
San Juan Power Plant
Shiprock
THE HOGBACK
San Juan River
Morgan Lake
Four Corners Power Plant
Navajo Nation
Chaco River

Appendix D

APPENDIX D

Navajo Mine Extension Project Background Information and Preliminary Mine Plans

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NAVAJO MINE EXTENSION PROJECT: BACKGROUND INFORMATION AND PRELIMINARY MINE PLANS

Navajo Mine Extension Project – Project Area Physical Description

The Navajo Mine Extension Project is located in San Juan County, northwestern New Mexico, adjacent to the existing Navajo Mine operations and within the existing BHP Navajo Coal Company Lease Area. The existing operations supply an average of 8.5 million tons per year of coal to the Four Corners Power Plant (FCPP), under a long-term contract. Navajo Mine has been operating on this deposit since the early 1960’s.

The Extension Project consists of the development of a second mine operation on the southern portion of the existing lease to supply coal to the proposed Desert Rock power plant. If constructed, the power plant will consume about 6.25 million tons of coal per year, over a period of 50 years.

Seismicity – The area around the project is seismically inactive, and is classified by the United States Geological Survey as a very low hazard region. The project is located in an area with potential for an earthquake causing peak accelerations equivalent to only 6% to 8% of gravity. This is lower than the accelerations caused by a typical blast during the overburden stripping process.

The terrain in the project area is typical of high, arid semi-desert regions. The project area lies within the Semi-Desert Province of the Colorado Plateau.

Surface Characteristics – The province consists of tablelands with moderate to considerable relief. Elevations range from 5,000 to 7,000 ft (1,500 m to 2,100 m), with local relief ranging from 500 to more than 3,000 ft (150 m to 900 m) in some of the deeper canyons that dissect the plateaus. In some areas, volcanic mountains and volcanic remnants rise 1,000 to 3,000 ft (300 to 900 m) above the plateau surface. Stream valleys are narrow and widely spaced; most drain watersheds of relatively small area.

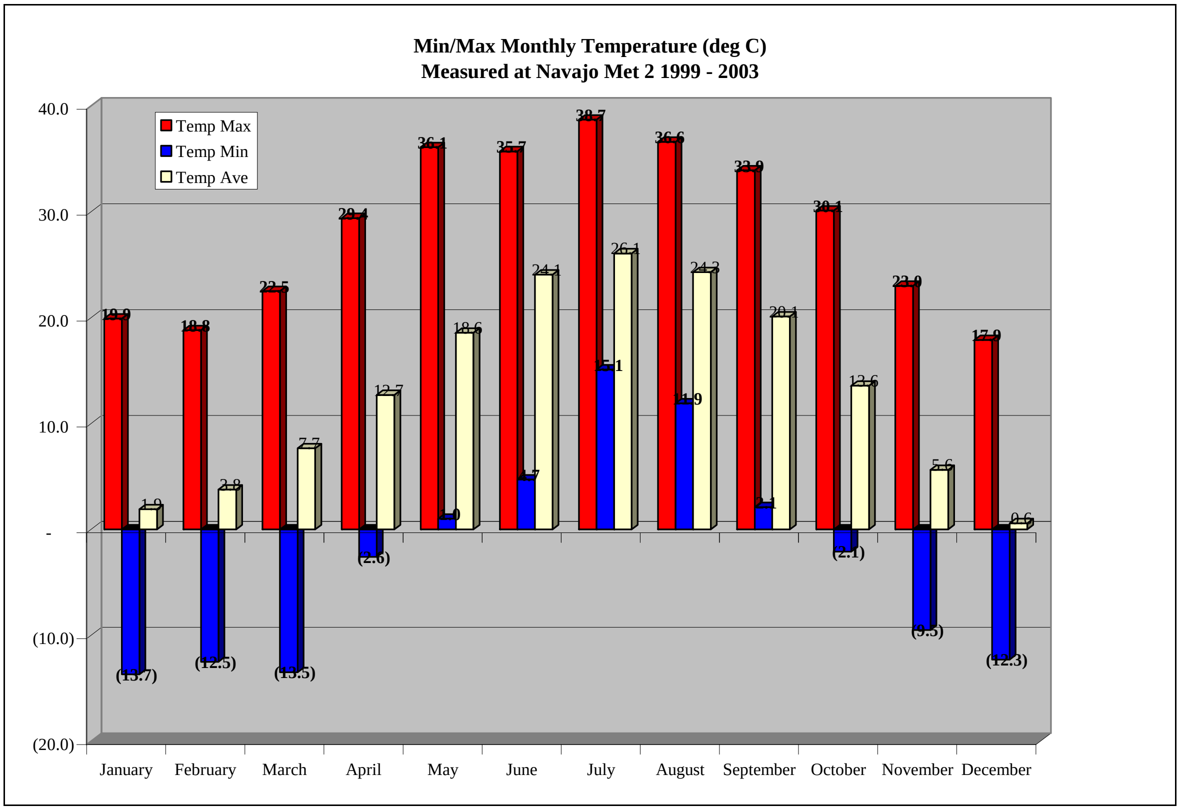
The San Juan River is the only perennial stream near the project area; it flows east to west some 18 miles (30 km) north of the project area. Other streams near the project area flow infrequently and the volume of water fluctuates considerably, usually in response to direct precipitation. The Chaco Wash flows north to the San Juan River, and lies completely outside the project area. The Pinabete and No-Name Washes cross the project area and flow to the Chaco Wash.

The Pinabete Wash bisects Area 4 South from the southeast to northwest, and will require diversion in advance of initial mining development. The No-Name Wash crosses Area 5 generally east to west and while it will also require diversion, the timing of the diversion is many (20+) years in the future.

Climate – Navajo Mine has collected meteorological data at two sites within the mine lease for over twenty years. Information provided graphically was collected from the meteorology station located nearest the project area. “Met 2” is located between Areas 2 and 3 of Navajo Mine, roughly 10 miles north of the project area.

The climate is characterized by cold winters and warm summers. Summer days are usually hot, but the high elevation and lack of cloud cover allows temperatures to drop considerably overnight. Accordingly, the diurnal variation in temperature is significant.

Chart 1 – Monthly Temperatures



Precipitation is low, averaging roughly 6 inches (150 mm) per year in the vicinity of the project. Most precipitation occurs during the seasonal 'monsoon' periods, when the prevailing winds shift to the southwest and carry sub-tropical moisture into the area. These generally occur in March and August of each year and are characterized by short, sudden cloudbursts, and often associated with thunderstorms.

Relative Humidity is very low, usually less than 30 percent. Evaporation is correspondingly high, averaging over 60 inches per year.

While snowfall is not unusual during the winter months, snow rarely accumulates in any significant depth over the project area. Operations at Navajo Mine are rarely disrupted by snow.

