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**A Simulation Study of Moisture
Movement In Proposed Barriers for the
Subsurface Disposal Area, INEL**

Swen O. Magnuson

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**A Simulation Study of Moisture Movement in
Proposed Barriers for the Subsurface Disposal Area,
INEL**

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Published September 1993

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ABSTRACT

This document presents a simulation study that was conducted to investigate moisture movement within two engineered barriers, which are proposed for use in eventual closure of the Subsurface Disposal Area. The results of the study are intended to guide the design and implementation of field test plots that will be constructed to test the barrier designs. Discussed are the sensitivity of barrier performance to changes in the conceptual model, which was used to simulate the barriers, and to changes in hydrologic parameters, which were used to describe the materials composing the barriers. In addition, estimates are presented concerning the time required for the moisture profile within the barriers to come into equilibrium with the meteorological conditions at the surface. In addition, the performance of the barriers under conditions of supplemental precipitation and ponding is presented.

EXECUTIVE SUMMARY

A simulation study was conducted to investigate moisture movement within two proposed engineered barriers being considered for use in eventual closure of low-level waste pits in the Subsurface Disposal Area. The two barrier designs are slated to be field tested in order to evaluate their performance in limiting drainage of meteoric water down through the barriers. The study had three objectives related to providing guidance in planning the field barrier evaluations.

The first objective in the simulation study was to determine where to place emphasis on sampling as part of the barrier evaluation effort. This was accomplished through a two-part sensitivity analysis of the UNSAT-H (Fayer and Jones, 1990) numerical modeling in Keck (1992), which resulted in the selection of the two proposed barrier designs. First, the sensitivity of barrier performance was tested by making changes in the conceptual model used to describe water movement within the barrier. The second part consisted of testing the sensitivity of the barrier performance to changes in the hydraulic parameters used to describe each of the barrier materials in the model.

The second objective was to provide an estimate of the time required for the barriers to come into equilibrium with the variable meteorological conditions at the surface. After the barriers are built, the initial moisture profile will begin to respond to surface conditions and to gravity and capillary forces. At low moisture conditions, changes in soil moisture can take considerable time, on the order of years. The monitoring period for the field test plots has to be long enough to measure the barrier response to variable surface conditions, not just the redistribution of the initial moisture profile.

The third and last objective related to failure analysis for the barriers. Part of the barrier evaluation project will involve supplemental infiltration. Guidance as to the appropriate water application rates and durations was provided through numerical simulations. In addition, the duration of ponding necessary for catastrophic failure from surface flooding was determined.

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A Simulation Study of Moisture Movement in Proposed Barriers for the Subsurface Disposal Area, INEL

1. INTRODUCTION

The Radioactive Waste Management Complex (RWMC) is located in the southwest portion of the Idaho National Engineering Laboratory (see Figure 1). Low-level, mixed, and transuranic radioactive wastes have been disposed in shallow pits and trenches at the RWMC from the early 1950s until 1970. Since 1970, transuranic wastes have been disposed in above-grade facilities. A radiological performance assessment (PA) is being conducted on the low-level waste facility at the RWMC (Maheras et al., 1993), as required by DOE Order 5820.2A. This PA considers the low-level waste that is already emplaced and that which is projected to be emplaced over the remaining lifetime of the facility.

The PA results are partly based on numerical simulation of flow and radionuclide transport in the subsurface at the RWMC. This PA modeling takes a conservative approach to predict the performance of a facility. For example, this conservative approach includes only taking credit for reduced infiltration due to an engineered barrier for a limited period of institutional control. The advantage of using a cover is to reduce infiltration in order to provide more opportunity for short-lived nuclides to decay.

1.1 Background

Two cover designs, identified by Keck (1992) as likely candidates, are being evaluated for use in eventual closure of low-level waste pits in the RWMC disposal facility. A study is being initiated to construct small-scale field plots of both barrier designs and to monitor them in order to evaluate their effectiveness in reducing infiltration. The field study will provide a basis for including the effects of a cover into the RWMC PA calculations.

The simulations conducted in Keck (1992) to evaluate proposed barrier designs were deterministic in that no variability in hydrologic parameters was considered. In addition, since the barriers are not constructed yet, site-specific descriptions of the hydraulic parameters for each of the barrier materials were not available. In place of site-specific parameters, the hydraulic characteristics of each of the barrier materials were assigned based on default values for U.S. Soil Conservation Service classifications tabulated in the HELP Manual (Schroeder et al., 1988).

1.2 Purpose and Objective

In this study, simulations of moisture movement within the proposed barriers were conducted which had the overall purpose of providing guidance to the ongoing cover evaluation project. The guidance was provided through three specific objectives addressed in this study. These objectives are covered in Sections 4, 5, and 6 and are briefly described below.

Figure 1. Location of the Radioactive Waste Management Complex.

The first objective was to perform a sensitivity analysis of the UNSAT-H (Fayer and Jones, 1990) numerical modeling, which resulted in the selection of the two proposed barrier designs. This sensitivity analysis had two parts. The first tested the sensitivity of the modeling results to changes in the conceptual model used to describe water movement in the barrier. For example, one change to the conceptual model was to include the effect of plant transpiration. The intent was to improve the conceptual model used in the simulations by making it more inclusive of the processes that will affect moisture movement within the barriers. The second part consisted of testing the sensitivity of the barrier performance to changes in the hydraulic parameters used to describe each of the barrier materials in the model. This latter part can then be used to determine where to place emphasis on sampling as part of the barrier evaluation effort.

The second objective in the simulation study was to provide an estimate of the time required for the barriers to come into equilibrium with the variable meteorological conditions at the surface. During construction, moisture content of the emplaced materials will be strictly controlled. After the barriers are built, the initial moisture profile will begin to respond to surface conditions and to gravity and capillary forces. At low moisture conditions, changes in soil moisture can take considerable time, on the order of years. The monitoring period for the field test plots has to be long enough to measure the barrier response to variable surface conditions, not just the redistribution of the initial moisture profile. The second objective of the simulation study provided a basis for defining this required monitoring period.

The third and last objective in the simulation study related to failure analysis for the barriers. Part of the ongoing barrier evaluation project involves supplemental infiltration. Guidance as to the appropriate water application rates and durations was provided through numerical simulations. In addition, the duration of ponding necessary for catastrophic failure from surface flooding was determined.

Section 2 of this report contains detailed discussions of the geometry and parameterization of the model that was used for this study. Section 3 presents the sources of meteorological data. Then, the three main objectives of the simulation study are presented in Sections 4, 5, and 6. Lastly, a summary of results and recommendations for further research is given in Section 7.

2. DESCRIPTION OF TWO BARRIERS

The two barrier designs that are being constructed in the field evaluation project are illustrated in Figure 2. The illustration indicates how the barriers were modeled in this study. Subsequent changes to these designs (McElroy et al., 1992) are minor and consist primarily of increasing the thickness of the Dispersal Area B (DAB) soil to 160 cm from 140 cm. These changes will not affect the results or conclusions of this study. The first design consists of a cover soil with an established vegetative cover over a capillary barrier. The capillary barrier is provided by a 15-cm gravel layer and a 76-cm cobble layer. The cobbles are included to also serve as a biotic barrier. The source for the cover soil will likely be the nearby spreading areas of the Big Lost River diversion. The top portion of the existing soils is also included in the figure as well as in the modeling exercises. This barrier design is intended to function by having the capillary barrier keep water up near the surface. Transpiration then removes any of this excess water that is stored above the capillary barrier.

The second barrier is simpler in design and consists of adding 230 cm of DAB soil over the existing soil. The operating concept for this design is that transpiration by a vegetative cover will utilize any excess water and thus prevent any infiltration below the rooting zone, which could contact disposed waste (Anderson et al., 1987). The DAB soils for both designs will not be excessively compacted as they are emplaced. Rather, they will be compacted to field bulk density (Keck, 1992) so the soil can support vegetation that will utilize soil moisture.

2.1 Numerical Model

The UNSAT-H Version 2.0 simulation code (Fayer and Jones, 1992) was used for all simulations in this study. UNSAT-H uses a finite-difference approximation to solve the one-

Figure 2. Two proposed barrier designs for RWMC closure.

dimensional vertical form of Richard's equation, which governs unsaturated moisture movement. UNSAT-H was designed for use in water balance studies and has capabilities to estimate evaporation resulting from meteorological surface conditions and transpiration from plants. The implementation of the Richard's equation solution in UNSAT-H was verified and benchmark tested by Baca and Magnuson (1990).

2.2 Hydraulic Properties

The UNSAT-H computer code requires as input the hydraulic conductivity and moisture characteristic curve for each material type present in the barrier. The moisture characteristic curve defines the relationship between degree of saturation and matric potential. There are many functions available to describe moisture characteristic curves. For consistency with the previous modeling study in Keck (1992), the Brooks-Corey (1966) functions were used to describe the moisture characteristic and hydraulic conductivity relations. These equations are

$$\theta = \theta_r + (\theta_s - \theta_r) \left(\frac{h_e}{h} \right)^{\frac{1}{b}}$$

and

$$K = K_s \left(\frac{h_e}{h} \right)^{2 + \frac{3}{b}}$$

where

- θ = volumetric moisture content
- θ_s = volumetric moisture content at saturation
- θ_r = irreducible moisture content
- h = tension head (cm H₂O)
- h_e = air entry head (cm H₂O)
- b = inverse pore size distribution index
- K = absolute hydraulic conductivity (cm/hr)
- K_s = saturated hydraulic conductivity (cm/hr).

For all barrier materials except the existing soil, default values tabulated in the HELP Manual (Schroeder et al., 1988) were used. The existing soil cover was sampled and moisture characteristic curve measurements made by Borghese (1989). A Brooks-Corey curve was fitted to an average of the Borghese (1989) measurements. Table 1 gives a complete listing of all hydraulic parameters for the barrier materials and the existing soil. These values are the same as those used in Keck (1992). The moisture characteristic curves obtained with these parameters are shown in Figure 3. These hydraulic parameters are used as the current best estimates for the material types in this study.

2.3 Grid, Boundary, and Initial Conditions

One-dimensional numerical grids were set up to solve for moisture movement within both barrier designs. Both grids simulated a total thickness of 300 cm (see Figure 2). The grid for the

Table 1. Brooks-Corey hydraulic parameters for barrier materials.

Material	K_s (cm/hr)	θ_s	θ_r	h_s (cm H ₂ O)	b
DAB Soil	0.684	0.501	0.007	20.76	4.7393
Gravel	36.0	0.417	0.006	6.53	1.5361
Cobbles	1800.	0.5	0.003	3.00	0.6666
Existing Soil	2.97	0.27	0.104	35.00	2.8571

Figure 3. Brooks-Corey moisture characteristic curves for (a) head-moisture content and (b) head-hydraulic conductivity.

capillary barrier problem used 102 nodes while the grid for the thick soil barrier used 59 nodes. More nodes were required in the capillary barrier grid due to finer discretization at the interfaces with the gravel and cobble layers.

The flux across the upper boundary was calculated as a function of meteorological conditions. The lower boundary was treated as free drainage so that water movement across the lower boundary was only influenced by gravity.

Initial conditions for the simulations in this study were determined through the following method. An optimum moisture content of 22% for was determined by Golder (1987) for compaction of soil in the existing cover at the RWMC. This was assumed to be the moisture content of the DAB soils as they will be emplaced. With the previously defined Brooks-Corey moisture characteristic curve for the DAB soils, the corresponding initial tension head from Figure 3a was 600 cm. This same tension head was arbitrarily applied to the gravel and cobbles layers as well. Measured moisture contents in soils at the INEL appear to have an approximate moisture content of 10% (Anderson et al., 1987). The tension head from the existing soil Brooks-Corey curve corresponding to a 10% moisture content is 1,000 cm and was assigned as the initial condition for the deep soil in the simulations.

2.4 Parameterization of Transpiration

One objective in this study was to include the effects of transpiration in the barrier moisture simulations. Crested wheatgrass has been used as a vegetative cover on the RWMC (Reynolds, 1990) and will also be planted on the barrier test plots (Keck, 1992). This plant species was chosen for its compatibility with the semi-arid climate and for its ability to crowd out competitors and create stable monocultures (Marlette and Anderson, 1986). The UNSAT-H code requires several parameters to estimate the effect of transpiration on the soil water balance. Where possible, these parameters were based on site-specific data for crested wheatgrass. When such data were not available, values were assumed and identified as such. Required inputs will be discussed in turn.

The first input required by UNSAT-H is the starting day and duration of the growing season. Anderson et al (1987) reported a growing season for 1986 of 117 days starting on Julian day 79 and ending on Julian day 196. These dates correspond to March 20 and July 15. The basis for the seemingly early cut-off date is that senescence is assumed to begin then. These dates were used for the growing season for each year in the simulation period. Obviously, the actual dates would vary from year to year.

UNSAT-H required several parameters related to plant roots. The first was the depth of rooting, which was assigned a value in the simulations of 140 cm. There are a considerable number of references that report values ranging around this number (e.g., Reynolds, 1990; Foxx et al., 1984; Anderson et al., 1987). The second requirement was an exponential root density function. Biomass data from Caldwell and Richards (1986) were fitted with an exponential curve as indicated in Figure 4. The fitted parameters in the figure correspond to the following equation:

Figure 4. Fitted root length density function.

$$RLD = Ae^{-Bz} + C$$

where

- RLD = root length density (cm root/cm soil)
- A = root density at surface (cm root/cm soil)
- B = exponential fitting parameter (1/cm)
- C = constant root density at depth (cm root/cm soil).

The third input requirement related to roots is an estimate of the growth day on which roots reach the depth corresponding to computational nodes in the numerical model. The roots were assumed to grow linearly beginning on the first growth day of the season from a depth of 0 cm to the 140 cm depth on the last day of the growing season. This growth function is shown in Figure 5. Also shown are two alternatively assumed growth functions that were used in the sensitivity analysis. These growth functions also assumed a linear behavior but varied the initially effective root depth on the first day of the growing season. One drawback of the implementation of transpiration in UNSAT-H is the requirement of a growth function for roots. This implies that the roots start from some fixed depth each year and grow downwards. This is correct for the first year but not for subsequent years when the roots are already at depth.

UNSAT-H requires a value for the head corresponding to the water content below which plants wilt and stop transpiring. Anderson et al (1987) reported a lower limit of extraction of 11 to 12% moisture content for crested wheatgrass, as well as three other species, grown on simulated waste trenches. Using the assumed Brooks-Corey curve for the DAB soil and an 11%

Figure 5. Assumed root growth function for UNSAT-H simulations.

moisture content, the corresponding tension head was 3.5×10^4 cm. Also required is the head value below which transpiration starts to decrease. This was assumed to happen when the hydraulic conductivity in the DAB soil was reduced two orders of magnitude. The corresponding tension head was 800 cm. Lastly, the head corresponding to the moisture content above which plants do not transpire because of anaerobic conditions was assumed to be the same as the air entry head, 20.76 cm.

Fractional coverage of the soil surface by plants was assigned a value of 35% based on information from Marlette and Anderson (1986). This value came from a site that was sown with crested wheatgrass. This parameter was also tested in the sensitivity analysis.

The last plant-related input for UNSAT-H was the plant shoot biomass factor. No information was available, so the default value of 220 g/m^2 was used. This default value was determined for cheatgrass near Hanford, Washington (Fayer and Jones, 1990).

The crested wheatgrass transpiration described by these parameters was used throughout this simulation study any time transpiration was included in a simulation. It is important to note that the method used in UNSAT-H for including transpiration is to partition the potential evaporation into evaporation and transpiration following the method of Hinds (1975). The result of this method is that the same amount of water is lost back to the atmosphere whether transpiration is included in a simulation or not. The difference that occurs when transpiration is included is that some of the water is lost from throughout the effective root zone rather than just at the surface. The appropriateness of this approach should be determined on a site-specific basis.

2.5 Implementation of Snow Cover

Another objective in this simulation study was to include the effect of a snow cover into the UNSAT-H simulations. There were two main components to this implementation. The first involved manipulating the meteorological data base so that precipitation received as snowfall was accumulated and released at a later time when the snow melted. The second consisted of reducing the potential evaporation during periods when a snow cover was present. Both of these changes will be discussed in turn.

2.5.1 Manipulation of Meteorological Data Base

Precipitation that falls as snow is stored on the ground and is therefore not immediately available for infiltration. Previous UNSAT-H cover simulations in Keck (1992) did not take this storage of moisture on the surface into account. The method by which this was implemented in the current UNSAT-H simulation study was to (a) for each day, calculate the average temperature as the midpoint between the minimum and maximum daily temperatures, (b) for days in which the average temperature was at or below 32°F, any precipitation was accumulated as snowfall, and (c) for days in which the average temperature was above 32°F, any precipitation was treated as rainwater, and snowmelt was calculated by the degree-day method (Mockus, 1972):

$$M = C D$$

where

M = snowmelt in inches per day

C = constant that varies with climatic conditions (in H_2O /degree-day

D = the number of degree-days for a given day.

A degree-day is a day with an average temperature one degree above 32°F. The number of degree-days is then the difference between the average daily temperature and 32°F. The constant C was assigned the recommended value of 0.06 in./day/degree-day (Mockus, 1972). The degree-day approach is quite simplistic but serves adequately in this study.

The result of accumulating snowfall during the winter is to concentrate that precipitation into a short period of time during the early spring when the snow melts. This is a reasonable approach based on observations of moisture contents in the surficial sediments of the RWMC (McElroy, 1990). During a 5-year period from 1985 to 1990, moisture contents in surficial soils were measured periodically. Although this period coincided with a regional drought, a substantial snowpack developed on the RWMC during the winter of 1988–1989. When this snowpack melted in the spring of 1989, a pulse of water infiltrated at least through the surficial sediments down to the basalt contact.

One shortcoming of the method used in this study to estimate the effect of the accumulated snowpack on infiltration is that snow deposited on the RWMC due to drifting is not considered. The location of the RWMC in a local topographical depression and the nature of the winters in Southeast Idaho increase the likelihood of drifting snow. Snow survey measurements at the

RWMC conducted in FY-93 indicate that the amount of additional water brought onto the RWMC by drifting snow can be substantial. This shortcoming is partially addressed in the study in the failure analysis section by considering infiltration due to larger pulses of water.

2.5.2 Reduction of Potential Evapotranspiration

When the ground surface is covered with snow, the snow acts as a sealant from the perspective of soil moisture near the surface. Additionally, soil moisture near the surface can freeze, which reduces the open pore area available for flow and thereby reduces the hydraulic conductivity. Lastly, plant transpiration is negligible during the winter. The combination of these processes leaves essentially no mechanism by which soil moisture can be evapotranspired back to the atmosphere. Previous cover simulations in Keck (1992) did not take into account these effects of a snow cover.

Fayer et al (1992) performed a calibration of an UNSAT-H simulation to soil moisture measurements from test lysimeters at the Hanford facility. They found a marked improvement in the comparison of simulation results for the amount of water stored in the cover to measured results when potential evapotranspiration was reduced to nothing during snow cover periods. Their findings provide a basis for including the effects of a snow cover to the simulations in this study. Periods in which no evapotranspiration was allowed were equivalent to imposing a no-flux boundary condition.

Each year of the meteorological data base, discussed in Section 3, was perused to subjectively determine the last day of snow cover in the spring and the first day of snow cover in the late fall or winter. The last day of snow cover in the spring ranged from 40 to 100 Julian days. The first day of snow cover in the fall ranged from 315 to 350 days. Rather than assign a single value for beginning and ending of snow cover, these parameters were assigned based on the meteorological data base for each year. These dates were used in the portion of the preprocessor to UNSAT-H which calculates potential evapotranspiration from meteorological data and plant transpiration parameters to override the calculated PET with null values.

This manipulation of the meteorological data base to account for snow cover relied on the existence of a meteorological data base. The types of data in this meteorologic data base and the sources from which it was derived is the topic of the following section.

3. METEOROLOGICAL DATA

Daily records of meteorological data are necessary to perform UNSAT-H simulations. This data consists of minimum and maximum air temperature, average dew point temperature, solar radiation, wind speed, cloud cover, and precipitation. Since meteorological data are used in the UNSAT-H infiltration simulations to determine the upper boundary conditions, the importance of having accurate or representative meteorological data cannot be overemphasized. This meteorological data set serves as the driver for all subsequent movement of water in the subsurface. And it is precisely this subsurface movement that this report is intended to investigate.

Sources of meteorological data for previous infiltration studies have consisted primarily of a mixture of measurements by the National Weather Service at the Pocatello Airport (NWS-POC) and measurements by the National Oceanographic and Atmospheric Administration (NOAA) at the Central Facilities Area (CFA) on the INEL. Both data sources have been necessary in order to cover gaps in measurements in the record. Neither of these data sources are exactly representative of weather conditions at the RWMC. However, the assumption used in previous studies (Baca et al., 1992; Keck, 1992) was that geographical proximity provided a reasonable basis for the use of data from nearby locations. Nearby, these cases ranged from 6 mi to CFA to 45 mi to NWS-POC.

The intent in this section is to provide a basis for this assumption of geographical proximity. This basis will be formulated by making graphical and statistical comparisons of weather data at CFA and NWS-POC, with two additional sources of weather data. First, with the Federal Aviation Administration Flight Service Station at the Idaho Falls Airport (IF-APT), which makes hourly observations of temperature, wind speed, cloud cover, and dew point temperature. The second source of data is a United States Geological Survey (USGS) weather monitoring station at the RWMC. This station has been operated periodically. Data are currently available for the second half of 1986 and 1987. The data consist of measurements of solar radiation, air temperature, dew point temperature (or humidity), wind speed, and precipitation. In short, this station measures all the necessary UNSAT-H parameters except cloud cover. The short period of time covered by the USGS data precludes using these data in UNSAT-H simulations for this study because longer periods are simulated. However, having some data measured at the RWMC provides an excellent opportunity to make comparisons of weather measurements at the RWMC with those taken elsewhere. Since weather patterns vary from year to year, a meteorological data base obtained from an extended period of time is desirable for testing barrier performance. For this reason, the decade from 1981 to 1990 was chosen for this simulation study.

In the following sections, graphical and/or statistical comparisons of air temperature, dew point temperature, wind speed, precipitation, and solar radiation measurements from different locations on the eastern Snake River Plain will be compared to measurements at the RWMC.

3.1 Air Temperature

The weather parameter with the most complete measurements over the longest period of time at CFA is air temperature. A comparison of daily average temperature between the NOAA station at CFA and the USGS station at the RWMC is given in Figure 6. The cross-correlation between the two data sets was 0.947. This high degree of correlation supports the use of the CFA temperature measurements as being representative at the RWMC.

3.2 Dew Point

Weather data for dew point temperatures from 1981 to 1990 are available from four sources: CFA, RWMC, NWS-POC, and IF-APT. None of these data sources have dew point temperatures available for the entire period, except IF-APT, from which data are available only in hardcopy form. The hardcopy data are more difficult to use due to rough averaging that must be used to come up with a daily value. This averaging allows ample opportunity for bias to enter the data set and, as a result, it is advisable to only use this data set when nothing else is available. The NWS-POC dew point measurements begin in 1984, and the CFA dew point measurements begin in 1987. Due to the sporadic nature of the available data, statistical comparisons were calculated for two time periods: August to December 1986, and July to December 1987. The dew point temperatures at the available locations for the two time periods are shown in Figures 7 and 8. Table 2 gives the cross-correlations for the same time periods.

Figure 6. Daily average temperature at CFA and RWMC.

Figure 7. Dew point temperatures at NWS-POC, APT-IF, and RWMC.

As can be seen from the figures and from the cross-correlations, the dew point temperature at each of the four locations behaves nearly the same. The magnitudes differ, however, with the RWMC being considerably lower. The source of this difference could be a result of differences in measurement elevation between locations or some geomorphological feature. In any case, the RWMC dew points are generally less than those at the other locations. Data from each of the other locations (CFA, NWS-POC, and IF-APT) were used to compile the data base used for the UNSAT-H simulations. One option that was considered and not used was to subtract the mean difference in the dew point temperature from each location that was used. This would improve the graphical "fit" between the data sets. This option was not used primarily because, in the latter part of the 1987 data, there is already essentially exact agreement. Down-shifting the dew points would introduce an artificial difference in this case. The effect of using slightly higher dew points from the other locations is to artificially elevate the water saturation in the air, which would result in less evaporation. Therefore, from a barrier performance standpoint, the higher dew point temperatures are conservative. From a time-to-equilibrium viewpoint, it is not known what effect the slightly elevated dew point temperatures have.

The dew points between each location range from correlated to strongly correlated. The distances from CFA to NWS-POC and IF-APT are roughly equidistant. CFA and the RWMC are much closer. Surprisingly, from both the 1986 and 1987 data, NWS-POC dew points agree more with the RWMC than do those from CFA. This is especially true for the 1987 data. This result

Figure 8. Dew point temperatures at CFA, NWS-POC, and RWMC.

Table 2. Cross-correlation between dew point temperatures.

1986			
	IF-APT	NWS-POC	USGS-RWMC
IF-APT	1.00	0.88	0.85
NWS-POC	--	1.00	0.94
USGS-RWMC	--	--	1.00
<hr/>			
1987			
	NOAA-CFA	NWS-POC	USGS-RWMC
NOAA-CFA	1.00	0.50	0.41
NWS-POC	--	1.00	0.91
USGS-RWMC	--	--	1.00

is counter-intuitive to the basis that has been used in past studies in which geographical proximity was used to support using data from closer locations over those from farther away. Due to the limited time periods available for comparison, no conclusive determination can be made as to which data set is best to use. The dew points at all four measurement stations show a quite strong correlation. Therefore, use of dew point data was based on two criteria: availability and

proximity. For this simulation study, only IF-APT dew points were available from 1981 to 1983, NWS-POC dew points were used from 1984 to 1986, and CFA dew points were used from 1987 to 1990.

3.3 Wind Speed

Wind speed measurements are affected by elevation above the ground. This can be seen in Figures 9 and 10, which show the wind speed measurements at CFA, NWS-POC, and the RWMC for two different time periods. The wind speeds for the 1987 CFA data were measured at 10 m above the ground. The RWMC wind speeds shown in both figures were measured at 2 m above the ground. This difference in measurement elevation explains why the CFA wind speeds for 1987 are consistently higher than those from the RWMC. For purposes of compiling the UNSAT-H meteorologic data base, the CFA wind speeds from 1987 to 1990 were decreased uniformly by 0.8 m/s. This value was determined to be the decrement that gave the best graphical fit to the 1987 RWMC data. Reducing the wind speeds in this fashion is also conservative from a barrier performance standpoint since lower wind speeds result in less evaporation.

The measurement elevation on the CFA data prior to 1987 was not ascertained, but it is reasonable to assume that it is the same, 10 m. However, a comparison of the 1986 RWMC and CFA data does not show the same difference as the 1987 data. For this reason, the CFA wind speeds prior to 1987 were not adjusted.

Figures 9 and 10 also show the wind speed measured at NWS-POC. Although the height of the measurement location at NWS-POC was not ascertained, it must be higher because the wind speed is generally greater than either CFA or the RWMC stations. In any case, the NWS-POC data were included in this comparison to illustrate that, in the case of wind speed, geographical proximity does result in increased correlation. This is shown in Table 3, which shows cross-correlations for both the 1986 and 1987 measurement periods between CFA, NWS-POC, and the RWMC.

In summary, the wind speeds from CFA that were entered in the UNSAT-H weather data base quite closely mimic conditions at the RWMC in both periodic character and in magnitude. They certainly do so more than the NWS-POC data base entries for dew point temperatures.

Table 3. Cross-correlation between wind speeds.

1986			
	NOAA-CFA	NWS-POC	USGS-RWMC
NOAA-CFA	1.00	0.67	0.90
NWS-POC	--	1.00	0.75
USGS-RWMC	--	--	1.00
1987			
	NOAA-CFA	NWS-POC	USGS-RWMC
NOAA-CFA	1.00	0.70	0.87
NWS-POC	--	1.00	0.70
USGS-RWMC	--	--	1.00

Figure 9. 1986 average daily wind speeds at CFA, NWS-POC, and RWMC.

Figure 10. 1987 average daily wind speeds at CFA, NWS-POC, and RWMC.

3.4 Precipitation

Precipitation is likely the easiest of all the necessary weather parameters to measure. As a result, precipitation is available at all locations except the RWMC for the entire period. The USGS meteorological station at the RWMC collects precipitation measurements but it has not operated continuously. From Figure 11, it can be seen that precipitation is the least correlated of the measured parameters. This is also evident from Table 4, which gives the cross-correlation between precipitation at CFA, NWS-POC, and the RWMC. In the case of precipitation, geographical proximity definitely results in much greater correlation. There is almost no correlation between NWS-POC and either CFA or RWMC. From this, it can be concluded that the use of CFA precipitation measurements for the RWMC is adequate but that NWS-POC precipitation measurements are not.

3.5 Solar Radiation

Solar radiation is not measured as a matter of course at any of the locations except the RWMC. At the RWMC, it is measured as part of an ongoing infiltration study being conducted by the USGS. The solar radiation values used in the UNSAT-H simulations are synthetically generated using the WGEN computer code (Richardson and Wright, 1984). The radiation values are conditioned on actual daily precipitation results at CFA, as well as statistical summaries of probabilities of dry and wet day relationships. In the interest of testing the data base values, the WGEN results were compared to measurements taken at the RWMC (see Figure 12). The results show a strong agreement in trend and variation. The cross-correlation between these two data sets was 0.87. This high degree of correlation is not surprising and indicates that the WGEN results are more than adequate for simulating conditions at the RWMC.

3.6 Summary of Meteorological Data Sources

Based on the correlation results of the various meteorological parameters, the best available data were used for the UNSAT-H simulations. The sources of data that were used for the period from 1981 to 1990 are given in Table 5. Occasionally, a value in the CFA data base was missing. In these cases, data were substituted from locations with the highest degree of correlation, if possible. For completeness, Appendix A contains the meteorological data for the period indicated in Table 5. The data are in the format required for input into UNSAT-H and has been revised to account for snow accumulation and snowmelt as described in Section 2.5.1.

Figure 11. Precipitation at CFA, NWS-POC, and RWMC.

Table 4. Cross-correlation between precipitation.

1986			
	NOAA-CFA	NWS-POC	USGS-RWMC
NOAA-CFA	1.00	0.31	0.77
NWS-POC	--	1.00	0.27
USGS-RWMC	--	--	1.00

1987			
	NOAA-CFA	NWS-POC	USGS-RWMC
NOAA-CFA	1.00	0.14	0.82
NWS-POC	--	1.00	0.16
USGS-RWMC	--	--	1.00

Figure 12. WGEN and USGS measured daily solar radiation at the RWMC.

Table 5. Sources of meteorological data from 1981 to 1990.

<u>Year</u>	<u>Temp.</u>	<u>Dew Pt.</u>	<u>Radiation</u>	<u>Wind Speed</u>	<u>Cloud Cover</u>	<u>PPT</u>
1981	CFA-81	IF-81	WGEN	CFA-81	POC-81	CFA-81
1982	CFA-82	IF-82	WGEN	CFA-82	POC-82	CFA-82
1983	CFA-83	IF-83	WGEN	CFA-82	POC-83	CFA-83
1984	CFA-84	POC-84	WGEN	CFA-82	POC-84	CFA-84
1985	CFA-85	POC-85	WGEN	CFA-85	POC-85	CFA-85
1986	CFA-86	POC-86	WGEN	CFA-86	POC-86	CFA-86
1987	CFA-87	CFA-87	WGEN	CFA-87	POC-87	CFA-87
1988	CFA-88	CFA-88	WGEN	CFA-88	POC-88	CFA-88
1989	CFA-89	CFA-89	WGEN	CFA-89	POC-89	CFA-89
1990	CFA-90	CFA-90	WGEN	CFA-90	POC-90	CFA-90

4. SENSITIVITY STUDY OF BARRIER PERFORMANCE

A sensitivity study looks at responses in system performance to changes in the numerical model that is used to represent the system. The changes can be to the conceptual model, i.e., the assumptions implemented within a numerical model, or to the parameters used to describe material properties within the numerical model. Both types of changes were considered in the sensitivity study that was conducted for the two proposed barrier designs. First, conceptual or structural changes were considered. These structural changes consisted of adding in the contributions of plant transpiration, a snow cover during the winter, and infilling of materials from overlying layers into underlying layers. Then, using one consistent conceptual model that included plant transpiration and a snow cover, parametric changes were evaluated as to their effect on system performance. The parameters tested were saturated hydraulic conductivity, effective porosity, residual saturation, and air-entry head for each material type.

The remainder of this section consists of discussions of the background and purpose for conducting this barrier performance sensitivity study, the performance measures used, the structural sensitivity results, the parametric sensitivity results, and lastly, conclusions.

4.1 Background and Purpose

A previous modeling study (Keck, 1992) investigated performance of four proposed barrier designs by comparing drainage and moisture contents at selected depths. The previous study was deterministic in that single values were assigned for each of the required hydraulic input parameters. A field-scale study is currently being initiated to construct test plots for two of the designs identified as feasible in Keck (1992). These field plots will be monitored for a multi-year period to provide estimates of performance. In addition, the monitoring data from these field plots will be used to calibrate numerical models. The calibrated numerical models can then be used to extend the performance predictions using either past or future weather regimes.

One of the tasks in the field study is to measure the hydraulic properties of the barrier materials after they are emplaced. These measurements are used for quality assurance/quality control of construction. Additionally, these measurements will be used in the numerical simulations of barrier performance. The intention in this sensitivity study was to identify the hydraulic parameters for the material types that will be most important in determining barrier performance. This information can be used to determine the precision required for measuring hydraulic parameters.

4.2 Performance Measures

Since the primary function of the proposed barriers is to reduce infiltration into disposed waste, the performance measure by which sensitivity was judged was related to infiltration that reaches below the barrier. Water that infiltrated to this depth continued "draining" down into the soil profile. For simulations in which drainage was predicted, the performance measure for comparison between simulations was maximum yearly drainage.

