

SECTION 12

CLIMATE

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Navajo Mine Met Station III Wind Rose for January 2007 to December 2011

SECTION 12

CLIMATE

LIST OF EXHIBITS

**EXHIBIT
NUMBER EXHIBIT TITLE**

[12.1-1](#) BNCC Meteorological Stations

SECTION 12

CLIMATE

LIST OF REVISIONS DURING PERMIT TERM

REV.		DATE
NUMBER	REVISION DESCRIPTION	APPROVED

SECTION 12 CLIMATE

12.1 Climatological Factors

BHP Navajo Coal Company's (BNCC) Pinabete Mine Plan permit area (permit area) is located in San Juan County; an arid and semiarid climatic region of northwest New Mexico. Elevation ranges from 5,300 to 5,600 ft in the permit area and adjacent lands, and is characterized by low relative humidity, a high percentage of sunshine, and relatively large annual and diurnal temperature ranges. The permit area and adjacent lands generally have limited relief and are sparsely vegetated, punctuated by ridges and buttes (e.g., Hogback Mountain and Shiprock Peak), and traversed by incised channels (e.g., Chaco River, Pinabete Arroyo, Cottonwood Arroyo, and No Name Arroyo). Surrounding areas of higher elevation include the Chuska and Carrizo Mountains in northeast Arizona and northwest New Mexico, Ute Mesa in Colorado and New Mexico, and San Juan Mountains in southwest Colorado and north-central New Mexico.

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 region, and in the fall and winter, when cold fronts moving to the east and southeast from the Pacific Ocean create steady, but usually light, rain and snow showers. The total amount of precipitation received at specific locations may be related to topographic features and changes in altitude. Most snowfall is light and melts within a few days. Vegetation is sparse and surface water is generally absent.

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 permit area are in the low to mid-50s. Summer temperatures generally range from the mid-60s to low 90s. Temperatures in excess of 100°F are infrequent. 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 midafternoon (Western Regional Climate Center 2006).

BNCC has collected data from two separate locations, Meteorological (Met) Stations I and II, for over 20 years at its Navajo Mine, which is immediately adjacent to the northern boundary of the permit area, ([Exhibit 12.1-1](#)). In 1991, meteorological sensors and data acquisition systems were installed at Met Stations I and II. Each station produces hourly averages of wind speed, wind direction, sigma theta (standard deviation of horizontal wind direction), temperature, relative humidity, and hourly precipitation totals. In addition, BNCC installed Met Station III in Area 4 North of the BNCC mining lease in April 2006 and has collected data from this station since 2007 ([Table 12.1-1](#) and [Table 12.1-2](#)). These data are consistent with the data collected from the Met I and II stations over the past 20 years.

Data from the Navajo Mine meteorological stations are used to characterize the climate of the Pinabete permit area as these locations are from a close proximity, equivalent climate, and reliable data source.

12.1.1 Precipitation

Based on the data collected by BNCC from Met Stations I and II (1991-2011), the average annual precipitation is 5.6 inches, and the annual average net evaporation rate based on the Class A Pan method (Williams 1986) is 55 inches. The average relative humidity ranges from 36% in July to 63% in January, with an annual average of 41%.

Most precipitation occurs during the monsoon period, which generally occurs in July and August of each year (National Oceanic and Atmospheric Administration 2002). The monsoon periods occur when the prevailing winds shift to the southwest and carry subtropical moisture into the area. Monsoons are characterized by short, sudden cloudbursts, and are often associated with thunderstorms.

[Table 12.1-1](#) depicts the monthly precipitation summary from the Navajo Mine Met Station III, with an annual total of 6.61 inches for the years 2007 through 2011. [Table 12.1-3](#) depicts the regional precipitation summary from Met Stations I and II from 1991 through 2011.

12.1.2 Temperature

Met Station III temperature data for the 2007 calendar year show wide variation in monthly temperatures, with an average annual temperature of 54°F ([Table 12.1-2](#)).

12.1.3 Wind

Wind patterns in the vicinity of the permit area 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 night-time and early morning drainage flows from the mountainous areas north and west of the site. The atmosphere in the vicinity of the permit area tends to be less stable (fewer temperature inversions), characterized by more synoptic southwest-to-northeast flows during warmer months. The area is known for moderate to strong, steady winds. The prevailing wind directions at the BNCC mining lease are out of the northwest and southeast.

