DEVELOPMENT OF EVAPOTRANSPIRATION CROP COEFFICIENTS, CLIMATOLOGICAL DATA, AND EVAPOTRANSPIRATION MODELS FOR THE UPPER GREEN RIVER

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ABSTRACT

Information on evapotranspiration in the Upper Green River Basin of Wyoming has been developed. The suitability of various evapotranspiration models for estimating water use of agricultural crops has been investigated. Measurements of water use and climatological data were taken in the Green River Basin to provide a source of data for calibration of evapotranspiration models.

Fourteen non-weighing water balance lysimeters were installed in the Basin during the fall of 1982 and spring of 1983. The lysimeters consisted of 3 with alfalfa, 3 with alta fescue, and 8 with mountain meadow vegetation. Weekly measurements of maximum water use were taken with these lysimeters during the 1984 and 1985 growing seasons. The alfalfa and mountain meadow lysimeters provided direct measurements for the primary vegetation in the Basin while the alta fescue served as a reference crop. In addition, three evaporation pans were operated to provide measurements of free water surface evaporation as well as provide another reference for crop water use rates. Seven automated weather stations were installed to give climatic data throughout the Basin.

Calibration of a number of evapotranspiration formulas, based on climatic data, was performed. The formulas ranged from those based only on temperature data to combination formulas which require temperature, radiation, wind, and humidity data. The ability of the models to estimate water use rates throughout the Basin was analyzed. Crop coefficients for alfalfa and mountain meadows were developed. Results indicated that no one equation provided the best results under all conditions. However, the temperature based equations did permit, with calibration, estimates of water use comparable to estimates obtained using the more complex equations.

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Chapter 1

INTRODUCTION

The Upper Green River Basin of Wyoming contains the headwaters of the Green River, one of four major tributaries to the Colorado River. The Basin encompasses approximately 17% of the land area in Wyoming and produces approximately 12% of the 15.8 million acre feet of water produced by the State. The water, originating mainly from snowfall, is vital to agriculture, tourism, municipalities, and industry.

Water produced within the Green River Basin of Wyoming is also important from a regional standpoint because downstream states, and even the Republic of Mexico, depend on a share of the water. The water originating within the Green River Basin of Wyoming is subject to the terms of the Upper Colorado River Basin Compact of 1948. Under the terms of the compact, each state is to assess its water uses directly attributable to the "works of man." Consumptive uses from naturally occurring vegetation are not considered a depletion according to the terms of the contract. In addition, collection and analysis of water use data provides essential information for decisions regarding the various proposals for alternate uses of the water within the State.

Agriculture is the largest land and water user within the Green River Basin with the major crops being irrigated alfalfa and mountain meadows. Information concerning the irrigation requirements of these crops in the Basin has been limited. Estimated water use rates are available (Trelease, et al., 1970) but have not been confirmed through extensive field measurements. Existing water use measurements within the Basin are several years old and are limited to one area (Burman and Loudon, 1967).

Objectives

The overall objective of this study was to develop technical data and models on evapotranspiration for the Upper Green River Basin. The specific objectives were:

1. To develop grass and alfalfa reference crop coefficients at Farson and Fontenelle, Wyoming.
2. To develop grass and alfalfa reference crop coefficients, and crop coefficients for mountain meadow grasses at Daniel, Wyoming.
3. To collect solar radiation, wind, humidity, temperature, and precipitation data from a network of seven sites in the Upper Green River Basin.
4. To develop methods for transferring crop coefficients from location to location.
5. To use existing ET models to estimate consumptive use of agriculture, reservoir evaporation, and phreatophyte use within the Upper Green River Basin.
6. To develop a basin wide model for estimating maximum consumptive use.
7. To obtain existing ET data applicable to the Upper Green River Basin.

Description of the Basin

The Green River Basin, situated in the Southwest corner of Wyoming (Figure 1), is considered climatically to be semi-arid. Typical annual precipitation normals are 7.61 inches at Farson, 8.60 inches at Big Piney, 8.79 inches at Rock Springs, 9.53 inches at Kemmerer, and 11.23 inches at Pinedale (U. S. Dept. Comm., 1973). Annual temperature normals include 34.5°F at Big Piney, 35.5°F at Pinedale, 36.9°F at Farson, 39.2°F at Kemmerer, and 42.5°F at Rock Springs. Average number of days between the last spring and first fall occurrence of low temperatures ranges dramatically across the Basin (Becker, et al., 1977). The average number of days between the last and first occurrence of 32° temperatures is 34, 60, 73, and 117 days at Pinedale, Farson, Kemmerer, and Rock Springs, respectively, while for 28°F temperatures the average number of days are 69, 92, 98, and 140 at Pinedale, Farson, Kemmerer, and Rock Springs, respectively.

High consumptive use rates within the Basin can be expected due to the dry-windy conditions, high radiation inputs as a result of the high elevations, and the oasis effect of irrigated agriculture and reservoirs. One or two cuttings of alfalfa are usually obtained with irrigation continuing throughout most of the growing season. Native hay is grown either for pasture or hay. The irrigation of the hay is often dependent upon water supplies, but usually continues until shortly before harvest.

General Approach

Development of evapotranspiration (ET) data and models within the Green River Basin was approached from the standpoint of incorporating both direct measurement and modeling techniques to define consumptive use rates. Direct measurements provided a data base to confirm the modeling efforts and permit calibration of different models. However, direct measurements were limited within cost and time restraints. Measurements included weekly ET rates during the growing season using non-weighing lysimeters with alfalfa, mountain meadow, and alta fescue vegetation. The lysimeters were installed during the fall of 1982 and spring of 1983 with measurements taken during 1983, 1984, and 1985. The 1983 season was considered to be an establishment year for the vegetation in the lysimeters as far as calibration and analysis were concerned. Since the locations and time periods for which direct measurements could be taken were limited, additional data was taken throughout the Basin in the form of intensive climatic data. This was used as a supplement to the direct ET measurements and as an input to calibrated ET models to provide maximum ET estimates extrapolated over the entire basin.

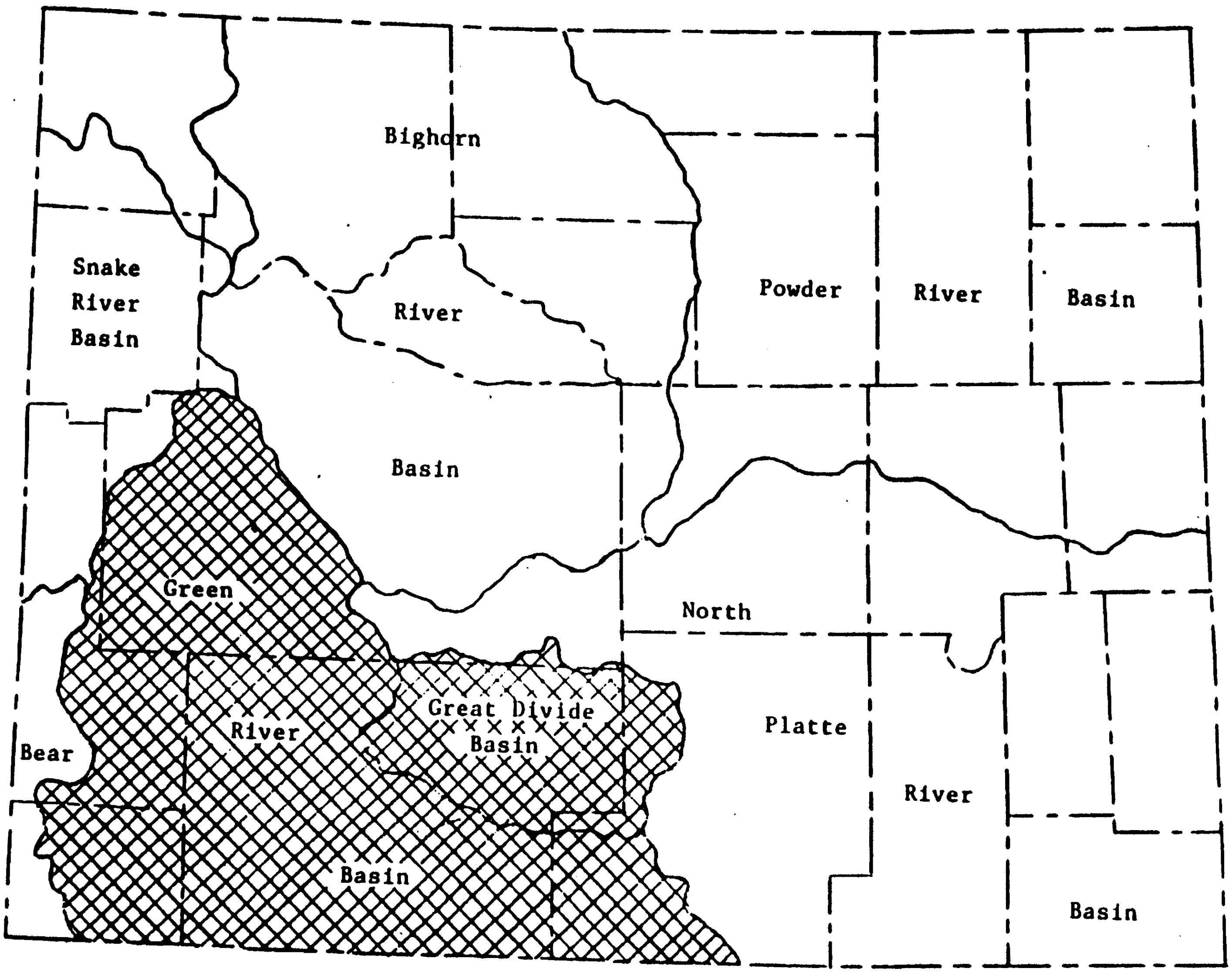

FIGURE 1. Map of Wyoming with the Green River Basin Shown.

Chapter 2

CLIMATOLOGICAL DATA

The availability of climatic data is a major consideration in selecting a model for calculating ET. Data input requirements for the different models vary, ranging in complexity from those that use only temperature data to those that require temperature, wind, humidity, and radiation data. Historical records of weather data have been available for the Upper Green River Basin primarily from the National Weather Service's Cooperative Network. The network consists mainly of stations recording maximum and minimum daily temperatures and precipitation. Depending upon the period of interest, approximately 12 of these stations exist in the Basin. In addition, the station at Rock Springs has data on wind, humidity, and solar radiation. Other historical weather data of interest includes records of evaporation rates from pans located at Green River and Farson, although the pan at Farson is no longer in operation. It is apparent that historical weather data for use in ET models are not widely available in the Basin for parameters other than temperature. Thus, one objective of this project was to acquire and analyze additional climatic data.

Weather Stations and Sites

Seven weather stations utilizing CR-21 microloggers manufactured by Campbell Scientific* of Logan, Utah for recording weather data were installed in the Green River Basin (Figure 2). The stations were installed during April and May 1983. Sites were selected to provide as even a distribution of area as possible and included Rock Springs, Farson, Merna, Daniel, Big Piney, Seedskadee, and Mountain View. However, the Merna and Daniel sites were selected to provide stations at both the upper and lower portions of Horse Creek which was the area of intensive measurements of mountain meadow ET. Detailed descriptions of each site are given in Appendix A.

The installed weather stations recorded temperature, precipitation, wind, relative humidity, and solar radiation data. The stations' data loggers were programmed to provide values at the following specified time intervals:

a. Air temperature--Average daily temperature, the magnitudes and times of occurrences of daily maximum and minimum temperatures, and temperatures at 4 hour intervals.
b. Precipitation--Daily total.
c. Wind--Total wind run at 6.5 ft for each 4 hour period (this permitted the day-night wind ratios to be calculated).
d. Relative humidity--Average daily relative humidity, the magnitudes and times of occurrences of daily maximum and minimum relative humidity, and relative humidities at 4 hour intervals.
e. Solar radiation--Daily total.

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*The mention of brand names does not imply endorsement.

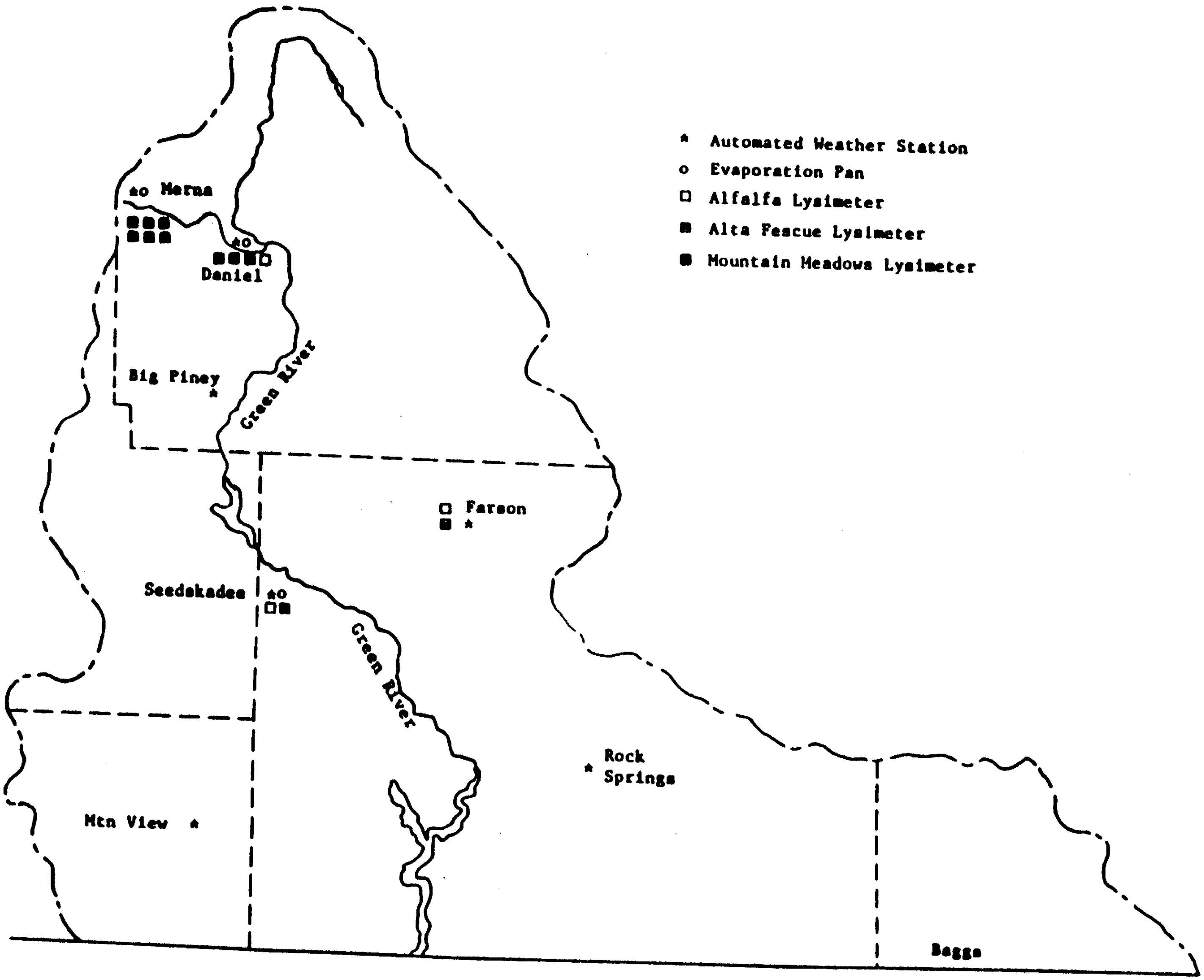

FIGURE 2. Map of the Green River Basin Showing the Project Sites.

In addition to the automated weather stations, instrumentation at each site included a 4 inch plastic rain gauge. These gauges were monitored weekly and were used as a check on the precipitation recorded by the automated weather stations. Two additional 4-inch plastic rain gauges were operated near the mountain meadow lysimeters along Horse Creek. These were located along the road immediately below the Bridger-Teton National Forest Boundary near lysimeters 3A and 3B and below Merna between lysimeters 3C and 3D. These rain gauges were used to determine the amount of precipitation received by lysimeters 3A through 3F.

Evaporation pans provide one of the simplest, inexpensive, and most widely used methods of estimating evaporative losses and are often used as a reference for ET rates. Thus, three standard class A evaporation pans, with automated reservoirs, were installed and operated during 1984 and 1985. The pans were located adjacent to the weather stations at Merna, Daniel, and Seedskadee. The pans were monitored weekly.

Climatic Data Collection and Reduction

The CR-21 data loggers were programmed to allow a maximum of 15 days between visits. The data stored on the microloggers were transferred to a portable cassette tape through a recorder. The cassette tape was used to transport the data to Laramie where it was transferred to the University of Wyoming Cyber computer system for permanent storage, reduction, and analysis. During the 1985 season the Mountain View station was interrogated via phone.

Monthly summaries of the weather data are given in Tables 1 through 3 while weekly summaries are given in Appendix B. Since all ET measurements were made on a weekly schedule, climatic data for daily and shorter periods are not given in this report but are stored at the University of Wyoming.

Analysis of Climatic Data

Analyses of long-term records were done to compare climatic conditions during 1984 and 1985 with long-term averages and variations (Tables 4 and 5). Data for the long-term averages and variations were derived from the published records of the National Weather Service cooperative network (NOAA, 1965...). The long-term averages used for these comparisons are not the published 30-year normals, which would include the years 1951-1980, but are based on the years 1965-1984.

In general, 1984 is shown to have been a relatively wet summer with the May through October accumulated precipitation at 5 of 6 stations being greater than the long-term average for each station while 1985 was a relatively dry summer with the May through October accumulated precipitation at all 6 of the stations being less than the long-term average for these stations (Table 5). Temperatures for individual months occasionally were considerably less than or greater than the long-term monthly values and are shown in Table 4. However, average temperatures for the entire May through Oct period during 1984 and 1985 were not greatly different than the long-term normal values, except for

TABLE 1. MONTHLY SUMMARY OF CLIMATIC DATA - 1983

STATION	MONTH	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/MO)	WIND RUN (MI/DY)	D/N WIND RATIO
	APR	55.	30.	98.	42.	32.7	458.	.16	178.	1.47
	MAY	60.	32.	96.	34.	31.2	590.	1.34	202.	1.50
	JUN	73.	41.	96.	28.	40.1	640.	1.34	153.	1.71
RCK SPR	JUL	84.	46.	91.	18.	39.5	621.	.87	150.	1.62
	AUG	88.	51.	93.	17.	44.9	582.	.59	136.	1.42
	SEP	74.	40.	87.	21.	33.5	492.	.35	175.	1.71
	APR	53.	26.	100.	44.	31.4	316.	.75	176.	1.79
	MAY	59.	28.	97.	35.	30.7	361.	.83	193.	1.86
	JUN	72.	38.	97.	28.	40.7	430.	1.10	154.	1.98
FARSON	JUL	80.	43.	94.	18.	38.9	428.	.67	140.	1.75
	AUG	84.	47.	94.	15.	40.8	456.	2.05	113.	1.55
	SEP	71.	32.	91.	18.	28.9	346.	.91	141.	2.11
	MAY	56.	25.	95.	33.	-99.0*	587.	.98	-99.	-.99
	JUN	66.	34.	99.	36.	38.4	538.	.87	117.	1.67
MERNA	JUL	72.	37.	98.	36.	43.3	545.	1.65	105.	1.51
	AUG	75.	43.	99.	39.	47.9	455.	2.36	86.	1.41
	SEP	65.	31.	97.	32.	33.6	400.	1.46	98.	1.95
	MAY	60.	27.	99.	31.	30.7	593.	.39	122.	1.58
	JUN	68.	36.	99.	32.	39.5	553.	.91	109.	1.60
DANIEL	JUL	75.	39.	100.	29.	43.4	535.	1.14	101.	1.61
	AUG	79.	43.	100.	29.	47.6	462.	1.97	82.	1.34
	SEP	67.	29.	99.	29.	34.6	389.	1.69	104.	1.70
	MAY	61.	26.	99.	32.	30.9	713.	1.22	127.	1.77
	JUN	71.	38.	99.	29.	40.1	700.	.43	126.	1.76
B. PINEY	JUL	78.	40.	100.	23.	42.4	705.	.63	128.	1.70
	AUG	82.	47.	100.	26.	48.5	605.	1.85	103.	1.61
	SEP	70.	32.	95.	26.	34.7	493.	1.34	121.	1.92
	APR	53.	28.	99.	41.	30.5	424.	1.57	168.	1.62
	MAY	59.	31.	96.	33.	30.2	548.	1.34	179.	1.64
	JUN	73.	41.	93.	26.	38.8	572.	1.26	132.	1.83
SEEDSK.	JUL	84.	46.	87.	17.	37.8	575.	.63	121.	1.68
	AUG	88.	52.	89.	16.	43.8	521.	.83	110.	1.44
	SEP	73.	38.	90.	21.	33.2	437.	1.57	150.	1.97
	APR	52.	27.	99.	53.	32.4	448.	.43	124.	1.38
	MAY	58.	30.	95.	42.	32.6	584.	1.81	170.	1.33
	JUN	69.	39.	99.	41.	43.8	631.	.98	151.	1.47
MTN VIEW	JUL	77.	43.	97.	33.	47.1	600.	.28	130.	1.33
	AUG	81.	48.	99.	37.	53.7	534.	3.39	107.	1.09
	SEP	72.	34.	95.	26.	37.2	498.	1.38	160.	1.57

* -99.0 INDICATES MISSING DATA

TABLE 2. MONTHLY SUMMARY OF CLIMATIC DATA - 1984

STATION	MONTH	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/MO)	WIND RUN (MI/DY)	D/N WIND RATIO
	APR	50.	24.	93.	42.	24.5	428.	.55	200.	1.36
	MAY	69.	36.	81.	23.	29.3	568.	.43	233.	1.67
	JUN	75.	41.	80.	21.	33.2	573.	.83	172.	1.67
	JUL	86.	50.	83.	17.	40.7	615.	.79	153.	1.57
RCK SPR	AUG	84.	50.	83.	18.	41.1	526.	.94	139.	1.61
	SEP	69.	37.	86.	24.	32.8	451.	1.57	169.	1.55
	OCT	54.	26.	90.	28.	23.3	319.	.24	163.	1.46
	NOV	47.	23.	96.	38.	24.3	214.	.24	203.	1.29
	APR	48.	19.	84.	27.	17.3	421.	.79	177.	1.63
	MAY	68.	28.	77.	15.	19.0	549.	.75	220.	2.16
	JUN	72.	33.	77.	16.	22.8	573.	.94	175.	1.73
	JUL	82.	35.	87.	20.	36.6	605.	3.58	121.	1.66
FARSON	AUG	81.	37.	93.	19.	39.8	530.	.43	108.	1.82
	SEP	68.	28.	94.	20.	28.0	433.	1.34	139.	1.72
	OCT	56.	17.	91.	20.	16.7	321.	.00	115.	1.73
	NOV	42.	11.	96.	39.	16.1	197.	.20	139.	1.56
	APR	45.	16.	91.	44.	19.1	487.	1.30	109.	1.65
	MAY	57.	28.	93.	37.	28.6	548.	1.18	130.	1.97
	JUN	63.	32.	93.	35.	34.8	582.	2.17	116.	1.84
	JUL	74.	41.	92.	35.	44.3	570.	2.99	92.	1.82
MERNA	AUG	72.	40.	96.	39.	45.3	494.	2.44	88.	1.55
	SEP	61.	29.	95.	35.	32.2	400.	2.28	101.	1.66
	OCT	49.	19.	94.	35.	21.8	293.	.63	102.	1.66
	NOV	39.	10.	96.	51.	18.3	164.	.71	99.	1.33
	APR	44.	17.	95.	48.	22.0	494.	.75	136.	1.53
	MAY	59.	27.	96.	35.	30.7	549.	1.14	146.	2.18
	JUN	66.	34.	94.	32.	36.8	599.	.94	143.	1.61
	JUL	77.	42.	95.	30.	45.6	590.	2.09	106.	1.44
DANIEL	AUG	76.	39.	96.	29.	44.1	502.	1.57	104.	1.59
	SEP	63.	26.	96.	29.	31.0	404.	2.09	121.	1.71
	OCT	50.	19.	95.	31.	21.7	305.	.28	126.	1.46
	NOV	39.	11.	96.	48.	18.2	200.	.31	112.	1.49
	APR	47.	19.	95.	43.	23.0	452.	.83	134.	1.81
	MAY	64.	28.	93.	27.	29.5	546.	.83	158.	2.09
	JUN	71.	34.	93.	24.	34.5	570.	.94	137.	1.77
	JUL	83.	44.	94.	21.	42.9	563.	1.69	115.	1.65
B. PINEY	AUG	81.	42.	95.	22.	43.1	476.	.28	105.	1.66
	SEP	67.	28.	96.	25.	31.5	403.	2.09	117.	1.66
	OCT	53.	17.	94.	24.	19.9	304.	.04	102.	1.83
	NOV	42.	12.	96.	46.	18.7	197.	.39	96.	1.51

Continued

TABLE 2. MONTHLY SUMMARY OF CLIMATIC DATA - 1984 (cont.)

STATION	MONTH	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/MO)	WIND RUN (MI/DY)	D/N WIND RATIO
	APR	49.	24.	91.	44.	23.3	443.	.83	168.	1.57
	MAY	66.	30.	86.	28.	29.4	573.	.55	208.	2.01
	JUN	75.	35.	84.	22.	33.0	576.	.75	167.	1.75
	JUL	85.	48.	87.	22.	43.8	592.	2.13	125.	1.70
SEEDSK.	AUG	84.	48.	86.	22.	42.6	506.	.63	121.	1.67
	SEP	69.	36.	89.	26.	34.1	427.	1.85	136.	1.84
	OCT	55.	24.	90.	27.	22.7	310.	.08	133.	1.61
	NOV	43.	19.	94.	56.	23.3	211.	.43	171.	1.33
	APR	48.	21.	92.	48.	24.5	456.	.63	191.	1.22
	MAY	64.	32.	88.	33.	33.1	568.	.55	224.	1.76
	JUN	69.	37.	93.	30.	38.9	577.	.67	174.	1.33
	JUL	80.	46.	90.	29.	46.5	561.	1.34	127.	1.22
MTN VIEW	AUG	78.	46.	89.	30.	46.6	471.	1.02	123.	1.10
	SEP	68.	34.	90.	30.	35.0	427.	1.50	157.	1.29
	OCT	52.	25.	91.	33.	25.2	321.	.28	158.	1.16
	NOV	45.	17.	92.	47.	22.4	208.	.24	165.	1.38

TABLE 3. MONTHLY SUMMARY OF CLIMATIC DATA - 1985

STATION	MONTH	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/MO)	WIND RUN (MI/DY)	D/N WIND RATIO
	APR	60.	28.	80.	20.	18.9	546.	.12	196.	1.74
	MAY	72.	36.	78.	15.	24.2	615.	.43	164.	1.74
	JUN	81.	45.	56.	16.	24.0	687.	.63	170.	1.60
RCK SPR	JUL	89.	52.	73.	11.	34.3	617.	.39	131.	1.78
	AUG	85.	45.	43.	11.	20.0	628.	.04	115.	1.81
	SEP	68.	35.	82.	18.	24.3	439.	.91	139.	1.26
	OCT	59.	27.	86.	25.	21.0	355.	.47	148.	1.76
	APR	61.	20.	90.	18.	17.3	534.	.16	175.	2.02
	MAY	70.	27.	96.	17.	25.3	605.	.91	174.	1.79
	JUN	77.	34.	85.	18.	27.8	646.	1.77	163.	1.91
FARSON	JUL	86.	40.	93.	12.	36.2	574.	.39	119.	1.67
	AUG	82.	37.	75.	11.	22.7	607.	.08	163.	2.16
	SEP	66.	25.	95.	18.	23.2	446.	1.26	162.	1.97
	OCT	58.	18.	92.	21.	16.4	342.	.43	151.	1.65
	APR	53.	21.	92.	23.	17.1	565.	.16	116.	1.73
	MAY	60.	27.	91.	25.	25.5	541.	.67	121.	1.77
	JUN	68.	33.	90.	23.	30.5	640.	.83	117.	1.76
MERNA	JUL	77.	41.	87.	22.	38.7	591.	1.97	100.	1.57
	AUG	72.	34.	80.	17.	27.3	582.	.12	115.	1.72
	SEP	58.	25.	93.	28.	26.0	389.	2.44	110.	1.91
	OCT	51.	20.	90.	28.	19.8	333.	.79	109.	1.67
	APR	56.	20.	96.	22.	20.0	530.	.20	147.	1.94
	MAY	64.	26.	95.	23.	27.8	534.	.67	142.	1.87
	JUN	69.	34.	92.	29.	37.3	622.	.94	138.	1.74
DANIEL	JUL	79.	43.	97.	33.	47.4	583.	1.57	110.	1.45
	AUG	76.	31.	97.	20.	33.5	564.	.16	131.	1.78
	SEP	60.	25.	98.	31.	29.6	398.	2.09	134.	2.06
	OCT	54.	17.	97.	30.	21.9	321.	.28	130.	1.65
	APR	59.	21.	95.	18.	18.6	536.	.00	131.	2.19
	MAY	67.	28.	95.	20.	26.5	560.	.67	134.	2.11
	JUN	77.	36.	90.	17.	30.3	625.	.55	126.	2.06
B. PINEY	JUL	86.	44.	97.	13.	39.1	566.	.98	96.	1.78
	AUG	81.	34.	86.	12.	26.1	583.	.04	124.	2.18
	SEP	63.	27.	98.	22.	27.4	419.	1.50	126.	2.36
	OCT	57.	18.	97.	21.	19.3	329.	.12	110.	2.04
	APR	61.	25.	76.	17.	16.6	540.	.04	188.	1.92
	MAY	71.	36.	78.	16.	24.2	591.	.83	176.	1.64
	JUN	80.	43.	63.	14.	25.8	650.	.59	161.	1.87
SEEDSK.	JUL	89.	52.	67.	11.	33.0	590.	.55	132.	1.57
	AUG	84.	44.	49.	11.	21.1	608.	.12	168.	2.05
	SEP	67.	34.	82.	18.	24.4	433.	.98	161.	1.77
	OCT	60.	24.	82.	19.	17.0	345.	.08	160.	1.48

Continued

TABLE 3. MONTHLY SUMMARY OF CLIMATIC DATA - 1985 (cont.)

