SECTION 36

POST-RECLAMATION SOIL

TABLE OF CONTENTS

SECTION	SECTION TITLE	PAGE NUMBER

SECTION 36

POST-RECLAMATION SOIL

LIST OF TABLES

SECTION 36

POST-RECLAMATION SOIL

LIST OF FIGURES

FIGURE NUMBER	FIGURE TITLE
36.4-1	Root-Zone Sampling Layout
36.4-2	Composite Sampling Procedures

SECTION 36

POST-RECLAMATION SOIL

LIST OF REVISIONS DURING PERMIT TERM

REV. NUMBER	REVISION DESCRIPTION	DATE APPROVED

SECTION 36 POST-RECLAMATION SOIL

BHP Navajo Coal Company (BNCC) will use the same topdressing and root-zone suitability criteria for the Pinabete Mine Plan permit area (permit area) as those approved for the adjacent Navajo Mine (Office of Surface Mining Reclamation and Enforcement [OSM] permit number NM-0003F) (BNCC 2009). The use of consistent topdressing and root-zone suitability criteria between Navajo Mine and the permit area is justified given the proximity of the two operations and similarity of controlling factors including climate, vegetation, soils, and geology.

The Pinabete Mine Plan permit area and Navajo Mine permit area are located adjacent to one another within the contiguous BNCC mining lease. The mining lease occupies approximately 33,400 acre and covers a linear distance of approximately 25 miles from Area 1 on the north to Area 5 on the south. The same geologic formations are present throughout the lease area, and both operations extract coal from the Fruitland Formation. Since the same geologic formations are present in both operations, the overburden material characteristics will be similar for both the Pinabete Mine Plan permit area and Navajo Mine permit area. The overburden analysis, presented in Section 17 (Geologic Information), concluded that the materials in Area 4 North and Area 4 South are net alkaline and there are no widespread occurrences of potentially acid- or toxic- forming materials (PATFM) or material that exceed the Navajo Mine root-zone suitability criteria for selenium (total and soluble), boron, and pH. These results are similar to overburden characterizations performed for Navajo Mine. Lastly, the same soil-forming factors (parent material, biota, climate, topography, and time) exist across the BNCC mining lease and have resulted in soils with consistent physical and chemical properties (Keetch et.al. 1980).

36.1 Soil Resources

The soil resources used for reclamation within the permit area are classified as topdressing, regolith, root-zone, or spoil material. How the soil resource is classified is a function of its position within the soil profile. Topdressing refers to unconsolidated material capable of supporting plant growth in the upper 60 inches of the native in-situ soil profile. This includes all topsoil material (A and E soil horizons) and suitable topsoil substitute material (B and C soil horizons). Topdressing is replaced on top of the regraded root-zone and spoil material during the reclamation process. Regolith is unconsolidated material capable of supporting plant growth located deeper than 60 inches the native in-situ soil profile. Regolith material may be used as either root-zone or topdressing material depending upon its chemical and physical characteristics. Root-zone material is the upper 3.5 feet of the overburden (spoil) material which has been regraded to the approximate original contours (AOC) or final surface configuration (FSC). Spoil is the remainder of the overburden material (i.e., deeper than 3.5 feet) in the soil profile which was removed and replaced to facilitate surface coal mining.

Section 14 (Soil) identifies and describes the location and estimated volumes of available topdressing material within the permit area. The estimated volume of topdressing material within the entire permit area is approximately 7,238,000 bank cubic yards (bcy) (Section 14, Soil). The estimated volume of topdressing within the Pinabete Mine Plan disturbance area is approximately 4,285,370 bcy. This volume of available topdressing will provide an approximate average replacement depth of 9.7 inches (Section 36.3.2).

The interpretations made in the baseline soil surveys with regard to topdressing suitability are limited to the upper 60 inches of unconsolidated material. The permit area likely contains sources of material below a depth of 60 inches that are capable of supporting plant growth (i.e., regolith). The baseline soil surveys did not evaluate and describe the potential volume of available regolith resources that may exist within the permit area. BNCC does not anticipate needing the regolith material for reclamation purposes for the permit area; if a need is identified, the regolith resources will be handled according to the procedures and processes described in Section 36.2.2.

36.1.1 Topsoil Substitutes and Supplements

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) defines topsoil as the A and E soil horizons (30 CFR 701.5). These are the uppermost soil horizons of a soil profile and are characterized by accumulations of organic matter (A horizon) or intensely weathered and leached horizons that have not accumulated organic matter (E horizon) (Brady and Weil 1996). The baseline soil resources within the permit area consist of Aridisols and Entisols soil types (Section 14, Soil). These soil types contain negligible resources that meet the SMCRA topsoil definition; therefore, BNCC relies on topsoil substitute material, or topdressing, for reclamation.

36.1.2 Soil Borrow Areas

BNCC may require soil borrow areas to provide additional fill material for the construction of roads and other support facilities. This fill material is necessary to achieve and/or maintain the designed grade of the structures and for structural backfill material. Borrow areas will be sampled and tested for topdressing resources according to the topdressing sampling and testing plan discussed in this section. Suitable topdressing resources will be salvaged and stockpiled or hauled directly to regraded areas. The borrow areas within the planned pit disturbance areas will be temporarily reclaimed and stabilized, regraded and seeded in accordance with Section 37 (Post-Reclamation Vegetation) and Section 38 (Post-Reclamation Surface Stabilization and Sediment Control). Borrow areas outside of planned pit disturbance areas will be regraded and reclaimed according to this section and Section 37 (Post-Reclamation Vegetation).

BNCC does not anticipate the need for topdressing borrow areas to facilitate reclamation of the permit area. This section will be updated in consultation with OSM if topdressing borrow areas are determined to be needed in the future.

36.2 Topdressing Sampling and Testing Plan

BNCC will conduct an intensive pre-salvage soil sampling program in advance of planned disturbance in order to identify soil material that is suitable for use as topdressing. The purpose of this program is to refine estimates and locations of available topdressing resources. The methodologies utilized in the topdressing sampling plan are based on the baseline soil surveys conducted for BNCC mining lease and are described below.

