

SECTION 14

SOIL

TABLE OF CONTENTS

SECTION	SECTION TITLE	PAGE NUMBER
SECTION 14	SOIL	1
14.1	Origin and General Nature of the Survey Area	1
14.2	Soil Types	1
14.2.1	Soil Series Classification	2
14.2.2	Description of Soil Mapping Units	2
14.3	Topdressing Volume	3
14.3.1	Pinabete Permit Area	4
14.3.2	Summary of Available Topdressing for Reclamation	4
14.4	Prime Farmland Reconnaissance Investigation Results	4
14.4.1	Results of Prime Farmland Investigation	4
14.5	Soil Information Collection and Analysis	4
	Personnel	5
	References	5
SECTION 14	SOIL	1
14.1	Origin and General Nature of the Survey Area	1
14.2	Soil Types	1
14.2.1	Soil Series Classification	2
14.2.2	Description of Soil Mapping Units	2
14.3	Topdressing Volume	3
14.3.1	Pinabete Mine Plan Permit Area	4
14.3.2	Summary of Available Topdressing for Reclamation	4
14.4	Prime Farmland Reconnaissance Investigation Results	4
14.4.1	Results of Prime Farmland Investigation	4
14.5	Soil Information Collection and Analysis	4
	Personnel	5
	References	5

Formatted: Default Paragraph Font, Check spelling and grammar

SECTION 14

SOIL

LIST OF TABLES

TABLE NUMBER	TABLE TITLE
14.2-1	Pinabete Mine Plan -Permit Area Soil Sample Sites (#) with Easting and Northing by Resource Area
14.2-2	Hydrologic Group and Family Classification of Each Soil Series Identified in the Pinabete Mine Plan -Permit Area
14.2-3	Pinabete Mine Plan -Permit Area Laboratory Analysis Results
14.2-4	OSM Topsoil and Topsoil Substitute Suitability Criteria for the Southwestern United States
14.2-5	Soil Mapping Units and Symbols Used for the Pinabete Mine Plan -Permit Area
14.3-1	Area, Percent of Survey Area and Volume of Suitable Topdressing Material From Each Soil Mapping Unit Located in Pinabete Mine Plan -Permit Area
14.3-2	Estimated Volume of Available Topdressing for Reclamation within the Pinabete Mine Plan -Permit Area

SECTION 14

SOIL

LIST OF EXHIBITS

EXHIBIT

NUMBER

EXHIBIT TITLE

[14.1-1](#)

Pinabete ~~Mine Plan~~ Permit Area Soil Mapping Units

SECTION 14

SOIL

LIST OF APPENDICES

APPENDIX

NUMBER APPENDIX TITLE

14.A	BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report
14.B	Key to Soils of the Pinabete Mine Plan Permit Area
14.C	Prime Farmland Determination Correspondence

SECTION 14

SOIL

LIST OF REVISIONS DURING PERMIT TERM

REV. NUMBER	REVISION DESCRIPTION	DATE APPROVED
------------------------	-----------------------------	--------------------------

SECTION 14 SOIL

14.1 Origin and General Nature of the Survey Area

The Pinabete ~~Mine Plan~~ Permit Area (permit area) comprises approximately 5,569 acres of ~~BHP Navajo Coal Navajo Transitional Energy~~ Company's (~~BNCNTEC~~) mining lease ([Exhibit 14.1-1](#)). The permit area is comprised of portions of both Area 4 North and Area 4 South of ~~BNCNTEC~~'s mining lease. Buchanan Consultants, Ltd. (BCL) conducted multiple soil surveys covering the permit area. In 1987, BCL conducted an Order 2 soil survey for ~~BNCNTEC~~ which included Area 4 North. In 1998, an Order 2 soil survey was conducted for Area 4 South. In 2008, an Order 2 soil survey was conducted for portions of Area 4 South and Area 5. These soils surveys, along with other soil surveys conducted within the ~~BNCNTEC~~ mining lease, are summarized in the Soil Resource Comprehensive Report ([Appendix 14.A](#)).

