METEOROLOGY, AIR QUALITY AND CLIMATOLOGY REPORT

Rev. 1 **Date: August 27, 2009**

IN SUPPORT OF THE APPLICATION FOR A LICENSE FOR SOURCE MATERIAL MILLING

PIÑON RIDGE URANIUM MILL
Montrose County, Colorado

Submitted to:

Radiation Management Unit
Colorado Department of Public Health and Environment

Prepared for:

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Project No. 83088
DCN: 83088.3.6.3-ALB09RP001

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Prepared for: **Energy Fuels Resources Corporation**
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1.0 INTRODUCTION

This report addresses the air quality, meteorology and climatology of the Energy Fuels Resources Corporation (EFR) proposed Piñon Ridge Mill Site (Mill Site) located in Montrose County, Colorado. EFR monitored and compiled air quality and meteorology data for a one year "baseline" period from April 2008 through March 2009. The baseline air quality data, meteorology data and description of the climatology are necessary to support the permitting and licensing (radioactive source materials license) of the proposed mill. The permitting and licensing are regulated through the Colorado Department of Public Health and Environment (CDPHE). The project air monitoring plan, *Work Plan for Ambient Air Monitoring Energy Fuels Resources Corporation Uranium Mill Licensing Support Piñon Ridge Mill* (Kleinfelder 2008 A) was previously submitted to CDPHE for review and approval and forms the basis for the type of baseline data collected and the collection methods used at the Mill Site.

The baseline data were acquired from three air monitoring stations and two meteorology towers on the Mill Site and two additional off site air monitoring stations. The monitoring sites were chosen according to guidance in Nuclear Regulatory Commission (NRC) guidance in Regulatory Guide (RG) 3.63, *Onsite Meteorological Measurement Program for Uranium Recovery Facilities – Data Acquisition and Reporting*, RG 4.14, *Radiological Effluent and Environmental Monitoring at Uranium Mills*, and the Environmental Protection Agency's *Meteorological Monitoring Guidance for Regulatory Modeling Applications* (MMGRMA) (EPA-454/R-99-005). Data from the monitoring sites were summarized in quarterly reports (Kleinfelder 2008 B, Kleinfelder 2008 C, Kleinfelder 2008 D, Energy Fuels Resource Corporation 2009). The quarterly reports included data recovery statistics, analysis of the data, details about station operations, and audit and calibration reports. The quarterly reports have been combined in this report to discuss annual meteorological and climatological trends in the area around the Mill Site.

Section 2 of this report presents descriptions of the monitoring program and monitoring sites. Section 3 presents the data collection and completeness in which the parameters used to acquire and analyze the data are described in detail. Section 4 presents a summary of the meteorological data collected during the monitoring program, along with a discussion of evaporation, precipitation, wind and atmospheric stability trends throughout the twelve-month monitoring period. Section 5 presents a discussion on the climatology related to the different measured parameters as well as the influence of climate change. Section 6 provides a description on the baseline air quality. Section 7 presents the quality assurance program procedures. Section 8 provides a summary of the standards and references used throughout this report.

2.0 PROGRAM DESCRIPTION AND MONITOR SITE DESCRIPTIONS

2.1 Ambient Air Monitoring Time Period

The baseline period of the ambient air monitoring program is April 2008 through March 2009. Quarterly reports have been prepared and submitted to the CDPHE during the baseline operating period. This report provides an annual summary of the air monitoring information presented in the quarterly reports.

2.2 Description of Project Site

The Mill Site is located approximately 13 miles northwest of Naturita, Colorado, and approximately 7 miles southeast of Bedrock, Colorado, at 16910 Highway 90, in Montrose County, Colorado. The property consists of approximately 880 acres that include the Southwest ¼ of the Southeast ¼ of Section 5, all of Section 8, the North ¼ of Section 17 and the Southeast ¼ of the Northwest ¼ of Section 17, Township 46 North, Range 17 West, of the New Mexico principal meridian. Figure 1 provides a vicinity map of the Mill Site with respect to nearby towns.

The Mill Site is located near the eastern end of Paradox Valley, within the East Paradox Creek watershed in the Dolores River Basin at the base of the northern slope of the Uncompahgre Plateau. Paradox Valley is approximately 20 miles long and 5 miles wide, oriented approximately west-northwest to south-southeast. Mesas on either side of the valley rise to more than 2,000 feet above the valley floor. The Mill Site terrain elevation ranges from approximately 6,000 feet above mean sea level (amsl) to the south to approximately 5,400 feet amsl to the north. Figure 2 shows the topography of Paradox Valley and the surrounding area.

The macro climate of the area around Nucla, Colorado, including the project site, is classified by the Koppen Climate Classification System as a BSk. A BSk indicates a semi-arid steppe with much of the characteristics of a desert. It has evaporation that exceeds the precipitation on average and the mean average temperature is below 18° C (64.4° F). Vegetation in the area consists mainly of low lying grasses and shrubs (blue grama, snakeweed, prickly pear, piñon juniper, sagebrush, and buffalograss [National Cooperative Soil Survey taken in 2006]).

2.3 Description of Monitoring Sites

Selection of air monitoring station locations was based on both the pre-operational and operational air monitoring criteria set forth in NRC RG 4.14. Three monitoring locations were selected near the Mill Site boundaries. A fourth location was selected as a background location to the northwest and a fifth location was selected at the nearest residence located to the southeast. Due to the topography of the Paradox Valley, the wind at the Mill Site is influenced by down-valley/up-valley flow through the area, predominantly from northwest and from the southeast depending on time of day.

EFR Monitoring Sites 1 and 2 are equipped with meteorological, particulate matter less than 10 microns (PM_{10}), and radionuclide monitoring instrumentation, while Sites 3, 4, and 5 only support radionuclide monitoring. Site 1 is located near the northern boundary of the Site, and has a 10-meter tower with meteorological sensors, and precipitation and evaporation gauges. Site 2 is near the eastern boundary of the Mill Site, and has meteorological sensors on a 30-meter tower. Site 3 is near the western boundary of the Mill Site. Site 4 is located upwind in accordance with NRC guidance and is approximately 2 miles northwest of the Mill Site near

Highway 90. Site 5 is located at the nearest residence in accordance with NRC guidance and is in a downwind location approximately 3 miles southeast of the Mill Site. The locations of the monitoring sites are provided in Figure 3 and the site descriptions and mapping coordinates are provided in Table 2-1.

Table 2-1
Monitor Site Locations

Site ID	UTM Zone 12 (NAD83)	
	Easting	Northing
Site #1 (North Site) – 10m Tower	695211.43	4237487.24
Site #2 (East Site) – 30m Tower	695930.42	4235452.56
Site #3 (West Site)	694443.09	4235724.28
Site #4 (Cooper Site) – Upwind Resident (Background)	691782.99	4239297.89
Site #5 (Carver Site) – Downwind Resident	700135.95	4232939.27

Photographs of the EFR meteorological stations at Sites 1 and 2 are provided in Figures 4 and 5. Figure 4 shows the 10-meter tower at Site #1 as viewed from the southeast and is located at the north portion of the property near Highway 90. Figure 5 shows the 30-meter tower at Site #2 as viewed from the north; it is located in the southeast portion of the property.

