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Civilian Radioactive Waste Management System
Management & Operating Contractor

Engineering Design Climatology and Regional Meteorological Conditions Report

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October 2, 1997

Prepared for:

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Yucca Mountain Site Characterization Office
P.O. Box 30307
North Las Vegas, NV 89036-0307

Prepared by:

TRW Environmental Safety Systems Inc.
1180 Town Center Drive
Las Vegas, Nevada 89134

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DISCLAIMER

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Prepared by:

Paul M Fransioli

Paul M. Fransioli, CCM

October 2, 1997

Date

Approved by:

Dale S Ambos

Dale S. Ambos, EFPD Manager

October 2, 1997

Date

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EXECUTIVE SUMMARY

Environmental and site characterization studies related to atmospheric dispersion, engineering design, geohydrology, and climate require information on regional and site-specific meteorological conditions. This report documents present meteorological conditions at and near Yucca Mountain. Data from the site-specific meteorological networks operating in the immediate vicinity of Yucca Mountain and long-term data from regional stations were compared to improve estimates of extreme wind and precipitation conditions.

The analyses confirmed results of previous investigations that the region around Yucca Mountain is arid and warm. Total rainfall is typically less than 10 inches per year. The air temperatures range between over 40°C during summer days to below 0°C during winter nights. Occasional stormy periods can have strong winds and/or significant rainfall. Snowfall is rarely reported at the nearby regional observing stations, though snowfall occasionally occurs at elevations over about 3,500 feet above mean sea level on, and north of, Yucca Mountain. Lightning can accompany summer thunderstorms, but very few tornadoes have been reported in the region. Other potentially severe weather events, such as blizzards and hurricanes, do not occur in the region. Regional and local topography, and large scale atmospheric circulation patterns, strongly influence the typical and extreme precipitation occurrences, air temperature, and airflow patterns.

Observed daily rainfall totals recently exceeded two to three inches at nearby sites within the last 15 years. The maximum daily precipitation event within 50 kilometers of Yucca Mountain is not expected to exceed five inches. This estimate is based on statistical analyses of observations, and considerations of atmospheric mechanisms. One guidance document produced by the National Oceanic and Atmospheric Administration (NWS 1977) developed estimates of maximum one-hour and daily precipitation events that could occur (Probable Maximum Precipitation) in the Great Basin and Colorado River drainage; both values for the Yucca Mountain area are approximately 10 inches of rainfall. This estimate is perceived as extremely conservative. Another guidance document, the NOAA Atlas 2 (NOAA 1973) shows the expected 100-year return period 24-hour rainfall for Yucca Mountain to be 2.60 inches.

Maximum observed wind gust speeds can exceed 40 meters per second (m/s), about 90 miles per hour (mph), particularly on hilltop, exposed terrain locations. Observed one-minute average wind speeds (frequently associated with previous "fastest-mile" data) are approximately 30 m/s (67 mph). Statistical estimates of the 100-year return period of the gust and one-minute speeds are about 50 m/s (112 mph) and about 45 m/s (101 mph), respectively. The fastest winds tend to be from either the northerly or southerly directions, with topographic channeling steering the winds along valley axes.

Engineering design calculations frequently utilize routine summaries made for the American Society of Refrigeration, Heating, and Air Conditioning Engineers. Table A-17 in Appendix A contains the American Society of Refrigeration, Heating, and Air Conditioning Engineers tables for the R/EFPD sites. The results for R/EFPD Site 1, which is located near the proposed location of some surface facilities, include a winter 99 percent dry-bulb design value of -5°C, and a summer one percent dry-bulb with coincident wet-bulb of 37°C and 16°C.

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1. INTRODUCTION

Regional meteorological conditions relevant to Yucca Mountain Site Characterization Office (YMSCO) studies such as environmental impacts and engineering design are described in this report. The two primary reasons for characterizing regional conditions are the needs to perform analyses of possible impacts of airborne material in populated areas near Yucca Mountain, and to characterize typical and extreme weather events using data sources with longer periods of record than those available in the site-specific measurement program.

The regional meteorology information presented in this report complements descriptions of meteorological conditions in the local Yucca Mountain vicinity given in annual summary reports on results from the network of nine stations operated by the Management and Operating Contractors (M&O) Radiological and Environmental Field Programs Department (R/EFPD) (CRWMS M&O 1993a; 1993b; 1995c; 1995d; and 1996). Data from the R/EFPD network were used in this regional analysis to identify the regional stations that are most representative of the Yucca Mountain area. Two other YMSCO sources of complementary information on regional meteorology include a topical report on regional airflow patterns being written in the same overall investigation of regional meteorology, and results from precipitation climatology studies in the geohydrology program. The purpose of including detailed data from the immediate Yucca Mountain study area in this report on regional meteorological conditions is to provide the basis for comparisons to the regional data sources. The primary purpose of studying data from regional sources is to minimize the uncertainties in characterizing the local conditions using site-specific data from a relatively short time period.

Remaining sections in this report include information on background of the study, purpose and objectives, and the technical approach. Further report sections include information on data sources, summary methods, and presentations of the data summaries.

1.1 BACKGROUND

The need for a consolidated source of information on typical and extreme recent regional meteorological conditions beyond that available at the time was recognized during planning for Yucca Mountain site characterization. Chapter 5 of the Yucca Mountain Site Characterization Plan (SCP) (DOE 1988), contains descriptions of regional meteorological conditions based on standard climatic data sources and early reports from Yucca Mountain and Nevada Test Site studies. Information needs identified in the SCP included general climatological data to support airborne material impact assessments, geohydrology and climate studies, engineering design, and environmental studies. Further specific data on extreme events were recognized as a probable need for engineering design purposes.

The Meteorology Program included in the SCP Section 8.3.1.12 focused on the plan to collect more information on general meteorological conditions, in contrast to specific precipitation and storm studies in the Geohydrology Program, Section 8.3.1.2, and longer term past and future climate studies included in the Climate Program, Section 8.3.1.5. The plan for the Meteorology Program in SCP Section 8.3.1.12 originally had four separate investigations. One investigation, 8.3.1.12.2, covered the operation of the nine (originally five) meteorological stations. The other three

investigations were related to descriptions and analyses of regional meteorological conditions, 8.3.1.12.1, 8.3.1.12.3 and 8.3.1.12.4. Rather than separately manage the three related regional meteorology studies, work on the three regional meteorology investigations were combined into a single planning document, the Scientific Investigation Implementation Package (SIIP) for Regional Meteorology (CRWMS M&O 1995). The SIIP organized the work into the following three primary areas: atmospheric dispersion, engineering design, and general regional meteorology, with each of the three work areas being reported separately. As work progressed on the engineering design and general regional meteorology, it became apparent to combine these two reports into one to facilitate production and utilization of the information. Results in the third work area, atmospheric dispersion and regional scale airflow patterns relative to population centers, will be presented in a separate report.

1.2 PURPOSE AND OBJECTIVES

The purpose and objectives of the overall regional meteorology investigation stated in the SIIP were simply to describe regional meteorological characteristics sufficiently to satisfy the three basic information needs related to: radiation dose calculations applicable to the regional area, identification of typical and extreme meteorological conditions related to engineering design of surface facilities, and general regional climate descriptions to be used by the climate and environmental studies. The specific purpose of this report is to provide the information described in Tasks 3 and 4 of the SIIP, which are the information needs for engineering design and general regional conditions. This report does not attempt to repeat the information presented in Chapter 5 of the SCP. More specifically, the objectives of this report are to:

- determine to what extent data from nearby regional sites are representative of the Yucca Mountain area by comparing results from regional and site-specific data sources for the same time periods

- summarize and present data from the Yucca Mountain Project and nearby regional sites to provide the climatological statistics needed for engineering design and general climatic descriptions.

The scope of this study includes analyses of meteorological data taken by the Yucca Mountain Project participants, data taken at the Nevada Test Site, and data taken by other agencies and groups in the region. The scope does not include climate modeling simulations, such as those being performed as part of the Yucca Mountain climate studies (Giorgi 1992).

1.3 TECHNICAL APPROACH

The objectives of this report were achieved in three basic steps. First, suitable regional data sources were identified; second, specific data information needs were identified; and third, the summary statistics were produced.

First, the known potential sources of regional data were summarized in the Meteorological Data Synthesis Report (M&O 1996). A subset of these sources was chosen for further analysis based on

data availability and probable representativeness of the source to the Yucca Mountain area. This selection process is described in Section 3.3 of this report.

Second, review of literature sources on engineering data and climatological summaries provided the basis of determining the appropriate summary statistics to use in the data analysis. This process is described in Section 3 of this report. The reviews were supplemented by meetings with engineering design staff to ensure that the proper data needs would be met.

Third, the data summaries and analyses were performed. Some summaries are reports of data in a format similar to that included in typical climatological data publications. Statistical analyses were used to estimate the probability of extreme wind and precipitation events occurring during various time periods. The results are provided in Section 4 of this report.

The geographic scope of the study was approached in two steps. Detailed data were sought from nearby stations within 80 kilometers of Yucca Mountain. These stations were the most likely to be utilized as representative of the Yucca Mountain area. Generalized summaries were also created for a few sites that are farther away from Yucca Mountain, but may be involved in the transportation of waste material into Nevada from other states.

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2. REGIONAL METEOROLOGICAL DATA SOURCES

The sources of regional meteorological data used in this report are identified in this section. These sources reflect the intent to focus on information that has become available since the climate descriptions were written for Chapter 5 of the SCP. Information on the data sources can be found in the Meteorological Data Synthesis Report (M&O 1996).

2.1 YMSCO: RADIOLOGICAL AND ENVIRONMENTAL FIELD PROGRAMS DEPARTMENT (R/EFPD)

The primary source of general meteorological data from the immediate vicinity of the Yucca Mountain studies is the R/EFPD network. The original network of five stations was established as an environmental monitoring network in December 1985. The network is the primary source of site-specific meteorological and climatic data required for various purposes (SCP, Section 8.3.1.12). The network was expanded to nine stations during 1992 to improve airflow characterization in and around Midway Valley and the nearest populated area in the community of Amargosa Valley. The meteorological measurements were modified during 1993 to conform with evolving regulatory guidance on meteorological data input for atmospheric dispersion modeling.

The data from these stations applicable to the regional meteorology study is limited to the basic meteorological measurements of air temperature and humidity, wind, and precipitation. The barometric pressure and indicators of atmospheric stability are not relevant for this report, but are important in characterizing local airflow and as input for atmospheric dispersion models used in assessing impacts of releases of airborne material.

Locations of the nine stations in the R/EFPD network are identified in Figure 2-1 and Table 2-1. The relevant measurements and data summaries for the regional meteorological analyses are:

- Air temperature and atmospheric humidity were measured at 2 meters above ground level (m-agl) in mechanically aspired shields since September 1993; prior measurements were made at 10 m-agl in naturally aspirated shields. Further information on the temperature measurements is given below.

- Horizontal wind speed and wind direction were measured at 10 m-agl using sensitive cup anemometers and wind vanes.

- Precipitation was measured approximately one m-agl using 8-inch orifice tipping bucket gauges with 0.01-inch precipitation measurement resolution. The data were stored as hourly totals. Storage gauges with 8-inch orifices were added during 1995.

- On-site data processing at the R/EFPD stations has always included one-second samples being averaged for clock hour periods. Beginning in September 1993, maximum three-second average wind speeds and maximum one-minute wind speed with corresponding direction were also recorded. The daily extreme one-minute average temperatures were added at the same time, intending to optimize comparisons with typical climatological daily extreme measurements made using glass thermometers.

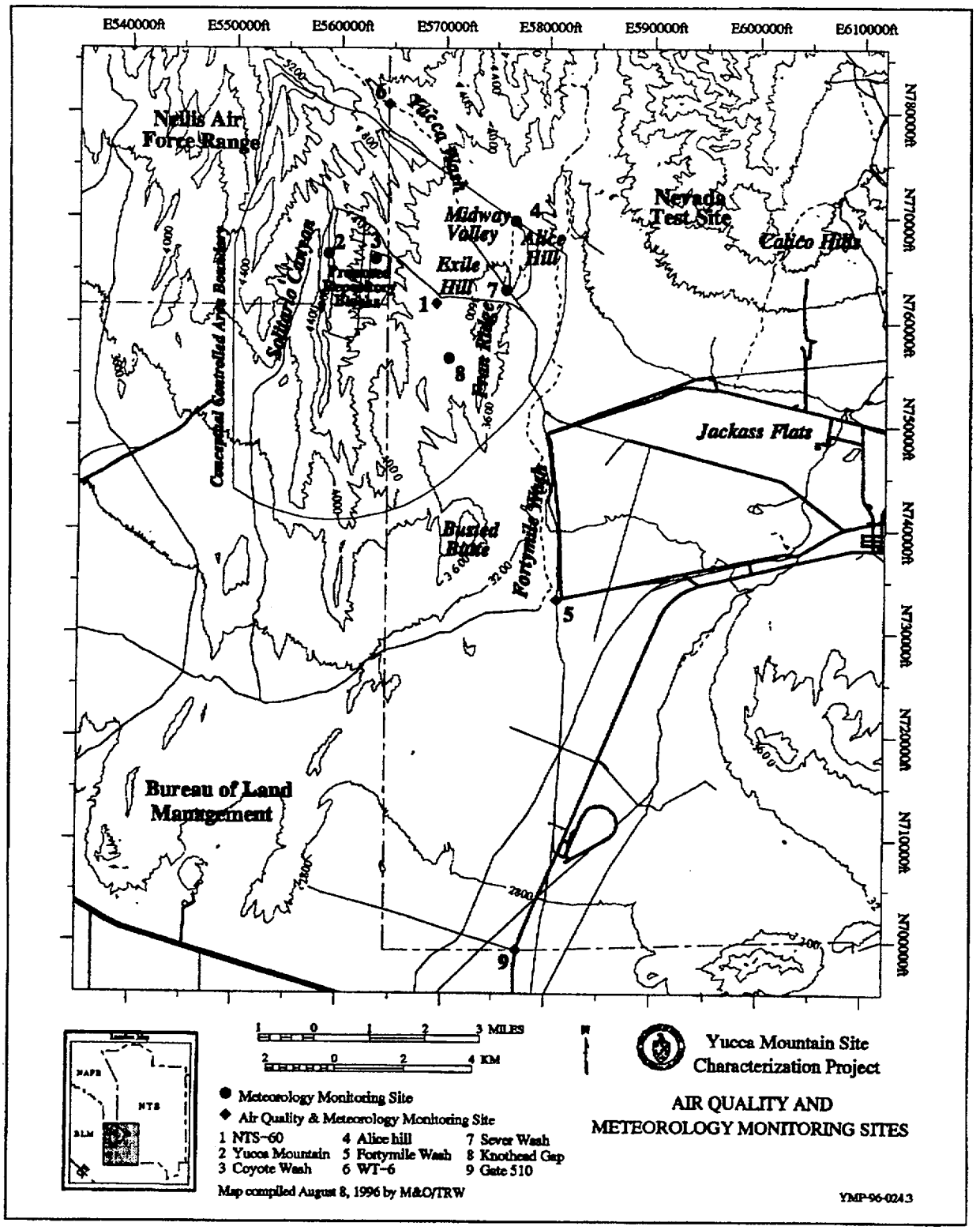


Figure 2-1. Locations of the Meteorological Monitoring Sites

Table 2-1. Coordinates of the Meteorological Monitoring Sites

Site	UTM Coordinates Zone 11 (meters)	Nevada Coordinates System Central Zone (feet)	Latitude-Longitude[1] (deg° min' sec")	Elevation (above mean sea level)
Site 1 (NTS-60)	550,784E 4,077,374N	569,126E 761,795N	116°25'50"W 36°50'34"N	3750 ft 1143 m
Site 2 (Yucca Mountain)	547,646E 4,078,753N	558,844E 766,356N	116°27'56"W 36°51'19"N	4850 ft 1478 m
Site 3 (Coyote Wash)	548,874E 4,078,701N	562,874E 766,171N	116°27'06"W 36°51'17"N	4195 ft 1279 m
Site 4 (Alice Hill)	553,117E 4,079,779N	576,810E 769,661N	116°24'15"W 36°51'51"N	4050 ft 1234 m
Site 5 (Fortymile Wash)	554,385E 4,068,727N	580,843E 733,378N	116°23'26"W 36°45'52"N	3125 ft 953 m
Site 6 (WT-6)	549,388E 4,083,097N	564,612E 780,592N	116°26'45"W 36°53'40"N	4315 ft 1315 m
Site 7 (Sever Wash)	552,800E 4,077,847N	575,747E 763,324N	116°24'28"W 36°50'49"N	3545 ft 1081 m
Site 8 (Knothead Gap)	551,161E 4,075,773N	570,344E 756,538N	116°25'35"W 36°49'42"N	3710 ft 1131 m
Site 9 (Gate-510)	553,418E 4,058,398N	577,554E 699,491N	116°24'08"W 36°40'17"N	2750 ft 838 m

[1] NAD27 (North American Datum of 1927)

The design and operation of the R/EFPD network complies with and the regulatory monitoring guidance used by the U.S. Environmental Protection Agency (EPA 1987) and the U.S. Nuclear Regulatory Commission (NRC 1972). The EPA monitoring guidance is a frequently used standard for routine data collection programs for environmental monitoring purposes. The NRC guidance was also utilized to ensure that adequate data would be collected suitable for NRC regulatory atmospheric modeling. In addition to environmental regulatory guidance, the R/EFPD meteorological monitoring program was operated in accordance with approved Yucca Mountain Quality assurance requirements, including oversight by quality assurance personnel. As such, the data are considered valid for "quality-affecting" purposes.

Air temperature and relative humidity data were taken at the R/EFPD stations using naturally ventilated shields mounted at 10 meters above ground level (m-agl) from the beginning of operations through August 1993. Beginning in September 1993, the air temperature and humidity measurements were moved to 2 m-agl, a more typical height for climatological measurements. Another change in temperature measurements made at the same time was the use of aspirated

temperature shields, which was needed for the delta-temperature measurement between 2 m-agl and 10 m-agl.

2.2 U.S. GEOLOGICAL SURVEY (USGS) - YUCCA MOUNTAIN GEOHYDROLOGY PROGRAM

The USGS operated five basic meteorological stations and a network of recording and non-recording precipitation stations during various periods from 1985 through 1995. These networks were deployed on and near Yucca Mountain to specifically characterize the spatial distribution of precipitation events caused in large part by the orographic effects of the area's complex terrain. The USGS meteorological monitoring program has also been operated as a "quality-affecting" activity. Rainfall rate and storm frequency information were also key to characterizing infiltration as related to the geohydrology of the unsaturated zone. The USGS used these site-specific data, plus regional precipitation data with a long-term record, in developing an infilitration model for the potential repository location. Precipitation data from the five meteorological stations were used with data from the R/EFPD network and nearby regional stations to study the spatial distribution of precipitation.

The USGS also collected precipitation data from many sources outside the Project from southern Nevada and southern California to determine the larger, or regional scale precipitation characteristics. An analysis of regional precipitation, using geostatistical techniques, resulted in an estimate of average annual precipitation amounts within the Yucca Mountain region.

2.3 NEVADA TEST SITE: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, AIR RESOURCES LABORATORY/SPECIAL OPERATIONS AND RESEARCH DIVISION (ARL/SORD)

Primary weather support for operations at the Nevada Test Site (NTS) has been provided for many years by the ARL/SORD group, under this designation and that of predecessor organizations, such as the National Weather Service Nuclear Support Office. Much of their data collection is focused on real time acquisition, analysis, and presentation for operational purposes. Some of the stations are focused more on the longer-term precipitation climatology of the NTS.

Data from some of the nearby NTS precipitation stations and Desert Rock airport were used for this study to identify representative stations with long term precipitation records. Stations included both the old and new locations of 4JA, and Cane Springs, which are about 15 and 30 km east of Yucca Mountain, respectively, and Rock Valley and Mercury, which about 30 and 45 km southeast of Yucca Mountain, respectively. These data were used to estimate the maximum daily precipitation that could occur in the area.

2.4 NATIONAL WEATHER SERVICE PRIMARY STATIONS

In addition to the Desert Rock station, data from Las Vegas, Battle Mountain, Elko, Ely, and Tonopah, Nevada were also included in this study to help provide the long-term period of record desirable for studies of this type. These data were included to support environmental analyses along potential transportation routes within Nevada.

2.5 COOPERATIVE OBSERVER STATIONS

In addition to the primary National Weather Service stations (NWS), the NWS also coordinates operation and data reporting from a network of smaller stations staffed by volunteer observers. These "cooperative observer" stations typically include daily measurements of precipitation total and/or the maximum and minimum air temperatures. The extreme temperature data are averaged to calculate the daily average temperature, and monthly averages of the extreme values. The data are sent by the observers to the NWS, and subsequently are validated and published by the National Climatic Data Center (NCDC).

Data from four cooperative observer stations, the Amargosa Farms station, two Beatty stations, and Caliente were selected for inclusion in this study. Their selection was primarily based on their proximity to the Yucca Mountain study area and a potential transportation center near Caliente. The Amargosa Farms site is at a private residence with some agricultural activities in Amargosa Valley and is about 10 kilometers (km) south of the R/EFPD Site 9, which is near Gate 510 of the Nevada Test Site. The current Beatty station is located approximately 13 km north of Beatty, along highway U.S. 95 at Boiling Pot road. It is about 25 km west-northwest of the primary Yucca Mountain study area. The original Beatty sites were located immediately northeast of the town of Beatty. Data from Caliente were also included in this report. Caliente is approximately 170 km northeast of Yucca Mountain; this area may be involved in environmental analyses related to transportation. The descriptions of the cooperative observer sites are in Table 2-2. Data from other cooperative observer stations around eastern and central Nevada that could be used in potential transportation route studies are mentioned in Section 4 and are reported in Appendix A.

Table 2-2. Nearby NWS Cooperative Observer Stations

Station	Number	Geographic Coordinate	Elevation (feet msl)	Operation
Amargosa Farms Garey	26-0150	36°34'N 116°28'W	2450	Dec 1965 to present
Beatty	26-0714	36°54'N 116°45'W, and 36°55'N 116°45'W	3310 3300	1948 - 1957, and 1957 - Nov 1972
Beatty 8N	26-0718	37°00'N 116°43'W	3550	Dec 1972 to present
Caliente	26-1358	37°37'N 114°31'W	4403	Aug 1928 to present

2.6 OTHER DATA SOURCES

Lightning data were collected by an ARL/SORD automated detection system installed on the NTS. A lightning strike density analyses was performed for a 3,600 square kilometer area and 100 square kilometer area centered around the North Portal. The data is for the years 1991 through 1996 and provides the following information about the lightning strike: latitude, longitude, date and time, and signal sign (positive or negative). The strikes are only cloud-to-ground strikes.

Tornado occurrences since 1985 in the southwestern United States were tabulated from the National Climatic Data Center Publication Storm Data. Tornado locations, intensity, and dates of occurrences were examined.

2.7 DATA QUALITY

The data used in this report came from four sources. The first two sources were the R/EFPD and USGS meteorological monitoring programs, which are part of the Yucca Mountain Site characterization Project (YMP). These two monitoring programs have met the appropriate quality assurance requirements to produce qualified data. These data may be used to resolve safety and waste isolation issues related to the proposed geologic repository.

The third data source was the precipitation data taken as part of the NOAA/ARL/SORD meteorological monitoring program operated in support of Nevada Test Site operations. The fourth data source is the National Weather Service climatological data, including the precipitation and temperature data from the Cooperative Observer network and the more complete meteorological data from the first order weather stations. These data have been validated by the National Climatic Data Center, and are considered valid for many engineering and environmental purposes. However, data from the last two sources have not been "qualified" under the YMP process at this time. The qualification process could be undertaken if the need were demonstrated.

An Activity Evaluation was performed according to CRWMS M&O Procedure QAP-2-0, *Conduct of Activities*. The evaluation determined that the Quality Assurance Requirements and Description (QARD) does apply to the activity Regional Meteorology, B00000000-01717-2200-00120.

3. DATA SUMMARY METHODS

The methods used to identify and analyze data are described in this section with some discussion of the rationale for the approach.

3.1 LITERATURE REVIEW

Despite the relatively sparse distribution of routine meteorological monitoring stations in the vicinity of Yucca Mountain, the region has been the subject of some intensive meteorological investigations. Relevant information from select sources has been included in this report to augment the data summaries and analyses performed for this study. Some of the investigations included for presentation relate airflow and precipitation patterns in and around the Nevada Test Site. Substantial population increases in southern Nevada have also raised the level of interest in regional precipitation characteristics. Great Basin precipitation is lower in annual totals than much of the rest of the western United States, which can challenge water supply projects. On the other hand, the occasional intense rainfall events that cause flash floods in the desert areas are also very important to the socioeconomic development of the desert southwestern United States.

The lack of site-specific information on Yucca Mountain early in the site characterization program necessitated early YMSCO investigations to rely on information from other sources. Much of the information available prior to about 1988 has already been presented in YMSCO publications. Chapter 5 of the Site Characterization Plan (CRWMS M & O 1988) contains discussions of relevant meteorological and climatological information. In addition to the SCP three other publications are noteworthy for their content. One was a report by Sandia National Laboratories (Eglinton & Dreicer 1984) that contained detailed descriptions of available information, particularly from work performed in support of Nevada Test Site activities. Similar information was presented in a Desert Research Institute publication (Bowen and Egami 1983a). A companion Desert Research Institute annotated bibliography publication (Bowen and Egami 1983b) presented a substantial resource of information organized by relevant topics.

Meteorologists working on this regional meteorology study searched atmospheric topic publications for relevant material. Select portions of the results of this literature search are presented with the relevant topical discussions in Section 4 of this report.

Meteorologists working on this regional meteorology study searched atmospheric topic publications for relevant material. Select portions of the results of this literature search are presented with the relevant topical discussions in Section 4 of this report. The publications discussed in this report are not considered to be quality-affecting data sources according to YMSCO quality assurance procedures.

3.2 STATISTICAL ANALYSES

Results of the statistical analyses presented in Section 4 of this report are grouped into two basic categories: simple and advanced. The statistical data summaries made to compare site-specific data with routine climatological data presentations are relatively simplified techniques, such as

calculating means and extremes. Temperature data are summarized relative to daily extreme values because many of the climatological measurements made until the last five to ten years were based on a pair of maximum and minimum thermometers (Section 3.5 in Randerson 1984). Advances in the electronics used in measurements and data recording techniques have increased the amount and type of data available for study, but comparisons with long-term statistics still must utilize the relatively simple techniques available to early investigators.

Two basic types of statistical analyses were performed depending on the focus of the analysis. Some analyses investigate spatial variations in meteorological conditions; spatial investigations involve two size scales. On the local scale, data from the site-specific networks in the immediate Yucca Mountain study area demonstrate the notable differences due to topography that exist over distances as short as a few kilometers. On the regional scale, data from surrounding stations can show similarities to some stations in the immediate Yucca Mountain area, and differences from other stations.

Other statistical analyses were performed to investigate the temporal characteristics of the data. One portion of this investigation focused on the distribution of observed events in order to estimate the probability of the occurrences of various extreme values occurring in the future. The analyses of extreme values of precipitation and wind, presented in Section 4.2 of this report, were made using established extreme value statistical tools. Another portion investigated the variations from year to year in observed precipitation amounts.

3.2.1 Precipitation Analyses

Precipitation analyses in this report address two topics: spatial and temporal precipitation characteristics. It is known (see Section 4) that average precipitation can vary by factors of two or more over a few kilometers distance in regions of variable topography such as that of the Yucca Mountain region. The extent of the analyses of spatial distributions of precipitation in this report is limited to regional scale differences, and relatively simple climatological comparisons. Other YMSCO investigators have examined precipitation distributions on a finer scale as needed for geohydrological characterization studies of precipitation infiltration, ground water recharge, and surface hydrology.

Temporal precipitation characteristics can be described for both short-term events and long-term periods. Of these two, short-term events can have the greater influence on engineering design of surface facilities to handle intense but short duration precipitation events. The shortest duration events addressed in this report is the daily precipitation total. The estimates of maximum daily precipitation events were made using statistical analyses of data from the R/EFPD network and regional stations, following guidance from U.S. Nuclear Regulatory Commission; see Section 4.2.2.1 of this report. Climatological characteristics of the Yucca Mountain area were also considered when performing the statistical analyses.

Statistical analyses were performed to estimate the potential extreme daily precipitation events. Daily precipitation values were sorted by value from the lowest to the highest daily measurement for which rain was recorded, and were plotted on a logarithmic probability scale to make a visual comparison between the model fit and the data. A log-normal distribution would plot as a straight line on this

type of plot; most of the data did not plot as straight lines, so this distribution was not used. The Weibull Distribution (Maidment 1993) plots as a curve and tended to fit the observed data. A modified version of the Weibull Distribution was used in this study. Details of the Weibull Distribution are presented in Appendix C of this report. The parameters in this model were adjusted using a non-linear regression technique so that the model provided a least-squares best fit to the higher precipitation rate data points, given the purpose of investigating maximum events.

Once a good fit was established between the model and the observed data, the model was used to extrapolate the data to make estimates of the magnitude of rain-fall events with return periods of 50, 100, and 200 years. The curve plots were fitted conservatively, that is, the plotted values exceeded the highest observations. These statistical methods do not include changes in precipitation occurrences due to climate changes greater than that occurring during the measurement period.

Data from 16 sites on and near Yucca Mountain and Las Vegas were examined. The length of time for the records at each of the stations varied from 6 to 74 years. Sometimes extreme value analyses are made by using the highest measured daily rainfall for each year. Eglinton and Dreicer (1984) use this method. The length of record for some of the stations used in this study was too short for this method to be very accurate. The technique ignores the second highest value for each year, which may be larger than some of the other yearly maximums. All of the stations contained daily data so it was prudent to use all of the daily data where precipitation occurred. This resulted in much larger data sets and consequently better statistical analyses. Because there were large variations in the period of record for the various sites, abbreviated data sets for some of the sites with longer periods of record were analyzed so that the results could be compared with the results from the sites with shorter periods of record.

3.2.2 Wind Speed Analyses

Wind speed analyses typically fall into two basic scales, averages and extremely high wind speeds. Average wind conditions over long periods of time are relevant to environmental and general meteorological characterizations. Basic observational averaging periods can be from ten minutes to one hour in duration. Extremely high wind speeds are relevant to engineering design tasks. Typically extreme values range from gusts lasting up to a few seconds duration to the fastest one-minute values.

The American Nuclear Society (ANS 1983) advocates the use of the Fisher-Tippett distribution to obtain design basis extreme wind speeds for nuclear power plants. Details on this distribution are presented in Appendix C. For high cumulative probability values (close to one) this distribution approaches a log-normal distribution.

The largest daily one-second wind speed data were sorted in ascending order and plotted on a probability scale. The mean and variance were adjusted using non-linear regression to obtain a least-squares best fit of the data. The resulting equations were then used to extrapolate the result to determine gust wind speeds with return periods of 50, 100, and 200 years. The same technique was used for the daily maximum one-minute wind speed data.

3.3 IDENTIFICATION OF REPRESENTATIVE STATIONS

One basic purpose for analyzing data from regional meteorological stations is to identify the long-term mean and extreme values that could occur at Yucca Mountain during a longer time period than that of the site-specific observation program. Given the spatial variations in meteorological conditions within the region and on Yucca Mountain itself, it is important to identify the extent to which data from other sources is representative of conditions in various portions of Yucca Mountain.

The results presented in Section 4 of this report show that some nearby precipitation stations with long periods of record are representative of some stations in the site-specific network, while other nearby long-term stations are more representative of different site-specific stations.

4. REGIONAL METEOROLOGICAL DATA SUMMARIES

Meteorological conditions in the Yucca Mountain region have four primary characteristics: the region is arid, warm, generally lacks severe weather, and experiences significant local variations due to topographic influences. The climate descriptions contained in previous project documents (SCP 1988 and Eglington & Driecer 1984) and a prime resource on Nevada weather (Houghton 1975) described the region as mid-latitude desert, experiencing hot summers, mild winters, and limited precipitation. The basin and range topography of Nevada has a strong influence on local meteorological conditions, so the work to characterize site-specific conditions in the Yucca Mountain study area has included analyses of 10 years of site-specific data in conjunction with long-term regional data. This analysis approach improves understanding of mean and extreme meteorological conditions than were previously available from regional sources alone.

4.1 REGIONAL METEOROLOGICAL CONDITIONS

Descriptions of the regional meteorological conditions are presented in this section, starting with an overview of southern Nevada climate, followed by a discussion of the spatial and temporal variations relevant to the study. Summaries of current climatic data from the most representative regional stations follow.

4.1.1 Southern Nevada Climate

The aridity of southern Nevada's climate is partly due to the blocking of Pacific moisture in westerly airflow by the Sierra Nevada mountains, an example of the classic "rain shadow" effect. Further blocking during winter is due to the Great Basin Anticyclone (Hidy & Klieforth 1990), a region of high pressure due to the cold continent that frequently steers storm paths northward, or at least reduces the storm impact by the time it reaches the Great Basin region. Some maritime polar air masses have strong enough westerly airflow and moisture sources to bring storms and precipitation into southern Nevada, typically during the winter months. These storms can be accompanied by strong winds and periods of relatively steady rainfall. Wetter winters typically occur when the Pacific High pressure area migrates westward, leaving the west coast of the United States under the influence of low pressure troughs more of the time. Some of the most significant storms associated with this pattern occur when a "closed" cyclone migrates eastward across southern Nevada (Ely 1994). The intense circulation of the closed cyclone provides the necessary dynamics to produce widespread precipitation. Snowfall is a rare occurrence at the lower elevations in southern Nevada, but it can occur a few times during the winter season at the elevations of the upper portion of Yucca Mountain.

