

# WHARF RESOURCES 2010 EXPANSION PROJECT METEOROLOGICAL CHARACTERIZATION

Topical Report RSI-2129

*prepared for*

Wharf Resources (USA) Inc.  
10928 Wharf Road  
Lead, South Dakota 57754

October 2010



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## FOREWORD

The purpose of this study was to characterize recent and historical meteorological conditions near the Wharf Resources' mine site. This characterization of the meteorological conditions will increase Wharf Resources' knowledge on fate and transport of any contaminants associated with the site.

The Wharf Mine is located in the northern Black Hills of South Dakota. Meteorological data used for this study were obtained from the Wharf meteorological station (2005–2008) and from the High Plains Regional Climate Center for stations in Lead, South Dakota (2005–2009), and Spearfish, South Dakota (2009). The Lead station is approximately 3 miles from the Wharf Mine, and the Spearfish station is approximately 10 miles from the Wharf Mine. Because of a closer proximity and more similar topography, data obtained from the Lead site were considered more representative of the Wharf Mine location. Parameters available from the Lead station include temperature and precipitation. Parameters available from the Spearfish station include temperature, precipitation, dew point, relative humidity, wind speed, and barometric pressure. Parameters available from the Wharf station (2005–2008) include temperature, relative humidity, and wind speed. On-site 2005, 2006, and 2009 precipitation data were also available from the Wharf site.

From 2005 to 2009, the Lead station had an average temperature of 44.5°F and average precipitation accumulation of 2.9 inches per month. During 2009, the average temperature and precipitation accumulation were both slightly lower (42.5°F and 2.8 inches per month, respectively). The average daily relative humidity in 2009 at the Spearfish station ranged from a low of 22.8 percent during January and a high of 98.9 percent during June. The average wind speed at the Spearfish station in 2009 was 9.1 miles per hour (mph), including calm winds which occurred approximately 13 percent of the time.



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## 1.0 INTRODUCTION

Wharf Resources (USA) Inc. (Wharf) is a surface gold mine proposing an expansion to its existing operations. Wharf is located 4 miles west of Lead, South Dakota, in Lawrence County. The regional topography is mountainous and the mine is located at an elevation of about 6,000 feet within a forested ridge system. The site lies upon Precambrian metamorphic rocks and the Cambrian Deadwood Formation in the Black Hills.

The objective of this study was to satisfy the South Dakota Department of Environmental and Natural Resources (SD DENR) meteorological characterization requirement of developing a meteorological monitoring plan (Administrative Rules of South Dakota, 74:29:02:11(8)). Meteorological data were collected and recorded at the mine from 1985 until early 2008, at which time, the station became dysfunctional and meteorological data were no longer required to be monitored by the Air Quality Permit and Technical Revision to the Mine Permit. No new on-site meteorological monitoring was requested by the SD DENR for current baseline investigations; hence, analysis is based on parameters measured at two nearby weather stations and supplemented by available Wharf data.

Existing data from the meteorological station located near Lead, South Dakota, (44°21" –103°46'12") were analyzed and summarized. The Lead meteorological station (also referred to as the Lead site) is approximately 3 miles east of the Wharf site. Desired data analysis parameters included temperature, dew point, humidity, wind speed, wind gust, pressure, and precipitation. However, not all listed parameters were available from the Lead station; thus, dew point, relative humidity, wind speed, wind gust, and barometric pressure parameters were obtained from the Spearfish Airport meteorological station (44°28'59", –103°46'59"). The Spearfish station (also referred to as the Spearfish site) is approximately 10 miles north of the Wharf site. Intermittent temperature, relative humidity, wind (2005–2008), and precipitation (2009) data were also available from Wharf Resources [Wharf Resources, 2006 and 2007; Waterland, 2010]. Both recent (2009) and historical data (2005–2009) were analyzed and summarized. Figure 1-1 and Table 1-1 show the location of both meteorological sites used for this investigation.

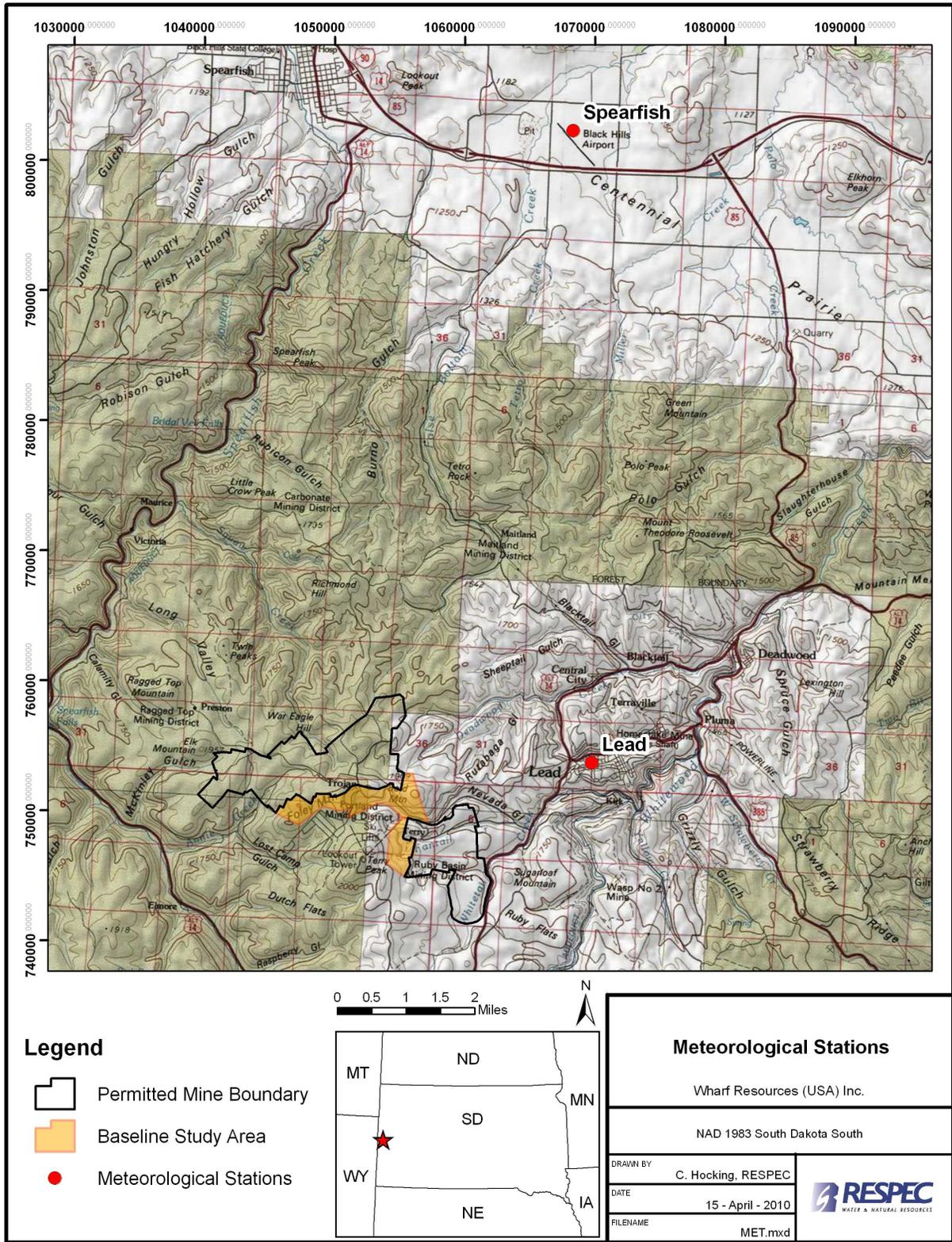


Figure 1-1. Baseline Study Area and Nearby Meteorological Stations.

**Table 1-1. Meteorological Stations Included in Climatology Analysis [High Plains Regional Climate Center, 2010; Umphlett, 2010]**

| <b>Name</b> | <b>Data Source</b> | <b>Latitude (ddmmss)<sup>(a)</sup></b> | <b>Longitude (dddmmss)</b> | <b>Elevation (ft)</b> | <b>Approximate Distance to Wharf Site (miles)</b> | <b>Years of Operation</b> |
|-------------|--------------------|--|----------------------------|-----------------------|---|---------------------------|
| Lead        | HPRCC              | 44°21'                                 | -103°46'12"                | 5,350                 | 3   | 1909-2010                 |
| Spearfish   | HPRCC              | 44°28'59"                              | -103°46'59"                | 1,188                 | 10  | 2008-2009                 |

(a) ddmss = degrees, minutes, seconds



## 2.0 METHODOLOGY

Much of the data were analyzed using Microsoft Excel. For parameters, including temperature, dew point, barometric pressure, and relative humidity, pivot tables were used to generate tables displaying number of datapoints ( $N$ ), maximum, mean, standard deviation, and minimum. For precipitation, snowfall, heating degree-days, and cooling degree-days, pivot tables were used to generate tables displaying number of datapoints ( $N$ ) and monthly sum. Tables used to generate graphs displayed throughout this report can be found in Appendices A and B.

Box plots provided throughout this report give visual summaries of five dataset numbers: minimum,  $Q1$ , median,  $Q3$ , and maximum. For box plots, Minitab software Version 14.0 was used to construct the following:

$n$  = number of datapoints

Minimum = smallest number in a dataset

$Q1$  = the datapoint at the  $(n+1)/4$  position.

Median = the datapoint at the  $(n+1)/2$  position

$Q3$  = the datapoint at the  $3(n+1)/4$  position

Maximum = largest number in a dataset

$IQR$  = interquartile range =  $Q3 - Q1$

Lower Fence =  $Q1 - (1.5)(IQR)$

Upper Fence =  $Q3 + (1.5)(IQR)$ .

Minitab then completes box plots by drawing:

1. A box from  $Q1$  to  $Q3$ .
2. A line at the median inside the box.
3. A solid line (whisker) from  $Q1$  to the smallest observation inside the lower fence.
4. A solid line (whisker) from  $Q3$  to the largest observation inside the upper fence.
5. Asterisks (\*) to mark outlier observations lying outside the fences.

Table 2-1 shows an example dataset representing recorded temperatures in 2008 to illustrate the data provided by a typical box plot. Statistics of the data are shown along with a box plot generated by Minitab shown in Figure 2-1.

**Table 2-1. Example Temperature Dataset for Figure 2-1**

|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 30 | 36 | 39 | 43 | 45 | 48 | 49 | 50 | 55 | 55 | 56 | 56 | 56 | 56 | 56 | 60 | 60 | 62 | 62 |
| 62 | 62 | 63 | 63 | 63 | 63 | 64 | 65 | 67 | 67 | 67 | 68 | 68 | 70 | 70 | 72 | 79 | 80 | 80 |

For this dataset:

$$n = 38$$

Minimum = smallest number in a dataset

$Q1$  = the datapoint at the  $(n+1)/4$  position.

Median = the datapoint at the  $(n+1)/2$  position

$Q3$  = the datapoint at the  $3(n+1)/4$  position

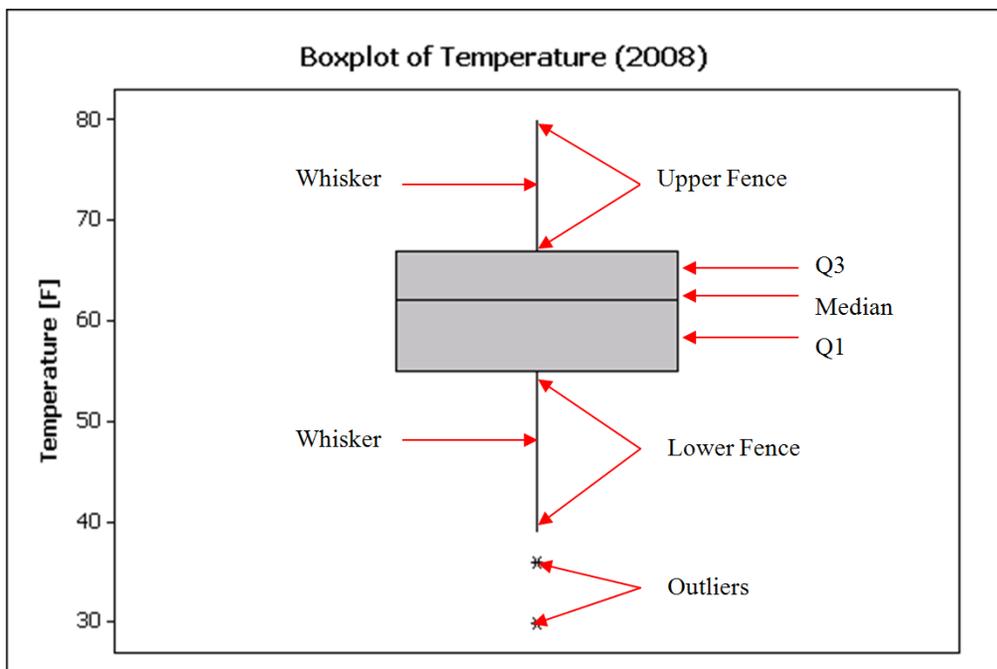
Maximum = largest number in a dataset

$$IQR = \text{interquartile range} = Q3 - Q1$$

$$\text{Lower Fence} = Q1 - (1.5)(IQR)$$

$$\text{Upper Fence} = Q3 + (1.5)(IQR).$$

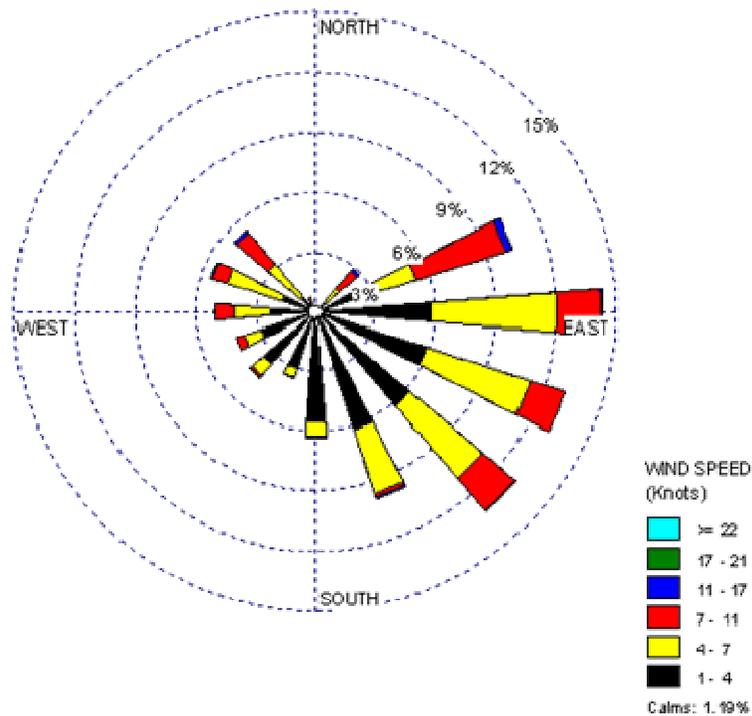
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**Figure 2-1.** Example Box Plot Generated by Minitab of Recorded Temperatures in 2008 Illustrating the Information Provided.

Wind roses are also used throughout this report and summarize recorded wind speeds and wind directions. Statistical analysis and visualization of wind data were performed using WRPLOT View Version 5.3 distributed by Lakes Environmental. This program generates wind rose statistics based on meteorological data. A wind rose depicts the frequency of occurrence of winds in each of the specified wind direction sectors and wind speed classes for a given location and time period. Figure 2-2 is an example of a wind rose. For this example, the wind speeds were separated into six different classes. The wind rose in Figure 2-2 illustrates that the winds most frequently originate from the east-southeast direction.

RSI-1924-10-018



**Figure 2-2.** Example Wind Rose Illustrating Wind Speed, Frequency, and Direction.



## 3.0 SITE ANALYSIS

The meteorological site analyses were performed using data from weather stations in Lead, South Dakota, and Spearfish, South Dakota. One year of recent data (January 1, 2009, to December 31, 2009) and 5 years of historical meteorological data (January 1, 2005, through December 31, 2009) were summarized as part of this investigation. Site data were obtained from High Plains Regional Climate Center (HPRCC), and parameters available from the meteorological station in Lead (temperature and precipitation) were used for both the recent analyses and the historical analyses. Heating and cooling degree-days, which are a function of temperature, were also used in recent and historical analyses. Data used from the Wharf Mine resources include temperature, relative humidity, and wind speed (January 1, 2005, to June 3, 2008). Wharf precipitation data were also incorporated into the analysis (January 1, 2005, to December 31, 2006, and January 1, 2009, to December 31, 2009). Additional desired parameters were obtained from the Spearfish station (dew point, relative humidity, wind speed, and barometric pressure). At the Spearfish station, only data from 2009 were available for analysis. Hourly data were available from both the Wharf and Spearfish sites, and daily data were available from the Lead site. Data were grouped at all three sites by month, day, and time, when available. The wind data and relative humidity data were also grouped seasonally. For this report, seasons were grouped as: winter (December, January, February), spring (March, April, May), summer (June, July, August), and fall (September, October, November).

### 3.1 TEMPERATURE

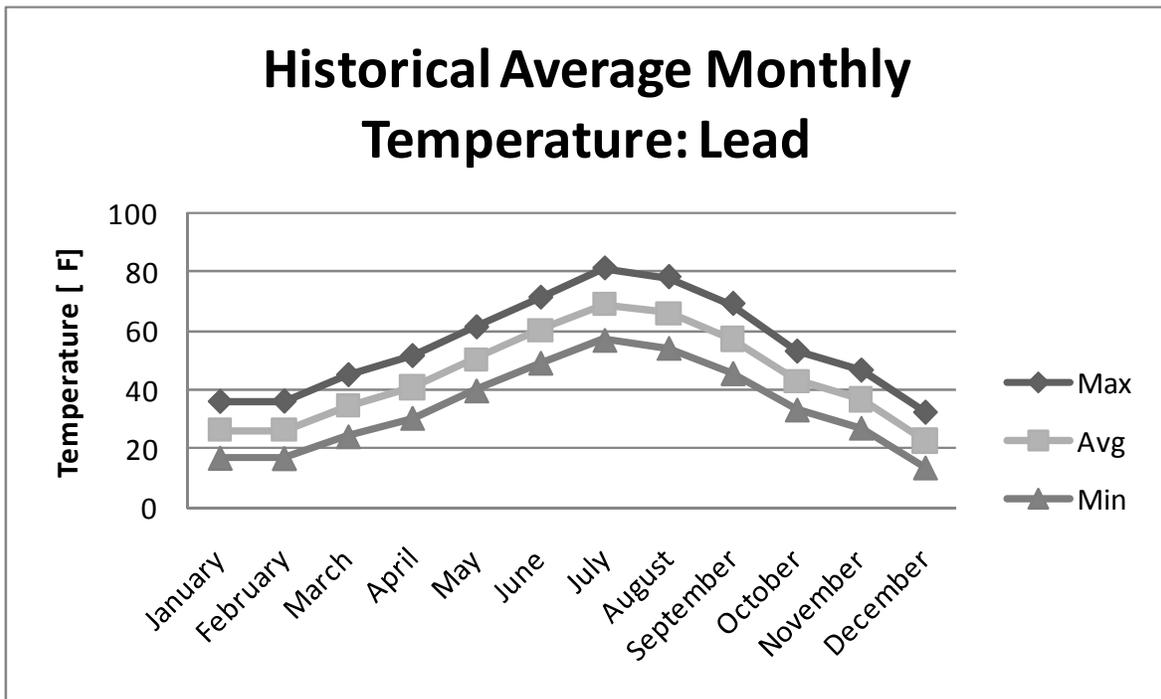
The 5-year average historical temperature for the Lead station was found to be (44.5°F), as shown in Table 3-1. Historical maximum, average, and minimum monthly temperatures are shown in Table 3-1 and in Figure 3-1. The warmest months historically occur within the summer months. The months having the highest average temperature and lowest average monthly temperature historically were July (69.1°F) and December (23.3°F), respectively.

Figure 3-2 provides a comparison of the maximum and minimum temperatures at the Lead and Wharf stations. The data compared include all temperature data from the Lead station from January 2005 through December 2009. Readily accessible Wharf temperature data were included, including all of the 2005 and 2006 data as well as data from June 2007 through June 2008, after which time, the Wharf station was disassembled. The Wharf temperature data tracks almost perfectly with the Lead data with minor variances of only a few degrees. This comparison demonstrates that the temperature at the Lead station serves as a suitable representation of conditions at the mine.

