3.6.1.1.3 Precipitation

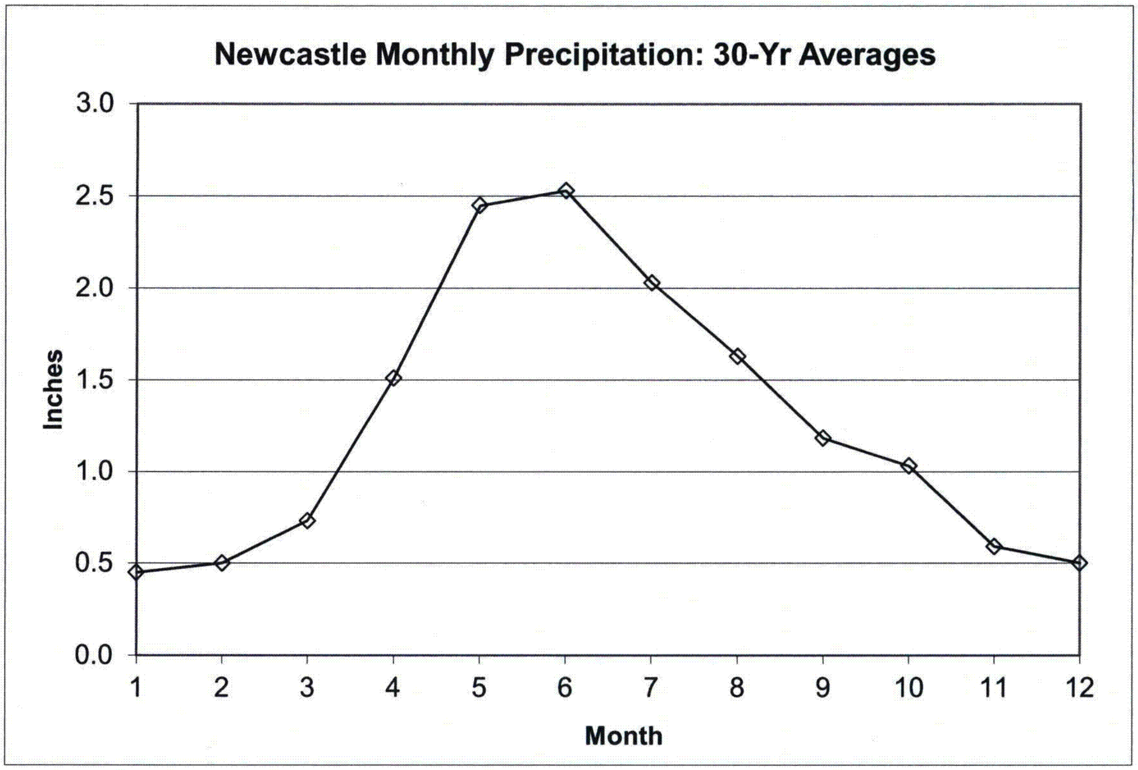
Figure 3.6-8 shows average monthly precipitation at the Newcastle NWS Coop site for the past 30 years. For comparison, Figure 3.6-9 shows monthly precipitation totals for the baseline monitoring year. It can be seen that unusually high precipitation was measured in the months of May and July of 2008.

Figure 3.6-10 and Table 3.6-5 show average monthly and seasonal precipitation amounts for all of the available meteorological monitoring sites in the area. This area can be very dry at times with a regional annual average precipitation of 16.5 inches. Most of the precipitation occurs during May, June, and July (48 percent of the annual). Typically, May is the wettest month of the year for this region with an average total of 2.8 inches. Winter receives roughly 8 percent of the total annual precipitation. January is the driest month of the year with an average accumulation of 0.36 inch of precipitation.

This region receives an average of 38 inches of snowfall each year. As shown in Figure 3.6-11, most snowfall occurs during the month of March with a regional average of 8.5 inches. Custer receives the most annual snowfall (48 inches). This can be attributed to the higher elevation and the influence of the surrounding Black Hills (Figure 3.6-12).

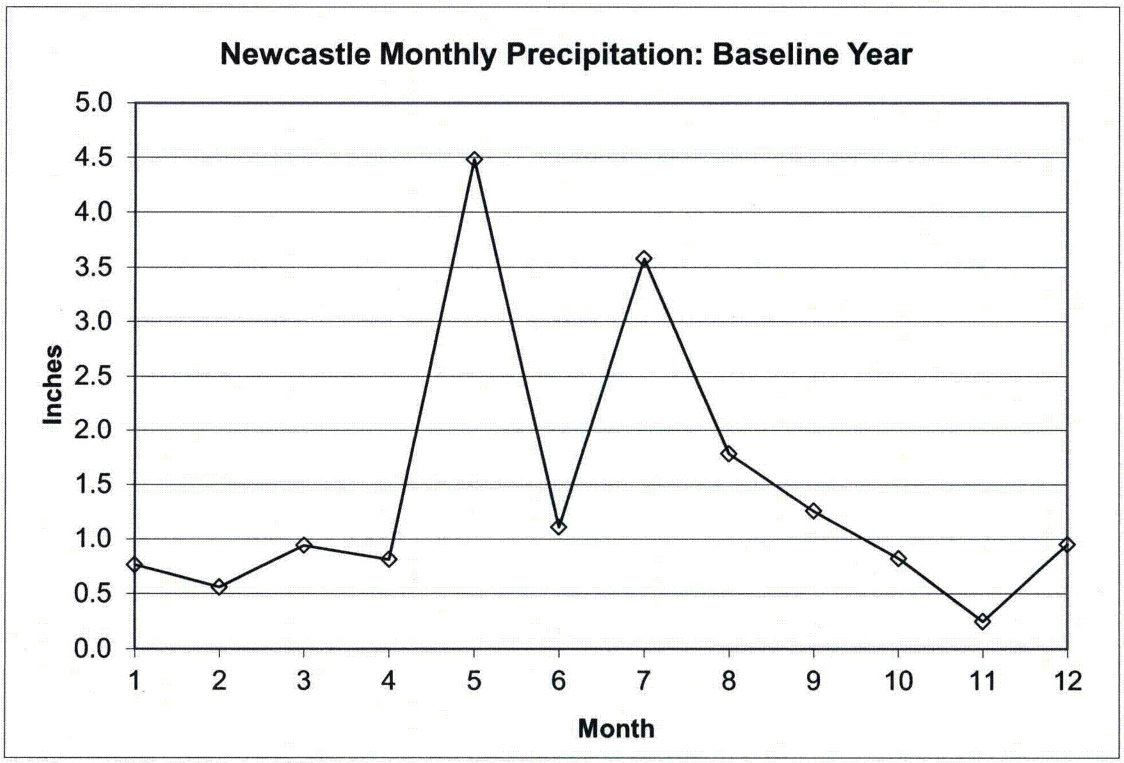
3.6.1.1.4 Wind Patterns

A meteorological station in Newcastle, Wyoming was used to evaluate long-term representativeness of the data collected at the site. The closest NWS station to the project site with hourly wind data is Chadron, Nebraska. Chadron was eliminated from consideration as it is more than 60 miles from the permit area and is lower in elevation. The wind patterns are substantially different, most likely due to the effect of the Black Hills on the Dewey-Burdock site. For demonstrating that baseline monitoring is representative of long-term conditions, particular emphasis is placed on wind speed, wind direction and atmospheric stability, as these parameters impact the modeling of potential radiological impacts from the Dewey-Burdock Project (MILDOS-AREA modeling) as well as air quality monitoring locations. While the Newcastle meteorological station is not strictly representative of the Dewey-Burdock site, it is sufficiently close in distance and geography to infer the regional relationship between the baseline monitoring period (7/18/2007 to 7/17/2008) and long-term conditions. The following describes how the baseline monitoring period is representative of long-term meteorological conditions in the region.



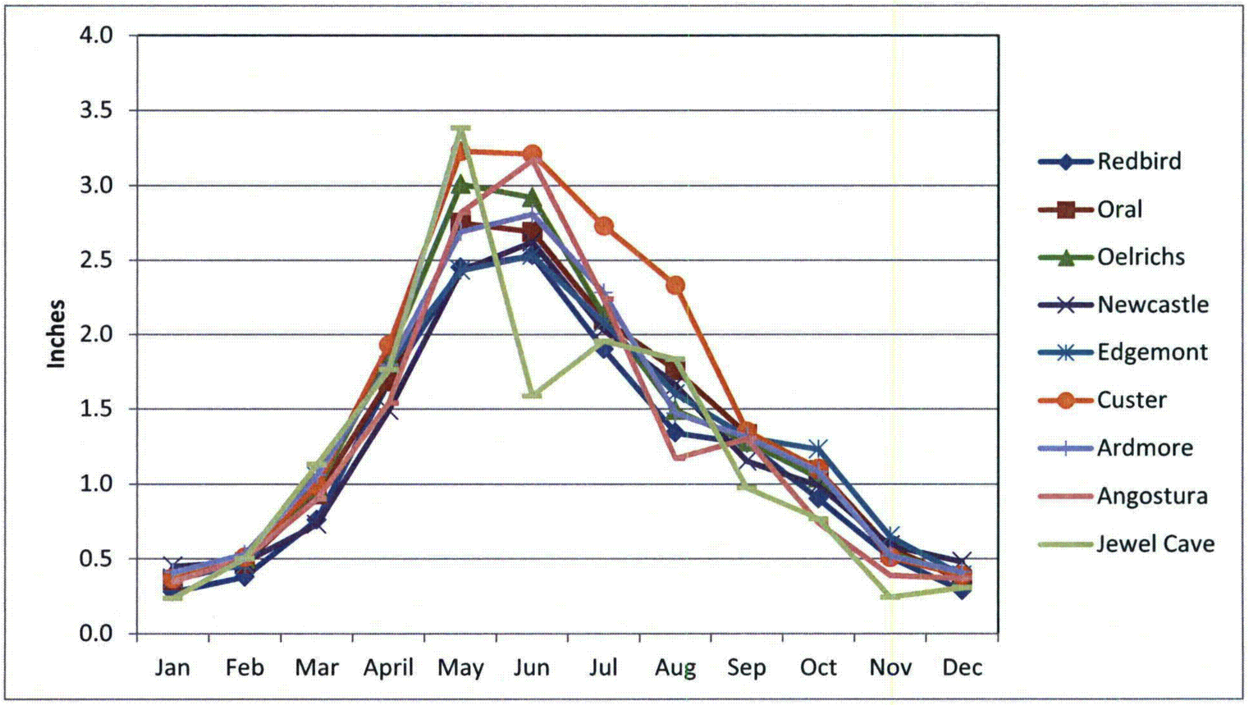
Source: IML Air Science, 2011

Figure 3.6-8: Average Monthly Precipitation for Newcastle, Wyoming



Source: IML Air Science, 2011

Figure 3.6-9: Baseline Year Monthly Precipitation for Newcastle, Wyoming



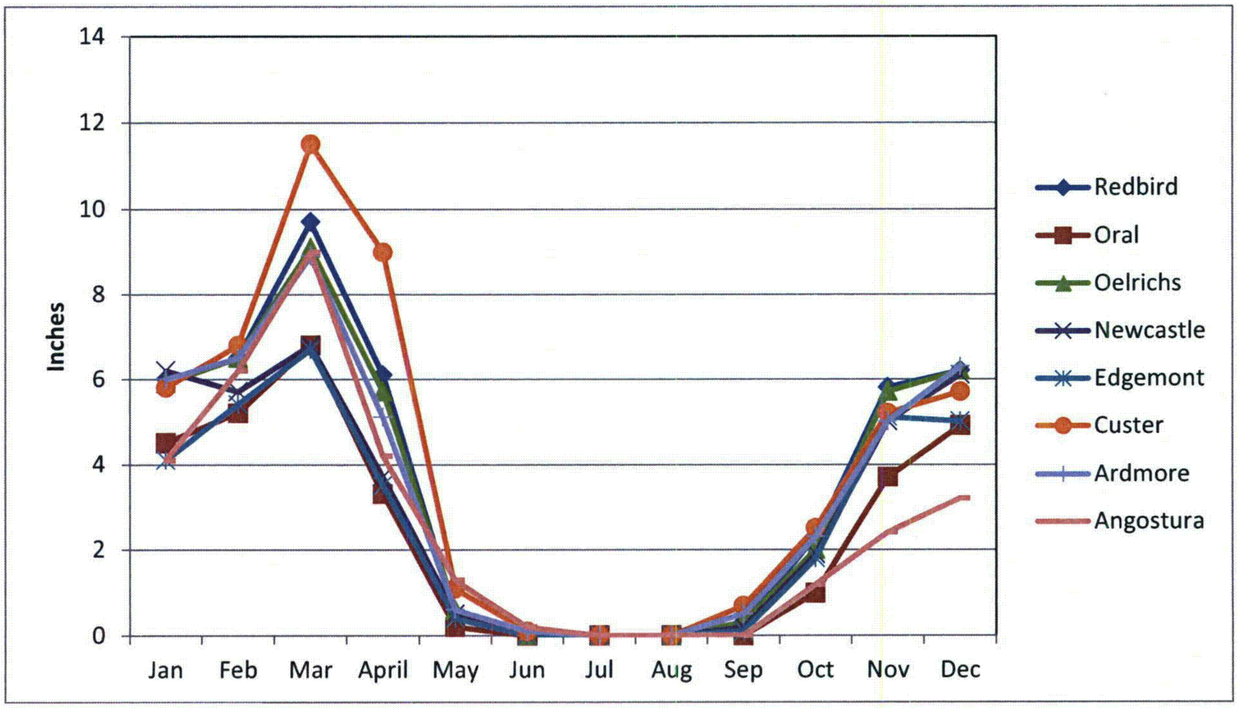
Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-10: Average Monthly Precipitation for Regional Sites

Table 3.6-5: Average Seasonal and Annual Precipitation for Regional Sites

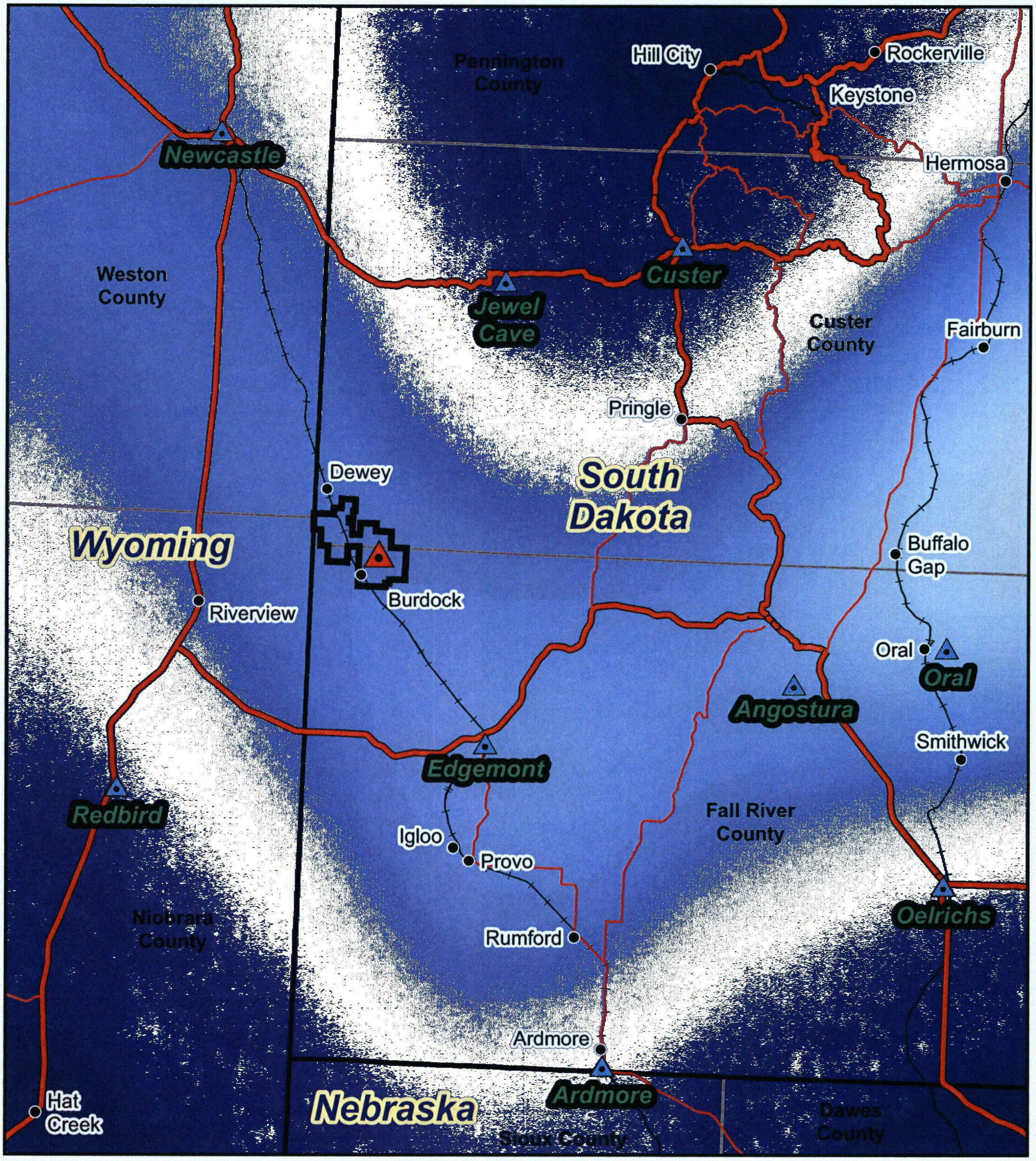
Name	Annual	Winter	Spring	Summer	Fall
Redbird	14.29	0.95	4.89	5.77	2.68
Oral	16.10	1.19	5.37	6.54	3.00
Oelrichs	16.50	1.28	5.83	6.54	2.85
Newcastle	15.11	1.41	4.65	6.32	2.73
Edgemont	15.87	1.22	5.26	6.20	3.19
Custer	18.66	1.27	6.15	8.28	2.96
Ardmore	16.35	1.34	5.54	6.56	2.91
Angostura	15.51	1.22	5.26	6.59	2.44
Jewel Cave	20.00	6.30	6.30	5.40	2.00
Region Average	16.49	1.80	5.47	6.47	2.75

Source: HPRCC, 2008; SDSU, 2008



Source: SDSU, 2008

Figure 3.6-11: Average Monthly Snowfall at Regional Sites



This figure is provided to fulfill the requirements of ARSD 74:29:02:11(1).

