

Appendix 14.A

BHP Navajo Coal Company
Coal Lease Soil Resource Comprehensive Report

**BHP Navajo Coal Company Coal Lease
Soil Resource
Comprehensive Report**

Presented to

BHP Navajo Coal Company

December 2011

BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Prepared by

Buchanan Consultants, Ltd.
220 West Main
Farmington, New Mexico

Presented to

BHP Navajo Coal Company

December 2011

EXECUTIVE SUMMARY

In December 2011, Buchanan Consultants, Ltd completed a Soil Resource Comprehensive Report (SRCR) for BHP Navajo Coal Company (BNCC). The report was completed to describe the soils and to provide an estimate of topdressing resources for the BNCC coal lease area. Two land conditions are represented in the report, baseline (lands undisturbed by mining) and 1993-status (land conditions in 1993 which includes pre-mine and mined areas). The SRCR was produced by combining three soil surveys submitted to BNCC in 1993, 1998 and 2008. The SRCR report has 41 mapping units: 32 are consociations, 6 are complexes and 3 are undifferentiated units. A total of 29 soil types were used to name the mapping units, 22 of the soil types were soil series and 7 were miscellaneous land types.

The area of the SRCR is approximately 33,371 acres and represents Areas 1, 2, 3, 4 North, 4 South and 5 of Navajo Mine. Area 1 has an area of approximately 4,764 ac, 14% of the SRCR area. The baseline topdressing volume was estimated to be 10,343,940 bcy and the 1993-status topdressing volume was estimated to be 2,049,705 bcy. Area 2 has an area of approximately 5,920 ac, 18% of the SRCR area. The baseline topdressing volume was estimated to be 6,304,399 bcy and the 1993-status topdressing volume was estimated to be 1,927,958 bcy. Area 3 has an area of approximately 4,953 ac, 15% of the SRCR area. The baseline topdressing volume was estimated to be 6,464,531 bcy and the 1993-status topdressing volume was estimated to be 5,810,624 bcy. Area 4 North has an area of approximately 4,728 ac, 14% of the SRCR area. The baseline and 1993-status topdressing volumes are the same and estimated to be 3,929,231 bcy. Area 4 South has an area of approximately 6,025 ac, 18% of the SRCR area. The baseline and 1993-status topdressing volumes are the same and estimated to be 14,098,931 bcy. Area 5 has an area of approximately 6,981 ac, 21% of the SRCR area. The baseline and the 1993-status topdressing volumes are the same and estimated to be 15,201,705 bcy.

The total estimated volumes of topdressing for the SRCR are for baseline 56,342,737 bcy and for 1993-status 43,018,154.

Table of Contents

EXECUTIVE SUMMARY i
INTRODUCTION 1
GENERAL NATURE OF THE SURVEY AREA..... 1
SOIL SURVEY PROCEDURES..... 2
RESULTS 5
 Soil Series Classification 5
 Map Units..... 6
 Mapping Unit Descriptions for BHP Navajo Coal Company Coal Lease
 Soil Resource Comprehensive Report 7
 Topdressing Availability..... 19
PRIME FARMLAND DETERMINATION..... 21
 Investigation of Prime Farmland..... 21
 Results of Investigation 21
 Conclusion..... 22
LITERATURE CITED 22

List of Tables

Table 1 Topsoil and Topsoil Substitute Suitability Criteria for the Southwestern
 United States 24
Table 2 Baseline Calculations for Area, Percent of Area, and Topdressing
 Volume Available from Each Soil Mapping Unit for the BHP
 Navajo Coal Company Coal Lease Soil Resource
 Comprehensive Report..... 26
Table 3 1993-status Calculations for Area, Percent of Area, and Topdressing
 Volume Available from Each Soil Mapping Unit for the BHP
 Navajo Coal Company Coal Lease Soil Resource
 Comprehensive Report..... 29

List of Tables (Continued)

Table 4	Family Classification of Each Soil Series and Hydrologic Group Identified in the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report	32
Table 5	Key to Soils of the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report	34
Table 6	1993-status Soil Mapping Units and their Associated Map Unit Symbol for the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report	39
Table 7	Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 1, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	42
Table 8	Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 2, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	44
Table 9	Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 3, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	46
Table 10	Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 4 North, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	48
Table 11	Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 4 South, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	50

List of Tables (Continued)

Table 12	Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 5, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	52
Table 13	1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 1, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	53
Table 14	1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 2, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	55
Table 15	1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 3, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	57
Table 16	1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 4 North, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	59
Table 17	1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 4 South, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	61
Table 18	1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 5, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report.....	63

List of Tables (Continued)

Table 19	Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Area for the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report	64
Table 20	1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Area for the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report	65

List of Exhibits

Exhibit 1	Baseline Soil Mapping Units
Exhibit 2	1993-status Soil Mapping Units

INTRODUCTION

In December 2011, Buchanan Consultants, Ltd. completed the Soil Resource Comprehensive Report (SRCR) for BHP Navajo Coal Company (BNCC) to summarize past soil surveys into a composite report for the entire BNCC coal lease area. The primary objectives of the past surveys were to describe the soils of the BNCC lease area and to provide the location and an estimate of salvageable topdressing material for Navajo Mine. The topdressing material is used for reclamation of disturbed lands resulting from surface coal mining operations.

The soil resources for the BNCC lease area were determined by combining three soil surveys, all completed by BCL. The surveys were completed at various times for different areas of the mine. The first was submitted as part of BNCC's Permit Application Package in September 1993. The second as a soil survey for Navajo Mine submitted in November 1998. The third soil survey was submitted as the Navajo Mine Extension Project in March 2008.

The SRCR is to be used as a planning tool and not to define precise site-specific unit delineations. The intent is for it to be used in obtaining mining permits and for general planning in the mine operations. It provides a supplement to on-site investigations of the various soil types described in the survey. Soil resource information provided in the report is intended to identify and describe the kinds of soil within the BNCC lease area, extent of soil mapping units, and amount of topdressing and soil depth.

GENERAL NATURE OF THE SURVEY AREA

BNCC lease area is located 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 lease 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 survey area are formed from alluvium and eolian sediments derived from shale and sandstone from the Fruitland formation. Some soils have a residual

component. Most of the soils in the survey area have been forming only since the late-Pleistocene and during the Holocene Era. It is very common to find buried soils that date back to the Pleistocene Era. The annual precipitation for the survey area averages approximately 6 inches and the mean annual air temperature near 51° F (11° C). Therefore, the survey is described as having an aridic moisture regime and a mesic temperature regime.

An order 3 soil survey of the Navajo Mine area was issued in November 1980 as the Soil Survey of San Juan County New Mexico, Eastern Part (USDA, 1980). This soil survey produced by the Natural Resources Conservation Service (NRCS) was presented at scales of 1:24,000 and 1:63,360. Many of the soil series names used in the SRCR are the same as those used in the 1980 soil survey. Additional soil series for the SRCR came from other NRCS soil surveys in Arizona, Colorado, New Mexico, and Utah. The soil series used in the SRCR represent the current correlation of soils for the BNCC lease area.

SOIL SURVEY PROCEDURES

The SRCR was created by combining previously completed soil surveys. In Areas 1 and 2 and parts of Area 3 the mapping units and associated soil series followed the 1980 NRCS soil survey. In the early 1990's much of these areas had been mined; therefore the soil survey completed in 1993 was based on air photo interpretation or the 1980 NRCS soil survey. In the other surveys (parts of Area 3 and Areas 4 and 5), transects were distributed in the unmined areas to provide a pattern for the location of soil test sites. Transects were oriented so that the major soil types were traversed. A combination of aerial photos from the National Aerial Photography Program (NAPP) and from BHP Navajo Coal Company (BNCC) was used to delineate major soil types. The NAPP photos were taken on September 24, 1991 at a scale of 1:15,840, the BNCC photos were taken on April 5, 1985 at a scale of 1:6,000 and on February 26, 1998 at a scale of 1:24,000.

Aerial photographs of each area were studied stereoscopically. This examination provided predictions about the types and boundaries of soils. Tentative soil delineations

were drawn on the photographs. Predictions of soil types and boundaries were then verified at test sites located in the field. As a group of transects and associated test sites were completed, delineations on aerial photographs were either verified or changed to reflect field observations. An attempt was made to place one or more test sites within each major map unit delineation. The miscellaneous areas were visited but few, if any test sites, were described or sampled. These areas are relatively easy to identify on aerial photographs and generally do not provide suitable topdressing material.

Soil test pits were positioned along transects or on unique landscapes representing the major soil types. The spacing of test pits was determined by the complexity of soils within an area. In complex areas, test pits were described at close intervals and in homogeneous areas they were more widely spaced. Generally, test pits were positioned at close intervals (approximately 500 ft apart) along transects in Areas 3 and 4 and were more widely spaced in Area 5. The wider spacing in Area 5 is a result of both the homogeneity of the soils and the scientist's familiarity with the soil types and associated landscapes. At each test site, a soil profile was excavated with a backhoe or with a hand auger. Excavations were completed to bedrock or a maximum depth of 60. At some test pit sites, a complete excavation was unnecessary because the soil type and its suitability for use as topdressing could be accurately predicted from surface characteristics. The natric soils are an example of these soil types. At excavated sites, a soil profile description was written or a record was made of depth of suitable topdressing, depth to bedrock, and soil type. Profile descriptions included depth, texture, consistence, structure, effervescence, color, visible salts, and quantity of coarse fragments for each soil horizon. Also included were soil type (series), depth of suitable topdressing, current vegetation, parent material, physiography, slope, aspect, degree of erosion, and any other information pertinent to pedon classification and topsoil/topdressing suitability determinations (Soil Survey Division Staff, 1993).

Soil samples were collected from selected soil profiles that represented either extensive soil components, soils that could not be classified in the field, or potential topdressing. Most samples were analyzed by Inter-Mountain Laboratories (IML). Samples from Area

5 were analyzed by Green Analytical Laboratories (GAL). The parameters measured included pH, electrical conductivity (EC), saturation percent (SP%), calcium, magnesium, sodium, sodium adsorption ratio (SAR), texture with percent sand, percent silt, and percent clay, percent carbonate, acid-base potential (ABP), hot-water-soluble boron, hot-water-soluble selenium, and total selenium. The methods of soil analysis used by IML and GAL are referenced in the original soils survey reports. Topdressing Suitability for the Southwestern United States (OSM, 1999) was used to evaluate the suitability of all soil samples, Table 1. It was beyond the scope of this soil survey to determine the suitability of topdressing (regolith) resources that may have existed below the depth of test site excavations. These deep regolith materials are expected to occur in some mapping units and they may be a resource of additional topdressing material.

One of the objectives of this report was to identify the soil resources available as topdressing material for the reclamation of disturbed areas on the BNCC lease area. To accomplish this objective soils were mapped at a large enough scale to produce mapping units of similar soil types. It is assumed that if similar soils can be mapped together, then characteristics of a few samples within the unit can be extrapolated for the entire unit. The assumption is valid for homogeneous areas or areas where small delineations can be made to maintain homogeneous components. The scale used in this survey allowed delineations of 0.5 acres. 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. The available topdressing volume was determined for each map unit delineation for both the baseline and 1993-status conditions. The volume amount is expressed as bank cubic yards (bcy). Also provided is a description of each soil mapping unit, including the proportion of named components and inclusions.

After mapping was complete for an area, soil map unit delineations were adjusted and transferred from aerial photographs to orthophotographs. The delineations were then digitized using ArcGIS. The base map scale for the SRCR was 1:15,840. Enlargement

or reduction of the map scale for presentation does not provide additional mapping detail beyond the scale of the base map.

The location of each soil profile was plotted on orthophotograph soil maps. These profile locations are numbered within each respective area. Therefore, each different survey area has its own set of numbered profiles. Map unit delineations were based on soil profile data that had been plotted on orthophotographic maps.

Topdressing availability was calculated for each map unit delineation as a volume estimated from the product of mean depth of suitable material and the area. Mean depths less than 6 inches were entered as 0 inches because it is operationally unfeasible to remove surface soils less than 6 inches thick. Volumes were summed to provide the quantity of topdressing material available from each delineation for each map unit. A total volume of topdressing was produced for each of the separate soil survey areas. The total volumes of topdressing for all areas were combined to represent the total topdressing volume for the SRCR. The topdressing estimates are expected to vary by no more than 20 percent (Buchanan and Musslewhite, 2011).

RESULTS

The soils of the SRCR 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 frequency of moderate and severely eroded surfaces. Additionally, many profiles were described with lithologic discontinuities. The location of each profile with northing and easting coordinates, soil type, depth of topdressing, and depth to bedrock is provided in each of the three soil surveys. The coordinate system used to designate each profile was the State Plane New Mexico West, North American Datum 1927.

Survey Area

The total area of the SRCR for both baseline and 1993-status is 33,370.7 ac, respectively Table 2 and Table 3. These tables also include the area, percent of area and topdressing volume for each soil mapping unit identified for baseline and 1993-status

Soil Series Classification

All of the soil series used in the SRCR are either Aridisols or Entisols and exist in 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 4. Series descriptions for each soil are available from the NRCS website. Laboratory data for each major series are included with each of the respective soil surveys. Several series (Chipeta, Mesa, Redlands, Sogzie and Uffens) occur only as inclusions in the mapping units. These were not used to name map units nor sampled because of their limited extent. The laboratory data were used to classify soils and determine topdressing suitability. The soil series used for the SRCR are included in the Key to Soils, Table 5. This key provides a procedure to separate the various soil series used as soil components for the mapping units.

