BLACK HILLS RESILIENT LANDSCAPE PROJECT
BLACK HILLS NATIONAL FOREST

SOILS REPORT

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Introduction

This report discusses the components of the Black Hills National Forest (BHNF) soil resources that could generally be expected to be affected by proposed activities identified to be implemented through the Action Alternative of the Black Hills Resilient Landscape (BHRL) Project.

Project Area Description

The project area includes National Forest System lands that are managed by the BHNF within the areas designated by the Secretary of Agriculture under the amended Healthy Forests Restoration Act (HFRA, 16 U.S.C. 6591), excluding Inventoried Roadless Areas and certain management areas. The project area includes approximately 1,098,000 acres of NFS lands.

The project area includes the following management areas (MAs).

MA	Emphasis	Acres*	Proposed activities
3.31	Backcountry motorized recreation	6,870	Fuels/hazard trees
3.32	Backcountry non-motorized recreation	8,948	Fuels/hazard trees
3.7	Late succession landscapes	18,484	Fuels/hazard trees
4.1	Limited motorized use and forest products	41,374	All
5.1	Resource production	558,520	All
5.1A	Southern Hills forest and grassland	27,845	Fuels/hazard trees
5.2A	Fort Meade VA Hospital watershed	3,299	Fuels/hazard trees
5.4	Big game winter range	388,950	All
5.43	Big game and resource production	10,083	All
5.6	Forest products, recreation, and big game	34,043	All
*MA acres in project area	Total	1,098,425	

Purpose and Need

The BHNF is proposing actions to move landscape-level vegetation conditions in the project area toward objectives of the Forest Plan in order to increase ecosystem resilience to insect infestation and other natural disturbances, contribute to public safety and the local economy, and reduce risk of wildfire to landscapes and communities.

Relevant Issues

Public comments resulted in the following issues relevant to the analysis.

1. Proposed timber harvest and fuel reduction could negatively affect scenery, particularly in combination with recent timber harvest and mountain pine beetle infestation. Indication of the project's response to this issue is reflected by the degree of achievement of scenic integrity objectives.
2. The Proposed Action includes ground-disturbing activities that could increase noxious weed infestation. Added to the effects of a variety of past and ongoing activities, this could increase costs of weed treatment and displace desirable plant communities. Indicators of the project's response to this issue include projected acreage of weed infestation and cost of treatment.
3. Timber harvest could reduce landscape-level structural diversity by creating or perpetuating large, monotypic stands. Indication of the project's response to this issue is reflected by degree of progress toward Forest Plan structural stage objectives over a 20-year timeframe.

Proposed Action Summary

The Forest Service is proposing to conduct the following land management activities in the project area, starting in approximately 2018 and continuing for about 10 years.

Fuel Reduction and Prescribed Fire

To increase ecosystem resilience and reduce wildfire hazard to landscapes and communities, the proposal includes mechanical fuel treatments (up to 7,000 acres per year), prescribed fire (up to 10,000 acres a year), and hazard tree removal. Total acres implemented annually would depend on budget constraints and, for prescribed burning, weather conditions. Priority criteria for treatment include wildland-urban interface (specifically, within one-half mile of at-risk communities and within 300 feet of other private property) and areas adjacent to egress roads and critical infrastructure.

Activities described in the following sections (precommercial thinning, removing encroaching pine, etc.) also would contribute toward fuel reduction goals.

Enhancement of Non-pine Vegetation and Within-stand Diversity

The project would cut encroaching pine from areas of hardwoods and grasslands. Pine and spruce removal from aspen stands would take place on up to 6,000 acres. On up to 30,900 acres of pine stands, pine and spruce would be removed from aspen inclusions. Regeneration of declining aspen stands would occur on up to 4,000 acres. Pine removal from oak stands would take place on up to 5,400 acres. Uneven-age management would occur on up to 10,000 acres of SS 4A stands.

Pine Structural Stage (SS) Modification

These activities would occur in MAs 4.1, 5.1, 5.4, 5.43, and 5.6.

Structural stage totals – All relevant management areas combined

Overstory removal would occur on up to 187,000 acres of SS 4A stands. This treatment would decrease 4A and increase younger structural stages, which are generally below Forest Plan objectives. Precommercial and/or POL thin would occur on up to 25,000 acres per year to increase SS 3A and 3B and to promote growth toward 4B.

Patch cuts would occur on up to 1,300 acres in MA 4.1 and 600 acres in MA 5.6. This treatment would produce SS 1, which is below Forest Plan objectives in these MAs. Tree planting would occur on up to 5,000 acres per year in large burned areas in the southern Black Hills. Without planting, reforestation of these areas may require decades.

Mechanical site preparation would occur in open, mature pine stands on up to 4,000 acres in the western Black Hills where thick sod hinders establishment of pine seedlings. This action would expose soil, creating conditions favorable for establishment of pine.

Summary Table

Maximum activity acres and miles are displayed below. The amount implemented may be less.

Fuel and hazard tree treatments	
Mechanical and manual fuel treatments *(shaded fuel break construction; thin, pile, and burn fuels; scatter, shred, or chip fuels; cut, lop, and scatter fuels); includes up to 4,000 acres of shaded fuel breaks with commercial removal*	70,000 acres (7,000 acres per year)
Prescribed fire	100,000 acres (10,000 acres per year)
Hazard tree treatments	As needed and funded
Enhancement of non-pine vegetation and within-stand diversity	
Removal of pine/spruce from aspen stands	6,000 acres
Regeneration of aspen stands	4,000 acres
Removal of pine/spruce from aspen inclusions (possibly commercial)	22,500 acres
Removal of pine/spruce from aspen inclusions (non-commercial)	8,400 acres
Removal of encroaching pine from oak stands	5,400 acres
Removal of encroaching pine from grasslands	14,200 acres
Uneven-age individual tree selection or group selection	As stand conditions allow (max. 10,000 acres, **out of the 185,210 acres below**)
Pine structural stage modification	
Overstory removal *By management area:* *MA 4.1: Approximately 7,670 acres* *MA 5.1: Approximately 129,890 acres* *MA 5.4: Approximately 41,210 acres* *MA 5.43: Approximately 250 acres* *MA 5.6: Approximately 6,190 acres*	**185,210** acres
Precommercial and/or POL thin	250,000 acres (25,000 acres per year)
Patch cut *By management area:* *MA 4.1: 1,300 acres* *MA 5.6: 600 acres*	1,900 acres
Tree planting *(MAs 5.1, 5.4, and 5.43)*	5,000 acres
Mechanical site preparation	4,000 acres
Connected actions	
Road construction – Specified	18 miles
Road construction – Temporary	39 miles
Temporary roads on existing templates	182 miles
Road conversion (unclassified to system)	20 miles (part of 182 miles above)
Road maintenance	2,500 miles (estimated)
Road reconstruction	375 miles (estimated)

Forest management activities all have the potential to create soil disturbances. Some disturbances can occur to a level that may have effects on site productivity and hydrologic responses. This document addresses soil quality conditions that could result in site productivity that could be altered in association with project activities. Effects to the water resource are discussed in the Watershed Specialist Report and Watershed section in Chapter Three of the BHRL FEIS.

Soil Productivity

Soil productivity is the ability of the soil to supply the water and nutrients needed to sustain plant growth. Variables that influence soil productivity include physical soil characteristics, organic matter and soil biological activity.

Physical Soil Characteristics

Physical soil characteristics include soil depth, pore space and bulk density. Changes in these can occur when ground-based equipment make repeated passes over the soil. These activities compress or compact soils and, if soils are wet enough, can result in rutting and puddling of the soil resource. Clay and loam soils generally compact more than sandy soils (USDA Forest Service 2006b, page 25). These changes to the physical soil characteristics reduce the pore space volume and water holding capacity. These physical changes reduce water infiltration rates, slow soil drainage, impede root growth and reduce plant-available water and nutrients. Physical soil disturbances also decrease gas exchange, affecting both plants and soil biota.

Organic Matter

Organic matter in the various forms contributes to soil productivity. Humus is decomposed organic matter. Duff and litter are partially decomposed leaves, needles and twigs on the surface of soils. Large woody debris consists of woody stems greater than three inches in diameter. Decomposed large woody debris can supply moisture to plants after the soils dry. Organic matter provides nutrients and can retain moisture for soil organisms and plants.

Soil Biological Activity

Soil organisms, including fungi and bacteria, are required by and drive the nutrient cycling process by decomposing organic matter components and releasing the nutrients for use by plants. Soil organisms depend on organic matter for the nutrients they need to carry out their life processes. Decomposed large woody debris provides important habitat for the survival of mycorrhizae fungi. These fungi form a symbiotic relationship with tree roots, increasing water and nutrient uptake by the trees and the fungi.

Soil Erosion

Soil erosion is the movement of soil particles by water, wind or ice. In forested sites on steep slopes, water is generally the most common driver of erosion. Generally, depending on a variety of site characteristics, potential for the greatest erosion is on steeper slopes (above 30%) and potential decreases as the slope decreases. Erosion is generally infrequent on undisturbed forest soils for two primary reasons: (1) organic matter is generally at levels that provides a protective layer on the soil surface that limits the impact of raindrops and allows water to infiltrate; and (2) the surface soil below the organic layer is by nature generally porous, allowing water to infiltrate into and through the soil profile.

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 or removed, such as by disturbances associated with management activities. Compaction, rutting and puddling can affect infiltration to the point that there can be a reduction in the movement of water into the soil and water can be channeled and concentrated. As a result, water runoff (overland surface flow) is increased and carries soil particles with it. Natural disturbance occurrences such as fire result in the removal of organic

matter layers from the soil surface. When surface organic matter is removed, soil pores can become plugged by material (particles) impacted from precipitation events (raindrops) resulting in overland surface flow and increased rates of soil erosion.

Mass Failure

In past projects, mass failures (also known as mass movement, soil slippage or landslides) were addressed in the soil specialist reports and soil sections of the project environmental impact statement or assessment. Mass failure discussions for the BHRL project are included in the geology report and geology section of the project FEIS. See the BHRL Geology Report or the Geology section in Chapter Three for information on geologic hazards.

Information Sources

Soil information specific to the Black Hills area is readily available to the public through various internet links provided by the Natural Resources Conservation Service (NRCS). Those links were accessed through the primary NRCS soil resources internet portal at https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/. Forest Service Manual (FSM) Section 2550 (USDA Forest Service 2010a) and the USDA Forest Service Region 2 Watershed Conservation Handbook (WCPH) (USDA Forest Service 2006b) reference scientific literature and based on science identify direction to be implemented during project activities on Forest Service administered land for maintaining or improving soil productivity. The FSM and WCPH, along with the revised Forest Plan as amended (USDA Forest Service 2006a), the 1996 EIS (USDA Forest Service 1996) to the 1997 Forest Plan Revision, the Phase II Amendment EIS (USDA Forest Service 2005), Forest monitoring reports and direction and information contained within the R2 WCPH identify project design options and document effectiveness to reduce anticipated detrimental soil disturbances associated with activities that may occur within the BHRL project activity areas on the BHNF. Numerous bulk density samples have been collected on the BHNF in various areas that have been managed for timber production (cutting units). Forest monitoring reports since 1998, with the most recent Forest monitoring report being issued in 2015 (USDA Forest Service 2015) have provided information regarding effects based on past timber harvest activities. Since the harvest activities proposed as part of this project can generally be expected to create varying levels of site and soil disturbances similar to harvest activities that have occurred previously on the Forest, and activities are to implement Forest Plan standards and guidelines, cumulative effects are generally expected to be within those that were described in the FEIS for the Phase II Amendment to the Forest Plan (USDA Forest Service 2005) and the FEIS for the 1997 Revised Land and Resource Management Plan for the Black Hills National Forest (USDA Forest Service 1996).

Analysis Area Description

The analysis area forms the boundary for the direct, indirect and the cumulative effects soils analysis. As identified above, the analysis area includes National Forest System lands that are managed by the BHNF within the areas designated by the Secretary of Agriculture under the amended Healthy Forests Restoration Act (HFRA, 16 U.S.C. 6591), excluding Inventoried Roadless Areas and certain management areas (refer to BHRL FEIS project maps). Potential activities could occur within that area. This analysis area was selected because that is where the effects of implementing the proposed activities would occur. The specific effects on soils are localized in association with those areas that would actually receive treatments, the construction and rehabilitation of temporary roads that may be created to access the treatment areas, the area adjacent

to the construction and maintenance of new permanent roads, where landings would be created, prescribed fire, etc. (see Project Description for entire list). Effects generally would not extend beyond the proposed specific localized activity unit (i.e. cutting unit) for treatment or along the routes created to access the treatment unit. For the temporal range of effects please refer to "Duration of Effects" in the discussion that follows.

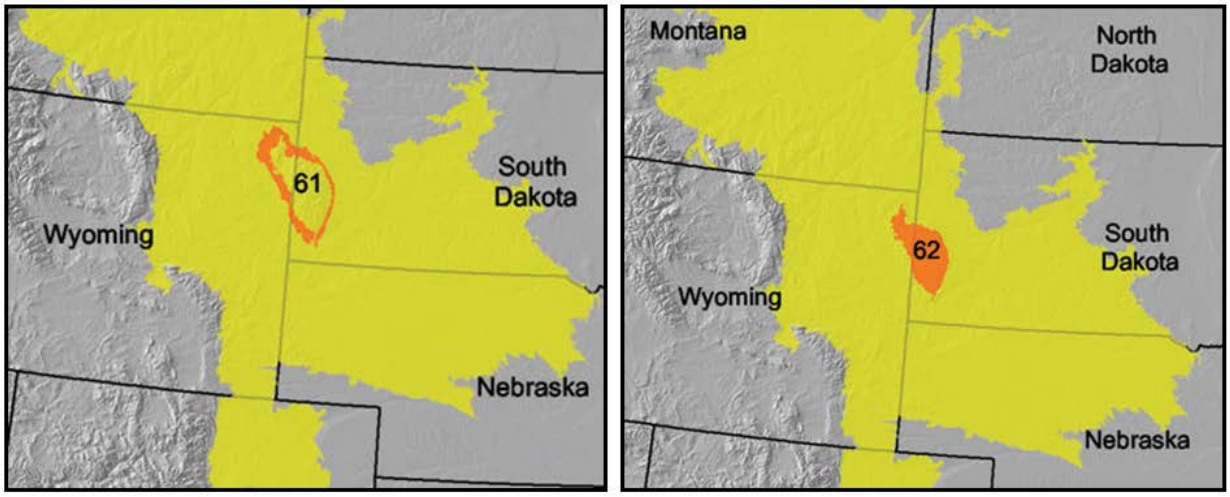
Affected Environment

As indicated earlier, this project has identified a combination of forest vegetation management actions to move landscape-level vegetation conditions toward some objectives of the Forest Plan in order to increase ecosystem resilience to insects infestation and other natural disturbances, contribute to public safety and the local economy, and reduce the risk of wildfire to landscapes and communities. While there is general soil information available for soils within the project area that is used for this report, this large landscape project relies on required pre-activity resource reviews, site investigations and route reviews prior to the implementation of project activities. Site specific locational design and Standard Operating Procedures (SOPs), would be identified at that time and to be implemented during activities. This would occur after a Decision for the project has been issued.

The BHRL potential Commercial Treatment Areas (CTAs), potential fuel and hazard tree treatment areas, prescribed burn areas, pre-commercial thin areas, pine encroachment removal areas, aspen regeneration areas, ponderosa pine patch cut areas, tree planting areas, mechanical site preparation (ponderosa pine) and potential access routes (roads) are located throughout various portions of the Black Hills Ecoregion and would be located on various soils. Soils of the BHNF (the analysis area) have generally been mapped and described at an Order 3 (USDA Forest Service 1991), which is the level of data generally mapped for various Forest uses, such as range planning (additional information on soil survey can be accessed at https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054262). Background soil resource information for the Forest is available in the Final Environmental Impact Statement (FEIS) for the Revised Land and Resource Management Plan for the Forest (USDA Forest Service 1996), and in the FEIS for the Phase II Amendment to the 1997 Revised Land and Resource Management Plan for the Black Forest (USDA Forest Service 2005). Information on various specific components for Forest soil map unit resources have been and are periodically updated by the Natural Resources Conservation Service (NRCS) and have become available to the public through a NRCS website located at https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/. Hard copy issues of Black Hills county soil surveys have become out-of-date and generally should not be used; therefore they were not referenced for this project analysis.

The project activities identified in the proposed action are located within two Major Land Resource Areas (MLRA) of the Black Hills Ecoregion: MLRA 61 – Black Hills Footslopes and MLRA 62 – Black Hills (MLRA information can be accessed at http://www.cei.psu.edu/mlra/).

Major Land Resource Areas (MLRA) of the Black Hills Ecoregion
MLRA 61 – Black Hills Foot Slopes
MLRA 62 – Black Hills



USDA NRCS 2017. Major Land Resource Areas Explorer. Accessed February 24, 2017 at: http://apps.cei.psu.edu/mlra/.

Black Hills soil resource information is publicly available for MLRA 61 and 62 and can be accessed through various web information sites, such as Web Soil Survey, Soil Data Viewer, MLRA Explorer, and other links that are available at https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/. Information posted to the NRCS web links can be updated at any time as new information is gained about specific soils.

Map unit polygons on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas (such as rock outcrops or water). A map unit is identified and named according to the taxonomic classification of the dominant soils. Inclusions of other soils occur within map units but in limited amounts (generally less than 15-20% of the soil map unit). Within a taxonomic class there are defined limits for the various properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed soil properties may extend beyond the limits defined for a specific soil taxonomic class. Based on this variability, areas of soils of a single taxonomic class rarely, if ever, can be mapped on the landscape without including areas of other soil taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic class other than those of the major (dominant) soils (Soil Survey Staff 2017) which can be accessed at https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/). Polygons on a soil map are identified with a symbol that includes both letters and numbers. Soil survey map unit symbols have changed over time. Currently, symbols for soil map units included in MLRA 62 soil survey area begin with the letter Q (example: Q0828C). Soil survey map unit symbols in MLRA 61 currently begin with a letter P (example: P386E). Some general information for both of the MLRAs is provided below:

MLRA 61 – Black Hills Footslopes: The general geology of MLRA 61 consists of marine sediments older than the Cretaceous Pierre Shale on the high plains surrounding this area. The older rocks were brought closer to the surface during the uplift that formed the Black Hills. The Lower Cretaceous Fall River and Lakota (Inyan Kara Group) sandstones occur on the outside boundary of the area and are referred to as the Dakota Hogback. Permian limestone and shale of the Minnekahta limestone form the inside boundary and occur in the mountains of the Black Hills (MLRA 62). The Triassic red beds of the Spearfish shale form a low valley, the "red valley," surrounding the Black Hills between the two ridges formed by the Inyan Kara and Minnekahta Formations. The red beds have gypsum and anhydrous layers. Ground-water seepage can dissolve these layers, creating sinkholes on the surface. Refer to the geology report for more information on the geology of the BHRL project area.

MLRA 62 – Black Hills: The core of the Black Hills is a mass of granite with steeply dipping metamorphic rocks, primarily slate and schist, directly surrounding it. A plateau of Mississippian limestone surrounds the igneous and metamorphic rock core. This Pahasapa (Madison) limestone is broken around the outer edges of the uplifted area. The Permian Minnekahta limestone forms the outermost boundary of the area. Many other tilted sandstone, shale, and limestone units are exposed like a bathtub ring inside the steeply dipping Pahasapa limestone. These older units are also exposed on the valley walls along the major drainages that cut through the rock layers. Refer to the geology report for more information on the geology of the BHRL project area.

Soil Series: Grizzly

Mapped in MLRA 62 in the Central Crystalline Area (Igneous). A dominant soil component in map units: Q0106E, Q0108E, Q0110E, Q0110G, Q0112G, Q0114D, Q0144E, and Q0114F.

Taxonomic Classification: Loamy-skeletal, mixed, superactive, frigid Haplic Glossudalfs

Soil map units located within the area designated by the Secretary of Agriculture under the amended Healthy Forests Restoration Act (HFRA, 16 U.S.C. 6591) were identified through Geographic Information System (GIS) capabilities. Based on that process, soil map units

occurring within the BHRL project area boundary are listed in the table below.

