5 Transpiration Results for Poplar Trees at Oneida

5.1 Results of White's Equation

Several aspects of White's Equation need to be examined when applying it to the Oneida site. Because rainfall recharge events create sudden changes in the water table, it is impossible to apply White's Equation when this happens. All applications of White's Equation resulted in a positive s-value (net fall in the water table during a 24-hour period). The value s ranged from 0.027 ft/day to 0.244 ft/day.

All applications of White's Equation in the literature have a positive r due to the recovery of the water table during the night when the trees' stoma are closed as is shown in Figure 3.4. The parameter r is often a negative value at the Oneida site (values range from –0.288 ft/day to 0.004 ft/day), even when the trees are active (See Figure 3.5.). There are several possible reasons for this.

- Low hydraulic conductivity at Oneida does not allow the water table to recover quickly
- High soil moisture content in the vadose zone limit the need to obtain water from the saturated zone
- Higher humidity levels in the eastern United States reduce the amount of transpiration taking place (compared to the west where White's research was done)
- The trees may be too young to have a large affect on the water table
- Data starts in late August which is after the peak transpiration months (June, July, and August)

In addition to leading to a negative r value, the reasons listed above also may explain why the amplitudes of the fluctuations at Oneida are not as large as seen in the literature. Even though negative r values were not reported in the literature, White's Equation should still be valid for this case as seen in Figure 3.5. The parameter still represents a change in slope due to the inactivity of the tree during the nighttime hours. The sum of (24r + s) is still a positive value ($|s|>|24r|$) indicating water consumption by the trees.

Unfortunately, the need for barometric pressure correction of the Solinst pressure transducers in P4 and P6 do not provide data precise enough to allow use of White's Equation. The pressure transducer in MW6 has provided very good data for applying White's Equation, but data collection did not begin until mid-August. This means no data is available for the peak transpiration months of June and July. Table 5.1 summarizes the data obtained from MW6. The series of dates reported are those periods with good recession curves (no rainfall), and the transpiration rates are averaged over those periods. The *readily available specific yield* (50% of S_y), y, was used as suggested by Meyboom (1967). The readily available specific yield is 0.05.

The data in Table 5.1 shows the expected trend. The highest reported transpiration rates occur in the summer at the earliest recording time (in August). These transpiration rates tail off as the average temperature declines and the daylight hours shorten through October when the trees lose their leaves. Negative values for flow, q, in November and December are a result of the error discussed above and indicate the dormancy of the trees.

September was an extremely dry month at the Oneida site. The decline of the water table was evident throughout the month until approximately September 21 when it dropped below the level of the P4, P6, and MW6 pressure transducers set near the bottom of the wells. Even at these low water levels, the data shows relatively high transpiration rates, indicating the trees in this area of the site have a robust root structure to the bottom of the aquifer (approximately 10 feet). This data also indicates transpiration rates do not depend on water table depth (as long as water is available).

Table 5.1 – Rate of water use results using White's Equation based on pressure transducer data from MW6 at the Oneida site

Dates 1999	(24r + s) ft/day	q = y(24r + s) ft/day y (readily avail.) = 0.05
Aug. 21 – Aug. 24	0.0661	0.0033
Aug. 27 – Sept. 9	0.0509	0.0025
Sept. 10 – Sept. 21	0.0309	0.0015
Oct. 12 – Oct. 21	0.0094	0.0005
Nov. 5 – Nov. 19	-0.0110	-0.0006
Dec. 15 – Dec. 20	-0.0442	-0.0022

5.2 Results of Groundwater Recession Method

As seen in Figure 4.3, the water table is generally much lower in the summer months than in the winter months. For this reason, it was difficult to find elevations in the summer and winter months that were the same. Results of the times at which this does occur are shown in Table 5.2. The slope difference is multiplied by the specific yield, S_y, to determine the water use rate within the porous medium. The dates that worked for the summer data were between 8/28/99 and

9/4/99. Results ranged from 0.00250 ft/day at MW6 on 8/30/99 to 0.0031 ft/day at MW6 on 8/28/99. The results compare well with the results obtained using White's Equation. During the period of 8/27/99 to 9/9/99, the average rate of water use at MW6 determined from White's Equation was 0.0025 ft/day. All three wells used in this analysis are relatively close (see Figure 3.1) and the trees around the wells all have approximately the same height. Therefore, water use by the trees in this area should be similar.

Table 5.2: Rate of water use results determined from the difference in slopes of summer and winter groundwater recession curves

Well	Target Water Level (ft)	Date	Slope at Target Level (ft/d)	Comparison Date	Slope at Comparison Date (ft/d)	Difference (absolute value) (ft/d)	Water Used by trees (ft/d) (S_y = 0.10)
P4	1426.2	8/31/99	-0.04679	11/9/99	-0.02015	0.02664	0.00266
P6	1425.2	9/4/99	-0.05259	11/16/99	-0.02006	0.03253	0.00325
MW6	1425.65	8/30/99	-0.09402	11/11/99	-0.06906	0.02496	0.00250
MW6	1425.9	8/28/99	-0.13091	12/8/99	-0.09780	0.03311	0.00331