APPENDIX A

SOIL RESOURCES OF THE BLACK MESA LEASE AREA

INTERMOUNTAIN SOILS, INC.

SOIL RESOURCES OF THE BLACK MESA LEASE AREA

December, 1985

prepared for

Peabody Coal Company
1300 South Yale
Flagstaff, Arizona 83066

1873 S. Bellaire St., Suite 330, Denver, CO 80222

intermountainsoil

SOIL RESOURCES OF THE BLACK MESA LEASE AREA

TABLE OF CONTENTS

	Page
List of Tables	iii
List of Exhibits	iv
List of Drawings	iv
List of Attachments	iv
Introduction	
Overview	1
The Black Mesa Lease Area	2
Soil Survey	
Methods	
Soils mapping	5
Soil classification and correlation	5
Results	9
Soil Characterization	
Methods	
Soil sampling and analysis	19
Topsoil suitability	24
Results	
Soil sampling and analysis	25
Evaluation of topsoil suitability	25
Hydrologic interpretations	31
Prime farmland assessment	31
Potential vegetation production estimates	33
Calculation of disturbed acreage	34

Geobotanical Studies

Background..... 39
Methods
1984 field survey..... 41
1984 soils and vegetation sampling..... 41
1984 laboratory analyses..... 42
1985 field survey..... 42
1985 soils and vegetation sampling..... 42
1985 laboratory analyses..... 43
Results
Field surveys..... 44
Species composition and range condition at 1985 sampling locations..... 44
Soil and vegetation laboratory analyses..... 45
Discussion..... 55
Conclusions..... 57

Literature Cited..... 58

Qualifications of Participants..... 60

LIST OF TABLES

Table		Page
1	Taxonomic classification of soil series of the Black Mesa lease area	10
2	Final correlation of soil series of the Black Mesa lease area	10
3	Order 1 and 2 soils survey map legend	12
4	Summary of Order 1 and 2 map unit descriptions	14
5	Order 3 and 4 soils survey map legend	18
6	Number of sampled pedons by soil series	19
7	Laboratory analyses of soils of the Black Mesa lease area	20
8	Laboratory methods for soil samples collected by IMS	21
9	Laboratory methods for soil samples collected by Mariah	22
10	Laboratory methods for soil samples collect by EH&A	23
11	Criteria for suitability of topsoil	24
12	Summary of deep hole investigations	28
13	"K" factor and Hydrologic Group of the soils of the Black Mesa lease area	31
14	Potential vegetation production of the soils of the Black Mesa lease area	34
15	Acres proposed for disturbance by map unit	36
16	Acres proposed for disturbance by soil series	38
17	Species composition at 1985 sampling locations	47
18	Plant species sampled for selenium analysis in 1984 and 1985	49
19	Selenium concentrations in 1984 vegetation samples	50
20	Selenium concentrations in 1985 vegetation samples	51
21	Selenium concentrations in 1984 soil samples	52
22	Selenium concentrations in 1985 soil samples	55

LIST OF EXHIBITS

Exhibit		Page
1	Black Mesa lease area	4
2	Letter to SCS regional soils correlator	8
3	SCS letter concerning Prime Farmland	32
4	SCS letter concerning vegetation production	35

LIST OF DRAWINGS

Drawing	
85300	Order 3 and 4 soil survey maps
85305A	Order 1 and 2 soil survey maps
85305B	Topsoil salvage maps
85310	Selenium sampling locations

LIST OF ATTACHMENTS

Attachment	
1	Map unit descriptions
2	Soil series and profile descriptions
3	Additional soil analysis results from the 1985 IMS study
4	Additional soil analysis results from the1984 Mariah study
5	Additional soil analysis results from the 1979 EH&A study
6	SCS Form 5 for soil series of the Black Mesa lease area
7	Root drawings from the 1985 geobotanical study

INTRODUCTION

OVERVIEW

Peabody Coal Company has undertaken three soils resource studies on the Black Mesa lease area. The first of these was conducted in 1979 by Espey, Huston & Associates, Inc. (EH&A). EH&A surveyed 1,127 acres designated by Peabody as areas which were to be disturbed by mining. These areas were surveyed at an Order 1 level of intensity. An Order 3 survey was conducted for the remaining 75,358 acres parts of the Black Mesa lease area, including Tracts 1 and 2 of the Joint Mineral Use Area leases. An Order 4 survey was conducted for a 78,443 acre buffer area surrounding the lease area. A report (EH&A 1980) of this work was included in Peabody's permit application for the Black Mesa and Kayenta mine submitted in 1981 to the Office of Surface Mining (OSM). In 1984, Peabody contracted with Mariah Associates, Inc. (Mariah) for an Order 2 survey of the soils in the valleys and of the deeper inclusions in the pinyon-juniper woodland within the Mine Plan Modification Area (MPMA). Approximately 4,400 acres were surveyed. A report of Mariah's work was submitted to OSM in 1984 as part of Peabody's permit application for the MPMA. In 1985, Intermountain Soils, Inc. (IMS) was contracted to map all remaining unmapped areas to be disturbed during the life-of-mine. Soils under pinyon-juniper vegetation were mapped at an Order 2 level of intensity. The remainder were surveyed at an Order 1 level of intensity.

The objectives of the three soils studies have been:

- To determine the types of soils occurring within the Black Mesa lease area.
- To assign the soils to mapping units and delineate the unit boundaries on a map.
- To assess the physical and chemical characteristics of the soils to be disturbed by mining as to their suitability as plant growth media.
- To determine the volumes of topsoil to be salvaged for reclamation.
- To identify soils related constraints to achieving the proposed post-mining land use.
- To comply with the regulatory requirements of the Office of Surface Mining for soils resource information.

This report consolidates the results of the three soils studies conducted for Peabody on the Black Mesa lease area. It is a comprehensive description of the soil resources of the Black

Mesa lease area. The report is divided into three main sections, Soil Survey, Soil Characterization, and Geobotanical Study. Soil Survey describes the methods and results of the various surveys which have been conducted at Black Mesa. The bulk of the results of the soil survey work is shown on the maps which accompany this report and in the map unit descriptions included in a separate attachment at the end of the report. Soil Characterization details studies conducted to evaluate the suitability of soils as plant growth media. The Geobotanical Study section presents the results of two years of related soils and vegetation investigations assessing potential selenium toxicity in the soils at Black Mesa.

The following brief section provides a description of Black Mesa and the mining areas within the Black Mesa lease area which have been the main subject of these investigations. Refer to Exhibit 1 for an index map showing the mining areas within the Black Mesa lease area.

THE BLACK MESA LEASE AREA

The Black Mesa lease area encompasses the Black Mesa and Kayenta surface mine located about 25 miles southwest of Kayenta, Arizona. The area is drained toward the southwest by two major washes, Dinnebito and Moenkopi, both of which are tributaries of the Little Colorado River. Elevation of the lease area ranges from about 6,200 feet (1,890 m) to about 7,300 feet (2,225 m) above sea level. Mean annual precipitation ranges from 9 to 13 inches. Vegetation is comprised predominantly of pinyon-juniper and sagebrush types.

Ten mining areas are planned for disturbance during the life-of-mine. Each is briefly described below.

J/19, J/20, J/21 and J/23 Mining Areas. Totalling more than 11,000 acres, these areas were mapped in 1984 and 1985. The soils are typical of the entire lease area: shallow soils on ridges under pinyon-juniper and deeper soils in the valleys under sagebrush. Not typical, however, are the deeper, reddish soils occurring in some areas under the pinyon-juniper woodland. In the southern and especially in the western parts of these areas are porcellanite-derived soils on hilltops and upper sideslopes. The eastern parts of these areas appear to receive more precipitation than other areas of the lease.

J/1-N/6 and J/16 Mining Areas. The upland ridges of these areas have soils that are very shallow due to erosion. The degree of erosion is severe, with bedrock frequently occurring at less than 6 inches. Similar to the J/19, J/20, J/21 and J/23 areas, these areas

have moderately deep to deep eolian soils on the valley sideslopes and deep alluvial soils in the valley bottoms.

N/14 Mining Area. This area is the northernmost area to be disturbed by mining. It appears that this area receives more precipitation than other areas of the lease. Most of the soils in the area are very shallow.

N/10 and N/11 Mining Areas. Located northeast of J/1-N/6, these areas are characterized by very steep, eroded ridges, on the crests of which porcellanite frequently occurs. Located on the lower sideslopes are shallow residual soils with deeper soils along the drainages.

J/7 Mining Area. This area is the southernmost area to be mined on the Black Mesa lease area. Since the shallow residual soils do not support trees, the area is probably drier than most of the other portions of the lease. Also found in J/7 are soils underlain by hard bedrock instead of soft bedrock found elsewhere on the lease. The deeper reddish soils are coarser textured and less developed than similar soils found in other mining areas.

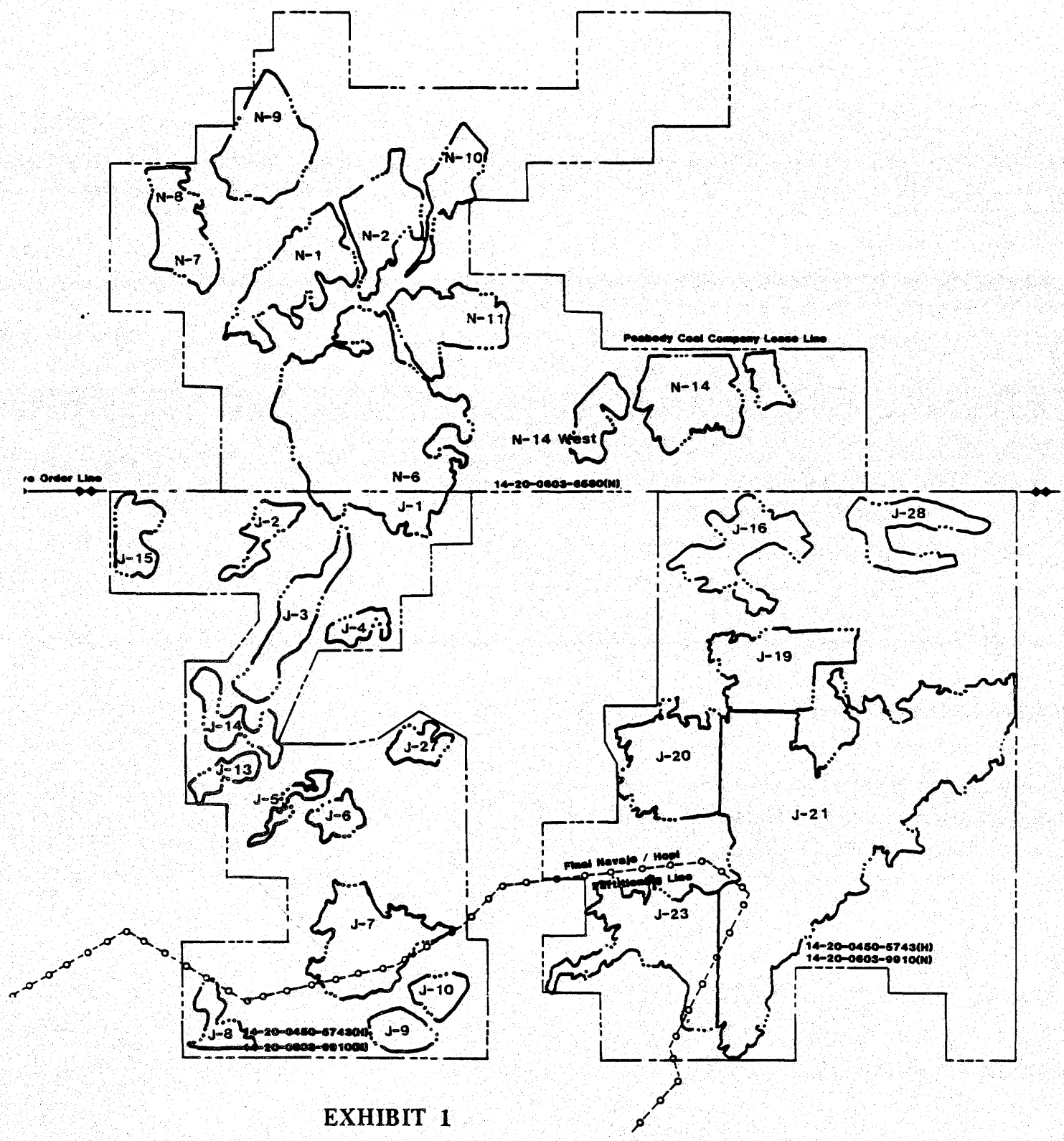


EXHIBIT 1

THE BLACK MESA LEASE AREA

SOIL SURVEY

Prior to the start of the 1985 soil studies, a meeting was held on April 30, 1985 at the Office of Surface Mining (OSM) Western Technical Center to present the methods proposed for the forthcoming studies. In attendance were representatives from Peabody, IMS and OSM. Methods of each proposed study were explained, including the levels of soil surveys, the intensity of soil and vegetation sampling, and the kinds of soil analyses. The scope and methods of the proposed studies were agreed upon, and the substantive points of this agreement were subsequently documented in a letter by IMS dated May 10, 1985 to Mr. Jerry Gavette of OSM.

Immediately following the meeting with OSM, a meeting was held with Leonard Robbins, Navajo Tribe representative, Caroline O'Brien, Hopi Tribe representative and John Lovell of OSM. The studies proposed for 1985 were again explained and clarified.

METHODS

Soils mapping. The soil surveys of the proposed permit area followed standards established by the Soil Conservation Service (SCS) for use in the National Cooperative Soil Survey. These standards are described in the *Soil Survey Manual* (Soil Survey Staff 1951) and the *National Soils Handbook* (Soil Survey Staff 1983). Revisions to the *Soil Survey Manual,* including revised horizon concepts and nomenclature, were integrated into the study (Soil Survey Staff 1980 and 1981).

Blueline prints of aerial photographs at a scale of approximately 1" = 400' were used as base maps for mapping soils. Color aerial photographs at a scale of 1" = 1,000' were used to assist in photo interpretation and soil mapping. Survey areas were traversed and numerous soil pedons were examined. Soil texture, consistence, depth, presence of rock fragments, and other soil characteristics affecting the quality and quantity for topsoil were noted. On the basis of these field observations, map units were established and their boundaries delineated on the aerial photo base maps. Map units are soil consociations except where the variability of the soils necessitated the establishment of soil complexes as map units.

Soil Classification and Correlation. Each soil has been classified to the family level according to the criteria in *Soil Taxonomy* (Soil Survey Staff 1975). Each soil was then further classified to the series level by correlation to established soil series. Any soils of

the Black Mesa lease area which could not be correlated to established soil series were classified either to the family level or as taxadjuncts to established soil series.

Over the years that soils investigations have been conducted on Black Mesa for Peabody, questions have arisen concerning the moisture regime of the soils of the Black Mesa lease area. In their original study, Espey, Huston and Associates classified the soils of the survey area in the mesic temperature regime and, with one exception, the Cahona series, in the typic aridic moisture regime. Cahona soils were classified in the ustic intergrade of the aridic moisture regime (EH&A 1980). The soils legend as developed by EH&A incorporated these temperature and moisture regimes in accordance with the then prevailing opinion of the SCS State Soil Scientist for the state of Arizona (EH&A 1980). In developing the legend for the 1984 Mariah study, soil scientists felt that the typic aridic moisture regime was not appropriate for the soils of Black Mesa, and that the ustic intergrade of the aridic was the more correct moisture regime. After the 1984 soil studies were completed, a Peabody soil scientist discussed soil classification with SCS personnel in Arizona. By then, it had become the opinion of the SCS in Arizona that soils occurring where pinyon-juniper is the dominant vegetation belong in the aridic intergrade of the ustic moisture regime, or wetter.

The SCS in Arizona and New Mexico presently classifies soils occurring in areas dominated by pinyon-juniper vegetation, with an inferred mean annual precipitation of greater than 12 inches, in the aridic intergrade of the ustic moisture regime. The SCS in Utah, Wyoming and Colorado classifies such soils with a mean annual precipitation up to 16 inches in the ustic intergrade of the aridic moisture regime. Early in 1985, Peabody and IMS representatives met with with Mr. Carl Gloker, State Soil Correlator (Arizona) for the SCS, to discuss soil classification and correlation. Mr. Gloker reconfirmed the Arizona SCS view that the soils should be classified in the aridic intergrade of the ustic moisture regime. Subsequently, IMS raised the issue of soil moisture regimes in a letter (Exhibit 2) to the SCS Regional Soil Correlator in Portland, Oregon. The Regional Soil Correlator has not responded to date.

In this report, all soils have been classified in the ustic intergrade of the aridic moisture regime. There are a number of reasons to justify this classification. First, meteorologic data collected on Black Mesa by Peabody over the past six years show a range in annual precipitation of 9 to 13 inches. Much of the lease area receives 12 inches or less mean annual precipitation (see Meteorological Data Reports, 1980—1985, prepared for the Office of Surface Mining, Denver, Colorado by Peabody Coal Company, Arizona Division for a

complete discussion of the climatic conditions at the mine). In addition, many of the soils have carbonates in the upper 12 inches of the soil profile, indicative of relatively dry conditions. Finally, many of the soils found on Black Mesa are similar to series established for soils in southwest Colorado, series which are classified in the ustic intergrade of the aridic moisture regime.

EXHIBIT 2

LETTER TO SCS REGIONAL SOILS CORRELATOR

ims
intermountain soils, inc.

April 22, 1985

Richard W. Kover
Head, Soils Staff
Soil Conservation Service
West National Technical Center
Portland, Oregon

Dear Mr. Kover:

I am writing to request your assistance in answering several questions I have about soils correlation which pertain to an upcoming soil survey project that Intermountain Soils will be conducting this summer for the Peabody Coal Company in Arizona. The project involves Order 1 and Order 2 soil surveys on nearly 8,000 acres. The landscape consists of dissected mesas which are composed of interbedded sedimentary rock. The dominant soils of the area are shallow to moderately deep and are mostly covered with pinyon-juniper vegetation. In the valleys, deeper soils, which formed from eolian material mixed with local alluvium, occur under a cover of sagebrush/saltbush and grass.

Although not required by either law or regulation, Peabody Coal Company is interested in having these surveys be consistent with an S.C.S. Order 3 soils survey which is expected to be completed on the Navajo Indian Reservation within the next ten years. To that end, Brian Dunfee of Peabody and I met with Carl Gloker, Arizona State Soil Correlator, on Monday, April 8, 1985 to discuss the classification and correlation of the soils in the area of Peabody's Black Mesa Mine. At the meeting, Mr. Gloker stated that he would expect the soil moisture regime to be the aridic intergrade to ustic, an interpretation based on several criteria, including a mean annual precipitation of 12 inches or more and a site index for the pinyon-juniper woodland of 30 to 35.

Using the recent final survey correlations of the La Plata County Area, Colorado and the Hopi Area, Arizona as examples, there appears to be a considerable difference in the S.C.S.'s interpretation of extant vegetation and mean annual precipitation (MAP) in determining soil moisture regimes. In the Hopi Area survey, soils with an MAP of 12 to 16 inches and upland vegetation dominated by pinyon-juniper were considered to have an aridic ustic moisture regime. In the La Plata survey area, less than 300 miles to the northwest with similar rainfall distribution patterns, soils were established with a MAP up to 17 inches in the ustic aridic moisture regime. In the latter survey, these soils, such as Zyme and Dulce, and, to a lesser extent, Pulpit, Sharps and Cahona, support pinyon-juniper vegetation. Based on experience mapping soils in southwest Colorado, in regions east of the Continental Divide, and for Peabody Coal Company in Arizona last year, it is my opinion that the ustic intergrade

1873 South Bellaire Street, Suite 330 Denver, CO 80222 (303) 692-8188

INTERMOUNTAIN SOILS

Richard W. Kower
Soil Conservation Service
April 22, 1985

to aridic would be the correct moisture regime for the soils under the pinyon-juniper in the Black Mesa area. Furthermore, many of the ustic aridic soils series established in La Plata County could be accurately correlated to the soils at Black Mesa.

I am interested in your views on the current concepts of soil moisture and, in particular, its relationship to vegetation and mean annual precipitation. More specifically, I would appreciate your consideration of the following questions:

—Which soil moisture regime(s) support pinyon-juniper woodland in the four corners area?

—Is the ability to grow dryland corn without fallowing always implicit in aridic ustic and ustic soils?

—What correlation, if any, is there between soil characteristics, such as surface and subsoil pH levels and carbonate distribution, and the two moisture regimes in question?

Thank you for your consideration. I look forward to hearing from you.

Sincerely,

Richard Trenholme

Richard Trenholme
President

RT/lk

cc: Brian Dunfee
Peabody Coal Company

RESULTS

Four major soils groups, distinguished on the basis of the parent materials from which they developed, are found within the lease area. These groups are residual soils, porcellanite-derived soils, alluvial soils, and eolian soils. Residual soils, primarily shallow Torriorthents, are found mainly on ridges throughout the lease area. They formed in residual material derived from the Mesa Verde formation, which consists of interbedded sandstones and shales. Dominant vegetation on the ridges is Colorado pinyon (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*), with a usually sparse understory of shrubs and grasses. Porcellanite is scattered throughout the lease area, but occurs on hill tops primarily in the southern and western parts. This material, locally called clinker or scoria, was formed by sandstone or shale being baked by burning coal. The soils which formed in this material are deep Torriorthents and Calciorthids high in rock fragments. These soils have a sparse vegetation cover of pinyon pine and Utah juniper, with little understory. On the valley sideslopes are soils derived from reddish eolian material. Studies by Price et al. (1984) on similar soils in southwestern Colorado show this material to be about 16,000 years old, an age determined by radiocarbon dating of the remains of a prehistoric muskox found buried in a soil of similar origin. These eolian soils are moderately deep or deep Haplargids. Soils found on the valley bottoms and drainage terraces are younger soils forming in recent alluvium. Dominant vegetation on the latter two soil groups is shrubs and grasses. A more thorough discussion of the regional geology can be found in Peabody Coal Company's permit application.

Fourteen soils have been identified and mapped on the Black Mesa lease area. The taxonomic classification of each soil is given in Table 1. The Dulce soil is considered a series taxadjunct because the colors of these soils as they occur in the Black Mesa lease area do not fall within the range of characteristics defined in the SCS series description. Two other soils, Soil A and Soil B, were not named because no soil series have been established by the SCS in their respective soil families. Both of these soils are derived from porcellanite.

A final correlation of the soils of the Black Mesa lease area is shown in Table 2. This final correlation is the culmination of survey and classification efforts by Peabody for the Black Mesa lease area. The correlation is consistent with taxonomic decisions regarding the soil moisture regime discussed earlier in this report.

Table 1. Taxonomic classification of soil series of the Black Mesa lease area.

Series	Family
Begay	Coarse-loamy, mixed, mesic Ustollic Camborthids
Bond	Loamy, mixed, mesic Lithic Ustollic Haplargids
Cahona	Fine-silty, mixed, mesic Ustollic Haplargids
Chilton	Loamy-skeletal, mixed (calcareous), mesic Ustic Torriorthents
Dulce[1]	Loamy, mixed (calcareous), mesic, shallow Ustic Torriorthents
Las Lucas	Fine-silty, mixed, mesic Ustollic Camborthids
Oelop	Fine-loamy, mixed, mesic Ustollic Haplargids
Pulpit	Fine-silty, mixed, mesic Ustollic Haplargids
San Mateo	Fine-loamy, mixed (calcareous), mesic Ustic Torrifluvents
Sharps	Fine-silty, mixed, mesic Ustollic Haplargids
Travessilla	Loamy, mixed (calcareous), mesic Lithic Ustic Torriorthents
Zyme	Clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthents
Soil A	Loamy-skeletal over fragmental, mixed (calcareous), mesic Ustic Torriorthents
Soil B	Loamy-skeletal over fragmental, mixed, mesic Ustollic Calciorthids

[1]This soil is a taxadjunct to the series.

Table 2. Final correlation of soil series of the Black Mesa lease area.

Final IMS correlation	1979 EH&A	1984 Mariah
Begay	Fruitland	Begay
Bond	Not mapped	Not mapped
Cahona	Clovis	Cahona
Chilton	Not mapped	Not mapped
Dulce	Moenkopi	Dulce
Las Lucas	Ives	Mikim
Oelop	Not mapped	Not mapped
Pulpit	Not mapped	Pulpit
San Mateo	Youngston	San Mateo
Sharps	Not mapped	Sharps
Travessilla	Moenkopi	Not mapped
Zyme	Claysprings	Not mapped
Soil A	Not mapped	Not mapped
Soil B	Not mapped	Not mapped

Fifty-four map units, comprised of 14 soil series or taxadjuncts and five miscellaneous areas, were identified during the 1984 and 1985 Order 1 and Order 2 surveys (Table 3). The map unit boundaries and symbols are shown on the Order 1 and 2 soils maps (Drawing 85305A). The map unit descriptions for map units established for the Order 1 and 2 soil surveys conducted 1984 and 1985 on all the areas planned for disturbance are given in Attachment 1 of this report. Percent map unit composition and other salient points about the map units are shown in Table 4. Each map unit description provides basic information about the map unit, such as its location on the landscape, predominant soil or soils of the unit, and contrasting and similar soils which may occur within any delineation. For the purposes of the descriptions, contrasting soils include only those which differ in quality or quantity of potentially suitable, salvageable topsoil, without consideration of differentia normally used to separate soil series.

Order 3 and 4 map unit descriptions are also presented in Attachment 1, following the Order 1 and 2 descriptions. Seventeen map units, comprised of six soil series and two miscellaneous land types were identified in the Order 3 soil survey. The Order 4 soil survey identified four map units. Map unit boundaries for these two surveys are shown on the Order 3 and 4 soils maps (Drawing 85300). The legend for both surveys are shown in Table 5. Each description provides basic information about the map unit, such as its location on the landscape, type of soil(s) dominating the unit, and contrasting and similar soils which may occur within any delineation. The Order 3 and 4 map unit descriptions were prepared by EH&A and have been modified only to achieve agreement with the most recent soil correlation.

Table 3. Order 1 and 2 soil survey map legend.

Symbol	Name	
1A	Dulce very channery fine sandy loam, 1 to 4 percent slopes	STRIPPING DEPTH = 0
1,1B	Dulce very channery fine sandy loam, 4 to 8 percent slopes	
1C	Dulce very channery fine sandy loam, 8 to 15 percent slopes	
1D	Dulce very channery fine sandy loam, 15 to 30 percent slopes	
2B	Bond very fine sandy loam, 1 to 8 percent slopes	STRIPPING DEPTH = 1'
3A	Zyme - Dulce complex, 2 to 8 percent slopes	STRIPPING DEPTH = 0
3BC	Zyme - Dulce complex, 2 to 15 percent slopes	
3C	Zyme - Dulce complex, 6 to 15 percent slopes	
3D	Zyme - Dulce complex, 15 to 30 percent slopes	
3DE	Zyme - Dulce complex, 15 to 50 percent slopes	
3E	Zyme - Dulce complex, 30 to 50 percent slopes	
3F	Ustic Torriorthents - Rock outcrop complex, 50 to 80 percent slopes	
4A	Zyme very channery loam, 1 to 4 percent slopes	STRIPPING DEPTH = 0
4B	Zyme very channery loam, 4 to 8 percent slopes	
4C	Zyme very channery loam, 8 to 15 percent slopes	
4D	Zyme very channery loam, 15 to 30 percent slopes	
5	Pulpit very fine sandy loam, 2 to 8 percent slopes	= 2.5'
6	Sharps very fine sandy loam, 2 to 8 percent slopes	STRIPPING DEPTH = 2.5'
6A	Sharps very fine sandy loam, 1 to 4 percent slopes	
6B	Sharps very fine sandy loam, 4 to 8 percent slopes	
6C	Sharps very fine sandy loam, 8 to 15 percent slopes	
7B	Travessilla - Zyme - Dulce complex, 2 to 6 percent slopes	STRIPPING DEPTH = 0
7C	Zyme - Travessilla - Rock outcrop complex, 6 to 15 percent slopes	
7D	Zyme - Travessilla - Rock outcrop complex, 15 to 30 percent slopes	
7E	Zyme - Travessilla - Rock outcrop complex, 30 to 50 percent slopes	
10	Cahona very fine sandy loam, bedrock substratum, 2 to 8 percent slopes	STRIPPING DEPTH = 5.0'
10A	Cahona very fine sandy loam, bedrock substratum, 1 to 4 percent slopes	
10B	Cahona very fine sandy loam, bedrock substratum, 4 to 8 percent slopes	
10C	Cahona very fine sandy loam, bedrock substratum, 8 to 15 percent slopes	
11	Cahona very fine sandy loam, 1 to 6 percent slopes	STRIPPING DEPTH = 10.0'
11A	Cahona very fine sandy loam, 1 to 4 percent slopes	
11B	Cahona very fine sandy loam, 4 to 8 percent slopes	
11C	Cahona very fine sandy loam, 8 to 15 percent slopes	
G11B	Cahona very fine sandy loam, gravelly substratum, 2 to 8 percent slopes	= 2.5'
X11	Cahona - Cahona, bedrock substratum, very fine sandy loams, 2 to 10 percent slopes	STRIPPING DEPTH = 7.6'
X11A	Cahona - Cahona, bedrock substratum, very fine sandy loams, 1 to 4 percent slopes	
X11B	Cahona - Cahona, bedrock substratum, very fine sandy loams, 4 to 8 percent slopes	
X11C	Cahona - Cahona, bedrock substratum, very fine sandy loams, 8 to 15 percent slopes	

Table 3. Order 1 and 2 soil survey map legend (continued).

Symbol	Name	
12	Begay loam, 2 to 10 percent slopes	STRIPPING DEPTH = 9.7'
12A	Begay loam, 1 to 4 percent slopes	
12B	Begay loam, 4 to 8 percent slopes	
12C	Begay loam, 8 to 15 percent slopes	
13,13A	San Mateo loam, 0 to 3 percent slopes = 14.7'	
14A	Oelop very fine sandy loam, 1 to 4 percent slopes	STRIPPING DEPTH = 9.7'
14B	Oelop very fine sandy loam, 4 to 8 percent slopes	
15,15A	Las Lucas sandy clay loam, 2 to 6 percent slopes = 11.6'	
16C	Soil A - Soil B extremely channery very fine sandy loams, 4 to 15 percent slopes	STRIPPING DEPTH=0
16E	Soil A - Soil B extremely channery very fine sandy loams, 15 to 50 percent slopes	
16F	Soil A - Soil B extremely channery very fine sandy loams, 50 to 70 percent slopes	
17C	Chilton gravelly fine sandy loam, 6 to 15 percent slopes = 0.5'	
DL	Disturbed land	
RL	Reclaimed land	
TS	Topsoil stockpile	
RW	Riverwash = 0	

Table 4. Summary of Order 1 and 2 map unit descriptions.

MU # & Name:	1-Dulce vch FSL				2-Bond VFSL	3- Zyme - Dulce Complex						3F
Slope Phase	A	1; 1B	C	D	B	A	BC	C	D	DE	E	F
Major Soil	Dulce	Dulce	Dulce	Dulce	Bond	Zyme	Zyme	Zyme	Zyme	Zyme	Zyme	Ustic Torriorthents
% Slope	1-4	4-8	8-15	15-30	1-8	2-8	2-15	6-15	15-30	15-50	30-50	50-80
Surface text.	vch FSL	vch FSL	vch FSL	vch FSL	VFSL	vch L	vch L	vch L	vch L	vch L	vch L	variable
K fact/Hydro Gp	.13/D	.13/D	.13/D	.13/D	.43/D	.22/D	.22/D	.22/D	.22/D	.22/D	.22/D	variable
Vegetation	PJ	PJ	PJ	PJ	variable	PJ	PJ	PJ	PJ	PJ	PJ	variable
Percentage	90	90	85	85	90	50	55	55	62	60	60	75
Minor Soil						Dulce	Dulce	Dulce	Dulce	Dulce	Dulce	rock outcrop
% Slope						2-8	4-15	6-15	15-30	15-30	30-50	50-100
Surface text.						vch FSL	vch FSL	vch FSL	vch FSL	vch FSL	vch FSL	variable
K fact/Hydro Gp						.13/D	.13/D	.13/D	.13/D	.13/D	.13/D	-
Vegetation						PJ	PJ	PJ	PJ	PJ	PJ	variable
Percentage						45	39	39	30	30	30	25
Inclusions												
Soil	Zyme	Zyme	Zyme	Zyme	Dulce	soils >20" deep	soils >20" deep	soils >20" deep				
Surface text.	vch L	vch L	vch L	vch L	vch FSL	variable	variable	variable				
K fact/Hydro Gp	.22/D	.22/D	.22/D	.22/D	.13/D	variable	variable	variable				
Vegetation	PJ	PJ	PJ	PJ	PJ	PJ	PJ	PJ				
Percentage	5	7	10	8	7	3	3	3				
Soil	Bond	Bond			Sharps	Bond	Soils A, B	Soils A, B				
Surface text.	vch FSL	vch FSL			VFSL	VFSL	exch VFSL	exch VFSL				
K fact/Hydro Gp	.43/D	.43/D			.49/B	.43/D	.04/B	.04/B				
Vegetation	variable	variable			sage	variable	PJ	PJ				
Percentage	3	1			3	2	1	1				
Soil	Soils >20" deep											
Surface text.	variable											
K fact/Hydro Gp	variable											
Vegetation	PJ											
Percentage	1											
Rock outcrop percentage	1	2	5	7		0	2	2	8	10	10	
Similar soils	Soils with >35% rock fragments; non-calcareous soils; Travessilla soils				Soils w/ less clay	Soils with >35% rock fragments; non-calcareous soils; Travessilla soils						

Table 4. Summary of Order 1 and 2 map unit descriptions. (continued)

MU # & Name:	4--Zyme vch L				5--Pulpit VFSL	6-Sharps VFSL				7--Zyme-Travessilla complexes			
Slope Phase	A	B	C	D	5	6	A	B	C	B	C	D	E
Major Soil	Zyme	Zyme	Zyme	Zyme	Pulpit	Sharps	Sharps	Sharps	Sharps	Travessilla	Zyme	Zyme	Zyme
% Slope	1-4	4-8	8-15	15-30	2-8	2-8	1-4	4-8	8-15	2-6	6-15	15-30	30-50
Surface text.	vch L	vch L	vch L	vch L	VFSL	VFSL	VFSL	VFSL	VFSL	vch FSL	vch L	vch L	vch L
K fact/ Hydro Gp	.22/D	.22/D	.22/D	.22/D	.49/B	.49/B	.49/B	.49/B	.49/B	.12/D	.22/D	.22/D	.22/D
Vegetation	PJ	PJ	PJ	PJ	sage	sage	sage	sage	sage	grass	grass	grass	grass
Percentage	85	87	90	90	90	90	90	90	93	40	50	55	65
Minor Soil										Zyme	Travessilla	Travessilla	Travessilla
% Slope										2-6	6-15	15-30	30-50
Surface text.										vch L	vch FSL	vch FSL	vch FSL
K fact/ Hydro Gp										.22/D	.12/D	.12/D	.12/D
Vegetation										grass	grass	grass	grass
Percentage										35	35	30	20
Minor Soil										Dulce	rock outcrop	rock outcrop	rock outcrop
% Slope										2-6	6-15	15-30	30-50
Surface text.										vch FSL	-	-	-
K fact/ Hydro Gp										.13/D	-	-	-
Vegetation										grass	-	-	-
Percentage										20	12	14	15
Inclusions													
Soil	Dulce	Dulce	Dulce	Dulce	Cahona, b.s.	Cahona,bs	Cahona,bs	Cahona,bs	Cahona,bs	Soils >20" deep---------->			
Surface text.	vch FSL	vch FSL	vch FSL	vch FSL	VFSL	VFSL	VFSL	VFSL	VFSL	variable	variable	variable	
K fact/ Hydro Gp	.13/D	.13/D	.13/D	.13/D	.49/B	.49/B	.49/B	.49/B	.49/B	variable	variable	variable	
Vegetation	PJ	PJ	PJ	PJ	sage	sage	sage	sage	sage	grass	grass	grass	
Percentage	10	10	8	8	6	6	6	6	5	3	3	1	
Soil	soils >20" deep	soils >20" deep			Cahona	Cahona	Cahona	Cahona	Cahona	Bond			
Surface text.	variable	variable			VFSL	VFSL	VFSL	VFSL	VFSL	VFSL			
K fact/ Hydro Gp	variable	variable			.49/B	.49/B	.49/B	.49/B	.49/B	.43/D			
Vegetation	PJ	PJ			sage	sage	sage	sage	sage	grass			
Percentage	1	1			2	2	2	2	1	2			
Soil	Bond				Bond	Bond	Bond	Bond	Bond				
Surface text.	VFSL				VFSL	VFSL	VFSL	VFSL	VFSL				
K fact/ Hydro Gp	.43/D				.43/D	.43/D	.43/D	.43/D	.43/D				
Vegetation	variable				variable	variable	variable	variable	variable				
Percentage	2				2	2	2	2	1				
Rock outcrop percentage	2	2	2	2									
Similar soils	Non-calcareous soils; soils w/ <35% clay				Soils w/ < 18% clay or >15% FS+; Sharps soils	Soils w/ < 18% clay or >15% FS+; Pulpit soils				-	Dulce	Dulce	Dulce

Table 4. Summary of Order 1 and 2 map unit descriptions. (continued)

MU # & Name:	10-Cahona VFSL, bedrock substratum				G11B-Cahona, gravelly substratum	X11--Cahona-Cahona, bs VFSLs				11--Cahona VFSL			
Slope Phase	10	A	B	C	B	X11	A	B	C	11	A	B	C
Major Soil	Cahona, bs	Cahona, bs	Cahona, bs	Cahona, bs	Cahona, g.s.	Cahona	Cahona	Cahona	Cahona	Cahona	Cahona	Cahona	Cahona
% Slope	2-8	1-4	4-8	8-15	2-8	2-10	1-4	4-8	8-15	1-6	1-4	4-8	8-15
Surface text.	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL
K fact/Hydro Gp	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B
Vegetation	sage	sage	sage	sage	sage	sage	sage	sage	sage	sage	sage	sage	sage
Percentage	90	90	90	90	90	55	55	55	50	95	95	95	95
Minor Soil						Cahona, bs	Cahona, bs	Cahona, bs	Cahona, bs				
% Slope						2-10	1-4	4-8	8-15				
Surface text.						VFSL	VFSL	VFSL	VFSL				
K fact/Hydro Gp						.49/B	.49/B	.49/B	.49/B				
Vegetation						sage	sage	sage	sage				
Percentage						40	40	40	45				
Inclusions													
Soil	Cahona	Cahona	Cahona	Cahona	Sharps	Sharps	Sharps	Sharps	Sharps	Cahona, bs	Cahona, bs	Cahona, bs	Cahona, bs
Surface text.	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL
K fact/Hydro Gp	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B	.49/B
Vegetation	sage	sage	sage	sage	sage	sage	sage	sage	sage	sage	sage	sage	sage
Percentage	7	7	6	5	7	5	5	5	5	3	3	3	3
Soil	Sharps	Sharps	Sharps	Sharps	Chilton					Sharps	Sharps	Sharps	Sharps
Surface text.	VFSL	VFSL	VFSL	VFSL	vgr SL.					VFSL	VFSL	VFSL	VFSL
K fact/Hydro Gp	.49/B	.49/B	.49/B	.49/B	.13/B					.49/B	.49/B	.49/B	.49/B
Vegetation	sage	sage	sage	sage	sage					sage	sage	sage	sage
Percentage	3	3	4	5	3					2	2	2	2
Soil													
Surface text.													
K fact/Hydro Gp													
Vegetation													
Percentage													
Similar soils	Soils w/ < 18% clay or >15% FS+; Oelop soils					Soils w/ < 18% clay or >15% FS+; Oelop soils				Soils w/ < 18% clay or >15% FS+; Oelop soils			

Note: Cahona, bs = Cahona, bedrock substratum

Table 4. Summary of Order 1 and 2 map unit descriptions. (continued)

MU # & Name:	12-Begay L				13-San Mateo L	14-Oelop VFSL		15-Las Lucas SCL	16--Soil A-Soil B exch VFSLs			17--Chilton vgr FSL
Slope Phase	12	A	B	C	A	A	B	A	C	E	F	C
Major Soil	Begay	Begay	Begay	Begay	San Mateo			Las Lucas	Soil A	Soil A	Soil A	Chilton
% Slope	2-10	1-4	4-8	8-15	0-3	1-4	4-8	2-6	4-15	15-50	50-70	6-15
Surface text.	L	L	L	L	L	VFSL	VFSL	SCL	exch VFSL	exch VFSL	exch VFSL	vgr FSL
K fact/Hydro Gp	.43/B	.43/B	.43/B	.43/B	.37/B	.37/B	.37/B	.28/B	.04/B	.04/B	.04/B	.13/B
Vegetation	grass	grass	grass	grass	shrub/grass	sage	sage	sage	PJ	PJ	PJ	sage
Percentage	98	98	98	98	100	100	100	100	60	60	60	95
Minor Soil									Soil B	Soil B	Soil B	
% Slope									4-15	15-50	50-70	
Surface text.									exch VFSL	exch VFSL	exch VFSL	
K fact/Hydro Gp									.04/B	.04/B	.04/B	
Vegetation									PJ	PJ	PJ	
Percentage									35	35	35	
Inclusions												
Soil	Soils < 72" deep---------->								Zyme	Zyme	Zyme	Cahona, gs
Surface text.	VFSL	VFSL	VFSL	VFSL					vch L	vch L	vch L	VFSL
K fact/Hydro Gp	.43/B	.43/B	.43/B	.43/B					.22/D	.22/D	.22/D	.49/B
Vegetation	grass	grass	grass	grass					PJ	PJ	PJ	Sage
Percentage	2	2	2	2					3	3	3	5
Soil									Dulce	Dulce	Dulce	
Surface text.									vch FSL	vch FSL	vch FSL	
K fact/Hydro Gp									.13/D	.13/D	.13/D	
Vegetation									PJ	PJ	PJ	
Percentage									2	2	2	
Similar soils	Cahona soils, soils w/ >18% clay				Las Lucas soils; Oelop soils; soils w/ <15% FS+	Las Lucas soils; Cahona soils; soils w/ <15% FS+						

Table 5. Order 3 and 4 soil survey map legend.

Symbol	Name
20	Zyme-Cahona-Dulce association, 0 to 30 percent slopes
21	Zyme-Las Lucas complex, 0 to 15 percent slopes
22	Zyme-Las Lucas-Dulce association, 0 to 30 percent slopes
23	Zyme-Dulce complex, severely eroded, 0 to 30 percent slopes
24	Zyme-Dulce association, 8 to 30 percent slopes
25	Zyme-Dulce-Las Lucas association, 0 to 30 percent slopes
26	Cahona-Zyme association, 0 to 30 percent slopes
27	Begay-Las Lucas association, 0 to 8 percent slopes
28	Las Lucas-Zyme-Dulce complex, 0 to 8 percent slopes
29	Dulce gravelly fine sandy loam, 0 to 30 percent slopes
30	Dulce-Zyme association, 15 to 30 percent slopes
31	Dulce-Cahona association, 0 to 30 percent slopes
32	Dulce-Las Lucas association, 0 to 15 percent slopes
33	Dulce-Las Lucas-Zyme association, 8 to 30 percent slopes
34	Pits and dumps
35	Torriorthents, reclaimed
36	San Mateo silt loam, 0 to 8 percent slopes
40	Haplargids-Torriorthents association, undulating to hilly
41	Torrifluvents, nearly level
42	Torriorthents, undulating to hilly
43	Torriorthents, sloping to very steep

SOIL CHARACTERIZATION

METHODS

Soil sampling and analysis. Representative pedons were chosen for sampling on the basis of completed soil survey information. Samples were collected in accordance with soil sampling procedures recommended by the SCS (1972). Profile descriptions were recorded at each sampling site. Soils were sampled by horizon; in both the 1984 Mariah and 1985 IMS studies, thick horizons were subdivided into two-foot sampling increments. Soils were sampled to bedrock in 1984 and 1985, and by EH&A in 1979 to 60 inches.

As shown in Table 6, the number of pedons sampled per soil type varied. Soils A and B and Chilton soils were not sampled. Soils A and B are high in rock fragments and are therefore not suitable for salvage. Chilton soils are high in rock fragments below six inches and also not suitable below that depth.

Table 6. Number of sampled pedons of each soil series.

	Number of pedons sampled			
Series	1979 EH&A	1984 Mariah	1985 IMS	Total
Begay	3	1	1	5
Bond	N/M[1]	N/M	1	1
Cahona	3	4	3	10
Chilton	N/M	N/M	N/S[2]	0
Dulce	3	1	2	6
Las Lucas	3	1	2	6
Oelop	N/M	N/M	2	2
Pulpit	N/M	1	N/M	1
San Mateo	1	1	1	3
Sharps	N/M	1	3	4
Travessilla	N/M	N/M	1	1
Zyme	3	N/M	2	5
Soil A	N/M	N/M	N/S	0
Soil B	N/M	N/M	N/S	0

[1]N/M Not mapped
[2]N/S Not sampled

To ensure that all suitable material was identified, more extensive investigations were conducted on the deep soils within the lease area. These are the Begay, Cahona, Las Lucas, Oelop and the San Mateo soils. At numerous locations, depth to bedrock was determined, using a backhoe, hand auger or both. Where soils were suspected of being intermittently saline and/or sodic, primarily the Las Lucas, Oelop and San Mateo soils,

samples were collected for analysis. At these deep sampling locations, soils below ten feet were sampled in two-foot increments to bedrock. If results of analyses of the soil samples below ten feet indicated plant growth medium suitability problems, samples from these locations from above ten feet were analyzed. Since sodicity and salinity tend to increase with depth, if no problems below ten feet were indicated, it was assumed that the material above ten feet also met the suitability criteria, and further analyses were not necessary.

Analyses of soil samples differed from year to year, depending on the cumulative results of previous years' studies. Table 7 summarizes and compares soil analyses performed to date. In 1985, analyses for boron, selenium and acid-base potential were not conducted on all samples. Over 130 samples were analyzed in 1984 for these three parameters. No sample had hot water extractable boron levels greater than 2.5 ppm, suggesting that elevated boron levels are not a problem in the soils at Black Mesa. Ten samples had extractable selenium levels greater than 0.1 ppm, but all were less than 0.5 ppm. All were from San Mateo soils from below ten feet with six of the samples coming from one location. Since a separate, comprehensive geobotanical study to evaluate potential selenium problems has also been conducted in 1984 and 1985, selenium analysis was eliminated in 1985. Finally, all samples collected in 1984 which had a negative acid-base potential were collected from below ten feet and had pH's under 6.0. In the 1985 study, samples with pH levels under 6.0 and/or from below ten feet were analyzed for acid-base potential.

Table 7. Laboratory analyses of soils of the Black Mesa lease area.

Parameter	1979 EH&A	1984 Mariah	1985 IMS
pH	X	X	X
particle size	X	X	X
saturation percentage	X	X	X
electrical conductivity	X	X	X
Sodium adsorption ratio	X	X	X
Acid-base accounting	X	X	X[1]
Boron, Selenium	X	X	
Potassium, phosphorus, zinc, molybdenum, mercury, copper, nitrate and ammonium nitrogen	X		

[1]On samples below 10 feet and/or with pH under 6.0.

Three laboratories have been used for sample analysis. In the EH&A study, the Peabody lab in St. Louis was used. The Mariah study used Inter-Mountain Laboratories, Inc. in Sheridan, Wyoming. The IMS study used the Soils Testing Laboratory at Colorado State

University. Methods of analysis for the IMS, Mariah and EH&A studies are shown in Tables 8, 9 and 10, respectively.

Table 8. Laboratory methods for soil samples collected by IMS.

Analysis	Reference
Saturation %	U.S. Salinity Laboratory Staff. 1954. Method (27a&b), p. 107.
pH	Soltanpour and Workman. 1981. Page 20.
Electrical conductivity	Soltanpour and Workman. 1981. Page 20.
Particle size analysis (hydrometer)	Day, P.R. 1965. Method 43-5, pp. 562-566. Sieve analysis for vfs.
Texture	Soil Survey Staff. 1981. Pages 205-223.
Sodium, Calcium, Magnesium	Soltanpour and Workman. 1981. Page 21.
Sodium Adsorption Ratio	U.S. Salinity Laboratory Staff. 1954. Method (20b), p. 26.
Total selenium	Extraction: Soltanpour et al. 1982. Method 3-5.5, p. 59. Analysis by hydride generation.
Extractable selenium	Extraction: Soltanpour et al. 1982. Methods 3-5.2 (AB-DTPA) and 3-5.5, pp. 55, 59. Analysis by hydride generation.
Carbonates	Soltanpour and Workman. 1981. Page 19.
Pyritic sulfur	ASTM Method D2492-79.
Total sulfur	Tabatabai, M.A. 1982. Method 28-2.2.3, p. 512.
Lime requirement	McLean, E.O. 1982. Method 12-3.4.4, p. 215.

Table 9. Laboratory methods for soil samples collected by Mariah.

Analysis	Reference
Saturation %	U.S. Salinity Laboratory Staff. 1954. Methods (27a&b), p. 107.
pH	U.S. Salinity Laboratory Staff. 1954. Method (21a), p. 102.
Electrical conductivity	U.S. Salinity Laboratory Staff. 1954. Method (3a), p. 84.
Particle size analysis (hydrometer)	Day, P.R. 1965. Method 43-5, pp. 562-566. Sieve analysis for vfs.
Texture	Soil survey staff. 1951. Pages 205-223.
Sodium, Calcium, Magnesium	Extraction: U.S. Salinity Laboratory Staff. 1954. Method (3a), p.84. Analysis by AAS.
Sodium Adsorption Ratio	U.S. Salinity Laboratory Staff. 1954. Method (20b), p. 26.
Carbonates	U.S. Salinity Laboratory Staff. 1954. method (23c), p. 105.
Selenium (Hot water soluble)	Extraction: Fine, L.O. 1965. Method 8-3, p. 1122. Analysis by AAS.
Boron (Hot water soluble)	Extraction: Wear, J.I. 1965. Method 75-4, p. 1062. Analysis by Auto-analyzer II Automated Method.
Acid-base potential (Leco furnace method)	Smith et al. 1974.

Table 10. Laboratory methods for soil samples collected by EH&A.

Analysis	Reference
Saturation %	U.S. Salinity Laboratory Staff. 1954. Method (27a&b), p. 107.
pH	U.S. Salinity Laboratory Staff. 1954. Method (21a), p. 102.
Electrical conductivity	U.S. Salinity Laboratory Staff. 1954. Method (4a), p. 89.
Particle size analysis/texture	Sobek et al. 1978. Page 123
Sodium, Calcium, Magnesium	Extraction: U.S. Salinity Laboratory Staff. 1954. Method (3a), p. 84. Analysis by AAS.
Sodium Absorption Ratio Exchangeable Sodium Ratio	U.S. Salinity Laboratory Staff. 1954. Method (20b), p. 26.
Carbonates	Sobek et al. 1978. Page 49.
Total Sulfur	Sobek et al. 1978. Page 53.
Selenium (Hot water soluble)	Extraction: Fine, L.O. 1965. Method 80-3, p. 1122. Analysis by AAS.
Boron (Hot water soluble)	Extraction: Wear, J.I. 1965. Method 75-4, p. 1062. Analysis by colorimetric determination with curcumin.
Molybdenum (NH_4 acetate extractable)	Extraction: Reisenauer, H.M. 1965. Method 74-2, p. 1056. Analysis by AAS.
Phosphorus ($NaHCO_3$ extractable)	Extraction: Sobek et al. 1978. Page 48. Analysis by AAS.
Mercury	Extraction: Sobek et al. 1978. Page 74. Analysis by AAS.
Potassium (NH_4 acetate extractable)	Extraction: Pratt, P.F. 1965. Method 71-3, p. 1026. Analysis by AAS.
Copper, Zinc (DTPA extractable)	Extraction: Walsh and Benton. 1973. Pages 164-166.
Nitrate nitrogen	Extraction: Bremmer, J.M. 1965. Method 84-5, p. 1226. Analysis: colorimetric.
Ammonium nitrogen	Extraction: Bremmer, J.M. 1965. Method 84-3, p. 1226. Analysis: Semi-micro steam distillation.

Topsoil suitability. Results of the laboratory analyses of soil samples were compared to suitability criteria for topsoil and overburden established by the Wyoming DEQ (1984). These criteria are presented in Table 11.

Table 11. Criteria for suitability of topsoil.

Parameter	Suitable	Marginal[1]	Unsuitable
pH	5.5-8.5	5.0-5.5 8.5-9.0	<5.0 >9.0
Texture		c,sic,s	
SAR	0-10	10-12[2] 10-15	>12[2] >15
Conductivity (mmho/cm)	0-8	8-12	>12
Saturation percentage	25-80	<25 >80	
Selenium	<0.1 ppm	>0.1 ppm	
Boron	<5.0 ppm		>5.0 ppm
Rock fragments	<25%	25-35%	>35%
Acid-base potential	>-5 tons $CaCO_3$/ 1,000 tons dry material		<-5 tons $CaCO_3$/ 1,000 tons dry material

[1]Soils with marginal suitability are evaluated for use on an individual basis.
[2]For fine-textured soils (clay >40%)

RESULTS

Soil sampling and analysis. Attachment 2 to this report gives profile descriptions and results of analyses of soil samples from the Mariah and IMS investigations conducted in 1984 and 1985. Additional analytical results, primarily of deep hole samples from 1984 and 1985, are given in Attachments 3 and 4. Results of analyses of samples collected by EH&A in 1979 are given in Attachment 5. Soil sampling locations are shown on the soils maps (Drawings 85305A).

Evaluation of topsoil suitability. The soils of the Black Mesa lease area comprise four groups, residual soils, porcellanite-derived soils, eolian soils, and alluvial soils. The soils of each group have generally similar characteristics. The residual soils found within the lease area are the Dulce, Travessilla and Zyme series. Although these soils have no chemical properties limiting suitability, high content of surficial rock fragments (20 to 50 percent by volume) makes these soils only marginally suitable as sources of salvageable topsoil. Zyme soils are marginally suitable also due to clayey texture. Since each of these soils is generally severely eroded, with bedrock occurring at less than six inches, stripping of these soils may be impractical.

The unnamed soils A and B are the porcellanite-derived soils, and are found primarily in the J/21 mining area. These soils were not sampled since the rock fragment content (35 to 70 percent by volume) makes these soils unsuitable for topsoil.

The soils which formed in eolian material, Cahona, Pulpit, Sharps, and Bond, are all suitable for topsoil. The Begay soils, formed in eolian material mixed with alluvium, are included here for discussion. The soils in this group have been extensively sampled to determine suitability. Of a total of 75 samples collected from ten Cahona pedons, with the deepest pedon extending to 186 inches, only one sample is outside the limit of a suitability criterion. Sample 11-1-8 has an acid-base potential (ABP) of -63.1 tons $CaCO_3$/1,000 tons dry material. This sample represents less than 10 percent of a 105-inch profile. The material directly above (sample 11-1-7) has an ABP of 117.0 tons $CaCO_3$/1,000 tons dry material. Because the volume of unsuitable material represented by a single sample is such a small percentage of the total volume of available material, mixing of materials during topsoil salvage and replacement operations should result in adequate dilution of unsuitable material by suitable material. In the same profile, samples 11-1-6 and 11-1-7 have marginally suitable EC levels of 10.8 mmhos/cm and 11.5 mmhos/cm, and clay contents of 3.1 percent and 2.2 percent, respectively. Cahona soils in G11B map unit are underlain by a horizon unsuitably high in rock fragments at a depth between 20 inches and 40 inches.

They are otherwise similar to other Cahona soils above that depth. The four remaining soils in this group are suitable for topsoil. One pedon of Begay soils (27-108) has a high SAR value (16.3) at 71 inches. This high value is anomalous for these soils.

The alluvial soils, Las Lucas, San Mateo and Oelop, have been extensively sampled as part of the deep hole studies as well as for representative profiles. Because of their position in the landscape, these soils are affected by high salt and sodium at varying depths. Most of the soils which are saline or sodic are in or near Reed Valley. Since Reed Valley is the main area in which high levels of salts are found, every side drainage of Reed Valley which will be disturbed by mining was sampled. A summary of the deep hole studies is presented in Table 12. Those sample locations which were dug to bedrock, but not sampled are indicated by "D" in the table. "DS" indicates those locations which were sampled from 10 feet to bedrock. Finally, those locations which were sampled from the soil surface to bedrock are indicated by "DSS".

San Mateo soils have been sampled at ten different locations. At three of these locations, the pedon was sampled either by horizon or in two-foot increments from the soil surface to bedrock; the remainder were sampled below ten feet in two-foot increments. Of the three pedons sampled from the soil surface, all of which are in Reed Valley, depth to high EC values ranges from 8 to 16 feet. Values for SAR do not exceed the suitability criterion in any of these three pedons. At one location (13-14DSS), layers below 14 feet exhibit low acid-base potential.

Of the remaining seven San Mateo pedons sampled, four were sampled in a tributary of Dinnebito Wash in the southern part of J/21 mining area. All of the samples from this area are suitable with respect to all criteria, with the exception of five samples. Sample site 13-2DS at 20 to 22 feet and at 22 to 22.5 feet, and sample site 15-23DS at 20 to 22 feet have slightly low ABP levels. Mixing with the overlying horizons should alleviate any deleterious effects of these levels. At sample site 13-10DS from 10 to 14 feet, selenium levels are slightly elevated, with two samples showing 0.11 ppm and 0.13 ppm, respectively. These levels are considered marginally suitable.

The other three sampled San Mateo pedons are located in Reed Valley Wash or a side tributary to Reed Valley Wash. High EC values occur at 10 feet in the two samples in Reed Valley Wash. At the other location (13-19DS), sampled to 18.7 feet, neither EC nor SAR values exceed suitability criteria.

Las Lucas soils have been sampled at 12 locations; five pedons were sampled from the soil surface to bedrock. Four of these five pedons are located in tributaries to Reed Valley

Wash; three of the four have high EC and SAR values. Depths to high values range from 31 inches at one location (19-64) to 10 feet at a location sampled at ten feet and below. Electrical conductivities are between 12 and 20 mmhos/cm. Site 19-67 does not exhibit any high EC or SAR levels. The fifth pedon sampled beginning at the surface (in N/14) has high a SAR value at 96 inches. All samples from the nine other locations do not show any unsuitably high EC or SAR values. Las Lucas is, therefore, suitable for topsoil down to bedrock except in the Reed Valley area, where close attention should be given to the topsoil stripping depths which are delineated on accompanying maps (Drawing 85305B).

The third series in the alluvial soils group is the Oelop soils. These soils were sampled at three locations from the soil surface to bedrock. High SAR levels were encountered at 12 feet at sample site 12-231, and at 20 inches at sample site 19-55. The samples from the third sample site (12-259) indicate suitability down to 17.5 feet. Sample site 19-55 is in the same drainage as the Las Lucas sample (19-64) which is unsuitable at 31 inches. In addition to high SAR values, both sites in this drainage have low acid-base potentials below 9 feet.

Chilton soils were mapped only at the site of the proposed Wild Ram Dam and will not be extensively disturbed. This series was not sampled since it is unsuitably high in rock fragment content below six inches. A recommended stripping depth of six inches is based on field observations.

Table 12. Summary of deep hole investigations.

Soil series	Map unit	Stop number	Depth to bedrock (feet)	Thickness of suitable material (feet)
Cahona	X11B	7- 8-D	8.4	8.4
Cahona	11B	7- 9-D	10.0	10.0
Cahona	11B	12- 1-D	8.0	8.0
Cahona	11B	12- 47-D	7.0	7.0
Cahona	11B	12- 48-DSS	7.3	7.3
Cahona	11B	12- 52-D	9.3	9.3
Cahona	11B	12- 67-D	7.0	7.0
Cahona	X11B	12- 72-D	10.0	10.0
Cahona	X11B	12- 85-D	7.0	7.0
Cahona	11B	12- 95-D	10.5	10.5
Cahona	11B	12- 98-D	7.4	7.4
Cahona	11B	12- 102-D	7.0	7.0
Cahona	11B	12- 104-D	10.0	10.0
Cahona	11B	12- 106-D	8.0	8.0
Cahona	11B	12- 208-D	11.0	11.0
Cahona	11C	12- 218-D	15.4	15.4
Cahona	11B	12- 224-DSS	15.5	15.5
Cahona	11B	12- 240-D	8.0	8.0
Cahona	11	11- 1-DSS	9.0	8.0
Cahona	11	11- 4-D	12.0	12.0
Cahona	11	11- 5-D	9.0	9.0
Cahona	11	11- 6-DSS	8.0	8.0
Cahona	11	11- 8-D	7.0	7.0
Cahona	11	11- 27-D	11.0+	11.0
Cahona	11	11- 28-D	11.0+	11.0
Cahona	11	11- 30-D	6.5	6.5
Cahona	11	11- 31-D	11.0+	11.0
Cahona	11	11- 25-D	11.0+	11.0
Cahona	11	11- 7-D	27.0+	27.0
Cahona	11	11- 32-D	12.0+	12.0
Cahona	X11	11- 33-D	8.0	8.0
Cahona	11	11- 34-D	12.5+	12.5
Cahona	11	11- 35-D	12.5+	12.5
Cahona	11	11- 42-D	6.5	6.5
Cahona	11	11- 45-D	12.6	12.6
Cahona	11	11- 48-D	10.0	10.0
Cahona	11	11- 53-D	9.0	9.0
Cahona	11	11- 63-D	11.0+	11.0
Cahona	11	11- 67-DSS	8.8	8.8
Cahona	11	11- 73-D	7.5	7.5
Cahona	11	11- 2-D	11.0	11.0
Cahona	11	11- 6-D	8.0	8.0
Cahona	11	11- 3-D	11.0	11.0
				AVERAGE=10.0

43 HOLES

D means dug to bedrock but not sampled
DS means sampled from 10 feet to bedrock
DSS means sampled from surface to bedrock

12% SAMPLED

Table 12. Summary of deep hole investigations (continued).

Soil series	Map unit	Stop number	Depth to bedrock (feet)	Thickness of suitable material (feet)
Begay	12	12- 1-D	11.0+	11.0
Begay	12	12- 12-DSS	11.5	11.5
Begay	12	12- 24-D	8.0	8.0
Begay	12	12- 4-D	11.0	11.0
Begay	12B	27- 108-DSS	7.2	7.2
				AVERAGE= 9.7
Las Lucas	15A	12- 28-D	8.0+	13.0
Las Lucas	15A	12- 31-D	10.0+	10.0
Las Lucas	15A	12- 37-D	8.0+	8.0
Las Lucas	15A	12- 41-D	10.0	10.0
Las Lucas	15A	12- 66-D	7.0+	7.0
Las Lucas	15A	12- 68-D	7.0+	7.0
Las Lucas	15A	12- 111-DS	17.5	17.5
Las Lucas	15A	12- 70-D	8.7	8.7
Las Lucas	15A	14- 13-DSS	11.0	8.0
Las Lucas	15A	19- 64-DSS	17.0	2.5
Las Lucas	15	15- 17-D	10.5	8.0
Las Lucas	15	15- 18-D	17.0	8.0
Las Lucas	15	15- 20-DS	15.6	15.6
Las Lucas	15	15- 29-D	12.5	12.5
Las Lucas	15A	19- 67-DSS	8.0+	8.0
Las Lucas	15A	19- 69-DSS	14.0+	8.0
Las Lucas	15	15- 6-D	26.0	26.0
Las Lucas	15	15- 8-DS	12.3	12.3
Las Lucas	15	15- 12-D	7.0	7.0
Las Lucas	15	15- 24-DS	7.5	7.5
Las Lucas	15	15- 25-D	12.5	12.5
Las Lucas	15	15- 26-DS	13.2	13.0
Las Lucas	15	15- 39-D	7.0	7.0
Las Lucas	15	15- 21-D	24.0+	24.0
Las Lucas	15	15- 22-DS	10.0	10.0
Las Lucas	15	15- 23-DS	22.0	22.0
Las Lucas	15	15- 9-DSS	22.0	22.0
				AVERAGE=11.6
Oelop	14	12- 32-D	8.0	8.0
Oelop	14	12- 259-DSS	17.5	17.5
Oelop	14	12- 231-DSS	17.5	10.0
Oelop	14	14- 6-D	12.0	12.0
Oelop	14	19- 55-DSS	13.0	3.5
Oelop	14	27- 28-D	8.0	8.0
				AVERAGE=9.8

5 HOLES 40% SAMPLED

27 HOLES 44% SAMPLED

6 HOLES 50% SAMPLED

D means dug to bedrock but not sampled
DS means sampled from 10 feet to bedrock
DSS means sampled from surface to bedrock

Table 12. Summary of deep hole investigations (continued).

Soil series	Map unit	Stop number	Depth to bedrock (feet)	Thickness of suitable material (feet)
San Mateo	13	13- 13-DS	18.5	8.0
San Mateo	13	13- 14-DSS	17.3	8.0
San Mateo	13	13- 15-DS	14.0	8.0
San Mateo	13	13- 16-D	14.0	8.0
San Mateo	13	13- 19-DS	18.5	18.5
San Mateo	13A	19- 65-DSS	19.0	7.0
San Mateo	13A	19- 69-DSS	12.0+	8.0
San Mateo	13	13- 10-DS	15.5	15.5
San Mateo	13	13- 11-DS	22.0+	22.0
San Mateo	13	13- 1-D	15.0	15.0
San Mateo	13	13- 2-DS	22.5	22.5
San Mateo	13	13- 3-D	25.0	25.0
San Mateo	13	13- 4-DS	26.0+	26.0
				AVERAGE=14.7

13 HOLES

77% SAMPLED

D means dug to bedrock but not sampled
DS means sampled from 10 feet to bedrock
DSS means sampled from surface to bedrock

Hydrologic interpretations. A "K" factor (soil erodibility factor) for each surface horizon was calculated using the soil erodibility nomograph published in the *National Soils Handbook* (SCS 1983). The "K" factor indicates the susceptibility of a soil to sheet erosion by water. Particle size information required by the nomograph came from the particle size analyses conducted on surface horizon samples.

Hydrologic groups have been developed by the SCS (1983) to describe the potential for a soil to produce surface water runoff under similar storm and vegetation cover conditions. Four groups are recognized (A, B, C, D) with the A group having the lowest runoff potential and the D group having the highest.

Table 13 gives calculated "K" factors and SCS designated hydrologic groups for each soil series from the Black Mesa lease area. Hydrologic groups for the unnamed soils A and B were determined based on SCS criteria (1983).

Table 13. "K" factor and Hydrologic Group of the soils of the Black Mesa lease area.

Soil series	"K" factor	Hydrologic group
Begay	.43	B
Bond	.43	D
Cahona	.49	B
Chilton	.13	B
Dulce	.13	D
Las Lucas	.28	B
Oelop	.37	B
Pulpit	.49	B
San Mateo	.37	B
Sharps	.49	B
Travessilla	.12	D
Zyme	.22	D
Soil A	.04	B
Soil B	.04	B

Prime farmland assessment. The SCS has established criteria for prime farmland soils. The critical criterion relevant to the soils of the Black Mesa lease area is that prime farmland soils must have "a developed irrigation water supply that is dependable and of adequate quality" (Soil Survey Staff 1983). Since no water supply has ever been developed for irrigated agriculture anywhere within the Black Mesa lease area, there are no soils which satisfy this criterion for prime farmland. A letter from the SCS supports this negative determination (Exhibit 3).

EXHIBIT 3.