Miles
0 5 10 20
0 10 20 30
Kilometers

Legend

- Towns
- Permit Boundary
- Dewey-Burdock MET Station
- Meteorological Sites

Transportation
- US Highway
- State Highway
- Railroad

Snowfall (Inches)
- 61 (High)
- 44
- 27 (Low)

N

Figure 3.6-12

Average Annual Snowfall

Dewey-Burdock Project

SIGNATURE OF PREPARER	John Mays
PREPARER	John Mays
DATE	24-Sep-2012
FILE	AnnualSnowfall.mxd

POWERTECH (USA) INC.

Figures 3.6-13 and 3.6-14 show wind roses at the Newcastle WRC site for the nearly 10 years of monitoring and for the one year corresponding to the Dewey-Burdock baseline monitoring period. Figure 3.6-15 presents a graphical representation of wind speed frequencies.

The long-term representativeness can be demonstrated quantitatively by isolating wind speed and wind direction variables to correlate short-term and long-term frequency distributions. IML Air Science has developed a statistical methodology for assessing the degree to which the distributions of wind speed class and wind direction frequencies from one year of monitoring at a particular location represent the long-term distributions at that same location.

For the joint frequency wind distribution used in the MILDOS-AREA model, wind speeds are divided into six classifications ranging from mild (0 – 3 mph) to strong (> 24 mph) as illustrated in Figure 3.6-15. Likewise, wind directions are divided into 16 categories corresponding to the compass directions illustrated in Figure 3.6-16.

The percent of the time that winds occur in each of the six wind speed categories can be calculated to produce a wind speed frequency distribution. The percent of the time that winds blow from each of the 16 directions can be calculated to produce a wind direction frequency distribution. For each parameter, the 1-year and 10-year distributions can then be compared. Linear regression analysis provides a useful tool to assess the degree of correlation between short and long-term distributions.

Figure 3.6-17 presents this correlation for the wind speed distributions at Newcastle. Each point represents one of the six wind speed classes. The x coordinate corresponds to the percent of the 1-year period during which the wind speed fell in a given class, while the y coordinate corresponds to the percent of the 10-year period during which the wind speed fell in that same class.

The regression line (red) in Figure 3.6-17 represents the least-squares fit to the six data points. The corresponding R^2 value of 99.3% implies very strong linear correlation. The linear slope of 0.98 further implies that short and long-term wind speed frequencies are substantially equivalent.

A similar analysis can be performed for wind direction frequencies. Figure 3.6-18 presents this correlation at Newcastle. Each point represents one of the 16 wind direction categories. The x coordinate corresponds to the percent of the 1-year period during which the wind blew from a given direction, while the y coordinate corresponds to the percent of the 10-year period during which the wind blew from that same direction.

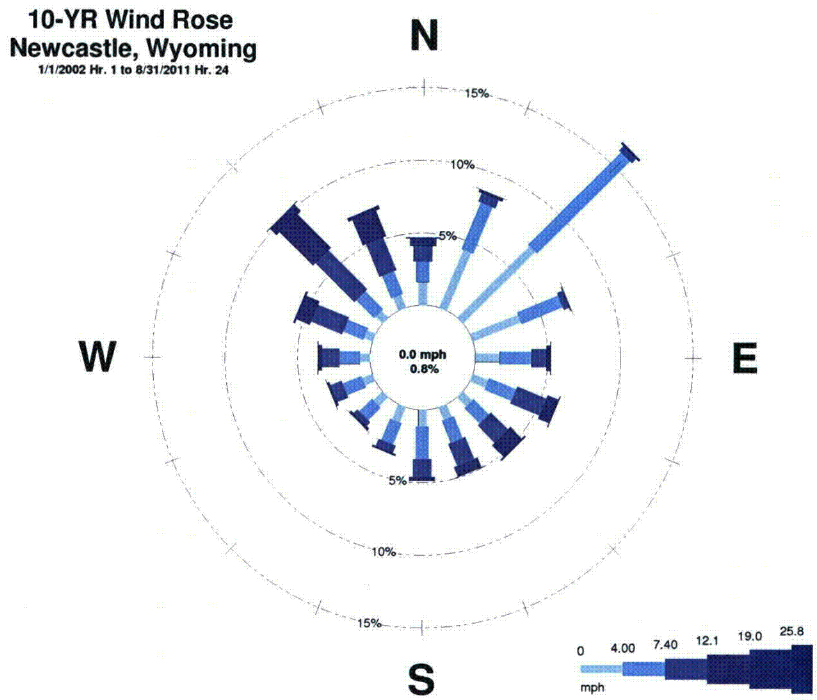


Figure 3.6-13: Newcastle 10-year Wind Rose

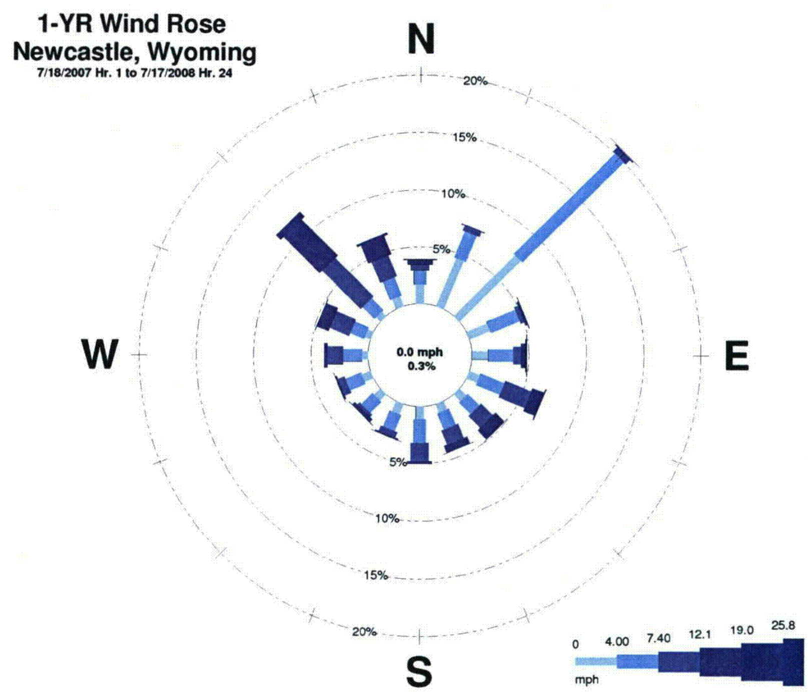
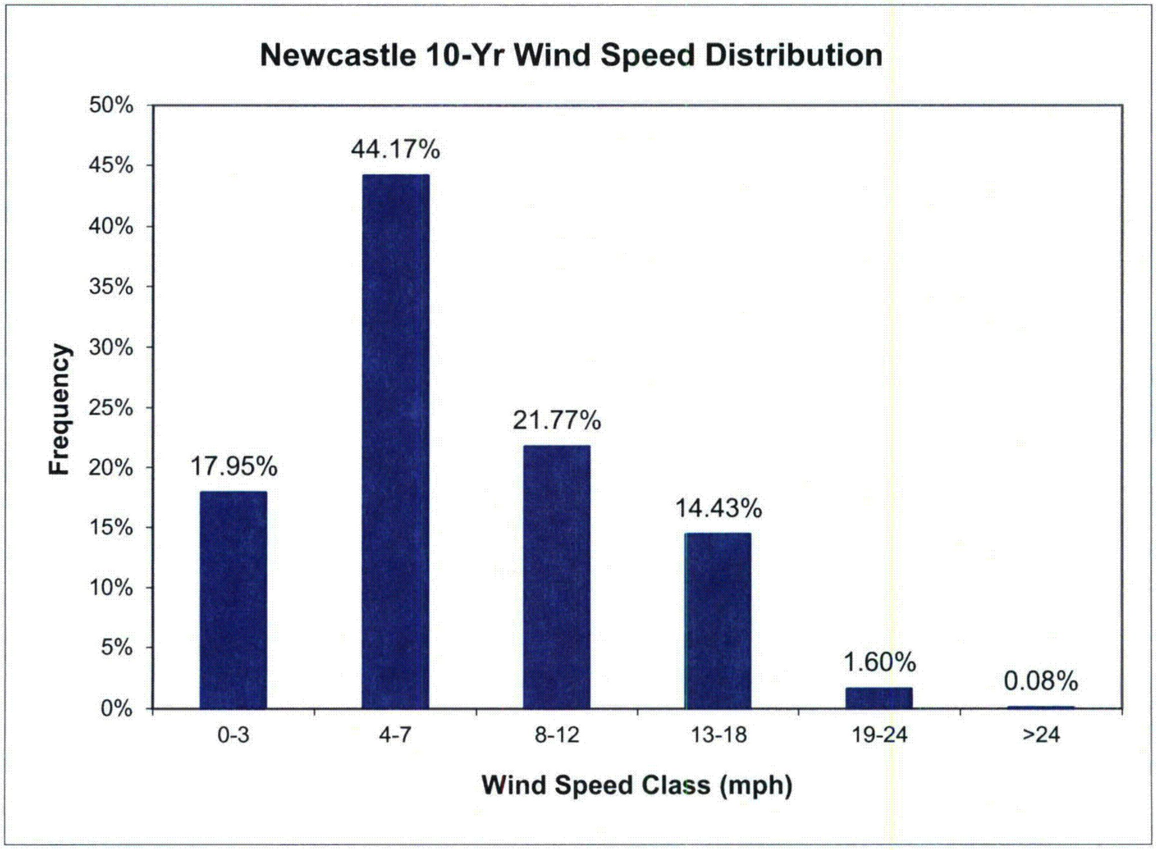


Figure 3.6-14: Newcastle 1-year Wind Rose



Source: IML Air Science, 2011

Figure 3.6-15: Wind Class Frequency Distribution for Newcastle, Wyoming from January 1, 2002 through August 31, 2011

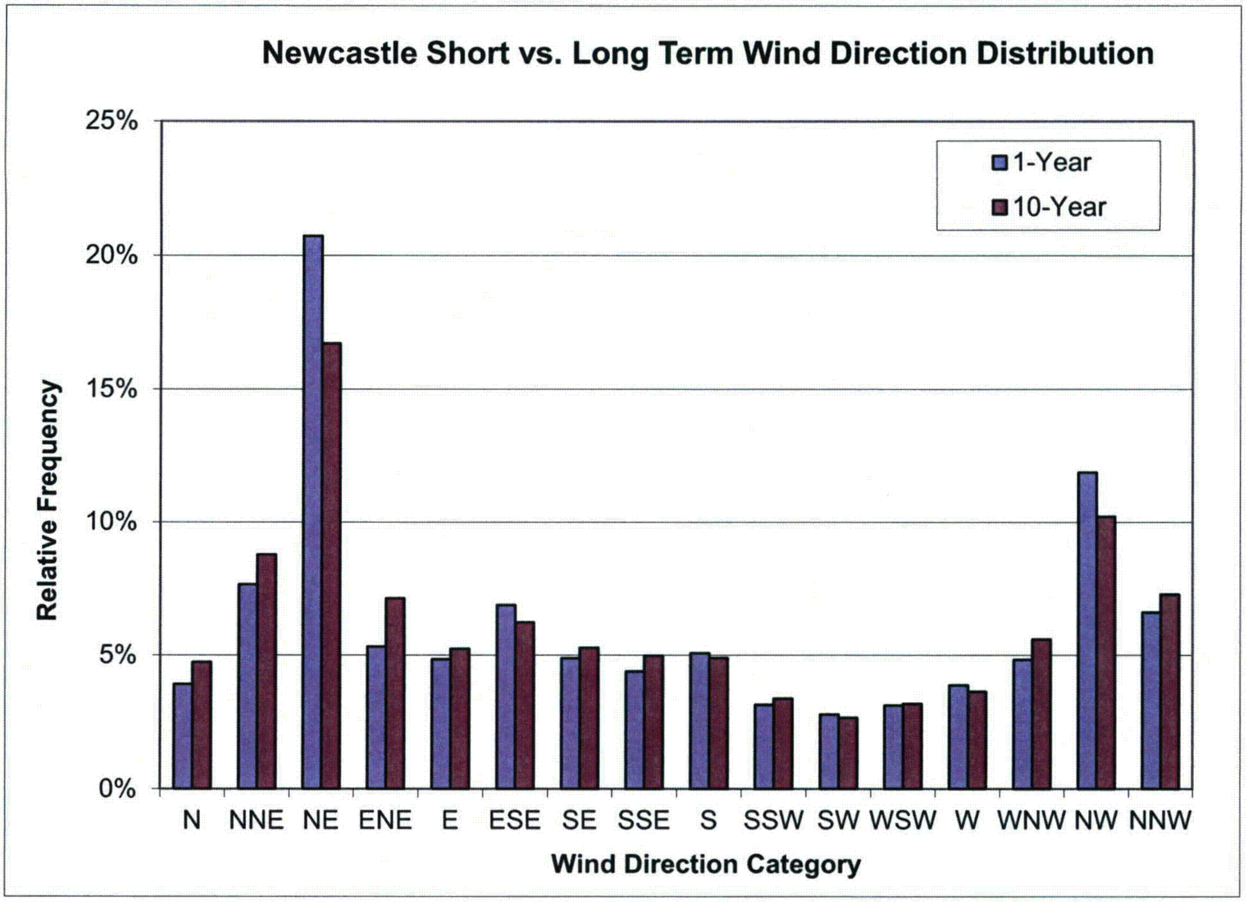


Figure 3.6-16: Newcastle Wind Direction Distributions

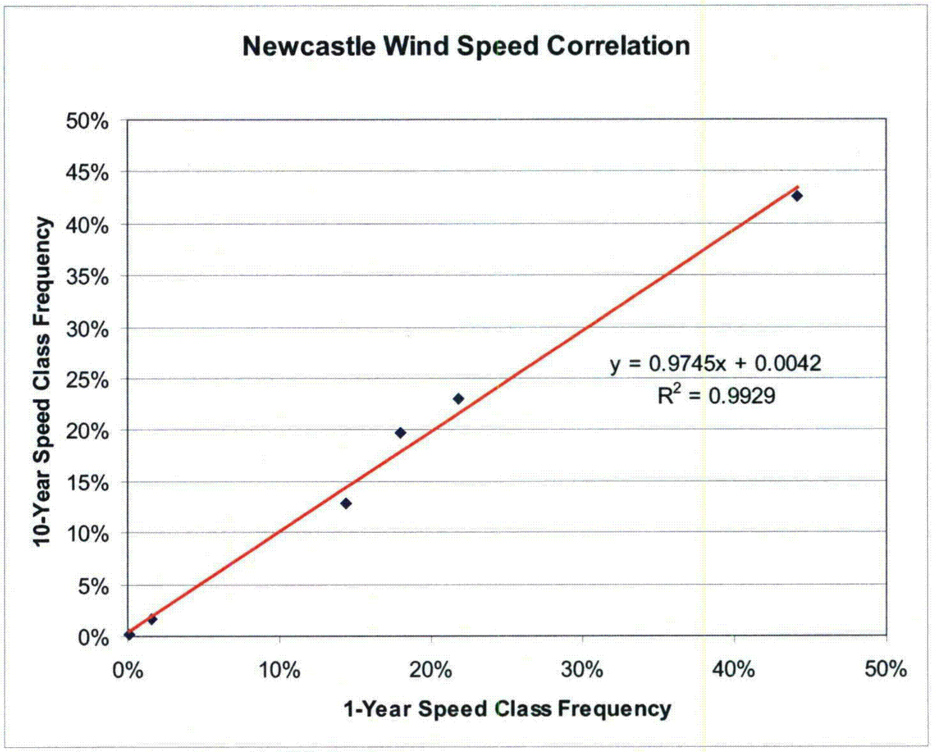


Figure 3.6-17: Newcastle Wind Speed Correlation

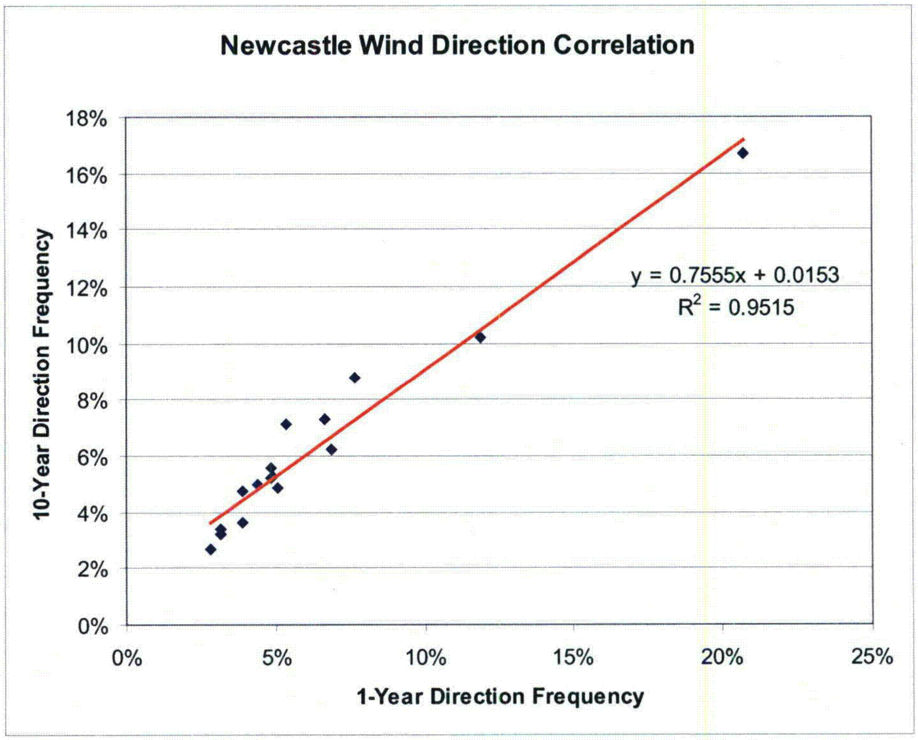


Figure 3.6-18: Newcastle Wind Direction Correlation

The regression line (red) in Figure 3.6-18 represents the least-squares fit to the 16 data points. The corresponding R^2 value of 95.2% implies very strong linear correlation. The linear slope of 0.76 further implies that short and long-term wind speed frequencies are similar.

