes	1	434.2	7
31K56	Holter-Whitlash families, complex, dissected mountain slopes	5	422.3	7
31B39	Trapps-Wilde families, complex, dissected mountain slopes	2	442.0	8
31D70	Agneston-Leighcan-Shermount families, complex, dissected mountain slopes	2	454.0	8
31B15	Totelake-Macmeal-Sharrott families, complex, dissected mountain slopes	8	1265.7	22
TOTAL		18	3018.2	52