PARTIAL RESEARCH TECHNICAL COMPLETION REPORT

WEATHER AND POTENTIAL EVAPOTRANSPIRATION AT IRRIGATED AND RANGELAND SITES IN SOUTHERN IDAHO

by

R. G. Allen

College of Engineering
College of Agriculture

Submitted to

Idaho Department of Water Resources
Boise, Idaho

This project was supported with funds provided
by the Idaho Department of Water Resources
Idaho Water and Energy Resources Research Institute
University of Idaho
Moscow, Idaho

July 1983

ABSTRACT

The environment of a weather station site is important in estimating consumptive use by irrigated crops. Consumptive use may be over-estimated when air temperature and vapor pressure data from a weather station with an arid local environment are used without modification. To document the effect of weather station aridity on consumptive use estimates, three sites in irrigated areas and two sites in nonirrigated, arid rangeland in southern Idaho were instrumented with weather stations during 1981. Air temperatures were higher and vapor pressures were lower at the arid sites. Use of air temperatures and dewpoint estimates from arid sites caused an overestimation of ET_r by 17% (210 mm) over the irrigation season. Results indicate the importance of weather site evaluation and adjustment of siting effects and weather before consumptive use estimates are made. A procedure is outlined for adjusting historical temperature data to reflect an irrigated condition.

ACKNOWLEDGEMENTS

The author wishes to thank Mr. Rick Kruse, Bell Rapids Project, and Mr. Gary Stiehl of Lawarence Grey Farms, Grindstone Butte Project, for permitting weather stations to be located on their farms during 1981. The Bureau of Land Management permitted siting of two weather stations on federal land during the same period.

Dr. James L. Wright, USDA-ARS, Kimberly, Idaho, provided weather measurements made at the Kimberly reseach center. In addition, the alfalfa reference evapotranspiration equation used in this study was developed by Dr. Wright at Kimberly.

The USDA-ARS at Kimberly provided office space and computer facilities used during this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (continued)

INTRODUCTION

Four weather sensing stations were located in the Bruneau Plateau area in southern Idaho during 1981 to measure and record hourly and daily meteorological data at two sites in irrigated areas and at two sites in nonirrigated, arid, rangeland areas. Names, locations, and weather parameters recorded at stations are listed in Table 1. Also included is a description of a station located at the USDA-ARS research center at Kimberly, Idaho during the same period. Period of measurement for all stations was April 8 through October 22, 1981. Locations of sites are shown in Figure 1.

One objective of this study was to evaluate differences in weather parameters and estimates of irrigation consumptive use requirements between the Bruneau Plateau area and Kimberly. Another study objective was to measure and evaluate differences in air temperature and water vapor pressure (dewpoint) between irrigated and desert areas in the Bruneau Plateau area.

Table 1. Names, locations and weather information collected at sites in southern Idaho during 1981.

Name	Elev.(m)	Location
1. Grindstone Butte Mutual Irrigation Project hourly solar radiation, air temperature, relative humidity, windrun and direction	960	T7S,R10E,s21
2. Grindstone Butte Desert daily maximum and minimum air temperature occaisional relative humidity (dewpoint)	980	T8S,R10E,s11
3. Bell Rapids Mutual Irrigation Project hourly solar radiation, air temperature, relative humidity and windrun	1050	T7S,R13E,s30
4. Bell Rapids Desert daily maximum and minimum air temperature occaisional relative humidity (dewpoint)	1050	T7S,R11E,s23
5. Kimberly USDA-ARS hourly solar radiation, air temperature, dewpoint, windrun and soil temperature	1200	T10S,R18E,s21

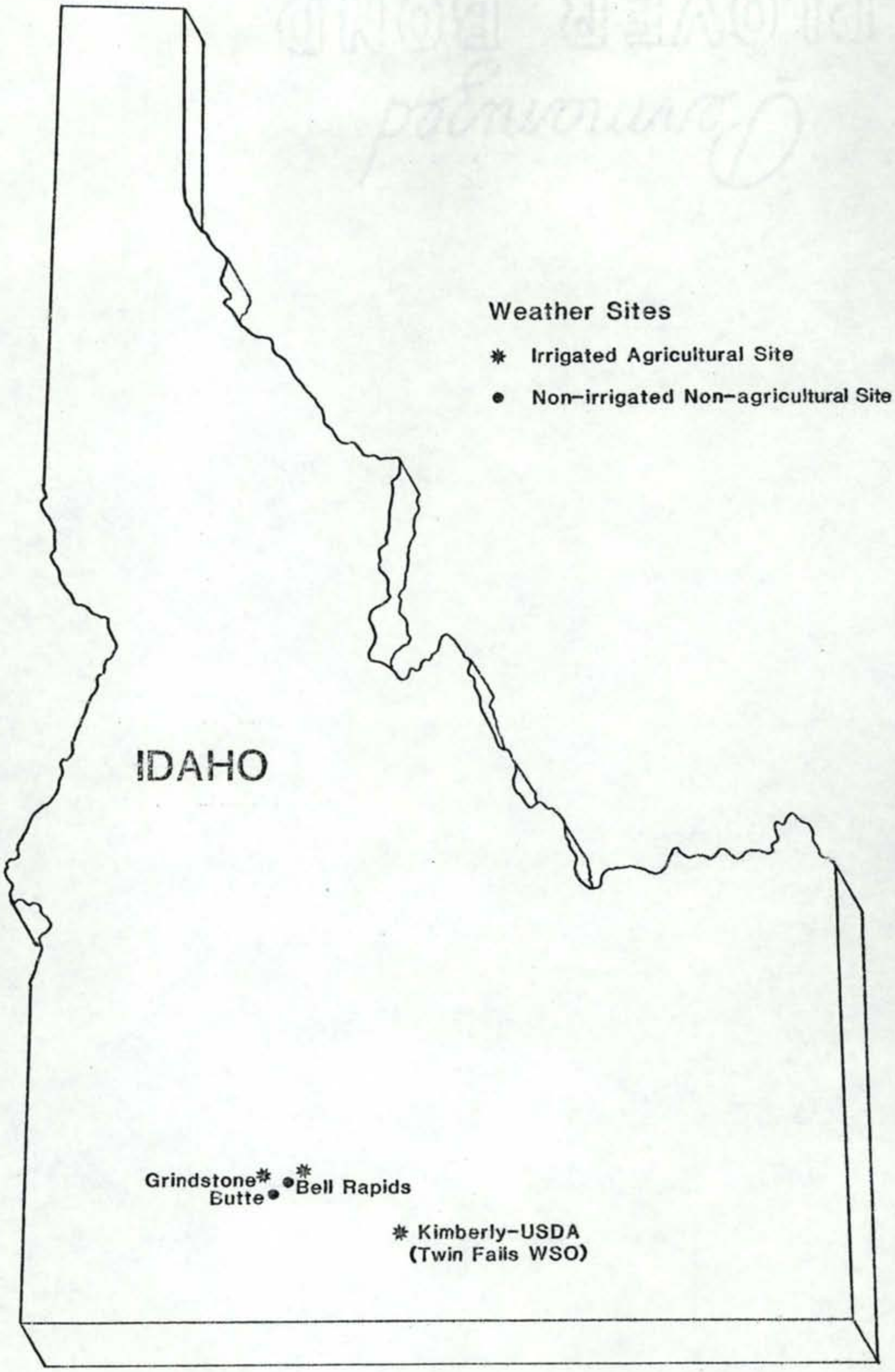

Figure 1. Locations of weather sites during the 1981 irrigation season.

PROCEDURE

The two irrigated weather sites on the Bruneau Plateau were located in alfalfa fields near the centers of two major irrigation projects. The site at Bell Rapids (site 3) was in a sprinkler irrigated alfalfa hay field harvested about June 10, July 20, September 1 and October 15. This site was adequately watered, well fertilized and was surrounded by irrigated alfalfa or grass pasture on all sides for over 500 meters. The Bell Rapids Irrigation Project is 15000 hectares surrounded by arid rangeland.

The Grindstone irrigated site (site 1) was located in a sprinkler-irrigated alfalfa field grown for seed production. This site was underirrigated from mid July through October to facilitate seed production and to discourage vegetative growth. The result of this underirrigation on air and dew point temperature measured over the site is discussed in a subsequent section of this paper. The Grindstone Irrigation Project is 5000 hectares surrounded by arid rangeland.

Weather stations at the Grindstone and Bell Rapids irrigated sites (sites 1 and 3) consisted of microprocessor based controller/recorder units with cassette storage. Air temperature, relative humidity, solar radiation and wind speed and direction were measured using electronically activated sensors interrogated at intervals of one minute duration. Values from each minute period were averaged over one hour and stored to memory. Hourly and daily maximum and minimum one-minute values of air temperature were also recorded. All sensors were mounted two meters above ground surface. Hourly estimates of dewpoint temperatures at the two irrigated sites on the Bruneau Plateau (sites 1 and 3) were calculated using average hourly values of recorded air temperature and relative humdity.

Weather stations at the Grindstone and Bell Rapids desert sites (sites 2 and 4) consisted of mechanical thermographs equipped with 30-day, circular charts located at two meters above ground surface. These stations were sited in areas of grass/sagebrush vegetation with no irrigation or cultivation within 4 kilometers in any direction.

The weather station equipment at Kimberly (site 5) was similar to sites 1 and 3, with the exception that dewpoint, rather than relative humidity, was measured using an aspirated electronic dewpoint sensor. The Kimberly sensors were located 2 meters above clipped turf grass. Weather data at Kimberly for 1981 were collected and made available by Wright and Stevens (1981).

All stations were visited and serviced at 3-week intervals. During each visit, psychrometer readings were taken with a hand-held pyschrometer to verify electronic measurements of air temperature and relative humidity and routine maintenance was done.

RESULTS

Weather Measurements at Irrigated Sites

Daily measurements of solar radiation, wind run, maximum air temperatures, mimimum air temperature and dewpoint temperature are shown in Figures 2 through 5 for the Kimberly, Grindstone and Bell Rapids irrigated sites. Tables of daily weather data are included in the appendix to this report. Hourly readings of weather data for the three irrigated sites are on file at the University of Idaho Research and Extension Center, Kimberly, Idaho. Ten-day running averages of solar radiation, wind run, maximum and minimum air temperatures and dewpoint temperature are shown in Figures 6 through 9. The ten-day averages smooth daily fluctuations within parameters and allow variations among sites to be observed. Seasonal averages of weather parameters from irrigated sites are summarized in Table 2.

Solar Radiation. As shown in Figure 6, solar radiation measurements at Kimberly, Grindstone Butte and Bell Rapids during 1981 are nearly indistinguishable, especially after June 1 (julian date 152). Pyronometer sensors used were the Eppley 8-48 and the LI-COR 200S. Both types are cosine corrected.

Wind Run. Ten-day averages of wind run shown in Figure 7 indicate wind run measured at Kimberly to be less than wind run measured at the

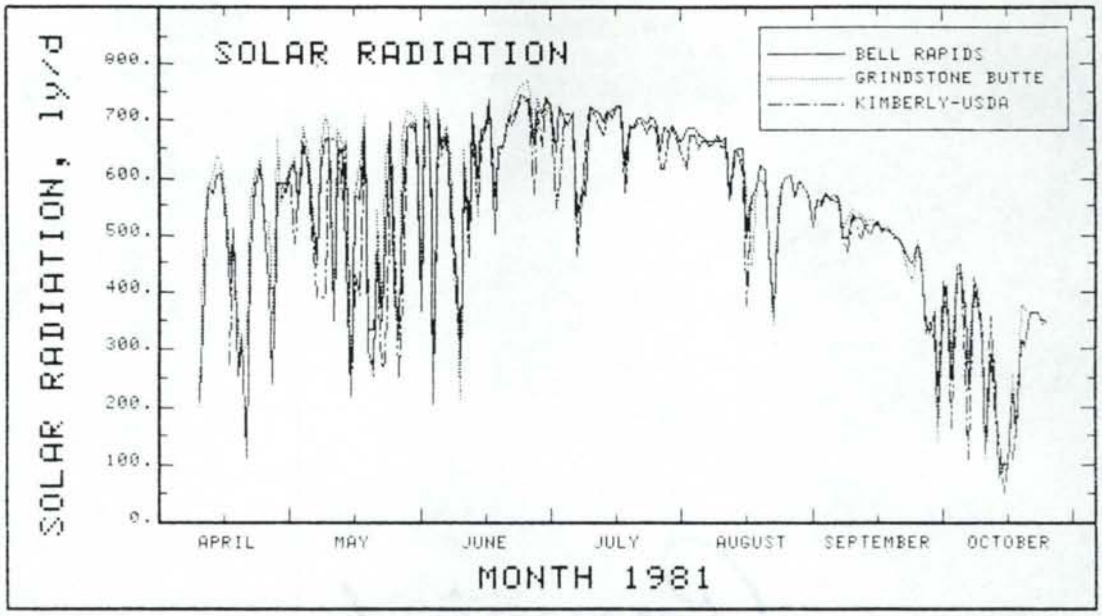

Figure 2. Daily solar radiation at Bell Rapids and Grindstone Butte irrigated sites and at Kimberly, Idaho during 1981.