36.2.1 Topdressing Sampling Plan

The conditions observed during the baseline soil surveys, discussed in Section 14 (Soil), served as a guideline to develop the topdressing sampling plan. BNCC will use a square grid with a maximum of 200-foot centers to establish test sites for evaluations of potential topdressing sources. This spacing results in minimum density of approximately one test site per acre and provides adequate representation of soils within the most heterogeneous mapping units. The badlands and natric (natrargids and natrigypsids) soil types typically lack perennial vegetation and have historically been unsuitable sources of topdressing, therefore, these soil types will not be sampled.

At each site, a test pit will be excavated with a backhoe or similarly effective piece of equipment, to an observable unsuitable layer (e.g., bedrock, paralithic contact, extreme clay accumulations, rock fragments, or extremely hard consistence) or to a depth of 5 feet, whichever is shallower. At depths greater than 5 feet, the possibility of the test pit wall collapsing increases and the test pit becomes a safety hazard. The test pit side walls will be benched during the excavation of the test pit to mitigate the risk of the test pit wall collapsing. A soil hydraulic probe outfitted with a Shelby tube sampler, or similar sampling method, may be used as an alternative to an excavated backhoe test pit to sample surficial soils (upper 5 feet of material).

A soil scientist, or similarly qualified environmental specialist, shall oversee the sampling of each test pit. The horizons of the soil profiles shall be described by depth, dry consistence, texture, and other physical characteristics which will aid in the classification of the soil type. Samples of representative soil horizons will be collected for topdressing suitability analysis. The collected samples for laboratory analysis will include on the sample container the following information: date of collection, sample site, and depth interval. Field notes and/or soil profile descriptions for each sample site and test pit are maintained on file at the mine site. If an unsuitable layer is identified in the field, the characteristics and depth of the layer are included as part of the field notes and/or soil profile description.

Collected soil samples are submitted to a soil analytical laboratory, and the suitability of all potential topdressing sources are determined according to the methods and criteria provided in Table 36.2-1 and Table 36.2-2, respectively, prior to salvage. Soils that have one or more parameters that meet the unsuitable category are designated as unsuitable for use as topdressing and, therefore, are not salvaged. Results of the topdressing analysis will be submitted annually to OSM in the annual soil resource report described in Section 36.6.

BNCC performed a comprehensive evaluation to calculate site-specific erosion factor, or K factor, values of the topdressing material within the permit area. The purpose of this evaluation was to assist in developing the baseline flood flow and sediment yield modeling presented in Section 18 (Water Resources). The baseline soil mapping units, presented in Section 14 (Soil), were assigned a soil texture class (i.e., fine, fine loamy, coarse loamy, and sandy) based on surface texture. A composite sample for each surface texture class was created from multiple samples randomly located within the respective soil texture delineation. Inter-Mountain Laboratories, of Sheridan, Wyoming, analyzed each of the composite samples according to the algebraic approximation of the Wischmeier nomograph described by Renard et.al. (1996) and Wischmeier and Smith (1978). The calculated erodibility values for topdressing resources range from 0.10 for coarse loamy soil textures to 0.27 for sandy and fine loamy textures (Table 36.2-3). OSM has recommended a 0.37 erodibility value suitability guideline for all topsoil and topsoil substitute materials (OSM 1999). The results of BNCC's evaluation indicate that potential topdressing materials from the permit area have erodibility values less than OSM's recommended value and are therefore are suitable for reclamation and continued erodibility value analysis is unnecessary (Table 36.2-3).

36.2.2 Regolith Sampling Plan

As stated earlier, BNCC does not anticipate a need to use regolith to meet the reclamation goals for the permit area. However, regolith material may be salvaged and used either as topdressing or root-zone material or it may be spoiled if deemed necessary. The decision to salvage or spoil regolith will be based on the reclamation needs within the particular resource area (Area 4 North or Area 4 South).

Regolith material used for reclamation purposes will be sampled in-situ and evaluated using the suitability criteria outlined in Table 36.2-2. The topdressing criteria are prescribed for suitability determinations since salvaged regolith may be stockpiled and used as either topdressing or root-zone material. Topdressing suitability criteria are generally more stringent than root-zone suitability criteria (Section 36.4.2) and a determination to a single suite of suitability criteria eliminates the need for segregated regolith stockpiles.

BNCC may propose to conduct a regolith characterization study to characterize the regolith resources in the permit area. If BNCC does conduct the regolith characterization study, a plan describing the areas of investigation and the sampling methods will be submitted to OSM for approval prior to commencing the study. Similar characterization studies completed at Navajo Mine were conducted on 800-foot centers using a drill rig outfitted with core barrel auger. BNCC may use these same general methods or modify them to best characterize the regolith resource found within the permit area. If conducted, the results of the regolith characterization study would be submitted to OSM as part of the annual soil resource report (Section 36.6).

BNCC may utilize regolith for topdressing or root-zone material prior to developing and implementing a characterization study. In the absence of a complete characterization study, the regolith resource will be sampled in-situ, or after placement according to the appropriate suitability criteria each time it is used. Results of this sampling will be submitted to OSM within the annual soil resource report described in Section 36.6.

36.3 Soil Handling Plan

The following describes the methods and procedures BNCC will use for the removal of vegetation and soils and the stockpiling of suitable topdressing material for the Pinabete Mine Plan. This information is also presented in Section 20 (Mining Operations).

36.3.1 Soil and Topdressing Handling Methods

36.3.1.1 Vegetation and Soil Removal

BNCC will salvage suitable soil materials for use as topdressing during reclamation. Topdressing salvage operations may occur anytime during the calendar year as equipment and personnel are available. Existing vegetation will be removed with the salvaged topdressing to improve the organic content. If the existing vegetation is too large to facilitate topdressing salvage operations, BNCC will use a bulldozer, or similarly effective piece of equipment, to grub the vegetation in advance of salvage operations. Where practical and feasible, BNCC will salvage and direct haul suitable topdressing material to graded areas. If direct haul is not practical or feasible, the salvaged topdressing material will be stockpiled in approved stockpiles in accordance with the procedures described in Section 22 (Support Facilities).

