SECTION 13

TOPOGRAPHY

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SECTION 13

TOPOGRAPHY

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SECTION 13

TOPOGRAPHY

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EXHIBIT NUMBER	EXHIBIT TITLE
13.1-1	Premining Topography (Sheet 1 of 2)
13.1-1	Premining Topography (Sheet 2 of 2)
13.1-2	Premining Slope Classes

SECTION 13

TOPOGRAPHY

LIST OF REVISIONS DURING PERMIT TERM

REV. NUMBER	REVISION DESCRIPTION	DATE APPROVED

SECTION 13 TOPOGRAPHY

13.1 Premining Topography

The topography of the Pinabete Mine Plan permit area (permit area) is defined by generally rolling terrain with areas of steep escarpments, badlands, sand dunes, and incised drainages and arroyos. The elevation within the permit area ranges between 5,300 and 5,600 feet. The area is bordered to the west by escarpments that are part of the ancient channel walls of the Chaco River. Along the western edge of the permit area, some terrain drains into the Chaco River. There are two major arroyos that traverse the permit area and adjacent areas, Pinabete Arroyo and Cottonwood Arroyo. The pre-mine watersheds that intersect the permit area are presented in Section 18 (Water Resources). The permit area is divided into two operational areas, Areas 4 North and Area 4 South.

Area 4 North is generally defined to the north by the Cottonwood Arroyo and the southern Navajo Mine permit boundary line to the south. Cottonwood Arroyo enters the BHP Navajo Coal Company mining lease boundary from the east as north, middle and south forks which confluence to a main Cottonwood channel near the center of the northern permit area boundary. The western edge of Area 4 North generally follows a bluff which rises 90 to 120 feet above the surrounding terrain which drains to the Chaco River, while the southern portion drains to Pinabete Arroyo.

Area 4 South is generally defined to the north by the Area 4 North resource area boundary line and to the south by No Name Arroyo. The western edge of Area 4 South is generally defined by two bluffs west of the permit boundary, which reach a height of approximately 80 feet above the surrounding terrain. Area 4 South is divided into western and eastern portions by the Pinabete Arroyo. This arroyo has headwaters of about 51.8 square miles off lease to the east. It enters Area 4 South at the southeast corner and exits at the northwest corner. The majority of terrain within Area 4 South drains to Pinabete Arroyo. Some of the terrain along the eastern edge drains east into a tributary of Cottonwood Arroyo.

Maps of the premining topography within and adjacent to the permit boundary are included as Exhibit 13.1-1. A summary of premining slopes is provided in Table 13.1-1. Nearly 58% of Area 4 North and 56% of Area 4 South are within the 0-3% slope class. The premining slope classes, identified in Table 13.1-1, for Area 4 North and Area 4 South presented on Exhibit 13.1-2.

13.2 Premining Topography Information Collection and Analysis

Topographic data were collected through an aerial flight conducted in March 2008. The data were used to develop a digital terrain model (DTM) of the surface. From the DTM, contours were generated at 10-feet intervals.

The slope analysis was performed using the 3D Analyst and Spatial Analyst extensions for ArcGIS. A triangular irregular network (TIN) surface was created using the DTM information developed by Aero-Graphics, Inc. TINs are a commonly accepted method to present three-dimensional surfaces using vector and planar digital geographic data. A TIN surface is constructed by triangulating a set of vertices, or points, within an area. These connected vertices form a network of contiguous, nonoverlapping triangular facets, which can be used to represent elevation, aspect, and slope.

The TIN surface was then converted to a percent slope raster dataset using tools in ArcGIS. A raster dataset is a tool used to divide an analysis area into a discrete grid with a known spacing or cell size. Individual characteristics (e.g., slope, elevation, etc.) can then be assigned to the raster cells. The computer software converts a TIN surface to a raster dataset by converting the three-dimensional TIN surface to a two-dimensional surface and overlaying the user specified raster cell spacing to the now flat surface. The software then analyzes and assigns numerical values based on the TIN surface to centers of the raster cells. This conversion creates a raster dataset with interpreted values (i.e., slope values) at known spacing over the entire analysis area.

The raster dataset was converted into a point shapefile, with each point representing the center of the raster cell and interpreted slope value. Therefore each point in the shapefile represented the slope value for a known area. By classifying the points in 3% slope increments, an approximate area of each of slope class could be determined. The slope class areas were than normalized to the permit area, and the total area of each slope class and percentage of the permit area areas were calculated.

