PART 2

MODEL OPERATION

CHAPTER 31

SWAT INPUT DATA: WATERSHED CONFIGURATION

The first step in setting up a watershed simulation is to define the relative arrangement of the parts or elements, i.e. the configuration, of the watershed. If the watershed has only one primary channel and there is very little variation in topography and climate across the watershed, there may not be a need to partition the watershed into smaller units. However, the majority of watersheds will exhibit enough complexity in the stream network, topography or climate to warrant subdivision for modeling purposes.

There are several techniques used to discretize a watershed. In the past, models could only apply one type of discretization scheme to a watershed. This resulted in the development of several models that differ only in the watershed discretization scheme used.

31.1 DISCRETIZATION SCHEMES

The three most common techniques used to discretize a watershed are:

- Grid cell. This configuration allows the user to incorporate significant spatial detail into a simulation. Models which use this technique include AGNPS (Young et al., 1987), ANSWERS (Beasley et al., 1980) and the WEPP grid version (Foster, 1987).
- Representative hillslope. This configuration is useful for modeling hillslope processes. This technique is used in APEX (Williams, et al., 1998) and the WEPP hillslope version (Lane and Nearing, 1989).
- Subwatershed. This configuration preserves the natural channels and flow paths of the watershed. This technique is used in the WEPP watershed version (Foster, 1987), HYMO (Williams and Hann, 1973) and SWRRB (Arnold et al., 1990).

All of these schemes have strengths and weaknesses and applications for which they are most appropriate. SWAT uses the subwatershed configuration as the primary discretization scheme for a watershed. However, because of the routing command language utilized in SWAT, it is possible to use any of these three, alone or in combination, to model a watershed.

31.2 WATERSHED CONFIGURATION FILE (.FIG)

The watershed configuration file contains information used by SWAT to simulate processes occurring within the HRU/subbasin and to route the stream loadings through the channel network of the watershed. A reach routing command structure, similar to that developed for HYMO (Williams and Hann, 1973), is utilized to route and add flows through the watershed. The following sections review the different features of the watershed configuration file.

31.2.1 INCORPORATION OF COMMENTS

To assist the user in interpreting the watershed configuration file, an unlimited number of comment lines are allowed. These comments can be used to isolate the routing commands for different reaches, etc. To included comments in the watershed configuration file, a line must have an asterisk (*) in the 1st space on the line. When SWAT reads the asterisk, it will skip to the next line.

31.2.2 COMMAND LINES

Thirteen different commands may be used in the watershed configuration file. The commands, along with their numeric codes, are:

finish	0
subbasin	1
route	2
routres	3
transfer	4
add	5
recmon	7
recyear	8
save	9
recday	10
reccnst	11
structur	12
saveconc	14

The most commonly used commands are: subbasin, route, add, and finish. In brief, these commands simulated the land phase of the hydrologic cycle and determine the loadings to the reach (subbasin), model the movement and transformations occurring in the reach (route), allow the output from different subbasins to be summed together (add), and identify the end of the routing command sequence (finish).

The remaining commands are utilized to model more unique configurations. This set of commands can be divided several subgroups: routing of water through a reservoir (routres), humanly contrived movement of water (transfer), aeration of water resulting from flow through structures along the channel (structur), incorporation of point source data (recday, recmon, recyear, reccnst), formatting of watershed outflow for input into a different SWAT simulation (save), and formatting of water quality simulation results at specified points in the reach network (saveconc).

31.2.2.1 SUBBASIN COMMAND (1)

The subbasin command simulates all processes involved in the land phase of the hydrologic cycle and computes runoff, sediment, and chemical loadings from each HRU within the subbasin. Variables required on the subbasin command line are:

Variable name	Definition
COMMAND	The command code = 1 for the subbasin command.
HYD_STOR	The hydrograph storage location number. After a command is executed, the results are stored in an array at the position defined by this number. It is crucial that all hydrograph storage location numbers are unique. If the same number is used twice, output from one command line will be overwritten by that from another and simulation results will be incorrect.
SUB_NUM	Subbasin number. This number is assigned in file.cio. Every subbasin in the watershed has a different number.
GIS_CODE	GIS code printed to output files (optional)

The format of the subbasin command line is:

Variable name	Position	Format	F90 Format
COMMAND	space 11-16	6-digit integer	i6
HYD_STOR	space 17-22	6-digit integer	i6
SUB_NUM	space 23-28	6-digit integer	i6
GIS_CODE	space 47-55	9-digit integer	i9

31.2.2.2 ROUTE COMMAND (2)

The route command routes the water, sediment, and chemical loadings through a main channel or reach. Variables required on the route command line are:

Variable name	Definition
COMMAND	The command code = 2 for the route command.
HYD_STOR	The hydrograph storage location number. After a command is executed, the results are stored in an array at the position defined by this number. It is crucial that all hydrograph storage location numbers are unique. If the same number is used twice, output from one command line will be overwritten by that from another and simulation results will be incorrect.
RCH_NUM	Reach number. The reach number is the same as the subbasin number.
HYD_NUM	Inflow hydrograph storage location number. The data that is to be routed through the reach.

