

Thornthwaite-Type Monthly Water Balance Model

THORNTHWAITE-TYPE MONTHLY WATER-BALANCE MODEL													
Based on a spreadsheet titled, "ThornEx.xls," by S.L. Dingman, Physical Hydrology, 2nd Ed. See Box 7-3. PET computed via Hamon equation [Eqn.(7-63)].													
Cell Color Codes: Input Data Computed Values (Protected) Titles, Labels, and Units (Protected)													
Data Source: www.weather.com													
Year: Average					Soil Field Capacity, θ_{fc} : 0.20				Root Zone Depth, Z_{rz} : 500 mm				
Location of Climate Data: Houghton County Airport, Michigan					Latitude: 47.1 decimal degrees				SOIL _{max} : 100 mm				
Previous December Snowpack, PACK ₀ : 143 mm (water equivalent)					0.82 rad				SOIL ₀ : 100 mm				
Month:	J	F	M	A	M	J	J	A	S	O	N	D	Average
Julian Day, J:	15	45	74.5	105	135.5	166	196.5	227.5	258	288.5	319	349.5	
Day Angle, Γ (radians):	0.241	0.757	1.265	1.790	2.315	2.840	3.365	3.899	4.424	4.949	5.474	5.999	
Declination, δ (radians):	-0.371	-0.232	-0.039	0.165	0.328	0.406	0.377	0.247	0.058	-0.147	-0.319	-0.406	
Day Length, D (hr):	8.7	10.0	11.7	13.4	14.9	15.7	15.4	14.1	12.5	10.8	9.2	8.3	12
WATER BALANCE													
Temperatures in degrees Celcius, Water-balance terms in mm water equivalent.													
Month:	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Monthly Precipitation, P:	85	47	52	49	73	70	73	71	83	66	69	74	811
Mean Monthly Temperature, T:	-9.6	-8.9	-4.2	3.2	10.1	15.3	18.4	17.7	12.9	7.0	-0.3	-6.4	5
Melting Factor, F:	0.00	0.00	0.00	0.53	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	1
Precipitation as Rain, RAIN:	0	0	0	26	73	70	73	71	83	66	0	0	462
Precipitation as Snow, SNOW:	85	47	52	23	0	0	0	0	0	0	69	74	349
Snow Pack, PACK:	228	274	326	163	0	0	0	0	0	0	69	143	100
Snow Melt, MELT:	0	0	0	186	163	0	0	0	0	0	0	0	348
Water Input, RAIN+MELT:	0	0	0	212	236	70	73	71	83	66	0	0	811
Potential Evapotranspiration, PET:	0	0	0	34	60	88	104	91	60	36	0	0	472
Net Water Input, RAIN + MELT - PET	0	0	0	177	176	-18	-30	-20	23	31	0	0	339
Soil Moisture, SOIL:	100	100	100	100	100	84	62	51	74	100	100	100	89
Change in Soil Moisture, Δ SOIL:	0	0	0	0	0	-16	-22	-11	23	26	0	0	0
Actual Evapotranspiration, ET:	0	0	0	34	60	86	95	82	60	36	0	0	453
Recharge & Runoff, RAIN+MELT-ET- Δ SOIL:	0	0	0	177	176	0	0	0	0	4	0	0	357
Month:	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Monthly Precipitation (inches):	3.3284	1.8315	2.0362	1.9133	2.8674	2.7494	2.8919	2.7947	3.2625	2.6084	2.706	2.9324	31.9
Mean Monthly Temperature (F):	14.793	16.044	24.422	37.758	50.115	59.609	65.2	63.887	55.131	44.535	31.511	20.391	40.3
Total Annual PET (inches) =													18.6

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Watershed Calculations	Area:	3.4	sq. miles	
Month	P (inches)	ET (inches)	RO+RCHG (inches)	RO+RCHG (cfs)
J	3.3	0.0	0.0	0
F	1.8	0.0	0.0	0
M	2.0	0.0	0.0	0
A	1.9	1.4	7.0	21
M	2.9	2.4	6.9	21
J	2.7	3.4	0.0	0
J	2.9	3.7	0.0	0
A	2.8	3.2	0.0	0
S	3.3	2.4	0.0	0
O	2.6	1.4	0.2	1
N	2.7	0.0	0.0	0
D	2.9	0.0	0.0	0
Annual Average:	31.9	17.8	14.1	inches/yr
Monthly Average:	2.66	1.49	1.17	inches/mo
Daily Average:	0.09	0.05	0.04	4