STATION	MONTH	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/MO)	WIND RUN (MI/DY)	D/N WIND RATIO
	APR	54.	24.	89.	28.	21.6	484.	.31	193.	1.68
	MAY	69.	32.	92.	17.	29.2	642.	.00	178.	1.50
	JUN	75.	38.	90.	20.	33.8	652.	1.38	154.	1.36
MTN VIEW	JUL	82.	48.	88.	21.	43.4	566.	1.57	125.	1.13
	AUG	79.	40.	76.	12.	27.2	612.	.05	171.	1.44
	SEP	66.	29.	90.	21.	27.6	432.	.59	160.	1.48
	OCT	58.	24.	89.	26.	22.7	342.	.98	158.	1.29

TABLE 4. LONG-TERM NORMAL VS MEAN 1984 AND 1985 TEMPERATURES*

STATION	YEAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	AVERAGE MAY-OCT
	1985	44.0	54.0	63.0	70.5	65.0	51.5	43.0	57.8
RCK SPR	1984	37.0	52.5	58.0	68.0	67.0	53.0	40.0	56.4
	NORMAL	39.9	50.1	59.7	67.9	65.6	55.5	43.6	57.1
	S. DEV.	3.28	2.70	3.05	1.23	2.69	3.40	3.58	
	1985	40.5	48.5	55.5	63.0	59.5	45.5	38.0	51.7
FARSON	1984	33.5	48.0	52.5	58.5	59.0	48.0	36.5	50.4
	NORMAL	36.9	47.0	56.0	63.2	61.0	51.0	39.4	52.9
	S. DEV.	3.36	2.35	2.69	1.65	2.21	2.95	3.60	
	1985	37.0	43.5	50.5	59.0	53.0	41.5	35.5	47.2
MERNA	1984	30.5	42.5	47.5	57.5	56.0	45.0	34.0	47.1
	NORMAL	30.1	41.1	49.1	56.2	55.1	46.9	37.1	47.6
	S. DEV.	3.39	2.14	2.10	1.28	2.24	2.98	3.21	
	1985	38.0	45.0	51.5	61.0	53.5	42.5	35.5	48.2
DANIEL	1984	30.5	43.0	50.0	59.5	57.5	44.5	34.5	48.2
	1985	40.0	47.5	56.5	65.0	57.5	45.0	37.5	51.5
B. PINEY	1984	33.0	46.0	52.5	63.5	61.5	47.5	35.0	51.0
	NORMAL	33.8	44.7	53.7	60.1	57.0	47.3	37.0	50.0
	S. DEV.	2.80	2.39	2.49	1.23	1.96	2.97	3.02	
	1985	43.0	53.5	61.5	70.5	64.0	50.5	42.0	57.0
SEEDSK.	1984	36.5	48.0	55.0	66.5	66.0	52.5	39.5	54.6
	NORMAL	37.5	47.3	56.8	64.4	62.7	51.9	40.0	53.9
	S. DEV.	3.06	2.44	2.34	1.54	2.60	2.66	3.04	
	1985	39.0	50.5	56.5	65.0	59.5	47.5	41.0	53.3
MTN VIEW	1984	34.5	48.0	53.0	63.0	62.0	51.0	38.5	52.6
	NORMAL	37.5	47.9	56.1	63.2	61.8	53.5	42.6	54.2
	S. DEV.	3.57	2.27	2.42	1.15	2.28	2.55	3.57	

* ALL TEMPERATURES ARE IN DEGREES F. NORMAL INCLUDES YEARS 1965 - 1984

TABLE 5. LONG-TERM NORMAL VS 1984 AND 1985 ACCUMULATED PRECIPITATION*

STATION	YEAR	MAY	JUNE	JULY	AUG	SEPT	OCT
	1985	0.43	1.24**	1.63	1.67	2.58	3.05
RCK SPR	1984	0.43	1.26	2.05	2.99	4.56	4.90**
	NORMAL	1.31	2.28	3.33	4.06	4.95	5.78
	1985	0.91	2.68	3.07	3.15	4.41	4.84
FARSON	1984	0.75	1.69	5.27	5.70	7.04	7.04**
	NORMAL	1.24	2.40	3.37	4.18	4.94	5.80
	1985	0.67	1.50	3.47	3.59	6.03	6.82
MERNA	1984	1.18	3.35	6.34	8.78	11.06	11.95**
	NORMAL	1.25	2.85	4.19	5.55	6.94	8.05
	1985	0.67	1.61	3.18	3.34	5.43	5.71
DANIEL	1984	1.14	2.08	4.17	5.74	7.83	9.35**
	1985	0.67	1.22	2.20	2.24	3.74	3.86
B. PINEY	1984	0.83	1.77	3.46	3.74	5.83	5.89**
	NORMAL	0.99	2.19	3.05	3.98	5.07	5.59
	1985	0.83	1.42	1.97	2.09	3.07	3.15
SEEDSK.	1984	0.55	1.30	3.43	4.06	5.91	6.02**
	NORMAL	0.96	2.06	2.85	3.50	4.51	5.12
	1985		1.38	2.95	3.00	3.59	4.57
MTN VIEW	1984		0.67	2.01	3.03	4.53	5.07**
	NORMAL		1.14	2.05	2.95	3.95	4.86

* ALL PRECIPITATION IS IN INCHES. NORMAL INCLUDES YEARS 1965 - 1984
** DATA EXTRAPOLATED TO INCLUDE ENTIRE MONTH

the 1985 temperature at Seedskadee. The seasonal temperature comparisons are extremely close considering that the sites of the project weather stations and the National Weather Service cooperative stations are not at the exact same locations (Appendix A gives information on specific locations).

In general, irrigation requirements of agricultural crops might be expected to be greater during hot dry years as compared to average years. Low precipitation leads not only to greater irrigation applications but tends to cause lower humidity conditions which usually increase water use rates. Increased consumptive use rates also are usually associated with higher temperatures. Thus, 1984 might be expected to be a year of lower than normal irrigation requirements while 1985 would be expected to be a year of greater than normal irrigation requirements.

Chapter 3

EVAPOTRANSPIRATION MEASUREMENTS

Many methods exist for measuring evapotranspiration rates. These include inflow-outflow procedures, soil-moisture and rainfall balance methods, eddy correlation techniques, lysimeters, and various biological approaches. Lysimeters are the most direct and are usually considered to be the most accurate method. Lysimeters, in general, can be defined as weighing and non-weighing. Weighing lysimeters are the most precise, but are expensive to install and operate. Non-weighing lysimeters, in which water use rates are determined through maintenance of a water budget, are less expensive and are usually considered accurate for periods of one month or more. For shorter periods, the accuracy becomes more questionable as the periods become shorter. Non-weighing lysimeters were selected for this project because of the remote locations involved, the numerous lysimeters required due to the variable conditions, and the lower cost compared to weighing lysimeters.

Previous measurements of water use rates in the Green River Basin are limited to measurements by Burman and Louden (1967) for alfalfa in the Farson area. The soil-moisture water balance procedure was used for those measurements. Other measurements of agricultural water use rates in Wyoming consist of lysimeter measurements of mountain meadow water use along the Little Laramie River (Borrelli and Burman, 1982; Burman and Borrelli, 1984).

Methods and Locations

Fourteen non-weighing water balance lysimeters (Figure 3) were installed in the Green River Basin and operated for three years to obtain water use measurements for mountain meadows, alfalfa, and alta fescue. The lysimeters were installed during the fall of 1982 and spring of 1983. Ten of the lysimeters were located along a 20 mile stretch of Horse Creek between the Bridger-Teton National Forest boundary and Daniel. These lysimeters consisted of eight with mountain meadow vegetation and one each of alfalfa and alta fescue. The other four lysimeters were one each of alfalfa and alta fescue located at both Farson and Seedskadee. Mountain meadow vegetation and alfalfa are the major agricultural crops in the Basin while alta fescue was used as a reference crop.

The lysimeters were constructed using one-eighth inch thick steel plate and measured 39.4 inches square by 60 inches deep (Figure 3). An aluminum tube, 1.5 inches in diameter by 60 inches long with the lower end sealed was installed in the center to provide access for the measurement of soil moisture by use of a neutron probe. A 4 inch diameter by 60 inches long perforated PVC pipe with a removable lid was installed for use as an access to measure water table depths and to remove water from the lysimeters when needed. The pipe was wrapped in fine mesh screen to prevent soil from entering the perforations. A small, 3/4 inch diameter by 60 inches long perforated PVC pipe was installed outside the lysimeter to monitor surrounding water table depths.

Sites for the mountain meadow lysimeters were selected to represent as much as possible the variable conditions of vegetation, location, and soils. The differences in soil are indicated by specific yields and field capacities

LYSIMETER INSTALLED

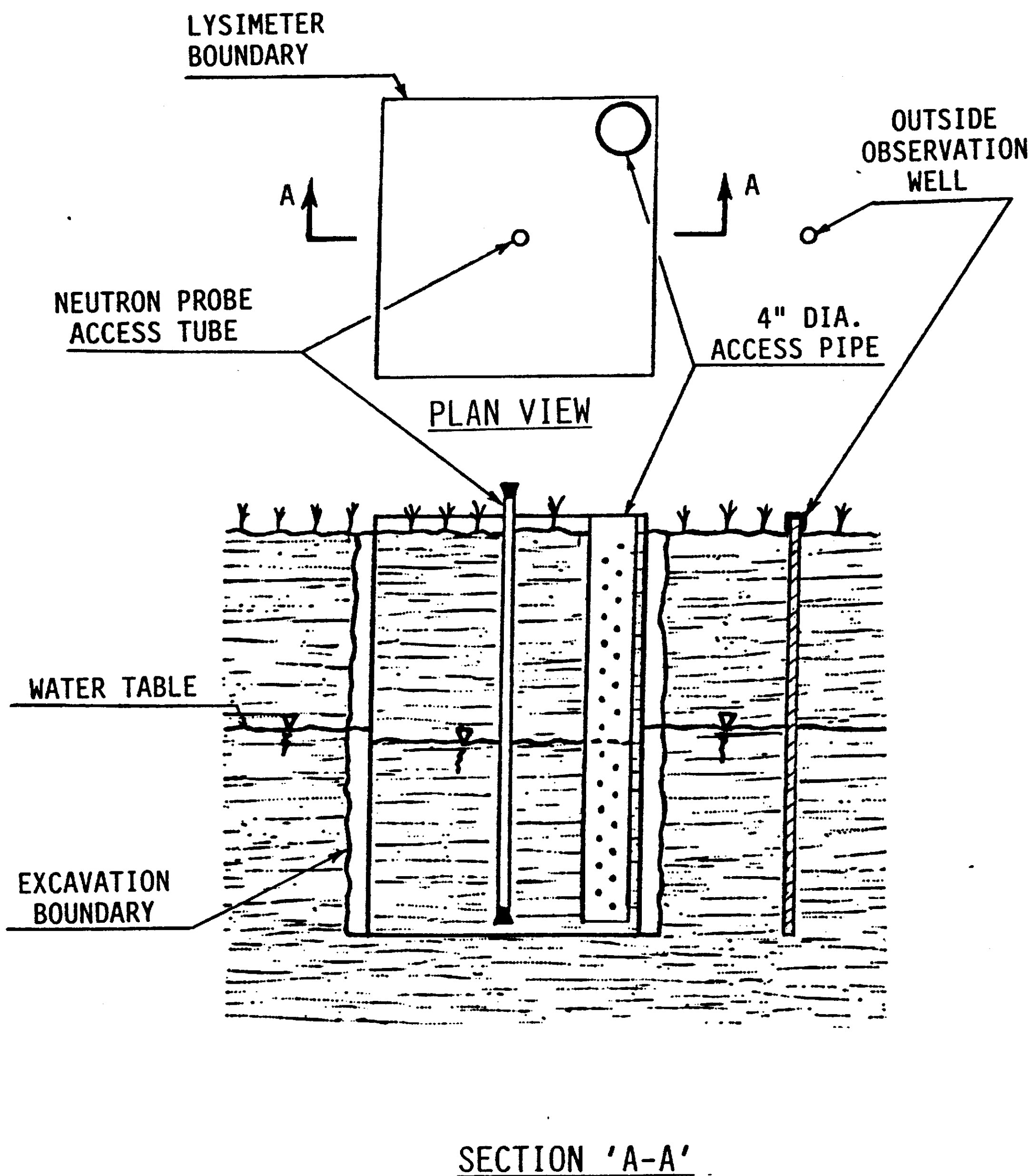

FIGURE 3. Details of Lysimeter Installation

(Table D7). The alfalfa sites were selected to represent average to extreme conditions within the Basin. The Seedskadee site represented a very dry oasis type location. The high elevation at the Daniel site probably created near marginal conditions for alfalfa growth since little alfalfa is grown in the immediately surrounding area. The alta fescue was installed at each alfalfa site.

Installation was performed to insure minimal disruption of soil stratification with each layer replaced in reverse order of removal. To develop a vegetative cover, the sod was replaced in the mountain meadow lysimeters while the alfalfa and alta fescue were planted from seed. Thus, 1983 is considered to be an establishment year for all lysimeters because of the time required to develop the crops.

Data Collection and Reduction

Weekly water use measurements were made throughout the growing season. Actual dates of the start-up and close-out of the lysimeters were dependent upon climatic conditions, especially soil temperatures and snowfall. Frost had to be completely out of the soil before start-up. It was also desirable to delay starting the lysimeters until after the last snowfall because it was difficult to measure the true amount of precipitation that was received by the lysimeters, especially in the presence of wind. The same conditions were considered in the fall, except snowfall was the primary concern at that time. Therefore, the period of lysimeter operation was somewhat shorter than the actual growing season. Start-up and close-out were generally scheduled so that water use measurements were made for at least the entire months of June, July, August, and September.

Start-up and close-out of the lysimeters followed somewhat the same procedures and were conducted to provide a check on seasonal water use values. This procedure consisted of water being added to the lysimeters until they were completely saturated to the soil surface. During the start-up procedure a measured amount of water was then removed and the resulting water table depth 24 hours later was measured. These measurements provided an estimate of the specific yield of each lysimeter. During the close-out procedure, water was added and the amount required to completely saturate each lysimeter was measured. The total seasonal water use was then calculated by considering the amount removed during start-up, the amount added during close-out and the amounts added and/or removed each week during the operational period.

Operation of the lysimeters included regular weekly irrigations and maintenance of a water table depth approximately the same as that of the surrounding fields. Detailed descriptions of the procedures are given in Appendix H. Weekly irrigation generally prevented soil moisture depletions in the layer above the water table from exceeding 50% (Appendix D3). The amount of water added was slightly in excess of the anticipated weekly ET. All water was added to the surface to simulate flood irrigation. Maintenance of the high water tables and surface irrigating the lysimeters served to give measurements which should simulate maximum water use rates.

days. Since most analyses which follow are based on monthly and/or seasonal periods, this interpolation of weekly data should not be of practical concern.

ANALYSIS OF EVAPOTRANSPIRATION DATA

In conjunction with the calibration of ET models and the estimation of water use for the Green River Basin, it is useful to evaluate the magnitudes of the ET measurements with respect to expected values. Various approaches might be considered for this verification. Techniques used in this report are comparisons of water use rates between crops within the study area, from other studies, and to values of evaporation from evaporation pans. In addition, an analysis of the consistency of measurements between years and sites should be of interest.

The variation of water use with location can best be depicted by comparing water use measurements at Daniel, Farson, and Seedskadee for alta fescue, alfalfa, and pan evaporation (Table 9). Results of accumulated ET and pan evaporation rates show the highest values at Seedskadee and the lowest at Daniel. Comparisons of measurements along Horse Creek for mountain meadows and evaporation pans show, at best, only a slight difference based on location (Table 10). The rates for both pan evaporation and mountain meadow ET are slightly greater at Daniel than at Merna.

Comparisons between crops show a much greater ET rate for alfalfa than for alta fescue and a slightly greater rate for alfalfa than for mountain meadows when comparing rates at the same locations. In addition, the measured ET rates for alfalfa are consistently greater than evaporation rates from class A evaporation pans. It should be recalled that measured ET rates were maximum rates. Tovey (1963) has shown that the consumptive use of alfalfa grown with surface irrigation but without a water table is less than with a static water table. His results indicate a water use rate of approximately 22% less without the water table. A reduction of alfalfa ET rates to approximately 80% of measured values gives rates slightly less than measured rates from evaporation pans. Such conditions (well watered alfalfa without a water table), are usually considered when comparing alfalfa ET rates with evaporation from a Class A evaporation pan. Measured ET rates for the mountain meadows varied somewhat between lysimeters. Reasons for this difference are not apparent, although some differences did exist in plant composition in the lysimeters (Table 11).

Results of water use efficiency calculations show that alfalfa had higher yield/water use ratios than did the mountain meadows (Tables 12-14). Considering only the first harvest gives average yield/water use ratios of 0.142 tons per acre per inch of water used for alfalfa (lysimeters 2B, 4A, and 6A) and 0.126 tons per acre per of inch water used for mountain meadows. Water use efficiencies beyond the first harvest are erratic.

Determination of the ET from each site was accomplished by use of a water balance considering precipitation, water added and/or removed, and the total change in soil moisture. The total change in soil moisture included the weekly fluctuation in water table depth and the change in the soil moisture in the layer above the water table, which was measured by use of a neutron probe. Occasionally, following a heavy rain, it was necessary to remove water from the lysimeters. This was done using a hand operated diaphragm pump.

Water use efficiencies measured in terms of yield/ET ratios in units of tons per acre per inch of water were determined for the mountain meadow and alfalfa lysimeters. The crops were harvested at approximately the same time that the surrounding fields were harvested. The cuttings were dried and weighed and used to determine crop yields as well as water use efficiencies. Harvesting was also done during close-out even though the surrounding fields were not harvested at that time. This harvesting permitted determination of seasonal water use efficiencies. The alta fescue was clipped once every week to maintain a height of 3 to 6 inches. Because of the difficulty in collecting the alta fescue clippings, no record of yields are available for the alta fescue lysimeters. Also, during 1983 the alta fescue and alfalfa sites were allowed to grow without cutting during the entire season. This permitted the newly seeded alta fescue and alfalfa to better establish themselves.

Operation of the lysimeters during 1983 differed slightly from that of 1984 and 1985. In 1983, all lysimeters were well-watered in order to minimize soil moisture depletions and obtain measurements simulating maximum water use rates. This procedure was also used during 1984 and 1985 for all lysimeters except four of the mountain meadow lysimeters. During 1984 and 1985, four of the mountain meadow lysimeters were operated in a manner similar to conditions outside the lysimeter. In this mode of operation, irrigation of the lysimeters was discontinued for the season at the same time irrigation of the surrounding fields was discontinued. This usually occurred at the time of harvest of the hay meadows. This operation permitted measurement of what will be termed actual water use as compared to maximum water use which was determined when continuing irrigations throughout the entire growing season.

Monthly summaries of the lysimeter and evaporation pan data taken at the various sites are given in Tables 6 through 8. Weekly summaries are given in Appendix C. Table 6 includes a classification of improved meadows, (grasses which have been sown). Water use rates (Table 8) and species composition (Table 11) for the improved meadows did not differ greatly from those for the mountain meadow vegetation. Thus, the analyses of data have been done without a distinction being made between these two types of vegetation. However, the raw data is listed by vegetation type for anyone wishing to treat the "improved meadows" and the "mountain meadows" separately. The first measurements indicate the approximate beginning of the growing season, although, there was obviously some water loss during the period of the year when measurements were not taken. The dates listed for the weekly periods in Appendix C are given so that 7 day weeks are used. Measurements of ET were not always on a 7 day schedule, and were not on the same date for all lysimeters for the same week. In order to have data that can more easily be compared, the measurements have been interpolated to the dates shown in Appendix C, thus actual measurement dates may differ from listed dates by as much as 3 or 4

TABLE 6. LYSIMETER AND SITE DESCRIPTIONS FOR WATER USE MEASUREMENTS

SITE ID	LOCATION	CROP	OPERATION METHOD	EVAP PAN INCLUDED
2A	FARSON	ALTA FESCUE	MAXIMUM	NO
2B	FARSON	ALFALFA	MAXIMUM	NO
3A	MERNA	MOUNTAIN MEADOWS	MAXIMUM	YES
3B	MERNA	MOUNTAIN MEADOWS	ACTUAL	YES
3C	MERNA	IMPROVED MEADOWS	ACTUAL	*
3D	MERNA	MOUNTAIN MEADOWS	MAXIMUM	*
3E	MERNA	IMPROVED MEADOWS	ACTUAL	*
3F	MERNA	IMPROVED MEADOWS	MAXIMUM	*
4A	DANIEL	ALFALFA	MAXIMUM	YES
4B	DANIEL	ALTA FESCUE	MAXIMUM	YES
4C	DANIEL	MOUNTAIN MEADOWS	MAXIMUM	YES
4D	DANIEL	MOUNTAIN MEADOWS	ACTUAL	YES
6A	SEEDSKADEE	ALFALFA	MAXIMUM	YES
6B	SEEDSKADEE	ALTA FESCUE	MAXIMUM	YES

* THE PAN LOCATED AT THE MERNA SITE IS APPROXIMATELY 5 MILES FROM THESE LYSIMETERS.

TABLE 7. MONTHLY MEASURED PAN EVAPORATION*

STATION	YEAR	MONTH MAY	JUN	JUL	AUG	SEP	OCT
MERNA	1984	--	7.06	7.37	5.45	5.04	1.99B
	1985	1.29A	7.47	7.17	6.79	4.17	--
DANIEL	1984	--	6.54	7.86	6.84	4.72	1.38C
	1985	1.82A	7.78	6.58	7.50	5.14	--
SEEDSKADEE	1984	--	10.13	11.09	8.70	6.76	2.16B
	1985	3.01A	11.21	11.41	12.49	7.09	--

* ALL MEASUREMENTS ARE IN INCHES
A = MAY 23 - MAY 31
B = OCT 1 - OCT 18
C = OCT 1 - OCT 11

TABLE 8. MONTHLY MEASURED EVAPOTRANSPIRATION*

LYS #	YEAR	MONTH MAY	JUN	JUL	AUG	SEP
2A	1983	--	--	3.98A	7.66	7.18
	1984	3.39	4.68	6.38	5.28	4.48
	1985	1.26B	6.42	6.25	7.52	4.65
2B	1983	--	--	5.47A	10.43	4.86
	1984	5.16	9.55	8.81	11.09	5.27
	1985	1.60B	8.50	9.96	10.24	5.23
3A	1983	--	--	2.12C	3.32	5.01
	1984	1.97D	6.78	7.32	8.38	--
	1985	1.18B	6.27	5.97	5.67	2.05
3B	1983	--	--	2.56C	5.21	3.87
	1984	1.08D	6.03	7.48	6.40	1.56
	1985	0.68B	6.11	6.22	2.43	1.71
3C	1983	--	--	2.33C	4.26	3.77
	1984	1.66E	4.14	4.94	2.22	1.51
	1985	0.73B	4.38	4.96	1.49	1.36
3D	1983	--	--	3.19C	4.44	3.99
	1984	1.16E	4.04	5.34	4.18	4.04
	1985	1.16B	5.41	6.50	3.47	2.73
3E	1983	--	--	2.84	4.26	4.29
	1984	1.44E	4.35	5.26	3.23	1.12
	1985	1.14B	5.86	6.48	1.76	1.18
3F	1983	--	--	4.30C	4.06	4.36
	1984	1.81E	4.26	5.92	4.96	2.02
	1985	1.31B	6.19	7.11	4.50	2.01
4A	1983	--	--	2.43C	6.10	4.80
	1984	1.59F	6.45	8.83	5.55	3.98
	1985	1.79B	9.13	11.98	6.71	5.17
4B	1983	--	--	2.04C	4.11	4.03
	1984	0.98F	3.54	5.96	5.08	4.91
	1985	1.61B	6.37	5.39	5.94	3.33
4C	1983	--	--	4.15C	5.83	3.77
	1984	2.53F	6.07	7.12	5.58	4.21
	1985	2.95B	8.60	8.59	5.40	3.17
4D	1983	--	--	3.43C	4.89	4.04
	1984	2.44F	6.19	6.89	2.94	2.13
	1985	1.72B	6.27	6.84	1.80	1.56

Continued

TABLE 8. MONTHLY MEASURED EVAPOTRANSPIRATION* (cont.)

LYS #	YEAR	MONTH MAY	JUN	JUL	AUG	SEP
6A	1983	--	--	5.65A	8.69	3.89
	1984	6.96	11.51	12.70	14.00	4.71
	1985	2.58B	12.46	14.14	16.26	5.40
6B	1983	--	--	7.56A	7.96	7.06
	1984	5.34	6.39	7.68	6.61	4.43
	1985	1.87B	7.88	6.88	6.98	4.47

* ALL MEASUREMENTS ARE LISTED IN INCHES.
A = JULY 8 - JULY 31
B = MAY 23 - MAY 31
C = JULY 15 - JULY 31
D = MAY 17 - MAY 31
E = MAY 15 - MAY 31
F = MAY 16 - MAY 31

TABLE 9. ACCUMULATED MEASURED ET AND EVAPORATION RATES*

	EVAPOTRANSPIRATION								
	ALTA FESCUE			ALFALFA			EVAPORATION		
MONTH	4B	2A	6B	4A	2B	6A	DANIEL	MERNA	SEEDS
JUN	5.0	5.6	7.1	7.8	9.0	12.0	7.2	7.3	10.7
JUL	10.6	11.9	14.4	18.2	18.4	25.4	14.4	14.5	21.9
AUG	16.2	18.3	21.2	24.3	29.1	40.5	21.6	20.7	32.5
SEP	20.3	22.9	25.7	28.9	34.3	45.6	26.5	25.3	39.5

* ALL VALUES ARE GIVEN IN INCHES.

TABLE 10. ACCUMULATED ET FOR MOUNTAIN MEADOWS*

	LYSIMETER SITE			
MONTH	3A	3D	3F	4C
JUN	6.5	4.7	5.2	7.3
JUL	13.2	10.7	11.8	15.2
AUG	20.2	14.5	16.5	20.7
SEP	22.3	17.9	18.5	24.4

* ALL VALUES ARE GIVEN IN INCHES.

TABLE 11. CLASSIFICATION OF VEGETATION ON LYSIMETERS*

LYSIMETER	SCIENTIFIC NAME	COMMON NAME	PERCENT
3A	Phleum pratense	TIMOTHY	30
	Melilotus	SWEET CLOVER	25
	Taraxacum officinale	DANDELION	25
	Agrostis stolonifera	RED TOP BENTGRASS	15
	Poa pratensis	KENTUCKY BLUEGRASS	5
3D	Melilotus	SWEET CLOVER	50
	Phleum pratense	TIMOTHY	40
	Taraxacum officianle	DANDYLION	10
3F	Phleum pratense	TIMOTHY	92
	Taraxacum officinale	DANDYLION	5
	Hordeum pusillum	LITTLE BARLEY	3
4C	Melilotus	SWEET CLOVER	25
	Poa pratensis	KENTUCKY BLUEGRASS	25
	Agropyron trachycaulum	SLENDER WHEATGRASS	20
	Hordeum pusillum	LITTLE BARLEY	10
	Phleum pratense	TIMOTHY	5
	Taraxacum officinale	DANDYLION	5
	Poa fendleriana	MUTTON BLUEGRASS	5

* TRACES OF OTHER VEGETATION MAY ALSO BE PRESENT. DATE OF THE SURVEY WAS AUG 8, 1985. VEGETATION CLASSIFICATIONS FOR THE OTHER LYSIMETERS ARE GIVEN IN APPENDIX D.