Interdecadal variation of west coast wintertime precipitation amounts (Chen 1996) was studied using data from 1950-1994. The relevance of this work to the regional meteorology around Yucca Mountain and the southwestern United States is the insight into both current long-term temporal precipitation trends, and the atmospheric circulation patterns that are important to seasonal precipitation patterns. One observation in the study presented statistical analyses of precipitation indicating opposite trends north and south of 36°N latitude: precipitation slightly decreased at stations north of this line, and slightly increased south of the line. Representative magnitudes of the trend estimates are -0.077 millimeters per day per year (mm/day/yr) for Raymond, Washington and

+0.014 mm/day/yr for Tustin, near Irvine, California. The second observation in the study discussed analyses of atmospheric circulation patterns tied the precipitation changes to west coast, and ultimately North American, atmospheric circulation patterns. The trends in 850 millibar (approximately 5,000 ft msl) and the 700 millibar (approximately 10,000 ft msl) pressure patterns were relevant to this study because much of the wintertime precipitation in the western United States is caused by orographic lifting of moist maritime air. The paper cited a pattern of an anomalous high pressure area centered over the Pacific Coast of British Columbia and a minor anomalous low pressure area centered off northern Baja California.

Maritime tropical air masses can bring moisture during summer months through southern California less impeded into southern Nevada than that experienced by westerly airflow, because the higher terrain of the Sierra Nevada is north of this pathway. During the summer months, moisture from both the eastern Pacific and the Gulf of Mexico can be transported into the southwestern United States during a so-called "monsoon" season of southerly moist airflow. This airflow can be enhanced by a thermal low pressure area that forms over the southwestern desert area of California and Arizona. Occasionally, this moisture can travel sufficiently north and west to reach southern Nevada, causing convective airmass thunderstorms with periods of intense rainfall, wind, and lightning in the region. A hydrometeorology study by the National Weather Service (NWS 1977) includes statements that near-maximum moisture necessary to produce a probable maximum precipitation (PMP) event in the Great Basin must enter the Southwest from the warm waters of the Gulf of California and the subtropical southeastern Pacific.

Storms that produced local flooding events in southern Nevada are infrequent, which makes them sufficiently interesting to warrant meteorological analyses to be reported. The analysis of the storm occurring on August 10, 1981 that apparently produced the largest precipitation totals observed in southern Nevada and some of the most dramatic flooding damage was reported in a NOAA Technical Memorandum (Randerson 1986). Rainfall measurements in excess of 0.50 to 1.00 inches were found in much of southeastern Nevada, southwestern Utah, and northwestern Arizona. The heaviest rainfall was estimated at nearly 6.5 inches during the storm; it occurred about 40 kilometers (km) northeast of Las Vegas, Nevada near the Ute exit from Interstate 15. Estimates of two to six inches include the area with considerable property damage near Moapa, Nevada about 24 km northeast of the Ute area. The corresponding measurement at the Valley of Fire State Park, about 10 miles east of the Ute area, was 3.05 inches. The rainfall rate for this storm was estimated between three and four inches per hour. The storm was described as a mesoscale convection complex (MCC). The storm covered a large area and lasted about 15 hours while traveling about 500 km from southeast Nevada into northwest Arizona. Much of the moisture for the storm was transported into the region from the south, but the meteorological mechanism responsible for the storm was a closed low pressure area that moved in from the north.

In a recent study of atmospheric circulation patterns relevant to streamflow in the southwestern United States, strong correlations were noted to exist between regional streamflow and Type 1 El Niño-Southern Oscillation (T1ENSO) and La Niña occurrences (Kahya 1994). T1ENSO occurrences are typically followed by a wet December through July precipitation season. Seven such events occurred during the 41 years of data used in the study. Conversely, the La Niña occurrences are typically followed by a dry February through July period. The data for this study included 1948 through 1988, which covers little of the period of site-specific monitoring. However, it did identify

1983 as the only year having streamflows above the median levels during all twelve months: the 1982-1983 T1ENSO occurrence was the "most intense warm event in this century" (Kahya 1994).

In another southwestern United States streamflow study (Ely 1994), the large floods in the Virgin/Muddy Rivers system were shown to demonstrate the same types of streamflow seasonal distribution differences that occur in other rivers over distances of a few hundred kilometers apart. These rivers are approximately 200 kilometers east of the Yucca Mountain study area, on the southeastern border of Nevada with Utah and Arizona. These seasonal differences are attributed to a combination of large scale topographic differences, and the different air masses affecting various portions of the southwestern United States. The flood periods in the Virgin/Muddy were correlated to the occurrence of deep low pressure systems off the northwestern United States coast combined with high pressure in the Aleutian Islands.

4.1.2 Spatial Variation

Southern Nevada's mostly arid, continental climate is primarily due to the large scale topographic features of the Great Basin. The study region is in the southern portion of the intermountain Great Basin, between the Sierra Nevada mountains to the west, and the Colorado Plateau to the east, with the Rocky Mountains further east. The Great Basin is a nearly continuous series of basins and mountain ranges oriented approximately north and south. The mountains frequently are at least 300 meters (m) higher than the intervening valleys.

Yucca Mountain is a ridge approximately 10 km long, 3 km wide, about 350 m higher than the valleys, oriented north and south. The primary study area is on the east side of the ridge, extending into the 2 km wide Midway Valley. Midway Valley is bordered on the west by the main ridge of Yucca Mountain, on east by the smaller Fran Ridge, on the south by a saddle between the two ridges, and on the north by Yucca Wash and higher terrain to the north. Jackass Flats is east of Fran Ridge; it slopes to the south into the Amargosa Valley area. Local topography is shown in Figure 2-1. The complexity of the topography in the study area is the primary reason for the large spatial variations of precipitation, temperature, and wind conditions seen in following data presentations.

Precipitation is an excellent example of a meteorological factor that can vary significantly over short distances due to topography. The relevant distance scale for this discussion is the order of kilometers, or less; distances much smaller than the "rain shadow" effect of whole mountain ranges.

Precipitation distributions in areas of complex topography are typically attributed to "orographic" meteorological mechanisms. The mechanisms range from enhanced precipitation on the windward side of a mountain obstacle to moist airflow, to increased precipitation at high elevations in convective conditions due to the additional lifting of moist air by the relatively higher heat source of a mountain area compared to surrounding valleys (Barry 1981).

Quantifying the patterns, and understanding the mechanisms causing the differences, is a challenge in an arid area. Precipitation is relatively infrequent, and totals are small compared to more humid areas. Apart from potentially needing information on precipitation occurrences at various elevations in an area of complex topography, the need to understand precipitation patterns also arises from the need to characterize "average" precipitation for an area containing topography with significantly

different elevations. Some methods to understand precipitation patterns based on sparse measurements have relied on direct analyses of precipitation measurements compared to the actual topography at the corresponding elevation of the measurement (Briggs 1996). Others have relied on simple relations between elevation and precipitation in a given area being extrapolated to areas without measurement data (Michaud 1995).

More powerful geostatistical tools, such as kriging, cokriging, and its variations, have been utilized by other investigators, including the USGS scientists studying precipitation patterns in southern Nevada (Hevesi 1992a and Hevesi 1992b). More recent analyses by Hevesi and Flint at the USGS have produced later estimates of Yucca Mountain precipitation. The results of these analyses will be published in a USGS publication in the near future. Other investigators are developing statistical tools that incorporate climatological information and additional topographic information, such as slope exposure (Daly 1994). These advanced approaches can be applied to well instrumented areas in developing relationships with larger scale meteorological variables, which can be useful in general circulation model comparisons (Johnson 1995). Similar tools can be used to interpolate average air temperatures in mountainous areas, which also depend on elevation (Willmott 1995).

4.1.3 Linkage Between Synoptic and Regional Scale Atmospheric Conditions

Relationships between meteorological conditions on the regional scale (approximately 100 km radius) and the synoptic scale (throughout the southwestern United States) are discussed in this section. The important factor for the linkage discussion is to understand the extent that synoptic data can be used to characterize regional conditions. A quantitative assessment of pressure anomalies or similar linkage measures is beyond the scope of this document. Two basic responses emerge from analyses of the data: some weather elements near ground level are linked to synoptic conditions, while others are dependent on topographic influences to the synoptic conditions. Wind and temperature are frequently not linked to synoptic conditions, while humidity, cloudiness, and solar radiation are linked strongly to synoptic conditions. Precipitation events are linked to synoptic conditions, but the localized pattern depends in a complex way on local topography.

The hierarchy of large to smaller scale climate controls (Mock 1996) are important in determining southwestern seasonal precipitation patterns. The larger scale climate controls are atmospheric circulation elements, such as the polar jet stream and large scale ridge and trough positions. The smaller scale climate controls relate to land physiography, from continental down to orographic influences at specific locations. The subtle interactions between the various spatial scales determine the seasonal precipitation patterns in a given region.

The most important factor in modifying synoptic conditions on the regional scale is topography. Topography acts on two scales, overall elevation changes and local differences due to mountain ranges and valleys (Barry 1981). Significant overall elevation increases occur northward from the Yucca Mountain area. The elevations in the immediate Yucca Mountain study area range between approximately 2,650 ft above mean sea level (msl) in northern Amargosa Valley to approximately 4,950 ft msl on top of the Yucca Mountain ridge. Much of the land in the northern portions of the Nevada Test Site is at least 5,000 ft msl, with peaks above 8,500 ft msl.

The presence of nearby mountain ranges and valleys with elevation differences over 1,000 ft contribute to localized modifications of synoptic, and even regional, conditions. Mountains and valleys tend to channel, or steer, synoptically driven winds along the valley orientation (Barry 1981). A nocturnal airflow study performed by R/EFPD meteorologists showed that the mountains and valleys in the area also exhibit nocturnal drainage winds, occurring on various scales and depths, (CRWMS M&O 1995b). During sufficiently weak pressure pattern synoptic scale conditions, the corresponding low speed regional scale winds can be totally decoupled from local drainage winds. Local airflow will be the topic of a separate report, which is planned for publication during September 1997.

4.1.4 Regional Meteorology Data Summaries

Data from site-specific and regional meteorological stations are summarized in this section, with data tables given in Appendix A. The summary tables include the typical climatological terms, such as mean and extreme values of temperature, precipitation, relative humidity, and wind speed. The site-specific data demonstrate the local variations in the study area itself. The regional stations provide data from longer-term periods of operation and for a broader spatial coverage than is available in the site-specific data.

Data summaries from the nine R/EFPD meteorological stations are in Appendix A, in Tables A-1 through A-9. The measurement methods were described in Section 2.1 of this report. Care is required in interpreting data from these tables because some stations operated during different time periods, and experienced some changes in temperature measurement methods. For example, the temperature extremes reported are a mix of the one-minute and one-hour average values using data from either 2 m-agl or 10 m-agl, depending which value providing the extreme value.

4.1.4.1 Precipitation

The first step in analyzing precipitation data for spatial and temporal variations was identifying regional precipitation sites that are representative of the Yucca Mountain study area. The candidate sites needed a climatic characteristics similar to those of Yucca Mountains sites, and data that overlapped Yucca Mountain data. The most representative sites can be used the most to investigate possible long-term conditions at Yucca Mountain. The primary candidate sites were the nearby NWS cooperative observer stations in Amargosa Farms and Beatty, and two of the ARL/SORD NTS stations, 4JA and Desert Rock. 4JA is in Area 25 of the NTS about 15 km east of Yucca mountain, and Desert Rock is at the ARL weather observation station at the Desert Rock Airport (DRA) south of Mercury, about 45 km east-southeast of Yucca Mountain.

Data from various time periods were selected to optimize the comparisons between sites. The four-year period 1993 through 1996 provided the best comparison between the nine R/EFPD stations and the candidate regional stations. Data from 1986 through 1996 from R/EFPD Site 1 were also analyzed to provide a longer-term comparison from a Yucca Mountain site to regional sites. Data from regional sites back to 1921 were included in the analyses of year-to-year variations in annual precipitation.

The annual precipitation totals during 1993 to 1996, and the average of the four-year period for the nine R/EFPD sites and candidate regional sites are shown in Table 4-1. The averages at the R/EFPD sites ranged from 4.20 inches at Site 9 (near Gate 510 along the southern NTS border) to 8.69 inches at Site 6 (in upper Yucca Wash, near the north end of Yucca Mountain). The averages at the regional stations ranged between 4.01 inches in Amargosa Farms to 7.18 inches at the 4JA site (in Area 25 east of Yucca Mountain). Desert Rock and Beatty had similar averages, with 5.80 and 5.85 inches, respectively. The annual precipitation totals were included in this table to show the large differences in precipitation totals between sites that can occur from year to year. The annual totals at individual sites differed by more than a factor of two.

Table 4-1 also shows the ratios of the four-year average precipitation at the R/EFPD and regional sites (listed in the left-hand column of the table) to the average precipitation at the four candidate regional sites (listed in the right four columns of the table). The ratios ranged from 0.56 to 2.16, showing a significant range of spatial variability in annual precipitation. The ratio results are also plotted in Figure 4-1. In this figure, the abcissa is the R/EFPD sites arranged in increasing order of the four-year average precipitation for each site; the ordinate is the ratio of each site's average precipitation to the averages of the regional site. The ratios for each site to an individual regional site were plotted as lines in the figure. The ratio data for Desert Rock were not plotted because that data were nearly identical to the Beatty site data.

Table 4-1 and Figure 4-1 show considerable variation between annual precipitation in the Yucca Mountain network and the nearby region. Results from the Amargosa Farms site are most similar to those from Site 9, and to a lesser extent, Site 5. This result conformed with proximity and similarity of exposure between the sites. These sites are within 20 km of each other, and are in broad valleys. The average from the 4JA station is about 10 percent higher than the average for the stations in Midway Valley (immediately east of Yucca Mountain), although the annual precipitation totals differed by a factor of two. The Yucca Mountain sites are north of Amargosa Farms, at least 150 meters higher in elevation, and closer to elevated terrain. Data from Site 1 closely match data from the Beatty and Desert Rock Airport sites. Therefore, both the Beatty and Desert Rock Airport data are considered representative of the Midway Valley area for limited purposes.

The second precipitation characteristic studied was the temporal variability. Short-term variations leading to the maximum daily precipitation occurrences are discussed in Section 4.2 of this report; the following long-term variation discussions are based on annual total precipitation. Some comments on the 1993 through 1996 period were made in the preceding material on spatial variation.

Annual precipitation totals from R/EFPD Site 1, Beatty, and Desert Rock Airport for the years 1986 through 1996 were studied to compare results for a longer period of record from the Yucca Mountain network to those from nearby stations that appeared to be representative of Yucca Mountain. The annual totals are shown in Table 4-2 and Figure 4-2. The 1989 and 1995 precipitation totals were approximately two and eight inches, respectively, at all sites, showing that the yearly variation exceeded a factor of four. Table 4-2 also shows the means and standard deviations of the 11 years

Table 4-1. Comparison of 1993-1996 R/EFPD and Regional Precipitation Results

Site	Precipitation totals (inches)					Ratio Averages (Ratio of 1993-1996 average precipitation values for the Sites listed in column 1 to the regional stations listed below)			
	1993	1994	1995	1996	1993-96 average	4JA	Amarg. Farms	Beatty	Desert Rock
Site 1	5.18	3.73	9.17	5.07	5.79	0.81	1.44	1.00	0.99
Site 2	8.16	4.65	9.89	4.73	6.86	0.96	1.71	1.18	1.17
Site 3	8.45	5.08	11.89	5.35	7.69	1.07	1.92	1.33	1.32
Site 4	8.01	4.43	10.60	4.94	7.00	0.97	1.74	1.21	1.20
Site 5	6.94	3.24	7.40	3.90	5.37	0.75	1.34	0.93	0.92
Site 6	9.86	5.50	13.64	5.74	8.69	1.21	2.16	1.50	1.49
Site 7	8.40	4.64	10.22	5.41	7.17	1.00	1.79	1.24	1.23
Site 8	8.07	4.44	10.24	5.21	6.99	0.97	1.74	1.21	1.20
Site 9	6.09	2.43	5.48	2.78	4.20	0.58	1.05	0.72	0.72
4JA	10.49	4.60	10.31	3.30	7.18	1	1.79	1.24	1.23
Am Frm	5.68	2.27	5.27	2.83	4.01	0.56	1	0.69	0.69
Beatty	5.71	3.44	8.45	5.60	5.80	0.81	1.45	1	0.99
Des. R.	7.55	3.28	7.90	4.65	5.85	0.81	1.46	1.01	1

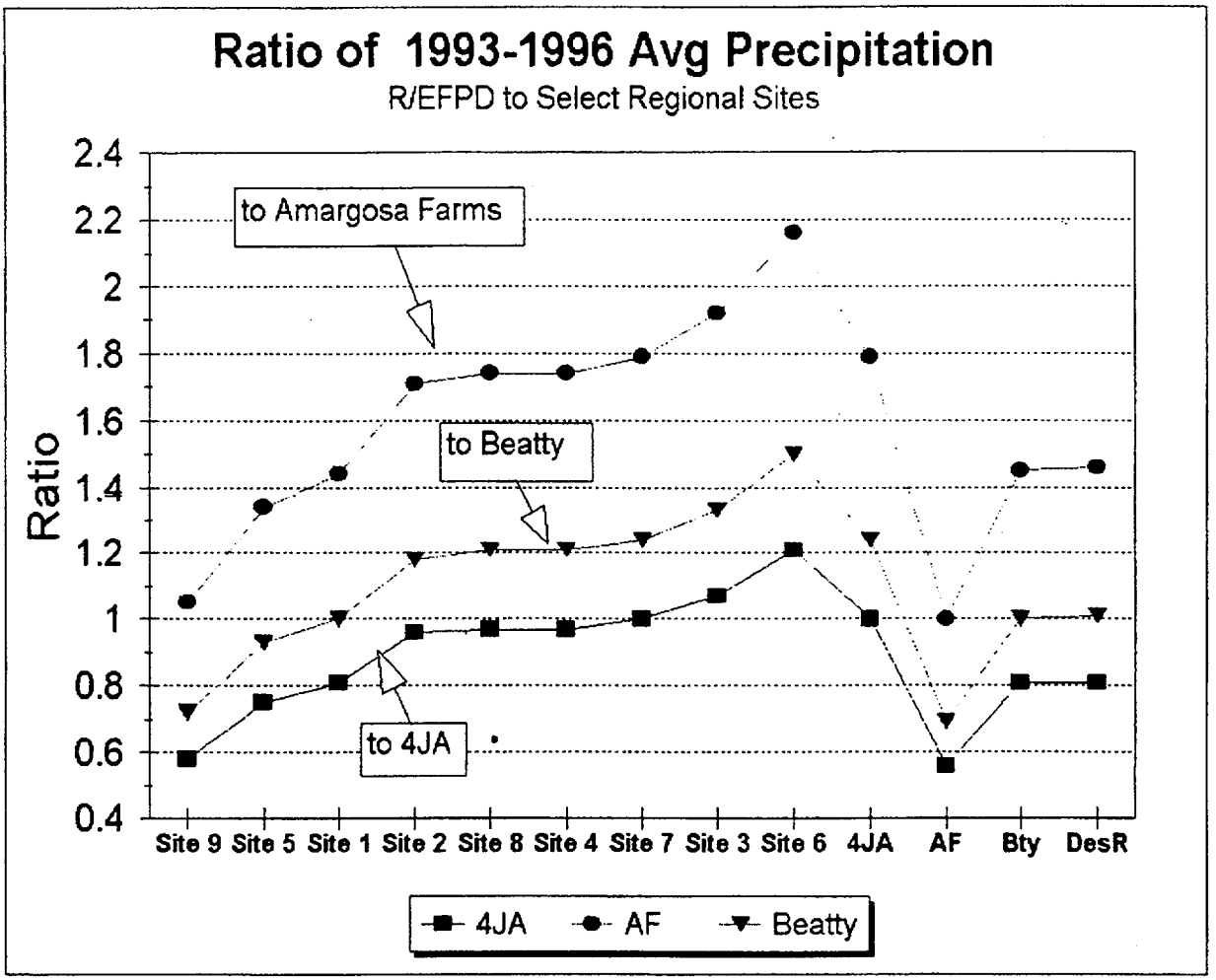


Figure 4-1. Ratio of the 1993 - 1996 R/EFPD Precipitation Results to Regional Meteorological Monitoring Sites

Table 4-2. Annual Precipitation Totals from 1986 - 1996

	Precipitation Totals and Statistics are in Inches		
	R/EFPD Site 1	Beatty 8N	Desert Rock Airport
1986	4.92	5.22	6.66
1987	7.80	7.38	8.56
1988	5.00	6.21	5.82
1989	1.44	2.43	1.25
1990	1.93	4.92	4.91
1991	5.36	5.15	5.37
1992	5.10	7.37	6.41
1993	5.18	5.71	7.55
1994	3.73	3.44	3.28
1995	9.17	8.45	7.90
1996	5.07	5.60	4.65
average	4.97	5.63	5.67
standard deviation	2.22	1.74	2.13

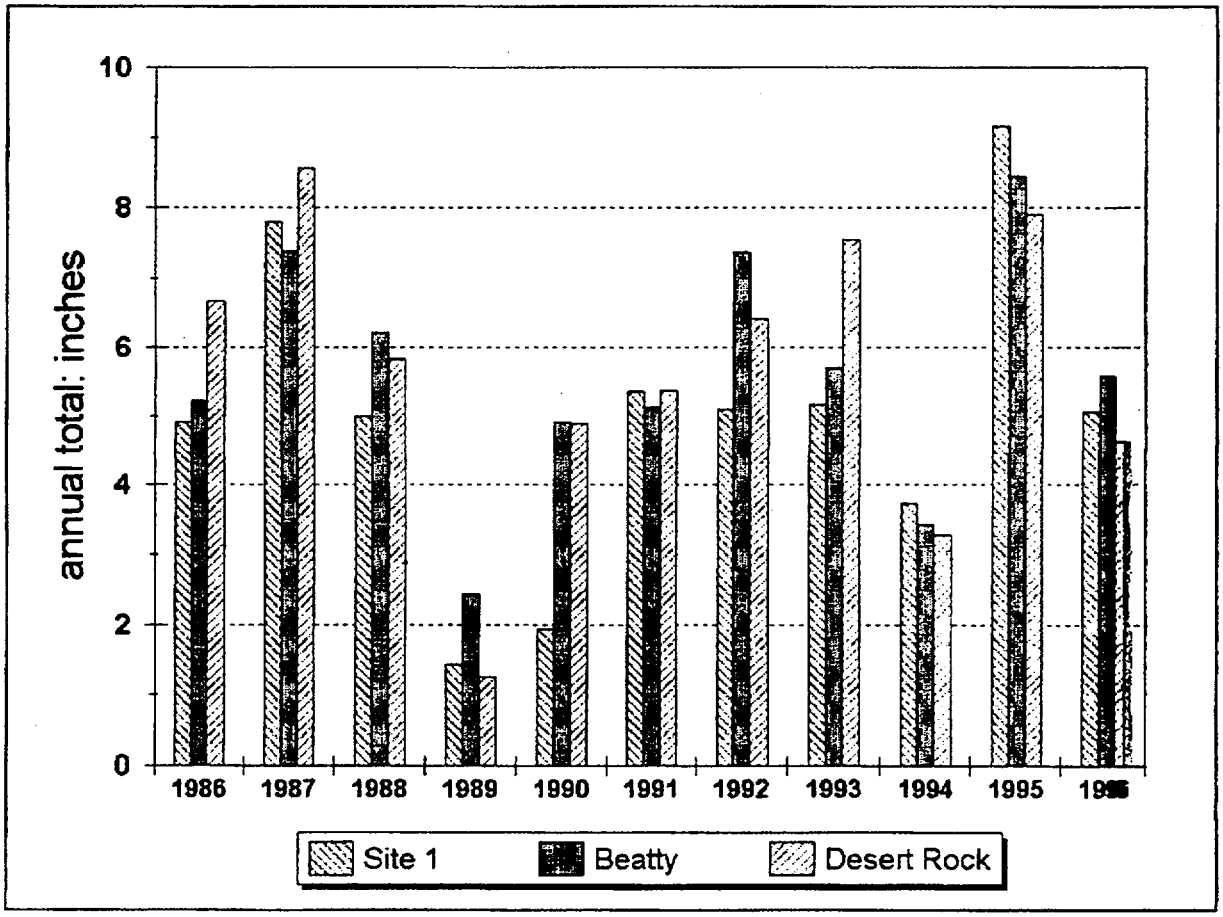


Figure 4-2.Annual Precipitation Totals from 1986-1996 from Site 1, Beatty 8N, and Desert Rock Airport

of annual total precipitation values for each of the three sites. The average for Site 1 was 4.97 inches, which is slightly less than the averages at Beatty and Desert Rock Airport of 5.63 and 5.67 inches, respectively. The standard deviations are approximately two inches, which is approximately 40 percent of the average. Note that precipitation data from Site 1 were similar to the data from Beatty and Desert Rock Airport during the 11-year period, which further demonstrates the good representativeness of the Beatty and Desert Rock Airport annual average data to the Site 1 data.

Annual total precipitation data from long-term stations were examined for annual precipitation variability over longer periods of time. Data from 1949 to 1995 for three stations are plotted in Figure 4-3. Amargosa Farms data were included to relate the pattern to precipitation near Yucca Mountain, even though the period of record at Amargosa Farms was shorter. Data from these sites show a similar pattern of relatively wet and dry years. The average amounts for Las Vegas, Desert National Wildlife Refuge, and Amargosa Valley were 4.14, 4.35, and 4.11 inches, respectively. The annual totals ranged from less than 1 to approximately 10 inches. The standard deviation of the annual values were approximately two inches, indicating a high variability relative to the average values.

Data from 1921 through 1995 were also studied to investigate a longer period of record. The nearby stations do not have periods of record that extend back this far, so data from Caliente and Austin (both in Nevada) were selected, and are plotted in Figure 4-4. The two lines show less similarity to each other than the ones for the closer sites shown in the previous figure. The plots do not show obvious long-term trends. The year-to-year variations cluster around the long-term averages. The averages for Austin and Caliente are 12.71 and 8.85 inches, respectively, which shows the wetter conditions in the central and eastern portions of Nevada compared to the more arid conditions with averages just over four inches that are typical of the Yucca Mountain area.

In summary, precipitation in the region around Yucca Mountain varies by as much as a factor of four from year to year. The long-term record does not show obvious trends. Average amounts vary between locations by a factor of two, depending on factors such as elevation, location relative to nearby topography, and location within the region. Sites at higher elevations generally receive more precipitation, but the immediate surrounding topography also influences precipitation. The stations in the central and eastern portions of Nevada receive more precipitation than those in the extreme southern and southwestern portions of the state, including Yucca Mountain. Precipitation differences in the small Yucca Mountain study area vary as much between specific locations as the differences that occur over hundreds of kilometers between different portions of the state.

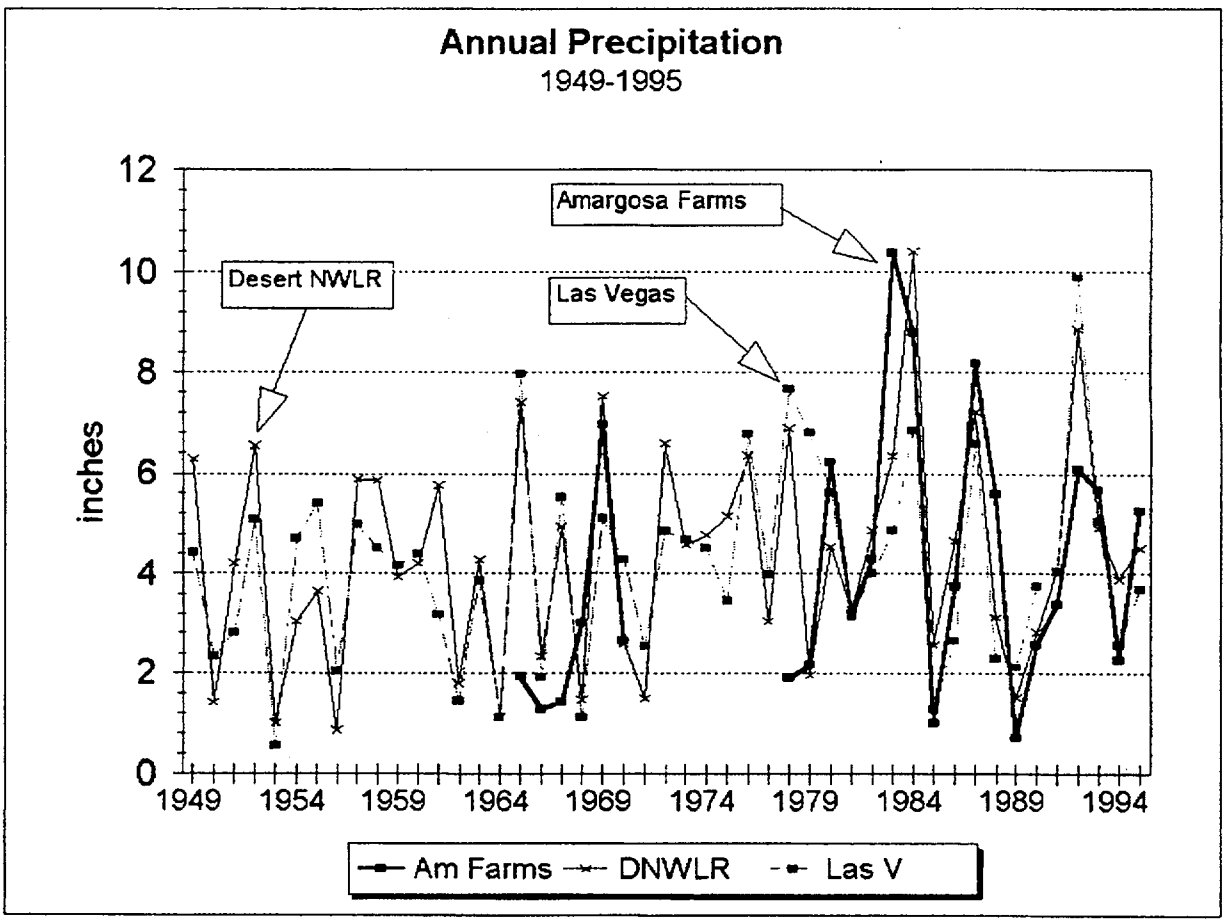


Figure 4-3. Annual Precipitation Totals from 1949-1995 at Regional Sites

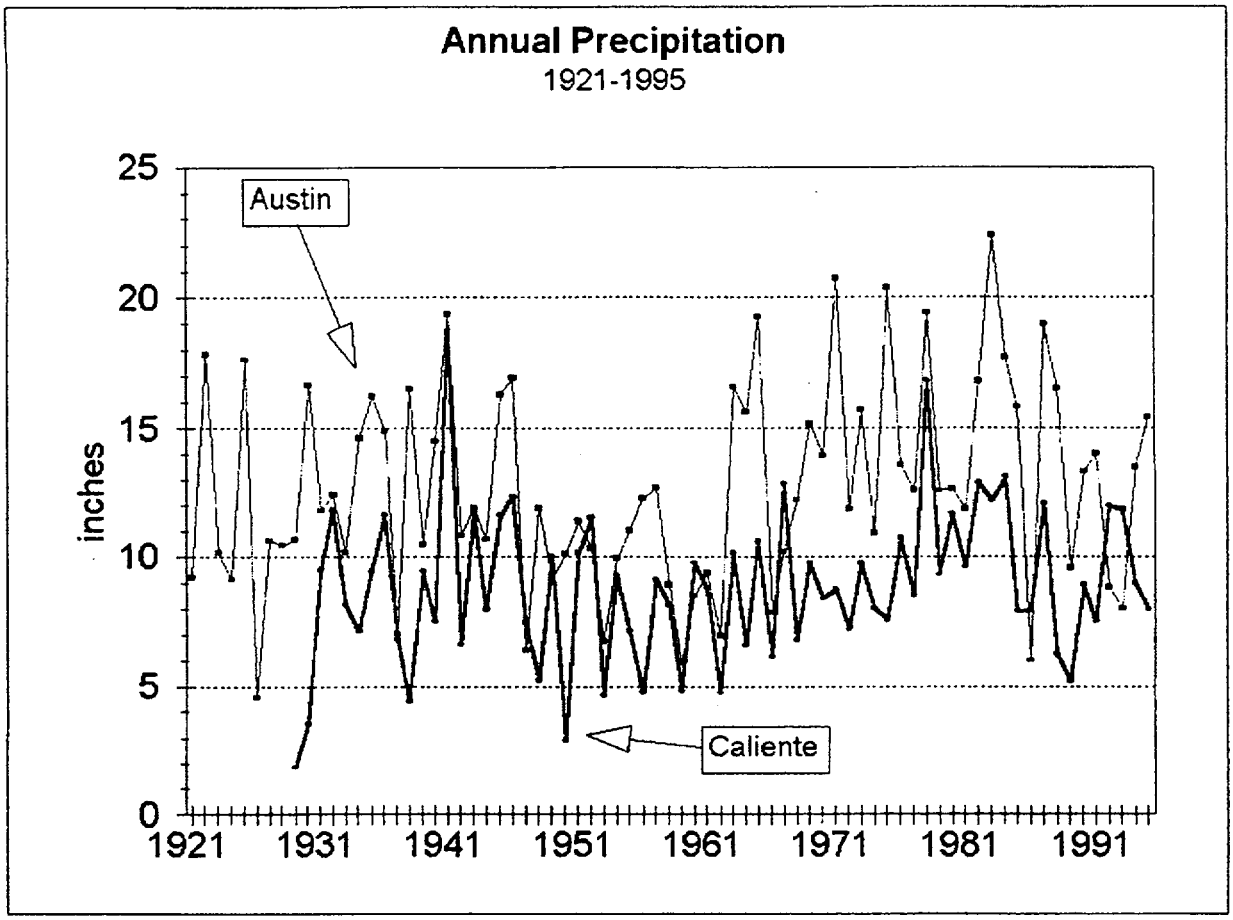


Figure 4-4. Annual Precipitation Totals from 1921-1995 at Regional Sites

4.1.4.2 Temperature

Air temperature data from the Yucca Mountain region shows less variation than the precipitation data. The lesser variation is partly due to temperature being measured continuously, while precipitation is a rare occurrence in the arid Yucca Mountain region. The climatology tables in Appendix A include monthly values of extreme maximum and minimum temperature, the mean maximum and minimum, and the mean of all temperatures.