Chart 2 – Average Monthly Precipitation

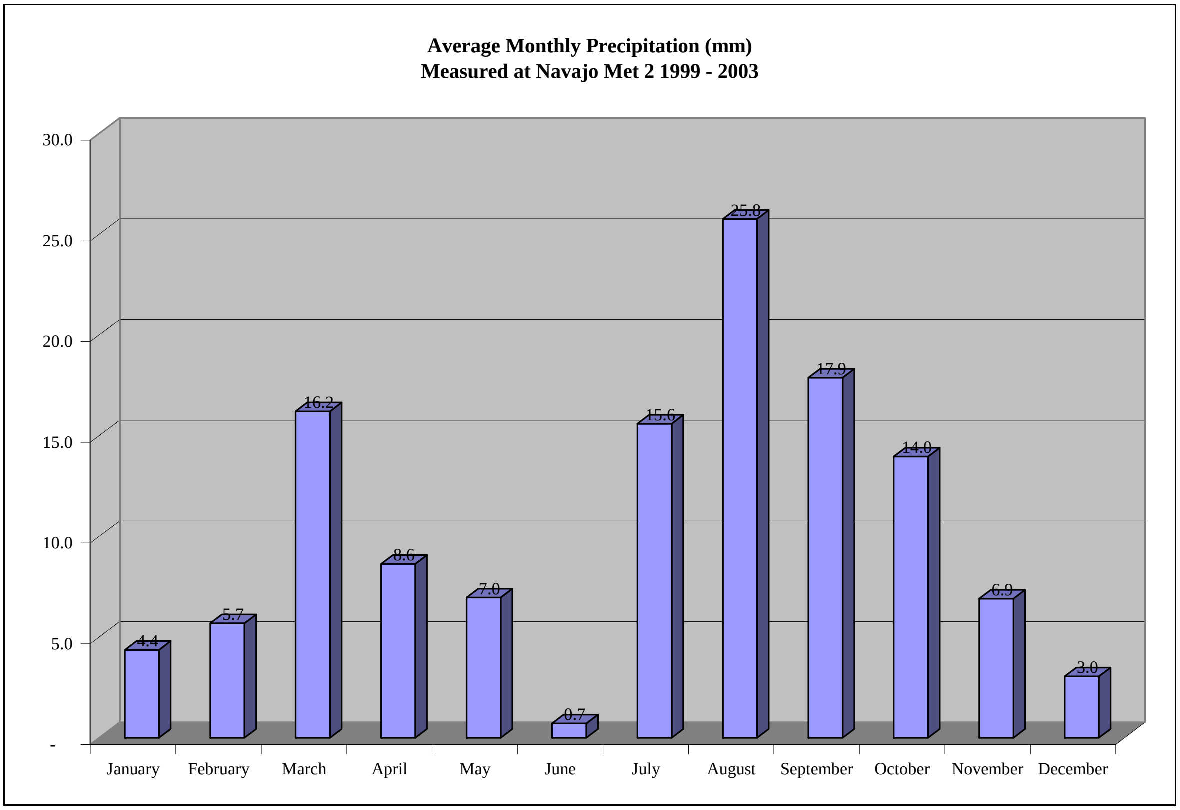


Table 1 gives the precipitation event maximums for the 6-hour storm event. While these event totals appear low by some measures, the relatively impermeable surfaces found around much of the project area have low infiltration rates and produce substantial runoff.

Table 1 – Precipitation Event Maximums for the 6-hour Storm Event

Design Storm Frequency (6-hour)	NOAA Atlas Point Values (inches)
2-year	0.8
10-year	1.4
25-year	1.6
100-year	2.1

Sources: NOAA Atlas II Precipitation – Frequency Atlas by the Western United States Volume IV – New Mexico. J. F. Miller. R. H. Fredrick and R.J. Tracey. U.S. Department of Commerce, 1973

The area is known for moderate to strong, steady winds. The prevailing wind directions are out of the east and northwest. High winds do create issues with blowing dust and reduced visibility, but these conditions typically do not become severe enough to disrupt operations.

Extreme weather is very uncommon in the region. Other than an occasional strong thunderstorm that produces heavy rain, high winds, and possibly damaging hail, more severe events like tornados are very rare.

Vegetation – Vegetation is conspicuous but lacks uniformity. The project area is covered with over-grazed arid grasslands, mainly shortgrass sod interspersed with bare areas. Xeric shrubs often grow in open stands among the grasses. An abundance of annuals and perennials blooms during the summer rainy season. Several kinds of cactus and yucca are common. Cottonwoods and, more rarely, other trees sporadically grow along some of the permanent streams.

Invasive species tolerant of salty, alkaline soils (i.e., Salt Cedar) have overtaken native species in areas around stream channels and stock ponds.

There are no woodlands or jurisdictional wetlands within the project area.

Soils – Soil is generally thin, poor, and often sodium-affected. Many of the soils in the project area are formed from alluvium and eolian sediments derived from shale and sandstone. Where suitable root zone material exists, it is usually a sandy loam. Identifying and managing sufficient soil resources to achieve reclamation objectives has been and will likely continue to be an issue for Navajo Mine and this project.

Fauna – Major mammal species larger than fox and coyote are nearly non-existent over the project area. Small mammal species (mainly rodents) are found throughout the project area but are still of limited abundance, except in pockets of suitable habitat.

Reptiles are the most commonly observed fauna and include the horned lizard, collared lizard, and rattlesnake.

Hydrogeologic Considerations

Extensive studies of surface and groundwater hydrology have been made for the Navajo Mine Extension Project area. For all alternatives evaluated, surface and groundwater issues are of low significance in terms of risk and potential impact.

Surface Water

Total precipitation in the project area averages less than 6 inches (150 mm) per year. There are no perennial streams within the project area; all drainages convey water only in response to a direct precipitation event.

Pinabete and No Name Arroyos are the primary surface water features within the mine permit area. The drainage basin areas where Pinabete Arroyo and No Name Arroyo exit the lease area are 54.0 square miles and 10.33 square miles, respectively. The drainage basin area for No Name Arroyo upstream of the lease is only about 1.9 square miles. Table 2 shows the estimated peak flows for significant precipitation events at locations ‘upstream’ (on the eastern lease boundary) and ‘downstream’ (on the western lease boundary) of the project area.

Table 2 – Peak Flows for Pinabete and No-Name Washes

	2-yr, 6-hr Event (0.8 inches)	10-yr, 6-hr Event (1.35 inches)	100-yr, 6-hr Event (2.1 inches)
Watershed Location	Flow (cfs)	Flow (cfs)	Flow (cfs)
Pinabete Upstream	914	3,087	7,287
Pinabete Downstream	796	2,675	6,307
No Name Upstream	50	191	469
No Name Downstream	130	446	1,045

Typical of ephemeral, flash-flooding arroyos, surface water quality is poor. Turbidity and salinity are high, as is the pH. Tables 3 and 4 show data from samples collected in Pinabete and No-Name Arroyos in 1998.

Table 3 – Water Quality Data – Pinabete Wash

Date Collected	Pinabete Upstream				Pinabete Downstream			
	7/29/1998	8/26/1998	9/30/1998	11/7/1998	7/29/1998	8/26/1998	9/30/1998	11/7/1998
pH (units)	8.1	7.8	7.6	8.2	7	7.6	8.1	8.2
Specific conductance (uS/cm)	930	1640	1460	880	1940	1530	410	600
Total Dissolved Solids (mg/l)	610	1200	1060	620	1410	1220	350	390
Total Suspended Solids (mg/l)	109000		178000	305000	279000		24200	34700
Settleable Solids (ml/l)	705	714	800	14.4	850	890	4.5	1
SAR	6.3	8	7.7	8	5.1	7.5	1.9	6
Potassium (mg/l)	5.5	5.7	5.3	8.6	10.7	6.6	9.1	5.4
Calcium (mg/l)	39.2	72.6	65	23.6	141	70.8	50.3	19.3
Magnesium(mg/l)	2.9	6.8	5.7	6.8	14.7	6	5.3	3.4
Sodium (mg/l)	151	265	242	166	238	243	52.8	108
Carbonate (mg/l)	<1	<1	<1	<1	<1	<1	<1	<1
Bicarbonate (mg/l)	207	178	269	156	464	307	132	125
Chloride (mg/l)	9	32	24	0	27	34	6	8
Fluoride (mg/l)	0.78	1.09	1.19	0.9	0.4	0.7	0.45	0.75
Sulfate (mg/l)	319	581	360	313	684	591	130	164
Boron (mg/l)	0.06	0.09	0.09	0.07	0.17	0.11	<0.05	0.14
Iron, dissolved (mg/l)	7	0.15	1.17	0.05	<0.02	1.35	1.66	20.3
Iron, total (mg/l)	118	286	1140	5.96	155	305	216	1490
Manganese, dissolved (mg/l)	0.357	0.007	0.453	<0.01	3.76	0.21	0.125	2.11
Manganese, total (mg/l)	12.8	12.9	24.4	2.2	28.4	21.4	4.07	52
Selenium (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005

