APPENDIX E: Baseline Soils Report

BASELINE SOILS REPORT

BLACK BUTTE COPPER PROJECT

MEAGHER COUNTY, MONTANA

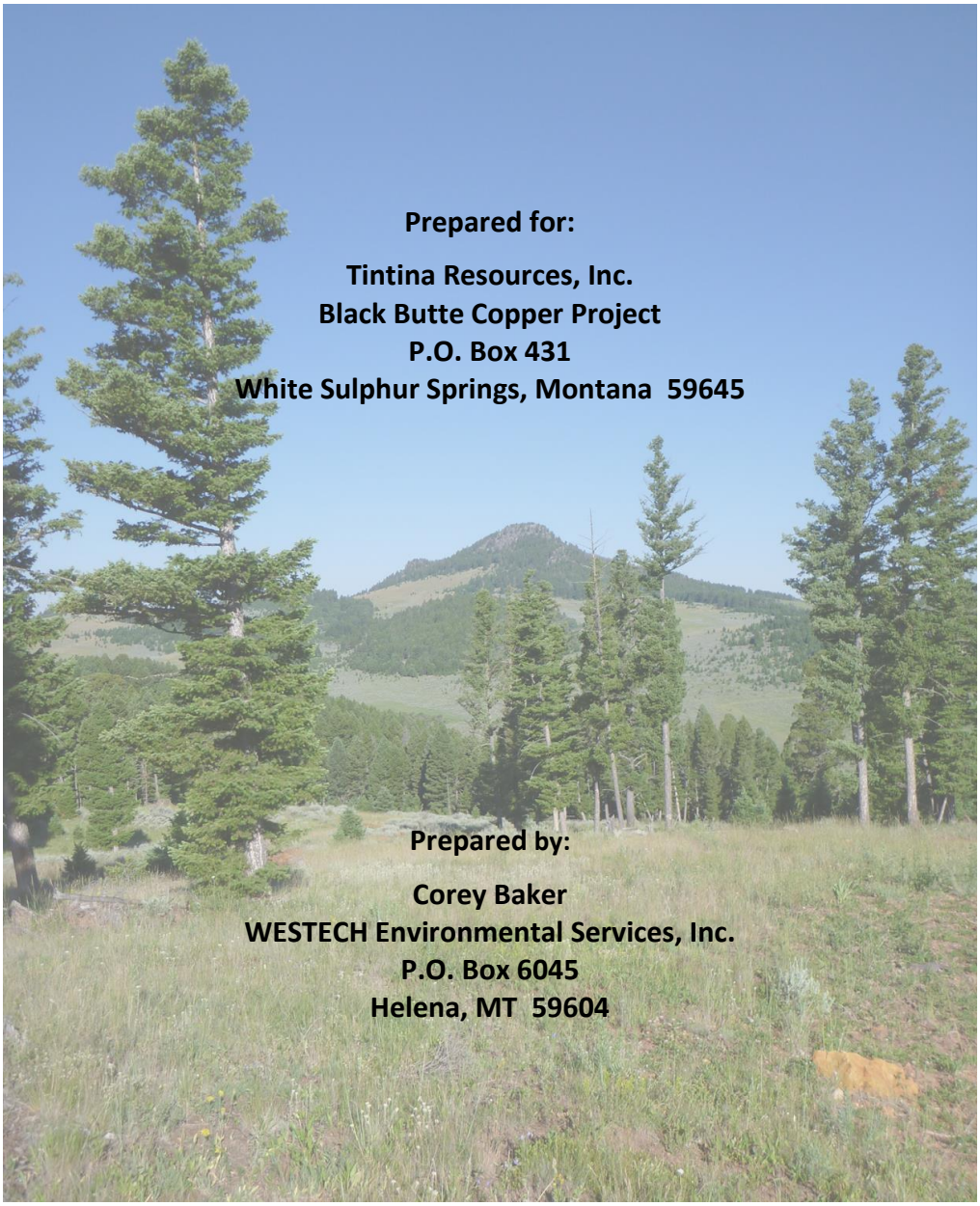

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TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Tintina Alaska Exploration, Inc. (Tintina) contracted WESTECH Environmental Services, Inc. (WESTECH) to conduct a baseline inventory of soil resources within the proposed Black Butte Copper Project (Study Area) in north-central Meagher County, approximately 15 miles north of White Sulphur Springs, Montana (Figure 1).

The soils baseline inventory was designed to provide information on existing soil resources and recommendations for soil salvage. Data from this inventory will be used to assist mine permitting and reclamation planning in accordance with the laws and regulations administered by the Montana Department of Environmental Quality - Hard Rock Mining Program (DEQ).

An Order 2 soil survey was conducted within the Study Area to provide the data presented in this report. The primary objectives of the Order 2 soils survey were to:

- Identify and describe soil profiles, and classify soils to the family level where such series have previously been identified as map unit names in the existing Natural Resources Conservation Service (NRCS) soil survey;
- Sample representative soil horizons from identified soils;
- Analyze soil samples for selected physical and chemical characteristics; and
- Determine soil suitability for reclamation.

2.0 METHODS

The Plan of Study (POS) was based on soil survey procedures developed by the NRCS and published in the Soil Survey Manual (USDA, 1993). Soil data included in this baseline report were compiled from literature review, field mapping, soil sampling, and laboratory analyses. These data were integrated with regulatory guidelines to determine salvage suitability for each soil type. A total of 30 survey sites were identified and described using field NRCS soil evaluation methods (USDA, 2012). Of the 30 survey sites, samples were collected from major horizons at 25 locations to provide laboratory-based analyses of physical and chemical properties representative of each soil series identified on the Baseline Soil Survey Map (Figure 2). These data and existing NRCS soil survey data were used to develop descriptions of each soil mapping unit in narrative form.

Corey Baker and Ryan Sparhawk conducted the field inventory in July 2015. Supplemental sampling was completed in October 2015 by Corey Baker and John Beaver. Energy Laboratories of Helena, Montana completed the original laboratory analyses in August 2015 and supplemental samples in November 2015, using standard methods and protocols.

2.1 LITERATURE REVIEW

A review of existing soils information for the Study Area included the soil map and associated soils data published by the Natural Resources Conservation Services (USDA, 2013). This information was used to

identify dominant soil series in the area and develop a preliminary soils map. The NRCS soil data were used to summarize dominant soil characteristics and to develop a preliminary list of field survey sites.

Other documentation used during the inventory includes the following: The Soil Survey Manual, Handbook 18 (USDA, 1993); Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys (2nd Edition) (USDA, 1999); The National Soils Handbook, Handbook 430 (USDA, 2009); NRCS Field Book for Describing and Sampling Soils (USDA, 2012), Keys to Soil Taxonomy (12th Edition) (USDA, 2014) and other pertinent soils engineering, erosion, and salvage suitability documents.

2.2 FIELD INVESTIGATIONS

Preliminary review of existing NRCS soil survey data, aerial photographs, topographic maps, and geological and climatic information for the survey area was used to identify proposed soil sample sites prior to conducting field investigations.

In the field, the 30 soil survey sites were selected by traversing the landscape and observing soil variability based on differences in landform, topographical position, parent material and vegetation. Soil pedons were described by manually excavating a pit using a shovel or hand auger to a depth of 40 inches, auger refusal or parent material, whichever was encountered first. At each soil sample site the following characteristics were recorded in the field:

- Drainage class
- Slope range
- Parent material
- Vegetation and land use
- Topography and position
- Aspect
- Surface runoff
- Erosion
- Permeability
- Horizon types, depths and thicknesses
- Color
- Texture
- Coarse fragment content
- Carbonates
- Clay films
- Effervescence
- Roots
- Structure

2.3 LABORATORY ANALYSIS

Samples for laboratory analysis were collected from 25 soil sample site locations using 1-quart samples collected from each identified soil horizon in the pedon. All soil samples were submitted to the laboratory to generate the soil properties listed below and the data presented in Appendix A:

Physical Properties:

- Soil texture
- Organic matter content
- Coarse fragment content

Chemical Properties:

- pH
- Arsenic
- Cadmium
- Copper
- Salinity/Conductivity
- Lead
- Zinc

2.4 SOIL MAP UNIT DEVELOPMENT

Preliminary map unit boundaries were identified in the field based on the results of pedon descriptions and development of conceptual map units. The final soil map units were refined based on review of all

available information, including laboratory results and final pedon classifications. Descriptions of each soil map unit are provided in Section 3.0 followed by a discussion of applicable reclamation or salvage considerations in Section 4.0 of this report.

3.0 RESULTS

Geology of the Survey Area consists of calcareous shales of the Newland Formation: dark bluish-gray argillaceous, dolomitic limestone with some argillite (USGS, 2015). Additionally, narrow dikes and sills of intrusive igneous rock occur throughout the Study Area.

Daily temperatures range from an average of 64 degrees Fahrenheit (F) in July to 19 degrees F in January (NRCS, 2015). Temperature data was measured at the White Sulphur Springs monitoring station, located 15 miles south of the Study Area. The average yearly precipitation, measured at the Deadman Creek monitoring station, 6 miles east of the Study Area, is 25.2 inches, and the average precipitation at the White Sulphur Springs monitoring station is 12.9 inches (NRCS, 2015).

3.1 PEDON DESCRIPTIONS

Profile descriptions for the 30 soil survey sites in the Study Area were used to classify soils to family level and then correlate to official NRCS soil series. Representative photographs of the soil profiles and sample sites are presented in Appendix B. A total of 18 established NRCS soil series were identified as components of soil map units within the Study Area.

3.2 SOIL MAP UNIT DESCRIPTIONS

The following paragraphs describe the dominant characteristics of the 18 soil series identified in the Study Area (Table A1) and shown on the Baseline Soil Survey Map (Figure 2). Specific physical and chemical data for survey or sample sites representing each soil series are provided in Tables A2 and A3 of Appendix A. Official NRCS descriptions of the soil series in the Study Area are presented in Appendix C.

Ad-b Adel loam – (5-15% slopes)

The Adel series consists of very deep, well drained soils with moderate permeability. These soils formed in alluvium, colluvium and slide deposits (Soil Survey Staff, 2015). Adel soils are located on terraces and swales at the base of moderate to steeply sloping hills. The coarse fragment content, mainly in the form of cobbles and boulders, increases with depth in these soils.

Map Unit Composition: Adel 80%, Medicinelodge 10%, Caseypeak 5%, Kimpton 5%

Cp-c: Caseypeak, skeletal loams – (15-40% slopes)

The Caseypeak series consists of shallow, well drained soils formed in residuum derived from granite and other coarse-grained igneous rock located on mountains and hills (Soil Survey Staff, 2015). Soils from this series contain a mix of gravels, cobbles and boulders overlying shallow granite bedrock. Caseypeak soils are located on ridges, shoulders and slopes in uplands and formed over fractured or indurated coarse-textured bedrock materials.

Map Unit Composition: Caseypeak 80%, Woodhall 10%, Kimpton 10%

Cp-d: Caseypeak, skeletal loams – steep – (40-70% slopes)

Similar to the Cp-c soil map unit, but occurs on steep slopes and ridges. Soils in this map unit are typically very shallow and consist of dense coarse fragments, with limited mineral soil materials.

Map Unit Composition: Caseypeak 90%, Woodhall 5%, Kimpton 5%

Ch-b: Cheadle, channery loams – (5-15% slopes)

The Cheadle series consists of shallow well drained soils that formed in colluvium and/or residuum derived mainly from hard sandstone, but may be underlain by hard phyllitic shale, argillite, quartzite or igneous rock (Soil Survey Staff, 2015). These soils are extensive within the Study Area and are located on gently rolling hills, broad swales and slopes in uplands.

Map Unit Composition: Cheadle 80%, Wineglass 10%, Duckcreek 5%, Medicinelodge 5%

Cl-a: Clunton, clay loams – frequently flooded – (0-5% slopes)

The Clunton series consists of very deep, very poorly drained soils that formed in alluvium located on flood plains, flood-plain steps and drainage-ways (Soil Survey Staff, 2015). Surface inundation and shallow groundwater are common in these soils. Clunton soils also exhibit histic epipedons with high organic matter content to a depth of six inches.

Map Unit composition: Clunton 90%, Wineglass 10%

Dc-a: Duckcreek, clay loams – (0-5% slopes)

The Duckcreek series consists of moderately deep, well drained soils with slow permeability. These soils typically form in interbedded shale, sandstone residuum and clayey sedimentary beds (Soil Survey Staff, 2015). Duckcreek soils are located on toe-slopes and low terraces at the base of rolling hills in the Study Area.

Map Unit Composition: Duckcreek 90%, Cheadle 5%, Medicinelodge 5%

Fa-a: Farlin, clay loams - (0-5% slopes)

The Farlin series consists of very deep, well drained soils with moderate permeability. These soils formed in alluvium, colluvium or slide deposits derived from limestone (Soil Survey Staff, 2015). Farlin soils are located on gentle slopes and terraces associated with escarpments adjacent to stream floodplains in the eastern portion of the Study Area.

Map Unit Composition: Farlin 90%, Medicinelodge 5%, Raynesford 5%

Hl-b: Houlihan, sandy loams – (5-15% slopes)

The Houlihan series consists of very deep, well drained soils with moderate permeability. These soils formed in alluvium, slope alluvium, and colluvium derived from igneous, metamorphic and sedimentary

rock (Soil Survey Staff, 2015). These soils are located on gentle to moderately sloping, north facing hills below broad ridges of coarse-textured bedrock.

Map Unit Composition: Houlihan 80%, Kimpton 10%, Caseypeak 5%, Cheadle 5%

Kp-c: Kimpton, skeletal loams – (15-40% slopes)

The Kimpton series consists of moderately deep, well drained soils with moderate permeability. These soils formed in colluvium or slope alluvium over residuum derived from hard fine-grained sandstone or fine-grained igneous rock (Soil Survey Staff, 2015). In the Study Area, these soils are located on moderately to steeply sloping hills and ridges.

Map Unit Composition: Kimpton 80%, Caseypeak 10%, Woodhall 10%

Kp-d: Kimpton, skeletal loams - steep – (40-70% slopes)

Similar to the Kp-c soil map unit, but located on steep to very steep slopes. These soils often contain dense coarse fragment content and shallow to very shallow soil depths.

Map Unit Composition: Kimpton 90%, Poin 5%, Woodhall 5%

Lb-b: Libeg, clay loams – (5-15% slopes)

The Libeg series consists of very deep, well drained soils with moderate permeability that formed in alluvium, outwash, colluvium, till or slide deposits (Soil Survey Staff, 2015). Libeg soils are located on gently to moderately sloping facing hills and mountain slopes.

Map Unit Composition: Libeg 90%, Caseypeak 5%, Cheadle 5%

Ml-a: Medicinelodge – frequently flooded – (0-5% slopes)

The Medicinelodge series consists of very deep, poorly drained soils with slow permeability that formed in clayey alluvium in depositional landscape features (Soil Survey Staff, 2015). These soils are located in broad floodplains and are often associated with areas of shallow groundwater. Medicinelodge soils exhibit histic epipedons to a depth of 14 inches in some areas.

Map Unit Composition: Medicinelodge 80%, Duckcreek 10%, Redfish 10%

Ml-b: Medicinelodge – occasionally flooded – (5-15% slopes)

Similar to the Ml-a map unit, except that these soils are associated with narrower drainages and wetlands, thus including some slopes and toeslopes adjacent to the drainage floodplains.

Map Unit Composition: Medicinelodge 90%, Wineglass 5%, Woodhurst 5%

Pn-b: Poin, skeletal sandy loams – (5-10% slopes)

The Poin series consists of shallow, well drained soils with moderately rapid permeability. These soils formed in colluvium and residuum derived from gneiss-schist, sandstone, rhyolite, granite, quartzite or welded tuff bedrock (Soil Survey Staff, 2015). This series exhibits moderate to high coarse fragment

content that increases with depth. Poin soils are located on ridges and shoulders and formed over fractured, coarse-grained bedrock.

Map Unit Composition: Poin 90%, Cheadle 5%, Kimpton 5%

Ry-b: Raynesford, silty clay loams – (5-15% slopes)

The Raynesford series consists of very deep, well drained soils with moderate permeability. These soils formed in alluvium, slope alluvium or colluvium derived mainly from limestone or marl shale (Soil Survey Staff, 2015). Raynesford soils formed over mixed alluvium on terraces and escarpments in the eastern portion of the study area.

Map Unit Composition: Raynesford 90%, Duckcreek 5%, Farlin 5%

Rc-b: Redchief, silty loams – (5-15% slopes)

The Redchief series consists of very deep, well drained soils with slow permeability. These soils formed in till, glaciofluvial deposits, slope alluvium or colluvium (Soil Survey Staff, 2015). Redchief soils are located on isolated plains and gentle slopes in uplands. These soils also exhibit dark red colors derived from a mix of metamorphic and sedimentary parent materials.

Map Unit Composition: Redchief 90%, Kimpton 5%, Woodhall 5%

Rf-a: Redfish, occasionally flooded – (0-5%slopes)

The Redfish Series consists of very deep, poorly drained soils that form in alluvium on floodplains and valley floors (Soil Survey Staff, 2015). These soils are associated with shallow groundwater and wetlands within the Sheep Creek floodplain. In general, Redfish soils contain deep, dark mineral soil epipedons and are used for grass hay production.

Map Unit Composition: Redfish 90%, Medicinelodge 10%

Sb-b: Sebud, gravelly loams – (5-15% slopes)

The Sebud series consists of very deep, well drained soils with moderate permeability. These soils formed in till, outwash, alluvium, slope alluvium and colluvium derived from igneous, metamorphic or sedimentary rock (Soil Survey Staff, 2015). Sebud soils are located at the base of slopes or rock outcrops in the Sheep Creek floodplain and formed over deep alluvial deposits.

Map Unit Composition: Sebud 90%, Cheadle 10%

Wg-b: Wineglass, channery clay loams – (5-15%)

The Wineglass series consists very deep well drained soils with moderately slow permeability. These soils formed in colluvium, alluvium and residuum derived from mixed sedimentary bedrock (Soil Survey Staff, 2015). Typically, coarse fragment content increases with depth in the form of channers and flagstones from sedimentary parent materials. Wineglass soils are located in swales on gently sloping hills and on terraces at the base of slopes.

Map Unit Composition: Wineglass 80%, Cheadle 10%, Clunton 5%, Medicinelodge 5%

Wa-b: Woodhall, skeletal loams – (5-15% slopes)

The Woodhall series consists of moderately deep, well drained soils with moderate permeability. These soils formed in noncalcareous gravelly colluvium and or slope alluvium derived from igneous and sedimentary rock (Soil Survey Staff, 2015). Woodhall soils are typically found on rolling upland slopes and terraces.

Map Unit Composition: Woodhall 80%, Caseypeak 10%, Kimpton 5%, Redchief 5%

Wu-b: Woodhurst, skeletal loams – (5-15% slopes)

The Woodhurst series consists of moderately deep, well drained soils with moderate permeability that formed in colluvium over residuum derived from nonacid igneous rocks (Soil Survey Staff, 2015). These soils are isolated to slopes and toeslopes in the northern portion of the Study Area.

Map Unit Composition: Woodhurst 90%, Caseypeak 5%, Kimpton 5%

4.0 SOIL SUITABILITY CRITERIA

The physical and chemical characteristics of soils within the Study Area were analyzed to determine suitability for use as reclamation material. Unsuitable soils are described by DEQ as "materials which are not conducive to revegetation techniques, establishment, and growth." (DEQ, 1998). In addition, DEQ has provided direction that soils that contain in excess of 50 percent coarse fragments and/or are located on slopes steeper than 2 to 1 are not suitable for salvage or reclamation use. Specific thresholds for maximum concentrations of inorganic elements in soils have been identified by both DEQ and the Environmental Protection Agency (EPA).

These guidelines and thresholds were applied to the physical and chemical soils data in the Survey Area to identify salvage and reclamation constraints. Specific salvage constraints and the reclamation suitability of each soil series are discussed below.

4.1 PHYSICAL PROPERTIES

Physical soil properties that can affect suitability for salvage include texture, coarse fragment content, depth to bedrock, depth to groundwater, slope, organic matter content and erosion potential.

Soil Texture

Soil textures high in sand, silt or clay content can pose suitability problems, specifically in regards to soil handling and site stability. The soil textures identified as unsuitable for reclamation include: clays (C), silty clays (SiC), silts (Si), sands (S), and sandy clays (SC).

The following sample sites exhibited soil textures that exceeded DEQ guidelines:

- Duckcreek
    - (Site BB25) = Clay textures at depths between 18 and 50 inches

- Kimpton
    - (Site BB12) = Clay textures at depths between 14 and 42 inches
- Raynesford
    - (Site BB27) = Clay textures at depths between 6 and 14 inches

The influence of undesirable soil textures will not significantly impact the reclamation potential of soils due to the limited distribution of these soils in the Study Area. Mechanical mixing of soils during soil salvage, storage and redistribution, will result in soils with suitable textures for reclamation purposes.

Coarse Fragments

High volumes of coarse fragments can limit soil salvage and inhibit reclamation success. Therefore, unsuitable soils are described as those with coarse fragment volumes of 50 percent or greater. Thirteen soil series in the Study Area exhibited 50 percent or greater coarse fragment content by volume:

Table 4-1 – Soils with High Coarse Fragment Content

Series	Survey Site	Depth	Volume (%)
Adel	BB15	15-32	50
		32-40	60
Caseypeak	BB02	0-3	75
	BB17	0-4	50
	BB17	4-12	75
Cheadle	BB05	4-9	50
	BB05	9+	80
	BB11	19-30	50
	BB24	6-10	90
Houlihan	BB11	19-30	50
Kimpton	BB09	12-20	60
	BB09	20-30	60
	BB12	36-42+	60
	BB13	5-14	55
	BB13	14-24+	70
Medicinelodge	BB26	24-36	50
	BB26	36-42	60
Poin	BB23	4-9	50
	BB23	9-16	55
Redchief	BB16	22-30	60
Redfish	BB19	17-28+	70
Sebud	BB20	32-48	60
	BB20	48+	85
Wineglass	BB06	34-50	65
Woodhall	BB03	13-22	60
	BB03	22-36	70
	BB07	9-14	50
	BB14	11-24	75
Woodhurst	BB18	24-35	70
	BB18	35-45	75

Despite the prevalence of coarse fragments in native soils, the majority of these are gravel-sized (<3 inches in diameter). These smaller sized fragments often do not negatively impact soil salvage effectiveness or reclamation potential of a soil, except in areas of extreme density. However, Adel, Caseypeak, Poin and Woodhurst soils also contain cobbles (3-10 inches in diameter) and/or boulders (>10 inches in diameter), which can impede soil handling and salvage effectiveness.

Depth to Bedrock

Soils with salvage depths potentially limited by depth to bedrock, regolith or para-lithic material are presented below.

Table 4-2 – Soils with Shallow Bedrock

Series	Survey Site	Depth to Bedrock (inches)
Caseypeak	BB02	20
	BB08	3
	BB17	12
Cheadle	BB05	9
	BB11	30
	BB24	10
Kimpton	BB09	30
	BB12	24
Poin	BB23	16
Redchief	BB16	30
Woodhall	BB07	14

Shallow bedrock will primarily influence soil salvage in Caseypeak, Cheadle and Poin soils, which all exhibited consistently shallow bedrock at all or most survey sites for those series. Soils such as Kimpton, Redchief and Woodhall are located in areas with moderate depths to bedrock and therefore contain salvageable soil quantities.

Depth to Groundwater

Groundwater can restrict equipment operation and in some cases, soil salvage. Shallow groundwater is also an indicator of wetlands in drainage bottoms on valley floors. The soils listed below are associated with shallow groundwater:

- Clunton
    - Depth to groundwater = 10 inches
- Medicinelodge
    - Depth to groundwater = 24-32 inches
- Redfish
    - Depth to groundwater = 20 inches

Slope

Very steep slopes (over 50 percent) limit soil salvage due to safety hazards associated with equipment operations. Slopes that may pose safety hazards are associated with dissected drainages and steep ridges or rock outcrops. The soils listed below are associated with steep slopes that could inhibit soil salvage:

- Caseypeak (Map Unit: Cp-d)
    - 40-70 percent slopes
- Kimpton (Map Unit: Kp-d)
    - 40-70 percent slopes

Organic Matter

Organic matter (OM) content is considered a beneficial soil characteristic and is directly associated with fertility, thus influencing salvage depths. In the western rangelands of the United States, organic matter content levels range from 0.5 to 3.4 percent (Smith et al. 1987). The US Forest Service rates topsoil as "good" if it contains more than 1.5 percent organic matter, "fair" if it contains 0.5 to 1.5 percent organic matter, and "poor" at less than 0.5 percent. The Utah Department of Natural Resources rates topsoil as "poor or unsuitable" if it contains less than 2 percent organic matter (Smith et al. 1987).

Within sampled soils OM content was measured as high as 49.4 percent in histic epipedons and as low as 1.9 percent in weathered bedrock materials. On average, OM within the upper 12 inches of the soil was 9.7 percent and decreased with depth in the soil profile to an average of 5.1 percent in deeper horizons. Current DEQ guidelines do not list organic matter as a soil suitability criteria, although organic matter content was considered when determining the recommended salvage depths.

Erosion Potential

Estimates of soil erosion are included in NRCS soil survey data for both wind and water erosion. These erosion factors are based on characteristics such as soil texture, coarse fragment content, organic matter content, and average slope. Two commonly reported erosion potential factors are K-factors for water erosion and Wind Erodibility Groups (WEGs) for wind erosion.