Several soil series names used in the 1980 NRCS soil survey were used in the 1993 soil survey for BNCC. In later surveys, these soil series were correlated to represent the most current soil series names used by the NRCS. Each subsequent soil survey also used the most current soil series name and soil classification nomenclature. The SRCR uses current series names to describe the soils of BNCC.

Map Units

A total of 41 different mapping units are used to describe the SRCR, 1993-status. Of these, 32 are consociations, 6 are complexes and 3 are undifferentiated units. Of the 33 soil series described for the SRCR 22 soil series and 7 miscellaneous types were used to name the mapping units. Each mapping unit names and map symbols are listed in Table 6.

The extent (area) and depth of topdressing for each map unit in the SRCR are available electronically from the detailed soil map, baseline, Exhibit 1 and 1993-status, Exhibit 2. Each map unit delineation, Exhibit 1 and Exhibit 2 represents an area on the landscape and consists of one or more soils for which the map unit is named. Map unit symbols were assigned to each delineation to identify the soil mapping unit name for both baseline and 1993-status.

One of the map units, named Natric soils, was comprised of several Natrargids and Natrigypsids. The Natrargids include Huerfano, Fajada, Muff, Patel and Uffens. The Natrigypsids include Hoskay and Benally. These sodium affected soils do not provide a source of topdressing because of EC and/or SAR that exceed the topsoil suitability guidelines, Table 1. Since none of these soil series provide a source of topdressing, there was no justification in separating them, therefore the Natric soils map unit was created.

Some of the Natric soils have a surface deposit of sandy eolian material suitable as a source of topdressing. A map unit, Natric soils, overblown phase, was created to differentiate these sources of topdressing from the unsuitable Natric soils map unit.

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 Descriptions for BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Bc - Bacobi sandy loam, 0 to 15 percent slopes. This map unit is on mesas and plateaus. Slopes are nearly level to moderately steep. Soils have formed from alluvium and eolian materials derived predominantly from sandstone and shale. The native vegetation is mainly galleta, alkali sacaton, shadscale, and broom snakeweed. This map unit is about 75 percent Bacobi, 15 percent Monierco, and 10 percent inclusions from adjacent mapping units. Included in this unit are small areas of Shiprock, Doak, Grieta, and Razito moderately deep soils. The Bacobi soils in this map unit are moderately deep and generally provide from 6 to 40 inches of topdressing material. Topdressing availability in this map unit is controlled by

depth to shale, siltstone, or sandstone bedrock. This map unit occupies 787.7 acres or 2.42 percent of the BNCC lease area, Table 3.

BM – Bacobi and Monierco soils, 0 to 8 percent slopes. This is an undifferentiated map unit of Bacobi and Monierco loamy sands, sandy loams and sandy clay loams. These soils have formed in alluvial and eolian material derived predominantly from sandstone and shale on mesas and plateaus. Bacobi soils occupy 30 to 50 percent of most delineations and Monierco soils 35 to 55 percent. The major inclusions (2 to 5 percent) are Avalon, Farb and Shiprock soils. The minor inclusions (less than one percent) are Fajada, Fruitland and Nakai soils. Bacobi (20 to 40 inches to bedrock) and Monierco (<20 inches to bedrock) soils generally provide from 5 to 40 inches of topdressing material. This map unit occupies 866.8 acres or 2.66 percent of the BNCC lease area, Table 3.

BA - Badlands. This miscellaneous area consists of barren shale uplands that are dissected by intermittent drainages and gullies. Also included are very steep to nearly vertical rock outcrops of sandstone and shale. This map unit is mostly void of vegetation except some atriplex species and annuals that occur on micro-sites with eolian and alluvial accumulations. The slopes range from 0 to 100 percent. Included in this map unit are small areas of Natric soils. Badlands are unstable, and most disturbances cause severe water erosion and a high soil blowing hazard. This unit has no usable topdressing material and occupies 5824.5 acres or 17.88 percent of the BNCC lease area, Table 3.

Bb - Beebe, loamy sand, 0 to 3 percent slopes. This map unit occurs on flood plains and channel bottoms. These soils have formed from either alluvium or eolian derived primarily from sandstone. Slopes are level to nearly level. Soils in this map unit are highly susceptible to frequent flooding. The vegetation is mainly alkali sacaton, galleta, black greasewood, and rabbitbrush. This map unit is over 80 percent Beebe and less than 20 percent inclusions. Included in this unit are small areas of Fruitland soils intermingled with Gilco, Jocity, and, to a lesser extent, Natric soils. The depth of suitable topdressing ranges from 0 to 60 inches. Topdressing availability is largely controlled by depth to sodium

affected horizons and proximity to ephemeral streams. This map unit occupies 297.9 acres or 0.91 percent of the BNCC lease area, Table 3.

Bl - Blancot sandy clay loam, 0 to 5 percent slopes. This map unit is on fans, valleys, terraces and mesas. Soils have formed in alluvium derived predominantly from sandstone and shale. This unit is 75 to 90 percent Blancot, sandy clay loam, and Blancot, sandy loam. Blancot soils are on fans and in upland valleys, and occur with inclusions on terraces and mesas. Included in this unit are areas of Doak sandy loam (5 percent) and small areas of Shiprock, Grieta, and deep Natric soils. These additional included areas individually make up less than 15 percent of the total acreage. The Blancot soils in this unit are deep and generally provide from 36 to 60 inches of topdressing material. These soils represent some of the most suitable topdressing resources in the survey area. This map unit occupies 92.0 acres or 0.28 percent of the BNCC lease area, Table 3.

Bh – Blancot sandy clay loam, very hard, 0 to 2 percent slopes. This map unit is on fans and in valleys. It occurs with inclusions on terraces and some valleys. Soils have formed in alluvium derived predominantly from sandstone and shale. This map unit is 80 percent Blancot sandy clay loam, very hard. Included in this map unit are small areas of Blancot sandy clay loams and sandy loams. Other included soils are Doak (10 to 15 percent), Shiprock (5 to 10 percent), Grieta (5 to 10 percent) and Natric soils. Included areas make up about 20 to 25 percent of the total acreage. The Blancot soils in this map unit have 40 inches of available topdressing because the lower horizons are very hard to extremely hard. These lower horizons generally have SAR values of 15 or higher. The cementation of these horizons is associated with sodium dispersed clay, which can be restrictive to root growth. This map unit occupies 124.7 acres or 0.38 percent of the BNCC lease area, Table 3.

Dst – Disturbed. This is a miscellaneous land type mapped as a consociation. These areas vary in nature but have the common feature of being disturbed by mining or associated activity. They can vary in size and degree of disturbance. They are identified in the 1993-status. Since 1993, some of these areas have been reclaimed. This map unit occupies 8,361.7 acres or 25.66 percent of the BNCC lease area, Table 3.

Dk - Doak sandy loam, 0 to 5 percent slopes. This map unit occurs on mesas, plateaus, fan remnants, and terraces as deep, well developed soils. Slopes are nearly level to gently sloping. These soils are similar to Shiprock soils. Shiprock is coarse-loamy and Doak is fine loamy. Doak soils were formed from alluvial and eolian sediments derived from sandstone and shale. The vegetation is mainly galleta, alkali sacaton, broom snakeweed, and atriplex species. In earlier surveys, Redlands Variant was used as a map unit. That map unit has been included with the Doak map unit. This map unit is about 80 percent Doak, 10 percent Shiprock and similar soils, and 10 percent Blancot and similar soils. The depth of suitable topdressing generally ranges from 24 to 60 inches and is controlled by depth to bedrock or highly contrasting substrata. These soils represent some of the most suitable topdressing resources in the survey area. This unit occupies 273.0 acres or 0.84 percent of the BNCC lease area, Table 3.

Dh – Doak sandy loam, very hard, 0 to 3 percent slopes. This map unit occurs on terraces and mesas. The soils are formed from eolian and alluvium deposits derived from sandstone and shale. These soils are similar to Doak soils except the subsoils are very hard to extremely hard. They have high levels of sodium, which are limiting to root growth. This map unit is over 70 percent Doak, very hard phase. The major inclusions are Doak and deep Natric soils. These soils are deep and the surface texture is loamy sands and sandy loams. Available topdressing material is limited to depths ranging from 10 to 20 inches. This map unit occupies 24.4 acres or 0.07 percent of the BNCC lease area, Table 3.

Fb - Farb sandy loam, 0 to 15 percent slopes. These shallow, nearly level to moderately steep soils are located on mesas, hills, ridges, and breaks. These soils are formed in residuum, colluvium, and alluvium derived from sandstone or shale. The current vegetation is primarily galleta, alkali sacaton, sand dropseed, broom snakeweed, and atriplex species. This map unit is about 80 percent Farb and similar soils, 10 percent Persayo and similar soils, 5 percent shallow Natric soils and similar soils, and 5 percent Rock Outcrop. The depth of suitable topdressing generally ranges from 0 to 20 inches. Topdressing availability is largely controlled by depth to bedrock. This map unit occupies 1,013.5 acres or 3.11 percent of the BNCC lease area, Table 3.

Fr - Fruitland sandy loam, 0 to 15 percent slopes. This map unit occurs on upland fans and on terraces. These soils are deep and well drained. They have formed in eolian and alluvial sediments derived predominantly from sandstone. The vegetation is largely alkali sacaton, sand dropseed, black greasewood, and atriplex species. This unit is about 75 percent Fruitland soils and 15 percent Shiprock, Sogzie, and similar soils. The remaining soils include Beebe, and other soils of minor extent. The depth of suitable topdressing ranges from 0 to 60 inches and is restricted by depth to bedrock or highly contrasting and limiting substrata. This map unit occupies 109.3 acres or 0.34 percent of the BNCC lease area, Table 3.

Fv - Fruitvale-Doak-Grieta sandy loams, 0 to 5 percent slopes. This complex of soils is on mesas and upland valleys with undulating slopes. These deep soils formed predominately in alluvium derived from mixed sources. The vegetation is mainly alkali sacaton, galleta, and atriplex species. This unit is nearly 60 percent Fruitvale and similar soils, 10 to 30 percent Doak, 10 – 30 percent Grieta and 5 to 10 percent Natric soils and similar soils. The components of this map unit are so intricately intermingled that it was not practical to map them separately at the scale used. The depth of suitable topdressing generally ranges from 24 to 60 inches and is restricted by depth to bedrock, gypsum or sodium affected substrata. This unit occupies 48.3 acres or 0.15 percent of the BNCC lease area, Table 3.

Gr - Grieta sandy loam, 0 to 8 percent slopes. This map unit is found on older stable landscapes where the soils have a well developed calcic layer and occur on mesas and plateaus. Slopes are level to moderately sloping. Soils have developed from both eolian and alluvium deposits derived from sandstone and shale. Vegetation is primarily galleta, alkali sacaton, and shadscale. Grieta soils occupy about 75 percent of the unit. Inclusions are Doak, Sogzie and soils from adjoining map units, Bacobi, Shiprock, and Monierco. The depth of suitable topdressing generally ranges from 10 to 60 inches. The depth of topdressing is controlled by depth to bedrock or highly limiting calcic substrata. This map unit occupies 177.9 acres or 0.55 percent of the BNCC lease area, Table 3.

Jc - Jocity sandy loam, 0 to 3 percent slopes. This map unit is on flood plains and alluvial fans. These soils are primarily formed in alluvium from mixed sources. The vegetation is mainly galleta, alkali sacaton, black greasewood, and atriplex species. This unit is about 75 percent Jocity and 5 percent Fruitland, Gilco, and similar soils. The remaining soils are inclusions from adjacent map units. The available topdressing from this unit is controlled by depth to sodium affected, skeletal textured substrata, and occasionally depth to bedrock and ranges from 0 to 60 inches of suitable material. This map unit occupies a total of 493.3 acres or 1.51 percent of the BNCC lease area, Table 3.

Jh – Jocity, very hard, 0 to 3 percent slopes. This map unit is found as deep alluvial deposits on stream terraces and flood plains. These soils are similar to those of the Jocity sandy loams and the Jocity-Gilco complex except they are sodium affected and the deposits are very hard to extremely hard when dry. The Jocity, very hard soils occupy 60 – 80 percent of the map unit. The included soils are Gilco (<15 percent) and deep Natric soils. The available topdressing from this unit is limited by sodium affected substratum and ranges from 0 to 16 inches of suitable material. This map unit occupies a total of 210.7 acres or 0.65 percent of the BNCC lease area, Table 3.

Jf - Jocity-Fruitland sandy loams, 0 to 3 percent slopes. This map unit is on flood plains and streams terraces on level to nearly level slopes. It is also associated with coppice dune areas located along ephemeral stream banks dominated by shrubs. This unit is susceptible to occasional flooding. The native vegetation is mainly alkali sacaton, galleta, black greasewood, and atriplex species. This unit is about 60 percent Jocity soils and 30 percent Fruitland sandy loam soils. The remaining areas of this unit are inclusions of Razito moderately deep soils intermingled with Beebe soils. The depth of topdressing ranges from 0 to 60 inches for these soils and is restricted by depth to sodium affected substrata or to bedrock. This map unit occupies 143.5 acres or 0.44 percent of the BNCC lease area, Table 3.