Personnel

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

Ron Van Valkenburg	Aero-Graphics, Inc.
Kent Applegate	Salt Lake City, UT
Ray Yazzie	
Matt Owens	
BHP Navajo Coal Company	

Table 13.1-1 Premining Topography Slope Analysis for Area 4 North, Area 4 South, and Pinabete Permit Area

Slope Class	Area 4 North Resource Area		Area 4 South Resource Area		Pinabete Permit Area	
	Acres	Percent (%)[1]	Acres	Percent (%)[1]	Acres	Percent (%)[1]
0 – 3%	~~2344.3~~2,092.0	~~57.4~~51.2	~~767.3~~723.2	~~51.7~~48.8	~~3,111.6~~2,815.3	~~55.9~~50.6
>3 – 6%	~~1182.6~~1,293.7	~~29.0~~31.6	~~425.0~~425.9	~~28.6~~28.8	~~1,607.6~~1,719.7	~~28.9~~30.9
>6 – 9%	~~337.3~~430.3	~~8.3~~10.5	~~169.9~~179.0	~~11.4~~12.1	~~507.2~~609.2	~~9.1~~10.9
>9 – 12%	~~130.4~~149.9	~~3.2~~3.7	~~65.0~~85.0	~~4.4~~5.7	~~195.4~~234.8	~~3.5~~4.2
>12 – 15%	~~61.5~~74.4	~~1.5~~1.8	~~36.0~~38.1	~~2.4~~2.6	~~97.6~~112.5	~~1.8~~2.0
>15 – 18%	~~18.6~~34.4	~~0.5~~0.8	~~11.5~~16.9	~~0.8~~1.1	~~30.1~~51.3	~~0.5~~0.9
>18 – 21%	~~6.2~~7.3	0.2	~~6.2~~7.2	~~0.4~~0.5	~~12.4~~14.5	~~0.2~~0.3
>21%	~~3.2~~6.0	0.1	~~3.7~~5.3	~~0.2~~0.4	~~6.9~~11.3	~~0.1~~0.2
Total[1]	~~4,084.1~~4,088.1	~~100.2~~99.9	~~1,484.5~~1,480.5	~~99.9~~100.0	~~5,568.8~~[2] 5,568.6	100.0

[1] Total percent may not equal 100 percent due to rounding

~~[2] Total permit area does not equal 5,568.6 acres due to rounding~~

AREA IV NORTH

Cottonwood Arroyo

Pinabete Arroyo

T-27-N

T-26-N

R-16-W

R-15-W

MATCH-LINE
EXHIBIT 13.1-1 SHEET 2

LEGEND

- PAVED ROAD
- DIRT ROAD
- HAUL ROAD
- TRAIL
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- 5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- INTERMEDIATE CONTOUR
- 218 5422.45 HORIZ. & VERT. CONTROL
- L-30 LEASE CORNER
- LEASE BOUNDARY
- POST-2016 PERMIT BOUNDARY
- MONITORING SITES

500' 0' 500' 1000'

CONTOUR INTERVAL: 10'

Topo Revised by

Aero-Graphics, Inc.

2930 South West Temple
Salt Lake City, Utah 84115

Notes:
1.Basis of Bearing; Static GPS observation using Trimble GPS by Daggett Enterprises Inc, Farmington New Mexico

2. All coordinates are based on New Mexico Coordinate System, West Zone 3003, NAD 83, NAVD-88, GEOD 03.

3. Date of Photography 03-06-08.
Aerial Mapping performed by;
Aero Graphy Inc..
40 West Oakland Avenue
Salt Lake City, Utah, 84115

4. This is not a boundary survey. Apparent property corners and property lines are shown for information only. No boundary monuments are set.

Original certified signed exhibits are maintained at the mine site and at OSM.

REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	PREP BY	S.S.	P.E.	DATE APPROVED
11A	JULY 2011	RY	PREPARED FOR SUBMITTAL TO OSM	RY	MO	ROY	

CERTIFICATION STATEMENT

I, Wilson Begay, New Mexico Professional Surveyor, hereby certify that this Topography Map prepared from an acrual ground survey control performed by me or under my supervision, that this survey is true and correct to the best of my knowledge and belief, that this topographic map, the field survey and aerial photography upon which it is based meets the Minimum Standard for the Surveying in New Mexico, and that this survey is not a land division or subdivision as defined in the New Mexico subdivision act.