Figures 3.6-17 and 3.6-18 offer conclusive evidence that the 2007-2008 baseline monitoring year adequately represents the last 10 years at Newcastle. Since the one-year wind data serve as reliable predictors of the long-term wind conditions at Newcastle, and since the Dewey-Burdock site experiences similar regional weather patterns, it is proposed here that the one-year baseline monitoring represents long-term meteorological conditions at the Dewey-Burdock site.

This same methodology can be used to determine whether or not Newcastle weather data are strictly representative of the Dewey-Burdock site. Figure 3.6-19 compares the wind direction distributions for the baseline monitoring year at the two sites. With an R^2 of 5.2%, Figure 3.6-19 indicates no correlation of wind direction frequencies between the two sites. Compared with the strong temporal correlation at the Newcastle site (short and long-term as demonstrated above), there appears to be very little spatial correlation between the two sites.

This result is heavily influenced by what appears to be an outlier. The NE sector constitutes 3.5% of the winds at the Dewey-Burdock site and 20.7% of the winds at Newcastle. This difference may stem from local topographic effects. Newcastle is situated in a "bowl" at the base of the Black Hills, and is subject to mild convection winds that tend to blow down the mountain from evening to early morning hours. This common phenomenon is related to differential air temperatures that cycle diurnally, with the cooler mountain air sinking to the adjoining valleys at night. Figure 3.6-20 shows the long-term wind rose for Newcastle for daytime hours only (9:00 a.m. to 5:00 p.m.). During these hours the NE component is substantially diminished relative to Figure 3.6-13, presumably due to the absence of down-slope convection breezes. It is reasonable to assume that the Dewey-Burdock site, situated several miles farther from the mountains than Newcastle, would not experience the same degree of diurnal convection breezes.

If the NE component is removed from each frequency distribution, a mild correlation between the two sites emerges. Figure 3.6-21 presents the same regression analysis as Figure 3.6-19, except with the NE outlier removed. While the much higher R^2 value of 60% still suggests no more than a weak correlation, it supports the premise that both sites are influenced by similar regional weather patterns. Hence, the conclusion that using the baseline year to represent long-term conditions is valid at either the Newcastle or the Dewey-Burdock site, but not between the two sites.

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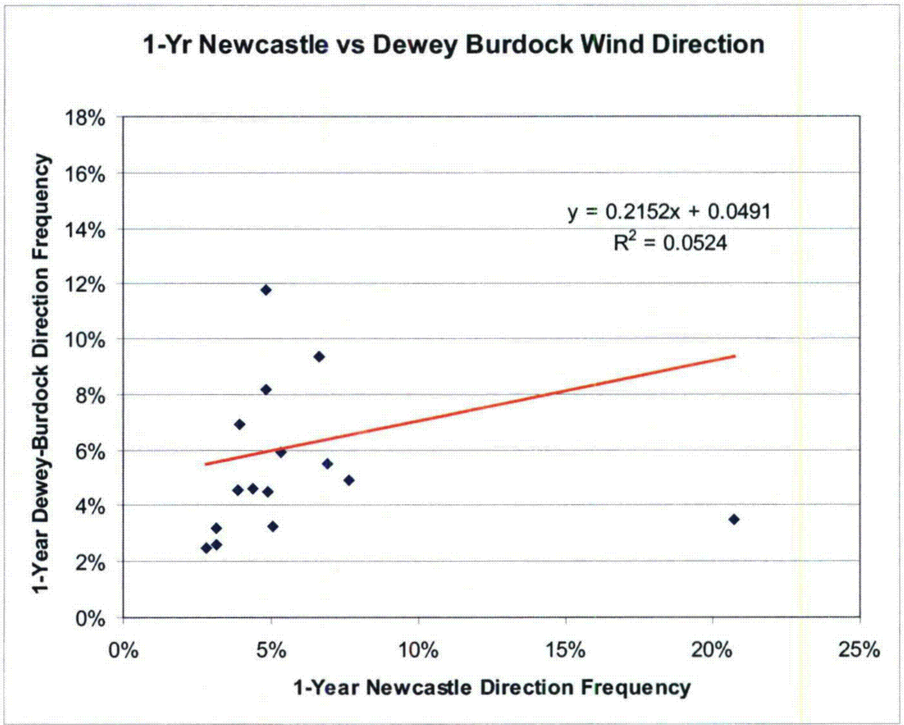


Figure 3.6-19: 1-year Newcastle vs. Dewey-Burdock Wind Direction

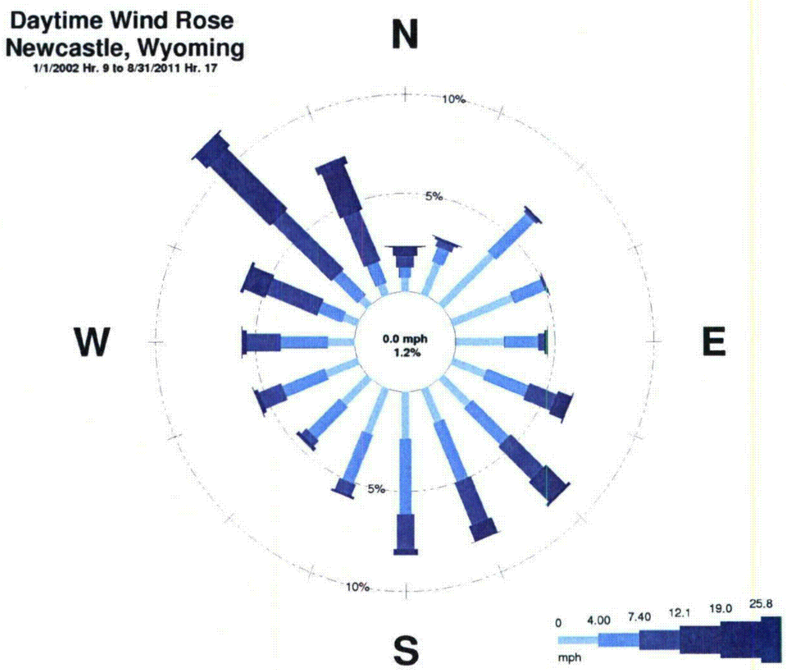


Figure 3.6-20: Newcastle Daytime Wind Rose

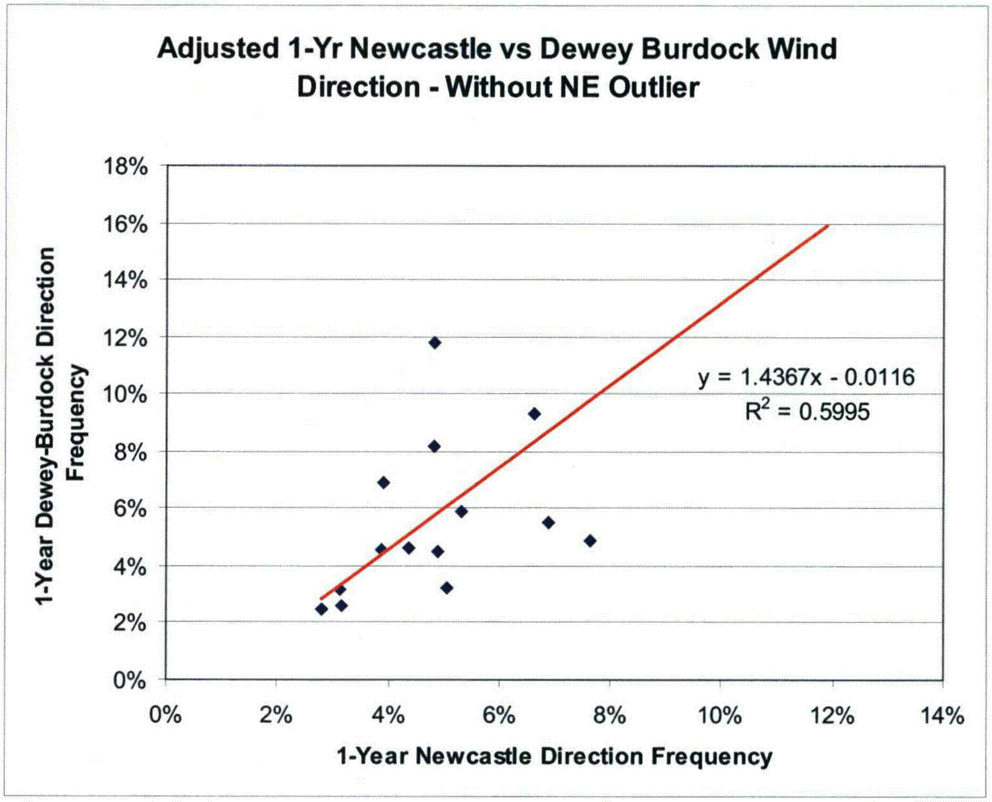


Figure 3.6-21: Adjusted 1-year Newcastle vs. Dewey-Burdock Wind Direction – Without NE Outlier

Figure 3.6-22 compares the baseline year wind roses from Newcastle, Dewey-Burdock, and Chadron. With the exception of the NE component discussed above, the Newcastle wind rose resembles that of Dewey-Burdock. On the other hand, the Chadron wind rose reflects an entirely different wind regime. The meteorological differences between Chadron and these other two sites may be attributed to the much greater distance from Chadron to the Black Hills, its lower elevation (3,280 ft), and the increased influence of Great Plains weather patterns.

3.6.1.1.5 Cooling, Heating and Growing Degree Days

The graphs shown in Figures 3.6-23, 3.6-24, and 3.6-25 summarize the growing degree, cooling degree, and heating degree days for the nine meteorological sites in the area. The data show a similar pattern for all three parameters throughout the sites with the exception of the Jewel Cave and Custer sites, the differences at which are likely caused by the higher relative elevation of these two sites.

Figure 3.6-26 presents these three measures for Newcastle on the same graph. All degree days calculations used a base temperature of 55°F. Heating and cooling degree days are included to show deviation of the average daily temperature from the chosen base temperature. The number of heating degree days is computed by taking the average of the high and low temperature occurring that day and subtracting it from the base temperature. The number of growing degree days and cooling degree days is computed in the opposite fashion where the base temperature is subtracted from the average of the high and low temperature for the day. Negative values are disregarded for both calculations.

3.6.1.1.6 Evapotranspiration

The American Society of Civil Engineers (ASCE) Standardized Reference Evapotranspiration Equation was used to calculate daily evapotranspiration (ET) using a tall reference crop coefficient. Note that these calculations were performed to estimate regional ET only; as described in Appendix 5.3-A and the GDP, hydrologic modeling of the land application systems conservatively assumed no crop (bare soil). The weather parameters needed to calculate ET using this method are daily maximum and minimum temperature, maximum and minimum relative humidity, total solar radiation, and average wind speed. The Oral site was the only one in the region with all these weather parameters being sampled and was, therefore, the site used for this analysis. The data were available from May 8, 2003, to July 20, 2008. Figure 3.6-27 displays a graph of the average accumulated ET for each month. Most ET occurs during the summer months of June, July, and August with an average monthly accumulation of 10.3 inches.

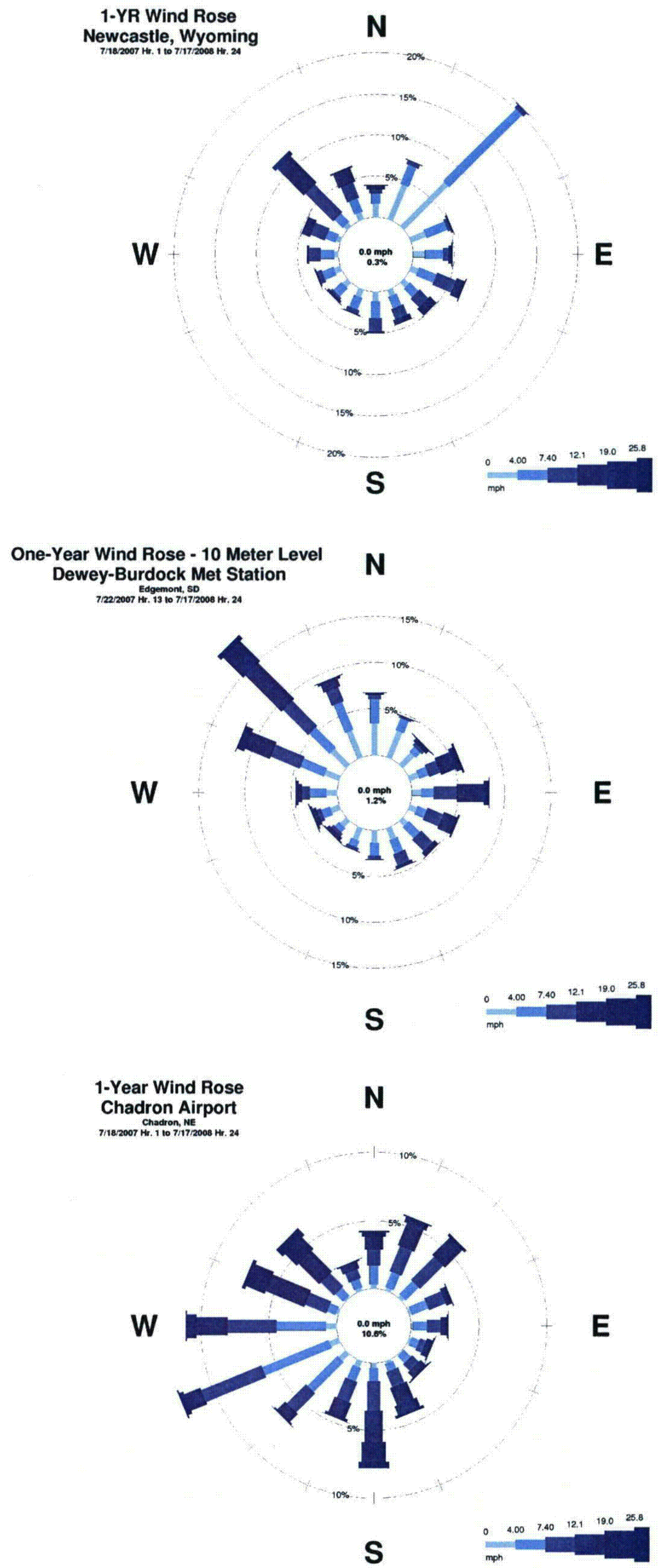
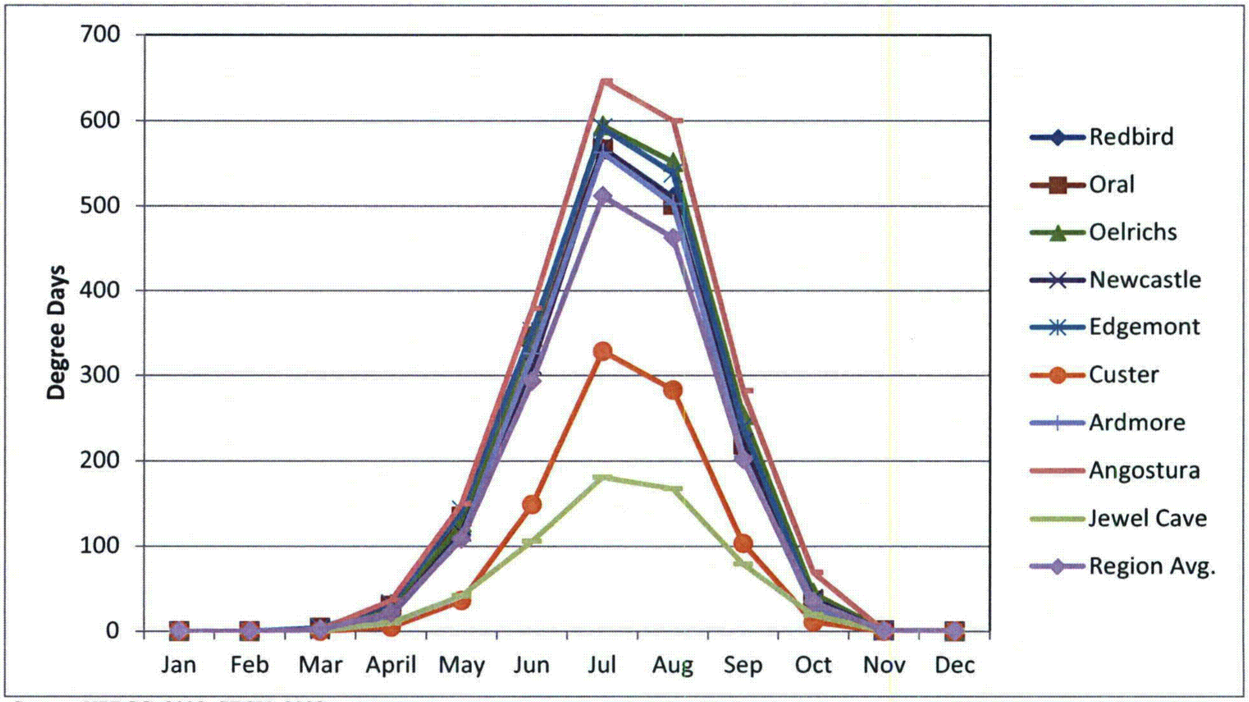
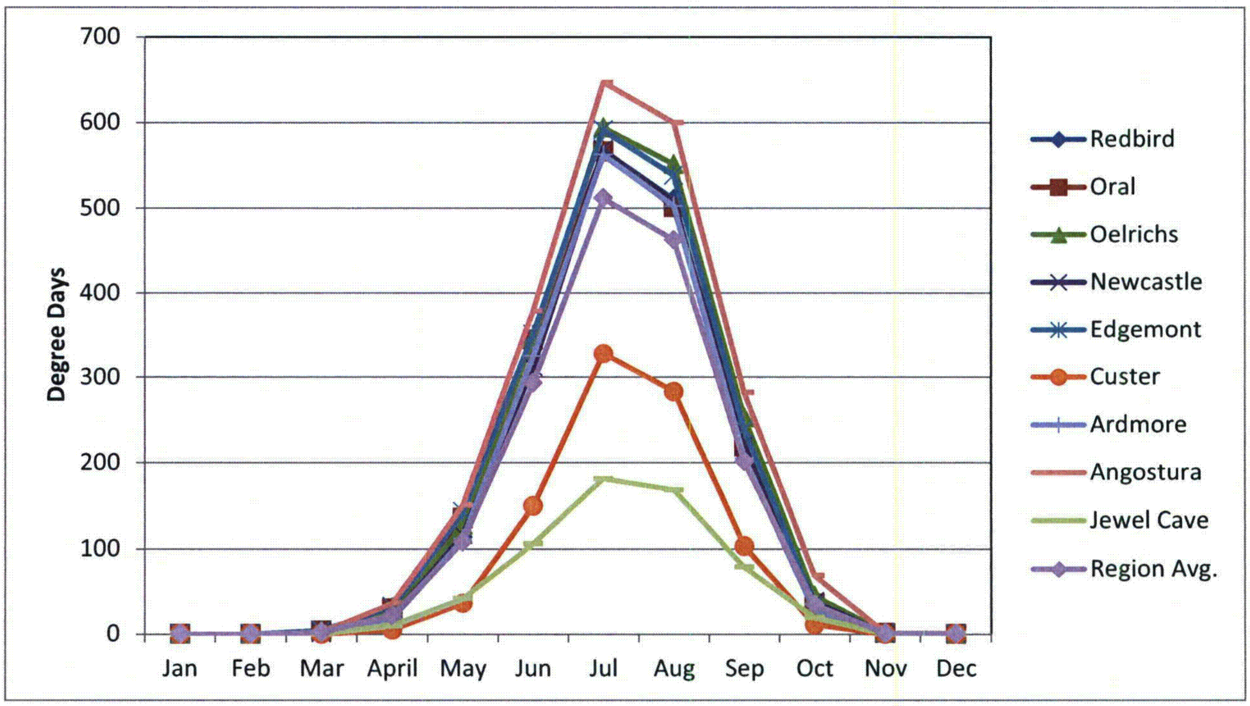


