CHAPTER 24

SWAT INPUT DATA: .GW

SWAT partitions groundwater into two aquifer systems: a shallow, unconfined aquifer which contributes return flow to streams within the watershed and a deep, confined aquifer which contributes no return flow to streams inside the watershed. The properties governing water movement into and out of the aquifers are initialized in the groundwater input file.

Following is a brief description of the variables in the groundwater input file. They are listed in the order they appear within the file.

Variable name	Definition
TITLE	The first line of the .gw file is reserved for user comments. The comments may take up to 80 spaces. The title line is not processed by the model and may be left blank. Optional.
SHALLST	Initial depth of water in the shallow aquifer (mm H_2O). We recommend using a 1 year equilibration period for the model where the watershed simulation is set to start 1 year prior to the period of interest. This allows the model to get the water cycling properly before any comparisons between measured and simulated data are made. When an equilibration period is incorporated, the value for SHALLST is not that important.
DEEPST	Initial depth of water in the deep aquifer (mm H_2O). We recommend using a 1 year equilibration period for the model where the watershed simulation is set to start 1 year prior to the period of interest. This allows the model to get the water cycling properly before any comparisons between measured and simulated data are made. When an equilibration period is incorporated, the value for DEEPST is not that important. In watersheds where there is no irrigation with water from the deep aquifer, this variable has no impact at all. If no value for DEEPST is entered, the model sets DEEPST = 1000.0 mm.
GW_DELAY	Groundwater delay time (days). Water that moves past the lowest depth of the soil profile by percolation or bypass flow enters and flows through the vadose zone before becoming shallow aquifer recharge. The lag between the time that water exits the soil profile and enters the shallow aquifer will depend on the depth to the water table and the hydraulic properties of the geologic formations in the vadose and groundwater zones.

Variable name	Definition
GW_DELAY	The delay time, δ_{gw}, cannot be directly measured. It can be estimated by simulating aquifer recharge using different values for δ_{gw} and comparing the simulated variations in water table level with observed values. Johnson (1977) developed a simple program to iteratively test and statistically evaluate different delay times for a watershed. Sangrey et al. (1984) noted that monitoring wells in the same area had similar values for δ_{gw}, so once a delay time value for a geomorphic area is defined, similar delay times can be used in adjoining watersheds within the same geomorphic province. Required.
ALPHA_BF	Baseflow alpha factor (1/days). The baseflow recession constant, α_{gw}, is a direct index of groundwater flow response to changes in recharge (Smedema and Rycroft, 1983). Values vary from 0.1-0.3 for land with slow response to recharge to 0.9-1.0 for land with a rapid response. Although the baseflow recession constant may be calculated, the best estimates are obtained by analyzing measured streamflow during periods of no recharge in the watershed. It is common to find the baseflow days reported for a stream gage or watershed. This is the number of days for base flow recession to decline through one log cycle. When baseflow days are known, the alpha factor can be calculated: $$\alpha_{gw} = \frac{1}{N} \cdot \ln\left[\frac{Q_{gw,N}}{Q_{gw,0}}\right] = \frac{1}{BFD} \cdot \ln[10] = \frac{2.3}{BFD}$$ where α_{gw} is the baseflow recession constant, and *BFD* is the number of baseflow days for the watershed. Required.
GWQMN	Threshold depth of water in the shallow aquifer required for return flow to occur (mm H_2O). Groundwater flow to the reach is allowed only if the depth of water in the shallow aquifer is equal to or greater than GWQMN. Required.