SCS LETTER CONCERNING PRIME FARMLAND

United States
Department of
Agriculture

Soil
Conservation
Service

3008 Federal Bldg.
Phoenix, AZ
85025

December 9, 1980

Ms. Ella Mulford
Peabody Coal Company
Arizona Division
1300 South Yale
Flagstaff, Arizona 86001

Dear Ms. Mulford:

As requested, I have reviewed the Black Mesa and Kayenta Mines Soil Survey and submit the following information pertaining to prime farmland:

> One of the primary requirements for a soil to qualify for prime farmland is to have an adequate and dependable moisture supply from precipitation or irrigation. The average annual precipitation in the area is less than 14 inches, not enough for sustained crop production, and there is no developed dependable water supply. Therefore, none of the soils in the area qualify for prime farmland.

If we can be of further assistance please feel free to call on us.

Sincerely,

Davie L. Richmond
Asst. State Soil Scientist

Potential vegetation production estimates. Estimates developed by the SCS of the potential vegetation production for each soil series are given in Table 14, and are representative of soils in excellent range condition. These figures are taken directly from the SCS Form 5, Soil Interpretation Record, for each soil correlated to an established soil series, with the following minor exceptions. Three soils, Dulce, Soil A and Soil B, are not correlated to established series and official Form 5's are therefore not available. Since the Dulce soil is a series taxadjunct only because of soil color differences, the Form 5 for the established Dulce series is used. For Soils A and B which support similar vegetation and occur in similar landscape positions as the Dulce and Zyme soils, the average of the potential production of the Dulce and Zyme series is given as an estimate of their potential vegetation production. A Form 5 for each established soil series is presented in Attachment 6.

For a number of the named soil series, the SCS has established ranges of potential vegetation production, in recognition of the fact that a soil series may vary in potential vegetation production due to differences in available moisture. These ranges are expressed in terms of moisture phases, and the SCS has estimated potential vegetation production for each moisture phase. Moisture phases of soil series have not been mapped for the Black Mesa lease area, but inferences regarding the distribution of moisture phases have been made. Factors such as mean annual precipitation, size and density of Colorado pinyon relative to Utah juniper, occurrence of certain understory species such as gambel oak (*Quercus gambelii*) and Mexican cliffrose (*Cowania mexicana*), and certain soil characteristics have been used as a basis to distinguish moisture phases. Since these factors are all generally related to elevation, it is concluded that above about 6,800 feet in elevation in N/14 and about 7,000 feet in J/21 are appropriate elevations for the separation between moist and dry phases, with the moist phases occurring at the higher elevations.

Because most of the soils of the Black Mesa lease area are eroded, and in the case of Dulce, Travessilla, and Zyme, usually severely eroded, the probability that the range condition will ever return to an excellent range condition is slight. It is also believed that the estimate of potential vegetation production developed by the SCS for Dulce soils is 25 percent to 50 percent too high. As shown in Table 14, Dulce, dry phase has the same potential production as the dry phase of the Pulpit and Sharps soils. The Dulce soil, as it occurs on the Black Mesa lease area, usually has bedrock within six inches. Pulpit and Sharps, on the other hand, are underlain by bedrock between 20 and 40 inches. It is highly unlikely that vegetation production on these soils in excellent range condition could ever be comparable. Since all three soils were established in southwest Colorado, the Range

Conservationist of the SCS in Colorado was consulted about the production figure for the Dulce soil. As discussed in his letter shown as Exhibit 4, the production figure of the Dulce soil is "based on limited information..., which may cause us [*the SCS*] to give the Dulce soil a better rating that [*sic*] it deserves."

Table 14. Potential vegetation production of the soils of the Black Mesa lease area.

Soil name	SCS Form 5 No.	Potential vegetation production[1] (lbs/ac. air dry wt.)	
		Moist phase	Dry phase
Begay	UT0359	1000	650
Bond	NM0220	500	500
Cahona	CO0578	1000	750
Chilton	NM0223	750	750
Dulce	CO0394	600	600
Las Lucas	NM0090	675	675
Oelop	NM0488	750	750
Pulpit	CO0538	800	600
San Mateo	NM0854	750	750
Sharps	CO0310	1200	600
Travessilla[2]	NM0690	225	225
Zyme[2]	CO0749	400	300
Soil A	N/A	500	450
Soil B	N/A	500	450
Ustic Torriorthents	CO7057	350	350

[1]Normal precipitation year; annual production for shrubs, half-shrubs, grasses and forbs; excellent range condition.
[2]Channery surface phase

In addition to the SCS estimates, Peabody has conducted extensive vegetation production sampling within the Black Mesa lease area. The results of this sampling work are presented in detail in the chapter on vegetation in the Peabody Coal Company's permit application.

Calculation of disturbed acreage. Table 15 and 16 show acreages of soils proposed for disturbance. Table 15 gives acreages by map unit. Table 16 gives acreages by soils series based on the composition of each map unit shown in Table 4. Acreages were calculated from planimetric data using standard techniques.

EXHIBIT 4.

SCS LETTER CONCERNING VEGETATION PRODUCTION

(22)

AUG 13 1985

United States
Department of
Agriculture

Soil
Conservation
Service

Bldg A, 3rd Floor, DHOC
2490 West 26th Avenue
Denver, Colorado 80211

August 12, 1985

Richard Trenholme, President
Intermountain Soils, Inc.
1873 S. Bellaire St., Suite 330
Denver, Colorado 80222

Dear Mr. Trenholme:

In response to your letter of August 1, I will try to respond to your questions to the extent that we have information. In addition, I consulted with Noel Wellborn, who was the Range Conservationist in this area of Colorado, until recently accepting an assignment as RC&D Coordinator in Durango, Colorado.

In response to your question on potential plant productivity on the Dulce, Pulpit, and Sharps soils, which are shown at 600 pounds/acre is based on limited information particularly on the Dulce soil. The areas available have had hard winter use which makes it difficult to get the best data. This may cause us to give the Dulce soil a better rating that it deserves. However, if you consider surface soil texture and the rest of the profile which is primarily sandy loam, we find that in low precipitation areas these sandy soils frequently out-produce loam and clay loam soils with similar profile depths. Also, the production shown is for understory species and does not take into account the green biomass production from vegetation which is out of the reach of grazing animals.

Colorado does not have a dry phase of the Dulce soil. In addition, no eroded phases have been established for either the Dulce or Zyme soils. In regard to production comparisons between Sharps and Cahona soils, the deeper Cahona soil is rated at 700 pounds/acre as compared to 600 pounds/acre for the Sharps soil. Both of these are being compared in the dry phase.

If you have any additional questions, please feel free to call or contact us.

Sincerely,

Leonard Jurgens
Range Conservationist

cc: D. W. Gillaspie, SRC
Noel Wellborn, RC&D Coordinator

Table 15. Acres proposed for disturbance by map unit.

Map unit	Number of acres									
	J/1-N/6	J/7	J/16	J/19	J/21		N/10	N/11	N/14	Total
					Moist	Dry				
1A	30.0	4.4	7.9	5.0	21.2	0.0	0.0	0.0	0.0	68.5
1,1B	66.2	22.3	12.2	236.1	308.5	29.3	4.5	28.6	6.2	713.9
1C	4.6	7.8	2.1	83.2	58.7	60.1	3.2	11.5	0.8	232.1
1D	0.0	0.0	1.4	6.8	11.5	0.0	0.0	0.0	0.9	20.6
2B	3.2	7.6	33.5	15.9	0.0	0.0	0.0	3.9	10.8	74.9
3A	53.3	0.0	12.3	0.0	0.0	0.0	12.2	0.0	6.1	83.9
3BC	0.0	0.0	0.0	651.6	878.3	114.1	0.0	0.0	0.0	1643.9
3C	456.3	8.3	109.9	0.0	0.0	0.0	101.8	67.8	188.8	933.0
3D	119.4	0.0	179.8	0.0	0.0	0.0	58.4	228.1	46.5	632.2
3DE	0.0	0.0	0.0	623.4	375.6	6.5	0.0	0.0	0.0	105.5
3E	49.3	1.7	193.7	0.0	31.0	0.0	70.8	259.8	42.3	648.8
3F	0.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	25.0
4A	1.8	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	3.1
4B	26.6	2.4	10.4	41.9	79.7	6.9	0.0	0.0	0.0	167.9
4C	66.8	0.0	13.9	32.7	102.9	16.1	0.0	0.0	23.2	255.6
4D	20.7	0.0	0.0	22.1	21.4	5.9	2.1	20.4	12.2	104.8
5	2.6	0.0	0.0	127.8	328.0	25.9	0.0	9.0	0.0	493.3
6	0.0	0.0	0.0	26.4	39.4	30.7	0.0	0.0	0.0	96.5
6A	87.4	20.3	17.4	5.5	0.0	0.0	0.0	0.0	1.6	132.1
6B	128.9	44.0	21.6	11.8	0.0	0.0	5.1	3.0	1.0	215.4
6C	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	5.3	7.0
7B	0.0	102.2	0.0	25.7	0.0	0.0	0.0	0.0	0.0	128.1
7C	0.0	42.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.4
7D	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7E	0.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5

Table 15. Acres proposed for disturbance by map unit (continued).

Map unit	Number of acres									
	J/1-N/6	J/7	J/16	J/19	J/21		N/10	N/11	N/14	Total
					Moist	Dry				
10	0.0	0.0	0.0	120.6	182.2	23.0	0.0	0.0	0.0	325.8
10A	37.3	37.6	0.0	1.3	0.0	0.0	0.0	0.0	0.0	76.2
10B	66.7	0.0	22.8	0.0	0.0	0.0	0.0	1.4	6.9	97.8
10C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	206.3	321.6	126.3	0.0	0.0	0.0	654.1
11A	5.5	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.5
11B	120.2	2.1	0.0	0.0	0.0	0.0	0.0	0.0	2.0	124.3
11C	10.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.9	140.0
G11B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
X11	0.0	0.0	0.0	97.4	37.8	51.2	0.0	0.0	0.0	186.4
X11A	15.9	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.3
X11B	73.1	10.8	12.4	1.5	0.0	0.0	9.5	5.2	0.0	112.5
X11C	1.7	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	4.5
12	0.0	0.0	0.0	107.0	69.3	12.5	0.0	0.0	0.0	188.8
12A	10.1	21.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.1
12B	6.9	5.4	5.2	0.0	0.0	0.0	0.0	0.0	9.4	26.9
12C	0.0	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	4.1
13A	0.0	0.0	0.0	143.2	37.3	0.0	0.0	1.9	0.0	182.4
14A	30.8	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	38.1
14B	6.5	0.0	7.1	0.0	0.0	0.0	0.0	16.5	0.0	30.2
15A	129.3	0.9	76.7	132.7	367.8	53.2	12.4	74.5	12.4	859.9
16C	5.5	0.0	0.0	202.8	38.8	1.6	0.5	24.5	0.0	273.8
16E	0.0	0.0	0.0	182.5	56.1	0.0	0.0	26.0	0.0	264.6
16F	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.0	0.0	3.3
17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DL	560.9	120.4	174.8	47.3	29.7	50.7	49.4	7.4	282.9	1323.9
RL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TS	19.7	0.0	14.8	0.0	0.0	0.0	0.0	0.0	0.0	34.6
RW	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Total	2218.9	487.1	938.1	3186.8	3396.8	614.0	329.9	796.8	663.2	12632.7

Table 16. Acres proposed for disturbance by soil series.

Soil series	Number of acres										
	J/1-N/6	J/7	J/16	J/19	J/21		N/10	N/11	N/14	Total	
					Moist	Dry				Moist[1]	Dry
Begay	17.0	27.3	9.3	107.0	69.3	12.6	0.0	0.0	9.4	78.7	173.2
Bond	9.9	10.6	31.6	21.6	12.7	1.6	0.4	4.0	10.0	22.7	79.7
Cahona	337.0	68.7	39.4	428.0	557.1	199.2	9.4	7.2	12.9	570.0	1088.9
Chilton	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Dulce	353.3	55.7	186.0	757.2	840.7	126.4	90.9	211.2	113.9	954.6	1780.7
Las Lucas	129.3	0.9	76.7	132.7	367.8	53.2	12.4	74.5	12.4	380.2	479.7
Oelop	37.3	0.0	7.1	0.0	0.0	0.0	0.0	23.8	0.0	0.0	68.2
Pulpit	2.3	0.0	0.0	115.0	295.2	23.3	0.0	8.1	0.0	295.2	148.7
San Mateo	0.0	0.0	0.0	143.2	37.3	0.0	0.0	1.9	0.0	37.3	145.1
Sharps	205.6	62.0	37.8	52.5	49.3	33.4	5.1	3.1	8.0	57.3	399.5
Travessilla	0.0	57.3	0.0	10.3	0.0	0.0	0.0	0.0	0.0	0.0	67.6
Zyme	491.5	72.0	318.6	864.6	940.4	100.6	143.3	357.8	193.8	1134.2	2348.4
Soils A	3.3	0.0	0.0	233.2	56.9	1.0	0.3	30.3	0.0	56.9	268.1
Soils B	6.5	0.1	1.1	142.5	42.0	1.7	1.2	18.4	1.9	43.9	171.5
other soils	15.9	4.7	3.9	20.8	27.4	3.5	3.4	2.0	5.9	33.3	54.2
Ustic Torriorthents	0.0	0.0	0.0	18.8	0.0	0.0	0.0	0.0	0.0	0.0	18.8
Rock outcrop	27.8	7.5	37.0	92.1	70.8	7.0	14.1	47.1	12.0	82.8	232.6
Disturbed land	560.9	120.4	174.8	47.3	29.7	50.7	49.4	7.4	283.0	312.7	1011.1
Riverwash	1.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6
Reclaimed land	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Topsoil stockpile	19.7	0.0	14.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.5
Total	**2218.9**	**487.4**	**938.1**	**3186.8**	**3396.6**	**614.2**	**329.9**	**796.8**	**663.2**	**4059.8**	**8572.1**

[1]Moist phase totals include J/21 moist and N/14; all other soils are in the dry phase.

GEOBOTANICAL STUDIES

BACKGROUND

The occurrence of "selenium indicator" or "selenium accumulator" plant species in areas proposed for surface coal mining is a concern to the Office of Surface Mining. It is a concern because soils high in plant-available selenium are not suitable for use in reclamation since forage produced on such soils can be toxic to livestock. By regulation, a permit for coal mining cannot be approved until it has been demonstrated that the reclamation plan can reasonably be expected to achieve the proposed post-mining land use (30 CFR 750.19), which for Peabody's Black Mesa and Kayenta mine is grazing by domestic livestock. It is further required that toxic materials, including soil or spoil high in selenium, be adequately covered to minimize potential limitations to the approved post-mining land use (30 CFR 750.102).

This report describes the results of field and laboratory studies intended to answer the questions of whether the occurrence of certain plant species within the Black Mesa lease area is indicative of soils high in plant-available selenium, and whether the occurrence of certain plant species is indicative of a hazard of toxic levels of selenium in forage species. In 1984 investigators from the Museum of Northern Arizona and Peabody Coal Company surveyed, sampled and analyzed soils and vegetation within the Black Mesa lease area in an effort to locate and characterize potential selenium problem areas. Additional studies were conducted in 1985 under the direction of Intermountain Soils, Inc. The 1985 work was intended further to clarify soil and plant selenium relationships established by the results of work done in 1984.

It is appropriate at this point to establish an understanding regarding certain terms commonly encountered in discussions of selenium in plants. Selenium "indicator" plants are said to grow primarily—or even exclusively—on "seleniferous" soils. The results of these studies, which are discussed later, suggest that the term selenium "indicator" species is inappropriate for describing any apparent relationships in the distribution of selenium in soils and vegetation of the Black Mesa lease area, and is not used further in this report. Whether or not the concept of selenium "indicator" plants may be accurately applied elsewhere will not be discussed here. In this report, the term selenium "accumulator" plant species is used in reference to plant species capable of accumulating selenium in above ground plant tissues at concentrations which can be toxic to livestock. Plant species which

may concentrate fairly high levels of selenium may be referred as "primary accumulator" species. Total selenium concentrations in primary accumulator plants may range from well below 100 ppm to several thousand parts per million, although such high concentrations were not encountered in any species within the Black Mesa lease area. "Secondary accumulator" plant species also concentrate selenium in their tissues, but not in such high concentrations as primary accumulators. The distinction between what is a primary or secondary selenium accumulator is vague. Finally, use of the term "seleniferous" is avoided in this report. A "seleniferous" soil may be defined functionally as a soil with plant-available selenium levels sufficient to produce selenium concentrations in non-accumulator plant species high enough to be toxic to livestock. There is no established or agreed upon empirical definition of seleniferous soils based on soil selenium concentrations.

METHODS

1984 field survey. Scientists from the Museum of Northern Arizona were contracted by Peabody Coal Company in 1984 to locate significant populations of known or suspected selenium accumulator plant species in portions of the Black Mesa lease area. An 11,700-acre study area encompassing the J/19, J/20, J/21 and J/23 mining areas (Drawing 85310) was subdivided into six sub-areas. One to two person-days were spent surveying each sub-area on foot or in vehicles. Survey efforts focused on those plant species which are reported to be accumulators of selenium (Schmutz et al. 1968; Kearney and Peebles 1960; and Barneby 1964), and which were known to occur within the Black Mesa lease area. Listed or candidate threatened or endangered plant species (U.S. Fish and Wildlife Service 1980 and 1983) were also a subject of the survey. Areas where selenium accumulator species were encountered, such as shale outcrops and steep canyon sides were surveyed more intensively on foot.

When a stand of selenium accumulator plants was found, its location was noted on an aerial photograph. Observations were made of the general characteristics of each site. In all, nineteen stands were identified.

1984 soils and vegetation sampling. Nine of the nineteen stands of selenium accumulator plants were selected for further study. Three of these nine locations were subdivided into smaller units because of variability within the locations. Each unit was sampled separately. Vegetation samples collected at each location included the selenium accumulator species present and, at some locations, secondary and/or non-accumulator species. For each species sampled, approximately 50 grams of sample material was composited from above ground portions of the current year's growth of several individual plants. Phenologic stages of each sampled species were noted. Sample material was placed in paper bags, weighed, and immediately placed on dry ice to retard metabolic activity and to minimize selenium volatilization. After freezing on dry ice, samples were dried at 40°C in a forced-draft oven until constant weights were obtained, sealed in plastic bags, and shipped to the laboratory for chemical analysis.

One or two soil pits were excavated at each sampling location, depending on the size of the sampling location and apparent soil variability within the location. Soil samples were collected at various depth intervals from each pit. Sample depth intervals were determined on the basis of horizon differentia and distinguishable changes in regolith. Sample depth intervals never exceeded 20 inches. At some locations, samples of unweathered regolith

were also collected. Soil samples were air dried before shipment to Inter-Mountain Laboratories, Inc. for analysis.

1984 laboratory analyses. Vegetation samples were analyzed for total selenium by two methods, a nitric acid-hydrogen peroxide (HNO_3-H_2O_2) digestion and a perchloric-hydrofluoric acid ($HClO_4$-HF) digestion. Soil samples were analyzed for total selenium using a perchloric-hydrofluoric acid digestion, and for available selenium using an ammonium bicarbonate-DTPA (AB-DTPA) extract and a hot water extract.

1985 field survey. In 1985, the survey area included the mining areas J/7, J/1-N/6, N/11, N/14, and J/16 (Drawing 85310). Survey methods in 1985 were the same as in the previous year, with the exception that the survey effort was intensified. As in 1984, the survey of the study area to locate stands of selenium accumulator plants was conducted by botanists from the Museum of Northern Arizona. Locations of stands of selenium accumulator plants were noted on aerial photographs. In all, 40 sites were identified (Drawing 85310). Observations were made of the general characteristics of each site.

1985 soils and vegetation sampling. Of the 40 stands of selenium accumulator species identified by the 1985 field survey, 13 were selected for soils and vegetation sampling. Locations of stands of selenium accumulator species and sampling locations for the 1985 study are also shown on Drawing 85310. In addition, two "control" sampling locations were selected where selenium accumulator species were not present, but the soils were similar to the soils where selenium accumulators did occur. At each sampling location, a soil pit was excavated with a backhoe. Except at the "control" locations, pits were situated right next to one or more individuals of the selenium accumulator species identified at the sampling site. Excavation of soil pits in this manner allowed for close observation of rooting depths and habits of the selenium accumulator species.

At each sampling location, vegetation species composition, range condition, soil characteristics, and root distributions of the selenium accumulator species were noted. At several sampling locations, roots of the selenium accumulator species which had been exposed by the excavation of the soil pit were drawn to scale. The intent of these observations was to identify which portions of the soil profile appeared to be the predominant portions of the root zone.

Soils and vegetation samples were collected at each sampling site in essentially the same manner as in 1984. Vegetation samples were collected of the selenium accumulator species at each sampling location. Indian ricegrass (*Oryzopsis hymenoides*) was also sampled at all but one sampling location. At several locations, other species were also sampled.

Species were sampled separately by clipping aerial portions of current year's growth from at least three individuals of each sampled species. Phenologic stage of each species was noted. Samples were immediately placed in a cooler containing dry ice. Samples were kept cool until delivery to the Soils Testing Laboratory at Colorado State University.

Soil samples were collected from various depth intervals at each sampling site. Sample depth intervals were selected on the basis of observed root distribution and on the characteristics of the soil profile. The intent was to sample whatever horizons or zones were apparent in each soil profile which might be relatively more suspect as selenium sources than other zones. These included zones exhibiting greatest proliferation of roots of the selenium accumulator species and zones containing carbonaceous material. Soil samples were collected from several depth intervals from the exposed soil profile and put into labelled Tyvek sample bags. Samples were allowed to air-dry in the porous sample bags in a cool, dry storage area. Air-dry samples were then sent to the Soils Testing Laboratory at Colorado State University.

1985 laboratory analyses. Vegetation samples were oven-dried at a temperature not exceeding 55°C. Samples were ground in a Wiley mill, digested in nitric-perchloric acid (HNO_3-$HClO_4$), and analyzed with a continuous hydride generator and an ICP multichannel analyzer. Soil samples were analyzed for total (nitric-perchloric acid digestion) and AB-DTPA-extractable selenium. In the case of the AB-DTPA-extractable analyses, an additional perchloric acid digestion was performed on some extracts to oxidize the organic matter which otherwise would have created interference problems with the ICP unit. Selenium recovery was checked with a number of spiked samples to verify the accuracy of the method as modified.

RESULTS

Field surveys. The 1984 survey of the J/19, J/20 and J/21 mining areas resulted in the identification of 18 stands of desert plume (*Stanleya pinnata*) and stinking milk-vetch (*Astragalus praelongus*). Forty stands of desert plume and stinking milk-vetch were identified in the J/6-N/1, J/7, J/16, N/11, and N/14 mining areas in 1985. Locations of these stands are shown in Drawing 85310. No other stands of known selenium accumulator species were located. No threatened or endangered species were encountered during these surveys.

Characteristic patterns in the distribution of the accumulator species are fairly apparent. Both stinking milk-vetch and desert plume tend to be found on disturbed sites and on certain soils. Disturbed areas where desert plume was predictably encountered include roadsides, particularly where wide shoulders had been bladed, and areas of intense livestock disturbance, such as sheep corrals and cattle resting areas under pinyon and juniper trees. Certain areas of topographic relief such as narrow canyons and shoulders of ridges where carbonaceous shale outcrops occur are also favored by these species. Apparent vigor of desert plume plants was generally low in areas associated with livestock use; at roadsides and other disturbed sites vigor was generally high. Stinking milk-vetch seems somewhat less specific than desert plume in its occurrences. It occurs, although infrequently, in open, undisturbed areas of the pinyon-juniper woodland. In a few areas in the J/7 area, it was found growing with sagebrush. It is rarely found in dense pinyon-juniper woodland stands where desert plume occurs. While it was most often noted on shallow shale-derived soils, it may also occur on shallow sandstone-derived soils, and very rarely on red eolian soils. In the 1984 field survey, certain types of areas were found consistently lacking in desert plume and stinking milk-vetch. These include broad, flat sagebrush valleys, fluvial terraces along drainageways, and dense old-growth pinyon-juniper woodland on deep, eolian soils. These patterns of distribution of selenium accumulator species were upheld during the 1985 field survey, with only a few exceptions. These exceptions are probably not due to any ecological differences between the 1984 and 1985 study areas, but rather to a more intensive survey effort made in 1985 in comparison to the level of intensity of the 1984 field survey.

Species composition and range condition at 1985 sampling locations. It is not believed that the occurrences of desert plume or stinking milk-vetch are a direct result of past grazing management practices. Otherwise these two species would be much more widespread. These species are not considered to be increasers nor to be particularly

aggressive. As shown in Table 17, they comprise only a very minor component of the already sparse understory vegetation cover.

All of the 1985 sampling locations were considered to have low forage production potential, reflecting low productive capability of the soils and low annual precipitation of the region. Moreover, with the exception of sampling locations 15 and 33 which were considered to be in fair condition, all of the 1985 sampling locations were in poor condition with respect to potential vegetation production. No sampling locations in the 1985 study were in good condition.

As shown in Table 17, total vegetation cover at the 1985 sampling locations is low. Densities of Utah juniper and pinyon pine are typical of this vegetation type. Livestock carrying capacity is low, in accordance with the poor range condition. Many of the desirable perennial grass species are present, but they are not abundant or high in vigor. With the possible exception of blue grama (*Bouteloua gracilis*), these species would be more predominant under good or excellent range condition at these locations. The relatively high vegetation cover component represented by blue grama at many of the 1985 sampling locations is not unusual for this type of range in poor condition, and is reflective of low species diversity. In spite of its relative abundance, blue grama was also low in vigor at all locations.

Soil and vegetation laboratory analyses. Plant species sampled in 1984 and 1985 are listed in Table 18. As shown in Table 19, selenium concentrations in stinking milk-vetch samples collected in 1984 range from 62 ppm to 325 ppm (nitric acid-hydrogen peroxide digestion). Concentrations in 1984 samples of desert plume range from 22.3 ppm to 261.0 ppm. Samples of these species collected in 1985 and analyzed for selenium using a nitric-perchloric acid digestion range from 37.3 ppm to 350 ppm for stinking milk-vetch and from 0.2 ppm to 97.7 ppm for desert plume (Table 20). All other species sampled in both years, including suspected "secondary" accumulators, are below 5 ppm total selenium. Selenium concentrations in vegetation above 5 ppm can be chronically toxic to livestock (Munshower 1983 and National Research Council 1976).

Results of soil selenium analyses for 1984 and 1985 are shown in Tables 21 and 22, respectively. The geometric means for total soil selenium concentrations for samples collected in 1984 and 1985 are 0.6 ppm and 1 ppm, respectively. AB-DTPA-extractable selenium concentrations in soil samples from both years range from less than 0.005 ppm to 0.320 ppm. Geometric means for AB-DTPA-extractable selenium concentrations in soil samples are 0.025 ppm and 0.034 ppm for 1984 and 1985 samples, respectively. Fewer

than five percent of the 84 soil samples analyzed in 1984 and 1985 exceed the suitability criterion of 0.1 ppm AB-DTPA-extractable selenium established by the Wyoming Department of Environmental Quality (Wyoming DEQ 1985). None of these samples is from the soil surface, and two are from control areas where no selenium accumulator species occurred. Hot water-extractable concentrations in 1984 soil samples range from less than 0.005 ppm to 0.054 ppm. Soil samples collected in 1985 were not analyzed for hot water extractable selenium.

Root sketches made of selenium accumulator species at 1985 sampling locations are included in Attachment 7.

Table 17. Species composition at 1985 sampling locations.

Scientific name	Common name	Sampling location												Control location	
		3	10	12	15	29	33	28	31	26	21	22	11	22	21
Grasses															
Agropyron smithii	Western wheatgrass				T										
Aristida fendleriana	Three awn						3	4							
Bouteloua gracilis	Blue grama	5	24	20	18	19	17	14	11	14	14	19	22	8	21
Bromus tectorum	Cheatgrass		8			3	3						1		
Hilaria jamesii	Galleta	8	T	5	8	4	24	16	21	9	17	12	23	13	22
Oryzopsis hymenoides	Indian ricegrass	14	16	9	4	11	2	7	7	5	6	5	3	9	16
Poa fendleriana	Mutton grass	8				2								2	
Poa secunda	Sandberg bluegrass				T										
Sitanion hystrix	Bottlebrush squirreltail	1	6	7	2	9	5	7	9	9	5	2	5	5	
Sporobalus cryptandrus	Sand dropseed									T					
Forbs and Succulents															
Agoseris sp.	Wild dandelion		T					T							
Arabis perennans	Rockcress										T				
Astragalus calycosus	Torrey milk-vetch	T													2
Astragalus praelongus	Stinking milk-vetch	T	1	T											
Astragalus wingatanus	Fort milk-vetch		1												
Brickellia brachyphylla										1					
Cryptantha bakeri						2		1	2	1	1	1	2		1
Cymopterus pupureus		2		4	2		1						1		
Descuriania pinnata	Tansy mustard								2	2	3	1			2
Draba cuneifolia	Whittow-grass				1										
Echinocereus triglochidiatus	Hedgehog cactus				T										
Eriogonum microthecum	Wild buckwheat				3										
Eriogonum umbellatum						1	T	2	3	3	T				
Hymenopappus filifolius				T											
Hymenoxys acaulis	Bitterweed	3	T	6	3					7					
Ipomopsis aggregata	Sky rocket					2	2	T	1						
Ipomopsis multiflora			T								T				
Lappula redowskii	Stick seed					2	2	2					1		6
Lesquerella intermedia	Bladder pad	T	T	T											
Leucelene ericoides	White aster		1	T	1	3	3	2	T	1	4	8	2	9	3
Lupinus brevicaulis					1			4							
Machaeranthera grindelioides					1										
Marrubium vulgare	Common horehound									T					
Mentzelia pumila	Blazing star		T												
Mirabilis multiflora	Colorado four o'clock					T				T			T		
Opuntia erinacea	Mojave prickly pear		T												

Table 17. Species composition at 1985 sampling locations. (continued)

Scientific name	Common name	Sampling location												Control location	
		3	10	12	15	29	33	28	31	26	21	22	11	22	21
Forbs and Succulents (cont'd)															
Opuntia sp.									T					2	
Opuntia whipplei	Whipple cholla							T		T					
Oxytropis lambertii	Lambert locoweed				3										
Pentstemon linarioides	Mat penstemon	5		1	T										
Petradoria pumila	Rock goldenrod				2										
Physaria newberryi	Twinpod							T			T	T			
Sclerocactus paraviflorus								T					T		
Senecio linearis	Butterweed					T									
Senecio spartioides	Ragwort	3					T								
Sphaeralcea coccinea	Scarlet globe mallow		4	4	1	1	1	3		3	3		3		3
Stanleya pinnata	Desert plume					T	1	T	1	5	2	2	3	T	
Townsendia exscapa	Ground daisy					T									
Shrubs															
Artemisia arbuscula spp. *nova*	Black sagebrush	22													
Artemisia tridentata	Big sagebrush		T	21	23					12	6		2		
Atriplex canescens	Four-wing saltbush		T		1	2	T	7	5	6	5	23	3	15	
Chrysothamnus depressus	Rabbitbrush				1										
Chrysothamnus greenei		20	28	9	11	19	15	2	5					8	
Chrysothamnus nauseosus	Rayless goldenrod									2			1		
Cowania mexicana	Mexican cliffrose			8		1	T	5	6	2					
Ephedra viridis	Green ephedra				5	T	1						T		
Eriogonum corymbosum					3	2		7	6	6	19	2	T	17	4
Gutierrezia sarothrae	Snakeweed	9	12	3	6	16	21	14	17	14	17	25	31	14	18
Quercus gambelii	Gambel oak									T					
Yucca angustissima	Spanish bayonet		2		T										
TOTAL		100	100	100	100	100	100	100	100	100	100	100	100	100	100
HERBAGE COVER (%)		4	6	3	12	14	17	8	4	3	2	3	3	3	4
DENSITY (plants per acre)															
Juniperus osteosperma	Utah juniper	19	5	22	14	18	18	21	15	26	35	12	15	17	18
Pinus edulis	Colorado pinyon	25	12	8	28	23	10	14	20	19	21	19	12	12	26

Table 18. Plant species sampled for selenium analysis in 1984 and 1985.

Species	Common name	Abbreviation	Year sampled 1984	Year sampled 1985
Astragalus praelongus	**stinking milk-vetch**	**ASPR**	x	x
Atriplex canescens	four-wing saltbush	ATCA	x	x
Bouteloua gracilis	blue grama	BOGR		x
Bromopsis inermis	smooth brome	BRIN		x
Chrysothamnus nauseosus	rabbitbrush	CHNA	x	x
Ephedra viridis	green ephedra	EPVI		x
Eriogonum corymbosum	Wild buckwheat	ERCO		x
Gutierrezia sarothrae	snakeweed	GUSA	x	
Hilaria jamesii	galleta	HIJA		x
Mentzelia albicaulis	blazing star	MEAL	x	
Oryzopsis hymenoides	Indian ricegrass	ORHY	x	x
Oxytropis lambertii	Lambert locoweed	OXLA		x
Penstemon linarioides	beard tongue	PELI	x	
Petradoria pumila	rock goldenrod	PEPU	x	
Poa fendleriana	mutton grass	POFE		x
Senecio douglassi var. *longilobus*	threadleaf groundsel	SELO	x	
Senecio spartioides	groundsel	SESP		x
Stanleya pinnata	**desert plume**	**STPI**	x	x

Species in bold type denote the known selenium accumulators.

Table 19. Selenium concentrations in 1984 vegetation samples.

Sampling location	Species	Total Selenium (ppm) HNO_3/H_2O_2	Total Selenium (ppm) $HC10_4/HF$
84-1	ATCA	0.39	1.50
	GUSA	0.37	1.20
	STPI	**129.00**	**127.00**
84-3	**ASPR**	**62.00**	**72.00**
	GUSA	0.47	1.50
84-6	ATCA	0.54	1.30
	GUSA	0.80	0.70
	ORHY	0.67	2.60
	STPI	**135.00**	**152.00**
84-10	**ASPR**	**226.00**	**320.00**
	ORHY	0.74	0.95
	SELO	0.56	1.60
84-11A	CHNA	0.43	1.20
	GUSA	0.73	2.00
	STPI	**169.00**	**221.00**
84-11B	ATCA	0.53	2.70
	GUSA	0.27	1.00
	STPI	**138.00**	**141.00**
84-13	GUSA	0.81	2.30
	STPI	**261.00**	**366.00**
84-14A	**ASPR**	**325.00**	**409.00**
	GUSA	0.97	2.30
	PEPU	0.50	1.20
84-14B	**ASPR**	**87.00**	**137.00**
	GUSA	1.47	1.80
	PELI	0.63	1.50
	STPI	**129.00**	**215.00**
84-16	**ASPR**	**67.00**	**75.00**
	PEPU	0.51	0.60
84-20A	**ASPR**	**280.00**	**362.00**
	ORHY	0.97	3.60
84-20B	CHNA	0.20	1.40
	GUSA	0.21	0.75
	MEAL	0.41	0.80
	ORHY	0.43	0.80
	STPI	**22.30**	**4.90**

Species in bold type denote the known selenium accumulators.

Table 20. Selenium concentrations in 1985 vegetation samples.

Sampling location	Soil type	Species	Total selenium (ppm)
85-3	Zyme	POFE	0.13
		ORHY	0.69
		ASPR	**37.50**
85-10	Soil A	BOGR	0.87
		SESP	2.42
		ASPR	**37.30**
85-11	Sharps	EPVI	0.54
		ORHY	0.44
		STPI	**8.85**
85-12	Zyme	ORHY	0.21
		ASPR	**350.00**
		HIJA	2.13
85-15	Cahona	ORHY	0.55
		OXLA	0.62
85-21	Zyme	ORHY	0.32
		ATCA	0.20
		STPI	**20.80**
85-21 (Control)	Zyme	ORHY	0.17
		HIJA	0.22
85-22	Zyme-like	ORHY	0.34
		STPI	**55.00**
85-22 (Control)	Zyme-like	ORHY	0.16
		ATCA	0.17
85-26	Zyme-like	ORHY	0.54
		ERCO	0.21
		STPI	**4.13**
85-28	Travessilla	ORHY	0.12
		SIHY	0.30
		STPI	**43.30**
		ATCA	0.26
85-29	Unnamed	ORHY	0.11
		STPI	**0.20**
		ATCA	0.18
		BRIN	0.12
85-31	Dulce	ORHY	0.10
		STPI	**30.30**
		HIJA	0.27
85-33	Bond-like	ORHY	0.22
		STPI	**97.70**
		ATCA	0.43
		BOGR	0.63
85-39	Zyme	**ASPR**	**43.30**
		ORHY	0.61

Table 21. Selenium concentrations in 1984 soil samples.

Sampling location	Sample depth (in.)	Lithology	Total selenium $HClO_4/HF$ (ppm)	Available selenium AB-DTPA (ppm)	Available selenium HOT H_2O (ppm)
84-1	0-7	Surface Soil	0.50	0.019	0.009
	7-13	Surface Soil	4.40	0.080	0.009
	13-19	Surface Soil	3.40	0.070	0.016
	19+	Shale; yellow	2.00	0.037	0.019
84-3	0-8	Surface Soil	2.70	0.024	0.018
	8-14	Surface Soil	0.15	0.090	0.019
	14+	Shale; light grey	1.80	0.067	0.046
84-6	0-6	Surface Soil	0.50	0.009	0.008
	6-16	Surface Soil	0.45	0.009	0.006
	16+	Sandstone; light grey	0.30	0.005	0.006
84-10	0-2	Surface Soil	0.85	0.013	0.008
	2-8	Surface Soil	0.60	0.015	0.008
	8-18	Sandstone; white	0.40	0.012	0.012
	18+	Sandstone; yellow	0.30	0.013	0.010
84-11A	0-6	Surface Soil	0.25	0.017	0.010
	6-12	Surface Soil	0.45	0.015	0.008
	12-18	Surface Soil	0.20	0.051	0.009
	18-24	Shale; grey	0.50	0.022	0.008
	24+	Shale; yellow	0.85	0.010	0.008
84-11B	0-6	Surface Soil	0.45	0.010	0.005
	6-16	Surface Soil	0.20	0.065	0.009
	16-26	Surface Soil	2.0	0.042	0.009
	26-30	Surface Soil	1.7	0.055	0.017
	30+	Shale; dk. brown	0.30	0.085	0.044
84-13	0-6	Surface Soil	0.60	0.014	<0.005
	6-13	Surface Soil	0.80	0.009	<0.005
	13-23	Surface Soil	0.50	<0.005	<0.005
	23-31	Shale; grey	2.90	0.072	0.011
	31+	Shale; lt. grey	0.50	0.017	0.028

INTERMOUNTAIN SOILS

Table 21. Selenium concentrations in 1984 soil samples (continued).

Sampling location	Sample depth (in.)	Lithology	Total selenium $HClO_4/HF$ (ppm)	Available selenium AB-DTPA (ppm)	Available selenium HOT H_2O (ppm)
84-14A	0-5	Surface Soil	0.65	0.012	0.007
	5-14	Surface Soil	1.30	0.022	0.005
	14-26	Shale; grey	0.20	0.055	0.015
	26-32	Shale; yellow	0.40	0.037	0.032
	32-40	Shale; grey	0.15	0.080	0.035
	40-42	Shale; black	0.75	0.034	0.054
	42-44	Sandstone; white	0.05	0.073	0.017
	44-61	Shale; grey	0.25	0.137	0.040
	61+	Shale; dk. brown	0.45	0.033	0.015
84-14B	0-5	Surface Soil	1.10	0.070	0.037
	5-15	Surface Soil	0.85	0.013	0.005
	15-24	Shale; grey	1.40	0.012	0.006
	24+	Shale; yellow	0.95	0.008	0.008
84-16	0-6	Surface Soil	0.50	0.029	<0.005
	6-18	Surface Soil	0.50	0.027	0.014
	18-30	Shale; grey	0.45	0.057	0.016
	30-50	Shale; dk. grey	0.10	0.033	0.010
	50-65+	Shale; dk. grey	0.60	0.035	0.019
84-20A	0-16	Surface Soil	0.65	0.080	0.041
	16+	Coal and Shale; black	----	----	----
84-20B	0-6	Surface Soil	0.20	0.009	<0.005
	6-15	Sandstone; yellow	0.15	<0.005	<0.005
	15-23	No notes	2.70	0.015	<0.005

Table 22. Selenium concentrations in 1985 soil samples.

Sampling location	Soil type	Sample depth (inches)	Lithology	AB-DTPA Selenium (ppm)	Total Selenium (ppm)
85-3	Zyme	5-7	Subsoil	0.040	1.40
		7-13	Subsoil	0.054	0.55
		13-21	Subsoil	0.048	0.50
85-10	Soil A	2-5	Subsoil	0.038	—
		6-18	Subsoil	0.044	—
85-11	Bond-like	3-8	Subsoil	0.013	—
		15-30	Shale	0.065	—
85-12	Zyme	3-6	Shale	0.066	—
		6-17	Shale	0.035	—
85-15	Cahona	10-14	Subsoil	0.023	—
		19-23	Subsoil	0.033	—
85-21	Zyme	3-5	Subsoil	0.020	1.03
		7-17	Shale	0.016	0.95
85-21 (Control)	Zyme	3-5	Subsoil	0.052	0.65
		7-17	Shale	0.006	0.78
85-22	Zyme-like	1-5	Surface Soil	0.050	0.68
		5-11	Subsoil	0.052	0.93
		11-23	Subsoil	0.079	2.55
85-22 (Control)	Zyme-like	1-5	Surface Soil	0.035	0.75
		5-11	Subsoil	**0.128**	3.33
		11-23	Subsoil	**0.320**	2.55
85-26	Zyme-like	6-13	Subsoil	0.023	—
		13-23	Subsoil	0.038	—
		23-30	Shale	0.029	—
85-28	Travessilla	3-9	Subsoil	0.035	—
		10-16	Sandstone	0.018	—
85-29	Dulce-like	3-6	Subsoil	**0.183**	—
		6-12	Sandstone	0.034	—
85-31	Dulce	4-7	Subsoil	0.065	—
		9-16	Sandstone	0.042	—
85-33	Bond-like	2-10	Subsoil	0.008	—
		12-22	Sandstone	0.013	—
85-39	Zyme	5-8	Sandstone	0.005	—
		9-11	Shale	0.016	—

DISCUSSION

Lindsay (1979) gives a common range of total selenium in soils as 0.1 ppm to 2 ppm. Raptis et al. (1983) similarly reports that total selenium concentrations of arid soils may be as high as 2 ppm. Because of the different chemical or mineralogic forms in which selenium may occur in soils, total soil selenium concentrations are seldom indicative of concentrations of plant-available selenium in the soil (Munshower 1983). Shales are the principal parent material of selenium-toxic soils of the Great Plains and Rocky Mountain foothills of the United States (Shamberger 1983).

Total selenium concentrations as high as 15,000 ppm have been reported in species of *Astragalus* (Raptis et al. 1983). Beath et al. (1940) collected stinking milk-vetch specimens near Jerome and Cameron, Arizona having concentrations ranging from 754 ppm to 2002 ppm. These same investigators reported 41 ppm and 485 ppm (air-dry basis), respectively, in samples of desert plume also collected in Arizona near Holbrook and Winslow. Selenium concentrations of these two species collected on Black Mesa in connection with the 1984 and 1985 sampling studies were substantially lower.

A "secondary selenium accumulator" species may be defined as a species which will accumulate selenium when grown on soils high in available selenium (Shamberger 1983). Such species probably do not have the ability to concentrate selenium to the extent that "primary accumulators" do. Four-wing saltbush (*Atriplex canescens*), ten petal mentzelia (*Mentzelia decapetala*) and snakeweeds (*Gutierrezia* spp.) have been reported to be so-called "secondary selenium accumulators." Raptis et al. (1983) and Shamberger (1983) have reported selenium concentrations in secondary accumulators up to 300 ppm on soils high in available selenium or in association with other known accumulators. Selenium concentrations in suspect secondary accumulator species sampled on Black Mesa (Tables 19 and 20) are relatively low compared to values reported in the literature.

Selenium concentrations in desert plume samples collected in 1984 show some correlation to the highest AB-DTPA-extractable soil selenium concentrations found in the samples from the soil pits at the same sampling locations. Only weak correlation between the highest concentrations of AB-DTPA-extractable selenium at a sampling location and selenium concentrations in Indian ricegrass, stinking milk-vetch or desert plume is apparent from the results of 1985 sampling. No significant correlations could be determined between any selenium concentrations in any accumulator species and total soil selenium, based on 1984 results. Moreover, there is no correlation between total and available soil selenium concentrations. These results support the observations of others that total selenium

concentrations in soils are not predictive of selenium concentrations in vegetation (Munshower 1983 and Raptis et al. 1983).

CONCLUSIONS

Field surveys show that populations of selenium accumulator plants occur within the Black Mesa lease area. Areas supporting such populations are usually in poor range condition. There is no apparent relationship between the occurrence of the two selenium accumulator plant species, desert plume and stinking milk-vetch, and selenium levels in soils or elevated levels of selenium in non-accumulator plant species. Extensive sampling of soils and vegetation and subsequent laboratory analyses have failed to substantiate the existence of soils capable of producing high selenium concentrations in common forage species, or the existence of any environmental hazard related to high selenium concentrations in plants. This conclusion is further supported by the fact that no incidence of selenium poisoning of livestock has been reported in or surrounding the Black Mesa lease area (personal communication, Leo Beno, Reclamation Specialist II, Navajo Coal Commission). Results of laboratory analyses have also shown generally poor correlations between total and extractable soil selenium levels and concentrations of selenium in both accumulator and non-accumulator plant species. This lack of clear correlation between soil and plant selenium concentrations may be in part attributable to the relatively low soil selenium concentrations and to the limited range of selenium concentrations exhibited in the samples of the 1984 and 1985 studies.

From the results of these studies it is apparent that within the Black Mesa lease area, there are no selenium "indicator" plant species, i.e., plant species whose occurrences are indicative of soils high in plant-available selenium. Desert plume and stinking milk-vetch are undoubtedly effective accumulators of selenium from the soil, although selenium concentrations of samples of these two plant species collected from Black Mesa are much lower than concentrations reported in samples of these species collected elsewhere. None of the non-accumulator plant species sampled at Black Mesa exhibited selenium concentrations which would render these plants toxic to livestock. Although desert plume and stinking milk-vetch are fairly conspicuous forbs, and scattered stands of these species are relatively easy to find on Black Mesa, according to an abundance of vegetation data collected by Peabody, these species comprise only a very minor component of the vegetation communities of the Black Mesa lease area.

LITERATURE CITED

Barneby, R.C. 1964. Atlas of North American *Astragalus*. Memoirs of the New York Botanical Garden Vol. 13.

Beath, O.A., C.S. Gilbert and H.F. Eppson. 1940. The use of indicator plants in locating seleniferous areas in Western United States. III. Further studies. Amer. J. Bot. 27:564-573.

Bremmer, J.M. 1965. Inorganic forms of nitrogen. *In* Black, C.A. et al. (ed.). 1965. Methods of soil analysis, Part 2. Agonomy 9:562-566. Amer. Soc. of Agron., Inc., Madison, WI.

Day, P.R. 1965. Practicle size fractionation and particle size analysis. *In* Black, C.A. et al. (ed.). 1965. Methods of soil analysis, Part 2. Agonomy 9:1050-1058. Amer. Soc. of Agron., Inc., Madison, WI.

Espey, Huston and Associates, Inc. 1980. Soil baseline studies of the Black Mesa and Kayenta Mines. Prepared for Peabody Coal Company, Arizona Division. Doc. No. 80187. Austin, TX.

Fine, L.O. 1965. Selenium. *In* Black, C.A. et al. (ed.). 1965. Methods of soil analysis, Part 2. Agonomy 9:1117-1123. Amer. Soc. of Agron., Inc., Madison, WI.

Kearney, T.H. and R.H. Peebles. 1960. Arizona Flora. 2nd ed. (with supplement). Univ. of Calif. Press, Berkeley and Los Angeles, CA.

Lindsay, W.L. 1979. Chemical equalibria in soils. John Wiley & Sons, Inc., New York, NY.

McLean, E.O. 1982. Soil pH and lime requirement. *In* Page, A.L. (ed.). 1982. Methods of soil analysis, Part 2, Second Edition. Agronomy 9:199-224. Amer. Soc.of Agron., Inc. Madison, WI.

Munshower, F.F. 1983. Microelements and their role in surface mine planning. *In* D. Books (ed.). 1983. Coal development: collected papers. Papers presented at Coal Development Workshops in Grand Junction, Colorado, and Casper, Wyoming.

National Research Council. 1976. Selenium—medical and biological effects of environ - mental pollutants. National Academy of Science, Washington, D.C.

Pratt, P.F. 1965. Potassium. *In* Black, C.A. et al. (ed.). 1965. Methods of soil analysis, Part 2. Agronomy 9:1022-1030. Amer. Soc. of Agron., Inc., Madison, WI.

Price, A.B., G.A. Bowman, V.L. Clay and W.D. Nettleton. 1984. Nature of eolian deposits and soils of southwest Colorado. Agron. Abstr., Amer. Soc. of Agron., Inc., Madison, WI. p. 237.

Raptis, S.E., G. Kaiser and G. Tolg. 1983. A survey of selenium in the environment and a critical review of its determination at trace levels. Fresenius Z. Anal. Chem. 316:105-123.

Reisenauer, H.M. 1965. Molybdenum. *In* Black, C.A. et al. (ed.). 1965. Methods of soil analysis, Part 2. Agonomy 9:1050-1058. Amer. Soc. of Agron., Inc., Madison, WI.

Schmutz, E.M., B.N. Freeman, and R. E. Reed. 1968. Livestock-poisoning plants of Arizona. Univ. of Ariz. Press, Tucson, AZ.

Shamberger, R.J. 1983. Biochemistry of selenium. Plenum Press, New York, NY.

Smith, R.M., W.E. Grube, Jr., T. Arkle, Jr. and A.A. Sobek. 1974. Mine spoil potentials for soil and water quality. Environ. Tech. Series. EPA-600/2-74-070, Washington, D.C.

Sobek, A.A., W.A. Schuller, J.R. Freeman, and R.M. Smith. 1978. Field and laboratory methods applicable to overburdens and mine soils. Environmental Protection Technology Series. EPA-600/2-78-054. Environmental Protection Agency, Cincinnati, OH.

Soil Conservation Service. 1972. Soil survey laboratory methods and procedures for collecting soil samples (revised). Soil survey investigations Report No. 1, U. S. Government Printing Office, Washington, D.C.

Soil Survey Staff. 1951. Soil survey manual. USDA—SCS Agric. Handb. 18. U. S. Government Printing Office, Washington, D.C.

Soil Survey Staff. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. USDA—SCS Agric. Handb. 436. U.S. Government Printing Office, Washington, D.C.

Soil Survey Staff. 1980. Soil survey manual. Map units (chapter 5). National Soils Handbook Notice 63, Sept. 1980. USDA—Soil Conservation Service, Washington, D.C.

Soil Survey Staff. 1981. Soil survey manual. Examination and description of soils in the field (Chapter 4). Issue 1, Directive 430-V-SSM, May 1981. USDA—Soil Conservation Service, Washington, D.C.

Soil Survey Staff. 1983. National soils handbook. USDA—Soil Conservation Service, U. S. Government Printing Office, Washington, D.C.

Soltanpour, P.N., J.B. Jones and S.M. Workman. 1982. Optical emission spectrometry. *In* Page, A.L. (ed.). 1982. Methods of soil analysis, Part 2, Second Edition. Agronomy 9:29-65. Amer. Soc.of Agron., Inc. Madison, WI.

Soltanpour, P.N. and S.M. Workman. 1981. Soil testing methods used at Colorado State University Soil Testing Laboratory for evaluation of fertility, salinity, and trace element toxicity. CSU Exp. Sta. Tech. Bull. 142. Fort Collins, CO.

Tabatabai, M.A. 1982. Sulfur. *In* Page, A.L. (ed.). 1982. Methods of soil analysis, Part 2, Second Edition. Agronomy 9:501-539. Amer. Soc.of Agron., Inc. Madison, WI.

U.S. Fish & Wildlife Service. 1980. Endangered and threatened wildlife and plants: review of plant taxa for listing as endangered or threatened species. pp. 82,480—82,569. Federal Register, Dec. 15, 1980, Vol. 45.

U.S. Fish and Wildlife Service. 1983. Endangered and threatened wildlife and plants: supplement to review of plant taxa for listing as endangered or threatened species. pp. 53,640—53,670. Federal Register, Nov. 28, 1983, Vol. 48.

U.S. Salinity Laboratory Staff. 1954. Diagnosis and improvement of saline and alkali soils. USDA Agric. Handb. 60, U.S. Government Printing Office, Washington, D.C. (1969 Printing).

Walsh, L.M. and T.D. Benton. (eds.). 1973. Soil testing and plant analysis. Soil Sci. Soc. of Amer., Inc., Madison, WI.

Wear, J.I. 1965. Boron. *In* Black, C.A. et al. (ed.). 1965. Methods of soil analysis, Part 2. Agronomy 9:1059-1063. Amer. Soc. of Agron., Inc., Madison, WI.

Wyoming Department of Environmental Quality. 1985. Guideline No. 1. Topsoil and overburden. Wyoming Department of Environmental Quality, Land Quality Division, Cheyenne, WY.

QUALIFICATIONS OF THE PARTICIPANTS

Richard B. Trenholme was the project manager for the 1985 soils and vegetation studies, and was responsible for the field soil surveys. In addition, he was substantially involved with the 1984 soil studies under subcontract to Mariah Associates, Inc. As President of Intermountain Soils, Inc., he has been involved in the environmental aspects of mining since 1981, and served clients both in private industry and government. Mr. Trenholme has a B.S. in Agronomy from Texas A&M University. He is a Certified Professional Soil Classifier.

Thomas A. Colbert, Vice President of IMS, was responsible for the geobotanical studies conducted in 1985. Mr. Colbert has been involved with regulatory and environmental issues affecting the mining industry since 1978. He received his B.S. degree in Agronomy from Colorado State University and a Master of Agriculture degree in Soils from Texas A&M University. He is a Certified Professional Soil Scientist.

Thomas E. Flack assisted IMS in all phases of the project with emphasis on field soil surveys and soils sampling in the geobotanical study. As a Certified Professional Soil Scientist, he has conducted numerous soil surveys, soil resource assessments and irrigability studies. Mr. Flack received both his B.S. and M.S. degrees in Agronomy from Colorado State University.

C. Wayne Cook provided assistance with the geobotanical study in 1985 by documenting the range condition at each site and characterizing the rooting behavior of the selenium accumulating speicesd. He is Professor Emeritus of range science at Colorado State University, having recently retired as chairman of the Range Science Department. Dr. Cook is the author of numerous publications, including *Techniques for Vegetation Measurements and Analysis for a Pre- and Post-mining Inventory,* which he co-authored with Charles Bonham.

Arthur M. Phillips was responsible for locating and qualitatively describing the selenium sites in both the 1984 and 1985 geobotanical studies. He is currently the Curator of Biology at the Museum of Northern Arizona with responsibility for the 30,000 specimen herbarium. Dr. Phillips is considered a leading authority on the flora, particularly threatened and endangered species, of the Colorado Plateau and upper Sonoran Desert. He has conducted numerous T&E studies for the U.S. Fish and Wildlife Service, National

Park Service and the Bureau of Land Management. Dr. Phillips has a Ph.D. in Botany from the University of Arizona.

INTERMOUNTAIN SOILS

ATTACHMENT 1

MAP UNIT DESCRIPTIONS

Order 1 and 2 Map Unit Descriptions

1A Dulce very channery fine sandy loam, 1 to 4 percent slopes.
1, 1B Dulce very channery fine sandy loam, 4 to 8 percent slopes.
1C Dulce very channery fine sandy loam, 8 to 15 percent slopes.
1D Dulce very channery fine sandy loam, 15 to 30 percent slopes.

The less steep phases of these map units are found on ridge crests and shoulders whereas the steeper phases are found on shoulders and sideslopes. The soils in these map units are reddish brown and have a surface layer high in rock fragments. Depth to soft or fractured sandstone bedrock is 2 to 10 inches with bedrock generally occurring at less than 6 inches. Contrasting soils which may occur in these map units include Zyme soils found on sideslopes and Bond soils found on ridge crests, soils with bedrock deeper than 20 inches found in concave areas and rock outcrop occurring as narrow escarpments. Similar soils which may occur in these map units include soils with over 35 percent rock fragments, soils that are non-calcareous throughout, and Travessilla soils.

Dulce soils are marginally suitable for topsoil and are limited by the amount of rock fragments on the soil surface. The shallow depth to bedrock of these soils may restrict the amount of soil which can be salvaged. The included Bond soils have a good suitability for topsoil and should be salvaged where practicable.

2B Bond very fine sandy loam, 1 to 8 percent slopes.

This map unit occurs on ridge crests and shoulders throughout the lease area. The Bond soils are reddish throughout and have a surface layer high in very fine sand. Depth to hard sandstone bedrock is between 12 and 20 inches. Contrasting soils which may occur in these map units include Dulce soils on shoulders and Sharps soils near the delineated boundaries of this map unit. Soils similar to Bond which may occur in these map units include soils with less than 18 percent clay, soils with less very fine sand, and soils underlain by soft bedrock.

Bond soils are suitable for topsoil and have an average stripping depth of 12 inches. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

3A Zyme-Dulce complex, 2 to 8 percent slopes.
3BC Zyme-Dulce complex, 2 to 15 percent slopes.
3C Zyme-Dulce complex, 6 to 15 percent slopes.
3D Zyme-Dulce complex, 15 to 30 percent slopes.
3DE Zyme-Dulce complex, 15 to 50 percent slopes.
3E Zyme-Dulce complex, 30 to 50 percent slopes.

The less steep phases of these map units are found on ridge crests and shoulders whereas the steeper phases are found on ridge sideslopes. Generally, Zyme soils are found on the steeper portions of the map units. Zyme soils are variable in color, depending on the color of the underlying shale bedrock. They are clayey throughout and have numerous surficial rock fragments. Dulce soils are reddish brown and also have a surface layer high in rock fragments. Both these soils in these map units are extremely eroded. Depth to soft or fractured bedrock is 2 to 10 inches with bedrock generally occurring at less than 6 inches. Contrasting soils which may occur in these map units include soils deeper than 20 inches, Bond soils, and Soils A and B. Bond soils and Soils A and B are found on ridge crests and sideslopes, and the soils deeper than 20 inches are found in concave areas. Rock outcrop occurs as narrow escarpments. Similar soils which may occur in these map units include those with over 35 percent rock fragments, soils that are non-calcareous throughout, and Travessilla soils.

The soils in these map units are marginally suitable for topsoil and are limited by clayey texture of the Zyme soils and high surficial rock fragment content of both soils. The shallow depth to bedrock of these soils may restrict the amount of soil which can be salvaged. The included Bond soils have a good suitability for topsoil and should be salvaged where practicable.

3F Ustic Torriorthents-rock outcrop complex, 50 to 80 percent slopes.

This map unit occurs on very steep sideslopes of ridges. Because of the slope steepness and the interbedded nature of the bedrock, soils are quite variable and mapped only to the subgroup level. Rock outcrop consists of areas of exposed sandstone or shale bedrock. The soils in this map unit are not considered salvageable because of the steep slopes and high amounts of rock outcrop.

4A Zyme very channery loam, 1 to 4 percent slopes.
4B Zyme very channery loam, 4 to 8 percent slopes.
4C Zyme very channery loam, 8 to 15 percent slopes.
4D Zyme very channery loam, 15 to 30 percent slopes.

The less steep phases of these map units are generally found on toeslopes or upper sideslopes, and the steeper phases are found on sideslopes. Zyme soils are variable in color, depending on color of the underlying shale bedrock. They are clayey throughout and have a surface high in rock fragments. Depth to shale bedrock is 2 to 10 inches with bedrock generally occurring at less than 6 inches. Contrasting soils which may occur in these map units include Dulce and Bond soils found on crests and sideslopes, and soils deeper than 20 inches occurring in concave areas. Rock outcrop, where present, occurs as narrow escarpments. Similar soils which may occur in these map units include soils that are non-calcareous throughout and soils with less clay.

The soils in these map units are marginally suitable for topsoil and are limited by clayey texture and high surficial rock fragment content. The shallow depth to bedrock of these soils may restrict the amount of soil which can be salvaged. The included Bond soils have a good suitability for topsoil and should be salvaged where practicable.

5 Pulpit very fine sandy loam, 2 to 8 percent slopes.

This map unit occurs on valley sideslopes, and crests and sideslopes of ridges. The soils in this map unit are reddish brown and have a surface layer high in very fine sand. Depth to hard sandstone bedrock is 20 to 40 inches. Contrasting soils which may occur in these map units include Cahona soils on sideslopes and Bond soils on crests. Soils similar to Pulpit which may occur in this map unit include soils with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand. The J/7 mining areas has more of these similar soils than the other mining areas. Sharps is also a similar soil.

Pulpit soils are suitable for topsoil and have an average stripping depth of 28 inches. The high very-fine and fine sand content make these soils susceptible to wind and water erosion.

6 Sharps very fine sandy loam, 2 to 8 percent slopes.
6A Sharps very fine sandy loam, 1 to 4 percent slopes.
6B Sharps very fine sandy loam, 4 to 8 percent slopes.
6C Sharps very fine sandy loam, 8 to 15 percent slopes.

The less steep phases of these map units are found on ridge crests and shoulders, and the steep phases are found on shoulders and sideslopes. The soils in these map units are reddish brown and have a surface layer high in very fine sand. Depth to soft or fractured bedrock is 20 to 40 inches. Contrasting soils which may occur in these map units include Cahona soils on sideslopes and Bond soils on crests. Similar soils which may occur in

this map unit include soils with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand. The J/7 mining areas has more of these similar soils than the other mining areas. Another similar soil is Pulpit.

Sharps soils are suitable for topsoil and have an average stripping depth of 28 inches. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

7B Travessilla-Zyme-Dulce complex, 2 to 6 percent.

This map unit is found primarily in the J/7 mining area on ridge crests and sideslopes. Zyme and Dulce soils are generally found on the sideslopes and the Travessilla soils on the crests. Zyme soils are variable in color, depending on the color of the underlying shale bedrock. They are clayey throughout. Travessilla and Dulce soils are reddish brown and are coarse-textured. All of these soils in this map unit are very eroded. Depth to bedrock is 2 to 10 inches with bedrock generally occurring at less than 6 inches. Contrasting soils which may occur in this map unit include soils deeper than 20 inches in concave areas and Bond soils on ridge crests. Rock outcrop also is included.

The soils in these map units are marginally suitable for topsoil and are limited by clayey texture of the Zyme soils and high surficial rock fragment content of each of the soils. The shallow depth to bedrock of these soils may restrict the amount of soil which can be salvaged. The included Bond soils have a good suitability for topsoil and should be salvaged where practicable.

7C Zyme-Travessilla-Rock outcrop complex, 6 to 15 percent slopes.
7D Zyme-Travessilla-Rock outcrop complex, 15 to 30 percent slopes.
7E Zyme-Travessilla-Rock outcrop complex, 30 to 50 percent slopes.

These map units are also found primarily in the J/7 mining area. They are found on sideslopes and include significant amounts of rock outcrop. Zyme soils are found on the steeper portion of the map unit. Zyme soils are variable in color, depending on the color of the underlying shale bedrock. They are clayey throughout. Travessilla soils are reddish brown and are coarse-textured. Both these soils in these map units are very eroded. Depth to bedrock is 2 to 10 inches with bedrock generally occurring at less than 6 inches. Rock outcrop occurs as narrow escarpments. Contrasting soils which may occur in these map units include soils deeper than 20 inches found in concave areas and Bond soils found randomly throughout. Similar soils which may occur in these map units are Dulce soils.

The soils in these map units are marginally suitable for topsoil and are limited by the clayey texture of the Zyme soils and the high surficial rock fragment content of both soils. The shallow depth to bedrock of these soils and the amount of rock outcrop occurring in these map units may restrict the amount of soil which can be salvaged. The included Bond soils have a good suitability for topsoil and should be salvaged where practicable.

10 Cahona very fine sandy loam, bedrock substratum, 2 to 8 percent slopes.
10A Cahona very fine sandy loam, bedrock substratum, 1 to 4 percent slopes.
10B Cahona very fine sandy loam, bedrock substratum, 4 to 8 percent slopes.
10C Cahona very fine sandy loam, bedrock substratum, 8 to 15 percent slopes.

These soils are found on valley sideslopes. The soils in these map units are reddish brown and have a surface layer high in very fine sand. Depth to bedrock is 40 to 72 inches. Contrasting soils which may occur in these map units include Cahona soils which are deeper than 72 inches on sideslopes, and Sharps soils on crests. Similar soils which may occur in these map units include soils with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand. The J/7 mining areas has more of these similar soils than the other mining areas.

Cahona soils are suitable for topsoil and have an average stripping depth of 58 inches. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

11 Cahona very fine sandy loam, 1 to 6 percent slopes.
11A Cahona very fine sandy loam, 1 to 4 percent slopes.
11B Cahona very fine sandy loam, 4 to 8 percent slopes.
11C Cahona very fine sandy loam, 8 to 15 percent slopes.

These soils are found on valley sideslopes. They are reddish brown and have a surface layer high in very fine sand. Depth to soft or fractured bedrock is 72 to more than 180 inches. Contrasting soils which may occur in these map units include Cahona, bedrock substratum, soils on upper sideslopes and Sharps soils on crests. Soils similar to Cahona which may occur in these map units include soils with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand. The J/7 mining areas has more of these similar soils than the other mining areas. Oelop soils are also similar.

Cahona soils are suitable for topsoil and have a weighted average stripping depth of 10.0 feet. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

G11C Cahona very fine sandy loam, gravelly substratum, 8 to 15 percent slopes.

This soils occurs on valley sideslopes and alluvial fans in the area of the proposed Wild Ram Dam. It is very similar to the Cahona soil in map unit 11, but is underlain by material high in rock fragments at a depth of 24 to 40 inches. Depth to soft or fractured bedrock is 40 to more than 72 inches.Contrasting soils which may occur in this map unit include Sharps on the upper slopes and Chilton soils on the steeper sideslopes. Similar soils which may occur in these map units include those with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand.

These soils are suitable for topsoil and have an average stripping depth of 2.5 feet. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

X11 Cahona-Cahona, bedrock substratum, very fine sandy loams, 2 to 10 percent slopes.
X11A Cahona-Cahona, bedrock substratum, very fine sandy loams, 1 to 4 percent slopes.
X11B Cahona-Cahona, bedrock substratum, very fine sandy loams, 4 to 8 percent slopes.
X11C Cahona-Cahona, bedrock substratum, very fine sandy loams, 8 to 15 percent slopes.

These soils are found on valley sideslopes. The soils in these map units are reddish brown and have a surface layer high in very fine sand. Depth to soft or fractured bedrock is 40 to more than 72 inches. Contrasting soils which may occur in these map units include Sharps soils on crests. Similar soils which may occur in these map units include those with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand. The J/7 mining areas has more of these similar soils than the other mining areas. Oelop soils are also similar.

These soils are suitable for topsoil and have an average stripping depth of 7.6 feet. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

12 Begay loam, 2 to 10 percent slopes.
12A Begay loam, 1 to 4 percent slopes.
12B Begay loam, 4 to 8 percent slopes.
12C Begay loam, 8 to 15 percent slopes.

These map units are found on valley-filling sideslopes. These soils are reddish to reddish brown and are coarse-textured. Contrasting inclusions which may occur in these map units are soils with bedrock between 40 and 72 inches, primarily in the J/7 area. Similar soils which may occur in these map units include soils with over 18 percent clay and soils lacking a structural B horizon.