When comparing data from the R/EFPD sites to those from other stations, it is important to recall the type of measurement and averaging time used. Within the R/EFPD data itself there are time periods when temperature data were taken at 10 and 2 m-agl, and there are hourly averages and extreme one-minute average data (for the 2 m-agl data). Data from the cooperative observers were all taken about 2 m-agl. Glass maximum and minimum thermometers were used until the early 1990s at the cooperative observer stations. The thermometers have a time constant of about one minute. This is the reason for adding the one-minute averaging time to the R/EFPD data collection systems. The glass thermometers were replaced by electronic systems with resistance thermometers. The electronic systems store the maximum and minimum values that are essentially instantaneous readings.

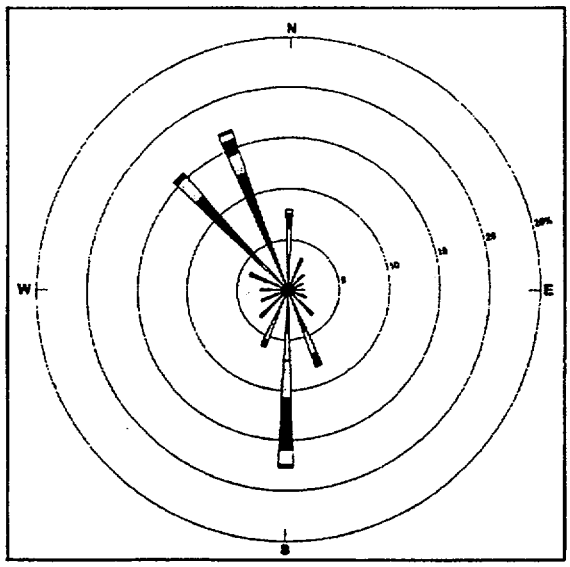
The mean maximum temperatures at the warmer R/EFPD sites, Sites 5 and 9, approach 40°C. The mean minimum temperatures at the coldest R/EFPD site, Site 7, was -2.1°C. The annual mean temperatures ranged between 15.1°C at Site 6 to 18.2°C at Site 9. These value are very close to the corresponding statistics for the long term records from Amargosa Farms, Beatty, and Las Vegas. Annual extreme maximums at the R/EFPD sites nearly all exceed 40°C, and all extreme minimums were below -7°C. The extreme maximum and minimum temperatures at the Las Vegas and cooperative observer stations were about 45°C and -15°C, respectively.

4.1.4.3 Wind

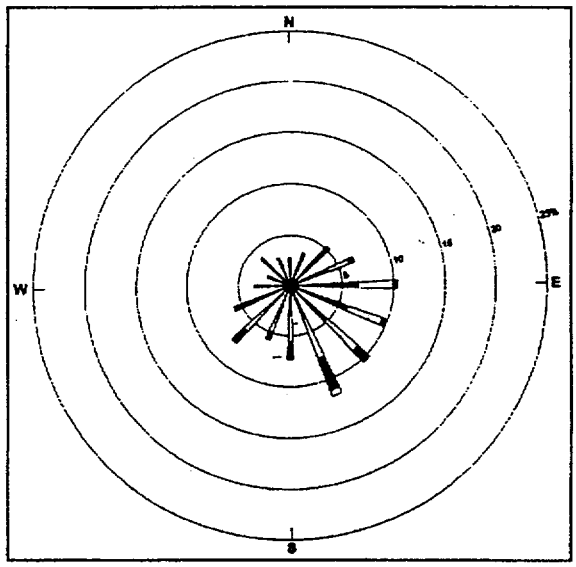
Standard joint-frequency distributions of hourly average wind direction and wind speed data were tabulated separately for day and night from the nine R/EFPD meteorological sites for the years 1993 through 1996 and data from the Desert Rock Airport for 1993 through 1995. Previous analyses of local wind data has shown that the diurnal (day/night) cycle of wind speed and direction is a significant characteristics of local winds in the Yucca Mountain area. Tabulations were also made for all hours for the total period of operation of the sites. Wind direction data were placed in 16 categories and wind speed data in six categories using routine climatological data summarizing categories. Tabulations of these results are shown in Appendix B. Plots of the wind summaries for all hours are shown in Figures 4-5 through Figure 4-7.

The wind distributions from the R/EFPD sites show the dominating influence of nearby topography on the wind direction, and to a less obvious extent, on the wind speed as well. The mountain and valley topography characteristic of the region causes topographic channeling of winds driven by regional scale meteorological forces. The same topography patterns can also cause certain wind occurrences when the regional scale forces are weak, such as nocturnal winds at all sites from directions corresponding to down slope airflow. The sites with 10 meter tall towers in valley locations reflect influence of nearby terrain, while data from the 60 meter level at Site 1 and the two sites on top of terrain features (Sites 2 and 4) show influence of larger scale down slope motion from higher terrain north and east of Midway Valley. The daytime winds at all sites show generally southerly airflow, which is up valley from Amargosa Valley and southern Jackass Flats. Daytime winds are channeled by local topography at the sites located in confined areas, such as Sites 3 and 6.

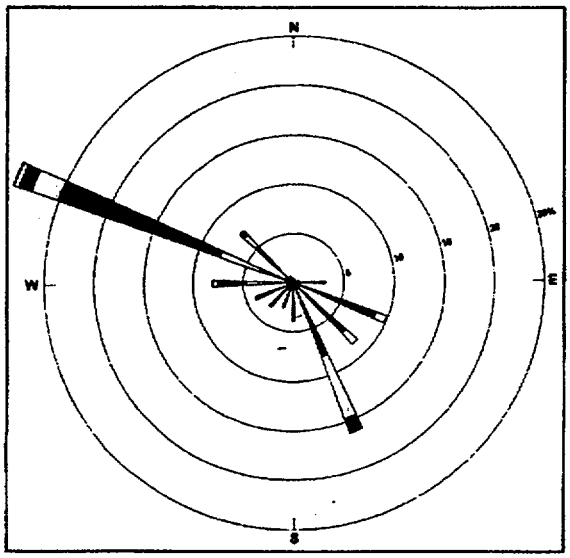
Wind data from the Desert Rock Airport show similar influences of topography for that location. The Las Vegas data show predominantly southerly through westerly wind or northerly directions. These data are recorded at McCarran Airport, which is in the south-central portion of the Las Vegas Valley. there are considerably fewer topographic constraints on the winds at Las Vegas Airport than at the R/EFPD or Desert Rock Airport sites.



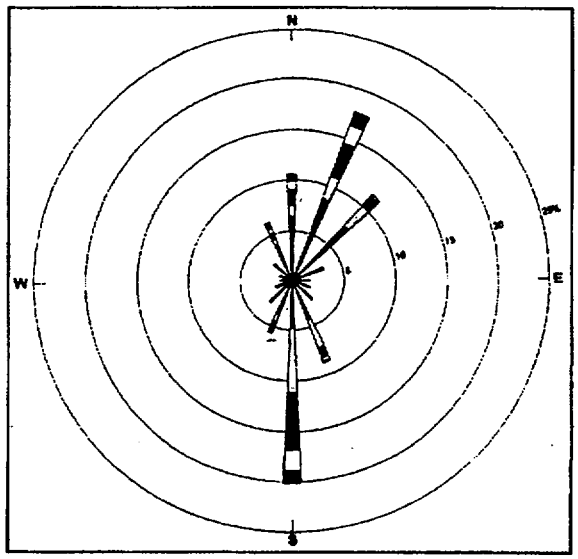
(a) Site 1 (all hours)



(b) Site 2 (all hours)



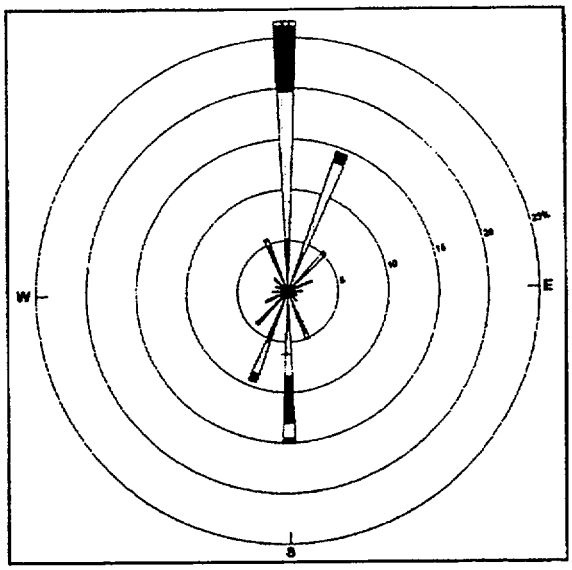
(c) Site 3 (all hours)



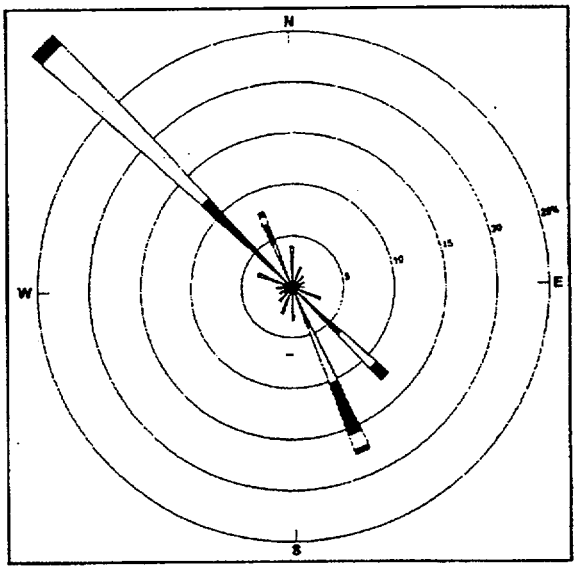
(d) Site 4 (all hours)

Note: The diagram is the frequency of occurrence for each wind direction from which the wind is blowing.

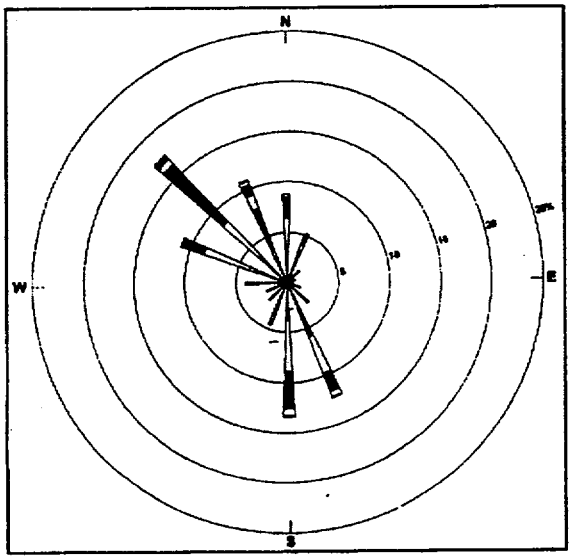
Figure 4-5. Wind Rose Plots for Site 1, Site 2, Site 3, and Site 4



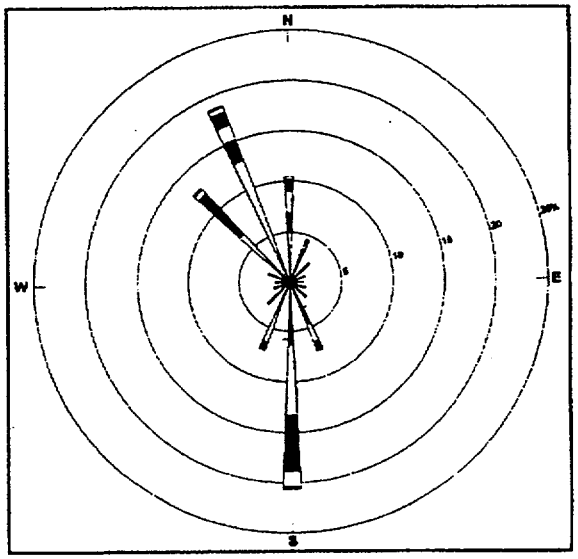
(a) Site 5 (all hours)



(b) Site 6 (all hours)



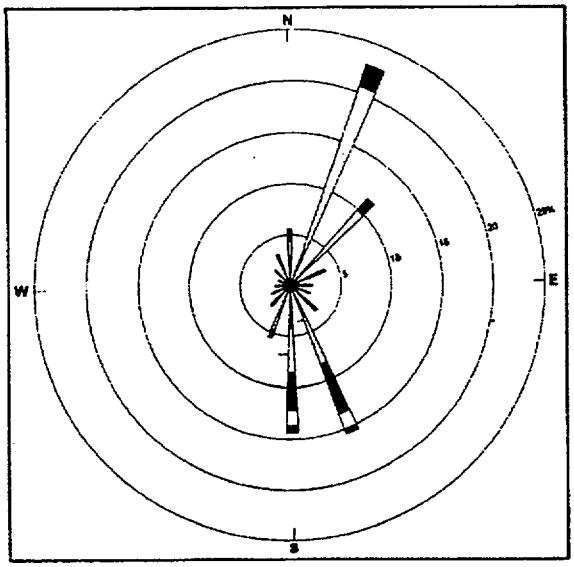
(c) Site 7 (all hours)



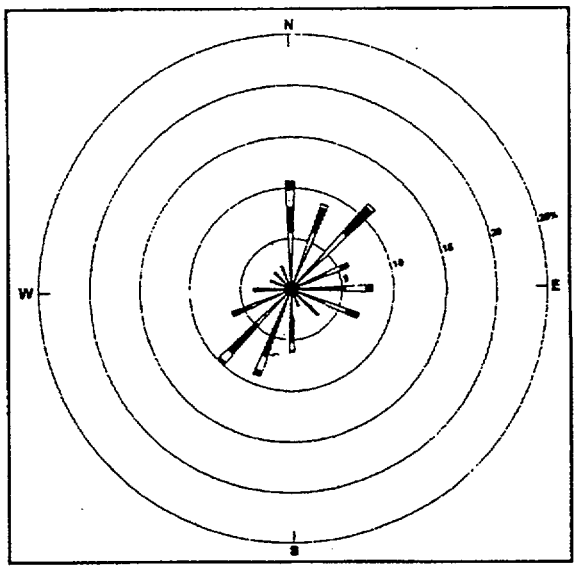
(d) Site 8 (all hours)

Note: The diagram is the frequency of occurrence for each wind direction from which the wind is blowing.

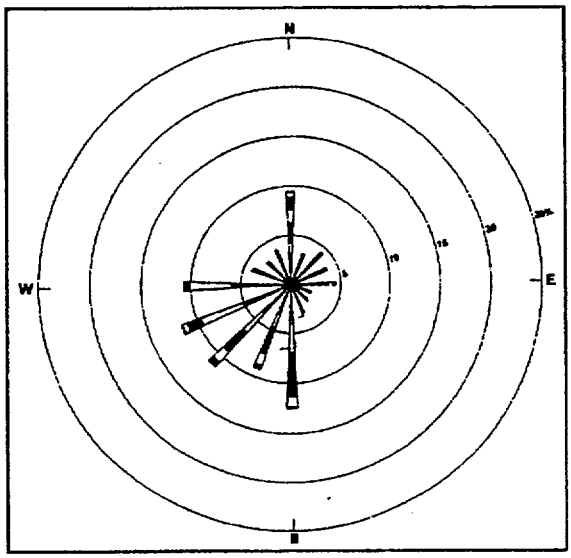
Figure 4-6. Wind Rose Plots for Site 5, Site 6, Site 7, and Site 8



(a) Site 9 (all hours)



(b) Desert Rock (all hours)



(c) Las Vegas-(all hours)

Note: The diagram is the frequency of occurrence for each wind direction from which the wind is blowing.

Figure 4-7. Wind Rose Plots for Site 9, Desert Rock, and Las Vegas

4.1.4.4 Humidity

The arid desert area of southern Nevada is known for its high frequency of very low atmospheric humidity. The climatological tables in Appendix A clearly demonstrate the very low average humidity conditions. The annual average relative humidity at the nine R/EFPD sites range from an early morning (0400) value of 38 percent to a late afternoon (1600) value of 21 percent. Afternoon summer humidity values less than 5 to 10 percent are not uncommon in the region.

4.2 ENGINEERING DESIGN CLIMATOLOGY

The meteorological data summarized in this section is included to provide the estimated maximum occurrences of precipitation and wind speed that are typically required for engineering design applications. These discussions of maximum occurrences are complemented by the routine climatology summaries described in Section 4.1 of this report.

4.2.1 Summary of Design Information Needs

In the absence of regulatory guidance covering design of the surface facilities associated with a geologic repository for high-level radioactive waste, some documents regarding the weather-related engineering design factors for nuclear power plants were examined. The topics addressed in this report are the highest daily (24-hour) events, maximum wind speeds, and the two examples of severe weather that have at least a low chance of occurrence at Yucca Mountain: lightning and tornadoes. Hurricanes are virtually impossible at Yucca Mountain, and blizzards appear to be highly unlikely in the current climate regime.

The design information needs fall into two categories: information based directly on regulatory guidance values, and estimates made using good scientific practice that may be based on regulatory guidance. The estimates are based on statistical analyses of observed data, expressed as the probabilities of occurrences expressed using the typical engineering concept of a "return period". The return period, also known as the recurrence interval, is the average time interval between the occurrence of a given quantity and that of an equal or greater quantity. The estimate of a precipitation occurrence or wind speed for a return period is not a forecast value during a particular period of time; it is an indication of the likelihood of a given event based on observed data.

4.2.2 Engineering Design Climatology Data Summaries

The typical meteorological conditions usually required for engineering design analyses are covered by the material presented in Section 4.1 of this report. One additional "typical" conditions summary provided is included as Table A-17 in Appendix A, the "ASHRAE" table. Regulatory documents are identified below. The estimates of maximum potential daily precipitation occurrences are based on statistical analyses of daily observations at nearby regional stations, and running 24-hour values based on the observed hourly precipitation totals from the R/EFPD and ARL/SORD stations. The wind speed estimates are based on maximum one-second wind gust speeds, and daily maximum one-minute wind speeds occurring at the R/EFPD sites.

4.2.2.1 Guidance Documents

The general design criteria for the geologic repository operations area given in Title 10 of the Code of Federal Regulations, Part 60.131 (10 CFR 60.131), paragraph (b) requires that structures important to safety be designed with "protection against natural phenomena and environmental conditions". These requirements are similar to those applicable to nuclear power plants (10 CFR 50. Appendix A). Regulatory guides showing specific recommended techniques to perform the analyses applicable to a geologic repository generally do not exist, so the regulatory guides written for nuclear power plants were used as guidance in these analyses.

Guidelines for design of nuclear reactors against tornado damage is provided by ANSI/ANS-2.3 (ANS, 1983), and Regulatory Guide 1.76 (AEC, 1974). The AEC guidance for the Yucca Mountain vicinity specifies design to withstand a tornado with maximum rotational winds of 190 mph and maximum translation speed of 50 mph. The ANS guide provides maps that show the maximum wind speed is 180 mph for a design basis tornado corresponding to a probability of 10^{-7} per year in the Yucca Mountain vicinity.

ANSI/ANS-2.3 (ANS 1983), provides guidelines for extreme winds as well as for tornado damage. It states that the 100-year return interval for wind speed using the Fisher-Tippett Distribution applied to existing fastest-mile wind speed data should be used in design of nuclear power plants. The data set should be composed of fastest-mile wind speeds, one sample per year for all years of record. USDOE (1995) establishes policy for construction of facilities, and protection of workers, the general public, and the environment from the impacts of natural phenomena. In Section 3.2.2 it recommends the use of the Gumbel Distribution (referred to as the Fisher-Tippett and Extreme Value distributions by other writers) to model straight wind hazards to determine extrapolated extreme values.

ANS 2.8 (ANS 1992) and Hydrometeorological Report No. 49 (NWS 1977) provide recommendations on calculation of Probable Maximum Precipitation for various applications, including power reactors. Specific information on this method is given in the next section of this report.

The NOAA Atlas 2 series of documents contain precipitation intensity information for the western states plotted as isopluvial contours on maps for a range of return period and precipitation durations. Volume VII of the Atlas (NOAA 1973) contains the information for Nevada.

4.2.2.2 Maximum Estimated Precipitation

Table 4-3 shows estimated maximum daily precipitation amounts for return periods of 50, 100, and 200 years calculated using the method summarized in Appendix C and the largest recorded values. The table includes data for the nine R/EFPD sites, nearby ARL/SORD stations at NTS, and the cooperative observer sites being analyzed, with the period of record included in the analyses. Separate analyses were performed for some stations for the period 1987-1996 to provide equitably comparable results for spatial difference comparisons covering the same time period. Recall that return periods are statistical properties of the distribution, and not true forcasts. Beatty is represented by two entries because the location of the weather station was moved in 1972.

Table 4-3. Estimated and Observed Maximum Daily Precipitation

Summary of Daily Precipitation Projections (inches)					
Location	50 yr return	100 yr return	200 yr return	largest recorded value	years covered
Site 1	2.68	3.03	3.40	1.39	1986 - 1996
Site 2	2.59	2.91	3.24	1.65	1990 - 1996
Site 3	1.91	2.14	2.38	1.33	1990 - 1996
Site 4	2.61	2.92	3.25	1.72	'90 & '92-'96
Site 5	2.05	2.3	2.56	1.63	1990 - 1996
Site 6	2.43	2.73	3.03	1.40	1993 - 1996
Site 7	2.38	2.65	2.93	1.21	1993 - 1996
Site 8	2.14	2.41	2.68	1.18	1993 - 1996
Site 9	1.6	1.79	1.98	0.90	1993 - 1996
4JA-all data	2.78	3.23	3.71	3.22	1957 - 1996
4JA - 10 yrs	2.92	3.33	3.76	2.04	1987 - 1996
Desert Rock	2.69	3.09	3.51	3.52	10/63-6/96
Mercury	2.77	3.19	3.64	3.63	12/68 - 12/93
Rock Valley	2.84	3.24	3.67	2.98	2/63 - 12/93
Cane Springs	3.10	3.52	3.96	3.47	9/64 to 12/93
Amargosa Farms	2.36	2.74	3.13	2.00	1965 - 1996
Am Fms - 10 yrs	2.07	2.34	2.62	1.45	1987 - 1996
Beatty	1.96	2.21	2.46	1.65	1948 - 1972
Beatty 8N	2.32	2.64	2.97	1.9	1972 - 1996
Beatty 8N-10 yrs	2.41	2.75	3.10	1.25	1987 - 1996
Las Vegas	2.13	2.43	2.74	2.58	1949 - 1992

The estimated maximum daily precipitation rates shown in Table 4-3 show some spatial and some temporal differences. The sites with shorter periods of record, less than 10 years, tend to have lower estimated maximums because the maximum observed storms in the area occurred prior to these sites beginning operation. For example, the R/EFPD sites have 100-year return periods that range between 1.79 inches at Site 9 to 3.03 inches at Site 1. Estimates for the nearby sites with over 20 years of data show 100-year return period estimates of between 2.21 and 3.52 inches. According to the NOAA Atlas 2 (NOAA 1973), the 100-year return period estimate for a 24-hour rainfall in the Yucca Mountain area is 2.60 inches.

The 100-year return period estimates tend to follow similar spatial relationships as the total annual precipitation records. For example, the precipitation totals in the Amargosa Valley area averages less than the totals for Beatty and 4JA, and Beatty averages less than 4JA. The maximum estimate for the Amargosa Farms Cooperative Observer site based on the 1987-1996 period is 2.34 inches, while the estimates for Beatty and 4JA for the same period are 2.75 and 3.33 inches, respectively. However, the results also show that the maximum events can occur throughout the area disproportionately to the annual totals. For example, the 100-year period maximum estimate for R/EFPD Site 3 (Coyote Wash) is 2.14 inches, compared to about 3 inches at the other nearby R/EFPD sites. Site 3 averages slightly more total precipitation than the other nearby R/EFPD sites.

For a comparison between results of the analyses performed for this report with previous results, Eglinton and Dreicer (1984) estimated maximum daily precipitation with a 100-year return period of 2.69 inches for Las Vegas, and 2.43 inches for Beatty. The corresponding estimates based on the current analyses are 2.43 inches for Las Vegas and 2.64 inches for Beatty.

The highest observed daily precipitation records at stations in the immediate vicinity of Yucca Mountain occurred on August 18, 1983 when many NTS stations experienced more than 3 inches of rain. The rainfall at Desert Rock Airport, Mercury, Rock Valley, and Cane Springs exceeded about 3.5 inches. Two stations were operating on Yucca Mountain during this period as part of the initial site investigations. Station YR on top of Yucca Mountain recorded 1.28 inches on this day, and station YA (at the location of R/EFPD Site 1) recorded 1.58 inches. At Site 4JA, 3.22 inches of rain was recorded; the second-highest value for this site was 2.44 inches. The second-highest value of 1.85 inches at Amargosa Farms occurred on this date; the highest amount was 2.00 inches, which occurred on January 14, 1967.

The two highest maximum daily observations for Las Vegas were 2.58 inches, which occurred during a flood-producing storm in Las Vegas on August 21, 1957 (Crow 1989) and 1.56 inches, which fell during August 1979. According to the statistical distributions, the highest event corresponds to a 300-year return period, and the second-highest is the magnitude of a 20-year event. The highest value falls above the statistical trend. When the highest observed value was included in the statistical distribution, the 100-year estimate was 2.43 inches; when it was excluded, the estimate was 2.17 inches, (about 11 percent lower).

The maximum rainfall in the R/EFPD network associated with the March 11, 1995 minor flooding of Fortymile Wash in southern Jackass Flats east of Yucca Mountain was 2.88 inches; this fell during the 36 hour period beginning on March 9. The six R/EFPD sites on Yucca Mountain and in Midway Valley had at least 1.75 inches. The two sites in Jackass Flats had about one inch during the storm. The highest 24-hour total during this storm was 2.14 inches, which occurred at R/EFPD Site 6 in upper Yucca Wash starting at 1000 Pacific Standard Time on March 10, 1995. This site and period registered a 1.24 inch total during six hours of the storm.

Previous climate discussions in Section 4.1.4 of this report showed that summer thunderstorms are capable of producing extremely heavy local precipitation that is not necessarily recorded at an official weather station. It is rare for a weather station in the Southern Nevada desert to record over 3 inches of rain in a day, though storms have had higher estimated amounts of rain based on from stream flows and flood damage assessments. For example, on August 10, 1983 Las Vegas had 0.45

inches of rain at the airport, but it was estimated that over 5 inches of rain fell in the Red Rocks Canyon area west of the city (Crow 1989). On July 3, 1975, the Las Vegas airport officially had 0.22 inches of rain. Unofficially, other parts of the Las Vegas Valley had 3.5 inches. Perhaps the largest documented storm in the regional area occurred on August 10, 1981, when an estimated 6 inches of rain fell in less than three hours near the Ute interchange on Interstate 15 northeast of Las Vegas (Randerson 1986). This storm was associated with both a closed low pressure area moving from the north across southern Nevada and warm moisture influx from the south along the Colorado River Valley.

The precipitation analyses in this report have focused on southern Nevada, the location of Yucca Mountain. Many of the precipitation studies cited utilized data from stations in California, Utah, and Arizona. Expanding the geographic coverage does not alter conclusions about Yucca Mountain rainfall. Information from these stations adds insight into the moisture sources and meteorological factors causing the observed extreme rainfall.

The National Weather Service (Hydrometeorological Report No. 49, NWS 1977) made an extensive hydrometeorology study to estimate the Probable Maximum Precipitation (PMP) for the Colorado River and Great Basin river drainages. The definition of PMP (NWS 1977) is the "theoretically greatest depth of precipitation for a given duration that is physically possible over a particular drainage basin at a particular time of year". PMP estimates are made for general storms with durations between 6 and 72 hours. Another analysis is made for intense local thunderstorms with durations between 15 minutes and 6 hours. The calculation of PMP patterns for a given area by season involves dynamic meteorology and existing precipitation records during a 90-year period in the desert southwest area of the United States, including California. The methods to calculate PMP do include regional differences, but the basic calculation includes extreme precipitation events that may have occurred hundreds of kilometers from a specific location.

The results of this report applicable to the Yucca Mountain area show the highest 24-hour convergence PMP value for a 26 square kilometer (km^2) area is approximately 10.5 inches, and the highest one-hour local-storm PMP for a 2.6 km^2 area is approximately 10.3 inches. In an extension of the local one-hour analyses in Figure 4.7 and Table 4.4 (NWS 1977), the percent of one-hour values and corresponding estimated precipitation for other time periods range between 68.5 percent (7.06 inches) in 15 minutes to 135 percent (13.90 inches) for six hours.

The conclusion from the statistical analyses of observed and estimated precipitation data performed for this report indicate that the maximum daily precipitation within 50 km of Yucca Mountain is not expected to exceed five inches. The isolated, and often unofficial, values greater than six inches in the historical record occurred far enough from Yucca Mountain to be considered climatologically unlikely for the immediate Yucca Mountain area. Notwithstanding the highly variable characteristics of precipitation in space and time in the intermountain west, it is difficult to expect that the PMP values given in the Hydrometeorological Report No. 49 (NWS 1977) exceeding 10 inches would be very likely to occur.

4.2.2.3 Winds

Maximum estimated and observed one-minute average wind speeds for the nine R/EFPD sites are shown in Table 4-4. Note that these estimates are based on three years of data for Sites 2 through 9, and only one year for Site 1. As with maximum precipitation estimates, the probabilistic estimates are reported as 50, 100, and 200 year return periods, but these do not imply predictions of occurrence during the given periods. The examples of the statistical analyses shown in Appendix C indicate the good fit of the observed data to the Gumbel distribution used to produce the maximum estimates. The statistical distribution fit the data extremely well, with a standard error of estimate of less than 0.3 in nearly all cases. The data consistently fall below the extrapolated best fit line at the higher wind speeds, consequently the estimates are conservative values.

Table 4-4. Estimated and Observed Maximum Daily One-Minute Wind Speeds

Summary of Projections for Maximum Daily 1-Minute Wind Speeds (m/sec)					
Location	50 yr return	100 yr return	200 yr return	Maximum recorded	Years covered
Site 1-10	32.78	34.57	36.35	23.26	1996
Site 1-60	42.01	44.36	46.72	27.89	1996
Site 2	42.23	44.59	46.95	29.95	1994-1996
Site 3	25.42	26.78	28.13	18.6	1994-1996
Site 4	45.93	48.47	51.00	33.16	1994-1996
Site 5	31.69	33.32	34.95	25.26	1994-1996
Site 6	34.30	36.14	37.97	22.65	1994-1996
Site 7	30.69	32.31	33.93	23.17	1994-1996
Site 8	31.54	33.25	34.96	21.3	1994-1996
Site 9	31.51	33.16	34.81	20.5	1994-1996

The highest one-minute wind speed estimate from the R/EFPD network stations occurred at Site 4, on top of Alice Hill, which is the northeastern land feature defining the northeast side of Midway Valley. The 100-year return period estimate for Site 4 is 48.47 meters per second (m/s). The 100 year estimates from Site 2, the ridgetop site on Yucca Mountain, and the 60-meter agl level at Site 1 are nearly identical at 44.59 and 44.36 m/s, respectively. The remaining sites show 100 year return period values less than about 36 m/s; the lowest 100 year return period estimate is 26.78 m/s, which is from the sheltered location at Site 3 in Coyote Wash. The maximum recorded values range from 18.6 m/s at Site 3 to 33.16 m/s at Site 4. The maximum recorded values are about 63 to 76 percent of the 100 year return period estimates.

Additional insight into these statistical results is seen in a comparison of the 50, 100, and 200 year return periods by Site. The difference between successively longer periods is about 3 m/s at all sites. This indicates a very low probability of maximum winds occurring that are more than about 3 to 6 m/s greater than the values shown.

The joint-frequency distribution analyses based on wind speed and direction were performed on the daily maximum one-minute winds to better understand the distribution of speeds, and the directions corresponding to the maximum speeds. The summary of the wind direction distributions in the 16 direction categories and the wind speed distributions in six categories are shown for the eight R/EFPD sites with three years of data in Table 4-5.

The direction data in Table 4-5 show the maximum winds generally are from the northerly and southerly directions at most of the sites. For example, 30 percent of the daily one-minute maximum winds at Site 5 (Fortymile Wash) were from the north and 27 percent were from the south-southeast to south directions. The sites with confined topography, such as Sites 3 and 6, show channeling of the maximum winds along the axes of nearby topography, much the same as occurs with the remainder of the winds. By contrast, the two primary directions on the ridgetop of Yucca Mountain (Site 2) were the south-southeast and southwest to west-southwest directions. The Site 4 (Alice Hill) data showed two well defined direction categories containing over 50 percent of the daily maximum: north-northeast and south.

