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Title : Semi-Empirical Methods for Estimating Evapotranspiration in a Modified Marine Climate

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A field experiment to evaluate semi-empirical evapotranspiration (ET) estimating methods in a modified marine climate was carried out from May to September of 1985. Prior to this experiment, none of the methods for the Willamette Valley of Oregon had been tested with field data. The methods tested in the study were the Original Penman, FAO Penman, SCS Blaney-Criddle, FAO Blaney-Criddle, Jensen-Haise, and Priestly-Taylor. The Original Penman and FAO Penman were each tested using four alternative algorithms for calculating vapor pressure deficits.

Measured ET values were compared to calculated ET values. ET values were measured on an experimental plot by applying a mass balance equation to neutron meter readings of soil water content. Neutron meter readings were taken on a daily basis from five replications. Calculated ET values were computed from weather data collected by a microprocessor weather station. Crop coefficients were applied to each of the methods.

Comparisons of measured ET to calculated ET values were done using three methods; (1) double mass balance, (2)

simple linear regression, and (3) regression line fitted through the origin. The effect of smoothing the data on the comparisons was studied to determine improvement in estimating ET from the smoothed data. The results showed the FAO Blaney-Criddle method to be superior to all other methods. The cumulative ET data computed by this method differed by only - 0.5 percent from the measured ET data over the entire test period. By comparison, the FAO Blaney-Criddle method showed an error of 3.5 percent. However, the FAO Penman method using an average saturation vapor pressure deficit proved to be a good estimator, but not as good as the FAO Blaney-Criddle. Errors, in comparison to the FAO Blaney-Criddle method, were - 1.0 and 5.2 percent. The sliding averages showed the largest improvement in estimating ET for the change from daily to 3 day.

Semi-Emperical Methods for Estimating
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# SEMI-EMPERICAL METHODS FOR ESTIMATING EVAPOTRANSPIRATION IN A MODIFIED MARINE CLIMATE

## INTRODUCTION

Water has long been considered an unlimited resource, but with the increased demands for water, it has become necessary to conserve this precious resource. Adding to the limited supply of surface water, groundwater is being withdrawn at higher rates than it is recharged. It has become apparent that unless conservation measures are implemented water will become less and less available. One way to implement conservation practices is to look at the hydrologic cycle.

The hydrologic cycle includes many processes that control the movement and distribution of water. This thesis is particularly interested in those processes which represent the addition or loss of water to the soil surface, namely evaporation, transpiration, and precipitation. There are many more processes involved in the hydrologic cycle (Fig. 1), but the balance between soil water and atmosphere water in the root zone of the plant is of prime importance. It is this balance that is used to develop a model of water use by plants. Using a model of plant water use, a farmer may determine how much water is needed to just meet the plant's demand. The type of management practices used

will also determine the amount of water applied.
By minimizing the amount of water applied to a crop, without stressing the plant and lowering yields, a farmer can expect to cut costs by conserving water.

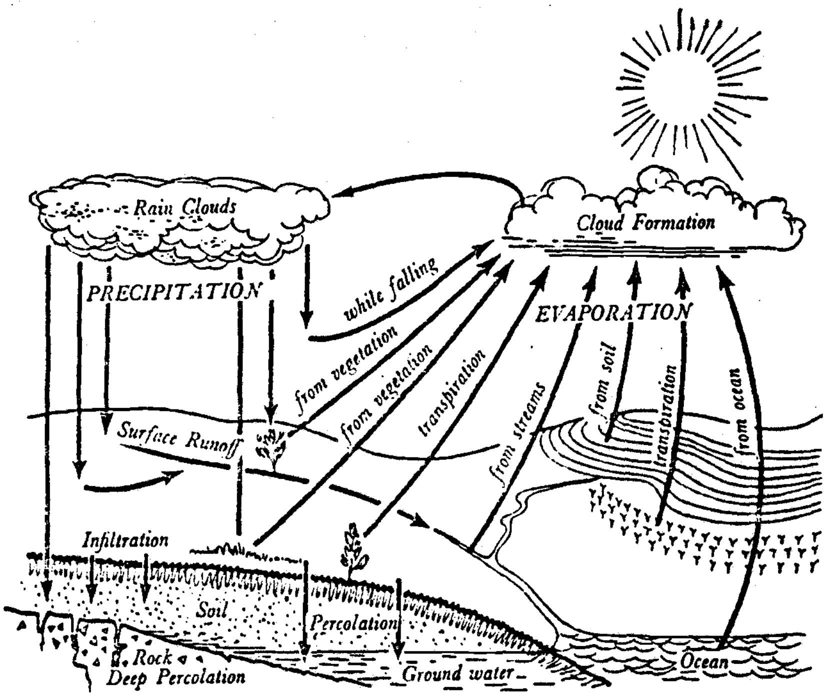


Figure 1 : The hydrologic cycle (Ackermann, Colman, and Ogrosky, 1955)

One class of evapotranspiration models are referred to as semi-empirical methods. Finding and calibrating a semi-empirical model for a specific region is not always straight forward. A study of the many methods that already exist will determine the method which best fits the crop and climate data available.

The objective of this thesis is to study twelve methods for estimating evapotranspiration and to find the method or methods that are best for the climate of the Willamette Valley. An experiment was performed to compare the Original Penman, FAO Modified Penman, SCS Blaney-Criddle, FAO Modified Blaney-Criddle, Jensen-Haise, and Priestly-Taylor methods for estimating evapotranspiration. Each method was compared using data on a daily, 3-day, 7-day, and 14-day average basis to see the range over which each method could best be used to predict evapotranspiration.

# LITERATURE REVIEW

A general definition for evaporation from a water surface is "A natural process by which water is changed from liquid to vapor" (Christiansen, 1965). This definition applies to a free water surface, not to a soil surface that contains water in soil pores. The fundamental law of evaporation from a free water surface was described by Dalton in 1798, who wrote, "If the actual vapor pressure of the air above water is less than the water surface, then evaporation will occur" (Dalton, 1798). Evaporation at the soil surface is driven by vapor pressure differences (Jensen, 1974), but the amount of evaporation will depend on the water content of the soil surface layer.

Evaporation from the soil surface will continue as long as the soil remains moist. The source of evaporating water is the relatively thin layer at the surface due to the slow capillary movement of water from greater depths. There is also vapor that moves through the soil. In most soils, evaporative losses of water are from the upper 10 to 20 cm of the soil. The amount of water found in the soil depends on the method used to apply water. After a light application of water, either irrigation or precipitation, followed by a drying weather pattern, the amount of evaporation may approach 100% of the water added to the soil. Providing a vegetative cover over the soil will decrease the amount of evaporation.

Transpiration is defined as "The loss of water from the plant, either on the surface or the roots" (Oliver, 1961). In semi-arid and arid conditions, transpiration causes the majority of the water losses (Doneen and Westcot, 1984). Transpiration losses are very hard to measure directly, but work has been done in trying to model water losses in relationship to the amount of leaf area associated with a plant (Morison, 1984: Van Bavel, 1983).

The combination of the terms evaporation and transpiration is known as evapotranspiration or more commonly "ET". Symbolically, ET is represented in this thesis by $E_t$.

Evapotranspiration as defined by Jensen (1974) is:

> "The combined process by which water is transfered from the earth's surface to the atmosphere. It includes evaporation of liquid or solid water from soil and plant surfaces plus transpiration of liquid water through plant tissues expressed as the latent heat transfer per unit area or its equivalent depth of water per unit area."

Evapotranspiration is also called "crop water requirement" and "consumptive use." Evapotranspiration is most frequently used as an estimate of the amount of water a crop uses.

The amount of ET that occurs depends upon the availability of soil moisture. When the amount of water directly available to the plant is "limiting", then the response of the crop may be affected and this condition is called a deficit. Assuming the supply of water available to the crop is limiting, it becomes increasingly important to design a system of irrigation, called deficit irrigation, that optimizes water use. Methods for estimating ET when soil moisture is limiting have been reviewed by Nuss (1982).

"Potential evapotranspiration", $E_{tp}$, is a term that is commonly used in describing water use. There are several definitions of this term. Burman et al (1983) defined potential evapotranspiration as:

> "$E_{tp}$ is the maximum rate at which water, if fully available, would be removed from the earth's surface and transpired by the plant expressed as the latent heat transfer per unit area or it's equivalent depth of water per unit area."

Van Bavel defines $E_{tp}$ as "the ET that occurs when the vapor pressure at the evaporating surface is at the saturation point" (Van Bavel, 1966). This definition sets no limitations on the stage of growth of the plant or the amount of vegetation present. As defined by Van Bavel (1966), $E_{tp}$ must be referenced to a specific crop under specific conditions (such as canopy cover, crop height, etc.. ). Crops that are commonly used for reference purposes are grass and alfalfa. Jensen (1980) relates the $E_t$ of a specific crop at a specific part of the growth stage to $E_{tp}$ by the following equation:

$$K_c = \frac{E_{tp}}{E_{tr}} \qquad (1)$$

where $K_c$ is a crop coefficient that incorporates cropping factors such as growth stage, density, and cultural practices. Equation 1 includes a term known as reference ET ($E_{tr}$) which is equivelant to $E_{tp}$, except that $E_{tr}$ applies to the specific reference crop used. Doorenbos and Pruitt (1977) define $E_{tr}$ as:

> "The rate of evapotranspiration from an extensive surface of 8 to 15 cm, green grass cover of uniform height, actively growing, completely shading the ground, and not short of water."

This definition sets the standard for a grass as the reference crop. The use of alfalfa as the other reference crop for estimating evapotranspiration, is based on a different set of standards as described by Jensen (1969).

> "$E_{tr}$ represents the upper limit or maximum evapotranspiration that occurs under given climatic conditions with a field having a well-watered agricultural crop with an aerodynamically rough surface, such as alfalfa with 12 to 18 in. of top growth."

From these two definitions, the actual $E_t$ can be calculated by:

$$E_t = K_c \times E_{tr} \qquad (2)$$

for alfalfa as the reference or

$$E_t = K_c \times E_{to} \qquad (3)$$

for grass used as the reference. $K_c$ is different for each formula, so it is very important to know which reference crop is used.

## Factors Affecting Evapotranspiration

There are many factors that influence the amount of $E_t$ from a crop, but many are frequently neglected to simplify calculations and because it is difficult to measure empirical coefficients accurately. Doorenbos and Pruitt (1977) recommended a three step procedure to calculate $E_t$.

1. Collect and evaluate available climatic and crop data.
2. Select a prediction method based on required accuracy and on available climatic data.
3. Choose a period of time to calculate $E_{tr}$.

They group the factors into climate, crop characteristics, local conditions, and agricultural practices. Though all of these factors should be included in the estimation, in practice, the final value of $E_t$ is usually found from climatic data and crop characteristics.

The methods used to calculate reference ET are based on semi-emperical equations. Some of these are Penman, Blaney-Criddle, Jensen-Haise, and Priestly-Taylor. Each of these will be discussed in more detail later. The choice of method is based on the climatic data available and the accuracy required in determining the ET. There are many publications available that describe each of these methods and how to use them to estimate ET. For example, Jensen (1974), Doorenbos and Pruitt (1977), and Hargreaves (1977). Jensen (1974), using data from 10 world wide locations, concluded:

> "No single existing method using meteorlogical data is universally adequate under all climatic regimes, especially for tropical areas and for high elevations, without some local or regional calibration."

Climatic data is usually used for estimating $E_{tr}$ because the approach is much simpler than actual on-site ET measurements.

The influence of the crop characteristics is in the crop coefficient ($K_c$). Values of $K_c$ depend on the stage of crop growth, length of growing season, crop density, and the prevailing weather conditions. A method proposed by Jensen (1969) accounts for the influence of soil moisture.

$$K_c = K_{co} \times K_a + K_s \qquad (4)$$

where $K_a = \ln(M_a + 1)/\ln(101)$

$M_a$ = % moisture available remaining at the time of the estimate

$K_s = (0.9 - K_{co} \times K_a) \times 0.8$ on first day after water application

$= (0.9 - K_{co} \times K_a) \times 0.5$ on second day after water application

$= (0.9 - K_{co} \times K_a) \times 0.3$ on third day after water application

$= 0$ at all other times

$K_{co}$, the basal crop coefficient, has the value of the original $K_c$ (Eqn 1). $K_a$ and $K_s$ account for soil moisture and soil surface wetness. The actual ET can then be calculated by either eqn. 2 or eqn. 3.

Local conditions and cropping practices include local variation in time, altitude, size of fields, advection, and salinity. Shouse et al (1980) discussed the effects of extreme advective enviromental conditions on evapotranspiration losses. They found that the Penman method corresponded most closely to the measured ET in an experiment using 5 methods.

Semi-emperical Methods

Models for predicting $E_{tp}$ range from physically based combination energy balance-mass transfer approaches (Penman, 1948; Van Bavel, 1966) to emperically-based correlations on temperature (Blaney and Criddle, 1950,1962) and solar and net radiation (Jensen and Haise, 1963; Priestly and Taylor, 1972). A commonly used procedure is to compute $E_{tp}$ using semi-emperical methods. The methods may be grouped into three catagories: combination methods, radiation methods, and temperature methods (Jensen, 1974; Hansen et al, 1980). The type of method selected will depend on the climatic data available, but a method should not be automatically rejected because the required data are unavailable. Methods exist to estimate some types of weather data (Brooker, 1967; Pochop and Howard, 1973).

A group from the American Society of Civil Engineers carried out an extensive evaluation of sixteen common methods for estimating reference ET (Jensen, 1974). They found the Jensen-Haise method, a radiation method, to be the best. It gave a ratio between predicted ET and measured ET of 0.91. The Penman method, a combination method, was the second best with a ratio of 1.09. Which means the method overpredicted by an average of 9 percent. The Blaney-Criddle method, a temperature method, had a 0.81 ratio. One of the methods to be used for comparison in this report is the Priestly-Taylor method, a radiation method, that was not tested by the ASCE group in the 1974 report. I included the Priestly-Taylor method in this thesis because it has proven to be a good estimator of evapotranspiration in some parts of the world. Fig. 2 shows a flow chart explaining how to calculate ET by the various methods.

## Combination Methods

Combination methods are based on an energy balance component and a mass transport or aerodynamic component. The relative importance of each component varies with climatic conditions. In climates with gentle winds, the energy term is more important than the aerodynamic component. The aerodynamic component is of greatest importance in windy and also arid climatic conditions.

Dalton (1798) proposed the original evaporation rate equation as:

$$E_o = f(u) \times (e_s - e_a) \qquad (5)$$

where $f(u)$ = a function of the windspeed at height h
$e_s$ = saturation vapor pressure at surface
$e_a$ = vapor pressure of air at height h

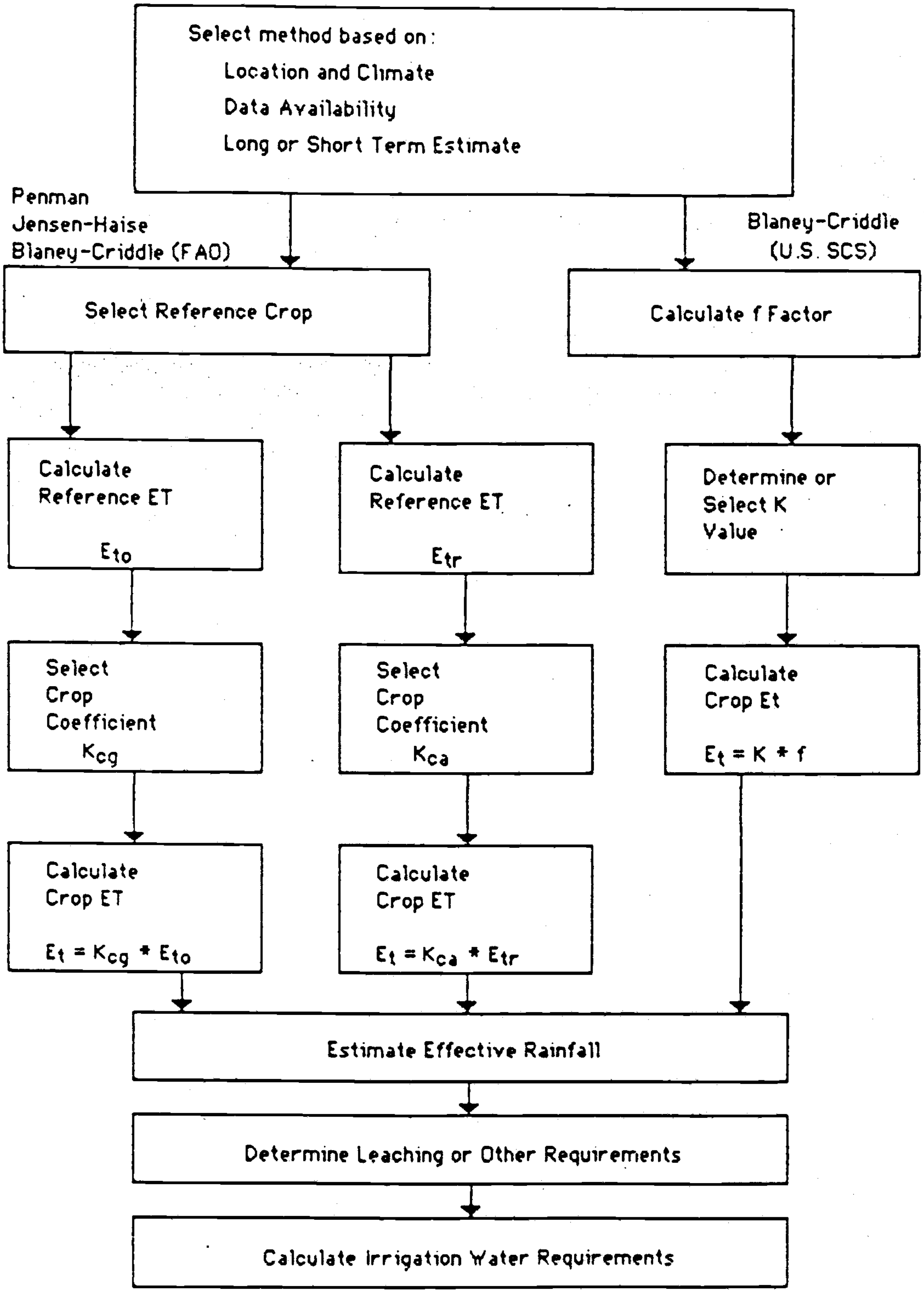


Figure 2 : Flowchart for estimating irrigation water requirements (Burman et al 1983).

The wind function f(u) may be determined emperically or computed analytically using an equation derived from turbulent transfer theory. The saturation vapor pressure may be attained from knowing the temperature at the surface. Since equation 5 is a rate-defining formula, results for any time period can be obtained by integration. Penman introduced his combination method in 1948 in a report that predicted evaporation from an open water surface. Penman made a theoretical approach and showed that consumptive use is inseparably connected to incoming solar energy. The original equation that was used by Penman (1948) is:

$$ET = W \times R_n + (1 - W) \times E_a \quad (6)$$

where W = a dimensionless weighting factor for temperature and pressure equal to

$$= \Delta/[\Delta+\Gamma] \quad (6a)$$

$R_n$ = net radiation

$E_a$ = $f(u)(e_s - e_a)$

$$= f(u)(\Delta e) \quad (6b)$$

$\Delta e$ = vapor pressure deficit term

This equation bears a very close resemblance to Dalton's equation (Eqn. 5). Penman concluded that the wind function could be described by a linear relationship between ET/($\Delta$ e) and U2, the wind speed:

$$f(u) = 0.35 \times (1 + 0.0098 \times U2) \quad (7)$$

where U2 = wind speed at 2 meters height.

substituting equation 7 into equation 6b gives the original Penman wind function term as:

$$E_a = 0.35 \times (1 + 0.0098 \times U2) \times \Delta e \quad (8)$$

In equation 8, 0.0098 was later rounded off to 0.01 to give the wind function term as:

$$E_a = 0.35 \times (1 + 0.01 \times U2) \times \Delta e \quad (9)$$

where $E_a$ = [mm/day] of evaporation
$U2$ = mean 24 hour wind velocity [miles/hour]
$\Delta e$ = vapor pressure deficit using mean temperature for day in [mm Hg].

Further work on the generalized wind function has been done by Tanner and Pelton (1960), Tanner and Fuchs (1968), Bartholic et al (1970). Jensen (1974) and Wright and Jensen (1972) give discussions on coefficients for the wind function. Penman proposed equation 9 be used for "a short green crop, completely shading the ground, of uniform height, and never short of water" (Cuenca et al, 1982). Estimates for this combination equation are reliable from a range of 1 day to 1 month, with hourly results being possible (Jensen, 1980).

There are six methods to compute the vapor pressure deficit term ( $\Delta e$), three of which use temperature averaging, while the other three use vapor pressure deficit averaging (Jensen, 1974). In either case, it is necessary to consistently use the same method. The results will not be the same since vapor pressure does not vary linearly with temperature.

The three temperature averaging methods used are:

1. Saturation vapor pressure at average temperature minus vapor pressure at minimum dewpoint temperature.

$$\Delta e = e_s \text{ avg} - e_{dp} \text{ min} \qquad (10)$$

2. Saturation vapor pressure at average temperature minus vapor pressure at average dewpoint temperature.

$$\Delta e = e_s \text{ avg} - e_{dp} \text{ avg} \qquad (11)$$

3. Saturation vapor pressure at average temperature minus the average relative humidity times the saturation vapor pressure at average temperature.

$$\Delta e = e_s \text{ avg} - \text{RH avg} \times e_s \text{ avg} \qquad (12)$$

The average daily air temperature is defined as $(T_{min} + T_{max})/2$ and is used to calculate the saturated vapor pressure and the dew point vapor pressure. However, Jensen (1974) reported the vapor pressure deficit computed on the basis of average temperature may not be indicative of the actual daily deficit.

The other three commonly used methods to compute $\Delta e$ use the deficit averaging technique.

4. Average of saturation vapor pressures at maximum and minimum temperatures minus vapor pressure at average dewpoint temperature.

$$\Delta e = \frac{e_s \text{ max} + e_s \text{ min}}{2} - e_{dp} \text{ avg} \qquad (13)$$

5. Average saturation vapor pressure deficit computed at maximum and minimum temperature.

$$\Delta e = \frac{(e_s \max - e \max) + (e_s \min - e \min)}{2} \qquad (14)$$

6. Saturation vapor pressure at average temperature minus actual vapor pressure (e air) computed using wet bulb depression ( $\Delta$ T wet) measured by a psychrometer.

$$\Delta e = e_s \text{ avg} - e \text{ air} \qquad (15)$$

$$e \text{ air} = e_s \text{ wet} - \Gamma \times \Delta T \text{ wet} \qquad (16)$$

Cuenca et al (1982) state that method 6 does not fit into either a temperature averaging method or a deficit averaging method, but computed values show close agreement with temperature averaging methods.

The energy balance component is defined as the weighting factor, W, times the net radiation, $R_n$ (Eqn. 6). Net radiation as defined by Penman (1948) is:

$$R_n = R_c \times (1 - r) - \sigma(T \text{ air})^4 \times (0.56 - 0.092 \times \sqrt{e_d}) \times (0.10 + 0.90 \times (n/N)) \qquad (17)$$

where $R_c$ = $R_a \times (0.18 + 0.55 \times (n/N))$ [mm/day]
$R_a$ = Value for $R_c$ in transparent atmosphere
n/N = Ratio of actual to possible sunshine hours
r = Radiation reflection coefficient
$\sigma(T \text{ air})^4$ = Theoretical black-body radiation [K]
$e_d$ = Saturation vapor pressure dewpoint [mm Hg]

Later work done by Penman (1963) simplified equation 17 to:

$$R_s = ( 0.18 + 0.55 \times S ) \times R_a \qquad (18)$$

where $R_s$ = solar radiation [cal $cm^{-2}$ $day^{-1}$]
$R_a$ = extraterrestial solar radiation [cal cm-2 day-1]
S = ratio of actual to possible sunlight hours

Tables for some of these values are given in Jensen (1974).

Since Penman first introduced his equation (6), modifications to the energy balance component and to the wind function have been made (Penman, 1948; Black et al, 1954).

The original Penman (1948) equation (Eqn. 6) predicts evaporation losses from open water. Doorenbos and Pruitt (1977) modified the Penman equation to:

1. Take into account the humid environment of Penman's work.
2. Revise the wind function to account for the variation in climatic data for day and night.

The form of the equation that is used in the FAO Modified Penman method is:

$$E_{to} = c \times (W \times R_n + (1-W) \times (f(U2)) \times ( \Delta e)) \qquad (19)$$

where $\Delta e$ = units of [mbar]
c = adjustment factor to account for the effect of day and night weather conditions.

W is a weighting factor that accounts for the effect of radiation, based on temperature ($^{o}$C) and elevation (m). Values for W are given in Table 1 where T = (Tmax + Tmin)/2.

An alternate way of finding the weighting factor (W) is by using formulas presented by Burman et al (1983). The value used in the weighting factor (W) is evaluated by using the following equation (Bosen, 1960).

$$\Delta = 2.00(0.00738Tmean + 0.8072)^7 - 0.0016 \qquad (20)$$

where Tmean = mean daily temperature [$^oC$]

| | Altitude (m) | 0 | 500 | 1000 | 2000 | 3000 | 4000 |
|---|---|---|---|---|---|---|---|
| | 2 | 0.43 | 0.44 | 0.46 | 0.49 | 0.52 | 0.54 |
| | 4 | 0.46 | 0.48 | 0.49 | 0.52 | 0.55 | 0.58 |
| | 6 | 0.49 | 0.51 | 0.52 | 0.55 | 0.58 | 0.61 |
| | 8 | 0.52 | 0.54 | 0.55 | 0.58 | 0.61 | 0.64 |
| T | 10 | 0.55 | 0.57 | 0.58 | 0.61 | 0.64 | 0.66 |
| E | 12 | 0.58 | 0.60 | 0.61 | 0.64 | 0.66 | 0.69 |
| M | 14 | 0.61 | 0.62 | 0.64 | 0.66 | 0.69 | 0.71 |
| P | 16 | 0.64 | 0.65 | 0.66 | 0.69 | 0.71 | 0.73 |
| E | 18 | 0.66 | 0.67 | 0.69 | 0.71 | 0.73 | 0.75 |
| R | 20 | 0.69 | 0.70 | 0.71 | 0.73 | 0.75 | 0.77 |
| A | 22 | 0.71 | 0.72 | 0.73 | 0.75 | 0.77 | 0.79 |
| T | 24 | 0.73 | 0.74 | 0.75 | 0.77 | 0.79 | 0.81 |
| U | 26 | 0.75 | 0.76 | 0.77 | 0.79 | 0.81 | 0.82 |
| R | 28 | 0.77 | 0.78 | 0.79 | 0.81 | 0.82 | 0.84 |
| E | 30 | 0.78 | 0.79 | 0.80 | 0.82 | 0.84 | 0.85 |
| | 32 | 0.80 | 0.81 | 0.82 | 0.84 | 0.85 | 0.86 |
| ($^oC$) | 34 | 0.82 | 0.82 | 0.83 | 0.85 | 0.86 | 0.87 |
| | 36 | 0.83 | 0.84 | 0.85 | 0.86 | 0.87 | 0.89 |
| | 38 | 0.84 | 0.85 | 0.86 | 0.87 | 0.88 | 0.90 |
| | 40 | 0.85 | 0.86 | 0.87 | 0.88 | 0.89 | 0.90 |

Table 1 : Values of weighting factor (W) for the effect of radiation on $E_{to}$ at different temperatures and altitudes (Doorenbos and Pruitt, 1977).

Brunt (1952) developed an equation that can be used to find gamma.

$$\Gamma = \frac{0.386\ P}{L} \qquad (21)$$

where P = 1013 - 0.1055 x elevation [m]
L = 595 - 0.51 x Tmean [$^oC$]

The net radiation formula used in this method is similar to the formula in the original Penman method (Eqn. 18).

$$R_n = (1 - A) \times R_s - R_b \qquad (22)$$

where $A$ = albedo
$R_b$ = net outgoing longwave radiation

The albedo is the reflected short wave radiation expressed as a decimal and is often taken to be 0.23 for commercial irrigated crops. The albedo depends on the nature of the surface cover and is approximately 5 to 7 percent for water and 15 to 25 percent for most crops. Merva (1975) presented an extensive list of albedo values for various surfaces. However, the albedo is known to change with the sun angle and can be estimated by an emperical equation derived from known weather data for a specific crop. Wright (1982) presented a formula specifically for the albedo of alfalfa derived in Kimberly, Idaho. He noted that this formula is to be used only in Kimberly and only for alfalfa as the reference crop. If sufficient data are available, an emperical equation can be very useful in calculating albedo.

The variable $R_b$ is hard to measure, but it can be estimated from a formula given by Jensen (1980):

$$R_b = \left( a \times \frac{R_s}{R_{so}} + b \right) \times R_{bo} \qquad (23)$$

where a,b = empirical constants (Table 2)
$R_s$ = incoming short wave radiation
$R_{so}$ = clear day solar radiation (no clouds)
$R_{bo}$ = e x 11.71 X 10-8 $T_k{}^4$

where $e$ = emissivity
= $(a_1 + b_1 \times (e_{sdp}))$
$T_k$ = T[oC] + 273 (Kelvin)

$a_1, b_1$ = empirical constants (Table 2)
$e_{sdp}$ = saturation vapor pressure at mean daily dew point temperature [mb]

| Region | a | b | a1 | b1 |
|---|---|---|---|---|
| Davis, California | 1.350 | -0.350 | 0.350 | -0.046 |
| Southern Idaho | 1.220 | -0.180 | 0.325 | -0.044 |
| England | N.A. | N.A. | 0.470 | -0.065 |
| | N.A. | N.A. | 0.440 | -0.080 |
| Australia | N.A. | N.A. | 0.350 | -0.042 |
| General | 1.200 | -0.200 | 0.390 | -0.050 |
| | 1.000 | 0.000 | --- | --- |

Table 2 : Experimental Coefficients for Net Radiation (Cuenca, 1982)

An alternative way to calculate the emissivity is with an equation given by Idso and Jackson (1969).

$$e = -0.02+0.261\exp(-.000777x(Tmean[^{o}C])^{2}) \quad (24)$$

A simpler procedure for calculating $R_n$ is presented by Jensen (1974) as:

$$R_n = a_3 \times R_s + b_3 \quad (25)$$

where $a_3, b_3$ = empirical coefficients (Jensen, 1974)

The adjustment factor (c) is used in FAO-24 (Doorenbos and Pruitt, 1977) as a calibration coefficient computed by climatic data which accounts for the day and night conditions of a given climate. The adjustment factor is a function of $RH_{max}$, $U_{day}/U_{night}$ , $R_s$, and $U_{day}$ . A set of tables to find c based on these meteorological parameters is given in FAO-24. Frevert et al (1983) derived a relationship for c using the tables in FAO-24 as:

$$
\begin{aligned}
c = {} & 0.6817006 + 0.0027864 x RH_{max} + 0.181768 x R_s \\
& - 0.0682501 x U_{day} + 0.0126514 x (U_d/U_n) \\
& + 0.0097297 x U_{day} x (U_d/U_n) \\
& + 0.43205 \text{ X } 10^{-4} x RH_{max} x R_s x U_{day} \\
& - 0.92118 \text{ X } 10^{-7} x RH_{max} x R_s x (U_d/U_n)
\end{aligned}
\qquad (26)
$$

where $RH_{max}$ = maximum relative humidity [percent]
$R_s$ = solar radiation [mm/day]
$U_{day}$ = mean daytime wind velocity at 2m [m/s]
$U_d/U_n$ = day to night wind run ratio between 0700 - 1900 as day and 1900 - 0700 night

The wind function given in equation 19 as f(U2) is defined in FAO-24 as:

$$
f(U2) = 0.27 \text{ x } \left( 1 + \frac{U2}{100} \right) \qquad (27)
$$

where U2 = 24 hour wind run in km/day at 2 meters height

This expression can be used when $\Delta$ e is calculated by methods 1, 2, or 3 (Eqns. 10, 11, or 12) and expressed in mbars. If the wind (run or speed) is not measured at 2 m height, then Table 3 gives a correction factor. This correction factor is not to be multiplied by the wind function, only the wind speed or wind run.

| Measurement height (m) | 0.5 | 1.0 | 1.5 | 2.0 | 2.5 |
|---|---|---|---|---|---|
| Correction factor | 1.32 | 1.15 | 1.06 | 1.00 | 0.96 |

| Measurement height (m) | 3.0 | 3.5 | 4.0 | 4.5 | 5.0 |
|---|---|---|---|---|---|
| Correction factor | 0.93 | 0.89 | 0.87 | 0.85 | 0.83 |

Table 3 : Wind function height correction factors (Doorenbos and Pruitt, 1977).

Doorenbos and Pruitt (1977) suggested methods I, II, or III for calculation of the vapor pressure deficit ( $\Delta$ e). If units other than millibars are used, then a conversion factor is needed (mm Hg X 1.33 = mbars).

## Temperature Methods

Temperature is commonly measured at most meteorological stations. Usually, minimum and maximum temperatures are measured on a daily basis. Highly accurate equipment to measure temperature is inexpensive. The Blaney-Criddle method for estimating evapotranspiration was developed to capitalize on the enormous amounts of available min/max temperature data.

Initial research involving temperature-based $E_t$ predictions was done by Blaney and Morin (1942) who also took into account relative humidity and mean percentage daylight hours. Blaney and Criddle (1945, 1950, and 1962) later modified this equation to exclude the relative humidity component. Blaney and Criddle assumed that $E_t$, for an actively growing crop with adequate soil moisture, is a function of mean monthly temperatures and monthly percentage of daytime hours. The original Blaney-Criddle formula is described by:

$$E_t = \text{summation } (k_i f_i) = KF \qquad (28)$$

where

$f$ = a monthly consumptive use factor

$$f = \frac{pt}{100} \qquad (29)$$

$p$ = percentage of annual daylight hours during the month

$t$ = mean monthly temperature [$^{o}F$]

$k$ = monthly crop coefficient [dimensionless]

$E_t$ = seasonal crop requirement (inches)

The subscript i refers to an individual month of the growing season. If the crop water requirement is desired for a particular month in the growing season, the k and f values for that month are multiplied to obtain a result for that month in inches. Values for $p_i$ are given in Table 6.4 of Jensen (1974).

The monthly crop coefficient used in equation 28 was studied by a group of Soil Conservation Service workers by applying a linear regression model to measure and estimate crop water use as a function of temperature. The result of this study led to a method known as the SCS modified Blaney-Criddle method (USDA Soil Conservation Service, 1970).

$$E_t = \text{sum } (k_{ti}k_if_i) = K \text{ sum } (k_{ti}f_i) \qquad (30)$$

where $k_{ti} = 0.0173\ T_i - 0.314$
$K$ = seasonal crop coefficient
$T_i$ = average monthly mean temperature [°C]

The seasonal crop coefficient depends on the crop (Table 4), where the smaller values are for humid environments, and the higher values are for arid environments. The values in Table 4 vary with $R_s/R_s$ (max) when the temperature and crop components are treated independantly of each other (Jensen, 1966; Quackenbush and Phelan, 1965).

The SCS modified Blaney-Criddle method has been shown to work well in humid areas, to underpredict actual crop water use in semi-arid low elevation sites by 19 percent on the average, and to underpredict by an average of 29 percent in high elevation arid areas (Jensen, 1974). An explanation for these results is that day and night conditions are simply combined together instead of applying a weighting factor. Weighting factors help improve the results for climates with large variations in day and night temperatures.

| Crop | Length of Normal Growing Season or Period[a] | Consumptive Use Coefficient K[b] | Maximum Monthly k[c] |
|---|---|---|---|
| Alfalfa | Between frosts | 0.80 to 0.90 | 0.95 to 1.25 |
| Bananas | Full year | 0.80 to 1.00 | -- |
| Beans | 3 months | 0.60 to 0.70 | 0.75 to 0.85 |
| Cocoa | Full year | 0.70 to 0.80 | -- |
| Coffee | Full year | 0.70 to 0.80 | -- |
| Corn (Maize) | 4 months | 0.75 to 0.85 | 0.80 to 1.20 |
| Cotton | 7 months | 0.60 to 0.70 | 0.75 to 1.10 |
| Dates | Full year | 0.65 to 0.80 | -- |
| Flax | 7 to 8 months | 0.70 to 0.80 | -- |
| Grains, small | 3 months | 0.75 to 0.85 | 0.85 to 1.00 |
| Grain, sorghums | 4 to 5 months | 0.70 to 0.80 | 0.85 to 1.10 |
| Oilseeds | 3 to 5 months | 0.65 to 0.75 | -- |
| Orchard crops: | | | |
| Avocado | Full year | 0.50 to 0.55 | -- |
| Grapefruit | Full year | 0.55 to 0.65 | -- |
| Orange and lemon | Full year | 0.45 to 0.55 | 0.65 to 0.75[d] |
| Walnuts | Between frosts | 0.60 to 0.70 | -- |
| Deciduous | Between frosts | 0.60 to 0.70 | 0.70 to 0.95 |
| Pasture crops: | | | |
| Grass | Between frosts | 0.75 to 0.85 | 0.85 to 1.15 |
| Ladino whiteclover | Between frosts | 0.80 to 0.85 | -- |
| Potatoes | 3 to 5 months | 0.65 to 0.75 | 0.85 to 1.00 |
| Rice | 3 to 5 months | 1.00 to 1.10 | 1.10 to 1.30 |
| Soybeans | 140 days | 0.65 to 0.70 | -- |
| Sugar beet | 6 months | 0.65 to 0.75 | 0.85 to 1.00 |
| Sugarcane | Full year | 0.80 to 0.90 | -- |
| Tobacco | 4 months | 0.70 to 0.80 | -- |
| Tomatoes | 4 months | 0.65 to 0.70 | -- |
| Truck crops, small | 2 to 4 months | 0.60 to 0.70 | -- |
| Vineyard | 5 to 7 months | 0.50 to 0.60 | -- |

[a] Length of season depends largely on variety and time of year when the crop is grown. Annual crops grown during the winter period may take much longer than if grown in the summertime.

[b] The lower values of K for use in the Blaney-Criddle formula, $U = KF$, are for the more humid areas, and the higher values are for the more arid climates.

[c] Dependent upon mean monthly temperature and crop growth stage.

[d] Given by Criddle as "Citrus orchard."

Table 4 : SCS consumptive use crop coefficients (USDA SCS Tech Release 21, 1970).

Doorenbos and Pruitt (1977) presented a different method to include other specific weather data namely relative humidity, sunshine, and wind. Their formula provides a way to calculate a reference $E_{to}$ for grass. This improves predictions, but it makes the method more site specific.

The formula recommended by Doorenbos and Pruitt (1977) for monthly $E_{to}$ is given by equation 31 as:

$$E_{to} = c \times (p \times (0.46T + 8)) \qquad (31)$$

where
- $c$ = adjustment factor that depends on relative humidity, sunshine, and daytime wind.
- $T$ = mean daily temperature [°C]
- $p$ = mean daily percentage of total annual daytime hours
- $E_{to}$ = reference crop evapotranspiration for the month considered [mm/day]

This equation was later modified by Frevert et al (1983) to include climatic calibration coefficients (a and b).

$$E_{to} = a + b \times (p \times (0.46T + 8.13)) \qquad (32)$$

The climatic calibration coefficients were included to help improve estimates when temperature is used as the main climatic variable. The a and b values were determined to be a function of minimum relative humidity, the ratio of actual to maximum sunshine hours, and daytime wind velocity. It is not necessary to measure these values to use this method. Instead, they can be found in graphs presented by Doorenbos and Pruitt (1977).

An empirical equation for finding values of a is

$$a = 0.0043\,(RH_{min}) - n/N - 1.41 \quad (33)$$

Frevert et al (1983) presented an empirically derived equation for b as

$$b = 0.81917 - 0.0040922x(RH_{min}) + 1.0705x(n/N) + 0.065649x(U_{day}) - 0.0059684x(RH_{min})x(n/N) - 0.0005967x(RH_{min})x(U_{day}) \quad (34)$$

The parameters $RH_{min}$, n/N, and $U_{day}$ have been previously defined in the section dealing with the Penman method, where $U_{day}$ must also be adjusted if it is not measured at 2 meters in height.

This FAO modified Blaney-Criddle method was originally derived to predict $E_t$ on a monthly basis, but has been found to be quite accurate for daily measurements (Allen et al, 1983).

Doorenbos and Pruitt (1977) feel there is still some uncertainties in using their method (1) in equatorial regions where temperature is constant, but other weather parameters are not; (2) in areas where air temperature is influenced by the sea temperature, such as small islands; (3) at high altitudes where temperature variations from day to night are extreme; and (4) in climates where there is great variability in the number of sunshine hours during transition months. Under one or more of these conditions, the radiation methods are prefered.

## Radiation Methods

Jensen and Haise (1963) presented an equation to evaluate $E_{tp}$ for an alfalfa crop based on over 3000 observations over a 35 year period. They presented thier formula as:

$$E_{tp} = C_t \times (T - T_x) \times R_s \qquad (35)$$

where
$C_t = 1/(C_1 + 7.3C_h)$
$C_h = (50 \text{ mbar})/(e_2 - e_1)$
$C_1 = 38 - E/152.5$
$T_x = -2.5 - 0.14(e_2 - e_1) - E/550$
$T$ = average temperature [oC]
$e_1, e_2$ = saturation vapor pressure at mean maximum temperature ($e_2$) and mean minimum temperature ($e_1$)

The Jensen-Haise method is not related to the Penman method. This method is classified as a solar radiation method. Air temperature is also used.

The Priestly-Taylor formula (Priestly and Taylor, 1972) is similar to the Penman formula but does not contain the wind function component. The general form of the equation is

$$E_{to} = W \times R_n + P_t \times W \times R_n \qquad (36)$$

where $P_t$ = constant of value 0.26

$P_t$ is a coefficient that accounts for the wind component which appears in the Penman method. If a value for $P_t$ is accepted as 0.26, then equation 36 reduces to equation 37.

$$E_{to} = 1.26W \times R_n \qquad (37)$$

The basic argument used to justify the use of the Priestly-Taylor method as a simplified version of Penman depends upon the accuracy and availability of weather data. The accuracy of the Priestly-Taylor method is reported by McNaughton (1983) to be within 20 percent in an 'advection free' climate, with only a solar radiation term used. Another advantage of this method, is that it saves the time and money needed to evaluate the wind function for a specific region.

# EXPERIMENTAL METHODS

A field experiment was carried out to test twelve semi-empirical ET estimating methods in the Mid-Willamette Valley of Oregon. The field data necessary for each method were collected at an experimental site located at the Oregon State University Vegetable Crops farm east of Corvallis, Oregon. A field of Alta Fescue (Festuca elatior) is located at the site. An experimental plot was established at the site in March of 1985. Measurements of weather variables and soil water content in the plot were made for a single growing season (late May 1985 to mid-September 1985). Weather variables were measured on 12 hour intervals using an automatic weather station. Soil water contents were measured daily at 5 stations within the experimental plot. All five stations were replications in size and treatments. Irrigation was used during the growing season to maintain crop growth.

## Site Characteristics

### Location of Vegetable Crops Farm

The experimental site was located approximately 3/4 mile east of the Corvallis city limits and 3/4 mile north of Highway 34 in sec. 36, T. 11S, R. 5W, Lat. 44°33', and Long.

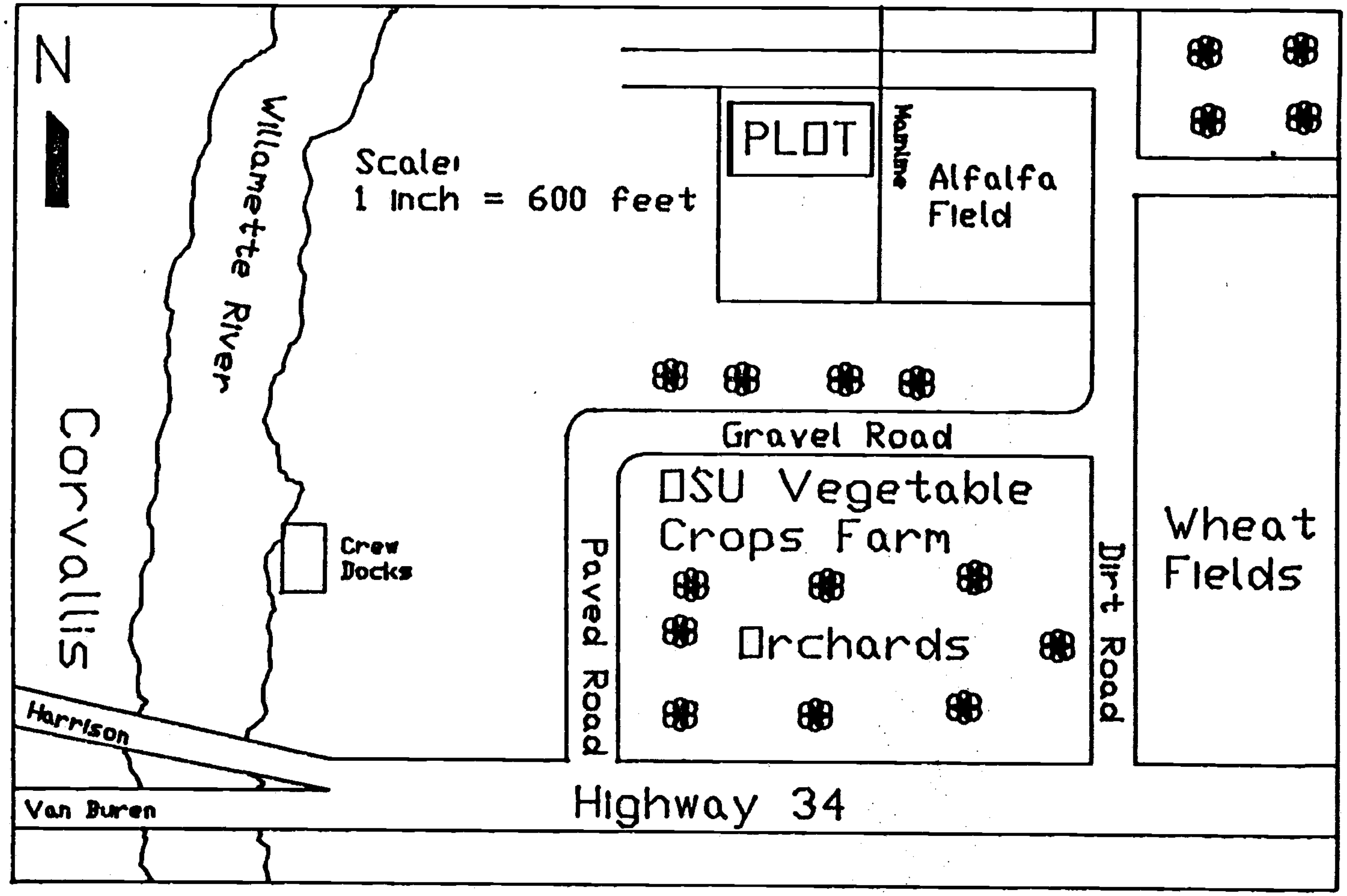


Figure 3 : Plan view of experimental site.

$123^{o}12'$ (Fig. 3). This site has been used by the Oregon State University Agricultural Engineering Department for research. A location close to Corvallis was chosen since data were to be taken on a daily basis.

## Climate

The experimental site is located in a modified marine climate (NOAA, 1974) on the Eastern foothills of the Coast Range mountains of Oregon. Average annual precipitation is 42.55 inches (1080 mm). The majority of the precipitation occurs as rain during the six month period from mid-October to mid-April. The climate is relatively free of extremes in temperatures. Table 5 shows average precipitation amounts and average, minimum, and maximum temperatures for each month for the OSU Hyslop farm weather station 4 miles north of the site.

During the summer months, winds at the site are warm and come from the West. High winds occur in late afternoon and, occasionally, in the early morning hours.

## Soils

The soils at the experimental site are classified as Chehalis (silty clay loam), Newburg (fine sandy loam), and Cloquato (silt loam) (USDA SCS,1975). These soils are deep, somewhat excessively drained to poorly drained bottom soils

| Month | Temperature [°C] max | min | avg | Precipitation inches | (mm) |
|---|---|---|---|---|---|
| Jan | 8.67 | 0.50 | 3.89 | 7.55 | (191) |
| Feb | 10.27 | 1.67 | 6.00 | 4.86 | (123) |
| Mar | 12.06 | 2.27 | 7.17 | 4.63 | (118) |
| Apr | 15.17 | 3.78 | 9.50 | 2.46 | ( 63) |
| May | 19.00 | 6.22 | 12.61 | 1.92 | ( 49) |
| Jun | 22.56 | 9.05 | 15.83 | 1.20 | ( 30) |
| Jul | 27.05 | 10.33 | 18.67 | 0.31 | ( 8) |
| Aug | 26.94 | 10.38 | 10.30 | 0.81 | ( 21) |
| Sep | 24.16 | 8.72 | 16.44 | 1.48 | ( 38) |
| Oct | 17.94 | 5.38 | 11.66 | 3.39 | ( 86) |
| Nov | 11.27 | 2.89 | 7.05 | 6.17 | (157) |
| Dec | 8.05 | 1.44 | 4.78 | 7.77 | (197) |
| Annual | 16.83 | 5.22 | 11.00 | 42.55 | (1080) |

Table 5 : Average monthly air temperatures and Precipitaion for Corvallis (1951-80). (National Climatic Center, 1983)

typical of the Willamette River floodplains and low terraces. Flooding and a seasonal (winter) high water table are common. Slopes are moderate, and range from 0 to 3 percent.

The available water holding capacity of these soils ranges from 0.13 to 0.15 inches of water per inch of soil. Permeability is quite high, between 2.0 to 6.0 inches per hour (51 to 153 mm per hour).

## Crop

A plot of a well-established stand of Alta Fescue (Festuca elatior) is located at the site. Alta Fescue is a deep-rooted, tufted, long-lived perennial grass having numerous dark green basal leaves and comparatively few seed stalks. The branched or panicle heads are 4 to 12 inches (10 to 30 cm) long.

Alta Fescue in old, well-established stands develops a uniform sod. The roots of the plant are numerous, coarse, and normally penetrate to a depth of 5 feet (1.5 m) in moist soils. It has a long growing season and remains green throughout the summers in Western Oregon.

Alta Fescue grows best on fertile, moist, and heavy lands. The grass will tolerate poorly drained conditions and will survive in standing water in the semi-dormant stage of winter. Alta Fescue is believed to possess real possibilities as an aid in perennial weed control because of its deep roots, dense growth, long growing season, and general aggressiveness (Rampton, 1945).

## Plot Layout

The experimental plot is 125 feet (38 m) wide by 300 feet (91 M) long. Five water content measuring stations were placed in a straight line and spaced 60 feet (18 m) apart within the plot (Figs. 4 and 5). A neutron meter access tube was installed at each station. Holes for the tubing were made with a Geddings auger. The access tubes were made of 2 inch (5.1 cm) diameter aluminum irrigation pipe and were installed to a depth of 6.5 feet (2 m). One foot (0.3 m) of tube was left above the soil surface. A

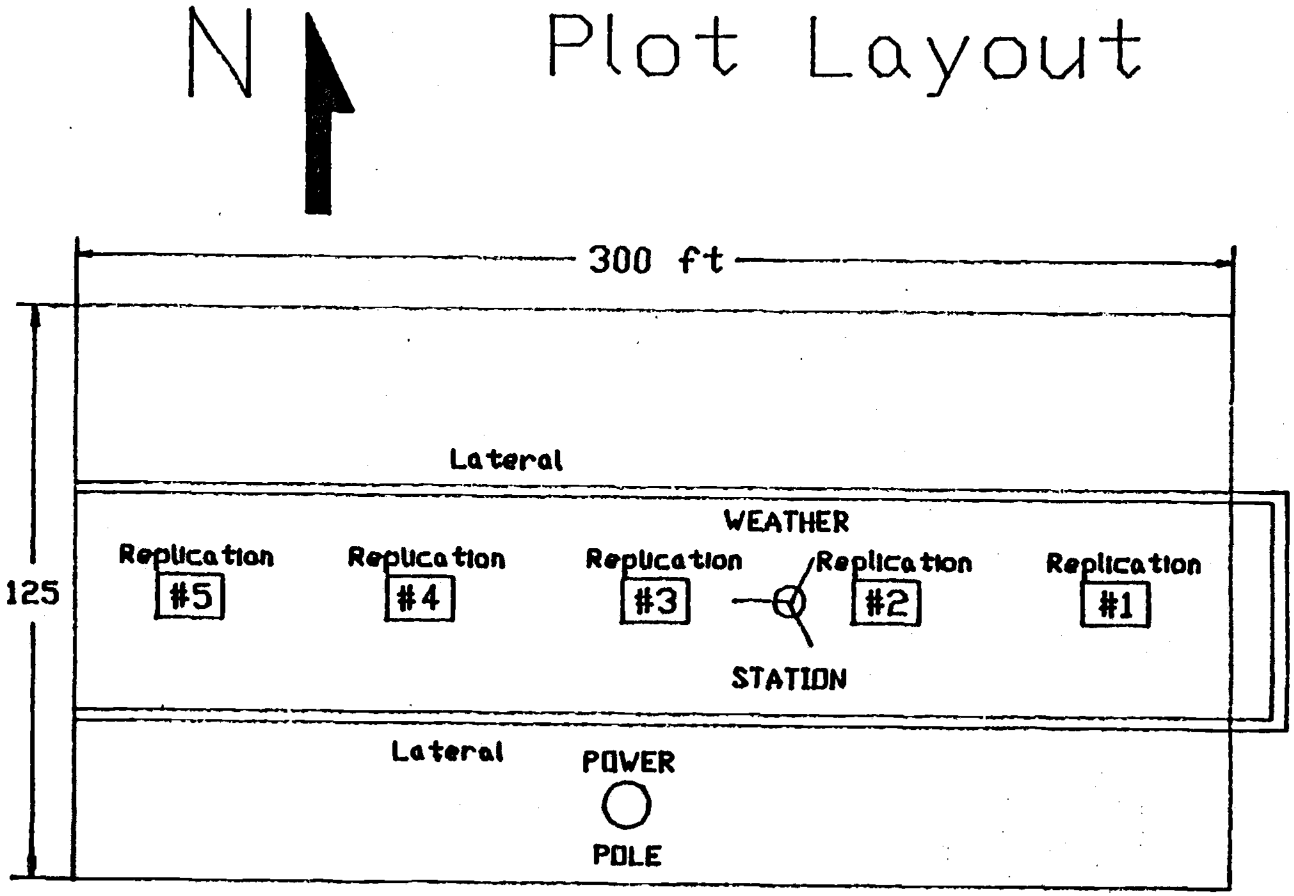


Figure 4 : Plan view of experimental plot.

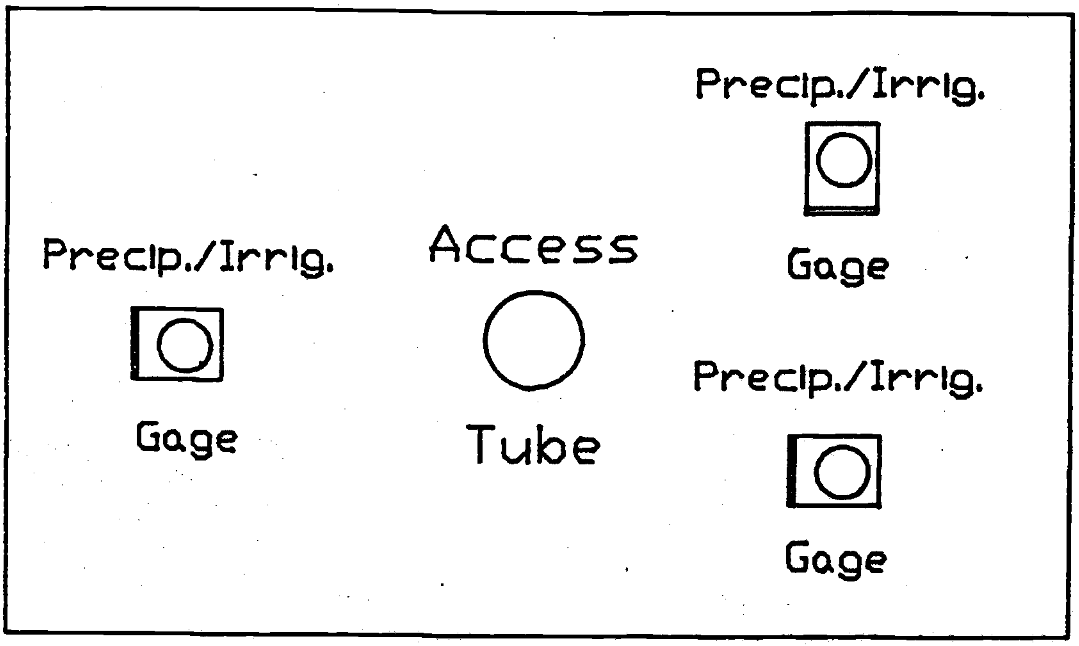


Figure 5 : Plan view of replication.