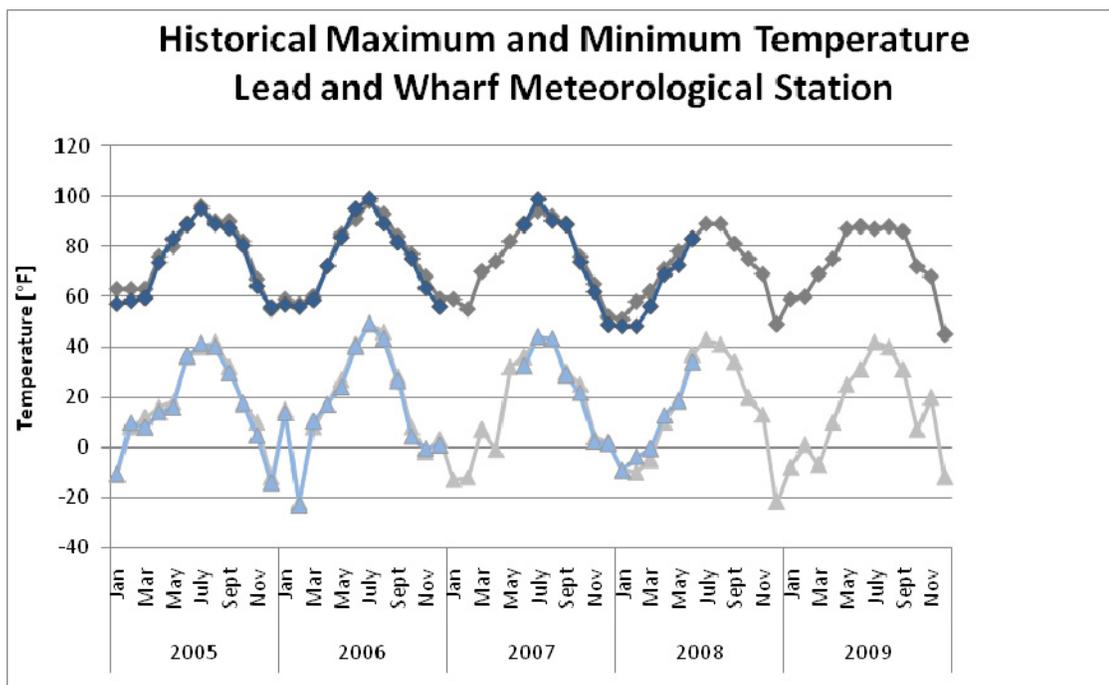
**Table 3-1. Maximum, Average, and Minimum Monthly and Annual Temperature for Lead, South Dakota, Meteorological Station in 2009 [High Plains Regional Climate Center, 2010]**

| Lead Historical (°F) | January | February | March | April | May  | June | July | August | September | October | November | December | Annual |
|----------------------|---------|----------|-------|-------|------|------|------|--------|-----------|---------|----------|----------|--------|
| Maximum Temperature  | 58.2    | 58.3     | 63.8  | 73.3  | 81.3 | 88.0 | 94.3 | 91.0   | 86.0      | 77.5    | 67.3     | 53.8     | 74.4   |
| Average Temperature  | 26.3    | 24.6     | 34.6  | 41.9  | 52.6 | 62.8 | 69.1 | 67.0   | 58.5      | 47.5    | 36.8     | 23.3     | 45.4   |
| Minimum Temperature  | -5.2    | -9.0     | 5.5   | 10.5  | 24.0 | 37.5 | 44.0 | 43.0   | 31.0      | 17.5    | 6.3      | -7.3     | 16.5   |

RSI-1924-10-019



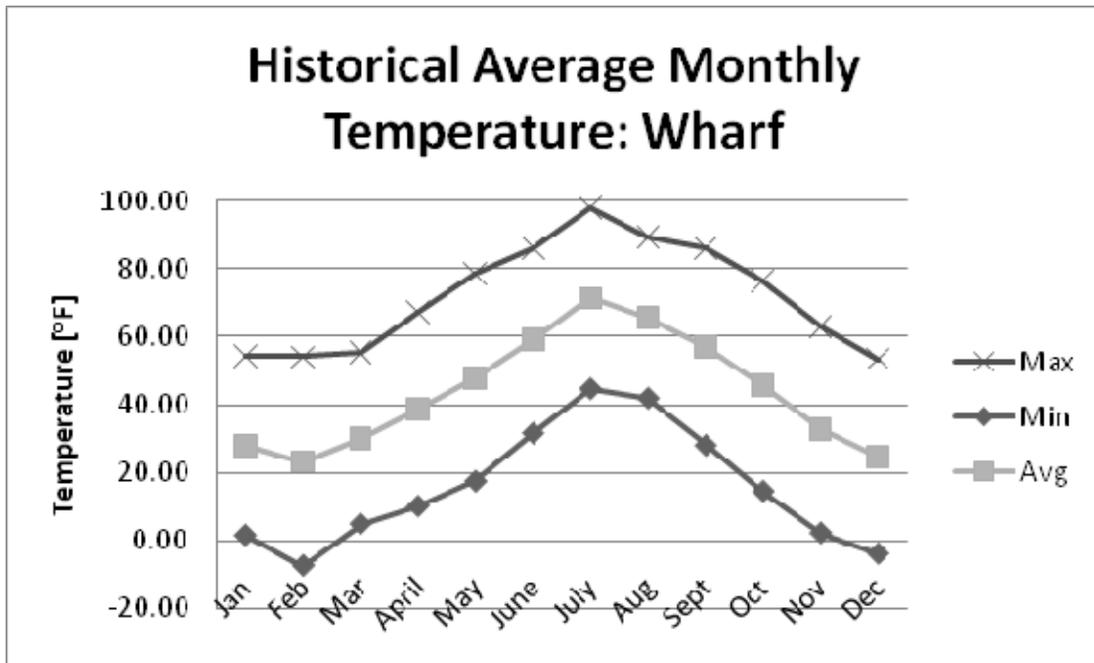
**Figure 3-1. Maximum, Average, and Minimum Monthly Temperatures Measured From January 1, 2005, to December 31, 2009, by the Meteorological Station in Lead, South Dakota [High Plains Regional Climate Center, 2010].**



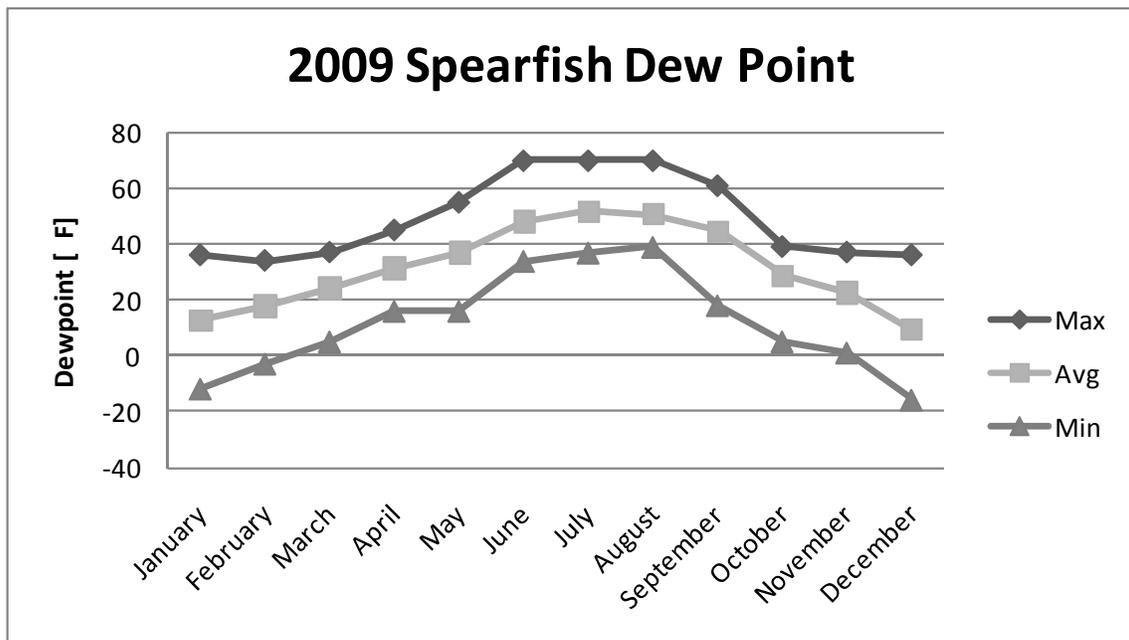
**Figure 3-2.** Comparison of Maximum and Minimum Monthly Temperatures Measured From January 1, 2005, to December 31, 2009, by the Meteorological Stations in Lead, South Dakota [High Plains Regional Climate Center, 2010] and Wharf Resources [Wharf Resources, 2006 and 2007; Waterland, 2010].

Historical maximum, average, and minimum monthly temperatures at the Wharf meteorological station are shown in Figure 3-3. Data from January 1, 2007, through May 11, 2007 were missing from the Wharf dataset. The months of January through May 2007 were not included in the historical average. The warmest months historically occur within the summer months. The months having the highest average temperature and lowest average monthly temperature historically were July (97.8°F) and February (-7.4°F), respectively.

Dew point is the temperature to which air must be cooled for water vapor to condense into water, or dew. Dew point temperatures were available from the Spearfish station in 2009. Figure 3-4 shows the maximum, average, and minimum dew point temperatures from the Spearfish station. As expected, maximum dew points occurred during summer months when air temperatures were high, while minimum dew points occurred during winter months when air temperatures were low. Dew point data were not available from the Lead site or the Wharf Mine site.



**Figure 3-3.** Maximum, Average, and Minimum Monthly Temperatures Measured From January 1, 2005, to June 3, 2008, With Missing Data From January 1, 2007, to May 11, 2007, From Wharf Resources [Wharf Resources, 2006 and 2007; Waterland, 2010].

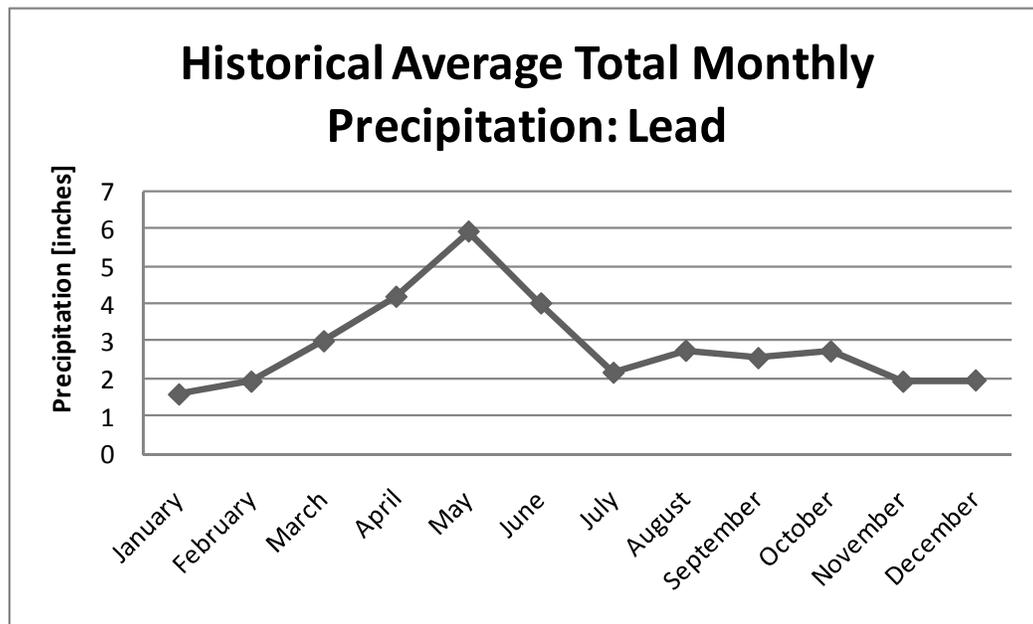


**Figure 3-4.** Maximum, Average, and Minimum Dew Points for Spearfish, South Dakota, in 2009 [Umphlett, 2010].

### 3.2 PRECIPITATION

From January 1, 2005, to December 31, 2009, the largest average monthly total precipitation amounts in the Lead area occurred during April, May, and June, as shown in Figure 3-5. Precipitation data from 2009 were also supplied from a rain gauge on site at Wharf. Historic precipitation data from the Wharf gauge was not analyzed. Figure 3-6 and Table 3-2 show that the Wharf precipitation data are quite comparable to the data of the Lead site, having the largest differences (> 1 inch) during March, May, and December.

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**Figure 3-5.** Average of Total Monthly Precipitation Which Occurred Each Month at the Lead, South Dakota, Meteorological Station for Years 2005–2009 [High Plains Regional Climate Center, 2010].

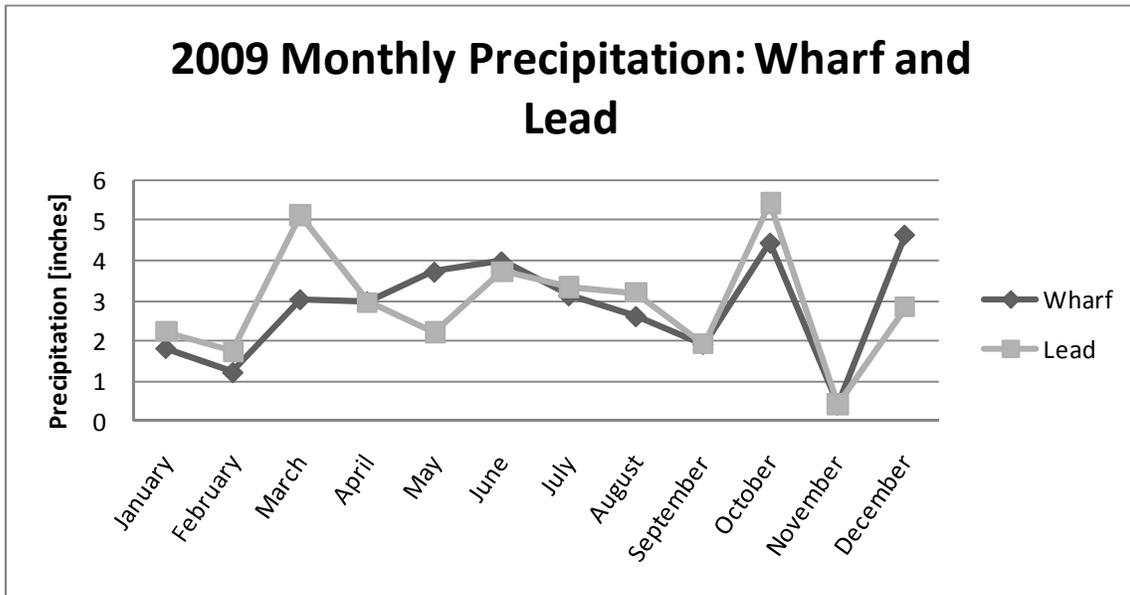
During the 5-year period analyzed, the Lead area received an average of 219.8 inches of snowfall per year. Graphs of recent and historical snowfall are shown in Figure 3-7. Although precipitation data were available for the Spearfish site, analysis was not completed because precipitation was not measured using melted snow depths and the Lead site is more representative of meteorological conditions near Wharf.

### 3.3 HEATING AND COOLING DEGREE-DAYS

Five-year analyses of heating and cooling degree-days for the Lead station are presented in Figures 3-8 and 3-9, respectively. Because of the small temperature differences and the proximity of the Lead site to the Wharf Mine, the Lead site heating and cooling days are used to represent the Wharf Mine site. Both heating and cooling degree-days used a base temperature of 65°F. Degree-days indicate the presence of deviation of the average daily temperature from

the base temperature selected. Heating degree-days were calculated by subtracting the average of the high and low daily temperature from the base temperature, while cooling degree-days were calculated by subtracting the base temperature from the average daily temperature. For both heating and cooling degree-days, calculated numbers less than or equal to zero are assumed to be zero.

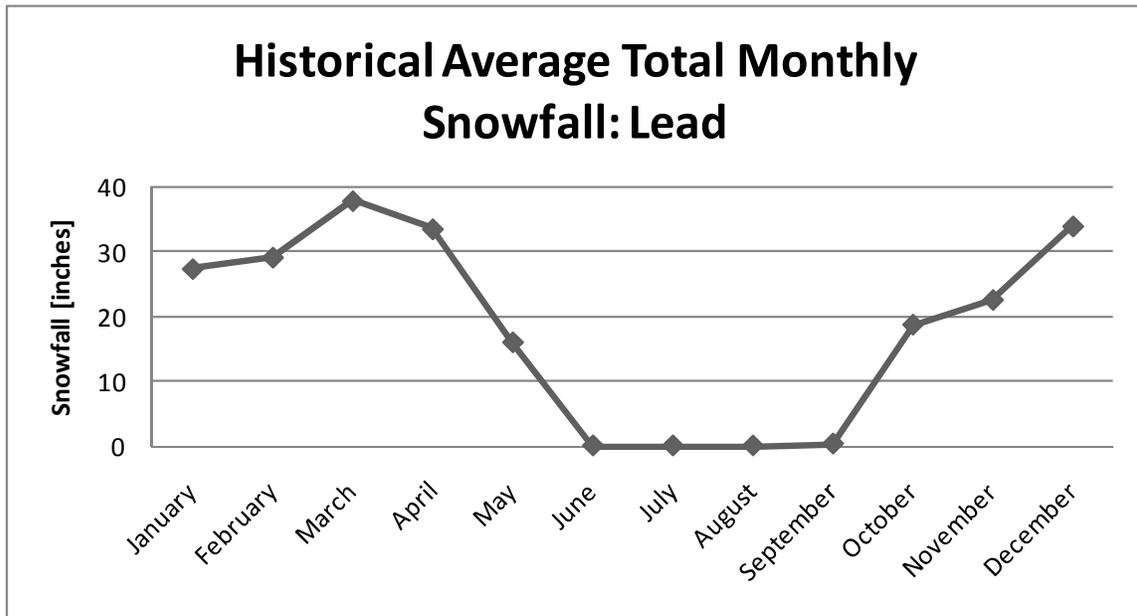
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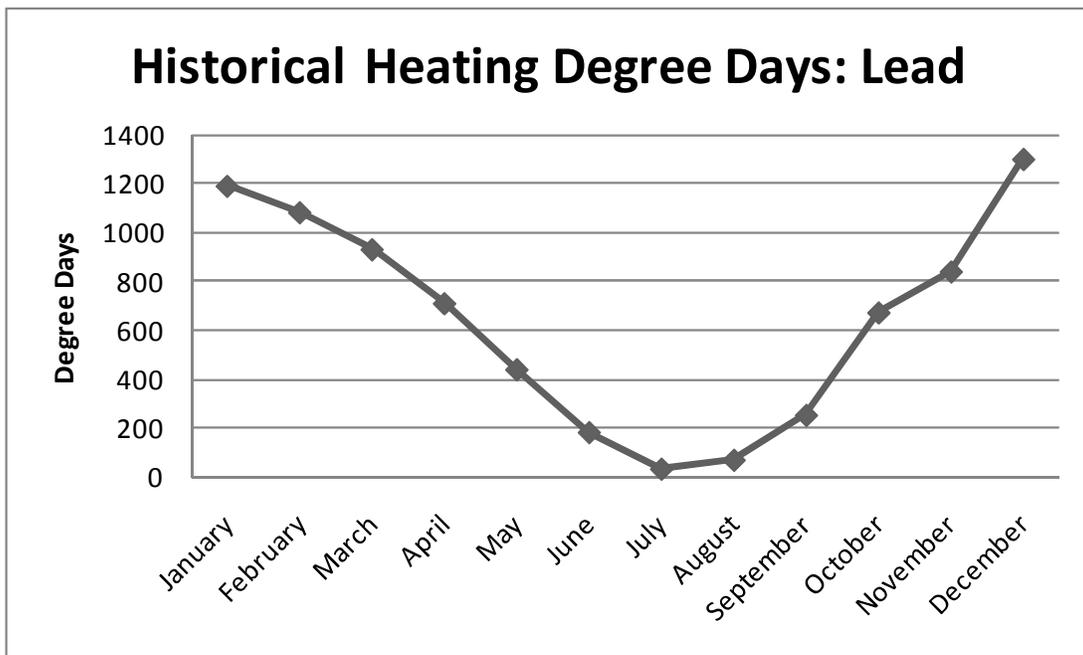
**Figure 3-6.** Total Precipitation Which Occurred Each Month at the Lead, South Dakota, and the Wharf, South Dakota, Meteorological Stations in 2009 [High Plains Regional Climate Center, 2010].

**Table 3-2. Comparison of Precipitation at Wharf On-Site Station and Lead Meteorological Station [Waterland, 2010; High Plains Regional Climate Center, 2010]**

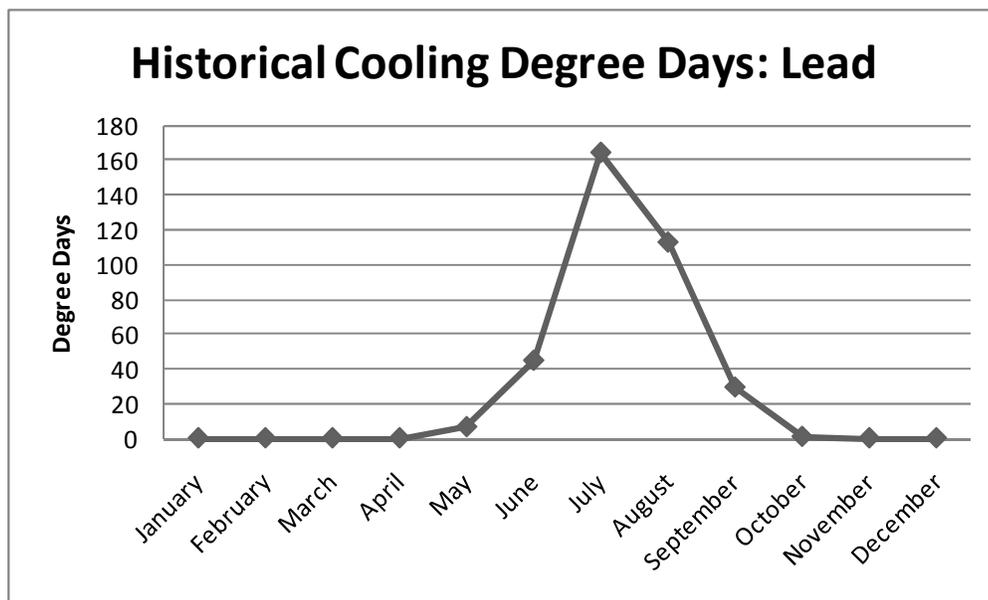
| Precipitation (inches) | January | February | March | April | May  | June | July | August | September | October | November | December |
|------------------------|---------|----------|-------|-------|------|------|------|--------|-----------|---------|----------|----------|
| Wharf                  | 1.81    | 1.21     | 3.03  | 2.98  | 3.72 | 3.98 | 3.13 | 2.61   | 1.92      | 4.45    | 0.4      | 4.65     |
| Lead                   | 2.22    | 1.73     | 5.12  | 2.95  | 2.2  | 3.73 | 3.33 | 3.2    | 1.91      | 5.44    | 0.41     | 2.84     |



**Figure 3-7.** Average of Total Monthly Snowfall Which Occurred Each Month at the Lead, South Dakota, Meteorological Station for Years 2005 Through 2009 [High Plains Regional Climate Center, 2010].