Figure 3.6-22: Comparative Wind Roses



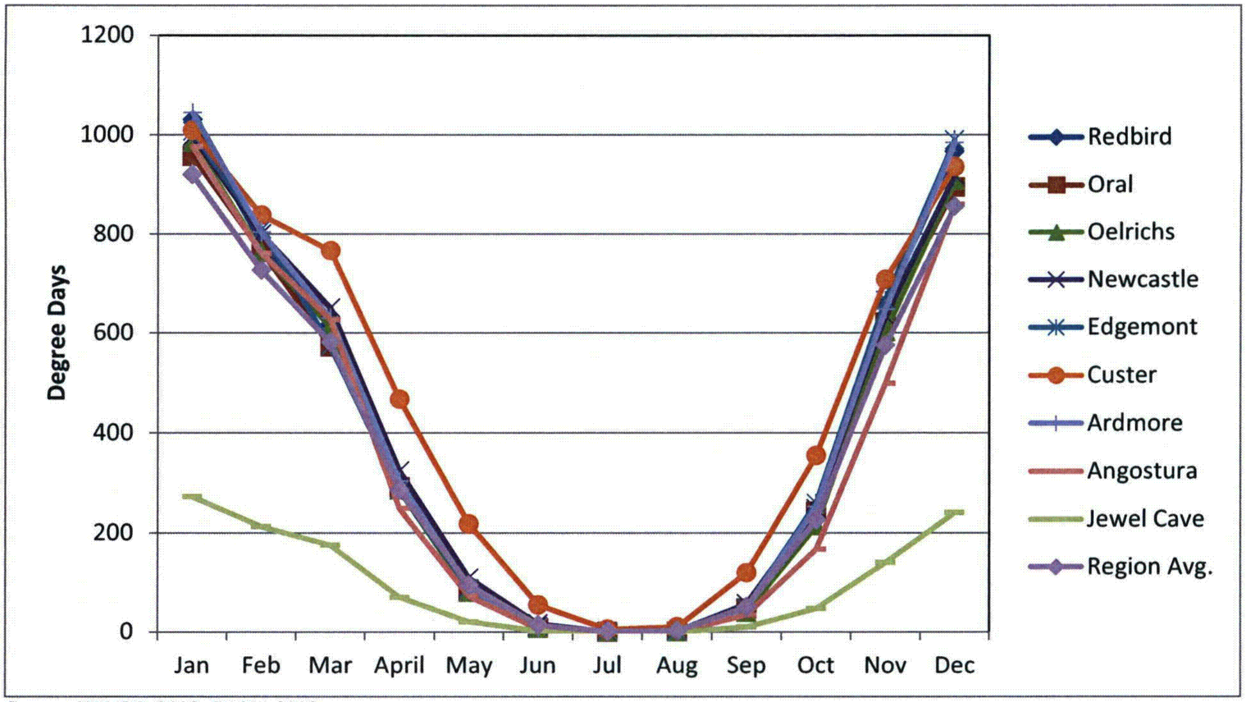
Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-23: Growing Degree Days for Regional Sites



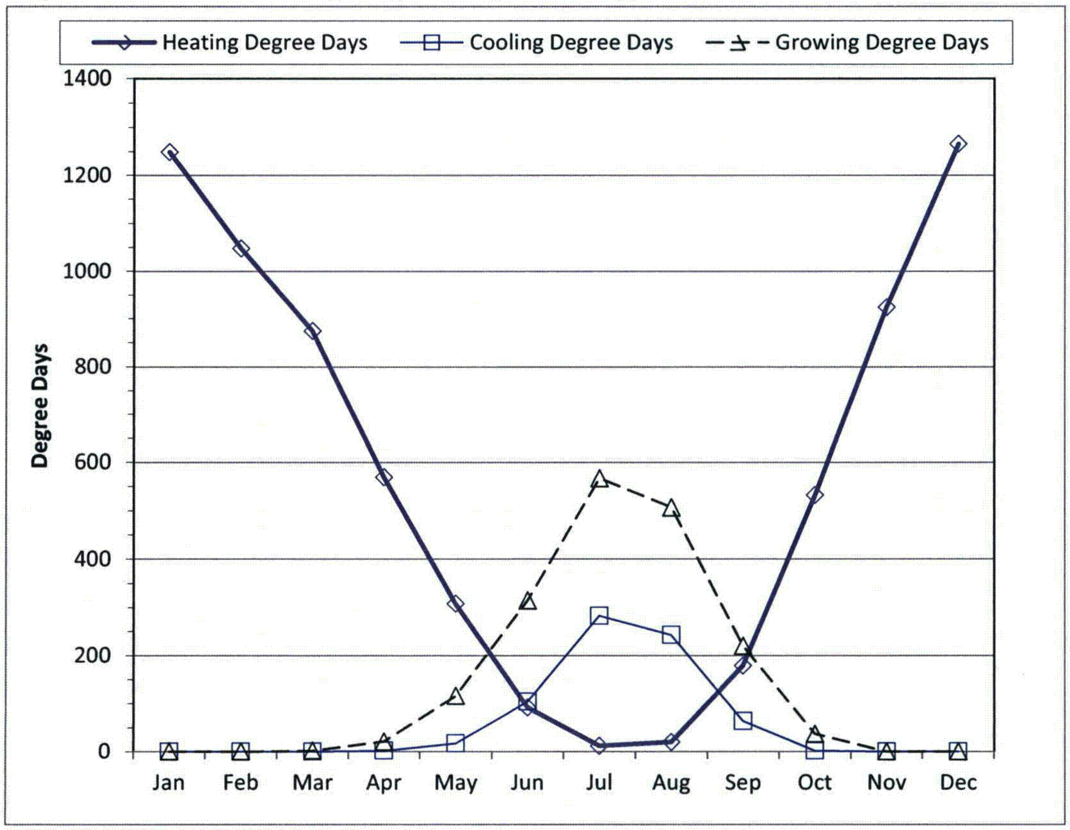
Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-24: Cooling Degree Days for Regional Sites



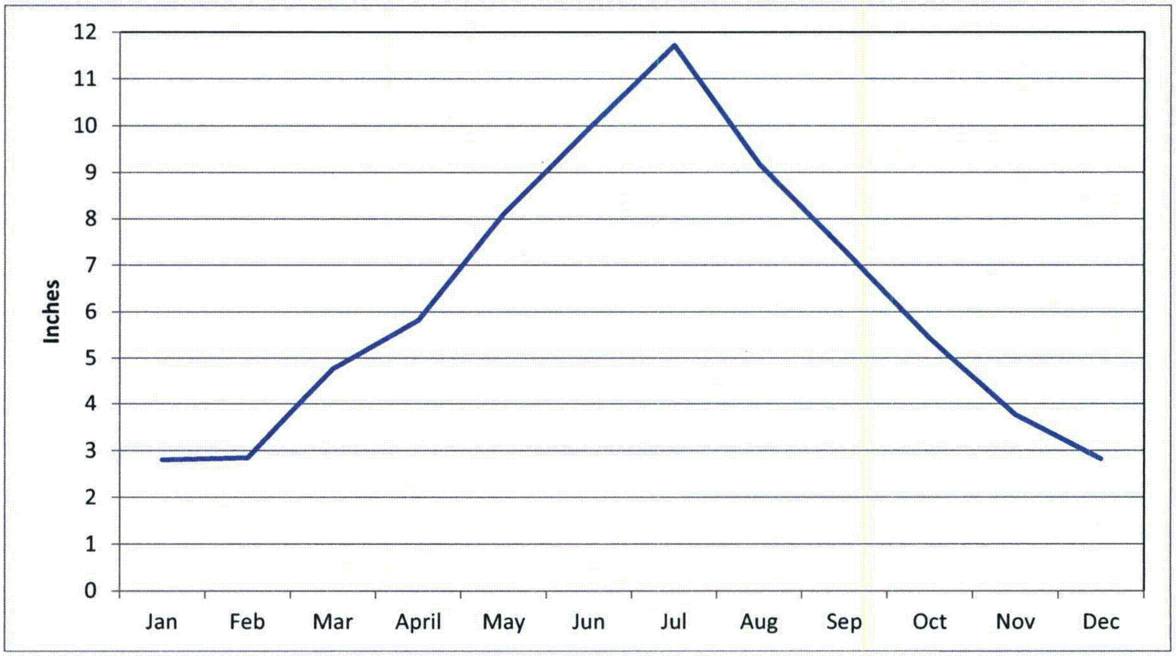
Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-25: Heating Degree Days for Regional Sites



Source: WRCC, 2011

Figure 3.6-26: Degree Days for Newcastle NWS Site



Source: HPRCC, 2008; SDSU, 2008

Figure 3.6-27: Average Monthly Accumulated Evapotranspiration for Oral, South Dakota

During the winter months, low ET (2.8 inches) occurs because of low temperatures and low solar radiation.

No ET data were available for the Newcastle site. The nearest relevant evaporation data in Wyoming were obtained from the Wyoming Water Research Center (WWRC) for Casper, Wyoming (Figure 3.6-28). Casper experiences solar radiation values similar to Newcastle. Higher winds and lower rainfall at Casper suggest that ET should be higher than at Newcastle.

The lake evaporation rates in Figure 3.6-28 are computed from pan evaporation measurements by applying a 0.70 multiplier, which is typical practice in this region. The WWRC source document states that "the potential evapotranspiration estimates are sometimes considered to be equivalent to lake evaporation." Therefore, the lake evaporation provides a surrogate measure of ET in Casper.

It will be noted by comparing Figures 3.6-27 and 3.6-28 that projected ET values are significantly higher at Oral, South Dakota than at Casper, Wyoming. This could be attributed to the use of a tall reference crop coefficient at the Oral, South Dakota site. Regardless, the Newcastle site is expected to more closely resemble Casper, Wyoming.

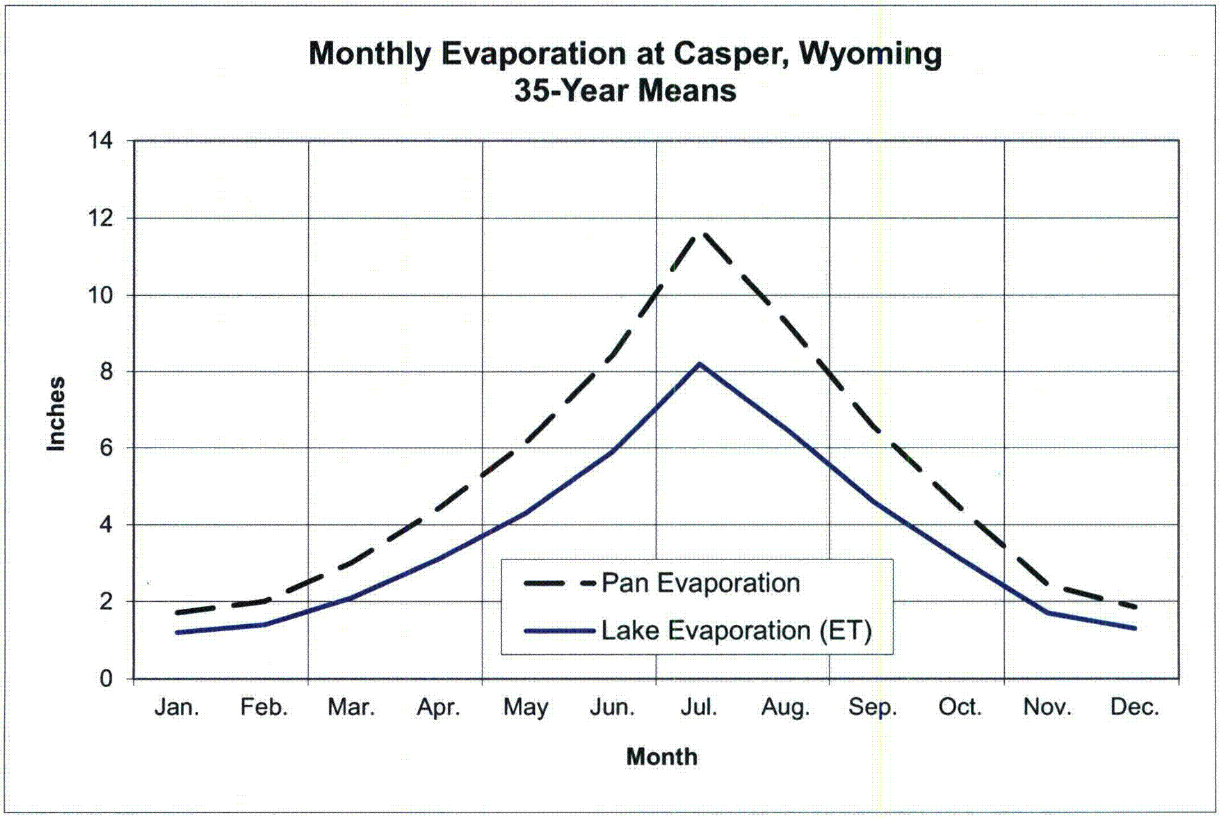
3.6.1.2 Site-Specific Analysis

The site-specific analysis was completed using data collected from a weather station installed in approximately the center of the proposed permit boundary. The station is located on a site that is representative of the area within the boundary. Twelve months of data from July 18, 2007 to July 17, 2008 are used for this analysis.

This site was installed in cooperation with the South Dakota State Climatology office according to the standards they use to install their Automatic Weather Data Network (AWDN) stations. The parameters being sampled at the site are air temperature, solar radiation, humidity, precipitation, and wind speed/direction at both 3- and 10-meter heights (9.8 and 32.8 feet). Table 3.6-6 lists the model number and specifications of the sensors that were installed. All results of the statistical analysis, completed using Minitab software version 14.0 for the parameters analyzed, are included in Appendix 3.6-B.

3.6.1.2.1 Temperature

The average hourly temperature over the year for the site was 45.5°F. A maximum temperature of 104°F was reached on both July 21, 2007 and August 13, 2007, while the minimum



Source: Wyoming Water Research Center, 1985

Figure 3.6-28: Average Monthly Evaporation for Casper, Wyoming

Table 3.6-6: Specifications for Weather Instruments Installed to Perform Site-Specific Analysis

Instrument	Model	Manufacturer	Accuracy/ Threshold	Operating Temperature	Required Standard
Precipitation	VR6101	Vaisala	0.01 inch	-40°C to 60°C	0.1 inch
Wind Direction	024A	Met-One	±5 degrees/1 mph	-50°C to 70°C	±5 degrees
Wind Speed	014A	Met-One	0.25 mph/1 mph (0.11 m/s)	-50°C to 70°C	1.0 mph (0.5 m/s)
Temperature and RH	HMP45C	Vaisala	Temp: ±2% for 10-90% RH: ±3% of 90-100% RH	-40°C to 60°C	Consistent with current state of the art
Solar Radiation	LI200X	Lt-Cor	Absolute error in natural daylight is ±5% max; ±3% typical	-40°C to 65°C	Consistent with current state of the art

temperature for the period of record was –28°F on January 22, 2008. A boxplot of the average temperature by month is shown in Figure 3.6-29. July was the warmest month with a median temperature of 76°F with a first quartile of 69°F and a third quartile value of 85°F. Conversely, December and January were the coolest months with a median temperature of 15°F.