BNCC will salvage topdressing material from all areas affected by mining operations or construction of major structures. Certain topdressing resources cannot be salvaged without jeopardizing the safety of the operators and equipment or diminishing the quality of the topdressing removed. Due to these limitations, topdressing is not salvaged where:

1. Slopes are greater than 4 horizontal to 1 vertical (4h:1v or > 25%),
2. Suitable surface deposits are less than 6 inches. This soil is too shallow to allow removal without considerable contamination from underlying unsuitable material,
3. Areas less than 1 acre in size (pockets),
4. Areas where rock rims and/or rock outcrops exist

The maximum allowable limit of topdressing removal in advance of the active mining area is 1,800 feet beyond the current extent of mining (e.g., highwall crest). Topdressing is removed far enough ahead of highwall drilling and blasting to prevent contamination from blasting flyrock, and to accommodate mining support infrastructure such as roads and power lines. In the event that a greater area is needed for topdressing removal, OSM will be notified prior to topdressing removal and the appropriate adjustments to the reclamation bond will be made. The extent of topdressing removal will fully consider and comply with the applicable hydrology performance standards.

BNCC will conduct topdressing salvage operations with haul trucks and front-end loaders, tractor scrapers, or similarly effective equipment. The salvaged topdressing will be hauled to a stockpile or to an area where it will be redistributed on regraded suitable root-zone material.

<u>36.3.1.2 Topdressing Storage</u>

BNCC shall use numerous stockpiles within the permit area for storing topdressing and, if needed, regolith material. The locations and information regarding the construction, operation, and maintenance of the topdressing stockpiles are presented in Section 22 (Support Facilities). Methods used to stabilize the surface of the topdressing stockpiles are presented in Section 25 (Sediment Control Plan). BNCC shall place signs at all stockpiles indicating the stockpile name and the type of material (e.g., topdressing or regolith) contained within the stockpile.

36.3.2 Topdressing Redistribution

All areas disturbed by mining or mining-related activities (e.g., ramps, primary haulroads, and support facilities) will have topdressing material replaced for the purpose of reclamation. Topdressing will be removed from stockpiles or direct hauled from salvage areas and redistributed on regraded areas. Traffic on replaced topdressing will be limited to reclamation equipment to minimize compaction of topdressing materials.

Areas of minimal surface disturbance (e.g., ancillary roads, power-line disturbances, drill sites) will not receive additional topdressing material. These features are typically constructed in the existing landscape without salvaging the topdressing material. The surface materials at these sites will be disked to create a suitable seedbed and seeded according to the methods and procedures described in Section 37 (Post-Reclamation Vegetation).

Occasionally, spoil fires may naturally ignite within the regraded spoil material. BNCC will not redistribute topdressing on areas of known active coal spoil fires. The measures BNCC will use to address coal spoil fires are presented in Section 20 (Mining Operations).

Prior to the placement of topdressing materials, heavily compacted regraded surfaces will be ripped or disked to alleviate compaction. Alternative implements, such as a V-ripper, may be used in lieu of ripping.

Compaction of final regraded surfaces is minor when dozers are used for final shaping activities. Compaction can be more prevalent when rubber-tired equipment, such as haul trucks and scrapers, repeatedly follow the same travel route. These heavy traffic areas will be deep ripped or disked to minimize compaction. With consideration to safety of operators and equipment, ripping and disking will be done on the contour whenever possible.

Applying topdressing at variable depths on regraded areas will help to promote the intent of the revegetation plan, presented in Section 37 (Post-Reclamation Vegetation), to "establish a diverse, stable, and self-sustaining vegetation community composed of native species capable of meeting the post-mining land use." Various studies (Bowen et.al. 2005; Buchanan et.al. 2005) and BNCC's experience have shown that variable topdressing depths promote plant diversity within the reclamation areas. Typical variances include applying deeper topdressing on level topographic areas to create a plant community typically dominated by grass species and applying shallower topdressing depths on slopes or lowland areas typically dominated by shrub species. BNCC will not design topdressing depth variances; rather, topdressing depth variances will occur opportunistically as a result of the replacement methods and equipment selection.

Topdressing will be replaced year-round with the equipment (i.e., scrapers or haul trucks) best suited for the conditions of the reclamation area. Compaction resulting from replacing topdressing material will be alleviated as discussed above and in Section 37 (Post-Reclamation Vegetation).

An average topdressing depth of 9.7 inches will be applied to all reclamation blocks in the permit area. The replaced topdressing depth will be approximated by load counts per reclamation block or survey staking. Variations in topdressing depth will be opportunistic and result from the equipment and process used for topdressing replacement. The average topdressing depth will be calculated over the entire reclamation block. BNCC will conduct topdressing depth verification surveys to ensure each area meets the average topdressing depth requirement. The methods used to verify the replaced topdressing depths include: physically sampling the topdressing depths, using surveyed elevation information, or using grade stakes.

When physical sampling of replaced topdressing depths occurs, it will be conducted at sample points arranged in a regular 330-feet grid. These topdressing verification sample points are coincidental with the root-zone subplot sampling points discussed in Section 36.4. Test holes are dug at each of the topdressing verification sample points and the depth of topdressing material is recorded for that location.

Survey elevation information may be used in lieu of physically digging samples, in which case the depth of topdressing replacement is calculated from the difference between the topdressing and regrade surface surveyed elevations. If grade stakes are used in an area to direct topdressing replacement, these may be used to verify replacement depth. Wooden lath will be placed throughout the regraded area with the appropriate replacement depth indicated on each side of the lath. The lath will be clearly marked and visible to the equipment operators. The lath shall remain in place until an OSM inspector has verified the topdressing depth.

If any of these methods determine the redistributed topdressing depth within the verification area does not meet the average topdressing depth of 9.7 inches, BNCC will spread additional topdressing material until the area meets the average topdressing depth requirement. The location of topdressing verification points and topdressing depths sampled between July 1 and June 30 will be submitted annually to OSM on or before August 31 in the annual soil resource report (Section 36.6).