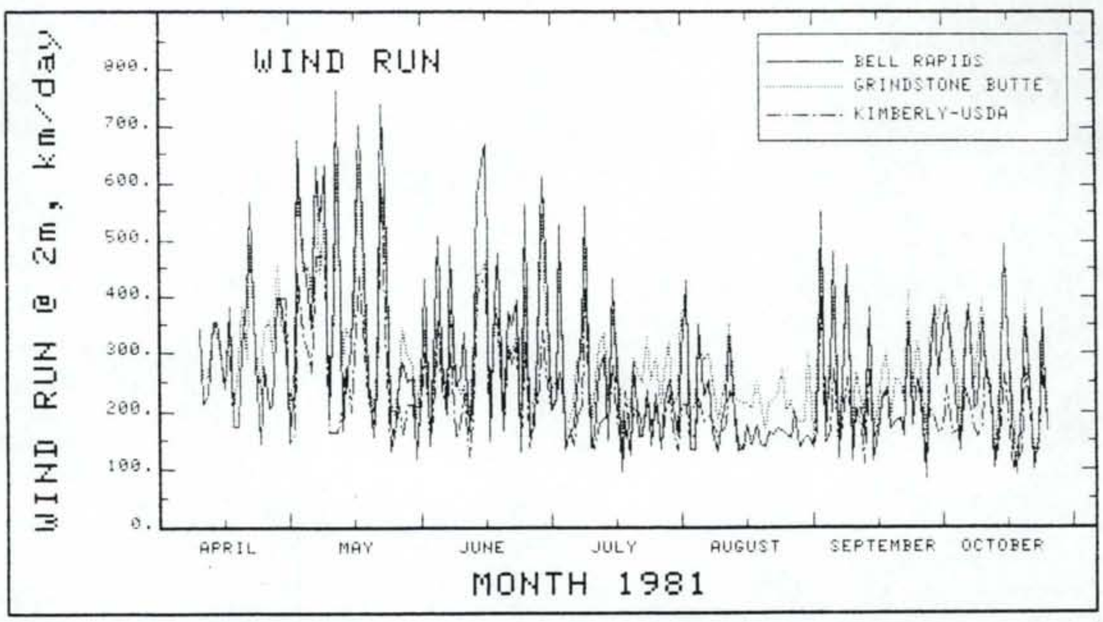

Figure 3. Daily wind run at Bell Rapids and Grindstone Butte irrigated sites and at Kimberly, Idaho during 1981.

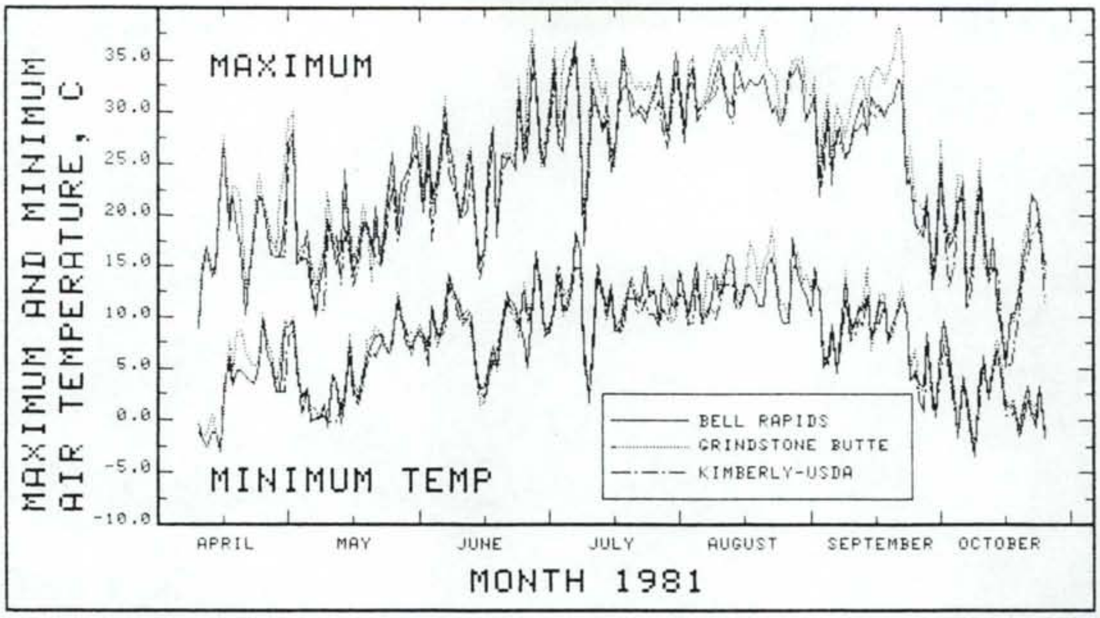

Figure 4. Daily maximum and minimum air temperatures at Bell Rapids and Grindstone Butte irrigated sites and at Kimberly, Idaho during 1981.

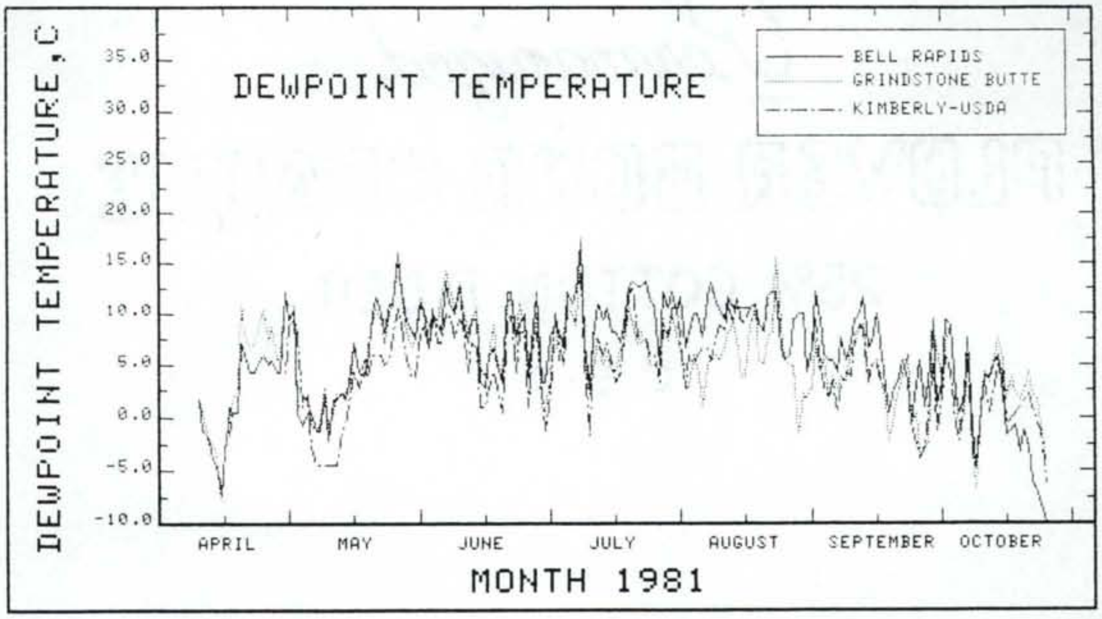

Figure 5. Daily dewpoint temperatures at Bell Rapids and Grindstone Butte irrigated sites and at Kimberly, Idaho during 1981.

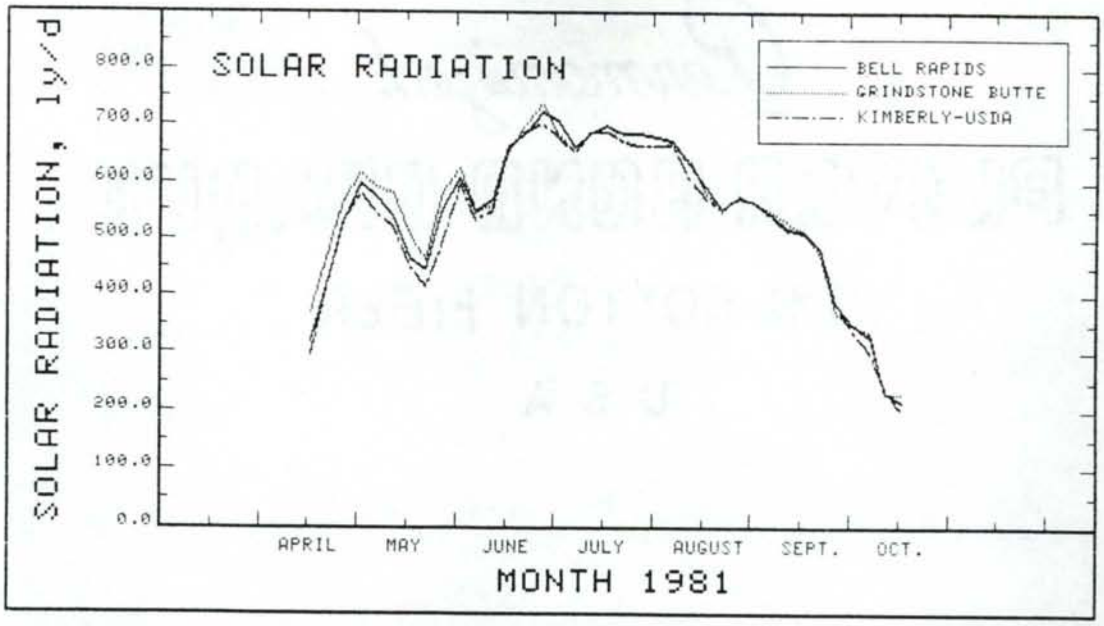

Figure 6. Ten-day average solar radiation at Bell Rapids and Grindstone Butte irrigated sites and at Kimberly, Idaho during 1981.

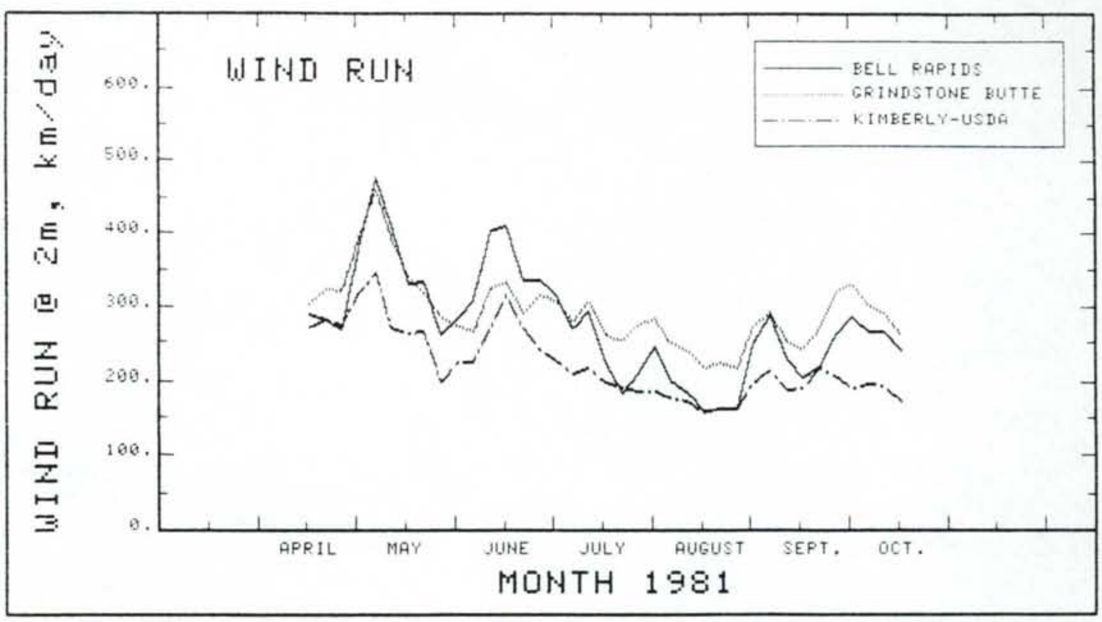

Figure 7. Ten-day average wind run at Bell Rapids and Grindstone Butte irrigated sites and at Kimberly, Idaho during 1981.