Wind speed and direction data are available from Navajo Mine Met Station I and Met Station II. Cumulative wind roses for Met Stations I and II stations are shown in [Figure 12.1-1](#) and [Figure 12.1-2](#), respectively, for the years March 1991 through December 2011. The wind rose data show hourly average wind speed in meters per second (m/s) and wind direction. The wind rose profiles at the Navajo Mine show the prevailing high and low velocity wind directions. Episodic wind events can reach velocities up to

51 m/s (114 mph). Generally, the highest winds occur in the spring and during summer thunderstorm events. These high velocity winds are responsible for and can be correlated to the collection of elevated fugitive dust emission data.

Approximately 75% of the wind speed data collected falls between 1.1 to 5.0 m/s (2.5 to 11 mph) and comes from the prevailing wind directions SSE, SE, ESE, and E. Approximately 25% of the collected wind speed data falls within 5.1 to 15.0 m/s (11 to 34 mph) and comes from the opposite NW and NNW directions.

The wind direction patterns differ between Met I and Met II. At Met Station I the predominant directions are NW-WNW and E-ESE ([Figure 12.1-1](#)). At Met Station II the predominant directions are NNW-NW and SE-SSE ([Figure 12.1-2](#)). These differences represent effects of the local topography. The northern Met Station I is affected by the San Juan River valley drainage winds, which account for the shift in the prevailing wind direction to a more easterly orientation. The Met Station II wind direction patterns are considered more representative of the wind direction patterns in Area 2 and Area 3 of Navajo Mine.

A wind rose diagram for Met Station III for the year 2007 through 2011 is shown in [Figure 12.1-3](#). The predominant wind directions at this location in Area 4 North are NW-WNW and SE-SSE, which are similar to those observed at Met Station II.

12.2 Climate Information Collection and Analysis

The meteorological equipment is operated in compliance with Ambient Air Monitoring Guidelines for Prevention of Significant Deterioration (PSD) (U.S. Environmental Protection Agency 1987) and the Meteorological Monitoring Program Guidance for Regulatory Modeling Applications (U.S. Environmental Protection Agency 2000). A companion reference to the PSD document is the U.S. Environmental Protection Agency Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements (U.S. Environmental Protection Agency 1995). The locations of the meteorological monitoring stations used to collect the data as described in this section of the permit are shown in [Exhibit 12.1-1](#). Class One Technical Services maintained and calibrated the equipment and collected and analyzed the data.

Personnel

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

Kent Applegate
Matt Owens

Class One Technical Services
Albuquerque, NM

BHP Navajo Coal Company

References

- National Oceanic and Atmospheric Administration. 2002. Special Feature: The North American Monsoon System. Available at: <http://www.srh.noaa.gov/abq/climate/Monthlyreports/July/nams.htm> (Verified March 29, 2012).
- U.S. Environmental Protection Agency. 1987. Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD). Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. EPA-450/4-8/00/, May.
- U.S. Environmental Protection Agency. 1995. Quality Assurance Handbook For Air Pollution Measurement Systems. Vol. IV, Meteorological Measurements. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. EPA/600/R-94/038d, March.
- U.S. Environmental Protection Agency. 2000. Meteorological Monitoring Guidance for Regulatory Modeling Applications. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. EPA-454/R-99-005, February.
- Western Regional Climate Center. 2006. Climate Summary – New Mexico. Available online at: <http://www.wrcc.dri.edu/narratives/NEWMEXICO.htm> (Verified March 29, 2012).
- Williams, Jerry, 1986. New Mexico in Maps. University of New Mexico. Albuquerque, New Mexico