The Soil Resource Comprehensive Report is a composite report that summarizes the soil surveys that apply to the permit area and describes the extent and proportion of soils, locations and estimated volumes of topdressing, soil profile descriptions, and prime farmland investigation results ([Appendix 14.A](#)).

The permit area occurs within the Colorado Plateau physiographic province (Fenneman 1931, Hunt 1956). The Colorado Plateau has within its borders a wide diversity of topography, geologic materials, soils, and vegetation. The general terrain in the vicinity of the permit area is characterized by rough and broken topography, badlands, plateaus, and mesas, intermingled with escarpments, and valleys or washes. Many of the soils in the permit area are formed from alluvium and eolian sediments derived out of shale and sandstone from the Fruitland formation. Some soils have formed directly from bedrock. Most of the soils in the permit area have formed since the late-Pleistocene and Holocene Eras. It is very common to find buried soils that date back to the Pleistocene Era. The average annual precipitation for the permit area is approximately 5.6 inches and the mean annual air temperature near 54° F (Section 12, Climate). Therefore, the permit area is described as having an arid moisture regime and a mesic temperature regime.

In November 1980, the Natural Resources Conservation Service (NRCS) issued the Soil Survey of San Juan County New Mexico, Eastern Part (Keetch 1980). The permit area is included in this Order 3 soil survey presented at a scale of 1:63,360. Many of the soil series names used to describe the soil resources in the permit area are the same as those used in the 1980 NRCS soil survey. Additional soil series names came from NRCS soil surveys in Arizona, Colorado, New Mexico, and Utah. The soil series names used to describe the soil resources of the permit area represent the current correlation of soil series for the ~~BNCNTEC~~ mining lease ([Appendix 14.A](#)).

14.2 Soil Types

The soils of the permit area are highly complex and variable. In most cases, the geomorphic surfaces have been influenced by constructional and erosional processes, thus resulting in a high occurrence of buried and

truncated soils. Nearly all of the soils were developed under the influence of erosion as indicated by the present day frequency of moderate and severely eroded surfaces. Additionally, many profiles were described with lithologic discontinuities. The soil sample site number of each profile with its northing and easting coordinates is provided in [Table 14.2-1](#). The coordinate system used to describe each soil sample site was the North American Datum 1927 State Plane New Mexico West projection.

14.2.1 Soil Series Classification

The soil series used to describe the soil resource in the permit area include Aridisol or Entisol soils that developing an aridic moisture regime and a mesic temperature regime. Each series was classified to the family level (Soil Survey Staff 2010) and each was assigned a hydrologic group (Soil Survey Staff 2008) ([Table 14.2-2](#)). Series descriptions for each soil series are available from the NRCS website (NRCS 2012). Laboratory data for each major series are included in [Table 14.2-3](#). The laboratory data were used to classify soils and determine topdressing suitability using the Office of Surface Mining Reclamation and Enforcement (OSM) Topsoil and Topsoil Substitute Suitability Criteria for the Southwestern United States ([Table 14.2-4](#)). The interpretations for soil classification and topdressing suitability are limited to the upper 60 inches of unconsolidated material.

All soil series used to describe the permit area soil resources are included in the Key to Soils ([Appendix 14.B](#)). A few series (Chipeta, Mesa, Redlands, Sogzie and Uffens) were only used to describe inclusions within the mapping units. These soil series were not used to name map units nor sampled because of their limited extent.

Most of the soil series names used in the 1987 soil survey for [BNCNTEC](#) came from the 1980 NRCS soil survey (Keetch 1980). The remaining soil series names were correlated to soil series used by the NRCS in adjacent states. In subsequent surveys for [BNCNTEC](#), soil series names used were correlated to represent current soil series names used by the NRCS. The soil series described for the permit area came from the Soil Resources Comprehensive Report ([Appendix 14.A](#)).