In the capillary barrier simulations, the predicted drainage was extremely low, on the order of the mass balance error of the simulation. In these cases, an alternative performance measure was required in order to make comparisons. Alternatives considered were maximum simulated moisture content in the cover soil immediately overlying the capillary barrier, maximum amount of infiltrating water at the surface, and the maximum or minimum trace of the moisture content above the capillary barrier. The latter consists of the maximum or minimum moisture content that occurs over a simulation period at each depth in the soil profile. The maximum or minimum at each depth would not all occur at the same time. The alternative performance measure that was finally chosen for the capillary barrier sensitivity study was the maximum amount of water stored at any one time in the soil profile over the simulation period. This measure was felt to be more indicative of the potential for drainage to occur than any of the other alternative performance measures that were considered. However, each of the other alternative performance measures were used at times in order to understand and explain observed hydrologic behavior.

4.3 Structural Sensitivity

This portion of the sensitivity study considered the effect of how structural or conceptual changes affected performance of both barrier designs. Several changes were made to the conceptual model that was simulated in Keck (1992). The first change was to include transpiration as described previously. The second change was to include the effect of a snow cover. This was done by both reducing the potential evapotranspiration during periods of snow cover and accumulating or shifting the amount of precipitation that fell as snowfall to a later time when the snow melted. The implementation of these changes was discussed previously. These two conceptual changes were applied and tested on both the capillary and thick soil barrier designs. A further change to the conceptual model for the capillary barrier consisted of infilling either DAB soil or gravel down into the more coarse layers below.

The sensitivity to the structural changes in both the capillary barrier and the thick soil barrier will be discussed in turn. These are followed by the sensitivity results to infilling.

4.3.1 Capillary Barrier Design

4.3.1.1 Base Case. As a starting point, a simulation of the same conceptual model as that used in Keck (1992) was performed. The only difference between this simulation and the former was the revised meteorological data base. Since the drainage through the capillary barrier was on the order of the mass balance error of the simulation, the alternative maximum storage performance measure was used. Table 6 shows the yearly maximum storage, drainage, and mass balance error for the 10-year simulation period. As can be seen, the maximum storage of 51.49 cm occurs in 1986. This value is used as a basis for further comparison in the structural sensitivity analysis of the capillary barrier design.

As mentioned previously, the mass balance errors are essentially on the same order as the drainage. Additionally, the drainage that did occur decreases monotonically and was due to excess water in the underlying soil as a result of the initially assigned moisture content.

Table 6. Maximum stored water, yearly drainage, and mass balance error for the capillary barrier base simulation

Year	Maximum Stored Water (cm)	Yearly Drainage (cm)	Mass Balance Error (cm)
1981	44.86	4.88×10^{-1}	0.69×10^{-2}
1982	47.05	2.00×10^{-1}	-0.22×10^{-2}
1983	46.70	1.25×10^{-1}	0.26×10^{-2}
1984	48.20	9.02×10^{-2}	0.35×10^{-2}
1985	48.56	7.02×10^{-2}	0.84×10^{-2}
1986	51.49	5.72×10^{-2}	-0.86×10^{-2}
1987	46.14	4.85×10^{-2}	-0.27×10^{-1}
1988	44.48	4.19×10^{-2}	-0.15×10^{-2}
1989	45.06	3.67×10^{-2}	-0.90×10^{-2}
1990	44.01	3.27×10^{-2}	-0.34×10^{-2}

4.3.1.2 Addition of Transpiration. The sensitivity of the maximum yearly storage to the addition of transpiration was tested in several ways. In addition to simply adding in transpiration as described previously, two key parameters related to transpiration were tested. These were the fraction of the soil surface covered by plants and the initially active root depth as the growing season began. Table 7 shows the maximum amount of water stored at any one time as a result of these variations. This maximum always occurred in 1986.

The results agree with intuition in that increasing the initially active root depth decreases the maximum amount of water that is stored. Likewise, as more of the soil surface is exposed, evaporation increased and the maximum soil water storage decreased. Overall, each of the transpiration simulations resulted in a decrease in the maximum amount of soil water stored when compared to a simulation without transpiration.

4.3.1.3 Addition of Snow Cover. Soil freezing and snow accumulation were added to the capillary barrier simulation as described previously. The resulting maximum amount of water stored in the soil profile increased to 57.39 cm from the base simulation of 51.49 cm, an increase of 11.5%. This increase was expected and is the result of preventing water loss during the winter and combining the winter snowmelt into an early spring melting event. Fayer et al (1992) showed a marked improvement in their cover simulation calibration when winter evaporation was reduced. This partially provided the basis for reducing winter evaporation in these sensitivity simulations. As data become available from the field test plots, the appropriateness of reducing winter evaporation can be determined. In this hypothetical study, it will be included in all the parametric sensitivity simulations discussed below.

4.3.1.4 Combining Transpiration and Snow Cover. A capillary barrier simulation was conducted which combined both the effects of transpiration and a snow cover. For clarity, in this combined simulation, the initial rooting depth was 0 cm and the bare soil surface fraction was 0.65. The results of this simulation are presented in Table 8 along with the previous simulations for comparison.

As can be seen, the effects of transpiration act in the opposite direction from that of soil freezing and snow accumulation. The simulation with all effects included resulted in a maximum

Table 7. Effect of transpiration on maximum amount of stored water in capillary barrier simulations.

Bare Soil Surface Fraction	Initial Root Depth (cm)	Maximum Stored Water (cm)	% Change from Base
0.65	0	47.90	-7.0
0.65	40	47.02	-8.7
0.65	80	46.32	-10.0
0.45	0—	46.05	-10.6
0.65	0	47.90	-7.0
0.85	0	49.75	-3.4
Base Simulation w/o Transpiration		51.49	

storage value that was damped into the middle range and was close to the result for the base simulation. However, the results are more presumably more realistic because the conceptual model incorporates more realistic processes. This combined simulation was used as the basis for comparison in the capillary barrier parametric sensitivity study discussed in Section 4.4 below). Appendix B contains the UNSAT-H data deck for the combined transpiration and snow cover capillary barrier simulation.

This concludes the structural sensitivity analysis of adding transpiration and a snow cover to the capillary barrier design. A similar suite of simulations were performed for the thick soil design and are discussed next.

4.3.2 Thick Soil Design

4.3.2.1 Base Case. In a similar fashion to the capillary barrier sensitivity study, the starting point for the thick soil structural sensitivity study was to simulate the same conceptual model as Keck (1992) with the revised weather data base for the 1981–1990 period. There was a significantly higher drainage for the thick soil barrier compared to the capillary barrier. Table 9 gives the net yearly drainage and mass balance errors for the thick soil cover design base case for the entire simulation period. Similar to the capillary barrier base simulation, the year with the maximum drainage was 1986, excluding the first 2 years of the simulation when excess drainage resulted from the initial conditions that were assigned. The 1986 drainage served as a comparison for the remainder of the structural sensitivity analysis.

Table 8. Sensitivity of capillary barrier simulation maximum storage results with combined transpiration and snow cover.

Simulation	Maximum Storage (cm)	% Change from Base
Base	51.49	—
Transpiration	47.90	-7.0
Snow Cover	57.39	11.5
Combined Transpiration and Snow Cover	54.40	5.6

Table 9. Yearly drainage and mass balance error for thick soil base case simulation.

Year	Yearly Drainage (cm)	Mass Balance Error (cm)
1981	1.84	-1.74×10^{-2}
1982	1.31	-1.75×10^{-2}
1983	0.98	-4.00×10^{-3}
1984	0.91	1.29×10^{-2}
1985	1.05	1.43×10^{-2}
1986	1.30	-3.00×10^{-3}
1987	1.28	-4.20×10^{-2}
1988	0.88	-1.04×10^{-2}
1989	0.65	-1.98×10^{-2}
1990	0.58	-1.34×10^{-2}

4.3.2.2 Addition of Transpiration. Transpiration was added to the thick soil simulation in exactly the same way as for the capillary barrier cover simulation. For clarity, the initial rooting depth was 0 cm, the maximum rooting depth was 140 cm, and the fraction of bare soil surface was 0.65. The 1986 simulated drainage was 0.46 cm, a reduction of 64.6% from the base simulation. The effects of the assumed initial rooting depth and bare surface fraction were tested previously in the capillary barrier analysis and were not simulated for the thick soil cover.

4.3.2.3 Addition of Snow Cover. Soil freezing and snow accumulation were added to the thick soil barrier simulation as described previously. The resulting 1986 drainage was 3.15 cm, an increase of 142%. The effect of the snow cover is dramatic and indicates its importance in the conceptual model. Dynamic visualization of the moisture profile over the simulation period confirms that the method of incorporating the snow cover focuses or concentrates the majority of the infiltration into the spring snowmelt period. Precipitation events during the remainder of the spring, summer, and fall result only in minor wetting front advances to shallow depths.

4.3.2.4 Combining Transpiration and Snow Cover. Adding both transpiration and a snow cover to the base simulation for the thick soil design resulted in a 1986 drainage of 1.36 cm, a net increase of 5%. Appendix C contains the complete UNSAT-H data deck for this simulation. Table 10 summarizes the structural sensitivity results for the thick soil design. As expected, transpiration works in the opposite direction as the snow cover. This result can also be seen in Figure 13, which illustrates the daily flux from the bottom of the simulation domain for the

Table 10. Sensitivity of maximum (1986) thick soil barrier yearly drainage to combined transpiration and snow cover.

Simulation	Yearly Drainage (cm)	% Change
Base	1.30	-
Transpiration	0.46	-65
Snow Cover	3.15	142
Combined Transpiration and Snow Cover	1.36	5

Figure 13. Daily drainage from the thick soil barrier for the base, transpiration, snow cover, and combined transpiration and snow cover simulations.

10-year simulation period. The combined result is very similar to the base case simulation. The difference is that the conceptual model has been improved by including a more realistic description of factors influencing water movement.

4.3.3 Effect of Infilling in the Gravel and Cobble Layers

An assumption inherent in the previous structural sensitivity simulations of the capillary barrier was that the effectiveness of the capillary barrier layers did not change with time. If the membranes that keep the different layers separate fail either upon emplacement or over time, the hydraulic properties of the capillary barrier will change and its effectiveness will be reduced. A series of simulations were conducted to address this possibility.

In the first simulation, the cobble layer was assumed to be completely infilled by the overlying gravel and, as a result, to have the same hydraulic characteristics as the gravel. The resulting maximum amount of water stored in the profile was 56.13 cm, an increase of 9.0%. Figure 14 illustrates the resulting trace of the minimum and maximum moisture contents for the year 1986 for the gravel and "cobbles replaced with gravel" layers. For comparison, the trace of

Figure 14. Comparison of minimum and maximum moisture content trace with cobbles replaced by gravel.

the maximum moisture content for the "all effects combined" capillary barrier simulation (Section 4.3.1.4) is also shown. The trace in the DAB soil is exactly the same for each simulation and was not included.

Figure 14 shows that the "cobbles replaced with gravel" simulation allows considerably more water to infiltrate. However, by comparing the maximum and minimum traces for the "cobbles replaced with gravel" simulation, it can be seen that the infiltrating pulses only penetrated to approximately the 210 cm depth and still did not make it to the underlying soil. The drainage from the bottom of the simulation profiles for the "cobble replaced with gravel" and the all effects combined case was 7.68×10^{-2} and 5.68×10^{-2} cm/yr, respectively. Both simulations show negligible drainage, indicating that maintaining the initial hydraulic properties of the cobble layer separate from those of the overlying gravel layer is not essential from a hydrologic viewpoint.

The second simulation consisted of DAB soil infilling both the gravel and the cobbles. Similar to the previous simulation, the hydraulic properties of the DAB soil replaced those of the gravel and the cobbles. This simulation was essentially the same as the thick soil cover design. The only difference was that this simulation had 231 cm of DAB soil over the underlying soil, instead of 230 cm in the thick soil design. This 1-cm difference was neglected, and the results of the thick soil barrier simulation were used. The maximum storage from this infilled DAB soil

simulation was 73.70 cm, an increase of 35.5%. Once the capillary break provided by either the gravel or the cobbles was gone, some drainage occurred. This is reflected in Table 11, which shows both the maximum amount stored and the maximum yearly drainage for the suite of infilled simulations. The implication from this series of simulations was that maintaining the initial hydraulic properties of either the gravel or cobbles is very important to barrier performance.

Also shown in Table 11 are the maximum storage and drainage for simulations with only one soil for the entire profile. This was done for both the DAB soil and the underlying soil. The simulation with only the DAB soil was represented using a thicker DAB cover. The last simulation with strictly the underlying soil was performed in order to determine the effect of adding the DAB cover soil. Based on the hydraulic descriptions used in the structural sensitivity study, the DAB soil as a cover alone provides a substantial reduction in infiltration compared to the simulation using only the underlying soil. The implication from these two simulations is that increasing the thickness of the DAB soil decreases the net drainage. However, even with the thicker DAB soil, a significant water component infiltrated the soil, compared to the capillary barrier simulations.

4.3.4 Structural Sensitivity Results Summary

A wide variation in both maximum water storage and drainage was observed in this study. The effects of both transpiration and a snow cover were important in the thick soil barrier since drainage occurred for all cases examined in all 10 years simulated. In the capillary barrier simulations, these effects were less important since drainage never occurred. However, this lack of drainage was shown to be dependent on maintaining the hydraulic properties that provided the capillary barrier.

4.4 Parametric Sensitivity

In the parametric sensitivity study, input parameters used to describe the hydraulic properties of the material were varied. The resulting change in performance was used as a measure of the sensitivity of each parameter. For both the capillary barrier and the thick soil barrier, the following parameters were varied: saturated hydraulic conductivity, saturated moisture content or effective porosity, air entry head, and residual moisture content. The latter two parameters were Brooks-Corey parameters describing the moisture characteristic curve.

Table 11. Structural sensitivity results from infilling of capillary barrier.

Simulation	Maximum Storage (cm)	Maximum Drainage (cm)
Gravel Infilling Cobbles	56.13	7.680×10^{-2}
DAB Soil Infilling Gravel and Cobbles	73.70	1.365×10^0
DAB Soil Only (3 m)	81.67	7.790×10^{-1}
Underlying Soil Only (3 m)	56.97	6.427×10^0

4.4.1 Capillary Barrier

In the capillary barrier parametric sensitivity study, the suite of hydraulic parameters were varied for DAB soil, gravel, and cobble materials. The properties of the underlying soil were not varied since drainage did not occur. Variations in parameters were assigned for the most part by doubling or halving the base value. Judgement was used to prevent using unrealistic parameter values, and in these cases, a constant delta was used to increment or decrement the base value.

The performance measure by which the results were judged was the maximum amount of water stored in the profile at any one time. This performance measure was used since any drainage that did occur was on the order of the mass balance error in the simulation. The base value for comparison is taken from the combined transpiration and snow cover capillary barrier simulation. This basis was chosen because it represents the best estimate of barrier performance. The results from the capillary barrier parametric study are shown in Table 12.

The results indicate that the maximum amount of water in the profile is most sensitive to the DAB soil parameters. This is not surprising and is a result of the DAB soil being the uppermost in the profile and therefore more influenced by the varying upper meteorological boundary condition. This can be seen in the results of varying the saturated hydraulic conductivity of the capillary barrier. As the hydraulic conductivity increased, the maximum amount of water stored in the profile decreased because, although wetting fronts could penetrate into the DAB soil faster, the infiltrating water could also be extracted back to the surface more easily. Likewise, by increasing either the saturated or residual moisture content, more water can be stored above the capillary barrier.

The effect of increasing the DAB air entry head is less obvious. Figure 15 shows the moisture content profiles on the day the maximum amount of stored water occurs for each air entry heads. Increasing the air entry head improved the extraction of water back to the surface and kept the profile drier. Increasing the air entry head in the gravel or the cobbles had the opposite result, allowing slightly more water to be stored. Figure 16 illustrates this increased storage when the cobble air entry head was increased. Also shown are the daily fluxes through the base of the cobble layer for 1986 as the cobble air entry head was increased. Although the water flow through the cobble barrier is still small (yearly flux of 7.7×10^{-2} cm with a cobble air entry head of 24 cm vs. 5.7×10^{-2} cm for the all effects combined simulation), it appears from the rapidly increasing peak flux in Figure 16 that increasing the cobble air entry head further could result in a significant amount of drainage.

This concludes the parametric sensitivity study for the capillary barrier. A similar suite of simulations was conducted for the thick soil barrier and will be discussed next.

4.4.2 Thick Soil Barrier

In the thick soil barrier parametric sensitivity study, the suite of hydraulic parameters were varied for the DAB soil and the native underlying soil. Variations in parameters were assigned in a similar fashion to the capillary barrier hydraulic parameters. The performance measure by which the results were judged was the maximum yearly drainage over the simulation period. The comprehensive results from the thick soil barrier parametric study are shown in Table 13. The

Table 12. Parametric sensitivity results for capillary barrier.

Saturated Hydraulic Conductivity, K (cm/hr)								
DAB Soil K	Max Storage (cm)	% Change	Gravel K	Max Storage (cm)	% Change	Cobbles K	Max Storage (cm)	% Change
0.35	54.97	1.0	18	54.40	0.0	900	54.40	0.0
0.684*	54.40	-	36*	54.40	-	1800*	54.40	-
1.4	51.78	-4.8	72	54.40	0.0	3600	54.40	0.0

Saturated Moisture Content, θ_s								
DAB Soil θ_s	Max Storage (cm)	% Change	Gravel θ_s	Max Storage (cm)	% Change	Cobbles θ_s	Max Storage (cm)	% Change
0.4	48.61	-10.6	0.3	54.30	-0.2	0.4	54.40	0.0
0.501*	54.40	-	0.417*	54.40	-	0.5*	54.40	-
0.6	59.69	9.7	0.5	54.48	0.1	0.6	54.41	0.0

Residual Moisture Content, θ_r								
DAB Soil θ_r	Max Storage (cm)	% Change	Gravel θ_r	Max Storage (cm)	% Change	Cobbles θ_r	Max Storage (cm)	% Change
0.007*	54.40	-	0.006*	54.40	-	0.003*	54.40	-
0.014	55.00	1.1	0.012	54.48	0.2	0.006	54.63	0.4
0.028	56.12	3.3	0.024	54.65	0.5	0.012	55.09	1.3
0.056	58.52	7.6				0.024	56.00	2.8

Air Entry Head, h_a (cm)								
DAB Soil h_a	Max Storage (cm)	% Change	Gravel h_a	Max Storage (cm)	% Change	Cobbles h_a	Max Storage (cm)	% Change
20.76*	54.40	-	6.53*	54.40	-	3.0*	54.40	-
40.0	52.10	-4.2	12.0	54.58	0.3	6.0	54.42	0.0
60.0	50.92	-6.4	24.0	54.88	0.9	12.0	54.49	0.2
						24.0	54.63	0.4

* Base value from all effects combined simulation

Figure 15. Moisture content profile corresponding to day of maximum stored water for three DAB soil air entry heads.

Figure 16. Effect of cobble air entry head on (a) maximum moisture content trace in cobbles and b) daily flux down through cobbles.

Table 13. Parametric sensitivity results for thick soil barrier.

Saturated Hydraulic Conductivity, K (cm/hr)					
DAB Soil K	Max Drainage (cm)	% Change	Existing Soil K	Max Drainage (cm)	% Change
0.684*	1.36	-	2.97*	1.36	-
1.4	1.29	-5.4	6.0	1.47	8.0
2.8	0.96	-29.4	12.0	1.55	24.7

Saturated Moisture Content, θ_s					
DAB Soil θ_s	Max Drainage (cm)	% Change	Existing Soil θ_s	Max Drainage (cm)	% Change
0.4	2.58	88.9	0.2	1.43	4.7
0.501*	1.36	-	0.27*	1.36	-
0.6	0.83	38.8	0.34	1.31	-4.1

Residual Moisture Content, θ_r					
DAB Soil θ_r	Max Drainage (cm)	% Change	Existing Soil θ_r	Max Drainage (cm)	% Change
0.007*	1.36	-	0.1043*	1.36	-
0.014	1.42	7.9	0.15	1.41	3.0
0.028	1.55	13.6	0.20	1.45	6.6
0.056	1.85	35.6			

Air Entry Pressure, h_a (cm)					
DAB Soil h_a	Max Drainage (cm)	% Change	Existing Soil h_a	Max Drainage (cm)	% Change
20.76*	1.36	-	35.0*	1.36	-
40.0	0.53	-61.1	70.0	1.56	14.4
60.0	0.12	-91.0	105.0	1.58	16.1

* Base value from all effects combined simulation

base value in each case was that from the combined transpiration and snow cover thick soil barrier simulation. Again, this basis was chosen because it represents the best estimate of barrier performance based on the proposed designs.

By comparing the results in Table 13, it can be seen that drainage variation is more sensitive to the DAB parameters than the native or underlying soil parameters. This result is reasonable since the DAB soil overlies the native soil and is more affected by the variable meteorological conditions at the upper boundary.

Some interesting results are contained in the table. Firstly, drainage decreases as the DAB soil conductivity increases, while drainage increases as the underlying soil conductivity increases. Increasing the conductivity of the DAB soil allowed wetting fronts to penetrate deeper into the DAB soil, but it also allowed that same water to be extracted back to the surface more easily. In contrast, higher conductivity in the underlying soil allowed any water that did penetrate below the DAB soil to drain more easily. Increasing the effective porosity for both the DAB and the underlying soils resulted in less drainage overall, less for the DAB soil than for the underlying soil. The increased porosity allowed for greater storage, allowing more opportunity for water to be extracted back to the surface. Increasing the residual moisture content for both soils kept the subsurface wetter overall, allowing more drainage. Lastly, increasing the air entry head in the DAB soil allowed infiltrating water to be brought back to the surface more easily. In contrast, increasing the air entry head in the underlying soil allowed water to enter from the DAB soil into the underlying soil more easily and thus increased drainage.

4.4.3 Parametric Sensitivity Results Summary

Since the overall performance objective in terms of drainage has yet to be defined, conclusive statements about the precision with which the hydraulic parameters need to be known cannot be made based on the information gained from this parametric sensitivity analysis. However, if the assumption is made that the performance objective will be the same as that for the Hanford cover project, the drainage through the cover should be less than 0.05 cm/yr (Fayer, 1990).

In this framework, the values assigned for hydraulic parameters of the gravel layer of the capillary barrier are very important as shown by the simulations with infilling. The gravel parameters need to be determined on a site-specific basis rather than strictly relying on literature values. The properties of the cobble layer were less critical and should be treated as if they were the same as the gravel. The hydraulic characteristics of the DAB soil will need to be defined with considerable precision since it is the uppermost soil in either barrier and is most influenced by meteorological conditions at the surface. The thick soil barrier parametric results showed the greatest sensitivity to the air entry head and the porosity. The saturated hydraulic conductivity and residual moisture content had a lesser effect. The degree of precision with which all these parameters need to be determined will have to be based on the eventual performance measure for the maximum allowed drainage rate.

5. TIME TO EQUILIBRIUM

The second main objective in this simulation study was to estimate the time required for the moisture content profile within both proposed barriers to come into equilibrium with the meteorological conditions at the surface. As the test plots of the two barriers are built, the moisture content will be monitored to ensure uniform compaction. This will result in a uniform soil moisture profile, at least for the DAB soils in each design. Once the cover construction is completed, this soil moisture profile will begin to respond to forces of gravity and capillarity and to the surface meteorological conditions resulting in redistribution of soil water. In unsaturated systems, this movement can be quite slow, on the order of years. The monitoring period for the test plots will have to be long enough to ensure that measurements being taken are representative of the performance of the barrier and not just the redistribution of the initial moisture profile.

Since the meteorological conditions at the surface are variable, a true equilibrium will never be established. Moisture contents will continually vary in response to surface conditions. However, by looking at the response of the soil moisture profile as a function of depth and time, an estimate of when the system comes into an approximate or quasi-equilibrium can be made.

Two approaches were used to estimate quasi-equilibrium in this study. Both considered the response of the soil moisture profile in terms of daily moisture fluxes near the bottom of the DAB soil layers and either in the gravel layer for the capillary barrier or near the top of the existing soil for the thick soil barrier. The first approach consisted of repetitively simulating a decade of meteorological data. The second considered repeating only 1 year of meteorological data. Using both these methods provided a bounding estimate of the time necessary to reach equilibrium. Each of these approaches will be discussed in turn.

5.1 Repetitive Decade Simulation

Simulations were performed for both the capillary and thick soil barriers using the same decade of meteorological data repetitively. For both barriers, the first decade of the simulation was completed previously in the sensitivity study. For the second decade, the ending conditions from the last year of the 1981–1990 simulation was used as the initial condition and the entire 1981–1990 meteorological data was reused as if it were 1991–2000 data. By looking at daily fluxes through selected depths for both the 1981–1990 and 1991–2000 periods simultaneously, an estimate of when equilibrium occurred could be made. For completeness, all the equilibrium simulations included both transpiration and a snow cover.

5.1.1 Capillary Barrier

Figure 17a shows the daily flux near the base of the DAB soil layer for both the 1981–1990 and 1991–2000 simulation periods superimposed onto the same 10-year time period. Positive fluxes represent downward water movement, and negative fluxes represent upward movement. The only difference between these two simulation periods is the starting conditions. The assumed initial conditions for the first decade were quite wet by comparison to those from the second decade. The effects of a prolonged drought from approximately 1986 through 1990 (years 6 through 10) can be seen by the predominance of upward fluxes and the low positive peaks for the

Figure 17. Repetitive decade simulation results for capillary barrier: (a) daily flux near base of DAB soil and (b) cross-correlation between decades.

occasional downward fluxes. This prolonged drought resulted in a very dry initial condition for the second decade. These dry initial conditions resulted in very slow water movement, especially in the gravel layer, during the first several years of the second decade. As a result, comparing these two simulation periods against each other provides a conservative estimate of the time to reach equilibrium.

Equilibrium can be considered to occur when the two simulations converge. This convergence is qualitatively difficult to determine. After 2 years, the simulations appear, for the most part, to have the same character in increases and decreases in fluxes. Most assuredly, after 5 years, this is the case. To overcome this problem with qualitative estimation, convergence was determined by calculating the cross-correlation between the two simulations. Figure 17b shows the cross-correlation between the simulation results for the two decades. Two different windows or lengths of times were used to calculate this cross-correlation to test the sensitivity to the window length. The shorter window, ± 0.5 years, would be expected to be more noisy but actually mimics the longer window quite well. For this study, equilibrium was said to be achieved when the correlation between the two simulations reached 0.9. From Figure 17b, then, equilibrium can be conservatively said to have occurred after 3.5 years. This estimate is valid from the barrier surface down to the base of the DAB soil layer.

Figure 18a and 18b show a similar time history of fluxes for the two decades and their cross-correlation within the gravel layer. The effect of the prolonged drought at the end of the first decade are even more pronounced in the daily fluxes through the gravel layer at the beginning of the second decade than it was in the DAB soil. Virtually no water movement occurred until the fourth year. The slow response of the water profile in the gravel is due to the extremely dry conditions at the end of the first decade. This slow response provides a conservative estimate of the time required to reach equilibrium.

For the flux through the gravel results, the shorter correlation window is considerably more noisy than the longer window. The cross-correlation between the two decades reached 0.9 after approximately 5 years and thus provides an estimate of the time required to reach equilibrium within the gravel layer.

5.1.2 Thick Soil Barrier

A similar repetitive decade simulation was performed for the thick soil barrier. Figures 19a and 19b show the daily fluxes at 185 cm within the DAB layer for the thick soil barrier for the two decades and the cross-correlation between the results. The flux results show a greater difference in magnitude than those from the capillary barrier simulation. Additionally, the flux is always downwards. This difference is due to the capillary barriers performance, which essentially prevents all water from continuing downward. The estimated time to equilibrium for the thick soil barrier repetitive decade simulation is somewhere between 4.5 and 5 years. A strict interpolation of the 0.9 cross-correlation yields 4.8 years. This is approximately 1 year longer than for the DAB soil in the capillary barrier.

The daily flux through the top of the existing soil was also analyzed. These results are shown in Figure 20. The divergence between the fluxes between the decades is slightly more pronounced than in the overlying DAB soil and persists longer. However, an estimate of

Figure 18. Repetitive decade simulation results for capillary barrier: (a) daily flux through the gravel and (b) cross-correlation between decades.

Figure 19. Repetitive decade simulation results for thick soil barrier: (a) daily flux at 185 cm in DAB soil and (b) cross-correlation between decades.

Figure 20. Repetitive decade simulation results for thick soil barrier: (a) daily flux through the existing soil and (b) cross-correlation between decades.

equilibrium based on 0.9 cross-correlation is 4.5 years, slightly less than for the overlying DAB soil.

5.2 Repetitive Year Simulation

Simulations were conducted for both barrier designs using 1 year of meteorological data repetitively. This provided another estimate of the time required to reach equilibrium to compare with that from the repetitive decade simulation. Since the same meteorological conditions occurred from one year to the next, equilibrium should occur more quickly. This provides an optimum or best-case estimate of the shortest time required to reach equilibrium. The year chosen for use in the repetitive simulations was 1981. Based on the daily flux through the base of the DAB layers (Figure 17), 1981 could be considered a representative year. It certainly is between the wettest year, 1986, and the drought conditions during the latter 4 years of the decade.

The simulations were performed by first using the initial conditions as described previously (Section 2.2) and simulating for 1 year with the 1981 meteorological data. Then, the ending conditions for that year were used as the initial conditions for the second year in which the same 1981 meteorological data were used again. This process was repeated for several years until the fluxes at depths closely followed the same pattern from one year to the next. The results for the capillary barrier simulation will be discussed first followed by those for the thick soil barrier.

5.2.1 Capillary Barrier

The daily flux at the base of the DAB soil in the capillary barrier for the repetitive year simulation is shown in Figure 21a. The results from 5 years of simulation are superimposed onto the same 1-year time axis. As expected, the simulation comes quickly into equilibrium as can be seen when years 2–5 essentially mimic each other. The difference in the early part of the first year is due to initial excess drainage as a result of the assigned uniform initial moisture profile. The fluxes appear to converge just after February on the second year. This is borne out in Figure 21b, which shows the cross-correlation for two different-sized time windows between the first and second years. The cross-correlation reaches 0.9 at slightly over 1.5 months (0.1 years).

Slightly deeper in the gravel layer, the daily flux results are similar (Figure 22). Excess drainage also occurs as can be seen by the steep slope on the January segment of the first-year results. The flux appears to take somewhat longer to reach equilibrium, approximately 6 months. The cross-correlations in Figure 22b were calculated with slightly longer windows than those for the fluxes at the base of the DAB soil layer. This was necessitated by the noisiness of the cross-correlations between the gravel fluxes from one year to the next. Correlations for years 1–2, 2–3, and 3–4 are shown. A persistent drop in correlation occurs at the end (or beginning) of each year, which prevents a quantitative estimate of time to equilibrium. This drop in correlation is likely due to the numerical solution being restarted each year with a slight loss of accuracy. For this particular case, the estimate of 6 months to equilibrium will be used based strictly on the convergence of the fluxes.

Figure 21. Repetitive year simulation results for capillary barrier: (a) daily flux near base of DAB soil and (b) cross-correlation between first and second years.

Figure 22. Repetitive year simulation results for capillary barrier: (a) daily flux in gravel and (b) cross-correlation between successive years.

5.2.2 Thick Soil Barrier

The same repetitive year simulation process was performed on the thick soil barrier. The daily flux results for the 185-cm depth in the DAB soil are given in Figures 23a and 23b. As can be seen, a longer time is required for the daily fluxes to come into equilibrium, somewhere around August or September. This longer time is due to the absence of the capillary barrier preventing downward movement of water. The time at which the cross-correlation reaches 0.9 is just over 6 months and is estimated as 0.6 years.

Lastly, the daily fluxes near the top of the existing soil are shown in Figure 24a. The vertical axis is truncated at the top to both match the axis from Figure 23a and to allow sufficient detail to be seen in the daily flux results for successive years. The primary difference in the first year is again drainage as a result of the initial conditions. The fluxes appear to begin converging in the latter half of the first year. From the cross-correlations in Figure 24b, this time to convergence was estimated as 0.7 years.

5.3 Summary of Equilibrium Results

In summary, the two simulation approaches of repetitive decades and years provided bounding estimates of the time required for the moisture content profiles to reach equilibrium with the surface meteorological conditions. The repetitive decade simulations provided a conservative or maximum time to equilibrium while the repetitive year simulations provided the shortest time. Table 14 summarizes the results of all the equilibrium simulations. The actual equilibration time is likely somewhere between the extremes indicated in the table. The dry initial conditions at the end of the repetitive decade simulation caused by a protracted drought are likely more extreme and less representative than the wetter initial conditions of the repetitive year simulations. For this reason, the equilibrium time is likely closer to that predicted by the repetitive year simulation than by the repetitive decade simulation. How much closer requires subjective judgement at this point. Depending on the sequence of weather during the first several years after construction, it could take anywhere from 1 to 3 years for the soil moisture profile to come into equilibrium, with 3 years certainly being a conservative estimate. The monitoring period for the test plots should consider this initial 1-to-3-year period as the minimum time period after which the performance of the barriers would be representative of a response to surface meteorological conditions rather than to the initial conditions. In any event, evaluation of data collected during this period would provide the best estimates of when equilibrium was reached.

Figure 23. Repetitive year simulation results for thick soil barrier: (a) daily flux at 185-cm depth in DAB soil and (b) cross-correlation between successive years.

Figure 24. Repetitive year simulation results for thick soil barrier: a) daily flux near top of existing soil and b) cross-correlation between successive years.

Table 14. Summary of equilibrium estimates from repetitive decade and repetitive year simulations.

