INTRODUCTION

Soils are a physical element of the environment made up of mineral particles (e.g., sand, silt, and clay), air, water, and organic matter. Soils form by the interaction between climate, organisms, topography, parent material, and time. Soils store water, supply nutrients for plants, and provide a medium for plant growth. Soils also provide habitat for a diverse number of below-ground organisms. Due to their slow rate of formation, soils are essentially a non-renewable resource.

Soils are described, and classified, in relation to their biological, chemical, and physical properties including texture, structure, consistence, drainage, permeability, depth to bedrock, rock fragment content, soil moisture regime, soil temperature regime, and pH (Soil Survey Staff 2001).

Soils information needed at both the programmatic planning level and the project level. This planning level DLMP/DEIS provides a general description of soils found within the planning area, and describes the potential impacts to those soils that may result from activities proposed under the different alternatives. More detailed site-specific soils information would be gathered and used in order to analyze impacts to soils at the project level.

LEGAL AND ADMINISTRATIVE FRAMEWORK

LAWS

- ***The National Forest Management Act of 1976***: This act requires that the agency ensure "...the effects of each management system to the end that it will not produce substantial and permanent impairment of the productivity of the land."
- ***The Multiple-Use Sustained-Yield Act of 1960***: This act established that the sustained yield of goods and services must be conducted without resulting in permanent impairment of the productivity of the land.
- ***The National Environmental Policy Act of 1969***: This act declares a national policy that encourages productive and enjoyable harmony between people and their environment, promotes efforts that will prevent or eliminate damage to the environment and biosphere, and enriches the understanding of the ecological systems and natural resources important to the nation.

AFFECTED ENVIRONMENT

EXISTING CONDITIONS

Within the planning area, soil productivity has not changed significantly since 1983 and 1985, when the San Juan National Forest (SJNF) Land Management Plan (LMP) and the BLM San Juan/San Miguel Resource Management Plan (RMP), respectively, were implemented. This is based on the USFS 15% guideline for determining when a change becomes detrimental or significant (FSH 2509.18). Most soils within the planning area have not been affected (impacted) by historic management activities. Project designs, as well as the implementation of BMPs and design criteria, have served to protect soils and soil productivity on lands where past management activities did occur.

Soils associated with some log landings, some heavily used skid trails, and some temporary roads used during past timber harvesting activities were detrimentally compacted. This is demonstrated by a lack of tree regeneration on those sites. However, these impacts are minor, and occur on less than 1% of the planning area. Timber harvesting operations and mechanical fuels projects have resulted in some short-term soil displacement and soil erosion. These impacts, however, were minor and are no longer occurring on those sites. Project design that eliminated unsuitable lands from these activities; focused on lands with gentle slopes, short slope lengths, and adequate ground cover; and implemented BMPs and design criteria, served to protect soils from major impacts.

Some lands, most notably in the mountain grassland vegetation type, display some soil compaction and erosion. This is the result of livestock grazing, most of which presumably occurred before 1983 (Romme et al. 2006). Evidence of compaction includes platy soil structure in soil surface horizons (Robinson and Alderfer 1952). Evidence of erosion includes pedestaled plants, soil deposition, rills, gullies, and altered surface horizons. Other management activities (including the construction of new roads, structures, and utility corridors; and recreation activities) have resulted in some short-term and long-term soil compaction and erosion. However, since 1983, very few acres within the planning area have been impacted by these activities.

Some soils within the planning area have experienced slope failures and mass movement of soils. Steep canyon sideslopes, lands with shale substrates, and lands found within the Morrison and Mancos Shale geologic formations are highly susceptible to these naturally occurring disturbance events. Some minor slope failures and mass movement of soils have also occurred due to management activities (including the construction of roads). The Missionary Ridge Wildfire of 2002 does not appear to have resulted in detrimental severe burning to soils. It also does not appear to have adversely impacted soil productivity (although high amounts of bare soil, as well as some erosion, did result from that fire). This is demonstrated by the excellent post-fire vegetation regeneration and productivity within the burn area.

The sand dunes on BLM-administered lands in Flodine Park and Yellowjacket Canyon are ecologically unique and subject to severe wind erosion.