3.0 DATA COLLECTION AND COMPLETNESS

This section summarizes the instrumentation and the annual data completeness of the EFR monitoring program. Both RG 3.63 and the EPA's MMGRMA monitoring guidance outline accuracy and performance specifications for monitoring instrumentation. Regulations for the Prevention of Significant Deterioration (PSD) set the minimum annual acceptable data recovery at 75 percent for PM_{10}, 80 percent for air quality parameters, and 90 percent for meteorological data. Furthermore, RG 3.63 specifies 75 percent data recovery for the joint frequency of wind speed, wind direction, and atmospheric stability,

3.1 Meteorological Data

The EFR meteorological sensors were operated based on EPA MMGRMA guidance. A summary of the monitoring guidelines and the specifications for the EFR instruments are outlined in the EFR Monitoring Plan (Kleinfelder 2008 A). Meteorological sensors met EPA instrument specifications and were calibrated quarterly per the requirements of the EFR Monitoring Plan (Kleinfelder 2008 A). The parameters monitored by the EFR meteorological sensors are listed in Table 3-1.

Table 3-1
Parameters Monitored by EFR Meteorological Sensors

Site #1 (10-meter tower)	Site #2 (30-meter tower)
Wind Speed	Wind Speed
Wind Direction	Wind Direction
Vertical Wind Speed	Vertical Wind Speed
Temperature (2m & 10m)	Temperature (2m & 30m)
Delta Temperature	Delta Temperature
Relative Humidity	Relative Humidity
Solar Radiation	Solar Radiation
Barometric Pressure	Barometric Pressure
Precipitation	---
Evaporation	---

For Site 1, wind speed, wind direction, sigma theta (standard deviation of wind direction), vertical wind speed, and upper-level delta temperature are measured at the 10-meter level, and temperature, relative humidity, lower-level delta temperature, barometric pressure, and solar radiation are measured at the 2-meter level. Precipitation and evaporation are measured near ground level. For Site 2, wind speed, wind direction, sigma theta, vertical wind speed, and delta temperature are measured at the 30-meter level, and temperature, relative humidity, delta temperature, barometric pressure, and solar radiation are measured at the 2-meter level. Sigma theta values for both sites are calculated from wind direction readings. Wind gusts are measured at both of the sites. The measurement indicates the speed of the gust based on a 3-second average of the wind speed, along with the gust direction and time of the gust.

The meteorological data were collected continuously at Sites 1 and 2 and are provided in Appendix A. EPA Air Quality System (AQS) data qualifiers were used to flag invalid data. Data qualifiers used for meteorological data are provided in Table 3-2. Daily, weekly, and monthly checks were performed on meteorological equipment at each site and instrument calibrations and quality assurance audits were completed bi-annually.

Table 3-2
Parameters Monitored by EFR Meteorological Sensors

AQS Qualifiers	Definition
BA	Maintenance / Routine Repairs
AQ	Collection Error
AT	Calibration
AZ	Audit
IL	Seasonally out of service

The time period of the data presented for precipitation measurements at Site 1 differs from the time period of data presented for the data collected by the other meteorological sensors due to data collection and recovery issues from the precipitation instrumentation. As described in Section 2.1, the meteorological data was collected from April 2008 through March 2009. However, precipitation data are presented for a monitoring period from May 2008 through April 2009. The precipitation monitoring period was chosen as the twelve-month period with available data most representative of the monitoring period for the other meteorological parameters. See Section 4.3 for more details about the precipitation data collection and recovery.

The evaporation pan at Site 1 was only operated from April 2008 to October 2008, and required cleaning, addition and/or removal of water, and calibration during this time. The evaporation pan was taken off-line on November 12, 2008, according to the evaporation pan operating schedule. There were five freezing events noted by the operator during the year where at least half of the evaporation pan had a thin layer of ice present. Based on a review of both evaporation and temperature, the evaporation pan may have been frozen several other times that were not noted by the operator. The evaporation pan was taken off-line on November 12, 2008, and the reinstallation was scheduled for March 31, 2009. Data recovery for the evaporation data was not calculated for the first quarter (January 1 - March 31) of 2009 as the evaporation pan was seasonally out of service, and data recovery was only calculated through October for the fourth quarter (October 1 – December 31) of 2008.

The data recovery results for the meteorological sensors at Sites 1 and 2 are provided in Table 3-3. Data recovery for all parameters for all quarters at Sites 1 and 2 is greater than 90%, except for the vertical wind speed and standard deviation from the 0.4 m/s propeller sensor at Site 2. In the second quarter (April 1 – June 30) of 2008 the data recovery of these parameters was 56%. This sensor is a redundant measurement of vertical wind speed and standard deviation, thus, does not count against the data recovery requirement. Each of the two towers has two vertical wind speed sensors: an R.M. Young 27106T sensor with a 0.4 m/s threshold and an R.M. Young 27106 sensor with a 0.25 m/s threshold. EPA modeling guidance states that the threshold for vertical wind should be 0.25 m/s or better. However, the propeller required for this threshold is fragile and in order to cover any data loss if the sensor was damaged, the less fragile 0.4 m/s propeller was installed as a backup instrument. The R.M. Young 27106T sensor (0.4m/s threshold) experienced a collection error from April 15 through May 24, 2008; the data have been flagged with the "Collection Error" (AQ) data qualifier. Due to the redundancy of the measurement, the collection error was not repaired until May 24, 2008, when the tower was lowered for a scheduled maintenance.

Overall, meteorological parameters at both sites had annual data recovery greater than 90 percent, thus, exceeding the minimum annual acceptable data recovery requirement.

Table 3-3
Data Recovery Results for EFR Meteorological Sensors

Meteorological Parameter	Data Recovery									
	Q2 2008 (Q1 baseline)[1a]		Q3 2008 (Q2 baseline)[1b]		Q4 2008 (Q3 baseline)[1c]		Q1 2009 (Q4 baseline)[1d]		ANNUAL [1e]	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
Wind Speed	99.8%	98.9%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	99.7%
Wind Direction	99.8%	98.9%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	99.7%
Sigma Theta Wind	99.8%	98.9%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	99.7%
Vertical Wind Speed (0.25 m/s propeller) Average	99.8%	98.9%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	99.7%
Vertical Wind Speed (0.25 m/s propeller) Standard Deviation	99.8%	98.9%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	99.7%
Vertical Wind Speed (0.4m/s propeller) Average	99.8%	56.0%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	88.9%
Vertical Wind Speed (0.4m/s propeller) Standard Deviation	99.8%	56.0%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	88.9%
2-m Temperature	99.8%	98.9%	100.0%	100.0%	99.7%	99.7%	99.9%	99.6%	99.9%	99.6%
10-m Temperature	99.8%	N/A [2]	100.0%	N/A	99.7%	N/A	99.9%	N/A	99.9%	N/A
30-m Temperature	N/A	98.9%	N/A	100.0%	N/A	99.6%	N/A	99.6%	N/A	99.5%
Delta T Average	99.8%	98.9%	100.0%	100.0%	99.7%	99.6%	99.9%	99.6%	99.9%	99.5%
Precipitation Total[3]	99.8%	N/A	100.0%	N/A	99.6%	N/A	99.8%	N/A	99.8%	N/A
Relative Humidity Average	99.8%	98.9%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	99.7%
Relative Humidity Temperature Average	99.8%	98.9%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	99.7%
Barometric Pressure	99.8%	98.9%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	99.7%
Solar Radiation Average	99.8%	98.9%	100.0%	99.9%	99.7%	99.8%	99.9%	99.4%	99.9%	99.5%