Soil Map Units on National Forest System Lands within the Areas Designated by HFRA

Soil Map Unit Symbol	**Soil Map Unit Name**	**Approx. Acres in Project Area (June 2016)**
P006C	Alice fine sandy loam, 6 to 10 percent slopes	2
P010C	Alice-Ucross complex, moist, 3 to 10 percent slopes	8
P010E	Alice-Ucross complex, moist, 10 to 30 percent slopes	50
P030A	Barnum very fine sandy loam, 0 to 3 percent slopes, rarely flooded	23
P034B	Barnum-Rapidcreek, warm complex, 0 to 6 percent slopes, flooded	117
P040B	Boneek loam, 2 to 6 percent slopes	93
P054D	Butche-Boneek, dry complex, 3 to 15 percent slopes	67
P056F	Butche-Rock outcrop complex, 9 to 60 percent slopes	4
P058C	Butche-Spangler complex, 3 to 10 percent slopes	103
P058E	Butche-Spangler complex, 10 to 30 percent slopes	90
P080D	Colby-Norka silt loams, cool, 6 to 15 percent slopes	<1
P082E	Colhill-Rothican complex, 10 to 40 percent slopes	<1
P098E	Corpening, warm-Rock outcrop-Tilford complex, 3 to 30 percent slopes	14
P102C	Cromack-Echeta-Leiter complex, 6 to 10 percent slopes	217
P102E	Cromack-Echeta-Leiter complex, 10 to 30 percent slopes	117
P128F	Fairburn-Rock outcrop complex, 15 to 60 percent slopes	841
P130E	Fairburn-Ucross loams, 6 to 30 percent slopes	285
P136C	Cromack clay loam, moist, 2 to 10 percent slopes	36
P148C	Gurney, warm-Butche complex, 2 to 9 percent slopes	46
P154D	Gypnevee-Rekop-Rock outcrop complex, 6 to 15 percent slopes	3370
P176C	Iwait-Ucross-Ziggy loams, 2 to 10 percent slopes	7
P182A	Jaywest loam, 0 to 2 percent slopes	<1
P184B	Kadoka loam, 1 to 6 percent slopes	19

P184C	Kadoka loam, 6 to 10 percent slopes	45
P188F	Lakoa-Crownest complex, 10 to 60 percent slopes	507
P196B	Lakoa-Recluse, moist loams, 1 to 6 percent slopes	5
P196C	Lakoa-Recluse, moist loams, 6 to 10 percent slopes	17
P196E	Lakoa-Recluse, moist loams, 10 to 30 percent slopes	67
P198F	Larkson, dry-Lakoa loams, 10 to 60 percent slopes	875
P224F	Mathias-Rockoa-Rock outcrop complex, 25 to 60 percent slopes, stony	326
P226E	Mathias, very stony-Samsil-Rock outcrop complex, 15 to 30 percent slopes	28
P244D	Nevee channery loam, dry, 6 to 15 percent slopes	69
P246C	Nevee silt loam, 6 to 10 percent slopes	4
P248E	Nevee silt loam, 10 to 30 percent slopes, eroded	36
P250C	Nevee silt loam, dry, 2 to 9 percent slopes	1623
P252E	Nevee, dry-Gullied land complex, 6 to 40 percent slopes	456
P254F	Nevee-Nihill, moderately deep complex, 10 to 50 percent slopes	6
P256D	Nevee-Spearfish silt loams, 6 to 20 percent slopes	3
P266E	Nihill, moist-Suglo complex, 10 to 40 percent slopes	15
P270F	Nihill-Ziggy complex, 15 to 50 percent slopes	353
P276B	Norka silt loam, 2 to 6 percent slopes	9
P284C	Nuncho clay loam, moist, 6 to 10 percent slopes	24
P344B	Rapidcreek very cobbly sandy loam, warm, 1 to 6 percent slopes, nonflooded	17
P352B	Recluse loam, 2 to 6 percent slopes	2
P354B	Recluse loam, dry, 2 to 6 percent slopes	60
P358B	Recluse silt loam, 3 to 6 percent slopes	50
P362B	Recluse-Hisle, deep complex, 2 to 6 percent slopes	<1
P364B	Recluse-Fairburn loams, 1 to 6 percent slopes	5
P364C	Recluse-Fairburn loams, 6 to 10 percent slopes	59
P386E	Rekop-Gypnevee, dry-Rock outcrop complex, 15 to 40 percent slopes	2,846
P388D	Rekop-Gypnevee, moderately deep-Tilford, dry complex, 6 to 15	72

	percent slopes	
P396D	Rock outcrop-Butche complex, 2 to 25 percent slopes	2
P398F	Rock outcrop-Gypnevee, moderately deep complex, 9 to 50 percent slopes	249
P400G	Rock outcrop-Mathias-Butche complex, 30 to 75 percent slopes, very stony	67
P402F	Rock outcrop-Rekop complex, 40 to 60 percent slopes	424
P404G	Rock outcrop-Vanocker, dry complex, 40 to 75 percent slopes	174
P408E	Rockerville-Pesowyo complex, warm, 10 to 30 percent slopes	<1
P410E	Rockerville, warm-Rock outcrop complex, 6 to 30 percent slopes	78
P412C	Rockoa-Lakoa complex, 3 to 12 percent slopes	102
P414E	Rockoa-Lakoa-Rock outcrop complex, 10 to 40 percent slopes	649
P416E	Rockoa-Recluse complex, 6 to 30 percent slopes	5
P418F	Rockoa, very bouldery-Rock outcrop complex, 25 to 60 percent slopes	2,084
P438C	Samsil-Cromack complex, 2 to 10 percent slopes	2
P438E	Samsil-Cromack complex, 10 to 30 percent slopes	982
P472C	Spangler-Butche complex, 6 to 10 percent slopes	82
P474C	Spangler-Norka loams, 6 to 10 percent slopes	23
P476E	Spearfish-Nevee silt loams, dry, 9 to 30 percent slopes	134
P480F	Spearfish-Rock outcrop complex, 10 to 60 percent slopes	26
P482F	Spearfish, dry-Rock outcrop complex, 10 to 60 percent slopes	55
P490B	St. Onge loam, 1 to 6 percent slopes	37
P504B	Suglo loam, 2 to 6 percent slopes	<1
P506C	Suglo-Nihill complex, 3 to 10 percent slopes	46
P514B	Tilford silt loam, 2 to 6 percent slopes	4
P514C	Tilford silt loam, 6 to 10 percent slopes	11
P516B	Tilford silt loam, dry, 2 to 6 percent slopes	61
P516D	Tilford silt loam, dry, 6 to 15 percent slopes	26
P522C	Tilford, dry-Gypnevee, moderately deep complex, 2 to 9 percent slopes	28
P524C	Tilford, dry-Rockerville, warm complex, 6 to 9 percent slopes	48

P528E	Turnercrest, moist-Ucross-Sodawells, occasionally flooded complex, 2 to 40 percent slopes	9
P538B	Vale silt loam, 2 to 6 percent slopes	54
P546B	Wages loam, 1 to 6 percent slopes	9
P546C	Wages loam, 6 to 10 percent slopes	<1
P552E	Work clay loam, 10 to 30 percent slopes	101
P558D	Ziggy-Fairburn complex, 2 to 15 percent slopes	350
P560D	Ziggy-Nihill complex, 6 to 20 percent slopes	50
Q0001E	Buska-Mocmont-Rock outcrop complex, 10 to 40 percent slopes	17,057
Q0003C	Mocmont gravelly loam, 2 to 12 percent slopes	452
Q0004E	Mocmont-Rock outcrop complex, 10 to 40 percent slopes	1,089
Q0005G	Mocmont-Rock outcrop complex, 40 to 80 percent slopes	8,073
Q0006E	Shirttail channery loam, 10 to 40 percent slopes	2,599
Q0100C	Goldmine loam, 3 to 12 percent slopes	196
Q0102E	Goldmine-Goldmine, moderately deep complex, 10 to 40 percent slopes	1,488
Q0104G	Goldmine-Rubbleland complex, 40 to 75 percent slopes	135
Q0106E	Grizzly-Grizzly, thick surface complex, 10 to 40 percent slopes	2,433
Q0108E	Grizzly-Mineshaft complex, 10 to 40 percent slopes	5,702
Q0108G	Grizzly-Mineshaft complex, 40 to 80 percent slopes	5,739
Q0110E	Grizzly-Rock outcrop complex, 10 to 40 percent slopes	3,437
Q0110G	Grizzly-Rock outcrop complex, 40 to 80 percent slopes	4,197
Q0112G	Grizzly-Rubbleland-Rock outcrop complex, 40 to 80 percent slopes	1,540
Q0114D	Grizzly-Virkula complex, 3 to 15 percent slopes	4,936
Q0114E	Grizzly-Virkula complex, 10 to 40 percent slopes	2,081
Q0114F	Grizzly-Virkula complex, 15 to 60 percent slopes	12,013
Q0200C	Bullflat, moist-Cordeston silt loams, high mica, 2 to 9 percent slopes	286
Q0202E	Buska-Rock outcrop complex, 10 to 40 percent slopes	23,329
Q0203D	Buska-Virkula, high mica loams, 2 to 15 percent slopes	5,902
Q0205C	Cordeston loam, high mica, 2 to 10 percent slopes, flooded	2,248

Q0206B	Cordeston-Marshbrook loams, 0 to 6 percent slopes, flooded	4,054
Q0208E	Heely channery loam, 10 to 40 percent slopes	2,310
Q0209D	Heely-Cordeston complex, 2 to 15 percent slopes	1,563
Q0211E	Hilger, moist-Virkula complex, 2 to 30 percent slopes	633
Q0213G	Hisega-Buska complex, 40 to 80 percent slopes	4
Q0214E	Hisega-Rock outcrop complex, 10 to 40 percent slopes	287
Q0216B	Marshbrook loam, 0 to 4 percent slopes, occasionally flooded	522
Q0217C	Marshbrook-Cordeston loams, 2 to 9 percent slopes, flooded	144
Q0219F	Typic Udarents-Rock outcrop complex, 6 to 60 percent slopes	8
Q0221F	Pactola-Buska channery silt loams, 20 to 60 percent slopes	436
Q0225D	Pactola-Virkula complex, 2 to 15 percent slopes, extremely bouldery	1,512
Q0226E	Pactola-Virkula-Rock outcrop complex, 10 to 40 percent slopes	102,162
Q0227E	Pactola-Virkula-Rock outcrop complex, 10 to 40 percent slopes, extremely bouldery	1,226
Q0229C	Rapidcreek very gravelly loam, noncalcareous, 1 to 9 percent slopes, rarely flooded	288
Q0231G	Buska-Rock outcrop complex, 40 to 80 percent slopes	3,486
Q0232G	Pactola-Pactola, shallow-Rock outcrop complex, 40 to 80 percent slopes	57,634
Q0235G	Rubbleland-Pactola-Rock outcrop complex, 40 to 75 percent slopes	777
Q0237F	Typic Udarents, reclaimed, 3 to 60 percent slopes	<1
Q0239D	Virkula-Pactola complex, 2 to 15 percent slopes	16,024
Q0300C	Bullflat-Cordeston, dry silt loams, high mica, 2 to 9 percent slopes	903
Q0302E	Buska, dry-Rock outcrop complex, 10 to 40 percent slopes	16,629
Q0304D	Buska-Virkula, high mica loams, dry, 2 to 15 percent slopes	10,987
Q0306C	Cordeston loams, dry, high mica, 2 to 10 percent slopes, flooded	1,016
Q0307B	Cordeston, dry-Marshbrook loams, 0 to 6 percent slopes, flooded	633
Q0309E	Heely channery loam, dry, 9 to 30 percent slopes	1,381
Q0310D	Heely-Cordeston complex, dry, 6 to 15 percent slopes	499
Q0312E	Roubaix-Virkula, complex, dry, 2 to 30 percent slopes	478
Q0315E	Pactola-Virkula-Rock outcrop complex, dry, 10 to 40 percent slope	25,099

Q0317G	Buska, dry-Rock outcrop complex, 40 to 80 percent slopes	4,019
Q0319G	Pactola-Pactola, shallow-Rock outcrop complex, dry, 40 to 80 percent slopes	18,104
Q0322D	Virkula-Pactola complex, dry, 2 to 15 percent slopes	1,136
Q0400B	Crydeston silt loam, 0 to 6 percent slopes, flooded	1,408
Q0401B	Crydeston-Marshbrook, cool complex, 0 to 6 percent slopes, flooded	740
Q0403B	Gillum silt loam, 0 to 6 percent slopes	430
Q0405D	Jenksdraw-Gillum-Rockerville, cool complex, 2 to 25 percent slopes	2,754
Q0407C	Riflepit-Stovho complex, 2 to 12 percent slopes	8,457
Q0408E	Riflepit-Stovho loams, 3 to 30 percent slopes	4,673
Q0409E	Riflepit-Trebor complex, 10 to 40 percent slopes	14,129
Q0411C	McCooley, cool-Riflepit complex, 3 to 10 percent slopes	1,486
Q0411E	McCooley, cool-Riflepit complex, 10 to 40 percent slopes	723
Q0412D	Pesowyo-Rockerville complex, cool, 3 to 20 percent slopes	478
Q0413C	Redbird-Gillum silt loams, 2 to 9 percent slopes	5,629
Q0414E	Rockerville, cool-Rock outcrop complex, 6 to 30 percent slopes	304
Q0415D	Stovho silt loam, 2 to 15 percent slopes	8,836
Q0416C	Stovho-Riflepit-Trebor complex, 2 to 12 percent slopes	43,618
Q0418E	Stovho-Trebor complex, 10 to 40 percent slopes	126,697
Q0420G	Trebor-Rock outcrop complex, 40 to 80 percent slopes	20,561
Q0422C	Bullflat, cool-Crydeston silt loams, 2 to 9 percent slopes	368
Q0501B	Bullflat silt loam, moist, 3 to 6 percent slopes	63
Q0501D	Bullflat silt loam, moist, 6 to 15 percent slopes	18
Q0502C	Bullflat, moist-Cordeston silt loams, 2 to 9 percent slopes	1,549
Q0506D	Citadel silt loam, 2 to 15 percent slopes	525
Q0508C	Citadel-Hickok loams, 3 to 10 percent slopes	225
Q0509C	Citadel-Tollflat complex, 2 to 12 percent slopes	1,836
Q0510E	Citadel-Tollflat-Danjay complex, 10 to 40 percent slopes	10,967
Q0512C	Citadel-McCooley complex, 3 to 10 percent slopes	8,815

Q0512E	Citadel-McCooley complex, 10 to 40 percent slopes	20,822
Q0514C	Citadel-Vanocker complex, 2 to 12 percent slopes	14,536
Q0516C	Colhill-Rothican complex, moist, 2 to 10 percent slopes	201
Q0518B	Cordeston loam, 1 to 6 percent slopes, flooded	3,241
Q0518C	Cordeston loam, 6 to 10 percent slopes	464
Q0519B	Cordeston-Hickok loams, 2 to 6 percent slopes	705
Q0520C	Cordeston-Rapidcreek, rarely flooded complex, 2 to 9 percent slopes	550
Q0528B	Hilger cobbly loam, moist, 0 to 6 percent slopes	29
Q0528E	Hilger cobbly loam, moist, 6 to 40 percent slopes	173
Q0530G	Hopdraw-Sawdust-Rock outcrop complex, moist, 40 to 80 percent slopes	1,539
Q0535C	Bullflat silt loam, moist, 2 to 10 percent slopes	339
Q0538A	Marshbrook silt loam, calcareous, 0 to 3 percent slopes, occasionally flooded	67
Q0540C	McCooley-Tollflat complex, 3 to 10 percent slopes	2,127
Q0540F	McCooley-Tollflat complex, 10 to 60 percent slopes	920
Q0551C	Rockerville complex, 2 to 12 percent slopes	1,377
Q0552D	Rockerville-Gurney complex, moist, 2 to 15 percent slopes	628
Q0553E	Rockerville, moist-Rock outcrop complex, 6 to 40 percent slopes	1,037
Q0554F	Rockerville, moist-Vanocker-Rock outcrop complex, 10 to 60 percent slopes	142
Q0556C	Pesowyo-Rockerville complex, moist, 6 to 10 percent slopes	2,463
Q0556F	Pesowyo-Rockerville complex, moist, 10 to 60 percent slopes	2,582
Q0560C	Rapidreek gravelly loam, 2 to 10 percent slopes, rarely flooded	224
Q0562F	Rock outcrop, limestone	814
Q0563G	Rock outcrop-Vanocker complex, 50 to 75 percent slopes	10,432
Q0564C	Hickok-Rockoa, moist complex, 3 to 12 percent slopes	2,686
Q0565E	Rockoa, moist-Hickok-Rock outcrop complex, 10 to 40 percent slopes	2,893
Q0566F	Rockoa, moist-Rock outcrop complex, 25 to 60 percent slopes	1,900
Q0568B	Roubaix silt loam, 0 to 6 percent slopes	565

Q0568E	Roubaix silt loam, 6 to 40 percent slopes	1,542
Q0570F	Opechekahta-Citivar-Schaeferville complex, 20 to 60 percent slopes	1,583
Q0571E	Sawdust, moist-Vanocker-Rockerville, moist complex, 10 to 40 percent slopes	3,272
Q0572D	Schaeferville-Citivar silt loams, 6 to 20 percent slopes	152
Q0576C	Tollflat-Vanocker complex, 2 to 12 percent slopes	638
Q0584E	Vanocker-Citadel complex, 10 to 40 percent slopes	58,436
Q0584F	Vanocker-Citadel complex, 20 to 60 percent slopes	13,644
Q0585G	Vanocker-Danjay-Hopdraw, moist complex, 40 to 80 percent slopes	8,168
Q0586E	Vanocker-Danjay-Tollflat complex, 10 to 40 percent slopes	3,310
Q0587E	Vanocker-Hickok complex, 10 to 40 percent slopes	8,829
Q0588D	Vanocker-Rockerville, moist complex, 2 to 15 percent slopes	3,162
Q0589G	Vanocker-Sawdust, moist-Rock outcrop complex, 40 to 80 percent slopes	28,598
Q0590E	Sawdust-Hopdraw-Rockerville complex, moist, 10 to 40 percent slopes	390
Q0591G	Sawdust, moist-Rock outcrop complex, 40 to 80 percent slopes	2,236
Q0602A	Barnum very fine sandy loam, cool, 0 to 3 percent slopes, rarely flooded	155
Q0603B	Barnum, cool-Rapidcreek complex, 0 to 6 percent slopes, rarely flooded	974
Q0608B	Bullflat silt loam, 3 to 6 percent slopes	444
Q0609C	Bullflat-Cordeston, dry silt loams, 2 to 9 percent slopes	2,037
Q0611C	Citadel-Vanocker complex, dry, 2 to 12 percent slopes	1,275
Q0613F	Colhill-Ziggy, cool complex, 15 to 50 percent slopes	375
Q0615D	Colnevee channery loam, 6 to 15 percent slopes	74
Q0616C	Colnevee silt loam, 2 to 9 percent slopes	54
Q0617B	Colombo loam, cool, 0 to 4 percent slopes, rarely flooded	<1
Q0619C	Cordeston loam, dry, 2 to 10 percent slopes	66
Q0620C	Cordeston-Rapidcreek, rarely flooded complex, dry, 2 to 9 percent slopes	2,194
Q0622F	Crownest-Rock outcrop complex, 9 to 60 percent slopes	161
Q0625B	Sodawells fine sandy loam, cool, 0 to 4 percent slopes, rarely	25

	flooded	
Q0629B	Hilger cobbly loam, 0 to 6 percent slopes	640
Q0629E	Hilger cobbly loam, 6 to 40 percent slopes	777
Q0630E	Hilger-Metre, cool complex, 10 to 40 percent slopes	14
Q0632E	Hilger-Virkula, dry complex, 2 to 30 percent slopes	124
Q0634G	Hopdraw-Sawdust-Rock outcrop complex, 40 to 80 percent slopes	15,907
Q0640B	Norkool silt loam, dry, 2 to 6 percent slopes	9
Q0645C	Rapidcreek cobbly loam, dry, 2 to 10 percent slopes, rarely flooded	406
Q0646C	Rapidcreek loam, dry, 3 to 9 percent slopes, rarely flooded	19
Q0653D	Crownest-Rock outcrop complex, 2 to 25 percent slopes	487
Q0655G	Sawdust-Rock outcrop complex, 40 to 80 percent slopes	5,565
Q0657D	Rockerville-Boneek, cool, complex, 6 to 15 percent slopes	300
Q0658D	Rockerville-Gurney complex, 2 to 15 percent slopes	15,526
Q0659E	Rockerville-Rock outcrop complex, 6 to 30 percent slopes	9,159
Q0660F	Rockerville-Sawdust-Rock outcrop complex, 9 to 60 percent slopes	1,466
Q0664E	Sawdust-Hopdraw-Rockerville complex, 10 to 40 percent slopes	14,244
Q0665E	Sawdust-Vanocker, dry-Rockerville complex, 10 to 40 percent slopes	57,332
Q0668F	Spearfish, cool-Rock outcrop complex, 9 to 50 percent slopes	42
Q0670B	Tilford silt loam, cool, 2 to 6 percent slopes	47
Q0672C	Tilford, cool-Rockerville complex, 6 to 9 percent slopes	80
Q0675E	Vanocker-Citadel complex, dry, 10 to 40 percent slopes	7,285
Q0676E	Vanocker-Hickok complex, dry, 10 to 40 percent slopes	5,390
Q0677D	Vanocker, dry-Rockerville complex, 2 to 15 percent slopes	3,617
Q0678G	Vanocker, dry-Sawdust-Rock outcrop complex, 40 to 80 percent slopes	15,507
Q0680D	Ziggy, cool-Colhill complex, 6 to 15 percent slopes	749
Q0701F	Orthents, loamy, earthen dams, 0 to 75 percent slopes	<1
Q0702F	Pits, quarry	197
Q0704E	Udarents, abandoned gravel pits	78

Q0705D	Udarents, reclaimed gravel pits	75
Q0801B	Boneek loam, cool, 2 to 6 percent slopes	85
Q0801C	Boneek loam, cool, 6 to 10 percent slopes	10
Q0803E	Shingle-Ucross loams, cool, 10 to 30 percent slopes	106
Q0807C	Alice-Ucross complex, cool, 3 to 10 percent slopes	17
Q0808A	Coaliams loam, cool, 0 to 3 percent slopes, flooded	312
Q0811C	Colsavage clay loam, 2 to 10 percent slopes	25
Q0812C	Colsavage-Bahl-Leiter clay loams, cool, 6 to 10 percent slopes	93
Q0812E	Colsavage-Bahl-Leiter clay loams, cool, 10 to 30 percent slopes	175
Q0813A	Cordeston silt loams, 0 to 3 percent slopes, flooded	326
Q0815C	Crownest-Regnaps complex, 3 to 10 percent slopes	508
Q0815E	Crownest-Regnaps complex, 10 to 30 percent slopes	57
Q0817A	Frazerton silty clay loam, cool, 0 to 3 percent slopes, occasionally flooded	208
Q0826C	Lakoa-Crownest complex, moist, 3 to 10 percent slopes	592
Q0826F	Lakoa-Crownest complex, moist, 10 to 60 percent slopes	4,665
Q0827C	Lakoa-Reicess loams, moist, 6 to 10 percent slopes	203
Q0827E	Lakoa-Reicess loams, moist, 10 to 30 percent slopes	32
Q0828C	Tollflat-Hickok loams, 3 to 10 percent slopes	15,560
Q0828F	Tollflat-Hickok-Vanocker complex, 10 to 60 percent slopes	36,811
Q0830C	Maitland loam, moist, 6 to 10 percent slopes	32
Q0834B	Nunnston clay loam, 2 to 6 percent slopes	99
Q0834C	Nunnston clay loam, 6 to 10 percent slopes	60
Q0836B	Nunnston loam, thick surface, 1 to 6 percent slopes	65
Q0836C	Nunnston loam, thick surface, 6 to 10 percent slopes	6
Q0838B	Norkool loam, moderately deep, moist, 2 to 6 percent slopes	3
Q0838C	Norkool loam, moderately deep, moist, 6 to 10 percent slopes	19
Q0840C	Regnaps-Crownest complex, 3 to 10 percent slopes	158
Q0841B	Reicess loam, moist, 1 to 6 percent slopes	79
Q0842C	Reicess-Shingle loams, moist, 6 to 10 percent slopes	63

Q0848B	Nunnston loam, moderately deep, 1 to 6 percent slopes	34
Q0852C	Samsil-Gaynor complex, cool, 2 to 10 percent slopes	31
Q0852E	Samsil-Gaynor complex, cool, 10 to 30 percent slopes	658
Q0854B	Work clay loam, 2 to 6 percent slopes	276
Q0854C	Work clay loam, 6 to 10 percent slopes	27
Q0854E	Work clay loam, 10 to 30 percent slopes	2,353
Q0901B	Boneek silt loam, moist, 2 to 6 percent slopes	30
Q0906D	Colnevee-Spearfish, cool silt loams, moist, 6 to 20 percent slopes	5
Q0910E	Corpening-Rock outcrop complex, 3 to 30 percent slopes	310
Q0912B	Norkool loam, 1 to 6 percent slopes	14
Q0912C	Norkool loam, 6 to 10 percent slopes	63
Q0913B	Nunnston, thick surface-Cordeston loams, 1 to 6 percent slopes	46
Q0918C	Rockerville-Pesowyo complex, 3 to 12 percent slopes	26
Q0918E	Rockerville-Pesowyo complex, 10 to 30 percent slopes	1
Q0922B	Sugakool loam, moist, 1 to 6 percent slopes	31
Q0922C	Sugakool loam, moist, 6 to 10 percent slopes	87
Q0924C	Tilford silt loam, cool, 6 to 10 percent slopes	3
Q0926G	Rock outcrop-Vanocker, dry complex, 50 to 75 percent slopes	6,821
Q0928B	Vassett silt loam, moist, 1 to 6 percent slopes	4
Q0928C	Vassett silt loam, moist, 6 to 10 percent slopes	8
QW	Water	24

Applicable Laws, Regulations, Policy, and Forest Plan Direction

The authorities governing Forest Service soil management are (USDA Forest Service 2010a):

1. The Organic Administration Act of 1897 (16 U.S.C. 473-475). Authorizes the Secretary of Agriculture to establish regulations to govern the occupancy and use of National Forests and "…to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States."