		Repetitive Decade	Repetitive Year
Capillary Barrier			
Material Type	Depth		
DAB Soil	139 cm	3.5 yrs	0.1 yrs
Gravel	155 cm	5.0 yrs	0.5 yrs
Thick Soil Barrier			
Material Type	Depth		
DAB Soil	185 cm	4.8 yrs	0.6 yrs
Existing Soil	234 cm	4.5 yrs	0.7 yrs

6. FAILURE ANALYSIS

The third and final major objective in this simulation study was to perform a failure analysis of the two engineered barrier designs. Failure testing will be conducted on the field test plots. The purpose of the a priori simulation study is to guide the design and implementation of these failure tests. By simulating possible responses before the test is conducted, insight into the amounts and duration of additional water that will be necessary to induce failure will be gained.

A definition of failure has yet to be determined for the engineered barrier test facility. By comparison, failure for the Hanford Field Lysimeter Test Facility has been defined as any drainage in excess of 0.05 cm/yr (Fayer, 1990). This definition is not necessarily applicable for the engineered barrier test facility. The earlier simulations in this report predict drainages in excess of 0.05 cm/yr for the thick soil barrier (see Section 3). The failure definition may be more appropriate for the capillary barrier since predicted drainage exceeded only 0.05 cm during the first year when excess drainage occurred primarily as a result of assigned initial conditions below the capillary barrier. Rather than use a strict definition of failure, the simulations were conducted and their results analyzed qualitatively in terms of likelihood of failure due to applying additional water.

Based on the failure testing done for the Hanford facility, and the likelihood that similar testing would be done for the engineered barrier test facility, two different methods of applying supplemental water were simulated. The first involved adding additional water every two weeks to simulate an increase in the precipitation rate. The purpose in this approach was to simulate the effect of a long-term climatic change. The second approach consisted of ponding water on the surface of the engineered barriers to simulate flooding and then monitoring the time required for wetting fronts to advance through the barriers. The simulations for each approach will be discussed in turn.

6.1 Supplemental Precipitation Simulation

As part of the field study for the engineered barrier test plots, supplemental precipitation will be applied and the barriers performance monitored. This portion of the simulation study was designed to estimate reasonable rates of additional precipitation that could be applied to the barriers to test this performance. Based on the Hanford Field Lysimeter Test Facility methodology, supplemental precipitation was applied twice a month based on the observed precipitation during the previous 2-week period (Campbell et al, 1990). This formed the basis for how additional precipitation was applied in the simulation study. The meteorological data base developed previously for the 1981–1990 period was used for these simulations. This data base had been previously altered to include the effects of accumulated snowfall. A further alteration was performed by summing up the precipitation for each 2-week period and adding either once or twice this additional precipitation back into the data base at the end of each 2-week period.

Simulations were performed for both barriers with these 2X and 3X normal precipitation rates for the period 1981–1990. The initial conditions in all cases were the same as those described in Section 2.2. The all-effects-combined simulation performed earlier (Sections 4.3.1.4 and 4.3.2.4) with normal (or 1X) precipitation served as the basis for comparison. The net yearly

drainage results for the supplemental precipitation simulations of the capillary barrier are shown graphically in Figure 25a, and for the thick soil barrier in Figure 25b. Both these figures use a logarithmic scale in order to capture the comparison between the normal or 1X precipitation performance and that with supplemental precipitation. There is a marked difference in performance, especially for the capillary barrier. The drainage shown in the capillary barrier for the 1X precipitation clearly results from excess moisture below the capillary barrier due to the exponentially decreasing shape of the curve. With the 2X precipitation rate, an appreciable amount of water drains through the barrier in years 83–86, followed by drainage of excess moisture in 87–90. In the 3X precipitation rate simulation, appreciable drainage occurs in all years except the initial year 81 and in the extreme drought years of 87–88.

Tables 15 and 16 present a summary of yearly results for precipitation, drainage, and mass balance error for the base and supplemental precipitation for both barrier designs. The mass balance results indicate that as the amount of precipitation and drainage increase, the quality of the solution decreases; however, the overall mass balance results for even the wettest (3X) simulation is quite good since it is less than 3.0%.

Several conclusions can be drawn from the supplemental precipitation simulations. First, the results indicate that a supplemental precipitation factor of 2X should be sufficient to cause failure of the capillary barrier as long as precipitation is at or above the average of 22 to 23 cm/yr. Every year in which this condition occurred during the 2X simulation, an appreciable amount of water drained through the barrier. Second, increasing the precipitation 3X will almost assuredly result in failure of the capillary barrier in every year except when extreme drought conditions occur. Third and last, since there is already a drainage of approximately 1 cm/yr for the thick soil barrier, increasing the precipitation by a factor of either two or three results in appreciably more drainage. Based on these results, a supplemental precipitation factor of 2X should be significant to test the barrier performance under most conditions. (It is beyond the scope of this document to indicate what the likely amount of additional precipitation would be under climatic change scenarios.)

6.2 Flooding Simulation

The second portion of the failure analysis involved simulating the performance of the engineered barriers under flooding conditions. The location of the RWMC in the bottom of the local drainage basin has resulted in localized flooding three times in the past (Barracough et al, 1976; Wood, 1989). The duration of these flooding events was limited. In the flooding simulations to test performance of the two barriers, the length of the flooding was treated as variable with durations of 0.5, 1, and 2 days. Three aspects of the barrier performance were monitored for each simulation: (a) the advance of the wetting front during flooding, (b) the amount of water that infiltrated through the barriers during the flooding, and (c) the net amount of water that drained through the base of the simulation domain as a result of the flooding. Aspect (c) tested the performance of the barrier after flooding ceased and is a key aspect of barrier performance.

The flooding simulations were performed by selecting a point in time from the all-effects-combined simulations (Sections 4.1.3.4 and 4.3.2.4) and then superimposing a period of flooding.

Figure 25. Simulation results for annual drainage with supplemental precipitation: (a) capillary barrier and (b) thick soil barrier.

Table 15. Simulation results for capillary barrier with supplemental precipitation.**1X (Normal) Precipitation**

<u>Year</u>	<u>Ppt. (cm)</u>	<u>Drainage (cm)</u>	<u>Mass Balance Error (cm)</u>	<u>MBE as a % of Ppt.</u>
81	22.81	0.49	0.01	0.0
82	22.05	0.20	-0.00	0.0
83	30.23	0.12	0.02	0.1
84	27.84	0.09	0.01	0.1
85	22.71	0.07	0.03	0.1
86	33.00	0.06	-0.00	0.0
87	19.76	0.05	-0.01	0.0
88	9.55	0.04	-0.00	0.0
89	21.06	0.04	0.01	0.1
90	17.12	0.03	0.01	0.0

2X Precipitation

81	45.62	0.49	0.20	0.4
82	44.09	0.20	0.02	0.0
83	60.45	0.12	0.08	0.1
84	55.68	4.96	0.24	0.4
85	45.42	1.69	0.25	0.5
86	65.99	9.43	0.14	0.2
87	39.52	0.49	0.16	0.4
88	19.10	0.23	0.00	0.0
89	42.11	0.16	0.42	1.0
90	34.24	0.11	0.23	0.7

3X Precipitation

81	68.43	0.49	0.60	0.9
82	66.14	5.69	0.46	0.7
83	90.68	18.83	0.91	1.0
84	83.52	30.01	0.99	1.2
85	68.12	14.06	0.74	1.1
86	98.98	26.69	0.98	1.0
87	59.28	0.55	0.62	1.0
88	28.65	0.25	0.36	1.3
89	63.17	7.43	-0.13	-0.2
90	51.36	2.36	0.26	0.5

The date chosen to begin flooding was the end of Julian day 69 in 1983. This date was chosen because the soil moisture profile in the DAB soil is completely in equilibrium with the surface meteorological boundary (see Section 5) and because it is shortly after snowmelt occurs in 1983 (Julian day 61). Using the initial conditions at the end of Julian day 69 of 1983, the upper boundary was fixed to saturation for periods of 0.5, 1, and 2 days. Then, the upper boundary reverted to a flux boundary in which the evapotranspiration potential was determined from meteorologic conditions. The capillary barrier simulations will be discussed first followed by those for the thick soil barrier.

Table 16. Simulation results for thick soil barrier with supplemental precipitation.**1X (Normal) Precipitation**

Year	Ppt. (cm)	Drainage (cm)	Mass Balance Error (cm)	MBE as a % of Ppt.
81	22.81	1.91	0.00	0.0
82	22.05	1.25	-0.01	-0.1
83	30.23	0.86	0.01	0.0
84	27.84	0.77	0.02	0.1
85	22.71	0.94	0.02	0.1
86	33.00	1.36	-0.00	-0.0
87	19.76	1.26	-0.03	-0.1
88	9.55	0.72	-0.01	-0.1
89	21.06	0.46	0.00	0.0
90	17.12	0.37	0.00	0.0

2X Precipitation

81	45.62	2.72	0.23	0.5
82	44.09	4.28	0.01	0.0
83	60.45	5.86	0.09	0.1
84	55.68	13.71	0.56	1.0
85	45.42	6.84	0.53	1.2
86	65.99	14.71	0.53	0.8
87	39.52	3.22	0.12	0.3
88	19.10	1.77	0.00	0.0
89	42.11	2.33	0.71	1.7
90	34.24	3.36	0.17	0.5

3X Precipitation

81	68.43	7.17	1.06	1.5
82	66.14	14.02	0.48	0.7
83	90.68	23.24	1.48	1.6
84	83.52	36.11	2.30	2.8
85	68.12	18.77	0.92	1.4
86	98.98	33.18	1.87	1.9
87	59.28	7.87	0.84	1.4
88	28.65	4.85	0.34	1.2
89	63.17	12.97	0.33	0.5
90	51.36	9.68	0.72	1.4

The hourly flux through the bottom of the simulation domain for the capillary barrier flooding simulations is shown in Figure 26. The shorter duration flood (0.5 days) did not result in any additional water draining past the capillary barrier. Rather, the flux that does occur is negligible and is a result of residual drainage still occurring as a result of the initial conditions. The maximum depth to which the wetting front advanced resulting from the 0.5-day flood was ~170 cm at Julian day 103, 33 days after the flooding ceased. The front advanced just into the cobble layer and could not penetrate any further since the driving force for additional infiltration had previously ceased.

Both the 1- and 2-day flooding periods resulted in additional drainage beneath the capillary barrier. Table 17 gives the depth to which the wetting front penetrated during the flooding period, the amount of water that infiltrated during flooding, the net amount of water that drained beneath

Figure 26. Flux at bottom of capillary barrier simulation domain (300 cm) in response to variable length flooding.

Both the 1- and 2-day flooding periods resulted in additional drainage beneath the capillary barrier. Table 17 gives the depth to which the wetting front penetrated during the flooding period, the amount of water that infiltrated during flooding, the net amount of water that drained beneath the barrier from the beginning of flooding to the end of 1983. The amount of water that drained prior to flooding was negligible to that occurring after flooding for the capillary barrier.

The indication from the capillary barrier flooding simulations is that there is limited storage capacity in the 140 cm of DAB soil to absorb water during any extended period of saturation of the surface. In Section 2, it was mentioned that the thickness of the DAB soil in the capillary barrier is actually going to be 160 cm instead of 140 cm. This will improve the storage capacity slightly but will not markedly affect these results.

6.2.2 Thick Soil Barrier

The hourly flux of water through the thick soil barrier is shown in Figure 27. Graphically, the results appear similar to those for flooding of the capillary barrier. However, the peak flux for

Table 17. Results for flooding of capillary barrier.

Flood Duration (days)	Wetting Front Depth at End of Flooding (cm)	Amount of Water Infiltrating During Flooding (cm)	Deep Drainage During 1983 (day 70-365) (cm)	Mass Balance Error (cm)
0.5	70	15.6	9.7×10^{-2}	2.7×10^{-4}
1.0	110	25.6	7.1×10^0	1.4×10^{-2}
2.0	215	44.5	2.6×10^1	1.2×10^{-1}
no flooding			9.7×10^{-2}	

the 1-day flood occurs later in the thick soil simulation. Also, the half-day flood results in additional drainage in the thick soil barrier simulation where it did not in the capillary barrier simulation.

Table 18 gives the advance of the wetting front during flooding, the net infiltration during flooding, the amount of drainage occurring for the remainder of the year after flooding, and the combined mass balance errors during the flooding and recovery stages of the simulation.

6.2.3 Comparison of Performance During and After Flooding

Comparison of Tables 17 and 18 reveals that the wetting front advance and amount of infiltrating water during flooding differs only for the 2-day flood. The wetting front advance during the shorter duration floods did not advance past the DAB soil in both simulations so the results should be the same. The differences in the 2-day flood is attributable to the gravel and cobble layers in the capillary barrier simulation.

Table 19 gives a summary of the maximum drainage flux occurring in both the capillary and thick soil barrier simulations, the time of the maximum flux, and the flux that would have occurred without flooding. Several observations can be drawn from this information. First, the peak drainage rates are higher for the capillary barrier than for the thick soil barrier in each case where drainage occurs. This results from faster movement through gravel and cobble layers once failure occurs. Second, the peak flux occurs later for the thick soil barrier than for the capillary barrier. This is also a result of the faster movement through the gravel and cobble layers. Lastly, from Tables 17 and 18, the net increase in drainage during the recovery period is greater for the thick soil barrier than for the capillary barrier for each flood duration. The capillary barrier appears to reestablish itself quick enough to reduce the overall net drainage compared to that of the thick soil barrier.

Figure 28 shows the amount of water in storage in the simulation profile for the complete 1983 simulation period for both the capillary and thick soil barriers. In both cases, the soil moisture conditions have not recovered to the nonflooding conditions by the end of the year. Part of the explanation for this slow recovery would be slow drainage from below the capillary barrier and from deeper in the thick soil barrier. Once the driving force of additional water at the surface is removed, the residual drainage decreases at an exponential rate, so as time progresses, the

Figure 27. Flux at bottom of thick soil barrier simulation domain (300 cm) in response to variable length flooding.

Table 18. Results for flooding of thick soil barrier.

Flood Duration (days)	Wetting Front Depth at End of Flooding (cm)	Amount of Water Infiltrating During Flooding (cm)	Deep Drainage During 1983 (day 70-365) (cm)	Mass Balance Error (cm)
0.5	70	15.6	4.5×10^0	1.7×10^{-1}
1.0	110	25.6	1.3×10^1	1.6×10^{-2}
2.0	180	44.3	3.2×10^1	5.5×10^{-2}
no flooding			6.7×10^{-1}	

Table 19. Comparison of peak drainage rate between flooding simulations for capillary barrier and thick soil barrier.

<u>Capillary Barrier</u>			
<u>Flood Duration</u>	<u>Peak Drainage (cm/hr)</u>	<u>Julian Day at Which Peak Occurs</u>	<u>Drainage Rate w/o Flooding (cm/hr)</u>
0.5	-*	-	1.5×10^{-5}
1.0	1.5×10^{-2}	79.8	1.5×10^{-5}
2.0	5.1×10^{-1}	71.5	1.5×10^{-5}

<u>Thick Soil Barrier</u>			
<u>Flood Duration</u>	<u>Peak Drainage (cm/hr)</u>	<u>Julian Day at Which Peak Occurs</u>	<u>Drainage Rate w/o Flooding (cm/hr)</u>
0.5	1.2×10^{-3}	159	9.4×10^{-5}
1.0	9.2×10^{-3}	94	1.0×10^{-4}
2.0	1.3×10^{-1}	73.6	1.1×10^{-4}

* no additional flooding occurred in 0.5 day flooding simulation

residual drainage decreases very slowly. Also apparent from Figure 28 is how quickly the upper portion of the soil profile begins to behave as if no flooding occurred. This can be seen by looking at the small changes in the storage as quickly as day 120, 50 days after flooding. Although the amount of water stored is different, the behavior is the same.

In conclusion, neither barrier design prevents water from draining through the barriers under almost any extended period of saturation at the surface. Both designs showed large increases in the amount of water that drained past the bottom of the simulation domain. The capillary barrier appeared to offer an advantage in that it began reducing the net drainage faster than the thick soil barrier.

Figure 28. Flooding simulation results for daily water storage (cm) for (a) capillary barrier and (b) thick soil barrier.

7. SUMMARY AND FUTURE DIRECTIONS

7.1 Summary

Two proposed engineered barrier designs are being considered for use in eventual closure of the RWMC. Field-scale plots of these two designs are being constructed to provide monitoring data with which to evaluate their performance. A simulation study was conducted to provide guidance in the design of these two barriers. The simulation study considered:

- The sensitivity of barrier performance to the conceptual model and hydrologic parameters used to simulate the test plots
- The time necessary for the moisture profile to attain equilibrium with meteorological conditions after construction of the test plots
- The performance of the barriers in the test plots under failure conditions due to supplemental precipitation or ponding.

In addition, a statistical comparison was performed on meteorological data sources in the general vicinity of the RWMC in order to justify using data from locations other than the RWMC.

The conceptual model that was used to simulate the covers was varied to include effects of plant transpiration, reduced evaporation during periods of snow cover, and degradation of the capillary barrier by infilling of overlying sediments. Including both transpiration and a snow cover tended to counterbalance each other but did result in a more defensible simulation since the simulation was more representative of actual anticipated conditions. Further conceptual model changes that were simulated included degradation of the gravel layer in the capillary barrier by infilling of overlying sediments. This degradation did have a marked effect on reducing the capillary barrier performance as drainage increased. Degradation of the cobble layer by infilling of the gravel layer had a minimal effect since the gravel still performed the function of a capillary barrier. Increasing the depth of the DAB soil in the thick soil barrier reduced the overall net drainage; however, the net drainage was still higher for the thick soil barrier compared to the capillary barrier.

The most sensitive hydrologic parameters were those describing the DAB soil. This was not surprising since the DAB soil is the uppermost in the cover and therefore more subject to meteorological influences. The residual moisture content and air entry potential of the gravel, cobble, and underlying soil were also found to have an influence on the drainage through the barrier. As such, the cobbles and gravel need to be hydrologically characterized as well.

Two different simulation approaches were used to estimate the time necessary for the soil profile within the barriers to come into equilibrium with the meteorological conditions at the surface. The first was to use meteorological data from one decade repetitively and based equilibrium upon when the daily flux at a midpoint in the profile from the second decade reached 0.9 correlation with the flux at the same depth from the first decade. The second simulation approach used 1 year of meteorological data repetitively instead of a decade and based

equilibrium again on correlation of daily flux at a middle depth in the profile. By using these two approaches, the estimated time to attain equilibrium could be bounded. The necessary time ranged from 0.1 years to 4.8 years. Depending on the actual weather pattern after the barrier plots are constructed, it was estimated that it could take from 1 to 3 years before the soil moisture profile attains equilibrium and is no longer influenced by the initial moisture profile.

In the supplemental precipitation simulations, the precipitation rate was either doubled or tripled, and barrier performance was compared to that under normal precipitation. The simulation results for the thick soil barrier showed increasing drainage with increasing precipitation, as expected. The results for the capillary barrier indicated that additional drainage would be expected to occur for the case of the double precipitation as long as the base precipitation is at or above the long-term average of 22 to 23 cm/yr. Tripling the precipitation resulted in additional drainage in almost every year except those with extreme drought conditions. As a result, doubling the infiltration rate should prove sufficient to test both barrier designs.

The last section of this simulation study considered the performance of the barriers under flooding conditions. These simulations were conducted by treating the surface as if it were saturated for periods of time ranging from 0.5 to 2 days. Then, the upper boundary reverted to a meteorologically controlled flux, and redistribution of the additional moisture in the soil profile was simulated for the duration of the year that was chosen for the flooding simulations. The simulation results indicated that neither barrier design offered appreciable resistance to flooding. If the surface of the DAB soil in the capillary barrier remained saturated longer than 0.5 days, the storage capacity within the DAB soil was quickly depleted and excess water began draining through the barriers. In the thick soil barrier, excess drainage resulted from even the 0.5-day saturation period. Simulation of the recovery or redistribution of the soil moisture profile after flooding ended indicated that the capillary barrier would be more effective at reducing overall drainage than the thick soil barrier.

7.2 Future Directions

This simulation study was designed to provide guidance in designing the field barrier plots and in conducting experiments to test their performance in limiting infiltrating water. There is at least one design feature that could benefit from an additional simulation study. In particular, a concern has been raised regarding induced vapor transport of moisture due to artificially imposed thermal gradients. These gradients are due to differences in temperature between the soil in the test plots and inside the access trench next to the plots. A simulation study could be performed to determine the amount of insulation required to minimize induced vapor transport below a prescribed level.

Even if this recommended study is not conducted, simulations of barriers at Hanford by Fayer et al. (1992) indicated the importance of considering thermal effects related to vapor movement under conditions of low infiltration such as those found in capillary barriers. This information has been considered in the design of the test barriers for the RWMC in that instrumentation is being included to profile temperatures vertically and horizontally in the plots so that thermal effects can be estimated.

The parameterization of wheatgrass transpiration used in this study was based on information contained in the literature, primarily related to studies conducted at or near the INEL. Even so, gaps in terms of biomass amounts and root growth functions had to be assumed for purposes of the study. Since a vegetative cover of crested wheatgrass will be used on the test barrier plots, accurate parameterization of transpiration is important to the cover simulations. The transpiration parameterization should be improved by incorporating results from wheatgrass studies that may be ongoing at the Radiological and Environmental Services Laboratory and elsewhere.

The future direction of modeling studies related to the RWMC barrier test plots should be in utilizing monitoring data collected after construction of the barrier plots. These simulations should be directed towards achieving a calibrated simulation of the soil moisture profile within both barrier designs. This calibration should be done for both the normal and supplemental precipitation plots. These simulations should also be conducted to investigate thermal effects such as vapor transport. As such, they will require two-dimensional simulations so the UNSAT-H code will be precluded from use.

By obtaining calibrated simulations of moisture movement through the barrier, different scenarios can then be defensively simulated to determine the amount of water that will infiltrate through the barriers and contact waste emplaced underneath. This information will be required in order that the beneficial effects of engineered covers or barriers can be included in future Performance Assessments for the RWMC.

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Appendix A

Meteorological Data Base

Appendix A

Meteorological Data Base

This appendix contains 1981-1990 data from the meteorological data base used in the UNSAT-H simulation study. The precipitation received during sub-freezing periods is shifted later to nonfreezing periods.

Year 1981

Temp Dew Solar Wind Cloud							Temp Dew Solar Wind Cloud							Temp Dew Solar Wind Cloud									
Day	Max	Min	Pt	Rad	Sp	Cov	Ppt	Day	Max	Min	Pt	Rad	Sp	Cov	Ppt	Day	Max	Min	Pt	Rad	Sp	Cov	Ppt
1	50.0	21.0	25.0	170	1.1	9	0.00	74	57.0	20.0	23.0	401	7.6	3	0.00	147	70.0	41.0	47.0	480	1.8	4	0.23
2	44.0	15.0	23.0	177	0.7	3	0.00	75	46.0	31.0	29.0	338	11.9	10	0.00	148	76.0	39.0	44.0	553	2.9	2	0.00
3	34.0	13.0	24.0	222	0.4	10	0.00	76	41.0	30.0	28.0	99	5.8	10	0.03	149	77.0	44.0	47.0	633	3.4	2	0.00
4	34.0	27.0	26.0	45	2.9	10	0.00	77	43.0	26.0	23.0	283	4.5	8	0.00	150	76.0	42.0	48.0	779	5.8	9	0.00
5	29.0	27.0	23.0	148	1.1	10	0.00	78	44.0	25.0	27.0	485	3.4	10	0.00	151	69.0	45.0	43.0	611	10.1	7	0.00
6	29.0	23.0	18.0	143	0.4	10	0.00	79	38.0	32.0	34.0	128	6.3	10	0.07	152	76.0	37.0	36.0	726	3.6	7	0.00
7	30.0	22.0	15.0	183	1.1	7	0.00	80	44.0	30.0	30.0	104	8.3	8	0.25	153	69.0	45.0	48.0	709	4.5	10	0.00
8	30.0	4.0	12.0	164	1.1	7	0.00	81	52.0	28.0	30.0	479	8.3	8	0.00	154	67.0	48.0	45.0	657	4.3	7	0.00
9	34.0	10.0	16.0	196	0.9	6	0.00	82	51.0	24.0	25.0	529	6.9	8	0.00	155	76.0	37.0	44.0	366	9.4	7	0.21
10	39.0	6.0	12.0	138	1.1	7	0.00	83	55.0	22.0	26.0	534	5.6	6	0.00	156	81.0	44.0	49.0	525	6.7	2	0.00
11	44.0	3.0	17.0	143	1.3	4	0.00	84	54.0	28.0	28.0	400	5.6	10	0.00	157	76.0	55.0	20.0	590	13.0	8	0.00
12	42.0	3.0	12.0	153	1.1	3	0.00	85	44.0	30.0	33.0	296	5.4	10	0.15	158	72.0	49.0	47.0	158	9.6	10	0.02
13	48.0	4.0	16.0	70	0.4	2	0.00	86	50.0	34.0	30.0	110	6.7	10	0.35	159	58.0	50.0	49.0	681	13.0	10	0.00
14	41.0	6.0	18.0	196	0.7	7	0.00	87	58.0	31.0	28.0	436	5.1	4	0.00	160	67.0	44.0	37.0	385	7.2	5	0.02
15	41.0	4.0	16.0	189	0.9	2	0.00	88	56.0	26.0	30.0	542	1.6	8	0.00	161	69.0	46.0	39.0	475	6.3	10	0.00
16	38.0	10.0	15.0	141	4.0	4	0.00	89	43.0	23.0	24.0	336	3.6	9	0.09	162	77.0	40.0	39.0	485	4.0	6	0.00
17	42.0	17.0	23.0	98	1.1	9	0.00	90	49.0	24.0	24.0	417	5.6	9	0.00	163	67.0	47.0	42.0	645	12.1	9	0.00
18	47.0	11.0	25.0	120	0.9	3	0.00	91	56.0	27.0	28.0	337	4.9	10	0.00	164	54.0	35.0	33.0	793	6.7	8	0.00
19	41.0	11.0	22.0	151	0.7	6	0.00	92	48.0	31.0	29.0	372	2.9	9	0.00	165	60.0	28.0	33.0	687	4.9	8	0.00
20	48.0	12.0	23.0	224	0.7	4	0.00	93	44.0	26.0	20.0	436	3.1	9	0.00	166	70.0	29.0	34.0	771	4.5	2	0.00
21	42.0	10.0	20.0	211	0.7	9	0.00	94	48.0	17.0	15.0	520	3.6	3	0.00	167	78.0	40.0	36.0	628	6.3	7	0.00
22	49.0	11.0	22.0	159	1.1	9	0.00	95	61.0	20.0	22.0	550	6.0	3	0.00	168	64.0	36.0	30.0	680	8.5	9	0.00
23	38.0	16.0	21.0	193	0.9	10	0.00	96	48.0	27.0	14.0	300	6.5	8	0.00	169	74.0	41.0	36.0	598	6.3	9	0.00
24	34.0	20.0	24.0	144	10.5	10	0.00	97	40.0	20.0	19.0	385	2.5	7	0.00	170	76.0	51.0	44.0	612	9.4	7	0.00
25	30.0	19.0	16.0	234	5.1	9	0.00	98	49.0	14.0	17.0	249	3.8	7	0.00	171	76.0	47.0	41.0	538	11.2	8	0.00
26	32.0	12.0	15.0	232	4.3	10	0.00	99	49.0	34.0	26.0	394	10.3	10	0.00	172	77.0	46.0	39.0	794	10.1	8	0.00
27	31.0	5.0	21.0	276	2.5	10	0.00	100	50.0	23.0	23.0	482	2.2	9	0.00	173	86.0	45.0	40.0	794	7.8	0	0.00
28	37.0	25.0	28.0	145	1.3	10	0.00	101	57.0	20.0	23.0	584	6.7	5	0.00	174	80.0	52.0	47.0	692	11.4	0	0.00
29	32.0	20.0	28.0	116	2.0	9	0.00	102	55.0	34.0	18.0	466	10.1	1	0.00	175	86.0	37.0	39.0	793	3.1	0	0.00
30	31.0	28.0	22.0	57	7.8	10	0.00	103	57.0	22.0	19.0	568	2.7	1	0.00	176	94.0	41.0	48.0	771	3.6	5	0.00
31	34.0	7.0	19.0	58	4.0	10	0.00	104	67.0	14.0	17.0	379	2.2	0	0.00	177	93.0	58.0	49.0	773	4.7	2	0.00
32	31.0	-2.0	15.0	197	3.8	7	0.00	105	73.0	22.0	29.0	394	2.9	5	0.00	178	85.0	49.0	46.0	784	7.6	5	0.00
33	23.0	4.0	16.0	226	1.6	6	0.00	106	67.0	34.0	28.0	504	6.5	8	0.00	179	79.0	39.0	34.0	791	3.4	0	0.00
34	25.0	3.0	8.0	214	2.5	4	0.00	107	69.0	24.0	28.0	592	2.5	9	0.00	180	85.0	39.0	34.0	619	3.4	0	0.00
35	28.0	-6.0	3.0	172	2.5	2	0.00	108	73.0	33.0	27.0	385	3.4	9	0.00	181	93.0	44.0	42.0	790	4.3	3	0.00
36	22.0	-10.0	5.0	213	1.8	8	0.00	109	60.0	46.0	43.0	350	5.4	10	0.19	182	87.0	60.0	51.0	789	6.5	6	0.00
37	27.0	-4.0	12.0	273	4.5	10	0.00	110	48.0	38.0	39.0	518	5.1	10	0.15	183	88.0	45.0	39.0	764	2.9	6	0.00
38	28.0	14.0	19.0	315	2.5	10	0.00	111	56.0	41.0	40.0	516	5.6	10	0.04	184	90.0	51.0	49.0	611	2.7	3	0.00
39	32.0	8.0	19.0	238	2.0	7	0.00	112	61.0	32.0	32.0	539	3.1	4	0.00	185	95.0	47.0	44.0	670	2.5	1	0.00
40	35.0	-3.0	18.0	171	5.6	9	0.00	113	70.0	35.0	40.0	483	2.5	1	0.00	186	97.0	53.0	48.0	540	4.5	2	0.00
41	10.0	-25.0	-17.0	256	7.2	0	0.00	114	71.0	38.0	41.0	652	7.6	8	0.00	187	83.0	66.0	54.0	783	7.8	5	0.00
42	21.0	-20.0	-11.0	332	1.1	10	0.00	115	64.0	44.0	38.0	483	8.3	10	0.00	188	68.0	52.0	46.0	549	13.2	5	0.05
43	25.0	4.0	16.0	310	1.6	9	0.00	116	63.0	38.0	38.0	683	5.8	10	0.00	189	77.0	29.0	30.0	570	2.2	0	0.00
44	39.0	2.0	22.0	256	1.3	8	0.00	117	57.0	37.0	37.0	564	6.7	8	0.05	190	91.0	37.0	44.0	638	3.4	0	0.00
45	40.0	24.0	34.0	193	8.3	8	0.00	118	66.0	30.0	37.0	548	4.9	10	0.04	191	89.0	58.0	55.0	709	4.5	3	0.00
46	38.0	21.0	29.0	168	4.7	10	0.00	119	72.0	44.0	43.0	698	3.4	10	0.00	192	87.0	52.0	48.0	723	6.5	3	0.11
47	39.0	21.0	32.0	203	3.6	10	0.00	120	77.0	39.0	38.0	451	2.0	9	0.00	193	93.0	45.0	49.0	775	6.3	2	0.00
48	45.0	30.0	31.0	108	4.5	3	0.44	121	81.0	38.0	40.0	337	4.7	7	0.00	194	83.0	54.0	46.0	753	6.0	1	0.00
49	44.0	28.0	30.0	271	2.9	10	0.24	122	68.0	44.0	39.0	459	8.3	7	0.00	195	83.0	44.0	37.0	760	13.4	0	0.00
50	56.0	29.0	33.0	178	3.4	10	0.26	123	60.0	31.0	28.0	491	6.5	5	0.00	196	88.0	40.0	36.0	714	7.8	0	0.00
51	37.0	23.0	20.0	74	2.5	7	0.00	124	68.0	29.0	25.0	594	8.9	2	0.00	197	93.0	40.0	42.0	767	7.6	5	0.00
52	39.0																						

Year 1981 (Cont'd)