Gypsum-derived soils on BLM-administered lands in Big Gypsum Valley are ecologically unique because they are associated with rare lichens and plants.

Organic soils (histosols) that occur in fens, as well as in some other high-elevation riparian areas and wetland ecosystems located within the planning area, are ecologically unique because they are rare in the southern Rocky Mountains.

The Lewis and Mancos shale geologic formations are highly erosive, contributing sediment and salts to the drainages of associated watersheds.

TRENDS

Most soils within the planning area may not be impacted by management activities; therefore, soil impacts may not occur. Soils, therefore, would continue to maintain their soil productivity. Projects would be designed in order to minimize adverse impacts, and the implementation of design criteria and guidelines would serve to protect soils and soil productivity. Sites that currently display compacted soils (including some mountain grasslands, log landings, heavily used skid trails, and temporary roads) are expected to recover over time as the natural processes of freeze/thaw, nutrient cycling, plant root movement, and soil biota movement act to create openings and pore space within the compacted soil. The high amount of bare soil that resulted from the Missionary Ridge Wildfire of 2002 may continue to be reduced as native vegetation and litter increase in abundance and distribution in the burn area.

ENVIRONMENTAL CONSEQUENCES

Under all of the alternatives, the primary goal of soil management would be to maintain or enhance soil productivity (FSH 2509.18). Soil productivity is defined as the inherent capacity of a soil to support the growth of specified plants or plant communities. Specified plants or plant communities consist, in most cases, of native plant species that occur, or that have the potential to, occur on the site.

Soil compaction, displacement, erosion, severe burning, and protective plant cover are the properties used to categorize and measure changes in soil productivity. A guideline of a 15% reduction in inherent soil productivity would be used for determining when a change in soil properties becomes significant or detrimental (FSH 2509.18).

Management activities with the greatest potential to impact soils within the planning area may be those that involve ground disturbance or vegetation removal (including oil and gas development, livestock grazing, timber harvesting, mechanical fuels treatments, fire management, recreation development, utility corridors, and solid minerals development).

DIRECT AND INDIRECT IMPACTS

The effects described below could occur in the future when specific projects are identified and implemented. Effects assume that direction and design criteria in the land management plan, and stipulations in the DEIS for oil and gas activity will be followed and implemented. Design criteria, presented in Part 3 of the accompanying land management plan, are environmental protection measures that will be applied at the project level to protect resources.

Most activities within the planning area are designed to avoid or minimize adverse impacts to soils, and to their associated ecosystems. This would be accomplished by using existing road networks, and by eliminating unsuitable lands from project areas (including lands associated with high mass movement potential, highly erosive soils, highly unproductive soils, steep slopes, and riparian areas and wetland ecosystems). Additionally, most activities have occurred, and would continue to occur, on lands that have thick litter layers, abundant dead wood on the ground surface, and abundant herb and shrub cover -- factors that protect the soils from natural and human-caused disturbances. Management activities, therefore, would not result in detrimental erosion, compaction, displacement, or severe burning; and would not detrimentally remove ground cover, organic matter, or nutrients from the soil; therefore, the long-term productivity of the soils within the planning area would be preserved. The desired conditions for soils within the planning area would, therefore, be achieved.

Impacts Related to Timber Harvesting

As the result of equipment operations involving cutting, skidding, decking, and loading trees, as well as the piling of logging slash, proposed timber harvesting activities within the planning area may would disturb the ground surface. Ground cover may be disturbed (including the removal of vegetation), and may, therefore, result in some exposure of mineral soil. Although direct timber harvesting operations may result in some local soil movement, soil displacement and soil erosion are expected to be minor. This is because most harvest units are designed to have slopes that are not steep (less than 35%), short slope lengths, and adequate ground cover and topsoil that would remain intact. Slash distribution in cut units following timber harvesting may also protect exposed mineral soils from raindrop impacts and erosion.