2. Bankhead-Jones Act of 1937. The Secretary is authorized and directed to develop a program of land conservation and land utilization, in order thereby to correct maladjustments in land use, and thus assist in controlling soil erosion (reforestation), preserving natural resources, (protecting fish and wildlife, developing and protecting recreational facilities), mitigating floods, (preventing impairment of dams and reservoirs, developing energy resources), conserving surface and subsurface moisture, protecting the watersheds of navigable streams, and protecting the public lands, health, safety, and welfare.

3. The Multiple-Use, Sustained-Yield Act of 1960 (P.L. 86-517, 74 Stat. 215; 16 U.S.C. 528-531). States that the National Forests are to be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes. This Act directs the Secretary to manage these resources in the combination that will best meet the needs of the American people; providing for periodic adjustments in use to conform to changing needs and conditions; and harmonious and coordinated management of the resources without impairment of the productivity of the land. Sustained yield means achieving and maintaining into perpetuity a high-level annual or regular periodic output of renewable resources without impairment of the productivity of the land.

4. The National Environmental Policy Act (NEPA) of 1969 (16 U.S.C. 4321). Declares it is the policy of the Federal Government to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans. The Act requires agencies to analyze the physical, social, and economic effects associated with proposed plans and decisions, to consider alternatives to the action proposed, and to document the results of the analysis.

5. The Forest and Rangeland Renewable Resources Planning Act (RPA) of 1974 (16 U.S.C. 1600-1614) (as amended by National Forest Management Act (NFMA) of 1976 (16 U.S.C. 472a). States that the development and administration of the renewable resources of the National Forest System are to be in full accord with the concepts for multiple use and sustained yield of products and services as set forth in the Multiple-Use Sustained Yield Act of 1960. The Act requires the maintenance of productivity of the land and the protection and, where appropriate, improvement of the quality of the soil and water resources. The Act specifies that substantial and permanent impairment of productivity must be avoided and has far-reaching implications for watershed management in the National Forest System.

Forest Service Manual, Chapter 2550 - Soil Management (USDA Forest Service 2010a)

The 1996 and 2005 FEIS documents to the Forest Plan, and as amended, referenced Forest Service Handbook 2509.18 Soil Management Handbook. The 2010 issuance of Forest Service Manual, Chapter 2550 - Soil Management (USDA Forest Service 2010a) specified that the older document (FSH 2509.18 Soil Management Handbook) had been removed from the Forest Service directive system (no longer valid). The FSM (USDA Forest Service 2010a), which was accessible to the public at:
https://forest.moscowfsl.wsu.edu/smp/solo/documents/MISC/soil_mgmt_manual_2010/wo_2550

.pdf specifies the use of adaptive management to design and implement land management activities in a manner that achieves desired soil conditions and objectives as identified in the applicable land management plan. The standards and guidelines in the plan are intended to prevent substantial and permanent damage or degradation that affects inherent ecosystem process. The standards and guidelines in the land management plan are to be reviewed periodically to determine if they are consistent with the best available science and to be revised as needed. Further the manual states that generally, soil management standards and guidelines are not applied to administrative sites or dedicated use areas (such as roads, recreation sites). Standards and guidelines may apply to off-site impacts related to these sites and areas.

Region 2 Watershed Conservation Practices Handbook (WCPH) (USDA Forest Service 2006)

This handbook provides direction with similar wording to Forest Plan Standard 1103 (see below). The following Management Measure 13:

> "Manage land treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15% of an activity area (commonly a timber sale cutting unit, prescribed fire burn unit or an allotment pasture)."

There are design criteria identified in the WCPH that have been identified for implementation in attaining the management measure.

Standards, guidelines and management directives set forth in the Revised Forest Plan as amended (USDA Forest Service 2006a) include measures for the conservation and protection of the soil resource on National Forest System lands. Forest Plan standards and guidelines for the soil resource considered applicable to the BHRL project include:

Soil Productivity

1101. When doing projects, analyze the cumulative effects of disturbances on long-term soil productivity. **STANDARD**

1102. Maintain or improve long-term levels of organic matter and nutrients on all lands. **STANDARD**

a. On soils with topsoil thinner than 1 inch, topsoil organic matter less than 2 percent, or effective rooting depth less than 15 inches, retain 90 percent or more of the fine (less than 3 inches in diameter) logging slash in the stand after each clearcut and seed-tree harvest, and retain 50 percent or more of such slash in the stand after each shelterwood and group-selection harvest, considering existing and projected levels of fine slash. **GUIDELINE**

b. For areas adjacent to roads and trails, retain slash described in (a) at levels that meet guideline 4112. **GUIDELINE**

Refer to the proposed Forest Plan amendment identified in Chapter Two of the BHRL FEIS for the above Standard.

If amended, Standard 1102 would be consistent with language found in the Regional Watershed Conservation Practices Handbook (WCPH) (USDA Forest Service 2006b):

Proposed Amended 1102. Maintain or improve long-term levels of organic matter and nutrients on all lands. On soils with surface soil (A-horizon) thinner than 1 inch, topsoil organic matter less than 2%, or effective rooting depth less than 15 inches,

retain 80-90% of the fine (less than 3 inches in diameter) post treatment logging slash in the stand after each clearcut and seed-tree harvest. Consider need for retention of coarse woody debris slash in each activity area to balance soil quality requirements and fuel loading concerns.

Soil Disturbance

1103. Manage land treatments to limit the sum of severely burned and detrimentally compacted, eroded, and displaced land to no more than 15% of any land unit. "Land treatments" are human actions that disturb vegetation, ground cover, or soil. "Land unit" is a mapped land type polygon or a mapped soil unit. **STANDARD**

1104. Minimize soil compaction by reducing off-road vehicle passes, by skidding on snow or frozen or dry soil conditions, or by off-ground logging systems. **GUIDELINE**

1105. Limit roads and other disturbed sites to the minimum feasible number, width, and total length consistent with the purpose of specific operations, local topography, and climate. **STANDARD**

1106. Stabilize and maintain roads and other disturbed sites during and after construction to control erosion. **STANDARD**

Slope Stability

****The following guideline is in the existing plan soil section. However, since the time that direction had been identified for the 1997 Forest Plan, additional information has been obtained and developed, and national direction now exists for addressing slope stability as a geologic hazard and to be addressed by geologists. Site stability examination is no longer limited to the soil information listed below but is based on a wider variety of site characteristics. Refer to the BHRL geology report and geology section of the BHRL FEIS for information and discussion of slope stability (also known as site stability).***

1108. Reduce resource damage and investment loss in areas that have a mass movement potential. **GUIDELINE**

a. Perform an on-site slope-stability examination on slopes over 30 percent prior to design of roads or activities that remove most or all of the timber canopy for the following areas and soils:

1. Lakoa, Larkson, and Citadel soils found in the Bear Lodge Mountains;
2. Rockoa and Mathias soils on the Dakota Hogback; and
3. Citadel soil found on in the northern and eastern [western] Black Hills.

b. Perform an on-site slope stability examination on slopes over 55 percent prior to design of roads or activities that remove most or all of the timber canopy on all other soil types. Limit intensive ground-disturbing activities on unstable slopes identified during slope-stability examinations.

Rehabilitation and Revegetation

1109. Reclaim roads and other disturbed sites when use ends, as needed, to prevent resource damage. **STANDARD**

1110. Initiate re-vegetation as soon as possible, not to exceed 6 months after termination of ground-disturbing activities. Revegetate all disturbed soils with native species in seed/plant mixtures that are noxious-weed free. On areas needing immediate establishment of vegetation, non-native, non-aggressive annuals (e.g., wheat, oats, rye) or sterile species may be used while native perennials are becoming established, or when native species are not available (e.g., during

drought years or years when wildfires burn large acreages in the United States). Other aggressive non-native perennials (e.g. smooth brome, timothy) will not be used. Seed will be tested for noxious weeds. If mulches are used they are to be noxious-weed free. Weed-free alfalfa seed may be used only when native legume seed is not available and only when there is extensive disturbance associated with road construction or mine reclamation where topsoil is no longer available. **STANDARD**
1111. Stabilize, scarify, or recontour temporary roads, constructed skid trails, and landings prior to seeding. **GUIDELINE**

Surface Water Runoff
While the following had been included in the 1997 Plan in the overall soils section these standards and guidelines are primarily for protecting water quantity and quality and are addressed through the Watershed Conservation Practices Handbook design criteria for projects. Water quantity and water quality conservation and protection are included in the project Watershed Report and the Watershed section in Chapter Three of the BHRL FEIS.
1112. Manage land treatments to maintain enough organic ground cover in each land unit to prevent harmful increased runoff. **STANDARD**
1113. Construct roads and other disturbed sites to minimize sediment discharge into streams, lakes, and wetlands. **STANDARD**
1114. When construction of maintenance level 1 roads, temporary roads, skid trails and landings occur, install structures to divert runoff when needed. **STANDARD**
1115. When ground disturbing or vegetation management occurs, use vegetative buffer strips or barriers to reduce sediment. Determine buffer width between stream and roads or trails using the equation in Appendix J. **GUIDELINE**
1116. Manage land treatments to conserve site moisture and to protect long-term stream health from damage by increased runoff. **STANDARD**

There is no specific soil resource direction included within any of the specific Management Area direction sections of the Forest Plan. Forest Plan standards and guidelines for the conservation and protection of soil resource productivity apply to all of the designated management areas on BHNF administered land.

Environmental Consequences

Introduction

The analysis of effects for soils assumes that Forest Plan Standards and Guidelines and the appropriate Watershed Conservation Practices Handbook (WCPH) Design Criteria would be implemented during all project activities and that site reviews would occur prior to implementation of all BHRL project activities. This analysis discusses the expected disturbance resulting from the implementation of the action alternative (Alternative A) and describes expected potential effects to the soil resource associated with various activity disturbances. Various similar harvest system activities and design and Standard Operation Procedures (SOPs) have been implemented during past Forest projects. Various sites have been evaluated (monitored) although types and methods for the evaluations (monitoring) have changed over time. Soil monitoring has been included in Forest monitoring reports. The most recent Forest Plan monitoring report was issued in 2015 (USDA Forest Service 2015). Forest Plan monitoring reports are currently available at: https://www.fs.usda.gov/detail/blackhills/landmanagement/planning/?cid=STELPRDB5112296

Cumulative effects for soil resources have generally been discussed in terms of the treatment activity areas. The Forest Service Manual (FSM) (USDA Forest Service 2010a) defines an activity area as a land area affected by a management activity to which soil quality standards are applied. An example of an activity area is a timber sale harvest unit. Per manual direction, soil quality standards do not apply outside of an activity area. Effects to the watershed resource as a whole are discussed in the Watershed Report and watershed section in Chapter Three of the BHRL FEIS.

The FSM (USDA Forest Service 2010a) defines soil quality guidelines in terms of detrimental soil disturbance which includes: compaction, rutting, displacement, severely-burned soil, surface erosion and soil mass movement (mass failures). It is important to consider and understand that not all site or soil disturbances are detrimental disturbance, or disturbances that would be to the level that would result in substantial soil impairment. For example, compaction of soil resources can occur, however soil bulk density increases associated with disturbances can occur to various levels which may not be at levels considered to be detrimental, or a change to that would result in changes to soil properties that would result in a loss of the inherent ecological capacity of hydrologic function of the soil resource.

Assumptions used discussing potential disturbance associated with various activities and used in this analysis:

- All figures are approximate.
- Actual acres/miles implemented would depend on weather, priorities, funding and other factors.
- Mapped stand boundary locations are approximate. Stand delineation and structure are subject to corrections based on field review.
- Project implementation will comply with the Forest Plan and all other relevant direction.
- Proposed activities will be implemented as designed.
- Proposed road construction mileage is a maximum that would provide access to all possible SS 4A commercial treatment stands. Miles of road actually constructed will be less than the maximum, roughly proportional to the 4A acres actually treated.
- Proposed non-commercial treatments will use the existing road system, as modified in conjunction with commercial treatments.
- Timber sales currently scheduled for sale, and those that have been sold but not yet cut, will occur as planned.
- Pending timber sales resulting from the Mountain Pine Beetle Response Project (MPBRP) will commercially treat an average of approximately 40 percent of the Potential Treatment Area acreage within each sale boundary.
- Forest Service Manual 2500 – Watershed and Air Management, Chapter 2550 – Soil Management (USDA Forest Service 2010a) and Watershed Conservation Practices (FSH2509.25) will be followed.
- Design features and standard operating procedures identified to be in compliance with Forest Plan direction would be implemented and adequate funding would be provided for effective implementation.
- The implementation of the wildlife standard for retaining large woody debris (Forest Plan Standard 2308a) is expected to attain the Forest Plan Objective (212) of 5 to 10 tons per acre of large woody debris retained within activity areas.

- If review of monitoring design criteria implementation indicated issues during implementation, that implementation or design criteria would be altered or adapted to address issues. If a soil issue was identified after implementation that actions would be identified and funding would be available to implement any needed rehabilitation.

Direct and Indirect Effects of Alternative B – No Action Alternative

Alternative B (No Action Alternative) provides a baseline to evaluate the effects of the action alternative (Alternative A). The no action alternative means that the proposed BHRL project wouldn't happen, but all other ongoing and planned activities would occur. The effects on soils are discussed as changes over time on soil productivity. The proposed Forest Plan Standard 1102 amendment would not be happen under this alternative.

Soil Productivity
Alternative B would not result in short-term effects on the soil resource over and above the existing condition. No additional road construction, timber harvest, precommercial thinning, prescribed fire, mechanized site preparation or other activities described for the BHRL project would disrupt natural soil processes.

Physical Soil Characteristics
Alternative B would not result in soil compaction, nutrient loss, etc. associated with any of the BHRL project activities. In areas where past Forest activities (such as timber management) may have resulted in compacted soil conditions, soil productivity would generally be expected to improve over time in association with natural factors of plant root growth, soil organism activity and/or freeze-thaw events that may loosen the soil. Where needed, various intensively used activity sites such as landings or temporary roads may be actively scarified or ripped to reduce compaction levels.

Organic Matter
With implementation of Alternative B, a majority of standing dead trees remaining that were associated with the mountain pine beetle activity would eventually fall over and contribute coarse woody debris to the soil surface. Needles and branches would generally remain on the site and fall to the ground. Soil organisms would decompose some level of organic materials thus adding humus to the soil. Over time, nutrients associated with this material would become available for plant growth. As the ponderosa pine tree canopies close in and shade the soil surface, soil organism activity generally slows in association with cooler temperatures and decomposition rates would generally reduce to levels that allow organic matter and nutrients to accumulate on the soil surface. This process would continue until another major disturbance, such as fire or a windstorm, opens the tree canopy allowing sites to have increased temperatures and contribute to increase downed wood recycling processes again.

Soil Organisms
Microorganism populations would fluctuate with the changes in the microclimate and the organic matter on the soil surface. These changes would be in response to the changing vegetation as a result of natural events such as fire, wind throw of trees and other sources of natural vegetation mortality.

Soil Erosion
Alternative B would generally be expected to result in the continuance of any current soil erosion to decrease as vegetation returns to soil surfaces capable of supporting vegetation that currently lack plant cover. Any wildfires that may occur would generally be expected to result in a short-term localized (within the burned boundaries) increase in soil erosion. Based on recent Black Hills Burned Area Emergency Response (BAER) assessment observations, this generally occurs within the first two to three years following the fire during favorable precipitation years. By three to five years following a wildfire, burned sites have generally revegetated to the extent that erosion rates have returned to general background levels. Soil erosion rates would fluctuate with natural changes in vegetation cover.

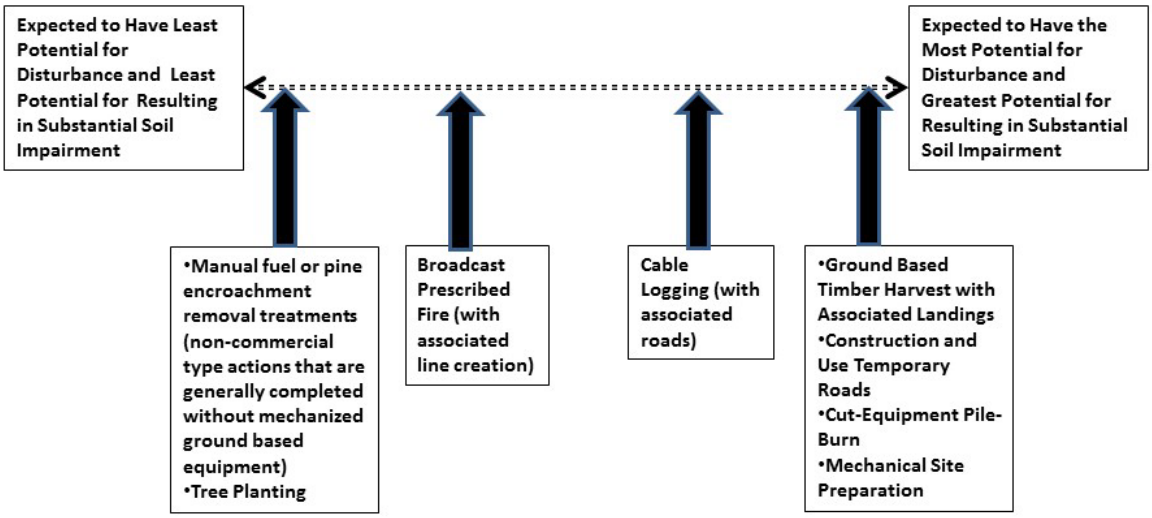
Mass Failures
In past projects, mass failures had been addressed within soil or watershed reports. For this project, mass failure (site stability) discussions are located within the Geology Specialist Report and Geology section of Chapter Three of the EIS.

Direct and Indirect Effects of the Action Alternative – Alternative A

Soil Productivity
The following paragraphs are based on the Forest intent to maintain soil productivity while addressing the purpose and need of the project. The project includes alternative design, treatment methods and Standard Operating Procedures (SOPs) that are expected to result in less disturbance to various soil resources that naturally have potential greater risks of productivity loss. Various project design and SOPs includes such options as operating during dry or frozen conditions, limiting the extent of temporary roads, skid trails and landings and rehabilitating those project activity features so that detrimental soil conditions do not occupy greater than 15 percent of each activity area.

While not on a true scale, the following visual feature provides a general comparison of BHRL potential activities and expected potential ground disturbance based on past activity field observations on the BHNF. These observations are consistent with what has been documented in a publication by the USFS Rocky Mountain Research Station for the USFS Northern Region (Reeves et al. 2011). In that publication, it was stated that there was a significant difference in an area extent of detrimental soil disturbance following timber harvest operations among ground based and skyline (cable logging), among harvest seasons and among National Forests. The frequency of detrimental soil disturbance (DSD) associated with harvest operations in the Northern Region followed the general trend of ground-based over that of skyline (cable). Further information in that document, similar to what the Black Hills has documented during monitoring (with the latest monitoring report available in 2015 accessible at https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd475802.pdf), identified that winter ground-based harvest resulted in a significantly lower areal extent of DSD than summer ground-based harvest. On the Black Hills, the DSD extent (of soil bulk density increases) on sites sampled was also very low to not even detectable when units (primarily ponderosa pine vegetation sites) were harvested during dry soil moisture conditions (generally drought years) during the growing season (USDA Forest Service 2015, pp. 14-16).

The following visual feature provides a quick general overview of which BHRL project activities would also likely have the greatest potential for detrimental soil disturbance. In association with the activities with the greatest potential for detrimental soil disturbance, those are the activities that would also be expected to have the most design and SOPs applied during implementation.



Photos displaying varying basal area retention, snags, coarse woody debris levels, piles where trees were processed, roads, etc.

<u>Physical Soil Characteristics</u>

A primary change that can be associated with activity implementation is that of compaction (an increase in soil bulk density). All soils can compact. However, some soils are less likely to compact than others. There are soils within the project boundary activity areas with greater potential to be compacted to detrimental levels (or a level that would result in substantial soil impairment) if activities would occur when soils are wet. The following soil survey map units, listed by soil survey map unit symbols, have at least one of the dominant map unit components with a severe hazard rating for compaction. Based on a GIS query, these map units comprise approximately 688,250 acres (or approximately 92%) of the BHRL project area acres (746,200 acres).

Major Land Resource Area 61 (Black Hills Footslopes)
**Approximately 7,105 acres*
Soil Map Unit Symbol: P010C, P010E, P040B, P054D, P058C, P058E, P080D, P098E, P102C, P102E, P128F, P130E, P136C, P148C, P176C, P182A, P184B, P184C, P188F, P196B, P196C, P196E, P198F, P224F, P226E, P266E, P270F, P276B, P284C, P352B, P354B, P358B, P362B, P364B, P364C, P388D, P412C, P414E, P416E, P438C, P438E, P472C, P474C, P504B, P506C, P514B, P514C, P516B, P516D, P522C, P524C, P528E, P538B, P546B, P546C, P552E, P558D, P560D.

Major Land Resource Area 62 – Black Hills
**Approximately 681,145 acres*

Soil Map Unit Symbol: Q0100C, Q0102E, Q0104G, Q0106E, Q0108E, Q0108G, Q0114D, Q0114E, Q0114F, Q0200C, Q0206B, Q0209D, Q0211E, Q0216B, Q0217C, Q0225D, Q0226E, Q0227E, Q0239D, Q0304D, Q0312E, Q0315E, Q0322D, Q0400B, Q0401B, Q0403B, Q0405D, Q0407C, Q0408E, Q0409E, Q0411C, Q0411E, Q0413C, Q0414E, Q0415D, Q0416C, Q0418E, Q0420G, Q0422C, Q0501B, Q0501D, Q0502C, Q0506D, Q0508C, Q0509C, Q0510E, Q0512C, Q0512E, Q0514C, Q0518B, Q0518C, Q0519B, Q0520C, Q0535C, Q0538A, Q0540C, Q0540F, Q0552D, Q0568B, Q0568E, Q0570F, Q0572D, Q0576C, Q0584E, Q0584F, Q0586E, Q0587E, Q0608B, Q0609C, Q0613F, Q0617B, Q0620C, Q0625B, Q0630E, Q0632E, Q0640B, Q0657D, Q0670B, Q0675E, Q0676E, Q0680D, Q0801B, Q0801C, Q0803E, Q0808A, Q0811C, Q0812C, Q0812E, Q0815C, Q0815E, Q0817A, Q0826C, Q0826F, Q0827C, Q0827E, Q0828C, Q0828F, Q0830C, Q0834B, Q0834C, Q0836B, Q0836C, Q0838B, Q0838C, Q0840C, Q0841B, Q0842C, Q0848B, Q0852C, Q0852E, Q0854B, Q0854C, Q0854E, Q0901B, Q0912B, Q0912C, Q0913B, Q0922B, Q0922C, Q0924C, Q0928B, Q0928C.

Citadel Series

The Citadel series consists of very deep, well drained soils formed in residuum and local alluvium from calcareous sandstone, limestone and soft shale on mountains. Slopes generally range from 2 to 50 percent. The series is extensive in the Black Hills and is a dominant component in soil map units represented by the following map unit symbols: Q0506D, Q0508C, Q0509C, Q0510E, Q0512C, Q0512E, Q0514C, Q0584E, Q0584F, Q611C, Q0675E.

Fuel and Hazard Tree Treatments

Manual Fuel Treatments - Shaded Fuel Break Construction; Thin, Pile, and Burn Fuels; Scatter, Shred or Chip Fuels; Cut, Lop and Scatter Fuels

These types of treatments generally result in little to no ground disturbance and some level of organic matter is generally left distributed throughout the area. At times, some limited weight ground based equipment (such as chippers) are used with these activities therefore compaction that would be to that of a detrimental level is generally not expected.