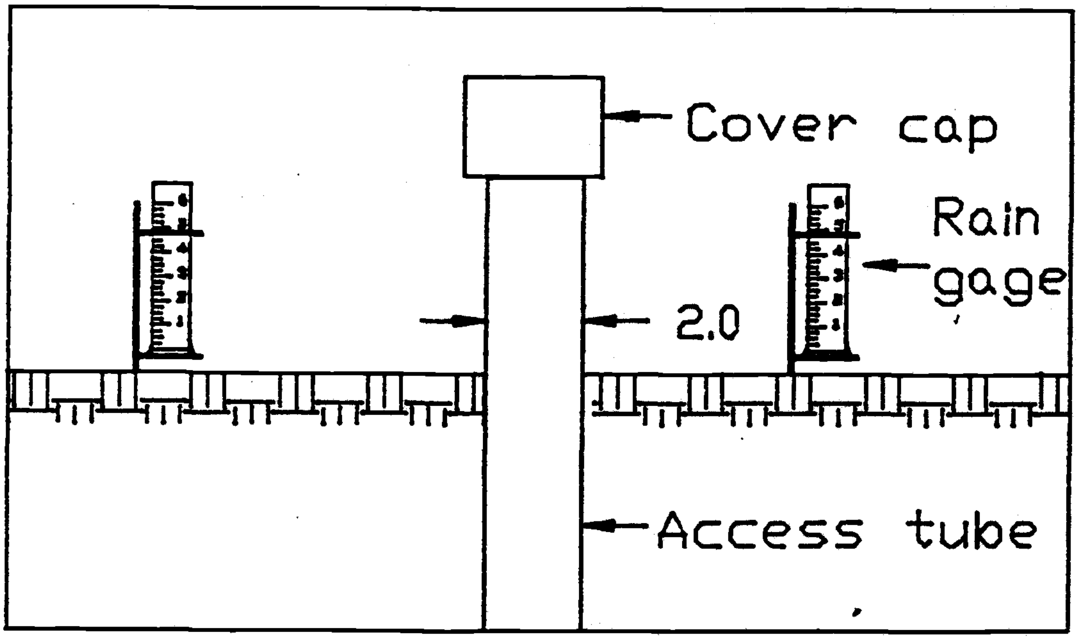


Figure 6 : Cross section of replication.

rubber stopper was placed on the lower end of each tube to prevent water from entering the tube during high water table conditions. A metal can was placed on top of each access tube to prevent water and debris from entering the tube (Fig. 6). Three plastic irrigation/precipatation gauges were placed around each access tube in a triangular formation to verify the precipitation amounts measured by the weather station. A weather station was placed on the highest part of the plot, between stations 2 and 3 (Fig. 4).

A lateral sprinkler line was set on each side of the plot (Fig. 4). Each line was positioned 20 feet (6 m) from the water content measuring stations. Each lateral was equipped with eight half-circle Rain-Bird sprinklers. The sprinkler system was controlled with an automatic timer switch.

## Data Collection Schedule

Field data were taken on a daily basis from May 27, 1985 to September 14, 1985. Water contents were measured at each station using a HYDROPROBE neutron meter. These measurements were made between 7:00 and 8:00 A.M. Neutron meter readings were made in each access tube at the following depths: 10, 20, 30, 45, 60, 75, 90, 120, 150, and 180 cm.

Irrigation and precipitation amounts were measured at the same time as neutron meter readings. The plot was irrigated at night. An average of the three irrigation gage measurements around each access tube was used as a measurement of irrigation and precipitaion water applied.

The data tapes for the weather station were changed every Friday morning between 7:30 and 8:00.

## Neutron Probe Calibration

A low level neutron emitting probe was used to measure soil water content. The neutron probe used, model no. 503 HYDROPROBE, is manufactured by Campbell Pacific Nuclear Corporation. The HYDROPROBE emits high speed (fast) neutrons from a radioactive Americium 241/Beryllium source. The sphere of influence of the fast neutrons is an average of 1 foot (30 cm) in diameter (Fig. 7). These fast neutrons are slowed and reflected when they collide with hydrogen atoms. These slow, reflected neutrons are then detected and counted for a specified time interval. The HYDROPROBE uses one minute as the counting time interval.

Most of the hydrogen atoms in the soil are in the form of water ($H_2O$), but some hydrogen is also present in organic matter, especially near the soil surface. The neutron probe was calibrated using soil samples taken during installation of the access tubes. Soil samples were taken using a Madera soil sampler at depths of 10, 20, 30, 45, 60, and 75 cm.

Linear regression was used to determine the

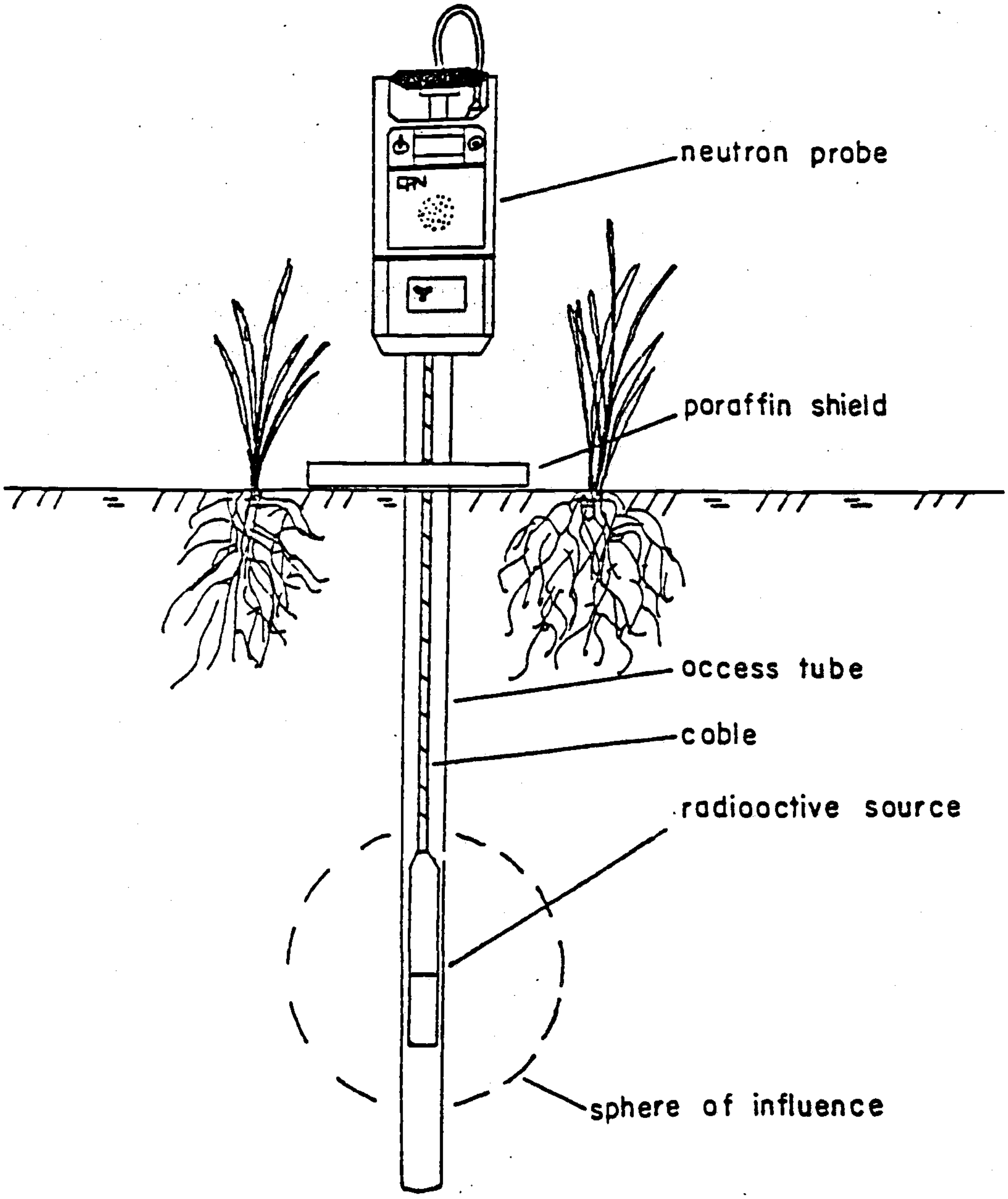


Figure 7 : Representative view of neutron meter in operation on access tube (Nuss, 1982).

relationship (the calibration curve) between measured water contents using the neutron probe and the water contents obtained by drying soil samples. The form of the regression equation used is:

$$\theta w = B_1 \times \text{ratio} - B_0 \quad (38)$$

where $\theta w$ = soil water content (percent) by weight

ratio = ratio of measured count to a standard count

$B_0, B_1$ = Coefficients of regression equation

The standard count used in equation 38 is the average of ten counts of the neutron probe on a paraffin shield. The standard count is used to help account for any random decay or day to day "drift" in the neutron emission (Campbell Pacific Nuclear, 1984). The standard count used for this experiment was 24736.

Four regression equations were used to convert neutron meter readings to soil water content. Three of these equations were used to describe the upper 30 cm of the soil surface where there might be inaccuracies due to the presence of high soil organic matter. Table 6 shows the values for $B_0$, $B_1$, and $r^2$ for each calibration equation.

The coefficients of correlation, $r^2$, in Table 6 measure how well the linear model fitted the experimental data. Figures 8, 9, 10, and 11 are graphs of the fitted linear models for each of the four neutron probe calibration equations.

| Depth (cm) | $B_0$ | $B_1$ | $r^2$ | # of samples |
|---|---|---|---|---|
| 10 | 0.1082 | 0.45134 | 0.79 | 7 |
| 20 | 0.1740 | 0.45868 | 0.79 | 7 |
| 30 | 0.0877 | 0.37490 | 0.83 | 7 |
| >30 | 0.3340 | 0.53423 | 0.94 | 18 |

Table 6 : Coefficients of regression equations used to convert neutron meter reading to soil water contents.

## Weather Data

The weather station used for this experiment was a Campbell Scientific CR21 Micrologger. The weather data measured and recorded by the Micrologger were: maximum, minimum, and average air temperature, incoming and outgoing solar radiation, precipitation, maximum, minimum, and average relative humidity at a height of 2 meters above the soil surface. Wind speed and run were measured at a height of 3 meters above the soil surface.

Once each minute, the Micrologger samples the input signals from each of the weather sensors. This data is then averaged over a thirty minute period and written onto a magnetic tape cassette. Each tape can hold approximately one week of data. The weather data on the tapes were transfered to an IBM PC microcomputer for analysis. Computer programs were written in the Basic language to convert this weather data into the form required by each of

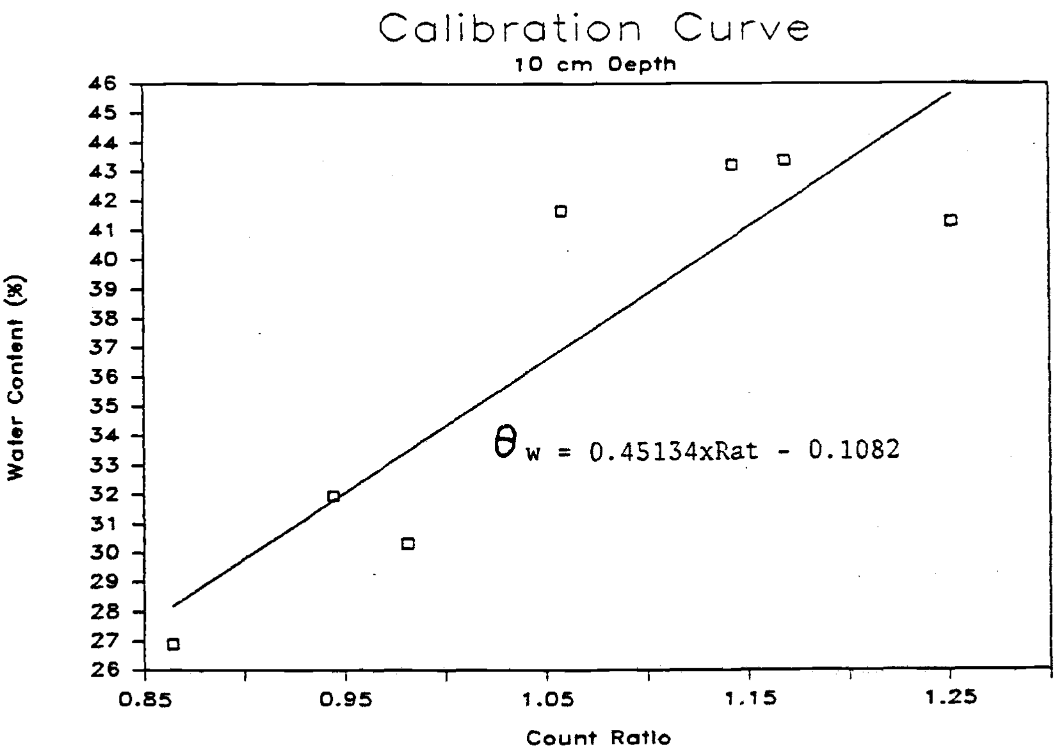


Figure 8 : Neutron probe calibration for 10 cm depth.

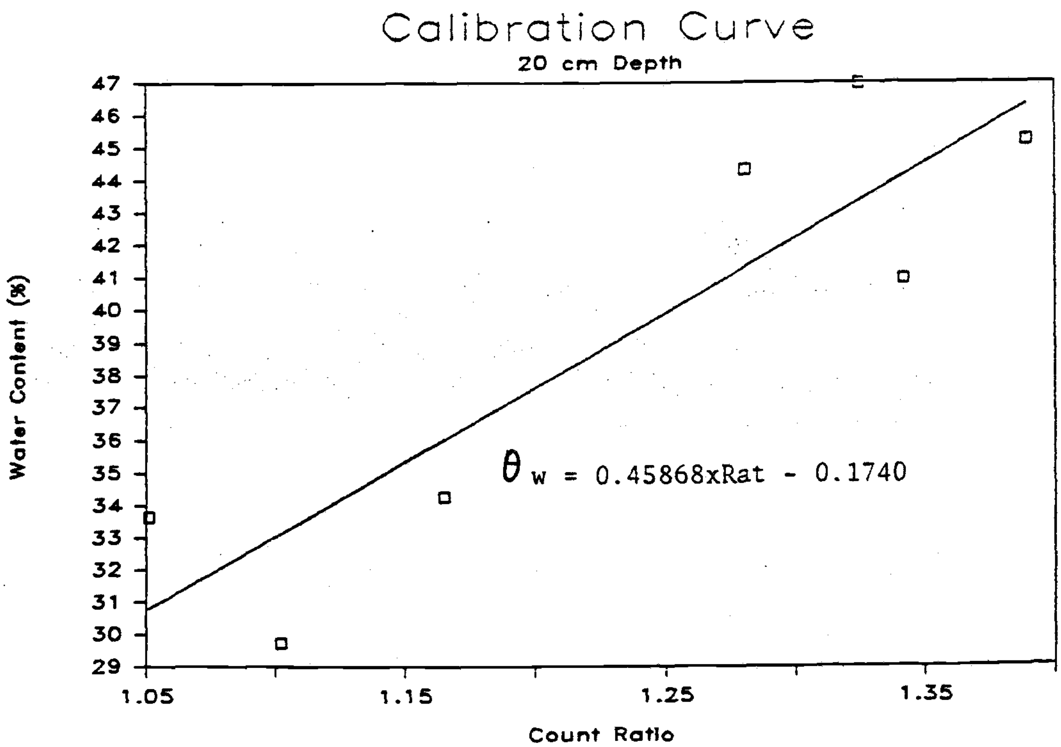


Figure 9 : Neutron probe calibration for 20 cm depth.

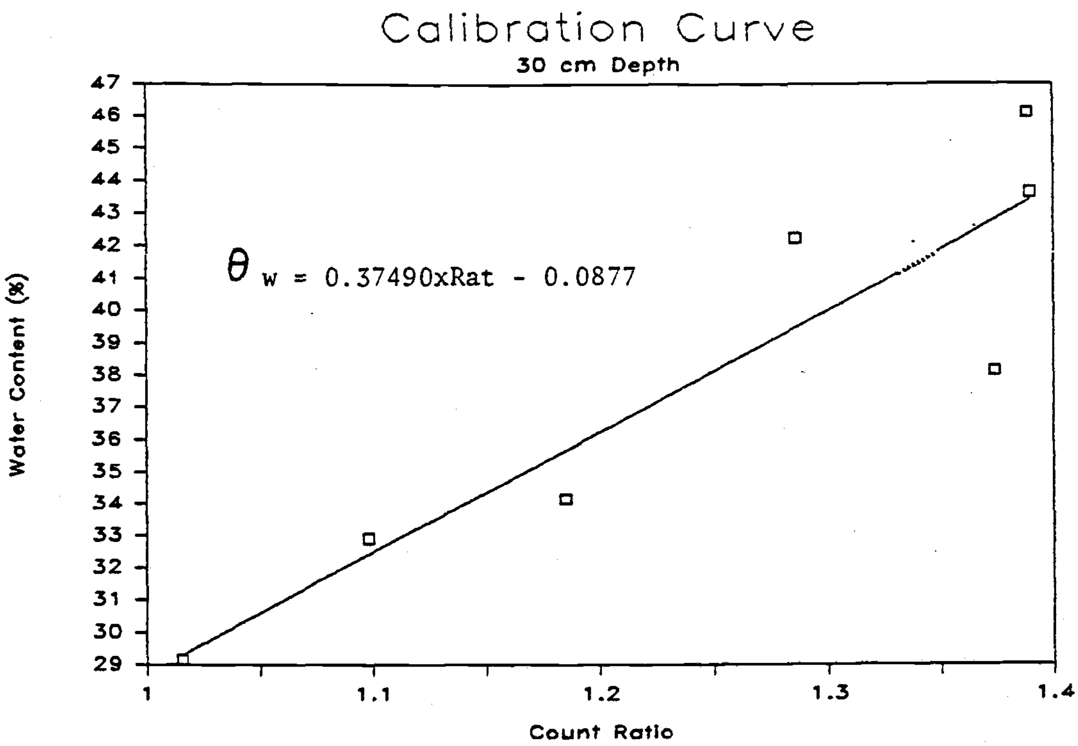


Figure 10 : Neutron probe calibration for 30 cm depth.

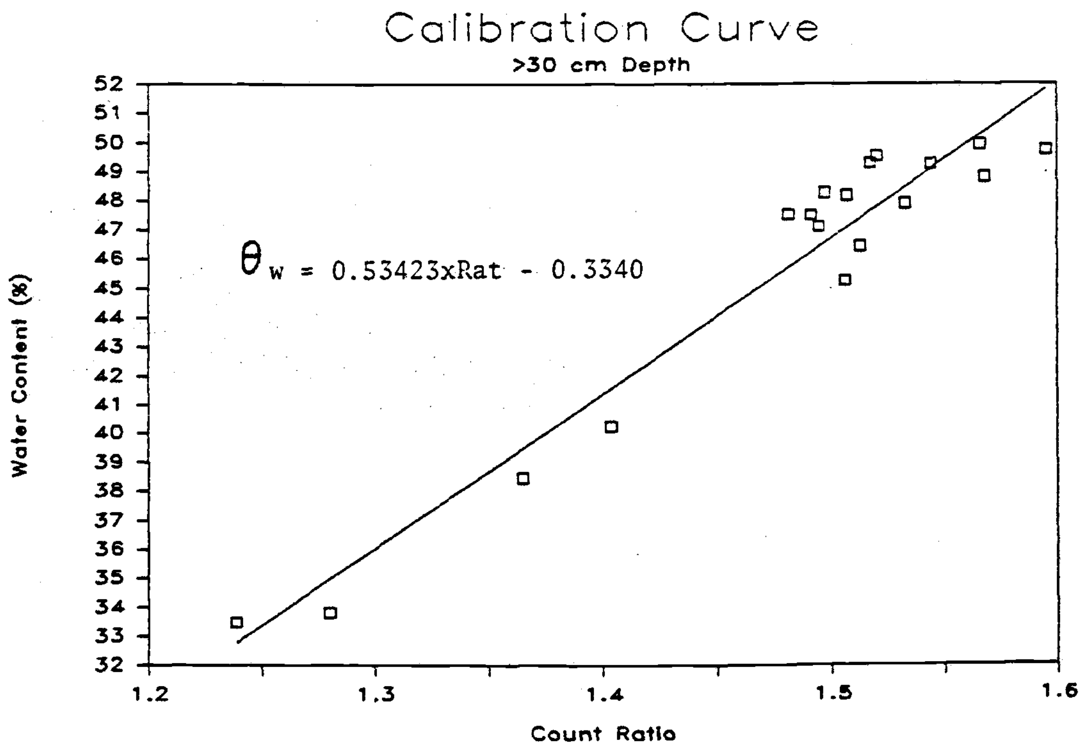


Figure 11 : Neutron probe calibration for depths greater than 30 cm.

the methods for measuring ET. Appendix A gives a listing of weather data collected in this study.

## Irrigation Data

Irrigation events were performed using 2 lateral lines, one on each side of the subplots. Figure 12 depicts the laterals and the sprinkler patterns for each sprinkler on the plot. The sprinklers used were Rain Bird 35PJ-TNT (part circle) with a 5/32" (4 mm) nozzle size. Lateral line pressure used by the sprinklers was kept in the range of 40 to 55 psi (276000 to 379000 Pascals). Table 7 gives performance information for the Rain Bird 35PJ-TNT sprinkler.

| Pressure (psi) | Wetted Diameter (ft) | Output Rate (GPM) | Application Rate * (in/hr) |
|---|---|---|---|
| 30 | 42 | 3.85 | 0.46 |
| 35 | 43 | 4.16 | 0.50 |
| 40 | 44 | 4.45 | 0.54 |
| 45 | 44 | 4.72 | 0.57 |
| 50 | 45 | 4.98 | 0.60 |
| 55 | 45 | 5.22 | 0.63 |
| 60 | 46 | 5.44 | 0.65 |

* Application rates were calculated using the following formula:

$$AR = \frac{192.6 \times Q}{LS \times MS} \qquad (39)$$

where AR = application rate [in/hr]
Q = output rate [GPM]
LS = lateral spacing [ft]
MS = mainline spacing [ft]

Table 7 : Design information for Rain Bird sprinkler 35PJ-TNT with 5/32" nozzle.

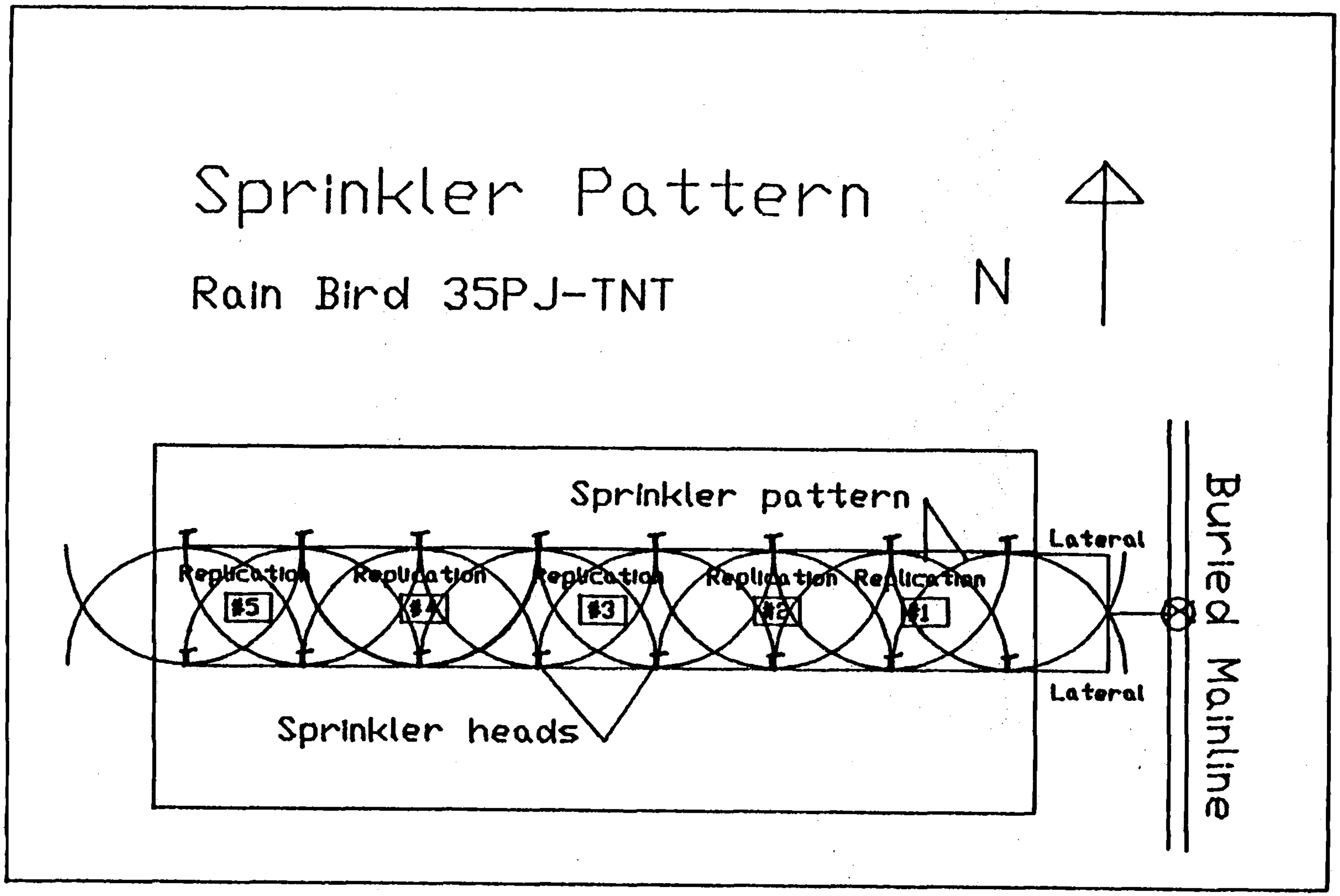


Figure 12 : Sprinkler irrigation pattern on plot.

The amount of water applied during an irrigation was determined from the water content measurements made with the neutron probe. Enough water was applied during each irrigation to bring the top three feet of the soil profile close to field capacity. This required between 1 and 4 inches (75-100 mm). Irrigation dates and amounts for the season are shown in Table 8.

| Date | 6/19 | 7/04 | 7/09 | 7/19 | 8/08 | 8/14 | 9/07 |
|---|---|---|---|---|---|---|---|
| Amount | | | | | | | |
| [in] | 3.9 | 0.3 | 1.9 | 3.6 | 1.5 | 1.5 | 1.6 |
| [mm] | 98.0 | 8.4 | 49.8 | 92.4 | 38.8 | 38.4 | 41.4 |

Table 8 : Irrigation dates and amounts for season on experimental plot.

# DATA ANALYSIS

## Collected Data

### Measured ET

Daily ET values were measured in the soil profile using a mass balance of water. A mass balance is defined as follows:

$$\frac{\Delta V}{\Delta t} = Q_{in} - Q_{out} \qquad (40)$$

where $\Delta V$ = change in water volume
$\Delta t$ = time interval being considered
$Q_{in}$ = mass flow rate in
$Q_{out}$ = mass flow rate out

Equation 40 is a general mass balance equation that can be applied to many situations. In using a mass balance, all mass flowing in or out must be taken into consideration. Equation 41 is a more specific equation that was used to obtain measured evapotranspiration in the soil profile.

$$ET_i = (TW_i - TW_{i-1}) + Irr_i + Rn_i \qquad (41)$$

where $ET_i$ = measured ET for day i
$TW_i$ = measured soil water content for total soil profile on day i [mm]
$TW_{i-1}$ = measured soil water content for total soil profile on day i-1 [mm]
$Irr_i$ = irrigation amount on day i [mm]
$Rn_i$ = rainfall amount on day i [mm]

Equation 41 assumes any horizontal movement of water is equal in all directions. Any losses due to deep percolation are also assumed to be zero. It appeared reasonable to assume no deep percolation since day to day changes in the soil moisture of the lowest two soil layers were very small.

A computer program was written to analyze the neutron meter readings (Appendix B). Figure 13 shows a sample printout generated by the computer for a single access tube over several days. The printout gives the date and the amount of water, in mm, for each of the ten soil layers. The sum of the mm of water for all ten soil layers is given as the total sum. The daily measured ET values are the differences, from day to day, in the total sums of water. The daily measured ET values are shown as depletion (per period) values.

The amount of water in a soil layer was found using equation 42 (Appendix C) and the neutron probe calibration equation used with this soil layer.

$$AW = t_i \times \theta_v \qquad (42)$$

where $AW$ = amount of water in soil layer [mm]
$t_i$ = thickness of soil layer [mm]
$\theta_v$ = soil water content [fraction]

The thickness of the soil layer was found by the following equation.

$$t_i = \frac{d_{i+1} + d_{i-1}}{2} \qquad (43)$$

EVAPOTRANSPIRATION EXPERIMENT: OSU VEG CROPS 1985

ACCESS TUBE # 3

WATER APPLICATION EVENTS

| | | |
|---|---|---|
| DATE | 08/08 | 08/14 |
| IRR (mm) | 35.0 | 35.0 |
| PRECIP (mm) | 0.0 | 0.0 |

TOTALS

| | |
|---|---|
| IRR (mm) | 70.0 |
| PRECIP (mm) | 0.0 |

UNADJUSTED mm OF SOIL MOISTURE

| | | DEPLETION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SOIL DEPTH (cm) | FC | 08/01 | 08/02 | 08/03 | 08/04 | 08/05 | 08/07 | 08/08 | 08/09 | 08/12 |
| 0.0 - 15.0 | 75.38 | 54.91 | 52.31 | 51.00 | 50.15 | 48.77 | 53.59 | 65.60 | 62.44 | 56.75 |
| 15.0 - 25.0 | 47.74 | 38.92 | 38.42 | 38.57 | 37.56 | 37.90 | 36.13 | 43.45 | 43.29 | 41.27 |
| 25.0 - 37.5 | 58.28 | 47.32 | 46.44 | 45.68 | 45.24 | 44.57 | 43.51 | 51.77 | 50.54 | 48.10 |
| 37.5 - 52.5 | 70.47 | 55.80 | 54.60 | 53.02 | 52.79 | 51.18 | 49.53 | 55.17 | 52.98 | 52.01 |
| 52.5 - 67.5 | 71.24 | 61.12 | 59.44 | 59.64 | 57.73 | 58.02 | 55.94 | 56.06 | 55.15 | 55.53 |
| 67.5 - 82.5 | 73.80 | 63.31 | 63.11 | 63.12 | 62.42 | 61.09 | 60.27 | 60.13 | 60.34 | 58.75 |
| 82.5 - 105.0 | 113.18 | 96.73 | 96.87 | 95.94 | 94.72 | 99.24 | 94.31 | 93.13 | 93.77 | 93.25 |
| 105.0 - 135.0 | 137.73 | 130.10 | 130.66 | 130.21 | 128.59 | 127.47 | 127.49 | 127.47 | 128.37 | 127.63 |
| 135.0 - 165.0 | 140.31 | 132.35 | 131.59 | 131.33 | 131.53 | 131.17 | 129.67 | 131.60 | 131.28 | 128.09 |
| 165.0 - 195.0 | 163.77 | 142.18 | 143.59 | 143.64 | 143.37 | 144.54 | 143.12 | 145.50 | 145.24 | 143.02 |
| TOTAL SUM | 951.85 | 822.74 | 817.03 | 813.75 | 804.10 | 803.95 | 793.56 | 829.88 | 823.40 | 804.40 |
| DEPLETION (PER PERIOD) | | 129.11 | 5.71 | 3.28 | 9.65 | 0.15 | 10.39 | -36.32 | 6.48 | 19.00 |
| DEPLETION (CUMULATIVE) | | 129.11 | 134.82 | 138.10 | 147.75 | 147.90 | 158.29 | 121.97 | 128.45 | 147.45 |

**Figure 13 : Example printout for measured ET computer program.**

where $t_i$ = thickness of soil layer i [mm]
$d_{i+1}$ = depth of neutron meter reading for soil layer i+1 [mm]
$d_{i-1}$ = depth of neutron meter reading for soil layer i-1 [mm]

Equation 43 is true for soil layers 2 to 9, but not the boundary layers 1 and 10. Soil layers 1 and 10 were given values of 150 mm and 300 mm.

The following example illustrates how to find the amount of water in a soil layer. Assume the neutron meter reading for depth layer 3 was 33804 and the standard count was 24736.

Step 1

Use equation 38 with the calibration coefficients for soil layer 3 (30 cm).

$$\theta_v = 0.37490 \times \text{ratio} - 0.0877$$

$$\theta_v = 0.37490 \times \frac{33804}{24736} - 0.0877$$

$$\theta_v = 0.4246$$

Step 2

Determine the soil layer thickness using equation 43.

$$t_i = \frac{450 - 200}{2}$$

$$t_i = 125 \text{ mm}$$

Step 3

Find the amount of water in soil layer 3 using equation 42.

AW = 125 mm x 0.4246

AW = 53.075 mm water

In order to find cumulative depletions, field capacity measurements were used as a reference value. A depletion value was the difference between the field capacity and total measured soil moisture in a soil layer. Field capacity measurements were measured for each access tube and each depth layer. Measurements of field capacity were made using the neutron meter readings from two days after an irrigation which saturated the whole soil profile. These volumetric field capacity measurements are given as fractions in Table 9. The field capacity for each soil layer and each tube station, in mm, is found using equation 42, but substituting values in Table 9 for $\theta_v$.

| | Field Capacity (% volume) | | | | |
|---|---|---|---|---|---|
| Depth (cm) | Tube 1 | Tube 2 | Tube 3 | Tube 4 | Tube 5 |
| 10 | 0.5169 | 0.5615 | 0.5025 | 0.5035 | 0.5003 |
| 20 | 0.5085 | 0.5224 | 0.4774 | 0.4743 | 0.4626 |
| 30 | 0.4715 | 0.4648 | 0.4662 | 0.4709 | 0.4298 |
| 45 | 0.4541 | 0.4570 | 0.4698 | 0.4704 | 0.3962 |
| 60 | 0.4815 | 0.4895 | 0.4749 | 0.4764 | 0.4002 |
| 75 | 0.5072 | 0.4959 | 0.4920 | 0.4816 | 0.3704 |
| 90 | 0.4852 | 0.5033 | 0.5030 | 0.4953 | 0.3692 |
| 120 | 0.4856 | 0.4668 | 0.4591 | 0.5481 | 0.4877 |
| 150 | 0.4881 | 0.4675 | 0.4688 | 0.5653 | 0.5130 |
| 180 | 0.4780 | 0.4803 | 0.5459 | 0.5948 | 0.4915 |

Table 9 : Field capacity measurements used to estimate water in soil profile.

A formula was used to find daily measured ET values for the day following an irrigation (Equation 44).

$$ET_i = IrrAmt_i + Dep \qquad (44)$$

where $ET_i$ = daily measured ET on day after irrigation [mm]

$IrrAmt_i$ = Amount of irrigation water applied on day i [mm]

Dep = depletion from day i to day i+1 [mm]

Since an irrigation adds water to the soil, the depletion will have a negative sign. The measured ET is the difference between the measured amount of irrigation water applied and the depletion for the previous day.

The daily measured ET values showed large fluctuations from day to day. These large fluctuations can partially be explained by:

1) time required for the redistribution of water in the soil profile,
2) inaccuracy of neutron meter calibration equations due to nonhomogeneous soil profiles, and
3) small fluctuations in the random decay of the radioctive elements in the HYDROPROBE.

To eliminate some of this daily variation, a moving average technique was used. The daily data were averaged over 3, 7, and 14 days using the following equation:

$$ETavg_j = \frac{\sum_{i=1}^{N} ET_{j+i}}{N} \qquad (45)$$

where $ETavg_j$ = measured evapotranspiration for day j averaged for N days

$ET_i$ = measured evapotranspiration for day i

N = number of days averaged

The results of this moving average analysis are tabulated in Appendix C.

## Calculated ET

Calculated ET values were computed using weather data collected by a Campbell Scientific CR21 Micrologger. The data files were converted from a formatted set of lines into tables using a computer program. These tables were then converted into the appropriate units needed for analysis. All the data were put into the same formatted tables and units. These data were averaged from one-half hour readings into 12 and 24 hour tables. Appendix A contains a list of the 24 hour averaged data.

A complete set of weather data was taken for the entire growing season with the exception of days 192 and 193. On those days, power to the Micrologger was accidently turned off. Data to complete the record for these days was acquired from the State Climatological Center in Corvallis. Data from this office correlated well with the data obtained at the experimental site at other times during the season.

Twelve semi-emperical models for predicting ET were selected to compare with the measured ET. The models chosen were the Original Penman, the FAO Modified Penman, the SCS Modified Blaney-Criddle, the FAO Modified Blaney-Criddle, the Jensen-Haise, and the Priestly-Taylor. The Original Penman and the FAO Modified Penman each have four methods to find the vapor pressure deficit term. The derivation of these models has already been discussed. Each model has been proven to predict ET well in specific climates, so a wide variety of models were chosen for analysis to help insure finding one that suits a modified marine climate, namely the Willamette Valley of Oregon. Table 10 is a list of the semi-empirical methods analyzed.

---

Semi-empirical methods

---

1. Original Penman using vapor deficit method 1
2. Original Penman using vapor deficit method 2
3. Original Penman using vapor deficit method 4
4. Original Penman using vapor deficit method 5
5. FAO Penman using vapor deficit method 1
6. FAO Penman using vapor deficit method 2
7. FAO Penman using vapor deficit method 4
8. FAO Penman using vapor deficit method 5
9. SCS Blaney-Criddle
10. FAO Blaney-Criddle
11. Jensen-Haise
12. Priestly-Taylor

Vapor pressure deficit methods

1. Saturation vapor pressure at average temperature minus vapor pressure at minimum dewpoint temperature.
2. Saturation vapor pressure at average temperature minus vapor pressure at average dewpoint temperature.
4. Average of saturation vapor pressure at maximum and minimum temperatures minus vapor pressure at average dewpoint temperature.
5. Average saturation vapor pressure deficit computed at maximum and minimum temperature.

---

Table 10 : Semi-empirical ET estimation methods used for analysis.

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Each of the models tested required the input of weather data. The number of weather parameters used by each method varies as shown in Table 11.

| ET Method | TAVG | TMIN | TMAX | HAVG | HMIN | HMAX | WIND | SRAD |
|---|---|---|---|---|---|---|---|---|
| Orig Penman | X | X | X | X | X | X | X | X |
| FAO Penman | X | X | X | X | X | X | X | X |
| SCS Blan-Crid | X | | | | | | | |
| FAO Blan-Crid | X | | | | X | | X | |
| Jensen-Haise | X | X | X | | | | | X |
| Pries-Taylor | X | X | X | | | | | X |

Table 11 : Weather parameters used in calculation of ET for various empirical methods.

Several of the methods use almost all of the weather parameters measured. The amount of weight put on the parameter determines the differences in the results between the different methods. Some of these methods also use location and crop factors such as elevation, latitude, and albedo.

Comparing Measured ET and Calculated ET

The procedures used in analyzing each evapotranspiration estimating method included the following steps:

1. Weather data files were read into a computer model for each estimating method and converted into selected units .

2. Calculation of evapotranspiration in each computer model using formulas presented earlier.

3. Graphs of cumulative ET measured vs cumulative ET calculated (double mass balance) were plotted with the theoretical line added for visual analysis (see Appendix E).

4. Graphs of ET measured vs ET calculated were generated with the theoretical line added for visual analysis (see Appendix F).

5. A linear regression of measured ET vs calculated ET was fitted through the origin.

6. Lines of all the sliding averages were plotted on the same graph with the theoretical line (see Appendix G).

# RESULTS

The results of this thesis were based on several techniques used to analyze the ET data.

1) The first technique employed a double mass balance (cumulative ET values) to observe the relationship between the measured and calculated ET.
2) Simple regression curves of measured ET ($ET_m$) vs calculated ET ($ET_c$) were visually compared with theoretical curves in the second analysis technique.
3) Another method of evaluation involved fitting a regression line through the origin using $ET_m$ vs $ET_c$ data. The slope of the regression line was compared to the theoretical slope.
4) Finally, improvements in ET estimates using sliding averages were tested for each of the twelve methods.

## Double Mass Balance

A double mass balance is used to compare cumulative measured and calculated values over a long period of time. Ideally, the graph of cumulative $ET_c$ values should closely follow the theoretical line over the entire test period, minor fluctuations in the cumulative ET should be centered around the theoretical line, and the magnitude of these fluctuations should not be large. The average of the residuals (difference between observed $ET_c$ and the corresponding fitted $ET_c$ using the regression line) should be aproximately zero. If the residuals are negative, the method underpredicts measured ET.

Analysis of the double mass balance curves showed a small deviation from the theoretical curve at the end of the test period for four methods. These four methods were the FAO Blaney-Criddle and the FAO Penman using vapor pressure deficit methods 1,4, and 5. Table 12 shows cumulative ET values and the error at the end of the test period for all 12 methods. All 12 methods underpredicted measured ET for the test period.

| Method Tested | Cum ET Measured [mm] | Cum ET Calculated [mm] | Percent Difference |
|---|---|---|---|
| Orig Pen 1 | 593 | 426 | - 28.16 |
| Orig Pen 2 | 593 | 398 | - 32.88 |
| Orig Pen 4 | 593 | 423 | - 28.67 |
| Orig Pen 5 | 593 | 440 | - 25.80 |
| FAO Pen 1 | 593 | 556 | - 6.24 |
| FAO Pen 2 | 593 | 493 | - 16.86 |
| FAO Pen 4 | 593 | 550 | - 7.25 |
| FAO Pen 5 | 593 | 587 | - 1.01 |
| SCS BC | 593 | 460 | - 22.43 |
| FAO BC | 593 | 590 | - 0.61 |
| Jens-Hais | 593 | 304 | - 48.75 |
| Pries-Tay | 593 | 412 | - 30.52 |

Table 12 : Cumulative ET values for growing season.

Double mass balance graphs are presented in Figs. 14 and 15. Fig. 14 shows a curve of the method with the least error, this being the FAO Blaney-Criddle. Fig. 15 presents the method with the worst error as the Jensen-Haise. Fig. 16 shows the four best double mass balance curves. Graphs for all the other methods can be found in Appendix E.

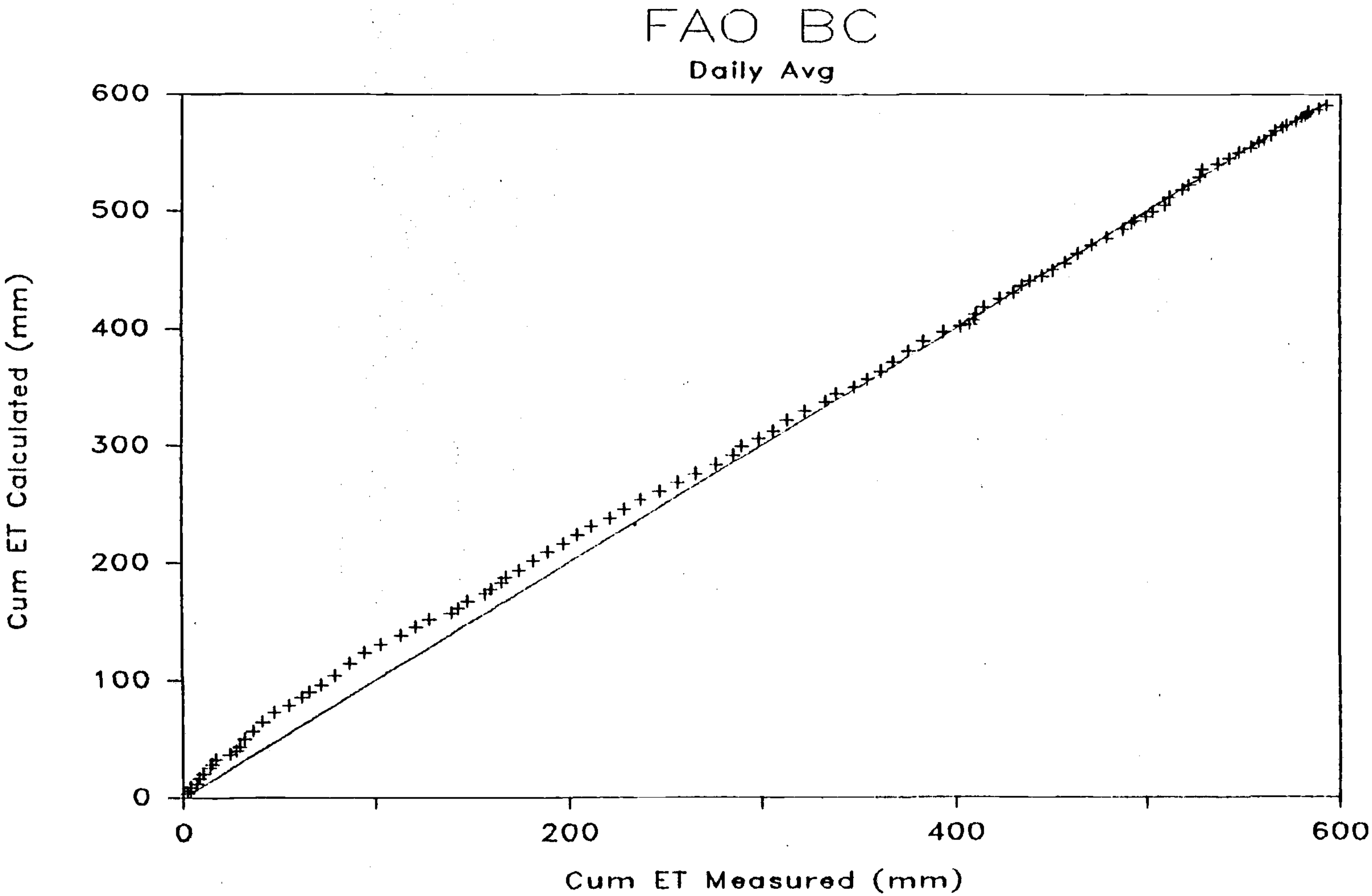


**Figure 14 : Double mass balance curve for FAO Blaney-Criddle method.**

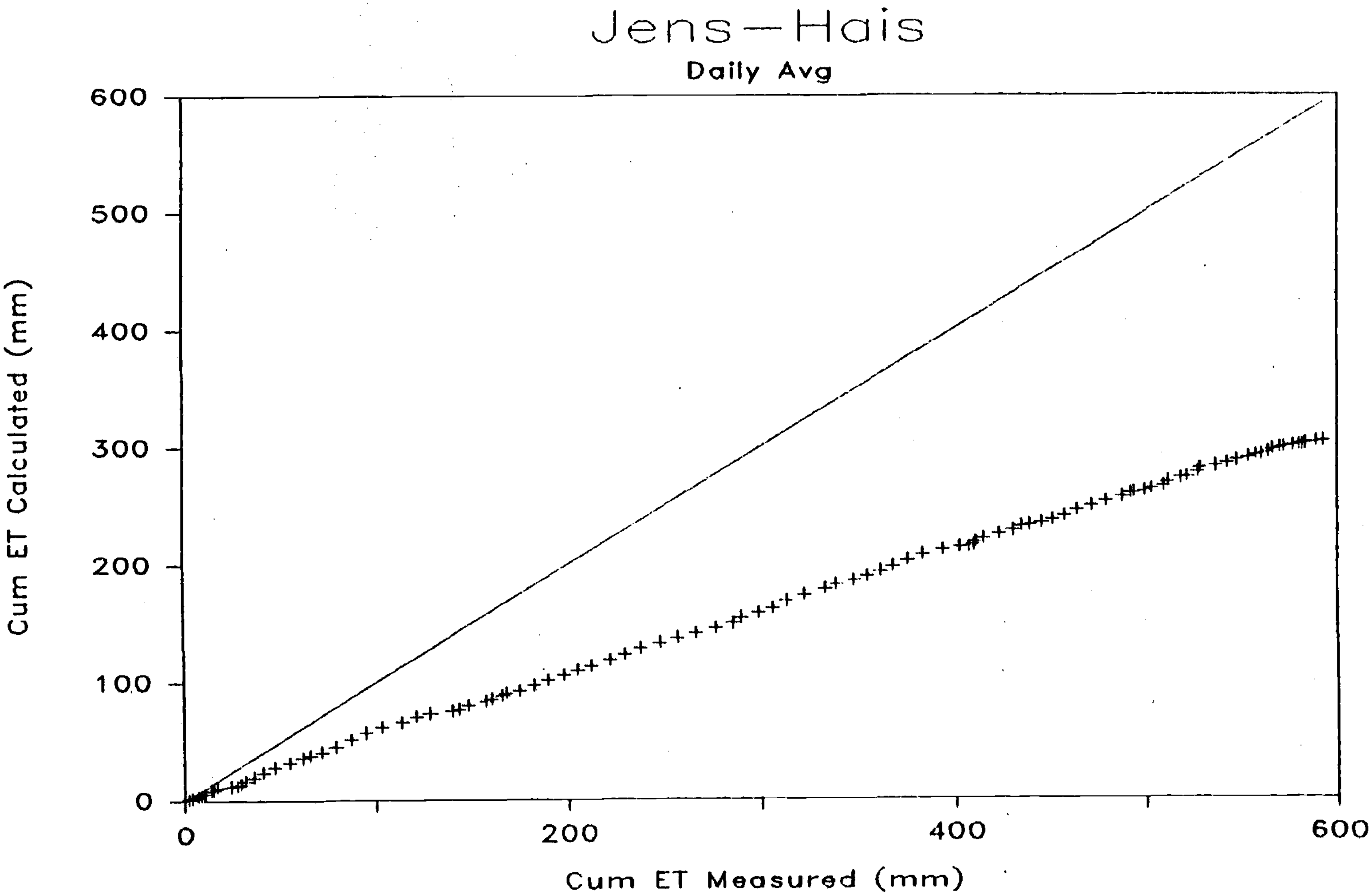


Figure 15 : Double mass balance curve for Jensen-Haise method.

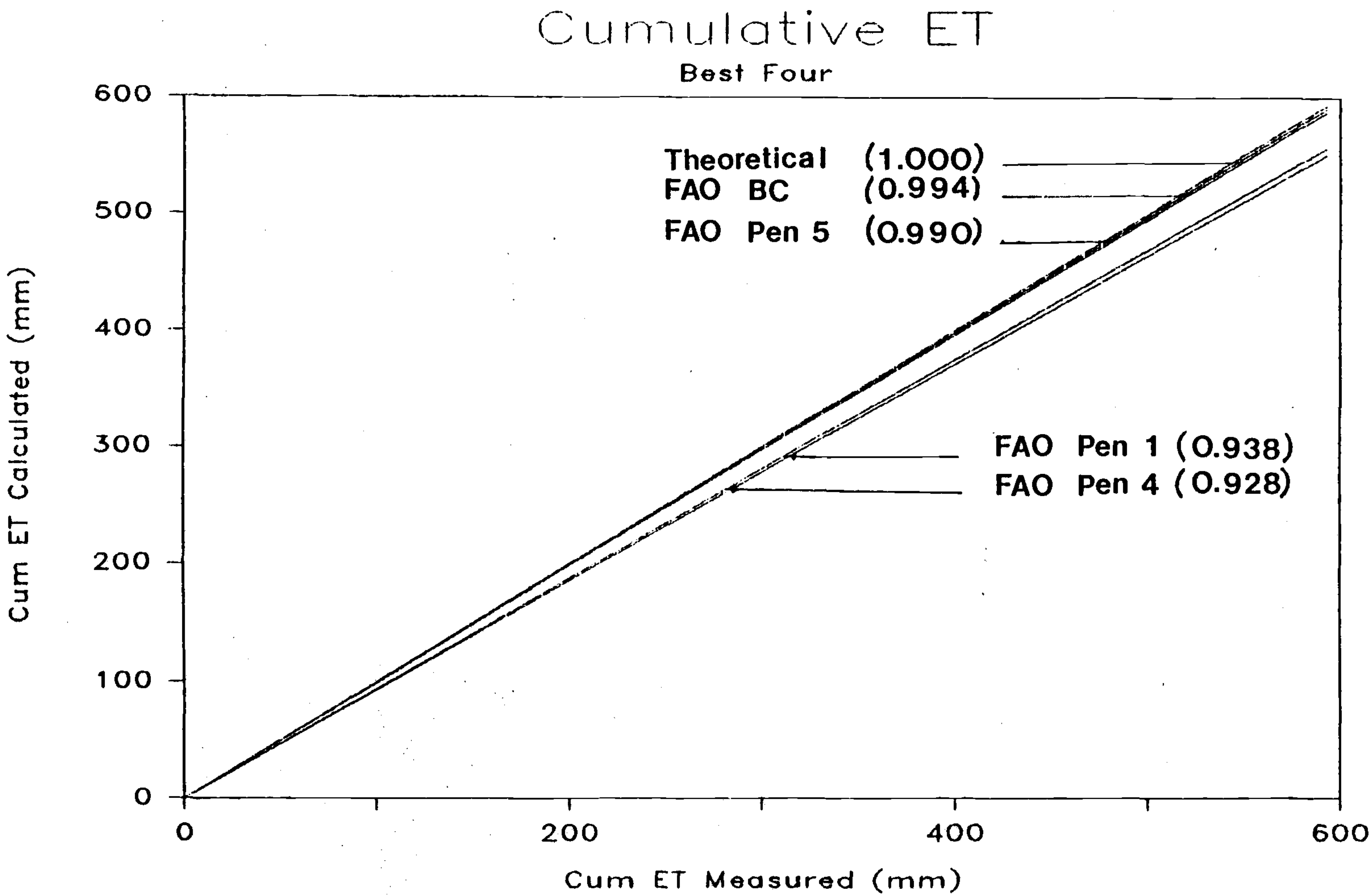


Figure 16 : Four best double mass balance curves.

Almost all of the double mass balance curves had a slight curvature near the origin. This curvature persisted throughout the first quarter of the growing season and then became linear. This curvature may be the result of adjustments made to the neutron meter data for June. During this time, the neutron meter cord with the radioactive source on the end stretched. This resulted in deeper neutron meter readings than anticipated. Adjustments were made to the June data by using linear regression to relate normal depth readings to the deeper neutron meter readings. A highly corrrelated linear equation was applied to each erroneous depth. The fact that all the methods showed a similar curve during this time period suggests that adjustments may have introduced some error.