BNCC will not operationally target placing topdressing material within the channel bottoms. However, topdressing material may migrate to the channel bottoms due to mechanical (e.g., equipment operations and placement activities) and natural means (e.g., wind and water movement of material).

<u>36.3.2.1 Temporary Distribution of Soil Materials</u>

BNCC will not temporarily distribute soil materials in the permit area. Therefore, this section is not applicable.

<u>36.3.2.2 Variance from Redistribution of Topsoil on Embankments</u>

An embankment is an artificial deposit of material that is raised above the surface of the land used to contain, divert, or store water, support roads or railways, or for similar purposes (30 CFR 701.5). OSM may grant applicants a variance, allowing them not to redistribute topsoil or topsoil substitute on post-reclamation embankments (30 CFR 816.22(d)(3)) provided the embankments will be stabilized and prevent sedimentation. BNCC is not requesting this variance since structures meeting the definition of embankments are not anticipated in the post-reclamation surface in the permit area.

The methods and practices BNCC will utilize to stabilize and prevent sedimentation in post-reclamation surfaces are presented in Section 38 (Post-Reclamation Surface Stabilization and Sediment Control). Sediment and drainage control associated with operational embankments are discussed in Section 25 (Sediment Control Plan) and Section 26 (Drainage Control Plan).

36.3.3 Topdressing Balance

The pre-mine topdressing material balance and summary of topdressing resources within the permit area is determined based on the soil survey information presented in Section 14 (Soil). BNCC will estimate the topdressing material balance from multiple sources of information including stockpile volumes, pre-salvage topdressing survey results, and baseline soil survey information. Topdressing stockpile volumes will be estimated by aerial flight, vehicle load counts, or survey data. The pre-salvage topdressing survey (Section

36.2) will estimate the volume of in-situ topdressing within the 1,800-feet pit disturbance limits. The volume of topdressing resources away from the active mining areas is calculated using the baseline soil survey information, presented in Section 14 (Soil). From the in-situ surveys and volume estimations, BNCC predicts a 10% loss of suitable topdressing material as a result of salvage, transportation, storage, and respread. Topdressing balance information will be submitted to OSM annually on or before August 31 as part of the annual soil resources report (Section 36.6).

36.4 Root-zone and Mitigation Sampling

The root-zone material for permit area is separated into two zones, the primary root zone (0-1 feet below the surface of the regraded spoil) and the secondary root zone (1-3.5 feet below the surface of the regraded spoil). The classification of these root-zone intervals is based upon the rooting depths and intervals of the greatest root concentrations of the revegetation species. Various studies have demonstrated that the greatest concentration of roots from the revegetation species will remain within the primary root zone rather than the secondary root zone. Sandia National Laboratories evaluated the rooting depth and root distribution of galleta (*Pleuraphis jamesii*), spike dropseed (*Sporobolus contractus*), and fourwing saltbush (*Atriplex canescens*) (Pearce et.al. 2004). These native species are either present in the baseline vegetation communities or included in the revegetation species mixes for the Pinabete Mine Plan. Sandia National Laboratories' (Pearce et.al. 2004) study concluded that galletta and spike dropseed have the greatest concentration of roots within the upper foot (30 cm) of the soil profile. Fourwing saltbush has a different root structure than grass species and is characterized by a well-developed pronounced taproot and lateral root system. Within the Sandia National Laboratories study, Pearce et.al. (2004) observed fourwing saltbush plants had the greatest concentration of roots within the upper 5.5 feet (170 cm) of the soil profile. Rooting depth studies on fourwing saltbush conducted at Navajo Mine observed similar results (Stutz and Buchanan 1987). Stutz and Buchanan observed that on native and reclaimed lands, fourwing saltbush had 92% and 68% of total root mass within upper 4.9 feet (150 cm), respectively. Within reclaimed lands of the study, fourwing saltbush had 35% and 54% of its root mass in the upper 10 in (25 cm) and 20 in (50 cm), respectively.

The procedures used to sample and determine root-zone suitability and mitigate unsuitable root-zone sites are described below.

36.4.1 Root-zone Sampling

Final regraded material will be sampled to determine suitability as root-zone material prior to placement of topdressing. Regraded root-zone material sampling takes place on a 330-feet regular square grid with the intersection of the northing and easting grid lines serving as the centroid of a 2.5-acre plot.

Each 2.5-acre plot is subdivided into four equal subplots (0.625-acre subplot area). A backhoe, or similar piece of equipment, excavates a 4-feet deep test pit at the center of each subplot (Figure 36.4-1). Samples of root-zone material are collected from both the 0-1-foot and 1-3.5-feet vertical intervals along a 3-feet horizontal cross-section of the test pit profile. Collecting the samples along a horizontal cross-section improves the representativeness of each sample. The collected sample is passed through a 1-inch sieve and sampling continues until approximately 2 liters of material are collected from each interval. This process is repeated at the remaining subplot test pits within the 2.5-acre plot. Once all subplots have been sampled, the eight individual samples (four 0-1-foot interval samples and four 1-3.5-feet interval samples) are split in the field using a corner-to-corner tarp sampling technique (U.S. Department of Agriculture 1996). An equal volume of sample (approximately 1 liter) is collected from each interval split and combined into a single composite sample representing the specific interval (i.e., 0-1 foot and 1-3.5 feet) for the respective plot. The remaining sample material from each subplot interval is retained and archived for a minimum of 6 months while laboratory analysis of plot composite samples is performed. If the results from laboratory analysis show a plot composite sample to be unsuitable, then the archived sample material is analyzed for root-zone suitability to further identify the extent of unsuitable material. The composite sampling procedure is presented in detail in Figure 36.4-2.