Variable name	Definition
FLOW_OVN	Fraction of overland flow (0.000 to 1.000). If flow leaving a subbasin is completely channelized, FLOW_OVN = 0.000. In cases where a hillslope is being simulated, overland flow from one subbasin to another occurs and the value of FLOW_OVN can be increased to account for the amount of non-channelized overland flow taking place between the subbasins. The overland flow to the next subbasin is added to the rainfall of the receiving subbasin and allowed to infiltrate or run off. The sediment and chemical loadings associated with the overland flow are assumed to be deposited on the upper soil layer of the receiving subbasin. The fraction of the flow in the channel is routed directly to the reach of the receiving subbasin.

The format of the route command line is:

Variable name	Position	Format	F90 Format
COMMAND	space 11-16	6-digit integer	i6
HYD_STOR	space 17-22	6-digit integer	i6
RCH_NUM	space 23-28	6-digit integer	i6
HYD_NUM	space 29-34	6-digit integer	i6
FLOW_OVN	space 41-46	decimal (xx.xxx)	f6.3

31.2.2.3 ADD COMMAND (5)

The add command is used to sum the water, sediment, and chemical loadings of any two flows. Variables required on the add command line are:

Variable name	Definition
COMMAND	The command code = 5 for the add command.
HYD_STOR	The hydrograph storage location number for the results.
HYD_NUM1	The hydrograph storage location number of the 1st set of data to be added.
HYD_NUM2	The hydrograph storage location number of the 2nd set of data to be added.

The format of the add command line is:

Variable name	Position	Format	F90 Format
COMMAND	space 11-16	6-digit integer	i6
HYD_STOR	space 17-22	6-digit integer	i6
HYD_NUM1	space 23-28	6-digit integer	i6
HYD_NUM2	space 29-34	6-digit integer	i6

31.2.2.4 FINISH COMMAND (0)

The last command line in the .fig file must be a finish command line. The finish command notifies the model that the end of the command lines in the watershed configuration file has been reached. Variables required on the finish command line are:

Variable name	Definition
COMMAND	The command code = 0 for the finish command

The format of the finish command line is:

Variable name	Position	Format	F90 Format
COMMAND	space 11-16	6-digit integer	i6

31.2.2.5 ROUTRES COMMAND (3)

The routres command routes water, sediment, and chemical loadings through a reservoir. The routres command requires two lines. Variables required on the routres command lines are:

Variable name	Definition
COMMAND	The command code = 3 for the routres command.
HYD_STOR	The hydrograph storage location number for results.
RES_NUM	Reservoir number. Each reservoir modeled in the watershed must be assigned a unique consecutive number beginning at 1.

Variable name	Definition
HYD_NUM	Inflow hydrograph storage location number. The data that is to be routed through the reservoir.
RESFILE	Name of reservoir input file (.res)
LWQFILE	Name of reservoir water quality input file (optional) (.lwq)

The format of the routres command lines is:

Variable name	Line #	Position	Format	F90 Format
COMMAND	1	space 11-16	6-digit integer	i6
HYD_STOR	1	space 17-22	6-digit integer	i6
RES_NUM	1	space 23-28	6-digit integer	i6
HYD_NUM	1	space 29-34	6-digit integer	i6
RESFILE	2	space 11-23	character	a13
LWQFILE	2	space 24-36	character	a13

31.2.2.6 TRANSFER COMMAND (4)

Originally, the transfer command was the only method available to irrigate an HRU. While the irrigation scenarios are now handled primarily in the management files, the transfer command was retained for flexibility.