## Simple Regression Analysis

$ET_m$ vs $ET_c$ data for all four sliding averages were fit with a simple linear model. The theoretical (1:1) line was added to these graphs for visual analysis. Ideally, the curve for each method should have a slope equal to 1 and an intercept of zero. The coefficient of determination ($r^2$) measures how well the data fit the assumed linear model. An $r^2$ value of 0 suggests the data have no linear relationship and a value of 1 is a perfect linear fit. However, the $r^2$ value does not measure how well the regression line fits the theoretical line. The intercept has no special meaning in

| Method | Days Avg. | Intercept | Slope | $r^2$ |
|---|---|---|---|---|
| Orig Penman 1 | 1 | 2.284 | 0.315 | 0.462 |
| | 3 | 1.748 | 0.412 | 0.674 |
| | 7 | 1.559 | 0.446 | 0.772 |
| | 14 | 1.494 | 0.458 | 0.774 |
| Orig Penman 2 | 1 | 2.082 | 0.303 | 0.461 |
| | 3 | 1.574 | 0.395 | 0.656 |
| | 7 | 1.363 | 0.433 | 0.740 |
| | 14 | 1.257 | 0.451 | 0.741 |
| Orig Penman 4 | 1 | 2.154 | 0.332 | 0.475 |
| | 3 | 1.592 | 0.434 | 0.687 |
| | 7 | 1.380 | 0.472 | 0.780 |
| | 14 | 1.279 | 0.490 | 0.793 |
| Orig Penman 5 | 1 | 2.240 | 0.345 | 0.475 |
| | 3 | 1.652 | 0.452 | 0.700 |
| | 7 | 1.461 | 0.486 | 0.804 |
| | 14 | 1.408 | 0.497 | 0.818 |
| FAO Penman 1 | 1 | 3.098 | 0.390 | 0.414 |
| | 3 | 2.418 | 0.513 | 0.650 |
| | 7 | 2.189 | 0.553 | 0.751 |
| | 14 | 2.215 | 0.550 | 0.738 |
| FAO Penman 2 | 1 | 2.646 | 0.364 | 0.416 |
| | 3 | 2.032 | 0.474 | 0.621 |
| | 7 | 1.765 | 0.521 | 0.704 |
| | 14 | 1.701 | 0.533 | 0.691 |
| FAO Penman 4 | 1 | 2.796 | 0.431 | 0.443 |
| | 3 | 2.056 | 0.564 | 0.681 |
| | 7 | 1.770 | 0.615 | 0.776 |
| | 14 | 1.719 | 0.625 | 0.784 |
| FAO Penman 5 | 1 | 2.982 | 0.461 | 0.444 |
| | 3 | 2.174 | 0.607 | 0.701 |
| | 7 | 1.925 | 0.651 | 0.809 |
| | 14 | 1.977 | 0.644 | 0.818 |
| SCS Blan-Crid | 1 | 3.054 | 0.235 | 0.397 |
| | 3 | 2.551 | 0.325 | 0.618 |
| | 7 | 2.409 | 0.352 | 0.716 |
| | 14 | 2.359 | 0.361 | 0.757 |
| FAO Blan-Crid | 1 | 2.763 | 0.506 | 0.470 |
| | 3 | 1.873 | 0.667 | 0.713 |
| | 7 | 1.647 | 0.709 | 0.839 |
| | 14 | 1.713 | 0.701 | 0.868 |
| Jensen-Haise | 1 | 0.706 | 0.388 | 0.495 |
| | 3 | 0.020 | 0.512 | 0.742 |
| | 7 | -0.203 | 0.551 | 0.886 |
| | 14 | -0.218 | 0.555 | 0.925 |
| Pries-Taylor | 1 | 2.095 | 0.324 | 0.463 |
| | 3 | 1.550 | 0.422 | 0.650 |
| | 7 | 1.287 | 0.469 | 0.731 |
| | 14 | 1.132 | 0.496 | 0.725 |

Table 13 : Regression results for simple model.

terms of fundamental relationships. In theory, an ideal method of estimating ET would have an intercept of zero and a slope of 1.0. The simple linear regression coefficients presented in Table 13 show no values close to theoretical for any method. Visual analysis of Figs. 17 and 18 show the best fit and the worst fit for the simple regression models. The FAO Blaney-Criddle was the best method, while the SCS Blaney-Criddle was the worst. The complete set of the simple regression graphs can be seen in Appendix F.

## Fitted-Through-the-Origin Regression

Linear regression models, using $ET_m$ vs $ET_c$ data for all methods, were forced through the origin resulting in a value of zero for the intercept. Theoretically, the reference ET is multiplied by a crop coefficient to find actual ET. The crop coefficient for each estimating method is based on the reference crop used in the original development of each method. Table 14 shows a list of the reference crop and grass crop coefficients for each method. The only method which required a correction to account for the reference crop was the Jensen-Haise. Crop coefficients are applied to calculated ET using the following equation.

$$ET_m = K_c \times ET_c \qquad (46)$$

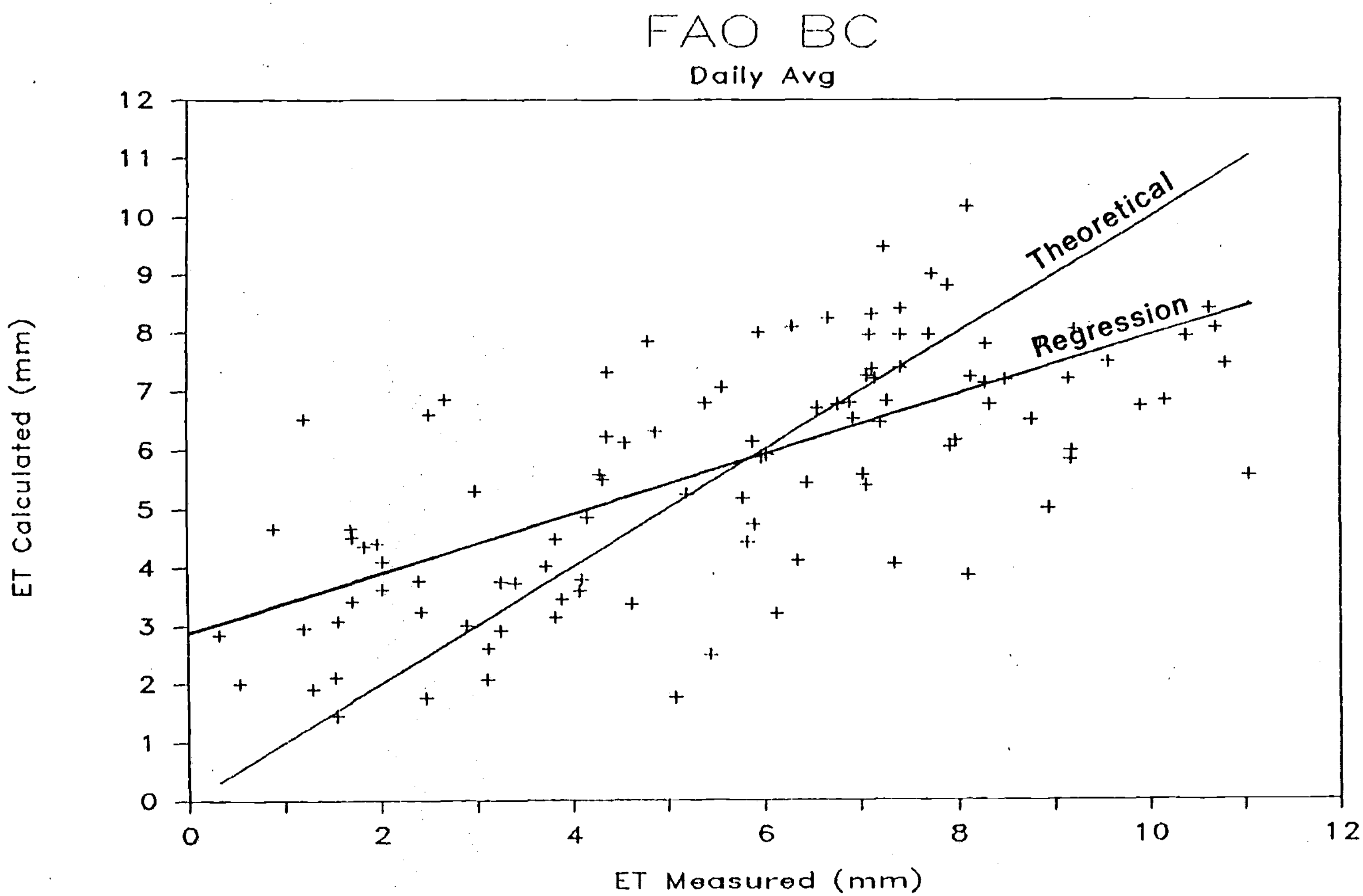


**Figure 17 : Sample linear regression curve and theoretical line for FAO Blaney-Criddle method.**

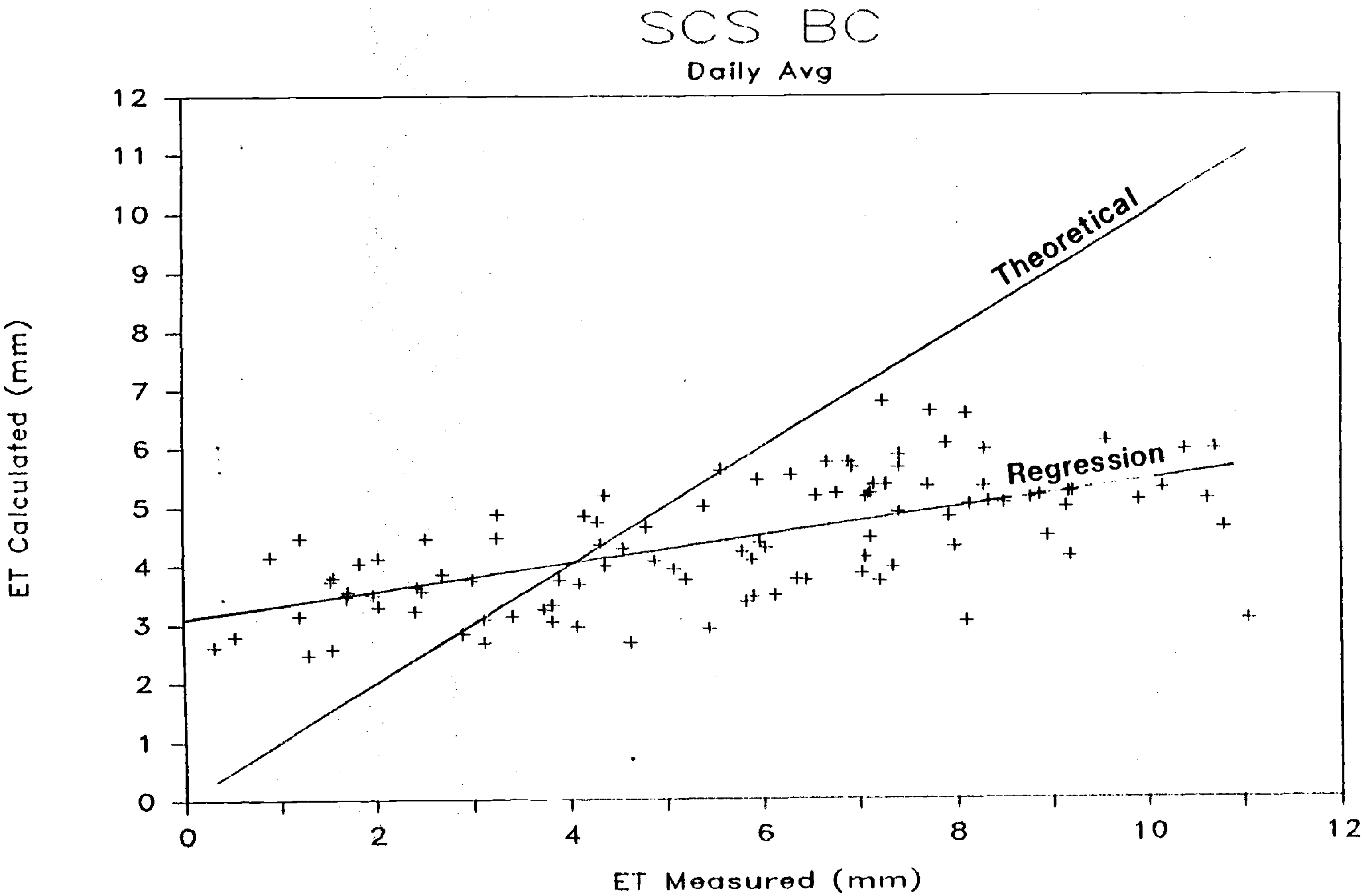


Figure 18 : Sample linear regression curve and theoretical line for SCS Blaney-Criddle method.

where $ET_m$ = measured ET
$K_c$ = crop coefficient
$ET_c$ = calculated ET

| Method | Reference Crop | Crop Coefficient |
|---|---|---|
| Original Penman | Grass | 1.00 |
| FAO Penman | Grass | 1.00 |
| SCS Blan-Crid | None | 1.00 |
| FAO Blan-Crid | Grass | 1.00 |
| Jensen-Haise | Alfalfa | 1.05* |
| Priestly-Taylor | Grass | 1.00 |

* (Jensen, 1980)

Table 14 : Reference crops and coefficients for each empirical method.

The inverse of the slope of the regression line through the origin can be interpreted as a correction factor between $ET_m$ and $ET_c$. Ideally, the correction factor should have a value of 1. Equation 47 is a modified version of equation 46 to include the correction factor.

$$ET_m = C \times K_c \times ET_c \qquad (47)$$

where C = inverse of the slope of the regression line

Results of comparisons between the correction factor and the slope of the regression line yielded two daily averaged methods with close correlations. The FAO Blaney-Criddle had a correction factor of 1.035 (3.5 % error) and the FAO Penman using vapor deficit method 5 had a value of 1.052 (5.2 % error). Slopes, correction factors, and percent errors are presented in Table 15.

| Method | Days Avg. | Slope | Correction | Error (%) |
|---|---|---|---|---|
| Orig Penman 1 | 1 | 0.642 | 1.558 | 55.8 |
| | 3 | 0.677 | 1.478 | 47.8 |
| | 7 | 0.687 | 1.456 | 45.6 |
| | 14 | 0.688 | 1.453 | 45.3 |
| Orig Penman 2 | 1 | 0.601 | 1.664 | 66.4 |
| | 3 | 0.634 | 1.578 | 57.8 |
| | 7 | 0.644 | 1.553 | 55.3 |
| | 14 | 0.646 | 1.548 | 54.8 |
| Orig Penman 4 | 1 | 0.641 | 1.560 | 56.0 |
| | 3 | 0.676 | 1.479 | 47.9 |
| | 7 | 0.685 | 1.460 | 46.0 |
| | 14 | 0.688 | 1.453 | 45.3 |
| Orig Penman 5 | 1 | 0.666 | 1.502 | 50.2 |
| | 3 | 0.702 | 1.425 | 42.5 |
| | 7 | 0.712 | 1.404 | 40.4 |
| | 14 | 0.714 | 1.401 | 40.1 |
| FAO Penman 1 | 1 | 0.834 | 1.199 | 19.9 |
| | 3 | 0.880 | 1.136 | 13.6 |
| | 7 | 0.891 | 1.122 | 12.2 |
| | 14 | 0.892 | 1.121 | 12.1 |
| FAO Penman 2 | 1 | 0.743 | 1.346 | 34.6 |
| | 3 | 0.782 | 1.279 | 27.9 |
| | 7 | 0.794 | 1.259 | 25.9 |
| | 14 | 0.796 | 1.256 | 25.6 |
| FAO Penman 4 | 1 | 0.832 | 1.202 | 20.2 |
| | 3 | 0.876 | 1.142 | 14.2 |
| | 7 | 0.888 | 1.126 | 12.6 |
| | 14 | 0.890 | 1.124 | 12.4 |
| FAO Penman 5 | 1 | 0.888 | 1.126 | 12.6 |
| | 3 | 0.936 | 1.068 | 6.8 |
| | 7 | 0.948 | 1.055 | 5.5 |
| | 14 | 0.950 | 1.052 | 5.2 |
| SCS Blan-Crid | 1 | 0.672 | 1.488 | 48.8 |
| | 3 | 0.712 | 1.404 | 40.4 |
| | 7 | 0.724 | 1.381 | 38.1 |
| | 14 | 0.725 | 1.379 | 37.9 |
| FAO Blan-Crid | 1 | 0.902 | 1.109 | 10.9 |
| | 3 | 0.951 | 1.052 | 5.2 |
| | 7 | 0.963 | 1.038 | 3.8 |
| | 14 | 0.966 | 1.035 | 3.5 |
| Jensen-Haise | 1 | 0.489 | 1.948 | 94.8 |
| | 3 | 0.515 | 1.849 | 84.9 |
| | 7 | 0.520 | 1.832 | 83.2 |
| | 14 | 0.522 | 1.824 | 82.4 |
| Pries-Taylor | 1 | 0.624 | 1.603 | 60.3 |
| | 3 | 0.657 | 1.522 | 52.2 |
| | 7 | 0.668 | 1.497 | 49.7 |
| | 14 | 0.671 | 1.490 | 49.0 |

Table 15 : Regression results for origin fitted models.

Model Performance Improvements using Sliding Averages

Deviations in calculated ET were reduced using sliding averages. The improvements to each method were measured by reductions in the mean squared error and decreases in the error correction factor. The mean squared error equals the variance of the estimator data plus the squared bias.

$$\text{var}\ (Y_i - \text{true}\ Y_i) = \text{Bias}^2 + (Y_i - Y_i)^2 \qquad (48)$$

where var $(Y_i$ - true $Y_i)$ = true mean squared error
Bias = difference between theoretical Y (true $Y_i$) and fitted Y $(Y_i)$
$(Y_i - Y_i)^2$ = variance of fitted line

The MSE (mean squared error) values presented in Table 16 reflect only the variances of the fitted line. The bias term used in equation 48 can be found using the following equation.

$$\text{Bias} = \text{true}\ Y_i \times (1 - S) \qquad (49)$$

where S = slope of fitted regression line

The slope continues to increase as the number of sliding days increase. Therefore, the true mean squared error will decrease so long as the mean squared error data (Table 16) do not increase when the number of sliding days increase. Figure 19 is a graphical interpretation of equation 48.

When an estimator (measured ET) has only a small bias and is substantially more precise than an unbiased

| Method | Days Avg. | MSE | % change | Corr. % change |
|---|---|---|---|---|
| Orig Penman 1 | 1 | 1.882 | 0.0 | 0.0 |
| | 3 | 0.841 | 55.3 | 5.3 |
| | 7 | 0.451 | 46.4 | 1.4 |
| | 14 | 0.282 | 37.5 | 0.2 |
| Orig Penman 2 | 1 | 1.653 | 0.0 | 0.0 |
| | 3 | 0.761 | 54.0 | 5.2 |
| | 7 | 0.422 | 44.5 | 1.6 |
| | 14 | 0.267 | 36.7 | 0.3 |
| Orig Penman 4 | 1 | 1.825 | 0.0 | 0.0 |
| | 3 | 0.788 | 56.8 | 5.2 |
| | 7 | 0.414 | 47.5 | 1.3 |
| | 14 | 0.248 | 40.1 | 0.5 |
| Orig Penman 5 | 1 | 1.972 | 0.0 | 0.0 |
| | 3 | 0.825 | 58.2 | 5.1 |
| | 7 | 0.416 | 49.6 | 1.5 |
| | 14 | 0.247 | 40.6 | 0.2 |
| FAO Penman 1 | 1 | 3.489 | 0.0 | 0.0 |
| | 3 | 1.533 | 56.1 | 5.3 |
| | 7 | 0.835 | 45.5 | 1.2 |
| | 14 | 0.548 | 34.4 | 0.1 |
| FAO Penman 2 | 1 | 2.762 | 0.0 | 0.0 |
| | 3 | 1.261 | 54.3 | 5.0 |
| | 7 | 0.715 | 43.3 | 1.5 |
| | 14 | 0.468 | 34.5 | 0.2 |
| FAO Penman 4 | 1 | 3.285 | 0.0 | 0.0 |
| | 3 | 1.335 | 59.4 | 5.0 |
| | 7 | 0.702 | 47.4 | 1.4 |
| | 14 | 0.425 | 39.5 | 0.2 |
| FAO Penman 5 | 1 | 3.740 | 0.0 | 0.0 |
| | 3 | 1.455 | 61.1 | 5.2 |
| | 7 | 0.725 | 50.2 | 1.2 |
| | 14 | 0.439 | 39.5 | 0.3 |
| SCS Blan-Crid | 1 | 2.435 | 0.0 | 0.0 |
| | 3 | 1.223 | 49.8 | 5.6 |
| | 7 | 0.737 | 39.7 | 1.6 |
| | 14 | 0.437 | 40.7 | 0.1 |
| FAO Blan-Crid | 1 | 3.667 | 0.0 | 0.0 |
| | 3 | 1.392 | 62.0 | 5.1 |
| | 7 | 0.595 | 57.3 | 1.3 |
| | 14 | 0.327 | 45.0 | 0.3 |
| Jensen-Haise | 1 | 1.261 | 0.0 | 0.0 |
| | 3 | 0.495 | 60.7 | 5.1 |
| | 7 | 0.169 | 65.9 | 0.9 |
| | 14 | 0.074 | 56.2 | 0.4 |
| Pries-Taylor | 1 | 1.772 | 0.0 | 0.0 |
| | 3 | 0.826 | 53.4 | 5.1 |
| | 7 | 0.458 | 44.6 | 1.6 |
| | 14 | 0.304 | 33.6 | 0.5 |

Table 16 : Improvements to errors using sliding averages.

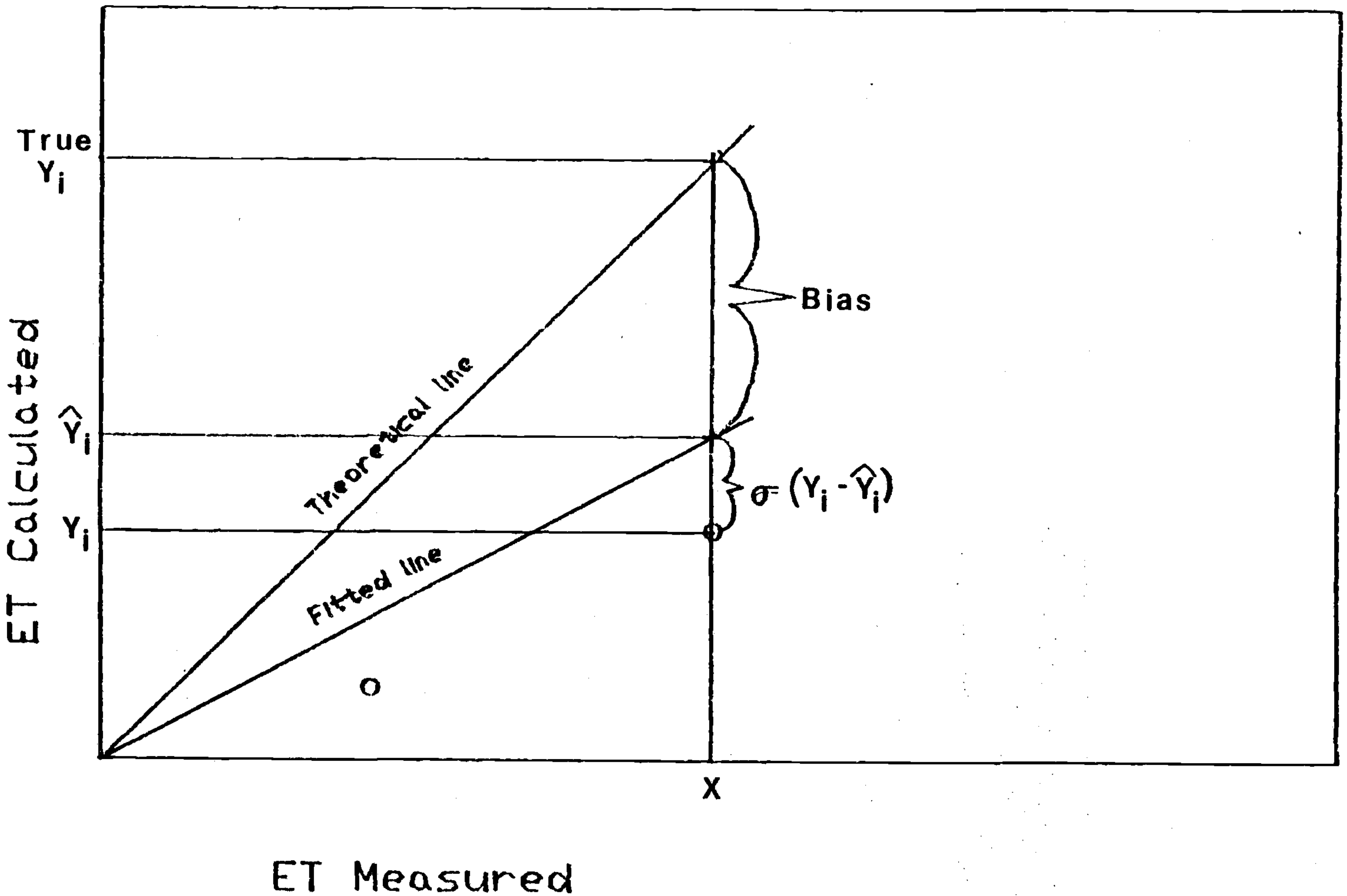


Figure 19 : Explanation of mean squared error.

estimator, it is preferred since it will have a larger probability of being close to the true parameter value. Estimator $ET_m$ is unbiased but imprecise, while estimator $ET_m^r$ is much more precise but has a small bias. The probability that $ET_m^r$ falls near the true value $ET_c$ is much greater than that for the unbiased estimator $ET_m$.

Measurements of the improvement made by each sliding average are shown in Table 16 as percentages. The percent improvements are with respect to the preceeding sliding average. The daily sliding average is initialized with a change of 0.0 percent for comparison purposes. Fig. 20 shows a graph of all 4 sliding averages for the FAO Blaney-Criddle method.

The choice of the number of days to use in the sliding average was based on the minimum required irrigation interval for the soil found at the experimental site. The irrigation interval depends on the rooting depth of the crop, the available water in the soil and the peak period consumptive use rate. The irrigation interval used should be the irrigation interval during the peak consumptive use period.

The moisture extraction depth is the depth to which the roots grow and extract available water. The maximum amount of available soil is the moisture difference between field capacity and wilting point. The peak period consumptive use rate is the maximum average daily rate of use of a crop occuring during a period between normal irrigations. It is

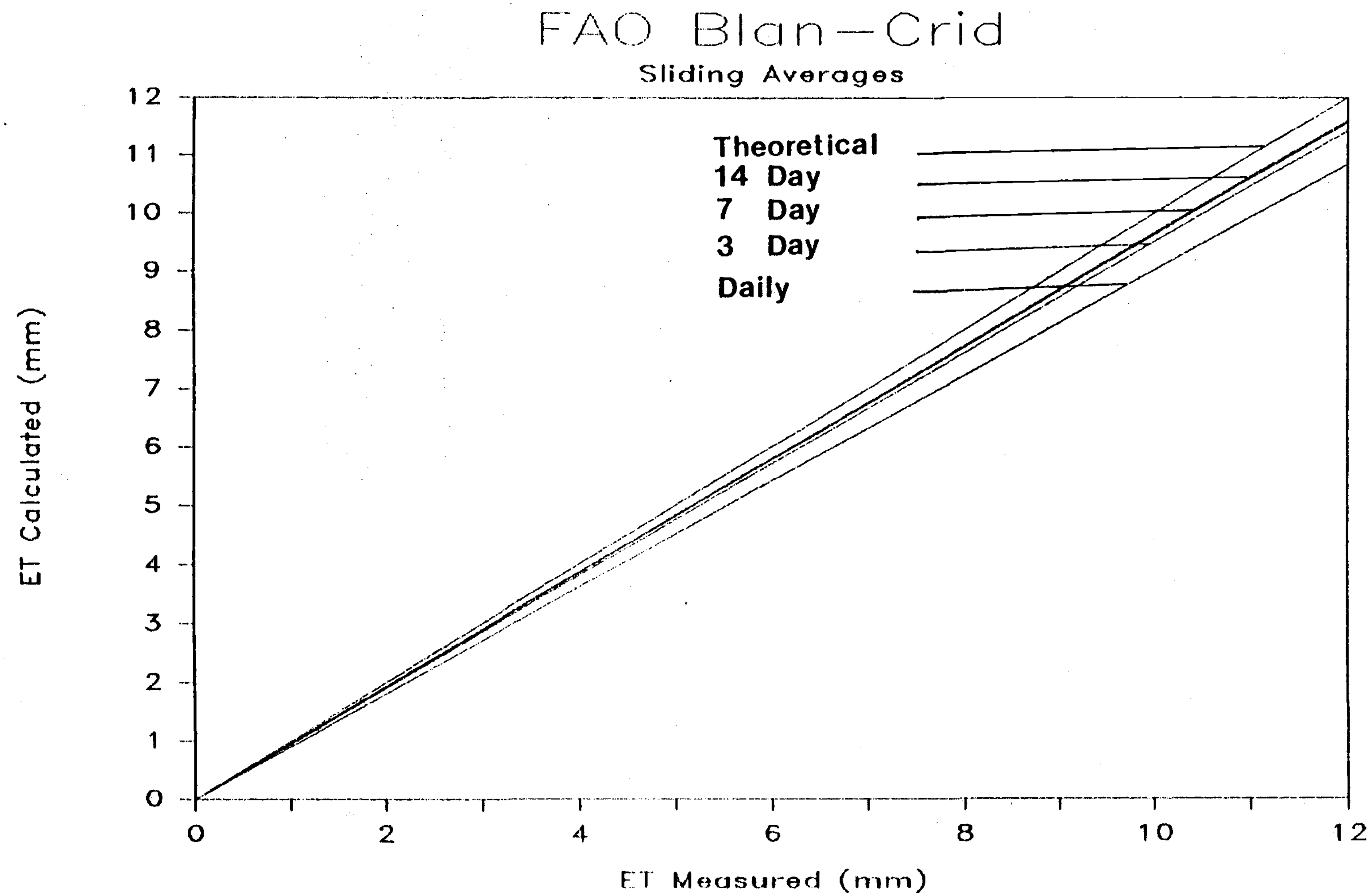


Figure 20 : Sliding average curves for daily, 3, 7, and 14 day - FAO Blaney-Criddle.

found by dividing the maximum available soil water by the average peak period consumptive use rate. Minimum irrigation intervals for the soils found on the experimental plot are given in Table 17.

| Soil type | RZD [ft] | NMTBR [in] | PPCUR [in/day] | Irr Freq. [days] |
|---|---|---|---|---|
| Chehalis | 3 | 4.2 | 0.19 | 22 |
| Cloquato | 3 | 4.4 | 0.19 | 22 |
| Newberg | 3 | 2.8 | 0.19 | 15 |

Note : These values are specific to a grass crop and should not be applied to other crops.

RZD = Root zone depth
NMTBR = Net moisture to be replaced
PPCUR = Peak period consumptive use rate
Irr freq. = Maximum irrigation frequency

Table 17 : Irrigation frequency calculations for experimental plot soils.

Based on the three soil types found on the experimental plot, the Newberg soil has the most limiting irrigation interval with 15 days. From this result, any of the four averaged data sets can be used since 14 days is the longest sliding average interval.

The mean square error change and the correction change terms, shown in Table 16, show improvements for all of the sliding averages. The improvement to the correction term is approximately the same for all methods. This consistency suggests the sliding averages "dampened" variations about equally for methods. The changes in the mean squared error show a large improvement to the Jensen-Haise method for all four sliding averages. Improvements were made to all methods, with the most significant improvement being accomplished with 3 day averages for most methods. Theoretically, the larger the number of days used in a sliding average, the smaller the errors in the regression model. Choosing a 14 day sliding average will greatly decrease the errors in the regression model.

## Sensitivity Study of Weather Parameters

An analysis of the effect of increasing each weather parameter for three estimating methods was carried out. The three methods tested were the FAO Blaney-Criddle, the FAO Penman with vapor pressure deficit method 5, and the Jensen-Haise method. The first two methods were chosen since they showed the best results in prior analysis. The Jensen-Haise was chosen due to the results in this thesis conflicting with results from previous studies. During the analysis, the value of each weather parameter was increased by 10 percent, while keeping the other weather data constant. The result was either an increase or decrease in the estimated ET. Table 15 shows the results of this analysis.

The results showed all three methods to be sensitive to temperature. The Jensen-Haise method gave a larger increase in ET when the temperature was varied than it showed when the radiation was increased. This result is interesting since Jensen-Haise is considered a radiation method, but is equally sensitive to temperature.

| Weather parameter | FAO Pen #5 % change ET | FAO BC % change ET | Jen-Haise % change ET |
|---|---|---|---|
| Min Temp | *** | *** | - 2.0 |
| Max Temp | 7.2 | *** | 10.5 |
| Avg Temp | - 0.5 | 6.9 | 7.8 |
| Min Humidity | - 2.3 | - 2.9 | *** |
| Max Humidity | - 1.9 | *** | *** |
| Avg Humidity | *** | *** | *** |
| Wind Run | 2.4 | *** | *** |
| UDay | - 0.1 | 1.0 | *** |
| URatio | - 0.1 | *** | *** |
| Solar Rad. | 4.4 | 4.7 | 10.2 |

Table 18 : Sensitivity analysis of weather parameters on three estimating methods.

## General Comments

The weight put on the weather parameters for each method can be expected to be related to the location where each method was developed. A method developed in a climate with large extremes in relative humidity might be expected to put special emphasis on relative humidity.

The original Penman equation was derived for a reference crop of grass in England. The original Penman method has proven to predict ET well in cool, humid regions and hot, semi-arid regions. However, the method breaks down when used under windy conditions (Doorenbos and Pruitt,1977).

The FAO Modified Penman method slighlty changed the Original Penman method by adding a revised wind function term. The revised wind function applies to conditions found during the summer, with moderate winds, maximum relative humidity of about 70 percent and day-night wind ratios of 1.5 to 2.0. These conditions are typical of Corvallis in the summer (Appendix A). Therefore, better results using the FAO Modified Penman, as opposed to the Original Penman method, were expected.

McIlroy (Slatyer and McIlroy, 1961) recommends determining specific wind functions for local conditions to improve results. Comparisons in combination methods (Jensen, 1974) appeared to show more accurate ET estimates by calibrating of the wind function and vapor deficit term for local conditions. With such calibration, the combination equations probably cannot be surpassed (Jensen, 1974).

The SCS Blaney-Criddle method was developed in various regions throughout the Western United States. This method has been shown to work well in humid areas (Jensen, 1974) excluding both wind and relative humidity in the method. The FAO Blaney-Criddle method modified the SCS Blaney-Criddle to include wind and relative humidity. Including wind and relative humidity in an ET estimating method is important in a modified marine climate. This is evident by comparison of the SCS and FAO Blaney-Criddle methods used in this thesis. Ths SCS Blaney-Criddle method underpredicted

ET by 22 percent, while the FAO Blaney-Criddle underestimated ET by only 0.6 percent.

Prior studies (Jensen, 1974) showed the SCS Blaney-Criddle method to underpredict ET by 26 percent in a climate similar to Corvallis (Davis, California).

The Jensen-Haise method was developed in Colorodo, which has a very different climate than Corvallis (continental). A study of this method in a climate similar to Corvallis (Lompac, California) gave ET underestimations of 7 percent (Jensen, 1974). Results of this thesis showed an underestimation of 49 percent. This difference is hard to explain, but may be dependant on wind and relative humidity terms excluded in the method development. Relative humidity values for Lompac were not tabulated, therefore the climates of Lompac and Corvallis may not be similar enough to compare ET values.

# SUMMARY AND CONCLUSIONS

## Data Collection and Analysis

The central purpose of this thesis was a comparison of measured ET and ET calculated by 12 different semi-empirical estimating methods for a modified marine climate. Measured ET values were found by applying a mass balance equation for each soil layer using data from a neutron meter. The error associated with measured ET values may be large one day and very small the next. These errors can largely be attributed to the random decay of radioactive elements used in the neutron probe. The mass balance assumed there was no loss of water by deep percolation.

The calculated ET values were computed from weather data. There were no special assumptions made in using the weather data with the estimating formulas.

All of the methods were found to underpredict actual evapotranspiration. However, the FAO methods (both the Penman and Blaney-Criddle) seemed to predict ET better than any other method tested. This seems logical when the methods are compared to the original Penman and the SCS Blaney-Criddle, since, the FAO methods are modifications designed to improve the original methods.

The large error in the Jensen-Haise method could come from the fact that radiation is the dominant parameter.

The considerable variation seen in the 5 vapor deficit methods used in the Penman equation show the impact that combinations of temperature and relative humidity can have in estimating ET. Perhaps the temperature and relative humidity terms need to have more weight in the Jensen-Haise method. Differences between minimum and maximum values for temperature and relative humidity are very large on a daily basis for this area.

The Priestly-Taylor method underpredicted ET by a large margin for both averaged and cumulative data. The basic input parameters and weighting are similar to the Jensen-Haise method in that no wind function is used. Instead, the wind function is "accounted for" by a coefficient. The value of this coefficient, from previous tests and theory, is about 0.26, which means the effect of radiation is simply increased by 26 percent to account for the wind function. This value was used in the analysis and proved insufficient in yielding good estimates of ET, although it did improve upon the Jensen-Haise estimate.

The cumulative data overestimated ET at the beginning of the growing season for most of the methods, but underestimated for the rest of the season. The underestimations were larger than the overestimations, resulting in a net underestimation for the entire growing season. The FAO methods predicted closer to the measured ET values for the season total.

"Best" Method Choice

The choice of which method is best depends on the amount of weather data available. Personal computers are more popular and available today. All the methods are easily programmed, resulting in minimum effort to the estimator.

Regardless of the irrigation interval required, the FAO Blaney-Criddle method proved to be the best for estimating crop water requirements. The FAO Penman method using vapor pressure deficit method 5 (see literature review for formula) came in a close second. Both methods require numerous calculations, so this should not be a deciding factor in choosing which of the two methods to use. The FAO Penman method requires the measurement of many weather parameters. The FAO Blaney-Criddle requires less weather data, these being temperature, minimum relative humidity, and wind run. The comparison of weather data needed for each method was presented earlier in Table 11.

# RECOMMENDATIONS

The analysis presented in this thesis for a Modified Marine Climate in the Willamette Valley of Oregon is the first of its kind to this authors knowledge. There are areas in estimating evapotranspiration that could use new or further studies that were beyond the scope of this thesis. I feel there are changes that could help improve results in similar studies. The following recommendations are presented to help overcome possible difficulties and yield better estimation results.

1. Use calibration equations for each soil layer measured by the neutron meter, regardless of whether the soil is deemed homogeneous or not.

2. Compare ET measured by a lysimeter to measured ET using a neutron meter at the same site.

3. Crop ET is inhibited when the crop is mowed. The crop coefficient takes crop cuttings into account. Further adjustments to the crop coefficient associated with cutting a crop should help in arriving at a better evaluation of the accuracy of an estimation method.

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# APPENDICES

# Appendix A

## Weather Data

WEATHER DATA

| DAY | TIME | AVG TEMP (C) | MIN TEMP (C) | MAX TEMP (C) | AVG HUMID (%) | MIN HUMID (%) | MAX HUMID (%) | PREC. (mm) | WIND RUN (m/s) | UDAY (m/s) | UDAY ----- UNGHT | NET SOLAR RADIATION (mm/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 146 | 700 | 13.91 | 12.23 | 19.37 | 66.18 | 48.98 | 70.27 | 0.00 | 1.01 | 0.00 | 2.69 | 0.16 |
| 146 | 1900 | 17.57 | 12.85 | 20.34 | 58.60 | 50.66 | 68.98 | 0.00 | 1.39 | 0.00 | 0.00 | 4.02 |
| 147 | 700 | 12.90 | 10.61 | 17.99 | 67.21 | 55.31 | 71.43 | 0.00 | 1.72 | 0.00 | 0.81 | 0.10 |
| 147 | 1900 | 14.81 | 12.32 | 17.50 | 63.73 | 53.83 | 68.95 | 0.00 | 2.15 | 2.15 | 0.00 | 2.98 |
| 148 | 700 | 11.96 | 10.74 | 15.73 | 68.14 | 57.21 | 72.14 | 1.00 | 1.68 | 0.00 | 1.28 | 0.21 |
| 148 | 1900 | 13.20 | 10.53 | 15.69 | 65.56 | 57.85 | 71.02 | 2.00 | 2.97 | 2.97 | 0.00 | 3.93 |
| 149 | 700 | 9.10 | 6.94 | 13.26 | 69.55 | 62.06 | 73.01 | 0.00 | 1.48 | 0.00 | 2.00 | 0.11 |
| 149 | 1900 | 13.19 | 7.52 | 15.69 | 62.43 | 54.87 | 72.23 | 0.00 | 3.14 | 3.14 | 0.00 | 3.48 |
| 150 | 700 | 11.09 | 9.65 | 14.51 | 67.53 | 57.21 | 71.20 | 0.00 | 1.67 | 0.00 | 1.89 | 0.12 |
| 150 | 1900 | 16.75 | 9.93 | 20.29 | 48.89 | 35.90 | 70.94 | 0.00 | 1.77 | 1.77 | 0.00 | 5.90 |
| 151 | 700 | 12.54 | 10.53 | 17.41 | 67.37 | 44.17 | 74.83 | 15.00 | 1.58 | 0.00 | 1.12 | 0.06 |
| 151 | 1900 | 15.16 | 10.70 | 19.24 | 60.84 | 45.06 | 72.93 | 4.00 | 1.99 | 1.99 | 0.00 | 5.07 |
| 152 | 700 | 10.28 | 7.05 | 12.60 | 74.77 | 68.02 | 85.20 | 4.00 | 1.02 | 0.00 | 1.97 | 0.07 |
| 152 | 1900 | 14.68 | 8.27 | 18.52 | 65.58 | 50.33 | 85.50 | 0.00 | 1.94 | 1.94 | 0.00 | 4.64 |
| 153 | 700 | 12.24 | 10.21 | 14.09 | 70.01 | 63.36 | 74.72 | 0.00 | 0.94 | 0.00 | 2.06 | 0.12 |
| 153 | 1900 | 18.68 | 11.95 | 22.52 | 50.27 | 37.78 | 72.52 | 0.00 | 1.30 | 1.30 | 0.00 | 7.48 |
| 154 | 700 | 11.58 | 7.64 | 20.62 | 67.85 | 40.08 | 78.60 | 0.00 | 0.44 | 0.00 | 2.97 | 0.24 |
| 154 | 1900 | 16.39 | 9.73 | 19.01 | 65.06 | 55.87 | 78.62 | 3.00 | 1.17 | 1.17 | 0.00 | 2.95 |
| 155 | 700 | 14.18 | 11.79 | 16.24 | 70.63 | 67.43 | 75.22 | 0.00 | 1.38 | 0.00 | 0.85 | 0.12 |
| 155 | 1900 | 18.65 | 13.88 | 21.27 | 57.62 | 50.44 | 68.68 | 0.00 | 1.75 | 1.75 | 0.00 | 5.48 |
| 156 | 700 | 13.75 | 12.03 | 17.54 | 65.57 | 56.48 | 70.46 | 0.00 | 1.49 | 0.00 | 1.17 | 0.21 |
| 156 | 1900 | 17.44 | 13.59 | 20.80 | 58.29 | 49.71 | 67.85 | 0.00 | 1.71 | 1.71 | 0.00 | 4.85 |
| 157 | 700 | 14.33 | 13.42 | 17.15 | 72.69 | 62.09 | 75.80 | 18.00 | 0.23 | 0.00 | 7.42 | 0.06 |
| 157 | 1900 | 16.97 | 13.59 | 18.79 | 71.62 | 67.98 | 76.34 | 24.00 | 2.11 | 2.11 | 0.00 | 2.03 |
| 158 | 700 | 18.27 | 16.54 | 19.37 | 69.43 | 65.79 | 87.30 | 12.00 | 2.76 | 0.00 | 0.76 | 0.02 |
| 158 | 1900 | 17.14 | 15.99 | 18.88 | 77.19 | 64.50 | 87.20 | 2.00 | 3.33 | 3.33 | 0.00 | 4.44 |
| 159 | 700 | 11.37 | 7.72 | 16.63 | 84.75 | 67.37 | 92.50 | 0.00 | 0.93 | 0.00 | 3.58 | 0.32 |
| 159 | 1900 | 17.97 | 11.26 | 21.23 | 55.70 | 31.77 | 89.40 | 0.00 | 4.54 | 4.54 | 0.00 | 8.43 |
| 160 | 700 | 13.01 | 7.33 | 20.34 | 61.83 | 34.75 | 88.30 | 0.00 | 0.92 | 0.00 | 4.92 | 0.32 |
| 160 | 1900 | 19.66 | 11.91 | 23.97 | 47.52 | 34.92 | 71.06 | 0.00 | 2.76 | 2.76 | 0.00 | 8.10 |
| 161 | 700 | 12.27 | 7.05 | 23.51 | 76.97 | 36.57 | 92.60 | 0.00 | 0.60 | 0.00 | 4.60 | 0.31 |
| 161 | 1900 | 22.05 | 10.49 | 27.14 | 42.95 | 17.53 | 90.80 | 0.00 | 2.54 | 2.54 | 0.00 | 8.30 |
| 162 | 700 | 14.33 | 8.62 | 26.05 | 73.18 | 22.84 | 91.70 | 0.00 | 0.37 | 0.00 | 6.83 | 0.33 |
| 162 | 1900 | 24.38 | 13.09 | 29.67 | 42.11 | 21.41 | 86.80 | 0.00 | 1.95 | 1.95 | 0.00 | 8.16 |
| 163 | 700 | 16.98 | 11.46 | 26.92 | 65.31 | 26.49 | 90.20 | 0.00 | 1.13 | 0.00 | 1.72 | 0.28 |
| 163 | 1900 | 22.89 | 14.88 | 27.31 | 58.71 | 41.70 | 85.10 | 0.00 | 1.46 | 1.46 | 0.00 | 7.74 |
| 164 | 700 | 14.65 | 10.49 | 23.51 | 74.64 | 43.80 | 91.50 | 0.00 | 0.64 | 0.00 | 2.28 | 0.26 |
| 164 | 1900 | 23.11 | 14.13 | 28.04 | 50.47 | 34.62 | 88.10 | 0.00 | 1.52 | 1.52 | 0.00 | 7.75 |
| 165 | 700 | 16.67 | 13.76 | 23.86 | 70.05 | 40.26 | 84.60 | 0.00 | 2.21 | 0.00 | 0.69 | 0.24 |
| 165 | 1900 | 20.99 | 14.93 | 25.04 | 66.69 | 56.70 | 81.80 | 0.00 | 2.10 | 2.10 | 0.00 | 6.15 |
| 166 | 700 | 16.75 | 15.14 | 20.80 | 79.38 | 64.08 | 87.60 | 0.00 | 1.10 | 0.00 | 1.92 | 0.26 |
| 166 | 1900 | 20.69 | 15.90 | 24.22 | 55.92 | 39.81 | 83.00 | 0.00 | 3.11 | 3.11 | 0.00 | 7.00 |
| 167 | 700 | 13.42 | 8.94 | 22.52 | 63.96 | 42.07 | 81.00 | 0.00 | 1.13 | 0.00 | 2.76 | 0.34 |

WEATHER DATA

| DAY | TIME | AVG TEMP (C) | MIN TEMP (C) | MAX TEMP (C) | AVG HUMID (%) | MIN HUMID (%) | MAX HUMID (%) | PREC. (mm) | WIND RUN (m/s) | UDAY (m/s) | UDAY ----- UNGHT | NET SOLAR RADIATION (mm/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 167 | 1900 | 20.96 | 12.19 | 27.14 | 41.76 | 28.29 | 65.72 | 0.00 | 4.51 | 4.51 | 0.00 | 8.39 |
| 168 | 700 | 19.02 | 10.70 | 26.37 | 43.84 | 29.12 | 79.17 | 0.00 | 2.45 | 0.00 | 1.84 | 0.36 |
| 168 | 1900 | 28.77 | 14.42 | 34.02 | 25.66 | 14.28 | 72.52 | 0.00 | 3.64 | 3.64 | 0.00 | 8.44 |
| 169 | 700 | 19.02 | 11.54 | 32.35 | 62.66 | 15.25 | 89.40 | 0.00 | 0.40 | 0.00 | 9.10 | 0.35 |
| 169 | 1900 | 29.46 | 15.86 | 35.13 | 35.32 | 21.93 | 81.80 | 0.00 | 2.22 | 2.22 | 0.00 | 8.20 |
| 170 | 700 | 18.59 | 12.32 | 31.07 | 74.15 | 35.15 | 90.50 | 0.00 | 0.39 | 0.00 | 5.74 | 0.35 |
| 170 | 1900 | 25.45 | 17.11 | 30.83 | 50.62 | 30.12 | 85.30 | 0.00 | 2.16 | 2.16 | 0.00 | 8.13 |
| 171 | 700 | 13.37 | 7.80 | 25.25 | 81.42 | 47.13 | 92.30 | 0.00 | 0.91 | 0.00 | 2.38 | 0.35 |
| 171 | 1900 | 22.52 | 11.95 | 27.47 | 48.26 | 22.90 | 88.70 | 0.00 | 2.38 | 2.38 | 0.00 | 8.27 |
| 172 | 700 | 13.80 | 8.58 | 25.89 | 69.14 | 31.06 | 90.40 | 0.00 | 0.84 | 0.00 | 2.83 | 0.34 |
| 172 | 1900 | 22.40 | 12.52 | 28.15 | 45.81 | 29.97 | 76.90 | 0.00 | 3.11 | 3.11 | 0.00 | 8.09 |
| 173 | 700 | 15.56 | 9.34 | 26.97 | 73.09 | 35.03 | 90.40 | 0.00 | 0.87 | 0.00 | 3.58 | 0.35 |
| 173 | 1900 | 18.96 | 12.36 | 23.71 | 53.04 | 30.34 | 79.90 | 0.00 | 3.66 | 3.66 | 0.00 | 8.02 |
| 174 | 700 | 11.14 | 6.27 | 21.80 | 70.01 | 41.15 | 83.90 | 0.00 | 1.04 | 0.00 | 3.51 | 0.34 |
| 174 | 1900 | 15.86 | 9.14 | 19.42 | 46.88 | 35.44 | 74.21 | 0.00 | 3.57 | 3.57 | 0.00 | 8.12 |
| 175 | 700 | 9.22 | 4.14 | 17.90 | 70.78 | 37.31 | 93.20 | 0.00 | 0.60 | 0.00 | 5.95 | 0.34 |
| 175 | 1900 | 14.96 | 8.86 | 17.72 | 56.40 | 50.49 | 81.80 | 0.00 | 2.40 | 2.40 | 0.00 | 4.91 |
| 176 | 700 | 9.27 | 4.72 | 16.85 | 81.83 | 52.64 | 94.50 | 0.00 | 0.29 | 0.00 | 8.30 | 0.31 |
| 176 | 1900 | 20.10 | 9.06 | 25.15 | 50.83 | 34.41 | 92.30 | 0.00 | 2.70 | 2.70 | 0.00 | 8.02 |
| 177 | 700 | 12.47 | 7.25 | 24.42 | 80.14 | 34.71 | 93.30 | 0.00 | 0.43 | 0.00 | 6.27 | 0.33 |
| 177 | 1900 | 21.11 | 11.58 | 26.48 | 53.51 | 39.98 | 88.20 | 0.00 | 2.89 | 2.89 | 0.00 | 7.77 |
| 178 | 700 | 12.00 | 6.86 | 21.18 | 72.33 | 45.02 | 92.40 | 0.00 | 1.33 | 0.00 | 2.17 | 0.24 |
| 178 | 1900 | 16.50 | 9.42 | 20.85 | 62.62 | 46.59 | 91.00 | 0.00 | 1.27 | 1.27 | 0.00 | 4.96 |
| 179 | 700 | 9.78 | 4.95 | 19.97 | 78.88 | 45.81 | 94.00 | 0.00 | 0.47 | 0.00 | 2.73 | 0.37 |
| 179 | 1900 | 19.57 | 10.09 | 25.10 | 49.75 | 33.51 | 83.40 | 0.00 | 2.09 | 2.09 | 0.00 | 7.94 |
| 180 | 700 | 13.12 | 9.38 | 20.62 | 61.09 | 43.33 | 81.30 | 0.00 | 2.40 | 0.00 | 0.87 | 0.22 |
| 180 | 1900 | 16.06 | 10.45 | 19.65 | 61.30 | 47.60 | 79.50 | 0.00 | 3.31 | 3.31 | 0.00 | 5.84 |
| 181 | 700 | 12.78 | 10.13 | 15.60 | 73.40 | 59.00 | 89.50 | 0.00 | 0.57 | 0.00 | 5.76 | 0.09 |
| 181 | 1900 | 19.20 | 10.41 | 23.61 | 49.77 | 37.27 | 89.70 | 0.00 | 1.65 | 1.65 | 0.00 | 7.51 |
| 182 | 700 | 12.71 | 8.07 | 21.70 | 74.62 | 39.80 | 92.90 | 0.00 | 0.43 | 0.00 | 3.85 | 0.32 |
| 182 | 1900 | 23.92 | 12.85 | 31.83 | 42.94 | 18.54 | 82.40 | 0.00 | 1.80 | 1.80 | 0.00 | 7.77 |
| 183 | 700 | 17.81 | 11.42 | 29.79 | 67.21 | 23.83 | 91.00 | 0.00 | 0.40 | 0.00 | 4.47 | 0.31 |
| 183 | 1900 | 25.30 | 15.26 | 29.08 | 32.83 | 15.37 | 82.20 | 0.00 | 2.16 | 2.16 | 0.00 | 7.43 |
| 184 | 700 | 15.38 | 8.98 | 25.31 | 60.53 | 16.89 | 90.50 | 0.00 | 0.82 | 0.00 | 2.66 | 0.34 |
| 184 | 1900 | 24.41 | 12.77 | 31.07 | 45.57 | 27.84 | 82.90 | 0.00 | 1.33 | 1.33 | 0.00 | 7.53 |
| 185 | 700 | 17.26 | 12.27 | 26.43 | 52.32 | 32.43 | 77.30 | 0.00 | 1.17 | 0.00 | 1.14 | 0.24 |
| 185 | 1900 | 22.55 | 13.92 | 26.64 | 36.92 | 22.04 | 63.04 | 0.00 | 2.81 | 2.81 | 0.00 | 7.90 |
| 186 | 700 | 13.52 | 8.62 | 21.66 | 78.65 | 41.76 | 93.10 | 9.00 | 1.02 | 0.00 | 2.76 | 0.27 |
| 186 | 1900 | 21.24 | 11.34 | 26.10 | 54.56 | 39.30 | 92.00 | 0.00 | 1.57 | 1.57 | 0.00 | 7.39 |
| 187 | 700 | 14.27 | 10.05 | 22.72 | 77.09 | 43.84 | 91.80 | 0.00 | 0.82 | 0.00 | 1.92 | 0.31 |
| 187 | 1900 | 23.83 | 13.88 | 29.61 | 48.55 | 31.27 | 88.30 | 0.00 | 2.14 | 2.14 | 0.00 | 7.54 |
| 188 | 700 | 18.00 | 11.67 | 25.00 | 60.12 | 46.34 | 90.25 | 0.00 | 0.97 | 0.00 | 2.21 | 0.29 |
| 188 | 1900 | 24.19 | 15.32 | 31.11 | 42.11 | 32.57 | 91.03 | 0.00 | 1.23 | 1.23 | 0.00 | 7.69 |