Day	Temp	Dew	Solar	Wind	Cloud
Max	Min	Pt	Rad	Sp	Cov Ppt
220	93.0	55.0	40.0	549	10.7 4 0.00
221	80.0	59.0	47.0	459	14.3 5 0.00
222	85.0	54.0	41.0	434	10.3 1 0.00
223	91.0	42.0	43.0	433	4.9 1 0.00
224	93.0	45.0	43.0	465	4.9 6 0.00
225	91.0	51.0	45.0	448	6.5 9 0.00
226	90.0	50.0	46.0	453	5.6 7 0.00
227	89.0	49.0	47.0	651	6.7 4 0.00
228	91.0	48.0	42.0	588	5.6 1 0.00
229	95.0	49.0	40.0	670	6.3 2 0.00
230	94.0	48.0	40.0	666	7.4 6 0.00
231	86.0	50.0	42.0	612	7.2 9 0.00
232	89.0	59.0	42.0	471	11.6 5 0.00
233	86.0	52.0	49.0	501	11.4 4 0.07
234	88.0	41.0	37.0	537	0.0 0 0.00
235	92.0	39.0	38.0	645	0.0 3 0.00
236	91.0	50.0	43.0	543	3.4 4 0.00
237	96.0	53.0	45.0	406	7.6 2 0.00
238	93.0	47.0	45.0	632	6.3 6 0.00
239	94.0	52.0	44.0	608	7.8 2 0.00
240	93.0	51.0	44.0	456	8.9 5 0.00
241	90.0	57.0	45.0	618	0.4 4 0.00
242	78.0	50.0	39.0	614	13.2 6 0.00
243	78.0	42.0	31.0	573	3.4 1 0.00
244	85.0	36.0	34.0	502	12.3 0 0.00
245	76.0	50.0	37.0	577	9.2 2 0.00
246	81.0	32.0	30.0	545	9.4 1 0.00
247	85.0	37.0	33.0	587	4.0 4 0.00
248	76.0	55.0	37.0	586	0.0 9 0.00
249	80.0	40.0	41.0	544	0.0 3 0.00
250	82.0	37.0	45.0	520	3.8 3 0.00
251	86.0	40.0	41.0	381	6.3 2 0.00
252	85.0	46.0	44.0	433	6.3 2 0.00
253	85.0	46.0	43.0	490	7.8 0 0.00
254	85.0	38.0	38.0	446	6.9 0 0.00
255	88.0	37.0	39.0	464	5.6 1 0.00
256	88.0	39.0	37.0	521	5.1 1 0.00
257	87.0	45.0	34.0	349	4.5 0 0.00
258	86.0	37.0	38.0	536	5.6 1 0.00
259	88.0	46.0	37.0	451	6.9 1 0.00
260	90.0	38.0	36.0	244	4.0 0 0.00
261	89.0	39.0	37.0	444	6.0 0 0.00
262	78.0	46.0	37.0	455	14.8 5 0.00
263	72.0	27.0	26.0	384	8.9 5 0.00
264	67.0	41.0	29.0	495	20.1 3 0.00
265	67.0	34.0	25.0	501	11.4 8 0.00
266	67.0	25.0	27.0	446	5.6 7 0.00
267	72.0	38.0	27.0	393	8.9 9 0.00
268	56.0	42.0	39.0	485	21.3 9 0.00
269	57.0	23.0	24.0	480	5.4 9 0.00
270	75.0	31.0	34.0	475	6.0 4 0.00
271	69.0	45.0	40.0	425	14.8 8 0.00
272	50.0	46.0	40.0	465	7.4 10 0.00
273	60.0	26.0	32.0	226	3.1 1 0.14
274	67.0	25.0	28.0	199	4.3 1 0.00
275	71.0	29.0	37.0	298	10.7 8 0.00
276	57.0	44.0	40.0	239	21.7 10 0.00
277	52.0	19.0	21.0	343	5.8 1 0.00
278	57.0	16.0	20.0	324	6.9 4 0.00
279	68.0	24.0	31.0	412	6.5 10 0.00
280	59.0	38.0	38.0	418	12.5 10 0.00
281	54.0	34.0	32.0	343	12.8 5 0.04
282	54.0	26.0	31.0	366	11.6 10 0.00
283	52.0	32.0	42.0	82	4.5 10 0.03
284	43.0	36.0	39.0	81	6.0 10 0.18
285	38.0	34.0	32.0	120	8.9 9 0.38
286	46.0	21.0	31.0	189	6.7 9 0.03
287	44.0	32.0	32.0	235	5.4 9 0.27
288	52.0	26.0	30.0	377	10.1 3 0.00
289	56.0	25.0	31.0	222	8.3 2 0.00
290	60.0	25.0	34.0	241	5.4 0 0.00
291	63.0	24.0	30.0	317	5.4 0 0.00
292	65.0	22.0	33.0	235	9.4 0 0.00
293	64.0	25.0	34.0	363	11.9 3 0.00
294	54.0	24.0	19.0	357	6.5 2 0.00
295	55.0	15.0	25.0	340	4.7 2 0.00
296	55.0	15.0	23.0	277	5.4 6 0.00
297	50.0	31.0	26.0	287	5.4 9 0.00
298	55.0	21.0	28.0	287	10.1 4 0.00
299	53.0	28.0	33.0	111	3.8 10 0.00
300	62.0	24.0	29.0	173	7.4 8 0.00
301	63.0	24.0	28.0	237	12.8 7 0.00
302	44.0	32.0	30.0	141	16.1 8 0.00
303	46.0	23.0	25.0	249	9.8 6 0.00

Day	Temp		Dew	Solar	Wind	Cloud	
	Max	Min	Pt	Rad	Sp	Cov	Ppt
304	52.0	20.0	26.0	185	6.5	10	0.00
305	58.0	16.0	30.0	252	2.9	3	0.00
306	64.0	19.0	34.0	242	3.1	2	0.00
307	65.0	16.0	29.0	221	3.1	3	0.00
308	55.0	17.0	28.0	153	3.4	10	0.00
309	57.0	25.0	30.0	264	4.0	5	0.00
310	61.0	22.0	29.0	294	2.9	7	0.00
311	55.0	21.0	34.0	290	4.9	0	0.00
312	55.0	17.0	28.0	287	4.5	0	0.00
313	55.0	14.0	28.0	183	3.8	3	0.00
314	55.0	13.0	26.0	280	3.6	6	0.00
315	57.0	15.0	27.0	220	5.8	2	0.00
316	48.0	23.0	28.0	274	4.9	8	0.00
317	48.0	38.0	40.0	158	11.4	10	0.14
318	49.0	37.0	33.0	138	17.4	10	0.20
319	33.0	29.0	32.0	88	4.3	10	0.00
320	50.0	31.0	37.0	110	2.5	9	0.25
321	47.0	32.0	33.0	156	10.3	10	0.00
322	45.0	32.0	30.0	93	11.0	6	0.05
323	35.0	16.0	24.0	58	4.5	10	0.00
324	35.0	22.0	27.0	204	2.2	10	0.00
325	43.0	28.0	33.0	153	7.8	10	0.00
326	44.0	32.0	32.0	96	19.7	9	0.03
327	35.0	24.0	33.0	112	6.5	10	0.00
328	36.0	30.0	30.0	48	13.6	10	0.59
329	36.0	22.0	20.0	86	8.7	9	0.00
330	26.0	6.0	16.0	120	6.5	3	0.00
331	25.0	7.0	20.0	155	7.6	10	0.00
332	27.0	4.0	19.0	54	3.4	8	0.00
333	26.0-11.0	9.0	69	5.4	7	7	0.00
334	29.0	4.0	17.0	108	4.3	10	0.00
335	25.0	4.0	22.0	160	2.5	10	0.00
336	37.0	1.0	28.0	155	15.2	10	0.00
337	28.0	5.0	21.0	108	3.4	1	0.00
338	34.0	5.0	24.0	224	4.5	10	0.00
339	37.0	9.0	20.0	208	0.4	10	0.00
340	45.0	12.0	27.0	133	0.0	10	0.00
341	46.0	27.0	33.0	123	2.9	9	0.08
342	41.0	20.0	30.0	219	3.8	9	0.00
343	41.0	17.0	28.0	218	4.0	9	0.00
344	46.0	18.0	29.0	217	13.9	5	0.00
345	33.0	24.0	23.0	204	11.2	10	0.00
346	27.0	16.0	19.0	197	3.1	10	0.00
347	38.0	21.0	27.0	168	2.5	10	0.00
348	39.0	25.0	31.0	43	12.8	9	0.00
349	41.0	27.0	32.0	43	11.6	8	0.11
350	39.0	25.0	22.0	44	8.1	8	0.00
351	38.0	9.0	18.0	143	4.5	7	0.00
352	26.0	10.0	16.0	142	4.5	9	0.00
353	42.0	12.0	28.0	186	4.9	10	0.00
354	38.0	24.0	36.0	54	18.3	10	0.00
355	39.0	28.0	27.0	213	5.6	10	0.09
356	30.0	20.0	16.0	164	6.0	8	0.00
357	26.0	5.0	12.0	124	4.0	10	0.00
358	24.0	5.0	16.0	185	2.2	10	0.00
359	35.0	11.0	18.0	198	5.4	7	0.00
360	16.0	9.0	17.0	215	5.1	10	0.00
361	21.0	1.0	12.0	44	1.8	8	0.00
362	23.0	-5.0	14.0	216	4.3	7	0.00
363	19.0	-3.0	12.0	217	3.1	10	0.00
364	26.0	3.0	20.0	53	10.7	8	0.00
365	15.0-15.0	6.0	164	5.1	10	10	0.00

Year 1982

	Temp		Dew	Solar	Wind	Cloud	
Day	Max	Min	Pt	Rad	Sp	Cov	Ppt
1	23.0	-7.0	25.0	44	10.1	6	0.00
2	18.0-10.0	0.0	0.0	177	3.1	10	0.00
3	25.0	-8.0	6.0	72	16.1	10	0.00
4	30.0	20.0	20.0	45	27.1	10	0.00
5	22.0	-4.0	18.0	148	19.9	9	0.00
6	8.0-22.0	-3.0	143	6.0	5	0.00	
7	5.0-23.0-17.0		183	3.1	5	0.00	
8	12.0	-8.0	-1.0	164	2.9	10	0.00
9	17.0-11.0	0.0	196	4.0	9	0.00	
10	24.0-10.0	4.0	138	4.3	10	0.00	
11	18.0	-8.0	7.0	143	4.9	8	0.00
12	23.0	-5.0	2.0	153	6.0	8	0.00
13	22.0	2.0	13.0	70	4.5	10	0.00
14	19.0	10.0	18.0	196	2.9	9	0.00
15	29.0	0.0	15.0	189	13.6	8	0.00
16	36.0	1.0	15.0	141	9.8	10	0.00
17	36.0	24.0	25.0	98	24.8	10	0.00
18	28.0	16.0	21.0	120	14.8	6	0.00
19	27.0	3.0	10.0	151	10.1	7	0.00

	Temp		Dew	Solar	Wind	Cloud	
Day	Max	Min	Pt	Rad	Sp	Cov	Ppt
20	18.0	-7.0	6.0	83	6.9	10	0.00
21	22.0	15.0	20.0	75	16.3	10	0.00
22	16.0	-6.0	7.0	52	17.0	9	0.00
23	32.0	14.0	25.0	193	23.3	10	0.00
24	36.0	12.0	26.0	144	24.2	10	0.00
25	26.0	6.0	19.0	234	3.8	10	0.00
26	38.0	8.0	28.0	232	15.0	10	0.00
27	27.0	16.0	19.0	276	13.6	8	0.00
28	26.0	4.0	20.0	279	4.7	10	0.00
29	22.0	-7.0	18.0	116	12.1	10	0.00
30	23.0	11.0	30.0	162	1.6	10	0.00
31	34.0	11.0	18.0	128	5.8	9	0.00
32	29.0	4.0	15.0	197	5.4	10	0.00
33	25.0	7.0	18.0	226	3.1	10	0.00
34	12.0	2.0	-2.0	214	17.0	6	0.00
35	7.0	-9.0	-16.0	172	17.0	0	0.00
36	1.0	-32.0	-14.0	213	5.4	6	0.00
37	5.0	-29.0	-10.0	273	4.7	10	0.00
38	15.0	0.0	5.0	315	2.0	10	0.00
39	14.0	-15.0	-5.0	105	4.9	4	0.00
40	12.0	-12.0	4.0	171	5.4	10	0.00
41	8.0	-22.0	35.0	256	5.1	3	0.00
42	22.0	-24.0	-4.0	332	3.1	8	0.00
43	25.0	-14.0	9.0	310	4.5	10	0.00
44	32.0	-7.0	19.0	256	5.1	10	0.00
45	36.0	23.0	33.0	193	16.8	10	0.00
46	38.0	33.0	33.0	168	18.3	10	0.27
47	41.0	33.0	34.0	71	21.7	5	0.47
48	38.0	27.0	32.0	246	6.3	10	0.03
49	34.0	26.0	29.0	271	7.6	10	0.00
50	37.0	31.0	35.0	312	10.1	10	0.12
51	49.0	31.0	35.0	188	9.8	9	0.39
52	53.0	31.0	36.0	376	7.6	9	0.00
53	36.0	30.0	21.0	198	22.1	9	0.00
54	32.0	24.0	9.0	255	18.6	4	0.00
55	31.0	12.0	12.0	143	7.6	4	0.00
56	39.0	11.0	18.0	202	6.0	7	0.00
57	46.0	19.0	27.0	257	4.3	8	0.00
58	43.0	22.0	25.0	322	13.9	10	0.00
59	48.0	20.0	26.0	249	4.3	7	0.00
60	48.0	29.0	30.0	301	5.4	10	0.00
61	42.0	33.0	30.0	183	18.3	9	0.06
62	40.0	21.0	23.0	397	12.1	9	0.00
63	40.0	26.0	23.0	253	8.5	10	0.00
64	39.0	20.0	20.0	435	8.7	7	0.00
65	39.0	20.0	20.0	205	8.7	9	0.00
66	48.0	24.0	26.0	272	9.4	5	0.00
67	47.0	20.0	30.0	451	10.3	10	0.00
68	50.0	29.0	28.0	405	18.8	8	0.00
69	52.0	31.0	28.0	399	16.8	7	0.00
70	49.0	36.0	33.0	345	20.8	10	0.00
71	37.0	18.0	15.0	282	15.7	6	0.00
72	48.0	17.0	21.0	157	6.0	3	0.00
73	37.0	25.0	32.0	465	5.4	10	0.00
74	44.0	32.0	27.0	264	17.7	8	0.16
75	31.0	22.0	30.0	338	11.6	10	0.00
76	40.0	23.0	18.0	99	4.3	10	0.00
77	37.0	29.0	31.0	101	10.7	10	0.11
78	34.0	22.0	24.0	372	13.4	10	0.00
79	36.0	23.0	18.0	307	6.3	10	0.00
80	36.0	16.0	21.0	202	3.6	7	0.00
81	40.0	18.0	20.0	479	7.4	7	0.00
82	45.0	23.0	25.0	529	13.0	6	0.12
83	47.0	28.0	17.0	534	12.3	3	0.01
84	53.0	19.0	25.0	400	6.0	5	0.00
85	49.0	32.0	35.0	296	7.8	8	0.01
86	51.0	31.0	28.0	110	13.2	9	0.02
87	38.0	31.0	31.0	289	8.5	10	0.16
88	37.0	28.0	18.0	440	19.5	8	0.45
89	38.0	22.0	21.0	336	14.1	10	0.00
90	44.0	26.0	27.0	256	17.2	10	0.12
91	36.0	31.0	26.0	136	15.0	10	0.01
92	36.0	16.0	22.0	184	14.3	8	0.00
93	44.0	30.0	31.0	276	18.3	10	0.16
94	38.0	27.0	17.0	396	18.3	8	0.04
95	40.0	15.0	13.0	550	6.7	3	0.00
96	41.0	26.0	17.0	300	12.5	9	0.00
97	39.0	19.0	22.0	385	8.1	8	0.00
98	41.0	7.0	18.0	122	8.7	8	0.00
99	46.0	24.0	18.0	394	8.3	7	0.02
100	58.0	18.0	20.0	482	11.0	4	0.00
101	58.0	40.0	40.0	584	12.8	10	0.00
102	52.0	36.0	32.0	297	20.4	8	0.18
103	56.0	33.0	31.0	568	15.7	5	0.00
104	52.0	34.0	41.0	379	21.9	8	0.00
105	42.0	27.0	8.0	394	17.0	7	0.00

Year 1982 (Cont'd)																																			
Temp						Dew						Solar						Wind						Cloud											
Day	Max	Min	Pt	Rad	SP	Day	Max	Min	Pt	Rad	SP	Day	Max	Min	Pt	Rad	SP	Day	Max	Min	Pt	Rad	SP	Day	Max	Min	Pt	Rad	SP	Day	Max	Min	Pt	Rad	SP
106	45.0	11.0	5.0	504	5.6	191	84.0	42.0	48.0	776	6.5	276	62.0	34.0	20.0	239	9.6	207	95.0	50.0	58.0	670	11.2	277	54.0	35.0	39.0	324	11.2	9	0.00	278	51.0	34.0	31.0
107	54.0	14.0	14.0	582	9.8	192	87.0	46.0	38.0	709	6.5	278	51.0	34.0	31.0	324	7.2	279	57.0	20.0	25.0	412	5.1	279	57.0	20.0	25.0	412	5.1	6	0.00	280	43.0	22.0	35.0
108	42.0	29.0	14.0	385	15.9	193	93.0	45.0	47.0	775	6.7	280	43.0	22.0	35.0	343	9.2	281	46.0	32.0	22.0	33.0	3.3	282	52.0	22.0	22.0	33.0	3.3	5.8	0.02	283	59.0	16.0	23.0
109	38.0	15.0	5.0	512	6.7	194	81.0	54.0	47.0	760	18.6	283	52.0	22.0	22.0	306	4.7	284	65.0	39.0	35.0	163	4.0	285	67.0	29.0	33.0	267	3.8	1	0.00	286	68.0	30.0	33.0
110	45.0	11.0	0.0	620	5.4	195	78.0	47.0	47.0	714	18.1	287	72.0	30.0	44.0	364	3.1	288	69.0	30.0	39.0	377	4.9	289	66.0	37.0	32.0	222	11.0	2	0.00	290	59.0	33.0	32.0
111	57.0	9.0	0.0	620	2.5	196	78.0	52.0	40.0	767	18.8	291	42.0	28.0	27.0	341	18.1	292	45.0	8.0	18.0	93	3.4	293	50.0	7.0	17.0	363	2.9	8	0.00	294	63.0	30.0	39.0
112	66.0	18.0	14.0	539	4.9	197	78.0	47.0	47.0	767	18.8	295	62.0	30.0	39.0	340	7.2	296	58.0	31.0	44.0	277	9.6	297	60.0	24.0	43.0	287	2.5	10	0.00	298	54.0	30.0	44.0
113	69.0	20.0	18.0	483	6.3	198	81.0	54.0	45.0	709	17.2	298	45.0	28.0	25.0	66	6.5	299	46.0	28.0	25.0	67	11.9	300	46.0	28.0	25.0	66	6.5	10	0.12	301	42.0	16.0	29.0
114	68.0	23.0	22.0	652	10.7	199	87.0	48.0	42.0	458	14.3	302	41.0	29.0	27.0	141	12.3	303	42.0	34.0	37.0	114	5.4	304	43.0	14.0	19.0	242	4.4	1	0.00	305	45.0	26.0	29.0
115	64.0	20.0	22.0	483	12.9	200	92.0	50.0	36.0	589	12.5	304	39.0	34.0	31.0	63	10.1	305	45.0	26.0	29.0	66	11.9	306	46.0	28.0	25.0	67	11.9	8	0.23	307	43.0	14.0	19.0
116	62.0	38.0	20.0	683	5.4	201	95.0	51.0	50.0	653	6.5	307	41.0	14.0	19.0	242	4.4	308	48.0	17.0	24.0	221	8.7	309	53.0	28.0	30.0	264	8.3	5	0.00	310	48.0	26.0	31.0
117	67.0	26.0	30.0	564	7.4	202	96.0	47.0	43.0	512	7.8	312	46.0	30.0	30.0	287	8.1	313	46.0	30.0	30.0	257	5.8	314	40.0	36.0	30.0	37	5.8	8	0.13	315	44.0	20.0	15.0
118	68.0	31.0	30.0	649	13.0	203	93.0	58.0	51.0	592	12.1	316	33.0	12.0	26.0	274	3.6	317	36.0	20.0	15.0	271	10.3	318	30.0	7.0	18.0	268	4.9	0	0.00	319	38.0	5.0	12.0
119	59.0	28.0	17.0	698	9.8	204	90.0	66.0	55.0	611	7.6	320	32.0	-2.0	15.0	120	3.1	321	44.0	25.0	25.0	156	7.4	322	42.0	12.0	12.0	256	3.8	7	0.00	323	44.0	25.0	25.0
120	64.0	28.0	22.0	451	6.0	205	83.0	60.0	62.0	634	5.1	324	36.0	30.0	25.0	236	6.9	325	36.0	30.0	25.0	51	18.1	326	28.0	12.0	9.0	246	4.5	4	0.00	327	26.0	-1.0	11.0
121	74.0	28.0	33.0	331	5.4	206	81.0	55.0	52.0	723	3.6	328	31.0	-2.0	12.0	168	3.6	329	32.0	-1.0	12.0	86	2.5	330	32.0	-2.0	15.0	120	3.1	6	0.00	331	33.0	21.0	31.0
122	77.0	45.0	35.0	459	15.3	207	95.0	50.0	58.0	670	11.2	332	33.0	21.0	31.0	188	1.3	333	37.0	27.0	33.0	46	11.9	334	34.0	-3.0	14.0	217	2.0	4	0.00	335	37.0	27.0	32.0
123	69.0	44.0	27.0	491	29.3	208	87.0	56.0	58.0	493	9.8	336	27.0	22.0	30.0	46	14.5	337	32.0	14.0	15.0	155	14.3	338	35.0	28.0	32.0	84	3.6	10	0.00	339	32.0	25.0	30.0
124	50.0	27.0	7.0	594	11.2	209	80.0	61.0	55.0	364	6.5	340	28.0	27.0	31.0	44	9.4	341	30.0	22.0	31.0	44	9.4	342	28.0	27.0	31.0	44	9.4	4	0.13	343	34.0	-3.0	14.0
125	56.0	14.0	10.0	464	10.7	210	81.0	56.0	53.0	628	8.1	344	26.0	-5.0	14.0	204	3.3	345	26.0	-5.0	14.0	204	3.3	346	26.0	-5.0	14.0	204	3.3	8	0.00	347	26.0	-3.0	17.0
126	63.0	29.0	23.0	674	8.7	211	89.0	53.0	50.0	605	6.5	348	23.0	6.0	18.0	136	2.5	349	36.0	6.0	28.0	136	2.5	350	44.0	27.0	22.0	43	17.4	10	0.00	351	39.0	23.0	28.0
127	63.0	31.0	25.0	725	12.9	212	92.0	52.0	50.0	730	8.9	352	32.0	15.0	22.0	142	8.7	353	32.0	15.0	22.0	142	8.7	354	32.0	15.0	22.0	142	8.7	5	0.00	355	35.0	17.0	24.0
128	58.0	33.0	30.0	595	7.8	213	90.0	48.0	46.0	657	15.0	356	33.0	27.0	32.0	63	10.1	357	35.0	27.0	32.0	213	1.8	358	33.0	27.0	32.0	63	10.1	9	0.00	359	37.0	27.0	32.0
129	53.0	36.0	37.0	731	9.4	214	80.0	52.0	41.0	527	8.1	360	27.0	22.0	25.0	43	12.8	361	27.0	22.0	25.0	43	12.8	362	27.0	22.0	25.0	43	12.8	10	0.00	363	35.0	27.0	32.0
130	47.0	28.0	33.0	666	5.4	215	81.0	44.0	44.0	665	17.0	364	27.0	22.0	25.0	43	12.8	365	27.0	22.0	25.0	43	12.8	366	27.0	22.0	25.0	43	12.8	10	0.00	367	35.0	27.0	32.0
131	51.0	35.0	32.0	350	5.4	216	91.0	43.0	36.0	561	8.1	368	27.0	22.0	25.0	43	12.8	369	27.0	22.0	25.0	43	12.8	370	27.0	22.0	25.0	43	12.8	10	0.00	371	35.0	27.0	32.0
132	57.0	25.0	30.0	682	2.9	217	95.0	45.0	45.0	465	8.1	372	27.0	22.0	25.0	43	12.8	373	27.0	22.0	25.0	43	12.8	374	27.0	22.0	25.0	43	12.8	10	0.00	375	35.0	27.0	32.0
133	66.0	31.0	26.0	738	7.6	218	95.0	50.0	50.0	537	4.9	376	27.0	22.0	25.0	43	12.8	377	27.0	22.0	25.0	43	12.8	378	27.0	22.0	25.0	43	12.8	10	0.00	379	35.0	27.0	32.0
134	70.0	31.0	25.0	601	5.1	219	96.0	49.0	41.0	458	8.7	380	27.0	22.0	25.0	43	12.8	381	27.0	22.0	25.0	43	12.8	382	27.0	22.0	25.0	43	12.8	10	0.00	383	35.0	27.0	32.0
135	70.0	34.0	38.0	726	6.3	220	85.0	64.0	55.0	529	12.1	384	27.0	22.0	25.0	43	12.8	385	27.0	22.0	25.0	43	12.8	386	27.0	22.0	25.0	43	12.8	10	0.00	387	35.0	27.0	32.0
136	66.0	42.0	39.0	637	3.8	221	85.0	55.0	52.0	527	8.1	388	27.0	22.0	25.0	43	12.8	389	27.0	22.0	25.0	43	12.8	390	27.0	22.0	25.0	43	12.8	10	0.00	391	35.0	27.0	32.0
137	72.0	32.0	37.0	416	6.5	222	92.0	53.0	42.0	434	8.9	392	27.0	22.0	25.0	43	12.8	393	27.0	22.0	25.0	43	12.8	394	27.0	22.0	25.0	43	12.8	10	0.00	395	35.0	27.0	32.0
138	58.0	47.0	44.0	328	10.5	223	87.0	48.0	44.0	433	13.0	396	27.0	22.0	25.0	43	12.8	397	27.0	22.0	25.0	43	12.8	398	27.0	22.0	25.0	43	12.8	10	0.00	399	35.0	27.0	32.0
139	51.0	40.0	37.0	758	6.0	224	88.0	49.0	41.0	458	8.7	400	27.0	22.0	25.0	43	12.8	401	27.0	22.0	25.0	43	12.8	402	27.0	22.0	25.0	43	12.8	10	0.00	403	35.0	27.0	32.0
140	63.0	28.0	34.0	385	4.3	225	86.0	39.0	47.0	443	8.9	404	27.0	22.0	25.0	43	12.8	405	27.0	22.0	25.0	43	12.8	406	27.0	22.0	25.0	43	12.8	10	0.00	407	35.0	27.0	32.0
141	72.0	32.0	31.0	666	4.5	226	85.0	53.0	47.0	451	5.1	408	27.0	22.0	25.0	43	12.8	409	27.0	22.0	25.0	43	12.8	410	27.0	22.0	25.0	43	12.8	10	0.00	411	35.0	27.0	32.0
142	73.0	35.0	43.0	765	5.4	227	89.0	52.0	44.0	651	7.8	412	27.0	22.0	25.0	43	12.8	413	27.0	22.0	25.0	43	12.8	414	27.0	22.0	25.0	43	12.8	10	0.00	415	35.0	27.0	32.0
143	71.0	35.0	41.0	767	6.7	228	93.0	46.0	50.0	588	6.9	416	27.0	22.0	25.0	43	12.8	417	27.0	22.0	25.0	43	12.8	418	27.0	22.0	25.0	43	12.8	10	0.00	419	35.0	27.0	32.0
144	73.0	44.0	29.0	657	12.1	229	95.0	50.0	43.0	670	7.6	420	27.0	22.0	25.0	43	12.8	421	27.0	22.0	25.0	43	12.8	422	27.0	22.0	25.0	43	12.8	10	0.00	423	35.0	27.0	32.0
145	81.0</																																		

	Temp		Dew	Solar	Wind	Cloud	
Day	Max	Min	Pt	Rad	Sp	Cov	Ppt
362	8.0-11.0		2.0	216	1.3	8	0.00
363	10.0-19.0		1.0	217	0.4	9	0.00
364	3.0-18.0		-5.0	207	0.4	10	0.00
365	9.0-18.0		-4.0	164	0.4	6	0.00

Year 1983

	Temp		Dew	Solar	Wind	Cloud	
Day	Max	Min	Pt	Rad	Sp	Cov	Ppt
1	10.0-15.0		3.0	170	0.7	6	0.00
2	13.0-17.0		5.0	177	0.4	6	0.00
3	25.0 4.0	20.0	72	0.4	10	0.00	
4	21.0 13.0	18.0	103	1.1	10	0.00	
5	41.0 20.0	31.0	148	12.5	10	0.00	
6	39.0 33.0	31.0	143	12.1	10	0.24	
7	36.0 34.0	32.0	183	11.0	10	0.18	
8	41.0 31.0	32.0	164	10.1	7	0.24	
9	28.0 17.0	29.0	196	7.6	8	0.00	
10	36.0 15.0	26.0	138	9.2	7	0.00	
11	32.0 5.0	21.0	143	0.7	1	0.00	
12	31.0 2.0	22.0	153	1.6	2	0.00	
13	30.0 2.0	15.0	70	1.1	0	0.00	
14	32.0 3.0	20.0	196	0.9	8	0.00	
15	32.0 0.0	18.0	189	0.4	3	0.00	
16	29.0 2.0	16.0	141	0.7	10	0.00	
17	32.0 20.0	25.0	50	0.7	10	0.00	
18	35.0 27.0	27.0	120	0.4	10	0.00	
19	35.0 28.0	28.0	151	2.9	10	0.00	
20	36.0 26.0	25.0	224	0.7	10	0.00	
21	33.0 18.0	25.0	211	0.4	10	0.00	
22	32.0 25.0	23.0	159	3.6	10	0.00	
23	36.0 24.0	27.0	64	7.8	9	0.00	
24	36.0 18.0	25.0	144	0.9	10	0.00	
25	31.0 17.0	28.0	95	1.8	10	0.00	
26	34.0 25.0	26.0	232	2.0	10	0.00	
27	40.0 18.0	30.0	276	1.6	10	0.00	
28	35.0 25.0	28.0	145	3.8	7	0.00	
29	25.0 13.0	25.0	256	4.3	10	0.00	
30	32.0 20.0	26.0	57	1.3	8	0.00	
31	36.0 23.0	23.0	128	1.1	10	0.00	
32	34.0 18.0	19.0	197	2.7	10	0.00	
33	30.0 0.0	15.0	226	1.8	7	0.00	
34	24.0 -4.0	10.0	214	2.2	3	0.00	
35	24.0 -9.0	9.0	172	5.8	6	0.00	
36	19.0-13.0	5.0	213	0.7	5	0.00	
37	20.0-11.0	10.0	273	0.9	9	0.00	
38	31.0 19.0	23.0	191	7.4	9	0.00	
39	31.0 18.0	22.0	105	2.9	10	0.00	
40	37.0 16.0	27.0	171	24.8	8	0.00	
41	38.0 25.0	29.0	256	6.0	7	0.00	
42	30.0 13.0	24.0	332	0.9	8	0.00	
43	41.0 16.0	26.0	310	0.4	10	0.00	
44	35.0 29.0	32.0	256	9.2	10	0.00	
45	39.0 22.0	28.0	193	2.5	6	0.00	
46	38.0 23.0	26.0	303	0.9	8	0.00	
47	38.0 28.0	30.0	71	7.6	8	0.08	
48	37.0 19.0	30.0	246	2.7	10	0.00	
49	40.0 22.0	28.0	271	3.8	10	0.00	
50	42.0 25.0	26.0	312	2.2	7	0.09	
51	38.0 13.0	20.0	188	0.7	6	0.00	
52	34.0 22.0	29.0	376	1.6	8	0.00	
53	36.0 12.0	26.0	198	0.9	9	0.00	
54	40.0 15.0	29.0	255	2.5	10	0.00	
55	43.0 14.0	32.0	143	1.3	4	0.00	
56	39.0 20.0	30.0	202	1.6	9	0.00	
57	37.0 33.0	30.0	257	10.3	9	0.18	
58	34.0 22.0	30.0	322	1.1	10	0.00	
59	42.0 28.0	33.0	98	6.9	9	0.28	
60	47.0 32.0	37.0	301	4.3	10	0.45	
61	43.0 37.0	32.0	183	4.7	9	0.35	
62	44.0 33.0	30.0	397	3.8	10	0.00	
63	45.0 29.0	40.0	253	3.8	10	0.00	
64	38.0 30.0	34.0	435	2.2	8	0.00	
65	43.0 25.0	22.0	205	5.6	7	0.00	
66	41.0 27.0	35.0	272	2.0	10	0.00	
67	44.0 22.0	31.0	451	0.7	8	0.00	
68	53.0 28.0	35.0	405	1.1	10	0.00	
69	60.0 27.0	37.0	399	1.1	10	0.00	
70	53.0 33.0	36.0	199	8.5	10	0.11	
71	46.0 28.0	29.0	115	6.7	9	0.08	
72	47.0 35.0	38.0	157	12.1	10	0.00	
73	43.0 32.0	28.0	351	8.9	8	0.43	
74	43.0 21.0	23.0	401	4.0	8	0.00	
75	42.0 18.0	26.0	338	3.6	6	0.00	
76	35.0 28.0	27.0	99	9.2	10	0.00	