Prescribed Fire

Broadcast burning generally results in limited to no alterations to soil bulk density levels. Burning itself generally does not result in increases in bulk density levels. Holding lines around broadcast prescribed burns can include existing roads, the creation of burned black lines and lines created by dozers. Dozers are generally making one or two passes to create the line. In addition, prescribed broadcast burns generally occur in the fall (drier soil conditions) or early spring (before spring vegetation growth and soil water may be in a frozen condition), therefore associated activities, such as holding line creation, are occurring generally when conditions limit the potential for compaction. Therefore, an increase in bulk density levels is generally not expected or would not be expected to occur to a level that would be considered to be at a detrimental level with these activities.

Pile burning, manual or mechanical, is not expected to result in increases to soil bulk density levels. The timing and conditions for manual and mechanical pile burning activities generally are during the winter and when there is snow cover. Frozen conditions or snow cover limits the potential for increases in bulk density. Therefore, an increase in soil bulk density levels is generally not expected to occur with prescribed pile burning activities.

Manual pile burning on the Mystic Ranger District, Black Hills National Forest. Photo taken in 2011 by Beth Steinauer.

Enhancement of Non-pine Vegetation and Within Stand Diversity
****Removal of pine/spruce from aspen stands, regeneration of aspen stands, removal of pine/spruce from aspen inclusions, removal of pine from oak stands, removal of pine from grasslands, uneven-age individual tree selection or group selection.***

Potential Commercial Methods: These would be expected to generally occur through ground-based equipment harvest or through cable harvest methods. Design, SOPs and effects discussion would be the same as those discussed the same methods under the Pine Structural Stage Modification section. Refer to that section of this document.

Non-Commercial Methods: A variety of non-commercial methods may be used to remove conifers to conserve or enhance the other vegetative type conditions. While not necessarily all inclusive, some methods could include Thin, Hand Pile, and Burn conifer materials, Scatter, Shred or Chip conifer materials or Cut, Lop and Scatter conifer materials. Prescribed broadcast fire can also be a useful and successful tool in the removal of pine from grasslands. Effects would be the same as those described for prescribed fire in the Fuel and Hazard Tree Treatments section. Refer to that section of this document.

Pine Structural Stage Modification

Overstory Removal

Ground-Based Harvest
****Including shaded fuel break construction with commercial removal.***
Ground-based harvesting would generally result in localized direct and indirect effects on soil physical characteristics within the boundaries of proposed activity areas (such as a harvest unit). Ground based systems would occur across the landscape on slopes generally less than 40 percent slopes. The likelihood for the greatest level of potential detrimental effects, including that of compaction, would be concentrated on skid trails and temporary roads and landings within, or associated with timber units that are treated. Minimizing the area occupied by landings or to reuse landings, skid trails or unauthorized roads are included in the project design or as SOPs to limit potential extent of detrimental effects. Design and SOPs such as including operating on dry or frozen conditions to prevent bulk density increases to a detrimental level on soils with characteristics that level may be more likely to occur (refer to the list of those soil map units above). Dry conditions are generally when soils are at moisture levels lower than what is at a field capacity level, below what is known as the plastic limit (USDA Forest Service 2006b). Rutting and puddling are most often associated with mechanical logging on soils that are wet, or above the plastic limit (generally when soil can be rolled into three millimeter threads without breaking or crumbling). By operating ground based equipment during low soil moisture conditions, there is the potential to limit the amount of detrimental soil disturbance on skid trails.

Operating equipment on slash is another SOP that is generally effective for buffering the effect of equipment operation on mineral soil. Thus, if harvest systems are used resulting

in significant slash maintenance on the skid trails during skidding operations, detrimental effects could be limited. Design and SOPs also include rehabilitation implementation of landings and skid trails (Example: USDA Forest Service 2006c, Provision BT6.63, page 130).

Cable Timber Harvest

This type of harvest operation on any of the identified commercial treatment areas (generally on areas over 40% slope areas) would generally be expected to result in direct and indirect effects on soil physical characteristics within the localized areas that the method would be used. In the past on the Black Hills, it has been observed that areas of compaction associated with cable systems have generally been less in extent than on areas associated with ground-based operations, and very localized. As stated earlier, this is generally consistent with what has been recently documented by the USFS Rocky Mountain Research Station in the Northern Region Forests (Reeves et al. 2011).

Design and SOPs include implementation of rehabilitation activities at the harvest landings, skid trails and temporary roads (Examples: USDA Forest Service 2006b, WCPH Management Measure 9, Design criteria j., page 19; USDA Forest Service 2006c, Provision BT6.64, page 130).

Precommercial and/or Products Other Than Logs (POL) Thin

Implementation currently generally occurs through a contract and with ground based equipment. In today's market, there has become more demand for these products in the Black Hills area. Since ground based activity effects were discussed under Pine Structural Stage Modification, Ground Based Harvest it is not repeated here. Please refer to that section for ground based activities.

Patch Cut

Patch cuts are generally a structural stage modification cut. All trees in an area covering generally less than 10 acres in size are harvested (USDA Forest Service 2006a, page Glossary-9). The harvest basically results in a Structural Stage 1 (grass/forb) for the patch cut area. Patch cuts are generally created through the use of ground based equipment, although they may also be created through other means such as a cable type harvest. Since ground based and cable harvest activity effects were discussed under Pine Structural Stage Modification, Ground Based Harvest and Cable Timber Harvest, it is not repeated here. Please refer to those sections in this document.

Tree Planting

****Forest Plan Management Areas 5.1, 5.4 and 5.43.***

The Action Alternative identifies a maximum of 5,000 acres of tree planting. Currently, some level of tree planting generally occurs on an annual basis on the Forest. Tree planting on the Forest has been completed manually (hand planting). While uncertain, it is assumed that future tree planting would continue to occur manually. Planting activities generally occur in areas that have been affected by wildfires (such as within the Jasper Fire burned area). These types of treatments generally result in little to no ground disturbance. No compaction to that of what would be considered a detrimental level is

expected with this activity.

Tree planting in the Jasper Fire burned area on the Black Hills National Forest. Photo taken by Michael Engelhart, April 2011.

Mechanical Site Preparation

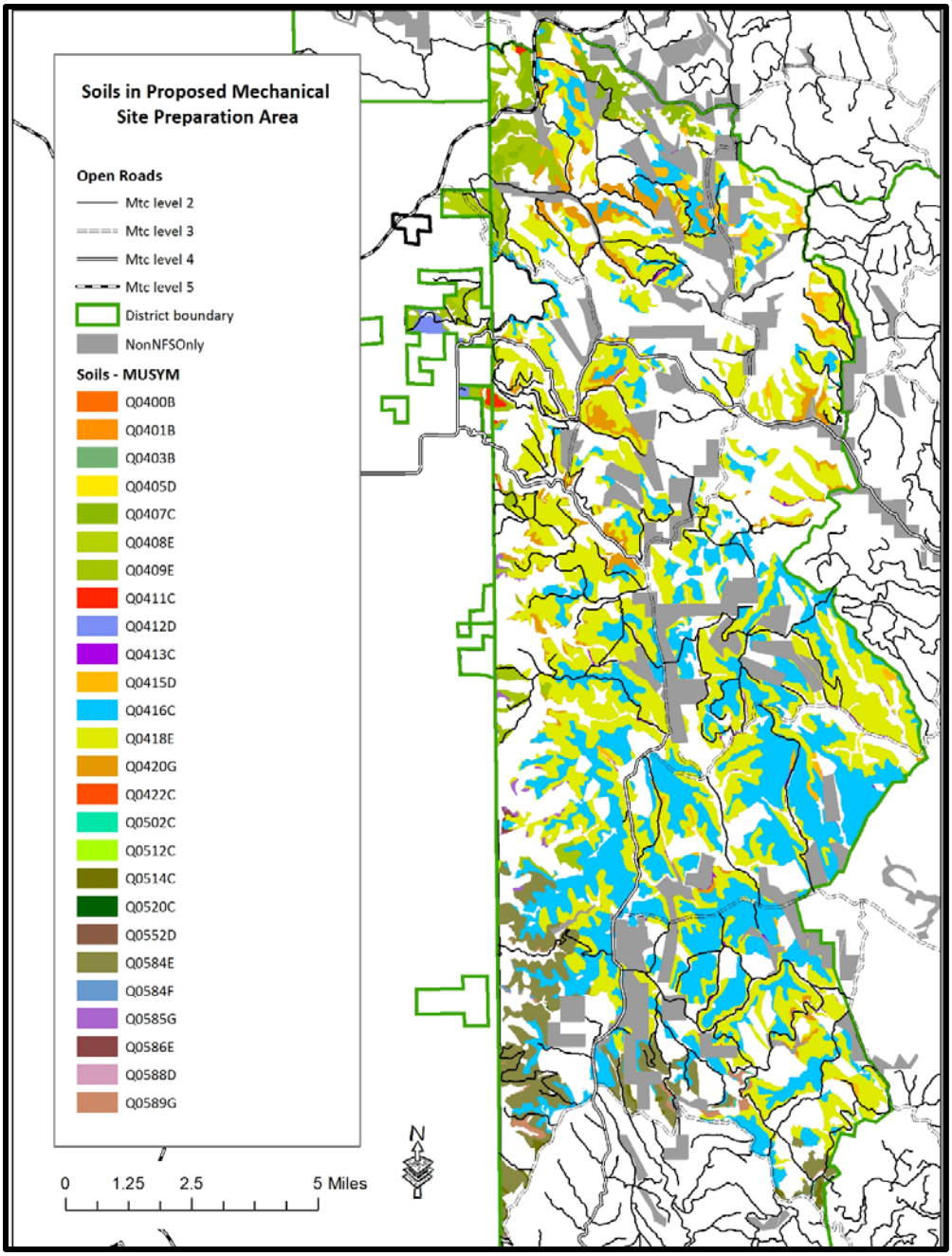
Mechanical site preparation is identified to occur in the western portion of the Black Hills where conditions have been reported to hinder the regeneration of pine to attain the minimal stocking level needed for certification identified in Forest Plan Standard 2416 (USDA Forest Service 2006a, page II-27). See a more thorough description and expected need for this activity in the Ponderosa Pine section in Chapter Three of the BHRL FEIS.

Based on past observations by both Forest Service personnel and members of the public regarding soil and visual concerns with the activity, the Forest Supervisor that had been present at that time, had issued a memo specific to the activity (USDA Forest Service 2008). The memo specified that the technology and knowledge clearly existed at that time to assure that adequate restocking within five years of the final shelterwood removal cut on the BHNF could be achieved. It further stated that site preparation was not generally necessary to meet restocking requirements and only in very rare situations would site preparation be needed.

A maximum of 4,000 acres of mechanical site preparation activity has been identified in the BHRL project action alternative. That 4,000 acres may occur anywhere on an area of approximately 47,200 acres that was identified on the western portion of the project area along the South Dakota and Wyoming state border. Of those 47,200 acres, approximately 46,595 acres (or approximately 99% of the acres) occur on soil map units where at least one of the dominant map unit components is identified to a greater potential for soil compaction to potentially occur to that of a detrimental level when soils are wet (46,595 acres of 47,200

total or approximately 99% of the area).

While uncertainties exist, effects associated with mechanical site preparation activities are expected to be similar to those identified in the Pine Structural Stage Modification Ground Based Harvest section above. Design and SOPs for all BHRL ground based mechanical ground based project activities for soil map units where at least one dominant soil component has a greater likelihood for compaction to potentially occur to that of a detrimental level includes operating on those soil types only when soils are frozen or dry. By operating ground based equipment during low soil moisture conditions, there is the potential to limit the amount of detrimental soil disturbance associated with activity. Of note, is that mechanical site preparation is considered a post-sale activity. Sites where the activity would occur would already have effects to some level with ground based harvest activities identified in the Pine Structural Stage Modification Ground Based Harvest section. Therefore, mechanical site preparation effects would be cumulative on those specific activity areas. Depending on pre-mechanized site preparation reviews of the mechanical site preparation identified treatment areas, the implementation team may need to reduce the areal extent of the treatment used on a specific activity area or some other method to keep disturbances of that of a detrimental level at no more than 15% of the activity area.


Soils in Proposed Mechanical Site Preparation Area
Open Roads
Mtc level 2
Mtc level 3
Mtc level 4
Mtc level 5
District boundary
NonNFSOnly
Soils - MUSYM
Q0400B
Q0401B
Q0403B
Q0405D
Q0407C
Q0408E
Q0409E
Q0411C
Q0412D
Q0413C
Q0415D
Q0416C
Q0418E
Q0420G
Q0422C
Q0502C
Q0512C
Q0514C
Q0520C
Q0552D
Q0584E
Q0584F
Q0585G
Q0586E
Q0588D
Q0589G
0
1.25
2.5
5 Miles
N

Mechanical site preparation equipment that that was used post-sale on the McInerny Timber Sale area on the Hell Canyon District of the Black Hills National Forest. Photo by Blaine Cook, Forest Silviculturist, October, 1, 2015.

Equipment and example of soil effects associated with post-sale mechanical site preparation activity on the McInerny Timber Sale area on the Hell Canyon District of the Black Hills National Forest. Photo by Blaine Cook, Forest Silviculturist, October, 1, 2015.

Summary: Generally, protection of the soil resource would be expected through the site specific or localized identified site specific design to be selected prior to implementation of the BHRL activities therefore any increases in soil bulk density would be expected to remain within the limits specified. Cable logging would generally be expected to result in fewer localized impacts to soil resources than ground-based harvest equipment when used on the appropriate slopes. Temporary roads, skid trails and landings associated with any of the commercial timber removal activities are to be rehabilitated. Mechanical site preparation, a post-sale activity to occur on previously harvested sites, is expected to have effects similar to that of ground based timber harvest. Very limited to no increases in soil bulk density is expected within the areas that have the manual treatment activities shaded fuel break construction; thin, pile, and burn fuels; scatter, shred or chip fuels; cut, lop and scatter fuels; and tree planting.

Organic Matter

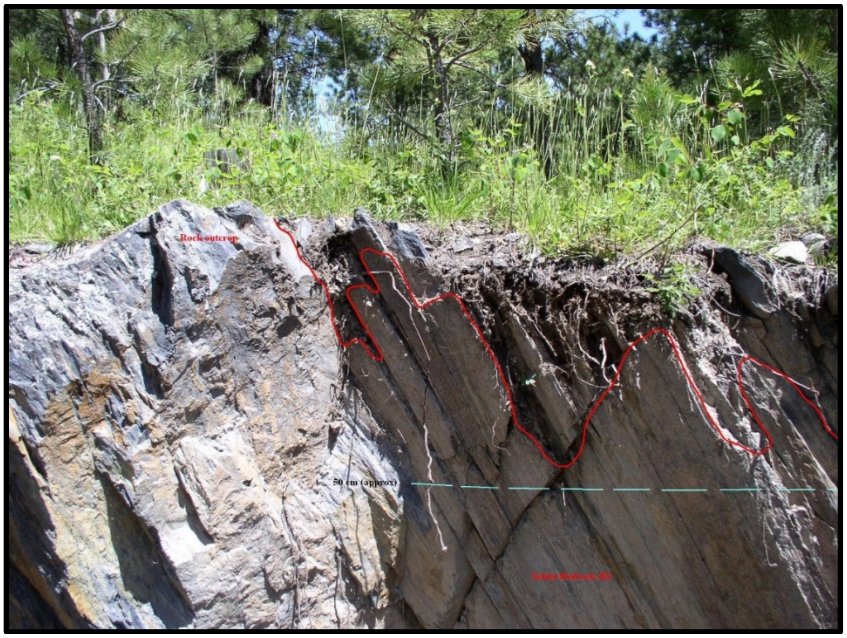
As identified in Chapter 2 of the BHRL FEIS, there are a number of different project treatments and activities. These treatments would leave varying localized amounts of organic matter on the site. Reduced organic matter can be associated with potential for reduced soil nutrient levels.

The total amount of nutrients on a site would likely be reduced where soil organic matter would be removed or displaced. If some type of non-commercial treatment would be used that retains material distributed on site, potentially pre-commercial thinning that is not followed by piling/burning or chipping with material that is hauled away, then soil productivity issues with nutrient removal would generally not be expected. Commercial vegetation management with ground based equipment often removes whole trees (including limbs and branches) from sites in order to also target the reduction of fuels in the stand to aid in fire suppression should a fire occur. Commercial harvest activities that utilizes cable logging systems may or may not remove just the larger bole stem of the tree. In years past, cable logging generally removed just the boles and retained non-commercial bole material and other tree components (branches and limbs) on site. In fuel break areas, this material may be hand-piled and burned (refer to Fire and Fuels section of the FEIS). In more recent years, many areas of cable yarding are now whole tree harvest operations with all material brought to landings for processing (refer to the Silviculture report or regarding harvest method information).

There are some soil resources with limited natural nutrient holding capacity capabilities and have a limited ability to naturally buffer potential productivity losses associated with nutrient cycling. These are generally soils with naturally limited organic matter levels in the soil profile, have little to no topsoil or are restricted in depth (shallow soil layers above bedrock). Not all soils in the Black Hills have been sampled for lab characterization and the NRCS has extrapolated lab results information to similar soils within the MLRAs. Generally, examples of some areas where soils with the features identified above are located are along rocky ridge tops or in the central crystalline core area of the Black Hills. These soils may occur as inclusions or minor components (approximately 10% or less of the map unit) within a number of other soil survey map units within the project area, but

are dominant unit components in a number of the soil map units. The proposed Forest Plan Standard 1102 amendment and WCPH Management Measure 14 (14.2 Design Criteria a.) (USDA Forest Service 2006b) specify amounts of organic material to be left during timber production treatment activities on those managed as suitable timber lands. The proposed amendment of FP Standard 1102 (refer to Chapter 2 of the BHRL FEIS), would result in consistency between the Forest Plan and WCPH wording (USDA Forest Service 2006b, page 26). Direction recognizes that when there are fuels loading concerns that the amount of slash to be retained for suitable timber land long term productivity may be adjusted. Soils identified for slash retention on those lands suitable to be managed for timber production:

- Surface soil (A horizon) thinner than 1 inch,
- Topsoil organic matter less than 2%, or
- Effective rooting depth less than 15 inches.



Soil: Pactola, shallow.
This is an example of a soil with characteristics for having limited natural nutrient holding capacity capabilities and a limited ability to naturally buffer potential productivity losses associated with nutrient cycling. This soil has a general effective rooting depth (total soil depth) of less than 15”.

Soil map units where the dominant soil components generally formed under a different vegetation condition other than ponderosa pine, such as grassland vegetation communities or riparian systems, and not generally considered likely to be managed for long term timber production were not assessed for those properties. Based on a GIS query that did not include soil map unit acreages where dominant components were indicated to have formed under grassland communities or riparian systems or acreages that formed under grassland communities, identified approximately 556,595 acres of the remaining activity area which have soil map units where at least one of the dominant components

met one of the above three criteria.

Major Land Resource Area 61 – Black Hills Footslopes
**Approximately 635 acres.*

Soil Map Unit Symbol: P188F, P408E, P410E, P524C.

Major Land Resource Area 62 – Black Hills
**Approximately 555,960 acres.*

Soil Map Unit Symbol: Q0001E, Q0003C, Q0004E, Q0005G, Q0106E, Q0108E, Q0108G, Q0110E, Q0110G, Q0112G, Q0114D, Q0114E, Q0114F, Q0202E, Q0203D, Q0213G, Q0221F, Q0231G, Q0232G, Q0235G, Q0302E, Q0304D, Q0317G, Q0319G, Q0405D, Q0407C, Q0408E, Q0409E, Q0411C, Q0411E, Q0412D, Q0414E, Q0416C, Q0418E, Q0420G, Q0551C, Q0552D, Q0553E, Q0554F, Q0556C, Q0556F, Q0571E, Q0588D, Q0590E, Q0657D, Q0658D, Q0659E, Q0660F, Q0664E, Q0665E, Q0668F, Q0677D, Q0826C, Q0826F, Q0918C, Q0918E.

Fuel and Hazard Tree Treatments

****Mechanical and manual fuel treatments, prescribed fire and hazard tree treatments***

These proposed project activities of the action alternative are not considered clear cut or seed tree harvests and are not subject to the slash retention direction specified in the proposed Forest Plan amendment to Standard 1102.

Manual Fuel Treatments

****Shaded Fuel Break Construction; Thin, Pile, and Burn Fuels; Scatter, Shred or Chip Fuels; Cut, Lop and Scatter Fuels***

These proposed project activities of the action alternative are not considered clearcut or seed tree harvests and are not subject to the slash retention direction specified in the proposed Forest Plan Standard 1102 amendment.

Enhancement of Non-Pine Vegetation and Within Stand Diversity

These proposed project activities of the action alternative are not considered clearcut or seed tree harvests and are not subject to the slash retention direction specified in the proposed Forest Plan Standard 1102 amendment.

Ground-Based and Cable Timber Harvest

Design features and SOPs are identified for post treatment slash retention on potential treatment areas with soils with specific characteristics (limited organic matter, limited topsoil, and/or limited depth) to address direction specified in the proposed Forest Standard 1102 amendment and WCPH Management Measure (14) (USDA Forest Service 2006b, page 26). Both documents specify levels of logging slash to be retained in association with various harvest prescriptions. The proposed Forest Standard 1102 amendment and WCPH

identifies slash retention levels for clearcut and seed-tree harvests. Slash retention direction is for designated suitable timber production lands to provide for sustained yields of the timber resource into the future. The measure is to be applied to complement tree regeneration. Leaving dead trees and implementing the design for activities to leave the organic material on site (lop and scatter, etc.) would generally be expected to maintain nutrient cycling capabilities of those localized areas that are classified as suitable timber lands and to be managed to continue to produce a sustained productivity of timber into the future. Various soils included within the BHRL project boundary are located within soil survey map units on soils that formed under grassland or riparian vegetation communities. It is expected that pine has encroached into those areas and removal of the trees in those areas would generally be in areas that have not been classified as suitable for timber production management or to be managed for timber production. Therefore, the proposed Forest Standard 1102 amendment and WCPH Management Measure 14 for the retention of material to aid with site regeneration and seedling establishment of ponderosa pine would not apply to those soil map units from the standpoint of maintaining nutrient cycling for a sustained level of long term timber production. Therefore, those soil survey map units were not included in the list above.

As stated above, proposed Forest Plan Standard 1102 amendment for slash retention applies to seed-tree and patch clearcut harvests. The BHRL proposed action alternative does not include seed tree harvest. Patch clearcut harvest is a specified clearcut harvest in the Forest Plan (USDA Forest Service 2006a, page Glossary-9). Patch clearcut harvests are proposed to occur on up to 1900 acres in the BHRL project area (up to 1,300 acres in MA 4.1 and up to 600 acres in MA 5.6). Therefore, per the proposed Forest Plan amendment, 80-90% or more of fine slash (less than 3 inches in diameter) of the logging material in each stand where patch clearcut harvest is to occur is expected to be retained on the soils in the soil map units identified above.

The last sentence of the proposed Forest amendment further identifies the consideration of retention of coarse woody debris slash (>3 inches in diameter) in each activity area to balance soil quality requirements and fuel loading concerns. Per this fuel loading concern direction, coarse woody debris slash would not be specified to be retained during harvest activities within areas identified as being in the Wildland Urban Interface (WUI). Per the Forest Plan amendment direction, retention of coarse woody debris would be specified to be retained in harvest activity units with low fuel loading concerns, such as in non-WUI areas. Forest Plan Standard 2308 specifies the specific amount of coarse woody debris to be retained per acre during any vegetation management activity located anywhere (no difference between WUI or non-WUI) within ponderosa pine or white spruce sites (USDA Forest Service, page II-21). For more information on WUI and non-WUI refer to the Fire and Fuels section in Chapter 3 of the BHRL FEIS.