The transfer command moves water from any reach or reservoir to any other reach or reservoir. Variables required on the transfer command line are:

Variable name	Definition
COMMAND	The command code = 4 for the transfer command.
DEP_TYPE	Water source type: 1 reach 2 reservoir

Variable name	Definition
DEP_NUM	Water source number. The number of the reach or reservoir from which the flow will be diverted.
DEST_TYPE	Destination type. Defines the receiving body. 1 reach 2 reservoir
DEST_NUM	Destination number. Number of reach or reservoir receiving the water.
TRANS_AMT	The flow amount transferred. (defined by TRANS_CODE)
TRANS_CODE	The rule code governing the transfer of water: 1 A fraction of the flow or volume to be transferred out of the reach or reservoir is specified 2 A minimum flow (reach) or volume (reservoir) to leave in the reach or reservoir is specified (m^3/day) 3 An exact amount of water to be transferred is specified (m^3/day)

The format of the transfer command line is:

Variable name	Position	Format	F90 Format
COMMAND	space 11-16	6-digit integer	i6
DEP_TYPE	space 17-22	6-digit integer	i6
DEP_NUM	space 23-28	6-digit integer	i6
DEST_TYPE	space 29-34	6-digit integer	i6
DEST_NUM	space 35-40	6-digit integer	i6
TRANS_AMT	space 41-46	decimal (xx.xxx)	f6.3
TRANS_CODE	space 47-55	9-digit integer	i9

31.2.2.7 STRUCTURE COMMAND (12)

The structure command simulates aeration caused by the tumbling of water as it moves over weirs or other structures along the stream network. In highly polluted streams, the aeration of the stream by this method is a significant source of oxygen. The structure command alters the dissolved oxygen content based on the aeration coefficient input by the user. Variables required on the structure command line are:

Variable name	Definition
COMMAND	The command code = 12 for the structur command.
HYD_STOR	The hydrograph storage location number for data.
HYD_NUM	Inflow hydrograph storage location number. The data that is to be adjusted to reflect aeration. (Dissolved oxygen content is the only value that is altered with this command.)
AERATION_COEF	Aeration coefficient.

The format of the structure command is:

Variable name	Position	Format	F90 Format
COMMAND	space 11-16	6-digit integer	i6
HYD_STOR	space 17-22	6-digit integer	i6
HYD_NUM	space 23-28	6-digit integer	i6
AERATION_COEF	space 41-46	decimal (xx.xxx)	f6.3

31.2.2.8 RECMON COMMAND (7)

The recmon command is one of four routing commands that reads in flow, sediment and chemical loading records from a file and routes the input through the watershed. The recmon command is used to read in data summarized by month. The recmon command requires two lines. Variables required on the recmon command lines are:

Variable name	Definition
COMMAND	The command code = 7 for the recmon command.
HYD_STOR	The hydrograph storage location number for data.
FILEMON_NUM	The file number. Unique file numbers should be used for each recmon command.
DRAINAGE_AREA	Drainage area associated with records (km^2) (optional)
FILE_MON	Name of the file containing the monthly records

The format of the recmon command lines is:

Variable name	Line #	Position	Format	F90 Format
COMMAND	1	space 11-16	6-digit integer	i6
HYD_STOR	1	space 17-22	6-digit integer	i6
FILEMON_NUM	1	space 23-28	6-digit integer	i6
DRAINAGE_AREA	1	space 41-46	decimal (xx.xxx)	f6.3
FILE_MON	2	space 11-23	character	a13

31.2.2.9 RECYEAR COMMAND (8)

The recyear command is one of four routing commands that reads in flow, sediment and chemical loading records from a file and routes the input through the watershed. The recyear command is used to read in annual output. The recyear command requires two lines. Variables required on the recyear command lines are:

Variable name	Definition
COMMAND	The command code = 8 for the recyear command.
HYD_STOR	The hydrograph storage location number for data.
FILEYR_NUM	The file number. Unique file numbers should be used for each recyear command.
DRAINAGE_AREA	Drainage area associated with records (km^2) (optional)
FILE_YR	Name of file containing annual output.

The format of the recyear command lines is:

Variable name	Line #	Position	Format	F90 Format
COMMAND	1	space 11-16	6-digit integer	i6
HYD_STOR	1	space 17-22	6-digit integer	i6
FILEYR_NUM	1	space 23-28	6-digit integer	i6
DRAINAGE_AREA	1	space 41-46	decimal(xx.xxx)	f6.3
FILE_YR	2	space 11-23	character	a13

31.2.2.10 RECDAY COMMAND (10)

The recday command is one of four routing commands that reads in flow, sediment and chemical loading records from a file and routes the input through the watershed. This command is useful for reading in point source data or data from simulations of upstream areas. The recday command is used to read in data summarized on a daily basis. The recday command requires two lines. Variables required on the recday command lines are:

Variable name	Definition
COMMAND	The command code = 10 for the recday command.
HYD_STOR	The hydrograph storage location number for data.
FILEDAY_NUM	The file number. Unique file numbers should be used for each recday command.
DRAINAGE_AREA	Drainage area associated with records (km^2) (optional)
FILE_DAY	Name of file containing daily records.