	Temp		Dew	Solar	Wind	Cloud	
Day	Max	Min	Pt	Rad	Sp	Cov	Ppt
77	39.0 18.0	26.0	101	2.7	9	0.00	
78	33.0 24.0	18.0	485	2.7	10	0.00	
79	36.0 15.0	12.0	307	6.9	3	0.00	
80	44.0 18.0	18.0	202	0.7	8	0.00	
81	48.0 21.0	30.0	479	1.8	9	0.15	
82	45.0 32.0	31.0	529	11.0	10	0.14	
83	42.0 24.0	22.0	534	1.6	10	0.00	
84	40.0 25.0	26.0	400	0.9	10	0.00	
85	46.0 24.0	27.0	438	1.8	10	0.00	
86	38.0 25.0	34.0	271	6.7	10	0.00	
87	43.0 24.0	21.0	289	4.3	8	0.11	
88	44.0 24.0	27.0	542	5.4	10	0.00	
89	53.0 34.0	32.0	336	18.6	9	0.03	
90	49.0 33.0	33.0	256	8.5	9	0.02	
91	47.0 23.0	24.0	337	2.5	4	0.00	
92	42.0 32.0	33.0	372	5.6	9	0.00	
93	39.0 31.0	34.0	276	13.4	10	0.14	
94	38.0 27.0	13.0	520	22.1	8	0.00	
95	41.0 17.0	8.0	550	9.6	1	0.00	
96	45.0 9.0	12.0	300	1.8	1	0.00	
97	52.0 18.0	20.0	385	1.6	3	0.00	
98	51.0 23.0	27.0	249	2.9	6	0.00	
99	51.0 26.0	25.0	394	3.1	9	0.00	
100	45.0 36.0	30.0	482	7.8	10	0.00	
101	45.0 30.0	23.0	584	1.3	10	0.00	
102	46.0 22.0	22.0	466	6.7	10	0.00	
103	43.0 30.0	24.0	568	5.1	9	0.00	
104	49.0 14.0	17.0	379	0.9	4	0.00	
105	52.0 17.0	19.0	394	1.6	2	0.00	
106	57.0 18.0	22.0	504	3.8	1	0.00	
107	63.0 22.0	21.0	592	1.3	2	0.00	
108	61.0 32.0	25.0	385	2.0	10	0.00	
109	62.0 32.0	35.0	512	2.5	7	0.00	
110	63.0 39.0	32.0	620	2.7	10	0.00	
111	61.0 30.0	40.0	620	2.0	10	0.00	
112	62.0 37.0	40.0	539	1.1	9	0.00	
113	63.0 32.0	35.0	293	4.0	9	0.03	
114	52.0 36.0	30.0	652	15.0	9	0.00	
115	50.0 28.0	25.0	483	12.1	10	0.00	
116	51.0 25.0	24.0	683	5.1	6	0.00	
117	55.0 29.0	31.0	564	6.5	5	0.01	
118	55.0 19.0	32.0	649	1.8	10	0.00	
119	54.0 34.0	35.0	698	2.9	9	0.24	
120	51.0 39.0	38.0	451	2.0	10	0.00	
121	60.0 35.0	35.0	337	3.1	8	0.00	
122	56.0 35.0	39.0	459	6.0	9	0.00	
123	60.0 38.0	35.0	279	5.1	7	0.02	
124	62.0 29.0	33.0	446	2.2	5	0.04	
125	49.0 42.0	40.0	229	15.7	10	0.12	
126	59.0 38.0	32.0	573	4.5	7	0.06	
127	64.0 30.0	33.0	725	14.3	7	0.00	
128	61.0 36.0	28.0	595	17.2	7	0.00	
129	42.0 30.0	26.0	731	12.8	7	0.00	
130	50.0 24.0	23.0	734	12.3	9	0.00	
131	42.0 32.0	27.0	350	15.4	10	0.03	
132	47.0 29.0	23.0	733	4.3	9	0.00	
133	50.0 26.0	24.0	743	3.8	8	0.00	
134	56.0 22.0	24.0	601	2.9	3	0.00	
135	55.0 30.0	37.0	726	7.2	10	0.00	
136	54.0 28.0	33.0	493	3.6	10	0.05	
137	62.0 30.0	28.0	593	6.9	2	0.00	
138	58.0 45.0	43.0	543	6.3	10	0.00	
139	63.0 41.0	28.0	758	6.9	6	0.08	
140	69.0 34.0	35.0	579	9.2	5	0.00	
141	71.0 42.0	32.0	666	5.8	4	0.00	
142	73.0 31.0	34.0	765	2.2	0	0.00	
143	79.0 35.0	22.0	767	7.6	4	0.00	
144	81.0 36.0	36.0	657	7.6	1	0.00	
145	84.0 38.0	39.0	721	4.9	2	0.00	
146	84.0 40.0	40.0	538	4.0	1	0.00	
147	87.0 36.0	28.0	641	1.8	3	0.00	
148	88.0 46.0	34.0	553	3.8	2	0.00	
149	84.0 52.0	43.0	633	8.7	4	0.00	
150	73.0 52.0	34.0	779	16.8	2	0.00	
151	66.0 44.0	33.0	611	7.4	9	0.00	
152	66.0 43.0	42.0	726	3.8	6	0.00	
153	69.0 33.0	47.0	709	5.1	5	0.00	
154	71.0 47.0	46.0	657	3.8	9	0.00	
155	72.0 47.0	48.0	582	1.8	10	0.00	
156	66.0 46.0	46.0	525	2.9	5	0.00	
157	68.0 54.0	45.0	379	0.9	6	0.63	
158	72.0 46.0	42.0	425	2.0	2	0.00	
159	77.0 48.0	44.0	537	3.1	7	0.05	
160	75.0 49.0	52.0	385	6.3	8	0.04	
161	74.0 46.0	52.0	174	9.2	6	0.15	
162	81.0 46.0	42.0	485	14.8	9	0.00	

	Temp		Dew	Solar	Wind	Cloud	
Day							

Year 1983 (Cont'd)

Day	Temp	Dew	Solar	Wind	Cloud	Ppt
Max	Min	Pt	Rad	Sp	Cov	Ppt
249	74.0	32.0	29.0	544	3.4	6 0.00
250	85.0	42.0	40.0	520	4.3	4 0.00
251	85.0	51.0	42.0	194	2.9	8 0.02
252	78.0	47.0	25.0	433	12.5	1 0.00
253	66.0	25.0	25.0	490	8.1	1 0.00
254	72.0	52.0	39.0	446	1.6	1 0.00
255	77.0	42.0	38.0	464	2.0	1 0.00
256	80.0	35.0	37.0	521	2.0	2 0.00
257	83.0	42.0	34.0	349	5.6	2 0.00
258	81.0	34.0	35.0	536	0.9	1 0.00
259	78.0	32.0	34.0	451	5.4	0 0.00
260	83.0	53.0	30.0	244	17.0	10 0.00
261	73.0	47.0	36.0	444	12.5	1 0.00
262	75.0	34.0	25.0	455	11.9	7 0.00
263	46.0	14.0	11.0	228	4.0	1 0.00
264	56.0	16.0	15.0	495	2.2	1 0.02
265	70.0	22.0	24.0	501	3.6	5 0.00
266	76.0	32.0	33.0	446	3.1	8 0.00
267	78.0	40.0	43.0	393	2.0	1 0.00
268	75.0	33.0	37.0	485	2.0	0 0.00
269	79.0	35.0	42.0	480	1.6	10 0.00
270	78.0	52.0	52.0	475	4.3	10 0.22
271	62.0	37.0	35.0	298	1.6	10 0.37
272	62.0	42.0	47.0	363	1.8	10 0.05
273	60.0	48.0	43.0	226	5.4	9 0.36
274	53.0	37.0	42.0	91	2.2	10 0.58
275	59.0	40.0	42.0	140	5.1	9 0.26
276	57.0	38.0	34.0	239	9.8	9 0.00
277	69.0	34.0	45.0	343	5.4	2 0.00
278	72.0	32.0	40.0	324	1.8	1 0.00
279	72.0	34.0	39.0	412	6.3	3 0.00
280	69.0	45.0	38.0	418	2.5	2 0.00
281	72.0	31.0	38.0	419	1.3	6 0.00
282	62.0	49.0	49.0	234	4.3	9 0.39
283	60.0	41.0	38.0	82	4.9	7 0.05
284	58.0	29.0	35.0	163	2.0	3 0.00
285	63.0	27.0	31.0	267	1.1	3 0.00
286	53.0	34.0	39.0	325	1.3	9 0.00
287	44.0	40.0	37.0	235	2.5	10 0.14
288	52.0	31.0	32.0	249	1.6	7 0.13
289	57.0	24.0	33.0	222	1.6	3 0.00
290	61.0	26.0	34.0	241	1.6	6 0.00
291	54.0	35.0	27.0	317	3.4	7 0.00
292	57.0	22.0	24.0	235	1.1	1 0.00
293	65.0	20.0	27.0	363	1.1	5 0.00
294	68.0	25.0	33.0	357	6.9	0 0.00
295	69.0	28.0	35.0	340	1.8	3 0.00
296	50.0	44.0	42.0	277	5.1	10 0.00
297	56.0	20.0	27.0	152	1.1	2 0.12
298	57.0	20.0	32.0	287	1.6	0 0.00
299	66.0	20.0	32.0	111	1.3	1 0.00
300	68.0	20.0	33.0	173	1.3	1 0.00
301	61.0	22.0	34.0	237	0.9	6 0.00
302	64.0	25.0	34.0	141	0.9	5 0.00
303	56.0	24.0	34.0	249	1.1	10 0.00
304	63.0	32.0	43.0	185	1.6	7 0.00
305	58.0	38.0	44.0	252	1.6	8 0.00
306	57.0	42.0	42.0	108	5.8	6 0.09
307	61.0	38.0	42.0	221	2.7	6 0.00
308	62.0	32.0	39.0	153	4.3	10 0.00
309	53.0	44.0	39.0	264	6.7	9 0.00
310	61.0	37.0	42.0	294	6.7	7 0.00
311	45.0	38.0	20.0	253	9.2	10 0.10
312	43.0	24.0	20.0	287	3.4	7 0.00
313	38.0	17.0	28.0	183	2.5	10 0.00
314	46.0	28.0	28.0	280	2.5	9 0.00
315	47.0	38.0	38.0	87	8.3	10 0.30
316	48.0	28.0	29.0	274	3.1	6 0.00
317	42.0	32.0	25.0	158	10.7	8 0.16
318	42.0	28.0	25.0	138	8.3	7 0.02
319	42.0	28.0	28.0	225	3.1	10 0.00
320	46.0	22.0	31.0	256	7.2	8 0.00
321	43.0	38.0	35.0	52	11.6	10 0.16
322	44.0	26.0	28.0	93	6.5	7 0.03
323	32.0	16.0	26.0	58	4.9	9 0.00
324	35.0	20.0	25.0	70	2.0	10 0.00
325	35.0	11.0	19.0	50	10.7	10 0.00
326	29.0	7.0	10.0	246	11.0	6 0.00
327	31.0	7.0	21.0	244	4.9	10 0.00
328	33.0	27.0	23.0	48	4.5	10 0.00
329	37.0	16.0	27.0	48	7.4	10 0.00
330	35.0	8.0	19.0	120	3.4	3 0.00
331	32.0	12.0	16.0	155	2.5	10 0.00
332	26.0	6.0	22.0	188	3.1	10 0.00

Temp Dew Solar Wind Cloud

Day	Temp	Dew	Solar	Wind	Cloud	Ppt
Max	Min	Pt	Rad	Sp	Cov	Ppt
333	27.0	10.0	5.0	69	5.1	2 0.00
334	19.0	-15.0	11.0	108	5.1	10 0.00
335	28.0	-4.0	22.0	46	2.5	10 0.00
336	31.0	2.0	19.0	135	3.8	10 0.00
337	27.0	19.0	22.0	108	4.9	10 0.00
338	27.0	18.0	15.0	84	3.6	10 0.00
339	12.0	-3.0	8.0	58	2.5	9 0.00
340	29.0	8.0	25.0	44	5.8	10 0.00
341	39.0	7.0	25.0	44	4.7	10 0.00
342	37.0	12.0	24.0	219	13.4	9 0.00
343	29.0	12.0	25.0	218	6.7	10 0.00
344	37.0	28.0	28.0	217	14.5	6 0.03
345	35.0	16.0	30.0	204	5.6	10 0.00
346	34.0	32.0	28.0	48	9.2	10 0.35
347	33.0	25.0	22.0	168	4.9	10 0.00
348	25.0	12.0	15.0	136	1.8	10 0.00
349	29.0	12.0	21.0	43	3.4	10 0.00
350	18.0	14.0	14.0	190	1.3	10 0.00
351	23.0	-8.0	7.0	143	2.5	10 0.00
352	12.0	-16.0	5.0	142	2.5	10 0.00
353	11.0	-4.0	5.0	43	2.2	10 0.00
354	5.0	-19.0	-17.0	54	3.1	9 0.00
355	-3.0	-38.0	-20.0	213	3.8	8 0.00
356	6.0	-36.0	-23.0	164	4.3	3 0.00
357	-8.0	-47.0	-30.0	124	11.0	10 0.00
358	11.0	-38.0	-3.0	185	12.1	10 0.00
359	25.0	11.0	18.0	198	10.5	10 0.00
360	28.0	22.0	28.0	215	3.8	10 0.00
361	25.0	3.0	17.0	189	4.0	10 0.00
362	7.0	-20.0	-14.0	216	4.3	5 0.00
363	16.0	-18.0	9.0	217	2.9	10 0.00
364	25.0	13.0	20.0	53	2.5	10 0.00
365	26.0	14.0	22.0	164	2.0	10 0.00

Year 1984

Day	Temp	Dew	Solar	Wind	Cloud	Ppt
Max	Min	Pt	Rad	Sp	Cov	Ppt
1	24.0	13.0	21.4	170	3.4	10 0.00
2	21.0	5.0	10.3	177	2.5	9 0.00
3	27.0	5.0	15.8	222	2.5	10 0.00
4	29.0	10.0	25.6	103	2.5	10 0.00
5	34.0	25.0	28.3	148	1.8	10 0.00
6	33.0	25.0	25.0	143	2.0	10 0.00
7	35.0	25.0	20.4	183	1.3	3 0.00
8	30.0	24.0	18.5	164	1.3	6 0.00
9	30.0	23.0	20.5	196	1.8	10 0.00
10	26.0	6.0	16.1	138	2.0	10 0.00
11	22.0	-2.0	21.2	143	3.1	10 0.00
12	19.0	-3.0	19.0	153	2.5	10 0.00
13	24.0	13.0	14.4	48	12.3	10 0.00
14	21.0	13.0	14.4	196	16.1	10 0.00
15	9.0	-12.0	4.4	189	3.1	4 0.00
16	11.0	-1.0	2.6	141	2.0	10 0.00
17	3.0	-8.0	-17.9	50	9.6	0 0.00
18	-6.0	-34.0	-24.5	120	3.6	5 0.00
19	2.0	-29.0	-18.1	151	3.6	6 0.00
20	0.0	-31.0	-13.0	224	3.8	9 0.00
21	16.0	-6.0	3.3	211	2.2	10 0.00
22	13.0	-7.0	16.5	159	3.6	10 0.00
23	16.0	0.0	20.2	64	3.6	10 0.00
24	28.0	14.0	28.7	144	2.5	10 0.00
25	36.0	22.0	31.3	234	10.1	9 0.00
26	31.0	8.0	24.1	232	5.4	9 0.00
27	28.0	16.0	21.5	276	2.0	10 0.00
28	24.0	20.0	17.6	279	1.6	2 0.00
29	24.0	21.0	14.1	256	2.1	7 0.00
30	21.0	0.0	11.0	162	2.0	7 0.00
31	19.0	-6.0	8.5	128	1.8	2 0.00
32	23.0	1.0	13.6	197	2.0	5 0.00
33	14.0	-7.0	12.5	226	1.8	9 0.00
34	17.0	5.0	8.5	214	1.8	8 0.00
35	22.0	-8.0	6.7	172	2.0	8 0.00
36	24.0	-5.0	8.3	213	1.8	6 0.00
37	29.0	-4.0	11.3	273	1.6	5 0.00
38	22.0	-4.0	19.0	315	1.6	10 0.00
39	18.0	17.0	16.7	238	0.9	7 0.00
40	25.0	-5.0	11.2	171	2.2	9 0.00
41	31.0	21.0	24.3	122	4.5	10 0.00
42	14.0	-9.0	16.5	332	1.8	6 0.00
43	21.0	7.0	22.3	175	2.0	10 0.00
44	38.0	21.0	30.9	121	5.1	10 0.00
45	35.0	20.0	25.3	193	5.8	9 0.00
46	24.0	-3.0	14.8	303	2.5	9 0.00
47	29.0	19.0	26.0	71	4.3	10 0.00
48	35.0	25.0	24.4	108	4.7	10 0.00

Temp Dew Solar Wind Cloud

Day	Temp	Dew	Solar	Wind	Cloud	Ppt
Max	Min	Pt	Rad	Sp	Cov	Ppt
49	23.0	3.0	15.5	271	2.7	6 0.00
50	24.0	9.0	8.6	312	1.8	5 0.00
51	11.0	-18.0	-2.0	188	2.2	3 0.00
52	25.0	0.0	11.0	376	2.9	10 0.00
53	24.0	19.0	17.9	76	12.1	8 0.00
54	18.0	6.0	14.4	255	2.7	10 0.00
55	26.0	10.0	17.9	143	2.0	9 0.00
56	23.0	1.0	24.2	202	2.7	10 0.00
57	25.0	0.0	17.1	257	3.1	6 0.00
58	20.0	15.0	7.5	322	2.7	5 0.00
59	26.0	-8.0	7.2	249	2.0	8

Year 1984 (Cont'd)

Day	Temp		Dew Pt	Solar Rad	Wind Sp	Cloud	
	Max	Min				Cov	Ppt
135	83.0	52.0	45.6	645	2.7	7	0.10
136	58.0	46.0	40.0	493	14.1	10	0.12
137	50.0	33.0	29.0	416	14.1	7	0.21
138	70.0	24.0	30.7	543	7.2	10	0.00
139	70.0	32.0	34.9	758	10.3	4	0.00
140	75.0	32.0	38.7	579	11.4	9	0.00
141	67.0	47.0	38.5	666	18.1	10	0.00
142	63.0	37.0	28.1	765	17.7	10	0.00
143	66.0	25.0	30.5	767	2.7	0	0.00
144	74.0	33.0	39.8	657	10.3	8	0.00
145	59.0	45.0	33.1	721	6.0	9	0.00
146	61.0	40.0	31.7	538	3.8	8	0.00
147	69.0	36.0	36.0	641	9.2	4	0.00
148	68.0	27.0	31.9	553	2.2	4	0.00
149	77.0	29.0	34.0	633	1.8	3	0.00
150	86.0	32.0	39.6	779	1.8	0	0.00
151	84.0	44.0	44.6	611	5.6	7	0.00
152	64.0	41.0	27.4	726	16.3	6	0.00
153	64.0	27.0	19.6	709	2.9	0	0.00
154	72.0	27.0	32.8	657	2.0	7	0.00
155	58.0	41.0	41.1	366	2.7	8	0.25
156	52.0	35.0	42.3	525	5.4	10	0.00
157	57.0	40.0	39.8	590	8.9	8	0.00
158	59.0	40.0	42.4	158	10.7	9	0.40
159	59.0	38.0	39.8	537	4.7	7	0.26
160	55.0	37.0	31.8	385	5.8	5	0.55
161	56.0	37.0	33.2	174	3.4	7	0.81
162	47.0	36.0	39.9	485	7.4	10	0.00
163	57.0	34.0	41.0	645	4.9	7	0.00
164	70.0	30.0	42.3	793	2.9	8	0.00
165	61.0	46.0	47.9	543	2.5	9	0.28
166	82.0	38.0	48.1	692	4.3	8	0.07
167	78.0	43.0	47.2	438	3.1	9	0.16
168	74.0	48.0	42.6	680	1.3	6	0.00
169	77.0	44.0	33.2	598	1.3	1	0.00
170	69.0	41.0	44.9	612	1.3	9	0.00
171	79.0	38.0	44.1	538	3.6	4	0.00
172	79.0	49.0	46.2	788	3.1	7	0.08
173	65.0	44.0	35.0	794	10.1	4	0.00
174	68.0	36.0	35.6	692	2.7	1	0.00
175	77.0	37.0	38.7	793	2.0	0	0.00
176	86.0	37.0	41.8	771	2.2	3	0.00
177	87.0	46.0	42.7	773	2.2	1	0.00
178	86.0	45.0	42.3	784	2.0	1	0.00
179	85.0	46.0	42.2	791	2.7	2	0.00
180	90.0	44.0	42.4	619	2.0	1	0.00
181	87.0	50.0	47.8	790	4.0	8	0.00
182	77.0	52.0	30.9	789	2.7	5	0.00
183	80.0	33.0	31.6	764	1.1	0	0.00
184	85.0	40.0	39.6	611	2.7	0	0.00
185	82.0	46.0	39.1	670	2.0	0	0.00
186	87.0	43.0	36.5	540	1.8	0	0.00
187	91.0	40.0	35.0	783	1.8	0	0.00
188	90.0	49.0	46.6	686	2.9	7	0.00
189	86.0	58.0	49.9	570	8.5	3	0.00
190	82.0	50.0	42.4	638	14.1	3	0.00
191	93.0	39.0	38.5	709	2.9	6	0.00
192	81.0	38.0	40.5	776	1.8	0	0.00
193	88.0	38.0	40.3	775	2.0	0	0.00
194	87.0	47.0	43.4	753	4.3	5	0.00
195	86.0	43.0	37.1	760	1.8	1	0.00
196	87.0	38.0	33.3	714	1.1	1	0.00
197	90.0	40.0	35.3	767	1.6	0	0.00
198	92.0	43.0	36.5	709	1.6	0	0.00
199	93.0	43.0	36.8	458	2.0	0	0.00
200	96.0	50.0	44.3	589	2.5	3	0.00
201	87.0	61.0	50.5	507	2.0	6	0.04
202	84.0	50.0	51.3	512	6.3	9	0.00
203	73.0	53.0	53.6	592	6.7	10	0.18
204	67.0	52.0	54.8	441	1.1	10	0.22
205	73.0	58.0	58.4	634	1.3	8	0.00
206	89.0	47.0	55.7	747	1.8	3	0.00
207	92.0	49.0	55.5	670	2.0	1	0.00
208	90.0	56.0	55.6	249	2.7	6	0.09
209	80.0	63.0	60.3	364	1.3	10	0.78
210	77.0	58.0	58.9	628	1.3	8	0.08
211	78.0	58.0	58.3	444	1.1	9	0.70
212	83.0	50.0	54.3	730	1.3	6	0.00
213	85.0	51.0	52.5	727	1.8	9	0.00
214	83.0	61.0	53.8	657	4.0	7	0.00
215	85.0	56.0	54.5	552	2.2	4	0.01
216	86.0	58.0	50.1	626	1.8	3	0.00
217	87.0	54.0	51.2	561	8.1	4	0.00
218	84.0	52.0	52.8	465	1.6	4	0.00

Day	Temp		Dew Pt	Solar Rad	Wind Sp	Cloud	
	Max	Min				Cov	Ppt
219	88.0	52.0	50.4	537	2.7	1	0.00
220	87.0	45.0	42.5	549	1.1	2	0.00
221	90.0	47.0	43.0	459	0.9	0	0.00
222	91.0	47.0	46.0	434	1.1	2	0.00
223	95.0	46.0	45.9	433	1.6	3	0.00
224	83.0	59.0	50.3	245	9.2	8	0.02
225	89.0	51.0	48.2	448	7.4	4	0.00
226	81.0	61.0	50.4	453	10.1	10	0.00
227	84.0	41.0	51.1	651	4.0	3	0.00
228	88.0	53.0	54.9	454	4.7	5	0.06
229	78.0	59.0	58.8	670	3.1	9	0.25
230	86.0	51.0	52.8	666	4.0	2	0.00
231	89.0	50.0	49.1	612	4.0	4	0.00
232	86.0	56.0	53.5	471	9.6	9	0.00
233	82.0	45.0	34.0	611	2.9	0	0.00
234	83.0	38.0	36.3	537	3.4	1	0.00
235	87.0	43.0	43.1	645	4.3	4	0.00
236	83.0	55.0	51.1	543	3.6	8	0.00
237	86.0	45.0	49.6	190	4.0	3	0.06
238	66.0	53.0	52.8	587	2.0	9	0.03
239	84.0	49.0	48.5	608	2.0	3	0.00
240	88.0	47.0	47.6	456	11.4	4	0.00
241	83.0	54.0	41.5	618	27.1	1	0.00
242	87.0	54.0	41.5	614	7.2	0	0.00
243	88.0	47.0	46.6	573	3.8	7	0.00
244	66.0	55.0	47.3	502	18.3	7	0.00
245	72.0	40.0	40.5	473	11.4	2	0.24
246	78.0	35.0	37.4	545	5.1	1	0.00
247	84.0	37.0	38.4	587	3.1	6	0.00
248	89.0	41.0	40.7	586	4.5	4	0.00
249	83.0	51.0	49.8	544	5.1	9	0.00
250	65.0	50.0	41.7	520	17.7	8	0.00
251	69.0	32.0	35.8	381	8.1	8	0.00
252	78.0	38.0	44.5	433	7.4	7	0.00
253	82.0	35.0	45.3	490	10.3	1	0.00
254	75.0	39.0	36.3	446	5.1	8	0.00
255	79.0	34.0	37.7	464	9.6	6	0.00
256	74.0	42.0	30.9	521	10.7	0	0.00
257	78.0	29.0	31.0	349	4.3	1	0.00
258	76.0	33.0	31.9	536	5.4	0	0.00
259	83.0	49.0	41.5	451	3.8	7	0.00
260	83.0	40.0	41.5	244	2.5	1	0.00
261	86.0	36.0	36.5	444	2.0	0	0.00
262	88.0	37.0	39.0	455	2.9	0	0.00
263	87.0	38.0	40.8	384	2.7	1	0.00
264	79.0	48.0	47.5	495	10.3	7	0.00
265	57.0	44.0	34.4	501	7.8	5	0.00
266	57.0	26.0	27.1	319	3.4	8	0.01
267	57.0	37.0	28.9	393	4.7	9	0.00
268	48.0	16.0	25.3	485	3.8	8	0.00
269	57.0	16.0	23.3	480	4.0	2	0.00
270	66.0	34.0	23.1	475	5.6	2	0.00
271	62.0	24.0	25.7	425	7.4	2	0.00
272	61.0	28.0	22.4	465	6.0	0	0.00
273	67.0	17.0	21.8	368	3.6	3	0.00
274	72.0	22.0	26.8	199	5.4	6	0.00
275	76.0	43.0	42.2	298	6.0	8	0.00
276	73.0	37.0	39.0	239	4.5	5	0.00
277	72.0	35.0	37.2	343	2.9	1	0.00
278	74.0	30.0	33.8	324	3.1	0	0.00
279	71.0	31.0	33.6	412	4.9	6	0.00
280	72.0	26.0	29.3	418	3.6	4	0.00
281	74.0	29.0	31.3	419	2.5	1	0.00
282	76.0	30.0	33.6	366	2.0	0	0.00
283	77.0	29.0	34.7	208	3.6	2	0.00
284	75.0	29.0	34.0	163	4.5	2	0.00
285	69.0	40.0	34.4	267	13.4	10	0.00
286	54.0	33.0	31.5	325	17.2	8	0.00
287	59.0	44.0	31.8	364	16.3	9	0.00
288	46.0	22.0	25.8	377	4.7	5	0.00
289	44.0	10.0	25.0	222	6.5	9	0.00
290	45.0	9.0	21.3	241	4.5	5	0.00
291	34.0	23.0	29.6	182	8.5	10	0.00
292	39.0	15.0	23.1	93	9.6	9	0.00
293	40.0	18.0	24.8	363	5.1	9	0.00
294	40.0	24.0	20.9	357	4.9	9	0.00
295	43.0	25.0	21.5	340	2.7	5	0.12
296	44.0	14.0	21.6	277	2.5	6	0.00
297	47.0	10.0	21.8	287	6.9	2	0.00
298	43.0	31.0	28.8	287	4.7	9	0.20
299	51.0	23.0	27.0	111	7.8	7	0.00
300	41.0	37.0	28.5	173	12.1	10	0.00
301	39.0	21.0	21.3	102	12.5	7	0.00
302	43.0	15.0	20.8	141	14.5	5	0.00
303	48.0	31.0	30.6	249	19.5	9	0.12
304	49.0	10.0	27.5	185	9.6	9	0.00

Year 1985 (Cont'd)

Day	Temp	Dew	Solar	Wind	Cloud	Ppt
Max	Min	Pt	Rad	Sp	Cov	Ppt
20	27.0	10.0	20.0	224	2.2	10 0.00
21	34.0	8.0	22.5	75	2.0	10 0.00
22	14.0	-6.0	14.5	52	1.8	10 0.00
23	17.0	-12.0	3.5	193	2.5	5 0.00
24	20.0	-14.0	-5.0	144	2.2	9 0.00
25	20.0	-14.0	-3.1	234	1.8	6 0.00
26	23.0	-13.0	-1.3	232	2.5	7 0.00
27	14.0	-14.0	-5.7	276	2.5	10 0.00
28	23.0	-9.0	7.5	145	1.3	10 0.00
29	20.0	-9.0	11.8	256	4.0	10 0.00
30	8.0	-27.0	-11.8	162	2.7	6 0.00
31	-1.0	-35.0	-23.9	128	2.5	6 0.00
32	-9.0	-36.0	-24.3	197	4.0	10 0.00
33	8.0	-24.0	-8.3	226	4.0	10 0.00
34	5.0	-26.0	-8.2	214	3.8	10 0.00
35	3.0	-34.0	-18.6	172	6.0	5 0.00
36	7.0	-17.0	-2.8	213	4.3	10 0.00
37	13.0	-21.0	-4.8	273	4.5	10 0.00
38	25.0	-8.0	13.6	315	6.0	10 0.00
39	30.0	2.0	24.8	105	22.8	10 0.00
40	19.0	-5.0	12.7	65	3.6	5 0.00
41	19.0	-13.0	13.8	256	3.8	9 0.00
42	17.0	-15.0	16.3	332	2.2	10 0.00
43	29.0	16.0	28.0	310	2.2	7 0.00
44	29.0	-1.0	24.3	256	2.0	10 0.00
45	27.0	-3.0	20.5	327	3.4	9 0.00
46	31.0	-2.0	20.0	303	2.0	9 0.00
47	27.0	-3.0	22.5	203	2.0	10 0.00
48	27.0	-3.0	17.7	246	2.2	9 0.00
49	23.0	-6.0	12.9	271	2.0	9 0.00
50	23.0	-10.0	14.4	312	2.5	5 0.00
51	32.0	5.0	23.7	74	3.6	10 0.00
52	23.0	-2.0	19.5	376	3.8	9 0.00
53	29.0	5.0	22.5	198	2.5	10 0.00
54	25.0	8.0	20.4	255	2.7	9 0.00
55	30.0	17.0	24.6	143	1.6	10 0.00
56	31.0	7.0	22.4	202	4.3	5 0.00
57	21.0	-11.0	13.0	257	2.9	9 0.00
58	25.0	-10.0	13.6	322	4.0	2 0.00
59	24.0	-8.0	14.5	249	2.7	5 0.00
60	27.0	-1.0	21.8	301	3.8	10 0.00
61	27.0	19.0	22.9	183	11.2	10 0.00
62	27.0	-5.0	10.3	272	14.8	8 0.00
63	15.0	-14.0	6.3	253	5.4	10 0.00
64	21.0	6.0	19.8	435	4.5	10 0.00
65	32.0	15.0	21.3	88	8.9	10 0.00
66	21.0	-2.0	11.7	272	6.9	9 0.00
67	28.0	-3.0	17.0	451	2.9	9 0.00
68	32.0	-8.0	11.4	405	2.0	6 0.00
69	33.0	-1.0	19.8	399	5.8	10 0.00
70	26.0	-2.0	17.2	345	2.7	8 0.00
71	32.0	3.0	22.9	282	4.5	4 0.00
72	32.0	-1.0	15.6	157	2.0	3 0.00
73	32.0	-6.0	14.5	465	2.2	5 0.00
74	36.0	-5.0	16.3	401	3.4	2 0.00
75	36.0	-1.0	19.0	338	2.5	3 0.00
76	43.0	1.0	21.7	107	2.5	4 0.00
77	43.0	7.0	24.4	283	2.5	6 0.00
78	40.0	10.0	27.0	485	2.9	1 0.00
79	42.0	9.0	26.0	307	2.5	6 0.00
80	29.0	15.0	22.7	202	10.7	9 0.00
81	29.0	10.0	21.8	479	14.1	6 0.00
82	35.0	6.0	29.5	529	5.1	10 0.00
83	48.0	11.0	27.6	534	4.9	8 0.00
84	30.0	25.0	28.2	400	14.8	10 0.00
85	31.0	17.0	21.3	438	13.6	6 0.00
86	32.0	15.0	23.0	110	22.1	6 0.00
87	27.0	2.0	19.7	436	6.0	10 0.00
88	35.0	-3.0	18.3	542	6.9	1 0.00
89	33.0	6.0	25.1	471	5.8	9 0.00
90	44.0	16.0	33.3	417	3.6	7 0.00
91	45.0	25.0	34.5	337	2.2	8 0.18
92	47.0	17.0	34.4	372	2.2	1 0.00
93	44.0	17.0	31.2	436	7.8	5 0.00
94	46.0	27.0	23.5	520	9.2	6 0.27
95	49.0	21.0	30.3	550	6.5	2 0.18
96	55.0	20.0	28.8	300	2.2	0 0.33
97	57.0	20.0	31.3	385	2.2	8 0.39
98	64.0	29.0	36.8	249	3.4	2 0.87
99	64.0	28.0	34.3	394	1.3	0 0.84
100	70.0	27.0	35.0	482	2.5	3 0.25
101	66.0	36.0	35.3	584	6.7	5 0.00
102	65.0	30.0	31.6	466	1.6	3 0.00
103	70.0	28.0	31.8	568	1.3	3 0.00