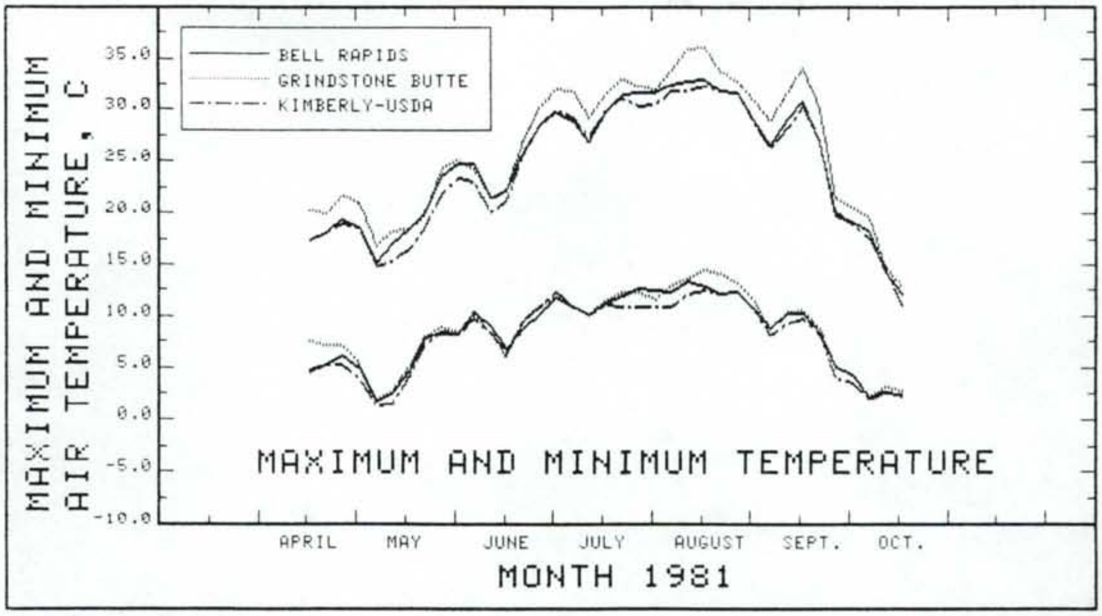

Figure 8. Ten-day average maximum and minimum air temperatures at Bell Rapids and Grindstone Butte irrigated sites and at Kimberly, Idaho during 1981.

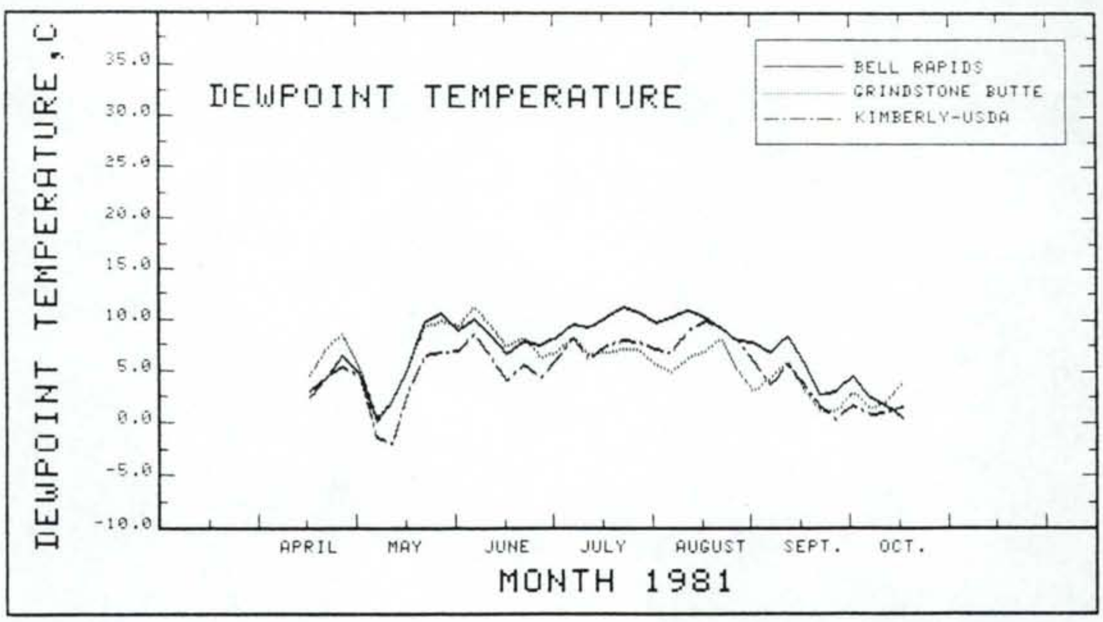

Figure 9. Ten-day average dewpoint temperatures at Bell Rapids and Grindstone Butte irrigated sites and at Kimberly, Idaho during 1981.

Table 2. Average values of measured weather parameters and estimated reference evapotranspiration. April 8 to October 22, 1981.

Parameter		Grindstone (site 1)	Bell Rapids (site 3)	Kimberly (site 5)
Solar Radiation, ly/day		545	539	524
		(+4%)*	(+3%)	
Windrun, miles/day		182	171	138
km/day		292	275	220
		(+33%)	(+25%)	
Maximum Air Temperature,	F	78.7	76.0	74.9
	C	25.9	24.5	23.8
		(+2.1C)**	(+0.7C)	
Minimum Air Temperature,	F	47.5	46.8	45.9
	C	8.6	8.2	7.7
		(+0.9C)	(+0.5C)	
Dewpoint Temperature,	F	42	44	41
	C	5.7	6.7	4.9
		(+0.8C)	(+1.8C)	
Ref. Evapotranspiration				
mm/day		7.4	6.5	6.2
mm/season		1390	1230	1170
in/season		54.8	48.6	46.1
		(+19%)	(+5%)	

* percent difference from measurements at Kimberly (site 5)

** difference in deg. Celsius from measurements at Kimberly

Bruneau plateau sites, which are nearer to the desert, throughout the 1981 irrigation season. Wind run at Bell Rapids (site 3) averaged 25% greater than at Kimberly, and wind run at Grindstone Butte (site 1) averaged 33% greater than at Kimberly. The lower values of wind run measured at the Kimberly site may be attributed to effects of windbreaks, buildings and cultivated fields in the vicinity of Kimberly. Established, irrigated farms and cities lie to the west of Kimberly, the predominant wind direction, for a distance of 40 kilometers.

Another contributing factor to higher speeds measured in the Bruneau Plateau area may be thermally induced turbulence in the desert regions surrounding the Grindstone and Bell Rapids sites. Strong heating of air at the arid, desert surfaces increases thermal updrafts and corresponding turbulent transport of air masses. Since the distance from sites 1 and 3 to the desert edge was 1 and 6 kilometers in an upwind (westerly) direction, at the Grindstone and Bell Rapids sites, the effect of desert wind would likely be sensed. Recorded wind run at Bell Rapids exceeded wind run at Grindstone during April, May and June. After early July measured wind runs were higher at the Grindstone site (Figure 7).

Air Temperature. Except for the period from mid May to early June, maximum daily air temperature at Bell Rapids was equal to maximum temperature at Kimberly (Figure 8). However, maximum daily air temperature at Grindstone was greater than at Bell Rapids and Kimberly from late June on. It was during this time that the alfalfa crop at the Grindstone site was underirrigated. This effect is discussed in a subsequent section. Average departure of maximum air temperature from

Kimberly during the irrigation season was 2.1 degrees Celsius at Grindstone and 0.7 degrees Celsius at Bell Rapids (Table 2). Essentially no difference in minimum daily air temperature was detected among the irrigated sites except during late July and early August (Figure 8).

Dewpoint. Ten-day running averages of dewpoint temperature at 0800 hours shown in Figure 9 indicate higher dewpoint temperatures (higher vapor pressures) at the Bell Rapids site than at the Grindstone site from July through September. This difference is attributed to the effect on dewpoint by the dry seed alfalfa crop at the Grindstone location. Dewpoint averaged 1.0 degrees Celsius higher at Bell Rapids than at Grindstone over the season.

Recorded dewpoint temperatures at Kimberly were lower than at the Bruneau Plateau sites during April, May and June and fluctuated in between Bell Rapids and Grindstone measurements during July and August. These results are surprising, since the Kimberly area is surrounded in all directions by more than 150,000 hectares of irrigated land which should contribute to the vapor pressure of the air and corresponding dewpoint at the Kimberly site. However, the weather site at Kimberly was located adjacent to moisture stress trials at the USDA research center during 1981. This may have influenced vapor pressure and air temperatures at the site, although this effect is not discernable in the maximum air temperature data plotted in Figure 8.

Another possible explanation of differences in dewpoint temperatures is the method of measurement used at each site. Dewpoint was measured directly at the Kimberly site, whereas it was calculated from air temperature and relative humidity measured at the Grindstone and Bell Rapids sites. Equipment bias in the dewpoint sensor at the Kimberly site or the relative humidity sensors at the Bell Rapids and Grindstone sites is possible. Relative humidity sensors at the Bruneau Plateau sites were checked at three week intervals using a sling psychrometer. Values recorded at the Bell Rapids site averaged 2% lower than the sling psychrometer measurements, with a standard deviation of 3%. Values of recorded relative humidity at the Grindstone site averaged 5% low with a standard deviation of 5% when compared to psychrometer readings. These values would indictate an even greater difference between dewpoint at Bell Rapids and dewpoint at Kimberly than was measured.

Reference Evapotranspiration Estimates for Irrigated Sites

Daily estimates of reference evapotranspiration (ET_r) were calculated for the Grindstone, Bell Rapids and Kimberly sites using a modified Penman combination equation and procedure adapted to Idaho conditions by Dr. J. L. Wright, USDA-ARS at Kimberly. This equation combines energy balance and mass transport theory in estimating evapotranspiration from an adequately watered, erect, disease-free alfalfa crop. Procedures for applying the Wright combination equation were reported by Wright (1982) and Burman et al (1980). Consumptive use by agricultural crops can be estimated by multiplying reference ET by crop coefficients developed by Wright (1981; 1982; Burman et al ,1980).

As shown in Figure 10, evapotranspiration demands fluctuate widely from day to day due to variability in wind run, solar radiation, air temperature and humidity. Ten-day running averages of reference evapotranspiration (ET_r) are plotted in Figure 11. Estimated ET_r at Bell Rapids was very similar to ET_r estimated for Kimberly during 1981, with Kimberly ET_r being occasionally lower. Lower wind movement at Kimberly was apparently counterbalanced by the greater vapor pressure deficits (lower dewpoint) at Kimberly as compared to Bell Rapids. Estimated ET_r at Bell Rapids was about 5% greater than ET_r estimated at Kimberly over the 1981 irrigation season.

As shown in Figure 11, ET_r at the Grindstone irrigated site increased over ET_r at Bell Rapids and Kimberly after about July 1. This increase in ET_r resulted from a siting effect, where an increase in maximum air temperature and a decrease in dewpoint temperature was brought about by underirrigation of the seed alfalfa crop. As a result of underirrigation, the seed crop experienced moisture stress and transpiration was reduced, resulting in increased conversion of radiant energy to sensible heat (air temperature) and decreased conversion to latent heat. Therefore, reference ET for the Grindstone site is felt to be overestimated for the months of July, August and September. Estimated ET_r for the season at Grindstone was 19% greater (220 millimeters) than at Kimberly (Table 2).

These results accentuate the likelihood of overestimation of ET_r and consumptive water use for areas where weather parameters used in calculating ET_r are not measured over an adequately watered alfalfa or grass crop located within an irrigated area. Results also indicate that

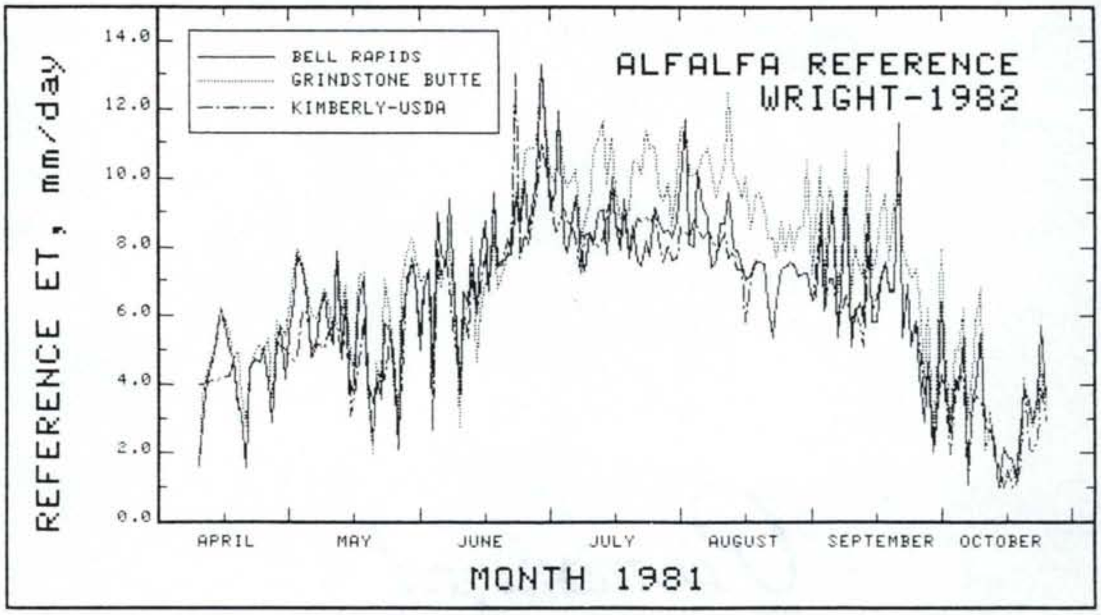

Figure 10. Estimated daily alfalfa reference evapotranspiration at Bell Rapids and Grindstone Butte irrigated sites and at Kimberly, Idaho during 1981.