14.2.2 Description of Soil Mapping Units

A total of 28 mapping units are described using 16 soils series and three miscellaneous land types (Badlands, Natric, and Rock Outcrop) ([Table 14.2-5](#)). Twenty-four of the 28 mapping units are consociations, two are complexes, and two are undifferentiated map units. The map components used to name the majority of mapping units were phases of soil series. Phase criteria included surface texture, depth of suitable topdressing, and slope. Mapping unit names and symbols are listed in [Table 14.2-5](#). A description of each soil mapping unit, including the proportion and distribution of named components and inclusions, is provided in [Appendix 14.A](#). The location and extents of the mapping units are presented in [Exhibit 14.1-1](#).

One of the map units, Natric soils, is comprised of two Great Groups Natrargids and Natrigypsid. The Natrargids include the soil series Huerfano, Fajada, Muff, Patel and Uffens. The Natrigypsid include the soil series Hoskay and Benally. These sodium affected soils do not provide a source of topdressing because of electrical conductivity (EC) and/or sodium adsorption ratio (SAR) levels that exceed topsoil suitability guidelines (Table 14.2-4). Since none of these soil series provide a source of topdressing, there was no justification in mapping them separately, therefore they were combined into one map unit called Natric soils.

Some Natric soils, however, have a surface deposit of sandy eolian material suitable as a source of topdressing. Therefore, a phase of the Natric soils was created to represent a soil type providing a potential suitable source of topdressing. This soil type was called Natric soils, overblown phase. The mapping unit used to describe these soils is called Natric soils, overblown phase and characterizes soils having a potential source of suitable topdressing.

14.3 Topdressing Volume

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) defines topsoil as the A and E soil horizons (30 CFR 701.5). These are the uppermost soil horizons of a soil profile and are characterized by accumulations of organic matter (A horizon) or intensely weathered and leached horizons that have not accumulated organic matter (E horizon) (Brady and Weil 1996). The baseline soil resources within the permit area consist of Aridisols and Entisols soil series (Section 14.2.1), which contain negligible resources that meet the SMCRA topsoil definition. Therefore, **BNCCNTEC** relies on topsoil substitute material, (topdressing) for reclamation. **BNCCNTEC** defines topdressing as all unconsolidated material capable of supporting plant growth in the upper 60 inches of the native *in-situ* soil profile. This includes all topsoil material (A and E soil horizons) and suitable topsoil substitute material (B and C soil horizons).

One objective of the various soil surveys was to determine the volume of available soil material for use as topdressing during reclamation of areas disturbed by mining activities. Soils were mapped at scales appropriate to produce, whenever possible, homogeneous mapping units. Generally, soils were mapped in the field at scales of either 1:6,000 or 1:12,000. It is assumed when similar soils are mapped together, then characteristics of a few soil samples within the unit can be extrapolated for the entire unit. The assumption is valid when homogeneous areas exist or when small delineations can be made to maintain homogeneous components. The mapping scales used in various soil surveys allow delineations of 0.5 to 1.0 acres, depending upon field mapping scales. In areas of very heterogeneous soils, the delineations tend to be smaller and more samples are required to describe the soils than in homogeneous areas where the delineations tend to be larger. Topdressing volume of any given map unit delineation is the product of its

area and its mean depth of suitable topdressing. Total topdressing volume for any given mapping unit is the sum of its mapping unit delineations.

14.3.1 Pinabete ~~Mine Plan~~ Permit Area

The total estimated volume of *in-situ* topdressing within the permit area is 8,042,225 back cubic yards (bcy) (Table 14.3-1). Table 14.3-1 also includes the *in-situ* topdressing volume for each individual map unit. Approximately 42% of the permit area provides all of the suitable *in-situ* topdressing and the remaining 58% of the area has no suitable topdressing (Table 14.3-1).

14.3.2 Summary of Available Topdressing for Reclamation

Using a conservative handling loss of 10%, it is estimated that the available topdressing in the permit area is approximately 7,238,000 bcy (Table 14.3-2). The estimation of available topdressing for reclamation is limited to the upper 60 inches of unconsolidated material. Potentially suitable sources of topdressing material likely exist below a depth of 60 inches (i.e., regolith) within the proposed permit area. These additional potential sources of topdressing were not evaluated, since sufficient quantities of suitable topdressing are available from the permit area to support successful reclamation.