The soil erodibility factor, or K-Factor, is an estimate of the susceptibility of water to detach and move soil particles and can vary from 0.02 to 0.69 (USDA, 2009). The K-Factor was developed as part of the Universal Soil Loss Equation (USLE), but can also be used to evaluate the relative erodibility of a given soil. The K-Factor value increases with higher estimates of soil erosion as a result of flowing water.

The WEG rating represents soils with similar physical and chemical properties, thus providing an estimate of susceptibility to wind erosion. The WEG of a given soil is typically calculated using factors such as soil texture, organic matter content, carbonates, coarse fragments and mineralogy. The classes range from 1 to 8, with the lower classes representing those soils that are most susceptible to wind erosion.

Table 4-3 – Wind Erodibility Groups and Soil Erodibility Factors

Soil Series	Wind Erodibility Group	Soil Erodibility Factor (K-Factor)
Adel	5	.20 - .32
Caseypeak	5	.24 - .32
Cheadle	6	.32 - .43
Clunton	5	.20 - .43
Duckcreek	6	.24 - .34
Farlin	6	.24 - .32
Houlihan	6	.28 - .37
Kimpton	6	.32 - .37
Libeg	7	.15 - .37
Medicinelodge	7	.20 - .32
Poin	6	.32 - .43
Raynesford	6	.28 - .43
Redchief	7	.24 - .28
Redfish	7	.17 - .20
Sebud	6	.20 - .28
Wineglass	6	.28 -.37
Woodhall	6	.17 - .43
Woodhurst	5	.24 - .43

Soils in the Study Area generally exhibit low to moderate susceptibility to erosion, based on the WEG and K-Factors (USDA, 2013).

4.2 CHEMICAL PROPERTIES

Chemical properties that affect soil suitability for reclamation in the Study Area include pH, electrical conductivity (EC) and concentrations of certain inorganic elements, including: arsenic (As), cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn).

pH

Soils with acidic pH values (below 5.5) or basic values (above 8.5) are not recommended for plant growth or establishment (Brady and Weil, 2008). Soils with a pH below 5.5 are susceptible to the confounding issues associated with toxic levels of some elements combined with deficiencies of other plant-essential elements.

Soils in the Survey Area generally exhibit relatively suitable pH conditions for plants (5.5 to 7.0), although these values vary between soil types and within individual soil pedons. The six sample locations that exhibited pH levels below 5.5 are presented on Table 4, below:

Table 4-4 – Soils with Low pH Values

Series	Sample Site	Depth (in)	pH (su)
Kimpton	BB09	5-12	5.4
Libeg	BB01	0-4	5.3
Medicinelodge	BB22	0-14	5.2
Poin	BB23	0-4 4-9 9-16	5.2 5.0 5.2
Redchief	BB16	5-10	5.4
Woodhall	BB03	4-13	5.2

Lower pH values observed in these soil sample sites occur within the rooting zone of the existing native plants. No adverse impacts on vegetative growth are expected from salvaged soils due to the prevalence of soil materials with neutral pH properties.

Electrical Conductivity (EC)

Salinity is caused by the concentration of soluble salts (ionic charged particles) in the soil, and is measured using electrical conductivity (EC). Elevated soil salinity can interfere with plant productivity by preventing the transfer of soil water into the plant root (Brady and Weil, 2008). Soils with EC values greater than 4 mmhos/cm are considered undesirable for topsoil, while soils with ECs greater than 8 mmhos/cm are considered undesirable for subsoils (DEQ, 1998).

No soils in the Study Area exhibit EC values that exceed DEQ guidelines for topsoil or subsoil salvage.

Inorganic Elements

Some inorganic elements naturally occur at concentrations higher than the Regional Screening Levels (RSL) established by the Environmental Protection Agency (EPA) for industrial soils in Montana (EPA 2015, DEQ 2005). Due to these elevated baseline concentrations, DEQ established a statewide study based on soil samples gathered from each county in Montana to identify background threshold values (BTV) for common inorganic elements in soils (DEQ, 2013).

Arsenic

The action threshold established by the EPA for arsenic in Montana soils is 3 mg/kg (EPA, 2015). All soil samples contained arsenic concentrations in excess of the EPA-RSL threshold, except for three horizons (8-14, 14-24 and 42-50 inches) at Sample Site BB26 (Medicinelodge series).

The DEQ-BTV for arsenic in native Montana soils is 22.5 mg/kg, which is based, in part, on two samples collected in Meagher County; samples 47-01 and 47-02 contained arsenic values of 8.1 and 9.4 mg/kg, respectively (DEQ, 2013).

The Study Area samples listed below contained arsenic concentrations in excess of DEQ-BTV:

Table 4-5 – Arsenic Concentrations Exceeding DEQ Background Threshold Value

Series	Sample Site	Depth (in)	As (mg/kg)
Adel	BB15	15-32	44
Caseypeak	BB17	4-12	27
Kimpton	BB12	0-4	26
Libeg	BB01	0-4	32
		4-11	26
		11-24	24
Woodhall	BB03	0-4	26
		13-22	26
		22-36	89
Woodhurst	BB18	0-6	51
		6-16	59
		16-24	168
		24-35	542
		35-45	516
Woodhurst	BB30	0-5	28
		5-11	26
		11-19	23

Cadmium

The EPA-RSL for cadmium (Cd) is 98 mg/kg for industrial soils (EPA 2015). None of the soils sampled in the Study Area exhibited cadmium concentrations in excess of EPA-RSL for industrial soils.

The DEQ-BTV for cadmium in native Montana soils is 0.7 mg/kg, which is based, in part, on two samples collected in Meagher County; samples 47-01 and 47-02 contained cadmium values of 0.3 and 0.2 mg/kg, respectively.

The samples listed below contained cadmium concentrations in excess of DEQ-BTV:

Table 4-6 – Cadmium Concentrations Exceeding DEQ Background Threshold Value

Series	Sample Site	Depth (in)	Cd (mg/kg)
Adel	BB15	15-32	1
Kimpton	BB12	0-4	2
		4-14	2
		14-36	2
		36-42+	4
Libeg	BB01	0-4	2
		4-11	2
Wineglass	BB21	0-4	1
Woodhall	BB03	0-4	1
Woodhurst	BB18	0-6	1
		16-24	1
		24-35	2
		35-45	2

Copper

The EPA-RSL for copper (Cu) is 4700 mg/kg in industrial soils (EPA 2015). None of the soils sampled in the Study Area exhibited copper concentrations in excess of EPA-RSL for industrial soils.

The DEQ-BTV for copper in native Montana soils is 165 mg/kg, which is based, in part, on two samples collected in Meagher County; samples 47-01 and 47-02 contained copper values of 40.9 and 36.1 mg/kg, respectively.

The samples listed below contained copper concentrations at or in excess of DEQ-BTV:

Table 4-7 – Copper Concentrations Exceeding DEQ Background Threshold Value

Series	Sample Site	Depth (in)	Cu mg/kg
Woodhurst	BB18	16-24	165
		24-35	660
		35-45	918

Lead

The EPA-RSL for lead (Pb) is 800 mg/kg for industrial soils (EPA 2015). The samples listed below contained lead concentrations in excess of the EPA-RSL for lead in industrial soils:

Table 4-8 – Lead Concentrations Exceeding EPA Regional Screening Level Thresholds

Series	Sample Site	Depth (in)	Pb (mg/kg)
Woodhurst	BB18	24-35	1680
		35-45	1300

The DEQ-BTV for lead in native Montana soils is 29.8 mg/kg, which is based, in part, on two samples collected in Meagher County; samples 47-01 and 47-02 contained lead values of 21 and 28 mg/kg, respectively.

The samples listed below contained lead concentrations in excess of DEQ-BTV:

Table 4-9 – Lead Concentrations Exceeding DEQ Background Threshold Value

Series	Sample Site	Depth (in)	Pb (mg/kg)
Adel	BB15	0-5	57
		5-15	51
		15-32	97
		32-40	58
Caseypeak	BB17	0-4	80
		4-12	91
Cheadle	BB05	0-4	31
Clunton	BB04	6-14	31
		14-24	33
		24-50	30

Table 4-9 – Lead Concentrations Exceeding DEQ Background Threshold Value

Series	Sample Site	Depth (in)	Pb (mg/kg)
Duckcreek	BB25	0-4 4-11 11-18 18-36 36+50+	40 40 44 32 45
Kimpton	BB09	0-5 20-30	34 33
Kimpton	BB12	0-4 4-14 14-36 36-42+	196 198 225 316
Libeg	BB01	0-4 4-11 11-24	202 189 172
Wineglass	BB06	34-50	30
Wineglass	BB21	0-4	32
Woodhall	BB03	0-4 4-13 13-22 22-36	55 68 59 97
Woodhall	BB14	0-6 6-11 11-24	57 57 62
Woodhall	BB29	0-7 7-14	39 107
Woodhurst	BB18	0-6 6-16 16-24 24-35 35-45	202 234 564 1680 1300
Woodhurst	BB30	0-5 5-11 11-19	144 162 139

Zinc

The EPA-RSL screening level for zinc (Zn) is 3700 mg/kg for industrial soils (EPA 2015). None of the soils sampled in the Study Areas exhibited zinc concentrations in excess of EPA screening levels.

The DEQ-BTV for zinc in native Montana soils is 118 mg/kg, which is based, in part, on two samples collected in Meagher County; samples 47-01 and 47-02 contained zinc values of 21 and 28 mg/kg, respectively.

The samples listed below contained zinc values in excess of DEQ-BTV:

Table 4-10 – Zinc Concentrations Exceeding DEQ Background Threshold Value

Series	Sample Site	Depth (in)	Zn (mg/kg)
Adel	BB15	0-5	252
		5-15	176
		15-32	140
		32-40	143
Caseypeak	BB17	0-4	144
		4-12	170
Kimpton	BB12	0-4	329
		4-14	295
		14-36	331
		36-42	1190
Libeg	BB01	0-4	856
		4-11	371
		11-24	375
Wineglass	BB21	0-4	143
		4-17	122
Woodhall	BB03	0-4	288
		4-13	555
		13-22	226
		22-36	346
Woodhall	BB29	0-7	171
Woodhurst	BB18	0-6	123
		6-16	134
		16-24	125

Multiple soils in the Study Area exhibited DEQ-BTV exceedances for arsenic, cadmium, lead and/or zinc. Woodhurst soils exhibited DEQ-BTV exceedances for copper as well as the other four inorganic elements. These exceedances in native soils, which currently support vegetation, are unlikely to substantially reduce soil suitability for reclamation. A possible exception is the high level of inorganic elements in the deeper horizons of Woodhurst soils; this was taken into consideration in the development of soil salvage depths.

4.3 SOIL SUITABILITY BY SOIL SERIES

The primary physical properties limiting soil salvage and reclamation potential are high coarse fragment content, shallow bedrock and shallow groundwater. Chemical properties limiting reclamation potential include low pH and elevated inorganic element concentrations. Each of the soil pedon descriptions were reviewed to determine the most effective salvage depth for each soil series, given soil properties and site conditions.

The salvage recommendations presented below are guidelines for salvage based on site observations and soil properties. Actual salvage depths and therefore soil volumes will be variable based on factors such as mechanical limitations of salvage equipment and site conditions such as slope and the presence of coarse fragments. Recommended salvage depths incorporate the observed range of characteristics and represent an average salvage depth for each of the soil map units in the Study Area. Actual salvage depths could vary by plus-or-minus four inches from the recommended depths. Salvage recommendations were grouped geographically to facilitate consistent soil salvage over larger areas.

Adel (Ad-b)

Salvage restrictions observed in the Adel soils include coarse fragment content of 50 percent occurring at 15 inches below the soil surface. Additionally, arsenic and cadmium levels exceeding DEQ-BTVs occur at depths of 15 to 32 inches below soil surface.

The recommended 1st lift salvage depth for Adel soils is 12 inches and a 2nd lift salvage depth of 24 inches, for a total salvage depth of 36 inches.

Caseypeak (Cp-c, Cd-d)

Caseypeak soils are rated as having poor salvage potential due to very high coarse fragment content, shallow bedrock, and steep slopes. Some samples of Caseypeak soils exceed DEQ-BTVs for arsenic at 4 to 12 inches, and for lead and zinc at 0 to 12 inches.

The recommended soil salvage depth for the Cp-c soil map unit is a single lift of 6 inches. No soil salvage is recommended for the Cp-d soil map unit.

Cheadle (Ch-b)

Cheadle soils exhibit coarse fragment content in excess of 50 percent below depths of 4 to 6 inches at two sites. The prevalence of coarse fragments and relatively shallow depth to bedrock restricts overall soil salvage depth. Exceedances of DEQ-BTVs for lead were observed in some Cheadle soils at 0 to 4 inches.

The recommended salvage depth for Cheadle soils is a single lift of 6 inches.

Clunton (Cl-a)

Clunton soils occur in valley bottoms and are associated with wetlands and shallow groundwater. There are no other physical restrictions associated with these soils. DEQ-BTV exceedances for lead were found in some Clunton soils below the upper 6 inches.

The recommended salvage depth for these soils is 12 inches for 1st lift and 24 inches for 2nd lift materials, for a total salvage of 36 inches. However, it should be noted that the upper six inches of these soils consists of accumulated organic materials that should not be included as mineral soil in calculations of salvaged soil materials.

Duckcreek (Dc-a)

Duckcreek soils did not exhibit any physical properties that exceed guidelines for reclamation suitability. Some Duckcreek soils exceed the DEQ-BTV for lead throughout the soil profile.

The recommended salvage depth for these soils is 12 inches for 1st lift and 24 inches for 2nd lift, for a total salvage depth of 36 inches.

Farlin (Fa-b)

Farlin soils exhibited clay soil textures below a depth of 18 inches, but did not exhibit any other physical or chemical properties that would limit salvage or reclamation suitability.

The recommended salvage depth for these soils is 12 inches for 1st lift and 24 inches for 2nd lift, for a total of 36 inches of salvageable material.

Houlihan (Hl-b)

Houlihan soils do not have any chemical properties that limit reclamation potential, but coarse fragment content does increase with depth.

The recommended soil salvage depth in this unit is limited to a single lift of 12 inches.

Kimpton (Kp-c, Kp-d)

Kimpton soils exhibit high coarse fragment content between 5 and 36 inches of the soil surface and pH ranging from 5.4 to 5.5 between 5 and 20 inches of depth. Additionally these soils can occur on slopes steeper than 50 percent, primarily in the Kp-d map unit. Some Kimpton soils exceed DEQ-BTVs for arsenic at 0 to 4 inches and for cadmium, lead and zinc throughout the soil profile.

The recommended soil salvage depth in the Kp-c soil map unit is a single lift of 12 inches. No soil salvage is recommended for the Kp-d map unit.

Libeg (Lb-b)

Libeg soils exhibits pH values below 5.5 at the soil surface. Some Libeg soils exceed DEQ-BTVs for cadmium at 0 to 11 inches and for arsenic, lead and zinc throughout the soil profile.

The recommended soil salvage in this unit is a single lift of 12 inches.

Medicinelodge (Ml-a, Ml-b)

Medicinelodge soils occur in valley bottoms and are associated with wetlands and shallow depths to groundwater. Coarse fragments in the form of alluvial gravels exceed DEQ criteria for salvage at a depth of 24 inches at site BB-26, but coarse fragment content is suitable for salvage at other sample sites in this unit.

The recommended salvage depth for Medicinelodge soils is 12 inches for 1st lift and 24 inches for 2nd lift, for a total of 36 inches of salvageable material.

Poin (Pn-b)

Poin soils have pH values ranging from 5.0 to 5.2 at depths of zero to 16 inches below the soil surface. Coarse fragment content increases with depth and exceeds 50 percent at a depth of 4 inches, with bedrock encountered below 16 inches.

The recommended salvage depth for soils in this unit is a single lift of 12 inches.

Raynesford (Ry-b)

Raynesford soils exhibited clay soil textures at a depth between 6 and 14 inches, but did not exhibit any other physical or chemical properties that would limit soil salvage suitability.

The recommended salvage depth for Raynesford soils is 12 inches for 1st lift and 24 inches for 2nd lift, for a total of 36 inches.

Redchief (Rc-b)

Redchief soils have pH values of 5.4 to 5.5 occurring from zero to 22 inches below soil surface. Additionally, coarse fragment content is 60 percent at depths below 22 inches.

The recommended salvage for these soils is 12 inches for 1st lift and 12 inches for 2nd lift, for a total salvage depth of 24 inches.

Redfish (Rf-a)

Redfish soils have coarse fragment contents of 70 percent at depths below 17 inches and are associated with shallow depth to groundwater.

The recommended salvage for these soils is 12 inches for 1st lift and 24 inches for 2nd lift, for a total salvage of 36 inches.

Sebud (Sb-b)

Sebud soils exhibit coarse fragment contents that exceed reclamation criteria at depths below 32 inches. However, no other physical or chemical constraints are associated with these soils.

The recommended salvage for Sebud soils is 12 inches for 1st lift and 24 inches for 2nd lift, for a total salvage of 36 inches.

Wineglass (Wg-b)

Wineglass soils exhibit coarse fragment content exceeding criteria for salvage at depths below 34 inches. Some Wineglass soils exceed DEQ-BTVs for cadmium at 0 to 4 inches and for lead and zinc at various depths throughout the soil profile.

The recommended salvage depth for Wineglass soils is 12 inches for 1st lift and 24 inches for 2nd lift, for a total salvage of 36 inches.

Woodhall (Wa-b)

On average, coarse fragment content exceeds salvage criteria at a depth of 12 inches in Woodhall soils. Additionally, pH ranges from 5.2 to 5.5 at depths of 4 to 22 inches. Some Woodhall soils exceed DEQ-BTVs for cadmium at 0 to 4 inches and for arsenic, lead and zinc throughout much of the soil profile.

The recommended salvage depth for Woodhall soils is 12 inches for 1st lift and 12 inches for 2nd lift, for a total salvage of 24 inches.

Woodhurst (Wu-b)

Woodhurst soils contain coarse fragment contents ranging from 60 to 75 percent at depths below 24 inches. However, the more limiting factor in these soils is the prevalence of arsenic, cadmium, copper,

lead and zinc concentrations exceeding DEQ-BTVs. The highest concentrations of these inorganic elements occur below 24 inches of depth.

The recommended salvage depth for Woodhurst soils is 12 inches for 1st lift and 12 inches for 2nd lift, for a total salvage of 24 inches.

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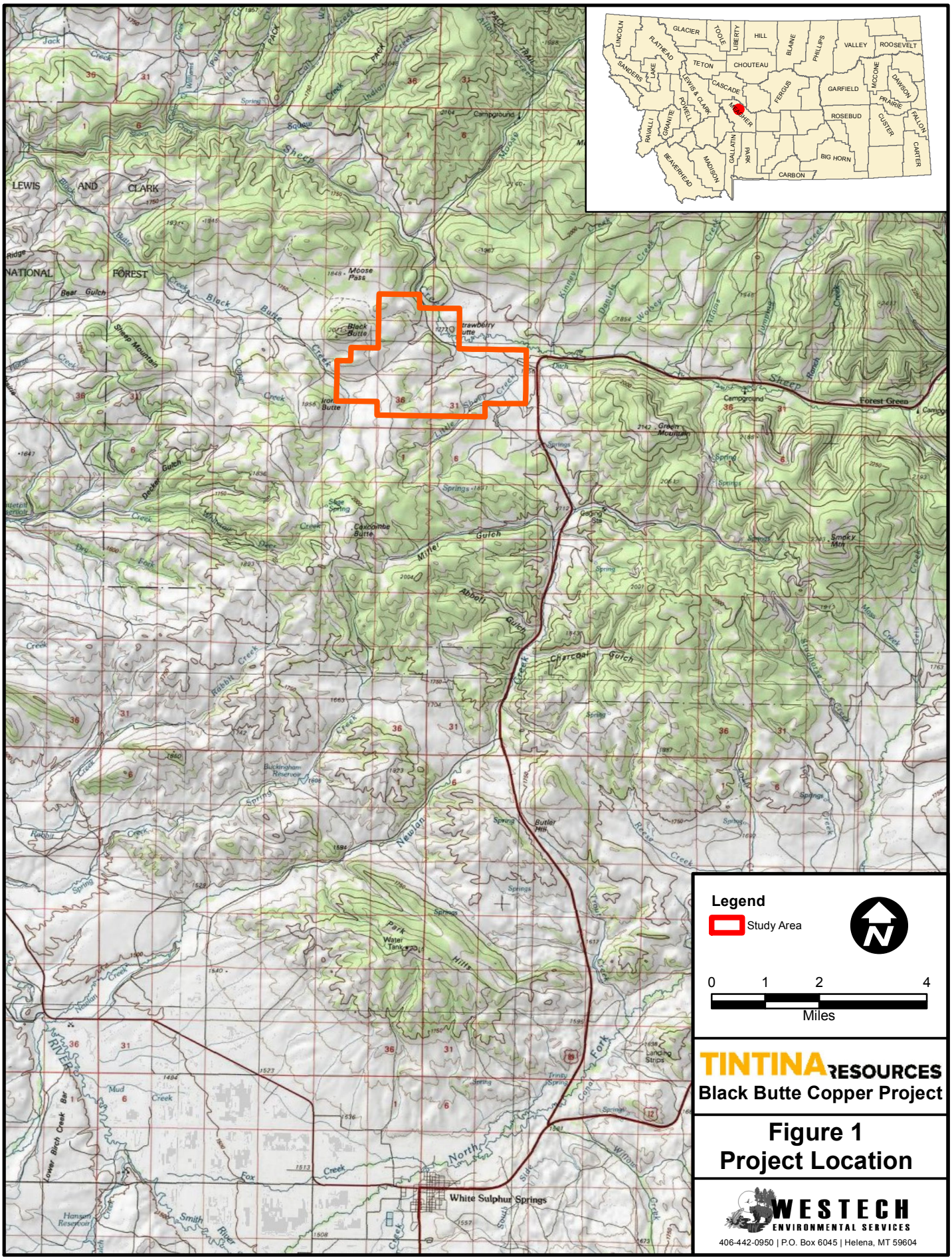


TINTINA RESOURCES

Black Butte Copper Project

Figure 1
Project Location

WESTECH ENVIRONMENTAL SERVICES
406-442-0950 | P.O. Box 6045 | Helena, MT 59604

8/31/2015 | Location.mxd | 1:150,000

Map Unit Symbol	Map Unit Name	Slope (%)	1st Lift Salvage (in)	2nd Lift Salvage (in)	Total Salvage (in)	Components and Proportions (%)	Acres in Study Area	Percent of Study Area
Ad-b	Adel loams	5-15	12	24	36	Adel 80% / Medicinelodge 10% / Caseypeak 5% / Kimpton 5%	26.9	0.8%
Ch-b	Cheadle, channery loams	5-15	6	0	6	Cheadle 80% / Wineglass 10% / Duckcreek 5% / Medicinelodge 5%	798.5	23.7%
Cl-a	Clunton, clay loams - frequently flooded	0-5	12	24	36	Clunton 90% / Wineglass 10%	26.5	0.8%
Cp-c	Caseypeak, skeletal loams	15-40	6	0	6	Caseypeak 80% / Woodhall 10% / Kimpton 10%	220.3	6.5%
Cp-d	Caseypeak, skeletal loams - steep	40-70	0	0	0	Caseypeak 90% / Woodhall 5% / Kimpton 5%	79.3	2.4%
Dc-a	Duckcreek, clay loams	0-5	12	24	36	Duckcreek 90% / Cheadle 5% / Medicinelodge 5%	138.0	4.1%
Fa-b	Farlin, clay loams	0-5	12	24	36	Farlin 90% / Medicinelodge 5% / Raynesford 5%	46.5	1.4%
Hl-b	Houlihan, sandy loams	5-15	12	0	12	Houlihan 80% / Kimpton 10% / Caseypeak 5% / Cheadle 5%	55.6	1.7%
Kp-c	Kimpton, skeletal loams	15-40	12	0	12	Kimpton 80% / Caseypeak 10% / Woodhall 10%	329.7	9.8%
Kp-d	Kimpton, skeletal loams - steep	40-70	0	0	0	Kimpton 90% / Poin 5% / Woodhall 5%	127.7	3.8%
Lb-b	Libeg, clay loams	5-15	12	0	12	Libeg 90% / Caseypeak 5% / Cheadle 5%	197.8	5.9%
Ml-a	Medicinelodge - frequently flooded	0-5	12	24	36	Medicinelodge 80% / Duckcreek 10% / Redfish 10%	256.4	7.6%
Ml-b	Medicinelodge - occasionally flooded	5-15	12	24	36	Medicinelodge 90% / Wineglass 5% / Woodhurst 5%	71.7	2.1%
Pn-b	Poin, skeletal sandy loams	5-15	12	0	12	Poin 90% / Cheadle 5% / Kimpton 5%	200.8	6.0%
Rc-b	Redchief, silty loams	5-15	12	12	24	Redchief 90% / Kimpton 5% / Woodhall 5%	86.5	2.6%
Rf-a	Redfish, occasionally flooded	0-5	12	24	36	Redfish 90% / Medicinelodge 10%	31.5	0.9%
Ry-b	Raynesford, silty clay loams	5-15	12	24	36	Raynesford 90% / Duckcreek 5% / Farlin 5%	67.5	2.0%
Se-b	Sebud, gravelly loams	5-15	12	24	36	Sebud 90% / Cheadle 10%	35.7	1.1%
Wa-b	Woodhall, skeletal loams	5-15	12	12	24	Woodhall 80% / Caseypeak 10% / Kimpton 5% / Redchief 5%	328.1	9.7%
Wg-b	Wineglass, channery clay loams	5-15	12	24	36	Wineglass 80% / Cheadle 10% / Clunton 5% / Medicinelodge 5%	166.4	4.9%
Wu-b	Woodhurst, skeletal loams	5-15	12	12	24	Woodhurst 90% / Caseypeak 5% / Kimpton 5%	27.9	0.8%
DL	Disturbed Land	Varies	0	0	0	Disturbed Land 100%	36.9	1.1%
RO	Rock Outcrop	30-90	0	0	0	Rock Outcrop 90% / Woodhall 5% / Libeg 5%	11.3	0.3%
						Total	**3367.5**	**100%**