Table 4 – Water Quality Data – No Name Wash

Date Collected	No Name Upstream 7/29/1998	No Name Upstream 9/30/1998	No Name Downstream 8/13/1998	No Name Downstream 8/13/1998	No Name Downstream 9/30/1998
pH (units)	8.1	8.4	7.6	8	7.7
Specific conductance (uS/cm)	150	290	1020	1050	730
Total Dissolved Solids (mg/l)	100	190	530	840	520
Total Suspended Solids (mg/l)	7400	1520	26100	78400	36800
Settleable Solids (ml/l)	3.2	0.1	162	194	251
SAR	0.82	0.7	2	2	1.7
Potassium (mg/l)	6	8.2	13.6	29.5	9.6
Calcium (mg/l)	35.3	42.1	91.7	121	77.4
Magnesium(mg/l)	2.1	2.3	10.7	14	8.8
Sodium (mg/l)	18.6	17.3	82.9	95	60.6
Carbonate (mg/l)	<1	3	<1	<1	<1
Bicarbonate (mg/l)	132	180	417	232	264
Chloride (mg/l)	8	7	11	17	9
Fluoride (mg/l)	0.19	0.26	0.64	0.68	0.89
Sulfate (mg/l)	16	7	131	383	142
Boron (mg/l)	<0.05	<0.05	0.16	0.16	0.12
Iron, dissolved (mg/l)	0.58	0.46	0.45	0.05	3.31
Iron, total (mg/l)	6020	4.74	4.5	1.26	290
Manganese, dissolved (mg/l)	0.24	0.043	0.034	<0.005	0.786
Manganese, total (mg/l)	1.28	0.13	0.13	0.022	6.38
Selenium (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005

Ground Water

Navajo Mine has conducted extensive exploration drilling within the project area. This, together with data from the active mine areas provides information about the ground water hydrology of the area to be mined.

Direct recharge of overburden is quite low; recharge rates measured by chloride mass balance methods at Navajo Mine ranged from 0.05 to 0.51 mm/yr. (Stone 1984). Based on the research by Kearns and Hendricks (1998), aerial recharge is thought to occur during very large precipitation events and during extended wet periods with increasing soil moisture. Recharge is expected to be higher along the arroyos and at surface depressions and impoundments.

No springs or seeps were observed during a stream channel inventory conducted during June 1998.

Alluvial fill deposits occur in the valley bottoms of the Chaco River, Pinabete Arroyo and No Name Arroyo. Portions of the alluvium of Pinabete Arroyo are saturated and will yield water to wells, as evidenced by the two dug wells located on Pinabete Arroyo adjacent to the permit area. The alluvium of the Chaco River also contains ground water as indicated by dug wells located adjacent to the Chaco River.

The alluvium of No Name Arroyo was found to be dry based on the alluvial monitoring well previously installed downstream of the coal lease boundary. This well was plugged and abandoned in 1994 by Navajo Mine at the request of OSM.

Groundwater in small amounts is observed as highwall seeps at varying locations within the actively mined areas. All of these water prone areas appear to be perched and confined; classifying the coal strata as aquifers is questionable. Production rates and the naturally poor quality of the groundwater preclude their use as a water source in the region.

Aquifer testing of wells completed in the coal units at the Navajo Mine indicates very low values for transmissivity and hydraulic conductivity. Water quality monitoring data shows that the ground water in the coal seams have very high concentrations of total dissolved solids (TDS) ranging from about 4,500 mg/L to over 50,000 mg/L. The lower concentrations occur within the mine area and closer to the outcrop. There are no known water supply wells completed in the Fruitland coals within the project area and adjacent area.

Table 5 provides a summary of water quality from samples collected from a well completed in 3 seam in Area 4 South.

Table 5 – Summary of Water Quality

	Primary & Secondary Drinking Water Standards	Livestock & Wildlife Watering Criteria	Sample Results	
Date Sampled			29-Mar-98	8-Nov-98
Arsenic (mg/l)	0.05	0.02	<0.005	0.007
Barium (mg/l)	2		0.25	0.07
Boron (mg/l)		5	0.09	0.44
Cadmium (mg/l)	0.005	0.05	<0.001	<0.001
Chromium (mg/l)	0.1	1	0.09* (total)	<0.01
Copper (mg/l)	13/1.0*	0.5	0.04	0.03
Iron (mg/l)	.3*		0.12	0.34
Lead (mg/l)	0.015	0.1	<0.005	<0.005
Manganese (mg/l)	.05*		<0.005	<0.01
Mercury (mg/l)	0.002	0.01	<0.001	<0.001
Selenium (mg/l)	0.05	0.05	0.0333	0.007
Silver (mg/l)	.1*		<0.01	<0.01
Zinc (mg/l)	5*	252	<0.025	0.081
Total Iron (mg/l)			0.4	0.45
Total Manganese (mg/l)			0.013	<0.01
pH (units)	6.5 to 8.5		12.6	12
EC (uS/cm)			12600	8540
TDS (mg/l)	500*		3760	3140
Fluoride (mg/l)			2.31	1.29
Bicarbonate (mg/l)			<1	<1
Carbonate (mg/l)			105	317
Chloride (mg/l)	250*		170	404
Sulfate (mg/l)	250*		796	251
Calcium (mg/l)			48.5	5.5
Magnesium(mg/l)			<2	<0.2
Potassium (mg/l)			111	50.5

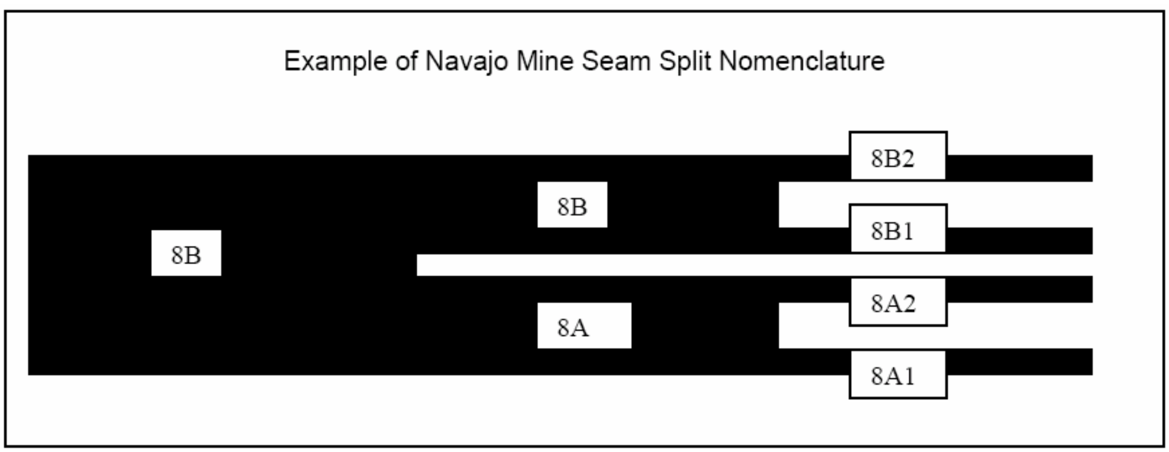
	Primary & Secondary Drinking Water Standards	Livestock & Wildlife Watering Criteria	Sample Results	
Sodium (mg/l)			1170	1120
Hydroxide (mg/l)			NM	NM
Total Alkalinity (mg/l)			2030	1830
Nitrate (mg/l-N)	10		3.56	NM
Ion Balance (%)			4.87	2.7
Radium-226 (pCi/l)	20	30**	<1.69	3.35
Radium-228 (pCi/l)	20	30**	2.61	7.82
*Secondary Standard ** Ra-226 + Ra-228				

Based on the mining experience at the Navajo Mine, the strata within the project area is not expected to yield substantial amounts of water during mining. The saturated sands that occur in the Fruitland Formation are of limited extent and only yield significant water when recharged by water from the Navajo Agricultural Products Industries (NAPI) irrigation project. NAPI irrigation project influences do not extend into the drainages associated with the Navajo Mine Extension Project.