The distributions of the maximum wind speeds in Table 4-5 showed that the daily maximum one-minute speeds were mostly greater than 5.4 m/s, although over 20 percent of the maximum winds at Site 3 were less than 5.4 m/s. All the sites except for Site 3 (Coyote Wash) had daily maximum one-minute speeds over 11 m/s on at least 24 percent of the days.

The maximum estimated one-second gust speeds for the nine R/EFPD sites are shown in Table 4-6. Data from 1993 through 1996 were used for Sites 2 through 9 to base the comparisons between results from the sites in the network on the same time period. Site 1 data are also shown, though the gust data were taken only during 1996. The 100-year one-second gust estimates range from 43.28 m/s at Site 3 to 57.01 m/s at Site 4. The highest recorded values range from 28.37 m/s at Site 3 to 40.22 m/s at Site 4. The ratio of highest recorded one-second gust speeds to the 100-year return period estimates are about the same as those discussed for the one-minute data.

The observed and estimated one-second gust speeds are generally closer to the one-minute maximum wind speeds at the exposed sites than those closer to the terrain. The observed one-second speeds are at least 75 percent of the one-minute speeds at all sites, except Site 3, which is 65 percent. The value for the 10-meter agl data at Site 1 is over 98 percent, but keep in mind these values are based on only one year of data.

Table 4-5. Wind Direction and Wind Speed Joint-Frequency Distributions of Maximum One-Minute Average Wind Speeds at R/EFPD Sites 2-9 for 1993-1996.

Direction	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
N	0.033	0.000	0.066	0.299	0.092	0.123	0.076	0.065
NNE	0.030	0.000	0.236	0.024	0.043	0.172	0.034	0.145
NE	0.047	0.000	0.067	0.020	0.014	0.013	0.013	0.100
ENE	0.025	0.004	0.008	0.048	0.003	0.002	0.005	0.039
E	0.029	0.190	0.008	0.030	0.005	0.010	0.017	0.014
ESE	0.052	0.213	0.004	0.006	0.008	0.018	0.014	0.003
SE	0.045	0.097	0.005	0.008	0.204	0.025	0.020	0.017
SSE	0.121	0.164	0.087	0.105	0.273	0.333	0.143	0.213
S	0.031	0.024	0.302	0.165	0.024	0.049	0.359	0.200
SSW	0.030	0.000	0.077	0.071	0.029	0.096	0.143	0.057
SW	0.179	0.004	0.041	0.052	0.006	0.023	0.014	0.018
WSW	0.159	0.001	0.028	0.045	0.007	0.009	0.011	0.014
W	0.082	0.033	0.006	0.018	0.002	0.008	0.004	0.015
WNW	0.029	0.216	0.006	0.009	0.013	0.010	0.011	0.010
NW	0.086	0.054	0.021	0.029	0.177	0.030	0.032	0.033
NNW	0.023	0.002	0.038	0.071	0.101	0.080	0.105	0.059

	Wind Speeds (meters/second)					
	≤1.8	1.8 to ≤3.3	3.3 to ≤5.4	5.4 to≤8.5	8.5 to≤11	>11
Site 2	0.000	0.000	0.056	0.237	0.295	0.412
Site 3	0.000	0.005	0.200	0.508	0.202	0.084
Site 4	0.000	0.000	0.052	0.180	0.200	0.568
Site 5	0.000	0.000	0.008	0.379	0.296	0.316
Site 6	0.000	0.001	0.016	0.397	0.246	0.340
Site 7	0.000	0.002	0.080	0.374	0.302	0.242
Site 8	0.000	0.006	0.138	0.360	0.259	0.237
Site9	0.000	0.000	0.015	0.362	0.229	0.394
Average	0.000	0.002	0.071	0.350	0.254	0.324

Table 4-6. Estimated and Observed Maximum 1-Second Gust Wind Speeds

Estimated and Observed Maximum 1-Second Gust Wind Speeds (meters per second)					
Location	50 yr return	100 yr return	200 yr return	Highest Recorded Value	Years covered
Site 1-60 meter elevation	50.97	53.78	56.60	34.34	1996
Site 1-10 meter elevation	45.00	47.46	49.93	28.29	1996
Site 2	52.15	55.03	57.90	40.22	1993-1996
Site 3	41.02	43.28	45.53	28.37	1993-1996
Site 4	54.11	57.01	59.91	40.22	1993-1996
Site 5	40.64	42.77	44.90	30.86	1993-1996
Site 6	47.98	50.61	53.25	31.29	1993-1996
Site 7	40.69	42.87	45.05	28.33	1993-1996
Site 8	40.02	42.19	44.36	29.22	1993-1996
Site 9	41.09	43.29	45.48	26.77	1993-1996

4.2.2.4 Lightning

An analysis of 1991 - 1996 lightning strike data from a 3600 km^2 area around the Yucca Mountain study area showed the most occurrences in August with a secondary maxima in May. The summer months of May through September had the most lightning strikes, with little or no lightning strikes outside the summer months. The annual flash density ranged from between 0.06 to 0.4 strikes per square kilometer per year. The greatest number of strikes was 1,478, which occurred in 1991, giving the year an average of 0.4 strikes per square kilometer. The percentage of positive strikes ranged from 2 percent to 3.2 percent. The most positive strikes for a year was 34 strikes, occurring in 1992.

Results from the 3,600 km^2 area show a slightly lower strike density than the results from a nationwide survey that showed southern Nevada in a narrow north to south zone with up to 0.5 flashes per square kilometer to the west, through a narrow 0.5 to 1 zone, and a 1 to 3 flashes per square kilometer in a large zone through Arizona and northward through the Rockies (Orville & Silver 1997). The trend for maximum occurrences in summer reported in the nationwide study are similar to the results seen in the ARL/SORD data. The positive flash percentage ranged from 1.6 percent to 3.1 percent for 1992 through 1994, which is similar to the results from the ARL/SORD data.

A similar analysis of lightning occurrences was performed for a 100 km^2 area centered on western Midway Valley. The maxima for the area occurs in August with no prominent secondary maxima. The flash density ranged from 0.07 to 0.4 strikes per square kilometer per year. The 100 km^2 area did not receive any positive strikes during the years the data were collected.

In conclusion, the results show no more than 0.41 strikes per square kilometer annually, with the maximums occurring during August and May. About two to three percent of the strikes are positive strikes to ground.

4.2.2.5 Tornadoes

Tornado occurrences in the Great Basin area of Nevada, Utah, Arizona and portions of California from October 1986 through November 1996 were tabulated as an update to the results reported in an earlier survey of meteorological data applicable to Yucca Mountain (Eglington and Dreicer 1984). The earlier survey identified no tornadoes on the NTS between 1916 and 1969 and only four within a 150 mile radius of the NTS. Only 12 tornadoes were reported in the entire State of Nevada between 1959 and 1973.

Out of a total of 73 reported tornadoes, identified in the current survey of the NOAA publication Storm Data and personal communication with NOAA/ARL/SORD staff, 15 were in the F1 category (wind speeds greater than 32 but less than or equal to 50 m/s), and four were in the F2 category (wind speeds greater than 50 but less than or equal to 70 m/s). No F2 tornadoes were reported in Nevada. The other 54 reported tornadoes were in the F0 category, with speeds up to 32 m/s. The tornado reported the closest to Yucca Mountain was in Amargosa Valley, approximately 50 km from Yucca Mountain. This was an F0 tornado that occurred July 16, 1987.

Although the chances of a tornado being observed are less in the sparsely populated rural areas of the Great Basin, the primary reason for these indications of infrequent and weak tornadoes is the lack of the proper meteorological conditions necessary for tornado formation. The prevailing dry conditions, plus the irregular, rough terrain tends to preclude the possibility of tornadoes. However, when the atmosphere is adequately moist and unstable from near the surface to several thousand meters above the surface, and vertical wind shear exists, then conditions could be favorable for tornado formation. These conditions are most likely when cold, closed, low-pressure systems migrate from the eastern Pacific Ocean over Nevada, or when deep layers of subtropical moisture stream into the region from the Gulf of Mexico and the Gulf of California.

NRC Regulatory Guide 1.76 (NCR 1974) addresses the magnitude of wind speeds associated with the design basis tornado. Yucca Mountain, and the most of the Great Basin area, are in Region III. The design basis tornado characteristics associated with Region III shown in Table 4-7 are taken from Table I in RG 1.76. Data in RG 1.76 are in English units; metric conversions are also shown in Table 4-7. The speeds shown in Table 4-7 are all higher than the speeds associated with the tornadoes reported in the survey, so the design basis characteristics are conservative estimates of wind speeds.

Table 4-7. Design Basis Tornado Characteristics

Characteristic	Values
Maximum wind speed (sum of rotational and translational speeds)	240 mph (107 m/s)
Rotational speed	190 mph (85 m/s)
Translational speeds Maximum Minimum	 50 mph (22 m/s) 5 mph (2 m/s)
Radius of maximum rotational speed	150 feet (46 m)
Pressure drop	1.5 pounds per square inch
Rate of pressure drop	0.6 pounds per square inch per second

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5. CONCLUSIONS

Analyses of regional meteorological conditions confirm previous descriptions of the area as an arid, warm climate with infrequent occurrences of severe weather. Variations occur in regional patterns of precipitation, temperature, and wind due to cumulative influences of large and small scale weather and topography features. The persistent influence synoptic weather patterns such as the Great Basin High dictates many regional weather characteristics. Storms from the Pacific Ocean that manage to cross the Sierra Nevada mountains with enough moisture can produce some regional rainfall; these storms are typically associated with winter. Other Pacific weather patterns combined with a Thermal Low pattern in the southwest can bring moisture into the region resulting in thunderstorms that produce significant rainfall events; this pattern is known as the summer monsoon in the area. The large scale topography features that control regional meteorological conditions include mountain ranges and the proximity to the primary moisture sources, the Pacific Ocean and Gulf of California. Smaller topographic features, such as local mountain and valley structure and orientation, down to the immediate influence of nearby terrain features, also influence local weather conditions.

The infrequent and typically low magnitude characteristics of regional precipitation are evident in the precipitation record. The occasional large rainfall events are a crucial interest to virtually any activities in the region. The infrequent, occasionally intense, and sometimes small areal coverage rainfall characteristics pose analytical problems when attempting to discern the magnitude, timing and spatial patterns of probable maximum events. Regional precipitation annual totals in the last 75 years vary between about two inches during a dry year to greater than 10 inches during the wetter years. Higher elevations tend to receive more precipitation than do the lower elevations, but the local slope and aspect of topographic features have at least as much influence on precipitation occurrences as elevation. The range for the immediate Yucca Mountain area tends to fall within the four to eight inches per year range during most years.

Air temperature, humidity and wind speed pose relatively fewer characterization problems, though these characteristics can also vary considerably over short distances and time periods. Air temperatures in the region frequently vary by 15°C on a diurnal (day and night) cycle during most of the year due to the prevailing clear skies and low atmospheric humidity. Daytime summer temperatures frequently exceed 35°C, but rarely do they exceed 45°C. Winter temperatures can reach 0°C during many nights, but -10°C is an unusually cold temperature.

Regional winds tend to follow the major mountain and valley topographic features. Calm periods do not occur very often or for very long a time. Nighttime winds tend to be at least a few meters per second (m/s) flowing either downslope from nearby topography or in organized downvalley airflow near major features. Daytime winds tend to be higher speed, and flow in upslope and/or upvalley directions. Maximum wind speeds can approach 40 m/s, particularly at locations of exposed terrain, such as hilltops.

The only severe weather phenomena to occur with any regularity in the region is lightning, which occurs during summer thunderstorms. Lightning occurs at a rate less than about 0.4 strikes per square kilometer per year in the 3,600 square kilometer area surrounding Yucca Mountain.

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APPENDIX A

CLIMATOLOGICAL SUMMARY TABLES

APPENDIX A

CLIMATOLOGICAL SUMMARY TABLES

Statistical terms used in Appendix A are defined as follows:

1. **Extreme maximum** - The absolute highest daily value
2. **Mean maximum** - The average of the highest values
3. **Mean** - The average of all values taken over a given period of time
4. **Mean minimum** - The average of the lowest values
5. **Extreme minimum** - The absolute lowest daily value
6. **Fastest 1-minute** - The highest wind speed measured over any 1-minute period, with the associated wind direction
7. **Peak 3-second wind speed** - The highest 3-second running average wind speed
8. **Mean diurnal range** - The average of the differences between the highest daily value and the lowest daily value
9. **Sigma** - The standard deviation of a variable

The tables in Appendix A are based on the following years for the R/EFPD sites:

Site 1: All measurements are based on an 11 year period running from 1986-1996.

Sites 2-5: Temperature, relative humidity, and average wind speed are based on a 11 year period running from 1986-1996. Barometric pressure and precipitation are based on an eight year period running from 1989-1996. Fastest one minute wind speed is based on a four year period running from 1993-1996 and peak three second gust on a 3.5 year period running from mid 1993-1996.

Sites 6- 9: All measurements except for peak three second gust are based on a four year period running from 1993-1996. Peak three second gust is based on a 3.5 year period running from mid 1993-1996.

Temperature
All sites, except Site 1, are based on one second data averaged over one hour up to 1994 and then from 1994 through 1996 on one second data averaged over one minute. Site 1 data was switched over to one second data averaged over one minute in 1996.

Number of Days
Based on calendar days for the year meeting the criteria and the average taken of the years.

Barometric Pressure
The average of one second data averaged over one hour for the entire period.

Mean Relative Humidity
The average of one second data averaged over one hour for only the hour stated in the table for the entire record period.

Precipitation
The maximum for the 6 and 24 hour periods are based on a continuous running period which may encompass more than one calender day. The total is based on the average of the entire period for each month. Entries with a "T" indicate that a trace of precipitation (or snowfall) was observed.

Wind
Average wind speed is based on one second data averaged over one hour for the entire record period. The fastest one minute wind speed and peak three second gust are based on one second data averaged over one minute and the extreme taken from the entire period.

Table A-1. R/EFPD Site 1 (NTS-60) Monthly and Annual Climatological Summaries

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Temperature (C)													
Extreme Maximum (2)	20.5	26.3	26.2	31.7	36.0	39.8	40.9	40.3	37.3	34.7	26.2	20.3	40.9
Mean Maximum (2)	10.9	13.4	16.1	21.1	24.9	31.0	34.2	33.7	29.0	23.5	15.5	10.6	22.0
Mean (2)	6.3	8.7	11.3	15.9	19.5	25.3	28.6	27.9	23.5	18.0	10.4	6.0	16.8
Mean Minimum (2)	2.4	4.4	6.5	10.2	13.4	18.6	22.1	21.7	17.7	12.8	5.9	2.1	11.5
Extreme Minimum (2)	-7.0	-11.1	-3.9	0.8	0.3	4.5	10.9	13.9	6.9	-0.3	-6.1	-11.7	-11.7
Number of Days													
Precipitation													
0.01 inch or more	4.5	4.3	5.2	2.9	4.2	2.7	1.9	3.2	2.8	3.5	2.8	3.8	41.8
Temperature (2)													
32C (90F) and above	0	0	0	0	3	13.8	22.9	21.5	6.4	2.7	0	0	70.3
0C (32F) and below	7.2	6	2.6	0	0	0	0	0	0	0	3.7	10.1	29.6
Barometric Pressure (mb)													
Mean (2)	888.4	886.7	884.6	884.2	882.4	883.1	885.1	885.7	885.7	886.7	888.4	888.8	885.8
Mean Relative Humidity (%)													
Hour 0400 (PST) (2)	44.6	45.3	41.5	32.3	31.5	22.8	23.5	25.5	25.9	28.0	37.2	45.9	33.7
Hour 1000 (2)	39.8	40.0	34.7	25.4	22.7	18.3	18.0	20.0	21.2	22.4	30.3	38.7	27.6
Hour 1600 (2)	33.1	30.9	26.2	18.8	17.1	13.0	13.4	14.3	14.8	18.1	25.1	31.9	21.4
Hour 2200 (2)	41.9	40.6	35.5	25.8	23.8	16.8	17.3	19.2	20.1	24.5	33.4	42.8	28.5
Precipitation (in)													
Max 1-hour total	0.19	0.16	0.58	0.21	0.27	0.12	0.47	0.66	0.12	0.19	0.40	0.23	0.66
Max 6-hour total (3)	0.77	0.49	0.84	0.71	0.42	0.16	0.86	1.18	0.39	0.48	0.66	0.70	1.18
Max 24-hour total (3)	1.39	0.76	1.33	1.32	0.46	0.24	1.22	1.18	0.44	0.62	1.29	1.00	1.39
Total	0.92	0.61	0.90	0.25	0.39	0.09	0.25	0.53	0.09	0.25	0.24	0.45	4.97
Wind													
Mean Speed (m/s) (2)	2.8	3.2	3.7	4.0	4.0	3.9	3.7	3.5	3.3	3.0	3.2	2.8	3.4
Fastest 1-minute (1)													
Speed (m/s)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Direction (deg)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Peak 3-sec Gust (m/s)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Note 1: Values derived from 1-second data averaged over 1 minute.
Note 2: Values derived from 1-second data averaged over 1 hour.
Note 3: Continuous running period which may encompass more than one calendar day.

Table A-2. R/EFPD Site 2 (Yucca Mountain) Monthly and Annual Climatological Summaries

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Temperature (C)													
Extreme Maximum (1)	18.5	23.6	24.0	29.8	34.2	39.9	39.7	39.1	36.1	33.5	24.3	18.9	39.9
Mean Maximum (1)	8.6	11.0	14.0	19.0	22.9	29.1	32.3	31.6	27.1	21.0	13.0	8.3	19.8
Mean (2)	5.6	7.4	10.2	14.6	18.2	23.9	27.1	26.7	22.7	17.1	9.5	5.5	15.7
Mean Minimum (1)	2.9	4.3	6.9	10.5	13.7	19.1	22.4	22.4	18.6	13.6	6.5	2.9	12.0
Extreme Minimum (1)	-10.1	-12.5	-3.7	-0.6	-1.2	2.4	10.2	12.7	5.6	-1.5	-7.3	-12.3	-12.5
Number of Days													
Precipitation													
0.01 inch or more	5.4	5.7	5.4	1.4	2.3	1.0	1.1	1.1	1.0	1.4	1.7	3.7	31.4
Temperature (2)													
32C (90F) and above	0	0	0	0	0.2	6.7	16.2	12.4	2.6	0.1	0	0	38.2
0C (32F) and below	7.3	5.6	2	0.3	0.2	0.1	0	0	0	0.3	2.9	6.7	25.4
Barometric Pressure (mb)													
Mean (2)	851.5	850.8	849.7	849.1	848.3	849.8	852.1	852.6	852.6	852.1	852.6	851.5	851.1
Mean Relative Humidity (%)													
Hour 0400 (PST) (2)	45.6	42.3	40.1	28.5	27.5	16.0	18.5	22.2	23.2	27.4	35.9	41.4	30.7
Hour 1000 (2)	43.2	41.2	38.0	25.5	22.9	13.6	14.9	19.2	19.8	25.1	33.0	38.7	27.9
Hour 1600 (2)	38.8	33.5	29.5	18.2	16.5	8.6	10.6	13.2	13.8	19.9	27.1	34.3	22.0
Hour 2200 (2)	43.8	39.4	34.7	23.7	22.0	12.3	14.4	17.9	18.4	24.5	32.4	39.9	27.0
Precipitation (in)													
Max 1-hour total	0.31	0.21	0.32	0.13	0.21	0.36	0.20	0.50	0.17	0.12	0.26	0.23	0.50
Max 6-hour total (3)	0.63	0.64	0.92	0.22	0.37	0.58	0.26	0.56	0.34	0.42	0.71	1.03	1.03
Max 24-hour total (3)	1.31	1.20	1.70	0.48	0.45	0.67	0.28	0.56	0.34	0.75	1.17	1.78	1.78
Total	1.29	1.51	1.55	0.14	0.22	0.14	0.11	0.23	0.09	0.23	0.31	0.74	6.56
Wind													
Mean Speed (m/s) (2)	3.6	4.1	4.5	5.0	4.8	4.6	4.2	4.6	4.2	4.1	4.0	3.8	4.3
Fastest 1-minute (1)													
Speed (m/s)	23.2	26.3	28.7	28.9	21.6	30.0	23.0	19.7	20.9	29.4	25.0	26.1	30.0
Direction (deg)	326	312	307	237	285	324	99	268	316	325	269	319	239
Peak 3-sec Gust (m/s)	27.2	31.0	34.8	38.2	27.2	33.4	28.5	25.2	24.1	33.3	31.9	31.6	38.2

Note 1: Values derived from 1-second data averaged over 1 minute.
Note 2: Values derived from 1-second data averaged over 1 hour.
Note 3: Continuous running period which may encompass more than one calendar day.

Table A-3. R/EFPDSite 3 (Coyote Wash) Monthly and Annual Climatological Summaries

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Temperature (C)													
Extreme Maximum (1)	19.5	24.9	25.0	30.9	34.6	40.4	39.9	39.6	36.6	33.6	25.2	19.7	40.4
Mean Maximum (1)	9.9	12.5	15.1	20.3	23.8	30.0	33.0	32.5	28.2	22.1	14.4	9.5	20.9
Mean (2)	6.3	8.6	10.8	15.6	19.0	24.8	28.0	27.5	23.4	17.8	10.3	5.9	16.5
Mean Minimum (1)	3.0	4.9	6.4	10.5	13.6	18.8	22.2	22.1	18.4	13.4	6.4	2.5	11.8
Extreme Minimum (1)	-7.9	-10.7	-4.3	-0.3	0.1	4.2	10.5	14.3	7.2	0.3	-5.9	-12.2	-12.2
Number of Days													
Precipitation													
0.01 inch or more	5.1	4.6	5.3	1.4	3.3	1.1	1.3	1.3	1.6	1.4	2.3	4.6	33.3
Temperature (2)													
32C (90F) and above	0	0	0	0	0.5	9.6	17.5	16.6	4.5	0.3	0	0	49.0
0C (32F) and below	6.8	4.1	1.9	0.1	0	0	0	0	0	0	1.9	8.2	23.0
Barometric Pressure (mb)													
Mean (2)	872.9	871.8	870.1	869.6	867.9	868.7	870.8	871.3	871.6	872.0	873.2	872.7	871.0
Mean Relative Humidity (%)													
Hour 0400 (PST) (2)	45.1	44.5	43.4	33.9	33.1	21.9	22.9	26.2	28.9	31.4	37.6	45.4	34.5
Hour 1000 (2)	39.4	39.6	37.3	27.2	24.7	16.8	16.8	20.8	22.3	25.1	30.8	38.3	28.3
Hour 1600 (2)	35.4	31.8	29.6	19.9	18.4	12.4	13.0	15.1	16.4	21.4	26.5	34.7	22.9
Hour 2200 (2)	42.9	40.8	38.0	26.9	25.2	16.6	17.1	20.3	22.5	27.9	33.8	42.9	29.6
Precipitation (in)													
Max 1-hour total	0.32	0.20	0.43	0.14	0.23	0.29	0.18	0.31	0.27	0.17	0.57	0.26	0.57
Max 6-hour total (3)	0.74	0.61	1.13	0.21	0.36	0.60	0.18	0.62	0.27	0.53	0.77	0.77	1.13
Max 24-hour total (3)	1.53	1.22	1.89	0.31	0.41	0.67	0.18	0.67	0.27	0.79	1.60	1.12	1.89
Total	1.33	1.29	1.57	0.14	0.33	0.14	0.09	0.20	0.15	0.31	0.39	0.75	6.70
Wind													
Mean Speed (m/s) (2)	2.2	2.4	2.7	2.8	2.8	2.8	2.6	2.4	2.4	2.4	2.6	2.3	2.5
Fastest 1-minute (1)													
Speed (m/s)	16.3	15.9	16.0	17.0	13.7	17.3	18.6	11.7	13.9	18.0	15.2	14.6	18.6
Direction (deg)	300	306	309	302	290	299	107	294	89	307	310	302	107
Peak 3-sec Gust (m/s)	23.3	21.8	25.2	24.5	19.2	24.3	21.0	17.3	19.5	26.2	21.5	22.0	26.2

Note 1: Values derived from 1-second data averaged over 1 minute.
Note 2: Values derived from 1-second data averaged over 1 hour.
Note 3: Continuous running period which may encompass more than one calendar day.

Table A-4. R/EFPDSite 4 (Alice Hill) Monthly and Annual Climatological Summaries

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Temperature (C)													
Extreme Maximum (1)	20.7	25.3	26.5	32.3	36.8	42.3	41.6	41.0	38.0	34.8	26.5	20.4	42.3
Mean Maximum (1)	10.4	12.8	15.8	20.6	24.4	30.5	33.7	33.5	28.9	22.6	14.7	10.0	21.5
Mean (2)	6.5	8.6	11.2	15.6	19.2	25.2	28.4	28.1	23.6	17.6	10.3	6.2	16.7
Mean Minimum (1)	2.9	4.5	6.8	10.3	13.8	19.2	22.7	22.5	18.1	12.5	6.2	2.6	11.8
Extreme Minimum (1)	-7.3	-11.0	-4.1	-0.0	-0.3	4.0	11.2	14.1	7.4	0.0	-6.0	-12.6	-12.6
Number of Days													
Precipitation													
0.01 inch or more	5.8	4.6	5.4	1.6	2.4	1.4	0.9	1.3	0.9	1.6	2.2	4.0	32.0
Temperature (2)													
32C (90F) and above	0	0	0	0	1	11.2	20.3	18.5	6	0.4	0	0	57.4
0C (32F) and below	5.3	4.3	1.4	0.1	0.1	0	0	0	0	0	1.4	6.3	18.9
Barometric Pressure (mb)													
Mean (2)	877.7	876.5	874.5	873.9	872.2	873.2	875.3	876.0	876.4	876.5	878.3	878.1	875.7
Mean Relative Humidity (%)													
Hour 0400 (PST) (2)	46.5	46.0	43.0	30.4	30.2	18.9	20.4	22.7	25.1	30.9	37.8	45.1	33.1
Hour 1000 (2)	43.7	42.7	37.7	24.4	22.3	14.7	15.5	18.0	20.3	24.9	32.9	40.0	28.1
Hour 1600 (2)	36.2	33.2	28.3	17.3	15.7	9.9	12.6	12.7	14.1	19.4	26.1	33.1	21.6
Hour 2200 (2)	44.0	42.1	37.3	24.2	22.3	13.9	15.3	17.6	19.9	26.8	33.3	42.4	28.3
Precipitation (in)													
Max 1-hour total	0.29	0.22	0.33	0.17	0.14	0.12	0.33	0.38	0.24	0.19	0.42	0.23	0.42
Max 6-hour total (3)	0.69	0.61	0.95	0.35	0.31	0.43	0.36	0.53	0.49	0.43	0.81	0.81	0.95
Max 24-hour total (3)	1.19	1.13	1.76	0.53	0.50	0.49	0.37	0.56	0.58	0.74	1.51	1.86	1.86
Total	1.49	1.16	1.43	0.21	0.22	0.12	0.16	0.17	0.11	0.32	0.37	0.84	6.57
Wind													
Mean Speed (m/s) (2)	3.7	4.2	4.6	5.2	5.1	4.8	4.3	4.1	4.1	4.1	4.5	3.7	4.4
Fastest 1-minute (1)													
Speed (m/s)	24.4	25.3	27.8	29.3	24.6	26.8	25.1	19.9	22.9	33.2	25.6	23.7	33.2
Direction (deg)	340	339	2	351	10	338	37	33	329	345	342	344	345
Peak 3-sec Gust (m/s)	28.0	29.2	31.4	32.2	29.3	30.0	28.3	28.5	24.9	37.2	29.8	27.9	37.2

Note 1: Values derived from 1-second data averaged over 1 minute.
Note 2: Values derived from 1-second data averaged over 1 hour.
Note 3: Continuous running period which may encompass more than one calendar day.

Table A-5. R/EFPD Site 5 (Fortymile Wash) Monthly and Annual Climatological Summaries

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Temperature (C)													
Extreme Maximum (1)	22.9	27.9	28.6	34.6	38.8	43.6	43.5	42.8	39.9	36.9	28.3	22.2	43.6
Mean Maximum (1)	12.6	15.3	18.4	23.4	27.2	33.1	36.3	35.7	31.3	25.6	17.5	12.3	24.1
Mean (2)	6.8	9.5	12.5	17.0	20.9	26.4	29.6	28.9	24.5	18.8	11.2	6.4	17.7
Mean Minimum (1)	1.8	4.3	6.5	10.2	13.6	18.3	21.8	21.4	17.4	12.6	5.7	1.4	11.2
Extreme Minimum (1)	-7.1	-11.8	-4.7	0.5	1.4	2.6	11.1	13.0	5.5	-0.7	-6.6	-13.1	-13.1
Number of Days													
Precipitation													
0.01 inch or more	4.7	4.6	4.9	1.6	2.7	0.9	1.0	1.3	0.7	1.1	1.4	3.3	28.1
Temperature (2)													
32C (90F) and above	0.0	0.0	0.0	0.6	3.1	18.8	27.4	25.0	13.3	2.8	0.0	0.0	91.0
0C (32F) and below	7.5	3.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.0	8.5	22.6
Barometric Pressure (mb)													
Mean (2)	908.1	906.7	904.5	903.5	901.5	901.9	903.6	904.5	904.8	905.9	908.2	908.2	905.1
Mean Relative Humidity (%)													
Hour 0400 (PST) (2)	49.1	47.3	46.1	33.2	34.0	21.4	22.5	25.4	25.8	29.2	36.8	44.4	34.6
Hour 1000 (2)	40.7	38.0	34.5	23.2	21.9	14.4	15.1	18.4	18.7	21.1	27.5	34.6	25.7
Hour 1600 (2)	32.2	28.8	26.3	16.6	15.8	9.4	10.5	12.4	12.5	15.9	20.7	26.6	19.0
Hour 2200 (2)	47.1	43.9	40.1	27.2	25.0	15.2	16.4	19.0	20.4	25.6	32.6	41.9	29.5
Precipitation (in)													
Max 1-hour total	0.23	0.26	0.16	0.22	0.10	0.19	0.50	0.38	0.33	0.25	0.16	0.23	0.50
Max 6-hour total (3)	0.50	0.59	0.53	0.26	0.25	0.50	0.72	0.53	0.74	0.49	0.70	0.78	0.78
Max 24-hour total (3)	1.02	0.89	0.94	0.26	0.49	0.53	0.72	0.53	0.84	0.97	1.05	1.63	1.63
Total	1.14	0.94	0.89	0.12	0.20	0.10	0.15	0.12	0.14	0.26	0.23	0.79	5.10
Wind													
Mean Speed (m/s) (2)	3.7	4.1	4.3	4.6	4.6	4.5	4.3	4.3	4.3	4.1	4.2	3.9	4.2
Fastest 1-minute (1)													
Speed (m/s)	17.2	19.7	19.7	21.6	20.3	20.9	18.4	16.7	16.7	25.3	18.2	18.4	25.3
Direction (deg)	350	185	349	346	317	344	82	227	178	337	336	178	337
Peak 3-sec Gust (m/s)	20.7	23.1	24.9	26.4	24.8	25.1	26.5	20.0	20.7	30.4	21.7	22.1	30.4

Note 1: Values derived from 1-second data averaged over 1 minute.
Note 2: Values derived from 1-second data averaged over 1 hour.
Note 3: Continuous running period which may encompass more than one calendar day.

Table A-6. R/EFPD Site 6 (WT-6) Montly and Annual Climatological Summaries

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Temperature (C)													
Extreme Maximum (1)	19.8	23.1	24.5	30.4	34.7	39.6	39.6	41.9	36.3	33.7	25.5	18.5	41.9
Mean Maximum (1)	9.8	12.3	16.2	19.8	24.2	30.5	33.9	33.9	29.1	22.1	14.2	10.0	21.3
Mean (2)	4.7	6.8	10.1	13.4	17.5	23.3	27.4	26.6	22.0	15.5	8.3	5.1	15.1
Mean Minimum (1)	0.2	1.5	4.1	6.4	9.9	14.6	18.4	18.3	14.5	9.4	2.7	-0.1	8.3
Extreme Minimum (1)	-9.9	-9.9	-6.9	-1.4	-0.3	2.3	11.0	12.0	6.2	-1.0	-7.8	-7.2	-9.9
Number of Days													
Precipitation													
0.01 inch or more	7.5	5.8	4.3	1.5	4.0	1.5	1.0	1.0	1.3	1.0	2.3	3.5	34.5
Temperature (2)													
32C (90F) and above	0.0	0.0	0.0	0.0	0.8	12.3	23.0	22.0	5.8	0.5	0.0	0.0	64.3
0C (32F) and below	12.3	10.8	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	13.3	45.3
Barometric Pressure (mb)													
Mean (2)	867.4	866.5	866.5	865.2	864.4	866.3	868.3	868.2	867.9	867.4	868.9	868.9	867.1
Mean Relative Humidity (%)													
Hour 0400 (PST) (2)	61.7	61.2	55.2	41.7	45.8	30.4	29.8	30.4	31.6	36.0	45.8	56.2	43.8
Hour 1000 (2)	49.2	45.3	38.7	26.3	26.2	18.3	16.5	17.3	18.7	23.8	31.4	39.6	29.3
Hour 1600 (2)	46.4	37.7	29.5	18.5	19.3	11.6	11.4	11.4	12.8	18.8	27.7	36.2	23.4
Hour 2200 (2)	59.3	57.9	47.1	33.4	34.9	22.0	20.3	21.5	23.2	31.0	41.9	53.0	37.1
Precipitation (in)													
Max 1-hour total	0.44	0.27	0.25	0.19	0.34	0.27	0.31	0.28	0.28	0.17	0.25	0.24	0.44
Max 6-hour total (3)	1.24	0.56	1.16	0.40	0.39	0.58	0.40	0.61	0.36	0.39	0.87	1.10	1.24
Max 24-hour total (3)	1.54	1.27	2.14	0.51	0.41	0.69	0.40	0.64	0.38	0.76	1.45	1.78	2.14
Total	2.35	1.50	1.52	0.34	0.38	0.25	0.21	0.26	0.17	0.36	0.68	0.68	8.69
Wind													
Mean Speed (m/s) (2)	3.4	3.6	4.1	4.6	4.2	4.2	4.1	4.0	4.0	3.8	3.8	3.6	4.0
Fastest 1-minute (1)													
Speed (m/s)	17.6	18.4	20.2	21.4	19.7	22.7	17.5	16.0	19.1	19.8	19.9	20.8	22.7
Direction (deg)	336	335	346	147	145	341	114	142	135	345	337	337	149
Peak 3-sec Gust (m/s)	21.5	25.7	26.1	28.7	26.5	28.8	23.6	21.1	24.0	27.0	26.7	23.6	28.8

Note 1: Values derived from 1-second data averaged over 1 minute.
Note 2: Values derived from 1-second data averaged over 1 hour.
Note 3: Continuous running period which may encompass more than one calendar day.