**Figure 3-8.** Historical Heating Degree-Days at the Lead, South Dakota, Meteorological Station [High Plains Regional Climate Center, 2010].



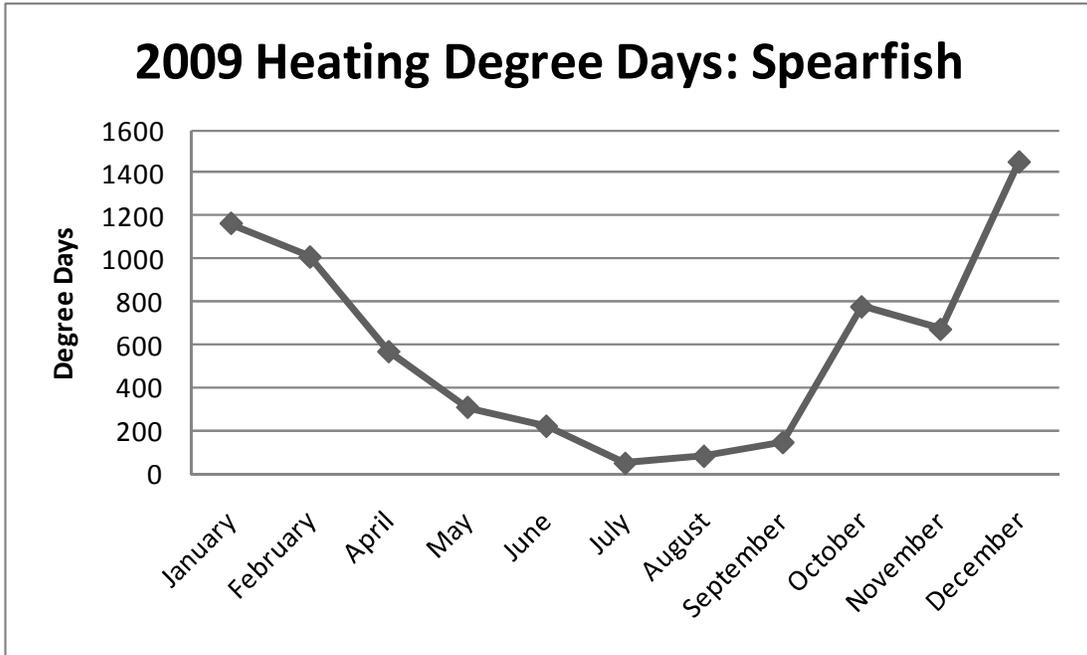
**Figure 3-9.** Historical Cooling Degree-Days at the Lead, South Dakota, Meteorological Station [High Plains Regional Climate Center, 2010].

The historical heating degree-days were highest during the winter months of December (1302°F), January (1191°F), and February (1084°F). The historical cooling degree days were peaked during June (45°F), July (164°F), and August (113°F) and were substantially warmer.

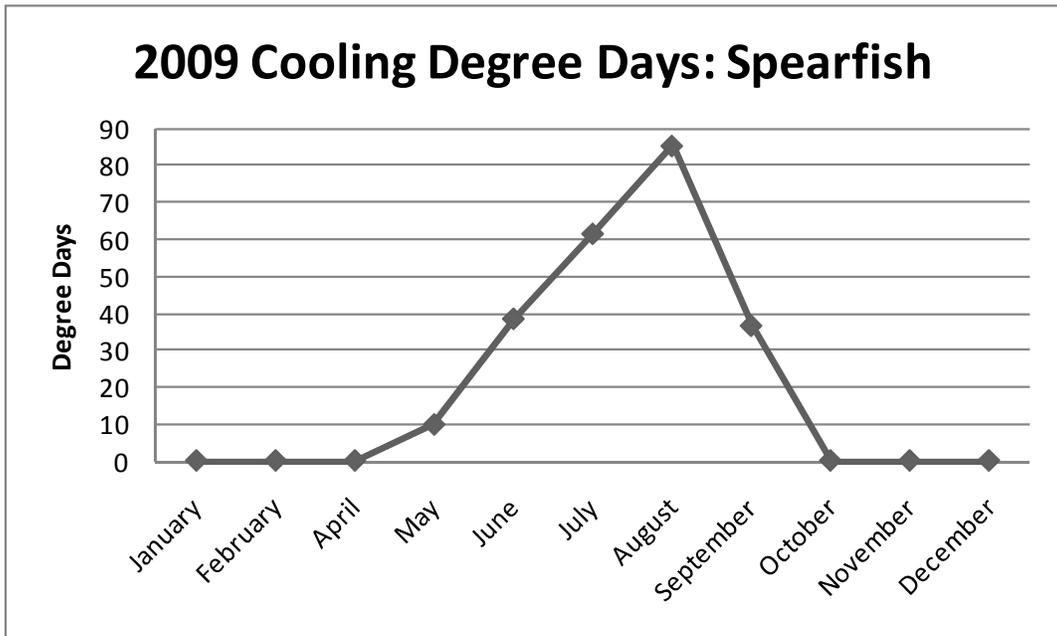
The Spearfish station does not have historical meteorological information, so only a 1-year analysis of heating degree-days (Figure 3-10) and cooling degree days (Figure 3-11) were calculated. March 9, 2009, through April 6, 2009, were missing from the Spearfish dataset. Thus March is not included in the graphs of Spearfish heating and cooling degree-days. The 2009 heating degree-days for Spearfish were the highest during the winter months of December (1452°F), January (1165°F), and February (1008°F). The 2009 cooling degree-days for Spearfish were highest during June (38°F), July (62°F), and August (85°F).

### 3.4 RELATIVE HUMIDITY

Relative humidity is the ratio of the amount of water vapor in the air at a specific temperature to the maximum amount of water vapor the air could hold. Relative humidity can be calculated using a location's dew point and temperature, assuming a standard atmospheric pressure. To calculate relative humidity, first the temperature and dew point need to be converted from degrees Fahrenheit ( $T_F$  and  $DP_F$ ) to degrees Celsius ( $T_C$  and  $DP_C$ ) using Equations 2-1 and 2-2.



**Figure 3-10.** Heating Degree-Days in 2009 at the Spearfish, South Dakota, Meteorological Station [Umphlett, 2010].



**Figure 3-11.** Cooling Degree-Days in 2009 at the Spearfish, South Dakota, Meteorological Station [Umphlett, 2010].

$$T_C = \frac{5}{9}(T_F - 32) \quad (2-1)$$

$$DP_C = \frac{5}{9}(DP_F - 32). \quad (2-2)$$

Once temperatures are in degrees Celsius, the saturation vapor pressure ( $E_s$ ) and the actual vapor pressure ( $E$ ) can be calculated using Equations 3 and 4.

$$E_s = (6.11) \left( 10^{\left( \frac{7.5T_C}{237.7+T_C} \right)} \right) \quad (2-3)$$

$$E = (6.11) \left( 10^{\left( \frac{7.5DP_C}{237.7+DP_C} \right)} \right). \quad (2-4)$$

Finally, relative humidity ( $RH$ ) can be computed using Equation 5.

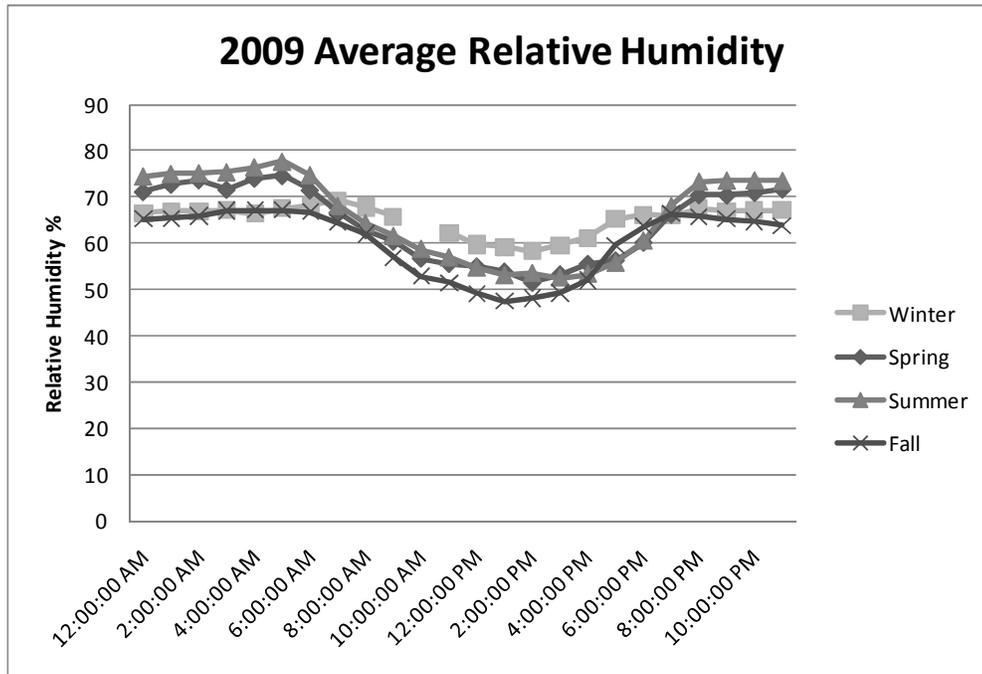
$$RH = \frac{E}{E_s}(100\%). \quad (2-5)$$

The seasonal average relative humidity for Spearfish is shown in Figure 3-12 by hour of day. During the summer, relative humidity for the Spearfish area was highest during the night time and early morning with the peak (77.7 percent) occurring at 5 a.m. During the winter, relative humidity was highest in the morning and evening with the peak (69.2 percent) occurring at 7 a.m. Overall, average monthly relative humidity was lowest during the fall (60.4 percent) and highest during the summer (66.0 percent).

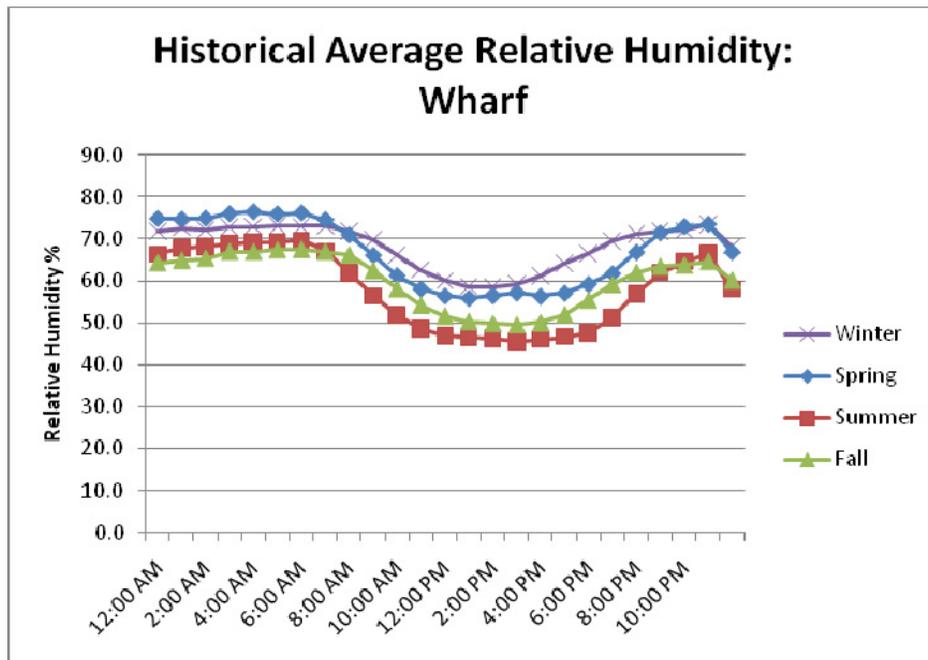
Historical relative humidity data were available from Wharf Resources. The historical average seasonal relative humidity is shown in Figure 3-13 by hour of day. During the summer, historical relative humidity for the Wharf Mine was highest during the night time and early morning with the peak (69.7 percent) occurring at 6 a.m. During the winter, historical relative humidity was highest in the morning and evening with the peak (73.5 percent) occurring at 11 p.m. Overall, average monthly relative humidity was lowest during the summer (58.0 percent) and highest during the winter (68.3 percent). Relative humidity was not computed for the Lead site because dew point or relative humidity data were not available.

### 3.5 BAROMETRIC PRESSURE

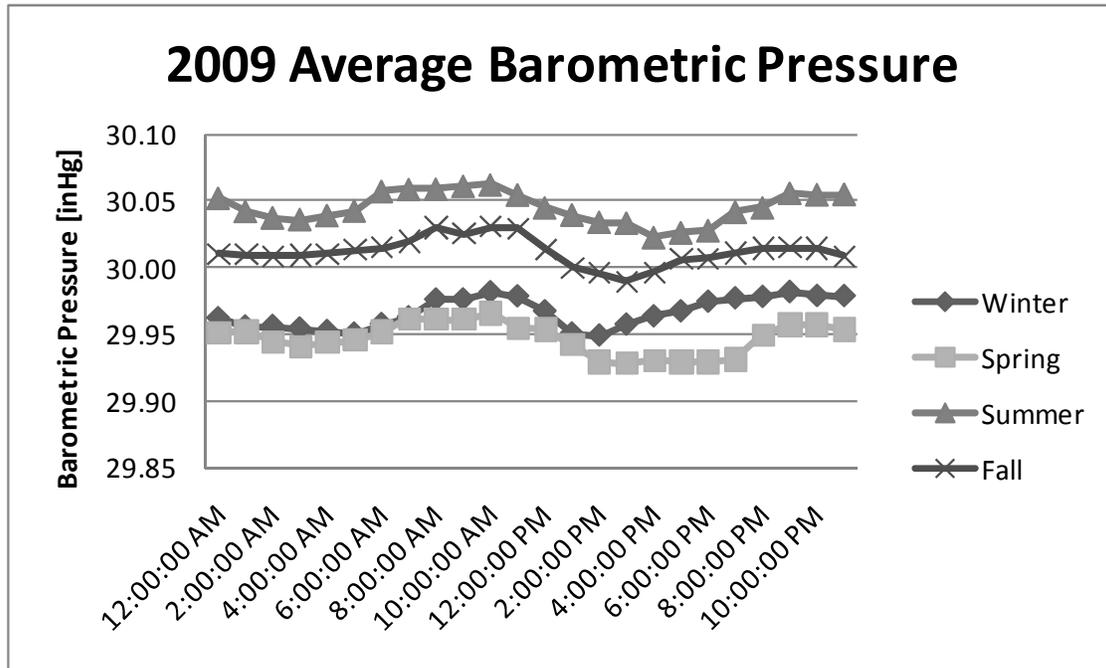
Barometric pressure is the force per unit area exerted by the air about the earth's surface. Recent barometric pressure data were available from the Spearfish station. A graph of the hourly data separated by seasons is shown in Figure 3-14. Overall, the 2009 average Spearfish barometric pressure was highest during summer and lowest during spring. The daily maximum (30.5 inHg) and minimum (29.2 inHg) pressure both occurred in February 2009. Barometric pressure data were not available for the Lead site or the Wharf Mine site.



**Figure 3-12.** Average Hourly Seasonal Relative Humidity for the Spearfish, South Dakota, Meteorological Station During 2009 [Umphlett, 2010].



**Figure 3-13.** Historical Average Hourly Seasonal Relative Humidity for the Wharf Mine From Wharf Resources [Wharf Resources, 2006 and 2007; Waterland, 2010].



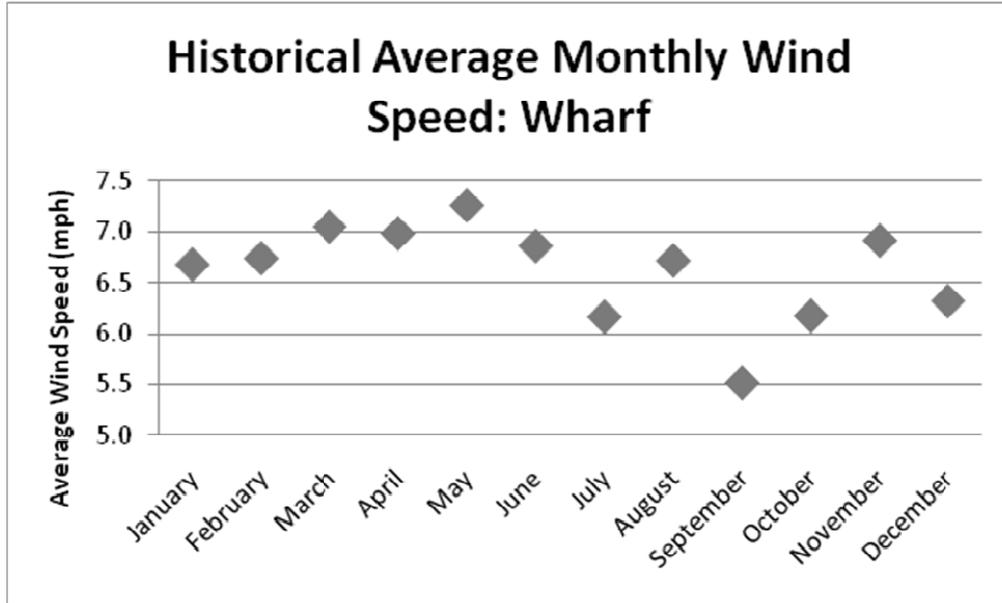
**Figure 3-14.** Average Hourly Seasonal Barometric Pressure for the Spearfish, South Dakota, Meteorological Station During 2009 [Umphlett, 2010].

### 3.6 WIND PATTERNS

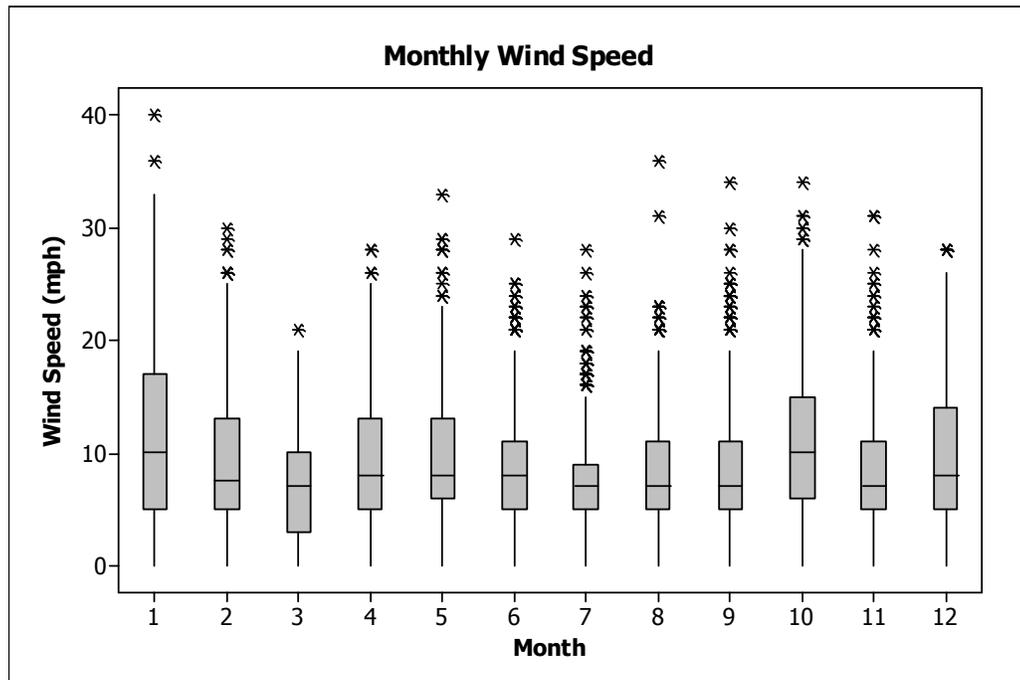
Historical wind speed data from the Wharf meteorological station were analyzed to show wind speed patterns. As shown in Figure 3-15, May was historically the windiest month at the Wharf Mine with an average wind speed of 7.3 miles per hour (mph). Historically, September is the calmest month with an average wind speed of 5.5 mph. The historical yearly average wind speed was found to be 6.6 mph. Wind speed data were not available for the Lead station.

Only recent 2009 wind data are available for the Spearfish station. The overall average wind speed at the Spearfish station in 2009 was 9.1 mph. The maximum wind speed (40 mph) and the maximum wind gust (60 mph) both occurred in January. A box plot of monthly wind speeds is shown in Figure 3-16; wind gusts are not included in the box plot.

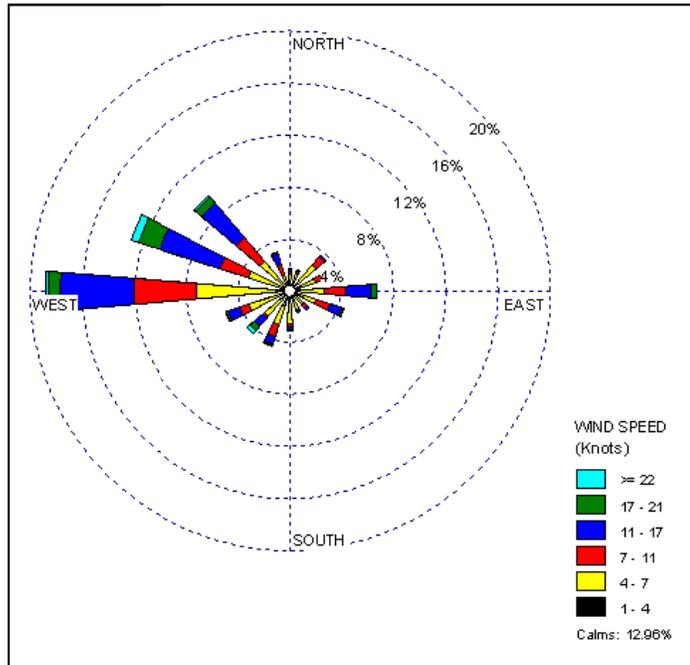
Wind roses were created for the Spearfish station using WRPLOT View Version 5.3 by Lakes Environmental. An overall 2009 wind rose for the Spearfish station is shown in Figure 3-17. Figure 3-17 demonstrates the majority of winds were out of the west and the northwest. The overall Spearfish 2009 wind class frequency distribution (Figure 3-18) shows the 4–7 knot (4.6–8.1 mph) wind class to be the most prevalent.