Soil compaction resulting from the weight of harvesting equipment, is expected to be minor if soils are adequately dry (with soil moisture content below the plastic limit) when harvesting activities occur. Thick litter layers, thick organic matter-rich soil surface horizons, abundant dead wood on the ground surface, and abundant herbaceous plant cover (all of which are common attributes of most harvest units within the planning area) may help to buffer mineral soils from compaction and erosion. Log landings, temporary roads, and heavily used skid trails would be designed in order to minimize compaction and erosion; however, soils may be compacted. These compacted soils would be expected to recover over time as the natural processes of freeze/thaw, nutrient cycling, plant root movement, and soil biota movement act to create openings and pore space within the compacted soil. In some cases, ripping may be implemented in order to reduce compaction more quickly.

Timber harvesting would remove organic matter, as well as the associated nutrients, from harvest units. However, the harvested stems (boles) would remove relatively small amounts of nutrients, when compared to the total nutrient reserves on most sites (Webber and Madgwick 1983). These nutrient losses may be replaced, in most cases, by soil weathering and natural inputs. Timber harvesting activities may not substantially impact the nutrients, organic matter, soil fertility, or soil productivity of harvest units. This is because the associated soils tend to be inherently fertile and contain adequate organic matter and adequate depths of mineral soil (including thick, nutrient-rich surface horizons). In addition, an abundance of organic matter, as well as the associated nutrients, would be left on harvest units. This would include most of the nutrient-rich leaves, branches, and bark, where the highest nutrient concentrations are found (Welch and Klemmendson 1975; Bockheim et al. 1983; Madgwick et al. 1977).

New road construction required for timber harvesting within the planning area would remove vegetation along the road corridor, expose mineral soil, and result in soil compaction along the roadbed. Roads are the dominant source of erosion and sediment in forests (Swank and Crossley 1988; Reid 1981). Typically, there is a pulse of erosion from roads during the first 2 years following road construction or reconstruction (USFS 1981). Slope failures and mass movement of soils may occur as the result of road construction. New roads may also provide an avenue for the invasion and establishment of invasive plant species. New temporary roads would be closed, obliterated, and revegetated following use, in most cases. Road design, avoidance of problem soils, appropriate design criteria, and road closures would be implemented in order to minimize impacts to soils.

DLMP/DEIS Alternatives: The impacts described above may occur, to varying degrees, under all of the alternatives. Alternative A would propose the largest amount of acres for timber harvesting; therefore, it may have the greatest potential to impact soils, when compared to the other alternatives. Alternative D may have the next greatest potential to impact soils, followed by Alternative B. Alternative C may have the least potential to impact soils (because it would propose the least amount of acres for timber harvesting).

Impacts Related to Mechanical Fuels Treatments

The impacts related to mechanical fuels treatments on soils may be similar to those described above for timber harvesting.

DLMP/DEIS Alternatives: The impacts to soils from mechanical fuels treatments may be similar under all of the alternatives. This is because the number of acres proposed for treatment would be similar under all of the alternatives.

Impacts Related to Fire Management

Impacts to soils tend to be greater from wildland fires and wildland fire use fires. This is because these fires tend to be high-intensity, stand-replacing events that burn hot and consume lots of vegetation and ground-cover. The impacts resulting from management-ignited prescribed burns would be minimal and would be minimized through effective planning, and through the avoidance of areas with high potential for adverse impacts. Stabilization and rehabilitation efforts designed to protect and sustain soils and ecosystems and to restore them to pre-burn conditions may include seeding, ripping, water-barring, and the installation of erosion-control devices. These efforts may result in short-term adverse impacts on soils.

DLMP/DEIS Alternatives: The impacts related to fire management activities may occur under all of the alternatives. The impacts to soils from wildfire and fire management may be similar under all of the alternatives. This is because the number of acres proposed for such treatments would be similar under all of the alternatives.

Impacts Related to Livestock Grazing

Within the planning area, livestock grazing occurs in all the major vegetation types. Potential adverse impacts resulting from livestock grazing may include overgrazing and trampling (Fleischner 1994, Wuerthner 1992, Clary and Webster 1989). This may decrease the abundance, distribution, and vigor of plant species, which, in turn, may decrease the amount of litter and organic matter and increase the amount of bare soil, leading to soil compaction (Dadkhah and Gifford 1980, Lewis 1980). Soil compaction may reduce infiltration (Lull 1959, Smith 1967) and increase run-off and erosion (Lull 1959, Orr 1975). Additionally, livestock grazing may impact biological soil crusts by crushing, breaking, or displacing the crusts.