Table A-7. R/EFPD Site 7 (Sever Wash) Monthly and Annual Climatological Summaries

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Temperature (C)													
Extreme Maximum (1)	22.2	25.3	27.1	33.3	37.8	42.3	42.8	42.3	39.3	36.1	27.8	20.5	42.8
Mean Maximum (1)	11.9	14.7	18.9	22.6	27.3	33.5	36.9	36.8	32.0	24.5	16.3	11.9	24.0
Mean (2)	5.0	7.4	11.1	14.7	18.9	24.5	28.4	27.6	22.6	15.6	8.5	5.1	15.8
Mean Minimum (1)	-1.6	-0.0	2.8	5.3	8.9	13.0	16.9	16.8	12.4	6.7	0.2	-2.4	6.6
Extreme Minimum (1)	-11.3	-10.8	-6.6	-1.7	-0.8	0.2	10.6	9.2	3.8	-5.0	-9.7	-12.8	-12.8
Number of Days													
Precipitation													
0.01 inch or more	5.8	5.3	4.8	1.5	3.5	1.3	1.0	1.0	1.0	1.8	3.3	2.8	32.8
Temperature (2)													
32C (90F) and above	0.0	0.0	0.0	0.3	2.0	19.3	30.3	28.5	14.0	2.3	0.0	0.0	96.5
0C (32F) and below	17.3	11.5	3.5	0.8	0.3	0.0	0.0	0.0	0.0	0.3	10.8	18.8	63.0
Barometric Pressure (mb)													
Mean (2)	893.1	891.9	891.6	890.2	888.8	890.0	891.7	891.7	891.9	892.2	893.8	894.0	891.7
Mean Relative Humidity (%)													
Hour 0400 (PST) (2)	66.9	67.5	59.9	44.9	48.8	32.9	31.8	31.4	33.5	39.5	50.4	62.5	47.5
Hour 1000 (2)	48.7	44.6	35.6	23.2	23.3	15.8	14.2	15.1	16.3	21.0	29.3	39.1	27.2
Hour 1600 (2)	41.9	34.3	25.9	16.4	16.5	9.4	9.1	9.4	10.5	16.2	23.8	31.5	20.4
Hour 2200 (2)	62.5	62.2	49.9	34.5	34.2	21.5	20.2	21.4	23.5	31.4	44.2	56.2	38.5
Precipitation (in)													
Max 1-hour total	0.41	0.23	0.24	0.15	0.18	0.12	0.59	0.33	0.05	0.20	0.40	0.28	0.59
Max 6-hour total (3)	0.97	0.52	0.94	0.26	0.24	0.46	0.60	0.50	0.07	0.48	0.81	0.93	0.97
Max 24-hour total (3)	1.18	1.25	1.69	0.37	0.35	0.49	0.60	0.55	0.08	0.73	1.49	2.15	2.15
Total	1.90	1.32	1.11	0.30	0.28	0.16	0.22	0.19	0.03	0.36	0.57	0.74	7.17
Wind													
Mean Speed (m/s) (2)	2.5	2.8	3.3	3.9	3.6	3.6	3.4	3.3	3.1	2.9	2.9	2.5	3.2
Fastest 1-minute (1)													
Speed (m/s)	15.8	16.7	18.1	21.3	18.9	18.5	15.6	15.2	16.9	23.2	18.0	17.1	23.2
Direction (deg)	320	328	329	331	163	162	165	152	218	331	333	162	333
Peak 3-sec Gust (m/s)	20.5	20.7	22.3	25.5	23.0	24.8	23.5	21.5	26.9	27.7	21.9	20.6	27.7

Note 1: Values derived from 1-second data averaged over 1 minute.
Note 2: Values derived from 1-second data averaged over 1 hour.
Note 3: Continuous running period which may encompass more than one calendar day.

Table A-8. R/EFPD Site 8 (Knothead Gap) Monthly and Annual Climatological Summaries

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Temperature (C)													
Extreme Maximum (1)	21.2	24.7	26.2	32.8	37.1	41.9	42.0	41.3	38.2	35.6	27.2	19.7	42.0
Mean Maximum (1)	11.4	14.1	18.3	21.9	26.6	32.8	36.2	36.2	31.3	24.0	15.8	11.5	23.4
Mean (2)	5.2	7.5	11.1	14.6	19.0	24.7	28.7	27.9	23.0	15.8	8.8	5.5	16.0
Mean Minimum (1)	-0.5	1.0	3.8	6.3	10.1	14.4	18.5	18.4	14.0	8.3	1.7	-0.7	7.9
Extreme Minimum (1)	-9.9	-9.5	-6.6	-1.0	0.0	2.5	12.0	11.1	5.9	-3.1	-8.0	-9.6	-9.9
Number of Days													
Precipitation													
0.01 inch or more	6.0	5.0	4.8	1.5	3.3	1.3	1.3	1.5	1.3	1.0	2.5	2.8	32.0
Temperature (2)													
32C (90F) and above	0.0	0.0	0.0	0.0	1.5	17.5	29.8	27.8	11.8	1.8	0.0	0.0	90.0
0C (32F) and below	11.8	10.5	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	7.5	14.3	46.3
Barometric Pressure (mb)													
Mean (2)	888.8	887.7	887.1	885.6	883.9	884.8	886.3	886.4	886.8	887.5	889.1	889.4	887.0
Mean Relative Humidity (%)													
Hour 0400 (PST) (2)	62.7	64.0	57.0	41.6	45.1	30.1	28.9	29.3	31.1	36.8	46.8	58.2	44.3
Hour 1000 (2)	47.6	44.4	35.4	22.9	23.2	15.4	13.9	15.2	16.0	20.5	29.0	38.3	26.8
Hour 1600 (2)	41.4	34.1	26.2	15.7	16.5	9.1	9.0	9.2	10.2	16.1	23.9	32.0	20.3
Hour 2200 (2)	59.2	57.5	47.0	32.2	32.8	20.0	18.8	19.9	21.9	30.1	41.3	52.9	36.1
Precipitation (in)													
Max 1-hour total	0.43	0.21	0.22	0.23	0.26	0.14	0.29	0.39	0.04	0.13	0.40	0.23	0.43
Max 6-hour total (3)	1.06	0.47	0.84	0.23	0.31	0.58	0.31	0.69	0.08	0.53	0.76	1.02	1.06
Max 24-hour total (3)	1.18	1.25	1.43	0.29	0.38	0.62	0.31	0.73	0.11	0.84	1.42	2.43	2.43
Total	1.94	1.36	1.14	0.25	0.32	0.19	0.20	0.27	0.04	0.22	0.52	0.56	6.99
Wind													
Mean Speed (m/s) (2)	2.4	2.7	3.2	3.8	3.6	3.5	3.3	3.2	2.9	2.7	2.7	2.4	3.0
Fastest 1-minute (1)													
Speed (m/s)	16.6	18.9	17.7	19.9	17.3	19.7	15.5	15.0	16.7	21.3	16.4	17.1	21.3
Direction (deg)	327.9	331.1	189.9	204.1	171.1	337.2	322.5	168.2	167.4	332.3	4.1	200.7	220
Peak 3-sec Gust (m/s)	20.5	22.6	25.0	27.6	20.7	23.9	20.5	18.9	21.4	27.3	21.9	20.8	27.6

Note 1: Values derived from 1-second data averaged over 1 minute.
Note 2: Values derived from 1-second data averaged over 1 hour.
Note 3: Continuous running period which may encompass more than one calendar day.

Table A-9. R/EFPD Site 9 (Gate 510) Monthly and Annual Climatological Summaries

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Temperature (C)													
Extreme Maximum (1)	22.9	26.6	29.2	35.4	39.5	45.1	44.7	43.8	40.5	37.8	28.5	22.5	45.1
Mean Maximum (1)	13.4	16.5	20.8	24.6	29.2	35.6	39.5	38.9	33.9	26.0	18.2	14.2	25.9
Mean (2)	7.0	9.7	13.3	16.8	21.3	27.6	31.4	30.5	25.4	17.8	10.5	7.1	18.2
Mean Minimum (1)	1.0	3.3	5.9	8.2	12.3	16.4	21.2	21.0	16.4	9.8	3.4	1.2	10.0
Extreme Minimum (1)	-7.6	-5.3	-3.8	0.0	1.2	2.5	12.2	13.8	7.5	0.6	-6.8	-7.7	-7.7
Number of Days													
Precipitation													
0.01 inch or more	6.5	5.0	4.5	2.0	3.5	0.8	1.0	0.5	0.3	1.0	1.8	2.5	29.3
Temperature (2)													
32C (90F) and above	1.5	1.0	1.3	3.0	8.5	24.5	31.0	30.8	21.0	3.3	1.8	1.3	128.8
0C (32F) and below	7.8	5.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.0	10.8	31.3
Barometric Pressure (mb)													
Mean (2)	919.7	918.4	918.2	916.6	914.4	915.0	916.3	916.3	916.5	917.7	919.5	920.5	917.4
Mean Relative Humidity (%)													
Hour 0400 (PST) (2)	61.0	59.3	53.9	39.1	42.5	26.4	23.7	24.2	26.6	32.6	44.6	55.1	40.7
Hour 1000 (2)	46.9	42.7	34.3	21.1	23.5	14.1	12.6	14.0	15.6	19.2	28.4	37.6	25.8
Hour 1600 (2)	39.0	30.9	23.3	14.2	16.0	7.8	7.2	8.2	9.1	14.0	21.2	28.5	18.3
Hour 2200 (2)	57.1	53.0	43.6	30.6	30.1	17.0	15.4	16.6	19.0	25.8	37.6	49.5	33.0
Precipitation (in)													
Max 1-hour total	0.13	0.29	0.12	0.16	0.18	0.32	0.02	0.04	0.01	0.19	0.16	0.20	0.32
Max 6-hour total (3)	0.39	0.57	0.40	0.16	0.43	0.68	0.03	0.05	0.02	0.44	0.50	0.42	0.68
Max 24-hour total (3)	0.65	0.94	0.61	0.18	0.57	0.68	0.04	0.05	0.02	0.63	0.63	0.97	0.97
Total	1.11	0.84	0.58	0.15	0.28	0.21	0.02	0.02	0.01	0.27	0.26	0.49	4.20
Wind													
Mean Speed (m/s) (2)	3.8	4.2	4.4	4.8	4.7	4.7	4.6	4.7	4.4	4.1	4.1	4.0	4.4
Fastest 1-minute (1)													
Speed (m/s)	16.5	19.3	19.1	19.9	18.5	17.8	19.2	20.5	16.8	19.1	16.7	19.8	20.5
Direction (deg)	320	182	171	195	163	356	85	137	164	335	335	167	354
Peak 3-sec Gust (m/s)	20.2	24.7	22.7	25.4	23.6	26.7	23.2	25.1	20.1	23.0	19.2	23.2	26.7

Note 1: Values derived from 1-second data averaged over 1 minute.
Note 2: Values derived from 1-second data averaged over 1 hour.
Note 3: Continuous running period which may encompass more than one calendar day.

Table A-10. Yearly Climatological Data Summary

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Temperature (C)									
Extreme Maximum (1)	40.9	39.9	40.4	42.3	43.6	41.9	42.8	42.0	45.1
Mean Maximum (1)	22.0	19.8	20.9	21.5	24.1	21.3	24.0	23.4	25.9
Mean (2)	16.8	15.7	16.5	16.7	17.7	15.1	15.8	16.0	18.2
Mean Minimum (1)	11.5	12.0	11.8	11.8	11.2	8.3	6.6	7.9	10.0
Extreme Minimum (1)	-11.7	-12.5	-12.2	-12.6	-13.1	-9.9	-12.8	-9.9	-7.7
Number of Day									
Precipitation 0.01 inch or more	41.8	31.4	33.3	32.0	28.1	34.5	32.8	32.0	29.3
Temperature (Hourly Averaged) 32C (90F) and above	70.3	38.2	49.0	57.4	91.0	64.3	96.5	90.0	128.8
0C (32F) and below	29.6	25.4	23.0	18.9	22.6	45.3	63.0	46.3	31.3
Mean Relative Humidity (%)									
Hour 0400 (PST) (2)	33.7	30.7	34.5	33.1	34.6	43.8	47.5	44.3	40.7
Hour 1000 (2)	27.6	27.9	28.3	28.1	25.7	29.3	27.2	26.8	25.8
Hour 1600 (2)	21.4	22.0	22.9	21.6	19.0	23.4	20.4	20.3	18.3
Hour 2200 (2)	28.5	27.0	29.6	28.3	29.5	37.1	38.5	36.1	33.0
Precipitation (in)									
Max 1-hour total	0.66	0.50	0.57	0.42	0.50	0.44	0.59	0.43	0.32
Max 6-hour total	1.18	1.03	1.13	0.95	0.78	1.24	0.97	1.06	0.68
Max 24-hour total	1.39	1.78	1.89	1.86	1.63	2.14	2.15	2.43	0.97
Total	4.97	6.56	6.70	6.57	5.10	8.69	7.17	6.99	4.20
Wind									
Mean Speed (m/s) (2)	3.4	4.3	2.5	4.4	4.2	4.0	3.2	3.0	4.4
Fastest 1-minute (2) Speed (m/s)	n/a	30.0	18.6	33.2	25.3	22.7	23.2	21.3	20.5
Direction (deg)	n/a	239	307	345	337	149	333	220	354
Peak 3-sec Gust (m/s)	n/a	38.2	26.2	37.2	30.4	28.8	27.7	27.6	26.7

Note 1: Values derived from 1-second data averaged over 1 minute.

Note 2: Values derived from 1-second data averaged over 1 hour.

Table A-11. Climatological Summary for Austin and Battle Mountain

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Austin													
Temperature (C)													
Extreme Maximum	18.3	21.1	23.3	28.3	32.8	36.1	40.6	37.8	36.1	30.0	23.9	21.1	40.6
Mean Maximum	4.9	6.7	9.1	13.6	18.7	24.7	30.6	29.5	24.5	17.8	9.9	5.9	16.4
Mean Minimum	-7.4	-5.9	-4.1	-0.8	3.2	7.4	12.1	11.3	7.1	2.1	-3.3	-6.4	1.3
Extreme Minimum	-31.7	-27.8	-21.1	-16.1	-11.1	-5.0	2.2	-1.1	-7.8	-16.7	-21.7	-28.9	-31.7
Precipitation (inches)													
Mean Monthly	1.18	1.15	1.61	1.62	1.53	0.97	0.56	0.61	0.60	0.96	1.03	1.20	13.51
Monthly Maximum	4.00	2.95	5.36	5.96	5.85	3.55	2.53	2.45	3.45	3.72	3.73	4.19	22.37
Maximum Daily	1.64	1.60	1.76	2.01	1.57	1.57	1.99	1.25	1.65	2.04	1.18	1.19	2.04
Snowfall (inches)													
Mean Monthly	0.92	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.05	1.13
Monthly Maximum	16.70	1.40	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	2.00	16.70
Daily Maximum	24.0	16.8	19.0	22.0	12.0	8.0	0.0	0.0T	9.0	20.0	13.0	10.4	24.0
Battle Mountain													
Temperature (C)													
Extreme Maximum	19.4	22.2	26.7	32.2	36.1	40.0	42.8	41.1	38.9	33.9	26.7	19.4	42.8
Mean Maximum	4.8	8.8	12.2	17.3	22.7	28.1	33.9	32.8	27.5	20.2	10.9	5.4	18.9
Mean Minimum	-9.6	-6.1	-4.0	-1.2	3.3	7.1	10.4	8.7	3.8	-1.3	-5.6	-9.0	-0.2
Extreme Minimum	-37.2	-31.7	-19.4	-13.3	-10.0	-4.4	-0.6	-2.2	-11.7	-14.4	-22.8	-39.4	-39.4
Precipitation (inches)													
Mean Monthly	0.65	0.58	0.69	0.78	1.01	0.88	0.28	0.32	0.51	0.64	0.68	0.75	7.60
Monthly Maximum	2.22	2.20	2.42	3.02	4.91	3.39	1.62	1.65	2.92	2.83	2.08	2.58	12.50
Maximum Daily	0.75	0.90	0.73	1.00	1.10	1.10	0.70	0.50	0.97	1.10	0.84	1.00	1.10
Snowfall (inches)													
Mean Monthly	7.72	3.09	1.16	0.91	0.12	0.00	0.00	0.00	0.00	0.12	2.35	3.35	18.82
Monthly Maximum	33.00	13.00	5.00	5.00	2.00	0.00	0.00	0.00	0.00	2.00	18.00	10.00	54.00
Daily Maximum	7.8	10.0	7.0	12.0	3.9	0.0T	0.0	0.0	0.0T	3.0	6.0	12.4	12.4

Table A-12. Climatological Summary for Caliente and Desert Rock

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Caliente													
Temperature (C)													
Extreme Maximum	21.7	27.2	32.2	33.3	36.7	42.8	42.8	42.2	41.1	34.4	26.7	21.7	42.8
Mean Maximum	7.8	11.3	15.6	20.7	25.8	31.5	35.3	33.9	29.8	23.1	14.8	9.0	21.6
Mean Minimum	-8.2	-5.3	-2.3	1.2	5.5	9.6	13.6	12.9	7.7	1.8	-4.0	-7.3	2.2
Extreme Minimum	-35.0	-28.3	-16.7	-9.4	-4.4	0.6	4.4	1.7	-3.9	-12.2	-17.8	-27.8	-35.0
Precipitation (inches)	0.86	0.84	1.08	0.71	0.61	0.34	0.80	0.96	0.63	0.76	0.76	0.70	8.82
Mean Monthly													
MonthlyMaximum	3.47	3.15	4.59	3.71	2.27	1.95	5.36	4.18	3.14	4.29	3.38	3.76	18.73
Maximum Daily	1.41	1.90	1.35	1.15	1.48	0.99	1.51	1.70	1.56	2.13	1.80	2.11	2.13
Snowfall (inches)	3.96	2.42	1.14	0.11	0.01	0.00	0.00	0.00	0.03	0.07	0.83	2.85	13.80
Mean Monthly													
Monthly Maximum	31.00	27.60	9.50	3.70	0.50	0.00	0.00	0.00	2.00	4.00	12.00	20.00	46.60
Daily Maximum	12.0	14.0	8.0	2.5	0.5	0.0	0.0	0.0	2.0	4.0	5.0	11.0	14.0
Desert Rock													
Temperature (C)													
Extreme Maximum	22.8	28.3	28.9	33.9	38.9	43.9	44.4	42.8	39.4	35.6	29.4	22.2	44.4
Mean Maximum	12.4	15.5	18.8	23.9	28.2	33.9	36.9	36.1	31.8	25.6	16.8	12.3	24.6
Mean Minimum	0.4	2.6	5.2	8.8	13.0	17.9	21.3	20.7	16.1	10.3	3.4	-0.2	10.2
Extreme Minimum	-8.9	-11.7	-5.0	-1.1	0.6	4.4	11.7	12.8	4.4	0.0	-7.2	-14.4	-14.4
Precipitation (inches)													
Mean Monthly	1.02	0.74	0.67	0.28	0.34	0.08	0.76	0.71	0.25	0.40	0.52	0.65	5.50
MonthlyMaximum	3.37	3.29	2.39	1.50	1.94	0.41	3.64	3.14	1.43	1.65	1.76	1.91	8.56
Maximum Daily	0.87	1.15	0.65	0.72	0.92	0.39	2.03	1.10	1.25	0.67	1.48	0.91	2.03
Snowfall (inches)													
Mean Monthly	1.33	0.77	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.83	2.86
Monthly Maximum	5.10	6.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.50	6.60	8.80
Daily Maximum	4.3	6.0	0.5	0.0	0.0T	0.0	0.0	0.0	0.0	0.0	1.5	4.0	6.0

Table A-13. Climatological Summary for Elko and Ely

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Elko													
Temperature (C)													
Extreme Maximum	17.8	21.1	25.0	30.0	33.3	40.0	41.7	41.7	37.2	31.1	25.6	18.3	41.7
Mean Maximum	2.2	5.5	9.9	15.3	20.6	26.3	32.5	31.4	26.1	18.8	9.4	3.5	16.8
Mean Minimum	-11.4	-7.9	-4.6	-1.7	2.2	5.8	9.4	8.1	2.9	-2.0	-6.6	-10.2	-1.3
Extreme Minimum	-41.7	-38.3	-22.8	-18.9	-12.2	-5.0	-1.1	-6.7	-12.8	-16.1	-24.4	-38.9	-41.7
Precipitation (inches)													
Mean Monthly	1.09	0.81	0.90	0.81	1.00	0.80	0.35	0.44	0.48	0.69	0.99	1.02	9.38
MonthlyMaximum	3.35	2.49	2.39	2.17	4.09	2.61	2.35	4.61	3.22	2.76	2.80	4.21	18.34
Maximum Daily	1.25	0.89	0.79	1.07	1.73	1.05	1.04	4.13	2.25	1.31	1.33	1.60	4.13
Snowfall (inches)													
Mean Monthly	10.05	6.09	5.07	2.29	0.78	0.00	0.00	0.00	0.06	0.70	4.74	7.85	37.75
Monthly Maximum	29.20	26.10	23.20	15.60	11.30	0.00	0.00	0.00	2.00	5.60	20.00	33.20	85.40
Daily Maximum	16.3	9.0	8.2	9.3	7.8	0.0T	0.0T	0.0T	2.0	5.2	10.6	9.3	16.3
Ely													
Temperature (C)													
Extreme Maximum	20.0	19.4	22.8	27.8	31.7	37.2	37.8	36.1	33.9	28.9	23.9	19.4	37.8
Mean Maximum	3.8	6.1	9.0	14.2	19.3	25.6	30.4	29.2	24.4	17.6	9.6	4.8	16.3
Mean Minimum	-12.7	-9.7	-6.4	-3.3	0.8	4.6	8.7	8.1	3.0	-2.2	-7.6	-11.8	-2.3
Extreme Minimum	-32.8	-34.4	-25.0	-20.6	-13.9	-7.8	-1.1	-4.4	-9.4	-19.4	-26.1	-33.9	-34.4
Precipitation (inches)													
Mean Monthly	0.74	0.66	0.99	0.89	1.17	0.74	0.63	0.75	0.83	0.75	0.62	0.68	9.48
MonthlyMaximum	2.08	2.19	2.40	3.41	3.26	3.53	2.30	2.51	4.99	3.67	1.82	2.11	15.98
Maximum Daily	0.88	1.38	0.69	0.80	1.37	1.44	1.20	1.01	2.52	1.09	1.17	0.84	2.52
Snowfall (inches)													
Mean Monthly	9.43	7.27	9.35	6.12	2.67	0.14	0.00	0.00	0.33	2.34	5.31	7.69	50.55
Monthly Maximum	24.80	20.00	25.30	24.50	12.10	1.70	0.00	0.00	6.30	12.10	17.30	22.30	101.30
Daily Maximum	0.88	1.38	0.69	0.80	1.37	1.44	1.20	1.01	2.52	1.09	1.17	0.84	2.52

Table A-14. Climatological Summary for Las Vegas and Tonopah

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
Las Vegas													
Temperature (C)													
Extreme Maximum	25.0	30.6	32.8	37.2	42.8	46.1	46.7	46.7	45.0	39.4	30.6	25.0	46.7
Mean Maximum	13.4	16.9	20.4	25.6	30.8	36.9	40.1	38.8	34.7	27.4	19.0	13.9	26.6
Mean Minimum	0.9	3.6	6.4	10.6	15.5	20.7	24.6	23.6	19.0	12.2	5.4	1.2	12.0
Extreme Minimum	-13.3	-8.9	-5.0	-0.6	4.4	8.9	15.6	13.3	7.8	-3.3	-6.1	-11.7	-13.3
Precipitation (inches)													
Mean Monthly	0.58	0.47	0.48	0.18	0.20	0.10	0.42	0.48	0.25	0.21	0.40	0.37	4.14
MonthlyMaximum	3.00	2.52	4.80	2.44	0.96	0.97	2.48	2.59	1.58	1.22	2.22	1.71	9.88
Maximum Daily	0.74	1.29	1.20	0.97	0.83	0.82	1.36	2.58	1.07	1.05	1.09	0.95	2.58
Snowfall (inches)													
Mean Monthly	0.92	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.05	1.13
Monthly Maximum	16.70	1.40	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	2.00	16.70
Daily Maximum	7.4	1.4	0.1	0.0T	0.0T	0.0T	0.0	0.0T	0.0	0.0T	3.0	2.0	7.4
Tonopah													
Temperature (C)													
Extreme Maximum	19.4	23.9	25.6	31.1	34.4	38.9	40.0	39.4	35.6	32.2	25.0	21.1	40.0
Mean Maximum	6.4	9.6	12.9	17.4	22.7	28.9	32.8	31.6	26.8	20.3	12.1	7.3	19.2
Mean Minimum	-7.6	-4.7	-2.3	0.7	5.5	10.3	13.4	12.5	8.3	2.8	-3.3	-7.0	2.4
Extreme Minimum	-26.1	-22.8	-15.6	-12.8	-7.2	-2.8	4.4	2.8	-3.9	-10.6	-15.6	-25.0	-26.1
Precipitation (inches)													
Mean Monthly	0.40	0.45	0.53	0.38	0.61	0.30	0.55	0.53	0.46	0.37	0.44	0.27	5.33
MonthlyMaximum	2.25	2.68	2.38	2.13	2.03	1.67	2.49	2.65	2.05	2.16	2.68	1.02	10.64
Maximum Daily	0.59	0.55	0.67	0.85	0.96	1.06	1.23	1.36	1.13	1.14	0.67	0.62	1.36
Snowfall (inches)													
Mean Monthly	3.22	2.71	2.43	1.14	0.42	0.00	0.00	0.00	0.01	0.07	1.50	1.85	13.53
Monthly Maximum	16.50	13.60	16.40	7.50	5.00	0.00	0.00	0.00	0.40	1.50	9.60	17.00	31.30
Daily Maximum	7.1	9.7	9.0	7.2	5.0	0.0T	0.0	0.0T	0.4	1.0	8.0	7.6	9.7

Table A-15. Annual Precipitation for NWS Sites: 1921 - 1947

Year	Amargosa Farms	Austin	Beatty	BeattyKN	Caliente	Desert Natl WL Range	Desert Rock	Elko Municipal AP	Ely Yelland Field	Indian Springs	Las Vegas Mccrn Intl	Pahranagat W L REF	Pioche	Ruby Lake	Snowball Ranch	Tonopah AP	Tonopah	Winnemucca
1921		9.21																
1922		17.86																
1923		10.15																
1924		9.14																
1925		17.66																
1926		4.57																
1927		10.64																
1928		10.44						5.17								2.63		5.52
1929		10.65			1.84			6.84								3.36		3.85
1930		16.67			3.56			13.30								4.49		9.60
1931		11.77			9.49			6.07								6.53		4.87
1932		12.43			11.81			12.23								3.88		8.70
1933		10.16			8.16			6.65								2.19		5.67
1934		14.63			7.14			6.72								3.48		9.07
1935		16.26			9.43			8.23								3.40		10.59
1936		14.91			11.60			10.52								4.62		8.76
1937		7.03			6.84			7.12								4.39		9.35
1938		16.51			4.43			9.75								7.71		11.98
1939		10.46			9.41			7.78								6.25		7.79
1940		14.51			7.49			10.76								4.59		11.69
1941		19.36			18.73			16.27								6.29		13.24
1942		10.81			6.63			12.26								2.19		10.07
1943		11.89			11.70			9.58								6.56		6.60
1944		10.68			7.96			9.59								3.49		10.34
1945		16.31			11.60			12.62								5.77		14.54
1946		16.93			12.36			10.18								10.27		10.65
1947		6.40			7.47			7.25								3.66		6.24

Table A-16. Annual Precipitation for NWS Sites: 1948 - 1995

Year	Amargosa Farms	Austin	Beatty	Beatty8N	Caliente	Desert Natl WL Range	Desert Rock	Elko Municipal AP	Ely Yelland Field	Indian Springs	Las Vegas Mccrn Intl	Pahranagat W L REF	Pioche	Ruby Lake	Snowball Ranch	Tonopah AP	Tonopah	Winnemucca
1948		11.90			5.23	0.70		7.41					3.86	4.86		6.11		7.52
1949		9.10	5.43		10.03	6.28		7.10	6.88	7.04	4.42		15.36	10.73		5.85		6.23
1950		10.12	2.05		2.92	1.41		14.60	6.03	0.66	2.34		7.11	18.18		5.08		10.61
1951		11.38	2.60		10.15	4.21		7.97	7.29	1.84	2.81		13.98	12.84		4.99		8.63
1952		10.34	8.36		11.52	6.54		7.28	10.98	3.26	5.08		16.14	10.49		7.89		10.33
1953		6.73	0.69		4.66	1.00		6.85	5.22	1.41	0.56		7.26	10.18		2.91		6.28
1954		9.92	6.44		9.31	3.05		6.58	7.89	2.92	4.71		13.28	8.20				3.13
1955		11.02	4.31		7.13	3.64		9.52	8.76	1.73	5.40		14.09	11.92			4.13	7.28
1956		12.30	1.67		4.77	0.85		10.04	6.36	1.86	2.04		3.81	12.98			2.51	7.29
1957		12.70	5.91		9.11	5.87		10.10	9.14	4.70	4.98		17.14	14.54			5.10	10.02
1958		8.93	4.23		8.13	5.86		6.40	7.58	4.38	4.52		15.51	9.39			3.38	9.61
1959		5.91	3.39		4.83	3.94		5.51	5.97	3.50	4.17		10.41	9.76			2.37	4.07
1960		8.49	5.12		9.77	4.20		7.84	7.89	5.14	4.40		12.85	13.81			3.69	8.11
1961		9.38	3.29		8.80	5.76		7.60	7.29	2.75	3.17		9.62	10.98			2.90	7.79
1962		6.96	2.67		4.76	1.79		8.24	7.36	2.02	1.45		7.53	12.20			5.84	6.83
1963		16.61	5.00		10.15	4.27		15.03	11.14	2.91	3.87		12.80	14.35			6.03	10.86
1964		15.62	2.11		6.58	1.11		12.14	12.70		1.12		7.88	16.25			3.88	10.47
1965		19.28	7.33		10.61	7.41		11.17	10.77		7.96	7.80	17.99	13.63			5.58	7.75
1966	1.28	7.85	3.22		6.15	2.34		6.50	6.08		1.91	3.93	16.04	7.46			3.00	4.51
1967	1.42	10.22	4.88		12.86	4.93		8.62	14.73		5.54	8.83	14.46	12.14	11.20		7.68	7.70
1968	3.00	12.23	4.45		6.79	1.47		14.63	10.03		1.11	6.60	12.38	11.97	8.35		6.56	8.48
1969	6.95	15.16	6.53		9.76	7.53		9.71	11.45		5.09	8.35	18.66	15.81	11.14		5.16	9.67
1970		13.95	3.00		8.39	2.60		15.19	10.69		4.29	4.41	18.07	13.97	8.37		3.11	9.09
1971		20.71	1.98		8.75	1.50		13.67	9.42		2.54	3.93	12.88	14.61	8.08		3.36	9.17
1972		11.85			7.20	6.57		8.47	6.59		4.85	5.36	8.99	9.89	6.02		5.59	6.62
1973		15.71		6.72	9.75	4.58		9.10	11.23		4.68	7.14	12.51	13.07	7.44		5.11	7.92
1974		10.92		5.80	8.01	4.77		4.77	4.22		4.52	5.45	10.28	5.94	5.32		4.43	6.33
1975		20.35		4.84	7.56	5.15		11.34	9.77		3.47	5.01	12.22	15.95	8.06		4.38	8.59
1976		13.58		7.82	10.74	6.35		7.10	8.25		6.77	8.16	11.78	10.24	10.93		7.14	7.31
1977		12.62		6.44	8.51	3.03		6.46	9.19		3.97	4.03	9.38	12.52	10.43		7.34	8.08
1978		19.42		10.80	16.83	6.88		11.14	12.47		7.65	9.46	27.29	17.84	11.63		10.64	8.10
1979	2.16	12.60		4.71	9.31	1.95		7.74	7.39		6.79	0.00	10.60	14.70	7.47		5.94	8.73
1980	6.24	12.67		6.01	11.67	4.54		12.81	12.78		5.63	5.58	18.38	19.41	13.16		4.18	7.36
1981	3.20	11.84		3.73	9.60	3.26		8.78	10.29		3.14	6.58	11.81	11.22	6.87		9.21	8.44
1982	4.30	16.82		6.07	12.90	4.87		13.72	15.98		3.99	9.87	17.50	16.87	10.57		6.29	9.04
1983	10.37	22.37		11.49	12.21	6.34		18.34	14.84		4.86	11.54	18.78	23.86	14.24		9.64	14.47
1984	8.80	17.72		6.53	13.11	10.38		10.36	14.84		6.85	8.86	9.40	17.78	8.27		6.95	12.87
1985	1.00	15.83		2.79	7.89	2.58	4.77	7.30	9.89		1.27	4.84	12.22	10.84	6.98		5.96	7.01
1986	3.75	5.98		5.22	7.94	4.66	6.92	6.08	8.60		2.65	4.37	11.36	12.00	6.35		2.53	5.51
1987	8.18	18.98		7.38	12.08	7.21	8.56	8.62	12.30		6.59	7.71	17.42	11.20	10.35		8.33	9.04
1988	5.59	16.53		6.21	6.22	3.12	5.84	6.72	8.66		2.29	5.32	6.69	9.34	10.21		5.67	6.73
1989	0.72	9.56		2.43	5.20	1.51	1.25	7.88	6.60		2.11	2.23	7.31	10.28	6.18		3.00	5.56
1990	2.58	13.32		4.92	8.93	2.82	4.88	9.43	8.76		3.75	5.70	2.06	9.78	7.25		5.18	6.37
1991	3.40	14.01		5.15	7.49	4.07	5.55	7.85	9.98		4.06	5.52	8.72	11.89	10.14		5.79	7.80
1992	6.09	8.83		7.37	12.00	8.85	6.35	7.56	9.78		9.88	9.66	15.75	10.62	7.30		3.30	4.14
1993	5.68	8.00		5.71	11.83	4.91	7.55	7.66	10.06		5.05	6.82	17.91	13.67	6.66		4.45	7.27
1994	2.27	13.47		3.44	9.00	3.89	3.28	8.32	9.22		2.56	6.27	14.36	12.02	8.76		4.10	7.58
1995	5.27	15.42		8.45	7.98	4.53	7.90	11.46	12.10		3.69	7.53	15.27	18.70	9.75		6.75	9.82