LEGEND

- Soils Study Area
- Fence
- Soil Map Unit Boundary
- Soil Survey Site

Aerial: 2013 NAIP
Topo: 20' Generated from ⅓ second NED

Scale 1" = 600'

0 300 600 1200

Feet

TINTINA RESOURCES

Black Butte Copper Project

Baseline Soil Survey Map

WESTECH ENVIRONMENTAL SERVICES

406-442-0950 | P.O. Box 6045 | Helena, MT 59604

Appendix E
Figure 2
Sheet 1 of 1

05/24/16 | BBC16_Soils_Baseline.dwg | 1:7,200

Appendix A

Data Tables

Table A-1. Soil Map Legend

MUSYM	Map Unit Name	Slope (%)	1st Lift Salvage (in)	2nd Lift Salvage (in)	Total Salvage (in)	Components and Proportions (%)	Acres in Study Area	Percent of Study Area
Ad-b	Adel loams	5-15	12	24	36	Adel 80% / Medicinelodge 10% / Caseypeak 5% / Kimpton 5%	26.9	0.8%
Ch-b	Cheadle, channery loams	5-15	6	0	6	Cheadle 80% / Wineglass 10% / Duckcreek 5% / Medicinelodge 5%	798.5	23.7%
Cl-a	Clunton, clay loams - frequently flooded	0-5	12	24	36	Clunton 90% / Wineglass 10%	26.5	0.8%
Cp-c	Caseypeak, skeletal loams	15-40	6	0	6	Caseypeak 80% / Woodhall 10% / Kimpton 10%	220.3	6.5%
Cp-d	Caseypeak, skeletal loams - steep	40-70	0	0	0	Caseypeak 90% / Woodhall 5% / Kimpton 5%	79.3	2.4%
Dc-a	Duckcreek, clay loams	0-5	12	24	36	Duckcreek 90% / Cheadle 5% / Medicinelodge 5%	138.0	4.1%
Fa-b	Farlin, clay loams	0-5	12	24	36	Farlin 90% / Medicinelodge 5% / Raynesford 5%	46.5	1.4%
Hl-b	Houlihan, sandy loams	5-15	12	0	12	Houlihan 80% / Kimpton 10% / Caseypeak 5% / Cheadle 5%	55.6	1.7%
Kp-c	Kimpton, skeletal loams	15-40	12	0	12	Kimpton 80% / Caseypeak 10% / Woodhall 10%	329.7	9.8%
Kp-d	Kimpton, skeletal loams - steep	40-70	0	0	0	Kimpton 90% / Poin 5% / Woodhall 5%	127.7	3.8%
Lb-b	Libeg, clay loams	5-15	12	0	12	Libeg 90% / Caseypeak 5% / Cheadle 5%	197.8	5.9%
Ml-a	Medicinelodge - frequently flooded	0-5	12	24	36	Medicinelodge 80% / Duckcreek 10% / Redfish 10% /	256.4	7.6%
Ml-b	Medicinelodge - occasionally flooded	5-15	12	24	36	Medicinelodge 90% / Wineglass 5% / Woodhurst 5% /	71.7	2.1%
Pn-b	Poin, skeletal sandy loams	5-15	12	0	12	Poin 90% / Cheadle 5% / Kimpton 5%	200.8	6.0%
Rc-b	Redchief, silty loams	5-15	12	12	24	Redchief 90% / Kimpton 5% / Woodhall 5%	86.5	2.6%
Rf-a	Redfish, occasionally flooded	0-5	12	24	36	Redfish 90% / Medicinelodge 10%	31.5	0.9%
Ry-b	Raynesford, silty clay loams	5-15	12	24	36	Raynesford 90% / Duckcreek 5% / Farlin 5%	67.5	2.0%
Se-b	Sebud, gravelly loams	5-15	12	24	36	Sebud 90% / Cheadle 10%	35.7	1.1%
Wa-b	Woodhall, skeletal loams	5-15	12	12	24	Woodhall 80% / Caseypeak 10% / Kimpton 5% / Redchief 5%	328.1	9.7%
Wg-b	Wineglass, channery clay loams	5-15	12	24	36	Wineglass 80% / Cheadle 10% / Clunton 5% / Medicinelodge 5%	166.4	4.9%
Wu-b	Woodhurst, skeletal loams	5-15	12	12	24	Woodhurst 90% / Caseypeak 5% / Kimpton 5%	27.9	0.8%
DL	Disturbed Land	Varies	0	0	0	Disturbed Land 100%	36.9	1.1%
RO	Rock Outcrop	30-90	0	0	0	Rock Outcrop 90%, Woodhall 5%, Libeg 5%	11.3	0.3%
						Total	**3367.5**	**100%**

Table A-2. Soil Baseline Report -
Physical Data

Site	Map Unit	Soil Series	Slope %	Horizon	Depth (in)	Coarse Fragments (% by size class)[1]	Texture[2]	Boundary[3]	Color[4]	Structure[5]	Roots[6]	Eff[7]
BB01	Lb-b	Libeg	5-15	A	0-4	10 GRV	CL	CW	10YR 3/2	2FSBK	3VF, 3F	NE
				Bt	4-11	15 GRV	CL	CS	10YR 4/2	2MSBK	2VF, 1F	NE
				B/C	11-24	25 GRV, 5 CBL,15 BLD	CL	-	10YR 4/4	2FSBK/M	1VF, 1F	NE
BB02	Cp-d	Caseypeak	15-35	A	0-3	25 GRV, 20 CBL, 30 BLD	L	CW	10YR 3/2	1FSBK	3VF, 1F, 1M	NE
				C	3-20	-	CL	CW	10YR 4/4	M	2VF, 1F	NE
				R	20+	-	-	-	-	-	-	-
BB03	Wa-b	Woodhall	15	A	0-4	5 GRV	L	CS	10YR 2/1	1VFGR	3VF, 3F, 1M	NE
				Bt	4-13	15 GRV	CL	CS	10YR 2/2	2FSBK	2VF, 1F	NE
				BC	13-22	60 GRV	CL	CS	7.5YR 4/4	1VFSBK/M	1VF, 1F	NE
				C	22-36	70 GRV	L	-	7.5YR 4/4	M	1VF, 1F	NE
BB04	Cl-a	Clunton	0-5	Oi	0-6	0	L	CW	10YR 2/2	GR	3VF, 3F, 2M	NE
				A/B	6-14	10 GRV	CL	CW	10YR 4/1	3MSBK	2VF, 2F, 1M	NE
				C1	14-24	30 GRV	SiCL	CW	5Y 5/1	M	1VF, 1M	NE
				C2	24-50	10 GRV	CL	-	5Y 5/1	M	1F, 1M	NE
BB05	Ch-b	Cheadle	5-15	A	0-4	15 CHN	L	CS	10YR 2/1	1FGR	3VF, 3F	NE
				Bk	4-9	50 CHN	CL	CS	10YR 3/2	2FSBK	2VF, 2F	SL
				Cr	9+	80 CHN	-	-	10YR 3/2	M	1VF, 1F	NE
BB06	Wg-b	Wineglass	5-15	A	0-5	5 CHN	L	CS	10YR 2/1	1FGR	3VF, 3F, 1M	NE
				B1	5-14	20 CHN	CL	CS	10YR 2/1	2MSBK	2VF, 2F, 1M	SL
				B2	14-34	25 CHN	CL	CS	10YR 2/2	2MSBK	1VF, 1F	SL
				C	34-50	65 CHN	CL	-	2.5Y 4/3	M	1VF, 1F	SL
BB07	Wa-b	Woodhall	5-15	A	0-4	10 GR	L	CS	10YR 2/1	1FGR	3VF, 3F, 1M	NE
				Bt	4-9	10 GRV, 25 CBL	L	CW	10YR 3/1	2MSBK	2VF, 2F	NE
				Bt2	9-14	40 GRV, 10 CBL	CL	CW	10YR 4/2	2FSBK	2VF, 2F	NE
				R	14+	-	-	-	-	-	-	-

Table A-2. Soil Baseline Report -
Physical Data

Site	Map Unit	Soil Series	Slope %	Horizon	Depth (in)	Coarse Fragments (% by size class)[1]	Texture[2]	Boundary[3]	Color[4]	Structure[5]	Roots[6]	Eff[7]
BB08	Cp-c	Caseypeak	30-50	A	0-3	40 CHN	L	CW	10YR 3/2	1FGR	3VF, 3F, 2M, 2C	NE
				C/Cr	3+	20 CHN, 60 FLG	L	-	10YR 4/4	1FSG/M	3VF, 3F, 2M, 2C	SE
BB09	Kp-c	Kimpton	15-30	A	0-5	40 CHN	L	CS	10YR 2/2	2FGR	3VF, 3F, 1M	NE
				Bt	5-12	40 GRV	L	CW	10YR 4/2	2FSBK	2VF, 2F, 1M	NE
				Bt2	12-20	60 GRV	CL	CW	10YR 5/2	3FSBK	2F, 1M	NE
				C	20-30	60 GRV	CL	-	10YR 4/3	M	1F	VE
BB10	Hl-b	Houlihan	5-15	A1	0-6	5 GRV	SL	CS	10YR 2/2	1MGR	3VF, 3F	NE
				A2	6-11	15 GRV	SL	CW	10YR 2/2	2MPR	2VF, 2F	NE
				B2	11-20+	40 GRV	SL	-	10YR 3/3	2MSBK	1VF, 1F	NE
BB11	Ch-b	Cheadle	5-15	A	0-6	15 GRV	L	CS	10YR 2/2	2FGR	3VF, 3F, 2M	NE
				Btk	6-19	15 GRV, 15 CBL	L	CS	10YR 3/2	3MABK	2VF, 2F, 1M	VSL
				Btk2	19-30	40 GRV, 10 CBL	CL	-	10 YR 4/3	3MABK	1VF, 1F	VSL
BB12	Kp-d	Kimpton	5-15	A	0-4	10 GRV	CL	CW	5YR 4/4	2FGR	3VF, 3F, 2M, 1C	NE
				Bt	4-14	15 GRV, 5 CBL	CL	CW	2.5YR 3/4	3MABK	2VF, 2F, 1M, 1C	NE
				B/C	14-36	15 GRV, 10 CBL	C	CW	2.5YR 3/6	2MABK/M	1F, 1M, 1C	NE
				C	36-42+	45 GRV, 15 CBL	C	-	2.5YR 4/6	M	1F, 1M	NE
BB13	Kp-d	Kimpton	15-40	A	0-5	20 GRV	L	CS	5YR 4/3	2FSBK	3VF,2F, 1M	NE
				Btk	5-14	40 GRV, 15 CBL	L	CW	7.5YR 4/4	2MASBK	2VF, 1F, 1M	NE/SL
				B/C	14-24+	50 GRV, 20 CB	CL	-	10YR 5/6	1FSBK/M	1VF, 1F	NE

Table A-2. Soil Baseline Report -
Physical Data

Site	Map Unit	Soil Series	Slope %	Horizon	Depth (in)	Coarse Fragments (% by size class)[1]	Texture[2]	Boundary[3]	Color[4]	Structure[5]	Roots[6]	Eff[7]
BB14	Wa-b	Woodhall	10-25	A	0-6	5 GRV, 5 CBL	CL	CW	10YR 2/1	1FSBK	3VF, 3F, 1M, 1C	NE
				Bt	6-11	15 CHN, 10 FL	CL	CW	10RY 2/2	3FSBK	3VF, 3F, 1M, 1C	SL
				C	11-24	30 GRV, 30 CHN, 15 FL	CL	-	10YR 4/4	M	1VF, 1F, 1M	NE
BB15	Ad-b	Adel	2-5	A1	0-5	15 GRV	L	CS	10YR 3/2	1FABK	3VF, 3F	NE
				A2	5-15	35 GRV, 5 CBL	L	CS	5YR 2.5/1	2MSBK	2VF, 1F	NE
				A3	15-32	20 GRV, 30 CBL	L	CW	5YR 2.5/2	2MSBK	1VF, 1F	NE
				Bk	32-40+	20 GRV, 40 CBL	L	-	7.5YR 4/3	1MSBK	1VF, 1F	VE
BB16	Rc-b	Redchief	3-10	A	0-5	5 GRV	SiL	CS	10YR 2/1	1FGR	3VF, 3F, 1M	NE
				Bt1	5-10	10 GRV	SiL	CS	5YR 2.5/1	3MSBK	2VF, 3F, 1M	NE
				Bt2	10-22	25 GRV, 5 CBL	SiCL	CS	7.5YR 2.5/1	3FABK	1VF, 2F, 1M	NE
				Bt3	22-30	45 GRV, 15 CBL	SiCL	-	10YR 4/3	3MABK	1F, 1M	NE
BB17	Cp-c	Caseypeak	10-25	A	0-4	20 GRV, 30 CBL	CL	CW	10YR 3/3	2FGR	3VF, 3F, 2M, 2C	SL
				C	4-12	25 GRV, 50 CBL	SiCL	CW	10YR 4/4	M	3VF, 3F, 2M ,1C	ST/VE
				Cr	12+	-	-	-	-	-	-	-
BB18	Wu-b	Woodhurst	5-15	A	0-6	15 GRV, 5 CBL, 5 STN, 10 BLDR	SiL	CS	10YR 3/1	2FSBK	3VF, 3F, 2M	NE
				Bt1	6-16	15 GRV, 15 CBL, 5 STN	CL	GW	10YR 3/2	3MABK	3VF, 3F, 1M	NE
				Bt2	16-24	15 GRV, 15 CBL, 5 STN	CL	GW	5YR 3/4	3MABK	1VF, 2F, 1M	NE
				C1	24-35	20 GRV, 20CBL, 10 STN, 10 BLDR	L	CS	2.5YR 3/6	M	1F	NE
				C2	35-45	20 GRV, 30 CBL, 15 STN, 10 BLDR	L	-	5YR 5/6	SG	1F	NE

Table A-2. Soil Baseline Report -
Physical Data

Site	Map Unit	Soil Series	Slope %	Horizon	Depth (in)	Coarse Fragments (% by size class)[1]	Texture[2]	Boundary[3]	Color[4]	Structure[5]	Roots[6]	Eff[7]
BB19	Rf-a	Redfish	0-3	A1	0-4	5 GRV	CL	CS	10YR 3/1	3FABK	3VF, 3F	NE
				A2	4-10	10 GRV	CL	CS	10RYR 3/2	2MABK/M	3VF, 3F	NE
				Bk	10-17	15 GRV	CL	CS	10YR 2/2	2MABK/M	1VF, 1F	SL
				C	17-28+	50 GRV, 20 CB	CL	-	2.5Y 3/1	M	1VF	VE
BB20	Sb-b	Sebud	5-15	A	0-9	30 GRV	SCL	CS	10YR 2/2	1FGR	3VF, 3F, 2M, 2C	NE
				Bw1	9-19	20 GRV	SiL	CS	10YR 4/2	1CABK/3FGR	2VF, 2F, 2M	NE
				Bw2	19-32	40 GRV	SiL	CS	10YR 3/3	1CABK/3FGR	1VF, 1F, 1M	NE
				C1	32-48	60 GRV	L	CS	10YR 5/6	SG	1VF, 1F	ST
				C2	48+	60 GRV, 25 CBL	-	-	-	SG	1VF, 1F	VE
BB21	Wg-b	Wineglass	3-10	A	0-4	15 CHN	L	CS	10YR 2/2	2FGR	3VF, 3F, 1M	NE
				Bt	4-17	20 CHN	CL	CS	10 YR 3/2	3MABK	2VF, 2F, 1M	NE
				Btk	17-30	25 CHN	CL	CW	10 YR 3/3	3MABK	1F	SE
				C	30-50	40 CHN	SiL	-	-	SG	1F	VE
BB22	Ml-b	Medicinelodge	1-5	Oe/A	0-14	0	SiL	CS	10YR 2/1	1FGR	3VF, 3F, 2M, 2C	NE
				Bg1	14-32	0	L	CS	10YR 2/2	2MSBK	2F, 1M	NE
				Btg2	32-48	0	SiCL	-	GLEY	M	1F	NE
BB23	Pn-b	Poin	0-10	Oi	1-0	-	-	CS	-	-	-	-
				A	0-4	15 GRV, 15 CBL	SL	CW	10YR 3/3	2CSBK	3VF, 3F, 2M	NE
				Bw	4-9	15 GRV, 15 CBL, 15 ST, 5 BLDR	SL	CW	10YR 4/2	1MABK	2VF, 2F, 1M	NE
				C	9-16	10 GRV, 20 CBL, 20 ST, 5 BLDR	SL	-	10YR 4/4	M	1VF, 1F	NE
BB24	Ch-b	Cheadle	5-15	A	0-6	20 CHN	CL	CS	10YR 3/1	1FSBK	3VF, 3F, 2M, 2C	NE
				C	6-10	80 CHN, 10 FLG	CL	CS	10YR 3/2	SG	2VF,2F, 1M, 1C	VE
				Cr	10+	-	-	-	-	-	1VF, 1F	-

Table A-2. Soil Baseline Report -
Physical Data

Site	Map Unit	Soil Series	Slope %	Horizon	Depth (in)	Coarse Fragments (% by size class)[1]	Texture[2]	Boundary[3]	Color[4]	Structure[5]	Roots[6]	Eff[7]
BB25	Dc-a	Duckcreek	3-8	A1	0-4	15 GVR	CL	CS	10YR 2/1	2MSBK	3VF, 3F, 1M, 1C	NE
				A2	4-11	10 GRV	C	CW	10YR 3/1	2MPR, 3MABK	2VF, 2F, 1M	NE
				B/C	11-18	20 GRV, 5 CBL	CL	CS	10YR 4/3	2FGR/M	1VF, 1F, 1M	SL
				C1	18-36	5 GRV	C	CS	10YR 7/2	M	1VF, 1F, 1M	ST
				C2	36-50+	10 GRV	C	-	10YR 5/3	M	1VF, 1F, 1M	ST
BB26	Ml-a	Medicinelodge	0-3	A	0-8	0	CL	CW	10YR 2/1	1FSBK	3VF, 3F, 2M, 1C	NE
				Bt	8-14	0	SiC	CW	10YR 2/1	3FSBK	1VF, 2F, 1M, 1C	NE
				Bg	14-24	20 GRV	CL	CW	5Y 6/1	3FSBK/M	1F, 1M	NE
				Cg1	24-36	50 GRV	CL	CW	10YR 5/3	M	1F, 1M	NE
				Cg2	36-42	60 GRV	CL	CW	5YR 5/6	M	1F, 1M	NE
				Cg3	42-50	40 GRV	CL	-	GLEY1 4/N	M	1F, 1M	NE
BB27	Ry-b	Raynesford	5-20	A	0-6	10 GRV, 10 CBL, 5 ST	CL	CS	10YR 3/3	2MSBK	2VF, 2F, 1C	ST
				Btk	6-14	5 GRV	C	CW	10YR 5/4	1MPR/2MABK	2VF, 2F, 1C	VE
				Bk	14-36	5GRV	SiCL	CW	10YR 5/3	2MABK/M	1VF, 1F, 1C	VE
				C1	36-50	5GRV	SiL	CW	10YR 4/4	M	1VF, 1F	VE
				C2	50-65	5GRV	SiL	-	10YR 6/3	M	1VF, 1F	VE
BB28	Fa-a	Farlin	3-8	A	0-5	10 GRV	CL	CS	10YR 2/2	2MABK	3VF, 3F, 1M	ST
				Bk	7-18	10 GRV	SiCL	CS	10YR 2/2	1MPR/2MABK	1VF, 1F, 1M	VE
				C	18-30	20 GRV	SiCL	-	10YR 3/2	M	1F, 1M	VE
BB29	Wa-b	Woodhall	5-20	A	0-7	10 GRV, 10 CBL	SiCL	CW	10YR 2/1	2MSBK	MF CM	
				Bt	7-14	10 CBL, 5 BLD	C	CS	10YR 2/1	2M Pr	CF CM	
				Btk	14-30	10 BLD	C	CS	10YR 4/4	2M Pr	FF	ST
				Cr	30-48	10 BLD	C		10YR 4/6	M	FF	VE

Table A-2. Soil Baseline Report -
Physical Data

Site	Map Unit	Soil Series	Slope %	Horizon	Depth (in)	Coarse Fragments (% by size class)[1]	Texture[2]	Boundary[3]	Color[4]	Structure[5]	Roots[6]	Eff[7]
BB30	Wu-b	Woodhurst	5-20	A	0-5	10 GRV	SiCL	CS	10YR 2/2	2MSBK	MF FM	
				Bt	5-11	10 GRV	SiCL	CS	10YR 3/2	3MABK	CF CM	
				C	11-19	20 GRV, 10 CBL, 5 BLD	SiCL		10YR 3/3	M	CF	

Footnotes:

Properties exceed MDEQ criteria for salvage

[1]Coarse Fragments: GRV = Gravel, CBL = Cobbles, ST = Stones, BLDR = Boulders, CHN = Channers, FLG = Flagstones

[2]Texture: SiC = silty clay, S = sand, SL = sandy loam,

[3]Boundary: A = abrupt, C = clear, G = gradual, D = diffuse; S = smooth, W = wavy, I = irregular, B = broken.

[4]Color: Munsell color notations.

[5]Structure: Grade: 1 = weak, 2 = moderate, 3 = strong.
Size: VF = very fine, F = fine, M = medium, C = coarse, VC = very coarse.
MA = massive

[6]Roots: Abundance: 1 = few, 2 = common, 3 = many.
Size: VF = very fine, F = fine, M = medium, C = coarse.

