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PACIFIC SOUTHWEST REGION (R5)
VALLEJO, CALIFORNIA

FSM 2500 - WATERSHED AND AIR MANAGEMENT

CHAPTER 2550 - SOIL MANAGEMENT

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TABLE OF CONTENTS

2551.11 - Assessments

The following Region 5 soil manual supplement direction applies to those lands dedicated to growing vegetation. But it is important that appropriate erosion control and soil stabilization measures are followed for areas dedicated to other specific uses such as roads, trails, recreation and administrative sites. Generally these dedicated uses are addressed by Best Management Practices in the Water Quality Management Handbook (R5 FSH 2509.22, Chapter 10, Supplement 2509.22-2011-1).

Three soil functions will be used by Region 5 for assessment and analysis to determine if the national soil quality objectives are being met: Support for Plant Growth Function;Soil Hydrologic Function; and Filtering - Buffering Function.

Descriptions of each function, the indicators that will be used to assess the condition of each function and the desired condition for each indicator are given below:

1. Support for Plant Growth Function description. The soil stores water, nutrients, and provides favorable habitat for soil organisms which cycle nutrients. Chemical, physical, and biological soil processes sustain plant growth which provides forage, fiber, wildlife habitat, and protective cover for watershed protection.

   The natural physical structure of the soil provides a favorable environment for root growth. The organic matter on the soil surface and within the mineral soil are major sources of ecosystem nutrients such as nitrogen, essential for plant growth. It is important to realize that surface organic matter levels fluctuate naturally over time. The amount of organic matter is a balance of inputs from vegetation and decomposition rates dependent upon the local climate. Fire and management can decrease surface organic matter temporarily but accumulation resumes with natural vegetative growth within a relatively short time frame (years to decades). Very fine, amorphous organic matter in the mineral soil, referred to as soil organic matter (SOM), has accumulated over long time periods (decades to centuries) from root turnover and the biomass of soil organisms. And because it is not readily subject to burning per se, the organic matter level in the mineral soil is more stable than that on the surface. SOM is a very valuable source of nutrients, increases the available water-holding capacity, and contributes to the formation and stability of soil structure. The conservation of organic matter in the mineral soil and on top of the soil is fundamental to maintaining the Support for Plant Growth function.

   Indicators for the Support for Plant Growth Function:

   a. Soil stability

   b. Surface organic matter

   c. Soil organic matter (SOM)

   d. Soil strength

   e. Soil moisture regime

   (1) Desired Condition for each indicator

   (a) Soil stability. An adequate level of soil cover is maintained to prevent accelerated erosion, and erosion prevention measures are effectively implemented following soil disturbing activities. Effective soil cover includes

organic surface materials, living vegetation less than 3 feet tall (grasses, forbs and low growing shrubs), surface rock fragments larger than ¾ inch, or where needed applied mulches.

Generally on slopes less than 35%, a minimum of 50% soil cover in a well distributed pattern is needed. Greater amounts of soil cover are generally needed for steeper slopes and in riparian zones. Some soil and ecological types may not be capable of producing 50 percent soil cover because of naturally low productivity, such as areas with shallow soils, serpentinized parent material or low annual precipitation.

(b) Surface organic matter. The amount of organic material on top of the mineral soil is maintained at levels to sustain soil microorganisms and provide for nutrient cycling. The size, amount, and distribution of organic matter maintained on the mineral soil on a long term basis is consistent with the amounts that occur given the local ecological type, climate, and normal fire return interval for the area. Organic materials may range in size from amorphous and fine organic matter that makes up the O horizon, needles and twigs, to coarser materials such as branches and logs. Generally the desired condition is most related to finer sizes of organic matter which contain the highest concentration of nutrients. It is important to note that an excess of organic matter on the mineral soil beyond the desired condition can pose a risk of adverse soil effects from fire.

(c) Soil organic matter (SOM). The amount of organic matter within the mineral soil, indicated by the color and thickness of the upper soil horizon, is within the normal range of characteristics for the site, and is distributed normally across the area. The upper soil horizon is not displaced or eroded to the degree or extent that soil productivity is decreased for the desired vegetation.