Navajo Mine Extension Project – Preliminary Mine Plans

Coal Resource Description

The identified resource held within the Navajo mining lease contains up to 11 named seams, of which 8 or 9 are consistently mineable. The named seams range in thickness from 1.5 feet (460 mm) to 20 feet (6.1 m). These seams often split into ‘A’ and ‘B’ elements, and occasionally into ‘A1’, ‘A2’ and ‘B1’, ‘B2’ elements if a parting exists in the ‘A’ or ‘B’ level splits.



In the project area, the mineable seams are:

8B	6B	3B
8A	6A	3A
7B	4B	2B
7A	4A	2A

The coal seams are highly continuous within the lease area and are nearly flat lying, with a dip of up to 2 degrees to the east. Localized pinches, rolls, and occasional faults with minor offsets are encountered but have not presented significant difficulty in the past. The topography within the project area rises gently from west to east, with overburdens in particular becoming thicker from west to east. This, combined with the dip of the coal, leads to strip ratios rising from west to east across the mining lease.

There are no igneous intrusions or other geologic anomalies within the project area.

The coal seams outcrop or subcrop close to the western limits of the mine lease, usually outside of the mine lease. The coal resource is burned or washed out beyond the western limit of the mine lease. Inside the mine lease, the upper seams typically do not exist over the entire area. As the topography rises to the east, the upper seams come into the sequence.

The overburden is typically formed of an upper layer of unconsolidated eolian sands, weathered shale and sandstone, or drainage channel sands and gravels. This overlies a column of competent overburden comprised of shales, sandstones, and siltstones. Seam 8 often lies directly under the unconsolidated layer and is typically weathered and of low quality (see resource summary information for Seams 8B1 and 8A2). Overburden depths range from just a few feet (~ 2 m) to 80 feet (24 m).

Interburdens and partings are generally composed of soft gray shale, a dark gray siltstone, carbonaceous shale, and medium hard buff-colored to hard white sandstones. The soft materials (shale and siltstone) are far and away the most prevalent. Silica contents and abrasiveness are relatively low except in the sandstones, which can be hard and highly abrasive. Most of the sandstones are found in lenses or stringers and are of limited extent and thickness. Interburden thicknesses range from less than 3 feet (1 m) to 60 feet (18 m).

Area 4 North has up to 11 mineable seams, ranging from 1.5 feet (460 mm) to 7 feet (2.1 m) in thickness. Area 4 North is characterized by thin partings, relatively little overburden, and dissected topography. Seam 9 is nearly non-existent. Seams 8, 7, and 6 have multiple subcrops within the mining area; their extents are controlled mainly by topography – mesas interspersed with drainage channels or basins. Total coal thickness ranges from 10 feet (3 m) to 30 feet (9 m).

Area 4 South also has up to 11 mineable seams, ranging from 1.5 feet (460 mm) to 9 feet (2.7 m) in thickness. Parting thicknesses and overburden depths are similar to Area 4 North, but the topography in Area 4 South is much more uniform. Seam 9 does not exist in Area 4 South. Seams 8 and 7 have fewer subcrops and tend to have a greater extent in Area 4 South, generally coming into the sequence on the east side of the Pinabete Wash and then being found continuously to the eastern lease limits. Seams 6 and below are more or less continuous throughout the area.

Area 5 has up to 9 mineable seams, with fewer splits than Areas 4 South and North. Seam thicknesses range from 1.5 feet (460 mm) to 12 feet (3.7 m). The topography in Area 5 becomes even more uniform than Area 4 South, producing fewer subcrops and greater upper seam extents than the other areas. The seam extents are controlled mainly by the rising topography from west to east. Seams 8, 7, and 6 are more or less continuous over the eastern two-thirds of the area, seam 4 and below are continuous throughout the area.

Mineable Coal Reserve Estimation

The conversion process first evaluates all partings (a parting is a non-coal material, usually shale or mudstone) included within the coal seams; if the included parting thickness is greater than 1 foot (25 cm) then the seam is treated as separate splits of the parent seam. If the included partings are less than 1 foot thick, the seam is left as-is since mining practices do not allow the separation of seams with less than 1 foot of parting.

After the seams are consolidated or split, all seams or splits less than 1 foot thick are removed from the mineable horizons. Current and planned mining methods do not facilitate consistent recovery of seams less than 1 foot thick. When these very thin seams are encountered during mining operations, they are recovered opportunistically where equipment and schedule constraints allow. This step removes most of the in-situ coal resource that is unsuitable for conversion to a mineable resource or reserve. Seams 9 and 1 generally drop completely out of the mineable resource after this step.

The cut-off grade is applied next. Generally, the cut-off grade is set at 7,000 BTU/lb and aside from outcrop or subcrop coal, very little of the in-situ resource is eliminated from conversion to a mineable resource through application of the cut-off grade.

All of the in-situ resource eliminated from the mineable horizons by the above process is now converted to waste.

Loss and dilution factors are then applied to the remaining resource. These factors are represented as percentages of the associated seam thickness and are based on pre- and post-mining surveys in active pits at Navajo Mine. The roof contact as observed in the highwall is compared to the actual coal seam roof after stripping and cleaning. The process is repeated for the seam floor, with the actual contact as observed in the highwall compared to the post-mining floor.

The dilution material has also been analyzed to establish average qualities that are used in the conversion process to adjust the in-situ resource quality to expected or ‘as-delivered’ quality.

This process generates both mineable resource quantities and qualities that are ready for use in pit layout development and subsequent production scheduling. In the project area, the mineable seams are reflected in Table 6.

Table 6 – Mineable Seams

8B	6B	3B
8A	6A	3A
7B	4B	2B
7A	4A	2A

Seams 9 and 1, which are reported in the in-situ resource models, are generally not mineable and will only be recovered opportunistically.

Mine Production Rate

The Desert Rock Energy Project station will require a nominal annual coal supply of up to 6.25 million tons.

Navajo Mine Extension Project – Mining Methods

Two draglines will be used as the primary stripping equipment.

Dragline stripping in the project area will require detailed planning to optimize operations in the multiple-seam environment of Areas IV South and V. BNCC has operated draglines ranging in size (bucket capacity) from 45 cubic yards to over 130 cubic yards in multiple seam conditions on this same deposit for nearly 50 years. In general terms, 'mid-sized' draglines of 80 to 100 cubic yard bucket capacity are viewed as the machines of choice, or those that strike the best balance between productivity and flexibility.

The typical sequence that will be used in multiple seam mining is:

1. Vegetation removal (where it exists).
2. Topdressing removal (where it exists).
3. Drilling and blasting of overburden.
4. Overburden removal using draglines and occasionally truck/shovel or truck/loader fleets.
5. Drilling and blasting of the uncovered coal.
6. Coal removal using front-end loaders and bottom-dump coal haul trucks.
7. Drilling and blasting of interburden.
8. Interburden removal using draglines and occasionally truck/shovel or truck/loader fleets or dozers.

Steps 5 through 8 are repeated for each additional mineable coal seam, until the pit bottom is reached at the bottom of the 2 seam horizon.

The coal seams in the project area will be exposed in strips ranging in width from 130 to 180 feet (40 m to 55 m), in depths from 5 to 240 feet (2 m to 75 m), and in lengths from 1,000 to 18,000 feet (305 m to 5,500 m).

Vegetation and Topdressing Removal

The removal of vegetation and topdressing, where present, is the first step in the preparation of a strip for mining. Topdressing is removed far enough ahead of drilling and blasting to prevent contamination from blasting flyrock, and to accommodate mining support infrastructure such as roads and power lines.

