Chapter 3 – Affected Environment

3.0 AFFECTED ENVIRONMENT

This chapter provides a description of the existing condition of the environment that could be affected by the proposed action or alternatives to the proposed action, as described in Chapter 2. The environmental resources described include air, water, geology, soils, wetlands, vegetation, fish and wildlife, cultural, visual, noise, land use, and socioeconomics.

For the purposes of describing the affected environment, the location and extent of the area studied depended on the resource component being evaluated. Most resources were evaluated within 0.5 to 1 mile from the project footprint, which includes the power plant site, associated infrastructure locations, and Areas IV South and V of the BHP Navajo Coal Company (BNCC) Lease Area. Some resources, such as air, water, environmental justice, socioeconomics, and ethnographic studies required a broader study area, as described in each resource section below.

3.1 AIR RESOURCES

3.1.1 Regional Climate

The project area is characterized by relatively level, sparsely vegetated high desert terrain, punctuated by ridges and buttes (Hogback Mountain, Shiprock Peak) and traversed by incised channels (Chaco Wash, San Juan River). Surrounding areas include higher elevations (Chuska and Carrizo Mountains in northeast Arizona and northwest New Mexico, Ute Mesa in Colorado and New Mexico, San Juan Mountains in southwest Colorado and north-central New Mexico). Table 3-1 summarizes meteorological conditions within and near the project area.

Table 3-1 Meteorological Conditions Within and Near the Project Area

Monitor	Winter Average	Spring Average	Summer Average	Fall Average	Annual Average
Mean Monthly Temperature Average (°F)[a]					
Aneth Plant, UT	33.5	55.3	77.4	55.8	55.5
Cortez, CO	29.4	47.1	68.6	49.9	48.7
Fruitland 2E, NM	32.3	51.4	72.7	53.2	52.4
Lukachukai, AZ	30.9	48.1	69.6	51.3	50.0
Newcomb, NM	30.8	51.9	73.6	53.0	52.3
Shiprock, NM	32.0	52.6	73.9	53.8	53.1
Teec Nos Pos, AZ	33.5	54.5	76.8	55.6	55.1
Mean Monthly Precipitation Average (inches)[a]					
Aneth Plant, UT	2.23	1.68	1.55	2.66	8.13
Cortez, CO	3.03	3.00	3.16	3.80	12.99
Fruitland 2E, NM	1.74	1.64	2.08	2.29	7.75
Lukachukai, AZ	1.92	1.65	2.94	2.68	9.20
Newcomb, NM	0.82	0.91	2.34	1.89	5.97
Shiprock, NM	1.51	1.48	1.98	2.10	7.07
Teec Nos Pos, AZ	1.79	1.72	2.33	2.34	8.18
Mean Monthly Snowfall Average (inches)[a]					
Aneth Plant, UT	2.1	0.1	0.0	0.3	2.6
Cortez, CO	23.5	7.0	0.0	3.2	33.7
Fruitland 2E, NM	8.5	1.1	0.0	1.3	10.9
Lukachukai, AZ	9.8	4.4	0.0	2.0	16.3

Monitor	Winter Average	Spring Average	Summer Average	Fall Average	Annual Average
Newcomb, NM	0.5	0.0	0.0	0.0	0.5
Shiprock, NM	3.2	0.6	0.0	0.2	4.0
Teec Nos Pos, AZ	4.3	0.4	0.0	0.5	5.2
Average Windspeed (miles per hour)[b]					
Window Rock AP, AZ	4.8	7.8	5.7	4.5	5.6
Cortez AP, CO	6.2	8.4	7.2	6.4	7.0
Farmington AP, NM	7.8	9.5	8.6	7.8	8.5

SOURCE: Western Regional Climate Center (WRCC) (http://www.wrcc.dri.edu/) 2006

NOTES: AP = Airport
AZ = Arizona
CO = Colorado
NM = New Mexico
UT = Utah
°F = degrees Fahrenheit
[a] For mean monthly temperature, mean monthly precipitation, and mean monthly snowfall, the period used for Aneth Plant is 1959 to 2005, for Cortez is 1929 to 2005, for Fruitland 2E is 1914 to 2005, for Lukachukai is 1951 to 2005, for Newcomb is 1948 to 1971, for Shiprock is 1926 to 2005, and for Teec Nos Pos is 1962 to 2005.
[b] For average wind speed values, averages are based on data collected between 1992-2002.

Wind patterns in the project vicinity are primarily influenced by seasonal and diurnal patterns and by local topography. Along the San Juan River basin during the cooler months, the atmosphere tends to be more stable (more frequent temperature inversions), with longer periods of localized nighttime and early morning drainage flows from the mountainous areas north and east of the site. The atmosphere tends to be less stable (fewer temperature inversions), characterized by more synoptic southwest-to-northeast flows during warmer months.

San Juan County in northwest New Mexico has an arid climate, characterized by wide variations in diurnal and annual temperature. The area receives precipitation during the summer months, when afternoon showers form as a result of moist air from the Gulf of Mexico moving over the area, and in the fall and winter, when cold fronts moving to the east and southeast from the Pacific Ocean create steady, usually light rain and snow showers across the area. The total amount of precipitation received at specific locations may be related to topographic features and changes in altitude. Most snowfall is light and evaporates within a few days.

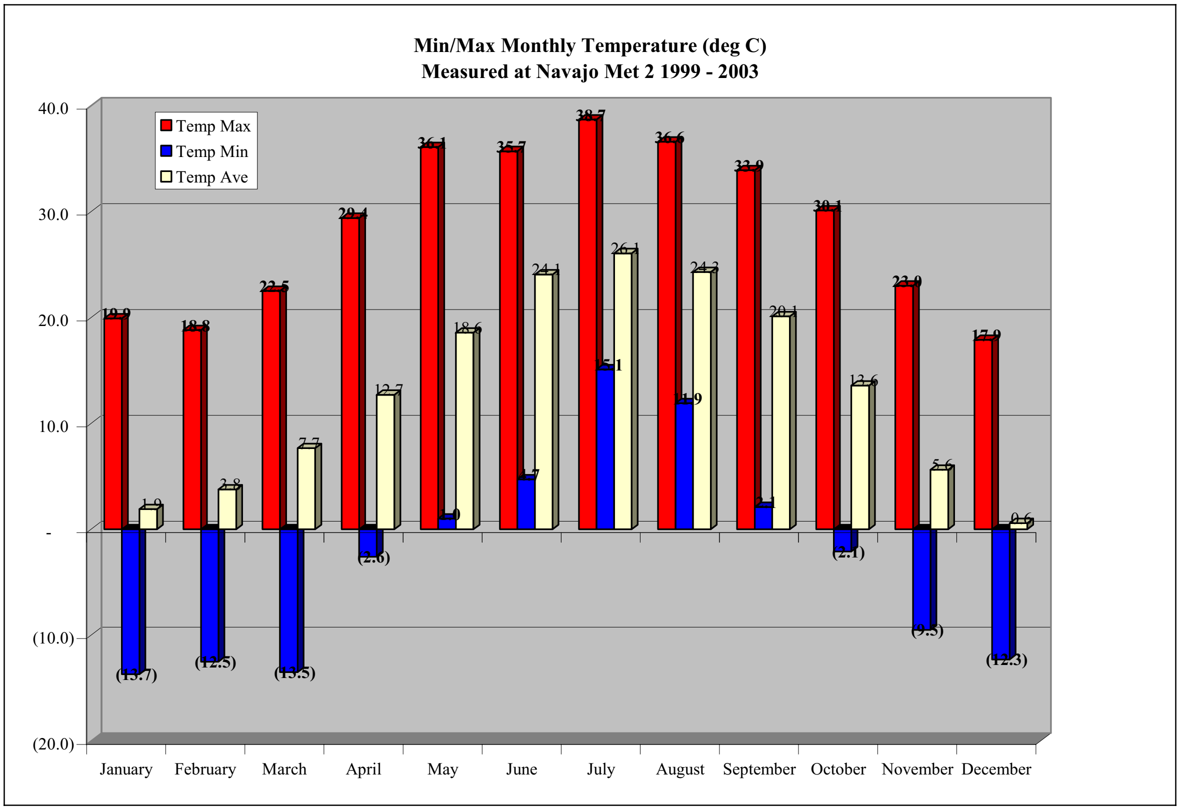
Due to its moderately high elevation (ranging from 5,000 to 6,600 feet above mean sea level [MSL]), San Juan County experiences mild summer and cold winter temperatures. Average annual temperatures near the project site are in the low to mid 50s. Summer temperatures generally range from the mid-60s to the low 90s. Temperatures in excess of 100 degrees Fahrenheit (100ºF) are rare. In winter, early morning temperatures normally drop to the high teens or low 20s; however, the air usually warms rapidly and reaches the upper 30s or low 40s by mid afternoon. (WRCC 2006).

3.1.2 Project Area Climate

Navajo Mine has collected meteorological data at two sites within the mine lease for over twenty years. Information provided graphically in Charts 3-1 and 3-2 was collected from the meteorology station located nearest the project area. "Met 2" is located between Areas II and III of Navajo Mine, roughly 6 miles north-northeast of the proposed project area. Detailed information on the Navajo Mine Extension project is described herein as well as Appendix E.

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 3-1 shows the observed monthly temperatures in the project area.

Chart 3-1 – Monthly Temperatures



Precipitation is low, averaging roughly 6 inches (150 millimeters) 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 to any significant depth over the project area. Operations at Navajo Mine are rarely disrupted by snow. Chart 3-2 shows the observed monthly precipitation in the project area.

Chart 3-2 – Average Monthly Precipitation within the Project Area

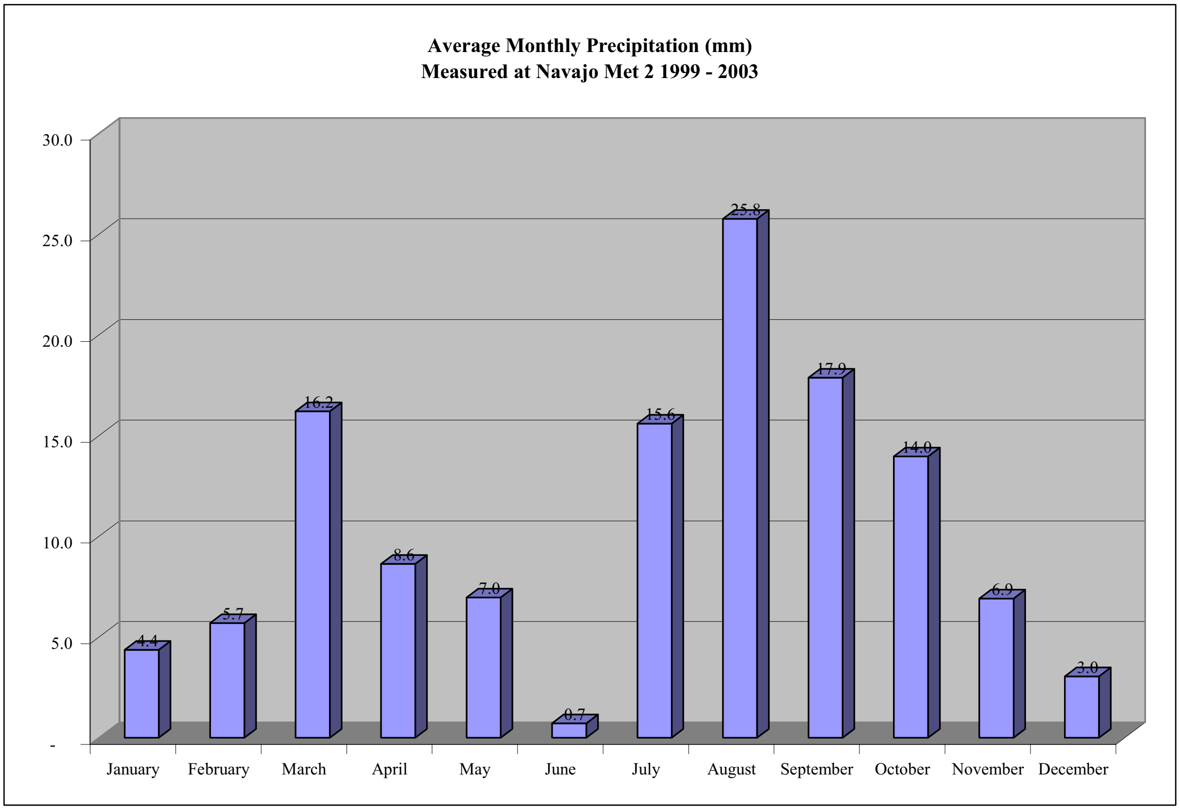


Table 3-2 gives the precipitation event maximums for the 6-hour storm event. While these event totals appear low by some measures, the relatively impermeable surfaces found around much of the project area have low infiltration rates and produce substantial runoff.

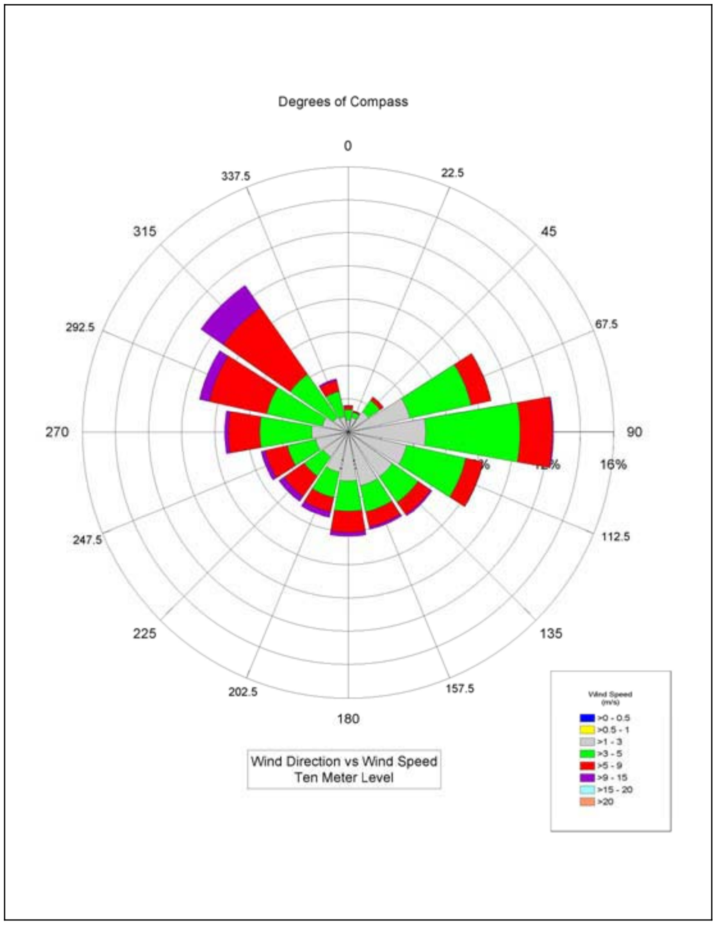
Table 3-2 Precipitation Event Frequency and Intensity within the Project Area 6-Hour Event

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: J.F. Miller. R.H. Fredrick, and R.J. Tracey; U.S. Department of Commerce 1973
NOAA = National Oceanic and Atmospheric Administration

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. Figure 3-1 shows the wind rose for 2004 as observed at the project area.

Figure 3-1 Wind Direction versus Wind Speed within the Project Area



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.

3.1.3 Air Quality

The criteria information to characterize the existing air quality conditions within the project area include the following quantifiable indicators:

- National Ambient Air Quality Standards (NAAQS), as identified in the Federal Clean Air Act (CAA) and regulated by the U.S. Environmental Protection Agency (USEPA) (Table 3-3)
- Ambient air quality measurements in project area (Table 3-4)

- Observed levels of visibility in Class I areas (Table 3-5);
- Identification of major permitted sources in the vicinity of the proposed project
- Criteria and hazardous air pollutant emissions from existing coal-fired power plants in the region

Data were available from Federal, State, and local air quality permitting authorities, including the USEPA, and Arizona, New Mexico, Colorado and Utah authorities.

3.1.3.1 Summary

Ambient air quality in northwest New Mexico is generally good, characterized by periodically monitored elevated concentrations of regulated criteria pollutants. No exceedances of these standards are listed on the USEPA Web site. Exceedances of the Federal particulate matter standard have been monitored at or near the Navajo Mine and other areas in the region; the data reflect microscale conditions influenced by industrial activity and/or dry windy conditions. Numerous major sources of regulated air pollutants exist throughout the project vicinity, including power plants, natural gas pipeline compressor stations, petroleum refineries, and other facilities, which contribute to the current air quality conditions in the area. The following subsections provide further technical details on the air quality status in the project area.

3.1.3.2 Regulatory Environment

3.1.3.2.1 National Ambient Air Quality Standards

Since 1970, the Federal CAA and subsequent amendments have provided the authority and framework for USEPA regulation of air emission sources. The USEPA regulations promulgated pursuant to the authority provided in the CAA serve to establish requirements for the monitoring, control, and documentation of activities that will affect ambient concentrations of certain pollutants that may endanger public health or welfare. In particular, these regulations have the overall objective of achieving and maintaining adherence to appropriate standards for ambient air quality.

As an enforcement tool, the CAA established the NAAQS, which currently apply to six criteria pollutants—sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen dioxide (NO_2), particulate matter equal to or less than 10 microns in diameter (PM_{10}), ozone (O_3), and lead (Pb). More recently, additional standards for 8-hour average O_3 concentrations and particulate matter equal to or less than 2.5 microns in diameter ($PM_{2.5}$) were added (Table 3-3). These standards are defined in terms of threshold concentration (e.g., micrograms per cubic meter [$\mu g/m^3$]) measured as an average for specified periods of time (averaging times). Short-term standards (i.e., 1-hour, 8-hour, or 24-hour averaging times) were established for pollutants with acute health effects, while long-term standards (i.e., annual averaging times) were established for pollutants with chronic health effects.

Table 3-3 Clean Air Act National Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS	
		Primary	Secondary
Sulfur dioxide (SO_2)	3-hour	—	1,300 µg/m^3
	24-hour	365 µg/m^3	—
	Annual	80 µg/m^3	—
Particulate matter equal to or less than 10 microns in diameter (PM_{10})	24-hour	150 µg/m^3	150 µg/m^3
	Annual	Revoked	Revoked
Particulate matter equal to or less than 2.5 microns in diameter ($PM_{2.5}$)	24-hour	35 µg/m^3	35 µg/m^3
	Annual	15 µg/m^3	15 µg/m^3
Carbon monoxide (CO)	1-hour	40,000 µg/m^3	—
	8-hour	10,000 µg/m^3	—
Nitrogen dioxide (NO_2)	Annual	100 µg/m^3	100 µg/m^3
Lead (Pb)	Quarterly	1.5 µg/m^3	1.5 µg/m^3
Ozone (O_3)	1-hour	235 µg/m^3	235 µg/m^3
	8-hour	160 µg/m^3	160 µg/m^3

SOURCE: U.S. Environmental Protection Agency 2003a, 2003b, 2003c, 2003d, 2003e, 2003f, 2003g, 2003h
NOTES: µg/m^3 = micrograms per cubic meter
NAAQS = National Ambient Air Quality Standards

On December 17, 2006, two changes to the Federal ambient air quality standards for particulate matter were made:

- The Federal annual average PM_{10} standard was rescinded with no replacement. The Federal 24-hour PM_{10} standard remains in effect.
- The Federal 24-hour $PM_{2.5}$ standard became more stringent, with a change from 65 µg/m^3 to 35 µg/m^3. The Federal annual average $PM_{2.5}$ standard remains unchanged.

Geographic areas are designated as "attainment," "nonattainment," or "unclassified" for each of the criteria pollutants with respect to the NAAQS. If sufficient monitoring data are available and air quality is shown to meet the NAAQS, the USEPA may designate an area as attainment. Areas in which air pollutant concentrations exceed the NAAQS are designated as nonattainment for specific pollutants and averaging times. Typically, nonattainment areas are urban regions and/or areas with higher-density industrial development. Because an area's status is designated separately for each criteria pollutant, one geographic area may have all three classifications. When permitting new sources, an unclassified area is treated as an attainment area.

All areas within 100 kilometers (km) from the proposed project site are currently classified as attainment or are unclassified.

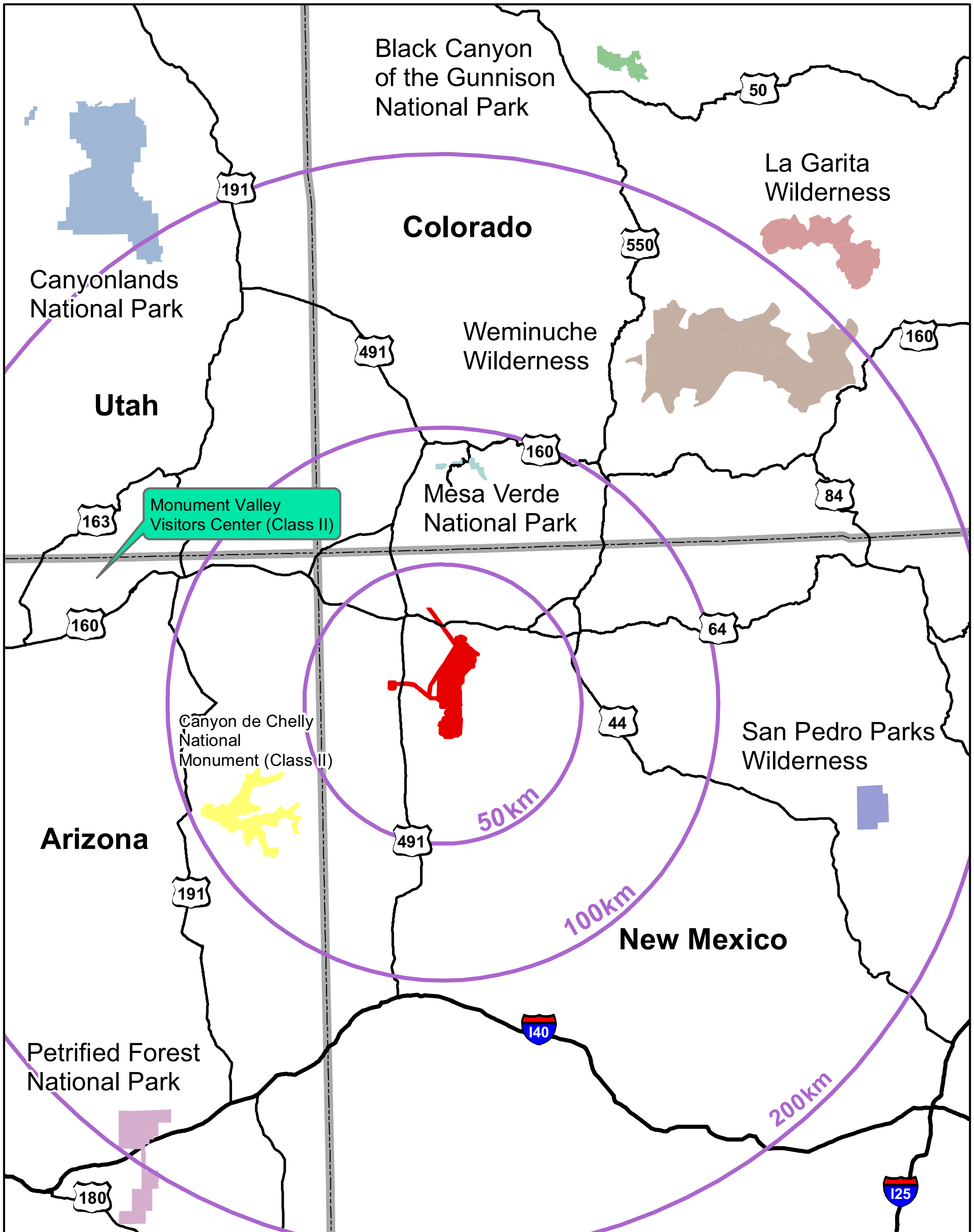
The CAA also defines air quality in terms of visibility. Areas meeting similar criteria for relatively pristine air quality (and unique natural features on a national level) may be designated as Class I areas. Specific provisions are included in Federal air quality regulations to preserve air quality in Class I areas. All areas not designated as Class I are, by default, designated as Class II areas. Designated Class I areas in the vicinity of the project site are identified on Figure 3-2.

3.1.3.2.2 Navajo Nation EPA Laws and Regulations

The Navajo Nation Environmental Protection Agency (NNEPA) has the authority and responsibility to enforce air quality regulations and standards within the Navajo Indian Reservation, which is where the proposed project would be located. The reservation is recognized as a sovereign land and is not subject to the regulations of the State of New Mexico. However, is the nation is subject to USEPA regulations. Since the majority of the reservation is located in Arizona, including the tribal headquarters in Window Rock, Arizona, USEPA Region IX has Federal jurisdiction over this project. NNEPA air quality control program operating permit regulations are provided in Navajo Nation Regulations Title 4-Environment Chapter 11-Air Pollution Prevention and Control Subchapter 2-Air Quality Control Programs Part H-Permits [4 NNR 11-2H]. These regulations establish ambient air quality operating permit standards. The USEPA delegated authority to the NNEPA to administer the Federal Title V operating permits program (Part 71) by entering into a Delegation of Authority Agreement on October 15, 2004. The Navajo Nation Air Pollution Prevention and Control Act references ambient air quality standards equivalent to the NAAQS.

3.1.3.2.3 Prevention of Significant Deterioration

Since the project will be a "major source" of criteria air pollutants, it is therefore subject to Prevention of Significant Deterioration (PSD) regulations. PSD review is a pollutant-specific review and a federally mandated program. PSD applies to new emission sources, which are to be located in an area designated as attainment or unclassified. Once a project is major for any PSD pollutant, PSD significance levels, which are lower than the major source level for most pollutants are used to determine whether additional pollutants at the major source are regulated by PSD. In order to be subject to PSD review, the potential to emit a criteria pollutant must exceed the PSD thresholds of 100 tons per year (tpy) if the source is one of the 28 named source categories or 250 tpy for all other sources. The Desert Rock Energy Project is a fossil fuel steam-generating plant with heat input greater than 250 MMBtu/hr, which is one of the 28 named categories. Therefore, the applicable PSD threshold is 100 tpy. The overall purpose of the PSD Permitting Program is to, (1) prevent violations of the Clean Air Act NAAQS and protect the environment, (2) protect air quality and visibility in national parks, national wilderness areas and other areas of special natural, recreational, scenic, or historic value, (3) allow economic growth while preserving good air quality, (4) require the Best Available Control Technology for new or modified major sources of air pollution to minimize air pollution and, (5) inform the public of USEPA's proposed PSD permitting decisions and allow the public to comment on these decisions (USEPA 2006b).



Legend

- U.S. Highway
- U.S. Interstate Highway
- State Boundary
- Study Area
- Black Canyon of the Gunnison National Park
- Canyon de Chelly National Monument (Class II)
- Canyonlands National Park
- La Garita Wilderness
- Mesa Verde Wilderness
- Petrified Forest National Park
- San Pedro Parks Wilderness
- Weminuche Wilderness

FIGURE 3-2
CLASS I AREAS AND SPECIAL CONSIDERATION CLASS II AREAS

Sithe Global Power, LLC
Desert Rock
Energy Project

0 20 40
Miles

N W E S

DPA

URS

Source:
URS Corporation 2005, 2006
Environmental Systems Research Institute 2004

UTM, NAD83, Zone12, Meters

3.1.3.3 Measured Ambient Air Pollutant Concentrations in Project Vicinity

For the purposes of evaluating current air quality in the vicinity of the proposed project, measured concentrations of NAAQS pollutant within a 50 km (31 mile) radius of the site were obtained from the USEPA. A 50 km radius was chosen to be consistent with common air permitting practices. Note that the PSD modeling used a 200 to 300 km radius when investigating air quality impacts. See Chapter 4 for more details.

Table 3-4 identifies the maximum measured concentrations of criteria pollutants in calendar years 2001 through 2005 at monitoring stations located near the project site (USEPA 2006c). None of the reported pollutant concentrations exceed the applicable NAAQS.

Table 3-4 Summary of Ambient Air Quality Background Measurements at Monitoring Stations Near the Project Site

Pollutant	Monitor Site	Averaging Period	Measured Concentration ($\mu g/m^3$)					Primary NAAQS
			2001	2002	2003	2004	2005	($\mu g/m^3$)
SO_2	Shiprock Substation (Waterflow) 35-045-1005-42401-1	1-hour	233	241	393	275	477	-
		3-hour	149	118	207	110	194	-
		8-hour	41.9	34.1	34.1	31.4	34.1	-
		Annual	10.5	7.9	7.9	7.9	5.2	78.8
PM_{10}	EIA Office 724 W. Animas Farmington, NM 35-045-0006-88102-1	24-hour	27.0	38.0	41.0	26.0	26.0	150
		Annual	17.0	17.0	20.0	14.0	15.0	Revoked
$PM_{2.5}$	EIA Office 724 W. Animas Farmington, NM 35-045-0006-88101-1	24-hour	15.0	21.0	16.0	15.0	11.0	35
		Annual	6.1	6.9	6.7	6.1	5.1	15.0
NO_2	Shiprock Substation (Farmington) 35-045-1005-42602-2	1-hour	86.5	90.3	127.9	92.2	88.4	-
		Annual	16.9	16.9	16.9	15.0	13.2	100
CO	040 Trading Post Road Sandoval, NM 35-43-9004-42101-1	1-hour	0	0	0	2,061	1,374	40,000
		8-hour	0	0	0	1031	573	10,000
O_3	Shiprock Substation (Waterflow) 35-045-1005-44201-1	1-hour	163	171	175	151	171	-
		8-hour	147	147	147	137	155	171.3

SOURCE: U.S. Environmental Protection Agency AirData Web site (http://epa.gov/air/data/) accessed June 2006c.
NOTES: km = kilometers
$\mu g/m^3$ = micrograms per cubic meter

Figure 3-3 shows the locations of the Shiprock Substation, and the Farmington and Sandoval monitoring stations.

3.1.3.4 Measured PM_{10} Concentrations at Navajo Mine

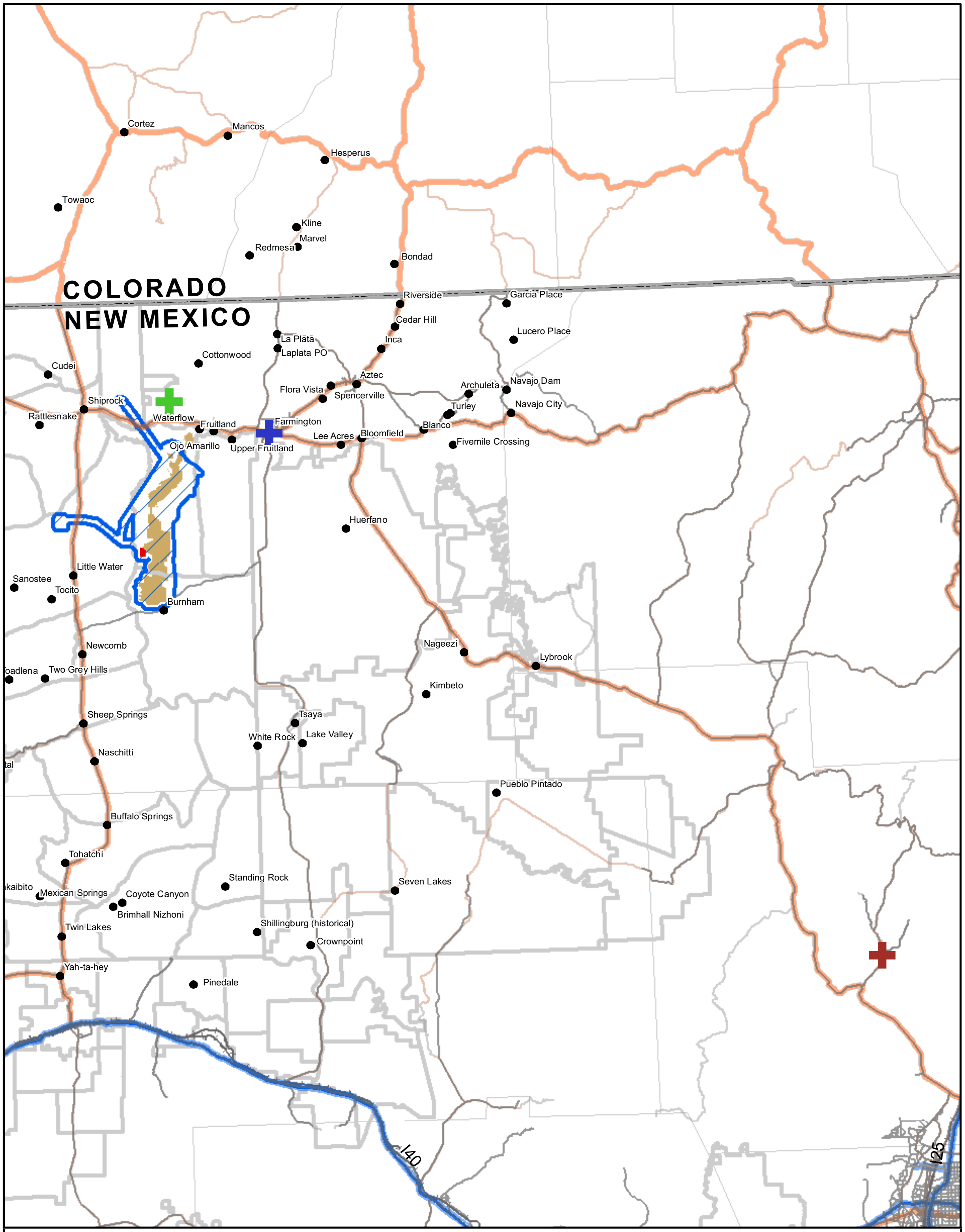
The air pollutant of primary concern associated with the proposed mining operations at the Navajo Mine Extension Project is fugitive dust containing particulate matter less than or equal to 10 microns, or PM_{10}. Emission sources for PM_{10} include blasting, overburden removal, coal extraction, transport, and handling, and general operation of mine vehicles and equipment. Operation of mine vehicles and equipment also produces emissions of other criteria pollutants, mainly CO, SO_2, oxides of nitrogen (NO_x), and volatile organic compounds (VOC). NO_x and VOC are precursors to the formation of ozone in the atmosphere.

Pursuant to 30 CFR §816.95, the Office of Surface Mining (OSM) requires BNCC to develop and implement a plan to effectively control fugitive dust. In addition, pursuant to 30 CFR §780.15(a)(1), OSM would require BNCC to conduct air quality monitoring to evaluate the effectiveness of the fugitive dust control program. Air quality data collected from the BNCC Lease Area are presented below. Figure 3-4 shows the location of the air monitoring stations on the BNCC Lease Area. The data presented here should not be considered as representative of the air quality throughout the study area or indicative of impacts from mining operations alone, as explained below.

Per the above requirements, BNCC operates four PM_{10} monitoring stations within the BNCC Lease Area. The current sampling network consists of two high-volume PM_{10} General Metal Works samplers and two BGI PQ 100 PM_{10} monitors. The samplers run simultaneously on a 24-hour, once-every-six-days schedule as per the USEPA Ambient Air Particulate Monitoring National 6-Day Schedule. Particulate sampling instrumentation, procedures, data reporting, and interpretation follow the applicable methodology described in 40 CFR Part 50, National Primary and Secondary Ambient Air Quality Standards. This program is intended to monitor air quality conditions on a microscale within the BNCC Lease Area. Calibration and quality assurance procedures are performed in accordance with USEPA guidelines, 40 CFR Part 50, 58, and the USEPA Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II Ambient Air Specific Methods.

The air monitors are positioned throughout the mine and located in areas that will facilitate the characterization of fugitive dust emissions from the mining and reclamation operations. Applicable USEPA guidance found in 40 CFR Part 58, Appendix E and in Section 2.11.3 of the handbook (April 1994), as well as various other applicable and general siting criteria, were used to locate monitor stations. The siting criteria included (1) access on existing public and/or tribal roads; (2) topography and vegetation; (3) proximity to active mine areas and local residences; (4) long range mine plan, and (5) bias from roads, structures, agricultural, and other non-mining activities.

Quarterly air monitoring reports are be submitted to OSM. The air monitoring report generally contains particulate monitoring results, analysis of samples collected, detailed particulate data, and quality assurance quality control summaries.



Legend

- CO - 040 Trading Post Road Sandoval, New Mexico
- $PM_{2.5}$ and PM_{10} - EIA Office 724 W. Animas Farmington, New Mexico
- SO_2, NO_2, and O_3 - USBR Shiprock Substation (Farmington)
- Facilities Study Area
- BHP Navajo Coal Company Lease Area (approximate)
- Navajo Chapter Boundaries

FIGURE 3-3
AMBIENT AIR MONITORING STATION LOCATIONS

Sithe Global Power, LLC
Desert Rock
Energy Project

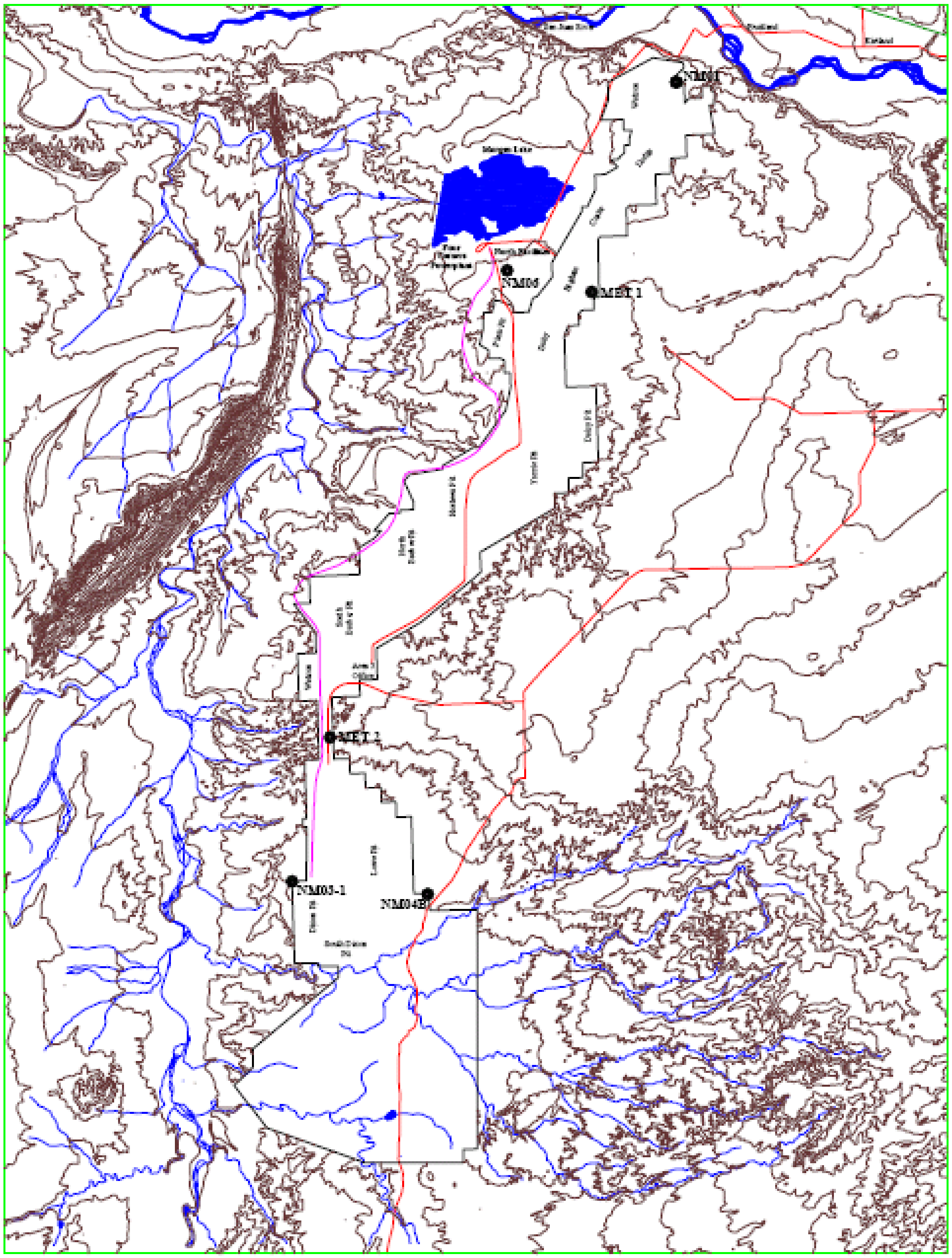
Navajo Chapter Boundary Disclaimer:
Information provided is still under development but is made available to the requesting party for the purpose of identifying, displaying general information on landstatus. No warranty, expressed or implied, is made by Navajo Land Department as to the accuracy of this data, nor shall the fact of distribution constitute any such warranty, and no such responsibility is assumed by the Navajo Land Department in connection therewith.

Source:
URS Corporation 2006
Environmental Systems Research Institute 2004

UTM, NAD83, Zone12, Meters

0 10 20
Miles

Figure 3-4 Location of PM_{10} Monitoring Stations within BNCC Lease Area



3.1.3.4.1 Average Annual Ambient Air Quality

Summary reports of the monitoring system operations and measured PM_{10} concentrations for 2004 and 2005 were reviewed (Class One Technical Services 2004, 2005). During this period, BNCC did not report any exceedances of the PM_{10} NAAQS of 50 ug/m^3. Table 3-5 provides a summary of the observed annual average PM_{10} concentrations.

Table 3-5 Annual Average PM_{10} Concentrations within the BNCC Lease Area

		Monitored Annual Average PM_{10} Concentration ($\mu g/m^3$)	
Monitor ID	**Location**	**2004**	**2005**
NM-01	Area I (Watson)	11.5	15.9
NM03-01	Area III (North Dixon)	24.3	47.5
NM04b	Area III (East Lowe)	23.3	40.5
NM06	Area I (North Facilities)	35.5	41.6

Monitor NM-01 is located in an area of the mine lease that has been completely reclaimed and is distant from any current mining or processing activities. Consequently, these results may be viewed as the closest representation of background conditions outside the mine lease. The other monitors are within active mining and processing areas and are therefore impacted by fugitive dust generation from these activities.

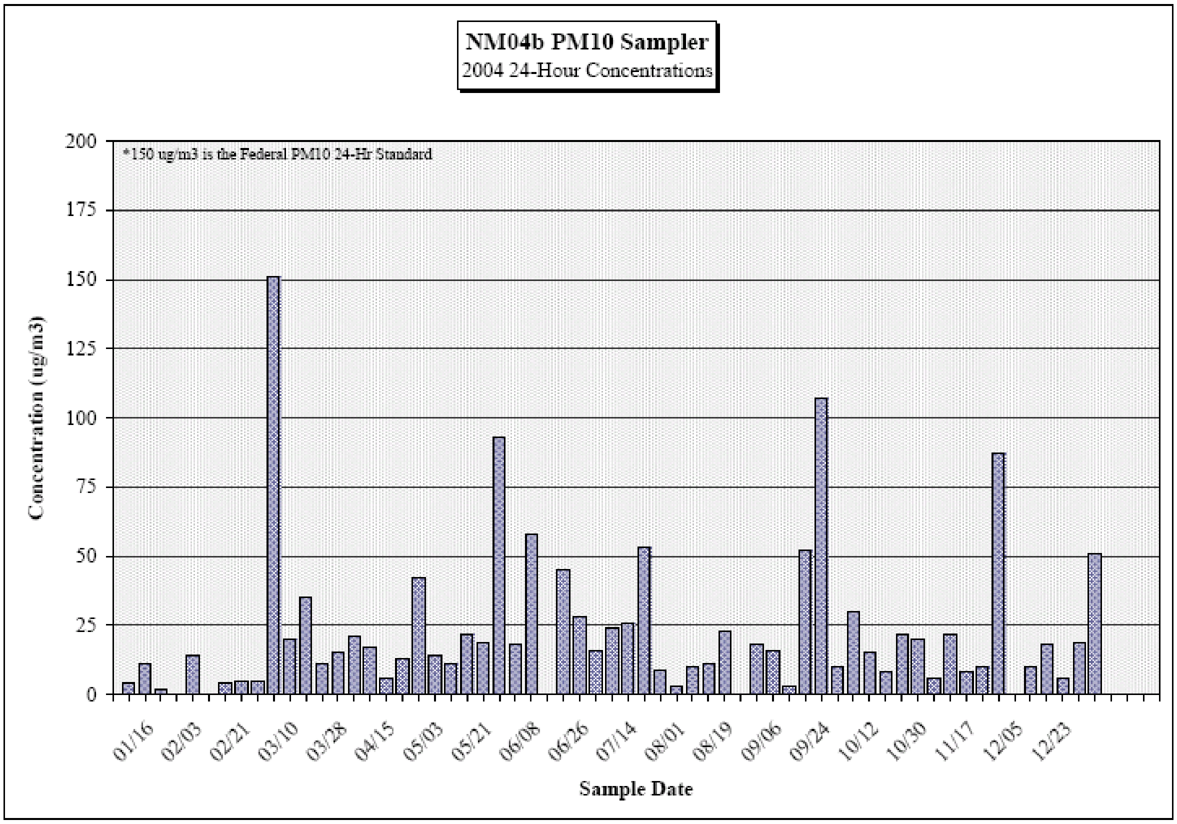
3.1.3.4.2 Short-Term (24-hour) Ambient Air Concentrations

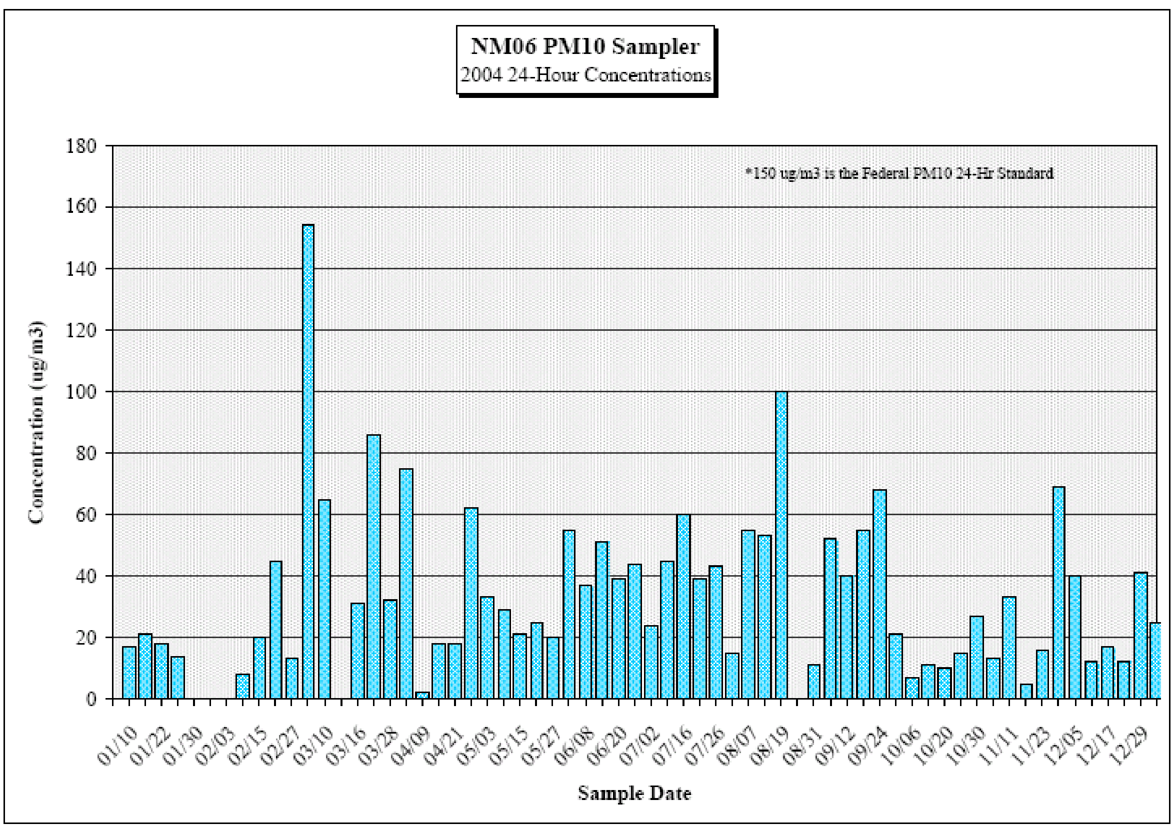
Table 3-6 shows the highest and second-highest measured PM_{10} concentrations at each of the four monitors during 2004 and 2005.

Table 3-6 24-Hour Average Ambient PM_{10} Concentrations within the BNCC Lease Area

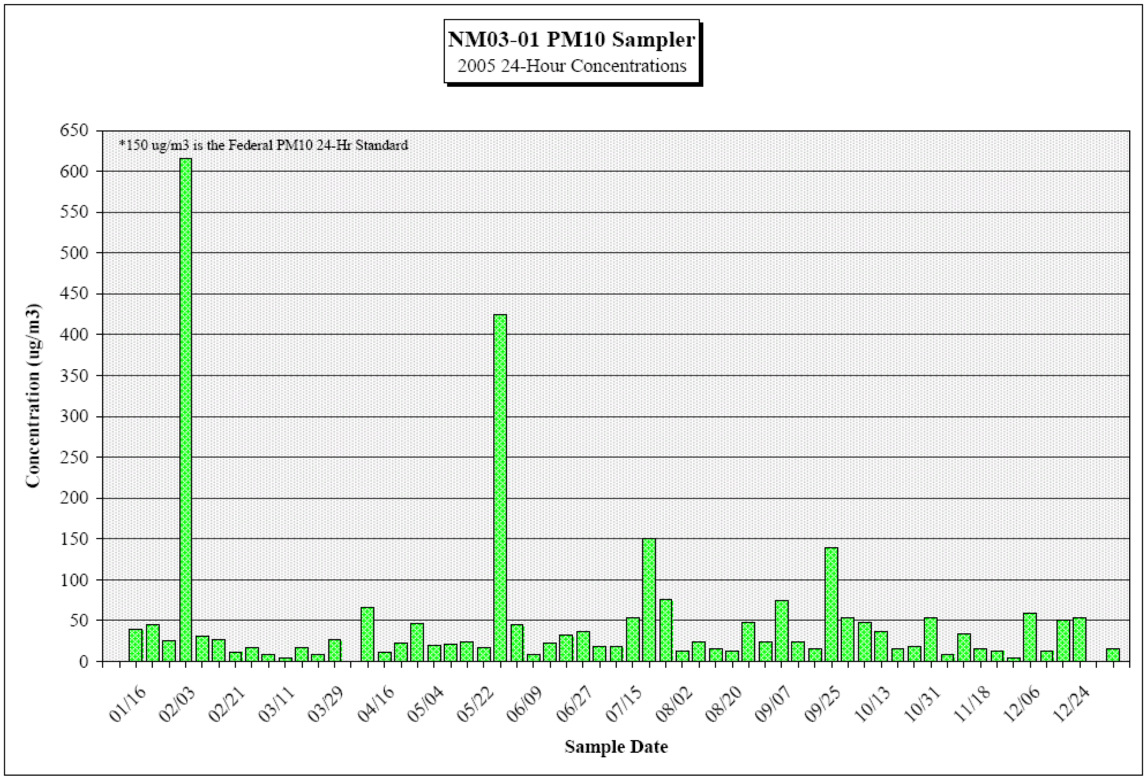
	2004		2005	
Monitor ID	**Highest**	**Second Highest**	**Highest**	**Second Highest**
NM-01	37	22	42	38
NM03-01	107	105	616	425
NM04b	151	107	449	308
NM06	154	109	199	106

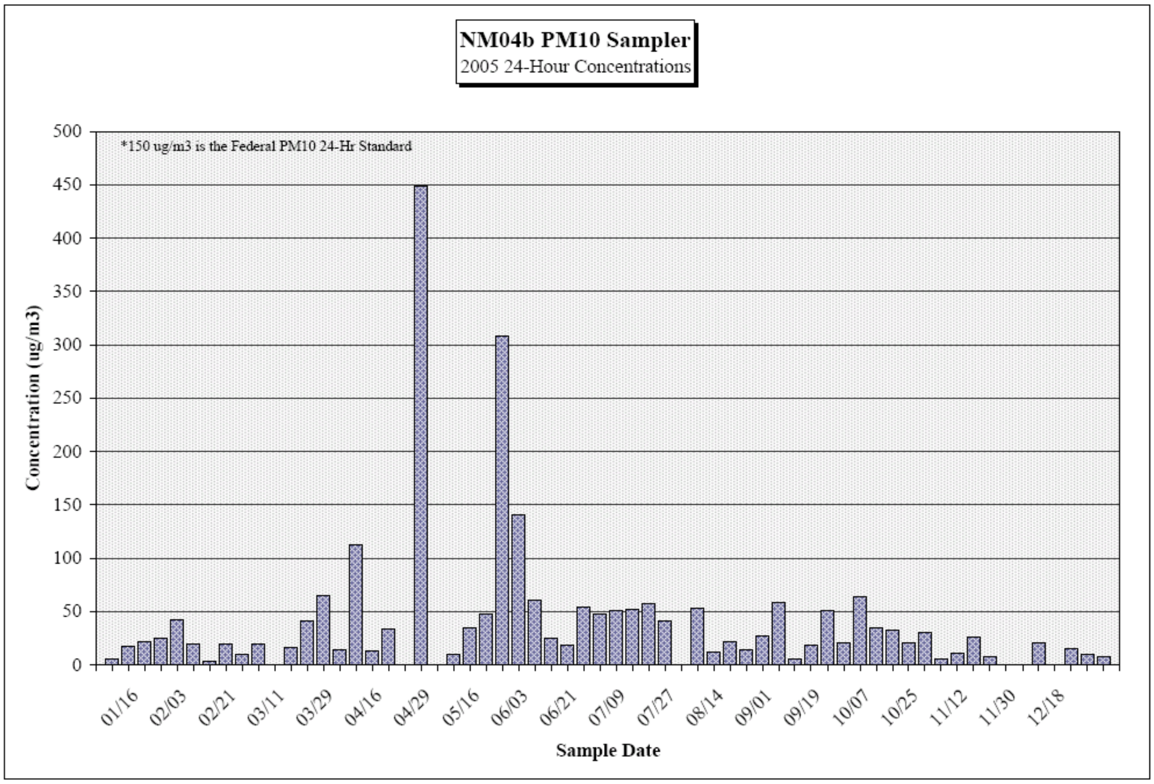
In 2004, two 24-hour PM_{10} samples exceeded the 150 $\mu g/m^3$ NAAQS value. Sampler NM04b measured a PM_{10} concentration of 151 $\mu g/m^3$ and Sampler NM06 measured a PM_{10} concentration of 154 $\mu g/m^3$ on February 27. As shown in the graphs below, these exceedances are anomalous when considered against the year-long profile recorded by each monitor.

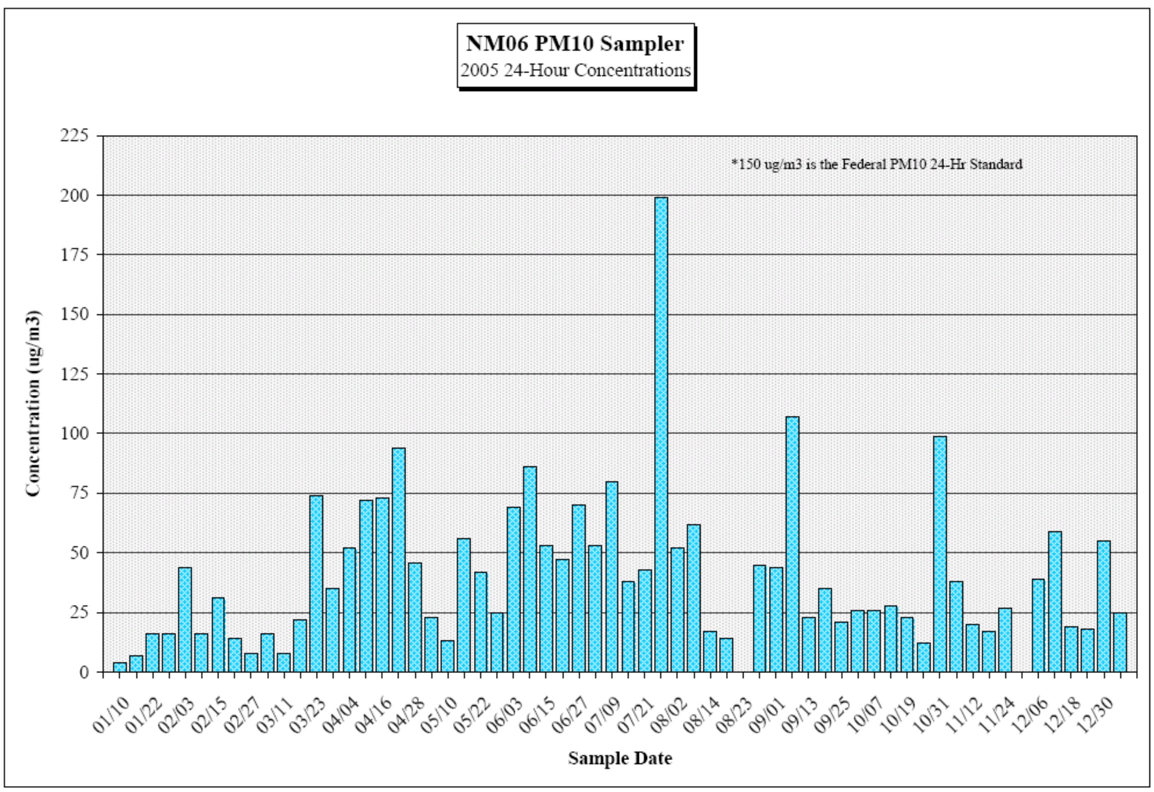

NM04b PM10 Sampler
2004 24-Hour Concentrations
*150 ug/m3 is the Federal PM10 24-Hr Standard
Concentration (ug/m3)
Sample Date
200
175
150
125
100
75
50
25
0
01/16
02/03
02/21
03/10
03/28
04/15
05/03
05/21
06/08
06/26
07/14
08/01
08/19
09/06
09/24
10/12
10/30
11/17
12/05
12/23


NM06 PM10 Sampler
2004 24-Hour Concentrations
*150 ug/m3 is the Federal PM10 24-Hr Standard
Concentration (ug/m3)
Sample Date
180
160
140
120
100
80
60
40
20
0
01/10
01/22
01/30
02/03
02/15
02/27
03/10
03/16
03/28
04/09
04/21
05/03
05/15
05/27
06/08
06/20
07/02
07/16
07/26
08/07
08/19
08/31
09/12
09/24
10/06
10/20
10/30
11/11
11/23
12/05
12/17
12/29

In 2005, six 24-hour PM_{10} samples exceeded the 150 µg/m^3 NAAQS. Sampler NM03-01 measured 24-hour PM_{10} concentrations of 616 µg/m^3 on January 28, 425 µg/m^3 on May 22, and 151 µg/m^3 on July 15. Sampler NM04b measured 24-hour PM_{10} concentrations of 449 µg/m^3 on April 27 and 308 µg/m^3 on May 22. Sampler NM06 measured 24-hour PM_{10} concentration of 199 µg/m^3 on July 21. As shown in the graphs below, these exceedances are anomalous when considered against the year-long profile recorded by each monitor.




NM04b PM10 Sampler
2005 24-Hour Concentrations
*150 ug/m3 is the Federal PM10 24-Hr Standard
Concentration (ug/m3)
0
50
100
150
200
250
300
350
400
450
500
01/16
02/03
02/21
03/11
03/29
04/16
04/29
05/16
06/03
06/21
07/09
07/27
08/14
09/01
09/19
10/07
10/25
11/12
11/30
12/18
Sample Date


NM06 PM10 Sampler
2005 24-Hour Concentrations
*150 ug/m3 is the Federal PM10 24-Hr Standard
Concentration (ug/m3)
0
25
50
75
100
125
150
175
200
225
01/10
01/22
02/03
02/15
02/27
03/11
03/23
04/04
04/16
04/28
05/10
05/22
06/03
06/15
06/27
07/09
07/21
08/02
08/14
08/23
09/01
09/13
09/25
10/07
10/19
10/31
11/12
11/24
12/06
12/18
12/30
Sample Date

These eight recorded exceedances over 2 years represent 1.1 percent of the total data points recorded during this period. The circumstances related to these exceedances are difficult to determine accurately, but it is likely that a combination of regional drought conditions, higher than normal wind velocities, and to a lesser extent, mining-related sources contributed to the exceedances. If the impacts of mining-related sources were considered as baseline levels, it is clear that other factors contributed to the exceedances, as the recorded PM_{10} concentrations are significantly greater than the established baseline.

It is important to note again that the monitored data from samplers located within the mine lease area do not represent "ambient" air, since the area is generally inaccessible to the public. Persons working within the lease area are protected by Mine Safety and Health Administration worker exposure standards, which consist of 8-hour time-weighted average values that are considerably higher than the NAAQS. In addition, monitored pollutant concentration data from locations close to significant emission sources tend to reflect micro-scale conditions, not usually representative of the broader region.

3.1.3.5 Visibility Conditions

The Cooperative Institute for Research in the Atmosphere operates a network of visibility monitoring stations in or near Class I areas, and publishes Integrated Monitoring of Protected Visual Environments (IMPROVE) data. The purpose is to identify and evaluate patterns and trends in regional visibility. Data from four IMPROVE monitors in and near the study area show that fine ($PM_{2.5}$) and coarse (PM_{10}) particulates are the largest contributors to the impairment of visibility; other air pollutants tend to have lesser impacts on visibility. These particulates impact the standard visual range—the distance that can be seen on a given day—from each monitor location. Standard visual ranges for each of the four monitors on their best (highest visibility), worst (lowest visibility), and intermediate (average visibility) visibility days are provided in Table 3-7.

Table 3-7 Standard Visual Ranges from IMPROVE Monitors Near the Project Site

Monitor	Best Visibility Days km (miles)	Intermediate Visibility Days km (miles)	Worst Visibility Days km (miles)
Canyonlands National Park, UT	239 (148)	177 (110)	119 (74)
Mesa Verde National Park, CO	189 (117)	165 (102)	105 (65)
Petrified Forest National Park, AZ	212 (132)	153 (95)	102 (63)
San Pedro Parks, NM	279 (173)	186 (116)	124 (77)
Weminuche Wilderness Area, CO	258 (160)	188 (117)	127 (79)

SOURCE: Interagency Monitoring of Protected Visual Environments 2005

3.1.3.6 Other Emission Sources in the Region

A number of diverse major sources are located within and near the air quality study area, including industrial categories such as gas- and coal-fired power plants, natural-gas-pipeline compressor stations, and refineries.

Table 3-8 provides a summary of these sources.

Table 3-8 Major Sources of Air Emissions Located within and near the Air Quality Study Area

Owner	Facility Type	Location	Permitting Authority
Ameramex Energy Group, Inc. (Bloomfield Energy Farm)	Electric utility	Bloomfield, NM	NMED
Arizona Public Service (Four Corners Generating Station)	Coal-fired electric generating station	Fruitland, NM	NNEPA
Arizona Public Service (Cholla Generating Station)	Coal-fired electric generating station	Joseph City, AZ	ADEQ
Burlington Resources Oil & Gas (Arch Rock, Cedar Hill, Hart Canyon, Middle Mesa, Pump Canyon and Rattlesnake)	Natural gas compressor stations	San Juan County, NM	NMED
Burlington Resources Oil & Gas (Valverde Gas Plant)	Natural gas processing	San Juan County, NM	NMED
City of Farmington (Animas Plant)	Electric power plant	San Juan County, NM	NMED
City of Farmington (Bluffview Power Plant)	Electric power plant	San Juan County, NM	NMED
City of Farmington (Navajo Dam Plant)	Electric power plant	San Juan County, NM	NMED
Conoco, Inc. (San Juan Gas Plant)	Natural gas processing	San Juan County, NM	NMED
El Paso Natural Gas (3b-1, Angel Peak, Ballard, Bisti #4, Blanco, Klutz, San Juan and White Rock)	Natural gas compressor stations	San Juan County, NM	NMED
El Paso Field Services (Chaco Gas Plant)	Natural gas processing	San Juan County, NM	NMED
EnCana Oil & Gas (USA) Incorporated	Natural gas processing plant	35 miles south of Moab, UT	UDAQ
Giant Industries (San Juan Refinery)	Petroleum refineries	San Juan County, NM	NMED
Giant Industries (Cineza Refinery)	Petroleum refineries	East of Gallup, NM	NMED
Plains Electric TriState Generating Station (Escalante Plant)	Coal-fired electric generating station	Prewitt, NM	NMED
Public Service Company of New Mexico (San Juan Generating Station)	Coal-fired electric generating station	Farmington, NM	NMED
Salt River Project (Navajo Generating Station)	Coal-fired electric generating station	Page, AZ	USEPA
Salt River Project (Coronado Generating Station)	Coal-fired electric generating station	St. Johns, AZ	ADEQ
Transwestern Pipeline Company (Bloomfield)	Natural gas compressor station	San Juan County, NM	NMED
Tucson Electric Power (Springerville Generating Station)	Coal-fired electric generating station	Springerville, AZ	ADEQ
Williams Field Services (30-8 CDP, 32-7 CDP, 32-8 #2 CDP, 32-8 #3 CDP, 32-9 CDP, Aztec, Cedar Hill, Decker Junction, Horse Canyon, Keblah, La Cosa, Manzanares, Middle Mesa CDP, Navajo CDP, North Crandall, Pump Mesa, Rosa #1, Trunk A, Truck B and Truck N)	Natural gas compressor stations	San Juan County, NM	NMED

Owner	Facility Type	Location	Permitting Authority
Williams Field Services (Huerfano Pump Station)	Natural gas liquids pump station	San Juan County, NM	NMED
Williams Field Services (Ballard, Blanco, Chaco, Crandall, Hare, Kutz Gas Plant, La Maquina, Milagro and Thompson)	Natural gas processing	San Juan County, NM	NMED

SOURCE: U.S. Environmental Protection Agency 2005a
NOTES: ADEQ = Arizona Department of Environmental Quality
NMED = New Mexico Environment Department
NNEPA = Navajo Nation Environmental Protection Agency
UDAQ = Utah Division of Air Quality
USEPA = U.S. Environmental Protection Agency

In addition to the major air pollutant sources listed above, seven coal-fired power plants are located within or near the Four Corners region; (four in northeast Arizona and two in northwest New Mexico). For purposes of comparison with maximum potential emission rates from the proposed project, the actual reported emissions of criteria and hazardous air pollutant from these six plants are summarized in Table 3-9.