Table 3-3 Continued
Data Recovery Results for EFR Meteorological Sensors

Meteorological Parameter	Data Recovery									
	Q2 2008 (Q1 baseline)[1a]		Q3 2008 (Q2 baseline)[1b]		Q4 2008 (Q3 baseline)[1c]		Q1 2009 (Q4 baseline)[1d]		ANNUAL [1e]	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
Evaporation Level Average	94.2%	N/A	99.3%	N/A	90.2%	N/A	N/D[4]	N/A	94.6%	N/A
Gust Speed	99.8%	98.9%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	99.7%
Gust Direction	99.8%	98.9%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	99.7%
Gust Time	99.8%	98.9%	100.0%	100.0%	99.7%	99.8%	99.9%	99.9%	99.9%	99.7%

Notes
1. Percentages calculated from total hours available in monitoring period:
   a. Quarter 2 2008 – April, May, June – 2,184 hours.
   b. Quarter 3 2008 – July, August, September – 2,208 hours.
   c. Quarter 4 2008 – October, November, December – 2,208 hours. Except for Evaporation (Oct. – 744 hours)
   d. Quarter 1 2009 – January, February, March – 2,184 hours.
   e. ANNUAL – All Months – 8,760 hours.
2. N/A – Not Available. Sensors for 10-meter Temperatures, Evaporation, and Precipitation were not installed at Site 2. Sensors for 30-meter Temperatures were not installed at Site 1.
3. Refer to Section 4.3
4. N/D – No Data. When "No Data" is indicated, data from sensors were flagged for maintenance, malfunction, or seasonally out of service.

3.2 PM_{10} Data

Partisol PM_{10} monitors were installed at Sites 1 and 2 and PM_{10} data were collected according to the EPA Ambient Particulate Monitoring Sample Day Schedule for 1-in-6 day sampling outlined in the EFR Monitoring Plan (Kleinfelder 2008 A). PM_{10} filters were collected from the PM_{10} monitors as soon as practical following the sampling day. The samples were placed in re-sealable plastic bags immediately following collection and stored in a secured location. The samples were shipped to Inter-Mountain Laboratories (IML) on a monthly basis under standard chain-of-custody procedures. IML analyzed the samples in accordance with their standard operating procedures. Daily, weekly, and monthly checks were completed for the PM_{10} monitors at each site. The PM_{10} data for the year of monitoring are provided in Appendix A.

The data recovery results from the PM_{10} monitors are provided in Table 3-4. Data recovery percentages were calculated as the percentage of samples collected from the number of samples initiated. In the second quarter of 2008, Site 1 data recovery was greater than 100% because a make-up sample was collected on April 1, 2008, for a missed sample on March 31, 2008 (accounted for in the first quarter of 2008). The lowest data recovery result occurred in the second quarter of 2008 for Site 2 data with 93.3% recovery as the result of a laboratory error. Overall, the annual PM_{10} data recovery exceeded the 75 percent minimum annual acceptable data recovery requirement.

Table 3-4
Data Recovery Results for EFR PM_{10} Monitors

PM_{10} Collection Parameters	Q2 2008 (Q1 baseline)		Q3 2008 (Q2 baseline)		Q4 2008 (Q3 baseline)		Q1 2009 (Q4 baseline)		ANNUAL	
	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2	Site 1	Site 2
# Samples	15	15	15	15	15	15	15	15	60	60
# Samples collected	16	14	15	15	15	15	15	15	61	59
Data Recovery (%)	106.7	93.3	100	100	100	100	100	100	101.7	98.3

3.3 Radionuclide Data

Tisch Hi-Vol monitors were installed at Sites 1, 2, 3, 4, and 5 to collect radionuclide data. The monitors were run continuously on a 14-day filter exchange schedule. Daily, weekly, and monthly checks were performed on the Hi-Vol monitors at each site. For data recovery, filters were collected from the Hi-Vol monitors and immediately placed in sample filter envelopes and into re-sealable plastic bags and stored in a secured location. The samples were shipped to ACZ Laboratories (ACZ) at the end of each quarter under standard chain-of-custody procedures. ACZ composited the sample filters by quarter. The sampling sheets and ACZ analytical data for the year of monitoring are provided in Appendix A.

ACZ Labs reported a concentration of analyte per composited filter set. The average air flow rate was calculated for each filter exposure period based on the calibration values of the samplers and average stagnation pressure, temperature and pressure during the filter exposure period. The formula used to calculate the average air flow is:

$$\text{Average Flow Rate } (m^3/\text{min}) = \frac{\left(\frac{P_a - P_{stag}}{P_a} - b\right) \times \sqrt{T_a + 273.15}}{m}$$

Where:
P_a = Average ambient pressure (inches Hg) (averaged over individual filter exposure periods)
T_a = Average ambient temperature (°C) (averaged over individual filter exposure periods)
P_{stag} = Average stagnation pressure (inches Hg) (measured at sample start and end)
b = Sampler calibration intercept value (unitless)
m = Sampler calibration slope value (unitless)

The air sample volume for each filter was calculated based on the average flow rate and time of exposure. Total air volume for each composite sample was calculated as the sum of the air sample volume of each filter included in the composite. A summary of the above calculations are provided in Appendix A.

The data recovery results from the radionuclide monitors are provided in Table 3-5. Data recovery percentages were calculated for each as the percentage of actual run time from the total run time. The Hi-Vol monitors at Sites 1, 2, 4, and 5 were powered by electrical power lines. The Hi-Vol monitor at Site 3 was powered by a diesel generator, and thus, had the lowest annual percentage of data recovery due to downtime for generator service, maintenance, and operational issues. During the third quarter of 2008, Sites 2 and 3 experienced power outages resulting in lower data recovery, but overall, the annual radionuclide data recovery exceeded the 80 percent minimum annual acceptable data recovery requirement at all five sites.

Table 3-5
Data Recovery Results for EFR Radionuclide Monitors

Monitoring Site	Collection Period	2Q08	3Q08	4Q08	1Q09	Annual
Site 1	Actual Run Time (hrs)	2313	2157	2204	2159.8	8833.8
	Total Run Time (hrs)	2323.05	2208	2208	2161.3	8900.35
	Data Recovery (%)	99.6%	97.7%	99.8%	99.9%	99.3%
Site 2	Actual Run Time (hrs)	2298.1	2115.5	2205.7	2161.1	8780.4
	Total Run Time (hrs)	2323.2	2208	2209.1	2162.4	8902.7
	Data Recovery (%)	98.9%	95.8%	99.8%	99.9%	98.6%
Site 3	Actual Run Time (hrs)	2283.3	2117.9	2182.2	2158.6	8742
	Total Run Time (hrs)	2328.88	2208	2210.7	2160	8907.58
	Data Recovery (%)	98.0%	95.9%	98.7%	99.9%	98.1%
Site 4	Actual Run Time (hrs)	2323.4	2155.3	2212.1	2154	8844.8
	Total Run Time (hrs)	2329.12	2208	2214.2	2155.2	8906.52
	Data Recovery (%)	99.8%	97.6%	99.9%	99.9%	99.3%
Site 5	Actual Run Time (hrs)	2293.5	2146.5	2214.3	2155.7	8810
	Total Run Time (hrs)	2304.82	2208	2216.4	2158.8	8888.02
	Data Recovery (%)	99.5%	97.2%	99.9%	99.9%	99.1%

4.0 METEOROLOGICAL DATA ANALYSIS

4.1 Site Data Summary

Monthly summaries of the 2-meter temperature, relative humidity, solar radiation, wind speed, and maximum wind gust collected at Sites 1 and 2 are shown in Table 4-1. Vertical wind speed, delta temperature, and barometric pressure are collected for analysis with air quality and localized meteorological events, thus, summaries of these parameters are not presented as they are not relevant in a review of the annual meteorological trends at the Mill Site.