The topdressing is removed by one of two methods depending on the thickness and extent of the material. Scrapers remove topsoil in lifts of three to twelve inches, and will be used in the shallower deposits (generally less than five feet in depth). End-dump trucks loaded by front-end loaders remove topdressing from deeper or more extensive deposits. Once removed, the suitable topdressing is placed either in stockpiles or directly on regraded spoil. Graders and water trucks maintain haul roads so the scrapers and trucks can operate as safely and efficiently as possible while minimizing fugitive dust.

Topdressing is salvaged from all areas to be affected by surface operations or construction of major structures. However, certain soils at the Navajo Mine cannot feasibly be removed without jeopardizing the safety of the equipment and operators or the quality of topdressing removed. Because of equipment limitations, topdressing is not salvaged where:

1. Slopes are greater than 4:1 (>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 one acre in size (pockets),
4. Rock rims and/or rock outcrops exist, and
5. Material occurs below an unsuitable layer having a thickness greater than six inches. If the unsuitable layer is less than 6 inches thick, the suitable topdressing must be at least 1,600 yards per acre to justify salvage.
6. The physical and chemical characteristics of the surface and subsurface soils to be used as topdressing are not different enough to warrant separate stripping or handling.

Overburden Drilling and Blasting

After the suitable topdressing material has been salvaged, rotary drills are used to drill overburden blast holes. Blast hole diameters range from 5 inches to 12 inches (125 mm to 305 mm).

Overburden blasting at the BNCC Lease Area uses two methods, cast blasting and stand-up or buffer blasting.

In areas of deep (>60 feet/18 m) overburden, cast blasting is used to move some of the in-place material off of the top of the uppermost coal seam. This improves the efficiency of the stripping operation and improves the economics of recovering deeper coals. In cast blocks, blast holes are typically drilled on an angle (15 to 25 degrees from vertical) to within 3 to 10 feet the top of the uppermost coal. This standoff drilling is done to prevent coal shattering (chilling) and accompanying coal loss from overburden blasting. Blast holes that have been drilled to the top of coal are backfilled with 3 to 10 feet of drill hole stemming, also to minimize the coal loss from blasting.

In most blocks that employ cast blasting, a prespilt line is also drilled and shot as part of the overburden blasting process. This involves a single row of closely spaced holes that are drilled on a similar angle to the holes in the production block. This row of holes is located and drilled to intersect the top of the uppermost coal seam at the predefined ‘coal line’ which defines the width of the strip being mined. These holes are very lightly loaded and shot in a manner that creates a line of breakage which defines the face of the next highwall. The dragline is then able to strip back to this line and create a clean, uniform highwall.

In areas of shallower (<60 feet) overburden, stand-up blasting is used to loosen the overburden for stripping. In this method blast holes are drilled vertically to the top of the uppermost mineable coal seam. The holes are then backfilled from 1 to 10 feet with drill cuttings. This backfill serves the same purpose as ‘standoff’ drilling, namely to reduce coal chilling and loss due to blasting. This blasting practice will be the most common one used in Area 4 South given the absence of overburdens thick enough for cast blasting.

Once the rotary drill has completed drilling any block of blast holes, the holes are loaded with bulk explosives. ANFO (Ammonium Nitrate prills and Fuel Oil) or a mixture of ANFO and emulsions are the most widely used blasting agents. The explosive column is detonated by a 1/2 to 3-pound primer initiated with non-electric detonating cord or cap. Normally, to ensure proper blast sequencing, the shots are controlled using in-hole delays and/or surface delays.

Where areas of unconsolidated overburden exist, this loose material will be pushed off the highwall by dozers in advance of drilling operations.

Overburden Removal

Overburden/Interburden Stripping Methods – Development Stripping

The boxcut is the initial phase of all stripping methods in the permit area because it produces the initial highwall. Boxcut development designs will vary based on depth of coal, number of coal seams, configuration of deposit, relation to lease boundaries, and dragline dimensions. The basic boxcut stripping method employed at the Navajo Mine is the 'side cut with rehandle' method.

The dragline is positioned on the side of the block to be stripped utilizing a swing angle of 180 degrees to cast the spoil material as far as possible from the cut over the topmost coal seam. This process is repeated until the entire strip has been completed. To achieve the designed pit width over the lowest coal seam, the boxcut can be up to 500 feet wide. Because of this width, the spoil material from the first strip must be rehandled another 180 degrees by the dragline. Total rehandle often exceeds 150% of prime; consequently the development phase is when the highest overall strip ratios and lowest rates of coal uncovery are encountered. The coal under the rehandled spoil material will then be exposed using the same method as above. This process is repeated for each successive coal seam until the lowest coal seam is exposed. The number of cycles is dependent on the number of coal seams, depth of coal seams, and pit width over the lowest coal seam required to facilitate mining equipment. Coal haulage ramps will be developed by the dragline at appropriate spacing during the boxcut process.

The boxcut placement is dependent on such factors as coal recovery, coal quality, relation to lease boundaries, depth of coal seams, quantity of spoil material rehandle, stockpiles, haulage ramps configurations, and haul ramp alignments. Coal recovery is typically in the 70% to 80% range.

Overburden/Interburden Stripping Methods – Production Stripping

Two methods of dragline stripping will be employed. The first is simple side-casting, which is generally employed on the upper seams, either from the topmost highwall bench or successively lower intermediate benches. 'Highwall' bench generally refers to the first dragline bench above the uppermost coal seam in any given pit. 'Intermediate' bench generally refers to successively lower benches located above intermediate coal seams.

When digging from the highwall bench, the dragline sits on the highwall or prime side and digs the prime waste material at or below machine grade, then swings the waste an average of 90 degrees where it is dumped into the void of the previous strip. Very little hoisting is required of the machine, and spoil placement is very straightforward. In the project area, this stripping method will be used on the 8 seam horizons. This is generally the most productive mode of stripping, as the machine benefits from relatively favorable dig depths and low swing angles.

The design pit width is established on the highwall bench using survey control to define the "coal line" or highwall-side limit of stripping for the current strip. Using the coal line as a guide, an initial keyway is dug with the dragline (utilizing dozers for assistance in keycutting). The positioning of the machine in relation to the coal line while digging the keyway is essential to ensure a uniform highwall. Once the keyway is complete, the machine repositions itself towards the open cut to obtain maximum spoiling reach for the remainder of the material in the cut. After completion of a cut, the dragline is repositioned to take another cut. This procedure is repeated until the dragline has stripped the entire pit length over a particular seam or until it becomes necessary to walk to another location to facilitate coal mining.

The coal line on at least two seams in each strip is offset away from the highwall so that a remnant safety bench is left. This safety bench can vary in widths from 10 to 40 feet depending on the geometry of the pit.

Each mineable seam will require a ‘pass’ of the dragline to uncover the coal. Each pass may incorporate several individual sequence steps that work to maximize coal recovery and operational efficiency.

When digging from the upper intermediate benches, the overall operating technique is the same as used on the highwall bench.

The dragline will continue to strip from the intermediate bench until the spoil toe encroaches into the coal edge of the current bench and machine geometry limits the ability to remove the spoil from the coal edge without incurring significant rehandle. Due to increasing rehandle with depth, limits on machine dump height, and reduced efficiency and recovery, stripping from the intermediate bench reaches a point of impracticality.

In limited instances, the machine may continue to strip from intermediate bench but will only strip a defined portion of the pit width or depth. This is referred to as ‘extended key’ stripping when it involves the full-depth removal of ¼ to ½ of the interburden material over the width of the pit, and as ‘half-pass’ stripping when it involves the partial depth removal of the interburden over the full pit width. These special cases are used to optimize the overall efficiency of the stripping operation, mainly by placing only enough spoil from the intermediate bench to achieve a specified design height for the spoil bench.

As the machine progresses deeper into the sequence, generally by the time the 6 seam horizon is reached, spoil placement becomes critical as the spoil side must be prepared for the transition to spoil-side stripping. The dragline will place spoil in a manner that allows dozers to build a spoil-side bench and a transition ramp from the intermediate bench. The transition to spoil side will generally occur on either the 4 seam or 3 seam horizon.