Only disturbed and regraded root-zone materials are sampled using the above procedure. When native materials are encountered (i.e., the area has not been mined), the following field observations will be collected:

1. Depth and thickness of interval,
2. Identification of lithological constituents,
3. Munsell color and if incompetent/unconsolidated,
4. Texture-by-feel analysis will be recorded to define each soil horizon of native material and a photograph will be taken of the test pit wall clearly showing the in-place native materials will be taken. To substantiate the existence of native materials, field observations and photographs will be included in the annual soil resource report submitted to OSM (Section 36.6).

36.4.2 Root-zone Suitability

Root-zone suitability will be determined using the methods of analysis and parameters listed in Table 36.2-1 and Table 36.4-1, respectively. When unsuitable material is identified from the plot composite samples, the archived subplot samples will be analyzed to further indentify the extent of the unsuitable material. Results of the root-zone suitability analysis will be submitted to OSM in the annual soil resource report described in Section 36.6.

36.4.3 Mitigation

The permit area will not contain widespread occurrences of unsuitable or PATFM based on the overburden characterization conducted in Section 17 (Geologic Information) and an analysis of spoil and root-zone samples collected at Navajo Mine. The overburden characterization for the permit area indicated the occurrences of unsuitable strata within the geologic column are largely isolated to thin interburden layers between the coal seams. However, when the geologic column is analyzed as a composite of all the overburden and interburden layers, these occurrences are attenuated and chemical and physical analytes are within the suitability criteria limits. This is demonstrated by the suitability of the majority of spoil and root-zone samples collected at Navajo Mine. BNCC analyzed over 13,000 spoil and root-zone samples between August 1990 and December 2011 to characterize the central tendency and variability of the chemical and physical analytes of the spoil and root-zone material at Navajo Mine (Table 36.4-2). This analysis of the Navajo Mine spoil and root-zone samples indicates there are no widespread occurrences of unsuitable materials present at Navajo Mine. This characterization is applicable for the permit area, as both the permit area and Navajo Mine permit area are in the same geologic region, the same coal seams will be mined, and the same overburden and interburden layers will be spoiled. In addition to the permit area overburden characterization and the analysis of Navajo Mine's spoil and root-zone samples, the overburden analysis in Section 17 (Geologic Information) demonstrates sufficient suitable overburden above the first coal seam to be mined to establish a suitable root zone throughout the permit area.

Subplots with samples exceeding the suitability criteria, as determined in previous sections, will be mitigated by either removing the upper 12 inches of material and replacing it with 12 inches of suitable root-zone material or burial with 12 inches of suitable root-zone material and covering with a minimum topdressing thickness of 12 inches. BNCC will monitor the secondary root zone (1-3.5 foot); however, the benefits of using the geomorphic reclamation approach would be negated by altering the final surface elevations with additional root-zone material. Traditional reclamation mitigated exceedances of suitability criteria in the secondary root-zone by burial with up to 4 foot of root-zone material. This can create an erosionally unstable raised "island" on the reclamation area surface. The additional root-zone material will alter the hillslope configuration and impact the designed channels and drainages densities. Based on expected limited occurrences of PATFM, the benefits of geomorphic reclamation far outweigh the potential benefits of additional mitigation material.

Suitable mitigation material will be obtained from various sources, including in-situ overburden ahead of the mining pits, regolith, or nearby ungraded spoil. All material used for mitigation will meet the suitability criteria listed in Table 36.4-1. The results of the mitigation sampling will be provided to OSM in the annual soil resource report as described in Section 36.6.

36.5 Prime Farmland Soils Handling Plan

There are no prime farmlands identified within the permit area; therefore, this section is not applicable. The prime farmland determination is described in Section 14 (Soil).

36.6 Annual Soil Resource Reporting

BNCC will submit post-mining soil resource information, when available, annually to OSM. This information will be included in the annual soil resource report submitted on or before August 31. Post-mining soil resource information presented in this report will be from the period July 1 through June 30. Typical information to be provided in this report includes:

1. Topdressing resource information

   - Pre-salvage sampling results (sample sites, depths, laboratory analyses, and maps of survey area at 1:6000 scale [1 in = 500 feet]),

   - Topdressing replacement results (sample sites, depths, and maps of survey area at 1:6000 scale), and

   - Topdressing balance (estimated volume of soil stockpiles and in-situ resources [pre-salvage topdressing sampling and baseline soil survey]).

2. Root-zone sampling information

   - Northing and easting of each 330-feet plot sampling site,

   - Laboratory analyses from each grid location sampled during the reporting period,

   - Recorded field observations and photographs of native materials encountered during sampling, and

   - Maps of the regraded area and sampling sites presented at 1:6000 scale.

3. Root-zone mitigation results

   - Plot locations requiring root-zone mitigation (locations and maps of mitigated sites presented at 1:6000),

   - Laboratory analyses of mitigation material.

36.7 Post-Reclamation Soil Information Collection and Analysis

BNCC relied on existing site specific data from Navajo Mine and Pinabete Mine Plan permit area information to complete this section. Soil and geology baseline information discussed in this section are presented in Section 14 (Soil) and 17 (Geologic Information), respectively.

Personnel

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

Kent Applegate

Matt Owens

BHP Navajo Coal Company

References

BHP Navajo Coal Company (BNCC). 2009. Navajo Mine Permit Application Package. OSM Permit No. NM-0003F. On file at Office of Surface Mining Reclamation and Enforcement- Western Region Technical Office. Denver, Colorado.

Bowen, C.K., G. Schuman, and R.A. Olson. 2005. Long-Term Plant Community Development in Response to Topsoil Replacement Depth on Mined Land in Wyoming. Proceeding of the 22nd meeting of the American Society of Mining and Reclamation: 108-114. Lexington, Kentucky.

Brady N.C., and R.R. Weil. 1996. The Nature and Properties of Soils. 11th Edition. Prentice-Hall, Inc., Upper Saddle River, New Jersey.

Buchanan A. B., M. Owens, J. Mexal, T. Ramsey, and B. Musslewhite. 2005. Long-Term Effects of Cover Soil Depth on Plant Community Development for Reclaimed Mined Lands in New Mexico. Proceeding of the 22nd meeting of the American Society of Mining and Reclamation: 115-126. Lexington, Kentucky.