Table 3-9 Emissions from Other Coal-Fired Power Plants in the Area

Plant Name		Four Corners Generating Station (Fruitland, NM) 15 miles N			Navajo Generating Station (Page, AZ) 100 miles WNW			San Juan Generating Station (Farmington ,NM) 25 miles NNE			Cholla Generating Station (Joseph City, AZ) 150 miles SW			Coronado Generating Station (St. John's, AZ) 130 miles SSW			Springerville Generating Station (Springerville, AZ) 150 miles SSW			Total		
		2002 [1]	2003 [2]	2004 [2]	2002 [1]	2003 [2]	2004 [2]	2002 [3]	2003 [3]	2004 [3]	2002 [4]	2003 [4]	2004 [4]	2002 [4]	2003 [4]	2004 [4]	2002 [4]	2003 [4]	2004 [4]	2002	2003	2004
POLLUTANTS	Unit of Measure																					
NOx	tons/year	41,577	44,483	41,486	35,569	31,196	NR	29,998	25,291	26,887	12,854	12,546	12,415	10,792	12,722	13,107	12,485	12,406	12,406	143,275	138,644	106,301
SO_2	tons/year	32,847	35,094	20,771	32,847	3,381	NR	16,824	14,569	16,198	20,770	17,147	18,241	17,742	18,815	13,950	19,565	19,308	19,308	140,596	108,313	88,468
PM_{10}	tons/year	5,558	1,127	758	4,100	473	NR	1,909	981	1,181	478	731	579	300	493	376	539	779	779	12,884	4,584	3,673
$PM_{2.5}$	tons/year	3,421	NR	NR	2,929	NR	NR	381	321	348	NR	NR	NR	NR	NR	NR	NR	NR	NR	NA	NA	NA
CO	tons/year	2,414	NR	NR	2,091	NR	NR	1,708	1,612	1,761	929	886	942	664	757	777	821	835	835	8,627	4,090	4,316
VOC	tons/year	282	17	16	251	21	NR	204	195	212	4	3	4	80	91	93	99	110	110	919	437	435

Plant Name		Four Corners Generating Station (Fruitland, NM) 15 miles N			Navajo Generating Station (Page, AZ) 100 miles WNW			San Juan Generating Station (Farmington ,NM) 25 miles NNE			Cholla Generating Station (Joseph City, AZ) 150 miles SW			Coronado Generating Station (St. John's, AZ)130 miles SSW			Springerville Generating Station (Springerville, AZ) 150 miles SSW			Total		
TOXICS	Unit of Measure	2002 [5]	2003 [5]	2004 [5]	2002 [5]	2003 [5]	2004 [5]	2002 [5]	2003 [5]	2004 [5]	2002 [5]	2003 [5]	2004 [5]	2002 [5]	2003 [5]	2004 [5]	2002 [5]	2003 [5]	2004 [5]	2002	2003	2004
Arsenic	pounds/year	NA	NA	NA	NA	NA	NA	170	150	130	NA	NA	NA	NA	NA	NA	10	11	10	180	161	140
Barium	pounds/year	976	852	591	5,744	3,777	6,186	7,400	11,600	11,400	320	1,142	970	966	1,142	1,153	552	927	865	15,958	19,440	21,165
Beryllium	pounds/year	16	14	9	23	20	21	NA	NA	NA	NA	NA	6	NA	NA	NA	NA	NA	NA	39	34	36
Chromium	pounds/year	269	272	202	484	398	423	210	240	242	131	265	231	251	265	238	193	208	206	1,538	1,648	1,542
Cobalt	pounds/year	57	56	41	NA	NA	NA	NA	NA	NA	NA	NA	52	NA	NA	NA	26	15	13	83	71	106
Copper	pounds/year	354	364	284	675	620	695	350	260	283	160	225	180	209	225	208	40	14	13	1,788	1,708	1,663
Nickel	pounds/year	281	281	221	657	636	636	NA	NA	NA	170	NA	200	NA	NA	NA	51	18	17	1,159	935	1,074
Selenium	pounds/year	661	751	721	NA	NA	NA	204	400	601	6,000	NA	NA	NA	NA	NA	NA	NA	NA	6,865	1,151	1,322
Manganese	pounds/year	680	670	510	1,242	987	1,015	1,850	2,740	2,640	345	785	473	735	785	677	147	220	205	4,999	6,187	5,520
Vanadium	pounds/year	327	307	217	303	289	325	380	480	400	130	439	220	NA	439	371	94	110	103	1,234	2,064	1,636
Zinc	pounds/year	1,203	1,203	973	1,857	1,672	1,871	900	760	1,160	500	1,032	770	NA	1,032	922	32	21	20	4,492	5,720	5,716
Naphthalene	pounds/year	NA	NA	NA	NA	0	111	NA	NA	84	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	195
Sodium Nitrite	pounds/year	NA	NA	NA	NA	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0	0
Hydrochloric Acid	pounds/year	37,037	44,044	35,035	42,537	38,971	41,585	25,000	23,000	26,000	300,000	191,545	170,000	278,935	191,545	158,998	33,730	34,323	32,707	717,239	523,428	464,325
Hydrogen Fluoride	pounds/year	92,092	110,110	85,085	66,232	60,582	64,950	79,000	71,000	78,000	140,000	158,062	250,000	193,463	158,062	124,382	54,564	58,527	55,772	625,351	616,343	658,189
Sulfuric Acid	pounds/year	33,033	33,033	34,034	128,496	116,223	121,851	70,000	69,000	78,000	56,000	79,176	74,000	NA	79,176	67,812	NA	NA	NA	287,529	376,608	375,697
Lead	pounds/year	364	354	248	335	248	260	111	194	225	94	195	162	179	195	151	93	92	90	1,176	1,278	1,136
Mercury	pounds/year	591	627	626	348	312	714	594	681	767	213	296	206	233	296	273	592	605	576	2,571	2,817	3,161
PAC	pounds/year	5.300	6.000	5.700	6.850	6.130	6.700	5.070	4.700	5.120	2.000	2.650	2.400	2.350	2.650	2.350	NA	NA	NA	22	22	22
Benzo(G,H,I)Perylene	pounds/year	0.210	0.240	0.200	0.300	0.300	0.300	0.200	0.190	0.200	0.110	0.100	0.100	0.100	0.100	0.100	NA	NA	NA	0.920	0.930	0.900
Dioxin and Dioxine like compounds	grams/year	1.000	1.200	1.100	3.818	3.418	1.310	NA	0.929	1.000	0.001	0.003	0.500	0.003	0.003	0.450	0.011	0.011	4.940	4.833	5.565	9.300

NA = Not Available
NR = Not Reported
[1] 2002 criteria pollutant data taken from U.S. Environmental Protection Agency - AirData Site
[2] 2003 and 2004 criteria pollutant data was provided by Iris Begaye at the Navajo Nation EPA
[3] 2002 through 2004 criteria pollutant data was provided by Heather Lancour at the New Mexico Environment Department
[4] 2002 through 2004 criteria pollutant data was provided by Latha Toopal at the Arizona Department of Environmental Quality
[5] 2002 through 2004 toxics data taken from U.S. Environmental Protection Agency TRI Database

3.2 WATER RESOURCES

3.2.1 Introduction

This section addresses the existing condition of water resources, both surface water and groundwater systems, that would be potentially affected by the proposed and alternative actions.

The Desert Rock Energy Project is located in northwest New Mexico in an arid area that receives less than 10 inches of rainfall per year. Most streams and washes in the proposed project area are intermittent or ephemeral, which means that they only carry surface water during infrequent periods resulting from heavy precipitation events within their discharge basin. Flash flooding occurs during these high intensity precipitation events which are often associated with the late summer monsoonal thunderstorms. Gradients near the source of these streams are often high, resulting in steeply incised channels. With distance from headlands, stream channels have a tendency to become shallow and broaden. Stream morphology often takes on the form of multiple channels, which are braided. It is not uncommon for braided channels to be created and abandoned on a seasonal basis. These channels can carry very high concentrations of suspended solids and bed loads during storm events. Overall, they are devoid of any water most of the time, particularly the smaller, less developed ones.

Surface water features in the study area include the San Juan River, the Chaco River, Morgan Lake, approximately eight named washes, and numerous unnamed washes. All of these washes are assumed to be intermittent or ephemeral and are heavily influenced by precipitation on the Chuska Mountains during the spring and monsoon seasons. Intermittent washes flow during seasonal precipitation, while ephemeral channels only flow during individual precipitation events. Most of the washes discharge into the Chaco River, which is an intermittent river in the proposed project area. The Chaco River flows north into the San Juan River, which is a perennial (constantly flowing) river. Originating in the San Juan Mountains of southwest Colorado, the San Juan flows southward into New Mexico and then generally westward into Utah where it eventually meets the Colorado River. One other prominent surface water feature in the proposed project area is Morgan Lake, which is manmade and used as cooling water for Arizona Public Service's Four Corners Generating Station. The San Juan River serves as the primary source of water for Morgan Lake. Water from Morgan Lake also is used by BNCC for dust suppression and for irrigation of reclaimed areas.

The primary source of groundwater in the San Juan Basin is derived from wells completed within surficial valley-fill deposits of Quaternary age and sandstones of Tertiary, Cretaceous, Jurassic, and Triassic age (Stone and others 1983). Groundwater in the sandstone sequences generally is under confined conditions, resulting in an artesian flow from wells completed in these units. There are seven distinct geologic units that supply the majority of groundwater to existing wells completed in the study area (Navajo Nation Department of Water Resources [NNDWR] 2005). With increasing depth these include alluvial deposits in washes, the Picture Cliffs Sandstone, Cliff House Sandstone, the Point Lookout Sandstone, the Gallup Sandstone, the Dakota Sandstone, and the Morrison Formation.

Over 100 domestic, municipal, and livestock watering wells have been identified in the study area. A majority of the Morrison aquifer wells in the project area are located west of highway 491 because the depth to the Morrison west of the highway is generally less than 1,000 feet, while the depth to the aquifer east of highway 491 increases significantly due to the geologic structure of the area. Many of these wells are potable artesian wells that are used by both livestock and for human consumption. Some of these wells flow unrestricted into stock watering ponds and have wetland features associated within them.

A monitoring project is under way to characterize springs and wells in the study area (Spring/Well Monitoring Project); results of these investigations will be included in the final environmental impact statement (EIS).

The remainder of this section provides (1) an overview of surface water, (2) an overview of groundwater resources, (3) a discussion of specific water resources in the vicinity of proposed project facilities, and (4) a summary of the regulatory environment.

3.2.2 Overview of Surface Water Resource

3.2.2.1 Alluvial Valley Floor Assessment

Major stream channels passing through the BNCC Lease Area were examined as part of a study by the New Mexico Bureau of Geology and Mineral Resources entitled "Identification of Alluvial Valley Floors in Strippable Coal Areas of New Mexico" (Love et al., 1981). In this report, the San Juan and Chaco river systems (among others) were investigated as part of a phase I study to distinguish "possible alluvial valley floors" from "lands clearly not alluvial valley floors" using guidelines released by OSM. No potential or possible alluvial valley floors were found in the permit area. Chinde Wash and Cottonwood Wash, the two largest drainages crossing the permit area, were specifically examined and found to be "clearly not alluvial valley floors". Adjacent drainages, including Pinabete Wash and Chaco Wash, were also found not to contain alluvial valley floors. OSM June 3, 1992, approved BHP's April 14, 1992 submittal for a negative determination for the two Washes. The only potential alluvial valley floors found near the permit area were along the San Juan River.

Most of the stream channels that pass through the permit area do not have adjacent alluvial deposits. Those few channels that do, such as Chinde Wash and Cottonwood Arroyo, are deeply incised, which acts to drain their adjacent alluvium of any groundwater. Surface flows in all of these streams are infrequent and typically occur only after precipitation events. Those flows that do occur are poor in quality with excessive levels of suspended and dissolved solids. Because of these factors, none of the streams within the permit area are considered to be capable of supporting any agricultural activity, and therefore do not warrant further study as potential alluvial valley floors. This finding is consistent with the conclusions of a phase I alluvial valley floor assessment done by Love et al. (1981) for the State of New Mexico.

3.2.2.2 Surface Water Data Collection Approach

Hydrology, water quality, and wetlands data for the proposed project site area were derived from regional studies that have been completed and published as well as studies that are being conducted specifically for the proposed project. Two studies being conducted concurrently with this EIS are (1) A *Jurisdictional Wetlands Determination*, including mapping "Waters of the U.S." crossed or impacted by project components and (2) *Seeps/Springs/Wells Mapping and Water Quality Analysis*. Analysis of aerial photography and topographic maps and global positioning system (GPS) surveying of hydrologic feature locations have been performed to put the results of these studies into geographic context.

The Waters of the U.S. Mapping effort (Appendix E) commenced in July 2006, and included determinations and measurements of wetlands and waters of the U.S. (Waters). 'Waters' for the purposes of this study include perennial streams and rivers, intermittent and ephemeral washes, and wetlands. Therefore, the surveyed Waters are not limited to perennially or seasonally flowing streams and rivers in the proposed project area, but rather include all washes with a defined channel. Proposed project area boundaries (e.g., power plant, well fields) and linear features (e.g., power lines, waterlines, and roads) were loaded into a sub-meter accuracy GPS unit to accurately locate them in the field. Waters were only mapped where they intersected with a linear project feature. Protocols specified in the U.S. Army Corps of Engineers (USACE) Wetland Delineation Manual (1987) were used to make upland-wetland determinations, where wetlands were encountered.

The Seeps/Springs/Wells Mapping and Water Quality Analysis Project commenced in September 2006. Selected springs, seeps and wells in the proposed project area were described, mapped, and analyzed for chemical water quality. These include springs/seeps/wells identified by Bureau of Indian Affairs (BIA), NNDWR, and the Sanostee, Nenahnezad, and Burnham Navajo chapters. The water quality samples will be analyzed to assess their geochemistry and demonstrate the hydrologic relationship between the Morrison formation aquifer, the Dakota formation aquifer, and the identified springs/seeps and wells. The spring water samples will be analyzed for the following physical and chemical constituents:

- Specific conductance
- Ph, temperature
- Alkalinity
- Bicarbonate
- TDS
- Sulfate, chlorides, fluorides, calcium, magnesium, manganese, sodium, potassium, nitrates, arsenic, and iron

3.2.2.3 Surface Water Existing Conditions

The most prominent surface water features within the project area include the following:

- San Juan River
- Morgan Lake
- Chaco River

Intermittent or ephemeral creeks, washes, or arroyos in the area include the following:

- Eagle Nest Arroyo
- Coal Mine Creek
- Chinde Wash
- Cottonwood Arroyo
- Pinabete Arroyo
- Coal Creek
- Pajarito Creek
- Dead Mans Wash
- Numerous unnamed washes and arroyos

These surface water features are within 0.5 mile of the proposed power plant site and the water well field Alternative A, and within a 1-mile-wide study corridor along the utility corridor/water pipeline, transmission line alternatives, proposed access road, and Areas IV South and V of the BNCC Lease Area. This area is referred to as the study area. The regional area examined for surface water includes land outside the study area, but generally within 15 miles of the proposed project facilities (unless otherwise noted), and provides a context for surface water in the general area of the project. Designated uses of these surface water features are listed in Table 3-10. The designated uses are based on the Navajo Nation Surface Water Quality Standards (NNEPA 2004).

Table 3-10 Surface Water Bodies and Designated Uses within 15 Miles of the Proposed Project Facilities

Project Area	Named Waterways Crossed By or Near To Alignment	Coordinates of Crossing Point (Latitude/Longitude)	Designated Uses for Navajo Nation Surface Waters
Plant Site	Pinabete Arroyo	108°32'54.37"W /36°29'1.67"N	*ScHC, AqHbt, L&W
	Chaco River	NA	ScHC, AqHbt, L&W
Transmission Lines	Eagle Nest Arroyo	108°34'29.81"W /36°47'1.87"N	ScHC, AqHbt, L&W
	San Juan River	108°32'33.76"W /36°44'36.62"N	Dom, PrHC, ScHC, AgWS, FC, AqHbt, L&W
	Chaco River	108°34'23.03"W /36°34'50.81"N	ScHC, AqHbt, L&W
	Coal Creek	NA	*ScHC, AqHbt, L&W
	Coal Mine Creek	NA	*ScHC, AqHbt, L&W
	Chinde Wash	108°31'0.36"W /36°38'48.43"N	ScHC, AqHbt, L&W
	Cottonwood Arroyo	108°33'47.52"W /36°31'27.30"N	ScHC, AqHbt, L&W
	Morgan Lake	NA	PrHC, ScHC, FC, AqHbt, L&W
Utility Corridor / Water Pipeline	Coal Creek	108°39'51.41"W /36°33'20.90"N	*ScHC, AqHbt, L&W
	Chaco River	108°34'23.40"W /36°30'30.19"N	ScHC, AqHbt, L&W
Access Roads	Cottonwood Arroyo	108°28'46.56"W /36°30'59.37"N	ScHC, AqHbt, L&W
	Pinabete Arroyo	108°30'20.74"W /36°28'54.66"N	*ScHC, AqHbt, L&W
BNCC Lease Area - IVS and V	Pinabete Arroyo	108°30'20.74"W /36°28'54.66"N	*ScHC, AqHbt, L&W
Well Field	Pajarito Creek	NA	*ScHC, AqHbt, L&W
	Dead Mans Wash	NA	ScHC, AqHbt, L&W

NA: Surface water feature is located near to but is not crossed by the indicated project area.
* = Not specifically designated by the Navajo Nation. Designated uses refer to all other ephemeral tributaries and playas within the Navajo Nation boundary.
Dom = Domestic Water Supply
PrHC = Primary Human Contact (i.e., for drinking)
ScHC = Secondary Human Contact (i.e., for bathing)
AgWS = Agricultural Water Supply
FC = Fish Consumption
AqHbt = Aquatic Habitat
L&W = Livestock and Wildlife Watering

The project area lies mostly within the Chaco Hydrologic Cataloging Unit (HUC) (14080106), one of nine subwatersheds of the larger San Juan Basin (Figure 3-5). The project also lies within the Middle San Juan River HUC where the transmission lines would cross the San Juan River and Eagle Nest Arroyo. The San Juan basin is within New Mexico, Arizona, Colorado, and Utah and comprises a drainage of 24,900 square miles (Abell 1994). The Chaco HUC watershed drainage area is approximately 4,550 square miles (Environmental Statistic Group 2003). The area of the Chaco HUC is 2,920,111 acres, of which 2,384,004 are within the Navajo Indian Reservation (San Juan Basin Watershed Management Plan 2005). There are 21 streams in the Chaco HUC; approximately 40 miles of perennial stream, and approximately 5,500 miles of ephemeral streams (Environmental Statistic Group 2003). The Chaco River watershed is located in the northwestern corner of New Mexico, 99 percent within New Mexico and 1 percent in Arizona (Environmental Statistic Group, 2003). The Chaco watershed is shown in Figure 3-6 and Figure 3-7.

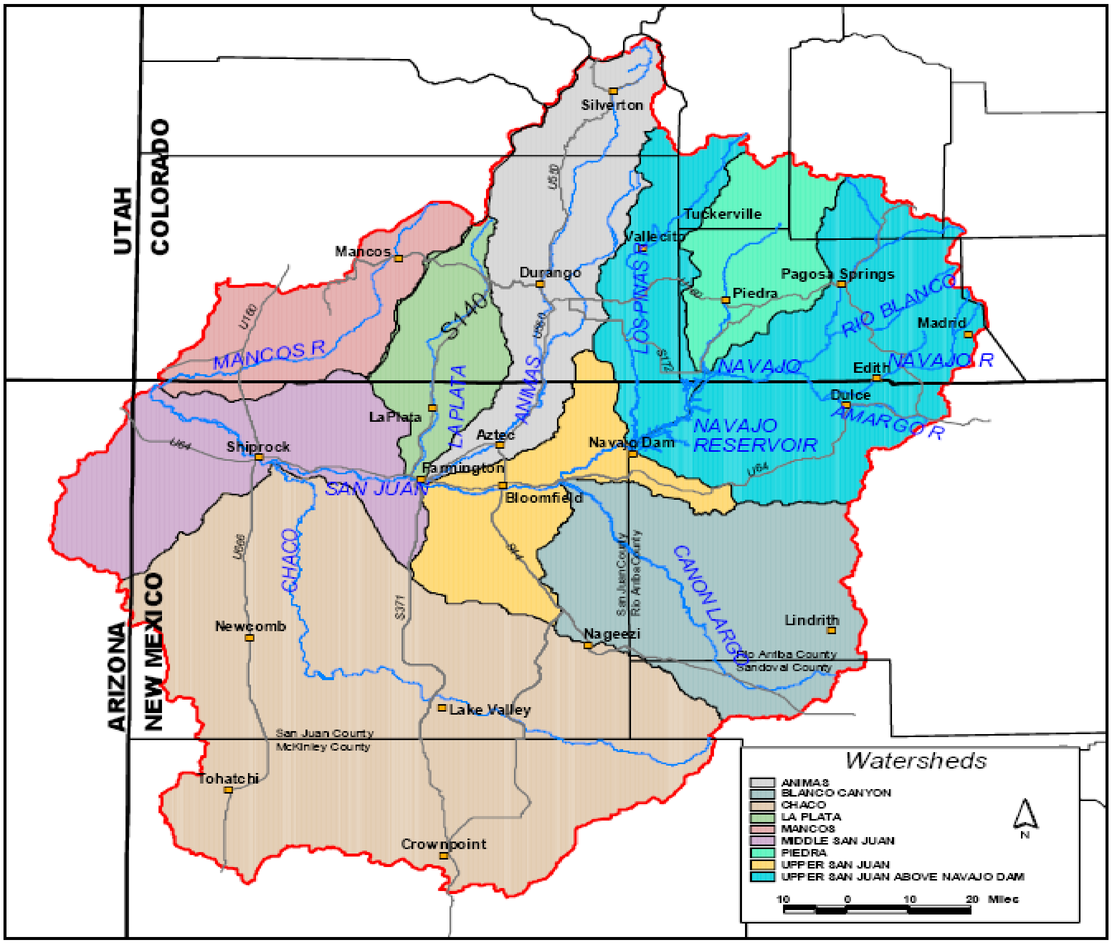
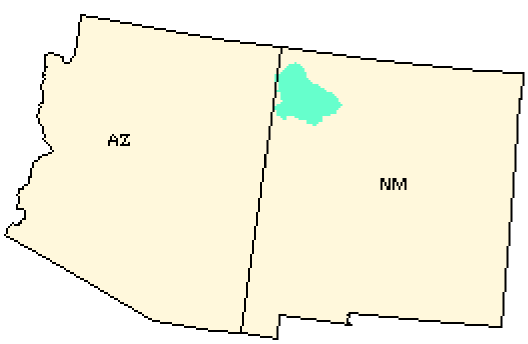


Figure 3-5 Locations of the Subwatersheds of the San Juan Basin in NW New Mexico and SW Colorado
SOURCE: San Juan Water Commission 2003



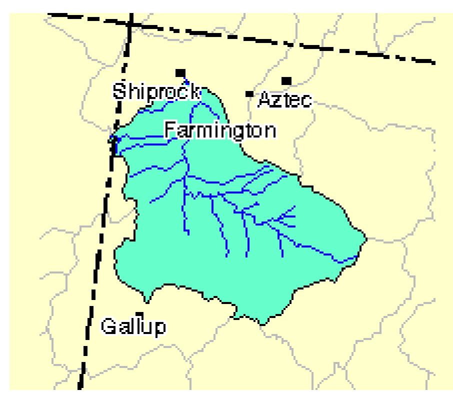


Figure 3-6 Location of Chaco Watershed **Figure 3-7 Hydrology of Chaco Watershed**

SOURCE: U.S. Environmental Protection Agency 2006d

Federal Emergency Management Agency Flood Insurance Rates Maps floodplain maps have not been completed or published for the Navajo Indian Reservation. Currently, USACE, under an agreement with the Navajo Nation and BIA, has been assigned the task of analyzing and mapping the floodplains on the reservation. Portions of the Desert Rock Energy Project could be in the 100-year floodplain of some watercourses. Proposed project area-drainage studies developed during the design and engineering phase of the project would most likely include tasks that would help determine the 100-year floodplain of the proposed project site.

3.2.2.3.1 Regional Surface Water Uses and Water Quality

Irrigation is the major use of water in this project area. In San Juan County, irrigation accounts for 78 percent of water use and power generation accounts for about 10 percent of water use (Blanchard et al. 1993). Virtually all irrigation water is obtained from surface water sources. Five irrigation projects sponsored by the U.S. Department of the Interior divert water from the San Juan River. Detailed information regarding irrigation projects and water rights is available in the U.S. Bureau of Reclamation Final EIS for Navajo Reservoir Operations (U.S. Bureau of Reclamation [USBR] 2006b). That document evaluates the potential impacts of implementing the San Juan River Basin Recovery Implementation Program's Flow Recommendations for the San Juan River, and of a reasonable alternative to those recommendations.

The San Juan Generating Station, which is operated by the Public Service Company of New Mexico, and the Four Corners Generating Station, which is operated by the Arizona Public Service Company, are the primary users of water for power generation. Water supplied by public or private utilities accounted for about 2 percent of water used in the county. Nearly all of this water was obtained from surface water sources.

The New Mexico Surface Water Quality Bureau has identified all parts of the San Juan River Basin as being impaired by one or more pollutants (San Juan River Basin Watershed Management Plan [SWBWMP] 2005). The segment of San Juan River Basin affected by this project (Hogback to confluence with Animas River) is listed as being impaired by fecal coliform and mercury in fish tissue. This impairment impacts Navajo Nation–designated uses of domestic water supply, primary human contact, secondary human contact, fish consumption, aquatic habitat, and livestock and wildlife watering for the San Juan River. The potential sources of fecal coliform are septic tanks, livestock grazing, and wildlife (SWBWMP 2005). The primary sources of fish tissue mercury in the San Juan Basin are probably atmospheric deposition, and runoff from areas impacted by historic and current mining (SWBWMP 2005). Many other sources exist, and much of the anthropogenic mercury present in the San Juan Basin was probably emitted elsewhere, and years ago. Also, according to the USEPA's 1997 report to Congress on mercury, coal-fired power plants are a major source of mercury in the atmosphere, accounting for a third of anthropogenic (human-generated) emissions in the United States.

Although fecal coliform and mercury are concerns as surface water pollutants in the San Juan Basin, the San Juan Hydrologic Unit Regional Water Plan (San Juan Water Commission 2003) reaches the following conclusions based on the data evaluated by their study:

- The surface water throughout the San Juan HUC supports all uses except for fisheries.
- The State of New Mexico Standards for surface waters are exceeded in the San Juan River primarily below the confluence with the Animas River.
- Total dissolved solids (TDS) exceed 1,200 milligrams per liter (mg/L) at several locations, but their frequency of exceedance is only 7.5 percent of the samples.

- Generally, the water quality of surface water supplies does not impair uses in the basin or reduce the available water supply.

As described under *San Juan River, Uses and Water Quality* below, the final 2004–2006 integrated 303(d)/305(b) report for New Mexico differs with the conclusions of the regional water plan.

3.2.2.3.2 Climate

The San Juan Basin is located in the arid southwestern United States and therefore typically has mild winters with periodic cold-front storms; warm, dry, and windy springs and early summers; hot and monsoonal late summers; and cool, clear autumns. Precipitation in the Chaco HUC typically occurs during the late summer and early fall; however, more mountainous and elevated portions of the region experience wetter and colder conditions. See Section 3.1.1 for more detail on the climate of the study area.

Because the precipitation in the study area varies from month to month, the stream flow characteristics of the Chaco Wash and its tributaries vary accordingly. Flow in the arroyos, creeks, and washes are ephemeral; e.g., sporadic, resulting from localized, short-duration, high-intensity thunderstorms, which occur usually during late spring and summer. The channels are mostly dry for the remainder of the year. Intense rainfall during thunderstorms causes flooding that may be of large magnitude but generally local in extent. Discharges of several hundred to several thousand cubic feet per second from drainages of only a few square miles are not uncommon during such floods. Winter storms, in contrast, are usually of low intensity and short duration and produce little or no runoff.

3.2.2.3.3 San Juan River

The San Juan River is a major tributary to the Colorado River. Originating on the western slope of the Continental Divide in southwestern Colorado, the San Juan River flows from the San Juan Mountains north of Pagosa Springs, Colorado, and enters northwestern New Mexico through the Navajo Reservoir in Rio Arriba County, west of the Jicarilla Apache Reservation and the Carson National Forest. The course of the San Juan River turns westward for approximately 140 miles through New Mexico and southern Utah to its confluence with the Colorado River. The San Juan River Basin encompasses lands in four New Mexico counties: all of San Juan County, most of the northern half of McKinley, the western half of Rio Arriba County, and a small portion of Sandoval County. Parts of the Navajo and Jicarilla Apache Reservations are within the basin. In this basin, USBR operates the Navajo Dam and Reservoir for storage to fulfill water contract demands such as irrigation water for the Navajo Nation's use on the Navajo Indian Irrigation Project. However, the Navajo Dam and Reservoir are upstream of any potential impacts from the proposed action.

Under the 1948 Upper Colorado River Basin Compact, New Mexico is entitled to 11.25 percent of the water available to the Upper Colorado River Basin States. Currently, the 11.25 percent is approximately 669,000 acre-feet that New Mexico is entitled to deplete from the San Juan River Basin. A 2005 water rights settlement between the Navajo Nation and the State of New Mexico provided water rights in the San Juan River Basin for the Navajo in exchange for a release of other claims to water. The settlement is contingent upon U.S. Congressional funding and project completion deadlines.

Uses and Water Quality

Designated Navajo Nation uses for the San Juan River in the region of the confluence of the Chaco and San Juan Rivers include domestic water supply, primary human contact, secondary human contact, agricultural water supply, fish consumption, aquatic habitat, and livestock/wildlife watering. At this time, the Navajo Nation has not completed a use assessment for the San Juan River at the location of the proposed project. However, several stream segments in the Upper and Middle San Juan Basins have been assessed by the New Mexico Environment Department (NMED) and are impaired. Sources of impairment include mercury in fish tissue that has been attributed by NMED to air deposition. The San Juan River was designated impaired pursuant to Section 303(d) of the Clean Water Act (CWA). Section 303(d) of the CWA and USEPA's implementing regulations at 40 CFR 130.7, require states and territories to develop lists of water-quality limited water still requiring Total Maximum Daily Loads (TMDLs); establish a priority ranking of these waters; identify pollutants causing their impairment; and identify waters targeted for TMDL development over the next 2 years. Approximately 31 waters, statewide, are under some form of fish consumption advisory due to mercury contamination. Other use impairments to the San Juan River include marginal cold-water fishery, warm-water fishery, and secondary contact. The pollutants include fecal coliform and sediment in a reach that is upstream of Chaco River.

The only area of the San Juan River that may be physically affected by this project is where the transmission line crosses the river. However, it is anticipated that no transmission line structures will be constructed within the active channel of the San Juan River. Analysis of water quality in the San Juan River in close proximity to this affected area was conducted by the U.S. Geological Survey (USGS) in cooperation with the USBR (Thorn 1993). Relevant results of that study are shown in Table 3-11. The decrease in discharge above and below the Hogback is the result of the diversion to the Hogback Canal.

Table 3-11 Water Quality Results from the San Juan River

Site Name	Date Sampled	Discharge (cfs)	Temperature (°C)	Total Dissolved Solids (mg/L)	Boron (µg/L)	Selenium (µg/L)
San Juan River Upstream of Hogback	08-08-90	298	27.5	418	50	<1
	02-05-91	827	3.0	415	50	<1
San Juan River Downstream Hogback	08-08-90	140	25.0	575	80	1
	02-05-91	815	5.0	415	50	<1

SOURCE: Thorn, Conde R. 1993
NOTES: cfs = cubic feet per second
°C = degrees Celsius
µg/L = micrograms per liter
mg/L = _milligrams per liter

Additional information on the water quality of the San Juan River near the project area was collected from 1994-2000 at the Shiprock Bridge. A summarization of the water chemistry data is shown on Table 3-12.

Table 3-12 Water Chemistry Data for San Juan River at Shiprock Bridge

San Juan River at Shiprock Parameter	1994-2000 No. of Cases	1994-2000 Minimum	1994-2000 Maximum	1994-2000 Mean	1994-2000 Standard Dev.	2001 No. of Cases	2001 Minimum	2001 Maximum	2001 Mean	2001 Standard Dev.
Bicarbonate (mg/L)	71	17	165	108.4	28.5	8	78	141	119.1	26.2
Alkalinity (mg/L)	71	17	166	109.4	28.9	8	78	141	119.5	26.5
Arsenic dissolved (mg/L)	130	0.5	5	2	0.8	8	0.6	0.8	0.7	0.1
Arsenic total (µg/l)	129	0.5	44	4	5.6	8	0.3	3.3	1.7	1.1
Calcium dissolved (mg/L)	71	30.8	96.3	59.9	16.2	8	31.9	79	64.6	20.4
Copper dissolved (µg/l)	71	1	18	4.4	3.1	8	1.3	2	1.5	0.3
Copper total (µg/l)	71	2.5	155	26.9	30.3	8	2.8	15.9	7.7	5.2
Hardness (mg/L)	71	98	317	195.1	54.9	8	102	255	208.5	66.3
Mercury dissolved (µg/l)	130	0.1	0.3	0.1	0	8	0.1	0.1	0.1	0
Mercury total (µg/l)	130	0.1	1.6	0.1	0.2	8	0.1	0.1	0.1	0
Magnesium Dissolved (mg/L)	71	5.2	18.6	11.1	3.7	8	5.3	14.2	11.4	3.7
Sodium dissolved (mg/L)	24	13	58.5	37.9	13.7	8	11.4	47	35.5	15.3
Lead dissolved (µg/l)	130	0.1	18	0.9	2.3	8	0.1	0.9	0.3	0.4
Lead total (µg/l)	129	0.5	323	25.8	43.1	8	1.6	28.9	11.4	11.6
Selenium dissolved (µg/l)	130	0.5	1	0.5	0.1	8	0.5	1	0.6	0.2
Selenium total (µg/l)	130	0.5	3	0.7	0.4	8	0.5	7	1.3	2.3
Selenium total recoverable (µg/l)	34	0.5	2	0.6	0.3	8	0.5	0.5	0.5	0
Total dissolved solids (mg/L)	70	130	550	339.3	103.3	8	170	440	337.5	114.9
Total suspended solids (mg/L)	128	2	17700	999.3	2917.5	8	34	356	161.3	113.4
Turbidity (NTU)	126	3	11100	594.3	1766.2	8	29	190	102.1	65
Zinc dissolved (µg/l)	130	5	50	7.8	6.4	8	5	20	10	4.6
Zinc total (µg/l)	130	5	1380	118.9	218.8	8	20	120	53.8	40.7
Temperature (^{o}C)	130	0.1	26.1	12.3	6.9	8	3.7	22.1	11.4	7.3
pH	130	7.7	9	8.3	0.3	8	7.5	8.5	8.2	0.4
Conductance (µmhos/cm)	130	244	826	516.9	147.7	8	247	645	529.8	176.3
Redox Potential (mv)	130	250	544	409.6	63	8	431	501	463.3	26.8
Oxygen dissolved (mg/L)	128	3.6	13.9	9.6	2.3	8	8.2	11.6	10	1.4

SOURCE: Bliesner and Lamara 2003

NOTES: µmhos/cm – reciprocal micro ohms per centimeter

mv = millivolts

NTU = Nephelometric Turbidity Units

3.2.2.3.4 Morgan Lake

Morgan Lake is the only large manmade storage reservoir within the Chaco subwatershed. It has a maximum depth of about 100 feet and a surface area of 1,260 acres at its maximum storage (San Juan Water Commission 2003). Built in 1961 and operated by APS, Morgan Lake holds approximately 39,200 acre-feet of water at normal storage and 42,800 acre-feet of water at maximum storage (San Juan Water Commission 2003). Water from the San Juan River is pumped to Morgan Lake for use as cooling water at the Four Corners Generating Station and also for use in dust suppression and reclamation irrigation activities associated with the BNCC Lease Area.

BNCC holds Surface Permit Number 2838 issued by the New Mexico Office of the State Engineer in October 1958 and supplies water to the Four Corners Generating Station , the San Juan Generating Station, and the Navajo Mine under this permit. This permit provides BNCC a total diversionary right of 51,600 acre-feet annually, with a consumptive right of 39,000 acre-feet annually, for waters drawn from the San Juan River. The additional consumption associated with the expansion of the surface mining operations at the Navajo Mine required to supply coal to the Desert Rock Energy Project is estimated to be approximately 600 acre-feet annually. The additional consumption is within the existing consumptive right and would cause no depletions to the San Juan River beyond those authorized under the current water right permit.

Uses and Water Quality

In 1961, an agreement between the owners and the Navajo Nation established the use of Morgan Lake for recreation, and various fish were stocked in 1962 (U.S. Fish and Wildlife Service (USFWS) 2005). Designated uses of Morgan Lake are primary human contact, secondary human contact, fish consumption, aquatic habitat, and livestock/wildlife watering (NNEPA 2004).

There have been several investigations into the quality of water or fish from Morgan Lake. These studies identified the relationship between blue-green (*Cyanophyta*) algal blooms, elevated water temperatures, early summer warming, and anoxic conditions in Morgan Lake. Concerns about on-site spills, including a spill of hydrazine in 1991, triggered additional monitoring of water and fish quality in Morgan Lake.

The most recent investigation into the quality of water or fish from Morgan Lake (FWS 2005) resulted in the NNEPA issuing a fish consumption advisory based on high selenium concentrations in fish tissues. Some selenium concentrations in fish from Morgan Lake may pose health risks to certain people who eat those fish frequently. Also, selenium contamination within Morgan Lake may be reducing the reproductive success of fish and wildlife. Boron was found in ambient water samples from Morgan Lake above the boron criteria for a domestic water supply. Although this boron concentration would not be expected to pose a substantial risk to aquatic life, it may limit Morgan Lake's value as a domestic water supply.

3.2.2.3.5 Chaco River

Overall, the Chaco River is an intermittent stream, although the National Pollutant Discharge Elimination System (NPDES) for Morgan Lake conveys discharges into the stream (15 miles from the project site) can cause constant flow conditions during certain time periods. The Chaco River is subject to sudden flooding during intense rainstorms. The Chaco River and other ephemeral streams in the region deliver large amounts of sediment and water to the San Juan River (north of the proposed power plant site) following precipitation events. The Chaco River cuts through the Mancos Shale which has high clay content. The erosion of the shale by the Chaco River contributes to additional sediment being transported into the San Juan River.

USGS operated two gauging stations on the Chaco River, Station 09367950 near Waterflow, New Mexico, and Station 09367938 near Burnham, New Mexico. Neither of these gauges is currently maintained. Considerably more data exist for the Waterflow Station than for the Burnham Station. Nearly 7,000 surface water records were taken at the Waterflow gauge between 1976 and 1993 and approximately 1,600 records were taken at the Burnham Station between 1978 and 1981. Lack of data from the Burnham Station prevents meaningful analysis of annual mean streamflow. However, average monthly streamflow recorded higher flows during the late summer / early fall precipitation cycle common to the region. Monthly streamflow data indicate highest flows during August—108 cubic feet per second (cfs) at Waterflow and 36.7 cfs at Burnham (USGS 2006) (Figure 3-8). Please note that these are mean monthly values. The flow gauged at the Waterflow Gauging Station is heavily influenced by effluent discharges from the Four Corners Generating Station, which is approximately 12.5 miles upstream of the gauging station. These discharges are from Morgan Lake. Therefore, parts of the Chaco River downstream of the Four Corners Generating Station exhibit perennial flow even though the river is considered intermittent overall.

Streamflow varies greatly from year to year. Data from the Waterflow Station vary from a low 315 cfs in 1962 to a high of 7,300 cfs in 1969, with an average of 3,778 cfs. Data from the Burnham Station vary from a low of 950 cfs in 1980 to a high of 6,740 cfs in 1979, with an average of 4,170 cfs (Figure 3-10). Figures 3-8 to 3-10 exhibit available Chaco River stream flow data from the USGS.

Uses and Water Quality

Designated uses of the Chaco River are primary human contact, secondary human contact, aquatic habitat, and livestock/wildlife watering (NNEPA 2004). Approximately 300 acres of the Chaco subwatershed are being irrigated within the Navajo Indian Reservation (San Juan Watershed Group 2003).

Sediment yield is an indicator of the sustainability of a watershed and the effect that surface disturbance would have on water quality. The area of Chaco River watershed is 2,918,965 acres, of which 28,999 acres are disturbed by 30 water wells and multiple roads. The density of roads is one road per 1.7 square miles. The BLM Farmington Field Office calculated an average sediment yield from this watershed at 5.8 tons per acre per year (BLM 2004).

TDS in the perennial reach of Chaco River average over 1,000 parts per million (Thorn 1993). This increase in salinity is believed to occur during use of water from the San Juan River for the Four Corners Generating Station. The USEPA has issued a discharge permit for disposal of this water. An analysis of water quality along the Chaco River was conducted by the USGS in cooperation with the USBR (Thorn 1993). Relevant results of that study are shown in Table 3-13. The intention of this data-collection effort was to gain an understanding of possible salinity contribution to the San Juan River from deep formation waters or from oil-field brines. Streamflow and dissolved solid loads for samples collected along the Chaco River showed only slight variation, except in February 1991.

Figure 3-8 Annual Mean Streamflows on Chaco River

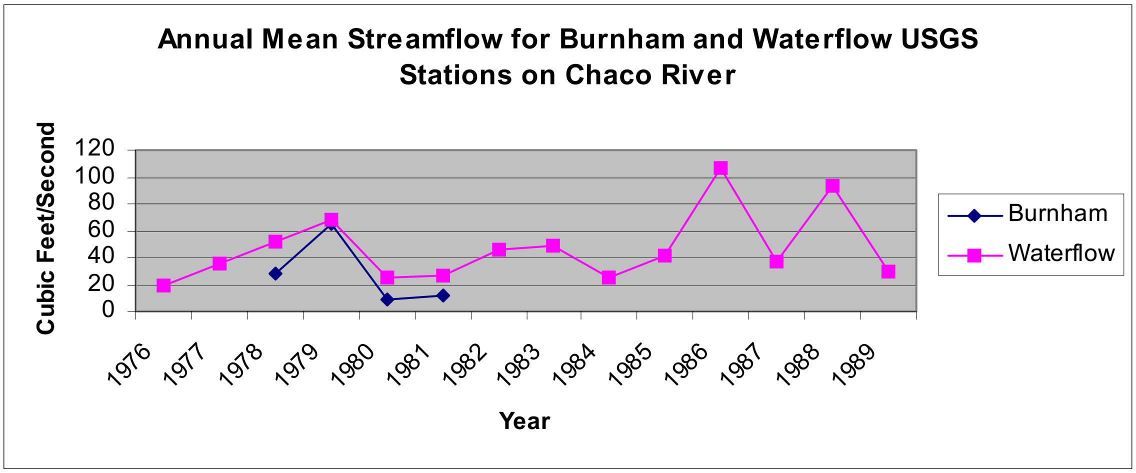


Figure 3-9 Monthly Mean Streamflows on the Chaco River

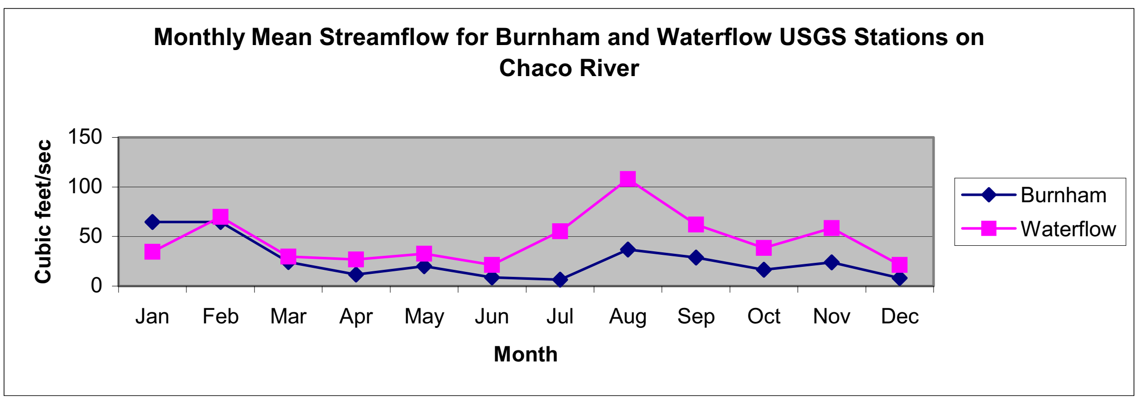


Figure 3-10 Peak Streamflow in the Chaco River from the Burnham Station (1978–1981)

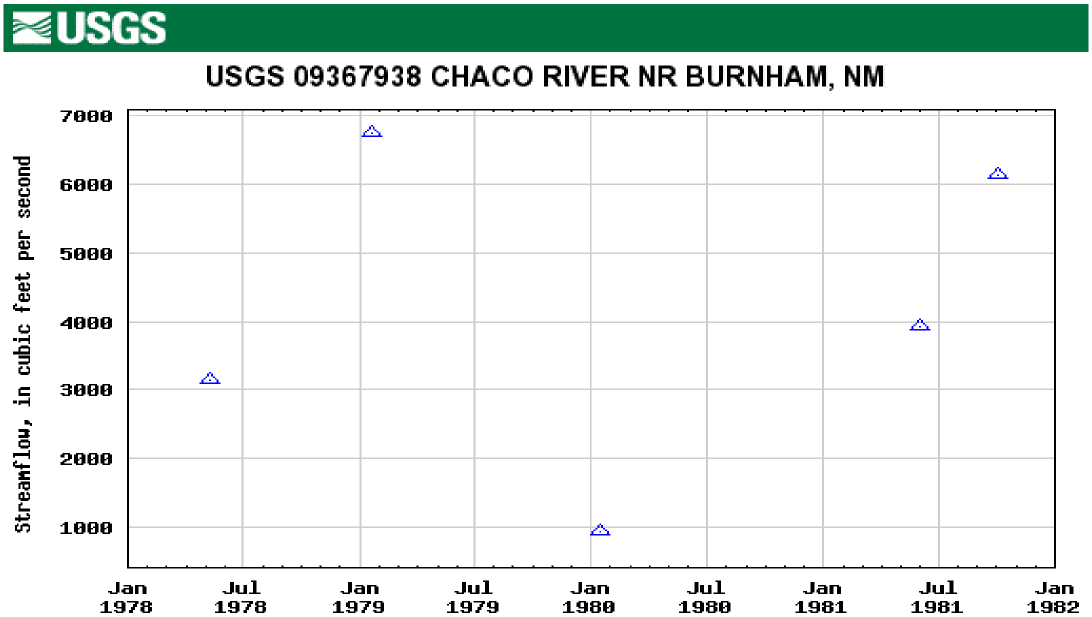


Table 3-13 Water Quality Results from the Chaco River

Site Name	Date Sampled	Discharge (cfs)	Temperature (°C)	Total Dissolved Solids (mg/L)	Boron (µg/L)	Selenium (µg/L)
Chaco River at Hogback	07-06-90	3.9	31.0	1030	440	3
	08-08-90	4.4	29.5	1040	440	2
	10-16-90	4.4	18.0	1210	500	3
	12-19-90	5.2	11.0	1220	480	3
	02-07-91	0.18	11.0	1090	2400	4
Chaco River below Hogback	07-06-90	4.1	31.5	1100	470	3
	08-08-90	4.1	19.5	1010	390	2
	10-16-90	5.4	19.5	1180	480	2
	12-19-90	NA	0.5	1140	430	2
	02-07-91	0.31	3.0	5690	1500	15

SOURCE: Thorn 1993
NOTE: NA – data not available

3.2.2.3.6 Other Surface Water Features

In addition to the larger surface water features (San Juan River, Chaco River, and Morgan Lake), the project area encompasses many smaller surface water features. These features include named and unnamed arroyos, washes, and creeks.

The larger of these surface water features include Eagle Nest Arroyo, Coal Mine Creek, Chinde Wash, Cottonwood Arroyo, Pinabete Arroyo, Pajarito Creek, Dead Mans Wash, and Coal Creek. These named surface water features are intermittent or, most commonly, ephemeral. Dead Mans Wash, Chinde Wash, Cottonwood Arroyo, Pinabete Arroyo, and Coal Creek are all tributaries of the Chaco River. Pajarito Wash Creek is a tributary of Dead Mans Wash. Coal Mine Creek is located north of the San Juan River and is a tributary to Eagle Nest Arroyo. In turn, Eagle Nest Arroyo is a tributary to the San Juan River. The NNEPA has collected periodic water quality samples from Chinde Wash and Eagle Nest Arroyo. Water quality data for Morgan Lake, Chaco River, Chinde Wash, Eagle Nest Arroyo, and Dead Mans Wash provided by NNEPA are included in Appendix F.

Natural washes perform a diversity of hydrologic and biogeochemical functions that directly affect the integrity and functional condition of the higher-order waters downstream. Healthy ephemeral waters with characteristic plant communities control rates of sediment deposition and dissipate the energy associated with flood flows. Ephemeral washes also provide habitat for breeding, shelter, foraging, and movement of wildlife. Many plant populations are dependent on these aquatic ecosystems and area adapted to the unique conditions of these systems.

Currently, the BIA is identifying springs, seeps, and wells that are in the study area. The purpose of this work is to develop a baseline of these features in the study area so the potential of impact of groundwater withdrawal can be predicted or assessed over time through investigation and sampling.

Uses and Water Quality

Designated uses of these intermittent and ephemeral waters are secondary human contact, aquatic habitat, and livestock/wildlife watering (NNEPA 2004). The only water quality information for these features is from Thorn (1993) for sampling conducted at the Chinde Wash. Relevant results from this sampling are shown in Table 3-14. Chinde Wash crosses Proposed Transmission Line Segment C near Milepost 3.

Table 3-14 Water Quality Results from the Chinde Wash

Site Name	Date Sampled	Discharge (cfs)	Temperature (°C)	Total Dissolved Solids (mg/L)	Boron (µg/L)	Seleniu m (µg/L)
Chinde Wash near Fruitland	07-07-90	0.13	27.5	934	100	3
	08-08-90	0.12	31.0	914	90	4
	10-17-90	0.14	14.5	1700	140	10

SOURCE: Thorn 1993

3.2.3 Overview of Groundwater Resources

3.2.3.1 Groundwater Data Collection Approach

An evaluation of hydrogeologic conditions was completed to assess the local groundwater resource availability within the Morrison Formation. For more details related to existing groundwater sources associated with the Morrison aquifer, please refer to the well impact studies (see Appendix B).

3.2.3.2 Existing Regional Hydrogeology Conditions

The study area is located in the northwestern portion of the San Juan Basin in Northwestern New Mexico. The San Juan Basin lies on the eastern edge of the Colorado Plateau and extends from northwestern New Mexico into portions of northeastern Arizona along the New Mexico/Arizona border, southwestern

Colorado, and the southeasternmost corner of Utah. The San Juan Basin is approximately 140 miles wide by 200 miles long, and covers a total area of 21,600 square miles (Dam et al. 1990).

The San Juan Basin is a northwest-trending asymmetrical structural depression that formed during the Laramide Orogeny (Late Cretaceous-Early Tertiary) at the eastern edge of the Colorado Plateau. Structural boundaries of the basin consist of large, elongate, domal uplifts; low, marginal platforms; and abrupt monoclines (Kelley 1951). The most distinctive structural feature in the study area is the Hogback Monocline, which forms a sharp boundary between the marginal platforms and the central basin. The interior of the basin contains a thick sequence of sedimentary rocks from Cambrian to Tertiary in age, but primarily Pennsylvanian through Tertiary in age. These rocks consist primarily of stacked sequences of sandstone, siltstone, mudstone, limestone, and shale. These rock sequences dip from the basin margins toward the center of the basin. Older sedimentary rocks outcrop around the basin margins and are successively overlain by younger sedimentary sequences toward the basin center. The maximum stratigraphic thickness of sedimentary rocks in the basin is over 14,000 feet (as recorded in an oil well) at the center of the basin, east of the Hogback Monocline (Fassett and Hinds 1971). Additional information on the subsurface geology of the project area is provided as part of Appendix D.

The primary source of groundwater in the San Juan Basin is derived from wells completed within surficial valley-fill deposits of Quaternary age and sandstones of Tertiary, Cretaceous, Jurassic, and Triassic age (Stone et al. 1983). Although in less quantities, groundwater is also encountered and has been used historically for uranium mining operations in the San Juan Basin from wells completed in the Morrison Formation and the overlying Dakota Sandstone (Stone et al. 1983). Groundwater from these two formations also supplies water to drinking water wells in the study area that are owned by the NNDWR (NNDWR 2005). Groundwater in sandstone sequences in the San Juan Basin is generally under confined conditions, resulting in an artesian flow from wells completed in these units.

3.2.3.3 Local Hydrogeologic Conditions

Groundwater in the study area is encountered primarily at or near the land surface, under artesian conditions. Artesian flow from a well occurs when it penetrates an aquifer that is overlain by an impermeable or semi-impermeable unit, such as shale. Under pressure (or confined/semi-confined conditions), that water will rise to the well's *potentiometric surface* without the use of a pump. *Potentiometric surface* is defined as the surface representative of the level to which water will rise in a well cased in the aquifer (Fetter 1988).

There are five distinct geologic units that supply the majority of groundwater to existing wells completed in the study area (NNDWR 2005). With increasing depth these include alluvial deposits in washes, the Point Lookout Sandstone, the Gallup Sandstone, the Dakota Sandstone, and the Morrison Formation. According to NNDWR (2005) records, NNDWR wells located in the study area that are screened within these geologic units produce the majority of their water from the Morrison Formation. Within the Morrison Formation, the Westwater Canyon Member (a coarse sequence of sandstone, conglomeritic sandstone, and mudstone) is considered the most productive unit (Dam et al. 1990; Stone et al. 1983). Recharge to the Morrison Aquifer is derived from precipitation infiltration, streamflow infiltration along outcrop areas, and from downward leakage (Dam et al. 1990).

Additional information on existing wells in the area and aquifer characteristics is provided in Appendix B.

3.2.3.4 Water Quality

Data collected from numerous oil/gas test wells throughout the San Juan Basin between 1948 and 1986 (kept in the NWIS and Petroleum Information Corporation's databases) were compiled and evaluated by Dam et al. (1990). The number of samples collected, along with the minimum, maximum, and median value for selected chemical constituents from those wells, is provided in Appendix B. As can be seen in this table, water chemistry (for the constituents listed) in the Morrison Formation is quite variable.

To further evaluate water quality in the study area, on May 11, 2005, water quality samples were collected from three wells that are documented as producing water from the Morrison Formation (NNDWR 2005). Two of the three wells sampled are domestic drinking water wells owned and operated by the Navajo Tribal Utility Authority (NTUA) and are located on the Sanostee Navajo chapter. The third well sampled is a stock irrigation well owned and maintained by NNDWR, located approximately 10 miles north of the Sanostee Navajo chapter (NNDWR, 2005). The analytical results from that sampling effort are summarized in Appendix B. Generally speaking, the water sampled is of good quality. No analyses tested were detected above Federal Primary or Secondary Drinking Water standards, and the water appears to be of acceptable quality (for the constituents tested) for use at the proposed power plant.

3.2.4 Water Resources in the Vicinity of Proposed Project Components

This section addresses each component of the proposed project, to highlight the water resources that would be potentially affected at each location. The focus is on surface water features, however groundwater considerations are addressed for the well field alternatives and mining operations on the BNCC Lease Area.

3.2.4.1 Proposed Power Plant Site

Two watercourses, Pinabete Arroyo and Chaco River, are located in the vicinity of the proposed power plant site by the transmission line Segment B (west side of Chaco River) and are discussed below.

3.2.4.1.1 Pinabete Arroyo

The Pinabete Arroyo traverses Area IV South of the BNCC Lease Area flowing to the northwest and is an ephemeral tributary to the Chaco River. The Navajo Nation–designated uses for ephemeral tributaries include secondary human contact, aquatic habitat, and livestock and wildlife watering.

3.2.4.1.2 Chaco River

The Chaco River flows for approximately 30 miles through the project area. The Chaco River is mostly intermittent through the project area; however, some perennial flow is present in the river due west of Morgan Lake. The proposed power plant site is located approximately 1 mile east of the Chaco River. The Chaco River empties into the San Juan River several miles downstream of the project area. The Navajo Nation–designated uses for the Chaco River include primary human contact, secondary human contact, aquatic habitat, and livestock and wildlife watering.

3.2.4.2 Proposed Transmission Line Alignment (Segments A, C, and D)

The following watercourses would be crossed by transmission line Segments A, C, and D and are discussed below. In addition to these larger creeks and rivers, the proposed transmission lines would cross approximately 53 smaller, unnamed arroyos and washes. These unnamed watercourses are ephemeral.

Each of the wash crossings are photographed, mapped, and detailed in the Waters of the U.S. Mapping Project Report (Appendix E).

3.2.4.2.1 Eagle Nest Arroyo

Eagle Nest Arroyo is an ephemeral drainage feature with an approximate length of 9 miles from its source tributaries to its mouth at the San Juan River. Numerous unnamed ephemeral tributaries connect to the Eagle Nest Arroyo. The arroyo empties into the San Juan River approximately 2.5 miles downstream from the crossing point. The Navajo Nation–designated uses for Eagle Nest Arroyo include secondary human contact, aquatic habitat, and livestock and wildlife watering.

3.2.4.2.2 San Juan River

The San Juan River is a larger perennial surface water body, which flows through this region. Transmission line Segment D crosses the San Juan River between Milepost 5 and Milepost 6. The San Juan River is the primary surface water drainageway in the San Juan River Basin. The Navajo Nation–designated uses for the San Juan River include domestic water supply, primary human contact, secondary human contact, agricultural water supply, fish consumption, aquatic habitat, and livestock and wildlife watering.

3.2.4.2.3 Chaco River

The Chaco River would flow parallel to transmission line Segments A, B, and C. Transmission line Segments A, C, and D never cross the Chaco River, but the alignments come within less than 0.5 mile of the river at several locations. The Chaco River empties into the San Juan River several miles downstream of the project area. The Navajo Nation–designated uses for the Chaco River include primary human contact, secondary human contact, aquatic habitat, and livestock and wildlife watering.

3.2.4.2.4 Coal Creek

Coal Creek is an intermittent/ephemeral tributary to the Chaco River. None of the transmission line alignment segments would cross Coal Creek. The Navajo Nation–designated uses for ephemeral tributaries include secondary human contact, aquatic habitat, and livestock and wildlife watering.

3.2.4.2.5 Coal Mine Creek

Coal Mine Creek is an intermittent/ephemeral tributary to Eagle Nest Arroyo. Coal Mine Creek empties into the Eagle Nest Arroyo approximately 0.3 mile upstream from the point where Segment D would cross Eagle Nest Arroyo. The source tributaries for Coal Mine Creek are located approximately 3 miles farther upstream from the mouth of the creek. No transmission line segments would actually cross this creek. The Navajo Nation–designated uses for ephemeral tributaries include secondary human contact, aquatic habitat, and livestock and wildlife watering.

3.2.4.2.6 Chinde Wash

Chinde Wash would be crossed by transmission line Segment C at Milepost 3, at the point where Chinde Wash empties into the Chaco River. The surface expression of Chinde Wash at the point appears to be a deeply incised channel. Chinde Wash originates within the Navajo Agricultural Products Industry (NAPI), upstream of the BNCC Lease Area, which is approximately 3.5 miles east of this potential crossing point. The Navajo Nation–designated uses for Chinde Wash include secondary human contact, aquatic habitat, and livestock and wildlife watering.

3.2.4.2.7 Cottonwood Arroyo

The Cottonwood Arroyo flows to the west and is an ephemeral tributary to the Chaco River. Transmission line Segment C would cross the Cottonwood Arroyo near Milepost 2, at which point it is within 0.10 mile of emptying into the Chaco River. At this crossing point, the Cottonwood Arroyo has a broader flatter surface expression than it has farther to the east. The Navajo Nation–designated uses for Cottonwood Arroyo include secondary human contact, aquatic habitat, and livestock and wildlife watering.

3.2.4.2.8 Morgan Lake

Morgan Lake is a perennial surface water body located approximately 0.25 mile northeast of the proposed transmission line Segment D, near the location where Segment C would join Segment D. Morgan Lake is a manmade reservoir that was constructed to supply water to mining and power generation activities in the area. The water is used for cooling at the Four Corners Generating Station and for dust suppression on the mining roads. Morgan Lake is approximately 1.2 miles wide and 2.2 miles long. The spillway empties into an unnamed wash, which discharges into the Chaco River 1.1 miles downstream from the dam. The Navajo Nation–designated uses for Morgan Lake include primary human contact, secondary human contact, fish consumption, aquatic habitat, and livestock and wildlife watering.

3.2.4.3 Alternative Transmission Line Segment B

In addition to these larger creeks and rivers listed below, the alternative transmission line Segment B would cross approximately 6 unnamed arroyos and washes, which are ephemeral. The alternative transmission line Segment B would cross the following named surface water features. Each of the wash crossings are photographed, mapped, and detailed in the Waters of the U.S. Mapping Project Report (Appendix E).

3.2.4.3.1 Chaco River

The Chaco River flows for many miles through the project area, parallel to the transmission line Segments A, B, and C. The surface expression of the Chaco River is about 0.1 mile wide. Alternative transmission line Segment B would cross the Chaco River twice. The Chaco River empties into the San Juan River several miles downstream of the project area. The Navajo Nation–designated uses for the Chaco River include primary human contact, secondary human contact, aquatic habitat, and livestock and wildlife watering.

3.2.4.3.2 Coal Creek

Coal Creek is an intermittent/ephemeral tributary to the Chaco River. None of the transmission line alignment segments cross Coal Creek, but alternative line Segment B would come within 0.5 mile of the point where Coal Creek empties into the Chaco River. The Navajo Nation–designated uses for ephemeral tributaries include secondary human contact, aquatic habitat, and livestock and wildlife watering.

3.2.4.4 Utility Corridor/Water Pipeline

The utility corridor/water pipeline associated with wellfield Alternative A would cross two named surface water features and approximately 13 smaller, unnamed arroyos, washes, and creeks. The corridor would not cross any wetland features; however, a 3-acre wetland that is fed by an artesian well would be located 300 feet north of the alignment and 300 feet east of the well field A boundary. The wetland is photographed, mapped, and detailed in the Waters of the U.S. Mapping Project Report (Appendix E).

3.2.4.4.1 Coal Creek

Coal Creek is an intermittent/ephemeral tributary to the Chaco River. From the point where the utility corridor/water pipeline would intersect it, Coal Creek flows approximately 8 miles to the northeast where it connects to the Chaco River. The Navajo Nation–designated uses for ephemeral tributaries include secondary human contact, aquatic habitat, and livestock and wildlife watering.

3.2.4.4.2 Chaco River

The utility corridor/water pipeline would cross the Chaco River between Milepost 1 and Milepost 2. The Chaco River empties into the San Juan River 15 miles north of this intersection. The Navajo Nation–designated uses for the Chaco River include primary human contact, secondary human contact, aquatic habitat, and livestock and wildlife watering.

In addition to these larger creeks and rivers, the proposed utility corridor would cross 16 smaller, unnamed arroyos, washes, and creeks. None of these watercourses are perennial. Seven of these unnamed drainages on the west end of the utility corridor flow to the east and northeast and are tributaries to Coal Creek. Seven of the unnamed drainages on the east end of the utility corridor also flow to the east and northeast, but flow directly into the Chaco River. The remaining two unnamed drainages on the east end of the utility corridor flow to the west and are tributaries to the Chaco River. Designated uses of these unnamed drainages include livestock watering, wildlife habitat, limited aquatic life, and secondary contact.

3.2.4.5 Access Road

Several watercourses would be traversed by the proposed access road. None of these watercourses are perennial. Designated uses of the unnamed drainages include livestock watering, wildlife habitat, limited aquatic life, and secondary contact. The access road also would run adjacent to a stock-watering pond. This small manmade pond receives surface water from an approximately 500-acre drainage area and outlets to the Pinabete Arroyo. The pond is known to be used for livestock watering and had a pooled area of approximately 1 acre during a site visit in July 2006 for the Waters of the U.S. Mapping Project. The pond is mapped on the USGS topographic quadrangle, showing a 10-acre extent. During the July study, a wetland determination showed that the pond receives enough seasonal moisture to have formed wetland vegetation and soil features. The wetland feature is photographed, mapped, and detailed in the Waters of the U.S. Mapping Project Report (Appendix E).

3.2.4.6 BNCC Lease Area – Areas IV and V

3.2.4.6.1 Surface Water

Pinabete and No Name Arroyos are the primary surface water features within the lease 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 3-15 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 lease area.

Table 3-15 Peak Flows for Pinabete and No-Name Washes (Primary Water Features within the Lease Area)

	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. Table 3-16 and Table 3-17 show data from samples collected in Pinabete and No-Name Arroyos in 1998.

Table 3-16 Turbidity and Salinity Data for Pinabete Wash

	Pinabete Upstream				Pinabete Downstream			
Date collected	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	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

SOURCE: BNCC 1998

Table 3-17 Turbidity and Salinity Data for No Name Washes

	No Name Upstream		No Name Downstream		
Date collected	7/29/1998	9/30/1998	8/13/1998	8/13/1998	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	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

SOURCE: BNCC 1998

3.2.4.6.2 Groundwater

The Navajo Mine Extension Project on the BNCC Lease Area is located on the western flank of the San Juan Structural Basin in northwestern San Juan County approximately 15 miles west of Farmington, New Mexico. The geologic formation dips gently to the east toward the center of the basin at an angle of one to two degrees and steepens toward the outcrop areas where a fairly abrupt monocline (Hogback) can be observed.

The mine and adjacent areas are underlain by the Pictured Cliffs Sandstone Formation, Fruitland-Kirtland Formation, and unconsolidated alluvial deposits in the valleys of the San Juan River, Chaco River, and the Chinde and Cottonwood Arroyos. A number of groundwater monitoring wells have been completed in the geologic formations on and near the permit area. To obtain hydrologic information, a piezometer (small diameter water well) installation program was conducted throughout the mine area to estimate the water-bearing potential of the above geologic formations. Information on the water-bearing zones within these formations was obtained during drilling by monitoring fluid return, air injection pressure, and lithology.

Aquifers were delineated using two different methods. The first approach treated the individual coal seams in the Fruitland Formation as separate aquifers. This resulted in the potentiometric surface maps for the major coal seams.

Since the coal seams are discontinuous through the formation, an alternate approach for delineation was considered which utilized USGS data and treated the coal seams and interbedded lithologic units of the

Fruitland Formation as a single aquifer. The single aquifer approach was previously evaluated (Billings 1987). Even though there is very little water present and transmissivities are low, the individual seams will be treated as separate aquifers in the quantity and quality descriptions in this chapter.

The Pictured Cliffs Sandstone was found to be water bearing throughout most of the permit area. Selected lenticular coal-bearing strata of the Fruitland Formation were also found to be marginally wet within the permit area; these strata include (1) the No. 8 seam, (2) the No. 7 seam, (3) the No. 4-6 seam, and (4) the No. 2-3 seam. Groundwater was only observed in the quaternary alluvial deposits within the stream channels of Chinde and Cottonwood Arroyos.

Springs and seeps occur along upper Chinde Wash, above the lease boundary. The springs and seeps are due to NAPI irrigation return flows. Because there are several springs along this reach of Chinde Wash, individual springs have not been identified.

The source of water for the transient springs and seeps appear to be extensive irrigation activities upgradient of Chinde Wash. It is unknown to what extent these springs will continue to flow in the future, as Navajo Mine has no effect on or control of the water source of the springs. The saturation of the regolith (loose material covering solid rock, in this instance, wind blown sand) and spring occurrence represents a distinct change from baseline conditions. No springs in the regolith would have been present prior to NAPI activities, and Chinde Wash would not have been a perennial stream.

The springs are the result of excess, unused irrigation water migrating downward through a spatially extensive and permeable eolian (wind blown) sand that underlies much of the irrigated fields. When this water encounters the less permeable siltstones and shales of the underlying Fruitland Formations, it migrates laterally along a stratigraphic contact of unconsolidated eolian sand and bedrock. As Chinde Wash progressively downcuts through the eolian sand and into the underlying bedrock, the water migrating along this stratigraphic contact discharges into the wash.

The springs are limited to the area of this contact along the banks of the wash. Areas further away from the contact and downstream within the badland areas of the Chinde Wash no longer receives spring discharges.

The quantity and quality of the spring discharges into Chinde Wash has not been characterized. However, BNCC Lease Area does collect a monthly grab sample from Chinde Wash surface water in the area of the springs (station CD-1A). The surface water at station CD-1A is a sodium sulfate water type. TDS ranges from 170 to 2240 mg/L. No seasonal correlation in the data is discernable. More detailed information on station CD-1A is available in the quarterly and annual reports.

Groundwater Quantity

In order to obtain representative baseline data, piezometers were completed using a rotary drilling rig. Piezometers were completed using air rotary drilling techniques and no drilling mud or additives were used which might have contaminated the well bore. Borings were completed by screening the single appropriate water-bearing zone. A gravel pack, gel seal, and 15-pound cement mixture were used to complete the well to reduce the possibility of cross contamination between water-bearing zones or bore hole leakage.

Following piezometer completion and development, water levels were measured in each piezometer. Static water levels were and will continue to be taken as part of the groundwater monitoring program employed by BNCC.

Pictured Cliffs Sandstone: The Pictured Cliffs Sandstone was found to be nearly 120 feet thick in the mine and adjacent areas. The formation strikes generally north-south and dips to the east and southeast from one to two degrees. The sandstone is a well-cemented shallow marine sand deposit and does not exhibit significant primary permeability, although secondary permeability is prevalent due to small scale fracturing. Aquifer tests performed on piezometers located in the Pictured Cliffs (Wells GM-30; T4-1) by Science Application, Inc. (1979) yields an average transmissivity of 0.13 ft^2/day for both slug and recovery tests. The average permeability and storage coefficients for this formation were determined to be 0.0015 ft/day and 3.4×10^{-4}, respectively. These values are consistent with aquifer tests performed on the Pictured Cliffs at other locations near the BNCC Lease Area (San Juan Coal Company 1982; 1983).

Fruitland Coal Seams: Water level elevations, vertical head difference, and the potentiometric surface maps for the four water-bearing coal seams were developed from field data. When the coal seams are combined with the rest of the Fruitland Formation and treated as a single aquifer, a potentiometric map can be drawn which more clearly shows the regional potentiometric surface.

Potential recharge areas include outcrop locations to the north and south along the subcrop and outcrops in stream channels. Discharge occurs at the contact with the San Juan River alluvium. Since the entire area has been disturbed by mining activities, it is impossible to obtain pre-mining or undisturbed data. However, from the potentiometric surface maps, it can be deduced that the pre-mining condition in the disturbed area was similar to conditions of areas to the east.

The analysis of the aquifer testing conducted on the coal seams of the Fruitland Formation assumes that water flow to the well bore is horizontal and aquifer transmissivities are the same in all directions (isotropic conditions). Coal is not isotropic since there is preferential permeability due to fractures and flow often along vertical as well as horizontal streamlines. However, the assumption is not invalidated because the coal is consistently cleated and fractured. Therefore, the transmissivities calculated are indicative of the overall characteristics of the coal.

Aquifer testing, as described previously, indicated extremely low transmissivity and permeability values. This situation is typical of other low yield systems in northwestern New Mexico. In some cases, the test well dewatered completely within a matter of minutes and recovery took place over several days, (e.g., KF84-22 (e)). Permeability and transmissivity values appear to be random over the permit area with no significant trends based on aquifer thickness or location.

Fruitland Coal Seams on the BNCC Lease Area: BNCC has conducted extensive exploration drilling within the project area. This, together with data from the active mine areas, provides information about the groundwater 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 1983). 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 groundwater, 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 show that the groundwater in the coal seams has very high concentrations of 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.

Based on the mining experience at the Navajo Mine, the strata within the project area are 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 NAPI irrigation project. NAPI irrigation project influences do not extend into the drainages associated with the Navajo Mine Extension.

No. 8 Coal Seam – For the No. 8 Seam, a mean transmissivity and permeability of 1.13 ft^2/day and 0.06 ft/day, respectively, were calculated for the mine area. Flow gradients range from 0.007ft/ft to 0.01ft/ft and flow velocities range from 1.12 x 10^{-2} ft/day. Flow is generally toward the east or downdip with discharge at the San Juan River and Cottonwood Arroyo subcrop areas.

No.7 Coal Seam – The No.7 Coal Seam has an average thickness of about 5 feet. The No. 7 Coal Seam exhibits mean transmissivity and permeability values of 1.87 ft^2/day and 0.37 ft/day, respectively.