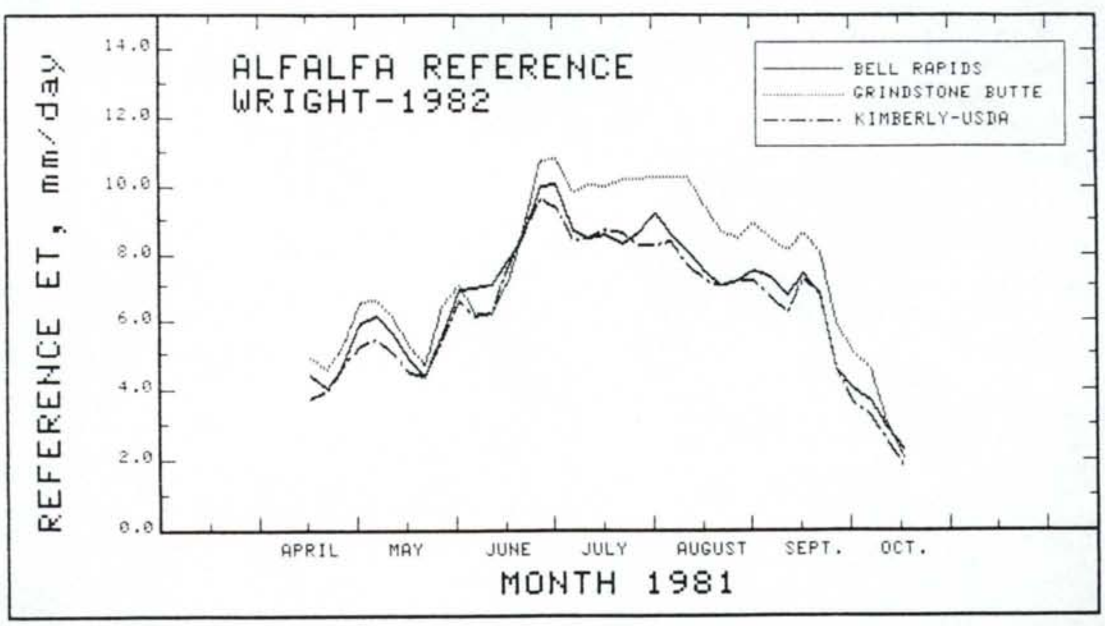

Figure 11. Ten-day average estimated alfalfa reference evapotranspiration at Bell Rapids and Grindstone Butte irrigated sites and at Kimberly, Idaho during 1981.

proximity of weather sites to large, nonirrigated areas has little effect on solar radiation, air temperature or dewpoint temperature, provided the weather site is located an adequate distance from the nonirrigated boundary. Wind speed, however, does decrease as distance from the nonirrigated boundary increases.

Effects of Irrigation on Air Temperature

Figures 12 through 14 are graphs showing the daily increase in maximum and minimum air temperatures measured over arid rangeland (sites 2 and 4) as compared to maximum and minimum air temperatures measured over irrigated alfalfa (sites 1 and 3). Maximum temperatures at the Grindstone irrigated site (1) were higher than maximum temperatures recorded at Bell Rapids (site 3) due to irrigation effects as previously discussed. Therefore, departure of maximum air temperature at the Grindstone desert site from the irrigated site would be expected to be less than for Bell Rapids. This effect is shown in Figure 12. However, the dryness of the Grindstone irrigated site had no effect on departure of minimum air temperature over arid rangeland from that measured over the seed alfalfa crop. This is probably due to sufficient transpiration by the seed alfalfa during nighttime hours to effectively lower nighttime air temperatures to levels measured at Bell Rapids.

Average departure of air temperatures at the Bell Rapids desert site from temperatures at the Bell Rapids irrigated site are summarized in Table 3 on a monthly basis. These averages should be representative of changes occuring in average air temperature when an arid site in

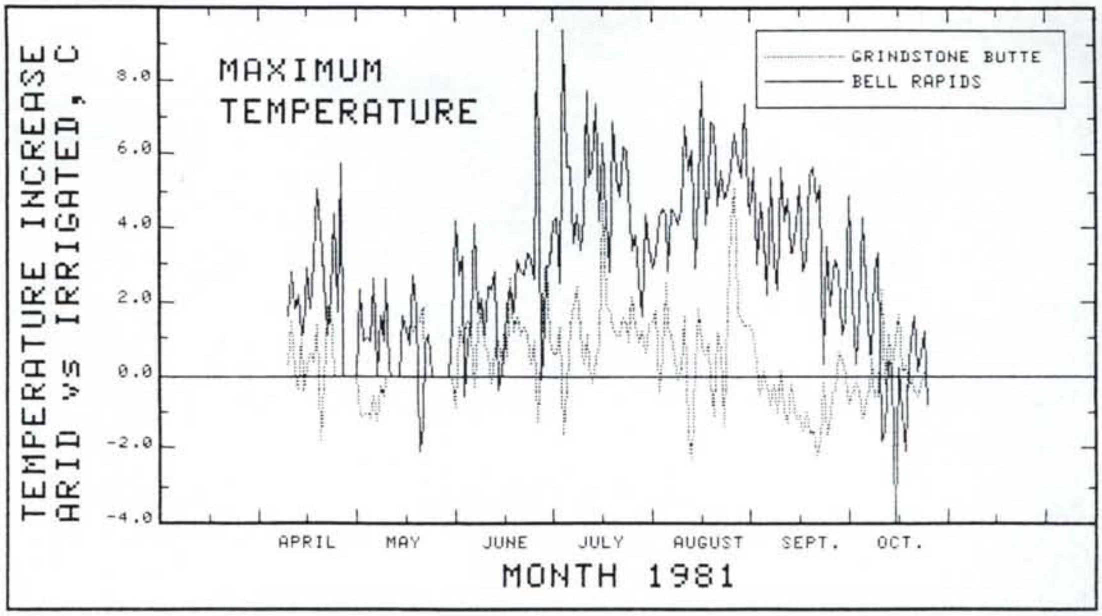

Figure 12. Daily increase in maximum air temperatures at desert sites over irrigated sites at Bell Rapids and Grindstone Butte during 1981.

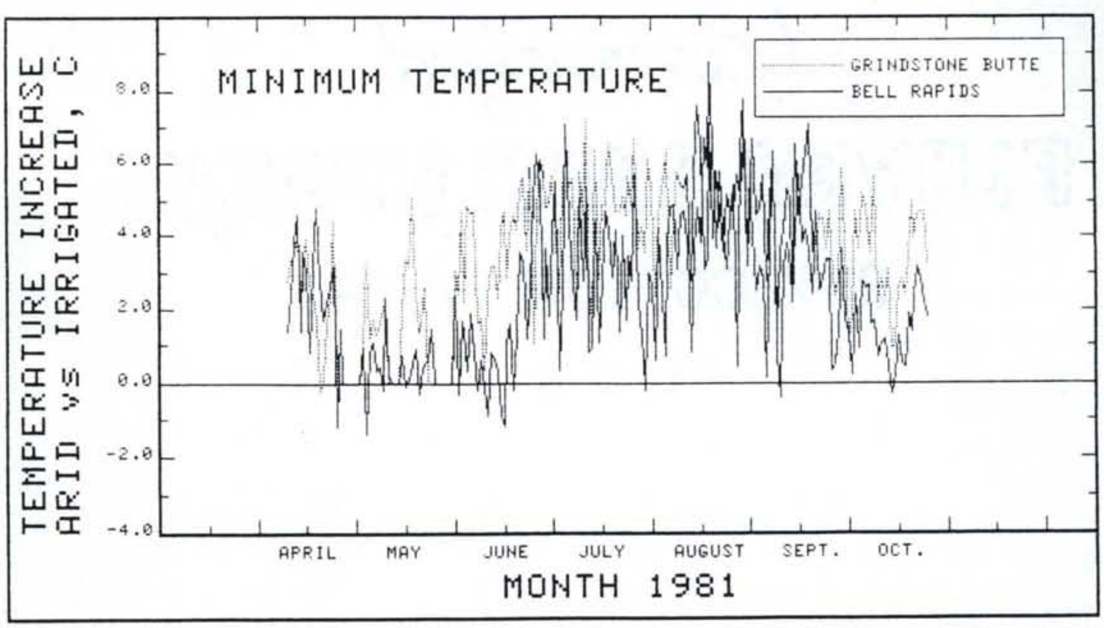

Figure 13. Daily increase in minimum air temperatures at desert sites over irrigated sites at Bell Rapids and Grindstone Butte during 1981.

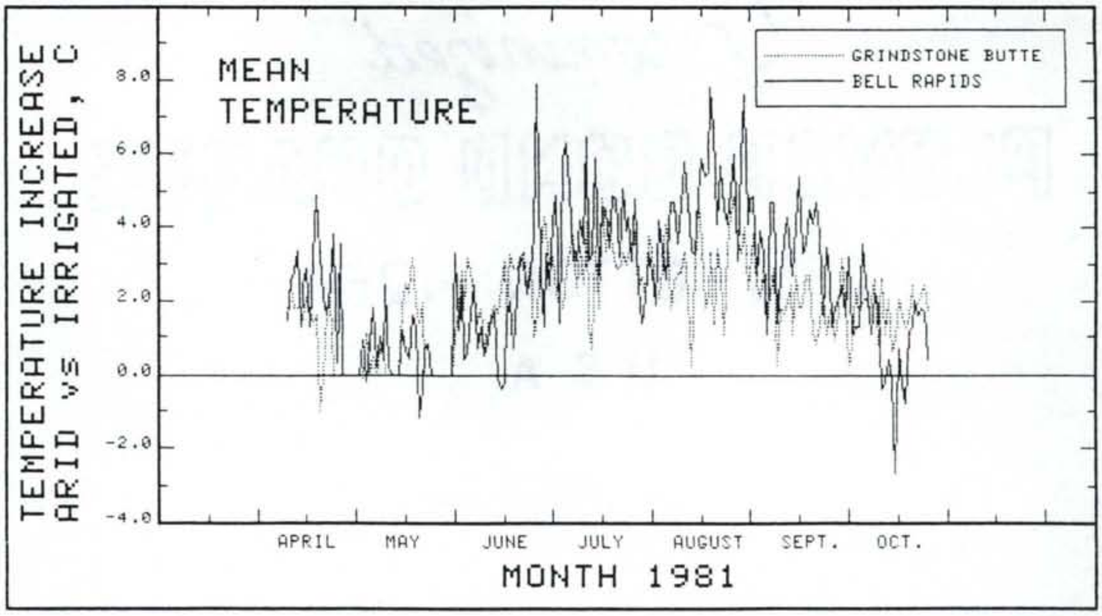

Figure 14. Daily increase in mean air temperature at desert sites over irrigated sites at Bell Rapids and Grindstone Butte during 1981.

Table 3. Average monthly departure of air temperatures over arid areas from air temperatures over irrigated areas at Bell Rapids and Grindstone Butte during 1981.

Month	Temperature Departure, C Maximum	Minimum	Average	Aridity
April	2.7*	2.4	2.5	1.0**
May	1.3	0.6	0.9	1.5
June	2.4	1.8	2.1	2.0
July	4.8	2.9	3.8	3.5
August	5.2	4.3	4.7	4.5
September	3.3	2.7	3.0	3.0
October	0.3	1.6	0.9	0.0

* difference between average of desert sites 2 and 4 and average of irrigated sites 1 and 3.

** smoothed aridity effect used to adjust mean air temperature data from NOAA stations, degrees Celsius.

southern Idaho is converted to irrigation. Departure of arid temperature from irrigated temperature in May is low due to precipitation during that month and the corresponding cooling effect of evapotranspiration from the rangeland areas.