The elevation of the spoil-side bench (relative to the pit floor) depends on factors such as the depth of seams, the number of remaining seams to be stripped and the configuration of the dragline. However, the best practice is to keep the bench as low as possible to minimize rehandle of the spoil bench material.

Spoil-side stripping requires both digging at depths well below machine grade and high hoisting of the spoil materials. Waste material from the lowest seams is hoisted out of the pit and dumped on the spoil-side bench; placement of this spoil often becomes critical in order to maintain sufficient operating room for the dragline. On the final pass over spoil-side, the waste material is dumped in a manner that ‘closes’ the bench to a specified remnant bench width, typically 25 to 50 feet (8 m to 16 m). This remnant bench serves the same purposes as the highwall side safety benches, namely to contain any material raveling down towards the pit. Variations to all of these methods do exist and are used when dictated by dragline efficiency requirements and pit configuration.

Once a strip is complete, the dragline may be walked out of the pit using the same walkroad used to enter the pit or via a haulage ramp.

Coal Removal

After the coal is exposed by the stripping operation, it is either drilled and blasted or ripped by dozers before mining. At BNCC, seams less than 5 feet thick are generally ripped; thicker seams are blasted.

Once the coal is broken up it is mined by front-end loaders and haul trucks. The entire thickness of the coal seam is mined in one pass except where a major shale parting or coal quality makes a distinct division in the coal seam. In this case, the top part of the seam is mined as usual, and then the parting is ripped by dozers and pushed into the adjoining spoil area. Finally the rest of the seam is ripped or blasted for mining with the front-end loaders and trucks. The face of the coal is generally across the width of the pit and is advanced evenly. The top of the coal is cleaned using small front-end loaders with the diluted coal piled on the spoil-side of the pit.

Although operations at BNCC are engineered and designed to recover the maximum amount of coal, a small percentage of coal is lost as coal wedges, coal ribs, and in the top and bottom of coal seams. There are a number of operational and safety related conditions which necessitate limited coal losses. In general, two types of wedge losses occur; a wedge left on upper seams in multiple seam pits as a safety berm and a wedge left on spoil encroached seams as a spoil barrier. A small percentage of coal may be lost on the top and bottom of the coal seam and as coal ribs due to the geologic condition of the coal and due to the equipment utilized in the stripping and mining sequences.

When mining multiple seams, upper seams are mined from benches where the bottom of coal elevation is higher than the toe of the spoil. When these conditions are encountered, a wedge of coal is typically left as a safety berm which prevents trucks and loaders from accidentally going over the highwall. Once the coal seam has been mined out, front-end loaders are used to recover as much of the wedge as possible.

Where a seam is encroached by the spoil toe, the coal wedge acts as a spoil barrier, contributing to spoil stability and reducing the occurrence of loose material rolling into the active pit. Both spoil slides and loose material rolling into the pit are potentially serious safety hazards. Once the seam has been mined out, front-end loaders are used to recover as much of the spoil-side wedges as safely possible.

Reclamation

BNCC is required to successfully reclaim all areas disturbed during strip mining operations. SMCRA requires that diverse, effective, and permanent vegetative plant communities, native to the BNCC Lease Area, will be established on all affected lands. All reclamation activities will comply with reclamation plans approved in the SMCRA permit. The productivity level and vegetative cover shall be compatible with the post mining land use of grazing and will be capable of stabilizing the soil surface from erosion with proper management. The revegetation seed mixture will consist of a variety of cool- and warm-season grass species as well as an assortment of shrubs.

In general, spoils (i.e., mined overburden and interburden) are regraded with dozers, trucks, or draglines to an approved final topography. Spoils are systematically sampled for subsoil suitability and mitigated as required. Salvaged topdressing is then re-distributed in varying depths, depending on the location. Topsoiled areas are disked, seeded, mulched, and crimped. Irrigation pipe is then set out and the area is irrigated for two growing seasons. This irrigation cycle is sufficient to establish growth but not develop a dependency on the additional moisture.

Delays in contemporaneous reclamation are required in some cases as explained below:

1. *Ramp Backfill*. A buffer zone will be required from the centerline of coal haulage ramps to match the ramp with the surrounding post-mining topography. This buffer must not be regraded until the ramp is no longer active. Exact dimensions of the buffer are, of course, dependent on the drainage plan and depth of ramps.
2. *Drainage Construction*. The re-establishment of post-mining drainages requires that some acres not be regraded contemporaneously, but regraded after the area is inactive. This allows ramps and pits to be backfilled to proper elevations to establish drainage either through the old pits and ramps or through other mined-out areas as dictated by the Final Surface Configuration (FSC).
3. *Maximization of Coal Recovery*. In some areas, the land must not be regraded contemporaneously to facilitate future coal recovery in adjacent areas.
4. *Use of Pits and Ramps as Ash Disposal Areas*. Current long-range plans call for certain pits and ramps to be used as ash disposal locations. This requires that the areas remain open until this activity is completed.
5. Boxcut spoils are often left un-regraded until near the end of the mine life as they represent a source of backfill material that may be required to complete reclamation to the final surface design.
6. Long-term facilities, such as haul roads, access roads, conveyors, and offices and shops would be reclaimed during the final reclamation phase

Mining Limits

The process of defining mining limits is ultimately constrained by the BNCC Lease Area boundaries, which were established in 1957.

Accepting that the lease boundary is the maximum potential stripping limit, the next level of constraints are the regulatory requirements applicable to the mine. Navajo Mine is compelled by the terms of both its SMCRA permit, issued by OSM, and its Resource Recovery and Protection Plan (R2P2), issued by BLM, to conduct mining operations in a manner that achieves maximum economic recovery (MER) of the available resource. MER is a key consideration in determining pit limits, strip layouts, and facility and infrastructure locations.

All resources within the Area IV South and V lease boundaries are economically recoverable using surface mining methods. Stripping limits have been established that maximize recovery of the resource while allowing sufficient space between the perimeter of the stripping area and the lease boundary for surface infrastructure (roads, power and water lines, coal stockpiles) and spoils placement. This ‘buffer’ ranges from an upper limit of 750 feet to as little as 300 feet, depending on whether the buffer is located on the boxcut (lowwall) side, final pit (i.e., highwall) side, or endwall sides of the pit.