TABLE 12. HARVEST DATES OF LYSIMETERS FOR 1984 AND 1985

			1984			1985		
LYSIMETER LOCATION	SITE I.D.	CROP	FIRST HARVEST	SECOND HARVEST	CLOSE OUT HARVEST	FIRST HARVEST	SECOND HARVEST	CLOSE OUT HARVEST
FARSON	2A	ALT.FES.						
FARSON	2B	ALFALFA	JUL 12	SEP 06	OCT 17	JUL 17	AUG 28	OCT 07
MERNA	3A	MTN.MED.	AUG 29			AUG 29		OCT 09
MERNA	3B	MTN.MED.	AUG 29			AUG 29		OCT 07
HORSE CR.	3C	IMP.MED.	AUG 09			AUG 08		OCT 09
HORSE CR.	3D	MTN.MED.	AUG 09			AUG 08		OCT 09
HORSE CR.	3E	IMP.MED.	AUG 30			AUG 08		OCT 09
HORSE CR.	3F	IMP.MED.	SEP 06			AUG 08		OCT 08
DANIEL	4A	ALFALFA	JUL 18		OCT 19	AUG 07		OCT 08
DANIEL	4B	ALT.FES.						
DANIEL	4C	MTN.MED.	JUL 19		OCT 19	AUG 07		OCT 08
DANIEL	4D	MTN.MED.	JUL 19		OCT 19	AUG 07		OCT 08
SEEDSKADEE	6A	ALFALFA	JUL 11	AUG 28	OCT 19	JUL 10	SEP 06	OCT 08
SEEDSKADEE	6B	ALT.FES.						

TABLE 13. HARVEST YIELDS AND YIELD/ET RATIOS OF LYSIMETERS FOR 1984*

		FIRST HARVEST			SECOND HARVEST			CLOSE OUT HARVEST		
LYSIMETER LOCATION	SITE ID	SITE ET	CROP YIELD	YIELD/ET RATIO	SITE ET	CROP YIELD	YIELD/ET RATIO	SITE ET	CROP YIELD	YIELD/ET RATIO
FARSON	2B	16.7	1.97	.118	17.1	1.92	.112	4.2	0.54	.128
MERNA	3A	24.3	2.17	.089						
MERNA	3B	21.0	2.00	.095						
HORSE CR.	3C	11.5	1.64	.143						
HORSE CR.	3D	11.7	1.84	.157						
HORSE CR.	3E	14.0	2.22	.159						
HORSE CR.	3F	17.3	2.15	.124						
DANIEL	4A	13.8	2.40	.174				14.0	0.53	.038
DANIEL	4C	12.9	2.29	.178				14.0	1.30	.093
DANIEL	4D	13.2	2.27	.172				7.1	0.45	.063
SEEDSKADEE	6A	19.0	2.23	.117	21.8	1.69	.078	7.3	1.22	.167

* CROP YIELD IS ABOUT 12% MOISTURE CONTENT.
YIELD/ET IS IN UNITS OF TONS PER ACRE PER INCH.

TABLE 14. HARVEST YIELDS AND YIELD/ET RATIOS OF LYSIMETERS FOR 1985*

		FIRST HARVEST			SECOND HARVEST			CLOSE TO HARVEST		
LYSIMETER LOCATION	SITE ID	SITE ET	CROP YIELD	YIELD/ET RATIO	SITE ET	CROP YIELD	YIELD/ET RATIO	SITE ET	CROP YIELD	YIELD/ET RATIO
FARSON	2B	17.0	3.00	.176	12.5	0.67	.054	6.7	0.24	.036
MERNA	3A	18.2	1.01	.055				3.1	0.10	.032
MERNA	3A	15.3	1.42	.093				2.1	0.06	.029
HORSE CR.	3C	10.3	0.83	.081				2.3	0.03	.013
HORSE CR.	3D	14.2	1.57	.111				5.4	0.02	.004
HORSE CR.	3E	14.4	1.05	.073				2.3	0.06	.026
HORSE CR.	3F	16.1	2.32	.144				4.9	0.11	.022
DANIEL	4A	24.5	1.86	.076				10.6	1.25	.118
DANIEL	4C	21.8	4.92	.226				7.6	0.64	.084
DANIEL	4D	15.5	2.16	.139				2.9	0.07	.024
SEEDSKADEE	6A	20.8	4.45	.214	27.2	2.23	.082	3.6	0.55	.153

* CROP YIELD IS ABOUT 12% MOISTURE CONTENT.
YIELD/ET IS IN UNITS OF TONS PER ACRE PER INCH.

Chapter 4

PROCEDURES FOR ESTIMATING EVAPOTRANSPIRATION

Among the most widely used methods for estimating evapotranspiration rates are the methods based on climatological data. The models range from those using only temperature data to those that require temperature, wind, humidity, and radiation data. Methods of estimating ET from climatic data may be classified in various ways with Hill, et al., (1983) stating that there are as many as 50 methods or variations for the estimation of ET. Three general classes will be considered in this report. These include (a) temperature, (b) radiation, and (c) combination methods. Some of the methods have been modified to include crop and soil parameters as well as climatological parameters. Although improving the theoretical basis of the models, the crop and soil parameters are usually fairly difficult to define. An application which often leads to some modification of the methods is that of estimating wide area or regional ET. These applications, however, are usually more the modification of the methodology of application of the models than modification of the actual models.

Selection of the appropriate ET model for a specific situation is difficult. Estimates can vary widely among the various methods and, unfortunately, no definite guidelines are available for defining the model or method of application most likely to give the best estimates. A recent study by Hill, et al., (1983) clearly depicts the difficulty in defining the accuracy and/or representativeness of the various ET models. This can lead to at least two possibilities. One is that, due to the lack of necessary climatological data, a simple technique might be used when a more complex model may provide more accurate estimates. Another is that the more complex models may be used even when the simpler models are adequate, due to the mistaken impression that the more complex models are always the best.

It does appear that as the time period of interest becomes shorter the complex data-intensive models generally provide the better estimates. Thus, these methods are probably preferred for applications such as irrigation scheduling. On the other hand, the temperature-based models may be entirely satisfactory for monthly or annual ET estimates, especially if locally calibrated. Another advantage of the data-intensive models are their apparent ability to better define the variation of ET rates (Allen and Wright, 1983). Therefore, another consideration in selecting the ET model to use is whether the main interest is in ET averages or in both the average and variations. Finally, a major consideration is that of acceptability and precedence. It is well-known that the Blaney-Criddle method has generally been the accepted procedure in legal negotiations. However, even with the Blaney-Criddle model there are a number of versions and the exact model being considered must be clearly specified.

Three evapotranspiration rates are usually of interest. These include reference crop evapotranspiration (ET_o), maximum evapotranspiration (ET_m), and actual evapotranspiration (ET_a). Reference crop evapotranspiration normally has been defined based either upon well-watered alfalfa or grass as being the reference crop. Maximum evapotranspiration refers to conditions when water is adequate for unrestricted growth and development of a specific crop and represents the rate of Et of a healthy crop, grown in large fields under optimum agronomic and irrigation management. Actual evapotranspiration is the rate of ET that occurs in the field under limited soil moisture conditions and other factors.

Calculations of water use rates are normally obtained from estimates based on climatological and field data. The first step is to determine reference crop ET from either field measurements or equations requiring climatological data. Field measurements at selected locations are required to calibrate the equations which may then be used to estimate ET_o at other locations using climatological data. Maximum evapotranspiration rates for specific crops are then determined by application of appropriate crop coefficients (k_c). The crop coefficients represent the effect of the crop characteristics on crop water requirements and are empirically determined values relating ET_o to ET_m. Calculation of actual evapotranspiration is very complex when soil moisture is limited. ET_a values are estimated from ET_m based upon soil moisture, overall climatic conditions, soil salinity, depth of ground water table, and agronomic and irrigation practices.

Reference crop ET must be compatible with the crop coefficients that are to be used. In the Western United States alfalfa has normally been used as the reference crop. However, alfalfa is a crop which is harvested and major adjustments must be made for the periods immediately prior to and following harvest. Also, the natural growth cycle gives a reference crop for which the height is not constant. Generally when alfalfa is used as a reference crop, it is assumed that the crop is at a growth stage that it occupies an extensive surface, is actively growing, and is approximately 7 to 8 inches in height or taller.

Clipped grass is often used as a reference crop. Grass, such as alta fescue, may be maintained at a near constant height throughout the growing season. A disadvantage often attributed to clipped grass is that under the dry windy conditions typical of arid regions, the clipped grass is not capable of ET rates as high as those reached by alfalfa and many other crops. This may result in the clipped grasses being somewhat insensitive to the increased evaporative potential caused by advection of energy from dry to irrigated areas.

Other approaches to the reference crop concept include (a) the use of the empirical formulas, without local calibration, as a reference and (b) the use of pan evaporation. Neither of these actually use a crop as a reference but do provide reference ET to which crop coefficients may be applied to estimate and/or ET_a. A major disadvantage in using either alfalfa or grass as a reference for estimating ET rates of mountain meadows is that climatic conditions usually limit and/or prohibit the growth of alfalfa and reference grasses in areas where mountain meadows are located. Thus, pan data and/or estimates from evaporation formulas may provide the best reference for mountain meadows.

Evapotranspiration Formulas

Because of the large number of ET formulas and modifications which exist, any attempt to analyze the most suitable for a particular use requires some selection to limit the cases considered. This selection process is, admittedly, rather arbitrary and may be dependent as much upon personal experience as scientific criteria. The formulas considered herein include those ranging from temperature based methods to the more data intensive combination methods. In general, those which appear to be most popular in the Western United States are emphasized. Those described herein include the original Blaney-Criddle, the SCS Blaney-Criddle, the original Jensen-Haise, the modified Jensen-Haise, the ASCE Penman modification, the FAO Blaney-Criddle, the FAO Radiation, the FAO Penman, and the Kohler-Nordenson-Fox formulas. The formulas are presented as they were taken from the original references which in many cases include metric units for the various parameters. No attempt has been made to convert these units for this presentation. Rather, it is recommended that, if the equations are used, conversion of input and output data be performed to achieve desired units. The presentation which follows includes a definition of each parameter, however, more complete details for calculating the various parameters are given in Appendix G.

The original Blaney-Criddle formula (Blaney and Criddle, 1950) is of the form:

$$U = KF$$

where:

- U = consumptive use over the period, inches
- K = an empirical coefficient for the period, usually the growing season
- F = the sum of monthly consumptive use factors f
- f = monthly consumptive use factor, tP/100
- t = mean monthly temperature, °F
- P = percentage of the daylight hours of the year occurring during a given month.

The SCS (SCS, 1970) modified the original Blaney-Criddle formula so that:

$$U = k_t\, k_c\, (tP/100)$$

where:

- k_c = a monthly crop growth stage coefficient
- k_t = a climatic coefficient related to the mean air temperature.

The SCS gave a relationship for $k_t = 0.0173t - 0.314$, with a minimum value of 0.300.

Doorenbos and Pruitt (1977) provided another modification of the Blaney-Criddle, which is generally referred to as the FAO Blaney-Criddle:

$$ET_o = A_B + B_B(p(0.46T + 8))$$

where:

ET_o = reference crop, clipped grass, evapotranspiration in mm/day

T = mean temperature over the period in degrees C

p = mean daily percentage of total annual daylight hours for the period

A_B, B_B = adjustment factors based on minimum relative humidity, sunshine and daytime windspeed estimates. Exact values of the input parameters are not required. Frevert et al. (1983) have given an equation to calculate B_B while Doorenbos and Pruitt (1977) gave an equation for A_B.

The Jensen-Haise (Jensen and Haise, 1963) formula is considered to be a radiation formula. It was derived from data collected in the western United States and is commonly considered to calculate reference crop ET for alfalfa. It takes the form:

$$ET_r = C_T (T - T_x) R_s$$

where:

ET_r = reference evapotranspiration in langleys per day (multiply by 0.000673 to convert to inches per day)

R_s = solar radiation in units of langleys per day

T = mean air temperature in degrees F

T_x = a temperature axis intercept with a value of 26.4

C_T = an empirical coefficient with a value of 0.014.

The formula was later modified (Jensen, 1966 and Jensen et.al., 1970) through defining the coefficients C_T and T_x as:

$$C_T = 1/(C_1 + C_2 C_H)$$

and

$$T_x = 27.5 - 0.25 (e_2 - e_1) - (elev/1000)$$

where:

C_1 = 68 - (3.6)(elev/1000) where elevation is in feet

C_2 = 13

C_H = $50/(e_2 - e_1)$ where e_2 and e_1 are the saturation vapor pressures at the mean maximum and mean minimum temperatures, respectively, for the warmest month of the year

The FAO radiation method (Doorenbos and Pruitt, 1977) is basically a modification of the Makkink formula (1957):

$$ET_o = A_R + B_R(W R_{se})$$

where:

ET_o = reference crop, clipped grass, evapotranspiration in mm/day

R_{se} = solar radiation in equivalent evaporation in mm/day

W = a weighting factor dependent on temperature and altitude and equal to the slope of the saturation vapor pressure-temperature curve at the air temperature in mb/degree C divided by the sum of the slope and the psychrometer constant also in mb/degree C

A_R, B_R = adjustment factors based on mean humidity and daytime windspeed. Frevert et al. (1983) have given equations to calculate B_R while Doorenbos and Pruitt (1977) recommend -0.3 for A_R.

Many modifications of the original Penman (1948) formula have been proposed. Most are adjustments of the coefficients in the wind term, although more extensive modifications have also been presented (e.g. Wright, 1982). The version used herein is that listed by Jensen et al. (1973) and which is sometimes referred to as the ASCE Penman:

$$ET_r = (\Delta/(\Delta+\gamma))(R_n + G) + (\gamma/(\Delta+\gamma))(15.36)(1.0 + 0.0062u_2)(e_{so} - e_a)$$

where:

- ET_r = reference evapotranspiration in langleys per day.
- Δ = slope of the saturation vapor pressure-temperature curve at the air temperature in mb per degree C
- γ = psychrometer constant in mb per degree C
- R_n = net radiation in langleys per day
- G = soil heat flux in langleys per day
- u_2 = wind speed at 2 meters height in km per day
- e_{so} = the saturation vapor pressure obtained as the average of the saturation vapor pressures at the mean maximum and mean minimum temperatures, in mb
- e_a = mean actual vapor pressure obtained as the saturation vapor pressure at the daily average dewpoint, in mb

The FAO Penman (Doorenbos and Pruitt, 1977) utilizes the same general format as given above with the addition of an adjustment factor and different wind coefficients. Also, the soil heat flux term is dropped giving:

$$ET_o = C_p(W\ R_n + (1 - W)(0.27)(1 + U/100)(e_s - e_a)$$

where:

- ET_o = reference crop, clipped grass, evapotranspiration in mm/day
- R_{ne} = net radiation in equivalent evaporation in mm/day
- W = the same factor as given previously in the FAO Radiation method
- U = the 24 hour wind run at 2 meters height in km/day
- e_s = the saturation vapor pressure obtained at the mean temperature, in mb
- e_a = the same as in the previous equation above
- C_p = an adjustment factor dependent on maximum relative humidity, solar radiation, daytime windspeed, and the ratio of daytime to nighttime windspeed. Frevert etal. (1983) have given an equation to calculate C_p.

A commonly used equation for prediction of evaporation from lakes and reservoirs is the Kohler-Nordenson-Fox formula (Kohler et.al., 1955):

$$E = 0.70(R_{ne}\Delta + \gamma\ ((e_s-e_a)^{.88})(0.37 + 0.0041U_p))/(\Delta + \gamma)$$

where:

E = lake evaporation in inches per day

0.70 = a coefficient adjusting pan evaporation to lake evaporation

Δ = slope of the saturation vapor pressure-temperature curve at the air temperature in inches of mercury per degree F

γ = psychrometric constant in inches of mercury per degree F

e_s = saturated vapor pressure evaluated at the mean air temperature, in inches of mercury

e_a = actual vapor pressure evaluated at the mean dewpoint, in inches of mercury

U_p = the wind speed 6 inches above the rim of a Class A evaporation pan in miles per day

R_{ne} = $\exp((T_a - 212)(0.1024 - 0.0166 \ln(R_s))) - 0.0001$

R_s = solar radiation in langleys per day

T_a = the mean air temperature in degrees F.

Uncalibrated Equation Estimates vs Measurements

The need for calibrating the various evapotranspiration formulas can be shown by comparing estimates obtained from the uncalibrated equations to measured ET rates. For the Green River Basin, four types of water use rates were available during the study period. These include alta fescue and alfalfa water use measurements at Daniel, Farson, and Seedskadee; mountain meadow water use measurements in eight lysimeters along Horse Creek from just above Merna to Daniel; and evaporation pan measurements at Merna, Daniel, and Seedskadee. The formulas which will be considered in this section include the original Blaney-Criddle, the SCS Blaney-Criddle, the original Jensen-Haise, the modified Jensen-Haise, a modified Penman, the Kohler-Nordenson-Fox, the FAO Blaney-Criddle, the FAO Radiation, and the FAO Penman methods.

All water use estimates from the equations will be compared with 80% of the measured alfalfa water use rates and 100% of the measured mountain meadow and alta fescue water use rates. The reason for this is, as mentioned in the last chapter, water use rates for alfalfa when surface irrigated appear to be greater in the presence of a water table (Tovey, 1963). All measurements, except those taken to measure actual water use, were taken from lysimeters which were surface irrigated and had water tables. It is not completely clear in the literature but it appears that previous applications of the various formulas for predicting alfalfa water use were to cases which were well-watered but did not include a water table. Thus, for comparison of measured versus estimated alfalfa water use rates, values of 80% of measured appear to be reasonable for use in the analyses. In the case of mountain meadows and alta fescue, 100% of the measured values will be used. Mountain meadows are, usually grown in the presence of a water table. Also, the vegetation has not been used as a reference for the formulas as has alfalfa, thus maximum water use rates, with a water table will be used for comparison. The effect of the presence of a water table with surface irrigation for alta fescue seems to be unknown, however, a water table of 2 ft depth or more is beyond the major influence of the roots for alta fescue.

SCS TR-21 (1967) gives crop growth stage coefficients for alfalfa and pasture grass. Pasture grass is not expected to apply directly to mountain meadows, but a comparison of the relative water use rates estimated for pasture grass versus those measured for mountain meadows is still given. Values given in Table 15, show that average seasonal estimated water use rates were 56% and 49% of measured rates for alfalfa and mountain meadows, respectively, when using the SCS Blaney-Criddle formula and crop growth stage coefficients and the temperature coefficient given in TR-21.

Trelease, et al. (1970) published water use estimates for several Wyoming stations including Farson and Pinedale. Estimates were calculated using the original Blaney-Criddle formula (1962). Comparison of the published estimates with measured water use rates for alfalfa at Farson and alfalfa and mountain meadows measured at Daniel compared with estimates at Pinedale are given in Table 16. Pinedale estimates are used to compare with Daniel measurements since Pinedale is the closest station for which published estimates are given. The comparisons show that the published estimates are slightly closer to the measured values than estimates obtained using the SCS Blaney-Criddle modification as given in Table 15. However, the estimates are still lower than measured values and range from 72% to 79% of the measured ET values for alfalfa.

The radiation based Jensen-Haise model and the modified Penman being considered herein use alfalfa as a reference crop. In the case of the Penman, at least, the reference is for a well-watered, actively growing alfalfa of minimum height, usually about 8 inches (Burman, et al., 1980). After planting, early in the growing season, and after cutting, alfalfa does not match the above definition. Thus, it is necessary to apply crop coefficients to the calculated reference ET rates to estimate alfalfa water use at times when the above conditions do not exist. The results shown in Table 17 indicate that estimated values using the original Jensen-Haise are lower than measured alfalfa water use while those using the modified Jensen-Haise are very nearly the same as the measured alfalfa water use rates. Estimated values using the ASCE Penman range from greater than measured alfalfa values early and late in the growing season to less than measured values during the mid-portion of the growing season (Table 18). The June and July values would be nearest the definition of an actively growing well-developed alfalfa crop. Application of crop coefficients early in the season and following cutting is necessary to compare estimated and measured values at those times. No effort is made here to apply proper crop coefficients since the intent of this section is simply to give a general comparison of measured vs estimated ET rates without local calibration of the various equations. The modified Jensen-Haise, however, predicts measured alfalfa water use rather well throughout the entire growing season, with the exception of May, without application of crop coefficients.

The FAO methods present a slightly different approach to the concept of a reference crop (Doorenbos and Pruitt, 1977). FAO uses four methods to obtain reference crop evapotranspiration, which is defined as the rate of evapotranspiration from a well-watered clipped grass. Three of the methods, the FAO Blaney-Criddle, the FAO Radiation, and the FAO Penman are considered here with estimates from each compared with measured ET rates of alta fescue (Table 19). The FAO Radiation and FAO Penman give similar results with seasonal estimates of 127% and 133%, respectively, of measured alta fescue ET. The FAO Blaney-Criddle estimates are consistently closer with seasonal values averaging 112% of the measured alta fescue ET. An advantage of using clipped grass as opposed to alfalfa is that it is not necessary to apply crop coefficients to the reference crop to indicate its growth stage. A disadvantage often cited

TABLE 15. UNCALIBRATED SCS BLANEY-CRIDDLE ESTIMATES VS MEASUREMENTS

	ALFALFA VS ALFALFA				PASTURE VS MOUNTAIN MEADOWS			
MONTH	TR-21 KC	ESTIMATED (INCHES)	MEASURED* (INCHES)	% OF MEASURED	TR-21 KC	ESTIMATED (INCHES)	MEASURED* (INCHES)	% OF MEASURED
MAY	1.08	1.63	2.62	62	0.90	0.83	1.76	47
JUN	1.13	3.98	7.69	52	0.92	2.54	5.95	43
JUL	1.11	5.71	8.86	64	0.92	3.95	6.73	59
AUG	1.06	4.45	8.51	52	0.91	3.06	5.27	58
SEP	0.99	2.01	3.97	51	0.79	1.26	2.89	44
OCT	0.91	0.66	1.47	45	0.79	0.46	2.05	22
SEASON		18.44	33.12	56		12.10	24.65	49

*ALFALFA VALUES ARE AVERAGES OF THE YEARS 1984 & 1985 AT DANIEL, FARSON, AND SEEDSKADEE. PASTURE AND MOUNTAIN MEADOW VALUES ARE AVERAGES OF THE YEARS 1984 & 1985 AT DANIEL AND MERNA. MAY AND OCTOBER ARE PARTIAL MONTHS. MEASURED VALUES SHOWN FOR ALFALFA ARE 80% OF THOSE ACTUALLY RECORDED DUE TO ADJUSTMENT FOR A WATER TABLE.

TABLE 16. MEASURED ET VS PREVIOUSLY PUBLISHED ESTIMATES*

		ALFALFA VS ALFALFA			PASTURE VS MOUNTAIN MEADOWS		
LOCATION	MONTH	PUBLISHED ESTIMATES (INCHES)	MEASURED (INCHES)	% OF MEASURED	PUBLISHED ESTIMATES (INCHES)	MEASURED (INCHES)	% OF MEASURED
FARSON	JUN	5.17	7.22	72	-	-	-
	JUL	6.45	7.51	86	-	-	-
	AUG	5.12	8.53	60	-	-	-
	SEP	2.94	4.20	70	-	-	-
	4 MONTHS	19.68	27.46	72	-	-	-
PINEDALE VS DANIEL	JUN	4.92	6.23	79	4.48	7.34	61
	JUL	6.00	8.32	72	5.56	7.86	74
	AUG	4.74	4.90	97	4.52	5.49	82
	SEP	2.64	3.66	72	2.52	3.69	68
	4 MONTHS	18.30	23.11	79	17.08	24.38	70

*ESTIMATES ARE FROM TRELEASE ET AL. (1970). FOR PINEDALE VS DANIEL. THE VALUES ARE ESTIMATED AT PINEDALE AND MEASURED AT DANIEL. MEASURED ALFALFA VALUES SHOWN ARE 80% OF THOSE ACTUALLY RECORDED DUE TO ADJUSTMENT FOR A WATER TABLE.

TABLE 17. UNCALIBRATED JENSEN-HAISE ESTIMATES VS ALFALFA MEASUREMENTS*

MONTH	ESTIMATED ET ORIGINAL J-H (INCHES)	ESTIMATED ET MODIFIED J-H (INCHES)	MEASURED ALFALFA ET (INCHES)	% OF MEASURED ORIGINAL J-H	% OF MEASURED MODIFIED J-H
MAY	2.10	3.57	2.62	80	136
JUN	4.77	7.53	7.69	62	98
JUL	5.81	8.98	8.86	66	101
AUG	5.34	7.88	8.51	63	93
SEP	2.47	4.27	3.97	62	108
OCT	0.75	1.56	1.47	51	106
SEASON	21.24	33.69	33.12	64	102

*VALUES ARE AVERAGES OF THE YEARS 1984 & 1985 AT DANIEL, FARSON, AND SEEDSKADEE. NO CROP COEFFICIENTS HAVE BEEN APPLIED FOR PERIODS OF LESS THAN 100% EFFECTIVE COVER. MAY AND OCTOBER ARE PARTIAL MONTHS. MEASURED ALFALFA VALUES SHOWN ARE 80% OF THOSE ACTUALLY RECORDED DUE TO ADJUSTMENT FOR A WATER TABLE.

TABLE 18. UNCALIBRATED MODIFIED PENMAN ESTIMATES VS ALFALFA MEASUREMENTS*

MONTH	ESTIMATED ET (INCHES)	MEASURED ET (INCHES)	% OF MEASURED
MAY	4.18	2.62	160
JUN	7.68	7.69	100
JUL	8.05	8.86	91
AUG	8.27	8.51	97
SEP	5.64	3.97	142
OCT	2.50	1.47	170
SEASON	36.32	33.12	110

*VALUES ARE AVERAGES OF THE YEARS 1984 AND 1985 AT DANIEL, FARSON AND SEEDSKADEE. NO CROP COEFFICIENTS HAVE BEEN APPLIED FOR PERIODS OF LESS THAN 100% EFFECTIVE COVER. MAY AND OCTOBER ARE PARTIAL MONTHS. MEASURED ALFALFA VALUES SHOWN ARE 80% OF THOSE ACTUALLY RECORDED DUE TO ADJUSTMENT FOR A WATER TABLE.

for clipped grass is that in windy arid areas the water use rate of the grass is limited by its reduced canopy and thus the crop is not as capable of responding to the effects of advection. Finally, the results presented in Table 19 indicate that the presence of a water table for the alta fescue may not have increased water use rates above normally expected values. In nearly all cases the measured water use rates were lower than the estimated FAO reference crop values.

Estimates of water losses from reservoirs, and other free water surfaces, are generally calculated using the Kohler-Nordenson-Fox equation. Warnaka (1985) has compared monthly evaporation estimates throughout Wyoming using seven climatological equations. The Kohler-Nordenson-Fox method was shown to give the overall best results in predicting pan evaporation. Measured pan evaporation rates vs Kohler-Nordenson-Fox estimates of evaporation in the Green River Basin for 1984 and 1985 are compared in Table 20. Measurements and estimates compare rather closely, with higher estimated values in the Merna and Daniel area and lower estimated values at Seedskadee. The Seedskadee values may be most representative of responses expected from the major reservoirs in the Green River Basin because of the climatic conditions being most comparable.

Model Calibrations

Results shown in the previous section indicate the need for calibration of the various evapotranspiration formulas. Calibration of the formulas usually involve either or both of two steps. The method of calculating reference crop ET may be calibrated and/or the crop coefficients may be calibrated. In most cases, the approach used herein consisted of determining new crop coefficients, except in the case of the Blaney-Criddle equation which uses crop growth stage coefficients. Only in the cases for which the estimated reference ET was considerably different than measured ET was the method of calculating reference crop ET considered for calibration. A large difference occurred for both the SCS Blaney-Criddle and original Jensen-Haise formulas, but only the SCS Blaney-Criddle has been calibrated.

The Blaney-Criddle formula does not employ a reference crop but rather crop growth stage coefficients for each type of crop. The original Blaney-Criddle uses only a crop growth stage coefficient while the SCS version of the Blaney-Criddle also includes a temperature coefficient k_t. Calibrations of both the original and SCS Blaney-Criddle formulas have been performed for alfalfa and mountain meadows in the Green River Basin (Table 21). Calibration of the SCS Blaney-Criddle includes calculation of k_t for each crop. The crop growth stage coefficients given in Table 21 must therefore be used only with the appropriate k_t as given in the table. An advantage of the SCS Blaney-Criddle is that the alfalfa crop growth stage coefficients are more uniform for the various locations at which data was taken than they are for the original Blaney-Criddle. In each case, Daniel has the smallest coefficients and Seedskadee the largest. For the original Blaney-Criddle the values at Daniel are about 16% below and at Seedskadee about 18% above the average of the values for the three sites while for the SCS Blaney-Criddle the values are about 5% below and 7% above at Daniel and Seedskadee, respectively. Separate k_t values for each crop indicate that the coefficients include crop factors as well as climatic factors.