WEATHER DATA

| DAY | TIME | AVG TEMP (C) | MIN TEMP (C) | MAX TEMP (C) | AVG HUMID (%) | MIN HUMID (%) | MAX HUMID (%) | PREC. (mm) | WIND RUN (m/s) | UDAY (m/s) | UDAY ----- UNGHT | NET SOLAR RADIATION (mm/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 189 | 700 | 15.99 | 11.67 | 25.58 | 76.33 | 46.49 | 88.61 | 0.00 | 0.49 | 0.00 | 2.52 | 0.26 |
| 189 | 1900 | 26.18 | 14.09 | 31.83 | 38.10 | 20.18 | 85.10 | 0.00 | 1.37 | 1.37 | 0.00 | 7.79 |
| 190 | 700 | 17.36 | 12.03 | 27.87 | 69.03 | 26.14 | 90.70 | 0.00 | 0.31 | 0.00 | 4.36 | 0.29 |
| 190 | 1900 | 27.87 | 16.03 | 33.74 | 42.34 | 27.97 | 86.70 | 0.00 | 1.66 | 1.66 | 0.00 | 7.72 |
| 191 | 700 | 17.52 | 11.30 | 28.38 | 58.94 | 31.77 | 87.70 | 0.00 | 1.57 | 0.00 | 1.06 | 0.30 |
| 191 | 1900 | 24.52 | 15.26 | 29.85 | 50.42 | 37.36 | 78.77 | 0.00 | 1.79 | 1.79 | 0.00 | 7.83 |
| 192 | 700 | 16.94 | 12.27 | 25.57 | 78.63 | 45.20 | 91.70 | 0.00 | 0.71 | 0.00 | 2.51 | 0.24 |
| 192 | 1900 | 24.91 | 13.09 | 30.39 | 46.73 | 19.13 | 90.90 | 0.00 | 2.63 | 2.63 | 0.00 | 7.63 |
| 193 | 700 | 16.24 | 10.57 | 26.05 | 74.75 | 42.18 | 92.10 | 0.00 | 0.83 | 0.00 | 3.18 | 0.32 |
| 193 | 1900 | 24.30 | 14.71 | 29.37 | 46.48 | 30.54 | 87.00 | 0.00 | 2.77 | 2.77 | 0.00 | 7.69 |
| 194 | 700 | 15.26 | 9.30 | 25.25 | 72.48 | 40.90 | 92.70 | 0.00 | 0.68 | 0.00 | 4.05 | 0.26 |
| 194 | 1900 | 23.22 | 12.93 | 29.19 | 43.26 | 16.73 | 84.70 | 0.00 | 3.46 | 3.46 | 0.00 | 7.83 |
| 195 | 700 | 17.04 | 10.37 | 28.09 | 67.44 | 22.32 | 92.00 | 0.00 | 0.60 | 0.00 | 5.81 | 0.27 |
| 195 | 1900 | 25.29 | 16.11 | 31.64 | 41.38 | 23.23 | 77.29 | 0.00 | 2.80 | 2.80 | 0.00 | 7.72 |
| 196 | 700 | 15.33 | 9.89 | 25.31 | 72.28 | 39.76 | 92.80 | 0.00 | 1.08 | 0.00 | 2.59 | 0.25 |
| 196 | 1900 | 24.52 | 14.80 | 30.52 | 47.81 | 27.32 | 83.00 | 0.00 | 1.94 | 1.94 | 0.00 | 7.74 |
| 197 | 700 | 16.23 | 10.82 | 26.26 | 75.91 | 42.59 | 92.40 | 0.00 | 0.66 | 0.00 | 2.93 | 0.24 |
| 197 | 1900 | 24.25 | 14.97 | 28.84 | 53.65 | 39.81 | 87.50 | 0.00 | 2.44 | 2.44 | 0.00 | 7.34 |
| 198 | 700 | 16.16 | 11.18 | 26.48 | 79.47 | 44.46 | 92.30 | 0.00 | 0.62 | 0.00 | 3.93 | 0.24 |
| 198 | 1900 | 23.78 | 15.05 | 29.08 | 58.11 | 40.31 | 87.70 | 0.00 | 3.13 | 3.13 | 0.00 | 7.36 |
| 199 | 700 | 18.03 | 12.97 | 28.84 | 78.46 | 42.07 | 91.40 | 0.00 | 0.34 | 0.00 | 9.26 | 0.23 |
| 199 | 1900 | 29.54 | 16.93 | 36.21 | 41.93 | 12.82 | 86.60 | 0.00 | 2.24 | 2.24 | .0.00 | 7.66 |
| 200 | 700 | 20.50 | 14.34 | 35.92 | 71.31 | 15.40 | 90.40 | 0.00 | 0.27 | 0.00 | 8.22 | 0.23 |
| 200 | 1900 | 29.63 | 18.03 | 34.50 | 45.38 | 32.13 | 85.60 | 0.00 | 1.70 | 1.70 | 0.00 | 7.49 |
| 201 | 700 | 16.58 | 11.46 | 28.55 | 78.21 | 38.92 | 91.90 | 0.00 | 0.65 | 0.00 | 2.60 | 0.23 |
| 201 | 1900 | 27.78 | 14.88 | 35.20 | 44.28 | 18.49 | 89.60 | 0.00 | 1.23 | 1.23 | 0.00 | 7.60 |
| 202 | 700 | 17.61 | 13.01 | 28.96 | 64.27 | 31.61 | 84.20 | 0.00 | 1.28 | 0.00 | 0.96 | 0.17 |
| 202 | 1900 | 24.90 | 14.17 | 33.20 | 47.88 | 23.45 | 84.00 | 0.00 | 1.18 | 1.18 | 0.00 | 6.67 |
| 203 | 700 | 18.35 | 15.14 | 26.32 | 68.39 | 44.61 | 86.10 | 0.00 | 1.01 | 0.00 | 1.17 | 0.19 |
| 203 | 1900 | 24.15 | 16.11 | 28.55 | 53.83 | 41.45 | 83.20 | 0.00 | 1.91 | 1.91 | 0.00 | 6.15 |
| 204 | 700 | 16.88 | 12.60 | 25.10 | 78.87 | 50.29 | 91.60 | 0.00 | 0.77 | 0.00 | 2.48 | 0.22 |
| 204 | 1900 | 24.73 | 16.54 | 29.25 | 53.95 | 40.68 | 83.00 | 0.00 | 2.12 | 2.12 | 0.00 | 6.88 |
| 205 | 700 | 18.90 | 14.17 | 27.87 | 74.05 | 44.23 | 89.00 | 0.00 | 1.35 | 0.00 | 1.57 | 0.26 |
| 205 | 1900 | 23.40 | 17.54 | 27.14 | 52.78 | 39.39 | 80.20 | 0.00 | 2.98 | 2.98 | 0.00 | 7.46 |
| 206 | 700 | 17.52 | 13.42 | 25.89 | 69.40 | 41.57 | 85.20 | 0.00 | 0.87 | 0.00 | 3.44 | 0.20 |
| 206 | 1900 | 25.43 | 15.14 | 31.64 | 46.06 | 20.68 | 82.90 | 0.00 | 2.86 | 2.86 | 0.00 | 7.44 |
| 207 | 700 | 17.34 | 10.86 | 31.01 | 72.03 | 20.65 | 92.80 | 0.00 | 0.28 | 0.00 | 10.14 | 0.21 |
| 207 | 1900 | 28.70 | 14.97 | 34.36 | 31.28 | 11.85 | 87.80 | 0.00 | 2.00 | 2.00 | 0.00 | 7.56 |
| 208 | 700 | 17.28 | 10.49 | 34.02 | 68.86 | 16.36 | 91.50 | 0.00 | 0.28 | 0.00 | 7.06 | 0.19 |
| 208 | 1900 | 27.92 | 13.51 | 33.95 | 28.48 | 11.66 | 84.90 | 0.00 | 1.98 | 1.98 | 0.00 | 7.19 |
| 209 | 700 | 16.92 | 11.18 | 32.87 | 71.62 | 11.85 | 91.50 | 0.00 | 0.15 | 0.00 | 12.85 | 0.13 |
| 209 | 1900 | 27.27 | 12.36 | 34.43 | 37.16 | 12.96 | 90.30 | 0.00 | 2.01 | 2.01 | 0.00 | 6.33 |
| 210 | 700 | 18.04 | 11.87 | 29.61 | 63.53 | 29.62 | 91.30 | 0.00 | 1.46 | 0.00 | 1.38 | 0.15 |

WEATHER DATA

| DAY | TIME | AVG TEMP (C) | MIN TEMP (C) | MAX TEMP (C) | AVG HUMID (%) | MIN HUMID (%) | MAX HUMID (%) | PREC. (mm) | WIND RUN (m/s) | UDAY (m/s) | UDAY ----- UNGHT | NET SOLAR RADIATION (mm/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| --- | ---- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ----- | ---------- |
| 210 | 1900 | 19.92 | 13.76 | 23.56 | 67.19 | 55.54 | 88.70 | 0.00 | 3.59 | 3.59 | 0.00 | 6.29 |
| 211 | 700 | 16.27 | 15.39 | 19.10 | 82.69 | 68.38 | 90.90 | 0.00 | 2.10 | 0.00 | 1.71 | 0.17 |
| 211 | 1900 | 16.48 | 15.35 | 18.12 | 89.50 | 86.00 | 90.90 | 12.00 | 1.60 | 1.60 | 0.00 | 0.86 |
| 212 | 700 | 15.86 | 14.88 | 17.99 | 89.55 | 86.10 | 90.50 | 0.00 | 0.17 | 0.00 | 9.20 | 0.05 |
| 212 | 1900 | 19.84 | 15.14 | 23.61 | 73.15 | 58.56 | 89.60 | 2.00 | 1.78 | 1.78 | 0.00 | 5.64 |
| 213 | 700 | 16.08 | 13.96 | 20.25 | 87.19 | 68.24 | 90.60 | 0.00 | 1.05 | 0.00 | 1.70 | 0.13 |
| 213 | 1900 | 20.93 | 15.26 | 25.04 | 66.49 | 47.00 | 90.00 | 0.00 | 1.85 | 1.85 | 0.00 | 5.62 |
| 214 | 700 | 15.25 | 11.62 | 22.77 | 82.61 | 54.15 | 91.70 | 0.00 | 0.64 | 0.00 | 2.89 | 0.18 |
| 214 | 1900 | 22.44 | 13.67 | 27.70 | 61.01 | 40.24 | 90.70 | 0.00 | 1.34 | 1.34 | 0.00 | 6.38 |
| 215 | 700 | 17.80 | 14.88 | 25.41 | 77.36 | 43.30 | 88.90 | 0.00 | 0.37 | 0.00 | 3.62 | 0.16 |
| 215 | 1900 | 24.77 | 17.46 | 29.55 | 54.00 | 34.21 | 84.70 | 0.00 | 2.72 | 2.72 | 0.00 | 7.08 |
| 216 | 700 | 17.70 | 15.31 | 24.78 | 75.47 | 46.02 | 83.70 | 0.00 | 1.33 | 0.00 | 2.04 | 0.09 |
| 216 | 1900 | 22.68 | 15.86 | 27.31 | 55.89 | 39.78 | 83.00 | 0.00 | 1.81 | 1.81 | 0.00 | 6.69 |
| 217 | 700 | 13.32 | 8.98 | 22.18 | 80.89 | 45.27 | 92.90 | 0.00 | 0.55 | 0.00 | 3.31 | 0.15 |
| 217 | 1900 | 23.00 | 11.34 | 28.96 | 50.27 | 30.77 | 92.10 | 0.00 | 1.62 | 1.62 | 0.00 | 7.11 |
| 218 | 700 | 14.14 | 8.62 | 24.84 | 73.66 | 35.14 | 93.00 | 0.00 | 0.63 | 0.00 | 2.56 | 0.15 |
| 218 | 1900 | 22.46 | 11.10 | 28.27 | 50.36 | 29.41 | 92.00 | 0.00 | 2.02 | 2.02 | 0.00 | 6.87 |
| 219 | 700 | 16.38 | 14.51 | 19.47 | 82.29 | 63.25 | 89.40 | 0.00 | 1.81 | 0.00 | 1.12 | 0.10 |
| 219 | 1900 | 17.99 | 14.76 | 20.80 | 68.16 | 50.86 | 87.60 | 1.00 | 2.96 | 2.96 | 0.00 | 4.02 |
| 220 | 700 | 14.72 | 13.51 | 18.07 | 82.59 | 56.63 | 91.50 | 2.00 | 2.78 | 0.00 | 1.07 | 0.09 |
| 222 | 1900 | 19.80 | 11.66 | 22.77 | 50.78 | 40.23 | 89.40 | 0.00 | 2.37 | 2.37 | 0.00 | 5.42 |
| 223 | 700 | 12.80 | 7.95 | 21.75 | 77.39 | 40.08 | 93.30 | 0.00 | 0.53 | 0.00 | 4.44 | 0.12 |
| 223 | 1900 | 23.38 | 10.01 | 29.37 | 45.54 | 21.96 | 92.70 | 0.00 | 1.90 | 1.90 | 0.00 | 6.90 |
| 224 | 700 | 15.15 | 8.58 | 25.10 | 71.29 | 32.98 | 93.20 | 0.00 | 1.43 | 0.00 | 1.33 | 0.11 |
| 220 | 1900 | 20.07 | 14.46 | 24.78 | 64.51 | 42.72 | 90.70 | 0.00 | 1.58 | 1.58 | 0.00 | 4.59 |
| 221 | 700 | 13.14 | 9.14 | 21.37 | 82.92 | 51.80 | 92.90 | 0.00 | 0.50 | 0.00 | 3.17 | 0.14 |
| 221 | 1900 | 21.36 | 11.02 | 25.20 | 56.40 | 42.62 | 91.90 | 0.00 | 2.10 | 2.10 | 0.00 | 6.24 |
| 222 | 700 | 15.38 | 10.45 | 22.33 | 73.56 | 49.84 | 89.40 | 0.00 | 1.51 | 0.00 | 1.39 | 0.09 |
| 222 | 1900 | 19.80 | 11.66 | 22.77 | 50.78 | 40.23 | 89.40 | 0.00 | 2.37 | 2.37 | 0.00 | 5.42 |
| 223 | 700 | 12.80 | 7.95 | 21.75 | 77.39 | 40.08 | 93.30 | 0.00 | 0.53 | 0.00 | 4.44 | 0.11 |
| 223 | 1900 | 23.38 | 10.01 | 29.37 | 45.54 | 21.96 | 92.70 | 0.00 | 1.90 | 1.90 | 0.00 | 6.90 |
| 224 | 700 | 15.15 | 8.58 | 25.10 | 71.29 | 32.98 | 93.20 | 0.00 | 1.43 | 0.00 | 1.33 | 0.11 |
| 224 | 1900 | 22.59 | 10.41 | 28.44 | 56.13 | 34.41 | 92.70 | 0.00 | 1.86 | 1.86 | 0.00 | 6.72 |
| 225 | 700 | 15.24 | 9.97 | 26.59 | 81.75 | 38.56 | 92.70 | 0.00 | 0.23 | 0.00 | 8.02 | 0.10 |
| 225 | 1900 | 27.48 | 11.38 | 33.14 | 33.45 | 11.79 | 92.30 | 0.00 | 2.38 | 2.38 | 0.00 | 6.65 |
| 226 | 700 | 19.30 | 9.97 | 30.15 | 52.55 | 14.73 | 91.80 | 0.00 | 0.96 | 0.00 | 2.48 | 0.06 |
| 226 | 1900 | 26.37 | 10.45 | 32.94 | 37.73 | 15.96 | 91.60 | 0.00 | 1.49 | 1.49 | 0.00 | 6.60 |
| 227 | 700 | 16.69 | 10.33 | 27.75 | 66.20 | 31.85 | 91.80 | 0.00 | 1.73 | 0.00 | 0.86 | 0.12 |
| 227 | 1900 | 23.09 | 11.34 | 30.58 | 53.03 | 23.72 | 91.10 | 0.00 | 1.28 | 1.28 | 0.00 | 6.68 |
| 228 | 700 | 14.24 | 9.30 | 25.57 | 81.77 | 42.86 | 93.10 | 0.00 | 0.51 | 0.00 | 2.52 | 0.09 |
| 228 | 1900 | 26.83 | 10.37 | 33.14 | 38.33 | 15.29 | 92.80 | 0.00 | 1.59 | 1.59 | 0.00 | 6.54 |
| 229 | 700 | 15.53 | 9.50 | 30.95 | 77.03 | 17.28 | 92.90 | 0.00 | 0.76 | 0.00 | 2.10 | 0.09 |
| 229 | 1900 | 22.45 | 11.18 | 27.81 | 57.23 | 40.54 | 92.40 | 0.00 | 2.21 | 2.21 | 0.00 | 6.50 |

WEATHER DATA

| DAY | TIME | AVG TEMP (C) | MIN TEMP (C) | MAX TEMP (C) | AVG HUMID (%) | MIN HUMID (%) | MAX HUMID (%) | PREC. (mm) | WIND RUN (m/s) | UDAY (m/s) | UDAY ----- UNGHT | NET SOLAR RADIATION (mm/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 700 | 15.11 | 14.30 | 18.52 | 82.33 | 65.53 | 86.00 | 0.00 | 2.63 | 0.00 | 0.84 | 0.07 |
| 230 | 1900 | 17.48 | 15.01 | 19.10 | 76.75 | 70.71 | 85.10 | 0.00 | 1.16 | 1.16 | 0.00 | 1.57 |
| 231 | 700 | 15.60 | 14.67 | 16.98 | 82.35 | 77.60 | 85.50 | 0.00 | 1.76 | 0.00 | 0.66 | 0.03 |
| 231 | 1900 | 18.08 | 14.84 | 20.94 | 63.47 | 47.66 | 81.20 | 0.00 | 1.76 | 1.76 | 0.00 | 3.08 |
| 232 | 700 | 13.11 | 10.45 | 17.54 | 79.49 | 57.21 | 89.40 | 0.00 | 0.42 | 0.00 | 4.19 | 0.04 |
| 232 | 1900 | 19.03 | 12.07 | 23.06 | 52.60 | 37.46 | 87.50 | 0.00 | 1.60 | 1.60 | 0.00 | 4.80 |
| 233 | 700 | 10.19 | 5.34 | 20.01 | 81.17 | 43.04 | 94.80 | 0.00 | 0.58 | 0.00 | 2.75 | 0.08 |
| 233 | 1900 | 19.71 | 6.00 | 24.42 | 51.30 | 28.52 | 94.40 | 0.00 | 2.13 | 2.13 | 0.00 | 6.17 |
| 234 | 700 | 13.43 | 9.02 | 22.67 | 75.94 | 33.81 | 92.90 | 0.00 | 0.24 | 0.00 | 8.76 | 0.07 |
| 234 | 1900 | 23.54 | 9.97 | 29.79 | 43.54 | 19.70 | 92.60 | 0.00 | 2.28 | 2.28 | 0.00 | 6.41 |
| 235 | 700 | 14.80 | 9.14 | 28.67 | 73.24 | 21.77 | 93.00 | 0.00 | 0.12 | 0.00 | 19.65 | 0.07 |
| 235 | 1900 | 26.45 | 10.17 | 32.81 | 37.26 | 15.85 | 92.80 | 0.00 | 1.39 | 1.39 | 0.00 | 5.21 |
| 236 | 700 | 20.30 | 16.33 | 29.61 | 64.61 | 27.96 | 85.40 | 0.00 | 0.73 | 0.00 | 1.91 | 0.04 |
| 236 | 1900 | 23.94 | 16.59 | 27.19 | 53.76 | 39.88 | 85.30 | 0.00 | 0.87 | 0.87 | 0.00 | 2.48 |
| 237 | 700 | 17.14 | 12.64 | 26.16 | 83.20 | 48.89 | 91.80 | 0.00 | 0.20 | 0.00 | 4.34 | 0.05 |
| 237 | 1900 | 27.06 | 12.93 | 33.14 | 44.77 | 18.29 | 91.70 | 0.00 | 1.77 | 1.77 | 0.00 | 6.08 |
| 238 | 700 | 14.96 | 8.86 | 28.50 | 74.31 | 30.25 | 92.80 | 0.00 | 0.29 | 0.00 | 6.06 | 0.05 |
| 238 | 1900 | 24.63 | 9.81 | 31.58 | 35.18 | 16.40 | 92.30 | 0.00 | 1.92 | 1.92 | 0.00 | 6.13 |
| 239 | 700 | 13.76 | 10.49 | 20.43 | 73.21 | 41.54 | 90.20 | 0.00 | 2.24 | 0.00 | 0.85 | 0.05 |
| 239 | 1900 | 17.69 | 10.70 | 21.09 | 61.05 | 49.72 | 90.00 | 0.00 | 2.83 | 2.83 | 0.00 | 5.60 |
| 240 | 700 | 9.78 | 5.84 | 16.98 | 83.51 | 56.31 | 94.30 | 0.00 | 0.61 | 0.00 | 4.66 | 0.05 |
| 240 | 1900 | 19.65 | 7.25 | 25.68 | 54.25 | 30.81 | 94.00 | 0.00 | 1.23 | 1.23 | 0.00 | 5.79 |
| 241 | 700 | 11.34 | 5.34 | 21.75 | 77.82 | 40.28 | 94.20 | 0.00 | 0.48 | 0.00 | 2.58 | 0.05 |
| 241 | 1900 | 19.19 | 5.96 | 24.58 | 52.95 | 31.58 | 94.10 | 0.00 | 2.19 | 2.19 | 0.00 | 6.00 |
| 242 | 700 | 14.15 | 10.33 | 19.33 | 74.33 | 42.38 | 92.90 | 0.00 | 1.55 | 0.00 | 1.42 | 0.04 |
| 244 | 1900 | 17.11 | 12.60 | 19.97 | 76.86 | 66.31 | 88.60 | 0.00 | 1.79 | 1.79 | 0.00 | 2.23 |
| 245 | 700 | 13.80 | 10.33 | 16.54 | 88.21 | 78.54 | 93.20 | 1.00 | 0.98 | 0.00 | 1.84 | 0.01 |
| 245 | 1900 | 19.57 | 11.42 | 24.07 | 60.30 | 42.35 | 93.00 | 0.00 | 1.08 | 1.08 | 0.00 | 5.09 |
| 246 | 700 | 11.84 | 6.82 | 21.32 | 84.36 | 47.97 | 93.80 | 0.00 | 0.48 | 0.00 | 2.24 | 0.02 |
| 246 | 1900 | 19.80 | 7.33 | 26.75 | 61.48 | 36.67 | 93.80 | 0.00 | 1.46 | 1.46 | 0.00 | 5.33 |
| 247 | 700 | 14.77 | 11.42 | 21.89 | 82.98 | 53.02 | 91.80 | 0.00 | 0.64 | 0.00 | 2.28 | 0.02 |
| 247 | 1900 | 20.06 | 14.21 | 23.91 | 66.13 | 53.56 | 88.60 | 0.00 | 1.53 | 1.53 | 0.00 | 4.20 |
| 248 | 700 | 16.54 | 15.22 | 19.65 | 79.86 | 63.27 | 90.20 | 0.00 | 1.59 | 0.00 | 0.96 | 0.01 |
| 248 | 1900 | 18.45 | 15.82 | 20.43 | 84.40 | 78.51 | 88.60 | 1.00 | 2.48 | 2.48 | 0.00 | 1.34 |
| 249 | 700 | 16.59 | 13.63 | 18.92 | 85.92 | 80.10 | 89.90 | 0.00 | 3.05 | 0.00 | 0.82 | 0.02 |
| 249 | 1900 | 18.08 | 13.22 | 21.56 | 56.87 | 39.33 | 88.50 | 0.00 | 2.48 | 2.48 | 0.00 | 4.10 |
| 250 | 700 | 9.23 | 4.99 | 17.06 | 84.71 | 46.80 | 94.80 | 0.00 | 0.57 | 0.00 | 4.34 | 0.02 |
| 250 | 1900 | 16.22 | 5.22 | 19.83 | 63.18 | 45.68 | 94.60 | 1.00 | 2.12 | 2.12 | 0.00 | 4.58 |
| 251 | 700 | 9.86 | 6.15 | 16.29 | 86.25 | 57.88 | 94.20 | 0.00 | 0.25 | 0.00 | 8.41 | 0.02 |
| 251 | 1900 | 15.34 | 8.19 | 21.23 | 69.19 | 43.78 | 93.90 | 0.00 | 1.20 | 1.20 | 0.00 | 3.00 |
| 252 | 700 | 12.03 | 8.74 | 16.07 | 84.46 | 65.27 | 92.70 | 0.00 | 0.86 | 0.00 | 1.40 | 0.01 |
| 252 | 1900 | 13.96 | 8.90 | 17.41 | 85.55 | 74.82 | 92.70 | 18.00 | 0.97 | 0.97 | 0.00 | 1.84 |
| 253 | 700 | 12.32 | 11.87 | 12.85 | 91.42 | 90.50 | 91.90 | 3.00 | 0.64 | 0.00 | 1.51 | 0.01 |

## WEATHER DATA

| DAY | TIME | AVG TEMP (C) | MIN TEMP (C) | MAX TEMP (C) | AVG HUMID (%) | MIN HUMID (%) | MAX HUMID (%) | PREC. (mm) | WIND RUN (m/s) | UDAY (m/s) | UDAY ----- UNGHT | NET SOLAR RADIATION (mm/day) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 253 | 1900 | 15.84 | 11.95 | 19.47 | 77.92 | 61.99 | 91.60 | 1.00 | 1.41 | 1.41 | 0.00 | 2.56 |
| 254 | 700 | 9.36 | 6.94 | 15.01 | 91.49 | 76.32 | 93.50 | 0.00 | 0.14 | 0.00 | 10.15 | 0.01 |
| 254 | 1900 | 14.26 | 7.05 | 18.30 | 76.48 | 61.88 | 93.50 | 0.00 | 1.70 | 1.70 | 0.00 | 2.15 |
| 255 | 700 | 14.06 | 13.09 | 15.39 | 85.19 | 76.86 | 89.20 | 3.00 | 2.09 | 0.00 | 0.81 | 0.00 |
| 255 | 1900 | 16.05 | 13.38 | 19.28 | 82.14 | 66.78 | 88.80 | 0.00 | 4.07 | 4.07 | 0.00 | 3.23 |
| 256 | 700 | 13.41 | 11.70 | 14.67 | 90.18 | 84.80 | 91.60 | 1.00 | 0.72 | 0.00 | 5.68 | 0.01 |
| 256 | 1900 | 16.96 | 11.58 | 20.15 | 78.25 | 55.20 | 91.70 | 0.00 | 3.49 | 3.49 | 0.00 | 3.93 |

# Appendix B

## Computer Program for Measured ET

```
10 REM ***********************************************************************
20 REM *                                                                     *
30 REM *            NEUTRON METER DATA ANALYSIS PROGRAM                      *
40 REM *                                                                     *
50 REM *                  PROGRAM BY JEFF SMITH                              *
60 REM *                                                                     *
70 REM *            OREGON STATE UNIVERSITY  SPRING 1985                     *
80 REM *                                                                     *
90 REM ***********************************************************************
100 REM
110 REM **********************************************************************
120 REM
130 REM      THIS SECTION USES SCREEN TO INPUT USER CHOICE OF ANALYSIS
140 REM
150 REM **********************************************************************
160 REM
170 CLS:CLEAR
180 PRINT:PRINT
190 PRINT:PRINT TAB(5) "1)  CREATE NEUTRON METER FILES "
200 PRINT:PRINT TAB(5) "    2)  ANALYZE NEUTRON METER AND
    IRRIGATION/PRECIPITATION DATA AND PRINT OUT TABLES TO PRINTER"
210 PRINT:PRINT TAB(5) "3) END"
220 PRINT:PRINT:INPUT"ENTER ONE OF THE ABOVE CHOICES";CHOICE$
230 IF CHOICE$ < "4" GOTO 260
240 CLS:PRINT:PRINT"ENTER 1,2, OR 3 AS YOUR CHOICE"
250 GOTO 180
260 IF CHOICE$="1" THEN GOSUB 330
270 IF CHOICE$="2" THEN GOSUB 2440
280 IF CHOICE$="3" THEN END
290 GOTO 170
300 REM
310 REM **********************************************************************
320 REM
330 REM
340 REM **********************************************************************
350 REM
360 REM            THIS SECTION CREATES NEUTRON METER DATA FILES
370 REM
380 REM **********************************************************************
390 REM
400 CLS
410 PRINT:PRINT"MAKE SURE DATA DISKETTE IS IN DRIVE B"
420 PRINT:INPUT"ENTER DATA FILE NAME (MAXIMUM 6 CHARACTERS) ";FILE$
425 FILE$="B:"+FILE$
430 PRINT:INPUT"IS THIS A NEW DATA FILE (Y)(N) ";ANS$
440 IF ANS$="N" GOTO 490
450 PRINT:INPUT"LOCATION OF EXPERIMENT (MAXIMUM OF 10 CHARACTERS) ";LOCAT$
460 PRINT:INPUT"CROP IDENTIFICATION (MAXIMUM OF 10 CHARACTERS) ";CROP$
470 PRINT:INPUT"YEAR OF EXPERIMENT ";YEAR
480 PRINT:INPUT"ENTER DATE OF PLANTING (MM/DD) ";DATPLT$
490 PRINT:INPUT"ENTER NUMBER OF ACCESS TUBES FOR THIS EXPERIMENT ";TUBES
500 PRINT:INPUT"ENTER MAXIMUM # OF NEUTRON METER READINGS PER ACCESS TUBE ";
    MAXNMR
```

```
510 PRINT:INPUT"ENTER NUMBER OF NEUTRON METER DATA SETS TO BE ENTERED AT THIS
    TIME (0 IF NONE)  ";NMDSET
520 REM ************************************************************************
530 REM              THIS SECTION INPUTS WATER APPLICATION EVENTS
540 REM
550 PRINT:INPUT"ENTER NUMBER OF WATER APPLICATION DATES (0 IF NONE) ";NUMWAT
560 DIM IRRIG(TUBES,NUMWAT),PRECIP(TUBES,NUMWAT),DAYWAT$(NUMWAT)
570 REM IRRIG=IRRIGATION MEASUREMENT FOR EACH TUBE, PRECIP=PRECIPITATION
580 FOR I=1 TO NUMWAT
590 PRINT:INPUT"ENTER DATE OF WATER APPLICATION (MM/DD) ";DAYWAT$(I)
595 XX$ = DAYWAT$(I)
597 GOSUB 6300
599 DAYWAT$(I) = XX$
600 FOR J=1 TO TUBES
610 PRINT:PRINT"ENTER AMOUNT OF PRECIPITATION IN mm ON ";DAYWAT$(I);" FOR
    TUBE ";J;" (0 IF NONE ) ":INPUT PRECIP(J,I)
620 PRINT:PRINT"ENTER AMOUNT OF IRRIGATION IN mm ON ";DAYWAT$(I);" FOR TUBE ";
    J;" (0 IF NONE ) ":INPUT IRRIG(J,I)
630 NEXT J
640 NEXT I
650 REM ************************************************************************
660 REM              THIS SECTION INPUTS NEUTRON METER READINGS
670 REM
680 PRINT:PRINT
690 DIM NEUTMR(NMDSET,TUBES,MAXNMR)
700 FOR I= 1 TO NMDSET
710 INPUT"ENTER DATE OF NEUTRON METER MEASUREMENT (MM/DD) ";DAYNMR$(I)
715 XX$ = DAYNMR$(I)
717 GOSUB 6300
719 DAYNMR$(I) = XX$
720 FOR J=1 TO TUBES
730 FOR K=1 TO MAXNMR
740 PRINT "ENTER NEUTRON METER READING FOR ";DAYNMR$(I);" IN ACCESS TUBE ";J;"
    AT DEPTH LEVEL ";K;" ":INPUT NEUTMR(I,J,K)
750 NEXT K
760 NEXT J
770 NEXT I
780 REM ************************************************************************
790 REM              THIS SECTION IS USED FOR GENERAL ADJUSTMENTS
800 REM
810 CLS:PRINT:PRINT
820 INPUT"DO YOU WISH TO MAKE ADJUSTMENTS AT THIS TIME (Y)(N) ";Y$
830 IF Y$="Y" GOTO 850
840 GOTO 960
850 PRINT:INPUT"INDEX OF FIRST DEPTH LAYER TO BE ADJUSTED, EXCLUDING SURFACE
    LAYER ";FDLADJ
860 PRINT:INPUT"INDEX OF LAST DEPTH LAYER TO BE ADJUSTED, EXCLUDING SURFACE
    LAYER ";LDLADJ
870 TDLADJ=LDLADJ-FDLADJ+1
880 DIM GENADJ(T,2*TDLADJ)
890 PRINT:PRINT"FOR EACH ACCESS TUBE STARTING WITH NUMBER 1, START AT THE FIRST
    DEPTH LAYER TO  BE ADJUSTED"
900 FOR I=1 TO TUBES
```

```
910 FOR J=1 TO TDLADJ*2 STEP 2
920 INPUT "# DATA SETS TO BE ADJUSTED ";GENADJ(I,J)
930 INPUT "mm FOR THIS ADJUSTMENT ";GENADJ(I,J+1)
940 NEXT J
950 NEXT I
960 REM ***********************************************************************
970 REM        THIS SECTION SETS UP VARIABLE DEPTH LAYER SPACINGS
980 REM
990 DIM VARDEP(TUBES,MAXNMR)
1000 OPEN"I",#1,"VARLAY.DAT"
1010 FOR I=1 TO TUBES
1020 FOR J=1 TO MAXNMR
1030 INPUT#1,VARDEP(I,J)
1040 NEXT J
1050 NEXT I
1060 CLOSE #1
1070 PRINT"DEFAULT VALUE FOR DEPTH LAYER THICKNESSES ARE:"
1080 FOR I= 1 TO MAXNMR
1090 PRINT"DEPTH ";I;" = ";VARDEP(1,I);" cm"
1100 NEXT I
1110 PRINT:PRINT"THESE VALUES ARE ASSUMED CONSTANT FOR EACH TUBE"
1120 PRINT:PRINT:INPUT"DO YOU WISH TO CHANGE THESE (Y)(N) ";Y$
1130 IF Y$="Y" GOTO 1150
1140 GOTO 1310
1150 PRINT:INPUT"ARE DEPTHS THE SAME FOR EACH TUBE (Y)(N) ";Y$
1160 IF Y$="Y" GOTO 1190
1170 FOR J=1 TO TUBES
1180 PRINT"FOR TUBE #";J
1190 FOR I= 1 TO MAXNMR
1200 IF Y$="Y" THEN J=1
1210 PRINT:PRINT"ENTER DEPTH IN cm FOR DEPTH ";I;" ":INPUT VARDEP(J,I)
1220 NEXT I
1230 IF Y$="Y" GOTO 1260
1240 NEXT J
1250 GOTO 1310
1260 FOR I=1 TO TUBES-1
1270 FOR J=1 TO MAXNMR
1280 VARDEP(I+1,J)=VARDEP(I,J)
1290 NEXT J
1300 NEXT I
1310 REM ***********************************************************************
1320 REM        THIS SECTION OPENS DATA FILES FOR ENTRY OF DATA FROM ABOVE
1330 REM
1340 B1$="1":B2$="2":B3$="3":B4$="4":B5$="5":B6$="6":B7$="7":B8$="8":B9$="9"
1350 F1$=FILE$+B1$:F2$=FILE$+B2$:F3$=FILE$+B3$:F4$=FILE$+B4$:F5$=FILE$+B5$:
     F6$=FILE$+B6$:F7$=FILE$+B7$:F8$=FILE$+B8$:F9$=FILE$+B9$
1360 IF ANS$="N" GOTO 1930
1370 OPEN"O",#1,F1$
1380 WRITE#1,LOCAT$
1382 WRITE#1,CROP$
1384 WRITE#1,YEAR
1390 CLOSE #1
1400 OPEN"O",#1,F2$
```

```
1410 FOR I=1 TO NUMWAT
1420 PRINT#1,DAYWAT$(I)
1430 NEXT I
1440 CLOSE #1
1450 OPEN"O",#1,F3$
1460 FOR J=1 TO NUMWAT
1470 FOR I=1 TO TUBES
1480 PRINT#1,IRRIG(I,J);
1490 NEXT I
1500 PRINT#1,""
1510 NEXT J
1520 CLOSE #1
1530 OPEN"O",#1,F4$
1540 FOR J=1 TO NUMWAT
1550 FOR I=1 TO TUBES
1560 PRINT#1,PRECIP(I,J);
1570 NEXT I
1575 PRINT#1,""
1580 NEXT J
1590 CLOSE #1
1600 OPEN"O",#1,F5$
1610 FOR I=1 TO NMDSET
1620 PRINT#1,DAYNMR$(I)
1630 NEXT I
1640 CLOSE #1
1650 OPEN"O",#1,F6$
1660 FOR I=1 TO NMDSET
1670 FOR J=1 TO TUBES
1680 FOR K=1 TO MAXNMR
1690 PRINT#1,NEUTMR(I,J,K);
1700 NEXT K
1710 PRINT#1," "
1720 NEXT J
1730 PRINT#1," "
1740 NEXT I
1750 CLOSE#1
1760 OPEN"O",#1,F7$
1770 FOR I=1 TO TUBES
1780 FOR J= 1 TO MAXNMR
1790 PRINT#1,VARDEP(I,J);
1800 NEXT J
1810 PRINT#1," "
1820 NEXT I
1830 CLOSE#1
1840 OPEN "O",#1,F1$
1850 FOR I=1 TO TUBES
1860 FOR J=1 TO 2*TDLADJ STEP 2
1870 PRINT#1,GENADJ(I,J),GENADJ(I,J+1);
1880 NEXT J
1890 PRINT#1," "
1900 NEXT I
1910 CLOSE#1
1920 GOTO 2400
```

```
1930 OPEN"A",#1,F2$
1940 FOR I=1 TO NUMWAT
1950 PRINT#1,DAYWAT$(I)
1960 NEXT I
1970 CLOSE #1
1980 OPEN"A",#1,F3$
1990 FOR J=1 TO NUMWAT
2010 FOR I=1 TO TUBES
2020 PRINT#1,IRRIG(I,J);
2030 NEXT I
2040 PRINT#1,""
2050 NEXT J
2060 CLOSE #1
2070 OPEN"A",#1,F4$
2080 FOR I=1 TO NUMWAT
2090 FOR J=1 TO TUBES
2100 PRINT#1,PRECIP(J,I);
2110 NEXT J
2115 PRINT#1,""
2120 NEXT I
2130 CLOSE #1
2140 OPEN"A",#1,F5$
2150 FOR I=1 TO NMDSET
2160 PRINT#1,DAYNMR$(I)
2170 NEXT I
2180 CLOSE #1
2190 OPEN"A",#1,F6$
2210 FOR I=1 TO NMDSET
2220 FOR J=1 TO TUBES
2230 FOR K=1 TO MAXNMR
2240 PRINT#1,NEUTMR(I,J,K);
2250 NEXT K
2260 PRINT#1," "
2270 NEXT J
2280 PRINT#1," "
2290 NEXT I
2300 CLOSE #1
2310 OPEN"O",#1,F7$
2320 PRINT#1," "
2330 FOR I=1 TO TUBES
2340 FOR J=1 TO MAXNMR
2350 PRINT#1,VARDEP(I,J);
2360 NEXT J
2370 PRINT#1," "
2380 NEXT I
2390 CLOSE #1
2400 RETURN
2410 REM
2420 REM
2430 REM
2440 REM ***********************************************************************
2450 REM ***********************************************************************
2460 REM
```

```
2470 REM     THIS SECTION ANALYZES DATA FROM NEUTRON METER AND IRRIGATION
2480 REM
2490 REM ***********************************************************************
2500 REM
2510 CLEAR
2520 CLS:INPUT"NAME OF FILE FOR DATA RETRIEVAL ";FILE$
2525 FILE$="B:"+FILE$
2530 TUBES = 5
2540 PRINT:INPUT"NUMBER OF SETS OF NEUTRON METER READINGS ";NMDSET
2550 PRINT:INPUT"NUMBER OF WATER APPLICATION EVENTS ";NUMWAT
2560 MAXNMR = 10
2570 A1 = 45.134:B1 = 10.82
2580 A2 = 45.868:B2 = 17.4
2590 STAND = 24736
2600 A3 = 37.49:B3 = 8.770001
2610 A4 = 53.423:B4 = 33.4
2620 A2SURF = -9.899999
2650 B1$="1":B2$="2":B3$="3":B4$="4":B5$="5":B6$="6":B7$="7":B8$="8":B9$="9"
2660 F1$=FILE$+B1$:F2$=FILE$+B2$:F3$=FILE$+B3$:F4$=FILE$+B4$:F5$=FILE$+B5$:
     F6$=FILE$+B6$:F7$=FILE$+B7$:F8$=FILE$+B8$:F9$=FILE$+B9$
2670 REM ***********************************************************************
2680 REM    THIS SECTION CONVERTS NEUTRON METER READINGS TO EQUIV mm MOISTURE
2690 REM    FOR EACH LAYER
2700 REM
2710 DIM VWC(NMDSET,TUBES,MAXNMR),NEUTMR(NMDSET,TUBES,MAXNMR),
     VARDEP(TUBES,MAXNMR),DAYWAT$(NUMWAT),DAYNMR$(NMDSET)
2720 OPEN"I",#1,F6$
2730 FOR I=1 TO NMDSET
2740 FOR J=1 TO TUBES
2750 FOR K=1 TO MAXNMR
2760 INPUT#1,NEUTMR(I,J,K)
2770 NEXT K
2780 NEXT J
2785 INPUT#1,JJ$
2790 NEXT I
2800 CLOSE#1
2810 OPEN"I",#1,F7$
2820 FOR I=1 TO TUBES
2830 FOR J=1 TO MAXNMR
2840 INPUT#1,VARDEP(I,J)
2850 NEXT J
2860 NEXT I
2870 CLOSE#1
2880 OPEN"I",#1,F2$
2890 FOR I=1 TO NUMWAT
2900 INPUT#1,DAYWAT$(I)
2910 NEXT I
2920 CLOSE#1
2930 OPEN"I",#1,F1$
2940 INPUT#1,LOCAT$,CROP$,YEAR
2950 CLOSE#1
2960 OPEN"I",#1,F5$
2970 FOR I=1 TO NMDSET
```

```
2980 INPUT#1,DAYNMR$(I)
2990 NEXT I
3000 CLOSE#1
3010 REM FOLLOWING LOOPS COMPUTE SOIL MOISTURE AND THEN mm IN EACH LAYER
3020 FOR I=1 TO NMDSET
3030 FOR J=1 TO TUBES
3040 REM THIS LITTLE LOOP COMPUTES SOIL MOISTURE AND THEN mm FOR SURFACE
3050 K = 1: AAA = A1:BBB = B1
3060 PERMOIS=(AAA*(NEUTMR(I,J,K)/STAND)-BBB)/100
3070 IF K=1 THEN HEIGHT=(VARDEP(J,K+1)+VARDEP(J,K))/2 ELSE HEIGHT=
     (VARDEP(J,K+1)+VARDEP(J,K))/2-(VARDEP(J,K)+VARDEP(J,K-1))/2
3080 VWC(I,J,K)=HEIGHT*10*PERMOIS
3090 REM VWC IS IN mm --- THAT IS WHY ABOVE FORMULA * 10
3100 K = K + 1
3105 IF K = 2 THEN AAA = A2:BBB = B2
3107 IF K = 3 THEN AAA = A3:BBB = B3
3108 IF K < 4 THEN GOTO 3060
3110 REM THIS LOOP FOR BELOW SURFACE LAYERS SINCE DIFFERENT A1 & A2 VALUES
3120 FOR K = 4 TO MAXNMR
3130 PERMOIS=(A4*(NEUTMR(I,J,K)/STAND)-B4)/100
3140 IF K=MAXNMR THEN HEIGHT=(VARDEP(J,K)-VARDEP(J,K-1)) ELSE HEIGHT=
     (VARDEP(J,K+1)+VARDEP(J,K))/2-(VARDEP(J,K)+VARDEP(J,K-1))/2
3150 VWC(I,J,K)=HEIGHT*10*PERMOIS
3160 NEXT K
3170 NEXT J
3180 NEXT I
3190 REM
3200 REM ************************************************************************
3210 REM
3220 REM         THIS SECTION IS USED TO AVERAGE TUBE READINGS
3230 DIM IRRIG(TUBES,NUMWAT),PRECIP(TUBES,NUMWAT)
3240 OPEN"I",#1,F3$
3250 FOR J=1 TO NUMWAT
3260 FOR I=1 TO TUBES
3270 INPUT#1,IRRIG(I,J)
3280 NEXT I
3290 NEXT J
3300 CLOSE#1
3310 OPEN"I",#1,F4$
3320 FOR J=1 TO NUMWAT
3330 FOR I=1 TO TUBES
3340 INPUT#1,PRECIP(I,J)
3350 NEXT I
3360 NEXT J
3370 CLOSE#1
3380 CLS:PRINT:PRINT
3390 PRINT"ONE OF THE FOLLOWING CHOICES ARE TO BE PRINTED:"
3400 PRINT:PRINT"     1) LIST APPLIED WATER AND UNADJUSTED SOIL MOISTURE FOR
     EACH ACCESS TUBE."
3410 PRINT:PRINT"     2) LIST AVERAGE APPLIED WATER AND AVERAGE UNADJUSTED
     SOIL MOISTURE FOR            ACCESS TUBES SPECIFIED."
3420 PRINT:PRINT"     3)LIST APPLIED WATER AND ADJUSTED SOIL MOISTURE FOR EACH
     ACCESS HOLE"
```

```
3430 PRINT:PRINT"     4) LIST AVERAGE APPLIED WATER AND AVERAGE ADJUSTED
     SOIL MOISTURE FOR EACH          ACCESS TUBE SPECIFIED"
3440 PRINT:INPUT"ENTER CHOICE 1,2,3, OR 4 ";SOCHOI$
3450 IF SOCHOI$="1" THEN GOTO 3480
3460 IF SOCHOI$="2" OR SOCHOI$="4" THEN GOSUB 3490
3470 IF SOCHOI$="3" OR SOCHOI$="4" THEN GOSUB 3870
3480 GOTO 4280
3490 REM
3500 REM **********************************************************************
3510 REM                THIS SECTION AVERAGES APPLIED WATER
3520 REM
3530 CLS:PRINT:PRINT
3540 PRINT:INPUT"NUMBER OF IRRIGATION/PRECIPITATION EVENTS TO AVERAGE ";AVGNIP
3550 PRINT:INPUT"NUMBER OF ACCESS TUBES TO BE AVERAGED ";NUTUBE
3560 PRINT
3570 DIM AVETUB(NUTUBE),AVEIRR(AVGNIP),AVEPRE(AVGNIP)
3580 FOR I=1 TO NUTUBE
3590 PRINT:INPUT"ENTER SINGLE ACCESS TUBE NUMBER TO AVERAGE ";AVETUB(I)
3600 NEXT I
3610 FOR I=1 TO AVGNIP
3620 SUMI=0:SUMP=0
3630 FOR J=1 TO NUTUBE
3640 SUMI=SUMI+IRRIG(AVETUB(J),I)/NUTUBE
3650 SUMP=SUMP+PRECIP(AVETUB(J),I)/NUTUBE
3660 NEXT J
3670 AVEIRR(I)=(INT(10*SUMI+.5))/10
3680 AVEPRE(I)=(INT(10*SUMP+.5))/10
3690 NEXT I
3700 IF SOCHOI$="4" THEN RETURN
3710 REM
3720 REM **********************************************************************
3730 REM           THIS SECTION AVERAGES UNADJUSTED SOIL MOISTURE
3740 REM
3750 PRINT:INPUT"NUMBER OF NEUTRON METER EVENTS TO AVERAGE ";AVENME
3760 DIM AVEUSM(AVENME,MAXNMR)
3770 FOR I=1 TO AVENME
3780 FOR J=1 TO MAXNMR
3790 SUM=0
3800 FOR K=1 TO NUTUBE
3810 SUM=SUM+VWC(I,AVETUB(K),J)/NUTUBE
3820 NEXT K
3830 IF SUM<0 THEN AVEUSM(I,J)=INT(100*SUM-.5)/100 ELSE AVEUSM(I,J)=
     INT(100*SUM+.5)/100
3840 NEXT J
3850 NEXT I
3860 RETURN
3870 REM
3880 REM **********************************************************************
3890 REM              THIS SECTION ADJUSTS SOIL MOISTURE DATA
3900 REM
3910 CLS:PRINT:INPUT"INDEX OF FIRST DEPTH LAYER TO BE ADJUSTED,EXCLUDING
     SURFACE LAYER ";FDLADJ
3920 PRINT:INPUT"INDEX OF LAST DEPTH LAYER TO BE ADJUSTED,EXCLUDIGN SURFACE
```

```
    LAYER ";LDLADJ
3930 TDLADJ=LDLADJ-FDLADJ+1
3940 DIM GENADJ(NMDSET,TUBES,TDLADJ)
3950 OPEN"I",#1,FB$
3960 FOR I=1 TO NMDSET
3970 FOR J=1 TO TUBES
3980 FOR K=1 TO TDLADJ
3990 INPUT#1,GENADJ(I,J,K)
4000 NEXT K
4010 NEXT J
4020 NEXT I
4030 CLOSE#1
4040 FOR I=1 TO NMDSET
4050 FOR J=1 TO TUBES
4060 FOR K=FDLADJ TO LDLADJ
4070 VWC(I,J,K)=GENADJ(I,J,K)
4080 NEXT K
4090 NEXT J
4100 NEXT I
4110 IF SOCHOI$="3" THEN RETURN
4120 REM
4130 REM ***********************************************************************
4140 REM           THIS SECTION AVERAGES ADJUSTED NEUTRON METER DATA
4150 REM
4160 PRINT:INPUT"NUMBER OF NEUTRON METER EVENTS TO AVERAGE ";AVENME
4170 DIM AVEASM(AVENME,MAXNMR)
4180 FOR I=1 TO AVENME
4190 FOR J=1 TO MAXNMR
4200 SUM=0
4210 FOR K=1 TO NUTUBE
4220 SUM=SUM+VWC(I,AVETUB(K),J)/NUTUBE
4230 NEXT K
4240 IF SUM<0 THEN AVEASM(I,J)=INT(SUM-.5) ELSE AVEASM(I,J)=INT(SUM+.5)
4250 NEXT J
4260 NEXT I
4270 RETURN
4280 REM
4290 REM ***********************************************************************
4300 REM           THIS SECTION SETS UP LAYER INCREMENT LIMITS
4310 REM
4320 DIM LAYINC(MAXNMR+1),SUM(NMDSET)
4330 FOR I =1 TO MAXNMR+1
4340 IF I=1 THEN LAYINC(I)=0
4350  IF I=MAXNMR+1 THEN LAYINC(I)=VARDEP(1,I-1)+15
4360 IF I>1 AND I<=MAXNMR THEN LAYINC(I)=(VARDEP(1,I)+VARDEP(1,I-1))/2
4370 NEXT I
4380 DIM MAXVWC(TUBES,MAXNMR)
4390 OPEN"I",#1,"MAXVAL.DAT"
4400 FOR J=1 TO TUBES
4410 FOR K=1 TO MAXNMR
4420 INPUT#1,MAXVWC(J,K)
4450 NEXT K
4460 NEXT J
```

```
4470 CLOSE#1
4490 FOR J=1 TO TUBES
4500 FOR K=1 TO MAXNMR
4545 MAXVWC(J,K)=MAXVWC(J,K)*(LAYINC(K+1)-LAYINC(K))/10
4550 NEXT K
4560 NEXT J
4660 REM
4670 REM ************************************************************************
4680 REM      THIS SECTION PRINTS OUT TABLES OF CHOICE TO PRINTER
4690 REM
4695 ZZ=0
4700 OPEN"O",#1,"PRINTTAB"
4710 IF SOCHOI$="2" OR SOCHOI$="4" THEN GOSUB 4830:GOSUB 5700:GOTO 4740
4720 GOSUB 4760
4730 CLOSE#1
4740 CLS:INPUT"DO YOU WANT TO ANALYZE MORE DATA (Y)(N) ";Q$
4750 IF Q$="Y" THEN 10 ELSE SYSTEM
4760 REM
4770 REM ************************************************************************
4780 REM THIS SECTION FOR APPLIED WATER AND ADJUSTED OR UNADJUSTED SOIL MOISTURE
4790 REM
4800 REM
4815 FIECAP = 0
4820 FOR K=1 TO TUBES
4830 PRINT#1,"EVAPOTRANSPIRATION EXPERIMENT: ";LOCAT$;"   ";YEAR
4840 GOSUB 5680
4845 IF SOCHOI$="2" OR SOCHOI$="4" THEN RETURN
4850 GOSUB 5680
4860 PRINT#1,"ACCESS TUBE #";K
4870 GOSUB 5680
4880 GOSUB 5680
4890 PRINT#1,"WATER APPLICATION EVENTS"
4900 GOSUB 5680
4910 PRINT#1,"     DATE            ";
4920 FOR I =1 TO NUMWAT
4930 PRINT#1,DAYWAT$(I);"  ";
4940 NEXT I
4950 GOSUB 5680
4960 PRINT#1,"     IRR (mm)        ";
4970 IF ZZ=1 THEN RETURN
4980 FOR I =1 TO NUMWAT
4990 PRINT#1,USING"###.#  ";IRRIG(K,I);
5000 NEXT I
5010 GOSUB 5680
5020 PRINT#1,"     PRECIP (mm)     ";
5030 FOR I = 1 TO NUMWAT
5040 PRINT#1,USING"###.#  ";PRECIP(K,I);
5050 NEXT I
5060 GOSUB 5680
5070 GOSUB 5680
5080 PRINT#1,"     TOTALS"
5090 PRECTOT=0:IRRIGTOT=0
5100 FOR I = 1 TO NUMWAT
```

```
5110 PRECTOT=PRECTOT+PRECIP(K,I)
5120 IRRIGTOT=IRRIGTOT+IRRIG(K,I)
5130 NEXT I
5140 PRINT#1,"       IRR (mm)      ";USING"###.#";IRRIGTOT
5150 PRINT#1,"       PRECIP (mm)   ";USING"###.#";PRECTOT
5160 GOSUB 5680
5170 GOSUB 5680
5180 IF ZZ=1 THEN RETURN
5190 IF SOCHOI$="1" THEN AA$="UNADJUSTED" ELSE AA$="ADJUSTED"
5200 GOSUB 5680
5210 PRINT#1,AA$;" mm OF SOIL MOISTURE"
5220 PRINT#1," "
5230 PRINT#1," " TAB(23+(9*NMDSET)/2) "DATES" TAB(30+9*NMDSET) "DEPLETION"
5240 GOSUB 5680
5250 PRINT#1,"SOIL DEPTH (cm)     FC     ";
5260 FOR I= 1 TO NMDSET
5270 PRINT#1,DAYNMR$(I);"    ";
5280 NEXT I
5290 PRINT#1,"    mm  %FC"
5300 GOSUB 5680
5310 IF ZZ=1 THEN RETURN
5320 FOR I=1 TO MAXNMR
5330 PRINT#1,USING"###.# - ###.#";LAYINC(I),LAYINC(I+1);
5335 PRINT#1,USING"    ###.##";MAXVWC(K,I);
5340 FOR J=1 TO NMDSET
5350 PRINT#1,TAB(18+9*J) USING"###.## ";INT(100*VWC(J,K,I)+.5)/100;
5360 NEXT J
5370 PRINT#1,"   ";USING"####.##  ";INT(100*MAXVWC(K,I)+.5)/100-INT(100
     *VWC(NMDSET,K,I)+.5)/100;
5380 PRINT#1,USING"###";INT(INT(VWC(NMDSET,K,I)+.5)/MAXVWC(K,I)*100)
5390 GOSUB 5680
5400 NEXT I
5410 GOSUB 5680
5420 PRINT#1,"TOTAL SUM";
5421 FIECAP=0
5422 FOR XX= 1 TO MAXNMR
5423 FIECAP=FIECAP+INT(100*MAXVWC(K,XX))/100
5424 NEXT XX
5425 PRINT#1,TAB(18) USING"####.##";INT(100*FIECAP+.5)/100;
5430 FOR I=1 TO NMDSET
5440 SUM(I)=0
5450 FOR J=1 TO MAXNMR
5460 SUM(I)=SUM(I)+INT(100*VWC(I,K,J)+.5)/100
5470 NEXT J
5480 PRINT#1,TAB(18+9*I) USING"###.##";SUM(I);
5490 NEXT I
5500 PRINT#1,USING"      ###.##";FIECAP-SUM(NMDSET);
5510 GOSUB 5680
5520 GOSUB 5680
5530 PRINT#1,"DEPLETION (PER PERIOD)";
5535 PRINT#1,TAB(26) USING"####.##";FIECAP - SUM(1);
5540 FOR I=2 TO NMDSET
5550 PRINT#1,TAB(26+9*(I-1)) USING"####.##";SUM(I-1)-SUM(I);
```

```
5560 NEXT I
5570 GOSUB 5680
5580 GOSUB 5680
5590 PRINT#1,"DEPLETION (CUMULATIVE)";
5593 CUM = FIECAP - SUM(1)
5595 PRINT#1,TAB(26) USING"####.##";CUM;
5600 FOR I=1 TO NMDSET-1
5610 CUM=CUM+(SUM(I)-SUM(I+1))
5620 PRINT#1,TAB(26+9*I) USING"####.##";CUM;
5630 NEXT I
5640 IF ZZ=1 THEN RETURN
5650 PRINT#1,CHR$(12)
5655 CUM = 0
5660 NEXT K
5670 RETURN
5680 PRINT#1," "
5690 RETURN
5700 REM
5710 REM ***********************************************************************
5720 REM   THIS SECTION IS FOR AVERAGE WATER AND AVERAGE SOIL MOISTURE
5730 REM
5740 ZZ=1:FIECAP = 0
5760 GOSUB 5680
5770 PRINT#1,"AVERAGE OF TUBES";
5780 FOR K=1 TO NUTUBE
5790 PRINT#1," ";AVETUB(K);
5800 NEXT K
5810 GOSUB 4870
5820 FOR I=1 TO NUMWAT
5830 PRINT#1,USING"###.#  ";AVEIRR(I);
5840 NEXT I
5850 GOSUB 5680
5860 PRINT#1,"      PRECIP (mm)     ";
5870 FOR I=1 TO NUMWAT
5880 PRINT#1,USING"###.#  ";AVEPRE(I);
5890 NEXT I
5900 GOSUB 5680
5910 PRINT#1,"      TOTALS"
5920 PRECTOT=0:IRRIGTOT=0
5930 FOR I=1 TO NUMWAT
5940 PRECTOT=PRECTOT+AVEPRE(I)
5950 IRRIGTOT=IRRIGTOT+AVEIRR(I)
5960 NEXT I
5970 GOSUB 5140
5980 IF SOCHOI$="2" THEN AA$="UNADJUSTED" ELSE AA$="ADJUSTED"
5990 NMDSET=AVENME
6000 GOSUB 5210
6010 FOR I=1 TO MAXNMR
6020 PRINT#1,USING"###.# - ###.#";LAYINC(I),LAYINC(I+1);
6030 FOR J=1 TO AVENME
6040 PRINT#1, TAB(18+9*J) USING"###.##";AVEUSM(J,I);
6050 NEXT J
6055 MAXVWC = 0
```

```
6060 FOR J=1 TO NUTUBE
6070 MAXVWC=MAXVWC+MAXVWC(AVETUB(J),I)/NUTUBE
6080 NEXT J
6085 FIECAP = FIECAP + MAXVWC
6090 PRINT#1,"    ";USING"####.##  ##";(MAXVWC-AVEUSM(AVENME,I)),
     INT((AVEUSM(AVENME,I)/MAXVWC)*100)
6100 GOSUB 5680
6110 NEXT I
6120 GOSUB 5680
6130 PRINT#1,"TOTAL SUM";
6140 FOR I=1 TO AVENME
6150 SUM(I)=0
6160 FOR J=1 TO MAXNMR
6170 SUM(I)=SUM(I)+AVEUSM(I,J)
6180 NEXT J
6190 PRINT#1,TAB(18+9*I) USING"###.##";SUM(I);
6200 NEXT I
6210 GOSUB 5500
6220 RETURN
6300 REM
6310 REM  ***************** THIS SECTION ADJUSTS DATES TO RIGHT DIGITS ********
6320 REM
6330 IF LEN(XX$) = 5 THEN RETURN
6340 IF MID$(XX$,2,1) = "/" THEN XX$ = "0" +XX$
6350 IF LEN(XX$) = 5 THEN RETURN
6360 IF MID$(XX$,3,1) = "/" THEN XX$ = LEFT$(XX$,3) + "0" + RIGHT$(XX$,1)
6370 RETURN
```