Begay soils are suitable for topsoil and have an average stripping depth of 9.8 feet. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

13, 13A San Mateo loam, 0 to 3 percent slopes.

This map unit is found on stream terraces and remnant floodplains. The soils in this unit are very deep and are brownish in color. There are no contrasting soils included in the mapping. Soils similar to San Mateo which may occur in this map unit are the Las Lucas and Oelop soils and soils with a sand fraction of less than 15 percent fine or coarser sand.

San Mateo soils are suitable for topsoil and have an average stripping depth of 14.7 feet. These soils are affected by salinity and/or sodicity at varying depths. Most of these soils which are saline or sodic are in or near Reed Valley. Depth to high salt or sodium levels ranged from 8 to more than 18 feet.

14A Oelop very fine sandy loam, 1 to 4 percent slopes.
14B Oelop very fine sandy loam, 4 to 8 percent slopes.

These map units are found on valley sideslopes and bottoms. These soils are brown and are high in very fine and fine sand. These map units tend to occupy relatively small areas but they occur commonly throughout the Black Mesa lease area. No inclusions of contrasting soils were observed within these map units. Soils similar to Oelop found in the study area are the Las Lucas and Cahona soils and soils with a sand fraction of less than 15 percent fine or coarser sand.

Oelop soils are suitable for topsoil and have an average stripping depth of 9.8 feet. These soils are affected by salinity and/or sodicity at varying depths. Most of these soils which are saline or sodic are in or near Reed Valley. Depth to unsuitably high levels ranged from 20 to more than 120 inches. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

15, 15A Las Lucas sandy clay loam, 2 to 6 percent slopes.

This map unit is found on lower valley sideslopes. The soils in this unit are very deep and are brownish in color. No inclusions of contrasting soils were observed within this map unit. Similar soils which may occur in this map unit include the Cahona, San Mateo and Oelop soils. Other similar soils included are those with a sand fraction with more than 15 percent fine or coarser sand and those lacking a structural B horizon.

Las Lucas soils are suitable for topsoil and have an average stripping depth of 11.6 feet. These soils are affected by salinity and/or sodicity at varying depths. Most of these soils which are saline or sodic are in or near Reed Valley. Depth to unsuitably high levels ranged from 31 to more than 120 inches. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

16C Soil A-Soil B extremely channery very fine sandy loams, 4 to 15 percent slopes.

16E Soil A-Soil B extremely channery very fine sandy loams, 15 to 50 percent slopes.

16F Soil A-Soil B extremely channery very fine sandy loams, 50 to 70 percent slopes.

These map units are found on the crests of hills throughout the lease. The soils in these map units formed in porcellanite, and as a result, contain a very high volume of rock fragments. Other surface textures found in this map unit are very channery, very cobbly or extremely cobbly very fine to fine sandy loams. Since these soils are unsuitable for topsoil because of high rock fragment content, they were not sampled or described.

17C--Chilton very gravelly fine sandy loam, 6 to 15 percent slopes.

This map unit occurs only at the proposed Wild Ram Dam site and is very limited in areal extent. It occurs on the sideslopes of the alluvial fans in this area. The soil in this map unit were not sampled or described. Based on field observations, this soil has a gravelly fine sandy loam surface layer and a very gravelly sandy loam substratum layers. Because of high rock fragment content in all but the surface layers, these soils are suitable for topsoil down to six inches.

RW Riverwash.

The riverwash map unit was mapped along the channel of some of the drainages in the permit area. Most of the areas are very narrow. These soils are affected by salinity and/or sodicity and are not suitable for topsoil.

DL Disturbed land.

This map unit consists of land disturbed by activities associated with mining. It is similar to map unit 34 in the Order 3 survey.

RL Reclaimed land.

This map unit is composed of areas that have been disturbed by mining and subsequently reclaimed. It is similar to map unit 35 in the Order 3 survey.

TS Topsoil Stockpile.

This map unit consists of stockpiled soil material to be used in reclamation.

Order 3 and 4 Map Unit Descriptions

20 Zyme-Cahona-Dulce association, 0 to 30 percent slopes.

This mapping unit consists of shallow, clayey soils on shale (Zyme), deep, moderately fine-textured, moderately well-developed soils (Cahona) and shallow, gravelly fine sandy loam soils on sandstone (Dulce). The unit is characterized by low hills having relatively short slopes and many small branching drainageways. It is found in large areas near the southwest part of the lease area. The Zyme soils usually occur on the sides of the hills, along the side slopes of drainageways of the unit, and also on the crests of some of the lower ridges and hills in the unit. These soils make up about 40 percent of the unit. Cahona soils are on the toe slopes of the hills above the larger drainageways, at the heads of many of the small drainageways and on the small, relatively level benches in the unit. They make up about 25 percent of the unit. Dulce soils are located on the tops of the low hills and along the crests of the higher ridges in the unit. They make up about 25 percent of the unit.

Included in this mapping unit in small amounts totaling about 10 percent are a moderately fine-textured alluvial soil, deep fine sandy loam soils, and rock outcrop.

21 Zyme-Las Lucas complex, 0 to 15 percent slopes.

This mapping unit consists of shallow, clayey soils over shale (Zyme) and deep, fine sandy loam soils (Las Lucas). These soils occur on low hills having relatively broad, flat drainageways. Zyme soils are located on the hills, along the ridges, and occasionally occur as very low, sometimes nearly level, randomly located areas in the unit. They make up about 65 percent of the unit. Las Lucas soils can be seen mainly along the drainageways, but also occur near the crests of ridges. These soils make up about 30 percent of the unit. This unit lies above a broad, relatively flat, relatively open area dominated by Las Lucas soils and below a hilly, relatively steeply sloping area dominated by shallow Zyme soils about 2 miles north of the Central Warehouse.

Included in this mapping unit are small areas of Dulce soils, rock outcrop, and severely eroded areas that total about 5 percent of the unit.

22 Zyme-Las Lucas-Dulce association, 0 to 30 percent slopes.

This unit consists of shallow, clayey soils on shale (Zyme), deep, fine sandy loam soils (Las Lucas), and shallow, gravelly fine sandy loam soils on sandstone (Dulce). This unit consists of low rounded hills with relatively broad drainageways. Relief within the unit is about 200 feet. Zyme soils make up about 60 percent of the unit. They are found on the side slopes of hills, along the side slopes of drainageways, and also along the tops of ridges in lower portions of the area just above the main drainageways. Slopes range from 8 to 15 percent. Las Lucas soils occur along small drainageways of the unit, on some relatively level benches, and at the toe slopes of hills above major drainageways. These soils make up about 15 percent of the unit. Slopes range from 0 to 8 percent. Dulce soils are found on the tops of hills and on the tops of higher ridges in this unit. Slopes range from 8 to 30 percent. These soils make up about 15 percent of the unit.

Included in this mapping unit are rock outcrops, severely eroded areas, and small amounts of alluvial soils. These inclusions total about 10 percent of the unit.

23 Zyme-Dulce complex, severely eroded, 0 to 30 percent slopes.

This mapping unit consists of nearly level to steep, shallow clayey and sandy soils on side slopes above major drainageways and severely eroded areas along minor drainageways of the area. This unit occurs in the western portion of the area and consists of one large, irregularly shaped area. The shallow sandy soils within the unit occur as small, irregularly shaped areas along the upper portions of the unit and are remnants of the plain

occurring above this unit. The shallow, clayey (Zyme) soils make up about 75 percent of this unit. The shallow, sandy (Dulce) soils make up about 15 percent of this unit.

Included in this mapping unit, in amounts up to 10 percent, are small level bench areas of deep, sandy loam soils, rock outcrop in the upper portions of the unit, and areas of sandy alluvial soils and riverwash along the included drainageways.

24 Zyme-Dulce association, 8 to 30 percent slopes.

This mapping unit consists of areas of shallow, clayey soils over shale (Zyme) and shallow sandy loam soils over sandstone (Dulce). These soils are formed on rounded hills of relatively low relief, dissected with northeast-southwest trending drainageways. Total relief in this unit is about 200 feet. Areas (as mapped) are relatively large, ranging in size from about 640 to about 1,290 acres. Zyme soils make up about 45 percent of the unit and Dulce soils make up about 45 percent. Zyme soils are usually located on the side slopes of low hills and ridges in the unit. Dulce soils usually occur on hilltops and along the tops of ridges in the unit.

Included in this mapping unit, in amounts up to 10 percent, are small areas of a deep, reddish brown, fine sandy loam soil usually found at the heads of small drainageways and on small, relatively level benches. Also included are rock outcrops along the sides of drainageways and on hills in the unit.

25 Zyme-Dulce-Las Lucas association, 0 to 30 percent slopes.

This unit consists of very hilly land having shallow, clayey (Zyme) soils on side slopes; shallow, sandy loam soils (Dulce) on hilltops; and small areas of deep, moderately-fine textured soils (Las Lucas) at the heads of small drainageways, on small relatively level benches, and on toe slopes of the hills. Zyme soils make up about 55 percent of the unit and usually occur on slopes of 15 to 30 percent, on the lower slopes of hills, and on slopes along drainageways. Clay, gravelly clay, and cobbly clay are prevalent surface textures in the Zyme soils. Dulce soils are found on the tops of hills and ridges. They usually occur on slopes of 8 to 15 percent, but occasionally slopes range down to about 5 percent or up to 25 percent. Fine sandy loam, gravelly fine sandy loam, and gravelly loam are the prevalent surface textures in the Dulce soils. These soils make up about 25 percent of the unit.

Included in this unit are rock outcrops on hillsides and along the sides of drainageways and riverwash and coarse-textured alluvium along drainageways in amounts that total about 5 percent.

26 Cahona-Zyme association, 0 to 30 percent slopes.

This unit consists of deep soils having developed subhorizons and lime accumulations at moderate depths (Cahona) and shallow, clayey soils (Zyme). These soils occur in an area with broad, relatively flat swales, drainageways, and low hills. Relief in this unit is about 100 feet. Areas mapped range from 640 to 1,000 acres or more in size and are generally uniform in outline. Cahona soils occur on gently sloping side slopes of swales and drainageways. Zyme soils are found on low hills of the unit and along steeper side slopes of the drainageways. Cahona soils make up about 45 percent of the unit and Zyme soils make up about 45 percent of the unit.

Included in this mapping unit are Las Lucas soils, usually along the axes of swales and the lower portions of the unit, and Dulce soils on the tops of low hills and on crests of some of the higher ridges. These inclusions total about 10 percent of the unit.

27 Begay-Las Lucas association, 0 to 8 percent slopes.

This unit consists of nearly level, deep sandy loam soils along drainageways and on terraces next to the drainageways. Individual areas of this unit range from about 10 to 100 acres and are long, narrow, and very irregular in shape. Begay soils usually occur on

the first terrace above the bottom of the drainageway. Las Lucas soils are usually found near the heads of small branching drainageways and on the second terrace levels and toe slopes of hills above the drainageways. Begay soils make up about 65 percent of the unit and Las Lucas soils make up about 20 percent of the unit.

Included in this mapping unit are small areas of brownish-gray soils with sandy loam textures; other moderately fine-textured soils; very gravelly, coarse-textured soils; and riverwash in the drainageway bottoms.

28 Las Lucas-Zyme-Dulce complex, 0 to 8 percent slopes.

This mapping unit consists of areas of deep sandy soils (Las Lucas), shallow clayey soils (Zyme) and shallow sandy soils (Dulce) so intermixed that separation at this scale of mapping is not feasible. The deep, moderately fine-textured soils occur along axes of drainageways, around heads of drainageways, and, in some instances, on saddles between the heads of drains. Shallow clayey and sandy soils occur on the sides and tops of low hills in the area and on upper portions of the sides of drainageways. Las Lucas soils make up about 40 percent of the unit, Zyme about 30 percent, and Dulce about 20 percent.

Included are areas of Cahona soils, as well as areas of rock outcrops. Collectively, these make up about 10 percent of the unit.

29 Dulce gravelly fine sandy loam, 0 to 30 percent slopes.

This mapping unit consists of shallow, fine sandy loam soils. These soils are located on the highest portion of the area on a mesa top. This unit is dissected by deeply incised drainageways with very steep sides, becoming vertical cliffs in their upper reaches. Dulce gravelly and Dulce cobbly fine sandy loam with dominant slopes of 0 to 15 percent make up about 65 percent of this unit. These same soils, with slopes ranging from 15 to 30 percent, make up another 20 percent of the unit.

Included in this mapping unit are rock outcrop; shallow clayey soils (Zyme); deep, fine sandy loam soils (Las Lucas); and deep, coarse-textured soils along the bottoms of drainageways. The rock outcrop is found on the near-vertical side slopes of incised drainageways and also on nearly level, bare rock surfaces on flatter portions of the unit. Zyme soils occur near the bottom of the steep slopes just above the drains. Las Lucas soils are located on flatter portions of the unit near the heads of some of the small side drainageways and occasionally on small saddles on the ridges. Collectively, these make up about 15 percent of the unit.

30 Dulce-Zyme association, 15 to 30 percent slopes.

This unit consists of shallow, sandy loam soils on sandstone and shallow, clayey soils on shale. The unit consists of hills and drains. The shallow, sandy loam soils (Dulce) occur on the upper two-thirds of the hills and the shallow, clayey soils (Zyme) are located on the lower one-third of the hills. Dulce soils make up about 60 percent of the unit, and Zyme soils make up about 30 percent of the unit. Mapped areas are large and relatively uniform in shape. They are located on the north and east portions of the area, immediately below the relatively flat, highest portion of the area. Relief in this unit is 300 to 400 feet.

Included in this unit are small areas of Las Lucas soils. These are located at the heads of small drainageways, under the crests of some ridges and at the toe slopes of some hills just above the larger drainageways.

31 Dulce-Cahona association, 0 to 30 percent slopes.

This unit consists of shallow, reddish brown, gravelly fine sandy loam soils on sandstone (Dulce) and deep, reddish brown, moderately fine-textured developed soils (Cahona). These soils occur on a plain dissected by numerous drainageways. The unit is one area,

covering about 1,920 acres. Dulce soils make up about 50 percent of the area and Cahona soils about 40 percent. Dulce soils usually occur on the crests of ridges and the tops of low hills. Cahona soils are located at the heads of small drainageways, along the sides of larger drainageways, and, in some instances, on the small saddles of ridges.

Included in this mapping unit, in amounts totaling up to about 10 percent, are Zyme soils, San Mateo soils, and areas of rock outcrop. Zyme soils occur along the lower slopes of ridges and eroded areas where shale is exposed. San Mateo soils are found along some drainageway bottoms. The rock outcrop occurs along the upper portion of the sides of drainageways and on the sides of small hills.

32 Dulce-Las Lucas association, 0 to 15 percent slopes.

This mapping unit consists of gently sloping to undulating, shallow, gravelly sandy loam (Dulce) soils and deep, sandy loam (Las Lucas) soils on nearly level to sloping benches between major drainageways. Individual areas of this unit range in size from about 100 to 320 acres.

Included in mapping and making up about 10 percent of the unit are small areas of Zyme and Cahona soils. Zyme soils occur along the edges of mapped units above drainageways and on the sides of low hills included in the units. Cahona soils are usually located along the upper edges of deep Las Lucas soils where they grade into Dulce soils.

33 Dulce-Las Lucas-Zyme association, 8 to 30 percent slopes.

This mapping unit consists of Dulce soils on hill tops and along the tops of ridges, Zyme soils on hillsides and along the sides of ridges, and Las Lucas soils at the heads of small drainageways, as terraces along drainageways of the area, and on the more level areas between hills of the unit. Dulce soils make up about 50 percent of the unit, Las Lucas soils about 25 percent, and Zyme soils about 20 percent. This unit consists of low hills separated by broad drainageways. Relief within the unit is about 200 feet; hills are rounded and ridges are broad. This unit occurs in parcels ranging in size from about 640 to 2,000 acres. These parcels are relatively regular and smooth in outline.

Included in this unit are severely eroded phases of the above soils and areas of rock outcrop in total amounts up to 10 percent.

34 Pits and Dumps.

This unit consists of areas where active mining is occurring. The pits are deep holes dug into the underlying shales and sandstones to gain access to the coal. The dumps are high, irregular mounds with narrow, sharp crests consisting of shale and sandstone fragments removed from the pits.

35 Torriorthents, reclaimed.

This mapping unit consists of areas of loamy over fragmental, mixed, mesic Ustic Torriorthents. These areas are made up of mine dumps and pits that have been reworked, with the rubble used to fill in the pits, which are then covered with a layer of topsoil. This results in a smooth, undulating to rolling surface with a grass cover.

36 San Mateo silt loam, 0 to 8 percent slopes.

This mapping unit consists of moderately fine-textured alluvial soils located along the larger drainageways in the southeast and southern portions of the survey area. These soils are formed in alluvium derived from mixed sources, dominantly sandstone and shale, and deposited along the major drainageways. Mapped areas are long, narrow, and irregular in shape. Total relief for this unit is about 200 feet. Slopes are gentle and concave. San Mateo soils make up about 90 percent of the unit. Included in the mapping unit are small areas of Begay soils and areas of riverwash along drainageway bottoms.

40 Haplargids-Torriorthents association, undulating to hilly.

This unit consists of loamy, mixed Haplargids; clayey, shallow Torriorthents; and loamy, Lithic Torriorthents. Haplargids occur on slopes of 0 to 8 percent above drainageways and below low hills in the area and make up about 25 percent of the area. The clayey, shallow Torriorthents are found along hill slopes, steeper side slopes above drainageways, and on flatter areas where shale approaches the surface. These soils make up about 40 percent of the unit. The loamy, Lithic Torriorthents are located on the tops of low hills and along the crests of higher ridges and make up about 30 percent of the area.

41 Torrifluvents, nearly level.

This unit consists of deep, stratified soils ranging in texture from coarse-loamy to fine-loamy that have been deposited along drainageways of the area. Coarse-loamy Torrifluvents are generally found in the northeastern portion of the area, generally northwest of Moenkopi Wash. The fine-loamy portions of this unit are generally southwest of Moenkopi Wash. A saline-alkali phase of the fine loamy Torrifluvents is located at the extreme southwestern portion of the survey area.

42 Torriorthents, undulating to hilly.

This unit consists of loamy, mixed (calcareous) mesic, Lithic Torriorthents and clayey, montmorillonitic (calcareous), mesic, shallow Typic Torriorthents. These soils occur in the higher, flatter portion of the Black Mesa as well as in the hilly portion of lower elevation located below the general mesa surface. Drainageways are deeply incised in the higher, flatter portion of the mesa and have very steep to nearly vertical sides. In the lower hilly portion of the unit, drainageways are not deeply incised, but are branching and have only moderately steep to steep side- slopes. The loamy Lithic Torriorthents occur on the higher, flatter portions of the unit and on the upper, hilly portion of the unit. These soils make up about 50 percent of the unit. Clayey, shallow Torriorthents are found on lower portions of the hills and on the sides of drainageways in the hilly portion of the unit. These soils make up about 40 percent of the unit.

43 Torriorthents complex, sloping to very steep.

This unit consists of shallow, clayey and loamy, severely eroded, usually steep Torriorthents, commonly located at the base of the Black Mesa escarpments on both the west and east sides. The steep, nearly vertical mesa escarpments are part of this unit. Also included and located in the extreme southwestern portion of the survey area are steep, sandy-skeletal Torriorthents. Clayey, shallow Typic Torriorthents and loamy Lithic Torriorthents are in a complex at the base of Black Mesa. These soils are severely eroded. Clayey, shallow Torriorthents make up about 40 percent of the complex; loamy Lithic Torriorthents make up about 30 percent of the unit; and sandy-skeletal Typic Torriorthents make up 20 percent of the unit.

intermountain soils

ATTACHMENT 2

SOIL SERIES AND PROFILE DESCRIPTIONS

BEGAY SERIES

Begay soils are deep and well drained. They typically have a loam surface layer about 3 inches thick. The upper subsoil is noncalcareous very fine sandy loam about 10 inches thick. The lower subsoil to a depth of 92 inches is calcareous sandy clay loam and very fine sandy loam. Soft sandstone bedrock occurs at 92 inches. Permeability is moderate and the available water capacity is high.

Range of Characteristics: Depth to bedrock ranges from 3.5 to more than 15 feet. Dominant soil color hue is 5YR to 7.5YR. These soils are generally coarsely-stratified and frequently have buried horizons. Weighted average clay content in the control section ranges from 12 to 18 percent and is highly variable below 40 inches. Calcium carbonate equivalent is below 15 percent and usually less than 5 percent. Some pedons, especially those in the pinyon-juniper woodland, are underlain by eolian material, usually loamy fine or very fine sand below 5 feet.

SOIL NAME:	BEGAY loam	Location:	SW1/4, NE1/4, Sec. 28, T35N, R18E
Map Unit Symbol:	12B	Elevation:	6400'
Stop Number:	27-108	Slope(%):	5
Parent Material:	Eolian, mixed with local alluvium	Aspect:	W
Vegetation:	Artr, Bogr, Sihy, Eula, Xasa		
Classification:	Coarse-loamy, mixed, mesic Ustollic Camborthids		

Horizon	A	Bw	Bk1	Bk2	Bk3	Bkn1	Bkn2	2Cr
Depth (inches)	0-3	3-13	13-33	33-50	50-71	71-86	86-92	92+
Color								
Dry	7.5YR 5/4	7.5YR 5/4	7.5YR 5/4	5YR 6/4	5YR 6/6	5YR 6/6	-------Not sampled------	
Moist	7.5YR 4/4	7.5YR 4/4	7.5YR 4/4	7.5YR 4/4	5YR 4/6	5YR 4/6	-------Not sampled------	
Texture (USDA)	L	SCL/VFSL	SCL	VFSL	VFSL	VFSL	-------Not sampled------	
%≥ FS	18	30	24	29	27	55	-------Not sampled------	
% VFS	33	32	29	35	45	28	-------Not sampled------	
% Sand	51	62	53	64	72	83	-------Not sampled------	
% Silt	31	18	25	17	14	5	-------Not sampled------	
% Clay	18	20	22	19	14	12	-------Not sampled------	
Structure							-------Not sampled------	
Primary	1 c pl	2 m&c sbk	1 m pr	m	m	m	-------Not sampled------	
Secondary	sbk						-------Not sampled------	
Consistence								
Dry	sh	h	vh	vh	vh	sh	-------Not sampled------	
Moist	vfr	vfr	vfr	vfr	vfr	vfr	-------Not sampled------	
Wet	ss/sp	ss/p	ss/p	ss/p	so/sp	so/sp	-------Not sampled------	
pH (paste)	7.4	7.7	7.9	8.3	8.1	8.1	-------Not sampled------	
Reaction (10% HCl)	eo	eo	es	es	es	e	-------Not sampled------	
Carbonates	-	-	3csf	3sm,sf	2sm,sf	1sm	-------Not sampled------	
Rock fragments	none	none	none	none	none	none	-------Not sampled------	
Roots	3 vf, 1f	3 vf, 1f	3 vf, 1f	1 vf	none	none	-------Not sampled------	
Pores	none	1vf,f	2vf,f	2vf,f	1vf	1vf	-------Not sampled------	
Clay Films	none	none	none	none	none	none	-------Not sampled------	
Boundary	cw	cw	gw	gw	cw	aw	-------Not sampled------	
Saturation %	30.0	28.5	29.7	29.6	26.3	23.9	-------Not sampled------	
Soluble cations								
Ca (ppm)	4.2	4.8	3.3	1.4	2.0	8.3	-------Not sampled------	
Mg (ppm)	1.0	0.9	1.2	0.7	1.5	7.0	-------Not sampled------	
Na (ppm)	0.2	0.2	0.9	2.0	7.9	14.2	-------Not sampled------	
SAR	0.1	0.1	0.6	2.0	5.9	16.3	-------Not sampled------	
EC (mmhos/cm)	0.5	0.6	0.5	0.4	1.0	2.7	-------Not sampled------	

SOIL NAME: BEGAY loam
Map Unit Symbol: 12
Stop Number: 12-12
Parent Material: Alluvium and eolian
Classification: Coase-loamy, mixed, mesic Usollic Camborthids

Horizon	A	Bw1	Bw2	Btkb1	Btkb2	Bk	C1	C2
Depth (inches)	0-3	3-9	9-21	21-35	35-59	59-83	83-112	112-137+
Color								
Dry	5YR 5/4	5YR 5/4	5YR 6/4	5YR 5/3	5YR 5/3	5YR 6/4	5YR 4/3	5YR 6/4
Moist	5YR 4/4	5YR 4/4	5YR 5/4	5YR 4/3	5YR 4/3	5YR 5/4	5YR 3/3	5YR 5/4
Texture (USDA)	L	L	L	L	SiL	L	SiL	L
% VFS	27.4	24.8	20.9	21.2	24.2	23.7	25.4	26.0
% Sand	44.2	43.3	50.5	31.5	31.5	38.7	28.7	36.9
% Silt	46.7	43.1	35.9	47.6	52.1	44.9	50.4	42.2
% Clay	9.1	13.6	13.6	20.9	16.4	16.4	20.9	20.9
Structure								
Primary	1 vf sbk	2 m&c sbk	2 m&c sbk	2 m&f sbk	2 m&f sbk	1 m&f sbk	m	m
Secondary								
Consistence								
Dry	so	sh	sh	h	h	sh	h	h
Moist	vfr	vfr	vfr	fr	fr	vfr	vfr	vfr
Wet	so/po	so/po	so/po	s/sp	ss/po	ss/po	s/sp	s/sp
pH (paste)	6.9	7.4	7.4	7.6	7.6	7.8	7.6	7.6
Reaction (10% HCl)	eo	eo	eo	es	es	e	es	e
Carbonates	none	none	none	d&csf	d&csf	d&csf, sm	d	d
Rock fragments	none	none	none	none	none	none	none	none
Roots	3f,m,c	3f,m,c	3f,m,c	3f,m,c	1f,m,c	none	none	none
Clay Films	none	none	none	3 n pf	3 n pf	none	none	none
Boundary	cs	cs	cs	gs	gw	gw	gw	
Saturation %	34.3	37.9	35.4	40.0	38.4	34.1	43.9	43.7
Soluble cations								
Ca (ppm)	2.84	2.74	3.18	2.22	1.85	2.23	9.66	7.71
Mg (ppm)	0.99	0.60	0.83	0.69	0.70	0.79	3.52	3.29
Na (ppm)	1.09	1.10	1.27	1.74	2.17	3.75	8.58	6.12
SAR	0.79	0.85	0.90	1.44	1.92	3.05	3.34	2.61
EC (mmhos)	0.45	0.39	0.49	0.38	0.44	0.56	2.13	1.66
$CaCO_3$	0.8	4.6	7.4	3.5	2.00	1.1	1.3	1.0
Boron (ppm)	0.41	0.49	0.34	0.35	0.33	0.38	0.47	0.39
Selenium (ppm)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	0.02
Total Sulfur	0.04	0.04	0.04	0.01	0.04	0.03	0.04	0.07
Acid-base	1.25	1.25	1.25	0.31	1.25	0.94	1.25	2.19
Neutralization potential	7.68	46.1	73.6	35.0	19.7	11.1	13.4	10.4
Acid-base potential	6.43	44.9	72.4	34.7	18.5	10.2	12.2	8.21

BOND SERIES

This shallow, well drained soil occurs on ridge crests and shoulders throughout the lease area. Bond soils typically have a very fine sandy loam surface layer about 3 inches thick. The upper subsoil is noncalcareous loam about 7 inches thick. The lower subsoil to a depth of 19 inches is calcareous loam. Hard sandstone bedrock occurs at 19 inches. Permeability is moderate and the available water capacity is low.

Range of Characteristics: Depth to bedrock and solum thickness ranges from 10 to 20 inches. Texture of A horizon is very fine sandy loam or loam with 5 to 18 percent clay. Texture of the Bt horizon is loam, very fine sandy loam or sandy clay loam with 18 to 25 percent clay. Some pedons have a Btk or Bk horizon, both of which are similar to the Bt horizon.

SOIL NAME:	BOND very fine sandy loam	Location:	SW1/4, NW1/4, Sec. 34, T36N, R19E
Map Unit Symbol:	2B	Elevation:	6830'
Stop Number:	19-5	Slope(%):	5
Parent Material:	Eolian material	Aspect:	NE
Vegetation:	Artr, Gusa, Bogr, Sihy		
Classification:	Loamy, mixed, mesic Lithic Ustollic Haplargids		

Horizon	A	Bt1	Bt2	Bt3	2R
Depth (inches)	0-3	3-10	10-16	16-19	19+
Color					
Dry	7.5YR 5/6	5YR 5/6	5YR 5/6	7.5YR 5/4	hard sandstone
Moist	7.5YR 4/4	5YR 4/4	5YR 4/4	7.5YR 4/4	
Texture (USDA)	VFSL/L	L	L	--------Not sampled--------	
%≥ FS	13	11	10	--------Not sampled--------	
% VFS	39	36	31	--------Not sampled--------	
% Sand	52	47	41	--------Not sampled--------	
% Silt	34	31	33	--------Not sampled--------	
% Clay	14	22	26	--------Not sampled--------	
Structure					
Primary	1 c pl	1 m pr	2 m pr	2 f sbk	
Secondary		2 m sbk	2 m sbk		
Consistence					
Dry	sh	h	vh	vh	
Moist	vfr	vfr	fr	fr	
Wet	so/sp	ss/p	ss/p	s/p	
pH (paste)	7.3	7.6	7.7	--------Not sampled--------	
Reaction (10% HCl)	eo	eo	eo	es	
Carbonates	—	—	—	d	
Rock fragments	none	none	none	60 ch & flag	
Roots	2vf,f	2vf,f,1m	1vf,f,m	1vf	
Pores	1vf	1vf	1vf	2vf	
Clay Films	none	2 n pf	3 n pf	4 n pf	
Boundary	cs	cw	cw	ab	
Saturation %	31.8	37.2	38.1	--------Not sampled--------	
Soluble cations				--------Not sampled--------	
Ca (ppm)	2.8	2.9	3.8	--------Not sampled--------	
Mg (ppm)	0.7	0.7	1.1	--------Not sampled--------	
Na (ppm)	0.2	0.3	0.4	--------Not sampled--------	
SAR	0.1	0.2	0.3	--------Not sampled--------	
EC (mmhos/cm)	0.3	0.3	0.5	--------Not sampled--------	

CAHONA SERIES

Cahona soils are deep and well drained. They typically have a very fine sandy loam surface layer about 2 inches thick. The upper subsoil is noncalcareous sandy clay loam about 8 inches thick. The lower subsoil to a depth of 88 inches is calcareous sandy clay loam and very fine sandy loam. Soft shale bedrock occurs at 88 inches. Permeability is moderate and the available water capacity is high.

Range of Characteristics: The A horizon is a very fine sandy loam, fine sandy loam or loam with 8 to 18 percent clay. A transition BA horizon is usually present. The base of the Bt or Btk horizon ranges from 18 to 42 inches and base of the Bk horizon from 40 to more than 72 inches. Calcium carbonate equivalent ranges from 2 to 15 percent. A few pedons have a calcic horizon, but it is usually thin, discontinuous and/or below 60 inches. Buried Btk horizons are common at deeper depths. Some pedons occurring on alluvial fans and most in the pinyon-juniper woodlands are underlain, at a depth of more than 6 feet, by loamy fine or very fine sand. Depth to bedrock in these soils ranges from 3.5 to more than 15 feet. In the Cahona, bedrock substratum phase, depth to bedrock ranges from 40 to 72 inches.

SOIL NAME:	CAHONA very fine sandy loam	Location:	NW1/4, SE1/4, Sec. 22, T36N, R18E
Map Unit Symbol:	11B	Elevation:	6680'
Stop Number:	12-48	Slope(%):	6
Parent Material:	Eolian material	Aspect:	NW
Vegetation:	Artr, Pied, Jumo, Bogr, Aster, Gusa		
Classification:	Fine-silty, mixed, mesic Ustollic Haplargids		

Horizon	A	Bt	Btk1	Btk2	Bk	Btkb	2 Cr
Depth (inches)	0-2	2-10	10-25	25-39	39-71	71-88	88+
Color							
Dry	7.5YR 4/6	5YR 5/6	5YR 5/6	7.5YR 6/6	7.5YR 6/4	7.5YR 6/6	shale
Moist	7.5YR 3/4	5YR 4/4	5YR 4/4	7.5YR 5/6	7.5YR 5/6	7.5YR 5/6	
Texture (USDA)	VFSL	SCL	SCL	VFSL	VFSL	SCL	
%≥ FS	17	14	15	26	24	18	
% VFS	41	36	42	47	46	40	
% Sand	58	50	57	73	70	58	
% Silt	24	24	19	10	14	21	
% Clay	18	26	24	17	16	21	
Structure							
Primary	1 f pl	2 m sbk	1 c sbk	1 m sbk	m	1 vc pr	
Secondary			2 m sbk				
Consistence							
Dry	so	vh	eh	eh	eh	eh	
Moist	vfr	vfr	vfr	vfr	vfr	fr	
Wet	so/sp	ss/p	ss/p	ss/p	ss/p	so/p	
pH (paste)	7.3	7.3	8.0	8.1	8.2	8.1	
Reaction (10% HCl)	eo	eo	e,d	es	e, f, sf	e,d	
Carbonates	-	-	es,msf/fsm	csf,sm	ev,sm	es,ss,sf	
Rock fragments	none	none	none	none	none	none	
Roots	2 vf,f	2 vf,f	1m lvf,f	1 vf,f	none	none	
Pores	1 vf	1 vf,f	2 vf	1 vf	2 vf	3 vf,1 f	
Clay Films	none	3 n pf	4 n pf	2 n pf	none	4 n pf	
Boundary	cw	cw	gw	gw	cw	cw	
Saturation %	32.3	42.6	37.0	30.6	29.3	32.3	
Soluble cations							
Ca (ppm)	2.3	3.8	2.4	1.5	2.1	5.1	
Mg (ppm)	0.9	1.3	1.3	1.0	1.5	3.6	
Na (ppm)	0.1	0.2	0.8	2.6	6.4	10.8	
SAR	0.1	0.2	0.6	2.3	4.8	5.2	
EC (mmhos/cm)	0.3	0.5	0.4	0.4	0.9	1.7	

SOIL NAME: CAHONA very fine sandy loam, bedrock substratum phase
Map Unit Symbol: 10
Stop Number: 10-2
Parent Material: Eolian material
Classification: Fine-silty, mixed, mesic Ustollic Haplargids

Horizon	A	BA	Bt	Btk	Bk	2C	2Cr
Depth (inches)	0-3	3-5	5-11	11-22	22-39	39-55	
Color							
Dry	5YR 6/4	5YR 5/4	5YR 5/4	5YR 6/4	5YR 6/4	10YR 6/3	soft
Moist	5YR 4/4	5YR 4/4	5YR 4/4	5YR 5/4	5YR 5/4	10YR 4/3	sandstone
Texture (USDA)	L	combined	L	L	L	L	
% VFS	34.9	with Bt	31.4	30.8	23.9	10.1	
% Sand	44.7	horizon	41.1	40.2	34.7	46.4	
% Silt	48.2	for	40.0	39.1	40.9	28.3	
% Clay	7.1	sampling	18.9	20.7	24.4	25.3	
Structure							
Primary	1 vf sbk	1 c sbk	2 c pr	2 m sbk	1 m sbk	m	
Secondary			2 m&c sbk				
Consistence							
Dry	so	sh	h	h	h	h	
Moist	vfr	vfr	fr	fr	vfr	vfr	
Wet	so/po	ss/po	s/sp	s/sp	s/sp	s/sp	
pH (paste)	6.9		6.9	7.6	7.9	7.4	
Reaction (10% HCl)	eo	eo	eo	es	es	es	
Carbonates	-	-	-	d&1sf,sm	d&2sf,sm		
Rock fragments	none	none	none	none	none	none	
Roots	3 f,m,c	3 f,m,c	3 f,m,c	2f, m, 1c	2m,1f	none	
Clay Films	none	none	4 n pf	3 n pf	none	none	
Boundary	cs	cs	gw	gw	gw	aw	
Saturation %	33.0		39.5	43.4	49.8	48.8	
Soluble cations							
Ca (ppm)	1.93		1.58	1.50	1.63	10.5	
Mg (ppm)	0.60		0.34	0.35	0.61	8.19	
Na (ppm)	0.65		1.38	2.00	3.34	14.3	
SAR	0.58		1.41	2.08	3.16	4.68	
EC (mmhos)	0.33		0.30	0.40	0.56	3.38	
$CaCO_3$	0.9		1.2	3.3	10.8	5.4	
Boron (ppm)	0.32		0.39	0.49	0.56	0.41	
Selenium (ppm)	<0.02		<0.02	<0.02	<0.02	<0.02	
Total Sulfur	0.04		0.07	0.06	0.11	0.19	
Acid-base	1.25		2.19	1.87	3.43	5.93	
Neutralization potential	8.69		12.4	32.6	108.0	54.4	
Acid-base potential	7.44		10.2	30.7	105.0	48.5	

SOIL NAME: CAHONA very fine sandy loam
Map Unit Symbol: 11B
Stop Number: 12-224
Parent Material: Eolian material
Vegetation: Artr, Xasa, Bogr, Aster, Cacti, Mallow
Classification: Fine-silty, mixed, mesic Ustollic Haplargids

Location: NE1/4, SE1/4, Sec.15, T36N, R18E
Elevation: 6680'
Slope(%): 6
Aspect: NNE

Horizon	A	Bt1	Bt2	Btk1	Btk2	Bk	Btkb	Bkb1	Bkb2	Bkb3	2C1	2C2
Depth (inches)	0-2	2-4	4-12	12-20	20-38	38-54	54-77	77-102	102-119	119-141	141-171	171-186+
Color												
Dry	5YR 5/4	5YR 5/4	5YR 5/6	5YR 6/6	5YR 6/6	5YR 6/6	5YR 6/6	Not described				
Moist	5YR 4/4	5YR 4/4	5YR 4/6	5 YR 5/6	5YR 5/6	5YR 5/6	5YR 5/6	Not described				
Texture (USDA)	VFSL	SCL	SCL	VFSL	SCL	SCL	SCL	SCL	SCL/VFSL	SCL	SCL	VFSL
%≥ FS	14	13	10	13	11	12	17	24	28	40	23	54
% VFS	46	40	43	50	49	41	36	39	43	30	30	20
% Sand	60	53	53	63	60	53	53	63	71	70	53	74
% Silt	26	21	23	18	18	26	20	16	9	8	22	11
% Clay	14	26	24	19	22	21	27	21	20	22	25	15
Structure												
Primary	1 f pl	2 c sbk	1 c pr	1 c pr	1 m sbk	m	2 c pr	Not described				
Secondary			2m+c sbk	2m+c sbk				Not described				
Consistence								Not described				
Dry	so	h	vh	eh	eh	sh	eh	Not described				
Moist	vfr	vfr	fr	vfr	vfr	vfr	fr	Not described				
Wet	ss/sp	ss/sp	ss/p	ss/sp	ss/sp	so/sp	ss/sp	Not described				
pH (paste)	7.4	7.2	7.4	8.0	8.2	8.4	8.6	8.5	8.3	8.0	7.9	7.9
Reaction (10% HCl)	eo	eo	ev	es,d	es	es	es	Not described				
Carbonates	-	-	csf,pf	f,sm,sf	d &,f f,m	d & mss,sf	d & ss,sf	Not described				
Rock fragments	none	none	none	none	none	none	none	Not described				
Roots	3vf,f,1m	2vf,f,1m	2vf,f,1m	1vf,f,1m	1vf,f,m	1vf,f	2vf,f(dead)	Not described				
Pores	none	1vf	1vf	1vf	1vf	3vf	3vf	Not described				
Clay Films	none	1 n pf	4 n pf	4 n pf	3 n pf	none	3 n pf	Not described				
Boundary	as	cs	aw	gs	gw	cw	cw	Not described				
Saturation %	32.8	37.4	35.1	32.6	35.2	32.3	33.6	30.3	35.4	31.6	30.0	39.4
Soluble cations												
Ca (ppm)	3.5	2.3	2.7	2.6	2.3	1.3	0.6	2.1	2.2	10.4	15.0	21.5
Mg (ppm)	1.5	0.8	0.9	1.1	1.5	2.6	1.5	1.9	6.2	25.1	36.8	44.1
Na (ppm)	0.2	0.1	0.2	0.2	0.4	1.4	3.7	6.3	12.3	22.3	21.5	22.5
SAR	0.1	0.1	0.2	0.2	0.3	1.0	3.5	4.4	6.0	5.3	4.2	3.9
EC (mmhos/cm)	0.5	0.3	0.4	0.4	0.4	0.5	0.5	0.9	2.0	4.9	6.1	8.0

SOIL NAME: CAHONA very fine sandy loam
Map Unit Symbol: 11
Stop Number: 11-1
Parent Material: Eolian
Classification: Fine-silty, mixed, mesic Ustollic Haplargids

Horizon	A	BA	Bt	Btk	Bk1	Bk2	Bk3	2C	2Cr
Depth (inches)	0-3	3-5	5-15	15-23	23-48	48-83	83-95	95-105	105+
Color									
Dry	5YR 6/4	5YR 5/4	5YR 5/4	5YR 5/4	5YR 6/4	5YR 6/4	7.5YR 7/4		soft
Moist	5YR 4/4	5YR 4/4	5YR 4/4	5YR 4/4	5YR 4/4	5YR 4/4	7.5YR 5/4		shale
Texture (USDA)	VFSL	combined	L	L	L	SiL	SiL	SL	
% VFS	38.3	with Bt	31.0	29.2	31.5	27.6	21.3	17.7	
% Sand	46.4	horizon	38.2	38.2	41.8	44.5	43.6	53.6	
% Silt	48.1	for	47.3	43.6	43.7	52.4	54.2	27.9	
% Clay	5.5	sampling	14.5	18.2	14.5	3.1	2.2	18.5	
Structure									
Primary	1 vf gr	2 m pr	2 m pr	2 m sbk	1 m&f sbk	similar to	2 m&f sbk	m	
Secondary		2 c&m sbk	2 c&m sbk			above			
Consistence						horizon;			
Dry	so	sh	h	h	h	split for	h	sh	
Moist	vfr	vfr	vfr	vfr	vfr	sampling	vfr	fr	
Wet	so/po	so/po	ss/sp	ss/sp	ss/po	purposes	so/po	so/po	
pH (paste)	7.0		6.9	7.5	8.0	8.0	7.9	6.6	
Reaction (10% HCl)	eo	eo	eo	es	es		ev	ev	
Carbonates	-	-	-	d&csf,ss,sm	d&csf,ss,sm		d&csf,ss	d	
Rock fragments	none	none	none	none	none		none	none	
Roots	3f,m,c	3f,m,c	3f,m,c	2f,m,c	2f,m,c		none	none	
Clay Films	none	none	4 n pf	3 n pf	none	none	none	none	
Boundary	cs	cs	gw	bw	gw		gw	aw	
Saturation %	39.0		43.4	42.3	34.6	39.1	42.2	44.6	
Soluble cations									
Ca (ppm)	2.60		1.37	2.02	1.01	26.0	25.1	20.5	
Mg (ppm)	1.70		0.86	1.71	1.50	116.0	132.0	87.2	
Na (ppm)	0.99		1.05	1.17	2.45	32.6	30.8	19.4	
SAR	0.68		0.99	0.86	2.19	3.87	3.48	2.64	
EC (mmhos)	0.49		0.26	0.44	0.47	3.7	11.5	7.48	
$CaCO_3$	0.7		0.8	0.8	2.0	3.7	13.6	3.2	
Boron (ppm)	0.22		0.27	0.52	0.28	0.80	0.71	0.27	
Selenium (ppm)	<0.02		<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	
Total Sulfur	0.05		0.04	0.04	0.04	0.29	0.6	3.04	
Acid-base	1.56		1.25	1.25	1.25	9.05	18.7	94.9	
Neutralization potential	7.42		7.53	7.94	20.2	37.0	136.0	31.8	
Acid-base potential	5.86		6.28	6.69	19	28.0	117.0	63.1	

SOIL NAME:	CAHONA very fine sandy loam	Location:	NW1/4, NE1/4, Sec. 3, T36N, R19E
Map Unit Symbol:	X11B	Elevation:	6780'
Stop Number:	19-61	Slope(%):	8
Parent Material:	Eolian material	Aspect:	NW
Vegetation:	Artr, Bogr, Sihy, Stco, Orhy		
Classification:	Fine-silty, mixed, mesic Ustollic Haplargids		

Horizon	A	BA	Bt1	Bt2	Btk	Bk1	Bk2	2 Cr
Depth (inches)	0-1	1-3	3-12	12-19	19-29	29-40	40-64	64+
Color								
Dry	7.5YR 5/4	7.5YR 5/4	7.5YR 5/6	7.5YR 5/6	7.5YR 6/6	7.5YR 5/6	7.5YR 5/6	gray calcareous
Moist	7.5YR 3/4	7.5YR 3/4	7.5YR 4/4	7.5YR 4/6	7.5YR 4/6	7.5YR 4/4	7.5YR 4/6	shale
Texture (USDA)	VFSL	VFSL	VFSL	VFSL	VFSL	VFSL	LS	
%≥ FS	26	26	40	32	42	47	73	
% VFS	33	29	23	25	26	22	11	
% Sand	59	55	63	57	68	69	84	
% Silt	29	26	18	26	14	14	4	
% Clay	12	19	19	17	18	17	12	
Structure								
Primary	1 f pl	1 m pl	2 m pr	2 m pr	m	m	m	
Secondary	sg		2 c sbk					
Consistence								
Dry	soft	sh	vh	vh	h	h	h	
Moist	loose	vfr	fr	fr	fr	fr	fr	
Wet	so/po	so/sp	ss/p	ss/p	so/p	so/po	so/po	
pH (paste)	7.3	7.0	7.3	7.8	8.2	8.3	8.4	
Reaction (10% HCl)	eo	eo	eo	e	ev	es	e	
Carbonates	-	-	-	d	d&sm	sm	sf,+sm	
Rock fragments	none	none	none	none	none	none	none	
Roots	2 vf	2 vf	2 vf,f lm	2 vf,f	1 vf	1 vf	1 vf	
Pores	1 vf	1 vf	2 vf	2 vf	1 vf	none	none	
Clay Films	none	none	3 n pf	2 n pf	1 n pf	none	none	
Boundary	cs	cs	gw	gw	gw	gw	aw	
Saturation %	27.4	33.8	31.3	26.2	27.7	24.9	22.5	
Soluble cations								
Ca (ppm)	2.2	1.7	2.3	3.1	1.7	1.4	1.2	
Mg (ppm)	1.0	0.6	0.7	1.3	1.2	1.2	1.4	
Na (ppm)	0.2	0.2	0.2	0.4	1.4	2.5	6.0	
SAR	0.2	0.2	0.2	0.3	1.1	2.3	5.3	
EC (mmhos/cm)	0.3	0.2	0.3	0.4	0.4	0.4	0.8	

DULCE SERIES

Dulce soils are shallow and well drained. They typically have a very channery fine sandy loam surface layer about 1 inch thick. The substratum to a depth of 6 inches is channery fine sandy loam. Soft sandstone bedrock occurs at 6 inches. Permeability is moderately rapid and the available water capacity is very low.

Range of Characteristics: These soils are a taxadjunct to the Dulce series because the redder hues found in the site-specific soil are outside of the color range established for Dulce series. They are otherwise similar. Depth to bedrock, usually soft or fractured sandstone, ranges from 2 to 20 inches. Because of the severe erosion that has occurred on these soils, bedrock is generally within 6 inches. Textures are loam or sandy loam with 10 to 25 percent clay. Surficial rock fragments, mainly sandstone channers or flagstones, are quite variable, ranging from 5 to 60 percent.

SOIL NAME:	DULCE very channery fine sandy loam		
Map Unit Symbol:	3C	Location:	SW1/4, NE1/4, Sec. 22, T36N, R18E
Stop Number:	12-110	Elevation:	6700'
Parent Material:	Sandstone residuum	Slope(%):	12
Vegetation:	Pied, Artr, Gusa	Aspect:	NW
Classification:	Loamy, mixed (calcareous), mesic, shallow Ustic Torriorthents		

Horizon	A	C	Cr
Depth (inches)	0-1	1-6	6+
Color			
Dry	7.5YR 6/4	7.5YR 6/4	fractured calcareous sandstone
Moist	7.5YR 4/4	7.5YR 4/4	
Texture (USDA)	FSL	FSL	
%≥ FS	53	58	
% VFS	19	14	
% Sand	72	72	
% Silt	14	12	
% Clay	14	16	
Structure			
Primary	1 m pl		
Secondary	2 vf gr	m	
Consistence			
Dry	so	so	
Moist	vfr	vfr	
Wet	so/po	so/po	
pH (paste)	7.9	7.7	
Reaction (10% HCl)	e	es	
Carbonates	d	d	
Rock fragments %	33.3	16.6	
Roots	2 vf, f	3 vf,f,1m	
Pores	none	none	
Clay Films	none	none	
Boundary	cw	cw	
Saturation %	26.7	35.0	
Soluble cations			
Ca (ppm)	3.8	6.6	
Mg (ppm)	0.4	0.7	
Na (ppm)	0.2	0.3	
SAR	0.2	0.1	
EC (mmhos/cm)	0.4	0.7	

SOIL NAME:	DULCE very channery loam	Location:	SE1/4, SE1/4, Sec. 15, T36N, R18E
Map Unit Symbol:	3A	Elevation:	6720'
Stop Number:	12-263	Slope(%):	6
Parent Material:	Sandstone residuum	Aspect:	NNW
Vegetation:	Pied, Jumo, Artr, Orhy, Sihy		
Classification:	Loamy, mixed (calcareous), mesic, shallow Ustic Torriorthents		

Horizon	A	C	Cr
Depth (inches)	0-2	2-7	7+
Color			
Dry	7.5YR 5/4	7.5YR 5/4	semihard, fractured calcareous sandstone
Moist	7.5YR 4/4	7.5YR 4/4	with some soil filling fractures in spots and carbonate
Texture (USDA)	SiCL/L	SCL	coating on underside of ss. fragments
%≥ FS	27	28	
% VFS	23	19	
% Sand	50	47	
% Silt	28	27	
% Clay	22	26	
Structure			
Primary	1 m pl		
Secondary	2 vf gr	m	
Consistence			
Dry	so	sh	
Moist	vfr	vfr	
Wet	so/sp	so/sp	
pH (paste)	7.9	7.7	
Reaction (10% HCl)	es	ev	
Carbonates	d	d	
Rock fragments %	38.1	20.3	
Roots	2vf,f,m,1c	2vf,f,m,1	
Pores	none	none	
Clay Films	none	none	
Boundary	cw	ai	
Saturation %	30.5	42.4	
Soluble cations			
Ca (ppm)	3.2	5.9	
Mg (ppm)	0.3	0.8	
Na (ppm)	0.1	0.2	
SAR	0.1	0.1	
EC (mmhos/cm)	0.3	0.6	

LAS LUCAS SERIES

Las Lucas soils are deep and well drained. They typically have a surface layer of sandy clay loam about 5 inches thick. The subsoil to a depth of 59 inches is calcareous clay loam. The substratum is stratified very gravelly loamy sand and sandy loam. Permeability is moderate and the available water capacity is high.

Range of Characteristics: Depth to bedrock is greater than 60 inches. The texture of A horizon is variable and ranges from very fine sandy loam to sandy clay loam. Surficial rock fragments are generally less than 5 percent. The Bk horizon is loam or clay loam, with a weighted clay percent of 25 to 35 percent. Most pedons have noncalcareous C horizons below 6 feet. These soils are frequently calcareous to the surface with disseminated carbonates.

SOIL NAME:	LAS LUCAS very fine sandy loam	Location:	SW1/4, SW1/4, Sec. 34, T36N, R19E
Map Unit Symbol:	15A	Elevation:	6680'
Stop Number:	19-64	Slope(%):	2
Parent Material:	Alluvium, colluvium	Aspect:	S
Vegetation:	Artr, Agsm, Bogr, Atca		
Classification:	Fine-silty, mixed, mesic Ustollic Camborthids		

Horizon	A1	A2	Bk1	2Bk1	2Bknz1	3Bknz1	71-90	90-108	108-132	132-156	156-180	180-204+
Depth (inches)	0-1	1-4	4-17	17-31	31-48	48-71						
Color												
Dry	10YR 6/3	10YR 5/3	10YR 5/3	10YR 5/3	10YR 5/3	10YR 5/3	Not described					
Moist	10YR 4/3	10YR 4/3	10YR 4/3	10YR 4/3	10YR 4/3	10YR 4/3	Not described					
Texture (USDA)	VFSL	CL/SiCL	CL	L	CL	SCL	CL	SCL	C/CL	CL	L	SiCL
%≥ FS	32	8	15	23	15	28	18	39	12	14	21	9
% VFS	25	12	11	18	18	22	17	11	9	19	19	10
% Sand	57	20	26	41	33	50	35	50	21	33	40	19
% Silt	29	43	37	33	36	26	32	19	39	34	36	43
% Clay	14	37	37	26	31	24	33	31	40	33	24	38
Structure												
Primary	1 f pl	1 c pl	2 f&m sbk	1 m sbk	1 m sbk	m	Not described					
Secondary		2 vf gr					Not described					
Consistence												
Dry	so	sh	vh	vh	vh	vh	Not described					
Moist	vfr	vfr	fr	fr	fr	fr	Not described					
Wet	so/sp	s/p	s/p	s/p	s/p	s/p	Not described					
pH (paste)	7.8	7.9	7.9	7.8	7.6	8.2	8.1	7.7	4.4	3.9	3.9	3.8
Reaction (10% HCl)	e	e	es	es	es	es	Not described					
Carbonates	d	d	d&msf	d&msf	d&msf	d&csf,sm	Not described					
Rock fragments	none	none	none	none	none	none	Not described					
Roots	2 vf,f,1m	2 vf,f,1m	2 vf,f	1 vf,f	1 vf,f	1 vf,f	Not described					
Pores	2 vf	2 vf	2 vf	2 vf	2 vf	2 vf	Not described					
Clay Films	none	none	none	none	none	none	Not described					
Boundary	cw	cw	cw	cw	cw		Not described					
Saturation %	32.0	33.3	37.8	33.7	36.7	33.2	39.8	38.3	43.4	38.2	33.4	44.1
Soluble cations												
Ca (ppm)	5.7	2.4	4.9	14.8	33.9	23.7	24.2	24.6	21.5	24.6	24.7	23.4
Mg (ppm)	2.6	1.2	1.7	6.5	74.6	198.2	214.6	228.6	112.7	35.0	31.7	30.4
Na (ppm)	0.4	0.3	0.6	10.3	59.1	77.8	86.1	102.2	69.1	31.0	13.8	11.3
SAR	0.2	0.2	0.4	3.1	8.0	7.4	7.9	9.1	8.4	5.7	2.6	2.2
EC (mmhos/cm)	1.0	0.4	0.6	2.7	11.8	16.0	16.7	18.0	12.3	6.4	4.8	4.7
$CaCO_3$									<0.1	<0.1	<0.1	<0.1
Total sulfur (%)									1.46	0.74	0.19	0.21
Sulfate sulfur (%)									1.41	0.67	0.19	0.21
Pyritic sulfur (%)									<0.05	<0.05	<0.05	<0.05
Organic sulfur (%)									0.05	0.03	<0.01	<0.01
Lime requirement (SMP)									16	25	25	31

SOIL NAME: Las Lucas clay loam
Map Unit Symbol: 15A
Stop Number: 14-13
Parent Material: Alluvium
Classification: Fine-silty, mixed, mesic Ustollic Camborthids

Horizon	A	Bk1	Bk2	2Bk3	3C	-----not described-----	
Depth (inches)	0-5	5-20	20-38	38-59	59-96	96-110	110-132
Color							
Dry	10YR 6/3	10YR 6/3	10YR 6/3	10YR 6/4	10YR 5/4	-----not described-----	
Moist	10YR 4/3	10YR 4/3	10YR 4/3	10YR 6/4	10YR 5/4	-----not described-----	
Texture (USDA)	CL	CL	CL	SiL	v gr LS	gr LS/SL	FSL
% FS+	19	15	14	14	79	73	63
% VFS	14	10	12	12	6	8	14
% Sand	33	25	26	26	85	81	77
% Silt	39	38	38	59	5	8	11
% Clay	28	37	36	15	10	11	12
Structure							
Primary	1 c pl	2 f&m sbk	1 f&m sbk	m	sg	-----not described-----	
Secondary	2 t pl					-----not described-----	
Consistence							
Dry	sh	sh	h	sh	loose	-----not described-----	
Moist	vfr	vfr	fr	vfr	loose	-----not described-----	
Wet	ss/sp	s/p	s/p	so/po	so/po	-----not described-----	
pH (paste)	7.8	7.9	7.6	7.8	7.2	8.1	8.0
Reaction (10% HCl)	e	e	e	es	e	-----not described-----	
Carbonates	d	d&1sf	d&2sf	d&1sf	d	-----not described-----	
Rock fragments	none	none	none	none	43.1	24.2	5.4
Roots	3vf, 2f	3vf, 2f	2vf,f	2vf,f,m,c	1vr,f	-----not described-----	
Clay Films	none	none	none	none	none	-----not described-----	
Boundary	cw	cw	cw	aw	aw	-----not described-----	
Saturation %	33.0	42.2	42.5	30.6	26.9	27.5	27.6
Soluble cations							
Ca (ppm)	3.5	6.9	39.8	9.8	22.1	22.6	16.1
Mg (ppm)	1.2	2.6	11.9	2.2	10.3	114.3	21.8
Na (ppm)	0.4	0.5	1.4	0.5	10.9	68.3	11.9
SAR	0.2	0.2	0.8	0.2	8.6	26.1	8.7
EC (mmhos)	0.6	0.9	3.8	1.1	3	11.6	3.3
$CaCO_3$						1.1	2.2
Total Sulfur (%)						0.3	0.09
Sulfate sulfur (%)						0.22	0.04
Pyritic sulfur (%)						<0.05	<0.05
Organic sulfur (%)						0.08	0.05
Lime requirement (SMP)						0	0

SOIL NAME: Las Lucas very fine sandy loam
Map Unit Symbol: 15
Stop Number: 15-9
Parent Material: alluvium
Classification: Fine-silty, mixed, mesic Ustollic Camborthids

Horizon	A	Bw	2Bk1	2Bk2	2Bk3	3C1	3C2
Depth (inches)	0-4	4-9	9-26	26-60	60-84	84-108	108-120
Color							
Dry	10YR 6/3	10YR 6/3	10YR 5/3	similar to	----------not described----------		
Moist	10YR 5/3	10YR 5/3	10YR 4/3	above horizon	----------not described----------		
Texture (USDA)	SL	L	CL	CL	----------not described----------		
% VFS	22.6	21.2	21.4	18.4	24.8	12.6	18.9
% Sand	60.9	49.1	34.5	29.1	55.5	69.1	49.1
% Silt	26.6	32.0	38.4	40.2	22.0	16.5	22.9
% Clay	12.5	18.9	27.1	30.7	22.5	14.4	28.0
Structure							
Primary	1 vf sbk	2 c sbk	1 m&c sbk	split	----------not described----------		
Secondary				for	----------not described----------		
Consistence				sampling	----------not described----------		
Dry	so	sh	h	purposes	----------not described----------		
Moist	vfr	vfr	vfr		----------not described----------		
Wet	so/po	ss/po	s/p		----------not described----------		
pH (paste)	7.4	7.6	7.7	7.5	7.4	7.3	7.5
Reaction (10% HCl)	e	es	es		----------not described----------		
Carbonates	d	d	d&2sf		----------not described----------		
Rock fragments	none	none	none		----------not described----------		
Roots	3m,c 2f	3m,c, 2f	2m,f, 1c		----------not described----------		
Clay Films	none	none	none		----------not described----------		
Boundary					----------not described----------		
Saturation %	30.4	36.3	44.9	47.9	37.8	30.5	42.0
Soluble cations							
Ca (ppm)	4.29	2.14	2.51	10.2	18.3	12.6	10.8
Mg (ppm)	0.65	0.33	0.54	3.27	5.77	4.21	3.64
Na (ppm)	2.63	1.53	2.25	2.65	4.26	5.62	7.68
SAR	1.67	1.38	1.82	1.02	1.23	1.94	2.86
EC (mmhos)	0.72	0.38	0.45	1.50	2.69	2.47	2.24
$CaCO_3$	2.2	2.7	2.2	3.6	3.5	4.2	2.5
Boron (ppm)	0.65	0.50	0.59	1.32	1.06	0.88	0.75
Selenium (ppm)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Total Sulfur	0.01	0.05	0.01	0.05	0.06	0.07	0.06
Acid-base	0.31	1.56	0.31	1.56	1.87	2.19	1.87
Neutralization potential	22.1	27.4	22.3	36.4	35.0	41.8	25.3
Acid-base potential	21.8	25.8	22.0	34.8	33.1	39.6	23.4

OELOP SERIES

Oelop soils are deep and well drained. They typically have a very fine sandy loam surface layer about 4 inches thick. The upper subsoil is noncalcareous very fine sandy loam about 6 inches thick. The lower subsoil to a depth of more than 60 inches is calcareous coarsely stratified loam, clay loam and silty clay loam. Permeability is moderately slow. Available water capacity is high.

Range of Characteristics: Depth to bedrock is greater than 60 inches. The A horizon is a very fine sandy loam or fine sandy loam with 10 to 18 percent clay. Surficial rock fragments are generally less than 5 percent. The Bt and Btk horizon is a loam or clay loam, with a weighted clay percent of 25 to 35 percent. Most pedons have noncalcareous C horizons below 6 feet. These soils are frequently calcareous to the surface with disseminated carbonates.

SOIL NAME:	OELOP very fine sandy loam	Location:	SE1/4, SE1/4, Sec.33, T36N, R19E
Map Unit Symbol:	14B	Elevation:	6680'
Stop Number:	19-55	Slope(%):	5
Parent Material:	Alluvium	Aspect:	S
Vegetation:	Artr, Gusa, Bogr		
Classification:	Fine-loamy, mixed, mesic Ustollic Haplargids		

Horizon	A1	BA	Bt	Bknz1	Bknz2	----------Not described----------			
Depth (inches)	0-4	4-10	10-20	20-40	40-60	60-84	84-108	108-132	132-156+
Color									
Dry	10YR 6/3	10YR 6/6	10YR 6/4	10YR 6/4	10YR 5/3	----------Not described----------			
Moist	10YR 4/3	10YR 4/4	10YR 4/4	10YR 4/4	10YR 4/3	----------Not described----------			
Texture (USDA)	VFSL	VFSL	L	CL	CL	SiC/CL	SiCL	SiCL	SiC
%≥ FS	30	34	23	20	25	4	3	4	7
% VFS	23	19	18	12	16	8	11	9	8
% Sand	53	53	41	32	41	12	14	13	15
% Silt	34	28	33	30	30	48	48	48	43
% Clay	13	19	26	38	29	40	38	39	42
Structure									
Primary	1 c pl	1 m sbk	2 m&c sbk	1 f&m sbk	m	----------Not described----------			
Secondary	2 t pl					----------Not described----------			
Consistence									
Dry	sh	h	vh	vh	vh	----------Not described----------			
Moist	vfr	vfr	vfr	vfr	vfr	----------Not described----------			
Wet	so/sp	so/sp	s/p	s/p	s/p	----------Not described----------			
pH (paste)	8.0	7.6	7.9	8.1	8.3	8.1	6.7	4.3	4.0
Reaction (10% HCl)	eo	eo	e/d	es	es	----------Not described----------			
Carbonates	-	-	-	d&msf	d&csf	----------Not described----------			
Rock fragments	none	none	none	none	none	----------Not described----------			
Roots	2vf	2vf	1vf	1vf	1vf	----------Not described----------			
Pores	1vf	2vf	3vf,1f	3vf,1f	2vf,f	----------Not described----------			
Clay Films	none	none	3 n pf	none	none	----------Not described----------			
Boundary	cs	cw	gw	gw	gw	----------Not described----------			
Saturation %	26.9	25.9	28.9	38.7	34.4	42.5	43.2	41.5	39.4
Soluble cations									
Ca (ppm)	3.1	2.9	2.2	22.5	24.6	26.1	24.4	21.6	26.2
Mg (ppm)	1.9	1.5	1.7	79.2	173.1	372.5	265.6	180.1	125.0
Na (ppm)	0.5	0.2	0.6	46.1	135.2	261.3	188.3	148.3	130.4
SAR	0.3	0.1	0.5	20.4	135.9	185.1	156.3	147.6	150.0
EC (mmhos/cm)	0.6	0.5	0.4	8.5	17.3	30.1	23.7	18.1	16.4
$CaCO_3$								<0.01	<0.01
Total sulfur (%)								0.57	0.80
Sulfate sulfur (%)								0.52	0.73
Pyritic sulfur (%)								<0.05	<0.05
Organic sulfur (%)								0.05	0.07
Lime requirement (SMP)								16	24

INTERMOUNTAIN SOILS

SOIL NAME: OELOP loam
Map Unit Symbol: 14A
Stop Number: 12-259
Parent Material: Eolian over alluvium
Vegetation: Artr, Gusa, Bogr, Orhy, Sihy
Classification: Fine-loamy, mixed, mesic Ustollic Haplargids

Location: SE1/4, NW1/4, Sec.15, T36N, R18E
Elevation: 6600'
Slope(%): 2
Aspect: NW

Horizon	A	B	Bt	Btk	2Btkb	3Bk					
Depth (inches)	0-3	3-7	7-13	13-28	28-55	55-72	72-96	96-132	132-156	156-180	180-210
Color											
Dry	7.5YR 6/4	7.5YR 6/4	10YR 6/3	10YR 6/3	10YR 6/3	10YR 5/4	Not described				
Moist	7.5YR 4/4	7.5YR 4/4	10YR 4/3	10YR 4/4	10YR 4/3	10YR 4/4	Not described				
Texture (USDA)	L	CL	CL	CL	CL	VFSL	Cl/LL	L	CL	SCL	SCL
%≥ FS	10	9	10	12	10	31	12	13	13	19	14
% VFS	28	22	20	25	24	31	29	28	37	42	41
% Sand	38	31	30	37	34	62	41	41	50	61	55
% Silt	36	39	35	35	34	19	32	35	33	18	24
% Clay	26	30	35	28	32	19	27	24	17	21	21
Structure											
Primary	2 c pl	2 vc pl	2 m&c sbk	2 m pr	2 m pr	m	Not described				
Secondary				2 c sbk	3 f abk		Not described				
Consistence							Not described				
Dry	h	h	vh	vh	vh	vh	Not described				
Moist	vfr	vfr	vfr	vfr	vfr	vfr	Not described				
Wet	so/sp	s/p	s/p	ss/sp	s/p	so/sp	Not described				
pH (paste)	7.3	7.5	7.8	8.0	8.0	7.9	7.8	7.7	7.7	8.0	8.0
Reaction (10% HCl)	eo	eo	eo	es	es	es/d	Not described				
Carbonates	--	--	--	css	css&sf	fsf	Not described				
Rock fragments	none	none	none	none	none	none	Not described				
Roots	2vf 1f,m	2vf 1f,m	2vf 1f,m	2vf,f lm	2vf,f	1vf	Not described				
Pores	none	none	2vf,f	2vf,f 1m	1vf,f	1vf,f	Not described				
Clay Films	none	none	3 n pf	3 n pf	2 n pf	none	Not described				
Boundary	cs	cw	gw	cw	gw	cw	Not described				
Saturation %	30.2	37.4	36.1	31.2	33.1	30.4	36.4	32.9	30.2	34.0	33.6
Soluble cations											
Ca (ppm)	2.0	2.4	2.8	2.6	2.2	9.6	19.1	12.2	8.2	10.0	9.2
Mg (ppm)	0.7	0.6	0.7	1.1	1.2	4.6	9.1	6.2	4.9	7.1	7.8
Na (ppm)	0.1	0.1	0.2	0.5	2.6	7.3	9.0	6.8	5.7	6.6	7.1
SAR	0.1	0.1	0.1	0.4	2.0	2.7	7.5	7.1	2.2	7.2	7.7
EC (mmhos/cm)	0.3	0.3	0.3	0.4	0.5	1.8	3.0	2.2	1.7	2.0	2.0
$CaCO_3$								0.8	0.5	6.7	9.4
Total sulfur (%)								0.01	0.01	0.02	0.03
Sulfate sulfur (%)								0.01	<0.01	0.01	0.01
Pyritic sulfur (%)								<0.05	<0.05	<0.05	<0.05
Organic sulfur (%)								<0.01	0.01	0.01	0.02
Lime requirement (SMP)								0	0	0	0

PULPIT SERIES

Pulpit soils are deep and well drained. They typically have a very fine sandy loam surface layer about 3 inches thick. The upper subsoil is noncalcareous loam and very fine sandy loam about 9 inches thick. The lower subsoil to a depth of 30 inches is calcareous loam. Hard sandstone bedrock occurs at 30 inches. Permeability is moderate and the available water capacity is moderate.