Table 4-1
Monthly Meteorology Data from EFR Sites 1 and 2

Monitoring Quarter	Month	EF Site	Temp [1] 2m	Relative Humidity	Solar Radiation		Wind Speed	Max Wind Gust
			ºF	%	W/m^2	kwh/m^2	mph	mph
Q2 2008 (Q1 baseline)	Apr 2008	Site 1	48.3	29.6	285.23	205.4	8.5	55.3
		Site 2	49.0	28.1	282.88	203.7	8.1	57.6
	May 2008	Site 1	57.1	34.9	297.36	221.2	8.1	61.7
		Site 2	57.7	33.0	300.51	223.6	8.0	51.2
	Jun 2008	Site 1	70.1	21.6	342.03	246.3	7.6	55.7
		Site 2	70.8	20.3	338.39	243.6	7.2	57.9
Q3 2008 (Q2 baseline)	Jul 2008	Site 1	76.2	32.9	291.75	217.1	6.5	42.0
		Site 2	76.7	31.5	288.03	214.3	6.5	47.6
	Aug 2008	Site 1	74.1	34.0	279.35	207.8	6.4	49.2
		Site 2	74.7	32.4	277.98	206.8	6.2	43.0
	Sep 2008	Site 1	64.0	34.8	241.30	173.7	5.9	45.6
		Site 2	65.1	32.1	240.61	173.2	5.5	50.1
Q4 2008 (Q3 baseline)	Oct 2008	Site 1	51.4	37.2	173.97	129.4	6.0	54.4
		Site 2	52.6	34.7	175.46	130.5	5.4	59.7
	Nov 2008	Site 1	40.2	50.5	125.49	90.4	4.3	48.0
		Site 2	41.7	47.7	121.73	87.6	3.7	49.9
	Dec 2008	Site 1	27.7	70.5	96.53	71.8	5.2	50.8
		Site 2	28.6	67.3	91.25	67.9	5.0	53.1
Q1 2009 (Q4 baseline)	Jan 2008	Site 1	27.5	69.5	120.56	89.7	4.0	45.5
		Site 2	28.2	66.3	114.86	85.5	3.2	43.8
	Feb 2008	Site 1	35.8	54.1	160.59	107.9	5.6	47.0
		Site 2	36.5	51.1	155.01	104.2	5.2	43.8
	Mar 2008	Site 1	43.5	39.0	215.22	160.1	7.8	57.3
		Site 2	44.0	37.3	212.23	157.9	7.3	63.5

Notes
1. Temperature from the 2-meter instruments at both Site 1 and 2.

4.2 Evaporation

Monthly total pan evaporation data collected at EFR Site 1 between April and October 2008 are presented in Table 4-2. As discussed in Section 3.1, pan evaporation measurements were not taken during the months when freezing conditions interfered with the measurements. The total pan evaporation for the seven month period is 55.26 inches.

Table 4-2
Summary of EFR Evaporation Data

Monitoring Period	2008						
	Apr	May	Jun	Jul	Aug	Sep	Oct
Inches	6.64	7.40	10.84	10.12	10.06	6.31	3.89

Notes
1. The evaporation instrument was taken offline to avoid freezing, thus, measurements were not collected for November 2008 through March 2009.

4.3 Precipitation

A malfunction in the tipping-bucket precipitation gauge at Site 1 was identified on October 12, 2008 during the calibration verification test. Review of the data did not indicate when the malfunction occurred, so the quality of data collected since the previous calibration on March 27, 2008, is uncertain, and therefore is unusable. The data affected is that data collected in the months from April through October 2008.

During most of the baseline monitoring period, EFR also operated a small on-site network of four manually-recorded gauges as part of Mill Site surface water studies. A comparison of the precipitation data from Site 1 and the surface water studies is presented in Appendix B. The locations of the surface water gauges are shown in Figure 3 with the EFR meteorological and air quality monitoring sites.

Data from a three month period (November 2008 and May/June 2009) were analyzed because data was collected from the surface water and the Site 1 precipitation gauges and the Site 1 gauge was known to be operating properly. The total precipitation measured during this three-month period was 4.98 inches for the recording gauge at Site 1 and 4.75 inches for the surface water manual gauges (on average), which is a difference of 4.6 percent. Section 3(a) in RG 3.63 has an accuracy specification of 10 percent for the recording gauge. Therefore a difference of 4.6% is considered small enough that the readings from the surface water manual gauges can be used to supplement the Site 1 precipitation gauge data. Operation of the surface water network precipitation gauges began in May 2008 and was discontinued at the end of November 2009 for the winter season. Therefore, the baseline monitoring period for precipitation is May 2008 through April 2009. Longer term climatology records present a more accurate reflection of precipitation and are presented in Section 5.

Monthly and annual total precipitation data from the sources at the Mill Site (recording gauge at Site 1 and the surface water gauges) are shown in Table 4-3 for the 12-month period from May 2008 through April 2009. The EFR Site precipitation data includes the data collected from the surface water network gauges from May through October 2008 and from the Site 1 precipitation gauge from November 2008 through April 2009. The table also contains precipitation totals from two National Weather Service Cooperative Observer Network (COOP) stations and one Remote Automated Weather Station (RAWS) operated by the Bureau of Land Management (BLM). These stations include the Uravan and Paradox 2N COOP Stations and the Nucla RAWS station as shown in Figure 2. The COOP and BLM RAWS stations used in Table 4-3 were active during the EFR monitoring program. Other nearby COOP stations in the Paradox Valley were not operating during the EFR monitoring program, but historic data from these stations is discussed in Section 5 of this report.

The annual total precipitation from the Mill Site sources is 10.01 inches, with monthly totals ranging from 0.20 inches in July to 2.62 inches in December. The total for the four-month period from September through December 2008 is 6.05 inches, which is 60 percent of the annual total. The annual precipitation totals at the nearby COOP stations during this baseline period were 9.52 and 9.53 inches. These totals are approximately five percent less than the EFR combined total. With the exception of the winter months, monthly precipitation totals at the Nucla RAWS station were similar to totals from the other stations. The lower values shown at the Nucla RAWS station during December through March may be due to the Nucla gauge being unheated or to natural differences due to terrain exposure and location.