# Appendix C

## Measured ET Data

Measured ET Values

| | -- 1 Day Avg -- | | -- 3 Day Avg -- | | -- 7 Day Avg -- | | -- 14 Day Avg -- | |
|---|---|---|---|---|---|---|---|---|
| Str Day | End Day | ET Meas | End Day | ET Meas | End Day | ET Meas | End Day | ET Meas |
| 146 | 146 | 2.42 | 148 | 1.31 | 152 | 1.94 | 159 | 2.59 |
| 147 | 147 | 1.20 | 149 | 1.47 | 153 | 1.81 | 160 | 2.76 |
| 148 | 148 | 0.32 | 150 | 1.64 | 154 | 1.90 | 161 | 3.10 |
| 149 | 149 | 2.90 | 151 | 2.21 | 155 | 2.91 | 162 | 3.65 |
| 150 | 150 | 1.70 | 152 | 2.24 | 156 | 2.96 | 163 | 3.91 |
| 151 | 151 | 2.02 | 153 | 2.19 | 157 | 2.96 | 164 | 4.08 |
| 152 | 152 | 2.99 | 154 | 2.13 | 158 | 3.05 | 165 | 4.37 |
| 153 | 153 | 1.56 | 155 | 3.58 | 159 | 3.25 | 166 | 4.66 |
| 154 | 154 | 1.83 | 156 | 4.14 | 160 | 3.71 | 167 | 5.13 |
| 155 | 155 | 7.35 | 157 | 4.10 | 161 | 4.30 | 168 | 5.55 |
| 156 | 156 | 3.25 | 158 | 2.55 | 162 | 4.38 | 169 | 5.61 |
| 157 | 157 | 1.71 | 159 | 2.92 | 163 | 4.86 | 170 | 6.15 |
| 158 | 158 | 2.68 | 160 | 3.95 | 164 | 5.21 | 171 | 6.56 |
| 159 | 159 | 4.36 | 161 | 5.04 | 165 | 5.68 | 172 | 6.88 |
| 160 | 160 | 4.80 | 162 | 6.23 | 166 | 6.08 | 173 | 7.36 |
| 161 | 161 | 5.95 | 163 | 6.81 | 167 | 6.55 | 174 | 7.31 |
| 162 | 162 | 7.93 | 164 | 6.22 | 168 | 6.81 | 175 | 7.23 |
| 163 | 163 | 6.56 | 165 | 5.58 | 169 | 6.84 | 176 | 7.32 |
| 164 | 164 | 4.16 | 166 | 5.77 | 170 | 7.44 | 177 | 7.02 |
| 165 | 165 | 6.03 | 167 | 7.09 | 171 | 7.91 | 178 | 7.15 |
| 166 | 166 | 7.12 | 168 | 7.66 | 172 | 8.08 | 179 | 6.84 |
| 167 | 167 | 8.11 | 169 | 8.00 | 173 | 8.64 | 180 | 6.83 |
| 168 | 168 | 7.74 | 170 | 8.89 | 174 | 8.06 | 181 | 6.80 |
| 169 | 169 | 8.14 | 171 | 8.78 | 175 | 7.65 | 182 | 6.76 |
| 170 | 170 | 10.80 | 172 | 8.47 | 176 | 7.80 | 183 | 6.77 |
| 171 | 171 | 7.41 | 173 | 8.56 | 177 | 6.60 | 184 | 6.50 |
| 172 | 172 | 7.21 | 174 | 7.45 | 178 | 6.38 | 185 | 6.49 |
| 173 | 173 | 11.05 | 175 | 6.67 | 179 | 5.60 | 186 | 6.68 |
| 174 | 174 | 4.08 | 176 | 6.05 | 180 | 5.02 | 187 | 6.42 |
| 175 | 175 | 4.88 | 177 | 5.49 | 181 | 5.54 | 188 | 6.72 |
| 176 | 176 | 9.18 | 178 | 5.82 | 182 | 5.86 | 189 | 7.10 |
| 177 | 177 | 2.40 | 179 | 3.33 | 183 | 5.73 | 190 | 7.10 |
| 178 | 178 | 5.89 | 180 | 4.88 | 184 | 6.41 | 191 | 7.58 |
| 179 | 179 | 1.71 | 181 | 5.48 | 185 | 6.59 | 192 | 7.92 |
| 180 | 180 | 7.03 | 182 | 7.28 | 186 | 7.76 | 193 | 8.43 |
| 181 | 181 | 7.71 | 183 | 7.70 | 187 | 7.81 | 194 | 8.24 |
| 182 | 182 | 7.10 | 184 | 7.50 | 188 | 7.90 | 195 | 8.32 |
| 183 | 183 | 8.29 | 185 | 7.52 | 189 | 8.33 | 196 | 8.33 |
| 184 | 184 | 7.12 | 186 | 8.06 | 190 | 8.47 | 197 | 8.25 |
| 185 | 185 | 7.16 | 187 | 8.16 | 191 | 8.76 | 198 | 8.43 |
| 186 | 186 | 9.90 | 188 | 8.54 | 192 | 9.25 | 199 | 8.68 |
| 187 | 187 | 7.41 | 189 | 8.62 | 193 | 9.10 | 200 | 8.37 |
| 188 | 188 | 8.30 | 190 | 9.22 | 194 | 8.67 | 201 | 8.50 |
| 189 | 189 | 10.16 | 191 | 9.51 | 195 | 8.74 | 202 | 8.40 |
| 190 | 190 | 9.21 | 192 | 9.66 | 196 | 8.32 | 203 | 8.16 |

Measured ET Values

| | -- 1 Day Avg -- | | -- 3 Day Avg -- | | -- 7 Day Avg -- | | -- 14 Day Avg -- | |
|---|---|---|---|---|---|---|---|---|
| Str Day | End Day | ET Meas | End Day | ET Meas | End Day | ET Meas | End Day | ET Meas |
| 191 | 191 | 9.15 | 193 | 9.55 | 197 | 8.04 | 204 | 7.95 |
| 192 | 192 | 10.63 | 194 | 7.95 | 198 | 8.10 | 205 | 7.86 |
| 193 | 193 | 8.87 | 195 | 7.33 | 199 | 8.11 | 206 | 7.63 |
| 194 | 194 | 4.36 | 196 | 6.80 | 200 | 7.64 | 207 | 7.74 |
| 195 | 195 | 8.77 | 197 | 7.76 | 201 | 8.33 | 208 | 8.07 |
| 196 | 196 | 7.28 | 198 | 8.03 | 202 | 8.06 | 209 | 7.80 |
| 197 | 197 | 7.24 | 199 | 9.17 | 203 | 7.99 | 210 | 7.43 |
| 198 | 198 | 9.56 | 200 | 8.61 | 204 | 7.86 | 211 | 6.98 |
| 199 | 199 | 10.70 | 201 | 8.48 | 205 | 7.62 | 212 | 6.60 |
| 200 | 200 | 5.57 | 202 | 7.22 | 206 | 7.15 | 213 | 6.43 |
| 201 | 201 | 9.17 | 203 | 7.62 | 207 | 7.84 | 214 | 6.54 |
| 202 | 202 | 6.93 | 204 | 6.67 | 208 | 7.81 | 215 | 6.21 |
| 203 | 203 | 6.77 | 205 | 6.99 | 209 | 7.54 | 216 | 6.00 |
| 204 | 204 | 6.30 | 206 | 7.20 | 210 | 6.87 | 217 | 5.97 |
| 205 | 205 | 7.90 | 207 | 8.57 | 211 | 6.09 | 218 | 5.94 |
| 206 | 206 | 7.41 | 208 | 8.92 | 212 | 5.58 | 219 | 5.80 |
| 207 | 207 | 10.40 | 209 | 8.14 | 213 | 5.71 | 220 | 5.75 |
| 208 | 208 | 8.95 | 210 | 5.35 | 214 | 5.23 | 221 | 5.51 |
| 209 | 209 | 5.08 | 211 | 2.66 | 215 | 4.60 | 222 | 5.44 |
| 210 | 210 | 2.02 | 212 | 2.40 | 216 | 4.46 | 223 | 5.68 |
| 211 | 211 | 0.89 | 213 | 4.51 | 217 | 5.08 | 224 | 5.85 |
| 212 | 212 | 4.29 | 214 | 6.56 | 218 | 5.78 | 225 | 5.89 |
| 213 | 213 | 8.34 | 215 | 6.65 | 219 | 6.02 | 226 | 6.03 |
| 214 | 214 | 7.06 | 216 | 5.24 | 220 | 5.78 | 227 | 5.70 |
| 215 | 215 | 4.55 | 217 | 5.00 | 221 | 5.79 | 228 | 5.65 |
| 216 | 216 | 4.10 | 218 | 5.41 | 222 | 6.28 | 229 | 5.51 |
| 217 | 217 | 6.35 | 219 | 6.04 | 223 | 6.90 | 230 | 5.71 |
| 218 | 218 | 5.79 | 220 | 6.14 | 224 | 6.61 | 231 | 5.49 |
| 219 | 219 | 5.97 | 221 | 6.57 | 225 | 6.01 | 232 | 5.46 |
| 220 | 220 | 6.67 | 222 | 7.24 | 226 | 6.03 | 233 | 5.12 |
| 221 | 221 | 7.07 | 223 | 7.85 | 227 | 5.61 | 234 | 5.22 |
| 222 | 222 | 7.98 | 224 | 6.93 | 228 | 5.52 | 235 | 5.14 |
| 223 | 223 | 8.50 | 225 | 4.78 | 229 | 4.74 | 236 | 4.94 |
| 224 | 224 | 4.32 | 226 | 3.99 | 230 | 4.51 | 237 | 4.75 |
| 225 | 225 | 1.53 | 227 | 3.80 | 231 | 4.36 | 238 | 4.71 |
| 226 | 226 | 6.13 | 228 | 5.44 | 232 | 4.91 | 239 | 4.83 |
| 227 | 227 | 3.73 | 229 | 4.23 | 233 | 4.21 | 240 | 4.63 |
| 228 | 228 | 6.45 | 230 | 5.29 | 234 | 4.84 | 241 | 4.51 |
| 229 | 229 | 2.52 | 231 | 4.22 | 235 | 4.76 | 242 | 4.32 |
| 230 | 230 | 6.89 | 232 | 5.18 | 236 | 5.14 | 243 | 4.32 |
| 231 | 231 | 3.26 | 233 | 3.29 | 237 | 4.99 | 244 | 4.16 |
| 232 | 232 | 5.40 | 234 | 4.91 | 238 | 5.07 | 245 | 4.15 |
| 233 | 233 | 1.22 | 235 | 5.08 | 239 | 4.74 | 246 | 3.87 |
| 234 | 234 | 8.11 | 236 | 6.41 | 240 | 5.06 | 247 | 3.88 |
| 235 | 235 | 5.90 | 237 | 5.65 | 241 | 4.18 | 248 | 3.34 |

Measured ET Values

| | -- 1 Day Avg -- | | -- 3 Day Avg -- | | -- 7 Day Avg -- | | -- 14 Day Avg -- | |
|---|---|---|---|---|---|---|---|---|
| Str Day | End Day | ET Meas | End Day | ET Meas | End Day | ET Meas | End Day | ET Meas |
| 236 | 236 | 5.21 | 238 | 4.95 | 242 | 3.89 | 249 | 3.31 |
| 237 | 237 | 5.83 | 239 | 4.25 | 243 | 3.50 | 250 | 3.21 |
| 238 | 238 | 3.82 | 240 | 3.45 | 244 | 3.33 | | |
| 239 | 239 | 3.11 | 241 | 2.83 | 245 | 3.23 | | |
| 240 | 240 | 3.41 | 242 | 3.09 | 246 | 3.00 | | |
| 241 | 241 | 1.97 | 243 | 2.78 | 247 | 2.70 | | |
| 242 | 242 | 3.89 | 244 | 3.66 | 248 | 2.50 | | |
| 243 | 243 | 2.47 | 245 | 3.41 | 249 | 2.72 | | |
| 244 | 244 | 4.63 | 246 | 3.10 | 250 | 2.91 | | |
| 245 | 245 | 3.12 | 247 | 1.98 | | | | |
| 246 | 246 | 1.54 | 248 | 1.12 | | | | |
| 247 | 247 | 1.29 | 249 | 2.42 | | | | |
| 248 | 248 | 0.53 | 250 | 3.27 | | | | |
| 249 | 249 | 5.45 | | | | | | |
| 250 | 250 | 3.82 | | | | | | |

# Appendix D

## Summary of Calculated ET Data

Summary ET Values - 1 Day Averages

| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 146 | 146 | 2.94 | 2.76 | 2.76 | 2.86 | 2.89 | 4.02 | 3.61 | 3.61 | 3.85 | 3.92 | 3.61 | 3.25 | 1.13 | 2.67 |
| 147 | 147 | 2.35 | 2.27 | 2.27 | 2.38 | 2.39 | 3.41 | 3.18 | 3.18 | 3.49 | 3.51 | 3.13 | 2.96 | 0.61 | 2.14 |
| 148 | 148 | 2.59 | 2.39 | 2.39 | 2.47 | 2.49 | 3.89 | 3.33 | 3.33 | 3.54 | 3.60 | 2.60 | 2.84 | 0.71 | 2.38 |
| 149 | 149 | 2.54 | 2.35 | 2.35 | 2.35 | 2.41 | 4.06 | 3.48 | 3.48 | 3.46 | 3.65 | 2.83 | 3.01 | 0.65 | 2.25 |
| 150 | 150 | 3.59 | 3.47 | 3.47 | 3.61 | 3.70 | 4.77 | 4.49 | 4.49 | 4.83 | 5.04 | 3.45 | 4.66 | 1.62 | 3.47 |
| 151 | 151 | 3.00 | 2.88 | 2.88 | 2.96 | 3.00 | 3.80 | 3.54 | 3.54 | 3.70 | 3.80 | 3.29 | 3.62 | 1.14 | 2.97 |
| 152 | 152 | 4.49 | 4.30 | 4.30 | 4.47 | 4.56 | 5.18 | 4.84 | 4.84 | 5.13 | 5.29 | 3.74 | 5.30 | 2.61 | 4.54 |
| 153 | 153 | 2.58 | 2.35 | 2.35 | 2.32 | 2.41 | 3.45 | 2.96 | 2.96 | 2.89 | 3.08 | 3.79 | 3.08 | 0.79 | 2.26 |
| 154 | 154 | 3.71 | 3.57 | 3.57 | 3.70 | 3.70 | 4.85 | 4.52 | 4.52 | 4.81 | 4.81 | 4.05 | 4.35 | 1.65 | 3.64 |
| 155 | 155 | 3.17 | 3.16 | 3.16 | 3.34 | 3.33 | 3.69 | 3.67 | 3.67 | 4.01 | 3.99 | 3.96 | 4.06 | 1.25 | 3.22 |
| 156 | 156 | 2.08 | 2.02 | 2.02 | 1.91 | 1.92 | 3.33 | 3.15 | 3.15 | 2.83 | 2.84 | 4.47 | 2.91 | 0.48 | 1.84 |
| 157 | 157 | 3.09 | 2.73 | 2.73 | 2.72 | 2.85 | 4.31 | 3.31 | 3.31 | 3.28 | 3.65 | 3.50 | 3.42 | 1.25 | 3.02 |
| 158 | 158 | 5.02 | 4.78 | 4.78 | 4.80 | 4.97 | 7.22 | 6.45 | 6.45 | 6.50 | 7.08 | 3.84 | 6.86 | 2.84 | 5.09 |
| 159 | 159 | 4.82 | 4.63 | 4.63 | 4.80 | 4.94 | 6.06 | 5.59 | 5.59 | 6.01 | 6.36 | 3.98 | 6.24 | 3.19 | 4.99 |
| 160 | 160 | 5.58 | 5.06 | 5.06 | 5.30 | 5.65 | 7.23 | 6.04 | 6.04 | 6.59 | 7.37 | 4.64 | 7.84 | 3.99 | 5.38 |
| 161 | 161 | 5.72 | 5.38 | 5.38 | 5.64 | 5.85 | 7.40 | 6.60 | 6.60 | 7.22 | 7.70 | 5.44 | 8.01 | 4.53 | 5.60 |
| 162 | 162 | 4.94 | 4.69 | 4.69 | 4.94 | 5.03 | 5.75 | 5.27 | 5.27 | 5.75 | 5.93 | 4.82 | 6.06 | 3.71 | 5.11 |
| 163 | 163 | 5.03 | 4.95 | 4.95 | 5.26 | 5.30 | 6.39 | 6.20 | 6.20 | 6.99 | 7.10 | 5.18 | 6.71 | 3.77 | 5.24 |
| 164 | 164 | 3.99 | 3.90 | 3.90 | 4.13 | 4.08 | 4.82 | 4.61 | 4.61 | 5.14 | 5.03 | 4.85 | 4.85 | 2.42 | 4.26 |
| 165 | 165 | 4.57 | 4.37 | 4.37 | 4.50 | 4.58 | 6.26 | 5.68 | 5.68 | 6.05 | 6.29 | 4.30 | 5.91 | 2.86 | 4.57 |
| 166 | 166 | 5.68 | 5.69 | 5.69 | 5.78 | 5.77 | 8.96 | 9.01 | 9.01 | 9.37 | 9.31 | 5.21 | 8.32 | 4.22 | 5.69 |
| 167 | 167 | 6.59 | 6.18 | 6.18 | 6.46 | 6.70 | 9.37 | 8.27 | 8.27 | 9.03 | 9.67 | 6.56 | 10.18 | 6.01 | 6.25 |
| 168 | 168 | 6.12 | 5.83 | 5.83 | 6.24 | 6.51 | 7.54 | 6.94 | 6.94 | 7.80 | 8.36 | 6.61 | 9.02 | 6.02 | 6.11 |
| 169 | 169 | 5.43 | 4.99 | 4.99 | 5.42 | 5.71 | 6.88 | 5.86 | 5.86 | 6.86 | 7.52 | 5.02 | 7.24 | 4.68 | 5.45 |
| 170 | 170 | 5.39 | 5.04 | 5.04 | 5.32 | 5.59 | 6.94 | 6.11 | 6.11 | 6.77 | 7.41 | 4.63 | 7.46 | 4.03 | 5.36 |
| 171 | 171 | 5.27 | 5.06 | 5.06 | 5.33 | 5.50 | 6.96 | 6.38 | 6.38 | 7.10 | 7.58 | 4.89 | 7.39 | 4.14 | 5.38 |
| 172 | 172 | 4.78 | 4.52 | 4.52 | 4.76 | 4.98 | 6.62 | 5.85 | 5.85 | 6.56 | 7.19 | 3.72 | 6.46 | 3.04 | 4.85 |
| 173 | 173 | 4.41 | 4.31 | 4.31 | 4.41 | 4.49 | 5.75 | 5.48 | 5.48 | 5.74 | 5.96 | 3.06 | 5.55 | 2.29 | 4.59 |
| 174 | 174 | 3.11 | 2.93 | 2.93 | 2.96 | 3.03 | 3.89 | 3.49 | 3.49 | 3.56 | 3.70 | 2.95 | 3.59 | 1.24 | 3.08 |
| 175 | 175 | 4.83 | 4.58 | 4.58 | 4.83 | 5.01 | 6.00 | 5.41 | 5.41 | 5.99 | 6.41 | 4.07 | 6.31 | 3.36 | 4.99 |
| 176 | 176 | 4.79 | 4.53 | 4.53 | 4.86 | 4.90 | 6.45 | 5.73 | 5.73 | 6.65 | 6.74 | 4.15 | 5.98 | 3.45 | 4.85 |
| 177 | 177 | 3.29 | 3.02 | 3.02 | 3.18 | 3.29 | 3.85 | 3.38 | 3.38 | 3.67 | 3.85 | 3.21 | 3.78 | 1.58 | 3.21 |
| 178 | 178 | 4.75 | 4.70 | 4.70 | 5.02 | 5.03 | 6.36 | 6.23 | 6.23 | 7.14 | 7.16 | 4.09 | 6.14 | 3.18 | 4.90 |
| 179 | 179 | 3.43 | 3.42 | 3.42 | 3.54 | 3.55 | 4.37 | 4.33 | 4.33 | 4.66 | 4.68 | 3.55 | 4.52 | 1.51 | 3.60 |
| 180 | 180 | 4.39 | 4.26 | 4.26 | 4.44 | 4.52 | 5.10 | 4.86 | 4.86 | 5.20 | 5.36 | 3.86 | 5.59 | 2.87 | 4.54 |
| 181 | 181 | 5.47 | 5.07 | 5.07 | 5.53 | 5.78 | 6.71 | 5.94 | 5.94 | 6.84 | 7.32 | 5.34 | 7.97 | 4.69 | 5.26 |
| 182 | 182 | 5.46 | 5.05 | 5.05 | 5.21 | 5.45 | 7.35 | 6.40 | 6.40 | 6.78 | 7.33 | 5.17 | 7.97 | 4.16 | 5.02 |
| 183 | 183 | 5.08 | 5.06 | 5.06 | 5.47 | 5.46 | 6.21 | 6.17 | 6.17 | 7.03 | 7.01 | 5.33 | 7.12 | 4.36 | 5.08 |
| 184 | 184 | 5.12 | 4.73 | 4.73 | 4.95 | 5.22 | 7.04 | 6.03 | 6.03 | 6.59 | 7.29 | 4.46 | 7.37 | 3.69 | 4.96 |
| 185 | 185 | 5.08 | 4.99 | 4.99 | 5.23 | 5.29 | 6.43 | 6.22 | 6.22 | 6.77 | 6.92 | 5.36 | 7.21 | 4.22 | 5.13 |
| 186 | 186 | 4.96 | 4.84 | 4.84 | 5.33 | 5.36 | 5.65 | 5.44 | 5.44 | 6.31 | 6.36 | 5.09 | 6.74 | 4.37 | 5.09 |
| 187 | 187 | 5.56 | 5.21 | 5.21 | 5.56 | 5.79 | 6.52 | 5.91 | 5.91 | 6.53 | 6.91 | 5.64 | 7.96 | 4.81 | 5.37 |

Summary ET Values - 1 Day Averages

| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 188 | 188 | 5.55 | 5.38 | 5.38 | 5.79 | 5.85 | 7.22 | 6.81 | 6.81 | 7.79 | 7.93 | 5.95 | 7.80 | 5.25 | 5.46 |
| 189 | 189 | 5.09 | 4.87 | 4.87 | 5.17 | 5.29 | 6.09 | 5.64 | 5.64 | 6.27 | 6.50 | 5.30 | 6.83 | 4.33 | 5.24 |
| 190 | 190 | 5.41 | 4.88 | 4.88 | 5.20 | 5.59 | 7.36 | 6.04 | 6.04 | 6.84 | 7.80 | 5.25 | 8.06 | 4.41 | 5.15 |
| 191 | 191 | 5.06 | 4.81 | 4.81 | 5.09 | 5.27 | 6.59 | 5.98 | 5.98 | 6.67 | 7.10 | 4.99 | 7.21 | 4.20 | 5.05 |
| 192 | 192 | 5.54 | 5.00 | 5.00 | 5.26 | 5.59 | 7.97 | 6.53 | 6.53 | 7.22 | 8.11 | 5.11 | 8.43 | 4.25 | 5.17 |
| 193 | 193 | 5.17 | 4.94 | 4.94 | 5.41 | 5.62 | 6.97 | 6.36 | 6.36 | 7.60 | 8.15 | 5.16 | 7.80 | 4.58 | 5.13 |
| 194 | 194 | 5.08 | 4.84 | 4.84 | 5.21 | 5.44 | 6.19 | 5.69 | 5.69 | 6.47 | 6.97 | 5.18 | 7.32 | 4.39 | 5.14 |
| 195 | 195 | 4.85 | 4.56 | 4.56 | 4.79 | 4.94 | 6.11 | 5.43 | 5.43 | 5.97 | 6.31 | 5.13 | 6.51 | 3.90 | 4.90 |
| 196 | 196 | 4.88 | 4.61 | 4.61 | 4.85 | 5.01 | 6.21 | 5.56 | 5.56 | 6.14 | 6.54 | 5.36 | 6.82 | 3.94 | 5.00 |
| 197 | 197 | 6.18 | 5.47 | 5.47 | 5.92 | 6.39 | 8.00 | 6.51 | 6.51 | 7.46 | 8.44 | 6.78 | 9.49 | 5.79 | 5.68 |
| 198 | 198 | 5.42 | 5.04 | 5.04 | 5.48 | 5.66 | 6.62 | 5.86 | 5.86 | 6.75 | 7.12 | 6.10 | 7.50 | 5.22 | 5.33 |
| 199 | 199 | 5.52 | 5.18 | 5.18 | 5.81 | 6.04 | 6.92 | 6.22 | 6.22 | 7.55 | 8.02 | 5.95 | 8.09 | 5.22 | 5.31 |
| 200 | 200 | 4.80 | 4.55 | 4.55 | 5.16 | 5.33 | 5.85 | 5.37 | 5.37 | 6.56 | 6.88 | 5.59 | 7.05 | 4.14 | 4.66 |
| 201 | 201 | 4.28 | 4.06 | 4.06 | 4.28 | 4.39 | 5.31 | 4.84 | 4.84 | 5.31 | 5.54 | 5.23 | 5.84 | 3.21 | 4.27 |
| 202 | 202 | 4.77 | 4.59 | 4.59 | 4.77 | 4.87 | 6.15 | 5.69 | 5.69 | 6.13 | 6.38 | 5.66 | 6.54 | 3.78 | 4.84 |
| 203 | 203 | 4.87 | 4.74 | 4.74 | 4.88 | 4.96 | 6.36 | 6.01 | 6.01 | 6.37 | 6.60 | 5.21 | 6.77 | 3.59 | 4.98 |
| 204 | 204 | 5.31 | 4.87 | 4.87 | 5.22 | 5.56 | 7.01 | 6.00 | 6.00 | 6.81 | 7.60 | 5.51 | 8.09 | 4.52 | 5.08 |
| 205 | 205 | 5.86 | 5.29 | 5.29 | 5.70 | 6.08 | 7.48 | 6.34 | 6.34 | 7.15 | 7.90 | 6.06 | 8.83 | 5.25 | 5.34 |
| 206 | 206 | 5.58 | 5.02 | 5.02 | 5.48 | 5.82 | 7.08 | 5.98 | 5.98 | 6.88 | 7.53 | 5.86 | 8.42 | 4.78 | 5.01 |
| 207 | 207 | 5.18 | 4.66 | 4.66 | 5.18 | 5.48 | 7.50 | 6.21 | 6.21 | 7.48 | 8.24 | 5.94 | 7.93 | 4.30 | 4.55 |
| 208 | 208 | 3.85 | 3.73 | 3.73 | 3.88 | 3.91 | 5.26 | 4.87 | 4.87 | 5.38 | 5.48 | 4.48 | 5.01 | 2.24 | 4.09 |
| 209 | 209 | 1.24 | 1.14 | 1.14 | 1.18 | 1.17 | 1.46 | 1.28 | 1.28 | 1.36 | 1.33 | 3.92 | 1.75 | 0.13 | 1.20 |
| 210 | 210 | 3.28 | 3.09 | 3.09 | 3.27 | 3.34 | 3.96 | 3.54 | 3.54 | 3.94 | 4.09 | 4.11 | 4.10 | 1.98 | 3.43 |
| 211 | 211 | 3.48 | 3.22 | 3.22 | 3.40 | 3.55 | 4.28 | 3.73 | 3.73 | 4.10 | 4.43 | 4.15 | 4.66 | 2.33 | 3.46 |
| 212 | 212 | 3.96 | 3.78 | 3.78 | 4.02 | 4.16 | 4.54 | 4.24 | 4.24 | 4.65 | 4.90 | 4.73 | 5.58 | 3.08 | 4.00 |
| 213 | 213 | 4.43 | 4.25 | 4.25 | 4.59 | 4.75 | 5.97 | 5.49 | 5.49 | 6.41 | 6.83 | 5.06 | 6.77 | 3.68 | 4.44 |
| 214 | 214 | 4.02 | 3.71 | 3.71 | 4.00 | 4.14 | 4.94 | 4.31 | 4.31 | 4.91 | 5.19 | 4.12 | 5.40 | 3.15 | 3.93 |
| 215 | 215 | 4.30 | 4.04 | 4.04 | 4.41 | 4.58 | 5.25 | 4.75 | 4.75 | 5.48 | 5.81 | 4.28 | 6.12 | 3.63 | 4.19 |
| 216 | 216 | 2.64 | 2.49 | 2.49 | 2.63 | 2.70 | 4.07 | 3.56 | 3.56 | 4.04 | 4.27 | 3.68 | 3.78 | 1.06 | 2.56 |
| 217 | 217 | 3.03 | 2.73 | 2.73 | 2.97 | 3.15 | 3.73 | 3.16 | 3.16 | 3.62 | 3.96 | 3.75 | 4.11 | 1.85 | 2.85 |
| 218 | 218 | 3.81 | 3.62 | 3.62 | 3.74 | 3.83 | 5.12 | 4.64 | 4.64 | 4.93 | 5.17 | 4.23 | 5.18 | 2.65 | 3.72 |
| 219 | 219 | 4.10 | 3.78 | 3.78 | 4.10 | 4.34 | 4.94 | 4.32 | 4.32 | 4.93 | 5.38 | 4.38 | 5.86 | 3.35 | 4.02 |
| 220 | 220 | 5.23 | 4.75 | 4.75 | 4.96 | 5.23 | 7.66 | 6.50 | 6.50 | 6.99 | 7.67 | 5.74 | 8.25 | 4.46 | 4.44 |
| 221 | 221 | 4.78 | 4.35 | 4.35 | 4.81 | 5.09 | 6.72 | 5.71 | 5.71 | 6.79 | 7.47 | 5.15 | 7.26 | 4.17 | 4.24 |
| 222 | 222 | 4.12 | 3.76 | 3.76 | 4.31 | 4.65 | 4.88 | 4.24 | 4.24 | 5.23 | 5.83 | 4.31 | 6.16 | 3.56 | 3.96 |
| 223 | 223 | 4.70 | 4.15 | 4.15 | 4.65 | 5.06 | 6.12 | 5.02 | 5.02 | 6.02 | 6.85 | 5.04 | 7.19 | 4.11 | 4.16 |
| 224 | 224 | 3.93 | 3.67 | 3.67 | 4.00 | 4.13 | 5.64 | 4.86 | 4.86 | 5.86 | 6.24 | 4.34 | 5.50 | 3.08 | 3.88 |
| 225 | 225 | 1.60 | 1.53 | 1.53 | 1.59 | 1.59 | 2.14 | 1.99 | 1.99 | 2.12 | 2.12 | 3.73 | 2.10 | 0.30 | 1.47 |
| 226 | 226 | 2.29 | 2.16 | 2.16 | 2.26 | 2.36 | 2.88 | 2.63 | 2.63 | 2.82 | 3.03 | 3.49 | 3.22 | 0.91 | 2.09 |
| 227 | 227 | 3.03 | 2.76 | 2.76 | 2.96 | 3.12 | 3.82 | 3.30 | 3.30 | 3.68 | 4.00 | 3.24 | 4.01 | 1.71 | 2.78 |
| 228 | 228 | 3.76 | 3.45 | 3.45 | 3.55 | 3.86 | 4.75 | 4.12 | 4.12 | 4.33 | 4.95 | 3.74 | 5.44 | 2.52 | 3.52 |
| 229 | 229 | 4.28 | 3.88 | 3.88 | 4.27 | 4.57 | 5.53 | 4.71 | 4.71 | 5.51 | 6.12 | 4.45 | 6.61 | 3.39 | 3.88 |

Summary ET Values - 1 Day Averages

| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 230 | 4.43 | 3.93 | 3.93 | 4.10 | 4.47 | 5.85 | 4.89 | 4.89 | 5.23 | 5.93 | 5.73 | 6.79 | 3.46 | 3.63 |
| 231 | 231 | 2.48 | 2.23 | 2.23 | 2.32 | 2.54 | 2.91 | 2.53 | 2.53 | 2.67 | 2.99 | 4.85 | 3.75 | 1.21 | 2.03 |
| 232 | 232 | 4.34 | 3.90 | 3.90 | 4.39 | 4.79 | 5.48 | 4.63 | 4.63 | 5.58 | 6.33 | 4.99 | 6.78 | 3.80 | 3.89 |
| 233 | 233 | 4.26 | 3.87 | 3.87 | 4.49 | 4.72 | 6.51 | 5.44 | 5.44 | 7.15 | 7.79 | 4.46 | 6.52 | 3.41 | 3.74 |
| 234 | 234 | 3.14 | 2.87 | 2.87 | 3.02 | 3.10 | 4.23 | 3.54 | 3.54 | 3.91 | 4.11 | 3.03 | 3.87 | 1.72 | 3.03 |
| 235 | 235 | 3.48 | 3.16 | 3.16 | 3.49 | 3.72 | 4.16 | 3.61 | 3.61 | 4.18 | 4.58 | 3.46 | 4.73 | 2.37 | 3.25 |
| 236 | 236 | 3.71 | 3.39 | 3.39 | 3.50 | 3.77 | 5.26 | 4.44 | 4.44 | 4.72 | 5.42 | 3.76 | 5.25 | 2.46 | 3.44 |
| 237 | 237 | 3.11 | 2.81 | 2.81 | 2.98 | 3.19 | 4.41 | 3.64 | 3.64 | 4.06 | 4.59 | 3.37 | 4.43 | 1.78 | 2.87 |
| 238 | 238 | 2.97 | 2.69 | 2.69 | 2.90 | 3.15 | 3.80 | 3.27 | 3.27 | 3.68 | 4.16 | 3.32 | 4.49 | 2.07 | 2.59 |
| 239 | 239 | 1.79 | 1.51 | 1.51 | 1.55 | 1.64 | 2.48 | 1.87 | 1.87 | 1.96 | 2.15 | 3.07 | 2.06 | 0.61 | 1.52 |
| 240 | 240 | 2.84 | 2.48 | 2.48 | 2.69 | 2.87 | 3.41 | 2.81 | 2.81 | 3.16 | 3.47 | 3.12 | 3.73 | 1.93 | 2.53 |
| 241 | 241 | 3.10 | 2.67 | 2.67 | 2.95 | 3.22 | 3.96 | 3.14 | 3.14 | 3.66 | 4.19 | 3.49 | 4.40 | 2.39 | 2.73 |
| 242 | 242 | 2.46 | 2.39 | 2.39 | 2.57 | 2.58 | 3.23 | 3.08 | 3.08 | 3.48 | 3.50 | 3.74 | 3.46 | 1.48 | 2.37 |
| 243 | 243 | 1.57 | 1.29 | 1.29 | 1.27 | 1.32 | 2.87 | 1.93 | 1.93 | 1.86 | 2.05 | 3.55 | 1.76 | 0.36 | 1.26 |
| 244 | 244 | 2.42 | 2.12 | 2.12 | 2.29 | 2.49 | 3.44 | 2.75 | 2.75 | 3.14 | 3.60 | 2.68 | 3.35 | 1.30 | 2.06 |
| 245 | 245 | 1.93 | 1.74 | 1.74 | 1.99 | 2.13 | 2.44 | 2.08 | 2.08 | 2.55 | 2.83 | 2.68 | 2.61 | 0.87 | 1.71 |
| 246 | 246 | 1.53 | 1.23 | 1.23 | 1.29 | 1.36 | 1.87 | 1.36 | 1.36 | 1.46 | 1.58 | 2.57 | 1.45 | 0.39 | 1.32 |
| 247 | 247 | 1.78 | 1.45 | 1.45 | 1.64 | 1.71 | 2.17 | 1.62 | 1.62 | 1.93 | 2.05 | 2.46 | 1.91 | 0.65 | 1.53 |
| 248 | 248 | 1.86 | 1.47 | 1.47 | 1.41 | 1.60 | 2.99 | 1.99 | 1.99 | 1.83 | 2.33 | 2.78 | 2.00 | 0.55 | 1.45 |
| 249 | 249 | 1.88 | 1.69 | 1.69 | 1.83 | 1.90 | 2.75 | 2.17 | 2.17 | 2.58 | 2.79 | 2.91 | 2.50 | 0.74 | 1.83 |
| 250 | 250 | 2.16 | 2.01 | 2.01 | 2.14 | 2.26 | 3.10 | 2.68 | 2.68 | 3.03 | 3.38 | 3.04 | 3.15 | 1.02 | 2.10 |

Summary ET Values - 3 Day Averages

| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 146 | 148 | 2.63 | 2.47 | 2.47 | 2.57 | 2.59 | 3.77 | 3.37 | 3.37 | 3.63 | 3.67 | 3.11 | 3.02 | 0.82 | 2.40 |
| 147 | 149 | 2.50 | 2.34 | 2.34 | 2.40 | 2.43 | 3.78 | 3.33 | 3.33 | 3.50 | 3.59 | 2.85 | 2.94 | 0.66 | 2.26 |
| 148 | 150 | 2.91 | 2.74 | 2.74 | 2.81 | 2.86 | 4.24 | 3.77 | 3.77 | 3.94 | 4.09 | 2.96 | 3.50 | 1.00 | 2.70 |
| 149 | 151 | 3.05 | 2.90 | 2.90 | 2.97 | 3.04 | 4.21 | 3.83 | 3.83 | 4.00 | 4.16 | 3.19 | 3.76 | 1.14 | 2.90 |
| 150 | 152 | 3.69 | 3.55 | 3.55 | 3.68 | 3.75 | 4.58 | 4.29 | 4.29 | 4.55 | 4.71 | 3.50 | 4.53 | 1.79 | 3.66 |
| 151 | 153 | 3.36 | 3.18 | 3.18 | 3.25 | 3.32 | 4.14 | 3.78 | 3.78 | 3.91 | 4.06 | 3.61 | 4.00 | 1.51 | 3.26 |
| 152 | 154 | 3.60 | 3.41 | 3.41 | 3.49 | 3.55 | 4.49 | 4.11 | 4.11 | 4.28 | 4.39 | 3.86 | 4.24 | 1.68 | 3.48 |
| 153 | 155 | 3.16 | 3.03 | 3.03 | 3.12 | 3.15 | 4.00 | 3.72 | 3.72 | 3.91 | 3.96 | 3.93 | 3.83 | 1.23 | 3.04 |
| 154 | 156 | 2.99 | 2.92 | 2.92 | 2.98 | 2.98 | 3.96 | 3.78 | 3.78 | 3.88 | 3.88 | 4.16 | 3.78 | 1.13 | 2.90 |
| 155 | 157 | 2.78 | 2.63 | 2.63 | 2.66 | 2.70 | 3.78 | 3.37 | 3.37 | 3.38 | 3.49 | 3.97 | 3.46 | 0.99 | 2.69 |
| 156 | 158 | 3.39 | 3.18 | 3.18 | 3.14 | 3.25 | 4.95 | 4.30 | 4.30 | 4.20 | 4.52 | 3.94 | 4.40 | 1.52 | 3.32 |
| 157 | 159 | 4.31 | 4.05 | 4.05 | 4.11 | 4.26 | 5.87 | 5.12 | 5.12 | 5.26 | 5.70 | 3.77 | 5.50 | 2.43 | 4.37 |
| 158 | 160 | 5.14 | 4.82 | 4.82 | 4.97 | 5.19 | 6.84 | 6.03 | 6.03 | 6.37 | 6.94 | 4.15 | 6.98 | 3.34 | 5.15 |
| 159 | 161 | 5.38 | 5.02 | 5.02 | 5.25 | 5.48 | 6.90 | 6.08 | 6.08 | 6.61 | 7.14 | 4.68 | 7.36 | 3.91 | 5.32 |
| 160 | 162 | 5.41 | 5.04 | 5.04 | 5.29 | 5.51 | 6.79 | 5.97 | 5.97 | 6.52 | 7.00 | 4.97 | 7.30 | 4.08 | 5.36 |
| 161 | 163 | 5.23 | 5.01 | 5.01 | 5.28 | 5.40 | 6.51 | 6.02 | 6.02 | 6.65 | 6.91 | 5.14 | 6.93 | 4.01 | 5.32 |
| 162 | 164 | 4.65 | 4.51 | 4.51 | 4.77 | 4.80 | 5.65 | 5.36 | 5.36 | 5.96 | 6.02 | 4.95 | 5.87 | 3.30 | 4.87 |
| 163 | 165 | 4.53 | 4.41 | 4.41 | 4.63 | 4.66 | 5.82 | 5.50 | 5.50 | 6.06 | 6.14 | 4.77 | 5.83 | 3.02 | 4.69 |
| 164 | 166 | 4.75 | 4.65 | 4.65 | 4.80 | 4.81 | 6.68 | 6.43 | 6.43 | 6.85 | 6.88 | 4.79 | 6.36 | 3.17 | 4.84 |
| 165 | 167 | 5.61 | 5.41 | 5.41 | 5.58 | 5.68 | 8.19 | 7.66 | 7.66 | 8.15 | 8.42 | 5.36 | 8.14 | 4.37 | 5.50 |
| 166 | 168 | 6.13 | 5.90 | 5.90 | 6.16 | 6.33 | 8.62 | 8.07 | 8.07 | 8.73 | 9.11 | 6.13 | 9.17 | 5.42 | 6.02 |
| 167 | 169 | 6.05 | 5.67 | 5.67 | 6.04 | 6.31 | 7.93 | 7.02 | 7.02 | 7.90 | 8.52 | 6.06 | 8.81 | 5.57 | 5.94 |
| 168 | 170 | 5.65 | 5.29 | 5.29 | 5.66 | 5.93 | 7.12 | 6.30 | 6.30 | 7.14 | 7.77 | 5.42 | 7.91 | 4.91 | 5.64 |
| 169 | 171 | 5.36 | 5.03 | 5.03 | 5.35 | 5.60 | 6.93 | 6.12 | 6.12 | 6.91 | 7.50 | 4.85 | 7.36 | 4.28 | 5.40 |
| 170 | 172 | 5.15 | 4.87 | 4.87 | 5.13 | 5.36 | 6.84 | 6.11 | 6.11 | 6.81 | 7.39 | 4.41 | 7.10 | 3.74 | 5.20 |
| 171 | 173 | 4.82 | 4.63 | 4.63 | 4.83 | 4.99 | 6.44 | 5.90 | 5.90 | 6.46 | 6.91 | 3.89 | 6.47 | 3.16 | 4.94 |
| 172 | 174 | 4.10 | 3.92 | 3.92 | 4.04 | 4.16 | 5.42 | 4.94 | 4.94 | 5.28 | 5.62 | 3.24 | 5.20 | 2.19 | 4.17 |
| 173 | 175 | 4.12 | 3.94 | 3.94 | 4.06 | 4.17 | 5.21 | 4.79 | 4.79 | 5.09 | 5.36 | 3.36 | 5.15 | 2.30 | 4.22 |
| 174 | 176 | 4.25 | 4.01 | 4.01 | 4.22 | 4.31 | 5.45 | 4.87 | 4.87 | 5.40 | 5.62 | 3.72 | 5.29 | 2.68 | 4.31 |
| 175 | 177 | 4.30 | 4.04 | 4.04 | 4.29 | 4.40 | 5.43 | 4.84 | 4.84 | 5.43 | 5.67 | 3.81 | 5.36 | 2.80 | 4.35 |
| 176 | 178 | 4.28 | 4.08 | 4.08 | 4.36 | 4.40 | 5.55 | 5.11 | 5.11 | 5.82 | 5.92 | 3.82 | 5.30 | 2.74 | 4.32 |
| 177 | 179 | 3.82 | 3.71 | 3.71 | 3.92 | 3.95 | 4.86 | 4.64 | 4.64 | 5.16 | 5.23 | 3.62 | 4.81 | 2.09 | 3.91 |
| 178 | 180 | 4.19 | 4.13 | 4.13 | 4.33 | 4.37 | 5.28 | 5.14 | 5.14 | 5.67 | 5.73 | 3.83 | 5.42 | 2.52 | 4.35 |
| 179 | 181 | 4.43 | 4.25 | 4.25 | 4.50 | 4.62 | 5.39 | 5.04 | 5.04 | 5.57 | 5.79 | 4.25 | 6.02 | 3.02 | 4.47 |
| 180 | 182 | 5.10 | 4.80 | 4.80 | 5.06 | 5.25 | 6.38 | 5.73 | 5.73 | 6.27 | 6.67 | 4.79 | 7.17 | 3.91 | 4.94 |
| 181 | 183 | 5.34 | 5.06 | 5.06 | 5.41 | 5.57 | 6.75 | 6.17 | 6.17 | 6.88 | 7.22 | 5.28 | 7.69 | 4.40 | 5.12 |
| 182 | 184 | 5.22 | 4.95 | 4.95 | 5.21 | 5.38 | 6.87 | 6.20 | 6.20 | 6.80 | 7.21 | 4.99 | 7.49 | 4.07 | 5.02 |
| 183 | 185 | 5.09 | 4.93 | 4.93 | 5.22 | 5.32 | 6.56 | 6.14 | 6.14 | 6.80 | 7.07 | 5.05 | 7.23 | 4.09 | 5.06 |
| 184 | 186 | 5.05 | 4.85 | 4.85 | 5.17 | 5.29 | 6.37 | 5.90 | 5.90 | 6.56 | 6.85 | 4.97 | 7.11 | 4.09 | 5.06 |
| 185 | 187 | 5.20 | 5.01 | 5.01 | 5.38 | 5.48 | 6.20 | 5.86 | 5.86 | 6.54 | 6.73 | 5.36 | 7.31 | 4.47 | 5.20 |
| 186 | 188 | 5.35 | 5.14 | 5.14 | 5.56 | 5.66 | 6.46 | 6.06 | 6.06 | 6.88 | 7.07 | 5.56 | 7.50 | 4.81 | 5.31 |
| 187 | 189 | 5.40 | 5.15 | 5.15 | 5.51 | 5.64 | 6.61 | 6.12 | 6.12 | 6.86 | 7.12 | 5.63 | 7.53 | 4.80 | 5.36 |

Summary ET Values - 3 Day Averages

| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 188 | 190 | 5.35 | 5.04 | 5.04 | 5.39 | 5.58 | 6.89 | 6.16 | 6.16 | 6.97 | 7.41 | 5.50 | 7.56 | 4.66 | 5.28 |
| 189 | 191 | 5.19 | 4.85 | 4.85 | 5.16 | 5.38 | 6.68 | 5.89 | 5.89 | 6.59 | 7.14 | 5.18 | 7.36 | 4.31 | 5.15 |
| 190 | 192 | 5.34 | 4.90 | 4.90 | 5.18 | 5.48 | 7.31 | 6.19 | 6.19 | 6.91 | 7.67 | 5.12 | 7.90 | 4.28 | 5.13 |
| 191 | 193 | 5.26 | 4.92 | 4.92 | 5.25 | 5.49 | 7.18 | 6.29 | 6.29 | 7.17 | 7.79 | 5.09 | 7.81 | 4.34 | 5.12 |
| 192 | 194 | 5.26 | 4.93 | 4.93 | 5.29 | 5.55 | 7.04 | 6.19 | 6.19 | 7.10 | 7.74 | 5.15 | 7.85 | 4.41 | 5.15 |
| 193 | 195 | 5.03 | 4.78 | 4.78 | 5.14 | 5.33 | 6.42 | 5.83 | 5.83 | 6.68 | 7.14 | 5.16 | 7.21 | 4.29 | 5.06 |
| 194 | 196 | 4.93 | 4.67 | 4.67 | 4.95 | 5.13 | 6.17 | 5.56 | 5.56 | 6.19 | 6.60 | 5.22 | 6.88 | 4.08 | 5.01 |
| 195 | 197 | 5.30 | 4.88 | 4.88 | 5.19 | 5.45 | 6.77 | 5.83 | 5.83 | 6.52 | 7.09 | 5.75 | 7.61 | 4.55 | 5.19 |
| 196 | 198 | 5.49 | 5.04 | 5.04 | 5.42 | 5.69 | 6.95 | 5.98 | 5.98 | 6.78 | 7.36 | 6.08 | 7.94 | 4.99 | 5.33 |
| 197 | 199 | 5.70 | 5.23 | 5.23 | 5.74 | 6.03 | 7.18 | 6.20 | 6.20 | 7.25 | 7.86 | 6.28 | 8.36 | 5.41 | 5.44 |
| 198 | 200 | 5.24 | 4.92 | 4.92 | 5.48 | 5.68 | 6.47 | 5.82 | 5.82 | 6.95 | 7.34 | 5.88 | 7.54 | 4.86 | 5.10 |
| 199 | 201 | 4.86 | 4.60 | 4.60 | 5.09 | 5.25 | 6.03 | 5.48 | 5.48 | 6.47 | 6.81 | 5.59 | 6.99 | 4.19 | 4.75 |
| 200 | 202 | 4.62 | 4.40 | 4.40 | 4.74 | 4.86 | 5.77 | 5.30 | 5.30 | 6.00 | 6.27 | 5.49 | 6.48 | 3.71 | 4.59 |
| 201 | 203 | 4.64 | 4.46 | 4.46 | 4.64 | 4.74 | 5.94 | 5.51 | 5.51 | 5.94 | 6.17 | 5.37 | 6.38 | 3.52 | 4.70 |
| 202 | 204 | 4.98 | 4.73 | 4.73 | 4.95 | 5.13 | 6.51 | 5.90 | 5.90 | 6.44 | 6.86 | 5.46 | 7.13 | 3.96 | 4.97 |
| 203 | 205 | 5.35 | 4.97 | 4.97 | 5.26 | 5.53 | 6.95 | 6.12 | 6.12 | 6.78 | 7.37 | 5.59 | 7.90 | 4.45 | 5.13 |
| 204 | 206 | 5.58 | 5.06 | 5.06 | 5.47 | 5.82 | 7.19 | 6.11 | 6.11 | 6.95 | 7.68 | 5.81 | 8.45 | 4.85 | 5.14 |
| 205 | 207 | 5.54 | 4.99 | 4.99 | 5.45 | 5.79 | 7.35 | 6.18 | 6.18 | 7.17 | 7.89 | 5.95 | 8.40 | 4.77 | 4.97 |
| 206 | 208 | 4.87 | 4.47 | 4.47 | 4.85 | 5.07 | 6.61 | 5.69 | 5.69 | 6.58 | 7.08 | 5.43 | 7.12 | 3.77 | 4.55 |
| 207 | 209 | 3.42 | 3.18 | 3.18 | 3.41 | 3.52 | 4.74 | 4.12 | 4.12 | 4.74 | 5.02 | 4.78 | 4.90 | 2.22 | 3.28 |
| 208 | 210 | 2.79 | 2.65 | 2.65 | 2.78 | 2.81 | 3.56 | 3.23 | 3.23 | 3.56 | 3.63 | 4.17 | 3.62 | 1.45 | 2.91 |
| 209 | 211 | 2.67 | 2.48 | 2.48 | 2.62 | 2.69 | 3.23 | 2.85 | 2.85 | 3.13 | 3.28 | 4.06 | 3.50 | 1.48 | 2.70 |
| 210 | 212 | 3.57 | 3.36 | 3.36 | 3.56 | 3.68 | 4.26 | 3.84 | 3.84 | 4.23 | 4.47 | 4.33 | 4.78 | 2.46 | 3.63 |
| 211 | 213 | 3.96 | 3.75 | 3.75 | 4.00 | 4.15 | 4.93 | 4.49 | 4.49 | 5.05 | 5.39 | 4.65 | 5.67 | 3.03 | 3.97 |
| 212 | 214 | 4.14 | 3.91 | 3.91 | 4.20 | 4.35 | 5.15 | 4.68 | 4.68 | 5.32 | 5.64 | 4.64 | 5.92 | 3.30 | 4.13 |
| 213 | 215 | 4.25 | 4.00 | 4.00 | 4.34 | 4.49 | 5.39 | 4.85 | 4.85 | 5.60 | 5.94 | 4.49 | 6.10 | 3.49 | 4.19 |
| 214 | 216 | 3.65 | 3.41 | 3.41 | 3.68 | 3.81 | 4.75 | 4.21 | 4.21 | 4.81 | 5.09 | 4.03 | 5.10 | 2.61 | 3.56 |
| 215 | 217 | 3.32 | 3.09 | 3.09 | 3.34 | 3.48 | 4.35 | 3.82 | 3.82 | 4.38 | 4.68 | 3.90 | 4.67 | 2.18 | 3.20 |
| 216 | 218 | 3.16 | 2.95 | 2.95 | 3.11 | 3.23 | 4.31 | 3.79 | 3.79 | 4.19 | 4.47 | 3.88 | 4.36 | 1.85 | 3.05 |
| 217 | 219 | 3.65 | 3.38 | 3.38 | 3.60 | 3.77 | 4.60 | 4.04 | 4.04 | 4.49 | 4.84 | 4.12 | 5.05 | 2.61 | 3.53 |
| 218 | 220 | 4.38 | 4.05 | 4.05 | 4.26 | 4.47 | 5.91 | 5.15 | 5.15 | 5.62 | 6.07 | 4.78 | 6.43 | 3.49 | 4.06 |
| 219 | 221 | 4.70 | 4.29 | 4.29 | 4.62 | 4.89 | 6.44 | 5.51 | 5.51 | 6.24 | 6.84 | 5.09 | 7.12 | 3.99 | 4.23 |
| 220 | 222 | 4.71 | 4.29 | 4.29 | 4.69 | 4.99 | 6.42 | 5.48 | 5.48 | 6.34 | 6.99 | 5.07 | 7.22 | 4.06 | 4.21 |
| 221 | 223 | 4.53 | 4.09 | 4.09 | 4.59 | 4.93 | 5.91 | 4.99 | 4.99 | 6.01 | 6.72 | 4.83 | 6.87 | 3.95 | 4.12 |
| 222 | 224 | 4.25 | 3.86 | 3.86 | 4.32 | 4.61 | 5.55 | 4.71 | 4.71 | 5.70 | 6.31 | 4.56 | 6.28 | 3.58 | 4.00 |
| 223 | 225 | 3.41 | 3.12 | 3.12 | 3.41 | 3.59 | 4.63 | 3.96 | 3.96 | 4.67 | 5.07 | 4.37 | 4.93 | 2.50 | 3.17 |
| 224 | 226 | 2.61 | 2.45 | 2.45 | 2.62 | 2.69 | 3.56 | 3.16 | 3.16 | 3.60 | 3.80 | 3.85 | 3.61 | 1.43 | 2.48 |
| 225 | 227 | 2.31 | 2.15 | 2.15 | 2.27 | 2.36 | 2.95 | 2.64 | 2.64 | 2.87 | 3.05 | 3.49 | 3.11 | 0.98 | 2.11 |
| 226 | 228 | 3.03 | 2.79 | 2.79 | 2.92 | 3.12 | 3.82 | 3.35 | 3.35 | 3.61 | 3.99 | 3.49 | 4.22 | 1.72 | 2.80 |
| 227 | 229 | 3.69 | 3.36 | 3.36 | 3.60 | 3.85 | 4.70 | 4.04 | 4.04 | 4.51 | 5.02 | 3.81 | 5.36 | 2.54 | 3.39 |
| 228 | 230 | 4.16 | 3.75 | 3.75 | 3.98 | 4.30 | 5.38 | 4.57 | 4.57 | 5.02 | 5.67 | 4.64 | 6.28 | 3.12 | 3.68 |
| 229 | 231 | 3.73 | 3.34 | 3.34 | 3.57 | 3.86 | 4.76 | 4.04 | 4.04 | 4.47 | 5.01 | 5.01 | 5.72 | 2.68 | 3.18 |