Keetch, C. Wesley et.al. 1980. Soil Survey of San Juan County, New Mexico, Eastern Part. U.S. Department of Agriculture, Soil Conservation Service, Washington, D.C.

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 Characterization and Monitoring Programs for Federal Lands in the Southwestern United States. Office of Surface Mining Reclamation and Enforcement, Western Region, Denver, Colorado.

Peace, Jerry L., Paul J. Knight, Thomas S. Ashton, and Timothy J. Goering. 2004. Vegetation Study in Support of the Design and Optimization of Vegetative Soil Covers, Sandia National Laboratories, Albuquerque, New Mexico. SAND Report No. 2004-6144. Sandia National Laboratories. Albuquerque, New Mexico

Renard, K.G., G.R. Foster, G.A. Weesies, D.K. McCool, D.C. and Yoder (coordinators). 1996. Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Soil Loss Equation (RUSLE). Agriculture Handbook No. 703. U.S. Dept. of Agriculture, Washington, D.C.

Stutz, Howard C., and B.A. Buchanan. 1987. Rooting-depth Studies of *Atriplex Canescens* at the Navajo Mine, Northwestern New Mexico. Internal report prepared for BHP Navajo Coal Company (formerly Utah International, Inc.).

United States Department of Agriculture. 1996. Soil Survey Laboratory Methods Manual. Soil Survey Investigation Report # 42 Ver. 3.0. http://soils.usda.gov/technical/lmm/ (Verified March 29, 2012).

Wischmeier, W. H., and D.D. Smith. 1978. Predicting Rainfall-Erosion Losses - A Guide to Conservation Planning. Agriculture Handbook No. 537. U.S. Dept. of Agriculture, Washington, D.C..

Table 36.2-1 Analysis Methods for Topdressing and Root-zone Samples for the Pinabete Permit Area

Analysis	Method
pH	Page, A.L., Miller, R.H. and Keeney, D.R., eds. Methods of Soil Analysis, Part 2 - Chemical and Microbiological Properties. ASA Monograph No. 9, 2nd edition. Madison, Wisconsin: American Society of Agronomy; 1982. Methods 9-3.1.2, pp. 160-161.
Electrical conductivity (EC)	Page, A.L., Miller, R.H. and Keeney, D.R., eds. Methods of Soil Analysis, Part 2 - Chemical and Microbiological Properties. ASA Monograph No. 9, 2nd edition. Madison, Wisconsin: American Society of Agronomy; 1982. Methods 9-3.1.2, pp. 160-161. Method 10-2.3.1,; pp 169. Method 10.3.3; pp 172. Richards, L.A., ed. Diagnosis and Improvement of Saline and Alkali Soils. USDA Handbook No. 60. Washington, D.C.: USDA; 1954. Method (4a), pp. 89.
Soluble calcium (Ca), magnesium (Mg), and sodium (Na)	Extraction: USDA Handbook 60, Method 3a-Saturation Extract, pp. 84. Analysis: Inductively Coupled Argon Plasma Atomic Emission Spectrometer (ICP).
Sodium adsorption ratio (SAR)	Extraction: USDA Handbook 60, Method 3a-Saturation Extract, pp. 84. Analysis: Inductively Coupled Argon Plasma Atomic Emission Spectrometer (ICP). Equation: USDA Handbook 60, Method 20b - Estimation of Exchangeable Sodium - Percentage and Exchangeable - Potassium - Percentage from Soluble Cations, pp. 102.
Texture	EPA 300/2-78-054. Field and Laboratories Methods Applicable to Overburden and Mine Soils. Method 3.4.3.5, pg 122. Black, C.A., Evans, D.D., White, J.L., Ensminger, L.E., and Clark, F.E. ASA Monograph No. 9; Methods of Soil Analysis, Part One. Method 43-5, p. 562. ASTM D422-68.
Saturation percent	Richards, L.A., ed. Diagnosis and Improvement of Saline and Alkali Soils. USDA Handbook No. 60, Washington, D.C.: USDA; 1954. Method 27a, pp. 107. Miller, R.H. and Keeny, D.R., eds. Methods of Soil Analysis: Part 2 - Chemical and Microbiological Properties. ASA Monograph No. 9, 2nd edition. Madison, Wisconsin: American Society of Agronomy; 1982: Method G10.2.3 pp. 169.

Analysis	Method
Boron	Page, A.L., Miller, R.H., and Keeney, D.R., eds. Methods of Soil Analysis: Part 2 - Chemical and Microbiological Properties. ASA Monograph No. 9. 2nd Edition. Madison, Wisconsin: American Society of Agronomy; 1982. Method 25-9.1, pp. 443-444.
Soluble selenium	Page, A.L., Miller, R.H., and Keeney, D.R., eds. Methods of Soil Analysis: Part 2 - Chemical and Microbiological Properties. ASA Monograph No. 9. 2nd Edition. Madison, Wisconsin: American Society of Agronomy; 1982. Method 25-9.1, pp. 443-444.
Total selenium, bajo, sixto	Analytical Chemistry, Vol. 50(4), 649-651-1978, Modified.
$CaCO_3$ percent	USDA. Handbook 60, 1954, Method 23c, pp. 105.
Neutralization potential	USDA. Handbook 60, 1954, pp. 105, Methodology 23c. EPA 600/2-78-054. Field and laboratory methods applicable to overburden and mine soils method 3.2.3., pp. 47-50.
Total sulfur	Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 3.2.6., 1978.
Total sulfur - acid-base	Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 3.2.6 and 1.3.1., 1978.
Sulfate sulfur percent	ASTM D 2492-84 with modification. Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 3.2.6., 1978. Mine Spoil Potentials for Soils and Water Quality. EPA 670/2-74-070. Pg. 49.
Pyritic sulfur percent	ASTM D 2492-84 with modification. Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 3.2.6., 1978. Mine Spoil Potentials for Soils and Water Quality. EPA 670/2-74-070. Pg. 49.
Organic sulfur percent	ASTM D 2492-84 with modification. Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 3.2.6., 1978. Mine Spoil Potentials for Soils and Water Quality. EPA 670/2-74-070. Pg. 49.
Pyritic sulfur acid-base	Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 1.3.1., 1978.
Pyritic sulfur - acid-base potential	Field and Laboratory Methods Applicable to Overburdens and Mine soils. EPA 600/2-78-054, Method 1.3.1., 1978.