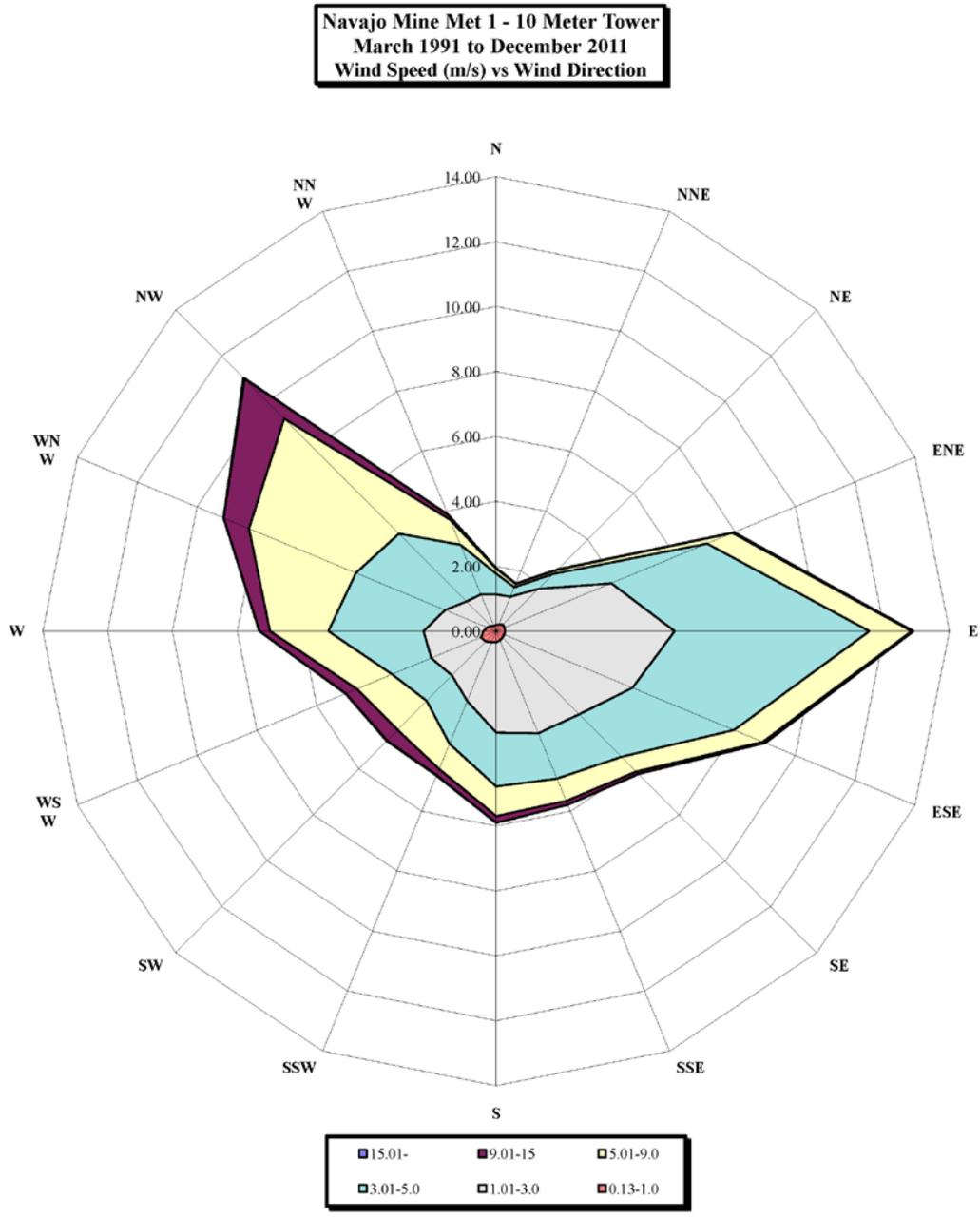


Figure 12.1-1 Navajo Mine Met Station I Wind Rose for March 1991 to December 2011