Summary ET Values - 3 Day Averages

| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 232 | 3.75 | 3.35 | 3.35 | 3.61 | 3.93 | 4.75 | 4.02 | 4.02 | 4.49 | 5.08 | 5.19 | 5.77 | 2.82 | 3.18 |
| 231 | 233 | 3.69 | 3.33 | 3.33 | 3.74 | 4.02 | 4.97 | 4.20 | 4.20 | 5.13 | 5.70 | 4.77 | 5.68 | 2.81 | 3.22 |
| 232 | 234 | 3.92 | 3.54 | 3.54 | 3.97 | 4.20 | 5.41 | 4.54 | 4.54 | 5.54 | 6.08 | 4.16 | 5.72 | 2.98 | 3.55 |
| 233 | 235 | 3.63 | 3.30 | 3.30 | 3.67 | 3.85 | 4.96 | 4.19 | 4.19 | 5.08 | 5.49 | 3.65 | 5.04 | 2.50 | 3.34 |
| 234 | 236 | 3.44 | 3.14 | 3.14 | 3.34 | 3.53 | 4.55 | 3.86 | 3.86 | 4.27 | 4.71 | 3.42 | 4.62 | 2.18 | 3.24 |
| 235 | 237 | 3.43 | 3.12 | 3.12 | 3.32 | 3.56 | 4.61 | 3.90 | 3.90 | 4.32 | 4.86 | 3.53 | 4.80 | 2.20 | 3.19 |
| 236 | 238 | 3.26 | 2.97 | 2.97 | 3.13 | 3.37 | 4.49 | 3.78 | 3.78 | 4.15 | 4.72 | 3.48 | 4.72 | 2.10 | 2.96 |
| 237 | 239 | 2.62 | 2.34 | 2.34 | 2.48 | 2.66 | 3.56 | 2.93 | 2.93 | 3.23 | 3.63 | 3.25 | 3.66 | 1.49 | 2.33 |
| 238 | 240 | 2.53 | 2.23 | 2.23 | 2.38 | 2.56 | 3.23 | 2.65 | 2.65 | 2.93 | 3.26 | 3.17 | 3.43 | 1.54 | 2.21 |
| 239 | 241 | 2.57 | 2.22 | 2.22 | 2.39 | 2.58 | 3.28 | 2.61 | 2.61 | 2.93 | 3.27 | 3.23 | 3.40 | 1.64 | 2.26 |
| 240 | 242 | 2.80 | 2.52 | 2.52 | 2.73 | 2.89 | 3.53 | 3.01 | 3.01 | 3.43 | 3.72 | 3.45 | 3.86 | 1.93 | 2.54 |
| 241 | 243 | 2.38 | 2.12 | 2.12 | 2.26 | 2.37 | 3.35 | 2.71 | 2.71 | 3.00 | 3.25 | 3.59 | 3.21 | 1.41 | 2.12 |
| 242 | 244 | 2.15 | 1.93 | 1.93 | 2.04 | 2.13 | 3.18 | 2.59 | 2.59 | 2.83 | 3.05 | 3.32 | 2.86 | 1.04 | 1.90 |
| 243 | 245 | 1.97 | 1.71 | 1.71 | 1.85 | 1.98 | 2.92 | 2.25 | 2.25 | 2.52 | 2.83 | 2.97 | 2.58 | 0.84 | 1.68 |
| 244 | 246 | 1.96 | 1.70 | 1.70 | 1.86 | 1.99 | 2.58 | 2.06 | 2.06 | 2.39 | 2.67 | 2.64 | 2.47 | 0.85 | 1.70 |
| 245 | 247 | 1.74 | 1.47 | 1.47 | 1.64 | 1.73 | 2.16 | 1.69 | 1.69 | 1.98 | 2.15 | 2.57 | 1.99 | 0.64 | 1.52 |
| 246 | 248 | 1.72 | 1.39 | 1.39 | 1.44 | 1.56 | 2.35 | 1.66 | 1.66 | 1.74 | 1.99 | 2.60 | 1.79 | 0.53 | 1.43 |
| 247 | 249 | 1.84 | 1.54 | 1.54 | 1.62 | 1.74 | 2.64 | 1.93 | 1.93 | 2.11 | 2.39 | 2.72 | 2.14 | 0.65 | 1.60 |
| 248 | 250 | 1.97 | 1.73 | 1.73 | 1.79 | 1.92 | 2.95 | 2.28 | 2.28 | 2.48 | 2.83 | 2.91 | 2.55 | 0.77 | 1.79 |

Summary ET Values - 7 Day Averages

| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 146 | 152 | 3.07 | 2.92 | 2.92 | 3.01 | 3.06 | 4.16 | 3.78 | 3.78 | 4.00 | 4.11 | 3.24 | 3.66 | 1.21 | 2.92 |
| 147 | 153 | 3.02 | 2.86 | 2.86 | 2.94 | 2.99 | 4.08 | 3.69 | 3.69 | 3.86 | 3.99 | 3.26 | 3.64 | 1.16 | 2.86 |
| 148 | 154 | 3.22 | 3.05 | 3.05 | 3.12 | 3.18 | 4.29 | 3.88 | 3.88 | 4.05 | 4.18 | 3.39 | 3.84 | 1.31 | 3.07 |
| 149 | 155 | 3.30 | 3.16 | 3.16 | 3.25 | 3.30 | 4.26 | 3.93 | 3.93 | 4.12 | 4.24 | 3.59 | 4.01 | 1.39 | 3.19 |
| 150 | 156 | 3.23 | 3.11 | 3.11 | 3.19 | 3.23 | 4.15 | 3.88 | 3.88 | 4.03 | 4.12 | 3.82 | 4.00 | 1.36 | 3.13 |
| 151 | 157 | 3.16 | 3.00 | 3.00 | 3.06 | 3.11 | 4.09 | 3.71 | 3.71 | 3.81 | 3.92 | 3.83 | 3.82 | 1.31 | 3.07 |
| 152 | 158 | 3.45 | 3.27 | 3.27 | 3.32 | 3.39 | 4.58 | 4.13 | 4.13 | 4.21 | 4.39 | 3.91 | 4.28 | 1.55 | 3.37 |
| 153 | 159 | 3.50 | 3.32 | 3.32 | 3.37 | 3.45 | 4.70 | 4.24 | 4.24 | 4.33 | 4.54 | 3.94 | 4.42 | 1.64 | 3.44 |
| 154 | 160 | 3.92 | 3.71 | 3.71 | 3.80 | 3.91 | 5.24 | 4.68 | 4.68 | 4.86 | 5.16 | 4.06 | 5.10 | 2.09 | 3.88 |
| 155 | 161 | 4.21 | 3.96 | 3.96 | 4.07 | 4.22 | 5.61 | 4.97 | 4.97 | 5.21 | 5.57 | 4.26 | 5.62 | 2.51 | 4.16 |
| 156 | 162 | 4.46 | 4.18 | 4.18 | 4.30 | 4.46 | 5.90 | 5.20 | 5.20 | 5.45 | 5.85 | 4.38 | 5.90 | 2.86 | 4.43 |
| 157 | 163 | 4.88 | 4.60 | 4.60 | 4.78 | 4.94 | 6.34 | 5.64 | 5.64 | 6.05 | 6.46 | 4.49 | 6.45 | 3.33 | 4.92 |
| 158 | 164 | 5.01 | 4.77 | 4.77 | 4.98 | 5.12 | 6.41 | 5.82 | 5.82 | 6.31 | 6.65 | 4.68 | 6.65 | 3.49 | 5.10 |
| 159 | 165 | 4.95 | 4.71 | 4.71 | 4.94 | 5.06 | 6.27 | 5.71 | 5.71 | 6.25 | 6.54 | 4.74 | 6.52 | 3.50 | 5.02 |
| 160 | 166 | 5.07 | 4.86 | 4.86 | 5.08 | 5.18 | 6.69 | 6.20 | 6.20 | 6.73 | 6.96 | 4.92 | 6.81 | 3.65 | 5.12 |
| 161 | 167 | 5.22 | 5.02 | 5.02 | 5.24 | 5.33 | 6.99 | 6.52 | 6.52 | 7.08 | 7.29 | 5.19 | 7.15 | 3.93 | 5.24 |
| 162 | 168 | 5.27 | 5.09 | 5.09 | 5.33 | 5.43 | 7.01 | 6.57 | 6.57 | 7.16 | 7.39 | 5.36 | 7.29 | 4.15 | 5.32 |
| 163 | 169 | 5.34 | 5.13 | 5.13 | 5.40 | 5.52 | 7.17 | 6.65 | 6.65 | 7.32 | 7.61 | 5.39 | 7.46 | 4.28 | 5.37 |
| 164 | 170 | 5.40 | 5.14 | 5.14 | 5.41 | 5.56 | 7.25 | 6.64 | 6.64 | 7.29 | 7.66 | 5.31 | 7.57 | 4.32 | 5.38 |
| 165 | 171 | 5.58 | 5.31 | 5.31 | 5.58 | 5.77 | 7.56 | 6.89 | 6.89 | 7.57 | 8.02 | 5.32 | 7.93 | 4.57 | 5.54 |
| 166 | 172 | 5.61 | 5.33 | 5.33 | 5.62 | 5.82 | 7.61 | 6.92 | 6.92 | 7.64 | 8.15 | 5.23 | 8.01 | 4.59 | 5.58 |
| 167 | 173 | 5.43 | 5.13 | 5.13 | 5.42 | 5.64 | 7.15 | 6.41 | 6.41 | 7.12 | 7.67 | 4.93 | 7.61 | 4.32 | 5.43 |
| 168 | 174 | 4.93 | 4.67 | 4.67 | 4.92 | 5.11 | 6.37 | 5.73 | 5.73 | 6.34 | 6.82 | 4.41 | 6.67 | 3.63 | 4.98 |
| 169 | 175 | 4.75 | 4.49 | 4.49 | 4.72 | 4.90 | 6.15 | 5.51 | 5.51 | 6.08 | 6.54 | 4.05 | 6.29 | 3.25 | 4.81 |
| 170 | 176 | 4.66 | 4.42 | 4.42 | 4.64 | 4.78 | 6.09 | 5.49 | 5.49 | 6.05 | 6.43 | 3.92 | 6.11 | 3.08 | 4.73 |
| 171 | 177 | 4.36 | 4.14 | 4.14 | 4.33 | 4.45 | 5.65 | 5.10 | 5.10 | 5.61 | 5.92 | 3.72 | 5.58 | 2.73 | 4.42 |
| 172 | 178 | 4.28 | 4.08 | 4.08 | 4.29 | 4.39 | 5.56 | 5.08 | 5.08 | 5.61 | 5.86 | 3.61 | 5.40 | 2.59 | 4.35 |
| 173 | 179 | 4.09 | 3.93 | 3.93 | 4.11 | 4.18 | 5.24 | 4.86 | 4.86 | 5.34 | 5.50 | 3.58 | 5.12 | 2.37 | 4.18 |
| 174 | 180 | 4.08 | 3.92 | 3.92 | 4.12 | 4.19 | 5.15 | 4.77 | 4.77 | 5.27 | 5.41 | 3.70 | 5.13 | 2.46 | 4.17 |
| 175 | 181 | 4.42 | 4.23 | 4.23 | 4.49 | 4.58 | 5.55 | 5.12 | 5.12 | 5.73 | 5.93 | 4.04 | 5.76 | 2.95 | 4.48 |
| 176 | 182 | 4.51 | 4.29 | 4.29 | 4.54 | 4.64 | 5.74 | 5.27 | 5.27 | 5.85 | 6.06 | 4.20 | 5.99 | 3.06 | 4.48 |
| 177 | 183 | 4.55 | 4.37 | 4.37 | 4.63 | 4.73 | 5.71 | 5.33 | 5.33 | 5.90 | 6.10 | 4.36 | 6.16 | 3.19 | 4.52 |
| 178 | 184 | 4.81 | 4.61 | 4.61 | 4.88 | 5.00 | 6.16 | 5.71 | 5.71 | 6.32 | 6.59 | 4.54 | 6.67 | 3.49 | 4.77 |
| 179 | 185 | 4.86 | 4.66 | 4.66 | 4.91 | 5.04 | 6.17 | 5.71 | 5.71 | 6.27 | 6.56 | 4.73 | 6.82 | 3.64 | 4.80 |
| 180 | 186 | 5.08 | 4.86 | 4.86 | 5.17 | 5.30 | 6.35 | 5.87 | 5.87 | 6.50 | 6.80 | 4.95 | 7.14 | 4.05 | 5.01 |
| 181 | 187 | 5.25 | 4.99 | 4.99 | 5.33 | 5.48 | 6.56 | 6.02 | 6.02 | 6.69 | 7.02 | 5.20 | 7.48 | 4.33 | 5.13 |
| 182 | 188 | 5.26 | 5.04 | 5.04 | 5.36 | 5.49 | 6.63 | 6.14 | 6.14 | 6.83 | 7.11 | 5.29 | 7.45 | 4.41 | 5.16 |
| 183 | 189 | 5.21 | 5.01 | 5.01 | 5.36 | 5.46 | 6.45 | 6.03 | 6.03 | 6.76 | 6.99 | 5.31 | 7.29 | 4.43 | 5.19 |
| 184 | 190 | 5.25 | 4.99 | 4.99 | 5.32 | 5.48 | 6.62 | 6.01 | 6.01 | 6.73 | 7.10 | 5.29 | 7.42 | 4.44 | 5.20 |
| 185 | 191 | 5.24 | 5.00 | 5.00 | 5.34 | 5.49 | 6.55 | 6.01 | 6.01 | 6.74 | 7.08 | 5.37 | 7.40 | 4.51 | 5.21 |
| 186 | 192 | 5.31 | 5.00 | 5.00 | 5.34 | 5.53 | 6.77 | 6.05 | 6.05 | 6.80 | 7.25 | 5.33 | 7.57 | 4.52 | 5.22 |
| 187 | 193 | 5.34 | 5.01 | 5.01 | 5.36 | 5.57 | 6.96 | 6.18 | 6.18 | 6.99 | 7.50 | 5.34 | 7.73 | 4.55 | 5.23 |

Summary ET Values - 7 Day Averages

| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 188 | 194 | 5.27 | 4.96 | 4.96 | 5.30 | 5.52 | 6.91 | 6.15 | 6.15 | 6.98 | 7.51 | 5.28 | 7.63 | 4.49 | 5.19 |
| 189 | 195 | 5.17 | 4.84 | 4.84 | 5.16 | 5.39 | 6.75 | 5.95 | 5.95 | 6.72 | 7.28 | 5.16 | 7.45 | 4.29 | 5.11 |
| 190 | 196 | 5.14 | 4.81 | 4.81 | 5.12 | 5.35 | 6.77 | 5.94 | 5.94 | 6.70 | 7.28 | 5.17 | 7.45 | 4.24 | 5.08 |
| 191 | 197 | 5.25 | 4.89 | 4.89 | 5.22 | 5.46 | 6.86 | 6.01 | 6.01 | 6.79 | 7.37 | 5.39 | 7.65 | 4.44 | 5.15 |
| 192 | 198 | 5.30 | 4.92 | 4.92 | 5.27 | 5.52 | 6.87 | 5.99 | 5.99 | 6.80 | 7.38 | 5.54 | 7.70 | 4.58 | 5.19 |
| 193 | 199 | 5.30 | 4.95 | 4.95 | 5.35 | 5.59 | 6.72 | 5.95 | 5.95 | 6.85 | 7.36 | 5.67 | 7.65 | 4.72 | 5.21 |
| 194 | 200 | 5.24 | 4.89 | 4.89 | 5.32 | 5.54 | 6.56 | 5.80 | 5.80 | 6.70 | 7.18 | 5.73 | 7.54 | 4.66 | 5.15 |
| 195 | 201 | 5.13 | 4.78 | 4.78 | 5.19 | 5.39 | 6.43 | 5.68 | 5.68 | 6.53 | 6.98 | 5.73 | 7.33 | 4.49 | 5.02 |
| 196 | 202 | 5.12 | 4.78 | 4.78 | 5.18 | 5.38 | 6.44 | 5.72 | 5.72 | 6.56 | 6.99 | 5.81 | 7.33 | 4.47 | 5.01 |
| 197 | 203 | 5.12 | 4.80 | 4.80 | 5.19 | 5.38 | 6.46 | 5.79 | 5.79 | 6.59 | 7.00 | 5.79 | 7.32 | 4.42 | 5.01 |
| 198 | 204 | 4.99 | 4.72 | 4.72 | 5.09 | 5.26 | 6.32 | 5.71 | 5.71 | 6.50 | 6.88 | 5.61 | 7.13 | 4.24 | 4.92 |
| 199 | 205 | 5.06 | 4.75 | 4.75 | 5.12 | 5.32 | 6.44 | 5.78 | 5.78 | 6.56 | 6.99 | 5.60 | 7.32 | 4.24 | 4.93 |
| 200 | 206 | 5.07 | 4.73 | 4.73 | 5.07 | 5.29 | 6.46 | 5.75 | 5.75 | 6.46 | 6.92 | 5.59 | 7.36 | 4.18 | 4.88 |
| 201 | 207 | 5.12 | 4.75 | 4.75 | 5.07 | 5.31 | 6.70 | 5.87 | 5.87 | 6.59 | 7.11 | 5.64 | 7.49 | 4.20 | 4.87 |
| 202 | 208 | 5.06 | 4.70 | 4.70 | 5.01 | 5.24 | 6.69 | 5.87 | 5.87 | 6.60 | 7.11 | 5.53 | 7.37 | 4.06 | 4.84 |
| 203 | 209 | 4.56 | 4.21 | 4.21 | 4.50 | 4.71 | 6.02 | 5.24 | 5.24 | 5.92 | 6.38 | 5.28 | 6.69 | 3.54 | 4.32 |
| 204 | 210 | 4.33 | 3.97 | 3.97 | 4.27 | 4.48 | 5.68 | 4.89 | 4.89 | 5.57 | 6.03 | 5.13 | 6.30 | 3.31 | 4.10 |
| 205 | 211 | 4.07 | 3.73 | 3.73 | 4.01 | 4.19 | 5.29 | 4.56 | 4.56 | 5.18 | 5.57 | 4.93 | 5.81 | 3.00 | 3.87 |
| 206 | 212 | 3.80 | 3.52 | 3.52 | 3.77 | 3.92 | 4.87 | 4.26 | 4.26 | 4.83 | 5.14 | 4.74 | 5.35 | 2.69 | 3.68 |
| 207 | 213 | 3.63 | 3.41 | 3.41 | 3.65 | 3.77 | 4.71 | 4.19 | 4.19 | 4.76 | 5.04 | 4.63 | 5.11 | 2.53 | 3.59 |
| 208 | 214 | 3.47 | 3.27 | 3.27 | 3.48 | 3.57 | 4.35 | 3.92 | 3.92 | 4.39 | 4.61 | 4.37 | 4.75 | 2.37 | 3.51 |
| 209 | 215 | 3.53 | 3.32 | 3.32 | 3.55 | 3.67 | 4.34 | 3.91 | 3.91 | 4.41 | 4.65 | 4.34 | 4.91 | 2.57 | 3.52 |
| 210 | 216 | 3.73 | 3.51 | 3.51 | 3.76 | 3.89 | 4.72 | 4.23 | 4.23 | 4.79 | 5.07 | 4.30 | 5.20 | 2.70 | 3.72 |
| 211 | 217 | 3.69 | 3.46 | 3.46 | 3.72 | 3.86 | 4.68 | 4.18 | 4.18 | 4.74 | 5.06 | 4.25 | 5.20 | 2.68 | 3.63 |
| 212 | 218 | 3.74 | 3.52 | 3.52 | 3.77 | 3.90 | 4.80 | 4.31 | 4.31 | 4.86 | 5.16 | 4.26 | 5.28 | 2.73 | 3.67 |
| 213 | 219 | 3.76 | 3.52 | 3.52 | 3.78 | 3.93 | 4.86 | 4.32 | 4.32 | 4.90 | 5.23 | 4.21 | 5.32 | 2.77 | 3.67 |
| 214 | 220 | 3.88 | 3.59 | 3.59 | 3.83 | 4.00 | 5.10 | 4.45 | 4.46 | 4.99 | 5.35 | 4.31 | 5.53 | 2.88 | 3.67 |
| 215 | 221 | 3.98 | 3.68 | 3.68 | 3.95 | 4.13 | 5.36 | 4.66 | 4.66 | 5.25 | 5.68 | 4.46 | 5.79 | 3.02 | 3.72 |
| 216 | 222 | 3.96 | 3.64 | 3.64 | 3.93 | 4.14 | 5.30 | 4.59 | 4.59 | 5.22 | 5.68 | 4.46 | 5.80 | 3.01 | 3.69 |
| 217 | 223 | 4.25 | 3.88 | 3.88 | 4.22 | 4.48 | 5.60 | 4.80 | 4.80 | 5.50 | 6.05 | 4.66 | 6.29 | 3.45 | 3.91 |
| 218 | 224 | 4.38 | 4.01 | 4.01 | 4.37 | 4.62 | 5.87 | 5.04 | 5.04 | 5.82 | 6.37 | 4.74 | 6.49 | 3.63 | 4.06 |
| 219 | 225 | 4.07 | 3.71 | 3.71 | 4.06 | 4.30 | 5.44 | 4.66 | 4.66 | 5.42 | 5.94 | 4.67 | 6.05 | 3.29 | 3.74 |
| 220 | 226 | 3.81 | 3.48 | 3.48 | 3.80 | 4.02 | 5.15 | 4.42 | 4.42 | 5.12 | 5.60 | 4.54 | 5.67 | 2.94 | 3.46 |
| 221 | 227 | 3.49 | 3.20 | 3.20 | 3.51 | 3.72 | 4.60 | 3.96 | 3.96 | 4.64 | 5.08 | 4.19 | 5.06 | 2.55 | 3.23 |
| 222 | 228 | 3.35 | 3.07 | 3.07 | 3.33 | 3.54 | 4.32 | 3.74 | 3.74 | 4.29 | 4.72 | 3.98 | 4.80 | 2.31 | 3.12 |
| 223 | 229 | 3.37 | 3.09 | 3.09 | 3.33 | 3.53 | 4.41 | 3.80 | 3.80 | 4.33 | 4.76 | 4.00 | 4.87 | 2.29 | 3.11 |
| 224 | 230 | 3.33 | 3.05 | 3.05 | 3.25 | 3.44 | 4.37 | 3.78 | 3.78 | 4.22 | 4.63 | 4.10 | 4.81 | 2.20 | 3.04 |
| 225 | 231 | 3.12 | 2.85 | 2.85 | 3.01 | 3.22 | 3.98 | 3.45 | 3.45 | 3.77 | 4.16 | 4.18 | 4.56 | 1.93 | 2.77 |
| 226 | 232 | 3.52 | 3.19 | 3.19 | 3.41 | 3.67 | 4.46 | 3.83 | 3.83 | 4.26 | 4.76 | 4.36 | 5.23 | 2.43 | 3.12 |
| 227 | 233 | 3.80 | 3.43 | 3.43 | 3.73 | 4.01 | 4.98 | 4.23 | 4.23 | 4.88 | 5.44 | 4.50 | 5.70 | 2.79 | 3.35 |
| 228 | 234 | 3.81 | 3.44 | 3.44 | 3.74 | 4.01 | 5.04 | 4.26 | 4.26 | 4.91 | 5.46 | 4.47 | 5.68 | 2.79 | 3.39 |
| 229 | 235 | 3.77 | 3.40 | 3.40 | 3.73 | 3.99 | 4.95 | 4.19 | 4.19 | 4.89 | 5.41 | 4.43 | 5.58 | 2.76 | 3.35 |

Summary ET Values - 7 Day Averages

| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 236 | 3.69 | 3.33 | 3.33 | 3.62 | 3.87 | 4.91 | 4.15 | 4.15 | 4.78 | 5.31 | 4.33 | 5.38 | 2.63 | 3.29 |
| 231 | 237 | 3.50 | 3.18 | 3.18 | 3.46 | 3.69 | 4.71 | 3.97 | 3.97 | 4.61 | 5.12 | 3.99 | 5.05 | 2.39 | 3.18 |
| 232 | 238 | 3.57 | 3.24 | 3.24 | 3.54 | 3.78 | 4.84 | 4.08 | 4.08 | 4.75 | 5.28 | 3.77 | 5.15 | 2.52 | 3.26 |
| 233 | 239 | 3.21 | 2.90 | 2.90 | 3.13 | 3.33 | 4.41 | 3.69 | 3.69 | 4.24 | 4.69 | 3.50 | 4.48 | 2.06 | 2.92 |
| 234 | 240 | 3.01 | 2.70 | 2.70 | 2.88 | 3.06 | 3.96 | 3.31 | 3.31 | 3.67 | 4.07 | 3.30 | 4.08 | 1.85 | 2.75 |
| 235 | 241 | 3.00 | 2.68 | 2.68 | 2.87 | 3.08 | 3.93 | 3.25 | 3.25 | 3.63 | 4.08 | 3.37 | 4.16 | 1.94 | 2.70 |
| 236 | 242 | 2.85 | 2.57 | 2.57 | 2.73 | 2.92 | 3.79 | 3.18 | 3.18 | 3.53 | 3.93 | 3.41 | 3.97 | 1.82 | 2.58 |
| 237 | 243 | 2.55 | 2.26 | 2.26 | 2.41 | 2.57 | 3.45 | 2.82 | 2.82 | 3.12 | 3.45 | 3.38 | 3.48 | 1.52 | 2.27 |
| 238 | 244 | 2.45 | 2.17 | 2.17 | 2.32 | 2.47 | 3.31 | 2.69 | 2.69 | 2.99 | 3.30 | 3.28 | 3.32 | 1.45 | 2.15 |
| 239 | 245 | 2.30 | 2.03 | 2.03 | 2.18 | 2.32 | 3.12 | 2.52 | 2.52 | 2.83 | 3.11 | 3.19 | 3.05 | 1.28 | 2.03 |
| 240 | 246 | 2.26 | 1.99 | 1.99 | 2.15 | 2.28 | 3.03 | 2.45 | 2.45 | 2.76 | 3.03 | 3.12 | 2.97 | 1.24 | 2.00 |
| 241 | 247 | 2.11 | 1.84 | 1.84 | 2.00 | 2.12 | 2.86 | 2.28 | 2.28 | 2.58 | 2.83 | 3.02 | 2.71 | 1.06 | 1.86 |
| 242 | 248 | 1.94 | 1.67 | 1.67 | 1.78 | 1.88 | 2.72 | 2.12 | 2.12 | 2.32 | 2.56 | 2.92 | 2.36 | 0.80 | 1.67 |
| 243 | 249 | 1.85 | 1.57 | 1.57 | 1.67 | 1.79 | 2.65 | 1.99 | 1.99 | 2.19 | 2.46 | 2.80 | 2.23 | 0.70 | 1.59 |
| 244 | 250 | 1.94 | 1.67 | 1.67 | 1.80 | 1.92 | 2.66 | 2.09 | 2.09 | 2.36 | 2.65 | 2.73 | 2.42 | 0.79 | 1.71 |

Summary ET Values - 14 Day Averages

| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 146 | 159 | 3.28 | 3.12 | 3.12 | 3.19 | 3.25 | 4.43 | 4.01 | 4.01 | 4.17 | 4.33 | 3.59 | 4.04 | 1.42 | 3.18 |
| 147 | 160 | 3.47 | 3.28 | 3.28 | 3.37 | 3.45 | 4.66 | 4.18 | 4.18 | 4.36 | 4.58 | 3.66 | 4.37 | 1.63 | 3.37 |
| 148 | 161 | 3.71 | 3.51 | 3.51 | 3.60 | 3.70 | 4.95 | 4.43 | 4.43 | 4.63 | 4.88 | 3.83 | 4.73 | 1.91 | 3.62 |
| 149 | 162 | 3.88 | 3.67 | 3.67 | 3.77 | 3.88 | 5.08 | 4.56 | 4.56 | 4.79 | 5.04 | 3.99 | 4.96 | 2.12 | 3.81 |
| 150 | 163 | 4.06 | 3.85 | 3.85 | 3.98 | 4.09 | 5.25 | 4.76 | 4.76 | 5.04 | 5.29 | 4.15 | 5.22 | 2.35 | 4.03 |
| 151 | 164 | 4.09 | 3.89 | 3.89 | 4.02 | 4.11 | 5.25 | 4.77 | 4.77 | 5.06 | 5.29 | 4.25 | 5.24 | 2.40 | 4.08 |
| 152 | 165 | 4.20 | 3.99 | 3.99 | 4.13 | 4.23 | 5.42 | 4.92 | 4.92 | 5.23 | 5.47 | 4.32 | 5.40 | 2.53 | 4.20 |
| 153 | 166 | 4.28 | 4.09 | 4.09 | 4.22 | 4.31 | 5.69 | 5.22 | 5.22 | 5.53 | 5.75 | 4.43 | 5.62 | 2.64 | 4.28 |
| 154 | 167 | 4.57 | 4.36 | 4.36 | 4.52 | 4.62 | 6.12 | 5.60 | 5.60 | 5.97 | 6.22 | 4.63 | 6.12 | 3.01 | 4.56 |
| 155 | 168 | 4.74 | 4.53 | 4.53 | 4.70 | 4.82 | 6.31 | 5.77 | 5.77 | 6.18 | 6.48 | 4.81 | 6.46 | 3.33 | 4.74 |
| 156 | 169 | 4.90 | 4.66 | 4.66 | 4.85 | 4.99 | 6.54 | 5.93 | 5.93 | 6.39 | 6.73 | 4.89 | 6.68 | 3.57 | 4.90 |
| 157 | 170 | 5.14 | 4.87 | 4.87 | 5.09 | 5.25 | 6.79 | 6.14 | 6.14 | 6.67 | 7.06 | 4.90 | 7.01 | 3.82 | 5.15 |
| 158 | 171 | 5.30 | 5.04 | 5.04 | 5.28 | 5.44 | 6.98 | 6.36 | 6.36 | 6.94 | 7.34 | 5.00 | 7.29 | 4.03 | 5.32 |
| 159 | 172 | 5.28 | 5.02 | 5.02 | 5.28 | 5.44 | 6.94 | 6.32 | 6.32 | 6.95 | 7.34 | 4.99 | 7.26 | 4.05 | 5.30 |
| 160 | 173 | 5.25 | 5.00 | 5.00 | 5.25 | 5.41 | 6.92 | 6.31 | 6.31 | 6.93 | 7.32 | 4.92 | 7.21 | 3.98 | 5.27 |
| 161 | 174 | 5.07 | 4.85 | 4.85 | 5.08 | 5.22 | 6.68 | 6.12 | 6.12 | 6.71 | 7.05 | 4.80 | 6.91 | 3.78 | 5.11 |
| 162 | 175 | 5.01 | 4.79 | 4.79 | 5.02 | 5.16 | 6.58 | 6.04 | 6.04 | 6.62 | 6.96 | 4.70 | 6.79 | 3.70 | 5.07 |
| 163 | 176 | 5.00 | 4.78 | 4.78 | 5.02 | 5.15 | 6.63 | 6.07 | 6.07 | 6.69 | 7.02 | 4.66 | 6.78 | 3.68 | 5.05 |
| 164 | 177 | 4.88 | 4.64 | 4.64 | 4.87 | 5.01 | 6.45 | 5.87 | 5.87 | 6.45 | 6.79 | 4.52 | 6.57 | 3.53 | 4.90 |
| 165 | 178 | 4.93 | 4.70 | 4.70 | 4.93 | 5.08 | 6.56 | 5.99 | 5.99 | 6.59 | 6.94 | 4.46 | 6.67 | 3.58 | 4.95 |
| 166 | 179 | 4.85 | 4.63 | 4.63 | 4.87 | 5.00 | 6.42 | 5.89 | 5.89 | 6.49 | 6.82 | 4.41 | 6.57 | 3.48 | 4.88 |
| 167 | 180 | 4.76 | 4.53 | 4.53 | 4.77 | 4.91 | 6.15 | 5.59 | 5.59 | 6.19 | 6.54 | 4.31 | 6.37 | 3.39 | 4.80 |
| 168 | 181 | 4.68 | 4.45 | 4.45 | 4.70 | 4.85 | 5.96 | 5.43 | 5.43 | 6.04 | 6.37 | 4.22 | 6.21 | 3.29 | 4.73 |
| 169 | 182 | 4.63 | 4.39 | 4.39 | 4.63 | 4.77 | 5.94 | 5.39 | 5.39 | 5.96 | 6.30 | 4.12 | 6.14 | 3.16 | 4.65 |
| 170 | 183 | 4.60 | 4.40 | 4.40 | 4.63 | 4.75 | 5.90 | 5.41 | 5.41 | 5.98 | 6.26 | 4.14 | 6.13 | 3.14 | 4.62 |
| 171 | 184 | 4.58 | 4.37 | 4.37 | 4.61 | 4.73 | 5.90 | 5.40 | 5.40 | 5.96 | 6.25 | 4.13 | 6.12 | 3.11 | 4.59 |
| 172 | 185 | 4.57 | 4.37 | 4.37 | 4.60 | 4.71 | 5.87 | 5.39 | 5.39 | 5.94 | 6.21 | 4.17 | 6.11 | 3.12 | 4.58 |
| 173 | 186 | 4.58 | 4.39 | 4.39 | 4.64 | 4.74 | 5.80 | 5.36 | 5.36 | 5.92 | 6.15 | 4.26 | 6.13 | 3.21 | 4.59 |
| 174 | 187 | 4.67 | 4.46 | 4.46 | 4.72 | 4.83 | 5.85 | 5.40 | 5.40 | 5.98 | 6.22 | 4.45 | 6.30 | 3.39 | 4.65 |
| 175 | 188 | 4.84 | 4.63 | 4.63 | 4.93 | 5.03 | 6.09 | 5.63 | 5.63 | 6.28 | 6.52 | 4.66 | 6.60 | 3.68 | 4.82 |
| 176 | 189 | 4.86 | 4.65 | 4.65 | 4.95 | 5.05 | 6.10 | 5.65 | 5.65 | 6.30 | 6.52 | 4.75 | 6.64 | 3.75 | 4.84 |
| 177 | 190 | 4.90 | 4.68 | 4.68 | 4.97 | 5.10 | 6.16 | 5.67 | 5.67 | 6.32 | 6.60 | 4.83 | 6.79 | 3.82 | 4.86 |
| 178 | 191 | 5.03 | 4.81 | 4.81 | 5.11 | 5.25 | 6.36 | 5.86 | 5.86 | 6.53 | 6.83 | 4.96 | 7.03 | 4.00 | 4.99 |
| 179 | 192 | 5.09 | 4.83 | 4.83 | 5.13 | 5.29 | 6.47 | 5.88 | 5.88 | 6.54 | 6.90 | 5.03 | 7.20 | 4.08 | 5.01 |
| 180 | 193 | 5.21 | 4.94 | 4.94 | 5.26 | 5.43 | 6.66 | 6.02 | 6.02 | 6.75 | 7.15 | 5.14 | 7.43 | 4.30 | 5.12 |
| 181 | 194 | 5.26 | 4.98 | 4.98 | 5.32 | 5.50 | 6.74 | 6.08 | 6.08 | 6.84 | 7.26 | 5.24 | 7.56 | 4.41 | 5.16 |
| 182 | 195 | 5.21 | 4.94 | 4.94 | 5.26 | 5.44 | 6.69 | 6.05 | 6.05 | 6.78 | 7.19 | 5.22 | 7.45 | 4.35 | 5.14 |
| 183 | 196 | 5.17 | 4.91 | 4.91 | 5.24 | 5.41 | 6.61 | 5.99 | 5.99 | 6.73 | 7.14 | 5.24 | 7.37 | 4.34 | 5.13 |
| 184 | 197 | 5.25 | 4.94 | 4.94 | 5.27 | 5.47 | 6.74 | 6.01 | 6.01 | 6.76 | 7.24 | 5.34 | 7.54 | 4.44 | 5.18 |
| 185 | 198 | 5.27 | 4.96 | 4.96 | 5.31 | 5.51 | 6.71 | 6.00 | 6.00 | 6.77 | 7.23 | 5.46 | 7.55 | 4.55 | 5.20 |
| 186 | 199 | 5.30 | 4.97 | 4.97 | 5.35 | 5.56 | 6.75 | 6.00 | 6.00 | 6.83 | 7.30 | 5.50 | 7.61 | 4.62 | 5.22 |
| 187 | 200 | 5.29 | 4.95 | 4.95 | 5.34 | 5.56 | 6.76 | 5.99 | 5.99 | 6.84 | 7.34 | 5.54 | 7.63 | 4.60 | 5.19 |

Summary ET Values - 14 Day Averages

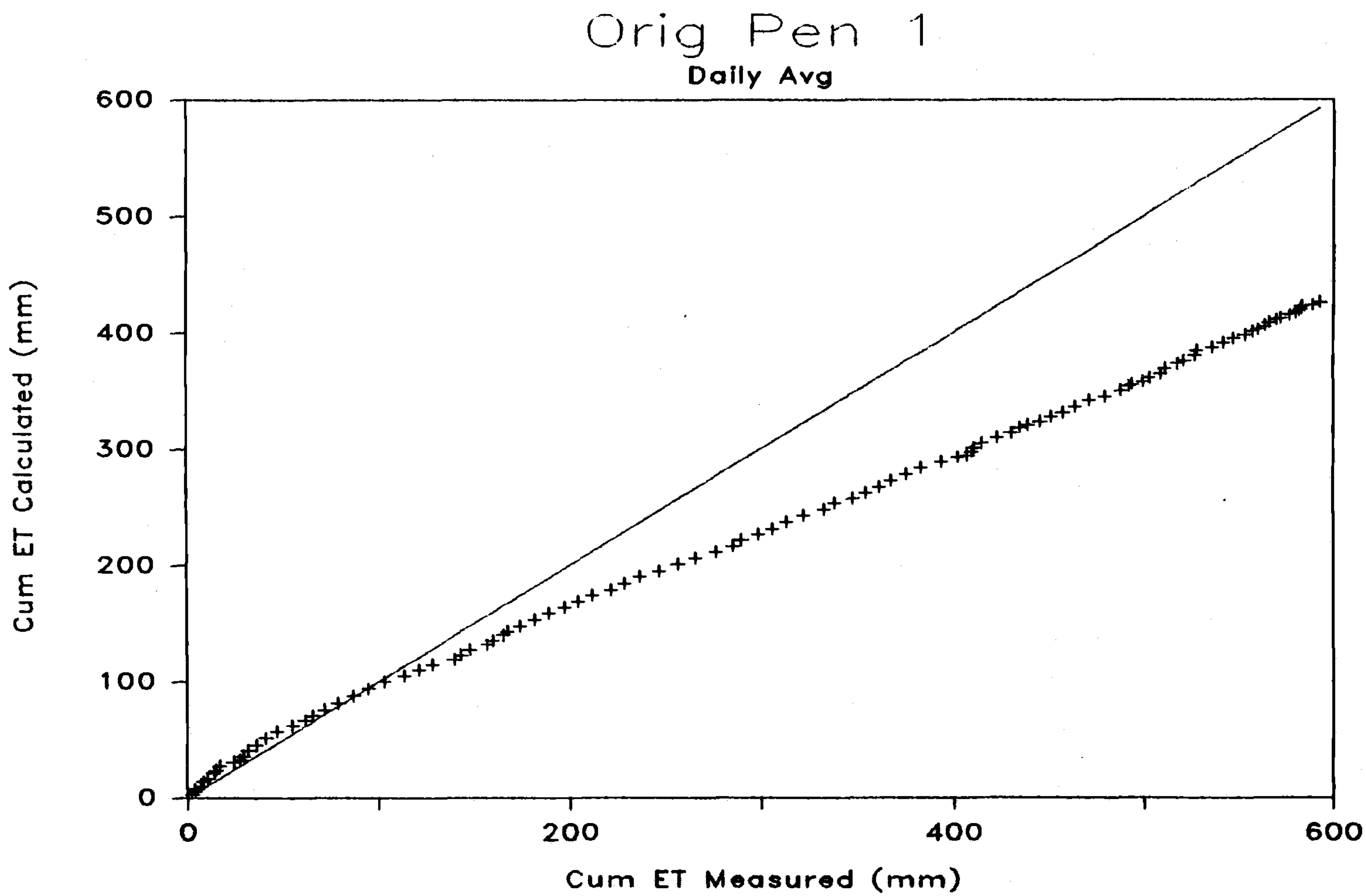
| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 188 | 201 | 5.20 | 4.87 | 4.87 | 5.25 | 5.46 | 6.67 | 5.92 | 5.92 | 6.76 | 7.24 | 5.51 | 7.48 | 4.49 | 5.11 |
| 189 | 202 | 5.15 | 4.81 | 4.81 | 5.17 | 5.39 | 6.60 | 5.84 | 5.84 | 6.64 | 7.13 | 5.48 | 7.39 | 4.38 | 5.06 |
| 190 | 203 | 5.13 | 4.80 | 4.80 | 5.15 | 5.36 | 6.62 | 5.86 | 5.86 | 6.65 | 7.14 | 5.48 | 7.39 | 4.33 | 5.04 |
| 191 | 204 | 5.12 | 4.80 | 4.80 | 5.15 | 5.36 | 6.59 | 5.86 | 5.86 | 6.64 | 7.13 | 5.50 | 7.39 | 4.34 | 5.04 |
| 192 | 205 | 5.18 | 4.84 | 4.84 | 5.20 | 5.42 | 6.65 | 5.89 | 5.89 | 6.68 | 7.18 | 5.57 | 7.51 | 4.41 | 5.06 |
| 193 | 206 | 5.18 | 4.84 | 4.84 | 5.21 | 5.44 | 6.59 | 5.85 | 5.85 | 6.65 | 7.14 | 5.63 | 7.51 | 4.45 | 5.05 |
| 194 | 207 | 5.18 | 4.82 | 4.82 | 5.19 | 5.43 | 6.63 | 5.84 | 5.84 | 6.65 | 7.15 | 5.68 | 7.51 | 4.43 | 5.01 |
| 195 | 208 | 5.10 | 4.74 | 4.74 | 5.10 | 5.32 | 6.56 | 5.78 | 5.78 | 6.57 | 7.04 | 5.63 | 7.35 | 4.28 | 4.93 |
| 196 | 209 | 4.84 | 4.50 | 4.50 | 4.84 | 5.05 | 6.23 | 5.48 | 5.48 | 6.24 | 6.69 | 5.55 | 7.01 | 4.01 | 4.67 |
| 197 | 210 | 4.72 | 4.39 | 4.39 | 4.73 | 4.93 | 6.07 | 5.34 | 5.34 | 6.08 | 6.51 | 5.46 | 6.81 | 3.87 | 4.55 |
| 198 | 211 | 4.53 | 4.23 | 4.23 | 4.55 | 4.73 | 5.80 | 5.14 | 5.14 | 5.84 | 6.23 | 5.27 | 6.47 | 3.62 | 4.40 |
| 199 | 212 | 4.43 | 4.14 | 4.14 | 4.44 | 4.62 | 5.65 | 5.02 | 5.02 | 5.69 | 6.07 | 5.17 | 6.33 | 3.47 | 4.30 |
| 200 | 213 | 4.35 | 4.07 | 4.07 | 4.36 | 4.53 | 5.59 | 4.97 | 4.97 | 5.61 | 5.98 | 5.11 | 6.24 | 3.36 | 4.24 |
| 201 | 214 | 4.29 | 4.01 | 4.01 | 4.27 | 4.44 | 5.52 | 4.89 | 4.89 | 5.49 | 5.86 | 5.00 | 6.12 | 3.29 | 4.19 |
| 202 | 215 | 4.30 | 4.01 | 4.01 | 4.28 | 4.46 | 5.52 | 4.89 | 4.89 | 5.50 | 5.88 | 4.93 | 6.14 | 3.32 | 4.18 |
| 203 | 216 | 4.14 | 3.86 | 3.86 | 4.13 | 4.30 | 5.37 | 4.74 | 4.74 | 5.35 | 5.73 | 4.79 | 5.94 | 3.12 | 4.02 |
| 204 | 217 | 4.01 | 3.72 | 3.72 | 4.00 | 4.17 | 5.18 | 4.53 | 4.53 | 5.16 | 5.54 | 4.69 | 5.75 | 3.00 | 3.87 |
| 205 | 218 | 3.90 | 3.63 | 3.63 | 3.89 | 4.05 | 5.05 | 4.44 | 4.44 | 5.02 | 5.37 | 4.60 | 5.55 | 2.86 | 3.77 |
| 206 | 219 | 3.78 | 3.52 | 3.52 | 3.78 | 3.92 | 4.86 | 4.29 | 4.29 | 4.86 | 5.19 | 4.48 | 5.33 | 2.73 | 3.68 |
| 207 | 220 | 3.75 | 3.50 | 3.50 | 3.74 | 3.88 | 4.91 | 4.33 | 4.33 | 4.87 | 5.20 | 4.47 | 5.32 | 2.71 | 3.63 |
| 208 | 221 | 3.73 | 3.48 | 3.48 | 3.71 | 3.85 | 4.85 | 4.29 | 4.29 | 4.82 | 5.14 | 4.41 | 5.27 | 2.70 | 3.61 |
| 209 | 222 | 3.74 | 3.48 | 3.48 | 3.74 | 3.91 | 4.82 | 4.25 | 4.25 | 4.81 | 5.17 | 4.40 | 5.36 | 2.79 | 3.60 |
| 210 | 223 | 3.99 | 3.70 | 3.70 | 3.99 | 4.18 | 5.16 | 4.52 | 4.52 | 5.15 | 5.56 | 4.48 | 5.74 | 3.08 | 3.81 |
| 211 | 224 | 4.04 | 3.74 | 3.74 | 4.04 | 4.24 | 5.28 | 4.61 | 4.61 | 5.28 | 5.71 | 4.50 | 5.84 | 3.15 | 3.85 |
| 212 | 225 | 3.90 | 3.62 | 3.62 | 3.91 | 4.10 | 5.12 | 4.49 | 4.49 | 5.14 | 5.55 | 4.47 | 5.66 | 3.01 | 3.71 |
| 213 | 226 | 3.78 | 3.50 | 3.50 | 3.79 | 3.97 | 5.01 | 4.37 | 4.37 | 5.01 | 5.42 | 4.38 | 5.49 | 2.85 | 3.57 |
| 214 | 227 | 3.68 | 3.39 | 3.39 | 3.67 | 3.86 | 4.85 | 4.21 | 4.21 | 4.81 | 5.21 | 4.25 | 5.30 | 2.71 | 3.45 |
| 215 | 228 | 3.67 | 3.38 | 3.38 | 3.64 | 3.84 | 4.84 | 4.20 | 4.20 | 4.77 | 5.20 | 4.22 | 5.30 | 2.67 | 3.42 |
| 216 | 229 | 3.66 | 3.36 | 3.36 | 3.63 | 3.84 | 4.86 | 4.20 | 4.20 | 4.78 | 5.22 | 4.23 | 5.33 | 2.65 | 3.40 |
| 217 | 230 | 3.79 | 3.47 | 3.47 | 3.73 | 3.96 | 4.99 | 4.29 | 4.29 | 4.86 | 5.34 | 4.38 | 5.55 | 2.82 | 3.48 |
| 218 | 231 | 3.75 | 3.43 | 3.43 | 3.69 | 3.92 | 4.93 | 4.25 | 4.25 | 4.79 | 5.27 | 4.46 | 5.52 | 2.78 | 3.42 |
| 219 | 232 | 3.79 | 3.45 | 3.45 | 3.73 | 3.99 | 4.95 | 4.25 | 4.25 | 4.84 | 5.35 | 4.51 | 5.64 | 2.86 | 3.43 |
| 220 | 233 | 3.80 | 3.46 | 3.46 | 3.76 | 4.01 | 5.06 | 4.33 | 4.33 | 5.00 | 5.52 | 4.52 | 5.68 | 2.86 | 3.41 |
| 221 | 234 | 3.65 | 3.32 | 3.32 | 3.62 | 3.86 | 4.82 | 4.11 | 4.11 | 4.78 | 5.27 | 4.33 | 5.37 | 2.67 | 3.31 |
| 222 | 235 | 3.56 | 3.24 | 3.24 | 3.53 | 3.76 | 4.64 | 3.96 | 3.96 | 4.59 | 5.06 | 4.20 | 5.19 | 2.54 | 3.24 |
| 223 | 236 | 3.53 | 3.21 | 3.21 | 3.47 | 3.70 | 4.66 | 3.98 | 3.98 | 4.56 | 5.03 | 4.17 | 5.13 | 2.46 | 3.20 |
| 224 | 237 | 3.42 | 3.11 | 3.11 | 3.35 | 3.57 | 4.54 | 3.88 | 3.88 | 4.42 | 4.87 | 4.05 | 4.93 | 2.29 | 3.11 |
| 225 | 238 | 3.35 | 3.04 | 3.04 | 3.27 | 3.50 | 4.41 | 3.77 | 3.77 | 4.26 | 4.72 | 3.97 | 4.86 | 2.22 | 3.01 |
| 226 | 239 | 3.36 | 3.04 | 3.04 | 3.27 | 3.50 | 4.43 | 3.76 | 3.76 | 4.25 | 4.73 | 3.93 | 4.85 | 2.24 | 3.02 |
| 227 | 240 | 3.40 | 3.07 | 3.07 | 3.30 | 3.54 | 4.47 | 3.77 | 3.77 | 4.27 | 4.76 | 3.90 | 4.89 | 2.32 | 3.05 |
| 228 | 241 | 3.41 | 3.06 | 3.06 | 3.30 | 3.54 | 4.48 | 3.76 | 3.76 | 4.27 | 4.77 | 3.92 | 4.92 | 2.37 | 3.05 |
| 229 | 242 | 3.31 | 2.98 | 2.98 | 3.23 | 3.45 | 4.37 | 3.69 | 3.69 | 4.21 | 4.67 | 3.92 | 4.78 | 2.29 | 2.96 |

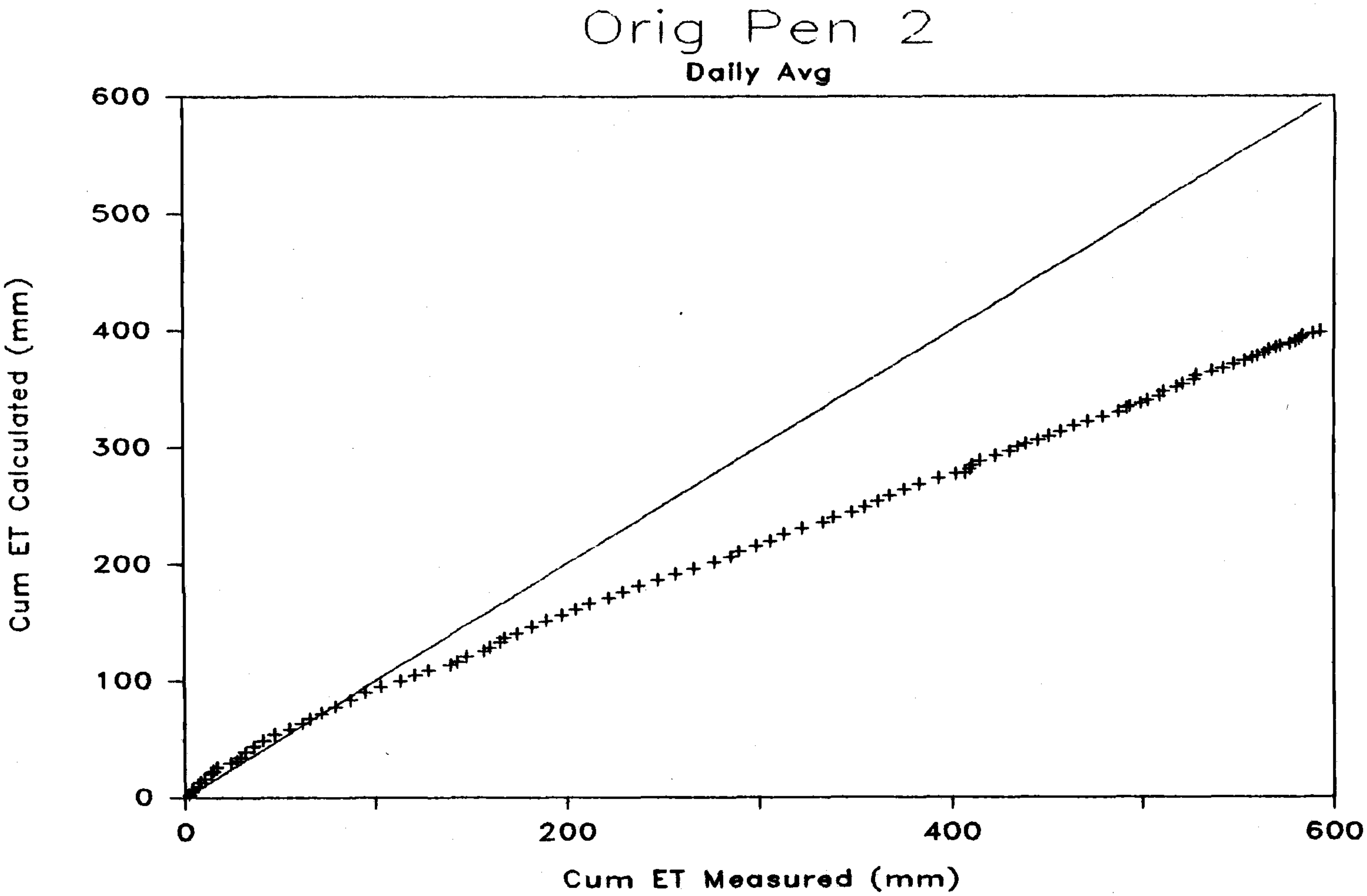
Summary ET Values - 14 Day Averages

| Str Day | End Day | Org Pen 1 | Org Pen 2 | Org Pen 3 | Org Pen 4 | Org Pen 5 | FAO Pen 1 | FAO Pen 2 | FAO Pen 3 | FAO Pen 4 | FAO Pen 5 | SCS Blan Crid | FAO Blan Crid | Jens Hais | PTay 0.26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 243 | 3.12 | 2.80 | 2.80 | 3.02 | 3.22 | 4.18 | 3.49 | 3.49 | 3.95 | 4.38 | 3.85 | 4.43 | 2.07 | 2.78 |
| 231 | 244 | 2.98 | 2.67 | 2.67 | 2.89 | 3.08 | 4.01 | 3.33 | 3.33 | 3.80 | 4.21 | 3.63 | 4.18 | 1.92 | 2.66 |
| 232 | 245 | 2.94 | 2.64 | 2.64 | 2.86 | 3.05 | 3.98 | 3.30 | 3.30 | 3.79 | 4.20 | 3.48 | 4.10 | 1.90 | 2.64 |
| 233 | 246 | 2.74 | 2.44 | 2.44 | 2.64 | 2.81 | 3.72 | 3.07 | 3.07 | 3.50 | 3.86 | 3.31 | 3.72 | 1.65 | 2.46 |
| 234 | 247 | 2.56 | 2.27 | 2.27 | 2.44 | 2.59 | 3.41 | 2.80 | 2.80 | 3.13 | 3.45 | 3.16 | 3.39 | 1.46 | 2.30 |
| 235 | 248 | 2.47 | 2.17 | 2.17 | 2.32 | 2.48 | 3.32 | 2.69 | 2.69 | 2.98 | 3.32 | 3.15 | 3.26 | 1.37 | 2.19 |
| 236 | 249 | 2.35 | 2.07 | 2.07 | 2.20 | 2.35 | 3.22 | 2.58 | 2.58 | 2.86 | 3.19 | 3.11 | 3.10 | 1.26 | 2.09 |
| 237 | 250 | 2.24 | 1.97 | 1.97 | 2.11 | 2.24 | 3.07 | 2.46 | 2.46 | 2.74 | 3.05 | 3.05 | 2.95 | 1.15 | 1.99 |