Range of Characteristics: Depth to bedrock and solum thickness range from 20 to 40 inches with bedrock usually occurring between 25 and 35 inches. Soil color hue is 5YR or 7.5YR. Texture of the A horizon is very fine sandy loam or loam with 5 to 18 percent clay. Texture of the Bt horizon is loam, very fine sandy loam or sandy clay loam with 18 to 25 percent clay. The Btk and Bk horizons have 5 to 25 percent calcium carbonate equivalent, which increases with depth and is generally highest immediately above bedrock.

SOIL NAME: PULPIT very fine sandy loam
Map Unit Symbol: 5
Stop Number: 5-1
Parent Material: Eolian
Classification: Fine-silty, mixed, mesic Ustollic Haplargids

Horizon	A	BA	Bt	Btk	Bk	R
Depth (inches)	0-3	3-5	3-12	12-23	23-30	30+
Color						
Dry	5YR 6/4	5YR 5/4	5YR 5/4	5YR 6/5	5YR 8/2	hard, calcareous
Moist	5YR 4/4	5YR 4/4	5YR 4/4	5YR 4/4	5YR 6/4	sandstone
Texture (USDA)	VFSL	combined	L	L	L	
% VFS	34.8	with Bt	24.3	30.2	22.8	
% Sand	48.4	horizon	38.4	44.7	37.5	
% Silt	45.4	for	41.6	34.6	40.0	
% Clay	6.2	sampling	20	20.7	22.5	
Structure						
Primary	1 f gr	1 m&c sbk	2 c pr	2 m&f sbk	1 f sbk	
Secondary			2 m&c sbk			
Consistence						
Dry	so	sh	h	h	h	
Moist	vfr	vfr	vfr	vfr	vfr	
Wet	so/po	ss/po	s/sp	s/sp	s/sp	
pH (paste)	6.9		7.1	7.8	7.9	
Reaction (10% HCl)	eo	eo	eo	es	ev	
Carbonates	-	-	-	d&c sm,sf,ss	d&c sm,sf	
Rock fragments	none	none	none	none	none	
Roots	3f,m, 1c	3f,m,c	2f, 1m,c	2f, 1m,c	1f,m,c	
Clay Films	none	none	4 n pf	3 n pf	none	
Boundary	cs	cs	gw	gw	aw	
Saturation %	35.1		44.3	41.1	40.3	
Soluble cations						
Ca (ppm)	2.56		1.44	1.80	1.62	
Mg (ppm)	1.09		0.57	0.60	1.25	
Na (ppm)	1.51		1.04	1.31	1.71	
SAR	1.12		1.04	1.20	1.43	
EC (mmhos)	0.54		0.31	0.36	0.44	
$CaCO_3$	0.6		1.0	6.3	20.1	
Boron (ppm)	0.33		0.37	0.23	0.33	
Selenium (ppm)	<0.02		<0.02	<0.02	<0.02	
Total Sulfur	0.01		0.04	0.01	0.04	
Acid-base	0.31		1.25	0.31	1.25	
Neutralization potential	6.39		9.51	62.7	201.0	
Acid-base potential	6.08		8.26	62.4	200.0	

SAN MATEO SERIES

San Mateo soils are deep and well drained. They typically have a loam surface layer about 1 inch thick and a clay loam subsurface layer about 5 inches thick. The subsoil is calcareous coarsely-stratified sandy clay loams, loams, clay loams and silty clay loams to a depth of more than 60 inches. Permeability is moderate to moderately slow and the available water capacity is high.

Range of Characteristics: Depth to bedrock ranges from 10 to more than 25 feet. As shown by the deep hole analysis results, depth to high salinity and sodicity is 10 to more than 25 feet. The soils exhibiting high salt and sodium concentrations are primarily associated with the Reed Valley Wash.

A thin Bw horizon occurs in some pedons. These soils commonly are finely- to coarsely-stratified with buried horizons, especially Bk horizons. Textures in the control section range from fine sandy loams to silty clay loams, with a weighted average clay content from 18 to 35 percent. Soil hues are either 7.5YR or 10YR.

SOIL NAME: SAN MATEO loam
Map Unit Symbol: 13
Stop Number: 13-14
Parent Material: Alluvium
Classification: Fine-loamy, mixed (calcareous), mesic Ustic Torrifluvents

Horizon	A	Bw	Bk1	Bk2	C1					2Cr
Depth (inches)	0-4	4-9	9-24	24-47	47-73	73-97	97-111	111-144	144-196	196
Color										
Dry	7.5YR 6/4	7.5YR 6/4	7.5YR 5/3	7.5YR 5/3	7.5YR 6/4	Not described				sandstone
Moist	7.5YR 5/4	7.5YR 5/4	7.5YR 4/4	7.5YR 4/3	7.5YR 5/4	Not described				
Texture (USDA)	L	L	CL	L	FSL	L	L	VFSL	VFSL	
% VFS	27.9	24.2	16.6	19.6	27.9	25.1	19.4	27.1	24.1	
% Sand	40.0	28.2	22.7	27.3	64.5	30.0	28.2	46.4	43.6	
% Silt	48.4	49.3	46.6	46.5	26.6	47.5	52.0	34.7	37.5	
% Clay	11.6	22.5	30.7	26.2	8.9	22.5	19.8	18.9	18.9	
Structure										
Primary	1 m&f sbk	2 m&c sbk	1 m sbk	1 m sbk	m	Not described				
Secondary										
Consistence										
Dry	so	sh	vh	h	so	Not described				
Moist	vfr	vfr	fi	vfr	vfr	Not described				
Wet	so/po	s/sp	s/p	s/p	so/po	Not described				
pH (paste)	7.5	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.4	
Reaction (10% HCl)	e	e	es	es	es	Not described				
Carbonates	d	d	d;1sf	d;1sf	d	Not described				
Rock fragments	none	none	none	none	none	Not described				
Roots	3f	3f,2m,c	2f,m,c	2f,m,c	2f,m,c	Not described				
Clay Films	none	none	none	none	none	Not described				
Boundary	cs	cs	gw	gw	gw	Not described				
Saturation %	37.1	36.7	48.0	45.9	30.3	41.8	43.9	38.6	38.4	
Soluble cations										
Ca (ppm)	4.84	1.38	2.69	4.07	2.87	9.91	28.9	19.7	21.8	
Mg (ppm)	1.56	0.31	0.62	1.20	1.66	6.12	15.4	12.3	47.5	
Na (ppm)	1.07	1.50	1.65	1.84	1.59	8.41	13.8	18.0	48.9	
SAR	0.60	1.63	1.28	1.13	1.06	2.97	2.93	4.50	8.31	
EC (mmhos)	1.06	0.35	0.50	0.68	0.70	2.58	4.77	4.26	8.30	
$CaCO_3$	3.0	3.4	3.5	3.9	2.6	3.0	2.1	2.3	2.6	
Boron (ppm)	2.12	0.76	0.58	0.48	0.53	0.78	1.15	0.63	0.52	
Selenium (ppm)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	0.02	
Total Sulfur	0.05	0.05	0.06	0.06	0.05	0.06	0.36	0.09	0.22	
Acid-base	1.56	1.56	1.87	1.87	1.56	1.87	11.2	2.81	6.87	
Neutralization potential	30.3	33.5	34.5	39.3	25.5	30.1	21.1	23.3	26.4	
Acid-base potential	28.7	31.9	32.6	37.4	23.9	28.2	9.86	20.5	19.5	

SOIL NAME:	SAN MATEO clay loam	Location:	NE1/4, NW1/4, Sec.4, T35N, R19E
Map Unit Symbol:	13A	Elevation:	6620'
Stop Number:	19-65	Slope(%):	1
Parent Material:	Alluvium	Aspect:	W
Vegetation:	Atca, Brte, Bogr, Agsm		
Classification:	Fine-loamy, mixed, mesic Ustic Torrifluvents		

Horizon	A	Bw	Bk1	Bk2	Bk3	48-72	72-96	96-120	120-144	144-168	168-192	192-216
Depth (inches)	0-6	6-13	13-30	30-48	48-72							
Color												
Dry	10YR 6/2	10YR 5/3	10YR 5/3	10YR 5/2	10YR 5/2	Not described						
Moist	10YR 4/2	10YR 3/3	10YR 4/3	10YR 4/2	10YR 4/2	Not described						
Texture (USDA)	CL	SCL	VFSL/SCL	CL	SiCL	CL	SiCL	SiCL	CL	CL	SCL	SCL
%≥ FS	13	29	51	11	3	6	4	4	26	18	46	48
% VFS	14	19	15	19	12	18	14	15	14	19	15	13
% Sand	27	48	66	30	15	24	18	19	40	37	61	61
% Silt	42	25	14	42	49	40	45	50	28	34	15	15
% Clay	31	27	20	28	36	36	37	31	32	29	24	24
Structure												
Primary	2 vc pl	1 vc pr	m	m	m	Not described						
Secondary		2 m&c sbk				Not described						
Consistence												
Dry	vh	vh	sh	h		Not described						
Moist	fi	fi	vfr	fr		Not described						
Wet	s/p	s/p	ss/sp	ss/p	s/p	Not described						
pH (paste)	7.8	7.9	7.9	7.9	7.7	7.7	7.7	7.8	7.9	8.1	7.9	8.0
Reaction (10% HCl)	e	e	e	e	e	Not described						
Carbonates	d	d	d	d	d&sf	Not described						
Rock fragments	none	none	none	none	none	Not described						
Roots	1vf,f,m	1vf,f,m	2vf,1f,1m	1vf,f,m	2f,vf	Not described						
Pores	2vf	3vf	2vf	3vf		Not described						
Clay Films	none	none	none	none	none	Not described						
Boundary	cs	cw	gw	gw		Not described						
Saturation %	28.8	26.2	28.8	35.1	42.1	41.0	39.4	38.6	37.8	38.1	34.6	32.3
Soluble cations												
Ca (ppm)	3.0	3.2	5.0	3.7	22.7	30.0	36.4	31.2	22.7	22.8	22.6	23.4
Mg (ppm)	1.4	1.4	2.4	2.1	11.2	14.8	23.7	36.3	108.3	191.6	170.2	129.1
Na (ppm)	0.3	0.3	0.7	0.8	8.3	18.2	37.5	67.0	108.3	146.5	126.5	99.1
SAR	0.2	0.2	0.3	0.5	2.0	3.9	6.8	11.5	13.1	14.2	12.9	11.4
EC (mmhos/cm)	0.7	0.7	0.8	0.6	3.8	5.3	7.8	10.2	14.9	20.2	18.0	14.5
$CaCO_3$								1.6	0.6	0.8	0.08	0.6
Total sulfur (%)								0.24	0.61	0.58	0.52	0.57
Sulfate sulfur (%)								0.15	0.46	0.53	0.43	0.53
Pyritic sulfur (%)								<0.05	<0.05	<0.05	<0.05	<0.05
Organic sulfur (%)								0.09	0.15	0.05	0.09	0.04
Lime requirement (SMP)								0	0	0	0	0

SHARPS SERIES

Sharps soils are moderately deep and well drained. They typically have a very fine sandy loam surface layer about 2 inches thick. The upper subsoil is noncalcareous sandy clay loam about 6 inches thick. The lower subsoil to a depth of 34 inches is calcareous sandy clay loam. Soft shale bedrock occurs at 34 inches. Permeability is moderate and the available water capacity is moderate.

Range of Characteristics: These soils are very similar to the Pulpit series with difference being in the type of underlying bedrock. Bedrock is shale or soft sandstone.

SOIL NAME:	SHARPS very fine sandy loam	Location:	NE1/4, NW1/4, Sec 22, T36N, R18E
Map Unit Symbol:	6A	Elevation:	6720
Stop Number:	12-213	Slope(%):	8
Parent Material:	Eolian material	Aspect:	NW
Vegetation:	Artr, Sihy, Bogr, Orhy, Gusa, Brte		
Classification:	Fine-silty, mixed, mesic Ustollic Haplargids		

Horizon	A	BA	Bt1	Bt2	Btk	2Bk	2Cr
Depth (inches)	0-2	2-5	5-10	10-17	17-24	24-31	31+
Color							
Dry	7.5YR 5/6	5YR 5/8	5YR 5/6	5YR 5/6	5YR 5/6	10YR 6/4	soft
Moist	7.5YR 4/6	5YR 4/4	5YR 4/4	5YR 4/4	5YR 4/6	10YR 5/4	shale
Texture (USDA)	VFSL	VFSL	SCL/VFSL	SCL	SCL	C	
%≥ FS	33	27	32	29	30	17	
% VFS	36	38	39	36	31	19	
% Sand	69	65	71	65	61	36	
% Silt	15	16	9	14	15	23	
% Clay	16	19	20	21	24	41	
Structure							
Primary	1 t pl	1 c pl	2 m sbk	2 m pr	2 m abk/	massive	
Secondary				2 m sbk	massive		
Consistence							
Dry	so	sh	h	vh	vh	h	
Moist	vfr	vfr	vfr	fr	fr	fi	
Wet	so/po	ss/sp	ss/p	ss/p	ss/p	s/p	
pH (paste)	7.3	7.3	7.7	7.9	7.9	8.1	
Reaction (10% HCl)	eo	eo	eo	e	es	ev	
Carbonates	-	-	-	d	d&sf	d&sf,sm	
Rock fragments	none	none	none	none	none	none	
Roots	2vf,f,m	2vf,f,m	2vf,1f,m	1vf,f,m	1vf,f	1vf,m	
Pores	1vf	1vf	1vf	2vf	1vf		
Clay Films	none	none	2 n pf	3 n pf	2 n pf	none	
Boundary	cs	cw	cw	gw	cw	cb	
Saturation %	29.9	30.6	33.0	35.6	35.2	46.6	
Soluble cations							
Ca (ppm)	2.3	2.3	3.3	3.3	2.2	2.2	
Mg (ppm)	1.0	0.8	1.3	1.6	1.5	1.5	
Na (ppm)	0.2	0.1	0.3	0.4	1.0	2.5	
SAR	0.1	0.1	0.2	0.3	0.7	1.8	
EC (mmhos/cm)	0.3	0.3	0.4	0.5	0.4	0.6	

SOIL NAME:	SHARPS loam	Location:	SW1/4, NW1/4, Sec 34, T36N, R19E
Map Unit Symbol:	6A	Elevation:	6850'
Stop Number:	19-48	Slope(%):	2
Parent Material:	Eolian material	Aspect:	N
Vegetation:	Artr, Sihy, Bogr, Orhy, Gusa, Brte		
Classification:	Fine-silty, mixed, mesic Ustollic Haplargids		

Horizon	A	Bt1	Bt2	Btk	2Bt	2Cr
Depth (inches)	0-2	2-6	6-15	15-21	21-27	27+
Color					(crushed)	
Dry	7.5YR 5/4	7.5YR 5/4	7.5YR 5/4	7.5YR 5/4	10YR 6/6	calcareous
Moist	7.5YR 3/4	7.5YR 4/4	7.5YR 3/4	7.5YR 4/4	10YR 5/6	siltstone
Texture (USDA)	L	L	CL	SCL	C	
%≥ FS	9	9	8	19	21	
% VFS	31	26	24	28	15	
% Sand	40	35	32	47	36	
% Silt	42	40	36	24	21	
% Clay	18	25	32	29	43	
Structure						
Primary	1 c pl	1 c pl	2 m sbk	2 m sbk	2 m abk	
Secondary	2 f gr					
Consistence						
Dry	so	h	h	vh	eh	
Moist	vfr	vfr	fr	fr	fi	
Wet	so/sp	s/p	s/p	s/p	s/p	
pH (paste)	7	7.2	7.1	7.8	7.8	
Reaction (10% HCl)	eo	eo	eo	e	es	
Carbonates	-	-	-	d&sm	d	
Rock fragments	none	none	none	none	none	
Roots	2vf,2f	2vf,2f	2vf,2f	2vf,2f,1m	1vf	
Pores	none	1vf	1vf	2vf	1vf	
Clay Films	none	2 n pf	3 n pf	3 n pf	none	
Boundary	cs	cw	gs	gw	cw	
Saturation %	30.1	36.0	37.8	37.3	46.6	
Soluble cations						
Ca (ppm)	2.5	2.6	2.4	2.6	2.1	
Mg (ppm)	1.0	1.0	0.8	1.2	1.3	
Na (ppm)	0.2	0.3	0.3	0.6	1.6	
SAR	0.2	0.2	0.2	0.4	1.2	
EC (mmhos/cm)	0.4	0.3	0.3	0.4	0.5	

SOIL NAME:	SHARPS very fine sandy loam	Location:	SE1/4, NW1/4, Sec. 22, T36N, R18E
Map Unit Symbol:	6A	Elevation:	6680'
Stop Number:	12-54	Slope(%):	3
Parent Material:	Water-reworked eolian material	Aspect:	NW
Vegetation:	Artr, Sihy, Bogr, Orhy, Gusa, Brte		
Classification:	Fine-silty, mixed, mesic Ustollic Haplargids		

Horizon	A	Bt1	Bt2	Btk	Bk	2Cr
Depth (inches)	0-2	2-5	5-11	11-27	27-34	34
Color						
Dry	7.5YR 5/6	7.5YR 5/6	7.5YR 5/6	7.5YR 6/6	7.5YR 6/6	soft calcareous
Moist	7.5YR 4/6	7.5YR 4/4	7.5YR 4/6	7.5YR 5/6	7.5YR 5/6	grey shale
Texture (USDA)	VFSL	SCL	SCL	SCL	SCL	
%≥ FS	24	17	24	20	16	
% VFS	36	33	36	41	35	
% Sand	60	50	60	61	51	
% Silt	27	21	16	15	17	
% Clay	13	29	24	24	32	
Structure						
Primary	1 t pl	2 c pl	2 c sbk	1 c pr	m	
Secondary				1 m sbk		
Consistence						
Dry	s	vh	eh	eh	eh	
Moist	vf	vfr	fr	fr	fr	
Wet	so/po	ss/sp	ss/sp	ss/sp	ss/sp	
pH (paste)	7.2	7.0	7.5	8.2	8.3	
Reaction (10% HCl)	eo	eo	*eo	es	es	
Carbonates	-	-	-	d&fsf,sm	d&fsf,sm	
Rock fragments	none	none	none	none	none	
Roots	2vf,f	2vf,f	2vf,f,1m	1vf,f,m	1vf	
Pores	1vf	1vf	2vf	2vf	2vf	
Clay Films	none	1 n pf	3 n pf	2 n pf	none	
Boundary	cw	cw	gw	gw	cw	
Saturation %	28.8	36.9	38.3	33.3	36.1	
Soluble cations						
Ca (ppm)	2.3	2.3	4.3	1.9	1.2	
Mg (ppm)	1.0	0.8	1.3	1.5	1.4	
Na (ppm)	0.2	0.2	0.3	0.5	1.5	
SAR	0.2	0.1	0.2	0.4	1.3	
EC (mmhos/cm)	0.3	0.3	0.5	0.4	0.4	

Note: * lower 3" is slightly effervescent

SOIL NAME: SHARPS very fine sandy loam
Map Unit Symbol: 6
Stop Number: 6-2
Parent Material: Eolian
Classification: Fine-silty, mixed, mesic Ustollic Haplargids

Horizon	A	Bt	Btk	Bk	Cr
Depth (inches)	0-2	2-5	5-10	10-30	30+
Color					
Dry	5YR 6/4	5YR 5/4	5YR 6/4	5YR 6/4	sandy shale
Moist	5YR 4/4	5YR 4/4	5YR 4/4	5YR 5/4	
Texture (USDA)	L	combined	SL	L	
% VFS	37.0	with Btk	66.7	29.8	
% Sand	47.3	horizon	71.8	39.1	
% Silt	45.6	for	23.8	45.6	
% Clay	7.1	sampling	4.4	15.3	
Structure					
Primary	1 vf sbk	2 m pr	2 m sbk	1 m&f sbk	
Secondary		2 m sbk			
Consistence					
Dry	so	sh	sh	sh	
Moist	vfr	vfr	vfr	vfr	
Wet	so/po	ss/po	ss/po	ss/po	
pH (paste)	7.0		7.1	7.6	
Reaction (10% HCl)	eo	eo	es	es	
Carbonates	-	-	d& sm, sf	d& sm, sf	
Rock fragments	none	none	none	none	
Roots	3f,m,c	3f,m,c	3f,m,c	3f,m	
Clay Films	none	4 n pf	3 n pf	none	
Boundary	cs	cs	gw	gw	
Saturation %	34.1		38.7	42.9	
Soluble cations					
Ca (ppm)	2.98		2.78	2.25	
Mg (ppm)	0.78		0.65	0.53	
Na (ppm)	1.02		0.81	1.04	
SAR	0.74		0.62	0.88	
EC (mmhos)	0.49		0.46	0.38	
$CaCO_3$	1.0		1.1	6.6	
Boron (ppm)	0.5		0.65	0.47	
Selenium (ppm)	<0.02		<0.02	<0.02	
Total Sulfur	0.08		0.10	0.11	
Acid-base	2.50		3.12	3.43	
Neutralization potential	9.77		10.7	66.2	
Acid-base potential	7.27		7.58	62.8	

TRAVESSILLA SERIES

Travessilla soils are shallow and well drained. They typically have a channery fine sandy loam surface layer about 2 inches thick. The substratum to a depth of 7 inches is fine sandy loam. Hard sandstone bedrock occurs at 7 inches. Permeability is moderately rapid and the available water capacity is low.

Range of Characteristics: Depth to bedrock, usually hard sandstone, ranges from 2 to 20 inches. Because of the severe erosion that has occurred on these soils, bedrock is generally within 6 inches. Textures are loam or fine sandy loam with 10 to 18 percent clay. Surficial rock fragments, mainly sandstone channers or flagstones, are quite variable, ranging from 5 to 60 percent.

SOIL NAME:	TRAVESSILLA channery fine sandy loam		
Map Unit Symbol:	7B	Location:	SE1/4, SW1/4, Sec. 27, T35N, R18E
Stop Number:	27-41	Elevation:	6390'
Parent Material:	Sandstone residuum	Slope(%):	7
Vegetation:	Pied, Jumo, Gusa, Orhy, Sihy	Aspect:	SW
Classification:	Loamy, mixed (calcareous), mesic, Lithic Ustic Torriorthents		

Horizon	A	C	R
Depth (inches)	0-2	2-7	7+
Color			
Dry	10YR 5/4	2.5Y 6/4	hard grayish white calcareous sandstone
Moist	10YR 4/4	2.5Y 5/6	
Texture (USDA)	FSL	FSL	
%≥ FS	61	71	
%VFS	15	9	
% Sand	76	80	
% Silt	11	7	
% Clay	13	13	
Structure			
Primary	1 m pl		
Secondary	2 f gr	m	
Consistence			
Dry	so	sh	
Moist	vfr	vfr	
Wet	so/po	so/po	
pH (paste)	8.0	7.7	
Reaction (10% HCl)	e	es	
Carbonates	d	d	
Rock fragments %	18.8	1.8	
Roots	1 vf	1 vf,f	
Pores	none	none	
Clay Films	none	none	
Boundary	cs	as	
Saturation %	29.6	34.8	
Soluble cations			
Ca (ppm)	4.1	4.4	
Mg (ppm)	0.5	1.1	
Na (ppm)	0.1	0.2	
SAR	0.1	0.1	
EC (mmhos/cm)	0.4	0.5	

ZYME SERIES

Zyme soils are shallow and well drained. They typically have a very channery loam surface layer about 1 inch thick. The substratum to a depth of 6 inches is clay. Soft shale bedrock occurs at 6 inches. Permeability is slow and the available water capacity is low.

Range of Characteristics: Depth to bedrock, usually shale, ranges from 2 to 20 inches. Because of the severe erosion that has occurred on these soils, bedrock is generally within 6 inches. Surface textures are variable and range from loam to clay. Surficial rock fragments, mainly sandstone channers or flagstones, are also quite variable, ranging from 5 to 60 percent. The textures of the horizons below the surface layer are clay loam, clay or silty clay with more than 35 percent clay.

SOIL NAME: ZYME very channery loam
Map Unit Symbol: 3C
Stop Number: 12-66
Parent Material: Residuum
Vegetation: Pied, Jumo, Atca, Sihy, Orhy, mustard, Artr
Classification: Clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthents

Location: NE1/4, SW1/4, Sec. 34, T36N, R19E
Elevation: 6840'
Slope(%): 6
Aspect: ESE

Horizon	A1	A2	C	Cr
Depth (inches)	0-1	1-3	3-6	6+
Color			(crushed)	
Dry	10YR 6/4	10YR 6/2	2.5Y 6/2	soft interbedded calcareous
Moist				shale and sandstone
Texture (USDA)	SCL/L	C	C	
%≥ FS	33	20	15	
% VFS	14	8	6	
% Sand	47	28	21	
% Silt	28	28	33	
% Clay	25	44	46	
Structure				
Primary	1 f gr	2 c-vc pr	2 f gr	
Secondary		3 vf gr	m	
Consistence				
Dry	so	vh	vh	
Moist	vfr	fr	fr	
Wet	s/p	s/p	s/p	
pH (paste)	7.9	7.9	7.7	
Reaction (10% HCl)	e	ev	ev	
Carbonates	d	d	d	
Rock fragments %	33	6.6	12.3	
Roots	none	1 vf,f,m	1 vf,f,m	
Pores	2 vf,f (v)	1 vf (i)	none	
Clay Films	none	none	none	
Boundary	aw	cw	cw	
Saturation %	28.5	43.1	48.1	
Soluble cations				
Ca (ppm)	3.8	2.7	3.9	
Mg (ppm)	0.7	0.5	0.9	
Na (ppm)	0.2	0.1	0.1	
SAR	0.1	0.1	0.1	
EC (mmhos/cm)	0.4	0.3	0.4	

SOIL NAME:	ZYME channery silty clay	Location:	SE1/4, SE1/4, Sec. 15, T36N, R18E
Map Unit Symbol:	4D	Elevation:	6720'
Stop Number:	12-261	Slope(%):	26
Parent Material:	Non-calcareous shale	Aspect:	East
Vegetation:	Pied, Jumo		
Classification:	Clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthents		

Horizon	A	Cr
Depth (inches)	0-3	3+
Color		
Dry	5Y 6/1	5Y 6/1
Moist	2.5Y 5/2	non calcareous shale
Texture (USDA)	SiC	SiC
%≥ FS	2	1
% VFS	2	1
% Sand	4	2
% Silt	46	51
% Clay	50	47
Structure		
Primary	2m c pr	
Secondary	3 vf gr	
Consistence		
Dry	h	
Moist	fr	
Wet	s/p	
pH (paste)	7.8	7.9
Reaction (10% HCl)	e	
Carbonates	d	
Rock fragments %	9.1	57.5
Roots	1 vf,f	
Pores	none	
Clay Films	none	
Boundary	cw	
Saturation %	48.2	54.0
Soluble cations		
Ca (ppm)	2.9	1.7
Mg (ppm)	3.3	2.0
Na (ppm)	0.3	0.4
SAR	0.2	0.3
EC (mmhos/cm)	0.7	0.4

intermountain soils

ATTACHMENT 4

ADDITIONAL SOIL ANALYSIS RESULTS FROM THE 1984 MARIAH STUDY

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 9, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth In.	pH	Conductivity mmhos/cm	Saturation %	Soluble Cations Ca meq/l	Mg meq/l	Na meq/l	SAR (1)	CaCO3 %	Very Fine Sand %	Sand %	Silt %	Clay %	Texture
28052	11-67-1	0-3	6.6	0.35	34.9	1.66	0.80	0.90	0.81	0.6	35.8	50.0	39.6	10.4	LOAM
28053	11-37-2	3-12	7.0	0.43	45.1	2.90	0.83	0.72	0.53	1.0	29.6	44.5	39.7	15.8	LOAM
28054	11-67-3	12-22	7.4	0.41	40.8	2.37	1.02	1.20	0.92	1.3	23.3	44.7	36.4	18.9	LOAM
28055	11-67-4	22-29	7.7	0.35	40.0	1.58	0.84	1.42	1.29	1.9	24.5	47.5	34.5	18.0	LOAM
28056	11-67-5	29-46	7.9	0.47	34.5	1.23	0.68	2.91	2.98	4.5	25.9	47.5	35.4	17.1	LOAM
28057	11-67-6	46-75	8.1	0.81	34.9	1.55	0.95	6.51	5.82	5.2	22.8	48.4	39.1	12.5	LOAM
28058	11-67-7	75-93	8.0	1.57	29.9	2.53	2.42	10.1	6.42	2.8	20.6	68.4	20.9	10.7	SANDY LOAM
28037	11-6-1	0-3	6.7	0.53	48.8	3.57	1.83	0.84	0.51	0.5	39.2	53.6	40.0	6.4	SANDY LOAM
28038	11-6-2&3	3-9	7.4	0.46	45.3	2.71	1.35	1.55	1.09	1.2	30.2	42.7	38.2	19.1	LOAM
28039	11-6-4	9-18	7.4	0.41	41.0	2.46	1.41	1.05	0.75	1.4	28.1	41.8	41.8	16.4	LOAM
28040	11-6-5	18-42	7.8	0.42	37.2	1.68	1.72	1.31	1.00	2.1	30.4	45.5	38.1	16.4	LOAM
28041	11-6-6	42-61	8.1	0.47	34.5	0.90	1.05	3.20	3.24	4.8	25.9	54.5	31.0	14.5	SANDY LOAM
28042	11-6-7	61-73	8.1	1.33	30.3	1.32	2.31	9.58	7.11	1.2	14.3	71.8	16.4	11.8	SANDY LOAM
28043	11-6-8	73-83	8.2	2.80	43.0	2.01	5.56	18.9	9.71	2.8	15.6	40.0	39.1	20.9	LOAM
28044	11-6-9	83-97	8.1	3.50	38.5	2.58	9.45	23.8	9.70	6.9	24.8	43.6	40.0	16.4	LOAM

(1) Sodium Adsorption Ratio.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 9, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth In.	Selenium ppm (2)	Boron ppm (2)	Total Sulfur %	Acid-Base (3)	Neutralization Potential (4)	Acid-Base Potential (4)
28052	11-67-1	0-3	-0.02	0.41	0.06	1.87	6.11	4.24
28053	11-37-2	3-12	-0.02	0.57	0.06	1.87	9.85	7.98
28054	11-67-3	12-22	-0.02	0.48	0.01	0.31	12.5	12.2
28055	11-67-4	22-29	-0.02	0.48	0.04	1.25	19.2	18.0
28056	11-67-5	29-46	-0.02	0.67	0.01	0.31	45.4	45.1
28057	11-67-6	46-75	-0.02	0.56	0.01	0.31	52.1	51.8
28058	11-67-7	75-93	-0.02	0.34	0.05	1.56	27.6	26.[illegible]
28037	16-6-1	0-3	-0.02	1.96	0.03	0.94	4.51	3.57
28038	11-6-2&3	3-9	-0.02	0.71	0.04	1.25	11.7	10.5
28039	11-6-4	9-18	-0.02	0.51	0.01	0.31	13.8	13.5
28040	11-6-5	18-42	-0.02	0.49	0.01	0.31	21.1	20.8
28041	11-6-6	42-61	-0.02	0.63	0.04	1.25	48.3	47.1
28042	11-6-7	61-73	-0.02	0.53	0.04	1.25	11.6	10.4
28043	11-6-8	73-83	-0.02	0.54	0.05	1.56	28.2	26.6
28044	11-6-9	83-97	-0.02	0.57	0.06	1.87	69.3	67.4

(2) Hot-water Soluble. (3) Calculated using Total Sulfur analysis. (4) Tons per 1000 Tons Material.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth ft.	pH	Conductivity mmhos/cm	Saturation %	Soluble Cations Ca meq/l	Mg meq/l	Na meq/l	SAR (1)	CaCO3 %	Very Fine Sand %	Sand %	Silt %	Clay %	Texture
28089	13-2DS	10.0-12.0	7.5	1.99	52.0	10.9	5.29	3.90	1.37	2.0	11.9	18.4	47.1	34.5	SILTY CLAY LOAM
28090		12.0-14.0	7.4	2.29	44.6	12.0	5.78	5.04	1.69	2.7	15.2	28.4	44.3	27.3	CLAY LOAM
28091		14.0-16.0	7.4	2.78	35.4	24.8	18.9	2.98	0.64	1.4	20.7	45.6	35.3	19.1	LOAM
28092		16.0-18.0	7.4	3.10	34.4	25.1	18.8	3.04	0.65	1.1	20.6	57.5	26.1	16.4	SANDY LOAM
28093		18.0-20.0	7.6	3.25	29.3	21.7	21.3	4.57	0.99	1.4	16.2	67.5	18.0	14.5	SANDY LOAM
28094		20.0-22.0	7.7	3.56	36.4	22.4	24.7	3.86	0.80	1.4	19.8	46.9	33.1	20.0	LOAM
28095		22.0-22.5	7.5	3.47	31.9	25.0	20.1	3.84	0.81	1.3	15.0	62.0	23.5	14.5	SANDY LOAM
28096	13-4DS	10.0-12.0	7.4	3.07	43.1	19.4	6.35	3.04	0.85	1.7	19.0	29.3	46.2	24.5	LOAM
28097		12.0-14.0	7.4	2.96	40.0	18.0	6.05	3.30	0.95	1.4	16.0	25.6	51.7	22.7	SILT LOAM
28098		14.0-16.0	7.4	2.69	44.3	16.4	5.73	3.18	0.96	2.4	14.9	23.8	46.2	30.0	CLAY LOAM
28099		16.0-18.0	7.4	2.52	38.2	16.3	6.00	3.57	1.07	1.5	18.4	32.9	42.6	24.5	LOAM
28100		18.0-20.0	7.5	2.26	36.2	13.6	5.17	4.13	1.35	1.2	21.5	40.2	38.9	20.9	LOAM
28101		20.0-22.0	7.6	2.24	41.0	12.7	4.70	4.12	1.40	1.3	17.8	29.3	46.2	24.5	LOAM
28102		22.0-24.0	7.6	2.17	42.7	13.4	4.55	5.04	1.68	1.4	17.3	22.0	50.7	27.3	CLAY LOAM
28103		24.0-26.0	7.3	2.22	34.5	13.4	4.51	5.14	1.72	1.0	21.9	52.9	29.8	17.3	SANDY LOAM

(1) Sodium Adsorption Ratio.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth In.	Selenium ppm (2)	Boron ppm (2)	Total Sulfur %	Acid-Base (3)	Neutralization Potential (4)	Acid-Base Potential (4)
28089	13-2DS	10.0-12.0	0.03	1.24	0.05	1.56	20.3	18.7
28090		12.0-14.0	0.04	1.12	0.04	1.25	27.1	25.9
28091		14.0-16.0	0.05	1.16	0.05	1.56	14.2	12.6
28092		16.0-18.0	-0.02	0.35	0.12	3.75	11.2	7.45
28093		18.0-20.0	-0.02	0.01	0.08	2.50	13.6	11.1
28094		20.0-22.0	-0.02	0.01	0.54	16.9	14.3	~~-2.55~~
28095		22.0-22.5	-0.02	0.01	0.54	16.9	13.4	~~-3.45~~
28096	13-4DS	10.0-12.0	0.02	1.50	0.08	2.50	17.0	14.5
28097		12.0-14.0	0.02	0.80	0.07	2.19	14.0	11.8
28098		14.0-16.0	0.02	0.59	0.06	1.87	23.7	21.8
28099		16.0-18.0	0.02	0.50	0.05	1.56	15.1	13.5
28100		18.0-20.0	0.04	0.17	0.05	1.56	12.2	10.6
28101		20.0-22.0	0.03	0.11	0.05	1.56	13.4	11.8
28102		22.0-24.0	0.05	0.02	0.05	1.56	13.7	12.1
28103		24.0-26.0	0.03	0.02	0.04	1.25	10.3	9.05

(2) Hot-water Soluble. (3) Calculated using Total Sulfur analysis. (4) Tons per 1000 Tons Material.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth ft.	pH	Conductivity mmhos/cm	Saturation %	Soluble Cations Ca meq/l	Mg meq/l	Na meq/l	SAR (1)	CaCO3 %	Very Fine Sand %	Sand %	Silt %	Clay %	Texture
28104	13-10DS	10.0-12.0	7.4	3.60	37.8	24.2	6.98	7.93	2.01	0.9	25.4	39.3	36.2	24.5	LOAM
28105	/	12.0-14.0	7.4	[illegible]	48.8	28.9	8.15	8.98	2.09	1.5	11.2	13.8	51.7	34.5	SILTY CLAY LOAM
28106		14.0-15.0	7.4	3.42	40.0	23.3	6.48	8.10	2.10	1.0	17.2	37.5	38.0	24.5	LOAM
28107		15.0-15.5	7.4	3.19	34.4	20.3	5.75	7.57	2.10	0.8	24.7	48.4	28.9	22.7	LOAM
28108	13-11DS	10.0-12.0	7.7	0.76	43.2	3.63	1.56	2.03	1.26	1.7	17.4	27.5	39.8	32.7	CLAY LOAM
28109		12.0-14.0	7.7	0.75	45.3	3.24	1.43	2.24	1.47	1.5	14.3	24.7	40.8	34.5	CLAY LOAM
28110		14.0-16.0	7.7	0.84	43.8	3.13	1.55	3.29	2.15	0.9	17.8	33.8	37.1	29.1	CLAY LOAM
28111		16.0-18.0	7.7	0.79	64.5	2.76	1.51	3.23	2.21	0.9	9.9	12.9	40.7	46.4	SILTY CLAY
28112		18.0-20.0	7.7	0.94	44.4	3.37	1.80	3.82	2.38	0.8	16.1	40.2	30.7	29.1	CLAY LOAM
28113		20.0-22.0	7.7	1.02	47.1	3.65	2.03	4.17	2.47	0.7	15.8	32.9	36.2	30.9	CLAY LOAM

(1) Sodium Adsorption Ratio.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth In.	Selenium ppm (2)	Boron ppm (2)	Total Sulfur %	Acid-Base (3)	Neutralization Potential (4)	Acid-Base Potential (4)
28104	13-10DS	10.0-12.0	0.11	0.01	0.06	1.87	9.29	7.42
28105		12.0-14.0	0.13	0.09	0.07	2.19	15.4	13.2
28106		14.0-15.0	0.08	0.01	0.05	1.56	10.3	8.74
28107		15.0-15.5	0.06	0.01	0.04	1.25	7.75	6.50
28108	13-11DS	10.0-12.0	0.02	0.02	0.04	1.25	16.8	15.6
28109		12.0-14.0	-0.02	1.08	0.01	0.31	15.1	14.8
28110		14.0-16.0	0.02	1.10	0.05	1.56	8.96	7.40
28111		16.0-18.0	0.02	1.05	0.05	1.56	9.21	7.65
28112		18.0-20.0	0.02	0.61	0.04	1.25	8.23	6.98
28113		20.0-22.0	0.03	0.55	0.05	1.56	6.73	5.17

(2) Hot-water Soluble. (3) Calculated using Total Sulfur analysis. (4) Tons per 1000 Tons Material.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth ft.	pH	Conductivity mmhos/cm	Saturation %	Soluble Cations Ca meq/l	Mg meq/l	Na meq/l	SAR (1)	CaCO3 %	Very Fine Sand %	Sand %	Silt %	Clay %	Texture
28114	13-13DS	10.0-12.0	7.9	12.9	33.7	30.1	143.	58.3	6.27	1.2	31.1	48.4	34.3	17.3	LOAM
28115		12.0-14.0	7.9	13.3	39.3	29.2	148.	59.5	6.32	0.9	20.0	41.1	47.1	11.8	LOAM
28116		14.0-16.0	6.7	14.7	48.4	33.5	151.	6.49	0.68	1.4	11.9	23.8	68.9	7.3	SILT LOAM
28117		16.0-18.0	8.2	21.4	37.1	32.8	218.	140.	12.5	1.2	27.5	51.1	44.4	4.5	SANDY LOAM
28118	13-14DS	14.0-16.0	4.0	7.07	36.1	23.2	38.9	28.7	5.15	-0.1	16.1	45.6	34.4	20.0	LOAM
28119		16.0-17.3	8.1	22.1	37.5	32.0	250.	170.	14.3	0.8	15.3	52.0	43.1	4.9	SANDY LOAM
28120	13-15DS	10.0-12.0	8.2	19.2	32.7	3.07	182.	152.	15.8	1.5	16.4	47.5	36.7	15.8	LOAM
28121		12.0-14.0	8.1	15.6	33.1	25.2	125.	124.	14.3	2.1	8.7	58.4	27.6	14.0	SANDY LOAM

(1) Sodium Adsorption Ratio.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth In.	Selenium ppm (2)	Boron ppm (2)	Total Sulfur %	Acid-Base (3)	Neutralization Potential (4)	Acid-Base Potential (4)
28114	13-13DS	10.0-12.0	-0.02	1.08	0.45	14.1	12.3	-1.74
28115		12.0-14.0	-0.02	1.31	0.46	14.4	9.16	-5.19
28116		14.0-16.0	-0.02	2.11	0.68	27.5	14.1	-13.4
28117		16.0-18.7	0.03	1.03	0.74	23.1	11.8	-11.3
28118	13-14DS	14.0-16.0	-0.02	0.66	0.55	17.2	-2.74	-19.9
28119		16.0-17.3	0.03	0.55	1.04	32.5	7.61	-24.9
28120	13-15DS	10.0-12.0	-0.02	0.50	0.48	15.0	15.2	0.21
28121		12.0-14.0	-0.02	0.38	0.41	12.8	21.3	8.50

(2) Hot-water Soluble. (3) Calculated using Total Sulfur analysis. (4) Tons per 1000 Tons Material.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth ft.	pH	Conductivity mmhos/cm	Saturation %	Soluble Cations Ca meq/l	Mg meq/l	Na meq/l	SAR (1)	CaCO3 %	Very Fine Sand %	Sand %	Silt %	Clay %	Texture
28122	13-19DS	10.0-12.0	7.5	0.91	48.1	5.90	1.69	1.14	0.59	2.9	9.3	11.1	57.6	31.3	SILTY CLAY LOAM
28123		12.0-14.0	7.5	0.69	47.2	4.68	1.11	0.82	0.48	2.6	13.1	15.6	61.3	23.1	SILT LOAM
28123		14.0-16.0	7.6	0.98	36.1	6.14	1.36	1.34	0.69	2.7	15.2	36.5	45.9	17.6	LOAM
28124		16.0-18.7	7.6	1.37	40.9	8.91	1.98	2.50	1.07	2.7	16.2	36.5	45.0	18.5	LOAM
28125	15-8DS	11.0-11.7	7.8	1.25	37.1	3.38	0.72	8.38	5.85	1.1	19.4	54.2	32.7	13.1	SANDY LOAM
28126		11.7-12.3	7.9	0.65	31.7	1.8[illegible]	0.76	4.80	4.23	6.0	22.9	41.5	40.9	17.6	LOAM
28127	15-9DSS	10.0-12.0	7.6	2.01	38.8	8.77	2.96	6.57	2.71	2.0	14.7	42.0	34.0	24.0	LOAM
28128		12.0-14.0	7.5	1.98	40.5	9.66	2.57	7.51	3.04	1.8	16.2	52.9	25.8	21.3	SANDY CLAY LOAM
28129		14.0-16.0	7.6	1.72	28.7	7.83	2.02	6.42	2.89	1.8	14.8	70.2	16.7	13.1	SANDY LOAM
28130		16.0-18.0	7.5	2.21	34.8	12.2	3.32	6.16	2.21	1.8	16.5	59.3	21.2	19.5	SANDY LOAM
28131		18.0-20.0	7.4	2.87	35.5	21.5	6.47	6.03	1.61	0.1	17.2	48.4	30.3	21.3	LOAM
28132		20.0-22.0	7.4	2.78	37.6	17.5	6.35	5.13	1.49	2.7	16.8	50.2	31.3	18.5	LOAM

(1) Sodium Adsorption Ratio.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth In.	Selenium ppm (2)	Boron ppm (2)	Total Sulfur %	Acid-Base (3)	Neutralization Potential (4)	Acid-Base Potential (4)
28122	13-19DS	10.0-12.0	-0.02	0.60	0.10	3.12	28.5	25.4
28123		12.0-14.0	-0.02	0.58	0.13	4.06	26.4	22.3
28123		14.0-16.0	-0.02	0.55	0.12	3.75	26.6	22.9
28124		16.0-18.7	0.02	0.54	0.14	4.37	27.4	23.0
28125	15-8DS	11.0-11.7	-0.02	0.19	0.04	1.25	10.9	9.65
28126		11.7-12.3	-0.02	0.16	0.01	0.31	6.02	5.71
28127	15-9DSS	10.0-12.0	0.03	0.37	0.06	1.87	20.1	18.2
28128		12.0-14.0	0.03	0.51	0.07	2.19	18.4	16.2
28129		14.0-16.0	0.02	0.26	0.04	1.25	17.5	16.3
28130		16.0-18.0	0.05	0.87	0.06	1.87	17.8	15.9
28131		18.0-20.0	0.09	0.83	0.05	1.56	9.41	7.85
28132		20.0-22.0	0.10	0.81	0.05	1.56	26.6	25.0

(2) Hot-water Soluble. (3) Calculated using Total Sulfur analysis. (4) Tons per 1000 Tons Material.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth ft.	pH	Conductivity mmhos/cm	Saturation %	Soluble Cations Ca meq/l	Mg meq/l	Na meq/l	SAR (1)	CaCO3 %	Very Fine Sand %	Sand %	Silt %	Clay %	Texture
28133	15-18DS	10.0-12.0	8.3	16.9	37.2	28.7	138.	130.	14.2	1.5	19.7	39.3	53.1	7.6	SILT LOAM
28134		12.0-14.0	8.2	18.8	32.5	24.0	156.	144.	15.2	1.4	17.6	59.3	34.9	5.8	SANDY LOAM
28135		14.0-16.0	8.1	11.6	36.2	23.0	88.7	98.7	13.2	1.6	17.3	52.9	42.2	4.9	SANDY LOAM
28136		16.0-17.0	7.8	7.18	38.8	18.9	39.5	41.6	7.70	2.1	17.9	46.5	48.6	4.9	SANDY LOAM
28137	15-20DS	10.0-12.0	7.8	0.45	31.7	2.59	1.14	1.04	0.76	3.1	24.4	47.5	35.8	16.7	LOAM
28138		12.0-14.0	7.9	0.49	28.0	1.73	1.41	1.38	1.10	1.4	23.0	56.9	30.9	12.2	SANDY LOAM
28139		14.0-15.7	7.8	1.02	27.4	4.45	4.05	2.53	1.23	3.2	22.0	62.4	25.4	12.2	SANDY LOAM
28140	15-22DS	8.0-10.0	7.7	4.26	31.5	12.4	11.7	25.6	7.37	2.2	19.4	62.4	24.5	13.1	SANDY LOAM

(1) Sodium Adsorption Ratio.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth In.	Selenium ppm (2)	Boron ppm (2)	Total Sulfur %	Acid-Base (3)	Neutralization Potential (4)	Acid-Base Potential (4)
28133	15-18DS	10.0-12.0	-0.02	0.87	0.54	16.9	14.6	-2.25
28134		12.0-14.0	-0.02	0.93	0.62	19.4	13.7	-5.65
28135		14.0-16.0	0.02	1.04	1.84	57.5	16.0	-41.4
28136		16.0-17.0	-0.02	0.81	1.00	31.2	21.1	-10.1
28137	15-20DS	10.0-12.0	-0.02	0.55	0.01	0.31	31.2	30.9
28138		12.0-14.0	-0.02	0.59	0.01	0.31	14.4	14.1
28139		14.0-15.7	-0.02	0.66	0.01	0.31	32.0	31.7
28140	15-22DS	8.0-10.0	0.09	0.57	0.09	2.81	22.4	19.6

(2) Hot-water Soluble. (3) Calculated using Total Sulfur analysis. (4) Tons per 1000 Tons Material.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth ft.	pH	Conductivity mmhos/cm	Saturation %	Soluble Cations Ca meq/l	Mg meq/l	Na meq/l	SAR (1)	CaCO3 %	Very Fine Sand %	Sand %	Silt %	Clay %	Texture
28141	15-23DS	10.0-12.0	7.6	1.75	45.1	9.13	2.52	5.51	2.28	2.7	17.5	20.5	51.0	28.5	CLAY LOAM
28142		12.0-14.0	7.7	1.72	34.2	7.25	2.25	7.90	3.62	2.1	20.3	36.0	42.7	21.3	LOAM
28143		14.0-16.0	7.8	1.70	38.8	4.42	1.78	12.5	7.10	1.8	21.2	29.6	44.6	25.8	LOAM
28144		16.0-18.0	8.0	3.78	46.8	7.20	6.44	30.9	11.8	1.6	16.8	29.6	41.9	28.5	CLAY LOAM
28145		18.0-20.0	7.8	3.27	51.2	19.4	36.2	60.2	41.4	1.0	15.6	21.5	50.0	28.5	CLAY LOAM
28146		20.0-22.0	7.8	9.59	58.6	21.5	56.7	68.9	11.0	1.3	17.1	20.5	45.5	34.0	CLAY LOAM
28147	15-25DS	6.0-7.7	7.7	7.12	39.3	19.0	35.1	36.6	7.04	1.3	24.0	45.1	31.8	23.1	LOAM
28148	15-26DS	10.0-11.0	7.7	2.24	34.6	7.14	5.17	5.68	2.29	3.0	21.3	44.2	36.3	19.5	LOAM
28149		11.0-12.0	7.5	3.08	26.2	20.2	13.1	7.70	1.89	4.7	25.6	75.1	14.5	10.4	SANDY LOAM
28150		12.0-13.2	7.7	1.37	48.3	5.15	4.28	5.05	2.33	1.8	14.7	26.0	41.8	32.2	CLAY LOAM

(1) Sodium Adsorption Ratio.

PEABODY COAL COMPANY
FLAGSTAFF, ARIZONA

Analysis by: INTER-MOUNTAIN LABORATORIES

July 10, 1984

Mine: KAYENTA/BLACK MESA

Topsoil Analysis

Lab No.	Sample ID	Depth In.	Selenium ppm (2)	Boron ppm (2)	Total Sulfur %	Acid-Base (3)	Neutralization Potential (4)	Acid-Base Potential (4)
28141	15-23DS	10.0-12.0	0.28	0.92	0.07	2.19	26.6	24.4
28142		12.0-14.0	0.33	0.87	0.05	1.56	21.0	19.4
28143		14.0-16.0	0.31	0.91	0.06	1.87	18.1	16.2
28144		16.0-18.0	0.29	0.90	0.10	3.12	16.2	13.1
28145		18.0-20.0	0.15	1.40	0.30	9.37	10.3	0.93
28146		20.0-22.0	0.13	1.06	0.50	15.6	12.6	-3.00
28147	15-24DS	6.0-7.7	0.16	0.76	0.10	3.1	13.3	10.2
28148	15-26DS	10.0-11.0	0.03	0.82	0.05	1.56	30.2	28.6
28149		11.0-12.0	-0.02	0.68	0.08	2.50	46.9	44.4
28150		12.0-13.2	-0.02	0.76	0.08	2.50	18.4	15.9

(2) Hot-water Soluble. (3) Calculated using Total Sulfur analysis. (4) Tons per 1000 Tons Material.

Inter-Mountain Laboratories, Inc.

1633 Terra Avenue
Sheridan, Wyoming 82801
Tel. (307) 672-8945

1714 Phillips Circle
Gillette, Wyoming 82716
Tel. (307) 682-8945

2-HR CLAY ANALYSIS

Lab. No.	Sample ID	Depth In.	2-Hr. Clay %
28038	11-6-2&3	3-9	19.6
28039	11-6-4	9-18	20.5
28053	11-67-2	3-12	21.5
28054	11-67-3	12-22	22.4
28070	6-2-1	0-2	11.5
28071	6-2-2	2-10	18.7
28072	6-2-3	10-30	17.8

Lab. No.	Sample ID	Depth Ft.	2-Hr. Clay %
28116	13-13DS	14.0-16.0	19.6
28117		16.0-18.7	14.2
28119	13-14DS	16.0-17.3	17.8
28123A	13-19DS	10.0-12.0	33.3
28133	15-18DS	10.0-12.0	23.2
28134		12.0-14.0	16.0
28135		14.0-16.0	10.5
28136		16.0-17.0	16.0

intermountainsoil

ATTACHMENT 5

ADDITIONAL SOIL ANALYSIS RESULTS FROM THE 1979 EH&A STUDY

PEABODY COAL COMPANY
Central Laboratory

MINE - Black Mesa
Core No. -
Date Cored -

Sec. -
Twp. -
Rge. -

*Dry Basis

SOIL SERIES NAME	LITHOLOGY	DEPTH	LAB NO.	PASTE pH	* SAT. %	SATURATED PASTE EXTRACT COND. mmhos/cm	Na meq/l	Ca meq/l	Mg meq/l	K meq/l	SAR	ESP
Begay	RSS-28979-1-A	0-6"	R-9-2320	7.3	40.5	0.4	0.9	3.0	0.5		0.7	-0.2
	RSS-28979-2-C1	6-12"	R-9-2321	7.4	42.5	0.3	0.8	2.9	0.5		0.6	-0.4
	RSS-28979-3-C2	12-38"	R-9-2322	7.7	38.3	0.6	1.1	3.3	1.4		0.7	-0.2
	RSS-28979-4-C3	38-50"	R-9-2323	7.8	34.2	0.8	2.1	3.4	1.5		1.3	0.6
	RSS-28979-5-C4	50-60"	R-9-2324	8.2	34.2	0.8	6.0	0.8	1.1		6.2	7.3
Begay	ISS-28979-6-A1	0-2"	R-9-2325	7.6	42.3	1.1	0.7	5.9	1.7		0.4	-0.7
	ISS-28979-7-C1	2-26"	R-9-2326	7.6	44.4	0.7	1.5	6.2	0.6		0.8	-0.1
	ISS-28979-8-C2	26-52"	R-9-2327	7.0	42.4	6.6	2.4	59.0	9.1		0.4	-0.7
	ISS-28979-9-C3	52-65"	R-9-2328	7.8	36.3	0.4	1.2	3.1	0.8		0.7	-0.2
Begay	ISS-28979-10-A	0-7"	R-9-2329	7.6	38.3	0.4	0.6	2.9	0.5		0.8	-0.1
	ISS-28979-11-C1	7-20"	R-9-2330	7.7	38.3	0.3	0.7	2.1	0.7		0.9	0.1
	ISS-28979-12-C2	20-41"	R-9-2331	7.8	34.2	0.4	0.9	1.7	1.3		0.8	-0.1
	ISS-28979-13-C3	41-54"	R-9-2332	7.9	32.2	0.6	3.5	1.2	1.2		0.9	0.1
	ISS-28979-14-C4	54-60"	R-9-2333	7.9	36.2	1.1	7.4	1.9	1.5		5.7	6.7
Las Lucas	ISS-28979-15-A1	0-10"	R-9-2334	7.4	40.5	0.9	0.7	6.4	1.4		0.5	0.4
	ISS-28979-16-C1	10-22"	R-9-2335	7.8	40.4	0.3	0.7	2.6	0.9		0.8	-0.1
	ISS-28979-17-C2	22-40"	R-9-2336	7.8	38.3	0.5	0.8	3.1	1.2		0.7	-0.2
	ISS-28979-18-C3	40-60"	R-9-2337	7.9	36.2	0.4	1.4	1.5	1.4		0.8	-0.1
Las Lucas	ISS-28979-19-A	0-8"	R-9-2338	7.6	42.6	0.4	0.5	3.8	0.5		0.7	-0.2
	ISS-28979-20-C1	8-19"	R-9-2339	7.6	42.6	0.3	0.6	3.1	0.4		0.8	-0.1
	ISS-28979-21-C2	19-43"	R-9-2340	7.8	40.8	0.4	0.8	3.4	0.5		0.7	-0.2
	ISS-28979-22-C3	43-60"	R-9-2341	7.8	40.8	0.3	0.9	2.4	0.5		0.8	-0.1

Central Laboratory

Mine - Black Mesa
Core No. -
Date Cored -

Sec. -
Twp. -
Rge. -

SOIL SERIES NAME	LAB NO.	* SULFUR %	*Tons of $CaCO_3$ Equivalent per 1000 Tons Material: MAX. REQ. FROM SULFUR	AMOUNT PRESENT BY TIT.	AMOUNT NEEDED FOR NEUT.	AMOUNT OF EXCESS $CaCO_3$	LIME TEST	* Mo ppm	*DTPA Extract: Cd ppm	Cu ppm	Fe ppm	Mn ppm	Ni ppm	Pb ppm	Zn ppm
Begay	R-9-2320	0.02	0.63	14.68		14.05		<1.0		0.8					0.6
	R-9-2321	<0.01	0.31	33.80		33.49		<1.0		0.6					0.3
	R-9-2322	0.02	0.63	40.34		39.71		<1.0		0.5					0.3
	R-9-2323	0.02	0.63	22.40		21.77		<1.0		0.4					0.4
	R-9-2324	0.03	0.94	136.49		135.55		<1.0		0.5					0.6
Begay	R-9-2325	0.04	1.25	22.93		21.68		<1.0		1.0					1.1
	R-9-2326	0.02	0.63	23.32		22.69		<1.0		1.1					0.9
	R-9-2327	0.05	1.56	13.75		12.19		<1.0		0.7					0.8
	R-9-2328	0.05	1.56	13.85		12.29		<1.0		0.6					0.7
Begay	R-9-2329	0.04	1.25	16.89		15.64		<1.0		0.9					0.8
	R-9-2330	0.02	0.63	58.21		57.58		<1.0		0.5					0.5
	R-9-2331	0.05	1.56	37.40		35.84		<1.0		0.5					0.4
	R-9-2332	0.05	1.56	54.01		52.45		<1.0		0.5					0.6
	R-9-2333	0.02	0.63	27.55		26.92		<1.0		0.4					0.4
Las Lucas	R-9-2334	<0.01	0.31	5.43		5.12		<1.0		0.7					0.5
	R-9-2335	0.03	0.94	19.17		18.23		<1.0		0.4					0.6
	R-9-2336	<0.001	0.31	19.38		19.07		<1.0		0.4					0.3
	R-9-2337	0.01	0.31	16.34		16.03		<1.0		0.5					0.3
Las Lucas	R-9-2338	0.03	0.94	33.73		32.79		<1.0		0.8					0.6
	R-9-2339	0.03	0.94	33.56		32.62		<1.0		0.9					0.3
	R-9-2340	0.02	0.63	34.45		33.82		<1.0		0.9					0.4
	R-9-2341	0.02	0.63	46.97		46.34		<1.0		0.9					0.5

PEABODY COAL COMPANY
Central Laboratory

[illegible] - Black Mesa
[illegible] No. -
[illegible] Cored -

Sec. -
Twp. -
Rge. -

A = Sample not preserved in field
B = Total N is NH_4-N plus NO_3-N

SOIL SERIES NAME	[illegible] NO.	* ORGANIC MATTER %	* $NaHCO_3$ P ppm	* NH_4OAc K ppm	*A NH_4-N ppm	*A NO_3-N ppm	*AB Total N ppm	* Se ppm	* B ppm	PARTICLE SIZE Sand %	Silt %	Clay %
Begay	R-9-2320		2.2	317.3	4	0.8		< 0.01	0.5	56.6	23.8	19.6
	R-9-2321		1.2	273.0	5	0.2		< 0.01	0.6	57.6	22.8	19.6
	R-9-2322		< 0.1	285.0	4	0.1		< 0.01	0.7	58.0	23.4	18.6
	R-9-2323		1.1	297.8	< 2	0.1		< 0.01	0.9	60.0	20.4	19.6
	R-9-2324		2.4	236.2	9	0.1		< 0.01	1.0	54.0	23.4	22.6
Begay	R-9-2325		11.5	744.9	3	9.3		< 0.01	1.1	47.6	33.8	18.6
	R-9-2326		2.0	219.4	< 2	1.3		< 0.01	1.0	66.6	15.8	17.6
	R-9-2327		0.9	140.3	< 2	252.1		< 0.01	0.8	59.6	22.8	17.6
	R-9-2328		0.9	100.8	3	1.1		< 0.01	0.6	61.6	24.8	13.6
Begay	R-9-2329		5.4	267.6	3	0.5		< 0.01	0.8	55.6	28.8	15.6
	R-9-2330		1.5	153.4	< 2	0.2		< 0.01	0.8	58.0	24.4	17.6
	R-9-2331		0.8	157.6	3	0.2		< 0.01	0.6	63.0	22.8	14.2
	R-9-2332		0.8	135.8	< 2	0.1		< 0.01	0.9	64.4	21.4	14.2
	R-9-2333		2.0	144.4	< 2	0.2		< 0.01	1.1	69.0	14.8	16.2
Las Lucas	R-9-2334		6.3	400.4	2	0.6		< 0.01	1.0	66.0	18.8	15.2
	R-9-2335		< 0.1	179.9	< 2	0.2		< 0.01	0.7	66.0	15.4	18.6
	R-9-2336		0.1	148.8	< 2	0.2		< 0.01	0.8	65.8	3.8	30.4
	R-9-2337		< 0.1	148.7	4	0.2		< 0.01	0.7	70.6	9.0	20.4
Las Lucas	R-9-2338		4.2	246.9	2	0.7		< 0.01	1.1	44.6	41.0	14.4
	R-9-2339		0.9	207.1	2	0.5		< 0.01	0.8	40.6	47.0	12.4
	-9-2340		1.1	159.7	2	0.5		< 0.01	0.7	49.6	30.0	20.4
	-9-2341		0.4	168.7	< 2	0.6		< 0.01	0.6	59.6	19.0	21.4

PEABODY COAL COMPANY
Central Laboratory

MINE - Black Mesa
Core No. -
Date Cored -

Sec. -
Twp. -
Rge. -

*Dry Basis

SOIL SERIES NAME	LITHOLOGY	DEPTH	LAB NO.	PASTE pH	* SAT. %	SATURATED PASTE EXTRACT COND. mmhos/cm	Na meq/l	Ca meq/l	Mg meq/l	K meq/l	SAR	ESP
Las Lucas	RSS 29879-1 A1	0-8"	R-9-2540	7.4	40.9	0.4	1.0	2.3	0.6		0.8	-0.1
	RSS 29879-2 C1	8-24" 16	R-9-2541	7.8	40.7	0.4	2.4	1.6	0.5		2.3	2.1
	RSS 29879-3 C2	24-36" 8	R-9-2542	8.0	34.3	0.4	1.2	2.7	0.9		0.9	0.1
	RSS 29879-4 C3	36-46" 10	R-9-2543	8.1	36.2	0.3	0.9	2.1	0.9		0.7	-0.2
	RSS 29879-5 C4	46-60" 14	R-9-2544	8.0	32.2	0.3	0.7	2.0	0.8		0.6	-0.4
Las Lucas	ISS 29879-6 A1	0-10"	R-9-2545	7.3	38.7	0.3	0.5	2.3	0.7		0.4	-0.7
	ISS 29879-7 C1	10-30" 20	R-9-2546	7.7	42.6	0.5	1.0	3.8	1.0		0.6	-0.4
	ISS 29879-8 C2	30-40" 10	R-9-2547	7.9	40.4	0.4	1.4	2.0	1.3		1.1	0.3
	ISS 29879-9 C3	40-50" 10	R-9-2548	8.1	38.3	0.5	3.7	1.0	0.7		4.0	4.4
	ISS 29879-10 C4	50-60" 10	R-9-2549	8.0	36.3	0.4	2.7	1.0	0.8		2.8	2.8
Cahona	RSS 29879-11 A1	0-9"	R-9-2550	7.4	41.2	0.4	0.4	1.9	0.6		0.4	-0.7

Central Laboratory

Mine : Black Mesa Sec. -
Core No. - Twp. -
Date Cored - Rge. -

SOIL SERIES NAME	LAB NO.	* SULFUR %	*Tons of $CaCO_3$ Equivalent per 1000 Tons Material: MAX. REQ. FROM SULFUR	AMOUNT PRESENT BY TIT.	AMOUNT NEEDED FOR NEUT.	AMOUNT OF EXCESS $CaCO_3$	LIME TEST	* Mo ppm	*DTPA Extract: Cd ppm	Cu ppm	Fe ppm	Mn ppm	Ni ppm	Pb ppm	Zn ppm
Las Lucas	8-9-2540	< 0.01	0.31	8.76		8.45		<1.0		0.9					0.4
	8-9-2541	0.02	0.63	44.38		43.75		<1.0		0.9					0.3
	8-9-2542	< 0.01	0.31	50.50		50.19		<1.0		0.5					0.3
	8-9-2543	< 0.01	0.31	24.30		23.99		<1.0		0.5					0.4
	8-9-2544	< 0.01	0.31	9.26		8.95		<1.0		0.6					0.3
Las Lucas	8-9-2545	0.02	0.63	25.07		24.44		<1.0		0.9					0.3
	8-9-2546	< 0.01	0.31	26.33		26.02		<1.0		0.7					0.4
	8-9-2547	< 0.01	0.31	25.42		25.11		<1.0		0.7					0.4
	8-9-2548	< 0.01	0.31	12.36		12.05		<1.0		0.6					0.2
	8-9-2549	< 0.01	0.31	15.91		15.60		<1.0		0.5					0.2
Cahona	8-9-2550	< 0.01	0.31	8.97		8.66		<1.0		1.0					0.4