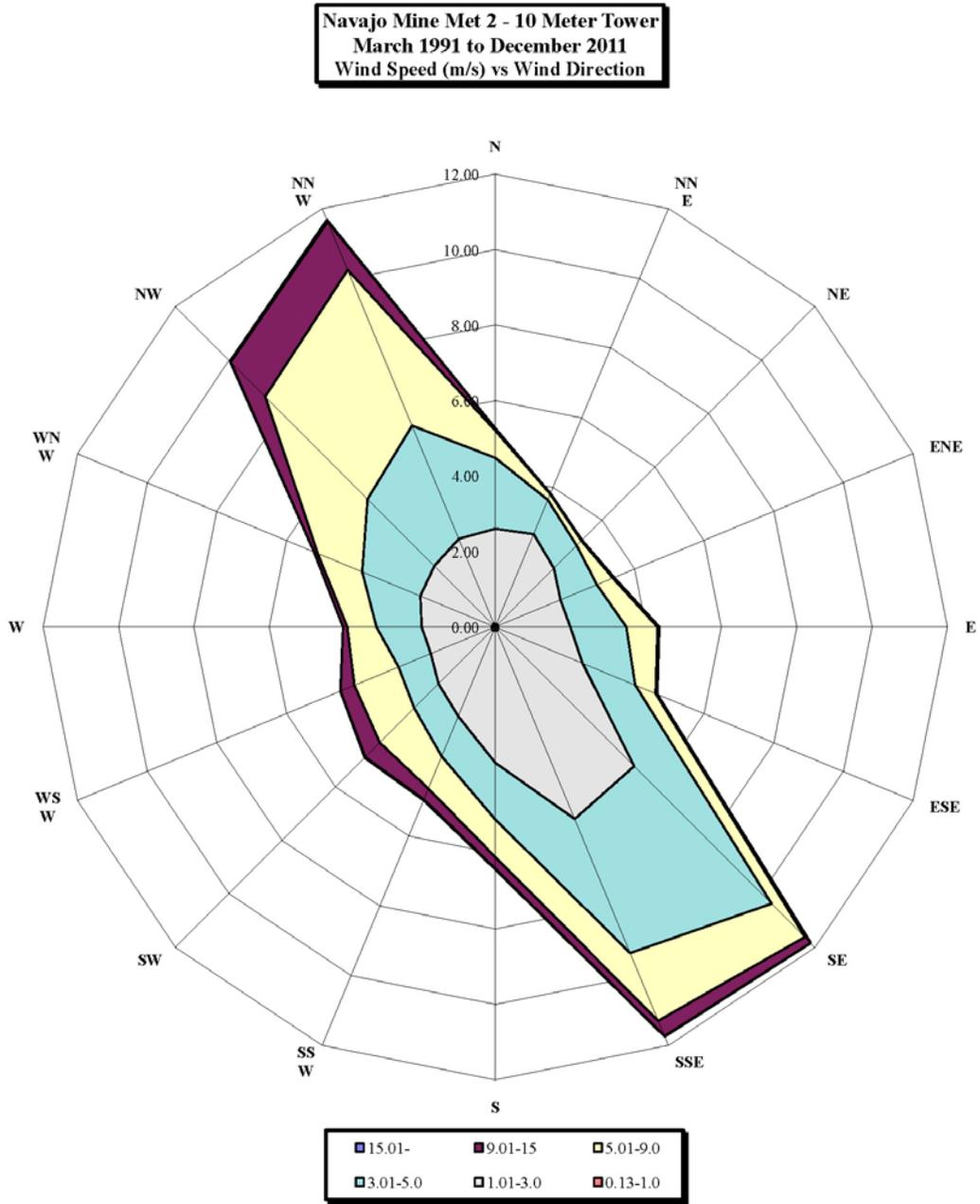


Figure 12.1-2 Navajo Mine Met Station II Wind Rose for March 1991 to December 2011

