CHAPTER 29

SWAT INPUT DATA: .RES

Reservoirs are impoundments located on the main channel network of the watershed. Reservoirs receive loadings from all upstream subbasins. The reservoir input file (.res) contains input data to simulate water and sediment processes while the lake water quality file (.lwq) contains input data to simulate nutrient and pesticide cycling in the water body.

29.1 RESERVOIR FILE

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

Variable name	Definition
TITLE	The first line of the 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.
RES_SUB	Number of the subbasin with which the reservoir is associated. Weather for the specified subbasin is used for the reservoir. If no subbasin number is assigned to RES_SUB, the model uses weather data from subbasin 1 to model climatic processes on the reservoir. Required.
MORES	Month the reservoir became operational (0-12). If 0 is input for MORES and IYRES, the model assumes the reservoir is in operation at the beginning of the simulation. Required.
IYRES	Year the reservoir became operational (eg 1980). If 0 is input for MORES and IYRES, the model assumes the reservoir is in operation at the beginning of the simulation. Required.
RES_ESA	Reservoir surface area when the reservoir is filled to the emergency spillway (ha). For SWAT to calculate the reservoir surface area each day the surface area at two different water volumes must to be defined. Variables referring to the principal spillway can be thought of as variables referring to the normal reservoir storage volume while variables referring to the emergency spillway can be thought of as variables referring to maximum reservoir storage volume. Required.

Variable name	Definition
RES_EVOL	Volume of water needed to fill the reservoir to the emergency spillway (10^4 m^3). See comment for RES_ESA. Required.
RES_PSA	Reservoir surface area when the reservoir is filled to the principal spillway (ha). See comment for RES_ESA. Required.
RES_PVOL	Volume of water needed to fill the reservoir to the principal spillway (10^4 m^3). See comment for RES_ESA. Required.
RES_VOL	Initial reservoir volume. If the reservoir is in existence at the beginning of the simulation period, the initial reservoir volume is the volume on the first day of simulation. If the reservoir begins operation in the midst of a SWAT simulation, the initial reservoir volume is the volume of the reservoir the day the reservoir becomes operational (10^4 m^3). Required.
RES_SED	Initial sediment concentration in the reservoir (mg/L). If the reservoir is in existence at the beginning of the simulation period, the initial sediment concentration is the concentration on the first day of simulation. If the reservoir begins operation in the midst of a SWAT simulation, the initial sediment concentration is the concentration the day the reservoir becomes operational (mg/L). Required.

Variable name	Definition
RES_NSED	Equilibrium sediment concentration in the reservoir (mg/L). The amount of suspended solid settling that occurs in the water body on a given day is calculated as a function of concentration. Settling occurs only when the sediment concentration in the water body exceeds the equilibrium sediment concentration specified by the user. Required.

Variable name	Definition
RES_D50	Median particle diameter of sediment (μm).

Sediment Class	Size (μm)	Approx. Size
Boulders	> 256,000	> Volley ball
Cobbles	> 64,000	> Tennis ball
Pebbles	> 2,000	> Match Head
Sand		
V. Course	1,500	
Medim	375	
V. Fine	94	
Silt		
V. Coarse	47	
Medium	11.7	No longer visible to the human eye
V. Fine	4.9	
Clay	1.95	

SWAT calculates the median sediment particle diameter for impoundments located within a subbasin using the equation:

$$d_{50} = \exp\left(0.41 \cdot \frac{m_c}{100} + 2.71 \cdot \frac{m_{silt}}{100} + 5.7 \cdot \frac{m_s}{100}\right)$$

where d_{50} is the median particle size of the sediment (μm), m_c is percent clay in the surface soil layer, m_{silt} is the percent silt in the surface soil layer, m_s is the percent sand in the surface soil layer.

Because reservoirs are located on the main channel network and receive sediment from the entire area upstream, defaulting the sand, silt, and clay fractions to those of a single subbasin or HRU in the upstream area is not appropriate. Instead the user is allowed to set the median particle size diameter to a representative value.

If no value is defined for the median particle diameter, the model will set RES_D50 = 10 μm.

Required.

Variable name	Definition
RES_K	Hydraulic conductivity of the reservoir bottom (mm/hr). If seepage occurs in the water body, the hydraulic conductivity must be set to a value other than 0. Required.
IRESCO	Outflow simulation code: 0 compute outflow for uncontrolled reservoir with average annual release rate (if IRESCO=0, need RES_RR) 1 measured monthly outflow (if IRESCO=1, need RESOUT) 2 simulated controlled outflow—target release (if IRESCO=2, need STARG, IFLOD1R, IFLOD2D, and NDTARGR 3 measured daily outflow (if IRESCO=3, need RESDAYO) Required.
OFLOWMX(mon)	Maximum daily outflow for the month (m^3/s). This variable allows the user to set the upper limit on the reservoir discharge rate. Set all months to zero if you do not want to trigger this requirement. Optional.
OFLOWMN(mon)	Minimum daily outflow for the month (m^3/s). This variable allows the user to set the lower limit on the reservoir discharge rate. Set all months to zero if you do not want to trigger this requirement. Optional.
RES_RR	Average daily principal spillway release rate (m^3/s). The name for this variable is slightly misleading. SWAT uses this variable when the volume of water in the reservoir is between the principal and emergency spillway volumes. If the amount of water exceeding the principal spillway volume can be released at a rate ≤ RES_RR, than all of the water volume in excess of the principal spillway volume is released. Otherwise the release rate, RES_RR is used.