Day	Temp	Dew	Solar	Wind	Cloud	Ppt
Max	Min	Pt	Rad	Sp	Cov	Ppt
104	76.0	30.0	32.4	379	1.6	1 0.00
105	77.0	35.0	34.3	394	1.6	9 0.00
106	74.0	41.0	26.6	504	6.5	9 0.00
107	70.0	42.0	34.3	592	11.6	9 0.00
108	65.0	43.0	32.0	385	15.7	5 0.00
109	49.0	27.0	23.2	512	25.9	7 0.00
110	43.0	22.0	17.0	620	17.9	7 0.00
111	47.0	30.0	27.9	620	15.4	10 0.00
112	50.0	33.0	26.2	385	12.3	8 0.06
113	54.0	27.0	25.8	483	13.9	8 0.00
114	49.0	20.0	17.0	652	8.7	8 0.00
115	49.0	29.0	16.8	483	14.3	9 0.00
116	58.0	33.0	15.8	683	14.8	1 0.60
117	67.0	29.0	18.6	658	7.2	9 0.00
118	74.0	30.0	25.9	649	10.5	8 0.00
119	74.0	35.0	31.8	698	9.6	3 0.00
120	76.0	35.0	30.4	451	6.0	0 0.00
121	82.0	31.0	30.5	337	6.0	8 0.00
122	83.0	42.0	34.4	459	8.7	10 0.00
123	75.0	45.0	41.4	491	16.1	9 0.00
124	57.0	31.0	19.8	446	15.4	1 0.02
125	63.0	23.0	18.3	464	6.9	1 0.00
126	76.0	32.0	30.1	674	8.1	6 0.00
127	76.0	44.0	26.8	725	11.6	4 0.00
128	74.0	32.0	28.9	595	11.6	8 0.00
129	67.0	40.0	36.4	731	8.3	10 0.00
130	53.0	40.0	41.9	666	6.9	10 0.08
131	55.0	36.0	27.3	350	21.9	6 0.17
132	55.0	30.0	20.7	733	6.9	2 0.00
133	62.0	17.0	19.3	743	6.3	0 0.00
134	60.0	27.0	29.8	601	10.1	7 0.00
135	58.0	41.0	39.3	645	8.3	9 0.22
136	74.0	46.0	41.2	493	12.5	4 0.19
137	68.0	43.0	40.7	593	8.1	3 0.00
138	76.0	40.0	38.5	328	4.5	3 0.05
139	76.0	38.0	38.5	758	5.1	4 0.00
140	66.0	40.0	42.9	579	8.9	9 0.00
141	74.0	38.0	42.5	666	5.4	5 0.00
142	80.0	41.0	41.4	765	6.9	3 0.00
143	82.0	42.0	40.5	767	5.8	3 0.00
144	83.0	45.0	42.0	657	7.2	6 0.00
145	78.0	48.0	47.1	622	8.5	8 0.08
146	76.0	42.0	44.8	303	6.9	8 0.02
147	72.0	44.0	47.9	641	7.2	9 0.00
148	70.0	42.0	45.0	326	10.7	6 0.08
149	70.0	38.0	32.5	633	19.9	7 0.00
150	70.0	37.0	30.5	779	18.3	5 0.00
151	70.0	34.0	34.2	611	7.2	6 0.00
152	70.0	42.0	40.1	622	14.8	9 0.02
153	70.0	37.0	35.3	590	6.3	5 0.14
154	74.0	35.0	38.7	657	5.4	3 0.00
155	72.0	46.0	41.6	582	9.8	10 0.00
156	74.0	56.0	45.8	525	17.9	8 0.00
157	77.0	53.0	46.5	590	18.3	8 0.00
158	92.0	46.0	45.6	425	14.1	3 0.00
159	76.0	52.0	37.8	681	18.8	4 0.00
160	78.0	40.0	30.3	595	9.4	3 0.00
161	76.0	48.0	31.1	475	10.3	6 0.00
162	79.0	38.0	32.7	485	4.9	2 0.00
163	83.0	39.0	36.7	645	8.1	8 0.00
164	84.0	48.0	39.3	793	13.9	5 0.00
165	82.0	44.0	39.5	687	8.9	2 0.00
166	85.0	47.0	42.9	771	14.3	0 0.00
167	85.0	52.0	39.8	628	7.2	0 0.00
168	87.0	53.0	40.6	680	7.2	2 0.00
169	89.0	51.0	39.5	598	7.8	0 0.00
170	93.0	48.0	40.0	612	6.7	1 0.00
171	90.0	62.0	40.9	538	17.9	4 0.00
172	80.0	52.0	31.3	794	12.8	0 0.00
173	87.0	44.0	33.3	794	13.4	0 0.00
174	89.0	48.0	39.5	692	13.9	5 0.00
175	55.0	43.0	34.8	793	14.8	10 0.00
176	57.0	43.0	40.0	771	8.5	10 0.00
177	68.0	35.0	34.2	695	5.4	1 0.01
178	78.0	37.0	36.3	713	5.8	1 0.23
179	86.0	46.0	40.4	791	6.7	10 0.00
180	88.0	45.0	42.3	619	10.1	7 0.00
181	90.0	41.0	40.3	790	8.3	4 0.00
182	93.0	52.0	42.8	789	6.0	5 0.00
183	96.0	46.0	42.6	764	6.9	9 0.00
184	98.0	49.0	40.3	611	7.4	2 0.00
185	99.0	49.0	42.8	670	9.6	9 0.00
186	98.0	52.0	42.1	540	11.4	0 0.00
187	98.0	60.0	44.8	783	11.0	5 0.00
188	95.0	71.0	46.2	686	12.8	9 0.00
189	95.0	60.0	48.7	570	6.9	3 0.00

	Temp		Dew	Solar	Wind	Cloud	
Day	Max	Min	Pt	Rad	Sp	Cov	Ppt
190	99.0	52.0	49.6	638	6.7	4	0.00
191	97.0	56.0	50.3	709	6.3	8	0.00
192	87.0	65.0	53.8	776	8.3	8	0.00
193	77.0	57.0	54.3	775	7.4	7	0.24
194	85.0	48.0	48.8	670	6.7	5	0.07
195	91.0	48.0	48.1	760	4.7	4	0.00
196	96.0	54.0	46.2	606	6.7	4	0.38
197	92.0	55.0	48.4	767	8.3	8	0.00
198	89.0	58.0	50.2	600	8.3	6	0.01
199	91.0	52.0	48.7	167	6.9	3	0.15
200	91.0	53.0	46.4	589	5.4	4	0.00
201	93.0	52.0	43.0	653	3.8	3	0.00
202	90.0	54.0	51.5	512	6.7	8	0.00
203	88.7	55.0	52.8	701	7.4	10	0.00
204	76.0	58.0	52.6	441	8.5	9	0.23
205	84.0	52.0	43.0	482	7.2	0	0.05
206	89.0	48.0	36.5	747	6.7	0	0.00
207	95.0	45.0	41.6	670	8.3	2	0.00
208	92.0	60.0	40.6	493	6.0	8	0.00
209	88.0	52.0	48.7	560	8.3	9	0.00
210	79.0	56.0	51.3	628	9.2	9	0.20
211	74.0	49.0	50.6	444	8.9	8	0.40
212	80.0	45.0	43.1	692	8.3	1	0.56
213	83.0	50.0	44.6	727	7.4	7	0.00
214	72.0	48.0	40.0	537	17.2	6	0.02
215	79.0	46.0	38.1	665	3.6	2	0.00
216	88.0	46.0	39.0	626	6.5	2	0.00
217	87.0	54.0	43.3	561	8.9	6	0.00
218	88.0	47.0	38.5	465	5.8	0	0.00
219	90.0	53.0	38.5	537	13.9	4	0.00
220	71.0	54.0	29.0	549	25.5	4	0.00
221	74.0	35.0	31.3	459	11.6	0	0.00
222	83.0	40.0	28.6	434	13.9	3	0.00
223	64.0	42.0	35.4	433	8.9	6	0.00
224	76.0	38.0	33.9	465	13.6	0	0.00
225	74.0	43.0	35.0	448	7.8	2	0.00
226	76.0	42.0	30.9	453	6.9	9	0.00
227	84.0	39.0	28.1	651	15.2	1	0.00
228	79.0	43.0	33.1	588	6.7	0	0.00
229	47.0	41.0	31.3	670	6.0	0	0.00
230	88.0	50.0	40.0	666	5.8	8	0.00
231	82.0	53.0	37.0	612	12.8	3	0.00
232	84.0	44.0	34.2	471	10.1	3	0.00
233	79.0	48.0	37.0	611	19.9	2	0.00
234	80.0	47.0	34.0	537	11.0	3	0.00
235	85.0	37.0	26.5	645	4.0	2	0.00
236	91.0	38.0	28.3	543	5.6	5	0.00
237	96.0	41.0	35.5	406	8.7	5	0.00
238	94.0	47.0	36.7	632	6.7	8	0.00
239	90.0	51.0	37.1	608	9.2	3	0.00
240	88.0	49.0	33.0	456	10.3	2	0.00
241	88.0	40.0	27.8	618	8.9	7	0.00
242	85.0	42.0	38.2	614	15.4	2	0.00
243	78.0	56.0	32.3	573	20.8	7	0.00
244	75.0	46.0	41.8	502	6.5	8	0.00
245	67.0	48.0	48.3	473	7.2	6	0.14
246	76.0	36.0	45.2	427	3.8	0	0.25
247	80.0	41.0	44.1	587	9.8	1	0.00
248	71.0	52.0	43.2	586	24.2	10	0.00
249	73.0	50.0	38.3	544	12.1	4	0.00
250	74.0	47.0	39.2	520	6.7	4	0.00
251	60.0	47.0	48.0	194	9.2	10	0.02
252	64.0	45.0	47.3	273	11.0	6	0.61
253	70.0	42.0	39.7	359	8.1	6	0.27
254	65.0	46.0	44.5	446	10.3	9	0.00
255	57.0	38.0	36.8	325	17.4	6	0.38
256	70.0	33.0	33.3	521	8.7	7	0.00
257	72.0	43.0	36.0	349	6.7	2	0.00
258	65.0	42.0	37.7	536	12.1	1	0.00
259	65.0	36.0	32.6	451	23.5	0	0.00
260	54.0	41.0	34.9	244	17.4	9	0.00
261	57.0	41.0	39.6	444	4.7	10	0.00
262	60.0	33.0	33.6	455	6.5	4	0.00
263	65.0	26.0	29.9	384	6.7	1	0.00
264	65.0	43.0	36.5	495	15.0	10	0.00
265	59.0	35.0	28.0	501	6.3	4	0.00
266	61.0	22.0	22.3	446	8.7	3	0.00
267	69.0	40.0	24.0	393	12.5	8	0.00
268	64.0	34.0	26.3	485	6.0	0	0.00
269	70.0	29.0	26.3	480	8.7	6	0.00
270	55.0	30.0	26.9	475	14.3	2	0.00
271	48.0	26.0	14.4	425	9.4	2	0.00
272	53.0	16.0	15.1	465	4.5	0	0.00
273	62.0	15.0	17.0	368	3.8	2	0.00
274	59.0	19.0	19.1	199	5.6	7	0.00
275	65.0	27.0	27.7	298	9.4	9	0.00

Year 1985 (Cont'd)

Day	Temp		Dew	Solar	Wind	Cloud	
	Max	Min				Cov	Ppt
276	66.0	34.0	29.5	239	12.1	8	0.00
277	61.0	24.0	15.9	343	3.8	0	0.00
278	70.0	22.0	20.8	324	4.0	2	0.00
279	68.0	29.0	29.2	412	9.2	10	0.00
280	49.0	23.0	33.3	418	20.4	9	0.00
281	31.0	19.0	19.8	343	7.6	10	0.00
282	44.0	20.0	17.1	234	4.3	4	0.00
283	50.0	14.0	21.0	208	3.1	0	0.00
284	56.0	17.0	25.6	163	10.1	6	0.11
285	47.0	26.0	28.0	267	14.8	8	0.00
286	52.0	16.0	22.0	325	7.6	0	0.00
287	54.0	18.0	20.3	364	13.4	6	0.00
288	62.0	28.0	25.8	377	7.8	0	0.00
289	64.0	23.0	25.2	222	9.4	2	0.00
290	60.0	24.0	26.8	241	5.8	0	0.00
291	65.0	19.0	26.6	317	4.0	4	0.00
292	68.0	22.0	26.2	235	3.4	3	0.00
293	69.0	35.0	26.8	363	14.1	9	0.00
294	59.0	35.0	32.4	357	16.6	10	0.00
295	37.0	30.0	30.0	208	20.8	9	0.17
296	52.0	34.0	37.1	277	25.5	9	0.00
297	57.0	35.0	40.1	287	12.3	3	0.00
298	60.0	33.0	37.5	287	14.8	4	0.00
299	58.0	29.0	36.5	111	4.7	6	0.00
300	66.0	24.0	31.3	173	4.7	2	0.00
301	58.0	29.0	32.3	237	17.7	0	0.00
302	58.0	18.0	27.8	141	3.4	1	0.00
303	52.0	21.0	29.3	249	11.6	9	0.00
304	45.0	25.0	23.2	185	12.8	2	0.00
305	48.0	18.0	28.1	252	11.6	8	0.00
306	55.0	23.0	32.7	242	8.5	10	0.00
307	59.0	19.0	30.8	221	4.9	4	0.00
308	60.0	20.0	30.4	153	6.9	7	0.00
309	42.0	26.0	21.7	264	20.8	4	0.00
310	48.0	25.0	24.8	294	19.7	8	0.00
311	46.0	31.0	30.5	290	18.6	10	0.00
312	42.0	15.0	27.3	287	19.2	6	0.00
313	31.0	7.0	20.2	183	8.3	10	0.00
314	27.0	11.0	18.5	280	6.7	10	0.00
315	30.0	19.0	23.8	87	11.0	10	0.00
316	32.0	18.0	19.3	274	11.2	10	0.00
317	29.0	19.0	20.7	271	3.1	10	0.00
318	30.0	21.0	20.3	268	1.6	10	0.00
319	29.0	18.0	17.0	225	3.6	4	0.00
320	27.0	18.0	23.3	256	2.5	10	0.00
321	29.0	22.0	23.3	156	9.6	10	0.00
322	23.0	5.0	19.0	93	8.7	10	0.00
323	18.0	3.0	9.9	51	8.3	6	0.00
324	23.0	8.0	16.0	70	4.5	10	0.00
325	16.0	-9.0	11.5	153	15.9	9	0.00
326	17.0	-20.0	6.5	246	8.9	9	0.00
327	4.0	-21.0	-0.2	244	5.6	9	0.00
328	18.0	-10.0	12.0	168	2.7	10	0.00
329	27.0	8.0	22.9	48	21.9	8	0.00
330	23.0	-12.0	6.9	120	4.3	4	0.00
331	29.0	-6.0	19.6	155	7.6	9	0.00
332	18.0	0.0	17.8	188	2.9	10	0.00
333	27.0	15.0	23.6	69	4.7	10	0.00
334	16.0	2.0	14.9	46	5.8	10	0.00
335	15.0	4.0	16.0	160	4.9	10	0.00
336	36.0	15.0	25.8	45	6.0	10	0.00
337	37.0	10.0	28.3	45	17.7	6	0.00
338	23.0	-2.0	11.3	224	2.9	7	0.00
339	31.0	1.0	14.7	208	4.3	10	0.00
340	22.0	-1.0	17.4	133	2.9	10	0.00
341	27.0	20.0	29.2	123	5.6	10	0.00
342	29.0	23.0	27.7	86	9.2	10	0.00
343	31.0	6.0	12.2	218	12.8	9	0.00
344	21.0	-5.0	4.7	217	14.1	9	0.00
345	8.0	-23.0	-11.3	204	4.0	1	0.00
346	8.0	-19.0	-3.9	197	2.0	10	0.00
347	11.0	-10.0	6.1	168	2.5	10	0.00
348	19.0	-7.0	5.0	136	1.8	10	0.00
349	19.0	-10.0	-1.5	130	4.0	10	0.00
350	20.0	-10.0	-2.6	190	2.7	6	0.00
351	17.0	-3.0	-1.8	143	2.2	9	0.00
352	19.0	-1.0	3.2	142	1.3	10	0.00
353	24.0	4.0	3.0	186	1.3	8	0.00
354	24.0	12.0	2.5	213	2.0	4	0.00
355	21.0	-6.0	0.8	213	1.8	5	0.00
356	19.0	-7.0	-1.1	164	1.3	4	0.00
357	12.0	-6.0	-2.1	124	2.7	4	0.00
358	21.0	-7.0	-2.3	185	2.2	8	0.00
359	16.0	-8.0	-1.9	198	1.6	7	0.00

Day	Temp		Dew	Solar	Wind	Cloud	
	Max	Min				Cov	Ppt
360	26.0	5.0	1.1	215	1.3	5	0.00
361	23.0	-2.0	4.7	189	0.9	6	0.00
362	15.0	-10.0	-3.6	216	2.0	5	0.00
363	17.0	-10.0	0.8	217	1.8	8	0.00
364	17.0	-11.0	16.5	207	2.2	10	0.00
365	17.0	-9.0	17.9	164	6.9	10	0.00

Year 1986

Day	Temp		Dew	Solar	Wind	Cloud	
	Max	Min				Cov	Ppt
1	31.0	15.0	25.5	44	1.3	9	0.00
2	20.0	2.0	15.7	44	4.5	7	0.00
3	27.0	-4.0	23.4	222	10.3	2	0.00
4	20.0	-12.0	3.8	103	1.6	10	0.00
5	21.0	-10.0	16.5	45	2.0	10	0.00
6	30.0	2.0	24.1	143	2.7	6	0.00
7	20.0	-6.0	-4.1	183	1.8	7	0.00
8	18.0	-10.0	4.0	164	2.5	9	0.00
9	25.0	-5.0	9.5	196	2.2	10	0.00
10	30.0	0.0	11.5	138	3.1	6	0.00
11	28.0	-5.0	6.2	143	3.4	5	0.00
12	24.0	-7.0	6.3	153	2.5	8	0.00
13	26.0	-3.0	7.0	70	3.8	5	0.00
14	23.0	-5.0	6.7	196	2.5	10	0.00
15	31.0	6.0	25.6	189	6.5	7	0.00
16	36.0	26.0	31.4	141	12.3	10	0.00
17	39.0	20.0	30.5	50	17.4	10	0.00
18	32.0	21.0	29.6	120	2.2	9	0.00
19	32.0	17.0	25.5	151	1.3	8	0.00
20	37.0	22.0	28.0	224	13.9	10	0.00
21	26.0	4.0	19.7	211	3.6	7	0.00
22	24.0	5.0	17.5	159	3.6	10	0.00
23	32.0	12.0	26.2	193	6.7	9	0.00
24	25.0	3.0	22.5	144	3.6	5	0.00
25	22.0	2.0	18.5	234	4.7	10	0.00
26	26.0	-3.0	13.0	232	2.5	8	0.00
27	30.0	-1.0	13.2	276	2.5	7	0.00
28	34.0	15.0	25.3	279	1.3	10	0.00
29	41.0	21.0	28.2	256	2.9	10	0.00
30	41.0	24.0	30.3	162	4.0	10	0.03
31	38.0	31.0	31.7	58	1.8	10	0.16
32	39.0	23.0	31.4	197	4.9	6	0.00
33	34.0	22.0	30.7	226	4.3	9	0.00
34	34.0	28.0	31.7	83	17.7	9	0.00
35	35.0	19.0	30.2	172	5.4	7	0.00
36	27.0	18.0	26.9	213	13.6	10	0.00
37	30.0	6.0	19.1	136	14.1	5	0.00
38	23.0	-16.0	9.8	315	3.4	1	0.00
39	18.0	-15.0	5.8	230	7.6	6	0.00
40	19.0	-15.0	10.9	171	4.7	6	0.00
41	18.0	8.0	15.6	122	6.5	10	0.00
42	18.0	-7.0	10.1	332	5.4	9	0.00
43	27.0	3.0	19.3	310	1.1	10	0.00
44	34.0	1.0	31.4	256	3.1	9	0.00
45	31.0	-2.0	31.9	193	2.2	10	0.00
46	41.0	28.0	35.3	168	17.4	9	0.76
47	39.0	33.0	34.5	71	27.3	9	0.63
48	37.0	33.0	35.7	246	26.5	10	0.18
49	42.0	32.0	37.3	135	25.7	10	1.09
50	38.0	29.0	36.7	178	15.2	10	0.11
51	35.0	27.0	31.0	74	12.8	8	0.00
52	36.0	30.0	29.8	376	23.3	8	0.06
53	40.0	30.0	35.5	198	23.9	10	0.18
54	44.0	34.0	41.0	255	25.3	10	0.42
55	55.0	31.0	40.5	143	7.4	7	0.66
56	54.0	27.0	39.9	202	4.9	6	0.09
57	53.0	29.0	39.5	257	5.1	6	0.00
58	57.0	22.0	31.5	322	4.0	2	0.00
59	59.0	21.0	30.7	249	3.1	2	0.00
60	59.0	23.0	34.3	301	3.6	8	0.00
61	61.0	27.0	35.5	323	4.5	7	0.00
62	63.0	22.0	31.3	397	5.1	3	0.00
63	55.0	20.0	31.5	253	6.5	8	0.00
64	59.0	20.0	34.6	435	3.6	3	0.00
65	58.0	20.0	35.1	205	3.1	9	0.00
66	52.0	22.0	39.0	272	8.1	10	0.00
67	45.0	34.0	39.5	379	10.5	10	0.16
68	46.0	32.0	31.7	278	12.1	7	0.35
69	41.0	32.0	33.0	268	2.9	10	0.05
70	48.0	33.0	34.0	199	4.5	9	0.50
71	45.0	28.0	30.6	282	6.5	9	0.00
72	45.0	26.0	25.8	157	5.4	7	0.00
73	45.0	26.0	28.7	465	3.8	8	0.00
74	43.0	24.0	21.9	401	3.1	7	0.00

Day	Temp	
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Year 1986 (Cont'd)

Day	Temp			Dew Pt	Solar Rad	Wind Sp	Cloud	
	Max	Min	Pt				Cov	Ppt
161	78.0	36.0	41.5	475	4.3		0	0.00
162	83.0	44.0	42.1	485	7.8		0	0.00
163	84.0	44.0	41.7	645	6.3		5	0.00
164	85.0	43.0	44.0	755	3.8		1	0.10
165	83.0	44.0	48.0	543	12.1		8	0.10
166	78.0	44.0	48.4	771	9.6		8	0.00
167	89.0	43.0	42.0	628	7.4		2	0.00
168	91.0	47.0	32.5	680	9.8		1	0.00
169	86.0	52.0	42.8	598	10.1		3	0.00
170	74.0	46.0	33.1	612	8.3		2	0.00
171	78.0	36.0	34.0	538	8.7		3	0.00
172	77.0	47.0	38.0	794	8.7		3	0.00
173	84.0	38.0	39.3	794	4.5		2	0.00
174	91.0	40.0	40.5	692	5.4		1	0.00
175	94.0	44.0	43.7	793	5.8		9	0.05
176	91.0	50.0	47.5	771	6.7		8	0.00
177	92.0	44.0	46.5	773	5.6		5	0.00
178	92.0	54.0	50.6	784	6.7		9	0.00
179	92.0	51.0	47.5	791	9.6		9	0.00
180	82.0	54.0	41.6	619	13.0		1	0.00
181	82.0	41.0	41.4	790	8.9		0	0.00
182	89.0	43.0	38.5	789	5.4		1	0.00
183	96.0	46.0	45.9	764	6.5		3	0.00
184	82.0	60.0	49.0	611	17.0		8	0.00
185	82.0	44.0	41.0	670	17.7		3	0.00
186	68.0	35.0	30.2	540	10.1		1	0.00
187	78.0	28.0	35.1	783	6.5		7	0.00
188	79.0	58.0	44.0	549	8.7		8	0.03
189	84.0	51.0	49.7	570	7.6		9	0.00
190	79.0	46.0	47.4	638	11.2		6	0.00
191	80.0	53.0	48.1	709	9.6		10	0.00
192	79.0	51.0	46.6	776	12.5		4	0.00
193	82.0	38.0	37.3	775	6.7		0	0.00
194	87.0	48.0	39.5	753	8.7		3	0.00
195	90.0	54.0	46.4	760	12.5		7	0.00
196	84.0	53.0	47.6	714	9.6		10	0.00
197	80.0	46.0	44.3	767	13.4		7	0.00
198	76.0	37.0	35.2	709	6.9		2	0.00
199	84.0	54.0	43.9	458	8.9		5	0.00
200	92.0	46.0	40.7	589	8.1		3	0.00
201	89.0	46.0	41.8	653	4.9		0	0.00
202	89.0	54.0	39.9	512	6.9		3	0.00
203	85.0	50.0	48.3	592	7.8		8	0.45
204	83.0	50.0	53.9	611	9.4		9	0.00
205	79.0	54.0	53.8	634	7.4		10	0.00
206	79.0	54.0	51.2	747	6.9		9	0.00
207	78.0	46.0	46.6	670	6.5		9	0.00
208	78.0	41.0	46.5	493	3.8		7	0.00
209	88.0	42.0	48.0	560	8.9		3	0.00
210	82.0	48.0	45.3	715	16.6		2	0.00
211	83.0	45.0	41.8	605	8.5		1	0.00
212	88.0	42.0	39.3	730	7.2		0	0.00
213	90.0	44.0	37.3	727	4.0		4	0.00
214	95.0	48.0	38.7	657	5.6		1	0.00
215	96.0	50.0	43.5	665	9.2		1	0.00
216	90.0	49.0	41.8	626	4.9		0	0.00
217	92.0	48.0	38.5	561	6.3		2	0.00
218	96.0	45.0	38.6	465	5.4		1	0.00
219	90.0	55.0	47.0	537	7.8		7	0.00
220	90.0	55.0	41.3	549	6.0		1	0.00
221	92.0	46.0	38.5	459	4.7		2	0.00
222	94.0	50.0	36.1	434	6.7		0	0.00
223	92.0	56.0	43.0	433	6.9		6	0.00
224	83.0	46.0	39.4	465	10.1		1	0.00
225	84.0	54.0	35.5	448	6.0		0	0.00
226	87.0	42.0	35.6	453	6.5		4	0.00
227	92.0	43.0	37.0	651	6.9		3	0.00
228	92.0	50.0	42.9	588	2.9		9	0.00
229	94.0	56.0	43.2	670	7.4		7	0.00
230	98.0	50.0	34.1	666	6.9		3	0.00
231	86.0	54.0	47.1	612	4.7		10	0.00
232	90.0	44.0	51.0	471	6.5		5	0.00
233	80.0	46.0	51.1	611	14.8		7	0.00
234	83.0	42.0	41.8	537	5.8		3	0.00
235	79.0	52.0	49.8	601	6.7		7	0.57
236	91.0	45.0	50.0	543	4.5		4	0.00
237	84.0	56.0	48.2	406	5.8		7	0.00
238	90.0	49.0	43.1	632	4.3		1	0.00
239	94.0	47.0	42.1	608	4.3		0	0.00
240	94.0	48.0	47.1	456	7.2		6	0.00
241	80.0	52.0	51.8	541	8.5		8	0.31
242	74.0	45.0	52.2	596	4.0		7	0.23
243	68.0	45.0	42.0	573	11.6		4	0.00
244	76.0	45.0	43.5	357	7.8		4	0.30

Day	Temp		Dew Pt	Solar Rad	Wind Sp	Cloud	
	Max	Min				Cov	Ppt
245	76.0	50.0	46.7	577	6.7		4 0.00
246	81.0	42.0	41.1	545	3.4		0 0.00
247	84.0	42.0	39.0	587	6.9		0 0.00
248	88.0	42.0	36.9	586	7.6		0 0.00
249	78.0	48.0	41.1	544	10.1		6 0.00
250	79.0	48.0	44.0	520	5.6		8 0.00
251	76.0	46.0	47.5	381	11.0		8 0.00
252	63.0	44.0	46.8	273	4.7	10	0.44
253	66.0	38.0	39.5	490	9.2	3	0.00
254	72.0	39.0	36.7	446	8.9	5	0.00
255	78.0	40.0	34.8	464	6.0	8	0.00
256	74.0	51.0	38.1	521	8.7	7	0.00
257	60.0	47.0	43.3	165	1.8	10	0.34
258	69.0	43.0	40.7	536	7.4	7	0.00
259	68.0	34.0	37.5	451	6.9	9	0.00
260	65.0	35.0	37.0	244	6.9	6	0.00
261	59.0	34.0	40.1	444	6.0	8	0.00
262	48.0	31.0	40.8	326	6.3	10	0.15
263	52.0	32.0	40.6	228	6.9	8	0.04
264	60.0	24.0	33.9	495	4.5	5	0.00
265	66.0	24.0	31.0	501	5.1	0	0.00
266	70.0	22.0	34.5	446	6.7	2	0.00
267	56.0	40.0	39.5	393	15.0	10	0.00
268	53.0	37.0	32.5	485	19.2	9	0.00
269	51.0	30.0	36.0	480	14.8	10	0.00
270	49.0	33.0	35.0	475	14.1	9	0.00
271	53.0	28.0	31.7	425	7.8	5	0.00
272	56.0	20.0	33.0	465	7.2	6	0.00
273	46.0	40.0	39.9	226	5.4	10	0.23
274	52.0	33.0	37.7	199	5.1	8	0.00
275	54.0	28.0	34.5	298	13.4	10	0.00
276	60.0	24.0	33.0	239	4.3	2	0.00
277	64.0	26.0	35.3	343	4.7	3	0.00
278	68.0	28.0	37.5	324	4.0	0	0.00
279	72.0	29.0	37.4	412	4.5	0	0.00
280	70.0	27.0	39.2	418	6.0	0	0.00
281	71.0	29.0	38.4	419	3.8	0	0.00
282	72.0	26.0	35.3	366	6.5	0	0.00
283	58.0	26.0	31.9	208	13.9	4	0.00
284	50.0	23.0	12.2	81	15.0	1	0.09
285	58.0	12.0	13.8	267	5.8	0	0.00
286	62.0	18.0	18.6	325	4.7	3	0.00
287	62.0	18.0	23.5	364	3.8	10	0.00
288	67.0	16.0	26.2	377	3.8	4	0.00
289	69.0	19.0	25.8	222	4.7	2	0.00
290	67.0	26.0	29.5	241	4.9	10	0.00
291	53.0	40.0	43.1	182	7.4	10	0.17
292	64.0	37.0	44.0	235	10.3	10	0.00
293	52.0	43.0	45.9	363	3.6	10	0.00
294	57.0	34.0	45.0	226	4.9	9	0.26
295	65.0	27.0	40.0	340	2.5	3	0.00
296	62.0	29.0	38.3	277	5.8	4	0.00
297	64.0	25.0	37.2	287	3.8	0	0.00
298	67.0	25.0	36.7	287	4.5	0	0.00
299	63.0	27.0	37.3	111	3.1	10	0.00
300	64.0	29.0	35.8	173	10.5	8	0.00
301	59.0	24.0	33.9	237	3.8	6	0.00
302	58.0	25.0	33.0	141	3.6	10	0.00
303	55.0	29.0	34.1	114	10.5	7	0.08
304	49.0	22.0	29.3	63	7.2	6	0.07
305	54.0	17.0	21.5	252	3.8	0	0.00
306	55.0	16.0	25.9	242	5.1	7	0.00
307	58.0	20.0	25.2	221	4.7	1	0.00
308	57.0	21.0	27.0	153	4.3	4	0.00
309	58.0	21.0	28.6	264	11.6	2	0.00
310	43.0	25.0	27.0	294	8.1	10	0.00
311	35.0	21.0	25.9	253	4.7	10	0.00
312	35.0	19.0	23.4	183	8.7	9	0.00
313	34.0	10.0	24.3	183	11.9	10	0.00
314	31.0	1.0	10.3	280	4.5	5	0.00
315	40.0	30.0	24.8	220	6.5	10	0.14
316	36.0	12.0	20.1	274	6.3	10	0.00
317	44.0	13.0	23.8	271	4.0	10	0.00
318	52.0	19.0	27.5	268	8.3	10	0.00
319	47.0	31.0	30.8	225	17.7	10	0.00
320	43.0	33.0	29.7	256	18.8	10	0.00
321	48.0	35.0	31.8	156	15.2	9	0.00
322	50.0	14.0	29.0	236	7.2	5	0.00
323	49.0	30.0	29.4	58	13.0	10	0.00
324	48.0	24.0	27.7	204	4.5	8	0.00
325	46.0	23.0	31.5	50	9.4	10	0.03
326	32.0	19.0	26.3	246	4.0	10	0.00
327	33.0	20.0	26.8	244	6.3	10	0.00
328	48.0	24.0	24.8	168	4.7	1	0.00
329	42.0	18.0	25.0	86	6.9	3	0.00
330	32.0	14.0	17.4	120	3.4	9	0.00

Year 1987 (Cont'd)