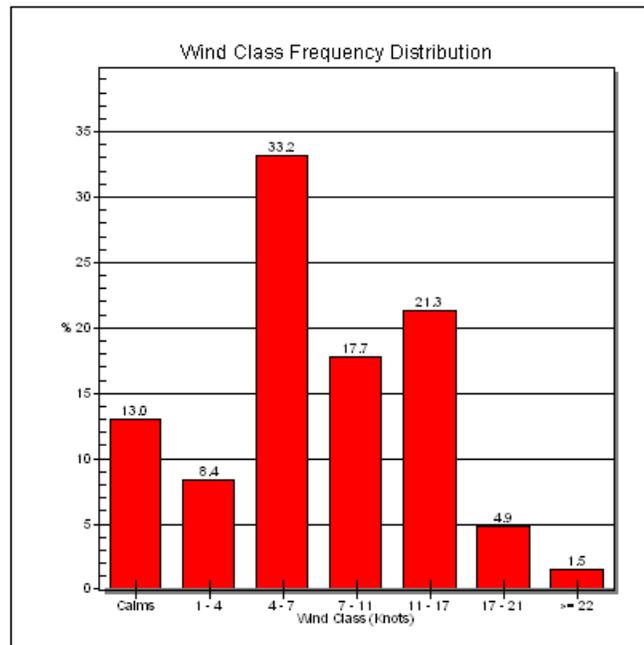
**Figure 3-15.** Plot of the Average Historical Wind Speed by Month From Wharf Resources [Wharf Resources, 2006 and 2007; Waterland, 2010].



**Figure 3-16.** Box Plot of Wind Speed by Month at Spearfish, South Dakota, for 2009 [Umphlett, 2010].



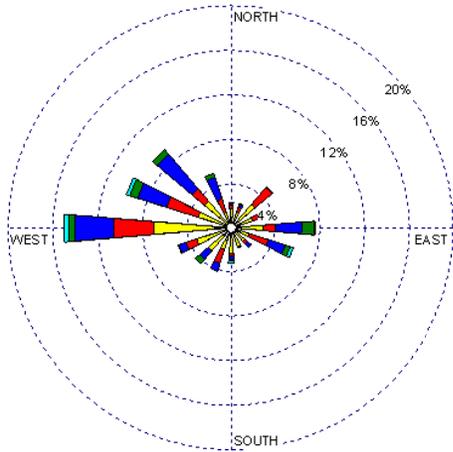
**Figure 3-17.** Overall 2009 Wind Rose for the Spearfish, South Dakota, Meteorological Station for 2009 [Umphlett, 2010].



**Figure 3-18.** Overall 2009 Wind Class Frequency Distribution for the Spearfish, South Dakota, Meteorological Station [Umphlett, 2010].

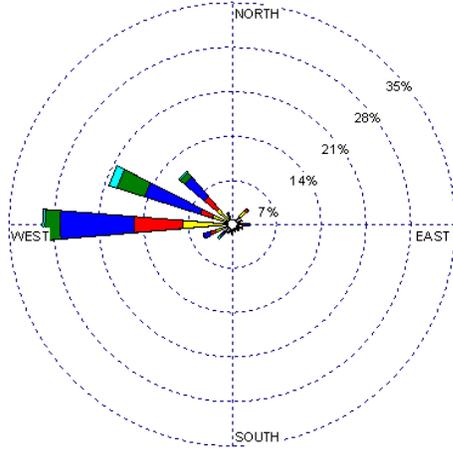
Seasonal wind roses were constructed for 2009 Spearfish data and are shown in Figure 3-19. Approximately 15 percent of the total winds originated from the west-northwest direction in the winter. Similarly, the most prevalent wind direction from which spring winds occurred (approximately 65 percent of total winds) was also west and northwest. Summer winds tended to be stronger and slightly more easterly than westerly (approximately 35 percent versus 30 percent of total winds, respectively). Finally, fall winds ranged mostly from northwest to southwest, with approximately 70 percent of total winds being more westerly than easterly. The Spearfish wind class frequency distribution for spring, summer, and fall presented the 4–7 knot wind class as the most prevalent, while the wind class frequency distribution for winter displayed both the 4–7 knot and the 11–17 knot wind classes as the most common (Figure 3-20).

According to the revised 1997 Clinton Project Mine Permit Application for Wharf, prevailing winds at the Wharf Mine during the early 1990s were westerly to southwesterly. During 2005 through early 2008, when the Wharf meteorological station was active, winds were predominantly directed from the west-southwest and occasionally from the south-southeast. Detailed historical meteorological data from the Wharf station, though not included here, have been provided in annual air quality reports submitted to the SD DENR. The difference between the Wharf wind data and the 2009 Spearfish wind data can be attributed to differences in topography.



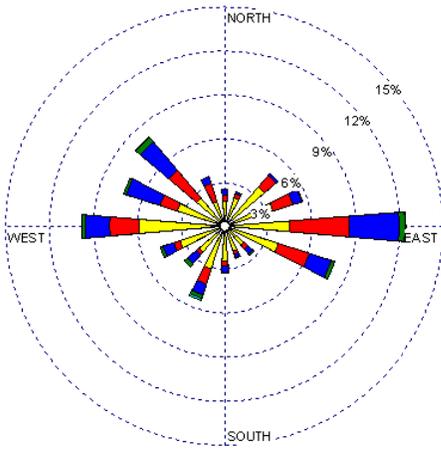
WIND SPEED (Knots)  
 ≥ 22  
 17 - 21  
 11 - 17  
 7 - 11  
 4 - 7  
 1 - 4  
 Calms: 13.34%

Winter



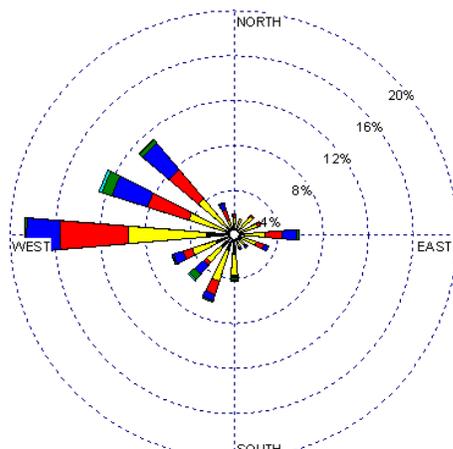
WIND SPEED (Knots)  
 ≥ 22  
 17 - 21  
 11 - 17  
 7 - 11  
 4 - 7  
 1 - 4  
 Calms: 11.03%

Spring



WIND SPEED (Knots)  
 ≥ 22  
 17 - 21  
 11 - 17  
 7 - 11  
 4 - 7  
 1 - 4  
 Calms: 13.48%

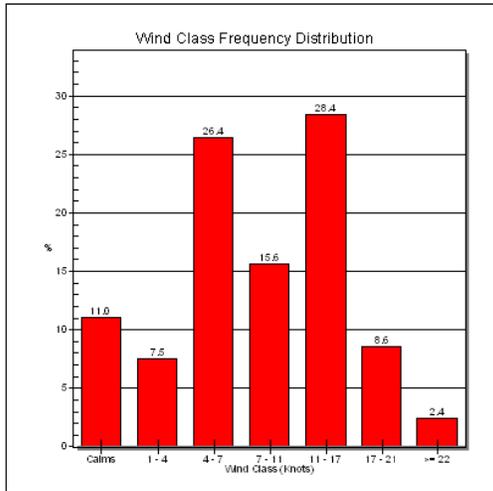
Summer



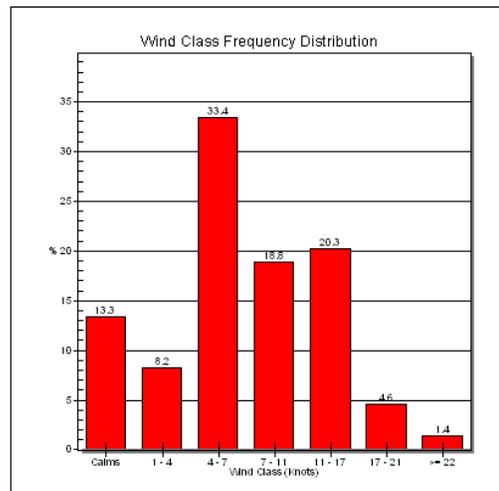
WIND SPEED (Knots)  
 ≥ 22  
 17 - 21  
 11 - 17  
 7 - 11  
 4 - 7  
 1 - 4  
 Calms: 11.83%

Fall

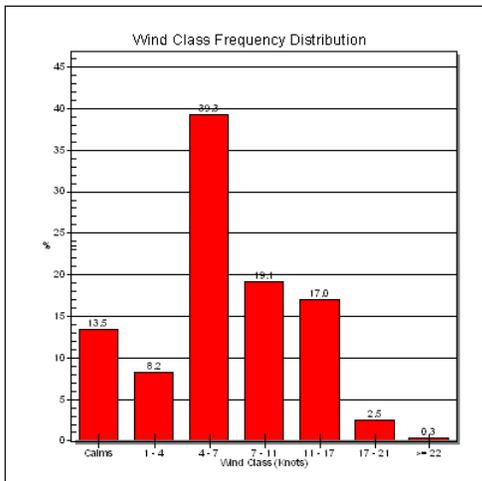
**Figure 3-19.** Winter, Spring, Summer, and Fall 2009 Wind Rose for the Spearfish, South Dakota, Meteorological Station [Umphlett, 2010].



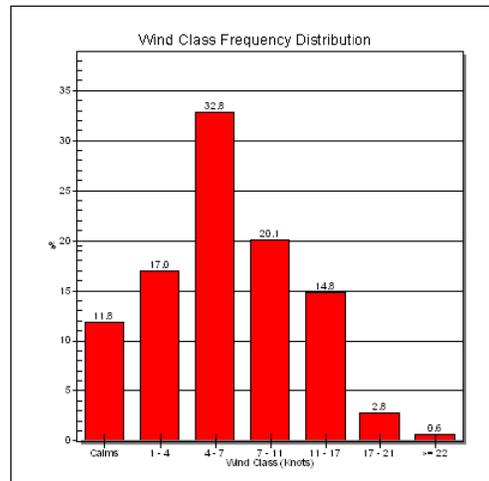
Winter



Spring



Fall



**Figure 3-20.** Winter, Spring, Summer, and Fall 2009 Wind Class Frequency Distributions for the Spearfish, South Dakota, Meteorological Station [Umphlett, 2010].



## 4.0 REPRESENTATIVENESS OF SPEARFISH, SOUTH DAKOTA, METEOROLOGICAL DATA

Average daily temperature and precipitation were key parameters available from the Lead station. Average daily temperature was available (2009 only) and calculated for the Spearfish station. Precipitation data, although available at Spearfish, were not measured using melted snow and statistics comparing this parameter between the two stations were not completed. A statistical comparison was completed on 2009 temperature data from the two locations to help determine whether the temperature conditions at Spearfish represent the conditions at the Lead and, in turn, the Wharf site.

To complete this analysis, basic statistics along with a Mann-Whitney test were performed using Minitab Software Version 14 to compare the temperature at the two stations. A Mann-Whitney test (also called a two-sample rank test or two-sample Wilcoxon rank sum test) is a nonparametric test that compares the equality of two population medians. The hypothesis is:

$$H_0 : \eta_1 = \eta_2 \text{ versus } H_1 : \eta_1 \neq \eta_2 \quad (4-1)$$

where:

$$\eta = \text{population median.}$$

The test was conducted at the 95 percent confidence interval. If the test is significant at 0.05 or greater, then the null hypothesis that the sample medians are equal is accepted.

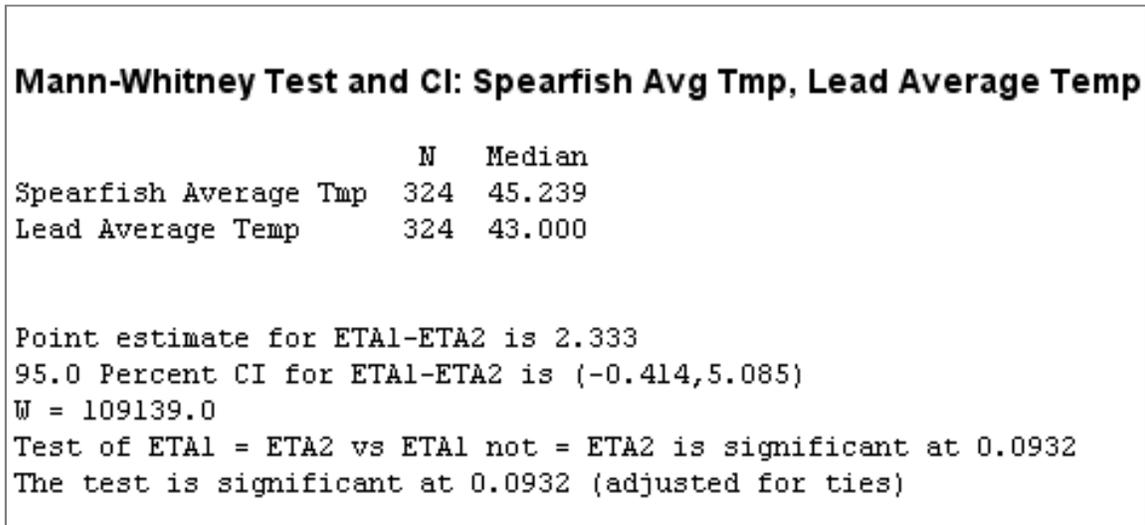
Table 4-1 displays the mean, median, maximum, minimum, and standard deviation for the average daily temperature and wind speed at the Spearfish and Lead stations. The Spearfish station was slightly warmer (mean average daily temperature of 44.9°F) than the Lead station (42.6°F). The results of the Mann-Whitney test generated by Minitab Software Version 14 for daily temperature are displayed in Figure 4-1. The test is significant at 0.0932, which is greater than the 0.05 required; hence, the null hypothesis stating the median temperature at the two sites is equal is accepted.

Spearfish average daily temperature data were shown to be representative of Lead. However, because other parameters were unavailable for statistical comparison, there is no way to conclude whether Spearfish dew point, humidity, wind speed, wind direction, and barometric pressure represent conditions near the Wharf site.

**Table 4-1. Average Daily Temperature Comparison Statistics for the Spearfish and Lead, South Dakota, Meteorological Stations [High Plains Regional Climate Center, 2010; Umphlett, 2010]**

|                    | <b>Spearfish Average Temperature (F)</b> | <b>Lead Average Temperature (F)</b> |
|--------------------|--|-------------------------------------|
| Mean               | 44.9                                     | 42.6                                |
| Median             | 45.2                                     | 43.0                                |
| Maximum            | 78.8                                     | 75.5                                |
| Minimum            | -1.0                                     | -4.0                                |
| Standard Deviation | 18.6                                     | 18.7                                |

RSI-1924-10-039



**Figure 4-1.** Results of Mann-Whitney Test for Average Daily Temperature Generated by Minitab Version 14 Statistical Software.

## 5.0 CONCLUSIONS AND RECOMMENDATIONS

The objective of this report was to satisfy SD DENR mining meteorological characterization requirements of describing the site meteorology and developing a meteorological monitoring plan (Administrative Rules of South Dakota 74:29:02:11(8)). This characterization of the meteorological conditions occurring near the Wharf site will assist Wharf Resources in gaining knowledge on fate and transport of any air-borne particulates associated with the site.

Data included in this baseline analysis were from both the Lead station and the Spearfish station. Data available from the Lead station (2005 through 2009) included temperature and precipitation, while available data from the Spearfish station (2009) included dew point, humidity, wind speed, wind direction, and barometric pressure. Because of data availability for the study period (2005 through 2009), recent data analysis (2009) was completed on both the Lead and Spearfish data, while historical data analysis (2005 through 2009) was only completed for the Lead station. Precipitation data from 2009 were also supplied from an on-site gauge at Wharf.

Based on the close proximity and representativeness of the data from the Lead station, it is recommended that no additional meteorological monitoring be necessary during operations at either Wharf or Golden Reward expansions. Although the Spearfish data are considered to be less representative of conditions near Wharf, it still serves as an important source of wind data.



## 6.0 REFERENCES

**High Plains Regional Climate Center, 2010.** *Climate Data Services*, retrieved January 21, 2010, from the World Wide Web at <http://www.hprcc.unl.edu/services/index.php?p=online>

**Umphlett, N., 2010.** Personal communication between N. Umphlett, High Plains Regional Climate Center, Lincoln, SD, and C. McCutcheon, RESPEC, Rapid City, SD, January 21.

**Waterland, R., 2010.** Personal communication between R. Waterland, Wharf Resources, Lead, SD, and C. Hocking, RESPEC, Rapid City, SD, April 2010.

**Wharf Resources, 2006.** *Annual Air Quality and Meteorological Data Summary of the Wharf Mine Project: January–December 2005*, prepared by Wharf Resources, Lead, SD, for South Dakota Department of Environment and Natural Resources, Pierre, SD.

**Wharf Resources, 2007.** *Annual Air Quality and Meteorological Data Summary of the Wharf Mine Project: January–December 2006*, prepared by Wharf Resources, Lead, SD, for South Dakota Department of Environment and Natural Resources, Pierre, SD.



**APPENDIX A**

**STATISTICAL REPORTS FOR THE LEAD, SOUTH DAKOTA,  
METEOROLOGICAL SITE**

**APPENDIX A  
STATISTICAL REPORTS FOR THE LEAD, SOUTH DAKOTA,  
METEOROLOGICAL SITE**

**Table A-1. 2005–2009 Temperatures (°F) for Lead, South Dakota**

| <b>Month</b> | <b><i>N</i></b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|--------------|-----------------|----------------|----------------|---------------|----------------|
| January      | 155             | 35.8           | 26.3           | 12.4          | 16.8           |
| February     | 141             | 35.9           | 26.3           | 11.3          | 16.7           |
| March        | 154             | 44.9           | 34.5           | 10.7          | 24.1           |
| April        | 149             | 51.3           | 40.8           | 10.9          | 30.4           |
| May          | 151             | 61.1           | 50.4           | 9.7           | 39.7           |
| June         | 150             | 71.1           | 60.1           | 8.3           | 49.1           |
| July         | 155             | 81.0           | 68.9           | 6.8           | 56.9           |
| August       | 155             | 78.0           | 66.1           | 6.8           | 54.2           |
| September    | 150             | 69.0           | 57.3           | 9.1           | 45.6           |
| October      | 155             | 52.8           | 43.0           | 11.0          | 33.2           |
| November     | 150             | 46.4           | 36.7           | 10.5          | 27.0           |
| December     | 155             | 32.2           | 22.8           | 12.6          | 13.5           |
| <b>Total</b> | <b>1,820</b>    | <b>55.0</b>    | <b>44.5</b>    | <b>18.4</b>   | <b>34.0</b>    |

**Table A-2. 2009 Temperatures (°F) for Lead, South Dakota**

| <b>Month</b> | <b><i>N</i></b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|--------------|-----------------|----------------|----------------|---------------|----------------|
| January      | 31              | 35.8           | 25.4           | 12.9          | 14.9           |
| February     | 28              | 38.0           | 28.2           | 9.4           | 18.3           |
| March        | 31              | 44.5           | 32.6           | 13.6          | 20.7           |
| April        | 30              | 48.4           | 38.8           | 10.7          | 29.2           |
| May          | 27              | 64.1           | 51.9           | 8.3           | 39.7           |
| June         | 30              | 66.1           | 56.4           | 9.6           | 46.7           |
| July         | 31              | 74.4           | 63.1           | 4.7           | 51.7           |
| August       | 31              | 74.8           | 62.8           | 6.5           | 50.8           |
| September    | 30              | 72.1           | 59.9           | 7.8           | 47.6           |
| October      | 31              | 42.5           | 34.9           | 9.9           | 27.3           |
| November     | 30              | 49.3           | 39.5           | 7.4           | 29.7           |
| December     | 31              | 25.7           | 17.1           | 12.5          | 8.5            |
| <b>Total</b> | <b>361</b>      | <b>52.9</b>    | <b>42.5</b>    | <b>18.0</b>   | <b>32.1</b>    |

**Table A-3. 2005–2009 Monthly Precipitation for Lead, South Dakota (Page 1 of 3)**

| <b>Year/Month</b> | <b>N</b>   | <b>Sum of Precipitation</b> |
|-------------------|------------|-----------------------------|
| <i>2005</i>       |            |                             |
| January           | 31         | 0.92                        |
| February          | 28         | 0.52                        |
| March             | 31         | 2.23                        |
| April             | 30         | 3.56                        |
| May               | 31         | 6.97                        |
| June              | 30         | 3.12                        |
| July              | 30         | 1.22                        |
| August            | 31         | 2.75                        |
| September         | 30         | 1.5                         |
| October           | 31         | 2.75                        |
| November          | 30         | 2.15                        |
| December          | 31         | 2.38                        |
| <b>Total</b>      | <b>364</b> | <b>30.07</b>                |
| <i>2006</i>       |            |                             |
| January           | 31         | 1.09                        |
| February          | 28         | 3.03                        |
| March             | 31         | 2.57                        |
| April             | 30         | 9                           |
| May               | 31         | 4.01                        |
| June              | 30         | 0.82                        |
| July              | 31         | 1.01                        |
| August            | 31         | 1.96                        |
| September         | 30         | 6.77                        |
| October           | 31         | 1.78                        |
| November          | 30         | 1.03                        |
| December          | 31         | 0.24                        |
| <b>Total</b>      | <b>365</b> | <b>33.31</b>                |