Jg - Jocity-Gilco complex, 0 to 3 percent slopes. This map unit is found as deep alluvial deposits on flood plains. The soils range in texture from Sandy to Fine-loamy and are formed from recent alluvium along drainages. These are some of the youngest soils in the

survey area. This unit is 35 to 45 percent Gilco soils, 30 to 40 percent Jocity soils, and 15 percent Blancot, Fruitland, and similar soils. Jocity soils average more than 18 percent clay in the control section and Gilco averages less than 18 percent clay. The components of this map unit are so intricately intermingled that it was not practical to map them separately at the scale used. Included soils consist mainly of Fruitland, Stumble, and Blancot, each generally averaging less than 5 percent of a delineation. When the soils are not sodium affected, they provide a highly suitable source of topdressing. The depth of topdressing ranges from 0 to 60 inches for these soils. This map unit occupies 235.0 acres or 0.72percent of the BNCC lease area, Table 3.

Mc – Mack sandy loam, 0 to 3 percent slopes. This map unit is located on stable mesas as a deep soil having well developed calcic horizons formed in alluvium derived from sandstone and shale. The substratum is gravelly or fine-loamy, which distinguishes these soils from Grieta soils which have coarse-loamy substrata. This map unit is over 80 percent Mack soils having sandy loam and loamy sand surfaces. The included soils are Doak (10 to 15 percent) and Grieta (5 to 10 percent). The depth of suitable topdressing ranges from 40 to 60 inches. Topdressing suitability is limited by depth to bedrock or limiting substratum. This map unit occupies 187.8 acres or 0.58 percent of the BNCC lease area, Table 3.

Mq - Mayqueen loamy sand, 0 to 8 percent slopes. These deep and very deep soils are on stabilized dunes, mesas and valleys. This map unit is primarily formed from stabilized eolian material derived primarily from sandstone. The vegetation is mainly galleta, sand dropseed, alkali sacaton, and atriplex species. The Mayqueen soils occupy over 80 percent of the unit. The major included soils are Razito, Shiprock, and Sogzie, approximately 5 percent each. The depth of suitable topdressing generally ranges from 20 to 60 inches and is controlled by depth to bedrock and highly contrasting, limiting subsurface horizons. This map unit occupies 63.0 acres or 0.19 percent of the BNCC lease area, Table 3.

Ms – Mayqueen-Shiprock loamy sands, 0 to 8 percent slopes. This map unit is on mesas and plateaus and consists of deep soils well suited for topdressing material. This unit is 40 to 60 percent Mayqueen and 30 to 40 percent Shiprock. The major included soils are

Razito, 5 percent, with lesser amounts of Bacobi, Blancot, Doak, Grieta, and Stumble. The depth of available topdressing ranges from 20 to 60 inches. This map unit occurs on 281.1 acres or 0.86 percent of the BNCC lease area, Table 3.

Mh – Mayqueen-Shiprock loamy sands, very hard, 0 to 8 percent slopes. This map unit is on mesas and plateaus. The soils consist of soils very similar to the Mayqueen-Shiprock complex except they are sodium affected and the dry consistence of the subsurface is very hard or extremely hard. The Mayqueen very hard soils occupy 35 to 45 percent of the map unit and Shiprock very hard occupy 30 to 40 percent of the map unit. Inclusions are few and mostly consist of soils from associated map units, Mayqueen, Shiprock and Grieta. The depth of suitable topdressing is limited by the dry consistence of the subsurface and averages 20 inches. This map unit occupies 8.6 acres or 0.03 percent of the BNCC lease area, Table 3.

Mo - Monierco sandy loam, 0 to 15 percent slopes. These shallow well drained soils are on mesas, ridges, and plateaus. They formed in alluvial and eolian materials overlying sedimentary rock on nearly level to moderately steep slopes. The current vegetation is mainly galleta, alkali sacaton, and shadscale. This unit is nearly 75 percent Monierco soils, 15 percent Bacobi soils, and 5 percent Persayo, Farb and similar soils. The remaining soils are inclusions from adjacent map units. The depth of suitable topdressing generally ranges from 0 to 20 inches and is primarily controlled by depth to bedrock. This unit occupies 927.0 acres or 2.85 percent of the BNCC lease area, Table 3.

Nk – Nakai sandy loam, 0 to 5 percent slopes. This map unit occurs on stable terraces and alluvial fans. Nakai soils are derived from eolian and alluvial material derived from sandstone and shale. The Nakai soils occupy over 80 percent of the map unit. Included are similar soils which are primarily Avalon and Grieta soils. The depth of suitable topdressing ranges from 10 to 20 inches and is primarily controlled by depth to bedrock or a calcic horizon. This unit occupies 49.5 acres or 0.15 percent of the BNCC lease area, Table 3.

NA – Natric soils, 0 to 8 percent slopes. This is an undifferentiated map unit of Natrargids and Natragypsids that are shallow, moderately deep and deep. These Natric soils occur on mesas, plateaus, alluvial fans and in valleys. They are derived primarily from alluvium or directly from shale. In most delineations, they lack vegetation except for sparsely distributed salt tolerant grasses, forbs and shrubs. Most of the components do not provide a source of topdressing; therefore, they were combined to form a single undifferentiated map unit. The Natric soils in this map unit are primarily: Huerfano, Muff, Fajada, Patel, Benally, Uffens and Hoskay. There are few inclusions in this mapping unit except at the boundary of other map delineations. These soils are not suitable as sources of topdressing because they are highly sodium affected with Natric horizons having SAR values ranging from 15 to over 50. This map unit occupies 7,448.4 acres or 22.86 percent of the total BNCC lease area, Table 3.

NO – Natric soils overblown, 0 to 8 percent slopes. This map unit is similar to the Natric soils map unit except the surface textures of these soils are sands and loamy sands that originate from recently deposited eolian material. In most cases, the eolian sands are less than 20 inches deep. When the eolian sands covering the Natric soils were greater than 20 inches deep, the soils were mapped as Razito, very hard soils. The Natric soils of this unit include Fajada, Uffens, Benally, Huerfano and Patel. Inclusions are Razito very hard, Trail, Blancot, Doak and Shiprock soils. Soils of this unit do provide a source of topdressing that ranges from 0 to 20 inches of material. This map unit occupies 550.2 acres or 1.69 percent of the total BNCC lease area, Table 3.

Pr - Persayo clay loam, 0 to 15 percent slopes. This map unit is on mesas, uplands, and ridges. Slopes cover a wide range of classes from level to strongly sloping. These shallow, well drained soils have formed in residuum and alluvium derived from carbonaceous shale, siltstone, and sandstone. Vegetation is mainly alkali sacaton, galleta, and atriplex species. This unit is about 75 percent Persayo, 15 percent Huerfano and similar soils, and 10 percent Patel and similar soils. The depth of topdressing in this unit ranges from 0 to 20 inches and is controlled by depth to bedrock and sodium affected strata. This map unit occupies 443.1 acres or 1.36 percent of the BNCC lease area, Table 3.

PF - Persayo, Farb, and Rock Outcrop soils, 0 to 50 percent slopes. This undifferentiated map unit is on hills, ridges, and mesas. Slopes range from nearly level to very steep. These soils formed in residuum derived mainly from sandstone and shale. The vegetation is primarily galleta, alkali sacaton, and atriplex species. This unit is about 35 to 45 percent Persayo and similar soils, 30 to 40 percent Farb and similar soils, and 15 to 25 percent Rock Outcrop and Badlands. The components of this map unit are so intricately intermingled it was not practical to map them separately at the scale used. Salvageable topdressing depth in this unit ranges from 0 to 20 inches. Topdressing availability is severely limited because of complex, steep slopes and depth to bedrock. This map unit occupies 240.4 acres or 0.74 percent of the BNCC lease area, Table 3.

Pnd – Pond. This is a miscellaneous land type mapped as a consociation. These areas consist of water catchment structures constructed to catch surface runoff. They may contain water at various times of the year or they may be dry for various lengths of time. This map unit occupies 11.0 acres or 0.03 percent of the BNCC lease area, Table 3.

Rz - Razito loamy sand, 0 to 8 percent slopes. This unit consists of deep, excessively drained soils on mesas and backslopes formed in eolian sands. The dominant landform for these soils are wind oriented, longitudinal sand ridges. The vegetation is primarily Indian ricegrass, alkali sacaton, galleta, sand dropseed, broom snakeweed, and atriplex species. The Razito soils occupy over 75 percent of the unit. The major inclusion is Mayqueen soils occupying nearly 15 percent of the unit. These soils are similarly managed as Razito soils. Other inclusions are Shiprock, Sogzie, and Stumble soils. The available topdressing material generally ranges from 20 to 60 or more inches. This map unit occupies 1,017.4 acres or 3.12 percent of the BNCC lease area, Table 3.

Rm - Razito loamy sand, moderately deep, 0 to 8 percent slopes. This unit consists of moderately deep, excessively drained soils on mesas and backslopes formed in eolian sands. The dominant landform for these soils are wind oriented, longitudinal sand ridges. The vegetation is primarily Indian ricegrass, alkali sacaton, galleta, sand dropseed, broom snakeweed, and atriplex species. This unit is nearly 75 percent Razito loamy sand,

moderately deep. Stumble inclusions are Mayqueen, Shiprock and similar soils. Other inclusions are mainly dissimilar soils, such as Huerfano and Patel, from adjacent map units. The available topdressing material generally ranges from 20 to 40 inches and is controlled by depth to bedrock or sodium affected substrata that has a dry consistence of very hard or extremely hard. This unit occupies 564.6 acres or 1.73 percent of the BNCC lease area, Table 3.

Rcl – Reclaimed Land. This is a miscellaneous land type mapped as a consociation. These are areas that have been reclaimed and are represented in the 1993-status. They can vary greatly in size. Typically, the spoil has been graded and topdressing applied. They vary in age since reclamation was initiated. In some cases, the present day conditions may represent something other than reclaimed land. This unit occupies 8.2 acres or 0.03 percent of the BNCC lease area, Table 3.

RO - Rock Outcrop. This miscellaneous area consists primarily of exposures of barren sandstone on cliffs, breaks, bluffs and ridges. Slope ranges from 0 to 100 percent. This map unit is mostly void of vegetation; however, some atriplex species and annuals occur on micro sites with eolian and alluvial accumulations. Included in this unit are small areas of Farb, Persayo, and Huerfano soils. This map unit from a practical standpoint has no suitable topdressing material. This unit occupies 20.3 acres or 0.06 percent of the BNCC lease area, Table 3.

Sp - Shiprock loamy sand-sandy loam, 0 to 8 percent slopes. The soils are formed in alluvium and eolian material derived from sandstone and shale. This map unit is on mesas and plateaus. The vegetation is mostly galleta, alkali sacaton, sand dropseed, broom snakeweed, rabbitbrush, and atriplex species. The unit is over 75 percent Shiprock soils. Included in this map unit are Grieta and Sogzie soils with minor areas of Doak and Mayqueen soils. These soils represent some of the most suitable sources of topdressing material. The depth of suitable topdressing generally ranges from 40 to 60 inches and is mainly controlled by depth to bedrock or highly contrasting, limiting substrata. This map unit occupies 501.7 acres or 1.54 percent of the BNCC lease area, Table 3.

Sh - Shiprock sandy loam, very hard, 0 to 8 percent slopes. This map unit occurs on mesas and terraces as deep, well developed soils. The soils and vegetation are similar to Shiprock soils but the substrata are very hard or extremely hard. Typically, the sodium levels in the substrata exceed the topsoil or topdressing suitability limits. Consistence is strongly associated with the sodicity and therefore is used to characterize this phase of Shiprock soils. Topdressing depth is limited by material that is either very hard or extremely hard. The map unit is about 70 percent Shiprock very hard soils with inclusions of Bacobi, Grieta, Mayqueen, Sogzie, and Razito. The depth of suitable topdressing generally ranges from 10 to 30 inches. This map unit occupies 234.8 acres or 0.72 percent of the BNCC lease area, Table 3.

Sb – Shiprock-Blancot complex, 0 to 8 percent slopes. This map unit is on fans, terraces and mesas. Soils have formed in alluvium derived predominantly from sandstone and shale. This unit is 40 to 50 percent Shiprock loamy sand and sandy loam and 30 to 40 percent Blancot soils. Shiprock soils occur on stable mesas and terraces whereas Blancot soils are associated with fans and stable terraces. Included in this unit are small areas of Doak, Mayqueen, and Grieta soils. Included areas make up less than 10 percent of the map unit. The Shiprock-Blancot soils are deep and provide 40 to 60 or more inches of available topdressing material. This unit occupies 33.2 acres of 0.10 percent of the BNCC lease area, Table 3.

SM - Shiprock, Mayqueen, and Bacobi sandy loams, 0 to 5 percent slopes. This undifferentiated map unit is on gently sloping areas of mesas, plateaus, and terraces. These soils formed in eolian and alluvial sediments derived from sandstone and shale. The vegetation is predominately galleta, alkali sacaton, sand dropseed, Indian ricegrass, broom snakeweed, and atriplex species. This map unit is about 25 to 45 percent Shiprock, 20 to 40 percent Mayqueen, 15 to 35 percent Bacobi, 5 percent Fruitvale, and 5 percent Natric soils. The components of this unit are so intricately intermingled and unpredictable in the landscape that it was not practical to map them separately at the scale used. The depth of suitable topdressing generally ranges from 10 to 60 or more inches and is mainly controlled

by depth to bedrock. This map unit occupies 1,345.4 acres or 4.13 percent of the BNCC lease area, Table 3.