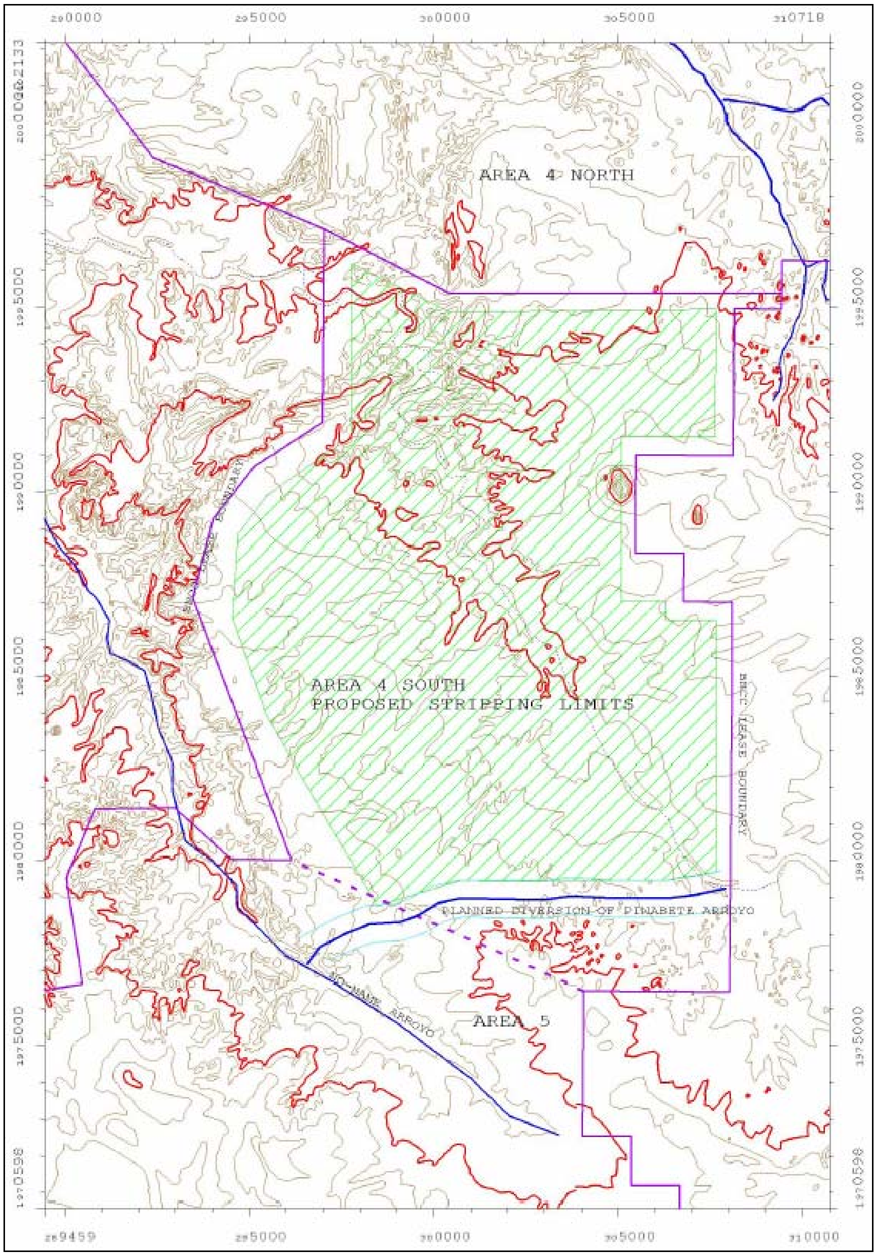
Experience at BNCC has shown that placing dragline (i.e. boxcut) spoils no closer than 300 feet to the lease boundary strikes the best balance between MER and environmental impacts that can arise when spoils are placed closer than this to the lease boundary. This requires the pit limit on the boxcut (lowwall) side of the pit to be established roughly 750 feet inside of the lease boundary, so that the boxcut spoils can be placed on the surface without encroaching on the lease boundary.

Placing the final highwall closer than 300 feet to the lease boundary will not allow sufficient space for final highwall reduction and tie-in to the final reclamation surface to occur.

Space must also be allowed between the lease boundaries and pit limits for field stockpiles and stream diversions, both of which are planned for Area IV South. A field stockpile location is planned for a block of roughly 120 acres along the western edge of the Area 4 South lease. The Pinabete Arroyo must be diverted in advance of stripping Area IV South.

After all of the required set-asides are considered, the general shape and maximum extent of the stripping limit emerges, as shown in Figure 1.

Figure 1 – Overall Stripping Limits in Area 4 South



Area V was delineated in much the same manner, but was not evaluated iteratively or to the same detail as Area IV South. Again, there is at least a 35-year interim between Desert Rock start-up and the first need to enter Area V for coal production intended to supply Desert Rock Energy Project.

Final Mine Layout

After establishing the preferred mining limits, several alternatives were developed for suitable pit orientations (layouts) in Area IV South.

In addition to the selected Area IV South mining limits, previously considered information for several other factors was revisited to check for constraints or risks. These included:

Geology

The coal seams dip roughly 2-3 degrees to the east; there are no significant structural concerns; the character of the coal seams is consistent in both the strike/dip directions; the vertical thickness of total coal is greatest over the eastern and southern one-thirds of Area IV South.; The seams outcrop or subcrop along the western lease boundary; the Pinabete Arroyo has washed out most of the coal from the far northwest portion of the mining area.

Topography

The topography rises in the same direction as the coal dips, to the east, so the total vertical thickness of the overburden increases to the east; the Pinabete Arroyo is the dominant topographic feature and bisects the mining area from southeast to northwest; there are fewer badlands/deeply incised areas in Area IV North and South than in Area V.

Hydrology

The Pinabete Arroyo requires diversion in advance of mining, regardless of mining direction selected; no other significant surface water inflows are present within the mining area; ground water is nearly non-existent; no water rights will be impacted within the mining area.

Geotechnical

There is little regional faulting or other structure, most structure is limited to low-angle compaction faults and jointing in the waste rock. Two independent studies aimed to identify geologic faulting in the area have been carried out. One of these identified potential fault orientations for the mine lease in Areas III, IV North, IV South and V, while the other attempted to identify basement faults (those located deep, below the sedimentary rocks) within the San Juan Basin. Both of these studies came up with very similar results, namely dominant structural patterns oriented east-northeast to northeast and weaker, less persistent orientations northwest. Potential orientations of strips in these directions would need to be assessed carefully.

Fugitive Dust

Mine Plans and facility designs have been iteratively designed to reduce fugitive dust generation to the practical minimum. Blended coal storage is planned to be fully enclosed, and bulk coal transport from Area IV North and South to the coal processing facility will use an overland conveyor rather than trucks.

Regulatory Framework

Pit layouts must achieve MER; boxcut spoils should not encroach within 300 feet of the lease boundary; pit layouts should facilitate contemporaneous reclamation; Areas IV South and V will be permitted separately from Area IV North.

Dragline Operating Parameters

The optimum pit lengths are greater than 8000 feet; consistent highwall sequences are most efficient; pit layouts that require gradual lengthening of the pit on each strip create increased rehandle and inefficiency on lower seams; pit alignments should help balance strip ratios over the long term.

Haulage Operating Parameters

The optimum haul lengths from the mining face to field stockpiles/truck dump are less than 11,000 feet; pit layouts should minimize the number of haulage ramps required; deep pits requiring steep ramp grades should be avoided where possible.

Coal Quality

The pit layouts should facilitate coal uncovery in a sequence that allows for consistent blending.

BNCC Lease Area Required Infrastructure

Off-Site Infrastructure

Very little off-site infrastructure will be required for the Desert Rock Energy Project. A single public road, referred to as the Burnham Road Realignment, will be re-routed to suit the needs of mining operation on the BNCC Lease Area.

This road requires re-alignment over its extent within Areas III and IV North of BNCC's existing permit area to suit the needs of the current mining operations, regardless of the disposition of the Desert Rock Energy Project. Navajo Mine staff have developed a preferred alignment and have submitted construction designs along with environmental and cultural resource inventories to the Bureau of Indian Affairs (BIA), the regulatory authority over the roads in the project area, for approval.

On-Site Infrastructure

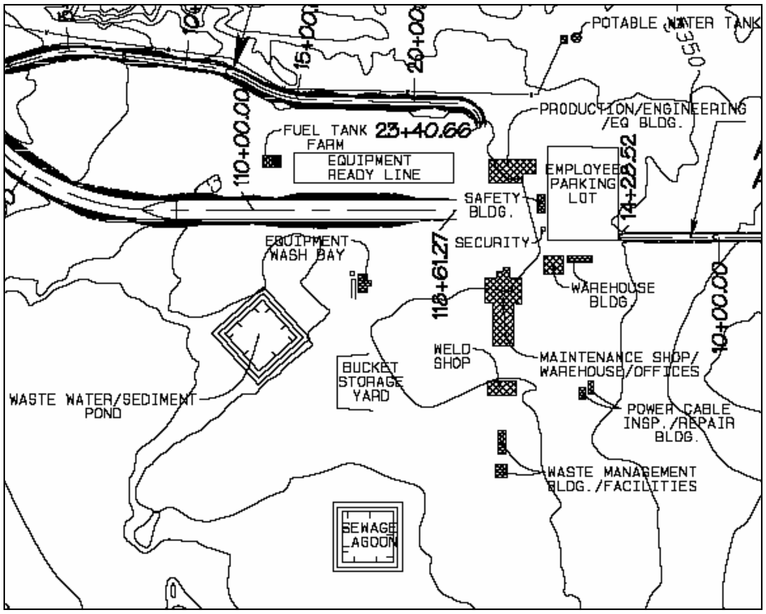
On-site infrastructure not already described will consist primarily of mine support facilities. Figure 2 provides an overview of the general arrangement of facilities and infrastructure for both the existing Navajo Mine operations and the Navajo Mine Extension Project (NMEP).