TABLE 19. FAO ESTIMATES VS ALTA FESCUE MEASUREMENTS*

	ESTIMATED ET			MEASURED ET	% OF MEASURED		
MONTH	BC	RAD	PEN	ALTA FESCUE	BC	RAD	PEN
MAY	3.32	4.08	4.51	2.41	137	170	187
JUNE	6.70	7.83	8.25	5.88	114	133	140
JULY	7.92	8.19	8.37	6.42	123	128	130
AUGUST	7.18	7.71	7.71	6.24	115	124	124
SEPTEMBER	3.86	4.65	4.99	4.38	88	106	114
OCTOBER	1.82	2.55	2.69	2.16	84	119	125
SEASON	30.80	35.01	36.25	27.49	112	127	133

* VALUES ARE AVERAGES OF THE YEARS 1984 AND 1985 FOR THE LOCATIONS OF DANIEL, FARSON, AND SEEDSKADEE. ET IS GIVEN IN INCHES.

TABLE 20. KOHLER-NORDENSON-FOX ESTIMATES VS PAN EVAPORATION MEASUREMENTS*

	ESTIMATED			MEASURED PAN			% OF MEASURED		
MONTH	MERNA	DANIEL	SEEDS	MERNA	DANIEL	SEEDS	MERNA	DANIEL	SEEDS
MAY	1.88	1.96	3.14	1.29	1.82	3.01	146	108	104
JUNE	7.84	7.99	10.47	7.27	7.16	10.67	108	112	98
JULY	8.22	8.48	10.77	7.27	7.22	11.25	113	117	96
AUGUST	7.46	7.72	10.35	6.12	7.17	10.60	112	108	98
SEPTEMBER	4.19	4.62	6.33	4.61	4.93	6.93	91	94	91
OCTOBER	1.79	2.02	2.52	1.99	1.38	2.16	90	146	117
SEASON	31.38	32.79	43.58	28.55	29.68	44.62	110	110	98

* PAN EVAPORATION ESTIMATES AND MEASUREMENTS ARE GIVEN IN INCHES. VALUES ARE AVERAGES OF THE YEARS 1984 AND 1985 FOR LOCATIONS DANIEL, MERNA, AND SEEDSKADEE. MAY AND OCTOBER ARE PARTIAL MONTHS.

Crop coefficients for the original Jensen-Haise, the modified Jensen-Haise, and the modified Penman equations are given in Table 22 for alfalfa and mountain meadows. The results show similar types of coefficients for the modified Jensen-Haise and Penman equations while the magnitudes of the crop coefficients for the original Jensen-Haise are rather large. The coefficients for the modified Penman form a relatively smooth bell-shaped curve for the season, whereas this is not true for either of the Jensen-Haise formulas. The effects of cutting are not apparent in any of the coefficients, although seasonal cycles do exist which reflect the development of the crops during the season.

Results for the three FAO methods show that the crop coefficients for the FAO Radiation and Penman methods are of nearly the same magnitude while those for the FAO Blaney-Criddle method are somewhat larger (Table 23). The basic concept of the FAO procedures is that each of the three methods will produce the same reference crop evapotranspiration values, which is obviously not quite the case for this set of data. The crop coefficients given in Table 23, however, are of approximately the same magnitude as those given by Doorenbos and Pruitt (1977) for both alfalfa and pasture and/or grass harvested for hay. There isn't a good explanation for the differences which occur between the crop coefficients in Table 23 for the FAO Radiation and Penman methods versus the FAO Blaney-Criddle method. Note, however, that the FAO Blaney-Criddle gave reference crop ET estimates nearest to measured alta fescue ET rates (Table 19).

TABLE 21. CROP GROWTH STAGE COEFFICIENTS FOR THE BLANEY-CRIDDLE FORMULAS

	ORIGINAL BLANEY-CRIDDLE		SCS BLANEY-CRIDDLE	
MONTH	ALFALFA	MTN MEADOWS	ALFALFA*	MTN MEADOWS**
MAY	1.05	0.92	0.91	-
JUN	1.37	1.17	1.12	1.19
JUL	1.34	1.10	0.91	0.96
AUG	1.45	1.00	1.04	0.92
SEP	1.01	0.79	0.99	0.91

* Coefficients are to be used only with kt = -0.2950 + 0.028t
** Coefficients are to be used only with kt = 0.1138 + 0.0175t

TABLE 22. CROP COEFFICIENTS FOR THE JENSEN-HAISE AND PENMAN FORMULAS

	ORIGINAL JEN-HAISE		MODIFIED JEN-HAISE		MODIFIED PENMAN	
MONTH	ALFALFA	MTN MDWS	ALFALFA	MTN MDWS	ALFALFA	MTN MDWS
MAY	1.24	1.22	0.73	0.76	0.63	0.63
JUN	1.61	1.51	1.02	1.00	1.00	0.92
JUL	1.52	1.24	0.99	0.91	1.10	0.97
AUG	1.59	1.20	1.08	0.85	1.03	0.78
SEP	1.61	1.56	0.93	0.91	0.70	0.62
OCT	1.96	-	0.94	-	0.59	-

TABLE 23. CROP COEFFICIENTS FOR THE FAO FORMULAS

	FAO BLANEY-CRIDDLE		FAO RADIATION		FAO PENMAN	
MONTH	ALFALFA	MTN MDWS	ALFALFA	MTN MDWS	ALFALFA	MTN MDWS
MAY	0.79	0.84	0.64	0.61	0.58	0.61
JUN	1.15	1.12	0.98	0.85	0.93	0.86
JUL	1.12	1.04	1.08	0.90	1.06	0.93
AUG	1.19	0.96	1.10	0.81	1.10	0.84
SEP	1.03	0.95	0.85	0.69	0.80	0.69
OCT	0.81	-	0.58	-	0.55	-

Chapter 5

BASIN ESTIMATES

Data collected during this study included water use measurements for mountain meadows along Horse Creek, water use measurements for alta fescue and alfalfa at three sites in the Green River Basin, and climatological data at seven sites in the Basin. A major reason for obtaining water use measurements was to permit calibration of evapotranspiration models which could then be used with climatological data from locations where water use measurements were not taken to estimate evapotranspiration rates throughout the Basin. In addition, calibrated models can be used with historical climatic data to estimate long-term water use rates.

Transferability of Estimates

The transferability of the various models can be considered from the standpoint of the comparisons presented in the previous chapter in the section entitled "uncalibrated equation estimates vs measurements". The results of that section indicate that local calibration of the equations are desirable. However, the transferability of calibrated models within and between basins for similar vegetation and climatic conditions is still of concern. The question of the transferability of models can be considered only for those models for which required climatic and ET data are available at other locations. In most cases, this limits the analyses to models based on temperature data, unless special climatological measurements have been taken as was done in the Green River Basin during the period of this study.

Analyses of variations within the Green River Basin can best be done by considering alfalfa and alta fescue, since ET rates of alfalfa and alta fescue were measured at three widely spaced sites while ET rates of mountain meadows were measured at sites which were rather closely spaced. Analyses of variations between basins is much more difficult. In Wyoming, for example, the only recent measurements of water use consist of mountain meadow water use along the Little Laramie River (Borrelli, et al., 1982) and Kentucky bluegrass water use on lawns in Laramie and Wheatland (Borrelli, et al., 1981).

As already mentioned in the previous chapter, a calibrated version of the SCS Blaney-Criddle better accounted for variations in water use between locations within the Green River Basin than did the original Blaney-Criddle formula (Table 24). The difficulty with the calibrated SCS Blaney-Criddle is that a different k_t is required for each crop, which makes the application of the formula somewhat cumbersome but still less complicated than methods such as the combination formulas. The larger spatial variation of the coefficients in the original formula indicates that the climatic differences between locations are not as well accounted for as in the SCS version of the Blaney-Criddle, except through inclusion in the coefficients themselves. This was, in fact, the reason for introduction of the k_t value in the SCS Blaney-Criddle modification.

Considering some of the other equations and their ability to account for spatial variations within the Green River Basin, there was not a great amount of difference between the ASCE Penman, the FAO Blaney-Criddle, the FAO Penman, and the modified Jensen-Haise (Table 25). In all cases, a consistent pattern exists, with largest values of the crop coefficients at Seedskadee and smallest values at Daniel. This pattern can probably be attributed to the amount of advection that occurs at the various sites. Seedskadee has by far the greater oasis condition with Daniel the least.

Mountain meadow water use measurements for the Green River Basin and Little Laramie River Valley (Borrelli, et al., 1981) are shown in Table 26. Comparison of the use rates indicate seasonal values that are very close for the two Basins. Average temperatures, however, in the Little Laramie River Valley are about 7.5°F higher. Application of the SCS Blaney-Criddle formula, calibrated using Green River data (Table 21), to estimate mountain meadow water use in the Little Laramie River Valley reflect these comparisons. The estimated values are about 20% higher than measured values in the Little Laramie River Valley.

Comparisons for clipped grass in the Green River Basin and the eastern portion of Wyoming (Borrelli, et al., 1981) are given in Table 27. Again, application of the calibrated SCS Blaney-Criddle formula to estimate the Laramie and Wheatland seasonal values gave overestimates of 10% and 24%, for Laramie and Wheatland, respectively. The same trends, between water use rates and temperatures at the various sites, which were present for mountain meadows are evident for the clipped grass. The SCS Blaney-Criddle formula was used for the comparisons in both cases since the only available climatic data was temperature. Actually, some differences might be expected due to the different grasses involved, which were Kentucky bluegrass in Laramie and Wheatland and alta fescue in the Green River Basin. The bluegrass did show an apparent high temperature stress during the mid-portion of the summer at Wheatland.

Water Use Rates

Analyses of water use data and models for estimating ET indicate that water use rates vary considerably across the Green River Basin. Thus, for most accurate estimates of the water use rates, local calculations are desired. Local calculations require local climatic data as well as use of a model that accounts for the differences in conditions across the basin. Results from the analyses of the previous section indicate that some formulas are better suited than others for calculation ET at several locations within the Green River Basin. Because long-term climatic data consist of only temperature and precipitation, the temperature based equations must be used to determine estimates of long-term water use rates. In general, analyses showed that estimates using the calibrated SCS Blaney-Criddle were as accurate as estimates from the more data intensive formulas. This is probably because all estimates were for monthly periods. If shorter term estimates were required, then the data intensive equations might perform better.

TABLE 24. AREAL COMPARISON OF BLANEY-CRIDDLE CROP GROWTH STAGE COEFFICIENTS*

CROP	METHOD	LOCATION DANIEL	FARSON	SEEDSKADEE	AVERAGE OF LOCATIONS
ALFALFA	ORIGINAL B-C	1.34	1.50	1.83	1.55
	SCS B-C	0.94	0.98	1.06	0.99

* THE VALUES SHOWN ARE FOR THE SEASON MAY THROUGH SEPTEMBER. THE VALUES ARE FOR COMPARISON PURPOSES ONLY. SEASONAL VALUES ARE NOT TO BE USED TO ESTIMATE CROP WATER USE.

TABLE 25. AREAL COMPARISON OF PENMAN, FAO, AND MODIFIED JENSEN-HAISE METHODS*

CROP	METHOD	LOCATION DANIEL	FARSON	SEEDSKADEE	AVERAGE OF LOCATIONS
ALFALFA	PENMAN	0.88	0.90	1.01	0.93
	FAO B-C	1.08	1.11	1.16	1.12
	FAO PENMAN	0.88	0.93	1.05	0.96
	MODIFIED JEN-HAISE	0.95	1.02	1.05	1.02

* THE VALUES SHOWN ARE SEASONAL CROP COEFFICIENTS FOR MAY THROUGH SEPT.

TABLE 26. MOUNTAIN MEADOW WATER USES FOR GREEN RIVER VS LARAMIE RIVER

	AVERAGE WATER USE*		AVERAGE TEMPERATURE	
MONTH	LARAMIE RIVER (INCHES)	GREEN RIVER (INCHES)	LARAMIE RIVER (F)	GREEN RIVER (F)
MAY	2.45A	1.76C	47.0	43.5
JUN	6.67	5.95	58.0	49.9
JUL	6.46	6.73	65.0	59.3
AUG	3.96	5.27	61.5	55.0
SEP	3.14B	2.89	56.9	43.4
SEASON	22.66	22.60	57.7	50.2

* YEARS ARE 1979 & 1980 FOR LARAMIE RIVER AND 1984 & 1985 FOR GREEN RIVER
A-MAY 14 THROUGH 31
B-SEP 1 THROUGH 18
C-AVERAGE FROM MAY 19 THROUGH 31

TABLE 27. CLIPPED GRASS WATER USE FOR GREEN RIVER VS LARAMIE AND WHEATLAND

	AVERAGE WATER USE*			AVERAGE TEMPERATURE		
MONTH	GREEN RIVER (INCHES)	LARARMIE (INCHES)	WHEATLAND (INCHES)	GREEN RIVER (F)	LARAMIE (F)	WHEATLAND (F)
MAY	2.41A	4.49	4.88	47.7	47.1	55.9
JUN	5.88	6.50	6.14	54.3	58.8	66.4
JUL	6.42	7.20	6.61	63.2	65.5	73.0
AUG	6.24	5.28	4.88	59.9	61.2	67.8
SEP	4.38	3.66	4.45	47.3	54.5	49.5
SEASON	25.33	27.13	26.96	54.5	57.4	64.9

* YEARS ARE 1984 & 1985 FOR THE GREEN RIVER BASIN AND 1976-1978 FOR LARAMIE AND WHEATLAND. STATIONS IN THE GREEN RIVER BASIN INCLUDE DANIEL, FARSON, AND SEEDSKADEE.
A-AVERAGE DATE FROM MAY 12 THROUGH 31

Comparisons of estimates using the calibrated versions of the SCS Blaney-Criddle, ASCE Penman, modified Jensen-Haise, and FAO Blaney-Criddle and Penman formulas for the seven sites at which intensive weather data were measured during 1984 and 1985 are given in the Appendix E. The results show that the estimates using the calibrated SCS Blaney-Criddle formula compare favorably with those from the other equations. However, as shown in Table 15 of Chapter 4, water use estimates using the SCS Blaney-Criddle without calibration for mountain meadow vegetation may be considerably lower than the estimates obtained herein using a calibrated version of the formula.

Measurements of water use taken during 1984 and 1985 in the Green River Basin were taken to permit calibration of ET formulas for estimating maximum consumptive use rates. Actual consumptive use rates under irrigation are expected to be less than the estimated maximum rates. Some of the factors that need to be defined to estimate actual irrigation water use include the total irrigated acreages, lengths of irrigation season, agronomic and irrigation practices, depth of ground water tables, and soil fertility and salinity levels. In addition, irrigation water use is also affected by the amount of precipitation received.

Chapter 6

SUMMARY

The primary purpose of this study has been to collect consumptive use data and to assess models for estimating evapotranspiration in the Green River Basin of Wyoming. The basin is a headwaters basin of the Colorado River and is subject to the terms of the Upper Colorado River Basin Compact of 1948. The study has been concerned mainly with water use as it relates to the compact. The main concern, therefore, has been to develop water use information concerning crop water use requirements.

Measurements of water use and climatic data were collected to provide a data base for defining evapotranspiration rates and model assessment. Water use measurements consisted of lysimeter and evaporation pan data. Fourteen water balance lysimeters were installed in the basin and operated for a three year period, with the first year considered as a start-up period. The 14 lysimeters consisted of 8 with mountain meadow vegetation, the main crop grown in the basin; 3 with alfalfa, the other major crop in the basin; and 3 with alta fescue as a reference crop. The major water use measurement obtained was that of maximum water use, with the intent of simulating water use conditions under intensive irrigation practices. Weekly water use measurements were taken, but most analyses were completed using monthly summaries of the water use rates since this was an assessment study where annual totals, and not short term variations, were of concern. Three evaporation pans were operated to obtain measurements of free water evaporation rates and to provide a second reference for the crop water use rates. Seven automated weather stations were operated with stations located to provide as complete coverage of the basin as possible. The stations measured weather parameters not available through other sources and provided data required for the most complex of the evapotranspiration formulas. Measured water use rates for alfalfa and mountain meadows were high and were close to the evaporation rates from Class A evaporation pans.

Eight evapotranspiration formulas, or variations thereof, and one evaporation formula were evaluated for their ability to predict water use rates in the Green River Basin. The evapotranspiration formulas included the original Blaney-Criddle, the SCS Blaney-Criddle, the original Jensen-Haise, the modified Jensen-Haise, the ASCE Penman, the FAO Blaney-Criddle, the FAO Radiation, and the FAO Penman. The Kohler-Nordenson-Fox formula was the evaporation formula considered. Analyses indicated a need for calibrating all formulas for Green River Basin conditions. Upon calibration, the SCS Blaney-Criddle, the modified Jensen-Haise, the ASCE Penman, and the FAO formulas all performed about the same in terms of predicting variations in water use across the basin. The other formulas, for one reason or another, did not perform as well as these equations. The calibrations consisted of developing crop coefficients for each equation, except in the case of the SCS Blaney-Criddle for which the temperature coefficient was also calibrated. The Kohler-Nordenson-Fox equation was compared with pan data, with estimated values comparing closely with measured pan evaporation. Calibrated versions of the temperature based formulas were found to perform as well as the more data-intensive formulas for the monthly and/or annual estimates required for water use assessment studies. The transfer of the calibrated models to other basins was shown to be only moderately successful, although differences between data taken in the Green River Basin and other sources may have contributed to the transferability question.

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APPENDIX A

TABLE A1. PROJECT PERSONNEL

NAME	STATUS
Burman, Robert*	Principal Investigator
Pochop, Larry*	Principal Investigator
Borrelli, John	Principal Investigator Resigned from the University, Jan 1985
Kerr, Greg*	Research Associate, WWRC Field supervision and operations
Schumaker, Joan	Graduate Student, Water Resources Field operations (1983) and data analyses
Crump, Tom	Graduate Student, Civil Engineering Field operations (1983 and 1984)
Baird, Del	Graduate Student, Civil Engineering Field operations (1985) and data analyses
Gao, Fang	Graduate Student, Agricultural Engineering Data analyses and water use modeling
Bajusz, Barbara	Graduate Student, Statistics Data analyses and climatic modeling
Vassar, Angela*	Student Assistant Data management and computer programming
Boelman, Scott	Student Assistant Data analyses and final report assistance
McCrea, Doug	Student Assistant Final report assistance
Wessman, Eric	Student Assistant Vegetative Survey, 1985
Ebsen, Mike	Student Assistant Installation of lysimeters assistance
Pliley, Connie*	Secretarial Staff
Lankford, Ginny	Secretarial Staff

* Were associated with the project for its entire duration.

TABLE A2. PROJECT COOPERATORS

NAME AND ADDRESS	STATUS
Applequest, Marvin II Farson, Wy 82932	Automated weather station #2 Lysimeters 2A and 2B
Carlson, Jay U.S. Forest Service Big Piney, Wy 83113	Automated weather station #5
Davidson, Mr. & Mrs. Edwin P.O. Box 938 Lyman Wy 82937	Automated weather station #7
Kanski, Steve Pinedale, Wy 82941	Lysimeters 3C, 3D, 3E, and 3F
Radike, Lynn White Mountain Golf Course P. O. Box 1030 Rock Springs, Wy. 82901	Automated weather station #1
Radzay, Jerry Wyoming Game & Fish Hay Farm Fontenelle Route Kemmerer, Wy 83101	Automated weather station #6 Lysimeters 6A and 6B
Roberts, Zack Daniel, Wy 83115	Automated weather station #4 Lysimeters 4A, 4B, 4C, 4D
Todd, Mr. & Mrs. Ed P. O. Box 146 Daniel, Wy 83115	Automated weather station #3 Lysimeters 3A and 3B
Asay, Wayne H. Univ. Ext. Agent, Uinta	Cropping and Irrigation Info.
Murdock, Robert S. Univ. Ext. Agent, Lincoln	Cropping and Irrigation Info.
Peterson, Eric Univ. Ext. Agent, Sublette	Cropping and Irrigation Info. Vegetative Survey, 1984

TABLE B1. WEEKLY CLIMATIC DATA FOR ROCK SPRINGS

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
5 3 83	53.3	31.5	100.	48.	34.8	456.	.59	174.	1.7
5 10 83	59.3	31.1	88.	26.	26.4	601.	.00	235.	1.5
5 17 83	46.8	26.3	99.	53.	28.8	493.	.39	234.	1.4
5 24 83	63.7	31.6	100.	32.	33.1	641.	.24	195.	1.5
5 31 83	75.6	38.3	95.	19.	35.1	686.	.28	145.	1.6
6 7 83	64.6	39.9	100.	50.	45.2	528.	1.06	124.	1.6
6 14 83	68.9	40.3	99.	29.	40.2	650.	.28	178.	1.6
6 21 83	77.5	40.4	88.	16.	33.2	778.	.00	171.	1.9
6 28 83	79.2	45.2	95.	21.	41.5	622.	.00	147.	1.7
7 5 83	76.4	40.8	99.	23.	38.2	594.	.12	149.	1.5
7 12 83	82.7	45.2	95.	18.	40.0	669.	.16	174.	1.6
7 19 83	86.1	43.5	79.	12.	31.0	679.	.04	156.	1.9
7 26 83	83.6	51.0	94.	23.	48.2	511.	.55	131.	1.5
8 2 83	88.6	51.7	89.	15.	43.7	631.	.00	136.	1.6
8 9 83	93.4	52.7	90.	12.	43.5	633.	.00	119.	1.4
8 16 83	88.3	56.0	95.	18.	49.5	576.	.20	142.	1.5
8 23 83	83.1	51.4	99.	24.	49.4	555.	.39	144.	1.3
8 30 83	86.0	43.3	88.	12.	34.4	549.	.00	137.	1.3
9 6 83	78.9	45.9	89.	26.	41.7	497.	.16	175.	1.5
9 13 83	78.2	40.3	95.	17.	36.2	553.	.04	160.	1.9
9 20 83	71.8	36.5	73.	14.	21.8	539.	.00	233.	1.9
9 27 83	72.0	35.2	88.	21.	31.1	458.	.16	136.	1.7
10 4 83	63.3	38.7	96.	37.	39.6	339.	.20	183.	1.4
4 12 84	47.7	26.1	91.	44.	24.7	389.	.08	263.	1.2
4 19 84	61.3	25.1	91.	25.	24.0	515.	.04	167.	1.4
4 26 84	46.1	24.1	92.	52.	25.9	356.	.28	224.	1.4
5 3 84	47.6	25.5	96.	44.	26.4	486.	.12	219.	1.8
5 10 84	60.2	28.6	78.	21.	21.3	552.	.00	240.	2.0
5 17 84	74.0	35.9	87.	24.	34.6	552.	.16	213.	1.7
5 24 84	72.7	42.4	77.	20.	31.6	594.	.20	241.	1.5
5 31 84	74.7	37.0	74.	18.	28.9	608.	.04	211.	1.4
6 7 84	64.9	35.4	89.	32.	33.3	512.	.31	212.	1.6
6 14 84	69.7	37.3	91.	22.	32.9	566.	.43	177.	1.6
6 21 84	79.3	44.0	80.	14.	34.3	563.	.00	159.	1.8
6 28 84	83.7	44.4	64.	12.	29.6	706.	.00	143.	1.9

Continued

TABLE B1. WEEKLY CLIMATIC DATA FOR ROCK SPRINGS (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
7 5 84	84.5	44.4	75.	15.	33.9	684.	.08	191.	1.4
7 12 84	87.5	47.7	86.	14.	38.7	611.	.08	148.	1.7
7 19 84	88.8	48.8	69.	12.	32.8	647.	.00	135.	1.5
7 26 84	85.6	53.9	95.	25.	50.8	543.	.63	152.	1.7
8 2 84	84.0	54.9	92.	26.	50.5	546.	.16	138.	1.6
8 9 84	86.8	47.0	84.	13.	37.0	592.	.00	115.	1.7
8 16 84	86.5	52.6	83.	19.	44.9	479.	.16	120.	1.5
8 23 84	81.4	51.4	93.	22.	44.7	509.	.59	126.	1.5
8 30 84	81.9	49.3	72.	18.	35.6	532.	.08	182.	1.5
9 6 84	78.9	41.4	79.	17.	31.5	494.	.63	195.	1.7
9 13 84	71.4	45.7	74.	29.	37.6	430.	.28	244.	1.7
9 20 84	77.5	39.9	92.	17.	37.6	463.	.24	115.	1.6
9 27 84	56.3	29.9	94.	34.	29.9	408.	.47	170.	1.4
10 4 84	63.4	28.9	92.	24.	28.7	375.	.00	100.	1.5
10 11 84	69.3	33.1	85.	16.	26.0	388.	.00	136.	1.6
10 18 84	43.8	22.9	88.	34.	18.5	278.	.08	240.	1.5
10 25 84	37.5	10.3	96.	37.	14.8	303.	.04	113.	1.2
11 1 84	43.1	22.5	97.	37.	20.6	258.	.12	175.	1.2
11 8 84	49.2	24.2	96.	36.	25.1	210.	.24	214.	1.3
4 26 85	45.8	24.0	85.	26.	15.9	467.	.00	261.	1.7
5 3 85	74.9	30.5	69.	13.	19.8	663.	.08	105.	1.6
5 10 85	70.4	36.8	69.	18.	21.4	565.	.16	178.	1.9
5 17 85	64.6	34.6	75.	16.	20.5	598.	.16	205.	1.3
5 24 85	75.9	36.9	91.	13.	29.2	663.	.04	119.	1.6
5 31 85	77.5	38.2	85.	12.	27.0	633.	.00	178.	2.2
6 7 85	93.6	41.3	96.	9.	28.7	755.	.00	164.	1.3
6 14 85	81.9	46.4	39.	11.	19.8	749.	.00	193.	1.5
6 21 85	84.2	48.6	34.	11.	20.6	761.	.00	176.	1.6
6 28 85	75.0	39.8	80.	27.	30.2	571.	.63	145.	1.7
7 5 85	91.5	47.2	66.	9.	25.7	689.	.00	138.	1.9
7 12 85	94.4	56.1	51.	9.	28.9	626.	.04	127.	1.6
7 19 85	88.8	53.5	81.	11.	38.5	582.	.00	131.	1.6
7 26 85	82.9	52.1	95.	15.	41.5	585.	.35	134.	1.9

Continued

TABLE B1. WEEKLY CLIMATIC DATA FOR ROCK SPRINGS (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
8 2 85	84.3	50.2	70.	12.	31.9	607.	.00	127.	1.9
8 9 85	85.2	45.5	39.	11.	19.6	684.	.00	179.	2.0
8 16 85	79.2	42.0	46.	12.	18.8	647.	.04	156.	2.0
8 23 85	85.7	44.2	52.	10.	20.6	614.	.00	108.	2.4
8 30 85	91.4	45.5	35.	9.	19.9	558.	.00	33.	0.9
9 6 85	81.1	46.5	65.	13.	28.3	521.	.08	112.	1.7
9 13 85	70.1	35.9	81.	16.	25.3	438.	.47	127.	3.0
9 20 85	69.5	36.7	84.	20.	27.8	402.	.24	136.	2.2
9 27 85	60.6	29.3	87.	20.	20.5	420.	.12	186.	2.0
10 4 85	56.2	23.1	63.	19.	11.3	448.	.00	165.	1.6
10 11 85	55.1	27.9	90.	39.	24.0	315.	.47	129.	2.0
10 18 85	57.6	27.4	84.	21.	17.7	385.	.00	131.	1.8
10 25 85	59.6	27.3	95.	27.	25.7	323.	.00	189.	1.7
11 1 85	59.4	24.5	93.	20.	21.4	330.	.00	112.	1.9