St - Stumble loamy fine sand, 0 to 15 percent slopes. This map unit occurs on sides of valleys and alluvial fans. Soils have formed in sandy alluvium and eolian deposits derived from sandstone and shale. The current vegetation is predominately sand dropseed, galleta, Indian ricegrass, broom, snakeweed, rabbitbrush, and atriplex species. This unit is 80 percent Stumble, loamy fine sand. Included are limited areas of Razito and Mayqueen soils. The soils are sandy and generally provide 15 to 60 inches of suitable topdressing material. Depth of suitable topdressing is controlled by depth to bedrock or skeletal textured substrata. This unit occupies 155.8 acres or 0.48 percent of the BNCC lease area, Table 3.

Ts – Topdressing Stockpile. This is a miscellaneous land type mapped as a consociation. These areas consist of stockpiled topdressing removed from baseline areas which are represented in the 1993-status; since then, new stockpiles may have been created, some added to and some may have been removed. The stockpile material can vary greatly in volume and may exist for extended periods of time. The stockpile material, at some time will be used as topdressing for reclamation. This unit occupies 52.8 acres or 0.16 percent of the SRCR survey area, Table 3.

Tr – Trail loamy sand-sandy loam, 0 to 8 percent slopes. These soils are on flood plains and low river terraces. They have formed in sandy alluvium derived from sandstone and shale. Trail soils usually occur in higher positions in the landscape than the related Gilco soils. The map unit is over 80 percent Trail soils. Inclusions are Trail very hard, Gilco and, on steeper slopes, Razito soils. The depth of available topdressing ranges from 20 to 60 or more inches. The map unit occupies 36.1 acres or 0.11 percent of the BNCC lease area, Table 3.

Th – Trail, very hard, 0 to 8 percent slopes. This map unit is on eroded terraces which resemble the substratum of stable mesas or flood plains. Soils have formed from alluvium derived from sandstone and shale. The soils are sodium affected and are generally very hard

or extremely hard throughout the profile. The unit is 80 percent Trail very hard soils with inclusions of Stumble, Razito, and various Natric soils. The depth of available topdressing ranges from 6 to 24 inches. The map unit occupies 41.1 acres or 0.13 percent of the BNCC lease area, Table 3.

Ty - Tsaya loam, 0 to 15 percent slopes. This map unit is on nearly level to strongly sloping areas of mesas, hills, and ridges. These shallow soils formed in residuum derived mainly from sandstone. Vegetation is mostly atriplex species and annuals with sparse stands of alkali sacaton and galleta occurring in eolian accumulations. This map unit is about 60 percent Tsaya and similar soils and 10 percent Rock Outcrop. Included soils of limited extent are Chipeta clay, Patel clay, Huerfano, and Jocity. Soil materials in this map unit generally range in depth from 0 to 20 inches, but typically are not suitable for use as topdressing because of high rock content and sodium hazard. This map unit occupies 65.0 acres or 0.2 percent of the BNCC lease area, Table 3.

Topdressing Availability

The estimated topdressing volume available is presented for each mapping unit, by area and as baseline or 1993-status calculation, respectively Tables 7 - 12 and Tables 13 - 18. The total volume of available topdressing for SRCR is 56,372,737 bcy for baseline, Table 19, and 43,018,154 bcy for 1993-status, Table 20. The acreage and topdressing volume by area follows.

Area 1

The total area for Area 1 is 4,763.6 ac, 14.27% of the SRCR area, Table 19. The baseline topdressing volume was 10,343,940 bcy, Table 19 and the 1993-status topdressing volume is 2,049,705 bcy, Table 20.

Area 2

The total area for Area 2 is 5,919.7 ac, 17.74% of the SRCR area, Table 19. The baseline topdressing volume was 6,304,399 bcy, Table 19 and the 1993-status topdressing volume is 1,927,958 bcy, Table 20.

Area 3

The total area for Area 3 is 4,953.2 ac, 14.84% of the SRCR area, Table 19. The baseline topdressing volume was 6,464,531 bcy, Table 19 and the 1993-status topdressing volume is 5,810,624 bcy, Table 20.

Area 4 North

The total area for Area 4 North is 4,728.0 ac, 14.17% of the SRCR area, Table 19. The baseline and 1993-status topdressing volumes are the same 3,929,231 bcy, Tables 19 and 20.

Area 4 South

The total area for Area 4 South is 6,025.2 ac, 18.06% of the SRCR area, Table 19. The baseline and 1993-status topdressing volumes are the same 14,098,931 bcy, Tables 19 and 20.

Area 5

The total area for Area 5 is 6,981.1 ac, 20.92% of the SRCR area, Table 19. The baseline and 1993-status topdressing volumes are the same 15,201,705 bcy, Tables 19 and 20.

PRIME FARMLAND DETERMINATION

Investigation of Prime Farmland

Multiple investigations were conducted to determine whether lands within the BNCC coal lease area were classified as prime farmland. Norman Vigil, Acting State Conservationist from the NRCS was asked to determine if the survey area contained prime farmland and to write a letter regarding the investigation.

Results of Investigation

1. The area within the BNCC coal lease area has not been historically used as crop land.
2. The area within the BNCC coal lease area has an average annual precipitation of six inches and has no naturally sub-irrigated lands.

3. The area within the BNCC coal lease 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)
4. Letter from Norman Vigil, Acting State Conservationist USDA-NRCS that verifies there is no prime farmland within the BNCC coal lease area, attached.

Conclusion

Based on the conditions (1-4) discussed above, it is concluded there is no prime farmland within the BNCC coal lease area.

LITERATURE CITED

Agricultural Research Service, U.S. Department of Agriculture, Draft. 1990. Predicting Soil Erosion by Water-A Guide to Conservation Planning with the Revised Universal Soil Loss Equation. Tucson, Arizona.

Buchanan, B.A., B.D. Musslewhite. 2011. Predicting Topsoil Balance From Different Levels of Soil Survey. 2011 National Meeting of the American Society of Mining and Reclamation, Bismarck, ND, June 12-16, 2011

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, 99p.

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. 25p.

Soil Conservation Service, U.S. Department of Agriculture. 1974. National Soils Handbook, 1983, Section 603.02-1. 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. Eleventh Edition, 2010. Keys to Soil Taxonomy. USDA-Soil Conservation Service. U.S. Gov. Print. Office, Washington, DC.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Official Soil Series Descriptions [Online WWW]. Available URL: "<http://soils.usda.gov/technical/classification/osd/index.html>" [Accessed 19 February 2008]. USDA-NRCS, Lincoln, NE.

United States Department of Agriculture (USDA). 1980. Soil Survey of San Juan County, New Mexico, Eastern part. USDA-Soil Conservation Service. U.S. Gov. Print. Office, Washington, D.C.

Table 1. Topsoil and Topsoil Substitute Suitability Criteria for the Southwestern United States* (OSM, 1999)

Parameter	Material Quality		
	Good	Marginal	Unsuitable
pH	6.0-8.4	5.5-6.0	< 5.5
EC mmhos/cm (1)	< 4.0	4.0-12.0	> 12.0
SAR (2)			
sl and coarser	<12.0	12.0-18.0	> 18.0
l and cl	<10.0	10.0-16.0	> 16.0
40% clay	<8.0	8.0-14.0	> 14.0
Texture (3)	ls, sl, l, 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./1000T	+0 T CaCo3 Equiv./1000T	-5 T CaCo3 Equiv./1000T
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 submitted data technically represent the site specific nature of the modification.

1. When EC is less than 2.0, then SAR's cannot be >18.
2. SAR values can be modified if adequate data is submitted to support proposed modifications.

Table 1. Continued

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; sil=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.
5. For each material proposed to reclaim slopes $\geq 25\%$ (4h:lv), a K factor must be determined from the results of appropriate physical and chemical analyses, as outlined in the National Soils Handbook (SCS, 1983). Material suitability will be determined using the Revised Universal Soil Loss Equation (Renard, ARS, 1990).

Table 2. Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit for the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi and Monierco soils, 0 to 8 % slopes	39,923,711	916.5	2.75	1,848,320
Bacobi sandy loam, 0 to 15 % slopes	35,176,502	807.5	2.42	2,690,387
Badlands	383,213,522	8,797.4	26.36	0
Beebe loamy sand, 0 to 3 % slopes	12,976,287	297.9	0.89	2,162,714
Blancot sandy clay loam, 0 to 5 % slopes	4,008,374	92.0	0.28	645,549
Blancot, sandy clay loam, very hard, 0 to 2 % slopes	5,454,115	125.2	0.38	656,514
Disturbed	9,455,809	217.1	0.65	0
Doak sandy loam, 0 to 5 % slopes	12,005,212	275.6	0.83	1,739,560
Doak sandy loam, very hard, 0 to 3 % slopes	1,063,092	24.4	0.07	157,495
Farb sandy loam, 0 to 15 % slopes	62,283,499	1,429.8	4.28	1,096,433
Fruitland sandy loam, 0 to 15 % slopes	4,763,238	109.3	0.33	579,664
Fruitvale-Doak-Grieta sandy loams, 0 to 5 % slopes	2,103,667	48.3	0.14	289,470
Grieta sandy loam, 0 to 8 % slopes	64,531,887	1,481.4	4.44	3,538,648
Jocity-Fruitland sandy loams, 0 to 3 % slopes	6,250,624	143.5	0.43	718,413
Jocity-Gilco complex, 0 to 3 % slopes	10,235,246	235.0	0.70	1,739,491
Jocity sandy loam, 0 to 3 % slopes	26,209,391	601.7	1.80	378,848
Jocity, very hard, 0 to 3 % slopes	17,555,609	403.0	1.21	1,190,572

Table 2. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Mack sandy loam, 0 to 3 % slopes	8,607,348	197.6	0.59	1,593,953
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	39,008,926	895.5	2.68	4,936,315
Mayqueen-Shiprock loamy sands, very hard, 0 to 8 % slopes	373,102	8.6	0.03	23,031
Mayqueen loamy sand, 0 to 8 % slopes	2,742,780	63.0	0.19	487,670
Monierco sandy loam, 0 to 15 % slopes	40,380,576	927.0	2.78	1,967,805
Nakai sandy loam, 0 to 5 % slopes	2,794,751	64.2	0.19	129,387
Natric soils, 0 to 8 % slopes	387,997,898	8,907.2	26.69	0
Natric soils, overblown, 0 to 8 % slopes	24,776,469	568.8	1.70	751,441
Persayo clay loam, 0 to 15 % slopes	19,300,433	443.1	1.33	0
Persayo, Farb, and Rock Outcrop soils, 0 to 50 % slopes	10,471,909	240.4	0.72	35,909
Razito loamy sand, 0 to 8 % slopes	24,995,057	573.8	1.72	2,089,627
Razito loamy sand, moderately deep, 0 to 8 % slopes	65,975,201	1,514.6	4.54	10,164,405
Rock Outcrop	883,746	20.3	0.06	0
Shiprock-Blancot complex, 0 to 8 % slopes	3,543,982	81.4	0.24	656,293
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	33,818,417	776.4	2.33	4,956,859
Shiprock sandy loam, very hard, 0 to 8 % slopes	19,044,906	437.2	1.31	1,048,171
Shiprock, Mayqueen, and Bacobi sandy loam, 0 to 5 % slopes	58,605,545	1,345.4	4.03	6,670,287
Stumble loamy fine sand, 0 to 15 % slopes	6,861,041	157.5	0.47	1,027,634

Table 2. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Trail loamy sand-sandy loam, 0 to 8 % slopes	1,617,528	37.1	0.11	294,550
Trail, very hard, 0 to 8 % slopes	1,789,472	41.1	0.12	77,323
Tsaya loam, 0 to 15 % slopes	2,830,283	65.0	0.19	0
Total	1,453,629,157	33,370.7	100.00	56,342,737

Table 3. 1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit for the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi sandy loam, 0 to 15 % slopes	34,311,743	787.7	2.42	2,639,676
Bacobi and Monierco soils, 0 to 8 % slopes	37,755,970	866.8	2.66	1,747,962
Badlands	253,716,523	5,824.5	17.88	0
Beebe loamy sand, 0 to 3 % slopes	12,976,287	297.9	0.91	2,162,714
Blancot sandy clay loam, 0 to 5 % slopes	4,008,374	92.0	0.28	645,549
Blancot, sandy clay loam, very hard, 0 to 2 % slopes	5,431,747	124.7	0.38	653,821
Disturbed	364,236,134	8,361.7	25.66	0
Doak sandy loam, 0 to 5 % slopes	11,892,866	273.0	0.84	1,724,996
Doak sandy loam, very hard, 0 to 3 % slopes	1,063,092	24.4	0.07	157,495
Farb sandy loam, 0 to 15 % slopes	44,149,407	1,013.5	3.11	648,678
Fruitland sandy loam, 0 to 15 % slopes	4,763,238	109.3	0.34	579,664
Fruitvale-Doak-Grieta sandy loams, 0 to 5 % slopes	2,103,667	48.3	0.15	289,470
Grieta sandy loam, 0 to 8 % slopes	7,749,226	177.9	0.55	559,311
Jocity sandy loam, 0 to 3 % slopes	21,489,498	493.3	1.51	320,578
Jocity, very hard, 0 to 3 % slopes	9,179,111	210.7	0.65	816,332
Jocity-Fruitland sandy loams, 0 to 3 % slopes	6,250,624	143.5	0.44	718,413
Jocity-Gilco complex, 0 to 3 % slopes	10,235,246	235.0	0.72	1,739,491