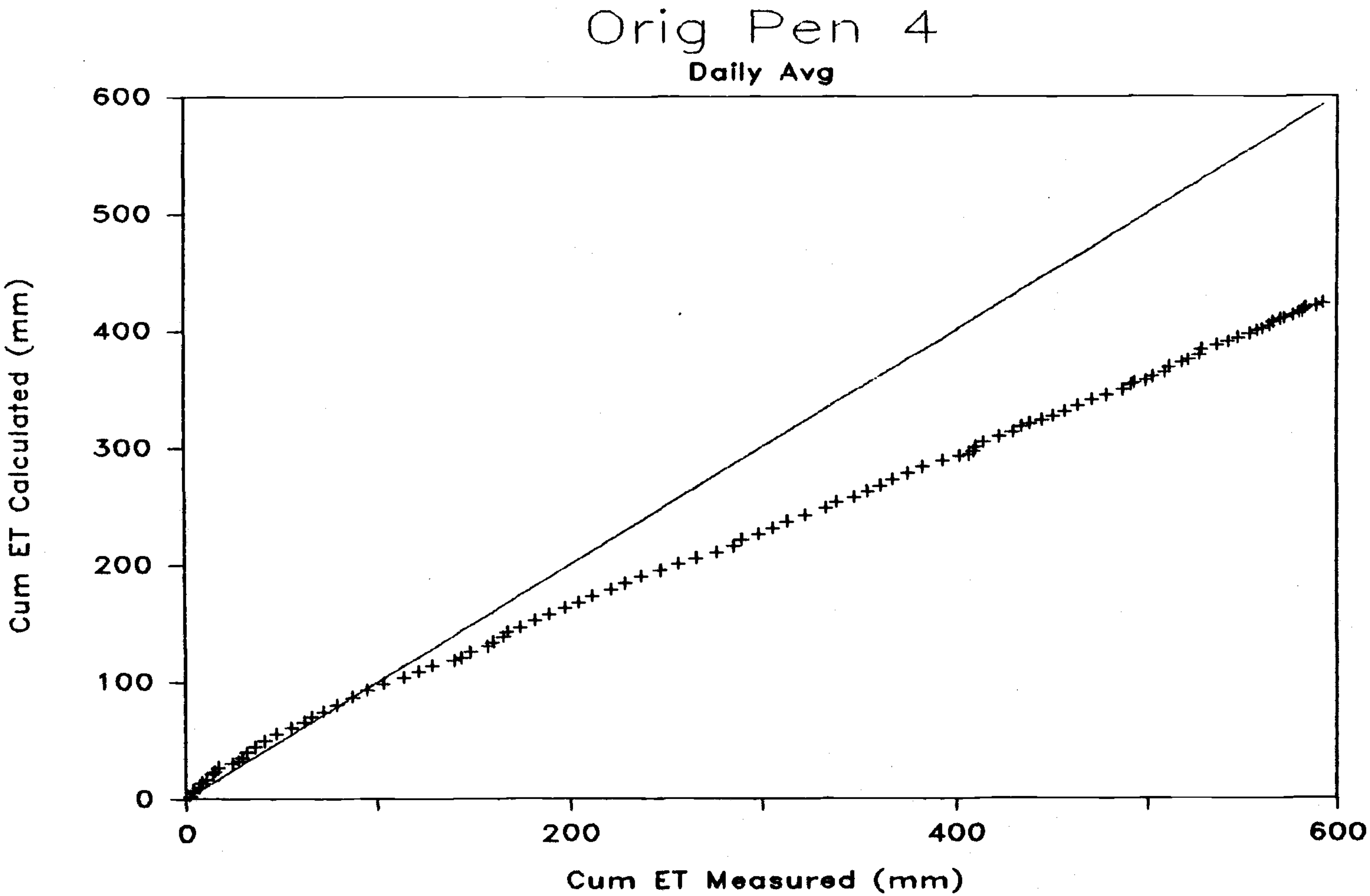
# Appendix E

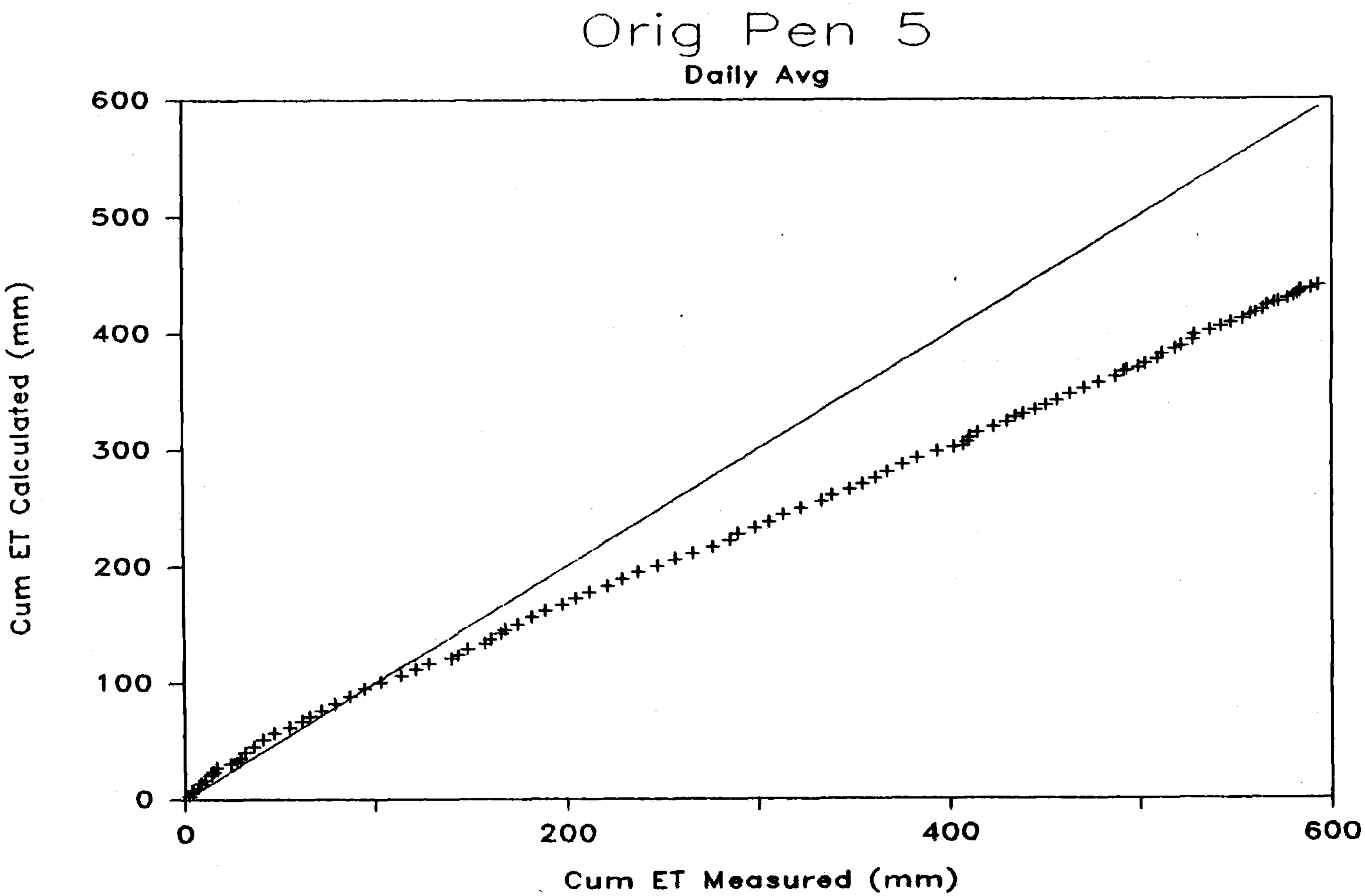
## Cumulative Measured ET vs Calculated ET Graphs


Orig Pen 1
Daily Avg
600
500
400
300
200
100
0
0
200
400
600
Cum ET Calculated (mm)
Cum ET Measured (mm)

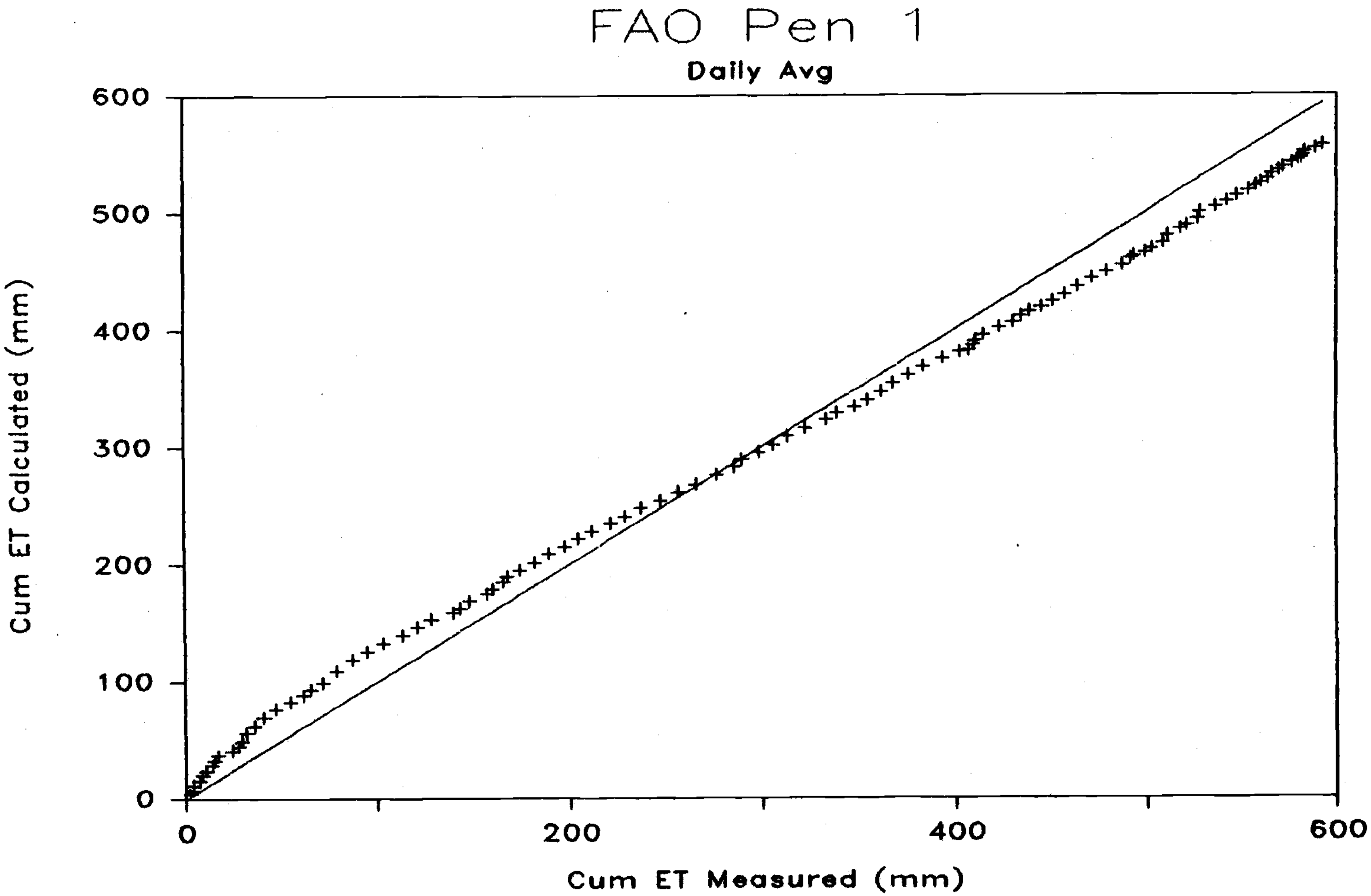


Orig Pen 2
Daily Avg
Cum ET Calculated (mm)
Cum ET Measured (mm)
0
100
200
300
400
500
600
0
200
400
600

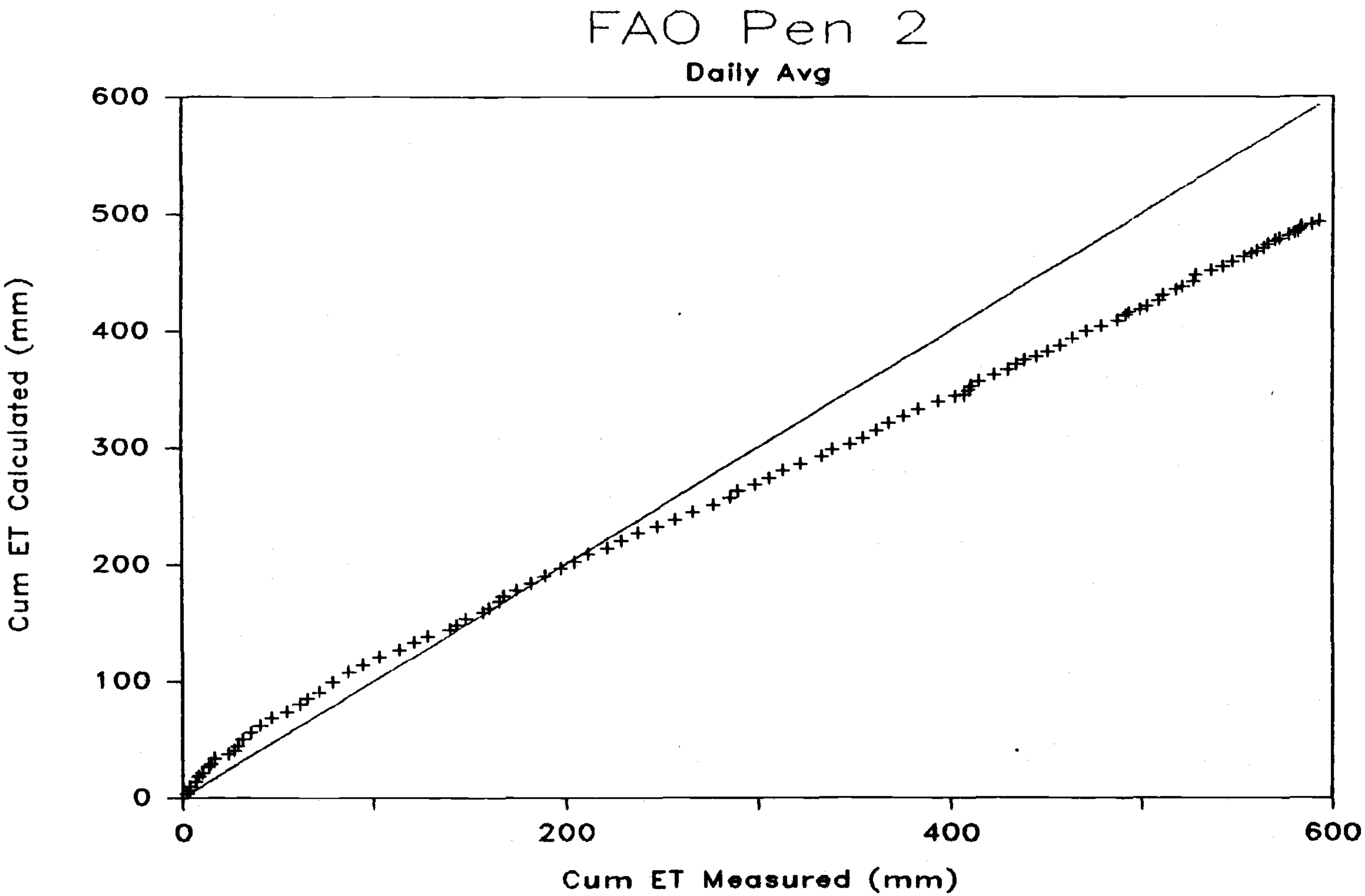

Orig Pen 4
Daily Avg
600
500
400
300
200
100
0
Cum ET Calculated (mm)
0
200
400
600
Cum ET Measured (mm)

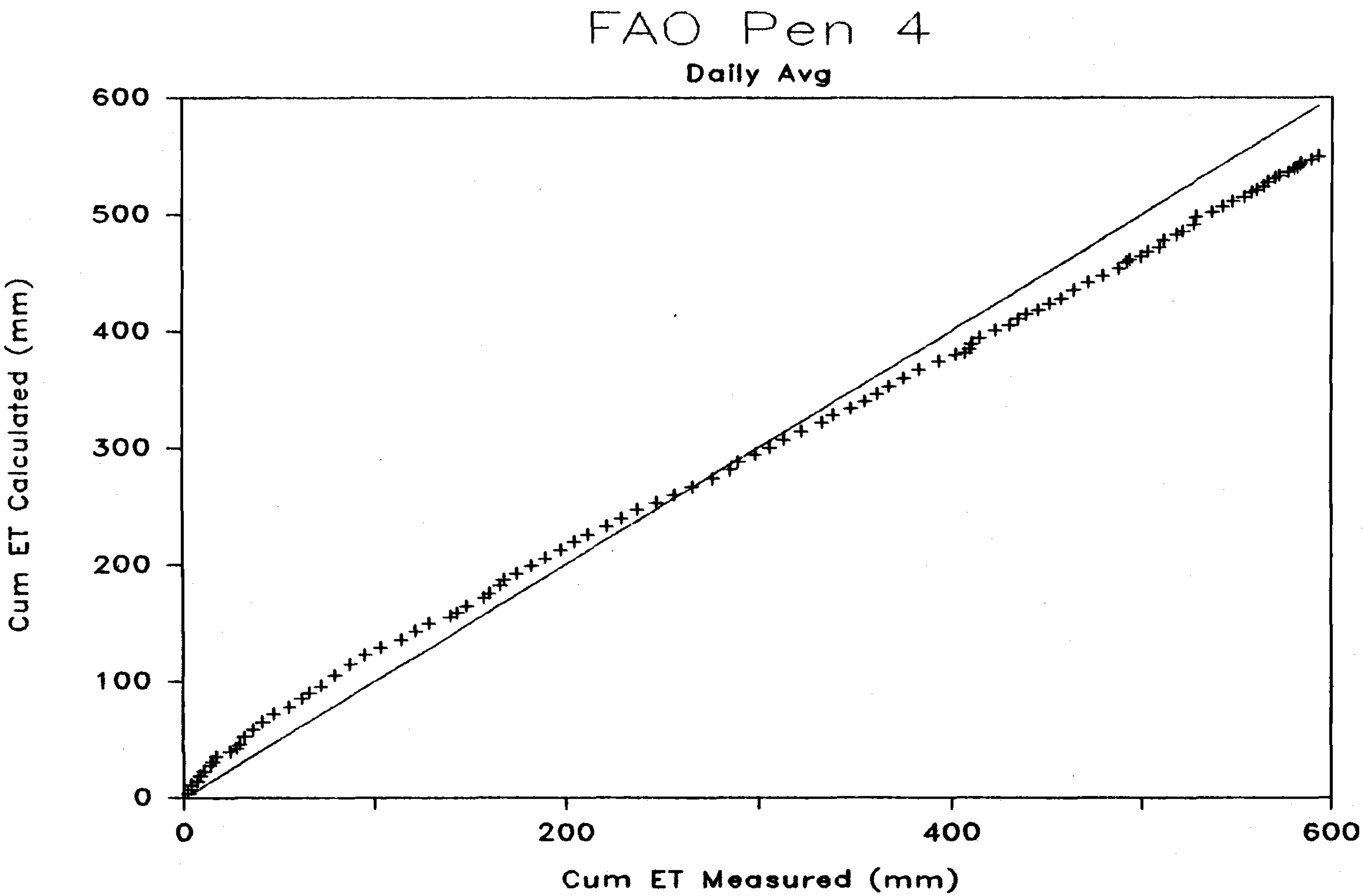


Orig Pen 5
Daily Avg
Cum ET Calculated (mm)
Cum ET Measured (mm)
0
100
200
300
400
500
600
0
200
400
600



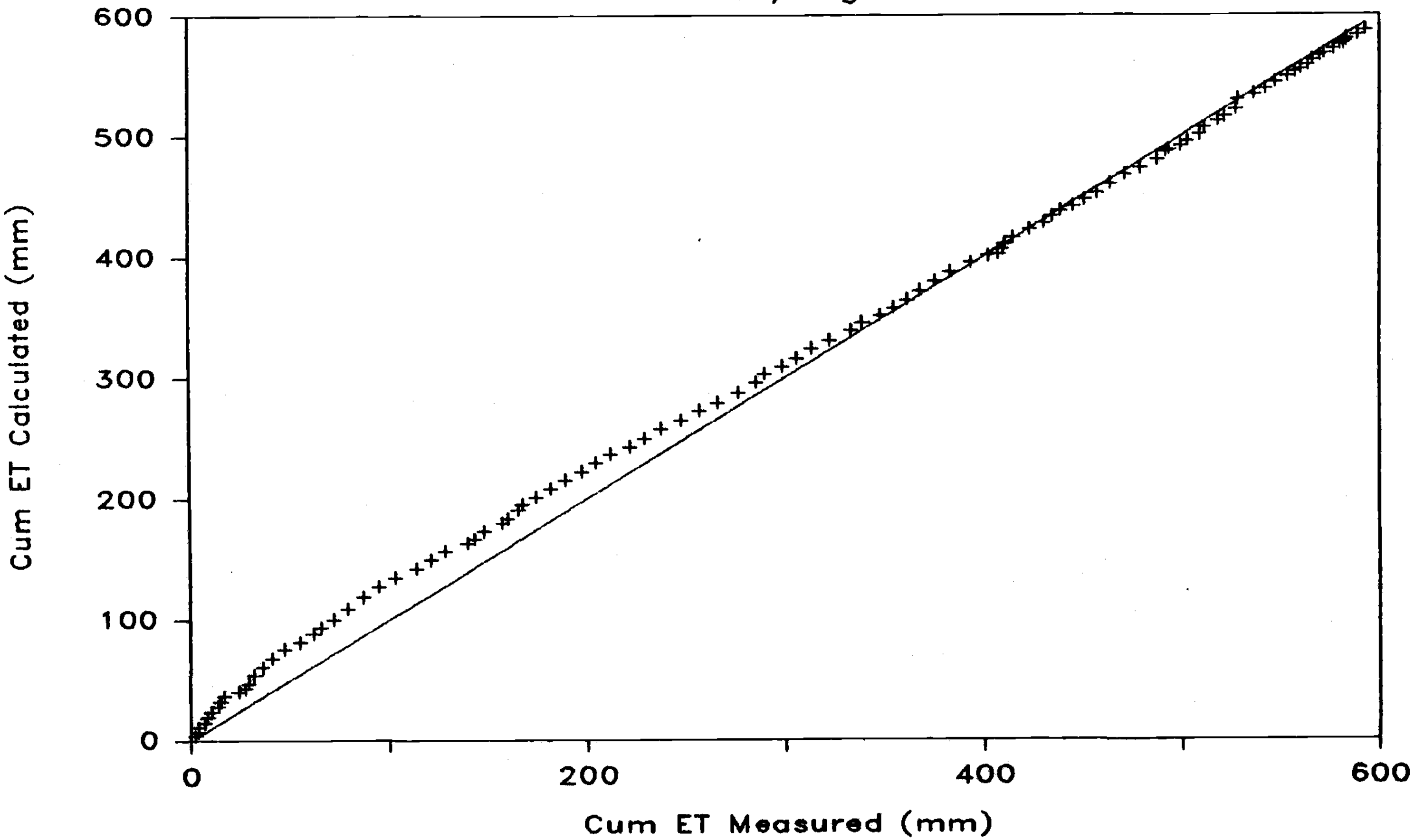
FAO Pen 1
Daily Avg
Cum ET Calculated (mm)
Cum ET Measured (mm)
0
100
200
300
400
500
600
0
200
400
600

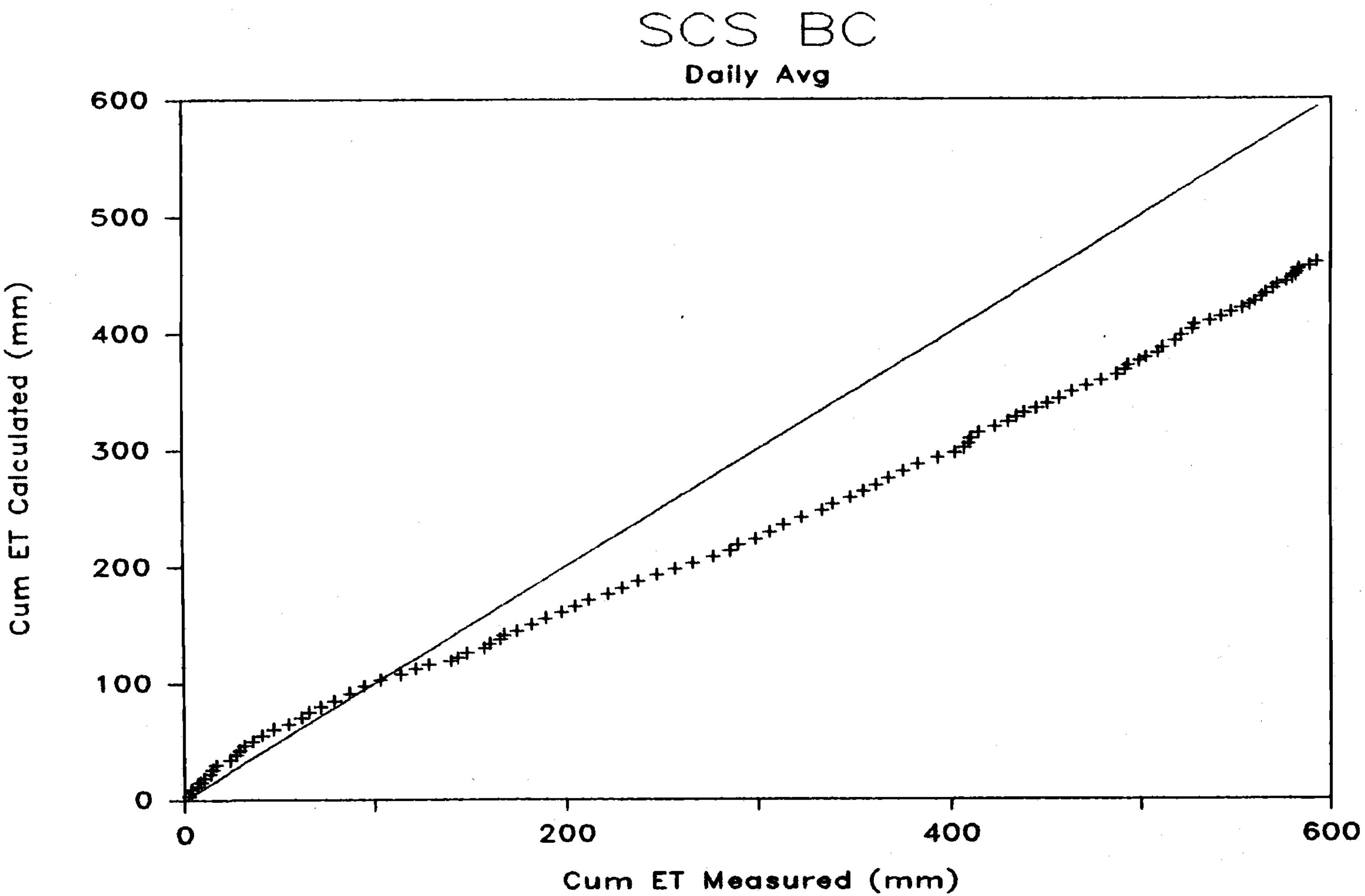

FAO Pen 2
Daily Avg
Cum ET Calculated (mm)
Cum ET Measured (mm)
0
100
200
300
400
500
600
0
200
400
600

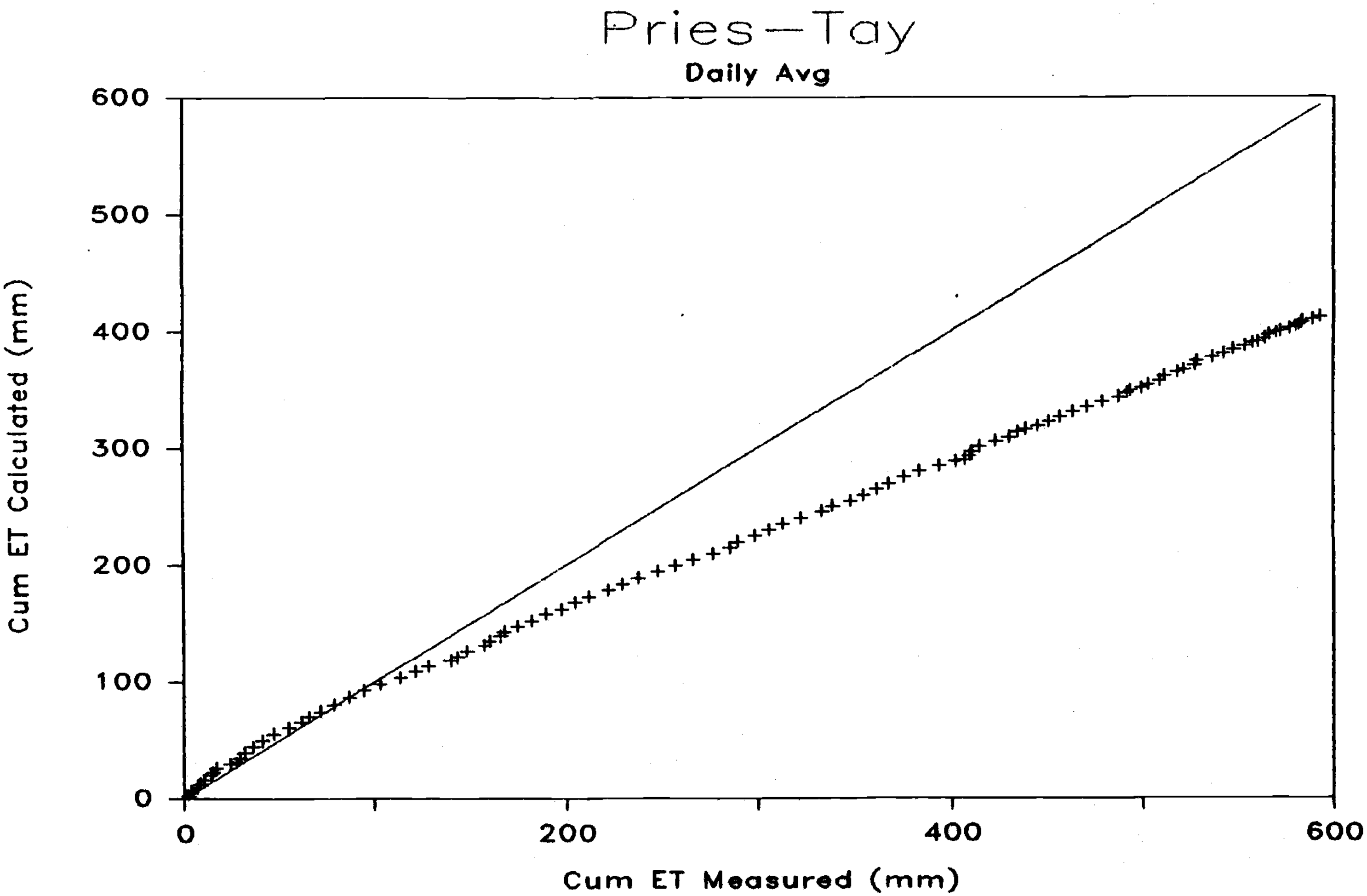

FAO Pen 4
Daily Avg
Cum ET Calculated (mm)
Cum ET Measured (mm)
0
100
200
300
400
500
600
0
200
400
600

## FAO Pen 5

**Daily Avg**

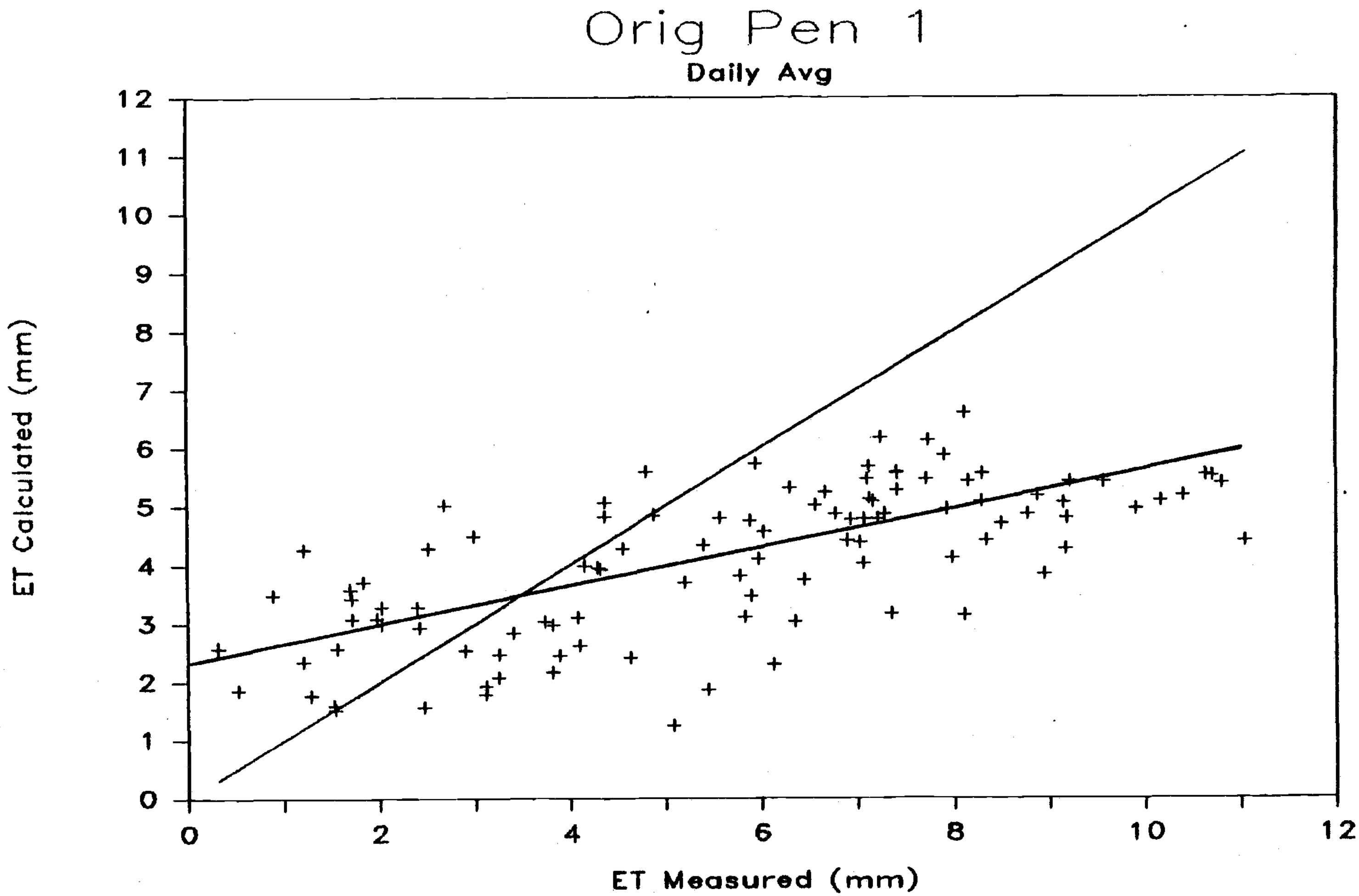



SCS BC
Daily Avg
Cum ET Calculated (mm)
Cum ET Measured (mm)
0
100
200
300
400
500
600
0
200
400
600

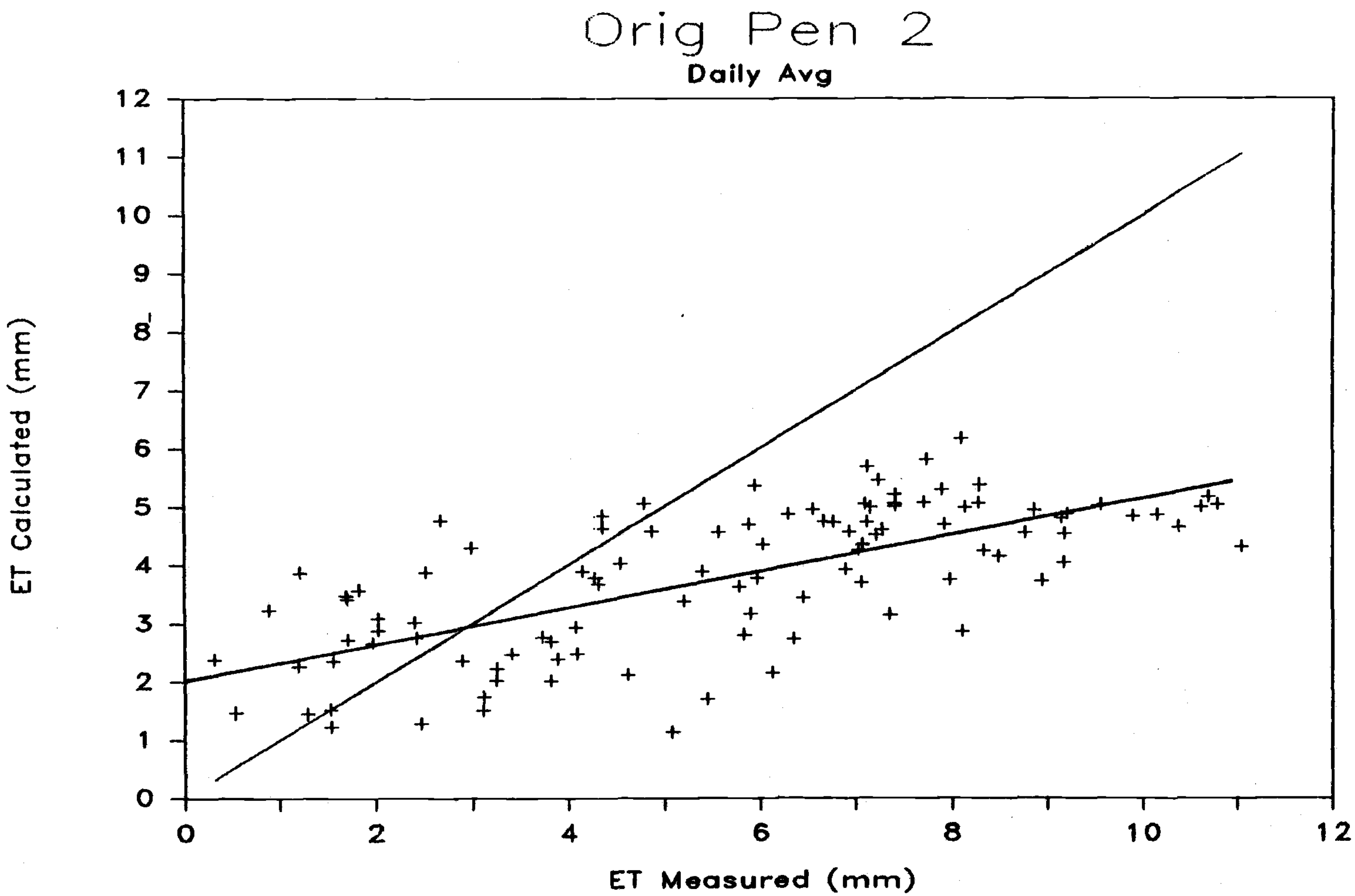

Pries-Tay
Daily Avg
Cum ET Calculated (mm)
Cum ET Measured (mm)
0
100
200
300
400
500
600
0
200
400
600

# Appendix F

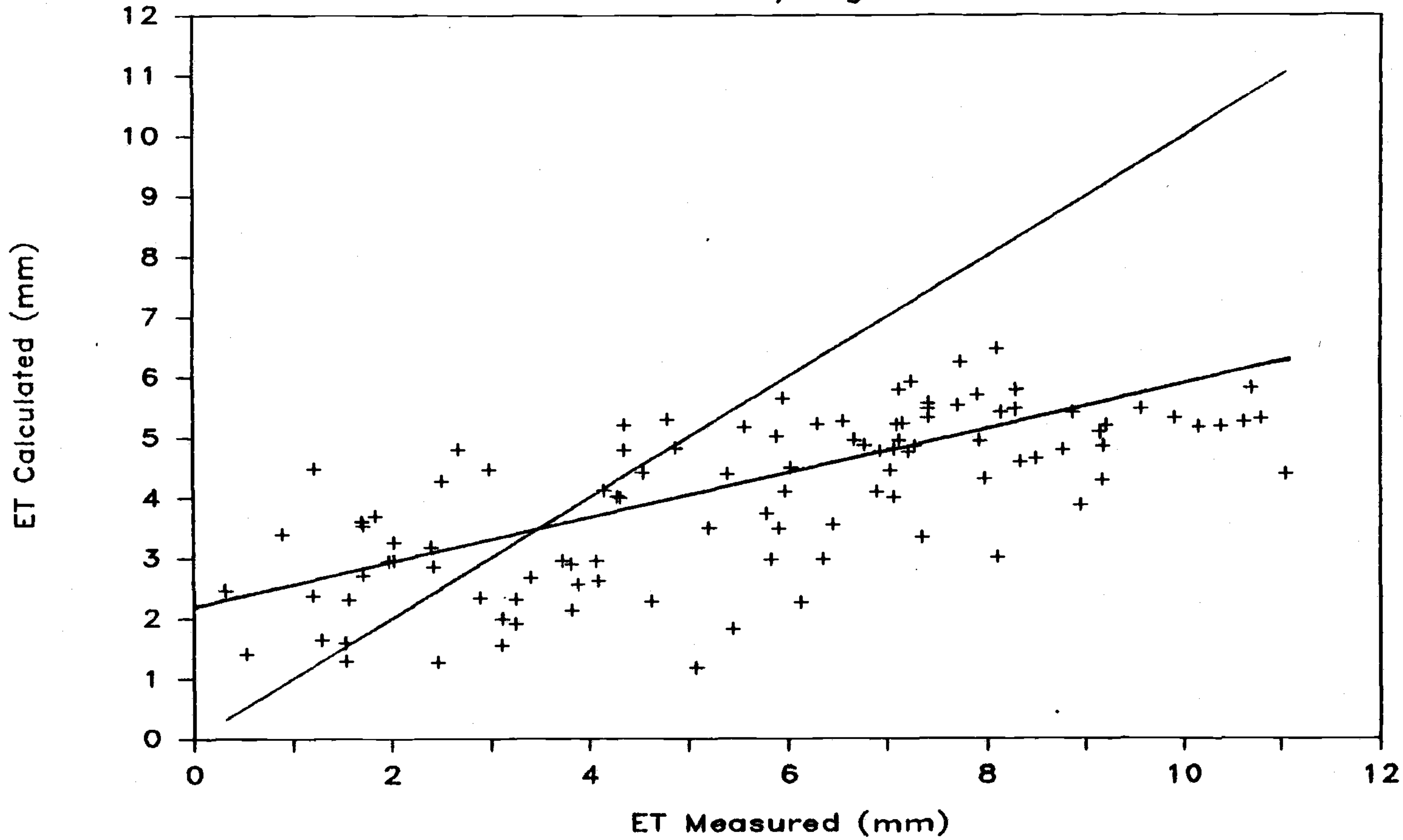
## Simple Regression Models

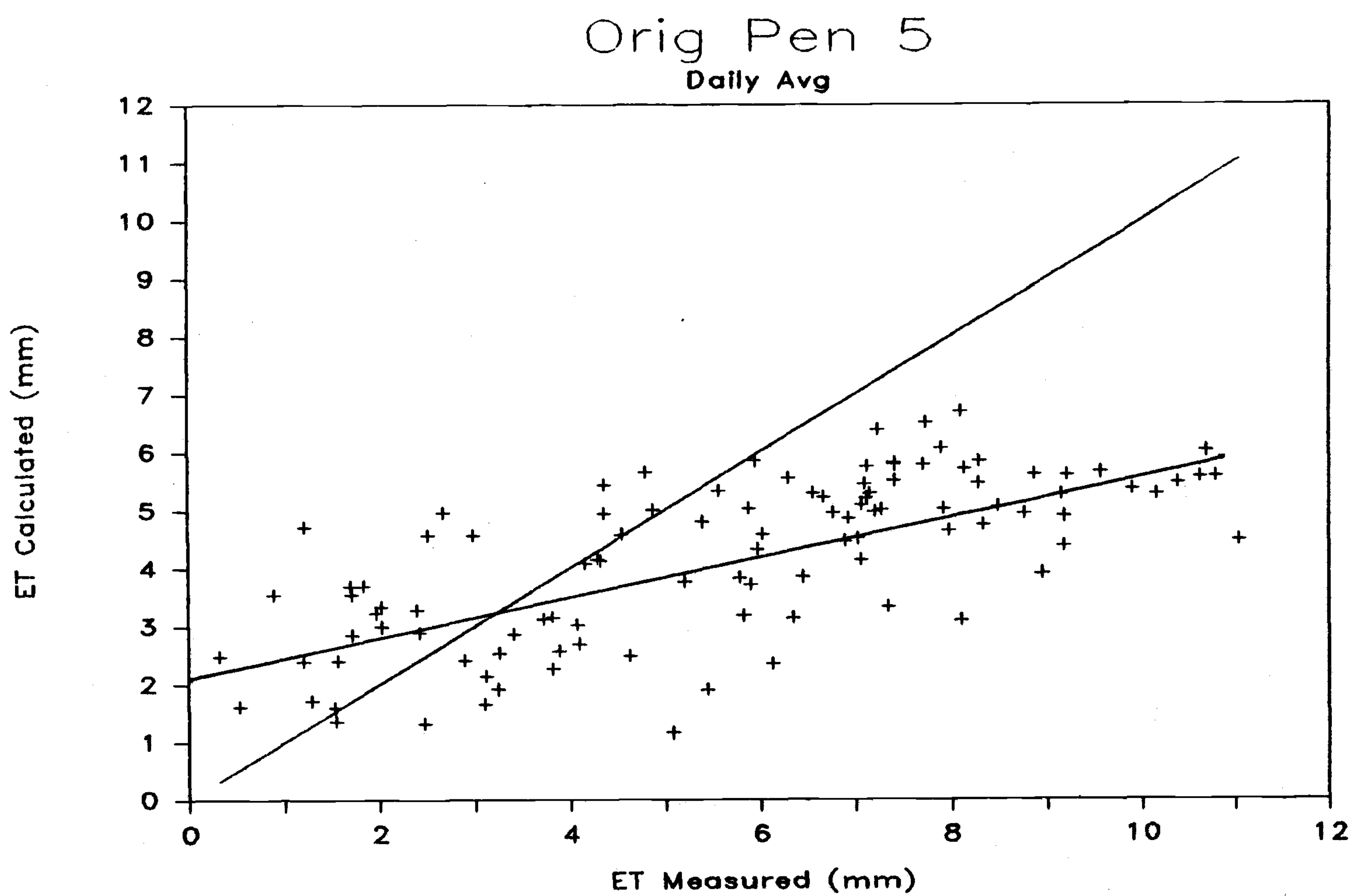


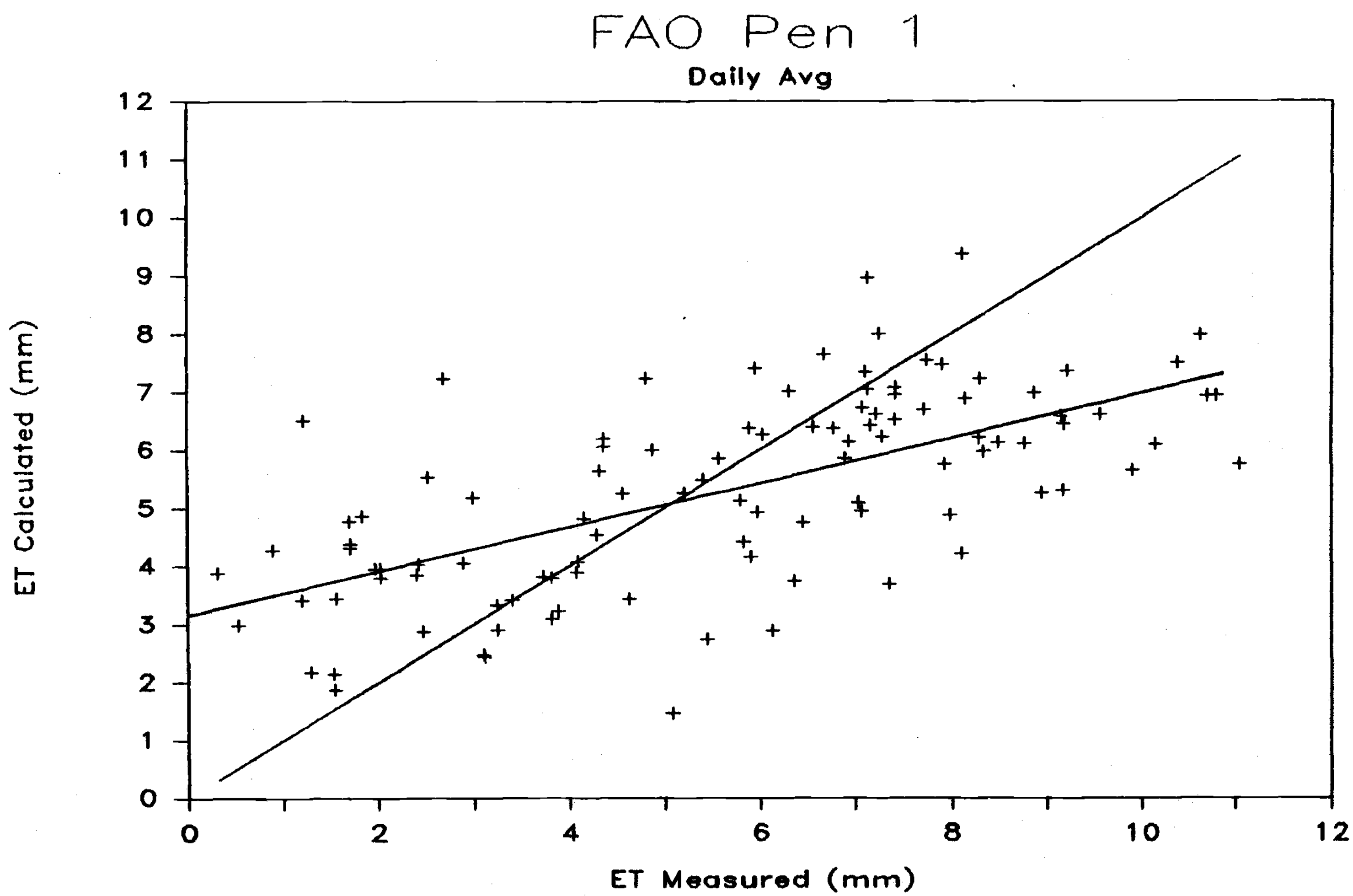
Orig Pen 1
Daily Avg
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12