Central Laboratory

Field - Sec. -
Core No - Twp. -
Date Cored - Rge. -

A = Sample not preserved in field
B = Total N is NH_4-N plus NO_3-N

SOIL SERIES NAME	Lab NO.	* ORGANIC MATTER %	* $NaHCO_3$ P ppm	* NH_4OAc K ppm	*A NH_4-N ppm	*A NO_3-N ppm	*AB Total N ppm	* Se ppm	* B ppm	PARTICLE SIZE Sand %	Silt %	Clay %
Las Lucas	-9-2540		8.8	424.2	< 2	4.7		< 0.01	0.1	50.8	31.6	17.6
	-9-2541		4.0	337.5	< 2	0.1		< 0.01	0.3	46.2	26.2	27.6
	-9-2542		4.5	100.4	< 2	< 0.1		< 0.01	0.4	74.4	12.4	13.2
	-9-2543		6.0	91.9	< 2	< 0.1		< 0.01	0.5	76.8	11.6	11.6
	-9-2544		3.5	83.5	< 2	< 0.1		< 0.01	0.5	78.4	10.0	11.6
Las Lucas	-9-2545		9.4	270.5	< 2	3.2		< 0.01	0.5	58.4	22.0	19.6
	-9-2546		2.3	159.9	< 2	0.1		< 0.01	0.6	53.8	25.6	20.6
	-9-2547		2.1	129.9	< 2	< 0.1		< 0.01	0.8	54.8	28.0	17.2
	-9-2548		2.8	113.0	< 2	0.2		< 0.01	1.1	60.2	25.6	14.2
	-9-2549		2.4	125.7	< 2	< 0.1		< 0.01	0.8	56.2	28.6	15.2
Cahona	-9-2550		10.0	363.0	< 2	3.4		< 0.01	0.2	52.7	26.1	21.2

PEABODY COAL COMPANY
Central Laboratory

MINE - Black Mesa Sec. -
Core No. - Twp. -
Date Cored - Rge. -

*Dry Basis

SOIL SERIES NAME	LITHOLOGY	DEPTH	LAB NO.	PASTE pH	* SAT. %	SATURATED PASTE EXTRACT COND. mmhos/cm	Na meq/l	Ca meq/l	Mg meq/l	K meq/l	SAR	ESP
	RSS 29879-12 C1	9-20"	R-9-2551	8.0	38.4	0.4	0.9	2.6	0.8		0.7	-0.2
	RSS 29879-13 C2	20-32"	R-9-2552	8.1	36.3	0.4	1.2	2.1	1.0		1.0	0.2
	RSS 29879-14 C3	32-60"	R-9-2553	8.3	48.5	0.9	5.2	1.6	1.4		4.2	4.7
Zyme	RSS 29879-15 Ac	0-6"	R-9-2554	8.0	47.4	0.4	1.1	3.0	0.6		0.7	-0.2
	RSS 29879-16 C1	6-11"	R-9-2555	7.8	53.2	0.7	1.0	4.2	0.9		0.7	-0.2
	RSS 29879-17 C2	11-15"	R-9-2556	8.0	53.0	1.2	1.1	8.2	1.3		0.5	-0.5
Dulce	RSS 29879-18 A1	0-2"	R-9-2557	7.5	40.6	0.4	0.8	2.5	0.5		0.7	-0.2
	RSS 29879-19 B2	2-9"	R-9-2558	7.3	47.5	0.9	1.2	6.0	0.6		0.7	-0.2
	RSS 29879-20 C	9-12"	R-9-2559	7.4	45.1	0.3	0.6	2.4	0.2		0.5	-0.5
Cahona	RSS 29979-1 A1	0-7"	R-9-2560	7.8	40.7	0.6	1.2	3.5	0.9		0.8	-0.1
	RSS 29979-2 B2	7-24"	R-9-2561	7.9	42.6	0.6	1.5	3.2	1.3		1.0	0.2
	RSS 29979-3 C1ca	24-45"	R-9-2562	8.0	56.8	4.5	17.5	11.9	16.2		4.7	5.4
	RSS 29979-4 C2ca	45-60"	R-9-2563	8.1	44.5	5.8	25.9	11.8	30.9		5.6	6.5
Zyme	RSS 29979-5 Ac	0-5"	R-9-2564	NO SAMPLE								
	RSS 29979-6 C	5-8"	R-9-2565	NO SAMPLE								
Cahona	RSS 29979-7 A1	0-10"	R-9-2566	7.5	43.0	0.5	0.6	3.1	1.1		0.4	-0.7
	RSS 29979-8 B2	10-22"	R-9-2567	8.2	38.4	0.9	0.9	6.3	1.3		0.5	-0.5
	RSS 29979-9 C1	22-35"	R-9-2568	8.3	35.3	0.6	1.6	3.1	1.1		1.1	0.3

Central Laboratory

Mine - Black Mesa Sec. -
Core No. - Twp. -
Date Cored - Rge. -

SOIL SERIES NAME	LAB NO.	* SULFUR %	*Tons of $CaCO_3$ Equivalent per 1000 Tons Material: MAX. REQ. FROM SULFUR	AMOUNT PRESENT BY TIT.	AMOUNT NEEDED FOR NEUT.	AMOUNT OF EXCESS $CaCO_3$	LIME TEST	* Mo ppm	*DTPA Extract: Cd ppm	Cu ppm	Fe ppm	Mn ppm	Ni ppm	Pb ppm	Zn ppm
	R-9-2551	< 0.01	0.31	27.41		27.10		< 1.0		1.5					0.3
	R-9-2552	< 0.01	0.31	22.56		22.25		< 1.0		0.9					0.3
	R-9-2553	< 0.01	0.31	216.08		215.77		< 1.0		1.5					0.4
Zyme	R-9-2554	0.06	1.88	29.88		28.00		< 1.0		4.9					0.5
	R-9-2555	< 0.01	0.31	15.09		14.78		< 1.0		4.8					1.3
	R-9-2556	< 0.01	0.31	11.67		11.36		< 1.0		8.8					0.8
Dulce	R-9-2557	0.02	0.63	10.20		9.57		< 1.0		1.4					1.1
	R-9-2558	< 0.01	0.31	9.89		9.58		< 1.0		1.2					0.2
	R-9-2559	< 0.01	0.31	15.99		15.68		< 1.0		1.2					0.7
Cahona	R-9-2560	< 0.01	0.31	9.89		9.58		< 1.0		2.1					0.8
	R-9-2561	< 0.01	0.31	29.51		29.20		< 1.0		2.3					0.5
	R-9-2562	0.06	1.88	200.65		198.77		< 1.0		1.7					0.7
	R-9-2563	0.02	0.63	76.24		75.61		< 1.0		1.3					0.6
Zyme	R-9-2564	NO SAMPLE													
	R-9-2565	NO SAMPLE													
Cahona	R-9-2566	< 0.01	0.31	7.98		7.67		< 1.0		1.3					0.7
	R-9-2567	< 0.01	0.31	22.88		22.57		< 1.0		0.9					0.4

Central Laboratory

MINE -
Core No. -
Date Cored -

Sec. -
Twp. -
Rge. -

A = Sample not preserved in field
B = Total N is NH_4-N plus NO_3-N

SOIL SERIES NAME	LAB NO.	* ORGANIC MATTER %	* $NaHCO_3$ P ppm	* NH_4OAc K ppm	*A NH_4-N ppm	*A NO_3-N ppm	*AB Total N ppm	* Se ppm	* B ppm	PARTICLE SIZE Sand %	Silt %	Clay %
	R-9-2551		1.4	159.8	< 2	1.0		0.01	0.2	59.2	20.6	20.2
	R-9-2552		1.2	126.8	< 2	0.8		0.01	< 0.1	68.2	12.6	19.2
	R-9-2553		3.4	124.0	< 2	2.5		0.01	0.8	31.2	29.6	39.2
Zyme	R-9-2554		2.4	113.1	< 2	6.8		0.01	< 0.1	16.2	45.6	38.2
	R-9-2555		1.0	141.9	< 2	2.5		0.01	< 0.1	8.2	50.6	41.2
	R-9-2556		0.8	125.0	< 2	0.9		0.01	< 0.1	14.2	48.6	37.2
Dulce	R-9-2557		6.8	219.5	< 2	7.6		0.01	< 0.1	55.0	27.8	17.2
	R-9-2558		1.4	123.4	< 2	2.0		0.01	< 0.1	53.6	22.2	24.2
	R-9-2559		1.6	128.8	< 2	1.2		0.01	< 0.1	55.6	25.2	19.2
Cahona	R-9-2560		9.7	367.6	< 2	15.2		0.01	0.5	43.6	37.2	19.2
	R-9-2561		1.5	281.1	< 2	0.9		0.01	< 0.1	49.6	26.2	24.2
	R-9-2562		2.5	157.0	< 2	1.0		0.01	0.5	29.6	27.2	43.2
	R-9-2563		3.3	123.9	< 2	0.8		0.01	1.4	51.0	23.8	25.2
Zyme	R-9-2564		NO SAMPLE									
	R-9-2565		NO SAMPLE									
Cahona	R-9-2566		8.4	310.5	< 2	17.8		0.01	0.2	65.6	19.2	15.2
	R-9-2567		0.8	123.8	< 2	0.8		0.01	0.1	51.2	31.6	17.2

PEABODY COAL COMPANY
Central Laboratory

MINE - Black Mesa
Core No. -
Date Cored -

Sec. -
Twp. -
Rge. -

*Dry Basis

SOIL SERIES NAME	LITHOLOGY	DEPTH	LAB NO.	PASTE pH	* SAT. %	SATURATED PASTE EXTRACT COND. mmhos/cm	Na meq/l	Ca meq/l	Mg meq/l	K meq/l	SAR	ESP
	ISS 29979-10 C2ca	35-46"	R-9-2569	8.3	38.4	0.9	5.5	1.4	1.4		4.7	5.4
Cahona	ISS 29979-11 A1	0-10"	R-9-2570	7.6	37.0	0.5	1.2	2.4	1.1		0.9	0.1
	ISS 29979-12 B1	10-17"	R-9-2571	7.6	33.4	0.4	1.1	1.9	0.8		0.9	0.1
	ISS 29979-13 B2t	17-30"	R-9-2572	8.1	45.0	0.5	2.3	1.1	1.0		2.2	1.9
	ISS 29979-14 Cca	30-40"	R-9-2573	8.0	59.1	5.1	16.7	2.2	29.0		4.3	4.8
Cahona	RSS 29979-15 A1	0-10"	R-9-2574	7.6	43.1	0.5	0.5	3.6	0.6		0.3	-0.8
	RSS 29979-16 B12	10-26"	R-9-2575	7.9	42.8	0.3	0.9	2.2	0.6		1.1	0.3
	RSS 29979-17 B22	26-39"	R-9-2576	8.0	42.8	0.9	1.3	6.1	1.1		0.7	-0.2
	RSS 29979-18 Cca	39-60"	R-9-2577	8.2	44.7	0.5	1.5	1.4	1.1		1.3	0.6
Zyme	ISS 30079-1 Ac	0-5"	R-9-2578	7.9	45.5	0.4	1.0	3.2	0.4		0.7	-0.2
	ISS 30079-2 C	5-8"	R-9-2579	7.8	53.7	0.4	1.4	3.1	0.4		1.1	0.3
Dulce	ISS 30079-3 A1	0-1"	R-9-2580	8.1	36.3	1.3	0.7	10.2	0.9		0.3	-0.8
	ISS 30079-4 B2	1-7"	R-9-2581	8.1	38.6	2.3	0.9	4.4	0.2		0.6	-0.4
	ISS 30079-5 C	7-12"	R-9-2582	8.1	48.8	0.3	0.5	2.9	0.1		0.4	-0.7
Dulce	ISS 30079-6 A1	0-2"	R-9-2583	7.6	42.8	0.6	0.5	4.4	1.0		0.3	-0.8
	ISS 30079-7 B	2-9"	R-9-2584	7.6	45.7	0.3	0.8	1.9	0.4		0.7	-0.2
	ISS 30079-8 C	9-14"	R-9-2585	7.4	36.8	0.3	0.7	1.4	0.3		0.8	-0.1
Zyme	ISS 30079-9 Ac	0-8"	R-9-2586	8.1	55.0	1.1	1.2	4.9	3.2		0.6	-0.4
	ISS 30079-10 C1	8-13"	R-9-2587	8.0	52.6	2.5	8.2	8.6	9.2		2.8	2.8
	ISS 30079-11 C2	13-16"	R-9-2588	8.0	63.5	3.3	11.9	13.0	15.1		3.2	3.4

PEABODY COAL COMPANY
Central Laboratory

Mine - Black Mesa Sec. -
Core No. - Twp. -
Date Cored - Rge. -

SOIL SERIES NAME	LAB NO.	* SULFUR %	*Tons of $CaCO_3$ Equivalent per 1000 Tons Material: MAX. REQ. FROM SULFUR	AMOUNT PRESENT BY TIT.	AMOUNT NEEDED FOR NEUT.	AMOUNT OF EXCESS $CaCO_3$	LIME TEST	* Mo ppm	*DTPA Extract: Cd ppm	Cu ppm	Fe ppm	Mn ppm	Ni ppm	Pb ppm	Zn ppm
	-9-2568	< 0.01	0.31	18.20		17.89		< 1.0		0.7					0.4
Cahona	-9-2569	< 0.01	0.31	74.27		73.96		< 1.0		0.8					0.6
	-9-2570	< 0.01	0.31	6.27		5.96		< 1.0		1.7					0.5
	-9-2571	< 0.01	0.31	4.83		4.52		< 1.0		2.6					1.2
	-9-2572	< 0.01	0.31	33.48		33.17		< 1.0		1.4					0.5
	-9-2573	0.09	2.81	164.45		161.64		< 1.0		1.2					0.4
Cahona	-9-2574	0.02	0.63	10.62		9.99		< 1.0		1.4					1.0
	-9-2575	< 0.01	0.31	25.83		25.52		< 1.0		1.2					0.7
	-9-2576	< 0.01	0.31	20.46		20.15		< 1.0		1.1					1.2
	-9-2577	0.03	0.94	96.31		95.37		< 1.0		1.4					0.6
Zyme	-9-2578	0.37	11.56	36.18		24.62		< 1.0		1.2					0.8
	-9-2579	0.55	17.19	24.64		17.45		< 1.0		1.5					0.7
Dulce	-9-2580	< 0.01	0.31	221.14		220.83		< 1.0		0.9					1.0
	-9-2581	< 0.01	0.31	216.95		216.64		< 1.0		1.0					0.6
	-9-2582	< 0.01	0.31	128.27		127.96		< 1.0		1.3					0.6
Dulce	-9-2583	0.03	0.94	8.43		7.49		< 1.0		0.9					1.2
	-9-2584	0.05	1.56	7.64		6.08		< 1.0		0.6					0.7
	-9-2585	0.11	3.44	5.17		1.73		< 1.0		1.6					1.2
Zyme	-9-2586	0.12	3.75	27.94		24.19		< 1.0		2.5					1.1
	-9-2587	0.12	3.75	11.65		7.90		< 1.0		3.6					1.0
	-9-2588	0.69	21.56	14.27	7.29			< 1.0		3.5					1.5

Hansen Core Company
Central Laboratory

SITE - Black Mesa Sec. -
Core No. - Twp. -
Date Cored - Rge. -

A = Sample not preserved in field
B = Total N is NH_4-N plus NO_3-N

SOIL SERIES NAME	LAB NO.	* ORGANIC MATTER %	* $NaHCO_3$ P ppm	* NH_4OAc K ppm	*A NH_4-N ppm	*A NO_3-N ppm	*AB Total N ppm	* Se ppm	* B ppm	PARTICLE SIZE Sand %	Silt %	Clay %
	-9-2568		3.0	97.6	< 2	0.4		< 0.01	< 0.1	69.6	19.2	11.2
Cahona	-9-2569		2.9	120.7	< 2	0.6		< 0.01	0.3	56.6	20.2	23.2
	-9-2570		3.8	139.4	< 2	5.8		< 0.01	< 0.1	53.2	25.6	21.2
	-9-2571		1.2	107.9	< 2	0.9		< 0.01	< 0.1	60.8	20.6	18.6
	-9-2572		2.7	148.6	< 2	0.5		< 0.01	< 0.1	40.8	23.6	35.6
	-9-2573		2.3	87.1	< 2	1.0		< 0.01	0.4	28.3	32.6	39.[illegible]
Cahona	-9-2574		5.4	162.7	< 2	7.0		< 0.01	< 0.1	48.8	34.6	16.6
	-9-2575		1.8	120.1	< 2	0.2		< 0.01	< 0.1	49.8	28.6	21.6
	-9-2576		1.2	115.9	< 2	0.1		< 0.01	< 0.1	55.8	22.6	21.6
	-9-2577		1.4	123.8	< 2	0.1		< 0.01	0.2	45.8	24.6	29.6
Zyme	-9-2578		2.9	193.3	< 2	1.8		< 0.01	0.1	42.2	27.2	30.6
	-9-2579		0.4	138.5	< 2	0.4		< 0.01	0.1	33.8	24.6	41.6
Dulce	-9-2580		5.6	98.5	< 2	1.4		< 0.01	< 0.1	28.7	57.7	13.6
	-9-2581		2.8	107.3	< 2	0.5		< 0.01	< 0.1	54.4	28.0	17.6
	-9-2582		1.6	49.6	< 2	0.4		< 0.01	< 0.1	55.4	27.0	17.6
Dulce	-9-2583		4.4	173.8	< 2	16.1		< 0.01	< 0.1	54.4	36.0	9.6
	-9-2584		1.5	109.8	< 2	1.8		< 0.01	0.2	49.4	31.0	19.6
	-9-2585		0.6	45.7	6	0.7		< 0.01	0.3	48.4	40.0	11.6
Zyme	-9-2586		1.7	368.5	< 2	4.4		< 0.01	1.7	16.8	51.2	32.0
	-9-2587		0.9	168.5	< 2	0.4		< 0.01	0.8	23.4	49.0	27.6
	-9-2588		1.2	174.8	< 2	0.5		< 0.01	0.2	9.9	49.1	41.[illegible]

Central Laboratory

Mine - Black Mesa
Core No.
Date Cored -

Sec. -
Twp. -
Rge. -

SOIL SERIES NAME	LAB NO.	* SULFUR %	*Tons of $CaCO_3$ Equivalent per 1000 Tons Material: MAX. REQ. FROM SULFUR	AMOUNT PRESENT BY TIT.	AMOUNT NEEDED FOR NEUT.	AMOUNT OF EXCESS $CaCO_3$	LIME TEST	* Mo ppm	*DTPA Extract: Cd ppm	Cu ppm	Fe ppm	Mn ppm	Ni ppm	Pb ppm	Zn ppm
Begay	-9-2589	0.04	1.25	13.02		11.77		< 1.0		1.1					1.3
	-9-2590	0.04	1.25	13.76		12.51		< 1.0		1.2					1.1
	-9-2591	0.05	1.56	24.13		22.57		< 1.0		1.0					1.0
	-9-2592	0.02	0.63	10.29		9.66		< 1.0		1.2					0.9
	-9-2593	0.01	0.31	18.67		18.36		< 1.0		1.0					0.8
Zyme	-9-2594	0.15	4.69	18.00		13.31		< 1.0		1.7					0.8
	-9-2595	0.11	3.44	17.98		14.54		< 1.0		1.9					0.7
	-9-2596	0.14	4.38	21.94		17.56		< 1.0		7.3					0.7
	-9-2597	0.12	3.75	14.40		13.65		< 1.0		2.4					0.5
	-9-2598	0.02	0.63	32.52		31.89		< 1.0		0.7					0.4
	-9-2599	< 0.01	0.31	55.89		55.58		< 1.0		0.9					0.6
	-9-2600	< 0.01	0.31	45.36		45.05		< 1.0		0.9					0.6
	-9-2601	0.03	0.94	25.97		25.03		< 1.0		4.4					2.7
	-9-2602	< 0.01	0.31	13.10		12.79		< 1.0		2.4					1.9
	-9-2603	0.01	0.31	16.73		16.42		< 1.0		2.9					1.5

PEABODY COAL COMPANY
Central Laboratory

MINE - Black Mesa
Core No. -
Date Cored -

Sec. -
Twp. -
Rge. -

A = Sample not preserved in field
B = Total N is NH_4-N plus NO_3-N

SOIL SERIES NAME	LAB NO.	* ORGANIC MATTER %	* $NaHCO_3$ P ppm	* NH_4OAc K ppm	*A NH_4-N ppm	*A NO_3-N ppm	*AB Total N ppm	* Se ppm	* B ppm	PARTICLE SIZE Sand %	Silt %	Clay %
Begay	-9-2589		1.7	208.6	< 2	3.8		< 0.01	0.6	73.4	17.0	9.6
	-9-2590		3.5	94.1	< 2	1.6		< 0.01	0.5	76.8	14.6	8.6
	-9-2591		1.5	77.8	< 2	3.2		< 0.01	0.5	69.8	19.6	10.6
	-9-2592		1.4	98.1	< 2	3.5		< 0.01	0.3	70.4	21.0	8.6
	-9-2593		2.7	53.1	< 2	2.0		< 0.01	0.2	76.4	16.0	7.6
Zyme	-9-2594		2.6	127.8	< 2	1.5		< 0.01	0.4	37.4	39.0	23.6
	-9-2595		1.9	103.3	< 2	0.3		< 0.01	0.3	35.4	37.0	27.6
	-9-2596		1.6	209.5	< 2	0.5		< 0.01	0.5	14.4	44.0	41.6
	-9-2597		2.7	168.8	< 2	0.3		0.01	0.7	33.2	52.2	14.6
	-9-2598		4.1	102.9	< 2	1.5		0.01	0.6	55.2	27.2	17.6
	-9-2599		2.5	107.2	< 2	2.8		< 0.01	0.4	51.8	28.6	19.6
	-9-2600		4.3	135.6	2	1.1		0.01	0.4	54.8	11.6	33.6
	-9-2601		3.3	145.6	< 2	1.4		0.01	0.4	38.8	29.6	31.6
	-9-2602		2.8	133.3	< 2	1.0		0.01	0.2	21.0	24.5	54.5
	-9-2603		2.4	197.4	< 2	0.4		0.01	0.5	7.7	39.0	53.3

PEABODY COAL COMPANY
Central Laboratory

MINE - Black Mesa
Core No. -
Date Cored -

Sec. -
Twp. -
Rge. -

*Dry Basis

SOIL SERIES NAME	LITHOLOGY	DEPTH	LAB NO.	PASTE pH	* SAT. %	SATURATED PASTE EXTRACT COND. mmhos/cm	Na meq/l	Ca meq/l	Mg meq/l	K meq/l	SAR	ESP
Begay	ISS 30079-12 A1	0-10"	R-9-2589	8.0	32.2	0.7	0.9	2.7	0.5		0.7	-0.2
	ISS 30079-13 C1	10-22"	R-9-2590	8.0	32.2	3.6	1.1	28.3	2.0		0.3	-0.8
	ISS 30079-14 C2	22-33"	R-9-2591	7.9	34.3	0.5	0.9	3.2	0.6		0.7	-0.2
	ISS 30079-15 C3	33-43"	R-9-2592	8.0	34.2	0.5	1.0	3.4	0.6		0.7	-0.2
	ISS 30079-16 C4	43-60"	R-9-2593	8.2	32.2	0.4	0.8	2.2	0.5		0.7	-0.2
Zyme	ISS 30079-17 A1	0-3"	R-9-2594	7.9	42.6	0.9	0.7	6.9	0.6		0.4	-0.7
	ISS 30079-18 Ac	3-9"	R-9-2595	7.8	42.7	0.5	1.3	3.2	0.5		1.0	0.2
	ISS 30079-19 C1	9-19"	R-9-2596	7.8	53.6	0.4	1.3	2.4	0.5		1.1	0.3
	ISS 30079-20 C2	19-23"	R-9-2597	7.6	48.6	0.7	3.8	2.5	0.8		3.0	3.1
	SSS 29079-25	0-20"	R-9-2598	7.6	42.5	0.6	2.4	2.5	1.2		1.8	1.4
	SSS 29079-26	20-40"	R-9-2599	7.5	44.6	0.6	1.4	3.7	1.2		0.9	0.1
	SSS 29079-27	40-60"	R-9-2600	7.3	42.5	0.5	0.9	3.8	1.2		0.6	-0.4
	RSS 35379-1	0-7"	R-9-2601	7.6	53.2	0.3	0.7	2.2	0.5		0.6	-0.4
	RSS 35379-2	7-11"	R-9-2602	7.8	59.4	0.3	0.8	1.8	0.7		0.7	-0.2
	RSS 35379-3	11-17"	R-9-2603	8.0	73.3	0.3	1.3	1.0	1.1		1.3	0.6

intermountainsoils

ATTACHMENT 6

SCS FORM 5 FOR SOIL SERIES

OF THE BLACK MESA LEASE AREA

S O I L I N T E R P R E T A T I O N S R E C O R D

MLRA(S): 35, 34 — BEGAY SERIES

REV. AJE,RLM, 1-84

USTOLLIC CAMBORTHIDS, COARSE-LOAMY, MIXED, MESIC

BEGAY SERIES ARE VERY DEEP, WELL DRAINED SOILS FORMED IN EOLIAN DEPOSITS ON ROLLING PLANDS AND BROAD MESAS UNDER GRAMA, GALLETA AND SHADSCALE. MAAT IS 45 TO 53F. AAP IS 8 TO 14 INCHES. FFP IS 110 TO 120 DAYS. A PROFILE HAS A YELLOWISH RED LOAMY FINE SAND SURFACE LAYER 3 INCHES THICK. THE SUBSOIL IS YELLOWISH RED, VERY FINE SANDY LOAM 13 INCHES THICK. THE SUBSTRATUM IS YELLOWISH RED, VERY FINE SANDY LOAM TO 60 INCHES OR MORE. SLOPES ARE 0 TO 30 PERCENT.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-3	LFS	SM	A-2, A-4	0	100	100	75-90	30-50	-	NP
0-3	VFSL	ML, CL-ML	A-4	0	100	100	80-95	50-60	15-25	NP-10
0-3	FSL, SL	SM	A-4	0	100	100	70-85	40-50	20-25	NP-5
3-42	VFSL, FSL, SL	ML, CL-ML	A-4	0	100	100	80-95	50-65	20-30	NP-10
42-60	VFSL, LFS, FSL	ML, SM	A-4, A-2	0	100	100	75-95	30-60	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTOR K	EROSION FACTOR T	WIND ERODIBILITY GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CORROSIVITY CONCRETE
0-3	2-10	1.40-1.50	2.0-6.0	0.08-0.11	7.9-8.4	-	LOW	.49	5	2	1-3	HIGH	MODERATE
0-3	8-15	1.40-1.50	2.0-6.0	0.10-0.15	7.9-8.4	-	LOW	.37	5	3	1-3		
0-3	8-15	1.40-1.50	2.0-6.0	0.09-0.14	7.9-8.4	-	LOW	.43	5	3	1-3		
3-42	12-18	1.40-1.50	2.0-6.0	0.13-0.18	7.9-9.0	<2	LOW	.43					
42-60	5-12	1.40-1.50	2.0-6.0	0.10-0.15	7.9-9.0	<2	LOW	.37					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	WIND GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-	-	8	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE
SANITARY LANDFILL (TRENCH)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SANITARY LANDFILL (AREA)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	0-8%: GOOD 8-15%: FAIR-SLOPE 15+%: POOR-SLOPE

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-15%: SEVERE-CUTBANKS CAVE 15+%: SEVERE-CUTBANKS CAVE,SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE

CONSTRUCTION MATERIAL

ROADFILL	0-15%: GOOD 15-25%: FAIR-SLOPE 25+%: POOR-SLOPE
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	0-8% VFSL,FSL,SL: GOOD 8-15% VFSL,FSL,SL: FAIR-SLOPE 0-8% LFS: FAIR-TOO SANDY 8-15% LFS: FAIR-TOO SANDY,SLOPE 15+%: POOR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-8%: SEVERE-SEEPAGE 8+%: SEVERE-SEEPAGE,SLOPE
EMBANKMENTS, DIKES AND LEVEES	SEVERE-PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3% VFSL,FSL,SL: SOIL BLOWING 3+% VFSL,FSL,SL: SOIL BLOWING,SLOPE 0-3% LFS: FAST INTAKE,SOIL BLOWING 3+% LFS: FAST INTAKE,SOIL BLOWING,SLOPE
TERRACES AND DIVERSIONS	0-8%: ERODES EASILY,SOIL BLOWING 8+%: SLOPE,ERODES EASILY,SOIL BLOWING
GRASSED WATERWAYS	0-8%: ERODES EASILY 8+%: SLOPE,ERODES EASILY

REGIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT

CAMP AREAS	0-8% LFS,FSL,SL: SLIGHT 8-15% LFS,FSL,SL: MODERATE-SLOPE 0-8% VFSL: MODERATE-DUSTY 8-15% VFSL: MODERATE-SLOPE,DUSTY 15+%: SEVERE-SLOPE	PLAYGROUNDS	0-2% LFS,FSL,SL: SLIGHT 2-6% LFS,FSL,SL: MODERATE-SLOPE 0-2% VFSL: MODERATE-DUSTY 2-6% VFSL: MODERATE-SLOPE,DUSTY 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8% LFS,FSL,SL: SLIGHT 8-15% LFS,FSL,SL: MODERATE-SLOPE 0-8% VFSL: MODERATE-DUSTY 8-15% VFSL: MODERATE-SLOPE,DUSTY 15+%: SEVERE-SLOPE	PATHS AND TRAILS	0-25%: SEVERE-ERODES EASILY 25+%: SEVERE-SLOPE,ERODES EASILY

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY																	
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	IRR	IRR.	NIRR	IRR.	NIRR	IRR.		
VFSL,FSL,SL	6E																	
LFS	7S																	

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROS HAZARD	EQUIP. LIMIT	SEEDL. MORTY	WIND HAZARD	PLANT COMPET	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDX	PROD CLAS	TREES TO PLANT
							NONE			

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
VFSL,FSL,SL	POOR	FAIR	FAIR	-		FAIR	V. POOR	V. POOR	FAIR		V. POOR	FAIR
LFS	V. POOR	POOR	FAIR	-	-	POOR	V. POOR	V. POOR	POOR	-	V. POOR	POOR

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION) BY CLASS DETERMINING PHASE

COMMON PLANT NAME	PLANT SYMBOL (ULSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT): DRY	MOIST			
INDIAN RICEGRASS	ORHY	20	15			
NEEDLEANDTHREAD	STCO4	15	10			
BLUE GRAMA	BOGR2	-	5			
BLUEGRASS	POA**	-	5			
GALLETA	HILA	10	5			
SAND DROPSEED	SPCR	-	5			
OTHER PERENNIAL FORBS	PPFF	10	10			
OTHER PERENNIAL GRASSES	PPGG	15	5			
WYOMING BIG SAGEBRUSH	ARTRW*	-	20			
WINTERFAT	EULAS	5	5			
FOURWING SALTBUSH	ATCA2	10	-			
MORMON-TEA	EPMED	5	5			
OTHER SHRUBS	SSSS	10	10			
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS		800	1500			
NORMAL YEARS		650	1000			
UNFAVORABLE YEARS		450	800			

FOOTNOTES

* ESTIMATES BASED ON ENGINEERING TEST DATA ON ONE PEDON FOR SAN JUAN COUNTY UTAH

MLRA(S): 36
REV. TLP.CWK. 11-78
LITHIC USTOLLIC HAPLARGIDS. LOAMY. MIXED. MESIC

BOND SERIES

THE BOND SERIES CONSISTS OF SHALLOW WELL-DRAINED SOILS FORMED ON RIDGETOPS AND MESAS. PARENT MATERIAL IS REDDISH SANDSTONE. THESE SOILS OCCUR BETWEEN 4500 AND 8000 FEET ELEVATION. AVERAGE ANNUAL PRECIPITATION RANGES FROM 12 TO 17 INCHES WITH MEAN ANNUAL AIR TEMPERATURES FROM 47 TO 54 F. THE FROST-FREE SEASON IS BETWEEN 110 AND 150 DAYS. TYPICALLY THE SURFACE LAYER IS ABOUT 4 INCHES OF REDDISH-BROWN SANDY LOAM UNDERLAIN BY A REDDISH-BROWN SANDY CLAY LOAM SUBSOIL. SANDSTONE BEDROCK IS BETWEEN 10 AND 20 IN. SLOPES RANGE FROM 1 TO 25 PERCENT.

ESTIMATED SOIL PROPERTIES (A)

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-4	SL. FSL	SM	A-2. A-4	0-15	100	95-100	60-75	30-50	15-25	NP-5
0-4	GR-SL. GR-FSL. GR-LS	SM	A-2. A-4	0-15	85-95	80-90	55-70	15-40	15-25	NP-5
0-4	LS	SM	A-2	0-15	100	95-100	50-65	15-30	-	NP
4-17	SCL. GR-SCL	SC	A-2. A-6	0-15	80-100	70-100	60-75	30-50	20-35	10-20
17	UWB									

DEPTH (IN.)	CLAY (PCT <2MM)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-4	8-17	-	0.6-2.0	0.12-0.14	6.6-7.8	-	LOW	.28	1	3	-	HIGH	LOW
0-4	4-17	-	2.0-6.0	0.10-0.12	6.6-7.8	-	LOW	.32	1	4	-		
0-4	4-9	-	2.0-6.0	0.06-0.08	6.6-7.8	-	LOW	.24	1	2	-		
4-17	20-35	-	0.2-0.6	0.11-0.13	6.6-8.4	-	MODERATE	.37					
17													

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		12-20	HARD	-		D	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	1-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK.SLOPE
SEWAGE LAGOON AREAS	1-7%: SEVERE-DEPTH TO ROCK 7+%: SEVERE-DEPTH TO ROCK.SLOPE
SANITARY LANDFILL (TRENCH)	1-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK.SLOPE
SANITARY LANDFILL (AREA)	1-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK.SLOPE
DAILY COVER FOR LANDFILL	1-15%: POOR-AREA RECLAIM 15+%: POOR-AREA RECLAIM.SLOPE

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	1-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK.SLOPE
DWELLINGS WITHOUT BASEMENTS	1-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-SLOPE.DEPTH TO ROCK
DWELLINGS WITH BASEMENTS	1-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK.SLOPE
SMALL COMMERCIAL BUILDINGS	1-8%: SEVERE-DEPTH TO ROCK 8+%: SEVERE-SLOPE.DEPTH TO ROCK
LOCAL ROADS AND STREETS	1-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK.SLOPE
LAWNS. LANDSCAPING AND GOLF FAIRWAYS	1-15%: SEVERE-THIN LAYER 15+%: SEVERE-SLOPE.THIN LAYER

CONSTRUCTION MATERIAL

ROADFILL	POOR-AREA RECLAIM
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	1-15%: POOR-AREA RECLAIM.SMALL STONES 15+%: POOR-AREA RECLAIM.SMALL STONES.SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	1-8%: SEVERE-DEPTH TO ROCK 8+%: SEVERE-DEPTH TO ROCK.SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-THIN LAYER
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	1-3% SL.FSL.GR-SL.GR-FSL.GR-LS: DEPTH TO ROCK 3+% SL.FSL.GR-SL.GR-FSL.GR-LS: DEPTH TO ROCK.SLOPE 1-3% LS: DROUGHTY.DEPTH TO ROCK ?
TERRACES AND DIVERSIONS	1-8%: DEPTH TO ROCK.ERODES EASILY 8+%: SLOPE.DEPTH TO ROCK.ERODES EASILY
GRASSED WATERWAYS	1-8% SL.FSL.GR-SL.GR-FSL.GR-LS: ERODES EASILY 8+% SL.FSL.GR-SL.GR-FSL.GR-LS: SLOPE. ERODES EASILY 1-8% LS: ERODES EASILY.DROUGHTY ?

REGIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT

CAMP AREAS	1-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-SLOPE,DEPTH TO ROCK	PLAYGROUNDS	1-6%: SEVERE-DEPTH TO ROCK 6+%: SEVERE-SLOPE,DEPTH TO ROCK
PICNIC AREAS	1-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-SLOPE,DEPTH TO ROCK	PATHS AND TRAILS	1-15%: SLIGHT 15-25%: MODERATE-SLOPE

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPA-BILITY															
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
ALL	6E															

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS					POTENTIAL PRODUCTIVITY		TREES TO PLANT
		EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	COMMON TREES	SITE INDX	
							NONE		

WINDBREAKS

CLASS-DETERMIN'G PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS								POTENTIAL AS HABITAT FOR:			
	GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	POOR	POOR	FAIR	-	FAIR	FAIR	V. POOR	V. POOR	POOR	FAIR	V. POOR	FAIR

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE: ALL				
PINYON 1/	PIED	8				
ONESEED JUNIPER 1/	JUMO	12				
PONDEROSA PINE 1/	PIPO	5				
GAMBEL OAK 2/	QUGA	10				
TRUE MOUNTAINMAHOGANY	CEMO2	3				
ANTELOPE BITTERBRUSH	PUTR2	2				
SIDEOATS GRAMA	BOCU	15				
BOTTLEBRUSH SQUIRRELTAIL	SIHY	2				
PINE DROPSEED	BLTR	3				
PRAIRIE JUNEGRASS	KOCR	2				
SAND DROPSEED	SPCR	3				
BLUE GRAMA	BOGR2	15				
GALLETA	HIJA	15				
OTHER PERENNIAL FORBS	PPFF	5				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS		700				
NORMAL YEARS		500				
UNFAVORABLE YEARS		300				

FOOTNOTES

A ESTIMATES OF ENGINEERING PROPERTIES ARE BASED ON TEST DATA OF 3 PEDONS FROM WASHINGTON COUNTY, UTAH.
1 NOT USUALLY UTILIZED BY CATTLE AND SHEEP.
2 NOT USUALLY UTILIZED BY CATTLE.

LRA(S): 35, 37, 48A, 39 CAHONA SERIES
REV. JP,RM, 11-84
ISTOLLIC HAPLARGIDS, FINE-SILTY, MIXED, MESIC

THE CAHONA SERIES CONSISTS OF DEEP WELL DRAINED SOILS FORMED IN REDDISH LOESS ON MESAS, CUESTAS, AND BENCHES. TYPICALLY, THE SURFACE IS VERY FINE SANDY LOAM ABOUT 11 INCHES THICK. THE SUBSOIL IS A CLAY LOAM ABOUT 13 INCHES THICK AND OVERLIES VERY FINE SANDY LOAM THAT EXTENDS TO 60 INCHES OR MORE. MAP IS 12 TO 15 INCHES AND MAAT IS ABOUT 47 F. VEGETATION IS SAGEBRUSH, GRASS, AND SCATTERED PINYON AND JUNIPER. SLOPES ARE 0 TO 15 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-11	VFSL	ML, CL-ML	A-4	0	100	100	95-100	50-80	10-20	NP-10
0-11	L, SIL	ML, CL-ML	A-4	0	100	100	95-100	60-75	15-25	NP-10
0-11	FSL	SM	A-4	0	100	100	95-100	40-50	15-25	NP-5
11-24	SCL, SICL, CL	CL	A-6	0	100	100	95-100	80-95	30-40	10-20
24-60	VFSL, L, FSL	CL-ML, CL	A-4, A-6	0	100	100	95-100	50-95	20-35	5-15

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-11	10-20	1.40-1.50	0.6-2.0	0.14-0.16	6.6-8.4	-	LOW	.37	5	3	1-2	HIGH	LOW
0-11	15-25	1.40-1.50	0.6-2.0	0.15-0.17	6.6-8.4	-	LOW	.37	5	4	1-2		
0-11	10-15	1.40-1.50	2.0-6.0	0.11-0.13	7.4-8.4	<2	LOW	.24	5	3	1-3		
11-24	20-35	1.30-1.40	0.2-0.6	0.15-0.17	6.6-8.4	<2	MODERATE	.37					
24-60	10-27	1.40-1.50	0.6-2.0	0.13-0.16	7.9-9.0	<2	LOW	.37					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYDIC GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-		B	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	0-8%: MODERATE-PERCS SLOWLY 8-15%: MODERATE-PERCS SLOWLY,SLOPE
SEWAGE LAGOON AREAS	0-2%: MODERATE-SEEPAGE 2-7%: MODERATE-SEEPAGE,SLOPE 7+%: SEVERE-SLOPE
SANITARY LANDFILL (TRENCH)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE
SANITARY LANDFILL (AREA)	0-8%: SLIGHT 8-15%: MODERATE-SLOPE
DAILY COVER FOR LANDFILL	0-8%: GOOD 8-15%: FAIR-SLOPE

CONSTRUCTION MATERIAL

ROADFILL	FAIR-LOW STRENGTH
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	0-8%: GOOD 8-15%: FAIR-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	0-3%: MODERATE-SEEPAGE 3-8%: MODERATE-SEEPAGE,SLOPE 8+%: SEVERE-SLOPE
EMBANKMENTS DIKES AND LEVEES	MODERATE-PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3% L,SIL: ROOTING DEPTH 3+% L,SIL: ROOTING DEPTH,SLOPE 0-3% VFSL,FSL: SOIL BLOWING,ROOTING DEPTH 3+%VFSL,FSL:SOIL BLOWING,ROOTING DEPTH,SLOPE
TERRACES AND DIVERSIONS	0-8% L,SIL: ERODES EASILY 8+% L,SIL: SLOPE,ERODES EASILY 0-8% VFSL,FSL: ERODES EASILY,SOIL BLOWING 8+%VFSL,FSL:SLOPE,ERODES EASILY,SOIL BLOWING
GRASSED WATERWAYS	0-8%: ERODES EASILY,ROOTING DEPTH 8+%: SLOPE,ERODES EASILY,ROOTING DEPTH

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE
DWELLINGS WITHOUT BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE
DWELLINGS WITH BASEMENTS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE
SMALL COMMERCIAL BUILDINGS	0-4%: SLIGHT 4-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	0-8%: MODERATE-LOW STRENGTH 8-15%: MODERATE-LOW STRENGTH,SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: SLIGHT 8-15%: MODERATE-SLOPE

RECREATIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT

GAME AREAS	0-8% FSL: SLIGHT 8-15% FSL: MODERATE-SLOPE 0-8% VFSL,L,SIL: MODERATE-DUSTY 8-15% VFSL,L,SIL: MODERATE-SLOPE,DUSTY	PLAYGROUNDS	0-2% FSL: SLIGHT 2-6% FSL: MODERATE-SLOPE 0-2% VFSL,L,SIL: MODERATE-DUSTY 2-6% VFSL,L,SIL: MODERATE-SLOPE,DUSTY 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8% FSL: SLIGHT 8-15% FSL: MODERATE-SLOPE 0-8% VFSL,L,SIL: MODERATE-DUSTY 8-15% VFSL,L,SIL: MODERATE-SLOPE,DUSTY	PATHS AND TRAILS	FSL: SLIGHT VFSL,L,SIL: SEVERE-ERODES EASILY

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY NIRR	CAPABILITY IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	IRR	IRR.	NIRR	IRR.	NIRR	IRR.
1-3%	3C	3C														
3-6%	3E	3E														
6-12%	4E	4E														
12+%	6E															

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	EROSN HAZARD	EQUIP. LIMIT	SEEDL. MORTY	WINDTH HAZARD	PLANT COMPET	COMMON TREES	SITE INDX	POTENTIAL PRODUCTIVITY CLAS	TREES TO PLANT
COOL							PINYON UTAH JUNIPER			
0-15%										

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
NIRR	POOR	FAIR	FAIR	-	-	FAIR	POOR	V. POOR	FAIR	-	V. POOR	FAIR
IRR	GOOD	GOOD							GOOD			

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE: LONG FFS	SHORT FFS	DRY		
MUTTONGRASS	POFE	20				
WESTERN WHEATGRASS	AGSM	15	5	5		
WYOMING BIG SAGEBRUSH	ARTRW8	15	15	5		
GALLETA	HIJA	15	20	20		
NEEDLEANDTHREAD	STCO4	5	10	15		
BLUE GRAMA	BOGR2	5	10	10		
RUBBER RABBITBRUSH 1/	CHNA2	5		5		
ANTELOPE BITTERBRUSH 1/	PUTR2	5				
BLUEGRASS	POA++		10			
OTHER PERENNIAL GRASSES	PPGG		5	10		
GLOBEMALLOW	SPHAE		5			
OTHER PERENNIAL FORBS	PPFF		5			
WINTERFAT	EULAE		5			
OTHER SHRUBS	SPSS		10			
INDIAN RICEGRASS	ORHY			10		
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS		1300	1500	900		
NORMAL YEARS		1000	1000	700		
UNFAVORABLE YEARS		700	500	500		

FOOTNOTES

1/ NOT USUALLY UTILIZED BY CATTLE OR SHEEP.

MLRA(S): 70, 48A
REV. MYM, 7-84
USTIC TORRIORTHENTS, LOAMY-SKELETAL, MIXED (CALCAREOUS), MESIC

CHILTON SERIES

THE CHILTON SERIES CONSIST OF DEEP EXCESSIVELY DRAINED SOILS FORMED IN GRAVELLY ALLUVIUM ON FANS AND PIEDMONTS. ELEVATION IS 5800 TO 6800 FT. ANNUAL PRECIPITATION IS 13 TO 15 INCHES. MEAN ANNUAL AIR TEMPERATURE IS 49 TO 51 F. FROST-FREE SEASON IS 160 TO 180 DAYS. IN A REPRESENTATIVE PROFILE THE SURFACE LAYER IS BROWN GRAVELLY LOAM ABOUT 9 IN. THICK. THE UNDERLYING LAYER IS LIGHT BROWN GRAVELLY LOAM ABOUT 6 IN. THICK. THE SUBSTRATUM IS LIGHT BROWN VERY GRAVELLY LOAM TO 60 INCHES OR MORE. SLOPES ARE 3 TO 25 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-9	GR-L, CN-L	SM	A-2, A-4	0-5	70-80	60-70	45-55	30-45	15-25	NP-5
0-9	GR-FSL	SM	A-2	0-5	70-80	60-70	50-60	20-35	-	NP
9-60	GRV-L, GRV-SCL	GM-GC, GC	A-2, A-1	5-10	40-60	30-50	25-40	15-35	25-30	5-15
60-70	GRV-SL,CBV-SL,CNV-SL	GM	A-2, A-1	5-30	40-60	35-50	25-40	15-35	-	NP

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTOR K	EROSION FACTOR T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CORROSIVITY CONCRETE
0-9	10-20	1.35-1.45	0.6-2.0	0.12-0.14	7.9-8.4	-	LOW	.20	3	5	.5-2	MODERATE	LOW
9-60	5-15	1.35-1.45	2.0-6.0	0.09-0.11	7.9-8.4	-	LOW	.15	3	4	.5-2		
60-70	18-30	1.20-1.30	2.0-6.0	0.07-0.09	7.9-8.4	-	LOW	.10					
	10-18	1.45-1.55	2.0-6.0	0.07-0.09	7.9-8.4	-	LOW	.10					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-		B	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	3-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	ROADFILL
SEWAGE LAGOON AREAS	3-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE,SLOPE	SAND
SANITARY LANDFILL (TRENCH)	3-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	GRAVEL
SANITARY LANDFILL (AREA)	3-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE	TOPSOIL
DAILY COVER FOR LANDFILL	3-15%: POOR-SMALL STONES 15+%: POOR-SMALL STONES,SLOPE	

CONSTRUCTION MATERIAL

ROADFILL	3-15%: GOOD 15-25%: FAIR-SLOPE
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	3-15%: POOR-SMALL STONES,AREA RECLAIM 15+%: POOR-SMALL STONES,AREA RECLAIM,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	3-8%: SEVERE-SEEPAGE 8+%: SEVERE-SEEPAGE,SLOPE
EMBANKMENTS, DIKES AND LEVEES	SLIGHT
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	DROUGHTY,SLOPE
TERRACES AND DIVERSIONS	3-8%: FAVORABLE 8+%: SLOPE
GRASSED WATERWAYS	3-8%: DROUGHTY 8+%: SLOPE,DROUGHTY

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	3-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	3-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	3-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	3-8%: SLIGHT 8-8%: MODERATE-SLOPE 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	3-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	3-8%: MODERATE-SMALL STONES,DROUGHTY 8-15%: MODERATE-SMALL STONES,DROUGHTY,SLOPE 15+%: SEVERE-SLOPE

REGIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT

CAMP AREAS	3-8% GR-FSL: MODERATE-SMALL STONES 8-15% GR-FSL: MODERATE-SLOPE,SMALL STONES 3-8% GR-L,CN-L: MODERATE-SMALL STONES,DUSTY 8-15% GR-L,CN-L: MODERATE-SLOPE,SMALL STONES 15+%: SEVERE-SLOPE	PLAYGROUNDS	3-6%: SEVERE-SMALL STONES 6+%: SEVERE-SLOPE,SMALL STONES
PICNIC AREAS	3-8% GR-FSL: MODERATE-SMALL STONES 8-15% GR-FSL: MODERATE-SLOPE,SMALL STONES 3-8% GR-L,CN-L: MODERATE-SMALL STONES,DUSTY 8-15% GR-L,CN-L: MODERATE-SLOPE,SMALL STONES 15+%: SEVERE-SLOPE	PATHS AND TRAILS	3-15% GR-FSL: SLIGHT 15-25% GR-FSL: MODERATE-SLOPE 3-15% GR-L,CN-L: MODERATE-DUSTY 15-25% GR-L,CN-L: MODERATE-SLOPE,DUSTY

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY															
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	IRR	IRR.	NIRR	IRR.	NIRR	IRR.
ALL	6E	-														

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROS HAZARD	EQUIP. LIMIT	SEEDL. MORTY	WINDTH HAZARD	PLANT COMPET	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDX	PROD CLAS	TREES TO PLANT
							NONE			

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	POOR	FAIR	FAIR	-	FAIR	FAIR	V. POOR	V. POOR	FAIR	FAIR	V. POOR	FAIR

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION) (A)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE: ALL					
SIDEOATS GRAMA	BOCU	10					
NEW MEXICO FEATHERGRASS	STNE2	15					
BLACK GRAMA	BOER4	15					
BLUE GRAMA	BOGR2	10					
JOLFTAIL	LYPH	5					
THREEAWN	ARIST	5					
HAIRY GRAMA	BOHI2	10					
PLAINS LOVEGRASS	ERIN	5					
OTHER PERENNIAL GRASSES	PPGG	5					
OTHER SHRUBS	SSSS	10					
WINTERFAT	CULA5	5					
OTHER PERENNIAL FORBS	PPFF	5					
POTENTIAL PRODUCTION (LBS./AC. DRY WT):							
FAVORABLE YEARS		1100					
NORMAL YEARS		-					
UNFAVORABLE YEARS		400					

FOOTNOTES

A ALL-070C119N.

C00394 S O I L I N T E R P R E T A T I O N S R E C O R D

MLRA(S): 36, 39 DULCE SERIES
REV. BWC,BM, 3-82
USTIC TORRIORTHENTS, LOAMY, MIXED (CALCAREOUS), MESIC, SHALLOW

THE DULCE SOILS CONSISTS OF SHALLOW, WELL DRAINED SOILS FORMED ON SLOPING TO STEEP FOOTHILL SLOPES AND RIDGES. THE SURFACE LAYER IS SANDY LOAM ABOUT 9 INCHES THICK. THE UNDERLYING LAYER IS SANDY LOAM OVERLYING SOFT SANDSTONE AT 13 INCHES. MEAN ANNUAL PRECIPITATION IS ABOUT 14 INCHES. MEAN ANNUAL TEMPERATURE IS ABOUT 49 F. NATIVE VEGETATION IS PINYON PINE, JUNIPER, SHRUBS, AND GRASSES. ELEVATION IS 5,000 TO 7,500 FEET. SLOPES RANGE FROM 6 TO 60 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-13	SL	SM	A-2, A-4	0-5	75-100	75-100	50-85	25-50	20-25	NP-5
13	WB									

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-13	5-18	1.45-1.55	2.0-6.0	0.11-0.13	7.9-8.4	-	LOW	.24	1	3	<1	MODERATE	LOW
13													

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		8-20	SOFT	-		D	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	6-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
SEWAGE LAGOON AREAS	6-7%: SEVERE-SEEPAGE,DEPTH TO ROCK 7+%: SEVERE-SEEPAGE,DEPTH TO ROCK,SLOPE
SANITARY LANDFILL (TRENCH)	6-15%: SEVERE-DEPTH TO ROCK,SEEPAGE 15+%: SEVERE-DEPTH TO ROCK,SEEPAGE,SLOPE
SANITARY LANDFILL (AREA)	6-15%: SEVERE-DEPTH TO ROCK,SEEPAGE 15+%: SEVERE-DEPTH TO ROCK,SEEPAGE,SLOPE
DAILY COVER FOR LANDFILL	6-15%: POOR-AREA RECLAIM 15+%: POOR-AREA RECLAIM,SLOPE

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	6-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
DWELLINGS WITHOUT BASEMENTS	6-8%: MODERATE-DEPTH TO ROCK 8-15%: MODERATE-SLOPE,DEPTH TO ROCK 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	6-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
SMALL COMMERCIAL BUILDINGS	6-8%: MODERATE-SLOPE,DEPTH TO ROCK 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	6-8%: MODERATE-DEPTH TO ROCK 8-15%: MODERATE-DEPTH TO ROCK,SLOPE 15+%: SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	6-15%: SEVERE-THIN LAYER 15+%: SEVERE-SLOPE,THIN LAYER

CONSTRUCTION MATERIAL

ROADFILL	6-25%: POOR-AREA RECLAIM 25+%: POOR-AREA RECLAIM,SLOPE
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	6-15%: POOR-AREA RECLAIM,SMALL STONES 15+%: POOR-AREA RECLAIM,SMALL STONES,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	6-8%: SEVERE-DEPTH TO ROCK 8+%: SEVERE-DEPTH TO ROCK,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	SOIL BLOWING,DEPTH TO ROCK,SLOPE
TERRACES AND DIVERSIONS	6-8%: DEPTH TO ROCK,SOIL BLOWING 8+%: SLOPE,DEPTH TO ROCK,SOIL BLOWING
GRASSED WATERWAYS	6-8%: DEPTH TO ROCK 8+%: SLOPE,DEPTH TO ROCK

REGIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT

CAMP AREAS	6-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-SLOPE,DEPTH TO ROCK	PLAYGROUNDS	SEVERE-SLOPE,DEPTH TO ROCK
PICNIC AREAS	6-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-SLOPE,DEPTH TO ROCK	PATHS AND TRAILS	6-15%: SLIGHT 15-25%: MODERATE-SLOPE 25+%: SEVERE-SLOPE

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY																	
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
ALL	7S																	

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDX	TREES TO PLANT
ALL							PINYON ROCKY MT. JUNIPER		

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	POTENTIAL AS HABITAT FOR: SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	V. POOR	V. POOR	POOR	-	V. POOR	FAIR	V. POOR	V. POOR	V. POOR	POOR	V. POOR	POOR

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE: ALL				
WESTERN WHEATGRASS	AGSM	15				
INDIAN RICEGRASS	ORHY	10				
PRAIRIE JUNEGRASS	KOCR	10				
ALKALI SACATON	SPAI	5				
NEEDLEANDTHREAD	STCO4	5				
BLUE GRAMA	BOGR2	5				
FENDLER THREEAWN	ARFE4	5				
BASIN BIG SAGEBRUSH 1/	ARTR2	10				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS		800				
NORMAL YEARS		600				
UNFAVORABLE YEARS		400				

FOOTNOTES

1 NOT USUALLY UTILIZED BY CATTLE OR SHEEP

MLRA(S): 36
JJF-OSP, 2-85
USTOLLI: CAMBORTHIDS, FINE-SILTY, MIXED, MESIC

LAS LUCAS SERIES

THE LAS LUCAS SERIES CONSISTS OF DEEP, WELL DRAINED SOILS. THEY FORMED IN MATERIAL WEATHERED FROM SHALE ON UPLANDS. ELEVATION RANGES FROM 6000 TO 7000 FEET. MEAN ANNUAL PRECIPITATION IS 12 TO 14 INCHES. MEAN ANNUAL AIR TEMPERATURE IS 48 TO 54 F, AND THE FROST FREE SEASON IS 150 TO 170 DAYS. IN A TYPICAL PROFILE THE SURFACE LAYER IS A PALE BROWN LOAM ABOUT 8 INCHES THICK. THE SUBSOIL IS A YELLOWISH BROWN CLAY LOAM ABOUT 14 INCHES THICK AND THE SUBSTRATUM IS A LIGHT YELLOWISH BROWN CLAY LOAM OVER SHALE. SLOPES RANGE FROM 0 TO 9 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-8	L	ML, CL-ML	A-4	0	100	100	95-100	60-75	20-30	NP-10
8-45	CL	CL	A-6	0	100	100	95-100	75-95	25-40	10-25
45	WB									

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-8	15-27	1.40-1.50	0.6-2.0	0.15-0.17	7.9-8.4	<2	LOW	.37	3	4L	1-2	HIGH	LOW
8-45	28-35	1.45-1.55	0.2-0.6	0.18-0.20	7.9-9.0	<2	MODERATE	.32					
45													

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYDROLOGIC GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60	SOFT	-	-	B	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PERCS SLOWLY	
SEWAGE LAGOON AREAS	0-2%: MODERATE-DEPTH TO ROCK 2-7%: MODERATE-DEPTH TO ROCK,SLOPE 7+%: SEVERE-SLOPE	
SANITARY LANDFILL (TRENCH)	SEVERE-DEPTH TO ROCK	
SANITARY LANDFILL (AREA)	0-8%: SLIGHT 8-9%: MODERATE-SLOPE	
DAILY COVER FOR LANDFILL	0-8%: FAIR-DEPTH TO ROCK,THIN LAYER 8-9%: FAIR-DEPTH TO ROCK,SLOPE,THIN LAYER	

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	0-8%: SLIGHT 8-9%: MODERATE-SLOPE	
DWELLINGS WITHOUT BASEMENTS	0-8%: MODERATE-SHRINK-SWELL 8-9%: MODERATE-SHRINK-SWELL,SLOPE	
DWELLINGS WITH BASEMENTS	0-8%: MODERATE-SHRINK-SWELL 8-9%: MODERATE-SLOPE,SHRINK-SWELL	
SMALL COMMERCIAL BUILDINGS	0-4%: MODERATE-SHRINK-SWELL 4-8%: MODERATE-SHRINK-SWELL,SLOPE 8+%: SEVERE-SLOPE	
LOCAL ROADS AND STREETS	SEVERE-LOW STRENGTH	
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	0-8%: SLIGHT 8-9%: MODERATE-SLOPE	

CONSTRUCTION MATERIAL

ROADFILL	POOR-LOW STRENGTH	
SAND	IMPROBABLE-EXCESS FINES	
GRAVEL	IMPROBABLE-EXCESS FINES	
TOPSOIL	0-8%: FAIR-TOO CLAYEY 8-9%: FAIR-TOO CLAYEY,SLOPE	

WATER MANAGEMENT

POND RESERVOIR AREA	0-3%: MODERATE-DEPTH TO ROCK 3-8%: MODERATE-DEPTH TO ROCK,SLOPE 8+%: SEVERE-SLOPE	
EMBANKMENTS, DIKES AND LEVEES	MODERATE-THIN LAYER,PIPING	
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER	
DRAINAGE	DEEP TO WATER	
IRRIGATION	0-3%: ERODES EASILY 3+%: SLOPE,ERODES EASILY	
TERRACES AND DIVERSIONS	0-8%: ERODES EASILY 8+%: SLOPE,ERODES EASILY	
GRASSED WATERWAYS	0-8%: TOO ARID,ERODES EASILY 8+%: TOO ARID,SLOPE,ERODES EASILY	

REGIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT

CAMP AREAS	0-8%: MODERATE-DUSTY 8-9%: MODERATE-SLOPE,DUSTY	PLAYGROUNDS	0-2%: MODERATE-DUSTY 2-6%: MODERATE-SLOPE,DUSTY 6+%: SEVERE-SLOPE
PICNIC AREAS	0-8%: MODERATE-DUSTY 8-9%: MODERATE-SLOPE,DUSTY	PATHS AND TRAILS	SEVERE-ERODES EASILY

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY															
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
ALL	6E															

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROS HAZARD	EQUIP. LIMIT	SEEDL. MORTY	WINDTH HAZARD	PLANT COMPET	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDX	PROD CLAS	TREES TO PLANT
							NONE			

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
IRR	EASTERN REDCEDAR HONEYLOCUST		ROCKY MT. JUNIPER SIBERIAN ELM		ORIENTAL ARBORVITAE WHITE MULBERRY		RUSSIAN-OLIVE SKUNKBUSH SUMAC	
NIRR								

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	POOR	FAIR	FAIR	-	-	POOR	POOR	V. POOR	POOR	-	V. POOR	POOR

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE: MAP12-14				
SPIKE MUHLY	MUWR	10				
WESTERN WHEATGRASS	AGSM	15				
BLUE GRAMA	BOGR2	22				
WINTERFAT	EULAS	5				
NEEDLEGRASS	STIPA	7				
BOTTLEBRUSH SQUIRRELTAIL	SIHY	7				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS		950				
NORMAL YEARS		-				
UNFAVORABLE YEARS		375				

FOOTNOTES

A MAP12-14: 03681124.

SOIL INTERPRETATIONS RECORD

MLRA(S): 36 — DELOP SERIES
REV. JER. 9-84

USTOLLIC HAPLARGIDS, FINE-LOAMY, MIXED, MESIC

THE DELOP SERIES CONSISTS OF DEEP, WELL DRAINED SOILS THAT FORMED IN ALLUVIAL AND EOLIAN MATERIAL DERIVED FROM SHALE AND SANDSTONE ON MESAS AND PLATEAUS. ELEVATION IS ABOUT 6800 FEET. AVERAGE ANNUAL AIR TEMPERATURE IS ABOUT 50F. AVERAGE ANNUAL PRECIPITATION IS 10 TO 13 INCHES. FROST-FREE SEASON IS 120 TO 150 DAYS. TYPICALLY, THE SURFACE LAYER IS BROWN LOAM ABOUT 2 INCHES THICK. THE SUBSOIL IS BROWN AND DARK BROWN CLAY LOAM ABOUT 28 INCHES THICK. THE SUBSTRATUM IS BROWN AND LIGHT BROWN LOAM AND SANDY LOAM TO 60 INCHES OR MORE. SLOPE RANGES FROM 0 TO 3 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLAS-TICITY INDEX
0-2	L	ML, CL-ML	A-4	0	100	100	85-95	60-75	25-35	5-10
0-2	SIL	ML, CL-ML	A-4	0	100	100	90-100	70-80	25-35	5-10
0-2	FSL	SM, ML	A-4	0	100	100	70-85	40-55	20-35	NP-5
2-39	L, CL, SICL	CL	A-6	0	100	100	85-100	65-85	30-40	10-20
39-60	SL	SM	A-2, A-4	0	100	100	60-70	30-40	20-25	NP-5

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEA-BILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTOR K	EROSION FACTOR T	WIND GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CORROSIVITY CONCRETE
0-2	18-27	1.20-1.30	0.6-2.0	0.16-0.18	7.9-8.4	<2	LOW	.37	5	6	1-2	HIGH	LOW
0-2	18-27	1.15-1.25	0.2-0.6	0.19-0.21	7.9-8.4	<2	LOW	.43	5	6	1-2		
0-2	10-17	1.40-1.50	2.0-6.0	0.13-0.15	7.9-8.4	<2	LOW	.28	5	3	.7-1		
2-39	18-35	1.45-1.55	0.2-0.6	0.17-0.20	7.9-8.4	2-4	MODERATE	.37					
39-60	10-17	1.40-1.50	2.0-6.0	0.11-0.13	7.9-9.0	2-4	LOW	.24					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE LIMIT (IN)	TOTAL (IN)	IRR GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		>60		-	-	2	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-PERCS SLOWLY	
SEWAGE LAGOON AREAS	0-7%: SEVERE-SEEPAGE 7+%: SEVERE-SEEPAGE, SLOPE	
SANITARY LANDFILL (TRENCH)	SLIGHT	
SANITARY LANDFILL (AREA)	SLIGHT	
DAILY COVER FOR LANDFILL	GOOD	

CONSTRUCTION MATERIAL

ROADFILL	GOOD	
SAND	IMPROBABLE-EXCESS FINES	
GRAVEL	IMPROBABLE-EXCESS FINES	
TOPSOIL	GOOD	

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-SEEPAGE
EMBANKMENTS, DIKES AND LEVEES	MODERATE-THIN LAYER, PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3% L,SIL: FAVORABLE 3+% L,SIL: SLOPE 0-3% FSL: SOIL BLOWING 3+% FSL: SOIL BLOWING, SLOPE
TERRACES AND DIVERSIONS	L,SIL: ERODES EASILY FSL: ERODES EASILY, SOIL BLOWING
GRASSED WATERWAYS	ERODES EASILY

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SLIGHT	MODERATE-THIN LAYER, PIPING
DWELLINGS WITHOUT BASEMENTS	MODERATE-SHRINK-SWELL	SEVERE-NO WATER
DWELLINGS WITH BASEMENTS	MODERATE-SHRINK-SWELL	DEEP TO WATER
SMALL COMMERCIAL BUILDINGS	0-4%: MODERATE-SHRINK-SWELL 4-8%: MODERATE-SHRINK-SWELL, SLOPE	0-3% L,SIL: FAVORABLE 3+% L,SIL: SLOPE 0-3% FSL: SOIL BLOWING 3+% FSL: SOIL BLOWING, SLOPE
LOCAL ROADS AND STREETS	SEVERE-LOW STRENGTH	L,SIL: ERODES EASILY FSL: ERODES EASILY, SOIL BLOWING
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SLIGHT	ERODES EASILY

REGIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT

CAMP AREAS	FSL: SLIGHT L.SIL: MODERATE-DUSTY	PLAYGROUNDS	0-2% FSL: SLIGHT 2-6% FSL: MODERATE-SLOPE 0-2% L.SIL: MODERATE-DUSTY 2-6% L.SIL: MODERATE-SLOPE,DUSTY 6+%: SEVERE-SLOPE
PICNIC AREAS	FSL: SLIGHT L.SIL: MODERATE-DUSTY	PATHS AND TRAILS	FSL: SLIGHT L.SIL: SEVERE-ERODES EASILY

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY	INTR	IRR.	INTR	IRR.	INTR	IRR.	INTR	IRR.	INTR	IRR.	INTR	IRR.	INTR	IRR.	INTR	IRR.
ALL	6E																

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	EROS HAZARD	MANAGEMENT PROBLEMS EQUIP. LIMIT	SEEDL. MORT.	WINDTH HAZARD	PLANT COMPET	POTENTIAL PRODUCTIVITY COMMON TREES	SITE INDX	PROD CLAS	TREES TO PLANT
							NONE			

WINDBREAKS

CLASS-DETERMING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN AND SEED	GRASS AND LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLND WILDLF	RANGELD WILDLF
ALL	POOR	POOR	FAIR	-	-	FAIR	POOR	V. POOR	POOR	-	V. POOR	GOOD

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION) (A)

COMMON PLANT NAME	PLANT SYMBOL (NLSPM)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE: MAP10-13				
WESTERN WHEATGRASS	AGSM	25				
NEEDLEANDTHREAD	STCOM	10				
GALLETA	HIJA	15				
BIG SAGEBRUSH	ARTR2	15				
FOURWING SALTBUSH	ATCA2	15				
INDIAN RICEGRASS	ORHY	10				
OTHER PERENNIAL FORBS	PPFF	10				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS		1100				
NORMAL YEARS		750				
UNFAVORABLE YEARS		500				

FOOTNOTES

A MAP10-13: 036A006M.