Table 4-3
Summary of EFR Precipitation Data

Totals in inches	Data sources			
Period 2008-09	**EFR Mill Site (combined)[1]**	**Uravan**	**Paradox 2N**	**Nucla**
May	0.61	0.73	0.62	0.98
June	0.45	0.42	0.48	0.37
July	0.20	0.13	0.48	0.60
August	0.84	1.79	1.78	1.37
September	1.08	0.38	0.49	0.17
October	1.16	0.69	0.68	0.51
November	1.19	0.89	0.89	0.89
December	2.62	2.72	2.40	0.83
January	0.46	0.27	0.45	0.07
February	0.32	0.36	0.73	0.20
March	0.61	0.59	0.17	0.39
April	0.47	0.55	0.36	0.91
Annual total	10.01	9.52	9.53	7.29
Difference [2]	---	-4.9%	-4.8%	-27.2%

Notes
1. Precipitation data was collected from the surface water network from May – October 2008 and from the Site 1 gauge from November 2008 – April 2009
2. The differences of the annual totals relative to the combined EFR data

Since the surface water network does not monitor precipitation on an hourly schedule, annual hourly precipitation results are not available for the entire monitoring period. However, a summary of the results from the precipitation gauge at Site 1 has been completed. From November 1, 2008 through April 1, 2009 the precipitation gauge at Site 1 recorded 155 hours with greater than 0.01 inches of precipitation for a total of 5.22 inches. The hourly average precipitation rate for this period was 0.03 inches per hour.

4.4 Wind Summary

Wind direction and wind speed are summarized in the “wind rose” presentations in Figures 6, 7, 8, 9, 10, and 11. In these figures, each hourly measurement of wind direction is assigned to a sixteen-point sector of the compass, and the frequency of occurrence of wind from a direction is proportional to the length of the solid line beginning in the central circle and extending outward. The color bars within each compass direction indicate the frequency of specific wind speeds within each wind direction.

Figure 6 summarizes the annual 10-m winds at Site 1, which is located in the northwest corner of the Mill Site towards the middle of the Paradox Valley. Figure 6a is an annual wind rose and Figure 6b presents average winds by hour of day. The various westerly winds with many speed groups are associated with the daytime hours. The two dominant directions (ESE and SE) with very light wind speeds are associated with nighttime, stable, drainage breezes that flow parallel along the axis of the Paradox Valley.

Figure 7 summarizes the annual 30-m winds at Site 2, which is located at the southeast corner of the Mill Site closer to mesas along the southwestern edge of the valley. Figure 7a is an annual wind rose and Figure 7b presents average winds by hour of day. Site 2 experiences westerly and southwesterly winds during both day and nighttime hours, and the wind patterns do not resemble the persistent nighttime valley flow observed at Site 1. The calm winds at Site 2 are most likely the result of local canyon drainage flows from the mesa located west and southwest of Site 2.

Figures 8 and 9 are quarterly wind roses for Sites 1 and 2. The quarterly wind roses for Site 1 in Figure 8 show the nighttime southeast valley flow through each quarter. In Figure 9, the wind roses for Site 2 indicate that the various westerly winds persist through the entire year. Both sites recorded more measurements with higher wind speeds in the third quarter of 2008 than in the other quarters.

Figures 10 and 11 are wind roses for the months in each quarter for Sites 1 and 2, respectively. These figures provide a more detailed wind summary for each site. At Site 1, westerly winds with higher speeds were observed in April, May, and June of 2008. March of 2009 recorded similar patterns. The southeasterly breezes were observed in all months, but the calmest conditions were recorded in the months of November, December, January, and February. Similar to Site 1, Site 2 exhibited westerly winds with higher speeds in April, May, and June of 2008, and March of 2009. Calm, nighttime westerly breezes were observed in all months, but the calmest conditions were recorded in November, December, and January.

These wind summaries show anticipated patterns for the region and topographic setting. This factor adds strength to the assessment that the wind data are representative of the Mill Site and surrounding areas for the purposes of modeling atmospheric dispersion for environmental impact analyses.

4.5 Atmospheric Stability

Atmospheric stability is typically used for assessing dispersion of emissions, as the stability describes the potential for vertical motion in the atmosphere. Unstable conditions encourage positive vertical motion or movement toward the sky, and stable conditions encourage negative vertical motion or movement toward the ground. Atmospheric stability conditions for Sites 1 and 2 were estimated using the Solar Radiation/ Delta T (SRDT) Method as outlined in the EPA MMGRMA. The SRDT method assigns a Pasquill-Gifford Stability Class (P-G Class) to each hourly measurement based on specific conditions of solar radiation, vertical temperature differences, and wind measurements. The P-G Classes range from A through F with A being unstable and F being the most stable.

For daytime hours, P-G Classes are assigned based on solar radiation and wind speed. Lower wind speeds and higher solar radiation result in more unstable conditions while higher wind speeds and lower radiation result in more stable conditions. For nighttime hours, P-G Classes are assigned based on the vertical temperature gradient (Delta T) and the wind speed. At night, only stable conditions (D, E, F) are assigned, but positive vertical temperature conditions and low wind speeds result is very stable conditions. The specific criteria for daytime and nighttime conditions are provided in Table 4-4.

Table 4-4
SRDT Method Criteria for P-G Stability Classes

DAYTIME				
Wind Speed (m/s)	**Solar Radiation (W/m^2)**			
	≥ 925	**925 – 675**	**675 – 175**	**< 175**
< 2	A	A	B	D
2 – 3	A	B	C	D
3 – 5	B	B	C	D
5 – 6	C	C	D	D
≥ 6	C	D	D	D
NIGHTTIME				
Wind Speed (m/s)	**Vertical Temperature Gradient**			
	< 0		**≥ 0**	
< 2.0	E		F	
2.0 – 2.5	D		E	
≥ 2.5	D		D	

The atmospheric stability summary for Sites 1 and 2 is provided in Figure 12. The data from both sites exhibit similar patterns with neutral to stable conditions being the most frequent. As shown in Figure 12, Site 2 does have a larger percentage of hours with very stable conditions than recorded at Site 1. These very stable conditions at Site 2 are most likely a result of the calmer nighttime, canyon winds discussed in Section 4.4.

Annual joint frequency tables with wind speed, wind direction, and stability class were produced to describe the wind patterns at Sites 1 and 2. The tables list the occurrence of 16 wind directions as measured in each stability class with specific wind speeds. The joint frequency tables quantitatively summarize the trends described in Sections 4.4 and 4.5. These tables are provided in Appendix C.

5.0 CLIMATOLOGY

5.1 Regional Climate Data Sources

Climate descriptions involve averaging meteorological records over a period of time. The National Oceanic and Atmospheric Administration's National Climatic Data Center uses 30 years of data to calculate the classical "normal" values often used to describe long-term climate conditions. In some cases, climate can be adequately described with shorter or longer periods of records, depending on the purpose of the data.

Sources of meteorology data in the region of the Mill Site were evaluated based on data availability, location, and topography to assess if the station was representative of the Mill Site conditions. The stations chosen as representative of climate conditions at the Mill Site are summarized in Table 5-1.