[7]Effervescence: NE=non effervescent VS=very slightly effervescent SL=slightly effervescent ST=strongly effervescent VE=violently effervescent

Table A-3. Soils Baseline Report -
Chemical Data

Site	Soil Series	Horizon	Depth (in)	pH[1] (std units)	Cond[2] (mmhos/cm2)	OM[3] (%)	As[4] (mg/kg)	Cd[5] (mg/kg)	Cu[6] (mg/kg)	Pb[7] (mg/kg)	Zn[8] (mg/kg)
BB01	Libeg	A	0-4	5.3	0.2	12.6	32	2	19	202	856
		Bt	4-11	5.8	0.3	8.1	26	2	23	189	371
		B/C	11-24	6.4	<0.1	4.8	24	<1	24	172	375
BB02	Caseypeak (not sampled)	A	0-3	-	-	-	-	-	-	-	-
		C	3-20	-	-	-	-	-	-	-	-
		R	20+	-	-	-	-	-	-	-	-
BB03	Woodhall	A	0-4	5.6	0.3	19.3	26	1	21	55	288
		Bt	4-13	5.2	0.1	8.2	20	<1	19	68	555
		BC	13-22	5.5	0.1	3.3	26	<1	21	59	226
		C	22-36	5.6	0.4	2.9	89	<1	32	97	346
BB04	Clunton	Oi	0-6	6.8	0.5	49.4	5	<1	12	14	66
		A/B	6-14	7.2	0.2	3.0	5	<1	11	31	87
		C1	14-24	7.2	0.2	4.1	3	<1	10	33	73
		C2	24-50	7.6	0.8	2.4	3	<1	7	30	55
BB05	Cheadle	A	0-4	5.5		9.7	10	<1	19	31	85
		Bk	4-9	6.6	0.6	7.2	9	<1	18	23	59
		Cr		-	-	-	-	-	-	-	-
BB06	Wineglass	A	0-5	5.7	0.2	9.9	8	<1	19	28	107
		B1	5-14	5.6	0.1	6.7	7	<1	20	26	96
		Bt	14-34	5.7	0.2	5.0	7	<1	18	22	86
		C	34-50	6.0	3.1	2.8	8	<1	14	30	67
BB07	Woodhall (not sampled)	A	0-4	-	-	-	-	-	-	-	-
		Bt	4-9	-	-	-	-	-	-	-	-
		Bt2	9-14	-	-	-	-	-	-	-	-
		R	14+	-	-	-	-	-	-	-	-
BB08	Caseypeak (not sampled)	A	0-3	-	-	-	-	-	-	-	-
		C/Cr	3+	-	-	-	-	-	-	-	-
BB09	Kimpton	A	0-5	6.1	0.4	18.3	13	<1	19	34	79
		Bt	5-12	5.4	0.3	3.0	9	<1	19	23	64
		Bt2	12-20	5.5	0.2	3.3	9	<1	22	28	73
		C	20-30	6.7	0.4	3.2	10	<1	24	33	79
BB10	Houlihan	A1	0-6	5.7	0.2	9.0	9	<1	16	16	62
		A2	6-11	5.8	0.1	4.1	5	<1	13	19	55
		B2	11-20+	6.1	0.2	3.3	5	<1	11	13	46
BB11	Cheadle (not sampled)	A	0-6	-	-	-	-	-	-	-	-
		Btk	6-19	-	-	-	-	-	-	-	-
		Btk2	19-30	-	-	-	-	-	-	-	-
BB12	Kimpton	A	0-4	6.1	0.3	4.7	26	2	16	196	329
		Bt	4-14	5.9	0.2	4.0	21	2	19	198	295
		B/C	14-36	6.1	0.4	3.4	21	2	22	225	331
		C	36-42+	7.0	0.4	2.9	18	4	58	316	1190
BB13	Kimpton (not sampled)	A	0-5	-	-	-	-	-	-	-	-
		Btk	5-14	-	-	-	-	-	-	-	-
		B/C	14-24+	-	-	-	-	-	-	-	-
BB14	Woodhall	A	0-6	5.6	0.1	11.5	17	<1	47	57	92
		Bt	6-11	5.8	0.3	5.7	18	<1	39	57	98
		C	11-24	7.6	0.5	4.0	21	<1	61	62	60
BB15	Adel	A1	0-5	6.5	0.4	8.8	19	<1	28	57	252
		A2	5-15	6.8	0.5	6.7	18	<1	29	51	176
		A3	15-32	7.7	0.4	5.7	44	1	44	97	140
		Bk	32-40+	7.9	0.5	3.9	20	<1	28	58	143
BB16	Redchief	A	0-5	5.5	0.2	21.5	16	<1	24	26	98
		Bt1	5-10	5.4	0.2	11.5	7	<1	22	18	86
		Bt2	10-22	5.5	0.1	6.0	7	<1	19	16	68
		Bt3	22-30	5.6	0.2	4.0	7	<1	16	22	60
BB17	Caseypeak	A	0-4	7.1	0.9	6.1	21	<1	18	80	144
		C	4-12	7.5	0.7	4.6	27	<1	37	91	170
		Cr	12+	-	-	-	-	-	-	-	-
BB18	Woodhurst	A	0-6	7.1	0.6	9.5	51	1	75	202	123
		Bt1	6-16	6.2	0.2	5.7	59	<1	85	234	134
		Bt2	16-24	6.0	<0.1	4.3	168	1	165	564	125
		C1	24-35	5.8	<0.1	3.7	542	2	660	1680	28
		C2	35-45	6.2	0.2	3.8	516	2	918	1300	27

Table A-3. Soils Baseline Report -
Chemical Data

Site	Soil Series	Horizon	Depth (in)	pH[1] (std units)	Cond[2] (mmhos/cm2)	OM[3] (%)	As[4] (mg/kg)	Cd[5] (mg/kg)	Cu[6] (mg/kg)	Pb[7] (mg/kg)	Zn[8] (mg/kg)
BB19	Redfish	A1	0-4	6.9	0.7	15.1	7	<1	17	18	58
		A2	4-10	7.5	0.5	8.4	4	<1	12	10	45
		Bk	10-17	7.6	0.4	6.6	4	<1	15	12	49
		C	17-28+	7.9	0.5	3.5	3	<1	12	10	44
BB20	Sebud	A	0-9	6.7	0.6	5.6	9	<1	25	12	50
		Bw1	9-19	6.8	0.2	3.6	7	<1	26	12	49
		Bw2	19-32	6.6	0.2	2.5	7	<1	22	9	35
		C1	32-48	7.8	0.3	1.9	7	<1	25	11	44
		C2	48+	-	-	-	-	-	-	-	-
BB21	Wineglass	A	0-4	5.9	0.4	12.6	18	1	25	32	143
		Bt	4-17	6.1	0.2	4.9	13	<1	23	28	122
		Btk	17-30	6.0	0.3	3.4	11	<1	19	27	100
		C	30-50	7.0	0.6	2.0	17	<1	23	29	107
BB22	Medicinelodge	Oe/A	0-14	5.2	1.9	32.9	7	<1	10	10	35
		Btg1	14-32	5.5	1.3	14.9	5	<1	15	16	44
		Btg2	32-48	6.1	0.4	7.1	3	<1	13	23	55
BB23	Poin	Oi	1-0	-	-	-	-	-	-	-	-
		A	0-4	5.2	0.2	2.6	6	<1	12	14	50
		Bw	4-9	5.0	0.3	3.0	4	<1	8	12	45
		C	9-16	5.2	0.2	2.4	4	<1	8	13	46
BB24	Cheadle	A	0-6	6.4	0.7	8.5	15	<1	21	22	83
		C	6-10	6.8	0.9	6.9	17	<1	22	18	62
		Cr		-	-	-	-	-	-	-	-
BB25	Duckcreek	A1	0-4	6.0	0.4	13.3	9	<1	25	40	80
		A2	4-11	5.9	0.3	8.4	9	<1	25	40	73
		B/C	11-18	6.9	0.7	4.5	15	<1	23	44	64
		C1	18-36	7.9	0.3	4.9	6	<1	18	32	48
		C2	36-50+	7.9	0.3	5.4	3	<1	27	45	55
BB26	Medicinelodge	A	0-8	7.0	0.8	21.4	3	<1	13	12	59
		Bt	8-14	7.2	0.4	10.6	2	<1	17	16	77
		Btg	14-24	7.5	0.2	3.3	2	<1	11	18	52
		Cg1	24-36	7.6	0.2	2.3	7	<1	13	17	55
		Cg2	36-42	7.6	0.2	2.2	11	<1	16	17	56
		Cg3	42-50	7.6	0.4	2.8	2	<1	15	24	53
BB27	Raynesford	A	0-6	7.5	0.6	9.8	10	<1	26	19	60
		Btk	6-14	7.7	0.4	6.4	4	<1	17	18	48
		Bk	14-36	7.8	0.3	5.2	3	<1	17	17	54
		C1	36-50	7.9	0.3	5.8	3	<1	18	19	56
		C2	50-65	8.0	0.3	7.4	4	<1	13	17	38
BB28	Farlin	A	0-5	7.5	0.7	9.7	9	<1	19	15	66
		Btk	7-18	7.6	0.5	7.7	8	<1	17	15	66
		C	18-30	7.8	0.4	5.3	7	<1	17	12	57
BB29	Woodhall	A	0-7	5.5	0.4	11.7	12	<1	20	39	171
		Bt	7-14	6.9	0.5	6.0	12	<1	18	107	117
		Btk	14-30	7.4	0.4	5.1	8	<1	24	18	65
		Cr	30-48	7.8	0.3	4.5	5	<1	19	22	76
BB30	Woodhurst	A	0-5	5.6	0.4	10.8	28	<1	38	144	90
		Bt	5-11	5.5	0.3	7.3	26	<1	34	162	73
		C	11-19	5.7	0.3	8.1	23	<1	31	139	75

Footnotes

Properties exceed MDEQ salvage guidelines for suitable pH (MDEQ 1998).
Properties exceed MDEQ - Background Threshold Value (MDEQ 2013).

[1] pH - Saturated Paste Method (standard units)
[2] Conductivity - Saturated Paste Method
[3] Organic Matter Percent - Loss on Ignition Method
[4] Total Arsenic (milligrams per kilogram) BTV = 22.5 mg/kg
[5] Total Cadmium (milligrams per kilogram) BTV = 0.7 mg/kg
[6] Total Copper (milligrams per kilogram) BTV = 165 mg/kg
[7] Total Lead (milligrams per kilogram) BTV = 29.8 mg/kg
[8] Total Zinc (milligrams per kilogram) BTV = 118 mg/kg

Appendix B

Soil Survey Site Photos

Soil Pedon ID: BB-01
Soil Series: Libeg

Soil Pedon ID: BB-02
Soil Series: Caseypeak

Soil Pedon ID: BB-03
Soil Series: Woodhall

Soil Pedon ID: BB-04
Soil Series: Clunton

Soil Pedon ID: BB-05
Soil Series: Cheadle

Soil Pedon ID: BB-06
Soil Series: Wineglass

Soil Pedon ID: BB-07
Soil Series: Woodhall

Soil Pedon ID: BB-08
Soil Series: Caseypeak

Soil Pedon ID: BB-09
Soil Series: Kimpton

Soil Pedon ID: BB-10
Soil Series: Houlihan

Soil Pedon ID: BB-11
Soil Series: Cheadle

Soil Pedon ID: BB-12
Soil Series: Kimpton

Soil Pedon ID: BB-13
Soil Series: Kimpton

Soil Pedon ID: BB-14
Soil Series: Woodhall

Soil Pedon ID: BB-15
Soil Series: Adel

Soil Pedon ID: BB-16
Soil Series: Redchief

Soil Pedon ID: BB-17
Soil Series: Caseypeak

Soil Pedon ID: BB-18
Soil Series: Woodhurst

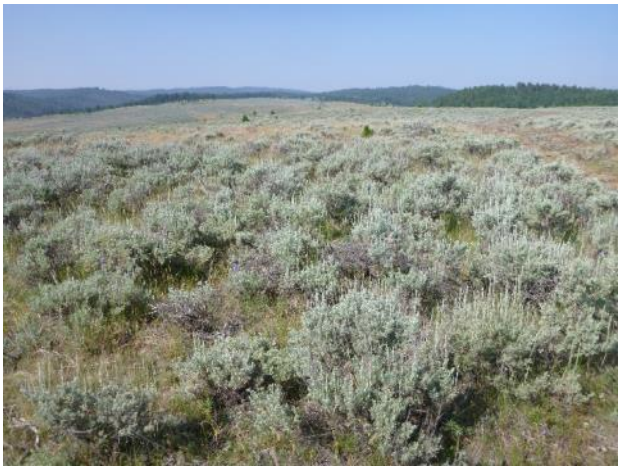
Soil Pedon ID: BB-19
Soil Series: Redfish

Soil Pedon ID: BB-20
Soil Series: Sebud

Soil Pedon ID: BB-21
Soil Series: Wineglass

Soil Pedon ID: BB-22
Soil Series: Medicinelodge

Soil Pedon ID: BB-23
Soil Series: Poin



Soil Pedon ID: BB-24
Soil Series: Cheadle

Soil Pedon ID: BB-25
Soil Series: Duckcreek

Soil Pedon ID: BB-26
Soil Series: Medicinelodge

Soil Pedon ID: BB-27
Soil Series: Raynesford

Soil Pedon ID: BB-28
Soil Series: Farlin

Soil Pedon ID: BB-29
Soil Series: Woodhall

Soil Pedon ID: BB-30
Soil Series: Woodhurst

Appendix C

NRCS Soil Series Descriptions

LOCATION ADEL MT+CO ID NM UT WY

Established Series
Rev. DES-CBR-RJS
04/2015

ADEL SERIES

The Adel series consists of very deep, well drained soils that formed in alluvium, colluvium or slide deposits. These soils are on alluvial fans, fan remnants, mountain slopes, hills, landslides, stream terraces, drainageways and swales. Slopes are 0 to 65 percent. Mean annual precipitation is about 25 inches, and mean annual temperature is about 40 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive Pachic Haplocryolls

TYPICAL PEDON: Adel loam, grassland (colors are for dry soil unless otherwise noted).

A1--0 to 13 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; moderate medium and fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; many very interstitial pores; many worm casts; slightly acid (pH 6.1); gradual wavy boundary.

A2--13 to 31 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and very fine roots; many very fine and fine pores; many worm casts; slightly acid (pH 6.1); diffuse wavy boundary.

A3--31 to 38 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure parting to moderate fine and very fine subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine and very fine roots; many fine and very fine pores; neutral (pH 7.0); gradual wavy boundary. (Combined thickness of A horizons is 6 to 50 inches)

Bw--38 to 60 inches: brown (10YR 5/3) channery loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure parting to moderate very fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; many very fine pores; 20 percent angular gravel, 5 percent angular cobbles; neutral (pH 7.0).

TYPE LOCATION: Fergus County, Montana; 1,050 feet west and 450 feet south of the NE corner of sec. 9, T. 13 N., R. 18 E.

RANGE IN CHARACTERISTICS:
Soil temperature - 35 to 46 degrees F.
Soil temperature, summer - 52 to 59 degrees F.
Moisture control section - between 4 and 12 inches.
Mollic epipedon thickness - 16 to 60 inches.

A1 horizon
Hue: 2.5Y or 10YR; dry or moist
Value: 2 to 4, or 5 dry; 2 or 3 moist
Chroma: 1 or 2; dry or moist
Texture: loam, silt loam, clay loam, silty clay loam
Clay content: 15 to 35 percent
Rock fragments: 0 to 35 percent--0 to 30 percent gravel, 0 to 5 percent stones and cobbles
Reaction: pH 6.1 to 7.3

A2 horizon
Hue: 2.5Y or 10YR; dry or moist
Value: 3 to 5 dry; 2 or 3 moist
Chroma: 1 to 3; dry or moist
Texture: loam, silt loam or clay loam
Clay content: 18 to 30 percent
Rock fragments: 0 to 35 percent--0 to 30 percent gravel, 0 to 5 percent stones and cobbles
Reaction: pH 6.1 to 7.8

A3 horizon
Hue: 2.5Y or 10YR; dry or moist
Value: 3 to 5 dry; 2 to 4 moist
Chroma: 1 to 3; dry or moist
Texture: loam, silt loam or clay loam
Clay content: 18 to 30 percent
Rock fragments: 0 to 35 percent--0 to 30 percent gravel, 0 to 5 percent stones and cobbles
Reaction: pH 6.1 to 7.8

Bw horizon
Hue: 2.5Y or 10YR; dry or moist
Value: 4 to 7 dry; 2 to 5 moist
Chroma: 1 to 4; dry or moist
Texture: loam, clay loam, silt loam, or silty clay loam
Clay content: 18 to 35 percent
Rock fragments: 0 to 35 percent--0 to 30 percent gravel, 0 to 10 percent stones and cobbles
Reaction: pH 6.1 to 7.8

Some pedons have a BC or C horizon that has a dry value of 4 to 6 and a moist value of 3 to 5 and hues of 2.5Y or 10YR. Textures are similar to the Bw horizon.

COMPETING SERIES:
Argee (NV) - is moderately deep to paralithic contact
Bullbasin (CO) - is deep to lithic contact
Duff (NV) - is deep to lithic contact
Hackwood (NV) - have a lithologic discontinuity
Houlihan (MT) - have an ustic moisture regime
Lamphier (CO) - have hues redder than 10YR
Leavittville (WY) - have secondary calcium carbonate accumulation
Lespate (CO) - is moderately deep to lithic contact
Ohbejoyful (CO) - contains rock fragments consisting of andesite, rhyolite, breccia or tuff

Osmund (WY) - have secondary calcium carbonate accumulation
Pavohroo (ID) - have a cambic horizon
Rhone (CO) - is deep to lithic contact
Secondset (CO) - is moderately deep to lithic contact
Strickland (NV) - is moderately deep to lithic contact
Taterheap (CO) - have a lithologic discontinuity
Winevada (CO) - is moderately deep to lithic contact

GEOGRAPHIC SETTING:
Landform - alluvial fans, fan remnants, mountain slopes, hills, landslides, stream terraces, drainageways and swales
Elevation - 4,500 to 8,500 feet in Montana; 7,800 to 11,300 feet in Colorado
Slope - 0 to 65 percent
Parent material - alluvium, colluvium or slide deposits
Climate - cold with long, cold winters; moist, cool springs; short, cool summers
Mean annual precipitation - 14 to 30 inches in Montana; 15 to 35 inches in Colorado; 20 to 30 inches in Wyoming
Mean annual temperature - 34 to 44 degrees F.
Frost-free period - 30 to 70 days

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cheadle and Teton series. Cheadle soils are shallow to bedrock, are loamy-skeletal, and are not pachic. Teton soils are moderately deep to bedrock and are not pachic. These soils are on more convex positions.

DRAINAGE AND PERMEABILITY: Well drained; moderate permeability.

USE AND VEGETATION: Used as dry and irrigated cropland and as rangeland. Potential native vegetation is bluebunch wheatgrass, Columbia needlegrass, Idaho fescue, rough fescue, bluegrass, lupine, shrubby cinquefoil, big sagebrush, and sagewort. Some areas have an overstory of aspen.

DISTRIBUTION AND EXTENT: Northern Rocky Mountain valleys in Montana and western Colorado, and adjacent portions of Idaho and Wyoming. Adel soils are of moderate extent. MLRA 43B, 44B, 46 and 48A.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES ESTABLISHED: Reconnaissance Soil Survey of central Montana, 1946.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - from 0 to 60 inches (A1, A2, A3 and Bw horizons)
Particle-size control section from 10 to 40 inches (part of A1, A2, A3, and part of Bw horizon)

Adel soils have a cryic temperature regime and a udic moisture regime. There are significant acres of soils mapped as Adel that have an ustic soil moisture regime. These areas should be investigated in the future to determine if they should be correlated to the Houlihan series (ustic counterpart to Adel).

Additional Information
Soil Interpretation Records: MT0075, MT0692, MT0831, MT1038.

National Cooperative Soil Survey
U.S.A.

LOCATION CASEYPEAK MT
Established Series
Rev. PEM-BDD-EMM
03/2008

CASEYPEAK SERIES

The Caseypeak series consists of shallow, well drained soils that formed in residuum derived from granite and other coarse grained igneous rocks. These soils are on mountains and hills. Slopes are 2 to 60 percent. Mean annual precipitation is about 18 inches, and mean annual air temperature is about 38 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive Lithic Haplocryepts

TYPICAL PEDON: Caseypeak gravelly coarse sandy loam, bouldery forested (colors are for dry soil unless otherwise noted).

Oi--0 to 1.5 inches; partially decomposed needles, twigs, and leaves. (1/2 to 3 inches thick)

E--1.5 to 6 inches; light brownish gray (10YR 6/2) gravelly coarse sandy loam, brown (10YR 5/3) moist; moderate medium granular structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and fine and few medium pores; 20 percent gravel; slightly acid (pH 6.2); clear wavy boundary. (3 to 6 inches thick)

Bw1--6 to 12 inches; brown (10YR 5/3) very gravelly coarse sandy loam, brown (10YR 4/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; many very fine and few fine tubular and interstitial pores; 40 percent gravel; neutral (pH 6.6); gradual wavy boundary. (4 to 8 inches thick)

Bw2--12 to 17 inches; pale brown (10YR 6/3) very gravelly coarse sandy loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; many very fine, common fine and few medium roots; many very fine and few fine tubular and interstitial pores; 40 percent gravel; neutral (pH 6.7); clear wavy boundary. (3 to 6 inches thick)

Cr--17 to 20 inches; light yellowish brown (2.5Y 6/4) decomposed granite bedrock (grus) that crushes to very gravelly loamy coarse sand; neutral (pH 6.8). (2 to 18 inches thick)

R--20 inches; hard granite bedrock.

TYPE LOCATION: Jefferson County, Montana; 1,550 feet north and 1,100 feet west of the SE corner of sec. 19, T. 4 N., R. 3 W.

RANGE IN CHARACTERISTICS:

Soil temperature - 36 to 42 degrees F.
Moisture control section - between 4 and 12 inches or to the lithic contact when bedrock is less than 12 inches.
Base saturation - greater than 60 percent throughout.
Depth to Cr horizon - 10 to 18 inches.
Depth to bedrock - 12 to 20 inches.
Surface stones or boulders - 0 to 50 percent
A thin A horizon is allowed.

E horizon - Hue: 10YR or 2.5Y
Value: 6 or 7 dry; 5 or 6 moist
Chroma: 2 or 3
Texture: coarse sandy loam, sandy loam, or loamy coarse sand
Clay content: 10 to 20 percent
Rock fragments: 10 to 60 percent--0 to 15 percent cobbles and stones, 10 to 50 percent gravel
Reaction: pH 5.6 to 6.5

Bw1 horizon - Hue: 10YR or 2.5Y
Value: 5 or 6 dry; 4 or 5 moist
Chroma: 3 or 4
Texture: coarse sandy loam, sandy loam, or sandy clay loam
Clay content: 10 to 22 percent
Rock fragments: 35 to 60 percent gravel (mainly less than 7mm in diameter)
Reaction: pH 6.1 to 7.3

Bw2 horizon - Hue: 10YR or 2.5Y
Value: 5 or 6 dry; 4 or 5 moist
Chroma: 2, 3, or 4
Texture: coarse sandy loam, sandy loam, or sandy clay loam
Clay content: 10 to 22 percent
Rock fragments: 35 to 60 percent gravel (mainly less than 10mm in diameter)
Reaction: pH 6.1 to 7.3

COMPETING SERIES:

Banker (WA) - has a xeric moisture regime.

Cobblank (AK) - has a subarctic climate.

Cowood (MT) - does not have a paralithic contact of grus above a lithic contact of granite; has a udic moisture regime.

Hechtman (WY) - slightly to strongly acid throughout; has a udic moisture regime; does not have a paralithic contact over the rhyolite rock.

Jarbidge (NV) - has a xeric moisture regime.

Luckiamute (OR) - has 27 to 35 percent clay in the particle-size control section; has a udic moisture regime; very strongly acid throughout.

Merino (CO) - does not have a cambic horizon.

Pendergrass (CO) - has hue of 5YR or redder throughout.

Sigbird (MT) - does not have a paralithic contact of grus above the lithic contact; formed in colluvium or residuum from shale.

Treebutte (WA) - has a xeric moisture regime.

GEOGRAPHIC SETTING:

Landform- mountains; hills.
Elevation - 5,500 to 8,000 feet.
Slope - 2 to 60 percent.
Parent material - residuum derived from granite and other coarse grained igneous rocks.
Climate - long, cold winters; cool, moist springs; short, cool summers.
Mean annual precipitation - 15 to 30 inches.
Mean annual air temperature - 34 to 40 degrees F.
Frost-free period - 30 to 70 days.

GEOGRAPHICALLY ASSOCIATED SOILS: None listed.

DRAINAGE AND PERMEABILITY: Well drained, moderately rapid permeability.

USE AND VEGETATION: Caseypeak soils are primarily used for timber production and wildlife habitat. The potential native vegetation is mainly Douglas fir, lodgepole pine, pinegrass, white spiraea, common snowberry, russet buffaloberry, common juniper, Kinnikinnick, raceme pussytoes, Oregongrape, heartleaf arnica, rough fescue, and Idaho fescue.

DISTRIBUTION AND EXTENT: Caseypeak soils are of small extent in southwestern Montana.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana

SERIES ESTABLISHED: Jefferson County, Montana, 1998.

REMARKS: Soil interpretation record: MT1594, MT3070, MT3073. Diagnostic horizons and features recognized in this pedon are: a layer of partially decomposed needles, twigs, and leaves from 1 1/2 inches to the mineral soil surface (Oi horizon); an ochric epipedon from the mineral surface to 7 inches, mixed (E, Bw horizons); a cambic horizon from 5 to 16 inches (Bw1, Bw2 horizon); a layer of decomposed granite (grus) from 16 to 19 inches (Cr horizon); hard granite bedrock at 19 inches (R horizon); a particle-size control section from 10 to 16 inches (Bw, Bw2 horizons). Caseypeak soils have a cryic temperature regime and an ustic moisture regime.

The 3/2008 description reflects a change in classification from Loamy-skeletal, mixed, superactive Lithic Eutrocryepts to Loamy-skeletal, mixed, superactive Lithic Haplocryepts due to revision of the cryepts great groups and subgroups. The competing series section was not updated and should be reviewed after all the cryepts have been re-classified.

LOCATION CHEADLE MT+CO UT WY

Established Series
Rev. DES-KTS-RJS
03/2011

CHEADLE SERIES

The Cheadle series consists of shallow, well drained soils that formed in colluvium and/or residuum derived mainly from hard sandstone, but may be underlain by hard phyllitic shale, argillite, quartzite or igneous rock. These soils are on bedrock-floored plains, hills, escarpments, mountains and ridges. Slopes are 2 to 70 percent. Mean annual precipitation is about 23 inches, and mean annual air temperature is about 40 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive Lithic Haplocryolls

TYPICAL PEDON: Cheadle channery loam, grassland (colors are for dry soil unless otherwise noted).

A1--0 to 7 inches; dark grayish brown (10YR 4/2) channery loam, very dark brown (10YR 2/2) moist; moderate fine and very fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine, and common medium roots; 25 percent channers; neutral (pH 6.6); clear wavy boundary. (2 to 8 inches thick)

A2--7 to 15 inches; brown (10YR 4/3) extremely channery loam, dark brown (10YR 3/3) moist; weak very fine and fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine, and common medium roots; 55 percent channers, 10 percent gravel; pockets of disseminated calcium carbonate and calcium carbonate coatings on undersides of rock fragments; strongly effervescent; moderately alkaline (pH 8.4); abrupt wavy boundary. (5 to 8 inches thick)

Bk--15 to 19 inches; light yellowish brown (10YR 6/4) extremely channery loam, dark yellowish brown (10YR 4/4) moist; weak very fine and fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots in mattings between rock fragments; 55 percent channers, 20 percent gravel; disseminated calcium carbonate and continuous faint calcium carbonate coatings on undersides of fragments; strongly effervescent; moderately alkaline (pH 8.4); abrupt smooth boundary. (3 to 8 inches thick)

R--19 inches; very pale brown (10YR 7/3) fractured hard sandstone.

TYPE LOCATION: Fergus County, Montana; 825 feet west and 1,120 feet south of the NE corner of sec. 29, T. 14 N., R. 18 E.

RANGE IN CHARACTERISTICS:
Mean annual soil temperature - 37 to 47 degrees F.
Mean summer soil temperature - less than 59 degrees F.
Mollic epipedon thickness - 7 to 16 inches

Rock fragments - mainly sandstone
Depth to bedrock - 10 to 20 inches
Depth to secondary calcium carbonate horizon - 7 to 16 inches

Note: Some pedons may have a BC or C horizon below the Bk horizon.