C00539

SOIL INTERPRETATIONS RECORD

MLRA(S): 48A, 39
REV. RD,PM, 4-83
USTOLLIC HAPLARGIDS, FINE-SILTY, MIXED, MESIC

PULPIT SERIES

THE PULPIT SERIES CONSISTS OF MODERATELY DEEP, WELL-DRAINED SOILS FORMED IN CALCAREOUS AEOLIAN MATERIAL OVERLYING SANDSTONE ON UPLAND MESAS, BENCHES AND HILLS. TYPICALLY THE SURFACE IS A LOAM, ABOUT 7 INCHES THICK. THE SUBSOIL IS A CLAY LOAM, ABOUT 18 INCHES THICK. THE UNDERLYING LAYER IS CALCAREOUS LOAM THAT LIES ON SANDSTONE AT ABOUT 36 INCHES. ELEVATION IS 5500 TO 6800 FEET. FROST-FREE SEASON 110 TO 135 DAYS. AVERAGE PRECIPITATION IS 15 INCHES. AVERAGE ANNUAL AIR TEMPERATURE IS 47 DEGREES. SLOPES ARE 2 TO 25 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-7	L, STL	ML, CL-ML	A-4	0	90-100	90-100	85-95	60-75	20-30	NP-10
0-7	FSL, SL	SM, ML	A-4	0	90-100	90-100	75-90	35-60	15-20	NP-5
7-25	CL, SICL	CL, CL-ML	A-4, A-6	0	95-100	95-100	95-100	80-95	25-40	5-20
25-36	L, FSL, CL	ML, CL-ML	A-4	0	90-100	90-100	90-95	65-80	15-30	NP-10
36	UWB									

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-7	10-25	1.35-1.35	0.6-2.0	0.16-0.18	6.6-7.8	-	LOW	.43	2	5	1-2	HIGH	LOW
0-7	10-15	1.35-1.45	0.6-2.0	0.14-0.17	6.6-7.8	-	LOW	.28	2	3	1-2		
7-25	18-35	1.40-1.50	0.2-0.6	0.19-0.21	6.6-8.4	-	MODERATE	.43					
25-36	10-30	1.35-1.45	0.6-2.0	0.16-0.18	7.4-8.4	<2	LOW	.43					
36													

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		20-40	HARD	-		C	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	2-15%: SEVERE-DEPTH TO ROCK,PERCS SLOWLY 15+%:SEVERE-DEPTH TO ROCK,PERCS SLOWLY,SLOPE	ROADFILL: POOR-AREA RECLAIM,LOW STRENGTH
SEWAGE LAGOON AREAS	2-7%: SEVERE-DEPTH TO ROCK 7+%: SEVERE-DEPTH TO ROCK,SLOPE	SAND: IMPROBABLE-EXCESS FINES
SANITARY LANDFILL (TRENCH)	2-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE	GRAVEL: IMPROBABLE-EXCESS FINES
SANITARY LANDFILL (AREA)	2-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE	TOPSOIL: 2-8%: FAIR-AREA RECLAIM,SMALL STONES 8-15%: FAIR-AREA RECLAIM,SMALL STONES,SLOPE 15+%: POOR-SLOPE
DAILY COVER FOR LANDFILL	2-15%: POOR-AREA RECLAIM 15+%: POOR-AREA RECLAIM,SLOPE	

WATER MANAGEMENT

POND RESERVOIR AREA	2-3%: MODERATE-SEEPAGE,DEPTH TO ROCK 3-8%: MODERATE-SEEPAGE,DEPTH TO ROCK,SLOPE 8+%: SEVERE-SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	2-3% L,SIL: DEPTH TO ROCK,SLOPE 3+% L,SIL: DEPTH TO ROCK,SLOPE 2-3% FSL,SL: SOIL BLOWING,DEPTH TO ROCK 3+% FSL,SL: SOIL BLOWING,DEPTH TO ROCK,SLOPE
TERRACES AND DIVERSIONS	2-8%: DEPTH TO ROCK,ERODES EASILY 8+%: SLOPE,DEPTH TO ROCK,ERODES EASILY
GRASSED WATERWAYS	2-8%: ERODES EASILY,DEPTH TO ROCK 8+%: SLOPE,ERODES EASILY,DEPTH TO ROCK

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	2-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
DWELLINGS WITHOUT BASEMENTS	2-8%: MODERATE-SHRINK-SWELL,DEPTH TO ROCK 8-15%: MODERATE-SHRINK-SWELL,SLOPE,DEPTH TO ROCK 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	2-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
SMALL COMMERCIAL BUILDINGS	2-4%: MODERATE-SHRINK-SWELL,DEPTH TO ROCK 4-8%: MODERATE-SHRINK-SWELL,SLOPE,DEPTH TO ROCK 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	2-15%: SEVERE-LOW STRENGTH 15+%: SEVERE-LOW STRENGTH,SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	2-8%: MODERATE-THIN LAYER 8-15%: MODERATE-SLOPE,THIN LAYER 15+%: SEVERE-SLOPE

REGIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT

CAMP AREAS	2-8% FSL,SL: SLIGHT 8-15% FSL,SL: MODERATE-SLOPE 2-8% L,SIL: MODERATE-DUSTY 8-15% L,SIL: MODERATE-SLOPE,DUSTY 15+%: SEVERE-SLOPE	PLAYGROUNDS	2-6% FSL,SL: MODERATE-SLOPE,DEPTH TO ROCK 2-6%L,SIL:MODERATE-SLOPE,DEPTH TO ROCK,DUSTY 6+%: SEVERE-SLOPE
PICNIC AREAS	2-8% FSL,SL: SLIGHT 8-15% FSL,SL: MODERATE-SLOPE 2-8% L,SIL: MODERATE-DUSTY 8-15% L,SIL: MODERATE-SLOPE,DUSTY 15+%: SEVERE-SLOPE	PATHS AND TRAILS	2-15% FSL,SL: SLIGHT 15-25% FSL,SL: MODERATE-SLOPE L,SIL: SEVERE-ERODES EASILY

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY		ALFALFA HAY (TONS)		WHEAT (BU)		BARLEY (BU)		OATS (BU)		BEANS, DRY PINTO (LBS)		CORN SILAGE (TONS)			
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
2-12%	4E	4E		2.0	15	35	17	40	17	40	200			14		
12+%	6E	6E														

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDX	TREES TO PLANT
COOL							PINYON UTAH JUNIPER		

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	POOR	POOR	FAIR		POOR	FAIR	V. POOR	V. POOR	POOR	POOR	V. POOR	FAIR

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE: MOIST	DRY			
WESTERN WHEATGRASS	AGSM	25	5			
INDIAN RICEGRASS	ORHY	15	10			
NEEDLEANDTHREAD	STCO4	5	15			
ROCKY MOUNTAIN JUNIPER 1/	JUSC2	5				
MUTTONGRASS	POFE	20				
PINYON 1/	PIED	5				
PRAIRIE JUNEGRASS	KOCR	5				
BASIN BIG SAGEBRUSH 1/	ARTR2	10	5			
RABBITBRUSH 1/	CHRYS9	3	5			
GALLETA	HIJA		20			
BOTTLEBRUSH SQUIRRELTAIL	SIHY		10			
BLUE GRAMA	BOGR2		10			
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS		1125	750			
NORMAL YEARS		800	600			
UNFAVORABLE YEARS		600	450			

FOOTNOTES

1/ NOT USUALLY UTILIZED BY SHEEP OR CATTLE.

MLRA(S): 36, 70 SAN MATEO SERIES
REV. TLP. 7-85
USTIC TORRIFLUVENTS, FINE-LOAMY, MIXED (CALCAREOUS), MESIC

THE SAN MATEO SERIES CONSISTS OF DEEP, WELL DRAINED SOILS FORMED IN ALLUVIUM ON FLOODPLAINS, ALLUVIAL FANS, VALLEYS, SWALES AND DRAINAGEWAYS. ELEVATION IS ABOUT 6500 FEET. AAP IS ABOUT 11 INCHES. AAAT IS ABOUT 50F. FFS IS ABOUT 150 DAYS. TYPICALLY, THE SURFACE LAYER IS LIGHT YELLOWISH BROWN LOAM 2 INCHES THICK. THE UNDERLYING MATERIAL IS DOMINANTLY LIGHT OLIVE BROWN LOAM AND SANDY CLAY LOAM TO 60 INCHES, BUT THIN STRATA OF CLAY LOAM, SILT LOAM, SILTY CLAY LOAM AND FINE SANDY LOAM IS COMMON BELOW 29 INCHES. SLOPE IS 0 TO 5 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-2	SL	SM, SM-SC	A-2, A-4	0	100	100	60-70	30-40	20-30	NP-10
0-2	L	CL-ML, CL	A-4, A-6	0	100	100	80-95	60-75	25-35	5-15
0-2	SICL	CL	A-6	0	100	100	90-100	80-100	35-45	15-20
2-29	L, SCL	SC, CL	A-6	0	85-100	75-90	60-75	45-65	30-40	10-20
29-60	SR-SL-SICL	CL	A-6	0	85-100	75-90	60-75	50-65	30-40	10-20

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-2	10-18	1.40-1.50	2.0-6.0	0.11-0.13	7.4-8.4	<2	LOW	.24	5	3	.5-.9	HIGH	LOW
0-2	15-25	1.35-1.45	0.6-2.0	0.16-0.18	7.4-8.4	<2	LOW	.37	5	4L	.5-.9		
0-2	30-40	1.35-1.45	0.2-0.6	0.19-0.21	7.4-8.4	<2	MODERATE	.37	5	4L	.5-.9		
2-29	20-35	1.35-1.45	0.6-2.0	0.15-0.17	7.4-8.4	2-4	MODERATE	.32					
29-60	18-35	1.35-1.45	0.6-2.0	0.15-0.17	7.4-9.0	2-4	MODERATE	.32					

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYDRIC GRP	POTENTIAL FROST ACTION
NONE-RARE			>6.0			-		>60		-		B	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	NONE: MODERATE-PERCS SLOWLY RARE: MODERATE-FLOODING,PERCS SLOWLY	
SEWAGE LAGOON AREAS	0-2%: MODERATE-SEEPAGE 2-5%: MODERATE-SEEPAGE,SLOPE	
SANITARY LANDFILL (TRENCH)	NONE: SLIGHT RARE: MODERATE-FLOODING	
SANITARY LANDFILL (AREA)	NONE: SLIGHT RARE: MODERATE-FLOODING	
DAILY COVER FOR LANDFILL	GOOD	

CONSTRUCTION MATERIAL

ROADFILL	FAIR-SHRINK-SWELL
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	FAIR-TOO CLAYEY,SMALL STONES

WATER MANAGEMENT

POND RESERVOIR AREA	0-3%: MODERATE-SEEPAGE 3-5%: MODERATE-SEEPAGE,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	0-3% L,SICL: FAVORABLE 3-5% L,SICL: SLOPE 0-3% SL: SOIL BLOWING 3-5% SL: SLOPE,SOIL BLOWING
TERRACES AND DIVERSIONS	SL: FAVORABLE L,SICL: ERODES EASILY
GRASSED WATERWAYS	SL: TOO ARID L,SICL: TOO ARID,ERODES EASILY

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SLIGHT
DWELLINGS WITHOUT BASEMENTS	NONE: MODERATE-SHRINK-SWELL RARE: SEVERE-FLOODING
DWELLINGS WITH BASEMENTS	NONE: MODERATE-SHRINK-SWELL RARE: SEVERE-FLOODING
SMALL COMMERCIAL BUILDINGS	0-4% NONE: MODERATE-SHRINK-SWELL 4-5% NONE: MODERATE-SHRINK-SWELL,SLOPE RARE: SEVERE-FLOODING
LOCAL ROADS AND STREETS	NONE: MODERATE-SHRINK-SWELL RARE: MODERATE-SHRINK-SWELL,FLOODING
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	SLIGHT

REGIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT

CAMP AREAS	SL.SICL.NONE: SLIGHT L.NONE: MODERATE-DUSTY RARE: SEVERE-FLOODING	PLAYGROUNDS	0-2% SL.SICL: SLIGHT 2-5% SL.SICL: MODERATE-SLOPE 0-2% L: MODERATE-DUSTY 2-5% L: MODERATE-SLOPE.DUSTY
PICNIC AREAS	SL.SICL: SLIGHT L: MODERATE-DUSTY	PATHS AND TRAILS	SL.SICL: SLIGHT L: MODERATE-DUSTY

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY IRR	CAPABILITY IRR.	IRR	IRR.	IRR	IRR.	IRR	IRR.	IRR	IRR.	IRR	IRR.	IRR	IRR.	IRR	IRR.
0-1%	6C	2C														
1-3%	6E	2E														
3-5%	6E	-														

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROS HAZARD	EQUIP. LIMIT	SEEDL. MORT.	WINDTH HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDEX	PROD CLASS	TREES TO PLANT
							NONE			

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SMALL WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
IRR	POOR	POOR	FAIR	-	-	FAIR	POOR	V. POOR	POOR	-	V. POOR	FAIR
IRR	GOOD	GOOD	GOOD	-	-	GOOD	POOR	V. POOR	GOOD	-	V. POOR	GOOD

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION) (A)

COMMON PLANT NAME	PLANT SYMBOL (NLSPM)	PERCENTAGE COMPOSITION BY CLASS DETERMINING PHASE: MAP10-13	MED PPT	DRY WEIGHT		
BLUE GRAMA	BOGR2	25	-	5		
SIDEOATS GRAMA	BOCU	10	-	-		
BOTTLEBRUSH SQUIRRELTAIL	SIHY	10	-	5		
SAND DROPSEED	SPCR	5	-	-		
ALKALI SACATON	SPAI	-	-	10		
OTHER PERENNIAL GRASSES	PPGG	25	-	5		
OTHER PERENNIAL FORBS	PPFF	5	10	5		
OTHER ANNUAL FORBS	AAFF	5	-	5		
OTHER HALF SHRUBS	HHSS	5	-	-		
OTHER SHRUBS	SSSS	10	5	5		
WESTERN WHEATGRASS	AGSM	-	25	45		
GALLETA	HIJA	-	15	5		
BIG SAGEBRUSH	ARTR2	-	15	-		
NEEDLE AND THREAD	STCO4	-	10	-		
INDIAN RICEGRASS	ORHY	-	10	-		
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS		1000	1100	1350		
NORMAL YEARS		-	750	-		
UNFAVORABLE YEARS		425	600	600		

FOOTNOTES

A MAP10-13: 036C104N; MED PPT: 036A006N; DRY: 0368120N.

MLRA(S): 35, 39, 48A, 70 SHARPS SERIES
REV. JP-RD, 1-83
USTOLLIC HAPLARGIDS, FINE-SILTY, MIXED, MESIC

THE SHARPS SERIES CONSISTS OF MODERATELY DEEP, WELL DRAINED SOILS THAT FORMED IN EOLIAN MATERIAL OVERLYING SHALE AND SOFT SANDSTONE ON MESAS AND HILLS. TYPICALLY THE SURFACE LAYER IS LOAM 9 INCHES THICK. THE SUBSOIL IS CLAY LOAM 10 INCHES THICK OVER LOAM THAT EXTENDS TO WEATHERED BEDROCK AT A DEPTH OF 30 INCHES. THE MEAN ANNUAL PRECIPITATION IS ABOUT 15 INCHES AND THE MEAN ANNUAL AIR TEMPERATURE IS ABOUT 47 F. VEGETATION IS MAINLY SAGEBRUSH, PINYON, JUNIPER AND GRASS. SLOPES RANGE FROM 2 TO 40 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-9	L, SIL	CL-ML, ML	A-4	0	85-100	85-100	60-95	50-90	20-30	NP-10
0-9	FSL	ML, SM	A-4	0	85-100	85-100	80-95	45-60	-	NP
9-19	CL, L, SICL	CL	A-6	0	85-100	85-100	60-95	50-85	25-40	10-20
19-30	L, CL, SICL	CL-ML, CL	A-4, A-6	0	85-100	85-100	60-95	50-80	25-35	10-15
30	WB									

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-9	10-20	1.30-1.40	0.6-2.0	0.16-0.18	6.6-7.8	-	LOW	.24	2	5	.5-2	HIGH	LOW
0-9	5-10	1.45-1.50	0.6-2.0	0.14-0.16	6.6-7.8	-	LOW	.20	2	3	.5-2		
9-19	20-35	1.25-1.35	0.2-0.6	0.15-0.17	6.6-8.4	-	MODERATE	.24					
19-30	20-30	1.25-1.35	0.6-2.0	0.13-0.15	7.9-9.0	<2	MODERATE	.24					
30													

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		20-40	SOFT	-		C	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	2-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-SLOPE,DEPTH TO ROCK
SEWAGE LAGOON AREAS	2-7%: SEVERE-DEPTH TO ROCK 7+%: SEVERE-SLOPE,DEPTH TO ROCK
SANITARY LANDFILL (TRENCH)	2-25%: SEVERE-DEPTH TO ROCK 25+%: SEVERE-SLOPE,DEPTH TO ROCK
SANITARY LANDFILL (AREA)	2-8%: SLIGHT 8-15%: MODERATE-SLOPE 15+%: SEVERE-SLOPE
DAILY COVER FOR LANDFILL	2-15%: POOR-AREA RECLAIM 15+%: POOR-SLOPE,AREA RECLAIM

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	2-8%: MODERATE-DEPTH TO ROCK 8-15%: MODERATE-SLOPE,DEPTH TO ROCK 15+%: SEVERE-SLOPE
DWELLINGS WITHOUT BASEMENTS	2-8%: MODERATE-SHRINK-SWELL 8-15%: MODERATE-SLOPE,SHRINK-SWELL 15+%: SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	2-8%: MODERATE-DEPTH TO ROCK,SHRINK-SWELL 8-15%: MODERATE-SLOPE,DEPTH TO ROCK, SHRINK-SWELL 15+%: SEVERE-SLOPE
SMALL COMMERCIAL BUILDINGS	2-4%: MODERATE-SHRINK-SWELL 4-8%: MODERATE-SLOPE,SHRINK-SWELL 8+%: SEVERE-SLOPE
LOCAL ROADS AND STREETS	2-15%: SEVERE-LOW STRENGTH 15+%: SEVERE-SLOPE,LOW STRENGTH
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	2-8%: MODERATE-THIN LAYER 8-15%: MODERATE-SLOPE,THIN LAYER 15+%: SEVERE-SLOPE

CONSTRUCTION MATERIAL

ROADFILL	POOR-LOW STRENGTH,THIN LAYER,AREA RECLAIM
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	2-8%: MODERATE-THIN LAYER,AREA RECLAIM 8-15%:MODERATE-SLOPE,THIN LAYER,AREA RECLAIM 15+%: SEVERE-SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	2-3%: MODERATE-SEEPAGE,DEPTH TO ROCK 3-8%: MODERATE-SEEPAGE,DEPTH TO ROCK,SLOPE 8+%: SEVERE-SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-PIPING
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	2-6%: DEPTH TO ROCK 6+%: SLOPE,DEPTH TO ROCK
IRRIGATION	2-6% L: ROOTING DEPTH 6+% L: SLOPE,ROOTING DEPTH 2-6% FSL: SOIL BLOWING,ROOTING DEPTH 6+% FSL: SLOPE,SOIL BLOWING,ROOTING DEPTH
TERRACES AND DIVERSIONS	2-12% L: FAVORABLE 12+% L: SLOPE 2-12% FSL: SOIL BLOWING 12+% FSL: SLOPE,SOIL BLOWING
GRASSED WATERWAYS	2-8%: FAVORABLE 8+%: SLOPE

REGIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT

CAMP AREAS	2-8%: MODERATE-PERCS SLOWLY 8-15%: MODERATE-SLOPE,PERCS SLOWLY 15+%: SEVERE-SLOPE	PLAYGROUNDS	2-6%: MODERATE-SLOPE,PERCS SLOWLY, DEPTH TO ROCK 6+%: SEVERE-SLOPE
PICNIC AREAS	2-8%: MODERATE-PERCS SLOWLY 8-15%: MODERATE-SLOPE,PERCS SLOWLY 15+%: SEVERE-SLOPE	PATHS AND TRAILS	2-15%: SLIGHT 15-25%: MODERATE-SLOPE 25+%: SEVERE-SLOPE

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY		ALFALFA HAY (TONS)		WHEAT (BU)		BEANS, DRY PINTO (LBS)									
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
2-6%	3E	3E	2	3	16		300									
6-12%	4E	4E	1.5	2.5	12		250									
12+%	6E															

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDX	TREES TO PLANT
							PINYON UTAH JUNIPER		

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
2-12%	FAIR	FAIR	FAIR	-	-	FAIR	V. POOR	V. POOR	FAIR	-	V. POOR	FAIR
12+%	POOR	FAIR	FAIR	-	-	FAIR	V. POOR	V. POOR	FAIR	-	V. POOR	FAIR

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE: MOIST	DRY			
BASIN BIG SAGEBRUSH	ARTR2	10	15			
WESTERN WHEATGRASS	AGSM	30	5			
INDIAN RICEGRASS	ORHY	~~5~~ 10	10			
MUTTONGRASS	POFE	10				
GALLETA	HIJA	~~1~~ 5	20			
BOTTLEBRUSH SQUIRRELTAIL	SIHY	16	10			
BLACK SAGEBRUSH	ARARN	5				
NEEDLEANDTHREAD	STCO4		15			
BLUE GRAMA	BOGR2		10			
RUBBER RABBITBRUSH	CHNA2		5			
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS		1500	750			
NORMAL YEARS		1200	600			
UNFAVORABLE YEARS		800	450			

FOOTNOTES

MLRA(S): 34, 35
REV. SMH, JM, 9-84
LITHIC USTIC TORRIORTHENTS, LOAMY, MIXED (CALCAREOUS), MESIC

THE TRAVESILLA SERIES CONSISTS OF VERY SHALLOW AND SHALLOW WELL DRAINED SOILS FORMED IN RESIDUUM ON BENCHES AND CUESTAS UNDER TREES AND SHRUBS. MAAT IS ABOUT 52F. AAP IS ABOUT 12 INCHES. FFS IS 70 TO 150 DAYS. TYPICALLY THE SURFACE LAYER IS LIGHT YELLOWISH BROWN SANDY LOAM 1 INCH THICK. THE UNDERLYING MATERIAL TO A DEPTH OF 8 INCHES IS LIGHT YELLOWISH BROWN FINE SANDY LOAM AND LOAM. SANDSTONE IS AT A DEPTH OF 8 INCHES. SLOPES ARE 3 TO 50 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-1	FSL, SL	SM	A-2, A-4	0-5	90-100	80-100	60-80	30-50	15-25	NP-5
0-1	CN-SL	SM	A-2, A-4	10-15	85-100	60-85	45-60	25-40	15-25	NP-5
1-8	FSL, SL, L	SM-SC, SM, CL-ML, ML	A-2, A-4	0-10	85-100	80-100	60-90	30-60	15-30	NP-10
8	UWB									

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND ERODIBILITY GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-1	3-13	1.45-1.60	2.0-6.0	0.09-0.13	7.4-8.4	<2	LOW	.28	2	3	.5-1	HIGH	MODERATE
0-1	6-13	1.45-1.60	2.0-6.0	0.10-0.14	7.4-8.4	<2	LOW	.15	2	8	.5-1		
1-8	8-18	1.30-1.45	0.6-6.0	0.12-0.16	7.4-9.0	<2	LOW	.32					
8													

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYDRIC GRP	POTENTIAL FROST ACTION
NONE			>6.0			-		6-20	HARD	-		D	MODERATE

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
SEWAGE LAGOON AREAS	3-7%: SEVERE-DEPTH TO ROCK 7+%: SEVERE-DEPTH TO ROCK,SLOPE
SANITARY LANDFILL (TRENCH)	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
SANITARY LANDFILL (AREA)	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
DAILY COVER FOR LANDFILL	3-15%: POOR-DEPTH TO ROCK 15+%: POOR-DEPTH TO ROCK,SLOPE

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
DWELLINGS WITHOUT BASEMENTS	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-SLOPE,DEPTH TO ROCK
DWELLINGS WITH BASEMENTS	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
SMALL COMMERCIAL BUILDINGS	3-8%: SEVERE-DEPTH TO ROCK 8+%: SEVERE-SLOPE,DEPTH TO ROCK
LOCAL ROADS AND STREETS	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-SLOPE,DEPTH TO ROCK

CONSTRUCTION MATERIAL

ROADFILL	3-25%: POOR-DEPTH TO ROCK 25+%: POOR-DEPTH TO ROCK,SLOPE
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	3-15%: POOR-DEPTH TO ROCK,SMALL STONES 15+%: POOR-DEPTH TO ROCK,SMALL STONES,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	3-8%: SEVERE-DEPTH TO ROCK 8+%: SEVERE-DEPTH TO ROCK,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-THIN LAYER
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	CN-SL: DEPTH TO ROCK,SLOPE FSL,SL: SOIL BLOWING,DEPTH TO ROCK,SLOPE
TERRACES AND DIVERSIONS	3-8% CN-SL: DEPTH TO ROCK 8+% CN-SL: SLOPE,DEPTH TO ROCK 3-8% FSL,SL: DEPTH TO ROCK,SOIL BLOWING 8+% FSL,SL: SLOPE,DEPTH TO ROCK,SOIL BLOWING
GRASSED WATERWAYS	3-8%: DEPTH TO ROCK 8+%: SLOPE,DEPTH TO ROCK

REGIONAL INTERPRETATIONS

TRAVESSILLA SERIES
DRY

NM0690

RECREATIONAL DEVELOPMENT

CAMP AREAS	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-SLOPE,DEPTH TO ROCK	PLAYGROUNDS	3-6% FSL,SL: SEVERE-DEPTH TO ROCK 6+% FSL,SL: SEVERE-SLOPE,DEPTH TO ROCK 3-6% CN: SEVERE-SMALL STONES,DEPTH TO ROCK 6+% CN: SEVERE-SLOPE,SMALL STONES, DEPTH TO ROCK
PICNIC AREAS	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-SLOPE,DEPTH TO ROCK	PATHS AND TRAILS	3-15%: SLIGHT 15-25%: MODERATE-SLOPE 25+%: SEVERE-SLOPE

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPA-BILITY																	
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
ALL	7S																	

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROS HAZARD	EQUIP. LIMIT	SEEDL. MORT'Y	WINDTH HAZARD	PLANT COMPET	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDEX	PROD CLASS	TREES TO PLANT
ALL							PINYON JUNIPER			

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	POTENTIAL AS HABITAT FOR: OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	V. POOR	V. POOR	POOR	-	-	POOR	V. POOR	V. POOR	POOR	POOR	-	V. POOR	POOR

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION) (A)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE: MOIST	FSL	CN-SL,V SHALLOW	CN-SL,WARM
GALLETA	HIJA		5		10
NEEDLEANDTHREAD	STCO4			10	
BLUEBUNCH WHEATGRASS	AGSP		10		
SALINE WILDRYE	ELSA		20		
OTHER PERENNIAL FORBS	PPFF	20	5	10	5
BLACKBRUSH	CORA	25			70
MORMON-TEA	EPHED	7	5	5	5
BLACK SAGEBRUSH	ARARN		20		
SHADSCALE	ATCO			5	
UTAH JUNIPER	JUOS			5	
BIGELOW SAGEBRUSH	ARBI3			15	
LITTLELEAF MOUNTAINMAHOGANY	CELET2			20	
MORMON-TEA	EPHED		10		
OTHER SHRUBS	SSSS	33	20	25	5
OTHER PERENNIAL GRASSES	PPGG	10	10	5	7
POTENTIAL PRODUCTION (LBS./AC. DRY WT):					
FAVORABLE YEARS		400	350	300	325
NORMAL YEARS		300	250	225	250
UNFAVORABLE YEARS		150	150	125	150

FOOTNOTES

C00749

S O I L I N T E R P R E T A T I O N S R E C O R D

ZYME SERIES
CHANNERY

MLRA(S): 37, 39
REV. DEC.8M, 4-84
USTIC TORRIORTHENTS, CLAYEY, MONTMORILLONITIC (CALCAREOUS), MESIC, SHALLCW

THE ZYME SERIES CONSISTS OF SHALLOW, WELL DRAINED SCILS FORMED IN CALCAREOUS RESIDUUM FROM SHALE ON KNOBS, RIDGES, AND HILLSIDES. THE SURFACE LAYER IS A VERY CHANNERY CLAY CLAY LOAM 1 INCH THICK. THE LOWER PART OF THE SURFACE IS A CLAY LOAM ABOUT 4 INCHES THICK. THE UNDERLYING MATERIAL TO A DEPTH OF 19 INCHES IS CLAY. WEATHERED SHALF TS AT A DEPTH OF 19 INCHES. ELEVATION IS 5400 TO 7400 FEET. MAP IS 11 TC 15 INCHES. MAAT IS 42 TO 52 F. NATIVE VEGETATION IS PINYON, JUNIPER, SAGEBRUSH AND GRASSES. SLOPES RANGE FROM 3 TO 65 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3" IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-1	CNV-CL	GC	A-2	0-10	35-45	30-40	25-35	20-30	40-55	20-35
0-1	GR-CL	SC, GC	A-7	0-10	65-75	60-70	45-55	40-50	40-55	20-35
1-19	CL, C	CL, CH	A-7	0-5	90-100	85-100	75-100	70-95	45-55	25-35
19	WB									

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-1	27-40	1.30-1.35	0.2-0.6	0.08-0.10	7.4-8.4	-	LOW	.10	1	8	1-3	HIGH	LOW
0-1	27-40	1.30-1.35	0.2-0.6	0.12-0.14	7.4-8.4	-	MOCERATE	.17	1	6	1-3		
1-19	35-45	1.30-1.40	0.06-0.2	0.15-0.17	7.4-8.4	<2	HIGH	-					
19													

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		6-20	SOFT	-		D	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
SEWAGE LAGOON AREAS	3-7%: SEVERE-DEPTH TO ROCK 7+%: SEVERE-DEPTH TO ROCK,SLOPE
SANITARY LANDFILL (TRENCH)	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
SANITARY LANDFILL (AREA)	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
DAILY COVER FOR LANDFILL	3-15%: POOR-AREA RECLAIM,HARD TO PACK 15+%: POOR-AREA RECLAIM,HARD TO PACK,SLOPE

CONSTRUCTION MATERIAL

ROADFILL	3-25%: POOR-AREA RECLAIM,LOW STRENGTH 25+%: POOR-AREA RECLAIM,LOW STRENGTH,SLOPE
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	3-15%: POOR-AREA RECLAIM 15+%: POOR-AREA RECLAIM,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	3-8%: SEVERE-DEPTH TO ROCK 8+%: SEVERE-DEPTH TO ROCK,SLOPE
EMBANKMENTS DIKES AND LEVEES	SEVERE-THIN LAYER
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	PERCS SLOWLY,DEPTH TO ROCK,SLOPE
TERRACES AND DIVERSIONS	3-8%: DEPTH TO ROCK,PERCS SLOWLY 8+%: SLOPE,DEPTH TO ROCK,PERCS SLOWLY
GRASSED WATERWAYS	3-8%: DEPTH TO ROCK,PERCS SLOWLY 8+%: SLOPE,DEPTH TO ROCK,PERCS SLOWLY

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	3-15%: SEVERE-DEPTH TO ROCK 15+%: SEVERE-DEPTH TO ROCK,SLOPE
DWELLINGS WITHOUT BASEMENTS	3-15%: SEVERE-SHRINK-SWELL 15+%: SEVERE-SHRINK-SWELL,SLOPE
DWELLINGS WITH BASEMENTS	3-15%: SEVERE-DEPTH TO ROCK,SHRINK-SWELL 15+%:SEVERE-DEPTH TO ROCK,SLOPE,SHRINK-SWELL
SMALL COMMERCIAL BUILDINGS	3-8%: SEVERE-SHRINK-SWELL 8+%: SEVERE-SHRINK-SWELL,SLOPF
LOCAL ROADS AND STREETS	3-15%: SEVERE-LOW STRENGTH,SHRINK-SWELL 15+%: SEVERE-LOW STRENGTH,SLOPE,SHRINK-SWELL
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	3-15% GR: SEVERE-THIN LAYER 15+% GR: SEVERE-SLOPE,THIN LAYER 3-15% CNV: SEVERE-SMALL STONES,THIN LAYER 15+%CNV:SEVERE-SMALL STONES,SLOPE,THIN LAYER

REGIONAL INTERPRETATIONS

RECREATIONAL DEVELOPMENT

CAMP AREAS	3-15% GR: SEVERE-DEPTH TO ROCK 15+% GR: SEVERE-SLOPE,DEPTH TO ROCK 3-15% CNV: SEVERE-SMALL STONES,DEPTH TO ROCK 15+% CNV: SEVERE-SLOPE,SMALL STONES, DEPTH TO ROCK	PLAYGROUNDS	3-6%: SEVERE-SMALL STONES,DEPTH TO ROCK 6+%: SEVERE-SLOPE,SMALL STONES,DEPTH TO ROCK
PICNIC AREAS	3-15% GR: SEVERE-DEPTH TO ROCK 15+% GR: SEVERE-SLOPE,DEPTH TO ROCK 3-15% CNV: SEVERE-SMALL STONES,DEPTH TO ROCK 15+% CNV: SEVERE-SLOPE,SMALL STONES, DEPTH TO ROCK	PATHS AND TRAILS	3-15% GR: SLIGHT 15-25% GR: MODERATE-SLOPE 25+% GR: SEVERE-SLOPE 3-25% CNV: SEVERE-SMALL STONES 25+% CNV: SEVERE-SLOPE,SMALL STONES

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY																	
	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
3-25%	6E																	
25-65%	7E																	

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDX	TREES TO PLANT
COOL							PINYON UTAH JUNIPER		
3-65%									

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
							POTENTIAL AS HABITAT FOR:					
3-25%	POOR	POOR	FAIR	-	POOR	FAIR	V. POOR	V. POOR	POOR	POOR	V. POOR	FAIR
25-65%	V. POOR	V. POOR	FAIR	-	POOR	FAIR	V. POOR	V. POOR	POOR	V. POOR	V. POOR	FAIR

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE: COOL	DRY			
INDIAN RICEGRASS	ORHY	15	15			
WESTERN WHEATGRASS	AGSM	10	10			
NEEDLEANDTHREAD	STCO4	5	5			
BOTTLEBRUSH SQUIRRELTAIL	SIHY	5	5			
BASIN BIG SAGEBRUSH	ARTR2	15	15			
TRUE MOUNTAINMAHOGANY	CEMO2	10	10			
SERVICEBERRY	AMELA	5				
ANTELOPE BITTERBRUSH	PUTR2	5				
GAMBEL OAK	QUGA	10				
MUTTONGRASS	POFE	10	5			
GALLETA	HIJA		10			
FOURWING SALTBUSH	ATCA2		5			
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS		600	500			
NORMAL YEARS		400	300			
UNFAVORABLE YEARS		300	200			

FOOTNOTES

C07057

S O I L I N T E P P R E T A T I O N S R E C O R D

MLRA(S): 49
TW.8M. 1-84
USTIC TORRIORTHENTS

USTIC TORRIORTHENTS
BOULDERY

USTIC TORRIORTHENTS, BOULDERY, CONSIST OF SHALLOW TO MODERATELY DEEP, WELL TO SOMEWHAT EXCESSIVELY DRAINED SOILS FORMED IN RESIDUUM AND COLLUVIUM OF IGNEOUS BEDROCK ON MOUNTAINSIDES. A REFERENCE PEDON HAS A BROWN VERY BOULDERY SANDY LOAM SURFACE LAYER ABOUT 4 INCHES THICK OVER EXTREMELY GRAVELLY SANDY LOAM ABOUT 3 INCHES THICK OVER SOFT GRANODIORITE ABOUT 11 INCHES THICK OVER HARD GRANODIORITE AT A DEPTH OF ABOUT 15 INCHES. AVERAGE ANNUAL PPT IS ABOUT 13 INCHES. AVERAGE ANNUAL AIR TEMP. IS ABOUT 46 F. SLOPES RANGE FROM 35 TO 80 PERCENT.

ESTIMATED SOIL PROPERTIES

DEPTH (IN.)	USDA TEXTURE	UNIFIED	AASHTO	FRACT >3 IN (PCT)	PERCENT OF MATERIAL LESS THAN 3" PASSING SIEVE NO. 4	10	40	200	LIQUID LIMIT	PLASTICITY INDEX
0-4	BYV-SL,STX-SL,CBX-SL	GM, GP-GM, SM, SP-SM	A-1	20-50	50-70	25-45	15-30	10-20	20-30	NP-5
0-4	STX-COSL	GM, GP-GM, SM, SP-SM	A-1	20-50	50-70	25-45	10-30	10-20	20-30	NP-5
0-4	GRV-SL, GRX-SL	GM, GP-GM, SM, SP-SM	A-1	0-20	45-65	20-40	10-30	5-15	20-30	NP-5
4-7	GRX-SL, GRX-COSL	GM, GP-GM, SM, SP-SM	A-1	0-20	45-65	20-40	10-30	5-15	20-30	NP-5
7-18	WB									
18	HWR									

DEPTH (IN.)	CLAY (PCT)	MOIST BULK DENSITY (G/CM3)	PERMEABILITY (IN/HR)	AVAILABLE WATER CAPACITY (IN/IN)	SOIL REACTION (PH)	SALINITY (MMHOS/CM)	SHRINK-SWELL POTENTIAL	EROSION FACTORS K	T	WIND EROD. GROUP	ORGANIC MATTER (PCT)	CORROSIVITY STEEL	CONCRETE
0-4	8-18	1.25-1.35	2.0-6.0	0.02-0.06	6.6-7.8	-	LOW	.02	1	8	1-2	MODERATE	LOW
0-4	8-18	1.25-1.35	2.0-6.0	0.02-0.06	6.6-7.8	-	LOW	.02	1	8	1-2		
0-4	8-18	1.25-1.35	2.0-6.0	0.02-0.06	6.6-7.8	-	LOW	.02	1	8	1-2		
4-7	8-18	1.40-1.50	2.0-6.0	0.02-0.06	6.6-8.4	-	LOW	.02					
7-18													
18													

FLOODING FREQUENCY	DURATION	MONTHS	HIGH WATER TABLE DEPTH (FT)	KIND	MONTHS	CEMENTED PAN DEPTH (IN)	HARDNESS	BEDROCK DEPTH (IN)	HARDNESS	SUBSIDENCE INIT. (IN)	TOTAL (IN)	HYD GRP	POTENT'L FROST ACTION
NONE			>6.0			-		4-30	SOFT	-		D	LOW

SANITARY FACILITIES

SEPTIC TANK ABSORPTION FIELDS	SEVERE-DEPTH TO ROCK,SLOPE
SEWAGE LAGOON AREAS	GRV,GRX: SEVERE-DEPTH TO ROCK,SLOPE BYV,STX,CBX: SEVERE-DEPTH TO ROCK,SLOPE, LARGE STONES
SANITARY LANDFILL (TRENCH)	SEVERE-DEPTH TO ROCK,SEEPAGE,SLOPE
SANITARY LANDFILL (AREA)	SEVERE-DEPTH TO ROCK,SLOPE
DAILY COVER FOR LANDFILL	POOR-AREA RECLAIM,SLOPE

BUILDING SITE DEVELOPMENT

SHALLOW EXCAVATIONS	SEVERE-DEPTH TO ROCK,SLOPE
DWELLINGS WITHOUT BASEMENTS	SEVERE-SLOPE
DWELLINGS WITH BASEMENTS	SEVERE-DEPTH TO ROCK,SLOPE
SMALL COMMERCIAL BUILDINGS	SEVERE-SLOPE
LOCAL ROADS AND STREETS	SEVERE-SLOPE
LAWNS, LANDSCAPING AND GOLF FAIRWAYS	GRV,GRX: SEVERE-SMALL STONES,DROUGHTY BYV,STX,CBX: SEVERE-SMALL STONES, LARGE STONES,DROUGHTY

CONSTRUCTION MATERIAL

ROADFILL	POOR-AREA RECLAIM,SLOPE
SAND	IMPROBABLE-EXCESS FINES
GRAVEL	IMPROBABLE-EXCESS FINES
TOPSOIL	POOR-AREA RECLAIM,SMALL STONES,SLOPE

WATER MANAGEMENT

POND RESERVOIR AREA	SEVERE-DEPTH TO ROCK,SLOPE
EMBANKMENTS DIKES AND LEVEES	GRV,GRX: MODERATE-LARGE STONES BYV,STX,CBX: SEVERE-LARGE STONES
EXCAVATED PONDS AQUIFER FED	SEVERE-NO WATER
DRAINAGE	DEEP TO WATER
IRRIGATION	GRV,GRX: DROUGHTY,DEPTH TO ROCK BYV,STX,CBX: LARGE STONES,DROUGHTY, DEPTH TO ROCK
TERRACES AND DIVERSIONS	SLOPE,LARGE STONES,DEPTH TO ROCK
GRASSED WATERWAYS	LARGE STONES,SLOPE,DROUGHTY

REGIONAL INTERPRETATIONS

USTIC TORRIORTHENTS
BOULDERY

C07057

RECREATIONAL DEVELOPMENT

CAMP AREAS	GRV,GRX,BYV: SEVERE-SLOPE,SMALL STONES STX,CBX: SEVERE-SLOPE,LARGE STONES, SMALL STONES	PLAYGROUNDS	GRV,GRX: SEVERE-SLOPE,SMALL STONES BYV,STX,CBX: SEVERE-LARGE STONES,SLOPE, SMALL STONES
PICNIC AREAS	GRV,GRX,BYV: SEVERE-SLOPE,SMALL STONES STX,CBX: SEVERE-SLOPE,LARGE STONES, SMALL STONES	PATHS AND TRAILS	SEVERE-SLOPE,SMALL STONES

CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE (HIGH LEVEL MANAGEMENT)

CLASS-DETERMINING PHASE	CAPABILITY NIRR	CAPABILITY IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.	NIRR	IRR.
35-65%	7S															
65+%	8															

WOODLAND SUITABILITY

CLASS-DETERMINING PHASE	ORD SYM	MANAGEMENT PROBLEMS: EROSION HAZARD	EQUIP. LIMIT	SEEDLING MORT'Y.	WINDTH. HAZARD	PLANT COMPET.	POTENTIAL PRODUCTIVITY: COMMON TREES	SITE INDX	TREES TO PLANT
35-50%	1R	MODERATE	SEVERE	SEVERE	SEVERE	SEVERE	PINYON	20	
50+%	1R	SEVERE	SEVERE	SEVERE	SEVERE	SEVERE	ROCKY MT. JUNIPER		

WINDBREAKS

CLASS-DETERMINING PHASE	SPECIES	HT	SPECIES	HT	SPECIES	HT	SPECIES	HT
	NONE							

WILDLIFE HABITAT SUITABILITY

CLASS-DETERMINING PHASE	POTENTIAL FOR HABITAT ELEMENTS: GRAIN & SEED	GRASS & LEGUME	WILD HERB.	HARDWD TREES	CONIFER PLANTS	SHRUBS	WETLAND PLANTS	SHALLOW WATER	OPENLD WILDLF	WOODLD WILDLF	WETLAND WILDLF	RANGELD WILDLF
ALL	V. POOR	V. POOR	V. POOR	-	V. POOR	FAIR	V. POOR	V. POOR	V. POOR	V. POOR	V. POOR	-

POTENTIAL NATIVE PLANT COMMUNITY (RANGELAND OR FOREST UNDERSTORY VEGETATION)

COMMON PLANT NAME	PLANT SYMBOL (NLSPN)	PERCENTAGE COMPOSITION (DRY WEIGHT) BY CLASS DETERMINING PHASE: ALL				
SCRIBNER NEEDLEGRASS	STSC2	25				
BLUE GRAMA	BOGR2	15				
MOUNTAINMAHOGANY	CERCO	30				
SIDEOATS GRAMA	BOCU	15				
SAND DROPSEED	SPCR	5				
OTHER PERENNIAL FORBS	PPFF	2				
GAMBEL OAK	QUGA	5				
OTHER SHRUBS	SSSS	1				
POTENTIAL PRODUCTION (LBS./AC. DRY WT):						
FAVORABLE YEARS		550				
NORMAL YEARS		350				
UNFAVORABLE YEARS		200				

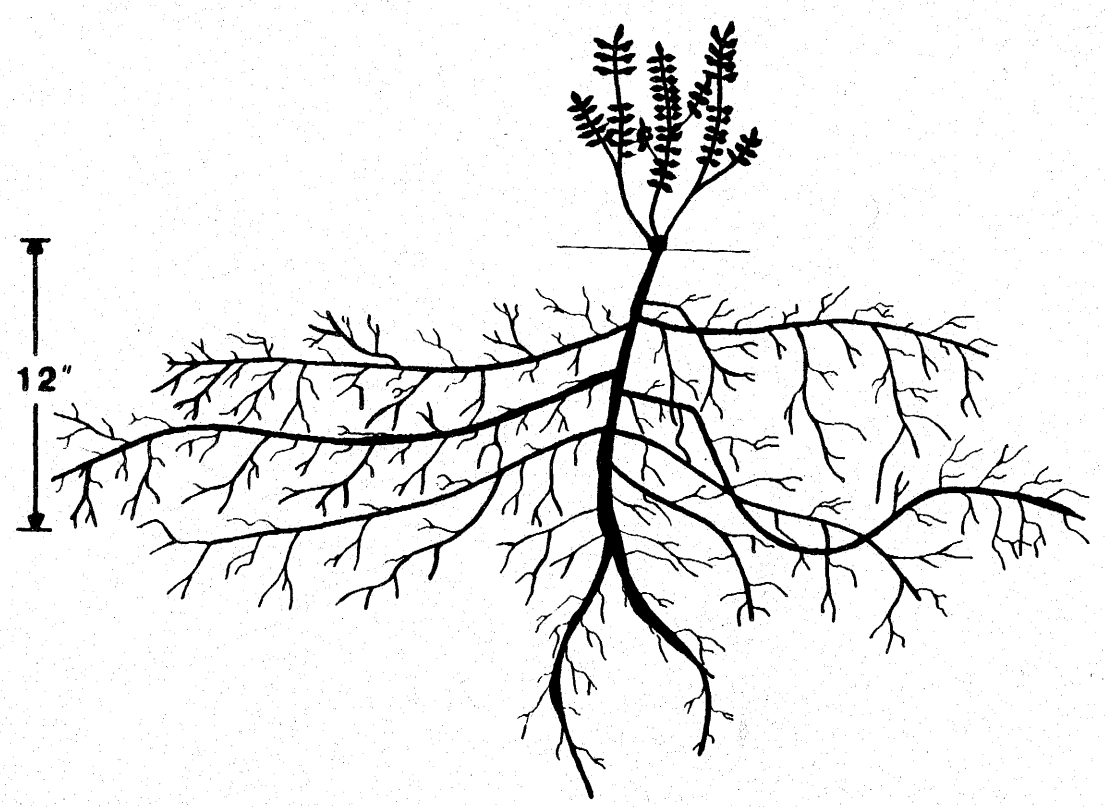
FOOTNOTES

intermountainsoils

ATTACHMENT 7

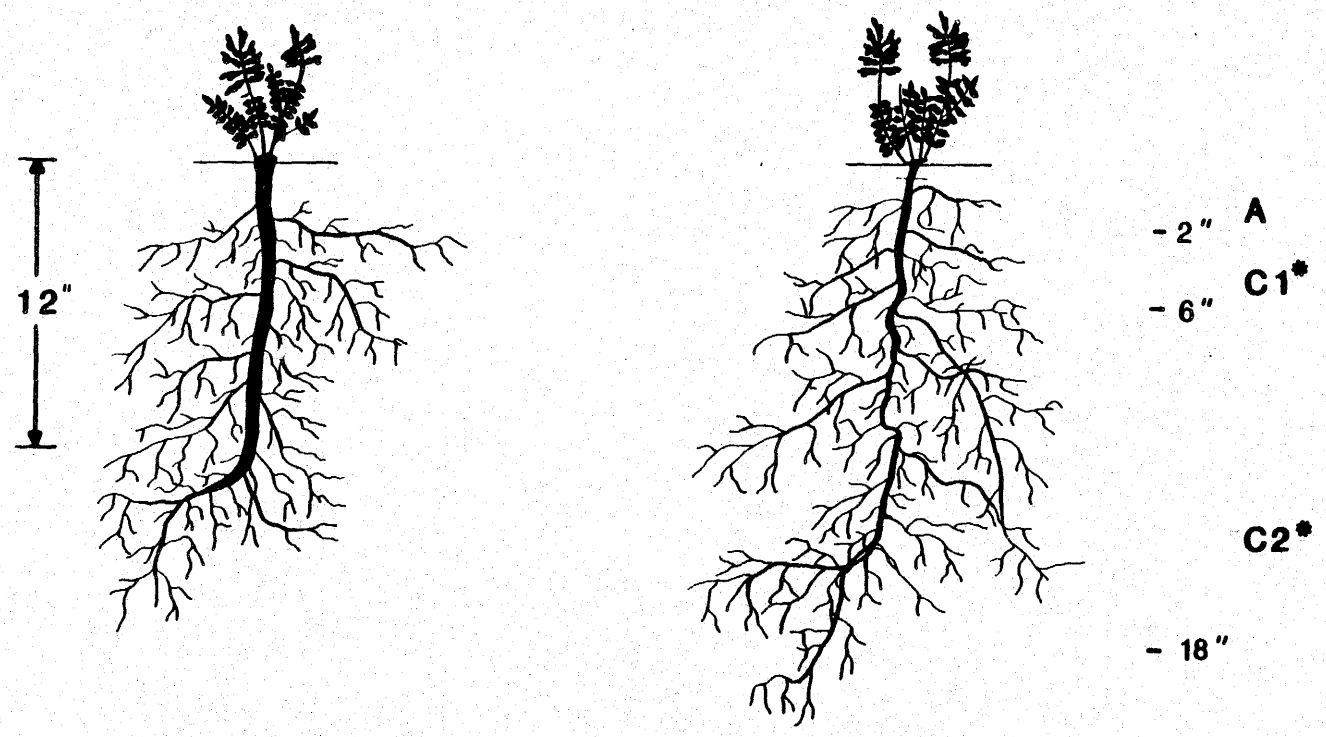
ROOT DRAWINGS FROM THE 1985 GEOBOTANICAL STUDY

Site: 85-3
Species: ASPR
Soil: Zyme

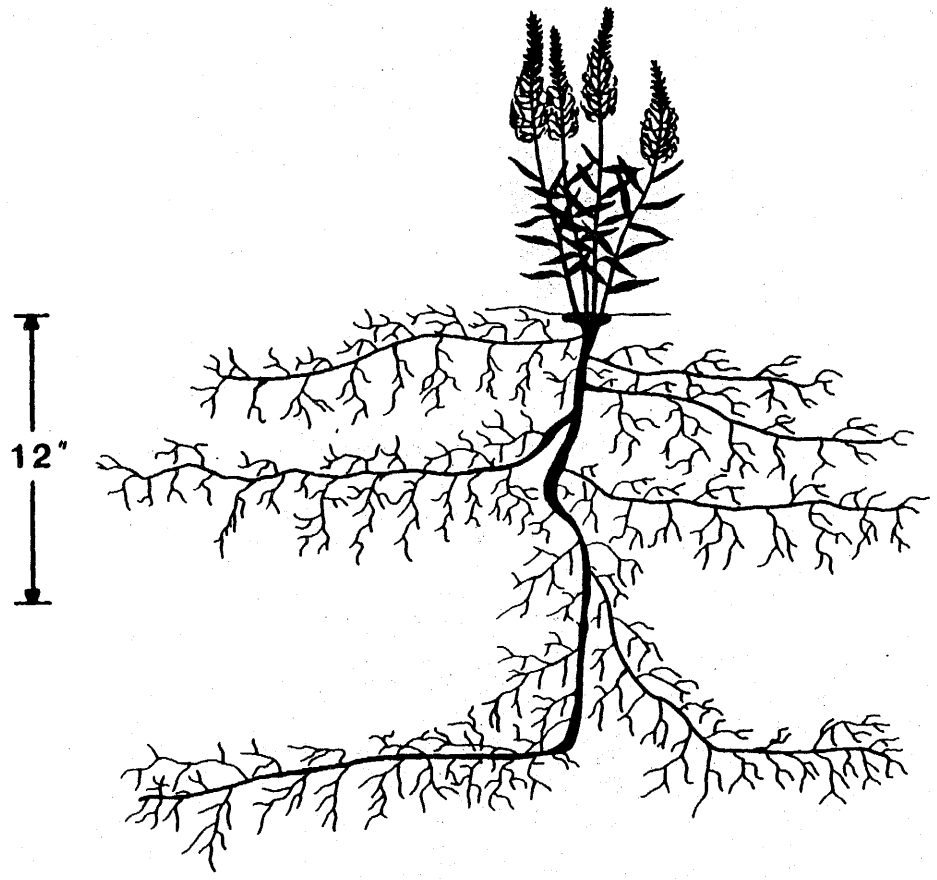


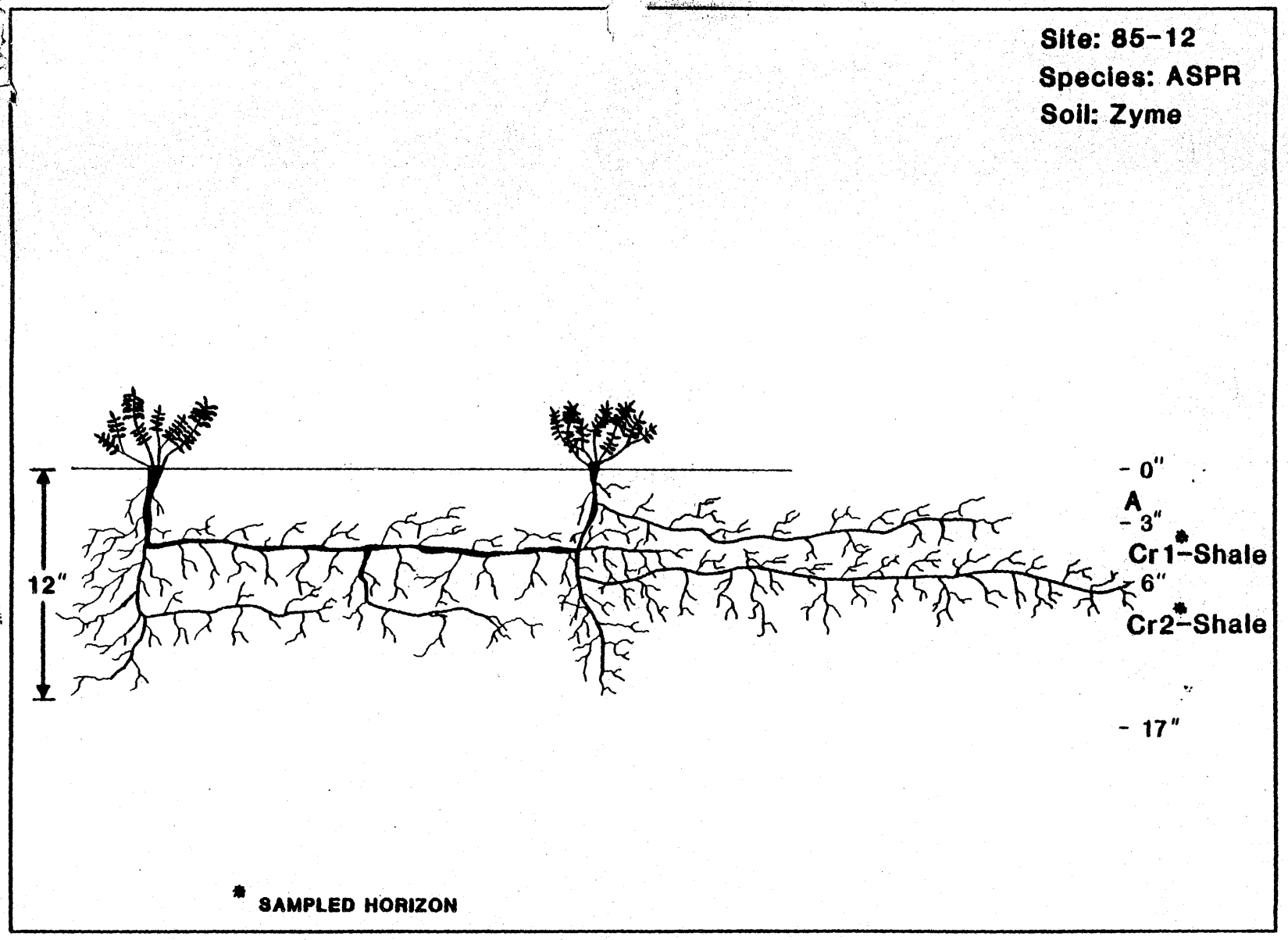
* SAMPLED HORIZON

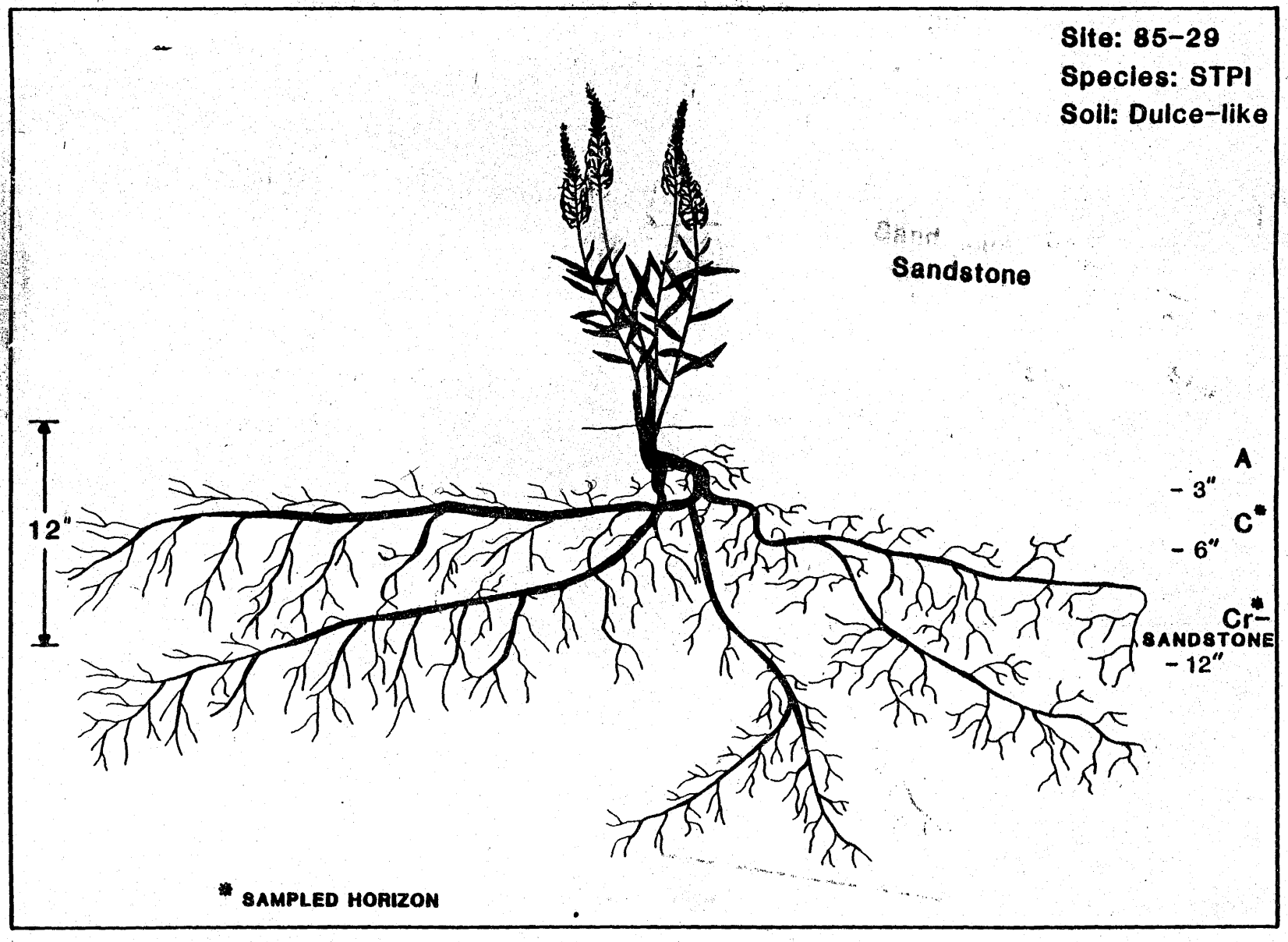
Site: 85-10
Species: ASPR
Soil: Soil A



* SAMPLED HORIZON


Site: 85-11
Species: STPI
Soil: Bond-like
12"
A
-3"
Bt*
-8"
C
-15"
2Cr*-Shale
-30"
3Cr-Coal
* SAMPLED HORIZON


Site: 85-12
Species: ASPR
Soil: Zyme
12"
- 0"
A
- 3"
Cr1*-Shale
- 6"
Cr2*-Shale
- 17"
* SAMPLED HORIZON


Site: 85-29
Species: STPI
Soil: Dulce-like
Sandstone
12"
A
- 3"
C*
- 6"
Cr*-
SANDSTONE
- 12"
* SAMPLED HORIZON

APPENDIX A-1

2003 SOIL SURVEY REPORT

N-9, N-12, & N-99 COAL RESOURCE AREAS

BLACK MESA MINING COMPLEX

SEP 2005
APPROVED

Revised 01/28/05

2003 SOIL SURVEY REPORT

N-9, N-12, AND N-99 COAL RESOURCE AREAS

BLACK MESA MINING COMPLEX

Submitted to:

Peabody Western Coal Company
Black Mesa Mining Complex
P.O. Box 650
Kayenta, Arizona 86033

Submitted by:

James Nyenhuis
Certified Professional Soil Scientist, ARCPACS #2753
600 Ramah Drive
Fort Collins, Colorado 80525

APPROVED
SEP 2005

Revised January 2005

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1

2.0 METHODS 2
- 2.1 Order 2 Soil Survey 2

3.0 RESULTS AND DISCUSSION 4
- 3.1 Soil Survey Maps 4
- 3.2 Soil Map Unit Legend 4
- 3.3 Soil Map Unit Descriptions 4
- 3.4 Soil Series 5
  - 3.4.1 Soil Series Names 5
  - 3.4.2 Soil Series Taxonomic Classification 5
  - 3.4.3 Soil Series Descriptions 5
- 3.5 Soil Moisture Regime and Soil Reclassification 6
- 3.6 Soil Laboratory Results 7
- 3.7 Topsoil Suitability and Salvage Depth Recommendation 7

4.0 REFERENCES 13

APPROVED
SEP 2005

LIST OF TABLES

Table | Page

1 2003 Soil Survey Map Unit Legend 14

2 Current Correlation of Soil Series on the Black Mesa Lease Area 15

3 Taxonomic Classification of Soil Series on the Black Mesa Lease Area 16

4 N-9, N-12, and N-99 Coal Resource Areas Soil Survey - Recommended Soil Salvage Depths 17

5 N-9, N-12, and N-99 Coal Resource Areas Soil Survey - List of Dug Soil Holes and Soil Characteristics for Each Coal Resource Area (N-9, N-12/N-99S, N-99N) 19

LIST OF ATTACHMENTS

Attachment

1 Approval Letter from Office of Surface Mining (OSM) Regarding Proposed Soils Scope-of-Work (SOW); and OSM Soil Suitability Table "Topsoil and Topsoil Substitute Suitability Criteria for the Southwestern United States"

2 Black Mesa Lease Area - Map Unit Descriptions (Intermountain Soils, Inc. 1985)

3 NRCS Official Soil Series Descriptions

4 SEP 2005 APPROVED

LIST OF MAPS

Map

85305C N9 Soil Type & Topsoil Salvage Map (Drawing File Name N09-SOIL.DWG)

85305C N12-N99S Soil Type & Topsoil Salvage Map (Drawing File Name N12-N99S-SOIL.DWG)

85305C N99N Soil Type & Topsoil Salvage Map (Drawing File Name N99N-SOIL.DWG)

SEP 2005 APPROVED

1.0 INTRODUCTION

The identification and proper management of topsoil resources in the various Coal Resource Areas of the Peabody Western Coal Company (PWCC) Black Mesa Lease Area is essential for: (1) the successful reclamation of any areas that might be disturbed during project activities and (2) the achievement of the post-mining land use. The information presented in this report is designed to aid in the formulation of a practical and successful reclamation plan.

A detailed Order 2 soil survey of the N-9, N-12, and N-99 Coal Resource Areas was completed as required by the Office of Surface Mining (OSM). Approximately 6,763 acres were included in the 2003 Black Mesa Mining Complex Soil Survey as follows:

- Coal Resource Area N-9 2345 acres
- Coal Resource Area N-12/N-99S 2773 acres
- Coal Resource Area N-99N 1645 acres

The federal Office of Surface Mining (OSM) was contacted prior to the start of soils fieldwork to ensure all requirements were met with this study. Only small portions of N-12 and N-99N were included in the previous PWCC Order 1 and Order 2 Black Mesa Lease Area soil survey (Intermountain Soils, Inc. 1985). All of the areas had been previously mapped to the less detailed Order 3 and Order 4 level of intensity (Intermountain Soils, Inc. 1985).

SEP 2005
APPROVED

2.0 METHODS

2.1 Order 2 Soil Survey

A detailed soil survey was conducted during the summer of 2003 on approximately 6,763 acres associated with the N-9, N-12, and N-99 coal resource areas.

The soil survey used the existing Peabody Black Mesa Lease Area soils map unit legend (Intermountain Soils, Inc. 1985), except many of the previous slope classes were combined into broader slope range map units. For instance, previous map unit 1A (Dulce very channery fine sandy loam, 1 to 4 percent slopes) was combined with map unit 1B (Dulce very channery fine sandy loam, 4 to 8 percent slopes) to create map unit 1AB (Dulce very channery fine sandy loam, 1 to 8 percent slopes).

Based on previous discussion with OSM personnel, no soils were to be sampled for laboratory characterization unless new soils were identified and mapped that were not on the previous soils legend. Attached to this report is a copy of a letter from Mr. Jerry D. Gavette (OSM Leader, Black Mesa/Kayenta Mine Team) to Mr. Brian Dunfee (PWCC Environmental Engineering Manager) concurring with a previously submitted proposed soils scope-of-work letter from Mr. Dunfee to Mr. Gavette which remains on file at both PWCC and OSM.

Soils description, classification, and mapping was conducted in accordance with the procedures and standards of the National Cooperative Soil Survey (Soil Survey Staff 1993 and 1999; and Schoeneberger et. al. 2002). The mapping was delineated on Peabody 1"=400' rectified orthophotoquad maps with topographic contour overlay. The photography date was September 3, 1997. The Coal Resource Areas study area boundaries are outlined on the maps as well.

Jim Nyenhuis and Tim Overdier, both Certified Professional Soil Scientists, investigated the soil resources of the study area during the summer of 2003. Based on previous discussion, the N-9, N-12, and N-99 Coal Resource Areas were mapped to the Order 2 level of intensity.

The entire areas were traversed by vehicle and on foot. Soil map unit boundaries were initially delineated by exposing soil profiles using a sharpshooter and bucket auger as well as observing topographic, geomorphic, vegetation, and geologic conditions. The primary tool for soil observation was the use of a backhoe. A total number of 204 holes were dug across the study area, approximately 90 percent of which were dug by backhoe. The backhoe was able to dig to 12 feet or deeper in the very deep alluvial soils under sagebrush vegetation, and to and into the weathered bedrock contact in the very shallow and shallow residual soils dominantly under Pinyon-Juniper woodland vegetation.

SEP 2005 APPROVED

The current study also benefited from experience gained in 1996 during which approximately 175 backhoe pits were dug throughout the Black Mesa and Kayenta Mines and adjacent areas. Soil profiles from these pits were described, photographed, and sampled for selective laboratory characterization.

SEP 2005
APPROVED

3.0 RESULTS AND DISCUSSION

3.1 Soil Survey Maps

The detailed soil survey maps for the N-9, N-12, and N-99 Coal Resource Areas are presented on Drawing 85305C (3 sheets total). Each base map is a rectified orthophotoquad with topographic contour overlay. The map scale is 1"=400'. The soils map unit legend, all field sample sites, and recommended soil salvage depths are provided on the maps as well. The maps were digitized by PWCC from the original soil field maps that are kept in the PWCC archive.