Livestock grazing may also adversely impact the ecological processes of energy flow and nutrient cycling when livestock utilize too much of the biomass (which leaves little organic matter for microorganisms to decompose and move through the detrital food chain (Golley 1960, Odum 1971).

Within the planning area, livestock grazing practices are designed to protect the soil productivity of the ecosystems that are impacted by such practices. Adverse impacts would be more likely if the timing, intensity, and duration of livestock grazing were not appropriate or sustainable. Impacts to soils from livestock grazing may be minor if DLMP/DEIS planning direction and design criteria, as well as the allotment management plans, are adhered to.

DLMP/DEIS Alternatives: The impacts related to livestock grazing may occur under all of the alternatives. Alternative D would propose the largest amount of suitable acres for livestock grazing; therefore, it may have the greatest potential to impact soils, when compared to the other alternatives. Alternative A may have the next greatest potential to impact soils (because it would propose the second largest number of suitable acres for livestock grazing), followed by Alternative B. Alternative C may have the least potential to impact soils as the result of livestock grazing (because it would propose the least number of suitable acres for livestock grazing).

Impacts Related to Oil and Gas Development

Oil and gas development may remove vegetation and litter, expose and remove mineral soil, and result in soil compaction on well pad locations (and on the roadbeds needed for access to the pads). Compaction of soils on well pads and roads may result in long-term adverse impacts, and may reduce soil productivity (vegetation growth) until reclamation efforts were implemented. Roads are a dominant source of erosion and sediment (Swank and Crossley 1988; Reid 1981). There is typically a pulse of erosion from roads during the first 2 years following road construction or reconstruction (USFS 1981). Slope failures and mass movement of soils may occur as the result of road construction, especially on steep slopes. New roads may also provide an avenue for the invasion and establishment of invasive plant species.

When oil and gas extraction is complete, which can be from 25 to 30 years, all roads and pads constructed specifically for the oil and gas development would be reclaimed. This activity may include contouring, plowing, mulching, fertilizing, and seeding. Erosion-control features would be installed, as necessary.

DLMP/DEIS Alternatives: The impacts from oil and gas development could occur under all of the alternatives. Alternative A would propose the largest number of “standard lease” acres and the least amount of NSO acres; therefore, it may result in the most ground-disturbing impacts, as well as in the most impacts to soils, when compared to the other alternatives. Alternative D may have the next greatest potential impacts to soils. Alternatives B and C may have the least ground-disturbing impacts, and the least impacts to soils from oil and gas development. This is because they would propose the least number of “standard lease” acres. The No Leasing Alternative would have no ground-disturbing impacts, so it would have no adverse direct or indirect impacts to soils.

Impacts Related to Solid Minerals and Utility Corridors

Impacts related to solid minerals development activities and utility corridors may disturb the ground surface (often due to the equipment operation involved in such activities). Ground-cover may be disturbed, and mineral soil may be exposed. Management activities would result in some local soil displacement and soil erosion. However, the impacts may be minor, and may only impact a small percentage of soils within the planning area. Implementing design criteria described in the Watershed Conservation Practices Handbook would minimize adverse soil impacts.

DLMP/DEIS Alternatives: The impacts from solid minerals development activities and utility corridors could occur under all of the alternatives. Impacts to soils from solid minerals development and utility corridors may be similar under all of the alternatives. This is because the number of acres proposed for such treatments would be similar under all of the alternatives.

Impacts Related to Recreation

Recreational uses shown to impact soils include off-road motor vehicles, camping, hiking, mountain biking, ski areas, and horseback riding -- all of which may result in erosion and compaction. These impacts tend to be minor, and may occur on only a small percentage of the planning area. Implementing design criteria described in the Watershed Conservation Practices Handbook would minimize adverse soil impacts.

DLMP/DEIS Alternatives: The impacts from recreation could occur under all of the alternatives. The impacts to soils from recreation may be similar under all of the alternatives. This is because the number of acres proposed for such treatment would be similar under all of the alternatives.