A1 horizon
Hue: 2.5Y, 10YR or 7.5YR; dry or moist
Value: 3 to 5 dry; 2 or 3 moist
Chroma: 1 to 3; dry or moist
Texture: loam, fine sandy loam, sandy loam or very fine sandy loam
Clay content: 10 to 27 percent
Rock fragments: 0 to 60 percent gravel, channers, cobbles and/or stones
Reaction: pH 6.1 to 7.8

A2 horizon
Hue: 2.5Y, 10YR or 7.5YR; dry or moist
Value: 4 or 5 dry; 2 or 3 moist
Chroma: 1 to 3; dry or moist
Texture: loam, fine sandy loam or sandy loam
Clay content: 10 to 27 percent
Rock fragments: 35 to 75 percent--10 to 55 percent gravel, 0 to 65 percent channers, cobbles and stones
Reaction: pH 6.6 to 8.4

Bk horizon
Hue: 2.5Y, 7.5YR or 10YR; dry or moist
Value: 5 or 6 dry; 4 or 5 moist
Chroma: 2 to 4; dry or moist
Texture: loam, fine sandy loam, sandy loam or coarse sandy loam
Clay content: 10 to 27 percent
Rock fragments: 35 to 85 percent--20 to 50 percent gravel, 0 to 65 percent channers, cobbles, and stones
Calcium carbonate equivalent: 3 to 10 percent
Reaction: pH 7.8 to 8.6

COMPETING SERIES:
Arrowpeak (MT) - does not have secondary calcium carbonate accumulation
Betemer (CO) - does not have secondary calcium carbonate accumulation
Chokecherry (ID) - have a xeric moisture regime
Clamp (OR) - does not have secondary calcium carbonate accumulation
Dalys (MT) - have a lithic contact at depths of less than 10 inches
Dollarhide (ID) - does not have secondary calcium carbonate accumulation
Eyre (CO) - does not have secondary calcium carbonate accumulation
Irigul (WY) - does not have secondary calcium carbonate accumulation
Irson (WY) - does not have secondary calcium carbonate accumulation
Jonlake (NV) - does not have secondary calcium carbonate accumulation
Labshaft (WY) - does not have secondary calcium carbonate accumulation
Mccadden (UT) - have an udic moisture regime

Milling (WA) - does not have secondary calcium carbonate accumulation
Poin (MT) - does not have secondary calcium carbonate accumulation
Rogert (CO) - does not have secondary calcium carbonate accumulation
Schwacheim (CO) - does not have secondary carbonate accumulation
Starley (WY) - have less than 35 percent fine and coarser sand in the control section
Topeki (NV) - does not have secondary calcium carbonate accumulation
Trump (CO) - have an ustic moisture regime bordering aridic.
Udel (NV) - does not have secondary carbonate accumulation

GEOGRAPHIC SETTING:
Landform - bedrock-floored plains, hills, escarpments, mountains and ridges
Elevation - 4,600 to 8,100 feet - in Colorado the elevations range to 9,000 feet
Slope - 2 to 70 percent
Parent material - colluvium and/or residuum derived mainly from hard sandstone, but may be underlain by hard phyllitic shale, argillite, quartzite, or igneous rock. (In Colorado the soils have formed in gneiss and schist.)
Climate - long, cold winters; moist springs; moist summers
Mean annual precipitation - 15 to 30 inches - in Colorado it is as low as 12 inches
Mean annual air temperature - 35 to 45 degrees F.
Frost-free period - 50 to 90 days

GEOGRAPHICALLY ASSOCIATED SOILS: None listed.

DRAINAGE AND PERMEABILITY: Well drained; moderate permeability.

USE AND VEGETATION: Cheadle soils are used mainly for native grass range. Potential native vegetation is mainly bluebunch wheatgrass, prairie junegrass, fringed sagewort, lupine, Idaho fescue, clubmoss and shrubby cinquefoil.

DISTRIBUTION AND EXTENT: Cheadle soils are extensive in central Montana and along the eastern front of the Rocky Mountains in Colorado. MLRAs - 43B, 44B, 46, 48A.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES ESTABLISHED: Reconnaissance Soil Survey of Central Montana, 1946.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - from 0 to 15 inches (A1 and A2 horizons)
Horizon of calcium carbonate accumulation - from 15 to 19 inches (Bk horizon)
Lithic contact - at 19 inches (R horizon)
Particle-size control section - from 10 to 19 inches (part of A2 and Bk horizons)

Cheadle soils have a cryic temperature regime and an ustic moisture regime that borders on udic.

ADDITIONAL DATA: Soil Interpretations Records - MT0087, MT0841, MT0202.

LOCATION CLUNTON MT

Established Series
Rev. DES-JAL-JCK
05/2013

CLUNTON SERIES

The Clunton series consists of very deep, very poorly drained soils that formed alluvium. These soils are on flood plains, flood-plain steps, and drainageways. Slopes are 0 to 4 percent. Mean annual precipitation is about 356 mm. Mean annual air temperature is about 6 degrees C.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, frigid Fluvaquentic Endoaquolls

TYPICAL PEDON: Clunton silty clay loam, in hay meadow (Colors are for moist soil unless otherwise noted).

Oe--0 to 10 cm; very dark gray (5Y 3/1) mucky-peat, very dark gray (5Y 3/1) dry; neutral (pH 6.8); clear smooth boundary. (0 to 10 cm thick)

Ag--10 to 46 cm; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; many distinct black (5Y 2.5/1) redox depletions; few faint strong brown (7.5YR 5/6) redox concentrations; moderate medium prismatic structure; hard, firm, moderately sticky and moderately plastic; common very fine roots; common very fine and fine interstitial pores; neutral (pH 7.0); abrupt smooth boundary. (25 to 60 cm thick)

Cg1--46 to 76 cm; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; common faint very dark gray (5Y 3/1) redox depletions; many distinct strong brown (7.5YR 5/6) redox concentrations; massive; hard, firm, moderately sticky and moderately plastic; common very fine roots; few very fine tubular pores; neutral (pH 7.2); clear wavy boundary. (20 to 51 cm thick)

Cg2--76 to 86 cm; very dark gray (5Y 3/1) loam consisting of strata of loam and sandy loam, dark gray (5Y 4/1) dry; common distinct strong brown (7.5YR 5/6) redox concentrations; common faint very dark gray (5Y 3/1) redox depletions; massive; hard, friable, slightly sticky and slightly plastic; few very fine roots; neutral (pH 7.2); gradual wavy boundary. (0 to 20 cm thick)

Cg3--86 to 107 cm; dark gray (5Y 4/1) silty clay loam consisting of strata of silty clay loam and sandy loam, gray (5Y 5/1) dry; common distinct strong brown (7.5YR 5/6) redox concentrations; common faint very dark gray (5Y 3/1) redox depletions; massive; slightly hard, friable, slightly sticky and slightly plastic; neutral (pH 7.0); gradual wavy boundary. (0 to 30 cm thick)

2Cg4--107 to 163 cm; dark gray (10YR 4/1) gravelly sandy loam, grayish brown (2.5Y 5/2) dry; many distinct strong brown (7.5YR 5/6) redox concentrations; few faint very dark gray (5Y 3/1) redox depletions; massive; slightly hard, friable, slightly sticky and nonplastic; 15 percent gravel; neutral (pH 7.0).

TYPE LOCATION: Jefferson County, Montana; 488 meters north and 366 meters west of the SE corner of sec. 30, T. 4 N., R. 2 W.

RANGE IN CHARACTERISTICS:
Mean annual soil temperature - 4.4 to 7.8 degrees C
Mollic epipedon thickness - 25 to 60 cm
Depth to seasonal high water table - 0 to 30 cm for extended periods during spring and summer
Depth to redoximorphic features - 0 to 10 cm
Particle-size control section (weighted average) - 18 to 27 percent clay

Ag horizon
Hue: 10YR, 2.5Y or 5Y
Value: 4 or 5 dry; 2 or 3 moist
Chroma: 1 or 2
Texture: silty clay loam, loam or silt loam
Clay content: 15 to 30 percent
Electrical conductivity: 0 to 2 mmhos/cm
Reaction: pH 6.1 to 7.3

Cg1 horizon
Hue: 10YR, 2.5Y or 5Y
Value: 4 or 5 dry
Chroma: 1 or 2
Texture: silty clay loam, loam, silt loam, or clay loam
Clay content: 18 to 35 percent
Rock fragments: 0 to 10 percent gravel
Electrical conductivity: 0 to 2 mmhos/cm
Reaction: pH 6.6 to 7.8

Cg2 and Cg3 horizons
Hue: 2.5Y or 5Y
Value: 4, 5 or 6 dry; 3, 4 or 5 moist
Texture: silt loam, loam, clay loam or silty clay loam with thin strata of finer and coarser materials.
Clay content: 18 to 35 percent
Rock fragments: 0 to 10 percent gravel
Electrical conductivity: 0 to 2 mmhos/cm
Reaction: pH 6.6 to 7.8

2Cg4 horizon
Hue: 10YR, 2.5Y, 5Y or N
Value: 4 or 5 dry; 3 or 4 moist
Chroma: 0, 1 or 2
Texture: sandy loam or loam with strata of loamy sand, silt loam or very fine sandy loam
Clay content: 5 to 25 percent
Rock fragments: 0 to 25 percent gravel
Electrical conductivity: 0 to 4 mmhos/cm
Reaction: pH 6.6 to 7.8

COMPETING SERIES:
Fairbirch (MT) - have a cambic horizon; have more than 35 percent rock fragments in the subsoil
Hayspur (NV) - have Mn oxide concretions; have more than 35 percent rock fragments in the lower part of the subsoil
Moynier (UT) - have a weighted average of more than 27 percent clay in the particle-size control section

GEOGRAPHIC SETTING:
Landform - flood plains, flood-plain steps, and drainageways
Elevation - 1,128 to 1,830 meters
Slope - 0 to 4 percent
Parent material - alluvium
Climate - long, cold winters; moist springs; warm summers
Mean annual precipitation - 250 to 480 mm
Mean annual air temperature - 3.3 to 7.8 degrees C
Frost-free period - 70 to 120 days

GEOGRAPHICALLY ASSOCIATED SOILS: None listed.

DRAINAGE AND PERMEABILITY: Very poorly drained, moderate permeability to a depth of 106 cm and moderately rapid below.

USE AND VEGETATION: Clunton soils are primarily used for native grass hay, pasture, and wetland wildlife habitat. The potential native vegetation is mainly tall reedgrass, mannagrass, American sloughgrass, tufted hairgrass, sedges and rushes, blue-eyedgrass and willows.

DISTRIBUTION AND EXTENT: Clunton soils are of moderate extent in the intermountain valleys and foothills of southwestern Montana. MLRAs 43B, 44B, 46, 58A.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana

SERIES ESTABLISHED: Jefferson County, Montana, 1998.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - from 10 to 36 cm (Ag horizon)
Redoximorphic features - from 10 to 163 cm (Ag, Cg1, Cg2, Cg3, and Cg4 horizons
Particle size control section - from 35 to 110 cm (Ag, Cg1, Cg2, Cg3, and 2Cg4 horizons)

Clunton soils have a frigid temperature regime and an aquic moisture regime.

ADDITIONAL DATA: Soil interpretations record - MT1557

National Cooperative Soil Survey
U.S.A.

LOCATION DUCKCREEK MT

Established Series
Rev. DRS-JAL-EMM
07/2012

DUCKCREEK SERIES

The Duckcreek series consists of moderately deep, well drained soils that formed in interbedded shale and sandstone residuum and clayey sedimentary beds. These soils are on hills, mountains and escarpments. Slopes are 4 to 60 percent. Mean annual precipitation is about 21 inches and mean annual temperature is about 39 degrees F.

TAXONOMIC CLASS: Fine, mixed, superactive Ustic Argicryolls

TYPICAL PEDON: Duckcreek loam, in rangeland (Colors are for dry soil unless otherwise noted).

A--0 to 6 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine and few fine and medium roots; many very fine and fine pores; 5 percent gravel, 5 percent stones; neutral (pH 7.2); clear smooth boundary. (5 to 12 inches thick)

Bt1--6 to 15 inches; dark yellowish brown (10YR 4/4) clay loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure parting to strong fine granular; hard, friable, moderately sticky and moderately plastic; common very fine and few fine and medium roots; common very fine pores; common faint discontinuous clay films on faces of peds; 10 percent gravel; neutral (pH 7.2); clear smooth boundary.

Bt2--15 to 29 inches; light yellowish brown (10YR 6/4) gravelly clay loam, brown (10YR 5/3) moist; weak medium subangular blocky structure parting to moderate fine granular; hard, friable, moderately sticky and moderately plastic; few very fine and fine roots; common very fine interstitial and tubular pores; common faint discontinuous clay films on faces of peds; 20 percent gravel; slightly alkaline (pH 7.4); clear smooth boundary. (Combined thickness of the Bt1 and Bt2 horizon 15 to 25 inches)

Bk--29 to 36 inches; light gray (2.5Y 7/2) sandy clay loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic structure; soft, very friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine interstitial and tubular pores; common fine soft masses of lime; 30 percent soft shale fragments; strongly effervescent; moderately alkaline (pH 8.2); clear wavy boundary. (5 to 17 inches thick)

Cr--36 to 60 inches; semiconsolidated black shale; strongly effervescent.

TYPE LOCATION: Sweet Grass County, Montana; 200 feet east and 2400 feet south of the northwest corner of section 19, T.2 N., R.12 E.; Latitude 45 degrees, 54 minutes, 31 seconds N., Longitude 110 degrees, 17 minutes, 28 seconds W.

RANGE IN CHARACTERISTICS:

Mean annual soil temperature - 36 to 40 degrees F.
Moisture control section - between 4 and 12 inches.
Mollic epipedon thickness - 8 to 15 inches.
Depth to Bk horizon - 15 to 35 inches.
Depth to Cr horizon - 20 to 40 inches.

A horizon - Hue: 10YR or 2.5Y
Value: 3, 4, or 5 dry; 2 or 3 moist
Chroma: 1, 2, or 3
Texture: loam or clay loam
Clay content: 18 to 35 percent
Rock fragments: 0 to 25 percent-- 0 to 5 percent flagstones or stones, 0 to 10 percent cobbles, 0 to 15 percent channers or gravel; 0 to 20 percent soft shale chips.
Reaction: pH 5.6 to 7.4

Bt1 horizon - Hue: 10YR or 2.5Y
Value: 4, 5 or 6 dry; 3, 4 or 5 moist
Chroma: 2, 3 or 4
Texture: clay loam or clay
Clay content: 35 to 50 percent
Rock fragments: 0 to 25 percent-- 0 to 5 percent cobbles, 0 to 20 percent channers or gravel; 0 to 20 percent soft shale chips.
Reaction: pH 5.6 to 7.3

Bt2 horizon - Hue: 10YR or 2.5Y
Value: 5 or 6 dry; 4 or 5 moist
Chroma: 2, 3 or 4
Texture: clay loam or clay
Clay content: 35 to 50 percent
Rock fragments: 0 to 35 percent -- 0 to 5 percent cobbles, 0 to 30 percent channers or gravel; 0 to 20 percent soft shale chips.
Reaction: pH 6.1 to 7.8

Bk horizon - Hue: 10YR or 2.5Y
Value: 5, 6, or 7 dry; 4, 5, or 6 moist
Chroma: 2, 3, or 4
Texture: loam, clay loam or clay
Clay content: 27 to 45 percent
Rock fragments: 0 to 35 percent--0 to 5 percent cobbles, 0 to 30 percent channers or gravel; 10 to 35 percent soft shale chips.
Calcium Carbonate equivalent: 5 to 15 percent
Reaction: pH 7.4 to 8.4

COMPETING SERIES:

Bangtail (MT) - does not have horizons of secondary calcium carbonate accumulation.

Bridger (MT) - does not have a paralithic contact above 60 inches.

Echard (UT) - does not have a paralithic contact above 60 inches; formed in soft rhyolitic tuff or strongly cemented ash.

Melville (MT) - does not have a paralithic contact above 60 inches.

Mollet (MT) - does not have a paralithic contact above 60 inches; does not have horizons of secondary calcium carbonate accumulation.

Rattler (MT) - does not have a paralithic contact above 60 inches.

Sevier (UT) - has Bt horizon which is 4 to 10 inches thick; is moderately well drained; does not have horizons of secondary calcium carbonate accumulation.

GEOGRAPHIC SETTING:

Landform - hills, mountains, escarpments.
Elevation - 5,600 to 8,300 feet.
Slope - 4 to 60 percent.
Parent material - residuum derived from cretaceous interbedded shale and sandstone.
Climate - long, cold winters; cool, moist springs; short summers.
Mean annual precipitation - 19 to 25 inches.
Mean annual air temperature - 35 to 43 degrees F.
Frost-free period - 50 to 70 days.

GEOGRAPHICALLY ASSOCIATED SOILS: None listed.

DRAINAGE AND PERMEABILITY: Well drained; slow permeability.

USE AND VEGETATION: Duckcreek soils are used mainly for rangeland and wildlife habitat. Potential native vegetation may include Idaho fescue, Richardson needlegrass, Columbia needlegrass, mountain brome, lupine, and sticky geranium.

DISTRIBUTION AND EXTENT: Duckcreek soils are of small extent in south central Montana. MLRAs 43B and 46.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana

SERIES ESTABLISHED: Sweet Grass County, Montana, 1999.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - from the surface to 15 inches (A and Bt1 horizons)
Argillic horizon - from 6 to 29 inches (Bt1 and Bt2 horizons)
Horizon of secondary calcium carbonate accumulation - from 29 to 36 inches (Bk horizon)
Paralithic contact - interbedded soft shale and sandstone from 36 to 60 inches (Cr horizon)

Duckcreek soils have a cryic temperature regime and an ustic moisture regime.

LOCATION FARLIN MT

Established Series
REV. KTS-GFB-EMM
04/2014

FARLIN SERIES

The Farlin series consists of very deep well drained soils that formed in alluvium, colluvium or slide deposits derived from limestone. These soils occur on fan remnants, hills, mountain slopes, ridges, escarpments, and landslides. Slopes are 2 to 60 percent. Mean annual precipitation is about 490 mm and mean annual air temperature is about 3 degrees C.

TAXONOMIC CLASS: Loamy-skeletal, carbonatic Calcic Haplocryolls

TYPICAL PEDON: Farlin gravelly loam, in rangeland on a 36 percent slope at an elevation of 2283 meters (colors are for dry soil unless otherwise noted).

A--0 to 25 cm; very dark gray (10YR 3/1) gravelly loam, black (10YR 2/1) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine, fine and medium roots; many very fine and fine dendritic tubular pores; 15 percent gravel; neutral (pH 7.0); clear smooth boundary. (13 to 40 cm thick)

Bk1--25 to 46 cm; pale brown (10YR 6/3) very gravelly loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine, and few medium roots; many very fine tubular and irregular pores; 35 percent gravel and 5 percent cobbles; finely disseminated calcium carbonate, 5 percent soft masses of calcium carbonate, and 75 percent fine distinct irregular carbonate nodules on bottom of rock fragments; violently effervescent; moderately alkaline (pH 8.0); clear wavy boundary. (13 to 50 cm thick)

Bk2--46 to 76 cm; light gray (2.5Y 7/2) very gravelly loam, grayish brown (10YR 5/2) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; many very fine irregular pores; 40 percent gravel and 10 percent cobbles; finely disseminated calcium carbonate, 10 percent soft masses of calcium carbonate, and 60 percent medium distinct irregular carbonate nodules on rock fragments; violently effervescent; moderately alkaline (pH 8.2); clear wavy boundary. (25 to 50 cm thick)

Bk3--76 to 152 cm; pale yellow (2.5Y 8/2) extremely gravelly fine sandy loam, light brownish gray (10YR 6/2) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; 50 percent gravel and 10 percent cobbles; finely disseminated calcium carbonate, 5 percent soft masses of calcium carbonate, and 60 percent medium distinct irregular carbonate nodules on rock fragments; violently effervescent; moderately alkaline (pH 8.4).

TYPE LOCATION: Beaverhead County, Montana; located about 200 feet east and 1300 feet south of the northwest corner of sec. 14 , T. 6 S., R. 12 W; Polaris topographic quadrangle; UTM

12T, 339455e, 5020389n, NAD 83.

RANGE IN CHARACTERISTICS:
Mean annual soil temperature - 1 to 4 degrees C.
Mollic epipedon thickness - 18 to 40 cm and may include part of the Bk1 horizon
Depth to calcic horizon - 18 to 40 cm
Control section - averages more the 40 percent calcium carbonate by weight

Note: Some pedons may have a Bw horizon.

A horizon
Hue: 10YR or 2.5Y; dry or moist
Value: 3 to 5 dry; 2 or 3 moist
Chroma: 1 to 3; dry or moist
Texture: silt loam or loam
Clay content: 18 to 27 percent
Rock fragments: 5 to 35 percent--5 to 30 percent gravel, 0 to 15 percent cobbles, 0 to 5 percent stones
Reaction: pH 6.6 to 7.6

Bk1 horizon
Hue: 7.5YR, 10YR or 2.5Y; dry or moist
Value: 4 to 6 dry; 2 to 4 moist
Chroma: 2 or 3; dry or moist
Texture: loam or fine sandy loam
Clay content: 18 to 27 percent
Rock fragments: 25 to 60 percent--20 to 50 percent gravel, 0 to 15 percent cobbles and stones
Calcium Carbonate Equivalent: 15 to 50 percent (includes coarse fragments less than 20 mm in size)
Reaction: pH 7.9 to 8.4

Bk2 and Bk3 horizons
Hue: 7.5YR, 10YR or 2.5Y; dry or moist
Value: 6 to 8 dry; 4 to 6 moist
Chroma: 2 to 4; dry or moist
Texture: loam or fine sandy loam
Clay content: 18 to 27 percent
Rock fragments: 35 to 70 percent--30 to 65 percent gravel, 5 to 25 percent cobbles and stones
Calcium Carbonate Equivalent: 40 to 60 percent (includes coarse fragments less than 20 mm in size)
Reaction: pH 7.9 to 8.4

COMPETING SERIES:
Hanson (MT) - have an udic moisture regime
Skaggs (MT) - is moderately deep to a lithic contact

GEOGRAPHIC SETTING:
Landform - fan remnants, hills, mountain slopes, ridges, escarpments, and landslides
Elevation - 1700 to 2745 meters

Slope - 2 to 60 percent
Parent material - alluvium, colluvium or slide deposits derived from limestone
Climate - long, cold winters; moist springs; warm summers
Mean annual precipitation - 380 to 610 mm
Mean annual air temperature - 1 to 4 degrees C.
Frost-free period - 30 to 70 days

GEOGRAPHICALLY ASSOCIATED SOILS: None listed.

DRAINAGE AND PERMEABILITY: Well drained; moderate permeability.

USE AND VEGETATION: Farlin soils are used mainly for rangeland. The vegetation is mainly bluebunch wheatgrass, Idaho fescue, kingspike fescue, POA (species), prairie junegrass, mountain big sagebrush, threetip sagebrush, rubber rabbitbrush, and other miscellaneous forbs.

DISTRIBUTION AND EXTENT: Farlin soils are of small extent in southwestern Montana. MLRAs - 43B, 44B, 46.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES ESTABLISHED: Horse Prairie-South Valley Area - Part of Beaverhead County, Montana, 2011; proposed in Beaverhead County, Montana, 2009.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - 0 to 25 cm (A horizon)
Calcic horizon - from 25 to 152 cm (Bk1, Bk2 and Bk3 horizons)
Particle-size control section - from 25 to 100 cm (Bk1, Bk2 and part of Bk3 horizons)

Farlin soils have a cryic temperature regime and an ustic moisture regime.

National Cooperative Soil Survey
U.S.A.

LOCATION HOULIHAN MT

Established Series
Rev. KTS-RJS-EMM
01/2013

HOULIHAN SERIES

The Houlihan series consists of very deep, well drained soils that formed in alluvium, slope alluvium, and colluvium derived from igneous, metamorphic and sedimentary rock. Houlihan soils are on hills, mountain slopes, swales and fan remnants. Slopes range from 1 to 60 percent. Mean annual precipitation is about 480 millimeters and the mean annual temperature is about 3 degrees C.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive Pachic Haplocryolls

TYPICAL PEDON: Houlihan loam on an 8 percent south facing slope, in rangeland at about 2067 meters elevation (colors are for air-dry soil unless otherwise stated).

A1--0 to 18 cm; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; moderate fine and medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine, fine and medium roots; many very fine and fine tubular pores; 5 percent gravel; slightly acid (pH 6.4); clear smooth boundary.

A2--18 to 38 cm; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure parting to moderate fine and medium granular; slightly hard, very friable, slightly sticky and slightly plastic; many very fine, fine and medium roots; many very fine and fine tubular pores; 5 percent gravel; slightly acid (pH 6.4); clear smooth boundary. (combined thickness of A horizons - 25 to 85 cm)

Bw1--38 to 58 cm; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots; common very fine and fine irregular pores; 5 percent gravel; neutral (pH 6.8); clear smooth boundary. (20 to 60 cm)

Bw2--58 to 152 cm; grayish brown (10YR 5/2) cobbly clay loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; hard, friable, moderately sticky and moderately plastic; common very fine and fine roots; common very fine and fine irregular pores; 10 percent gravel, 10 percent cobbles; neutral (pH 7.0).

TYPE LOCATION: Beaverhead County, Montana; located about 900 feet south and 1600 feet east of the northwest corner of sec. 33, T. 9S., R 14W; Coyote Creek topographic quadrangle; UTM 12T, 316460e, 4987121n, NAD 83.

RANGE IN CHARACTERISTICS:
Mean annual soil temperature: 2 to 5 degrees C.
Mollic epipedon thickness: greater than or equal to 40 cm

Note: Some pedons may have a BC or C horizon.