Ground based harvest, utilizing a whole tree harvest system, has the most potential for removing woody material from the site. A whole tree harvest system, removing the tree bole as well as the tree canopy (tops, branches, needles) generally removes the majority of that material from the site. A whole tree harvest system is often used when there is a fuel loading concern. Some stumps and the below ground tree roots would still be on site

and provide some material for nutrient cycling in those areas. However, if a whole tree harvest system was desired to be used, a requirement in the harvest contract would be expected to include that slash would be returned to the site in order to meet the slash retention direction for patch clearcut units to maintain nutrient cycling capabilities on the specific soil map units identified. Other ground based systems that are not a whole tree harvest system would generally result in lop and scatter of harvest activity slash and would be expected to meet the slash retention direction for the patch clearcut units. Cable harvest systems may also be whole tree harvest or conventional (lop and scatter at the site of the tree). The conventional system would generally retain slash on site and the material would provide for nutrient cycling and would be expected to meet the Forest Plan amendment direction for slash retention. It would be difficult, if even possible, to return slash under a whole tree cable harvest system.

Summary: Generally, while effects are expected to occur, protection of the soil resource would generally be met through the site specific or localized identified design and SOPs to be selected prior to implementation. Therefore, nutrient cycling material on sites to be managed as suitable timber land would be expected to remain within the limits specified in the proposed Forest Plan amendment. A logging system that results in lop and scatter of slash would generally be expected to result in fewer potential localized impacts for retention of woody material on the soil survey map units specified than in areas that are harvested with whole tree harvest systems. In addition to the slash retention requirements, it is expected that the wildlife standard for retaining large woody debris (Forest Plan Standard 2308a) would occur on all treated areas and the woody debris would be well distributed throughout any vegetation treatment activities areas occurring in ponderosa pine identified as suitable areas for commercial timber production.

Soil Microorganisms

It is readily observable that there are significant levels of organic material in the BHNF where recent mountain pine beetle mortality has occurred without fuel reduction activities. In other areas, such as in fuel break areas or in areas where fuels have been treated to address public safety concerns, it is also readily observable that in many of those areas that surface organic materials are at limited levels.

A variety of organic matter components of various types and size, retained or left on the potential commercial treatment areas would generally be expected to benefit soil microorganisms by providing substrate and habitat for the various species. While uncertain, an assumption is that during the implementation of activities and design there would generally be some component of both dead and live trees that are distributed across the landscape. In addition, in order to meet Forest Plan Standard 1103 (USDA Forest Service 2006a, page II-5) the potential treatments are to be implemented so that not more than 15 percent of the area be disturbed to a level that would be considered to be that of a detrimental level. There are areas that would generally be expected to be undisturbed by equipment. Manual fuel treatments and tree planting are generally expected to have the some of the least ground disturbance of the project activities. Applicable to all BHRL treatments, there are design and SOPs for wildlife (refer to the

BHRL Wildlife report) that include coarse woody debris retention (FP Guideline 2307 and FP Standard 2308a), snag retention (FP Standards 2301a and b, 2304a, and 2305) and retention of a specific number of small unburned hand piles (FP Standard 3117) to support wildlife prey species. Implementation of those design and SOPs, as well as the remains of cut trees (remaining stumps and underground roots), would continue to provide various components of woody material for microorganism persistence.

Soil compaction and other disturbances alter conditions that can reduce the ability of soils to exchange oxygen and carbon dioxide thus potentially affecting soil microorganism survival, abundance or persistence. Favorable habitat for soil organisms would generally be maintained because the design and SOPs that are applicable to all proposed project activities to limit soil disturbance to a level that is expected to meet Regional and Forest direction.

Fuel and Hazard Tree Treatments

****Mechanical and manual fuel treatments, prescribed fire and hazard tree treatments***

In areas where this occurs, the intent is to address fuel concerns. These areas would generally be expected to have some of the lowest levels of surface organic substrate material for soil microorganisms. However, there are some trees that would still remain in the area that would continue to drop needles, branches, limbs, etc. that would provide substrate. Prescribed fire would consume some substrate. However, for all treatment methods, stumps and roots from removed trees would also provide some level of organic substrate. Wildlife direction that was mentioned above for coarse woody debris, snag retention and small hand pile retention is to be implemented even within fuel treatment activity areas and would continue to provide some level of substrate material for microorganisms.

Manual Fuel Treatments

****Shaded Fuel Break Construction; Thin, Pile, and Burn Fuels; Scatter, Shred or Chip Fuels; Cut, Lop and Scatter Fuels***

In areas where this occurs, the intent is to address fuel concerns. Areas with thin, pile and burn fuels would generally be expected to have some of the lowest levels of substrate material for soil microorganisms. Scatter, shred or chip fuels would still have substrate material but would likely favor the decomposer species associated with small material over decomposer species associated with larger substrate materials. However, there are some trees that would still remain in the area that would continue to drop needles, branches, limbs, etc. Stumps and roots from removed trees would also provide substrate material. The method of cut, lop and scatter fuels would generally be expected to provide the greatest level of substrate material available for microorganism species. Wildlife direction that was mentioned above for coarse woody debris, snag retention and small hand pile retention is to be implemented within these treatment activity areas and would continue to provide some level of substrate material for microorganisms.

Enhancement of Non-pine Vegetation and Within-stand Diversity

In treatment areas where this occurs, the intent is to focus on actually enhancing vegetation other than ponderosa pine. It is generally expected, whether sites were treated through commercial or non-commercial means that some level of living and dead hardwood material would remain. The remaining material would continue to provide substrate associated with the microorganisms of those vegetative types. Similar for grassland situations. While uncertain, microorganisms that are associated with grassland vegetation communities may actually benefit from the removal of competing pine vegetation. Wildlife direction that was mentioned above for coarse woody debris, snag retention and small hand pile retention in forested systems is to be implemented within these treatment activity areas and would continue to provide some level of substrate that would contribute material to support microorganisms.

Pine Structural Stage Modification

****Overstory removal, pre-commercial and/or POL thin, patch cut.***

The total amount of organic substrate of varying sizes and amounts on a site would generally be associated with the type of harvest system or method used (whole tree harvest vs. conventional) for any commercial tree removal. Conventional systems generally leave greater levels of material as compared to whole tree systems, therefore greater levels of organic substrate would generally remain for microorganisms where conventional systems are used. If some type of non-commercial treatment would be used that retains material distributed on site, potentially pre-commercial thinning that is not followed by piling/burning or chipping with material that is hauled away, then various levels of substrate for micro-organisms would be retained. As identified above, there are still wildlife standards to be met during activity implementation for coarse woody debris, snag retention and hand piles that would provide organic substrate. Remaining stumps and roots would also continue to provide substrate.

****Tree planting***

Tree planting activities would not be expected to reduce or increase woody substrate for microorganisms associated with conifer systems.

****Mechanical site preparation***

Mechanical treatments are used to remove or reduce the amount of live and dead vegetation on site to meet management objectives, such as site preparation for reforestation (USDA Forest Service 2012, p. 138). Uncertainties exist as to the level mechanical site preparation activities could potentially be expected to remove or reduce organic substrates supporting microorganisms associated with conifer systems. Site preparation would be expected to result in alterations to the organic substrates that occur at sites, such as potentially reducing larger woody material (logs or limbs) to smaller sizes or chunks. Other altered conditions, such as creating furrows in the soil or resulting in increased bulk density could contribute to warming or drying of soil or resulting in reduced moisture availability that could result in impacts to microorganism activity levels or numbers.

Summary

Because the amount of detrimental physical soil changes are to be minimized through implementation of design and SOPs and because some level of organic matter in various forms and levels are generally expected to remain within project activity sites, the soil microorganisms would generally be expected to have some level of nutrient availability and adequate site conditions to continue to exist or persist with their associated vegetation communities. Implementation would retain a variety of organic matter components to remain on sites, including living trees and other forest vegetation on forested sites. In addition, activities would implement actions so that the organic layer on the soil surface would be retained on the majority of the area, providing habitat and nutrients for soil microorganisms. The implementation of the Forest Plan wildlife standard for retaining large woody debris (FP Standard 2308a) in treatment areas is expected to be implemented and that woody debris would be a source of material for microorganisms associated with forested communities.

Soil Erosion

Where there is greater than a low risk of soil erosion on some map units, there are design features and standard operating procedures that are included in the Forest Plan and the WCPH that are specified at the time of project implementation. Project required review of site conditions prior to treatment is to result in identification of the specific design or SOP to be used at the specific sites. Effective implementation designs and SOPs are generally expected to limit erosion to acceptable limits that would not result in substantial impairment of the soil resources within the activity area (Examples: USDA Forest Service 2006b, WCPH Management Measure 12, Design Criteria a-d, pp. 23 and 24; USDA Forest Service 2006c, Timber Sale Contract Provision BT6.6. page 129).

Sediment from the designated permanent transportation system (with associated cut and fill and adjacent parking or pull out features, etc.) can have direct and indirect effects on water quality through sedimentation, but is not a component of the soil quality assessment process. Refer to the sedimentation effects discussion Watershed section of Chapter Three of the BHRL FEIS.

As can be expected, the erosion hazard rating for soils is strongly influenced by slope steepness. The erosion hazard ratings for soils within potential treatment areas were obtained by accessing the NRCS Web Soil Survey site and selecting FOR – Potential Erosion Hazard (Off-Road/Off Trail) (Soil Survey Staff 2017 accessed at https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx. The ratings in this interpretation indicate the hazard of soil loss from off-road and off-trail areas after disturbance activities that expose the soil surface. The ratings are based on slope and soil erosion factor K (susceptibility of soil to erosion and the amount and rate of runoff). The soil loss is caused by sheet or rill erosion in off-road or off-trail areas where 50 to 75 percent of the surface has been exposed by logging, grazing, mining, or other kinds of disturbance. The hazard is described as "slight," "moderate," "severe," or "very severe." A rating of "slight" indicates that erosion is unlikely under ordinary climatic conditions; "moderate" indicates that some erosion is likely and that erosion-control measures may be needed; "severe" indicates that erosion is very likely and that erosion-control

measures, including revegetation of bare areas, are advised; and "very severe" indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical. There are BHRL project potential commercial treatment units located in areas with severe and very severe erosion hazard ratings for soils. The following soil survey map units in each of the various county potential treatment areas were identified to have a least one of the dominant map unit components with a severe or very severe hazard rating for erosion. Based on a GIS query, these map units comprise approximately 177,680 acres (approximately 24%) of the 746,200 acres of where project activities may occur.

Major Land Resource Area 61 – Black Hills Footslopes
**Approximate Acres: 5,940*
Soil Map Unit Symbol: P056F, P128F, P198F, P224F, P252E, P254F, P270F, P398F, P400G, P402F, P404G, P418F, P480F, P482F.

Major Land Resource Area 61 – Black Hills
**Approximate Acres: 171,740*
Soil Map Unit Symbol: Q0005G, Q0104G, Q0108G, Q0110E, Q0110G Q0112G, Q0114F, Q0213G, Q0231G, Q0232G, Q235G, Q0317G, Q0319G, Q0420G, Q0530G, Q0540F, Q0554F, Q0556F, Q0563G, Q0566F, Q0570F, Q0584F, Q0585G, Q0589G, Q0591G, Q0613F, Q0634G, Q0655G, Q0660F, Q0668F, Q0678G, Q0826F, Q0926G.

Most dominant soils within the soil map units identified with a severe or very severe erosion hazard rating are located on slopes over 40%. The action alternative would result in implementing Forest direction and SOPs specific to the sites to address the hazards. Standard SOPs generally include not using ground based mechanized harvest equipment on sustained areas over 40%. Cable harvest, as well as the other activities with a generally lower potential for disturbance have been specified for those areas. Another SOP is to avoid activities on portions of units with slopes over 40%.

Rather than include a list of all of the soil map units with a dominant map unit component with a moderate erosion hazard as compared to those with slight hazards for erosion, a generalization is provided here. In general, dominant soil survey map unit components on slopes of 15 to 40% are identified as having a moderate hazard rating for potential erosion. Soils on slopes below 15% are generally identified to have a slight hazard for potential erosion. Examples of site characteristics that can influence those slope percentage breaks can include the amount of surface rock a site has or if there may be a significant amount of mica in the soil.

Pre-Harvest

One Year Post-Harvest

Two Years Post-Harvest

Three Years Post-Harvest

Above: Series of photos showing the progression of understory vegetation establishment following ground based harvest operations. Photos from the Dark Canyon area (eastern side of the Black Hills) taken by personnel from the Rocky Mountain Research Station Rapid City Forest and Grassland Research Laboratory.

Ground-Based Harvest

****Including shaded fuel break construction with commercial removal.***

Ground-based harvesting would generally result in localized direct and indirect soil erosion effects within the boundaries of treatment activity areas. Ground based systems would generally occur across the landscape on areas with generally less than 40 percent slopes. Soils on slopes between 15% and 40% have greater potential for erosion (moderate erosion hazard) to occur to a level that could be detrimental than soils on slopes below 15% (generally an erosion hazard of slight). The likelihood for the most potential detrimental effects would be concentrated on skid trails and temporary roads associated with timber units where trees are removed. Minimizing the area occupied by skid trails or to use unauthorized roads are a part of SOPs to limit potential likelihood and extent of detrimental effects. Basic SOPs also includes operating during dry or frozen soil conditions, or when a foot of packed snow is present on soils with a greater likelihood for

the potential of compaction to that of a detrimental level (refer to the list of those soil map units in the Physical Soil Characteristics section). This SOP is also beneficial from the standpoint of limiting the effects of soil erosion. Operating in the winter when the ground is frozen or when there is snow pack generally limits ground disturbance potential thereby resulting in a level of vegetation to protect against erosion.

Operating on slash is generally effective for buffering the effect of equipment operation on mineral soil. Thus if systems are used that results in significant slash being maintained on the skid trails, detrimental effects could be limited.

Management activities that implement SOPs for retention or placement of organic matter components on the soil surface would be expected to keep soil erosion to levels not considered to be detrimental.

Refer to the Timber Sale Contract, Division B which includes SOPs (contract provisions) used for keeping erosion within acceptable limits (USDA Forest Service 2006c).

Cable Timber Harvest

Cable harvest is generally expected to result in limited potential for erosion. Cable harvest has changed over the years. A number of years ago, most of the tops and slash were left on site and only the bole of the tree was suspended by cable to the landing. In the last several years this has changed on many areas and has become more of a whole tree system where all of the tree is cabled to the landings (refer to the Silviculture report or ponderosa pine section in Chapter Three of the BHRL FEIS regarding various harvest systems or methods that may be used). Ground disturbance, except at landings and roads, has generally been more limited with this type of harvest as compared to past ground based systems. In addition to disturbance associated with landings and temporary roads, there may occasionally be a landscape feature, such as a rise or a knob, which would be scraped by the base of suspended logs that would result in exposed mineral soil. Potential areas of erosion associated with cable harvest is generally expected to be localized in association with temporary roads and landings or as described with a landscape feature. There are timber contract SOPs (provisions) for required implementation of erosion control (USDA Forest Service 2006c).

Manual Fuel Treatments

****Such as thin, pile and burn fuels; scatter, shred or chip fuels; cut, lop and scatter fuels.***

Soil erosion would generally be limited, if any, as a result of these types of treatments since there is limited ground disturbance expected. Thinned woody material would generally add cover to the soil surface, contributing to ground cover conditions that limit the potential risk of erosion. Hand piling activities would generally not be expected to increase risk of soil erosion since there are low levels of surface soil disturbance associated with those activities. Hand piles for burning are generally small (generally less than 20 feet in diameter) and scattered across units with expanses of vegetated areas in between. Associated with their size, small piles generally have limited to no issues with

soil heating and have been observed to generally revegetate within two to three years of when they were burned.

Prescribed Fire

Depending on various conditions at the time of burn, such as types, levels and moisture of fuels, climatic conditions, soil moisture conditions, etc. at the time of implementation, broadcast burning can result in the consumption of fuels to expose the soil mineral surface. However, prescribed fire burn plans are prepared that specify SOPs for implementation that address many of those conditions and broadcast burns are specified to only take place when various conditions are met so that conservation or protection of various resources, such as soils are provided for. The photo comparison below provides an example of a prescribed broadcast burn that had some larger fuels that contributed to a longer burning residence time on some microsites. The longer burning residence time resulted in some exposed areas of mineral soil. However, note remaining fuels and intact vegetative material remaining. The photo is an example of what has generally been experienced on prescribed burns in the Black Hills. A mosaic of remaining material and live plants along with seeds available in the soil seed bank contributes to the area being able to resist erosion and to revegetate during the growing season.

Anti-Horse Prescribed Burn
Black Hills National Forest
Hell Canyon District
Unit J – Photo Point #1-1

Pre-burn – Photo taken 9/14/2016

Post-burn – Photo taken 10/27/2016:

The following photo shows the vegetation growth that was present following a single growing season on the Norbeck Section 2 prescribed broadcast burn area.

Norbeck Section 2 Prescribed Burn Photo Point #4. Photo Taken One Year Post Burn (October 27, 2015). Prescribed Fire Implemented October 20 and 21, 2014.

As had been described in an earlier portion of this document, some of the holding lines around a prescribed broadcast fire area are created through the use of dozers. Dozers generally make one to two passes to create the holding line. In addition, prescribed broadcast burns generally occur in the fall (drier soil conditions) or early spring (before spring vegetation growth and soil water is generally in a frozen state). An SOP generally identified in prescribed burn plans are that mechanical lines would be rehabilitated following the burn, including drainage feature construction and seeding. Therefore, while some limited amounts of erosion may occur along the lines, rehabilitation actions, such as incorporating drainage features (water bars) and promoting seedling growth would generally be expected to keep erosion of the holding line areas to a minimum level.

Pile burning, manual or mechanical, is generally not expected to result in significant levels of erosion. The large mechanical landing piles associated with timber harvest are generally located on slopes of <15 percent. Following burning, SOPs include pile scarification (ripping) and seeding. The timing and conditions for manual and mechanical pile burning activities generally are during the winter and when there is snow cover. Once the piles are burned, areas often receive additional snow that adds a contributing factor to initiating the revegetation process. Rehabilitation efforts, seeding and timing of burning are factors that generally contribute to limiting erosion effects.

Smaller piles (generally less than an estimated 20 feet in diameter) may be located on a variety of slopes. Similar to what was documented for vegetation recovery on small piles in Colorado (Rhoades et al. 2015), small piles in the Black Hills generally have vegetation cover similar to surrounding conditions within approximately two years. Based on what has been personally observed and in association with their small size and the revegetation timeframe, erosion generally is expected to be limited or non-existent at most sites with this BHRL activity.

Mechanical Site Preparation

A maximum of 4,000 acres of mechanical site preparation activity has been identified in the project action alternative. However, those 4,000 acres have been identified to potentially occur anywhere on an approximate 47,200 acre area. See description and expected need for this activity in the ponderosa pine section of Chapter Three of the BHRL FEIS.

As already identified in the Physical Soil Properties Section for the mechanical site preparation activity, past soil concerns have been expressed with this activity (USDA Forest Service 2008).

Proposed mechanical site preparation activities are identified for soil map units where at least one of the dominant soil components has at least an erosion hazard rating of moderate to very severe. However, it is considered generally unlikely that site preparation activities would actually occur within map units Q0420G (1,740 acres), Q0585G (149 acres) and Q589G (244 acres). These map units are identified to generally occur on 40-80% slopes and have erosion hazard ratings of very severe. An additional 16 acres is mapped in soil map unit Q0584F (20-60% slopes) where at least one of the dominant components is rated with a severe erosion hazard. Those map units, are a combined total of approximately 2,149 acres (or approx. 5%) of the possible 47,200 acres where mechanical site preparation may occur. Even though silviculture specialists identified those areas as potential desired areas for where mechanical site preparation is desired it would seem unlikely that it would be safe to operate the specific equipment needed on such slopes. However, since included it is possible that that mechanical site preparation would occur on those slopes. Soil disturbance rapid assessment monitoring utilizing the USFS Soil Disturbance protocols (USDA Forest Service 2009) has not occurred specific to a mechanical site preparation activity area on the Forest. However, while uncertainty exists, the level of disturbance that could generally be expected from mechanical site preparation (as a follow-up disturbance to other harvest activities and potential other post sale activities) on such steep slopes, with the creation of the furrows and the potential for equipment slippage that could result in soil displacement and additional bare mineral soil exposure, there is potential for erosion levels on those slopes that could be considered to attain conditions that could contribute to effects to be considered to a detrimental level. If that would occur then it could result in substantial soil impairment or impacts to long term site productivity at those locations.

Mechanical Site Preparation Soil Map Units with an Erosion Hazard Rating of Moderate to Very Severe

Soil Map Unit Symbol	Acres	Erosion Hazard Rating
Q0408E	272	Moderate
Q0409E	1,905	Moderate

Q0418E	21,319	Moderate
Q0420G	1,740	Very Severe
Q0584E	2,988	Moderate
Q0584F	16	Severe
Q0585G	149	Very Severe
Q0586E	26	Moderate
Q0589G	244	Very Severe

For those soil map units where at least one of the dominant map unit soil components have a moderate soil erosion rating, it is generally expected that mechanical site preparation activities would result in a short term loss of effective ground cover wherever the disturbance occurs. However, since the issue for site regeneration seems to be with competitive vegetation, and based on personal observations and revegetation investigations associated with BMP and soil disturbance monitoring that have occurred on the Forest (most recently reported in USDA Forest Service 2013 and 2015) it is generally expected that sites would revegetate within 2-3 years following the activity. Limited to no soil erosion is expected for soil map units with a low soil erosion hazard rating (generally map units with less than 15% slopes).

Summary

Generally, protection of the soil resource would be expected through the site specific or localized activity design and SOPs to be selected by project watershed specialists prior to implementation. Any potential increases in erosion to levels defined as detrimental would be expected to remain within the limits specified in the WCPH and Forest Plan. Cable type harvest operations may generally be expected to result in potentially fewer localized impacts to soil resources as compared to the use of ground-based equipment when used on the appropriate slopes. As part of Forest SOPs and the timber sale contract provisions, temporary roads, skid trails and landings associated with any of the commercial timber removal activities are to be rehabilitated, including taking such actions as providing proper drainage, to place slash, or to seed such features to limit potential for erosion. Mechanical site preparation contracts would be expected to incorporate resource protection contract requirements, such as limiting activities to dry or frozen conditions, limit disturbance to an activity area to the minimum level to achieve the minimum regeneration objective or potentially operate the equipment on the contour on slopes above 15% slopes. Limited to no increases in erosion to a level considered to be detrimental is expected within the areas that have generally low ground disturbance activities, such as for manual fuel treatments or tree planting.