Table 3. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Mack sandy loam, 0 to 3 % slopes	8,180,820	187.8	0.58	1,514,967
Mayqueen loamy sand, 0 to 8 % slopes	2,742,780	63.0	0.19	487,670
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	12,243,755	281.1	0.86	1,549,364
Mayqueen-Shiprock loamy sands, very hard, 0 to 8 % slopes	373,102	8.6	0.03	23,031
Monierco sandy loam, 0 to 15 % slopes	40,380,576	927.0	2.85	1,967,805
Nakai sandy loam, 0 to 5 % slopes	2,156,531	49.5	0.15	99,839
Natric soils, 0 to 8 % slopes	324,452,854	7,448.4	22.86	0
Natric soils, overblown, 0 to 8 % slopes	23,966,379	550.2	1.69	726,438
Persayo clay loam, 0 to 15 % slopes	19,300,433	443.1	1.36	0
Persayo, Farb, and Rock Outcrop soils, 0 to 50 % slopes	10,471,909	240.4	0.74	35,909
Pond	479,069	11.0	0.03	0
Razito loamy sand, 0 to 8 % slopes	44,318,615	1,017.4	3.12	7,022,864
Razito loamy sand, moderately deep, 0 to 8 % slopes	24,592,121	564.6	1.73	2,052,318
Reclaimed Land	356,614	8.2	0.03	0
Rock Outcrop	883,746	20.3	0.06	0
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	21,854,778	501.7	1.54	3,258,317
Shiprock sandy loam, very hard, 0 to 8 % slopes	10,229,297	234.8	0.72	558,415
Shiprock-Blancot complex, 0 to 8 % slopes	1,447,643	33.2	0.10	268,082

Table 3. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Shiprock, Mayqueen, and Bacobi sandy loam, 0 to 5 % slopes	58,605,545	1,345.4	4.13	6,670,287
Stumble loamy fine sand, 0 to 15 % slopes	6,786,856	155.8	0.48	1,015,041
Topdressing stockpile	2,300,812	52.8	0.16	0
Trail loamy sand-sandy loam, 0 to 8 % slopes	1,572,409	36.1	0.11	286,334
Trail, very hard, 0 to 8 % slopes	1,789,472	41.1	0.13	77,323
Tsaya loam, 0 to 15 % slopes	2,830,283	65.0	0.20	0
Total	1,453,629,157	33,370.7	100.00	43,018,154

Table 4. Family Classification of Each Soil Series and Hydrologic Group Identified in the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Series	Taxonomic Classification of Soils	Hydrologic Group
Avalon	Fine-loamy, mixed, superactive, mesic Typic Haplocalcid.....	B
Bacobi	Fine-loamy, mixed, superactive, mesic Typic Haplargids.....	C
Badlands	Miscellaneous land type.....	D
Beebe	Sandy, mixed, mesic Typic Torrifuvents.....	A
Benally	Fine-loamy, mixed, active, mesic Typic Natrigypsids	D
Blancot	Fine-loamy, mixed, superactive, mesic Ustic Haplargids.....	B
Chipeta	Clayey, mixed, calcareous, mesic, shallow Typic Torriorthents	D
Doak	Fine-loamy, mixed, active, mesic Typic Haplargids	B
Fajada	Fine-loamy, mixed, superactive, mesic Typic Natrargids	D
Farb	Loamy, mixed, calcareous, mesic Lithic Torriorthents	D
Fruitland	Coarse-loamy, mixed, superactive, calcareous, mesic Typic Torriorthents	B
Fruitvale	Fine-loamy, mixed, active, mesic Typic Argigypsids	B
Gilco	Coarse-loamy, mixed, superactive, calcareous, mesic Typic Torrifuvents	B
Grieta	Fine-loamy, mixed, superactive, mesic Typic Calciargids.....	B
Hoskay	Fine, mixed, superactive, mesic Vertic Natrigypsids	D
Huerfano	Loamy, mixed, superactive, mesic, shallow Typic Natrargids.....	D
Jocity	Fine-loamy, mixed, superactive, calcareous, mesic Typic Torrifuvents ...	B
Mack	Fine-loamy, mixed, superactive, mesic Typic Calciargids.....	B
Mayqueen	Coarse-loamy, mixed, superactive, mesic Typic Haplargids.....	B
Mesa	Finy-loamy, mixed, superactive, mesic Typic Calciargids.....	B
Monierco	Loamy, mixed, superactive, mesic, shallow Typic Haplargids	D
Muff	Fine-loamy, mixed, superactive, mesic Typic Natrargids	D
Nakai	Coarse-loamy, mixed, superactive, mesic Typic Haplocalcid.....	B
Patel	Fine, mixed, active, mesic Typic Natrargids	D

Table 4. Continued

Series	Taxonomic Classification of Soils	Hydrologic Group
Persayo	Loamy, mixed, active, calcareous, mesic, shallow Typic Torriorthents.....	D
Razito	Sandy, mixed, mesic Typic Torripsammets.....	A
Redlands	Fine-loamy, mixed, superactive, mesic Typic Haplargid	B
Rock Outcrop	Miscellaneous land type.....	D
Shiprock	Coarse-loamy, mixed, superactive, mesic Typic Haplargids.....	B
Sogzie	Coarse-loamy, mixed, superactive, mesic Typic Calciargids.....	B
Stumble	Mixed, mesic Typic Torripsammets	A
Trail	Sandy, mixed, mesic Typic Torrifluvent	A
Tsaya	Loamy-skeletal, mixed, superactive, calcareous, mesic Lithic Torriorthents	D
Turley	Fine-loamy, mixed, active, calcareous, mesic Typic Torriorthent	D
Uffens	Fine-loamy, mixed, superactive, mesic Typic Natrargids	D

Table 5. Key to Soils of the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

DIAGNOSTIC EPIPEDON OR SUBSURFACE HORIZONS LACKING

ENTISOL

Less than 35% rock fragments, loamy fine sand or coarser in all subhorizons to 100 cm, lithic or paralithic contact. **Psamments**

Deeper than 25 cm, slope less than 25% and an irregular decrease in organic matter with depth or remains above 0.2% o.m. to 125 cm **Fluvents**

Other Entisols **Orthents**

Psamments

All are Typic Torripsamments

Typic Torripsamment (>100 to Lithic contact)

Eolian or Alluvial

Rock fragments - 0 to 5% throughout Razito

Eolian or Alluvial

Gravelly substratum, rock fragments
5 to 35% in some horizons Stumble

Fluvents

All are Typic Torrifluvents (>100 cm to lithic contact)

Sandy (loamy fine sand or coarser)

ESP - 20 to 70% upper 50 cm

Color - 7.5YR to 10 YR Beebe

Table 5. Continued

Sandy (loamy fine sand or coarser)
 ESP - <20% upper 50 cm
 Color - 2.5YR to 7.5YR Trail

Coarse-loamy (<18% clay but not sandy)
 Salinity - 0 to 16 dS/m
 Sodic - <13 SAR Gilco

Fine-loamy (18 to 35% clay)
 Salinity - 0 – 2 dS/m but can be 30
 Sodic – 0 – 10 SAR but can be 35 Jocity

Orthents

All are Torriorthents

Lithic contact with 50 cm **Lithic Torriorthents**

Lithic contact >50 cm **Typic Torriorthents**

Lithic Torriorthents

Loamy-skeletal
 Rock fragments – 35 to 80
 Clay content – 18 to 35% Tsaya

Loamy (Coarse-loamy <18% clay) Farb

Loamy (Fine-loamy 18 – 35% clay) Persayo

Clayey (Clayey >35% clay) Chipeta

Table 5. Continued

Typic Torriorthents

Coarse-loamy (<18% clay)

Fruitland

Fine-loamy (18 – 35% clay)

Turley

DIAGNOSTIC SUBSURFACE HORIZON PRESENT

ARIDISOL

Gypsic or Petrogypsic horizon

Gypsid

Argillic or Natric horizon

Argid

Calcic horizon

Calcid

Gypsid

Natric horizon

Fine (>35% clay)

Hoskay

Fine-loamy (18% - 35% clay)

Benally

Argillic horizon

Fine-loamy (18 – 35% clay)

Fruitvale

Argids

Natric horizon

Natrargids

Calcic horizon

Calciargids

Other argids

Haplargids

Table 5. Continued

Natrargids

Paralithic contact < 50 cm	<u>Huerfano</u>
Paralithic contact 50 – 100 cm	
Fine-loamy (By present)	<u>Fajada</u>
Fine-loamy (By lacking)	<u>Muff</u>
Fine	<u>Patel</u>
Paralithic contact >100 cm	
Fine-loamy (By lacking)	<u>Uffens</u>

Calciargids

Coarse-loamy	<u>Sogzie</u>
Fine-loamy	
Substratum - Fine-loamy	<u>Mack</u>
Substratum – Coarse-loamy	<u>Grieta</u>
Substratum – Loamy-skeletal	<u>Mesa</u>

Haplargids

Lithic or Paralithic <50 cm	<u>Monierco</u>
Lithic or paralithic 50 to 100 cm	<u>Bacobi (Kiki)</u>
Lithic or paralithic >100 cm	
Coarse-loamy (Bk lacking)	<u>Mayqueen</u>
Coarse-loamy (Bk present)	<u>Shiprock</u>
Fine-loamy (Bk lacking)	<u>Blancot</u>
Fine-loamy	
(Bk & Bt present less than 25 cm)	<u>Doak</u>
Fine-loamy	
(Bk & Bt present more than 25 cm)	<u>Redlands</u>

Table 5. Continued

Calcids

Coarse-loamy

Nakai

Fine-loamy

Avalon

Table 6. Soil Mapping Units and their Associated Map Unit Symbol for the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Map Unit Symbol
Bacobi sandy loam, 0 to 15 % slopes	Bc
Bacobi and Monierco soils, 0 to 8 % slopes	BM
Badlands	BA
Beebe loamy sand, 0 to 3 % slopes	Bb
Blancot sandy clay loam, 0 to 5 % slopes	Bl
Blancot, sandy clay loam, very hard, 0 to 2 % slopes	Bh
Disturbed	Dst
Doak sandy loam, 0 to 5 % slopes	Dk
Doak sandy loam, very hard, 0 to 3 % slopes	Dh
Farb sandy loam, 0 to 15 % slopes	Fb
Fruitland sandy loam, 0 to 15 % slopes	Fr
Fruitvale-Doak-Grieta sandy loams, 0 to 5 % slopes	Fv
Grieta sandy loam, 0 to 8 % slopes	Gr
Jocity sandy loam, 0 to 3 % slopes	Jc
Jocity, very hard, 0 to 3 % slopes	Jh
Jocity-Fruitland sandy loams, 0 to 3 % slopes	Jf
Jocity-Gilco complex, 0 to 3 % slopes	Jg

Table 6. Continued

Soil Mapping Unit	Map Unit Symbol
Mack sandy loam, 0 to 3 % slopes	Mc
Mayqueen loamy sand, 0 to 8 % slopes	Mq
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	Ms
Mayqueen-Shiprock loamy sands, very hard, 0 to 8 % slopes	Mh
Monierco sandy loam, 0 to 15 % slopes	Mo
Nakai sandy loam, 0 to 5 % slopes	Nk
Natric soils, 0 to 8 % slopes	NA
Natric soils, overblown, 0 to 8 % slopes	NO
Persayo clay loam, 0 to 15 % slopes	Pr
Persayo, Farb, and Rock Outcrop soils, 0 to 50 % slopes	PF
Pond	Pnd
Razito loamy sand, 0 to 8 % slopes	Rz
Razito loamy sand, moderately deep, 0 to 8 % slopes	Rm
Reclaimed Land	Rcl
Rock Outcrop	RO
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	Sp
Shiprock sandy loam, very hard, 0 to 8 % slopes	Sh
Shiprock-Blancot complex, 0 to 8 % slopes	Sb
Shiprock, Mayqueen, and Bacobi sandy loam, 0 to 5 % slopes	SM

Table 6. Continued

Soil Mapping Unit	Map Unit Symbol
Stumble loamy fine sand, 0 to 15 % slopes	St
Topdressing stockpile	Ts
Trail loamy sand-sandy loam, 0 to 8 % slopes	Tr
Trail, very hard, 0 to 8 % slopes	Th
Tsaya loam, 0 to 15 % slopes	Ty