Orig Pen 2
Daily Avg
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12

Orig Pen 4
Daily Avg

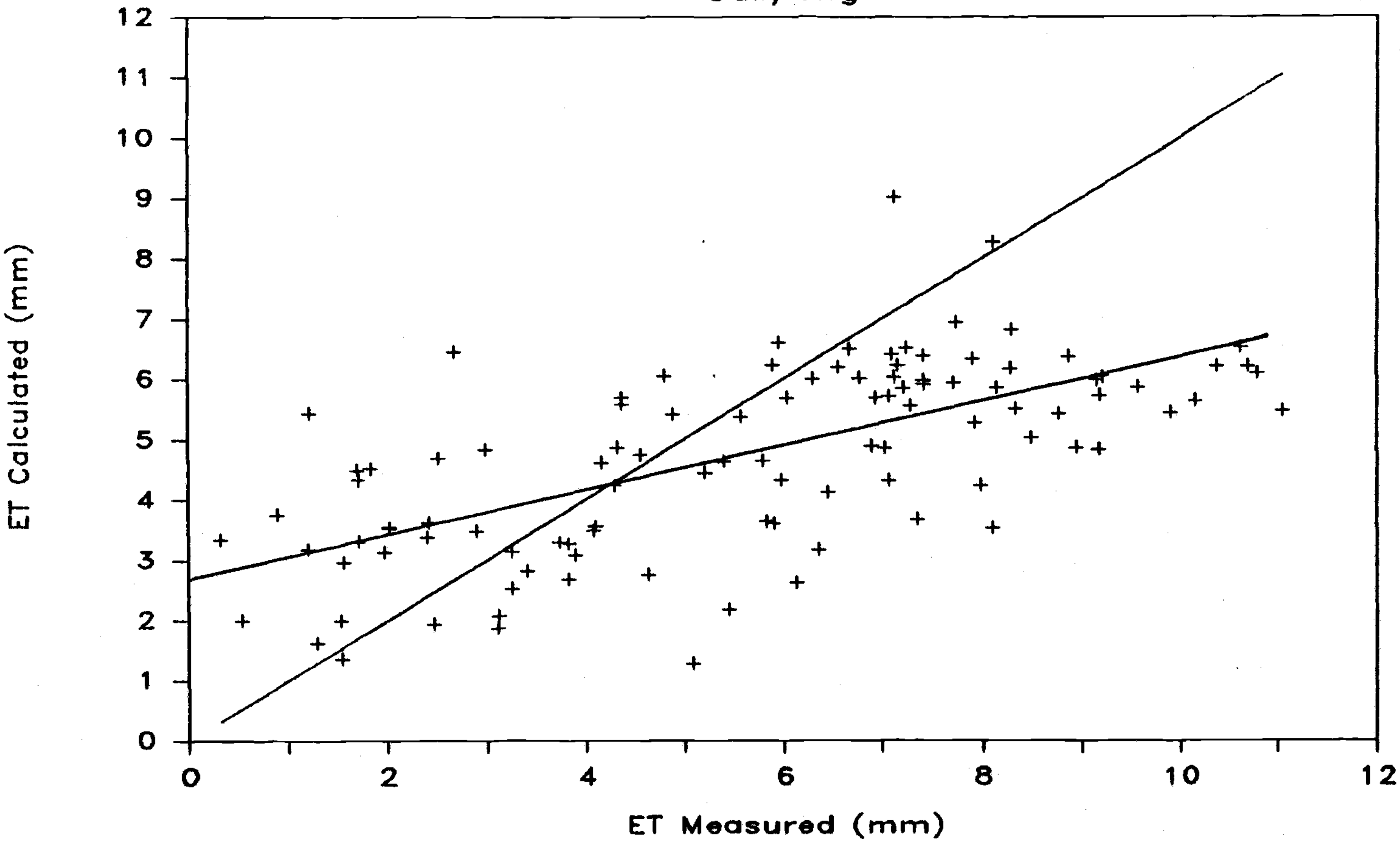


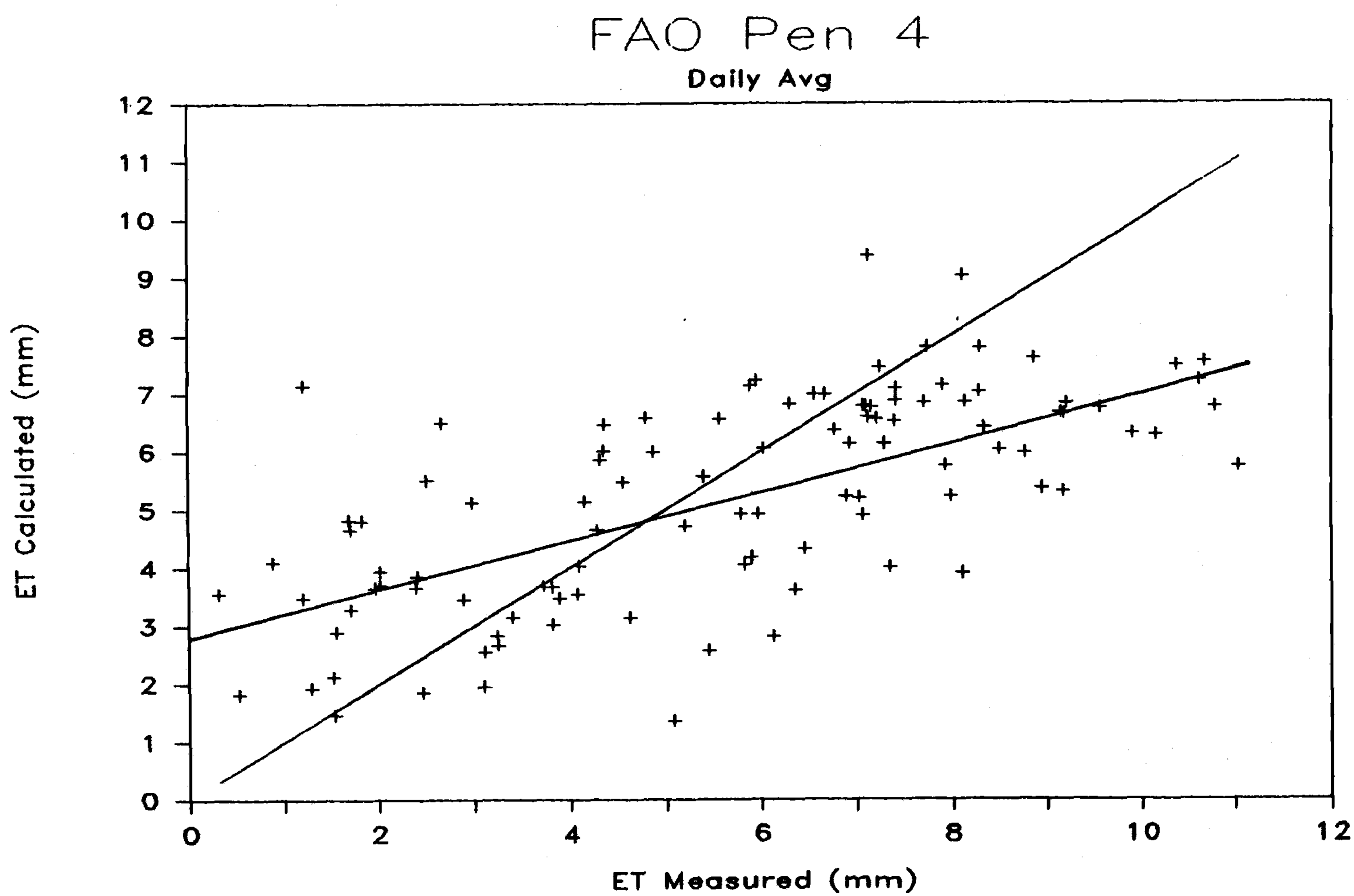

Orig Pen 5
Daily Avg
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12


FAO Pen 1
Daily Avg
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12

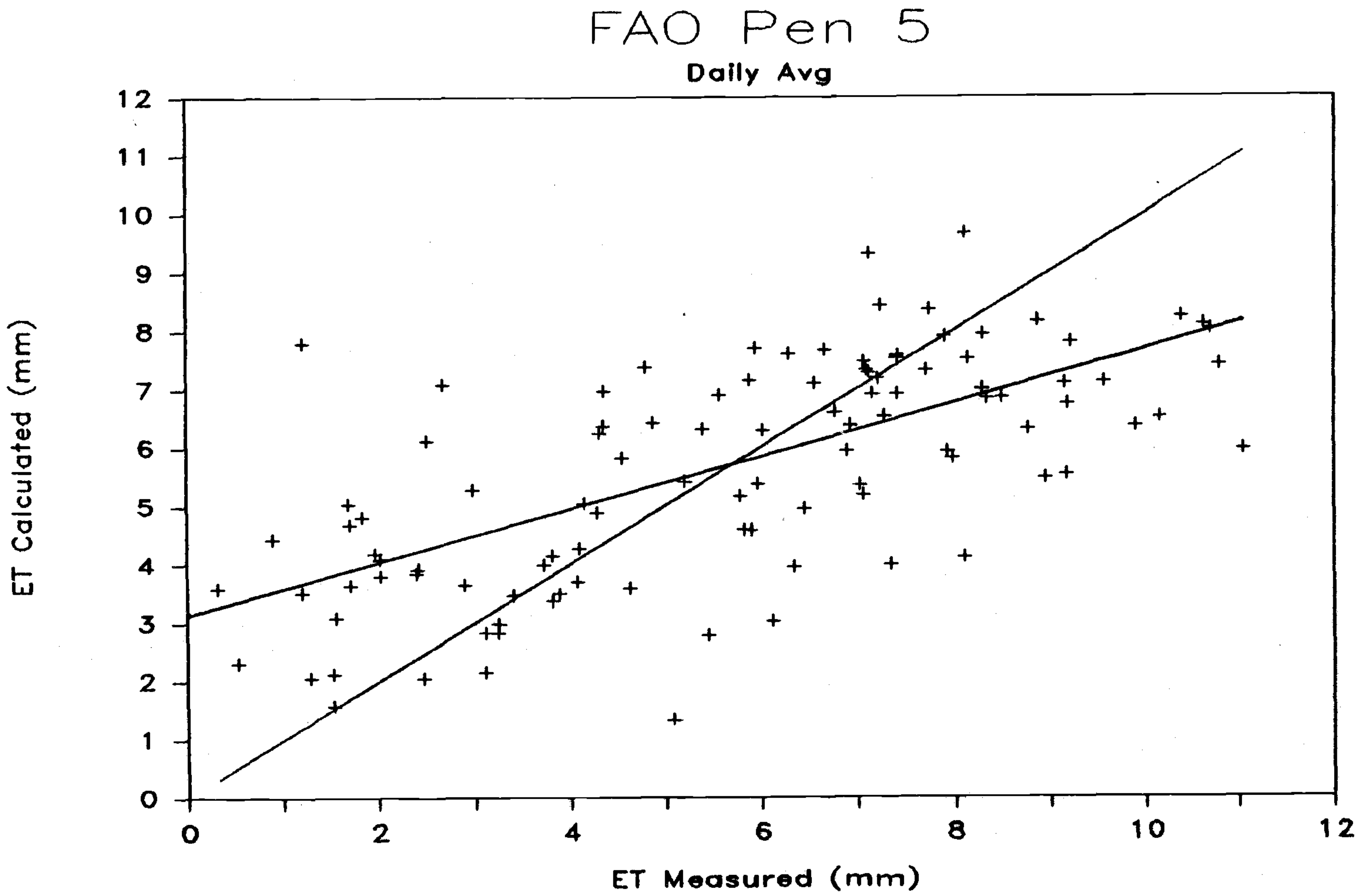
FAO Pen 2

Daily Avg



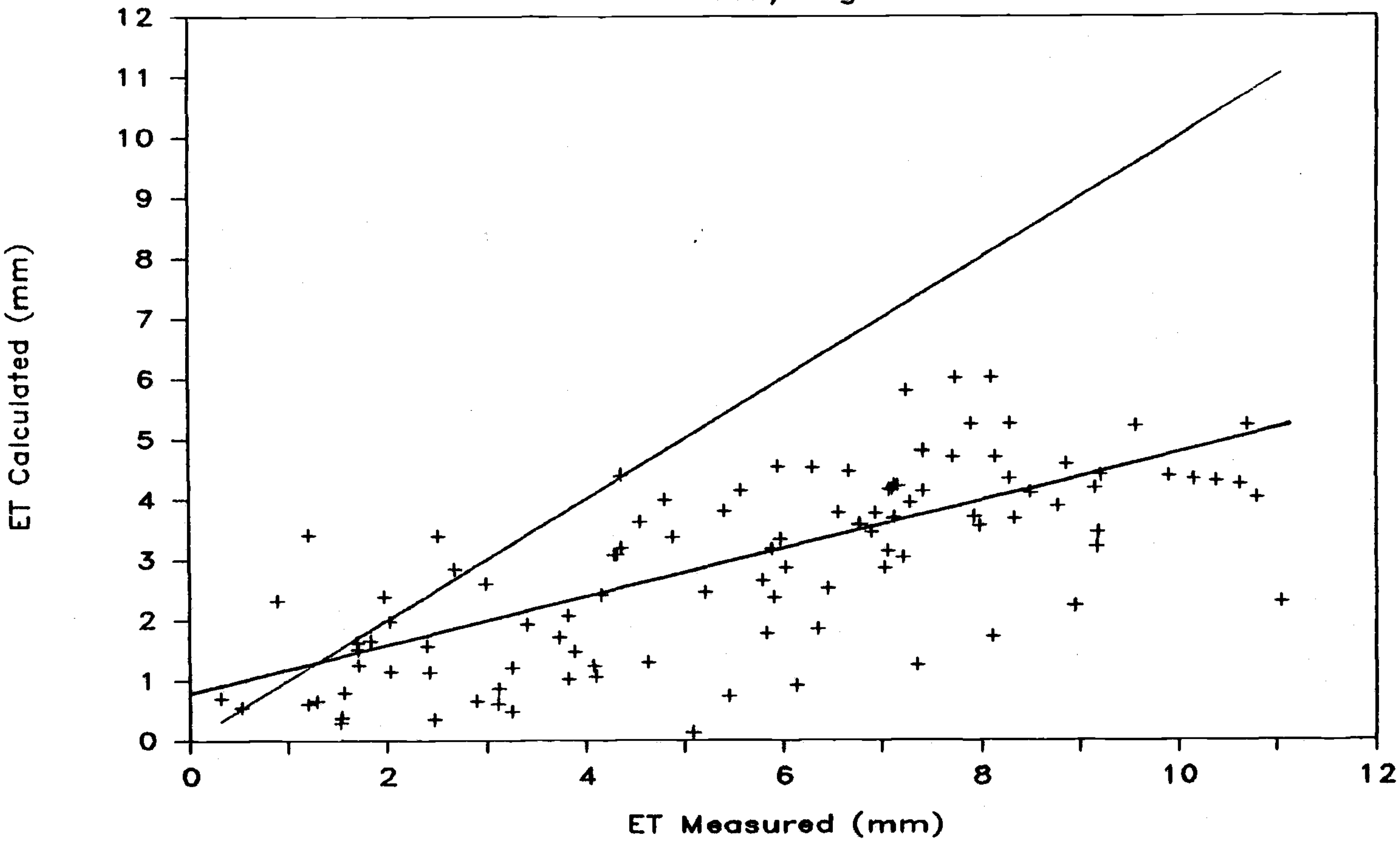


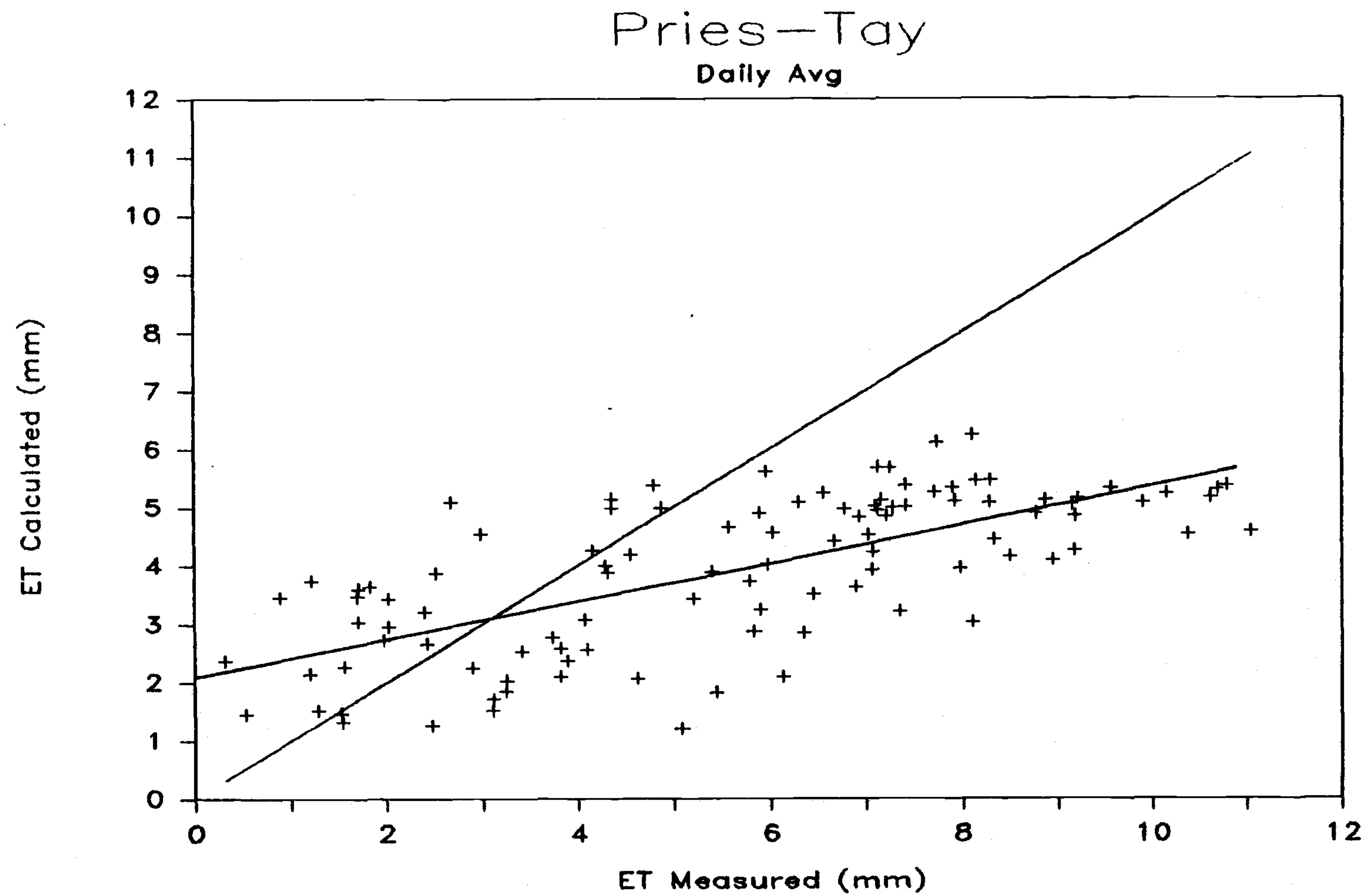
FAO Pen 4
Daily Avg
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12


FAO Pen 5
Daily Avg
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12

# Jens–Hais

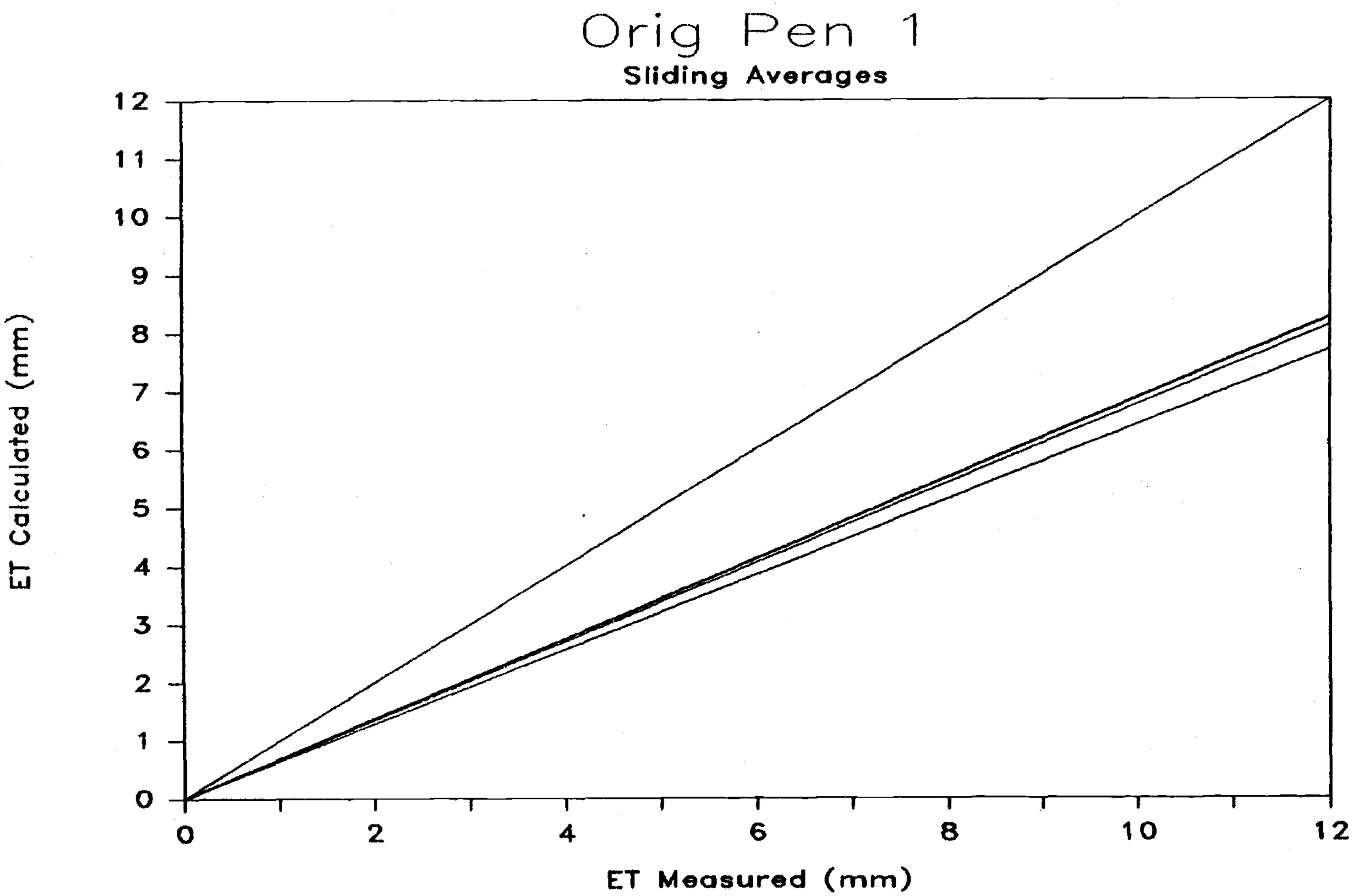
**Daily Avg**

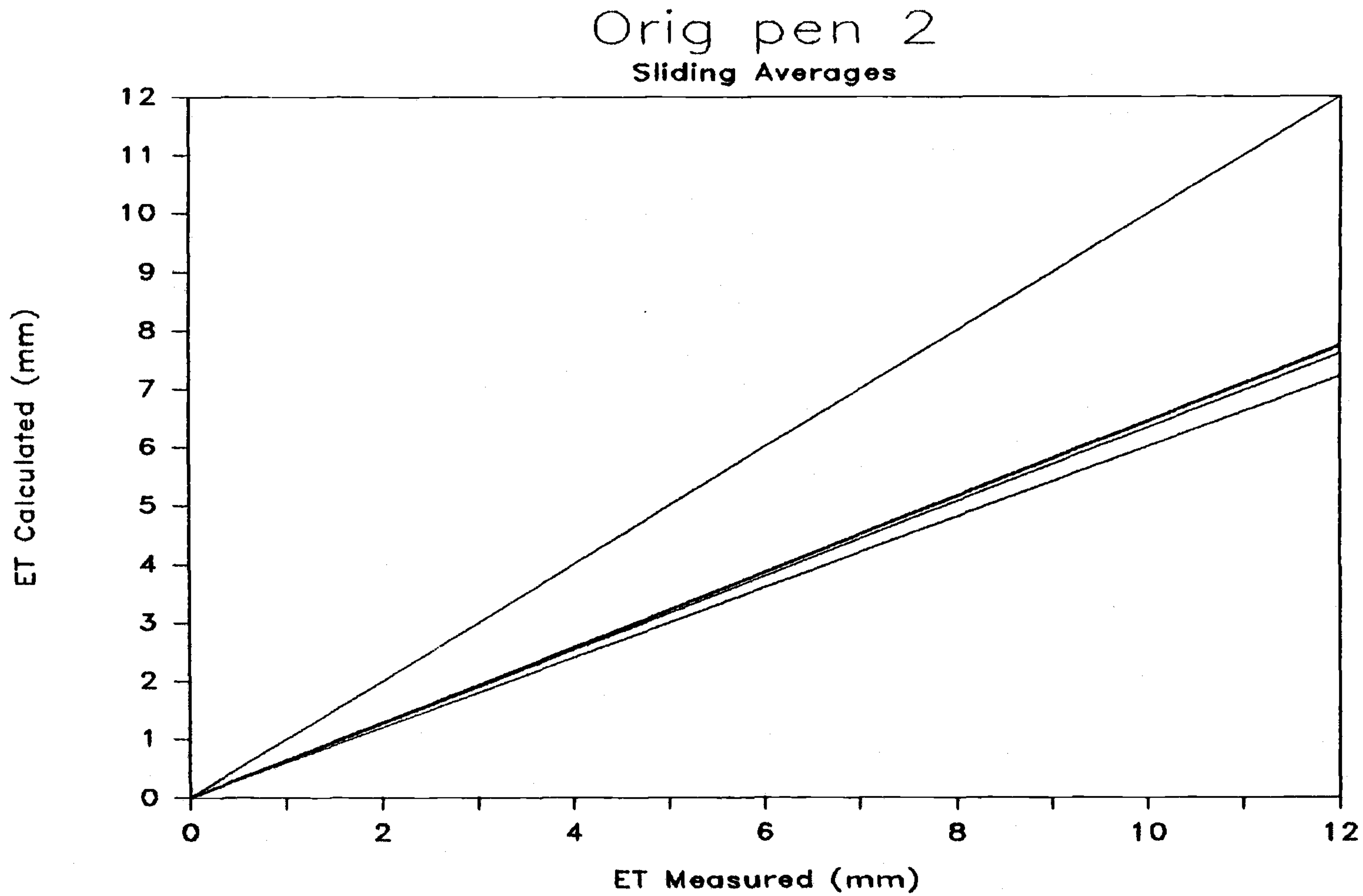


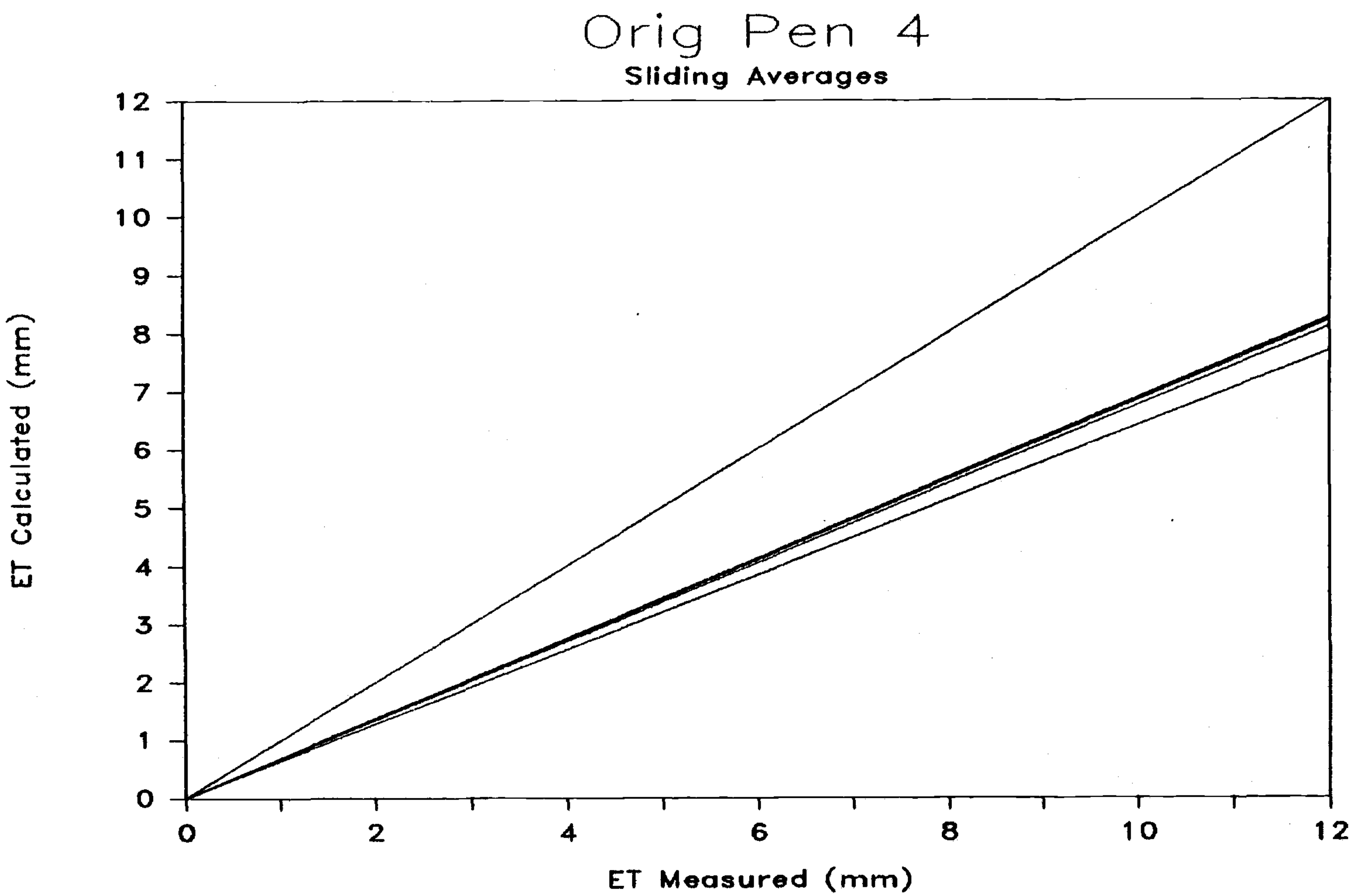

Pries-Tay
Daily Avg
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12

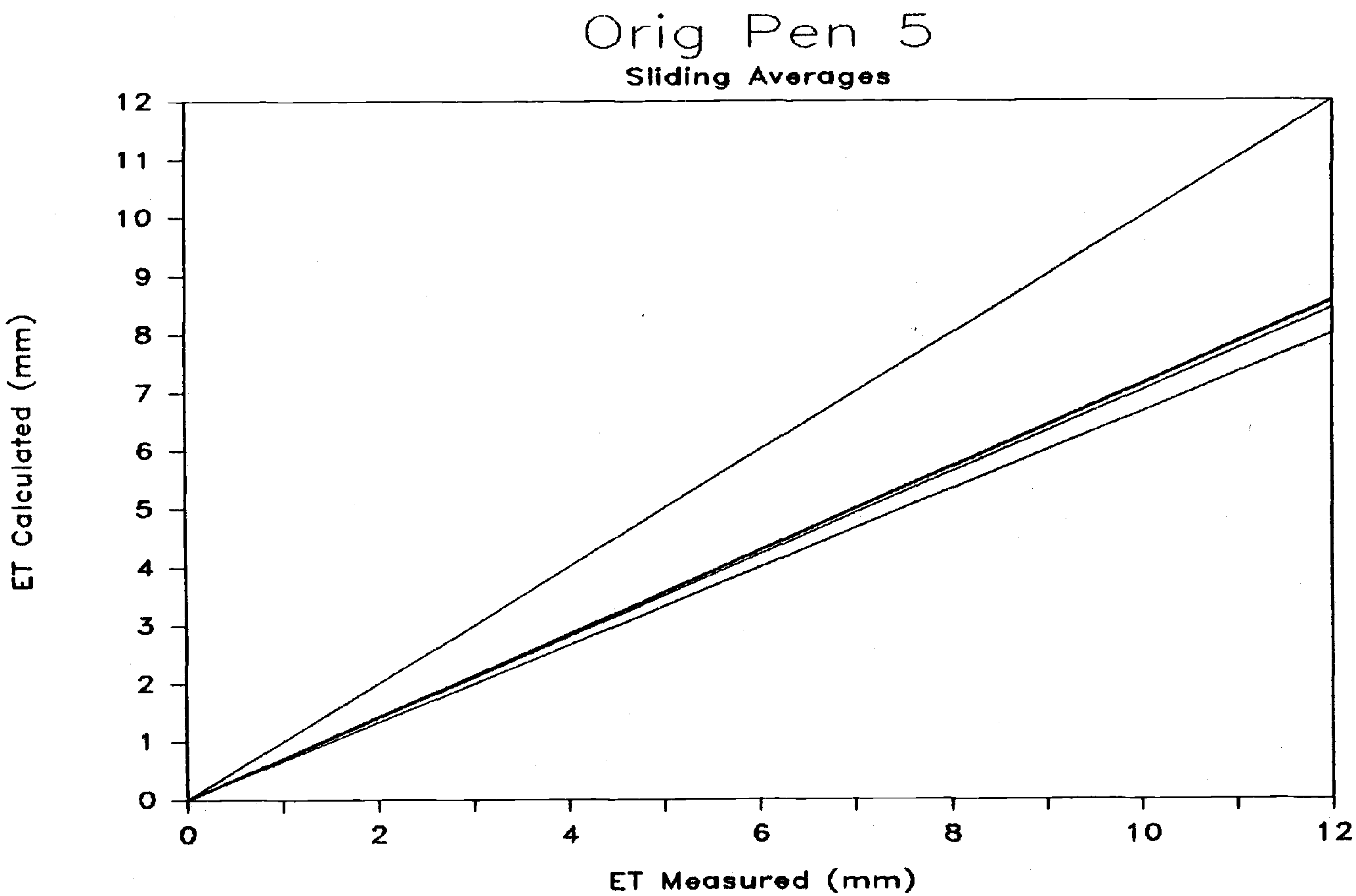
# Appendix G

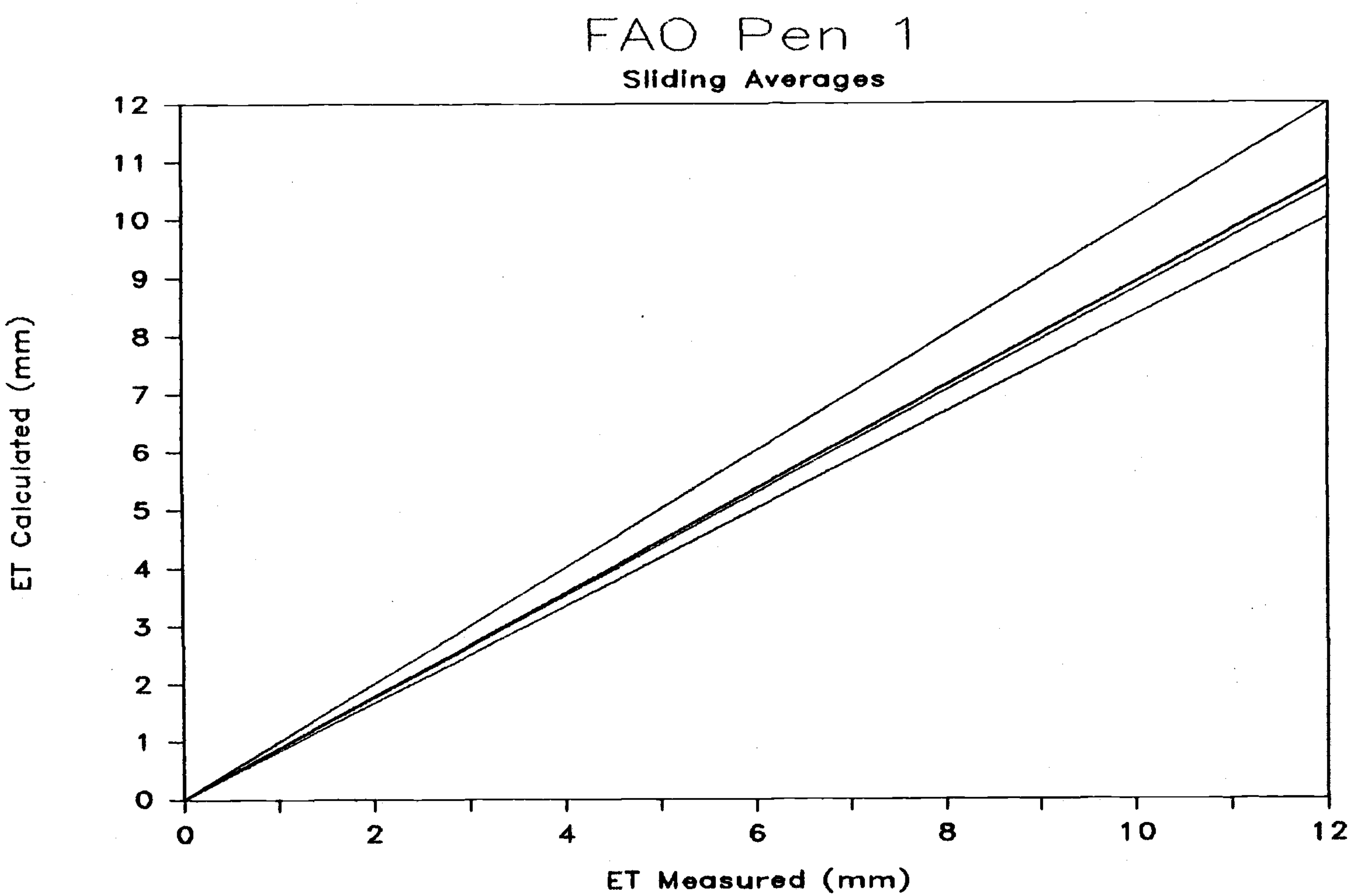
## Sliding Day Average Curves


Orig Pen 1
Sliding Averages
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12

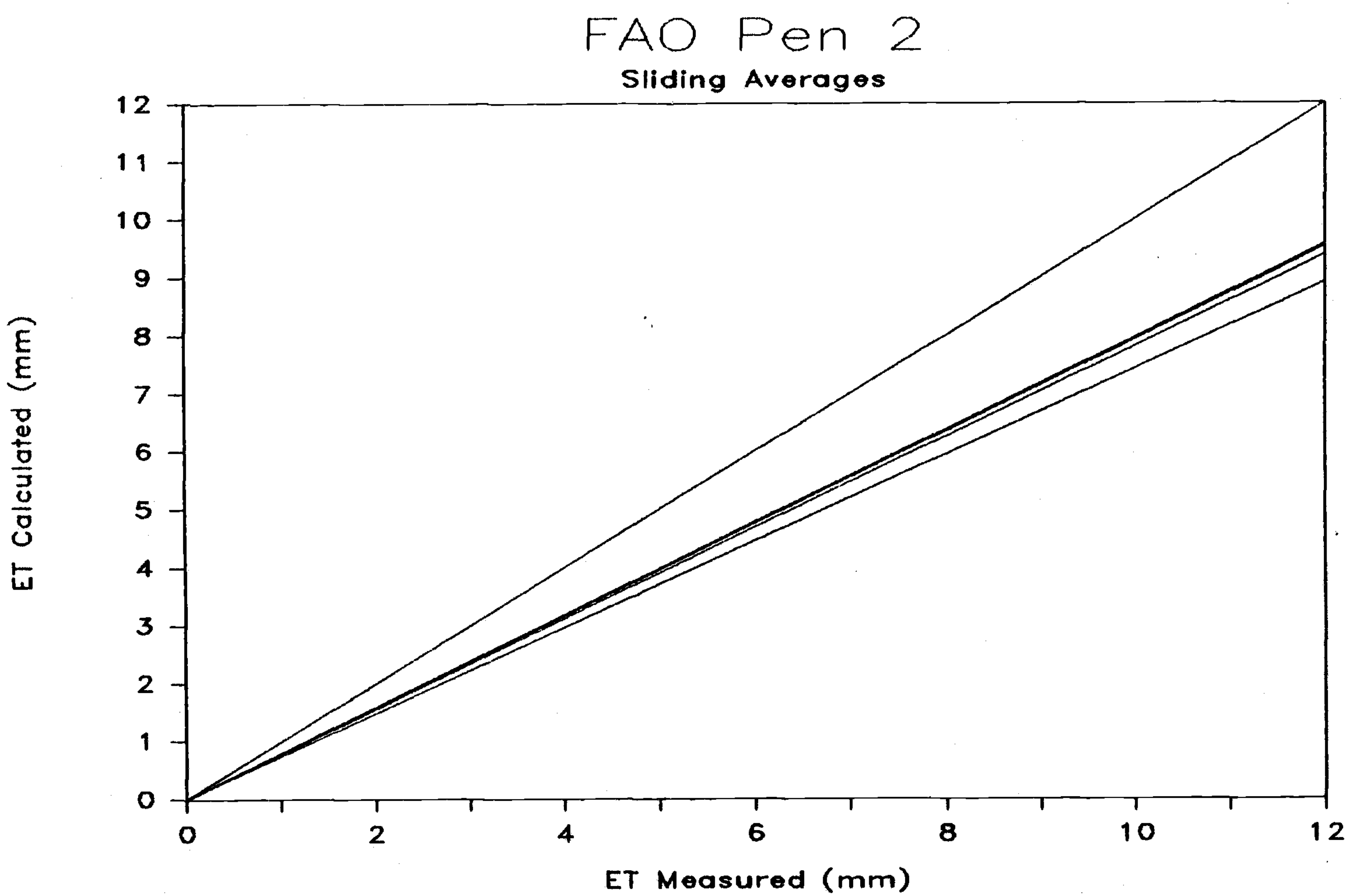

Orig pen 2
Sliding Averages
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12

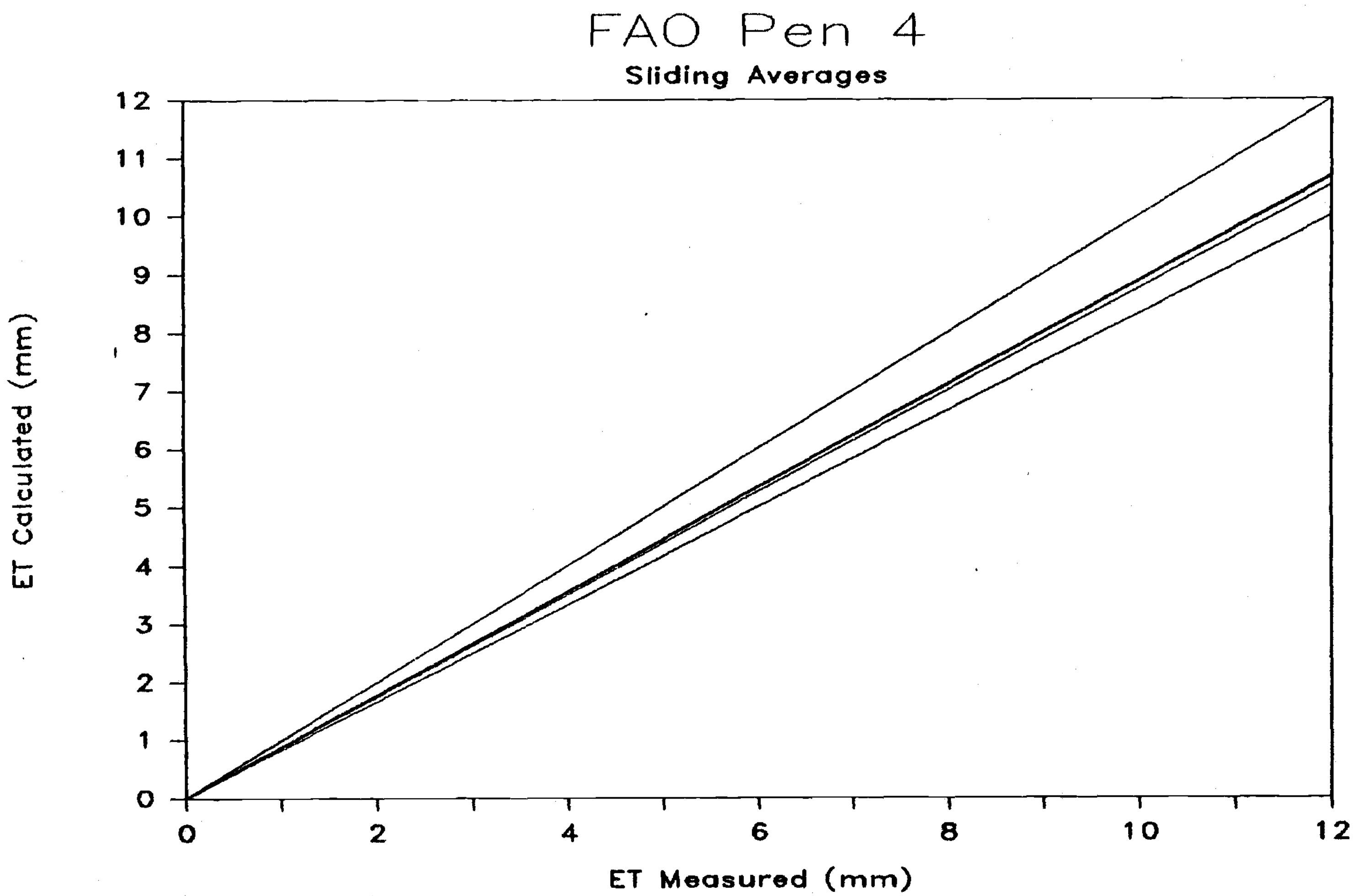

Orig Pen 4
Sliding Averages
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12

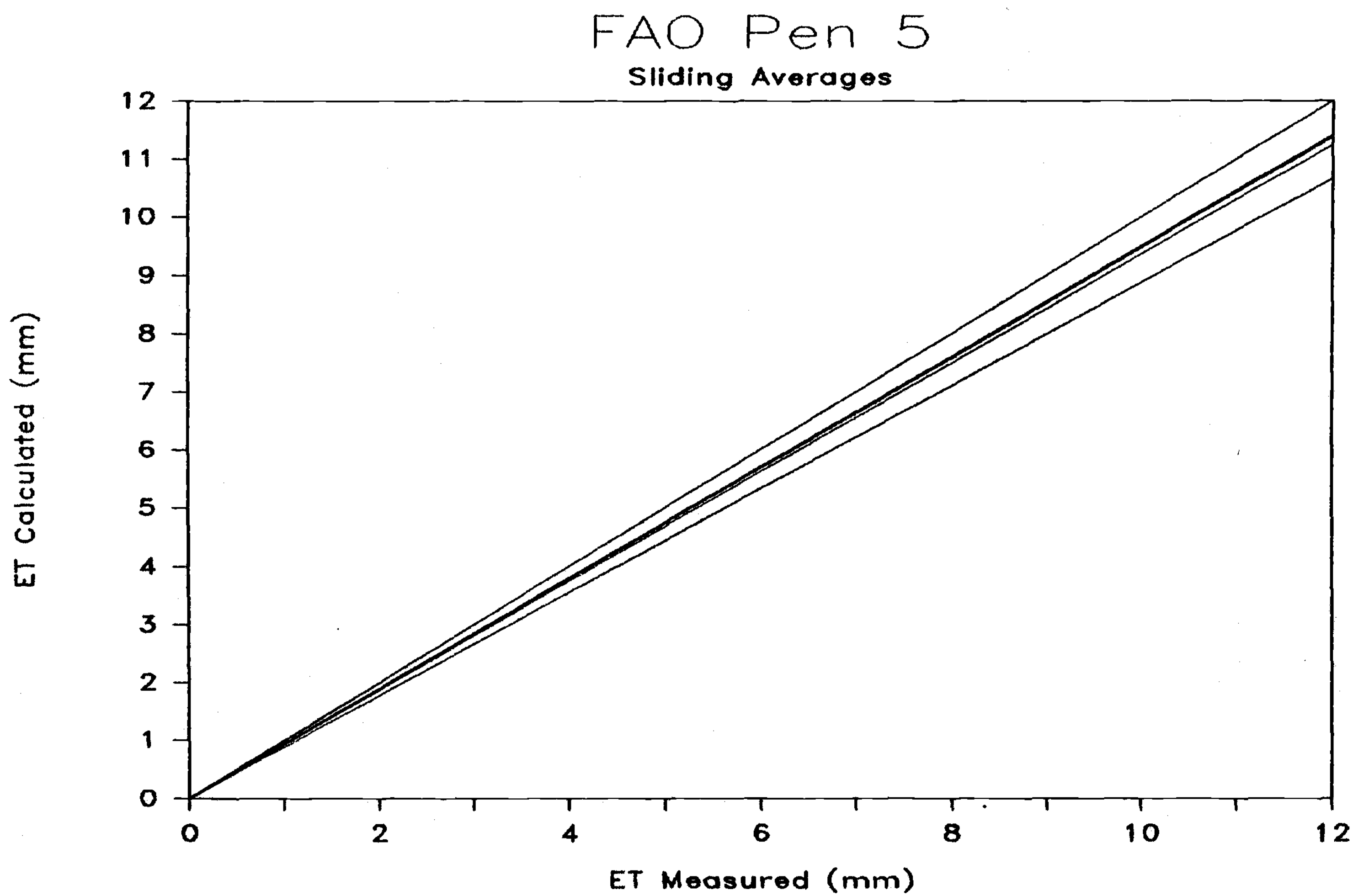

Orig Pen 5
Sliding Averages
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12

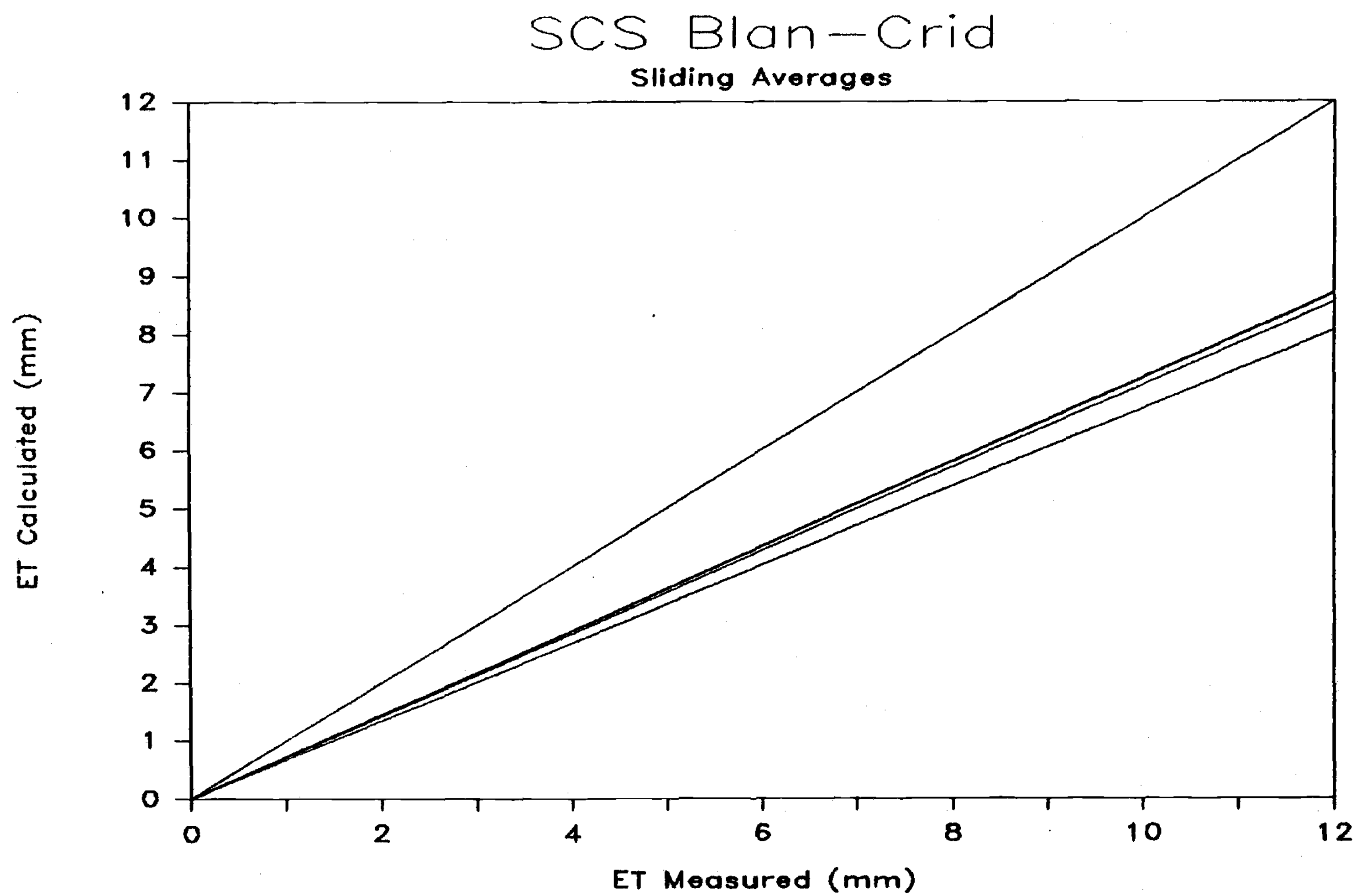


FAO Pen 1
Sliding Averages
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12


FAO Pen 2
Sliding Averages
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12


FAO Pen 4
Sliding Averages
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12

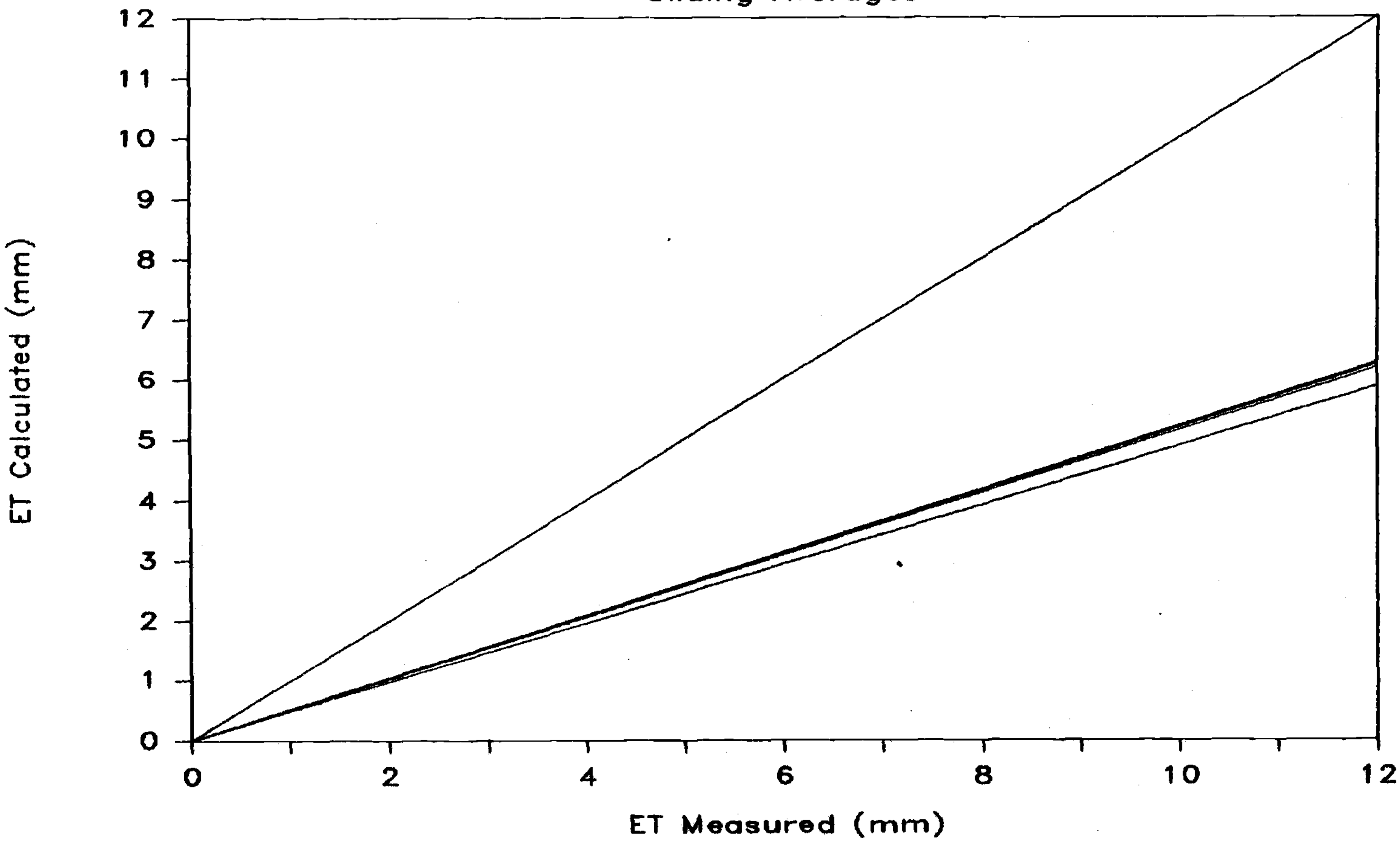

FAO Pen 5
Sliding Averages
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12

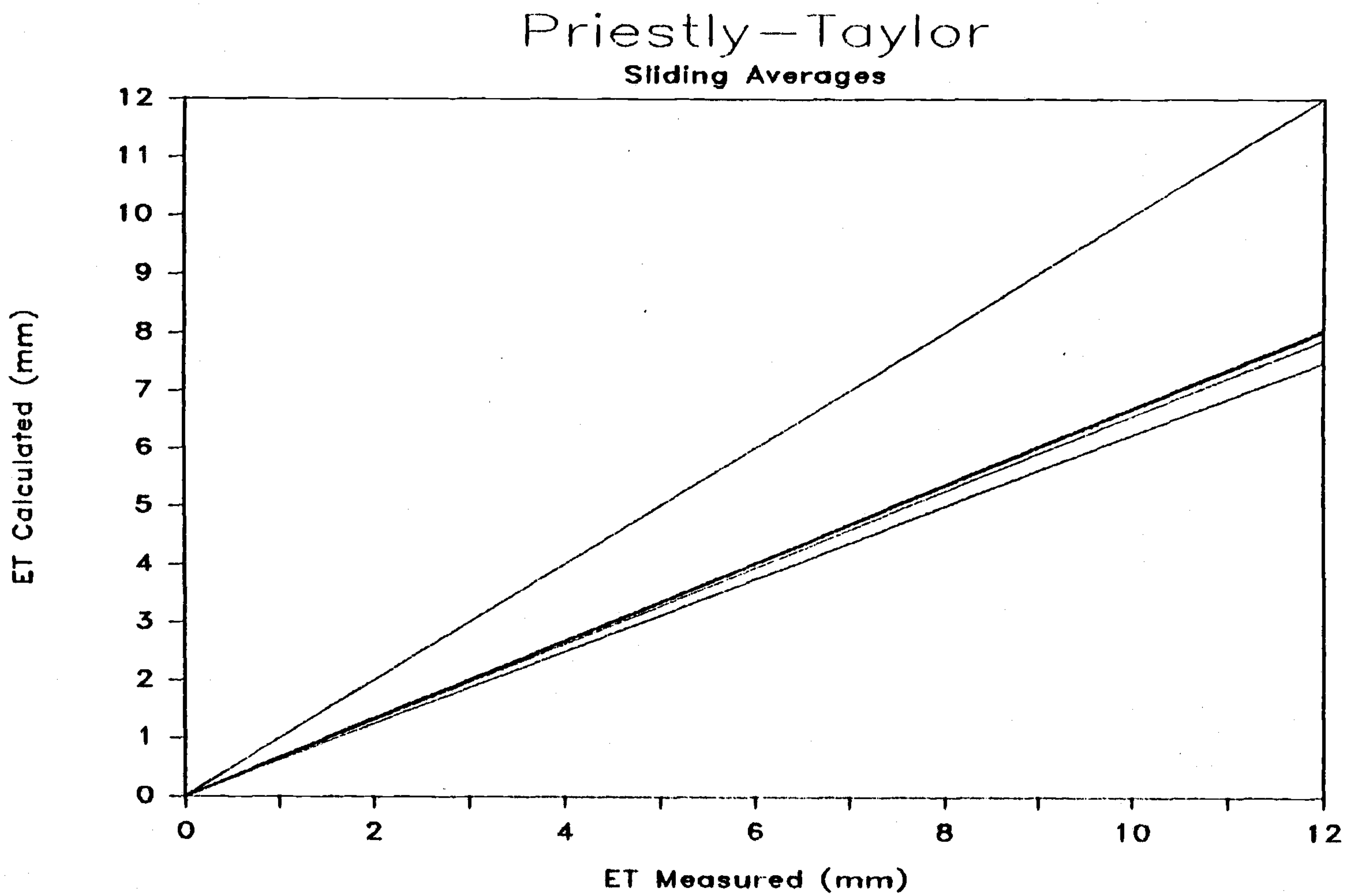


SCS Blan-Crid
Sliding Averages
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12

## Jensen—Haise

**Sliding Averages**




Priestly-Taylor
Sliding Averages
ET Calculated (mm)
ET Measured (mm)
0
1
2
3
4
5
6
7
8
9
10
11
12
0
2
4
6
8
10
12