(d) Soil strength. The soil strength level is conducive to a favorable rooting environment for the desired plant species. Some level of increase in strength compared to a natural undisturbed condition may not be undesirable. Consider the findings of the Long Term Soil Productivity study and other current science in regard to compaction effects on fundamental soil productivity for tree growth and total biomass production. A depth range of interest for the desired plant species should be used for assessment (e.g. 4-8 inches depth).

(e) Soil moisture regime. The inherent soil moisture regime is maintained, especially in wet meadows and fens. If needed, propose projects that will restore the soil moisture regime. During land management project analysis evaluate whether the proposed activities will result in changes to the soil moisture regime, particularly in wet meadows and fens.

2. Soil Hydrologic Function description. The soil hydrologic function is the inherent capability of the soil to absorb, store and transmit water within the soil profile. The capability is dependent upon an adequate level of cover to reduce rainfall impact and runoff energy, stable soil structure, and sufficient macro-porosity to permit water infiltration and movement through the soil.

   Indicators for the Soil Hydrologic Function:

   a. Soil stability

b. Soil Structure and Macro-porosity

(1) Desired Condition for each indicator

(a) Soil stability - See desired condition description under Support for Plant Growth Function.

(b) Soil Structure and Macro-porosity. Most of the area has soil structure and macro-porosity (defined here as pores 1mm or larger) that is similar to the undisturbed, natural condition for the soil type and provides sufficient infiltration and permeability to accommodate precipitation inputs for the given climate.

3. Filtering - Buffering Function description. The soil acts as a filter and buffer to protect the quality of water, air, and other resources by immobilizing, degrading or detoxifying chemical compounds or excess nutrients. The actual effectiveness of the soil filtering and buffering function is dependent upon the particular physical, chemical, and biological properties of the soil types involved, properties of the chemical(s), and the climate or leaching environment.

   Indicator for the Filtering - Buffering Function:

   a. An analysis is completed as described under Desired Condition

   (1) Desired Condition.

   (a) For projects that involve the application of chemicals, such as herbicides, pesticides, or other supplements (e.g. biosolids), analyze the effects to soil micro-organisms, post-project erosion risk, leaching potential, and risk of off-site movement of the chemicals. When necessary, provide recommendations to prevent undesirable effects.

2551.11 - Exhibit 01 - Region 5 Assessment Procedure

Indicators are used to assess the existing condition of a Soil Function. Assessments can be conducted on individual treatment units, entire activity areas, or specially designated land management areas. The area bounded by the assessment would be described or defined.

The National Forest Soil Disturbance Monitoring Protocol (NFSDMP: GTR WO-82a and WO-82b) may be used as a guide for sampling an area. The strength of this protocol is consistency, repeatability, and statistical validity. However, the visual soil disturbance classes (especially classes D2 and D3) do not predetermine adverse impacts to soil functions. The significance of visual disturbance classes needs to be interpreted on a soil type and site specific basis in light of current science and monitoring. For example, a D3 may be highly consequential for a sensitive soil, but not consequential for a resilient soil; further, the NFSDMP disturbance indicator that caused the D3 call may or may not be significant depending upon the particular soil type and site.

Use the Field Book for Describing and Sampling Soils (Version 2.0, USDA-NRCS) to evaluate soil structure and macro-porosity.

Use the rating system presented in 2551.11 - Exhibit 02 to visually assess the existing condition of the various indicators for each soil function. When evaluating soil indicator condition and the significance of any change observed, it is important to consider the particular soil type, site environmental factors, and current science. When available, quantitative measurements can be

used in conjunction with visual methods to arrive at a rating. The indicator condition is rated as: Good (Meets Desired Condition); Fair (Partially Meets Desired Condition); or Poor (Does Not Meet Desired Condition).

Both the degree and extent of significant soil indicator change needs to be weighed when deciding upon each Indicator rating. But often the difference between Fair and Poor ratings is based upon areal extent. Duration of impacts (short-term or long-term) should also be a consideration.

Use the following descriptions as a guide:

GOOD - Nearly all the area meets the desired condition for the indicator. Some changes may have occurred, but given the degree and extent it is negligible.

FAIR - Changes in indicator condition both in degree and extent can no longer be considered negligible. Degree of indicator change may be slight in large parts of the area or great in minor portions of the area. As a general rule the indicator desired condition may be unmet in 5 - 15% of the area. This percentage range is given to help describe a Fair condition but does not represent absolute limits or standards.

POOR - The degree and extent of indicator change is significant compared to the desired condition.