Table 7. Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 1, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi and Monierco soils, 0 to 8 % slopes	5,808,845	133.4	2.80	268,928
Badlands	32,811,427	753.2	15.81	0
Disturbed	9,455,809	217.1	4.56	0
Doak sandy loam, 0 to 5 % slopes	154,114	3.5	0.07	19,978
Doak sandy loam, very hard, 0 to 3 % slopes	22,804	0.5	0.01	3,378
Farb sandy loam, 0 to 15 % slopes	11,792,949	270.7	5.68	291,184
Grieta sandy loam, 0 to 8 % slopes	54,809,789	1,258.3	26.41	2,875,822
Jocity sandy loam, 0 to 3 % slopes	3,997,486	91.8	1.93	49,352
Jocity, very hard, 0 to 3 % slopes	4,267,861	98.0	2.06	6,491
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	13,327,054	305.9	6.42	1,686,448
Nakai sandy loam, 0 to 5 % slopes	1,389,522	31.9	0.67	64,330
Natric soils, 0 to 8 % slopes	30,865,867	708.6	14.88	0
Natric soils, overblown, 0 to 8 % slopes	1,088,324	25.0	0.52	33,590
Razito loamy sands, 0 to 8 % slopes	1,302,314	29.9	0.63	120,585
Razito loamy sand, moderately deep, 0 to 8 % slopes	15,718,667	360.9	7.58	2,280,177
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	11,765,254	270.1	5.67	1,670,376

Table 7. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Shiprock sandy loam, very hard, 0 to 8 % slopes	5,229,753	120.1	2.52	290,542
Shiprock-Blancot complex, 0 to 8 % slopes	3,350,642	76.9	1.61	620,489
Trail loamy sand-sandy loam, 0 to 8 % slopes	341,960	7.9	0.16	62,270
Total	207,500,443	4,763.6	100.00	10,343,940

Table 8. Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 2, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi and Monierco soils, 0 to 8 % slopes	4,188,529	96.2	1.62	193,913
Badlands	144,454,421	3,316.2	56.03	0
Doak sandy loam, 0 to 5 % slopes	213,978	4.9	0.08	27,738
Farb sandy loam, 0 to 15 % slopes	10,301,824	236.5	4.00	254,366
Grieta sandy loam, 0 to 8 % slopes	1,972,872	45.3	0.77	103,515
Jocity sandy loam, 0 to 3 % slopes	7,211,206	165.5	2.80	89,027
Jocity, very hard, 0 to 3 % slopes	7,119,650	163.4	2.76	637,253
Mack sandy loam, 0 to 3 % slopes	747,133	17.2	0.29	138,358
Mayqueen loamy sand, 0 to 8 % slopes	158,449	3.6	0.06	26,408
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	20,433,625	469.1	7.93	2,585,737
Nakai sandy loam, 0 to 5 % slopes	227,341	5.2	0.09	10,525
Natric soils, 0 to 8 % slopes	41,481,221	952.3	16.09	0
Natric soils, overblown, 0 to 8 % slopes	1,671,983	38.4	0.65	51,604
Razito loamy sand, 0 to 8 % slopes	7,808,300	179.3	3.03	1,132,685
Razito loamy sand, moderately deep, 0 to 8 % slopes	22,964	0.5	0.01	2,126
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	5,636,869	129.4	2.19	800,296

Table 8. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Shiprock sandy loam, very hard, 0 to 8 % slopes	4,013,613	92.1	1.56	222,979
Shiprock-Blancot complex, 0 to 8 % slopes	29,700	0.7	0.01	5,500
Trail loamy sand-sandy loam, 0 to 8 % slopes	108,629	2.5	0.04	19,781
Trail, very hard, 0 to 8 % slopes	59,865	1.4	0.02	2,587
Total	257,802,307	5,918.3	100.00	6,301,812

Table 9. Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 3, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi and Monierco soils, 0 to 8 % slopes	4,242,846	97.4	2.01	248,809
Bacobi and Monierco soils, 0 to 8 % slopes	10,962,063	251.7	5.18	507,503
Badlands	66,642,003	1,529.9	31.51	0
Blancot sandy clay loam, very hard, 0 to 2 % slopes	5,454,115	125.2	2.58	656,514
Doak sandy loam, 0 to 5 % slopes	4,039,139	92.7	1.91	523,592
Grieta sandy loam, 0 to 8 % slopes	2,178,061	50.0	1.03	114,281
Jocity sandy loam, 0 to 3 % slopes	8,217,110	188.6	3.88	101,446
Jocity, very hard, 0 to 3 % slopes	2,012,276	46.2	0.95	180,111
Mack sandy loam, 0 to 3 % slopes	6,416,083	147.3	3.03	1,188,163
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	4,160,549	95.5	1.97	526,489
Mayqueen-Shiprock loamy sands, very hard, 0 to 8 % slopes	373,102	8.6	0.18	23,031
Natric soils, 0 to 8 % slopes	81,235,255	1,864.9	38.41	0
Natric soils, overblown, 0 to 8 % slopes	2,251,944	51.7	1.06	69,504
Razito loamy sand, 0 to 8 % slopes	6,088,674	139.8	2.88	883,234
Razito loamy sand, moderately deep, 0 to 8 % slopes	287,987	6.6	0.14	26,665
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	7,156,714	164.3	3.38	1,016,077

Table 9. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Shiprock sandy loam, very hard, 0 to 8 % slopes	1,102,067	25.3	0.52	61,226
Shiprock-Blancot complex, 0 to 8 % slopes	163,640	3.8	0.08	30,304
Trail loamy sand-sandy loam, 0 to 8 % slopes	201,306	4.6	0.10	34,172
Trail loamy sand-sandy loam, 0 to 8 % slopes	1,166,939	26.8	0.55	212,498
Trail, very hard, 0 to 8 % slopes	1,409,664	32.4	0.67	60,911
Total	211,518,692	4,855.8	100.00	6,215,722

Table 10. Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 4 North, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi and Monierco soils, 0 to 8 % slopes	18,964,274	435.4	9.21	877,976
Bacobi and Monierco soils, 0 to 8 % slopes	72,780,243	1,670.8	35.34	0
Doak sandy loam, 0 to 5 % slopes	1,047,689	24.1	0.51	135,812
Doak sandy loam, very hard, 0 to 3 % slopes	1,040,288	23.9	0.51	154,117
Farb sandy loam, 0 to 15 % slopes	14,224,462	326.5	6.91	351,221
Grieta sandy loam, 0 to 8 % slopes	2,542,174	58.4	1.23	133,386
Jocity sandy loam, 0 to 3 % slopes	3,959,419	90.9	1.92	48,882
Jocity, very hard, 0 to 3 % slopes	4,097,109	94.1	1.99	366,717
Mack sandy loam, 0 to 3 % slopes	1,444,133	33.2	0.70	267,432
Mayqueen loamy sand, 0 to 8 % slopes	221,803	5.1	0.11	36,967
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	1,087,698	25.0	0.53	137,641
Nakai sandy loam, 0 to 5 % slopes	1,177,888	27.0	0.57	54,532
Natric soils, 0 to 8 % slopes	63,951,535	1,468.1	31.05	0
Natric soils, overblown, 0 to 8 % slopes	9,378,441	215.3	4.55	289,458
Razito loamy sand, 0 to 8 % slopes	3,093,769	71.0	1.50	448,787
Razito loamy sand, moderately deep, 0 to 8 % slopes	2,579,448	59.2	1.25	238,838

Table 10. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	1,161,744	26.7	0.56	164,939
Shiprock-Blancot complex, 0 to 8 % slopes	2,453,422	56.3	1.19	136,301
Trail loamy sand-sandy loam, 0 to 8 % slopes	426,514	9.8	0.21	72,402
Trail, very hard, 0 to 8 % slopes	319,944	7.3	0.16	13,825
Total	205,951,994	4,728.0	100.00	3,929,231

Table 11. Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 4 South, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi and Monierco soils, 0 to 8 % slopes	12,685,079	291.2	4.83	907,478
Bacobi and Monierco soils, 0 to 8 % slopes	28,792,665	661.0	10.97	0
Beebe loamy sand, 0 to 3 % slopes	12,976,287	297.9	4.94	2,162,714
Blancot sandy clay loam, 0 to 5 % slopes	231,229	5.3	0.09	37,824
Doak sandy loam, 0 to 5 % slopes	4,328,847	99.4	1.65	659,104
Farb sandy loam, 0 to 15 % slopes	1,129,429	25.9	0.43	29,012
Fruitland sandy loam, 0 to 15 % slopes	4,549,346	104.4	1.73	540,054
Fruitvale-Doak-Grieta sandy loams, 0 to 5 % slopes	2,103,667	48.3	0.80	289,470
Grieta sandy loam, 0 to 8 % slopes	2,671,410	61.3	1.02	245,426
Jocity sandy loam, 0 to 3 % slopes	2,824,170	64.8	1.08	90,142
Jocity, very hard, 0 to 3 % slopes	58,713	1.3	0.02	0
Jocity-Fruitland sandy loams, 0 to 3 % slopes	6,250,624	143.5	2.38	718,413
Jocity-Gilco complex, 0 to 3 % slopes	8,104,807	186.1	3.09	1,375,816
Mayqueen loamy sand, 0 to 8 % slopes	2,362,528	54.2	0.90	424,295
Monierco sandy loam, 0 to 15 % slopes	3,956,747	90.8	1.51	183,867
Natric soils, 0 to 8 % slopes	82,333,592	1,890.1	31.37	0

Table 11. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Natric soils, overblown, 0 to 8 % slopes	9,005,639	206.7	3.43	255,933
Shiprock-Blancot complex, 0 to 8 % slopes	19,300,433	443.1	7.35	0
Trail loamy sand-sandy loam, 0 to 8 % slopes	10,471,909	240.4	3.99	35,909
Razito loamy sands, 0 to 8 % slopes	20,266,074	465.2	7.72	3,502,363
Razito loamy sand, moderately deep, 0 to 8 % slopes	3,154,160	72.4	1.20	303,240
Rock Outcrop	883,746	20.3	0.34	0
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	3,190,696	73.2	1.22	514,901
Shiprock sandy loam, very hard, 0 to 8 % slopes	6,246,051	143.4	2.38	337,123
Shiprock, Mayqueen and Bacobi sandy loam, 0 to 5 % slopes	5,516,704	126.6	2.10	564,786
Stumble loamy fine sand, 0 to 15 % slopes	6,233,222	143.1	2.37	921,060
Tsaya loam, 0 to 15 % slopes	2,830,283	65.0	1.08	0
Total	262,458,055	6,025.2	100.00	14,098,931

Table 12. Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 5, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi and Monierco soils, 0 to 8 % slopes	18,248,577	418.9	6.00	1,534,100
Bacobi and Monierco soils, 0 to 8 % slopes	37,732,764	866.2	12.41	0
Blancot sandy clay loam, 0 to 5 % slopes	3,777,145	86.7	1.24	607,724
Doak sandy loam, 0 to 5 % slopes	2,221,445	51.0	0.73	373,337
Farb sandy loam, 0 to 15 % slopes	24,834,835	570.1	8.17	170,650
Fruitland sandy loam, 0 to 15 % slopes	213,893	4.9	0.07	39,610
Grieta sandy loam, 0 to 8 % slopes	357,581	8.2	0.12	66,219
Jocity-Gilco complex, 0 to 3 % slopes	2,130,439	48.9	0.70	363,675
Monierco sandy loam, 0 to 15 % slopes	36,423,829	836.2	11.98	1,783,938
Natric soils, 0 to 8 % slopes	88,130,428	2,023.2	28.98	0
Natric soils, overblown, 0 to 8 % slopes	1,380,138	31.7	0.45	51,351
Razito loamy sand, 0 to 8 % slopes	12,999,716	298.4	24.49	1,917,158
Razito loamy sand, moderately deep, 0 to 8 % slopes	17,648,185	405.1	33.24	1,398,173
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	4,907,139	112.7	1.61	790,270
Shiprock, Mayqueen and Bacobi sandy loam, 0 to 5 % slopes	53,088,841	1,218.8	17.46	6,105,500
Total	304,094,955	6,981.1	147.65	15,201,705

Table 13. 1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 1, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi and Monierco soils, 0 to 8 % slopes	4,717,895	108.3	2.27	218,421
Badlands	1,963,151	45.1	0.95	0
Disturbed	174,526,113	4,006.6	84.11	0
Doak sandy loam, 0 to 5 % slopes	144,548	3.3	0.07	18,738
Doak sandy loam, very hard, 0 to 3 % slopes	22,804	0.5	0.01	3,378
Farb sandy loam, 0 to 15 % slopes	974,766	22.4	0.47	24,068
Jocity sandy loam, 0 to 3 % slopes	2,774,117	63.7	1.34	34,248
Jocity, very hard, 0 to 3 % slopes	11,323	0.3	0.01	1,014
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	3,833,524	88.0	1.85	485,106
Nakai sandy loam, 0 to 5 % slopes	773,965	17.8	0.37	35,832
Natric soils, 0 to 8 % slopes	7,101,619	163.0	3.42	0
Natric soils, overblown, 0 to 8 % slopes	667,462	15.3	0.32	20,601
Razito loamy sand, 0 to 8 % slopes	2,896,878	66.5	1.40	420,226
Razito loamy sand, moderately deep, 0 to 8 % slopes	936,161	21.5	0.45	86,682
Shiprock-Blancot complex, 0 to 8 % slopes	1,254,304	28.8	0.60	232,278
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	2,685,151	61.6	1.29	381,225