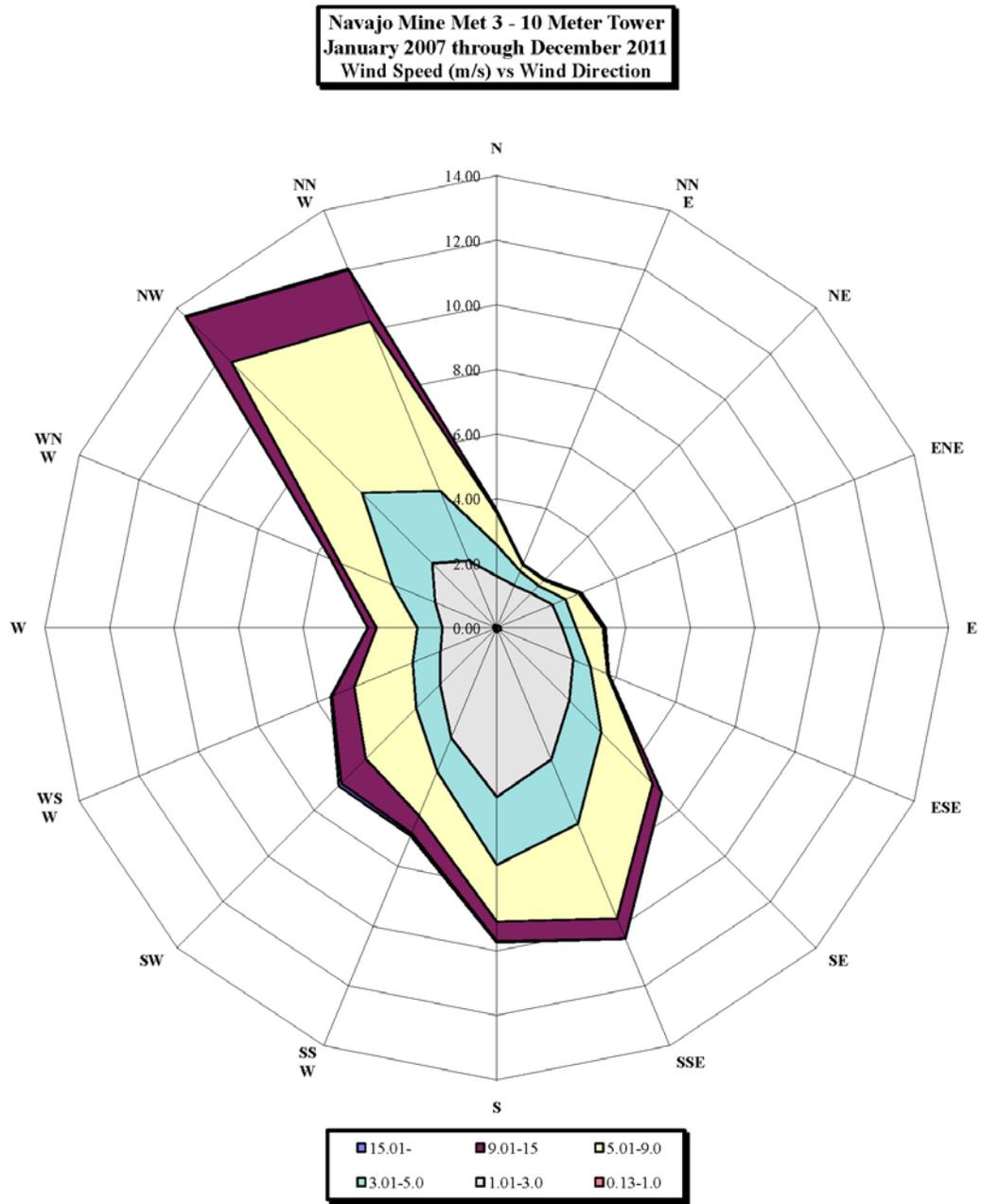


Figure 12.1-3 Navajo Mine Met Station III Wind Rose for January 2007to December 2011

Table 12.1-1 Met Station III Average Monthly Precipitation Summary for 2007- 2011.

Month	Total precipitation (inches)
Jan	0.55
Feb	0.44
Mar	0.39
Apr	0.43
May	0.51
Jun	0.13
Jul	0.92
Aug	1.21
Sep	0.75
Oct	0.48
Nov	0.43
Dec	0.37
Annual	6.61

Table 12.1-2 Met Station III Mean Monthly Temperature for 2007-2011.

Month	Minimum hourly temperature 2m* (Fahrenheit)	Maximum hourly temperature 2m (Fahrenheit)	Mean hourly temperature 2m (Fahrenheit)
Jan	2.0	53.1	27.0
Feb	7.4	62.0	35.9
Mar	19.7	73.9	45.9
Apr	24.4	79.9	53.2
May	32.7	89.6	62.4
Jun	45.7	96.8	74.4
Jul	55.4	98.9	79.0
Aug	54.5	96.9	76.6
Sep	41.79	90.3	68.2
Oct	26.5	82.2	54.6
Nov	15.2	70.1	41.4
Dec	5.8	56.7	31.4
Mean Annual	27.6	79.2	54.2

*Note: 2m is the height at which the reading was taken from at the meteorological station.