Connected Actions

***Road construction - specified; road construction – temporary; temporary roads on existing templates; road conversion (unclassified to system)**

As discussed in earlier sections, FSM 2550 (USDA Forest Service 2010a) and the Region 2 WCPH (USDA Forest Service 2006b) provide direction targeted at protection soil resources and soil productivity, which includes the inherent capacity of a soil under

management to generally support the growth of specified plants, plant communities or a sequence of plant communities. Both documents include information that the direction applies to areas where vegetation management prescriptions are being applied, including timber production sites. Both documents specify that the direction does not apply to administrative sites or other areas with dedicated uses such as the permanent transportation system (USDA Forest Service 2010a, page 14; USDA Forest Service 2006b, page 25). This had previously been discussed in the Final Environmental Impact Statement for the BHNF Travel Management Plan (USDA Forest Service 2010b, pp. 122-124). That document shared that designated use sites such as the permanent transportation system are dedicated to a specific management use that precludes other uses of the land, such as growing trees for harvest, and removes the majority of the productive capability of soils at the specific location where they occur. As had been identified in the Travel Management document, that if the permanent transportation system is managed to the Forest Service transportation facility standards, any indirect effects associated with the routes to adjacent Forest Service resources are expected to be very limited in spatial extent (USDA Forest Service 2010b, page 132).

Temporary roads constructed for this project are generally in association with the commercial harvest activities and not with the other proposed activities. Temporary roads that utilize existing road templates would be expected to be rehabilitated by site-appropriate combinations of project design and as required through the specific timber contract SOPs (USDA Forest Service 2006c). Various rehabilitation actions would generally include such actions as removing any installed culverts or temporary bridges, installing erosion control features (such as drainage features), ripping or scarifying the template, placing woody material on the temporary road template and/or seeding or planting with native plant species. If post activity evaluations or monitoring indicates that implementation of SOPs for the activity locations are not accomplishing resource objectives, additional measures are expected to be identified for implementation to achieve those resource objectives.

In addition, newly constructed temporary roads are also to be rehabilitated after use. Rehabilitation of new temporary roads would occur utilizing specific timber contract SOPs (USDA Forest Service 2006c) and based on site review of specific site conditions or features. If post activity evaluations or monitoring indicates that implementation of SOPs for the activity locations are not accomplishing resource objectives, additional measures are expected to be identified for implementation to achieve those resource objectives.

Rehabilitation activities would generally not ameliorate any detrimental soil impacts immediately, but they would be expected to improve conditions compared to not taking any action. The establishment of vegetation and any associated additions of organic matter (such as slash, wood shreds or chips) would generally contribute to the recovery of some level of vegetative production of the temporary road features. Any action taken to recontour the temporary road to that similar to the adjacent natural landscape would generally be expected to contribute to a more natural hydrologic function of the area and contribute to additional vegetation of the site. These actions would generally be expected

to limit effects to soil resources to some level as compared to not taking actions.

As identified in the earlier section on erosion, some level of erosion is expected from temporary road construction and re-construction where native material surfaces are exposed to rainfall impact and overland flow. These areas are expected to have short-term increases of erosion (above two to five tons per acre). As has been observed on the Forest, effects would be expected to decrease as roads are rehabilitated and revegetate following use.

Cumulative Effects

Action Alternative A

The BHRL Activity Summary Table at the beginning of this document displays the maximum acres by activity type. Anticipated miles of various types of access route construction and reconstruction are also displayed. Project implementation of activities would have pre-site reviews and implementations of activities are to be in compliance with Forest SOPs (Forest Plan standards and guidelines, WCPH direction and project design features). Monitoring is to occur for implementation and effectiveness. If project design or an SOP that was implemented did not achieve resource objectives it is expected that it would be adjusted. An assumption, not knowing where a project activity is to be used, the precipitation patterns and soil moisture conditions present at the time of implementation, etc. is that the level of soil disturbance impacts are attributable to the implementation of project designs and SOPs, amount of temporary road construction, and how well and successfully effective the rehabilitation of those project activity features occur. Since many of the proposed BHRL activities are similar to those described in the Forest level FEIS documents, effects to soils are generally expected to be similar to those described in the 1997 Forest Plan EIS (USDA Forest Service 1996) and Phase II Amendment FEIS (USDA Forest Service 2005). Implementing the actions as described in Chapter 2 of the BHRL FEIS, utilizing the Forest SOPs, monitoring and taking action to immediately adjust any design feature or SOP to achieve resource protection objectives would generally be expected to comply with soil direction in the R2 WCPH (USDA Forest Service 2006b) and the BHNF Forest Plan (USDA Forest Service 2006a) through implementation of the action alternative.

Contrasting Effects of Proposed Action with Past Actions

Generally, the estimated level of detrimental disturbance from this proposed project is expected to be similar to past Forest activities since there are similar implementation activities and similar design features and SOPs to be implemented during project activities to protect soil resources. While the purpose and need for this project is for moving landscape-level vegetation conditions toward objectives of the Forest Plan, the direction for maintaining or improving soil productivity continues to be National, Region 2 and Forest direction. While different to many projects, this project is similar to the Mountain Pine Beetle Response Project in that site reviews for treatment and for specifying the design features or SOPs for the specific activity area is to occur following the BHRL Project decision. Whether before or after the specific project decision, site reviews for implementation has occurred.

Duration of Effects

Displacement and erosion that would result in the loss of topsoil, is a long-term effect and can be

a permanent loss of soil productivity. However, design and SOPs, such as restricting various activities on slopes greater than 40%, operating during dry of frozen conditions or operating over packed snow, etc., as well as the rehabilitation of temporary roads would be expected to protect areas against topsoil losses. Revegetation of sites following harvest activities in the Black Hills generally occurs within two to three years. This has been observed during site visits, through specific revegetation monitoring as documented for Forest Plan Monitoring Reports (such as in USDA Forest Service 2007, pp. 13-15), as a component of a more recent soil disturbance monitoring protocol process that is currently being used for Forest Plan monitoring reports (USDA Forest Service 2013, pp. 10-25; USDA Forest Service 2015, pp 11-17) and whether or not a site retains or grows vegetation to a level to protect water quality is part of the BMP monitoring that is summarized in the Forest Plan monitoring reports (most recent report with BMP information USDA Forest Service 2013, pp. 27-29). While the most recent monitoring report has the most recent information (USDA Forest Service 2015), the Forest Plan monitoring reports that have been posted over the years can be accessed at https://www.fs.usda.gov/detail/blackhills/landmanagement/planning/?cid=STELPRDB5112296.

Timber harvest activity sites or post sale activity sites that have not generally revegetated in a two to three year time frame have generally had some other unrelated post activity disturbance (such as Off Highway Vehicle use activity). The 2010 Forest Travel Management Decision did not authorize OHV use on areas other than Forest specific designated routes (USDA Forest Service 2010c). Therefore, it is generally expected that disturbed sites associated with BHRL project activities would generally revegetate within the two to three year timeframe that has been observed and documented during past site reviews, BMP monitoring and BMP Audit reviews. Temporary roads and landings have been observed to take longer to revegetate, generally in association with increases in soil bulk densities and greater levels of multiple disturbances. Design and SOPs for those project features include placement of drainage features, slash placement and rehabilitation to limit erosion. Depending on specific site and climatic conditions, some level of revegetation of those features can occur as early as the two to three year time frame, however, revegetation to levels similar to pre-activity conditions may take up to five years on sites with less potential. Rehabilitation and timeframes are within those identified in the national and regional direction identified earlier in this report.

Uncertainties exist as to how long soil compaction to that considered to be a detrimental level may persist in the Black Hills. As has been documented in several Forest monitoring reports since 1998 (can be accessed at https://www.fs.usda.gov/detail/blackhills/landmanagement/planning/?cid=STELPRDB5112296), specific soil bulk density sampling has occurred on areas of various levels of harvest activities at various locations within the Black Hills area. Following the issuance of the FSM 2550 (USDA Forest Service 2010a) soil bulk density sampling was discontinued and the monitoring utilized the more recently identified national agency protocol. Both types of monitoring provide evidence to support:

- That sampling results are generally consistent with statements made in the Watershed Conservation Practices Handbook, Chapter 10 – Management Measures and Design Criteria, Amendment 2509.25-2600-2 (effective 4/20/2006) and FSM 2550 (USDA Forest Service 2010a) regarding soil compaction. These direction documents describe

that soil compaction is caused by the weight of vehicles and animals on the ground and soils compact when soil moisture exceeds the plastic limit. Consistent with both documents, there is evidence that soils in the Black Hills can compact when some level of timber harvest (or post sale activity) equipment activity occurs when some degree of moist to wet soil conditions exist.

- Also consistent with the same documents, the data generally collected for sites that were harvested during the below average precipitation years (2000 through 2008) provided evidence that operating timber harvest equipment (not specific to various volumes removed or silviculture prescription applied) during dry soil moisture conditions can be expected to prevent or limit increases in soil bulk densities, or limit the likelihood for increases in soil bulk density effects.

- While uncertain that soil bulk density levels would decrease or decrease as fast on every soil within the Black Hills, there is evidence that conditions were such that within one geographic area, on one type of soil, and to the depth sampled, that the mean soil bulk density decreased from levels above the threshold classified as "detrimental compaction" to levels below the threshold within the time period of one year. It is unknown what factors may have contributed to this level of decrease, but potentially the decrease may have been associated with soil moisture and temperature conditions that favored active freezing and thawing conditions at the site during that specific year, that the flush of herbaceous growth (and the associated increased root activity) that was observed on site may have contributed to the decline in soil bulk density levels, that water movement on the cutting unit slope may have influenced site conditions within the upper 10 cm (approx. upper 7 inches) of the soil profile, or some other unknown site characteristics.

- A site that had been assessed in 2014 had been harvested when the ground was frozen. The low disturbance level (approx. 0%) observed on that unit continued to support that harvesting during frozen conditions generally results in limiting soil disturbances of attaining a level that would be considered detrimental (USDA Forest Service 2015, pp. 14-15).

Sites that experience reductions in organic matter content are generally expected to reverse as vegetation establishes and growth occurs. Organic debris accumulates on the soil surface and plant roots establish and are decomposed in the soil. These organic materials break down and release nutrients and improve the quality of the soil by improving soil structure and contribute to reducing compacted conditions and other detrimental soil disturbances. Organic matter accumulation is often associated with the revegetation timelines. General disturbance of wood removal sites would be expected to accumulate organic debris within the two to three year time frame. Some of those sites would have beetle killed trees associated with the recent significant mountain pine beetle mortality event and ground surfaces would accumulate material as needles and branches drop, and eventually as larger material (tree boles) fall over time. Organic matter accumulation on temporary roads and landings will take longer and unless slash is placed on those sites it is expected that it could take up to five years following final use of the temporary road to develop organic debris to levels to contribute to some level of improved soil structure.

Changes in soil microorganisms are generally not expected to be permanent. Remaining tree stumps and below ground roots in harvested areas would remain in activity areas. Slash, chips, wood shreds, etc. would be retained at other locations. The greatest impact areas to soil microorganisms are generally at harvest landings and temporary roads. Landing and temporary roads SOPs include rehabilitation and revegetation recovery actions. Soil microorganism levels and activity would be expected to begin to increase to some level again as soon as various organic matter components in the soil begin increasing. This is generally expected to begin within two to five years after site activities have occurred.

In addition to the Forest and state monitoring (Forest Plan Monitoring and state BMP Audits) that had been identified previously in this document, a variety of other methods (visual and measured) for project analysis have been used over the years to identify soil conditions and revegetation within project areas to assess conditions associated with previous actions (site disturbance) and how sites recovered. The Forest has begun to assess locations using an agency approved protocol identified in FSM 2550 (USDA Forest Service 2010a) to collect soil disturbance information for HFRA and other timber harvest projects that have occurred throughout the Black Hills. Various BHNF project area environmental documents have included soil disturbance information in the soils analyses. Generally, assessments include locating previously disturbed areas to identify if there were residual effects from past similar activities. Since 2009, project soil assessment, monitoring and observations are included in a number of BHNF HFRA and timber/fuels reduction related project environmental documents which are available at: http://www.fs.usda.gov/projects/blackhills/landmanagement/projects. The following is just a sampling of some soil assessment summary information from recent project analysis documents that are available to the public at that website location. Additional project documents can be reviewed at that internet location for soil monitoring and assessment information.

> Vestal Project Area (southern Black Hills): Eleven (11) sites were observed. At nine (9) sites the R2 Soil Health Monitoring/Assessment Protocol was used and the findings were that all sites that were visited had Properly Functioning Soil Health Ratings. The other two (2) sites used the new National Soil Monitoring Protocol and detrimentally disturbed soil was not documented anywhere along the site transects. The areas had adequate ground cover, infiltration was adequate and no erosion was occurring.
>
> Herman Project Area (northern Bearlodge): Soil disturbance surveys in this project area identified soil disturbance conditions that were within acceptable limits as identified per Regional Direction (USDA Forest Service 2006b). Site reviews conducted where recent land management activities and natural events had occurred identified some level of erosion at three percent of the surveyed points. The site reviews conducted identified that recent land management activities resulted in very limited detrimental compaction of soils.
>
> Cold Springs Project Area (northern Black Hills): Recent monitoring of past harvest areas within the project area identified relatively minimal detrimental soil-disturbance impacts. The monitoring indicated that features were readily rehabilitated due to the local soil productivity and resilience of basal vegetation. This is most likely due to the

implementation of WCPs/BMPs and the natural aggressive revegetation of ground vegetation.

Rattlesnake Forest Management Project (northwestern Black Hills): Six of the seven stands that were evaluated in 2007 were rated as "functioning properly" for the soil assessment method used. One unit was rated as "at risk"; the rating due to effects from a 2005 wildfire, which left sheet, rill, and gully networks and reduced effective ground cover and was also during a climatic period that was experiencing below average precipitation. The unit was not "at risk" because of past timber management but rather because of the wildfire that burned at high intensities throughout the unit. That stand was revisited in July 2009 (precipitation levels were closer to average conditions for the year) and an estimated 95 percent of the stand was densely vegetated with grasses and forbs. There were still areas of bare soil on steeper slopes and one distinct gully in a drainage at the bottom of the stand. In 2009, the site (soil) was identified to be functioning properly.

Nautilus Project (northern portion of Forest): Soil health assessments were completed in 2008 and 2009 within the project area on stands where some forest management activity took place previously (i.e. disturbed areas) and in areas where no such activities have been documented to occur (i.e. undisturbed areas). The objective of these assessments was to determine whether or not the Forest Plan standards and Regional WCP Handbook Management Measures were likely to be met if similar activities are implemented within the Nautilus project area. These assessments were conducted using the Draft Northern Region Soil Quality Monitoring Protocol that the Forest Service (Region 2) was testing. A total of 47 transects within the Nautilus project area were surveyed. The majority of points along these transects (37 transects out of 47) were rated as either undisturbed or lightly disturbed. Ten transects had at least one point (one transect point out of 30 points) that was rated as either moderately disturbed or severely disturbed. All of specific transect points with a disturbance rating occurred on or near a skid trail, landing or road.

Effects of Ongoing and Reasonably Foreseeable Activities

Most ongoing and foreseeable activities would not overlap with the action alternative in both time and space. Specifically, their effects do not overlap in space as they occur outside of the activity areas. The effects of some planned activities may overlap spatially and temporally with proposed activities; this may be expected to be the exception, but there is potential for some level of cumulative effects due to the extensive level of harvest activities that occurred through various project decisions associated with the mountain pine beetle epidemic.

Combined Effects from Past, Proposed, Ongoing and Foreseeable Activities

Areas of project activities in the action alternative would have localized cumulative effects from the combination of past and proposed activities. Some would have few cumulative effects because some BHRL activity treatment areas have not had, or had limited similar activities in the past. Examples of these types of areas are on locations with slopes over 40%, some hardwood enhancement locations or pine encroachment removal sites. A number of areas may have cumulative effects. Examples of this are areas that had treatments to address the recent mountain pine beetle epidemic (over approximately the last 15-20 years) that resulted in Structural Stage 4A. Many of those areas are now being considered for treatment in the BHRL project for

structural stage modification through the use of commercial timber harvest. Site reviews of BHRL activities are to be implemented. If it would be identified during those reviews that effects associated with a potential site specific BHRL activity combined with a previous project activity, such as previous MPBRP treatments, would likely exceed the Forest Plan Standard of 15% then appropriate action would be taken. Potential options would be that the BHRL activity would not occur or that some rehabilitation activity would be implemented to keep effects within those specified in the Forest Plan Standard (1103).

Post-implementation monitoring of BHRL is to be performed to identify implementation effectiveness and if adjustment to design or SOPs may need to occur during continuing project activities to continue to meet resource protection objectives. This monitoring would also demonstrate compliance with Forest Plan and Regional direction. For the commercial activities, the Sale Administrator would monitor all units during management activities to assure that contract harvest activities would occur as specified for a particular area and that they are adequate to minimize effects to the soil resource of the site.

If monitoring results document an area where detrimental soil disturbance may be in excess of 15 percent within an activity area, design or SOPs are to be adjusted and rehabilitation and restoration activities would be identified and would occur to move the activity units towards improved soil conditions. Other units that were treated in a similar fashion would be expected to be reviewed at this time as well.

The project design and SOPs include restoration activities to improve soil conditions including scarification or ripping of temporary roads, some of the more intensively used skid trails and landing areas with the intent to reduce soil compaction. A basic intent is to improve the potential for tree seedling establishment, survival and growth through restoring site conditions that support biological processes, improved root penetration and soil drainage. Soil rehabilitation at these sites is not the immediate result of ripping, planting or any other activity. The goal of soil rehabilitation activities is to create favorable conditions for impaired soils to begin the recovery process.

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Appendix A – Information Used in Identification of Soil Map Units for Soil Resource Concerns and Identification of BHRL Project Design and Standard Operating Procedures (SOP)

Soil Productivity – Nutrient Cycling

The proposed Forest Plan Standard 1102 amendment and WCPH Management Measure 14 (Design Criteria 1.a.) provide direction to maintain or improve long-term levels of organic matter and nutrients on Forest Service managed lands. In areas that are to continue to be managed as suitable timber lands into the future, both the Forest Plan and the WCPH contain direction for retention of some level of organic material on soils with a lower potential capability of buffering against a reduction in nutrients over the long term. Direction in both documents recognizes that consideration of slash retention may need to be balanced with high fire hazard (fuel loading concerns) that may need to override the slash onsite in some areas. Soil characteristics have been identified as: soils with surface soil (A-horizon) thinner than 1 inch, topsoil organic matter of less than 2% or effective rooting depths less than 15". To obtain the soil characteristics information specified, NRCS internet soil links at the through the following main site were reviewed: https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/.

During past NRCS soil surveys, O (organic) horizons, were described or documented above the soil pedon description starting point surface. At that time, the top of the soil mineral surface horizon was the start of the official soil pedon description. During the MLRA 62 soil survey update, the national direction for the soil survey soil pedon description process was changed to include the top of the O horizons as the starting point for pedon descriptions. It became apparent that this affected ratings and interpretations for various uses, has affected how soil information can be queried, how information can be compared, etc. Rooting depths and the soil A horizon depths were not difficult to obtain through the NRCS soil internet links. However, multiple links needed to be accessed and compared to identify topsoil (A horizon) organic matter levels for each of the dominant soil series components located in the numerous soil map units identified to occur within the BHRL project area. Organic matter levels are generally provided as a percentage range. If the range included 2% then it was not included in less than 2%. To identify soil map units with one or more of the dominant map unit components with likelihood for potential nutrient cycling concerns for soils identified as developing under timber (refer to NRCS Official Series Descriptions) the information was obtained from the publicly available online NRCS links (available through the main portal identified above).

Map units with dominant components of soil series identified as having formed under vegetation communities other than ponderosa pine, such as under grassland communities, cropland areas, riparian systems, etc. (refer to NRCS Official Series Descriptions) were not included for areas needing slash retention during harvest activities for nutrient cycling. Existing dense stands of ponderosa pine in these map units are generally expected to be a primary result of fire suppression resulting in pine having encroached into the areas. Pine stands within these soil map units would generally not be expected to be managed for suitable timber production, but to be targeted for pine encroachment removal and managed for grasslands, shrublands, etc. Therefore, in general, these soils and map units were not reviewed further for rooting depth, organic matter levels, or depth of the topsoil (A horizon).

To comply with the proposed Forest Plan Standard 1102 amendment, 80-90% of the activity slash is to be retained on any seed tree or patch clearcut harvest sites that may occur on a soil with one of the characteristics identified above. The map units listed had at least one of the dominant map unit soil components with a characteristic of that identified above.

Soil Bulk Density – Soil Compaction

Forest Plan Standard 1103 and WCPH Management Measure 13 provide direction to manage land treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15% of an activity area. Soil bulk density increases (soil compaction) has been documented in the Black Hills on some soils (reported in a number of BHNF monitoring reports that can currently be accessed at https://www.fs.usda.gov/main/blackhills/landmanagement/planning). This information has been collected through a past process of collecting and analyzing pre- and post-harvest soil core samples, or most recently through the use of a more recent national USFS soil disturbance assessment process identified in Forest Service Manual 2500, Chapter 2550 – Soil Management, Amendment No. 2500-2010-1 (effective November 23, 2010).

Natural Resource Conservation Service (NRCS) internet soil links through the main site at https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/ were reviewed to identify soils that would be expected to have a greater likelihood for increased potential soil compaction issues. The FOR - Soil Rutting Hazard interpretation was primarily used for soil compaction identification potential with a primary indicator being that of soil strength listed for the soil series. Specific interpretations or ratings for compaction potential or compaction resistance are not currently an option at this time for soils in this project area. During the review of the soil interpretations and ratings, issues were noted. Some feature of MLRA soil information is affecting ratings and limitations for various uses, has affected how soil information can be queried, how information can be compared, etc. Based on soil interpretations knowledge associated with personal experience from working in the Black Hills for several years, it was noted that a number of soils in map units that had previously been identified to have limited to no limitations (good bearing strength with limited to low risk of potential for deformation) are now identified as having a severe limitation rating in the NRCS Web Soil Survey tool. Based on review of the website information, the rating was often based on a low strength indicator. While uncertain, there may be issues with organic horizon depth changes mapped in MLRA 62. Organic fractions are known to influence soil properties. Organic materials increases porosity and lower bulk density, promote water infiltration, reduces plasticity and cohesion, and increases the available water capacity. Soils that are very high in organic matter have poor engineering properties and subside upon drying. Therefore, questions have risen regarding the potential that existing generated interpretations may not have been adjusted to reflect the change in soil pedon horizon depth data documentation. Through discussions with a local NRCS soil scientist, the rating is also focusing on just the fine earth fraction. The modelling does not appear to be considering levels of rock fragments located within the soil profile. Therefore, each soil series within MLRAs 61 and 62 with severe ratings within the project area were reviewed against other information such as the percentage of the rock fragment component. The severe rating was adjusted if there was a significant rock component at the surface and throughout the soil profile.

To comply with Forest Plan Standard 1103, Forest Plan 1105 and WCPH Management Measure 13, Forest Plan Guideline 1104 and design criteria from the WCPH are basic Forest SOPs to be implemented during project activities. Map units included were identified to have had at least one of the dominant map unit components with a severe limitation.