No. 4-6 Coal Seam – The No. 4-6 Coal Seam has an average thickness of 7 feet and outcrops to the west of the permit area. No. 4-6 Coal Seam, as with the other coal strata, exhibits extremely low levels of transmissivity and permeability with values of 0.025 ft^2/day and 0.0037 ft/day, respectively. Flow from the No. 4-6 Seam is both northeasterly and southwesterly toward the Cottonwood Arroyo discharge area. Flow gradients within the seam range from 0.0001 ft/ft to 0.001ft/ft and flow velocities range from 7.4 x 10^{-6} ft/day to 4.0 x 10^{-5} ft/day.

Quaternary Alluvium: Alluvial fill deposits occupying the valley bottoms of Chinde Arroyo, and the Cottonwood Arroyo, drainage have an average thickness of 10-15 feet. Chinde Arroyo has been mined through within the permit area and replaced with a temporary diversion structure. Cottonwood Arroyo, in Area IV North, contains alluvial deposits ranging from fine-grained wind blown sand to coarse-grained gravels. The Pinabete Arroyo, south of Area IV North and outside the permit boundary, is an ephemeral stream with a sandy channel bed. This is typical of ephemeral drainages of the southwest and it is estimated that transmissivity values will be similar to those found in other localities near the Navajo Mine (e.g., 218 ft^2/day, San Juan Coal Company 1982).

Generally, the direction of the flow gradient in the alluvial formations is towards the topograghic low areas in the adjacent washes. Groundwater may flow away from the washes during periods of peak flow. Water levels in the quality assurance (QA) wells rise in the winter and spring during the period of low evapotranspiration and recharge from snow melt runoff. The water levels in wells begin to decline with the increase of evapotranspiration during the summer. The lowest levels occur during the fall when there is little to no precipitation. Short term increases of the water levels occur during peak runoff caused by precipitation related flows. An exception to geohydrology characteristics of the QA is irrigation fluctuations occurring in alluvial well QAC-1 within the Chinde Wash. Monitoring well QAC-1 has the highest water levels occurring during the NAPI irrigation season April through October. These fluctuations can be correlated to increases in water quantity discharged from NAPI canals into the Chinde Wash.

Groundwater Quality

As previously stated, groundwater exists within the Pictured Cliffs Sandstone, in selected lenticular coal strata of the Fruitland Formation, and in the Chinde Arroyo and Cottonwood Arroyo alluvial deposits. In order to obtain representative baseline water quality information from the deposits, the piezometers were purged at least twenty-four hours prior to sampling. The piezometers were sampled, preserved, shipped and analyzed in accordance with USEPA guidelines (Guidelines Estimating Test Procedures for the Analysis of Pollutants 40 CFR Part 136). Based on the limited seasonal water quality data available, it is evident that analytical parameters do not fluctuate seasonally within the bedrock water-bearing units. The lack of seasonality is typical for aquifers with very low transmissivities and constant static water levels.

Pictured Cliffs Sandstone: Water within the Pictured Cliffs is of poor quality and is classified as a sodium sulfate water type with high concentrations of chloride and abundant hydrogen sulfide gas evident during sampling. Generally, water quality increases toward the outcrop or recharge areas and quickly decreases down dip to near connate conditions. Connate refers to water trapped in pores in the rock during formation of the rock. Since 1986, data has been submitted to the OSM on a quarterly basis.

Close to the mine area, the water quality of the Pictured Cliffs varies significantly as indicated below in Table 3-18:

Table 3-18 Pictured Cliffs Water Quality Near the Mine Area

Total Dissolved Solids	5,200mg/L to 16,960 mg/L
Chloride	170 mg/L to 9,000 mg/L
Sodium	1,330 mg/L to 6,100 mg/L
Sulfate	1,100 mg/L to 4,750 mg/L
pH	6.8 to 9.1

Such large ranges in dissolved constituents are reflective of the low permeability and production rates of the Pictured Cliffs.

Water quality of the Pictured Cliffs Sandstone, as well as the Fruitland Formation discussed below, is poor, and does not meet standards and criteria for domestic and livestock use. Due to the low permeabilities, poor water quality and limited production, regional use is limited. Local use does occur in areas closer to the outcrop, however, it is restricted entirely to marginal livestock watering. For these reasons, the classification of the Pictured Cliffs and the Fruitland Formations as aquifers is questionable.

Fruitland Formation. No. 8 Coal Seam – The No. 8 Coal Seam water can be classified as a sodium-bicarbonate–chloride type with high concentrations of calcium, manganese, nitrates and boron. Total dissolved solids range from 4,475 mg/L to 50,010 mg/L and pH averages 7.6 units. Generally, better water is observed closer to the mine area and extremely poor water is seen at potential discharge locations, e.g. San Juan River.

No. 7 Coal Seam – The No. 7 Coal Seam water is also classified as a sodium-bicarbonate-chloride type with high concentrations of carbonates, nitrates, and manganese. TDS' average 7,250 mg/L and pH averages 7.06 units.

No. 4-6 Coal Seam – The No. 4-6 Coal Seam water is classified as sodium – chloride type with high concentrations of calcium and potassium. TDS concentrations average 9,100 mg/L and pH averages 9.01 units and was found as high as 12.20 units. Hydroxides were also present in concentrations of 2,460 mg/L.

No. 2-3 Coal Seam – The No. 2-3 Coal Seam is classified as sodium–chloride–bicarbonate type with high concentrations of nitrates. TDS average approximately 7,000 mg/L and pH ranges between 7.8 and 8.2.

Quaternary Alluvium: As previously stated, within the permit area water occurs in the alluvial deposits of the Chinde Arroyo and Cottonwood Arroyo drainages. Since 1986, data has been submitted to OSM on a quarterly basis. Water quality within these fill deposits can generally be described as poor with TDS concentrations at well QAC-1 (Chinde alluvium) ranging from 7,700 to 13,700 mg/L, with a mean of 12,340 mg/L. The elevated TDS is the result of high concentrations of sodium, sulfate and chloride, (sodium chloride-sulfate water type) which is typical of these ephemeral wash alluvial aquifers. The concentrations for the major ions are: sulfate ranges from 500–5,520 with a mean of 4,150 mg/L; sodium ranges from 1,410–4,460 mg/L with a mean of 3,669 mg/L; chloride ranges from 1,200–4,900 mg/L with a mean of 3,392 mg/L.

Weak seasonal correlation is evident at well QAC-1 for static water levels, pH, sulfate, and manganese; however, it does not appear to fluctuate consistently from year to year, and in some years no seasonality is apparent. Seasonal fluctuations in the water quality are related to the changes in water quantity, as recorded by changing static water levels. Generally the water quantity increases in the winter and spring during the period of low evapotranspiration and greater recharge from snow melt runoff. In Chinde Wash, discharge rates by NAPI may play a larger role in fluctuations in water chemistry than does seasonality.

3.2.4.7 Water Well Field

The Morrison Formation dips steeply in the project area from west to east (see Section 3.5 for additional discussion). Due to the dip, the depth to the top of the Morrison Formation is highly variable in the study area. At the proposed generating facility, the depth to the top of the Morrison Formation is estimated at approximately 4,800 feet below ground surface (bgs), and at the northern end of Well Field B, along Transmission Line Segment A, the depth is estimated at approximately 2,500 feet bgs (Dam et al. 1990 and NNDWR 2005) For Water Well Field Alternative A, the depth is 1,250 feet bgs.

3.2.4.7.1 Alternative Water Well Field A

Groundwater

Alternative Water Well Field A would be located approximately 7 miles north of Little Water, at an elevation of 5,500 feet above MSL. This location is approximately 12 miles northwest of the proposed generating facility. Based on data from Dam et al. (1990) and NNDWR (2005), the depth to the top of the Morrison Formation is estimated at approximately 1,250 feet bgs.

Surface Water

Only two unnamed watercourses would cross Water Well Field A. These two unnamed drainages flow to the northeast and connect to Dead Mans Wash approximately 2 miles north of Well Field A. Dead Mans Wash flows to the northwest directly into the Chaco River. Many Devils Wash is located further west and flows directly into the San Juan River. Designated uses of the Chaco River, Dead Mans Wash, and Many Devils Wash include livestock watering, wildlife habitat, limited aquatic life, and secondary contact.

3.2.4.7.2 Proposed Water Well Field B

Groundwater

Proposed Water Well Field B would be located on the proposed power plant site and extend north of the proposed generating facility for approximately 8 miles, along Transmission Line Segment A. The northernmost extent of Water Well Field B would be approximately 5 miles southwest of the Four Corners Generating Station. The elevation at the northern part of proposed Water Well Field B is 5,500 feet above MSL.

Surface Water

Approximately nine watercourses as well as the Pinabete Arroyo and Cottonwood Arroyo surface water features would cross Water Well Field B.

Cottonwood Arroyo: The Cottonwood Arroyo is an ephemeral tributary to the Chaco River. The Cottonwood Arroyo would cross Water Well Field B near Milepost 2 along the proposed Transmission Line Segment A. From the intersection with the water well field, the Cottonwood arroyo flows approximately 0.25 mile to the west where it connects to the Chaco River.

Pinabete Arroyo: The Pinabete Arroyo is an ephemeral tributary to the Chaco River. The Pinabete Arroyo would traverse Water Well Field B just south of the proposed power plant site. From the intersection with the water well field, the Pinabete Arroyo flows approximately 0.5 mile to the west where it connects to the Chaco River.

Designated uses of the Chaco River, Pinabete Arroyo, and Cottonwood Arroyo include livestock watering, wildlife habitat, limited aquatic life, and secondary contact.

In addition to these named surface water features, the proposed Water Well Field B would cross seven smaller, unnamed arroyos, washes, and creeks. None of these watercourses are perennial. All of these unnamed drainages would be crossed where Water Well Field B follows the proposed Transmission Line Segment A. All these drainages flow to the west and are tributaries to the Chaco River.

Designated uses of these unnamed drainages include livestock watering, wildlife habitat, limited aquatic life, and secondary contact.

3.2.5 Regulatory Environment

A variety of Federal, State and tribal regulatory agencies and requirements must be addressed with respect to the potentially affected hydrologic resources within and in close proximity to the project area.

3.2.5.1 Water Resource Regulation

The Safe Drinking Water Act (SDWA) applies to every public water system in the United States. The law was amended in 1986 and 1996 and requires many actions to protect drinking water and its sources: rivers, lakes, reservoirs, springs, and ground water wells. (SDWA does not regulate private wells which serve fewer than 25 individuals.) SDWA authorizes the USEPA to set national-health-based standards for drinking water to protect against both naturally occurring and manmade contaminants that may be found in drinking water. USEPA, states, and water systems then work together to make sure that these standards are met. The NNEPA ensures that the standards are equal to or more stringent than USEPA's criteria.

The CWA established the basic structure for regulating discharges of pollutants into the waters of the United States. It gave USEPA the authority to implement pollution control programs such as setting wastewater standards for industry. The CWA also continued requirements to set water quality standards for all contaminants in surface waters. The Act made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions. Since January 20, 2006, the NNEPA has the authority to administer water quality standards under the CWA. NNEPA's surface water quality standards were approved by USEPA on March 23, 2006.

An NPDES permit would be required for discharges to waters of the United States. USEPA is the NPDES permit-issuing entity because the Navajo Nation has not been authorized to implement the NPDES program.

Under the CWA, any construction project disturbing a land area of one or more acres requires a construction storm water discharge permit.

Section 404 of the CWA regulates the discharge of dredged or fill material into waters of the United States, including wetlands and other "special aquatic sites." If a CWA Section 404 permit is needed, it would be issued by USACE, and USEPA would review the project for compliance with Federal Guidelines for Specification of Disposal Sites for Dredged or Fill Materials (40 CFR 230 Section 404(b)(l)), promulgated pursuant to Section 404(b)(l) of the CWA. Pursuant to 40 CFR 230 Section 404(b)(l), any permitted discharge into waters of the U.S. must be the least environmentally damaging practicable alternative available to achieve the project purpose.

Section 401 of the CWA requires that an applicant for a Federal license or permit provide a certification that any discharges from the facility will comply with the Act, including water quality standard requirements. Effective January 20, 2006 USEPA approved the Navajo Nation application to administer Water Quality Standards under the CWA. Therefore, the NNEPA is authorized to grant or deny certification for federally permitted activities that occur within the borders of the Navajo Nation in compliance with USEPA approved Water Quality Standards.

FWS states that "Under Executive Orders 11988 and 11990, Federal agencies are required to minimize the destruction, loss, or degradation of wetlands and floodplains, and preserve and enhance their natural and beneficial values. USACE has authority for permitting requirements under Section 404 of the CWA."

3.3 BIOLOGICAL RESOURCES

3.3.1 <u>Introduction</u>

The study area is located in the Colorado Plateau physiographic region of northwestern New Mexico. The area has a variety of physical features that offer a diversity of habitat types, represented by a characteristic assemblage of plant species. The large size of the area, together with its geology, soils, climate, and anthropogenic influences have combined to produce a mosaic of floristic components and associated wildlife species. Dry air masses, high summer temperatures, infrequent precipitation, and a high rate of evaporation characterize the climate of the study area and surrounding region. Precipitation averages approximately 7 inches annually and occurs primarily during the late summer months (Kunkel et al. 1999). The greatest monthly precipitation is typically received in July and August. Late-summer, monsoonal storms are commonly preceded by rainfall that saturates the ground and increases surface runoff. As a result, melting of snowpack that accumulates in the winter months in the mountains may combine with spring rainfall to produce severe flooding (Kunkel et al. 1999). For most of the region, the availability of water and soil moisture are critical factors that determine the broad distribution of vegetation types and associated wildlife species. Weather data specific to the project area are available in Section 1.1.1, Climate.

3.3.1.1 Regulatory Compliance Framework

The Endangered Species Act (16 U.S.C. 1531-1544; ESA) was passed by Congress in 1973 in recognition that many of our Nation's native plants and animals were in danger of becoming extinct. The purposes of the Act are to protect these endangered and threatened species and to provide a means to conserve their ecosystems. To this end, Federal agencies are directed to utilize their authorities to conserve listed species, and make sure that their actions do not jeopardize the continued existence of these species. For the proposed action, the law is administered by the USFWS. The USFWS works with other agencies to plan or modify Federal projects so that they will have minimal impact on listed species and their habitats.

Similarly, the proposed action is subject to compliance with the Navajo Endangered Species List, pursuant to the Navajo Tribal Code. This code (17 NNC § 507) makes it "unlawful for any person to take, possess, transport, export, process, sell or offer for sale or ship" any species listed on the Navajo Endangered Species List (in Groups 2 & 3).

The Navajo Natural Heritage Program (NNHP) is the Navajo Nation's rare, threatened and endangered species office. NNHP's purpose is to collect, manage and disseminate biological and ecological information for land-use planning to promote the conservation of biological diversity on the Navajo Nation. The NNHP maintains a comprehensive database of information on rare and protected plant and animal species and biological communities on the Navajo Nation. Many of the non-federally listed special status species addressed above are on the Navajo Endangered Species List.

During vegetation clearing activities, the project will be subject to compliance with the Migratory Bird Treaty Act. In accordance with the mitigation measures described below, prior to ground or vegetation clearing activities, nest searches and avoidance measures will be implemented to protect breeding migratory birds. Other potentially relevant regulatory compliance may be warranted should an active golden eagle or bald eagle nest be discovered. Under authority of the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d; BGEPA), bald and golden eagles are afforded additional legal protection.

3.3.2 <u>Vegetation</u>

3.3.2.1 Vegetation Communities within the Study Area

Vegetative communities in the study area were identified using the Provisional Digital Land Cover Map for the southwestern United States (USGS National GAP Analysis Program 2004). The purpose of the Gap Analysis Program (GAP) is to provide broad geographic information on the status of ordinary species and their habitats in order to provide land managers, planners, and scientists, with consistent and comparable data. Satellite imagery and computer modeling were used for developing the land cover map. Minimal ground truthing of vegetation communities to verify land cover types has been conducted to date. It is important to note that land cover maps are estimates of the true land cover and subsequently contain some level of error. However, the GAP analysis provides a cost effective and relatively accurate land management tool (Lowry et al. 2005). The quality (accuracy) of the land cover data used varies between the vegetative cover types and wildlife habitat types. Detailed information on the data quality used in this document can be accessed online at http://earch.gis.usu.edu/swgap/mapquality.html.

The GAP analysis uses the National Vegetation Classification System as the basic land cover mapping system for all states to use. This hierarchical system was created by the Nature Conservancy to address the problem of describing vegetation cover types consistently across political boundaries. The system uses physiognomic and floristic characteristics to describe the vegetation.

Eighteen National Vegetation Classification System vegetative cover types were identified within the study area, including two non-vegetative cover classes—Open Water and Recently Mined or Quarried (Table 3-19, Figure 3-11). Table 3-19 describes the proportions of each of the 18 vegetative communities according to the total number of acres that occur in the study area and the total proportion of the study area it comprises; Figure 3-11 illustrates the geographic distribution of these cover classes within the study area. The two most abundant vegetative community types are inter-mountain basins semi-desert grassland, comprising approximately 44,819 acres (44 percent of the study area), and inter-mountain basins salt desert scrub, encompassing approximately 21,260 acres (20 percent of the study area). The remaining vegetative cover types each make up less than 10 percent of the study area acreage. Vegetation cover classes comprising between 5 and 10 percent of the study area include inter-mountain basins greasewood flat (8,348 acres; 8.2 percent) and inter-mountain basins semi-desert shrub (5,754 acres; 5.7 percent). Areas that have been recently mined or quarried encompass approximately 4.9 percent (4,978 acres) of the study area.

The Provisional Digital Land Cover Map for the southwestern United States identified areas that have been recently mined or quarried within BNCC Areas I, II, and III (USGS National GAP Analysis Program 2004). Portions of BNCC Permit Areas I, II and III have been reclaimed. To more accurately describe the study area, data from BNCC's reclamation efforts were extrapolated to characterize reclaimed areas and then categorize into the GAP Analysis classifications (BHP Billiton 2005).

A description of each vegetation cover class is provided below. Water resources are discussed in detail in Section 3.2. Mining within the study area is discussed in Section 3.4.3.

Previous surveys of the BNCC Permit Area completed for Surface Mining Control and Reclamation Act (SMCRA) permitting identified vegetative communities by analyzing aerial photography and ground truthing of 21,690 acres within Permit Areas I, II, III, and IV. These surveys utilized a different classification than the GAP Analysis. Five vegetative communities were identified in the BNCC Permit Area: arroyo shrub, alkaline wash, sands, thin breaks/badlands, and upland shrub/dunal sands. (BNCC

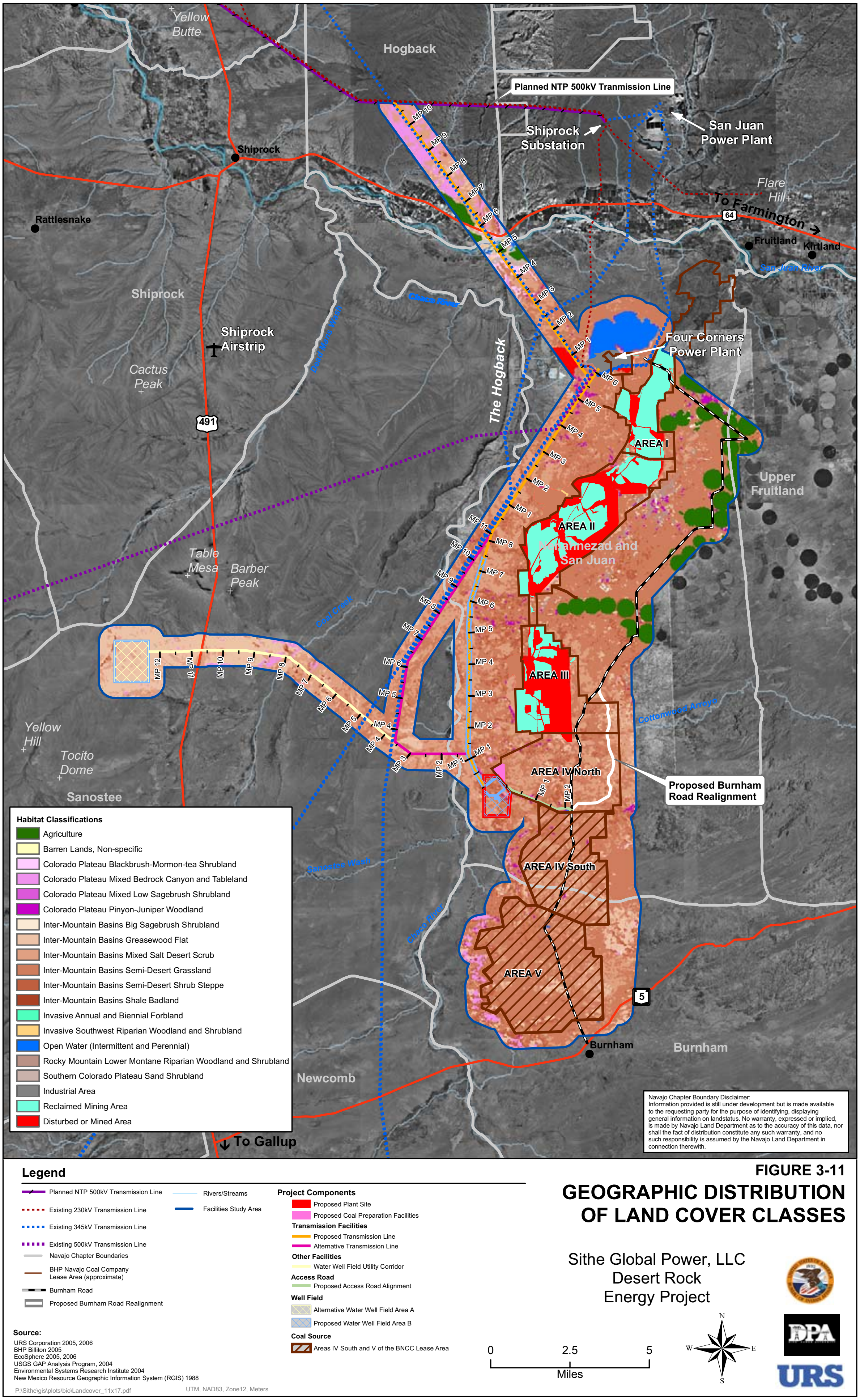


FIGURE 3-11
GEOGRAPHIC DISTRIBUTION OF LAND COVER CLASSES

SMCRA NM-0003A 1987). The most common vegetative communities identified were alkali wash (27 percent) and badlands (27 percent). Because eighteen cover types were identified using satellite imagery, direct comparisons with the vegetative communities in the BNCC SMCRA Report (1987) cannot be made. However, the characteristics and plants species described for alkali wash in the BNCC SMCRA Report (1987) are most similar to inter-mountain basins mixed salt desert scrub outlined below and badlands most similar to inter-mountain basins shale badland as characterized below. Other comparable vegetative communities identified in the BNCC SMCRA Report (1987) are described in the corresponding sections below.

The Provisional Digital Land Cover Map for the southwestern United States identified areas that have been recently mined or quarried within BNCC Areas I, II, and III (USGS National GAP Analysis Program 2004). Portions of BNCC Permit Areas I, II and III have been reclaimed. To more accurately describe the study area, data from BNCC's reclamation efforts were extrapolated to characterize reclaimed areas and then categorized into the GAP Analysis classifications (BHP Billiton 2005).

Table 3-19 Land Cover Types within the Study Area

Land Cover Type[1]	Acres	Percent of Total
Inter-mountain basins semi-desert grassland	44,819	44.1
Inter-mountain basins mixed salt desert scrub	21,260	20.9
Inter-mountain basins greasewood flat	8,348	8.2
Mined - revegetated	5,754	5.7
Inter-mountain basins semi-desert shrub steppe	5,524	5.4
Mined - not revegetated	4,978	4.9
Agriculture	4,495	4.4
Colorado plateau mixed bedrock canyon and tableland	2,018	2.0
Open water	1,538	1.5
Rocky Mountain lower montane riparian woodland and shrubland	901	0.9
Colorado plateau piñon-juniper woodland	784	0.8
Recently mined or quarried	414	0.4
Colorado plateau blackbrush mormon-tea shrubland	322	0.3
Southern Colorado plateau sand shrubland	188	0.2
Inter-mountain basins big sagebrush shrubland	122	0.1
Invasive southwest riparian woodland and shrubland	93	0.1
Inter-mountain basins shale badland	81	0.1
Colorado plateau mixed low sagebrush shrubland	7	<0.1
Invasive annual and biennial forbland	4	<0.1
Total	101,652	100.0

SOURCE: U.S. Geological Survey 2004
NOTE: [1] Land cover classes obtained from the Provisional Digital Land Cover Map for the southwestern United States.

3.3.2.1.1 Inter-Mountain Basins Semi-Desert Grassland

Inter-mountain basins semi-desert grasslands are restricted to shallow sloping swales dominated by alkali saccaton (*Sporobolus airoides*) with scattered New Mexico saltbush (*Atriplex obovata*), shadscale (*Atriplex confertifolia*), sparse greasewood (*Sarcobatus vermiculatus*), and plains prickly pear (*Opuntia polyacantha*). Other minor grass components representative of this vegetative cover type include galleta (*Plueraphis jamesii*) and Indian ricegrass (*Achnatherum hymenoides*). Associate herbaceous forbs include annual townsendia (*Townsendia annua*), yellow bee plant (*Cleome lutea*), Russian thistle (*Salsola tragus*), crownbeard (*Verbesina encelioides*), pinnate tansy mustard (*Descurainia pinnata*), and western stickseed (*Lappula occidentalis*). Total vegetation cover ranges from 15 to 40 percent. Alluvial deposited soils are silty to silty clay in texture with scattered platy shale fragments. Inter-mountain basins semi-desert grasslands are observed in lowland playas, low-gradient alluvial fans, and gentle sloping drainages. This vegetation cover type is usually invaded by annual weedy species within lowland drainage areas. The weedy plant species composition is a combination of non-native invasive and native annual forbs.

3.3.2.1.2 Inter-Mountain Basins Mixed Salt Desert Scrub

Inter-mountain basins mixed salt desert scrub is represented by a mixture of several halophytic shrub species of saltbush. Co-dominant species include Castle Valley saltbush (*Atriplex gardneri* var. *cuneata*), mat saltbush (*Atriplex corrugata*), shadscale, and bud sage (*Artemisia spinescens*). Other minor associate shrub species include franken bush (*Frankenia jamesii*), winterfat (*Krascheninnikovia lanata*), and Torrey's ephedra (*Ephedra torreyana*). The mixed salt desert scrub community also is composed of sparsely scattered grasses including alkali saccaton *(Sporobolus airoides)*, galleta, and Indian ricegrass. Associated annual forbs within this vegetative community include onion spring parsley (*Cymopterus bulbosus*), dwarf false gilia (*Ipomopsis pumila*), morning lily (*Oenothera caespitosa*), stevia dustymaiden (*Chaenactis stevioides*), stalked orach (*Atriplex saccaria*), prince's plume (*Stanleya pinnata*), large-flower onion (*Allium macropetalum*), pepperweed (*Lepidium* sp.), and corrugate phacelia (*Phacelia crenulata* var. *corrugata*). Total vegetation cover ranges from 5 to 20 percent. Soils of inter-mountain basins mixed salt desert scrub are derived from weathered bedrock and are generally clayey to silty clay. This cover type is observed on eroded shale ridges, benches, and adobe clay knolls and hills. Salt desert scrub communities provide habitat for several rare and sensitive plants species that may include Mesa Verde cactus (*Sclerocactus mesae-verdae*), Cronquist's milkvetch (*Astragalus cronquistii*), Comb Wash buckwheat (*Eriogonum clavellatum*), and Sleeping Ute milkvetch (*Astragalus tortipes*). In the BNCC SMCRA Report (1987) alkali wash is described most similiarly to this vegetative community. Total vegetataive cover in this community was reportedly low, as was plant production and shrub density compared with the other seven vegetative communities (BNCC SMCRA Report 1987).

3.3.2.1.3 Inter-Mountain Basins Greasewood Flat

Inter-mountain basins greasewood flats are dominated by greasewood; however, other minor shrub associates that may occur include four-winged saltbush (*Atriplex canescens*), Torrey's seepweed (*Suaeda torreyana*), New Mexico saltbush, Greene's rabbitbrush (*Chrysothamnus greenei*), and Drummond's goldenweed (*Haplopappus drummondii*). Grass cover is sparse in greasewood flats and species are generally limited to annual wheatgrass (*Eremopyrum triticium*), western wheatgrass (*Elymus smithii*), and cheatgrass (*Bromus tectorum*). Associate herbaceous forbs include Powell's orach (*Atriplex powellii*), stickleaf (*Mentzelia albicaulis*), woolly plantain (*Plantago patagonica*), yellow bee plant, dwarf false gilia, and annual townsendia. Total vegetation cover ranges from 15 to 30 percent. Alluvial sheet wash deposited soils are silty to siltyclay in texture. Inter-mountain basins greasewood flat communities are located on low lying playas, and flat floodplain terraces adjacent to major ephemeral drainages that exhibit small hummocky terrains called boondocks. This vegetation community is comparable to the arroyo shrub community type identified in the BNCC SMCRA Report and described below in Section 3.3.2.2.

3.3.2.1.4 Inter-Mountain Basins Semi-Desert Shrub Steppe

Inter-mountain basins semi-desert shrub steppe systems are characterized with an open shrub cover that is dominated by an understory of grasses, which comprise more than 25 percent of the total vegetative cover. Characteristic grasses includeIndian ricegrass, blue grama (*Bouteloua gracilis)*, salt grass (*Distichlis spicata)*, needle and thread (*Hesperostipa comata)*, galleta (*Pleuraphis jamesii)*, sandberg bluegrass (*Poa secunda)*, and sand dropseed (*Sporobolus cryptandrus)*. The most common shrub species include fourwing saltbush, big sagebrush (*Artemisia tridentata)*, Green's rabbitbrush, Douglas rabbitbrush (*Chrysothamnus viscidiflorus*), Mormon tea (*Ephedra* spp.), gray rabbitbrush (*Ericameria nauseosa)*, broom snakeweed (*Gutierrezia sarothrae)*, and winterfat.

3.3.2.1.5 Agriculture

Agricultural lands in the study area include irrigated fields, livestock pastures, and dryland farms located adjacent to the San Juan River floodplain and glacial outwash, gravel terrace benches. NAPI [Navajo Agricultural Products Industry, an enterprise of the Navajo Nation] is located between the BNCC Lease Area and U.S. Highway 550 (formerly U.S. Highway 44). In the northern portion, NAPI extends close to the San Juan River. NAPI's north-south length is approximately 10 miles. The DREP study area is west of NAPI and BNCC (refer to Section 3.4). Agricultural crops grown in the San Juan River Valley include alfalfa (*Medicago sativa*), corn (*Zea mays*), watermelon (*Citrullus lanatus*), cantaloupe (*Cucumis melo*), potatoes (*Solanum* spp.), and fall squash (*Cucurbita maxima*).

3.3.2.1.6 Colorado Plateau Mixed Bedrock Canyon and Tableland

The Colorado Plateau mixed bedrock canyons and tablelands include slickrock, rimrock, and talus habitats. The composition of shrubs and grasses varies from outcrop to outcrop; however, a mixture of the following shrub species is most often observed within tablelands: Bigelow's sagebrush (*Artemisia bigelovii*), rough brickellbush (*Brickellia microphylla* var. *scabra*), Torrey's ephedra, broom snakeweed, Bigelow's rabbitbrush (*Chrysothamnus nauseosus* var. *bigelovii*), winterfat, shadscale, and Harriman's yucca (*Yucca harrimaniae*). Grass cover is limited and may include galleta, purple threeawn (*Aristida purpurea*), alkali saccaton, squirrel tail (*Elymus elymoides*), needle and thread grass, fluffgrass (*Erioneuron pulchellum*), and desert needlegrass (*Stipa speciosa*). Annual forbs associates include common globemallow (*Sphaeralcea coccinea*), Fendler's euphorb (*Chameasyce fendleri*), many branched false gilia (*Ipomopsis polycladon*), woolly locoweed (*Astragalus mollissimus* var. *thompsonae*), and rockgoldenrod (*Petradoria pumila*). Total vegetation cover ranges from 10 to 20 percent. There is little or no soil development in Colorado Plateau mixed bedrock canyons and tablelands. Often, soil development is restricted to sandstone depressions and areas of loose rocky talus. Poorly developed soils are shallow and usually silty to silty sand in texture. These vegetation communities occur on massive exposures of sandstone bedrock, uplifted hogback ridges, and mesa tops. Tablelands or slickrock settings provide habitat for two very rare flora species—Mancos milkvetch (*Astragalus humillimus*) and Naturita milkvetch (*Astragalus naturitensis*). Thinbreak, described in the BNCC SMCRA Report, is most similar to this vegetative community. Thinkbreaks were characterized as having relatively high percent cover, high plant production, and moderate shrub density (BNCC SMCRA 1987).

3.3.2.1.7 Rocky Mountain Lower Montane Riparian Woodland and Shrubland

Rocky Mountain lower montane riparian woodland and shrublands occur throughout the Rocky Mountain and Colorado Plateau regions at elevations that range from approximately 2,900 feet to 9,184 feet. This community type is commonly dominated by trees, but maintains a diverse assortment of shrub species. This system is dependent on a natural hydrologic regime, especially annual to episodic flooding. This community type occurs most frequently within the flood zone of rivers, on islands, sand or cobble bars, and immediate streambanks. In addition, this community type also can occur on perennially wet sites, including swales and irrigation ditches. Dominant trees may include boxelder (*Acer negundo)*, narrowleaf cottonwood (*Populus angustifolia)*, western cottonwood (*Populus fremontii)*, Douglas fir (*Pseudotsuga menziesii)*, or peachleaf willow (*Salix amygdaloides)*. Russian olive (*Elaeagnus angustifolia)* and saltcedar (*Tamarix* sp.) are the primary exotic trees found in this community type. Dominant shrubs include speckled alder (*Alnus incana)*, water birch (*Betula occidentalis)*, dogwood (*Cornus sericea)*, skunkbush sumac (*Rhus trilobata)*, and an assortment of willows (*Salix* spp.).

3.3.2.1.8 Colorado Plateau Piñon-Juniper Woodland

Colorado Plateau piñon-juniper woodlands occur in dry mountains and foothills of the Colorado Plateau region including the northwestern corner of New Mexico. This community type is typically found at lower elevations ranging from 4,900 feet to 8,000 feet on warm and dry mountain slopes, mesas, plateaus, and ridges. Severe climatic events occurring during the growing season, such as frosts and drought, are thought to limit the distribution of piñon-juniper woodlands to relatively narrow altitudinal belts on mountainsides. Soils supporting this system vary in texture ranging from stony, cobbly, gravelly sandy loams to clay loam or clay. Piñon pine (*Pinus edulis)* and/or Utah juniper (*Juniperus osteosperma)* dominate the tree canopy. In the southern portion of the Colorado Plateau in northern Arizona and northwestern New Mexico, one-seeded juniper (*Juniperus monosperma)* and juniper hybrids may dominate or codominate the tree canopy. Rocky Mountain juniper (*Juniperus scopulorum)* may codominate or replace Utah juniper at higher elevations. Understory layers are variable and may be dominated by shrubs, grasses, or be absent. Associated species include Greenleaf manzanita (*Arctostaphylos patula)*, big sagebrush, mountain mahogany (*Cercocarpus montanus)*, antelope bitterbrush (*Purshia tridentata)*, Gambel's oak (*Quercus gambelii)*, blue grama, galleta, or muttongrass (*Poa fendleriana)*. This system occurs at higher elevations than Great Basin piñon-juniper woodland and Colorado Plateau shrubland systems where these communities are sympatric.

3.3.2.1.9 Colorado Plateau Blackbrush-Mormon Tea Shrubland

Colorado Plateau blackbrush-Mormon tea shrublands occur within the Colorado Plateau along benchlands, colluvial slopes, pediments, or bajadas at elevations ranging from 1,800 feet to 5,400 feet. Substrates in this community type are shallow and typically calcareous, non-saline and gravelly or sandy soils over sandstone or limestone bedrock, caliche, or limestone alluvium. These vegetative shrublands also can occur in deeper soils on sandy plains that have invaded desert grasslands. Vegative coverage is characterized by extensive open shrublands dominated by blackbrush (*Coleogyne ramosissima*), Mormon tea (*Ephedra viridis)*, Torrey's ephedra, or hopsage (*Grayia spinosa)*. Particularly sandy portions of this community type may include a large amount of sand sagebrush (*Artemisia filifolia*). The herbaceous layer is sparse and composed of grasses such as Indian ricegrass, galleta (*Pleuraphis jamesii)*, and sand dropseed.

3.3.2.1.10 Southern Colorado Plateau Sand Shrubland

Southern Colorado Plateau **s**and shrublands consists of several intermixed shrub species including four-winged saltbush, Bigelow's rabbitbrush, Greene's rabbitbrush, broom snakeweed, sand buckwheat (*Eriogonum leptocladon*), sand sagebrush (*Artemisia filifolia*), Cutler's ephedra (*Ephedra cutleri*), and narrowleaf yucca (*Yucca angustissima*). Codominant grasses include galleta, Indian ricegrass, sand dropseed, spike dropseed (*Sporobolus contractus*), sand muhly (*Muhlenbergia pungens*), and giant dropseed (*Sporobolus giganteus*). Diversified associate forbs include hoary aster (*Macaeranthera canescens*), silvery townsendia (*Townsendia incana*), dwarf lupine (*Lupinus pusillus*), pale evening primrose (*Oenothera pallida*), woolly dalea (*Dalea lanata*), gravel milkvetch (*Astragalus sabulonum*), annual wirelettuce (*Stephanomeria exigua*), fragrant sand verbena (*Abronia fragrans*), Brandegee's sandplant (*Dicoria canescens* ssp. *brandegeei*), and showy rush (*Lygodesmia grandiflora*). Total vegetation cover ranges from 30 to 65 percent. Eolian (wind blown) derived soils of Southern Colorado Plateau **s**and shrublands are sandy to fine silty sand. This vegetation cover type is observed on extensive sand sheets and small dunes located on eroded ridges, wide flat mesa tops, large depressions, and alluvial flood terraces adjacent to major ephemeral drainages. Sand shrublands are often host to one rare and sensitive plant species, San Juan milkweed (*Asclepias sanjuanensis*). Both sands and dunes were described as most similar to this vegetative community in the BNCC SMCRA Report (1987).

Sands had the highest shrub density of the five community types measured on the Navajo Mine Permit Areas, as well as the highest perennial plant production, and higher percent cover than all but two of the other areas. Further, dunes were reported to be one of the more productive areas with relatively high perecent cover, productivity, and shrub density (BNCC SMCRA Report).

3.3.2.1.11 Inter-Mountain Basins Big Sagebrush Shrubland

Inter-mountain basins big sagebrush shrublands occur throughout much of the western United States, typically in broad basins between mountain ranges, plains, and foothills at elevations ranging between 4,920 feet and and 7,544 feet. Soils in this community type are typically deep, well-drained and non-saline. These shrublands are dominated by big sagebrush and associated subspecies, assorted juniper species, greasewood, and saltbush. Disturbed stands also may be abundant in gray rabbitbrush, Greene's rabbitbrush, antelope bitterbrush, or mountain snowberry (*Symphoricarpos oreophilus).* Perennial herbaceous vegetation typically contributes less than 25 percent pf the total vegetative cover. Common grass species include *Indian ricegrass*, blue grama, thickspike wheatgrass (*Elymus lanceolatus)*, Idaho fescue (*Festuca idahoensis)*, needle and thread, basin wildrye (*Leymus cinereus)*, galleta, western wheatgrass, sandberg bluegrass (*Poa secunda)*, and bluebunch wheatgrass (*Pseudoroegneria spicata)*.

3.3.2.1.12 Invasive Southwest Riparian Woodland and Shrubland

The invasive southwest riparian woodland and shrubland vegetation type is a densely covered community type that includes non-native, invasive species including saltcedar (*Tamarix chinensis*) and Russian olive. These species have invaded riparian plant communities and replaced native shrubs, such as willow (*Salix* spp.) and cottonwood (*Populus* spp.), and have become a monoculture or mixture of the two non-native species.

3.3.2.1.13 Inter-Mountain Basins Shale Badland

Inter-mountain basins shale badlands include extensive regions of nearly barren slopes dominated by mono-cultural stands of one or two saltbush species. Barren slopes observed within the affected environment area have limited to no perennial vegetation cover. Sparsely scattered shrub cover is often composed of one or two species that may include Castle Valley saltbush, mat saltbush, and shadscale. Grass cover is absent or consists of very sparsely scattered galleta, alkali saccaton, or Indian ricegrass. Annual forbs associated with this cover type may include any of the following: spreading buckwheat (*Eriogonum divaricatum*), Gordon's buckwheat (*Eriogonum gordonii*), Powell's orach, stalked orach, smooth buckwheat (*Eriogonum salsuginosum*), stevia dustymaiden, Palmer's cleomella (*Cleomella palmeriana*), and corrugate phacelia. In barren areas with exposed and weathered coal outcrops, sparse shrub cover is restricted to corymb buckwheat (*Eriogonum corymbosum*) and greasewood, no grasses are present, and annual forb cover is limited to Westwater buckwheat (*Eriogonum scabrellum*). Total vegetation cover is less than 5 percent. Soils in this vegetation cover type are derived from weathered bedrock and are generally clayey to silty clay in texture. Inter-mountain basins shale badlands occur along steep escarpments and extensive exposures of weathered shale bedrock. Barren badlands provide habitat for three rare and sensitive plant species, including Four Corners orach (*Atriplex plieantha*), Eastwood's phacelia (*Phacelia splendens*), and Bolack's sandverbena (*Abronia bolackii*).

3.3.2.1.14 Colorado Plateau Mixed Low Sagebrush Shrubland

This ecological system occurs in the Colorado Plateau in canyons, gravelly draws, hilltops, and dry flats at elevations generally below 5,900 feet. Soils in this community are often rocky, shallow, and alkaline. This community type extends across northern New Mexico into the southern Great Plains on limestone hills and includes open shrublands and steppe dominated by black sagebrush (*Artemisia nova)* or dwarf sagebrush (*Artemisia bigelovii)*, sometimes with big sagebrush. Semi-arid grasses such as Indian ricegrass, purple three-awn, blue grama, needle and thread, galleta, or muttongrass are often present and may form a grass layer with over 25 percent cover.

3.3.2.1.15 Invasive Annual and Biennial Forbland

Invasive annual and biennial forbland include areas that are dominated by introduced annual and/or biennial forb species such as halogeton (*Halogeton glomeratum)*, fireweed (*Kochia scoparia)*, and Russian thistle (*Salsola* spp.).

3.3.2.1.16 Barren Lands, Non-specific

Barren lands, non-specific encompasses barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulation of earthen material. Generally, vegetation accounts for less than 15 percent of total cover in this community type.

3.3.2.2 Vegetation Communities within the BNCC Lease Area

During 1998, a vegetation study was conducted within the portions of the Desert Rock project area. The 7,104-acre vegetation study area (VSA) included all of BNCC mine lease Area IV South and the northern one-quarter of Area V. Five vegetation types were delineated within the VSA: arroyo shrub, alkaline wash, sands, thin breaks/badlands, and upland shrub/dunal sands. This section provides an overview of these five vegetation types and a table of acreage of these types within the VSA (Table 3-20).

Table 3-20 Acreage of Vegetation Types within BNCC Mine Lease Area IV South and Portions of Area V

Vegetation Type	Total Acres	% Total
Arroyo Shrub	457	6.4%
Alkaline Wash	2,586	36.4%
Sands	2,273	32.0%
Thin Breaks/Badlands	1,129	15.9%
Upland Shrub/Dunal Sands	651	9.2%
Disturbed	9	0.1%
Total	**7,104**	**100.0%**

3.3.2.2.1 Arroyo Shrub

The arroyo shrub vegetation type is dominated by greasewood and rubber rabbitbrush, with significant amounts of shadscale, Indian ricegrass, alkali sacaton, galleta, fourwing saltbush, and broom snakeweed are also common. Other common grass, forb, and subshrub species include western wheatgrass, Russian thistle, broom snakeweed, and Torrey's seepweed. In 1998, summer vegetative cover averaged 33.95-35.83%, which was relatively high compared with other types in the study area; shrub density was in the range of 745-852 shrubs/acre and 2,350-2,816 shrubs and subshrubs/acre, which ranks second highest in comparison to the other vegetation types; and production averaged 219.5-352.4 lbs/acre, which ranks third among the five types.

The arroyo shrub vegetation type occurs in low-lying areas along the bottoms and banks of major arroyos in the VSA, and occurs primarily along No Name and Pinabete arroyos and their larger tributaries. It is the least abundant vegetation type in the VSA, occurring on 456.5 acres and exists predominantly on the Beebe variant loamy sand which is deep and well-drained. These soils are typically found on floodplains and lower river terraces and are formed in sandy alluvium. This vegetation type is most similar to Inter-Mountain Basins Greasewood Flat described above in Section 3.3.2.1.3 and Inter-Mountain Basins Semi-Desert Grassland.

3.3.2.2.2 Alkaline Wash

The alkaline wash vegetation type is dominated by broadscale, galleta, and alkali sacaton. Other common species include Russian thistle, Gardner's saltbush, and shadscale. In the summer of 1998, alkaline wash vegetative cover averaged 8.00-9.53%, the lowest in the VSA; shrub density was also lowest of all vegetation types, averaging 8-96 shrubs/acre and 797-1,618 shrubs and subshrubs/acre; and production was lower than any other vegetation type, averaging 67.8-200.7 lbs/acre. Surfaces within this vegetation type are relatively barren and stony. The alkaline wash vegetation type occurs primarily on Persayo clay loams and Patel-Chipeta clays. Persayo soils are shallow and well-drained and are formed in residuum from weathered shale (Keetch 1980). In places, this vegetation type is intricately intermixed with the sands vegetation type. The alkaline wash vegetation type is widely distributed throughout the VSA on flat to gently sloping uplands and is the most abundant vegetation type in the area (2,585.7 acres). It occurs primarily in the southern portion of the project area. This vegetation type is most similar to Inter-Mountain Basins Mixed Salt Desert Scrub described above in Section 3.3.2.1.2.

3.3.2.2.3 Sands

The sands vegetation type is dominated by perennial grasses such as galleta, alkali sacaton, Indian ricegrass, sand dropseed, and snakeweed. Other common species included Russian thistle and shadscale. Summer vegetative cover in 1998 was in the range of 34.61-43.15%; average shrub/subshrub density ranged from 353 to 374 shrubs/acre and 1,316 to 4,213 shrubs and subshrubs/acre; and production ranged from 274.8 to 339.0 lbs/acre. The sands vegetation type is also widely distributed throughout the VSA, occupying flat to gently sloping uplands. It is the second most abundant vegetation type in the area, occupying 2,273.4 acres, and occurs on a wide variety of soils, including but not limited to Patel-Chipeta clays, Persayo clay loams, badlands, Bacobi sandy loams, Tsaya series, and Shiprock-Bacobi-Mayqueen sandy loams. The sands vegetation type provides habitat for a wide variety of wildlife species. This vegetation type is most similar to Intermountain Basins Semi-Desert Grassland described in Section 3.3.2.1.1.

3.3.2.2.4 Thin Breaks/Badlands

The thin breaks/badlands vegetation type is dominated by galleta, alkali sacaton, and broadscale saltbush. Other common species included Gardner's saltbush, shadscale, Russian thistle, and sand dropseed. In 1998, summer vegetative cover averaged 11.90-17.35%; shrub/subshrub density ranged from 263 to 631 shrubs/acre and 1,149 to 2,142 shrubs and subshrubs/acre; and production ranged from 67.8 to 243.6 lbs/acre, ranking second lowest among types. The thin breaks/badlands vegetation type occupies 1,128.5 acres within the VSA. It occurs on upland ridges and moderate to steep slopes on soils that range from thin and stony (thin breaks) to undeveloped weathered rock (badlands). A predominant soil is the Huerfano sandy clay loam which is shallow and well-drained and formed in alluvium and residuum derived from shale and siltstone. Soils are saline, and effective rooting depth is 10-20 inches. This vegetation type is most similar to Inter-Mountain Basins Shale Badland described above in Section 3.3.2.1.13.

3.3.2.2.5 Upland Shrub/Dunal Sands

The 1998 study showed that the upland shrub/dunal sands type supported the most abundant vegetation compared with other types in the area, and perennial grasses were prevalent. Dominant species included alkali sacaton, Indian ricegrass, galleta, sand dropseed, and Mormon tea. Other common species included rubber rabbitbrush, corymbed wildbuckwheat, and snakeweed. Summer cover in 1998 was the highest of all types, averaging 43.00 to 43.33%; shrub/subshrub density was also highest and averaged 769 to 1,196 shrubs/acre and 5,839 to 6,888 shrubs and subshrubs/acre; and production ranged from 186.5-403.3 lbs/acre. The upland shrub/dunal sands vegetation type occurs on flat to gently sloping uplands and sand dunes in the project area and occupies 650.9 acres within the VSA. The predominant soils include the Razito loamy sand, the Benally loamy sand, and the Patel-Huerfano association. This vegetation type provides habitat for a wide variety of wildlife species and is similar to Southern Colorado Plateau Sand Shrubland described above in Section 3.3.2.1.10.

3.3.2.3 Noxious Weeds

The Navajo Nation currently does not have a management plan for noxious weeds or an official list of noxious weeds. However, species that are of particular concern to the Navajo Natural Heritage Program include cheatgrass (*Bromus tectorum),* red brome (*Bromus rubens),* blue mustard (*Chorispora tenella),* and annual wheatgrass (*Eremopyrum triticeum;* Daniella Roth, Personal Communication). All of these species have potential to occur within the study area.

Executive Order 13112, *Invasive Species* (February 3, 1999), mandates that Federal agencies take actions to prevent the introduction of invasive species, provide for their control, and minimize the economic, ecological, and human health impacts that invasive species cause. Also, pursuant to the Noxious Weed Management Act of 1998, the New Mexico Department of Agriculture has identified several species to be targeted as noxious weeds for control or eradication. New Mexico's noxious weeds are classified into three divisions: Class A, Class B and Class C, all of which are non-native to New Mexico (Table 3-21). Class A weeds are species that currently are not present in New Mexico or have limited distribution; preventing new infestations of these species and eradicating existing infestations is the highest priority. Class B weeds are species that are limited to portions of the State. In areas that are not infested, these species should be treated as Class A weeds. In areas with severe infestations, management plans should be designed to contain the infestation and prevent any further spread. Class C weeds are species that are widespread in the State. An inventory of noxious weeds has not been conducted in the study area. However, salt cedar and Russian olive, two New Mexico State Class C noxious weeds, commonly occur in emphemeral waterways, along the perimeter or stock ponds and other catchment basins, and within the San Juan River floodplain in the study area.

Table 3-21 Noxious Weeds Listed by the New Mexico Department of Agriculture

	Potential to Occur in the Study Area
Class A Weeds	
Alfombrilla *(Drymaria arenarioides)*	NP
Black henbane *(Hyoscyamus niger)*	P
Camelthorn *(Alhagi maurorum)*	NP
Canada thistle *(Cirsium arvense)*	P
Dalmation toadflax (*Linaria dalmatica)*	NP
Diffuse knapweed (*Centaurea diffusa)*	NP
Dyer's woad *(Isatis tinctoria)*	NP
Eurasian watermilfoil *(Myriophyllum spicatum)*	NP
Hoary cress *(Cardaria draba)*	NP
Hydrilla (*Hydrilla verticillata)*	NP
Leafy spurge (*Euphorbia esula)*	P
Onionweed (*Asphodelus fistulosus)*	NP
Perennial pepperweed (*Lepidium latifolium)*	P
Purple loosestrife (*Lythrum salicaria)*	NP
Purple starthistle (*Centaurea calcitrapa)*	NP
Scotch thistle *(Onopordum acanthium)*	P
Spotted knapweed *Centaurea biebersteinii)*	P
Yellow starthistle (*Centaurea solstitialis)*	P
Yellow toadflax (*Linaria vulgaris*)	NP
Class B Weeds	
African rue (*Peganum harmala*)	NP
Bull thistle (*Cirsium vulgare*)	P
Halogeton (*Halogeton glomeratus*)	K
Malta starthistle (*Centaurea melitensis*)	NP
Musk thistle (*Carduus nutans*)	K
Russian knapweed (*Acroptilon repens*)	K
Poison hemlock (*Conium maculatum*)	NP
Teasel (*Dipsacus fullonum)*	NP
Class C Weeds	
Field bindweed (*Convolvulus arvensis*)	K
Jointed goatgrass (*Aegilops cylindrica*)	K
Russian olive (*Elaeagnus angustifolia*)	K
Saltcedar (*Tamarix spp.*)	K
Siberian Elm (*Ulmus pumila*)	K

SOURCE: Lee 1999
NOTES: K = Denotes species known to occur in the study area
NP = Indicates species with little or no potential to occur in the study area
P = Indicates species with potential to occur within the study area

3.3.3 Wildlife

3.3.3.1 Wildlife Habitats

The study area and surrounding region support a variety of natural vegetation communities and landscape features that offer a diversity of wildlife habitat types. While these habitat types correspond with the vegetation community types discussed in Section 3.3.2, they also are defined by a number of distinct landscape features such as washes and gullies, rock outcrops and hillsides, cliffs and taluses, and cave and mine entrances. All contribute to the diversity of wildlife in the area as they generally provide a microhabitat for wildlife uniquely adapted to or dependent on these features. Figure 3-12 illustrates the geographic distribution of general wildlife habitat types within the study area. Appendix G provides a listing of the wildlife and raptor species that have been historically documented in desert scrub / semi-desert grassland habitat, the dominant habitat communities found in the study area.

Most wildlife species within the study area are adapted to drought conditions, including sparse vegetative cover and limited sources of permanent water. However, a number of perennial sources of water in the study area support a relatively high concentration of vegetation and cover that contribute to increased wildlife diversity in these areas. Large mammals, such as coyote (*Canis latrans*) and kit fox (*Vulpes macrotis*), use these water sources and return to them regularly. Bats also may forage over these areas because of increased abundance of invertebrate prey. More common bird species may nest and forage in these areas year-round, while migratory bird species may forage and rest in these areas during their migration.

While riparian habitat covers less than 1 percent of the study area, it provides habitat for the majority of the species recorded in the region. While many species of wildlife commonly feed in upland habitats, they also depend on riparian-wetland habitat for breeding and cover. The riparian-wetland generally has more structured and complex vegetative assemblages, along with higher wildlife diversity and the surrounding upland areas. These areas effectively function as movement corridors for mammals and serve as congregation and feeding areas for a variety of bird species. Wildlife habitat types are described in Table 3-22.

Table 3-22 Wildlife Habitat Types within the Study Area

Habitat Type	Acres	Percent of Total
Grasslands	44,819	44.1
Shrublands	27,101	26.7
Blackbrush ephedra greasewood shrubland	86,70	8.5
Mined - revegetated	5,754	5.7
Mined - not revegetated	4,978	4.9
Agriculture	4,495	4.4
Canyonlands	2,018	2.0
Open water	1,538	1.5
Riparian shrublands	994	1.0
Piñon-juniper woodland	784	0.8
Recently mined	414	0.4
Barren lands and badlands	85	0.1
Invasive forblands	4	<0.1
Total	**101,652**	**100.0**

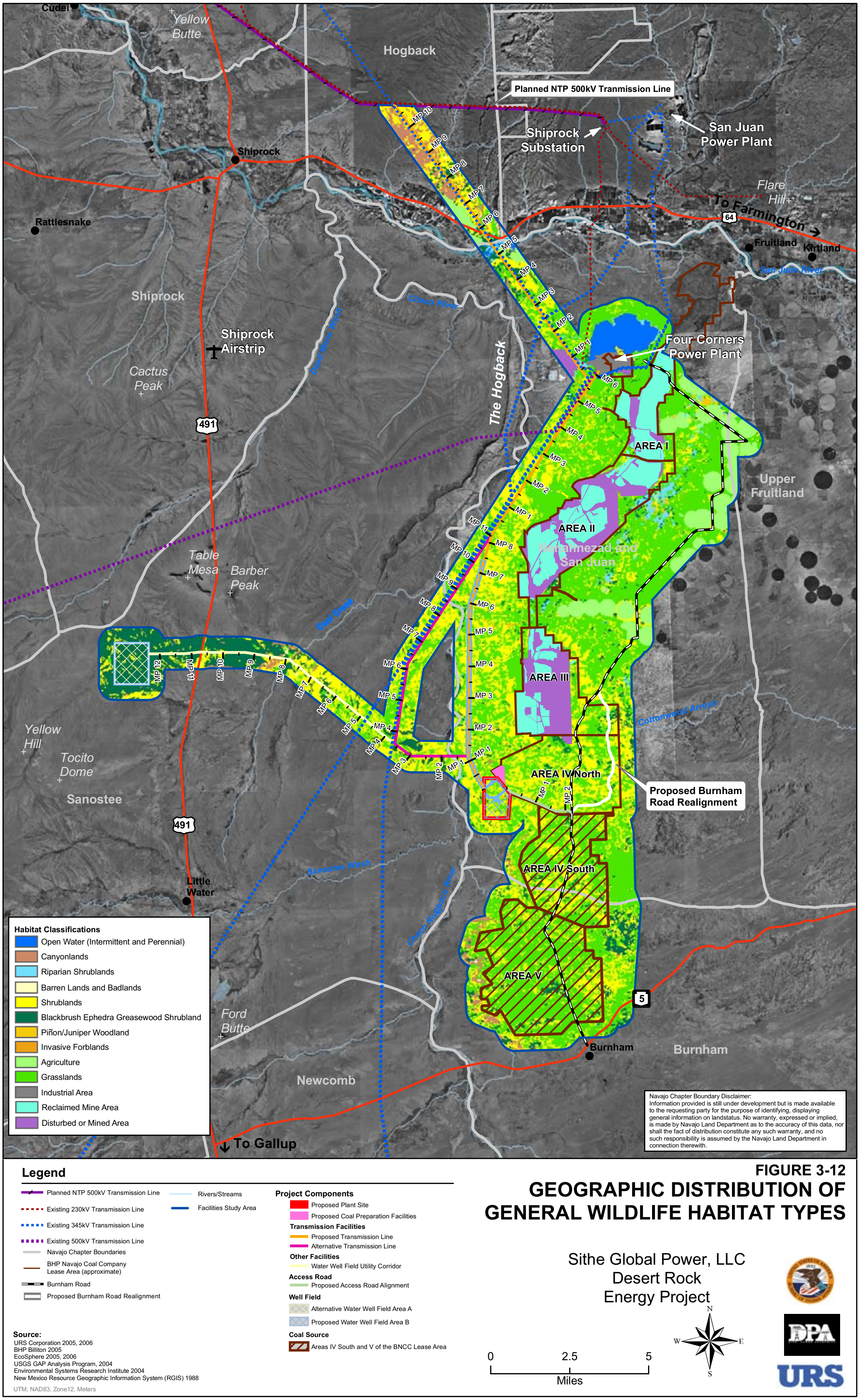


FIGURE 3-12
GEOGRAPHIC DISTRIBUTION OF GENERAL WILDLIFE HABITAT TYPES

3.3.3.2 General Wildlife

3.3.3.2.1 Mammals

The study area provides several unique (see Figure 3-11 and Figure 3-12) vegetation community types and therefore, provides potential habitat for a broad range of mammalian species. Because of the large number of mammalian species with potential to occur in the study area, mammals have been grouped into the following five categories:

- **Fossorial and Semi-Fossorial Small Mammals**: This category includes animals from several families that are typically considered to be "small mammals" including Soricidae (shrews), Heteromyidae (pocket mice and kangaroo rats), Muridae (New World rats and mice), and Arvicolidae (voles and muskrats). Also included in this category are members of the families Sciuridae (squirrels) and Geomyidae (pocket gophers). Fossorial and semi-fossorial small mammals are highly dependent on shrubs for forage, nesting sites, and to provide cover from predators (Findley 1987). Small mammals such as deer mice (Peromyscus maniculatus), Ord's kangaroo rats (Dipodomys ordii), banner-tailed kangaroo rats (Dipodomys spectabilis), silky pocket mice (Perognathus flavus), white-tailed antelope squirrels (Ammospermophilus leucurus), and rock squirrels (Spermophilus variegatus) are relatively common in the general region of the study area (Burt et al. 1976). A recent small mammal survey in Area IV North of BNCC Lease Area (adjacent to the proposed power plant site) indicated that small mammal densities were low in the study area (Ecosphere Environmental Services [Ecosphere] 2004, unpublished report). The reported density estimates were substantially lower than small mammal densities reported elsewhere in northern New Mexico (Root et al. 2005). However, this study was conducted in summer 2004, during a serious drought. Further, the study was not replicated and trap-grids were run only two consecutive trap-nights, and only minimum number alive was used to estimate density (Ecosphere 2004); therefore, the density estimates should be used with caution. In 2005, Ecosphere conducted live-trapping for banner-tailed kangaroo rats in similar habitats throughout Area V and although density was not estimated *per se*, trap success was significantly higher than any previous small mammal trapping efforts in the BNCC Lease Area (Ecosphere 2004).
- **Bats**: This category contains members of the families Vespertilionidae (common bats) and Molossidae (free-tailed bats). The study area provides potential habitat for a number of bat species, including the small-footed bat (*Myotis ciliolabrum meloanorhinus*), Yuma bat (*Myotis yumanensis yumanensis*), big free-tailed bat (*Nyctinomops macrotis*), fringed myotis (*Myotis thysanodes*), Townsend's big-eared bat (*Corynorhinus townsendii*), spotted bat (*Euderma maculatum*), pallid bat (*Antrozous pallidus*), and western pipistrel (*Pipistrellus hesperus*). Bats may utilize grassland and shrubland habitats within the study area for foraging and also may frequent riparian areas or water holes. For roosting, bats prefer structures like rock outcroppings, cliff faces, mine shafts, and building ledges and are likely to occur in mixed bedrock canyons and tableland habitat. Piñon and juniper trees may provide roosting sites for bats. Agricultural lands near the study area may provide sources of standing water that may be frequented by bats; however, this habitat type is not expected to provide ample roosting sites to support a resident bat population. Recent wildlife surveys conducted on the BNCC Lease Area indicate that bats are relatively abundant in the study area (Ecosphere 2004; Hawks 2005).
- **Leporids**: Leporids include members of family Leporidae (rabbits and hares). Leporids rely on open expanses for predator evasion and as such may be found in a number of vegetative communities. In recent surveys of the study area, desert cottontails (*Sylvilagus audubonii*) and black-tailed jackrabbits (*Lepus californicus*) were the most common and abundant species sighted. They were sighted in grassland and shrubland habitats, as well as in areas nearly devoid

of vegetation (Hawks 2005). Both black-tailed jackrabbits and desert cottontails possess a large number of behavioral and physiological adaptations that allow them to survive in xeric environments (Fitzgerald 1994); thus, it is expected that both black-tailed jackrabbits and desert cottontails will occur in most vegetative communities within the study area. However, because leporids' consumption of grasses reportedly increases during periods when the grass is green and lush (Vorhies and Taylor 1999), these species may occur most commonly in semi-dessert grasslands during spring and early summer.

- **Carnivores**: This category contains members of families Canidae (foxes and coyotes), Felidae (cats), Erethizontidae (porcupines), Procyonidae (raccoons), and Mustelidae (weasels, badgers and skunks). The study area provides potential habitat for a number of carnivores including mountain lion (*Felis concolor*), coyote, raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), American badger (*Taxidea taxus*), and kit fox. The kit fox is a Navajo Endangered Species List (NESL) species and is discussed in detail in Section 3.3.5.2. The density of carnivores is directly related to the density of prey in lower trophic levels and, in general, leporids and small mammals constitute the bulk of the carnivore diet. High leporid density would be expected to be most beneficial for highly generalized predators like foxes, raccoons, and coyotes. Generalist predators typically occupy large territories and roam diverse vegetative communities in order to find substantial prey. Thus, predators that are habitat generalists would be expected to occur in semi-desert grasslands, salt desert scrublands, semi-desert and other shrublands, shale badlands, bedrock canyons and tablelands, piñon-juniper woodlands, and agricultural areas within the study area. Recent surveys of the study area documented that coyote and red fox (*Vulpes vulpes*) were the most common and abundant predators occurring within the study area (Hawks 2005). In recent spotlighting surveys, several individual foxes, including kit foxes were observed in Area V (Ecosphere, 2005 unpublished data). In contrast, more specialized predators would be expected to be less common. For example, sightings of American badger in the study area have been rare (Hawks 2004); One badger was observed in a prairie dog colony in Area IV N in summer 2004 (Ecosphere 2004). Because these predators are specialized for digging, the paucity of moderately sized, semi-fossorial prey, like Gunnison's prairie dogs or valley pocket gophers, may preclude higher badger densities.
- **Ungulates**: Ungulates include members of the families Cervidae (deer) and Antilocapridae (pronghorn). The most common ungulate expected to occur within the study area is the mule deer (*Odocoileus hemionus*). Mule deer are nearly ubiquitous in grassland and shrubland communities in the western United States, with a geographic range that extends westward from Texas to California (Fitzgerald 1994). Although mule deer have the potential to occur in the study area, sightings of these ungulates are extremely rare and have been limited primarily to the San Juan River bottom and agricultural lands associated with NAPI (BHP SMCRA NM-0003C Report 1992; Dave Mikesic pers.comm.). The BHP SMCRA Report 1992 suggests that declines in large herbivore populations may be related to increased habitat disturbance in the study area, as well as over-harvesting by recreational hunters. Likewise, low vegetative coverage in the study area and the general vicinity limits its utility for mule deer; thus, low densities of mule deer and other ungulates may be a natural phenomenon.

3.3.3.2.2 Birds

This section describes the current condition of avian wildlife resources within the study area that have potential to be affected by the proposed action. General bird use throughout the study area can be divided into two categories, upland habitats and riparian habitats:

- **Upland Habitats**: The majority of the study area is composed of some variety of semi-desert grassland, shrubland, or salt-desert scrub habitat types. These vegetation community types are discussed in detail in Section 3.3.3.1. Common passerines and other small birds found in semi-desert and salt-desert habitats include common raven (*Corvus corax*), American crow (*Corvus brachyrhyncos*), horned lark (*Eremophila alpestris*), vesper sparrow (*Pooecetes gramineus*), savannah sparrow (*Passerculus sanwichensis*), lark sparrow (*Chondestes grammacus*), mourning dove (*Zenaida macroura*), western meadowlark (*Sturnella neglecta*), and scaled quail (*Callipela squamata*). Upland vegetation cover and structure in the study area is also appropriate habitat for numerous raptor species, such as red-tailed hawk (*Buteo jamaicensis*), turkey vulture (*Cathartes aura*), great-horned owl (*Bubo virginianus*), golden eagle (*Aquila chrysaetos*), ferruginous hawk (*Buteo regalis*), and American kestrel (*Falco sparverius*). Vegetation cover types for raptor use throughout the study area can be broken into two separate groups foraging and nesting habitat. Foraging habitat for raptors occurs in semi-desert grasslands and shrublands, salt desert scrub, shale badlands, greasewood flats, and sand shrublands. Nesting habitat for most raptors found in the study area occurs in the cliffs, spires, and badlands associated with the shale badlands and canyon and tableland habitats. Piñon and juniper trees may serve as important foraging, perching, or nesting sites for some avian species in the study area. Because of their abundant seed production, agricultural lands provide foraging habitat for a number of birds, including raptors and passerines.
- **Riparian Habitats**: Riparian woodlands in the study area occur along the San Juan River; exotic riparian shrublands occur at Morgan Lake and along the Chaco River and other ephemeral washes within the study area. Common passerines that may occur within these riparian habitats include yellow warbler (*Dendroica petechia*), blue-gray gnatcatcher (*Polioptila caerulea*), western wood-pewee (*Contopus sordidulus*), house wren (*Troglodytes aedon*), white-breasted nuthatch (*Sitta carolinensis*), song sparrow (*Melospiza melodia*), house finch (*Carpodacus mexicanus*), western kingbird (*Tyrannus verticalis*), American robin (*Turdus migratorius*) and spotted towhee (*Pipilo maculatus*). Several woodpecker species also are common in riparian habitats, including northern flicker (*Colaptes auratus*), Lewis's woodpecker (*Melanerpes lewis*), and hairy woodpecker (*Picoides villosus*). Riparian habitats provide nesting habitat for raptors species such as Cooper's hawk (*Accipiter cooperi*), sharp-shinned hawk (*Accipiter striatus*), northern harrier, long-eared owl (*Asio otus*), and bald eagle (*Haliaeetus leucocephalus)*. The bald eagle is a federally listed and NESL species and is discussed in detail in Section 3.3.5.2. Upland gamebirds potentially occurring in riparian habitats may include Gambel's quail (*Callipela gambelii*). Waterfowl and shorebirds are likely to occur in the vicinity of riparian habitats, specifically at perennial water sources like Morgan Lake. Waterfowl abundance may be higher at Morgan Lake during the fall and winter months, when individuals generally migrate to lower latitudes. Waterfowl species that are known to occur at Morgan Lake include mallard (*Anas platyrhyncos*), Canada goose (*Branta canadensis*), and cinnamon teal (*Anas cyanoptera*) (Reeves and Nelson 1996). Shorebirds may utilize the lake during the migration and nesting seasons. Common shorebirds that are known to utilize Morgan Lake include western grebe (*Aechmophorus occidentalis*), great blue heron (*Ardea herodias*), black-crowned night heron (*Nycticorax nycticorax*), white-faced ibis (*Plegadis chihi*), American coot (*Fulica americana*), and killdeer (*Charadrius vociferous*). The San Juan River also may attract certain waterfowl species, such as common merganser (*Mergus merganser*), which is often found in river habitats. Colonial, tree-nesting shorebirds, such as great blue heron and double-crested cormorants (*Phalacrocorax auritus*), may occur along the San Juan River because of the availability of nesting trees (see Biological Assessment and Biological Evaluation [BA/BE], Appendix G).