TABLE B2. WEEKLY CLIMATIC DATA FOR FARSON

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
5 3 83	52.0	28.1	100.	48.	33.3	325.	.79	172.	2.0
5 10 83	56.8	26.2	95.	29.	26.3	384.	.00	245.	1.9
5 17 83	45.3	21.0	100.	51.	26.9	329.	.39	225.	1.8
5 24 83	60.9	29.4	97.	33.	33.6	319.	.24	148.	2.2
5 31 83	74.5	34.3	96.	21.	35.0	426.	.12	162.	1.4
6 7 83	65.1	36.9	100.	46.	44.4	373.	.16	137.	1.7
6 14 83	68.7	34.6	100.	29.	40.5	426.	.59	157.	1.9
6 21 83	75.7	37.1	90.	16.	33.4	508.	.00	185.	1.5
6 28 83	78.0	43.2	97.	22.	42.7	422.	.35	143.	1.8
7 5 83	73.6	39.5	99.	25.	40.4	431.	.20	146.	1.7
7 12 83	79.9	43.9	99.	19.	43.2	448.	.28	155.	1.8
7 19 83	81.7	39.3	92.	14.	33.1	454.	.12	139.	1.7
7 26 83	80.7	47.4	98.	22.	44.2	354.	.08	118.	1.8
8 2 83	85.8	48.8	84.	13.	37.4	433.	.00	131.	1.9
8 9 83	92.2	51.1	89.	10.	39.1	437.	.00	106.	1.3
8 16 83	85.8	50.7	95.	14.	43.0	365.	.04	124.	1.7
8 23 83	78.4	44.3	100.	23.	48.3	356.	2.01	110.	1.4
8 30 83	81.4	40.5	94.	12.	33.2	620.	.00	113.	1.6
9 6 83	74.9	38.8	98.	25.	37.5	453.	.08	139.	2.0
9 13 83	74.9	34.4	96.	15.	31.9	369.	.39	140.	2.3
9 20 83	69.1	27.8	85.	14.	19.4	349.	.00	176.	2.7
9 27 83	69.7	28.5	84.	16.	25.1	330.	.35	114.	1.9
10 4 83	62.4	25.3	99.	28.	29.9	238.	.43	138.	1.6
4 12 84	45.5	19.3	84.	27.	18.5	425.	.28	175.	1.5
4 19 84	59.7	23.6	83.	18.	19.2	445.	.04	154.	1.5
4 26 84	46.8	19.5	83.	28.	17.0	382.	.28	196.	1.7
5 3 84	46.5	18.7	83.	22.	16.3	471.	.31	221.	2.3
5 10 84	61.9	19.6	78.	16.	11.9	516.	.00	215.	2.5
5 17 84	71.6	29.6	81.	14.	23.5	529.	.16	209.	2.2
5 24 84	70.8	32.6	76.	14.	20.1	582.	.20	230.	2.2
5 31 84	72.9	31.8	69.	13.	19.3	606.	.16	205.	1.7
6 7 84	61.3	27.3	83.	20.	23.2	507.	.47	199.	1.9
6 14 84	66.2	30.9	80.	17.	21.7	588.	.35	199.	1.4
6 21 84	77.3	38.1	70.	12.	20.9	542.	.00	174.	1.8
6 28 84	80.6	35.3	74.	12.	22.2	679.	.04	140.	1.9

Continued

TABLE B2. WEEKLY CLIMATIC DATA FOR FARSON (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
7 5 84	82.0	37.3	78.	15.	28.8	676.	.08	141.	1.9
7 12 84	82.7	36.8	82.	13.	32.8	627.	.51	133.	1.8
7 19 84	83.8	37.8	81.	13.	32.8	634.	.24	102.	1.7
7 26 84	80.0	31.5	96.	31.	44.6	514.	1.30	119.	1.2
8 2 84	79.4	33.3	97.	32.	46.1	521.	1.54	105.	1.8
8 9 84	82.6	36.2	93.	16.	38.9	579.	.00	100.	1.5
8 16 84	83.7	42.1	93.	19.	43.3	516.	.04	97.	1.6
8 23 84	81.0	37.6	94.	19.	39.6	515.	.28	101.	1.8
8 30 84	78.2	34.0	94.	19.	35.6	527.	.04	129.	1.2
9 6 84	75.9	33.3	91.	17.	29.5	478.	.59	148.	1.9
9 13 84	69.2	32.1	94.	22.	32.2	433.	.43	185.	2.1
9 20 84	76.0	32.6	94.	15.	32.7	451.	.08	102.	1.5
9 27 84	54.2	19.1	97.	27.	24.0	363.	.31	141.	1.6
10 4 84	63.5	22.2	94.	20.	23.5	373.	.00	100.	1.2
10 11 84	70.5	25.3	91.	14.	21.9	378.	.00	100.	1.8
10 18 84	45.6	12.7	91.	23.	12.1	292.	.00	153.	2.1
10 25 84	37.8	2.7	88.	22.	4.3	269.	.00	90.	1.5
11 1 84	-99.0	-99.0	-99.	-99.	-99.0	-99.	-.99	-99.	-99.0*
11 8 84	44.8	13.6	96.	35.	16.2	196.	.16	152.	1.6
11 15 84	40.0	7.7	97.	43.	16.1	198.	.04	126.	1.5
4 26 85	47.1	15.1	94.	24.	14.4	485.	.04	222.	2.4
5 3 85	73.8	26.1	82.	14.	21.6	627.	.31	117.	1.5
5 10 85	66.6	25.8	97.	26.	23.6	537.	.28	173.	2.0
5 17 85	63.6	26.6	96.	17.	20.8	611.	.00	218.	1.6
5 24 85	76.6	27.0	99.	13.	27.6	643.	.00	137.	1.7
5 31 85	70.7	26.2	98.	15.	28.5	641.	.35	192.	2.0
6 7 85	72.5	29.0	100.	19.	36.3	540.	.94	150.	2.1
6 14 85	79.1	37.8	80.	12.	23.6	738.	.00	177.	2.0
6 21 85	81.9	43.3	62.	11.	23.0	731.	.00	185.	1.8
6 28 85	72.4	26.5	96.	30.	28.2	584.	.83	143.	1.9
7 5 85	88.1	42.0	84.	10.	29.1	672.	.00	132.	1.7
7 12 85	90.6	45.6	87.	10.	35.5	557.	.08	119.	1.5
7 19 85	87.5	40.2	98.	11.	36.8	547.	.04	116.	1.6
7 26 85	82.2	37.2	100.	17.	39.0	557.	.08	118.	1.8

Continued

TABLE B2. WEEKLY CLIMATIC DATA FOR FARSON (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
8 2 85	80.7	35.3	99.	14.	36.4	576.	.20	142.	2.0
8 9 85	82.6	37.2	71.	11.	22.0	666.	.00	161.	2.1
8 16 85	75.0	32.0	84.	13.	21.6	581.	.00	188.	2.4
8 23 85	82.8	38.0	76.	11.	23.1	616.	.08	162.	2.2
8 30 85	88.2	39.2	67.	10.	22.6	553.	.00	126.	1.6
9 6 85	78.2	34.6	88.	16.	29.7	534.	.28	165.	2.0
9 13 85	68.5	26.7	92.	18.	26.0	423.	.59	161.	1.8
9 20 85	68.3	25.6	98.	18.	25.0	441.	.31	145.	2.3
9 27 85	59.5	19.3	95.	20.	17.8	417.	.08	178.	2.2
10 4 85	56.0	16.5	81.	18.	9.8	430.	.00	169.	1.6
10 11 85	55.3	17.1	92.	25.	15.8	315.	.43	156.	1.7
10 18 85	58.3	16.5	96.	18.	13.8	364.	.00	129.	1.5
10 25 85	58.2	18.3	91.	26.	20.4	312.	.00	186.	1.8
11 1 85	58.5	16.6	100.	17.	18.9	312.	.00	127.	1.6

* -99 INDICATES MISSING DATA

TABLE B3. WEEKLY CLIMATIC DATA FOR MERNA

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
5 17 83	-99.0	-99.0	-99.	-99.	-99.0	-99.	-.99	-99.	-99.0*
5 24 83	-99.0	-99.0	-99.	-99.	-99.0	-99.	-.99	-99.	-99.0
5 31 83	-99.0	-99.0	-99.	-99.	-99.0	-99.	-.99	-99.	-99.0
6 7 83	-99.0	-99.0	-99.	-99.	-99.0	-99.	-.99	-99.	-99.0
6 14 83	-99.0	-99.0	-99.	-99.	-99.0	-99.	-.99	-99.	-99.0
6 21 83	63.6	29.8	99.	28.	32.5	622.	.00	125.	1.9
6 28 83	70.7	36.2	96.	29.	39.8	549.	.39	116.	1.6
7 5 83	65.2	34.6	100.	46.	41.5	544.	.51	106.	1.5
7 12 83	71.4	36.7	100.	39.	44.5	577.	.43	115.	1.8
7 19 83	73.6	34.3	95.	26.	38.8	580.	.04	114.	1.4
7 26 83	72.2	40.7	99.	40.	47.6	455.	.71	92.	1.5
8 2 83	76.5	41.7	98.	32.	46.5	544.	.04	91.	1.4
8 9 83	83.8	46.6	99.	27.	50.8	538.	.16	85.	1.1
8 16 83	75.7	44.7	99.	43.	50.6	432.	.51	88.	1.5
8 23 83	66.6	43.8	100.	64.	50.2	318.	1.65	81.	1.6
8 30 83	75.1	36.8	98.	22.	39.3	535.	.00	92.	1.4
9 6 83	69.3	35.8	98.	36.	41.3	440.	.24	83.	2.1
9 13 83	66.6	30.7	100.	29.	36.7	452.	.55	97.	1.9
9 20 83	62.6	25.9	95.	24.	24.9	428.	.08	120.	2.1
9 27 83	65.4	28.9	93.	29.	30.1	356.	.28	88.	1.6
10 4 83	52.5	32.0	100.	59.	37.0	213.	.75	91.	1.6
4 12 84	38.2	15.9	93.	57.	19.3	452.	.31	122.	1.7
4 19 84	53.7	20.9	88.	35.	22.8	523.	.59	92.	1.1
4 26 84	45.2	18.1	92.	43.	19.5	464.	.20	122.	1.9
5 3 84	43.9	18.2	96.	43.	19.4	522.	.47	118.	2.3
5 10 84	47.4	20.1	88.	35.	20.8	595.	.08	119.	2.2
5 17 84	59.9	29.0	97.	41.	33.5	427.	.20	114.	2.0
5 24 84	59.6	29.9	94.	36.	30.9	578.	.35	147.	1.7
5 31 84	63.2	32.2	88.	31.	30.8	614.	.16	136.	1.9
6 7 84	52.5	26.9	94.	45.	29.8	520.	1.10	119.	2.1
6 14 84	57.4	28.9	96.	44.	33.2	471.	.79	99.	2.2
6 21 84	68.1	36.0	93.	25.	37.1	637.	.00	123.	1.6
6 28 84	72.6	36.1	90.	24.	36.6	716.	.00	121.	1.5

Continued

TABLE B3. WEEKLY CLIMATIC DATA FOR MERNA (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
7 5 84	72.0	36.2	89.	28.	38.8	676.	.28	124.	1.7
7 12 84	75.0	38.9	95.	28.	41.8	599.	.47	97.	1.5
7 19 84	78.3	40.1	82.	22.	39.3	625.	.00	92.	1.7
7 26 84	72.4	45.9	97.	51.	51.9	446.	.98	72.	2.3
8 2 84	71.5	44.6	97.	54.	51.2	480.	2.24	79.	1.8
8 9 84	74.6	41.1	95.	35.	46.2	569.	.47	84.	1.5
8 16 84	74.1	42.4	95.	40.	47.1	466.	.00	89.	1.4
8 23 84	72.3	39.5	97.	36.	44.9	493.	.67	84.	1.4
8 30 84	71.0	37.5	97.	35.	42.7	473.	.51	97.	1.7
9 6 84	67.5	33.1	94.	33.	36.7	437.	.28	107.	1.6
9 13 84	61.0	32.2	96.	40.	35.1	442.	.35	130.	1.8
9 20 84	70.4	33.1	93.	29.	36.5	428.	.08	95.	1.5
9 27 84	47.3	20.9	97.	44.	25.5	307.	1.57	81.	1.9
10 4 84	59.0	25.3	96.	31.	28.3	346.	.35	85.	1.6
10 11 84	63.0	28.7	94.	23.	29.7	349.	.04	104.	1.9
10 18 84	37.1	14.0	94.	44.	16.7	261.	.16	122.	1.6
10 25 84	36.1	4.4	93.	38.	9.4	241.	.08	82.	1.3
11 1 84	44.5	1.4	90.	23.	8.6	306.	.08	81.	1.0
11 8 84	39.9	11.6	96.	50.	19.1	166.	.24	109.	1.2
4 26 85	40.0	13.5	94.	31.	12.2	490.	.00	123.	1.8
5 3 85	65.9	27.9	84.	18.	21.7	624.	.24	114.	1.5
5 10 85	57.3	27.4	87.	30.	21.2	509.	.20	126.	1.8
5 17 85	53.2	22.1	89.	26.	19.9	518.	.24	128.	1.9
5 24 85	67.5	29.7	96.	17.	29.6	601.	.04	107.	1.8
5 31 85	60.4	27.2	97.	28.	30.6	538.	.12	126.	1.8
6 7 85	63.6	30.8	97.	34.	35.5	518.	.28	105.	1.9
6 14 85	68.6	31.4	90.	17.	26.6	734.	.00	126.	1.9
6 21 85	73.0	36.6	84.	15.	28.8	752.	.00	136.	1.5
6 28 85	66.4	31.3	91.	28.	30.8	588.	.55	104.	1.8
7 5 85	79.3	39.3	73.	13.	30.2	648.	.00	108.	1.5
7 12 85	81.4	45.5	80.	19.	40.2	596.	.00	105.	1.5
7 19 85	76.1	40.3	95.	23.	40.5	584.	.31	97.	1.7
7 26 85	76.1	39.9	93.	25.	40.1	607.	.79	100.	1.5

Continued

TABLE B3. WEEKLY CLIMATIC DATA FOR MERNA (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
8 2 85	70.3	35.3	95.	29.	39.7	508.	.87	96.	1.7
8 9 85	71.3	34.7	82.	18.	28.9	647.	.00	120.	1.6
8 16 85	66.3	29.0	88.	17.	25.0	622.	.00	128.	2.0
8 23 85	74.4	33.0	75.	14.	24.3	593.	.04	114.	1.8
8 30 85	78.9	37.1	73.	17.	28.5	482.	.08	97.	1.4
9 6 85	68.4	34.4	92.	25.	34.4	421.	.24	102.	1.5
9 13 85	60.8	27.5	94.	27.	29.2	340.	1.26	112.	2.0
9 20 85	60.4	26.9	94.	27.	27.1	409.	.28	105.	1.8
9 27 85	50.8	21.3	90.	28.	19.5	389.	.43	126.	2.5
10 4 85	49.3	15.5	85.	28.	13.3	404.	.24	122.	1.5
10 11 85	47.7	16.5	90.	32.	19.4	318.	.79	102.	1.7
10 18 85	50.6	18.0	92.	23.	17.6	380.	.00	105.	1.8
10 25 85	50.5	23.6	93.	35.	23.7	283.	.00	111.	1.6
11 1 85	50.4	20.4	92.	30.	22.0	285.	.00	107.	1.5

* -99 INDICATES MISSING DATA

TABLE B4. WEEKLY CLIMATIC DATA FOR DANIEL

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
5 24 83	59.4	28.5	100.	34.	32.4	564.	.16	127.	1.9
5 31 83	71.6	33.8	99.	22.	34.2	587.	.00	113.	1.6
6 7 83	63.1	34.9	100.	40.	41.2	504.	.63	102.	1.7
6 14 83	64.4	34.1	100.	37.	38.6	553.	.12	120.	1.6
6 21 83	68.2	34.3	98.	24.	35.0	606.	.00	120.	1.7
6 28 83	74.4	38.4	100.	26.	41.7	553.	.12	97.	1.5
7 5 83	67.8	38.0	100.	37.	42.2	528.	.28	106.	1.5
7 12 83	74.7	40.7	100.	31.	45.4	577.	.55	116.	1.7
7 19 83	76.6	34.5	99.	23.	39.8	550.	.04	97.	1.5
7 26 83	74.5	42.2	100.	36.	47.1	451.	.20	93.	1.7
8 2 83	80.9	40.9	100.	23.	45.4	541.	.16	86.	1.5
8 9 83	87.5	45.5	100.	17.	48.7	543.	.00	83.	1.2
8 16 83	79.8	45.9	100.	27.	50.1	448.	1.02	90.	1.3
8 23 83	70.1	45.7	100.	54.	52.0	346.	.91	82.	1.5
8 30 83	78.3	34.0	100.	17.	39.6	513.	.00	75.	1.4
9 6 83	72.6	35.4	100.	32.	42.0	423.	.59	87.	1.7
9 13 83	69.8	29.8	100.	26.	37.2	443.	.63	108.	1.5
9 20 83	64.3	25.3	96.	22.	25.8	426.	.00	130.	2.3
9 27 83	67.1	25.3	99.	27.	31.0	354.	.12	89.	1.5
10 4 83	55.1	31.9	100.	53.	37.9	209.	.59	90.	1.6
4 12 84	39.2	16.3	96.	63.	22.5	490.	.08	147.	1.6
4 19 84	52.4	19.1	95.	39.	24.5	528.	.24	116.	1.3
4 26 84	43.9	19.3	96.	45.	22.6	437.	.31	166.	1.8
5 3 84	42.7	20.7	98.	46.	22.9	483.	.24	154.	1.7
5 10 84	50.9	20.3	96.	32.	22.5	572.	.04	151.	2.7
5 17 84	63.0	28.9	99.	41.	35.7	451.	.47	121.	2.1
5 24 84	62.4	29.1	95.	34.	32.6	592.	.16	159.	2.1
5 31 84	65.6	31.2	93.	29.	33.4	616.	.31	142.	1.9
6 7 84	54.2	28.3	95.	44.	32.9	518.	.63	163.	1.8
6 14 84	61.0	31.3	97.	36.	34.7	543.	.24	134.	1.7
6 21 84	70.5	38.8	89.	25.	38.5	640.	.00	147.	1.6
6 28 84	74.3	36.1	95.	21.	38.9	726.	.00	125.	1.4
7 5 84	74.3	36.9	97.	25.	41.3	674.	.08	129.	1.5
7 12 84	78.7	41.4	96.	25.	44.3	617.	.35	105.	1.2
7 19 84	80.5	41.1	89.	22.	42.2	633.	.00	101.	1.2
7 26 84	76.8	46.0	97.	40.	51.0	479.	.90	95.	1.7

Continued

TABLE B4. WEEKLY CLIMATIC DATA FOR DANIEL (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
8 2 84	74.3	46.8	96.	42.	50.3	489.	1.22	111.	1.6
8 9 84	77.8	41.0	95.	23.	43.5	583.	.00	108.	1.3
8 16 84	76.1	41.6	96.	36.	47.0	448.	.59	101.	1.4
8 23 84	75.1	39.8	96.	27.	43.6	522.	.39	96.	1.5
8 30 84	74.3	34.3	97.	27.	41.2	475.	.16	107.	2.1
9 6 84	70.7	31.6	96.	25.	35.3	453.	.31	139.	1.6
9 13 84	64.0	28.5	96.	33.	33.9	408.	.39	132.	2.3
9 20 84	73.0	29.7	95.	22.	34.9	443.	.20	114.	1.3
9 27 84	49.8	20.7	97.	39.	25.5	321.	1.22	107.	1.8
10 4 84	60.0	23.4	96.	26.	27.4	355.	.12	104.	1.3
10 11 84	64.9	26.7	94.	20.	28.2	359.	.08	133.	1.5
10 18 84	37.8	15.1	95.	42.	17.4	252.	.08	146.	1.7
10 25 84	35.2	6.2	93.	32.	10.3	284.	.00	99.	1.3
11 1 84	43.1	7.7	92.	20.	8.2	295.	.00	96.	1.0
11 8 84	38.9	13.4	95.	50.	19.8	183.	.16	118.	1.4
4 26 85	43.9	14.8	97.	29.	15.7	479.	.20	154.	1.9
5 3 85	68.5	26.9	89.	17.	24.3	592.	.04	132.	1.6
5 10 85	61.1	24.4	95.	26.	24.0	511.	.28	138.	1.8
5 17 85	56.2	21.9	94.	25.	22.9	525.	.08	160.	2.0
5 24 85	70.9	27.5	99.	16.	31.4	584.	.00	122.	1.8
5 31 85	63.5	28.1	95.	26.	32.5	527.	.28	158.	1.9
6 7 85	65.7	30.0	84.	27.	36.4	520.	.12	122.	2.1
6 14 85	67.9	31.8	98.	20.	32.5	710.	.00	163.	1.9
6 21 85	74.0	38.5	88.	30.	39.4	721.	.00	153.	1.5
6 28 85	67.1	33.8	98.	41.	39.1	555.	.83	124.	1.6
7 5 85	80.5	37.0	97.	22.	43.1	647.	.00	110.	1.4
7 12 85	82.0	46.3	94.	34.	49.7	596.	.59	116.	1.5
7 19 85	77.7	44.1	98.	36.	48.9	570.	.39	108.	1.6
7 26 85	77.9	43.5	97.	34.	47.3	595.	.12	111.	1.3
8 2 85	74.4	38.2	99.	35.	44.4	500.	.47	110.	1.8
8 9 85	75.3	31.4	98.	22.	34.6	626.	.00	139.	1.8
8 16 85	70.5	28.1	97.	21.	31.0	594.	.00	144.	2.0
8 23 85	78.0	28.8	96.	15.	30.5	594.	.00	127.	1.6
8 30 85	82.4	31.6	95.	17.	35.8	467.	.16	112.	1.3

Continued

TABLE B4. WEEKLY CLIMATIC DATA FOR DANIEL (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
9 6 85	71.5	34.2	99.	30.	38.1	429.	.24	123.	2.1
9 13 85	64.0	27.3	99.	31.	32.5	380.	.83	127.	2.2
9 20 85	62.3	25.0	100.	30.	30.8	394.	.55	127.	1.8
9 27 85	53.2	20.2	97.	33.	24.2	399.	.39	166.	2.4
10 4 85	51.0	17.1	94.	29.	17.4	392.	.08	151.	1.7
10 11 85	50.9	14.8	96.	32.	21.2	318.	.28	127.	1.9
10 18 85	53.1	16.3	97.	28.	20.8	343.	.00	136.	1.8
10 25 85	54.1	19.7	98.	36.	25.1	275.	.00	123.	1.4
11 1 85	53.7	15.7	97.	30.	22.0	277.	.00	111.	1.6

TABLE B5. WEEKLY CLIMATIC DATA FOR BIG PINEY

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
5 17 83	51.5	17.5	99.	42.	25.0	723.	.91	109.	2.0
5 24 83	62.6	27.5	100.	33.	33.9	692.	.24	119.	2.0
5 31 83	73.6	34.5	99.	23.	36.8	745.	.08	126.	1.5
6 7 83	64.6	36.4	100.	43.	42.5	619.	.08	111.	1.5
6 14 83	67.8	35.1	100.	33.	38.9	685.	.12	127.	1.7
6 21 83	73.1	37.0	96.	17.	34.4	822.	.00	146.	2.1
6 28 83	76.9	40.0	100.	22.	42.8	695.	.24	121.	1.8
7 5 83	71.6	39.8	100.	32.	42.1	678.	.20	126.	1.5
7 12 83	79.6	41.3	100.	22.	44.8	772.	.16	144.	1.9
7 19 83	79.5	35.8	100.	18.	38.2	724.	.04	130.	1.7
7 26 83	77.4	44.0	100.	29.	46.5	589.	.16	121.	1.7
8 2 83	83.6	42.8	100.	20.	44.3	693.	.12	107.	1.5
8 9 83	89.9	48.2	99.	15.	47.8	726.	.00	100.	1.3
8 16 83	83.0	48.2	100.	25.	49.3	606.	.35	102.	1.7
8 23 83	73.7	49.0	100.	45.	53.7	494.	1.34	105.	1.7
8 30 83	79.8	38.3	100.	15.	39.2	594.	.12	111.	1.9
9 6 83	74.1	39.3	98.	32.	43.3	475.	.98	117.	2.0
9 13 83	73.4	32.6	100.	25.	37.8	554.	.12	118.	1.9
9 20 83	68.4	28.9	86.	17.	24.2	580.	.04	150.	1.8
9 27 83	69.5	28.5	97.	24.	31.3	459.	.08	102.	1.8
10 4 83	58.4	32.1	100.	44.	37.7	332.	.20	102.	2.4
4 12 84	44.0	18.5	97.	52.	23.7	438.	.12	149.	2.1
4 19 84	57.7	21.6	94.	28.	25.0	512.	.16	125.	1.7
4 26 84	45.0	19.9	96.	45.	23.4	388.	.39	162.	2.0
5 3 84	46.1	19.6	96.	37.	22.6	450.	.12	143.	2.1
5 10 84	56.0	20.5	89.	24.	20.6	551.	.00	153.	2.4
5 17 84	67.5	31.3	95.	30.	35.0	497.	.31	157.	2.1
5 24 84	67.5	30.9	93.	26.	32.2	575.	.31	162.	2.0
5 31 84	70.4	33.0	91.	24.	31.6	609.	.12	156.	1.7
6 7 84	59.8	29.0	93.	36.	32.0	505.	.47	150.	2.0
6 14 84	65.5	31.6	94.	28.	33.6	512.	.24	140.	1.7
6 21 84	75.9	36.7	94.	16.	35.1	621.	.00	143.	2.0
6 28 84	81.0	36.8	91.	14.	34.0	678.	.00	118.	1.5

Continued

TABLE B5. WEEKLY CLIMATIC DATA FOR BIG PINEY (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
7 5 84	81.4	38.2	95.	19.	38.5	634.	.24	123.	1.6
7 12 84	84.2	41.3	93.	14.	38.8	601.	.08	137.	1.7
7 19 84	86.7	41.5	88.	15.	37.7	605.	.00	107.	1.5
7 26 84	81.2	49.4	96.	29.	51.3	451.	.47	105.	1.7
8 2 84	78.2	49.3	96.	36.	51.8	470.	1.14	100.	1.7
8 9 84	82.6	41.0	96.	20.	43.0	537.	.00	102.	1.5
8 16 84	83.4	45.3	95.	23.	45.4	408.	.00	95.	1.4
8 23 84	79.8	41.7	96.	21.	42.9	502.	.20	96.	1.4
8 30 84	78.9	37.4	95.	20.	39.3	459.	.08	124.	2.2
9 6 84	76.3	32.8	95.	17.	33.2	474.	.00	143.	1.8
9 13 84	69.4	32.4	95.	26.	34.7	406.	1.14	142.	2.0
9 20 84	76.0	31.9	96.	19.	35.5	432.	.04	93.	1.6
9 27 84	51.8	22.3	97.	37.	27.0	308.	.91	108.	1.5
10 4 84	62.2	23.3	97.	26.	28.6	347.	.00	85.	1.5
10 11 84	68.6	24.5	96.	17.	27.1	345.	.00	101.	1.9
10 18 84	43.2	14.9	92.	29.	14.4	284.	.04	129.	2.0
10 25 84	37.4	5.6	92.	27.	8.8	274.	.00	78.	1.5
11 1 84	45.9	5.2	93.	20.	9.2	279.	.00	101.	2.0
11 8 84	42.8	15.5	97.	44.	20.2	187.	.24	107.	1.5
4 26 85	45.9	16.1	94.	23.	13.8	484.	.00	148.	2.2
5 3 85	72.5	26.7	96.	16.	22.7	588.	.04	105.	1.8
5 10 85	64.4	26.1	91.	25.	22.7	530.	.12	141.	2.1
5 17 85	60.8	25.2	88.	20.	20.0	557.	.08	158.	2.6
5 24 85	74.8	30.1	100.	13.	30.5	629.	.04	110.	1.8
5 31 85	67.0	31.2	100.	22.	32.8	554.	.39	139.	2.1
6 7 85	71.9	34.2	99.	22.	35.5	545.	.00	124.	2.5
6 14 85	77.9	34.0	87.	13.	27.1	713.	.00	134.	2.2
6 21 85	82.4	41.7	74.	12.	26.5	708.	.00	140.	1.6
6 28 85	72.6	34.6	99.	25.	32.7	543.	.55	111.	2.1
7 5 85	88.7	37.7	96.	10.	30.3	642.	.00	99.	1.8
7 12 85	89.9	48.2	90.	11.	38.6	577.	.24	95.	1.7
7 19 85	85.1	44.5	99.	14.	40.8	548.	.16	102.	1.9
7 26 85	84.0	43.0	99.	15.	40.8	563.	.04	96.	1.7