Temp							Dew							Solar							Wind							Cloud							Day Max							Min							Pt							Rad							Sp							Cov							Ppt							Day Max							Min							Pt							Rad							Sp							Cov							Ppt						
Day	Max	Min	Pt	Rad	Sp	Cov	Ppt	Day	Max	Min	Pt	Rad	Sp	Cov	Ppt	Day	Max	Min	Pt	Rad	Sp	Cov	Ppt	Day	Max	Min	Pt	Rad	Sp	Cov	Ppt	Day	Max	Min	Pt	Rad	Sp	Cov	Ppt	Day	Max	Min	Pt	Rad	Sp	Cov	Ppt	Day	Max	Min	Pt	Rad	Sp	Cov	Ppt																																																																													
47	43.0	24.1	27.3	203	6.0	10	0.00	132	82.9	43.0	13.8	733	13.6	5	0.00	218	91.9	59.0	34.5	561	14.5	5	0.00	217	91.9	59.0	34.5	561	14.5	5	0.00	219	82.9	43.0	38.3	537	6.7	1	0.00	218	88.0	45.0	31.5	465	10.7	1	0.00	219	82.9	43.0	38.3	537	6.7	1	0.00																																																																													
48	41.0	19.9	22.5	246	4.0	8	0.00	134	84.9	41.0	19.9	601	6.3	0	0.00	220	88.0	42.1	39.6	549	4.7	0	0.00	220	88.0	42.1	39.6	549	4.7	0	0.00	221	90.0	43.0	38.1	459	6.9	1	0.00	221	90.0	43.0	38.1	459	6.9	1	0.00																																																																																					
49	36.0	21.9	26.2	271	8.5	10	0.00	135	86.0	41.0	18.3	726	7.8	6	0.00	221	90.0	43.0	38.1	459	6.9	1	0.00	222	91.0	44.1	39.2	434	9.2	5	0.00	222	91.0	44.1	39.2	434	9.2	5	0.00	222	91.0	44.1	39.2	434	9.2	5	0.00																																																																																					
50	36.0	12.9	17.9	312	7.8	5	0.00	136	61.0	51.1	25.5	493	4.7	10	0.95	222	91.0	44.1	39.2	434	9.2	5	0.00	223	84.9	48.9	37.2	433	13.9	1	0.00	223	84.9	48.9	37.2	433	13.9	1	0.00	223	84.9	48.9	37.2	433	13.9	1	0.00																																																																																					
51	37.9	12.0	16.5	188	5.8	0	0.00	137	60.1	48.0	30.9	416	7.2	10	0.46	223	84.9	48.9	37.2	433	13.9	1	0.00	224	80.1	39.9	35.8	465	10.5	5	0.00	224	80.1	39.9	35.8	465	10.5	5	0.00	224	80.1	39.9	35.8	465	10.5	5	0.00																																																																																					
52	37.9	10.0	16.9	376	4.3	5	0.00	138	66.0	46.0	31.1	328	8.3	8	0.04	224	80.1	39.9	35.8	465	10.5	5	0.00	225	73.9	51.1	36.3	448	11.0	10	0.00	225	73.9	51.1	36.3	448	11.0	10	0.00	225	73.9	51.1	36.3	448	11.0	10	0.00																																																																																					
53	34.0	15.1	21.0	198	10.7	10	0.00	139	59.0	39.9	29.7	758	8.5	9	0.07	225	73.9	51.1	36.3	448	11.0	10	0.00	226	73.9	46.9	42.6	453	12.3	9	0.00	226	73.9	46.9	42.6	453	12.3	9	0.00	226	73.9	46.9	42.6	453	12.3	9	0.00																																																																																					
54	28.0	24.1	20.8	112	15.7	10	0.00	140	60.1	42.1	28.9	579	6.3	9	0.00	226	73.9	46.9	42.6	453	12.3	9	0.00	227	70.0	48.9	40.3	651	12.5	4	0.00	227	70.0	48.9	40.3	651	12.5	4	0.00	227	70.0	48.9	40.3	651	12.5	4	0.00																																																																																					
55	28.0	14.0	17.4	143	18.6	9	0.00	141	62.1	39.9	29.3	533	7.8	6	0.04	227	70.0	48.9	40.3	651	12.5	4	0.00	228	73.9	36.0	34.7	588	11.2	0	0.00	228	73.9	36.0	34.7	588	11.2	0	0.00	228	73.9	36.0	34.7	588	11.2	0	0.00																																																																																					
56	28.0	9.0	4.8	79	7.8	8	0.00	142	64.9	32.0	29.7	765	4.7	4	0.00	228	73.9	36.0	34.7	588	11.2	0	0.00	229	79.0	32.0	33.6	670	7.6	0	0.00	229	79.0	32.0	33.6	670	7.6	0	0.00	229	79.0	32.0	33.6	670	7.6	0	0.00																																																																																					
57	36.0	-9.9	-1.5	257	4.5	1	0.00	143	68.0	37.0	35.6	767	6.9	6	0.00	229	79.0	32.0	33.6	670	7.6	0	0.00	230	84.0	35.1	34.0	666	8.1	0	0.00	230	84.0	35.1	34.0	666	8.1	0	0.00	230	84.0	35.1	34.0	666	8.1	0	0.00																																																																																					
58	34.0	-6.0	9.7	322	4.3	5	0.00	144	63.0	39.9	41.4	513	5.8	10	0.19	230	84.0	35.1	34.0	666	8.1	0	0.00	231	88.0	39.0	37.9	612	6.7	5	0.00	231	88.0	39.0	37.9	612	6.7	5	0.00	231	88.0	39.0	37.9	612	6.7	5	0.00																																																																																					
59	37.9	3.9	14.5	249	5.8	2	0.00	145	63.0	37.9	42.6	622	6.5	10	0.12	231	88.0	39.0	37.9	612	6.7	5	0.00	232	90.0	57.9	41.2	471	12.3	9	0.00	232	90.0	57.9	41.2	471	12.3	9	0.00	232	90.0	57.9	41.2	471	12.3	9	0.00																																																																																					
60	44.1	17.1	19.8	301	10.5	5	0.00	146	63.0	37.9	40.6	303	5.1	9	0.01	232	90.0	57.9	41.2	471	12.3	9	0.00	233	81.0	55.9	41.9	611	7.4	9	0.00	233	81.0	55.9	41.9	611	7.4	9	0.00	233	81.0	55.9	41.9	611	7.4	9	0.00																																																																																					
61	51.1	21.9	23.2	323	7.4	9	0.12	147	64.0	42.1	41.7	641	13.9	9	0.00	233	81.0	55.9	41.9	611	7.4	9	0.00	234	87.1	46.0	43.3	537	8.3	8	0.00	234	87.1	46.0	43.3	537	8.3	8	0.00	234	87.1	46.0	43.3	537	8.3	8	0.00																																																																																					
62	57.9	26.1	25.9	397	4.3	8	0.00	148	64.9	44.1	45.0	326	8.9	9	0.06	234	87.1	46.0	43.3	537	8.3	8	0.00	235	88.0	51.1	40.3	601	9.4	6	0.02	235	88.0	51.1	40.3	601	9.4	6	0.02	235	88.0	51.1	40.3	601	9.4	6	0.02																																																																																					
63	55.9	26.1	26.1	253	6.3	9	0.00	149	71.1	37.9	36.9	633	7.4	7	0.00	235	88.0	51.1	40.3	601	9.4	6	0.02	236	77.0	52.0	24.4	401	8.5	10	0.18	236	77.0	52.0	24.4	401	8.5	10	0.18	236	77.0	52.0	24.4	401	8.5	10	0.18																																																																																					
64	51.1	26.1	28.2	435	6.5	10	0.00	150	72.0	41.0	40.6	779	10.1	10	0.00	236	77.0	52.0	24.4	401	8.5	10	0.18	237	71.1	41.0	31.6	190	7.8	3	0.01	237	71.1	41.0	31.6	190	7.8	3	0.01	237	71.1	41.0	31.6	190	7.8	3	0.01																																																																																					
65	48.0	39.0	25.7	205	8.3	10	0.00	151	64.0	41.0	33.6	611	17.7	9	0.00	237	71.1	41.0	31.6	190	7.8	3	0.01	238	77.0	39.9	31.6	632	5.6	2	0.00	238	77.0	39.9	31.6	632	5.6	2	0.00	238	77.0	39.9	31.6	632	5.6	2	0.00																																																																																					
66	46.9	36.0	19.9	272	3.6	10	0.00	152	63.0	30.0	23.5	726	12.8	0	0.00	238	77.0	39.9	31.6	632	5.6	2	0.00	239	82.0	39.0	29.5	608	6.3	4	0.00	239	82.0	39.0	29.5	608	6.3	4	0.00	239	82.0	39.0	29.5	608	6.3	4	0.00																																																																																					
67	39.9	34.0	22.6	451	9.4	10	0.00	153	71.1	28.0	24.4	709	7.2	0	0.00	239	82.0	39.0	29.5	608	6.3	4	0.00	240	86.0	37.9	31.8	456	4.5	5	0.00	240	86.0	37.9	31.8	456	4.5	5	0.00	240	86.0	37.9	31.8	456	4.5	5	0.00																																																																																					
68	52.0	26.1	30.4	405	6.3	7	0.00	154	79.0	34.0	27.0	657	6.3	5	0.00	240	86.0	37.9	31.8	456	4.5	5	0.00	241	91.0	39.9	33.5	618	8.9	1	0.00	241	91.0	39.9	33.5	618	8.9	1	0.00	241	91.0	39.9	33.5	618	8.9	1	0.00																																																																																					
69	52.0	26.1	30.0	399	4.3	10	0.00	155	84.9	35.1	30.7	582	5.8	5	0.00	241	91.0	39.9	33.5	618	8.9	1	0.00	242	91.9	42.1	31.1	614	6.5	6	0.00	242	91.9	42.1	31.1	614	6.5	6	0.00	242	91.9	42.1	31.1	614	6.5	6	0.00																																																																																					
70	52.0	33.1	30.0	345	10.5	7	0.00	156	86.0	48.9	37.6	525	8.5	9	0.00	242	91.9	42.1	31.1	614	6.5	6	0.00	243	93.9	42.1	32.5	573	4.9	4	0.00	243	93.9	42.1	32.5	573	4.9	4	0.00	243	93.9	42.1	32.5	573	4.9	4	0.00																																																																																					
71	54.0	30.0	29.5	282	6.0	10	0.00	157	80.1	50.0	44.2	590	7.4	10	0.00	243	93.9	42.1	32.5	573	4.9	4	0.00	244	95.0	43.0	31.5	502	5.8	8	0.00	244	95.0	43.0	31.5	502	5.8	8	0.00	244	95.0	43.0	31.5	502	5.8	8	0.00																																																																																					
72	46.0	34.0	31.1	95	11.4	9	0.08	158	64.0	48.9	55.4	158	3.8	9	0.31	244	95.0	43.0	31.5	502	5.8	8	0.00	245	91.9	44.1	34.0	577	11.0	6	0.00	245	91.9	44.1	34.0	577	11.0	6	0.00	245	91.9	44.1	34.0	577	11.0	6	0.00																																																																																					
73	46.0	26.1	25.7	465	6.5	10	0.00	159	78.1	44.1	49.5	537	4.9	7	0.04	245	91.9	44.1	34.0	577	11.0	6	0.00	246	72.0	46.0	32.2	545	15.2	9	0.00	246	72.0	46.0	32.2	545	15.2	9	0.00	246	72.0	46.0	32.2	545	15.2	9	0.00																																																																																					
74	50.0	28.0	27.0	401	11.2	10	0.00	160	73.9	45.0	50.0	385	5.8	9	0.11	246	72.0	46.0	32.2	545	15.2	9	0.00	247	73.0	35.1	30.7	587	5.1	2	0.00	247	73.0	35.1	30.7	587	5.1	2	0.00	247	73.0	35.1	30.7	587	5.1	2	0.00																																																																																					
75	52.0	18.0	29.8	338	4.7	10	0.00	161	77.0	45.0	47.5	475	6.9	5	0.00	247	73.0	35.1	30.7	587	5.1	2	0.00	248	78.1	35.1	33.4	586	6.5	1	0.00	248	78.1	35.1	33.4	586	6.5	1	0.00	248	78.1	35.1	33.4	586	6.5	1	0.00																																																																																					
76	52.0	24.1	22.6	107	10.1	9	0.00	162	82.0	46.9	43.5	485	7.6	5	0.00	248	78.1	3																																																																																																																		

Year 1987 (Cont'd)

Day	Temp		Dew Pt	Solar Rad	Wind Sp	Cloud	
	Max	Min				Cov	Ppt
303	59.0	39.9	40.8	249	6.5	10	0.00
304	60.1	41.0	42.6	185	2.9	8	0.00
305	52.0	44.1	45.2	117	3.4	10	0.23
306	51.1	45.0	47.8	108	3.8	10	0.16
307	50.0	41.0	46.0	89	8.3	10	0.01
308	53.1	27.0	41.2	153	3.6	5	0.00
309	57.9	23.0	35.6	264	5.6	4	0.00
310	45.0	35.1	40.1	180	4.0	10	0.18
311	54.0	33.1	40.6	253	4.7	9	0.01
312	45.0	24.1	35.0	287	5.1	5	0.00
313	54.0	21.9	33.7	183	6.3	3	0.00
314	46.0	28.9	38.1	280	5.4	10	0.00
315	45.0	23.0	33.3	220	3.6	10	0.00
316	46.0	28.0	35.8	133	5.1	10	0.01
317	46.0	35.1	38.0	271	6.9	10	0.00
318	39.9	26.1	32.1	138	11.0	10	0.10
319	37.9	14.0	21.4	225	7.6	6	0.00
320	37.9	21.9	27.3	256	11.6	10	0.00
321	41.0	15.1	18.9	156	8.5	0	0.00
322	39.0	5.0	17.8	236	3.8	8	0.00
323	43.0	12.9	19.2	58	4.7	8	0.00
324	46.0	8.1	19.4	204	5.1	9	0.00
325	45.0	12.0	23.3	153	7.2	4	0.00
326	42.1	19.9	24.9	246	6.7	7	0.00
327	37.9	14.0	24.4	112	4.7	9	0.00
328	30.9	9.0	21.4	168	5.4	8	0.00
329	39.9	21.9	25.3	86	12.1	8	0.00
330	39.9	9.0	21.5	120	6.3	6	0.00
331	32.0	7.0	17.9	155	4.0	9	0.00
332	39.9	10.0	17.9	188	5.1	6	0.00
333	42.1	5.0	18.8	69	3.4	10	0.00
334	37.9	3.9	21.0	108	3.8	7	0.00
335	39.9	25.0	27.9	46	6.5	10	0.03
336	45.0	35.1	34.3	45	13.0	10	0.06
337	51.1	25.0	31.2	108	2.9	7	0.00
338	43.0	24.1	30.3	224	4.0	10	0.00
339	51.1	25.0	31.3	208	2.7	2	0.00
340	52.0	28.9	34.0	44	6.7	8	0.02
341	37.9	24.1	29.9	44	15.4	5	0.00
342	28.0	16.0	22.3	86	7.6	10	0.00
343	36.0	15.1	27.8	218	9.2	10	0.00
344	45.0	25.0	33.9	217	14.5	8	0.15
345	35.1	16.0	21.2	204	8.7	4	0.00
346	30.9	7.0	15.6	197	6.9	4	0.00
347	27.0	1.9	5.5	168	11.6	3	0.00
348	23.0	-4.0	4.8	136	5.6	9	0.00
349	24.1	-6.0	6.7	130	4.9	9	0.00
350	21.0	3.0	17.3	190	5.4	10	0.00
351	35.1	6.1	22.2	143	4.3	6	0.00
352	21.0	-2.0	23.2	43	3.1	10	0.00
353	30.9	3.9	21.4	186	4.7	9	0.00
354	23.0	-4.0	13.1	213	3.4	6	0.00
355	36.0	8.1	25.8	213	8.3	10	0.00
356	32.0	9.0	28.8	43	5.4	10	0.00
357	25.0	7.0	13.5	124	11.9	10	0.00
358	24.1	-8.0	1.5	185	6.5	0	0.00
359	24.1	-8.0	1.3	198	4.3	5	0.00
360	28.0	-6.0	2.3	215	3.8	1	0.00
361	27.0	-6.0	3.7	189	3.8	2	0.00
362	28.9	-7.1	9.8	216	5.6	6	0.00
363	36.0	7.0	17.4	68	4.7	9	0.00
364	25.0	10.9	21.1	53	7.6	10	0.00
365	28.0	-2.0	19.7	164	6.3	10	0.00

Year 1988

Day	Temp		Dew Pt	Solar Rad	Wind Sp	Cloud	
	Max	Min				Cov	Ppt
1	18.0	-9.9	10.8	170	2.7	7	0.00
2	21.9	-15.0	-4.7	177	2.2	7	0.00
3	14.0	-17.0	-3.7	222	3.8	10	0.00
4	14.0	-9.9	8.4	45	4.9	10	0.00
5	30.9	10.9	21.3	148	5.6	10	0.00
6	30.9	0.0	22.3	143	4.7	10	0.00
7	26.1	9.0	24.3	47	3.4	10	0.00
8	28.0	3.0	23.1	46	6.0	10	0.00
9	33.1	15.1	28.8	196	6.3	10	0.00
10	39.9	21.9	32.1	138	15.7	10	0.00
11	34.0	19.0	24.5	47	18.1	8	0.00
12	28.0	10.9	16.6	153	8.7	2	0.00
13	32.0	17.1	16.6	70	4.3	9	0.00
14	32.0	19.0	23.5	196	4.3	10	0.00
15	33.1	16.0	26.2	57	11.4	10	0.00
16	28.9	5.0	15.6	49	9.6	6	0.00

Day	Temp		Dew Pt	Solar Rad	Wind Sp	Cloud	
	Max	Min				Cov	Ppt
17	26.1	-7.1	18.8	50	9.4	9	0.00
18	30.0	-11.9	9.5	120	8.5	7	0.00
19	18.0	-26.0	6.4	151	3.6	9	0.00
20	17.1	-14.1	8.0	224	3.1	10	0.00
21	19.9	-17.0	11.5	211	4.3	8	0.00
22	16.0	-11.9	15.0	159	3.4	10	0.00
23	32.0	-2.0	19.6	193	15.0	10	0.00
24	28.0	-9.9	13.4	144	5.6	4	0.00
25	25.0	-5.1	7.9	234	3.8	10	0.00
26	25.0	-9.9	8.8	232	4.9	9	0.00
27	37.0	1.9	17.9	276	3.4	10	0.00
28	44.1	1.9	20.1	279	4.3	10	0.00
29	36.0	10.0	26.1	256	8.5	10	0.00
30	32.0	18.0	23.9	162	19.2	7	0.00
31	28.0	1.0	10.2	128	6.3	10	0.00
32	26.1	-2.9	7.7	197	4.0	9	0.00
33	25.0	-6.0	6.6	226	4.9	4	0.00
34	23.0	-6.0	6.4	214	4.9	6	0.00
35	30.0	-8.0	4.5	172	4.7	3	0.00
36	26.1	-8.0	5.2	213	4.3	9	0.00
37	30.9	-5.1	6.6	273	4.3	8	0.00
38	34.0	6.1	13.3	315	4.3	10	0.00
39	37.0	7.0	20.5	238	6.3	10	0.00
40	39.9	19.9	31.1	171	13.9	10	0.00
41	41.0	23.0	22.6	256	9.6	5	0.00
42	41.0	23.0	28.8	332	8.9	9	0.00
43	43.0	17.1	26.2	310	4.0	1	0.00
44	39.9	19.9	22.5	256	10.5	7	0.00
45	35.1	19.0	22.3	327	8.3	8	0.00
46	43.0	24.1	25.0	303	14.1	6	0.09
47	37.0	16.0	16.5	203	7.6	4	0.00
48	34.0	12.0	19.3	246	3.4	6	0.00
49	39.9	14.0	17.8	271	6.7	5	0.00
50	37.0	15.1	22.1	312	10.1	8	0.00
51	46.9	15.1	23.4	188	4.5	4	0.00
52	45.0	12.9	23.2	376	8.3	6	0.00
53	44.1	21.0	18.5	198	8.3	2	0.03
54	41.0	12.9	17.1	255	6.7	5	0.00
55	46.0	12.0	17.8	143	5.1	8	0.00
56	51.1	10.0	18.7	202	4.7	1	0.00
57	55.0	14.0	20.8	257	4.7	1	0.15
58	54.0	12.9	20.8	322	4.7	4	0.09
59	53.1	19.0	26.1	249	4.9	8	0.24
60	45.0	26.1	32.2	301	4.5	10	0.07
61	50.0	23.0	30.0	323	6.0	4	0.00
62	51.1	30.9	29.5	397	13.6	9	0.00
63	46.9	12.9	17.6	253	4.5	4	0.00
64	51.1	24.1	27.3	435	5.4	9	0.00
65	43.0	23.0	27.3	88	15.4	10	0.03
66	45.0	16.0	14.5	272	8.3	3	0.00
67	48.0	15.1	20.7	451	4.9	7	0.00
68	45.0	19.0	24.1	405	9.8	10	0.00
69	39.9	26.1	11.7	399	15.0	10	0.00
70	37.9	19.0	7.3	345	14.1	8	0.00
71	36.0	6.1	9.3	282	6.7	8	0.00
72	43.0	7.0	12.2	157	7.8	2	0.00
73	36.0	10.0	20.5	351	6.7	8	0.00
74	43.0	21.9	21.4	401	15.9	10	0.03
75	41.0	18.0	11.1	338	10.5	1	0.00
76	48.0	7.0	11.3	107	5.4	0	0.00
77	57.0	17.1	18.5	283	4.9	5	0.00
78	62.1	16.0	21.4	485	6.9	7	0.00
79	62.1	21.9	20.5	307	8.5	10	0.00
80	53.1	32.0	27.7	202	15.2	10	0.00
81	48.9	27.0	27.0	479	15.2	8	0.00
82	48.0	24.1	23.5	529	13.6	9	0.00
83	45.0	21.9	17.2	534	13.0	7	0.00
84	55.9	27.0	26.2	400	13.9	6	0.00
85	64.0	24.1	27.5	438	13.9	2	0.00
86	51.1	19.0	30.4	271	21.3	6	0.00
87	41.0	12.0	3.6	436	11.9	2	0.00
88	37.9	21.0	19.4	440	11.6	8	0.00
89	39.9	7.0	15.1	471	7.8	8	0.00
90	50.0	10.0	11.8	417	6.3	0	0.00
91	60.1	15.1	17.8	337	5.1	1	0.02
92	64.9	17.1	22.5	372	9.4	8	0.00
93	50.0	37.0	27.9	276	11.4	10	0.06
94	57.9	28.0	16.5	520	21.0	6	0.00
95	57.0	10.9	17.4	550	7.2	4	0.00
96	71.1	23.0	23.4	300	9.2	6	0.00
97	63.0	28.0	27.3	188	17.0	10	0.03
98	43.0	14.0	16.5	249	7.2	7	0.00
99	48.0	18.0	8.1	394	6.7	0	0.00
100	63.0	9.0	9.3	482	5.1	0	0.00
101	72.0	16.0	15.8	584	4.9	6	0.00
102	77.0	21.9	20.1	466	5.6	5	0.00

Day

Year 1988 (Cont'd)

		Temp		Dew	Solar	Wind	Cloud		
Day	Max	Min	Pt	Rad	Sp	Cov	Ppt		
189	93.0	37.0	33.3	570	6.7	3	0.00		
190	96.1	43.0	37.8	638	6.5	0	0.00		
191	93.9	48.0	39.9	709	6.3	3	0.00		
192	90.0	59.0	44.4	776	13.0	4	0.00		
193	82.9	61.0	42.4	775	21.3	9	0.00		
194	93.0	52.0	46.0	753	10.7	2	0.00		
195	91.9	59.0	46.9	760	14.8	0	0.00		
196	93.0	53.1	50.0	714	11.4	1	0.00		
197	93.0	52.0	48.7	767	10.3	2	0.00		
198	90.0	52.0	45.9	709	10.3	0	0.00		
199	90.0	48.9	45.1	458	7.6	0	0.00		
200	88.0	55.9	45.5	589	10.7	0	0.00		
201	97.0	48.0	46.9	653	6.7	0	0.00		
202	100.0	48.0	46.9	512	6.9	0	0.00		
203	99.0	55.0	25.5	701	12.5	1	0.00		
204	97.0	53.1	28.8	611	11.0	0	0.00		
205	99.0	50.0	28.6	634	8.1	0	0.00		
206	99.0	52.0	30.6	747	7.6	7	0.00		
207	93.9	52.0	35.4	670	8.5	8	0.00		
208	91.0	64.0	47.1	249	6.5	7	0.04		
209	93.0	52.0	43.9	560	8.3	5	0.00		
210	96.1	54.0	35.4	715	5.6	5	0.00		
211	99.0	51.1	33.8	605	6.5	0	0.00		
212	98.1	54.0	36.3	730	8.9	3	0.00		
213	89.1	59.0	38.5	727	17.4	0	0.00		
214	84.9	48.0	23.4	657	12.1	4	0.00		
215	84.9	54.0	21.0	665	8.1	4	0.00		
216	87.1	41.0	19.9	626	5.6	2	0.00		
217	91.9	41.0	27.0	561	9.4	6	0.00		
218	84.0	59.0	43.3	465	14.5	3	0.00		
219	84.0	54.0	38.5	537	10.1	5	0.00		
220	84.9	41.0	32.5	549	6.5	3	0.00		
221	90.0	43.0	26.1	459	8.1	1	0.00		
222	93.0	46.9	28.9	434	8.3	5	0.00		
223	93.9	46.0	30.4	433	8.7	5	0.00		
224	69.1	55.9	49.6	245	10.1	9	0.04		
225	89.1	39.9	34.0	448	8.5	1	0.00		
226	89.1	45.0	27.3	453	5.8	0	0.00		
227	88.0	39.9	25.2	651	10.1	0	0.00		
228	82.9	46.0	33.8	588	6.7	0	0.00		
229	93.0	39.0	25.5	670	7.8	0	0.00		
230	90.0	42.1	27.7	666	11.0	1	0.00		
231	91.0	39.0	24.4	612	8.5	2	0.00		
232	89.1	48.9	22.5	471	18.3	1	0.00		
233	82.0	46.0	21.9	611	7.6	0	0.00		
234	88.0	33.1	16.2	537	5.4	0	0.00		
235	93.9	35.1	16.0	645	5.1	0	0.00		
236	98.1	39.0	19.2	543	5.4	4	0.00		
237	99.0	46.0	29.3	406	8.5	1	0.00		
238	93.0	54.0	30.7	632	9.6	4	0.00		
239	82.9	51.1	35.4	608	10.5	7	0.00		
240	90.0	43.0	26.4	456	5.6	7	0.00		
241	91.9	41.0	22.5	618	6.5	3	0.00		
242	91.0	44.1	26.1	614	11.0	1	0.00		
243	89.1	39.9	21.9	573	4.9	1	0.00		
244	91.0	41.0	19.9	502	4.5	5	0.00		
245	93.0	39.0	17.8	577	6.9	10	0.00		
246	86.0	48.0	27.9	545	6.3	9	0.00		
247	90.0	50.0	37.2	587	6.5	9	0.00		
248	91.0	42.1	38.5	586	6.9	2	0.00		
249	91.0	45.0	31.1	544	11.6	3	0.00		
250	86.0	55.0	21.9	520	17.7	0	0.00		
251	82.0	34.0	15.8	381	7.6	1	0.00		
252	90.0	33.1	11.2	433	8.3	3	0.00		
253	71.1	46.9	18.1	490	21.5	7	0.00		
254	55.0	37.9	26.4	297	11.2	9	0.01		
255	66.9	34.0	23.0	464	12.3	3	0.00		
256	59.0	50.0	37.6	521	12.1	10	0.00		
257	70.0	41.0	38.7	349	4.7	6	0.00		
258	79.0	28.9	30.4	536	5.6	3	0.00		
259	75.0	39.0	28.0	451	9.2	8	0.00		
260	64.9	34.0	19.2	244	14.8	3	0.00		
261	61.0	23.0	14.9	444	5.4	2	0.00		
262	64.9	27.0	25.5	326	8.7	10	0.05		
263	48.9	41.0	42.8	228	4.5	10	0.17		
264	69.1	32.0	38.3	495	6.5	3	0.00		
265	66.9	34.0	35.2	501	6.7	0	0.00		
266	73.0	26.1	24.6	446	9.2	3	0.00		
267	73.9	39.9	27.0	393	11.0	1	0.00		
268	75.0	37.9	26.4	485	11.6	3	0.00		
269	75.0	35.1	25.7	480	8.5	1	0.00		
270	60.1	39.9	31.6	475	10.5	7	0.00		
271	64.9	27.0	21.9	425	7.8	1	0.00		
272	75.9	28.9	27.7	465	4.9	5	0.00		

Day	Temp		Dew	Solar	Wind	Cloud	Ppt
	Max	Min	Pt	Rad	Sp	Cov	
273	82.9	30.9	29.7	368	5.4	0	0.00
274	82.0	36.0	31.6	199	4.9	0	0.00
275	82.9	32.0	27.7	298	5.4	0	0.00
276	79.0	33.1	27.3	239	4.5	9	0.00
277	82.0	36.0	27.1	343	5.6	8	0.00
278	82.0	33.1	23.9	324	4.5	1	0.00
279	78.1	28.0	16.0	412	4.7	1	0.00
280	79.0	27.0	18.5	418	4.9	0	0.00
281	81.0	28.0	21.2	419	4.7	1	0.00
282	77.0	46.0	26.8	366	10.3	3	0.00
283	73.9	32.0	26.2	208	4.9	0	0.00
284	77.0	23.0	21.4	163	4.3	1	0.00
285	68.0	28.0	28.6	267	6.9	9	0.00
286	69.1	28.9	36.0	325	4.9	9	0.00
287	69.1	35.1	32.2	364	11.2	4	0.00
288	69.1	41.0	35.2	377	14.1	6	0.00
289	73.0	48.9	39.7	222	17.0	9	0.00
290	66.9	39.9	38.1	241	8.9	7	0.00
291	68.0	28.0	30.2	317	5.4	4	0.00
292	69.1	37.9	35.8	93	5.8	5	0.01
293	66.0	26.1	31.3	363	4.5	8	0.00
294	70.0	23.0	29.3	357	6.7	3	0.00
295	68.0	34.0	28.4	340	11.6	9	0.00
296	69.1	23.0	24.4	277	5.8	1	0.00
297	69.1	23.0	25.0	287	5.4	5	0.00
298	69.1	27.0	28.6	287	5.8	3	0.00
299	66.9	27.0	26.4	111	11.4	10	0.00
300	53.1	30.0	18.7	173	6.7	5	0.00
301	64.0	19.0	16.7	237	6.7	8	0.00
302	66.0	27.0	17.4	141	4.5	10	0.00
303	68.0	21.9	21.0	249	6.3	1	0.00
304	68.0	19.0	20.7	185	4.9	1	0.00
305	64.9	21.0	24.1	252	8.3	8	0.00
306	54.0	39.9	31.5	242	18.1	10	0.00
307	54.0	37.0	27.5	221	17.2	8	0.00
308	55.0	30.9	22.6	153	12.5	4	0.00
309	51.1	19.0	16.3	264	4.0	10	0.00
310	53.1	27.0	31.8	294	13.4	8	0.00
311	41.0	15.1	27.2	290	4.3	9	0.00
312	42.1	30.0	31.7	183	8.9	9	0.12
313	42.1	21.9	29.4	183	6.5	7	0.00
314	39.0	27.0	33.5	145	5.8	10	0.06
315	43.0	26.1	30.0	220	12.5	6	0.00
316	35.1	25.0	30.4	133	11.6	10	0.00
317	34.0	28.9	34.5	158	8.1	10	0.00
318	35.1	21.9	27.3	268	9.4	10	0.00
319	30.0	7.0	15.1	225	4.9	10	0.00
320	30.0	5.0	19.9	110	5.1	10	0.00
321	33.1	21.9	28.8	52	5.8	10	0.00
322	33.1	12.0	19.4	236	5.1	8	0.00
323	30.9	10.9	17.8	58	2.5	8	0.00
324	28.0	12.9	19.8	204	2.0	10	0.00
325	30.9	10.9	20.3	153	3.4	7	0.00
326	36.0	30.9	34.2	246	13.0	10	0.09
327	39.9	27.0	35.4	112	15.7	10	0.45
328	37.9	16.0	21.2	168	13.4	7	0.00
329	26.1	7.0	16.9	48	3.8	9	0.00
330	28.0	1.9	10.9	120	4.3	9	0.00
331	23.0	0.0	9.7	155	4.7	7	0.00
332	36.0	10.9	19.0	54	6.9	10	0.00
333	27.9	8.1	13.3	69	8.5	10	0.00
334	24.1	9.0	16.9	108	2.9	10	0.00
335	26.1	0.0	10.4	160	4.5	6	0.00
336	33.1	-2.9	6.8	155	4.3	7	0.00
337	39.0	5.0	10.4	108	4.0	8	0.00
338	37.9	3.0	10.0	224	4.9	8	0.00
339	28.9	1.9	4.3	208	4.7	5	0.00
340	26.1	0.0	12.9	133	4.0	10	0.00
341	33.1	3.0	13.5	123	1.6	10	0.00
342	15.1	1.0	9.9	219	0.4	10	0.00
343	25.0	12.0	19.0	218	0.4	10	0.00
344	26.1	19.9	22.8	217	0.4	10	0.00
345	26.1	19.0	23.0	52	0.4	10	0.00
346	27.0	21.9	26.2	197	0.4	10	0.00
347	36.0	14.0	25.9	168	9.2	7	0.00
348	28.0	12.0	15.3	136	12.1	10	0.00
349	21.9	-2.9	3.7	130	9.8	0	0.00
350	25.0	-2.9	3.9	190	5.1	1	0.00
351	32.0	-2.0	8.1	143	6.0	1	0.00
352	32.0	-2.0	7.0	142	4.7	3	0.00
353	34.0	-2.9	9.7	186	4.5	10	0.00
354	19.9	12.0	16.3	54	4.0	10	0.00
355	30.0	12.0	23.7	63	15.0	10	0.00
356	17.1	-2.0	12.6	43	3.6	10	0.00
357	21.0	-5.1	13.8	43	10.5	8	0.00
358	18.0	3.0	12.4	43	8.3	10	0.00