3.3.3.2.3 Amphibians and Reptiles

Herpetofauna distribution and abundance are closely related to the abundance of aquatic habitat, vegetation structure, geology, elevation, climate and temperature, as well as anthropogenic influences. There are approximately 30 herptile species in the study area, the majority of which require temporary or permanent water sources for breeding. Because of the high number of herpetofauna with potential to occur in the study area, these species have been grouped into 1 of 6 categories as follows:

- **Frogs and Toads**: Four families of frogs and toads have potential to occur in the study area, including Pelobatidae (spadefoot frogs), Bufonidae (toads), Hylidae (treefrogs), and Ranidae (true frogs). Spadefoot frogs, including plains spadefoot (*Spea bombifrons)* and New Mexico spadefoot (*Spea multiplicata),* have potential to occur in grassland habitats or sagebrush habitats near temporary water sources, as well as in river valleys within the study area. Two toad species have potential to occur in the study area—the red-spotted toad (*Bufo punctatus*) and Woodhouse's toad (*Bufo woodhousii*). Red-spotted toads are found in dry, rocky habitats, like canyon or table lands, near water sources. Woodhouse's toads are typically found in the vicinity of streams and river valleys, like the San Juan River, as well as in agricultural areas. Bullffrogs (*Rana catesbeiana*), a true frog species, have potential to occur near the periphery of streams and may occur near Morgan Lake or the San Juan River within the study area. Two other frog species, the western chorus frog (*Pseudacris triseriata*) and northern leopard frog (*Rana pipiens*), have potential to occur in the study area. Western chorus frogs are found in varied habitats, including: high mountain lakes, flooded fields, ditches, playa lakes, and wet meadows. Tadpoles are found in waters varying in size from stream eddies to large ponds. Northern leopard frogs, which are included on the NESL, breed in wetlands usually with permanent water and aquatic vegetation especially cattails (Mikesic et al. 2005). Both of these species have the potential to occur near Morgan Lake, the San Juan River and stock ponds or other catchment basins in the study area.
- **Salamanders**: One salamander species, the tiger salamander (*Ambystoma tigrinum*), has potential to occur in the study area. Tiger salamanders breed in areas of still water, often where a mud bottom is present, pool areas in streams, stock ponds, lakes and ditches. The San Juan River, Morgan Lake and stock ponds within the study area provide potential habitat for this species.
- **Turtles**: Painted turtles (*Chrysemys picta*) are the only turtle with potential to occur in the study area. Painted turtles inhabit slow-moving areas of rivers, marshes, lakes, and ponds; thus, potential habitats within the study area are limited to Morgan Lake and the San Juan River.
- **Lizards**: Lizards with potential to occur in the study area include members of family Crotaphytidae and Phrynosomatidae. Within Crotaphytidae, collard lizards (*Crotaphytus collaris*) and leopard lizards (*Gambelia wislizenii*) may occur in canyon or tableland habitats within the study area. Seven species within the family Phrynosomatidae family also may occur within the study area, including the earless lizard (*Holbrookia maculata*), short-horned lizard (*Phrynosoma douglasii*), sagebrush lizard (*Sceloporus graciosus*), desert spiny lizard (*Sceloporus magister*), prairie lizard (S*celoporus undulatus*), tree lizard (*Urosaurus ornatus*), and side blotched lizard (*Uta stansburiana*). These species have potential to occur in a variety of habitats within the study area, including primarily sagebrush or other shrub-dominated communities.
- **Whiptails**: Three species of whiptails (Telldae family) may occur in the study area. Western whiptail (*Cnemidophorus tigris*) may occur in grassland communities, as well as in riparian areas with exposed rock in the study area. Plateau striped whiptails (*Cnemidophorus velox*) are generally found in open habitats along riparian corridors and would be limited to the areas around Morgan Lake, the San Juan River, and ephemeral drainages in the study area such as the Chaco

River. The little striped whip (*Aspidoscelis inornatus juniperus*) is essentially an upland (woodland-grassland) race which occurs in New Mexico from the San Juan Basin in the vicinity of Farmington and north of Gallup.

- **Snakes**: Two families of snakes, Colubridae (colubrids) and Viperidae (vipers), have potential to occur in the study area. Colubrid snake species include the glossy snake (*Arizona elegans*), racer (*Coluber constrictor*), western hognose snake (*Heterodon nasious*), striped whip snake (*Masticophis taeniatus*), bullsnake (*Pituophis melanoleucus*), blackneck garter snake (*Thamnophis cyrtopsis*), and western terrestrial garter (*Thamnophis elegans*). Most of the Colubrids are expected to occur in grassland and shrubland habitats within the study area, whereas garter snakes are most abundant near water sources like Morgan Lake, the San Juan River, or stock ponds. Milk snakes (*Lampropeltis triangulum*), also a Colubrid, are found in river valleys, desert scrub and grassland, and piñon-juniper woodlands. One Viperidae species, the western rattlesnake (*Crotalus viridis*), has potential to occur in the study area and are most likely to be found in grassland habitats, as well as rocky areas.

3.3.3.2.4 Fish

Potential habitat for fish species is limited to two perennial water resources within the study area—Morgan Lake and the San Juan River. Fish species known to occur in Morgan Lake include gizzard shad (*Dorosoma cepedianum*), channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides salmoides*), bluegill (*Lepomis macrochirus*), catfish (*Plecostomus* spp.), and white crappie (*Pomoxis annularis*) (http://www. emnrd.state.nm.us; H. Bradley and C. Woolfolk, APS, personal communication). The latter five species are sport fish and therefore are considered economically valuable for the Navajo Nation. Fish species that are known to occur in San Juan County, including the San Juan River, are listed in Table 3-23.

3.3.3.2.5 Invertebrates

Invertebrates can be broken into two main groups, aquatic and terrestrial. Terrestrial invertebrates have potential to occur in all habitats throughout the study area. Several invertebrate taxa are known to occur in northwestern New Mexico including:

- Lepidoptera (butterflies and moths); Families Nymphalidae, Satyriade, Danaidae, Sphingidae, Hesperiidae and Megathymidae
- Homoptera (cicadas, leafhoppers, aphids, scales, etc.); Family Cicadida
- Orthoptera (crickets, grasshoppers, katydids); Families Acrididae, Tettigoniidae, and Gryllidae
- Hymenoptera (wasps, ants, bees); Family Formicidae
- Coleoptera (beetles); Families Rhysodidae, Meloidae, and Amblycheila
- Diptera (flies)
- Gastropoda (snails); Families Oreohelicidae, Succineidae, and Polygyridae
- Arachnida (spiders, mites, scorpions)

Table 3-23 Fish Species Known to Occur in San Juan County, New Mexico

Common Name	Scientific Name	Status	Location
Bass, Largemouth	*Micropterus salmoides salmoides*	HG:G5, NM:SE	San Juan River, Morgan Lake
Bass, Smallmouth	*Micropterus dolomieui*	HG:G5, NM:SE	San Juan River
Bass, Striped	*Morone saxatilis*	HG:G5, NM:SE	San Juan River
Bluegill	*Lepomis macrochirus*	HG:G5, NM:SE	San Juan River, Morgan Lake
Bullhead, Black	*Ameiurus (=Ictalurus) melas*	HG:G5, NM:SE	San Juan River
Carp, Common	*Cyprinus carpio*	HG:G5, NM:SE	San Juan River
Carp, Grass	*Ctenopharyngodon idella*	HG:G5, NM:SE	San Juan River
Catfish, Channel	*Ictalurus punctatus*	HG:G5, NM:SE	San Juan River, Morgan Lake
Chub, Bonytail	*Gila elegans*	HG:G1, NM:SX; NN:G1	San Juan River (historically)
Chub, Roundtail [1]	*Gila robusta*	HG:G3, NM; S1/S2, NN:G3	San Juan River
Crappie, White	*Pomoxis annularis*	HG:G5, NM:SE	San Juan River, Morgan Lake
Dace, Speckled	*Rhinichthys osculus*	HG:G5, NM: S5	San Juan River
Killifish, Plains	*Fundulus zebrinus*	HG:G5, NM:SE	San Juan River
Minnow, Fathead	*Pimephales promelas*	HG:G5, NM:SE	San Juan River
Mosquitofish, Western	*Gambusia affinis*	HG:G5, NM:SE	San Juan River
Perch, Yellow	*Perca flavescens*	HG:G5, NM:SE	San Juan River
Pikeminnow, Colorado [1]	*Ptychocheilus lucius* *	HG:G1,NM:S1, NN:G2	San Juan River
Sculpin, Mottled [1]	*Cottus bairdi*	HG:G5, NM:S2	San Juan River
Shad, Threadfin	*Dorosoma petenense*	HG:G5, NM:SE	San Juan River
Shiner, Red	*Cyprinella lutrensis*	HG:G5, NM:SE	San Juan River
Sucker, Bluehead [1]	*Catostomus discobolus discobolus**	HG:G4, NM:S2	San Juan River
Sucker, Flannelmouth	*Catostomus latipinnis*	HG:G3/G4,NM:S3/S4	San Juan River
Sucker, Razorback [1]	*Xyrauchen texanus* *	HG:G1 NM:S1, NN:G2	San Juan River
Sucker, White	*Catostomus commersoni*	HG:G5, NM:SE	San Juan River
Sunfish, Green	*Lepomis cyanellus*	HG:G5, NM:SE	San Juan River
Trout, Brook	*Salvelinus fontinalis*	HG:G5, NM:SE	San Juan River
Trout, Brown	*Salmo trutta*	HG:G5, NM:SE	San Juan River
Trout, Cutthroat, Hatchery	*Oncorhynchus clarki*	HG:G4, NM:SE	San Juan River
Trout, Cutthroat, CO River	*Oncorhynchus clarki pleuriticus*	Federal Candidate	San Juan River (historically)
Trout, Rainbow	*Oncorhynchus mykiss*	HG:G5, NM:SE	San Juan River
Walleye	*Stizostedion vitreum*	HG:G5, NM:SE	San Juan River

SOURCES: Arizona Public Service Company, personal communication; Natural Resources Department 2006; Navajo Nation Natural Heritage Program 2005; New Mexico Energy, Minerals, and; Natural Heritage New Mexico 2006; ,.

NOTES: HG = Global Natural Heritage Ranks: G5 – Secure; G4 – Apparently Secure; G3 – Vulnerable; G2 – Imperiled; G1 – Critically Imperiled

NM = Natural Heritage New Mexico Ranks: SE – Exotic; SX – Presumed Extirpated; S1 – Critically Imperiled; S2 – Imperiled; S3 – Vulnerable; S4 – Apparently Secure; S5 - Secure

NN = Navajo Nation Natural Heritage Program status: G1 – No longer occurs on Navajo Nation; G2 – Endangered, a species or subspecies whose prospects of survival or recruitment are in jeopardy; G3 – Endangered, a species or subspecies whose prospects of surviaval or recruitment are likely to be in jeopardy in the foreseeable future

[1] Special status species – addressed in Section 3.3.1.6

Within the study area, aquatic invertebrates are limited to Morgan Lake, the San Juan River, stock ponds, and temporary pools within the study area. Table 3-24 lists the aquatic invertebrates known to occur in San Juan County (BISONM 2006).

Table 3-24 Species List of Freshwater Invertebrates Found in San Juan County, New Mexico

Common Name	Scientific Name
Crayfish, Verile	*Orconectes virilis*
Damselfly, Bluet, Civil	*Enallagma civile*
Damselfly, Lestes, Dark	*Lestes congener*
Damselfly, Narrow-winged	*Argia plana*
Damselfly, Narrow-winged	*Argia vivida*
Damselfly, Narrow-winged	*Enallagma carunculatu*
Damselfly, Narrow-winged	*Enallagma praevarum*
Damselfly, Narrow-winged	*Ischnura damula*
Damselfly, Narrow-winged	*Ischnura denticollis*
Damselfly, Short, Southwestern	*Amphiagrion abbreviatum*
Damselfly, Spot, Ruby, American	*Hetaerina americana*
Mayfly	*Acentrella insignificans*
Mayfly	*Ametropus albrighti*
Mayfly	*Baetis flavistriga*
Mayfly	*Baetis tricaudatus*
Mayfly	*Callibaetis ferrugineus hageni*
Mayfly	*Callibaetis montanus*
Mayfly	*Camelobaetidius warreni*
Mayfly	*Ephemerella inermis*
Mayfly	*Ephemerella mollitia*
Mayfly	*Heptagenia elegantula*
Mayfly	*Heptagenia solitaria*
Mayfly	*Labiobaetis apache*
Mayfly	*Lachlania saskatchewanensis*
Mayfly	*Nixe criddlei*
Mayfly	*Nixe simplicioides*
Mayfly	*Paraleptophlebia memorialis*
Mayfly	*Procloen conturbatum*
Mayfly	*Rhithrogena morrisoni*
Mayfly	*Rhithrogena undulata*
Mayfly	*Serratella micheneri*
Mayfly	*Siphlonurus occidentalis*
Mayfly	*Tricorythodes explicatus*
Mayfly	*Tricorythodes minutus*
Shrimp, Tadpole	*Triops longicaudatus*
Sideswimmers/Scuds	*Hyalella azteca*
Snail, Column, Crestless	*Pupilla hebes*
Snail, Column, Rocky Mtn.	*Pupilla blandi*
Snail, Disc, Forest	*Discus whitneyi*
Snail, Disc, Striate, Cockerell's	*Discus shimeki cockerelli*
Snail, Gem, Minute	*Hawaiia minuscula*
Snail, Glass, Amber	*Nesovitrea hammonis electrina*
Snail, Gloss, Quick	*Zonitoides arboreus*
Snail, Hive, Brown	*Euconulus fulvus*
Snail, Pillar, Glossy	*Cionella lubrica*
Snail, Snaggletooth, Montane	*Gastrocopta pilsbryana*
Snail, Vallonia, Lovely	*Vallonia pulchella*
Snail, Vallonia, Multirib	*Vallonia gracilicosta*
Snail, Vallonia, Silky	*Vallonia cyclophorella*
Snail, Vallonia, Thin-lipped	*Vallonia perspective*
Snail, Vertigo, Cross	*Vertigo modesta ingersolli*
Snail, Vertigo, Variable	*Vertigo gouldi*
Stonefly, Springfly, Summer	*Cultus aestivalis*
Valvata, Glossy	*Valvata humeralis*

SOURCE: BISONM 2006

3.3.4 Special Status Species

The following sections present information on special status plant and wildlife species known to occur, or with reasonable potential to occur in the study area. Special status species include (1) species included on the Federal Endangered Species Act (ESA), (2) FWS species of concern, (3) species included on the NESL (Navajo Endangered Species List), (4) New Mexico Species of Concern, and (5) other special status species protected by Federal legislation.

Under provisions of the ESA, endangered species are defined as species that are in danger of extinction throughout all or a significant portion of their range. Threatened species are those species that are likely to become an endangered species within the foreseeable future throughout all or a significant portion of their range. Candidates for listing under the ESA are those species for which the FWS has sufficient data to support issuance of a proposed rule for listing as threatened or endangered.

The NESL designates species as either Group 1, 2, 3 or 4. Group 1 (G1) species are those that no longer occur on the Navajo Nation. Group 2 (G2) species are those whose prospects of survival or recruitment are in jeopardy. Group 3 (G3) species are those whose prospects of survival or recruitment are likely to be in jeopardy in the foreseeable future. Group 4 (G4) are those species for which the Navajo Nation Department of Fish and Wildlife (NNDFW) does not currently have sufficient information to support their being listed in G2 or G3, but has reason to consider them.

The State of New Mexico designates species as either endangered, threatened, or as species of concern. Endangered species are those in danger of extinction throughout all or a significant portion of its range. Threatened species are those likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Species of concern are those for which further biological research and field study are needed to resolve their conservation status, or those considered sensitive, rare or declining on lists maintained by Natural Heritage Programs, State wildlife agencies, Federal agencies, or professional scientific societies.

In this document, "other special status species protected by Federal legislation" include those species that are protected by legislation including the Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, and Neotropical Migratory Bird Conservation Act.

3.3.4.1 Special Status Plants

There are three federally listed threatened, endangered or candidate plant species with potential to occur in San Juan County, as follows:

- **Mancos Milkvetch** (*Astragalus humillimus)*: Mancos milkvetch is federally listed as endangered and is also a NESL G2 species. Mancos milkvetch is a perennial plant that forms compact mounds with small flowers, blooming in late April to early May. In San Juan County, this species occurs in open piñon-juniper woodlands and mixed desert shrub communities. Mancos milkvetch also grows in shallow sandstone depressions, joint fractures, and weathered bedding planes on rimrock-slickrock exposures of Pointlookout Sandstone at elevations ranging from 4,900 feet to 6,500 feet. This species is known to occur within the study area in small populations on the Hogback monocline and in isolated exposures of Pointlookout Sandstone (Ecosphere 2005b). No populations were detected during 2005 and 2006 botanical surveys of the proposed project.
- **Mesa Verde Cactus** (*Sclerocactus mesae-verdae)*: Mesa Verde cactus is federally listed as threatened and is also a NESL G2 species. This species generally occurs as a solitary stem, but

may form clusters of up to 15 stems or more. Flowers are cream to a pale yellow in color, blooming in late April to early May. Mesa Verde cactus is found in salt desert scrub communities at elevations ranging from 4,700 feet to 6,000 feet. Within these habitats, Mesa Verde cactus is restricted to the Mancos, Lewis, and Fruitland shale formations on weathered benches and ridges. Mesa Verde cactus is known to occur at a number of isolated locations within the study area (Ecosphere 2005b). Small populations of Mesa verde cactus occur east of the proposed plant site and west of the Chaco River along the proposed water utility corridor. Numerous cacti populations occur along the proposed transmission line corridor north of the San Juan River extending to an existing transmission line corridor and to the proposed Navajo Transmission Project corridor.

- **Knowlton Cactus** (*Pediocactus knowltonii)*: Knowlton cactus is federally listed as endangered. This species can occur as a solitary stem or as a cluster of stems that are each less than 5.5 centimeters tall. Knowlton cacti produce flowers with yellow centers that bloom on top of the stems. This species occurs on tertiary alluvial deposits in open areas and in piñon-juniper woodlands at elevations ranging from 5,900 feet to 6,500 feet. In San Juan County, the distribution of Knowlton cactus is limited to about 5 hectares of land along the Los Pinos River corridor, near the Colorado border. This species is not known to occur within the study area, nor were suitable potential habitats located during 2005 and 2006 botanical investigations (Ecosphere 2005b).

In San Juan County, there are 10 plant species listed as species of concern by the State of New Mexico and 15 species included on the NESL. These species, as well as their state and tribal status are presented in Table 3-25. Due to the large number of species included in this group, more detailed descriptions of their life histories, habitat requirements, and potential to occur in the study area are provided in the BA and BE.

Table 3-25 Special Status Plant Species with Potential to Occur in San Juan County, New Mexico

Species Name	State of New Mexico	Navajo Nation
Bolack's sand verbena (*Abronia bolackii)*	Species of concern	None
San Juan false carrot (*Aletes macdogalii ssp. breviradiatus)*	Species of concern	None
Aztec gilia (*Aliciella formosa)*	Endangered	None
San Juan milkweed *(Asclepias sanjuanensis)*	Species of concern	G4
Chuska milkvetch *(Astragalus chuskanus)*	Species of concern	None
Cottam's milkvetch *(Astragalus cottamii)*	Species of concern	None
Mancos milkvetch *(Astragalus humillimus)*	Endangered	G2
Chaco milkvetch *(Astragalus micromerius)*	Species of concern	None
Naturita milkvetch *(Astragalus naturitensis)*	Species of concern	G4
Arboles milkvetch *(Astragalus oocalycis)*	Species of concern	None
Zuni fleabane *(Erigeron rhizomatus)*	Endangered	G2
Knowlton cactus *(Pediocactus knowltonii)*	Endangered	None
Navajo mountain phlox *(Phlox cluteana)*	Species of concern	None
Mancos saltplant *(Proatriplex pleiantha)*	Species of concern	None
Parish's alkali grass *(Puccinellia parishii)*	Endangered	G3
Brack hardwall cactus *(Sclerocactus cloverae ssp. brackii)*	Endangered	None
Mesa Verde cactus *(Sclerocactus mesae-verdae)*	Endangered	G3

SOURCES: Natural Heritage New Mexico 2006; Navajo Nation Natural Heritage Program 2005
NOTES: G2 = Group 2 species on the Navajo Endangered Species List
G3 = Group 3 species on the Navajo Endangered Species List
G4 = Group 4 species on the Navajo Endangered Species List

3.3.4.2 Special Status Wildlife

There are seven wildlife species federally listed under the ESA as threatened, endangered or candidates for listing with potential to occur in San Juan County, five of which have potential to occur in the study area. A brief summary of the natural history and habitat requirements of each of these federally listed species, their status under ESA, and potential to occur in the study area are presented below:

- **Black-footed ferret:** (*Mustela nigripes*): Black-footed ferrets are small (about 1 kilogram) carnivorous mammals that belong to family Mustelidae. Black-footed ferrets are obligate predators of prairie dogs (*Cynomys* spp.) and occur in open grasslands with large prairie dog colonies (> 80 hectares and $\geq$ 20 burrows/hectares). Although the former range of this species extended from southern Canada into northern Mexico, black-footed ferrets have been extirpated from most of their historic range and are currently known to occur in a handful of experimental populations in the northern Great Plains. The last confirmed occurrence of black-footed ferret in New Mexico was in 1934 (BISONM 2006). Black-footed ferrets are currently listed as endangered under the ESA and also are designated as a G2 species on the NESL. Surveys for black-footed ferret have been conducted periodically since 1973 in much of the study area in support of the BNCC Navajo Mine SMCRA permit (2005). Black-footed ferret has not been recorded in the BNCC mine lease or study area. Additionally, the study area lacks active prairie dog colonies large enough to support black-footed ferrets. Therefore, it is likely that black-footed ferrets do not occur in the study area.
- **Bald eagle** (*Haliaeetus leucocephalus*): Bald eagles are short-distance migrants that breed and nest near open water. Likewise, fish comprise the majority of the bald eagle diet and as such, this species is particularly common near reservoirs, rivers, and streams with abundant prey. Bald eagles are listed as threatened under the ESA, are listed as threatened by the State of New Mexico, and are included on the NESL. Bald eagles also are afforded protection under the Bald and Golden Eagle Protection Act and by the Migratory Bird Treaty Act (MBTA). Within the study area, bald eagles have potential to occur near the San Juan River and may roost in large trees or cliffs adjacent to this body of water.
- **Southwestern willow flycatcher** (*Epidonax traillii extimus)*: Southwestern willow flycatchers are small passerine birds that nest in dense riprarian vegetation near surface water or saturated soils, either in mixed sands of native (e.g., willow) and exotic (e.g., Russian olive, tamarisk) vegetation. The breeding range of this species extends into the Navajo Nation, and breeding has been documented along the San Juan and Colorado Rivers. Migrant flycatchers have been found in less dense riparian habitat across the Navajo Nation. Southwestern willow flycatchers are listed as endangered under ESA, listed as endangered by the State of New Mexico, and a G2 species on the NESL. This species also is protected by the MBTA. Within the study area potential habitat occurs along the San Juan River, as well as near Morgan Lake and in portions of riparian habitat along the Chaco River.
- **Mexican spotted owl** (*Strix occidentalis lucida)*: Mexican spotted owls are one of the largest owls in North America that prey on a variety of small mammals, reptiles, arthropods, and birds. The range of this species extends across mountain ranges of Utah, Colorado, Arizona, New Mexico, and western Texas. On the Navajo Nation, Mexican spotted owls are known to occur in or adjacent to the Chuska Mountain Range, Defiance Plateau, Canyon de Chelly, and Black Mesa. In particular, this species favors caves, cliffs, or trees within mixed conifer forests for nesting. Mexican spotted owls are listed as threatened under the ESA and are designated as a G3 species on the NESL. This species also is protected by the MBTA. Due to a lack of potentials nesting habitat, Mexican spotted owls are not likely to occur in the study area.

- **Yellow-billed cuckoo** (*Coccyzus americanus)*: Yellow-billed cuckoos are small neotropical migratory birds that winter in South America and reside in riparian habitats associated with major river valleys during the summer months. This species nests in close proximity to water in mature riparian woodlands composed of willow, cottonwood, and alder with dense understories. On the Navajo Nation, yellow-billed cuckoo populations are rare and limited to a few local breeding individuals. Breeding is only known to occur on a handful of sections on the San Juan River within the Navajo Nation. This species is currently a candidate for listing under the ESA and is designated as a G2 species on the NESL. Within the study area, yellow-billed cuckoos have potential to occur along the San Juan River and at Morgan Lake.
- **Colorado pikeminnow** (*Ptychocheilus lucius)*: Colorado pikeminnow are large, torpedo-shaped fish that occur in large rivers with warm, swift, and turbid waters. This species can migrate more than 200 miles to spawn. Colorado pikeminnow were once abundant in the main stem of the Colorado River and most of its major tributaries, but are currently restricted to the Upper Colorado River from Wyoming to New Mexico. On the Navajo Nation, this species has been documented on portions of the Colorado River from Shiprock to Lake Powell. In particular, adults frequent the stretch of river between Shiprock and Four Corners and spawn in the "Mixer Area," whereas young of the year occur primarily on the lower stretch of the San Juan River, upstream from Lake Powell. Colorado pikeminnow are listed as endangered under the ESA, endangered by the State of New Mexico, and designated as a G2 species on the NESL.

  Critical habitat for the Colorado pikeminnow includes the San Juan River and its 100-year flood plain from the State Route 371 Bridge near Farmington, New Mexico, to Neskahai Canyon in the San Juan arm of Lake Powell up to the full pool elevation. The portion of the San Juan River within the study area is within designated critical habitat and Colorado pikeminnow are known to occur in the river section.
- **Razorback sucker** (*Xyrauchen texanus*): Razorback suckers are one of the largest suckers in North America. The razorback sucker was once widespread throughout most of the Colorado River Basin but are now restricted to portions of the upper Green River in Utah, and the lower Yampa and Colorado Rivers in Colorado. Small numbers of razorback suckers also have been found in Lake Powell at the mouth of the San Juan River. Razorback suckers are listed as endangered under the ESA and designated as a G2 species on the NESL. The razorback sucker can be found in the San Juan River from Farmington to Lake Powell.

In San Juan County, there are 10 wildlife species listed as species of concern by the State of New Mexico and 14 wildlife species included on the NESL. These species, as well as their state and tribal status, are presented in Table 3-26. This table does not include species that are listed under ESA, as these were discussed above. Due to the large number of species included in this group, more detailed descriptions of their life histories, habitat requirements, and potential to occur in the study area are included in the BE.

Table 3-26 Special Status Wildlife Species with Potential to Occur in San Juan County, New Mexico

Species Name	State of New Mexico	Navajo Nation
Pronghorn (*Antilocapra americana*)	None	G3
Banner-tail kangaroo rat (*Dipodomys spectabilis*)	None	G4
Kit fox (*Vulpes macrotis*)	None	G4
Spotted bat *(Euderma maculatum)*	T	None
Baird's sparrow (*Ammodramus bairdii)*	T	None
Common blackhawk (*Buteogallus anthracinus anthracinus)*	T	None
Gray vireo (*Vireo vicinior)*	T	None
Brown pelican (*Pelecanus occidentalis carolinensis)*	E	None
Mountain plover (*Charadrius montanus*)	None	G3
Golden eagle (*Aquila chrysaetos*)	None	G3
Western burrowing owl *(Athene cunicularia hypugea)*	None	G4
Ferruginous hawk (*Buteo regalis*)	None	G3
American peregrine falcon (*Falco peregrinus*)	T	G3
Sora (*Porzana carolina*)	None	G4
Roundtail Chub (*Gila robusta*)	E	G2
Mottled sculpin (*Cottus bairdi*)	None	G4
Bluehead sucker (*Catostomus discobolus*)	None	G4
Milk snake (*Lampropeltis triangulum*)	None	G4
Northern leopard frog (*Rana pipiens*)	None	G2

Sources: Natural Heritage New Mexico 2006; Navajo Nation Natural Heritage Program 2005
NOTES: E = Endangered species
T = Threatened species
G2 = Group 2 species on the Navajo Endangered Species List
G3 = Group 3 species on the Navajo Endangered Species List
G4 = Group 4 species on the Navajo Endangered Species List

3.4 LAND USE AND RECREATION

3.4.1 Introduction

The study area examined for land use and recreation resources encompasses approximately 20 square miles located in northwestern New Mexico, southwest of the City of Farmington in San Juan County. Land within the study area includes American Indian Reservation lands held in trust by the Federal Government for the Navajo Nation (approximately 101,347.6 acres), privately owned land (approximately 55.4 acres), and land managed by the BLM (approximately 0.1 acre). All local Navajo chapters potentially affected by the project footprints (e.g., transmission line, power plant, coal mine, etc.) are under the jurisdiction of the BIA Shiprock Agency and include Hogback, San Juan, Nenahnezad, Burnham, and Sanostee Chapters.

3.4.2 Data Collection and Approach

Existing land use and recreation data were collected through analysis of aerial photography, field verification, review of existing studies and plans, and coordination with state and tribal agencies. Land use data were field-verified and mapped for the area within 0.5 mile of the power plant site and the water well field and within a 1-mile-wide study corridor along the proposed utility corridor/water pipeline, proposed transmission lines, proposed access road, and Areas IV South and V of the BNCC Lease Area

(Figure 3-13). This area is referred to as the study area. The regional area examined for land use includes land outside the study area, but generally within 15 miles of the proposed project (unless otherwise noted), and provides a context for land uses in the general area of the project. Data for grazing allotments and grazing use in the area were obtained from records and spatial data maintained by the BIA and Navajo Nation Natural Resources Department.

Future or planned land use and recreation information was collected through review of existing plans for local jurisdictions and Navajo chapters and agencies. State, local, and tribal agencies were contacted to identify potential or approved developments in the vicinity of the proposed project.

3.4.3 Existing Conditions

3.4.3.1 Overview of Regional Land Use and Recreation

Land use patterns in the study area are influenced primarily by traditional usage livestock grazing and major transportation corridors. A majority of the regional study area is characterized as occasional low intensity livestock grazing and scattered dwellings, with primitive roads traversing the land. Most cultivated agriculture within the region is concentrated near the San Juan River and east of the BNCC Lease Area. However, dispersed miscellaneous farm plots (including family gardens) that use the agricultural technique for cultivation known as "dryland farming" also are known to occur throughout the regional area (Thomas 2006) (refer to Section 3.6).

As the predominant land uses are low-density sporadic grazing and mining, most of the land in and near the study area is either unoccupied or is occupied by dispersed residences. A notable exception to the dispersed residential uses occurs in the northern portion of the study area along U.S. Highway 64, a major transportation route within the region, and on either side of the San Juan River. Typically, residences within the region are located on small homesites leased from the Navajo Nation and include one or more residential/agricultural outstructures. Community mixed-use areas that include residential, commercial, industrial, and public facilities are located outside the study area in Shiprock, Fruitland, Kirtland, Farmington, Burnham, and Newcomb. Public facilities such as schools, chapter houses, and churches are located near the study area in surrounding communities, but outside the 1-mile-wide study corridor.

Large industrial areas within the region consist of the Four Corners Generating Station, San Juan Generating Station, and the Navajo Mine. Infrastructure and transportation corridors associated with the mining operation on the BNCC Lease Area include the BNCC railroad and railway located along the western mine boundary, east of the Transmission Line Alignment Segment C, just inside the BNCC Lease Area; a 69kV transmission line; an access road to Area III of the mine; two haul roads; and a potable water line. A regional airport is located in Farmington, which has commercial airlines serving major destinations, and airstrips are located south of Burnham Chapter House and south of the Four Corners Generating Station. A Navajo Nation Primary Airport is located in Shiprock, used primarily for medical emergencies and secondarily for tribal government. The Federal Aviation Administration has indicated that an aeronautical study would be required prior to construction of the project.

Many large irrigated agricultural fields are located east of the study area, just beyond the BNCC Lease Area and are associated with NAPI, a farming enterprise of the Navajo Nation. NAPI farms cover over 68,000 acres in production growing alfalfa, corn, wheat, barley, pumpkins, beans, potatoes, and sod.

Commercial land uses, such as gas stations and small convenience stores, are dispersed throughout the region along major transportation corridors (U.S. Highway 64, U.S. Highway 491, and Navajo Road 5 [N5]). Similar to the residential uses, commercial uses tend to be more common in the northern region of the study area and associated with the communities along U.S. Highway 64 which include Shiprock, Fruitland, Kirtland, and Farmington. No commercial uses were found within the 1-mile-wide corridor that was field-verified for land use. Utility corridors in the area contain facilities such as transmission lines and pipelines.

Developed recreation areas within the region include two campsites—one located near Shiprock, the Four Corners Monument Campsite, and the other approximately 15 miles southwest of Farmington, New Mexico. Tourist attractions within 30 miles of the project include Ute Mountain and casino and Mesa Verde National Park to the north, Aztec Ruins National Monument and Bisti Badlands to the east, Bowl Canyon Recreation Area to the south, and the Chuska Mountains and Shiprock Peak to the west. Chaco Culture National Historical Park is also a notable attraction in the region, located approximately 50 miles from the project. Dispersed recreation occurring in the region includes fishing, and small game/bird hunting and trapping.

The NNDFW has divided the entire Navajo Nation into six types of environmentally sensitive areas. These areas were developed to assist the Navajo Nation government and chapters to expedite the land clearance process for land withdrawals, rights-of-way, leases, subleases, assignments, land use permits and other similar land uses, as well as assist the 110 Chapters of the Navajo Nation in developing land use plans (NNDFW 2006). Most areas identified by NNDFW as having high and moderate sensitivity have been associated with an open space designation in land use plans for the Burnham, Sanostee, San Juan, and Nenhanezad Chapters. Areas designated either high or moderate sensitivity within 5 miles of the proposed facilities are located near the San Juan River, the Hogback, the Chaco River and its banks, Table Mesa, and Barber Peak. Refer to Appendix H for detailed definitions of these sensitivity designations developed by the NNDFW to assist Navajo Nation Chapters in land use planning efforts.

The BLM Farmington Field Office manages one special management area just outside of the 1-mile-wide study corridor—the Hogback Area of Critical Environmental Concern (ACEC). The Hogback ACEC was designated to protect habitat for threatened, endangered, proposed, or other sensitive plant species.

Ceremonial areas are scattered throughout the region and include plant gathering areas or areas of cultural significance (JJ Clacs and Company et al. 2002). Navajo people use the plants found throughout the region for fodder or fuel; construction of cloth, textiles, mats, ropes, baskets, soap, dyes, paints or toys; medicinal (topical or internal); ceremonial; and edible (food, drink or smoke) purposes (Ecosphere 2005b). Some areas of ceremonial usage or significance are undisclosed in order to protect the resources.

Future land use developments within the region are anticipated to include proposed oil and gas drilling, community development/expansion, and a 300-megawatt (MW) coal-fired power plant. Several gas companies plan to extract oil and gas in the NAPI area (Draper 2006). These activities would require well pads (approximately 50 by 50 feet each) and construction areas, in addition to access roads, pipelines, or distribution power lines as needed (for productive wells). Also, Western Oil and Gas has proposed approximately 600 natural gas wells in eastern Burnham Chapter extending north into Upper Fruitland and Nenahnezad/San Juan Chapters.

An EIS is currently being prepared for the Phoenix Expansion Project, which would expand the Transwestern Pipeline Company's natural gas pipeline system by approximately 260 miles from its mainline in Yavapai, County, Arizona, to delivery points in the Phoenix metropolitan area market. As part of the overall project, Transwestern Pipeline Company plans to build approximately 25 miles of pipeline looping parallel to its existing San Juan Lateral, in San Juan County (Federal Energy Regulatory

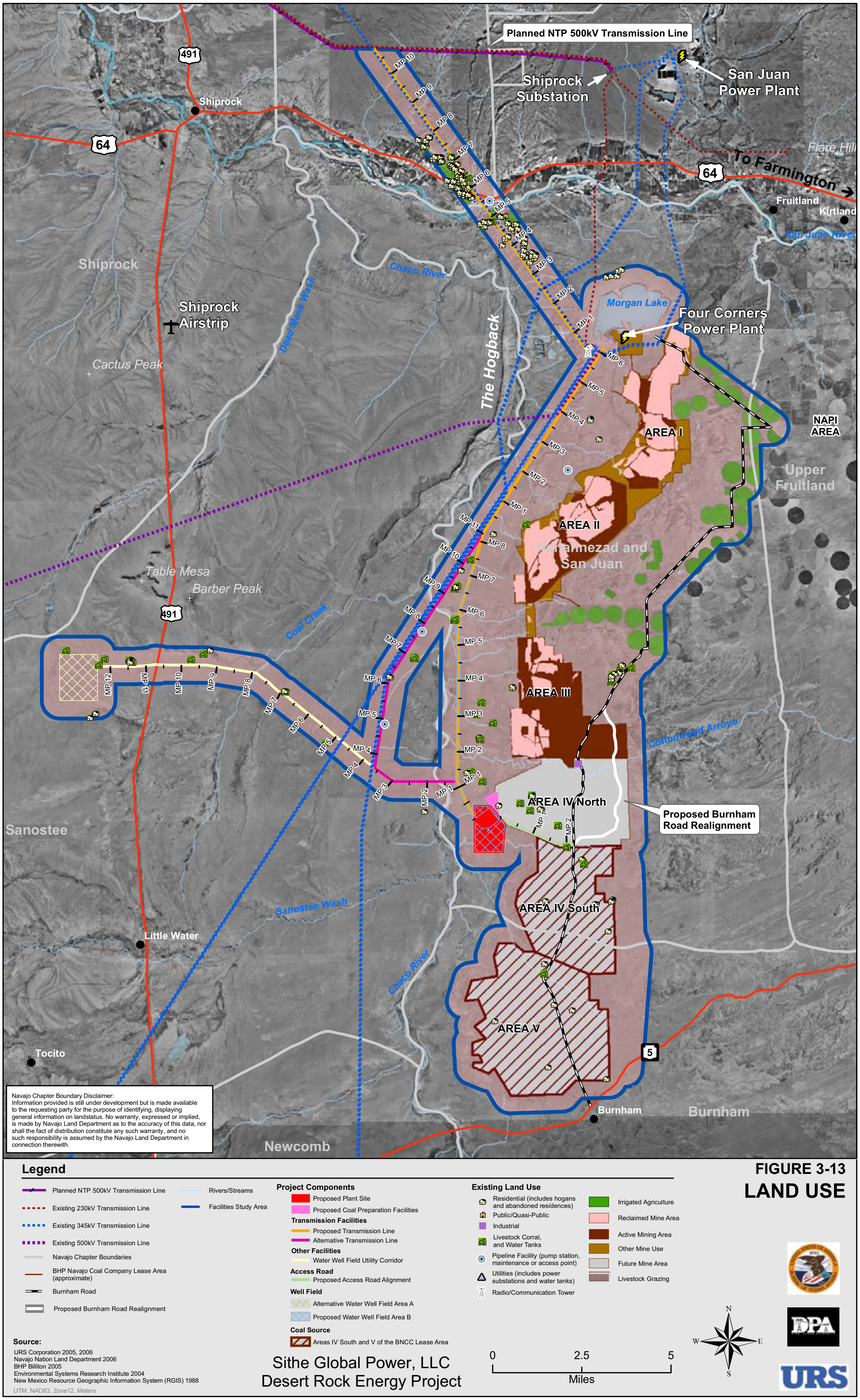


FIGURE 3-13
LAND USE

Commission 2006). The San Juan Lateral extends from San Juan County, New Mexico, to connect with Transwestern Pipeline Company's mainline in McKinley County, New Mexico, and is located approximately 15 miles or farther from the study area. Peabody Western Coal Company (Peabody) has proposed a 300-MW coal-fired power plant north of Grants, New Mexico, as the Mustang Project. The plant would use coal from the existing Lee Ranch Mine operated by Peabody. Finally, communities located along U.S. Highway 491 plan to expand upon completion of route improvements, affecting development patterns in the general region of the project (Benally 2006). For an extensive list of future projects within the region, refer to Table 5-1.

3.4.3.2 Power Plant Site

The proposed power plant site is located on approximately 600 acres of Tribal Trust Land that would be leased from the Navajo Nation, approximately 30 miles southwest of Farmington, New Mexico, between the Chaco River and Area IV North of the BNCC Lease Area. The site is within the boundaries of the Nenahnezad Chapter (Figure 3-13).

Residential: One residence was identified within 0.5 mile of the power plant site; the primary land use is grazing, which continues year-round.

Commercial, Industrial, Other Public Uses: There are no existing commercial or industrial uses on the power plant site; however, the northeast boundary of the site is adjacent to Area IV North of the BNCC Lease Area. A study completed by Ecosphere (2005b) indicated that over half of the plants in the power plant area had at least one type of ethnobotanical plant use, with many plants having two or more uses.

Rights-of-Way: No existing rights-of-way were identified within the power plant site.

Recreation: There are no developed recreation facilities within 10 miles of the power plant site. Dispersed recreation, including small game, furbearer, game-bird hunting, and trapping, may occur within the power plant site, but is not common. Hunting and trapping on the Navajo Indian Reservation requires a permit from the Navajo Nation. The annual number of fishing and small game permits issued by the Navajo Nation is shown in Table 3-27.

Table 3-27 Fishing and Small Game Permits Issued on the Navajo Nation

Year	Number of Permits
2005	7,546
2004	8,534
2003	10,057
2002	12,163
2001	18,792

SOURCE: Cole 2006a
NOTES: Fishing and small game permits are combined into one permit, and permits are valid for the entire Navajo Nation. Data specific to the study area were not available.

Future Land Use: There have been no future land uses identified for this area other than customary grazing by local residences. However, the power plant site is located in an area near the Chaco River that is designated as moderate sensitivity for biological species by the NNDFW and may be characterized by local land use plans as open space.

3.4.3.3 Transmission Lines

Seventy-five to ninety percent of each alternative route is parallel to existing transmission lines, of which most are connected to the large industrial uses in the area (generally existing power plants). The Western Utility Group (an ad hoc organization of major western, gas, electric, and telecommunication companies) developed the Western Regional Corridor Study in 1992 to promote ongoing interagency dialogue on future utility corridor needs (Western Utility Group 1992). This reference document identifies segments of existing utility corridors within the study area; 30 to 50 percent of each alternative route is located within the utility corridors defined by the study (Western Utility Group 1992). A programmatic EIS is currently under way by an interagency project management team (U.S. Department of Energy, BLM, U.S. Forest Service [Forest Service], and U.S. Department of Defense) to identify energy utility corridors for the implementation of Section 368 of the Energy Policy Act of 2005 (designation of energy corridors). At the time of this draft, the interagency team is developing criteria for designation of corridors and alternatives that will be used for evaluation in the programmatic EIS; the Western Utility Group study is being used as a starting point for this process, which also will incorporate input from current plans and conditions.

3.4.3.3.1 Proposed Transmission Line Alignment (Segments A, C, and D)

The Transmission Line Alignments A (8.3 miles), C (6.2 miles), and D (10.8 miles) are within tribal jurisdiction of the Navajo Nation and three Navajo chapters: the Nenhanezad and San Juan Chapters (approximately 19.9 miles) and Hogback Chapter (approximately 5.5 miles). The 1-mile-wide study corridor boundary crosses a small amount of private land (approximately 55.4 acres) and a small amount of BLM land (approximately 0.1 acre) under the jurisdiction of San Juan County near the midsection of Segment D; however, the transmission line right-of-way is anticipated to be fully located on tribal land.

Existing land uses along Transmission Line Alignment Segments A, C, and D are primarily occasional livestock grazing and dispersed related facilities (water tanks and corrals dispersed throughout), with the exception of irrigated agricultural and residential uses north and south of the San Juan River.

Irrigated farmland within the study area is associated with residences and small farms (ranging from small family gardens to larger fields) and is supported by two irrigation projects along the San Juan River: the Fruitland and Hogback projects. As a result, numerous farming plots are located along the midsection of Segment D.

Residential: Residences (including hogans) are sparsely dispersed along this alignment throughout the 1-mile-wide study corridor with rural residential areas located near transportation corridors located north and south of the San Juan River (State Route 64 and N36) (refer to Figure 3–13). Approximately five dispersed residences, including one hogan, are located within 0.5 mile of the alignment along Segments A and C. Along Segment D, approximately 124 residences including several hogans are located within 0.5 mile of the alignment. A majority of the residences within the study area along Segment D are located within 1 mile on the north side of the San Juan River and 2 miles south of the river.

Commercial, Industrial, Other Public Uses: The San Juan Chapter House is located within the 1-mile-wide corridor north of Segment D's junction with N36. Small commercial sites (such as convenience stores, gas stations, and a trading post), churches, and a school are located beyond the study area, but within 3 miles of the alignment along State Route 64. A grave plot was inventoried within 250 feet of Segment D, approximately 1 mile north of State Route 64. Two large irrigation projects (with water distribution canals) are within the 1-mile-wide corridor and are crossed by Segment D: the Hogback and Fruitland Canals.

The Four Corners Generating Station is located east of the intersection of Segments C and D. An associated tailings pond is located west of the intersection. Both are partially located within the 1-mile-wide corridor.

Rights-of-Way: Four 345kV transmission lines parallel the southern half of Segment C. Two of the four transmission lines parallel one-half of the length of Segment C and then diverge from the alignment and head north to cross the southern portion of Segment D, while the other two parallel the remainder of the length of Segment C. Another 500kV transmission line briefly parallels the northern portion of Segment C for approximately 2.25 miles. One of the 345kV transmission lines parallels Segment D for its entire length. A 230kV transmission line briefly parallels the southernmost portion of Alignment D for less than 1 mile. Various 12kV distribution lines are located within the 1-mile-wide corridor and cross or briefly parallel the alignment along Segment D.

A natural gas pipeline operated by NTUA crosses the proposed alignment twice—once along the northern section of Alignment A and again along the middle of Alignment C. A water pipeline is crossed by Segment D, near the San Juan River.

Recreation: The NNDFW has designated Morgan Lake as a recreation area, which is used seasonally for boating, fishing, and windsurfing. The 1,200-acre manmade lake is a cooling pond for the Four Corners Generating Station and generally has a constant water level and temperature year-round (75°F) (New Mexico Energy, Minerals, and Natural Resources Department 2006). The southwestern corner of Morgan Lake is located within the 1-mile-wide corridor of the southern end of Segment D. The annual number of watercraft permits issued for boats and windsurfers is shown in Table 3-28.

Table 3-28 Watercraft Permits Issued on the Navajo Nation

Year	Number of Permits
2005	434
2004	598
2003	490

SOURCE: Cole 2006b
NOTES: Watercraft permits (for boating and windsurfing) are valid for all bodies of water on the Navajo Nation, and are not specific to Morgan Lake. Data specific to Morgan Lake were not available.

There are no developed or designated recreation facilities along these transmission line segments. Dispersed recreation occurs along washes, the banks of the San Juan River, and in/near Morgan Lake. Big game and waterfowl hunting is uncommon in the study area; however, some small game/furbearer/game bird hunting and trapping occurs in washes (Cole 2006c). Dispersed fishing occurs in the study area along the banks of the San Juan River (catfish) and Morgan Lake (bass, sunfish and catfish) (Cole 2006c).

The annual number of fishing and small game permits issued by the Navajo Nation is shown in Table 3-27.

Future Land Use: It should be noted that while local chapter plans may not have been certified/finalized as of the date of this document, these draft land use plans have been considered in the analysis of potential impacts on such plans.

The San Juan Chapter Community-Based Land Use Plan (2002) has identified Navajo land along Segment C for grazing use and a planned burial area that would be located directly beneath Segment C and located approximately 2 miles southwest of the Four Corners Generating Station. Segment D crosses areas planned for industrial (Four Corners Generating Station tailings pond), grazing, residential, and farming uses between the San Juan River and the Four Corners Generating Station. Other areas within 0.5 mile of Segment D are planned commercial enterprises along N36, for locals, tourist enterprises near the San Juan Chapter house (which might include logging, boat rentals, or a place to hire fishing or hiking guides), community facilities including a multi-purpose building and a fire station near the chapter house, and ceremonial/culturally sensitive areas along the Hogback and near the chapter house (and others that are not disclosed). According to the San Juan Chapter Community-Based Land Use Plan, burial and ceremonial sites should not be disturbed by development (several burial grounds are scattered throughout farming areas). The San Juan Chapter Community-Based Land Use Plan has not planned any future areas for industrial uses; the existing developments (power plant, tailings pond, large power lines) are identified by the community as intrusions. The San Juan Chapter Land Use Plan identifies the east and west sides of the Hogback and San Juan River for open space. A nature trail is planned from the San Juan River to the San Juan Chapter house to Morgan Lake, which is identified as a possible recreation center for the chapter.

The Sanostee Land Use Plan (2004) has identified an area approximately 2 miles west of the southern end of Segment C (Milepost 0) as a possible location for the construction of a prison.

A land use plan for Hogback Chapter was not available at the time of this draft (December 2006).

Transmission Line Segment D crosses the proposed Navajo Nation Municipal Pipeline (NNMP) near Milepost 5.5. The NNMP is a part of the Animas-La Plata Project that is a multi-purpose project primarily for irrigation and municipal and industrial uses located in La Plata and Montezuma Counties in southwestern Colorado and in San Juan County in northwestern New Mexico. The NNMP will upgrade/augment the existing pipeline system to transmit 4,680 acre feet per year of Animas-La Plata Project water from the City of Farmington to Shiprock and Navajo Nation communities in between. The new pipeline will follow the alignment of the existing water pipeline for a majority of the route. However, the existing pipeline would be abandoned at a point north of the San Juan River just west of the Hogback (near the existing hogback diversion structure). The new right-of-way would be located south of U.S. Highway 550 and north of the Hogback Canal. Designs, drawings, and specifications for the pipeline are expected to be completed by December 2006 and construction of the NNMP would be approximately from 2008-2011 (BOR 2006a).

Segment A crosses an area designated as moderately sensitive by the NNDFW (2005) for approximately 6 miles along the Chaco River. Segment D crosses approximately 5 miles of highly sensitive (see Appendix H for sensitivity definitions) areas near the Hogback and the San Juan River.

3.4.3.3.2 Alternative Transmission Line Segment B

Alternative Transmission Line Segment B (11.1 miles) is located on the Navajo Indian Reservation within the Nenahnezad/San Juan Chapters (approximately 4.2 miles) and Sanostee Chapter (approximately 6.9 miles). Most of the undeveloped land along Segment B is permitted for livestock grazing with water tanks and corrals dispersed throughout.

Residential: Six dispersed residences (including three hogans) are located within approximately 0.5 mile of the alignment. A residential outstructure was found near the northern end of the segment.

Commercial, Industrial, Other Public Uses: None of these uses were found along Segment B. The BNCC Lease Area is located about 0.75 mile east of Segment B.

Rights-of-Way: Segment B parallels two 345kV power lines along the mid portions of the segment for approximately 2.5 miles. Two additional 345kV power lines converge with the alignment and the four power lines parallel Segment B for approximately 3 miles. A natural gas pipeline operated by NTUA parallels the mid and northern portions of the segment for approximately 5 miles, crossing the alignment three times.

Recreation: There are no developed recreation facilities along Segment B. Dispersed recreation, including small game, furbearer, game-bird hunting, and trapping, occurs along washes including the Chaco River, which is crossed by the segment.

Future Land Use: Segment B crosses an area designated as moderately sensitive for approximately 2 miles along the Chaco River (see Appendix H). The Sanostee Land Use Plan (2004) has identified an area approximately 2 miles west of the northern end of Segment B as a possible location for the construction of a prison.

3.4.3.4 Utility Corridor/Water Pipeline

The proposed 12.4-mile utility corridor/water pipeline is located on the Navajo Indian Reservation, within the Sanostee and Nenahnezad Chapters. Most of the vacant and undeveloped land along the proposed utility corridor/water pipeline is permitted for livestock grazing with water tanks and corrals dispersed throughout. Additionally, this project feature parallels an unpaved road for the majority of its length.

Residential: Seven dispersed residences, including two hogans, are located within 0.5 mile of the proposed utility corridor/water pipeline.

Commercial, Industrial, Other Public Uses: None of these uses were found along the proposed utility corridor/water pipeline. The BNCC Lease Area is located about 0.75 mile east of the eastern end of the proposed utility corridor/water pipeline.

Rights-of-Way: On the eastern half of the proposed utility corridor/water pipeline, rights-of-way crossed include two sets of two 345kV power lines and a natural gas pipeline operated by NTUA. On the western portion, rights-of-way crossed include a second pipeline, U.S. Highway 491, a distribution power line and a telephone line parallel and to the east of U.S. Highway 491, as well as a water line leading to a residence.

Recreation: There are no developed recreational facilities along the proposed utility corridor/water pipeline. Dispersed recreation, including small game, furbearer and game-bird hunting and trapping, occurs along washes including the Chaco River, which is crossed by the eastern half of the proposed utility corridor/water pipeline. Table Mesa and Barber Peak, scenic tourist attractions, are located approximately 2 miles north of the intersection of the proposed utility corridor/water pipeline and U.S. Highway 491.

Future Land Use: The Sanostee Land Use Plan identifies a possible 100-acre housing site within the 1-mile-wide corridor, adjacent to the eastern side of U.S. Highway 491 and directly south of the proposed utility corridor/water pipeline. Table Mesa and Barber Peak, two distinguishable "scenic" landforms, are located approximately 2 miles north of the proposed utility corridor/water pipeline. The features are designated highly sensitive by the NNDFW and are proposed as open space by the Sanostee Chapter (Architectural Research Consultants 2004). The Sanostee Chapter Land Use Plan has proposed the development of camping sites and recreational vehicle parks near the features. The proposed utility corridor/water pipeline crosses an area designated as moderately sensitive for approximately 2 miles along the Chaco River (NNDFW 2005). Highway improvements have been planned for U.S. Highway 491 and include widening the existing two-lane highway to four lanes. The new roadway will be constructed on the eastern side of the existing roadway and will be fully contained within the existing right-of-way (Federal Highway Administration et al. 2006). In addition, the proposed utility corridor alignment crosses the two structural alternatives proposed by the Navajo-Gallup Water Supply Project between Mileposts 10 and 11. The Navajo-Gallup Water Supply Project is a proposal to construct pipelines to supply long-term, high-quality municipal and industrial water (approximately 40,000 acre-feet) to the New Mexico portion of the Navajo Nation south of the San Juan River, the Window Rock area within Arizona, and the City of Gallup, New Mexico. The USBR developed an EIS for the project with a range of alternatives that include two structural alternatives, a water conservation alternative, and a no-action alternative (BOR 2006b). The preferred alternative includes two pipelines, one that partially parallels U.S. Highway 491 (diverting water directly out of the San Juan River) and another along Highway 550 (diverting water from the Cutter Reservoir). The San Juan Lateral preferred alignment would run parallel to highways N36 and 491 in the study area.

3.4.3.5 Access Road

The proposed access road is located on the Navajo Indian Reservation within the Nenahnezad Chapter. The alignment would pass between Areas IV North and IV South of the BNCC Lease Area. Much of the vacant and undeveloped land along Alignment A is permitted for livestock grazing with water tanks and corrals dispersed along the alignment.

Residential: Ten intermittently occupied dispersed residences, including two hogans, are located within approximately 0.5 mile of Access Road Alignment A and portions of the Burnham Road Realignment Project. It is assumed that independent of the Desert Rock Energy Project coal from Area 4 North would be mined and some of these residences would ultimately be displaced.

Commercial, Industrial, Other Public Uses: Alignment A crosses approximately 7 miles of the BNCC Lease Area, the most prominent industrial use in and near the study area. No commercial or public uses were found within 0.5 mile of Alignment A; however, the NAPI farming enterprise is located approximately 1 mile northeast of the north end of the alignment.

Rights-of-Way: Alignment A crosses/intersects Burnham Road once. If Burnham Road is realigned as planned, the access road will intersect the Burnham Road only once, at the eastern-most end of the access road.

Recreation: There are no developed recreation facilities along Alignment A. Dispersed recreation, including small game, furbearer and game-bird hunting and trapping, may occur along the alignment, but is not common.

Future Land Use: A portion (approximately 3.5 miles) of Alignment A is located along the southern edge of Area IV north of the BNCC Lease Area, which was approved for coal mining under BNCC's SMCRA Permit (2005). In addition, portions (approximately 4.5 miles) of the alignment cross areas designated as moderately sensitive by NNDFW near Chaco River and Cottonwood Arroyo (NNDFW 2005).

3.4.3.6 BNCC Lease Area – Areas IV and V

Land Use in the BNCC Lease Area prior to coal mining operations is characterized as very low intensity livestock grazing, with few scattered dwellings (approximately 14, most of which are not permanently occupied) and few primitive roads crossing the area. Existing land use in the lease area and adjacent areas exhibits much of the pre-mining use character, where traditional Navajo society is based on rangeland resources and livestock, principally sheep, goats, cattle, and horses. Rangeland plants, primarily through livestock grazing, provide the principal means by which the scant and scattered rainfall of the area is useful to the Navajo people.

Presently, the BNCC Lease Area and associated facilities constitute a substantial portion of land use in the project area. Adjacent to the north permit area on the west is the Four Corners Generating Station. East of the Lease Area is the Navajo Indian Irrigation Project. Minor land uses in the permit area presently are two public roads (Table Mesa Road between Area III complex and Highway 491, and Burnham Road see Exhibit 11-82 and 11-83) and several natural gas pipelines and power transmission line easements. An existing dwelling, which is within 100 feet of an active haulroad, is a private residence in the Pinto area.

On the reservation, individuals and families are granted permits to use this land for grazing. Claims to land use are based on traditional (customary) use rights and grazing permits. Grazing permits issued by the BIA Agency Superintendent based on recommendations of the tribe's District Grazing Committee entitle the permittee to a range area of sufficient size to graze a specified number of animals. Original grazing permits, established by the BIA, were limited to 10 head of horses or 350 sheep units (minimum 10 to 350 maximum) annually. However, severe over-grazing has reduced the carrying capacity of the grazing permit areas (Navajo Grazing Handbook, Published by Navajo Tribal Council Jan 1958).

It should be noted that grazing unit boundaries generally are unfenced and rely primarily on topographic features, roads, arroyos, and streams. Grazing seasons are year-long on all range units.

Sources of livestock water are located in appropriate watersheds by constructing earthen ponds after consultation with the BIA Branch of Land Operations, Tribal District Grazing Committee, and customary users. These earthen ponds are located off the permit area. There are two BIA stock ponds located within the permit area: one at Area III and the other in Area IV North.

The postmining land use for the Navajo Mine coal leasehold has been designated as rangeland for the grazing of domestic livestock and for wildlife habitat. This designated land use was developed in agreement with the Navajo Nation and BIA and is the same as the premining land use. Objective No. 2 of Navajo Mine's Land Reclamation Program states, “Adequate forage at least equal in extent of cover to the natural vegetation of the area.”

BNCC will replace several pre-existing livestock watering ponds that have been or are scheduled to be disturbed in the mining process. The BNCC will coordinate with the BIA and Navajo Nation to determine if fences and or roads used in the mining process may remain after reclamation. Roads and fences that the BIA and Navajo Nation agree to maintain in order to support livestock grazing postmining will remain following land release.

3.4.3.7 Water Well Fields

The alternative water well field is located on approximately 889 acres on the Navajo Indian Reservation, within the Sanostee Chapter. The vacant and undeveloped land within the proposed water well field is permitted for livestock grazing with water tanks and corrals dispersed throughout. The Proposed Water Well Field Alternative B would be located on the plant site proper and along transmission line Segment A. Land use and recreational resources for this alternative have been identified under the power plant site and Transmission Line Segment A discussions.

Residential: No residences are located within the proposed locations for the water well fields being evaluated. Three residences, including one hogan, are located within 0.5 mile of the southern water well field boundary, with four additional residences located just beyond 0.5 mile.

Commercial, Industrial, Other Public Uses: A grave plot is located approximately 0.25 mile from Alternative A's southern water well field boundary. No other commercial, industrial, or public uses were found within the water well field.

Rights-of-Way: U.S. Highway 491, a major transportation route within the region, is located approximately 2 miles east of the Water Well Field Alternative A.

Recreation: There are no developed recreational facilities within the locations of the water well fields. Dispersed recreation, including small game, furbearer, game-bird hunting, and trapping, might occur within the water well fields, but is not common.

Future Land Use: A 100-acre housing site (#3) is proposed by Sanostee Chapter along U.S. Highway 491, approximately 2 miles east of the water well field Alternative A.

3.5 TOPOGRAPHY, SOILS, GEOLOGY, AND MINERAL RESOURCES

3.5.1 Introduction

3.5.1.1 Topography and Landforms

The project study area is located within the Colorado Plateau physiographic province. The Colorado Plateau is defined by an abrupt change in elevation, coincident with uplifted and gently folded sedimentary layers internal to the plateau, and steep-sided valleys that incise the plateau perimeter. The Colorado Plateau province is higher in elevation than surrounding provinces, with elevations generally between 5,000 and 7,000 feet above MSL.

Elevations in the project study area average from a high of approximately 5,500 feet at the southeast corner in Area IV South, to a low of approximately 5,000 feet where proposed transmission line segment D crosses the San Juan River. The highest elevation in the study area is 6,314 feet at the top of The Hogback (the Hogback Monocline), west of proposed Transmission Line Segment C.

The topography of the study area is characterized by low-lying, gently rolling hills that slope to the Chaco River, and small escarpments (steep cliffs) or cuestas (a ridge with a gentle slope on one side and a cliff on the other) about 80 to 160 feet high. Escarpments on the east side of the Chaco River face to the west and are generally of greater height than those west of the river that face east. The most distinctive topographic feature in the study area is The Hogback, a folded or downwarped geologic structure that slopes to the southeast and east. The Hogback forms a long outcropping ridge of eastward-sloping rock that roughly parallels the Chaco River northward and continues north of the San Juan River. The San Juan River has eroded a gap in the ridge through which the river flows, U.S. Highway 64 passes, and the proposed Transmission Line Segment D will cross.

The part of the Colorado Plateau province in northwestern New Mexico is drained by the perennial San Juan River, which crosses the northern portion of the study area from east to west. The central portion of the study area is drained by the Chaco River and its tributaries, including Cottonwood Arroyo and Pinabete Arroyo. All are intermittent or ephemeral drainages. The Chaco River is located immediately west of the proposed power plant site and proposed transmission line segments A and C, and flows from south to north to the San Juan River.

3.5.1.2 Soils

The soils of the study area are the subject of two Natural Resource Conservation Service (NRCS) reports: Soil Survey of San Juan County, New Mexico – Eastern Part (NRCS 1980), and Soil Survey of Shiprock Area, Parts of San Juan County, New Mexico and Apache County, Arizona (NRCS 1992). The Chaco River divides the east and west soil survey areas, with the Shiprock survey area to the west of the Chaco River.

Descriptions, names, and delineations of soils in the Shiprock Area soil survey do not fully agree with those for the adjacent San Juan County-Eastern Part soil survey. These differences are the result of different scales of mapping, intensity of mapping, better knowledge of soils, modifications in soil series concepts, or the extent of soils within the survey areas. Soil descriptions are provided separately for areas west and east of the Chaco River as obtained from the two soil survey references listed above.

3.5.1.2.1 East of the Chaco River

Soils east of the Chaco River are primarily Sheppard-Huerfano-Notal and Badland-Rock Outcrop-Monierco complexes. Both complexes share the following characteristics: average annual precipitation is 6 to 10 inches, and the average annual air temperature is 51°F to 55ºF. Elevation is 5,500 feet to 6,400 feet and 4,800 feet to 7,200 feet, respectively. Both map units are irregularly shaped areas in the south and eastern parts of the study area.

Sheppard-Huerfano-Notal Complex: shallow to deep, nearly level to steep, well drained to somewhat excessively drained soils that formed in eolian material, alluvium, and residuum; and on uplands, bottom lands, and fans. It is nearly level to gently sloping soils on valley bottoms and nearly level to steep soils on mesas and plateaus. Slope is 0 to 40 percent.

This unit is made up of 25 percent Sheppard and similar soils, 23 percent Huerfano and similar soils, 13 percent Notal and similar soils, 6 percent Avalon soils and 6 percent Doak and similar soils. The remaining 27 percent is Muff, Uffens, Blancot, Stumble, Shiprock, and, Fruitland soils, and other soils of minor extent.

Sheppard soils are on mesas and plateaus. These soils are deep and somewhat excessively drained. They formed in eolian materials derived from mixed sources. Typically the surface layer is light brown loamy fine sand and fine sand. Huerfano soils are on mesas and upland valley bottoms. These soils are shallow and well drained. They formed in alluvium and residuum derived predominantly from shale and siltstone. Typically, the surface layer is light yellowish brown sandy clay loam. The subsoil is brown, dark yellowish brown, and yellowish brown clay loam and sandy clay loam. Notal soils are on valley bottoms and fans. These soils are deep and well drained. They formed in alluvium derived from sandstone and shale. Typically, the surface layer is brown silty clay loam. The subsoil and substratum are grayish brown clay.

Sheppard-Huerfano-Notal Complex soils are used for irrigated crops, livestock grazing, urban development, and wildlife habitat. The complex is well suited to rangeland wildlife habitat. The main limitations are low precipitation and varying degrees of salinity and alkalinity. Suitable wildlife habitat improvement practices include wildlife watering facilities and proper use of forage by livestock and wildlife.

Badland-Rock Outcrop-Monierco: characteristic of badlands and rock outcrops, these shallow, nearly level to gently sloping, well-drained soils formed in alluvial and eolian material, and on uplands. This map unit consists of irregularly shaped areas in the southeastern part of the study area. It is nearly level to gently sloping soils on uplands and moderately sloping to extremely steep areas of Badland on upland hills, ridges, and canyons.

This complex averages 74 percent Badland, 15 percent Rock Outcrop, and 8 percent Monicero. The remaining 3 percent consists of other soils. Badland is on uplands that are dissected by deep intermittent drainage ways and gullies. It is moderately sloping to extremely sloping, non-stony, and barren shale. It is moderately sloping to extremely steep exposures of barren stone. Monierco soils are on mesas, knolls, and plateaus. These soils are shallow and well drained. They formed in alluvial and eolian material derived predominantly from sandstone and shale. Typically, the surface layer is light yellowish brown fine sandy loam. The subsoil is brown, yellowish brown, and pale brown fine sandy loam and clay loam.

Uses for the Badland-Rock Outcrop-Monierco include the following. Badland includes livestock grazing and wildlife habitat. The area is suited to rangeland wildlife habitat. The main limitations are shallow soil depth, low precipitation, and low plant productivity.

3.5.1.2.2 West of the Chaco River

Soils west of the Chaco River lie in the warm, arid climate of Major Land Resource Area (MLRA) 37—San Juan River Valley, Mesas and Plateaus (NRCS 1992). The MLRA 37 group consists of five map units, making up about 42 percent of the survey area. The two primary soils in the study area west of the Chaco River are Persayo-Fordbutte-Ravola and Kimbeto-Farb-Denazar Complexes. These complexes share the following characteristics. The average elevation is about 5,300 feet. The average annual precipitation is about 7 inches, the average annual air temperature is about 52°F, and the average frost-free period is about 150 days. The vegetation is mainly a mixture of warm and cool season grasses and shrubs. Many of the shrubs are various species of saltbush (Atriplex).

Persayo-Fordbutte-Ravola Complex: shallow to very deep, nearly level to moderately sloping, well–drained soils that formed on alluvium derived from siltstone. It is nearly level to gently sloping soils on floodplains and nearly level to moderately steep soils on cuestas and plateaus. Slope is 0 to 15 percent. This unit is made up of 40 percent Persayo and similar soils, 16 percent Fordbutte and similar soils, 13 percent Ravola and similar soils, 9 percent Gyptur soils, and 6 percent Badlands. The remaining 16 percent is Littlehat, Cairn, Nageezi, Razito and Blackston soils.

The major soils in this complex are light yellowish brown in color, are generally slightly saline and moderately sodic, and formed in materials derived from siltstone and shale bedrock of Cretaceous age. This complex is used for livestock grazing and wildlife habitat. Major management concerns are the very low average annual precipitation, soil salinity and sodium absorption ratio, continuous overgrazing, and the hazards of water erosion and soil blowing.

Littlehat-Persayo-Nataani Complex: shallow to moderately deep, gently to moderately sloping, well drained soils that formed on alluvium derived from siltstone and shale. It is found on gentle to moderate slopes on undulating plateaus and cuestas. Slope is 1 to 15 percent. This unit is made up of 35 percent Littlehat and similar soils, 30 percent Persayo and similar soils, 20 percent Nataani and similar soils, and 15 percent local inclusions of other soil series.

The major soils in this complex are light yellowish brown in color, are generally moderately to strongly saline and slightly to strongly sodic, and formed in materials derived from siltstone and shale bedrock of

Cretaceous age. This complex is used for livestock grazing and wildlife habitat. Major management concerns are the very low average annual precipitation, soil salinity and sodium absorption ratio, continuous overgrazing, and the hazards of water erosion and soil blowing.

Kimbeto-Farb-Denazar Complex: shallow to deep, nearly level to moderately sloping, well drained to somewhat excessively drained soils on plateaus, mesa and cuestas; soils that formed on alluvium derived from sandstone and shale. It is nearly level to gently sloping soils on floodplains and nearly level to moderately steep soils on cuestas and plateaus. Slope is 0 to 25 percent. This unit is made up of 19 percent Kimbeto and similar soils, 16 percent Farb and similar soils, 15 percent Denazar and similar soils, 13 percent Huerfano and similar soils, and 8 percent Badlands. The remaining 29 percent is Hamburn, Genats, Jeddito, Escavada, and Nageezi soils.