3.2 Soil Map Unit Legend

The map unit legend contained in the previous Black Mesa Lease Area soil survey (Intermountain Soils, Inc. 1985) was used for the 2003 soil survey except certain slope classes were combined. No new soils were identified, and no new map units were necessary for the current survey. The revised map unit legend is provided as **Table 1, 2003 Soil Survey Map Unit Legend**.

Based on recent taxonomic reclassification of three soils by the USDA Natural Resources Conservation Service (NRCS), the site-specific Peabody soils that were previously named Cahona, Pulpit, and Sharps had been recorrelated, and those changes were used in the current 2003 soil survey.

The soil that was named Cahona is renamed Blanding. An "ustic-aridic" soil moisture regime modifier has been added to the Pulpit and Sharps soil names (Pulpit, ustic-aridic; and Sharps, ustic-aridic). Because these soils are not new soils, but rather recorrelated to different soil names or soil name modifiers, they were not sampled for baseline laboratory characterization.

3.3 Soil Map Unit Descriptions

Map unit descriptions are contained in the previous Black Mesa Lease Area soil survey, and can be used for the 2003 soil survey. **Attachment 2** is a copy of the map unit descriptions taken from the previous survey (Intermountain Soils, Inc. 1985). The soil name "Blanding" should be substituted for "Cahona" in the map unit name for Map Units 10, 10A, 10B, 10C, 11, 11A, 11B, 11C, G11C, X11, X11A, X11B, and X11C. Similarly, the soil name "Pulpit ustic-aridic" should be substituted for "Pulpit" in the map unit name for Map Unit 5. And finally, the soil name "Sharps ustic-aridic" should be substituted for "Sharps" in the map unit name for Map Units 6, 6A, 6B, and 6C.

SEP 4 2005 APPROVED

3.4 Soil Series

3.4.1 Soil Series Names

Table 2 lists the soil series currently identified and mapped on the Black Mesa Lease Area. The table also shows the soil correlation changes over time on the lease area, beginning with the 1979 Espey Huston & Associates soil survey (Espey, Huston, & Associates, Inc. 1980), and continuing with the 1984 Mariah Associates soil survey, the 1985 Intermountain Soils soil survey, and ending with the 2003 Nyenhuis soil survey.

This soil list could change in the future if there are additional NRCS taxonomic and/or soil correlation changes for these soils, or if new soils are identified on newly mapped areas.

Table 5 lists all 204 soil holes that were dug and described during soil survey field activities. These holes were distributed across the three Coal Resource Areas as follows: N-9, 2345 acres, 82 holes; N-12/N-99S, 2773 acres, 70 holes; and N-99N, 1645 acres, 52 holes.

Table 5 is subdivided into the three Coal Resource Areas. Areas N12 and N99S are combined into one area. Each area contains a numeric listing of all soil holes dug, as well as for each hole the soil name, soil map unit symbol, depth to rock, and any pertinent comments including whether the hole received a brief soil profile description.

3.4.2 Soil Series Taxonomic Classification

Table 3 provides the current taxonomic classification for the soils of the Black Mesa Lease Area. This information was obtained in September 2003 from the official NRCS web site.

3.4.3 Soil Series Descriptions

Because no new soils were identified and mapped on the 2003 Soil Survey area, the collection of soil samples and additional detailed profile descriptions were not necessary. Numerous detailed soil profile descriptions for each of the soils on the Black Mesa Lease Area are contained in the previous soil survey report (Intermountain Soils, Inc. 1985).

In addition, there were approximately 175 detailed profile descriptions completed from deep backhoe pits in 1996 (one half of which were on nondisturbed native areas).

A copy of the current NRCS official soil series descriptions for each of the soils mapped on the 2003 soil survey area is attached to this report (Attachment 3). All of these soils are active, established soil series. Please refer to the NRCS descriptions for additional information as needed. The series descriptions included the following soils: Begay, Blanding (formerly Cahona), Bond, Cahona, Dulce, Las Lucas, Oelop, Pulpit, San Mateo, Sharps, Travessilla, and Zyme.

SEP 2005
APPROVED

3.5 Soil Moisture Regime and Soil Reclassification

One of the issues in the previous soil survey was the determination of the proper "soil moisture regime". The original soil survey considered the lease area to be dominately "typic-aridic" (Espey, Huston & Associates, 1980). However, the NRCS considered the area to be a slightly wetter "aridic-ustic". In order to resolve this difference, a letter was written in early 1985 to NRCS seeking information concerning the inter-relationships among soil moisture regime, mean annual precipitation, vegetation, and soil characteristics particularly in northeast Arizona (letter to Mr. R. Kover, SCS West National Technical Center, Portland Oregon, April 22, 1985).

No reply was received by late 1985, and the soil moisture regime for the lease area was subsequently changed by Intermountain Soils to "ustic-aridic" (see discussion on pages 6, 7, and 8 of the Soil Resources of the Black Mesa Lease Area, Intermountain Soils, Inc., 1985). The "ustic-aridic" soil moisture regime is midway between the drier "typic-aridic" and the wetter "aridic-ustic".

Because the soil moisture regime was considered to be "ustic-aridic", all of the soil names used in the 1985 soil survey were correlated to this moisture regime. This included the Cahona, Sharps, and Pulpit soil series. All three soils were classified as "Fine-silty, mixed, mesic Ustollic Haplargids". Cahona is a very deep soil, and Sharps and Pulpit are moderately deep.

In 1992 the NRCS held a "Four Corners Moisture and Temperature Meeting" in order to adopt consistent criteria for use in moisture and temperature classifications in the four state region (NRCS, 1992). Although no site-specific information was presented for the Black Mesa area, two sites in northeast Arizona were discussed. Navajo Mountain (6020 feet elevation, 9.34 inches mean annual precipitation, 49.6 degrees mean annual temperature) was considered "ustic-aridic". Teec Nos Pos (5290 feet elevation, 7.99 inches precipitation was considered "typic-aridic".

Based on these two Arizona sites, and other sites in the Four Corners Area, the Black Mesa lease area would be consistent with an "ustic-aridic" moisture regime placement. Site-specific data also supports this conclusion. Sixteen years of precipitation data has been collected by Peabody at three sites on the Black Mesa Lease Area (sites 1, 8, and 12). The average annual precipitation between 1983 and 1998 was 8.7 inches with a general range of 8 to 10 inches. The high and low values during this time period were 3 inches (1989) and 11.6 inches (1997) (Esco Associates, 1998).

As a result of these data, the conclusion reached by Intermountain Soils in 1985 for the Black Mesa Lease area appears correct, and the area should be considered "ustic-aridic".

As part of the overall changes adopted at the Four Corners meeting, NRCS reclassified Cahona, Sharps, and Pulpit soils from an "ustic-aridic" to a slightly wetter "aridic-ustic" moisture regime. Cahona is now classified as a "Fine-silty, mixed, superactive mesic Calcidic Haplustalfs". Sharps and Pulpit are classified as "Fine-silty, mixed, superactive, mesic Aridic Haplustalfs".

Because the Black Mesa Lease Area is in an "ustic-aridic", not "aridic-ustic", moisture regime, the Cahona, Sharps, and Pulpit soil names are no longer appropriate. The Blanding soil series is similar in morphology to Cahona but is "ustic-aridic" and therefore Blanding is suitable for use on the Black Mesa Lease Area (Sasser, 2000).

Neither the Sharps nor Pulpit soils currently have an "ustic-aridic" soil counterpart. Therefore, these soil names have been retained for the current survey, but an "ustic-aridic" has been added to the name for use in the lease area. In the future there may be new names for an "ustic-aridic" Sharps and Pulpit, but there are none at the present time.

3.6 Soil Laboratory Results

Because no new soils were identified and mapped on the 2003 Soil Survey area, the collection of soil samples and additional detailed profile descriptions were not necessary. Extensive laboratory results for each of the soils on the Black Mesa Lease Area are contained in the previous Soil Survey report (Intermountain Soils, Inc. 1985).

3.7 Topsoil Suitability and Salvage Depth Recommendation

A topsoil suitability evaluation and salvage depth recommendation was completed for all soils in the previous Black Mesa Lease Area soil survey (Intermountain Soils, Inc. 1985). Because no new soils were found during the current survey, the previous evaluations were considered the starting point for use in the 2003 soil survey. However, the soils and map units were reevaluated based on site-specific data.

The major change from the previous survey is the recommendation of soil salvage of shallow residual soils under Pinyon-Juniper vegetation. Previously, all #1 map units (1, 1A, 1B, 1C, and 1D), #3 map units (3A, 3BC, 3C, 3D, 3E, 3DE, and 3F), #4 map units (4B, 4C, 4D, and 4E), #7 map units (7B, 7C, 7D, and 7E), and #16 map units (16C, 16E, and 16F) were not recommended for soil salvage based on high content of surficial rock fragments, clay content of the Zyme soil, erosion status, and shallow nature of the soils (Intermountain Soils, Inc., 1985). The previous report does state these soils (Dulce, Zyme, Travessilla, and Ustic Torriorthents) do not have any chemical properties limiting soil suitability.

The concept of soil suitability has evolved since 1985. The presence of gravel (2mm to 3") and cobble (3" to 10") size rock coarse fragments, including sandstone channers and shale chips, is not considered limiting or unsuitable for coarse fragment content as high as 35 to 45 percent. The State of Utah Division of Oil, Gas, and Mining (UDOGM) has even removed coarse fragment content as a criterion in their current soil suitability table (UDOGM, 2002).

The presence of 15 to even 50 percent sandstone channers and shale chips predominantly on the surface of residual soils such as Dulce, Zyme, and Travessilla should not be considered unsuitable for salvage, especially when the overall volume of available soil is limiting. This range of coarse fragment content can be beneficial for erosion resistance and should not create droughty conditions in the reclaimed soil profile. Additionally, coarse

SEP 2005 APPROVED

fragment content often decreases in the underlying soil horizons above the weathered bedrock contact.

Soil erosion itself is not limiting for salvage. It makes the actual salvage operation more difficult but does not make the remaining soil material unsuitable. Shallow soils (less than 20 inches to bedrock) are not by definition unsuitable. There is just less soil material to salvage. Soil depth as low as 6 inches can be salvaged. However, soil salvage may not be feasible in the steeper portions of certain map units that approach 40 to 50 percent slopes due to equipment limitations and operator safety concerns.

In addition, the upper part (up to 1 foot in thickness) of the weathered sandstone or shale bedrock (the "paralithic" Cr horizon) in residual soils is also suitable for salvage, if needed. This weathered upper bedrock material was consistently observed in backhoe pits to have many roots and no signs of salinity and/or sodicity. The soil backhoe easily and consistently dug through this upper bedrock material. Furthermore, the current contract salvage operators at Black Mesa have coined a term for this material, "toprock", and consider it to be suitable soil or soil substitute material available for salvage if and when needed.

Based on extensive backhoe pit observations, it is recommended that approximately 0.5 foot of suitable soil material be salvaged from residual soils (Dulce, Zyme, Travessilla) under Pinyon-Juniper vegetation, especially when soil resources are limited and these soils are needed for successful reclamation. Actual average depth of residual soil to the weathered sandstone or shale bedrock contact is slightly deeper, but has been rounded to the nearest 0.5 foot. Map units 3F (Ustic Torriorthents-Rock Outcrop, 50 to 80% slopes) and 7E (Zyme-Travessilla-Rock Outcrop complex, 30 to 50% slopes) continue to have no recommended salvage due to steep slopes and rock outcrop.

Table 4 is a list of recommended salvage depths for soils in the 2003 Soil Survey Area of Coal Resource Areas N-9, N-12/N-99S, and N-99N. The list includes an overall recommended salvage depth for each map unit as well as differentiated "Topsoil" and "Subsoil" salvage depths as an additional option for some map units. Based on Peabody practice, salvage depths are listed to the nearest 0.5 feet.

The following is a discussion of recommended salvage depths for each map unit. **Table 5** lists the 204 soil observations and soil characteristics from which the following data evaluation and salvage recommendations were generated.

Map Unit 1AB (Dulce very channery fine sandy loam, 1 to 8 percent slopes) is composed of the shallow, residual Dulce soil and generally occupies sloping uplands under Pinyon-Juniper vegetation. Dulce was observed in 28 backhoe pits in Map Unit 1AB and averaged 9 inches to the weathered bedrock contact. Dulce very channery loam ranged in depth from 5 to 18 inches. One soil inclusion (Pulpit) was observed in three backhoe pits within Map Unit 1AB, and averaged 28 inches to bedrock with soil depths of 24, 27, and 32 inches. Soil inclusions comprised about 10 percent of Map Unit 1AB. The recommended soil salvage depth for Map Unit 1AB is 0.5 feet, with the concept that all soil to weathered bedrock contact is suitable and could be salvaged where deeper than 0.5 feet.

APPROVED SEP 2005

Map Unit 1CD (Dulce very channery loam, 8 to 30 percent slopes) is similar to Map Unit 1AB except for slope. Dulce under these slope conditions was not observed in any backhoe pits in Map Unit 1CD. The recommended salvage depth for Map Unit 1CD is 0.5 feet which is consistent with Dulce in Map Unit 1AB.

Map Unit 2B (Bond very fine sandy loam) is composed of the shallow Bond soil and generally occupies gently sloping upland areas under a sagebrush and mixed grasses vegetation. Delineations of Map Unit 2B are also mapped in gently sloping open Pinyon-Juniper woodland. A total of 13 backhoe pits were dug in Bond very fine sandy loam, and these averaged 14 inches to the weathered bedrock contact, with a depth range of 8 to 19 inches. Soil inclusions were observed in another 8 backhoe pits (comprising 38% of the total observation in Map Unit 2B) and these averaged 27 inches in depth with a range of 6 to 72 inches.

Bond has an overall recommended salvage depth of 1 foot, the rounded average depth to sandstone or shale bedrock. All soil parameters are suitable. The upper 0.5 feet (the surface "A" horizon and the underlying "Bt" argillic horizon) have higher organic matter content than below and could be salvaged as an upper or "topsoil" lift. The underlying 0.5 feet to the bedrock contact could be salvaged as a lower or "subsoil" lift. The previous survey also recommended a salvage depth of 1.0 feet.

Map Units 3AB, 3CD, and 3DE (Zyme-Dulce complex) are composed of shallow residual soils under Pinyon-Juniper vegetation. Map Unit 3AB had 6 backhoe pit observations that averaged 8 inches to the weathered bedrock contact with a soil depth range of 3 to 12 inches. The total recommended salvage depth is rounded to 0.5 feet.

Zyme and Dulce soils were observed in 28 backhoe pits in Map Unit 3CD and averaged 8 inches to the weathered bedrock contact with a soil depth range of 3 to 17 inches. Two additional backhoe pits had soil inclusions that were 24 inches to bedrock. The overall total recommended salvage depth of Map Unit 3CD is rounded to 0.5 feet.

Zyme and Dulce soils were observed in 5 backhoe pits in Map Unit 3DE and averaged 12 inches to the weathered bedrock contact with a depth range of 6 to 18 inches. The overall total recommended salvage depth of Map Unit 3DE is rounded to 0.5 feet to be consistent with Map Units 3AB and 3DC. Topsoil salvage may not be feasible in the steeper portions of this map unit that approach 40 to 50 percent slopes due to equipment limitations and operator safety concerns.

Map Unit 3F (Ustic Torriorthents – Rock Outcrop Complex) Soils in Map Unit 3F are not recommended for salvage due to the high percentage of Rock Outcrop and very steep slopes. This map unit often has bedrock ledges and cliffs.

Map Unit 5 (Pulpit, ustic-aridic, very fine sandy loam) is composed of the moderately deep Pulpit soil over hard sandstone bedrock. Pulpit is located on gently sloping uplands. Vegetation is a mix of sagebrush, mixed grasses, and scattered Pinyon-Juniper. Pulpit was observed in 11 backhoe pits and averaged 31 inches to sandstone bedrock with a depth

SEP 2005 APPROVED

range of 23 to 39 inches. Soil inclusions were observed in an additional eight backhoe pits (comprising about 42% of the map unit) and averaged 40 inches to bedrock. The total recommended salvage depth for Map Unit 5 is rounded to 3 feet. The previous survey recommended a salvage depth of 2.5 feet. The upper 1.0-feet (the surface "A" horizon and the underlying "Bt" argillic horizon) could be salvaged as an upper or "topsoil" lift. The underlying 2 feet to the bedrock contact could be salvaged as a lower or "subsoil" lift.

Map Unit 6AB (Sharps, ustic-aridic, very fine sandy loam) is composed of the moderately deep Sharps soil and is located on gently sloping to sloping uplands dominantly under a sagebrush and mixed grasses vegetation. Sharps was observed in Map Unit 6AB in 5 backhoe pits and averaged 25 inches to the shale contact, with a depth range of 23 to 32 inches. A soil inclusion was observed in one backhoe pit (comprising about 16% of the map unit) with a depth of 14 inches to bedrock. The weighted average soil depth of Map Unit 6AB is 23 inches. The total recommended salvage of Map Unit 6AB is rounded to 2.0 feet. The upper 1.0-feet (the surface "A" horizon and the underlying "Bt" argillic horizon) could be salvaged as an upper or "topsoil" lift. The underlying 1.0-feet to the bedrock contact could be salvaged as a lower or "subsoil" lift. The previous survey recommended a salvage depth of 2.5 feet.

Map Units 7CD and 7E (Zyme - Travessilla - Rock Outcrop complex) are composed of shallow soils over sandstone and shale bedrock. They are located on weathered upland ridges with scattered rock outcrop and have dominantly Pinyon-Juniper vegetation. Soils in Map Units 7CD and 7E were observed in 2 backhoe pits and averaged 5 inches to bedrock with a depth range of 0 to 9 inches. The total recommended salvage depth of Map Unit 7CD is rounded to 0.5 feet. Map Unit 7E is not recommended for salvage due to high amounts of Rock Outcrop and very steep slopes.

Map Units 11AB and 11C (Blanding very fine sandy loam); G11B (Blanding very fine sandy loam, gravelly substratum); and X11AB and X11C (Blanding - Blanding, bedrock substratum) are composed of very deep local alluvial and reworked aeolian soils on alluvial fans, flats, sideslopes, and toeslopes scattered across the study area. Blanding generally has a sagebrush and mixed grasses vegetation. Blanding was observed in 19 backhoe pits with depths ranging from 3.5 to more than 12 feet. Two backhoe pits were described for inclusions within these map units with an average thickness of more than 3.7 feet.

The average depth for Blanding in Map Units X11AB, X11C, and G11B is 7.5 feet, and 10 feet for Map Unit 11AB and 11C. All of this material is suitable and constitutes the total recommended salvage depths for these map units. The upper foot of soil is recommended for a "topsoil" lift and the remaining material for the "subsoil" lift. The previous survey also recommended similar salvage depths.

Map Unit 12AB (Begay loam) is composed of the very deep alluvial Begay soil located on nearly level to strongly sloping terraces of drainages scattered throughout the study area. Begay loam was identified in 21 backhoe pits with suitable soil depths ranging from more than 6 to 17 feet. Total soil depth was an average of at least 12 feet. All soil parameters of Begay are suitable, although very gravelly loamy sand and sandy loam material can be

SEP 2005 APPROVED

encountered at depth in some areas. This material, when encountered, is droughty and has high erosion hazard. The overall salvage depth is conservatively estimated to be 9.5 feet. The upper 1.5 feet, including the surface "A" horizon and the underlying "Bw" cambic horizon, could be salvaged as a "topsoil" lift. The underlying 8 feet, or the depth to the dominantly very gravelly loamy sand contact, could be salvaged as a "subsoil" lift.

Map Unit 13A (San Mateo loam) is composed of fine-loamy material on nearly level to very gently sloping stream terraces, drainageway bottomlands, and floodplains. San Mateo was observed at 3 sites with depths ranging from more than 8 to 15 feet with an average of more than 10.3 feet. The overall recommended salvage depth is projected to be 14.5 feet. The upper 1.5 feet (including the surface "A" horizon and the underlying upper part of the "C" horizon) can be salvaged as a "topsoil" lift. The underlying 13 feet can be salvaged as a "subsoil" lift. Individual delineations of San Mateo may have high electrical conductivity (EC) and/or high sodicity (Sodium Adsorption Ratio - SAR) at depths between 8 to18 feet which could limit subsoil salvage to more shallow depths in these areas.

Map Unit 14AB (Oelop very fine sandy loam) is composed of the deep Oelop soil on gently sloping valley sideslopes and bottoms. Oelop was observed at 14 sites with depths ranging from more than 4 to more than 14 feet with an average of more than 8.7 feet. One backhoe pit was described for an inclusion within this map unit with a thickness of more than 5 feet. The overall salvage depth is conservatively estimated to be 9.5 feet. The upper 1.5 feet (including the surface "A" horizon and the underlying "Bt" argillic horizon) can be salvaged as a "topsoil" lift. The underlying 8 feet can be salvaged as a "subsoil" lift.

Map Unit 15A (Las Lucas sandy clay loam) is composed of the very deep Las Lucas soil located on terraces and drainage bottomlands throughout the study area. Las Lucas was observed at four sites with depths ranging from more than 4 to more than 20 feet with an average of more than 11.5 feet. The overall recommended salvage depth is conservatively placed at 11.5 feet. The upper 1.5 feet can be salvaged as a "topsoil" lift, and the underlying 10 feet as a "subsoil" lift. The previous survey recommended a maximum salvage depth of 11.6 feet.

Map Units 16C, 16CE, and 16F (Soil A- Soil B extremely channery very fine sandy loams) are composed of soils on crests, summits, and sideslopes of some hills scattered across the study area. These soils formed in porcellanite (scoria) and contain a very high volume of rock fragments. These soils were previously considered unsuitable for salvage due to their very high rock fragment content. However, these soils have been selectively salvaged at Black Mesa with positive results. Six soil backhoe pits were dug in Map Unit 16C and eleven in Map Unit 16CE. Soil depth averaged 6 inches for Map Unit 16C, with a depth range of 4 to 6 inches. Soil depth for Map Unit 16CE averaged 9 inches, with a depth range of 2 to 27 inches. The total recommended salvage depth for these map units is rounded to 0.5 feet. Topsoil salvage may not be feasible in the steeper portions of Map Unit 16CE that approach 40 to 50 percent slopes due to equipment limitations and operator safety concerns. Map Unit 16F is not recommended for salvage due to very steep slopes, from 50 to 70 percent or greater.

SEP 2005 APPROVED

Map Unit DL (Disturbed Land) is composed of various delineations of previously disturbed areas. There is no soil for salvage within these disturbed areas.

Map Unit P (Pond) contains various constructed ponds distributed across the study area. There is no soil for salvage within these delineations although the pond and embankment "soil materials" will be tested for suitability when the ponds are reclaimed.

Map Unit RL (Reclaimed Land, no topsoil) is composed of various small delineations of previously reclaimed areas. For various reasons, these areas are not presently topsoiled and therefore have no soil available for salvage. Although no topsoil is presently available for salvage, the current 6 inch surface layer may be suitable for salvage and used as a topsoil substitute material if these areas are projected to be redisturbed.

Map Unit RLT (Reclaimed Land, topsoiled) is composed of various delineations of previously reclaimed areas that were topsoiled during reclamation activities. This reapplied topsoil was not sampled for laboratory analysis, but it is assumed that 6 to 12 inches of suitable topsoil can be salvaged from these areas if they are projected to be redisturbed.

Map Unit TS (Topsoil Stockpile) is composed of some areas where stockpiled topsoil is located. This material will be used during overall reclamation activities, but it was not studied as part of the current soil survey.

Map Unit RD (Reconstructed Drainage) is composed of a few areas where drainage channels have been reconstructed across reclaimed areas. Soil material is not available for salvage from these areas if they are projected to be redisturbed.

APPROVED
SEP 2005

4.0 REFERENCES

ESCO Associates, Inc. 1998. Vegetation Monitoring Report – Black Mesa-Kayenta Mines. For Peabody Western Coal Company.

Espey, Huston & Associates, Inc. 1980. Soils Baseline Studies of the Black Mesa and Kayenta Mines. Peabody Coal Company.

Intermountain Soils, Inc. 1985. Soil Resources of the Black Mesa Lease Area. For Peabody Coal Company. December 1985.

Natural Resources Conservation Service (NRCS). 1992. Four Corners Moisture and Temperature Meeting. Cortez, Colorado. October 5-9, 1992.

Nyenhuis, J. 2000. Soil Survey Report - J9 Coal Resource Area, Black Mesa Mine. Kayenta, Arizona. Revised November 20, 2000.

Sasser, L. 2000. Soil Survey Project Leader, Natural Resources Conservation Service. Price, Utah. Personal communication with Jim Nyenhuis. October 3, 2000.

Schoeneberger, P.J., et al. 2002. Field Book for Describing and Sampling Soils. Version 2.0. U.S.D.A.-Natural Resources Conservation Service-National Soil Survey Center. Lincoln, Nebraska. September 2002.

Soil Survey Staff. 1993. Soil Survey Manual. Agricultural Handbook No. 18. U.S.D.A.-Natural Resources Conservation Service.

Soil Survey Staff. 1999. Soil Taxonomy. Second Edition. Agricultural Handbook No. 436. U.S.D.A.-Natural Resources Conservation Service.

UDOGM. 2002. Guidelines for Management of Topoil and Overburden. R645-301-200 Soils. Table 4, Soil and Spoil Suitability/Unsuitability Evaluation. State of Utah, Department of Natural Resources, Division of Oil, Gas, and Mining. Salt Lake City, Utah. January 2002.

SEP 2005
APPROVED

TABLE 1

2003 Soil Survey Map Unit Legend

1AB	Dulce very channery fine sandy loam, 1 to 8 percent slopes
1CD	Dulce very channery fine sandy loam, 8 to 30 percent slopes
2B	Bond very fine sandy loam, 1 to 8 percent slopes
3AB	Zyme - Dulce complex, 1 to 8 percent slopes
3CD	Zyme - Dulce complex, 8 to 30 percent slopes
3DE	Zyme - Dulce complex, 30 to 50 percent slopes
3F	Ustic Torriorthents - Rock Outcrop complex, 50 to 80 percent slopes
5	Pulpit very fine sandy loam, ustic-aridic, 2 to 8 percent slopes
6AB	Sharps very fine sandy loam, ustic-aridic, 1 to 8 percent slopes
7CD	Zyme-Travessilla-Rock Outcrop complex, 6 to 30 percent slopes
7E	Zyme-Travessilla-Rock Outcrop complex, 30 to 50 percent slopes
X11AB	Blanding - Blanding, bedrock substratum, very fine sandy loams 1 to 8 percent slopes
X11C	Blanding - Blanding, bedrock substratum, very fine sandy loams, 8 to 15 percent slopes
11AB	Blanding very fine sandy loam, 1 to 8 percent slopes
11C	Blanding very fine sandy loam, 8 to 15 percent slopes
G11B	Blanding very fine sandy loam, gravelly substratum, 2 to 8 percent slopes
12AB	Begay loam, 1 to 8 percent slopes
13A	San Mateo loam, 0 to 3 percent slopes
14AB	Oelop very fine sandy loam, 1 to 8 percent slopes
15A	Las Lucas sandy clay loam, 2 to 6 percent slopes
16C	Soil A - Soil B, extremely channery very fine sandy loams, 4 to 15 percent slopes
16CE	Soil A - Soil B, extremely channery very fine sandy loams, 15 to 50 percent slopes
16F	Soil A - Soil B, extremely channery very fine sandy loams, 50 to 70 percent slopes
DL	Disturbed Land
P	Pond
RL	Reclaimed Land, no topsoil
RLT	Reclaimed Land, topsoiled
TS	Topsoil Stockpile
RD	Reconstructed Drainage

SEP 2005 APPROVED

TABLE 2

Current Correlation of Soil Series on the Black Mesa Lease Area

1980 Espey Huston & Associates	1984 Mariah Associates	1985 Intermountain Soils	2003 Nyenhuis
Fruitland	Begay	Begay	Begay
Not mapped	Not mapped	Bond	Bond
Clovis	Cahona	Cahona	Blanding
Not mapped	Not mapped	Chilton	Not mapped
Moenkopi	Dulce	Dulce	Dulce
Ives	Mikim	Las Lucas	Las Lucas
Not Mapped	Not mapped	Oelop	Oelop
Not Mapped	Pulpit	Pulpit	Pulpit, ustic-aridic
Youngston	San Mateo	San Mateo	San Mateo
Not mapped	Sharps	Sharps	Sharps, ustic-aridic
Moenkopi	Not mapped	Travessilla	Travessilla
Claysprings	Not mapped	Zyme	Zyme
Not mapped	Not mapped	Soil A	Soil A
Not mapped	Not mapped	Soil B	Soil B

SEP 2005
APPROVED

TABLE 3

Taxonomic Classification of Soil Series of the Black Mesa Lease Area

Series	Family
Begay	Coarse-loamy, mixed, superactive, mesic Ustic Haplocambid
Blanding	Fine-silty, mixed, superactive, mesic Ustic Haplargid
Bond	Loamy, mixed, superactive, mesic Lithic Ustic Haplargid
Chilton	Loamy-skeletal, mixed, calcareous, mesic Ustic Torriorthent
Dulce	Loamy, mixed, superactive, calcareous, mesic, shallow Ustic Torriorthent
Las Lucas	Fine-silty, mixed, active, mesic Ustic Haplocambid
Oelop	Fine-loamy, mixed, superactive, mesic Ustic Haplargid
Pulpit, ustic-aridic	Fine-silty, mixed, superactive, mesic Aridic Haplustalf
San Mateo	Fine-loamy, mixed, superactive, calcareous, mesic Ustic Torrifluvent
Sharps, ustic-aridic	Fine-silty, mixed, superactive, mesic Aridic Haplustalf
Travessilla	Loamy, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthent
Zyme	Clayey, smectitic, calcareous, mesic, shallow Ustic Torriorthent
Soil A	Loamy-skeletal over fragmental, mixed, calcareous, mesic Ustic Torriorthent
Soil B	Loamy-skeletal over fragmental, mixed, mesic Ustic Haplocalcid

APPROVED
SEP 2005

TABLE 4

2003 N-9, N-12, and N-99 Coal Resource Areas Soil Survey Recommended Soil Salvage Depths

Symbol	Map Unit Name	Total Recommended Salvage Depth[1] (feet)	Topsoil/Subsoil Salvage Thickness[1] (feet)
1AB	Dulce very channery fine sandy loam, 1 to 8 percent slopes	0.5	0.5/0.0
1CD	Dulce very channery fine sandy loam, 8 to 30 percent slopes	0.5	0.5/0.0
2B	Bond very fine sandy loam, 1 to 8 percent slopes	1.0	1.0/0.0
3AB	Zyme - Dulce complex, 1 to 8 percent slopes	0.5	0.5/0.0
3CD	Zyme - Dulce complex, 8 to 30 percent slopes	0.5	0.5/0.0
3DE	Zyme - Dulce complex, 30 to 50 percent slopes	0.5[2]	0.5/0.0
3F	Ustic Torriorthents - Rock Outcrop complex, 50 to 80 percent slopes	0.0	-
5	Pulpit, ustic-aridic, very fine sandy loam, 2 to 8 percent slopes	3.0	1.0/2.0
6AB	Sharps, ustic-aridic, very fine sandy loam, 1 to 8 percent slopes	2.0	1.0/1.0
7CD	Zyme-Travessilla-Rock Outcrop complex, 6 to 30 percent slopes	0.5	0.5/0.0
7E	Zyme-Travessilla-Rock Outcrop complex, 30 to 50 percent slopes	0.0	-
X11AB	Blanding - Blanding, bedrock substratum, very fine sandy loams 1 to 8 percent slopes	7.5	1.0/6.5
X11C	Blanding - Blanding, bedrock substratum, very fine sandy loams, 8 to 15 percent slopes	7.5	1.0/6.5
11AB	Blanding very fine sandy loam, 1 to 8 percent slopes	10.0	1.0/9.0
11C	Blanding very fine sandy loam, 8 to 15 percent slopes	10.0	1.0/9.0
G11B	Blanding very fine sandy loam, gravelly substratum, 2 to 8 percent slopes	7.5	1.0/6.5
12AB	Begay loam, 1 to 8 percent slopes	9.5	1.5/8.0
13A	San Mateo loam, 0 to 3 percent slopes	14.5	1.5/13.0

SEP 2005 APPROVED

Symbol	Map Unit Name	Total Recommended Salvage Depth[1] (feet)	Topsoil/Subsoil Salvage Thickness[1] (feet)
14AB	Oelop very fine sandy loam 1 to 8 percent slopes	9.5	1.5/8.0
15A	Las Lucas sandy clay loam, 2 to 6 percent slopes	11.5	1.5/10.0
16C	Soil A - Soil B, extremely channery very fine sandy loams, 4 to 15 percent slopes	0.5	0.5/0.0
16CE	Soil A - Soil B, extremely channery very fine sandy loams, 15 to 50 percent slopes	0.5[2]	0.5/0.0
16F	Soil A - Soil B, extremely channery very fine sandy loams, 50 to 70 percent slopes	0.0	-
DL	Disturbed land	0.0	-
P	Pond	0.0	-
RL	Reclaimed Land, no topsoil	0.0	-
RLT	Reclaimed Land, topsoiled	0.5	0.5/0.0
TS	Topsoil Stockpile	0.0	-
RD	Reconstructed Drainage	0.0	-

1 Salvage depths are estimated to the nearest 0.5 feet based on data presented in Table 5, List of Dug Holes and Soil Characteristics. Salvage depth information for each map unit is also presented on the Soil Maps for each Coal Resource Area.

2 Topsoil salvage may not be feasible in the steeper portions of this map unit that approach 40 to 50 percent slopes due to equipment limitations and operator safety concerns.

SEP 2005 APPROVED

TABLE 5

N9 COAL RESOURCE AREA, 2345 Acres

Hole#	Soil Name - surface texture	Map Unit	Depth to rock	Comments / profile description
1	Begay sandy loam	12AB	6'+	Profile description, valley fill
2	Begay sandy loam	12AB	7'+	Drainage cut
3	Begay sandy loam	12AB	10'+	Profile description, valley fill, major rooting depth 30"
4	San Mateo loam	13A	15'	Drainage cut
5	Begay fine sandy loam	12AB	12'+	Profile description, major rooting depth 34"
6	Blanding fine sandy loam	11C	50" to SS	
7	Begay fine sandy loam	12AB	17'+	Drainage cut, coarse-loamy alluvium
8	Begay fine sandy loam	12AB	17'+	Drainage cut, coarse-loamy alluvium
9	Begay sandy loam	12AB	12'+	Middle of drainage
10	Begay sandy loam	12AB	12'+	Middle of drainage
11	Dulce channery sandy loam	3CD	10" to scoria	
12	Begay sandy loam	12AB	12'+	Middle of drainage
13	Zyme clay loam	3DE	18" to carb SH	
14	Begay fine sandy loam	12AB	6'+ to SS	
15	Zyme clay loam	3DE	14" to weathered SH	
16	Begay sandy loam	12AB	15'+	Drainage cut
17	Begay sandy loam	12AB	15'+	Drainage cut
18	Begay fine sandy loam	12AB	15'+	Drainage cut
19	Begay fine sandy loam	12AB	15'+	Drainage cut
20	Begay sandy loam	12AB	15'+	Drainage cut
21	Begay sandy loam	12AB	15'+	Drainage cut
22	Begay sandy loam	12AB	15'+	Drainage cut
23	Begay fine sandy loam	12AB	15'+	Drainage cut
24	Dulce channery loam	1AB	18" to weath platy siltstone	Profile description, ridge crest flat (x), photos
25	Pulpit fine sandy loam	1AB (inclusion)	32" to SH	Profile description, photos
26	Dulce loam	1AB	9" to fract. SS	
27	Dulce channery loam	1AB	6" to fract. SS	
28	Dulce channery loam	1AB	5" to fract. SS	
29	Dulce channery loam	1AB	13" to weath. SH over fract. SS	
30	Pulpit fine sandy loam	5	26" to fract. SS	Profile description
31	Blanding sandy loam	5 (inclusion)	5'+	Profile description, photos
32	Dulce channery loam	3CD	12" to weath. SH	Shale Cr 12 to 24" with roots
33	Soil A-B gravelly loam	16CE	8" to fract. SS	Sideslope of scoria hill
34	Blanding loam	X11C	42" to weath. SH	Major rooting depth 17", photo
35	Pulpit fine sandy loam	5	30" to weath. soft SS	Profile description, photo
36	Dulce channery loam	3CD	12" to weath. sandy SH	
37	Pulpit very fine sandy loam	X11C (inclusion)	24" to scoria SH	

APPROVED SEP 2005

TABLE 5

N9 COAL RESOURCE AREA, 2345 Acres

Hole#	Soil Name - surface texture	Map Unit	Depth to rock	Comments / profile description
38	Dulce fine sandy loam	5 (inclusion)	17" to hard, shaly SS	
39	Pulpit very fine sandy loam	5	27" to weath. hard SH	
40	Pulpit sandy loam/loam	5	30" to fract. SS	
41	Oelop very fine sandy loam	5 (inclusion)	7.7'+	Profile description
42	Dulce channery loam	3CD	4" to fract. SS	
43	Pulpit very fine sandy loam	5	38" to weath. SS	Contains old buried 7.5YR Bt
44	Sharps very fine sandy loam	5 (inclusion)	28" to weath. fract. SS	Profile description
45	Oelop very fine sandy loam	14AB	6'+	Drainage cut
46	Oelop very fine sandy loam	14AB	6'+	Drainage cut
47	Oelop very fine sandy loam	14AB	6'+	Drainage cut
48	Dulce channery loam	3CD	5" to fract. SS	
49	Dulce channery loam	3CD	5" to fract. scoria	
50	Dulce channery loam	3CD	5" to scoria SS	
51	Dulce channery loam	3CD	5" to scoria SS	
52	Blanding sandy loam/loam	X11AB	6.8'+	Major rooting depth 18"
53	Oelop very fine sandy loam	14AB	6'+	
54	Pulpit fine sandy loam	2B (inclusion)	39" to SS	Profile description, photos
55	Dulce channery loam	1AB	6" to fract. Siltstone	Photos
56	Blanding fine sandy loam	11AB	7'+	Profile descripton
57	Oelop very fine sandy loam	14AB	10'+	Drainage cut
58	Oelop very fine sandy loam	14AB	10'+	Drainage cut
59	Dulce channery loam	1AB	5" to scoria SS	
60	Dulce channery loam	1AB	6" to weath. scoria SH	Major rooting depth goes to 14" in weath. SH, photos
61	Dulce channery loam	1AB	6" to weath. SH	Major rooting depth goes to 14" in weath. SH, photos
62	Dulce channery loam	1AB	14" to weath. SH	
63	Blanding fine sandy loam	5 (inclusion)	4.5'+	Major rooting depth 16"
64	Dulce channery loam	3CD	8" to fract. Siltstone	
65	Blanding fine sandy loam	11AB	7'+	Major rooting depth 26"
66	Dulce channery loam	2B (inclusion)	18" to weath. SH	
67	Bond fine sandy loam	2B	14" to fract. Hard SS	
68	Dulce channery loam	1AB	6" to fract. SS	
69	Bond fine sandy loam	2B	9" to hard SS	
70	Blanding very fine sandy loam	X11C	40"+	
71	Pulpit very fine sandy loam	5	35" to weath. SS	Photos

APPROVED SEP 2005

TABLE 5

N9 COAL RESOURCE AREA, 2345 Acres

Hole#	Soil Name - surface texture	Map Unit	Depth to rock	Comments / profile description
72	Dulce channery loam	3CD	6" to fract. SS	
73	Blanding very fine sandy loam	5 (inclusion)	53" to weath. SH	
74	Soil A-B very channeryloam	16CE	16" to weath. scoria	Weath. scoria SS & SH from 16 to 40"
75	Begay sandy loam	12AB	6'+	Drainage cut
76	Dulce channery loam	1AB	6" to fract. SS	
77	Dulce channery loam	3CD	10" to weath. sandy SH	Photos
78	Pulpit very fine sandy loam	2B (inclusion)	28" to hard SS	Photos
79	Pulpit very fine sandy loam	2B (inclusion)	29" to hard SS	
80	Bond very fine sandy loam	2B	18" to fract. SS	Photos
81	San Mateo loam	13A	8'+	
82	San Mateo loam	13A	8'+	

APPROVED SEP 2005

TABLE 5

N12/N99S COAL RESOURCE AREA, 2773 Acres

Hole#	Soil Name - surface texture	Map Unit	Depth to rock	Comments / profile description
1	Blanding fine sandy loam	X11AB	11'+	Buried Btk at 6 to 7.5'
2	Blanding fine sandy loam	X11AB	6.5' to SS	
3	Dulce channery loam	1AB	6" to weath. shaly SS	
4	Oelop very fine sandy loam	14AB	14' to SS	Drainage cut, sage terrace
5	Blanding fine sandy loam	X11AB	9' to SS	
6	Blanding fine sandy loam	X11AB	64" to SS	Hard Bk at 30"
7	Dulce channery loam	16CE (inclusion)	5" to fract. SS	
8	Dulce channery sandy loam	1AB	5" to fract. SS	
9	Dulce channery sandy loam	16CE (inclusion)	16" to fract. SS	
10	Soil A-B very channery loam	16CE	4" to fract. scoria	
11	Blanding very fine sandy loam	11AB	12'+	Gravelly lense at 8 to 9'
12	Oelop very fine sandy loam	14AB	14'	Drainage cut
13	Dulce channery loam	1AB	5" to fract. SS	Slight scoria influence
14	Dulce channery loam	1AB	5" to fract. SS	
15	Dulce channery sandy loam	1AB	6" to fract. SS	Photos
16	Blanding very fine sandy loam	14AB (inclusion)	63"+ to SS	Profile description, photos
17	Oelop very fine sandy loam	14AB	8.3'+	Lower fan-valley sideslope, very channery loam lense at 4 to 5'
18	Oelop very fine sandy loam	14AB	12'+	Drainage cut
19	Oelop very fine sandy loam	14AB	8'+	Local alluvium from trib. drainage
20	Oelop channery sandy loam	14AB	8'+	Drainage cut
21	Oelop channery sandy loam	14AB	9'+	Drainage cut
22	Blanding very fine sandy loam	X11AB	4'+	
23	Blanding very fine sandy loam	X11AB	5'+	
24	Blanding very fine sandy loam	X11AB	5'+	Drainage cut
25	Blanding channery sandy loam	X11AB	54" to whitish gray SH	
26	Blanding fine sandy loam	X11AB	9'+	
27	Dulce channery loam	1AB	12" to fract. SS	
28	Oelop channery fine sandy loam	14AB	4'+	Drainage cut
29	Dulce channery loam	1AB	12" to fract. SS	
30	Pulpit very fine sandy loam	5	32" to hard, fract. SS	
31	Pulpit very fine sandy loam	5	30" to hard, fract. SS	Photos
32	Dulce very cobbly loam	1AB	4 to 8" to fract. SS (6")	
33	Dulce loam	1AB	12" to fract. SS	
34	Dulce loam	G11B (inclusion)	9" to fract. SS	
35	Soil A-B very channery loam	16C	5"	Scoria hilltop
36	Soil A-B very channery loam	16C	6"	Scoria hilltop
37	Soil A-B very channery loam	16C	6"	Scoria sideslope, roots in upper part of scoria, photos

APPROVED SEP 2005

TABLE 5

N12/N99S COAL RESOURCE AREA, 2773 Acres

Hole#	Soil Name - surface texture	Map Unit	Depth to rock	Comments / profile description
38	Blanding very fine sandy loam	X11C	9.5' to SS	Small saddle between 2 knob ridges, photos
39	Blanding fine sandy loam	X11C	4' to SS	
40	Bond channery loam	2B	8" to SS	Photos
41	Bond loam	2B	16" to weath. SS & SH	Weath. bedrock with roots from 16 to 25", photos
42	Bond loam	2B	15" to weath. SS & SH	Weath. bedrock with roots, photos
43	Bond loam	2B	12" to scoria	
44	Dulce channery loam	3CD	13" to SH	
45	Zyme channery silty clay loam	3CD	12" to fract. SS	Photos
46	Soil A-B flaggy sandy loam	16C	6" to fract. Scoria SS	
47	Soil A-B cobbly sandy loam	16C	6" to fract., hard scoria	
48	Soil A-B cobbly loam	16C	4" to scoria	
49	Begay fine sandy loam	12AB	12'+	Slopewash alluvium, photo
50	Dulce fine sandy loam	1AB	5" to fract., hard SS	
51	Blanding fine sandy loam	G11B	54"+	Profile description, photo
52	Begay fine sandy loam	G11B (inclusion)	8'+	Drainage cut
53	Zyme clay loam	3DE	12" to weath. SH	
54	Dulce channery loam	16CE (inclusion)	8" to weath. scoria	
55	Dulce fine sandy loam	3AB	5" to fract., hard SS	
56	Dulce fine sandy loam	3AB	5" to fract., hard SS	
57	Zyme clay loam	3AB	5" to weath. SH	
58	Zyme clay loam	3CD	17" to weath. platy SH	
59	Zyme channery clay loam	3CD	5" to weath., platy SH	Roots go into SH to 12"
60	Bond fine sandy loam	2B	17" to weath. sandy SH	
61	Dulce gravelly fine sandy loam	2B (inclusion)	14" to weath. SH	Weath. SH with roots 14 to 24"
62	Bond fine sandy loam	2B	12" to fract. SS	
63	Dulce fine sandy loam	2B (inclusion)	7" to hard, fract. SS	
64	Dulce fine sandy loam	2B (inclusion)	6" to hard, fract. SS	
65	Bond fine sandy loam	2B	13" to hard, fract. SS	Photos
66	Zyme clay loam	3AB	9" to weath. SH over SS	
67	Reclaimed Land	RL	-	Old sed. pond basin – taken out, reclaimed

SEP 2005 APPROVED

TABLE 5

N12/N99S COAL RESOURCE AREA, 2773 Acres

Hole#	Soil Name - surface texture	Map Unit	Depth to rock	Comments / profile description
68	Las Lucas sandy clay loam	15A	4'+	
69	Soil A-B very channery loam	16CE	3" to scoria	
70	Dulce channery loam	1AB	12" to fract. SS	Photos

SEP 2005
APPROVED

TABLE 5

N-99N COAL RESOURCE AREA, 1645 Acres

Hole#	Soil Name - surface texture	Map Unit	Depth to rock	Comments /profile description
1	Pulpit fine sandy loam	5	39"	Profile description
2	Dulce channery loam	1AB	9" to fract. SS	
3	Dulce channery loam	5 (inclusion)	17" to fract. SS	
4	Dulce channery loam	1AB	14" to fract. shaly SS	
5	Pulpit very fine sandy loam	5	29" to hard, fract. SS	
6	Pulpit very fine sandy loam	5	23" to hard, fract. SS	
7	Blanding fine sandy loam	5 (inclusion)	7' to hard, fract. SS	
8	Zyme clay loam	3CD	4" to sandy SH	
9	Zyme clay loam	3CD	3" to sandy SH	
10	Las Lucas sandy clay loam	15A	6.3'	Drainage cut
11	Sharps very fine sandy loam	6AB	23" to SH & soft SS	
12	Sharps very fine sandy loam	6AB	24" to soft SH	
13	Zyme clay loam	3CD	13" to soft, sandy SH	
14	Sharps channery sandy loam	6AB	23"	Residual material from scoria
15	Scoria Rock Outcrop	16CE	2" to baked SS	
16	Dulce channery fine sandy loam	16CE (inclusion)	6" to baked SS	
17	Zyme clay loam	3CD	3" to SH	
18	Pulpit very fine sandy loam	1AB (inclusion)	27" to hard SS	
19	Dulce channery loam	3CD	14" to SS	
20	Soil A-B very channery sandy loam	16CE	27" to weath. baked bedrx	
21	Dulce channery sandy loam	6AB (inclusion)	14" to weath. SH	14 to 40" very weath. SH with roots
22	Sharps very fine sandy loam	6AB	32" to weath. SH	
23	Dulce channery loam	3CD	11" to fract. SS	
24	Las Lucas sandy clay loam	15A	7'+	Drainage cut
25	Sharps very fine sandy loam	6AB	23" to weath. SH	
26	Las Lucas sandy clay loam	15A	15'	Drainage cut
27	Las Lucas sandy clay loam	15A	20'	Drainage cut
28	Zyme clay loam	3CD	7" to weath. SH	Roots in SH to 24"
29	Soil A-B extremely channery sandy loam	16CE	11" to baked SH	
30	Sharps very fine sandy loam	3CD (inclusion)	24"	11 to 24" very weath. SH, photos
31	Blanding very fine sandy loam	2B (inclusion)	6' to weath. carb.SH	Major rooting depth to 38", photo
32	Bond channery fine sandy loam	2B	19" to weath. SH	Weath. SH 19 to 50", photo

SEP 2005 APPROVED

TABLE 5

N-99N COAL RESOURCE AREA, 1645 Acres

Hole#	Soil Name - surface texture	Map Unit	Depth to rock	Comments /profile description
33	Bond channery fine sandy loam	2B	19" to weath. SH	
34	Bond channery fine sandy loam	2B	14" to fract. scoria SS	
35	Soil A-B channery sandy loam	16CE	12" to mixed scoria	
36	Dulce channery loam	3DE	6" to fract. SS	
37	Zyme clay loam to clay	3DE	12" to weath. SH	
38	Sharps loam	3CD (inclusion)	24" to weath. SH	Major rooting depth 12"
39	Zyme clay loam	3CD	6" to weath. SH	
40	Dulce channery loam	3CD	11" to weath. SS	
41	Zyme clay loam	3CD	9" to weath. SH	
42	Zyme clay loam	3CD	6" to weath. SH	
43	Zyme clay loam	3CD	5" to weath. SH	
44	Dulce channery loam	1AB	10" to weath. SH	
45	Dulce channery sandy loam	1AB	8" to weath. SS	
46	Sandstone Rock Outcrop	7E	0"	
47	Travessilla channery sandy loam	7E	9" to SS	
48	Dulce channery sandy loam	3CD	4" to fract. SS	
49	Dulce channery loam	3AB	10" to fract. SS	
50	Dulce channery loam	3AB	12" to fract. SS	
51	Dulce channery loam	1AB	12" to weath. SH	
52	Pulpit very fine sandy loam	1AB (inclusion)	24" to fract. SS	

SEP 2005 APPROVED

ATTACHMENT 1

Approval Letter from Office of Surface Mining (OSM) Regarding Proposed Soils Scope-of-Work (SOW); and OSM Soil SuitabilityTable "Topsoil and Topsoil Substitute Suitability Criteria for the Southwestern United States"

DEC 2004
APPROVED

c: Wendt
Schlewozt
Pfannenstiel
Cohen
Lehn

United States Department of the Interior

OFFICE OF SURFACE MINING
Reclamation and Enforcement
1999 Broadway, Suite 3320
Denver, Colorado 80202-5733

IN REPLY REFER TO:

AZ0001

June 25, 2003

Mr. Brian Dunfee
Environmental Engineering Manager
Peabody Western Coal Company
P.O. Box 650
Navajo Route 41
Kayenta, Arizona 86033

RE: **Baseline Wildlife, Soils and Overburden Studies-Black Mesa Complex**

Dear Mr. Dunfee:

The Office of Surface Mining (OSM) is in receipt of Peabody Western Coal Company's (PWCC) letters dated June 3, 2003 and June 19, 2003. The letters described PWCC's proposals for gathering baseline data regarding wildlife, soils and overburden in un-mined coal resource areas. This data will be used for future mine planning and permitting activities.

We have discussed PWCC's approach to gathering this data during phone conversations and you have received, via email, OSM's Guidance for soil and overburden sampling. PWCC's previous sampling (122 deep cores) and the continuing regraded spoil sampling program, in the existing mining areas, has resulted in excess of 6,000 samples and analyses. The current proposal for soil and overburden sampling is less intense than is recommended in the OSM Guidance. However, based on the above information, OSM is confident that the proposed sampling schemes will provide the needed information as to soil and overburden quality. In addition, PWCC has committed to doing additional overburden sampling if the results of the initial sampling indicates there are unexpected changes in overburden quality from mined areas or areas currently being mined.

PWCC has continued to monitor, on an annual basis, several threatened and endangered (T&E) wildlife species and species of special interest and has conducted wildlife studies on an ongoing basis within the leasehold. Therefore, focusing on T&E species and species of special interest and their critical habitat should be satisfactory baseline for future mine planning and permitting activities.

DEC 2004
APPROVED

Therefore, based upon PWCC's description of proposed baseline studies for wildlife, soils and overburden OSM concurs with the proposals referenced in the above cited letters.

By copy of this letter, OSM/WRCC requests PWCC, other OSM offices, and other agencies to file the attached material appropriately.

If you have questions or concerns please contact me at 303-844-1400 x1496.

Sincerely;

Jerry D. Gavette

Jerry D. Gavette, Leader
Black Mesa/Kayenta Mine Team

cc/with enc: AFO
BIA-Navajo Regional Office
BIA-Western Regional Office
BLM-Phoenix
Forest Lake Chapter House
Hopi Office of Realty Services
Hopi Office of Mining & Mineral Resources
Navajo Minerals Department

DEC 2004
APPROVED

TOPSOIL AND TOPSOIL SUBSTITUTE SUITABILITY CRITERIA*
FOR THE SOUTHWESTERN UNITED STATES

Parameter		Material Quality		
		Good	Marginal	Unsuitable
PH		6.0-8.4	5.5-6.0 8.4-8.8	< 5.5 > 8.8
EC mmhos/cm (1)		< 4.0	4.0-12.0	> 12.0
SAR (2)				
	sl and coarser	< 12.O	12.0-18.0	> 18.0
	1 and cl	< 1O.O	10.0-16.0	> 16.0
	40% clay	< 8.O	8.0-14.0	> 14.0
Texture (3)		ls, sl, 1, sil, with 35% c	s, lcs, cl, sicl with 45% c	>45% c
Saturation %		25-80	25-80	<25 or >80
CaCo3 %		0-15	15-30	30
Coarse Fragments (4)				
< 3 inch %		15	15-35	35
> 3 inch %		3	3-10	10
Erosion Factor (5)		< .37	< .37	
Acid-base potential		+5 T CaCO3 equiv./IOOOT	+0 T CaCo3 equiv./IOOOT	-5 T CaCO3 equiv./IOOOT
Boron		5 ppm	5 ppm	>5 ppm
Selenium (Total)			≤ 0.8 ppm	> 0.8 ppm
Selenium (Extractable)			≤ 0.15 ppm	> 0.15 ppm

*These suitability criteria may be modified on a case by case basis if sufficient data are submitted to support the modifications and the

APPROVED DEC 2001

submitted data technically represent the site specific nature of the modification.

1. When EC is less than 2.0, then SAR's can not be >18.

2. SAR values can be modified if adequate data is submitted to support proposed modifications.

3. ls=loamy sand; lcs=loamy coarse sand; sl=sandy loam; l=loam; sil=silt loam; scl=sandy clay loam; s=sand; cl=clay loam; sicl=silty clay loam; cl=clay.

4. For topsoil substitutes/supplements, percentage can be increased if it is shown that the higher percentage will increase slope stability and/or vegetation establishment. Suitabilities will be determined on a site specific basis.

DEC 2004
APPROVED

ATTACHMENT 2

Black Mesa Lease Area
Map Unit Descriptions
(Intermountain Soils, Inc. 1985)

DEC 2004
APPROVED

Order 1 and 2 Map Unit Descriptions

1A Dulce very channery fine sandy loam, 1 to 4 percent slopes.
1, 1B Dulce very channery fine sandy loam, 4 to 8 percent slopes.
1C Dulce very channery fine sandy loam, 8 to 15 percent slopes.
1D Dulce very channery fine sandy loam, 15 to 30 percent slopes.

The less steep phases of these map units are found on ridge crests and shoulders whereas the steeper phases are found on shoulders and sideslopes. The soils in these map units are reddish brown and have a surface layer high in rock fragments. Depth to soft or fractured sandstone bedrock is 2 to 10 inches with bedrock generally occurring at less than 6 inches. Contrasting soils which may occur in these map units include Zyme soils found on sideslopes and Bond soils found on ridge crests, soils with bedrock deeper than 20 inches found in concave areas and rock outcrop occurring as narrow escarpments. Similar soils which may occur in these map units include soils with over 35 percent rock fragments, soils that are non-calcareous throughout, and Travessilla soils.

Dulce soils are marginally suitable for topsoil and are limited by the amount of rock fragments on the soil surface. The shallow depth to bedrock of these soils may restrict the amount of soil which can be salvaged. The included Bond soils have a good suitability for topsoil and should be salvaged where practicable.

2B Bond very fine sandy loam, 1 to 8 percent slopes.

This map unit occurs on ridge crests and shoulders throughout the lease area. The Bond soils are reddish throughout and have a surface layer high in very fine sand. Depth to hard sandstone bedrock is between 12 and 20 inches. Contrasting soils which may occur in these map units include Dulce soils on shoulders and Sharps soils near the delineated boundaries of this map unit. Soils similar to Bond which may occur in these map units include soils with less than 18 percent clay, soils with less very fine sand, and soils underlain by soft bedrock.

Bond soils are suitable for topsoil and have an average stripping depth of 12 inches. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

3A Zyme-Dulce complex, 2 to 8 percent slopes.
3BC Zyme-Dulce complex, 2 to 15 percent slopes.
3C Zyme-Dulce complex, 6 to 15 percent slopes.
3D Zyme-Dulce complex, 15 to 30 percent slopes.
3DE Zyme-Dulce complex, 15 to 50 percent slopes.
3E Zyme-Dulce complex, 30 to 50 percent slopes.

The less steep phases of these map units are found on ridge crests and shoulders whereas the steeper phases are found on ridge sideslopes. Generally, Zyme soils are found on the steeper portions of the map units. Zyme soils are variable in color, depending on the color of the underlying shale bedrock. They are clayey throughout and have numerous surficial rock fragments. Dulce soils are reddish brown and also have a surface layer high in rock fragments. Both these soils in these map units are extremely eroded. Depth to soft or fractured bedrock is 2 to 10 inches with bedrock generally occurring at less than 6 inches. Contrasting soils which may occur in these map units include soils deeper than 20 inches, Bond soils, and Soils A and B. Bond soils and Soils A and B are found on ridge crests and sideslopes, and the soils deeper than 20 inches are found in concave areas. Rock outcrop occurs as narrow escarpments. Similar soils which may occur in these map units include those with over 35 percent rock fragments, soils that are non-calcareous throughout, and Travessilla soils.

APPROVED DEC 2004

The soils in these map units are marginally suitable for topsoil and are limited by clayey texture of the Zyme soils and high surficial rock fragment content of both soils. The shallow depth to bedrock of these soils may restrict the amount of soil which can be salvaged. The included Bond soils have a good suitability for topsoil and should be salvaged where practicable.

3F Ustic Torriorthents-rock outcrop complex, 50 to 80 percent slopes.

This map unit occurs on very steep sideslopes of ridges. Because of the slope steepness and the interbedded nature of the bedrock, soils are quite variable and mapped only to the subgroup level. Rock outcrop consists of areas of exposed sandstone or shale bedrock. The soils in this map unit are not considered salvageable because of the steep slopes and high amounts of rock outcrop.

4A Zyme very channery loam, 1 to 4 percent slopes.
4B Zyme very channery loam, 4 to 8 percent slopes.
4C Zyme very channery loam, 8 to 15 percent slopes.
4D Zyme very channery loam, 15 to 30 percent slopes.

The less steep phases of these map units are generally found on toeslopes or upper sideslopes, and the steeper phases are found on sideslopes. Zyme soils are variable in color, depending on color of the underlying shale bedrock. They are clayey throughout and have a surface high in rock fragments. Depth to shale bedrock is 2 to 10 inches with bedrock generally occurring at less than 6 inches. Contrasting soils which may occur in these map units include Dulce and Bond soils found on crests and sideslopes, and soils deeper than 20 inches occurring in concave areas. Rock outcrop, where present, occurs as narrow escarpments. Similar soils which may occur in these map units include soils that are non-calcareous throughout and soils with less clay.

The soils in these map units are marginally suitable for topsoil and are limited by clayey texture and high surficial rock fragment content. The shallow depth to bedrock of these soils may restrict the amount of soil which can be salvaged. The included Bond soils have a good suitability for topsoil and should be salvaged where practicable.

5 Pulpit very fine sandy loam, 2 to 8 percent slopes.

This map unit occurs on valley sideslopes, and crests and sideslopes of ridges. The soils in this map unit are reddish brown and have a surface layer high in very fine sand. Depth to hard sandstone bedrock is 20 to 40 inches. Contrasting soils which may occur in these map units include Cahona soils on sideslopes and Bond soils on crests. Soils similar to Pulpit which may occur in this map unit include soils with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand. The J/7 mining areas has more of these similar soils than the other mining areas. Sharps is also a similar soil.

DEC 2004 APPROVED

Pulpit soils are suitable for topsoil and have an average stripping depth of 28 inches. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

6 Sharps very fine sandy loam, 2 to 8 percent slopes.
6A Sharps very fine sandy loam, 1 to 4 percent slopes.
6B Sharps very fine sandy loam, 4 to 8 percent slopes.
6C Sharps very fine sandy loam, 8 to 15 percent slopes.

The less steep phases of these map units are found on ridge crests and shoulders, and the steep phases are found on shoulders and sideslopes. The soils in these map units are reddish brown and have a surface layer high in very fine sand. Depth to soft or fractured bedrock is 20 to 40 inches. Contrasting soils which may occur in these map units include Cahona soils on sideslopes and Bond soils on crests. Similar soils which may occur in

this map unit include soils with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand. The J/7 mining areas has more of these similar soils than the other mining areas. Another similar soil is Pulpit.

Sharps soils are suitable for topsoil and have an average stripping depth of 28 inches. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

7B Travessilla-Zyme-Dulce complex, 2 to 6 percent.

This map unit is found primarily in the J/7 mining area on ridge crests and sideslopes. Zyme and Dulce soils are generally found on the sideslopes and the Travessilla soils on the crests. Zyme soils are variable in color, depending on the color of the underlying shale bedrock. They are clayey throughout. Travessilla and Dulce soils are reddish brown and are coarse-textured. All of these soils in this map unit are very eroded. Depth to bedrock is 2 to 10 inches with bedrock generally occurring at less than 6 inches. Contrasting soils which may occur in this map unit include soils deeper than 20 inches in concave areas and Bond soils on ridge crests. Rock outcrop also is included.

The soils in these map units are marginally suitable for topsoil and are limited by clayey texture of the Zyme soils and high surficial rock fragment content of each of the soils. The shallow depth to bedrock of these soils may restrict the amount of soil which can be salvaged. The included Bond soils have a good suitability for topsoil and should be salvaged where practicable.

7C Zyme-Travessilla-Rock outcrop complex, 6 to 15 percent slopes.
7D Zyme-Travessilla-Rock outcrop complex, 15 to 30 percent slopes.
7E Zyme-Travessilla-Rock outcrop complex, 30 to 50 percent slopes.

These map units are also found primarily in the J/7 mining area. They are found on sideslopes and include significant amounts of rock outcrop. Zyme soils are found on the steeper portion of the map unit. Zyme soils are variable in color, depending on the color of the underlying shale bedrock. They are clayey throughout. Travessilla soils are reddish brown and are coarse-textured. Both these soils in these map units are very eroded. Depth to bedrock is 2 to 10 inches with bedrock generally occurring at less than 6 inches. Rock outcrop occurs as narrow escarpments. Contrasting soils which may occur in these map units include soils deeper than 20 inches found in concave areas and Bond soils found randomly throughout. Similar soils which may occur in these map units are Dulce soils.

The soils in these map units are marginally suitable for topsoil and are limited by the clayey texture of the Zyme soils and the high surficial rock fragment content of both soils. The shallow depth to bedrock of these soils and the amount of rock outcrop occurring in these map units may restrict the amount of soil which can be salvaged. The included Bond soils have a good suitability for topsoil and should be salvaged where practicable.

APPROVED DEC 2004

10 Cahona very fine sandy loam, bedrock substratum, 2 to 8 percent slopes.
10A Cahona very fine sandy loam, bedrock substratum, 1 to 4 percent slopes.
10B Cahona very fine sandy loam, bedrock substratum, 4 to 8 percent slopes.
10C Cahona very fine sandy loam, bedrock substratum, 8 to 15 percent slopes.

These soils are found on valley sideslopes. The soils in these map units are reddish brown and have a surface layer high in very fine sand. Depth to bedrock is 40 to 72 inches. Contrasting soils which may occur in these map units include Cahona soils which are deeper than 72 inches on sideslopes, and Sharps soils on crests. Similar soils which may occur in these map units include soils with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand. The J/7 mining areas has more of these similar soils than the other mining areas.

Cahona soils are suitable for topsoil and have an average stripping depth of 58 inches. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

11 Cahona very fine sandy loam, 1 to 6 percent slopes.
11A Cahona very fine sandy loam, 1 to 4 percent slopes.
11B Cahona very fine sandy loam, 4 to 8 percent slopes.
11C Cahona very fine sandy loam, 8 to 15 percent slopes.

These soils are found on valley sideslopes. They are reddish brown and have a surface layer high in very fine sand. Depth to soft or fractured bedrock is 72 to more than 180 inches. Contrasting soils which may occur in these map units include Cahona, bedrock substratum, soils on upper sideslopes and Sharps soils on crests. Soils similar to Cahona which may occur in these map units include soils with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand. The J/7 mining areas has more of these similar soils than the other mining areas. Oelop soils are also similar.

Cahona soils are suitable for topsoil and have a weighted average stripping depth of 10.0 feet. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

G11C Cahona very fine sandy loam, gravelly substratum, 8 to 15 percent slopes.

This soils occurs on valley sideslopes and alluvial fans in the area of the proposed Wild Ram Dam. It is very similar to the Cahona soil in map unit 11, but is underlain by material high in rock fragments at a depth of 24 to 40 inches. Depth to soft or fractured bedrock is 40 to more than 72 inches.Contrasting soils which may occur in this map unit include Sharps on the upper slopes and Chilton soils on the steeper sideslopes. Similar soils which may occur in these map units include those with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand.

These soils are suitable for topsoil and have an average stripping depth of 2.5 feet. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

X11 Cahona-Cahona, bedrock substratum, very fine sandy loams, 2 to 10 percent slopes.
X11A Cahona-Cahona, bedrock substratum, very fine sandy loams, 1 to 4 percent slopes.
X11B Cahona-Cahona, bedrock substratum, very fine sandy loams, 4 to 8 percent slopes.
X11C Cahona-Cahona, bedrock substratum, very fine sandy loams, 8 to 15 percent slopes.

These soils are found on valley sideslopes. The soils in these map units are reddish brown and have a surface layer high in very fine sand. Depth to soft or fractured bedrock is 40 to more than 72 inches. Contrasting soils which may occur in these map units include Sharps soils on crests. Similar soils which may occur in these map units include those with less than 18 percent clay and/or a sand fraction with more than 15 percent fine or coarser sand. The J/7 mining areas has more of these similar soils than the other mining areas. Oelop soils are also similar.

These soils are suitable for topsoil and have an average stripping depth of 7.6 feet. The high very fine ~~and fine~~ sand content make these soils susceptible to wind and water erosion.

DEC 2004 APPROVED

12 Begay loam, 2 to 10 percent slopes.
12A Begay loam, 1 to 4 percent slopes.
12B Begay loam, 4 to 8 percent slopes.
12C Begay loam, 8 to 15 percent slopes.