Table 12.1-3 Navajo Mine Regional Precipitation Data Summary 1991-2011 for Met Stations I and II

Navajo Mine Met Station I

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total	Annual monthly maximum	Annual monthly minimum
1991	*	*	*	0.10	0.71	0.11	0.28	0.78	1.52	0.47	1.96	1.43	-	-	-
1992	0.14	0.17	0.97	0.04	1.27	0.01	0.88	1.58	0.52	0.39	0.19	0.48	6.64	1.58	0.01
1993	1.79	0.69	0.48	0.12	0.19	*	0.01	2.55	0.55	0.89	*	0.07	-	-	-
1994	0.04	0.38	0.12	0.24	1.27	0.11	0.18	0.59	1.18	0.85	0.47	0.42	5.85	1.27	0.04
1995	0.44	0.28	0.79	1.20	0.45	0.38	0.13	0.76	0.97	0.03	0.18	0.49	6.10	1.20	0.03
1996	0.16	0.31	0.24	0.14	0.14	0.67	0.08	0.36	0.47	1.73	0.32	0.16	4.78	1.73	0.08
1997	0.53	0.10	0.00	2.62	0.71	0.66	1.02	1.61	1.28	0.26	0.54	0.60	9.93	2.62	0.00
1998	0.24	0.53	0.23	0.03	0.01	0.00	0.54	1.37	0.68	1.87	1.00	0.04	6.54	1.87	0.00
1999	0.16	0.00	0.14	1.18	1.43	0.41	1.29	3.34	0.23	0.01	0.13	0.14	8.46	3.34	0.00
2000	0.47	0.10	1.80	0.00	0.00	0.05	0.28	0.08	*	1.14	0.46	0.14	-	-	-
2001	0.39	0.41	1.39	0.36	0.60	0.01	0.32	1.23	0.31	0.30	0.53	0.36	6.21	1.39	0.01
2002	0.01	0.00	0.06	0.32	0.00	0.00	0.09	0.22	2.77	1.33	0.57	0.26	5.63	2.77	0.00
2003	0.18	1.15	0.37	0.01	0.06	0.00	0.01	0.66	0.22	1.12	0.07	0.03	3.88	1.15	0.00
2004	*	*	*	0.06	0.03	0.04	0.37	0.16	1.78	0.56	0.56	0.14	-	-	-
2005	1.00	1.30	0.33	0.86	0.22	0.23	0.21	1.67	0.00	0.72	0.00	0.02	6.56	1.67	0.00
2006	0.12	0.04	0.12	0.28	0.01	0.00	1.26	0.18	0.63	1.35	0.00	0.28	4.27	1.35	0.00
2007	0.38	0.30	0.00	0.06	0.23	0.02	*	1.34	0.54	0.16	0.01	0.20	-	-	-
2008	0.62	0.68	0.02	0.08	0.27	0.03	0.99	1.01	0.08	0.39	0.67	0.61	5.45	1.01	0.02
2009	0.19	0.15	0.13	0.47	1.30	0.47	0.15	0.03	0.08	0.47	0.19	0.12	3.75	1.3	0.03
2010	1.20	0.85	0.72	0.23	0.10	0.13	0.54	1.25	0.81	1.05	0.06	0.57	7.51	1.25	0.06
2011	0.15	0.04	0.24	0.91	0.47	0.00	0.56	0.20	0.42	1.71	0.62	0.18	5.50	1.71	0.00

Navajo Mine Met Station I 1991 through 2011 average annual precipitation: 5.86 inches

Navajo Mine Met I and II average annual precipitation 1991-2011: 5.56 inches

*data not available

- dataset incomplete

Table 12.1-3 (Continued)