Continued

TABLE B5. WEEKLY CLIMATIC DATA FOR BIG PINEY (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
8 2 85	79.0	41.5	100.	16.	39.8	529.	.55	110.	2.1
8 9 85	81.4	35.2	88.	12.	26.9	633.	.00	128.	2.2
8 16 85	75.3	29.7	87.	13.	23.5	600.	.00	135.	2.3
8 23 85	82.0	32.7	81.	11.	23.3	578.	.00	123.	2.1
8 30 85	86.3	34.7	86.	11.	28.4	505.	.04	103.	1.8
9 6 85	74.5	37.7	93.	19.	34.4	464.	.20	125.	2.7
9 13 85	65.6	29.0	98.	23.	30.6	409.	.51	133.	2.0
9 20 85	64.2	28.2	100.	23.	28.6	429.	.51	122.	2.5
9 27 85	58.0	21.8	99.	22.	21.4	407.	.20	129.	2.8
10 4 85	54.6	15.8	94.	21.	15.1	409.	.08	119.	1.7
10 11 85	52.8	17.5	96.	25.	19.8	309.	.12	113.	1.8
10 18 85	56.8	16.6	97.	18.	17.2	351.	.00	97.	2.0
10 25 85	56.5	20.3	100.	25.	23.3	302.	.00	131.	2.2
11 1 85	56.4	15.3	99.	20.	18.5	293.	.00	88.	2.2

TABLE B6. WEEKLY CLIMATIC DATA FOR SEEDSKADEE

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
5 3 83	52.7	29.7	99.	48.	33.6	414.	1.89	169.	1.7
5 10 83	56.4	28.4	93.	25.	25.7	542.	.04	223.	1.8
5 17 83	44.6	21.9	99.	55.	26.9	539.	.63	186.	1.7
5 24 83	63.0	32.4	99.	30.	33.1	567.	.31	168.	1.7
5 31 83	76.0	38.9	91.	16.	33.5	601.	.00	130.	1.5
6 7 83	66.2	38.8	99.	44.	43.9	500.	.63	116.	1.5
6 14 83	68.3	38.5	98.	29.	38.5	563.	.31	152.	1.5
6 21 83	75.5	40.9	82.	15.	30.9	685.	.00	156.	2.3
6 28 83	80.2	45.8	92.	19.	40.9	558.	.24	114.	1.8
7 5 83	76.3	42.3	97.	23.	39.1	560.	.24	120.	1.6
7 12 83	82.9	45.4	96.	19.	42.8	585.	.47	133.	1.6
7 19 83	85.0	41.8	80.	13.	31.0	620.	.00	124.	1.8
7 26 83	84.2	50.8	90.	19.	42.1	499.	.00	109.	1.8
8 2 83	89.4	52.3	78.	13.	37.9	569.	.00	113.	1.7
8 9 83	97.1	56.2	78.	9.	41.2	572.	.08	100.	1.2
8 16 83	88.5	53.2	90.	16.	45.1	509.	.24	118.	1.7
8 23 83	81.7	51.3	98.	27.	52.1	479.	.51	105.	1.3
8 30 83	85.4	46.1	91.	12.	37.4	526.	.00	114.	1.5
9 6 83	77.5	45.5	97.	28.	42.3	429.	1.14	138.	1.9
9 13 83	76.0	40.1	97.	16.	36.3	503.	.20	147.	2.4
9 20 83	69.9	33.7	76.	15.	21.5	475.	.00	200.	2.0
9 27 83	72.3	34.7	85.	19.	30.2	416.	.08	127.	1.9
10 4 83	61.8	35.0	99.	37.	37.7	308.	.20	153.	1.4
4 12 84	44.7	23.8	90.	47.	23.2	415.	.16	193.	1.4
4 19 84	59.1	28.0	87.	28.	20.7	512.	.04	141.	1.4
4 26 84	48.1	24.0	92.	50.	25.2	378.	.43	172.	1.7
5 3 84	46.3	23.2	92.	46.	25.5	488.	.31	210.	2.2
5 10 84	56.4	24.2	87.	26.	20.0	568.	.00	215.	2.3
5 17 84	70.6	33.8	91.	30.	35.4	541.	.16	188.	2.1
5 24 84	70.0	32.6	86.	27.	33.1	590.	.12	209.	2.1
5 31 84	73.2	31.3	78.	21.	29.6	630.	.12	193.	1.6
6 7 84	62.3	33.2	93.	34.	33.3	524.	.12	212.	1.7
6 14 84	69.3	29.6	90.	23.	30.6	559.	.04	178.	1.4
6 21 84	80.1	33.4	81.	15.	32.8	557.	.00	155.	1.9
6 28 84	84.2	41.3	74.	12.	31.8	684.	.00	133.	2.0

Continued

TABLE B6. WEEKLY CLIMATIC DATA FOR SEEDSKADEE (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
7 5 84	82.9	43.5	86.	18.	37.5	662.	.59	152.	2.0
7 12 84	85.7	46.0	85.	18.	41.1	614.	.75	131.	1.6
7 19 84	87.6	46.8	78.	15.	36.4	630.	.00	116.	1.7
7 26 84	84.0	52.5	93.	33.	54.6	497.	.71	108.	1.5
8 2 84	83.3	52.7	93.	30.	52.2	526.	.71	117.	1.7
8 9 84	85.6	48.9	84.	17.	40.6	564.	.00	103.	1.5
8 16 84	87.2	52.7	81.	20.	44.3	476.	.00	115.	1.5
8 23 84	82.4	47.8	89.	24.	44.1	491.	.20	110.	1.6
8 30 84	80.2	43.6	86.	22.	38.7	499.	.08	151.	2.0
9 6 84	79.3	40.8	86.	19.	34.8	475.	.87	169.	1.7
9 13 84	69.4	42.2	88.	31.	39.0	408.	.35	214.	2.2
9 20 84	78.3	42.4	89.	20.	39.2	440.	.51	61.	1.7
9 27 84	54.2	27.4	94.	37.	29.8	366.	.43	137.	2.0
10 4 84	63.9	29.5	93.	26.	29.7	362.	.00	74.	1.5
10 11 84	70.2	30.8	91.	16.	27.7	375.	.00	101.	1.7
10 18 84	43.3	20.1	85.	34.	17.5	292.	.04	204.	1.7
10 25 84	38.9	9.1	92.	30.	11.2	259.	.00	89.	1.4
11 1 84	43.5	15.9	91.	33.	17.3	258.	.04	205.	1.3
11 8 84	43.9	20.7	94.	52.	24.3	211.	.35	181.	1.4
4 26 85	46.8	20.3	84.	22.	13.6	488.	.04	227.	2.2
5 3 85	75.7	32.5	58.	13.	19.2	615.	.00	126.	1.4
5 10 85	67.4	34.4	68.	23.	20.9	529.	.75	181.	1.8
5 17 85	63.3	32.8	83.	17.	21.7	573.	.00	204.	1.4
5 24 85	76.4	37.3	84.	13.	28.3	649.	.00	142.	1.5
5 31 85	72.2	36.4	87.	14.	26.4	626.	.08	192.	2.0
6 7 85	75.2	39.5	85.	15.	32.1	590.	.04	156.	2.2
6 14 85	82.2	44.4	45.	11.	20.1	724.	.00	169.	1.9
6 21 85	85.1	47.2	45.	11.	21.4	720.	.00	175.	1.7
6 28 85	76.9	38.6	79.	21.	29.8	575.	.55	147.	1.7
7 5 85	92.8	48.3	46.	9.	23.3	676.	.00	127.	1.7
7 12 85	93.7	57.4	51.	9.	29.3	603.	.12	146.	1.4
7 19 85	88.7	52.2	77.	10.	36.5	569.	.04	131.	1.5
7 26 85	84.9	50.3	76.	13.	35.3	580.	.00	138.	1.8

Continued

TABLE B6. WEEKLY CLIMATIC DATA FOR SEEDSKADEE (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
8 2 85	82.9	47.2	82.	12.	36.2	548.	.39	147.	1.7
8 9 85	84.2	44.3	42.	11.	20.0	666.	.00	173.	2.0
8 16 85	76.9	38.4	54.	12.	18.7	597.	.00	202.	2.4
8 23 85	85.3	43.6	44.	11.	20.0	613.	.00	159.	2.1
8 30 85	91.0	46.5	54.	9.	24.1	550.	.12	126.	1.6
9 6 85	79.2	44.7	74.	14.	30.7	520.	.28	159.	1.7
9 13 85	68.3	36.3	84.	20.	27.8	379.	.43	162.	1.6
9 20 85	68.5	35.4	85.	18.	26.6	434.	.16	153.	2.0
9 27 85	60.6	28.3	77.	19.	18.0	428.	.12	192.	1.9
10 4 85	58.8	21.6	67.	17.	11.1	429.	.00	159.	1.5
10 11 85	56.6	21.8	85.	22.	18.1	318.	.08	164.	1.5
10 18 85	59.4	21.5	80.	18.	13.2	381.	.00	144.	1.6
10 25 85	60.0	26.9	87.	24.	21.9	299.	.00	184.	1.4
11 1 85	59.1	24.2	82.	18.	17.1	320.	.00	155.	1.4

TABLE B7. WEEKLY CLIMATIC DATA FOR MOUNTAIN VIEW

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
5 3 83	49.1	28.8	100.	62.	34.5	376.	.28	147.	1.5
5 10 83	45.9	18.8	99.	35.	22.7	482.	.00	217.	2.0
5 17 83	45.4	23.2	100.	58.	28.4	537.	.55	159.	1.4
5 24 83	60.4	32.0	96.	42.	34.9	607.	.47	185.	1.4
5 31 83	73.3	38.3	89.	23.	37.1	677.	.67	154.	1.0
6 7 83	62.5	37.6	100.	56.	44.4	566.	.63	130.	1.4
6 14 83	64.0	38.4	100.	45.	42.1	596.	.31	180.	1.3
6 21 83	72.1	37.8	97.	30.	41.0	765.	.00	167.	1.8
6 28 83	74.0	42.8	98.	33.	46.9	603.	.04	135.	1.6
7 5 83	71.9	39.5	99.	36.	44.6	603.	.08	131.	1.3
7 12 83	76.8	44.1	98.	35.	48.1	618.	.04	147.	1.4
7 19 83	79.4	39.8	95.	24.	41.7	668.	.04	132.	1.3
7 26 83	76.2	46.1	99.	43.	52.2	510.	.12	116.	1.4
8 2 83	81.3	47.9	97.	33.	51.3	577.	.67	118.	1.2
8 9 83	87.1	51.4	99.	30.	55.7	598.	.59	104.	0.9
8 16 83	79.8	52.7	99.	43.	57.4	505.	.79	114.	1.1
8 23 83	76.7	45.1	100.	50.	54.0	483.	1.02	91.	1.3
8 30 83	80.6	43.2	99.	24.	47.7	555.	.31	121.	1.0
9 6 83	75.6	41.2	98.	37.	46.6	485.	.98	139.	1.3
9 13 83	75.1	36.0	98.	24.	40.2	558.	.28	164.	1.6
9 20 83	68.3	31.2	88.	18.	28.4	535.	.00	210.	1.9
9 27 83	70.8	31.0	97.	21.	34.0	479.	.04	147.	1.3
10 4 83	60.4	31.8	100.	47.	38.2	331.	.31	144.	1.6
4 12 84	42.4	21.0	97.	57.	24.3	405.	.04	225.	1.2
4 19 84	58.2	24.5	86.	33.	27.0	532.	.04	163.	1.1
4 26 84	44.9	21.1	96.	56.	25.5	403.	.28	218.	1.4
5 3 84	47.9	22.5	95.	50.	26.2	483.	.31	216.	1.5
5 10 84	55.4	26.4	87.	32.	25.7	587.	.12	233.	2.0
5 17 84	69.9	32.7	90.	31.	36.7	539.	.12	204.	1.7
5 24 84	68.0	36.1	88.	33.	36.3	598.	.12	224.	2.0
5 31 84	70.7	35.4	85.	25.	33.7	602.	.00	213.	1.4
6 7 84	58.2	31.3	94.	43.	36.3	519.	.35	214.	1.5
6 14 84	65.4	33.0	94.	35.	36.0	577.	.12	167.	1.4
6 21 84	72.2	38.3	93.	25.	40.3	572.	.00	176.	1.4
6 28 84	78.2	41.2	91.	19.	39.7	653.	.04	151.	1.0

Continued

TABLE B7. WEEKLY CLIMATIC DATA FOR MOUNTAIN VIEW (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
7 5 84	78.6	42.9	91.	22.	41.2	672.	.16	160.	1.4
7 12 84	81.9	44.0	88.	21.	43.8	602.	.35	142.	1.2
7 19 84	82.3	47.1	88.	20.	42.6	601.	.00	122.	0.9
7 26 84	78.5	48.9	93.	45.	54.0	445.	.47	106.	1.4
8 2 84	78.9	47.7	93.	39.	53.0	470.	.75	105.	1.2
8 9 84	80.5	44.6	90.	24.	44.6	531.	.04	111.	0.9
8 16 84	80.1	49.7	91.	34.	50.2	444.	.08	117.	1.1
8 23 84	76.0	44.5	92.	35.	47.8	453.	.31	110.	1.0
8 30 84	76.6	43.9	85.	26.	42.7	457.	.20	146.	1.2
9 6 84	75.6	39.2	89.	22.	37.0	466.	.71	178.	1.3
9 13 84	69.0	41.5	85.	36.	40.8	413.	.24	188.	1.8
9 20 84	76.0	40.4	91.	23.	40.8	431.	.16	143.	0.9
9 27 84	55.6	21.7	94.	38.	27.9	384.	.55	148.	1.3
10 4 84	62.6	27.1	93.	28.	29.9	381.	.00	114.	1.0
10 11 84	67.3	33.3	87.	18.	29.1	372.	.00	170.	0.9
10 18 84	42.4	19.7	92.	36.	20.5	303.	.04	189.	1.4
10 25 84	35.1	10.7	93.	50.	17.0	247.	.12	111.	1.1
11 1 84	43.9	17.9	91.	42.	18.5	299.	.12	170.	1.3
11 8 84	47.2	17.6	92.	44.	23.1	210.	.20	176.	1.5
4 26 85	43.5	19.7	93.	36.	19.5	500.	.28	188.	2.1
5 3 85	-99.0	-99.0	-99.	-99.	-99.0	-99.	-.99	-99.	-99.0*
5 10 85	-99.0	-99.0	-99.	-99.	-99.0	-99.	-.99	-99.	-99.0
5 17 85	-99.0	-99.0	-99.	-99.	-99.0	-99.	-.99	-99.	-99.0
5 24 85	75.2	37.4	92.	15.	36.2	579.	.00	144.	1.3
5 31 85	68.2	30.8	92.	18.	28.2	651.	.00	182.	1.5
6 7 85	70.6	35.9	95.	27.	39.0	582.	.00	152.	1.6
6 14 85	76.0	39.4	90.	15.	31.2	712.	.00	154.	1.3
6 21 85	79.4	41.0	86.	14.	32.9	734.	.98	149.	1.3
6 28 85	71.9	36.3	92.	24.	32.5	596.	.39	162.	1.3
7 5 85	85.4	43.5	84.	11.	34.6	666.	.00	132.	1.0
7 12 85	87.7	52.3	83.	14.	42.6	593.	.24	137.	0.9
7 19 85	81.8	48.9	92.	24.	47.4	519.	.31	114.	1.1
7 26 85	77.3	47.4	91.	30.	45.3	554.	.87	124.	1.4

Continued

TABLE B7. WEEKLY CLIMATIC DATA FOR MOUNTAIN VIEW (cont.)

WEEK ENDING MO DY YR	MAX TEMP (F)	MIN TEMP (F)	MAX RH (%)	MIN RH (%)	DEW PT (F)	SOLAR RADTN (LY/DY)	TOTAL PRECIP (IN/WK)	WIND RUN (MI/DY)	D/N WIND RATIO
8 2 85	77.0	42.8	92.	22.	41.7	531.	.16	133.	1.4
8 9 85	78.9	38.9	79.	13.	26.5	662.	.00	152.	1.4
8 16 85	74.3	34.2	77.	14.	22.5	627.	.00	204.	1.6
8 23 85	80.0	41.1	75.	12.	26.6	610.	.05	175.	1.5
8 30 85	85.4	43.6	70.	11.	30.1	545.	.00	153.	1.1
9 6 85	74.9	39.8	89.	21.	37.6	490.	.31	143.	1.4
9 13 85	68.5	31.4	93.	21.	32.5	388.	.12	149.	1.4
9 20 85	66.6	28.9	90.	21.	28.7	440.	.12	157.	1.7
9 27 85	60.1	25.3	88.	19.	18.7	431.	.04	208.	1.6
10 4 85	58.1	20.2	74.	18.	14.2	429.	.00	162.	1.3
10 11 85	53.8	22.5	93.	44.	25.3	313.	.55	154.	1.5
10 18 85	57.3	23.1	90.	23.	19.5	369.	.12	139.	1.2
10 25 85	58.7	25.9	93.	25.	26.1	315.	.28	180.	1.3
11 1 85	57.4	22.9	90.	20.	23.3	310.	.04	150.	1.2

* -99 INDICATES MISSING DATA

TABLE C1: WEEKLY MEASURED EVAPOTRANSPIRATION FOR 1983*

DATE**		LYSIMETER NUMBER													
MO	DY	2A	2B	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	6A	6B
7	12	0.78	1.46	0.87	1.67	1.52	1.36	1.49	1.45	-99.	-99.	-99.	-99.	0.82	0.87
7	19	1.34	1.78	1.36	1.59	0.98	1.39	1.18	1.41	1.19	0.85	2.39	1.71	2.40	1.93
7	26	1.12	1.28	0.82	1.01	1.09	1.51	1.33	2.07	1.26	0.84	1.92	1.36	1.15	3.26
8	2	1.44	1.64	0.92	1.10	1.07	1.33	1.36	1.82	0.38	1.11	0.94	1.39	2.15	2.44
8	9	1.71	2.32	1.40	1.76	1.57	1.55	1.95	2.42	1.39	0.88	1.68	1.44	1.68	2.22
8	16	2.12	3.19	0.06	0.07	0.96	1.12	0.53	1.17	0.84	0.63	1.81	1.44	2.21	1.97
8	23	1.60	1.90	0.89	0.96	0.41	0.60	0.25	0.00	2.38	0.75	0.83	0.78	1.67	0.04
8	30	1.52	2.13	0.58	1.80	0.93	0.74	1.00	0.16	1.30	1.34	1.16	0.72	2.05	2.76
9	6	1.86	1.64	1.88	1.73	0.99	0.94	1.42	1.09	1.44	0.91	1.05	1.22	0.70	1.40
9	13	2.31	1.11	1.75	0.27	0.97	1.21	1.35	1.34	1.21	1.44	0.60	1.23	0.00	2.41
9	20	1.57	1.02	1.17	0.57	0.58	0.71	0.65	0.86	1.15	1.20	1.34	0.84	2.48	2.79
9	27	1.17	1.00	1.20	1.20	0.98	0.90	0.75	0.85	0.97	0.55	0.90	0.69	1.52	0.81
10	4	0.92	0.86	-99.	-99.	-99.	-99.	-99.	-99.	-99.	-99.	-99.	-99.	0.61	0.00

* ALL MEASUREMENTS ARE LISTED IN INCHES
** DATES INDICATED ARE ENDS OF WEEKS

TABLE C2: WEEKLY MEASURED EVAPOTRANSPIRATION FOR 1984*

DATE**		LYSIMETER NUMBER													
MO	DY	2A	2B	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	6A	6B
5	10	0.67	1.11	-99.	-99.	-99.	-99.	-99.	-99.	-99.	-99.	-99.	-99.	1.00	0.95
5	17	0.74	1.18	-99.	-99.	-99.	-99.	-99.	-99.	-99.	-99.	-99.	-99.	1.21	1.09
5	24	0.70	1.03	1.18	0.55	0.44	0.38	0.35	0.69	0.69	0.49	1.24	0.88	2.35	1.64
5	31	0.90	1.42	0.90	0.56	1.15	1.02	0.99	1.04	0.96	0.77	1.36	1.37	2.10	1.33
6	7	1.05	1.65	1.68	1.45	0.96	1.08	1.22	1.03	0.96	0.48	1.12	1.09	2.12	0.94
6	14	0.86	1.63	0.21	0.26	0.54	0.52	0.56	0.42	1.00	0.64	1.20	1.12	2.11	1.17
6	21	1.17	2.52	2.00	1.47	0.85	1.01	0.68	0.83	1.47	0.61	1.25	1.08	2.88	1.80
6	28	1.24	2.85	2.85	2.65	1.49	1.09	1.61	1.60	2.48	1.45	2.08	2.42	3.54	2.10
7	5	1.24	3.16	0.14	0.67	1.05	1.16	1.01	1.31	1.91	1.25	1.46	1.69	3.05	1.34
7	12	1.64	3.39	3.43	1.87	1.71	1.36	1.91	1.68	2.79	1.80	2.39	2.57	3.39	1.29
7	19	1.66	1.17	0.00	1.90	1.11	1.48	1.44	1.46	2.31	1.16	1.80	1.56	2.41	2.47
7	26	1.45	1.14	2.23	1.64	0.52	0.93	0.63	0.90	1.36	1.21	1.19	0.85	2.38	1.49
8	2	1.05	1.20	2.96	2.29	1.15	1.05	0.75	1.27	1.39	1.20	0.96	0.96	3.09	1.67
8	9	1.32	2.23	2.55	2.26	0.65	0.86	0.88	0.83	1.25	1.06	1.13	0.64	2.99	1.13
8	16	1.23	2.56	1.51	1.28	0.24	1.06	0.87	1.25	1.39	1.27	1.38	0.65	3.68	1.94
8	23	0.93	2.86	2.04	1.20	0.58	0.89	0.71	1.35	1.15	1.16	1.23	0.90	3.52	1.52
8	30	1.30	3.09	1.70	0.89	0.41	0.91	0.54	1.05	1.19	1.10	1.36	0.44	2.86	1.58
9	6	1.37	2.84	0.00	0.55	0.31	1.07	0.27	1.10	1.24	1.28	1.41	0.47	1.30	1.51
9	13	1.37	1.02	1.30	0.44	0.41	0.76	0.38	0.84	1.14	1.05	1.15	0.57	1.21	1.19
9	20	0.97	0.53	0.00	0.36	0.28	0.83	0.16	0.14	0.86	0.80	0.95	0.45	1.12	1.15
9	27	0.67	0.70	0.40	0.11	0.49	0.44	0.31	0.01	0.65	0.59	0.62	0.60	0.88	0.55
10	4	0.70	0.51	0.02	0.36	0.20	0.37	0.12	0.27	0.65	0.54	0.74	0.22	0.88	0.70
10	11	0.67	0.90	0.62	0.00	0.31	0.43	0.23	0.45	0.66	0.59	0.89	0.25	0.75	0.71
10	18	1.60	0.73	0.00	-99.	0.66	1.40	1.08	1.32	0.66	0.41	0.81	0.00	0.63	1.36

* ALL MEASUREMENTS ARE LISTED IN INCHES

** DATES INDICATED ARE ENDS OF WEEKS

TABLE C3: WEEKLY MEASURED EVAPOTRANSPIRATION FOR 1985*

DATE**		LYSIMETER NUMBER													
MO	DY	2A	2B	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	6A	6B
5	31	1.10	1.36	1.04	0.62	0.59	0.92	0.92	1.05	1.45	1.31	2.31	1.42	2.12	1.59
6	7	1.55	1.86	1.98	1.60	0.92	1.19	1.45	1.37	1.57	1.60	2.27	1.59	2.66	2.03
6	14	1.33	1.64	0.77	1.66	0.99	1.14	1.46	1.31	1.70	1.60	2.14	1.37	2.13	1.96
6	21	1.59	2.05	1.57	1.34	1.12	1.25	1.17	1.69	2.51	1.58	1.95	1.55	2.84	1.98
6	28	1.65	2.47	1.77	1.21	1.11	1.45	1.40	1.64	2.70	1.31	1.72	1.39	3.82	1.46
7	5	1.01	2.33	0.80	1.24	0.95	1.29	1.40	1.06	2.30	1.18	2.24	1.66	3.94	1.75
7	12	1.36	3.14	1.33	1.57	1.26	1.33	1.75	1.90	2.75	1.44	2.41	1.63	3.82	2.09
7	19	1.80	2.42	1.46	1.43	1.28	1.59	1.84	1.41	3.19	1.27	1.76	1.27	2.58	1.77
7	26	1.45	1.50	1.61	1.44	1.13	1.75	1.10	1.55	2.77	1.00	1.61	1.65	2.66	0.99
8	2	1.35	1.55	1.31	1.06	0.76	1.24	1.03	1.81	2.14	1.16	1.73	1.20	2.89	1.23
8	9	1.83	2.07	1.25	0.77	0.62	0.85	0.73	1.35	1.75	1.33	1.56	0.61	3.67	1.85
8	16	1.92	2.52	1.19	0.64	0.29	0.45	0.24	0.86	1.42	1.28	0.83	0.28	4.57	1.80
8	23	1.54	2.64	1.25	0.41	0.07	0.93	0.23	0.80	1.26	1.45	1.13	0.29	3.61	1.40
8	30	1.58	2.27	1.34	0.35	0.29	0.83	0.27	0.95	1.51	1.35	1.19	0.38	3.21	1.26
9	6	1.57	1.64	1.96	0.26	0.26	0.64	0.19	0.72	1.72	1.05	0.84	0.39	3.02	1.29
9	13	1.45	1.68	0.00	0.88	0.39	1.07	0.40	0.61	1.55	1.06	0.81	0.77	1.37	1.61
9	20	0.98	1.35	0.58	0.51	0.31	0.68	0.30	0.40	1.12	0.45	0.85	0.07	0.13	0.64
9	27	0.43	0.81	0.30	0.00	0.38	0.34	0.26	0.41	0.91	0.68	0.50	0.28	1.04	0.74
10	4	0.89	0.42	0.20	0.26	0.12	0.25	0.18	0.00	0.23	0.47	0.59	0.14	0.69	0.89

* ALL MEASUREMENTS ARE LISTED IN INCHES
** DATES INDICATED ARE ENDS OF WEEKS

TABLE C4. WEEKLY MEASURED PAN EVAPORATION*

DATE**		MERNA		DANIEL		SEEDSKADEE	
MO	DY	1984	1985	1984	1985	1984	1985
5	31	--	1.00	1.47	1.43	--	2.03
6	7	1.55	1.02	1.33	1.51	1.86	2.22
6	14	1.17	1.86	1.05	2.05	1.76	2.87
6	21	1.80	2.15	1.63	2.32	2.53	3.04
6	28	2.00	2.04	1.79	1.72	2.91	2.58
7	5	2.15	1.55	2.08	1.22	3.20	2.35
7	12	1.71	1.78	2.21	1.82	2.62	2.94
7	19	1.69	1.63	1.59	1.55	2.43	2.72
7	26	1.01	1.71	1.43	1.31	1.89	2.27
8	2	1.85	1.29	1.44	1.39	2.27	2.61
8	9	1.15	1.47	1.38	1.68	1.88	3.01
8	16	1.16	1.64	1.94	1.84	2.12	3.05
8	23	1.29	1.73	1.43	1.71	1.78	2.74
8	30	1.13	1.40	1.51	1.63	2.09	2.51
9	6	1.42	0.95	1.36	1.33	2.19	2.40
9	13	1.14	2.29	1.22	1.73	1.92	1.57
9	20	1.01	0.34	0.97	0.76	1.14	1.32
9	27	1.23	0.47	0.98	0.75	1.27	1.63
10	4	0.92	0.65	0.68	1.73	0.89	1.26
10	11	0.99	--	0.88	--	0.96	--
10	18	0.38	--	--	--	0.75	--

* ALL MEASUREMENTS ARE IN INCHES

** DATES INDICATED ARE ENDS OF WEEKS

TABLE D1. DATES OF WATER BALANCE MEASUREMENTS*

	LYSIMETER SITE													
YEAR	2A	2B	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	6A	6B
1983	0602	0602	0602	0602	0602	0602	0602	0602	0601	0601	0601	0601	0602	0602
	0610	0610	0610	0610	0610	0610	0610	0610	0610	0610	0610	0610	0611	0611
	0618	0618	0618	0618	0618	0618	0618	0618	0617	0617	0617	0617	0617	0617
	0625	0625	0625	0625	0625	0625	0625	0625	0624	0624	0624	0624	0624	0624
	0702	0702	0702	0702	0702	0702	0702	0702	0701	0701	0701	0701	0701	0701
	0709	0709	0709	0709	0709	0709	0709	0709	0709	0709	0709	0709	0708	0708
	0715	0715	0716	0716	0716	0716	0716	0716	0715	0715	0715	0715	0716	0716
	0721	0721	0722	0722	0722	0722	0722	0722	0722	0722	0722	0722	0721	0721
	0730	0730	0730	0730	0730	0730	0730	0730	0729	0729	0729	0729	0729	0729
	0805	0805	0805	0805	0805	0805	0805	0805	0804	0804	0804	0804	0804	0804
	0812	0812	0811	0811	0811	0811	0811	0811	0810	0810	0810	0810	0810	0810
	0819	0819	0819	0819	0819	0819	0819	0819	0819	0819	0819	0819	0818	0818
	0825	0825	0825	0825	0825	0825	0825	0825	0824	0824	0824	0824	0824	0824
	0903	0903	0903	0903	0903	0903	0903	0903	0902	0902	0902	0902	0902	0902
	0911	0911	0910	0910	0910	0910	0910	0910	0911	0911	0911	0911	0910	0910
	0916	0916	0916	0916	0916	0916	0916	0916	0916	0916	0916	0916	0916	0916
	0924	0924	0924	0924	0924	0924	0924	0924	0924	0924	0924	0924	0923	0923
	0930	0930	0930	0930	0930	0930	0930	0930	0930	0930	0930	0930	0930	0930
	1007	1007											1006	1006
1984	0428	0428											0428	0428
	0509	0509											0507	0507
	0514	0514	0518	0518	0515	0515	0515	0516	0517	0517	0517	0517	0518	0518
	0524	0524	0523	0523	0523	0523	0523	0523	0523	0523	0523	0523	0522	0522
	0531	0531	0531	0531	0531	0531	0531	0531	0530	0530	0530	0530	0530	0530
	0607	0607	0606	0606	0606	0606	0606	0606	0606	0606	0606	0606	0605	0605
	0614	0614	0614	0614	0614	0614	0614	0614	0613	0613	0613	0613	0613	0613
	0621	0621	0621	0621	0621	0621	0621	0621	0621	0621	0621	0621	0620	0620
	0628	0628	0628	0628	0628	0628	0628	0628	0627	0627	0627	0627	0627	0627
	0706	0706	0706	0706	0706	0706	0706	0706	0706	0706	0706	0706	0705	0705
	0712	0712	0712	0712	0712	0712	0712	0712	0711	0711	0711	0711	0711	0711
	0720	0720	0719	0719	0719	0719	0719	0719	0718	0718	0718	0718	0718	0718
	0727	0727	0727	0727	0727	0727	0727	0727	0726	0726	0726	0726	0726	0726
	0803	0803	0802	0802	0802	0802	0802	0802	0802	0802	0802	0802	0801	0801
	0809	0809	0809	0809	0809	0809	0809	0809	0808	0808	0808	0808	0808	0808
	0817	0817	0816	0816	0816	0816	0816	0816	0816	0816	0816	0816	0815	0815
	0823	0823	0823	0823	0823	0823	0823	0823	0822	0822	0822	0822	0822	0822
	0830	0830	0829	0829	0830	0830	0830	0830	0829	0829	0829	0829	0828	0828
	0906	0906	0906	0906	0906	0906	0906	0906	0905	0905	0905	0905	0905	0905
	0913	0913	0913	0913	0913	0913	0913	0913	0912	0912	0912	0912	0912	0912
	0920	0920	0920	0920	0919	0919	0919	0919	0919	0919	0919	0919	0919	0919
	0927	0927	0927	0927	0927	0927	0927	0927	0926	0926	0926	0926	0926	0926
	1004	1004	1003	1003	1003	1003	1003	1003	1004	1004	1004	1004	1003	1003
	1012	1012	1011	1011	1012	1012	1012	1012	1011	1011	1011	1011	1010	1010
				1012										
	1017	1017	1018		1018	1018	1018	1018	1018	1018			1017	1017

TABLE D1. DATES OF WATER BALANCE MEASUREMENTS (cont.)