Effect of Weather Station Aridity on ET_r Estimates

One desired result of this study was to show the effect of using air temperature and dewpoint (relative humidity) data measured over an arid site on estimates of ET_r for an irrigated region. This often occurs when weather information from stations sited at airports or near residential areas where streets, roads or adjacent, unirrigated areas is used to estimate consumptive use.

Air temperatures measured at arid sites are normally higher than for irrigated areas (Figure 13) and dewpoint temperatures are normally lower. To show the effect of an arid site on ET_r, ten-day running averages of ET_r were calculated using solar radiation, air temperature, wind run and dewpoint temperature measured at the Bell Rapids irrigated site (site 3). These calculations were compared with ET_r estimated using solar radiation and wind run from the Bell Rapids irrigated site and measured air temperature and estimated dewpoint temperature data for the Bell Rapids desert site (site 4). Results of this comparison are shown in Figure 15.

Dewpoint temperature at the desert site was estimated by calculating expected saturation vapor pressure at the desert site using

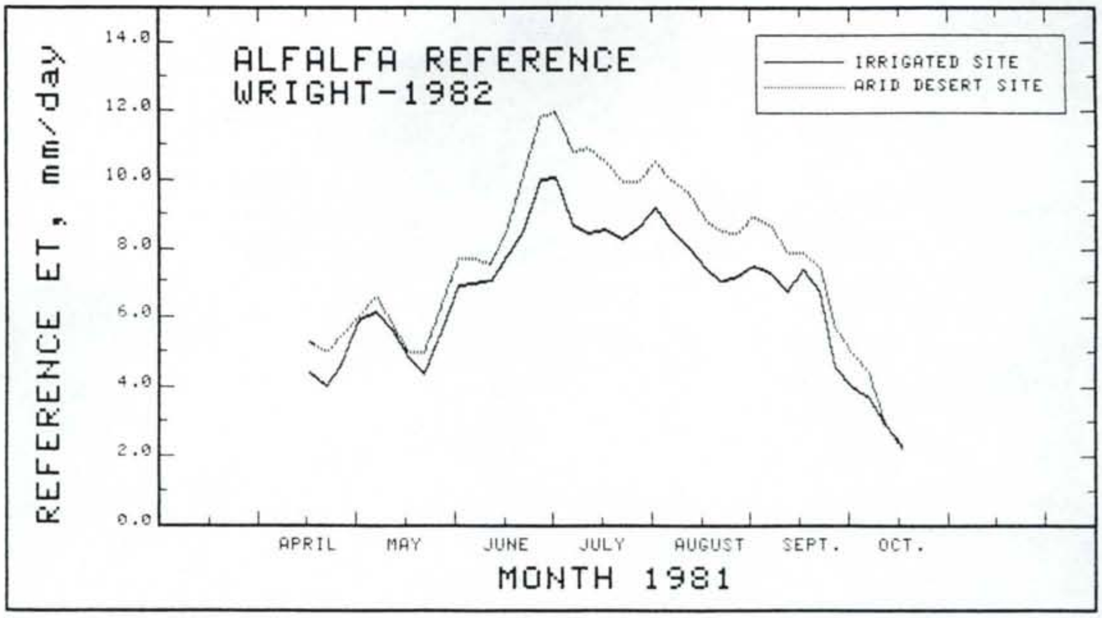

Figure 15. Ten-day alfalfa reference evapotranspiration calculated for Bell Rapids irrigated and desert sites during 1981 using Wright (1982).

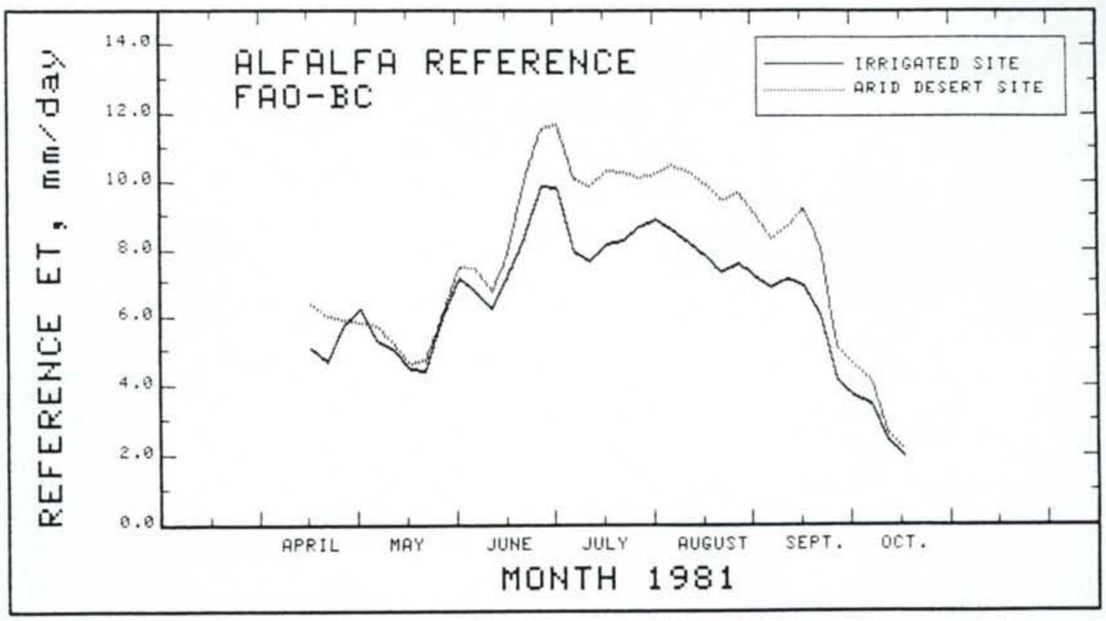

Figure 16. Ten-day alfalfa reference evapotranspiration calculated for Bell Rapids irrigated and desert sites during 1981 using the FAO-Blaney-Criddle with Kimberly alfalfa/FAO-BC reference ratios (Allen and Brockway, 1982) and elevation correction.

the following adiabatic pyschrometric relationship between latent and sensible heat:

$$(e_i - e_d) = G(T_d - T_i)$$

where:

e_i = saturation vapor pressure at dewpoint at the irrigated site, mb
e_d = estimated saturation vapor pressure at the desert site, mb
G = psychrometric constant, mb/^oK
T_i = average air temperature over irrigated areas, ^oK
T_d = average air temperature over desert, ^oK

The parameters T_d and T_i were measured parameters and e_i was calculated using measured relative humidity at the irrigated site. Estimated desert dewpoint was calculated as the temperature at which e_d is the saturation vapor pressure.

Estimated dewpoint temperatures for the desert sites were compared to dewpoint temperatures measured during station visits at three week intervals. Large amounts of scatter among estimated and measured dewpoints were found, although means were similar. Comparisons indicated that estimated dewpoint temperatures approximated measured values adequately enough to be used to represent expected dewpoint temperatures at the Bell Rapids desert site for demonstration of effects of aridity on estimation of ET_r.

As shown in Figure 15, ET_r estimated using measured air temperature and estimated dewpoint temperatures for the desert site exceeds estimated ET_r using weather parameters measured over the irrigated site throughout the irrigation season. Use of air and dewpoint temperatures from the arid site caused an overestimation of ET_r of 17% (210 millimeters) over the season and 21% (56mm) for the peak month of July. Reference evapotranspiration averaged 10.5 millimeters per day during July when air and dewpoint temperatures from the arid site were used and averaged 8.7 millimeters per day where air and dewpoint temperature data from the irrigated site were used. This difference (1.8 mm/day) caused by overestimation of ET_r can result in application of excess irrigation water when an irrigation scheduling program is followed, oversizing of irrigation delivery and application systems and the resulting waste of energy for pumping.

When the FAO-Blaney-Criddle grass reference ET equation (Doorenbos and Pruitt, 1977) was applied to the desert and irrigation data, results were similar. Grass reference ET (ETo) estimated using air and dewpoint temperature over desert exceeded ETo estimated using weather data measured over irrigated alfalfa by 21% (220 millimeters) over the season. Calculated FAO grass reference estimates, converted to an alfalfa reference using reference ratios presented by Allen and Brockway (1982), are shown in Figure 16.

SUMMARY AND CONCLUSIONS

Estimates of reference evapotranspiration (ET_r) calculated using weather data measured at Kimberly, Idaho and at an irrigated site located in the Bell Rapids Mutual Irrigation Project indicate that evapotranspirative demands at the two locations are very similar throughout the irrigation season (Figure 11). This result is important in that the large amount of daily weather and consumptive use information measured at the Kimberly site since 1965 for irrigation scheduling or for irrigation system sizing and design can be used in the Bell Rapids area and probably for areas further east and west of Kimberly. The Bell Rapids site is 65 kilometers north and west of Kimberly and 150 meters lower and is within 6 kilometers of a large region of arid, grass/sagebrush rangeland.

Estimates of ET_r calculated for the Grindstone irrigated site exceeded ET_r estimated for both Bell Rapids and Kimberly. This overestimation is most likely due to siting of the station at Grindstone over a drying, seed alfalfa field. No alfalfa hay was grown in the area. It is concluded from solar radiation and wind data measured at the Grindstone site that ET_r in this area closely follows that for Bell Rapids and Kimberly.

Comparison of air temperatures measured over the arid rangeland areas to air temperatures measured over irrigated alfalfa clearly shows the large increase in sensible heat of air over desert areas as compared to air over irrigated areas. This increase in sensible heat (temperature) results from a decrease in conversion of energy to latent heat (evaporation) as compared to conversion at irrigated sites.

Results emphasize the importance of using air temperature and humidity measurements from sites located over an adequately watered alfalfa or grass cover when estimating crop water requirements, whether for irrigation scheduling , irrigation and water resources planning or for review of water rights.

REFERENCES

1. Allen, R.G. and C.E. Brockway. 1982. Consumptive irrigation requirements for crops in Idaho. Final Technical Completion Report, Idaho Water and Energy Resources Research Institute, University of Idaho, Moscow, Idaho. 120 pages.

2. Burman, R.D., P.R. Nixon, J.L. Wright and W.O. Pruitt. 1980. Water requirements. pages 189-232 in M.E. Jensen, ed., Design and Operation of Farm Irrigation Systems. American Society of Agricultural Engineers Monograph 3. 2950 Niles Road, P.O. Box 410, St. Joseph, Michigan 49085.

3. Doorenbos, D. and W.O. Pruitt. 1977. Guidelines for predicting crop water requirements. Food and Agricultural Organization of the United Nations, FAO Irrigation and Drainage Paper 24. Rome, Italy. 144 pages.

4. Wright, J.L. 1981. Crop coefficients for estimates of daily crop evapotranspiration. In Irrigation Scheduling for Water and Energy Conservation in the 80's, Proceedings of the Irrigation Scheduling Conference of the American Society of Agricultural Engineers, Chicago, Il., Dec. 14-15, 1981. p 18-26.

5. Wright, J.L. 1982. New evapotranspiration crop coefficients. Proceedings of the American Society of Civil Engineers, Irrigation and Drainage Division, 108(IR2):57-74.

6. Wright, J.L. and J.L. Stevens. 1981. Hourly weather information measured at Kimberly, Idaho during 1981. Unpublished data. USDA-ARS Snake River Conservation Research Center, Kimberly, Idaho.