Table A-17. ASHRAE Table for the R/EFPD Meteorological Sites

State and Station	Latitude	Longitude	Elev. Meters	Winter, C		Summer, C							Prevailing Winds		Temp, C	
				Design Dry-Bulb		Design Dry-Bulb and Mean Coincident Wet-Bulb			Mean Daily Range	Design Wet-Bulb			Winter	Summer	Median of Annual Extr.	
				99%	97.5%	1%	2.5%	5%		1%	2.5%	5%	M/S		Max	Min
Site 1 (NTS - 60)	36° 50' 34" N	116° 25' 50" W	1143	-5	-3	37/16	36/16	35/15	12	18	17	16	NNW 3	S	39	-6
Site 2 (Yucca MT)	36° 51' 19" N	116° 27' 56" W	1478	-6	-4	35/13	34/13	33/13	9	17	16	15	NE 6	WSW	36	-7
Site 3 (Coyote Wash)	36° 51' 17" N	116° 27' 06" W	1279	-5	-3	36/15	35/15	34/15	10	19	18	17	WNW 3	SSE	38	-7
Site 4 (Alice Hill)	36° 51' 51" N	116° 24' 15" W	1234	-5	-3	37/16	36/16	34/15	10	18	18	17	NNE 5	S	38	-6
Site 5 (Fortymile Wash)	36° 45' 52" N	116° 23' 26" W	953	-4	-2	39/15	38/15	37/15	14	20	19	18	N 4	S	41	-9
Site 6 (WT - 6)	36° 53' 40" N	116° 26' 45" W	1315	-4	-2	36/15	35/14	34/14	14	18	17	16	NW 3	SSE	38	-6
Site 7 (Sever Wash)	36° 50' 49" N	116° 24' 28" W	1081	-6	-5	39/15	38/15	37/15	18	19	18	17	WNW 1	S	41	-10
Site 8 (Knothead Gap)	36° 49' 42" N	116° 25' 35" W	1131	-5	-4	39/15	38/14	36/14	16	18	18	17	NNW 1	S	41	-8
Site 9 (Gate - 510)	36° 40' 17" N	116° 24' 17" W	838	-3	-2	42/16	40/16	39/16	17	20	19	18	NNE 4	SW	44	-6

ASHRAE DESCRIPTION

The column contents of the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) table is as follows:

- **Column 1, Station**: Site number and (name) for the Environmental Field Programs Division meteorological monitoring station.
- **Column 2, Latitude**: Site latitude in degrees, minutes, and seconds.
- **Column 3, Longitude**: Site longitude in degrees, minutes, and seconds.
- **Column 4, Elevation**: Site elevation in meters.
- **Column 5, Design Dry-Bulb**: The dry-bulb temperatures in degrees Celsius that have been equaled or exceeded by 99 percent and 97.5 percent of the total hours in December, January, and February.
- **Column 6, Design Dry-Bulb and Mean Coincident Wet-Bulb**: The dry-bulb temperatures in degrees Celsius that have been equaled or exceeded by 1 percent, 2.5 percent, and 5 percent of the total hours in June, July, August, and September. The listed wet-bulb temperature is the mean of all wet-bulb temperatures coincident with those dry-bulb temperatures exceeding the given levels.
- **Column 7, Mean Daily Range**: The difference between the average daily maximum and average daily minimum temperatures in degrees Celsius for the warmest month.
- **Column 8, Design Wet-Bulb**: The wet-bulb temperatures in degrees Celsius that have been equaled or exceeded by 1 percent, 2.5 percent, and 5 percent of the total hours in June, July, August, and September.
- **Column 9, Prevailing Wind**: (Winter) The wind direction occurring coincidentally with the 97.5 percent dry-bulb temperature in December, January, and February. (Summer) The wind direction occurring coincidentally with the 2.5 percent dry-bulb temperature in June, July, August, and September. (M/S) The mean wind speed in meters per second occurring coincidentally with the 97.5 percent dry-bulb temperature in December, January, and February.
- **Column 10, Median of Annual Extremes**: The median of the annual extreme maximum and minimum temperature in degrees Celsius.

APPENDIX B

JOINT WIND FREQUENCY DISTRIBUTION TABLES

APPENDIX B

JOINT WIND FREQUENCY DISTRIBUTION TABLES

Note: The wind speed classes used in this report are the same as those used by the National Climatic Data Center for STAR programs. These classes are:

Class 1	=	0.0 to less than 1.8 m/s (0 - 3 knots)
Class 2	=	1.8 to less than 3.3 m/s (4 - 6 knots)
Class 3	=	3.3 to less than 5.4 m/s (7 - 10 knots)
Class 4	=	5.4 to less than 8.5 m/s (11 - 16 knots)
Class 5	=	8.5 to less than 11.0 m/s (17 - 21 knots)
Class 6	=	Greater than or equal to 11.0 m/s (greater than or equal to 21 knots)

Table B-1. Site 1 (NTS-60) 10m Joint Frequency Wind Distributions
for 1993 through 1996

DAY Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0124	0.0101	0.0136	0.0105	0.0014	0.0002	0.0481
North-Northeast	0.0095	0.0081	0.0161	0.0074	0.0005	0.0000	0.0417
Northeast	0.0133	0.0080	0.0113	0.0029	0.0000	0.0000	0.0354
East-Northeast	0.0160	0.0084	0.0043	0.0009	0.0000	0.0000	0.0296
East	0.0149	0.0092	0.0021	0.0002	0.0000	0.0000	0.0264
East-Southeast	0.0158	0.0121	0.0033	0.0002	0.0000	0.0000	0.0315
Southeast	0.0214	0.0311	0.0075	0.0002	0.0000	0.0000	0.0602
South-Southeast	0.0180	0.0653	0.0390	0.0147	0.0038	0.0002	0.1410
South	0.0112	0.0543	0.1057	0.0868	0.0231	0.0057	0.2866
South-Southwest	0.0058	0.0205	0.0326	0.0100	0.0012	0.0001	0.0702
Southwest	0.0051	0.0122	0.0241	0.0045	0.0005	0.0001	0.0465
West-Southwest	0.0047	0.0076	0.0090	0.0017	0.0000	0.0000	0.0230
West	0.0052	0.0044	0.0042	0.0010	0.0000	0.0000	0.0148
West-Northwest	0.0086	0.0054	0.0046	0.0014	0.0001	0.0000	0.0200
Northwest	0.0155	0.0177	0.0068	0.0038	0.0005	0.0000	0.0443
North-Northwest	0.0192	0.0297	0.0107	0.0143	0.0050	0.0017	0.0807
Sums	0.1966	0.3042	0.2950	0.1602	0.0361	0.0080	

NIGHT Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0144	0.0329	0.0405	0.0166	0.0021	0.0004	0.1068
North-Northeast	0.0050	0.0096	0.0096	0.0055	0.0006	0.0000	0.0303
Northeast	0.0019	0.0029	0.0005	0.0008	0.0000	0.0000	0.0062
East-Northeast	0.0014	0.0009	0.0006	0.0002	0.0000	0.0000	0.0031
East	0.0014	0.0007	0.0002	0.0002	0.0001	0.0000	0.0026
East-Southeast	0.0011	0.0014	0.0007	0.0001	0.0000	0.0000	0.0033
Southeast	0.0018	0.0022	0.0004	0.0000	0.0000	0.0000	0.0044
South-Southeast	0.0031	0.0051	0.0034	0.0017	0.0001	0.0000	0.0133
South	0.0047	0.0141	0.0234	0.0232	0.0070	0.0010	0.0733
South-Southwest	0.0072	0.0246	0.0178	0.0060	0.0004	0.0000	0.0560
Southwest	0.0117	0.0199	0.0051	0.0007	0.0000	0.0001	0.0375
West-Southwest	0.0114	0.0200	0.0057	0.0005	0.0001	0.0000	0.0377
West	0.0156	0.0182	0.0041	0.0003	0.0001	0.0000	0.0383
West-Northwest	0.0268	0.0295	0.0019	0.0005	0.0001	0.0000	0.0587
Northwest	0.0424	0.1635	0.0423	0.0018	0.0002	0.0001	0.2502
North-Northwest	0.0469	0.1786	0.0301	0.0143	0.0058	0.0028	0.2784
Sums	0.1967	0.5243	0.1862	0.0722	0.0164	0.0042	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-2. Site 1 (NTS-60) 60m Joint Frequency Wind Distributions
for 1993 through 1996

DAY Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0235	0.0096	0.0133	0.0144	0.0048	0.0018	0.0673
North-Northeast	0.0179	0.0131	0.0154	0.0125	0.0034	0.0006	0.0630
Northeast	0.0137	0.0092	0.0118	0.0058	0.0005	0.0000	0.0410
East-Northeast	0.0114	0.0071	0.0046	0.0007	0.0001	0.0000	0.0238
East	0.0099	0.0082	0.0031	0.0005	0.0000	0.0000	0.0217
East-Southeast	0.0125	0.0117	0.0047	0.0005	0.0000	0.0000	0.0295
Southeast	0.0153	0.0285	0.0107	0.0015	0.0001	0.0000	0.0561
South-Southeast	0.0141	0.0598	0.0407	0.0165	0.0053	0.0021	0.1384
South	0.0112	0.0469	0.0899	0.0991	0.0367	0.0241	0.3080
South-Southwest	0.0084	0.0147	0.0271	0.0166	0.0023	0.0010	0.0700
Southwest	0.0052	0.0091	0.0211	0.0113	0.0008	0.0005	0.0480
West-Southwest	0.0053	0.0047	0.0094	0.0037	0.0003	0.0000	0.0234
West	0.0057	0.0025	0.0046	0.0018	0.0000	0.0000	0.0147
West-Northwest	0.0067	0.0018	0.0044	0.0024	0.0002	0.0000	0.0157
Northwest	0.0109	0.0024	0.0037	0.0057	0.0003	0.0001	0.0231
North-Northwest	0.0184	0.0076	0.0066	0.0121	0.0066	0.0050	0.0564
Sums	0.1901	0.2369	0.2712	0.2052	0.0614	0.0351	

NIGHT Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.1065	0.0466	0.0404	0.0347	0.0105	0.0034	0.2420
North-Northeast	0.0463	0.0376	0.0199	0.0171	0.0044	0.0006	0.1259
Northeast	0.0171	0.0083	0.0033	0.0011	0.0003	0.0000	0.0302
East-Northeast	0.0094	0.0023	0.0007	0.0001	0.0001	0.0000	0.0125
East	0.0062	0.0035	0.0007	0.0002	0.0002	0.0000	0.0108
East-Southeast	0.0062	0.0031	0.0019	0.0001	0.0000	0.0000	0.0112
Southeast	0.0092	0.0064	0.0018	0.0002	0.0000	0.0000	0.0176
South-Southeast	0.0082	0.0108	0.0070	0.0037	0.0009	0.0002	0.0308
South	0.0128	0.0249	0.0298	0.0398	0.0160	0.0072	0.1305
South-Southwest	0.0148	0.0189	0.0166	0.0096	0.0023	0.0002	0.0624
Southwest	0.0142	0.0131	0.0083	0.0028	0.0002	0.0001	0.0387
West-Southwest	0.0131	0.0087	0.0076	0.0019	0.0002	0.0000	0.0315
West	0.0156	0.0055	0.0032	0.0012	0.0000	0.0001	0.0255
West-Northwest	0.0243	0.0045	0.0022	0.0006	0.0002	0.0001	0.0319
Northwest	0.0391	0.0082	0.0030	0.0020	0.0006	0.0001	0.0530
North-Northwest	0.0847	0.0307	0.0065	0.0092	0.0078	0.0065	0.1454
Sums	0.4277	0.2332	0.1529	0.1242	0.0435	0.0185	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-3. Site 2 (Yucca Mountain) Joint Frequency Wind Distributions for 1993 through 1996

DAY Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0010	0.0019	0.0055	0.0055	0.0010	0.0003	0.0152
North-Northeast	0.0012	0.0047	0.0071	0.0046	0.0011	0.0001	0.0187
Northeast	0.0013	0.0072	0.0106	0.0078	0.0006	0.0000	0.0275
East-Northeast	0.0035	0.0185	0.0159	0.0039	0.0006	0.0001	0.0424
East	0.0071	0.0422	0.0309	0.0042	0.0002	0.0000	0.0846
East-Southeast	0.0086	0.0531	0.0409	0.0061	0.0002	0.0000	0.1090
Southeast	0.0091	0.0440	0.0422	0.0138	0.0007	0.0000	0.1097
South-Southeast	0.0074	0.0284	0.0471	0.0381	0.0054	0.0001	0.1266
South	0.0079	0.0214	0.0355	0.0195	0.0016	0.0001	0.0859
South-Southwest	0.0079	0.0210	0.0315	0.0125	0.0015	0.0006	0.0750
Southwest	0.0081	0.0237	0.0451	0.0245	0.0028	0.0015	0.1057
West-Southwest	0.0058	0.0110	0.0221	0.0306	0.0073	0.0031	0.0798
West	0.0039	0.0053	0.0100	0.0126	0.0039	0.0007	0.0364
West-Northwest	0.0015	0.0030	0.0050	0.0077	0.0030	0.0019	0.0220
Northwest	0.0012	0.0024	0.0062	0.0117	0.0084	0.0096	0.0395
North-Northwest	0.0006	0.0024	0.0057	0.0084	0.0029	0.0018	0.0220
Sums	0.0762	0.2903	0.3613	0.2113	0.0411	0.0197	

NIGHT Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0025	0.0055	0.0113	0.0154	0.0042	0.0008	0.0397
North-Northeast	0.0033	0.0096	0.0187	0.0184	0.0029	0.0004	0.0533
Northeast	0.0052	0.0142	0.0299	0.0172	0.0016	0.0001	0.0681
East-Northeast	0.0107	0.0364	0.0278	0.0038	0.0008	0.0002	0.0797
East	0.0145	0.0656	0.0459	0.0035	0.0001	0.0002	0.1298
East-Southeast	0.0120	0.0439	0.0399	0.0052	0.0000	0.0001	0.1012
Southeast	0.0109	0.0319	0.0392	0.0172	0.0012	0.0000	0.1003
South-Southeast	0.0091	0.0205	0.0358	0.0347	0.0073	0.0004	0.1079
South	0.0082	0.0139	0.0138	0.0155	0.0015	0.0002	0.0531
South-Southwest	0.0103	0.0111	0.0061	0.0039	0.0005	0.0001	0.0320
Southwest	0.0129	0.0143	0.0086	0.0031	0.0009	0.0002	0.0401
West-Southwest	0.0133	0.0181	0.0134	0.0074	0.0013	0.0011	0.0546
West	0.0138	0.0163	0.0061	0.0018	0.0006	0.0002	0.0389
West-Northwest	0.0069	0.0065	0.0054	0.0038	0.0013	0.0016	0.0254
Northwest	0.0042	0.0048	0.0062	0.0052	0.0049	0.0134	0.0388
North-Northwest	0.0034	0.0052	0.0069	0.0089	0.0068	0.0061	0.0373
Sums	0.1412	0.3178	0.3151	0.1648	0.0358	0.0251	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-4. Site 3 (Coyote Wash) Joint Frequency Wind Distributions for 1993 through 1996

DAY	Speed Categories (m/s)						
Wind Directions	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0018	0.0010	0.0001	0.0000	0.0000	0.0000	0.0030
North-Northeast	0.0021	0.0009	0.0002	0.0000	0.0000	0.0000	0.0032
Northeast	0.0018	0.0012	0.0003	0.0000	0.0000	0.0000	0.0033
East-Northeast	0.0048	0.0032	0.0006	0.0000	0.0000	0.0000	0.0087
East	0.0186	0.0283	0.0092	0.0005	0.0000	0.0000	0.0565
East-Southeast	0.0454	0.1162	0.0211	0.0004	0.0000	0.0000	0.1830
Southeast	0.0357	0.0813	0.0259	0.0004	0.0000	0.0000	0.1433
South-Southeast	0.0174	0.0762	0.1054	0.0291	0.0009	0.0000	0.2290
South	0.0113	0.0232	0.0059	0.0002	0.0000	0.0000	0.0406
South-Southwest	0.0084	0.0193	0.0021	0.0002	0.0000	0.0000	0.0299
Southwest	0.0083	0.0234	0.0024	0.0003	0.0000	0.0000	0.0343
West-Southwest	0.0109	0.0241	0.0026	0.0001	0.0000	0.0000	0.0377
West	0.0157	0.0238	0.0045	0.0002	0.0000	0.0000	0.0442
West-Northwest	0.0325	0.0554	0.0348	0.0148	0.0024	0.0007	0.1406
Northwest	0.0140	0.0104	0.0089	0.0031	0.0006	0.0002	0.0373
North-Northwest	0.0039	0.0013	0.0004	0.0000	0.0000	0.0000	0.0056
Sums	0.2325	0.4893	0.2243	0.0491	0.0039	0.0009	

NIGHT	Speed Categories (m/s)						
Wind Directions	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0019	0.0007	0.0000	0.0001	0.0000	0.0000	0.0027
North-Northeast	0.0017	0.0007	0.0002	0.0000	0.0000	0.0000	0.0026
Northeast	0.0016	0.0004	0.0001	0.0000	0.0000	0.0000	0.0021
East-Northeast	0.0024	0.0012	0.0007	0.0000	0.0000	0.0000	0.0043
East	0.0044	0.0046	0.0016	0.0005	0.0000	0.0000	0.0111
East-Southeast	0.0076	0.0077	0.0026	0.0001	0.0000	0.0000	0.0179
Southeast	0.0080	0.0072	0.0008	0.0000	0.0000	0.0000	0.0159
South-Southeast	0.0158	0.0429	0.0384	0.0111	0.0004	0.0000	0.1086
South	0.0196	0.0127	0.0012	0.0001	0.0000	0.0000	0.0337
South-Southwest	0.0152	0.0038	0.0005	0.0000	0.0000	0.0000	0.0195
Southwest	0.0224	0.0051	0.0005	0.0001	0.0000	0.0000	0.0281
West-Southwest	0.0381	0.0092	0.0008	0.0000	0.0000	0.0000	0.0482
West	0.0673	0.0394	0.0036	0.0002	0.0001	0.0000	0.1105
West-Northwest	0.0944	0.3263	0.0253	0.0135	0.0051	0.0020	0.4665
Northwest	0.0396	0.0478	0.0233	0.0074	0.0008	0.0003	0.1190
North-Northwest	0.0069	0.0021	0.0003	0.0000	0.0000	0.0000	0.0093
Sums	0.3468	0.5120	0.0999	0.0329	0.0062	0.0023	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-5. Site 4 (Alice Hill) Joint Frequency Wind Distributions for 1993 through 1996

DAY Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0056	0.0109	0.0054	0.0094	0.0049	0.0040	0.0402
North-Northeast	0.0097	0.0226	0.0136	0.0249	0.0165	0.0089	0.0963
Northeast	0.0102	0.0407	0.0340	0.0167	0.0032	0.0010	0.1058
East-Northeast	0.0073	0.0288	0.0081	0.0024	0.0003	0.0000	0.0469
East	0.0051	0.0076	0.0033	0.0008	0.0001	0.0000	0.0169
East-Southeast	0.0051	0.0084	0.0043	0.0014	0.0001	0.0000	0.0192
Southeast	0.0040	0.0133	0.0070	0.0010	0.0001	0.0000	0.0254
South-Southeast	0.0059	0.0432	0.0362	0.0096	0.0022	0.0015	0.0986
South	0.0073	0.0635	0.0947	0.0878	0.0375	0.0253	0.3160
South-Southwest	0.0060	0.0232	0.0373	0.0219	0.0031	0.0019	0.0932
Southwest	0.0040	0.0094	0.0150	0.0153	0.0018	0.0010	0.0465
West-Southwest	0.0031	0.0040	0.0058	0.0080	0.0015	0.0001	0.0225
West	0.0027	0.0027	0.0016	0.0023	0.0003	0.0001	0.0097
West-Northwest	0.0023	0.0028	0.0020	0.0030	0.0009	0.0001	0.0110
Northwest	0.0030	0.0028	0.0031	0.0070	0.0031	0.0008	0.0198
North-Northwest	0.0042	0.0056	0.0031	0.0061	0.0062	0.0069	0.0322
Sums	0.0853	0.2893	0.2747	0.2175	0.0816	0.0516	

NIGHT Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0293	0.0815	0.0167	0.0210	0.0107	0.0119	0.1710
North-Northeast	0.0318	0.1118	0.0290	0.0450	0.0266	0.0255	0.2696
Northeast	0.0185	0.0765	0.0228	0.0091	0.0012	0.0009	0.1290
East-Northeast	0.0094	0.0074	0.0015	0.0005	0.0000	0.0002	0.0190
East	0.0067	0.0038	0.0011	0.0011	0.0000	0.0004	0.0131
East-Southeast	0.0069	0.0083	0.0020	0.0006	0.0000	0.0000	0.0177
Southeast	0.0045	0.0150	0.0055	0.0004	0.0000	0.0000	0.0255
South-Southeast	0.0057	0.0187	0.0158	0.0049	0.0008	0.0002	0.0460
South	0.0040	0.0181	0.0298	0.0226	0.0079	0.0071	0.0895
South-Southwest	0.0052	0.0130	0.0099	0.0038	0.0015	0.0004	0.0338
Southwest	0.0044	0.0105	0.0052	0.0013	0.0003	0.0002	0.0219
West-Southwest	0.0053	0.0076	0.0034	0.0020	0.0004	0.0002	0.0189
West	0.0046	0.0066	0.0020	0.0007	0.0002	0.0001	0.0141
West-Northwest	0.0070	0.0070	0.0019	0.0006	0.0001	0.0001	0.0167
Northwest	0.0095	0.0127	0.0025	0.0014	0.0007	0.0007	0.0276
North-Northwest	0.0146	0.0484	0.0108	0.0050	0.0024	0.0054	0.0866
Sums	0.1672	0.4469	0.1599	0.1200	0.0528	0.0533	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-6. Site 5 (Fortymile Wash) Joint Frequency Wind Distributions for 1993 through 1996

DAY Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0059	0.0294	0.0690	0.0408	0.0029	0.0005	0.1486
North-Northeast	0.0050	0.0228	0.0328	0.0067	0.0005	0.0000	0.0679
Northeast	0.0042	0.0125	0.0091	0.0034	0.0007	0.0001	0.0300
East-Northeast	0.0035	0.0082	0.0090	0.0082	0.0009	0.0002	0.0300
East	0.0030	0.0057	0.0074	0.0030	0.0001	0.0000	0.0192
East-Southeast	0.0038	0.0073	0.0034	0.0002	0.0001	0.0000	0.0146
Southeast	0.0039	0.0094	0.0029	0.0010	0.0001	0.0000	0.0174
South-Southeast	0.0058	0.0175	0.0130	0.0148	0.0051	0.0020	0.0582
South	0.0081	0.0478	0.0644	0.0777	0.0252	0.0110	0.2340
South-Southwest	0.0118	0.0768	0.0638	0.0190	0.0026	0.0013	0.1752
Southwest	0.0077	0.0308	0.0264	0.0064	0.0008	0.0002	0.0723
West-Southwest	0.0061	0.0113	0.0135	0.0054	0.0005	0.0004	0.0372
West	0.0043	0.0059	0.0034	0.0023	0.0001	0.0000	0.0160
West-Northwest	0.0044	0.0045	0.0028	0.0030	0.0001	0.0000	0.0147
Northwest	0.0045	0.0051	0.0040	0.0055	0.0011	0.0001	0.0202
North-Northwest	0.0054	0.0137	0.0075	0.0113	0.0042	0.0025	0.0446
Sums	0.0873	0.3086	0.3324	0.2087	0.0449	0.0181	

NIGHT Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0064	0.0504	0.2150	0.1186	0.0051	0.0010	0.3965
North-Northeast	0.0054	0.0401	0.1700	0.0166	0.0004	0.0001	0.2324
Northeast	0.0025	0.0202	0.0464	0.0026	0.0003	0.0001	0.0721
East-Northeast	0.0020	0.0076	0.0084	0.0025	0.0002	0.0002	0.0209
East	0.0023	0.0031	0.0024	0.0005	0.0001	0.0001	0.0083
East-Southeast	0.0016	0.0037	0.0010	0.0002	0.0000	0.0000	0.0066
Southeast	0.0015	0.0040	0.0017	0.0003	0.0000	0.0000	0.0075
South-Southeast	0.0020	0.0064	0.0130	0.0145	0.0035	0.0007	0.0401
South	0.0032	0.0100	0.0195	0.0201	0.0074	0.0046	0.0649
South-Southwest	0.0035	0.0114	0.0064	0.0029	0.0004	0.0000	0.0245
Southwest	0.0057	0.0091	0.0026	0.0005	0.0001	0.0001	0.0180
West-Southwest	0.0068	0.0070	0.0030	0.0008	0.0001	0.0000	0.0177
West	0.0060	0.0048	0.0034	0.0005	0.0001	0.0001	0.0148
West-Northwest	0.0060	0.0033	0.0015	0.0004	0.0000	0.0000	0.0112
Northwest	0.0051	0.0056	0.0012	0.0014	0.0004	0.0002	0.0139
North-Northwest	0.0066	0.0189	0.0110	0.0076	0.0044	0.0023	0.0507
Sums	0.0663	0.2057	0.5064	0.1901	0.0224	0.0092	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories

Table B-7. Site 6 (WT-6) Joint Frequency Wind Distributions
for 1993 through 1996

DAY Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0050	0.0079	0.0091	0.0100	0.0024	0.0009	0.0353
North-Northeast	0.0037	0.0064	0.0077	0.0035	0.0002	0.0000	0.0215
Northeast	0.0035	0.0087	0.0108	0.0017	0.0000	0.0000	0.0247
East-Northeast	0.0060	0.0103	0.0057	0.0003	0.0000	0.0000	0.0223
East	0.0078	0.0112	0.0023	0.0002	0.0000	0.0000	0.0214
East-Southeast	0.0102	0.0323	0.0045	0.0001	0.0000	0.0000	0.0471
Southeast	0.0130	0.0904	0.0648	0.0101	0.0015	0.0005	0.1803
South-Southeast	0.0074	0.0562	0.1051	0.0947	0.0255	0.0078	0.2968
South	0.0049	0.0191	0.0225	0.0029	0.0001	0.0000	0.0494
South-Southwest	0.0037	0.0141	0.0207	0.0019	0.0000	0.0000	0.0403
Southwest	0.0022	0.0091	0.0118	0.0006	0.0000	0.0000	0.0236
West-Southwest	0.0024	0.0043	0.0047	0.0005	0.0000	0.0000	0.0119
West	0.0021	0.0033	0.0029	0.0002	0.0000	0.0000	0.0084
West-Northwest	0.0046	0.0055	0.0068	0.0014	0.0001	0.0000	0.0183
Northwest	0.0094	0.0383	0.0671	0.0102	0.0005	0.0000	0.1255
North-Northwest	0.0076	0.0150	0.0174	0.0210	0.0084	0.0039	0.0733
Sums	0.0934	0.3320	0.3639	0.1591	0.0385	0.0131	

NIGHT Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0039	0.0088	0.0100	0.0141	0.0058	0.0025	0.0451
North-Northeast	0.0014	0.0046	0.0088	0.0060	0.0009	0.0000	0.0218
Northeast	0.0011	0.0025	0.0020	0.0009	0.0000	0.0000	0.0065
East-Northeast	0.0012	0.0008	0.0005	0.0001	0.0000	0.0000	0.0026
East	0.0018	0.0015	0.0004	0.0002	0.0000	0.0000	0.0037
East-Southeast	0.0036	0.0044	0.0018	0.0002	0.0000	0.0000	0.0100
Southeast	0.0076	0.0165	0.0238	0.0153	0.0029	0.0002	0.0663
South-Southeast	0.0069	0.0150	0.0150	0.0151	0.0057	0.0016	0.0594
South	0.0043	0.0072	0.0024	0.0001	0.0000	0.0000	0.0140
South-Southwest	0.0050	0.0071	0.0009	0.0002	0.0000	0.0000	0.0132
Southwest	0.0043	0.0073	0.0006	0.0000	0.0000	0.0000	0.0122
West-Southwest	0.0057	0.0082	0.0019	0.0001	0.0000	0.0000	0.0159
West	0.0093	0.0126	0.0023	0.0002	0.0000	0.0000	0.0244
West-Northwest	0.0138	0.0255	0.0126	0.0013	0.0001	0.0000	0.0532
Northwest	0.0258	0.1673	0.3562	0.0156	0.0004	0.0001	0.5654
North-Northwest	0.0099	0.0249	0.0202	0.0195	0.0069	0.0049	0.0863
Sums	0.1057	0.3142	0.4595	0.0887	0.0227	0.0093	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-8. Site 7 (Sever Wash) Joint Frequency Wind Distributions for 1993 through 1996

DAY	Speed Categories (m/s)						
Wind Directions	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0055	0.0145	0.0211	0.0156	0.0021	0.0002	0.0591
North-Northeast	0.0035	0.0179	0.0311	0.0119	0.0004	0.0001	0.0650
Northeast	0.0034	0.0127	0.0089	0.0005	0.0001	0.0000	0.0256
East-Northeast	0.0034	0.0067	0.0018	0.0004	0.0001	0.0000	0.0125
East	0.0036	0.0050	0.0016	0.0002	0.0001	0.0000	0.0105
East-Southeast	0.0050	0.0087	0.0055	0.0008	0.0000	0.0000	0.0200
Southeast	0.0103	0.0288	0.0091	0.0009	0.0001	0.0000	0.0492
South-Southeast	0.0146	0.0851	0.0710	0.0343	0.0103	0.0023	0.2176
South	0.0105	0.0419	0.0773	0.0592	0.0115	0.0026	0.2030
South-Southwest	0.0073	0.0227	0.0327	0.0072	0.0008	0.0000	0.0707
Southwest	0.0077	0.0100	0.0172	0.0032	0.0005	0.0000	0.0387
West-Southwest	0.0121	0.0054	0.0082	0.0016	0.0000	0.0000	0.0274
West	0.0284	0.0035	0.0037	0.0008	0.0000	0.0000	0.0365
West-Northwest	0.0398	0.0084	0.0042	0.0009	0.0000	0.0000	0.0533
Northwest	0.0305	0.0151	0.0072	0.0069	0.0008	0.0003	0.0608
North-Northwest	0.0115	0.0132	0.0072	0.0119	0.0042	0.0021	0.0501
Sums	0.1974	0.2998	0.3079	0.1564	0.0310	0.0076	

NIGHT	Speed Categories (m/s)						
Wind Directions	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0159	0.0296	0.0402	0.0285	0.0034	0.0001	0.1177
North-Northeast	0.0053	0.0071	0.0142	0.0086	0.0010	0.0002	0.0364
Northeast	0.0036	0.0034	0.0016	0.0005	0.0000	0.0000	0.0091
East-Northeast	0.0030	0.0019	0.0001	0.0001	0.0000	0.0000	0.0051
East	0.0029	0.0016	0.0005	0.0001	0.0000	0.0000	0.0051
East-Southeast	0.0037	0.0039	0.0014	0.0002	0.0001	0.0000	0.0093
Southeast	0.0043	0.0037	0.0012	0.0000	0.0000	0.0000	0.0093
South-Southeast	0.0054	0.0100	0.0059	0.0037	0.0011	0.0001	0.0261
South	0.0053	0.0150	0.0232	0.0142	0.0020	0.0001	0.0598
South-Southwest	0.0037	0.0080	0.0043	0.0014	0.0001	0.0000	0.0174
Southwest	0.0046	0.0046	0.0008	0.0004	0.0000	0.0001	0.0104
West-Southwest	0.0109	0.0040	0.0013	0.0004	0.0000	0.0000	0.0166
West	0.0428	0.0030	0.0008	0.0001	0.0000	0.0000	0.0467
West-Northwest	0.1314	0.0351	0.0006	0.0004	0.0000	0.0000	0.1675
Northwest	0.1339	0.1483	0.0059	0.0025	0.0004	0.0001	0.2911
North-Northwest	0.0544	0.0813	0.0223	0.0100	0.0030	0.0015	0.1724
Sums	0.4312	0.3606	0.1243	0.0708	0.0111	0.0019	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-9. Site 8 (Knothead Gap) Joint Frequency Wind Distributions for 1993 through 1996