A1, A2 horizons:
Hue: 2.5Y or 10YR; dry or moist
Value: 2 to 5 dry; 2 or 3 moist
Chroma: 1 or 2; dry or moist
Texture: loam, silt loam
Clay content: 18 to 27 percent
Rock fragments: 0 to 15 percent--0 to 15 percent gravel, 0 to 5 percent cobbles and stones
Reaction: pH 6.1 to 7.8

Bw1, Bw2 horizons:
Hue: 2.5Y or 10YR; dry or moist
Value: 4 to 7 dry; 2 to 5 moist
Chroma: 1 to 4; dry or moist
Texture: loam, silt loam, silty clay loam, clay loam
Clay content: 18 to 35 percent
Rock fragments: 0 to 35 percent--0 to 30 percent gravel, 0 to 15 percent cobbles and stones
Reaction: pH 6.1 to 7.8

COMPETING SERIES:
Adel (MT) - have an udic moisture regime
Argee (NV) - are moderately deep to a paralithic contact
Bullbasin (CO) - are deep to a lithic contact
Duff (NV) - are deep to a lithic contact
Hackwood (NV) - have a lithologic discontinuity
Lamphier (CO) - have hues redder than 10YR
Leavittville (WY) - have secondary calcium carbonate accumulation
Lespate (CO) - are moderately deep to a lithic contact
Ohbejoyful (CO) - have an udic moisture regime
Osmund (WY) - have secondary calcium carbonate accumulation
Pavohroo (ID) - have a cambic horizon
Rhone (CO) - are deep to a lithic contact
Secondset (CO) - are moderately deep to a lithic contact
Strickland (NV) - are moderately deep to a lithic contact
Taterheap (CO) - have an udic moisture regime
Winevada (CO) - are moderately deep to a lithic contact

GEOGRAPHIC SETTING:
Landform - hills, mountain slopes, plateaus, swales and fan remnants
Elevation - 1800 to 2800 meters
Slope - 1 to 60 percent
Parent material - alluvium, slope alluvium, and colluvium derived from igneous, metamorphic and sedimentary rock
Climate - long, cold winters; moist springs; short warm summers
Mean annual precipitation - 380 to 610 mm
Mean annual air temperature - 1 to 4 degrees C.
Frost-free period - 30 to 70 days

GEOGRAPHICALLY ASSOCIATED SOILS: None listed.

DRAINAGE AND PERMEABILITY: Well drained; moderate permeability.

USE AND VEGETATION: These soils are used mainly for rangeland. The vegetation is mainly bluebunch wheatgrass, Columbia needlegrass, rough fescue, Idaho fescue, POA (species), prairie junegrass, mountain big sagebrush, threetip sagebrush, cinquefoil, lupine and other miscellaneous forbs. Some areas have an overstory of aspen.

DISTRIBUTION AND EXTENT: Houlihan soils are of moderate extent in southwestern Montana. MLRAs - 43B, 44B, 46.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES ESTABLISHED: Horse Prairie-South Valley Area - Part of Beaverhead County, Montana, 2011; proposed in Beaverhead County, Montana, 2009.

REMARKS:
Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - from 0 to 152 cm. (A1, A2, Bw1, Bw2 horizons)
Particle-size control section - from 25 to 100 cm (part of A2, Bw1, part of Bw2 horizons)

Houlihan soils have a cryic temperature regime and an ustic moisture regime.

National Cooperative Soil Survey
U.S.A.

LOCATION KIMPTON MT

Established Series
Rev. DES-KTS-RJS
04/2011

KIMPTON SERIES

The Kimpton series consists of moderately deep, well drained soils that formed in colluvium, slope alluvium over residuum derived from hard fine grained sandstone or fine grained igneous rock. These soils are on bedrock-floored plains, ridges, hills, and mountain slopes. Slopes are 15 to 50 percent. Mean annual precipitation is about 17 inches, and mean annual air temperature is about 38 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive Ustic Haplocryalfs

TYPICAL PEDON: Kimpton very cobbly loam, very bouldery, forested (colors are for dry soil unless otherwise noted).

Oi--0 to 1 inch; partially decomposed needles, twigs, and leaves. (1/2 to 3 inches thick)

A--1 to 5 inches; dark grayish brown (10YR 4/2) very cobbly loam, dark brown (10YR 3/3) moist; moderate medium granular structure; soft, very friable, slightly sticky and nonplastic; common very fine and fine, and few medium roots; many very fine and fine interstitial and tubular pores; 25 percent gravel, 20 percent cobbles; neutral (pH 6.6); clear wavy boundary. (0 to 4 inches thick)

E--5 to 7 inches; grayish brown (10YR 5/2) very cobbly loam, brown (10YR 4/3) moist; moderate medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine, and few medium roots; many very fine and fine interstitial and tubular pores; 20 percent gravel, 20 percent cobbles; slightly acid (pH 6.4); clear wavy boundary. (2 to 6 inches thick)

Bt--7 to 14 inches; brown (10YR 5/3) very cobbly clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, firm, slightly sticky and slightly plastic; common very fine and fine roots; common medium interstitial and tubular pores; common distinct very dark grayish brown (10YR 3/2) clay films on faces of peds and bridging sand grains; 25 percent gravel, 20 percent cobbles; neutral (pH 6.8); clear wavy boundary. (5 to 12 inches thick)

Bk--14 to 33 inches; pale brown (10YR 6/3) very cobbly loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine and fine roots; common very fine and fine interstitial and tubular pores; 25 percent gravel, 25 percent cobbles; common fine and medium masses and threads of calcium carbonate and common distinct calcium carbonate coatings on undersides of fragments; slightly alkaline (pH 7.8); clear smooth boundary. (11 to 23 inches thick)

R--33 inches; hard fine grained sandstone bedrock.

TYPE LOCATION: Jefferson County, Montana; 300 feet south and 150 feet east of the NW corner of sec. 4, T. 5N., R. 2W.

RANGE IN CHARACTERISTICS:
Soil temperature - 38 to 42 degrees F.
Depth to top of argillic horizon - 6 to 10 inches
Depth to calcic horizon - 11 to 20 inches
Depth to lithic contact - 20 to 40 inches

Note: The surface layer, when mixed to 7 inches, does not meet the color requirements of a mollic epipedon. A thin transitional horizon between the E and Bt horizons is allowed, but it does not meet the requirements of a glossic horizon.

A horizon
Hue: 10YR or 2.5Y; dry or moist
Value: 4 or 5 dry; 3 or 4 moist
Chroma: 2 or 3; dry or moist
Texture: loam or silt loam
Clay content: 15 to 27 percent
Rock fragments: 25 to 50 percent--10 to 30 percent gravel, 10 to 20 percent cobbles, 0 to 5 percent stones
Reaction: pH 6.1 to 7.3

E horizon
Hue: 10YR or 2.5Y; dry or moist
Value: 5 to 7 dry; 4 to 6 moist
Chroma: 2 or 3; dry or moist
Texture: loam or fine sandy loam
Clay content: 15 to 27 percent
Rock fragments: 25 to 55 percent--15 to 35 percent gravel, 10 to 20 percent cobbles, 0 to 10 percent stones
Reaction: pH 6.1 to 7.3

Bt horizon
Hue: 7.5YR, 10YR or 2.5Y; dry or moist
Value: 5 or 6 dry; 3 to 5 moist
Chroma: 2 or 3; dry or moist
Texture: loam, sandy clay loam or clay loam
Clay content: 23 to 35 percent
Rock fragments: 35 to 60 percent--25 to 40 percent gravel, 10 to 25 percent cobbles, 0 to 5 percent stones
Reaction: pH 6.6 to 7.3

Bk horizon
Hue: 10YR or 2.5Y; dry or moist
Value: 6 or 7 dry; 5 or 6 moist
Chroma: 2 or 3; dry or moist

Texture: loam, sandy clay loam or fine sandy loam
Clay content: 15 to 27 percent
Rock fragments: 35 to 60 percent--25 to 40 percent gravel, 10 to 25 percent cobbles, 0 to 5 percent stones
Calcium carbonate equivalent: 12 to 25 percent
Reaction: pH 7.4 to 8.4

COMPETING SERIES:
Cadotte (MT) - have a lithologic discontinuity
Cloud Peak (WY) - have less than 12 percent calcium carbonate equivalent in the Bk horizon
Cundiyo (NM) - have a lithologic discontinuity
Edloe (CO) - have an udic moisture regime
Fulvance (CO) - are very deep
Goosepeak (CO) - are very deep
Guffey (CO) - are moderately deep to a paralithic contact
Hyattville (WY) - have a Btk horizon.
Lake Creek (WY) - does not have secondary calcium carbonate accumulation
Lakehelen (WY) - does not have secondary calcium carbonate accumulation
Laveta (CO) - does not have secondary calcium carbonate accumulation
Lulude (CO) - does not have secondary calcium carbonate accumulation
Reinecker (CO) - are very deep
Tepecreek (MT) - does not have secondary calcium carbonate accumulation

GEOGRAPHIC SETTING:
Landform - bedrock-floored plains, ridges, hills and mountain slopes
Elevation - 5,500 to 7,200 feet
Slope - 15 to 50 percent
Parent material - colluvium, slope alluvium over residuum derived from hard fine grained sandstone or fine grained igneous rock
Climate - long, cold winters; cool, moist springs; short, cool summers
Mean annual precipitation - 15 to 24 inches
Mean annual air temperature - 36 to 40 degrees F.
Frost-free period - 50 to 70 days

GEOGRAPHICALLY ASSOCIATED SOILS: None listed.

DRAINAGE AND PERMEABILITY: Well drained; moderate permeability.

USE AND VEGETATION: Kimpton soils are primarily used for timber production, wildlife habitat, and watershed. The potential native vegetation is mainly Douglas-fir, lodgepole pine, and subalpine fir with an understory of common juniper, white spiraea, kinnikinnick, Oregon-grape, russet buffaloberry, and pinegrass.

DISTRIBUTION AND EXTENT: Kimpton soils are of moderate extent in southwestern Montana. MLRA - 43B.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES ESTABLISHED: Jefferson County, Montana, 1998.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon - from 0 to 7 inches (Oi, A, E horizons)
Argillic horizon - from 7 to 14 inches (Bt horizon)
Calcic horizon - from 14 to 33 inches (Bk horizon)
Lithic contact - at 33 inches (R horizon)
Particle-size control section - from 7 to 14 inches (Bt horizon)

Kimpton soils have a cryic temperature regime and an ustic moisture regime bordering on udic.

ADDITIONAL DATA: Soil interpretation record - MT3010.

National Cooperative Soil Survey
U.S.A.

LOCATION LIBEG MT+CO

Established Series
Rev. CNG-KTS-RJS
04/2011

LIBEG SERIES

The Libeg series consists of very deep, well drained soils that formed in alluvium, outwash, colluvium, till or slide deposits. These soils are on stream terraces, alluvial fans, fan remnants, alpine moraines, outwash plains, hills, mountain slopes, ridges, escarpments, avalanche chutes and landslides. Slopes are 0 to 70 percent. Mean annual precipitation is about 22 inches, and mean annual air temperature is about 40 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive Ustic Argicryolls

TYPICAL PEDON: Libeg stony loam, grassland (colors are for dry soil unless otherwise noted).

A--0 to 6 inches; dark grayish brown (10YR 4/2) stony loam, black (10YR 2/1) moist; weak thin platy structure parting to moderate very fine and fine granular; slightly hard, very friable, slightly sticky and slightly plastic; many very fine and fine roots and few medium roots; many very fine and fine pores; 25 percent sandstone fragments; slightly acid (pH 6.4); clear wavy boundary. (4 to 15 inches thick)

Bt1--6 to 11 inches; brown (10YR 5/3) very channery loam, dark brown (10YR 3/3) moist; strong very fine subangular blocky structure; hard, friable, moderately sticky and moderately plastic; many very fine and fine roots; many very fine and fine pores; pale brown (10YR 6/3) fine sand coatings on some faces of peds; faint clay films on faces of some peds and on rock fragments; 35 percent sandstone channers; slightly acid (pH 6.5); clear wavy boundary.

Bt2--11 to 16 inches; brown (7.5YR 5/4) very channery clay loam, brown (7.5YR 4/4) moist; strong very fine and fine angular blocky structure; very hard, friable, moderately sticky and moderately plastic; many very fine and fine roots; many very fine and fine pores; pale brown (10YR 6/3) fine sand coatings on vertical faces of peds; faint clay films on faces of some peds and on rock fragments; 40 percent sandstone channers; slightly acid (pH 6.5); clear wavy boundary.

Bt3--16 to 30 inches; reddish brown (5YR 5/4) very channery sandy clay loam, reddish brown (5YR 4/4) moist; strong fine and medium angular blocky structure; extremely hard, friable, moderately sticky and moderately plastic; common very fine and fine roots and few coarse roots; many very fine and fine pores and few medium pores; distinct continuous clay films on all faces of peds and on rock fragments; 60 percent channers; slightly acid (pH 6.2); gradual irregular boundary. (combined thickness of Bt horizons - 19 to 40 inches)

BC--30 to 60 inches; light reddish brown (5YR 6/4) very stony sandy loam, yellowish red (5YR 5/6) moist; weak fine and medium subangular blocky structure; very hard, friable, moderately

sticky and moderately plastic: few very fine and fine roots; common very fine and fine pores; 80 percent sandstone fragments; 30 percent angular gravel and 50 percent stones; slightly acid (pH 6.5). (0 to 50 inches thick)

TYPE LOCATION: Cascade County, Montana; 1,900 feet west and 2,280 feet south of the NE corner of sec. 16, T. 17N, R. 6E.

RANGE IN CHARACTERISTICS:
Soil temperature: 35 to 44 degrees F.
Mollic epipedon thickness: 7 to 15 inches
Depth to top of argillic horizon - 4 to 15 inches
Rock fragments: mainly argillite, igneous, quartzite, and sandstone
Surface fragments: 0 to 15 percent stones and/or boulders

A horizon
Hue: 7.5YR or 10YR; dry or moist
Value: 3 to 5 dry; 2 or 3 moist
Chroma: 1 to 3; dry or moist
Texture: loam, clay loam, silty clay loam or sandy loam
Clay content: 10 to 40 percent
Rock fragments: 10 to 60 percent--5 to 50 percent gravel, 0 to 50 percent cobbles and stones
Reaction: pH 5.6 to 7.3

Bt1, Bt2 horizons
Hue: 5YR, 7.5YR or 10YR; dry or moist
Value: 4 to 6 dry; 3 to 5 moist
Chroma: 2 to 6; dry or moist
Texture: loam, sandy loam, sandy clay loam or clay loam
Clay content: 15 to 35 percent
Rock fragments: 35 to 80 percent--10 to 45 percent gravel, 5 to 50 percent cobbles and stones
Reaction: pH 5.6 to 7.8

Bt3 horizon
Hue: 5YR to 10YR; dry or moist
Value: 5 or 6 dry; 4 or 5 moist
Chroma: 2 to 6; dry or moist
Texture: clay loam, sandy clay loam or loam
Clay content: 20 to 35 percent
Rock fragments: 35 to 85 percent--10 to 50 percent gravel, 5 to 50 percent cobbles and stones
Reaction: pH 5.6 to 7.3

BC horizon
Hue: 5YR to 10YR; dry or moist
Value: 5 or 6 dry; 4 or 5 moist
Chroma: 2 to 6; dry or moist
Texture: sandy loam, sandy clay loam or loam
Clay content: 10 to 22 percent
Rock fragments: 40 to 85 percent--30 to 55 percent gravel, 10 to 50 percent cobbles and stones
Reaction: pH 5.6 to 7.8

COMPETING SERIES:
Anniesdraw (WY) - have a lithologic discontinuity
Bassel (CO) - are deep to a paralithic contact
Blaine (MT) - are moderately deep to a lithic contact
Bowen (CO) - are moderately deep to a lithic contact
Fingerrock (CO) - have a C horizon with less than 10 percent clay
Fornor (WY) - have secondary calcium carbonate accumulation
Fourmile (CO) - have a lithologic discontinuity
Geertsen (UT) - are deep to a lithic contact
Hoodle (UT) - have secondary calcium carbonate accumulation
Hungryhill (MT) - are moderately deep to a lithic contact
Lagarita (CO) - have secondary calcium carbonate accumulation
Lambe (CO) - have secondary calcium carbonate accumulation
Nathale (WY) - are moderately deep to a lithic contact
Nathrop (CO) - are moderately deep to a lithic contact
Norriston (CO) - have a lithologic discontinuity
Quander (CO) - have a soil moisture control section that is usually moist in mid to late summer
Ratiopeak (MT) - have secondary calcium carbonate accumulation
Silverheels (CO) - greatest amount of precipitation occurs during July and August
Spanpeak (MT) - have an O horizon
Woodhall (CO) - are moderately deep to a lithic contact

GEOGRAPHIC SETTING:
Landform: stream terraces, alluvial fans, fan remnants, alpine moraines, outwash plains, hills, mountain slopes, ridges, escarpments, avalanche chutes and landslides
Elevation: 4,500 to 8,500 feet
Slope: 0 to 70 percent
Parent material: alluvium, outwash, colluvium, till or slide deposits
Climate: long, cold winters; cool, moist springs; short summers
Mean annual precipitation: 14 to 30 inches with the greatest amount of precipitation occurring during May and June
Mean annual air temperature: 34 to 42 degrees F.
Frost-free period: 30 to 70 days

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Adel and Copenhaver series. Adel soils have less than 35 percent rock fragments and do not have an argillic horizon. Copenhaver soils are shallow.

DRAINAGE AND PERMEABILITY: Well drained; moderate permeability.

USE AND VEGETATION: Libeg soils are used mainly as rangeland. Potential native vegetation is mainly rough fescue, subalpine needlegrass, Idaho fescue, bluebunch wheatgrass, timber danthonia, forbs and shrubs.

DISTRIBUTION AND EXTENT: Libeg soils are of moderate extent along the eastern front of the Rocky Mountains in central Montana and Colorado. LRR E; MLRAs - 43B, 44B, 46, 47, 48A, 49.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES ESTABLISHED: Glacier County area, Montana, 1969.

REMARKS: Diagnostic horizons and features recognized in this soil are:
Mollic epipedon - from 0 to 11 inches (A, Bt1 horizons)
Argillic horizon - from 6 to 30 inches (Bt1, Bt2, Bt3 horizons)
Particle-size control section - from 6 to 26 inches. (Bt1, Bt2, part of Bt3 horizons)

Libeg soils have a cryic temperature regime and an ustic moisture regime that borders on udic.

ADDITIONAL DATA: Soil interpretation records - MT0109, MT1034, MT8160, MT1041, MT0353, MT0788, MT3152.

Classification changed from Argic Cryoboroll to Ustic Argicryoll 7/98.

National Cooperative Soil Survey
U.S.A.

LOCATION MEDICINELODGE MT

Established Series
REV. JJU-RJS
01/2012

MEDICINELODGE SERIES

The Medicinelodge series consists of very deep, poorly drained soils that formed in clayey alluvium derived from mixed sources. These soils occur on flood-plain steps, stream terraces, drainageways, depressions and landslides. Slopes are 0 to 15 percent. Mean annual precipitation is about 400 mm, and the mean annual air temperature is about 4 degrees C.

TAXONOMIC CLASS: Fine, smectitic Typic Cryaquolls

TYPICAL PEDON: Medicinelodge silt loam, in rangeland on a 2 percent slope at an elevation of 2072 meters (colors are for moist soil unless otherwise noted).

Oi--0 to 10 cm; slightly decomposed fibers and roots that texture to peat. (0 to 12 cm thick)

A-- 10 to 32 cm; black (10YR 2/1) silt loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine granular structure; moderately hard, very friable, slightly sticky and moderately plastic; many fine and medium roots; many very fine and fine irregular pores; neutral (pH 6.6); clear smooth boundary. (15 to 25 cm thick)

Bw--32 to 46 cm; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium and coarse subangular blocky structure; rigid, very firm, very sticky and very plastic; many fine and medium roots; many very fine and fine irregular pores; neutral (pH 6.8); clear smooth boundary. (15 to 30 cm thick)

Bg--46 to 67 cm; dark greenish gray (5GY 4/1) clay, gray (10YR 5/1) dry; many medium prominent brownish yellow (10YR 6/6) redox concentrations; strong coarse subangular blocky structure; rigid, very firm, very sticky and very plastic; few very fine roots; neutral (pH 6.8); clear smooth boundary. (20 to 35 cm thick)

Cg1--67 to 89 cm; dark greenish gray (10Y 4/1) clay loam, gray (10YR 6/1) dry; many medium prominent brownish yellow (10YR 6/8) redox concentrations; massive; hard, firm, moderately sticky and moderately plastic; few very fine roots; neutral (pH 7.0); gradual wavy boundary. (15 to 25 cm thick)

Cg2--89 to 152 cm; light brownish gray (10YR 6/2) very gravelly sandy clay loam, light gray (10YR 7/2) dry; many medium prominent brownish yellow (10YR 6/8) redox concentrations; massive; slightly hard, friable, slightly sticky and slightly plastic; 40 percent gravel and 5 percent cobbles; neutral (pH 7.2).

TYPE LOCATION: Beaverhead County, Montana; located about 1900 feet north and 500 feet east of the southwest corner of sec. 9, T. 11S, R. 8W; Beech Creek topographic quadrangle;

UTM 12T, 374291e, 4971989n, NAD 83.

RANGE IN CHARACTERISTICS:
Mean annual soil temperature - 1 to 4 degrees C.
Thickness of mollic epipedon - 18 to 49 cm
Depth to a seasonally high water table - 30 to 60 cm
Linear extensibility percent - averages less than 6.0 between 0 to 100 cm

Note: The Bw horizon can be part of the mollic epipedon. However, in this pedon it does not meet the rupture resistance requirement for a mollic epipedon.

A horizon
Value: 2 or 3 moist; 3 to 5 dry
Chroma: 1 or 2; moist or dry
Clay content: 20 to 27 percent
Rock fragments: 0 to 10 percent gravel
Reaction: pH 6.1 to 7.3

Bw horizon
Value: 2 or 3 moist; 3 to 5 dry
Chroma: 1 or 2; moist or dry
Texture: clay loam or silty clay loam
Clay content: 27 to 35 percent
Rock fragments: 0 to 10 percent gravel
Reaction: pH 6.1 to 7.3

Bg horizon
Hue: 10Y or 5GY moist; 10YR or 2.5Y dry
Value: 4 or 5 moist; 5 or 6 dry
Chroma: 1 or 2; moist or dry
Texture: clay loam, clay, silty clay loam or silty clay
Clay content: 35 to 50 percent
Rock fragments: 0 to 10 percent gravel
Reaction: pH 6.1 to 7.3

Cg1 horizon
Hue: 10Y or 5GY moist; 10YR or 2.5Y dry
Value: 4 or 5 moist; 5 or 6 dry
Chroma: 1 or 2; moist or dry
Texture: clay loam or silty clay loam
Clay content: 35 to 45 percent
Rock fragments: 0 to 10 percent gravel
Reaction: pH 6.1 to 7.3

Cg2 horizon
Value: 5 or 6 moist; 5 to 7 dry
Chroma: 1 or 2 moist; 2 or 3 dry
Texture: sandy clay loam or clay loam
Clay content: 27 to 35 percent

Rock fragments: 15 to 45 percent--15 to 45 percent gravel, 0 to 5 percent cobbles
Reaction: pH 6.1 to 7.3

COMPETING SERIES:
Cabarton (ID) - do not have a Bw or Bg horizon
Saladon (NM) - do not have a Bw or Bg horizon
Sawtelpeak (ID) - have a buried A horizon

GEOGRAPHIC SETTING:
Landform - flood-plain steps, stream terraces, drainageways, depressions and landslides
Elevation - 1980 to 2625 meters
Slope - 0 to 15 percent
Parent material - clayey alluvium derived from mixed sources
Climate - long, cold winters; moist springs; short warm summers
Mean annual precipitation - 380 to 900 mm
Mean annual air temperature - 1 to 4 degrees C.
Frost-free period - 30 to 70 days

GEOGRAPHICALLY ASSOCIATED SOILS: None listed.

DRAINAGE AND PERMEABILITY: Poorly drained; slow permeability.

USE AND VEGETATION: Medicinelodge soils are used mainly for irrigated pasture and rangeland. The vegetation is mainly meadow foxtail, timothy, tufted hairgrass, bluegrasses, and other miscellaneous sedges, rushes and forbs.

DISTRIBUTION AND EXTENT: Medicinelodge soils are of small extent in southwestern Montana. MLRAs - 43B, 44B.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana

SERIES ESTABLISHED: Horse Prairie-South Valley Area - Part of Beaverhead County, Montana, 2011; proposed in Beaverhead County, Montana, 2009.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - from 10 to 46 cm (A horizon)
Redoximorphic features - from 46 to 152 cm (Bg, Cg1, Cg2 horizons)
Particle-size control section - from 35 to 110 cm (part of Bw, Bg, Cg1, part of the Cg2 horizons)

Medicinelodge soils have a cryic temperature regime and an aquic moisture regime.

National Cooperative Soil Survey
U.S.A.