APPENDIX

Final Dialy Weather and Alfalfa

Reference Evapotranspiration

FINAL WEATHER AND ETR ESTIMATES FOR BELL RAPIDS 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY	
99	210.	214.	48.1	31.5	898.	35	1.67	
100	337.	131.	57.0	29.2	898.	30	2.83	
101	583.	142.	62.3	27.2	898.	29	4.16	
102	572.	221.	57.1	29.8	898.	25	4.72	
103	606.	222.	59.1	29.9	898.	24	5.30	
104	607.	180.	72.9	26.5	898.	19	6.16	
105	556.	149.	80.2	37.6	898.	26	5.72	
106	394.	238.	65.8	43.1	898.	34	4.96	
107	512.	109.	71.5	38.2	882.	33	4.77	MISSING, KIMBERLY SUB
108	254.	109.	65.4	40.8	882.	33	3.35	MISSING, KIMBERLY SUB
109	325.	193.	62.5	40.9	882.	45	3.19	MISSING, KIMBERLY SUB
110	110.	247.	50.4	40.0	882.	42	1.55	MISSING, KIMBERLY SUB
111	468.	353.	57.1	39.0	882.	40	4.45	MISSING, KIMBERLY SUB
112	587.	179.	64.5	38.4	882.	40	4.79	MISSING, KIMBERLY SUB
113	621.	91.	71.5	41.7	882.	42	4.67	MISSING, KIMBERLY SUB
114	526.	173.	70.4	50.1	882.	43	5.08	MISSING, KIMBERLY SUB
115	408.	127.	64.6	43.3	882.	41	4.04	MISSING, KIMBERLY SUB
116	241.	131.	60.9	42.4	882.	42	2.89	MISSING, KIMBERLY SUB
117	590.	248.	60.7	36.8	882.	40	5.27	MISSING, KIMBERLY SUB
118	590.	248.	60.7	36.8	882.	40	5.27	MISSING, KIMBERLY SUB
119	576.	199.	67.2	48.2	898.	54	4.49	
120	612.	103.	80.4	48.2	898.	49	5.35	
121	626.	147.	82.8	49.2	898.	51	6.29	
122	555.	422.	59.3	40.9	898.	33	7.76	
123	657.	295.	60.2	36.0	898.	31	7.32	
124	621.	254.	60.3	37.6	898.	33	6.44	
125	537.	215.	55.9	32.1	898.	33	4.80	
126	459.	393.	50.5	32.0	898.	30	5.12	
127	615.	332.	55.7	32.3	898.	30	6.12	
128	667.	394.	59.8	34.8	898.	36	6.65	
129	667.	116.	67.3	30.9	898.	28	5.72	
130	349.	254.	62.8	40.2	898.	35	5.15	
131	639.	478.	59.6	38.3	898.	35	7.85	
132	651.	105.	62.3	31.5	898.	36	5.07	
133	457.	157.	76.1	36.0	898.	35	6.39	
134	216.	193.	62.1	45.7	898.	40	3.68	
135	569.	278.	57.3	37.2	898.	45	4.09	
136	561.	439.	61.6	35.8	898.	40	6.54	
137	684.	270.	66.6	40.6	898.	39	7.09	
138	298.	159.	66.7	42.9	898.	41	4.20	
139	269.	98.	61.8	45.6	898.	50	2.29	
140	469.	149.	69.4	46.7	898.	53	4.15	
141	351.	463.	59.4	47.1	898.	50	3.58	
142	499.	370.	64.6	45.0	898.	47	5.77	
143	699.	111.	73.7	43.8	898.	52	5.59	
144	405.	97.	78.8	46.3	898.	52	4.62	
145	339.	157.	66.0	53.8	898.	61	2.09	
146	555.	178.	73.9	50.0	898.	54	5.70	
147	689.	156.	75.0	45.4	898.	49	6.88	
148	699.	162.	77.5	44.8	898.	47	7.46	
149	693.	74.	83.5	46.4	898.	46	7.14	

FINAL WEATHER AND ETR ESTIMATES FOR BELL RAPIDS 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY
150	368.	154.	74.9	47.7	898.	52	5.04
151	703.	269.	68.6	47.1	898.	51	6.81
152	694.	89.	82.2	44.9	898.	44	7.32
153	239.	183.	71.0	51.5	898.	49	4.40
154	710.	317.	74.9	47.4	898.	48	8.98
155	656.	183.	79.4	46.5	898.	47	7.85
156	678.	124.	86.7	52.5	898.	56	7.41
157	557.	307.	80.5	57.8	898.	52	9.38
158	451.	152.	76.3	53.9	898.	50	6.52
159	288.	162.	68.0	52.2	898.	55	3.69
160	619.	211.	68.6	50.6	898.	49	6.71
161	509.	106.	76.8	51.5	898.	45	6.38
162	711.	151.	78.9	50.0	898.	49	7.82
163	602.	361.	65.7	41.4	898.	49	6.19
164	682.	387.	59.3	37.6	898.	38	7.84
165	682.	419.	62.4	38.1	898.	37	8.73
166	738.	92.	76.5	41.0	898.	43	6.79
167	503.	242.	83.6	45.1	898.	44	9.35
168	654.	299.	64.5	41.8	898.	41	7.51
169	654.	112.	78.4	48.7	898.	38	7.60
170	703.	233.	77.9	52.6	898.	54	7.78
171	693.	218.	78.1	53.0	898.	54	7.77
172	717.	246.	76.1	51.9	898.	46	9.41
173	742.	81.	90.4	49.1	898.	48	8.49
174	741.	352.	77.4	45.8	898.	50	9.95
175	736.	97.	79.0	41.6	898.	39	8.43
176	656.	110.	97.1	53.4	898.	48	9.41
177	716.	198.	89.5	61.8	898.	54	10.03
178	713.	383.	77.7	53.4	898.	38	13.27
179	733.	292.	76.6	47.8	898.	38	11.61
180	728.	128.	85.4	48.6	898.	46	9.03
181	644.	139.	94.3	52.1	898.	48	9.60
182	724.	328.	80.5	57.4	898.	47	11.96
183	701.	85.	79.1	51.5	898.	44	8.12
184	691.	97.	89.8	51.3	898.	54	7.85
185	712.	110.	94.7	55.2	898.	52	8.86
186	529.	143.	98.5	65.2	898.	54	9.48
187	577.	217.	83.0	61.9	898.	63	7.62
188	568.	349.	62.8	42.9	898.	45	7.25
189	722.	87.	79.2	36.9	898.	37	8.44
190	718.	102.	87.1	42.5	898.	46	8.08
191	714.	170.	87.2	57.5	898.	52	8.96
192	698.	186.	82.7	53.4	898.	49	9.10
193	715.	94.	84.7	52.1	898.	51	7.77
194	705.	268.	75.5	56.0	898.	47	10.04
195	726.	173.	78.7	49.0	898.	47	8.69
196	726.	60.	90.2	47.5	898.	45	7.91
197	620.	112.	97.0	51.5	898.	48	9.36
198	693.	77.	88.6	53.7	898.	55	7.70
199	690.	176.	85.3	53.4	898.	56	8.61
200	704.	97.	86.2	53.4	898.	55	7.57

FINAL WEATHER AND ETR ESTIMATES FOR BELL RAPIDS 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY	
201	705.	100.	85.8	52.8	898.	55	7.45	
202	694.	148.	84.0	59.0	898.	56	8.17	
203	707.	88.	86.9	53.7	898.	53	7.71	
204	701.	142.	88.9	54.9	898.	51	9.14	
205	647.	85.	93.1	49.7	898.	41	8.61	
206	688.	135.	87.3	56.1	898.	54	8.43	
207	678.	158.	82.1	54.7	898.	51	8.48	
208	693.	129.	88.0	53.4	898.	54	8.29	
209	672.	100.	96.7	52.6	898.	50	8.72	
210	661.	186.	90.8	58.2	898.	53	9.86	
211	682.	266.	83.0	54.0	898.	44	11.71	
212	686.	84.	91.2	50.5	898.	47	8.08	
213	685.	83.	93.9	55.8	898.	50	8.05	
214	675.	219.	86.1	59.7	898.	50	10.24	
215	671.	140.	86.9	49.2	898.	46	9.15	
216	654.	158.	87.9	51.4	898.	53	8.85	
217	655.	103.	89.1	52.1	898.	56	7.36	
218	674.	80.	92.7	57.4	898.	52	7.70	
219	663.	112.	94.9	53.7	898.	51	8.70	
220	670.	137.	89.7	56.5	898.	49	8.70	
221	569.	206.	87.9	61.2	898.	53	9.58	
222	643.	118.	87.0	60.6	898.	51	7.97	
223	651.	81.	94.8	53.4	898.	51	7.94	
224	650.	85.	91.8	52.3	898.	51	7.43	
225	496.	110.	89.6	55.2	898.	51	7.00	
226	569.	91.	91.6	55.9	882.	51	7.18	MISSING, KIMBERLY SUB
227	587.	111.	90.9	54.3	882.	52	7.64	MISSING, KIMBERLY SUB
228	622.	91.	90.6	52.1	882.	48	7.57	MISSING, KIMBERLY SUB
229	613.	87.	92.7	52.3	882.	47	7.55	MISSING, KIMBERLY SUB
230	476.	104.	89.8	59.3	882.	53	6.42	MISSING, KIMBERLY SUB
231	358.	102.	85.9	60.6	882.	54	5.39	MISSING, KIMBERLY SUB
232	506.	108.	87.3	56.6	882.	54	6.49	MISSING, KIMBERLY SUB
233	593.	106.	83.9	50.5	882.	44	7.32	MISSING, KIMBERLY SUB
234	603.	102.	85.7	48.9	882.	42	7.37	MISSING, KIMBERLY SUB
235	604.	95.	93.1	49.2	882.	43	7.57	MISSING, KIMBERLY SUB
236	565.	125.	92.5	64.2	882.	49	7.52	MISSING, KIMBERLY SUB
237	596.	86.	94.3	57.5	882.	50	7.12	MISSING, KIMBERLY SUB
238	581.	96.	90.7	55.0	882.	50	7.22	MISSING, KIMBERLY SUB
239	572.	98.	84.3	53.9	882.	40	7.22	MISSING, KIMBERLY SUB
240	516.	87.	87.1	50.5	882.	44	6.49	MISSING, KIMBERLY SUB
241	561.	105.	88.8	56.7	898.	54	6.55	
242	556.	344.	71.6	54.5	898.	49	8.58	
243	572.	101.	78.6	41.3	898.	43	6.27	
244	561.	171.	86.3	43.8	898.	42	8.49	
245	560.	301.	75.0	48.9	898.	42	9.30	
246	555.	73.	81.3	40.9	898.	40	5.36	
247	500.	153.	83.6	47.4	898.	46	6.72	
248	495.	285.	77.9	56.8	898.	42	9.61	
249	535.	71.	79.7	48.7	898.	45	5.12	
250	530.	125.	83.5	48.3	898.	49	6.11	
251	531.	127.	86.3	52.1	898.	50	6.43	

FINAL WEATHER AND ETR ESTIMATES FOR BELL RAPIDS 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY	
252	515.	100.	88.0	51.5	898.	53	5.83	
253	504.	238.	82.0	54.1	898.	44	8.94	
254	514.	72.	88.7	46.5	898.	45	5.81	
255	520.	101.	86.7	49.7	898.	50	5.87	
256	505.	139.	87.0	53.2	898.	45	6.98	
257	514.	151.	85.5	52.5	882.	37	7.59	MISSING, KIMBERLY SUB
258	507.	108.	87.1	45.6	882.	33	6.82	MISSING, KIMBERLY SUB
259	501.	115.	87.7	49.6	882.	37	6.74	MISSING, KIMBERLY SUB
260	492.	119.	91.5	51.5	882.	39	11.58	MISSING, KIMBERLY SUB
261	475.	100.	90.7	53.5	882.	42	5.36	MISSING, KIMBERLY SUB
262	455.	221.	73.5	50.7	882.	38	6.91	MISSING, KIMBERLY SUB
263	450.	111.	74.7	38.8	882.	31	5.13	MISSING, KIMBERLY SUB
264	486.	160.	66.6	40.9	882.	32	5.89	MISSING, KIMBERLY SUB
265	452.	144.	65.7	38.5	898.	42	4.32	
266	340.	53.	64.4	38.1	898.	34	2.90	
267	328.	158.	70.0	47.4	898.	38	4.66	
268	368.	240.	57.1	37.3	898.	49	2.01	
269	168.	164.	58.3	32.9	898.	34	2.89	
270	417.	215.	76.1	44.5	898.	38	6.44	
271	383.	238.	67.3	49.7	898.	49	4.14	
272	247.	185.	62.4	43.7	898.	48	2.59	
273	427.	120.	64.9	36.3	898.	36	4.15	
274	432.	82.	70.2	28.9	898.	33	3.82	
275	372.	203.	71.5	39.4	898.	36	5.35	
276	231.	243.	53.9	35.2	898.	46	1.32	
277	408.	127.	57.9	29.1	898.	30	3.59	
278	382.	131.	63.0	25.9	898.	24	4.00	
279	321.	225.	73.1	40.8	898.	34	5.46	
280	121.	170.	64.2	42.1	898.	39	2.78	
281	293.	151.	56.7	35.8	898.	39	2.72	
282	279.	63.	64.2	41.3	898.	41	2.40	
283	79.	115.	51.6	44.5	898.	43	1.02	
284	101.	309.	47.0	38.6	898.	36	2.18	
285	99.	198.	41.6	34.7	898.	29	1.91	
286	223.	89.	50.8	34.1	898.	32	1.80	
287	151.	57.	50.7	34.3	898.	31	1.30	
288	316.	138.	54.3	29.5	898.	26	2.77	
289	304.	227.	60.6	31.5	898.	30	3.81	
290	363.	145.	64.1	35.6	898.	27	3.54	
291	364.	62.	71.9	33.3	898.	21	2.93	
292	364.	93.	69.9	30.7	898.	19	3.67	
293	348.	236.	63.8	38.0	898.	17	5.72	
294	346.	105.	59.5	29.8	898.	11	3.62	