The major soils in this complex are light brown to very pale brown in color, are generally moderately saline and moderately sodic, and formed in materials derived from sandstone and shale bedrock of Cretaceous age. This complex is used for livestock grazing and wildlife habitat. Major management concerns are the very low average annual precipitation, soil salinity and sodium absorption ratio, continuous overgrazing, and the hazards of water erosion and soil blowing

3.5.1.2.3 Additional Soil Characteristics

While the occurrence of biological soil crusts has not been documented, they could exist in the study area. Disturbance of biological soil crusts requires considerable time to revegetate, up to 56 years from one study (Kade and Warren 2002). Less frequent and intensive disturbance may be more easily correctable. Vehicle tires are particularly destructive to biological soil crusts (Belnap et al. 2001; Kade and Warren 2002).

Desert pavement is also of management interest due to its scientific value (i.e., the deposits are a measure of the antiquity of the process and the age of the surface upon which they sit), and because they are slow to form and are often vulnerable to disruption and destruction by human disturbance.

Desert pavement is a flat surface covered with a more or less complete layer of pebbles, gravel, or rocks, which have surfaces that have been varnished by a slow accumulation of micron-thick black metallic oxide films and clear protein-rich coatings where exposed to air. Desert pavements form via the removal of finer sediments from rocky soils or sediments that cover a bajada surface, caused by wind or sheet wash removal of surficial fine material, aided by subsurface upward creep of rocks as fines settle downward in expansive clay-bearing soils.

Arroyos are distinct parts of the upland ecosystem in the Four Corners Region that have specific ecological utility to the larger environment. Environmental management should distinguish between soil erosion and deposition that is normal and consequent to stable down-slope movement of sediment, and destructive erosion and deposition that prevents the healthy growth of desert-wash plants and the animals that use them.

3.5.1.2.4 Soils on the BNCC Lease Area

A soils survey was conducted beginning in February 1998 to determine soil resources in the project area. The northern limit of the survey area was the permit boundary of Area IV North and the southern limit was an arroyo locally referenced as No Name Wash. The objective of this survey was to document the types and proportions of soil and to assess the quantity of salvageable topdressing material for each area. The topdressing material is used in reclamation of the disturbed land resulting from the proposed surface coal mine operation. A total area of 6,806 acres was surveyed, including the entirety of Area IV South of the BNCC Lease Area.

General Nature of the Survey Area

The soil survey area is located within the Colorado Plateau physiographic province (Fennemon 1983; USDA 1980). The Colorado Plateau has within its borders a broad diversity of geologic materials, topography, soils, wildlife, and vegetation. The general terrain in the vicinity of the No Name Project area is characterized by rough and broken topography consisting of mesas, plateaus, and badlands intermingled with escarpments and valleys or arroyos. The two main drainage features in the survey area are No Name and Pinabete, both of which drain to the west where they join the Chaco Wash. Most of the soils in the area have formed in eolian and alluvial sediments derived from sedimentary rocks of the Fruitland Formation. Some soils have a residual component. Most of the soils in the survey area have been forming only since the Late Pleistocene and during the Holocene Epochs. Annual precipitation averages about 6.8 inches, which makes this area an aridic moisture regime, and the mean annual air temperature is about 51º F (11º C).

General Description of Soil Types

The soils of Area IV South are highly complex and variable. The geomorphic surface has been influenced by constructional and erosional processes. Most soils are moderately or severely eroded. This is supported by the high occurrence of buried and truncated soils. Erosion is currently a significant problem in the area.

A total of 27 mapping units were described using 25 soil series, 2 series variants, and 2 miscellaneous land types (Badlands and Rock Outcrop). Each soil series, family classification, and hydrologic group is given in Table 3-29.

Table 3-29 Soil Series, Classification, and Hydrologic Group for Area IV South

Series	Taxonomic Classification of Soils	Hydrologic Group
Badlands	Miscellaneous land type	D
Bacobi	Fine-loamy, mixed, mesic Typic Haplargids	C
Beebe Variant	Sandy, mixed, mesic Typic Torrifluvents	A
Benally	Fine-loamy, mixed, mesic Typic Natrargids	D
Blancot	Fine-loamy, mixed, mesic Typic Haplargids	B
Chipeta	Clayey, mixed, calcareous, mesic, shallow Typic Torriorthents	D
Doak	Fine-loamy, mixed, mesic Typic Haplargids	B
Fajada	Fine-loamy, mixed, mesic Typic Natrargids	D
Farb	Loamy, mixed, calcareous, mesic Lithic Torriorthents	D
Fruitland	Coarse-loamy, mixed, calcareous, mesic Typic Torriorthents	B
Fruitvale	Fine-loamy, mixed, mesic Typic Haplargids	B
Gilco	Coarse-loamy, mixed, calcareous, mesic Typic Torrifluvents	B
Grieta	Fine-loamy, mixed, mesic Typic Haplargids	B
Hoskay	Fine, mixed, mesic Vertic Natrargids	D
Huerfano	Loamy, mixed, mesic, shallow Typic Natrargids	D
Jocity	Fine-loamy, mixed, calcaresous, mesic Typic Torrifluvents	B
Mayqueen	Coarse-loamy, mixed, mesic Typic Haplargids	B
Monierco	Loamy, mixed, mesic, shallow Typic Haplargids	D
Muff	Fine-loamy, mixed, mesic, Typic Natrargids	D
Patel	Fine, mixed, mesic Typic Natrargids	D
Persayo	Loamy, mixed, calcareous, mesic, shallow Typic Torriorthents	D
Razito	Mixed, mesic Typic Torripsamments	A
Rock Outcrop	Miscellaneous land type	D
Shiprock	Coarse-loamy, mixed, mesic Typic Haplargids	B
Shiprock	Variant Fine-loamy, mixed, mesic Typic Haplargids	B

Series	Taxonomic Classification of Soils	Hydrologic Group
Stumble	Mixed, mesic Typic Torripsamments	A
Tsaya	Loamy-skeletal, mixed, calcareous, mesic Lithic Torriorthents	D
Uffens	Fine-loamy, mixed, mesic Typic Natrargids	D

Soils within the BNCC Lease Area

An Order II soil survey of 6,800 acres was conducted in Area IV South and the northern portion of Area V. A total of 469 profiles were described and 27 soil mapping units identified. Seventeen of the map units are consociations, five are complexes, two are undifferentiated groups, and two are miscellaneous land types, which contain no available topdressing material (Table 3-30).

Table 3-30 Soil Mapping Units for Area IV South

Soil Symbol	Soil Mapping Unit	Acres	Percent of Area	Available Topdressing Volume (CYD)
Ba	Badlands	1133.9	16.7%	-
Bc	Bacobi sandy loam, 0 to 15 percent slopes	290	4.3%	894,049
Bn	Benally, 0 to 3 percent slopes	408.7	6.0%	134,306
Bv	Beebe Variant loamy sand, 0 to 3 percent slopes	318.3	4.7%	2,307,835
Fa	Farb sandy loam, 0 to 15 percent slopes	47.7	0.7%	64,433
Fr	Fruitland sandy loam, 0 to 15 percent slopes	122.1	1.8%	652,413
Fv	Fruitvale-Shiprock Variant complex, 0 to 5 percent slopes	60.9	0.9%	356,060
Gr	Grieta sandy loam, 0 to 8 percent slopes	61.3	0.9%	244,041
Hf	Huerfano, 0 to 8 percent slopes	178.2	2.6%	47,666
Jc	Jocity, 0 to 3 percent slopes	214.3	3.2%	404,558
Jf	Jocity-Fruitland sandy loam complex, 0 to 3 percent slopes	144.7	2.1%	725,982
Mc	Monierco, 0 to 5 percent slopes	99.1	1.5%	195,099
MF	Muff and Fajada soils, 0 to 3 percent slopes	33.9	0.5%	28,710
Mq	Mayqueen loamy sand, 0 to 3 percent slopes	54.2	0.8%	480,100
Pc	Patel-Chipeta clays, 0 to 10 percent slopes	298.7	4.4%	-
PF	Persayo, Farb, and Rock outcrop, 0 to 50 percent slopes	307.6	4.5%	37,278
Ph	Patel-Huerfano complex, 0 to 10 percent slopes	1098.6	16.2%	131,898
Po	Patel, 0 to 5 percent slopes, overwashed	18.8	0.3%	18,993
Ps	Persayo, 0 to 10 percent slopes	701.9	10.3%	3,865
Pt	Patel clay, 0 to 3 percent slopes	0.9	0.0%	-
Rm	Razito loamy sand, moderately deep, 0 to 5 percent slopes	63.9	0.9%	272,495
RO	Rock outcrop	5.4	0.1%	-
Rz	Razito loamy sand, 0 to 15 percent slopes	470.4	6.9%	3,675,233
Sb	Shiprock-Bacobi-Mayqueen sandy loams, 0 to 5 percent slopes	139.6	2.1%	670,155
Sd	Shiprock very hard, 0 to 8 percent slopes	143.1	2.1%	338,519
Sh	Shiprock sandy loam, 0 to 8 percent slopes	70.5	1.0%	493,257
St	Stumble loamy sand, 0 to 15 percent slopes	143.2	2.1%	948,764
Sv	Shiprock Variant, 0 to 5 percent slopes	94.7	1.4%	622,840
Ts	Tsaya, 0 to 15 percent slopes, very rocky	75.4	1.1%	-
	Totals	6,800	100.0%	13,748,549

A total of 13,750,000 yds^3 of suitable topdressing was identified in the project area. This volume was reduced by 10 percent to account for experienced handling losses during the removal and redistribution of topdressing material. Therefore, it is estimated that 12,400,000 yds^3 of topdressing material is available from the project area. This estimate does not account for any sources of suitable regolith materials deeper than 60 inches that may exist in the area.

The project area is dominated by moderately eroded and severely eroded soils. Non-eroded surfaces are uncommon. The northern and central parts of the area are mostly composed of moderately deep soils formed on mesas and upland valleys. These soils provide most of the available topdressing in the project area. The southern part of the area consists mostly of severely eroded, sodium affected, clayey soils and miscellaneous areas that provide limited quantities of suitable topdressing. Suitable soils in this area are sparsely distributed on alluvial fans and as dune remnants on paleo-stream terraces.

The majority of the northeast portion of the project consists of elongated, longitudinal dunes with sodium affected soils occurring within the interdune (blowout) areas. The western part of this area is incised by the Pinabete Wash. Much of this western area is composed of shallow, sodium affected soils with deep entisols occurring along Pinabete Wash. The upland dune areas provide most of the suitable topdressing in this area.

The southern portions of the project area are dominated by severely eroded soils and miscellaneous land types. The northwestern part of this area is dominated by moderately shallow soils that formed on mesas and upland valleys. These soils provide most of the available topdressing. The eastern part of the area consists of deep, sodium affected soils that provide moderate quantities of topdressing. The remaining part of the area consists mostly of miscellaneous land types (Badlands and Rock Outcrop) that do not provide any suitable sources of topdressing.

Soil Descriptions

Ba – Badlands. This map unit consists of barren shale uplands that are dissected by deep intermittent drainage ways and gullies. Also included are very steep to nearly vertical rock outcrops of sandstone and shale. The slope is zero to eight percent.

Bb – Bacobi and Monierco soils, zero to eight percent slopes. This is an undifferentiated map unit of Bacobi and Monierco loamy sands, sandy loams, and sandy clay loams. These soils have formed in alluvial and eolian material derived predominantly from sandstone and shale on mesas and plateaus. Bacobi soils occupy 30-50 percent of most delineations and Monierco soils 35-55 percent. The major inclusions (2-5 percent) are Avalon, Farb and Shiprock soils. The minor inclusions (less than one percent) are Fajada, Fruitland, Nakai and Wingrock soils. Bacobi (20-40 inches to bedrock) and Monierco (<20 inches to bedrock) soils provide from 5 to 25 inches of topdressing material.

Bc – Blancot sandy clay loam, zero to five percent slopes. This map unit is on fans, valleys, terraces and mesas. Soils have formed in alluvium derived predominantly from sandstone and shale. This unit is 85-90 percent Blancot sandy clay loam and Blancot sandy loam. Blancot soils are on fans and in upland valleys, and occur with inclusions on terraces and mesas. Included in this unit are areas of Doak sandy loam (5 percent) and small areas of Shiprock, Shiprock Variant, Redlands Variant and deep Natrargids.

Bh – Blancot sandy clay loam, very hard, zero to two percent slopes. Soils have formed in alluvium derived predominantly from sandstone and shale. This unit is 80 percent Blancot sandy clay loam, very hard. These Blancot soils are on fans and in valleys and occur with inclusions on terraces and some valleys. Included in this unit are small areas of Blancot sandy clay loams and sandy loams. Other included soils are Doak (15 percent), Shiprock (5 percent) and deep Natrargids. The Blancot soils in this unit have 40 inches of available topdressing because the lower horizons are very hard to extremely hard. These lower horizons generally have sodium adsorption ration (SAR) values of 15 or higher. The cementation of these horizons is associated with sodium dispersed clay and, when dry, will restrict root growth.

Fa – Farb and Persayo soils, zero to 8 percent slopes. This map unit is primarily found on mesa tops where the soils are shallow. These soils are derived from sandstone or sandstone interbedded with shale. Farb soils occupy 60 percent and Persayo soils occupy about 10 percent of the delineation. The major inclusions include Tsaya, Wingrock, Huerfano, Monierco, and Patel soils (<5 percent each).

Gr – Grieta sandy loam, zero to five percent slopes. This map unit is found on older stable landscapes where the soils have a well developed calcic layer. Soils have developed from alluvium derived from sandstone and shale. Grieta soils occupy 95 percent of the unit. Inclusions are soils from associated map units, Bacobi, Mack, Monierco, and Nakai.

Jc – Jocity-Gilco complex, zero to three percent slopes. This unit is found as deep alluvial deposits on flood plains. The soils range in texture from sandy to clay loam and are formed from recent alluvium along drainages. These are some of the youngest soils in the survey area. Jocity and Gilco soils each occupy from 35 to 55 percent of the map unit. Jocity soils average more than 18 percent clay in the control section and Gilco averages less than 18 percent clay. Included soils consist mainly of Fruitland, Stumble, Trail and Tewa, each generally averaging less than 2 percent of a delineation. When the soils are not sodium affected, they provide a desirable source of topdressing.

Jh – Jocity, very hard, zero to three percent slopes. This unit is found as deep alluvial deposits on stream terraces and flood plains. These soils are similar to those of the Jocity-Gilco complex except they are sodium affected and the deposits have a consistence of very hard to extremely hard when dry. The Jocity soils occupy 60 to 80 percent of the map unit. The included soils are Gilco (<15 percent) and deep Natrargids (Benally and Hoskey).

Ma – Mack sandy loam, zero to three percent slopes. This unit is located on stable mesas as a deep soil having well developed calcic horizons formed in alluvium derived from sandstone and shale. The substratum is gravelly, which distinguishes these soils from Grieta soils. This unit is over 80 percent Mack soils having sandy loam and loamy sand surfaces. The included soils are Redlands Variant (<15 percent) and Shiprock Variant (<5 percent).

Mn – Mayqueen loamy sands, zero to eight percent slopes. This map unit is primarily formed from stabilized eolian material derived from sandstone and shale. The Mayqueen soils occupy over 90 percent of the unit. The major included soils are Razito and Shiprock, approximately five percent each.

Ms – Mayqueen-Shiprock loamy sands, zero to eight percent slopes. This map unit is on mesas and plateaus and consists of deep soils well suited for topdressing material. This unit is nearly 50 percent Mayqueen and 40 percent Shiprock. The major included soils are Razito (<3 percent) with lesser amounts of Bacobi, Blancot, Doak, Redlands Variant, Shiprock Variant and Stumble.

Mv – Mayqueen-Shiprock loamy sands, very hard, zero to 8 percent slopes. This map unit is on mesas and plateaus. The soils consist of soils very similar to the Mayqueen-Shiprock complex except they are sodium affected and the dry consistence of the subsurface is very hard or extremely hard. The Mayqueen very hard soils occupy more than 15 percent of the map unit. Inclusions are few and mostly consist of soils from associated map units, Mayqueen, Shiprock, and Shiprock Variant.

Na – Nakai sandy loam, zero to five percent slopes. This unit occurs on stable terraces and alluvial fans. These soils are derived from eolian and alluvial material derived from sandstone and shale. The Nakai soils occupy over 90 percent of the map unit. Included are soils from associated map units, which are primarily Avalon, Shiprock Variant, and Wingrock.

Nt – Natrargids, zero to 8 percent slopes. This is a unit of six soils that are shallow, moderately deep, and deep Natrargids. Soils occur on mesas and in valleys. They are derived from alluvium or directly from shale. In most delineations, they lack vegetation except for sparsely distributed salt tolerant grasses, forbs and shrubs. The components of this unit are so intricately intermingled that it would have been time consuming to map them separately.

Since none of the components constitute a source of topdressing, they were combined to form an undifferentiated map unit. The Natrargids in the map unit are: Huerfano shallow (42 percent), Fajada moderately deep (four percent), Patel moderately deep (4 percent), Benally deep (6 percent), Uffens deep (24 percent) and Hoskey deep (4 percent). The common inclusions are Blancot very hard, Chipeta, Farb, Jocity very hard, and Trail. The soils are not suitable as sources of topdressing material.

Nv – Natrargids overblown, zero to 8 percent slopes. This map unit is similar to the Natrargids map unit except the surface textures of these soils are sands and loamy sands that originate from recently deposited eolian material. In most cases the eolian sands are less than 20 inches deep. When the eolian sands covering the Natrargids soils were greater than 20 inches deep, the soils were mapped as Razito, very hard soils. The Natrargids of this unit include Fajada (27 percent), Uffens (22 percent), Benally (19 percent), Huerfano (10 percent) and Patel (3 percent). Inclusions are Razito very hard (12 percent) and Trail, Blancot, Doak and Shiprock soils (all less than 1 percent).

Ra – Razito sands-loamy sands, zero to 8 percent slopes. This unit consists of deep soils on mesas and plateaus formed in eolian sands. The soils occur as dunes that are young and lack soil development. The Razito soils occupy over 70 percent of the unit. The major inclusion is Mayqueen soils occupying nearly 25 percent of the unit. These soils are similarly managed as Razito soils. Other inclusions are Blancot, Shiprock and Stumble soils.

Rh – Razito sands-loamy sands, very hard, zero to 8 percent slopes. This unit consists of soils that have formed from eolian sands similar to the Razito soils. These very hard soils have higher levels of sodium and have very hard to extremely hard consistence in the subsoils. The soils are derived from eolian sands and occur on mesas and plateaus. In some areas, the sands are deposited over bedrock or Natrargids that limit the available topdressing. Razito, very hard soils occupy nearly 80 percent of the unit. Major inclusions consist of Razito, Mayqueen, Patel and Stumble soils. The textures of these soils are sands and loamy sands.

Rl – Redlands Variant sandy loam, zero to 4 percent slopes. This map unit is on stable mesas and terraces. The soils are alluvial and formed from sandstone and shale. They are well developed and provide one of the best sources of topdressing material. Redlands variant soils occur in nearly 85 percent of the map unit and the major inclusions are Shiprock and Doak soils. This map unit was set up to describe soils that have more clay than Shiprock soils, less clay than Doak and Blancot soils, and lack a calcic horizon.

Rv – Redlands Variant sandy loam, very hard, zero to 3 percent slopes. This map unit occurs on terraces and mesas. The soils are formed from alluvium derived from sandstone and shale. These soils are similar to the Redlands Variant except the subsoils are very hard and extremely hard and have high levels of sodium. This unit is over 70 percent Redlands Variant, very hard phase. The major inclusions are Redlands Variant, Doak, and Patel soils. The soils are deep and the surface texture is loamy sands, and sandy loams.

Sc – Shiprock loamy sand-sandy loam, zero to 8 percent slopes. The soils are formed in alluvium and eolian material derived from sandstone and shale. This map unit is on mesas and plateaus. The unit is over 80 percent Shiprock soils. Included in this map unit are Redlands Variant and Shiprock Variant soils with minor areas of Grieta, Mack and Mayqueen soils. These soils represent some of the most suitable sources of topdressing material.

Sh – Shiprock loamy sand-sandy loam, very hard, zero to 8 percent slopes. This map unit occurs on mesas and terraces as deep, well developed soils. The soils are similar to Shiprock soils but the subsoils are very hard or extremely hard. Typically, the sodium levels are higher than for Shiprock soils. Topdressing depth is limited by material that is either very hard or extremely hard. The map unit is about 70 percent Shiprock very hard soils with inclusions of Bacobi, Grieta, Mayqueen, Razito, Redlands Variant and Shiprock Variant soils.

Sl – Shiprock-Blancot complex, zero to 8 percent slopes. This map unit is on fans, terraces and mesas. Soils have formed in alluvium derived predominantly from sandstone and shale. This unit is 45 percent Shiprock loamy sand and sandy loam. Shiprock soils occur on stable mesas and terraces whereas Blancot soils are associated with fans and stable terraces. Included in this unit are small areas of Doak, Mayqueen, Redlands Variant and Uffens soils. Included areas make up about 0.5 percent of the map unit.

Sv – Shiprock Variant sandy loam, zero to 5 percent slopes. These soils are on mesas and plateaus. They have formed in calcareous alluvium derived from sandstone and shale. The soils are similar to Shiprock soils except for the presence of a calcic layer within 60 inches of the surface that limits the depth of topdressing available. The map unit is nearly 80 percent Shiprock Variant soils and the major inclusions are Bacobi, Grieta, Shiprock, and Redlands Variant collectively occupying 30 percent of the unit.

Sz – Stumble sand-loamy sand, 0 to 12 percent slopes. This map unit occurs on sides of valleys and alluvial fans. Soils have formed in sandy alluvium derived from sandstone and shale. This unit is 50 percent Stumble sand and 30 percent Stumble loamy sand. Included are limited areas of Razito and steep Stumble soils.

Ta – Trail loamy sand-sandy loam, zero to 8 percent slopes. These soils are on flood plains and low river terraces. They formed in sandy alluvium derived from sandstone and shale. Trail soils usually occur in higher positions in the landscape than the related Gilco soils. The map unit is over 80 percent Trail soils. Inclusions are Trail very hard, Gilco and, on steeper slopes, Razito soils.

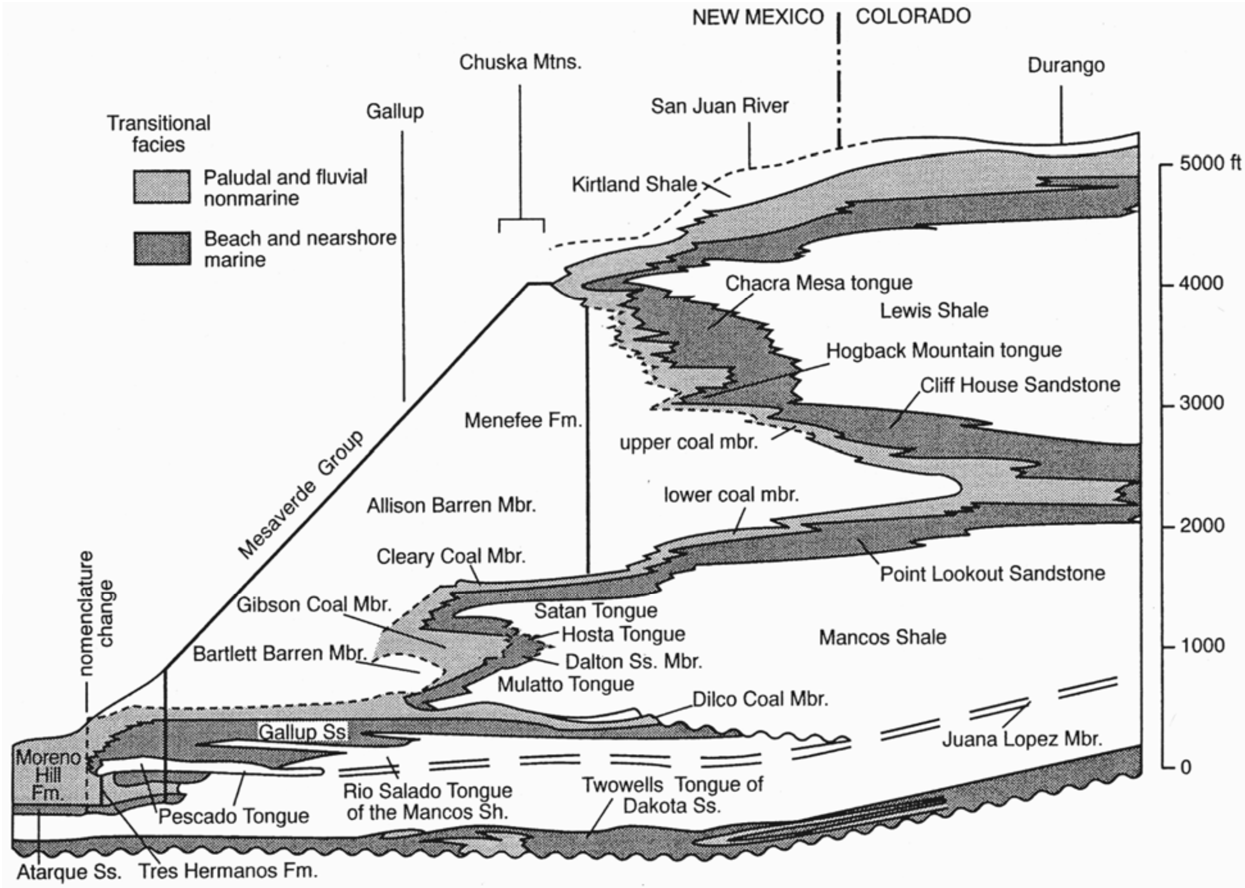
Th – Trail, very hard, zero to 8 percent slopes. This unit is on eroded terraces that resemble the substratum of stable mesas or floodplains. Soils have formed from alluvium derived from sandstone and shale. The soils are sodium affected and are generally very hard or extremely hard throughout the profile. The unit is 80 percent Trail very hard soils with inclusions of Stumble, Razito, and various Natrargids.

3.5.1.3 Geologic Setting

3.5.1.3.1 Regional Geologic Setting

Rocks that outcrop in the study area are Upper Cretaceous sandstones, siltstones, shales, and coal. These sedimentary rocks dip gently eastward at approximately 2 degrees toward the center of the San Juan Basin such that the older formations outcrop to the west in the area of the proposed water well field and younger formations outcrop to the east in the area of the proposed access road. Upper Cretaceous rocks in the study area are shown in Figure 3-14 and include strata from oldest to youngest (Kirschbaum and Biewick 2000):

Figure 3-14 Stratigraphic Diagram of Cretaceous Rocks



SOURCE: Stratigraphic diagram showing sequence, thickness, and nomenclature of Cretaceous rocks in San Juan Basin, New Mexico and Colorado. Modified from Beaumont 1982.

- **Mancos Shale** (Kmu). This is a thick, dark gray to black, carbonaceous marine shale with thin interbeds of limestone, siltstone, and fine-grained sandstone.
- **Point Lookout Sandstone** (Kpl). This basal member of the Mesaverde Group is a very fine- to medium-grained, immature to submature coastal marine sandstone that conformably overlies the Mancos Shale. It is water-bearing but does not usually have good water quality.
- **Menefee Formation** (Kmf). This middle member of the Mesaverde Group consists of light gray sandstone interbedded with carbonaceous siltstone and shale, bentonitic claystone, and coal. The formation was deposited in a coastal river and swamp environment. It is an aquifer with acceptable quality water for livestock and domestic use.
- **Cliff House Formation** (Kch). The upper member of the Mesaverde Group is a complex sequence of marine sandstones with locally interbedded shales. The massive sandstone was deposited in a barrier/beach environment and forms prominent cliffs. An abundance of ripple marks and a wide variety of fossils are visible in this unit. The upper part of the Cliff House intertongues with the overlying Lewis Shale. It is locally an aquifer with acceptable quality water for livestock and domestic use.

- **Lewis Shale** (Kls). This is a thick, light to dark gray, silty marine shale with interbedded sandy limestones, brown sandstone, and bentonitic clay.
- **Pictured Cliff Sandstone** (Kpc). This light gray delta front and barrier bar sandstone consists of alternating sandstone and gray siltstone and mudstone beds that interfinger with the Lewis Shale. The sandstone is a very fine- to fine-grained with glauconite and clay, and is not considered a major aquifer.
- **Kirtland-Fruitland Formation** (Kkf). This is the principal coal-bearing formation in the San Juan Basin. The Fruitland Formation contains interbedded sandy shale, carbonaceous shale, sandstone, and multiple coal layers deposited by rivers in a swampy delta plain and back beach environment. It contains at least 10 coal beds of varying quality having thicknesses greater than about 30 inches. Fruitland Formation coal is classified as *subbituminous B and C* (Hoffman 1996). The interbedded Kirtland Shale consists of a lower gray shale member with thin siltstone and sandstone interbeds, and an upper member containing interbedded sandstones and bentonitic claystones.

Geologic resources are those natural areas or national natural landmarks containing distinctive landforms or geologic features created by geologic processes or geologic history, and geologic areas with high ecosystem values related to watershed characteristics. There is no information that geologic resources have been surveyed and identified in the study area.

3.5.1.3.2 BNCC Lease Area Geologic Setting

The project area is located on the west flank of the San Juan Basin. This basin is an asymmetric, structural basin with a northwest-trending axis parallel to the Hogback monocline in northwest New Mexico. The basin is bounded on the northwest by the Hogback monocline and on the north by the San Juan Uplift. The eastern rim is formed by the Brazos Uplift and the Nacimiento Uplift. The Zuni Uplift and the Chaco Slope form the southern margin of the basin while the Defiance Uplift, and Four Corners Platform complete the northwestern basin rim (Fasset and Hinds 1977).

The rock strata in the southern part of the project area strike north-south while the strata in the northern part strike northeast-southwest. The average dip in the area is 2^o to the east. No major faults cut the project area, although minor low angle compaction faults and slumps up to eight feet in displacement are common. Seismically, the area is very stable with no historically recorded earthquakes of sufficient magnitude to damage structures (BOR 1975).

The stratigraphic section in the project area reflects the Late Cretaceous transition of shallow marine depositional environment to a terrestrial fluvial depositional environment. The four formations encompassing this depositional environment change are (in ascending order): the Lewis Shale, the Pictured Cliffs Sandstone, the Fruitland Formation, and the Kirtland Shale.

The Lewis Shale contains the last purely marine shales deposited in the Upper Cretaceous epeiric seaway. It consists of gray to black shale with some interbeds of sandy limestone, brown sandstone, and bentonite.

The Pictured Cliffs Sandstone conformably (strata that lies parallel) overlies and intertongues with the Lewis Shale. This formation consists of both delta-front and barrier-beach sediments and marks the change to a littoral (near-shore) depositional environment (Flores and Erpenbeck 1981). The upper two-thirds of the Pictured Cliffs sandstone consists of a generally coarsening upward sequence of light gray, fine- to medium-grained sandstone while the lower one-third of the formation consists of interbedded shale and sandstone.

The upper 20 meters of this sandstone is consistently massive, light gray to light brown, fine to medium grained with predominately rounded quartz grains, and has a salt-and-pepper texture. The total thickness of the Pictured Cliffs Sandstone is approximately 110 feet in the project area.

The Fruitland Formation, which conformably overlies the Pictured Cliffs Sandstone, contains sediments deposited in fluvially influenced delta plain and adjoining back beach-bar depositional environments (Flores and Erpenbeck 1981). The lithologies of the rock units encountered in the Fruitland Formation include fine- to medium-grained sandstones, siltstones, sandy and silty claystones, carbonaceous claystones, bentonitic claystones, and coal.

The Kirtland Shale conformably overlies the Fruitland Formation. This formation is divided into two units, the upper shale member which includes Farmington Sandstone Member, and the lower shale member. Sediments in the Kirtland Shale were deposited in an upland flood-plain environment where aggrading stream channels were separated by narrow, parallel flood plains. The lower shale member is composed of gray claystone shales that contain a few thin interbeds of siltstone and sandstone. The upper shale member is composed of a series of interbedded sandstone lenses and claystone shales. The shale beds in the upper shale member of the Kirtland Shale are much more colorful than those in the lower shale member and are purple, green, white, and gray. No coal beds exist in the Kirtland Shale (Fasset and Hinds 1971).

Several deposits of Quaternary alluvial and eolian sands occur within the project area. These are important sources of topdressing material for reclamation.

The economically important stratigraphic interval in the project area is the lower 250 feet of the Fruitland Formation where 11 different mineable coal seams occur. Up to nine different mineable seams occur in any one location in the project area. A mineable seam is defined as a seam with a minimum thickness of two feet, a minimum heating value of 6,000 British Thermal Unit Per Pound (Btu/lb) and an aerial extent and stratigraphic position that makes the seam economically viable to mine. Fruitland coal seams are very lenticular in nature and most are mineable in very localized areas only. Details on the characteristics of the coal seams in the project area are provided in Appendix D.

3.5.1.3.3 BNCC Lease Area Overburden Characteristics

The overburden material at Navajo Mine has been sampled and characterized in Areas I, II, III, IV North, and IV South. Overburden is defined here as consolidated geologic strata from the Fruitland Formation that lies above the uppermost coal seam and between the intermediate coal seams. Overburden samples are represented by undisturbed cores that are crushed and subsampled for chemical and physical analysis.

Five drill holes were sampled in 1987, all in Area IV North.

Nine drill holes were sampled in 1989: five in Area II and four in Area III.

Ten drill holes were sampled in 1998: all in Area IV South.

Drill holes were cored from ground surface to 10 feet below the bottom mineable seam and continuous core samples were collected. Major strata were sampled in five foot increments. Strataless than one foot thick were combined with adjacent layers.

The general nature of the overburden is a geologic formation composed of sandstone, siltstone, claystone, mudstone and shale. The variation in the lithology of the overburden is a result of the environment in which the Fruitland Formation was deposited.

The Cretaceous aged land forms were comparable to modern deltas and shorelines receiving successive deposits of sand, silts and clays. The ancient swamps (coal deposits) were buried by meandering stream deposits that contained high amounts of salts.

The strata are mostly tan or gray and gray shale dominates. The pH values are highly alkaline (pH > 8.0) with very few examples of strongly acid material. It is most frequently nonsaline (electrical conductivity [EC] < 4 millimhos per centimeter (mmhos/cm) but the dominant soluble cation is sodium (SAR values are frequently above 18). The fine earth textures of crushed samples are most frequently clay loams and silty clay loams. The clays are commonly highly expansive and believed to be smectites because the saturation percentages are high, frequently exceeding 85 percent. The potential to form acidic material from the oxidation of sulfur exists but is not common. It is expected that these acid-forming materials will not be a concern but will help reduce the dominantly high pH of the material.

Two trace elements of interest are boron and selenium. Elevated levels of the soluble forms are not common and when averaged throughout the mined overburden and are expected to present only a minor impact. OSM's root-zone suitability standards prohibit the use of acid or toxic forming materials from use during reclamation.

Table 3-31 summarizes the results of the BNCC overburden characterization study(ies).

Table 3-31 Summary of BNCC Overburden Characterization Studies

pH	EC (mmhos/cm) @25C	SAR	Boron (ppm)	H_2O Sol. Selenium (ppm)	Pyritic acid-base potential tons per 1,000 tons (t/1000T)	Clay %	Sat %
8.6	2.72	30.5	0.77	0.06	49.29	30.11	96.2

3.5.1.4 Minerals

Mineral resources of economic value that are known or have the potential to occur in or in proximity to the study area are identified as follows:

- Nonrenewable energy fluid minerals (oil and gas, including coal bed methane);
- Nonrenewable energy solid minerals (coal);
- Nonrenewable nonenergy fluid minerals (CO_2 and helium);
- Metallic minerals (e.g., gold, silver, uranium and vanadium);
- Nonmetallic minerals (e.g., gemstones, fluorspar, perlite); and
- Mineral material resources (e.g., sand, gravel, limestone, cinders, and building stone).

3.5.1.5 Renewable Energy

Renewable energy resources such as wind, solar, and biomass are discussed in Section 3.5.2.

3.5.2 Existing Conditions

3.5.2.1 Power Plant Site

3.5.2.1.1 Topography and Landforms

The topography at the proposed power plant site consists of relatively flat to gently rolling hills that slope to the west toward the Chaco River. Elevation ranges from 5,240 feet near the Chaco River to 5,360 feet at the top of an escarpment east of the site. The slopes have a sand- and gravel-covered surface with sparse vegetation. Outcrops of resistant bedrock dip gently to the east at about 1 degree and form west-facing steep-sided escarpments or cuestas and eroded knobs typically less than 50 feet high. The escarpments are cut by arroyos that have developed a west-flowing drainage pattern that meets the meandering channel of the north-flowing Chaco River. The stream channels slope to the west at a gradient of about 120 feet per mile.

3.5.2.1.2 Soils

Soil types mapped at the Power Plant Site include the Sheppard-Huerfano-Notal Complex and the Badland-Monierco-Rock Outcrop Complex (Keetch 1980). Soils of the Sheppard-Huerfano-Notal Complex are found on the gentle slopes above the Chaco River floodplain. Soils of the Badland-Monierco-Rock Outcrop Complex are found on the steeper slopes and escarpments of cuestas and mesas at the eastern part of the site. Since much of the area currently is subject to erosional processes, the soils are moderately to severely eroded. The soil horizon is relatively thin because bedrock shale and siltstone occur at shallow depths—typically less than 20 inches. The amount of topdressing available for removal and stockpiling prior to construction of the power plant would be limited by the thin soil horizon.

3.5.2.1.3 Geology

The proposed power plant is sited on outcrops of Lewis Shale and Pictured Cliff Sandstone. There are no existing or proposed areas of geologic significance or important fragile lands or natural areas in or around the power plant site. The presence of thin bentonitic clay layers in the Lewis Shale may cause swelling in soil during construction.

There is minor earthquake potential in the study area (USGS 2002).

There is a low incidence of landslides and a low susceptibility for landslides in the study area (USGS 1978). However, the presence of bentonitic clays in some of the geologic formations in the study area suggests there is potential for failure on steeper slopes where those formations are exposed.

3.5.2.1.4 Mineral Resources

Oil and Gas: Coal beds in the Upper Cretaceous Fruitland Formation of the San Juan Basin have a long history of producing economic quantities of methane gas, known as coal bed methane. Although the greatest coal bed methane production has occurred in the deeper parts of the basin east of the study area, several small gas fields produce gas from Fruitland, Mesaverde, and Dakota coal beds in and near the study area (USGS 2006a), including the Hogback, Slick Rock, Fruitland, and Table Mesa fields

(Table 3-32). In addition to Cretaceous rocks, Pennsylvanian and Permian strata produce oil and gas from fields near the study area (USGS 2006a), including the Hogback, Table Mesa, Tocito Dome, and Pajarito fields (Table 3-32). There are no oil or gas wells in or near the power plant site.

Table 3-32 Oil and Gas Fields near Desert Rock Energy Project San Juan County, New Mexico

Field Name	Location T; R; S	Producing Formation	Production Type
Slick Rock	29N; 17W; 1, 12 29N; 16W; 6, 7	Dakota	gas
Hogback	29N; 16W; 19, 20, 30	Dakota	gas
Hogback	29N; 17W; 13, 24 29N; 16W; 17, 18	Pennsylvanian	oil and gas
Jewet Valley	29N; 16W; 3, 4, 9, 10	Gallup	gas
Waterflow	29N; 16W; 24 29N; 15W; 19, 20, 29, 30	Gallup	gas
Ojo/Basin	28N; 15W; 25, 26, 35, 36	Fruitland	gas
Table Mesa	27N; 17W; 3, 4, 9, 10	Dakota	gas
Table Mesa	28N; 17W; 21-23, 26-28, 33-35	Pennsylvanian	oil and gas
Pajarito	29N; 17W; 29, 30, 31, 32	Pennsylvanian	oil and gas
Tocito Dome	26N; 18W; 21, 22, 27, 28, 33, 34	Pennsylvanian	oil and gas

NOTES: T = Township N = North
R = Range W = West
S = Section

CO_2 and Helium: In addition to crude oil and natural gas, some oil and gas wells typically produce small percentages of mixed gases that may include CO_2 and/or helium. No wells in the western San Juan Basin have encountered reportable quantities of those gases and there are no wells near the power plant site.

Geothermal: A total of 5 wells drilled near the study area encountered elevated temperatures that can be classified as geothermal resources (Table 3-33). Bottom-hole temperatures in those wells, where reported, ranged from 30.5 to 33 degrees Celsius (ºC); 87 to 91ºF. Witcher and others (1982) reported that temperatures below 90ºC are considered low-temperature geothermal resources. There is no reported occurrence or use of geothermal resources at or near the power plant site.

Table 3-33 Geothermal Resources near Desert Rock Energy Project San Juan County, New Mexico

Name	Location T; R; S	Latitude	Longitude	Temperature (ºC)
Navajo 12T-630 Well		36.7153	-108.6369	33
Navajo Well		36.7889	-108.6806	32
Navajo 12T-520 Well		36.7764	-108.6939	31
Navajo12T-629 Well	29N; 17W; 32	36.6822	-108.6572	30.5
Suphur Spring unnamed well		36.6508	-108.718	not reported
unnamed spring/well		36.4314	-108.724	not reported
unnamed spring/well		36.3778	-108.748	not reported

NOTES: T = Township
R = Range
S = Section

Coal: The thickest and most extensive coal beds are mined from Upper Cretaceous sedimentary rocks that outcrop on the BNCC Lease Area east of the power plant site. Minor coal seams are present in the Dakota Formation, which underlies the power plant site.

Metallic and Nonmetallic Minerals: A review of Federal and state mineral resource databases identified mines and mineral deposits within 5 miles of the study area and right-of-way corridors (Table 3-34). The review identified several metallic mineral deposits in the area west of the mines. Outcrops of Menefee Formation and Point Lookout Sandstone west of the BNCC Lease Area historically have been explored and mined for uranium and there is potential for radioactive mine tailings in the study area. There are no mines or leases for these types of minerals at the power plant site.

Table 3-34 Metallic and Nonmetallic Mineral Mines and Prospects near Desert Rock Energy Project — San Juan County, New Mexico

Name	Latitude	Longitude	Mineral Commodity	Production Status
Shiprock Area				
Nelson/Shadyside	36.7847	-108.682	uranium, vanadium	past producer
Enos Johnson	36.7847	-108.682	uranium	past producer
Al Cook prospect	36.775	-108.700	uranium	unknown
Chimney Rock Area				
Hogback claims	36.7967	-108.511	uranium	unknown
The Hogback				
none	36.5275	-108.242	uranium	past producer
Table Mesa Area				
none	36.5367	-108.663	uranium	unknown
none	36.515	-108.722	uranium	unknown
Little Water				
none	36.485	-108.685	uranium	producer
none	36.4833	-108.685	uranium	producer
none	36.4828	-108.686	uranium	producer

Mineral Materials: There are undoubtedly deposits of mineral materials in the area of the plant site. However, they have never been developed due to a lack of demand. A review of Federal and state mineral resource databases identified 18 active and inactive mineral material pits in the Farmington and Shiprock area (Table 3-35). Sixteen of those pits are located within 2 miles of the San Juan River channel. Two pits are located within 2 miles of the Four Corners Generating Station. The nearest reported sand and gravel pit is located about 2 miles southwest of the Four Corners Generating Station and produces from the Chaco River channel.

3.5.2.1.5 Renewable Energy

There currently is no major commercial or residential development of wind, solar, or biomass energy resources at or near the power plant site. However, there is potential for development of solar energy resources. The National Renewable Energy Laboratory (NREL) map (Appendix I) of solar radiation power shows that northwest New Mexico has high solar-energy potential, with solar energy resources rated at 6,000 to 6,500 watt-hours per square meter per day at the power plant site (NREL 2006a).

Table 3-35 Mineral Material Pits and Quarries near Desert Rock Energy Project San Juan County, New Mexico

Name	Latitude	Longitude	Mineral Commodity	Production Status
Shiprock Area				
pit	36.8083	-108.683	sand and gravel	unknown
pit	36.7917	-108.666	sand and gravel	unknown
BLM pit	36.7847	-108.682	sand and gravel	producer
pit	36.7667	-108.683	sand and gravel	unknown
Chimney Rock Area				
BLM pit	36.7833	-108.600	sand and gravel	unknown
BLM/Pit 78-28-5	36.7519	-108.535	sand and gravel	producer
Waterflow Area				
BLM pit	36.7625	-108.464	sand and gravel	producer
BLM pit/Caudell Mine	36.7819	-108.425	sand and gravel	past producer
BLM pit	36.7744	-108.423	sand and gravel	past producer
Youngs Lake Area				
BLM/Pit 72-10-N	36.7556	-108.278	sand and gravel	unknown
Kirtland Area				
Harper Hill Pit	36.7414	-108.663	sand and gravel	unknown
Pit 77-11-5	36.7011	-108.722	sand and gravel	producer
Fruitland Area				
BLM/Richey Pit	36.7286	-108.405	sand and gravel	unknown
BLM pit	36.7283	-108.395	sand and gravel	unknown
Lookout quarry	36.700	-108.450	limestone, dimension	past producer
Hogback North Area				
Wheeler pit	36.7367	-108.535	sand and gravel	unknown
BLM pit	36.7294	-108.535	sand and gravel	unknown
BLM pit	36.7258	-108.525	sand and gravel	unknown
BLM pit	36.7247	-108.525	sand and gravel	unknown
BLM pit	36.6922	-108.515	sand and gravel	unknown
Huerfano Area				
pit	36.5275	-108.242	sand and gravel	past producer

The NREL map of wind power classification for New Mexico shows that there are no commercial-scale wind energy resources available at the power plant site (NREL 2006). Locally, windmills are used to mechanically operate pumps in water wells.

The NREL map of biomass analysis shows there is no significant biomass resource availability in the power plant area (NREL 2006)

3.5.2.2 Transmission Lines

3.5.2.2.1 Proposed Transmission Line Segments A, C, and D

Topography and Landforms

The topography along Transmission Line Segments A and C consists of relatively flat to gently rolling hills that slope to the west toward the Chaco River. The slopes have a sand- and gravel-covered surface with sparse vegetation.

The elevation along the alignment ranges from 5,240 feet at the proposed power plant site down to 5,100 feet along the Chaco River then rises to 5,360 feet at the Four Corners receiving station. Where the Chaco River turns north the alignment continues northeast and climbs a 160-foot high escarpment of resistant sandstone that dips gently to the east. The escarpment is cut by washes that have developed a west-flowing drainage pattern that meets the meandering channel of the north-flowing Chaco River.

The topography along Transmission Line Segment D is comparable to that for Segments A and C except where it crosses the San Juan River through the water gap in steeply dipping sedimentary rocks of The Hogback. The elevation decreases to about 5,000 feet at the San Juan River crossing, then rises to about 5,220 feet atop a gently southward sloping mesa, where it is planned to intersect with the NTP alignment.

Soils

Soil types mapped along the transmission line alignments are both variable and complex because of the variable terrain and distance traversed by the transmission lines. The soil types identified along Transmission Line Segments A and C, and the part of Segment D south of the San Juan River, include the Sheppard-Huerfano-Notal Complex and the Badland-Monierco-Rock Outcrop Complex. Soils of the Sheppard-Huerfano-Notal Complex are found on the gentle slopes above the Chaco River floodplain. Soils of the Badland-Monierco-Rock Outcrop Complex are found on where the alignment diverges from the Chaco River and climbs the steeper slopes and cuestas. The Huerfano soil type becomes more prevalent on the top of the mesas and cuestas near Morgan Lake. Since much of the area currently is undergoing erosion, the soils are moderately to severely eroded. The soil horizon is relatively thin because bedrock shale and siltstone occur at shallow depths. This alignment also traverses more badland topography along the cuesta escarpment where there is no soil horizon developed.

The soil types identified along Transmission Line Segment D north of the San Juan River include the Littlehat-Persayo-Nataani Complex, which is found on gentle to moderately steep slopes ranging from 1 to 15 percent, and on the top of mesas and cuestas. The Tocito-Gullied Land Complex is found in sopes and canyon washes at gentle slopes of 1 to 3 percent, and closely associated with badlands.

Geology

Rocks that outcrop in these transmission line segments are correlative with those described in Section 3.5.1.3. There are no existing or proposed areas of geologic significance or important fragile lands or natural areas in or around the transmission line segments. Segment D traverses the San Juan River floodplain at the gap in the Hogback. The steeply dipping sedimentary rocks at the Hogback can result in geologic hazards such as unstable slopes and rock slides along Segment D.

Mineral Resources

Oil and Gas: There are no oil and gas resources reported along Transmission Line Segments A and C. At the San Juan River, Segment D traverses the Jewet Valley gas field that produces from the Upper Cretaceous Gallup Sandstone.

CO_2 and Helium: No wells along these transmission line segments have encountered reportable quantities of CO_2 and helium resources.

Geothermal: There is no reported occurrence or use of geothermal resources along or near these transmission line segments.

Coal: Minor coal seams are present in the Dakota Formation, which underlies these transmission line segments.

Metallic and Nonmetallic Minerals: There are no metallic or nometallic mineral deposits along these transmission line segments.

Mineral Materials: There are no mineral material pits along Transmission Line Segments A and C. There are four mineral material pits along Segment D: three south of the San Juan River and one north of the river.

Renewable Energy

There currently is no substantive commercial or residential development of wind, solar, or biomass energy resources along or near these transmission line segments.

3.5.2.2.2 Alternative Transmission Line Segment B

Topography and Landforms

The topography along Transmission Line Segment B consists of relatively flat to gently rolling hills that slope to the east toward the Chaco River. The slopes have a sand- and gravel-covered surface with sparse vegetation. Outcrops of resistant rock that dip gently to the east form west-facing steep-sided escarpments or cuestas and eroded knobs typically less than 50 feet high. An east-flowing drainage pattern of shallow washes meets the meandering channel of the north-flowing Chaco River. The topography along Segment B is comparable to Segment C after crossing the Chaco River.

Soils

Soil types mapped along Transmission Line Segment B include the Littlehat-Persayo-Nataani Complex. This soil complex is found on the gentle slopes west of the Chaco River floodplain. Locally the Benally Series also occurs along this alignment. The Benally is a fine sandy loam on slopes of 1 to 5 percent. It is a very deep, well-drained soil that is strongly sodic and saline. Since much of the area currently is undergoing erosion, the soils are moderately to severely eroded. The soil horizon is relatively thin because bedrock shale and siltstone occur at shallow depths.

Geology

Rocks that outcrop along Transmission Line Segment B are correlative with those described in Section 3.5.1.3. There are no existing or proposed areas of geologic significance or important fragile lands or natural areas in or around the Transmission Line Segment B.

Mineral Resources

Oil and Gas: There are no oil and gas resources reported along the Transmission Line Segment B.

CO_2 and Helium: No wells in the Transmission Line Segment B have encountered reportable quantities of CO_2 and helium resources.

Geothermal: There is no reported occurrence or use of geothermal resources along or near Transmission Line Segment B.

Coal: Minor coal seams are present in the Dakota Formation, which underlies Transmission Line Segment B.

Metallic and Nonmetallic Minerals: There are no metallic or nonmetallic mineral deposits along Transmission Line Segment B.

Mineral Materials: There are no mineral material pits along Transmission Line Segment B.

Renewable Energy

There currently is no substantial commercial or residential development of wind, solar, or biomass energy resources along or near Transmission Line Segment B.

3.5.2.3 Water Well Fields

3.5.2.3.1 Topography and Landforms

There are two proposed water well field alternatives: Water Well Field Alternative Area A is located about 3 miles southwest of Table Mesa and approximately 13 miles west-northwest of the plant site. The preferred Water Well Field Alternative Area B is located at the plant site proper and along proposed transmission line Segment A.

As observed on the topographic map of the area, the topography in the proposed Water Well Field Alternative Area A, located about three miles southwest of Table Mesa, consists of relatively flat to gently rolling hills that slope to the north toward Many Devils Wash. Elevation ranges from 5,380 feet in Many Devils Wash to 5,460 feet at the top of a gentle rise east of the site. The slopes have a sand-and gravel-covered surface with sparse vegetation. The gently rolling hills are cut by washes that have developed a northwest- to northeast-flowing drainage pattern that meets the meandering channel of the north-flowing Many Devils Wash.

As observed on the topographic map of the area, the Water Well Field Alternative Area B, located at and adjacent to the plant site, consists of relatively flat to gently rolling hills that slope to the west toward the Chaco River. Elevation ranges from 5,240 feet near the Chaco River to 5,360 feet at the top of an escarpment east of the site. The slopes have a sand- and gravel-covered surface with sparse vegetation. Outcrops of resistant bedrock dip gently to the east at about 1 degree and form west-facing steep-sided escarpments or cuestas and eroded knobs typically less than 50 feet high. The escarpments are cut by washes that have developed a west-flowing drainage pattern that meets the meandering channel of the north-flowing Chaco River. The stream channels slope to the west at a gradient of about 120 feet per mile.

3.5.2.3.2 Soils

For Water Well Field Alternative Area A, soil types mapped include the Persayo-Fordbutte-Ravola Complex. Soils of the Persayo and Fordbutte Series are found on the relatively flat tops and gentle slopes of 1 to 10 percent. Soils of the Ravola Series are found on the steeper slopes and the sides of washes and channels. Since much of the area currently is subject to erosional processes, the soils are moderately to severely eroded. The soil horizon is relatively thin because bedrock shale and siltstone occur at shallow depths–typically less than 20 inches.

For Water Well Field Alternative Area B, soil types mapped at the Power Plant Site include the Sheppard-Huerfano-Notal Complex and the Badland-Monierco-Rock Outcrop Complex. Soils of the Sheppard-Huerfano-Notal Complex are found on the gentle slopes above the Chaco River floodplain. Soils of the Badland-Monierco-Rock Outcrop Complex are found on the steeper slopes and escarpments of cuestas and mesas at the eastern part of the site. Since much of the area currently is subject to erosional processes, the soils are moderately to severely eroded. The soil horizon is relatively thin because bedrock shale and siltstone occur at shallow depths–typically less than 20 inches. The amount of topdressing available for removal and stockpiling prior to construction of the power plant would be limited by the thin soil horizon.

3.5.2.3.3 Geology

Rocks that outcrop in the Water Well Field Alternative Area A are correlative with those of the Mancos Shale as described in Section 3.5.1.3. There are no existing or proposed areas of geologic significance or important fragile lands or natural areas in or around this proposed water well field area.

Rocks that outcrop in the Water Well Field Alternative Area B are correlative with those of the Lewis Shale as described in Section 3.5.1.3. There are no existing or proposed areas of geologic significance or important fragile lands or natural areas in or around this proposed water well field area.

3.5.2.3.4 Mineral Resources

Oil and Gas: There are no oil and gas resources reported in the two water well field areas. The Tocito Dome oil field is located about 2 miles south of Water Well Field Alternative Area A.

CO_2 and Helium: No wells in the two proposed water well field areas have encountered reportable quantities of CO_2 and/or helium resources.

Geothermal: There is no reported occurrence or use of geothermal resources at or near the two water well field areas. Two low-temperature geothermal wells are reported south of Little Water, which is located 9 miles south of Water Well Field Alternative Area A.

Coal: Minor coal seams are present in the Dakota Formation, which underlies both of the water well field areas.

Metallic and Nonmetallic Minerals: There are no metallic or nonmetallic mineral deposits in the vicinity of the two water well field areas.

Mineral Materials: There are no mineral material pits in the vicinity of the two water well field areas.

3.5.2.3.5 Renewable Energy

There currently is no substantial commercial or residential development of wind, solar, or biomass energy resources at or near the two water well field areas.

3.5.2.4 Utility Corridor/Water Pipeline

3.5.2.4.1 Topography and Landforms

The proposed utility corridor/water pipeline alignment extends from Water Well Field Alternative Area A to the plant site. As observed on the topographic map of the area, the topography along the utility corridor/water pipeline alignment can be divided into three sections:

- From the power plant site to the Chaco River, the topography is a relatively flat slope to the west and the Chaco River. Elevation varies from 5,240 feet to 5,360 feet at the plant site, and decreases to a low of 5,210 feet at the river. The ground has a sand- and gravel-covered surface with sparse vegetation.
- From the Chaco River to Coal Creek, the topography is relatively flat to gently rolling hills that slope to the northeast and east toward the Chaco River. Elevation ranges from a high of 5,350 feet where the utility corridor crosses the ridge between Chaco Creek and Coal Creek, to 5,280 feet at Coal Creek. An east-flowing drainage pattern of shallow washes meets the meandering channel of the north-flowing Chaco River. Outcrops of resistant rock that dip gently to the east form west-facing steep-sided escarpments or cuestas and eroded knobs typically less than 50 feet high. Beyond the escarpments, the topography is relatively flat to gently rolling hills that are drained by north-flowing washes until the corridor reaches Coal Creek.
- From Coal Creek to the proposed water well field, the topography is hilly as the corridor climbs a low saddle at the top of The Hogback, then traverses relatively flat to gently rolling hills westward across the northward-sloping Table Mesa to the proposed Water Well Field Alternative Area A. Elevation ranges from 5,280 at Coal Creek up to 5,500 feet near Table Mountain, then down to 5,380 feet at the water well field.

3.5.2.4.2 Geology

Rocks that outcrop in the utility corridor/water pipeline alignment are correlative with those described in Section 3.5.1.3. There are no existing or proposed areas of geologic significance or important fragile lands or natural areas in or around the utility corridor/water pipeline alignment.

3.5.2.4.3 Mineral Resources

Oil and Gas: There are no oil and gas resources reported along the utility corridor/water pipeline alignment. The corridor is south of the Table Mesa oil and gas field.

CO_2 and Helium: No wells in the utility corridor/water pipeline alignment have encountered reportable quantities of CO_2 and helium resources.

Geothermal: There is no reported occurrence or use of geothermal resources at or near the utility corridor/water pipeline alignment.

Coal: Minor coal seams are present in the Dakota Formation, which underlies the utility corridor/water pipeline alignment.

Metallic and Nonmetallic Minerals: There are historical uranium and vanadium mineral deposits and at least one mapped mine in the utility corridor/water pipeline alignment. The mine is shown on a topographic map on The Hogback west of Coal Creek.

Mineral Materials: There are no mineral material pits in the utility corridor/water pipeline alignment.

3.5.2.4.4 Renewable Energy

There currently is no substantial commercial or residential development of wind, solar, or biomass energy resources at or near the utility corridor/water pipeline alignment.

3.5.2.5 Proposed Access Road

3.5.2.5.1 Topography and Landforms

As observed on the topographic map of the area, along the proposed access road alignment, the topography is relatively flat to gently rolling hills that slope to the west toward the Chaco River. Elevation ranges from 5,240 feet at the western end of the plant site and rises to 5,400 feet at the junction with Burnham Road (BIA 5082). Outcrops of resistant rock that dip gently to the east form west-facing steep-sided escarpments or cuestas and eroded knobs typically 80 to 120 feet high. The escarpments are cut by washes that have developed a west-flowing drainage pattern that meets the meandering channel of the north-flowing Chaco River. The slopes have a sand- and gravel-covered surface with sparse vegetation.

3.5.2.5.2 Soils

Soil types mapped between the power plant site and Burnham Road include the Sheppard-Huerfano-Notal Complex and the Badland-Monierco-Rock Outcrop Complex. Soils of the Sheppard-Huerfano-Notal Complex are found on the gentle slopes above the Chaco River floodplain and on the relatively flat tops of cuestas and mesas. Soils of the Badland-Monierco-Rock Outcrop Complex are found on the steeper slopes and escarpments of cuestas and mesas at the eastern part of the site. Since much of the area currently is subject to erosional processes, the soils are moderately to severely eroded. The soil horizon is relatively thin because bedrock shale and siltstone occur at shallow depths—typically less than 20 inches.

3.5.2.5.3 Geology

Rocks that outcrop in the preferred access road alignment are correlative with the Kirtland-Fruitland Formation described in Section 3.5.1.3. There are no existing or proposed areas of geologic significance or important fragile lands or natural areas along or around the preferred Alternative Access Road Alignment.

3.5.2.5.4 Mineral Resources

Oil and Gas: There are no oil and gas resources reported along the Proposed Access Road Alignment.

CO_2 and Helium: No wells along this Proposed Access Road Alignment have encountered reportable quantities of CO_2 and helium resources.

Geothermal: There is no reported occurrence or use of geothermal resources at or near the Proposed Alternative Access Road Alignment.

Coal: Coal beds in the Fruitland Formation, which outcrops in the mine leasehold west of the Proposed Access Road Alignment, are generally greater than 250 feet bgs. Coal beds greater than 250 feet deep are considered unminable using surface mining methods. Minor coal seams also are present in the Dakota Formation, which underlies the Fruitland Formation.

Metallic and Nonmetallic Minerals: There are no metallic or nonmetallic mineral deposits along the Proposed Access Road Alignment.

Mineral Materials: There are no mineral material pits along the Proposed Access Road Alignment.

3.5.2.5.5 Renewable Energy

There currently is no substantial commercial or residential development of wind, solar, or biomass energy resources at or near the Proposed Access Road Alignment.

3.5.2.6 BNCC Lease Area – Areas IV and V

The proposed action would use mined coal resources from Area IV South and Area V of the BNCC Lease Area.

3.5.2.6.1 Topography and Landforms

As observed on the topographic map of the area, the topography in Areas IV North, IV South and V, located to the west and southeast of the proposed power plant site, consists of relatively flat to gently rolling hills that rise gradually to the east. The western boundary of the BNCC Lease area is characterized by escarpments and drainage breaks above the floor of the Chaco River valley. Two well-developed washes meander across the leasehold: Pinabete Arroyo, which crosses Area IV South from southeast to northwest and north, before turning west to the Desert Rock plant site; and No Name Arroyo, which crosses the northern part of Area V from southeast to northwest. Elevations in Area IV South range from 5,295 feet in Pinabete Arroyo at the northwest corner of the area to 5,520 feet along the tops of cuestas and mesas on the south side of the lease area. Elevations in Area V range from 5,375 feet in No Name Arroyo at the north boundary of the area to about 5,600 feet on the south side of the area. Outcrops of resistant rock that dip gently to the east form west-facing steep-sided escarpments or cuestas and eroded knobs 80 to 160 feet high. The escarpments are cut by washes that have developed a northwest- to west-flowing drainage pattern that meets the meandering channel of the north-flowing Chaco River. The slopes have a sand- and gravel-covered surface with sparse vegetation.

3.5.2.6.2 Soils

Soil types mapped in Area IV South and Area V include the Sheppard-Huerfano-Notal Complex and the Badland-Monierco-Rock Outcrop Complex. Soils of the Sheppard-Huerfano-Notal Complex are found on the relatively flat to gently rolling tops of cuestas and mesas at the eastern and southern parts of the two areas. Soils of the Badland-Monierco-Rock Outcrop Complex are found on the steeper slopes and escarpments along named arroyos and unnamed washes that have eroded into the cuestas. Since much of the area currently is subject to erosional processes, the soils are moderately to severely eroded.

In 1998, BNCC commissioned a study of soil conditions at and in the vicinity of the No Name Mine, which is located within the Area IV South between the north boundary of Area IV South and No Name Arroyo, and encompassing approximately 6,800 acres (BNCC 1999). The purpose of the survey was to identify and record the soil types and proportions, and to test and quantify salvageable topdressing material for the area. Soil mapping units were delineated and placed on maps at a scale of 1:6,000 (one inch equals 500 feet). Test pits were excavated to facilitate soil descriptions and soil samples were collected for analysis of topdressing suitability criteria including pH; EC; saturation percent, major cations (calcium, magnesium, sodium); SAR; texture with percent sand, silt and clay; percent carbonate; acid-base potential; and selenium.

The results of this study provided useful information on the current conditions of soil resources in Areas IV South and V. The study estimated that an average of 7.6 inches of topdressing would be available if all 4,166 acres on the No Name Mine were disturbed (BNCC 1999).

The areas are dominated by moderately eroded and severely eroded soils. The northern and central parts of the area are mostly composed of Sheppard-Huerfano-Notal Complex with moderately deep soils formed on mesas and upland valleys. These moderately deep soils could provide much of the topdressing salvageable for reclamation. The southern part of the area consists mostly of severely eroded and strongly sodic clayey soils. Soils suitable for topdressing in this area occur on alluvial fans and upland dune remnants on paleo-stream terraces.

The soil horizon is relatively thin in the Badland-Monierco-Rock Outcrop Complex because bedrock shale and siltstone are exposed or occur at shallow depths. Because the Badland-Monierco-Rock Outcrop Complex is commonly found on steeper slopes along arroyos and washes, and topsoil is thin to nonexistent, salvage of topdressing from this soil complex is not considered feasible.

3.5.2.6.3 Geology

Rocks that outcrop in Areas IV South and V are the Kirkland-Fruitland Formation as described in Section 3.5.1.3. There are no existing or proposed areas of geologic significance or important fragile lands or natural areas in or around those areas.

3.5.2.6.4 Mineral Resources

Oil and Gas: There are no oil and gas resources reported in Areas IV South and V.

CO_2 and Helium: No wells in Areas IV South and V have encountered reportable quantities of CO_2 and helium resources.

Geothermal: There is no reported occurrence or use of geothermal resources at or near Areas IV South and V.

Coal: Coal beds in the Fruitland Formation, which outcrops in the Areas IV South and V, are generally less than 250 feet bgs and contain up to 10 coal-bearing horizons suitable for mining. The proposed project would remove and process coal beds down to 250 feet.

Coal beds greater than 250 feet deep are considered unminable using surface-mining methods. Minor coal seams are present in the Dakota Formation, which underlies Areas IV South and V at depths greater than 250 feet.

Metallic and Nonmetallic Minerals: There are no metallic or nonmetallic mineral deposits in Areas IV South and V.

Mineral Materials: There are no mineral material pits in Areas IV South and V.

3.5.2.6.5 Renewable Energy

There currently is no significant commercial or residential development of wind, solar, or biomass energy resources at or near Areas IV South and V.

3.5.2.7 Uranium Mines and Mills

Historical mining and processing of uranium ore during the 1950s through 1970s has impacted portions of the Navajo Indian Reservation. The USEPA and Navajo Nation have surveyed, identified, and mapped locations having high levels of radiation (USEPA 2004a). Using information obtained from the USEPA and Navajo Nation, the potential of encountering abandoned mine sites and radioactive waste piles or mill tailings during construction of the project can be mapped. The map can be used to: (1) develop alternative corridors that avoid radioactive areas and (2) inform construction contractors of areas having hazardous conditions due to highly radioactive soil so they can develop appropriate health and safety programs and procedures to protect construction crews. The USEPA recommends preparing such a map for planning purposes prior to construction along the pipeline corridors.

3.6 AGRICULTURE

3.6.1 Introduction

Agriculture is examined separately from land use because its important uses are subject to different issues, regulations and impacts. The study area examined for agriculture (farming and livestock grazing) includes the area within 0.5 mile of the proposed facilities (the boundary is shown on Figure 3-13). Agriculture is jointly managed by the Navajo Nation and the BIA Natural Resources Department, based in Window Rock, Arizona, and Gallup, New Mexico, respectively, but both have regional offices in Shiprock, New Mexico.

3.6.2 Data Collection and Approach

Agricultural data were collected through analysis of aerial photography, review of existing studies and plans, and coordination with state and tribal agencies. Data for livestock grazing customary use areas were obtained from records maintained by the BIA Natural Resources Department. Data for irrigation projects were obtained from records and spatial data maintained by the Navajo Nation Department of Agriculture and the Navajo Nation Department of Water Resources Water Management Branch. Data for irrigation projects, dryland farmland, and livestock grazing were compiled, field-verified, and mapped for the area within 0.5 mile of the power plant site and the water well field and within a 1-mile-wide study corridor along the utility corridor, proposed transmission lines, and road alignments. This area is referred to as the study area. The regional area examined for agriculture includes land outside the study area, but generally within 15 miles of the proposed action, and provides a context for agriculture in the general area of the Desert Rock Energy Project.

Future or planned agricultural information was collected through review of existing plans and maps for local jurisdictions and Navajo chapters and agencies from March through June 2006. The New Mexico State Land Department, Navajo Nation Natural Resources Department, and BIA Natural Resources Department were contacted for information regarding livestock grazing and farming permits issued in the proposed study area. Two NRCS Soil and Water Conservation Districts were contacted regarding prime and unique farmland and farmland of statewide importance within the study area—the San Juan Office and Shiprock Office. The Shiprock Area Soil Survey was reviewed for information on prime and unique farmlands in the study area (NRCS 2004).

3.6.3 Existing Conditions

3.6.3.1 Overview of Agriculture (Farming and Grazing)

Agricultural activities within the region consist of livestock grazing and farming. Livestock grazing is prevalent throughout a majority of the study area, while irrigated farmland is concentrated along the San Juan River in the northern portion of the study area. Farm plots that use a technique known as "dryland farming" are located in the general region of the proposed action; however, few were inventoried within the study area (March 2006).

3.6.3.1.1 Livestock Grazing

Traditional Navajo culture is based on rangeland resources and livestock grazing, which remains an important practice in the region (BHP 2005). Individuals and families of Navajo descendents are granted permits to use reservation land for grazing a fixed number of animals (primarily sheep, goats, cattle, and horses) within areas that often overlap, known as "customary use areas" (BHP 2005). Grazing in the region is jointly managed by the BIA, Shiprock Agency, and tribal grazing committees. Grazing permits just outside of the study area within the Hogback ACEC are managed by the BLM Farmington Field Office.

The study area is located within Navajo Grazing Districts 12 and 13, in which all classes of livestock are grazed (Thomas 2006). The Chaco River forms the boundary between the two grazing districts (District 12 to the east and District 13 to the west) that jointly cover approximately 12 chapters. The two grazing districts have a combined total of 1,410 grazing permits issued for 63,092 sheep units[1] (approximately 1,198 permits are issued for 52,066 sheep units within grazing district 12 and approximately 212 permits are issued for 11,026 sheep units within grazing district 13). Most of the study area is located within grazing district 13, except portions of Alternative Transmission Line Segment B, Proposed Transmission Line Segment D, the Water Well Field Utility Corridor, and the Alternative Water Well Field Area A are located in District 12.