LOCATION POIN MT+WY

Established Series
Rev. JB-JJU-EMM
04/2014

POIN SERIES

The Poin series consists of shallow, well drained soils that formed in colluvium and residuum derived from gneiss-schist, sandstone, rhyolite, granite, quartzite or welded tuff bedrock. These soils are on bedrock floored plains, hills, ridges and mountains. Slopes are 4 to 60 percent. Mean annual precipitation is about 17 inches, and mean annual temperature is about 38 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive Lithic Haplocryolls

TYPICAL PEDON: Poin very flaggy sandy loam, native grassland. (colors are for dry soil unless otherwise noted)

A--0 to 5 inches; grayish brown (10YR 5/2) very flaggy sandy loam, very dark brown (10YR 2/2) moist; moderate very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; common very fine and fine tubular pores; 25 percent channers and 15 percent flagstones; neutral (pH 7.2); abrupt wavy boundary. (3 to 8 inches thick)

Bw1--5 to 12 inches; brown (10YR 5/3) extremely channery sandy loam, brown (10YR 4/3) moist; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine roots; common very fine and fine tubular pores; 45 channers and 15 percent flagstones; neutral (pH 7.2); clear smooth boundary.

Bw2--12 to 19 inches; pale brown (10YR 6/3) extremely flaggy sandy loam, brown (10YR 5/3) moist; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; 20 percent channers and 60 percent flagstones; neutral (pH 7.3); gradual irregular boundary. (combined thickness of Bw1, Bw2 horizons - 7 to 15 inches)

R--19 inches; fractured gneiss-schist bedrock; few fine roots in some cracks.

TYPE LOCATION: Madison County, Montana; approximately 2,500 feet north and 1,900 feet east of the southwest corner of sec. 4, T. 2S, R. 7W.

RANGE IN CHARACTERISTICS:
Soil temperature: 36 to 42 degrees F.
Mollic epipedon thickness: 7 to 15 inches
Depth to a lithic contact: 10 to 20 inches, but mainly 12 to 20 inches

Note: Some pedons may have a thin C horizon overlying the bedrock.

A horizon
Hues: 10YR or 7.5YR; dry or moist

Value: 4 or 5 dry; 2 or 3 moist
Chroma: 2 to 3; dry or moist
Texture: sandy loam, coarse sandy loam or loam
Clay content: 5 to 25 percent
Rock fragments: 5 to 60 percent--5 to 45 percent gravel or channers, 0 to 30 percent flagstones or cobbles, 0 to 5 percent stones
Reaction: pH 5.6 to 7.4

Bw1 horizon
Hues: 10YR or 7.5YR; dry or moist
Value: 4 or 5 dry; 3 or 4 moist
Chroma: 2 to 3; dry or moist
Texture: loam, sandy loam or coarse sandy loam
Clay content: 5 to 18 percent
Rock fragments: 35 to 70 percent--25 to 50 percent gravel or channers, 10 to 35 percent cobbles or flagstones
Reaction: pH 6.1 to 7.8

Bw2 horizon
Hues: 10YR or 7.5YR; dry or moist
Value: 5 or 6 dry; 4 or 5 moist
Chroma: 2 to 3; dry or moist
Texture: sandy loam or coarse sandy loam
Clay content: 5 to 18 percent
Rock fragments: 60 to 90 percent--45 to 65 percent gravel or channers, 15 to 35 percent cobbles or flagstones
Reaction: pH 6.1 to 7.8

C horizon (where present)
Hues: 10YR or 7.5YR; dry or moist
Value: 5 or 6 dry; 4 or 5 moist
Chroma: 2 to 3; dry or moist
Texture: sandy loam, coarse sandy loam or loamy sand
Clay content: 5 to 15 percent
Rock fragments: 60 to 90 percent--45 to 65 percent gravel or channers, 15 to 35 percent cobbles or flagstones
Reaction: pH 6.1 to 7.8

COMPETING SERIES:
Arrowpeak (MT) - have an udic moisture regime
Betemer (CO) - have greater than 18 percent clay throughout
Catlinsprings (MT) - have greater than 18 percent clay in the Bw horizon
Cheadle (MT) - have secondary calcium carbonate accumulation
Chokecherry (ID) - have a xeric moisture regime
Clamp (OR) - have a xeric moisture regime
Dalys (MT) - have a lithic contact at less than 10 inches
Dollarhide (ID) - have a xeric moisture regime
Eyre (CO) - do not have a cambic horizon
Irigul (WY) - do not have a cambic horizon

Irson (WY) - do not have a cambic horizon
Jonlake (NV) - have a xeric moisture regime
Labshaft (NV) - have 25 to 35 percent clay in the Bw horizon
Mccadden (UT) - have secondary calcium carbonate accumulation
Rogert (CO) - do not have a cambic horizon
Schwacheim (CO) - have an udic moisture regime
Starley (WY) - have secondary calcium carbonate accumulation
Topeki (NV) - have a xeric moisture regime
Trump (CO) - have secondary calcium carbonate accumulation
Udel (NV) - have a lithic contact at less than 10 inches

GEOGRAPHIC SETTING:
Landform - bedrock floored plains, hills, ridges and mountains
Elevation - 5,500 to 8,500 feet
Slope - 4 to 60 percent
Parent material - colluvium and residuum derived from gneiss-schist, sandstone, rhyolite, granite, quartzite or welded tuff bedrock
Climate - cool with long, cold winters and moist springs
Mean annual precipitation - 14 to 24 inches
Mean annual temperature - 34 to 40 degrees F.
Frost-free period - 30 to 70 days

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Oro fino and Sebud soils. These soils are very deep and occur on similar landforms.

DRAINAGE AND PERMEABILITY: Well drained; moderately rapid permeability.

USE AND VEGETATION: These soils are used mainly as rangeland. The potential native vegetation is mainly bluebunch wheatgrass, Idaho fescue, Columbia needlegrass, forbs and shrubs.

DISTRIBUTION AND EXTENT: These soils are of moderate extent in southwestern Montana. MLRAs - 43B, 44B, 46, 48A.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES ESTABLISHED: Madison County, Montana, 1983.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - from 0 to 7 inches mixed (A, part of Bw1 horizons)
Cambic horizon - from 7 to 19 inches (part of Bw1, Bw2 horizons)
Lithic contact - at 19 inches (R horizon)
Particle-size control section - from 10 to 19 inches (part of Bw1, Bw2 horizons)

Poin soils have a cryic temperature regime an ustic moisture regime.

LOCATION RAYNESFORD MT+WY

Established Series
Rev. EW-JJU-RJS
06/2011

RAYNESFORD SERIES

The Raynesford series consists of very deep, well drained soils that formed in alluvium, slope alluvium or colluvium derived mainly from limestone or marly shale. These soils are on alluvial fans, fan remnants, swales, drainageways, stream terraces, hills and mountain slopes. Slopes are 0 to 45 percent. The mean annual precipitation is about 500 mm, and the mean annual air temperature is about 2.5 degrees C.

TAXONOMIC CLASS: Fine-loamy, carbonatic Calcic Haplocryolls

TYPICAL PEDON: Raynesford loam, in rangeland (colors are for dry soil unless otherwise noted).

A--0 to 30 cm; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate very fine granular structure; soft, very friable, slightly sticky and nonplastic; many very fine, fine and medium roots; many very fine and fine dendritic tubular pores; 10 percent gravel; slightly alkaline (pH 7.6); clear smooth boundary. (25 to 39 cm thick)

Bk1--30 to 53 cm; pale yellow (2.5Y 7/4) gravelly silt loam, light yellowish brown (2.5Y 6/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; many very fine and fine dendritic tubular pores; 20 percent gravel and 5 percent cobbles; many soft masses of calcium carbonate and continuous distinct calcium carbonate crusts on underside of rock fragments; violently effervescent; moderately alkaline (pH 8.2); clear wavy boundary. (20 to 65 cm thick)

Bk2--53 to 69 cm; pale yellow (2.5Y 8/4) very gravelly silt loam, very pale brown (10YR 7/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few very fine and fine roots; common very fine and fine dendritic tubular pores; 25 percent gravel and 10 percent cobbles; many soft masses of calcium carbonate and continuous distinct calcium carbonate crusts on underside of rock fragments; violently effervescent; moderately alkaline (pH 8.4); clear wavy boundary.

Bk3--69 to 152 cm; pale yellow (2.5Y 8/4) gravelly silt loam, very pale brown (10YR 7/4) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few very fine and fine roots; 15 percent gravel and 5 percent cobbles; finely disseminated calcium carbonate and continuous distinct calcium carbonate coats on rock fragments; violently effervescent; moderately alkaline (pH 8.4). (combined thickness of Bk2, Bk3 horizons - greater than 50 cm)

TYPE LOCATION: Beaverhead County, Montana; Eli Spring topographic quadrangle; UTM 12T, 345987e, 4992488n, NAD 83.

RANGE IN CHARACTERISTICS:
Mean annual soil temperature - 1.5 to 5.0 degrees C.
Mollic epipedon thickness - 25 to 39 cm
Depth to calcic horizon - 25 to 39 cm
Particle-size control section (weighted average) - less than 35 percent rock fragments
Particle-size control section (weighted average) - 18 to 35 percent clay

Note: Some pedons may have a Bw horizon with mollic colors.

A horizon
Hue: 10YR or 2.5Y; dry or moist
Value: 3 or 4 dry; 1 to 3 moist
Chroma: 1 or 2; dry or moist
Texture: loam, silt loam or clay loam
Clay content: 18 to 30 percent
Rock fragments: 0 to 35 percent--0 to 30 percent gravel, 0 to 20 percent cobbles, 0 to 5 percent stones
Reaction: pH 6.4 to 7.8

Bk1 horizon
Hue: 2.5Y, 10YR or 7.5YR; dry or moist
Value: 6 to 8 dry; 5 to 7 moist
Chroma: 1 to 4; dry or moist
Texture: loam, silt loam or clay loam
Clay content: 15 to 35 percent
Rock fragments: 0 to 35 percent--0 to 25 percent gravel, 0 to 10 percent cobbles
Calcium carbonate equivalent: 40 to 50 percent
Reaction: pH 7.9 to 8.4

Bk2, Bk3 horizons
Hue: 2.5Y, 10YR or 7.5YR; dry or moist
Value: 6 to 8 dry; 5 to 7 moist
Chroma: 1 to 4; dry or moist
Texture: loam, silt loam, clay loam or silty clay loam
Clay content: 10 to 35 percent
Rock fragments: 10 to 60 percent--10 to 40 percent gravel, 0 to 25 percent cobbles
Calcium carbonate equivalent: 40 to 50 percent
Reaction: pH 7.9 to 8.4

COMPETING SERIES: There are no competing series.

GEOGRAPHIC SETTING:
Landform - alluvial fans, fan remnants, swales, drainageways, stream terraces, hills and mountain slopes
Elevation - 1,400 to 2,750 meters
Slope - 0 to 45 percent
Parent material - alluvium, slope alluvium or colluvium derived mainly from limestone or marly shale

Climate - long, cold winters; cool, moist springs; short summers
Mean annual precipitation - 380 to 600 mm
Mean annual air temperature - 1.0 to 4.5 degrees C.
Frost-free period - 30 to 70 days

GEOGRAPHICALLY ASSOCIATED SOILS: None listed.

DRAINAGE AND PERMEABILITY: Well drained; moderate permeability.

USE AND VEGETATION: Raynesford soils are used mainly for grazing. Potential native vegetation is mainly rough fescue, Idaho fescue, bluebunch wheatgrass, Richardson's needlegrass, mountain brome, forbs and shrubs.

DISTRIBUTION AND EXTENT: Raynesford soils are moderately extensive and in central and southwestern Montana, and Wyoming. MLRAs - 43B, 44B and 46.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES ESTABLISHED: Judith Basin County, Montana, 1963.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - from 0 to 30 cm (A horizon)
Calcic horizon - from 30 to 152 cm (Bk1, Bk2, Bk3 horizons)
Particle-size control section - from 25 to 100 cm (part of A, Bk1, Bk2, part of Bk3 horizons)

Raynesford soils have a cryic temperature regime and an ustic moisture regime.

Note: In 2011, the type location was moved to Beaverhead County because the profile description did not meet the taxonomic classification.

ADDITIONAL DATA: Soil interpretation records - MT0119, MT0665, MT1681.

National Cooperative Soil Survey
U.S.A.

LOCATION REDCHIEF MT

Established Series
Rev. JB-JJU-RJS
06/2011

REDCHIEF SERIES

The Redchief series consists of very deep, well drained soils that formed in till, glaciofuvial deposits, slope alluvium or colluvium. These soils are on till plains, outwash plains, hills, and mountains. Slopes are 0 to 60 percent. Mean annual precipitation is about 18 inches, and mean annual air temperature is about 39 degrees F.

TAXONOMIC CLASS: Clayey-skeletal, smectitic Ustic Argicryolls

TYPICAL PEDON: Redchief gravelly loam, rangeland (colors are for dry soil unless otherwise noted).

A--0 to 10 inches; very dark grayish brown (10YR 3/2) gravelly loam, very dark brown (10YR 2/2) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and slightly plastic; many very fine and fine, and common medium roots; many very fine and fine interstitial pores; 20 percent gravel and 5 percent cobbles; moderately acid (pH 5.6); clear wavy boundary. (10 to 16 inches thick)

Bt1--10 to 18 inches; yellowish brown (10YR 5/4) very gravelly clay loam, dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; hard, friable, slightly sticky and moderately plastic; common very fine and fine, and few medium and coarse roots; many very fine, fine and medium interstitial pores; many faint clay films of faces of peds; 35 percent gravel and 15 percent cobbles; slightly acid (pH 6.1); clear wavy boundary. (5 to 10 inches thick)

Bt2--18 to 28 inches; light yellowish brown (10YR 6/4) very gravelly clay loam, yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; very hard, friable, moderately sticky and moderately plastic; few very fine and fine roots; common very fine and fine interstitial pores; many faint clay films on faces of peds; 35 percent gravel and 20 percent cobbles; neutral (pH 6.6); gradual wavy boundary. (4 to 12 inches thick)

Bt3--28 to 60 inches; pale brown (10YR 6/3) extremely gravelly clay loam; dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; very hard, friable, moderately sticky and moderately plastic; few very fine and fine roots; few very fine and fine interstitial pores; many faint clay films on faces of peds; 45 percent gravel and 20 percent cobbles; neutral (pH 6.6).

TYPE LOCATION: Powell County, Montana; 1,900 feet north and 50 feet west of the southeast corner of sec. 3, T. 10N, R. 6W.

RANGE IN CHARACTERISTICS:
Soil temperature - 36 to 45 degrees F.

Mollic epipedon thickness - 10 to 16 inches
Depth to base of argillic horizon - greater than 50 inches

A horizon
Hue: 10YR or 7.5YR; dry or moist
Value: 2 to 5 dry; 2 or 3 moist
Chroma: 1 to 3; dry or moist
Texture: loam or clay loam
Clay content: 20 to 35 percent
Rock fragments: 15 to 40 percent--5 to 35 percent gravel, 0 to 25 percent cobbles, stones and boulders
Reaction: pH 5.1 to 7.3

Bt1 horizon
Hue: 5YR, 7.5YR or 10YR; dry or moist
Value: 4 or 5 dry; 3 or 4 moist
Chroma: 2 to 8; dry or moist
Texture: clay loam or clay
Clay content: 35 to 60 percent
Rock fragments: 25 to 60 percent--15 to 50 percent gravel, 0 to 20 percent cobbles and stones
Reaction: pH 5.1 to 7.3

Bt2 horizon
Hue: 5YR, 7.5YR or 10YR; dry or moist
Value: 4 to 6 dry; 4 or 5 moist
Chroma: 4 to 8; dry or moist
Clay content: 35 to 60 percent
Rock fragments: 35 to 70 percent--30 to 50 percent gravel, 5 to 30 percent cobbles and stones
Reaction: pH 5.1 to 7.3

Bt3 horizon
Hue: 2.5YR, 5YR, 7.5YR or 10YR; dry or moist
Value: 4 to 6 dry; 4 or 5 moist
Chroma: 2 to 8; dry or moist
Clay content: 35 to 60 percent
Rock fragments: 35 to 70 percent--30 to 60 percent gravel, 5 to 20 percent cobbles and stones
Reaction: pH 5.1 to 7.3

COMPETING SERIES:
Embargo (CO) - are moderately deep to a lithic contact
Evna (CO) - have 5 to 30 percent boulders in the Range In Characteristics for the Bt horizons
Passar (CO) - have rock fragments mainly larger than 10 inches in diameter
Rooset (WY) - have secondary calcium carbonate accumulation
Tellura (CO) - the base of the argillic horizon is at a depth of less than 50 inches

GEOGRAPHIC SETTING:
Landform - till plains, outwash plains, hills and mountains
Elevation - 4,800 to 8,600 feet
Slope - 0 to 60 percent

Parent material - till, glaciofluvial deposits, slope alluvium or colluvium
Climate - long, cold winters; cool, moist springs; warm summers
Mean annual precipitation - 15 to 24 inches
Mean annual air temperature - 34 to 43 degrees F.
Frost-free period - 30 to 70 days

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Copenhaver and Mollet series. Copenhaver soils are loamy-skeletal and shallow to a lithic contact. They are on hills. Mollet soils are fine textured and on alluvial fans.

DRAINAGE AND PERMEABILITY: Well drained; slow permeability.

USE AND VEGETATION: Redchief soils are used for rangeland except for a few fields of introduced grasses for hay and pasture. Potential native vegetation is mainly rough fescue, Idaho fescue, bluebunch wheatgrass, Columbia needlegrass, forbs, and shrubs. Scattered lodgepole pine, aspen, and alpine fir are present in higher elevation areas.

DISTRIBUTION AND EXTENT: Redchief soils are of moderate extent in central and western Montana. MLRAs - 43B, 44B, 46.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES ESTABLISHED: Glacier County (Blackfeet Reservation), Montana, 1969. Type location moved to Powell County, Montana, 1993.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - from 0 to 10 inches (A horizon)
Argillic horizon - from 10 to greater than 60 inches (Bt1, Bt2, Bt3 horizons)
Particle-size control section from 10 to 30 inches (Bt1, Bt2, part of Bt3 horizons)

Redchief soils have a cryic temperature regime and an ustic moisture regime.

ADDITIONAL DATA: Soil interpretations records - MT0453, MT8192, MT8077, MT8193, MT9030.

National Cooperative Soil Survey
U.S.A.

LOCATION REDFISH ID+MT
Established Series
Rev. KWH/CBR/FCF
02/2008

REDFISH SERIES

The Redfish series consists of very deep, poorly and very poorly drained soils that formed in alluvium. Redfish soils are on flood plains, fan remnants, and valley floors. Slopes are 0 to 4 percent. The average annual precipitation is about 356 mm and the average annual air temperature is about 2 degrees C.

TAXONOMIC CLASS: Sandy-skeletal, mixed Typic Cryaquolls

TYPICAL PEDON: Redfish mucky peat, in a pasture; on a 1 percent slightly concave slope at 2103 meters elevation. When described on July 17, 1985 the soil was moist from the surface to a water table at 36 cm. (Colors are for dry soil unless otherwise noted.)

Oe--0 to 8 cm; mucky peat. (0 to 15 cm thick)

A--8 to 18 cm; grayish brown (10YR 5/2) gravelly sandy loam, very dark grayish brown (2.5Y 3/2) moist; weak fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; common very fine and fine tubular pores; 25 percent gravel; moderately acid (pH 5.8); clear smooth boundary. (8 to 30 cm thick)

Ag1--18 to 28 cm; grayish brown (2.5Y 5/2) very gravelly sandy loam, very dark grayish brown (2.5Y 3/2) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine and fine roots; common very fine and fine tubular pores; few fine prominent brown (10YR 5/3) iron masses; 45 percent fine gravel; moderately acid (pH 5.8); clear smooth boundary.

Ag2--28 to 46 cm; grayish brown (2.5Y 5/2) very gravelly sandy loam, very dark grayish brown (2.5Y 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; common very fine and fine tubular pores; common fine prominent strong brown (7.5YR 5/6) and reddish yellow (7.5YR 6/6) iron masses; 50 percent fine gravel; moderately acid (pH 6.0); gradual smooth boundary.

Ag3--46 to 64 cm; grayish brown (2.5Y 5/2) very gravelly sandy loam, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; common very fine and fine tubular pores; 50 percent fine gravel, 5 percent cobbles; moderately acid (pH 6.0); gradual wavy boundary. (Combined thickness of the Ag horizons or when present the Bg horizon is 0 to 50 cm)

2Cg--64 to 160 cm; grayish brown (2.5Y 5/2) extremely gravelly coarse sand, dark grayish brown (2.5Y 4/2) moist; single grain; loose; nonsticky and nonplastic; few very fine roots; common fine irregular pores; 55 percent gravel, 15 percent cobbles; moderately acid (pH 6.0).

TYPE LOCATION: Blaine County, Idaho; about 3.2 kilometers east of Pettit Lake; about 213 meters south and 183 meters west of the northeast corner of section 32, T. 8 N., R. 14 E.

RANGE IN CHARACTERISTICS:
Mollic epipedon thickness: 25 to 46 cm
Depth to high water table: 30 cm above to 30 cm below the surface in March to November
Depth to redoximorphic features (iron concentrations/depletions): 0 to 40 cm
Control section total clay: 4 to 10 percent
Depth to the sandy-skeletal material (2Cg horizon: 25 to 64 cm
Rock fragments: 5 to 60 percent rounded gravels in the mineral horizons; average of more than 35 percent in the particle size control section
Soil reaction: neutral to slightly alkaline
Calcium carbonate equivalent: less than 5 percent in horizons directly below the mollic epipedon, occasionally greater than 5 percent in lower subsoil
Mean annual soil temperature: 1.7 to 7.2 degrees C.
Mean summer soil temperature: 4.4 to 12.8 degrees C. (The O horizon is not always present) cryic temperature regime

A and Ag horizons
Hue: 10YR to 5Y
Value: 3 to 6 dry, 2 to 4 moist
Chroma: 1 to 3 dry or moist
Texture: L or SL with 5 to 40 percent gravel
Rock fragments: 5 to 40 percent gravel
Redoximorphic features (where they occur): 7.5YR or 10YR, value 3 to 5, chroma 4 or 6 moist

Bw horizon (when present)
Hue: 10YR or 2.5Y moist
Value: 3 or 4 moist
Chroma: 2 or 3 moist
Texture: GR-SL, GRV-SL, GRX-L
Rock fragments: 20 to 65 percent total; 20 to 55 percent gravel; 0 to 10 percent cobble
Redoximorphic features (where they occur): 5YR to 10YR, value 3 to 5, chroma 4 or 6 moist
Calcium carbonate equivalent: less than 5 percent

2Cg horizon
Texture: GRX-COS or GRX-LCOS
Rock fragments: 60 to 90 percent total; 40 to 60 percent gravel; 15 to 30 percent cobble

COMPETING SERIES: This is the Newfork series. Newfork soils have a mean summer soil temperatures of 11.1 to 14.4 degrees C.

GEOGRAPHIC SETTING:
Landscape: Alluvial plain, outwash plain
Landform: Flood plain, fan remnant, valley floor
Elevation: 1372 to 2256 meters
Slope: 0 to 4 percent

Parent material: Alluvium
Mean annual precipitation: 250 to 510 mm
Mean annual air temperature: 1.1 to 6 degrees C
Climate: The cool subhumid continental climate has warm summers and cold moist winters.
Frost free period: 5 to 60 days

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Busterback, Fezip, Lilylake, Foxcreek, Furniss, Boquet, Zohner, Driggs, Feltonia, Badgerton, and Wiggleton soils. Busterback soils are on outwash fans and stream terraces, are pachic and have loamy-skeletal particle-size control sections. Fezip soils are on flood plains and have strongly contrasting particle-size control sections. Lilylake soils are on flood plains and have histic epipedons that are 25 to 41 cm thick. Foxcreek soils are on valley floors, flood plains and lower fan remnants and are fine-loamy over sandy or sandy-skeletal. Furniss and Boquet soils are on valley floors, swales, and flood plains and are fine-loamy. Zohner soils are on valley floors and are fine-loamy. Driggs, Feltonia, Badgerton and Wiggleton soils are on fan remnants and have a xeric soil moisture regime.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY:
Drainage class: Poorly and very poorly drained
Runoff: Negligible to very low
Saturated hydraulic conductivity: High over very high
Flooding frequency and duration: Occasional to frequent flooding for brief to long periods in March to August.

USE AND VEGETATION:
Major uses: Pasture and hay
Range/ecological site:
R043AY007ID
R043AY011ID
R013XY038ID
R013XY049ID
Dominant native vegetation: grasses, sedges, and willows or cottonwoods

DISTRIBUTION AND EXTENT:
Distribution: Central Idaho and Southwest Montana; MLRA 12, 13, 43 and 44
Extent: These soils are not extensive.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Portland, Oregon

SERIES ESTABLISHED: Custer County, Idaho, 1999

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon: The zone from 8 to 46 cm
Redoximorphic features (iron concentrations/depletions): Beginning at a depth of 5 cm
Particle-size control section: From a depth of 25 to 100 cm
Soil temperature regime: Cryic
Soil moisture regime: Aquic

LOCATION SEBUD MT+ID WY

Established Series
Rev. DES-JJU-EMM
06/2014

SEBUD SERIES

The Sebud series consists of very deep, well drained soils that formed in till, outwash, alluvium, slope alluvium and colluvium derived from igneous, metamorphic or sedimentary rock. These soils are on alluvial fans, fan remnants, till plains, moraines, hills and mountains. Slopes are 2 to 60 percent. Mean annual precipitation is about 22 inches, and mean annual air temperature is about 40 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive Ustic Haplocryolls

TYPICAL PEDON: Sebud loam, with 3 percent surface stones and boulders, in rangeland (colors are for dry soil unless otherwise noted).

A1--0 to 4 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak granular structure; soft, friable, nonsticky and nonplastic; many very fine and fine roots; 10 percent gravel; neutral (pH 7.2); clear boundary.