YEAR	LYSIMETER SITE													
	2A	2B	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	6A	6B
1985	0522	0522	0523	0523	0523	0523	0523	0523	0523	0523	0523	0523	0522	0522
	0529	0529	0530	0530	0530	0530	0530	0530	0529	0529	0529	0529	0529	0529
	0605	0605	0606	0606	0606	0606	0606	0606	0605	0605	0605	0605	0605	0605
	0612	0612	0613	0613	0613	0613	0613	0613	0612	0612	0612	0612	0612	0612
	0619	0619	0620	0620	0620	0620	0620	0620	0619	0619	0619	0619	0619	0619
	0626	0626	0627	0627	0627	0627	0627	0627	0626	0626	0626	0626	0626	0626
	0703	0703	0704	0704	0704	0704	0704	0704	0703	0703	0703	0703	0703	0703
	0710	0710	0711	0711	0711	0711	0711	0711	0710	0710	0710	0710	0710	0710
	0717	0717	0718	0718	0718	0718	0718	0718	0717	0717	0717	0717	0717	0717
	0724	0724	0725	0725	0725	0725	0725	0725	0724	0724	0724	0724	0724	0724
	0731	0731	0801	0801	0801	0801	0801	0801	0731	0731	0731	0731	0731	0731
	0807	0807	0808	0808	0808	0808	0808	0808	0807	0807	0807	0807	0807	0807
	0814	0814	0815	0815	0815	0815	0815	0815	0814	0814	0814	0814	0814	0814
	0821	0821	0820	0820	0820	0820	0820	0820	0820	0820	0820	0820	0821	0821
	0828	0828	0829	0829	0829	0829	0829	0829	0828	0828	0828	0828	0828	0828
	0907	0907	0907	0907	0907	0907	0907	0907	0906	0906	0906	0906	0906	0906
	0913	0913	0912	0912	0912	0912	0912	0912	0912	0912	0912	0912	0913	0913
	0920	0920	0919	0919	0919	0919	0919	0919	0919	0919	0919	0919	0920	0920
	0927	0927	0926	0926	0926	0926	0926	0926	0926	0926	0926	0926	0927	0927
	1007	1007	1009	1009	1009	1009	1009	1009	1008	1008	1008	1008	1008	1007

* (FIRST TWO DIGITS = MONTH, LAST TWO DIGITS = DAY)

TABLE D2. DEPTH TO WATER TABLE IN LYSIMETERS FOR 1984 AND 1985*

DATE	LYSIMETER SITE													
	2A	2B	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	6A	6B
5-03-84	13.5	15.1											25.5	19.3
5-10-84	20.0	23.8											35.9	32.6
5-17-84	27.8	31.5	11.8	22.1	56.6	52.5	53.1	38.8	28.1	33.0	25.5	28.9	44.8	45.0
5-24-84	30.8	36.0	20.5	27.6	47.0	42.6	39.4	45.5	35.4	37.8	34.6	36.5	51.0	49.6
5-31-84	31.0	37.9	21.6	17.0	52.1	46.5	45.0	50.8	39.3	41.6	35.8	37.4	52.1	51.9
6-07-84	30.4	40.5	27.6	27.4	40.9	40.5	38.9	41.6	30.3	30.1	30.4	31.1	53.1	49.0
6-14-84	31.8	45.5	25.1	25.9	40.5	40.5	38.9	42.2	37.6	35.8	36.6	39.0	53.0	40.3
6-21-84	33.8	45.0	32.9	32.1	35.1	35.3	30.6	28.3	36.5	29.5	35.4	34.8	50.0	37.5
6-28-84	16.9	46.3	45.1	53.1	41.5	39.8	39.4	37.1	38.9	26.7	36.4	37.0	51.0	40.8
7-05-84	24.8	48.8	38.8	43.9	44.3	40.6	42.4	40.1	43.9	32.3	38.9	41.1	53.5	43.5
7-12-84	28.6	48.3	50.4	45.4	45.1	42.8	49.5	36.6	46.8	35.5	39.9	43.3	54.4	41.0
7-19-84	31.3	40.0	33.4	44.9	40.0	38.4	39.4	40.8	46.3	39.8	39.9	52.5	53.5	43.6
7-26-84	26.8	27.9	37.8	43.9	53.0	35.4	51,9	38.1	43.3	35.9	33.9	56.3	49.5	40.6
8-02-84	20.6	23.0	16.3	46.1	55.5	38.9	54.0	41.6	36.9	29.0	26.8	57.0	49.3	44.5
8-09-84	26.0	31.8	30.8	54.9	55.3	38.1	54.0	42.4	35.9	30.9	25.4	57.0	52.0	37.5
8-16-84	25.8	30.7	32.6	58.1	55.1	35.1	54.1	37.8	35.1	30.4	26.4	57.0	53.9	00.0
8-23-84	30.1	34.4	35.4	58.1	55.0	38.8	54.3	33.3	31.6	27.3	17.8	57.0	54.0	27.5
8-30-84	34.8	39.5	45.5	58.1	55.0	37.4	54.5	39.6	28.3	32.9	25.6	57.0	57.9	35.5
9-06-84	37.3	42.0	27.8	58.1	55.0	32.8	54.6	34.6	32.1	35.0	29.3	57.0	53.5	35.6
9-13-84	33.5	39.3	35.4	58.1	55.3	36.3	54.9	41.6	32.6	35.6	24.6	57.0	40.4	25.6
9-20-84	33.3	33.5	18.3	58.1	55.3	35.0	54.9	37.1	31.4	34.0	25.8	57.0	42.9	36.5
9-27-84	31.4	32.4	5.9	58.1	55.3	30.0	54.9	25.3	19.4	26.1	13.6	57.0	36.4	17.8
10-04-84	29.6	30.8	18.8	58.1	55.3	29.8	55.0	25.4	24.9	28.6	20.8	57.0	39.9	27.0
10-11-84	30.4	32.0	22.3	58.1	56.6	31.6	55.1	26.9	29.5	32.6	26.5	57.0	40.0	28.0
10-18-84	27.8	29.8	24.8		55.5	34.8	55.1	29.6	36.3	33.3	28.1	57.0	40.3	24.8
5-24-85	27.5	26.9	22.5	31.0	48.5	42.1	38.8	38.3	29.5	31.8	22.0	20.8	34.0	26.0
5-31-85	30.5	34.0	22.0	24.0	46.5	40.9	37.3	37.3	34.5	34.0	29.0	25.0	39.5	38.6
6-07-85	27.8	36.5	24.5	28.5	45.8	40.1	37.8	37.3	40.0	38.0	35.0	30.5	46.5	46.5
6-14-85	35.3	41.1	30.5	40.8	47.5	42.1	41.8	42.0	46.3	46.0	42.0	37.5	53.0	53.0
6-21-85	41.5	47.5	35.5	51.5	49.8	42.6	48.3	47.5	51.5	47.5	45.0	37.5	54.5	26.3
6-28-85	36.5	43.5	46.0	46.5	48.8	42.6	52.0	48.0	52.0	41.0	43.5	30.5	54.5	41.0
7-05-85	27.5	39.5	18.0	27.0	39.8	36.4	37.8	36.0	40.8	29.8	34.0	36.0	51.0	33.5
7-12-85	34.3	40.5	27.5	43.0	42.0	38.1	44.8	41.5	50.5	38.5	38.5	41.5	53.5	44.5
7-19-85	30.5	40.5	32.8	40.3	41.3	38.1	47.0	40.3	48.5	30.0	32.5	38.5	45.5	37.3
7-26-85	29.5	31.5	24.5	52.5	47.0	35.1	53.8	34.3	46.5	34.5	32.5	48.5	39.3	36.0
8-02-85	27.8	30.5	15.5	52.5	47.0	32.1	54.3	28.8	46.5	39.0	31.5	54.5	47.5	30.0
8-09-85	28.0	39.5	29.5	54.0	56.0	30.6	54.8	35.8	39.0	41.5	32.8	53.5	51.0	47.0
8-16-85	29.5	46.5	30.5	54.5	56.5	30.9	55.3	32.8	36.8	39.5	30.0	54.5	51.5	28.3
8-23-85	30.5	45.0	28.8	54.5	56.0	33.1	55.3	34.5	32.0	37.5	26.5	54.5	47.8	43.3
8-30-85	29.5	45.5	26.8	54.5	55.5	33.1	55.8	34.3	37.5	44.3	30.5	55.5	48.5	36.0
9-06-85	32.3	45.0	44.5	54.5	55.5	32.6	55.8	33.3	39.8	41.0	27.5	55.5	52.5	33.5
9-13-85	29.0	41.3	17.8	54.5	54.5	33.0	55.5	30.5	38.6	44.1	25.0	55.5	48.4	22.5
9-20-85	28.9	36.0	20.9	54.5	54.3	31.5	55.6	28.9	36.3	35.0	27.5	55.5	37.0	32.9
9-27-85	27.4	34.4	20.0	54.5	54.4	31.8	55.8	36.5	37.4	36.9	26.1	55.5	40.1	40.9
10-04-85	28.9	34.2	17.6	54.5	54.5	32.2	55.8	32.6	39.7	39.9	30.8	55.5	44.0	43.0

* WATER TABLE DEPTH GIVEN IN INCHES.

TABLE D3. PERCENT MOISTURE DEPLETION IN LYSIMETERS FOR 1984 AND 1985

	LYSIMETER SITE													
DATE*	2A	2B	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	6A	6B
4-28-84	0	0											0	0
5-08-84	0	0											15	3
5-16-84	0	12	0	0	0	0	0	0	0	0	0	0	29	15
5-23-84	0	16	3	6	28	16	22	8	11	8	10	9	32	18
5-31-84	0	21	6	12	28	20	23	11	18	14	17	16	37	25
6-07-84	0	19	9	8	23	18	23	14	10	1	8	7	38	20
6-14-84	0	21	8	7	24	17	23	10	16	10	17	15	36	18
6-21-84	1	26	12	13	31	20	26	14	17	3	16	13	37	13
6-28-84	0	30	21	17	36	27	34	24	26	5	22	23	43	20
7-05-84	0	31	19	18	32	32	31	27	31	10	23	25	42	16
7-12-84	0	30	19	20	25	27	24	29	29	10	20	24	43	13
7-19-84	3	24	20	24	34	34	33	32	35	15	25	38	33	16
7-27-84	0	5	15	21	24	17	25	12	24	9	15	36	29	13
8-02-84	0	0	7	7	23	5	20	4	18	0	2	37	28	12
8-09-84	0	8	12	14	32	17	29	13	18	6	0	39	34	11
8-16-84	0	10	14	21	35	17	39	20	20	5	0	45	39	0
8-23-84	0	16	12	24	34	12	39	16	13	0	0	45	38	1
8-29-84	0	22	13	26	36	11	42	14	8	5	0	49	40	6
9-06-84	0	24	11	28	38	13	43	16	11	12	5	52	31	7
9-13-84	0	13	10	28	36	9	41	9	8	5	0	53	25	1
9-20-84	0	14	8	30	38	13	42	8	11	10	0	55	25	7
9-27-84	0	9	0	24	31	0	34	0	0	0	0	49	18	0
10-04-84	0	8	4	23	31	2	33	0	3	0	0	50	23	0
10-11-84	0	10	6	25	34	6	34	3	11	4	0	53	23	0
10-18-84	0	12	7		33	5	34	4	15	2	1	54	22	0
5-23-85	0	0	0	1	0	0	0	0	0	0	0	0	4	1
5-30-85	0	0	6	11	8	8	11	9	7	5	16	6	18	2
6-06-85	18	12	39	23	28	27	34	34	27	26	40	31	37	18
6-13-85	28	34	33	25	32	36	48	40	33	31	40	36	45	23
6-20-85	35	41	33	22	32	44	36	38	34	32	51	37	49	16
6-27-85	17	26	26	20	20	40	19	36	31	20	36	26	49	14
7-04-85	10	28	43	36	33	44	37	41	30	27	45	36	39	15
7-11-85	8	27	36	28	34	48	38	49	35	30	51	46	42	16
7-18-85	14	28	31	29	21	37	29	37	31	20	38	32	27	14
7-25-85	17	18	29	24	18	39	24	33	32	25	36	38	29	10
8-01-85	10	12	39	27	22	32	30	30	26	24	33	41	29	13
8-08-85	9	24	31	33	30	47	41	40	20	29	38	51	28	16
8-15-85	24	36	34	38	37	51	45	39	28	30	38	54	42	16
8-21-85	20	33	31	40	36	40	45	24	27	27	32	55	40	16
8-29-85	18	32	32	43	39	43	46	32	27	27	33	57	32	10
9-06-85	21	30	20	43	41	40	46	33	31	27	31	58	39	6
9-13-85	12	14	36	39	34	21	38	15	16	12	18	59	25	20
9-20-85	13	18	33	42	35	22	38	23	17	14	20	52	22	11
9-27-85	4	22	35	38	37	22	38	22	31	17	27	52	28	8
10-08-85	17	23	35	36	32	20	35	19	30	23	30	53	34	13

* ACTUAL DATES OF MEASUREMENTS MAY VARY BY ONE DAY FROM THOSE LISTED FOR ANY SPECIFIC VALUE.

TABLE D4. AVERAGE CROP HEIGHT IN LYSIMETERS*

DATE	2A	2B	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	6A	6B
	LYSIMETER SITE													
6-14-83								6						
6-21-83	1	1	3	3	4	2	5	6	1	1	4	4	1	1
6-28-83	1	1	5	7	6	3	7	7	1	1	5	7	1	2
7-05-83			3						3	2			2	3
7-12-83		5	8	9	8	6	8	13	3	3				
7-19-83	4	6								2				
7-26-83														
8-02-83	5	7	12	12	6	7	13	12	2	2	9	10	7	8
8-09-83	6	10	17	18	16	16	20	18	2	3	4	3	9	10
8-16-83	8	10	19	20	2	20	24	21	2	2	3	3	14	14
8-23-83	12	15	3	3	3	3	3	4	4	2	3	3		
8-30-83	17	17	4	3	5	3	2	4	5	3	3	3	19	20
9-06-83	20	19	4	2	5	3	2	4	2	4	4	4	28	23
9-13-83	18	3	3	3	4	4	3	5	6	4	3	3	6	25
9-20-83	25	3	3	3	4	4	3	5	6	4	3	3	6	27
9-27-83	22	4	4	3	2	3	3	3	5	3	2	3	5	26
10-04-83	3	3	3	3	2	3	3	2	2	3	3	3	3	4
10-11-83	4	3											4	5
5-03-84	2	2											2	2
5-10-84	1	1											1	2
5-17-84	2	3	2	2	2	1	2	2	1	1	1	1	5	4
5-24-84	4	4	3	2	3	3	3	4	2	3	2	2	5	4
5-31-84	4	5	3	4	3	3	3	5	3	4	3	3	9	4
6-07-84	4	6	4	4	4	3	4	5	5	4	3	4	10	4
6-14-84	4	7	5	4	5	3	4	6	4	1	3	6	12	6
6-21-84	4	11	9	9	8	5	6	9	7	3	6	9	15	4
6-28-84	5	15	10	11	12	6	7	13	11	3	10	12	18	7
7-05-84	5	20	15	15	16	13	13	16	16	4	15	20	23	7
7-12-84	5	27	20	19	22	18	17	21	18	5	18	22	21	5
7-19-84	5	5	27	28	27	23	24	28	24	4	24	26	6	6
7-26-84	4	8	35	36	39	32	31	40	5	6	5	4	12	6
8-02-84	4	12	37	41	44	36	37	45	9	5	6	5	16	6
8-09-84	6	17	44	42	46	38	42	46	11	5	7	5	22	6
8-16-84	3	21	42	45	3	4	42	46	8	5	8	6	25	7
8-23-84	4	23	42	45	3	5	42	47	8	6	7	8	26	6
8-30-84	4	25	43	44	3	5	3	48	9	4	7	6	27	6
9-06-84	4	4	4	3	3	6	3	4	9	5	8	6	5	6
9-13-84	4	3	4	3	3	5	4	5	7	4	10	5	7	5
9-20-84	5	5	4	3	3	5	3	5	7	5	9	6	9	6
9-27-84	4	4	3	3	3	3	3	5	7	4	9	6	9	3
10-04-84	3	5	3	3	3	3	3	5	6	4	5	7	7	5
10-11-84	3	4	4	3	3	3	3	4	5	3	5	5	7	3
10-18-84	3	3							5	4			7	3

Continued

TABLE D4. AVERAGE CROP HEIGHT IN LYSIMETERS* (cont.)

DATE	LYSIMETER SITE													
	2A	2B	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	6A	6B
5-24-85	2	3	3	2	2	1	3	4	3	4	4	3	5	6
5-31-85	4	4	4	4	3	2	5	5	4	5	6	4	10	7
6-07-85	4	5	5	4	4	2	5	7	5	6	6	6	12	5
6-14-85	4	8	7	6	6	3	6	8	8	5	8	7	15	5
6-21-85	5	8	8		6	5	7	11	13	5	13	8	19	7
6-28-85	3	12	8	9	7	5	7	12	15	4	16	10	22	6
7-05-85	4	15	9	10	10	7	8	13	20	5	21	14	25	7
7-12-85	4	18	12	16	10	10	11	20	24	6	25	12	27	7
7-19-85	5	21	12	13	13	10	10	19	26	4	28	15	7	6
7-26-85	4	5	10	13	15	10	12	19	28	3	27	20	12	5
8-02-85	6	10	14	12	20	15	13	23	29	6	28	17	17	6
8-09-85	6	10	15	18	20	18	15	22	27	6	28	18	17	7
8-16-85	5	10	15	15	4	4	4	4	4	3	4	3	17	4
8-23-85	5	13	13	14	3	4	4	4	6	4	5	3	20	4
8-30-85	5	12	15	12	4	4		4	6	4	6	3	20	5
9-06-85	3	4	4	3	4	4	4	4	9	4	7	3	21	5
9-13-85	5	5	4	4	4	4	4	4	9	5	7	3	5	5
9-20-85	5	5	4	4	4	4	4	4	9	5	7	3	5	5
9-27-85	5	5	4	4	4	4	4	4	9	5	7	3	5	5

* CROP HEIGHT GIVEN IN INCHES

TABLE D5. PERCENT VEGETATIVE COVERAGE IN LYSIMETERS

	LYSIMETER SITE													
DATE	2A	2B	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	6A	6B
6-28-83				90	50		80	75						
7-05-83														
7-12-83														
7-19-83					60								25	100
7-26-83	75	75	100	100	75	100	100	75	25	50	100	100		
8-02-83	75	75	100	100	50	100	75	75	25	100	100	100	75	100
8-09-83	75	75	100	100	75	100	75	75	25	100	100	100	75	100
8-16-83	100	100	100	100	75	100	100	75	50	100	100	100	100	100
8-23-83	100	100	100	100	75	100	100	75	75	100	100	100	100	100
8-30-83	100	100	100	100	75	100	100	75	75	100	100	100	100	100
9-06-83	100	100	100	100	75	100	100	75	100	100	100	100	100	100
9-13-83	100	50	100	100	75	100	100	75	75	100	100	100	50	100
9-20-83	100	50	100	100	100	100	75	100	75	100	100	100	75	100
9-27-83	100	75	100	100	75	100	100	75	50	100	100	100	75	100
10-04-83	50	75	100	100	75	100	100	75	75	100	100	100	75	75
10-11-83	50	75											75	75
5-03-84	75	75											75	75
5-10-84	20	25											40	75
5-17-84	60	50	100	100	75	100	100	75	50	25	100	100	75	100
5-24-84	50	75	100	100	75	75	100	75	50	25	100	100	75	75
5-31-84	50	100	100	100	75	75	90	85	50	35	100	100	100	75
6-07-84	50	75	100	100	75	100	100	75	50	25	100	100	100	75
6-14-84	60	100	100	100	85	100	100	100	65	100	100	100	100	85
6-21-84			100	100	100	100	100	100					100	100
6-28-84	75	100	100	100	100	100	100	100	100	100	100	100	100	100
7-05-84	75	100	100	100	100	100	100	100	100	100	100	100	100	100
7-12-84	75	100	100	100	100	100	100	100	100	100	100	100	100	100
7-19-84	75	75	100	100	100	100	100	100	100	100	100	100	75	100
7-26-84	100	75	100	100	100	100	100	100	75	100	100	100	100	100
8-02-84	100	100	100	100	100	100	100	100	100	100	100	100	100	100
8-09-84	100	100	100	100	100	100	100	100	75	100	100	100	100	100
8-16-84	100	100	100	100	75	100	100	100	75	100	100	100	100	100
8-23-84	100	100	100	100	75	100	100	100	75	100	100	100	100	100
8-30-84	100	100	100	100	75	100	100	100	75	100	100	100	100	100
9-06-84	100	100	100	75	75	100	100	100	100	100	100	100	50	100
9-13-84	100	50	100	100	75	100	100	75	100	100	100	100	75	100
9-20-84	100	75	100	100	75	100	100	75	75	100	100	100	100	100
9-27-84	100	75	100	100	100	100	100	75	100	100	100	100	100	100
10-04-84	100	75	100	100	100	100	100	75	100	100	100	100	100	100
10-11-84	100	75	100	100	75	100	100	75	100	100	100	100	100	100
10-18-84	100	75	100		100	100	100		75	100	100	100	100	100

Continued

TABLE D5. PERCENT VEGETATIVE COVERAGE IN LYSIMETERS (cont.)

DATE	LYSIMETER SITE 2A	2B	3A	3B	3C	3D	3E	3F	4A	4B	4C	4D	6A	6B
5-24-85	87	60	98	50	85	72	83	80	90	98	100	98	55	90
5-31-85	75	78	98	90	80	80	98	93	90	93	100		85	98
6-07-85	75	80	98	85	70	80	98	95	98	90	100	98	98	96
6-14-85	75	85	100	90	70	80	100	98	100	100	100	95	100	98
6-21-85	75	80	100		80	85	90	98	100	100	100	98	98	95
6-28-85	80	93	100	100	80	100	100	100	100	100	100	98	100	100
7-05-85	80	98	100	100	80	100	100	100	100	100	100	100	100	100
7-12-85	85	100	100	100	100	90	100	100	100	100	100	100	100	98
7-19-85	90	100	100	100	90	100	100	100	100	98	100	100	85	100
7-26-85	95	50	100	100	98	100	100	100	100	100	100	100	98	100
8-02-85	100	80	100	100	95	100	100	100	100	100	100	100	100	100
8-09-85	98	95	100	100	95	100	100	100	100	100	100	100	100	
8-16-85	100	95	100	100	95	100	100	98					100	100
8-23-85	100	98	100		85	98	100	95	95	100	100	98	100	100
8-30-85	100	100	100		95	98	99	98	90	100	100	95	100	100
9-06-85	100	90	100	98	90	85	98	98	95	100	100	100	100	100
9-13-85	100	100	100	100	95	85	98	98	100	100	100	100	100	100
9-20-85	100	100	100	100	100	85	98	98	100	100	100	100	100	100
9-27-85	100	100	100	100	95	85	98	98	100	100	100	100	100	100
10-11-85	100	100	100	100									100	100

TABLE D6. VEGETATION ON LYSIMETERS MEASURING ACTUAL ET

LYSIMETER	DEFINITION	VEGETATION TYPE*	PERCENT
3B	MOUNTAIN MEADOW	SWEET CLOVER	40
		TIMOTHY	35
		DANDELION	20
		RED TOP BENTGRASS	5
3C	IMPROVED MEADOW	TIMOTHY	60
		RED TOP BENTGRASS	15
		WESTERN YARROW	10
		DANDELION	10
		MUTTON BLUEGRASS	5
3E	IMPROVED MEADOW	DANDELION	45
		SWEET CLOVER	25
		TIMOTHY	20
		RED TOP BENTGRASS	5
		LITTLE BARLEY	5
4D	MOUNTAIN MEADOW	SLENDER WHEATGRASS	25
		SWEET CLOVER	25
		BLUEBURCH WHEATGRASS	20
		KENTUCKY BLUEGRASS	15
		TIMOTHY	5
		WESTERN YARROW	5
		LITTLE BARLEY	5

* TRACES OF OTHER VEGETATION MAY ALSO BE PRESENT. DATE OF THE SURVEY WAS AUG 8, 1985. VEGETATION CLASSIFICATIONS FOR THE OTHER MOUNTAIN MEADOW LYSIMETERS ARE GIVEN IN TABLE 11.