Corrals, tanks, and earthen ponds associated with livestock grazing are dispersed throughout the region's vast areas of rangeland (range improvements located within the study area are shown on Figure 3-13). Construction of rangeland improvements requires consultation with the BIA Branch of Land Operations, Tribal District Grazing Committee, and customary users (BHP 2005).

3.6.3.1.2 Farming

Farming in the study area has been influenced by traditional customs and water sources. A majority of farmland in the region is supported by irrigation projects that use water from the San Juan River (agricultural areas within the study area are shown on Figure 3-13). As a result, numerous farming plots are located along the San Juan River. Some farmers, such as a few in Burnham Chapter, use the non-irrigated cultivation method known as "dryland farming" and have several small fields in different locations, such as at the base of mesas, on sand slopes, in small canyons, along alluvial plains in washes, and in the valleys between mesas. Farming permits to individuals are allocated through the Navajo Nation in conjunction with the BIA (Navajo Nation Council 2005).

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[1] The Navajo define an animal unit (AU) in sheep units as follows: one cow is equal to four sheep, or one horse or one burro or one mule is equal to five sheep, or one goat is equal to one sheep.

The NAPI, a farming enterprise of the Navajo Nation, is located east of the study area, just beyond the BNCC Lease Area. The NAPI area is composed of over 60,000 acres of cultivated agricultural fields that produce alfalfa, corn, wheat, barley, pumpkins, beans, potatoes, and sod (NAPI 2006).

As defined by the Farmland Protection Policy Act, prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, fiber, forage, or other agricultural crops. Unique farmland is land other than prime farmland that is used for the production of specific high values food and fiber crops. Designation of prime or unique farmland is made by the NRCS. The NRCS has determined that the sites of the proposed action located within the San Juan Soil and Water Conservation District are not considered prime or unique.

Farmland of statewide importance is located in the regional study area along the San Juan River, and southeast of Morgan Lake (NRCS 2006). Farmland of statewide importance is land other than prime and unique farmland that is of statewide or local importance for the production of food, feed, fiber, forage, and oilseed crops.

3.6.3.2 Power Plant Site

3.6.3.2.1 Livestock Grazing

The power plant site is located within Grazing District 13, on the claimed use areas[2] of 6 grazing permit holders (BIA 2006). All classes of livestock are grazed year-round.

3.6.3.2.2 Farming

No farmland was identified during inventories within 0.5 mile of the plant site. Prime and unique farmland and farmland of statewide importance data were not available for the power plant site.

3.6.3.3 Transmission Lines

3.6.3.3.1 Proposed Transmission Line Segments A, C, and D

Livestock Grazing

Grazing and related facilities (dispersed water tanks and corrals) occur along the proposed transmission line alignment. The proposed transmission line alignment crosses portions of Grazing Districts 12 and 13 (Segments A, C, and portions of D are located in Grazing District 13, and the remainder of Segment D is located in District 12). Based on available data, it is confirmed that the proposed transmission line alignment will cross claim use and grazing permit areas. (BIA 2006). All classes of livestock are grazed year-round.

Ranching and sheepherding have been major occupations and a way of life in the San Juan Chapter for many years (JJ Clacs and Company et al. 2002). As a result, a majority of the chapter is grazed; however, valleys in the southern portion of the community are showing signs of overgrazing (JJ Clacs and

[2] "Claimed use areas" are areas that permittees have indicated are used for grazing. These areas are used by the BIA to define "customary use areas" and to manage grazing on the Navajo Indian Reservation. Customary use areas were not available for the study area at the time of this draft (July 2006).

Company et al. 2002). The San Juan Chapter community has voiced concern about protecting and preserving grazing lands from encroachment.

As a result, the San Juan Chapter Community-Based Land Use Plan (2002) identifies open space areas, where grazing should be limited and carefully monitored to ensure that overgrazing does not occur (JJ Clacs and Company et al. 2002). Grazing areas in the San Juan Chapter are managed by the grazing manager, and regulated by the grazing management plan (JJ Clacs and Company et al. 2002).

The San Juan Chapter Community-Based Land Use Plan (2002) has identified Navajo land along Segment C for grazing. Segment D crosses an area planned for grazing between the San Juan River and the Four Corners Generating Station. The San Juan Chapter Community Based Land Use Plan identifies the east and west sides of the Hogback and San Juan River for open space, which is open to limited grazing.

Farming

The study area contains multiple agricultural plots associated with residences and small farms within 0.5 mile of the proposed transmission line alignment near the San Juan River (refer to Figure 3-13). Farmland is supported by two irrigation networks that use water supplied by the San Juan River—the Fruitland and Hogback Canals. Approximately 31 farming permits occupying 600 acres within the 1-mile-wide study corridor are allocated through the Navajo Nation in conjunction with the BIA (Navajo Nation Council 2005).

San Juan Chapter has designated farming areas along both sides of Segment D. The cultivation of land for crops has a long history in the community and has made farming an important way of life (JJ Clacs and Company et al. 2002). Crops grown for food or to provide feed for livestock are the major farming enterprises in the area and include squash, corn, melons, alfalfa, and sod (JJ Clacs and Company et al. 2002).

In addition, a majority of families in Nenahnezad have strong ties to farming; however, today many of the farm plots in Nenahnezad Chapter are dormant (Navajo Nation Council 2005). The chapter has encouraged the Farm Board to explore innovative strategies to revitalize the farming practices (Navajo Nation Council 2005).

Farmland of statewide importance that is located north and south of the San Juan River is crossed by Segment D.

3.6.3.3.2 Alternative Transmission Line Segment B

Livestock Grazing

Most land along the Segment B is permitted for livestock grazing with water tanks and corrals dispersed throughout. Based on available data, it is estimated that the alternative transmission line alignment crosses portions of Grazing Districts 12 and 13 (a majority of the segment is located in Grazing District 12) and the claimed use areas of approximately 6 grazing permit holders (BIA 2006). All classes of livestock are grazed year-round.

A portion of the alternative transmission line would be co-located within the utility corridor. Land along the proposed utility corridor/water pipeline within Sanostee Chapter is designated “open range;” however, the Sanostee community would like to adopt best management practices to reduce soil erosion and deterioration of rangeland (Architectural Research Consultants 2004).

Farming

No farmland was identified during the inventory within 0.5 mile of Segment B. Sanostee community members have expressed a desire to establish an irrigation system for farming in the chapter and there is a concept to build a reservoir to store runoff water from the mountains for irrigation use; however, it is unclear if it would be located in the area of Segment B.

3.6.3.4 Utility Corridor/Water Pipeline

3.6.3.4.1 Livestock Grazing

Most land along the proposed utility corridor/water pipeline is permitted for livestock grazing with water tanks and corrals dispersed throughout. Based on available data, it is estimated that the utility corridor/water pipeline crosses portions of Grazing Districts 12 and 13 (mostly Grazing District 12) and the claimed use areas of approximately 18 grazing permit holders (BIA 2006). All classes of livestock are grazed year-round.

3.6.3.4.2 Farming

No farmland was identified during inventory within 0.5 mile of the proposed utility corridor/water pipeline. Sanostee community members have expressed a desire to establish an irrigation system for farming in the chapter and there is a concept to build a reservoir to store runoff water from the mountains for irrigation use.

3.6.3.5 Access Road

3.6.3.5.1 Livestock Grazing

Much of the land along proposed access road alignment A is permitted by the BIA for livestock grazing with water tanks and corrals dispersed throughout the area. Based on available data, it is estimated that access road alignment A crosses a portion of Grazing District 13 and the claimed use areas of approximately three grazing permit holders (BIA 2006). All classes of livestock are grazed year-round.

A portion of access road alignment A is located between Areas IV North and IV South of the BNCC Lease Area. Lease Area IV North was approved for coal mining in October 2005 (see Appendix A), and would be reclaimed post-mining to support livestock grazing.

3.6.3.5.2 Farming

No farmland was inventoried within 0.5 mile of Access Road Alignment A. The NAPI area is located approximately 1 mile northeast of the northern end of the alignment.

3.6.3.6 BNCC Lease Area – Areas IV and V

As stated previous, grazing rights on the Navajo Indian Reservation are administered by the BIA and Navajo Nation Grazing Committees. Individuals or families of Navajo descent are issued grazing permits that allow them to graze a fixed number of livestock in a specific area, often called a "customary use area." With the development of the Areas IV North and South and Area V, mining leasehold land within a grazing permit area will be withdrawn from that permit area and the holder of the permit will be compensated for the loss of grazing rights. This land will be returned to the Navajo Nation following reclamation and compliance with all applicable laws and regulations.

The predominant use on those areas not disturbed of the BNCC Lease Area was and is currently for the grazing of livestock. In discussions with representatives of the Navajo Nation, the trend is toward the use of cattle. Sheep will still be the primary class of livestock grazed on the reclaimed areas. However, the end use is optional to the user.

Revegetation success standards for vegetation cover, production, species diversity and woody plant density ensure that a productive and nutritious balance of forage will be available to domestic livestock, as well as meeting wildlife species needs for food and cover habitat. The plant species used in the revegetation program were selected on the basis of:

- Adaptability to local environmental conditions,
- Palatability and nutritional value to livestock and wildlife, and
- Ability to provide cover for wildlife.

To meet basic physiological functions, range livestock and wildlife species require a proper balance of forage nutrition. Positive benefits in terms of animal gains and conditioning are realized when the quality of forage is above that which is necessary to meet minimum nutritional needs. Providing forage above nutritional minimums not only improves economic returns, but also better allows animals to maintain themselves during seasonal periods when forage quality and quantity is low. Protein, energy, phosphorus and carotene (Vitamin A) are the four nutrients most critical to range livestock production. In "Nutritive Value of Seasonal Ranges" (Cook and Harris 1968), the authors demonstrated that digestible protein was the best indicator of forage quality and was one of the better nutrients associated with animal gains. Forage nutrient quality is directly related to the growth stage of the plant species, the plant's palatability, and seasonal variations in both of these factors. Proper range and livestock management is therefore related to sustaining the quantity and quality of range forage during different seasons and over the succeeding future years.

A suitable grazing management plan would be applied to reclaimed areas to ensure the long-term availa-bility and sustained productive capability of the forage resource on these areas. The Navajo Nation has indicated that livestock will be grazed year-round on the areas in and around the Navajo Mine leasehold.

3.6.3.7 Water Well Field

3.6.3.7.1 Livestock Grazing

The land within alternative water well field A is permitted for livestock grazing with water tanks and corrals dispersed throughout. The alternative is located on Grazing District 12 on parts of the claimed use areas of approximately three grazing permit holders (BIA 2006). All classes of livestock are grazed year-round. Permitted grazing data within proposed water well field B water well field site are located in the discussions related to the power plant site proper and within proposed transmission line alignment A.

The water well field area is designated "open range" by the Sanostee Land Use Plan; however, the community would like to adopt best management practices to reduce soil erosion and deterioration of rangeland (Architectural Research Consultants 2004).

3.6.3.7.2 Farming

No farmland was identified during inventory within 0.5 mile of the water well field. As mentioned earlier, Sanostee community members have expressed a desire to establish an irrigation system for farming in the chapter and there is an idea to build a reservoir to store runoff water from the mountains for irrigation use.

3.7 VISUAL RESOURCES

3.7.1 Introduction

The visual resource inventory describes existing visual conditions and includes the evaluation of existing visual conditions such as landscape character, visibility and viewer sensitivity, and scenic integrity.

There are no formal guidelines for managing visual resources on tribal lands; therefore, visual resource management guidelines established by the Forest Service and BLM were used to develop an objective methodology to assess the aesthetic conditions of the landscape and establish a characterization of the current viewing environment. These methods and guidelines were used in assessing landscapes outside of areas where formal guidelines apply. Aspects of both the Forest Service Scenery Management System (Forest Service 1995) and BLM Visual Resource Management System (BLM 1986) were used to thoroughly inventory:

- Inherent aesthetic resources within landscape character units
- Project visibility (refer to Section 3.1.2.3) and viewer sensitivity to change
- Scenic integrity, or the degree and effect of existing human modifications to the natural landscape

In determining landscape character, visibility and viewer sensitivity, and scenic integrity, sources used included aerial photography, ground reconnaissance, topographic maps, agency contacts, field reviews, and reference documents.

The study area for visual resources is defined as the area wherein potential visual effects from construction, operation, and maintenance of the proposed project may be discerned. A 6-mile-wide study corridor, 3 miles on each side of the overhead utility reference centerline and plant property boundary, was used to inventory visual resources as it represents an approximate threshold for potential visual impacts to occur. Nonvertical linear features such as access roads and pipelines were studied up to 0.5 mile on each side of the reference centerline or feature as these features would be sited on nearly level to gently rolling terrain. In locations identified as culturally or visually sensitive, resources beyond 3 miles were included in the analysis.

3.7.2 Existing Conditions

3.7.2.1 Overview of Regional Visual Resources

The visual region of influence includes a diverse range of largely undeveloped, natural landscapes. These landscapes are generally vast and expansive, permitting extensive views of undisturbed land. Developed areas include dispersed residences, agricultural land and ranches, mines and coal-mining facilities, a regional power plant, and other utility facilities. Residential settlements are most densely located adjacent to the San Juan River corridor; other residences are sparsely scattered throughout the study area. Typical residential settlements in this area include multiple dwellings, agricultural fields, and related out-structures.

The visual nature of a landscape is largely derived from the physical features (physiographic) of the land. Physical features are identified by terrain texture, rock type, and geologic structure and history. The study area is contained entirely within the Colorado Plateau physiographic region, which exhibits several unique landscape settings and viewing conditions. The Colorado Plateau's major distinguishing features are landforms cut by wind and water erosion (Fenneman 1931).

3.7.2.2 Landscape Character Types

Landscape character types were inventoried and mapped within the visual resources study area (Figure 3-15). Landscape character gives a geographic area its visual and cultural image, and consists of a combination of physical, biological, and cultural attributes that make each landscape unique or identifiable. Landscape character embodies distinct landscape attributes that exist throughout a specific geographic area (Forest Service 1995).

The Navajo Landscape Character Type, described as an area of young plateaus with broad open valleys, comprises all of the study area. Horizontal sandstone beds, eroded tablelands, cuestas, rock terraces, receding escarpments, shallow canyons, rolling desert plains, dry washes, and riparian corridors are characteristic of this landscape. Vegetation within this landscape is typically sparse and consists of desert plains, grasslands, salt brush, and sagebrush; bare soil and rock are also common.

For purposes of the visual resource inventory, landscape character was subdivided into character type, subtypes, and units to further delineate physical attributes. While landscape character type is the largest and broadest scale of landscape character delineation, landscape character subtypes are subregional areas of substantial size having common distinguishing physical and visual characteristics. Subtypes have significantly different visual characteristics from one another. Landscape character units are local areas of considerable size with common distinguishing physical and visual attributes, and are divisions of the subtype that contain different visual characteristics (Forest Service 1995). Each landscape character unit that appears on Figure 3-15 are described in the following sections.

Within the Navajo landscape character type, three landscape character subtypes were developed for the visual region of influence—High Plateau Tablelands, San Juan River Lands, and Navajo Modified Lands. These three subtypes have been subdivided further into landscape character units to define basic landscape character within the study area, as identified on Figure 3-15.

The most dominant landform in the visual resources study area is the Hogback, a monocline that runs northeasterly from the central portion of the study area. The Hogback is a long ridge that varies in both width and elevation and is typified by cross-bedding or layered rock striations inclined at angles of up to 35 degrees from horizontal. Because the Hogback traverses several miles through the study area, the vegetation and topography ranges from bare rock and exposed sandstone layering to sparse desert scrub vegetation along the flank of the long, narrow ridge. Outside of the study area is the regionally dominant and culturally significant Shiprock landform. Shiprock is a volcanic neck that juts out of the relatively flat desert plains landscape. Within these subtypes, the following landscape units were evaluated:

- **Desert Plains Landscape Character Unit**. The desert plains landscape character unit is the most common landscape in the study area and the region. The desert plains landscape character unit ranges from virtual desert pavement to relatively dense low-lying desert scrub vegetation. Various types of sedimentary rock lend texture and color variation to the landscape. The topography in the desert plains landscape can vary from flat to rolling hills but remains relatively homogenous. Dominant landforms within the region such as Shiprock, Hogback, Table Mesa, Barber's Peak, and the scattered volcanic outcrops are more visually noticeable from a desert plains setting because of the flat unobstructed viewing conditions. As such, cultural modifications including settlements, industrial development (e.g., transmission lines, power plants, switchyards, water tanks), and roads also can be more visually evident within a desert plains landscape.

- **Eroding Escarpment Landscape Character Unit**. The eroding escarpment unit encompasses landforms such as the broken and weathered geologic uplifts, cuestas, buttes, spires, volcanic dikes, steep-sloped windblown sand dunes (e.g., barchan dunes), sandstone outcropping defined by erosion and geologic deposits, tilted fault-block mountains, and retreating cliffs and bluffs. Landforms in the eroding escarpment unit can range from jagged edged steeply sloped escarpments with sharp bare rock ridges to the gently dipping slopes of barchan (crescent-shaped sand dune formed under an almost unidirectional wind) dunes. Eroding escarpments are typically bare rock landforms that provide texture to the desert plains landscape, color and visible rock striation is often evident on the landforms and provides a unique visual contrast to the relatively monochromatic plains landscape.
- **Playas Landscape Character Unit**. Visually similar to the desert plains landscape unit, the playas unit typically encompasses lands that are flat, dry-bottomed "lakes." With little or no vegetation, the major distinguishing feature of the playa is the relatively large cracked or broken desert pavement lake bed. Water may pool temporarily in the playa landscape dependent on seasonal precipitation.
- **Weathered Badlands Landscape Character Unit**. The weathered badlands landscape character unit is visually unique because of the distinctive sandstone layering of the escarpments. The weathered badlands have stratified color variation and ranges from flat beaches and bars to rolling hills and cross-bedded escarpments. Weathered badlands are concentrated mostly in the central and southern portion of the study area.
- **Mesa Landscape Character Unit**. The mesa landscape unit is distinguished from the tablelands in general because of the dominance of the landform. Mesas are larger and more dominant with eroded edges and cliffs. Vegetation upon the mesa ranges from bare rock to mesa grasslands as follows:
  - San Juan River Landscape Character Subtype: The San Juan River Landscape Character Subtype encompasses the water-related landforms within the study area. The San Juan River, Chaco River, Dry Wash, and Morgan Lake landscape character units are the major water features that occur in the region. The San Juan River is the only east/west flowing river in the region; water flow ranges from rapids to a slowly moving creek depending on season and location. The San Juan River corridor is visually distinctive because of its cut banks, rocky streambed, flowing water, and the dense vegetation that line the corridor.
  - Chaco River Landscape Character Subtype: The Chaco River, an ephemeral water feature, meanders through the study area in a north/south direction, its width and depth varying dramatically. Dense vegetation is visible within the channel and varies from desert grasses to mature paloverde and mesquite trees. The Chaco River has cut banks, replete with a sandy channel bed.
  - Morgan Lake Landscape Character Subtype: The man made Morgan Lake is the only lake in the study area and is located adjacent to the Four Corners Generating Station. The lake is designed for and used by the power plant and also used by local recreationists. It is a dominant water form within the region.

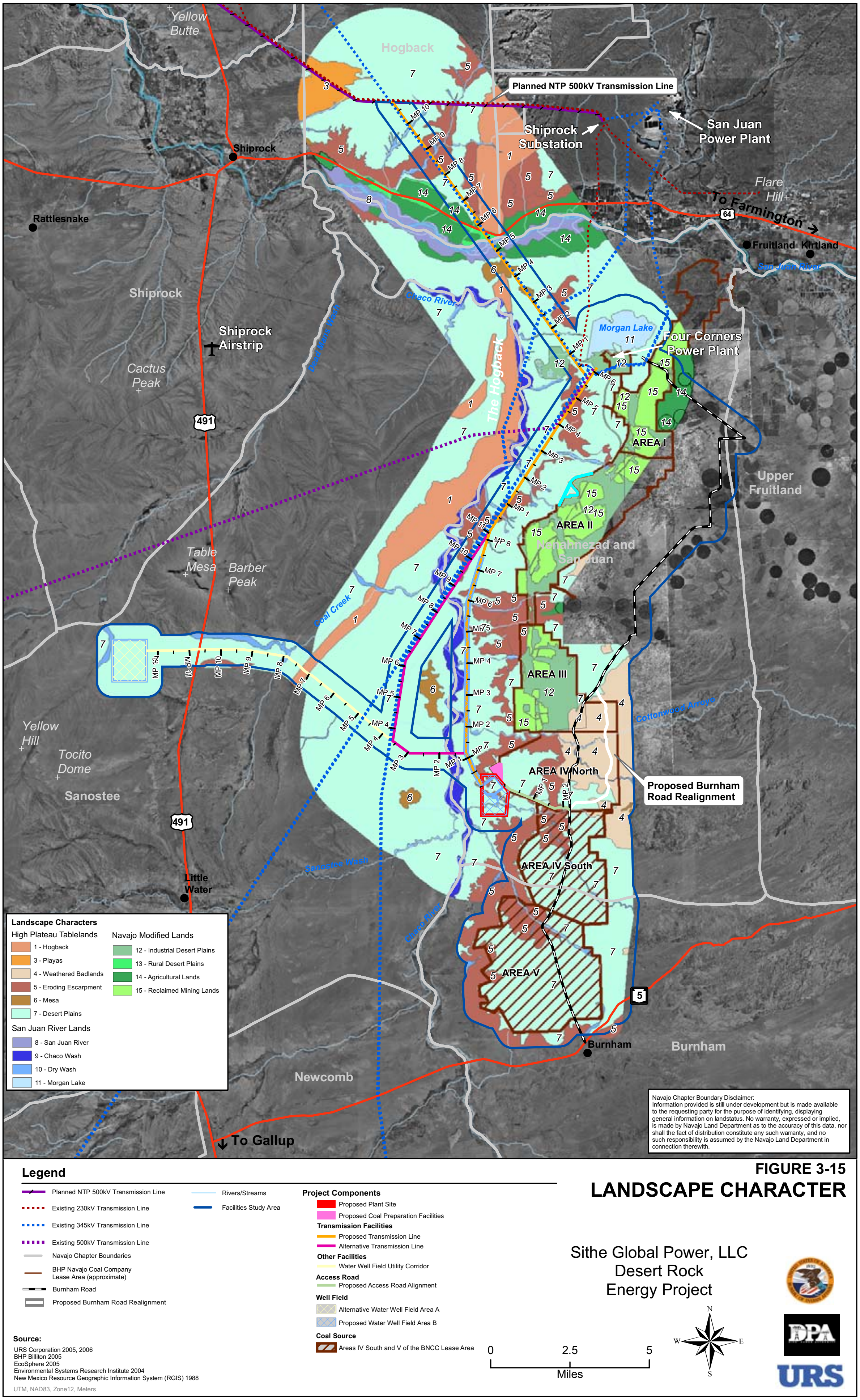

FIGURE 3-15
LANDSCAPE CHARACTER

- Dry Wash Landscape Character Subtype: Multitudes of dry washes, or tributaries to the San Juan River, dissect the landscape throughout the study area. Typically, dry washes flow with water only seasonally in a desert landscape, and over time the washes erode to varying widths and depths. Dry washes are visually evident but, in most cases, are not dominant in the landscape.

- **Navajo Modified Landscape Character Unit**. Navajo modified landscapes, or culturally modified lands, include industrial desert plains, reclaimed mining lands, rural desert plains, and agricultural lands.

Development is sporadic within the study area with the most prevalent modification occurring in the central region associated with both active and inactive coal mining, the Four Corners Generating Station, and numerous transmission lines and pipelines traversing the landscape. This industrial development is considered part of the industrial desert plains landscape character unit. The reclaimed mining landscape character unit encompasses lands that have been mined and are currently in stages of reclamation to convert the land to appear similar to surrounding conditions. Residential development is sparse throughout the region, and is most densely located adjacent to the San Juan River. Residences in the region are typically settlements with multiple dwelling units (e.g., hogans, trailers, modular homes, recreational vehicles), and agricultural outstructures (e.g., corrals, sheds, roofs) and associated structures. Agricultural land within the study area includes residences, agricultural outstructures, ranches, fields, and all other associated facilities. Agriculture is common within the study area but is concentrated heavily to the east of the Four Corners Generating Station and is visually evident because of color contrast during growing seasons, the circular pattern of the irrigated fields, and the density of vegetation.

3.7.2.3 Project Visibility and Viewer Sensitivity

Project visibility and viewer sensitivity are important aspects of the visual resource analysis. Viewer sensitivity is a measure of the degree of concern about change in the visual character of a landscape. Viewer sensitivity was determined to be high through assessment of types of viewers (e.g., residents that see the project from their settlements, recreational users in remote areas, or travelers from scenic roads), land uses oriented toward proposed project facilities (e.g., residents or natural recreation areas), volume (or numbers) of viewers, duration of time spent viewing the landscape, and influence of adjacent land use on the view (e.g., the presence of an existing industrial facility within the viewshed).

Viewing distances also were considered to assess project visibility. The distance zones, derived from BLM methodology described in Table 3-36 are based on visual perception thresholds of the basic design elements: form, line, texture, and color. For example, as distance increases, the details become less apparent and the elements of form and line become more dominant than color or texture. These distance zones or thresholds are defined based on relative visibility from travel routes or observation points within the study area. Distance zones are used in subsequent sections to assess impacts further.

Table 3-36 Visual Distance Zone Definitions

Distance Zone	Distance (in miles)	Description
Foreground-middleground	0-3 up to 5	This is the area that can be seen from each travel route for a distance of 0 to 3 up to 5 miles where management activities might be viewed in detail. The outer boundary of this distance zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape. In some areas, atmospheric conditions can reduce visibility and shorten the distances normally covered by each zone.
Background	5 to 15	This is the remaining area that can be seen from each travel route to approximately 15 miles. Vegetation is visible as patterns of light and dark.
Seldom-seen	15+	These are areas that are not visible within the foreground-middleground and background zones and areas beyond the background zones.

SOURCE: Bureau of Land Management 1976

A viewer sensitivity inventory was performed to document and map areas where there could be a concern for potential changes to the landscape. Potentially sensitive viewpoints were identified and inventoried within the study area and, in a few cases, outside of the study area where long distance views were of concern. Viewpoints were identified through a ground reconnaissance review of aerial photography, and a literature review. The inventory of sensitive viewpoints included:

- Residences – primary, seasonal, or ceremonial settlements (e.g., hogans, mobile homes, trailers, corrals, and associated agricultural facilities);
- Sensitive cultural sites – unobstructed views of landscapes associated with traditional cultural values or religious significance;
- Travel routes – designated scenic roads, or unpaved rural routes; and
- Recreation or preservation areas – dispersed, undeveloped recreational areas or open space, ACEC (e.g., Hogback) and areas of local importance.

Scenic integrity indicates the degree of intactness and wholeness of the landscape character (Forest Service 1995). Human alterations can sometimes raise, maintain, or lower scenic integrity. For the purpose of analysis, scenic integrity was determined using baseline inventory information provided by landscape character and visibility analysis of the affected environment. The existing condition of the landscape and domination of cultural modifications was used to assess the level of deviation from the natural environment. The scenic integrity analysis is used in subsequent sections to assess impacts further. The results of the visual resource inventory are detailed below.

3.7.3 Project Siting Areas

3.7.3.1 Power Plant Site Siting Area

The power plant site is located in the south-central portion of the study area, in a landscape characterized by flat to rolling desert plains topography with sparse desert scrub vegetation. An eroded escarpment bisects the proposed power plant site creating a steep sandstone bluff. Viewing conditions and potential views of the power plant would be evident from several distance zones given the elements of the proposed project (e.g., height of cooling towers, potential water vapor plume) and the nature of the relatively flat landscape. The proposed power plant is located adjacent to mining area Area IV North, constituting a largely unmodified landscape with a high degree of naturalness. The southern boundary of the plant site ends at the Pinabete Wash. A typical view can be seen in Figure 3-16, Photo A.

3.7.3.2 Transmission Lines Siting Areas

3.7.3.2.1 Proposed Transmission Line Segments A, C, and D

Transmission line segment D (the northernmost segment) traverses an area characterized by desert plains and eroding escarpments along an existing 345kV transmission line corridor. Segment D also crosses a portion of the Hogback at the San Juan River. Slightly north of the 345kV corridor at the San Juan River crossing is the highest concentration of viewers, as residences are most densely located along the San Juan River corridor. The northern portion of Segment D exhibits little residential development and consists primarily of unobstructed views of desert plains landscape and eroded escarpment as seen in Figure 3-16, Photo B. Most notably, the area north of Segment D is characterized by pockets of sandstone buttes, cuestas, barchan dunes, spires, mesas, and a portion of the Hogback. The southern portion bisects an industrial landscape (e.g., Four Corners Generating Station and associated facilities) and Morgan Lake. A high degree of cultural modification lends to the decreased degree of naturalness or scenic integrity along the central and southern portion of Segment D.

Transmission line segment C is proposed to parallel existing 345kV transmission lines through landscape characterized by desert plains and eroding escarpment featuring the Chaco River, and the Hogback to the west of the utility corridor and reclaimed mine lands to the east, see Figure 3-16, Photo C. Viewing conditions along Segment C are largely from industrial facilities (e.g., Four Corners Generating Station, mining operations), as few residents live in this area.

Transmission line segment A diverges from the existing 345kV corridor, near Chaco River, and runs south through landscape characterized by badlands, desert plains, and eroding escarpment to connect with the proposed Desert Rock Power Plant. A typical view toward the east can be seen in Figure 3-16, Photo D. Few residential viewers are present along this Segment A. Segment A traverses a natural landscape that is common to the area and has not been modified.

3.7.3.2.2 Alternative Transmission Line Segment B

Transmission line segment B traverses landscape characterized by desert plains and eroding escarpment along an existing 345kV transmission line corridor and an underground pipeline. Segment B also crosses the Chaco River in two locations and several dry washes. Viewing conditions to the west of Segment B are open and expansive and are of several dominant landforms such as the Hogback, Table Mesa, and Shiprock in the background. An example view can be seen in Figure 3-16, Photo E. The landscape is currently modified within the utility corridor.

3.7.3.3 Water Well Field Siting Area

Water well field alternative A is located west of the proposed power plant site in a flat desert plains landscape with little or no topographic relief, vegetation, or color variation. Viewing conditions from the water well field are unobstructed due to the flat nature of the desert plains setting, and distant landforms are evident in the landscape. Few residences are located near water well field alternative A, and cultural modification is negligible within the proposed water well field boundaries. See Figure 3-16, Photo F.

Discussion related to proposed water well field B can be found in previous sections related to the power plant site and Transmission Line Segment A.

3.7.3.4 Utility Corridor/Water Pipeline Siting Area

The proposed utility corridor/water pipeline connects the water well field alternative A to the proposed power plant through predominantly flat, open desert plains landscape along an existing unpaved road. A small portion of the Hogback, near Coal Creek, as well as a large dry wash, is crossed by the alignment. Viewing conditions along the utility corridor are predominantly unobstructed views of the natural desert plains landscape, see Figure 3-16, Photo E. Depending on the orientation of the viewer, dominant landforms are visible in the distance. Very few residences are located adjacent to the utility corridor and cultural modification is negligible along the alignment.

3.7.3.5 Access Road Siting Area

The proposed access road traverses weathered badlands, an area of striated sedimentary rock outcrops with unique and distinguishable color tones, and desert plains landscape. Access road alignment A crosses an arroyo and dry washes just east of the mine lease area boundaries. Viewing conditions along Alignment A include industrial and agricultural facilities, but for the most part are unmodified weathered badlands and desert plains landscapes, as seen in Figure 3-16, Photo H. Residential viewers are concentrated at the northernmost portion of the alignment along Burnham Road. Access road alignment A is located within a natural and predominantly unmodified setting adjacent to industrial (e.g., active and inactive mining) and agricultural (e.g., circle-irrigated crops, grazing areas, and farming outstructures) facilities.

3.7.3.6 BNCC Lease Area IV and V

The BNCC Lease Areas IV and V are located in a landscape characterized by desert plains and eroding escarpment with stringers of dry washes bisecting the landscape to the southeast. Landscape within the mine lease boundaries that are not being mined currently varies in topographic relief and vegetation density. Pockets of eroding escarpment and sandstone outcropping are discernible mostly to the east and north of the mine-lease boundaries. Primarily the landscape is typically flat desert plains with variation in color and texture, see Figure 3-16, Photo I. Few residences are located within the mine lease boundary and immediately adjacent. Viewing conditions are currently natural with the exception of Burnham Road and N5. As such, few cultural modifications exist and currently no industrial modifications are present within Areas IV South and V. The area has been classified as Class IV under BLM Visual Resource Inventory Handbook 8410-1. The BLM manual describes the class as:

> Class IV: Contrasts may attract attention and be a dominant feature of the landscape in terms of scale; however, the change should repeat the basic element inherent in the characteristic landscape.

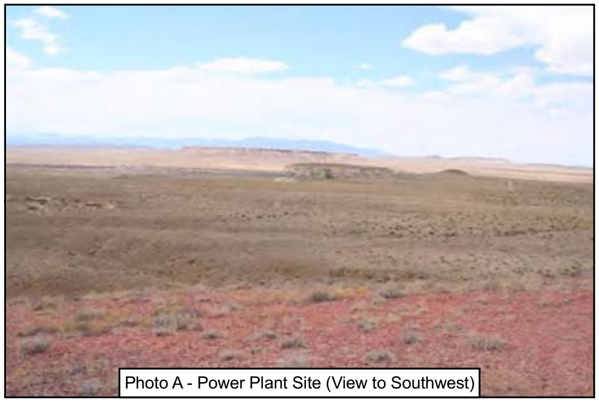

Photo A - Power Plant Site (View to Southwest)

Photo B - Proposed Tranmission Line Segment D (View to Southeast)

Photo C - Proposed Tranmission Line Segment C (View to West)

Photo D - Proposed Tranmission Line Segment A (View to East)

Photo E - Alternative Tranmission Line Segment B (View to Northwest)

Photo F - Water Well Field Alternative A (View to South)

Photo G - Utility Corridor/Water Pipeline (View to Northeast)

Photo H - Proposed Access Road Alignment A (View to Southwest)

Photo I - BNCC Area IV South (View to Northwest)

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Figure 3-16
Typical View Photographs

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3.7.4 Visual Resources Summary

Taken as a whole, the project study area exhibits a mix of rural to undeveloped natural landscapes. In general, the landscapes are vast and expansive, permitting extensive views of undisturbed land. Often, these same views contain evidence of existing disturbance. Areas with existing disturbance include agricultural and rural housing mainly along the San Juan River corridor, dispersed residential scattered throughout the study area, grazing or livestock facilities, transmission corridors, pipeline corridors, an active coal mine, and a regional power plant.

3.8 SOCIOECONOMIC CONDITIONS/ENVIRONMENTAL JUSTICE/ TRIBAL ASSETS

3.8.1 Introduction

The analysis of social and economic conditions addresses the relationships between the proposed project and the community it may affect. The following characterization of current social and economic conditions describes demographics, employment, income, fiscal and budgetary information, and community facilities in the region that potentially could be affected by the proposed project.

3.8.2 Data Collection Approach

Socioeconomic data from various tribal, Federal, state, and local sources are used in this analysis. Census data for 1990 and 2000 are the most uniform detailed data series at the regional and local levels. NEPA guidelines direct the use of some additional data series. Other data serve to update the existing–conditions descriptions post–Census 2000. Some of the more recent data series are available only for the larger geographic units.

Some data sources used in this analysis are special data that provide pertinent information in a cultural context for the Navajo Indian Reservation and for American Indians, in general. Section 3.8.4 includes information on the "informal economy," an important part of the American Indian economy. The same section also includes information that illuminates the complex interweaving of culture and natural resources, or "the unbreakable relation between Native American people and their homeland" (Harris and Harper 1999), as it applies to the Navajo Nation. The economic and cultural aspects of both grazing and the craft of weaving cannot be disentangled, so both simple statistics and other cultural information connected to grazing appear in this analysis. The details that illustrate the interweaving of culture and resources also pertain to uses of plants and animals, including subsistence or practical uses, as well as ceremonial uses.

3.8.2.1 Areas of Influence

The local area of influence is the area within which there is much daily interaction between the project sites and the residents of the area. It is defined based on communities' locations within commuting distance of the project site (taking the road network into account); the locations of the air quality study areas, coal, and water resources connected to the project; and social, economic, and health care characteristics as reported by the chapters.

The region of influence includes additional areas that typically do not have as much daily interaction with the project sites, but that still have one or more special connections to the project. The region of influence includes the entire Navajo Nation because of DPA's objective for the project to provide maximum economic benefits to the entire Navajo Nation (in addition to benefits to the local communities). Both the area from which the bulk of scoping comments were received and the content of those comments was considered in the definition of the region of influence.

A factual basis is important for excluding areas from analysis, as well as for including areas—ruling out, as well as ruling in. In determining the local area of influence, communities were excluded where it was found that their residents would have opportunities closer to home for employment (in places such as Window Rock and Gallup).

3.8.2.2 Local Area of Influence

The local area of influence (Figure 3-17) comprises 15 Navajo Nation chapters and the area of Farmington, New Mexico (including the City of Farmington and environs). The 15 chapters had a population of over 29,000 persons according to the 2000 Census. Detailed review of the distribution of the population within those chapters indicates that most of the persons lived 10 or more miles from the power plant site in communities such as Shiprock, Upper Fruitland, Ojo Amarillo, Nenahnezad, and Sanostee. Seventy-six or fewer persons lived within 7 miles of the site.

Most of the information on the local area within the Navajo Nation is reported at the chapter level in this document. For cross-reference purposes, Table 3-37 indicates those chapters that had population centers within them that were categorized as Census Designated Places for Census 2000.

Table 3-37 Chapters and Census Designated Places in the Local Area of Influence, Desert Rock Project, Census 2000

Chapter	Community within the Chapter
Beclabito	Beclabito
Burnham	N/A
Crystal	Crystal
Fruitland	Ojo Amarillo, Upper Fruitland
Hogback	N/A
Huerfano	Huerfano, Napi HQ
Naschitti	Naschitti
Nenahnezad	Nenahnezad
Red Valley	N/A
Sanostee	Sanostee
Sheep Springs	Sheep Springs
Shiprock	Shiprock
Teec Nos Pos	Teec Nos Pos
Two Grey Hills	Newcomb
White Rock	N/A

The perimeter of the local area is, on the average, about 45 miles by road from the project site, a distance that could be traveled in 60 to 80 minutes. Certain other communities within 40 miles' linear distance of the site are not in the local area of influence because their road access to the site is much more distant (e.g., Lake Valley Chapter). According to Census 2000, on the Navajo Indian Reservation over 17 percent of workers have commuting times that exceed 60 minutes. The current long-commuting times support the inclusion of the areas as indicated in the local area. Local-commuting areas in most of the United States are more compact than they are in the area of the project. For example, in the three-state region of New Mexico, Colorado, and Arizona, only 6 percent of workers have commuting times that exceed 60 minutes.

Employment (by place of residence) for most chapters in the local area includes many jobs in utilities, mining, and construction—three industries that are connected to the project (Table 3-38). Burnham and White Rock, two very sparsely populated chapters, are exceptions. Other influences tie them to the local area, notably their coal resource base (refer to Table 3-38).

Table 3-38 Distribution of Employment in the Local Area of Influence, Year 2000 Employment by Industries of Importance to the Project

Chapter	Employed Civilian Population 16 Years and Over						
	Total	Number in Three Selected Industries			Percentage in Three Selected Industries:		
		Mining	Construction	Utilities	Mining	Construction	Utilities
Beclabito	225	8	20	0	3.6	8.9	0.0
Burnham	60	0	0	0	0.0	0.0	0.0
Crystal	161	0	15	21	0.0	9.3	13.0
Fruitland	714	80	82	44	11.2	11.5	6.2
Hogback	197	0	42	12	0.0	21.3	6.1
Huerfano	665	4	114	11	0.6	17.1	1.7
Naschitti	326	0	32	0	0.0	9.8	0.0
Nenahnezad	431	20	115	45	4.6	26.7	10.4
Red Valley[1]	354	5	57	40	1.4	16.1	11.3
Sanostee	388	0	38	30	0.0	9.8	7.7
Sheep Springs	128	0	26	5	0.0	20.3	3.9
Shiprock[1]	2670	142	282	214	5.3	10.6	8.0
Teec Nos Pos	246	0	29	23	0.0	11.8	9.3
Two Grey Hills[1]	395	18	43	22	4.6	10.9	5.6
White Rock	17	0	0	0	0.0	0.0	0.0
City							
Farmington	16,928	1,731	1,091	569	10.2	6.4	3.3

SOURCE: U.S. Census Bureau 2000
NOTE: [1]The Census compilation includes Cove as part of Red Valley, Gadiiahi as part of Shiprock, and Newcomb as part of Two Grey Hills.

Economic and health care characteristics were recently reported by individual chapter officials (Navajo Nation, Division of Community Development 2004) (Table 3-39). The Shiprock-Northern Navajo Medical Center (listed by most of the chapters as "Navajo Nation Medical Center") is the primary health care facility in the area. Medical facilities are also located in Farmington, including the San Juan Regional Medical Center, Rehoboth McKinley Christian Hospital, and Farmington Community Health Center. The Gallup Indian Medical Center serves the local population in the City of Gallup. Chapters also reported identified employers (generally by place of work within the chapter), commercial establishments, and local natural resources.

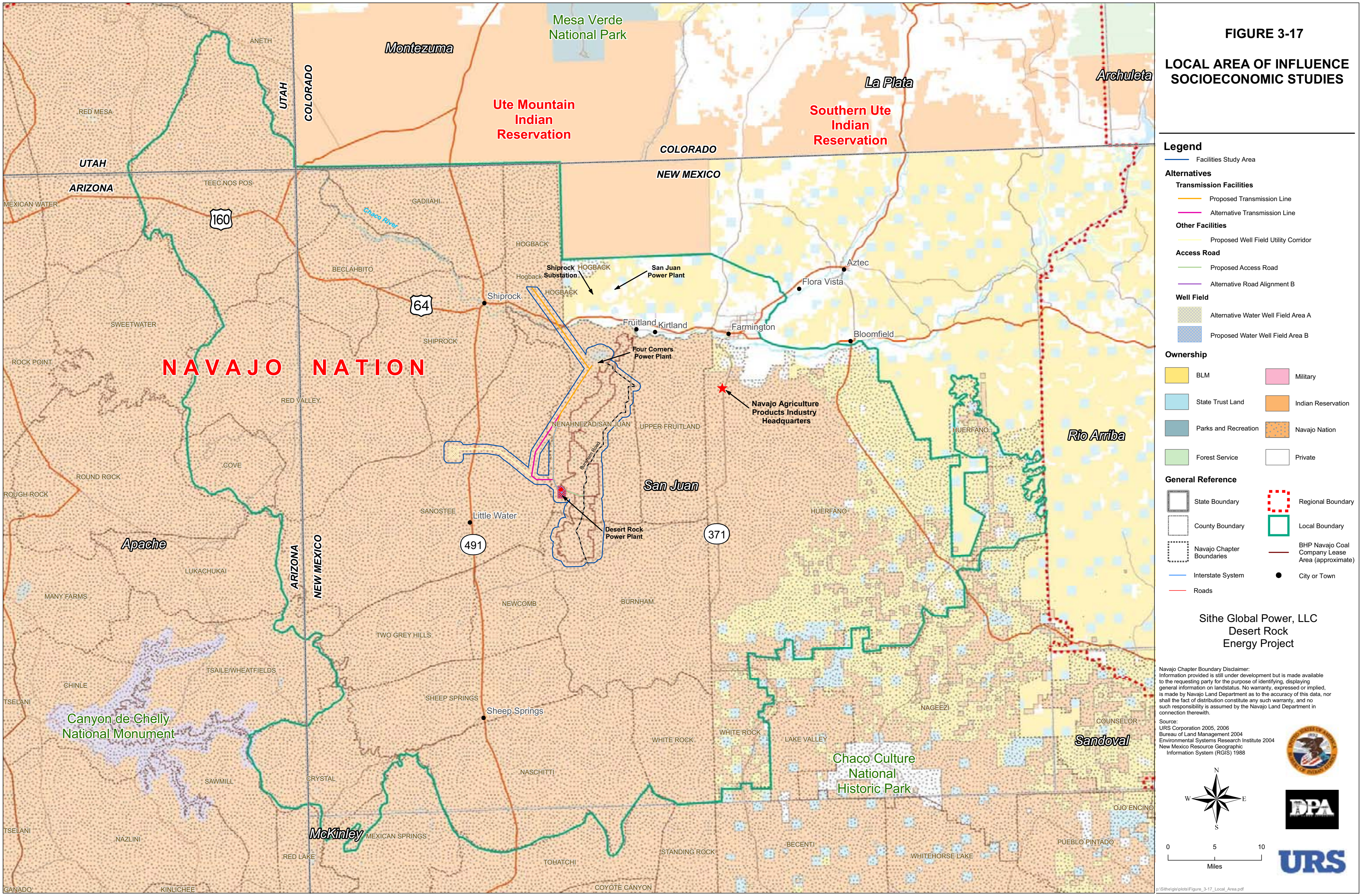


FIGURE 3-17
LOCAL AREA OF INFLUENCE SOCIOECONOMIC STUDIES
Legend
Facilities Study Area
Alternatives
Transmission Facilities
Proposed Transmission Line
Alternative Transmission Line
Other Facilities
Proposed Well Field Utility Corridor
Access Road
Proposed Access Road
Alternative Road Alignment B
Well Field
Alternative Water Well Field Area A
Proposed Water Well Field Area B
Ownership
BLM
Military
State Trust Land
Indian Reservation
Parks and Recreation
Navajo Nation
Forest Service
Private
General Reference
State Boundary
Regional Boundary
County Boundary
Local Boundary
Navajo Chapter Boundaries
BHP Navajo Coal Company Lease Area (approximate)
Interstate System
City or Town
Roads
Sithe Global Power, LLC
Desert Rock
Energy Project
Navajo Chapter Boundary Disclaimer:
Information provided is still under development but is made available to the requesting party for the purpose of identifying, displaying general information on landstatus. No warranty, expressed or implied, is made by Navajo Land Department as to the accuracy of this data, nor shall the fact of distribution constitute any such warranty, and no such responsibility is assumed by the Navajo Land Department in connection therewith.
Source:
URS Corporation 2005, 2006
Bureau of Land Management 2004
Environmental Systems Research Institute 2004
New Mexico Resource Geographic Information System (RGIS) 1988
N
W
E
S
0
5
10
Miles
NAVAJO NATION
Mesa Verde National Park
Montezuma
Ute Mountain Indian Reservation
La Plata
Southern Ute Indian Reservation
Archuleta
UTAH
COLORADO
ARIZONA
NEW MEXICO
Shiprock Substation
San Juan Power Plant
Four Corners Power Plant
Navajo Agriculture Products Industry Headquarters
Desert Rock Power Plant
Shiprock
Aztec
Flora Vista
Fruitland
Kirtland
Farmington
Bloomfield
Little Water
Sheep Springs
San Juan
Rio Arriba
Apache
McKinley
Sandoval
Canyon de Chelly National Monument
Chaco Culture National Historic Park
Chaco River
160
64
491
371
ANETH
RED MESA
TEEC NOS POS
MEXICAN WATER
GADIIAHI
BECLAHBITO
HOGBACK
SWEETWATER
SHIPROCK
ROCK POINT
RED VALLEY
NENAHNEZAD/SAN JUAN
UPPER FRUITLAND
HUERFANO
COVE
ROUND ROCK
ROUGH ROCK
SANOSTEE
LUKACHUKAI
MANY FARMS
NEWCOMB
BURNHAM
TWO GREY HILLS
TSAILE/WHEATFIELDS
CHINLE
TSELANI
SHEEP SPRINGS
NAGEEZI
COUNSELOR
WHITE ROCK
LAKE VALLEY
CRYSTAL
SAWMILL
NASCHITTI
OJO ENCINO
MEXICAN SPRINGS
NAZLINI
RED LAKE
STANDING ROCK
BECENTI
WHITEHORSE LAKE
PUEBLO PINTADO
TOHATCHI
GANADO
KINLICHEE
COYOTE CANYON

This analysis looks at the projects potential for jobs against the backdrop of the current economic characteristics. In some cases, chapter economies are already closely connected to the utility and mining industries.

Table 3-39 Economic and Health Care Characteristics as Reported by Chapters, Navajo Nation Local Area

Chapter	Identified Employers	Commercial	Local Natural Resources	Medical (Hospital)
Beclabito	Navajo Nation, schools	gas station, convenience store	sand, gravel, oil	Navajo Nation Medical Center, San Juan Medical Center
Burnham	Navajo Nation,	none	coal	Navajo Nation Medical Center, San Juan Medical Center, Gallup Medical Center
Crystal	Bureau of Indian Affairs (BIA), Navajo Nation	none	water, timber, farming	Ft. Defiance Hospital
Fruitland	Arizona Public Service (APS), BHP Navajo Coal Company (BNCC), and Pinnacle West Energy.	Johnson Septic Tank	coal, crude oil, sand, gravel, river rocks, water, farming	Navajo Nation Medical Center, San Juan Medical Center
Hogback	Navajo Nation, APS, government agencies, schools	trading post	sand, gravel, oil, water, farming, grazing	Navajo Nation Medical Center, San Juan Medical Center
Huerfano	Navajo Ag Products, schools, Navajo Nation, medical	gas stations, trading post, Convenience Store	oil, gas, coal, water	San Juan Medical Center, Shiprock Indian Hospital
Naschitti	Navajo Nation, schools, trading post	gas stations, trading post, laundromat	water, timber, sand, coal, uranium, oil, natural gas, game	Gallup Med Cntr, Navajo Nation Medical Center, Ft. Defiance Indian Hospital, Rehoboth McKinley Christian Hospital
Nenahnezad	schools, Arizona Public Service, BNCC Lease Area, Public Service New Mexico	Platereo septic tank service, Nenahnezad auto service	coal, water, oil, gas	Navajo Nation Medical Center, San Juan Medical Center
Red Valley	San Juan Medical Center, schools	gas station, trading post	crude oil, helium, timber, farming	Navajo Nation Medical Center, San Juan Medical Center
Sanostee	Navajo Nation, retail, schools	gas, retail,	oil, gas, coal, uranium, timber, water	Navajo Nation Medical Center, Gallup Medical Center
Sheep Springs	Navajo Nation, post office, store	gas stations, convenience store	none	Gallup Medical Center, Navajo Nation Medical Center
Shiprock	service, government agencies, retail, food service, medical, financial, construction, and coal and utilities	service and consumer establishments	water, sand, gravel, farming, oil, gas, helium, coal, wood	Navajo Nation Medical Center, San Juan Medical Center
Teec Nos Pos	Navajo Nation, Arizona Department of Transportation, retail, Apache County, Arizona Department of Economic Security	service and retail	uranium, oil	Navajo Nation Medical Center, San Juan Medical Center
Two Grey Hills	schools, Newcomb Transportation Department	gas stations, convenience store, trading post	timber, sand, gravel, coal, water	Navajo Nation Medical Center, Gallup Medical Center
White Rock	Navajo Nation, BIA	none	coal, sand, gravel, sandstone	n/a

SOURCE: Navajo Nation Division of Community Development 2004

3.8.2.3 Region of Influence

The region of influence comprises the entire Navajo Nation, the remainder of San Juan and McKinley Counties in New Mexico, and the counties of Montezuma and La Plata in Colorado. While the project generally would have lesser connections to Navajo Nation areas beyond the local area of influence, there still would be social, employment, health care, and natural resource connections. Similar connections would occur to the areas outside the Navajo Nation (Figure 3-18).

The area from which the bulk of scoping comments were received, and the content of those comments, also were considered in the definition of the region of influence. More scoping comments came from the areas of Cortez and Durango in Colorado, north of the proposed project site, than from areas at a similar distance south of the proposed project site, such as Gallup, New Mexico. Still, Gallup is in the regional area, given its location surrounded by the Navajo Indian Reservation.

3.8.3 Existing Conditions

The proposed Desert Rock Power Plant site is in Nenahnezad Chapter, close to the center of the local area of influence. All of the components, including alternative alignments, are within 30 miles of the proposed power plant site. The local area of influence boundary is the same for the entire project; it does not differ according to the various components. The existing conditions are discussed below for the entire local area.

3.8.3.1 Population

In 2000, there were over 193,000 persons living on the Navajo, Ute Mountain, and Southern Ute reservations in the region of influence. There were over 183,000 persons living in the remainder of the four counties in the region of influence (Table 3-40), and over 40,000 of those persons were American Indian.

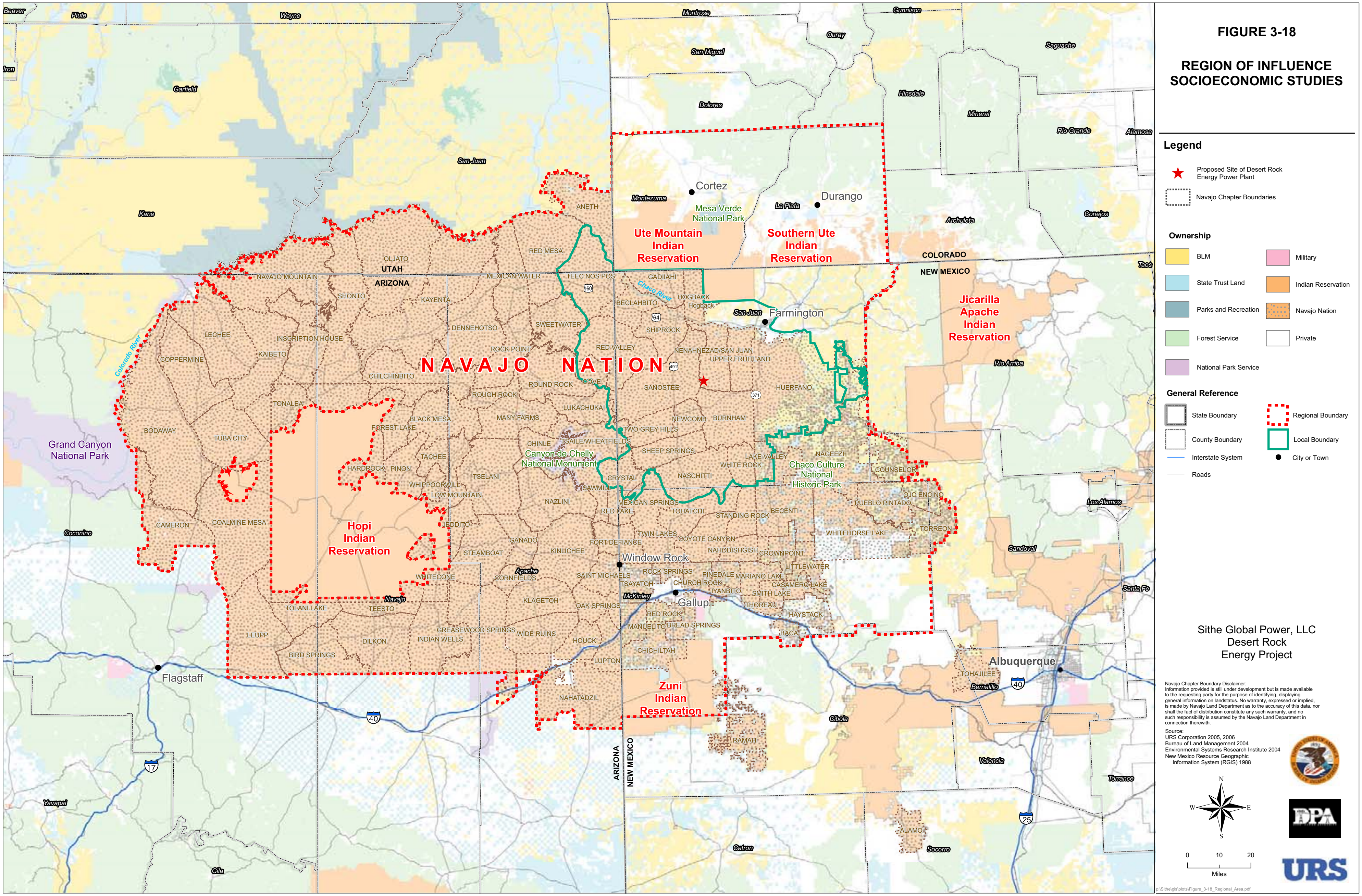


FIGURE 3-18
REGION OF INFLUENCE SOCIOECONOMIC STUDIES
Legend
Proposed Site of Desert Rock Energy Power Plant
Navajo Chapter Boundaries
Ownership
BLM
Military
State Trust Land
Indian Reservation
Parks and Recreation
Navajo Nation
Forest Service
Private
National Park Service
General Reference
State Boundary
Regional Boundary
County Boundary
Local Boundary
Interstate System
City or Town
Roads
Sithe Global Power, LLC
Desert Rock
Energy Project
NAVAJO NATION
Hopi Indian Reservation
Zuni Indian Reservation
Ute Mountain Indian Reservation
Southern Ute Indian Reservation
Jicarilla Apache Indian Reservation
Grand Canyon National Park
Mesa Verde National Park
Canyon de Chelly National Monument
Chaco Culture National Historic Park
UTAH
ARIZONA
COLORADO
NEW MEXICO
Cortez
Durango
Farmington
Window Rock
Gallup
Flagstaff
Albuquerque
Colorado River
Chaco River
Miles
0
10
20
URS

Table 3-40 Population and Households in the Region of Influence

	Population (1990)	Population (2000)	Population (est. 2004)	Percent Annual Growth, 1990-00	Percent Annual Growth, 2000-2004	Households (2000)
United States	248,709,873	281,421,906	293,655,404	1.3	1.1	105,480,101
Tribes						
Navajo Indian Reservation	148,451	180,462	187,152	2.2	0.9	47,603
Ute Mountain	1,320	1,712	N/A	3.0	N/A	4,159
Southern Ute	7,804	11,159	N/A	4.3	N/A	507
States						
Arizona	3,665,228	5,130,632	5,743,834	4.0	3.4	1,901,327
Colorado	3,294,394	4,301,261	4,601,403	3.1	1.7	1,658,238
New Mexico	1,515,069	1,819,046	1,903,289	2.0	1.2	751,165
Counties						
La Plata County, Colorado	32,458	43,941	46,155	3.5	1.7	17,342
Montezuma County, Colorado	18,708	23,830	24,491	2.7	0.9	9,201
McKinley County, New Mexico	60,686	74,798	72,555	2.3	-1.0	21,476
San Juan County, New Mexico	91,605	113,801	122,272	2.4	2.5	37,711

SOURCES: Colorado State Demography office 2005; Navajo Nation, Division of Economic Development 2005; New Mexico Department of Labor 2005; U.S. Census Bureau 1990, 2000

NOTE: Colorado and New Mexico county estimates and annual growth estimates are for 2003.

Since 1990, the population of the region of influence has grown more rapidly than the population of the United States as a whole (refer to Table 3-40). The three states of which the region is a part have grown much more rapidly than the nation. The Navajo Nation's 10-year growth rate from 1990 to 2000 was 21.6 percent; its growth rate was more rapid during the 1990s than its growth rate since 2000. San Juan County, particularly the portion not within the Navajo Indian Reservation, has been the fastest growing county in the region since 2000.

The key population and household characteristics for the local area of influence appear in Table 3-41. There is a younger median age for most of the chapters in the local area than for Farmington (33.6) or the state of New Mexico (34.6). The median household income for most of the chapters in the local area is lower [see Table 3-41] than the median household income of both San Juan County ($25,005) and the state of New Mexico ($47,203).

Table 3-41 Key Population Characteristics, Local Area of Influence (2000 Census)

	Total Population	Median Age	Percent of Population Under 18 Years	Percent of Population 65 Years and Older	Persons per Household	Median Household Income ($)
Chapter						
Beclabito	819	30.2	35.4%	10.0%	3.37	19,205
Burnham	240	35.3	30.4%	15.4%	3.08	11,875
Crystal	778	29.9	35.5%	10.5%	3.35	13,462
Fruitland	2,892	22.4	42.4%	4.2%	4.13	25,638
Hogback	1,386	26.4	37.8%	7.0%	3.89	16,500
Huerfano	2,366	23.8	41.4%	6.8%	3.91	18,224
Naschitti	1,695	28.4	37.6%	10.4%	3.53	18,750
Nenahnezad	1,695	24.5	39.0%	6.5%	3.78	21,336
Red Valley[3]	1,742	27.9	36.3%	10.2%	3.36	15,199
Sanostee	1,908	28.4	36.0%	10.5%	3.41	13,547
Sheep Springs	821	26.5	39.8%	10.2%	3.63	7,388
Shiprock[3]	9,279	25	38.6%	5.2%	3.73	24,798
Teec Nos Pos	1,323	26.7	38.8%	8.8%	3.38	12,639
Two Grey Hills[3]	1,838	30.8	35.5%	11.0%	3.29	14,148
White Rock	60	45.5	16.7%	18.3%	2.5	3,393
Farmington Area (San Juan County, New Mexico)[4]						
Farmington city	37,844	33.6	29.3%	10.7%	2.67	37,663
Census Tract 4.02	2,984	32.2	27.1%	12.4%	2.35	25,020
Census Tract 5.02	7,803	28.3	35.3%	6.4%	3.35	44,663

3.8.4 Environmental Justice

A key indicator of the potential for environmental justice concerns is whether an area's proportion of minority and/or low-income population exceeds the proportion of such populations in an area of reference. Typically, an area of reference is the next larger governmental jurisdiction than the area itself. For example, for a subject county, the entire state is typically the area of reference.

Except for some portions of the Farmington area of New Mexico, every local and regional area of influence cited below has a proportion of minority population and low-income population that exceeds the respective reference area population in New Mexico, Arizona, or Colorado. American Indians are the largest part of the minority population in the region.

Environmental justice guidelines also call for examination of minority and low-income populations who may be clustered within, or isolated within, a larger community. This analysis also addresses clustered and isolated populations.

The proportion of the San Juan County population that is American Indian (36.3 percent) and the proportion of the county's families whose incomes are below the poverty level (18 percent) were compared with the corresponding statistics for the individual chapters. Compared to the county, all 15 chapters had a larger proportion of American Indian population and a larger proportion of families in poverty (Table 3-42).

The Farmington area was analyzed at the census tract level to determine which portions of it have clusters of minority and/or poverty populations. Census Tracts 4.02 and 5.02, the closest off-reservation areas to the Navajo chapters, have clusters of American Indian population.

The four entire counties that are included in the regional area each have higher proportions of American Indian population and higher proportions of families in poverty than do their respective states (their areas of reference; Table 3-42).

Table 3-42 Distribution of Minority and Poverty Population in the Local Area of Influence, Desert Rock Energy Project, Year 2000

	Total Population	Percent American Indian[1]	Percent Other Minority Race[1]	Percent Hispanic[2]	Families: Total	Percent of Families, Income Below Poverty level
Chapter						
Beclabito	819	97.9	0.6	1.0	220	35.0
Burnham	240	99.2	0.4	0.4	47	19.1
Crystal	778	97.3	0.3	1.3	180	49.4
Fruitland	2,892	96.4	1.1	1.6	627	33.7
Hogback	1,386	98.6	0.5	0.4	251	40.6
Huerfano	2,366	95.3	0.6	3.1	504	48.4
Naschitti	1,695	98.6	0.2	0.3	431	29.5
Nenahnezad	1,695	96.6	1.2	1.5	376	41.0
Red Valley[3]	1,742	98.3	0.3	1.0	382	44.2
Sanostee	1,908	99.1	0.3	0.4	425	43.5
Sheep Springs	821	96.1	1.6	1.6	190	70.0
Shiprock[3]	9,279	96.0	0.9	1.2	2,132	36.3
Teec Nos Pos	1,323	96.1	1.5	1.4	296	44.6
Two Grey Hills[3]	1,838	94.2	0.9	1.2	423	57.9
White Rock	60	96.7	3.3	0.0	25	100.0
Farmington Area (San Juan County, New Mexico)[4]						
Farmington city	37,844	16.4	3.1	17.7	10,293	12.9
Census Tract 4.02	2,984	32.1	3.8	19.5	688	25.1
Census Tract 5.02	7,803	45.1	2.5	9.5	1,983	12.3

SOURCE: U.S. Census 2000

NOTE: [1]Race is other than white and population is not Hispanic.
[2]Hispanic persons may be of any race.
[3]The Census compilation includes Cove as part of Red Valley, Gadiiahi as part of Shiprock, and Newcomb as part of Two Grey Hills.
[4]Census Tract 4.02 is within Farmington, while Census Tract 5.02 is west of Farmington.

Table 3-43 Distribution of Minority and Poverty Population in the Region of Influence, Desert Rock Project, Year 2000

	Total Population	Percent American Indian[2]	Percent Other Minority Race[2]	Percent Hispanic[3]	Families: Total	Percent of Families, Income Below Poverty level
Navajo Nation[1]	180,462	95.7	0.8	1.3	38,162	40.1
State (area of reference)						
Arizona	5,130,632	4.5	6.4	25.3	1,296,593	9.9
Colorado	4,301,261	0.7	7.8	17.1	1,092,352	6.2
New Mexico	1,819,046	8.9	4.3	42.1	468,899	14.5
County						
La Plata County, Colorado	43,941	5.0	2.3	10.4	10,945	6.7
Montezuma County, Colorado	23,830	10.8	2.2	9.5	6,546	13.1
McKinley County, New Mexico	74,798	73.2	2.5	12.4	16,615	31.9
San Juan County, New Mexico	113,801	36.3	2.2	15.0	29,188	18.0

SOURCE: U.S. Census 2000

NOTE: [1]Navajo Nation Reservation and Off-Reservation Trust Land, Arizona, New Mexico, and Utah.
[2]Race is other than white and population is not Hispanic.
[3]Hispanic persons may be of any race.

According to the latest version of the Federal poverty population estimates that the Council on Environmental Quality recommends for post-Census updates for environmental justice analysis, New Mexico's proportion of persons with incomes below the poverty level declined slightly (from 18.4 percent in 2000 to 17.5 percent in 2003) in the three years following Census 2000. However, the change was not statistically significant (U.S. Census Bureau 2004). (e.g., analysts are advised to use the Bureau of Census Series P60, according to the Council on Environmental Quality 1997)

Yearly poverty population estimates are prepared for school districts. Those statistics appear in the education and training subsection.

3.8.4.1 Economy

The major employers in the local area are school districts and colleges, local governments, and 17 private companies who employ more than 100 employees each. The top 10 private employers as of 2004 appear in Table 3-44. BNCC's coal mines are the second largest employer in the area, and the Four Corners and San Juan Generating Stations are fourth and fifth-ranked. New Mexico Coal employs 946 people of whom 65 percent are American Indian. The BNCC Lease Area, a surface mine, employs approximately 400 persons and currently supplies coal to the Four Corners Generating Station, while its San Juan Mine, an underground mine, employs approximately 550 persons and supplies coal to the San Juan Generating Station. The Four Corners Generating Station is situated on Navajo tribal land and 73 percent of its employees are members of the Navajo Nation.

There are as many as six other private establishments in San Juan County that employ 100 or more workers each. There are 46 businesses in Shiprock (Navajo Nation Division of Economic Development 2006), the largest local community on the Navajo reservation, including retail as well as business, health, and personal services businesses. Four of the most rural chapters in the area report no private employers within the chapter. Table 3-44 indicated the commercial establishments reported in the Navajo chapter portions of the local area.

Table 3-44 Large Private Employers in the Local Area of Influence, 2004

Employer	Category	Number of Employees (FTE)
San Juan Regional Medical Center	Health care	1,056
BNCC (New Mexico Coal)	Mining/Coal	946
Basin Home Health/Coordinated	Home health	640
Arizona Public Service	Four Corners Generating Station	579
Public Service Company of New Mexico	San Juan Power Plant	567
Independent Mobility Systems	Mfg: Accessible Minivans	300
Presbyterian Medical Services	Health services	300
Burlington Resources	Oil and gas	273
Navajo Agricultural Products Industries	Agriculture	245
Williams Energy	Oil and gas	230

SOURCE: San Juan County Economic Development Service 2004.
NOTE: FTE – full time equivalent

NAPI has agricultural lands and an industrial park. NAPI is an enterprise of the Navajo Nation location within the Fruitland, San Juan, Nenahnezad, and Huerfano Chapters, and currently has 68,000 acres under cultivation—many with the trademarked Navajo Pride™ brand agricultural products (NAPI 2005). NAPI offers leasing opportunities for other agricultural producers. Currently, NAPI has land lease contracts with Navajo Mesa Farms, Pumpkin Patch Fundraisers, and LGM, Inc.

The NAPI industrial park, which is the home of the Raytheon Missile Systems Company and the LGM Bean Plant, is in Huerfano Chapter. The Raytheon Missile Systems Company NAPI Facility currently employs an average of 100 individuals, 93 percent Navajo. The Raytheon Missile Systems Company NAPI Facility manufactures and integrates electromechanical systems, interconnect assembles, and complete launcher systems for all branches of the U.S. Military Services (Choudhary 2003).

While labor force statistics serve a number of purposes in this analysis, many persons in the region are left uncounted by a number of the statistical series. Many of those persons are considered to be “discouraged workers” according to Federal government definitions (U.S. Department of Labor 2005).

Many Navajo workers are entrepreneurial artists and craftsmen. This analysis includes some information regarding the region’s markets in which those persons participate. Some of the artists and craftsmen are employed by others, some are self-employed, and some are in the “discouraged worker” category.