Table 5-1
Summary of Meteorology Stations Used for Climate Analysis

Station Type	Site Locations	Elevation [4]	Period of Record	Available Parameters for Climate Analysis
COOP [1]	Paradox, CO (Pdox1E)	5,282 ft.	1948 - 1977	Precipitation * Temperature *
	Paradox, CO (Pdox1W)	5,530 ft.	1977 - 1995	
	Paradox, CO (Pdox2N)	5,440 ft.	2005 - 2008	
	Bedrock, CO	4,980 ft.	1997 - 2005	
	Uravan, CO	5,010 ft.	1960 - 2008	
RAWS [2]	Nucla, CO	5,860 ft.	1999 - 2008	Precipitation Temperature * Dew Point Temp * Relative Humidity * Wind Speed * Wind Direction Solar Radiation * Barometric Pressure
NWS [3]	Grand Junction, CO [5]	4,859 ft.	1962 - 2005	Evaporation *
	Montrose-1, CO [6]	5,758 ft.	1948 - 1982	

Notes
1. COOP Stations refer to National Weather Service (NWS) Cooperative Observer Network.
2. RAWS stations refer to the Bureau of Land Management (BLM) Remote Automatic Weather Station.
3. NWS stations are official stations operated by NWS offices.
4. The Site elevation is approximately 5,450 ft.
5. NWS at Grand Junction includes information shown for Nucla, CO; only evaporation data were used
6. NWS evaporation stations Montrose-1 is also a COOP station
* Marked parameters from the corresponding stations are used in the Mill Site climate analysis. Discussion of site relevance is provided in the following text.

The La Sal, UT, (424946) and La Sal 2 SE, UT, (424947) COOP stations, the Big Indian RAWS station, and the evaporation station in Moab, Utah, were considered for the climate analysis.

The La Sal COOP stations and the Big Indian RAWS station are located approximately 25 miles west of the Site in the La Sal Mountains and have similar vegetation and topography. However, the elevation of these stations is greater than 1,200 feet above the elevation of the Mill Site (approx. 5,450 ft.). Since elevation differences can have large influences on temperatures and precipitation totals, these stations are not considered to be as representative as other sites and were therefore excluded as a basis of climate data. The evaporation station in Moab, Utah is in a high desert environment, more than 50 miles away, and at an elevation near 4,000 feet amsl. Hence, these data were not used in the analysis, either.

The locations of the COOP and RAWS sites listed in Table 5-1 are shown with the Paradox Valley topography in Figure 2. The summary tables of the climate data discussed in this section are provided in Appendix D.

COOP stations operate with volunteer observers who record daily temperature and precipitation conditions using National Weather Service standardized methods. Data from the COOP sites were obtained from the Western Region Climate Center and are included in this report. Four NWS COOP stations have been located near the Mill Site within Paradox Valley. The three Paradox and the Bedrock COOP station locations are in terrain similar to the Mill Site. The Uravan COOP site is located in a shallow canyon along the San Miguel River approximately 9 miles north northwest of the Mill Site.

The RAWS stations are automated stations that measure precipitation, temperature, humidity, pressure, wind, and solar radiation with hourly data records. The Nucla site is on an open ridge at an elevation of 5,860 feet amsl about two miles south-southwest of Nucla, Colorado. Nucla, Colorado, is an arid region that experiences a wide range of temperatures and limited precipitation, but the exposure and vegetation around the station is similar to much of the Paradox Valley, making it reasonably representative of the overall climate conditions.

As presented in Section 4.3, the annual precipitation totals from the two COOP stations, Uravan and Paradox 2N, differed from the EFR data by less than five percent during the baseline period. For long-term analysis, the Paradox 2N station only has three years of data, but the Uravan station have over 30 years of continuous precipitation and temperature data. Thus, the Uravan COOP station was identified as the long-term continuous data source for temperature and precipitation trends in the Mill Site area. Data from the other COOP stations are also provided as a summary of variations throughout the Paradox Valley.

Since the COOP stations only recorded temperature and precipitation data, the Nucla RAWS station is the primary source of long-term data for temperature, wind speed, humidity, and solar radiation. The Nucla RAWS station data were obtained from the Western Regional Climate Center (WRCC) and are summarized in this report. Since the Nucla RAWS station is not located in the Paradox Valley and the valley topography dominates the local wind direction patterns at the Mill Site, wind direction data from the Nucla RAWS station is not representative of long term wind directions at the Mill Site.

5.2 Long Term Statistics and 30-year Normal Values

Climate data from nearby stations relevant to characterizing the Mill Site area are presented in this section, with a focus on precipitation data. In addition to the 30-year normal values often used in climate analyses, data from other time periods are presented when available.

5.2.1 Precipitation Averages and Extremes

The full period of record precipitation data taken at the five COOP stations and the Nucla RAWS station are summarized in Tables D-1a, D-1b, D-1c, D-1d, D-1e, and D-2 provided in Appendix D. The COOP summary tables include the following information:

- Monthly, seasonal and annual mean and extreme totals, and the year the extreme event occurred;
- One-day maximum amounts, with the date it occurred;
- Average number of days that the precipitation total exceeded 0.01, 0.10, 0.50 and 1.00 inches, and
- Average and maximum snowfall accumulation, with the year the monthly maximum occurred.

The data for Uravan (Table D-1a) show the annual average precipitation for the period from 1960 through 2008 is 12.63 inches. Note that the Uravan annual total of 9.52 inches over the baseline monitoring period (Table 4-3) was 24.6 percent less than the long-term annual average of 12.63 inches. The extreme annual values range from 7.13 inches in 1989 to 21.40 inches in 1965. The monthly averages range from 0.48 inches in June to 1.51 inches in September. The extreme one-day total was 1.90 inches, which occurred on August 21, 1971. The annual average number of days with measurable precipitation, that is at least 0.01 inch, is 76. The average occurrences of days with precipitation at least 0.10 and 0.50 inch are 39 and 6, respectively. The average annual snowfall is 10.0 inches; the maximum year was 1979, when 40.9 inches of snowfall was measured.

Thirty year normal values for the period 1971-2000 for Uravan, the station identified as the most representative of the Mill Site area, are presented in Table D-3 of Appendix D. The precipitation data in this table include monthly and annual mean and extreme totals. The 30-year normal values for the preceding statistics were very similar to the long-term results.

During the baseline year of onsite monitoring, 10.01 inches of precipitation were recorded as representative of the Mill Site area as presented in Section 4.3 of this report. During the same period, Uravan recorded 9.52, which is 4.9 percent less than the EFR total. Applying the difference observed between the EFR and Uravan annual totals during the monitoring year, -4.9 percent, to the long-term average annual total for Uravan, 12.63 inches, the expected average annual total precipitation for the Mill Site is 13.28 inches.

5.2.2 Temperature Averages and Extremes

Data recorded at the five COOP stations are summarized in Tables D-1a through D-1e in Appendix D. The Nucla RAWS station long-term temperature data are summarized in Table D-4. The tables include the following information for monthly, seasonal and annual periods:

- Averages of daily maximum, minimum, and mean values of the monthly average temperature;
- Daily high and low extremes, with the date of occurrence;
- Extreme monthly mean values;

- Number of days with the daily maximum temperature at least 90ºF;
- Number of days with the daily maximum temperature less than or equal to 32ºF;
- Number of days with the daily minimum temperature less than or equal to 32ºF; and
- Number of days with the daily minimum temperature less than or equal to 0ºF.

The overall annual average high temperature at Uravan is 69.0ºF. The range of daily maximum temperature is from 42.7ºF in January to 95.5ºF in July; the range of daily minimum temperature is from 15.5ºF in January to 59.5ºF in July. The extreme temperatures range from -23ºF to 110ºF. The average annual number of days with a maximum temperature at least 90ºF is 75.3, and the average number of days with a minimum temperature less than or equal to 32ºF is 149.1.

As with the precipitation data, the 30-year normal temperature from 1971-2000 are also shown in Table D-3. Temperature summaries used to calculate normal values are similar to the long-term values reported in Table D-1a.