**Table A-3. 2005–2009 Monthly Precipitation for Lead, South Dakota (Page 2 of 3)**

| <b>Year/Month</b> | <b>N</b>   | <b>Sum of Precipitation</b> |
|-------------------|------------|-----------------------------|
| <i>2007</i>       |            |                             |
| January           | 31         | 1.58                        |
| February          | 28         | 2.18                        |
| March             | 31         | 2.84                        |
| April             | 30         | 1.96                        |
| May               | 31         | 6.27                        |
| June              | 30         | 6.42                        |
| July              | 31         | 2.65                        |
| August            | 31         | 2.98                        |
| September         | 30         | 0.79                        |
| October           | 31         | 1.75                        |
| November          | 30         | 0.44                        |
| December          | 31         | 2.34                        |
| <b>Total</b>      | <b>365</b> | <b>32.2</b>                 |
| <i>2008</i>       |            |                             |
| January           | 31         | 2.1                         |
| February          | 29         | 2.17                        |
| March             | 30         | 2.26                        |
| April             | 29         | 3.47                        |
| May               | 31         | 10.18                       |
| June              | 30         | 5.98                        |
| July              | 31         | 2.61                        |
| August            | 31         | 2.85                        |
| September         | 30         | 1.79                        |
| October           | 31         | 1.94                        |
| November          | 30         | 5.58                        |
| December          | 31         | 1.99                        |
| <b>Total</b>      | <b>364</b> | <b>42.92</b>                |

**Table A-3. Monthly Precipitation for Lead, South Dakota, 2005–2009 (Page 3 of 3)**

| <b>Year/Month</b>      | <b><i>N</i></b> | <b>Sum of Precipitation</b> |
|------------------------|-----------------|-----------------------------|
| <i>2009</i>            |                 |                             |
| January                | 31              | 2.22                        |
| February               | 28              | 1.73                        |
| March                  | 31              | 5.12                        |
| April                  | 30              | 2.95                        |
| May                    | 28              | 2.2                         |
| June                   | 30              | 3.73                        |
| July                   | 31              | 3.33                        |
| August                 | 31              | 3.2                         |
| September              | 30              | 1.91                        |
| October                | 31              | 5.44                        |
| November               | 30              | 0.41                        |
| December               | 31              | 2.84                        |
| <b>Total</b>           | <b>362</b>      | <b>35.08</b>                |
| <b>2005–2009 Total</b> | <b>1,820</b>    | <b>173.58</b>               |

**Table A-4. 2005–2009 Average Total Precipitation for Lead, South Dakota**

| <b>Month</b> | <b>N</b>  | <b>Average</b> | <b>StdDev</b> |
|--------------|-----------|----------------|---------------|
| January      | 5         | 1.6            | 0.6           |
| February     | 5         | 1.9            | 0.9           |
| March        | 5         | 3.0            | 1.2           |
| April        | 5         | 4.2            | 2.8           |
| May          | 5         | 5.9            | 3.0           |
| June         | 5         | 4.0            | 2.3           |
| July         | 5         | 2.2            | 1.0           |
| August       | 5         | 2.7            | 0.5           |
| September    | 5         | 2.6            | 2.4           |
| October      | 5         | 2.7            | 1.6           |
| November     | 5         | 1.9            | 2.2           |
| December     | 5         | 2.0            | 1.0           |
| <b>Total</b> | <b>60</b> | <b>2.9</b>     | <b>2.0</b>    |

**Table A-5. 2005–2009 Total Precipitation for Lead, South Dakota**

| <b>Month</b> | <b>N</b>   | <b>Sum</b>   |
|--------------|------------|--------------|
| January      | 31         | 2.22         |
| February     | 28         | 1.73         |
| March        | 31         | 5.12         |
| April        | 30         | 2.95         |
| May          | 28         | 2.2          |
| June         | 30         | 3.73         |
| July         | 31         | 3.33         |
| August       | 31         | 3.2          |
| September    | 30         | 1.91         |
| October      | 31         | 5.44         |
| November     | 30         | 0.41         |
| December     | 31         | 2.84         |
| <b>Total</b> | <b>362</b> | <b>35.08</b> |

**Table A-6. 2005–2009 Monthly Snowfall for Lead, South Dakota (Page 1 of 3)**

| <b>Year/Month</b> | <b><i>N</i></b> | <b>Sum of Snowfall<br/>(inches)</b> |
|-------------------|-----------------|-------------------------------------|
| <i>2005</i>       |                 |                                     |
| January           | 30              | 15.6                                |
| February          | 28              | 6.4                                 |
| March             | 31              | 23.2                                |
| April             | 30              | 10.9                                |
| May               | 31              | 2.3                                 |
| June              | 30              | 0                                   |
| July              | 31              | 0                                   |
| August            | 31              | 0                                   |
| September         | 30              | 0                                   |
| October           | 31              | 10.4                                |
| November          | 30              | 31.4                                |
| December          | 31              | 33.9                                |
| <b>Total</b>      | <b>364</b>      | <b>134.1</b>                        |
| <i>2006</i>       |                 |                                     |
| January           | 31              | 8.8                                 |
| February          | 28              | 45.4                                |
| March             | 31              | 29.5                                |
| April             | 30              | 82.7                                |
| May               | 31              | 14                                  |
| June              | 30              | 0                                   |
| July              | 31              | 0                                   |
| August            | 31              | 0                                   |
| September         | 28              | 1.5                                 |
| October           | 31              | 13.5                                |
| November          | 30              | 10.6                                |
| December          | 31              | 2.5                                 |
| <b>Total</b>      | <b>363</b>      | <b>208.5</b>                        |

**Table A-6. 2005–2009 Monthly Snowfall for Lead, South Dakota (Page 2 of 3)**

| <b>Year/Month</b> | <b>N</b>   | <b>Sum of Snowfall<br/>(inches)</b> |
|-------------------|------------|-------------------------------------|
| <i>2007</i>       |            |                                     |
| January           | 31         | 34                                  |
| February          | 28         | 29.6                                |
| March             | 31         | 26.2                                |
| April             | 30         | 12.4                                |
| May               | 31         | 0                                   |
| June              | 30         | 0                                   |
| July              | 31         | 0                                   |
| August            | 31         | 0                                   |
| September         | 30         | 0                                   |
| October           | 31         | 3                                   |
| November          | 30         | 5.8                                 |
| December          | 31         | 36.9                                |
| <b>Total</b>      | <b>365</b> | <b>147.9</b>                        |
| <i>2008</i>       |            |                                     |
| January           | 31         | 49                                  |
| February          | 29         | 41.9                                |
| March             | 29         | 20.8                                |
| April             | 29         | 34.8                                |
| May               | 31         | 61.6                                |
| June              | 30         | 0                                   |
| July              | 31         | 0                                   |
| August            | 31         | 0                                   |
| September         | 30         | 0                                   |
| October           | 31         | 13.6                                |
| November          | 30         | 61.7                                |
| December          | 31         | 33.8                                |
| <b>Total</b>      | <b>363</b> | <b>317.2</b>                        |

**Table A-6. 2005–2009 Monthly Snowfall for Lead, South Dakota (Page 3 of 3)**

| <b>Year/Month</b>      | <b><i>N</i></b> | <b>Sum of Snowfall<br/>(inches)</b> |
|------------------------|-----------------|-------------------------------------|
| <i>2009</i>            |                 |                                     |
| January                | 31              | 29.6                                |
| February               | 28              | 22.5                                |
| March                  | 31              | 90                                  |
| April                  | 30              | 27.1                                |
| May                    | 26              | 2.2                                 |
| June                   | 30              | 0                                   |
| July                   | 31              | 0                                   |
| August                 | 31              | 0                                   |
| September              | 30              | 0                                   |
| October                | 31              | 53.3                                |
| November               | 30              | 3.5                                 |
| December               | 31              | 63                                  |
| <b>Total</b>           | <b>360</b>      | <b>291.2</b>                        |
| <b>2005–2009 Total</b> | <b>1,815</b>    | <b>1,098.9</b>                      |

**Table A-7. 2005–2009 Average Total Snowfall (Inches) for Lead, South Dakota**

| Month        | <i>N</i>  | Average     | StdDev      |
|--------------|-----------|-------------|-------------|
| January      | 5         | 27.4        | 15.8        |
| February     | 5         | 29.2        | 15.7        |
| March        | 5         | 37.9        | 29.3        |
| April        | 5         | 33.6        | 29.2        |
| May          | 5         | 16.0        | 26.1        |
| June         | 5         | 0.0         | 0.0         |
| July         | 5         | 0.0         | 0.0         |
| August       | 5         | 0.0         | 0.0         |
| September    | 5         | 0.3         | 0.7         |
| October      | 5         | 18.8        | 19.8        |
| November     | 5         | 22.6        | 24.5        |
| December     | 5         | 34.0        | 21.5        |
| <b>Total</b> | <b>60</b> | <b>18.3</b> | <b>22.3</b> |

**Table A-8. 2009 Total Snowfall (Inches) for Lead, South Dakota**

| Month        | <i>N</i>   | Sum          |
|--------------|------------|--------------|
| January      | 31         | 29.6         |
| February     | 28         | 22.5         |
| March        | 31         | 90.0         |
| April        | 30         | 27.1         |
| May          | 26         | 2.2          |
| June         | 30         | 0.0          |
| July         | 31         | 0.0          |
| August       | 31         | 0.0          |
| September    | 30         | 0.0          |
| October      | 31         | 53.3         |
| November     | 30         | 3.5          |
| December     | 31         | 63.0         |
| <b>Total</b> | <b>360</b> | <b>291.2</b> |

**Table A-9. Total Heating Degree-Days (°F) in 2009 for Lead, South Dakota**

| <b>Month</b> | <b><i>N</i></b> | <b>Sum</b>   |
|--------------|-----------------|--------------|
| January      | 31              | 1,221        |
| February     | 28              | 1022         |
| March        | 31              | 994          |
| April        | 30              | 778          |
| May          | 27              | 357          |
| June         | 30              | 275          |
| July         | 31              | 87           |
| August       | 31              | 118          |
| September    | 30              | 177          |
| October      | 31              | 925          |
| November     | 30              | 760          |
| December     | 31              | 1,479        |
| <b>Total</b> | <b>361</b>      | <b>8,193</b> |

**Table A-10. Total Cooling Degree-Days (°F) in 2009 for Lead, South Dakota**

| <b>Month</b> | <b><i>N</i></b> | <b>Sum</b> |
|--------------|-----------------|------------|
| January      | 31              | 0          |
| February     | 28              | 0          |
| March        | 31              | 0          |
| April        | 30              | 0          |
| May          | 27              | 9          |
| June         | 30              | 25         |
| July         | 31              | 36         |
| August       | 31              | 59         |
| September    | 30              | 29         |
| October      | 31              | 0          |
| November     | 30              | 0          |
| December     | 31              | 0          |
| <b>Total</b> | <b>361</b>      | <b>158</b> |