Somewhat related to the question of persons missing from the labor force is the question of accounting for the income from arts and crafts products. While some arts and crafts transactions take place in the regulated formal economy, an “informal” economy also exists. It focuses on non-business-related social, traditional, and avocational activity and reflects the production of traditional goods. Bartering is one form of trade in traditional goods (although not as common as it was in the past) about which there is a lack of recent data.

For the artists and craftsmen who are self-employed, there are several local organizations that assist in furthering the continuation of the traditional arts through marketing, artistic collaboration, and reduction of the costs of production. The Nenahnezad Chapter government has partnered with local rug weavers to market their rugs.

At Diné College in Shiprock, the Navajo Textile Project capitalizes on the capacity of textile artists and the reservation's sheep and wool industry. It addresses how to help the weavers earn a more sustainable income through this traditional industry (Diné College 2005).

The rug auction location with the largest volume on the Navajo Nation is in Crownpoint, just southeast of the local area. Run by the Crownpoint Rug Weavers Association, the auction occurs frequently. In its promotional materials the association indirectly states that the artists are self-employed: "The money you save buying *directly from the artists* will help pay for your vacation" (Crownpoint Rug Weavers Association 2005).

The Navajo Nation produced a Comprehensive Economic Development Strategy in 2003. The Diné Power Authority's prospective power and transmission projects are featured in the strategy. The development of basic industries also is stressed. Basic industries bring dollars from outside the region into the region.

A 2004 project priority listing by the Navajo Nation Division of Economic Development (Table 3-45) listed 16 potential projects in the local area of influence, accounting for almost 756 permanent jobs and $34 million in proposed project costs, or almost 13 percent of the proposed project costs for the entire Navajo Nation. The proposals are the most numerous in the Shiprock area.

Several of the projects support tourism and manufacturing, two basic industrial sectors; some of the retail sites will include outlets for arts and crafts entrepreneurs. Other projects are local commercial establishments.

Unemployment statistics at the county level for the region of influence reveal unemployment levels similar to the nation or the respective states. San Juan and McKinley Counties have somewhat higher unemployment than the other areas. All of the areas had an increase in unemployment over the 3-year period 2001-2003 (Table 3-46), but the 2005 rate was lower than the rate in 2003.

Unemployment rates on the Navajo Indian Reservation, however, are typically much higher than those in surrounding areas. While the calculation of an unemployment rate for the entire Navajo Indian Reservation or the New Mexico portion is not a part of an ongoing Federal or state program, the state of Arizona has a Special Unemployment Report program that calculates the rates for the Arizona portion of the reservation and for other small local areas. The 2005 annual unemployment rate for the Arizona portion of the Navajo Indian Reservation was 16.2 percent, while the rate for Teec Nos Pos (in the Desert Rock local area) was 13.1 percent.

The unemployment rate according to the year 2000 Census was computed for each of the communities in the local area, given the dearth of more recent unemployment information available at the local level. The civilian labor force in 2000 comprised 31,825 persons, of whom 28 percent were residents of the Navajo Nation chapters. The unemployment rate of the civilian labor force was 20.4 percent for the fifteen Navajo Nation chapters together, while it was 7.2 percent for the city of Farmington and the two other census tracts in the local area.

Table 3-45 Navajo Nation Economic Development Projects in the Local Area of Influence 2004

Project Description	Location	Projected Cost	Permanent Jobs to be Created
Four Corners Monument	Four Corners	4,900,000	60
Hotel, casino, etc.	Huerfano	10,000,000	300
Sheep Springs Welcome Center	Sheepsprings	1,014,500	6
Convenience store and gas station	Sheepsprings	1,500,000	15
ACE Hardware/Subway/Pizza Hut	Shiprock	950,000	70
Shiprock Recreational Vehicle Park	Shiprock	1,000,000	9
Sun Valley Deli-Mart	Shiprock	2,050,000	20
Motel and Restaurant Best Western Inn	Shiprock	2,900,000	15
Open air vending market	Shiprock	150,000	2
Naastíliid Printing, Trophies and Awards	Shiprock	150,000	1
Mini Mall Shiprock, New Mexico	Shiprock	300,000	10
New Fairgrounds	Shiprock	5,000,000	2
Commercial development	Shiprock	300,000	1
Conoco C-Store and Gas Station	Shiprock	500,000	0
Denny's Restaurant	Shiprock	700,000	20
Raytheon Expansion	NAPI, NM	2,500,000	225
Total Area Projects		**$33,914,500**	**756**

SOURCE: Navajo Nation 2004

Table 3-46 Unemployment, Regional Area of Influence, 2001 to 2005

	2001	2002	2003	2004	2005
United States	4.7	5.8	6.0	5.5	5.1
States					
Arizona	4.7	6.0	6.2	5.0	4.7
Colorado	3.9	5.9	6.2	5.6	5.0
New Mexico	4.9	5.5	5.9	5.7	5.3
Counties					
La Plata County, Colorado	3.4	4.3	5.0	4.1	3.9
Montezuma County, Colorado	4.5	5.9	6.3	5.7	5.3
McKinley County, New Mexico	6.2	6.4	7.3	7.6	7.4
San Juan County, New Mexico	5.3	6.1	6.7	6.1	5.5

SOURCE: U.S. Department of Labor 2005

3.8.4.2 Fiscal Conditions

Large industrial establishments in the area are responsible for many types of government payments, including taxes, fees, royalties, and others collected by Federal, state, and tribal agencies. The establishments pay property, gross receipts, and corporate income taxes to the State of New Mexico. Property taxes are collected and distributed by county treasurers. Major revenue recipients include counties, municipalities, and school districts (New Mexico Factbook 2006). New Mexico's gross receipts tax is levied on the total amount of money or other consideration a business receives from four kinds of transactions in New Mexico, including one that would be pertinent to the construction phase of the Desert Rock Energy Project: performance of services in New Mexico. For gross receipt tax purposes, construction is a service that includes all the ingredient and component materials and subcontracted construction services.

On the Navajo Indian Reservation, industrial establishments are responsible for paying taxes that are administered by the Office of Navajo Tax Commission. The Possessory Interest Tax is a tax on the taxable value of a possessory interest granted by the Navajo Nation, which provides a right to be on Navajo land performing a particular activity. The most common types of uses are oil and gas leases, coal leases, rights-of-way, and business site leases. The Business Activity Tax is a tax on the net source gains (gross receipts minus deductions) from the sale of Navajo goods and services. The tax applies to goods that are produced, processed, or extracted within the Navajo Indian Reservation, and on all services performed within the reservation. In addition, the Fuel Excise Tax went into effect in 1999 and the Navajo Sales Tax, imposed on all goods or services purchased within the reservation, became effective on April 1, 2002.

3.8.4.3 Local Utility Service

The utility provider for the local area of influence is NTUA. NTUA's Shiprock District includes all of the 15 chapters in the local area of influence except Crystal, which is served by the Fort Defiance District. The Shiprock District reports the following numbers of customers, including households and businesses:

- Electricity 6,562
- Water 6,522
- Natural gas 1,511
- Wastewater 2,158

Combining the utility information above with Census 2000 data provides a rough estimate of water utility service in the local area. The Census reported that there were over 8,000 households (occupied housing units) in the 15 chapters. Meanwhile, 33 percent of the housing units lacked complete plumbing facilities and 30 percent lacked complete kitchen facilities.

Many Navajo families wish to reside in sparsely populated areas because of a variety of cultural factors. That preference makes for very high costs to connect homes to the electric utility grid. The organizations continue to find ways to provide modern conveniences to those who choose a lifestyle in accordance with cultural traditions (NTUA 2005). Service connections to new customers are provided via Federal grant money from the Navajo Electrification Demonstration Program to connect homes that are within 1 to 1.5 miles from existing power lines. That same program and chapter initiatives also provide service to more remote homes, in some cases to install solar power and in other cases to provide connections to the grid for more remote areas. As of June, 2006, power line extensions were reported to be in progress through contracts with NTUA in the following chapters in the Desert Rock local area: Burnham, Red Valley, and Sanostee. The same report indicated solar power projects to be underway in Sheep Springs and Two Grey Hills.

3.8.4.4 Education and Training

The public school districts that cover the bulk of the local area are Central Consolidated Schools and the Farmington Municipal Schools. Central Consolidated Schools, a pre-kindergarten through high school New Mexico district based in Shiprock, takes in 12 of the chapters. Almost 33 percent of its nearly 9,000 students ages 5 to 17 were from families living in poverty. The corresponding figures for the Farmington district were 19 percent out of almost 12,000 students. The figures were for 2002, and are used for the administration of Federal programs and the allocation of Federal funds to local jurisdictions.

At least 11 BIA schools are within the region, including high schools in Shiprock and Farmington. Some of the BIA schools are operated by the BIA while others are operated by the Navajo Nation through contracts with the BIA.

The major employers in the region support higher education in various ways. They contribute scholarships to local students, some unrestricted and others targeted to the jobs available at their facilities. They also work cooperatively with local higher educational institutions in training programs specifically connected to their workforce needs, in some cases including work-study and/or internship programs. One example is that BNCC funds a number of college scholarships for area American Indian students (BHP 2005).

The Four Corners Generating Station, which leases land from the Navajo Nation, has a scholarship program to prepare selected local Navajo students for careers related to the electric utility industry. The scholarships are available to Navajo students residing in the vicinity of the plant. Forty-one students have graduated from the program since 1995, with eight hired full time by APS (Pinnacle West 2005).

> According to the San Juan Generating Station's public information materials regarding the economic impact of the station, the San Juan Generating Station has donated $600,000 to the Industrial Process Operator Program at San Juan College and has donated more than $125,000 to nonprofit organizations. It has also supported programs that have generated scholarships through the San Juan College Foundation (Public Service New Mexico 2005).

Training for the Raytheon Missile Systems facility at NAPI is contracted with the Navajo Department of Workforce Development and San Juan Community College through their Business and Industry Training Center. According to the Navajo Nation, this process brings together business, technology, and academia to the classroom in the form of specific curriculum. Training includes quality awareness, electronic assembly, and mechanical assembly. More than 400 Native American students received training designed to meet Raytheon Missile Systems' requirements (Choudhary 2003).

Diné College has its main campus in Tsaile, Arizona, just outside the local area of influence. The college has several branches—two of which are in New Mexico at Crownpoint and Shiprock. The Shiprock campus is the home of Diné College's Mathematics, Natural Science, and Technology Department. The college curriculum emphasizes the types of technical knowledge that are relevant to the local industrial base.

Diné College's Shiprock branch is a member institution in the Environmental Health Information Outreach Program of the National Institutes of Health. The program's purpose is to enhance the capacity of minority-serving academic institutions to reduce health disparities through the access, use, and delivery of environmental health information on their campuses and in their communities. In the Shiprock area, the college, the IHS's Navajo Nation Medical Center, and various other educational institutions operate that program and many other health research and educational programs cooperatively.

Other nearby colleges within the regional area of influence include the following:

- University of New Mexico, Gallup
- Crownpoint Institute of Technology (a New Mexico Community College)
- San Juan Technical College (Cortez, Colorado Community College System)

- Fort Lewis College (Colorado state-assisted liberal arts college in Durango)
- San Juan College (Farmington, New Mexico)

3.8.4.5 Agriculture and Grazing

The grazing of livestock—primarily cattle, sheep, and goats—is integral to the Navajo culture. Some Navajo ranchers participate in the formal agricultural economy, while others engage in subsistence grazing activities. According to the 2002 Census of Agriculture, County Data for San Juan County (USDA, National Agricultural Statistics Service), livestock sales yielded just over $10 million in 2002 in the county, including the Navajo Indian Reservation portion of the county. Each of the chapters in the local area has a designated grazing official who serves on a district board under the Navajo Nation Division of Natural Resources, Department of Agriculture. The grazing official administers the grazing permits held by some persons, which include designations as to the number of animal units of each type that the permittee is authorized to hold.

Grazing permits are specific as to which rangelands are to be used by the permit holder. While the rangeland districts are large (thousands of square miles), permit holders generally tend animals within a local area. In some cases, the permit holders make a number of range improvements. Beyond the typical range improvements, the Navajo Nation, in conjunction with BIA, has a resource management program whereby range management units are established for the preservation and restoration of rangelands. Range management units have been established in Naschitti Chapter, within the Desert Rock local area.

The grazing economy has been affected by the recent drought, which worsened for several years through 2003. The drought subsided somewhat into late 2005, and then the lack of winter precipitation worsened the drought once again as of 2006. Many Navajo ranchers reduced the size of their herds during the drought.

NAPI has an innovative program to work with ranchers. NAPI is the Navajo Nation's farming and agri-business enterprise, established in 1970 and responsible for farming the lands of the Navajo Indian Irrigation Project. According to NAPI publications, there are two types of grazing opportunities: winter grazing and summer pasture. NAPI offers this land for grazing to owners of sheep and cattle. Grazing provides NAPI with another crop rotation while it keeps cover on the land before the next crop is planted. It also helps minimize erosion problems.

Grazing provides NAPI with a source of income, and provides owners with alternative pasture needs in times of drought. Livestock owners have taken advantage of this service, and each year has seen an increase in demand for NAPI pastures.

Farming operations on the Navajo Indian Irrigation Project began in 1976. Currently, 68,000 of the planned 110,630 irrigable acres are developed. NAPI crops and livestock are marketed throughout the United States, Mexico, and other markets under NAPI's trademark "Navajo Pride." The vast stores of potatoes are a large source for the United States' potato chip industry, and there are large onion and bean processing plants (NAPI 2005).

In addition to NAPI, there are many individual farm plots maintained by local residents.

3.8.4.5.1 Plants and Animals

The ethnobotanical study for the project inventoried the native plants and found many that are used for various purposes. Field studies were performed that identified flora and also assigned up to seven categories of subsistence use of the plant species (Ecosphere 2005b). None of the plants that are present are limited to the study area. Some plants are utilized more than others, (e.g., cymopteris species) and they can also be found in markets outside the study area.

A Navajo cultural specialist was consulted regarding the practical and ceremonial uses of the plants and animals that were identified in the study area through biological data research (Tso 2005). Twenty-five percent of the plants in the area have known ethnobotanical uses.

The Navajo Nation Office of Language and Culture provided some examples of animals that are rarely marketed yet are important to cultural traditions and for subsistence consumption. They are present within the eastern portion of the Navajo Indian Reservation, but some are definitely not present within the project site. Note that some of them (e.g., bighorn sheep) are not used consumptively, but their continued presence in an area is important to cultural traditions. The following are examples:

- ***Bighorn sheep***: The image is used in the Lightning Way Ceremony in sand paintings.
- ***Prairie dogs***: Balance the land and nature (beliefs).
- ***Red-tailed hawks***: Related to various ceremonies.
- ***Porcupine***: The quills were once used for beading, though less frequently now.
- ***Deer***: The skin is used for ceremonies; antlers are used, and meat is eaten and shared.
- ***Coyote***: The tails are used in the Yei be chi ceremony. Coyotes are not killed for ceremonial purposes, but if they are killed to protect livestock from them, the tails are kept.

3.8.4.6 Social and Cultural Situation

The connection of Navajo people to the study area is expressed both in terms of cultural identity and in official documents kept by the Navajo Nation and the United States government. Persons who are members of the chapters may reside in the chapters, but there are many chapter members who reside elsewhere on the Navajo Indian Reservation or off the reservation. Enrolled members of the Navajo Nation typically maintain membership in a chapter to which they have a strong family connection, most often on their mother's side of the family. They vote as a member of that chapter, even if they reside elsewhere.

It would be expected that some of the persons living off the reservations in the four counties (and elsewhere) would be tribal members. Many would be registered in a local tribal community such as Nenahnezad, so that they could vote in tribal elections.

The chapter lands may be used intermittently for the gathering of plants or animals for ceremonial purposes, or for the ceremonies themselves. A noted Navajo writer who lives within the local area of influence states that because the Navajo views himself as part of a delicately balanced universe in which all life forms and natural elements interrelate and interact, he tries to learn all that he can from nature without destroying its purpose" (Louis 2005). The section above provides examples of the plants and animals from the area that are used for practical purposes as well as for ceremonies.

A Navajo Nation official speaking about cultural preservation states that "if any development impacts one small species it will impact all species because they are all related. If mice populations were lowered it would mean culturally significant animals like the coyote and birds of prey would have less food, and thus would result in less of those animals, which are a large part of Navajo culture."

3.8.4.7 Health Conditions and Health Care Situation

Much of the region of influence is designated as a medically underserved area. A medically underserved area is a designation indicating that the number of primary care physicians per thousand of population is low, while the proportion of persons in poverty, the proportion of elderly persons, and the infant mortality rate are high. According to the formula, medically underserved areas include the entire counties of San Juan and McKinley in New Mexico, the low-income population in La Plata and Montezuma Counties, Colorado, the entire counties of Apache and Navajo in Arizona, and the Flagstaff Service area and Tuba City Service area in Coconino County, Arizona.

The Shiprock Service Unit of the Navajo Area IHS has the largest service area on the Navajo Nation. The Shiprock hospital, known as the Northern Navajo Medical Center, has 55 beds. Approximately 45,500 American Indians, mostly Navajo, live in the service unit. The daily number of patients who stay overnight in the hospital averages 40, and the daily number of outpatients averages 400. Annual obstetrics cases number 700 to 750, and annual emergency room cases average 15,000 to 16,000. Multiple field clinics are open from 1 to 5 days per week, and each is staffed by a Shiprock physician (IHS 2005).

The current health condition of those American Indians who live in IHS's areas was summarized as part of a 2005 report on IHS. The report's geographic coverage included all of the tribal areas within the Desert Rock regional area of influence, as well as many other areas throughout the country. The background summary concerning the state of American Indian health is summarized below:

"Native Americans living in IHS areas have lower life expectancies than the U.S. population as a whole and face considerably higher mortality rates for some conditions. For Native Americans ages 15 to 44 living in those areas, mortality rates are more than twice those of the general population. Native Americans living in IHS areas have substantially higher rates for diseases such as diabetes. Fatal accidents, suicide, and homicide are also more common among them. Mortality rates for some leading causes of death—such as heart disease, cancer, and chronic lower respiratory diseases—are nearly the same for these Native Americans as for the general population. However, these Native Americans also have substantially lower rates of mortality for other conditions, such as Alzheimer's disease" (U.S. Government Accountability Office 2005).

3.8.4.8 Summary of Socioeconomic Issues

There are various economic and social concerns related to environmental justice in this region. With a high unemployment rate and percentage of individuals living below the poverty level higher than surrounding areas, there is a need to provide training and job opportunities to eligible individuals in the Navajo Nation. A large portion of revenue that is generated on the Navajo reservation comes from large industrial establishments, which are responsible for various payments to Federal, state, and tribal agencies. Any goods that are produced, processed, or extracted within the Navajo Nation are subject to the Possessory Interest Tax, which allows outside businesses to work out of Navajo lands.

Basic utility services are not distributed throughout all parts of the Navajo Nation. Some families prefer to live in sparsely populated areas that are not connected to the electrical grid. Costs to connect to this grid are high and many homes located on the reservation are without electrical power. Solar power projects and other distribution line projects are underway to resolve this issue.

Industrial establishments on the reservation such as the Four Corners Generating Station have provided scholarship funds and created internship and training programs that would serve to educate interested participants in energy-related projects. Other businesses in the area have also contributed to educating and providing monetary assistance to students.

Livestock grazing is an integral part of the Navajo culture. The grazing economy has experienced negative impacts from drought and fiscal conditions. NAPI, the Navajo Nation's farming and agri-business enterprise has been responsible for creating the Navajo Indian Irrigation Project that provides ranchers with alternative pasture needs in times of drought. There are specific types of plants and animals of importance to the Navajo culture. Many native plants and in conjunction with certain animals, are used for various purposes including practical and ceremonial use. Cultural preservation is also important to the Navajo and concerns over development can conflict with this need. Plants and animals play an integral part in the natural balance and development can potentially infringe upon those cultural views and values.

Health concerns are also of great importance in the Navajo Nation. Much of the region of influence is considered medically underserved. The IHS has reported lower life expectances than the rest of the U.S. population, higher mortality rates, and substantially higher rates for diseases such as diabetes, cancer, respiratory and heart disease. There are also many cases of suicide and homicide.

3.8.5 Indian Trust Assets

The United States has a trust responsibility to protect and maintain rights reserved by or granted to Indian Tribes by treaty, statutes, and executive orders. This trust responsibility extends to all agencies of the Federal government such as the BIA to take actions reasonably necessary to protect Indian Trust Assets.

Department of the Interior Secretary's Order Number 3215, dated April 28, 2000 addressed Principles for the Discharge of the Secretary's Trust Responsibility:

> Sec. 1 Purpose. This Order is intended to provide guidance to the employees of the Department of the Interior who are responsible for carrying out the Secretary's trust responsibility as it pertains to Indian trust assets.
>
> Sec. 2 Background. The trust responsibility is defined by treaties, statutes, and Executive orders. The most comprehensive and informative legislative statement of Secretarial duties in regard to the trust responsibility of the United States was set out in the American Indian Trust Fund Management Reform Act of 1994 (Reform Act), Pub. L. 103-412, Oct. 25, 1994, 108 Stat. 4239. The Reform Act provides:
>
>> The Secretary's proper discharge of the trust responsibilities of the United States shall include (but are not limited to) the following:
>>
>> (8) Appropriately managing the natural resources located within the boundaries of Indian reservations and trust lands. (25 U.S.C. § 162a(d), cited in Babbitt 2000).

The business site lease/sublease for the Desert Rock Energy Project was approved by the Navajo Nation Tribal Council on May 12, 2006 (see Section 2.3). The lease is subject to approval by the BIA.

Indian water rights are not defined by statute. The BIA performs a limited role in assisting tribes to litigate or seek to settle their water rights claims. In some cases, the BIA has been given a role in assisting tribes to implement a water rights settlement.

The source of Indian water rights is found in the 1908 Supreme Court decision *Winters v. United States* (207 U.S. 564, 576 cited in McCarty 2004) which held that the creation of the Fort Belknap Indian Reservation in Montana under a treaty entered into in 1888 by necessity implied the reservation of sufficient water rights to fulfill the purposes of the reservation. Under the Winters Doctrine, the Indian federal reserved water rights of a given reservation consist of those rights necessary to carry out the purposes for which the reservation was created.

A water right belonging to a Tribe under the Winters Doctrine has a priority date no later than the date of the creation of the reservation unlike water rights permitted, licensed or adjudicated under state statutes, such rights under the Winters Doctrine cannot be lost through non-use (BOR 2006).

3.9 CULTURAL RESOURCES

3.9.1 Introduction

The cultural environment includes those aspects of the physical environment that relate to human culture and society, along with the institutions that form and maintain communities and link them to their surroundings. Public and agency scoping identified issues related to potential impacts on two aspects of the cultural environment: archaeological and historical resources, and traditional cultural lifeways and resources (including human burials associated with some archaeological sites). These issues were addressed pursuant to Federal and tribal laws and regulations protecting cultural resources. In addition to NEPA, Section 106 of the National Historic Preservation Act is a primary regulatory requirement that requires Federal agencies to consider the effects of their undertakings on properties eligible for the National Register.

To be eligible for the National Register, properties must be 50 years old (unless they have special significance) and have national, state, or local significance in American history, architecture, archaeology, engineering, or culture. They also must possess integrity of location, design, setting, materials, workmanship, feeling, and association, and meet at least one of four criteria:

Criterion A: be associated with important historical events or trends

Criterion B: be associated with important people

Criterion C: have important characteristics of style, type, or have artistic value

Criterion D: have yielded or have potential to yield important information (36 CFR 60)

To address these identified issues, studies were undertaken to inventory, evaluate, and assess impacts on the following elements of the cultural environment:

- Archaeological and historical resources that are tangible links to the cultural heritage of the region; and
- Traditional cultural lifeways and resources significant to the Navajo people, as well as other tribal groups with traditional cultural affiliations with land in the project vicinity, including the Acoma, Hopi, Jicarilla Apache, Kiowa Tribe of Oklahoma, Laguna, Ohkay Owingeh, Southern Ute, Ute Mountain Ute, Zia, and Zuni Tribe.

The area of potential effects (or region of influence) on cultural resources was defined as the geographic area within which the proposed project may cause effects (positive or negative) on those resources. The area of potential effects varies for each type of potential impact on the cultural environment. For direct disturbance due to mining and project construction activities, the region of influence was defined to include:

- The power plant construction site (up to about 600 acres).
- A water well field (about 890 acres); the alternative ground-water pumping plan would be within areas disturbed by construction of other components of the project
- A water supply pipeline and utilities corridor (about 100 feet wide and 12.5 miles long, 152 acres).
- Interconnecting transmission lines (about 1,250 acres), including a corridor about 500 feet wide and 1.45 miles long between the proposed power plant and the Four Corners Substation, a corridor 250 feet wide 10.8 miles long between the Four Corners Substation and the planned Navajo Transmission Project transmission line, and interconnection facilities (Segment B of the dual lines between the power plant and the Four Corners Substation is being considered as an alternative to Segment A; it is about 2.8 miles longer and would disturb about 170 more acres).
- Access road (about 75 feet wide and 6.4 miles long, 60 acres).
- Coal mining in Area IV South and Area V of the BNCC Lease Area (about 13,000 acres or 20.3 square miles).

The potential for less-direct impacts on cultural resources also was considered. The area of potential effects on cultural resources for increases in noise, vibration, and visual changes due to construction and operation of the power plant and associated coal mining, including blasting was defined as extending 1 mile beyond the plant site and coal mining areas. The area of potential effects for similar impacts of the ancillary facilities was defined as a 1-mile-wide corridor centered on the linear ancillary facilities and 0.5 mile around the water well field.

Potential effects on cultural resources due to air quality impacts also were considered. Dust generation due to construction and mining could affect the settings of cultural resources, but dust would be controlled in accordance with applicable permits and is not expected to affect the integrity of cultural resources more than 1 mile beyond the coal mining areas and plant site or more than 0.5 mile beyond the ancillary facilities. The potential for affecting the settings of cultural resources due to regional haze or damage of cultural resources such as rock art or stone ruins due to acid deposition also was considered in conjunction with the modeling of air quality impacts. The analysis focused on “Class 1 areas” such as Mesa Verde National Park, Aztec Ruins National Monument, and Chaco Culture National Historical Park. Biological resources that could have traditional cultural significance include plants and animals collected for food, medicine, ceremonies, crafts, and other traditional uses. Other natural resources that could have traditional cultural significance include minerals, sand, or clay deposits and sources of surface water or shallow groundwater used for traditional purposes. The region of influence for impacts on plants, minerals, sand, and clays would be the same as for direct construction impacts. Impacts on traditionally important animal species are likely to result from increased noise, human presence, or visual intrusions; thus, the region of influence was defined as extending 1 mile around the power plant site and coal mining areas, and 0.5 mile from the ancillary facilities. Potential impacts on traditional Navajo lifeways and knowledge could have an affect on the entire traditional culture. Therefore, the region of influence for those types of impacts encompasses the traditional Navajo land. Potential effects on other tribes with traditional cultural associations with the study area would be similar.

3.9.1.1 Cultural History Summary

The cultural history of the region is briefly summarized in this section to provide a context for evaluating archaeological, historical, and traditional cultural properties within the area of potential effects. The following account is based on archaeological and historical research and differs from the traditional Navajo creation accounts and histories that maintain that the homeland of the Navajo people has always been within four sacred mountains that surround the Four Corners area of the Colorado Plateau.

Archaeologists have documented the human occupation of this region as extending back approximately 12,000 years and they divide this past occupation into the Paleoindian, Archaic, Anasazi, and Navajo periods (Meiniger and Baker 2006). The Paleoindian period (ca. 10,000 B.C. to 5500 B.C.) is characterized by a hunting strategy focused on large game animals, and most sites are represented by kill localities defined by projectile points and tools associated with butchering. The Archaic period (5500 B.C. to A.D. 500) is marked by a change in adaptive strategies reflected by a shift from the previous exploitation of big game to a subsistence based on the utilization of a broad spectrum of plant and animal resources.

The Archaic period was followed by the Anasazi period, when corn farming became the dominant lifeway for the prehistoric occupants of the region. The Anasazi period (A.D. 500 to 1300) lasts approximately 800 years with the period between A.D. 900 and 1100 being the zenith of the prehistoric cultural development in the northern Southwest. During this time, population increased and pueblos increased in size and density across the landscape, culminating in the architectural development of great houses constructed in Chaco Canyon and in outlying communities around the San Juan Basin. Farming practices became more sophisticated and irrigation systems were developed. Between A.D. 1100 and 1300 the agricultural lifeway of the region continued; but resource depletion, population pressures, and prolonged droughts affected the Anasazi. These culminating pressures resulted in populations declining and moving into fewer but larger pueblos. By A.D. 1300, archaeologists believe that the Anasazi were no longer living in the San Juan Basin; however, Navajo traditions recognize a cultural affiliation with the Anasazi that results in a continuous occupation of the San Juan Basin.

Archaeological evidence for the entry of Athabascan populations (from whom the Navajo are descended) into the region dates from around A.D. 1500, but Navajo traditional history contends that the Navajo have been in the region since time immemorial. Early Navajo typically relied on hunting and gathering during this time period, but some also practiced agriculture. The arrival of the Spanish dramatically altered the Navajo economy by introducing European technologies and animal husbandry. The adoption of sheep herding, results in a new pastoral lifestyle that was compatible with the traditional hunting and gathering mobility, but as herds grew it triggered expansion of Navajo territory.

The traditional lifestyle of the Navajo living in the San Juan Basin was abruptly altered in 1863 when the U.S. Army began a punitive military campaign in reaction to increased Navajo raiding in northern New Mexico. Under the leadership of Kit Carson, the Navajo were defeated in 1864 and marched to Bosque Redondo near Fort Sumner, New Mexico. Not all Navajos were removed to the Bosque Redondo area. Navajos living in parts of southern Utah and farther west near the Grand Canyon and around the current town of Tuba City, Arizona eluded capture. After four years of incarceration the Treaty of 1868 was signed and the Navajo survivors of the Bosque Redondo relocation were allowed to return to their homes on the newly formed Navajo Indian Reservation. Since then, the Navajo Indian Reservation has expanded 15 times, and by 1934 had become the largest Indian reservation in the United States.

The signing and implementation of the Treaty of 1868 brought many changes to the Navajo people. Schooling was mandated for Navajo children and breeding stock was supplied to reestablish herds for rebuilding a livestock economy based on subsistence herding. Sheep herding became a dominant subsistence strategy and many Navajos used the grasslands to the east of the defined reservation in the San Juan Basin.

3.9.2 Existing Condition

Reviews of prior cultural resource studies, field surveys, and ethnographic interviews were conducted to inventory archaeological and historical resources and traditional Navajo cultural resources within the area of potential effects. The BIA Navajo Regional Office also contacted 10 other tribes to solicit information and concerns about potential impacts on traditional cultural resources that might be significant to them. For all components of the proposed project described below, The Hopi Tribe views all archaeological sites, known as *kiikiqö* (literally ruins) that are attributed to the Anasazi as traditional cultural properties important in Hopi history and culture. The Hopi Tribe believes that these sites are considered eligible for the National Register based on the important role they play in Hopi history.

3.9.2.1 Power Plant

Intensive cultural resource pedestrian survey of the 149 acres for the proposed power plant construction identified 7 archaeological and historic sites that represent 8 historic components. Only one of these sites, a prehistoric lithic scatter, is considered to be historically significant and eligible for the National Register (Table 3-47).

Table 3-47 Summary of Cultural Components in the Plant Site Area

Site Type	Prehistoric	Anasazi	Navajo	Totals
National Register Eligible[1]				
Check dam			1	1
Rock art			1	1
Rock cairn			3	3
Lithic scatter	2	1		3
Totals	2	1	5	8

NOTE: [1] Consultations with the Navajo Nation Tribal Historic Preservation Officer regarding eligibility for the National Register are ongoing.

The one Anasazi archaeological site within the power plant area is considered to be a traditional cultural property by the Hopi Tribe. In addition, the Hopi Tribe has identified many natural resources that have traditional value and significance such as plant species (sagebrush, mountain sagebrush, snakeweed, gray willow, alkali sacaton grass, cocklebur, rabbitbrush, cottonwood, greasewood, yellow composite, sand muhly grass, and prickly pear), animal species (bald and golden eagles, hawks, falcons, jackrabbits, cottontail rabbits, deer, antelope, and rattlesnakes), stone and mineral resources (red and white clay, quartz crystal, petrified wood, stone for grinding tools, stone for cooking slabs, stone for polishing, coarse river sand, and exfoliating rock), and water sources.

3.9.2.1.1 Coal Preparation Facilities

Intensive pedestrian survey of the 101 acres for the proposed coal preparation facilities identified 3 archaeological sites that represent 3 Navajo components and 1 Anasazi component. Two of the components are represented by a Navajo sheep camp and a Navajo temporary camp, and both are considered ineligible for the National Register. One site contains two historic components that are represented by a PII artifact scatter and a Navajo (1900-1940) multi-resident habitation complex with two burials. Both of these components are consider eligible for the National Register.

The one Anasazi component within coal preparation facilities is considered to be a traditional cultural property by the Hopi Tribe.

3.9.2.2 Transmission Lines

3.9.2.2.1 Proposed Transmission Line Segments A, C, and D

Twenty-three archaeological and historical properties were identified within the proposed Transmission Line Segment A and representing 20 Anasazi components and 7 Navajo components. The 20 Anasazi components consist of 5 PII habitations, 4 PII field houses, 3 PI-PII special use areas, 3 PII special use areas, a PII-PIII special use area, a PI-PII artifact scatter, a PII artifact scatter, a PII-PIII artifact scatter, and a PII-PIII habitation site. The 7 historic Navajo components consist of 3 habitation sites, a trash dump and cairn, a trash scatter, a special use area, and a cairn. Of the 27 components, one (NM-H-29-132; a PIII Chuskan habitation site) is listed on the National Register, 19 are considered eligible for inclusion in the National Register, one is potentially eligible, and 6 are considered ineligible.

Three Navajo traditional cultural properties were identified within or near proposed Transmission Line Segment A and consist of a lightning struck corral and offering area (Tradition Cultural Properties [TCP] 23), a lightning struck house (TCP 14), and a death hogan (TCP 26). The lightning struck corral and offering area (*ntł'iz*) is located 0.3 mile east of Transmission Line Segment A and is considered eligible for the National Register. The lightning struck house is located 0.6 mile west of segment A and is considered ineligible for the National Register. The death hogan (*hook'eeghan*) is located 0.6 mile west of Segment A and is considered eligible for the National Register.

Three Navajo burials were located within or near proposed Transmission Line Segment A. Two burials, both unmarked graves (Burials 21 and 22), are within the transmission line corridor. Burial 21 is located on the western corridor boundary of Segment A and Burial 22 is located near the western corridor boundary.

The 20 Anasazi components located within Transmission Line Segment A are considered to be traditional cultural properties by the Hopi Tribe.

Additionally, the Hopi Tribe has identified many natural resources that have traditional value and significance such as plant species (sagebrush, mountain sagebrush, snakeweed, gray willow, alkali sacaton grass, cocklebur, rabbitbrush, cottonwood, greasewood, yellow composite, sand muhly grass, and prickly pear), animal species (bald and golden eagles, hawks, falcons, jackrabbits, cottontail rabbits, deer, antelope, and rattlesnakes), stone and mineral resources (red and white clay, quartz crystal, petrified wood, stone for grinding tools, stone for cooking slabs, stone for polishing, coarse river sand, and exfoliating rock), and water sources.

Eleven archaeological sites and historic properties were identified within proposed Transmission Line Segment C and representing 10 Anasazi components and 2 historic Navajo components. The 10 Anasazi components consist of 2 PII special use areas, 2 PII field houses, a PII-PIII habitation, a PIII habitation, a PIII artifact scatter, a PI-PII special use area, a PII-PIII special use area, and a PIII special use area. The 2 historic Navajo components consist of a lambing pen and corrals, and a special use area. Ten components are considered eligible for inclusion in the National Register, one (Navajo special use area) is considered potentially eligible, and one (PIII artifact scatter) is considered ineligible.

Four Navajo traditional cultural properties were identified within or near the proposed Transmission Line Segment C. A Navajo personal shrine (TCP 27) is located within the proposed segment C, but is considered ineligible for inclusion in the National Register. Three National Register-eligible offering areas (TCP 2, 4 and 5) are located outside and west of the proposed Transmission Line Segment C at distances from 0.5 to 1.3 miles.

The Hopi Tribe considers the 10 Anasazi components located within Transmission Line Segment C to be traditional cultural properties by the Hopi Tribe. The Hopi Tribe believes that these sites are considered eligible for inclusion in the National Register based on the important role they play in Hopi history. The 10 Anasazi components located within Transmission Line Segment C are considered to be traditional cultural properties by the Hopi Tribe.

Five archaeological and historic properties were identified within proposed Transmission Line Segment D representing six components that consist of 1 Anasazi component, 4 historic Navajo components, and 1 indeterminate component. The Anasazi component consists of a PIII field house that is considered eligible for the National Register. The 4 historic Navajo components consist of 2 habitation sites, a sweat lodge, and a site exhibiting a rock bin, rock art, and graffiti. Two of the Navajo components are considered eligible to the National Register, one (a Navajo habitation) is considered potentially eligible, and one (sweat lodge) is considered ineligible. The sixth component consists of historic mine adits of unknown cultural affiliation which are considered ineligible for the National Register.

Ten Navajo traditional cultural properties were identified within or near the proposed Transmission Line Segment D. An enemy way ceremonial site (TCP 1), considered ineligible for the National Register, is located 1,200 feet west of the proposed transmission line segment and a Register eligible offering area (TCP 3) is located 1,500 feet east of the Segment D. Two offering areas, one eligible (TCP 7) and one ineligible (TCP 6), are located 100 and 700 feet, respectively, east of Segment D. An ineligible ceremonial hogan (TCP 11) is located 800 feet north of Segment D and an ineligible enemy way ceremonial site (TCP 21) is located 100 feet east of Segment D. Two ineligible traditional cultural properties, an offering area (TCP 13) and an enemy way ceremonial site (TCP 20), are located within the corridor of Segment D. The central portion of proposed Transmission Line Segment D crosses the San Juan River (TCP 18) which is considered a National Register eligible property for the significant role it plays in Navajo history and the continuation of Navajo culture. In addition, the San Juan River is a traditionally important named place to the Hopi Tribe and is called *Yotavayu* (Ute River).

Another significant topographic feature, the Hogback Monocline (TCP 19), is located 0.3 mile west of Segment D and is considered a National Register-eligible property.

Three Navajo burials were identified within or close to proposed Transmission Line Segment D. Two burials, an unmarked grave (Burial 1) and a fenced burial plot (Burial 2), are located within the corridor for Segment D. Specifically, Burial 1 is located somewhere near the centerline of Segment D, but its precise location is unknown. Burial 2 is also located near the centerline of Segment D. The third burial is a marked burial (Burial 15) that is located 800 feet west of Segment D.

The one Anasazi component within Transmission Line Segment D is considered to be a traditional cultural property by the Hopi Tribe.

3.9.2.2.2 Alternative Transmission Line Segment B

Five archaeological and historic properties were identified within alternative Transmission Line Segment B representing 4 Anasazi sites and a historic Navajo habitation site. The 4 Anasazi sites are composed of a PI permanent use site, PI-PII habitation site, a PII habitation site, and a PII-PIII habitation site. All 5 properties are considered eligible for the National Register.

Four Navajo traditional cultural properties were identified within or near alternative Transmission Line Segment B. A death home (TCP 15) and a ceremonial hogan (TCP 16) are located within the alternative Transmission Line Segment B corridor and both are considered ineligible for the National Register. The other 2 Navajo traditional cultural properties are located outside of the corridor for Segment B and consist of an offering area (TCP 17) and a death hogan (TCP 26), both are considered eligible for the National Register.

Three Navajo burials are located within or near alternative Transmission Line Segment B. Burial 17, an unmarked grave, is located near the centerline of segment B. Burial 19, a fenced family burial plot with multiple graves, and Burial 20, a marked grave, are both located on the eastern edge of alternative Transmission Line Segment B corridor.

The Hopi tribe considers the 4 Anasazi sites located within alternative Transmission line Segment B is considered to be a traditional cultural property. The Tribe believes that these sites are considered eligible for the National Register based on the important role they play in Hopi history. The 4 Anasazi sites located within alternative Transmission Line Segment B is considered to be a traditional cultural property by the Hopi Tribe.

3.9.2.3 Water Well Field

Alternative Water Well Field A has one Anasazi site and one historic Navajo habitation site. The Anasazi site consists of a PII permanent use area. Both sites are considered eligible for the National Register.

One Navajo fenced burial plot (Burial 4) is located 300 feet south of alternative Water Well Field A.

The one Anasazi site within Alternative Water Well Field A is considered to be a traditional cultural property by the Hopi Tribe.

Alternative Water Well Field B is defined by an approximately 451 acres that surround the power plant footprint and approximately 438 acres that are contained within the buffer zone corridor of proposed transmission line segment A. There are 27 archaeological and historic sites containing 34 historic components located within the area that surrounds the power plant footprint. The 34 historic components are composed of 19 Navajo components, 8 Anasazi components, 6 prehistoric components and one unknown component. Of these, 12 components are considered eligible for the National Register and 22 are considered ineligible.

The portion of Alternative Water Well Field B that is contained within the 592 acres that follows the buffer zone corridor of transmission line segment A contains 22 archaeological and historic properties that represent 19 Anasazi and 6 Navajo components. Of these, 1 is listed on the National Register (NM-H-29-132; a PIII Chuskan habitation site), 18 are considered eligible for listing, and 6 are ineligible for listing.

In addition, Burial 21, an unmarked grave, is located within the portion of alternative Water Well Field B that is contained within the portion that follows the buffer zone corridor of Transmission Line Segment A.

The Hopi Tribe believes that these sites are considered eligible for the National Register based on the important role they play in Hopi history. The 27 Anasazi components located within alternative Water Well Field B are considered to be traditional cultural properties by the Hopi Tribe.

3.9.2.4 Utility Corridor/Water Pipeline

Ten archaeological and historical properties were identified within the utility corridor representing 3 Anasazi components and 8 Navajo components. The 3 Anasazi components consist of a PII habitation site and 2 PII special use areas. All three are considered eligible for the National Register. The 8 historic Navajo components consist of a cairn, a check dam site, 3 habitation sites, a rock art site, a trail and rock cairn site, and a coal mine. The rock art site and the trail and rock cairn site are considered potentially eligible for the National Register, the check dam site and the coal mine site are considered ineligible, and the remaining sites are eligible.

Two Navajo traditional cultural properties were identified within the general area of the proposed utility corridor. Table Mesa, a Navajo offering area (TCP 9), is located 1.9 miles north of the utility corridor and is considered a National Register-eligible property. A National Register-eligible Navajo offering area (TCP 25) is located near the southern edge of the proposed utility corridor.

Two Navajo burials were identified within the proposed utility corridor. Burial 9, a burial inside a house, is located near the southern edge of the corridor and Burial 8, a hogan burial, is located along the southern edge of the corridor boundary. Four Navajo burials are located outside of the utility corridor boundary. Two unmarked burials (Burials 6 & 7) are located adjacent to the southern edge of the utility corridor boundary. Another unmarked burial (Burial 5) is located approximately 0.7 mile south of the utility corridor boundary. A marked burial (Burial 11) is located 1.3 miles north of the utility corridor buffer zone.

The Hopi Tribe believes that these sites are considered eligible for the National Register based on the important role they play in Hopi history. The 3 Anasazi components located within the proposed utility corridor are considered to be traditional cultural properties by the Hopi Tribe.

3.9.2.5 Proposed Access Road

Four archaeological sites (NM-H-36-26; NM-H-36-28, NM-H-36-35 & NM-H-36-87) were identified within the proposed route of the access road. Three of the archaeological sites contain 3 Anasazi components and 2 historic Navajo components represented by a Navajo sheep camp dating from 1900-1950, a Navajo habitation dating from 1880-1950, a PI-PII artifact scatter, a PII field house, and a PII-PIII activity area. All 5 historic components are considered eligible for listing in the National Register. The fourth archaeological site consists of a Navajo sheep camp that dates from 1900-1970 and is considered ineligible for the National Register.

The Hopi Tribe believes that these sites are considered eligible for the National Register based on the important role they play in Hopi history. The 3 Anasazi components within the proposed access road are considered to be traditional cultural properties by the Hopi Tribe.

BNCC is conditionally authorized to realign a portion of Burnham Road in conjunction with their BNCC Lease Area SMCRA permit. Those impacts are addressed by a separate environmental assessment (see

Environmental Assessment [EA] Permit No. NM-0003E; Navajo Tribal Lease 14-2-603-2505; and OSM Project No. NM-0003-E-R-01 and associated Finding of No Significant Impact signed November 7, 2005 in Appendix A).

3.9.2.6 BNCC Lease Area – Areas IV and V

In 2004, BHP contracted with the San Juan County Museum Association's Division of Conservation Archaeology (DCA) to perform an updated inventory/evaluation of archaeological and historical properties within the Area IV North portion of the Navajo Mine lease area. In performing this work DCA reviewed the literature and conducted field inventories to re-locate and characterize 57 sites that had been identified within this area during previous archaeological survey work (Hogan and Winter 1983; Reher 1977). In addition, DCA identified 16 new sites of varying potential significance. A total of 73 historic properties were located and/or identified during the evaluation project. A report of their survey and findings is found under separate cover titled "The Eligibility Evaluation of Cultural Resources Located Within Lease Area IV North of BNCC Mine." This document is to be kept as a confidential report. Thirty-nine of the 73 sites in Area IV North have been recommended not eligible for listing for the National Register and the remaining 34 sites have been recommended potentially National Register-eligible. Following the Navajo Nation Historic Preservation Department's (NNHPD) review of the DCA report, a Cultural Resources Compliance Form will be issued in which the Effects and Conditions of Compliance will be outlined. These will constitute the findings of the NNHPD. For those sites that may be determined not National Register-eligible, no further action will be required to protect them from potential mining impact ("No Historic Properties Affected"). For sites that are determined for the National Register-eligible and will be potentially impacted by the proposed mining operations (Historic Properties Affected – Adverse Effect"), measures to mitigate the adverse effects of the mining will be requested. These measures could include data recovery from excavations and/or additional ethnographic study. Mitigation plans will be developed for these sites, the development and implementation of which will occur prior to disturbance of the sites. OSM will consult with the NNHPD about the adequacy of the mitigation plans.

DCA has also identified TCPs within the Area IV North lease area. Consultations with the NNHPD resulted in determination that ethnographic interviews be conducted with the individuals and their families familiar with the TCPs. The ethnographic interviews and assessments of 10 TCPs and 17 burials were performed by the Navajo Nation Archaeology Department (NNAD) in 2006, Archaeological and historical resources within the BNCC Lease Area IV South and Area V were inventoried in the 1970s as part of a 70-square-mile survey for a once proposed but never developed coal gasification project (Reher 1977). Information from that survey and subsequent studies summarized information about archaeological and historical resources recorded within Area IV South and the adjacent Area V, and a 1-mile-wide buffer around each. A total of 103 archaeological and historical sites have been recorded within Area IV South (Table 3-48). Some of these sites were occupied during multiple periods and they represent 112 separate components, including 1 Paleoindian, 38 Archaic, 16 Anasazi, 46 Navajo, and 3 indeterminate components. A total of 82 archaeological and historical sites have been recorded in Area V, representing 11 Archaic, 12 Anasazi, 57 Navajo, and 4 indeterminate components.

Table 3-48 Archaeological and Historical Sites/Components within the BNCC Lease Area

Area	Paleoindian	Archaic	Anasazi	Navajo	Unknown	Other	Total
IV –South	1	38	16	54	3	0	112 (103 sites)
V	0	11	12	57	4	0	84 (82 sites)
Lease Area Totals							
Area IV South Buffer							
Area V Buffer							
Buffer Totals							
Total	1	49	28	111	7	0	196 (185 sites)

The National Register–eligibility of most of those sites has not been evaluated, but many are likely to have potential to yield important information and therefore would be eligible under Criterion D. Those sites would be re-evaluated over the coming decadesas mining plans are developed for those lease areas. Additional surveys in Area IV North may find additional archaeological sites.

The Hopi Tribe believes that these sites are considered eligible to the National Register based on the important role they play in Hopi history. The 28 Anasazi components located within mining lease Area IV South and Area V are considered to be traditional cultural properties by the Hopi Tribe.

A study of traditional Navajo cultural resources identified 1 burial [death hogan/house (*hook'eeghan*)] in Area IV South and an eagle-nesting area and an offering place (*ntł'iz*) within the 1-mile buffer zone around Area IV South (Table 3-49). One offering place that has been in use since the 1930s and 1 Navajo burial were identified in Area V. Another offering place and three Navajo burials are located within the buffer zone around lease Area V.

Table 3-49 Traditional Navajo Cultural Resources and Burials within the BNCC Lease Area

Area	Traditional Cultural Resources	Burials
IV South		1
V	1	1
Coal Lease Subtotals	1	2
IV South Buffer	2	
V Buffer		3
Buffer Subtotals	2	3
Totals	3	5

NOTE:
[1] The traditional cultural properties are considered eligible for the National Register of Historic Places. Although the burials are not considered eligible, they are protected by the Native American Graves Protection Act and the Navajo Nation Jischchaá policy. Consultations with the Navajo Nation Tribal Historic Preservation Officer regarding eligibility for the National Register are ongoing

3.10 PALEONTOLOGY

3.10.1 Introduction

The study area is located in a portion of the San Juan Basin, an asymmetric structural basin in northwestern New Mexico and southwestern Colorado containing sedimentary rocks that range from Cambrian to Holocene in age (Fassett and Hinds 1977). Late Cretaceous sedimentary rock units crop out across most of the study area with some recent to Quaternary alluvial deposits in washes and arroyos. During the Cretaceous period, the area was at the edge of a vast epicontinental seaway that split the North

American continent into two landmasses. A series of transgressive and regressive cycles moved the western shoreline between what is now eastern Arizona and western New Mexico. As the sea transgressed and regressed, marine and nonmarine sediments were deposited. The deposits formed a range of intertonguing and interbedded sandstones, mudstones, shale, and coal. The interbedded deposits and intertonguing units range in thickness from a few feet to thousands of feet. The fossil-bearing geologic units in the study area are primarily Late Cretaceous in age with some found in the Recent to Quaternary alluvial deposits. Some of the vertebrate fauna are very diverse and represent the most continuous vertebrate record in the Cretaceous of the southern United States.

The largest and most diverse Cretaceous vertebrate fauna comes from the Fruitland Formation with other important fauna in the overlying Kirtland Formation (Hunt and Lucas 1993).

Paleontological resources have not been well documented for the area of the Navajo Indian Reservation although the San Juan Basin region is known for rich and diverse vertebrate, invertebrate, and plant fossils. Information on paleontological resources of the study area are based on evaluations within Section 3.5 and documented localities in the New Mexico Museum of Natural History and Science (NMMNHS) database; Paleontology Portal database; various NMMNHS, New Mexico Geological Society, New Mexico Bureau of Geology and Mineral Resources, and USGS professional papers; and miscellaneous paleontological resources references. Geology and paleontological resources were developed from the bedrock geology and known or potential occurrences of paleontological resources in those geologic units. For protection of resources, exact locations are often not disclosed but general locations by broad geographic areas and geologic formation provide information on known resources and the potential for additional resources to be found in the area. More than 10,000 fossil specimens are listed in the NMMNHS database for San Juan County, but only a small number of those are actually from the immediate study area, most likely because of the lack of resource surveys of the Navajo Indian Reservation. Therefore, this section of the Draft EIS presents a summary of the types of fossils found in the geologic units that are exposed in the study area and notes which units may yield scientifically significant fossils.

3.10.2 Existing Conditions

Paleontological resources constitute a fragile and nonrenewable scientific record of the history of life on earth. Once damaged, destroyed, or improperly collected, their scientific and educational value may be greatly reduced or lost forever. In addition to their scientific, educational, and recreational values, paleontological resources can be used to understand the interrelationships between the biological and geological components of ecosystems over long periods of time.

Many of the fossils found in New Mexico are part of the extensive collection of the NMMNHS (2006a). Portions of New Mexico have an abundance of fossils, some of which have been quite significant in documenting early life forms in the Southwest. Numerous New Mexico fossils are also in the collections (and databases) of the University of California Museum of Paleontology, American Museum of Natural History, Philadelphia Academy of Natural Sciences, Yale Peabody Museum (The Paleontology Portal 2006), and other notable collections.

Known paleontological resources are used to determine the potential for a geologic unit to yield scientifically significant fossils. This potential, or sensitivity, depends on the rock type, the past history of the rock unit in yielding fossil materials, and what fossil sites are recorded in the unit. Scientific significance is based on the fossil's importance in research and educational value. Fossil material is important if it contributes to the understanding of taxonomy (the classification of organisms), phylogeny (evolutionary development of plants and animals), stratigraphy (the study of stratified rocks, including the age of the rock), tectonics (the study of rock movement and relative time of occurrence), and paleoecology (the study of ancient environments).

Fossils that may be found in the study area are based on the rock types and known paleontological resources found in those formations. Paleontological resources are based on the surface geology evaluations and documented localities in the NMMNHS database and other sources. Geology and paleontological resources were developed based on the bedrock geology and known or potential occurrences of paleontological resources in those geologic units (New Mexico Bureau of Geology and Mineral Resources 2003; USGS 1997).

The exposed geologic units range in the study area from Late Cretaceous (100 to 65 million years old) with some younger alluvial deposits (less than 1 million years old). There are also important Tertiary aged geologic units located near the study area that when subject to erosion may contribute fossil resources in the alluvial deposits. The fossils in this portion of the San Juan Basin are found in sediments formed from marine and nonmarine deposits. The deposits consist of a range of intertonguing and interbedded sandstones, mudstones, shale, and coal.

The Cretaceous Period is part of the Mesozoic Era and also is known as the Age of Reptiles, which included dinosaurs. Triassic and Jurassic Period deposits are not exposed in the study area. During the Cretaceous Period, New Mexico was on the western margin of a vast epicontinental seaway that split the North American continent into two landmasses. A series of transgressive-regressive cycles moved the shoreline from central Arizona to northeastern New Mexico. The Cretaceous units consist of shoreline and near-shore deposits (sandstone, siltstone, shale, and coal) from the numerous marine transgressive and regressive sequences. Most Cretaceous vertebrate fossils are found in the nonmarine and shallow marine sequences (Hunt and Lucas 1993). Vertebrate fauna includes fish, crocodiles, turtles, and dinosaurs. The Cretaceous sedimentary rocks that crop out in the area include (from oldest to youngest) Mancos Shale (marine shale), Point Lookout Sandstone, Menefee Formation (mudstone, shale, sandstone, and coal), Lewis Shale (shale and siltstone), Pictured Cliffs Sandstone, Fruitland Formation (interbedded siltstone, sandstone, shale, and coal beds), and Kirtland Formation (mudstone, siltstone, shale, sandstone, and conglomerate). There are several overlying Tertiary-aged sedimentary deposits that crop out near the study area including the Ojo Alamo Sandstone and the Nacimiento Formation (sandstone and conglomerate). These units when eroded may yield some fossils that may be found in unconsolidated deposits and some of these may be found in washes in the area. Unconsolidated silts, sands, and gravels of the Holocene-Pleistocene are typically alluvial, pluvial, and colluvial deposits in the washes and arroyos. Some of the vertebrate fauna are very diverse and represent the most continuous vertebrate record in the Cretaceous of the southern United States. The largest and most diverse Cretaceous vertebrate fauna comes from the Fruitland Formation with other important fauna in the overlying Kirtland Formation (Hunt and Lucas 1993; Lucas and Williamson 1993).

The Mancos Shale (marine shale) has no recorded fossils in San Juan County. The Point Lookout Sandstone has some chondrichthyes (cartilaginous fish, rays, and sharks). The Menefee Formation (mudstone, shale, sandstone, and coal) has yielded turtles, bivalves, crocodiles, hadrosaur, and tyrannosaur (NMMNHS 2006a).

The Lewis Shale represents the last inundation of the San Juan Basin by marine waters and contains a locally rich fossil record of ammonites, inoceramid bivalves and gastropods, chondrichthyes, sharks, mosasaurs, and plesiosaurs. The Pictured Cliffs Sandstone represents a regressive delta environment and has an extensive vertebrate assemblage at Mesa Portales, although none are recorded for San Juan County. Mesa Portales is a fairly large mesa located about 60 miles southeast of the actual project area, but it is part of the San Juan Basin and the resources in the formations that occur in many portions of the basin may be indicative of resources in the formations in the site area. In some parts of the San Juan Basin, the Pictured Cliffs Sandstone yielded a diverse fauna of selachians (sharks) and isolated bones and teeth of turtles, plesiosaurs, crocodiles, dinosaurs, and mammals (Lucas and Williamson 1993).

The Fruitland Formation represents a delta plain environment that is overlain by the Kirtland Formation, an accumulation of a variety of riverine floodplain deposits. The Fruitland and Kirtland formations have yielded numerous fossils in the areas of Cottonwood Arroyo, Ojo Amarillo Creek, Pinabete Wash and Brimhall Wash, which drain into the Chaco River along the western portion of the San Juan Basin and the study area.

The Fruitland Formation has yielded a diverse fauna of selachians and osteichthyans (boney fish), frogs, turtles, lizards, snakes, crocodiles, a broad variety of dinosaurs (Plesiosaurs, Mosasaur, Albertosaur, Tyrannosaur, Hadrosaur, Triceratops, and Pentaceratops) and mammals. In the study area, the Kirtland Formation has yielded a vertebrate assemblage nearly as diverse as that of the Fruitland (Lucas and Williamson 1993). Fossilized tree stumps and isolated logs also have been noted in the Fruitland/Kirtland formation (Ecosphere 2005).

The Tertiary-aged Ojo Alamo Sandstone was deposited by several flowing streams in braided alluvial plain environments and, thus, has yielded only a few fossil fragments. These generally appear to be from reworked underlying Cretaceous strata. The Ojo Alamo grades into and intertongues with the overlying Nacimiento Formation, the result of floodplain and floodplain lake deposits. When the San Juan Basin was visited as part of the Wheeler Survey of 1874, the Nacimiento Formation (at that time described as the Puerco marls) was described and later found to be very fossiliferous, producing the first Paleocene mammals discovered in North America. The early discoveries led to numerous expeditions from several institutions and resulted in important collections of several prominent natural history museums. The Nacimiento Formation has yielded some of the most diverse early Paleocene fauna known. The distinct fauna in these deposits became the type reference faunas for the Puercan and Torrejonian land-mammal ages (Lucas and Williamson 1993; Williamson and Lucas 1993).

Table 3-50 summarizes the fossils (including bones, teeth, bone fragments) found within the study area that are included in the NMMNHS and Paleontology Portal databases.

This information is based on the types of fossils that have been found in geologic units in San Juan County and may be found in the study area. Many areas on the Navajo Indian Reservation have not been explored or surveyed for paleontological resources. To date, there has not been a comprehensive survey conducted for the entire study area although significant and important paleontological resources occur in the formations that crop out across San Juan County and Navajo Indian Reservation. Two surveys were recently completed for BNCC, one for Area IV North (Clifford 2005) and the other for Lease Area V (Ecosphere 2005). No vertebrate fossils were found during the field survey of Area V, although it was noted that vertebrate and invertebrate fossils may be found in the area and are probably still unexposed. The survey conducted of Area IV South of the BNCC Lease Area resulted in 14 fossil sites. These sites were located in portions of Cottonwood Wash and related tributaries and surrounding badlands. The sites yielded crocodile teeth and fragmented scute plates, turtle shells, fish gar scale, fish teeth, brackish water ray stingers and teeth, plant fragments (including stems and leaves), crocodile teeth and bone fragments, dinosaur (plesiosaur) vertebra, hadrosaur bones, tyrannosaurus bones, unionid bivalves, freshwater gastropods, and numerous scattered petrified logs and stumps.

Table 3-50 List of Paleontological Resources Reported in San Juan County and Navajo Indian Reservation

Fossil Types	Geologic Period	Geologic Unit	General Study Area Location
None recorded	Holocene/ Pleistocene	Valley fill sediments, alluvial/colluvial deposits	San Juan River, Chaco River
Mammals, reptiles, plants	Paleocene	Nacimiento Formation	Not in study area
Plants, mammals	Paleocene	Ojo Alamo Sandstone	Not in study area
A diverse fauna of selachians and osteichthyans, frogs, turtles, lizards, snakes, crocodiles, a broad variety of dinosaurs (Plesiosaurs, Mosasaur, Albertosaur, Tyrannosaur, Hadrosaur, Triceratops, and Pentaceratops) and mammals	Cretaceous	Kirtland Formation (aka Kirtland Shale)	Areas I, II, III, IV North, IV South, V, power plant site
A diverse fauna of selachians and osteichthyans, frogs, turtles, lizards, snakes, crocodiles, marsupials, a broad variety of dinosaurs (Plesiosaurs, Mosasaur, Albertosaur, Tyrannosaur, Hadrosaur, Triceratops, and Pentaceratops) and mammals, fossilized tree stumps and isolated logs	Cretaceous	Kirtland Shale/Fruitland Formation	Areas I, II, III, IV North, IV South, V, power plant site
A diverse fauna of selachians and osteichthyans, frogs, turtles, lizards, snakes, crocodiles, marsupials, a broad variety of dinosaurs (Plesiosaurs, Mosasaur, Albertosaur, Tyrannosaur, Hadrosaur, Triceratops, and Pentaceratops) and mammals	Cretaceous	Fruitland Formation	Areas I, II, III, IV North, IV South, V, power plant site
A diverse fauna of selachians and isolated bones and teeth of turtles, plesiosaurs, crocodiles, dinosaurs, and mammals	Cretaceous	Pictured Cliffs Formation	Areas II, III, IV North, V, power plant site
Ammonites, inoceramid bivalves and gastropods, chondrichthyes, sharks, mosasaurs, and plesiosaurs	Cretaceous	Lewis Shale	Transmission Line Segments A, B, C; Road Alignments A, B
Chondrichthyes, dinosaur bone fragments	Cretaceous	Cliff House Sandstone	Proposed utility corridor; transmission line Segment D
Bivalves, turtles, crocodiles, tyrannosaur, hadrosaur	Cretaceous	Menefee Formation	Proposed utility corridor; transmission line Segment D
Chondrichthyes	Cretaceous	Point Lookout Sandstone	Proposed utility corridor; transmission line Segment D
None recorded	Cretaceous	Mancos Shale	Proposed water well field; proposed utility corridor

SOURCES: New Mexico Museum of Natural History and Science 2006b; Paleontology Portal 2006

3.10.2.1 Project Components

3.10.2.1.1 Power Plant Site

The power plant site is located on Kirtland, Fruitland, Pictured Cliffs, and Lewis Shale deposits. There is a potential for Cretaceous fossils from these deposits (refer to Table 3-50).

3.10.2.1.2 Transmission Lines

Proposed Transmission Line Segments A, C, and D

Transmission Line Alignment Segments A and C cross Pictured Cliffs and Lewis Shale deposits. Segment D crosses Pictured Cliffs, Lewis Shale, Cliff House, Menefee, Point Lookout, and Mancos Shale geologic units. Many of these deposits have potential for Cretaceous paleontological resources (refer to Table 3-50).

Alternative Transmission Line Segment B

Transmission Line Segment B crosses Pictured Cliffs and Lewis Shale deposits. These deposits have potential for Cretaceous paleontological resources (refer to Table 3-50).

3.10.2.1.3 Water Well Field

The alternative water well field A is located on Mancos Shale deposits. These deposits have not yielded fossil resources in the area (refer to Table 3-50). Proposed water well field B is discussed under the power plant site and transmission line segment A.

3.10.2.1.4 Utility Corridor/Water Pipeline

The utility corridor for the water pipeline crosses Pictured Cliffs, Lewis Shale, Cliff House, Menefee, Point Lookout, and Mancos Shale geologic units. Many of these deposits have potential for Cretaceous paleontological resources (refer to Table 3-50).

3.10.2.1.5 Access Road

The proposed access road would cross Kirtland and Fruitland deposits. These deposits have potential for Cretaceous paleontological resources (refer to Table 3-50).

3.10.2.1.6 BNCC Lease Area – Areas IV and V

BNCC Lease Area IV South is located on Kirtland and Fruitland deposits. BNCC Lease Area V is located on Kirtland, Fruitland, and Pictured Cliffs deposits. These deposits have potential for Cretaceous paleontological resources (refer to Table 3-50). Two paleontological resource surveys were recently completed for BNCC, one for Area IV North (Clifford 2005) and the other for Lease Area V (Ecosphere 2005). No vertebrate fossils were found during the field survey of Area V, although it was noted that vertebrate and invertebrate fossils may be found in the area and are probably still unexposed. The survey conducted of Area IV South of the BNCC Lease Area resulted in 14 fossil sites. These sites were located in portions of Cottonwood Wash and related tributaries and surrounding badlands. The sites yielded crocodile teeth and fragmented scute plates, turtle shells, fish gar scale, fish teeth, brackish water ray stingers and teeth, plant fragments (including stems and leaves), crocodile teeth and bone fragments, dinosaur (plesiosaur) vertebra, hadrosaur bones, tyrannosaurus bones, unionid bivalves, freshwater gastropods, and numerous scattered petrified logs and stumps.

3.11 TRAFFIC AND TRANSPORTATION

3.11.1 Introduction

This section discusses the existing transportation system within the study area for the Desert Rock Energy Project. The discussion includes a description of the existing roads and access for each alternative corridor on the Navajo Indian Reservation, and quantification of existing traffic patterns. Figure 3-19 shows the existing roads and highways in the vicinity of the project, including unnamed roads labeled as U-X (X being a number).

3.11.2 Data Collection Approach

Data obtained for existing traffic uses were obtained from the New Mexico Department of Transportation (NMDOT). The data compiled for the existing transportation network were derived from geographic information system calculations and observations made in the field from March 13, 2006 to March 17, 2006.

3.11.3 Existing Conditions

The jurisdiction of routes was inventoried based on the ownership of land the access/travel route traverses, or the agency with legal control, liability, or responsibility for the access/travel route. Route jurisdiction lies primarily with the Navajo Nation, the Federal Highway Administration, and the State of New Mexico. Excluding the primary continuous transporting links, most roads within the study area are not maintained or paved. Some of these non-maintained or unpaved roads have surface conditions in which due to roughness, grade, drainage crossings or other obstructions may require four-wheel drive. Maintained roadways are improved and graded, and provide reliable access for school bus and passenger vehicles.

Main access to and from the study area consists of the north-south U.S. Highway 491, which borders the western portion of the plant site and the east-west U.S. Highway 64 to the north of the plant site. The Federal Highway Administration administers these roads. Burnham Road (southern portion BIA 5082, northern portion BIA 5085, proposed portion N3005) is an additional access road that travels north-south and is located to the east of the plant site, while southernmost access is gained by N5, which travels east-west. Both of these roads border the BNCC Lease Area and are administered by the BIA.

3.11.3.1 Traffic Counts

Traffic counts for U.S. Highway 491 and U.S. Highway 64 were taken by NMDOT in 2004. Traffic counts for U.S. Highway 491 at intersection with U.S. Highway 64 are 5,149 vehicles per day traveling southbound and 5,129 vehicles per day traveling northbound. Traffic counts for U.S. Highway 64 from the intersection with U.S. Highway 491 are 11,385 vehicles per day traveling eastbound and 11,538 vehicles per day traveling westbound (Garcia 2006).

3.11.3.2 Power Plant Site

3.11.3.2.1 Existing Transportation Routes

As shown in Figure 3-19, U.S. Highway 491 is the primary continuous transportation link running north to south between Shiprock and Gallup, while the primary continuous transportation link running east to west between Farmington and Shiprock is U.S. Highway 64. Burnham Road is an unpaved transportation link running north to south within the eastern portion of the study area and connects to U.S. Highway 491 via N5. The project site is located 170 miles northwest of Albuquerque, New Mexico, if traveling Interstate 25 to U.S. Highway 550 to Bloomfield, then U.S. Highway 64 to U.S. Highway 371 to the entrance to the mine off N3005. If transported materials are to exceed the gross weight of 80,000 pounds, the NMDOT would need to validate and authorize the route to the project site. Trucks under this weight would move via U.S. Highway 471 north toward Toadlena and onto N5 until heading north on Burnham Road to the site (approximately 93 miles from Gallup).

3.11.3.2.2 Existing Access

Primary points of access to the plant site from U.S. Highway 491 consist of three routes: one exiting U.S. Highway 491 at BIA 5017 and connecting to U-1, which travels east into the project site, the second route by exiting U.S. Highway 491 at BIA 5017, then south to BIA 69 to N-5, east on N-5, north on Burnham Road to U-1 traveling west into the project site, and the third by exiting U.S. Highway 491 east on N5 until heading North on Burnham Road (BIA 5082 segment) and then U-1 to the project site (see Figure 3-19).

3.11.3.3 Transmission Line Alternatives

3.11.3.3.1 Proposed Transmission Line Segments A, C, and D

Existing Transportation Routes

As discussed in the previous sections, U.S. Highways 491 and 64 are the primary continuous transportation link running north to south and east to west, respectively. Also, Burnham Road runs north to south in the eastern portion of the study area, while east to west traveling N5 occurs in the southern portion of the study area.