Soil Erosion

Forest Plan Standard 1103 and WCPH Management Measure 13 provide direction to manage land treatments to limit the sum of severely burned soil and detrimentally compacted, eroded, and displaced soil to no more than 15% of an activity area. NRCS internet soil information links through the main site at https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/ to review dominant component soils of soil map units to identify erosion hazard interpretations. The rating feature selected was Erosion Hazard (Off Road or Off Trail). The ratings in this interpretation indicate the hazard of soil loss from off-road and off-trail areas after disturbance activities that could expose the soil surface. The ratings are based on slope and soil erosion factor K (particle size of the soil, organic matter content, soil structure and profile permeability). The soil loss is generally a result of sheet or rill erosion in off-road or off-trail areas where 50 to 75 percent of the soil surface has been exposed by an activity such as logging, grazing, mining, or other types of disturbance. The NRCS ratings are both text and numerical. The hazard is described as "slight," "moderate," "severe," or "very severe." A rating of "slight" indicates that erosion is unlikely under ordinary climatic conditions; "moderate" indicates that some erosion is likely and that erosion-control measures may be needed; "severe" indicates that erosion is very likely and that erosion-control measures, including revegetation of bare areas, are advised; and "very severe" indicates that significant erosion is expected, loss of soil productivity and off-site damage are likely, and erosion-control measures are costly and generally impractical.

Soil map units with a dominant soil map unit component with a rating of severe or very severe have been included in the FEIS as areas were Forest SOPs are expected to be implemented to limit the potential for erosion to occur at a level that is considered to be detrimental as defined in the WCPH. This WCPH definition for detrimental erosion is: Sheet erosion – the general loss of soil from the soil surface: Indicators of detrimental erosion include pedestalled rocks and plants, deposition of soil on the uphill side of rocks and plants and/or erosion pavement; Rills and Gullies.

Black Hills Resilient Landscape (BHRL) Soil Map Unit Information

Map Unit Symbol	Map Unit Name	Acres	Erosion Hazard Potential	Compaction Potential *When Soils Are Wet	Slash Retention Criteria Depth to Bedrock less than 15" *NRCS makes the break on <20"	Slash Retention Criteria Topsoil < 1" (2.5 cm)	Slash Retention Criteria Topsoil Organic Matter <2% *A horizons
P006C	Alice fine sandy loam, 6 to 10 percent slopes	2	Slight	Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	No (up to 3%)
P010C	Alice-Ucross complex, moist, 3 to 10 percent slopes	8	Slight	Moderate/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	No (2%)
P010E	Alice-Ucross complex, moist, 10 to 30 percent slopes	50	Slight	Moderate/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	No (2%)
P030A	Barnum very fine sandy loam, 0 to 3 percent slopes, rarely flooded	23	Slight	Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P034B	Barnum-Rapidcreek, warm complex, 0 to 6 percent slopes, flooded	117	Slight	Moderate/Slight	Grassland/Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply
P040B	Boneek loam, 2 to 6 percent slopes	93	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P054D	Butche-Boneek, dry complex, 3 to 15 percent slopes	67	Slight	Slight/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P056F	Butche-Rock outcrop complex, 9 to 60 percent slopes	4	Moderate to Severe	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P058C	Butche-Spangler complex, 3 to 10 percent slopes	103	Slight	Slight/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply

Map Unit Symbol	Map Unit Name	Acres	Erosion Hazard Potential	Compaction Potential ***When Soils Are Wet***	Slash Retention Criteria **Depth to Bedrock less than 15"** ***NRCS makes the break on <20"***	Slash Retention Criteria **Topsoil < 1" (2.5 cm)**	Slash Retention Criteria **Topsoil Organic Matter <2%** ***A horizons***
P058E	Butche-Spangler complex, 10 to 30 percent slopes	90	Moderate	Slight/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P080D	Colby-Norka silt loams, cool, 6 to 15 percent slopes	<1	Slight	Moderate/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P082E	Colhill-Rothican complex, 10 to 40 percent slopes	<1	Moderate	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P098E	Corpening, warm-Rock outcrop-Tilford complex, 3 to 30 percent slopes	14	Moderate	Slight/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P102C	Cromack-Echeta-Leiter complex, 6 to 10 percent slopes	217	Slight	Severe/Severe/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P102E	Cromack-Echeta-Leiter complex, 10 to 30 percent slopes	117	Moderate	Severe/Severe/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P128F	Fairburn-Rock outcrop complex, 15 to 60 percent slopes	841	Severe	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P130E	Fairburn-Ucross loams, 6 to 30 percent slopes	285	Moderate	Severe/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P136C	Cromack clay loam, moist, 2 to 10 percent slopes	36	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P148C	Gurney, warm-Butche complex, 2 to 9 percent slopes	46	Slight	Severe/Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply

Map Unit Symbol	Map Unit Name	Acres	Erosion Hazard Potential	Compaction Potential ***When Soils Are Wet***	Slash Retention Criteria **Depth to Bedrock less than 15"** ***NRCS makes the break on <20"***	Slash Retention Criteria **Topsoil < 1" (2.5 cm)**	Slash Retention Criteria **Topsoil Organic Matter <2%** ***A horizons***
P154D	Gypnevee-Rekop-Rock outcrop complex, 6 to 15 percent slopes	3370	Moderate	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P176C	Iwait-Ucross-Ziggy loams, 2 to 10 percent slopes	7	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P182A	Jaywest loam, 0 to 2 percent slopes	<1	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P184B	Kadoka loam, 1 to 6 percent slopes	19	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P184C	Kadoka loam, 6 to 10 percent slopes	45	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P188F	Lakoa-Crownest complex, 10 to 60 percent slopes	507	Moderate	Severe/Slight	Yes (Crownest)	No (~2-3")	No (Up to ~2-3%
P196B	Lakoa-Recluse, moist loams, 1 to 6 percent slopes	5	Slight	Severe/Severe	No	No (>2")	No (>2%)
P196C	Lakoa-Recluse, moist loams, 6 to 10 percent slopes	17	Slight	Severe/Severe	No	No (>2")	No (>2%)
P196E	Lakoa-Recluse, moist loams, 10 to 30 percent slopes	67	Moderate	Severe/Severe	No	No (>2")	No (>2%)
P198F	Larkson, dry-Lakoa loams, 10 to 60 percent slopes	875	Moderate to Severe	Severe/Severe	No	No	No (Up to 6%)

Map Unit Symbol	Map Unit Name	Acres	Erosion Hazard Potential	Compaction Potential ***When Soils Are Wet***	Slash Retention Criteria **Depth to Bedrock less than 15"** ***NRCS makes the break on <20"***	Slash Retention Criteria **Topsoil < 1" (2.5 cm)**	Slash Retention Criteria **Topsoil Organic Matter <2%** ***A horizons***
P224F	Mathias-Rockoa-Rock outcrop complex, 25 to 60 percent slopes, stony	326	Severe	Severe/Moderate	No	No (>2")	No (>2%)
P226E	Mathias, very stony-Samsil-Rock outcrop complex, 15 to 30 percent slopes	28	Moderate	Slight/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P244D	Nevee channery loam, dry, 6 to 15 percent slopes	69	Moderate	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P246C	Nevee silt loam, 6 to 10 percent slopes	4	Moderate	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P248E	Nevee silt loam, 10 to 30 percent slopes, eroded	36	Severe	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P250C	Nevee silt loam, dry, 2 to 9 percent slopes	1623	Moderate	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P252E	Nevee, dry-Gullied land complex, 6 to 40 percent slopes	456	Severe	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P254F	Nevee-Nihill, moderately deep complex, 10 to 50 percent slopes	6	Severe	Slight/Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P256D	Nevee-Spearfish silt loams, 6 to 20 percent slopes	3	Moderate	Slight/Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P266E	Nihill, moist-Suglo complex, 10 to 40 percent slopes	15	Moderate	Moderate/Moderate To Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply

Map Unit Symbol	Map Unit Name	Acres	Erosion Hazard Potential	Compaction Potential ***When Soils Are Wet***	Slash Retention Criteria **Depth to Bedrock less than 15"** ***NRCS makes the break on <20"***	Slash Retention Criteria **Topsoil < 1" (2.5 cm)**	Slash Retention Criteria **Topsoil Organic Matter <2%** ***A horizons***
P270F	Nihill-Ziggy complex, 15 to 50 percent slopes	353	Severe/Moderate	Moderate/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P276B	Norka silt loam, 2 to 6 percent slopes	9	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P284C	Nuncho clay loam, moist, 6 to 10 percent slopes	24	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P344B	Rapidcreek very cobbly sandy loam, warm, 1 to 6 percent slopes, nonflooded	17	Slight	Slight	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply
P352B	Recluse loam, 2 to 6 percent slopes	2	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P354B	Recluse loam, dry, 2 to 6 percent slopes	60	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P358B	Recluse silt loam, 3 to 6 percent slopes	50	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P362B	Recluse-Hisle, deep complex, 2 to 6 percent slopes	<1	Moderate	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P364B	Recluse-Fairburn loams, 1 to 6 percent slopes	5	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P364C	Recluse-Fairburn loams, 6 to 10 percent slopes	59	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P386E	Rekop-Gypnevee, dry-Rock outcrop complex, 15 to 40 percent slopes	2,846	Moderate	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply

Map Unit Symbol	Map Unit Name	Acres	Erosion Hazard Potential	Compaction Potential ***When Soils Are Wet**	Slash Retention Criteria **Depth to Bedrock less than 15"** ***NRCS makes the break on <20"**	Slash Retention Criteria **Topsoil < 1" (2.5 cm)**	Slash Retention Criteria **Topsoil Organic Matter <2%** ***A horizons**
P388D	Rekop-Gypnevee, moderately deep-Tilford, dry complex, 6 to 15 percent slopes	72	Slight	Slight/Slight/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P396D	Rock outcrop-Butche complex, 2 to 25 percent slopes	2	Moderate	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P398F	Rock outcrop-Gypnevee, moderately deep complex, 9 to 50 percent slopes	249	Moderate/ Severe	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P400G	Rock outcrop-Mathias-Butche complex, 30 to 75 percent slopes, very stony	67	Severe	Moderate/Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P402F	Rock outcrop-Rekop complex, 40 to 60 percent slopes	424	Severe	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P404G	Rock outcrop-Vanocker, dry complex, 40 to 75 percent slopes	174	Very Severe	Slight	No	No (~ 2+")	No (~ 2%)
P408E	Rockerville-Pesowyo complex, warm, 10 to 30 percent slopes	<1	Moderate	Slight/Slight	Yes (Rockerville)	No (>2")	No (>2%)
P410E	Rockerville, warm-Rock outcrop complex, 6 to 30 percent slopes	78	Moderate	Slight	Yes (Rockerville)	No (>2")	No (>2%)
P412C	Rockoa-Lakoa complex, 3	102	Slight	Moderate/Severe	No	No (>2")	No (>2%)

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	to 12 percent slopes						
P414E	Rockoa-Lakoa-Rock outcrop complex, 10 to 40 percent slopes	649	Moderate	Moderate/Severe	No	No (>2")	No (>2%)
P416E	Rockoa-Recluse complex, 6 to 30 percent slopes	5	Moderate	Moderate/Severe	No	No (>2")	No (>2%)
P418F	Rockoa, very bouldery-Rock outcrop complex, 25 to 60 percent slopes	2,084	Severe	Moderate	No	No (>2")	No (>2%)
P438C	Samsil-Cromack complex, 2 to 10 percent slopes	2	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P438E	Samsil-Cromack complex, 10 to 30 percent slopes	982	Moderate	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P472C	Spangler-Butche complex, 6 to 10 percent slopes	82	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P474C	Spangler-Norka loams, 6 to 10 percent slopes	23	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P476E	Spearfish-Nevee silt loams, dry, 9 to 30 percent slopes	134	Moderate	Moderate/Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P480F	Spearfish-Rock outcrop complex, 10 to 60 percent slopes	26	Severe	Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P482F	Spearfish, dry-Rock outcrop complex, 10 to 60 percent slopes	55	Severe	Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply

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P490B	St. Onge loam, 1 to 6 percent slopes	37	Slight	Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P504B	Suglo loam, 2 to 6 percent slopes	<1	Slight	Moderate to Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P506C	Suglo-Nihill complex, 3 to 10 percent slopes	46	Slight	Moderate to Severe/Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P514B	Tilford silt loam, 2 to 6 percent slopes	4	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P514C	Tilford silt loam, 6 to 10 percent slopes	11	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P516B	Tilford silt loam, dry, 2 to 6 percent slopes	61	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P516D	Tilford silt loam, dry, 6 to 15 percent slopes	26	Moderate	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P522C	Tilford, dry-Gypnevee, moderately deep complex, 2 to 9 percent slopes	28	Slight	Severe/Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P524C	Tilford, dry-Rockerville, warm complex, 6 to 9 percent slopes	48	Slight	Severe/Slight	Yes (Rockerville)	No (>2")	No (>2%)
P528E	Turnercrest, moist-Ucross-Sodawells, occasionally flooded complex, 2 to 40 percent slopes	9	Moderate	Severe/Severe/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply

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P538B	Vale silt loam, 2 to 6 percent slopes	54	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P546B	Wages loam, 1 to 6 percent slopes	9	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P546C	Wages loam, 6 to 10 percent slopes	<1	Moderate	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P552E	Work clay loam, 10 to 30 percent slopes	101	Moderate	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P558D	Ziggy-Fairburn complex, 2 to 15 percent slopes	350	Slight	Severe/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
P560D	Ziggy-Nihill complex, 6 to 20 percent slopes	50	Moderate	Severe/Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0001E	Buska-Mocmont-Rock outcrop complex, 10 to 40 percent slopes	17,057	Moderate	Slight	No	Yes (Buska and Mocmont -No A)	Yes (Buska and Mocmont - 0% - No A)
Q0003C	Mocmont gravelly loam, 2 to 12 percent slopes	452	Slight	Slight	No	Yes (Mocmont - No A	Yes (Mocmont - 0% - No A)
Q0004E	Mocmont-Rock outcrop complex, 10 to 40 percent slopes	1,089	Moderate	Slight	No	Yes (Mocmont - No A	Yes (Mocmont - 0% - No A)
Q0005G	Mocmont-Rock outcrop complex, 40 to 80 percent slopes	8,073	Very Severe	Slight	No	Yes (Mocmont - No A	Yes (Mocmont - 0% - No A)
Q0006E	Shirttail channery loam, 10 to 40 percent slopes	2,599	Moderate	Moderate	No	No (~6")	No (>2%)

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Q0100C	Goldmine loam, 3 to 12 percent slopes	196	Slight	Severe	No	OK (Up to 11")	Approx. 2%+
Q0102E	Goldmine-Goldmine, moderately deep complex, 10 to 40 percent slopes	1,488	Moderate	Severe	No	OK (Up to 11")	Approx. 2%+
Q0104G	Goldmine-Rubbleland complex, 40 to 75 percent slopes	135	Very Severe	Severe	No	OK (Up to 11")	Approx. 2%+
Q0106E	Grizzly-Grizzly, thick surface complex, 10 to 40 percent slopes	2,433	Moderate	Moderate/Severe	No	Yes (Grizzly - no A horizon)	Yes (Grizzly - 0% - no A)
Q0108E	Grizzly-Mineshaft complex, 10 to 40 percent slopes	5,702	Moderate	Moderate/Severe	No	Yes (Grizzly - no A horizon)	Yes (Grizzly - 0% - no A)
Q0108G	Grizzly-Mineshaft complex, 40 to 80 percent slopes	5,739	Very E76Severe	Moderate/Severe	No	Yes (Grizzly - no A horizon)	Yes (Grizzly - 0% - no A)
Q0110E	Grizzly-Rock outcrop complex, 10 to 40 percent slopes	3,437	Moderate/ Severe	Moderate	No	Yes (Grizzly - no A horizon)	Yes (Grizzly - 0% - no A)
Q0110G	Grizzly-Rock outcrop complex, 40 to 80 percent slopes	4,197	Very Severe	Moderate	No	Yes (Grizzly - no A horizon)	Yes (Grizzly - 0% - no A)
Q0112G	Grizzly-Rubbleland-Rock outcrop complex, 40 to 80 percent slopes	1,540	Very Severe	Moderate	No	Yes (Grizzly - no A horizon)	Yes (Grizzly - 0% - no A)

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Q0114D	Grizzly-Virkula complex, 3 to 15 percent slopes	4,936	Slight	Moderate/Severe	No	Yes (Grizzly - no A horizon)	Yes (Grizzly - 0% - no A)
Q0114E	Grizzly-Virkula complex, 10 to 40 percent slopes	2,081	Moderate	Moderate/Severe	No	Yes (Grizzly - no A horizon)	Yes (Grizzly - 0% - no A)
Q0114F	Grizzly-Virkula complex, 15 to 60 percent slopes	12,013	Severe	Moderate/Severe	No	Yes (Grizzly - no A horizon)	Yes (Grizzly - 0% - no A)
Q0200C	Bullflat, moist-Cordeston silt loams, high mica, 2 to 9 percent slopes	286	Slight	Severe	Grassland and Riparian - Doesn't Apply	Riparian - Doesn't Apply	Riparian - Doesn't Apply
Q0202E	Buska-Rock outcrop complex, 10 to 40 percent slopes	23,329	Moderate	Slight	No	Yes (Buska- no A horizon)	Yes (Buska - 0% - no A)
Q0203D	Buska-Virkula, high mica loams, 2 to 15 percent slopes	5,902	Slight	Slight/Moderate (mica)	No	Yes (Buska- no A)	Yes (Buska - 0% - no A)
Q0205C	Cordeston loam, high mica, 2 to 10 percent slopes, flooded	2,248	Slight	Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0206B	Cordeston-Marshbrook loams, 0 to 6 percent slopes, flooded	4,054	Slight	Severe	No	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply
Q0208E	Heely channery loam, 10 to 40 percent slopes	2,310	Moderate	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0209D	Heely-Cordeston complex, 2 to 15 percent slopes	1,563	Slight	Slight/Severe	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply

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Q0211E	Hilger, moist-Virkula complex, 2 to 30 percent slopes	633	Moderate/ Slight	Slight/Severe	No	No (~ 1")	No (>2")
Q0213G	Hisega-Buska complex, 40 to 80 percent slopes	4	Very Severe	Slight	No	Yes (Buska- no A horizon)	Yes (Buska - 0% - no A)
Q0214E	Hisega-Rock outcrop complex, 10 to 40 percent slopes	287	Moderate	Slight	No	OK (4")	No (Up to 4%)
Q0216B	Marshbrook loam, 0 to 4 percent slopes, occasionally flooded	522	Slight	Severe	Riparian - Doesn't Apply	Riparian - Doesn't Apply	Riparian - Doesn't Apply
Q0217C	Marshbrook-Cordeston loams, 2 to 9 percent slopes, flooded	144	Slight	Severe	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply
Q0219F	Typic Udarents-Rock outcrop complex, 6 to 60 percent slopes	8	NA	NA	NA	NA	NA
Q0221F	Pactola-Buska channery silt loams, 20 to 60 percent slopes	436	Slight	Slight/Moderate (mica)	No	Yes (Buska- no A horizon)	Yes (Buska - 0% - no A)
Q0225D	Pactola-Virkula complex, 2 to 15 percent slopes, extremely bouldery	1,512	Slight	Slight/Severe	No	No (2 and 1")	No (>2")
Q0226E	Pactola-Virkula-Rock outcrop complex, 10 to 40 percent slopes	102,162	Moderate	Slight/Severe	No	No (2 and 1")	No (>2")

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Q0227E	Pactola-Virkula-Rock outcrop complex, 10 to 40 percent slopes, extremely bouldery	1,226	Moderate	Slight/Severe	No	No (2 and 1")	No (>2")
Q0229C	Rapidcreek very gravelly loam, noncalcareous, 1 to 9 percent slopes, rarely flooded	288	Slight	Slight	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply	No (2%)
Q0231G	Buska-Rock outcrop complex, 40 to 80 percent slopes	3,486	Very Severe	Slight	No	Yes (Buska- no A horizon)	Yes (Buska - 0% - no A)
Q0232G	Pactola-Pactola, shallow-Rock outcrop complex, 40 to 80 percent slopes	57,634	Very Severe	Slight	Yes (Pactola, shallow)	No (2")	No (>2")
Q0235G	Rubbleland-Pactola-Rock outcrop complex, 40 to 75 percent slopes	777	Very Severe	Slight	Yes (Pactola, shallow)	No (2")	No (>2")
Q0237F	Typic Udarents, reclaimed, 3 to 60 percent slopes	<1	NA	NA	NA	NA	NA
Q0239D	Virkula-Pactola complex, 2 to 15 percent slopes	16,024	Slight	Severe/Slight	No	No (1 and 2")	No (>2")
Q0300C	Bullflat-Cordeston, dry silt loams, high mica, 2 to 9 percent slopes	903	Slight	Moderate	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply
Q0302E	Buska, dry-Rock outcrop complex, 10 to 40 percent slopes	16,629	Moderate	Slight	No	Yes (Buska)	Yes (Buska - 0% - No A)

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Q0304D	Buska-Virkula, high mica loams, dry, 2 to 15 percent slopes	10,987	Slight	Slight/Severe (Virkula)	No	Yes (Buska)	Yes (Buska - 0% - No A)
Q0306C	Cordeston loams, dry, high mica, 2 to 10 percent slopes, flooded	1,016	Slight	Moderate	Grassland Meadow Soils - Doesn't Apply	Grassland Meadow Soils - Doesn't Apply	Grassland Meadow Soils - Doesn't Apply
Q0307B	Cordeston, dry-Marshbrook loams, 0 to 6 percent slopes, flooded	633	Slight	Moderate	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply
Q0309E	Heely channery loam, dry, 9 to 30 percent slopes	1,381	Moderate	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0310D	Heely-Cordeston complex, dry, 6 to 15 percent slopes	499	Slight	Slight/Moderate (Cord.)	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0312E	Roubaix-Virkula, complex, dry, 2 to 30 percent slopes	478	Moderate	Slight/Severe (Virkula)	No	No (1"	No (~2%+)
Q0315E	Pactola-Virkula-Rock outcrop complex, dry, 10 to 40 percent slopes	25,099	Moderate	Slight/Severe (Virkula)	No	No (2 and 1")	No (>2")
Q0317G	Buska, dry-Rock outcrop complex, 40 to 80 percent slopes	4,019	Severe	Slight	No	Yes (Buska)	Yes (Buska - 0% - No A)
Q0319G	Pactola-Pactola, shallow-Rock outcrop complex, dry, 40 to 80 percent slopes	18,104	Very Severe	Slight	Yes (Pactola, shallow)	No	No (~2%)
Q0322D	Virkula-Pactola complex, dry, 2 to 15 percent slopes	1,136	Slight	Severe/Slight	No	No	No (~2%)

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Q0400B	Crydeston silt loam, 0 to 6 percent slopes, flooded	1,408	Slight	Severe To Moderate	Grassland Meadow Soils - Doesn't Apply	Grassland Meadow Soils - Doesn't Apply	Grassland Meadow Soils - Doesn't Apply
Q0401B	Crydeston-Marshbrook, cool complex, 0 to 6 percent slopes, flooded	740	Slight	Severe	Grassland Meadow Soils and Riparian - Doesn’t Apply	Grassland Meadow Soils and Riparian - Doesn’t Apply	Grassland Meadow Soils and Riparian - Doesn’t Apply
Q0403B	Gillum silt loam, 0 to 6 percent slopes	430	Slight	Severe	No	No - 10"	No (>2%)
Q0405D	Jenksdraw-Gillum-Rockerville, cool complex, 2 to 25 percent slopes	2,754	Slight	Severe/Severe/Slight	Yes (Rockerville)	No (>7")	No (~2%+)
Q0407C	Riflepit-Stovho complex, 2 to 12 percent slopes	8,457	Slight	Severe	No	Yes (Riflepit - no A horizon)	Yes (Riflepit - 0% - no A)
Q0408E	Riflepit-Stovho loams, 3 to 30 percent slopes	4,673	Moderate	Severe	No	Yes (Riflepit - no A horizon)	Yes (Riflepit - 0% - no A)
Q0409E	Riflepit-Trebor complex, 10 to 40 percent slopes	14,129	Moderate	Severe	No	Yes (Riflepit - no A horizon)	Yes (Riflepit - 0% - no A)
Q0411C	McCooley, cool-Riflepit complex, 3 to 10 percent slopes	1,486	Slight	Moderate/Severe	No	Yes (Riflepit - no A horizon)	Yes (Riflepit - 0% - no A)
Q0411E	McCooley, cool-Riflepit complex, 10 to 40 percent slopes	723	Moderate	Moderate/Severe	No	Yes (Riflepit - no A horizon)	Yes (Riflepit - 0% - no A)
Q0412D	Pesowyo-Rockerville complex, cool, 3 to 20 percent slopes	478	Slight	Slight	Yes (Rockerville)	No (~6+")	Yes (Pesowyo 0.5-1%)