BNCC engineering staff completed an infrastructure requirements and siting study during 2006, with the objective of determining infrastructure requirements (primarily shops, offices, and civil works).

Utilities

Power for both mine and support operations will be supplied by a 69-kV loop running along the perimeter of the mine lease and mining areas.

Figure 2 – Facilities Layout for Desert Rock Energy Project



Motor fuel will be trucked to site and stored in up to four 25,000 gallon double-walled storage tanks. The tanks will be part of an appropriately constructed (i.e., impermeable secondary containment) fuel depot located at the main facility. Fuel distribution to mobile equipment will be completed using service trucks.

Non-potable water will be sourced from the San Juan River, under existing diversionary rights held by BNCC. A 16-inch mainline will convey the water to the project area for use in coal processing, reclamation plot irrigation, and maintenance washdown operations. Mine operations will use approximately 500 acre-feet of water per year.

Potable water will be sourced from existing infrastructure at BNCC facilities and transported via dedicated tank truck to a 200,000 gallon potable water storage tank located at the main mine facility.

Disposal and Drainage

The facilities design includes an impermeable sewage lagoon sized to meet the needs of the anticipated 200-person workforce. All permanent and regularly occupied buildings will include conventional built-in toilet and washing amenities. Conventional civil sewage collection and aerobic treatment practices will be employed. Work to determine the feasibility of utilizing a gray water/black water collection and treatment system will be conducted prior to construction.

Waste (rubbish) disposal will fall into two categories: typical household waste such as paper, wood, and plastic and special waste such as used lubricants. Household rubbish will be collected at the source and transferred to large roll-on/roll-off dumpsters that are collected weekly by the local waste management contractor for final disposal in a regulated municipal landfill facility. Special and/or hazardous wastes will be collected at the waste management building for preparation and transfer to a RCRA permitted transportation, storage, and disposal contractor for recycling or destruction.

Stormwater collected from disturbed areas must be contained on site for evaporation or in some cases settling.. Current plans call for the NMEP facilities to be ‘zero discharge’, meaning that the sedimentation ponds will capture and hold all runoff. Evaporation rates in the project area are extremely high; this will be the primary method of stormwater treatment.

Buildings and Facilities

Mine management, administrative, and professional staff (except those associated with maintenance and safety functions) will be located in the structure referred to as the ‘Production/Engineering/EQ Building’ in Figure 2.

Transport Infrastructure

The Desert Rock facilities will require a short access road to be constructed from the Burnham Road to the facilities parking area. This road will likely be constructed to prevailing county road standards and surfaced with gravel.

Other Infrastructure

Security requirements include fencing, night-time illumination of most areas, and 24/7/365 security patrols. Appropriate fencing, lighting, and a single building for use by security staff are included in the infrastructure plan.

Fire protection will include combustion detection and warning systems (fire alarms) and pressurized hydrant and sprinkler systems throughout the facilities. Where water-based suppression is unavailable or inappropriate, sufficient numbers of hand-operated extinguishers will be provided or dry suppression systems will be installed.

Coal Combustion Byproducts

As a part of required mine reclamation activities, BNCC plans to accept coal combustion byproducts (CCBs) generated by the Desert Rock Energy Project for use as mine backfill. CCBs will be mixed and backfilled in mined-out pits and ramps to restore the natural contour of the land, providing the prospect of future beneficial use of the mined area while simultaneously managing the CCBs generated at the power plant. Mine reclamation activities using CCBs will be conducted and managed in a manner that is environmentally sound and protective of human health and the environment.

Defining Coal Combustion By-Products

CCBs generated by the plant will include bottom ash, fly ash, and scrubber byproduct. Fly ash and bottom ash are generated by the combustion of coal. The fly ash is collected in emission control baghouses or electrostatic precipitators which remove fly ash from the flue gas stream. Ash particles that are too large to be carried by the flue gas fall to the bottom of the boiler during the combustion process and are removed as bottom ash. Scrubber product, also known as Flue Gas Desulfurization (FGD) product, results from the removal of SO_2 from the flue gas emissions. The SO_2 reacts with lime to form calcium sulfite and calcium sulfate.

In general, the major chemical constituents of CCBs include: Silicon Dioxide (SiO_2), Aluminum Oxide (Al_2O_3) and Calcium Sulfite ($CaSO_3$). Trace metals such as Arsenic, Cadmium, Selenium, Mercury, and Boron are also present in most CCBs. The metals concentrations vary depending on the type of coal used and the combustion processes of the plant. Testing for metals concentrations of the CCBs will be performed as part of the SMCRA permitting process.

Beneficial Reuse of CCBs

According to the American Coal Ash Association's (ACAA) 2004 Annual Survey, approximately 122 million tons of CCBs were produced in the United States in 2004. Approximately 40% of these materials were beneficially reused in various applications.

Fly ash is commonly used as an additive in concrete and soil amendment applications due to its pozzolanic behavior. The addition of fly ash to cement mixtures has been shown to provide additional strength and workability to concrete. This practice is widely accepted in the United States. Fly ash and bottom ash are also commonly used as structural fill in road construction and pavement projects and is an approved practice for use by the Department of Transportation. FGD Gypsum is an excellent feedstock in the manufacturing of commercial grade wallboard.

Such CCB reuse applications would be beneficial for the Desert Rock Energy Project. The Coal Combustion By Products Partnership (C^2P^2) program is a cooperative effort between the U.S. EPA, American Coal Ash Association, Utility Solid Waste Activities Group, US Department of Energy, and US Federal Highway Administration to help promote the beneficial use of CCBs. Coordination with the C^2P^2 Program can help target specific markets for CCB reuse. Preliminary conversations with USEPA Region 9 C^2P^2 coordinators indicate that potential markets may exist in the area of the project. Reuse applications will be pursued in the future through continued coordination with the C^2P^2 partnership and other interested parties. However, relying on possible beneficial use applications is not a responsible solution to managing the future CCB generation at the plant.

CCB Use in Mine Reclamation

Using the CCB material as a backfill for the reclamation of the coal mine provides a cost-effective and environmentally conscious solution for managing CCBs produced by the power plant. Similar reclamation activities are currently being conducted in the BNCC Lease Area, as well as the nearby San Juan mine. The OSM, DOE and non-government organizations including ACAA, USWAG and others have long recognized the practice of mine reclamation using CCBs as a viable, cost-effective and environmentally responsible practice when managed correctly.

Typical reclamation practices using CCBs as backfill require placement of the CCBs in dry areas of mine-out pits and ramps. The CCB fill is then capped with an average of 10 feet of low permeability material. Final reclamation surfaces are designed to prevent water from flowing along the length of an ash placement area, to minimize the potential for erosion and infiltration.

CCB Generation

Up to 1.35 million tons of CCBs could potentially be backfilled in the site surface mine annually. The CCB generation rate will vary dependent on power plant output and coal quality. Efforts will be made to market CCBs; the sale of CCBs will effectively reduce the annual mine backfilling quantities.

By performing a thorough analysis of the mine site and working with the OSM to address all regulatory concerns, a reclamation plan will be developed and implemented that will minimize the risk of negative environmental impacts while restoring the mined area to its natural topography, allowing for future land use, and providing a beneficial use of the CCBs generated by the power plant.