**APPENDIX B**

**STATISTICAL REPORTS FOR THE SPEARFISH, SOUTH DAKOTA,  
METEOROLOGICAL SITE**

## APPENDIX B

### STATISTICAL REPORTS FOR THE SPEARFISH, SOUTH DAKOTA, METEOROLOGICAL SITE

**Table B-1. 2009 Dew Point (°F) for Spearfish, South Dakota**

| <b>Month</b> | <b><i>N</i></b> | <b>Maximum</b> | <b>Average</b>  | <b>StdDev of Dew Point</b> | <b>Minimum</b> |
|--------------|-----------------|----------------|-----------------|----------------------------|----------------|
| January      | 737             | 36             | 12.7924         | 11.11765                   | -12            |
| February     | 663             | 34             | 17.63952        | 8.226481                   | -3             |
| March        | 183             | 37             | 24.13187        | 8.007881                   | 5              |
| April        | 588             | 45             | 31.2619         | 5.226011                   | 16             |
| May          | 557             | 55             | 36.67325        | 7.365891                   | 16             |
| June         | 637             | 70             | 48.02987        | 6.960681                   | 34             |
| July         | 697             | 70             | 51.59971        | 6.330382                   | 37             |
| August       | 700             | 70             | 50.64429        | 6.344252                   | 39             |
| September    | 663             | 61             | 44.49774        | 8.56182                    | 18             |
| October      | 630             | 39             | 28.69841        | 7.570621                   | 5              |
| November     | 637             | 37             | 22.48352        | 5.545563                   | 1              |
| December     | 736             | 36             | 9.222826        | 10.98555                   | -16            |
| <b>Total</b> | <b>7,428</b>    | <b>70</b>      | <b>31.64274</b> | <b>16.93359</b>            | <b>-16</b>     |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota (Page 1 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|----------|----------------|----------------|---------------|----------------|
| 12 a.m.           | 312      | 30.42          | 30.00          | 0.19          | 29.35          |
| January           | 31       | 30.40          | 29.99          | 0.27          | 29.47          |
| February          | 28       | 30.32          | 29.94          | 0.22          | 29.35          |
| March             | 8        | 30.42          | 29.86          | 0.26          | 29.57          |
| April             | 23       | 30.26          | 29.94          | 0.16          | 29.64          |
| May               | 22       | 30.31          | 30.00          | 0.18          | 29.68          |
| June              | 27       | 30.33          | 29.99          | 0.15          | 29.67          |
| July              | 31       | 30.29          | 30.09          | 0.12          | 29.81          |
| August            | 30       | 30.31          | 30.06          | 0.14          | 29.80          |
| September         | 29       | 30.31          | 30.07          | 0.17          | 29.63          |
| October           | 25       | 30.33          | 29.94          | 0.21          | 29.47          |
| November          | 27       | 30.33          | 30.02          | 0.19          | 29.67          |
| December          | 31       | 30.22          | 29.96          | 0.17          | 29.65          |
| 1 a.m.            | 311      | 30.38          | 29.99          | 0.19          | 29.36          |
| January           | 30       | 30.37          | 29.98          | 0.27          | 29.48          |
| February          | 28       | 30.32          | 29.93          | 0.22          | 29.36          |
| March             | 9        | 30.38          | 29.87          | 0.24          | 29.56          |
| April             | 23       | 30.32          | 29.94          | 0.19          | 29.62          |
| May               | 22       | 30.31          | 29.99          | 0.18          | 29.67          |
| June              | 26       | 30.32          | 29.97          | 0.15          | 29.67          |
| July              | 30       | 30.30          | 30.09          | 0.12          | 29.82          |
| August            | 30       | 30.31          | 30.05          | 0.14          | 29.78          |
| September         | 29       | 30.31          | 30.07          | 0.18          | 29.61          |
| October           | 26       | 30.33          | 29.94          | 0.21          | 29.44          |
| November          | 27       | 30.32          | 30.01          | 0.19          | 29.65          |
| December          | 31       | 30.22          | 29.95          | 0.17          | 29.63          |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota (Page 2 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|----------|----------------|----------------|---------------|----------------|
| 2 a.m.            | 312      | 30.37          | 29.99          | 0.19          | 29.38          |
| January           | 30       | 30.37          | 29.98          | 0.26          | 29.47          |
| February          | 27       | 30.33          | 29.93          | 0.23          | 29.38          |
| March             | 9        | 30.35          | 29.86          | 0.24          | 29.55          |
| April             | 24       | 30.30          | 29.94          | 0.18          | 29.60          |
| May               | 23       | 30.31          | 29.98          | 0.17          | 29.68          |
| June              | 26       | 30.29          | 29.96          | 0.15          | 29.68          |
| July              | 30       | 30.29          | 30.09          | 0.12          | 29.84          |
| August            | 30       | 30.31          | 30.05          | 0.14          | 29.77          |
| September         | 29       | 30.31          | 30.06          | 0.18          | 29.59          |
| October           | 26       | 30.33          | 29.94          | 0.21          | 29.43          |
| November          | 27       | 30.32          | 30.01          | 0.19          | 29.64          |
| December          | 31       | 30.24          | 29.96          | 0.17          | 29.63          |
| 3 a.m.            | 314      | 30.38          | 29.99          | 0.19          | 29.36          |
| January           | 30       | 30.38          | 29.98          | 0.26          | 29.47          |
| February          | 28       | 30.32          | 29.92          | 0.22          | 29.38          |
| March             | 9        | 30.33          | 29.85          | 0.23          | 29.56          |
| April             | 24       | 30.31          | 29.94          | 0.19          | 29.59          |
| May               | 23       | 30.34          | 29.98          | 0.17          | 29.69          |
| June              | 27       | 30.29          | 29.96          | 0.15          | 29.66          |
| July              | 31       | 30.28          | 30.09          | 0.11          | 29.87          |
| August            | 30       | 30.32          | 30.05          | 0.14          | 29.76          |
| September         | 29       | 30.31          | 30.06          | 0.18          | 29.58          |
| October           | 26       | 30.30          | 29.93          | 0.21          | 29.36          |
| November          | 26       | 30.32          | 30.02          | 0.18          | 29.62          |
| December          | 31       | 30.25          | 29.95          | 0.17          | 29.62          |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota (Page 3 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|----------|----------------|----------------|---------------|----------------|
| 4 a.m.            | 313      | 30.36          | 29.99          | 0.19          | 29.36          |
| January           | 31       | 30.36          | 29.98          | 0.26          | 29.44          |
| February          | 28       | 30.33          | 29.93          | 0.23          | 29.37          |
| March             | 8        | 30.31          | 29.87          | 0.23          | 29.56          |
| April             | 24       | 30.32          | 29.94          | 0.19          | 29.61          |
| May               | 23       | 30.33          | 29.98          | 0.17          | 29.68          |
| June              | 27       | 30.31          | 29.97          | 0.15          | 29.67          |
| July              | 31       | 30.28          | 30.09          | 0.11          | 29.87          |
| August            | 30       | 30.32          | 30.05          | 0.14          | 29.76          |
| September         | 28       | 30.32          | 30.06          | 0.19          | 29.56          |
| October           | 26       | 30.29          | 29.94          | 0.21          | 29.36          |
| November          | 26       | 30.33          | 30.03          | 0.18          | 29.59          |
| December          | 31       | 30.25          | 29.95          | 0.17          | 29.60          |
| 5 a.m.            | 311      | 30.35          | 29.99          | 0.19          | 29.35          |
| January           | 31       | 30.35          | 29.98          | 0.26          | 29.44          |
| February          | 28       | 30.35          | 29.93          | 0.23          | 29.35          |
| March             | 9        | 30.30          | 29.85          | 0.22          | 29.56          |
| April             | 24       | 30.33          | 29.94          | 0.18          | 29.60          |
| May               | 23       | 30.33          | 29.98          | 0.18          | 29.68          |
| June              | 27       | 30.33          | 29.97          | 0.16          | 29.65          |
| July              | 29       | 30.28          | 30.10          | 0.11          | 29.87          |
| August            | 30       | 30.32          | 30.05          | 0.14          | 29.76          |
| September         | 29       | 30.34          | 30.07          | 0.19          | 29.54          |
| October           | 26       | 30.30          | 29.94          | 0.21          | 29.37          |
| November          | 26       | 30.34          | 30.03          | 0.18          | 29.57          |
| December          | 29       | 30.25          | 29.94          | 0.17          | 29.61          |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota (Page 4 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|----------|----------------|----------------|---------------|----------------|
| 6 a.m.            | 314      | 30.37          | 30.00          | 0.19          | 29.33          |
| January           | 31       | 30.35          | 29.98          | 0.26          | 29.44          |
| February          | 28       | 30.37          | 29.94          | 0.23          | 29.33          |
| March             | 9        | 30.26          | 29.86          | 0.21          | 29.57          |
| April             | 24       | 30.35          | 29.95          | 0.18          | 29.62          |
| May               | 23       | 30.33          | 29.99          | 0.17          | 29.67          |
| June              | 27       | 30.35          | 29.98          | 0.15          | 29.67          |
| July              | 30       | 30.28          | 30.11          | 0.10          | 29.88          |
| August            | 29       | 30.33          | 30.07          | 0.12          | 29.88          |
| September         | 29       | 30.35          | 30.08          | 0.18          | 29.53          |
| October           | 26       | 30.29          | 29.94          | 0.21          | 29.38          |
| November          | 27       | 30.35          | 30.02          | 0.19          | 29.57          |
| December          | 31       | 30.27          | 29.95          | 0.17          | 29.60          |
| 7 a.m.            | 306      | 30.38          | 30.00          | 0.19          | 29.32          |
| January           | 31       | 30.36          | 29.99          | 0.26          | 29.46          |
| February          | 28       | 30.38          | 29.94          | 0.24          | 29.32          |
| March             | 7        | 30.25          | 29.85          | 0.22          | 29.58          |
| April             | 24       | 30.35          | 29.96          | 0.18          | 29.62          |
| May               | 23       | 30.33          | 30.00          | 0.17          | 29.68          |
| June              | 27       | 30.36          | 29.98          | 0.15          | 29.69          |
| July              | 27       | 30.28          | 30.11          | 0.10          | 29.86          |
| August            | 28       | 30.35          | 30.08          | 0.13          | 29.80          |
| September         | 27       | 30.35          | 30.08          | 0.18          | 29.51          |
| October           | 26       | 30.30          | 29.95          | 0.20          | 29.42          |
| November          | 27       | 30.37          | 30.03          | 0.19          | 29.57          |
| December          | 31       | 30.29          | 29.96          | 0.17          | 29.60          |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota (Page 5 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|----------|----------------|----------------|---------------|----------------|
| 8 a.m.            | 304      | 30.40          | 30.01          | 0.19          | 29.32          |
| January           | 29       | 30.39          | 30.01          | 0.26          | 29.44          |
| February          | 27       | 30.40          | 29.95          | 0.24          | 29.32          |
| March             | 7        | 30.24          | 29.82          | 0.21          | 29.59          |
| April             | 24       | 30.35          | 29.96          | 0.18          | 29.62          |
| May               | 24       | 30.33          | 30.00          | 0.17          | 29.66          |
| June              | 26       | 30.38          | 29.98          | 0.16          | 29.70          |
| July              | 30       | 30.29          | 30.11          | 0.11          | 29.85          |
| August            | 30       | 30.35          | 30.08          | 0.13          | 29.82          |
| September         | 25       | 30.36          | 30.09          | 0.18          | 29.51          |
| October           | 25       | 30.30          | 29.96          | 0.20          | 29.44          |
| November          | 27       | 30.39          | 30.03          | 0.19          | 29.58          |
| December          | 30       | 30.29          | 29.97          | 0.17          | 29.60          |
| 9 a.m.            | 306      | 30.41          | 30.01          | 0.20          | 29.29          |
| January           | 31       | 30.41          | 30.01          | 0.28          | 29.43          |
| February          | 27       | 30.41          | 29.95          | 0.24          | 29.29          |
| March             | 7        | 30.22          | 29.82          | 0.20          | 29.59          |
| April             | 24       | 30.34          | 29.96          | 0.18          | 29.61          |
| May               | 23       | 30.33          | 30.00          | 0.17          | 29.64          |
| June              | 27       | 30.38          | 29.98          | 0.16          | 29.70          |
| July              | 28       | 30.29          | 30.12          | 0.11          | 29.84          |
| August            | 31       | 30.36          | 30.08          | 0.13          | 29.82          |
| September         | 26       | 30.37          | 30.09          | 0.19          | 29.50          |
| October           | 26       | 30.30          | 29.96          | 0.20          | 29.46          |
| November          | 25       | 30.32          | 30.02          | 0.18          | 29.59          |
| December          | 31       | 30.31          | 29.97          | 0.17          | 29.62          |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota (Page 6 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|----------|----------------|----------------|---------------|----------------|
| 10 a.m.           | 307      | 30.43          | 30.01          | 0.20          | 29.28          |
| January           | 31       | 30.43          | 30.01          | 0.28          | 29.40          |
| February          | 27       | 30.42          | 29.95          | 0.24          | 29.28          |
| March             | 7        | 30.21          | 29.82          | 0.20          | 29.58          |
| April             | 25       | 30.39          | 29.98          | 0.20          | 29.59          |
| May               | 24       | 30.31          | 29.99          | 0.17          | 29.60          |
| June              | 24       | 30.39          | 29.97          | 0.16          | 29.72          |
| July              | 29       | 30.30          | 30.12          | 0.10          | 29.83          |
| August            | 29       | 30.36          | 30.08          | 0.13          | 29.83          |
| September         | 28       | 30.37          | 30.10          | 0.18          | 29.49          |
| October           | 26       | 30.29          | 29.96          | 0.19          | 29.47          |
| November          | 26       | 30.40          | 30.02          | 0.19          | 29.58          |
| December          | 31       | 30.31          | 29.97          | 0.17          | 29.62          |
| 11 a.m.           | 301      | 30.44          | 30.01          | 0.20          | 29.25          |
| January           | 31       | 30.44          | 30.01          | 0.29          | 29.35          |
| February          | 26       | 30.43          | 29.97          | 0.24          | 29.25          |
| March             | 6        | 29.91          | 29.74          | 0.11          | 29.59          |
| April             | 25       | 30.38          | 29.98          | 0.20          | 29.58          |
| May               | 24       | 30.29          | 29.99          | 0.17          | 29.58          |
| June              | 27       | 30.39          | 29.97          | 0.15          | 29.72          |
| July              | 26       | 30.31          | 30.12          | 0.10          | 29.82          |
| August            | 30       | 30.36          | 30.07          | 0.13          | 29.83          |
| September         | 24       | 30.36          | 30.10          | 0.19          | 29.51          |
| October           | 25       | 30.28          | 29.97          | 0.17          | 29.61          |
| November          | 26       | 30.39          | 30.02          | 0.19          | 29.58          |
| December          | 31       | 30.29          | 29.96          | 0.17          | 29.60          |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota (Page 7 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|----------|----------------|----------------|---------------|----------------|
| 12 p.m.           | 306      | 30.44          | 30.00          | 0.20          | 29.22          |
| January           | 30       | 30.44          | 29.99          | 0.30          | 29.30          |
| February          | 28       | 30.44          | 29.96          | 0.25          | 29.22          |
| March             | 7        | 30.17          | 29.82          | 0.20          | 29.60          |
| April             | 25       | 30.35          | 29.96          | 0.20          | 29.56          |
| May               | 24       | 30.26          | 29.98          | 0.17          | 29.52          |
| June              | 25       | 30.39          | 29.95          | 0.15          | 29.71          |
| July              | 29       | 30.30          | 30.10          | 0.11          | 29.79          |
| August            | 29       | 30.35          | 30.06          | 0.13          | 29.83          |
| September         | 26       | 30.34          | 30.09          | 0.18          | 29.57          |
| October           | 27       | 30.27          | 29.95          | 0.19          | 29.51          |
| November          | 27       | 30.37          | 30.00          | 0.19          | 29.57          |
| December          | 29       | 30.26          | 29.95          | 0.17          | 29.59          |
| 1 p.m.            | 312      | 30.43          | 29.99          | 0.20          | 29.21          |
| January           | 31       | 30.43          | 29.97          | 0.29          | 29.25          |
| February          | 28       | 30.43          | 29.95          | 0.25          | 29.21          |
| March             | 8        | 30.12          | 29.80          | 0.17          | 29.62          |
| April             | 25       | 30.32          | 29.95          | 0.19          | 29.54          |
| May               | 23       | 30.24          | 29.98          | 0.17          | 29.48          |
| June              | 28       | 30.38          | 29.96          | 0.15          | 29.72          |
| July              | 28       | 30.29          | 30.10          | 0.11          | 29.77          |
| August            | 29       | 30.23          | 30.05          | 0.11          | 29.82          |
| September         | 27       | 30.32          | 30.07          | 0.18          | 29.58          |
| October           | 27       | 30.26          | 29.94          | 0.19          | 29.50          |
| November          | 27       | 30.35          | 29.99          | 0.19          | 29.59          |
| December          | 31       | 30.23          | 29.93          | 0.17          | 29.59          |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota (Page 8 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|----------|----------------|----------------|---------------|----------------|
| 2 p.m.            | 309      | 30.44          | 29.98          | 0.20          | 29.19          |
| January           | 31       | 30.44          | 29.97          | 0.29          | 29.25          |
| February          | 28       | 30.43          | 29.94          | 0.25          | 29.19          |
| March             | 8        | 30.10          | 29.79          | 0.17          | 29.61          |
| April             | 25       | 30.29          | 29.95          | 0.19          | 29.53          |
| May               | 24       | 30.21          | 29.96          | 0.19          | 29.41          |
| June              | 28       | 30.38          | 29.96          | 0.14          | 29.73          |
| July              | 29       | 30.25          | 30.09          | 0.10          | 29.78          |
| August            | 25       | 30.22          | 30.05          | 0.11          | 29.80          |
| September         | 28       | 30.31          | 30.07          | 0.17          | 29.59          |
| October           | 26       | 30.27          | 29.94          | 0.19          | 29.52          |
| November          | 26       | 30.33          | 29.98          | 0.19          | 29.57          |
| December          | 31       | 30.21          | 29.93          | 0.17          | 29.60          |
| 3 p.m.            | 303      | 30.45          | 29.98          | 0.20          | 29.21          |
| January           | 31       | 30.45          | 29.98          | 0.29          | 29.26          |
| February          | 28       | 30.43          | 29.95          | 0.25          | 29.21          |
| March             | 8        | 30.08          | 29.79          | 0.17          | 29.61          |
| April             | 25       | 30.27          | 29.94          | 0.20          | 29.52          |
| May               | 23       | 30.19          | 29.96          | 0.18          | 29.45          |
| June              | 27       | 30.37          | 29.96          | 0.15          | 29.72          |
| July              | 24       | 30.29          | 30.10          | 0.09          | 29.89          |
| August            | 27       | 30.30          | 30.05          | 0.12          | 29.80          |
| September         | 25       | 30.30          | 30.05          | 0.16          | 29.64          |
| October           | 27       | 30.30          | 29.93          | 0.19          | 29.53          |
| November          | 27       | 30.31          | 29.99          | 0.19          | 29.59          |
| December          | 31       | 30.20          | 29.94          | 0.17          | 29.62          |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota (Page 9 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|----------|----------------|----------------|---------------|----------------|
| 4 p.m.            | 301      | 30.45          | 29.98          | 0.19          | 29.23          |
| January           | 31       | 30.45          | 29.98          | 0.29          | 29.26          |
| February          | 27       | 30.45          | 29.95          | 0.25          | 29.23          |
| March             | 8        | 30.07          | 29.80          | 0.16          | 29.60          |
| April             | 25       | 30.25          | 29.94          | 0.19          | 29.58          |
| May               | 23       | 30.20          | 29.96          | 0.17          | 29.56          |
| June              | 26       | 30.20          | 29.94          | 0.12          | 29.72          |
| July              | 24       | 30.28          | 30.09          | 0.11          | 29.76          |
| August            | 30       | 30.29          | 30.04          | 0.13          | 29.79          |
| September         | 25       | 30.30          | 30.05          | 0.16          | 29.67          |
| October           | 26       | 30.32          | 29.95          | 0.18          | 29.55          |
| November          | 26       | 30.29          | 30.00          | 0.19          | 29.63          |
| December          | 30       | 30.20          | 29.96          | 0.17          | 29.64          |
| 5 p.m.            | 306      | 30.46          | 29.99          | 0.19          | 29.24          |
| January           | 30       | 30.46          | 29.98          | 0.29          | 29.26          |
| February          | 27       | 30.45          | 29.96          | 0.25          | 29.24          |
| March             | 7        | 29.94          | 29.77          | 0.14          | 29.58          |
| April             | 25       | 30.24          | 29.95          | 0.18          | 29.63          |
| May               | 23       | 30.21          | 29.96          | 0.18          | 29.51          |
| June              | 26       | 30.35          | 29.96          | 0.14          | 29.72          |
| July              | 29       | 30.28          | 30.07          | 0.12          | 29.73          |
| August            | 29       | 30.29          | 30.04          | 0.13          | 29.78          |
| September         | 28       | 30.31          | 30.06          | 0.17          | 29.66          |
| October           | 27       | 30.34          | 29.94          | 0.19          | 29.56          |
| November          | 25       | 30.29          | 30.02          | 0.18          | 29.65          |
| December          | 30       | 30.20          | 29.96          | 0.17          | 29.65          |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota  
(Page 10 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|----------|----------------|----------------|---------------|----------------|
| 6 p.m.            | 311      | 30.46          | 29.99          | 0.19          | 29.26          |
| January           | 31       | 30.46          | 29.99          | 0.28          | 29.29          |
| February          | 28       | 30.46          | 29.97          | 0.24          | 29.26          |
| March             | 7        | 29.95          | 29.78          | 0.13          | 29.59          |
| April             | 25       | 30.25          | 29.95          | 0.18          | 29.65          |
| May               | 24       | 30.22          | 29.95          | 0.18          | 29.54          |
| June              | 26       | 30.34          | 29.96          | 0.13          | 29.72          |
| July              | 30       | 30.28          | 30.07          | 0.12          | 29.74          |
| August            | 28       | 30.28          | 30.04          | 0.12          | 29.78          |
| September         | 27       | 30.33          | 30.06          | 0.17          | 29.69          |
| October           | 27       | 30.36          | 29.96          | 0.19          | 29.60          |
| November          | 27       | 30.29          | 30.01          | 0.19          | 29.66          |
| December          | 31       | 30.20          | 29.97          | 0.17          | 29.66          |
| 7 p.m.            | 314      | 30.47          | 30.00          | 0.19          | 29.27          |
| January           | 31       | 30.44          | 29.99          | 0.28          | 29.28          |
| February          | 28       | 30.47          | 29.97          | 0.24          | 29.27          |
| March             | 7        | 29.96          | 29.79          | 0.13          | 29.59          |
| April             | 25       | 30.27          | 29.95          | 0.18          | 29.65          |
| May               | 23       | 30.24          | 29.95          | 0.17          | 29.60          |
| June              | 27       | 30.35          | 29.98          | 0.14          | 29.69          |
| July              | 30       | 30.28          | 30.09          | 0.11          | 29.77          |
| August            | 29       | 30.28          | 30.06          | 0.13          | 29.76          |
| September         | 29       | 30.33          | 30.06          | 0.17          | 29.70          |
| October           | 27       | 30.36          | 29.96          | 0.19          | 29.60          |
| November          | 27       | 30.30          | 30.01          | 0.19          | 29.66          |
| December          | 31       | 30.20          | 29.97          | 0.16          | 29.67          |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota  
(Page 11 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|----------|----------------|----------------|---------------|----------------|
| 8 p.m.            | 313      | 30.46          | 30.00          | 0.19          | 29.30          |
| January           | 31       | 30.43          | 30.00          | 0.27          | 29.47          |
| February          | 28       | 30.46          | 29.96          | 0.24          | 29.30          |
| March             | 7        | 29.98          | 29.80          | 0.14          | 29.60          |
| April             | 25       | 30.30          | 29.97          | 0.18          | 29.66          |
| May               | 24       | 30.26          | 29.97          | 0.17          | 29.60          |
| June              | 27       | 30.35          | 29.98          | 0.15          | 29.67          |
| July              | 29       | 30.28          | 30.09          | 0.11          | 29.84          |
| August            | 29       | 30.30          | 30.05          | 0.13          | 29.82          |
| September         | 29       | 30.32          | 30.06          | 0.17          | 29.69          |
| October           | 27       | 30.35          | 29.96          | 0.19          | 29.60          |
| November          | 27       | 30.29          | 30.01          | 0.19          | 29.69          |
| December          | 30       | 30.20          | 29.97          | 0.16          | 29.68          |
| 9 p.m.            | 315      | 30.47          | 30.01          | 0.19          | 29.31          |
| January           | 31       | 30.41          | 30.00          | 0.27          | 29.47          |
| February          | 27       | 30.47          | 29.97          | 0.25          | 29.31          |
| March             | 7        | 29.98          | 29.81          | 0.14          | 29.60          |
| April             | 25       | 30.30          | 29.98          | 0.18          | 29.67          |
| May               | 24       | 30.28          | 29.98          | 0.17          | 29.63          |
| June              | 26       | 30.36          | 29.99          | 0.14          | 29.67          |
| July              | 31       | 30.30          | 30.11          | 0.10          | 29.90          |
| August            | 30       | 30.30          | 30.06          | 0.13          | 29.84          |
| September         | 29       | 30.31          | 30.06          | 0.17          | 29.69          |
| October           | 27       | 30.35          | 29.96          | 0.20          | 29.56          |
| November          | 27       | 30.29          | 30.02          | 0.19          | 29.70          |
| December          | 31       | 30.21          | 29.97          | 0.16          | 29.67          |

**Table B-2. Barometric Pressure (Hg) in 2009 for Spearfish, South Dakota  
(Page 12 of 12)**

| <b>Time/Month</b> | <b>N</b>     | <b>Maximum</b> | <b>Average</b> | <b>StdDev</b> | <b>Minimum</b> |
|-------------------|--------------|----------------|----------------|---------------|----------------|
| 10 p.m.           | 314          | 30.46          | 30.00          | 0.19          | 29.33          |
| January           | 31           | 30.40          | 30.00          | 0.26          | 29.48          |
| February          | 28           | 30.46          | 29.96          | 0.24          | 29.33          |
| March             | 7            | 29.98          | 29.80          | 0.14          | 29.60          |
| April             | 25           | 30.31          | 29.97          | 0.18          | 29.67          |
| May               | 23           | 30.30          | 29.99          | 0.17          | 29.67          |
| June              | 26           | 30.34          | 29.99          | 0.15          | 29.67          |
| July              | 31           | 30.30          | 30.10          | 0.10          | 29.88          |
| August            | 29           | 30.30          | 30.06          | 0.14          | 29.81          |
| September         | 29           | 30.31          | 30.06          | 0.18          | 29.67          |
| October           | 27           | 30.35          | 29.96          | 0.20          | 29.53          |
| November          | 27           | 30.30          | 30.01          | 0.19          | 29.69          |
| December          | 31           | 30.22          | 29.98          | 0.16          | 29.67          |
| 11 p.m.           | 313          | 30.44          | 30.00          | 0.19          | 29.33          |
| January           | 31           | 30.40          | 30.00          | 0.26          | 29.48          |
| February          | 28           | 30.44          | 29.95          | 0.24          | 29.33          |
| March             | 7            | 29.98          | 29.79          | 0.14          | 29.59          |
| April             | 25           | 30.31          | 29.97          | 0.18          | 29.67          |
| May               | 22           | 30.31          | 29.99          | 0.18          | 29.67          |
| June              | 27           | 30.34          | 30.00          | 0.15          | 29.67          |
| July              | 31           | 30.30          | 30.10          | 0.12          | 29.82          |
| August            | 29           | 30.31          | 30.06          | 0.14          | 29.82          |
| September         | 29           | 30.31          | 30.06          | 0.18          | 29.65          |
| October           | 26           | 30.34          | 29.95          | 0.20          | 29.49          |
| November          | 27           | 30.32          | 30.01          | 0.19          | 29.67          |
| December          | 31           | 30.23          | 29.98          | 0.16          | 29.66          |
| <b>Total</b>      | <b>7,428</b> | <b>30.47</b>   | <b>30.00</b>   | <b>0.19</b>   | <b>29.19</b>   |

**Table B-3. Relative Humidity (%) in 2009 for Spearfish, South Dakota (Page 1 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Average</b> | <b>StdDev</b> |
|-------------------|----------|----------------|---------------|
| 12 a.m.           | 332      | 69.1           | 18.1          |
| January           | 51       | 63.9           | 19.3          |
| February          | 28       | 67.4           | 18.2          |
| March             | 8        | 80.0           | 19.4          |
| April             | 23       | 71.2           | 14.6          |
| May               | 22       | 68.0           | 16.9          |
| June              | 27       | 80.6           | 16.2          |
| July              | 31       | 72.5           | 11.9          |
| August            | 30       | 71.2           | 15.0          |
| September         | 29       | 61.4           | 20.8          |
| October           | 25       | 76.3           | 19.5          |
| November          | 27       | 59.2           | 18.1          |
| December          | 31       | 70.1           | 16.5          |
| 1 a.m.            | 331      | 69.6           | 18.5          |
| January           | 50       | 65.7           | 19.9          |
| February          | 28       | 65.5           | 18.3          |
| March             | 9        | 78.2           | 17.2          |
| April             | 23       | 74.2           | 16.4          |
| May               | 22       | 69.1           | 17.4          |
| June              | 26       | 78.3           | 18.2          |
| July              | 30       | 74.9           | 15.7          |
| August            | 30       | 72.3           | 14.9          |
| September         | 29       | 61.2           | 19.5          |
| October           | 26       | 76.0           | 19.3          |
| November          | 27       | 59.6           | 17.1          |
| December          | 31       | 70.0           | 17.1          |

**Table B-3. Relative Humidity (%) in 2009, South Dakota (Page 2 of 12)**

| <b>T</b>  | <b>N</b> | <b>Average</b> | <b>StdDev</b> |
|-----------|----------|----------------|---------------|
| 2 a.m.    | 332      | 70.0           | 18.6          |
| January   | 50       | 65.3           | 20.3          |
| February  | 27       | 65.8           | 18.9          |
| March     | 9        | 75.7           | 17.8          |
| April     | 24       | 74.3           | 18.6          |
| May       | 23       | 72.4           | 17.4          |
| June      | 26       | 77.1           | 18.1          |
| July      | 30       | 76.9           | 14.2          |
| August    | 30       | 71.8           | 14.9          |
| September | 29       | 63.7           | 19.0          |
| October   | 26       | 77.5           | 18.6          |
| November  | 27       | 57.3           | 17.3          |
| December  | 31       | 70.4           | 16.8          |
| 3 a.m.    | 334      | 70.1           | 18.5          |
| January   | 50       | 65.3           | 19.3          |
| February  | 28       | 66.1           | 18.9          |
| March     | 9        | 65.6           | 19.2          |
| April     | 24       | 74.3           | 19.0          |
| May       | 23       | 71.3           | 15.9          |
| June      | 27       | 77.2           | 20.3          |
| July      | 31       | 76.2           | 15.0          |
| August    | 30       | 73.0           | 16.3          |
| September | 29       | 65.9           | 18.4          |
| October   | 26       | 76.9           | 20.2          |
| November  | 26       | 58.4           | 14.5          |
| December  | 31       | 71.1           | 16.7          |

**Table B-3. Relative Humidity (%) in 2009 for Spearfish, South Dakota (Page 3 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Average</b> | <b>StdDev</b> |
|-------------------|----------|----------------|---------------|
| 4 a.m.            | 332      | 70.6           | 18.4          |
| January           | 50       | 64.0           | 20.8          |
| February          | 28       | 65.6           | 18.9          |
| March             | 8        | 70.5           | 16.8          |
| April             | 24       | 75.4           | 18.2          |
| May               | 23       | 73.9           | 15.2          |
| June              | 27       | 79.2           | 19.7          |
| July              | 31       | 78.2           | 14.8          |
| August            | 30       | 72.3           | 15.9          |
| September         | 28       | 66.4           | 17.2          |
| October           | 26       | 78.1           | 17.9          |
| November          | 26       | 57.1           | 13.8          |
| December          | 31       | 71.3           | 16.6          |
| 5 a.m.            | 331      | 71.3           | 18.9          |
| January           | 51       | 64.8           | 20.8          |
| February          | 28       | 67.5           | 18.4          |
| March             | 9        | 69.3           | 20.0          |
| April             | 24       | 76.5           | 20.9          |
| May               | 23       | 74.9           | 16.0          |
| June              | 27       | 79.3           | 18.7          |
| July              | 29       | 79.8           | 14.8          |
| August            | 30       | 74.3           | 16.2          |
| September         | 29       | 67.6           | 18.1          |
| October           | 26       | 77.6           | 19.6          |
| November          | 26       | 56.3           | 13.0          |
| December          | 29       | 72.6           | 16.8          |

