2.3 TECHNIQUES USED TO CALCULATE POTENTIAL EVAPOTRANSPIRATION

There are numerous approaches used to estimate ET and potential evapotranspiration (ET_p). The following methods are frequently used: mass (water vapor) transfer, energy budget, watershed water budget, soil water budget, groundwater fluctuations, and empirical formulae. The different techniques have been developed partly in response to the availability of data for estimating ET. Each method has certain advantages and limitations. The availability of data is often the limiting factor in the choice of calculation technique for practical applications.

The choice of calculation technique also depends on the intended use (Burman et al., 1981; Doorenbos and Pruitt, 1977; Jensen, 1974; Linsley et al., 1975; Saxton, 1982) and on the time scale required by the problem. For example, irrigation management requires daily estimates of ET to allow producers to make rational decisions concerning the timing and amount of irrigation. In contrast, basin level planning may require monthly estimates of ET to project changes in water supplies and requirements during the year.

2.3.1 Penman Method

The Penman (1948) equation was derived by rearranging the energy balance equation (Equation 2) without the small photosynthetic component. When applying the Penman formula over a 24-hour period, the net energy component going into heating the soil is small, because a large part of the energy absorbed by the soil during the day is lost at night. Therefore, the soil heat flux density term, G, can be dropped for 24-hour calculations. The sensible heat flux density term, H, is replaced in the Penman formulation by mathematical substitutions, using the saturation vapor pressure vs. temperature relationships. Finally, these procedures yield the Penman formula for potential evapotranspiration based on four major climatic factors: net radiation, air temperature, wind speed, and vapor pressure deficit. The reader is referred to Penman (1948, 1956, 1963), Tanner and Pelton (1960), Monteith (1964), Tanner and Fuchs (1968), Jensen (1974), Doorenbos and Pruitt (1977) and Burman et al. (1981) for more thorough discussions of the derivation and its application. The potential ET for each day can be expressed as

$$ET_p = \frac{\Delta R_n/\lambda + \gamma E_a}{\Delta + \gamma} \tag{3}$$

where ET_p = daily potential evapotranspiration, mm/day

Δ = slope of saturated vapor pressure curve of air, mb/°C

R_n = net radiation, cal/cm^2 · day

λ = latent heat of vaporization of water, $59.59 - 0.055\ T_{avg}$ cal/cm^2 · mm or about 58 cal/cm^2 · mm at 29°C

$E_a = 0.263\ (e_a - e_d)(0.5 + 0.0062u_2)$