Soil Function Quality Summary

Several soil functions have multiple indicators. The overall soil function quality may need to be summarized as GOOD, FAIR, or POOR.

Soil Function Quality GOOD - All the indicators meet the desired condition, and the soil function quality fully meets national objectives to maintain soil quality.

Soil Function Quality FAIR - The desired condition for some of the soil indicators is Fair, but none are Poor. The soil function quality has been partially met and unless further impacted would be expected to improve from natural recovery.

Soil Function Quality POOR - One or more of the indicators are rated Poor. Restoration activities should be considered with future management activities.

If the soil function quality is rated POOR, a separate determination needs to be made as to whether this constitutes a substantial and permanent impairment of the land with respect to the 1976 National Forest Management Act. Again, degree and extent, as well as duration of impacts (short-term or long-term) must be considered, as well as whether the quality of the soil function will naturally recover or if restoration is needed.

End - 2551.11 - Exhibit 01 - Region 5 Assessment Procedure

2551.11 - Exhibit 02 - Indicator Condition Assessment

Soil Function	Indicator	Good (Meets Desired Condition)	Fair (Partially Meets Desired Condition)	Poor (Does Not Meet Desired Condition)
Support for Plant Growth and Soil Hydrologic Functions	Soil Stability	An adequate level of soil cover is present and signs of erosion are not visible or very limited in degree and extent. Any existing erosion control measures are effective. Generally soil cover level is 50% or greater and is well distributed for soil types capable of supporting this level.	For minor portions of the area, soil cover is lacking and/or existing erosion control measures are ineffective and there are signs of erosion such as pedestals, sheet, rill, and/or gully erosion visible.	Major portions of the area lack soil cover and/or lack effective erosion control measures. Signs of erosion such as pedestals, sheet, rill, and/or gully erosion are common.
Support for Plant Growth	Surface Organic Matter	Throughout the area, the size, amount and distribution of organic matter present is within the range of the ecological type and normal fire return interval.	For minor portions of the area, the size, amount or distribution of organic matter does not meet the desired condition. The departure can either be a deficiency or excess.	Major portions of the area do not meet the desired condition. The departure can either be a deficiency or excess.
Support for Plant Growth	Soil Organic Matter (SOM)	The thickness and color of the upper soil layer is within the normal range of characteristics for the site and is distributed normally across the area. Localized areas of displacement may have occurred but it will not affect the productivity for the desired plant species.	For minor portions of the area, the upper soil layer has been displaced or removed to a depth and area large enough to affect productivity for the desired plant species. Generally an area will be considered displaced if more than one-half of the upper soil layer or 4 inches (whichever is less) is removed from a contiguous area larger than 100 sq. ft.	Major portions of the area have had the upper soil layer displaced or removed to a depth and area large enough to affect productivity for the desired plant species
Support for Plant Growth	Soil Strength	Over most of the area the soil strength level is conducive to a favorable rooting environment for the desired plant species.	For minor portions of the area, soil strength has increased in degree and depth such that it limits the growth of desired plant species.	Over major portions of the area soil strength has increased in degree and depth such that it limits the growth of desired plant species.

Soil Function	Indicator	Good (Meets Desired Condition)	Fair (Partially Meets Desired Condition)	Poor (Does Not Meet Desired Condition)
Soil Hydrologic Function	Soil Structure and Macro-porosity	Visually soil structure and macro-porosity (defined here as pores 1mm or larger) are relatively unchanged from natural condition for nearly all the area. Signs of erosion or overland flow are absent or very limited in degree and extent. Infiltration and permeability capacity of the soil is sufficient for the local climate.	For minor portions of the area: soil structure and macro-porosity are changed; or platy structure and/or increased density evident; or overland flow and signs of erosion are visible. Infiltration and permeability capacity is insufficient in localized portions of the area.	Major portions of the area have reduced infiltration and permeability capacity indicated by soil structure and macro-porosity changes; or platy structure and/or increased density; or signs of overland flow and erosion