These map units are found on valley-filling sideslopes. These soils are reddish to reddish brown and are coarse-textured. Contrasting inclusions which may occur in these map units are soils with bedrock between 40 and 72 inches, primarily in the J/7 area. Similar soils which may occur in these map units include soils with over 18 percent clay and soils lacking a structural B horizon.

Begay soils are suitable for topsoil and have an average stripping depth of 9.8 feet. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

13, 13A San Mateo loam, 0 to 3 percent slopes.

This map unit is found on stream terraces and remnant floodplains. The soils in this unit are very deep and are brownish in color. There are no contrasting soils included in the mapping. Soils similar to San Mateo which may occur in this map unit are the Las Lucas and Oelop soils and soils with a sand fraction of less than 15 percent fine or coarser sand.

San Mateo soils are suitable for topsoil and have an average stripping depth of 14.7 feet. These soils are affected by salinity and/or sodicity at varying depths. Most of these soils which are saline or sodic are in or near Reed Valley. Depth to high salt or sodium levels ranged from 8 to more than 18 feet.

14A Oelop very fine sandy loam, 1 to 4 percent slopes.
14B Oelop very fine sandy loam, 4 to 8 percent slopes.

These map units are found on valley sideslopes and bottoms. These soils are brown and are high in very fine and fine sand. These map units tend to occupy relatively small areas but they occur commonly throughout the Black Mesa lease area. No inclusions of contrasting soils were observed within these map units. Soils similar to Oelop found in the study area are the Las Lucas and Cahona soils and soils with a sand fraction of less than 15 percent fine or coarser sand.

Oelop soils are suitable for topsoil and have an average stripping depth of 9.8 feet. These soils are affected by salinity and/or sodicity at varying depths. Most of these soils which are saline or sodic are in or near Reed Valley. Depth to unsuitably high levels ranged from 20 to more than 120 inches. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

15, 15A Las Lucas sandy clay loam, 2 to 6 percent slopes.

This map unit is found on lower valley sideslopes. The soils in this unit are very deep and are brownish in color. No inclusions of contrasting soils were observed within this map unit. Similar soils which may occur in this map unit include the Cahona, San Mateo and Oelop soils. Other similar soils included are those with a sand fraction with more than 15 percent fine or coarser sand and those lacking a structural B horizon.

Las Lucas soils are suitable for topsoil and have an average stripping depth of 11.6 feet. These soils are affected by salinity and/or sodicity at varying depths. Most of these soils which are saline or sodic are in or near Reed Valley. Depth to unsuitably high levels ranged from 31 to more than 120 inches. The high very fine and fine sand content make these soils susceptible to wind and water erosion.

APPROVED DEC 2004

16C Soil A-Soil B extremely channery very fine sandy loams, 4 to 15 percent slopes.
16E Soil A-Soil B extremely channery very fine sandy loams, 15 to 50 percent slopes.
16F Soil A-Soil B extremely channery very fine sandy loams, 50 to 70 percent slopes.

These map units are found on the crests of hills throughout the lease. The soils in these map units formed in porcellanite, and as a result, contain a very high volume of rock fragments. Other surface textures found in this map unit are very channery, very cobbly or extremely cobbly very fine to fine sandy loams. Since these soils are unsuitable for topsoil because of high rock fragment content, they were not sampled or described.

17C--Chilton very gravelly fine sandy loam, 6 to 15 percent slopes.

This map unit occurs only at the proposed Wild Ram Dam site and is very limited in areal extent. It occurs on the sideslopes of the alluvial fans in this area. The soil in this map unit were not sampled or described. Based on field observations, this soil has a gravelly fine sandy loam surface layer and a very gravelly sandy loam substratum layers. Because of high rock fragment content in all but the surface layers, these soils are suitable for topsoil down to six inches.

RW Riverwash.

The riverwash map unit was mapped along the channel of some of the drainages in the permit area. Most of the areas are very narrow. These soils are affected by salinity and/or sodicity and are not suitable for topsoil.

DL Disturbed land.

This map unit consists of land disturbed by activities associated with mining. It is similar to map unit 34 in the Order 3 survey.

RL Reclaimed land.

This map unit is composed of areas that have been disturbed by mining and subsequently reclaimed. It is similar to map unit 35 in the Order 3 survey.

TS Topsoil Stockpile.

This map unit consists of stockpiled soil material to be used in reclamation.

DEC 2004 APPROVED

ATTACHMENT 3

NRCS Official Soil Series Descriptions

Begay
Blanding
Bond
Cahona
Dulce
Las Lucas
Oelop
Pulpit
San Mateo
Sharps
Travessilla
Zyme

DEC 2004
APPROVED

LOCATION BEGAY UT+AZ CO

Established Series
Rev. RLM/GWL/RLB
10/2002

BEGAY SERIES

The Begay series consists of very deep, well drained, moderately rapidly permeable soils that formed in eolian deposits and alluvium, derived mainly from sandstone. Begay soils are on structural benches, broad mesas, fan remnants and have slopes of 0 to 30 percent. The average annual precipitation is about 12 inches, and the mean annual temperature is about 48 degrees F.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, mesic Ustic Haplocambids

TYPICAL PEDON: Begay loamy fine sand, rangeland. (Colors are for air-dry soil unless otherwise noted.)

A--0 to 3 inches; yellowish red (5YR 5/6) loamy fine sand, yellowish red (5YR 4/6) moist; single grained; loose; very slightly effervescent, carbonates are disseminated; moderately alkaline (pH 7.9); clear smooth boundary. (2 to 5 inches thick)

Bw--3 to 16 inches; yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) moist; weak medium subangular blocky structure; soft, friable; common fine roots; few fine pores; slightly alkaline (pH 7.8); clear wavy boundary. (11 to 17 inches thick)

Bk1--16 to 28 inches; yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, firm; few fine roots; common fine pores; very slightly effervescent, carbonates are disseminated; moderately alkaline (pH 7.9); gradual wavy boundary. (10 to 14 inches thick)

Bk2--28 to 42 inches; yellowish red (5YR 5/6) very fine sandy loam, yellowish red (5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, firm; strongly effervescent, moderately alkaline (pH 8.0); gradual wavy boundary. (12 to 16 inches thick)

C--42 to 60 inches; yellowish red (5YR 5/8) very fine sandy loam, yellowish red (5YR 5/8 or 4/6) moist; massive; soft, very friable; few fine pores; very slightly effervescent, carbonates are disseminated; moderately alkaline (pH 8.1).

TYPE LOCATION: San Juan County, Utah; 7 miles east and 5 miles north of Navajo Mountain School; SW 1/4, SE 1/4 sec. 31, T. 42 S., R. 17 E.

DEC 2004 APPROVED

RANGE IN CHARACTERISTICS:

Soil moisture: In 7 out of 10 years the soils are dry in all parts of the moisture control section for 50 to 75 percent of the time (cumulative) that the soil temperature at depth of 20 inches is above 41

degrees F. The soils are moist in some part of the moisture control section for 30 to 40 days during the summer and are dry in some part of the moisture control section for 60 to 90 consecutive days during winter and early spring and are moist in some parts between July and October.

Mean annual soil temperature ranges from - 47 to 57 degrees F

Mean summer soil temperature at a depth of 20 inches ranges from - 61 to 65 degrees F.

Combined thickness of A and B horizons is - 35 to 50 inches.

Depth to secondary carbonates accumulation ranges from - 7 to 22 inches.

Particle-size control section ranges from - 15 to 40 percent fine sand or coarser

Rock fragments: 0 to 15 percent

A horizon

Hue: 2.5YR to 10YR

Value: 4 to 6 dry, 3 to 5 moist

Chroma: 3 to 6 dry or moist

Reaction: slightly alkaline or moderately alkaline

Calcium carbonate equivalent: ranges from 0 to 3 percent.

Bw horizon

Hue: 2.5YR to 7.5YR

Value: 4 to 6 dry, 3 to 5 moist

Chroma: 4 to 8 dry or moist

Texture: ranges from very fine sandy loam, loamy very fine sand, fine sandy loam, sandy loam

Reaction: slightly alkaline to strongly alkaline

Calcium carbonate equivalent: ranges from 0 to 3 percent.

Bk and C horizons

Hue: 2.5YR to 7.5YR

Value: 5 to 8 dry, and 4 to 8 moist

DEC 2004 APPROVED

Chroma: 4 to 6 dry or moist

Textures: ranges from very fine sandy loam, fine sandy loam, or sandy loam, and thin strata of gravelly fine sandy loam, or loamy fine sand, below a depth of 40 inches

Reaction: ranges from slightly alkaline to strongly alkaline.

Calcium carbonates equivalent: ranges from 0 to 5 percent.

COMPETING SERIES: These are the Delvalle (NM), Ignacio (NM), Kitsili (NM), Koshare (NM), Ojito (NM), Parida (NM), Remmit (CO), Sandspring (T AZ), and Turnback (WY) series.
Delvalle soils have a lithologic discontinuity at 27 to 60 inches and contain 55 to 70 percent sand; Fine sand or coarser content: more than 50 percent.
Ignacio and Turnback soils have bedrock at depths of 20 to 40 inches.
Parida soils have more than 15 percent rock fragments in the particle-size control section.
Remmit and Sandspring soils have hue yellower than 7.5YR.
Koshare soils contain 10 to 25 percent mica content in the coarse silt to fine sand fraction.
Kitsili soils are effervescence throughout the entire profile and contain less than .6 percent organic matter.
Ojito soils are moderately deep to bedrock.

GEOGRAPHIC SETTING: Begay soils occur on fan remnants, structural benches, broad and mesa tops at elevations of 4,700 to 7,400 feet. Slopes are 0 to 30 percent. These soils formed in deep eolian deposits and alluvium from sedimentary rocks. The climate is semiarid and the average annual precipitation ranges from 8 to 14 inches. The mean annual temperature is 44 to 55 degrees F. The mean summer temperature is 59 to 63 degrees F. and the freeze-free period ranges from 110 to 175 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are Anasazi, Aneth and Sogzie soils. Anasazi soils have calcic horizon and lithic contact at 20 to 40 inches. Aneth soils do not have cambic horizons but have a sandy particle size control section. Sogzie soils have calcic horizons.

DRAINAGE AND PERMEABILITY: Well drained; very slow to medium runoff; moderately rapid permeability.

USE AND VEGETATION: Used only as rangeland. Potential vegetation is needleandthread, big sagebrush, blue grama, Indian ricegrass.

DISTRIBUTION AND EXTENT: Southeastern Utah and northwestern Colorado. Begay soils are moderately extensive. MLRA 34, 35 and 48A.

MLRA OFFICE RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: San Juan County, Utah, 1976.

REMARKS:

These soils have been correlated to semidesert range sites in Utah.

DEC 2004 APPROVED

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon - from 0 to 3 inches (A horizon).

Cambic horizon - from 3 to 16 inches (Bw horizon).

The Bk horizon is assumed to have too little carbonate to be a calcic horizon.

In December 1994 the classification was changed from Ustollic Camborthids to Ustic Haplocambids.

Classified according to Soil Taxonomy Second Edition, 1999.

National Cooperative Soil Survey
U.S.A.

DEC 2004 APPROVED

LOCATION BLANDING UT+NM

Established Series
Rev. TBH/AJE/MJD
7/97

BLANDING SERIES

The Blanding series consists of very deep, well drained soils that formed in eolian deposits derived mainly from sandstone. Blanding soils occur on gently sloping and rolling uplands, and have slopes of 2 to 10 percent. The average annual precipitation is about 12 inches, and the mean annual air temperature is about 50 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, mesic Ustic Haplargids

TYPICAL PEDON: Blanding very fine sandy loam, rangeland. (Colors are for air dry soil unless otherwise stated.)

A--0 to 4 inches; reddish brown (5YR 5/4) very fine sandy loam, reddish brown (5YR 4/4) moist; weak thin and medium platy structure; slightly hard, friable, nonsticky and nonplastic; many fine roots; moderately alkaline (pH 8.1); abrupt wavy boundary. (3 to 8 inches thick)

Bt--4 to 16 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 3/6) moist; weak coarse prismatic structure that parts to very weak medium subangular blocky, slightly hard, friable, slightly sticky and slightly plastic; many fine pores; slightly alkaline (pH 7.7); clear wavy boundary. (9 to 25 inches thick)

Btk1--16 to 50 inches; reddish yellow (5YR 4/6) very fine sandy loam, yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure; extremely hard, firm, slightly sticky and slightly plastic; few fine roots; few fine pores; moderately calcareous; moderately alkaline (pH 8.1); clear smooth boundary. (15 to 35 inches thick)

Btk2--50 to 60 inches; reddish yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure; very hard, firm, slightly plastic; moderately calcareous; moderately alkaline (pH 8.2). (8 to 15 inches thick)

TYPE LOCATION: San Juan County, Utah; about 6.5 miles south of Blanding; 200 feet south of trail and 0.4 miles west of Utah Highway 47; NW1/4 NE1/4 sec. 33, T.37S., R.22E.

RANGE IN CHARACTERISTICS: The depth to carbonate accumulation ranges from 9 to 30 inches. Organic matter in the upper 15 inches ranges from .4 to .9 percent. The mean annual soil temperature at depth of 20 inches ranges from 52 degrees to 55 degrees F., and the average summer soil temperature ranges from 68 degrees to 73 degrees F. In more than 7 out of 10 years, the moisture control section is dry in some parts 25 to 45 consecutive days during the summer and is dry in all parts 50 to 75 percent of the time when the soil temperature is above 41 degrees F.

DEC 2004 APPROVED

The A horizon has value of 3 or 4 moist, 5 or 6 dry, and chroma of 4 through 6. It is dominantly very fine sandy loam but ranges to fine sandy loam. The A horizon is neutral to moderately alkaline. In some pedons thin BA horizons are present above the argillic horizon.

The Bt horizon has value of 3 through 5 moist, 5 or 6 dry, and chroma of 4 through 6. It is dominantly sandy clay loam, but includes very fine sandy loam or loam. This horizon has 18 to 27 percent clay and less than 15 percent coarser than very fine sand. It is neutral to moderately alkaline.

The Btk or Bk horizons have value of 4 or 5 moist, 5 or 6 dry, and chroma of 4 through 6. It ranges from very fine sandy loam to sandy clay loam. This horizon has 3 to 12 percent calcium carbonate. It is slightly or moderately alkaline.

Buried horizons occur in places at depths below 40 inches.

COMPETING SERIES: This is the Snapill (T) series. Snapill soils have a calcic horizon.

GEOGRAPHIC SETTING: Blanding soils are on uplands and plateaus, at elevations of 5,000 to 6,500 feet in a semiarid climate. Slopes are 2 to 10 percent. These soils formed in eolian deposits derived mainly from sandstone. Average annual precipitation is 8 to 13 inches. The mean annual temperature is 50 degrees to 54 degrees F. The mean summer temperature is 70 degrees to 73 degrees F. The frost-free period is 130 to 150 days.

GEOGRAPHICALLY ASSOCIATED SOILS: This is the the Northdale series. Northdale soils have mollic epipedons.

DRAINAGE AND PERMEABILITY: Well drained; slow runoff; moderate permeability.

USE AND VEGETATION: Used mainly for rangeland. Some areas are used for irrigated or nonirrigated cropland. Vegetation is dominantly blue grama, galleta, Wyoming big sagebrush, Indian ricegrass, and snakeweed.

DISTRIBUTION AND EXTENT: Southeastern Utah, western Colorado, northeastern Arizona, northwestern New Mexico. These soils are of moderate extent.

MLRA OFFICE RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: San Juan County, Utah, 1952.

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

DEC 2004 APPROVED

Ochric epipedon - the zone from 0 to 4 inches (A horizon).

Argillic horizon - the zone from 4 to 16 inches (Bt horizon)

Ustalfic feature - dry in all parts of the moisture control half to three-fourths of the time, and soil moisture regime is aridic bordering on ustic.

National Cooperative Soil Survey
U.S.A.

DEC 2004
APPROVED

LOCATION BOND NM+AZ CO UT

Established Series
Rev. TLP/CDL/LWH/SAZ/WWJ
04/2002

BOND SERIES

The Bond series consists of very shallow and shallow, well drained, moderately permeable soils that formed in alluvium, slope alluvium, and eolian deposits derived from sandstone on cuestas, mesas, hills and ridges. Slopes range from 0 to 50 percent. The mean annual precipitation is about 11 inches and mean annual temperature is about 51 degrees F.

TAXONOMIC CLASS: Loamy, mixed, superactive, mesic Lithic Ustic Haplargids

TYPICAL PEDON: Bond sandy loam - on dipslopes; northeast aspect of cuesta with 4 percent slopes - rangeland. (Colors are for dry soil unless otherwise noted.)

A--0 to 3 inches; brown (7.5YR 5/4) sandy loam, brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few medium, fine and very fine roots; few very fine irregular pores; neutral; clear smooth boundary. (2 to 4 inches thick)

BA--3 to 7 inches; brown (7.5YR 5/4) sandy loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine irregular pores; neutral; abrupt smooth boundary. (0 to 4 inches thick)

Bt--7 to 13 inches; reddish brown (5YR 4/4) sandy clay loam, reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, sticky and slightly plastic; common moderately thick clay films on faces of peds and lining pores; common very fine and few fine roots; common very fine and fine tubular pores; neutral; abrupt smooth boundary. (5 to 12 inches thick)

C--13 to 16 inches; light brown (7.5YR 6/4) sandy clay loam; brown (7.5YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine irregular pores; strongly effervescent; moderately alkaline; abrupt smooth boundary. (0 to 4 inches thick)

2R--16 inches; sandstone.

TYPE LOCATION: Cibola County, New Mexico; about 7 miles north of Milan; Bluewater Quadrangle; 300 feet south and 2,600 feet east of the northwest corner, sec. 8, T. 12 N., R. 10 W.

RANGE IN CHARACTERISTICS:

Soil Moisture: Usually dry, dry in all parts of the soil moisture control section in late spring and early summer, but moist intermittently in some part of the soil moisture control section from July to October.

Soil Temperature: 51 to 55 degrees F.

Depth to lithic contact: 6 to 20 inches

Rock fragments in the profile: 0 to 35 inches

Clay content in the particle-size control section: 18 to 35 percent

A horizon
Hue: 5YR, 7.5YR or 10YR
Value: 4 to 6 dry, 3 through 5 moist
Chroma: 2 to 4
Texture: loamy fine sand, sandy loam or fine sandy loam

BA horizon (where present)
Hue: 5YR or 7.5YR
Value: 4 to 6 dry, 4 or 5 moist
Chroma: 3 or 4
Texture: sandy loam, sandy clay loam or fine sandy loam

Bt horizon
Hue: 5YR or 7.5YR
Value: 4 or 6 dry, 3 to 6 moist
Chroma: 3 to 6
Texture: sandy clay loam, loam, sandy loam or clay loam

C horizon
Hue: 5YR or 7.5YR
Value: 5 to 8 dry, 5 or 6 moist
Chroma: 4 through 6 dry and moist
Fine earth fraction: sandy clay loam, loam, sandy loam or clay loam

Some pedons have Btk horizons

COMPETING SERIES: These are the Barboncito, Bondman, Frontier, and Kech series. series. The Barboncito soils have cooler mean annual temperatures and receive more effective winter moisture. Bondman soils have soil temperatures ranging from 47 to 50 degrees F, and receive more winter moisture. Frontier and Kech soils have horizons with segregated secondary carbonates. In addition, Frontier soils have hue yellower than 7.5YR in the argillic horizon and are in LRR-G and are moist in May and June.

GEOGRAPHIC SETTING: Bond soils are on cuestas, mesas, hills, and ridges with slopes ranging from 0 to 50 percent. They formed in alluvium, slope alluvium, and eolian deposits from sandstone. Elevations are 5,600 to 7,200 feet. Typically, the average annual precipitation is 10 to 13 inches, but ranges to 15 inches in some areas; mean annual temperature is 49 to 54 degrees F. The frost-free period is 110 to 160 days. In Colorado, the temperature ranges as low as 45 degrees F. In Arizona elevations are as low as 4,500 feet, temperatures as high 55 degrees and frost free as long as 165 days

DEC 2004 APPROVED

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Aparejo, Hagerman, Penistaja and Skyvillage soils. Aparejo and Penistaja soils are deep. Hagerman soils have lithic contact between 20 and 40 inches. Skyvillage soils do not have argillic horizons.

DRAINAGE AND PERMEABILITY: Well drained; medium runoff; moderately permeable.

USE AND VEGETATION: The major use of this soil is for livestock grazing. The present vegetation is blue grama, sideoats grama, New Mexico feathergrass, Indian ricegrass, scattered oneseed juniper, and winterfat.

DISTRIBUTION AND EXTENT: West-central New Mexico, Northern Arizona, southwestern Colorado and southern Utah. MLRA 36, LRR-D. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Zuni Mountain Area, New Mexico; McKinley County, New Mexico; 1964.

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

Ochric Horizon - The zone from 0 to 3 inches (A horizon).

Argillic Horizon - The zone from about 7 to 13 inches (Bt horizon).

Lithic contact - the boundary with sandstone at 16 inches

The type location of the Bond series was moved from McKinley to Cibola County in 1984 to better reflect the present concepts of the Bond series.

Classified according to Soil Taxonomy Second Edition, 1999.

National Cooperative Soil Survey
U.S.A.

DEC 2004 APPROVED

LOCATION CAHONA CO+UT

Established Series
Rev. DKR/JWH/WWJ
06/2000

CAHONA SERIES

The Cahona series consists of very deep, well drained soils that formed in eolian material derived from sandstone. Cahona soils are on hills and mesas. Slopes range from 1 to 12 percent. Mean annual precipitation is about 14 inches and the mean annual temperature is about 48 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, mesic Calcidic Haplustalfs

TYPICAL PEDON: Cahona loam, on a south facing, 4 percent slope in rangeland at an elevation of 6,800 feet. (Colors are for dry soil unless otherwise noted.)

A1--0 to 1 inch; reddish brown (5YR 4/4) loam, dark reddish brown (5YR 3/4) moist; single grain; loose, loose, nonsticky and nonplastic; slightly effervescent; slightly alkaline (pH 7.5); clear smooth boundary. (1 to 8 inches thick)

A2--1 to 5 inches; reddish brown (5YR 4/4) loam, dark reddish brown (5YR 3/4) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine roots throughout; common very fine discontinuous tubular pores; noneffervescent; slightly alkaline (pH 7.4); clear smooth boundary. (0 to 6 inches thick)

Bt--5 to 15 inches; yellowish red (5YR 4/6) clay loam, reddish brown (5YR 4/4) moist; moderate medium prismatic structure parting to moderate medium angular blocky; hard, friable, slightly sticky and moderately plastic; common fine roots throughout; common fine discontinuous tubular pores; slightly effervescent; slightly alkaline (pH 7.8); gradual smooth boundary. (4 to 16 inches thick).

Btk--15 to 25 inches; yellowish red (5YR 5/6) clay loam, reddish brown (5YR 4/4) moist; weak medium prismatic structure parting to moderate medium angular blocky; hard, friable, moderately sticky and moderately plastic; common fine and medium roots throughout; common fine discontinuous tubular pores; common fine irregular soft masses of carbonate; violently effervescent; moderately alkaline (pH 8.0); clear wavy boundary. (3 to 15 inches thick).

Bk1--25 to 38 inches; pinkish white (5YR 8/2) loam, light reddish brown (5YR 6/3) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, slightly sticky and moderately plastic; common medium roots throughout; 43 percent calcium carbonate equivalent; violently effervescent; strongly alkaline (pH 8.6); clear wavy boundary. (6 to 20 inches thick).

Bk2--38 to 60 inches; pinkish gray (5YR 7/2) loam, light reddish brown (5YR 6/3) moist; massive; hard, firm, slightly sticky and slightly plastic; common medium roots throughout; violently effervescent; moderately alkaline (pH 8.4)

DEC 2004 APPROVED

TYPE LOCATION: Dolores County, Colorado; about 5 miles northwest of Dove Creek; located about 500 feet south and 1500 feet east of the northwest corner of sec. 9, T. 41 N., R. 19 W.; Dove Creek USGS quad; lat. 37 degrees 47 minutes 12 seconds N. and long. 108 degrees 56 minutes 24 seconds W., NAD

RANGE IN CHARACTERISTICS:

Soil moisture regime: ustic bordering on aridic

Soil temperature regime: mesic

Mean annual soil temperature: 48 to 52 degrees F

Mean annual summer soil temperature: 63 to 67 degrees F

Particle-size control section: 18 to 35 percent clay

Depth to calcic horizon: 20 to 40 inches

Depth to secondary calcium carbonate: 5 to 30 inches

Depth to the base of the argillic horizon: 20 to 30 inches

A horizon:
Hue: 5YR or 7.5YR
Value: 4 to 7 (3 to 6 moist)
Chroma: 2 to 6
Texture: fine sandy loam or loam
Rock fragments: 0 to 5 percent
Calcium carbonate equivalent: 0 to 1 percent
Reaction: neutral or slightly alkaline

Bt and Btk horizon:
Value: 4 to 7 dry (3 to 5 moist)
Chroma: 3 to 6
Texture: loam or clay loam
Calcium carbonate equivalent: 0 to 10 percent
Rock fragments: 0 to 5 percent
Reaction: slightly to strongly alkaline

DEC 2004 APPROVED

Bk horizon:
Hue: 5YR to 7.5YR
Calcium carbonate equivalent: 15 to 50 percent
Reaction: slightly to strongly alkaline

COMPETING SERIES: This is the Plughat and Villegreen series. Plughat soils are deep. Villegreen soils are moderately deep.

GEOGRAPHIC SETTING:

Parent material: eolian material derived from sandstone

Landform: hills and mesas

Slopes: 1 to 12 percent

Elevation: 6,200 to 7,400 feet

Mean annual temperature: 46 to 50 degrees F

Mean annual precipitation: 13 to 16 inches

Precipitation is fairly evenly distributed throughout the year with July and August being slightly wetter and June being slightly dryer.

Frost-free period: 100 to 120 days

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Wetherill, Pulpit, and Sharps series. All these soils are on the same landscape positions as Cahona. Wetherill soils have a calcic horizon below 40 inches. Pulpit and Sharps soils have bedrock above 40 inches.

DRAINAGE AND PERMEABILITY: well drained, medium to very high runoff, moderately slow or slow permeability

USE AND VEGETATION: These soils are used for dryland and irrigated cropland, and for grazing. The native vegetation is scattered pinyon and juniper, big sagebrush, Indian ricegrass, muttongrass, and western wheatgrass.

DISTRIBUTION AND EXTENT: Southwest Colorado and southeast Utah. LRR D, MLRA 36. This series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Canyonlands Area, Utah - parts of Grand and San Juan counties Utah. August 1983.

REMARKS: This OSED reclassified the Cahona series into the 13 to 16 inch precipitation zone in southwest Colorado and Utah. Change results from the Four Corners Climate Conference of 10/92. Type location was moved to better reflect the central concept of the Cahona series.

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon: The zone from 0 to 5 inches. (A1, A2 horizons)

Argillic horizon: The zone from 5 to 25 inches. (Bt, Btk horizons)

DEC 2004 APPROVED

Calcic horizon: The zone from 25 to 60 inches. (Bk1, Bk2)

Particle size control section: The zone from 5 to 25 inches. (Bt, Btk)

Particle size control section: The zone from 5 to 25 inches. (Bt, Btk)

Soil Taxonomy Second Edition, 1999

National Cooperative Soil Survey
U.S.A.

DEC 2004
APPROVED

LOCATION DULCE CO

Tentative Series
Rev. GB/JPP
02/2003

DULCE SERIES

The Dulce series consists of shallow, or very shallow, well drained soil that formed in residuum from sandstone. Dulce soils are on foothill slopes and ridges. Slopes range from 6 to 60 percent. Mean annual precipitation is about 14 inches, and mean annual temperature is about 49 degrees F.

TAXONOMIC CLASS: Loamy, mixed, superactive, calcareous, mesic, shallow Ustic Torriorthents

TYPICAL PEDON: Dulce sandy loam - native range with pinyon-juniper (Colors are for dry soils unless otherwise noted).

A--0 to 4 inches; brown (10YR 5/3) sandy loam, brown (10YR 4/3) moist; weak medium granular structure; soft, very friable; nonsticky and nonplastic; 2 percent stones; moderately alkaline (pH 8.0); clear smooth boundary. (2 to 6 inches thick)

AC--4 to 9 inches; grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; very weak medium subangular blocky structure parting to weak fine granular; soft, very friable; nonstick nonplastic; 2 percent stones; slightly effervescent; moderately alkaline. (3 to 10 inches thick)

Ck--9 to 13 inches; very pale brown (10YR 7/3) sandy loam, pale brown (10YR 6/3) moist; massive; soft, very friable, nonsticky and nonplastic; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary. (2 to 5 inches thick)

Cr--13 to 17 inches; soft sandstone and interbedded sandy shale that can be dug with an auger and a spade.

TYPE LOCATION: La Plata County, Colorado; 700 feet south and 300 feet west of the northeast corner of Sec. 4, T. 32 N., R. 10 W. U.S.G.S. Long Mountain quad.; Lat. 37 degrees, 03 minutes, 05 seconds N., and Long. 107 degrees, 55 minutes, 49 seconds W.

RANGE IN CHARACTERISTICS: Mean annual soil temperature ranges from 47 to 52 degrees F. Depth to the paralithic contact is 8 to 20 inches. Bedrock is soft sandstone or sandy shale. Coarse fragments range from 0 to 20 percent and are typically sandstone chips ranging from pebble to stone size. Typically, these soils contain free carbonates throughout, but some pedons may be leached as much as 5 inches. Clay content of the particle-size control section ranges from 5 to 18 percent, sand from 50 to 80 percent, and silt from 5 to 45 percent. The moisture control section is dry for 15 consecutive days from May 15 to July 15 when the soil temperature at 20 inches is greater than 41 degrees F., (5 degrees C.). It is not dry in all parts of the moisture control section for at least 45 consecutive days following the summer solstice to October 20, and for at least 90 cumulative days during that period.

DEC 2004 APPROVED

The A horizon has hue of 10YR or 2.5Y, value of 5 or 6, 4 or 5 moist, and chroma or 2 or 3. It is slightly alkaline or moderately alkaline.

The AC horizon has hue of 10YR or 2.5Y, value of 5 to 6, 4 or 5 moist, and chroma of 2 or 3. Reaction is slightly alkaline or moderately alkaline.

The C horizon has hue of 10YR or 2.5Y, value of 6 or 7 dry, or 6 moist, and chroma of 2 through 4. It is slightly alkaline or moderately alkaline.

COMPETING SERIES: These are the Canyon (NE), Epping (NE), Eslendo (NM), Fairburn (SD), Gerst (UT), Kinusta (AZ), Klondike (AZ), Picante, (CO), Redarrow (WY), Sandoval (NM), Shingle (WY), Spearfish (SD), Taluce (WY), and Tassel (NE) series. The Canyon, Eslendo, Fairburn, Gerst, Picante, Sandoval, Shingle, and Spearfish soils have more than 18 percent clay in the particle-size control section. Epping and Tassell soils are dry less than 15 consecutive days throughout the soil moisture control section between May 15 and July 15, and are in a climatic setting that receives over half of the precipitation between April and August. Kinusta soils have particle-size control sections that are very fine sandy loam or silt loam. Klondike and Redarrow soils have hue of 5YR or redder. Taluce soils are dry in all parts of the moisture control section for at least 60 consecutive days from July 15 to October 25, and for at least 90 cumulative days during this period.

GEOGRAPHIC SETTING: Dulce soils are on foothill slopes and ridges. Slope ranges from 6 to 60 percent. The soils formed in residuum from sandstone. Elevation ranges from 5,000 to 7,500 feet. Average annual precipitation ranges from 13 to 16 inches and about half comes as snow. The precipitation is distributed fairly evenly throughout the year with May and June being the driest months. Mean annual temperature ranges from 45 to 50 degrees F., and mean summer temperature ranges from 60 to 66 degrees F. P.E. Index is about 42 at the type location and ranges from 35 to 50 for the series.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Lazear, Mikim, Travessilla, and Zyme soils. Lazear and Travessilla soils are shallow, loamy soils over hard sandstone. Mikim soils are deep, loamy soils on gently sloping to sloping alluvial fans, toe slopes, and foothill valleys. Zyme soils are shallow, fine-textured soils over shale.

DRAINAGE AND PERMEABILITY: Well drained; slow to medium runoff; moderately rapid permeability to bedrock.

USE AND VEGETATION: Dulce soils are used primarily for rangeland and wildlife habitat. Native vegetation consists of western wheatgrass, Indian ricegrass, junegrass, sand dropseed, needleandthread grass, blue grama, Red three-awn, big sagebrush, pinyon pine, and Rocky Mountain juniper.

DISTRIBUTION AND EXTENT: Dulce soils occur in southwestern Colorado and possibly adjacent parts of Utah. The series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Phoenix, Arizona

SERIES PROPOSED: La Plata County Area, Colorado, 1982.

DEC 2004 APPROVED

REMARKS: Diagnostic features include an ochric epipedon from 0 to 4 inches. Particle-size control section with 5 to 18 percent clay. A paralithic contact at 13 inches, and a mesic temperature regime. Last updated by the state 3/95.

National Cooperative Soil Survey
U.S.A.

DEC 2004 APPROVED

LOCATION LAS LUCAS NM

Established Series
Rev. ARA/WWJ
10/2002

LAS LUCAS SERIES

The Las Lucas series consists of deep, well drained, slowly permeable soils that formed from gray and olive shales on alluvial fans and valley fill side slopes. Mean annual precipitation is about 15 inches, and mean annual temperature is about 50 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, active, mesic Ustic Haplocambids

TYPICAL PEDON: Las Lucas clay loam

A--0 to 8 inches; pale brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; weak medium platy structure in the upper 1 or 2 inches, moderate fine granular structure in the lower part; slightly hard, friable; abundant roots; weakly calcareous in upper 4 inches becoming strongly calcareous in lower part; clear boundary. 5 to 10 inches thick.

Bw--8 to 15 inches; brown (10YR 5/3) heavy clay loam, brown (10YR 4/3) moist; moderate medium and coarse subangular blocky structure; hard, friable; roots are common; very strongly calcareous; clear irregular boundary. 5 to 9 inches thick.

Bk--15 to 22 inches; yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) moist; weak angular and subangular blocky structure; very hard, firm; very strongly calcareous; this is a weak ca horizon with a few small calcium carbonate concretions; gradual boundary. 5 to 10 inches thick.

Ck--22 to 40 inches; pale olive (5Y 6/3) light clay loam, light olive brown (2.5Y 5/3) moist; massive; hard, friable; strongly calcareous; this is a weak ca horizon with a few small calcium carbonate concretions and thin seams; gradual boundary. 8 to 14 inches thick.

R--40 to 50 inches +; Gray and olive shales, laminated and with common salt crystals between the laminations.

TYPE LOCATION: Sandoval County, New Mexico, ~~20 feet~~ NE of SW corner of section 16, T19N, R2W.

DEC 2004 APPROVED

RANGE IN CHARACTERISTICS:

A horizon
Hue: 10YR and 2.5Y
Chroma: 2 and 3
Value: 5 and 6 dry and 3 and 4 moist (Surface horizons having values as dark as 5 dry and 3 moist

should not exceed 4 inches in thickness)
Texture: loam or clay loam
Calcium carbonate: noncalcareous to weakly calcareous

B horizon
Hue: 10YR to 5Y
Chroma: 3 through 4
Value: 5 to 7 dry and 3 to 5 moist
Texture: clay loam
Clay content: 27 to 35 percent
Silt content: 20 to 60 percent
Sand content: 10 to 45 percent
Depth to shale bedrock: greater than 40 inches

COMPETING SERIES: There are no competing series.

GEOGRAPHIC SETTING: Nearly level to sloping alluvial fans and valley filling slopes.

GEOGRAPHICALLY ASSOCIATED SOILS:

DRAINAGE AND PERMEABILITY: Well drained; slow permeability; runoff is rapid.

USE AND VEGETATION: Western wheatgrass, alkali sacaton, blue grama and galleta. Rangeland.

DISTRIBUTION AND EXTENT: Central and north central New Mexico.

MLRA OFFICE RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: The Upper Puerco Reconn. Survey, SCS, 1937.

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

Ochric Epipedon - The zone from the surface to a depth of 8 inches. (A horizon)

Cambic horizon - The zone from 8 to 15 inches. (Bw horizon)

Classified according to Soil Taxonomy Second Edition, 1999.

Series name after a small village in Bernalillo County, New Mexico. Soil at type location differs from typical profile for series description by having a light clay texture at 8 to 15 inches and having slightly coarser structure throughout the horizon.

OSED scanned by SSQA. Last revised by state on 1/24/64.

National Cooperative Soil Survey
U.S.A.

DEC 2004 APPROVED

LOCATION OELOP NM

Established Series
Rev. JER/RJA/LWH
11/2000

OELOP SERIES

The Oelop series consists of very deep, well drained soils that formed in alluvium and eolian material derived from sandstone and shale. Oelop soils are on stream terraces, mesas, plateaus and alluvial fans. Slopes are 0 to 10 percent. The mean annual precipitation is about 11 inches, and the mean annual temperature is about 51 degrees F.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, mesic Ustic Haplargids

TYPICAL PEDON: Oelop loam--rangeland. (Colors are for dry soil unless otherwise stated.)

A--0 to 3 inches; dark yellowish brown (10YR 4/4) loam, dark yellowish brown (10YR 3/4) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; few fine and medium roots; few fine irregular pores; slightly alkaline; abrupt smooth boundary. (3 to 6 inches thick)

Bt1--3 to 8 inches; dark yellowish brown (10YR 4/4) clay loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and medium roots; few fine tubular pores; common moderately thick clay films on faces of peds and in pores; slightly alkaline; clear smooth boundary. (4 to 9 inches thick)

Bt2--8 to 16 inches; dark yellowish brown (10YR 4/4) clay loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine and medium and common fine roots; few fine tubular pores; common moderately thick clay films on faces of peds and in pores; slightly alkaline; clear smooth boundary. (3 to 15 inches thick)

Bk1--16 to 34 inches; dark yellowish brown (10YR 4/4) clay loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, friable, sticky and plastic; few very fine and fine roots; few fine irregular pores; slightly effervescent with disseminated calcium carbonate; moderately alkaline; clear smooth boundary. (3 to 26 inches thick)

Bk2--34 to 44 inches; dark yellowish brown (10YR 4/4) loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine and irregular pores; strongly effervescent; calcium carbonate occurs as few fine irregular filaments; moderately alkaline; clear smooth boundary. (3 to 30 inches thick)

Bk3--44 to 64 inches; dark yellowish brown (10YR 4/4) loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine irregular pores; strongly effervescent; calcium carbonate occurs as few fine irregular filaments; moderately alkaline.

DEC 2004 APPROVED

TYPE LOCATION: Cibola County; about 4.5 miles southwest of south Garcia; 2,480 feet east and 100 feet north of the southwest corner of Sec. 33, T. 8 N., R. 3 W. 107 degrees, 10 minutes, 00 seconds west longitude; 34 degrees, 52 minutes, 28 seconds north latitude.

RANGE IN CHARACTERISTICS:

Soil moisture - The soil moisture control section is typically dry in all parts during April, May and June and are moist in some part periodically July through October. It is dry in all parts 50 to 75 percent of the time that the soil temperature is above 41 degrees F.

Soil temperature - 50 to 55 degrees F.

Depth to the base of the argillic horizon - 15 to 30 inches.

Particle-size control section - Texture: loam, clay loam or silty clay loam. Clay content: 18 to 35 percent Sand content: 15 to 40 percent with less than 15 finer than fine sand. Rock fragments: less than 5 percent dominantly pebbles.

A horizon - Hue: 5YR through 10YR. Value: 4 through 6 dry, 3 through 5 moist. Chroma: 3 or 4. Texture: loam, silt loam, fine sandy loam, or sandy loam.

Bt horizon - Hue: 5YR through 10YR. Value: 4 through 6 dry, 3 through 5 moist. Chroma: 3 or 4. Lower subhorizons have fine seams of carbonate in some pedons.

Bk horizon - Hue: 5YR through 10YR. Value: 4 through 7 dry, 4 through 6 moist. Chroma: 3 through 6. Texture: sandy loam, loam, sandy clay loam, clay loam or silty clay loam. Calcium carbonate equivalent: less than 15 percent.

COMPETING SERIES: These are the Balon(AZ), Barx(UT), Bowbac(WY), Buckle(NM), Cambria (WY), Cerrillos(NM), Clovis(NM), Cushman(WY), Decolney(T)(AZ), Fattig(MT), Fernando(NM), Flaco(NM), Forkwood(WY), Fort Collins(CO), Gaddes(AZ), Gapbutte(T)(AZ), Hagerman(NM), Harbord(CO), Hiland(WY), Los Alamos(NM), Maysdorf(WY), Millett(AZ), Olney(NM), Palacid (NM), Penistaja(NM), Pokeman(WY), Potts(WY), Progresso(CO), Pugsley(WY), Rauzi(T)(WY), Scholle(NM), Spangler(WY), Spenlo(UT), Stoneham(CO), Sundance(CO), Tapia(NM), Threetop (WY), Toluca(MT), Tuweep(AZ), and Yenlo(CO) series. Balon, Decolney, Gaddes and Rauzi soils are noncalcareous throughout. Barx, Cerrillos, Clovis, Fernando, Hiland, Los Alamos, Millett, Scholle, Sundance, Tapia, Toluca and Tuweep soils have calcic horizons. Bowbac, Cushman, Fattig, Flaco, Gaddes, Gapbutte, Hagerman, Pokeman, Progresso, Pugsley and Spangler soils have bedrock at depths between 20 and 40 inches. Buckle, Maysdorf and Palacid soils are deeper than 40 inches to the base of the argillic horizon. Cambria and Stoneham soils are 10 to 15 inches to the base of the Bt horizon. Forkwood, Fort Collins, Harbord, Olney, Potts and Threetop soils are moist in some part periodically, during April, May and June. Penistaja and Yenlo soils have more than 40 percent sand. Spenlo soils are deeper than 30 inches to the base of the argillic horizon and are noncalcareous to depths of 30 inches.

GEOGRAPHIC SETTING: Oelop soils are on stream terraces, mesas, plateaus and alluvial fans with slopes of 0 to 10 percent. Elevations range from 5,900 to 7,500 feet. The mean annual precipitation ranges from 10 to 12 inches. The mean annual temperature is about 48 to 53 degrees F.,

DEC 2004 APPROVED

and the frost-free period is about 120 to 160 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Shingle, Skyvillage and competing Penistaja soils. The Shingle and Skyvillage soils are both shallow to bedrock.

DRAINAGE AND PERMEABILITY: Well drained; medium runoff, moderately slow permeability.

USE AND VEGETATION: These soils are used mainly for grazing. Present vegetation is sage, blue grama, galleta and Indian ricegrass.

DISTRIBUTION AND EXTENT: Northwestern New Mexico. Series is moderately extensive.

MLRA OFFICE RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Cibola County, New Mexico, 1985.

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

Ochric epipedon - The zone from the surface to a depth of about 3 inches. (A horizon)

Argillic horizon - The zone from about 3 to 16 inches. (Bt1, Bt2 horizons)

Ustollic feature - organic carbon content and soil moisture regime meets the requirements for "Ustollic".

In October 2000, taxonomic classification was converted to the closest match found in Soil Taxonomy, Second Edition 1999. No update was made to horizon nomenclature, competing series section, etc. Other placements may be more appropriate after a complete update.

National Cooperative Soil Survey
U.S.A.

DEC 2004 APPROVED

LOCATION PULPIT CO

Established Series
Rev. DKR/JWH/WWJ
06/2000

PULPIT SERIES

The Pulpit series consists of moderately deep, well drained soils that formed in eolian material derived from sandstone. Pulpit soils are on hills and mesas. Slopes range from 2 to 12 percent. Mean annual precipitation is about 14 inches and the mean annual temperature is about 48 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, mesic Aridic Haplustalfs

TYPICAL PEDON: Pulpit loam, on a southeast facing slope, in nonirrigated cropland at an elevation of 6,680 feet. (Colors are for dry soil unless otherwise noted.)

Ap--0 to 7 inches; reddish brown (5YR 5/4) loam, dark reddish brown (5YR 3/4) moist; moderate medium granular structure; soft, very friable; neutral (pH 7.2); clear smooth boundary. (3 to 8 inches thick)

Bt1--7 to 10 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, very friable, slightly sticky and slightly plastic; few faint clay films on faces of peds and in root channels; few fine pores; slightly alkaline (pH 7.4); clear smooth boundary. (0 to 4 inches thick)

Bt2--10 to 20 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common faint clay films on faces of peds and in root channels; few tubular pores; slightly alkaline (pH 7.6); clear wavy boundary. (7 to 30 inches thick)

Btk--20 to 25 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few faint clay films on faces of peds and in root channels; common medium calcium carbonate threads and soft masses; strongly effervescent; moderately alkaline (pH 8.2); gradual wavy boundary. (3 to 8 inches thick)

Bk1--25 to 30 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; massive; hard, firm, slightly sticky and slightly plastic; common medium calcium carbonate threads and soft masses; strongly effervescent; moderately alkaline (pH 8.2); clear wavy boundary. (0 to 29 inches thick)

Bk2--30 to 36 inches; pink (7.5YR 8/4) fine sandy loam, pink (7.5YR 7/4) moist; massive; slightly hard, friable; common medium calcium carbonate threads and soft masses; violently effervescent; moderately alkaline (pH 8.2); abrupt wavy boundary. (0 to 10 inches thick)

2R--36 inches; hard calcareous sandstone.

DEC 2004 APPROVED

TYPE LOCATION: Dolores County, Colorado.; about 6 miles northwest of Dove Creek; located in the northeast quarter of sec. 24, T. 41 N., R. 20 W.; Northdale USGS quad; lat. 37 degrees 48 minutes 21 seconds N. and long. 109 degrees 01 minutes 41 seconds E., NAD

RANGE IN CHARACTERISTICS:

Soil moisture regime: ustic bordering on aridic

Soil temperature regime: mesic

Mean annual soil temperature: 49 to 53 degrees F

Mean summer soil temperature: 66 to 70 degrees F

Particle-size control section: 18 to 35 percent clay

Depth to lithic contact: 20 to 40 inches

Depth to secondary calcium carbonate: 6 to 20 inches

A horizon:
Hue: 2.5YR to 7.5YR
Value: 5 to 7 and (3 to 6 moist)
Chroma: 2 to 4
Texture: loam, fine sandy loam, silt loam, or sandy loam
Rock fragments: 0 to 10 percent gravel
Calcium carbonate equivalent: 0 to 1 percent
Reaction: neutral or slightly alkaline

Bt horizon:
Hue: 5YR to 10R
Value: 5 to 7 and 3 to 6 (moist)
Chroma: 3 to 6
Texture: clay loam, silty clay loam, loam, silt loam, or sandy clay loam
Rock fragments: 0 to 10 percent gravel
Calcium carbonate equivalent: 0 to 5 percent
Reaction: neutral to moderately alkaline

Bk horizon:
Hue: 5YR to 7.5YR
Value: 5 to 8 (4 to 7 moist)
Chroma: 2 to 4
Texture: loam, fine sandy loam, or clay loam
Rock fragments: 0 to 10 percent gravel
Calcium carbonate equivalent: 5 to 10 percent
Reaction: slightly or moderately alkaline

DEC 2004 APPROVED

COMPETING SERIES: These are the Buick, Keiser, Klinedraw, Oshoto, Roubideau, Sharps,

Verde, Wetherill, and Wiley soils. Potential competitors that do not yet have CEA class assigned are the Amal, Chita, Elpedro, and Moncha series. Amal, Buick, Chita, Elpedro, Keiser, Moncha, Oshoto, Wetherill, and Wiley soils are very deep. Klinedraw and Sharps soils are moderately deep over soft sandstone or shale. Roubideau soils lack carbonates in the lower part of the solum. Verde soils have a fragipan-like horizon.

GEOGRAPHIC SETTING:

Parent material: eolian material derived from calcareous sandstone

Landform: hills and mesas

Slopes: 2 to 12 percent

Elevation: 6,200 to 7,800 feet

Mean annual air temperature: 46 to 50 degrees F

Mean annual precipitation: 13 to 16 inches

Precipitation is fairly evenly distributed throughout the year with July and August being slightly wetter and June being slightly dryer.

Frost-free period: 100 to 120 days

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cahona, Gladel, Wetherill, and Sharps series. All soils are found on the same landforms. Gladel soils are shallow over hard bedrock.

DRAINAGE AND PERMEABILITY: well drained, low to high runoff, moderately slow permeability

USE AND VEGETATION: These soils are used for grazing and for dry or irrigated cropland. Native vegetation is predominantly sagebrush, pinyon, juniper, western wheatgrass, and Indian ricegrass.

DISTRIBUTION AND EXTENT: Southwest Colorado. LRR D, MLRA 36. This series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: La Plata County Area, La Plata County, Colorado. 1982.

REMARKS: Reclassified due to moisture regime change resulting from Four Corners Climate Conference 10/92.

Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon: The zone from 0 to 7 inches. (Ap)

DEC 2004 APPROVED

Argillic horizon: The zone from 10 to 20 inches. (Bt)

Lithic contact: The zone at 36 inches. (R)

Particle size control section: The zone from 10 to 25 inches. (Bt, Btk)

Soil Taxonomy Second Edition, 1999

National Cooperative Soil Survey
U.S.A.

DEC 2004
APPROVED

LOCATION SAN MATEO NM

Established Series
Rev. TLP/RJA/LWH/SAZ/WWJ
04/2002

SAN MATEO SERIES

The San Mateo series consists of very deep, well drained, moderately slowly permeable soils that formed in alluvium, fan alluvium and stream alluvium from mixed sources on alluvial fans on valley sides and flood plains on valley floors. Slopes are 0 to 5 percent. Average annual temperature is about 52 degrees F. Average annual precipitation is about 11 inches.

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, calcareous, mesic Ustic Torrifluvents

TYPICAL PEDON: San Mateo loam -- rangeland. (Colors are for dry soil unless otherwise noted.)

A--0 to 2 inches; light yellowish brown (2.5Y 6/4) loam, olive brown (2.5Y 4/4) moist; moderate fine granular structure; soft, friable, nonsticky and nonplastic; common fine and very fine roots; strongly effervescent; slightly alkaline; abrupt smooth boundary. (1 to 12 inches thick)

C1--2 to 12 inches; light olive brown (2.5Y 5/4) loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; common fine and very fine roots; 5 percent pebbles; strongly effervescent; slightly alkaline; clear smooth boundary.

C2--12 to 29 inches; light olive brown (2.5Y 5/6) sandy clay loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine irregular pores; 5 percent pebbles; strongly effervescent; slightly alkaline; gradual smooth boundary.

C3--29 to 70 inches; light olive brown (2.5Y 5/6) sandy clay loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine irregular pores; 5 percent pebbles; strongly effervescent; slightly alkaline. (Combined thickness of the C horizon is greater than 40 inches.)

TYPE LOCATION: Cibola County, New Mexico, Moquino Quadrangle; about 1 mile northwest of Moquino, New Mexico, at 35 degrees, 11 minutes and 10 seconds north latitude, and 107 degrees, 18 minutes and 21 seconds west longitude .

RANGE IN CHARACTERISTICS:

Soil Moisture: Intermittently moist in some part of the soil moisture control section December through March and July through October. The soil is driest during May and June. Ustic aridic moisture regime.

Soil Temperature: 51 to 57 degrees.

DEC 2004 APPROVED

Reaction: slightly to strongly alkaline.

Carbonates: Calcareous throughout.

Salinity: EC of 1 to 8 mmhos/cm

Control section: weighted average - 18 to 35 percent clay and more than 15 percent fine sand or coarser.

A horizon
Hue: 10YR or 2.5YValue: 5 or 6 dry, 3 through 5 moist
Chroma: 2 to 4 dry and moist
When the surface mantle has colors and organic carbon content of a mollic epipedon, it lacks the thickness requirements.
Chroma: 2 through 6
Texture: sandy loam, fine sandy loam, loam, sandy clay loam, silt loam, silty clay loam, and clay loam

C horizon
Hue - 10YR or 2.5Y
Value: 5 or 6 dry; 3 through 5, moist
Chroma: 2 through 6
Texture: Stratified sandy loam, fine sandy loam, loam, sandy clay loam, silt loam, silty clay loam, and clay loam.
Sodicity: SAR of 5 to 30

COMPETING SERIES: Current competitor is the Hamburn, Haverdad, Haversid, and Manikan, series. Potential competitors that do not yet have the CEA class assigned are the Barnum, Panitchen and Suwanee series. Manikan and Suwanee soils are redder than 10YR. Hamburn and Panitchen soils have gypsum accumulations. The Barnum, Haversid, and Haverdad soils are more moist in May and June.

GEOGRAPHIC SETTING: The San Mateo soils formed in alluvium, fan alluvium and stream alluvium from mixed sources on flood plains on valley floors, and alluvial fans on valley sides. Slopes are 0 to 5 percent. Elevations range from 5,200 to 7,800 feet. The mean annual temperature is 49 to 54 degrees F. The average annual precipitation is 9 to 13 inches. Peak precipitation occurs in July, August, September and October. The frost-free period is 120 to 180 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Sparank soils. Sparank soils have more than 35 percent clay in the control section.

DRAINAGE AND PERMEABILITY: Well drained, low to medium runoff, and moderately slowly permeability.

USE AND VEGETATION: This series is used for rangeland. The present vegetation is alkalai sacaton, western wheatgrass, blue gram, fourwing saltbush, and galleta.

DISTRIBUTION AND EXTENT: Northwestern New Mexico, Arizona and Utah. MLRA 36, LRR-

DEC 2004 APPROVED

D. This series is of large extent.

MLRA OFFICE RESPONSIBLE: Phoenix, Arizona

SERIES ESTABLISHED: Cibola County, New Mexico, 1956.

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

Ochric epipedon: the zone from 0 to 2 inches. (A horizon)

Fluventic feature - An irregular decrease in organic carbon due to stratification.

Classified according to Soil Taxonomy Second Edition, 1999.

National Cooperative Soil Survey
U.S.A.

DEC 2004 APPROVED

LOCATION SHARPS CO+NM

Established Series
Rev. DKR/JWH/WWJ
06/2000

SHARPS SERIES

The Sharps series consists of moderately deep, well drained soils that formed in eolian material derived from sandstone overlaying shale. Sharps soils are on mesas, ridges, and hills. Slopes range from 2 to 12 percent. Mean annual precipitation is about 14 inches and the mean annual temperature is about 48 degrees F.

TAXONOMIC CLASS: Fine-silty, mixed, superactive, mesic Aridic Haplustalfs

TYPICAL PEDON: Sharps loam, in a cultivated field. (Colors are for dry soil unless otherwise noted.)

Ap--0 to 6 inches; light reddish brown (5YR 6/4) loam, reddish brown (5YR 4/4) moist; moderate medium granular structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; clear smooth boundary. (4 to 8 inches thick)

BA--6 to 9 inches; light reddish brown (5YR 6/4) loam, reddish brown (5YR 4/4) moist; weak medium subangular blocky structure parting to moderate medium granular; slightly hard, very friable, slightly sticky and slightly plastic; few faint clay films in root channels; slightly alkaline; clear smooth boundary. (0 to 6 inches thick)

Bt--9 to 19 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common faint clay films on faces of peds and in root channels; slightly alkaline; clear wavy boundary. (4 to 32 inches thick)

Bk1--19 to 25 inches; light reddish brown (5YR 6/4) loam, reddish brown (5YR 5/4) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few faint clay films on faces of peds and in root channels; common calcium carbonate threads and soft masses; strongly effervescent; moderately alkaline; gradual wavy boundary. (4 to 8 inches thick)

Bk2--25 to 30 inches; pink (5YR 8/4) loam, pink (5YR 7/4) moist; massive; hard, friable, slightly sticky and slightly plastic; many soft masses of calcium carbonate; strongly effervescent; moderately alkaline; gradual wavy boundary. (0 to 28 inches thick)

2Cr--30 inches; shale and soft sandstone.

TYPE LOCATION: Dolores County, Colorado; about 6 miles northwest of Dove Creek; located in the northwest quarter of sec. 18, T. 41 N., R. 19 W.; Northdale USGS quad; lat. 39 degrees 49 minutes 19 seconds N. and long. 109 degrees 00 minutes 46 seconds E., NAD27

RANGE IN CHARACTERISTICS:

Soil moisture regime: ustic bordering on aridic

Soil temperature regime: mesic

Mean annual soil temperature: 49 to 52 degrees F

Mean summer soil temperature: 58 to 64 degrees F

Rock fragments: 0 to 15 percent gravel

Particle-size control section: 18 to 35 percent clay
with 15 to 70 percent sand, most being very fine sand

Depth to paralithic contact: 20 to 40 inches to soft shale or sandstone

Depth to secondary calcium carbonate: 10 to 36 inches

A horizon:
Hue: 5YR to 10YR
Value: 5 to 7 and 3 to 6 moist
Chroma: 2 to 6
Texture: loam, silt loam, or fine sandy loam
Rock fragments: 0 to 20 percent gravel
Calcium carbonate equivalent: 0 to 1 percent
Reaction: neutral or slightly alkaline

Bt horizon:
Hue: 5YR or 7.5YR
Value: 5 to 7 (3 to 6 moist)
Chroma: 3 to 6
Texture: loam, silty clay loam, or clay loam
Rock fragments: 0 to 15 percent gravel
Calcium carbonate equivalent: 5 to 10 percent
Reaction: Neutral to moderately alkaline

DEC 2004 APPROVED

Bk horizon:
Hue: 5YR to 10YR
Value: 4 to 8 (4 to 7 moist)
Chroma: 4 to 8 (moist)
Texture: loam, silty clay loam, or clay loam
Rock fragments: 0 to 15 percent gravel
Calcium carbonate equivalent: 10 to 15 percent
Reaction: moderately alkaline or strongly alkaline

COMPETING SERIES: These are the Buick, Keiser, Klinedraw, Oshoto, Pulpit, Roubideau, Verde, Wetherill, and Wiley series. Potential competitors that do not yet have CEA class assigned are the

Amal, Chita, Elpedro, and Moncha soils. Amal, Buick, Chita, Elpedro, Keiser, Moncha, Oshoto, Wetherill, and Wiley soils are very deep. Klinedraw soils have hue of 10YR or 2.5Y. Pulpit, Roubideau, and Verde soils are moderately deep over hard sandstone. In addition, Roubideau soils lack carbonates in the lower part of the solum, and Verde soils have a fragipan-like horizon.

GEOGRAPHIC SETTING:

Parent material: eolian material derived from sandstone and shale.

Landform: mesas, ridges, and hills

Slopes: 2 to 12 percent

Elevation: 6,200 to 7,400 feet

Mean annual temperature: 46 to 50 degrees F

Mean annual precipitation: 13 to 16 inches

Precipitation is fairly evenly distributed throughout the year with July and August being slightly wetter and June being slightly dryer.

Frost-free period: 100 to 120 days

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Cahona, Pulpit, and Wetherill series. All these soils are on the same landscape position as Sharps. Cahona soils have a calcic horizon. Wetherill soils are very deep.

DRAINAGE AND PERMEABILITY: well drained, low to high runoff, moderate and moderately slow permeability

USE AND VEGETATION: Sharps soils are used for grazing or as irrigated or dry cropland. Native vegetation is mainly sagebrush, cactus, pinyon, juniper, western wheatgrass, and Indian ricegrass.

DISTRIBUTION AND EXTENT: Southwest Colorado and New Mexico. LRR D, MLRA 35, 36 and 39. This series is of moderate extent.

MLRA OFFICE RESPONSIBLE: Phoenix, Arizona.

SERIES ESTABLISHED: Lincoln County, NM. 1981.

REMARKS: Classification changed due to the change in moisture regime due to the Four Corners Climate Conference of 10/92. Diagnostic horizons and features recognized in this pedon are:

Ochric epipedon: The zone from 0 to 6 inches. (Ap)

Argillic horizon: The zone from 9 to 19 inches. (Bt)

Particle size control section: The zone from 9 to 19 inches. (Bt)

DEC 2004 APPROVED

Soil Taxonomy Second Edition, 1999

National Cooperative Soil Survey
U.S.A.

APPROVED
DEC 2004

LOCATION TRAVESSILLA NM+AZ CO KS MT OK SD UT WY

Established Series
Rev. VGL-AJC-RJA-ACT
05/2002

TRAVESSILLA SERIES

The Travessilla series consists of very shallow and shallow, well drained soils that formed in calcareous eolian sediments and material weathered from sandstone. These soils are on hills, cuestas, scarps, and mesas with slopes ranging from 0 to 75 percent. Mean annual precipitation is about 11 inches. The mean annual temperature is above 53 degrees F.

TAXONOMIC CLASS: Loamy, mixed, superactive, calcareous, mesic Lithic Ustic Torriorthents

TYPICAL PEDON: Travessilla stony sandy loam - rangeland. (Colors are for dry soil unless otherwise noted.)

A--0 to 4 inches; light brownish gray (10YR 6/2) stony sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine and medium roots; common fine pores; 15 percent stones; slightly effervescent; slightly alkaline; clear smooth boundary. (2 to 6 inches thick)

C--4 to 8 inches; pale brown (10YR 6/3) channery loam, brown (10YR 4/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common fine and medium roots; common fine pores; 20 percent channers; slightly effervescent; moderately alkaline; abrupt smooth boundary. (2 to 14 inches thick)

R--8 inches; hard sandstone with some fractures.

TYPE LOCATION: Union County, New Mexico; approximately 1,560 feet north and 4,200 feet west of the southeast corner, sec. 24, T. 31 N., R. 36 E.

RANGE IN CHARACTERISTICS:

Soil Moisture - Typically, moist intermittently from April 30 through October in some part of the soil moisture control section and dry in all parts periodically from November 1 to April 30.

Soil Temperature - 50 to 58 degrees F.
Depth to lithic contact: typically 4 to 10 inches but ranges to 20 inches.

Particle-size Control Section:
Clay Content: 5 to 18 percent.
Silt Content: 5 to 50 percent.
Sand Content: 40 to 90 percent with more than 25 percent fine sand or coarser.
Rock fragment content: 0 to 10 percent stones, 0 to 10 percent cobbles and 0 to 25 percent pebbles

DEC 2004 APPROVED

but weighted average is less than 35 percent.

A and C horizons - (an AC horizon is present in some pedons)
Hue: 7.5YR to 2.5Y
Value: 5 to 7 dry, 3 to 5 moist
Chroma: 2 to 4
Texture of the Fine Earth Fraction: sandy loam, fine sandy loam, loam or very fine sandy loam.
Rock fragment content: 0 to 35 percent
Reaction: slightly alkaline or moderately alkaline.

COMPETING SERIES: These are the Hideout (UT), Kenzo (T UT), Lazear (CO), Redspear (WY), Rizno (UT), Rizozo (NM), Simel (UT), Skyvillage (NM), Tesihim (AZ), Travson (WY), and Zukan (UT) series.
Hideout soils: have a mean annual temperature of 47 to 50 degrees F.
Kenzo soils: have hue of 7.5YR or redder.
Lazear soils: have more than 18 percent clay.
Redspear, Rizno and Rizozo soils: have hue of 5YR or redder.
Simel soils: average 27 to 35 percent clay.
Skyvillage soils: are dry in all parts of the soil moisture control section periodically from May 1 to June 30.
Tesihim soils: are derived from soft volcanic tuff.
Travson soils: are dry in the soil moisture control section July through September.
Zuchan soils: have accumulated carbonates in the form of a Bk horizon.

GEOGRAPHIC SETTING:
Parent material: calcareous eolian sediments and residuum weathered from sandstone and shale. Outcrops of sandstone with a minor amount of shale are common on steep slopes.
Landform: hills, cuestas, scarps, and mesas
Slopes: 0 to 75 percent.
Elevation: 4,700 to 8,000 feet.
Mean annual precipitation: 10 to 16 inches, but has ranged higher.
Mean annual temperature: 50 to 57 degrees F.
Frost-free period is typically 115 to 170 days. Utah has a frost-free period as low as 70 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Bernal, Carnero, Hagerman, Quay and Pajarito soils.
Bernal and Hagerman soils: have an argillic horizon.
Carnero soils: have bedrock at depths of 20 to 40 inches.
Quay and Pajarito soils: do not have bedrock within a depth of 40 inches.
Quay soils have more than 18 percent clay in the particle size control section and have a prominent zone of lime accumulation

DRAINAGE AND PERMEABILITY: Well drained; runoff is high on slopes less than 1 percent and very high on slopes greater than 1 percent; moderate or moderately rapid permeability.

USE AND VEGETATION: Rangeland. Juniper, pinyon, squawbush, oakbrush, blue grama, sideoats grama and snakeweed are the principal plants.

DISTRIBUTION AND EXTENT: Northern New Mexico, Arizona, Colorado, Montana, western

Oklahoma, Utah and Wyoming. LRR E, G; MLRA'S 49, 67, 69, 70, 77. The series is extensive.

MLRA OFFICE RESPONSIBLE: Temple, Texas

SERIES ESTABLISHED: Eastern New Mexico Reconnaissance, Harding County, New Mexico, 1937.

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

Ochric Epipedon - 0 to 4 inches. (A horizon).
Lithic Contact - 8 inches. (R horizon).
Particle-size Control Section - The zone from the surface of the soil to about 8 inches: (A, C horizons).

Additional data: None

Taxonomic Version: Second Edition, 1999

National Cooperative Soil Survey
U.S.A.

DEC 2004 APPROVED

LOCATION ZYME CO+UT+AZ

Established Series
Rev. JPP/JWH/DKR/SAZ/WWJ
09/2001

ZYME SERIES

The Zyme series consists of shallow or very shallow, well drained soils that formed in residuum derived from shale. Zyme soils are on ridges, knobs, and hills. Slopes range from 3 to 80 percent. The mean annual precipitation is about 13 inches and the mean annual temperature is about 46 degrees F.

TAXONOMIC CLASS: Clayey, smectitic, calcareous, mesic, shallow Ustic Torriorthents

TYPICAL PEDON: Zyme clay loam, on a southeast facing, simple, 30 percent slope in pinyon and juniper woodland at an elevation of 6760 feet. (Colors are for dry soil unless otherwise noted.) When described on 7/12/79 the soil was dry from 0 to 10 inches.

A1--0 to 1 inch; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; medium fine granular structure; loose, friable, sticky and plastic; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary. (0 to 2 inches thick)

A2--1 to 4 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; massive; very hard, firm, sticky and plastic; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary. (2 to 5 inches thick)

C--4 to 10 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; massive; hard, firm, sticky and plastic; 10 percent shale chips; violently effervescent; moderately alkaline (pH 8.2); clear smooth boundary. (4 to 14 inches thick)

Cr--10 to 14 inches; gray platy calcareous shale.

TYPE LOCATION: La Plata County, Colorado; west of the cemetery on the west side of Durango; located about 2,700 feet west and 300 feet north of the southeast corner of Sec. 19, T. 35 N., R. 9 W.; Durango West USGS quad; lat. 37 degrees 16 minutes 40 seconds N. and long. 107 degrees 53 minutes 34 seconds W., NAD 27

RANGE IN CHARACTERISTICS:

Soil moisture regime: Ustic-aridic. The soil moisture control section is dry for 15 consecutive days from May 15 to July 15 when the soil temperature at 20 inches is greater than 41 degrees F. It is not dry in all parts of the moisture control section for at least 45 consecutive days following the summer solstice to October 20 and for at least 90 cumulative days during that period.

Soil temperature regime: mesic

DEC 2004 APPROVED

U.S.A.

DEC 2004
APPROVED