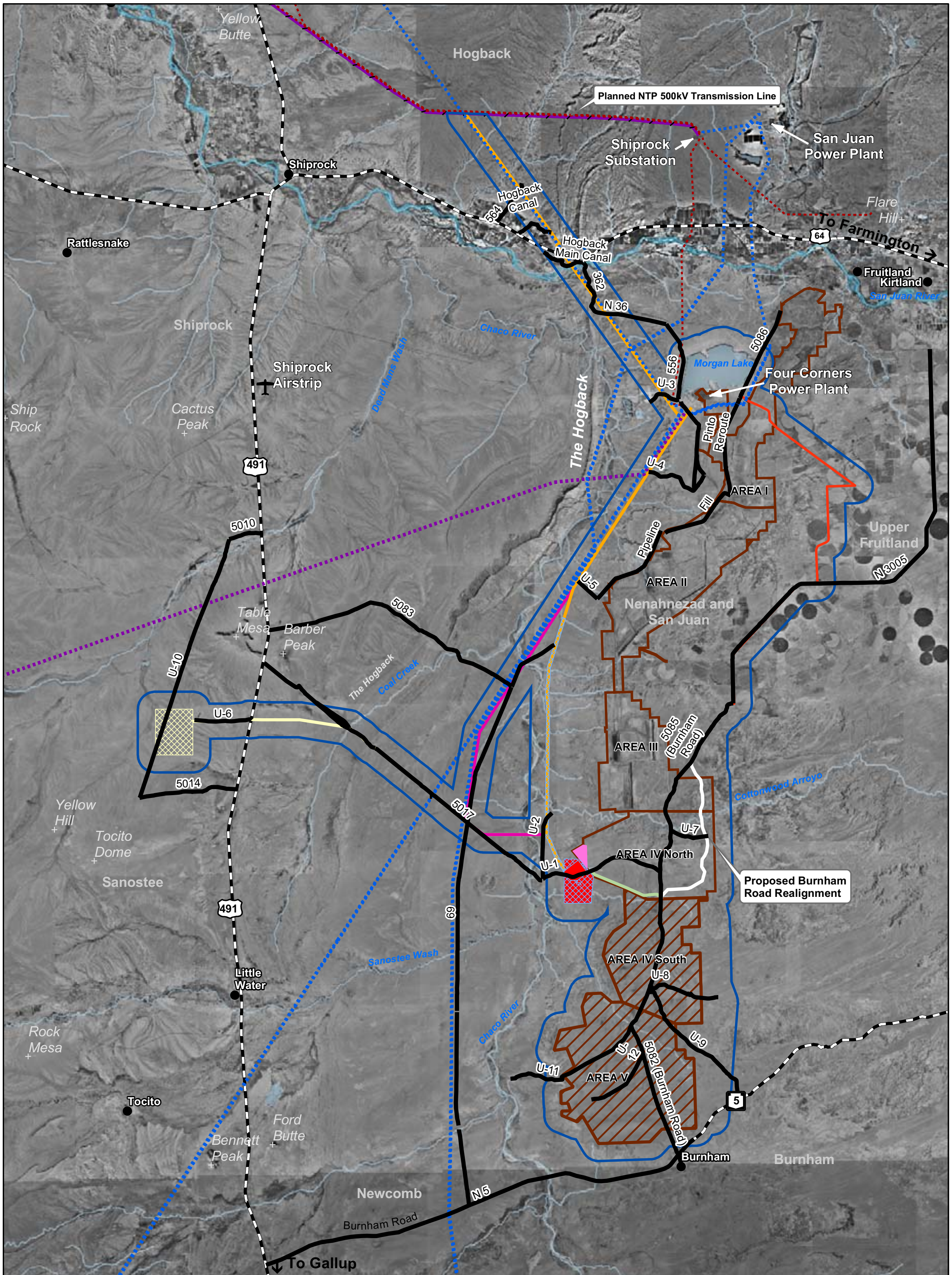
3.11.3.3.2 Existing Access

Transmission Line Segment A

Access to the southern portion of Transmission Line Segment A is provided primarily by U-2. This route travels north from the intersection of BIA 5017 and U-1 to the proposed segment. The central and northern portion of the segment can be accessed from U.S. Highway 491 by exiting at BIA 5083 and following this route east until intersecting with BIA 69, and then by continuing on BIA 69 north until intersecting with Transmission Line Segment C.

Transmission Line Segment C

Access to the southern portion of Transmission Line Segment C is provided primarily by BIA 5083, which can be accessed from U.S. Highway 491. Access to this portion can also be gained by following BIA 5086 south to the Pinto Reroute Road to Fill Road and then northwest on U-5 to the proposed



Legend

- Planned NTP 500kV Transmission Line
- Existing 230kV Transmission Line
- Existing 345kV Transmission Line
- Existing 500kV Transmission Line
- Access Road
- Primary Road
- Secondary Road
- Other Road (mostly unimproved)
- Proposed Burnham Road Realignment
- Rivers/Streams
- BHP Navajo Coal Company Lease Area (approximate)
- Facilities Study Area

Project Components
- Proposed Plant Site
- Proposed Coal Preparation Facilities

Transmission Facilities
- Proposed Transmission Line
- Alternative Transmission Line

Other Facilities
- Water Well Field Utility Corridor

Access Road
- Proposed Access Road Alignment

Well Field
- Alternative Water Well Field Area A
- Proposed Water Well Field Area B

Coal Source
- Areas IV South and V of the BNCC Lease Area

Source:
URS Corporation 2005, 2006
BHP_Billiton 2005
EcoSphere 2005
New Mexico Resource Geographic Information System (RGIS) 1988
UTM, NAD83, Zone12, Meters

0 2.5 5
Miles

N S E W

FIGURE 3-19
EXISTING TRANSPORTATION NETWORK

Sithe Global Power, LLC
Desert Rock
Energy Project

DPA

URS

alignment. The north-central portion of the segment can be accessed by exiting U.S. Highway 64 at BIA 362, then east on N36, south on N556, along Morgan Lake, then west on U-4 to the proposed alignment. The northernmost portion of the segment can be reached by the same route as the central portion, but by following N556 directly to the proposed alignment. Transmission Line Segment C parallels an existing 345kV transmission line and a portion of an existing 500kV transmission line; therefore, access routes associated with these lines could be used to access points along the proposed segment.

Transmission Line Segment D

Transmission Line Segment D can be accessed primarily from points exiting U.S. Highway 64, which runs approximately through the center portion of the segment. The northern portion of this segment can be accessed by exiting U.S. Highway 64 at BIA 564 northeast to the proposed alignment, or by exiting U.S. Highway 64 at Hogback Canal Road northeast and following this road east to the proposed alignment. The southern portion (south of U.S. Highway 64) can be accessed primarily by exiting U.S. Highway 64 at Hogback Main Canal Road and following the road east to the proposed alignment. This portion can also be accessed by exiting U.S. Highway 64 at BIA 362 and traveling south to N36 connecting to the alignment in multiple locations along N36. Continued travel on N36 and then south on BIA 556 to west on U-3 will allow access to the southernmost part of Segment D. Transmission Line Segment D parallels an existing 345kV transmission line, therefore; access routes associated with this line could be used to access points along the proposed segment.

3.11.3.3.3 Alternative Transmission Line Segment B

Existing Transportation Routes

Various existing transportation routes exist within the study area as discussed in the previous sections; however, the most relevant continuous transportation routes for Transmission Line Segment B are U.S. Highway 491 and Burnham Road.

Existing Access

The northern portion of Transmission Line Segment B can be accessed directly by exiting U.S. Highway 491 at BIA 5083 and traveling east. Southern access can be gained by exiting U.S. Highway 491 at BIA 5017 and traveling southeast to the proposed alignment. Access from the east can be gained by exiting Burnham Road (BIA 5082 segment) at U-1, traveling west to U-2, and connecting to the alternative's southern terminus.

3.11.3.4 Utility Corridor/Water Pipeline/Water Well Field (Alternatives A and Proposed B)

3.11.3.4.1 Existing Transportation Routes

U.S. Highway 491 is the primary continuous transportation route traveling north to south near the water pipeline utility corridor. N5 is the primary east to west traveling continuous transportation route south of the corridor, while U.S. Highway 64 is the primary east to west traveling continuous transportation route north of the corridor.

3.11.3.4.2 Existing Access

Access to the utility corridor west of U.S. Highway 491 can be gained by exiting U.S. Highway 491 at U-6. The entire U-6 segment travels west along the utility corridor until reaching its western terminus at Alternative A water well field. Access to the Utility Corridor east of U.S. Highway 491 can be gained by exiting U.S. Highway 491 at BIA 5017 and traveling southeast until intersection with the corridor. Once intersection with the corridor is made, BIA 5017 travels along the remaining length of the corridor to its eastern terminus.

3.11.3.5 Proposed Access Road

The easternmost portion of the proposed access road would be accessed by following N3005 to Burnham Road (BIA 5085 segment). The central portion of the alignment can be accessed by exiting Burnham Road (BIA 5082 segment) at U-7 and traveling east directly to the alignment. The westernnmost portion of the alignment cannot currently be accessed.

3.11.3.6 BNCC Lease Area – Areas IV and V

3.11.3.6.1 Existing Transportation Routes

Burnham Road is the primary continuous transportation link running north to south in Areas IV and V, while the primary continuous transportation link running east to west is U.S. Highway 64 to the north and N5 to the south.

3.11.3.6.2 Existing Access

Area IV North

The BNCC Lease Area IV North can be accessed by Burnham Road (BIA 5082 segment), which travels north and south through the center of the lease area. U-1 and U-7 also provide access to interior portions of Lease Area IV from exits off of Burnham Road.

Area IV South

The BNCC Lease Area IV South can be accessed by Burnham Road (BIA 5082 segment) traveling north and south through the center of the BNCC Lease Area.

Area V

The BNCC Lease Area V can be accessed by primarily by Burnham Road (BIA 5082 segment), which travels through the center of the BNCC Lease Area. Interior portions also can be accessed by exiting Burnham Road at U-11 or U-12.

3.11.3.7 Water Well Field

3.11.3.7.1 Existing Transportation Routes

The primary continuous transportation route to access the Water Well Field Alternative A area is U.S. Highway 491 (north-south traveling route. Access to Water Well Field Alternative B would be similar to accessing the power plant and transmission line Segment A as discussed previously.

3.11.3.7.2 Existing Access

Access to the water well field alternative is primarily obtained by exiting U.S. Highway 491 at U-6 and traveling west to the site. Northernmost access can be gained by exiting U.S. Highway 491 at BIA 5010, traveling west to U-10 and then south on U-10 to the water well field. Southernmost access can be achieved by exiting U.S. Highway 491 at BIA 5014, traveling west to U-10 and then north on U-10 to the water well field.

3.12 NOISE AND GROUND VIBRATIONS

3.12.1 <u>Introduction</u>

The following discussion describes the fundamentals of acoustics, the results of a detailed site reconnaissance, and sound level measurements. Throughout the section, the term “site” will be used to identify the center of the proposed power plant facility.

3.12.1.1 Fundamentals of Acoustics

Noise is generally defined as loud, unpleasant, unexpected, or undesired sound that is typically associated with human activity and that interferes with or disrupts normal activities. Although exposure to high noise levels has been demonstrated to cause hearing loss, the principal human response to environmental noise is annoyance. The response of individuals to similar noise events is diverse and influenced by the type of noise, the perceived importance of the noise and its appropriateness in the setting, the time of day and the type of activity during which the noise occurs, and the sensitivity of the individual.

Sound is a physical phenomenon consisting of minute vibrations that travel through a medium, such as air, and are sensed by the human ear. Sound is generally characterized by several variables, including frequency and intensity. Frequency describes the pitch of the sound and is measured in Hertz (Hz), while intensity describes the sound’s loudness and is measured in decibels (dB). Decibels are measured using a logarithmic scale. A sound level of 0 dB is approximately the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level of approximately 60 dB. Sound levels above about 120 dB begin to be felt inside the human ear as discomfort and eventually pain at still higher levels. The minimum change in the sound level of individual events that an average human ear can detect is about 1 to 2 dB. A 3 to 5 dB change is readily perceived. A change in sound level of about 10 dB is usually perceived by the average person as a doubling (or if -10 dB, halving) of the sound’s loudness.

Due to the logarithmic nature of the decibel unit, sound levels cannot be added or subtracted directly and are somewhat cumbersome to handle mathematically. However, some simple rules are useful in dealing with sound levels. First, if a sound’s intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example: 60 dB + 60 dB = 63 dB, and 80 dB + 80 dB = 83 dB.

Sound level is usually expressed by reference to a known standard. This report refers to sound pressure level. In expressing sound pressure on a logarithmic scale, the sound pressure is compared to a reference value of 20 micropascals (μPa). Sound pressure level depends not only on the power of the source, but also on the distance from the source and on the acoustical characteristics of the space surrounding the source.

Hz is a measure of how many times each second the crest of a sound pressure wave passes a fixed point. For example, when a drummer beats a drum, the skin of the drum vibrates a number of times per second. When the drum skin vibrates 100 times per second it generates a sound pressure wave that is oscillating at 100 Hz, and this pressure oscillation is perceived by the ear/brain as a tonal pitch of 100 Hz. Sound frequencies between 20 and 20,000 Hz are within the range of sensitivity of the best human ear.

Sound from a tuning fork contains a single frequency (a pure tone), but most sounds one hears in the environment do not consist of a single frequency but rather a broad band of frequencies differing in sound level. The method commonly used to quantify environmental sounds consists of evaluating all frequencies of a sound according to a weighting system that reflects that human hearing is less sensitive at low frequencies and extremely high frequencies than at the mid-range frequencies. This is called "A-weighting," and the decibel level measured is called the A-weighted sound level (dBA). In practice, the level of a noise source is conveniently measured using a sound level meter that includes a filter corresponding to the dBA curve.

Although the dBA may adequately indicate the level of environmental noise at any instant in time, community noise levels vary continuously. Most environmental noise includes a mixture of noise from distant sources that creates a relatively steady background noise in which no particular source is identifiable. A single descriptor called the equivalent sound level (L_{eq}) may be used to describe sound that is changing in level. L_{eq} is the energy-mean dBA during a measured time interval. It is the "equivalent" constant sound level that would have to be produced by a given source to equal the acoustic energy contained in the fluctuating sound level measured. In addition to the energy-average level, it is often desirable to know the acoustic range of the noise source being measured. This is accomplished through the maximum L_{eq} (L_{max}) and minimum L_{eq} (L_{min}) indicators that represent the root-mean-square maximum and minimum noise levels measured during the monitoring interval. The L_{min} value obtained for a particular monitoring location is often called the acoustic floor for that location.

To describe time-varying character of environmental noise, the statistical noise descriptors L_{10}, L_{50}, and L_{90} are commonly used. They are the noise levels equaled or exceeded 10 percent, 50 percent, and 90 percent of the measured time interval. Sound levels associated with the L_{10} typically describe transient or short-term events, half of the sounds during the measurement interval are softer than L_{50} and half are louder, while levels associated with L_{90} often describe background noise conditions and/or continuous, steady-state sound sources.

Finally, another sound measure known as the Community Noise Equivalent Level (CNEL) is defined as the dBA for a 24-hour day. It is calculated by adding a 5-decibel penalty to sound levels during the evening period (7:00 P.M. to 10:00 P.M.) and a 10-decibel penalty to sound levels during the night period (10:00 P.M. to 7:00 A.M.) to compensate for the increased sensitivity to noise during the quieter evening and nighttime hours. The Day-Night Average Sound Level (L_{dn} or DNL) also represents the average sound level for a 24-hour day and is calculated by adding a 10-decibel penalty only to sound levels during the night period (10:00 P.M. to 7:00 A.M.). The CNEL and L_{dn} are typically used to define acceptable land use compatibility with respect to noise. Because of the time-of-day penalties associated with the CNEL and L_{dn} descriptors, the L_{eq} for a continuously operating sound source during a 24-hour period will be numerically less. Thus, for a power plant operating continuously for periods of 24 hours, the L_{eq} will be 6 dB lower than the L_{dn} value and 7 dB lower than the CNEL value. Sound levels of typical noise sources and environments are provided in Table 3-51 to provide a frame of reference.

Table 3-51 Sound Levels of Typical Noise Sources and Noise Environments

Noise Source (at a Given Distance)	Scale of A-Weighted Sound Level in Decibels	Noise Environment	Human Judgment of Noise Loudness (Relative to a Reference Loudness of 70 Decibels*)
Military jet take-off with after-burner (50 feet) Civil-defense siren (100 feet)	140 130	Aircraft carrier flight deck	
Commercial jet take-off (200 feet)	120		Threshold of pain 32 times as loud*
Pile driver (50 feet)	110	Rock music concert	16 times as loud*
Ambulance siren (100 feet) Newspaper press (5 feet) Power lawn mower (3 feet)	100		Very loud 8 times as loud*
Motorcycle (25 feet) Propeller plane flyover (1,000 feet) Diesel truck, 40 miles per hour (50 feet)	90	Boiler room Printing press plant	High urban ambient sound
Garbage disposal (3 feet)	80		
Passenger car, 65 miles per hour (25 feet) Vacuum cleaner (10 feet)	70	Data processing center Department store	
Normal conversation (5 feet) Air-conditioning unit (100 feet)	60	Private business office	
Light traffic (100 feet)	50		Lower limit of urban ambient sound
Bird calls (distant)	40	Quiet bedroom	
Soft whisper (5 feet)	30	Recording studio	
	20		
	10		

SOURCE: URS Corporation 2006

3.12.1.2 Fundamentals of Vibration

Vibration consists of waves transmitted through solid material (Baranek and Ver 1992). Unlike the case for gases and liquids, there are several types of wave motion in solids including compression, shear, and torsion and bending. The solid medium can be excited by forces, moments or pressure fields. This leads to the terminology "air-borne" (pressure fields) or "structure-borne/ground-borne" (forces and moments) vibration.

Ground-borne vibration propagates from the source through the ground to adjacent buildings by surface waves. Vibration may be composed of a single pulse, a series of pulses, or a continuous oscillatory motion. The frequency of a vibrating object describes how rapidly it is oscillating, measured in Hz. Most environmental vibrations consist of a composite, or "spectrum" of many frequencies, and generally are classified as broadband or random vibrations. The normal frequency range of most ground-borne vibration, which can be felt, generally starts from a low frequency of less than 1 Hz to a high of about 200 Hz. Ambient and source vibration information for this study has been measured in terms of the peak particle velocity (PPV) in inches per second that correlates best with human perception.

Vibration energy dissipates as it travels through the ground, causing the vibration amplitude to decrease with the distance away from the source. High-frequency vibrations reduce much more rapidly than do low frequencies, so that in the far-field from a source the low frequencies tend to dominate. Soil properties also affect the propagation of vibration. When ground-borne vibration interacts with a building there is usually a ground-to-foundation coupling loss; but the vibration also can be amplified by the structural resonances of the walls and floors. Vibration in buildings is typically perceived as rattling of windows, shaking of loose items, or the motion of building surfaces. The vibration of building surfaces also can be radiated as sound and heard as a low-frequency rumbling noise, known as ground-borne noise.

Ground-borne vibration is generally limited to areas within a few hundred feet of certain types of industrial operations, and construction activities, such as pile driving. Road vehicles rarely create enough ground-borne vibration amplitude to be perceptible to humans unless the receiver is in immediate proximity to the source or the road surface is poorly maintained and has potholes or bumps. If traffic, typically heavy trucks, does induce perceptible building vibration, it is most likely an effect of low-frequency air-borne noise or ground characteristics.

Building structural components also can be excited by high levels of low-frequency noise (typically less than 100 Hz). The many structural components of a building, excited by low-frequency noise, can be coupled together to create complex vibrating systems. The low frequency vibration of the structural components can cause smaller items such as ornaments, pictures, and shelves to rattle, which can cause annoyance to building occupants.

Human sensitivity to vibration varies by frequency and by perceiver. Generally people are more sensitive to low-frequency vibration. Human annoyance also is related to the number and duration of events; the more events or the greater the duration, the more annoying it becomes.

Construction activities also can produce varying degrees of ground vibration, depending on the equipment and methods employed. Ground vibrations from construction activities very rarely reach levels high enough to cause damage to structures, although special consideration must be made in cases where fragile historical buildings are near the construction site. The construction activities that typically generate the highest levels of vibration are blasting and impact pile driving.

Ground-vibration levels from construction activities vary considerably depending on soil conditions. Among the most important factors are the stiffness and internal damping properties of the soil and its depth to bedrock. Experience with ground-borne vibration suggests that vibration propagation is more efficient in stiff clay soils, and shallow rock seems to concentrate the vibration energy close to the surface and can result in ground-borne vibration problems at large distances from the source. Factors such as layering of the soil and depth to water table can have substantive effects on the propagation of ground-borne vibration. Table 3-52 presents PPV levels at a distance of 25 feet from measured data of various types of construction equipment (Federal Transit Administration 1995). Although the table gives one level for each piece of equipment, it should be noted that there is a considerable variation in reported ground-vibration levels from construction activities. The data provide a reasonable estimate for a wide range of soil conditions.

Table 3-52 Vibration Source Levels For Construction Equipment

Equipment		PPV at 25 Feet (inch per second)	Approximately L_V* at 25 Feet
Pile driver (impact)	Upper Range	1.518	112
	Typical	0.644	104
Pile driver (vibratory)	Upper Range	0.734	105
	Typical	0.170	93
Clam shovel drop (slurry wall)		0.202	94
Hydromill (slurry wall)	In soil	0.008	66
	In rock	0.017	75
Large bulldozer		0.089	87
Caisson drilling		0.089	87
Loaded trucks		0.076	86
Jackhammer		0.035	79
Small bulldozer		0.003	58

SOURCE: Federal Transit Administration 1995
NOTE: * Root-mean-square velocity in decibels (V dB) re 1 inch per second

Vibration from construction can be evaluated for potential impacts at sensitive receptors. Typical activities evaluated for potential building damage due to construction vibration include demolition, pile driving, and drilling or excavation in proximity to structures. The ground-borne vibration can also be evaluated for perception to reduce or eliminate annoyance or its likelihood. Vibration propagates according to the following expression, based on point sources with normal propagation conditions:

$$PPV_{equip} = PPV_{ref}\left(\frac{D_{ref}}{D}\right)^{1.5}$$

where: PPV_{equip} = the peak particle velocity in in/sec of the equipment adjusted for distance.
PPV_{ref} = the reference vibration level in in/sec at 25 feet (from Table 3-52)
D_{ref} = the reference distance (25 feet if using data (from Table 3-52)
D = the distance from the equipment to the receiver

The criteria for acceptable ground-borne vibration are expressed in terms of root-mean-square velocity levels in decibels and the criteria for acceptable ground-borne noise are expressed in terms of A-weighted sound level. The limits are specified for the three land use categories defined below:

Vibration Category 1 – High Sensitivity: Included in Category 1 are buildings where low ambient vibration is essential for the operations within the building, which may be well below levels associated with human annoyance. Typical land uses covered by Category 1 are: vibration-sensitive research and manufacturing, hospitals with vibration-sensitive equipment, and university research operations.

Vibration Category 2 – Residential: This category covers all residential land uses and any buildings where people sleep, such as hotels and hospitals.

Vibration Category 3 – Institutional: This category includes schools, churches, other institutions, and quiet offices that do not have vibration-sensitive equipment, but still have the potential for activity interference.

The power plant would have a conveyor to transport coal between locations. Such equipment is central to such a facility; therefore vibrations generated would likely dissipate to operationally acceptable levels prior reaching the property limits of the plant. Higher levels may possibly stem from usage of a pulverizer, pile driver, or controlled blasting for earth-moving purposes. However, construction-related vibration yields only a minor impact due to its temporary nature.

3.12.2 Existing Conditions

Noise-sensitive receptors are defined as land uses associated with indoor and outdoor activities that may be subject to stress or significant interference from noise. They include residential dwellings, mobile homes, hotels, motels, hospitals, nursing homes, educational facilities, and libraries.

A series of sound-level measurements were taken on March 22 and 23, 2006 at the closest residences southeast of the proposed project site to quantify the existing noise environment. Two types of measurements were conducted: short-term (1-hour duration) and long-term (24-hour duration). The results of the short-term measurement are summarized in Table 3-54. The measurement locations are shown in Figure 3-20.

Table 3-53 Ground-Borne Vibration and Noise Impact Criteria

Land Use Category	Ground-Borne Vibration Impact Levels (VdB[1] re 1 micro inch/sec)		Ground-Borne Noise Impact Levels (dB re 20 micropascals)	
	Frequent[2] Events	Infrequent[3] Events	Frequent[2] Events	Infrequent[3] Events
Category 1	65*	65*	**	**
Category 2	72	80	35	43
Category 3	75	83	40	48

SOURCE: FTA Transit Noise and Vibration Impact Assessment (1995)

NOTES: [1] VdB = Velocity Decibels

[2] Frequent Events is defined as more than 70 vibration events per day. Most rapid transit projects fall into this category.

[3] Infrequent Events is defined as fewer than 70 vibration events per day. This category includes most commuter rail systems.

* This criterion limit is based on levels that are acceptable for most moderately sensitive equipment such as optical microscopes. Vibration sensitive manufacturing or research will require detailed evaluation to define the acceptable vibration levels. Ensuring lower vibration levels in a building often requires special design of the heating, ventilation, and air conditioning systems and stiffened floors.

** Vibration-sensitive equipment is not sensitive to ground-borne noise.

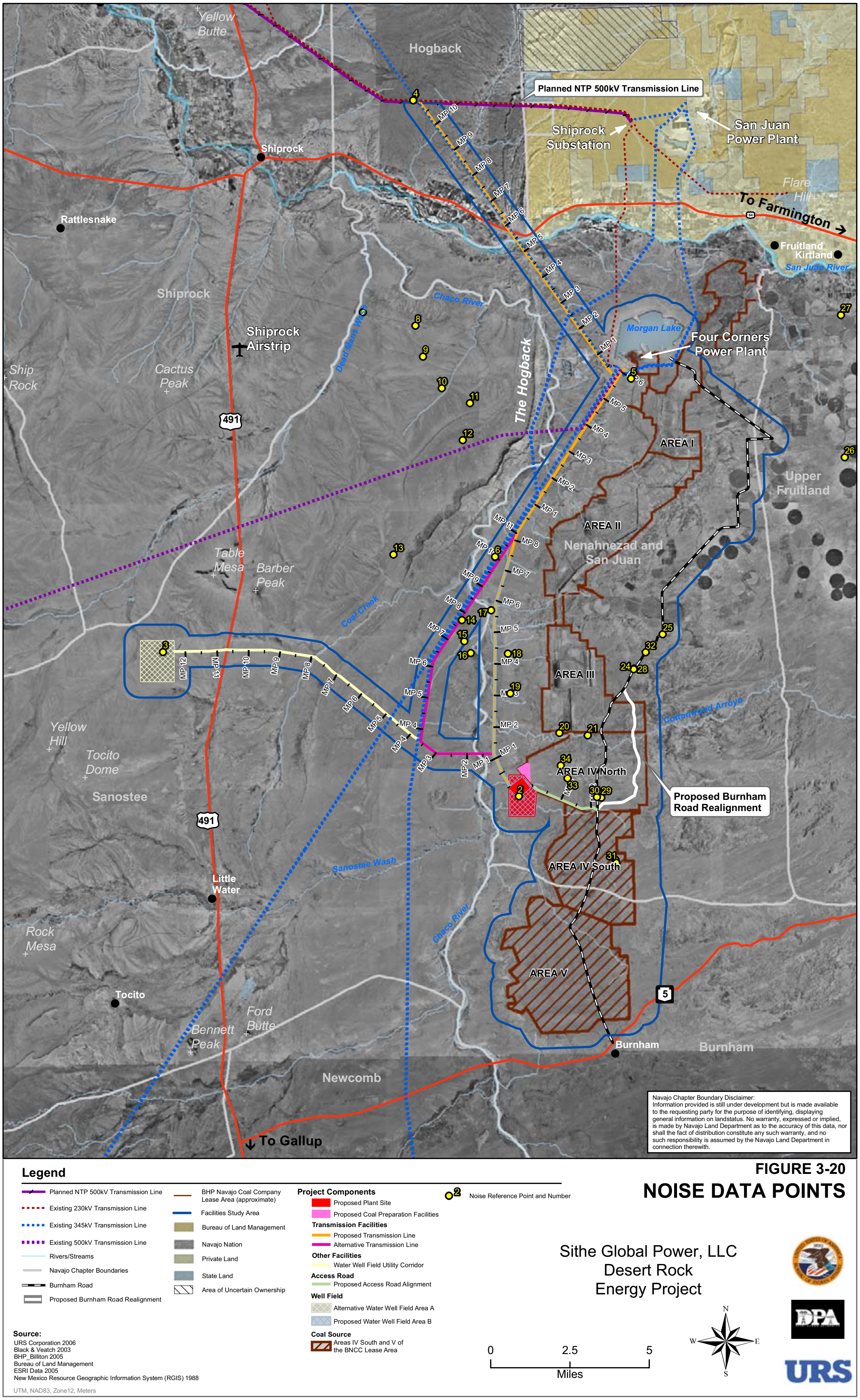


FIGURE 3-20
NOISE DATA POINTS

Table 3-54 Short-Term Sound Level Measurement (dBA)

Measurement Identification	Location Description	Time	L_{eq}	L_{min}	L_{max}	L_{10}	L_{50}	L_{90}
ST1	Residence B	18:00-19:00	43	25	57	47	39	32
		00:0-01:00	23	19	40	25	21	20

SOURCE: URS Corporation 2006

3.12.2.1 Power Plant

The proposed power plant site is located in a vast flat area adjacent to the BNCC Lease Area. The site is centrally located among a perimeter of mesas. The topography within a 2,600 feet radius of the proposed site is within an elevation of 60 feet in respect to the site itself. Beyond this radius up to a circumference 2 miles distant from the site the elevation of the topography over this respective area fluctuates from -110 feet to +170 feet.

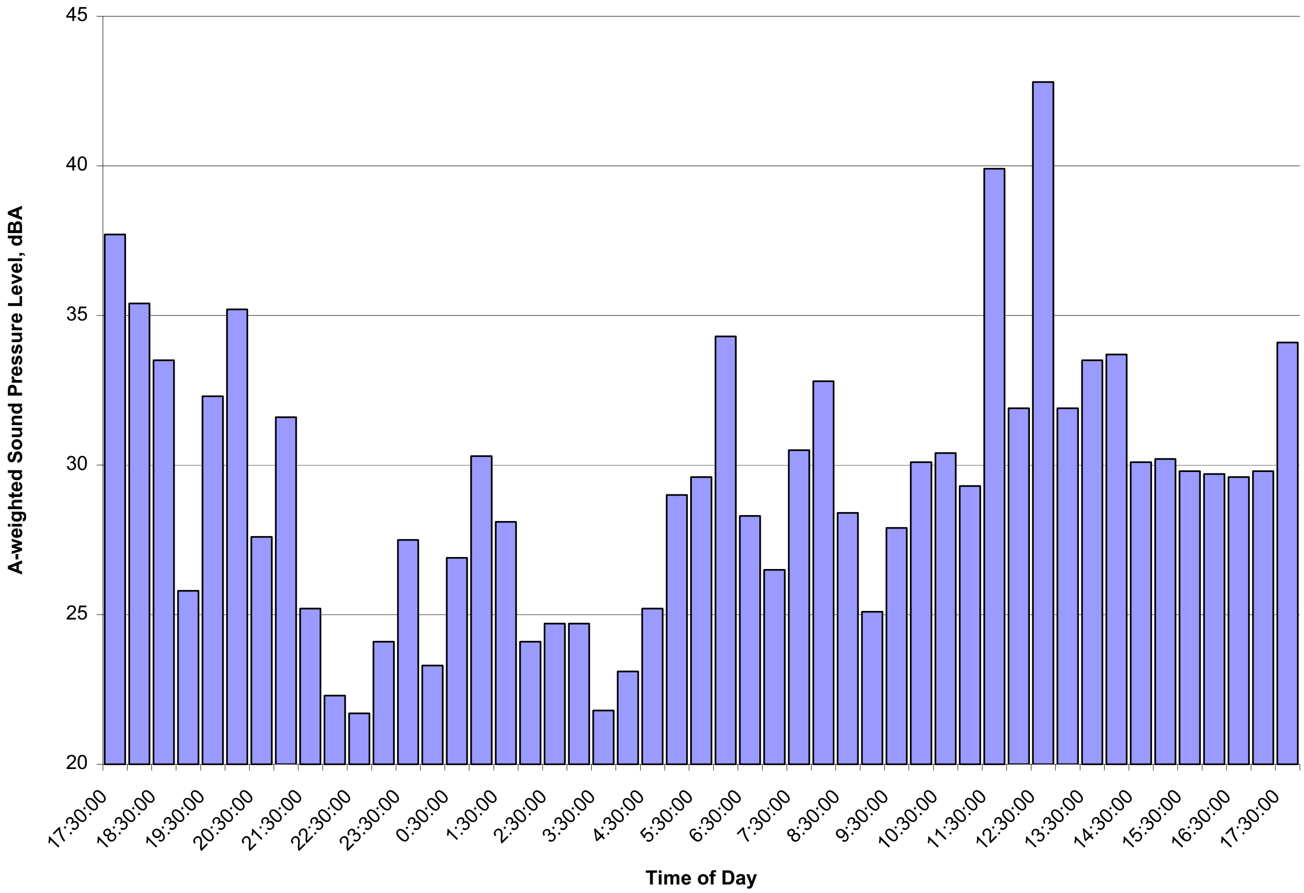
The roadways near the facility are unpaved. BIA 5082 is a major access road 2.5 miles to the east of the proposed site. The width and grade of this unpaved road suggests that it may have been used for utility traffic as well as local traffic. An undeveloped path passes 80 feet to the north of the acoustical center of the proposed site.

There are four residences within 3 miles of the proposed plant site: one approximately 1.5 miles northeast, one approximately 2 miles northeast, one approximately 2.5 miles east, and one approximately 3 miles southeast. The residences to the northeast do not have a direct line of sight to the proposed power plant due to intervening topography. The residence to the east (Residence A) is approximately 160 feet higher in elevation than the proposed power plant, but does not have a direct line of sight due to intervening hills. The residence to the southeast (Residence B) is approximately 174 feet higher in elevation the proposed plant location and is situated on a mesa; therefore, it has a direct line of sight to the proposed site.

The following information details the measurement locations.

Short-Term Site 1 (ST1): Two 1-hour measurements were conducted during the daytime and nighttime at Residence B, approximately 3 miles southeast of the proposed plant location. The daytime measurement was taken between 6:00 and 7:00 P.M. on March 22, 2006. The nighttime measurement was taken between 12:00 and 1:00 A.M. on March 23, 2006. The site topography was similar to the proposed site and slightly elevated, within 50 feet. There are no stationary noise sources between the plant and this measurement site. The land is flat and sparsely covered by vegetation. The dominant daytime noise sources were the wind and the wind-induced vegetation noise. A combination of jet and propeller planes flew over the measurement site during this measurement. No traffic was observed during the measurements. Nighttime noise sources consisted of aircraft overflights and distant dog barking, and coyote howling. The daytime one-hour L_{eq} was 43 dBA and the nighttime one-hour L_{eq} was 23 dBA.

Long-Term Site 1 (LT1): A 24-hour measurement was conducted on a moderate hill with sparse desert vegetation 290 feet from BIA 5082, which was representative of Residence A. This measurement location is approximately 2.5 miles east of the acoustical center of the plant site. The measurement location is approximately 2 miles due south of the BNCC Lease Area. The measurement was taken between 6:30 P.M. on March 22, 2006 and 6:30 P.M. on March 23, 2006. Daytime noise sources were dominated



by wind noise but also consisted of wind induced brush noise, distant operational noise from the BNCC Lease Area, and infrequent vehicular traffic on BIA 5082.

Figure 3-21 Hourly Intervals of Long-Term Site 1

Nighttime noise sources consisted of mining equipment (front loader) noise and engine whine, occasional aircraft overflight, distant dog barking, and coyote howling. The 30-minute L_{eq} ranged from 21 to 43 dBA (average = 32 dBA). The 30-minute L_{90} ranged from 18 to 41 dBA (average = 21.4 dBA). Figure 3-21 shows the hourly intervals of LT1. Relative to the aforementioned distance to the BNCC Lease Area, the midday peaks approaching and exceeding 40 dBA may be indicative of blasting.

Sound levels at the residences to the northeast are expected to be similar to the long-term measurement, due to the similarity of topography, atmospheric effects, and proximity of noise sources. Therefore, additional noise measurements were not conducted at these residences.

3.12.2.2 Transmission Lines

The general study area was surveyed on March 22, 2006. Visual inspection was used to determine the proximity and potential affect the proposed transmission line would have on the existing area.

The existing 345 kV transmission line is adjacent to a mountain ridgeline on the west and is predominantly open and uninhabited. The ridgeline extends in a northwestern direction. The land to the east and south of the transmission line is arid and open. Rolling hills are the general topography. Two residences were found within 2 miles of the existing 345kV transmission line. These residences are in direct line of sight with the transmission lines. The BNCC Lease Area is approximately 3.5 miles to the east of the transmission line. The operational engine noise from the mining equipment, specifically the front loaders and cranes, is the dominating noise source as no other activity was found.

The existing 500kV transmission line is on the western side of the mountain ridgeline mentioned earlier. This western side of the ridgeline has a growing pastoral use. The land has more vegetation, though not much. The western side of the ridgeline has a flatter topography in relation to its eastern side. One residence was found within 2,600 feet of the existing 500kV transmission line. One additional residence was sighted within 3 miles away.

Existing sound levels along the transmission line are expected to be similar to the long-term measurement, due to the similarity of topography, atmospheric effects, and proximity of noise sources. Therefore, additional noise measurements were not conducted at these residences.

3.12.2.3 Proposed Transmission Line Segments A, C, and D

Transmission Line Segment A originates from the proposed power plant site extending northwards 7.5 miles. Segment C originates approximately 7.5 miles north of the plant and extends north-northeast 7.4 miles towards Morgan Lake. Segment D originates at the southern extent of Morgan Lake and extends approx. 10.8 miles north-northwest.

The alignment of Segment A extends north and is parallel to a peaking ridgeline. The area is currently used for pastoral purposes; the boundaries for such are not defined. The arid and sparsely vegetated area is common along the line. The topography is flat as the elevation along the transmission line only varies ±20 feet from the highest to lowest points. There are three residences within 2,600 feet along the run, measured perpendicularly. The residences are each on top of their respective hill. A direct line of sight to the transmission line is likely. The mine is approximately 100 feet higher than the base of the proposed transmission line poles. The equipment operation and potential blasting at the BNCC Lease Area, 1.6 miles to the east, is the only identifiable noise source.

Transmission Line Segment C, beginning approximately 7.5 miles north of the plant and extending towards Morgan Lake, is on the eastern side of a mountainous ridgeline nearly 1,000 feet higher than the immediately surrounding topography. The area is currently used for pastoral purposes; the boundaries for such are not defined. The arid and sparsely vegetated area is common along the line. The proposed transmission line segment is parallel to two existing 345kV transmission lines. The closest receptors are a school and a residence that are each approximately 3 miles west of the transmission line, but are shielded by the ridgeline. The BNCC Lease Area is 3.2 miles to the southeast of the beginning of Segment C. The mine is approximately 100 feet higher than the base of the proposed line transmission line poles. There is no direct line of sight from the BNCC Lease Area to Segment C.

Transmission Line Segment D crosses land of varying use. Starting at Morgan Lake, it crosses New Mexico State Route 64. The State Route 64 corridor is more densely populated than either of the termination sites for this proposed line. The State Route 64 corridor is in a valley. From Morgan Lake to the termination point of the transmission line the elevation gradually decreases. No receptors were identified along Segment D.

Existing sound levels along the transmission line are expected to be similar to the long-term measurement, due to the similarity of topography, atmospheric effects, and proximity of noise sources.

3.12.2.4 Alternative Transmission Line Segment B

Transmission Line Segment B extends northwest from the plant approximately 2.5 miles, turns north for 2.5 miles, then north-northeast for approximately 4 miles. Segments A and B meet at a common junction with Segment C approximately 7.5 miles north of the power plant site.

No residences were found within 2 miles of Segment B. The land use is consistent with the area near power plant. This area is hilly and barren with sparse vegetation. The area is currently used for pastoral purposes; the boundaries for such are not defined. The arid and sparsely vegetated area is common along the line.

Existing sound levels along the transmission line are expected to be similar to the long-term measurement, due to the similarity of topography, atmospheric effects, and proximity of noise sources.

3.12.2.5 Water Well Field Alternatives

Land uses adjacent to the Water Well Field Alternative A area are open or pastoral. Grazing cattle and a watering hole was found. The general topography around the well field is flat and the well itself is stationed in a valley. Several important geological features were noted. The first features are the Table Mesa and Barber Peak situated approximately 2.5 miles to the northeast. Hogback Mountain lies approximately 2 miles to the east. Finally, there is Coal Creek approximately 3.5 miles to the east. Land uses around the project as well as the current land use of the property, where the proposed water well field would be located, consists of open landscape. No sensitive receptors were identified within 2 miles of the water well field site.

Existing sound levels along the transmission line are expected to be similar to the long-term measurement, due to the similarity of topography, atmospheric effects, and proximity of noise sources. For the Proposed Water Well Field B, existing acoustical data can be found in the sections pertaining to the power plant site proper and within Transmission Line Segment A discussed previously.

3.12.2.6 Utility Corridor/Water Pipeline

The general area for the water pipeline was surveyed on March 22, 2006. The proposed water-supply-pipeline corridor extends north-westward from the proposed power plant site. The area immediately surrounding the utility line was a combination of pastoral and otherwise barren landscape. No residences were identified 2 miles of the utility corridor. The land use is consistent with the area near the power plant site. This area is hilly and barren with sparse vegetation. The area is currently used for pastoral purposes;

the boundaries for such are not defined. The sparsely vegetated area is common along the proposed pipeline corridor.

Existing sound levels along the transmission line are expected to be similar to the long-term measurement, due to the similarity of topography, atmospheric effects, and proximity of noise sources.

3.12.2.7 Access Roads

The general area in for the access roads was surveyed on March 22, 2006. The proposed access roads were not yet developed to the extent of some existing, but unpaved roads in the vicinity of the BNCC Lease Area.

Proposed Access Road A does not currently exist as a discernible roadway. Alternative A begins at the power plant site and travels east to the realign portion of Burnham Road. The land use is consistent with the area near the proposed power plant. This area is hilly and barren with sparse vegetation. The area is currently used for pastoral purposes; the boundaries for such are not defined. The arid and sparsely vegetated area is common along the proposed access road.

3.12.2.8 BNCC Lease Areas IV and V

The land uses on which Areas IV South and V reside are predominantly open landscape. Residences exist sporadically through the coal lease areas. The residents are either pastoral workers or farm hands. Therefore, land uses adjacent to the study area can be defined as pastoral or open. The topography of the land is predominantly flat from north to south, although there is an east-to-west decline in Areas IV South and V. The existing noise environment around noise sensitive areas is dominated by wind interacting with vegetation on the desert surface. Other noise sources include propeller and jet aircraft overflights, which occur at a relatively high frequency, barking from dogs, mooing cows, and other noise-producing wildlife.

3.13 PUBLIC HEALTH

3.13.1 Introduction

Section 3.1.2 provided information on the chemicals emitted from existing sources in the area, including power plants, and provided current concentrations of criteria pollutants in ambient air (refer to Table 3-3). The concentrations of the criteria pollutants meet the requirements of air regulations regarding the amount of chemicals allowed in ambient air; therefore, health effects from existing conditions for the chemicals associated with power plant emissions are likely minimal. This section provides information regarding the health basis of the existing air regulations and discusses the chemicals (of those being emitted from the existing power plants) that are most likely to be a health concern should concentrations increase above the air regulation limits with the addition of the proposed facility. Finally, this section examines the ways in which air emissions might reach people living in the region. The discussion is generally divided among the criteria pollutants, including particulate matter (PM_{10} and $PM_{2.5}$), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), lead (Pb), and carbon monoxide (CO) and numerous other chemicals, referred to as "air toxics," as health effects from these broad groupings are assessed under different regulatory programs that use different methodologies.

For a more detailed discussion on public health, please see Appendix J.

3.13.2 Existing Concentrations, Acceptable Concentrations, and Public Health

The ambient concentrations of criteria pollutants in the vicinity of the proposed project currently meet Federal and state air quality levels, and under current conditions, are anticipated to have minimal to no adverse health impacts. In general, the USEPA process for establishing NAAQS is exhaustive and thorough. Their mandate is to protect human health with an adequate margin of safety. Federal regulations require all six of the NAAQS (e.g., the criteria pollutants) be evaluated periodically to ensure they remain health protective. Each of these evaluations represents an extensive process consisting of examining the available health data and assessing whether the existing air concentration standard is adequately health-protective. In addition, an independent committee of non-EPA experts conducts peer review of the USEPA's work and provides the USEPA Administrator with advice and recommendations regarding the scientific adequacy of USEPA's evaluation. For example, USEPA's most recent review for particulates, entitled Air Quality Criteria for Particulate Matter, Volumes I – II (USEPA 2004c), consists of literally thousands of pages summarizing and evaluating the many health studies that address particulates. USEPA evaluates the entire body of available data and evaluates the data for "coherence." Determination of coherence involves:

- Examining all the epidemiological studies, including those that did not find an association between a pollutant and an adverse health outcome;
- Reviewing medical and toxicological data for consistency across a variety of health outcomes;
- Reviewing observational data at varying levels of ambient particulate matter in different populations with different circumstances and at different locations, and seeing how that information coordinates with the medical and toxicological data; and
- Evaluating how background concentrations, measurement, and analytical techniques could affect study results.

USEPA has completed its latest health information review of particulates in 2004 and has made recommendations to policy makers that some of the NAAQS levels for particulates should change. These recommended changes were promulgated into law in December 2006. Specifically, USEPA has finalized the regulations indicating the PM_{10} annual standard be dropped as without health benefits, but has retained the 24-hour PM_{10} standard (USEPA 2006h).

For $PM_{2.5}$, the USEPA's recent recommendations have resulted in retaining annual standard of 15 $\mu g/m^3$ combined with lowering the 24-hour standard to 35 $\mu g/m^3$. The $PM_{2.5}$ background concentrations in the area of the proposed plant shown on Table 3-4 are below the current December 2006 revisions to NAAQS.

Information regarding current ambient concentrations of air toxics in New Mexico is not available. There are no Federal ambient air quality standards for air toxics; however, there are guideline levels, including:

- USEPA Region 9 chronic Preliminary Remediation Goals for ambient air (USEPA 2004b);
- USEPA National Advisory Committee Acute Exposure Guideline Levels (USEPA 2006e);
- American Industrial Hygiene Association Acute Emergency Response Planning Guidelines (American Industrial Hygiene Association 2005); and
- U.S. Department of Energy acute Temporary Emergency Exposure Limits (U.S. Department of Energy 2006).

In addition some states have published or promulgated guidelines for air toxics, including:

- New Mexico Toxic Air Pollutants occupational exposure levels and allowed emission rates (New Mexico Air Quality Board 2006b);
- California EPA acute and chronic reference exposure levels and unit risk factors (California EPA 2006); and
- Arizona Ambient Air Quality Guidelines for 1-hour, 24-hour, or annual exposures (Arizona Department of Environmental Quality 1999).

In general, establishing guidelines and standards for air toxics is not the lengthy and rigorous procedure required for the criteria pollutants; however, guidelines and standards are peer reviewed, periodically updated, and based on the best available health information. Like the criteria pollutants, the USEPA's guidelines and standard recommendations for air toxics are established to protect public health with an adequate margin of safety.

3.13.3 Chemicals of Potential Concern

3.13.3.1 Criteria Pollutants

Existing concentrations are at or below acceptable levels for the criteria pollutants; however, the purpose of the EIS is to address whether the emissions that would be emitted from the proposed power plant would add incrementally to the chemicals already present. While the evaluation of the plant emissions on the existing environment is presented in Chapter 4, general information on the chemicals associated with power plants that likely would be the greatest health concern are introduced here, both for the criteria pollutants and air toxics. Many of these chemicals, in varying amounts, are currently being emitted by industrial sources within the study area.

With regard to the seven criteria pollutants, the particulate matter formed in the atmosphere through oxidation of emitted SO_2 and NO_x associated with coal-fired power plants is generally of greatest health concern (International Energy Agency 2003), and these secondary particulates are more closely associated with mortality and morbidity than gaseous SO_2 or NO_x (Levy and others 2004). The majority (usually in excess of 99 percent) of the particulate matter produced directly by coal-fired power plants are captured by the plant filtration system; however, the gaseous SO_2 and NO_x form into particulate matter when emitted to the atmosphere due to complex chemical reactions in the air (USEPA 2004e). Consequently, the make-up of the particulates that form from power plant emissions is primarily sulfates and nitrates with some limited unburned carbon (Electric Power Research Institute 2005b). The size of the particulates that form from power plant gaseous emissions are very small, $PM_{2.5}$ or smaller. Of the PM_{10} emissions data presented in Section 3.1.2.4, the majority of the particulate matter emitted from power plant emissions is likely to be less than 2.5 micrometers in diameter (USEPA 2004e). Size is an important issue where public health is concerned because the most toxic effects appear to be related to particles of 2.5 micrometers in diameter and less. This is due to the fact that smaller particles are inhaled more deeply into the lungs while larger particles are more likely to be filtered out by the upper respiratory tract. Possible health effects from combined exposures to existing and proposed plant emissions for SO_2, NO_x, and particulates are discussed in Section 4.13.

Of the remaining three priority pollutants, ozone, lead, and carbon monoxide, ozone is possibly the next most important from a public health perspective after particulates in the area of the site. Ozone is not directly emitted from coal-fired power plants, rather ground-level ozone is produced when NO_x combines with VOCs in the presence of sunlight. Power plants emit negligible amounts of VOCs, but NO_x is a common by-product of coal burning power plants.

Motor vehicle exhaust and power plants are the primary contributors to NO_x in ambient air. Some research indicates that in urban areas, NO_x emitted from tall stacks (i.e., power plants), is less of a concern for ground-level ozone formation than cars (Electric Power Research Institute 2005a). How much of the NO_x emitted from power plants contributes to ground-level ozone formation is difficult to determine because ozone formation depends on many different climate variables combined with different emission sources. Adding further complexity, ozone formation conditions can vary rapidly and may change from hour to hour. As shown on Table 3-4, current ozone levels in the Four Corners area approach Federal and state air quality standards (University of New Mexico 2004). However, a recent study by the New Mexico Environmental Department concluded that even with proposed new sources (including Desert Rock), ozone concentrations would continue to meet standards and even decrease slightly in the period up to 2012 (www.nmenv.state.nm.us/ozonetf). With regard to the remaining two criteria pollutants, current local air levels of carbon monoxide are orders of magnitude below ambient air quality criteria and are very unlikely to present a health concern (see Table 3-4). Local air concentrations are not available for lead, but New Mexico is considered an "attainment" area, e.g., airborne lead concentrations are below the NAAQS at every location for which lead is monitored, both in New Mexico and in the surrounding states (USEPA, 2001). Therefore, current levels of lead are also very unlikely to be present at levels that are a health concern.

3.13.3.2 Air Toxics

There are approximately 60 air toxic chemicals (also called hazardous air pollutants or HAPs) that can be emitted from coal-fired power plants, based on USEPA evaluations of bituminous coal combustion (USEPA 1998a), including VOCs, semi-volatile organic compounds (SVOC) (e.g., dioxins/furans), and metals (e.g., mercury, arsenic, chromium VI [Cr VI]). Not all of these chemicals will necessarily be emitted from the proposed Desert Rock power plant, or are being emitted from the six existing coal-fired power plants in the area because of variations that are the result of the specific type of coal, control technology, and combustion processes used. Four air toxics (mercury, arsenic, CR VI, and monomethyl hydrazine) were selected for further discussion in this section. Mercury was selected because concerns were raised during the scoping process about current exposure to mercury and potential bioaccumulation of mercury in the environment. Arsenic, CR VI, and monomethyl hydrazine were selected because, based on emission rates calculated for the proposed plant for the air permitting process, predicted contributions of arsenic, Cr VI, and monomethyl hydrazine to annual air concentrations were within one order of magnitude of protective (health-based) air concentrations. Concentrations of other air toxics (including mercury) were at least two orders of magnitude less than protective (health-based) air concentrations (Appendix J).

Mercury: Mercury occurs naturally in the environment in several forms—elemental mercury, inorganic mercury, and organic mercury (Agency for Toxic Substances and Disease Registry [ATSDR] 1999). Elemental mercury is the pure form of mercury. Inorganic mercury compounds occur when mercury combines with elements (such as chlorine, sulfur, or oxygen). Elemental and inorganic mercury can enter the air from mining, from the emissions of coal-fired power plants, from burning municipal and medical waste, from the production of cement, and from uncontrolled releases in factories that use mercury (ATSDR 1999). Inorganic mercury does not accumulate up the food chain to any degree. Stack emissions from power plants include both vapor (elemental and oxidixed [Hg+2] mercury) and particulate forms (inorganic mercury as mercuric chloride [Hg+2]; USEPA 2005b). As reported in USEPA 2005b, most of the mercury that exits the stack is not deposited in the immediate vicinity of the site but enters the global mercury cycle via dispersion through the atmosphere.

Mercury is present at low levels in air, water, and food (ATSDR 1999). Background levels of mercury in air in rural settings are generally 0.006 µg/m³ or less. Between 0.010 and 0.020 µg/m³ of mercury have been measured in urban outdoor air (ATSDR 1999). These levels are lower than levels considered to be safe to breathe (Section 3.13.2). Information regarding current concentrations of mercury in air in the 31-mile (50-km) air quality study area was not located.

While a portion of the mercury present in industrial emissions is deposited in surrounding soil, almost all the deposited mercury will be inorganic, rather than organic mercury (USEPA 2005b). In addition, mercury is naturally present in soil (typically within 10 km of the emitting facility [USEPA 2005b]). The USGS (1984) reported that the geometric mean, arithmetic mean, and range of naturally occurring mercury in soil in the western United States is 0.046, 0.065, and <0.01 to 4.6 milligrams per kilogram (mg/kg), respectively. The concentration of mercury in shallow soil (6 inches or less bgs) in San Juan County ranged from <0.01 to 0.03 mg/kg (Table 3-55). For soil of unspecified depth, the concentration of mercury in San Juan County ranged from <0.01 to 0.04 mg/kg (Table 3-55). The concentrations of mercury in twenty-four surface soil samples collected in 2006 within a 25-km radius air impact area ranged from 0.0051 to 0.03 mg/kg (Table 2.1-1 in Appendix J).

Table 3-55 Arsenic, Chromium, and Mercury in Soil Samples in San Juan County

	Arsenic		Chromium		Mercury	
Database Category(1)	**Number of Samples**	**Range of Concentrations (mg/kg)**	**Number of Samples**	**Range of Concentrations (mg/kg)**	**Number of Samples**	**Range of Concentrations (mg/kg)**
Surface soil	9	2.39 to 4.12	9	5 to 10	9	< 0.01 to 0.03
Soil, 0-6"	11	1 to 25	22	7 to 70	11	< 0.01 to 0.03
Soil - 6"	9	1.6 to 13	9	5 to 17	9	< 0.01 to 0.02
Total for Shallow Soil	**29**	**1 to 25**	**40**	**5 to 70**	**29**	**< 0.01 to 0.03**
Soil	55	2 to 40	55	7 to 140	4	0.02 to 0.02
Soil under Native Vegetation	49	2.1 to 9.4	49	5.4 to 47	49	< 0.01 to 0.04
Total for Soil of Unspecified Depth	**104**	**1 to 40**	**104**	**5.4 to 140**	**53**	**< 0.01 to 0.04**

SOURCE: Baedecker, P.A. et al 1998

Some mercury would be transported into surface water by deposition from air and surface runoff. Once mercury is in contact with water, some of the inorganic mercury is transformed into organic mercury (USEPA 2005b). Mercury levels in rivers and streams in New Mexico are very low. The NMED (2006a) reported that the average concentration of mercury in New Mexico's waters is less than 0.0025 micrograms per liter (µg/L). NMED (2006a) reported that "no water sample drawn from any major waterway in New Mexico has been found to contain mercury at a level that could pose any degree of direct risk via water ingestion or contact to humans or wildlife" (NMED 2006a). Local mercury data are available for the San Juan River. While mercury concentrations reported for the San Juan River are higher than the state average concentration, the maximum reported mercury concentration in the San Juan River of 1.6 µg/L is still below the Federal MCL for mercury of 2 µg/L.

The most common organic form of mercury, methyl mercury, is soluble, mobile, and easily enters the aquatic food chain (ATSDR 1999). Concentrations of methyl mercury in carnivorous fish at the top of freshwater food chains are biomagnified on the order of 10,000 to 100,000 times the concentrations found in ambient waters (ATSDR 1999). Despite the extremely low concentrations of mercury in the waters of New Mexico, levels of methyl mercury in the tissues of certain fish still exceed the U.S. Food and Drug Administration action limit of 1.0 part per million (NMED 2006a). The New Mexico Department of Health, NMED, and the New Mexico Department of Game and Fish have set fish consumption guidelines based on methyl mercury concentrations in fish in New Mexico (NMED 2001), including fish caught from the San Juan River.

Mercury is taken up to a lesser degree in terrestrial plants and animals (ATSDR 1999). Data from higher plants indicate that essentially no mercury is taken up from the soil into the shoots of plants, although mercury concentrations in the roots may reflect the mercury concentrations of the surrounding soil. Plants (e.g., corn, wheat, and peas) have very low levels of mercury even if grown in soils containing mercury levels that are much higher than background. However, mushrooms can accumulate high levels of mercury if grown in contaminated soils (ATSDR 1999).

Mercury does not typically bioaccumulate in birds or mammals that do not ingest fish. Other than fish, food ingested by humans (e.g., cereals, potatoes, vegetables, fruits, meat, poultry, eggs, milk, and milk products) is generally low in mercury content. The Food and Drug Administration estimates that most people ingest only about 0.000050 milligrams of mercury per kilogram of body weight per day in the food they eat (nearly all from consumption of fish). This level of mercury is not expected to result in harmful effects (ATSDR 1999).

Arsenic: Arsenic is usually found in the environment combined with other elements such as oxygen, chlorine, and sulfur (ATSDR 2005). Arsenic combined with these elements is called inorganic arsenic.

Arsenic occurring naturally in soil and minerals may enter air, water, and land from wind-blown dust and may get into water from runoff and leaching. Volcanic eruptions are another source of arsenic (ATSDR 2005). Small amounts of arsenic can be released into the atmosphere from coal-fired power plants and incinerators. Average levels of arsenic in ambient air in the United States have been reported to range from <0.001 to 0.003 $\mu g/m^3$ in remote areas and from 0.020 to 0.030 $\mu g/m^3$ in urban areas (ATSDR 2005). Information regarding current concentrations of arsenic in air in the 31-mile (50-km) air quality study area was not located.

Some portion of the arsenic in industrial emissions would be deposited on the surrounding soil. In addition, arsenic is naturally present in soil. The USGS (1984) reported that the geometric mean, arithmetic mean, and range of naturally occurring arsenic in soil in the western United States is 5.5, 7.0 and <0.1 to 97 milligrams of mercury per kilogram, respectively. Background concentrations of arsenic soil very commonly exceed the most protective health based screening levels for arsenic in soil. The USEPA Region 9 residential soil PRG for arsenic of 0.39 mg/kg is protective of child and adult residential exposures and is based on a lifetime cancer risk of 1×10^{-6}. See Chapter 4.13 for further information on the health affects associated with exposures to arsenic in soil. The concentration of arsenic in soil in San Juan County is well within the range of natural background in the western United States. In shallow soil (6 inches or less bgs) in concentrations ranged from 1 to 25 milligrams of arsenic per kilogram (Table 3-55). For soil of unspecified depth, the concentration of arsenic in San Juan County ranged from 1 to 40 mg/kg (Table 3-55). The concentrations of arsenic in twenty-four surface soil samples collected in 2006 within a 25-km radius air impact area ranged from 1.1 to 6.4 mg/kg (Table 2.1-1 in Appendix J).

Some arsenic would be transported into surface water by deposition from air and surface runoff. Bioaccumulation in aquatic food chains does not appear to be significant for arsenic, although some fish and invertebrates contain high levels of a nontoxic organic form of arsenic (ATSDR 2005). Arsenic does not generally bioaccumulate through the terrestrial food chain (National Research Council 2005; Sample and others 1998).

Chromium VI: Chromium occurs naturally in the environment and exists in several forms. The predominant form is trivalent chromium (Cr III), which is an essential nutrient that is relatively nontoxic. Hexavalent chromium (Cr VI) is toxic and typically represents a small fraction of total chromium in the environment (ATSDR 2000).

Almost all hexavalent chromium in the environment arises from human activities (ATSDR 2000). Cr VI has been detected in fly ash from coal-fired power plants. The concentration of total chromium in outdoor air in the United States is typically <0.010 $\mu g/m^3$ in rural areas and 0.010 to 0.030 $\mu g/m^3$ in urban areas. Background urban outdoor Cr VI concentrations have been reported to be 0.004 $\mu g/m^3$ (ATSDR 2000). These levels are lower than levels considered being safe to breathe. Information regarding current concentrations of Cr VI in air in the 31-mile (50-km) air quality study area was not located.

A portion of the Cr VI in industrial emissions would be deposited on the surrounding soil. Once deposited, a portion of the CR VI would transform into less toxic chromium species, such as Cr+3. In addition, chromium is naturally present in soil. The USGS (1984) reported that the geometric mean, arithmetic mean, and range of naturally occurring total chromium in soil in the western United States is 41, 56, and <3 to 2000 milligrams of chromium per kilogram, respectively. The concentration of total chromium in soil within 31 miles (50 kms) of the Desert Rock Power Plant site ranged from 7 to 200 milligrams of chromium per kilogram (Table 3-55), and well within the range of natural background in the western United States. In addition, these concentrations are below the levels that are associated with health concerns. Chromium generally does not bioaccumulate through the aquatic or terrestrial food chain (ATSDR 2000).

3.13.4 Human Exposures to Chemicals of Potential Concern

Whatever chemicals are present in a particular area, they are only a health concern if they reach humans in sufficient amounts to result in an adverse health outcome. A "conceptual site model" is a term used in risk assessment for a methodology that describes the sources of chemicals at a site, their release and transfer through environmental media (e.g., air), and the points and means by which human populations might contact the chemicals. The goal of the conceptual site model is to provide an understanding of where the site-related chemicals are present and where they may be present in the future, so that the populations that could encounter the chemicals can be identified. The pathways of exposure for these populations can then be selected for a quantitative evaluation of health risks (refer to Chapter 4, Section 4.13.2).

3.13.4.1 Affected Media

Previous sections have described the existing sources in the vicinity of the site that are contributing chemicals to the air. In addition to air, the chemicals also could be present in soil, surface water, plants, and animals because some of the air toxics could be deposited on plants and surface soil where they could be taken up from soil by plants, washed into surface water, or be eaten by local fauna.

3.13.4.2 Land Use

Land use, for the purposes of the health evaluation, was examined within 31 miles (50 km) of the proposed power plant (refer to Figure 3-13). Thirty-one miles (50 km) were selected as a boundary line to match the area being evaluated for air quality impacts (refer to Section 3.2.2). The proposed power plant site and the majority of the land within 31 miles (50 km) is Navajo Indian Reservation land. Land use in the immediate vicinity of the site is primarily open range used for the grazing of livestock (sheep, goats, cattle, and horses) (refer to Section 3.4 for land use within 0.5 mile of the proposed plant). The Navajo Nation and BIA have indicated that future land use in this vicinity will continue to be the grazing of domestic livestock. The nearest agricultural land to the proposed plant is land farmed by the NAPI. The nearest NAPI land is located approximately 2 miles east and slightly north of the proposed power plant site, and extends in that direction to the San Juan River. Wheat, barley, small grains, alfalfa, potatoes, and corn are grown by the NAPI. The NAPI has approximately 68,000 acres in cultivation, at least half of which is within 31 miles (50 km) of the proposed site (NAPI 2006). Morgan Lake (~15 miles north of the proposed power plant site) is the nearest recreation area and is used for fishing, camping, and wind surfing. In addition to Morgan Lake, Navajo Nation Parks and Recreation operates a campground just south of Shiprock and the Shiprock Peak tourism site to the west of U.S. Highway 491.

Human development close to the proposed power plant is limited to a few scattered residences and dirt or gravel roads. Only about 75 people were identified as living within 7 miles of the site. The nearest residential area is the town of Burnham, home to about 50 families, located approximately 10 miles southeast of the proposed power plant. The bulk of the population in the area is located north of the proposed plant site in the towns of Shiprock, Kirtland, Fruitland, and Farmington along U.S. Highway 64 approximately 20 to 35 miles (32 to 56 km) from the proposed plant. Ojo Amarillo also is located to the north about 15 miles (25 km) from the proposed power plant. Other towns within the 31-mile (50-km) air quality study area include Naschitti and Newcomb Tocito to the south and Sanostee, Red Rock, and Rattlesnake to the west. Section 3.8 contains a description of the levels of population in each of the 15 tribal chapters within a 1-hour commuting distance of the proposed plant.

3.13.4.3 Potentially Affected Populations

There are four categories of human populations that could encounter chemicals in the air or those that have been deposited on plants and soil in the area from industrial sources. These four categories would be exposed to the same concentrations of chemicals but their duration of exposure would be different and they could be exposed to differing types of media (e.g., some people might just inhale chemicals in air while other could inhale chemicals in air and also eat local plants that contained chemicals). The four broad exposure categories are as follows:

- Occupational Exposures (adults only) – exposures to chemicals encountered by those who work within the study area boundaries but may live outside the boundaries;
- Residential Exposures (adults and children) – exposures to chemicals encountered by those who live within the study area boundaries;
- Recreational Exposures (adults and children) – exposures to chemicals encountered by those who are pursuing recreational activities within the study area boundaries but may live elsewhere; and
- Subsistence Exposures (adults and children) – exposures to chemicals in plants and animals harvested from within the study area as part of a subsistence/traditional life style.

3.13.4.4 Exposure Pathways

An exposure pathway is the mechanism by which a receptor (human) is exposed to chemicals from a source. The following four elements constitute a complete exposure pathway:

- A source and mechanism of chemical release;
- A retention or transport medium (e.g., soil);
- A point of potential human contact with the affected medium; and
- A means of entry into the body (e.g., ingestion) at the contact point.

Only complete pathways containing all four elements result in exposures. However, in some circumstances, an exposure pathway may be considered complete (e.g., meet all four of the elements), but insignificant. An exposure pathway is considered complete but insignificant if one or more of the following three conditions are met (USEPA 1989):

- The exposure resulting from the pathway is much less than the exposure resulting from another pathway involving the same medium.
- The potential magnitude of exposure from the pathway is low or of limited toxicological importance.
- The probability of the exposure occurring is very low, and the risks associated with the occurrence are not high.

Only complete and significant pathways of exposure require quantitative evaluation in the risk assessment presented in Chapter 4. Complete but insignificant pathways of exposure will not be quantitatively evaluated, but will be assessed in a qualitative discussion. The schematic conceptual site model (Figure 3-22) shows which complete pathways will be evaluated quantitatively and which complete pathways will be evaluated qualitatively.

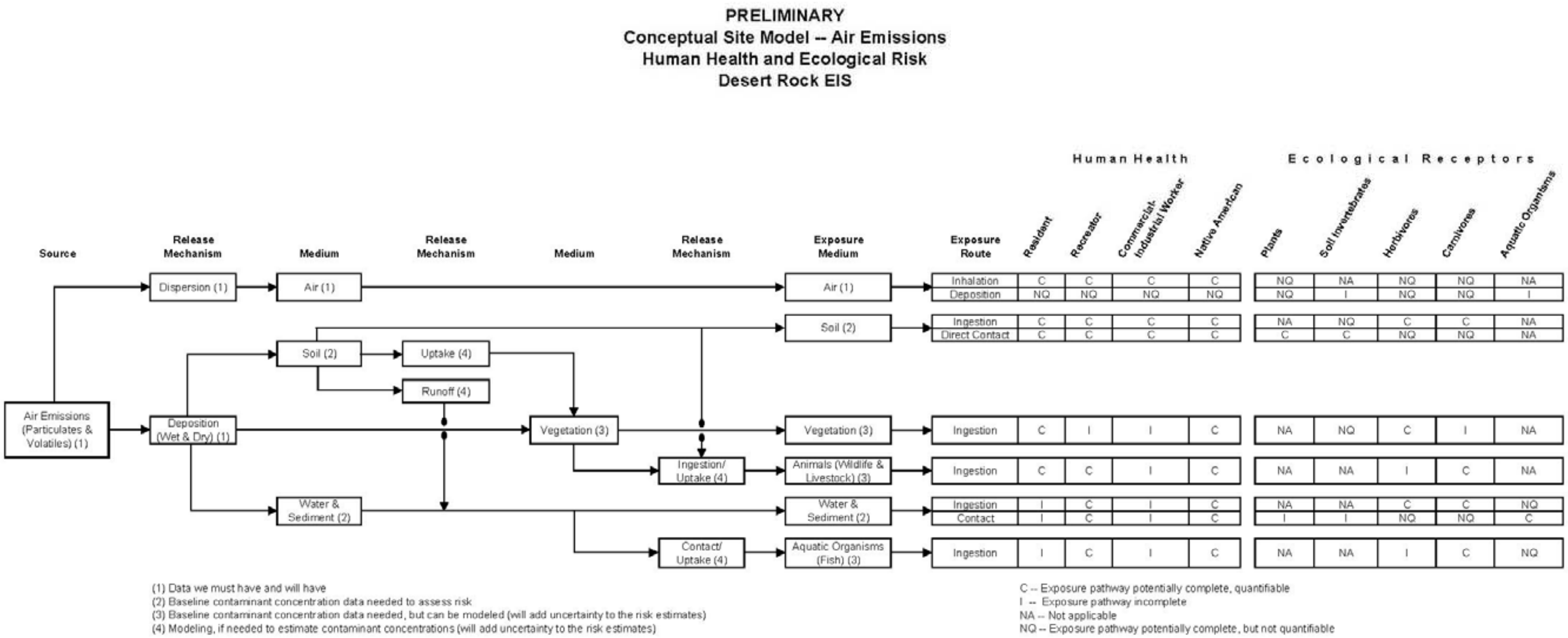


Figure 3-22 Conceptual Site Model – Air Emissions