FINAL ETR ESTIMATES FOR GRINDSTONE BUTTE 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY
99	203.	202.	49.0	30.0	907.	35	1.62
100	478.	161.	59.3	29.1	907.	32	3.64
101	581.	161.	62.4	29.6	907.	29	4.41
102	608.	219.	57.7	33.3	907.	27	4.93
103	638.	207.	57.6	30.0	907.	26	5.07
104	625.	176.	73.4	26.2	907.	18	6.26
105	571.	147.	81.9	34.9	907.	27	5.92
106	448.	221.	67.9	46.1	907.	32	5.48
107	475.	120.	73.3	40.6	907.	35	4.73
108	329.	180.	73.0	47.4	907.	37	4.99
109	291.	241.	70.7	47.9	907.	52	3.68
110	308.	183.	55.3	44.3	907.	45	2.80
111	557.	307.	57.3	42.6	907.	44	4.54
112	607.	191.	66.7	41.4	907.	45	4.94
113	638.	144.	75.3	43.1	907.	49	5.18
114	525.	212.	70.9	50.8	907.	51	4.90
115	522.	226.	66.9	45.3	907.	45	5.39
116	361.	188.	63.7	44.5	907.	48	3.63
117	664.	285.	61.9	38.3	907.	42	5.80
118	557.	223.	71.2	41.9	907.	43	5.72
119	593.	196.	76.1	49.4	907.	53	5.40
120	619.	130.	84.8	48.4	907.	52	6.12
121	637.	175.	86.0	50.3	907.	52	7.23
122	551.	392.	61.0	43.1	907.	34	7.99
123	688.	280.	62.8	33.1	907.	32	7.48
124	640.	284.	62.6	36.8	907.	36	6.74
125	569.	249.	60.6	34.0	907.	31	6.06
126	446.	386.	54.8	34.2	907.	30	5.96
127	637.	273.	58.6	32.5	907.	31	6.15
128	706.	346.	62.6	33.3	907.	37	6.80
129	690.	134.	71.9	33.6	907.	30	6.45
130	354.	234.	64.1	38.9	907.	33	5.42
131	687.	395.	62.3	39.1	907.	36	7.93
132	660.	174.	64.5	33.3	907.	36	6.01
133	642.	214.	70.5	34.3	907.	36	6.90
134	243.	203.	66.2	47.4	907.	38	4.78
135	570.	237.	59.7	38.3	907.	45	4.48
136	619.	396.	63.7	36.8	907.	40	7.12
137	706.	227.	69.8	37.8	907.	39	7.22
138	301.	153.	66.0	46.0	907.	44	3.92
139	253.	125.	56.3	46.5	907.	49	2.01
140	543.	172.	66.6	48.2	907.	51	4.61
141	350.	373.	61.4	47.4	907.	49	3.98
142	635.	315.	66.8	46.2	907.	45	7.02
143	690.	135.	74.7	44.3	907.	50	6.13
144	385.	122.	75.1	45.6	907.	52	4.20
145	318.	158.	68.4	54.5	907.	59	2.74
146	670.	217.	73.2	51.0	907.	53	6.85
147	715.	185.	75.8	46.7	907.	47	7.83
148	711.	176.	77.6	47.4	907.	44	8.26
149	700.	118.	83.1	46.9	907.	46	7.72

FINAL ETR ESTIMATES FOR GRINDSTONE BUTTE 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY
150	415.	174.	83.6	48.9	907.	53	6.98
151	733.	214.	70.1	46.7	907.	50	7.12
152	703.	104.	81.3	43.6	907.	48	7.23
153	226.	157.	68.8	51.5	907.	50	3.73
154	722.	226.	73.3	44.7	907.	49	7.53
155	654.	168.	77.6	47.7	907.	52	6.86
156	692.	151.	89.0	50.6	907.	58	7.78
157	630.	234.	77.7	56.6	907.	55	7.84
158	433.	155.	75.7	54.3	907.	51	6.28
159	215.	142.	66.5	53.4	907.	56	2.81
160	647.	152.	70.0	48.8	907.	51	6.14
161	483.	114.	78.4	50.3	907.	47	6.32
162	714.	178.	79.7	47.8	907.	49	8.26
163	534.	274.	64.4	40.8	907.	51	4.71
164	676.	272.	59.3	34.9	907.	41	6.16
165	681.	290.	62.4	35.0	907.	39	6.98
166	729.	121.	76.1	38.8	907.	43	6.88
167	507.	223.	83.4	44.8	907.	48	8.37
168	652.	212.	64.9	40.7	907.	41	6.76
169	653.	108.	78.6	47.4	907.	41	7.23
170	694.	196.	78.6	53.4	907.	52	7.84
171	724.	187.	78.7	52.0	907.	53	7.86
172	751.	208.	78.1	51.5	907.	45	9.59
173	758.	108.	91.5	46.4	907.	52	8.78
174	769.	259.	79.3	56.1	907.	48	10.68
175	771.	132.	92.3	51.5	907.	42	10.84
176	672.	135.	100.0	53.0	907.	45	10.86
177	736.	196.	90.7	59.7	907.	50	10.92
178	708.	340.	76.6	53.4	907.	34	13.24
179	711.	230.	80.2	47.0	907.	33	11.63
180	726.	149.	86.9	48.7	907.	39	10.12
181	544.	160.	97.0	53.0	907.	50	9.77
182	597.	285.	82.6	56.7	907.	42	11.70
183	707.	113.	94.9	50.5	907.	47	10.06
184	710.	115.	96.6	53.0	907.	51	9.74
185	707.	131.	97.5	56.4	907.	50	10.00
186	465.	177.	96.5	63.0	907.	48	10.29
187	566.	189.	87.6	62.0	907.	64	8.12
188	649.	311.	65.8	44.6	907.	43	8.69
189	725.	109.	83.4	36.8	907.	36	9.26
190	714.	137.	96.1	42.8	907.	40	10.64
191	689.	200.	91.7	57.4	907.	46	11.09
192	675.	210.	88.3	55.2	907.	41	11.70
193	711.	135.	91.1	49.4	907.	43	9.84
194	718.	237.	79.5	54.9	907.	40	11.18
195	720.	199.	76.6	49.1	907.	40	9.59
196	723.	101.	89.6	49.2	907.	44	8.80
197	573.	115.	94.7	52.2	907.	45	8.79
198	685.	124.	93.7	54.8	907.	51	9.05
199	685.	182.	91.0	55.5	907.	48	10.48
200	696.	162.	90.0	54.5	907.	45	10.41

FINAL ETR ESTIMATES FOR GRINDSTONE BUTTE 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY
201	698.	156.	91.1	52.8	907.	47	10.09
202	677.	204.	89.5	58.7	907.	45	11.40
203	691.	157.	91.4	54.7	907.	41	10.85
204	688.	184.	88.0	55.1	907.	41	10.87
205	618.	131.	92.7	49.0	907.	40	9.49
206	618.	166.	88.3	57.3	907.	49	9.35
207	679.	201.	82.9	53.2	907.	45	9.81
208	682.	129.	89.0	49.6	907.	50	8.59
209	662.	142.	96.5	50.0	907.	46	9.88
210	642.	231.	89.3	58.4	907.	44	11.40
211	617.	247.	81.7	53.8	907.	37	11.51
212	675.	125.	93.7	49.9	907.	37	10.10
213	675.	133.	96.0	54.5	907.	43	10.09
214	651.	197.	85.5	56.6	907.	41	10.17
215	665.	181.	87.6	49.7	907.	34	10.62
216	661.	187.	89.1	58.5	907.	41	10.84
217	663.	157.	93.1	56.9	907.	42	10.29
218	666.	118.	96.2	57.6	907.	43	9.43
219	653.	134.	97.7	55.3	907.	42	9.91
220	665.	163.	95.1	58.5	907.	44	10.44
221	573.	219.	96.9	58.7	907.	47	12.48
222	651.	141.	96.1	58.0	907.	48	10.10
223	648.	135.	97.7	55.6	907.	46	9.98
224	624.	134.	94.8	53.4	907.	39	9.36
225	573.	134.	99.6	54.3	907.	39	10.10
226	442.	128.	96.0	63.5	907.	48	8.54
227	593.	158.	95.3	60.9	907.	51	9.54
228	599.	138.	97.3	55.3	907.	42	9.60
229	588.	106.	101.0	59.9	907.	41	9.07
230	481.	134.	93.9	60.6	907.	46	8.27
231	339.	138.	92.8	65.7	907.	47	8.26
232	541.	141.	92.5	58.6	907.	60	7.66
233	593.	169.	85.8	52.6	907.	48	8.76
234	603.	126.	84.6	52.5	907.	42	7.90
235	604.	135.	90.8	49.6	907.	41	8.63
236	565.	118.	94.9	57.8	907.	41	7.95
237	596.	115.	95.3	61.9	907.	29	8.60
238	581.	115.	95.7	55.9	907.	36	8.61
239	572.	189.	89.5	57.3	907.	35	10.61
240	516.	99.	88.7	55.0	907.	37	7.16
241	554.	159.	92.1	58.0	907.	45	8.74
242	551.	307.	75.4	53.7	907.	40	10.31
243	574.	98.	83.1	43.3	907.	42	6.84
244	562.	191.	88.8	42.7	907.	35	9.73
245	571.	250.	77.5	48.9	907.	39	9.32
246	566.	100.	87.4	40.9	907.	37	6.72
247	506.	154.	85.3	46.0	907.	39	7.51
248	526.	268.	81.8	58.3	907.	38	10.79
249	544.	103.	85.8	46.5	907.	44	6.49
250	539.	168.	88.8	49.4	907.	44	8.07
251	537.	138.	91.4	51.4	907.	48	7.32

FINAL ETR ESTIMATES FOR GRINDSTONE BUTTE 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY
252	525.	120.	92.3	51.8	907.	48	7.06
253	527.	221.	87.0	59.2	907.	39	10.40
254	528.	105.	92.1	44.1	907.	41	7.10
255	521.	131.	93.9	50.7	907.	42	7.80
256	508.	165.	93.7	54.1	907.	39	8.90
257	510.	189.	90.8	54.4	907.	35	9.55
258	508.	113.	92.8	45.3	907.	28	7.63
259	495.	159.	95.7	47.5	907.	33	9.25
260	489.	156.	101.0	53.1	907.	37	9.60
261	463.	133.	99.1	55.7	907.	39	7.98
262	431.	256.	74.3	49.9	907.	43	7.41
263	415.	139.	79.8	41.3	907.	31	7.08
264	491.	201.	70.9	44.6	907.	33	7.39
265	462.	170.	69.9	37.3	907.	26	6.51
266	325.	100.	68.8	37.8	907.	27	4.16
267	345.	198.	70.8	44.9	907.	28	6.29
268	357.	238.	59.3	36.3	907.	47	2.66
269	140.	223.	61.0	33.1	907.	32	3.90
270	370.	253.	81.4	45.0	907.	39	7.98
271	388.	242.	68.9	49.6	907.	45	5.07
272	286.	196.	64.4	41.5	907.	48	2.96
273	441.	168.	65.8	37.4	907.	36	5.00
274	447.	113.	75.1	29.7	907.	30	5.01
275	354.	209.	75.2	40.3	907.	33	6.24
276	278.	242.	57.7	37.2	907.	42	2.96
277	421.	148.	59.1	31.5	907.	26	4.35
278	403.	193.	67.0	25.8	907.	20	5.78
279	303.	250.	78.0	40.1	907.	34	6.87
280	104.	168.	59.9	40.8	907.	40	2.07
281	290.	135.	56.4	36.8	907.	38	2.75
282	270.	80.	64.1	41.5	907.	41	2.49
283	85.	153.	53.7	46.3	907.	46	1.03
284	105.	291.	46.4	41.0	907.	42	1.08
285	89.	207.	42.0	35.4	907.	35	1.27
286	258.	125.	50.8	34.7	907.	39	1.67
287	144.	73.	49.5	35.6	907.	36	1.11
288	379.	130.	56.5	29.8	907.	35	2.47
289	367.	247.	64.1	32.0	907.	36	4.03
290	363.	159.	67.7	37.9	907.	40	3.26
291	364.	73.	71.1	34.7	907.	36	2.75
292	363.	100.	70.6	34.5	907.	35	3.38
293	340.	199.	66.8	37.6	907.	32	4.64
294	352.	131.	56.8	29.1	907.	25	3.31