End - 2551.11 - Exhibit 02 - Indicator Condition Assessment

2551.12 - Analysis

1. Analysis first requires an assessment of the existing condition or baseline condition and then a prediction of the effects from the proposed activities. Existing soil condition must be determined in the field, and field work needs to be focused where risks are greatest. Generally it is not feasible or practical to field visit all proposed management areas, so priority sites must be chosen. Highest priority areas to field review are where soil condition may have been adversely affected by past management, and where proposed activities have the greatest potential to cause adverse effects to soil functions. Examples are:
    a. Areas where multiple ground-based management projects involving heavy equipment have occurred in the past.
    b. Areas where ground-based management activities involving heavy equipment are proposed.
    c. Areas where proposed activities could result in a large reduction in soil cover and increased soil erosion risk.
    d. Areas where soil has a high or very high Erosion Hazard Rating (EHR).
    e. Areas with concentrated range use.
    f. Areas with high soil burn severity.
    g. Areas with soils especially susceptible to adverse impact (i.e. sensitive soils), such as shallow soils or soils with thin A horizons.
    h. Areas with a history or potential of soil mass-wasting; these areas must be carefully considered regarding management suitability and design.
    i. Other areas where past natural or human activities have resulted in significant soil disturbance.

2. The rationale used to select areas for field review needs to be documented in the specialist report.

   Consider the information below before field work begins.

   a. The forest soil survey offers a first source of information regarding what soil types are likely to occur in the project area. The forest soil survey needs to be field verified to a reasonable extent.

   b. Utilize the forest soil survey and soil interpretations or risk ratings to determine which soils are more susceptible or more resistant to adverse effects from the proposed management activities.

   c. Recent or historic aerial photo coverage of the area may provide a general indication of the extent of past management disturbance and pre-fire conditions, as well as soil mass-wasting potential. Actual soil condition must be determined from field observations.

   d. Management history for the area may be available to give an indication of how intensely or frequently the area has been managed. Possible sources of information include: stand record cards, timber cruises, previous cumulative watershed effect analyses, wildlife surveys, FACTS database, and talking with people familiar with the area's history.

   e. For projects in wildfire burned areas the BAER soil burn severity map and soil and hydrology specialist reports created during the BAER assessment will provide valuable information about post-fire changes in soil cover, soil infiltration rate changes (hydrophobicity) and erosion potential. Areas that experienced High Soil Burn Severity should receive special attention in regard to field investigation and the development of design measures for proposed post-fire activities.

During NEPA analysis complete the assessments and risk evaluations listed in 2551.12 - Exhibit 01 for the areas with proposed activities which have the greatest potential to cause adverse effects to soil functions.

2551.12 - Exhibit 01 - Soil Resource NEPA Risk Analyses

Soil Quality Element	Analysis Element	Analysis
Existing Soil Condition	Assessment (Exhibit 1)	Complete an assessment (2551.11 – Exhibits 01 and 02) for the priority areas to determine existing soil condition.
Support for Plant Growth and Hydrologic Functions	Soil Stability	Evaluate soil erosion risk during project planning and provide recommendations for soil cover retention and other erosion control measures. In addition to the R5 Erosion Hazard Rating system (R-5 FSH 2509.22, Soil and Water Conservation handbook), locally adapted standard erosion models, measurements, and monitoring can be used to determine adequate soil cover levels.
Support for Plant Growth Function (nutrient conservation)	Surface organic matter	Evaluate expected changes in surface organic matter sizes, amount, and distribution. If needed, provide recommendations to sustain adequate levels of surface organic matter for soil microorganisms and nutrient cycling.
Support for Plant Growth Function	Soil Organic Matter (SOM)	Evaluate the risk of SOM loss due to displacement, prescribed burning or other effects from proposed activities. Where needed, provide recommendations to reduce the risk.
Support for Plant Growth and Hydrologic Functions	Soil Strength,Soil Structure and Macro-porosity	Evaluate compaction risk and the outcome for plant growth and hydrologic function for the major soil types. Evaluate the risk to the functions based upon findings from the Long Term Soil Productivity study and other current science. Where needed, provide recommendations to reduce risk.
Support for Plant Growth and Hydrologic Functions	Soil Moisture Regime	Evaluate if proposed activities will result in changes to soil moisture regime in wet meadows and fens. If needed, provide recommendations to sustain or restore the soil moisture regime.
Filtering - Buffering Function	Analysis	For projects that involve the application of chemicals, such as herbicides, pesticides, or other supplements, evaluate the effects to soil micro-organisms, the risk of post-project erosion, and the risk of leaching and off-site movement of the chemical. When necessary, provide recommendations to prevent undesirable effects.