Table 36.2-2 Topdressing Suitability Criteria for the Pinabete Permit Area[1, 2]

	Good	Marginal	Unsuitable
pH	6.0-8.4	5.5-6.0	< 5.5
		8.4-8.8	> 8.8
Electrical Conductivity (EC) (mmhos/cm)	< 4.0	4.0-12.0	> 12.0
Sodium Adsorption Ratio (SAR)[3]			
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	< 35% clay	< 45% clay	> 45% clay
Saturation percent	20-80	20-80	< 20 - > 80
Selenium			
Hot-water soluble		0.15 ppm	> 0.15 ppm

1. 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.
2. When spoil/overburden materials are used as topdressing, then these materials must also be analyzed for total selenium and acid-base potential (ABP). Analysis of these constituents is in addition to the parameters listed in this table. Materials that exceed 0.80 mg/kg total selenium or have pyritic sulfur ABP < -5t/Kt are unsuitable for use as topdressing.
3. SAR values can be modified if adequate data are submitted to support proposed modifications.

l - loam, cl - clay loam, and sl - silt loam.

Table 36.2-3 Soil Texture Class Erodibility Factors (K-Factor) for the Pinabete Permit Area

Soil Texture Class[1]	K-factor[2]
Fine[3]	0.20
Fine loamy[3]	0.27
Coarse loamy[3]	0.10
Sandy[3]	0.27
OSM recommended erodibility factor guideline[4]	< 0.37

[1] All baseline soil types present at Pinabete permit area are assigned to one of the four listed soil texture classes.

[2] Calculated per the algebraic approximation of the Wischmeier nomograph described by Renard et.al. (1996) and Wischmeier and Smith (1978).

[3] Reported values are mean values, calculations performed as part of the baseline SEDCAD[tm] modeling of baseline flood flows and sediment yields reported in Section 18 Water Resources.

[4] Erodibility factor suitability guideline proposed by the Office of Surface Mining Reclamation and Enforcement (OSM 1999)

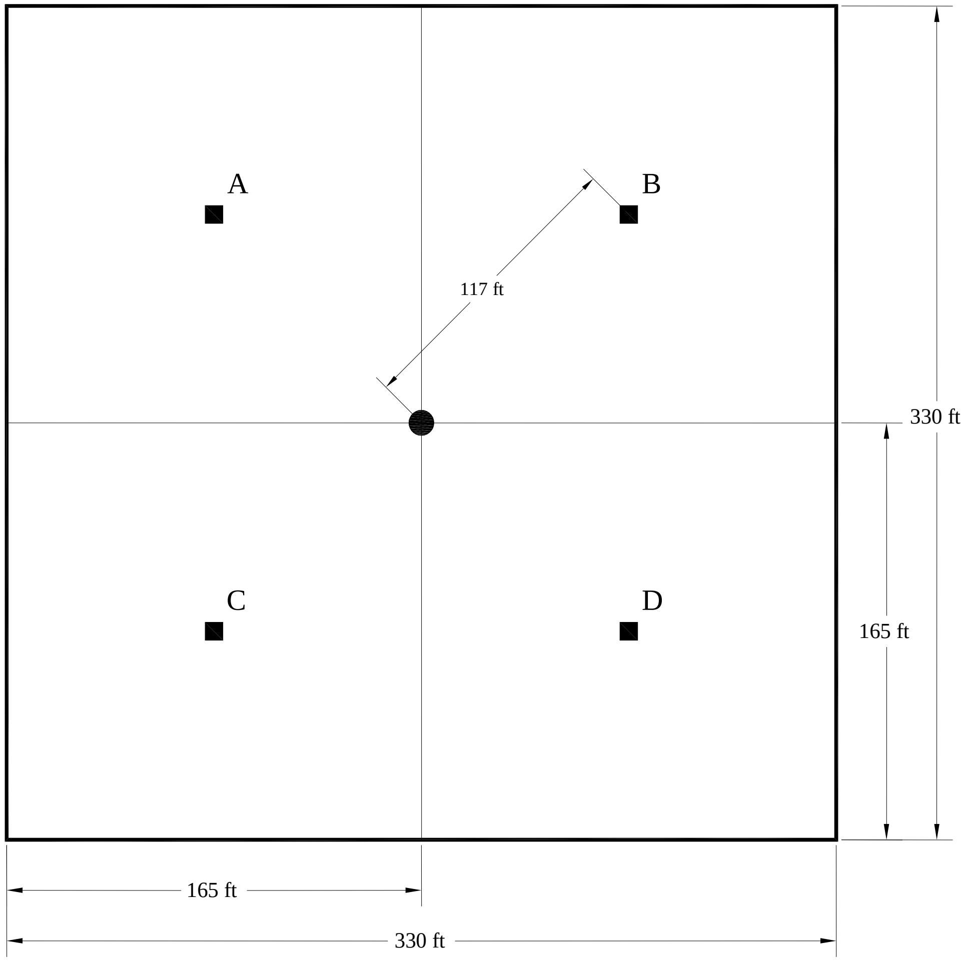
Table 36.4-1 Root-Zone Suitability Criteria for the Pinabete Permit Area

Characteristic[1]	Suitability limits
pH	> 5 and < 9
Electrical conductivity (EC)	< 16 mmhos/cm
Saturation percent	< 85% or < 100% only if EC > 4 mmhos/cm
Sodium Adsorption Ratio (SAR)	< 18 or < 40 only if EC > 4 mmhos/cm
Texture	< 50% Clay
Acid base account	> -5t $CaCo_3$/1000t
Selenium (total)	< 2.5 ppm
Selenium (soluble)	< 0.26 ppm

[1] Criteria to be applied to each separate sample interval.