**Table B-3. Relative Humidity (%) in 2009 for Spearfish, South Dakota (Page 4 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Average</b> | <b>StdDev</b> |
|-------------------|----------|----------------|---------------|
| 6 a.m.            | 334      | 70.1           | 18.2          |
| January           | 51       | 65.2           | 20.6          |
| February          | 28       | 68.9           | 17.3          |
| March             | 9        | 68.2           | 15.6          |
| April             | 24       | 76.5           | 21.4          |
| May               | 23       | 67.7           | 14.2          |
| June              | 27       | 74.9           | 15.5          |
| July              | 30       | 75.3           | 15.6          |
| August            | 29       | 74.0           | 15.1          |
| September         | 29       | 68.6           | 18.2          |
| October           | 26       | 77.4           | 18.5          |
| November          | 27       | 54.6           | 14.1          |
| December          | 31       | 72.6           | 17.6          |
| 7 a.m.            | 325      | 67.4           | 18.4          |
| January           | 51       | 65.4           | 21.2          |
| February          | 28       | 70.4           | 17.1          |
| March             | 7        | 77.2           | 19.3          |
| April             | 24       | 71.5           | 20.9          |
| May               | 23       | 58.5           | 11.9          |
| June              | 26       | 69.5           | 17.3          |
| July              | 27       | 65.4           | 14.8          |
| August            | 28       | 69.3           | 14.4          |
| September         | 27       | 62.9           | 17.1          |
| October           | 26       | 76.9           | 19.9          |
| November          | 27       | 54.3           | 14.4          |
| December          | 31       | 74.6           | 17.3          |

**Table B-3. Relative Humidity (%) in 2009 for Spearfish, South Dakota (Page 5 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Average</b> | <b>StdDev</b> |
|-------------------|----------|----------------|---------------|
| 8 a.m.            | 324      | 64.7           | 19.8          |
| January           | 49       | 63.8           | 21.0          |
| February          | 27       | 69.8           | 17.9          |
| March             | 7        | 73.4           | 25.7          |
| April             | 24       | 68.3           | 23.8          |
| May               | 24       | 54.3           | 15.5          |
| June              | 26       | 66.9           | 19.3          |
| July              | 30       | 60.8           | 16.7          |
| August            | 30       | 65.6           | 18.4          |
| September         | 25       | 57.9           | 17.9          |
| October           | 25       | 76.8           | 19.2          |
| November          | 27       | 52.3           | 14.9          |
| December          | 30       | 72.7           | 18.1          |
| 9 a.m.            | 326      | 61.7           | 21.1          |
| January           | 51       | 62.7           | 23.0          |
| February          | 27       | 67.1           | 18.0          |
| March             | 7        | 67.9           | 24.7          |
| April             | 24       | 65.8           | 25.9          |
| May               | 23       | 52.5           | 15.5          |
| June              | 27       | 64.4           | 19.3          |
| July              | 28       | 59.7           | 19.0          |
| August            | 31       | 60.8           | 20.0          |
| September         | 26       | 52.3           | 19.1          |
| October           | 26       | 73.1           | 21.4          |
| November          | 25       | 44.7           | 14.5          |
| December          | 31       | 69.7           | 17.9          |

**Table B-3. Relative Humidity (%) in 2009 for Spearfish, South Dakota (Page 6 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Average</b> | <b>StdDev</b> |
|-------------------|----------|----------------|---------------|
| 10 a.m.           | 326      | 58.7           | 21.3          |
| January           | 50       | 60.6           | 23.7          |
| February          | 27       | 64.6           | 20.5          |
| March             | 7        | 64.5           | 27.7          |
| April             | 25       | 62.3           | 25.3          |
| May               | 24       | 48.8           | 10.8          |
| June              | 24       | 65.0           | 19.3          |
| July              | 29       | 55.3           | 17.5          |
| August            | 29       | 57.0           | 19.8          |
| September         | 28       | 50.2           | 17.2          |
| October           | 26       | 69.4           | 21.3          |
| November          | 26       | 39.2           | 15.7          |
| December          | 31       | 68.7           | 17.6          |
| 11 a.m.           | 321      | 57.2           | 21.4          |
| January           | 51       | 57.9           | 22.7          |
| February          | 26       | 63.3           | 20.3          |
| March             | 6        | 60.7           | 31.6          |
| April             | 25       | 62.8           | 24.6          |
| May               | 24       | 46.8           | 11.3          |
| June              | 27       | 63.6           | 17.7          |
| July              | 26       | 53.2           | 17.8          |
| August            | 30       | 54.0           | 16.9          |
| September         | 24       | 47.4           | 17.6          |
| October           | 25       | 69.8           | 22.7          |
| November          | 26       | 37.7           | 16.0          |
| December          | 31       | 68.7           | 19.6          |

**Table B-3. Relative Humidity (%) in 2009 for Spearfish, South Dakota (Page 7 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Average</b> | <b>StdDev</b> |
|-------------------|----------|----------------|---------------|
| 12 p.m.           | 325      | 55.0           | 21.5          |
| January           | 50       | 55.3           | 22.5          |
| February          | 28       | 58.9           | 21.3          |
| March             | 6        | 65.5           | 25.9          |
| April             | 25       | 60.9           | 25.7          |
| May               | 24       | 46.4           | 13.7          |
| June              | 25       | 64.4           | 19.9          |
| July              | 29       | 50.8           | 17.8          |
| August            | 29       | 50.2           | 15.8          |
| September         | 26       | 46.1           | 14.4          |
| October           | 27       | 66.0           | 23.3          |
| November          | 27       | 35.3           | 13.3          |
| December          | 29       | 68.0           | 20.8          |
| 1 p.m.            | 332      | 53.8           | 21.7          |
| January           | 51       | 55.1           | 21.8          |
| February          | 28       | 59.6           | 21.8          |
| March             | 8        | 60.8           | 27.2          |
| April             | 25       | 59.6           | 24.5          |
| May               | 23       | 45.2           | 14.8          |
| June              | 28       | 61.7           | 20.6          |
| July              | 28       | 47.9           | 16.1          |
| August            | 29       | 49.4           | 16.4          |
| September         | 27       | 42.8           | 16.5          |
| October           | 27       | 65.7           | 23.9          |
| November          | 27       | 33.8           | 12.4          |
| December          | 31       | 65.4           | 20.8          |

**Table B-3. Relative Humidity (%) in 2009 for Spearfish, South Dakota (Page 8 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Average</b> | <b>StdDev</b> |
|-------------------|----------|----------------|---------------|
| 2 p.m.            | 329      | 53.5           | 21.5          |
| January           | 51       | 54.4           | 21.9          |
| February          | 28       | 58.4           | 21.4          |
| March             | 8        | 58.3           | 25.1          |
| April             | 25       | 58.7           | 24.1          |
| May               | 24       | 41.7           | 12.7          |
| June              | 28       | 64.3           | 23.1          |
| July              | 29       | 47.5           | 14.7          |
| August            | 25       | 48.1           | 17.5          |
| September         | 28       | 42.8           | 15.1          |
| October           | 26       | 66.7           | 23.1          |
| November          | 26       | 35.2           | 12.5          |
| December          | 31       | 64.8           | 19.9          |
| 3 p.m.            | 323      | 54.3           | 21.2          |
| January           | 51       | 55.4           | 21.1          |
| February          | 28       | 59.8           | 22.0          |
| March             | 8        | 61.2           | 23.0          |
| April             | 25       | 61.3           | 23.3          |
| May               | 23       | 42.0           | 11.8          |
| June              | 27       | 63.1           | 21.4          |
| July              | 24       | 46.4           | 15.0          |
| August            | 27       | 47.4           | 17.2          |
| September         | 25       | 45.3           | 17.7          |
| October           | 27       | 64.8           | 22.8          |
| November          | 27       | 37.3           | 12.6          |
| December          | 31       | 66.3           | 19.8          |

**Table B-3. Relative Humidity (%) in 2009 for Spearfish, South Dakota (Page 9 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Average</b> | <b>StdDev</b> |
|-------------------|----------|----------------|---------------|
| 4 p.m.            | 321      | 56.0           | 20.7          |
| January           | 51       | 57.9           | 21.5          |
| February          | 27       | 61.8           | 22.2          |
| March             | 8        | 67.4           | 19.7          |
| April             | 25       | 61.7           | 22.1          |
| May               | 23       | 44.9           | 13.9          |
| June              | 26       | 62.7           | 21.7          |
| July              | 24       | 50.4           | 14.8          |
| August            | 30       | 47.5           | 15.6          |
| September         | 25       | 45.2           | 17.8          |
| October           | 26       | 67.1           | 21.8          |
| November          | 26       | 43.3           | 13.3          |
| December          | 30       | 66.2           | 19.9          |
| 5 p.m.            | 325      | 59.9           | 20.2          |
| January           | 49       | 61.8           | 20.6          |
| February          | 27       | 65.2           | 20.5          |
| March             | 7        | 74.7           | 14.9          |
| April             | 25       | 61.9           | 21.4          |
| May               | 23       | 44.6           | 12.5          |
| June              | 26       | 66.2           | 21.6          |
| July              | 29       | 50.2           | 17.9          |
| August            | 29       | 51.8           | 16.2          |
| September         | 28       | 51.2           | 18.1          |
| October           | 27       | 71.5           | 19.0          |
| November          | 25       | 56.1           | 16.2          |
| December          | 30       | 70.8           | 17.8          |

**Table B-3. Relative Humidity (%) in 2009 for Spearfish, South Dakota (Page 10 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Average</b> | <b>StdDev</b> |
|-------------------|----------|----------------|---------------|
| 6 p.m.            | 330      | 63.1           | 19.0          |
| January           | 50       | 61.1           | 21.0          |
| February          | 28       | 70.5           | 18.0          |
| March             | 7        | 78.9           | 17.6          |
| April             | 25       | 66.5           | 20.3          |
| May               | 24       | 48.1           | 11.3          |
| June              | 26       | 69.4           | 16.2          |
| July              | 30       | 55.3           | 17.2          |
| August            | 28       | 57.9           | 15.0          |
| September         | 27       | 61.4           | 17.9          |
| October           | 27       | 74.4           | 18.8          |
| November          | 27       | 55.2           | 15.6          |
| December          | 31       | 70.5           | 17.8          |
| 7 p.m.            | 333      | 66.7           | 17.5          |
| January           | 50       | 60.5           | 19.9          |
| February          | 28       | 70.5           | 17.6          |
| March             | 7        | 81.6           | 12.2          |
| April             | 25       | 70.9           | 17.9          |
| May               | 23       | 56.7           | 9.2           |
| June              | 27       | 73.6           | 15.8          |
| July              | 30       | 64.2           | 16.5          |
| August            | 29       | 66.9           | 15.0          |
| September         | 29       | 66.4           | 17.3          |
| October           | 27       | 75.9           | 16.7          |
| November          | 27       | 57.0           | 15.0          |
| December          | 31       | 70.9           | 16.5          |

**Table B-3. Relative Humidity (%) in 2009 for Spearfish, South Dakota (Page 11 of 12)**

| <b>Time/Month</b> | <b>N</b> | <b>Average</b> | <b>StdDev</b> |
|-------------------|----------|----------------|---------------|
| 8 p.m.            | 332      | 69.1           | 17.4          |
| January           | 50       | 62.6           | 19.6          |
| February          | 28       | 72.4           | 18.1          |
| March             | 7        | 78.3           | 17.2          |
| April             | 25       | 74.4           | 15.7          |
| May               | 24       | 64.2           | 11.3          |
| June              | 27       | 79.4           | 14.6          |
| July              | 29       | 71.4           | 14.8          |
| August            | 29       | 69.7           | 15.2          |
| September         | 29       | 64.4           | 17.2          |
| October           | 27       | 76.2           | 17.3          |
| November          | 27       | 56.7           | 16.4          |
| December          | 30       | 71.3           | 15.6          |
| 9 p.m.            | 334      | 68.8           | 18.1          |
| January           | 50       | 62.5           | 19.5          |
| February          | 27       | 71.0           | 18.2          |
| March             | 7        | 81.0           | 15.5          |
| April             | 25       | 74.7           | 16.0          |
| May               | 24       | 62.9           | 13.5          |
| June              | 26       | 81.4           | 14.4          |
| July              | 31       | 72.8           | 14.2          |
| August            | 30       | 67.7           | 15.2          |
| September         | 29       | 62.3           | 21.6          |
| October           | 27       | 75.9           | 18.5          |
| November          | 27       | 57.8           | 16.0          |
| December          | 31       | 70.5           | 16.2          |

**Table B-3. Relative Humidity (%) in 2009 for Spearfish, South Dakota (Page 12 of 12)**

| <b>Time/Month</b> | <b>N</b>     | <b>Average</b> | <b>StdDev</b> |
|-------------------|--------------|----------------|---------------|
| 10 p.m.           | 333          | 68.9           | 18.2          |
| January           | 50           | 63.6           | 19.0          |
| February          | 28           | 69.5           | 17.2          |
| March             | 7            | 82.0           | 17.6          |
| April             | 25           | 72.6           | 17.8          |
| May               | 23           | 65.9           | 11.7          |
| June              | 26           | 81.1           | 15.7          |
| July              | 31           | 72.3           | 12.8          |
| August            | 29           | 68.4           | 16.4          |
| September         | 29           | 60.5           | 22.4          |
| October           | 27           | 75.9           | 19.5          |
| November          | 27           | 58.1           | 17.7          |
| December          | 31           | 70.8           | 15.4          |
| 11 p.m.           | 332          | 68.7           | 18.9          |
| January           | 50           | 63.5           | 20.4          |
| February          | 28           | 68.4           | 17.2          |
| March             | 7            | 79.6           | 19.2          |
| April             | 25           | 74.7           | 16.7          |
| May               | 22           | 65.9           | 15.3          |
| June              | 27           | 81.7           | 16.5          |
| July              | 31           | 70.1           | 12.5          |
| August            | 29           | 69.6           | 17.2          |
| September         | 29           | 59.5           | 22.6          |
| October           | 26           | 75.8           | 20.9          |
| November          | 27           | 56.8           | 17.1          |
| December          | 31           | 71.9           | 15.7          |
| <b>Total</b>      | <b>7,897</b> | <b>64.1</b>    | <b>20.4</b>   |

## **APPENDIX C**

### **WIND SPEED ASSESSMENT FOR THE SPEARFISH, SOUTH DAKOTA, METEOROLOGICAL STATION**

## APPENDIX C

### WIND SPEED ASSESSMENT FOR THE SPEARFISH, SOUTH DAKOTA, METEOROLOGICAL SITE

**Table C-1. Overall 2009 Frequency Distribution (Count)**

| Speed Knots<br>Wind Direction | 1-4 | 4-7   | 7-11  | 11-17 | 17-21 | >= 22 | Total        |
|-------------------------------|-----|-------|-------|-------|-------|-------|--------------|
| 348.75-11.25                  | 26  | 79    | 19    | 15    | 0     | 0     | 139          |
| 11.25-33.75                   | 30  | 85    | 18    | 6     | 1     | 0     | 140          |
| 33.75-56.25                   | 28  | 185   | 66    | 9     | 0     | 0     | 288          |
| 56.25-78.75                   | 26  | 142   | 58    | 22    | 1     | 0     | 249          |
| 78.75-101.25                  | 43  | 166   | 132   | 157   | 31    | 2     | 531          |
| 101.25-123.75                 | 46  | 125   | 88    | 73    | 12    | 4     | 348          |
| 123.75-146.25                 | 34  | 84    | 20    | 20    | 2     | 0     | 160          |
| 146.25-168.75                 | 35  | 88    | 9     | 10    | 2     | 0     | 144          |
| 168.75-191.25                 | 57  | 148   | 13    | 18    | 4     | 8     | 248          |
| 191.25-213.75                 | 31  | 188   | 75    | 47    | 8     | 7     | 356          |
| 213.75-236.25                 | 51  | 151   | 16    | 66    | 36    | 25    | 345          |
| 236.25-258.75                 | 56  | 207   | 59    | 75    | 12    | 3     | 412          |
| 258.75-281.25                 | 91  | 473   | 387   | 442   | 73    | 15    | 1,481        |
| 281.25-303.75                 | 49  | 215   | 180   | 384   | 142   | 47    | 1017         |
| 303.75-326.25                 | 32  | 208   | 184   | 275   | 48    | 10    | 757          |
| 326.25-348.75                 | 27  | 73    | 76    | 65    | 11    | 1     | 253          |
| Subtotal                      | 662 | 2,617 | 1,400 | 1,684 | 383   | 122   | 6,868        |
| Calms                         |     |       |       |       |       |       | 1,023        |
| Missing/Incomplete            |     |       |       |       |       |       | 9            |
| <b>Total</b>                  |     |       |       |       |       |       | <b>7,900</b> |

Frequency of Calm Winds: 12.96%  
Average Wind Speed: 7.77 Knots

**Table C-2. Overall 2009 Frequency Distribution (Normalized)**

| <b>Speed Knots<br/>Wind Direction</b> | <b>1-4</b>      | <b>4-7</b>      | <b>7-11</b>     | <b>11-17</b>    | <b>17-21</b>    | <b>&gt;= 22</b> | <b>Total</b>    |
|---------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 348.75-11.25                          | 0.003295        | 0.010011        | 0.002408        | 0.001901        | 0.000000        | 0.000000        | 0.017615        |
| 11.25-33.75                           | 0.003802        | 0.010772        | 0.002281        | 0.000760        | 0.000127        | 0.000000        | 0.017742        |
| 33.75-56.25                           | 0.003548        | 0.023444        | 0.008364        | 0.001141        | 0.000000        | 0.000000        | 0.036497        |
| 56.25-78.75                           | 0.003295        | 0.017995        | 0.007350        | 0.002788        | 0.000127        | 0.000000        | 0.031555        |
| 78.75-101.25                          | 0.005449        | 0.021037        | 0.016728        | 0.019896        | 0.003929        | 0.000253        | 0.067292        |
| 101.25-123.75                         | 0.005829        | 0.015841        | 0.011152        | 0.009251        | 0.001521        | 0.000507        | 0.044101        |
| 123.75-146.25                         | 0.004309        | 0.010645        | 0.002535        | 0.002535        | 0.000253        | 0.000000        | 0.020276        |
| 146.25-168.75                         | 0.004435        | 0.011152        | 0.001141        | 0.001267        | 0.000253        | 0.000000        | 0.018249        |
| 168.75-191.25                         | 0.007223        | 0.018756        | 0.001647        | 0.002281        | 0.000507        | 0.001014        | 0.031428        |
| 191.25-213.75                         | 0.003929        | 0.023825        | 0.009504        | 0.005956        | 0.001014        | 0.000887        | 0.045115        |
| 213.75-236.25                         | 0.006463        | 0.019136        | 0.002028        | 0.008364        | 0.004562        | 0.003168        | 0.043721        |
| 236.25-258.75                         | 0.007097        | 0.026232        | 0.007477        | 0.009504        | 0.001521        | 0.000380        | 0.052211        |
| 258.75-281.25                         | 0.011532        | 0.059942        | 0.049043        | 0.056013        | 0.009251        | 0.001901        | 0.187682        |
| 281.25-303.75                         | 0.006210        | 0.027246        | 0.022811        | 0.048663        | 0.017995        | 0.005956        | 0.128881        |
| 303.75-326.25                         | 0.004055        | 0.026359        | 0.023318        | 0.034850        | 0.006083        | 0.001267        | 0.095932        |
| 326.25-348.75                         | 0.003422        | 0.009251        | 0.009631        | 0.008237        | 0.001394        | 0.000127        | 0.032062        |
| <b>Subtotal</b>                       | <b>0.083893</b> | <b>0.331644</b> | <b>0.177417</b> | <b>0.213408</b> | <b>0.048536</b> | <b>0.015461</b> | <b>0.869367</b> |
| <b>Calms</b>                          |                 |                 |                 |                 |                 |                 | <b>0.129494</b> |
| <b>Missing/Incomplete</b>             |                 |                 |                 |                 |                 |                 | <b>0.001139</b> |
| <b>Total</b>                          |                 |                 |                 |                 |                 |                 | <b>1.000000</b> |

Frequency of Calm Winds: 12.96%  
Average Wind Speed: 7.77 Knots

**Table C-3. Winter 2009 (January 1–February 29, December 1–December 31) Frequency Distribution (Count)**

| <b>Speed Knots<br/>Wind Direction</b> | <b>1-4</b> | <b>4-7</b> | <b>7-11</b> | <b>11-17</b> | <b>17-21</b> | <b>&gt;= 22</b> | <b>Total</b> |
|---------------------------------------|------------|------------|-------------|--------------|--------------|-----------------|--------------|
| 348.75–11.25                          | 5          | 11         | 0           | 1            | 0            | 0               | 17           |
| 11.25–33.75                           | 5          | 13         | 3           | 0            | 0            | 0               | 21           |
| 33.75–56.25                           | 10         | 52         | 9           | 3            | 0            | 0               | 74           |
| 56.25–78.75                           | 3          | 26         | 3           | 4            | 0            | 0               | 36           |
| 78.75–101.25                          | 8          | 21         | 14          | 16           | 0            | 0               | 59           |
| 101.25–123.75                         | 16         | 14         | 2           | 6            | 1            | 0               | 39           |
| 123.75–146.25                         | 11         | 15         | 3           | 2            | 0            | 0               | 31           |
| 146.25–168.75                         | 13         | 13         | 0           | 2            | 0            | 0               | 28           |
| 168.75–191.25                         | 15         | 21         | 1           | 0            | 0            | 0               | 37           |
| 191.25–213.75                         | 3          | 26         | 4           | 2            | 0            | 0               | 35           |
| 213.75–236.25                         | 9          | 27         | 3           | 12           | 9            | 9               | 69           |
| 236.25–258.75                         | 8          | 52         | 21          | 21           | 2            | 1               | 105          |
| 258.75–281.25                         | 23         | 145        | 161         | 245          | 51           | 8               | 633          |
| 281.25–303.75                         | 17         | 53         | 44          | 194          | 97           | 28              | 433          |
| 303.75–326.25                         | 7          | 62         | 56          | 85           | 21           | 4               | 235          |
| 326.25–348.75                         | 7          | 12         | 9           | 13           | 2            | 1               | 44           |
| <b>Subtotal</b>                       | <b>160</b> | <b>563</b> | <b>333</b>  | <b>606</b>   | <b>183</b>   | <b>51</b>       | <b>1,896</b> |
| <b>Calms</b>                          |            |            |             |              |              |                 | <b>235</b>   |
| <b>Missing/Incomplete</b>             |            |            |             |              |              |                 | <b>5</b>     |
| <b>Total</b>                          |            |            |             |              |              |                 | <b>2,136</b> |