5.2.3 Wind and Local Airflow Patterns

Data of the average annual wind speed and maximum wind gusts for the Nucla RAWS station is provided in Table D-5. The average annual wind speed from 1999 through 2008 at the Nucla RAWS station is 5.2 miles per hour (mph). The ten-year monthly averages range from 3.6 mph in December and January to 6.7 mph in April and June.

Extreme values of wind gusts are less likely to show regular patterns than the monthly average and total values that are typically presented. The monthly average wind gusts for the 1999 through 2008 period ranged from 40.3 mph to 54.0 mph, with a tendency for the higher speeds to occur during April through June. The overall maximum gust speed recorded was 76 mph in June 2005. The next highest maximum gust speed was 60 mph in May 2004.

The Nucla RAWS station wind sensor is located approximately 3 meters above ground surface while the EFR wind sensors were installed at 10 meters and 30 meters for Sites 1 and 2, respectively. Average wind speeds typically increase with height. Accordingly, the EFR monthly wind speed averages are higher than the Nucla RAWS long-term averages, however, both data sets exhibit similar annual patterns. Both the RAWS station and EFR sites record the highest monthly wind speed averages in the months of March, April, May, and June, and the lowest wind speeds are collected during the winter months.

5.2.4 Humidity

Long-term dew-point temperature monthly summaries for the Nucla RAWS station are provided in Table D-6. The overall annual average dew-point temperature at Nucla is 24.8ºF. The monthly mean values range from 16.1ºF in January to 42.8ºF in August.

The average annual relative humidity for the period from 1999 through 2008 at the Nucla RAWS station is 41.9 percent. The monthly averages are provided in Table D-7. June has the lowest monthly average relative humidity, with 22.7 percent. The highest monthly average is December, with 58.4 percent. This opposite cycle (summer minimum) to the temperature data is, in part, due to the opposite relation between relative humidity and temperature.

For the EFR monitoring period, April 2008 through March 2009, the monthly average relative humidity values at the EFR Sites 1 and 2 are very similar to the data from the Nucla RAWS station. The overall average of monthly differences for EFR Sites 1 and 2 (Nucla minus EFR values) is 2.4% and -0.2%, respectively.

5.2.5 Solar Radiation

The monthly total incoming solar radiation values on a flat surface, in langleys (cal/cm^2), were obtained for the Nucla RAWS station. The average monthly values ranged from 6,727 langleys in December to 20,350 langleys in June. To facilitate using this information in the metric form, the values in langleys were calculated in kilowatt-hours per square meter (kwh/m^2) by a multiplication factor of 0.01163. The corresponding average monthly values for the ten-year period in kilowatt-hours per square meter were 78.2 in December and 236.7 in June. The monthly totals for each year, and the overall monthly averages of the totals, are summarized in Table D-8.

The comparisons between the Nucla RAWS station and EFR sites show that measured solar radiation from EFR Sites 1 and 2 occurred within the range of values measured at the Nucla RAWS station.

5.2.6 Evaporation

Summaries of pan evaporation data from the two NWS stations were obtained to estimate pan evaporation in the region. The Grand Junction data were taken from 1962 through 2005; and Montrose data were taken from 1948 through 1982. The locations of these cities with respect to the Mill Site are shown in Figure 1. A summary of the monthly and annual totals is provided in Table D-9. The months at Grand Junction with no measurements due to freezing conditions are shown as “n/a” in the table.

The long-term pan evaporation rate for the Mill Site was estimated by taking an average of the available monthly values from Grand Junction and Montrose shown in Table D-9. The calculated values for the Mill Site are averages of the two sites, except the Montrose data were taken from the months when the Grand Junction data were not provided. The calculated results for the Mill Site are shown in Table D-9. The estimated long-term monthly average pan evaporation rates ranged from 1.30 inches (33.0 mm) during December to 10.7 inches (270.5) mm) in June. The annual total estimated pan evaporation is 64.75 inches (1,644.7 mm). An accepted pan evaporation coefficient to calculate lake (free water) evaporation is 0.77 (Linacre, 1994). According to this method, the corresponding lake evaporation would be 49.9 inches (1,266 mm) per year.

Evaporation data were collected at EFR Site 1 during the non-freezing months and resulted in a seven-month total of 55.26 inches. The total for the same seven months for the calculated average of Montrose and Grand Junction shown in Table D-9 is 55.1 inches, which is very nearly identical to the measured value of 55.26 inches. Evaporation at the Mill Site during the winter period was also estimated based on the data available from Montrose since winter evaporation measurements were taken at Montrose. Accordingly, the evaporation from April through June accounts for 84% of the evaporation at Montrose. Applying this factor to the Mill Site evaporation, the total annual Mill Site evaporation is estimated as 65.8 inches (55.26/0.84). This is only a 1.5% difference from the average annual pan evaporation from Grand Junction and Montrose of 64.8 inches. A graph of the long-term monthly averages from the two NWS stations, the seven-month results from the EFR Site 1 data and the estimated Mill Site evaporation rate based on the NWS data are shown in Figure 13.

In addition to the pan evaporation estimates from the NWS stations, evaporation was also examined with a method from United States Geological Survey (USGS). The USGS has a method for estimating the evaporation for areas in the western U.S. for use in estimating runoff and possible contamination of water sources from various minerals in the soil (USGS Fact Sheet, 1997). This method uses historic measurements of precipitation rates and measured or estimated evaporation rates to calculate an evaporation index (EI). The data used for the USGS fact sheet on this method are unavailable; however, using the EI in the USGS fact sheet along with the average historical precipitation for the area, the annual evaporation can be estimated. The equation for EI is:

$$EI = \frac{FWSE}{PRECIP}$$

Where EI is the evaporation index, FWSE is the annual free-water-surface evaporation, and PRECIP is the annual precipitation. The EI for the Site area is between 2.5 and 3.0, according to the evaporation index map provided in the USGS fact sheet. Using this information and the range of annual average precipitation for the area summarized for the COOP stations shown in Table D-10 of 10.77 inches (273.6 mm) to 16.02 inches (406.9 mm), the estimated annual free-water-surface evaporation for the area would be between 26.9 and 48.1 inches (684 to 1,221 mm).

The USGS method result is lower than the EFR Site 1 results, but are generalized for the area and not considered unreasonable for the Mill Site.

5.3 Severe Weather Phenomena

Excerpts from the "Climate of Colorado" publication, Climatography of the United States No. 60 (updated January 2003) by Nolan J. Doesken, Roger Pielke, Sr., and Odilia A.P. Bliss from the state climate office (http://ccc.atmos.colostate.edu/climateofcolorado.php) follow.

> *Thunderstorms are quite prevalent in the eastern plains and along the eastern slopes of the mountains during the spring and summer. No specific mention is made of these occurrences in southwestern Colorado. Tornadoes are relatively rare in the mountains and western valleys but do occur. Lightning has emerged as one of the greatest weather hazards in Colorado. Each year there are typically several fatalities and injuries. Unlike tornadoes that are most common in selected areas of the state, lightning occurs everywhere.*
>
> *Heavy snows in the high mountains are common. Avalanches pose a serious problem to residents, road maintenance crews and back country travelers. Considerable effort is made each year to predict and manage avalanches.*
>
> *A spring flood potential results from the melting of the snow pack at the higher elevations. In a year of near-normal snow accumulations in the mountains and normal spring temperatures, river stages become high, but there is no general flooding. In years when snow cover is heavy, or when there is widespread lower elevation snow accumulation and a sudden warming in the spring, there may be extensive flooding.*

Avalanches could not occur at the Mill Site due to its relatively low elevation (i.e., as compared to high mountains); however, the other severe weather phenomena discussed above could occur at or in the vicinity of the Mill Site.