Map Unit Symbol	Map Unit Name	Acres	Erosion Hazard Potential	Compaction Potential ***When Soils Are Wet***	Slash Retention Criteria **Depth to Bedrock less than 15"** ***NRCS makes the break on <20"***	Slash Retention Criteria **Topsoil < 1" (2.5 cm)**	Slash Retention Criteria **Topsoil Organic Matter <2%** ***A horizons***
Q0413C	Redbird-Gillum silt loams, 2 to 9 percent slopes	5,629	Slight	Severe	No	No (7-10")	No (>2%)
Q0414E	Rockerville, cool-Rock outcrop complex, 6 to 30 percent slopes	304	Moderate	Slight	Yes (Rockerville, cool)	No	No (>2%)
Q0415D	Stovho silt loam, 2 to 15 percent slopes	8,836	Slight	Severe	No	No (~3")	No (~2%+)
Q0416C	Stovho-Riflepit-Trebor complex, 2 to 12 percent slopes	43,618	Slight	Severe	No	Yes (Riflepit -No A)	Yes (Riflepit)
Q0418E	Stovho-Trebor complex, 10 to 40 percent slopes	126,697	Moderate	Severe	No	Yes (Trebor - No O Horizon)	Yes (Trebor - 0% - No A)
Q0420G	Trebor-Rock outcrop complex, 40 to 80 percent slopes	20,561	Very Severe	Severe	No	Yes (Trebor - No O Horizon)	Yes (Trebor - 0% - No A)
Q0422C	Bullflat, cool-Crydeston silt loams, 2 to 9 percent slopes	368	Slight	Severe	Grassland Meadow Soils and Riparian - Doesn’t Apply	Grassland Meadow Soils and Riparian - Doesn’t Apply	Grassland Meadow and Riparian - Doesn’t Apply
Q0501B	Bullflat silt loam, moist, 3 to 6 percent slopes	63	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0501D	Bullflat silt loam, moist, 6 to 15 percent slopes	18	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0502C	Bullflat, moist-Cordeston silt loams, 2 to 9 percent slopes	1,549	Slight	Severe	Grassland Meadow Soils and Riparian - Doesn’t Apply	Grassland Meadow Soils and Riparian - Doesn’t Apply	Grassland Meadow Soils and Riparian - Doesn’t Apply

Map Unit Symbol	Map Unit Name	Acres	Erosion Hazard Potential	Compaction Potential ***When Soils Are Wet***	Slash Retention Criteria **Depth to Bedrock less than 15"** ***NRCS makes the break on <20"***	Slash Retention Criteria **Topsoil < 1" (2.5 cm)**	Slash Retention Criteria **Topsoil Organic Matter <2%** ***A horizons***
Q0506D	Citadel silt loam, 2 to 15 percent slopes	525	Slight	Severe	No	No (>2")	No (Up to 2%+)
Q0508C	Citadel-Hickok loams, 3 to 10 percent slopes	225	Slight	Severe	No	No (>2")	No (Up to 2%+)
Q0509C	Citadel-Tollflat complex, 2 to 12 percent slopes	1,836	Slight	Severe	No	No (>2")	No (Up to 2%+)
Q0510E	Citadel-Tollflat-Danjay complex, 10 to 40 percent slopes	10,967	Moderate	Severe/Moderate	No	No (>2")	No (Up to 2%+)
Q0512C	Citadel-McCooley complex, 3 to 10 percent slopes	8,815	Slight	Severe/Moderate	No	No (>2")	No (Up to 2%+)
Q0512E	Citadel-McCooley complex, 10 to 40 percent slopes	20,822	Moderate	Severe/Moderate	No	No (>2")	No (Up to 2%+)
Q0514C	Citadel-Vanocker complex, 2 to 12 percent slopes	14,536	Slight	Severe/Slight	No	No	No (~2%)
Q0516C	Colhill-Rothican complex, moist, 2 to 10 percent slopes	201	Slight	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0518B	Cordeston loam, 1 to 6 percent slopes, flooded	3,241	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0518C	Cordeston loam, 6 to 10 percent slopes	464	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0519B	Cordeston-Hickok loams, 2 to 6 percent slopes	705	Slight	Severe	No	No (>2")	No (>2%)

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Q0520C	Cordeston-Rapidcreek, rarely flooded complex, 2 to 9 percent slopes	550	Slight	Severe/Slight	Floodplains and riparian areas - Doesn't Apply	Floodplains and riparian areas - Doesn't Apply	Floodplains and riparian areas - Doesn't Apply
Q0528B	Hilger cobbly loam, moist, 0 to 6 percent slopes	29	Moderate	Slight	No	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0528E	Hilger cobbly loam, moist, 6 to 40 percent slopes	173	Moderate	Slight	No	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0530G	Hopdraw-Sawdust-Rock outcrop complex, moist, 40 to 80 percent slopes	1,539	Very Severe	Slight	No	No	No (>2%)
Q0535C	Bullflat silt loam, moist, 2 to 10 percent slopes	339	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0538A	Marshbrook silt loam, calcareous, 0 to 3 percent slopes, occasionally flooded	67	Slight	Severe	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply
Q0540C	McCooley-Tollflat complex, 3 to 10 percent slopes	2,127	Slight	Moderate/Severe	No	No (>2")	No (~2%)
Q0540F	McCooley-Tollflat complex, 10 to 60 percent slopes	920	Moderate/ Severe	Moderate/Severe	No	No (>2")	No (~2%)
Q0551C	Rockerville complex, 2 to 12 percent slopes	1,377	Slight	Slight	Yes (Rockerville)	No (>2")	No (>2%)
Q0552D	Rockerville-Gurney complex, moist, 2 to 15 percent slopes	628	Slight	Slight/Severe	Yes (Rockerville)	No	No (>2%)

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Q0553E	Rockerville, moist-Rock outcrop complex, 6 to 40 percent slopes	1,037	Moderate	Slight	Yes (Rockerville)	No (>2")	No (>2%)
Q0554F	Rockerville, moist-Vanocker-Rock outcrop complex, 10 to 60 percent slopes	142	Severe	Slight	Yes (Rockerville)	No (>2")	No (>2%)
Q0556C	Pesowyo-Rockerville complex, moist, 6 to 10 percent slopes	2,463	Slight	Slight/Slight	Yes (Rockerville)	No (>2")	No (>2%)
Q0556F	Pesowyo-Rockerville complex, moist, 10 to 60 percent slopes	2,582	Moderate to Severe	Slight/Slight	Yes (Rockerville)	No (>2")	No (>2%)
Q0560C	Rapidreek gravelly loam, 2 to 10 percent slopes, rarely flooded	224	Slight	Slight	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply	Grassland and Riparian - Doesn't Apply
Q0562F	Rock outcrop, limestone	814	NA	NA	NA	NA	NA
Q0563G	Rock outcrop-Vanocker complex, 50 to 75 percent slopes	10,432	Severe	Slight	No	No	No (~2%)
Q0564C	Hickok-Rockoa, moist complex, 3 to 12 percent slopes	2,686	Slight	Moderate	No	No (>2")	No (>2%)
Q0565E	Rockoa, moist-Hickok-Rock outcrop complex, 10 to 40 percent slopes	2,893	Moderate	Moderate	No	No (>2")	No (>2%)

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Q0566F	Rockoa, moist-Rock outcrop complex, 25 to 60 percent slopes	1,900	Severe	Moderate	No	No (>2")	No (>2%)
Q0568B	Roubaix silt loam, 0 to 6 percent slopes	565	Moderate	Severe	No	No (>2")	No (Up to 2%+)
Q0568E	Roubaix silt loam, 6 to 40 percent slopes	1,542	Moderate	Severe	No	No (>2")	No (Up to 2%+)
Q0570F	Opechekahta-Citivar-Schaeferville complex, 20 to 60 percent slopes	1,583	Severe	Moderate/Severe/ Moderate	No	No (>1")	No (Up to 2%+)
Q0571E	Sawdust, moist-Vanocker-Rockerville, moist complex, 10 to 40 percent slopes	3,272	Moderate	Slight	Yes (Rockerville)	No	No (~2%)
Q0572D	Schaeferville-Citivar silt loams, 6 to 20 percent slopes	152	Moderate/ Slight	Moderate/Severe	No	No (>1")	No (Up to 2%+)
Q0576C	Tollflat-Vanocker complex, 2 to 12 percent slopes	638	Slight	Severe/Slight	No	No	No (Up to 2%+)
Q0584E	Vanocker-Citadel complex, 10 to 40 percent slopes	58,436	Moderate	Slight/Severe	No	No	No (>2%)
Q0584F	Vanocker-Citadel complex, 20 to 60 percent slopes	13,644	Severe/Moderate	Slight/Severe	No	No (~2")	No (>2%)
Q0585G	Vanocker-Danjay-Hopdraw, moist complex, 40 to 80 percent slopes	8,168	Very Severe/Severe	Slight	No	No (~ 2+")	No (Up to 2%)

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Q0586E	Vanocker-Danjay-Tollflat complex, 10 to 40 percent slopes	3,310	Moderate	Slight/Severe	No	No (~ 2+")	No (Up to 2%)
Q0587E	Vanocker-Hickok complex, 10 to 40 percent slopes	8,829	Moderate	Slight/Severe	No	No	No (~2%)
Q0588D	Vanocker-Rockerville, moist complex, 2 to 15 percent slopes	3,162	Slight	Slight	Yes (Rockerville)	No	No (~2%)
Q0589G	Vanocker-Sawdust, moist-Rock outcrop complex, 40 to 80 percent slopes	28,598	Severe	Slight	No	No	No (~2%)
Q0590E	Sawdust-Hopdraw-Rockerville complex, moist, 10 to 40 percent slopes	390	Moderate	Slight	Yes (Rockerville)	No	No (up to 2%)
Q0591G	Sawdust, moist-Rock outcrop complex, 40 to 80 percent slopes	2,236	Very Severe	Slight	No	No	No (~2%)
Q0602A	Barnum very fine sandy loam, cool, 0 to 3 percent slopes, rarely flooded	155	Slight	Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0603B	Barnum, cool-Rapidcreek complex, 0 to 6 percent slopes, rarely flooded	974	Slight	Moderate/Slight	Grassland, Floodplains and Riparian - Doesn't Apply	Grassland, Floodplains and Riparian - Doesn't Apply	Grassland, Floodplains and Riparian - Doesn't Apply
Q0608B	Bullflat silt loam, 3 to 6 percent slopes	444	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply

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Q0609C	Bullflat-Cordeston, dry silt loams, 2 to 9 percent slopes	2,037	Slight	Severe	Grassland and Meadows - Doesn't Apply	Grassland and Meadows - Doesn't Apply	Grassland and Meadows - Doesn't Apply
Q0611C	Citadel-Vanocker complex, dry, 2 to 12 percent slopes	1,275	Slight	Moderate/Slight	No	No	No (~2%)
Q0613F	Colhill-Ziggy, cool complex, 15 to 50 percent slopes	375	Severe/Moderate	Slight/Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0615D	Colnevee channery loam, 6 to 15 percent slopes	74	Slight	Slight	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0616C	Colnevee silt loam, 2 to 9 percent slopes	54	Slight	Moderate	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0617B	Colombo loam, cool, 0 to 4 percent slopes, rarely flooded	<1	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0619C	Cordeston loam, dry, 2 to 10 percent slopes	66	Slight	Moderate	Grassland Meadow Soils - Doesn't Apply	Grassland Meadow Soils - Doesn't Apply	Grassland Meadow Soils - Doesn't Apply
Q0620C	Cordeston-Rapidcreek, rarely flooded complex, dry, 2 to 9 percent slopes	2,194	Slight	Severe/Slight	Floodplains and riparian areas - Doesn't Apply	Floodplains and riparian areas - Doesn't Apply	Floodplains and riparian areas - Doesn't Apply
Q0622F	Crownest-Rock outcrop complex, 9 to 60 percent slopes	161	Moderate	Slight	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0625B	Sodawells fine sandy loam, cool, 0 to 4 percent slopes, rarely flooded	25	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply

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Q0629B	Hilger cobbly loam, 0 to 6 percent slopes	640	Slight	Slight	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0629E	Hilger cobbly loam, 6 to 40 percent slopes	777	Moderate	Slight	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0630E	Hilger-Metre, cool complex, 10 to 40 percent slopes	14	Moderate	Slight/Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0632E	Hilger-Virkula, dry complex, 2 to 30 percent slopes	124	Moderate	Slight/Severe	No	No	No
Q0634G	Hopdraw-Sawdust-Rock outcrop complex, 40 to 80 percent slopes	15,907	Very Severe/ Severe	Slight	No	No	No (up to 2%)
Q0640B	Norkool silt loam, dry, 2 to 6 percent slopes	9	Slight	Severe	Grassland - Doesn't Apply	Grassland - Doesn't Apply	Grassland - Doesn't Apply
Q0645C	Rapidcreek cobbly loam, dry, 2 to 10 percent slopes, rarely flooded	406	Slight	Slight	Floodplains and riparian areas - Doesn't Apply	Floodplains and riparian areas - Doesn't Apply	Floodplains and riparian areas - Doesn't Apply
Q0646C	Rapidcreek loam, dry, 3 to 9 percent slopes, rarely flooded	19	Slight	Slight	Floodplains and riparian areas - Doesn't Apply	Floodplains and riparian areas - Doesn't Apply	Floodplains and riparian areas - Doesn't Apply
Q0653D	Crownest-Rock outcrop complex, 2 to 25 percent slopes	487	Slight	Slight	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0655G	Sawdust-Rock outcrop complex, 40 to 80 percent slopes	5,565	Very Severe	Slight	No	No	No (up to 2%)

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Q0657D	Rockerville-Boneek, cool, complex, 6 to 15 percent slopes	300	Slight	Slight/Severe	Yes (Rockerville)	No	No
Q0658D	Rockerville-Gurney complex, 2 to 15 percent slopes	15,526	Slight	Slight	Yes (Rockerville)	No	No (up to 2%)
Q0659E	Rockerville-Rock outcrop complex, 6 to 30 percent slopes	9,159	Moderate	Slight	Yes (Rockerville)	No (~14")	No (up to 2%)
Q0660F	Rockerville-Sawdust-Rock outcrop complex, 9 to 60 percent slopes	1,466	Severe	Slight	Yes (Rockerville)	No	No
Q0664E	Sawdust-Hopdraw-Rockerville complex, 10 to 40 percent slopes	14,244	Moderate	Slight	Yes (Rockerville)	No	Yes (Hopdraw)
Q0665E	Sawdust-Vanocker, dry-Rockerville complex, 10 to 40 percent slopes	57,332	Moderate	Slight	Yes (Rockerville)	No	No (up to 2%)
Q0668F	Spearfish, cool-Rock outcrop complex, 9 to 50 percent slopes	42	Severe	Moderate	Yes (Spearfish)	No	No (Up to 3%)
Q0670B	Tilford silt loam, cool, 2 to 6 percent slopes	47	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0672C	Tilford, cool-Rockerville complex, 6 to 9 percent slopes	80	Slight	Slight	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0675E	Vanocker-Citadel complex, dry, 10 to 40 percent slopes	7,285	Moderate	Slight/Severe	No	No (~2-3")	No (up to 2%)

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Q0676E	Vanocker-Hickok complex, dry, 10 to 40 percent slopes	5,390	Moderate	Slight/Severe	No	No (~2-3")	No (up to 2%)
Q0677D	Vanocker, dry-Rockerville complex, 2 to 15 percent slopes	3,617	Slight	Slight	Yes (Rockerville)	No (~2-14")	No (up to 2%)
Q0678G	Vanocker, dry-Sawdust-Rock outcrop complex, 40 to 80 percent slopes	15,507	Severe	Slight	No	No	No (up to 2%)
Q0680D	Ziggy, cool-Colhill complex, 6 to 15 percent slopes	749	Slight	Severe/Slight	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0701F	Orthents, loamy, earthen dams, 0 to 75 percent slopes	<1	NA	NA	NA	NA	NA
Q0702F	Pits, quarry	197	NA	NA	NA	NA	NA
Q0704E	Udarents, abandoned gravel pits	78	NA	NA	NA	NA	NA
Q0705D	Udarents, reclaimed gravel pits	75	NA	NA	NA	NA	NA
Q0801B	Boneek loam, cool, 2 to 6 percent slopes	85	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply
Q0801C	Boneek loam, cool, 6 to 10 percent slopes	10	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply
Q0803E	Shingle-Ucross loams, cool, 10 to 30 percent slopes	106	Moderate	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply
Q0807C	Alice-Ucross complex, cool, 3 to 10 percent slopes	17	Slight	Moderate/Moderate	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply

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Q0808A	Coaliams loam, cool, 0 to 3 percent slopes, flooded	312	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply
Q0811C	Colsavage clay loam, 2 to 10 percent slopes	25	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply
Q0812C	Colsavage-Bahl-Leiter clay loams, cool, 6 to 10 percent slopes	93	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply
Q0812E	Colsavage-Bahl-Leiter clay loams, cool, 10 to 30 percent slopes	175	Moderate	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply
Q0813A	Cordeston silt loams, 0 to 3 percent slopes, flooded	326	Slight	Moderate	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply
Q0815C	Crownest-Regnaps complex, 3 to 10 percent slopes	508	Slight	Slight/Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply
Q0815E	Crownest-Regnaps complex, 10 to 30 percent slopes	57	Moderate	Slight/Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply
Q0817A	Frazerton silty clay loam, cool, 0 to 3 percent slopes, occasionally flooded	208	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland - Doesn't Apply
Q0826C	Lakoa-Crownest complex, moist, 3 to 10 percent slopes	592	Slight	Severe/Slight	Yes (Crownest)	No (~2")	No (Up to 2%+)

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Q0826F	Lakoa-Crownest complex, moist, 10 to 60 percent slopes	4,665	Severe/Moderate	Severe/Slight	Yes (Crownest)	No (~2")	No (Up to 2%+)
Q0827C	Lakoa-Reicess loams, moist, 6 to 10 percent slopes	203	Slight	Severe	No	No (~2"+)	No (Up to 2%+)
Q0827E	Lakoa-Reicess loams, moist, 10 to 30 percent slopes	32	Moderate	Severe	No	No (~2"+)	No (Up to 2%+)
Q0828C	Tollflat-Hickok loams, 3 to 10 percent slopes	15,560	Slight	Severe/Moderate	No	No (3.5 - 7")	No(Up to 2 %+)
Q0828F	Tollflat-Hickok-Vanocker complex, 10 to 60 percent slopes	36,811	Moderate	Severe/Moderate/Slight	No	No (3.5 - 7")	No(Range up to 9%+)
Q0830C	Maitland loam, moist, 6 to 10 percent slopes	32	Slight	Severe	No	No	No (Range up to 4%)
Q0834B	Nunnston clay loam, 2 to 6 percent slopes	99	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0834C	Nunnston clay loam, 6 to 10 percent slopes	60	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0836B	Nunnston loam, thick surface, 1 to 6 percent slopes	65	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0836C	Nunnston loam, thick surface, 6 to 10 percent slopes	6	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply

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Q0838B	Norkool loam, moderately deep, moist, 2 to 6 percent slopes	3	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0838C	Norkool loam, moderately deep, moist, 6 to 10 percent slopes	19	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0840C	Regnaps-Crownest complex, 3 to 10 percent slopes	158	Slight	Severe/Slight	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0841B	Reicess loam, moist, 1 to 6 percent slopes	79	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0842C	Reicess-Shingle loams, moist, 6 to 10 percent slopes	63	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0848B	Nunnston loam, moderately deep, 1 to 6 percent slopes	34	Slight	Severe	No	No (8")	No (Range up to 2%)
Q0852C	Samsil-Gaynor complex, cool, 2 to 10 percent slopes	31	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0852E	Samsil-Gaynor complex, cool, 10 to 30 percent slopes	658	Moderate	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0854B	Work clay loam, 2 to 6 percent slopes	276	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0854C	Work clay loam, 6 to 10 percent slopes	27	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0854E	Work clay loam, 10 to 30 percent slopes	2,353	Moderate	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply

Map Unit Symbol	Map Unit Name	Acres	Erosion Hazard Potential	Compaction Potential ***When Soils Are Wet***	Slash Retention Criteria **Depth to Bedrock less than 15"** ***NRCS makes the break on <20"***	Slash Retention Criteria **Topsoil < 1" (2.5 cm)**	Slash Retention Criteria **Topsoil Organic Matter <2%** ***A horizons***
Q0901B	Boneek silt loam, moist, 2 to 6 percent slopes	30	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0906D	Colnevee-Spearfish, cool silt loams, moist, 6 to 20 percent slopes	5	Slight/Moderate	Moderate	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0910E	Corpening-Rock outcrop complex, 3 to 30 percent slopes	310	Moderate	Slight	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0912B	Norkool loam, 1 to 6 percent slopes	14	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0912C	Norkool loam, 6 to 10 percent slopes	63	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0913B	Nunnston, thick surface-Cordeston loams, 1 to 6 percent slopes	46	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0918C	Rockerville-Pesowyo complex, 3 to 12 percent slopes	26	Slight	Slight	Yes (Rockerville)	No(~ 6+ inches)	Yes (Pesowyo 0.5 - 1%)
Q0918E	Rockerville-Pesowyo complex, 10 to 30 percent slopes	1	Moderate	Slight	Yes (Rockerville)	No(~ 6+ inches)	Yes (Pesowyo 0.5 - 1%)
Q0922B	Sugakool loam, moist, 1 to 6 percent slopes	31	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0922C	Sugakool loam, moist, 6 to 10 percent slopes	87	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply

Map Unit Symbol	Map Unit Name	Acres	Erosion Hazard Potential	Compaction Potential ***When Soils Are Wet***	Slash Retention Criteria **Depth to Bedrock less than 15"** ***NRCS makes the break on <20"***	Slash Retention Criteria **Topsoil < 1" (2.5 cm)**	Slash Retention Criteria **Topsoil Organic Matter <2%** ***A horizons***
Q0924C	Tilford silt loam, cool, 6 to 10 percent slopes	3	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0926G	Rock outcrop-Vanocker, dry complex, 50 to 75 percent slopes	6,821	Very Severe.	Slight	No	No (~ 2+")	No (~ 2%)
Q0928B	Vassett silt loam, moist, 1 to 6 percent slopes	4	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
Q0928C	Vassett silt loam, moist, 6 to 10 percent slopes	8	Slight	Severe	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply	Grassland Soils - Doesn't Apply
QW	Water	24	NA	NA	NA	NA	NA