Year 1989 (Cont'd)							Temp		Dew	Solar	Wind	Cloud	Temp							Dew	Solar	Wind	Cloud									
Day	Temp	Max	Min	Pt	Rad	Sp	Cov	Ppt	Day	Max	Min	Pt	Rad	Sp	Cov	Ppt	Day	Max	Min	Pt	Rad	Sp	Cov	Ppt	Day	Max	Min	Pt	Rad	Sp	Cov	Ppt
75	43.0	21.9	27.9		179	5.6	10	0.09	159	84.9	42.1	42.1	681	6.7	2	0.00	245	75.9	45.0	25.5	577	13.9	1	0.00	245	75.9	45.0	25.5	577	13.9	1	0.00
76	37.9	27.0	24.3		107	16.6	6	0.03	160	82.0	41.0	44.1	595	6.0	7	0.00	246	77.0	36.0	25.5	545	4.7	0	0.00	246	77.0	36.0	25.5	545	4.7	0	0.00
77	43.0	25.0	29.7		283	7.8	10	0.12	161	75.9	50.0	35.8	475	13.4	2	0.00	247	82.9	33.1	23.9	587	7.8	0	0.00	247	82.9	33.1	23.9	587	7.8	0	0.00
78	39.0	23.0	31.6		372	7.4	10	0.00	162	79.0	39.9	33.8	485	5.8	5	0.00	248	84.0	37.9	24.8	586	11.2	2	0.00	248	84.0	37.9	24.8	586	11.2	2	0.00
79	37.9	7.0	20.8		307	7.2	4	0.00	163	82.0	45.0	43.2	645	8.3	3	0.00	249	70.0	52.0	36.0	544	8.7	9	0.00	249	70.0	52.0	36.0	544	8.7	9	0.00
80	36.0	19.9	28.9		202	5.4	10	0.00	164	80.1	41.0	42.8	793	6.0	10	0.00	250	82.9	46.0	34.7	520	9.6	1	0.00	250	82.9	46.0	34.7	520	9.6	1	0.00
81	46.0	33.1	30.6		479	16.3	9	0.18	165	82.0	51.1	46.8	687	6.0	8	0.00	251	79.0	43.0	36.7	381	8.3	5	0.00	251	79.0	43.0	36.7	381	8.3	5	0.00
82	48.9	23.0	25.0		529	12.1	7	0.00	166	90.0	48.9	48.0	692	8.7	2	0.06	252	64.0	45.0	42.4	273	10.3	8	0.16	252	64.0	45.0	42.4	273	10.3	8	0.16
83	44.1	27.0	30.2		434	5.8	10	0.03	167	70.0	46.0	36.1	628	19.7	7	0.00	253	64.0	32.0	30.4	490	6.5	3	0.00	253	64.0	32.0	30.4	490	6.5	3	0.00
84	42.1	28.0	35.2		245	5.6	10	0.08	168	77.0	34.0	34.5	680	9.6	0	0.00	254	68.0	41.0	22.8	446	9.2	9	0.00	254	68.0	41.0	22.8	446	9.2	9	0.00
85	46.0	34.0	36.7		438	7.2	10	0.00	169	86.0	37.9	34.2	598	10.5	0	0.00	255	70.0	33.1	14.7	464	8.5	0	0.00	255	70.0	33.1	14.7	464	8.5	0	0.00
86	48.0	33.1	29.7		271	18.6	9	0.00	170	84.9	39.0	30.9	612	13.6	7	0.00	256	79.0	25.0	13.3	521	5.4	0	0.00	256	79.0	25.0	13.3	521	5.4	0	0.00
87	52.0	33.1	31.5		436	16.1	9	0.00	171	62.1	37.9	24.8	538	15.9	7	0.00	257	81.0	27.0	16.5	349	6.3	0	0.00	257	81.0	27.0	16.5	349	6.3	0	0.00
88	46.9	26.1	23.5		542	13.4	5	0.00	172	66.0	26.1	25.2	794	5.1	1	0.00	258	82.9	28.9	18.1	536	8.7	1	0.00	258	82.9	28.9	18.1	536	8.7	1	0.00
89	46.0	19.0	16.3		471	6.5	3	0.00	173	62.1	35.1	31.3	794	5.4	10	0.00	259	87.1	36.0	20.5	451	10.1	6	0.00	259	87.1	36.0	20.5	451	10.1	6	0.00
90	41.0	27.0	28.8		256	9.2	10	0.06	174	70.0	43.0	34.2	692	14.3	9	0.00	260	73.9	44.1	45.7	105	16.6	10	0.38	260	73.9	44.1	45.7	105	16.6	10	0.38
91	48.0	21.9	28.6		337	10.7	9	0.00	175	73.0	39.9	37.0	793	9.2	4	0.49	261	64.9	35.1	39.2	444	8.7	4	0.00	261	64.9	35.1	39.2	444	8.7	4	0.00
92	46.9	25.0	23.5		372	16.6	9	0.00	176	75.9	36.0	39.6	771	6.0	1	0.00	262	75.0	28.9	34.3	455	4.0	2	0.00	262	75.0	28.9	34.3	455	4.0	2	0.00
93	45.0	24.1	19.9		436	8.9	9	0.00	177	82.9	39.0	37.2	773	8.1	6	0.00	263	73.9	35.1	30.0	384	7.6	6	0.00	263	73.9	35.1	30.0	384	7.6	6	0.00
94	50.0	21.0	19.9		520	8.9	7	0.00	178	82.9	55.0	38.5	784	9.4	6	0.00	264	78.1	34.0	33.8	495	4.3	0	0.00	264	78.1	34.0	33.8	495	4.3	0	0.00
95	66.0	33.1	30.4		550	13.6	6	0.00	179	82.9	51.1	35.2	791	7.8	3	0.00	265	78.1	35.1	33.3	501	6.5	1	0.00	265	78.1	35.1	33.3	501	6.5	1	0.00
96	72.0	35.1	27.7		300	11.6	7	0.00	180	87.1	41.0	31.1	619	7.6	0	0.00	266	81.0	37.0	32.0	446	5.8	0	0.00	266	81.0	37.0	32.0	446	5.8	0	0.00
97	75.0	37.0	29.3		385	12.3	9	0.00	181	84.0	43.0	32.2	790	10.5	0	0.00	267	84.0	37.0	28.9	393	4.3	3	0.00	267	84.0	37.0	28.9	393	4.3	3	0.00
98	64.9	33.1	22.1		249	7.4	7	0.00	182	82.0	44.1	27.7	789	12.3	2	0.00	268	84.0	34.0	29.3	485	6.0	7	0.00	268	84.0	34.0	29.3	485	6.0	7	0.00
99	46.9	23.0	10.9		394	16.6	3	0.00	183	88.0	43.0	24.4	764	9.8	0	0.00	269	80.1	46.9	42.6	480	6.3	5	0.13	269	80.1	46.9	42.6	480	6.3	5	0.13
100	52.0	12.0	9.9		482	8.3	9	0.00	184	96.1	39.0	27.9	611	5.8	1	0.00	270	75.0	48.9	51.1	475	6.7	9	0.93	270	75.0	48.9	51.1	475	6.7	9	0.93
101	60.1	19.0	19.6		584	6.7	3	0.00	185	95.0	45.0	28.9	670	9.4	0	0.00	271	78.1	46.0	50.0	425	6.9	1	0.00	271	78.1	46.0	50.0	425	6.9	1	0.00
102	64.9	33.1	21.9		466	7.2	0	0.00	186	91.9	46.0	24.4	540	10.5	0	0.00	272	84.0	39.0	39.4	465	6.0	0	0.00	272	84.0	39.0	39.4	465	6.0	0	0.00
103	70.0	28.9	23.4		568	6.3	5	0.00	187	97.0	41.0	22.5	783	8.7	0	0.00	273	66.9	45.0	43.5	226	13.4	4	0.26	273	66.9	45.0	43.5	226	13.4	4	0.26
104	71.1	30.9	25.3		379	5.4	10	0.00	188	99.0	44.1	25.7	686	8.5	0	0.00	274	61.0	42.1	42.3	199	13.0	8	0.00	274	61.0	42.1	42.3	199	13.0	8	0.00
105	70.0	45.0	33.6		394	9.6	9	0.00	189	93.9	59.0	34.5	570	13.6	4	0.00	275	46.9	39.0	38.5	140	11.2	10	0.04	275	46.9	39.0	38.5	140	11.2	10	0.04
106	63.0	42.1	35.2		504	15.4	9	0.00	190	89.1	60.1	36.5	638	8.7	10	0.00	276	48.0	37.9	38.3	239	8.5	10	0.00	276	48.0	37.9	38.3	239	8.5	10	0.00
107	73.9	28.9	29.3		592	13.0	3	0.00	191	87.1	53.1	31.1	591	9.6	1	0.01	277	54.0	33.1	37.8	343	11.6	6	0.00	277	54.0	33.1	37.8	343	11.6	6	0.00
108	77.0	34.0	30.4		385	6.3	2	0.00	192	95.0	43.0	28.8	776	5.6	2	0.00	278	60.1	25.0	32.4	324	3.8	4	0.00	278	60.1	25.0	32.4	324	3.8	4	0.00
109	79.0	37.0	29.8		512	7.6	10	0.00	193	81.0	55.0	47.7	775	8.1	9	0.03	279	62.1	30.9	35.1	412	4.7	4	0.00	279	62.1	30.9	35.1	412	4.7	4	0.00
110	79.0	39.0	30.2		620	8.5	10	0.00	194	89.1	55.0	48.9	670	6.3	4	0.01	280	66.0	27.0	32.9	418	6.3	3	0.00	280	66.0	27.0	32.9	418	6.3	3	0.00
111	77.0	44.1	30.7</																													

Year 1989 (Cont'd)

Day	Temp		Dew Pt	Solar Rad	Wind Sp	Cloud	
	Max	Min				Cov	Ppt
331	34.0	0.0	10.9	155	7.4	7	0.00
332	23.0	-8.0	6.8	188	4.0	7	0.00
333	28.0	-9.0	1.6	69	4.0	4	0.00
334	32.0	-7.1	0.7	108	4.3	10	0.00
335	30.0	-5.1	4.3	160	4.9	7	0.00
336	34.0	-2.0	7.7	155	4.9	6	0.00
337	37.0	8.1	12.6	108	4.3	8	0.00
338	41.0	9.0	16.2	224	3.8	10	0.00
339	45.0	15.1	22.5	208	3.1	9	0.00
340	37.9	17.1	25.5	133	7.6	8	0.00
341	32.0	10.0	16.9	123	4.9	10	0.00
342	33.1	7.0	18.7	219	4.0	9	0.00
343	39.9	10.9	18.9	218	6.7	6	0.00
344	30.0	8.1	13.1	217	6.7	9	0.00
345	21.9	-9.0	4.5	204	7.2	7	0.00
346	27.0	0.0	6.6	197	4.3	6	0.00
347	30.9	8.1	12.7	168	4.3	8	0.00
348	36.0	7.0	17.1	136	6.0	10	0.00
349	37.9	12.0	18.0	130	4.7	6	0.00
350	30.9	16.0	18.5	190	3.8	6	0.00
351	23.0	7.0	15.4	43	6.9	10	0.00
352	25.0	-9.9	-1.7	142	4.7	5	0.00
353	21.9	-9.0	-1.5	186	4.3	10	0.00
354	28.0	-2.9	4.5	213	3.6	10	0.00
355	41.0	1.0	11.1	213	6.0	2	0.00
356	32.0	-0.9	8.1	164	4.0	3	0.00
357	41.0	1.9	11.3	124	3.4	4	0.00
358	30.9	3.9	11.3	185	3.1	7	0.00
359	33.1	1.0	9.3	198	2.7	5	0.00
360	37.0	0.0	8.1	215	3.6	5	0.00
361	34.0	0.0	8.8	189	3.8	10	0.00
362	39.0	3.9	11.5	216	4.5	9	0.00
363	21.9	-2.0	11.3	217	2.5	10	0.00
364	21.9	15.1	16.9	207	2.5	7	0.00
365	23.0	15.1	19.4	164	3.1	10	0.00

Year 1990

Day	Temp		Dew Pt	Solar Rad	Wind Sp	Cloud	
	Max	Min				Cov	Ppt
1	27.0	14.0	19.8	170	4.0	10	0.00
2	30.9	-0.9	17.1	177	10.5	10	0.00
3	24.1	-6.0	1.8	222	4.3	6	0.00
4	24.1	8.1	10.2	103	3.8	10	0.00
5	28.9	-2.0	10.9	148	4.3	10	0.00
6	30.0	5.0	15.6	143	3.6	10	0.00
7	37.0	9.0	24.4	47	8.7	9	0.00
8	45.0	32.0	30.9	46	17.4	10	0.44
9	50.0	28.0	28.6	196	8.1	10	0.12
10	50.0	35.1	25.5	138	15.9	9	0.00
11	41.0	28.0	29.7	143	6.5	8	0.00
12	45.0	24.1	26.4	153	6.3	10	0.00
13	39.9	26.1	29.7	48	3.1	8	0.05
14	37.0	32.0	32.9	60	5.6	8	0.58
15	37.0	30.9	31.1	57	8.5	6	0.35
16	35.1	19.0	26.8	141	5.8	10	0.00
17	28.0	0.0	16.2	98	3.6	6	0.00
18	21.0	-7.1	1.6	120	4.0	7	0.00
19	27.0	-11.0	0.5	151	4.3	4	0.00
20	21.0	-7.1	6.6	224	4.0	7	0.00
21	21.9	1.0	9.7	211	4.0	9	0.00
22	30.9	3.9	13.5	159	6.9	10	0.00
23	35.1	6.1	17.1	193	14.1	10	0.00
24	26.1	3.0	11.8	144	10.5	4	0.00
25	34.0	9.0	16.0	234	6.5	5	0.00
26	35.1	-0.9	15.4	232	12.8	6	0.00
27	25.0	-0.9	12.2	276	15.0	1	0.00
28	30.9	14.0	20.5	279	17.9	4	0.00
29	34.0	19.9	20.8	256	19.5	10	0.00
30	37.0	21.0	22.1	162	12.3	8	0.00
31	30.0	15.1	19.6	128	12.8	6	0.00
32	30.9	10.9	21.0	197	11.2	10	0.00
33	27.0	0.0	9.9	226	6.3	9	0.00
34	28.0	-2.0	9.7	214	6.0	9	0.00
35	33.1	6.1	19.6	172	11.2	10	0.00
36	26.1	12.9	16.2	213	8.3	3	0.00
37	30.9	16.0	19.9	273	18.3	0	0.00
38	23.0	10.0	12.0	315	14.8	5	0.00
39	27.0	8.1	16.2	238	20.1	4	0.00
40	33.1	24.1	27.5	171	21.0	8	0.00
41	41.0	30.9	32.4	256	14.8	10	0.00
42	45.0	26.1	30.4	332	17.4	10	0.00
43	36.0	9.0	17.8	310	21.5	10	0.00
44	23.0	3.0	7.9	256	11.0	10	0.00

Day	Temp		Dew Pt	Solar Rad	Wind Sp	Cloud	
	Max	Min				Cov	Ppt
45	25.0	-0.9	1.8	327	8.1	6	0.00
46	24.1	-2.9	4.1	303	14.5	7	0.00
47	26.1	8.1	15.4	71	29.3	10	0.00
48	26.1	-9.0	14.7	246	15.9	10	0.00
49	24.1	-22.0	-4.4	271	10.1	10	0.00
50	32.0	-17.0	0.1	312	5.4	10	0.00
51	23.0	-15.0	2.7	188	5.4	9	0.00
52	33.1	3.0	16.0	376	4.9	10	0.00
53	32.0	15.1	23.9	198	4.5	10	0.00
54	35.1	16.0	25.3	255	5.4	5	0.00
55	39.9	12.9	23.2	143	3.8	10	0.00
56	42.1	15.1	24.1	202	3.6	7	0.00
57	45.0	15.1	23.9	257	3.6	4	0.00
58	43.0	21.9	21.7	322	7.6	10	0.03
59	43.0	21.9	21.9	249	8.9	10	0.03
60	44.1	21.9	21.4	301	6.9	8	0.06
61	42.1	23.0	27.7	323	3.8	10	0.03
62	44.1	30.9	33.3	272	8.1	6	0.19
63	46.0	25.0	28.6	253	8.1	7	0.00
64	44.1	32.0	28.4	435	8.3	10	0.00
65	50.0	27.0	24.4	205	6.3	9	0.00
66	52.0	24.1	26.8	272	5.6	10	0.00
67	48.0	28.9	27.9	451	10.7	10	0.00
68	52.0	27.0	23.5	405	7.8	10	0.00
69	59.0	23.0	26.8	399	7.8	8	0.00
70	42.1	24.1	26.4	345	19.0	6	0.00
71	36.0	19.0	19.0	282	7.2	1	0.00
72	36.0	12.9	17.2	157	3.6	9	0.00
73	46.0	25.0	20.3	465	6.3	5	0.00
74	48.0	21.9	19.2	401	7.6	9	0.00
75	53.1	19.0	21.0	338	4.3	10	0.00
76	55.0	30.9	29.1	107	3.6	6	0.00
77	61.0	33.1	30.6	283	4.0	10	0.00
78	63.0	26.1	29.1	485	5.6	10	0.00
79	62.1	33.1	27.7	307	9.8	4	0.00
80	61.0	32.0	26.8	202	11.0	10	0.00
81	64.0	33.1	26.6	479	9.8	9	0.00
82	51.1	27.0	27.1	529	10.5	7	0.00
83	45.0	18.0	18.0	534	6.5	10	0.00
84	51.1	19.0	16.2	400	6.9	10	0.00
85	60.1	16.0	19.6	438	6.7	10	0.00
86	51.1	37.9	26.8	271	8.9	9	0.00
87	46.9	28.9	20.8	436	15.9	9	0.00
88	55.9	17.1	18.1	542	4.3	5	0.00
89	63.0	19.9	19.8	471	5.4	3	0.00
90	66.9	23.0	21.2	417	4.5	10	0.00
91	71.1	25.0	22.8	337	5.8	9	0.00
92	75.0	26.1	23.9	372	4.7	9	0.00
93	73.9	28.9	24.6	436	5.8	9	0.00
94	72.0	28.0	20.7	520	6.3	7	0.00
95	60.1	33.1	24.8	550	10.7	6	0.00
96	66.9	18.0	17.4	300	4.0	7	0.00
97	64.0	33.1	28.8	385	6.9	9	0.00
98	52.0	37.0	40.3	122	5.4	7	0.54
99	60.1	36.0	33.1	394	8.9	3	0.00
100	66.9	28.9	27.5	482	6.5	9	0.00
101	66.9	37.9	33.3	584	6.0	3	0.00
102	64.0	37.9	31.6	466	8.5	0	0.00
103	64.9	27.0	27.0	568	8.3	5	0.00
104	78.1	39.9	31.1	379	13.0	10	0.00
105	79.0	34.0	35.6	178	4.7	9	0.01
106	73.9	43.0	35.1	504	13.0	9	0.00
107	66.9	42.1	35.8	592	9.2	3	0.00
108	69.1	30.0	33.8	385	5.6	2	0.00
109	72.0	36.0	34.9	512	5.6	10	0.00
110	73.0	39.0	36.1	620	5.8	10	0.00
111	59.0	39.9	43.9	516	6.0	9	0.26
112	64.9	41.0	43.2	539	9.2	6	0.00
113	60.1	43.0	41.0	593	9.6	8	0.13
114	54.0	43.0	37.8	560	6.7	8	0.02
115	59.0	33.1	32.9	288	11.9	8	0.01
116	54.0	34.0	18.0	683	8.5	10	0.00
117	53.1	35.1	32.5	658	13.6	10	0.00
118	48.0	27.0	23.5	649	16.8	9	0.00
119	48.9	19.0	16.0	698	6.0	5	0.00
120	52.0	18.0	15.6	451	11.4	1	0.00
121	62.1	19.0	19.2	337	6.5	10	0.00
122	64.0	37.0	30.2	459	5.8	9	0.00
123	69.1	32.0	27.1	491	6.9	5	0.00
124	73.0	35.1	27.5	594	6.9	1	0.00
125	77.0	30.9	30.4	464	6.7	7	0.00
126	80.1	37.9	31.1	674	14.5	8	0.00
127	55.0	33.1	16.9	725	13.4	10	0.00
128	53.1	30.9	23.5	595	6.5	7	0.00
129	63.0	26.1	22.6	731	5.8	7	0.00
130	72.0	27.0	21.9	734	6.3	4	0.00

Year 1990 (Cont'd)

		Temp		Dew	Solar	Wind	Cloud		
Day	Max	Min	Pt	Rad	Sp	Cov	Ppt		
217	93.9	53.1	34.9	561	6.0	1	0.00		
218	98.1	48.9	29.3	465	4.7	0	0.00		
219	100.0	51.1	30.0	537	6.0	4	0.00		
220	100.9	55.9	32.2	549	6.5	9	0.00		
221	97.0	54.0	35.4	459	7.2	6	0.00		
222	91.9	53.1	39.7	434	7.6	6	0.00		
223	88.0	59.0	51.4	189	6.0	10	0.04		
224	88.0	51.1	47.7	465	6.7	7	0.00		
225	91.9	46.9	38.5	448	4.9	4	0.00		
226	93.0	51.1	36.0	453	5.4	8	0.00		
227	91.9	52.0	39.9	651	8.3	5	0.00		
228	81.0	50.0	49.3	588	6.0	1	0.00		
229	77.0	46.0	49.5	670	7.4	3	0.00		
230	79.0	48.0	51.6	666	6.9	8	0.55		
231	70.0	46.9	50.2	500	5.6	6	0.01		
232	71.1	48.9	50.2	277	10.7	9	0.08		
233	80.1	43.0	37.9	611	8.3	7	0.00		
234	77.0	48.0	43.7	537	11.2	4	0.00		
235	80.1	43.0	43.7	645	6.3	7	0.00		
236	71.1	48.9	44.1	543	7.2	9	0.00		
237	77.0	39.9	43.3	406	5.1	5	0.00		
238	82.0	48.0	35.2	632	8.9	1	0.00		
239	84.9	39.0	31.5	608	6.3	2	0.00		
240	89.1	41.0	31.3	456	5.4	4	0.00		
241	95.0	43.0	27.3	618	8.5	6	0.00		
242	81.0	48.9	36.0	614	17.2	0	0.00		
243	82.9	39.0	29.3	573	5.6	0	0.00		
244	90.0	39.0	30.9	502	5.8	2	0.00		
245	88.0	46.9	41.9	577	7.6	1	0.00		
246	87.1	51.1	51.6	427	7.2	0	0.03		
247	77.0	57.9	54.5	587	6.7	0	0.00		
248	79.0	53.1	58.5	492	6.0	2	0.02		
249	87.1	42.1	45.9	544	5.1	9	0.00		
250	89.1	43.0	42.8	520	6.0	1	0.00		
251	90.0	43.0	40.1	381	6.0	5	0.00		
252	90.0	44.1	39.4	433	5.8	8	0.00		
253	88.0	42.1	33.1	490	4.9	3	0.00		
254	93.9	37.9	28.6	446	5.6	9	0.00		
255	91.0	44.1	23.7	464	9.8	0	0.00		
256	86.0	46.0	21.6	521	4.9	0	0.00		
257	93.0	35.1	25.3	349	6.9	0	0.00		
258	88.0	44.1	27.7	536	8.1	1	0.00		
259	78.1	45.0	22.1	451	9.4	6	0.00		
260	75.0	39.0	28.4	244	6.9	10	0.00		
261	77.0	39.0	31.1	444	4.7	4	0.00		
262	62.1	52.0	40.6	455	4.5	2	0.00		
263	70.0	41.0	40.1	384	4.0	6	0.00		
264	75.9	33.1	31.5	495	3.6	0	0.00		
265	79.0	37.0	29.3	501	6.7	1	0.00		
266	82.9	34.0	31.8	446	5.4	0	0.00		
267	81.0	46.0	42.6	393	4.5	3	0.00		
268	80.1	39.9	38.3	485	4.9	7	0.00		
269	75.0	42.1	36.7	480	6.3	5	0.00		
270	78.1	41.0	36.3	475	6.9	9	0.00		
271	79.0	46.0	34.3	425	10.5	1	0.00		
272	79.0	33.1	26.2	465	4.7	0	0.00		
273	81.0	33.1	26.1	368	5.8	4	0.00		
274	82.0	36.0	28.8	199	8.7	8	0.00		
275	62.1	39.9	18.5	298	12.3	10	0.00		
276	63.0	30.0	27.5	239	13.4	10	0.00		
277	75.0	43.0	35.8	343	12.8	6	0.00		
278	72.0	44.1	33.3	324	19.0	4	0.00		
279	48.9	35.1	33.8	289	6.3	4	0.25		
280	48.9	28.9	20.8	418	7.4	3	0.00		
281	52.0	19.0	18.9	419	4.5	4	0.00		
282	60.1	19.9	21.7	366	5.1	0	0.00		
283	57.0	27.0	26.8	208	8.5	0	0.00		
284	52.0	18.0	18.1	163	8.1	6	0.00		
285	57.9	27.0	18.9	267	11.9	4	0.00		
286	57.9	32.0	20.7	325	13.6	10	0.00		
287	52.0	25.0	24.4	364	10.3	5	0.00		
288	63.0	37.9	34.5	377	12.3	10	0.00		
289	59.0	26.1	29.3	222	15.7	0	0.00		
290	52.0	12.0	15.4	241	4.3	1	0.00		
291	57.9	15.1	22.1	317	9.2	1	0.00		
292	52.0	25.0	29.7	235	9.8	1	0.00		
293	48.0	12.9	17.1	363	5.8	9	0.00		
294	55.0	14.0	15.6	357	7.6	10	0.00		
295	57.0	27.0	32.0	340	12.1	9	0.00		
296	59.0	25.0	22.3	277	3.1	5	0.00		
297	64.0	19.0	19.8	287	4.0	4	0.00		
298	73.0	21.9	25.3	287	5.1	8	0.00		
299	69.1	33.1	27.1	111	8.9	4	0.00		
300	71.1	21.0	21.6	173	4.3	10	0.00		

	Temp		Dew	Solar	Wind	Cloud	
Day	Max	Min	Pt	Rad	Sp	Cov	Ppt
301	70.0	23.0	22.5	237	8.7	10	0.00
302	64.5	34.0	28.9	141	10.1	5	0.00
303	66.9	24.1	21.6	249	6.0	6	0.00
304	60.1	24.1	23.7	185	11.2	7	0.00
305	43.0	34.0	29.5	252	10.5	8	0.00
306	43.0	10.9	9.0	242	6.9	1	0.00
307	45.0	3.0	10.9	221	4.9	10	0.00
308	37.9	17.1	23.4	153	6.3	8	0.00
309	42.1	26.1	25.2	127	7.8	10	0.05
310	41.0	5.0	11.7	294	8.3	6	0.00
311	30.9	-2.0	9.1	290	4.0	6	0.00
312	42.1	23.0	22.6	287	4.3	10	0.00
313	54.0	30.0	29.8	183	13.0	5	0.00
314	59.0	19.0	22.6	280	6.5	9	0.00
315	57.9	14.0	18.5	220	4.5	0	0.00
316	55.9	15.1	14.9	274	4.5	8	0.00
317	53.1	16.0	15.6	271	3.8	10	0.00
318	55.9	21.9	23.0	268	10.3	3	0.00
319	45.0	10.9	21.6	225	9.4	7	0.00
320	43.0	5.0	12.7	256	5.8	7	0.00
321	54.0	21.9	21.2	156	7.8	10	0.00
322	50.0	23.0	25.5	236	4.3	10	0.00
323	48.9	21.9	29.8	58	5.4	1	0.00
324	39.0	19.0	26.6	204	14.5	3	0.00
325	34.0	19.0	24.3	153	16.3	1	0.00
326	44.1	28.9	29.1	246	20.6	1	0.00
327	48.9	21.9	24.1	244	8.3	7	0.00
328	54.0	15.1	19.4	168	10.1	9	0.00
329	55.9	28.0	14.2	86	13.9	9	0.00
330	34.0	15.1	24.4	48	5.8	10	0.00
331	32.0	3.9	13.6	155	6.9	7	0.00
332	33.1	9.0	14.7	188	8.3	7	0.00
333	39.0	3.0	15.4	69	4.7	4	0.00
334	42.1	12.9	19.6	108	14.3	10	0.00
335	33.1	0.0	12.0	160	7.2	7	0.00
336	30.9	12.0	10.8	155	9.4	6	0.00
337	28.9	-0.9	8.8	108	4.0	8	0.00
338	39.9	3.9	13.8	224	6.3	10	0.00
339	37.9	7.0	14.4	208	7.2	9	0.00
340	35.1	1.0	8.1	133	3.4	8	0.00
341	35.1	-4.0	6.6	123	3.1	10	0.00
342	39.0	1.9	8.2	219	3.8	9	0.00
343	46.0	3.0	9.5	218	3.6	6	0.00
344	52.0	6.1	11.7	217	4.9	9	0.00
345	42.1	26.1	27.9	204	11.6	7	0.13
346	30.0	6.1	15.1	197	4.3	6	0.00
347	27.0	9.0	17.4	43	4.7	8	0.00
348	24.1	-8.0	11.3	136	6.9	10	0.00
349	19.9	-8.0	-0.6	130	2.9	6	0.00
350	26.1	-11.0	2.1	190	4.5	6	0.00
351	24.1	-9.9	5.5	143	4.7	10	0.00
352	37.0	7.0	21.0	142	16.6	5	0.00
353	9.0	-7.1	-0.8	43	12.3	10	0.00
354	-2.0	-20.0	-15.5	213	10.5	10	0.00
355	-4.0	-34.1	-21.5	213	3.6	2	0.00
356	-9.0	-38.0	-22.7	164	4.0	3	0.00
357	-7.1	-36.0	-22.4	124	4.0	4	0.00
358	-0.9	-18.9	-12.8	185	3.4	7	0.00
359	1.0	-24.0	-10.8	47	4.0	5	0.00
360	15.1	-9.0	-0.6	215	2.7	5	0.00
361	26.1	-7.1	5.2	44	5.4	10	0.00
362	10.0	-5.1	6.4	216	4.3	9	0.00
363	5.0	-27.0	-9.8	217	6.0	10	0.00
364	-4.0	-27.9	-17.5	207	4.3	7	0.00
365	10.0	-11.9	-6.0	164	2.7	10	0.00

Appendix B

UNSAT-H Capillary Barrier Simulation Data Deck

Appendix B

UNSAT-H Capillary Barrier Simulation Data Deck

This appendix contains the UNSAT-H data deck for the capillary barrier simulations. It includes transpiration and reduced evaporation due to a snow cover. The meteorological input for the data deck is not included because it is given for each year in Appendix A.

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RWMC CAPILLARY BARRIER: Soil 1.4 m, Gravel 6 in, Cobbles 2.5 ft
1 1 1 1 0 1 1 IPLANT,LOWER,NGRAV,ISWDIF,IHEAT,UPPERH,LOWERH
0 365 365 1 1 0 1.0 NPRINT,DAYEND,NDAYS,NYRS,IRAIN,ICONVH,OUTTIM
1 2 0 1 1 NSURPE,NFHOURL,ITOPBC,ET_OPT,ICLOUD
3 3 1 0 5 5 KOPT,KEST,IVAPOR,SH_OPT,INMAX,INHMAX
0.000E+00 5.000E+04 50.0 5.0E+1 HIRRI,HDRY,HTOP,DHMAX
1.000E-04 1.00 1.E-04 24.0 DMAXBA,DELMAX,DELMIN,STOPHR
0.66 283.00 .24 0.0 TORT,TSOIL,VAPDIF,QHTOP
-1.E-4 283.00 10.00E+00 0.0 TGRAD,TSMEAN,TSAMP,QHLEAK
0.5 2.00 1.000E-03 5.0E-1 1. WTF,RFACT,RAINIF,DHFACT,ISNOW
4 102 MATN,NPT
1 0.000 1 0.050 1 0.100 1 0.150
1 0.200 1 0.300 1 0.450 1 0.650
1 1.000 1 1.500 1 2.000 1 3.000
1 4.000 1 5.000 1 6.000 1 8.000
1 10.000 1 13.000 1 16.000 1 20.000
1 25.000 1 30.000 1 40.000 1 50.000
1 60.000 1 70.000 1 80.000 1 90.000
1 100.000 1 110.000 1 115.000 1 120.000
1 125.000 1 130.000 1 134.000 1 136.000
1 137.000 1 138.000 1 139.000 1 139.800
2 140.200 2 141.000 2 142.000 2 143.000
2 144.000 2 146.000 2 148.000 2 150.000
2 152.000 2 153.000 2 154.000 2 154.500
2 154.900 3 155.100 3 155.500 3 156.000
3 156.500 3 157.000 3 158.000 3 159.000
3 161.000 3 163.000 3 166.000 3 169.000
3 172.000 3 176.000 3 180.000 3 185.000
3 190.000 3 195.000 3 200.000 3 205.000
3 210.000 3 215.000 3 220.000 3 224.000
3 227.000 3 229.000 3 230.000 3 230.500
3 230.900 4 231.100 4 231.500 4 232.000
4 234.000 4 235.500 4 237.000 4 239.000
4 242.000 4 245.000 4 249.000 4 253.000
4 257.000 4 261.000 4 265.000 4 270.000
4 275.000 4 280.000 4 285.000 4 290.000
4 295.000 4 300.000
Soil Number 1 Moisture Characteristic (Cover soil: ML: #9)
0.50100 0.007 20.7600 4.73930
Soil Number 1 Hydraulic Conductivity
1.00 0.6840000 20.7600 4.73930 2.00
Soil Number 2 Moisture Characteristic (Gravel: GS)
0.417 0.0060 6.5300 1.53610
Soil Number 2 Hydraulic Conductivity
1.00 36.0 6.5300 1.53610 2.00
Soil Number 3 Moisture Characteristic (Cobbles)
0.500 0.0030 3.0000 0.66666
Soil Number 3 Hydraulic Conductivity
1.00 1800.0 3.0000 0.66666 2.00
Soil Number 4 Moisture Characteristic (Existing Cover, Borghese)
0.270 0.1043 35.0000 2.85710
Soil Number 4 Hydraulic Conductivity
1.00 2.9700 35.0000 2.85710 2.00

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Appendix C

UNSAT-H Thick Soil Barrier Simulation Data Deck

UNSAT-H Thick Soil Barrier Simulation Data Deck

This appendix contains the UNSAT-H data deck for the thick soil barrier simulations. It includes transpiration and reduced evaporation due to a snow cover. The meteorological input for the data deck is not included because it is given for each year in Appendix A.

[illegible]

2	3	3	4	5	7	8	11	13	17
21	25	33	42	50	59	67	75	84	92
100	109	117	365	365	365	365	365	365	365
365	365	365	365	365	365	365	365	365	365
365	365	365	365	365	365	365	365	365	
3.5e+4		800.		20.76				HW,HD,HN	
3.5e+4		800.		20.76				HW,HD,HN	
220.0		0.65						BIOMAS,BARE	
0.2000	1500.0			6.0	845.0			ALBEDO,ALT,ZU,PMB	

DATE

FILMED

5/23/94

END