Impacts Related to Special Soils

Impacts to the sand dunes on BLM-administered lands in Flodine Park and Yellowjacket Canyon, the gypsum-derived soils in Big Gypsum Valley, and the organic soils (histosols) that occur in fens and other higher-elevation wetlands may not occur, or may be minor. This is because these lands, and their soils, would be avoided, whenever practicable.

DLMP/DEIS Alternatives: The impacts to special soils could occur under all of the alternatives. The impacts to special soils may be similar under all of the alternatives because these lands, and their soils, would be avoided, whenever practicable, for all alternatives.

Positive Impacts Related to Soils

SJPLC management objectives designed to restore or improve soil productivity on 20 miles of road that would be closed and reclaimed; and to improve the soil productivity on 2 middle elevation Kentucky bluegrass-dominated mountain grasslands, would apply to all of the alternatives. This may, in turn, result in beneficial impacts to the soils within the planning area. The impacts of fire on soils may include increased nutrient availability, which may, in turn, lead to increased vigor and productivity in plants.

DLMP/DEIS Alternatives: The positive impacts to soils could occur under all of the alternatives. These positive impacts to soils may be similar under all of the alternatives because all of the alternatives would have the same objectives.

CUMULATIVE IMPACTS

Historic, current, and foreseeable future impacts to the soils within the planning area would be result of the combination of management activities (including oil and gas development, livestock grazing, timber harvesting, mechanical fuels treatments, fire management, recreation development, utility corridors, and solid minerals development).

Historic timber harvesting and mechanical fuels treatment activities within the planning area have resulted in some short-term soil compaction, displacement, and erosion. However, they have not resulted in long-term detrimental erosion, compaction, or displacement. They have not detrimentally removed ground cover, organic matter, or nutrients from the harvest sites. Foreseeable future timber harvesting and mechanical fuels treatment activities within the planning area may result in some minor short-term soil compaction, displacement, and erosion. However, these activities are not expected to result in long-term detrimental erosion, compaction, displacement, or detrimentally remove ground cover, organic matter, or nutrients from the harvest units. The impacts described above may occur under all of the alternatives.

Historic adverse impacts related to livestock grazing within the planning area began around the turn of the Twentieth Century, as livestock grazed and overgrazed rangelands. This resulted in soil compaction and erosion on some lands. These impacts are still present in some places. Foreseeable future livestock grazing within the planning area may result in some additional impacts to soils. However, these impacts are expected to be minor. Past oil and gas development activities within the planning area resulted in some short-term and long-term soil compaction, displacement, and erosion. Many of these impacts are still present, as wells continue to operate. Foreseeable future oil and gas development activities within the planning area may result in some additional impacts to soils. However, these impacts may be minor.

Historic impacts to soils within the planning area related to recreation, solid minerals development, and utility corridors were localized and relatively small in extent. However, many of these impacts are still present. Foreseeable future impacts on soils from these activities may result in some additional impacts to soils. However, these impacts may be minor.

Historic impacts to soils within the planning area related to road construction permanently reduced soil productivity along the road corridors. These impacts are still present. Foreseeable future impacts on soils from new permanent road construction may result in some additional impacts to soils. However, these impacts may be minor.

Past WFU and prescribed burns have not resulted in detrimental soils impacts. Future impacts related to WFU and prescribed burns may be minor. The Missionary Ridge Wildfire of 2002 created a large area of bare soil and produced a high amount of soil erosion. Foreseeable future wildfires similar to the Missionary Ridge Fire, should they occur, may result in similar detrimental impacts to soils (due to erosion and severe burning).

In summary, there have been minor short-term and long-term adverse impacts to soils from past management activities within the planning area. However, those that have occurred were relatively small, considering the almost 2.6 million acres within the planning area. Foreseeable future management activities may impact soils, as described above. However, these activities are not expected to result in detrimental short and long-term adverse impacts to soils due to project designs and the implementation of the design criteria. Overall, there has not been, nor are there likely to be anticipated detrimental short-term or long-term adverse cumulative impacts to the soils and soil productivity within the planning related to management activities.