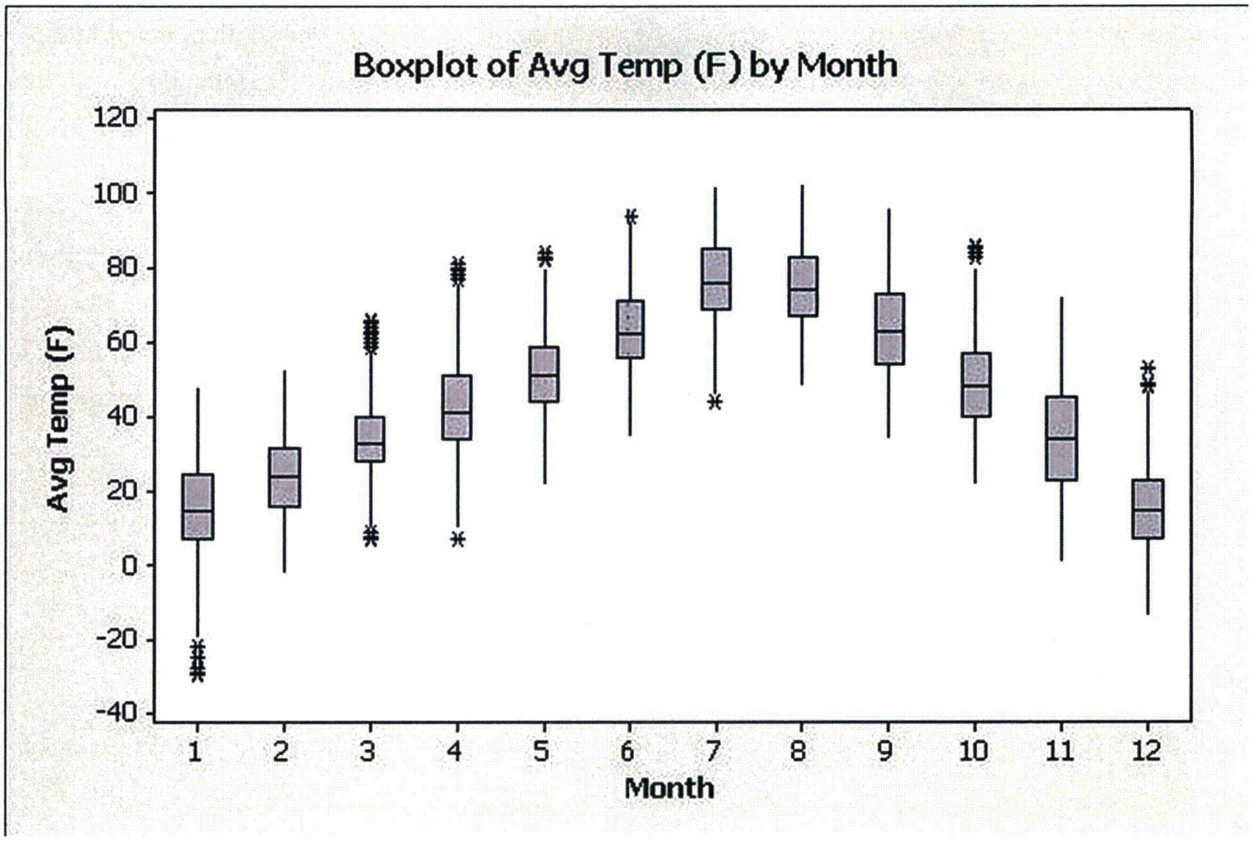
There were large variations in seasonal and diurnal temperature (Figure 3.6-30). In the summer season, average temperatures were from 60°F at 6 a.m. to 83.6°F at 5 p.m. In the winter season, temperatures averaged 11°F between 7 a.m. and 8 a.m. and rose to nearly 27°F at 4 p.m. The diurnal variations are the result of the lack of relative humidity in the atmosphere at the site, which causes the earth's surface to rapidly absorb and release the energy supplied by the sun.

Figure 3.6-31 shows a probability plot of average hourly temperature for the year. Temperatures above or below 46°F were expected at the site 50 percent of the time, and temperatures dipped below the freezing mark (32°F) 31 percent of the time.

3.6.1.2.2 Wind Patterns

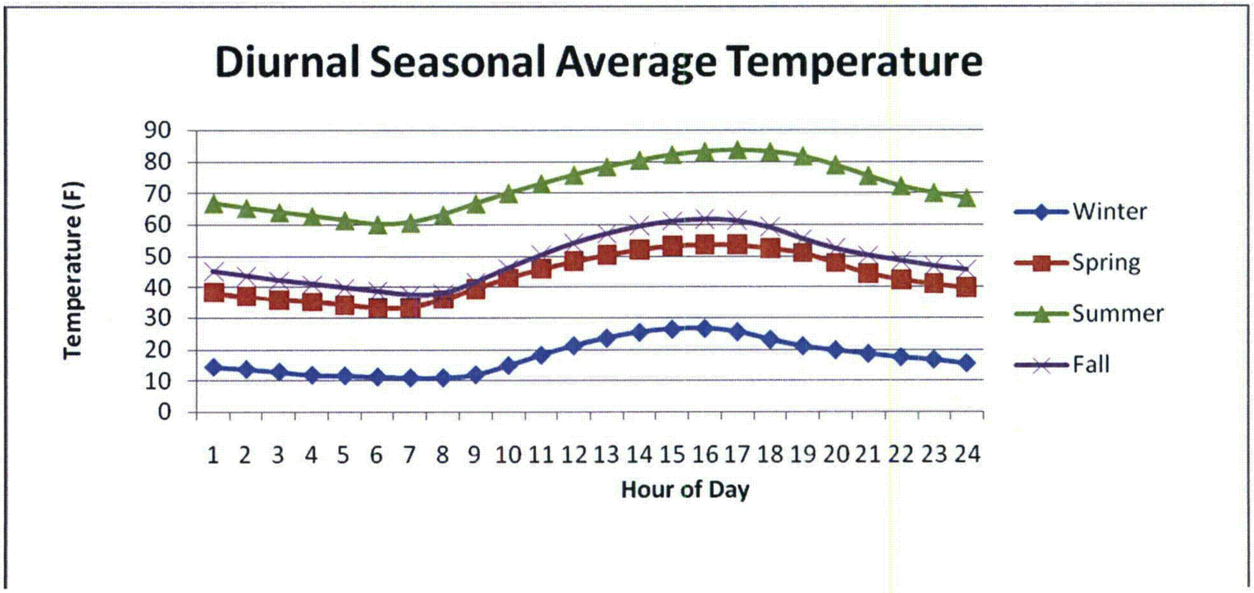
Wind speed and direction were measured in the field using Met-One 014A and 024A model sensors. Wind data analysis outputs are included in Appendix 3.6-C. The average wind speed over the period of record was approximately 9 mph, while calm winds occurred only 1.2 percent of the time.

As shown in Table 3.6-7, over a third of the winds (34 percent) come from the north-northwest, northwest and west-northwest. Approximately 24 percent of all winds were less than 3.5 mph. Northwesterly, west-northwesterly and north-northwesterly winds were prevalent in the winter months. Easterly, east-northeasterly and east-south easterly winds were prevalent in summer months. Figures 3.6-32 and 3.6-33 show the quarterly wind roses for the Dewey-Burdock permit area. The period from January through March was used for the 1st Quarter, April through June for 2nd Quarter, July through September for 3rd Quarter and October through December for 4th Quarter. The 3rd Quarter wind rose reflects hourly data from both 2007 and 2008. Figure 3.6-34 shows the annual wind rose for the project site, with northwesterly and west-northwesterly winds dominating. Figure 3.6-35 shows that December had the least amount of wind with an average wind speed of 5 mph. In contrast, May was the windiest month with an average wind speed of 12 mph.



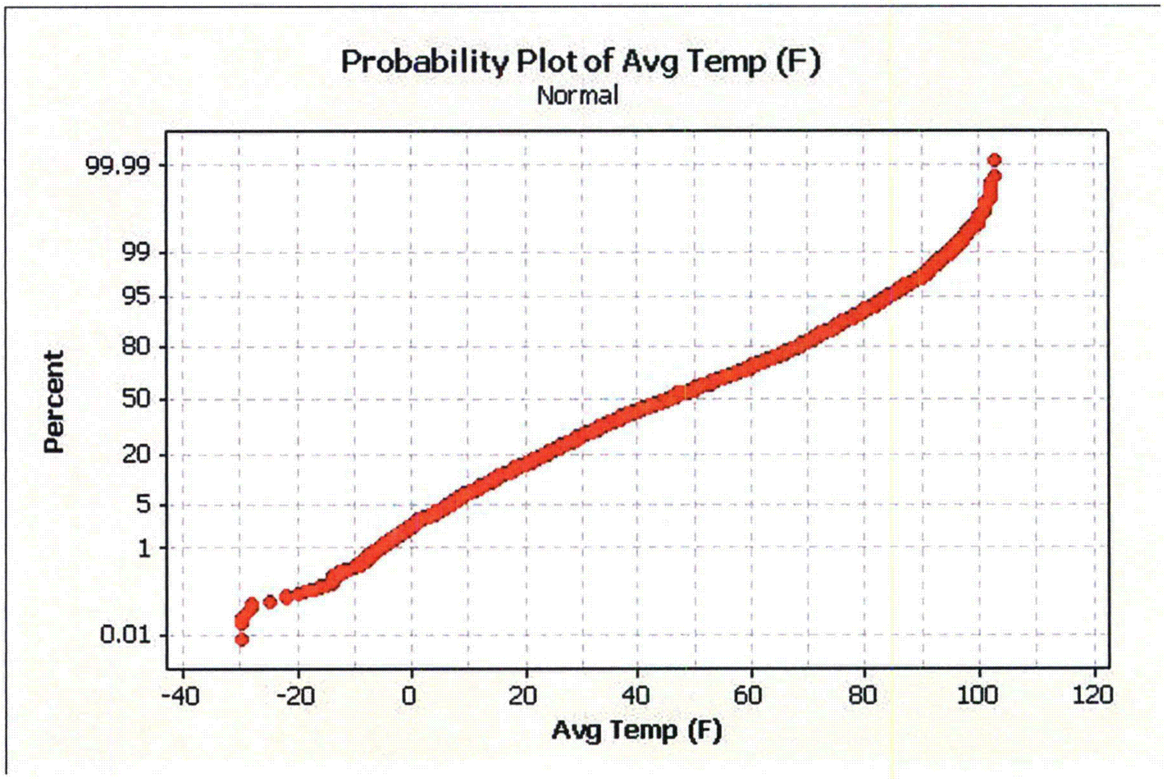
Source: SDSU, 2008

Figure 3.6-29: Average Temperature by Month from the Project Meteorological Site



Source: SDSU, 2008

Figure 3.6-30: Diurnal Average Temperature for the Project Meteorological Site by Season



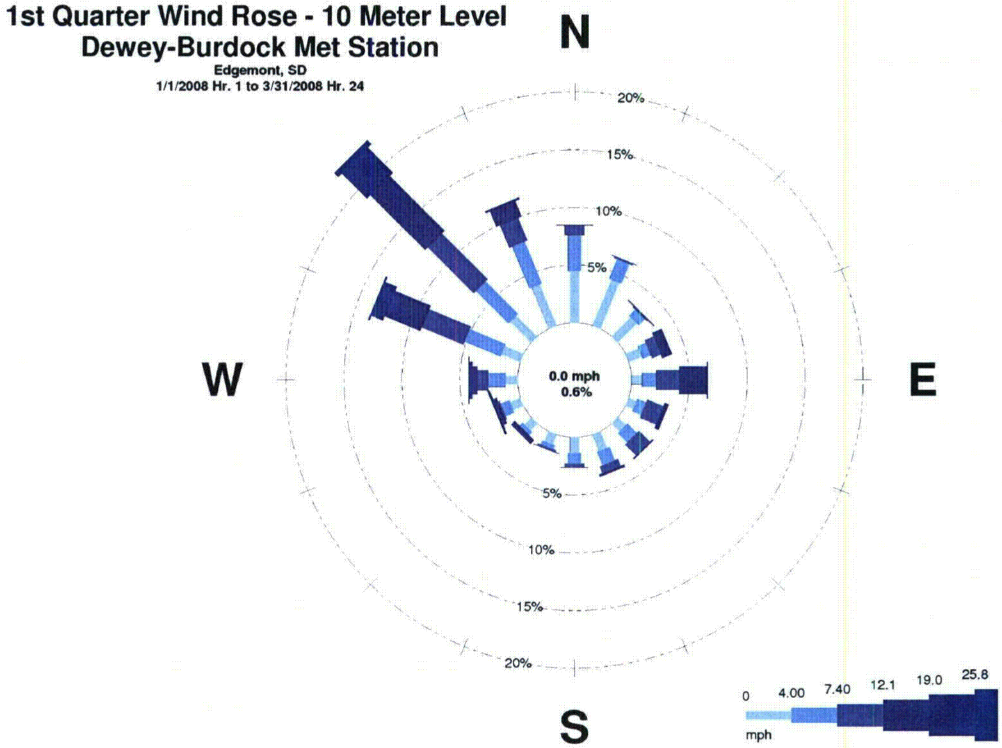
Source: SDSU, 2008

Figure 3.6-31: Probability Plot of Average Temperature from the Project Meteorological Site

Table 3.6-7: Normalized Frequency Distribution of Wind at the Project Meteorological Site

Frequency Distribution (Normalized)							
Wind Direction	**Wind Speed Classification (mph)**						
	1–3	**4–7**	**8–12**	**13–18**	**19–24**	**≥ 24**	**Total**
N	0.030713	0.024749	0.002587	0.001125	0.000337	0.000000	**0.059511**
NNE	0.027653	0.012374	0.001575	0.000450	0.000000	0.000112	**0.042165**
NE	0.016474	0.007087	0.004050	0.002025	0.000112	0.000337	**0.030086**
ENE	0.009649	0.011924	0.013612	0.011812	0.002025	0.001800	**0.050822**
E	0.009178	0.016424	0.028573	0.014174	0.001350	0.000562	**0.070262**
ESE	0.007531	0.014399	0.016312	0.008437	0.000787	0.000000	**0.047466**
SE	0.006825	0.015862	0.013837	0.002025	0.000225	0.000000	**0.038773**
SSE	0.011885	0.018224	0.008212	0.001237	0.000337	0.000000	**0.039896**
S	0.012120	0.013724	0.002025	0.000112	0.000000	0.000000	**0.027982**
SSW	0.012356	0.007087	0.002587	0.000337	0.000000	0.000000	**0.022368**
SW	0.008472	0.006750	0.002925	0.002137	0.000787	0.000112	**0.021184**
WSW	0.009414	0.010124	0.003600	0.002812	0.000900	0.000562	**0.027413**
W	0.009884	0.018449	0.006075	0.003262	0.001462	0.000112	**0.039245**
WNW	0.015650	0.031498	0.030486	0.018899	0.004162	0.000337	**0.101033**
NW	0.021299	0.035323	0.042298	0.042185	0.016762	0.002700	**0.160566**
NNW	0.028594	0.032623	0.012262	0.004837	0.001575	0.000337	**0.080229**
Subtotal	**0.237699**	**0.276621**	**0.191014**	**0.115868**	**0.030823**	**0.006975**	**0.859000**
Calms							**0.012200**
Missing/Incomplete							**0.128800**
Total							**1.000000**

Source: SDSU, 2008



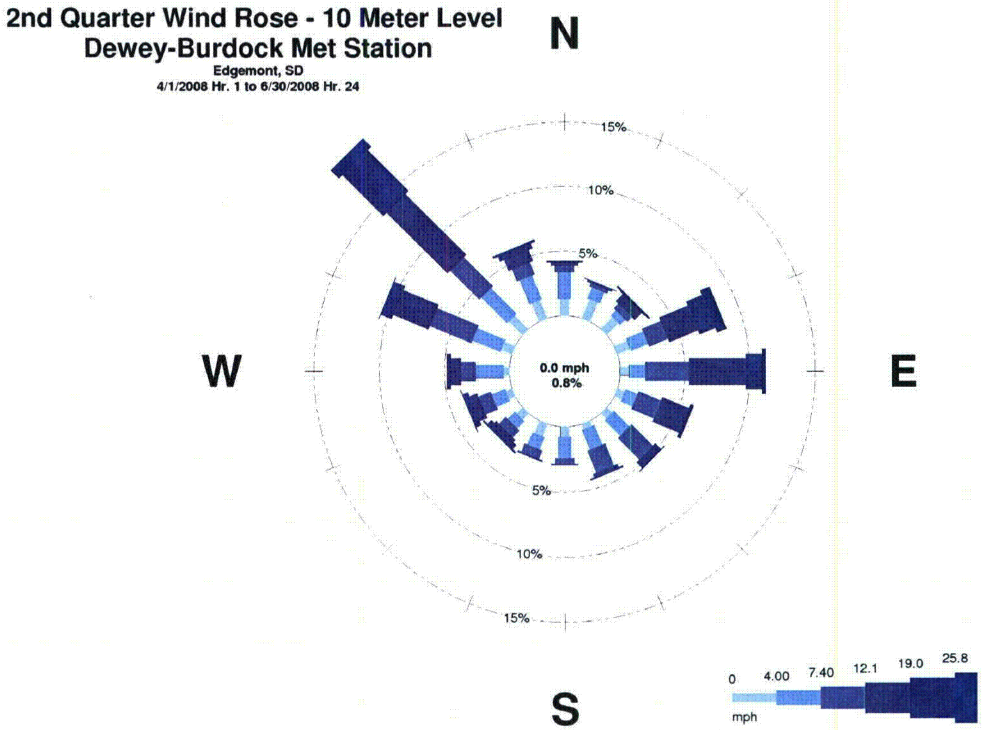
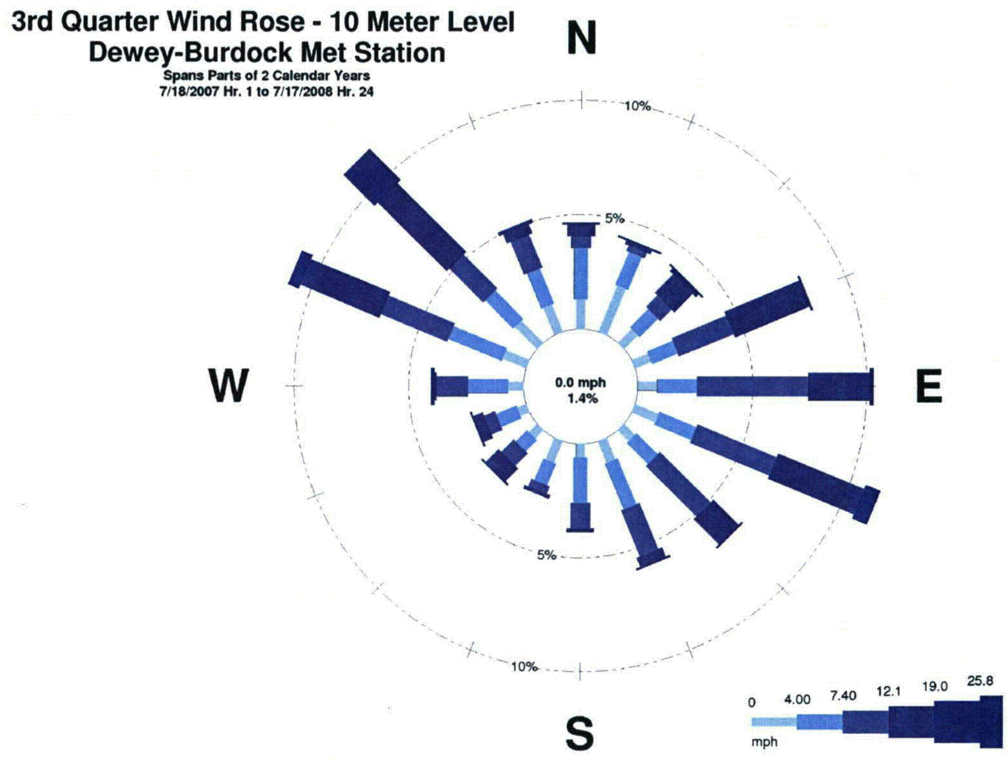