Table 13. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Shiprock sandy loam, very hard, 0 to 8 % slopes	609,003	14.0	0.29	33,833
Topdressing stockpile	1,310,819	30.1	0.63	0
Trail loamy sand-sandy loam, 0 to 8 % slopes	296,841	6.8	0.14	54,054
Total	207,500,443	4,763.6	100.00	2,049,705

Table 14. 1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 2, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi and Monierco soils, 0 to 8 % slopes	3,216,566	73.8	1.25	148,915
Badlands	59,269,955	1,360.7	22.99	0
Disturbed	154,634,887	3,549.9	59.97	0
Doak sandy loam, 0 to 5 % slopes	146,645	3.4	0.06	19,010
Doak sandy loam, very hard, 0 to 3 % slopes	2,985,915	68.5	1.16	73,726
Jocity sandy loam, 0 to 3 % slopes	4,529,158	104.0	1.76	55,916
Jocity, very hard, 0 to 3 % slopes	3,119,119	71.6	1.21	279,180
Mack sandy loam, 0 to 3 % slopes	320,605	7.4	0.12	59,371
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	3,557,469	81.7	1.38	450,174
Mayqueen loamy sand, 0 to 8 % slopes	158,449	3.6	0.06	26,408
Nakai sandy loam, 0 to 5 % slopes	204,678	4.7	0.08	9,476
Natric soils, 0 to 8 % slopes	18,315,015	420.5	7.10	0
Natric soils, overblown, 0 to 8 % slopes	1,324,840	30.4	0.51	40,890
Pond	235,357	5.4	0.09	0
Shiprock-Blancot complex, 0 to 8 % slopes	2,102,507	48.3	0.82	304,993
Razito loamy sand, moderately deep, 0 to 8 % slopes	22,964	0.5	0.01	2,126

Table 14. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Shiprock-Blancot complex, 0 to 8 % slopes	29,700	0.7	0.01	5,500
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	2,924,044	67.1	1.13	415,142
Shiprock sandy loam, very hard, 0 to 8 % slopes	265,728	6.1	0.10	14,763
Topdressing stockpile	330,078	7.6	0.13	0
Trail loamy sand-sandy loam, 0 to 8 % slopes	108,629	2.5	0.04	19,781
Trail loamy sand-sandy loam, 0 to 8 % slopes	59,865	1.4	0.02	2,587
Total	257,862,172	5,919.7	100.00	1,927,958

Table 15. 1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 3, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi and Monierco soils, 0 to 8 % slopes	10,857,235	249.2	5.03	502,650
Bacobi sandy loam, 0 to 15 % slopes	3,378,088	77.6	1.57	198,098
Badlands	53,177,745	1,220.8	24.65	0
Blancot sandy clay loam, very hard, 0 to 2 % slopes	5,431,747	124.7	2.52	653,821
Disturbed	35,075,135	805.2	16.26	0
Doak sandy loam, 0 to 5 % slopes	4,003,692	91.9	1.86	518,997
Grieta sandy loam, 0 to 8 % slopes	2,178,061	50.0	1.01	114,281
Jocity sandy loam, 0 to 3 % slopes	7,402,635	169.9	3.43	91,391
Jocity, very hard, 0 to 3 % slopes	1,892,847	43.5	0.88	169,421
Mack sandy loam, 0 to 3 % slopes	6,416,083	147.3	2.97	1,188,163
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	3,765,065	86.4	1.75	476,443
Mayqueen-Shiprock loamy sands, very hard, 0 to 8 % slopes	373,102	8.6	0.17	23,031
Natric soils, 0 to 8 % slopes	64,620,665	1,483.5	29.95	0
Natric soils, overblown, 0 to 8 % slopes	2,209,860	50.7	1.02	68,206
Pond	243,713	5.6	0.11	0
Razito loamy sand, 0 to 8 % slopes	2,959,671	67.9	1.37	429,335

Table 15. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Razito loamy sand, moderately deep, 0 to 8 % slopes	251,204	5.8	0.12	23,260
Reclamation	356,614	8.2	0.17	0
Shiprock-Blancot complex, 0 to 8 % slopes	163,640	3.8	0.08	30,304
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	6,986,004	160.4	3.24	991,840
Shiprock sandy loam, very hard, 0 to 8 % slopes	655,094	15.0	0.30	36,394
Stumble loamy fine sand, 0 to 15 % slopes	127,121	2.9	0.06	21,579
Topdressing stockpile	659,915	15.1	0.31	0
Trail loamy sand-sandy loam, 0 to 8 % slopes	1,166,939	26.8	0.54	212,498
Trail, very hard, 0 to 8 % slopes	1,409,664	32.4	0.65	60,911
Total	215,761,538	4,953.2	100.00	5,810,624

Table 16. 1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 4 North, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi and Monierco soils, 0 to 8 % slopes	18,964,274	435.4	9.21	877,976
Badlands	72,780,242	1,670.8	35.34	0
Doak sandy loam, 0 to 5 % slopes	1,047,689	24.1	0.51	135,812
Doak sandy loam, very hard, 0 to 3 % slopes	1,040,288	23.9	0.51	154,117
Farb sandy loam, 0 to 15 % slopes	14,224,462	326.5	6.91	351,221
Grieta sandy loam, 0 to 8 % slopes	2,542,174	58.4	1.23	133,386
Jocity sandy loam, 0 to 3 % slopes	3,959,419	90.9	1.92	48,882
Jocity, very hard, 0 to 3 % slopes	4,097,109	94.1	1.99	366,717
Mack sandy loam, 0 to 3 % slopes	1,444,133	33.2	0.70	267,432
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	1,087,698	25.0	0.53	137,641
Mayqueen loamy sand, 0 to 8 % slopes	221,803	5.1	0.11	36,967
Nakai sandy loam, 0 to 5 % slopes	1,177,888	27.0	0.57	54,532
Natric soils, 0 to 8 % slopes	63,951,535	1,468.1	31.05	0
Natric soils, overblown, 0 to 8 % slopes	9,378,441	215.3	4.55	289,458
Razito loamy sand, 0 to 8 % slopes	3,093,769	71.0	1.50	448,787
Razito loamy sand, moderately deep, 0 to 8 % slopes	2,579,448	59.2	1.25	238,838

Table 16. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	1,161,744	26.7	0.56	164,939
Shiprock sandy loam, very hard, 0 to 8 % slopes	2,453,422	56.3	1.19	136,301
Stumble loamy fine sand, 0 to 15 % slopes	426,514	9.8	0.21	72,402
Trail, very hard, 0 to 8 % slopes	319,944	7.3	0.16	13,825
Total	205,951,993	4,728.0	100.00	3,929,231

Table 17. 1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 4 South, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi sandy loam, 0 to 15 % slopes	12,685,079	291.2	4.83	907,478
Badlands	28,792,665	661.0	10.97	0
Beebe loamy sand, 0 to 3 % slopes	12,976,287	297.9	4.94	2,162,714
Blancot sandy clay loam, 0 to 5 % slopes	231,229	5.3	0.09	37,824
Doak sandy loam, 0 to 5 % slopes	4,328,847	99.4	1.65	659,104
Farb sandy loam, 0 to 15 % slopes	1,129,429	25.9	0.43	29,012
Fruitland sandy loam, 0 to 15 % slopes	4,549,346	104.4	1.73	540,054
Fruitvale-Doak-Grieta sandy loams, 0 to 5 % slopes	2,103,667	48.3	0.80	289,470
Grieta sandy loam, 0 to 8 % slopes	2,671,410	61.3	1.02	245,426
Jocity-Fruitland sandy loams, 0 to 3 % slopes	6,250,624	143.5	2.38	718,413
Jocity-Gilco complex, 0 to 3 % slopes	8,104,807	186.1	3.09	1,375,816
Jocity sandy loam, 0 to 3 % slopes	2,824,170	64.8	1.08	90,142
Jocity, very hard, 0 to 3 % slopes	58,713	1.3	0.02	0
Mayqueen loamy sand, 0 to 8 % slopes	2,362,528	54.2	0.90	424,295
Monierco sandy loam, 0 to 15 % slopes	3,956,747	90.8	1.51	183,867
Natric soils, 0 to 8 % slopes	82,333,592	1,890.1	31.37	0

Table 17. Continued

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bey)
Natric soils, overblown, 0 to 8 % slopes	9,005,639	206.7	3.43	255,933
Persayo clay loam, 0 to 15 % slopes	19,300,433	443.1	7.35	0
Persayo, Farb, and Rock Outcrop soils, 0 to 50 % slopes	10,471,909	240.4	3.99	35,909
Razito loamy sands, 0 to 8 % slopes	20,266,074	465.2	7.72	3,502,363
Razito loamy sand, moderately deep, 0 to 8 % slopes	3,154,160	72.4	1.20	303,240
Rock Outcrop	883,746	20.3	0.34	0
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	3,190,696	73.2	1.22	514,901
Shiprock sandy loam, very hard, 0 to 8 % slopes	6,246,051	143.4	2.38	337,123
Shiprock, Mayqueen and Bacobi sandy loam, 0 to 5 % slopes	5,516,704	126.6	2.10	564,786
Stumble loamy fine sand, 0 to 15 % slopes	6,233,222	143.1	2.37	921,060
Tsaya loam, 0 to 15 % slopes	2,830,283	65.0	1.08	0
Total	262,458,055	6,025.2	100.00	14,098,931

Table 18. 1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Soil Mapping Unit Located in Area 5, BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

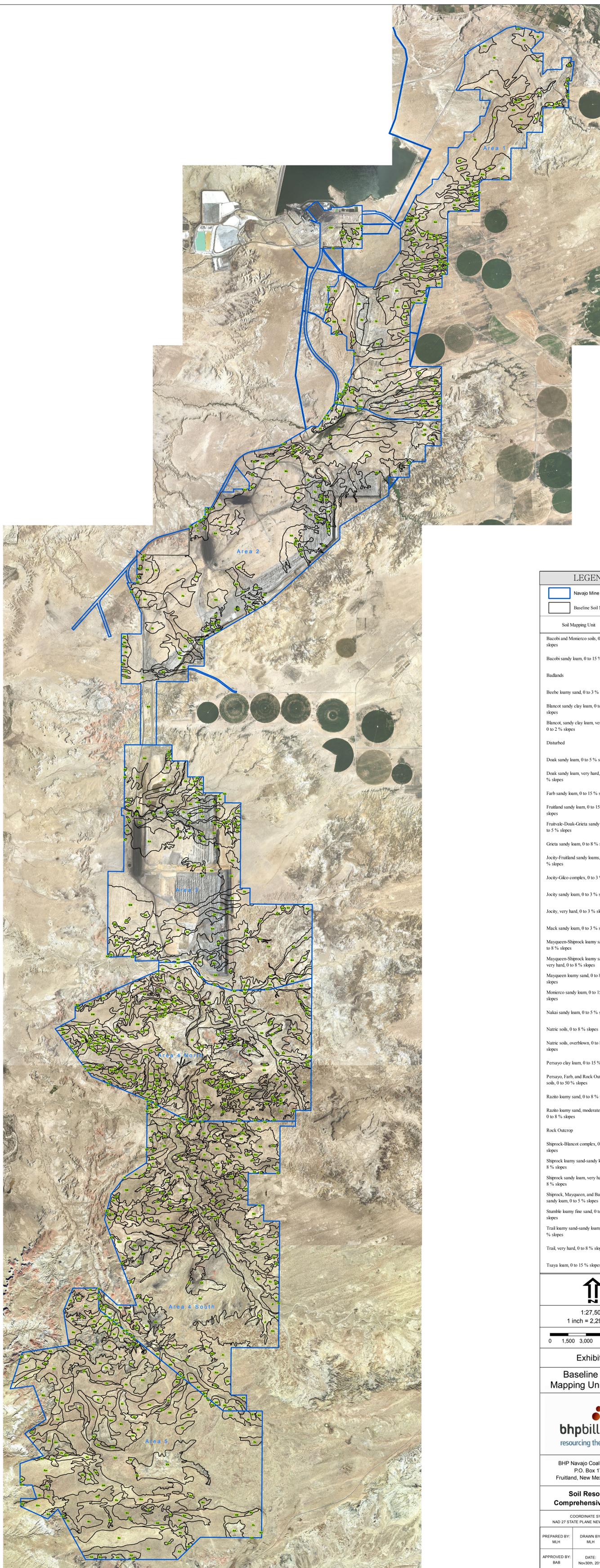
Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Bacobi sandy loam, 0 to 15 % slopes	18,248,576	418.9	6.00	1,534,100
Badlands	37,732,764	866.2	12.41	0
Blancot sandy clay loam, 0 to 5 % slopes	3,777,145	86.7	1.24	607,724
Doak sandy loam, 0 to 5 % slopes	2,221,445	51.0	0.73	373,337
Farb sandy loam, 0 to 15 % slopes	24,834,835	570.1	8.17	170,650
Fruitland sandy loam, 0 to 15 % slopes	213,893	4.9	0.07	39,610
Grieta sandy loam, 0 to 8 % slopes	357,581	8.2	0.12	66,219
Jocity-Gilco complex, 0 to 3 % slopes	2,130,439	48.9	0.70	363,675
Monierco sandy loam, 0 to 15 % slopes	36,423,829	836.2	11.98	1,783,938
Natric soils, 0 to 8 % slopes	88,130,428	2,023.2	28.98	0
Natric soils, overblown, 0 to 8 % slopes	1,380,138	31.7	0.45	51,351
Razito loamy sand, 0 to 8 % slopes	12,999,716	298.4	4.27	1,917,158
Razito loamy sand, moderately deep, 0 to 8 % slopes	17,648,185	405.1	5.80	1,398,173
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	4,907,139	112.7	1.61	790,270
Shiprock, Mayqueen and Bacobi sandy loam, 0 to 5 % slopes	53,088,841	1,218.8	17.46	6,105,500
Total	304,094,955	6,981.1	100.00	15,201,705