5.4 Climate Change

Most of the data presented in the preceding sections describe conditions occurring during the last ten-year period, 1999 through 2008. As noted in Section 2.3 of this report, data from longer periods of time are available from more distant sites and could have been included. However, the issue of how well data from more distant sites with differing geography represent conditions in the Paradox Valley resulted in using data from closer sites that have data availability over a shorter period of time. Trends in climate change from these data are not clearly evident. Therefore, in addition to that data, information from a recent report on climate change in Colorado was evaluated to assist with projecting the climatic conditions that could occur during the lifetime of the Site, a period of approximately 40 years.

The Western Water Assessment (WWA) group associated with the University of Colorado prepared a report for the Colorado Water Conservation Board in 2008, "Climate Change in Colorado", which is available at:

http://cwcb.state.co.us/Home/ClimateChange/ClimateChangeInColoradoReport/

The report acknowledges the difficulty in projecting regional changes in response to global-scale changes in climate conditions and weather system occurrences, though temperature and precipitation trends on a regional basis are shown. Montrose, Colorado, is one of the stations depicted in the WWA report which is located approximately 50 miles north northeast of the Mill Site.

The primary points from this report relevant to the Mill Site are:

- Temperature: climate models project Colorado will warm by 4ºF by 2050, relative to the 1950-99 baseline values.
- Precipitation: climate models do not agree on changes in annual mean precipitation, though seasonal shifts may occur, including a lower snowpack occurring by 2050.

The WWA report shows that since 1970 10-year average observed temperatures have increased across the state. The increase from 1977 through 2006 for the southwestern regional corner of the State is reported as 2ºF. The Montrose data in the WWA report are representative of trends at other regional stations in the report. Year-to-year variations of average temperature have exceeded 1ºF, including during the most recent period. The warming trend could include shorter periods during the year of freezing temperature occurrences. Although not documented in the WWA report, evaporation rates are expected to increase associated with warmer temperatures.

In the WWA report, no apparent precipitation trends in the water-year (October through September) were presented for the regional stations. This lack of trend is also found in the climate model projections. The WWA report also discusses that annual values can range from one-half to twice the long-term average values. The annual variation in annual precipitation at the Uravan COOP station (as discussed in Section 5.2.1 of this report) was nearly a factor of three, demonstrating the large year-to-year variability that occurs in the Mill Site area. In another section of the WWA report, the regional drought during 2000 through 2007 is seen to be consistent with natural variability observed in the long-term and paleoclimatic records covering thousands of years.

Because of complex interactions between climatic elements and factors affecting water use, the lack of apparent trend and projected changes in total precipitation do not carry through to future water resource expectations. The WWA report concludes that a reduction in total water supply will occur during the projection period. Drought severity could be increased due to higher temperatures alone. Runoff in the Upper Basin of the Colorado River is expected to decline by 6% to 20% by the year 2050 (Sections 5.3 and 6.0 of the WWA report).

6.0 BASELINE AIR QUALITY

6.1 Attainment Status

According to Chapter 40 of the Code of Federal Regulations, Montrose County, Colorado, is in attainment of all EPA National Ambient Air Quality Standards.

6.2 Nearby Sources

Most of the Paradox Valley including the land surrounding the Mill Site is considered unincorporated. Most of the valley is utilized for open ranching, but some agricultural sources exist near Bedrock and Nucla, CO. There are several minor sources throughout the valley including aggregate processing operations, concrete batch plants, and uranium/vanadium ore mining. These operations are primarily sources of particulate matter, but can also utilize processes and/or equipment that emit nitrogen oxides (NO_x), sulfur dioxide (SO_2), carbon monoxide (CO), and some Hazardous Air Pollutants (HAPs). Tri-State Generation and Transmission also operates a coal strip mine and a coal-fired power plant in Nucla, CO. The mining activities are another source of particulate matter, while the power plan is a major source for NO_x, SO_2, CO, particulate matter, and HAPs.

7.0 QUALITY ASSURANCE PROGRAM

7.1 Quarterly Calibrations

Calibrations were performed on particulate matter and meteorological equipment according to the procedures listed in the EFR Air Monitoring Plan. The particulate matter equipment was calibrated during each quarter of baseline monitoring and the meteorological equipment was calibrated bi-annually. For the first three quarters of the baseline monitoring period, the calibrations were completed by Intermountain Laboratories Air Science (IML). For the final quarter of the baseline monitoring period, EFR personnel calibrated the particulate matter equipment and IML calibrated the meteorological equipment. Copies of the calibration reports are provided in Appendix A.

7.2 Independent Quarterly Audit Program

Independent auditing of the particulate matter and meteorological equipment was completed according to procedures and acceptable audit performance limits outlined in the EFR Air Monitoring Plan. For the first three quarters of the baseline monitoring period, the equipment audits were completed by VSI. For the final quarter of the baseline monitoring period, IML performed audits of the meteorological equipment. Copies of the audit reports are provided in Appendix A.

7.3 Internal Quality Control Procedures

The EFR monitoring program includes corrective action plans in the event that operational errors occur. During the monitoring period, five operational errors and equipment malfunctions/failures occurred that resulted in data collection loss. In these instances the EFR monitoring project manager and field personnel, as well as the monitoring project manager for Kleinfelder as necessary, investigated the root cause of the problems and initiated corrective actions. In addition, the CDPHE Air Pollution Control Division (APCD) was notified of the issues and the corrective actions taken as required by the Ambient Air Monitoring Work Plan (REF). Refer to Table 7-1 below for a summary of the data loss events and the corrective actions taken.

Table 7-1
Summary of Events of Significant Operational Errors and Corrective Actions

Equipment	Date(s)	Error/Cause	Corrective Action
Site 2 Vertical Wind Speed (0.4 m/s propeller)	4/15/08 – 5/24/08	Equipment Malfunction	• Repair and recalibration • Continuance of daily equipment monitoring program
Site 1 Precipitation Gauge	3/2708 – 10/12/08	Equipment Malfunction	• Repair was conducted upon discovery of malfunction during equipment calibration • Monthly operational checks of the gauge were included in monitoring program
Site 1, 2 TSP Samplers	2008 - 7/8, 7/9, 7/12, 7/18, 7/25, 7/26, 8/6, 8/7,	Power loss caused sampler to not run until reset	• Rewiring of the samplers eliminated need to reset, minimizing data loss

Table 7-1
Summary of Events of Significant Operational Errors and Corrective Actions

Equipment	Date(s)	Error/Cause	Corrective Action
Site 3 TSP Sampler	9/4/08 – 9/8/08	Generator failure	• Back-up generator was installed for use during primary generator failure and maintenance periods
Site 3 TSP Sampler	3/31/09 – 4/1/09	Sampler motor failure	• Back-up motor was installed
PM10 Samplers	3/31/08 7/11/08	Operator error and power failures resulted in scheduled sample not being collected	• Make-up samples were collected • APCD was notified of make-up sample collection

8.0 STANDARDS AND REFERENCES

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