A2--4 to 10 inches; dark grayish brown (10YR 4/2) very stony clay loam, very dark grayish brown (10YR 3/2) moist; very dark brown (10YR 2/2) moist coatings; moderate fine and medium blocky structure; slightly hard, friable, moderately sticky and moderately plastic; many very fine roots; many very fine pores; 10 percent gravel and cobbles, 40 percent stones and 1 percent boulders; slightly alkaline (pH 7.5); clear wavy boundary. (combined thickness of A1, A2 horizons - 10 to 16 inches)

Bw1--10 to 22 inches; yellowish brown (10YR 5/4) very stony clay loam, dark brown (10YR 3/3) moist; dark yellowish brown (10YR 3/4) moist coatings; moderate fine and medium subangular blocky structure; slightly hard, friable, moderately sticky and moderately plastic; few very fine roots; few very fine pores; 10 percent gravel and cobbles, 40 percent stones and 1 percent boulders; slightly alkaline (pH 7.4); clear smooth boundary. (8 to 14 inches thick)

Bw2--22 to 28 inches; light yellowish brown (10YR 6/4) very stony coarse sandy clay loam, yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly moderately sticky and slightly plastic; few very fine roots; few very fine pores; 5 percent gravel and cobbles, 40 percent stones and 1 percent boulders; slightly alkaline (pH 7.6); gradual boundary.

Bw3--28 to 49 inches; very pale brown (10YR 7/3) very stony coarse sandy clay loam, yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and moderately plastic; few very fine roots; many clear quartz sand grains, 5 percent gravel and cobbles, 40 percent stones and 1 percent boulders; slightly alkaline (pH 7.8); gradual boundary.

Bw4--49 to 62 inches; very pale brown (10YR 7/3) very stony clay loam, yellowish brown (10YR 5/4) moist; moderate coarse subangular blocky structure; hard, firm, moderately sticky and moderately plastic; few very fine tubular pores; 5 percent gravel and cobbles, 40 percent stones and 1 percent boulders; slightly alkaline (pH 7.8).

TYPE LOCATION: Carbon County, Montana; 2,900 feet west and 1,000 feet south of the northeast corner of sec. 16, T. 6S, R. 18E.

RANGE IN CHARACTERISTICS:
Mean annual soil temperature - 36 to 46 degrees F.
Mollic epipedon thickness - 10 to 16 inches
Particle-size control section (weighted average) - 18 to 35 percent clay

Note: Some pedons may have a BC and/or C horizons.

A1, A2 horizons
Hue: 2.5Y or 10YR; dry or moist
Value: 3 or 4 dry; 2 or 3 moist
Chroma: 1 to 3; dry or moist
Texture: loam or sandy loam
Clay content: 12 to 27 percent
Rock fragments: 10 to 60 percent--5 to 25 percent gravel, 0 to 45 percent cobbles or stones
Reaction: pH 6.1 to 7.8

Bw1, Bw2, Bw3, Bw4 horizons
Hue: 2.5Y or 10YR; dry or moist
Value: 5 to 7 dry; 3 to 6 moist
Chroma: 2 to 4; dry or moist
Texture: loam, clay loam, sandy clay loam, coarse sandy loam or sandy loam
Clay content: 15 to 35 percent
Rock fragments: 35 to 60 percent--5 to 40 percent gravel, 5 to 45 percent cobbles, stones or boulders
Reaction: pH 5.6 to 7.8

BC, C horizons (where present)
Hue: 2.5Y or 10YR; dry or moist
Value: 5 to 7 dry; 3 to 6 moist
Chroma: 2 to 4; dry or moist
Texture: loam, clay loam, sandy clay loam, coarse sandy loam or sandy loam
Clay content: 15 to 30 percent
Rock fragments: 45 to 70 percent--30 to 55 percent gravel, 5 to 30 percent cobbles, stones or boulders
Reaction: pH 5.6 to 7.2

COMPETING SERIES:
Antrobus (CO) - do not have a cambic horizon
Grafen (CO) - are moderately deep to a paralithic contact
Greyback (WY) - have secondary calcium carbonate accumulation

Handran (CO) - do not have a cambic horizon
Maurice (MT) - average less than 18 percent clay in the particle-size control section
Mccort (WY) - average less than 18 percent clay in the particle-size control section
Midelight (WY) - are deep to a lithic contact
Parachute (CO) - are moderately deep to a lithic contact
Supervisor (NM) - are moderately deep to a lithic contact
Surdal (MT) - are moderately deep to a lithic contact
Teemat (WY) - have secondary calcium carbonate accumulation
Thornburgh (CO) - average less than 18 percent clay in the particle-size control section
Tiban (MT) - have secondary calcium carbonate accumulation
Tineman (WY) - have a lithologic discontinuity
Vanwirt (CO) - have Bt horizons

GEOGRAPHIC SETTING:
Landform - alluvial fans, fan remnants, till plains, outwash fans, moraines, hills, and mountains
Elevation - 4,500 to 8,450 feet
Slope - 2 to 60 percent
Parent material - till, alluvium, slope alluvium and colluvium derived from igneous, metamorphic or sedimentary rock
Climate - long, cold winters; moist springs; early, cool summers; and late falls
Mean annual air temperature - 34 to 44 degrees F.
Mean annual precipitation - 14 to 35 inches
Frost-free period - 30 to 70 days

GEOGRAPHICALLY ASSOCIATED SOILS: None listed.

DRAINAGE AND PERMEABILITY: Well drained; moderate permeability.

USE AND VEGETATION: Sebud soils are used mainly for rangeland. Potential native vegetation is mainly western wheatgrass, rough fescue, bluebunch wheatgrass, green needlegrass, Idaho fescue, annual forbs, and woody plants.

DISTRIBUTION AND EXTENT: Sebud soils are of small extent in Montana and Wyoming. MLRAs - 43B, 44B, 46.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES ESTABLISHED: Carbon County (Bridger Area), Montana, 1971.

REMARKS: Diagnostic horizons and features recognized in this soil are:
Mollic epipedon - from 0 to 10 inches (A1, A2 horizons)
Cambic horizon - from 10 to 60 inches (Bw1, Bw2, Bw3, Bw4 horizons)
Particle-size control section - from 10 to 40 inches (Bw1, Bw2, part of Bw3 horizons)

Sebud soils have a cryic temperature regime and an ustic moisture regime that borders on udic.

ADDITIONAL DATA: Soil interpretations records - MT0190, MT0669, MT1108, MT0247.

National Cooperative Soil Survey
U.S.A.

LOCATION WINEGLASS MT
Tentative Series
Rev. TDL/EMM
06/2005

WINEGLASS SERIES

The Wineglass series consists of very deep, well drained soils that formed in colluvium, alluvium and residuum derived from mixed rock sources. These soils are on mountain sideslopes. Slopes are 8 to 65 percent. Mean annual precipitation is about 21 inches, and the mean annual temperature is about 36 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive Calcic Pachic Argicryolls

TYPICAL PEDON: Wineglass very gravelly loam, forested, on a 26 percent slope at 5480 feet elevation. When described on October 26, 1999 the soil was dry throughout. (Colors are for air dry soil unless otherwise noted).

Oi--0 to 1 inch; slightly decomposed plant material; clear smooth boundary. (1 to 3 inches thick)

A--1 to 12 inches; very dark gray (10YR 3/1) very gravelly loam, black (10YR 2/1) moist; strong fine and moderate medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and common medium roots; common fine and medium irregular pores; 25 percent gravel and 10 percent cobbles; slightly alkaline (pH 7.4); clear wavy boundary. (6 to 12 inches thick)

Bt1--12 to 25 inches; very dark grayish brown (10YR 3/2) gravelly clay loam, very dark brown (10YR 2/2) moist; moderate coarse and moderate very coarse subangular blocky structure; slightly hard, friable, nonsticky and slightly plastic; many fine and common medium roots; common fine and medium irregular pores; few distinct and faint clay films on vertical faces of peds; 20 percent gravel and 10 percent cobbles; neutral (pH 7.2); clear wavy boundary.

Bt2--25 to 34 inches; brown (10YR 4/3) cobbly clay loam, very dark grayish brown (10YR 3/2) moist; moderate coarse and very coarse subangular blocky structure; hard, very firm, nonsticky and slightly plastic; common fine and medium roots; many fine and common medium irregular pores; few distinct clay films on faces of peds and few distinct clay films on surfaces along root channels; 15 percent gravel and 10 percent cobbles; slightly alkaline (pH 7.5); clear wavy boundary. (Combined thickness of Bt horizons is 10 to 24 inches thick)

Bk1--34 to 44 inches; brownish yellow (10YR 6/6) extremely cobbly loam, yellowish brown (10YR 5/6) moist; moderate medium and coarse subangular blocky structure; hard, very firm, nonsticky and nonplastic; common fine medium and coarse roots; common medium and coarse irregular pores; common fine faint carbonate coats around and on the bottom surfaces of rock fragments; common fine prominent carbonate masses on faces of peds; few fine prominent carbonate nodules; 35 percent gravel and 30 percent cobbles; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary. (10 to 20 inches thick)

Bk2--44 to 60 inches; brownish yellow (10YR 6/6) extremely cobbly loam, yellowish brown (10YR 5/8) moist; weak fine subangular blocky structure; very hard, extremely firm, nonsticky and nonplastic; common fine medium and very coarse roots; common medium and few coarse irregular pores; common fine faint carbonate coats around and on the bottom surfaces rock fragments; common fine prominent carbonate masses throughout; 30 percent gravel, 30 percent cobbles and 5 percent stones; violently effervescent; moderately alkaline (pH 8.4).

TYPE LOCATION: Park County, Montana; Brisbin topographic quadrangle; UTM zone 12T, 0537476E, 5050493 N, NAD83.

RANGE IN CHARACTERISTICS:

Mean annual soil temperature - 36 to 40 degrees F.
Moisture control section - between 4 and 12 inches.
Mollic epipedon thickness - 16 to 40 inches.
Depth to argillic horizon 4 to 25 inches.
Depth to calcic horizon 18 to 40 inches.
Clay content 27 to 35 in the particle size control section.
Rock fragments 5 to 35 percent in the particle size control section, greater than 35 percent in the Bk horizons.
Soil phases very stony and extremely bouldery.

A horizon - Value: 3 or 4 dry; 2 or 3 moist
Chroma: 1 or 2
Texture: sandy loam or loam
Clay content: 12 to 25 percent
Rock fragments: 5 to 35 percent--5 to 25 percent gravel, 0 to 10 percent cobbles, 0 to 5 percent stones
Reaction: pH 7.2 to 8.4

Bt horizon - Value: 3 to 6 dry; 2 to 4 moist
Chroma: 2 to 4
Texture: sandy clay loam or clay loam
Clay content: 22 to 35 percent
Rock fragments: 5 to 35 percent--5 to 25 percent gravel, 0 to 10 percent cobbles
Reaction: pH 7.2 to 7.8

Bk horizon - Value: 5 or 6 dry; 4 or 5 moist
Chroma: 6 to 8
Texture: sandy clay loam, clay loam or loam
Clay content: 20 to 35 percent
Rock fragments: 35 to 70 percent--10 to 35 percent gravel,
10 to 35 percent cobbles, 0 to 10 percent stones
Calcium carbonate equivalent: 15 to 40 percent
Reaction: pH 7.9 to 8.4

COMPETING SERIES:

Decross (WY) - has Bk horizons with less than 35 percent rock fragments and does not have an O horizon.

GEOGRAPHIC SETTING:

Landform - Mountain sideslopes.
Elevation - 5,000 to 8,700 feet.
Slope - 8 to 65 percent.
Parent material colluvium, alluvium and residuum derived from mixed rock sources.
Climate - long, cold winters; cool, moist springs; short summers.
Mean annual precipitation - 17 to 25 inches.
Mean annual air temperature - 34 to 38 degrees F.
Frost-free period - 50 to 70 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Woodhall and Booneville series. Woodhall soils are not pachic and are on upland hills, ridges, mesa and mountain side slopes. Booneville soils are loamy-skeletal and are on concave back slopes and foot slopes of mountains and foothills.

DRAINAGE AND PERMEABILITY: Well drained; moderately slow permeability.

USE AND VEGETATION: Wineglass soils are used mainly for understory grazing and wildlife habitat. Native vegetation is mainly Douglas fir, choke cherry, common snowberry, rose, brome, bedstraw, timothy, heartleaf arnica and lupine.

DISTRIBUTION AND EXTENT: Wineglass soils are of small extent in south western and south central Montana. MLRA 43B

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES PROPOSED: Park County, Montana, 2005. Wineglass is named after nearby Wineglass Mountain.

REMARKS: Diagnostic horizons and features recognized in this pedon are:

Mollic epipedon the zone 1 to 34 inches (A, Bt1 and Bt2 horizons).

Argillic horizon the zone from 12 to 34 inches (Bt1 and Bt2 horizons).

Calcic horizon the zone from 34 to 60 inches (Bk1 and Bk2 horizons).

Particle size control section from 12 to 32 inches (Bt1 and part of the Bt2 horizon).

Wineglass soils have a cryic temperature regime and an ustic moisture regime.

LOCATION WOODHALL CO+MT

Established Series
Rev. RHM/AJS/EMM
04/2014

WOODHALL SERIES

The Woodhall series consists of moderately deep, well drained soils that formed in noncalcareous gravelly colluvium and or slope alluvium derived from igneous and sedimentary rock. Woodhall soils are on upland hills, ridges, structural benches, u-shaped valleys, mesa and mountain side slopes. Slopes range from 3 to 65 percent. The mean annual precipitation is about 20 inches. Mean annual temperature is about 40 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive Ustic Argicryolls

TYPICAL PEDON: Woodhall stony loam - mixed grass and timber. (Colors are for dry soil unless otherwise noted.)

A--0 to 5 inches; dark grayish brown (10YR 4/2) stony loam, very dark brown (10YR 2/2) moist; strong fine granular and crumb structure; soft, very friable, slightly plastic; 20 percent stones; neutral; clear smooth boundary. (0 to 8 inches thick)

BA--5 to 9 inches; brown (10YR 5/3) very stony loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure parting to strong fine granular; hard, friable, slightly plastic; few faint clay films on faces of peds and in some root channels; 40 percent stones; neutral; gradual smooth boundary. (0 to 6 inches thick)

Bt--9 to 20 inches; brown (10YR 5/3) very stony clay loam, brown (10YR 4/3) moist; moderate medium subangular blocky structure; very hard, friable, sticky and plastic; many distinct clay films on faces of peds, in root channels, and on surfaces of many rock fragments; 50 percent stones; neutral; gradual smooth boundary. (6 to 30 inches thick)

BC--20 to 24 inches; brown (10YR 5/3) extremely stony loam, brown (10YR 4/3) moist; weak fine subangular blocky structure; very hard, friable, slightly plastic; 60 percent stones; neutral; gradual wavy boundary. (0 to 6 inches thick)

R--24 inches; rhyolite.

TYPE LOCATION: Gunnison County, Colorado; near the center of Sec. 1, T. 46 N., R. 3 W.

RANGE IN CHARACTERISTICS:
Soil moisture regime: ustic-udic
Mean annual soil temperature: 34 to 44 degrees F (1.1 to degrees C)
Mean summer soil temperature: 42 to 52 degrees F (5.6 to 11.1 degrees C)
Depth to bedrock (lithic): 20 to 40 inches (51 to 102 centimeters)
Depth to top of argillic: less than 24 inches (61 centimeters)

Depth to base of argillic: 15 to 40 inches (38 to 102 centimeters)
Thickness of mollic epipedon: 4 to 15 inches (10 to 38 centimeters)
Thickness of argillic: 19 to 23 inches (48 to 58 centimeters)
Rock fragments: 35 to 75 percent by volume in the solum and C horizon and are greater than 10 inches (25 centimeters) in diameter.
Reaction of solum: slightly acid to slightly alkaline

A horizon:
Hue: 5Y to 7.5YR
Value: 3 to 5 dry, 2 or 3 moist
Chroma: 1 to 3, dry or moist
Rock fragments: less than 35 percent (in some pedons)

Bt horizon:
Hue: 5Y to 7.5YR
Value: 4 to 6 dry, 2 to 5 moist
Chroma: 2 to 5, dry or moist
Texture: clay loam, sandy clay loam, or loam
Clay: 18 to 34 percent
Sand: 20 to 70 percent with more than 15 percent fine or coarser sand
Silt: 5 to 65 percent
Rock fragments: 35 to 75 percent

BC or C horizon:
Hue: 5Y to 7.5YR
Value: 4 to 6 dry; 3 to 5 moist
Chroma: 2 or 3, dry or moist
Texture: loam, fine sandy loam, or sandy loam
Clay content: 5 to 18 percent
Sand content: 30 to 60 percent
Silt content: 30 to 65 percent
Rock fragments: 35 to 75 percent

COMPETING SERIES:
Anniesdraw soils (WY) - are very deep
Bassel soils (CO) - are deep to a paralithic contact.
Blaine soils (MT) - have calcic horizons
Bowen soils - (CO) have mica fragments throughout the profile
Fingerrock soils (CO) - are very deep
Fornor soils (WY) - are very deep
Fourmile soils (CO) - are very deep
Geertsen soils (UT) - are deep
Hoodle soils (UT) - are very deep
Lambe soils (CO) - are very deep
Libeg soils (MT) - are very deep
Nathale soils (WY) - have calcic horizons
Nathrop (CO) soils - have calcic horizons
Norriston (CO) soils - are very deep
Quander soils (CO) - are very deep

Ratiopeak soils (MT) - are very deep
Silverheels soils (CO) - are very deep
Spanpeak soils (MT) - are very deep

GEOGRAPHIC SETTING:
Parent material: formed in noncalcareous gravelly colluvium and or slope alluvium derived from igneous and sedimentary rock.
Landform: upland hills, ridges, structural benches, u-shaped valleys, mesa and mountain side slopes
Slopes: 3 to 65 percent
Elevation: 5,600 to 11,500 feet (1,705 to 3,505 meters); at the type location is about 8,840 feet (2,694 meters)
Mean annual air temperature: 32 to 44 degrees F (0.0 to 6.7 degrees C)
Mean annual precipitation: 16 to 34 inches (41 to 86 centimeters)
Precipitation pattern: The soil moisture control section is affected by snow melt in early spring and peak precipitation in the form of thunderstorms occurring from June to September
Frost free period: 40 to 75 days

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Ruby and Vulcan soils. Ruby soils are deep, have fewer coarse fragments in the solum and overlie fragmental substratums. Vulcan soils do not have a mollic epipedon and have an argillic horizon overlying fragmental materials.

DRAINAGE AND PERMEABILITY: Well drained; medium to rapid runoff; moderate permeability.

USE AND VEGETATION: The soils are used as native pastureland, for recreation, and for limited forest purposes. Native vegetation is sagebrush, buckbrush, native bluegrass, shrubs, and open timber stands.

DISTRIBUTION AND EXTENT: Mountain areas of Colorado and Montana; MLRAs 43B and 48A. The series is of moderate extent.

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana

SERIES ESTABLISHED: Gunnison County, Colorado, 1971.

REMARKS:
Diagnostic features include:
Mollic epipedon: 0 to 9 inches (0 to 23 centimeters) (A, BA horizons)
Argillic horizon: 9 to 20 inches (23 to 51 centimeters) (Bt horizon).
Lithic contact at 24 inches (61 centimeters) (R horizon).

The soils are normally noncalcareous throughout and do not have continuous subhorizons of visible secondary carbonate, but are weakly and inconsistently calcareous and have some inconsistent accumulation of secondary carbonate below the solum in some pedons.

Taxonomic version: Tenth Edition, 2006.

National Cooperative Soil Survey
U.S.A.

LOCATION WOODHURST MT

Established Series
Rev. CAM-JJU-EMM
04/2014

WOODHURST SERIES

The Woodhurst series consists of moderately deep, well drained soils formed in colluvium over residuum derived from nonacid igneous rocks. These soils are on hills and mountains. Slopes are 8 to 40 percent. Mean annual precipitation is about 22 inches, and mean annual air temperature is about 40 degrees F.

TAXONOMIC CLASS: Loamy-skeletal, mixed, superactive Pachic Argicryolls

TYPICAL PEDON: Woodhurst stony loam, in native grass (colors are for dry soil unless otherwise noted).

A--0 to 12 inches; very dark grayish brown (10YR 3/2) stony loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; many very fine roots; many fine interstitial pores; 20 percent stones; slightly alkaline (pH 7.6); clear boundary. (8 to 19 inches thick)

Bt1--12 to 20 inches; dark grayish brown (10YR 4/2) very stony clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine blocky structure that parts to very fine granular;; soft, friable, moderately sticky and moderately plastic; many very fine roots; many fine tubular pores; continuous distinct clay films on vertical faces and patchy clay films on horizontal faces with organically stained glossy films on weathered rock fragments; 50 percent rock fragments and weathered igneous rock fragments that crush easily in the hand; slightly alkaline (pH 7.8); clear boundary. (5 to 15 inches thick)

Bt2--20 to 26 inches; brown (10YR 4/3) extremely stony clay loam, dark brown (10YR 3/3) moist; moderate fine and medium blocky structure; slightly hard, friable, moderately sticky and moderately plastic; few very fine roots; distinct continuous clay films on all faces of peds; moderately alkaline (pH 8.3); 80 percent rock fragments; clear wavy boundary. (2 to 10 inches thick)

R--26 inches; light colored hard quartz monzonite porphyry rock in situ. Weathered rock has organic stainings which give rise to a darker colored appearance.

TYPE LOCATION: Judith Basin County, Montana; Little Belt Mountains; 1,500 feet north and 450 feet east of center of sec. 26, T. 14N, R. 11E.

RANGE IN CHARACTERISTICS:
Mean annual soil temperature - 44 to 47 degrees F.
Average summer soil temperature - 55 to 59 degrees F.
Depth to lithic contact - 20 to 40 inches

A horizon
Hue: 2.5Y, 10YR or 7.5YR; dry or moist
Value: 3 or 4; dry
Chroma: 1 or 2; dry or moist
Texture: loam or sandy loam
Clay content: 13 to 27 percent
Rock fragments: 15 to 60 percent--0 to 25 percent gravel, 0 to 35 percent cobbles and stones
Reaction: pH 6.4 to 7.8

AB horizon present in some pedons.

Bt1 horizon
Hue: 2.5Y, 10YR or 7.5YR; dry or moist
Value: 4 or 5 dry; 3 or 4 moist
Chroma: 2 or 4; dry or moist
Texture: clay loam or sandy clay loam
Clay content: 22 to 35 percent
Rock fragments: 40 to 85 percent--15 to 35 percent gravel, 5 to 55 percent cobbles and stones
Reaction: pH 6.4 to 8.4

Bt2 horizon
Hue: 2.5Y, 10YR or 7.5YR; dry or moist
Value: 4 or 5 dry; 3 or 4 moist
Chroma: 2 to 4; dry or moist
Texture: loam, clay loam or sandy clay loam
Clay content: 20 to 35 percent
Rock fragments: 50 to 85 percent--20 to 60 percent gravel, 5 to 55 percent cobbles and stones
Reaction: pH 7.0 to 8.4

COMPETING SERIES:
Angelwhine (CA) - are very deep
Aspetill (CA) - are very deep
Badwater (WY) - are very deep
Bickmore (UT) - have secondary calcium carbonate accumulation
Bigcoulee (MT) - are very deep
Blackbear (MT) - have an udic moisture regime
Bluebell (NV) - are slightly or moderately acid in the argillic horizon
Booneville (ID) - are very deep
Buena vista (CO) - have secondary calcium carbonate accumulation
Dab (NV) - are very deep
Dailybasin (MT) - are very deep
Delhew (NV) - are very deep
Hawkinspeak (CA) - have a xeric moisture regime
Igor (WY) - are very deep
Keman (ID) - are very deep
Littlemud (NV) - have a xeric moisture regime
Lostcannon (CA) - are very deep
Monibasin (CA) - are very deep

Panin (NV) - have a xeric moisture regime
Parkalley (ID) - are very deep
Parkay (UT) - are very deep
Rangertaft (NV) - have a xeric moisture regime
Redbird (SD) - are very deep
Rutherford (ID) - have a xeric moisture regime
Sweetmount (CA) - are deep to a paralithic contact

GEOGRAPHIC SETTING:
Landform - hills and mountains
Elevation - 5,000 to 9,000 feet
Slope - 8 to 40 percent
Parent material - colluvium over residuum derived from nonacid igneous rocks
Mean annual precipitation - 20 to 24 inches
Mean annual air temperature - 36 to 45 degrees F.
Mean summer air temperature - 54 to 60 degrees F.
Frost-free period - 30 to 60 days

GEOGRAPHICALLY ASSOCIATED SOILS: None listed.

DRAINAGE AND PERMEABILITY: Well-drained; moderate permeability.

USE AND VEGETATION: Used as rangeland. Vegetation is bluebunch wheatgrass, Idaho fescue, rough rescue, needle-and-thread grass, sedges, balsamroot, fringed sagewort, lupine and silver sagebrush.

DISTRIBUTION AND EXTENT: Woodhurst soils are moderately extensive in central and southwestern Montana. MLRA 43B

MLRA SOIL SURVEY REGIONAL OFFICE (MO) RESPONSIBLE: Bozeman, Montana.

SERIES ESTABLISHED: Judith Basin County, Montana, 1963.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Mollic epipedon - from 0 to 26 inches (A, Bt1, Bt2 horizons)
Argillic horizon - from 12 to 26 inches Bt1, Bt2 horizons)
Particle-size control section - from 12 to 26 inches (Bt1, Bt2 horizons)
Lithic contact - at 26 inches (R horizon)

Woodhurst soils have a cryic temperature regime and an ustic moisture regime.

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