Figure 3.6-32: First and Second Quarter Wind Roses



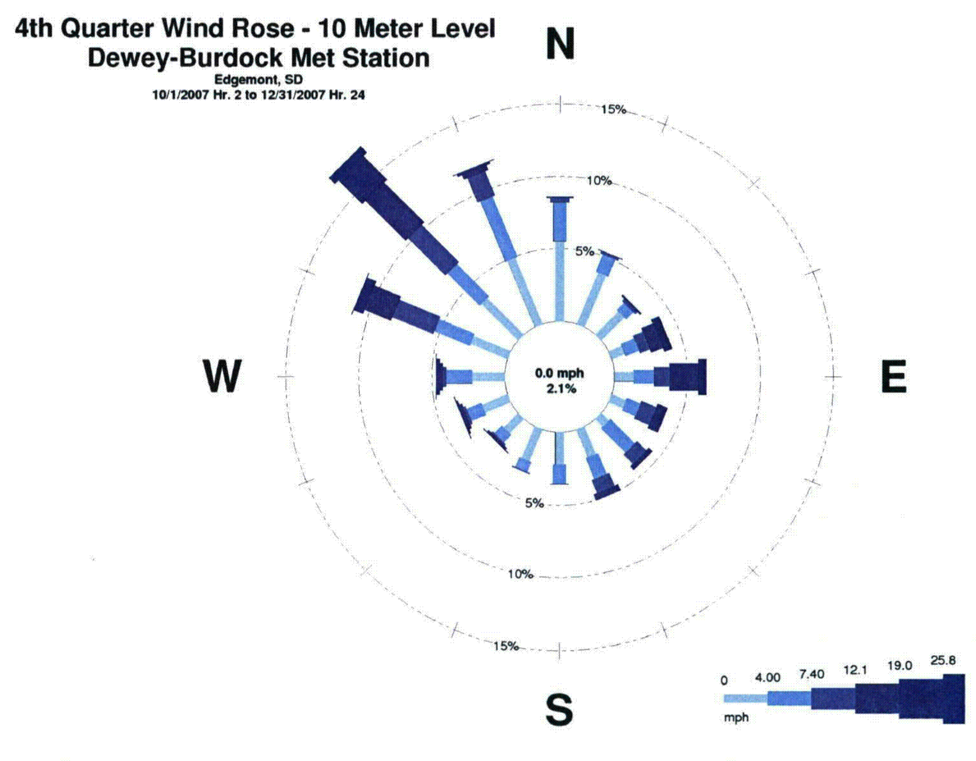


Figure 3.6-33: Third and Fourth Quarter Wind Roses

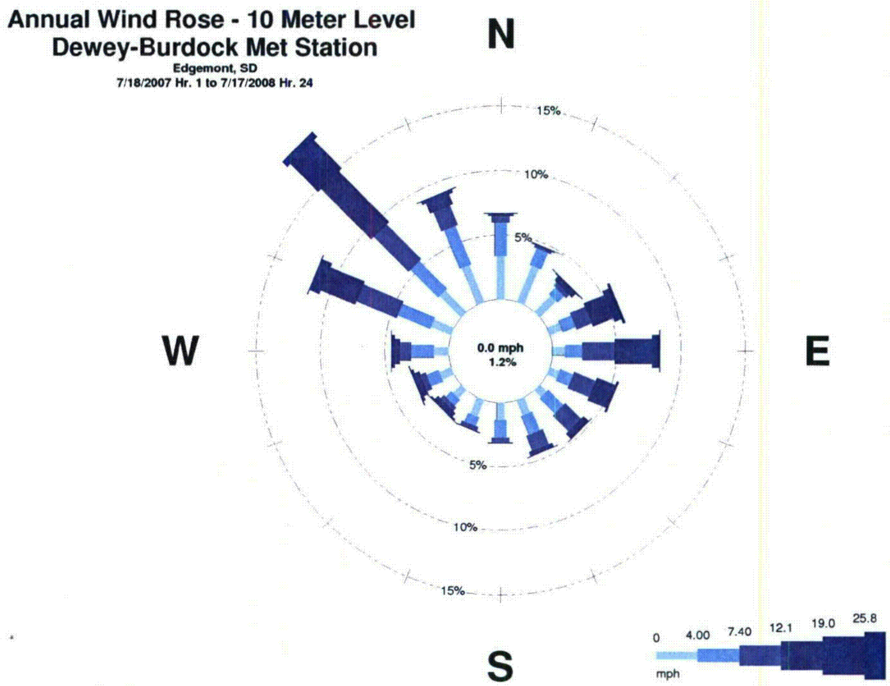


Figure 3.6-34: Annual Wind Rose

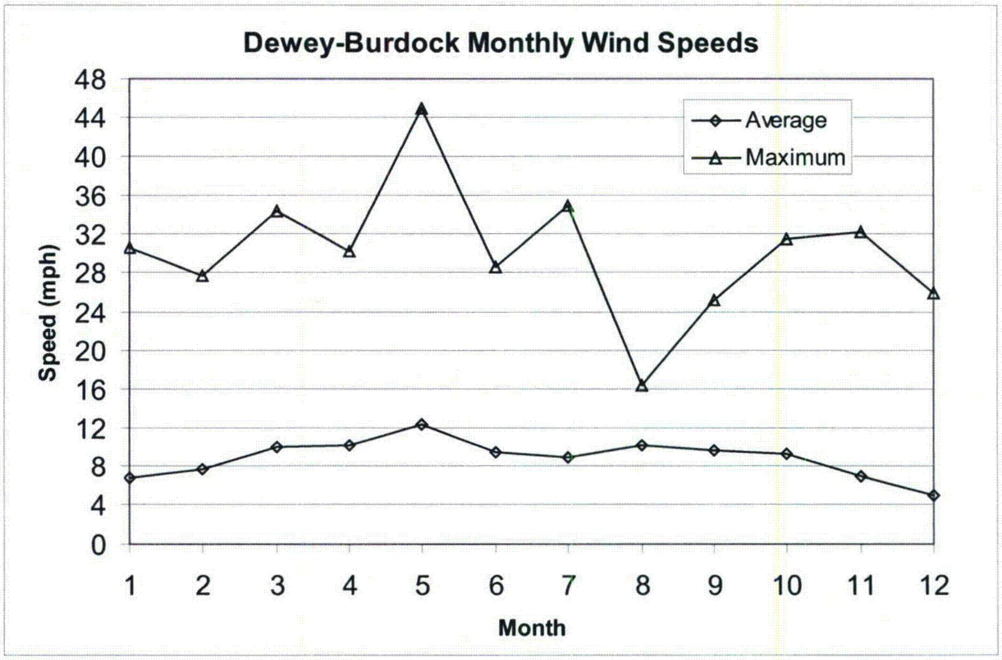


Figure 3.6-35: Dewey-Burdock Monthly Wind Speeds

3.6.1.2.3 Relative Humidity

As mentioned in previous sections, the relative humidity at the site is low. Mean values range from a low of 51 percent in the summer months to a high of 77 percent in the winter months. Relative humidity values varied greatly throughout the day, especially in the summer and spring months. On average, during the spring, summer, and fall months, relative humidity reached its maximum from 5 a.m. to 7 a.m. and then declined steadily until 4 p.m. to 5 p.m. when it began its evening ascent (Figure 3.6-36). During the winter months, the diurnal relative humidity range was much less because of less intense and shorter duration solar radiation.

3.6.1.2.4 Precipitation

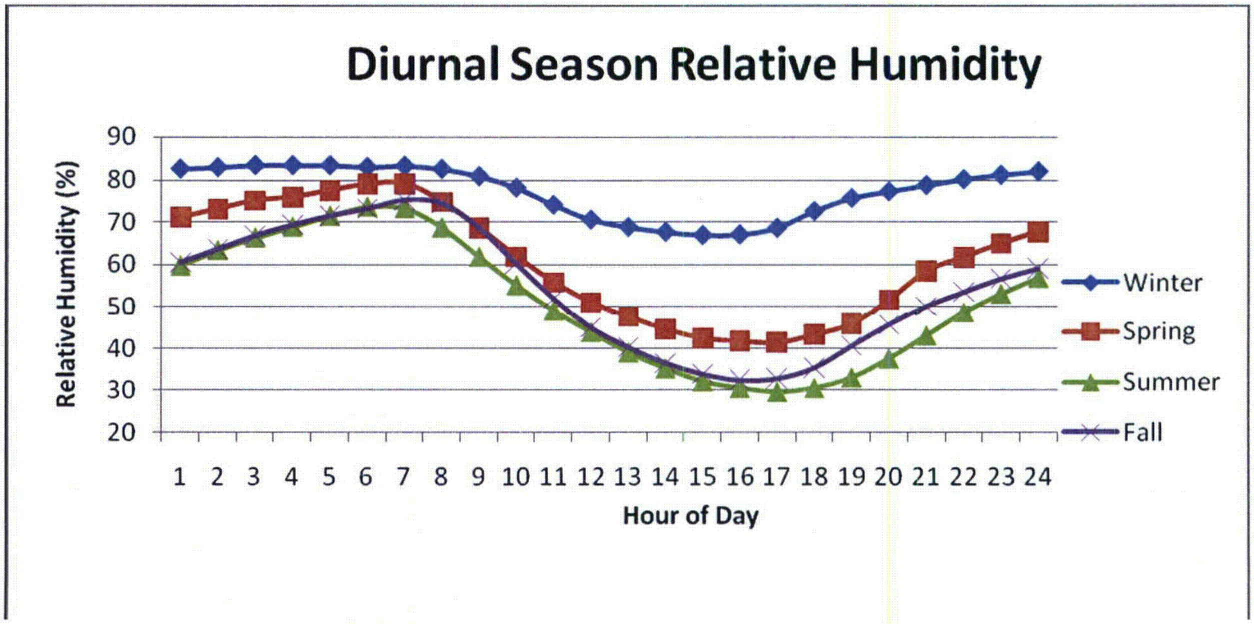
Data for this site were collected using a Vaisala VRG 101 all-weather precipitation gauge. The region received 12.42 inches of precipitation during the year of monitoring. Figure 3.6-37 displays the precipitation totals by month. The largest monthly precipitation total occurred in May (3.8 inches) and the least occurred in November (0.10 inch). The greatest daily precipitation total (1.29 inches) occurred on May 23, 2008. Also on May 23, 2008, the area received 0.71 inch of precipitation between the hours of 8 p.m. and 9 p.m., which was the most intense event of the sampled year.

3.6.1.2.5 Potential Evapotranspiration

The potential ET data were taken from July 18, 2007 to July 14, 2008. The ASCE Standardized Reference Evapotranspiration Equation for a tall reference crop was used to estimate daily ET. The weather parameters needed to estimate ET using this method are daily, maximum and minimum temperature, maximum and minimum relative humidity, total solar radiation, and average wind speed. Most ET occurs during the months of July, August, and September with an average monthly accumulation of 10.3 inches (Figure 3.6-38) because of the high temperatures and unstable weather. During the winter, low ET occurs because of low temperatures and low solar radiation. The average ET during the winter months is 1.5 inches.

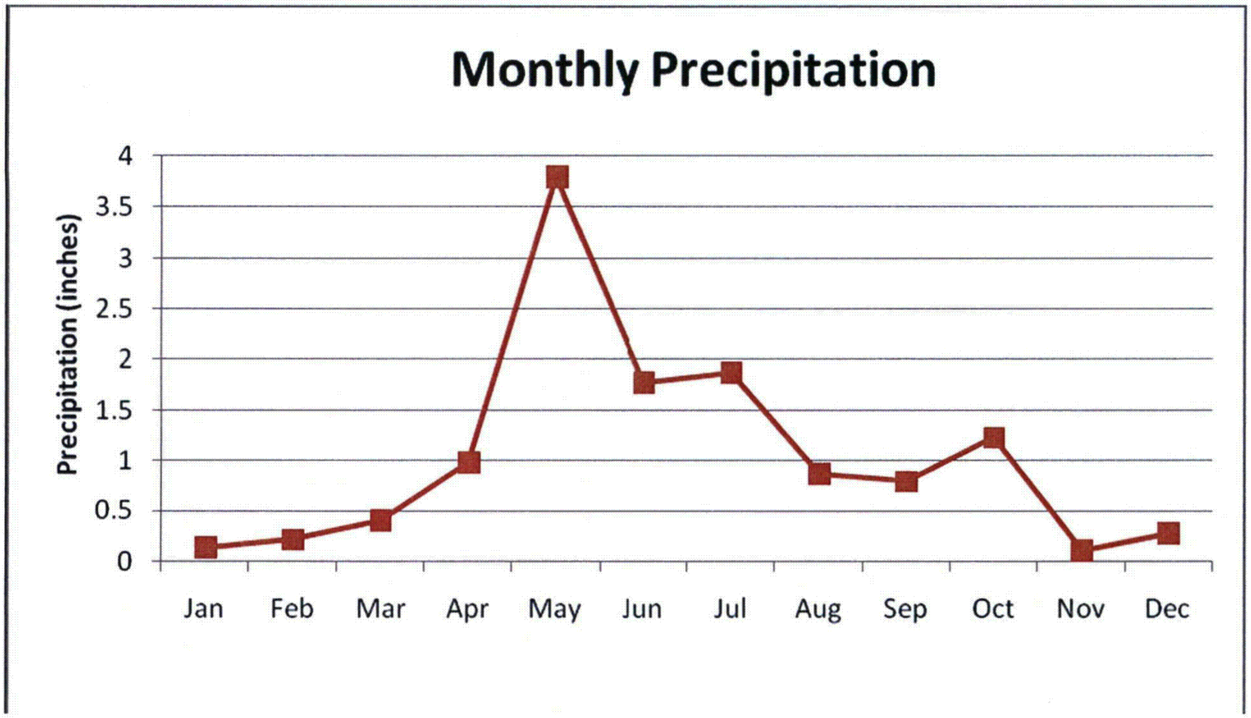
3.6.1.2.6 Upper Atmosphere Characterization

Mixing height is the height of the atmosphere above the ground that is well mixed due either to mechanical turbulence or convective turbulence. The air layer above this height is stable. Higher mixing heights are associated with greater dispersion, all other parameters being the same. Stable periods have much lower mixing heights and accompanying lapse rates allowing for less temperature variation. Unstable air leads to more dispersion, which leads to lower predicted impacts on ambient air quality. The default mixing height used by MILDOS-AREA is



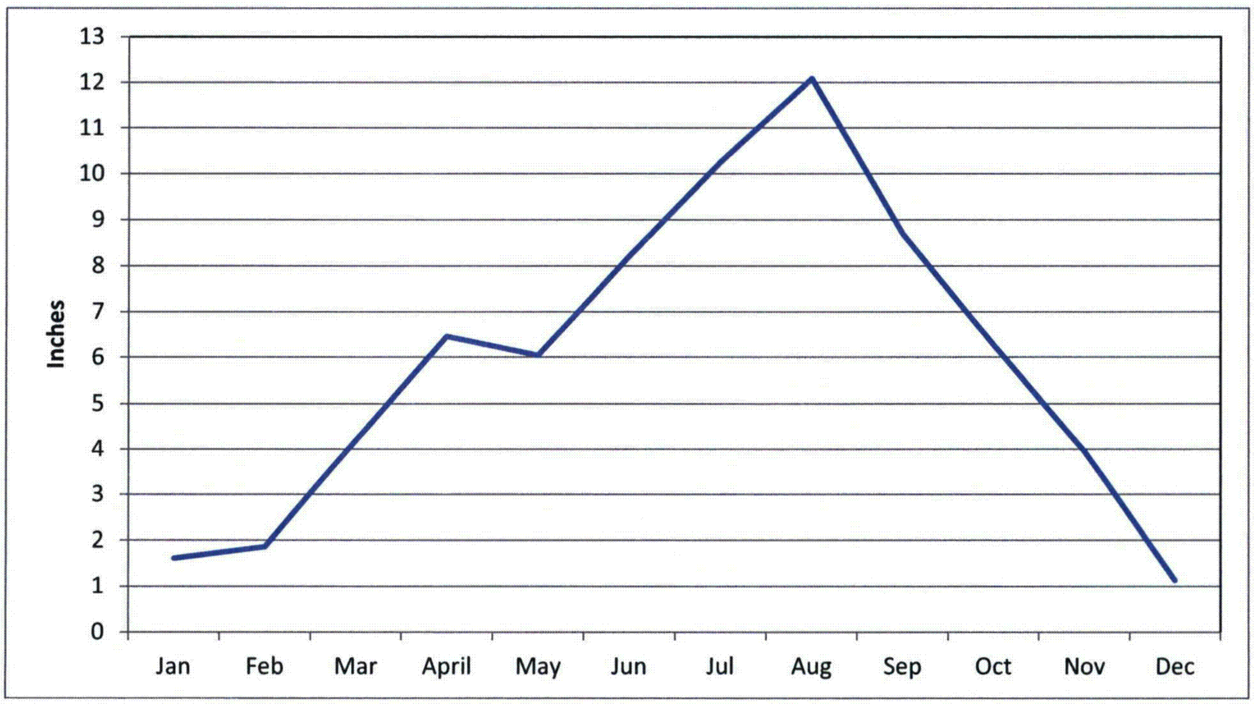
Source: SDSU, 2008

Figure 3.6-36: Diurnal Relative Humidity by Season from Project Meteorological Site



Source: SDSU, 2008

Figure 3.6-37: Monthly Precipitation from the Project Meteorological Site



Source: SDSU, 2008

Figure 3.6-38: Estimated Evapotranspiration Calculated Using Weather Data Collected at the Project Meteorological Site

100 meters, a very conservative value given that typical mixing heights exceed 1,000 meters. Table 3.6-8 provides the average mixing heights, computed from upper air and surface data, at the Rapid City Airport, which is the closest site to the permit area with upper air data.