14.4 Prime Farmland Reconnaissance Investigation Results

BNCNTEC has conducted multiple investigations to determine whether lands within the BNCNTEC mining lease area were classified as prime farmland. Norman Vigil, Acting State Conservationist from the NRCS, was asked to determine if the BNCNTEC mining lease, including the permit area, contained prime farmland and to provide a letter of documentation (Appendix 14.C). The results of his investigation follow.

14.4.1 Results of Prime Farmland Investigation

1. The area within the BNCNTEC mining lease, including the permit area, has not been historically used as crop land.
2. The area within the BNCNTEC mining lease, including the permit area, has an average annual precipitation of six inches and has no naturally sub-irrigated lands.
3. The area within the BNCNTEC mining lease, including the permit area, has no soil mapping units that can be classified as prime farmland under the definition of prime farmland by the USDA-NRCS (7 CFR 657.5)

14.5 Soil Information Collection and Analysis

Detailed soils information including methods and procedures are described in the preceding sections and are fully detailed in the “BHP Navajo Coal Company Coal Lease Soil Resources Comprehensive Report” (Appendix 14.A).

Personnel

Persons or organizations responsible for data collection, analysis, and preparation of this permit application package section:

Kent Applegate

Matt Owens

BHP Navajo Coal Navajo Transitional

Energy Company

BHP Billiton Mine Management

Company (disclosed agent)

Farmington, NM

Buchanan Consultants, Ltd.

Farmington, NM

References

- Agricultural Research Service (ARS). 1990. Predicting Soil Erosion by Water-A Guide to Conservation Planning with the Revised Universal Soil Loss Equation. U.S. Department of Agriculture. Tucson, Arizona.
- Brady N.C., and R.R. Weil. 1996. The Nature and Properties of Soils. 11th Edition. Prentice-Hall, Inc., Upper Saddle River, New Jersey.
- Fenneman, N.M. 1931. Physiography of the Western United States. McGraw-Hill, New York, New York.
- Hunt, C.B. 1956. Cenozoic Geology of the Colorado Plateau: U.S. Geological Survey Professional Paper 279.
- Keetch, C. Wesley. 1980. Soil Survey of San Juan County, New Mexico, Eastern Part. United States Department of Agriculture, Soil Conservation Service, Washington, D.C. Survey Available at <http://soildatamart.nrcs.usda.gov/manuscripts/NM618/0/sanjuan.pdf> (Verified 2 February 2012)
- Natural Resources Conservation Service. 2012. NRCS Soils. <http://www.soils.usda.gov> (verified 11 February 2012).
- Office of Surface Mining Reclamation and Enforcement (OSM). 1999. Overburden Sampling and Analytical Quality Assurance and Quality Control (QA/QC) Requirements for Soils, Overburden, and Regraded Spoil Characterizations and Monitoring Programs, for Federal Lands in the Southwestern United States. Office of Surface Mining Reclamation and Enforcement. Western Region.
- Soil Conservation Service. National Soils Handbook. 1983. Section 603.02-1. U.S. Department of Agriculture. Washington, D.C.
- Soil Survey Division Staff. 1993. Soil Survey Manual. USDA-Soil Conservation Service Handbook 18. U.S. Gov. Print. Office, Washington, DC.
- Soil Survey Staff. 2006. Keys to Soil Taxonomy. Tenth Edition, U.S. Department of Agriculture Soil Conservation Service. Government Printing Office, Washington, D.C.

Pinabete Permit Application Package

Soil Survey Staff. 2008. Official Soil Series Descriptions. Natural Resources Conservation Service, U.S. Department of Agriculture, Lincoln, Nebraska. <http://soils.usda.gov/technical/classification/osd/index.html> (Verified 3 February 2012).

~~Soil~~ Soil Survey Staff. 2010. Keys to Soil Taxonomy, 11th ed. USDA-Natural Resources Conservation Service, Washington, DC. http://soils.usda.gov/technical/classification/tax_keys/ (Verified 5 March 2012).

Formatted: Hyperlink