Table 36.4-2 BNCC Navajo Mine Spoil Quality 1990-2011

Analyte	No. of Samples	Mean	95% confidence interval	Median	1st quartile	3rd quartile
pH (s.u.)	13080	7.20	7.22 to 7.19	7.30	7.00	7.70
Conductitvity (mS/cm)	13080	9.66	9.81 to 9.51	9.00	6.85	10.70
Saturation (%)	13080	65.53	65.89 to 65.16	63.50	52.40	75.90
Calcium (meq/L)	13080	18.15	18.28 to 18.02	19.85	15.00	23.00
Magnesium (meq/L)	13080	11.15	11.51 to 10.79	7.50	4.91	12.00
Sodium (meq/L)	13080	85.06	85.82 to 84.30	87.80	58.58	110.00
SAR	13080	24.70	24.89 to 24.51	25.55	18.50	31.00
Sand (%)	13080	35.26	35.52 to 35.01	32.00	25.00	41.00
Silt (%)	13080	31.57	31.72 to 31.42	32.50	27.00	37.00
Clay (%)	13080	29.72	29.94 to 29.51	33.00	26.00	28.00
Acid-base potential total sulfur (t/kt)	344	16.37	17.23 to 15.50	17.00	13.00	21.00
Boron (ppm)	12924	0.74	0.76 to 0.73	0.68	0.30	1.00
Total selenium (ppm)	13078	0.56	0.56 to 56.00	0.55	0.40	0.70
Soluble selenium (ppm)	13051	0.06	0.06 to 0.06	0.05	0.02	0.08



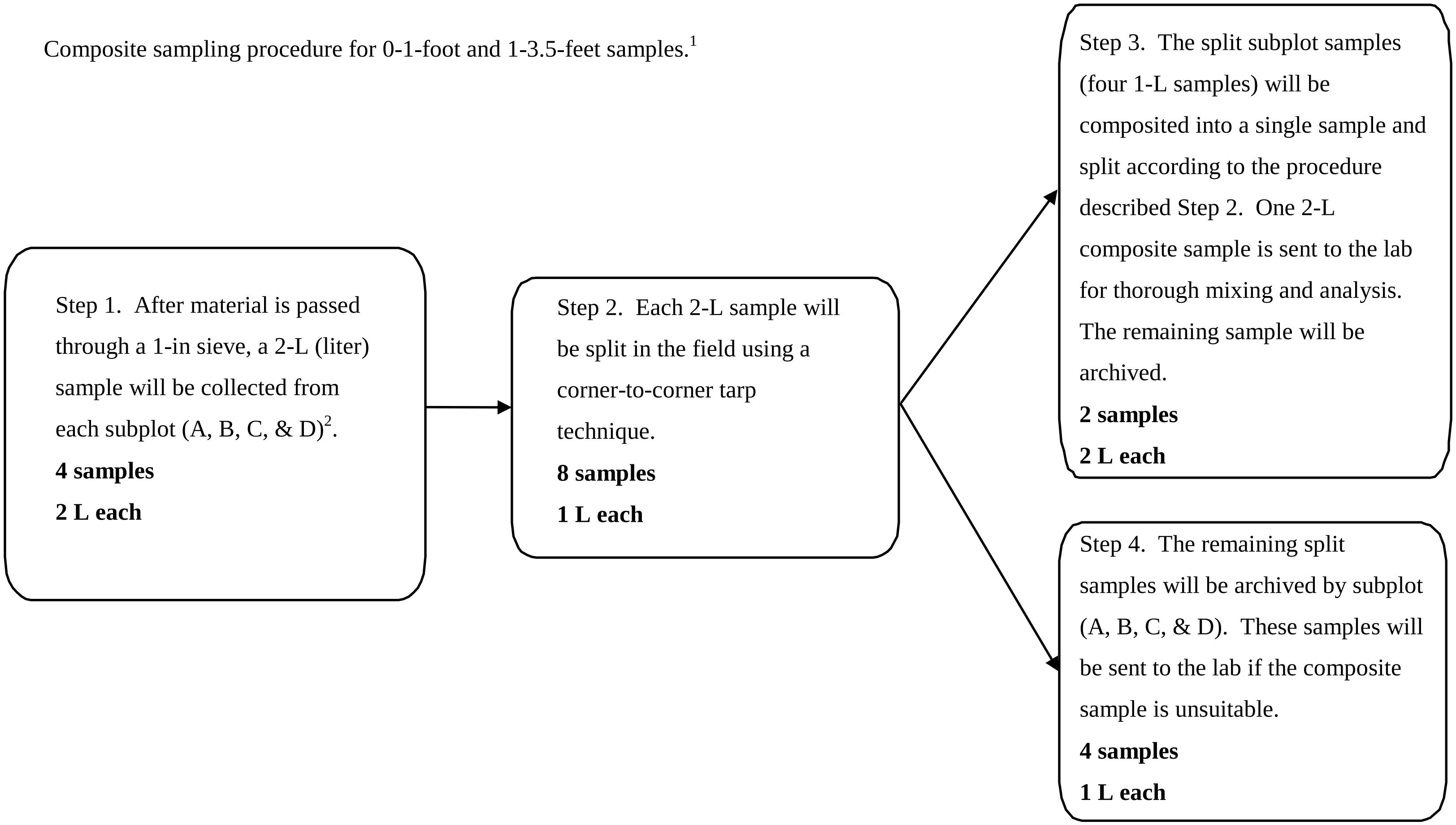
330-ft root-zone sample grid point

C Composite sample points (0.625-ac areas)

Total root-zone sampling grid area 2.5 ac

Figure 36.4-1 Root-zone Sampling Layout

Composite sampling procedure for 0-1-foot and 1-3.5-feet samples.[1]



[1] Flow chart describes the sampling procedure for one sampling interval (i.e., 0-1 foot or 1-3.5 feet)

[2] The 1-3.5-feet composite sample is collected in an even distribution from the sidewall of the test pit.

Figure 36.4-2 Composite Sampling Procedures