Frequency of Calm Winds: 11.03%  
Average Wind Speed: 9.14 Knots

**Table C-4. Winter 2009 (January 1–February 29, December 1–December 31) Frequency Distribution (Normalized)**

| <b>Speed Knots<br/>Wind Direction</b> | <b>1-4</b> | <b>4-7</b> | <b>7-11</b> | <b>11-17</b> | <b>17-21</b> | <b>&gt;= 22</b> | <b>Total</b>    |
|---------------------------------------|------------|------------|-------------|--------------|--------------|-----------------|-----------------|
| 348.75–11.25                          | 0.002346   | 0.005162   | 0.000000    | 0.000469     | 0.000000     | 0.000000        | 0.007977        |
| 11.25–33.75                           | 0.002346   | 0.006100   | 0.001408    | 0.000000     | 0.000000     | 0.000000        | 0.009855        |
| 33.75–56.25                           | 0.004693   | 0.024402   | 0.004223    | 0.001408     | 0.000000     | 0.000000        | 0.034725        |
| 56.25–78.75                           | 0.001408   | 0.012201   | 0.001408    | 0.001877     | 0.000000     | 0.000000        | 0.016893        |
| 78.75–101.25                          | 0.003754   | 0.009855   | 0.006570    | 0.007508     | 0.000000     | 0.000000        | 0.027687        |
| 101.25–123.75                         | 0.007508   | 0.006570   | 0.000939    | 0.002816     | 0.000469     | 0.000000        | 0.018301        |
| 123.75–146.25                         | 0.005162   | 0.007039   | 0.001408    | 0.000939     | 0.000000     | 0.000000        | 0.014547        |
| 146.25–168.75                         | 0.006100   | 0.006100   | 0.000000    | 0.000939     | 0.000000     | 0.000000        | 0.013139        |
| 168.75–191.25                         | 0.007039   | 0.009855   | 0.000469    | 0.000000     | 0.000000     | 0.000000        | 0.017363        |
| 191.25–213.75                         | 0.001408   | 0.012201   | 0.001877    | 0.000939     | 0.000000     | 0.000000        | 0.016424        |
| 213.75–236.25                         | 0.004223   | 0.012670   | 0.001408    | 0.005631     | 0.004223     | 0.004223        | 0.032379        |
| 236.25–258.75                         | 0.003754   | 0.024402   | 0.009855    | 0.009855     | 0.000939     | 0.000469        | 0.049273        |
| 258.75–281.25                         | 0.010793   | 0.068043   | 0.075551    | 0.114969     | 0.023932     | 0.003754        | 0.297044        |
| 281.25–303.75                         | 0.007977   | 0.024871   | 0.020648    | 0.091037     | 0.045519     | 0.013139        | 0.203191        |
| 303.75–326.25                         | 0.003285   | 0.029094   | 0.026279    | 0.039887     | 0.009855     | 0.001877        | 0.110277        |
| 326.25–348.75                         | 0.003285   | 0.005631   | 0.004223    | 0.006100     | 0.000939     | 0.000469        | 0.020648        |
| Subtotal                              | 0.075082   | 0.264195   | 0.156265    | 0.284374     | 0.085875     | 0.023932        | 0.887640        |
| Calms                                 |            |            |             |              |              |                 | 0.110019        |
| Missing/Incomplete                    |            |            |             |              |              |                 | 0.002341        |
| <b>Total</b>                          |            |            |             |              |              |                 | <b>1.000000</b> |

Frequency of Calm Winds: 11.03%  
Average Wind Speed: 9.14 Knots

**Table C-5. Spring 2009 (March 1–May 31) Frequency Distribution (Count)**

| <b>Speed Knots<br/>Wind Direction</b> | <b>1-4</b> | <b>4-7</b> | <b>7-11</b> | <b>11-17</b> | <b>17-21</b> | <b>&gt;= 22</b> | <b>Total</b> |
|---------------------------------------|------------|------------|-------------|--------------|--------------|-----------------|--------------|
| 348.75–11.25                          | 3          | 20         | 5           | 3            | 0            | 0               | 31           |
| 11.25–33.75                           | 4          | 17         | 6           | 3            | 1            | 0               | 31           |
| 33.75–56.25                           | 7          | 30         | 27          | 1            | 0            | 0               | 65           |
| 56.25–78.75                           | 5          | 22         | 13          | 3            | 0            | 0               | 43           |
| 78.75–101.25                          | 13         | 26         | 14          | 31           | 15           | 1               | 100          |
| 101.25–123.75                         | 7          | 16         | 24          | 21           | 6            | 4               | 78           |
| 123.75–146.25                         | 7          | 15         | 4           | 6            | 0            | 0               | 32           |
| 146.25–168.75                         | 6          | 18         | 1           | 1            | 0            | 0               | 26           |
| 168.75–191.25                         | 6          | 26         | 2           | 4            | 2            | 3               | 43           |
| 191.25–213.75                         | 3          | 25         | 17          | 10           | 0            | 0               | 55           |
| 213.75–236.25                         | 5          | 31         | 1           | 13           | 7            | 0               | 57           |
| 236.25–258.75                         | 10         | 34         | 13          | 9            | 1            | 0               | 67           |
| 258.75–281.25                         | 20         | 72         | 48          | 46           | 7            | 6               | 199          |
| 281.25–303.75                         | 6          | 36         | 39          | 36           | 10           | 4               | 131          |
| 303.75–326.25                         | 3          | 39         | 19          | 55           | 7            | 0               | 123          |
| 326.25–348.75                         | 4          | 16         | 17          | 27           | 5            | 0               | 69           |
| <b>Subtotal</b>                       | <b>109</b> | <b>443</b> | <b>250</b>  | <b>269</b>   | <b>61</b>    | <b>18</b>       | <b>1,150</b> |
| <b>Calms</b>                          |            |            |             |              |              |                 | <b>177</b>   |
| <b>Missing/Incomplete</b>             |            |            |             |              |              |                 | <b>1</b>     |
| <b>Total</b>                          |            |            |             |              |              |                 | <b>1,328</b> |

Frequency of Calm Winds: 13.34%

Average Wind Speed: 7.62 Knots

**Table C-6. Spring 2009 (March 1–May 31) Frequency Distribution (Normalized)**

| <b>Speed Knots<br/>Wind Direction</b> | <b>1-4</b>      | <b>4-7</b>      | <b>7-11</b>     | <b>11-17</b>    | <b>17-21</b>    | <b>&gt;= 22</b> | <b>Total</b>    |
|---------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 348.75-11.25                          | 0.002261        | 0.015072        | 0.003768        | 0.002261        | 0.000000        | 0.000000        | 0.023361        |
| 11.25-33.75                           | 0.003014        | 0.012811        | 0.004521        | 0.002261        | 0.000754        | 0.000000        | 0.023361        |
| 33.75-56.25                           | 0.005275        | 0.022607        | 0.020347        | 0.000754        | 0.000000        | 0.000000        | 0.048983        |
| 56.25-78.75                           | 0.003768        | 0.016579        | 0.009797        | 0.002261        | 0.000000        | 0.000000        | 0.032404        |
| 78.75-101.25                          | 0.009797        | 0.019593        | 0.010550        | 0.023361        | 0.011304        | 0.000754        | 0.075358        |
| 101.25-123.75                         | 0.005275        | 0.012057        | 0.018086        | 0.015825        | 0.004521        | 0.003014        | 0.058779        |
| 123.75-146.25                         | 0.005275        | 0.011304        | 0.003014        | 0.004521        | 0.000000        | 0.000000        | 0.024115        |
| 146.25-168.75                         | 0.004521        | 0.013564        | 0.000754        | 0.000754        | 0.000000        | 0.000000        | 0.019593        |
| 168.75-191.25                         | 0.004521        | 0.019593        | 0.001507        | 0.003014        | 0.001507        | 0.002261        | 0.032404        |
| 191.25-213.75                         | 0.002261        | 0.018839        | 0.012811        | 0.007536        | 0.000000        | 0.000000        | 0.041447        |
| 213.75-236.25                         | 0.003768        | 0.023361        | 0.000754        | 0.009797        | 0.005275        | 0.000000        | 0.042954        |
| 236.25-258.75                         | 0.007536        | 0.025622        | 0.009797        | 0.006782        | 0.000754        | 0.000000        | 0.050490        |
| 258.75-281.25                         | 0.015072        | 0.054258        | 0.036172        | 0.034665        | 0.005275        | 0.004521        | 0.149962        |
| 281.25-303.75                         | 0.004521        | 0.027129        | 0.029390        | 0.027129        | 0.007536        | 0.003014        | 0.098719        |
| 303.75-326.25                         | 0.002261        | 0.029390        | 0.014318        | 0.041447        | 0.005275        | 0.000000        | 0.092690        |
| 326.25-348.75                         | 0.003014        | 0.012057        | 0.012811        | 0.020347        | 0.003768        | 0.000000        | 0.051997        |
| <b>Subtotal</b>                       | <b>0.082140</b> | <b>0.333836</b> | <b>0.188395</b> | <b>0.202713</b> | <b>0.045968</b> | <b>0.013564</b> | <b>0.865964</b> |
| Calms                                 |                 |                 |                 |                 |                 |                 | 0.133283        |
| Missing/Incomplete                    |                 |                 |                 |                 |                 |                 | 0.000753        |
| <b>Total</b>                          |                 |                 |                 |                 |                 |                 | <b>1.000000</b> |

Frequency of Calm Winds: 13.34%

Average Wind Speed: 7.62 Knots

**Table C-7. Summer 2009 (June 1–August 31) Frequency Distribution (Count)**

| <b>Speed Knots<br/>Wind Direction</b> | <b>1-4</b> | <b>4-7</b> | <b>7-11</b> | <b>11-17</b> | <b>17-21</b> | <b>&gt;= 22</b> | <b>Total</b> |
|---------------------------------------|------------|------------|-------------|--------------|--------------|-----------------|--------------|
| 348.75–11.25                          | 8          | 28         | 7           | 9            | 0            | 0               | 52           |
| 11.25–33.75                           | 10         | 32         | 6           | 3            | 0            | 0               | 51           |
| 33.75–56.25                           | 7          | 65         | 21          | 4            | 0            | 0               | 97           |
| 56.25–78.75                           | 10         | 61         | 29          | 13           | 1            | 0               | 114          |
| 78.75–101.25                          | 10         | 80         | 83          | 69           | 10           | 1               | 253          |
| 101.25–123.75                         | 10         | 69         | 45          | 32           | 5            | 0               | 161          |
| 123.75–146.25                         | 4          | 31         | 8           | 9            | 2            | 0               | 54           |
| 146.25–168.75                         | 8          | 29         | 5           | 5            | 1            | 0               | 48           |
| 168.75–191.25                         | 13         | 37         | 6           | 9            | 0            | 1               | 66           |
| 191.25–213.75                         | 12         | 51         | 22          | 16           | 5            | 3               | 109          |
| 213.75–236.25                         | 13         | 35         | 5           | 16           | 6            | 0               | 75           |
| 236.25–258.75                         | 8          | 58         | 9           | 16           | 4            | 0               | 95           |
| 258.75–281.25                         | 20         | 99         | 41          | 34           | 5            | 0               | 199          |
| 281.25–303.75                         | 13         | 57         | 25          | 49           | 4            | 0               | 148          |
| 303.75–326.25                         | 9          | 43         | 50          | 52           | 8            | 2               | 164          |
| 326.25–348.75                         | 12         | 24         | 27          | 10           | 0            | 0               | 73           |
| <b>Subtotal</b>                       | <b>167</b> | <b>799</b> | <b>389</b>  | <b>346</b>   | <b>51</b>    | <b>7</b>        | <b>1,759</b> |
| <b>Calms</b>                          |            |            |             |              |              |                 | <b>274</b>   |
| <b>Missing/Incomplete</b>             |            |            |             |              |              |                 | <b>1</b>     |
| <b>Total</b>                          |            |            |             |              |              |                 | <b>2,034</b> |

Frequency of Calm Winds: 13.48%

Average Wind Speed: 6.84 Knots

**Table C-8. Summer 2009 (June 1–August 31) Frequency Distribution (Normalized)**

| <b>Speed Knots<br/>Wind Direction</b> | <b>1-4</b> | <b>4-7</b> | <b>7-11</b> | <b>11-17</b> | <b>17-21</b> | <b>&gt;= 22</b> | <b>Total</b>    |
|---------------------------------------|------------|------------|-------------|--------------|--------------|-----------------|-----------------|
| 348.75–11.25                          | 0.003935   | 0.013773   | 0.003443    | 0.004427     | 0.000000     | 0.000000        | 0.025578        |
| 11.25–33.75                           | 0.004919   | 0.015740   | 0.002951    | 0.001476     | 0.000000     | 0.000000        | 0.025086        |
| 33.75–56.25                           | 0.003443   | 0.031972   | 0.010330    | 0.001968     | 0.000000     | 0.000000        | 0.047713        |
| 56.25–78.75                           | 0.004919   | 0.030005   | 0.014265    | 0.006394     | 0.000492     | 0.000000        | 0.056075        |
| 78.75–101.25                          | 0.004919   | 0.039351   | 0.040826    | 0.033940     | 0.004919     | 0.000492        | 0.124447        |
| 101.25–123.75                         | 0.004919   | 0.033940   | 0.022135    | 0.015740     | 0.002459     | 0.000000        | 0.079193        |
| 123.75–146.25                         | 0.001968   | 0.015248   | 0.003935    | 0.004427     | 0.000984     | 0.000000        | 0.026562        |
| 146.25–168.75                         | 0.003935   | 0.014265   | 0.002459    | 0.002459     | 0.000492     | 0.000000        | 0.023610        |
| 168.75–191.25                         | 0.006394   | 0.018200   | 0.002951    | 0.004427     | 0.000000     | 0.000492        | 0.032464        |
| 191.25–213.75                         | 0.005903   | 0.025086   | 0.010821    | 0.007870     | 0.002459     | 0.001476        | 0.053615        |
| 213.75–236.25                         | 0.006394   | 0.017216   | 0.002459    | 0.007870     | 0.002951     | 0.000000        | 0.036891        |
| 236.25–258.75                         | 0.003935   | 0.028529   | 0.004427    | 0.007870     | 0.001968     | 0.000000        | 0.046729        |
| 258.75–281.25                         | 0.009838   | 0.048697   | 0.020167    | 0.016724     | 0.002459     | 0.000000        | 0.097885        |
| 281.25–303.75                         | 0.006394   | 0.028037   | 0.012297    | 0.024102     | 0.001968     | 0.000000        | 0.072799        |
| 303.75–326.25                         | 0.004427   | 0.021151   | 0.024594    | 0.025578     | 0.003935     | 0.000984        | 0.080669        |
| 326.25–348.75                         | 0.005903   | 0.011805   | 0.013281    | 0.004919     | 0.000000     | 0.000000        | 0.035908        |
| Subtotal                              | 0.082145   | 0.393015   | 0.191343    | 0.170192     | 0.025086     | 0.003443        | 0.864798        |
| Calms:                                |            |            |             |              |              |                 | 0.134710        |
| Missing/Incomplete                    |            |            |             |              |              |                 | 0.000492        |
| <b>Total</b>                          |            |            |             |              |              |                 | <b>1.000000</b> |

Frequency of Calm Winds: 13.48%

Average Wind Speed: 6.84 Knots

**Table C-9. Fall 2009 (September 1–November 30) Frequency Distribution (Count)**

| <b>Speed Knots<br/>Wind Direction</b> | <b>1-4</b> | <b>4-7</b> | <b>7-11</b> | <b>11-17</b> | <b>17-21</b> | <b>&gt;= 22</b> | <b>Total</b> |
|---------------------------------------|------------|------------|-------------|--------------|--------------|-----------------|--------------|
| 348.75–11.25                          | 16         | 14         | 6           | 1            | 0            | 0               | 37           |
| 11.25–33.75                           | 11         | 19         | 0           | 0            | 0            | 0               | 30           |
| 33.75–56.25                           | 12         | 31         | 3           | 0            | 0            | 0               | 46           |
| 56.25–78.75                           | 12         | 31         | 6           | 1            | 0            | 0               | 50           |
| 78.75–101.25                          | 18         | 35         | 30          | 26           | 3            | 0               | 112          |
| 101.25–123.75                         | 15         | 26         | 14          | 8            | 0            | 0               | 63           |
| 123.75–146.25                         | 14         | 11         | 3           | 3            | 0            | 0               | 31           |
| 146.25–168.75                         | 7          | 18         | 1           | 3            | 0            | 0               | 29           |
| 168.75–191.25                         | 35         | 35         | 3           | 3            | 4            | 2               | 82           |
| 191.25–213.75                         | 30         | 55         | 24          | 11           | 3            | 0               | 123          |
| 213.75–236.25                         | 31         | 33         | 6           | 20           | 12           | 3               | 105          |
| 236.25–258.75                         | 34         | 43         | 16          | 18           | 2            | 1               | 114          |
| 258.75–281.25                         | 48         | 134        | 117         | 58           | 3            | 0               | 360          |
| 281.25–303.75                         | 20         | 63         | 74          | 64           | 18           | 5               | 244          |
| 303.75–326.25                         | 18         | 64         | 66          | 58           | 8            | 1               | 215          |
| 326.25–348.75                         | 7          | 20         | 19          | 12           | 1            | 0               | 59           |
| Subtotal                              | 328        | 632        | 388         | 286          | 54           | 12              | 1700         |
| Calms                                 |            |            |             |              |              |                 | 228          |
| Missing/Incomplete                    |            |            |             |              |              |                 | 2            |
| <b>Total</b>                          |            |            |             |              |              |                 | <b>1,930</b> |

Frequency of Calm Winds: 11.83%

Average Wind Speed: 6.77 Knots

**Table C-10. Fall 2009 (September 1–November 30) Frequency Distribution (Normalized)**

| <b>Speed Knots<br/>Wind Direction</b> | <b>1-4</b> | <b>4-7</b> | <b>7-11</b> | <b>11-17</b> | <b>17-21</b> | <b>&gt;= 22</b> | <b>Total</b> |
|---------------------------------------|------------|------------|-------------|--------------|--------------|-----------------|--------------|
| 348.75–11.25                          | 0.008299   | 0.007261   | 0.003112    | 0.000519     | 0.000000     | 0.000000        | 0.019191     |
| 11.25–33.75                           | 0.005705   | 0.009855   | 0.000000    | 0.000000     | 0.000000     | 0.000000        | 0.015560     |
| 33.75–56.25                           | 0.006224   | 0.016079   | 0.001556    | 0.000000     | 0.000000     | 0.000000        | 0.023859     |
| 56.25–78.75                           | 0.006224   | 0.016079   | 0.003112    | 0.000519     | 0.000000     | 0.000000        | 0.025934     |
| 78.75–101.25                          | 0.009336   | 0.018154   | 0.015560    | 0.013485     | 0.001556     | 0.000000        | 0.058091     |
| 101.25–123.75                         | 0.007780   | 0.013485   | 0.007261    | 0.004149     | 0.000000     | 0.000000        | 0.032676     |
| 123.75–146.25                         | 0.007261   | 0.005705   | 0.001556    | 0.001556     | 0.000000     | 0.000000        | 0.016079     |
| 146.25–168.75                         | 0.003631   | 0.009336   | 0.000519    | 0.001556     | 0.000000     | 0.000000        | 0.015041     |
| 168.75–191.25                         | 0.018154   | 0.018154   | 0.001556    | 0.001556     | 0.002075     | 0.001037        | 0.042531     |
| 191.25–213.75                         | 0.015560   | 0.028527   | 0.012448    | 0.005705     | 0.001556     | 0.000000        | 0.063797     |
| 213.75–236.25                         | 0.016079   | 0.017116   | 0.003112    | 0.010373     | 0.006224     | 0.001556        | 0.054461     |
| 236.25–258.75                         | 0.017635   | 0.022303   | 0.008299    | 0.009336     | 0.001037     | 0.000519        | 0.059129     |
| 258.75–281.25                         | 0.024896   | 0.069502   | 0.060685    | 0.030083     | 0.001556     | 0.000000        | 0.186722     |
| 281.25–303.75                         | 0.010373   | 0.032676   | 0.038382    | 0.033195     | 0.009336     | 0.002593        | 0.126556     |
| 303.75–326.25                         | 0.009336   | 0.033195   | 0.034232    | 0.030083     | 0.004149     | 0.000519        | 0.111515     |
| 326.25–348.75                         | 0.003631   | 0.010373   | 0.009855    | 0.006224     | 0.000519     | 0.000000        | 0.030602     |
| Subtotal                              | 0.170124   | 0.327801   | 0.201245    | 0.148340     | 0.028008     | 0.006224        | 0.880829     |
| Calms                                 |            |            |             |              |              |                 | 0.118135     |
| Missing/Incomplete                    |            |            |             |              |              |                 | 0.001036     |
| Total                                 |            |            |             |              |              |                 | 1.000000     |

Frequency of Calm Winds: 11.83%  
Average Wind Speed: 6.77 Knots