Table 19. Baseline Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Area for the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Area 1	207,500,443	4,763.6	14.27	10,343,940
Area 2	257,862,171	5,919.7	17.74	6,304,399
Area 3	215,761,538	4,953.2	14.84	6,464,531
Area 4 North	205,951,994	4,728.0	14.17	3,929,231
Area 4 South	262,458,055	6,025.2	18.06	14,098,931
Area 5	304,094,955	6,981.1	20.92	15,201,705
Total	1,453,629,157	33,370.7	100.00	56,342,737

Table 20. 1993-status Calculations for Area, Percent of Area, and Topdressing Volume Available from Each Area for the BHP Navajo Coal Company Coal Lease Soil Resource Comprehensive Report

Soil Mapping Unit	Area (Sq. Ft.)	Area (ac)	% of Area	Topdressing Volume (bcy)
Area 1	207,500,443	4,763.6	14.27	2,049,705
Area 2	257,862,172	5,919.7	17.74	1,927,958
Area 3	215,761,538	4,953.2	14.84	5,810,624
Area 4 North	205,951,993	4,728.0	14.17	3,929,231
Area 4 South	262,458,055	6,025.2	18.06	14,098,931
Area 5	304,094,955	6,981.1	20.92	15,201,705
Total	1,453,629,157	33,370.7	100.00	43,018,154



LEGEND

- Navajo Mine Lease Boundary
- Baseline Soil Mapping Units

Soil Mapping Unit	Map Unit Symbol
Bacobi and Monierco soils, 0 to 8 % slopes	Bm
Bacobi sandy loam, 0 to 15 % slopes	Bc
Badlands	BA
Beebe loamy sand, 0 to 3 % slopes	Bb
Blancot sandy clay loam, 0 to 5 % slopes	Bl
Blancot, sandy clay loam, very hard, 0 to 2 % slopes	Bh
Disturbed	Dst
Doak sandy loam, 0 to 5 % slopes	Dk
Doak sandy loam, very hard, 0 to 3 % slopes	Dh
Farb sandy loam, 0 to 15 % slopes	Fb
Fruitland sandy loam, 0 to 15 % slopes	Fr
Fruitvale-Doak-Grieta sandy loams, 0 to 5 % slopes	Fv
Grieta sandy loam, 0 to 8 % slopes	Gr
Jocity-Fruitland sandy loams, 0 to 3 % slopes	Jf
Jocity-Gilco complex, 0 to 3 % slopes	Jg
Jocity sandy loam, 0 to 3 % slopes	Jc
Jocity, very hard, 0 to 3 % slopes	Jh
Mack sandy loam, 0 to 3 % slopes	Mc
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	Ms
Mayqueen-Shiprock loamy sands, very hard, 0 to 8 % slopes	Mh
Mayqueen loamy sand, 0 to 8 % slopes	Mq
Monierco sandy loam, 0 to 15 % slopes	Mo
Nakai sandy loam, 0 to 5 % slopes	Nk
Natric soils, 0 to 8 % slopes	NA
Natric soils, overblown, 0 to 8 % slopes	NO
Persayo clay loam, 0 to 15 % slopes	Pr
Persayo, Farb, and Rock Outcrop soils, 0 to 50 % slopes	Pf
Razio loamy sand, 0 to 8 % slopes	Rz
Razio loamy sand, moderately deep, 0 to 8 % slopes	Rm
Rock Outcrop	RO
Shiprock-Blancot complex, 0 to 8 % slopes	Sb
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	Sp
Shiprock sandy loam, very hard, 0 to 8 % slopes	Sh
Shiprock, Mayqueen, and Bacobi sandy loam, 0 to 5 % slopes	SM
Stumble loamy fine sand, 0 to 15 % slopes	St
Trail loamy sand-sandy loam, 0 to 8 % slopes	Tr
Trail, very hard, 0 to 8 % slopes	Th
Tsaya loam, 0 to 15 % slopes	Ty

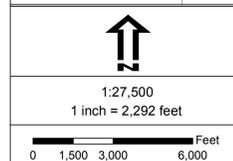


Exhibit 1
Baseline Soil Mapping Units Map



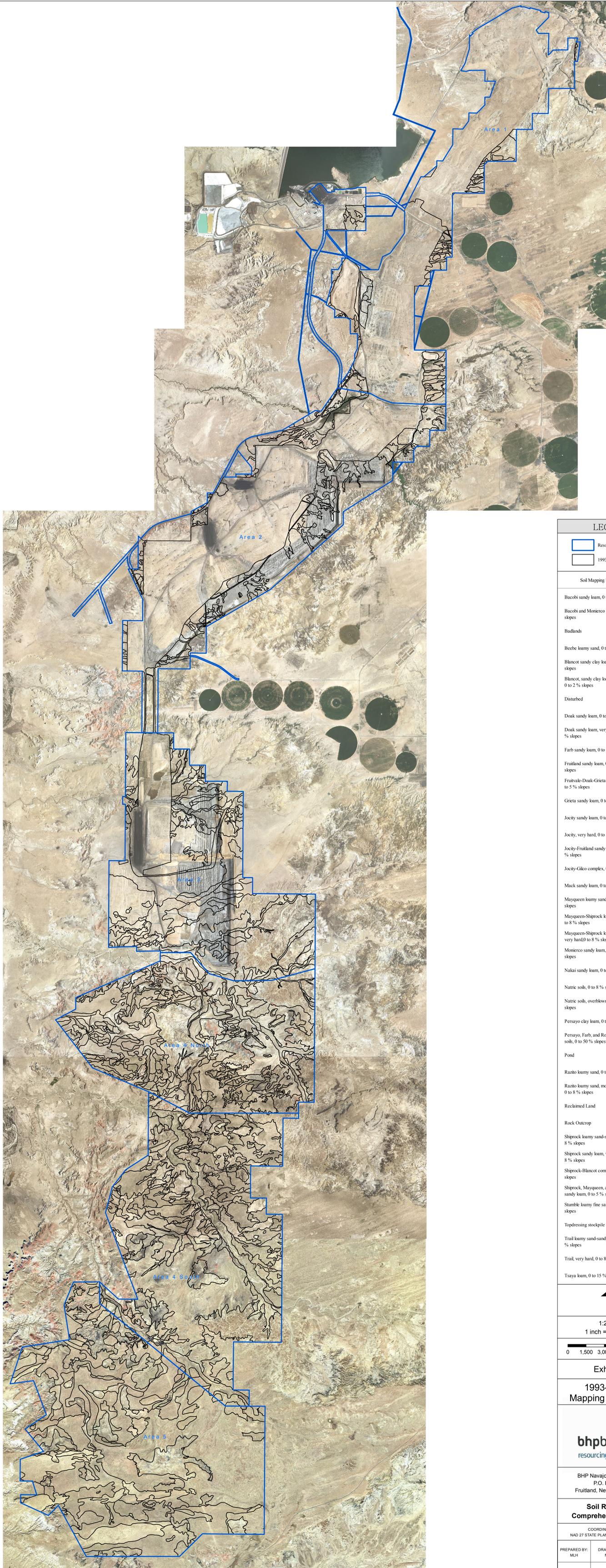
BHP Navajo Coal Company
P.O. Box 1717
Fruitland, New Mexico 87416

Soil Resource Comprehensive Report

COORDINATE SYSTEM:
NAD 27 STATE PLANE NEW MEXICO WEST

PREPARED BY: MLH DRAWN BY: MLH PAPER SIZE: 28" x 60"

APPROVED BY: BAB DATE: Nov30th, 2011



LEGEND

- Resource Area Boundaries
- 1993-Status Mapping Units

Soil Mapping Unit	Map Unit Symbol
Bacobi sandy loam, 0 to 15 % slopes	Bc
Bacobi and Monerco soils, 0 to 8 % slopes	BM
Badlands	BA
Beebe loamy sand, 0 to 3 % slopes	Bb
Blancot sandy clay loam, 0 to 5 % slopes	Bl
Blancot, sandy clay loam, very hard, 0 to 2 % slopes	Bh
Disturbed	Dst
Doak sandy loam, 0 to 5 % slopes	Dk
Doak sandy loam, very hard, 0 to 3 % slopes	Dh
Farb sandy loam, 0 to 15 % slopes	Fb
Fruitland sandy loam, 0 to 15 % slopes	Fr
Fruitvale-Doak-Grieta sandy loams, 0 to 5 % slopes	Fv
Grieta sandy loam, 0 to 8 % slopes	Gr
Jocity sandy loam, 0 to 3 % slopes	Jc
Jocity, very hard, 0 to 3 % slopes	Jh
Jocity-Fruitland sandy loams, 0 to 3 % slopes	Jf
Jocity-Gilco complex, 0 to 3 % slopes	Jg
Mack sandy loam, 0 to 3 % slopes	Mc
Mayqueen kaamy sand, 0 to 8 % slopes	Mq
Mayqueen-Shiprock loamy sands, 0 to 8 % slopes	Ms
Mayqueen-Shiprock loamy sands, very hard, 0 to 8 % slopes	Mh
Monerco sandy loam, 0 to 15 % slopes	Mo
Nakai sandy loam, 0 to 5 % slopes	Nk
Natric soils, 0 to 8 % slopes	NA
Natric soils, overblown, 0 to 8 % slopes	NO
Persayo clay loam, 0 to 15 % slopes	Pr
Persayo, Farb, and Rock Outcrop soils, 0 to 50 % slopes	PF
Pond	Pnd
Razio kaamy sand, 0 to 8 % slopes	Rz
Razio kaamy sand, moderately deep, 0 to 8 % slopes	Rm
Reclaimed Land	Rcl
Rock Outcrop	RO
Shiprock loamy sand-sandy loam, 0 to 8 % slopes	Sp
Shiprock sandy loam, very hard, 0 to 8 % slopes	Sh
Shiprock-Blancot complex, 0 to 8 % slopes	Sb
Shiprock, Mayqueen, and Bacobi sandy loam, 0 to 5 % slopes	SM
Stumble loamy fine sand, 0 to 15 % slopes	St
Topdressing stockpile	Ts
Trail loamy sand-sandy loam, 0 to 8 % slopes	Tr
Trail, very hard, 0 to 8 % slopes	Th
Tsaya loam, 0 to 15 % slopes	Ty



1:27,500
1 inch = 2,292 feet

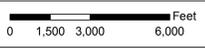


Exhibit 2

1993-Status Mapping Units Map



BHP Navajo Coal Company
P.O. Box 1717
Fruitland, New Mexico 87416

Soil Resource Comprehensive Report

COORDINATE SYSTEM:
NAD 27 STATE PLANE NEW MEXICO WEST

PREPARED BY: MLH	DRAWN BY: MLH	PAPER SIZE: 28" x 60"
APPROVED BY: BAB	DATE: Nov 30th, 2011	

United States Department of Agriculture



Natural Resources Conservation Service
6200 Jefferson NE, Room 305
Albuquerque, NM 87109
Phone: (505) 761-4400 Fax: (505) 761-4462
Web site: www.nm.nrcs.usda.gov

December 5, 2011

Mr. Mark Heil, GIS Director
Buchanan Consultants, Ltd.
P.O. Box 2549
Farmington, New Mexico 87499

Dear Mr. Heil:

Thank you for allowing the Natural Resources Conservation Service (NRCS) the opportunity to review the Navajo Mine Lease Boundary project in San Juan County, New Mexico. In review of the NRCS Soil Survey, there are no soil types within the project area that are described by the NRCS as prime farmland, farmland of local importance, farmland of statewide importance, unique farmland; or those farmlands that have previously been converted to non agricultural uses. With this acknowledged, the proposed project will not cause Prime or Unique Farmlands to be converted to nonagricultural uses. In addition, the NRCS soil survey does not identify hydric soils as occurring in the proposed project area. Hydric soils may identify potential areas of wetlands. If wetlands or waterways do exist, it is recommended that you contact the U.S. Army Corp of Engineers.

If you have any questions concerning soils information please contact Mr. Clarence Chavez, Soil Data Quality Specialist, at (505) 761-4435 or by email clarence.chavez@nm.usda.gov. Any questions concerning wetlands or other environmental impacts please contact Ms. Chanda Pettie, State Biologist, at (505) 761-4432 or by email chanda.pettie@nm.usda.gov.

Sincerely,

A handwritten signature in blue ink that reads "Norman Vigil, Acting".

for NORMAN VIGIL
Acting State Conservationist

cc:

Clarence Chavez, Soil Data Quality Scientist, NRCS, Albuquerque, NM
Chanda Pettie, State Wildlife Biologist, NRCS, Albuquerque, NM

Helping People Help the Land

An Equal Opportunity Provider and Employer