EXHIBIT 13.1-1

BHP NAVAJO COAL COMPANY

bhpbilliton

P.O. BOX 1717
FRUITLAND, NEW MEXICO 87416

PHONE (505) 598-4200
Fax (505) 598-4229

PRE-MINING TOPOGRAPHY

(T 26 N, R 15 W, T 26 N, R 16 W
N.M.P.M., SAN JUAN COUNTY, NEW MEXICO)

PREPARED BY	RY	DRAWN BY	PJF	SCALE:	1" =500'
APPROVED BY	W. Begay	DATE	Nov 2011	Sheet 1 of 2	

AREA IV SOUTH

AREA V

MATCH-LINE
EXHIBIT 13.1-1 SHEET 1

Pinabete Arroyo

Pinabete Arroyo

No Name Arroyo

T-26-N
T-25-N

22 23 24 27 26 25 34 35 36 3 2 1

E 295,000 E 300,000 E 305,000

N 1,990,000 N 1,985,000 N 1,980,000 N 1,975,000

LEGEND

- PAVED ROAD
- DIRT ROAD
- HAUL ROAD
- TRAIL
- BUILDING
- FENCE
- IRRIGATION LINE
- CULVERT
- DAM
- DRAINAGE
- RAILROAD
- TREES
- POWERLINE
- × 5338.5 SPOT ELEVATION
- 5300 INDEX CONTOUR
- INTERMEDIATE CONTOUR
- 218 5422.45 HORIZ. & VERT. CONTROL
- L-90 LEASE CORNER
- LEASE BOUNDARY
- POST-2016 PERMIT BOUNDARY
- MONITORING SITES

500' 0' 500' 1000'
CONTOUR INTERVAL: 10'

Topo Revised by
Aero-Graphics, Inc.
2930 South West Temple
Salt Lake City, Utah 84115

Notes:
1.Basis of Bearing: Static GPS observation using Trimble GPS by Daggett Enterprises Inc. Farmington New Mexico
2. All coordinates are based on New Mexico Coordinate System, West Zone 3003, NAD 83, NAVD-88, GEOD 03.
3. Date of Photography 03-08-08.
Aerial Mapping performed by:
Aero-Graphics, Inc.
40 West Oquirrh Avenue
Salt Lake City, Utah, 84115
4. This is not a boundary survey. Apparent property corners and property lines are shown for information only. No boundary monuments are set.

Original certified signed wet/ink are maintained at the mine site and at CEAL.

REV. No.	DATE	BY	PROJECT MGR.	REVISION DESCRIPTION	BY	MD	NOV
1-A	2017	RY	RY	PREPARED FOR SUBMITTAL TO OSM	PREP BY	ENG. APPROVAL	P.E. DATE STAMPED

CERTIFICATION STATEMENT

I, Wilson Begay, New Mexico Professional Surveyor, hereby certify that this Topography Map prepared from an actual ground survey control performed by me or under my supervision, that this survey is true and correct to the best of my knowledge and belief, and that the ground control for field survey and aerial photography upon which it is based meets the Minimum Standard for the Surveying in New Mexico, and that this survey is not a land division or subdivision as defined in the New Mexico subdivision act.

EXHIBIT 13.1-1

BHP NAVAJO COAL COMPANY

bhpbilliton

P.O. BOX 1717
FRUITLAND, NEW MEXICO 87419
PHONE (505) 598-4200
Fax: (505) 598-4239

PRE-MINING TOPOGRAPHY

(T 26 N, R 15 W, T 26 N, R 16 W
N.M.P.M., SAN JUAN COUNTY, NEW MEXICO)

PREPARED BY	RY	DRAWN BY	PJF	SCALE:	1"=500'
APPROVED BY		DATE	Nov 2011	Sheet	2 of 2

287500 290000 292500 295000 297500 300000 302500 305000 307500 310000 312500

2007500 2005000 2002500 2000000 1997500 1995000 1992500 1990000 1987500

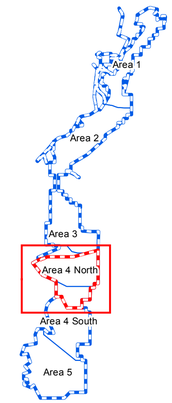
Legend

SMCRA Permit Area

Mining Lease and ROWs

Premining Slopes

- <3%
- 3-6%
- 6-9%
- 9-12%
- 12-15%
- 15-18%
- 18-21%
- >21%



Coordinate System:
NAD 1927 State Plane New Mexico West FIPS 3003
Projection: Transverse Mercator
Datum: North American 1927
Units: Foot US

N

0 875 1,750 3,500 Feet

1:12,000

REV. No.	DATE	DRAFT BY	REVISION DESCRIPTION	ENG.	EGO.	PE.
				APPROVALS		
14-A	2/6/2014	MPO	Revised Premine Topography Slope Raster		CKA	
13-A	4/3/12	MPO	Revised Legend Items & Location Map		CKA	
12-A	2/29/2012	MPO	Prepared for Submittal to OSM		CKA	

Exhibit 13.1-2

bhpbilliton
resourcing the future

BHP NAVAJO COAL COMPANY

Premining Slope Classes

PREPARED BY: MPO	DRAWN BY: MPO	PAPER SIZE: ARCH D
APPROVED BY: CKA	DATE: 1/28/2012	