DAY	Speed Categories (m/s)						
Wind Directions	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0332	0.0108	0.0133	0.0110	0.0021	0.0002	0.0705
North-Northeast	0.0263	0.0105	0.0142	0.0070	0.0002	0.0000	0.0583
Northeast	0.0234	0.0101	0.0085	0.0017	0.0001	0.0000	0.0437
East-Northeast	0.0170	0.0075	0.0020	0.0003	0.0000	0.0000	0.0268
East	0.0112	0.0083	0.0025	0.0003	0.0000	0.0000	0.0224
East-Southeast	0.0130	0.0102	0.0037	0.0001	0.0000	0.0000	0.0269
Southeast	0.0122	0.0198	0.0029	0.0002	0.0000	0.0000	0.0350
South-Southeast	0.0149	0.0576	0.0311	0.0110	0.0037	0.0006	0.1188
South	0.0137	0.0764	0.1115	0.0866	0.0240	0.0062	0.3184
South-Southwest	0.0075	0.0274	0.0433	0.0096	0.0015	0.0002	0.0896
Southwest	0.0048	0.0123	0.0156	0.0019	0.0002	0.0000	0.0349
West-Southwest	0.0027	0.0050	0.0053	0.0006	0.0000	0.0000	0.0136
West	0.0029	0.0037	0.0029	0.0003	0.0000	0.0000	0.0097
West-Northwest	0.0056	0.0033	0.0040	0.0008	0.0000	0.0000	0.0137
Northwest	0.0185	0.0112	0.0062	0.0031	0.0003	0.0001	0.0395
North-Northwest	0.0390	0.0075	0.0098	0.0153	0.0051	0.0016	0.0783
Sums	0.2459	0.2815	0.2771	0.1498	0.0370	0.0088	

NIGHT	Speed Categories (m/s)						
Wind Directions	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0660	0.0264	0.0291	0.0153	0.0021	0.0001	0.1389
North-Northeast	0.0185	0.0049	0.0053	0.0025	0.0000	0.0001	0.0312
Northeast	0.0063	0.0012	0.0007	0.0005	0.0000	0.0000	0.0087
East-Northeast	0.0037	0.0007	0.0005	0.0001	0.0000	0.0000	0.0050
East	0.0027	0.0012	0.0004	0.0001	0.0001	0.0000	0.0045
East-Southeast	0.0036	0.0016	0.0003	0.0000	0.0000	0.0000	0.0055
Southeast	0.0056	0.0025	0.0004	0.0000	0.0000	0.0000	0.0085
South-Southeast	0.0078	0.0094	0.0063	0.0031	0.0004	0.0001	0.0270
South	0.0157	0.0209	0.0211	0.0241	0.0070	0.0009	0.0897
South-Southwest	0.0175	0.0162	0.0153	0.0049	0.0004	0.0000	0.0543
Southwest	0.0119	0.0123	0.0039	0.0005	0.0000	0.0001	0.0286
West-Southwest	0.0095	0.0088	0.0031	0.0002	0.0000	0.0000	0.0215
West	0.0124	0.0053	0.0021	0.0002	0.0001	0.0000	0.0200
West-Northwest	0.0243	0.0080	0.0005	0.0002	0.0001	0.0000	0.0330
Northwest	0.1117	0.1023	0.0036	0.0013	0.0001	0.0000	0.2189
North-Northwest	0.2222	0.0391	0.0212	0.0146	0.0057	0.0021	0.3048
Sums	0.5394	0.2606	0.1138	0.0674	0.0158	0.0032	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-10. Site 9 (Gate 510) Joint Frequency Wind Distributions for 1993 through 1996

DAY	Speed Categories (m/s)						
Wind Directions	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0042	0.0126	0.0120	0.0081	0.0018	0.0004	0.0391
North-Northeast	0.0039	0.0278	0.0497	0.0098	0.0006	0.0000	0.0918
Northeast	0.0038	0.0265	0.0489	0.0129	0.0018	0.0002	0.0941
East-Northeast	0.0050	0.0154	0.0126	0.0032	0.0001	0.0001	0.0363
East	0.0041	0.0109	0.0070	0.0021	0.0000	0.0000	0.0242
East-Southeast	0.0049	0.0114	0.0041	0.0005	0.0000	0.0001	0.0210
Southeast	0.0048	0.0150	0.0067	0.0017	0.0002	0.0001	0.0284
South-Southeast	0.0079	0.0311	0.0378	0.0520	0.0194	0.0074	0.1556
South	0.0099	0.0586	0.0715	0.0616	0.0246	0.0096	0.2358
South-Southwest	0.0100	0.0408	0.0271	0.0101	0.0026	0.0011	0.0916
Southwest	0.0067	0.0236	0.0130	0.0026	0.0002	0.0000	0.0460
West-Southwest	0.0053	0.0164	0.0098	0.0016	0.0002	0.0000	0.0334
West	0.0040	0.0104	0.0070	0.0014	0.0001	0.0000	0.0229
West-Northwest	0.0027	0.0077	0.0059	0.0020	0.0001	0.0000	0.0184
Northwest	0.0029	0.0073	0.0073	0.0081	0.0013	0.0002	0.0271
North-Northwest	0.0031	0.0078	0.0076	0.0094	0.0049	0.0018	0.0346
Sums	0.0832	0.3232	0.3281	0.1870	0.0577	0.0209	

NIGHT	Speed Categories (m/s)						
Wind Directions	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0031	0.0179	0.0388	0.0112	0.0019	0.0004	0.0733
North-Northeast	0.0029	0.0430	0.2916	0.0340	0.0010	0.0001	0.3726
Northeast	0.0033	0.0348	0.0813	0.0164	0.0007	0.0001	0.1367
East-Northeast	0.0037	0.0173	0.0137	0.0035	0.0001	0.0002	0.0386
East	0.0031	0.0123	0.0032	0.0010	0.0001	0.0003	0.0200
East-Southeast	0.0031	0.0120	0.0055	0.0005	0.0000	0.0000	0.0210
Southeast	0.0041	0.0154	0.0193	0.0047	0.0005	0.0000	0.0440
South-Southeast	0.0038	0.0206	0.0649	0.0516	0.0108	0.0026	0.1544
South	0.0031	0.0124	0.0130	0.0101	0.0047	0.0026	0.0458
South-Southwest	0.0034	0.0074	0.0028	0.0021	0.0004	0.0001	0.0162
Southwest	0.0023	0.0044	0.0014	0.0006	0.0000	0.0001	0.0088
West-Southwest	0.0019	0.0035	0.0008	0.0001	0.0000	0.0000	0.0064
West	0.0017	0.0035	0.0011	0.0004	0.0001	0.0000	0.0068
West-Northwest	0.0013	0.0041	0.0014	0.0004	0.0000	0.0000	0.0072
Northwest	0.0016	0.0055	0.0056	0.0023	0.0003	0.0001	0.0154
North-Northwest	0.0024	0.0081	0.0137	0.0061	0.0021	0.0006	0.0330
Sums	0.0448	0.2223	0.5581	0.1449	0.0227	0.0071	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-11. Desert Rock Airport Joint Frequency Wind Distributions for 1993 through 1995

DAY	Speed Categories (m/s)						
Wind Directions	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0281	0.0175	0.0211	0.0121	0.0014	0.0003	0.0806
North-Northeast	0.0027	0.0129	0.0288	0.0369	0.0026	0.0004	0.0843
Northeast	0.0018	0.0123	0.0202	0.0242	0.0018	0.0000	0.0603
East-Northeast	0.0028	0.0132	0.0095	0.0041	0.0002	0.0000	0.0298
East	0.0050	0.0170	0.0136	0.0069	0.0002	0.0000	0.0427
East-Southeast	0.0045	0.0168	0.0212	0.0187	0.0008	0.0001	0.0620
Southeast	0.0038	0.0117	0.0152	0.0084	0.0002	0.0000	0.0393
South-Southeast	0.0032	0.0079	0.0060	0.0015	0.0005	0.0001	0.0191
South	0.0045	0.0149	0.0180	0.0311	0.0120	0.0045	0.0850
South-Southwest	0.0021	0.0125	0.0287	0.0598	0.0258	0.0073	0.1362
Southwest	0.0026	0.0189	0.0459	0.0658	0.0166	0.0035	0.1533
West-Southwest	0.0026	0.0213	0.0348	0.0287	0.0029	0.0002	0.0905
West	0.0030	0.0189	0.0185	0.0062	0.0003	0.0001	0.0470
West-Northwest	0.0022	0.0134	0.0069	0.0015	0.0002	0.0000	0.0241
Northwest	0.0023	0.0121	0.0063	0.0018	0.0007	0.0001	0.0234
North-Northwest	0.0022	0.0120	0.0056	0.0020	0.0005	0.0000	0.0223
Sums	0.0734	0.2334	0.3004	0.3098	0.0666	0.0165	

NIGHT	Speed Categories (m/s)						
Wind Directions	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0504	0.0395	0.0203	0.0046	0.0012	0.0004	0.1164
North-Northeast	0.0052	0.0390	0.0459	0.0335	0.0036	0.0003	0.1275
Northeast	0.0060	0.0526	0.0479	0.0314	0.0016	0.0003	0.1398
East-Northeast	0.0077	0.0509	0.0230	0.0038	0.0000	0.0001	0.0854
East	0.0116	0.0626	0.0291	0.0039	0.0003	0.0003	0.1077
East-Southeast	0.0081	0.0382	0.0244	0.0071	0.0003	0.0001	0.0781
Southeast	0.0046	0.0166	0.0076	0.0021	0.0000	0.0000	0.0308
South-Southeast	0.0029	0.0098	0.0047	0.0010	0.0002	0.0000	0.0186
South	0.0032	0.0136	0.0173	0.0173	0.0044	0.0012	0.0570
South-Southwest	0.0016	0.0086	0.0192	0.0275	0.0083	0.0031	0.0683
Southwest	0.0011	0.0117	0.0186	0.0169	0.0029	0.0005	0.0518
West-Southwest	0.0020	0.0105	0.0130	0.0057	0.0005	0.0001	0.0318
West	0.0017	0.0121	0.0063	0.0010	0.0000	0.0000	0.0211
West-Northwest	0.0021	0.0124	0.0041	0.0006	0.0001	0.0000	0.0193
Northwest	0.0019	0.0120	0.0073	0.0003	0.0001	0.0000	0.0216
North-Northwest	0.0020	0.0159	0.0060	0.0009	0.0002	0.0000	0.0249
Sums	0.1119	0.4060	0.2945	0.1575	0.0237	0.0065	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-12. Annual Joint Frequency Wind Distributions
for 1993 through 1996

DAY Wind Directions	S1	S1 60M	S2	S3	S4	S5	S6	S7	S8	S9	DRA
North	0.0481	0.0673	0.0152	0.0030	0.0402	0.1486	0.0353	0.0591	0.0705	0.0391	0.0806
North-Northeast	0.0417	0.0630	0.0187	0.0032	0.0963	0.0679	0.0215	0.0650	0.0583	0.0918	0.0843
Northeast	0.0354	0.0410	0.0275	0.0033	0.1058	0.0300	0.0247	0.0256	0.0437	0.0941	0.0603
East-Northeast	0.0296	0.0238	0.0424	0.0087	0.0469	0.0300	0.0223	0.0125	0.0268	0.0363	0.0298
East	0.0264	0.0217	0.0846	0.0565	0.0169	0.0192	0.0214	0.0105	0.0224	0.0242	0.0427
East-Southeast	0.0315	0.0295	0.1090	0.1830	0.0192	0.0146	0.0471	0.0200	0.0269	0.0210	0.0620
Southeast	0.0602	0.0561	0.1097	0.1433	0.0254	0.0174	0.1803	0.0492	0.0350	0.0284	0.0393
South-Southeast	0.1410	0.1384	0.1266	0.2290	0.0986	0.0582	0.2968	0.2176	0.1188	0.1556	0.0191
South	0.2866	0.3080	0.0859	0.0406	0.3160	0.2340	0.0494	0.2030	0.3184	0.2358	0.0850
South-Southwest	0.0702	0.0700	0.0750	0.0299	0.0932	0.1752	0.0403	0.0707	0.0896	0.0916	0.1362
Southwest	0.0465	0.0480	0.1057	0.0343	0.0465	0.0723	0.0236	0.0387	0.0349	0.0460	0.1533
West-Southwest	0.0230	0.0234	0.0798	0.0377	0.0225	0.0372	0.0119	0.0274	0.0136	0.0334	0.0905
West	0.0148	0.0147	0.0364	0.0442	0.0097	0.0160	0.0084	0.0365	0.0097	0.0229	0.0470
West-Northwest	0.0200	0.0157	0.0220	0.1406	0.0110	0.0147	0.0183	0.0533	0.0137	0.0184	0.0241
Northwest	0.0443	0.0231	0.0395	0.0373	0.0198	0.0202	0.1255	0.0608	0.0395	0.0271	0.0234
North-Northwest	0.0807	0.0564	0.0220	0.0056	0.0322	0.0446	0.0733	0.0501	0.0783	0.0346	0.0223

DAY Sites	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0
S1	0.1966	0.3042	0.2950	0.1602	0.0361	0.0080
S1 60 M	0.1902	0.2369	0.2712	0.2052	0.0614	0.0351
S2	0.0762	0.2903	0.3613	0.2113	0.0411	0.0197
S3	0.2325	0.4893	0.2243	0.0491	0.0039	0.0009
S4	0.0853	0.2893	0.2747	0.2175	0.0816	0.0516
S5	0.0873	0.3086	0.3324	0.2087	0.0449	0.0181
S6	0.0934	0.3320	0.3639	0.1591	0.0385	0.0131
S7	0.1974	0.2998	0.3079	0.1564	0.0310	0.0076
S8	0.2459	0.2815	0.2771	0.1498	0.0370	0.0088
S9	0.0831	0.3232	0.3281	0.1870	0.0577	0.0209
DRA	0.0734	0.2334	0.3004	0.3098	0.0666	0.0165

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-13. Annual Joint Frequency Wind Distributions
for 1993 through 1996

NIGHT Wind Directions	S1	S1 60M	S2	S3	S4	S5	S6	S7	S8	S9	DRA
North	0.1068	0.2420	0.0397	0.0027	0.1710	0.3965	0.0451	0.1177	0.1389	0.0733	0.1164
North-Northeast	0.0303	0.1259	0.0533	0.0026	0.2696	0.2324	0.0218	0.0364	0.0312	0.3726	0.1275
Northeast	0.0062	0.0302	0.0681	0.0021	0.1290	0.0721	0.0065	0.0091	0.0087	0.1367	0.1398
East-Northeast	0.0031	0.0125	0.0797	0.0043	0.0190	0.0209	0.0026	0.0051	0.0050	0.0386	0.0854
East	0.0026	0.0108	0.1298	0.0111	0.0131	0.0083	0.0037	0.0051	0.0045	0.0200	0.1077
East-Southeast	0.0033	0.0112	0.1012	0.0179	0.0177	0.0066	0.0100	0.0093	0.0055	0.0210	0.0781
Southeast	0.0044	0.0176	0.1003	0.0159	0.0255	0.0075	0.0663	0.0093	0.0085	0.0440	0.0308
South-Southeast	0.0133	0.0308	0.1079	0.1086	0.0460	0.0401	0.0594	0.0261	0.0270	0.1544	0.0186
South	0.0733	0.1305	0.0531	0.0337	0.0895	0.0649	0.0140	0.0598	0.0897	0.0458	0.0570
South-Southwest	0.0560	0.0624	0.0320	0.0195	0.0338	0.0245	0.0132	0.0174	0.0543	0.0162	0.0683
Southwest	0.0375	0.0387	0.0401	0.0281	0.0219	0.0180	0.0122	0.0104	0.0286	0.0088	0.0518
West-Southwest	0.0377	0.0315	0.0546	0.0482	0.0189	0.0177	0.0159	0.0166	0.0215	0.0064	0.0318
West	0.0383	0.0255	0.0389	0.1105	0.0141	0.0148	0.0244	0.0467	0.0200	0.0068	0.0211
West-Northwest	0.0587	0.0319	0.0254	0.4665	0.0167	0.0112	0.0532	0.1675	0.0330	0.0072	0.0193
Northwest	0.2502	0.0530	0.0388	0.1190	0.0276	0.0139	0.5654	0.2911	0.2189	0.0154	0.0216
North-Northwest	0.2784	0.1454	0.0373	0.0093	0.0866	0.0507	0.0863	0.1724	0.3048	0.0330	0.0249

NIGHT Sites	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0
S1	0.5243	0.1967	0.1862	0.0722	0.0164	0.0042
S1 60 M	0.4277	0.2332	0.1529	0.1242	0.0435	0.0185
S2	0.3178	0.1412	0.3151	0.1648	0.0358	0.0251
S3	0.5120	0.3468	0.0999	0.0329	0.0062	0.0023
S4	0.4469	0.1672	0.1599	0.1200	0.0528	0.0533
S5	0.2057	0.0663	0.5064	0.1901	0.0224	0.0092
S6	0.3142	0.1057	0.4595	0.0887	0.0227	0.0093
S7	0.3606	0.4312	0.1243	0.0708	0.0111	0.0019
S8	0.2606	0.5392	0.1138	0.0674	0.0158	0.0032
S9	0.2223	0.0448	0.5581	0.1449	0.0227	0.0071
DRA	0.4060	0.1119	0.2945	0.1575	0.0237	0.0065

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-14. Site 1 (NTS-60) 10m Joint Frequency Wind Distributions for 1986 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0142	0.0208	0.0262	0.0153	0.0029	0.0008	0.0800
North-Northeast	0.0077	0.0085	0.0115	0.0060	0.0005	0.0000	0.0342
Northeast	0.0084	0.0056	0.0057	0.0021	0.0000	0.0000	0.0218
East-Northeast	0.0092	0.0044	0.0024	0.0005	0.0000	0.0000	0.0165
East	0.0094	0.0046	0.0020	0.0006	0.0000	0.0000	0.0166
East-Southeast	0.0099	0.0065	0.0024	0.0003	0.0000	0.0000	0.0191
Southeast	0.0126	0.0166	0.0044	0.0004	0.0001	0.0000	0.0340
South-Southeast	0.0114	0.0336	0.0226	0.0107	0.0025	0.0007	0.0814
South	0.0089	0.0338	0.0644	0.0533	0.0137	0.0035	0.1776
South-Southwest	0.0077	0.0221	0.0246	0.0061	0.0006	0.0001	0.0612
Southwest	0.0085	0.0154	0.0116	0.0020	0.0003	0.0001	0.0379
West-Southwest	0.0089	0.0117	0.0065	0.0010	0.0000	0.0000	0.0281
West	0.0121	0.0101	0.0039	0.0009	0.0001	0.0000	0.0270
West-Northwest	0.0201	0.0162	0.0031	0.0012	0.0002	0.0000	0.0409
Northwest	0.0366	0.0892	0.0249	0.0041	0.0008	0.0004	0.1559
North-Northwest	0.0358	0.0876	0.0207	0.0147	0.0064	0.0026	0.1677
Sums	0.2212	0.3866	0.2368	0.1190	0.0280	0.0083	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-15. Site 1 (NTS-60) 60m Joint Frequency Wind Distributions for 1986 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0650	0.0248	0.0253	0.0243	0.0084	0.0036	0.1513
North-Northeast	0.0297	0.0194	0.0140	0.0128	0.0032	0.0010	0.0801
Northeast	0.0164	0.0082	0.0068	0.0041	0.0005	0.0000	0.0360
East-Northeast	0.0107	0.0050	0.0028	0.0009	0.0001	0.0000	0.0196
East	0.0097	0.0056	0.0026	0.0010	0.0001	0.0000	0.0190
East-Southeast	0.0110	0.0077	0.0035	0.0008	0.0000	0.0000	0.0230
Southeast	0.0127	0.0181	0.0083	0.0033	0.0003	0.0003	0.0431
South-Southeast	0.0142	0.0331	0.0274	0.0160	0.0077	0.0032	0.1016
South	0.0131	0.0318	0.0579	0.0596	0.0219	0.0141	0.1984
South-Southwest	0.0118	0.0150	0.0209	0.0105	0.0017	0.0007	0.0606
Southwest	0.0110	0.0094	0.0130	0.0053	0.0006	0.0003	0.0396
West-Southwest	0.0091	0.0059	0.0075	0.0024	0.0003	0.0001	0.0253
West	0.0110	0.0032	0.0034	0.0013	0.0002	0.0001	0.0192
West-Northwest	0.0154	0.0029	0.0026	0.0015	0.0003	0.0001	0.0229
Northwest	0.0292	0.0050	0.0035	0.0043	0.0014	0.0009	0.0443
North-Northwest	0.0589	0.0164	0.0086	0.0136	0.0089	0.0096	0.1160
Sums	0.3291	0.2116	0.2080	0.1618	0.0556	0.0339	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-16. Site 2 (Yucca Mountain) Joint Frequency Wind Distributions for 1986 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0028	0.0042	0.0085	0.0093	0.0024	0.0005	0.0278
North-Northeast	0.0028	0.0070	0.0129	0.0101	0.0017	0.0004	0.0348
Northeast	0.0042	0.0118	0.0223	0.0131	0.0011	0.0001	0.0526
East-Northeast	0.0086	0.0310	0.0213	0.0048	0.0005	0.0001	0.0664
East	0.0134	0.0521	0.0338	0.0045	0.0005	0.0001	0.1043
East-Southeast	0.0129	0.0465	0.0352	0.0052	0.0002	0.0000	0.0999
Southeast	0.0128	0.0352	0.0400	0.0145	0.0012	0.0000	0.1038
South-Southeast	0.0103	0.0242	0.0422	0.0339	0.0058	0.0004	0.1168
South	0.0102	0.0188	0.0262	0.0165	0.0012	0.0001	0.0730
South-Southwest	0.0103	0.0177	0.0208	0.0076	0.0009	0.0003	0.0576
Southwest	0.0124	0.0193	0.0292	0.0135	0.0015	0.0009	0.0769
West-Southwest	0.0108	0.0134	0.0154	0.0147	0.0025	0.0012	0.0579
West	0.0087	0.0099	0.0070	0.0063	0.0020	0.0007	0.0345
West-Northwest	0.0046	0.0046	0.0047	0.0053	0.0023	0.0023	0.0239
Northwest	0.0033	0.0033	0.0054	0.0089	0.0066	0.0122	0.0397
North-Northwest	0.0027	0.0038	0.0068	0.0089	0.0044	0.0034	0.0301
Sums	0.1307	0.3027	0.3318	0.1772	0.0347	0.0228	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-17. Site 3 (Coyote Wash) Joint Frequency Wind Distributions for 1986 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0029	0.0016	0.0005	0.0002	0.0000	0.0000	0.0053
North-Northeast	0.0024	0.0012	0.0005	0.0001	0.0000	0.0000	0.0041
Northeast	0.0024	0.0014	0.0002	0.0001	0.0000	0.0000	0.0040
East-Northeast	0.0038	0.0026	0.0005	0.0000	0.0000	0.0000	0.0069
East	0.0111	0.0153	0.0053	0.0004	0.0000	0.0000	0.0322
East-Southeast	0.0295	0.0579	0.0108	0.0007	0.0000	0.0000	0.0989
Southeast	0.0238	0.0467	0.0144	0.0007	0.0000	0.0000	0.0856
South-Southeast	0.0184	0.0619	0.0663	0.0156	0.0004	0.0000	0.1626
South	0.0188	0.0170	0.0028	0.0003	0.0000	0.0000	0.0390
South-Southwest	0.0149	0.0109	0.0010	0.0000	0.0000	0.0000	0.0269
Southwest	0.0194	0.0121	0.0012	0.0001	0.0000	0.0000	0.0328
West-Southwest	0.0268	0.0127	0.0013	0.0001	0.0000	0.0000	0.0408
West	0.0474	0.0283	0.0045	0.0008	0.0000	0.0000	0.0810
West-Northwest	0.0774	0.1736	0.0279	0.0144	0.0043	0.0014	0.2989
Northwest	0.0275	0.0243	0.0146	0.0054	0.0009	0.0003	0.0729
North-Northwest	0.0053	0.0020	0.0006	0.0001	0.0000	0.0000	0.0081
Sums	0.3316	0.4694	0.1524	0.0391	0.0058	0.0017	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-18. Site 4 (Alice Hill) Joint Frequency Wind Distributions for 1986 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0252	0.0392	0.0103	0.0156	0.0079	0.0078	0.1061
North-Northeast	0.0304	0.0562	0.0232	0.0351	0.0186	0.0138	0.1774
Northeast	0.0194	0.0552	0.0259	0.0120	0.0022	0.0006	0.1153
East-Northeast	0.0101	0.0158	0.0044	0.0016	0.0003	0.0002	0.0325
East	0.0069	0.0058	0.0024	0.0016	0.0002	0.0001	0.0170
East-Southeast	0.0069	0.0078	0.0030	0.0011	0.0001	0.0000	0.0188
Southeast	0.0066	0.0140	0.0063	0.0009	0.0001	0.0000	0.0278
South-Southeast	0.0076	0.0344	0.0299	0.0103	0.0036	0.0018	0.0876
South	0.0075	0.0407	0.0636	0.0557	0.0212	0.0131	0.2017
South-Southwest	0.0062	0.0163	0.0214	0.0103	0.0015	0.0007	0.0563
Southwest	0.0052	0.0088	0.0085	0.0065	0.0007	0.0005	0.0302
West-Southwest	0.0045	0.0050	0.0036	0.0035	0.0005	0.0002	0.0174
West	0.0046	0.0040	0.0016	0.0013	0.0003	0.0000	0.0117
West-Northwest	0.0047	0.0040	0.0018	0.0017	0.0005	0.0001	0.0129
Northwest	0.0067	0.0072	0.0026	0.0040	0.0022	0.0016	0.0243
North-Northwest	0.0126	0.0267	0.0061	0.0062	0.0045	0.0069	0.0630
Sums	0.1652	0.3409	0.2146	0.1673	0.0644	0.0476	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-19. Site 5 (Fortymile Wash) Joint Frequency Wind Distributions for 1986 through 1995

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0083	0.0434	0.1446	0.0661	0.0036	0.0006	0.2667
North-Northeast	0.0063	0.0334	0.0952	0.0104	0.0004	0.0001	0.1458
Northeast	0.0049	0.0181	0.0257	0.0037	0.0005	0.0000	0.0528
East-Northeast	0.0032	0.0076	0.0084	0.0058	0.0008	0.0001	0.0259
East	0.0030	0.0055	0.0047	0.0019	0.0002	0.0000	0.0153
East-Southeast	0.0030	0.0049	0.0021	0.0004	0.0000	0.0000	0.0104
Southeast	0.0033	0.0066	0.0029	0.0007	0.0001	0.0000	0.0137
South-Southeast	0.0044	0.0126	0.0135	0.0145	0.0045	0.0014	0.0510
South	0.0072	0.0309	0.0458	0.0471	0.0142	0.0057	0.1510
South-Southwest	0.0104	0.0428	0.0326	0.0076	0.0011	0.0005	0.0951
Southwest	0.0093	0.0190	0.0129	0.0023	0.0002	0.0001	0.0439
West-Southwest	0.0072	0.0086	0.0066	0.0021	0.0002	0.0001	0.0249
West	0.0058	0.0051	0.0036	0.0011	0.0001	0.0000	0.0157
West-Northwest	0.0052	0.0039	0.0019	0.0013	0.0001	0.0000	0.0125
Northwest	0.0055	0.0054	0.0028	0.0039	0.0012	0.0004	0.0193
North-Northwest	0.0073	0.0158	0.0137	0.0120	0.0048	0.0025	0.0561
Sums	0.0943	0.2635	0.4172	0.1811	0.0322	0.0117	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-20. Site 6 (WT-6) Joint Frequency Wind Distributions for 1992 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0046	0.0081	0.0095	0.0117	0.0040	0.0015	0.0394
North-Northeast	0.0025	0.0056	0.0085	0.0048	0.0006	0.0000	0.0220
Northeast	0.0024	0.0058	0.0063	0.0012	0.0000	0.0000	0.0155
East-Northeast	0.0036	0.0057	0.0031	0.0002	0.0000	0.0000	0.0125
East	0.0047	0.0064	0.0013	0.0002	0.0000	0.0000	0.0127
East-Southeast	0.0073	0.0189	0.0032	0.0001	0.0000	0.0000	0.0296
Southeast	0.0103	0.0550	0.0456	0.0134	0.0026	0.0005	0.1273
South-Southeast	0.0070	0.0355	0.0600	0.0545	0.0148	0.0045	0.1763
South	0.0047	0.0136	0.0127	0.0015	0.0000	0.0000	0.0325
South-Southwest	0.0045	0.0109	0.0109	0.0010	0.0000	0.0000	0.0273
Southwest	0.0033	0.0083	0.0059	0.0003	0.0000	0.0000	0.0178
West-Southwest	0.0041	0.0062	0.0031	0.0003	0.0000	0.0000	0.0137
West	0.0054	0.0079	0.0025	0.0002	0.0000	0.0000	0.0161
West-Northwest	0.0094	0.0157	0.0099	0.0013	0.0001	0.0000	0.0364
Northwest	0.0169	0.1020	0.2104	0.0126	0.0004	0.0000	0.3424
North-Northwest	0.0089	0.0194	0.0180	0.0200	0.0080	0.0043	0.0785
Sums	0.0994	0.3250	0.4110	0.1233	0.0305	0.0108	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-21. Site 7 (Sever Wash) Joint Frequency Wind Distributions for 1992 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0109	0.0223	0.0306	0.0210	0.0027	0.0002	0.0876
North-Northeast	0.0043	0.0129	0.0237	0.0104	0.0006	0.0001	0.0520
Northeast	0.0035	0.0081	0.0051	0.0005	0.0001	0.0000	0.0172
East-Northeast	0.0031	0.0045	0.0009	0.0002	0.0000	0.0000	0.0088
East	0.0032	0.0033	0.0010	0.0002	0.0000	0.0000	0.0078
East-Southeast	0.0046	0.0059	0.0035	0.0005	0.0000	0.0000	0.0144
Southeast	0.0073	0.0162	0.0049	0.0004	0.0001	0.0000	0.0289
South-Southeast	0.0101	0.0488	0.0383	0.0194	0.0056	0.0012	0.1234
South	0.0082	0.0289	0.0514	0.0372	0.0068	0.0014	0.1339
South-Southwest	0.0055	0.0158	0.0191	0.0045	0.0004	0.0000	0.0454
Southwest	0.0062	0.0072	0.0091	0.0016	0.0002	0.0000	0.0245
West-Southwest	0.0113	0.0047	0.0047	0.0009	0.0000	0.0000	0.0216
West	0.0351	0.0031	0.0021	0.0005	0.0000	0.0000	0.0408
West-Northwest	0.0857	0.0208	0.0025	0.0007	0.0000	0.0000	0.1096
Northwest	0.0839	0.0788	0.0064	0.0047	0.0006	0.0002	0.1744
North-Northwest	0.0332	0.0460	0.0141	0.0109	0.0037	0.0017	0.1097
Sums	0.3163	0.3274	0.2173	0.1136	0.0207	0.0047	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-22. Site 8 (Knothead Gap) Joint Frequency Wind Distributions for 1992 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0501	0.0181	0.0209	0.0130	0.0021	0.0001	0.1043
North-Northeast	0.0230	0.0078	0.0098	0.0047	0.0001	0.0000	0.0454
Northeast	0.0155	0.0057	0.0046	0.0011	0.0000	0.0000	0.0268
East-Northeast	0.0106	0.0041	0.0013	0.0002	0.0000	0.0000	0.0161
East	0.0072	0.0047	0.0015	0.0002	0.0000	0.0000	0.0135
East-Southeast	0.0083	0.0059	0.0018	0.0000	0.0000	0.0000	0.0160
Southeast	0.0089	0.0115	0.0016	0.0001	0.0000	0.0000	0.0220
South-Southeast	0.0117	0.0341	0.0187	0.0078	0.0020	0.0003	0.0747
South	0.0145	0.0496	0.0683	0.0557	0.0152	0.0036	0.2069
South-Southwest	0.0128	0.0221	0.0297	0.0074	0.0009	0.0001	0.0730
Southwest	0.0082	0.0122	0.0096	0.0011	0.0001	0.0000	0.0313
West-Southwest	0.0058	0.0069	0.0041	0.0004	0.0000	0.0000	0.0171
West	0.0075	0.0044	0.0023	0.0003	0.0000	0.0000	0.0145
West-Northwest	0.0142	0.0054	0.0023	0.0005	0.0000	0.0000	0.0225
Northwest	0.0661	0.0546	0.0049	0.0022	0.0002	0.0000	0.1280
North-Northwest	0.1288	0.0227	0.0152	0.0143	0.0050	0.0017	0.1877
Sums	0.3933	0.2697	0.1966	0.1089	0.0256	0.0059	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-23. Site 9 (Gate 510) Joint Frequency Wind Distributions for 1995 Daylight Hours