Variable name	Definition
RES_RR, cont.	When the water volume exceeds the emergency spillway volume, all water in excess of the emergency spillway volume is released plus the volume of water corresponding to the release rate from the principal spillway defined by RES_RR. Required if IRESCO = 0.
RESMONO	Name of monthly reservoir outflow file. Required if IRESCO = 1.
IFLOD1R	Beginning month of non-flood season. The target release approach tries to mimic general release rules that may be used by reservoir operators. Although the method is simplistic and cannot account for all decision criteria, it can realistically simulate major outflow and low flow periods. For the target release approach, the principal spillway volume corresponds to maximum flood control reservation while the emergency spillway volume corresponds to no flood control reservation. The model requires the beginning and ending month of the flood season. In the non-flood season, no flood control reservation is required, and the target storage is set at the emergency spillway volume. During the flood season, the flood control reservation is a function of soil water content. The flood control reservation for wet ground conditions is set at the maximum. For dry ground conditions, the flood control reservation is set at 50% of the maximum. The target storage may be specified by the user on a monthly basis or it can be calculated as a function of flood season and soil water content. If the target storage is specified: $V_{targ} = starg$ where V_{targ} is the target reservoir volume for a given day (m^3 H_2O), and *starg* is the target reservoir volume specified for a given month (m^3 H_2O). If the target storage is not specified, the target reservoir volume is calculated:

Variable name	Definition
IFLOD1R, cont.	$V_{targ} = V_{em}$ if $mon_{fld,beg} < mon < mon_{fld,end}$ $V_{targ} = V_{pr} + \frac{\left(1 - \min\left[\frac{SW}{FC}, \quad 1\right]\right)}{2} \cdot \left(V_{em} - V_{pr}\right)$ if $mon \le mon_{fld,beg}$ or $mon \ge mon_{fld,end}$ where V_{targ} is the target reservoir volume for a given day (m^3 H_2O), V_{em} is the volume of water held in the reservoir when filled to the emergency spillway (m^3 H_2O), V_{pr} is the volume of water held in the reservoir when filled to the principal spillway (m^3 H_2O), *SW* is the average soil water content in the subbasin (mm H_2O), *FC* is the water content of the subbasin soil at field capacity (mm H_2O), *mon* is the month of the year, $mon_{fld,beg}$ is the beginning month of the flood season, and $mon_{fld,end}$ is the ending month of the flood season. Required if IRESCO = 2.
IFLOD2R	Ending month of non-flood season. See explanation for IFLOD1R. Required if IRESCO = 2.
NDTARGR	Number of days to reach target storage from current reservoir storage. The reservoir outflow is calculated: $V_{flowout} = \frac{V - V_{targ}}{ND_{targ}}$ where $V_{flowout}$ is the volume of water flowing out of the water body during the day (m^3 H_2O), *V* is the volume of water stored in the reservoir (m^3 H_2O), V_{targ} is the target reservoir volume for a given day (m^3 H_2O), and ND_{targ} is the number of days required for the reservoir to reach target storage. See explanation for IFLOD1R for more information. Required if IRESCO = 2.

Variable name	Definition
STARG(mon)	Monthly target reservoir storage (10^4 m^3). This parameter allows the user to define the target storage for each month. See explanation for IFLOD1R for more information. Required if IRESCO = 2.
RESDAYO	Name of daily reservoir outflow file. Required if IRESCO = 3.
WURESN(mon)	Average amount of water withdrawn from reservoir each day in the month for consumptive use (10^4 m^3). This variable allows water to be removed from the reservoir for use outside the watershed. Optional.
WURTNF	Fraction of water removed from the reservoir via WURESN that is returned and becomes flow out of reservoir (m^3/m^3). Optional.
EVRSV	Lake evaporation coefficient. Default = 0.6
OFLOWMN_FPS	Minimum reservoir outflow as a fraction of the principal spillway volume (0-1).
STARG_FPS	Target volume as a fraction of the principal spillway volume. This input is needed if ISRECO = 2. Default = 1.0

The reservoir 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. The format of the reservoir input file is:

Variable name	Line #	Format	F90 Format
TITLE	1	character	a80
RES_SUB	2	integer	free
MORES	3	integer	free
IYRES	4	integer	free
RES_ESA	5	real	free
RES_EVOL	6	real	free
RES_PSA	7	real	free
RES_PVOL	8	real	free
RES_VOL	9	real	free
RES_SED	10	real	free
RES_NSED	11	real	free
RES_D50	12	real	free
RES_K	13	real	free
IRESCO	14	integer	free
COMMENT LINE	15	character	a80
OFLOWMX(1)	16	real	free
OFLOWMX(2)	16	real	free
OFLOWMX(3)	16	real	free
OFLOWMX(4)	16	real	free
OFLOWMX(5)	16	real	free
OFLOWMX(6)	16	real	free
COMMENT LINE	17	character	a80
OFLOWMX(7)	18	real	free
OFLOWMX(8)	18	real	free
OFLOWMX(9)	18	real	free
OFLOWMX(10)	18	real	free
OFLOWMX(11)	18	real	free
OFLOWMX(12)	18	real	free
COMMENT LINE	19	character	a80
OFLOWMN(1)	20	real	free
OFLOWMN(2)	20	real	free

Variable name	Line #	Format	F90 Format
OFLOWMN(3)	20	real	free
OFLOWMN(4)	20	real	free
OFLOWMN(5)	20	real	free
OFLOWMN(6)	20	real	free
COMMENT LINE	21	character	a80
OFLOWMN(7)	22	real	free
OFLOWMN(8)	22	real	free
OFLOWMN(9)	22	real	free
OFLOWMN(10)	22	real	free
OFLOWMN(11)	22	real	free
OFLOWMN(12)	22	real	free
RES_RR	23	real	free
RESMONO	24	character (len=13)	a13
IFLOD1R	25	integer	free
IFLOD2R	26	integer	free
NDTARGR	27	integer	free
COMMENT LINE	28	character	a80
STARG(1)	29	real	free
STARG(2)	29	real	free
STARG(3)	29	real	free
STARG(4)	29	real	free
STARG(5)	29	real	Free
STARG(6)	29	real	Free
COMMENT LINE	30	character	a80
STARG(7)	31	real	Free
STARG(8)	31	real	Free
STARG(9)	31	real	Free
STARG(10)	31	real	Free
STARG(11)	31	real	Free
STARG(12)	31	real	Free
RESDAYO	32	character (len=13)	a13
COMMENT LINE	33	character	a80
WURESN(1)	34	real	Free
WURESN(2)	34	real	Free
WURESN(3)	34	real	Free

Variable name	Line #	Format	F90 Format
WURESN(4)	34	real	Free
WURESN(5)	34	real	Free
WURESN(6)	34	real	Free
COMMENT LINE	35	character	a80
WURESN(7)	36	real	Free
WURESN(8)	36	real	Free
WURESN(9)	36	real	Free
WURESN(10)	36	real	Free
WURESN(11)	36	real	Free
WURESN(12)	36	real	Free
WURTNF	37	real	Free
EVRSV	38	real	Free
OFLOWMN_FPS	39	real	Free
STARG_FPS	40	real	Free

29.2 DAILY RESERVOIR OUTFLOW FILE

When measured daily outflow is used for a reservoir, the name of the file containing the data is assigned to the variable RESDAYO. The daily outflow file contains the flow rate for every day of operation of the reservoir, beginning with the first day of operation in the simulation. The daily outflow file contains one variable:

Variable name	Definition
TITLE	The first line of the file is reserved for a description. The description may take up to 80 spaces. The title line is not processed by the model and may be left blank.
RES_OUTFLOW	The water release rate for the day (m^3/sec).

The format of the daily reservoir outflow file is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	space 1-80	character	a80
RES_OUTFLOW	2-END	space 1-8	decimal(xxxxx.xx)	f8.2

29.3 MONTHLY RESERVOIR OUTFLOW FILE

When outflow data summarized on a monthly basis is used for a reservoir, the name of the file containing the data is assigned to the variable RESMONO. The monthly outflow file contains the average daily flow rate for every month of operation of the reservoir, beginning with the first month of operation in the simulation. The monthly outflow file contains the following variables:

Variable name	Definition
TITLE	The first line of the file is reserved for a description. The description may take up to 80 spaces. The title line is not processed by the model and may be left blank.
RES_OUT(mon,yr)	Measured average daily outflow from the reservoir for the month (m^3/s). Needed when IRESCO = 1. There must be a line of input for every year of simulation.

Variable name	Line #	Format	F90 Format
TITLE	1	character	a80
If IRESCO = 1, the model will read the input data for RESOUT. There should be one line for data for RESOUT for each year of simulation beginning with the 1st year of simulation.			
RES_OUT(1,yr)	2-END	real	free
RES_OUT(2,yr)	2-END	real	free
RES_OUT(3,yr)	2-END	real	free
RES_OUT(4,yr)	2-END	real	free
RES_OUT(5,yr)	2-END	real	free
RES_OUT(6,yr)	2-END	real	free
RES_OUT(7,yr)	2-END	real	free
RES_OUT(8,yr)	2-END	real	free
RES_OUT(9,yr)	2-END	real	free
RES_OUT(10,yr)	2-END	real	free
RES_OUT(11,yr)	2-END	real	free
RES_OUT(12,yr)	2-END	real	free