Variable name	Definition
GW_REVAP	Groundwater "revap" coefficient. Water may move from the shallow aquifer into the overlying unsaturated zone. In periods when the material overlying the aquifer is dry, water in the capillary fringe that separates the saturated and unsaturated zones will evaporate and diffuse upward. As water is removed from the capillary fringe by evaporation, it is replaced by water from the underlying aquifer. Water may also be removed from the aquifer by deep-rooted plants which are able to uptake water directly from the aquifer. This process is significant in watersheds where the saturated zone is not very far below the surface or where deep-rooted plants are growing. Because the type of plant cover will affect the importance of revap in the water balance, the parameters governing revap can be varied by land use. As GW_REVAP approaches 0, movement of water from the shallow aquifer to the root zone is restricted. As GW_REVAP approaches 1, the rate of transfer from the shallow aquifer to the root zone approaches the rate of potential evapotranspiration. The value for GW_REVAP should be between 0.02 and 0.20. This variable, along with REVAPMN, is the reason a different groundwater file is created for each HRU rather than each subbasin. Required.
REVAPMN	Threshold depth of water in the shallow aquifer for “revap” or percolation to the deep aquifer to occur (mm H_2O). Movement of water from the shallow aquifer to the unsaturated zone is allowed only if the volume of water in the shallow aquifer is equal to or greater than REVAPMN. This variable, along with GW_REVAP, is the reason a different groundwater file is created for each HRU rather than each subbasin. Required.

Variable name	Definition
RCHRG_DP	Deep aquifer percolation fraction. The fraction of percolation from the root zone which recharges the deep aquifer. The value for RCHRG_DP should be between 0.0 and 1.0. Required.
GWHT	Initial groundwater height (m). Steady-state groundwater flow and the height of the water table are linearly proportional. The equations used to calculate the change in groundwater height with change in flow are included in SWAT. However, the groundwater height is not currently printed out in any of the output files. *This variable is not active*.
GW_SPYLD	Specific yield of the shallow aquifer (m^3/m^3). Specific yield is defined as the ratio of the volume of water that drains by gravity to the total volume of rock. Specific yield is required to calculate groundwater height fluctuations. *This variable is not active*
SHALLST_N	Initial concentration of nitrate in shallow aquifer. (mg N/L or ppm). Nitrate levels in the shallow aquifer are modeled, allowing for variation in nitrate concentration and groundwater loadings of nitrate contributed to streamflow in the subbasin. Optional.
GWSOLP	Concentration of soluble phosphorus in groundwater contribution to streamflow from subbasin (mg P/L or ppm). This is a fixed concentration used throughout the entire period of simulation. Optional.

Variable name	Definition
HLIFE_NGW	Half-life of nitrate in the shallow aquifer (days). Nitrate in the shallow aquifer may be removed by uptake by bacteria present in the aquifer or by chemical conversion to other compounds in regions of the aquifer that are depleted in oxygen (reduced environment). The half-life, as for half-life values reported for pesticides, is the time period required for the concentration of nitrate to drop to one-half its original value. The reduction is a net reduction by all processes occurring in the shallow aquifer. Optional.
LAT_ORGN	Organic N in the base flow (mg/L) (range 0.0 – 200.0) default = 0.0 Optional.
LAT_ORGP	Organic P in the base flow (mg/L) (range 0.0 – 200.0) default = 0.0 Optional.
ALPHA_BF_D	Alpha factor for groundwater recession curve of the deep aquifer (1/days)

The groundwater file is a free format file. The variables may be placed in any position the user wishes on the line. Values for variables classified as integers *should not* include a decimal while values for variables classified as reals *must* contain a decimal. A blank space denotes the end of an input value and the beginning of the next value if there is another on the line.

Variable name	Line #	Format	F90 Format
TITLE	1	character	a80
SHALLST	2	real	free
DEEPST	3	real	free
GW_DELAY	4	real	free
ALPHA_BF	5	real	free
GWQMN	6	real	free
GW_REVAP	7	real	free
REVAPMN	8	real	free
RCHRG_DP	9	real	free
GWHT	10	real	free
GW_SPYLD	11	real	free
SHALLST_N	12	real	free
GWSOLP	13	real	free
HLIFE_NGW	14	real	free
LAT_ORGN	15	real	free
LAT_ORGP	16	real	free

REFERENCES

Johnson, K.H. 1977. A predictive method for ground water levels. Master's Thesis, Cornell University, Ithica, N.Y.

Sangrey, D.A., K.O. Harrop-Williams, and J.A. Klaiber. 1984. Predicting ground-water response to precipitation. ASCE J. Geotech. Eng. 110(7): 957-975.

Smedema, L.K. and D.W. Rycroft. 1983. Land drainage—planning and design of agricultural drainage systems, Cornell University Press, Ithica, N.Y.