FINAL WEATHER AND ETR ESTIMATES FOR KIMBERLY 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY	
99								
100								
101								
102	NO DATA RECORDED DURING THIS PERIOD							
103								
104								
105								
106	274.	185.	65.5	41.5	882.	29	4.24	
107	512.	109.	71.5	38.2	882.	33	4.70	
108	254.	109.	65.4	40.8	882.	33	3.24	
109	325.	193.	62.5	40.9	882.	45	3.16	
110	110.	247.	50.4	40.0	882.	42	1.55	
111	468.	353.	57.1	39.0	882.	40	4.45	
112	587.	179.	64.5	38.4	882.	40	4.79	
113	621.	91.	71.5	41.7	882.	42	4.67	
114	526.	173.	70.4	50.1	882.	43	5.08	
115	408.	127.	64.6	43.3	882.	41	4.04	
116	241.	131.	60.9	42.4	882.	42	2.89	
117	590.	248.	60.7	36.8	882.	40	5.27	
118	590.	248.	60.7	36.8	882.	40	5.27	MISSING (ESTIMATED)
119	590.	248.	60.7	36.8	882.	40	5.27	MISSING (ESTIMATED)
120	607.	91.	78.3	46.9	882.	48	5.72	
121	484.	103.	81.6	47.6	882.	49	4.80	
122	564.	274.	61.6	42.0	882.	47	4.84	
123	661.	207.	60.1	33.2	882.	34	6.16	
124	613.	189.	65.5	37.7	882.	36	6.05	
125	508.	168.	57.6	31.9	882.	27	5.01	
126	392.	295.	51.3	32.8	882.	24	5.21	
127	392.	295.	51.3	32.8	882.	24	5.21	MISSING (ESTIMATED)
128	392.	295.	51.3	32.8	882.	24	5.21	MISSING (ESTIMATED)
129	667.	103.	64.8	31.6	882.	24	5.83	
130	667.	103.	64.8	31.6	882.	24	5.83	MISSING (ESTIMATED)
131	667.	103.	64.8	31.6	882.	24	5.83	MISSING (ESTIMATED)
132	561.	129.	56.0	34.6	882.	30	4.61	
133	663.	173.	66.1	37.0	882.	31	6.39	
134	215.	124.	61.0	43.1	882.	36	3.13	
135	427.	190.	55.6	36.1	882.	40	3.67	
136	394.	270.	59.2	34.6	882.	37	4.73	
137	682.	190.	66.3	39.5	882.	42	5.94	
138	333.	137.	65.9	41.8	882.	39	4.05	
139	334.	112.	63.0	44.0	882.	43	3.45	
140	438.	147.	60.3	43.3	882.	43	4.14	
141	269.	370.	58.9	45.3	882.	43	4.36	
142	277.	218.	62.1	45.1	882.	41	4.18	
143	619.	79.	69.5	44.4	882.	42	5.37	
144	499.	99.	72.9	46.7	882.	47	5.00	
145	251.	129.	63.7	52.5	882.	51	2.80	
146	398.	102.	66.8	49.4	882.	48	4.13	
147	679.	131.	73.3	47.8	882.	42	7.06	
148	693.	131.	76.5	43.5	882.	39	7.67	

FINAL WEATHER AND ETR ESTIMATES FOR KIMBERLY 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY
149	674.	82.	78.5	46.2	882.	39	7.09
150	371.	139.	76.9	46.7	882.	47	5.47
151	704.	187.	69.3	46.3	882.	48	6.80
152	681.	90.	78.1	41.8	882.	44	6.99
153	205.	123.	63.6	52.3	882.	51	2.70
154	702.	224.	72.6	47.2	882.	45	7.94
155	638.	149.	76.0	46.9	882.	45	7.19
156	674.	123.	84.1	47.8	882.	50	7.56
157	554.	189.	75.4	55.9	882.	50	6.93
158	393.	98.	72.6	53.0	882.	46	5.27
159	300.	116.	69.3	49.8	882.	49	4.21
160	630.	142.	67.3	49.9	882.	48	6.12
161	459.	75.	69.1	49.6	882.	40	5.37
162	696.	116.	76.3	49.9	882.	45	7.27
163	547.	252.	63.9	39.7	882.	44	6.07
164	654.	264.	56.4	37.2	882.	34	6.87
165	700.	275.	61.8	35.7	882.	34	7.77
166	734.	100.	70.6	39.5	882.	37	6.68
167	565.	243.	83.7	42.2	882.	40	9.56
168	637.	220.	64.3	44.2	882.	37	7.35
169	653.	105.	75.3	48.5	882.	33	7.51
170	707.	192.	77.6	54.8	882.	49	8.24
171	706.	177.	77.8	51.0	882.	50	7.88
172	720.	198.	76.2	49.7	882.	40	13.01
173	730.	90.	87.7	48.5	882.	47	7.69
174	734.	200.	77.1	55.3	882.	47	8.37
175	734.	87.	84.4	49.2	882.	34	8.10
176	573.	130.	92.7	52.5	882.	46	8.97
177	714.	134.	90.6	60.2	882.	47	9.63
178	652.	213.	79.6	55.7	882.	32	11.01
179	739.	168.	77.8	47.1	882.	30	10.44
180	726.	126.	83.7	47.4	882.	36	9.59
181	544.	137.	91.1	53.0	882.	50	8.42
182	597.	170.	80.7	59.3	882.	45	8.62
183	707.	113.	85.2	54.1	882.	41	9.06
184	710.	109.	89.7	54.8	882.	52	8.75
185	707.	88.	92.4	55.2	882.	52	8.58
186	465.	120.	96.7	58.9	882.	54	8.13
187	566.	132.	82.8	58.6	882.	57	7.18
188	649.	259.	65.5	45.3	882.	42	8.33
189	725.	91.	76.5	35.0	882.	29	8.43
190	714.	84.	91.1	44.7	882.	47	8.20
191	689.	112.	86.1	59.5	882.	45	8.05
192	675.	118.	83.2	54.8	882.	43	8.32
193	711.	113.	87.3	50.3	882.	45	8.97
194	718.	177.	78.0	54.6	882.	41	9.58
195	720.	119.	80.1	47.8	882.	38	8.72
196	723.	81.	87.3	48.0	882.	40	8.38
197	573.	146.	90.7	47.8	882.	46	8.92
198	685.	95.	90.2	54.8	882.	53	7.89
199	685.	128.	88.6	57.0	882.	55	8.34

FINAL WEATHER AND ETR ESTIMATES FOR KIMBERLY 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY
200	696.	124.	85.3	51.4	882.	46	8.81
201	698.	107.	87.3	50.8	882.	45	8.71
202	677.	134.	85.9	53.5	882.	46	8.85
203	691.	111.	87.0	50.7	882.	43	8.69
204	688.	130.	86.1	50.7	882.	43	8.99
205	618.	86.	88.0	48.3	882.	38	7.98
206	618.	117.	83.7	51.7	882.	48	7.60
207	679.	140.	79.6	49.9	882.	46	8.06
208	682.	107.	85.2	52.8	882.	51	7.61
209	662.	81.	93.1	51.7	882.	51	7.68
210	642.	132.	88.0	54.4	882.	46	8.59
211	617.	131.	80.7	53.5	882.	37	8.42
212	675.	91.	89.7	48.5	882.	43	8.28
213	675.	104.	92.0	49.2	882.	41	8.80
214	651.	137.	84.3	56.6	882.	43	8.53
215	665.	114.	85.9	48.9	882.	44	8.27
216	661.	121.	87.0	50.1	882.	44	8.45
217	663.	112.	88.0	52.5	882.	42	8.35
218	666.	97.	88.8	49.9	882.	46	7.89
219	653.	101.	92.2	52.1	882.	48	8.10
220	654.	113.	92.0	56.2	882.	47	8.42
221	561.	146.	85.9	55.9	882.	52	7.67
222	630.	125.	84.1	56.2	882.	48	7.86
223	640.	89.	89.7	51.7	882.	53	7.31
224	605.	87.	90.7	52.3	882.	48	7.30
225	376.	88.	89.8	56.1	882.	49	5.83
226	569.	91.	91.6	55.9	882.	51	7.06
227	587.	111.	90.9	54.3	882.	52	7.58
228	622.	91.	90.6	52.1	882.	48	7.57
229	613.	87.	92.7	52.3	882.	47	7.55
230	476.	104.	89.8	59.3	882.	53	6.42
231	358.	102.	85.9	60.6	882.	54	5.39
232	506.	108.	87.3	56.6	882.	54	6.49
233	593.	106.	83.9	50.5	882.	44	7.32
234	603.	102.	85.7	48.9	882.	42	7.37
235	604.	95.	93.1	49.2	882.	43	7.57
236	565.	125.	92.5	64.2	882.	49	7.52
237	596.	86.	94.3	57.5	882.	50	7.12
238	581.	96.	90.7	55.0	882.	50	7.22
239	572.	98.	84.3	53.9	882.	40	7.22
240	516.	87.	87.1	50.5	882.	44	6.49
241	554.	127.	88.8	58.8	882.	49	7.28
242	551.	250.	74.9	53.7	882.	41	8.97
243	574.	91.	74.0	43.5	882.	37	6.11
244	562.	105.	85.7	41.7	882.	35	7.08
245	571.	171.	73.5	47.8	882.	38	7.08
246	559.	81.	82.6	40.4	882.	33	5.99
247	498.	115.	80.3	45.3	882.	38	6.10
248	469.	162.	78.5	53.0	882.	40	6.61
249	534.	100.	79.2	46.0	882.	39	5.88
250	525.	127.	82.8	46.5	882.	46	6.27
251	494.	109.	83.2	49.8	882.	48	5.65

FINAL WEATHER AND ETR ESTIMATES FOR KIMBERLY 1981

JULIAN DATE	SOLAR LY/D	WIND MPD	TMAX F	TMIN F	PRES. MB	DEW F	ETR-WRIGHT MM/DAY
252	519.	68.	84.3	48.3	882.	47	5.12
253	517.	171.	83.0	54.3	882.	38	7.75
254	518.	93.	86.1	46.5	882.	41	6.11
255	525.	113.	85.5	48.0	882.	41	6.55
256	510.	132.	86.6	49.6	882.	38	7.11
257	514.	151.	85.5	52.5	882.	37	7.50
258	507.	108.	87.1	45.6	882.	33	6.73
259	501.	115.	87.7	49.6	882.	37	6.70
260	492.	119.	91.5	51.5	882.	39	11.58
261	475.	100.	90.7	53.5	882.	42	5.36
262	455.	221.	73.5	50.7	882.	38	6.91
263	450.	111.	74.7	38.8	882.	31	5.13
264	486.	160.	66.6	40.9	882.	32	5.89
265	452.	131.	65.0	35.7	882.	25	5.15
266	331.	79.	66.6	33.7	882.	27	3.65
267	345.	129.	71.8	47.2	882.	32	4.48
268	317.	117.	54.6	34.6	882.	41	2.48
269	238.	102.	62.5	32.8	882.	30	3.12
270	391.	109.	77.2	40.4	882.	35	4.32
271	413.	152.	66.6	45.4	882.	43	3.82
272	167.	102.	55.3	40.8	882.	40	1.98
273	441.	105.	59.2	34.6	882.	31	3.77
274	447.	104.	69.0	30.1	882.	28	4.27
275	270.	149.	74.5	39.0	882.	36	4.16
276	109.	135.	51.7	36.6	882.	43	1.09
277	424.	108.	54.9	29.4	882.	26	3.44
278	401.	100.	62.8	27.8	882.	23	3.66
279	328.	110.	75.4	35.7	882.	34	3.52
280	116.	176.	66.3	43.5	882.	38	2.92
281	357.	138.	55.8	35.7	882.	33	3.23
282	200.	63.	58.7	40.0	882.	36	1.97
283	141.	98.	58.3	44.0	882.	41	1.63
284	52.	166.	47.9	38.8	882.	40	.99
285	111.	124.	42.9	33.0	882.	31	1.51
286	109.	61.	41.4	32.5	882.	32	1.00
287	168.	68.	45.2	33.4	882.	32	1.11
288	316.	80.	51.0	31.0	882.	32	1.69
289	304.	171.	57.6	34.6	882.	32	4.19
290	363.	125.	60.9	38.2	882.	36	2.13
291	364.	75.	64.8	33.7	882.	32	2.06
292	364.	86.	66.6	32.7	882.	31	2.43
293	348.	172.	64.5	37.7	882.	30	3.98
294	346.	112.	52.9	29.2	882.	21	2.97
295	340.	95.	55.1	26.4	882.	22	2.68
296	335.	139.	58.3	26.4	882.	20	3.26
297	283.	307.	61.4	37.5	882.	24	5.29
298	319.	100.	60.1	33.2	882.	29	2.37
299	199.	82.	63.4	38.2	882.	30	1.95
300	228.	106.	63.0	38.4	882.	30	2.47
301	90.	201.	65.5	38.1	882.	31	3.32
302	103.	146.	43.9	32.1	882.	28	1.81
303	214.	179.	46.8	29.6	882.	29	2.13
304	286.	75.	54.4	30.3	882.	25	1.76