Navajo Mine Met Station II

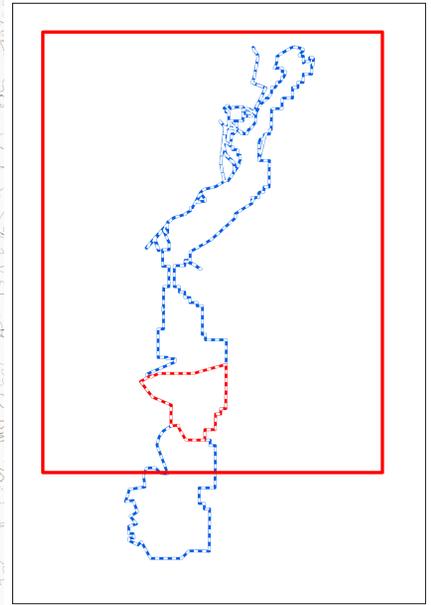
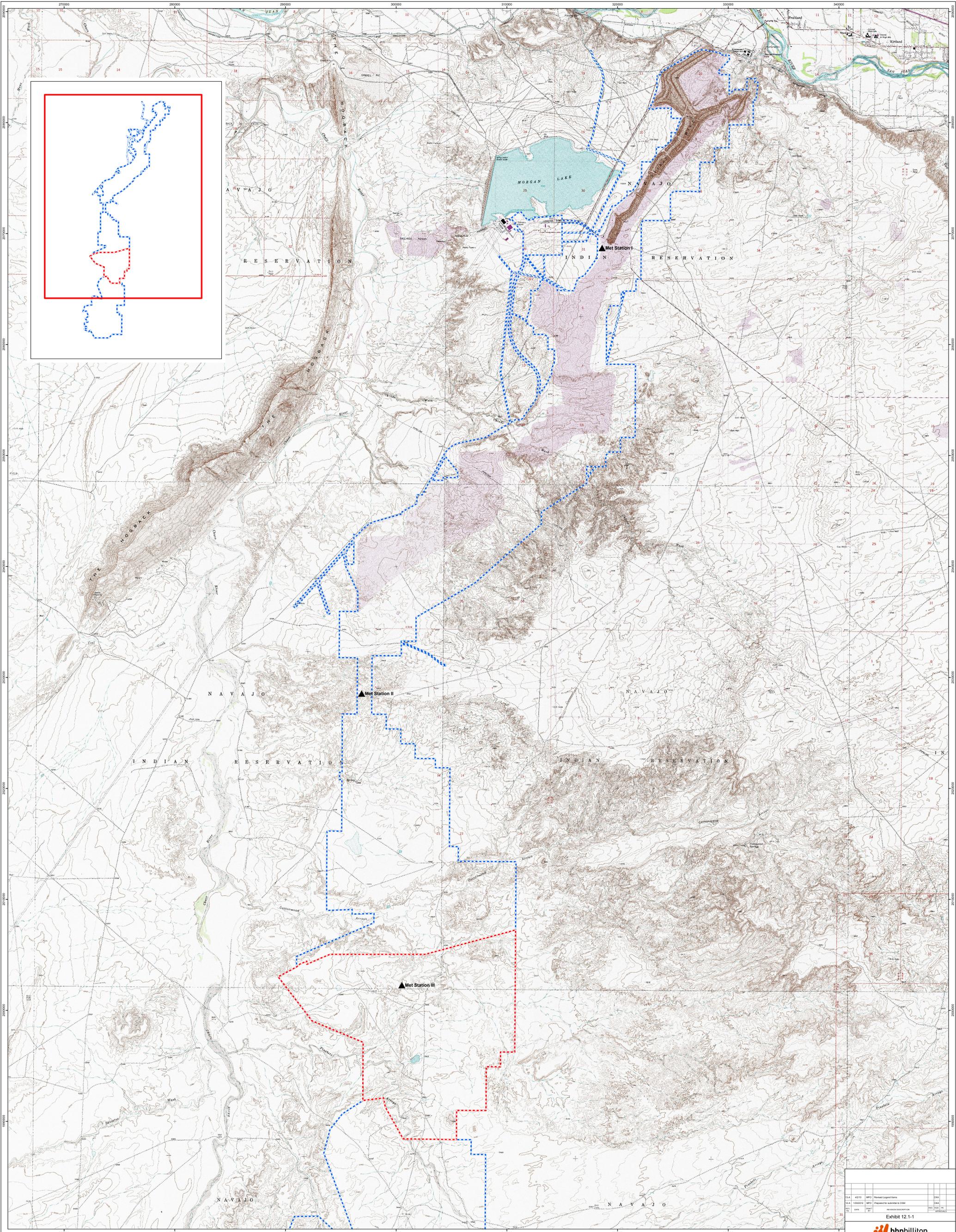
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual total	Annual monthly maximum	Annual monthly minimum
1991	*	*	*	*	1.01	0.27	0.05	1.33	0.12	0.19	0.20	0.29	-	-	-
1992	0.10	0.11	0.87	0.01	0.88	0.02	0.04	2.47	0.57	0.33	0.10	0.27	5.77	2.47	0.01
1993	1.23	0.50	0.33	0.20	0.55	*	0.07	1.13	1.18	0.80	0.45	*	-	-	-
1994	0.01	0.50	0.14	0.27	1.07	0.13	0.60	0.19	1.02	0.69	0.33	0.30	5.25	1.07	0.01
1995	0.19	0.22	0.35	0.61	0.37	0.31	0.20	0.96	0.58	0.01	0.07	0.44	4.31	0.96	0.01
1996	0.06	0.16	0.07	0.05	0.03	1.15	0.42	0.88	0.26	0.93	0.29	0.06	4.36	1.15	0.03
1997	0.22	0.05	0.00	2.23	0.87	0.27	1.38	1.26	0.94	0.23	0.27	0.48	8.20	2.23	0.00
1998	0.10	0.33	0.17	0.05	0.00	0.00	0.38	0.52	0.48	1.50	0.67	0.01	4.21	1.50	0.00
1999	0.13	0.00	0.38	1.04	0.94	0.11	0.84	2.19	0.17	0.00	0.00	0.04	5.84	2.19	0.00
2000	0.34	0.05	1.50	0.03	0.00	0.01	0.50	0.54	0.14	0.93	0.27	0.10	4.41	1.50	0.00
2001	0.25	0.28	0.93	0.19	0.35	0.01	0.94	1.03	0.16	0.10	0.11	0.25	4.60	1.03	0.01
2002	0.00	0.00	0.03	0.27	0.00	0.00	0.13	0.39	2.36	0.84	0.49	0.16	4.67	2.36	0.00
2003	0.14	0.79	0.35	0.17	0.08	0.01	0.66	0.92	0.69	0.88	0.49	0.05	5.23	0.92	0.01
2004	0.19	0.38	0.01	0.04	0.00	0.10	0.20	0.03	1.45	0.87	0.42	0.13	3.82	1.45	0.00