TABLE D7. SPECIFIC YIELD AND FIELD CAPACITY*

LOCATION	LYS ID	SPECIFIC YIELD 1984	SPECIFIC YIELD 1985	FIELD CAPACITY 1984	FIELD CAPACITY 1985
FARSON	2A	15	13	13	12
	2B	16	13	14	11
MERNA	3A	15	8	27	25
	3B	8	7	27	24
	3C	17	19	13	10
	3D	11	13	16	14
	3E	10	13	16	12
	3F	11	11	14	13
DANIEL	4A	6	8	16	14
	4B	9	10	15	13
	4C	9	11	16	18
	4D	8	9	16	16
SEEDSKADEE	6A	10	9	21	18
	6B	7	6	23	20

* ALL VALUES ARE IN PERCENT

TABLE E1. ESTIMATED ET USING CALIBRATED EQUATIONS FOR ALFALFA - 1984

STATION	MONTH	FAO PENMAN (IN)	ASCE PENMAN (IN)	FAO BLANEY CRIDDLE (IN)	SCS BLANEY CRIDDLE (IN)	ORIG BLANEY CRIDDLE (IN)	MODIFIED JENSEN-HAISE (IN)
ROCK SPRINGS	MAY	4.99	6.36	5.12	5.61	5.60	5.00
	JUN	8.06	9.68	6.47	8.88	8.16	8.02
	JUL	10.30	12.07	10.71	10.41	9.46	10.40
	AUG	9.57	10.15	9.54	10.63	9.37	9.48
	SEP	4.74	5.63	4.89	5.31	4.50	5.04
	OCT	1.98	2.62	1.81	2.55	3.08	2.49
	SEASON	39.64	46.51	38.54	43.39	40.17	40.43
FARSON	MAY	4.89	6.70	4.79	4.60	5.12	4.36
	JUN	7.73	9.95	5.79	7.11	7.39	7.00
	JUL	8.39	10.15	8.27	7.46	8.14	8.55
	AUG	8.07	8.38	7.83	8.04	8.25	8.25
	SEP	4.10	4.89	4.06	4.11	4.07	4.21
	OCT	1.11	1.60	1.18	1.49	2.81	1.54
	SEASON	34.29	41.67	31.92	32.81	35.78	33.91
MERNA	MAY	1.85	2.09	1.75	2.00	4.53	1.85
	JUN	5.86	6.12	4.07	5.75	6.68	5.46
	JUL	6.95	7.26	6.60	7.17	8.00	6.94
	AUG	6.46	6.20	5.84	7.23	7.83	6.47
	SEP	3.03	3.38	2.83	3.55	3.82	3.10
	OCT	0.84	1.14	0.79	1.29	2.61	1.12
	SEASON	24.99	26.19	21.88	26.99	33.47	24.94
DANIEL	MAY	2.19	2.48	2.16	2.51	4.59	2.31
	JUN	6.38	6.80	4.64	6.28	7.03	6.15
	JUL	7.62	8.13	7.53	7.80	8.28	7.80
	AUG	6.96	7.01	6.62	7.54	8.04	6.85
	SEP	3.26	3.85	3.14	3.59	3.78	3.26
	OCT	0.91	1.30	0.88	1.32	2.65	1.18
	SEASON	27.32	29.57	24.97	29.04	34.37	27.55
BIG PINEY	MAY	3.86	4.47	3.77	4.26	4.91	3.93
	JUN	6.79	7.63	5.19	7.08	7.39	6.63
	JUL	8.33	9.38	8.61	8.86	8.83	8.42
	AUG	7.51	7.84	7.44	8.67	8.60	7.41
	SEP	3.58	4.28	3.63	4.15	4.03	3.76
	OCT	1.46	1.98	1.28	1.88	2.69	1.87
	SEASON	31.53	35.58	29.92	34.90	36.45	32.02

Continued

TABLE E1. ESTIMATED ET USING CALIBRATED EQUATIONS FOR ALFALFA-1984 (cont)

STATION	MONTH	FAO PENMAN (IN)	ASCE PENMAN (IN)	FAO BLANEY CRIDDLE (IN)	SCS BLANEY CRIDDLE (IN)	ORIG BLANEY CRIDDLE (IN)	MODIFIED JENSEN-HAISE (IN)
SEEDSK.	MAY	4.48	5.54	4.33	4.67	5.12	4.56
	JUN	7.56	9.21	5.85	7.84	7.74	7.42
	JUL	9.11	10.24	9.53	9.85	9.25	9.78
	AUG	8.77	9.18	8.75	10.25	9.23	9.02
	SEP	4.24	4.87	4.43	5.17	4.45	4.74
	OCT	1.13	1.59	1.25	1.75	3.04	1.66
	SEASON	35.29	40.63	34.14	39.53	38.83	37.18
MOUNTAIN VIEW	MAY	4.31	5.22	4.13	4.71	5.12	4.13
	JUN	6.78	7.71	5.10	7.20	7.46	6.44
	JUL	7.94	8.87	8.02	8.81	8.76	7.97
	AUG	7.26	7.55	6.95	8.91	8.67	7.10
	SEP	4.04	4.77	4.04	4.74	4.33	4.09
	OCT	1.77	2.34	1.52	2.33	2.96	2.14
	SEASON	32.10	36.46	29.76	36.70	37.30	31.87

TABLE E2. ESTIMATED IT USING CALIBRATED EQUATIONS FOR ALFALFA - 1985

STATION	MONTH	FAO PENMAN (IN)	ASCE PENMAN (IN)	FAO BLANEY CRIDDLE (IN)	SCS BLANEY CRIDDLE (IN)	ORIG. BLANEY CRIDDLE (IN)	MODIFIED JENSEN-HAISE (IN)
ROCK SPRINGS	MAY	5.08	5.07	5.69	6.16	5.76	5.73
	JUN	9.34	10.13	8.28	10.66	8.86	10.49
	JUL	10.31	10.90	11.48	11.15	9.81	10.83
	AUG	9.51	10.35	10.83	9.93	9.09	10.89
	SEP	4.66	4.44	4.71	4.86	4.37	4.65
	OCT	2.11	2.19	2.32	3.00	3.31	3.07
	SEASON	41.01	43.08	43.31	45.76	41.20	45.66
FARSON	MAY	1.47	1.46	1.55	1.48	5.17	1.58
	JUN	8.74	8.65	6.62	8.06	7.81	8.51
	JUL	9.11	9.45	9.28	8.75	8.76	8.91
	AUG	10.94	10.34	9.91	8.21	8.32	9.56
	SEP	4.46	4.36	4.03	3.68	3.86	4.06
	OCT	1.94	2.19	1.90	2.26	2.92	2.52
	SEASON	36.66	36.45	33.29	32.44	36.84	35.14
MERNA	MAY	1.00	0.98	1.02	1.21	4.64	1.01
	JUN	7.01	6.66	5.25	6.50	7.11	6.49
	JUL	7.83	7.96	7.86	7.54	8.21	7.43
	AUG	8.24	7.70	7.39	6.33	7.41	6.91
	SEP	3.06	3.00	2.65	3.00	3.52	2.70
	OCT	1.45	1.54	1.33	1.89	2.73	1.86
	SEASON	28.59	27.84	25.50	26.47	33.62	26.40
DANIEL	MAY	1.03	1.05	1.11	1.29	4.80	1.07
	JUN	6.71	6.41	5.10	6.75	7.25	6.68
	JUL	7.66	7.65	7.46	8.08	8.48	7.88
	AUG	8.36	7.85	7.22	6.40	7.48	6.98
	SEP	3.21	3.18	2.85	3.20	3.61	2.99
	OCT	1.46	1.66	1.32	1.92	2.73	1.88
	SEASON	28.43	27.80	25.06	27.64	34.35	27.48
BIG PINEY	MAY	4.07	3.99	4.19	4.61	5.07	4.23
	JUN	8.04	7.74	6.41	8.32	7.95	8.01
	JUL	8.70	8.91	9.23	9.26	9.04	8.68
	AUG	9.59	9.07	8.76	7.52	8.04	8.34
	SEP	3.73	3.56	3.55	3.63	3.82	3.59
	OCT	1.61	1.79	1.66	2.14	2.88	2.21
	SEASON	35.74	35.06	33.80	35.48	36.80	35.06

Continued

TABLE E2. ESTIMATED ET USING CALIBRATED EQUATIONS FOR ALFALFA - 1985 (cont)

STATION	MONTH	FAO PENMAN (IN)	ASCE PENMAN (IN)	FAO BLANEY CRIDDLE (IN)	SCS BLANEY CRIDDLE (IN)	ORIG. BLANEY CRIDDLE (IN)	MODIFIED JENSEN-HAISE (IN)
	MAY	1.61	1.55	1.79	1.87	5.71	1.77
	JUN	8.91	9.35	7.80	10.07	8.65	9.69
SEEDSK.	JUL	9.84	10.81	11.12	11.10	9.81	10.42
	AUG	10.53	11.06	10.92	9.56	8.95	10.41
	SEP	4.68	4.53	4.65	4.69	4.28	4.54
	OCT	2.15	2.36	2.32	2.82	3.23	2.90
	SEASON	37.72	39.66	38.60	40.11	40.63	39.73
	MAY	4.95	4.76	5.20	5.18	5.39	4.95
	JUN	8.31	7.94	6.53	8.34	7.95	7.96
MOUNTAIN	JUL	8.56	8.68	8.84	9.39	9.04	8.36
VIEW	AUG	10.65	9.93	9.65	8.16	8.32	8.76
	SEP	4.12	4.03	4.03	4.07	4.03	3.77
	OCT	1.94	2.08	2.02	2.68	3.15	2.51
	SEASON	38.53	37.42	36.27	37.82	37.88	36.31

TABLE E3. ESTIMATED ET USING CALIBRATED EQUATIONS FOR MTN MDWS - 1984

STATION	MONTH	FAO PENMAN (IN)	ASCE PENMAN (IN)	FAO BLANEY CRIDDLE (IN)	SCS BLANEY CRIDDLE (IN)	ORIG. BLANEY CRIDDLE (IN)	MODIFIED JENSEN-HAISE (IN)
ROCK SPRINGS	MAY	5.25	6.36	5.44	5.43	4.91	5.21
	JUN	7.46	8.91	8.14	8.01	6.97	7.86
	JUL	9.30	10.64	9.94	8.89	7.76	9.56
	AUG	6.93	7.68	7.70	7.65	6.46	7.46
	SEP	4.09	4.98	4.65	4.26	3.52	4.93
	OCT	3.67	5.24	2.23	2.51	3.08	2.65
	SEASON	36.70	43.81	38.10	36.75	32.70	37.67
FARSON	MAY	5.14	6.70	5.09	4.60	4.49	4.54
	JUN	7.15	9.15	7.29	6.64	6.31	6.86
	JUL	7.58	8.95	7.68	6.66	6.68	7.86
	AUG	5.85	6.35	6.32	6.00	5.69	6.49
	SEP	3.54	4.33	3.86	3.44	3.19	4.12
	OCT	2.05	3.20	1.46	1.47	2.81	1.64
	SEASON	31.31	38.68	31.70	28.81	29.17	31.51
MERNA	MAY	1.95	2.09	1.86	2.04	3.97	1.93
	JUN	5.42	5.63	5.12	5.56	5.71	5.35
	JUL	6.28	6.40	6.13	6.43	6.57	6.38
	AUG	4.68	4.70	4.71	5.48	5.40	5.09
	SEP	2.62	2.99	2.69	3.06	2.99	3.03
	OCT	1.56	2.28	0.98	1.31	2.61	1.19
	SEASON	22.51	24.09	21.49	23.88	27.25	22.97
DANIEL	MAY	2.31	2.48	2.29	2.54	4.02	2.41
	JUN	5.90	6.26	5.84	5.99	6.01	6.03
	JUL	6.88	7.17	6.99	6.91	6.79	7.17
	AUG	5.04	5.31	5.34	5.69	5.54	5.39
	SEP	2.82	3.41	2.98	3.08	2.95	3.19
	OCT	1.69	2.59	1.09	1.33	2.65	1.26
	SEASON	24.64	27.22	24.53	25.54	27.96	25.54
BIG PINEY	MAY	4.06	4.47	4.01	4.32	4.30	4.10
	JUN	6.28	7.02	6.53	6.62	6.31	6.50
	JUL	7.52	8.27	8.00	7.72	7.25	7.74
	AUG	5.43	5.94	6.00	6.41	5.93	5.83
	SEP	3.09	3.79	3.45	3.48	3.15	3.68
	OCT	2.70	3.96	1.58	1.98	2.69	1.99
	SEASON	29.08	33.45	29.57	30.53	29.63	29.84

Continued

TABLE E3. ESTIMATED ET USING CALIBRATED EQUATIONS FOR MTN MDWS-1984 (cont)

STATION	MONTH	FAO PENMAN (IN)	ASCE PENMAN (IN)	FAO BLANEY CRIDDLE (IN)	SCS BLANEY CRIDDLE (IN)	ORIG. BLANEY CRIDDLE (IN)	MODIFIED JENSEN-HAISE (IN)
	MAY	4.72	5.54	4.60	4.66	4.49	4.75
	JUN	6.99	8.47	7.36	7.20	6.61	7.27
SEEDSK.	JUL	8.22	9.03	8.85	8.47	7.59	8.99
	AUG	6.35	6.95	7.06	7.42	6.36	7.10
	SEP	3.66	4.32	4.21	4.17	3.48	4.64
	OCT	2.10	3.18	1.54	1.67	3.04	1.77
	SEASON	32.04	37.49	33.62	33.59	31.57	34.52
	MAY	4.53	5.22	4.39	4.70	4.49	4.30
	JUN	6.27	7.09	6.42	6.70	6.37	6.31
MOUNTAIN	JUL	7.17	7.82	7.45	7.68	7.19	7.33
VIEW	AUG	5.26	5.72	5.61	6.56	5.98	5.58
	SEP	3.48	4.23	3.84	3.88	3.38	4.00
	OCT	3.28	4.68	1.88	2.34	2.96	2.28
	SEASON	29.99	34.76	29.59	31.86	30.37	29.80

TABLE E4. ESTIMATED ET USING CALIBRATED EQUATIONS FOR MTN MDWS - 1985

STATION	MONTH	FAO PENMAN (IN)	ASCE PENMAN (IN)	FAO BLANEY CRIDDLE (IN)	SCS BLANEY CRIDDLE (IN)	ORIG. BLANEY CRIDDLE (IN)	MODIFIED JENSEN-HAISE (IN)
ROCK SPRINGS	MAY	5.34	5.07	6.05	5.87	5.05	5.97
	JUN	8.63	9.32	10.42	9.38	7.57	10.28
	JUL	9.31	9.61	10.66	9.44	8.05	9.96
	AUG	6.89	7.84	8.74	7.21	6.27	8.57
	SEP	4.02	3.94	4.47	3.96	3.42	4.55
	OCT	3.90	4.38	2.87	2.86	3.31	3.27
	SEASON	38.09	40.16	43.21	38.72	33.67	42.60
FARSON	MAY	1.55	1.46	1.65	1.46	4.53	1.64
	JUN	8.08	7.96	8.33	7.38	6.67	8.34
	JUL	8.22	8.33	8.62	7.64	7.19	8.19
	AUG	7.92	7.83	8.00	6.11	5.74	7.52
	SEP	3.84	3.86	3.83	3.15	3.02	3.98
	OCT	3.60	4.37	2.34	2.28	2.92	2.68
	SEASON	33.21	33.81	32.77	28.02	30.07	32.35
MERNA	MAY	1.05	0.98	1.08	1.23	4.07	1.05
	JUN	6.48	6.13	6.61	6.15	6.07	6.36
	JUL	7.07	7.02	7.30	6.72	6.74	6.83
	AUG	5.96	5.83	5.96	4.90	5.11	5.44
	SEP	2.64	2.65	2.52	2.67	2.75	2.64
	OCT	2.68	3.07	1.64	1.99	2.73	1.98
	SEASON	25.88	25.68	25.11	23.66	27.47	24.30
DANIEL	MAY	1.08	1.05	1.18	1.30	4.21	1.11
	JUN	6.20	5.90	6.42	6.35	6.19	6.55
	JUL	6.92	6.74	6.93	7.13	6.96	7.24
	AUG	6.06	5.94	5.83	4.94	5.16	5.49
	SEP	2.77	2.81	2.71	2.81	2.82	2.92
	OCT	2.70	3.31	1.63	2.01	2.73	2.00
	SEASON	25.73	25.75	24.70	24.54	28.07	25.31
BIG PINEY	MAY	4.28	3.99	4.46	4.62	4.44	4.41
	JUN	7.43	7.12	8.06	7.58	6.79	7.85
	JUL	7.86	7.86	8.57	8.03	7.42	7.98
	AUG	6.95	6.87	7.07	5.67	5.54	6.56
	SEP	3.22	3.16	3.37	3.11	2.99	3.51
	OCT	2.99	3.58	2.05	2.19	2.88	2.35
	SEASON	32.73	32.58	33.58	31.20	30.06	32.66

Continued

TABLE E4. ESTIMATED ET USING CALIBRATED EQUATIONS FOR MTN MDWS - 1985 (cont)

STATION	MONTH	FAO PENMAN (IN)	ASCE PENMAN (IN)	FAO BLANEY CRIDDLE (IN)	SCS BLANEY CRIDDLE (IN)	ORIG. BLANEY CRIDDLE (IN)	MODIFIED JENSEN-HAISE (IN)
SEEDSK.	MAY	1.70	1.55	1.90	1.77	5.00	1.84
	JUN	8.24	8.60	9.81	8.93	7.39	9.50
	JUL	8.88	9.54	10.33	9.40	8.05	9.58
	AUG	7.63	8.38	8.81	6.97	6.17	8.19
	SEP	4.04	4.01	4.42	3.85	3.35	4.44
	OCT	3.99	4.71	2.86	2.72	3.23	3.08
	SEASON	34.48	36.79	38.13	33.64	33.19	36.63
MOUNTAIN VIEW	MAY	5.20	4.76	5.53	5.08	4.72	5.15
	JUN	7.69	7.30	8.22	7.59	6.79	7.80
	JUL	7.73	7.65	8.21	8.12	7.42	7.68
	AUG	7.71	7.52	7.79	6.08	5.74	6.89
	SEP	3.55	3.57	3.83	3.42	3.15	3.69
	OCT	3.59	4.15	2.49	2.62	3.15	2.67
	SEASON	35.47	34.95	36.07	32.91	30.97	33.88

TABLE F1. LOCATIONS AND ELEVATIONS OF PROJECT SITES

LOCATION	LATITUDE (DEG MIN)	LONGITUDE (DEG MIN)	ELEVATION (FEET)
LYSIMETERS 2A,2B	42 07	109 28W	6600
LYSIMETERS 3A,3B	42 57	110 22W	7800
LYSIMETERS 3C,3D,3E,3F	42 56	110 17W	7500
LYSIMETERS 4A,4B,4C,4D	42 52	110 04W	7200
LYSIMETERS 6A,6B	41 55	109 54W	6395
ROCK SPRINGS WEATHER STATION	41 36	109 04W	6650
FARSON WEATHER STATION	42 07	109 28W	6600
MERNA WEATHER STATION	42 57	110 22W	7800
DANIEL WEATHER STATION	42 52	110 04W	7200
BIG PINEY WEATHER STATION	42 32	110 06W	6800
SEEDSKADEE WEATHER STATION	41 55	109 54W	6395
MTN VIEW WEATHER STATION	41 20	110 21W	6650

TABLE F2. LOCATIONS AND ELEVATIONS OF NWS STATIONS

LOCATION	COUNTY	LATITUDE (DEG MIN)	LONGITUDE (DEG MIN)	ELEVATION (FEET)
BAGGS	CARBON	42 02	107 39W	6240
DIXON	CARBON	41 02	107 32W	6360
MOUNTAIN VIEW	UINTA	41 16	110 21W	6800
KEMMERER	LINCOLN	41 43	110 40W	6958
FONTENELLE DAM	LINCOLN	41 59	110 04W	6480
BIG PINEY	SUBLETTE	42 33	110 07W	6820
MERNA	SUBLETTE	42 57	110 22W	7700
PINEDALE	SUBLETTE	42 52	109 52W	7175
FARSON	SWEETWATER	42 07	109 26W	6590
RCK SPR FAA AP	SWEETWATER	41 36	109 04W	6741

Appendix G:

The following defines the methodology for determining the various parameters for the ET formulas presented in Chapter 4.

1. FAO Blaney Criddle:

$ET_o = A_b + B_b\ (p(0.46T + 8))$

a) $A_b = 0.0043\ RH_{min}$ - SS-1.41, p. 110-FA024

where:

RH_{min} = minimum relative humidity (%)

SS = mean monthly percent of possible sunshine

b) $B_b = B_1 + B_2$

$B_1 = a_1 + a_2\ RH_{min} + a_3\ SS_1$

$B_2 = a_4\ U_d + a_5\ RH_{min}\ SS + a_6\ RH_{min}\ U_d$

where:

U_d = daytime wind (m/s)

$a_1 = 0.81917$

$a_2 = -0.0040922$

$a_3 = 1.0705$

$a_4 = 0.065649$

$a_5 = 0.0059684$

$a_6 = -0.0005967$

c) p = found in Table 6.4, p. 82 - ASCE report

2. FAO Radiation (Makkink)

$ET_o = A_r + B_r\ (W\ Rse)$

a) $A_r = -\ 0.3$

b) $B_r = B_1 + B_2$

$B_1 = a_1 + a_2\ RH_{mean} = a_3\ U_d$

$B_2 = a_4\ RH_{mean}\ U_d + a_5\ RH_{mean}{}^2 + a_6\ U_d{}^2$

where:

RH_{mean} = mean relative humidity (%)

U_d = daytime wind (m/s)

$a_1 = 1.0656$

$a_2 = -0.0012795$

$a_3 = 0.044953$

$a_4 = -2.0033 \times 10^{-4}$

$a_5 = -3.1508 \times 10^{-5}$

$a_6 = -0.0011026$

2. FAO Radiation (cont.)

c) $W = \Delta / \Delta + \gamma$

$\Delta = 33.8639(0.05904(0.00738\ T + 0.8072)\ \ 7 - 0.0000342)$

$\gamma = 0.240\ P/(0.622\lambda)$

$P = 1013.0 - 0.1093\ E$

$\lambda = 595.0 - 0.51\ T$

where:

T = mean temperature (°C)

E = elevation (m)

P = atmospheric pressure (mbar), p. 122-ASCE report

λ = function of mean temperature, p. 122-ASCE report

γ = psychrometric constant, p. 123-ASCE report

Δ = slope of saturation vapor pressure-temp. curve at temperature of interest, p. 123-ASCE report

d) R_{se} = solar radiation in equivalent evaporation (mm/day)

3. ASCE Penman

$ET_r = (\Delta/(\Delta+\gamma))(Rn+G) + (\gamma/(\Delta+\gamma))(15.36)(1.0+0.0062U_2)(e_s-e_a)$

a) Δ,γ = described in previous equation

b) $R_n = (1-0.23)R_s(58.5)-R_B$

$R_B = (ADOT(R_s(58.5)/R_{so}) + BDOT)R_{Bo}$

$R_{Bo} = EDOT(SIG)(T+273.)\ 4$

$EDOT = -0.02 + 0.261\ EXP(-0.000777(T\ 2))$

where:

R_B = net longwave radiation (ly/dy), p.26-ASCE report

R_{Bo} = net outgoing clear day longwave radiation (ly/dy), p.26-ASCE report

EDOT = net emissivity, p.27-ASCE report

R_s = solar radiation (mm/day)

ADOT = 1.2

BDOT = -0.2, p. 27-ASCE report

R_{so} = mean solar radiation for cloudless skies (ly/dy), Table 3.1, p. 22-ASCE report

SIG = Stefan-Boltzmann Constant ($ly/day/k^4$)

$= 11.71 \times 10^{-8}$, p.26-ASCE report

T = mean temperature (°C)

c) $G = (\frac{T_{i-1} - T_{i+1}}{\Delta t}) * 100$, p.32-ASCE report

3. ASCE Penman (cont.)

T_i = mean temperature for time period i (°C)

Δt = time (days) between the midpoints of the two periods

d) $e_s = (e_{max} + e_{min})/2$

Press (val) = 33.8639((0.00738 val + 0.8072) 8-0.000019 x 1.8 val + 48 + 0.001316), p. 129-ASCE report

where:

e_{max} = Press (T_{max}) , (mbar)

e_{min} = Press (T_{min}) , (mbar)

T_{max} = maximum temperature (°C)

T_{min} = minimum temperature (°C)

e) e_a = Press (Tdp) , (mbar)

where:

T_{dp} = average daily dewpoint temperature (°C)

4. FAO Penman:

$$ET_o = C_p(WR_n + (1-W)(.27)(1+U/100)(e_s - e_a)$$

a) $C_p = a_o + a_1 RH_{max} + a_2 R_s - a_3 U_d + a_4 \text{ DNR} + a_5 U_d \text{DNR} + A_6 RH_{max} R_s U_d - a_7 RH_{max} R_s \text{DNR}$,

where:

a_o = 0.6817006

a_1 = 0.0027864

a_2 = 0.0181767

a_3 = 0.0682501

a_4 = 0.0126514

a_5 = 0.0097297

$a_6 = 0.43025 \times 10^{-4}$

$a_7 = 0.92118 \times 10^{-7}$

DNR = Ud/Un

Ud = daytime wind (m/s)

Un = night wind (m/s)

RH_{max} = maximum relative humidity (%)

Rs = solar radiation (mm/day)

b) R_n = 0.75Rs-Rnl, p.19-FAO 24

Rnl = $F_t F_{ed} F_{nn}$

F_t = σT_k 4/58.5, p.27-FA024

T_k = T+273

4. FAO Penman (cont.)

$\sigma = 1.171 \times 10^{-7}$

$F_{ed} = 0.34 - 0.044\sqrt{e_a}$, p.27-FA024

F_{nn} = 0.1+0.9 nN 1, p.27-FA024

nN = $(R_s - R_a 0.25)/(0.5R_a)$

where:

R_s = solar radiation (mm/day)

R_a = extraterrestrial radiation (mm/day), Table 10, p.25-FA024

nN = percentage of sunshine data required

F_{nn} = sunshine function

F_{ed} = vapor pressure function

T = mean temperature (°C)

F_t = temperature function

R_{nl} = net longwave radiation (mm/day)

e_a = actual vapor pressure at dewpoint (mbar)

c) e_s = press (T) , p. 129-ASCE report

- use same pressure equation as for ASCE Penman method

where:

T = mean temperature (°C)

APPENDIX H

FIELD OPERATIONS

The interpretation of water use measurements appears to be dependent on the procedures used to obtain the measurements. Because of this dependency, the methods used in this study are described in detail below. The field operations of this study were conducted in a consistent and careful manner. The description of the field operations was originally prepared by Tom Crump. What follows is an abbreviated version of his original description.

Start-up and Shut-down Procedures

The date of lysimeter start-up was dependent on two factors. These were frost in the soil and snowfall conditions. The frost had to be out of the soil to enable the voids to be saturated with water during start-up and it was desirable not to start-up until after the last snowfall because it was difficult to measure the amount of precipitation that was caught, especially in the presence of wind. In particular, it was desirable to avoid dryer light snow that could easily be blown. The allowable starting times, thus, were around the last week in May for the lower elevations and about the first week in June for the higher elevations. The start-up procedure was as follows:

1. Water was added to the lysimeter via the 4 inch PVC corner access pipe until the water table reached the soil surface.
2. The lysimeter was allowed to stabilize for at least 24 hours.
3. After 24 hours, water was added if necessary to assure that the water table was at the soil surface.
4. Neutron probe readings at 6 inch increments were taken for the full depth of the lysimeter with the soil in the saturated condition.
5. Water was removed via the corner access tube using a hand pump. The amount was measured and recorded.
6. Again the lysimeter was allowed to set for 24 hours.
7. After 24 hours, the water table depth was carefully recorded. This permitted calculation of specific yield for each lysimeter. Neutron probe readings were then taken at 6 inch intervals.
   These readings were used to determine field capacity above the water table.

The shut-down procedure was similar to the start-up procedure. Weather conditions again affected the date on which the lysimeters were shut-down. This was usually near the end of October. The procedure was as follows:

1. The crop was first harvested.
2. Neutron probe readings were taken at 6 inch intervals and the water table depth carefully recorded.
3. Measured amounts of water were added until the water table was at the soil surface.
4. After 24 hours, additional water was added if necessary to bring the water table to the soil surface.
5. All excess water was pumped from the lysimeter for winter.

Weekly Operation Procedure

Two types of operation were maintained during the season. To simplify the terminology, these will be referred to as maximum and actual water use measurements. The maximum water use measurements included:

1. Regular surface irrigation for the entire season. An attempt was made to maintain soil moisture depletion levels at no greater than 50 percent.
2. Water table depths were maintained as close as possible to outside levels, or at 3 to 4 ft. when outside water levels dropped for the season. Water table depths were recorded each week before any water was added or removed.
3. Soil moisture measurements were taken each week at 6 inch increments using a neutron probe. Probe readings were taken using a Campbell Pacific Nuclear neutron moisture probe (Model 503, Serial Number H38122580).
4. All water, including precipitation, added to or removed from the lysimeters was measured. Water was added or removed to maintain the water table at the desired level. If water was removed, then some water was pumped through the soil profile to assure that the profile was near field capacity. If water was added, it was added through surface irrigation which accomplished the same objective.
5. Average crop height was measured and recorded. Percent crop coverage was estimated.
6. The alta fescue grass was maintained clipped to a height of 3 to 6 inches. The areas surrounding the alta fescue and alfalfa sites was also maintained clipped to a distance of 10 to 15 ft.
7. The alfalfa and mountain meadow lysimeters were harvested at the time that the surrounding fields were harvested and at the end of the season.

The actual water measurement included the above with the exception that irrigation was discontinued when irrigation outside of the lysimeter was discontinued for the season.

Evaporation Pan Operation

Three Class A evaporation pans were operated during this study. The procedures were standard for Class A pans. Reservoirs were used to maintain the water level at approximately 2 inches below the lip of the pan. The surrounding areas were maintained clipped and debris etc., were removed from the pans weekly.