For comparison purposes, average mixing heights were derived from the AERMOD calculations used for dispersion modeling, based on hourly data obtained from the NWS stations in Rapid City (upper air), Custer, and the local Edgemont station. The AERMOD calculation is based on a combination of mechanically and convectively driven boundary layer processes. The results of these calculations are provided on a quarterly basis in Table 3.6-9. The annual average mixing height is 1,110 meters, an order of magnitude higher than the default used for modeling potential radiological impacts.

3.6.2 Air Quality

Air particulate monitoring was conducted at the project for one year. Particulates were collected using high volume air samplers.

3.6.2.1 Methods

Eight Hi-Q Model HVP-4200AFC high volume air samplers were established within and surrounding the proposed permit area. The samplers operated continuously from August 2007 to August 2008 except for minor down time due to filter changes and short-term power outages. The locations of the air samplers are shown on Figure 3.6-39 and Plate 3.6-1.

The air particulate sampling locations were established in accordance with NRC regulatory guidance. The criteria used to establish air particulate sampling locations include the following factors:

1) Average meteorological conditions such as wind speed, wind direction and atmospheric stability
2) Prevailing wind direction
3) Site boundaries nearest to proposed facility processing areas, land application areas, and well fields
4) Direction of nearest occupiable structure
5) Locations of estimated maximum concentrations of radioactive materials
6) Locations of existing features near or within the proposed permit boundary, but unrelated to proposed site activities, that may impact background radiological conditions (e.g., railroads and historical surface mines)
7) Location of nearest multiple resident area or town

Table 3.6-8: Rapid City Mixing Height Averages, 1984-1991

Averaging Period	Morning	Afternoon
Average Mixing Height (meters)	333	1,547

Table 3.6-9: Quarterly Mixing Height Averages

	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Average Mixing Height (meters)	936	1,285	1,382	839

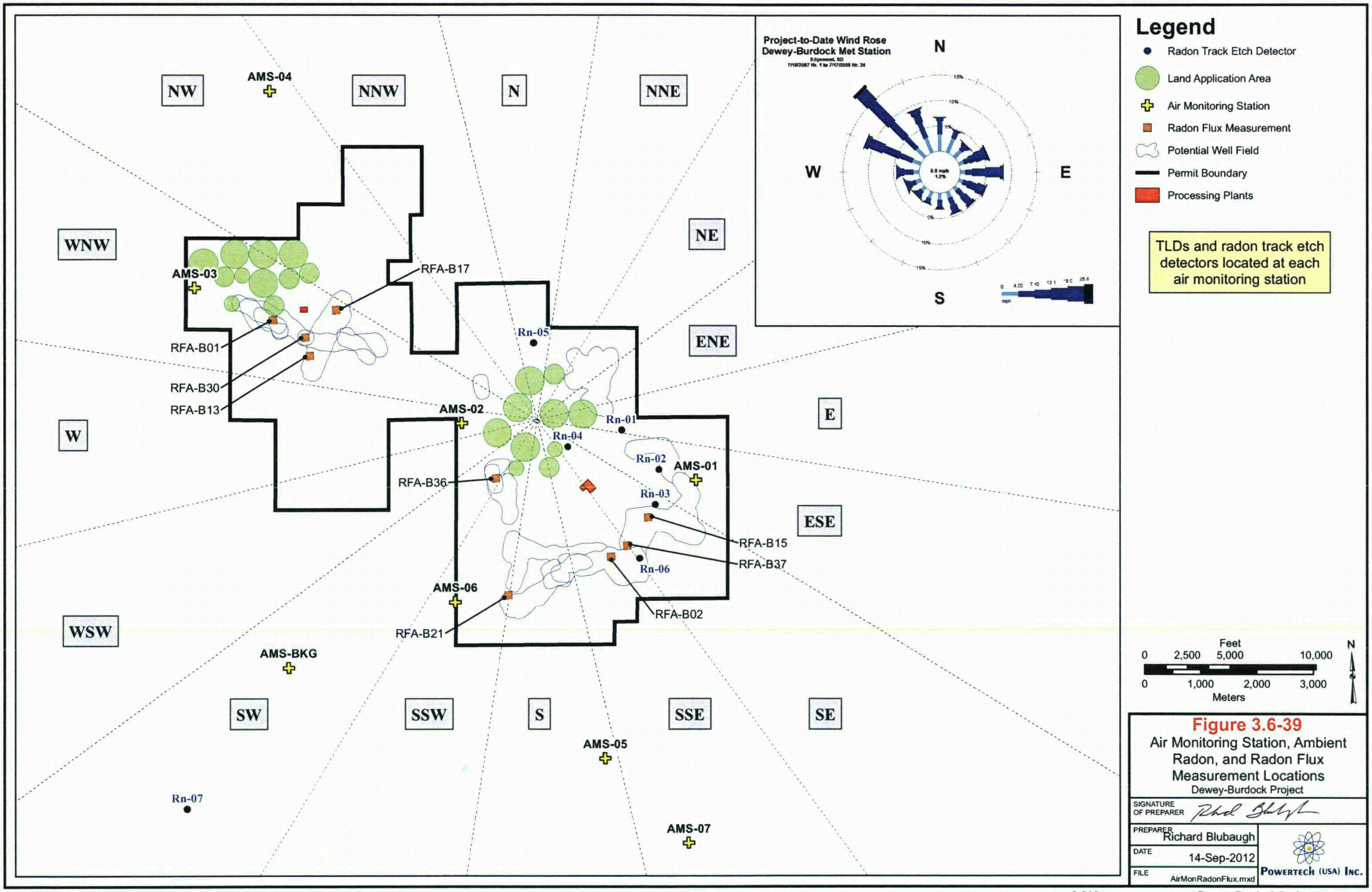


Figure 3.6-39
Air Monitoring Station, Ambient Radon, and Radon Flux Measurement Locations
Dewey-Burdock Project

Each high volume air sampler was equipped with an 8-in. by 10-in. 0.8 micron glass fiber filter paper. The air filters were collected approximately bi-weekly, prior to saturation, from each of the eight air samplers. Flow rate and total flow data were recorded at the same time. The samples were collected as follows:

- Period 1: August 13 to October 2, 2007
- Period 2: October 2, 2007 to January 4, 2008
- Period 3: January 4 to April 1, 2008
- Period 4: April 1 to July 9, 2008
- Period 5: July 9 to August 13, 2008

The air particulate samplers were equipped with air flow totalizers, which were recorded and reset during each filter change. Qualitative checks of air particulate sampler operation were also performed during each filter change. No anomalous flow volumes or conditions were observed.

The samples were composited and digested by the external independent analytical laboratory. The samples were analyzed for radium-226, thorium-230, natural uranium, and lead-210.

3.6.2.2 Sampling Results

In general and relative to one another (e.g., natural uranium to radium-226), the average concentrations of radionuclides were consistent at each location from period to period. The lowest average concentration was radium-226, followed by thorium-230, natural uranium, and lead-210. Average radium-226 concentrations were five orders of magnitude lower than lead-210 concentrations. The data are summarized in Table 3.6-10.

Site-wide, the data can be summarized as follows:

- Natural uranium concentrations ranged from $-8.1*10^{-18}$ to $1.5*10^{-14}$ μCi/ml and averaged $1.4*10^{-15}$ μCi/ml.
- Thorium-230 concentrations ranged from $-9.5*10^{-19}$ to $5.6*10^{-17}$ μCi/ml and averaged $1.2*10^{-17}$ μCi/ml.
- Radium-226 concentrations ranged from $-4.9*10^{-17}$ to $4.7*10^{-17}$ μCi/ml and averaged $1.7*10^{-18}$ μCi/ml.
- Lead-210 concentrations ranged from $7.0*10^{-18}$ to $4.3*10^{-17}$ μCi/ml and averaged $1.45*10^{-14}$ μCi/ml.

There are no clear patterns in the data, in terms of radionuclide concentrations, when evaluating them spatially or temporally. Natural uranium concentrations at each location were on the order

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Table 3.6-10: Summary of Radionuclide Concentrations in Air

Location	U-nat Concentration (µCi/ml)				Th-230 Concentration (µCi/ml)				Ra-226 Concentration (µCi/ml)				Pb-210 Concentration (µCi/ml)			
	Average	σ	Min	Max	Average	σ	Min	Max	Average	σ	Min	Max	Average	σ	Min	Max
AMS-01	1.4E-15	3.2E-15	-1.7E-17	7.1E-15	8.2E-18	6.4E-18	1.6E-18	1.7E-17	1.2E-17	3.0E-17	-3.1E-17	5.3E-17	2.3E-14	1.4E-17	9.1E-18	4.3E-17
AMS-02	1.4E-15	3.1E-15	-2.0E-17	7.0E-15	4.9E-18	6.5E-18	0.0E+00	1.6E-17	-1.4E-17	1.9E-17	-4.9E-17	-2.3E-18	1.3E-14	9.7E-18	7.0E-18	2.9E-17
AMS-03	1.0E-15	2.2E-15	-3.0E-17	5.0E-15	9.0E-18	7.2E-18	-1.5E-18	1.9E-17	-1.6E-18	9.3E-18	-1.4E-17	9.6E-18	1.1E-14	9.2E-18	8.9E-18	3.1E-17
AMS-04	1.0E-15	2.2E-15	-2.6E-17	5.0E-15	1.0E-17	9.8E-18	2.5E-18	2.7E-17	5.3E-18	2.7E-17	-2.8E-17	4.6E-17	1.3E-14	1.1E-17	8.3E-18	3.3E-17
AMS-05	1.2E-15	2.6E-15	0.0E+00	5.9E-15	2.4E-17	1.9E-17	4.7E-18	5.6E-17	9.6E-18	3.4E-17	-4.5E-17	4.7E-17	1.3E-14	1.0E-17	9.0E-18	3.4E-17
AMS-06	1.0E-15	2.3E-15	-1.4E-17	5.0E-15	9.9E-18	7.2E-18	1.5E-18	2.0E-17	-2.6E-18	2.3E-17	-3.9E-17	2.3E-17	1.4E-14	9.9E-18	7.4E-18	3.3E-17
AMS-07	3.1E-15	6.9E-15	-1.1E-17	1.5E-14	1.3E-17	5.7E-18	6.3E-18	2.0E-17	4.9E-18	1.7E-17	-1.3E-17	2.9E-17	1.6E-14	1.0E-17	7.5E-18	3.0E-17
AMS-BKG	1.1E-15	2.5E-15	-8.1E-18	5.7E-15	1.5E-17	1.4E-17	-7.8E-19	3.0E-17	-6.3E-19	1.1E-17	-1.7E-17	1.2E-17	1.3E-14	9.8E-18	8.0E-18	3.1E-17
Overall	1.4E-15		-3.0E-17	1.5E-14	1.2E-17		1.5E-18	5.6E-17	1.6E-18		-4.9E-17	5.3E-17	1.45E-14		7.0E-18	4.3E-17

of 10^{-17} µCi/ml over the course of monitoring. Thorium-230 concentrations fluctuated between the orders of 10^{-17} and 10^{-18} µCi/ml. Radium-226 concentrations fluctuated between the orders of 10^{-17} and 10^{-18} µCi/ml. Finally, lead-210 concentrations at each location were on the order of 10^{-15} µCi/ml over the course of monitoring.

3.6.2.3 Conclusions

With the exception of natural uranium, the values determined above are similar to U.S. background concentrations reported in the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) Report to the General Assembly, Sources and Effects of Ionizing Radiation, Annex B. The regional concentrations reported in this reference document are: uranium-238 ($2.4*10^{-17}$ to $1.4*10^{-16}$ µCi/ml), thorium-230 ($1.6*10^{-17}$ µCi/ml), radium-226 ($1.6*10^{-17}$ µCi/ml), and lead-210 ($2.7*10^{-15}$ to $2.7*10^{-14}$ µCi/ml).

3.7 Vegetation

A detailed vegetation study report is included in Appendix 3.7-A. The following information is provided as a summary of the information in the full report. Plate 3.7-1 was developed using the information presented in Appendix 3.7-A.

3.7.1 Methodology

All vegetation sampling procedures were designed according to previous experience with similar projects and in collaboration with SDGF&P. Refer to Appendix 3.7-A for the detailed vegetation study report, including the submitted methodology.

Vegetation sampling was conducted by BKS. Initial surveys were conducted during July 2007, with supplemental sampling performed to adjust to subsequent changes in the proposed permit boundary.

<u>Mapping</u>

Seven different plant communities were identified for the proposed permit area, i.e., Big Sagebrush Shrubland (BS), Greasewood Shrubland (GW), Ponderosa Pine Woodland (PP), Upland Grassland (UG), Cottonwood Gallery (CG), Silver Sagebrush Shrubland (SS), and Agricultural Land (AG), using 2001 color infrared (CIR) aerial photography, which was verified by field survey. The Agricultural Land was not sampled as it was actively being used for crop production. The Silver Sagebrush Shrubland will be described as an inclusion of the Greasewood Shrubland Community.

Transect Origin Selection

The transects were randomly located in the field within each sampled vegetation community. Each transect was at least 150 feet from the previous transect. Random numbers between 1 and 360 were generated to determine cover transect direction, and compasses were utilized to orient transects to the nearest 1/8 of 360 degrees in the field. Each sample site was marked with a hand-held Garmin global positioning system (GPS), and these points were later plotted on the final vegetation survey map (Plate 3.7-1).

Cover

A sample size of 37 50-meter point-intercept cover transects were sampled within the Ponderosa Pine Woodland and Greasewood Shrubland communities, while 27 samples were taken in the Big Sagebrush Shrubland, 26 samples in the Cottonwood Gallery and 30 samples in the Upland Grassland community for a total of 157 cover points in the proposed permit area.

In the vegetation communities, each 50-meter transect represented a single sample point. Percent cover measurements were taken from point-intercepts at 1-meter intervals along a 50-meter transect. Transects that exceeded the boundaries of the vegetation community being sampled were redirected back into its vegetation community at a 90 degree angle from the original transect direction at the point of intercept. In instances where a 90 degree angle of reflection did not place the transect within the sampled community, a 45 degree angle of reflection was used. Each point-intercept represents 2 percent towards cover measurements.

Percent cover measurements record "first-hit" point-intercepts by live foliar vegetation species, litter, rock, or bare ground. Multiple hits on vegetation were recorded, but used only for the purpose of constructing a plant species list for each plant community (Appendix 3.7-A).

Total Vegetation Cover

Vegetation cover data were recorded by species, using first hit data. All point intercepts of living vegetation and growth produced during the current growing season were counted toward total vegetation cover. Total vegetation cover measurements were expressed in absolute percentages for each sample point. Percent vegetation cover is the vertical projection of the general outline of plants to the ground surface. Cover summaries for each vegetation community within the proposed permit area are contained in Appendix 3.7-A.

Total Ground Cover

Total ground cover data was recorded by live vegetation, litter, or rock, minus bare ground. Litter includes all organic material that is dead including manure. Rock fragments were recorded when equal to or greater than two centimeters in size (i.e., sheet flow, minimum non-erodible particle size). Total ground cover measurements were expressed in absolute percentages for each sample point. Total ground cover equals the sum of cover values for percent vegetation, percent litter, and percent rock.

Shrub Density

These data were taken at the time of cover sampling to ensure adequate use of field time. Shrub density data were collected in conjunction with randomly selected cover transects, wherever possible. All shrubs, full, half, or sub, were counted within 50 centimeters on either side of the 50 meter cover transect (1 meter x 50 meter belt transect), yielding a 100 m^2 belt transect. Sample adequacy was not calculated for shrub density. The number of belt transects equaled the number of cover transects for a given vegetation type.

Tree Density

Data were collected at the time of cover sampling to ensure adequate use of field time. Tree density data were collected in the Ponderosa Pine Woodland vegetation community in conjunction with randomly selected cover transects, wherever possible. Tree density in this community was determined using the point-center quarter method. Trees within the Cottonwood Gallery or Riparian areas were directly counted on an aerial photograph. Within other vegetation communities, individual *Pinus ponderosa* (Ponderosa Pine) or other tree species found were directly counted for numbers. Sample adequacy was not calculated on the point-center quarter plots.

Species Composition

A list of plant species encountered during 2007 quantitative sampling is compiled in Appendix 3.7-A by vegetation community type for each of the vegetation communities. The species list includes plant species sampled in cover transects as well as plant species observed along the belt transect. Plant names in the Rocky Mountain Vascular Plants of Wyoming (Dorn, 2001) were utilized. Plant identification was confirmed by Robert Dorn, when necessary. Scientific nomenclature followed that in use at the Rocky Mountain Herbarium in Laramie, Wyoming, during 2007.

3.7.2 Vegetation Survey Results and Discussion

The permit area comprises five main vegetative communities: Big Sagebrush Shrubland, Greasewood Shrubland, Upland Grassland, Ponderosa Pine Woodland, and Cottonwood Gallery. Minor vegetation communities also include: Agricultural Land, Disturbed Areas, Existing Mine Pits, Silver Sagebrush Shrubland, Water, and Shale Outcrop. Refer to Table 3.7-1 for acreage of each vegetation community within the permit area. Plate 3.7-1 provides the vegetation map for Dewey-Burdock Project.

3.7.3 Species of State and Federal Interest

No threatened or endangered species were encountered within the permit area. The presence of the South Dakota-designated weed Canada thistle was present within the Cottonwood Gallery vegetation community. The presence of the Fall River County-designated weed field bindweed was present within the Greasewood Shrubland vegetation community.

3.8 Wetlands

A detailed wetland study report for the 2007 assessment is included in Appendix 3.8-A. Note that Section 3.8.3 describes updates in 2008 due to a change in the proposed permit area. The following information is provided as a summary of the information in the full report. Plate 3.8-1 was developed using the information presented in Appendix 3.8-A.