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0037	0.0152	0.0250	0.0096	0.0019	0.0004	0.0557
North-Northeast	0.0034	0.0352	0.1674	0.0215	0.0008	0.0000	0.2284
Northeast	0.0036	0.0305	0.0647	0.0146	0.0013	0.0001	0.1148
East-Northeast	0.0044	0.0163	0.0131	0.0034	0.0001	0.0001	0.0374
East	0.0036	0.0116	0.0052	0.0015	0.0000	0.0001	0.0221
East-Southeast	0.0040	0.0117	0.0048	0.0005	0.0000	0.0000	0.0210
Southeast	0.0044	0.0152	0.0128	0.0032	0.0004	0.0000	0.0360
South-Southeast	0.0059	0.0260	0.0510	0.0518	0.0152	0.0051	0.1550
South	0.0066	0.0361	0.0430	0.0365	0.0149	0.0062	0.1434
South-Southwest	0.0068	0.0245	0.0153	0.0062	0.0015	0.0006	0.0549
Southwest	0.0045	0.0143	0.0073	0.0016	0.0001	0.0000	0.0279
West-Southwest	0.0037	0.0101	0.0054	0.0009	0.0001	0.0000	0.0202
West	0.0029	0.0071	0.0041	0.0009	0.0001	0.0000	0.0151
West-Northwest	0.0020	0.0060	0.0037	0.0013	0.0000	0.0000	0.0130
Northwest	0.0023	0.0064	0.0065	0.0053	0.0008	0.0001	0.0214
North-Northwest	0.0027	0.0080	0.0106	0.0078	0.0035	0.0012	0.0338
Sums	0.0645	0.2741	0.4400	0.1665	0.0407	0.0142	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-24. Desert Rock Airport Joint Frequency Wind Distributions for 1978 through 1995

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0564	0.0248	0.0163	0.0075	0.0013	0.0003	0.1067
North-Northeast	0.0080	0.0230	0.0286	0.0262	0.0035	0.0007	0.0900
Northeast	0.0104	0.0290	0.0361	0.0342	0.0034	0.0003	0.1135
East-Northeast	0.0106	0.0265	0.0161	0.0072	0.0005	0.0000	0.0609
East	0.0174	0.0365	0.0189	0.0064	0.0007	0.0001	0.0800
East-Southeast	0.0099	0.0249	0.0234	0.0120	0.0007	0.0001	0.0710
Southeast	0.0066	0.0129	0.0123	0.0054	0.0001	0.0000	0.0373
South-Southeast	0.0045	0.0072	0.0049	0.0013	0.0003	0.0000	0.0182
South	0.0066	0.0120	0.0147	0.0192	0.0076	0.0025	0.0625
South-Southwest	0.0042	0.0099	0.0205	0.0359	0.0150	0.0058	0.0912
Southwest	0.0043	0.0136	0.0295	0.0380	0.0111	0.0021	0.0986
West-Southwest	0.0050	0.0148	0.0232	0.0175	0.0020	0.0002	0.0626
West	0.0063	0.0147	0.0119	0.0042	0.0001	0.0000	0.0372
West-Northwest	0.0058	0.0105	0.0043	0.0014	0.0001	0.0000	0.0221
Northwest	0.0061	0.0107	0.0046	0.0014	0.0004	0.0001	0.0234
North-Northwest	0.0054	0.0122	0.0047	0.0019	0.0004	0.0001	0.0247
Sums	0.1674	0.2832	0.2699	0.2198	0.0473	0.0124	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-25. Site 2 (Yucca Mountain) Joint Frequency Wind Distributions for max one minute wind speeds for 1994 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0000	0.0000	0.0009	0.0036	0.0090	0.0199	0.0334
North-Northeast	0.0000	0.0000	0.0018	0.0054	0.0081	0.0144	0.0298
Northeast	0.0000	0.0000	0.0000	0.0171	0.0171	0.0126	0.0469
East-Northeast	0.0000	0.0000	0.0045	0.0081	0.0063	0.0063	0.0253
East	0.0000	0.0000	0.0072	0.0063	0.0117	0.0036	0.0289
East-Southeast	0.0000	0.0000	0.0190	0.0244	0.0081	0.0009	0.0523
Southeast	0.0000	0.0000	0.0045	0.0217	0.0135	0.0054	0.0451
South-Southeast	0.0000	0.0000	0.0009	0.0280	0.0469	0.0451	0.1209
South	0.0000	0.0000	0.0009	0.0081	0.0108	0.0108	0.0307
South-Southwest	0.0000	0.0000	0.0000	0.0063	0.0117	0.0117	0.0298
Southwest	0.0000	0.0000	0.0081	0.0433	0.0731	0.0542	0.1787
West-Southwest	0.0000	0.0000	0.0063	0.0388	0.0442	0.0695	0.1588
West	0.0000	0.0000	0.0009	0.0181	0.0190	0.0442	0.0821
West-Northwest	0.0000	0.0000	0.0009	0.0018	0.0090	0.0171	0.0289
Northwest	0.0000	0.0000	0.0000	0.0036	0.0036	0.0785	0.0857
North-Northwest	0.0000	0.0000	0.0000	0.0027	0.0027	0.0171	0.0226
Sums	0.0000	0.0000	0.0560	0.2374	0.2951	0.4116	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-26. Site 3 (Coyote Wash) Joint Frequency Wind Distributions
for max one minute wind speeds for 1994 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
North-Northeast	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Northeast	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
East-Northeast	0.0000	0.0000	0.0000	0.0036	0.0000	0.0000	0.0036
East	0.0000	0.0009	0.0373	0.1211	0.0255	0.0055	0.1903
East-Southeast	0.0000	0.0018	0.0838	0.1138	0.0100	0.0036	0.2131
Southeast	0.0000	0.0000	0.0082	0.0574	0.0246	0.0064	0.0965
South-Southeast	0.0000	0.0000	0.0137	0.0783	0.0592	0.0128	0.1639
South	0.0000	0.0000	0.0018	0.0137	0.0082	0.0000	0.0237
South-Southwest	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Southwest	0.0000	0.0000	0.0027	0.0000	0.0009	0.0000	0.0036
West-Southwest	0.0000	0.0000	0.0000	0.0009	0.0000	0.0000	0.0009
West	0.0000	0.0000	0.0109	0.0173	0.0036	0.0009	0.0328
West-Northwest	0.0000	0.0027	0.0355	0.0801	0.0565	0.0410	0.2158
Northwest	0.0000	0.0000	0.0064	0.0200	0.0137	0.0137	0.0537
North-Northwest	0.0000	0.0000	0.0000	0.0018	0.0000	0.0000	0.0018
Sums	0.0000	0.0055	0.2004	0.5082	0.2022	0.0838	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-27. Site 4 (Alice Hill) Joint Frequency Wind Distributions
for max one minute wind speeds for 1994 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0000	0.0000	0.0009	0.0027	0.0045	0.0579	0.0661
North-Northeast	0.0000	0.0000	0.0054	0.0244	0.0326	0.1738	0.2362
Northeast	0.0000	0.0000	0.0181	0.0299	0.0081	0.0109	0.0670
East-Northeast	0.0000	0.0000	0.0000	0.0009	0.0027	0.0045	0.0081
East	0.0000	0.0000	0.0000	0.0018	0.0027	0.0036	0.0081
East-Southeast	0.0000	0.0000	0.0000	0.0000	0.0027	0.0009	0.0036
Southeast	0.0000	0.0000	0.0009	0.0027	0.0009	0.0000	0.0045
South-Southeast	0.0000	0.0000	0.0081	0.0353	0.0145	0.0290	0.0869
South	0.0000	0.0000	0.0109	0.0534	0.0606	0.1774	0.3023
South-Southwest	0.0000	0.0000	0.0027	0.0163	0.0344	0.0235	0.0769
Southwest	0.0000	0.0000	0.0000	0.0063	0.0163	0.0181	0.0407
West-Southwest	0.0000	0.0000	0.0000	0.0045	0.0100	0.0136	0.0281
West	0.0000	0.0000	0.0009	0.0000	0.0027	0.0027	0.0063
West-Northwest	0.0000	0.0000	0.0000	0.0000	0.0018	0.0045	0.0063
Northwest	0.0000	0.0000	0.0000	0.0000	0.0027	0.0181	0.0208
North-Northwest	0.0000	0.0000	0.0036	0.0018	0.0027	0.0299	0.0380
Sums	0.0000	0.0000	0.0516	0.1801	0.2000	0.5683	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-28. Site 5 (Fortymile Wash) Joint Frequency Wind Distributions for max one minute wind speeds for 1994 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0000	0.0000	0.0027	0.2064	0.0636	0.0264	0.2991
North-Northeast	0.0000	0.0000	0.0009	0.0182	0.0009	0.0036	0.0236
Northeast	0.0000	0.0000	0.0018	0.0055	0.0064	0.0064	0.0200
East-Northeast	0.0000	0.0000	0.0018	0.0145	0.0227	0.0091	0.0482
East	0.0000	0.0000	0.0009	0.0145	0.0118	0.0027	0.0300
East-Southeast	0.0000	0.0000	0.0000	0.0009	0.0027	0.0027	0.0064
Southeast	0.0000	0.0000	0.0000	0.0036	0.0036	0.0009	0.0082
South-Southeast	0.0000	0.0000	0.0000	0.0155	0.0345	0.0555	0.1055
South	0.0000	0.0000	0.0000	0.0227	0.0482	0.0936	0.1645
South-Southwest	0.0000	0.0000	0.0000	0.0264	0.0264	0.0182	0.0709
Southwest	0.0000	0.0000	0.0000	0.0200	0.0182	0.0136	0.0518
West-Southwest	0.0000	0.0000	0.0000	0.0118	0.0209	0.0118	0.0445
West	0.0000	0.0000	0.0000	0.0018	0.0118	0.0045	0.0182
West-Northwest	0.0000	0.0000	0.0000	0.0018	0.0045	0.0027	0.0091
Northwest	0.0000	0.0000	0.0000	0.0064	0.0082	0.0145	0.0291
North-Northwest	0.0000	0.0000	0.0000	0.0091	0.0118	0.0500	0.0709
Sums	0.0000	0.0000	0.0082	0.3791	0.2964	0.3164	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-29. Site 6 (WT-6) Joint Frequency Wind Distributions
for max one minute wind speeds for 1994 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0000	0.0000	0.0000	0.0145	0.0245	0.0534	0.0924
North-Northeast	0.0000	0.0000	0.0000	0.0163	0.0145	0.0118	0.0426
Northeast	0.0000	0.0000	0.0000	0.0091	0.0045	0.0009	0.0145
East-Northeast	0.0000	0.0000	0.0000	0.0027	0.0000	0.0000	0.0027
East	0.0000	0.0000	0.0000	0.0027	0.0009	0.0009	0.0045
East-Southeast	0.0000	0.0000	0.0009	0.0045	0.0000	0.0027	0.0082
Southeast	0.0000	0.0000	0.0018	0.0598	0.0670	0.0752	0.2038
South-Southeast	0.0000	0.0000	0.0036	0.0770	0.0761	0.1159	0.2726
South	0.0000	0.0000	0.0000	0.0127	0.0091	0.0027	0.0245
South-Southwest	0.0000	0.0000	0.0000	0.0163	0.0118	0.0009	0.0290
Southwest	0.0000	0.0000	0.0000	0.0027	0.0027	0.0009	0.0063
West-Southwest	0.0000	0.0000	0.0000	0.0054	0.0009	0.0009	0.0072
West	0.0000	0.0000	0.0000	0.0009	0.0009	0.0000	0.0018
West-Northwest	0.0000	0.0000	0.0009	0.0063	0.0027	0.0027	0.0127
Northwest	0.0000	0.0009	0.0082	0.1476	0.0100	0.0100	0.1766
North-Northwest	0.0000	0.0000	0.0009	0.0181	0.0208	0.0607	0.1005
Sums	0.0000	0.0009	0.0163	0.3967	0.2464	0.3397	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-30. Site 7 (Sever Wash) Joint Frequency Wind Distributions
for max one minute wind speeds for 1994 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0000	0.0000	0.0082	0.0381	0.0481	0.0282	0.1226
North-Northeast	0.0000	0.0000	0.0145	0.0990	0.0354	0.0227	0.1717
Northeast	0.0000	0.0000	0.0045	0.0073	0.0000	0.0009	0.0127
East-Northeast	0.0000	0.0000	0.0000	0.0009	0.0000	0.0009	0.0018
East	0.0000	0.0000	0.0009	0.0027	0.0045	0.0018	0.0100
East-Southeast	0.0000	0.0000	0.0009	0.0136	0.0018	0.0018	0.0182
Southeast	0.0000	0.0000	0.0054	0.0136	0.0036	0.0018	0.0245
South-Southeast	0.0000	0.0000	0.0173	0.0981	0.1026	0.1153	0.3333
South	0.0000	0.0009	0.0009	0.0218	0.0154	0.0100	0.0490
South-Southwest	0.0000	0.0000	0.0045	0.0472	0.0381	0.0064	0.0963
Southwest	0.0000	0.0000	0.0009	0.0100	0.0091	0.0027	0.0227
West-Southwest	0.0000	0.0000	0.0009	0.0027	0.0045	0.0009	0.0091
West	0.0000	0.0000	0.0000	0.0018	0.0018	0.0045	0.0082
West-Northwest	0.0000	0.0000	0.0009	0.0036	0.0054	0.0000	0.0100
Northwest	0.0000	0.0009	0.0036	0.0045	0.0118	0.0091	0.0300
North-Northwest	0.0000	0.0000	0.0163	0.0091	0.0200	0.0345	0.0799
Sums	0.0000	0.0018	0.0799	0.3742	0.3025	0.2416	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-31. Site 8 (Knothead Gap) Joint Frequency Wind Distributions
for max one minute wind speeds for 1994 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0000	0.0000	0.0018	0.0309	0.0209	0.0227	0.0762
North-Northeast	0.0000	0.0000	0.0009	0.0163	0.0118	0.0045	0.0336
Northeast	0.0000	0.0000	0.0000	0.0091	0.0009	0.0027	0.0127
East-Northeast	0.0000	0.0000	0.0009	0.0036	0.0000	0.0000	0.0045
East	0.0000	0.0009	0.0018	0.0118	0.0009	0.0018	0.0172
East-Southeast	0.0000	0.0000	0.0018	0.0100	0.0018	0.0000	0.0136
Southeast	0.0000	0.0000	0.0118	0.0082	0.0000	0.0000	0.0200
South-Southeast	0.0000	0.0009	0.0245	0.0408	0.0390	0.0381	0.1434
South	0.0000	0.0018	0.0581	0.1071	0.1062	0.0862	0.3593
South-Southwest	0.0000	0.0018	0.0118	0.0735	0.0336	0.0227	0.1434
Southwest	0.0000	0.0000	0.0027	0.0091	0.0018	0.0000	0.0136
West-Southwest	0.0000	0.0000	0.0018	0.0054	0.0027	0.0009	0.0109
West	0.0000	0.0000	0.0018	0.0009	0.0009	0.0000	0.0036
West-Northwest	0.0000	0.0000	0.0027	0.0054	0.0018	0.0009	0.0109
Northwest	0.0000	0.0009	0.0082	0.0082	0.0082	0.0064	0.0318
North-Northwest	0.0000	0.0000	0.0073	0.0200	0.0281	0.0499	0.1053
Sums	0.0000	0.0064	0.1379	0.3603	0.2586	0.2368	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

Table B-32. Site 9 (Gate 510) Joint Frequency Wind Distributions
for max one minute wind speeds for 1994 through 1996

Wind Directions	Speed Categories (m/s)						
	0 to <1.8	1.8 to <3.3	3.3 to <5.4	5.4 to <8.5	8.5 to <11.0	≥11.0	Sums
North	0.0000	0.0000	0.0011	0.0170	0.0227	0.0238	0.0646
North-Northeast	0.0000	0.0000	0.0091	0.1110	0.0193	0.0057	0.1450
Northeast	0.0000	0.0000	0.0011	0.0634	0.0193	0.0159	0.0997
East-Northeast	0.0000	0.0000	0.0000	0.0215	0.0023	0.0147	0.0385
East	0.0000	0.0000	0.0000	0.0068	0.0011	0.0057	0.0136
East-Southeast	0.0000	0.0000	0.0000	0.0011	0.0011	0.0011	0.0034
Southeast	0.0000	0.0000	0.0011	0.0034	0.0034	0.0091	0.0170
South-Southeast	0.0000	0.0000	0.0000	0.0215	0.0510	0.1404	0.2129
South	0.0000	0.0000	0.0011	0.0442	0.0476	0.1076	0.2005
South-Southwest	0.0000	0.0000	0.0000	0.0204	0.0193	0.0170	0.0566
Southwest	0.0000	0.0000	0.0000	0.0159	0.0011	0.0011	0.0181
West-Southwest	0.0000	0.0000	0.0000	0.0079	0.0045	0.0011	0.0136
West	0.0000	0.0000	0.0011	0.0079	0.0057	0.0000	0.0147
West-Northwest	0.0000	0.0000	0.0000	0.0057	0.0034	0.0011	0.0102
Northwest	0.0000	0.0000	0.0000	0.0057	0.0136	0.0136	0.0328
North-Northwest	0.0000	0.0000	0.0000	0.0091	0.0136	0.0362	0.0589
Sums	0.0000	0.0000	0.0147	0.3624	0.2288	0.3941	

Note: Table entries are the decimal fraction of the total number of observations that hourly average wind data occurred jointly in the speed and direction categories.

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APPENDIX C

STATISTICAL ANALYSIS OF METEOROLOGICAL DATA

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STATISTICAL ANALYSIS OF METEOROLOGICAL DATA

Weibull Distribution

In this report the Weibull Distribution was used to describe the statistical distribution of precipitation and make estimates of extreme values. Bergström (1996) uses the two parameter version of the distribution to describe the geostrophic wind speed. It is described as an extreme value type III distribution according to The Handbook of Hydrology (Maidment, 1993). It is often used in defining the distribution of minimum stream flows. Walpole and Myers (1989) list this distribution as a good distribution for the prediction of failure rates.

The following equation gives the three-parameter version of the Weibull Distribution:

$$f_i(p_i) = \alpha(-\ln(1-p_i))^{\frac{1}{k}} + f_{offset} \qquad (1)$$

In this equation, $f_i(p_i)$ is the calculated value as a function of the probability p_i that $f_i(p_i)$ is less than that calculated. Alpha, f_{offset} and k are the parameters for the this distribution. The offset term was added to the Weibull distribution for the analysis of precipitation data because it provides a better fit to the data. When it rains in the desert, it often rains only a small amount. The offset term in equation (1) appears to account for these small values.

The mean and variance are related to these parameters by the following equations:

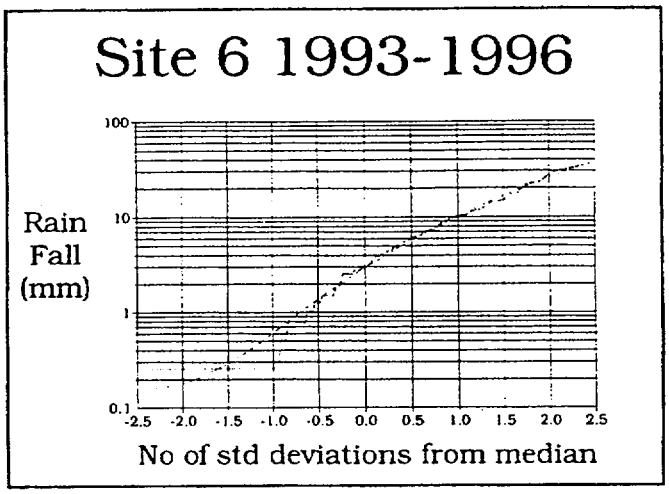
$$\mu = \alpha\Gamma(1+\frac{1}{k}) + f_{offset}$$
$$\sigma^2 = \alpha^2\{\Gamma(1+\frac{2}{k}) - [\Gamma(1+\frac{1}{k})]^2\} \qquad (2)$$

Gamma in the above is the Gamma Function. The equations in (2) are derived assuming an infinite data set. In practice the mean and variance calculated from the best values of alpha and k will be slightly different. The larger the data set is, the better agreement between the actual mean and variance and the values calculated using (2).

Cumulative probability is calculated using the following equation: $p_i = i/(n+1)$, where n is the number of data points and i is the index number of the data point being plotted.

An example of how the Weibull distribution is used is illustrated in the following illustration of data analysis for precipitation from Site 6 (WT-6) for the years 1993-1996. There were 138 days where there was precipitation during this period at this site. The rainfall amounts were arranged in ascending order. The cumulative probability associated with each data point was calculated using: $p_i = i/(1+138)$. Estimates of Alpha, f_{offset} and k were made using equations in (2), then calculated precipitation values associated with each measurement were made using equation (1).

The parameters were adjusted automatically until a minimum was found in the sum of the squares of the differences between the calculated and observed values. The data and calculated curve are plotted on a log probability plot, shown at the right. The smooth curve is the calculated value, and the irregular one is the data. This curve shows very good agreement between the data and the calculated statistical distribution. The values resulting from calculation are:



Mean = 5.4261
Variance = 48.1814
k = .769306974464834
alpha = 4.52325033300996
offset = .149181491587348
std error = .242040449113198

Extrapolation of the statistical distribution to determine recurrence values is made by calculating the probability associated with the extreme events then substituting that value into the equation for the statistical distribution. The extreme projections are calculated using the following equation:

$$s = n \cdot \frac{R}{rec} \qquad (3)$$

Where:
s = *number of samples needed*
n = *number of samples measured*
R = *return period in years*
rec = *number of years in the data set*

Cumulative probability associated with R is calculated using s:

$$p_r = \frac{s}{s+1} \qquad (4)$$

This value is substituted into the equation for the statistical distribution to calculate the value associated with the return period, R.

If there were 138 days of precipitation in 4 years the projected number of days of precipitation in 100 years will be 138 x 100/4 = 3450 days. The 100 year return event will have a cumulative probability of 3450/(3450+1) = 0.99971023. If we substitute this value and the values for the above parameters into equation (1) we obtain 69.26 mm for the 100 year return period. Similarly

precipitation = 61.72 mm for the 50 year return period and 77.00 mm for the 200 year return period.

Fisher-Tippet, Gumbel or Extreme Value Distribution

USDOE (1995) establishes policy for construction of facilities, and protection of workers, the general public, and the environment from the impacts of natural phenomena. In section 3.2.2 it recommends the use of the Gumbel Distribution (referred to as the Fisher-Tippett and Extreme Value distributions by other writers) to model straight wind hazards to determine extrapolated extreme values.

The American Nuclear Society (ANS, 1983) advocates the use of the Fisher-Tippett distribution to obtain design basis extreme wind speeds for nuclear power plants. It states that the 100-year return interval for wind speed using the Fisher-Tippett Distribution applied to existing fastest-mile wind speed data should be used in design of nuclear power plants. The data set should be composed of fastest-mile wind speeds, one sample per year for all years of record. More recent meteorological practice uses the fastest minute wind speeds (USNRC, 1981). Maidment (1993) states that the distribution is often used to describe the distribution of annual-maximum 24 hour rainfall depths.

In this report the Gumbel distribution was used to analyze the wind speed data. Many of the records analyzed only had a few years worth of data. The method of taking one sample per year (as advocated by the ANS) also ignores the second fastest values in a given year. The approach used in this report was to take the largest daily value for one second and fastest minute wind speeds. This resulted in much larger data sets, which were more suitable for statistical analysis. This report also presents results for 50 and 200 year return periods as an indication of the sensitivity of the value to return period.

Yucca Mountain wind speed data appears to be nearly Log-Normal, but often has an S-shape. Thomas, et al. (1970) used the Log-Normal distribution to extrapolate wind speed data to obtain a return period of 100 years. The high wind speed data have a curvature similar to that in the Gumbel, Weibull, or Pearson Distributions, but the data do not fit either distribution over the entire range.

The Gumbel Distribution is defined by equation (5). The calculated value of the i th point as a function of the cumulative probability of that point is given by:

$$f_i(p_i) = \xi - \alpha \ln[(-\ln(p_i))] \qquad (5)$$

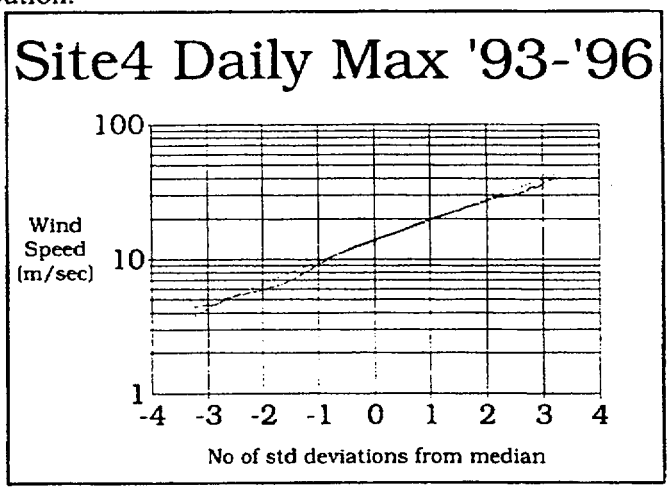
This is a two parameter distribution with the parameters of ξ and α. For high cumulative probability values (close to one) this distribution approaches that of a log normal distribution. The parameters in this equation are related to the mean and variance by the following:

$$mean,\ \mu = \xi + 0.5772\ \alpha$$

$$variance,\ \sigma^2 = \frac{\pi^2\alpha^2}{6} \qquad (6)$$

The shape of the Weibull and Gumbel distributions are similar except for low values. Extrapolations to extreme values using the Gumbel Distribution appear to produce higher values (more conservative) than the Weibull Distribution.

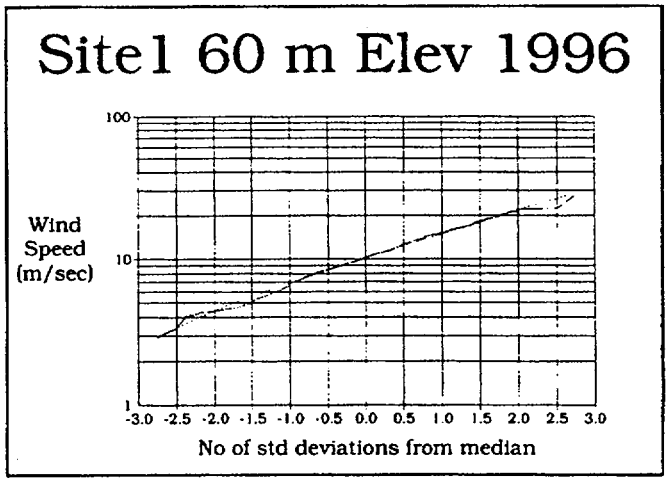
Site 4 (Alice Hill) is the most windy site monitored by EFPD. The figure at the right shows an example of how well the Gumbel Distribution fit the daily maximums of the largest hourly 1-second maximum wind speeds for the years 1993 through 1996 at this site. The straight line is the best fit line and the irregular line is the data. The regression curve is a little higher than the data at the upper end, making the extrapolation conservative.



There were 1807 data points in the data set that was analyzed. The results of the regression analysis were:

Mean = 14.5786
Variance = 28.7991
Xi = 12.1634921892324
alpha = 4.18422729413662
std error = .297527706145338

The wind data from most of the sites examined resembled the data in this example. The Gumbel Distribution curve has a slight curvature, but the data could be fit nearly as well using a Log-normal Distribution. As in the example, the data in all cases fell below the regression curve at the upper end, making extrapolation to extreme values conservative. Another example is shown at the right, which contains fastest minute data from 1996 for site 1 at the 60 m elevation.



Tables of Values of Statistical Parameters

The following tables list the values of the statistical parameters that were determined using a nonlinear regression method. The parameter values for the Gumbel Distribution (equations 5 and 6) were adjusted to produce the smallest standard error of estimate (residual sum of squares of the difference between the calculated and observed values). The number of points is the number days that there was data. Because of instrument or power problems or down time for calibration, the number of days is sometimes less than the period of record.

Gumbel Distribution Parameters for Daily Maximum 1-Second Wind Speed						
Location	Mean (m/sec)	Variance $(m/sec)^2$	Xi (m/sec)	alpha (m/sec)	Std. error of estimate	Number of points
Site 1-10m	12.1693	20.7882	10.117368	3.5549548	0.3033341	365
Site 1-60m	13.4768	27.111	11.133541	4.059742	0.2056008	365
Site 2	13.9057	28.2348	11.514318	4.1430309	0.0883021	1456
Site 3	11.0953	17.4497	9.2153630	3.2570141	0.0733242	1392
Site 4	14.5786	28.7991	12.16349	4.184227	0.2975277	1807
Site 5	12.4264	15.519	10.653507	3.0715502	0.0673273	1390
Site 6	13.0067	23.7911	10.8116	3.803055	0.4500493	1404
Site 7	11.7072	16.3237	9.8889036	3.1501806	0.1681114	1409
Site 8	11.1908	16.1627	9.3814533	3.1346058	0.2618666	1405
Site 9	12.0624	16.4949	10.234576	3.1666535	0.2642349	1365

Gumbel Distribution Parameters for Daily Maximum 1-Minute Wind Speeds						
Location	Mean (m/sec)	Variance $(m/sec)^2$	Xi (m/sec)	alpha (m/sec)	Std. error of estimate	Number of points
Site 1-10m	9.22826	10.915	7.7414182	2.5759511	0.0778064	333
Site 1-60m	10.9146	19.0215	8.9517835	3.4005417	0.1412841	333
Site 2	10.9557	19.017	8.9931235	3.4001356	0.0866405	1057
Site 3	7.4521	6.28177	6.3241445	1.9541899	0.0088956	1054
Site 4	12.2903	22.0167	10.178587	3.6584928	0.2276784	1053
Site 5	10.0472	9.10595	8.6891265	2.3528179	0.0540645	1056
Site 6	9.99585	11.4831	8.4708051	2.6421344	0.1954681	1058
Site 7	9.16839	8.98765	7.8191907	2.337485	0.0636163	1063
Site 8	8.8061	10.0351	7.3804453	2.4699445	0.1569913	1062
Site 9	9.62852	9.29927	8.2561377	2.3776619	0.1300965	1061

The following table lists the Weibull distribution parameters (equations 1 and 2) for the best least squares fit to the daily precipitation values at several sites. The data analysis only used precipitation values on days where there was more than 0.24 mm.

Some of the sites near Yucca Mountain had long periods of record. The entire period was analyzed and an abbreviated set, consisting of the last 10 years, was analyzed so that they could be compared with the shorter period of record of EFPD sites 1 through 9. The eighth column lists the number of days where there was precipitation during the period analyzed. The data were used to extrapolate the data to determine extreme precipitation return periods. The data often did not fit the statistical model (Weibull distribution) over the entire range, so the last column lists the data points that were actually used in the analysis. The mean, variance and Weibull parameters that are calculated are the values that are needed to fit the data range listed in the last column, and are not meant to be interpreted as mean, variance, etc of the entire data set. The offset value was sometimes constrained and calculated by the regression. Those cases are indicated by the letter "c" along with the value of the offset that was used. The offset only has impact on the lower range of the distribution, so it does not change the values of the projections.

Weibull Parameters for Statistical Analysis of Daily Precipitation								
Location	Mean (mm>.24)	Var (mm^2)	k (-)	alpha (mm)	offset (mm)	std error	no of pts	range of pts used
Site 1	3.71591	33.1104	0.65117	2.65183	0.1 c	0.321727	391	1-391
Site 2	5.447429	52.81207	0.759535	4.622439	0 c	0.409828	220	111-222
Site 3	4.268465	30.7565	0.778024	3.690719	0 c	0.702686	234	118-234
Site 4	5.592374	54.17642	0.768904	4.791689	0 c	0.218059	187	1-187
Site 5	4.72041	37.4956	0.779149	4.085984	0 c	0.837322	198	32-198
Site 6	5.4261	48.1814	0.769307	4.523250	0.149181	0.24204	138	1-138
Site 7	5.9521	52.6524	0.825276	5.367596	0 c	0.699290	128	1-128
Site 8	5.76356	50.7044	0.815051	5.153885	0 c	0.638785	128	1-128
Site 9	3.849905	23.43262	0.801856	3.40359	0 c	0.388776	117	1-117
4JA-**all data**	4.31353	44.5294	0.596793	2.488408	0.543157	0.454975	1190	1-1190
4JA - **10 yrs**	5.23898	59.3841	0.674949	3.849355	0.187263	0.131624	310	1-310
Desert Rock	4.5227	44.5007	0.638837	2.940649	0.42552	0 .988229	1097	1-1097
Mercury	4.17464	45.2318	0.618876	2.747176	0.2 c	1.922429	868	1- 868
Rock Valley	5.05657	55.9235	0.674741	3.732975	0.156024	0.270471	974	1- 974
Cane Springs	5.49553	63.2561	0.683252	4.080189	0.206948	0.522421	1100	1-1100
Amargosa Fms	5.115402	50.79346	0.669194	3.493362	0.377093	0.489958	506	1-506
Am Fms-**10 yrs**	4.894019	41.2153	0.771238	4.20322	0 c	0.156424	224	36-224
Beatty 1	5.170829	40.25497	0 .800191	4.444445	0.136118	0 .119904	482	1-482
Beatty 2	4.751894	40.678	0.705971	3.507054	0.123674	0 .348077	776	1-776
Beatty 2-**10 yrs**	4.63536	40.01068	0.676267	3.173211	0.479316	0.203632	313	1 to 313
Las Vegas	4.09827	35.7132	0.701773	3.24543	0 c	0 .40039	1191	190-1191

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