2005	0.65	1.26	0.22	0.63	0.25	0.08	0.48	1.06	0.40	0.56	0.00	0.01	5.60	1.26	0.00
2006	0.12	0.02	0.12	0.08	0.08	0.07	1.15	0.05	0.03	1.32	0.00	0.39	3.43	1.32	0.00
2007	0.39	0.38	0.38	0.36	1.38	0.01	1.23	1.27	0.30	0.19	0.43	0.12	6.44	1.38	0.01
2008	0.81	0.51	0.06	0.04	0.18	0.15	0.37	0.09	0.00	0.35	0.45	0.37	3.38	0.81	0.00
2009	0.19	0.10	0.18	0.40	0.44	0.21	0.06	0.07	0.10	0.35	0.16	0.14	2.40	0.44	0.06
2010	0.99	0.45	0.36	0.21	0.08	0.14	0.17	0.64	0.51	2.91	0.03	0.46	6.95	2.91	0.03
2011	0.00	0.09	0.14	0.99	0.11	0.00	0.81	0.30	1.29	1.19	0.25	0.26	5.43	1.29	0.00

Navajo Mine Met Station II 1991 through 2011 average annual precipitation: 4.97 inches

Navajo Mine Met I and II average annual precipitation 1991-2011: 5.56 inches

* data not available

- dataset incomplete



Coordinate System:
 NAD 1983 State Plane New Mexico West FIPS 5003
 Projection: Transverse Mercator
 Datum: North American 1982
 Units: Foot US

Legend

- ▲ Meteorological Station Sites
- ▭ SMCRA Permit Area
- ▭ Mining Lease and ROWs

15-A	4513	MPO	Permit Logbook Items	DKA
15-A	1302012	MPO	Prepared for submittal to OSM	DKA
15-A	1302012	MPO	Permit Logbook Items	DKA
15-A	1302012	MPO	Permit Logbook Items	DKA

Exhibit 12.1-1

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 BNCC Meteorological Stations

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 APPROVED BY: CKA DATE: 1/30/2012