3.8.1 Methodology

BKS Environmental Associates, Inc. (BKS), of Gillette, Wyoming, completed the baseline wetland inventory fieldwork. The wetland surveys were conducted in accordance with the Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region. All Waters of the U.S. (WoUS) and Other Waters of the U.S. (OWUS) were assessed during the surveys. The routine wetland delineation approach with onsite inspection was utilized, and the survey was conducted by pedestrian reconnaissance and review of existing maps of the permit area. Identification of potential wetlands was based on visual assessment of vegetation and hydrology indicators, as well as intrusive soil sampling to determine the presence of wetland criteria indicators. Wetland Determination Data Forms-Great Plains Region (DRAFT), were utilized for each observation point. Hydrology and soils were evaluated whenever a plant community type met hydrophytic vegetation parameters based on the Dominance Test and Prevalence Index (as defined by the Great Plains Regional Supplement), or whenever indicators suggested the potential presence of a seasonal wetland area under normal circumstances.

Table 3.7-1: Vegetation Mapping Unit Acreage within Proposed Permit Area

Map Unit	Acreage	% of Area
Sampled Vegetation Communities		
Big Sagebrush Shrubland	2,501.56	23.70
Greasewood Shrubland	2,190.45	20.75
Ponderosa Pine Woodland	2,183.76	20.69
Upland Grassland	2,187.56	20.72
Cottonwood Gallery	240.60	2.28
Described Vegetation Communities		
Agricultural Land	780.79	7.40
Disturbed	14.70	0.14
Existing Mine Pit	326.99	3.10
Silver Sagebrush Shrubland	119.49	1.13
Shale Outcrop	2.19	0.02
Water	8.94	0.08
TOTAL	**10,557.03**	**100.0**

Natural Resources Conservation Service (NRCS) soils mapping for Custer and Fall River counties, South Dakota (2007) and BKS soil mapping of the permit area were reviewed for general soils information.

Potential wetlands (WoUS) and OWUS were initially identified via review of area maps to include the following:

- 1977 USFWS National Wetland Inventory (NWI) mapping for the Dewey, Burdock and Twenty-one Quads
- Custer Quad Digital Elevation Model
- Burdock Quad Digital Elevation Model

Wetland indicator categories were identified for each dominant plant species noted through use of the National List of Vascular Plant Species that Occur in Wetlands, 1996 National Summary. Region 4 (North Plains) indicator categories were utilized for the permit area.

Field sample locations and resulting wetland boundaries were recorded with a hand-held Garmin GPS map 60Cx GPS unit in NAD 1983 UTM Zone 13.

3.8.2 Wetland Assessment Results and Discussion

The permit area generally occurs on uplands, with inclusions of two main drainages, Beaver Creek and Pass Creek, and several depressed areas. Beaver Creek and Pass Creek were evaluated using pedestrian reconnaissance, while the remaining small drainages were evaluated based on existing mapping. Wetlands were identified throughout the Beaver Creek drainage; however, Pass Creek only had wetlands present near an old open flowing well close to the project boundary. Wetlands were also identified in the majority of the old mine pits as well as depressed areas. The wetland classification along Beaver Creek was Riverine Lower Perennial Emergent (R2EM) WoUS, while that in Pass Creek and other small drainages was Palustrine Emergent (PEM) WoUS. The mine pits were primarily designated as Palustrine Unconsolidated Bottom (PUB) OWUS and depressions were typically PEM or PUB designations.

Beaver Creek had water present continuously in the drainage and wetland species near the banks. The upper banks were comprised mainly of *Artemisia tridentata* (big sagebrush), *Sarcobatus vermiculatus* (Greasewood), and *Elymus smithii* (Western wheatgrass). The wetland indicator status of these plants are UPL (upland), UPL, and FACU (facultative upland), respectively. The entire stretch of Beaver Creek within the permit area is designated as a R2EM wetland. Pass Creek was comprised of the Cottonwood Gallery vegetation community comprised mainly of

Bromus inermis (smooth brome), Western wheatgrass, and *Populus deltoides* (cottonwood trees). The wetland indicator statuses of these plants are UPL, FACU, and FAC (facultative), respectively.

There were several NWI 1977 previously mapped wetlands that were confirmed as non-wetland or not present during the 2007 field survey. The areas generally lacked hydrophytic vegetation, hydric soils, and hydrology. Most areas had geomorphic position but often lacked another secondary indicator. Datasheets were filled out to confirm no presence of these wetlands and can be found in Appendix 3.8-A.

There are seven historical open mine pits present within the permit area. Four of the mine pits were classified as non-wetland primarily due to lack of hydrophytic vegetation and/or hydrology presence. Two mine pits located in Section 1, T7S, R1E were classified as PUB wetlands. The only mine pit in Section 2 was classified as both a PEM and Open Water (OW). The PEM is located along the bank of the pit and OW throughout the rest of the pit. The mine pit in Section 34, T6S, R1E was classified as OW, and another small mine pit located at waypoint 92 in Section 1, T7S, R1E was classified as OW.

All the depressional areas identified as wetlands in 2007 were also previously identified during the 1977 NWI mapping. All of these wetlands are recommended to be non-jurisdictional based on the isolated nature of the wetlands. The wetlands were primarily classified as PEM, PEMC, PABJh, PUS, PUSA and PUB wetlands based primarily on the hydrology conditions of each waypoint.

Appendix 3.8-B includes a U.S. Army Corps of Engineers jurisdictional determination for some of the potential wetland sites within the permit area. Final determination of jurisdictional decision for all sites lies within the U.S. Army Corps of Engineers.

3.8.3 2008 Wetland Assessment Update

The following describes updates made in 2008 to the 2007 wetland assessment that occurred due to a change in the proposed permit area. The 2007 and 2008 boundaries are depicted in Appendix 3.8-A.

Beaver Creek Update

Beaver Creek is likely to have wetlands throughout the entire permit area as it is a major drainage and had a good flow of water when the surveys were conducted in 2007. The boundary change took out 1.956 acres of R2EM wetlands along Beaver Creek in the NW1/4 of Section 31, T6S, R1E. The boundary change also added 4.81 acres of R2EM wetlands along Beaver Creek in the SE1/4 of Section 31, T6S, R1E and E1/2 of Section 5 and SW1/4 of Section 4, T7S R1E. The total acreage addition to the wetlands along Beaver Creek was 2.86 acres of R2EM.

Small PEM and PUB isolated wetlands may be found southwest of the Beaver Creek drainage in Section 5, T7S, R1E; however, accessibility to the area was not present to confirm. There are two depressions that can be seen on the map and based on the 2007 surveys the likelihood of either of the depressions being classified as a wetland is rare.

Pass Creek Update

In 2007, Pass Creek had 0.503 acre of PEM wetlands surveyed along its stretch; however due to the recent boundary change there are now only 0.05 acre of wetlands present on Pass Creek. The boundary change moved the boundary east of W22, and now excludes the three wetland points of W20, W21, and W22. The wetlands present on Pass Creek are primarily due to an old open flowing well on the other side of the road outside the permit boundary.

In 2007, Pass Creek was surveyed from the southern permit boundary to the old mine pit and no wetlands were identified except near the spring. No surveys were conducted on Pass Creek in 2008 as the map indicated that the area is likely dry.

Old Mine Pits

There were no changes in 2008 to the acreages identified in 2007 of old mine pits wetland occurrences.

Depressional Areas and Ponded Areas Identified as Wetlands

No changes were made in 2008 to the acreages on the 2007 depressional areas and ponded areas identified as wetlands. As noted above there may be some isolated PUB or PEM depressional areas southwest of Beaver Creek, but accessibility to the area was not present during the 2008 surveys. However, it is unlikely that the areas indicated contain wetlands as the 2007 surveys proved that many of the potential wetlands indicated on the map and NWI no longer existed.

3.9 Wildlife

A detailed wildlife study report is included in Appendix 3.9-A. The following information is provided as a summary of the information in the full report. Plate 3.9-1 was developed using the information presented in Appendix 3.9-A.

3.9.1 Methodology

Wildlife sampling was conducted by ICF Jones & Stokes (formerly Thunderbird Wildlife Consulting) of Gillette, Wyoming. Appendix 3.9-B contains a letter from SDGF&P approving ICF Jones & Stokes as the wildlife consultant. Background information on terrestrial vertebrate wildlife species and aquatic vertebrates and invertebrates in the vicinity of the permit area was obtained from several sources, including records from SDGF&P, BLM, USFWS, U.S. Forest Service (USFS), and the original Draft Environmental Statement (DES) prepared by TVA in 1979. Previous site-specific data for the permit area and surrounding perimeter were obtained from those same sources.

Current baseline wildlife information was collected from July 2007 through early August 2008 to meet agency requirements for one year of baseline data, and to accommodate changes to the permit area boundary during that period. The survey area included the entire permit area and a perimeter offset 1 mile from the permit area boundary for threatened and endangered (T&E) species, bald eagle winter roosts, all nesting raptors, upland game bird leks, and big game. Survey protocols and timing were developed collaboratively with SDGF&P to meet species-specific requirements. Surveys and documentation of occurrence conducted only in the permit area included other vertebrate species of concern tracked by the South Dakota Natural Heritage Program (SDNHP), as well as bats, small mammals, lagomorphs, prairie dog colonies, breeding birds, predators, and herptiles.

All surveys were conducted by qualified biologists using standard field equipment and appropriate field guides. Most terrestrial data were collected from vantage points during pedestrian or vehicular surveys to avoid disturbing wildlife; exceptions included breeding bird surveys and small mammal trapping. Raptor nests, prairie dog colonies, and other features or points of special interest were mapped in the field using a hand-held GPS receiver. Species were identified with the aid of field guides and other literature including, but not limited to, Robbins et al. (1966), Burt and Grossenheider (1976), Jones et al. (1983), Clark and Stromberg (1987), Peterson (1990), South Dakota Ornithological Union (1991), Baxter and Stone (1995), Stokes and Stokes (1996), and Kiesow (2006).

3.9.2 Wildlife Survey Results

Appendix 3.8-A lists all species that could potentially reside in the vicinity of the permit area or pass through during migration. Species actually observed in or adjacent to the permit area are noted. The appendix includes various tables listing sightings of targeted wildlife species, including those tracked by SDNHP, recorded in the vicinity of the permit area from July 2007 through August 2008. Appendix 3.8-A also includes representative photographs of the permit area and wildlife species observed and resumes for the IFC Jones & Stokes staff who conducted the surveys and prepared the baseline report. Following is a brief summary of the wildlife survey results. Refer to Section 3.10 for aquatic resources survey results.

Habitat Mapping

A general description of the location, extent, and characteristics of each habitat is described in Appendix 3.8-A.

Big Game

Pronghorn (*Antilocapra americana*) and mule deer (*Odocoileus hemionus*) are the only two big game species that regularly occur in the survey area, and both are considered year-round residents. The pronghorn is the most common big game species in the survey area, though no species is prevalent. Elk (*Cervus elaphus*) and white-tailed deer (*Odocoileus virginianus*) are also present in the survey area, but only in small herds. The latter two species can also be seen in the survey area year-round, but may be more common during certain seasons.

Small Mammals

Four species of small mammals were captured in September 2007: the deer mouse (*Peromyscus maniculatus*), olive-backed pocket mouse (*Perognathus fasciatus*), western harvest mouse (*Reithrodontomys megalotis*), and northern grasshopper mouse (*Onychomys leucogaster*). The deer mouse was by far the most abundant small mammal captured during the baseline study, representing approximately 95 percent of the total, and was the only species trapped in all habitats. Each of the three other species captured accounted for less than 3 percent.

Lagomorphs

Two lagomorph species were observed within the survey area during spotlight surveys conducted in 2007: the white-tailed jackrabbit (*Lepus townsendii)* and cottontail (*Sylvilagus* spp.). Cottontail abundance was twice that of jackrabbits, though neither count was especially high. Results from lagomorph surveys conducted in northeast Wyoming annually since 1984, and periodic surveys in northwestern South Dakota in recent years, indicate that the regional lagomorph population recently experience a downward trend in its regular cyclic pattern. Although no data are available from the permit area prior to 2007, its proximity to other regional survey areas and the low counts recorded during the baseline survey period suggest the survey area lagomorph population was in a similar low cycle at that time. Declines in the Wyoming population have been attributed to Tularemia, a disease known to infect lagomorph populations once they reach a certain threshold. It is possible that a similar disease event occurred recently in western South Dakota.

Other Mammals

A variety of small and medium-sized mammalian species have the potential to occur in the survey area, although not all were observed in the permit area itself during the baseline wildlife surveys. These potential species include a variety of common predators and furbearers such as the coyote (*Canis latrans*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*), bobcat (*Lynx rufus*), badger (*Taxidea taxus*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethicus*). Numerous prey species, including rodents (e.g., mice, rats, voles, gophers, ground squirrels, chipmunks, prairie dogs, etc.), can also be found in the survey area. These species are cyclically common and widespread throughout the region, and are important food sources for raptors and other predators. Each of these prey species, with the exception of chipmunks and rats, were either directly observed during the field surveys, or were known to exist through burrow formation or scat. Observations of small mammals occurred most often near Beaver Creek and Pass Creek, in the northwestern and central portions of the survey area, respectively.

One black-tailed prairie dog colony overlaps the northwestern corner of the permit area, and two others are present in the southwestern portion of the one-mile perimeter. Portions of all three colonies were unoccupied during the baseline survey period. Local ranchers use shooting and other control methods to reduce and/or eradicate prairie dogs from private surface in the permit area and on surrounding lands. Other mammalian species such as the striped skunk (*Mephitis mephitis*), porcupine (*Erethizon dorsatum*), and various weasels (*Mustela* spp.) could inhabit the survey area, but no sightings or confirmed scat were recorded for those species during the baseline surveys. Infrequent, incidental bat sightings (species unknown) occurred during nocturnal amphibian surveys and spotlighting efforts conducted at targeted ponds in the permit area during the baseline period.

Game Birds

The wild turkey (*Meleagris gallopavo*) and mourning dove (*Zenaida Macroura*) were the only upland game bird species observed in the survey area during baseline inventories conducted from July 2007 to August 2008. Both species are relatively common and occur in a variety of woodland and open habitats in the permit area. No sage-grouse were observed during the entire year-long baseline survey period. Limited potential habitat for this species is present in the general survey area, but only in small stands of sage surrounded by less suitable grasslands and pine breaks. Although sage-grouse were historically recorded in the general vicinity (TVA DES, 1979), no leks have been documented by agency biologists within 6 miles of the permit area in recent years.

Raptors

Raptor species observed during the baseline wildlife surveys included the bald eagle, red-tailed hawk (*Buteo jamaicensis*), golden eagle, northern harrier (*Circus cyaneus*), American kestrel (*Falco sparverius*), turkey vulture (*Cathartes aura*), Cooper's hawk (*Accipiter cooperii*), rough-legged hawk (*Buteo lagopus*), merlin (*Falco columbarius*), great horned owl, and long-eared owl (*Asio otus*). Other raptor species also could occur in the survey area, particularly as seasonal migrants, but were not seen during the 2007 and 2008 inventories. The bald eagle, red-tailed hawk, American kestrel, and northern harrier were the most commonly seen raptor species in the area. Raptor sightings for those species were recorded with regularity during all four seasons throughout the baseline survey period, though some of those species may leave the area under harsh winter conditions. Five confirmed, intact (i.e., material present) raptor nests and one potential nest site were located in the permit area and two additional nest sites (one confirmed and one potential) were recorded in the one-mile survey perimeter.

Breeding Birds

Thirty-four species were identified within the breeding bird transects during spring 2008. Two additional unknown species were logged during the surveys, with two other species recorded only while flying over the transects; those observations were not included in data analyses. The western meadowlark (*Sturnella neglecta*) was the most common species, followed by the mourning dove. The dove was the only species recorded in all six habitat types. The long-billed curlew (*Numenius americanus*) was the only observed species that is tracked by the SDNHP. Defensive behavior recorded during the transect surveys indicated that up to three pairs may have nested near the south-central edge of the permit area.

Reptiles

Lizards (species unknown) were often observed sunning themselves on rocks and on sandy soil in the summer months during all except the early morning hours. These sightings were widespread throughout the survey area, with observations increasing as the summer progressed and the days got hotter. The shed remains of a snakeskin were found in the north central portion of the survey perimeter in early May 2007. The skin was at the base of a rock outcrop and looked as though it may have belonged to a bullsnake (*Pituophis cantenifer*).

3.9.3 Species of State and Federal Interest

The USFWS issued a block-clearance for ferrets throughout most of South Dakota in recent years, including the survey area in extreme southwestern Custer County and northwestern Custer County. No ferrets or evidence of their presence were observed during historical TVA surveys, or during the recent survey period.

The USFWS removed (delisted) the bald eagle from protection under the ESA in July 2007, and the ruling became effective that August. However, this species is still considered as a state-listed threatened species in South Dakota. In addition, bald eagles continue to be protected under the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act, as well as any applicable state regulations. Bald eagles were repeatedly observed along Beaver Creek in the western portion of the permit area and perimeter during winter roost surveys conducted in late 2007 and early 2008.

Prior to initiating field surveys, biologists reviewed the list of rare, threatened, or endangered vertebrate species tracked by the SDNHP that could occur as permanent or seasonal residents on or within 1 mile of the permit area, based on each species' range and the habitats present in that area. Appendix 3.8-A includes a summary of vertebrate SDNHP species that were recorded in or within 1 mile of the permit area.

Seven vertebrate sensitive species or species of local concern other than the bald eagle were documented with the permit area during the baseline survey period: the long-billed curlew, great blue heron, golden eagle, Cooper's hawk, merlin, American white pelican, and long-eared owl. The long-eared owl and curlew are known or are suspected to have nested in the permit area, based on evidence (young present) or persistent defensive behavior, respectively. The remaining five species were observed perched in or flying over the permit area only once or twice each. These seven species of special interest are considered as secure populations within their respective overall ranges, though one or more could be less common in parts of a given range, especially in the periphery. Likewise, all seven are considered to be either rare and local throughout their statewide ranges, or locally abundant in restricted portions of those ranges. One other vertebrate species of concern was documented at least once in the one-mile perimeter: the Clark's nutcracker.