The format of the recday command lines is:

Variable name	Line #	Position	Format	F90 Format
COMMAND	1	space 11-16	6-digit integer	i6
HYD_STOR	1	space 17-22	6-digit integer	i6
FILEDAY_NUM	1	space 23-28	6-digit integer	i6
DRAINAGE_AREA	1	space 41-46	decimal (xx.xxx)	f6.3
FILE_DAY	2	space 11-23	character	a13

31.2.2.11 RECCNST COMMAND (11)

The reccnst command is one of four routing commands that reads in flow, sediment and chemical loading records from a file and routes the input through the watershed. This command is useful for reading in point source data. The reccnst command is used to read in average annual data. The reccnst command requires two lines. Variables required on the reccnst command lines are:

Variable name	Definition
COMMAND	The command code = 11 for the reccnst command.
HYD_STOR	The hydrograph storage location number for data.
FILECNST_NUM	The file number. Unique file numbers should be used for each reccnst command.
DRAINAGE_AREA	Drainage area associated with records (km^2) (optional)
FILE_CNST	Name of file containing average annual records.

The format of the reccnst command lines is:

Variable name	Line #	Position	Format	F90 Format
COMMAND	1	space 11-16	6-digit integer	i6
HYD_STOR	1	space 17-22	6-digit integer	i6
FILECNST_NUM	1	space 23-28	6-digit integer	i6
DRAINAGE_AREA	1	space 41-46	decimal(xx.xxx)	f6.3
FILE_CNST	2	space 11-23	character	a13

31.2.2.12 SAVE COMMAND (9)

The save command allows the user to print daily SWAT output to the event output file specified in file.cio. This output file can then be read into another SWAT run using the recday command. Variables required on the save command line are:

Variable name	Definition
COMMAND	The command code = 9 for save command.
HYD_NUM	The hydrograph storage location number of the data to be printed to file.

The format of the save command line is:

Variable name	Position	Format	F90 Format
COMMAND	space 11-16	6-digit integer	i6
HYD_NUM	space 17-22	6-digit integer	i6

31.2.2.13 SAVECONC COMMAND (14)

The saveconc command saves flow, sediment and water quality indicator information from a specified point on the reach network to a file. The water quality information is reported as concentrations. This command is useful for isolating reach information at a particular point on the channel network. Up to 50 saveconc commands can be specified in the watershed configuration file.

The saveconc command requires two lines. Variables required on the saveconc command lines are:

Variable name	Definition
COMMAND	The command code = 14 for the saveconc command.
HYD_NUM	The hydrograph storage location number of the data to be printed to file.
FILECONC_NUM	The file number. Unique file numbers should be used for each saveconc command.
PRINT_FREQ	Printing frequency. For simulations using a sub-daily time step, water quality information may be summarized and printed for every hour or every day. Simulations using a daily time step will always print daily average values. 0 report daily averages 1 report hourly averages *(currently not operational)* If no printing frequency is specified, the model will print daily averages.
FILE_CONC	Name of file to which the water quality information is written.

The format of the saveconc command lines is:

Variable name	Line #	Position	Format	F90 Format
COMMAND	1	space 11-16	6-digit integer	i6
HYD_NUM	1	space 17-22	6-digit integer	i6
FILECONC_NUM	1	space 23-28	6-digit integer	i6
PRINT_FREQ	1	space 29-34	6-digit integer	i6
FILE_CONC	2	space 11-23	character	a13

31.3 REFERENCES

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CHAPTER 32

SWAT INPUT DATA: SIMULATION MANAGEMENT

Two different files contain information used by SWAT to govern the processing of input data and the formatting and type of output data produced by the simulation. These files also include parameters that identify any specialized processes to be simulated. They are the control input/output file (file.cio) and the input control code file (.cod).

32.1 CONTROL INPUT/OUTPUT FILE (FILE.CIO)

File management is performed with the control input/output file (file.cio). The control input/output file contains the name of files associated with the subbasins, database files, climate files and watershed-level input files accessed by SWAT during a simulation as well as the name of the files in which output will be stored. While the user may adopt any file naming scheme, we recommend that the file extensions listed in the manual are used to facilitate identification of the different file types.

Files required by the model that are not listed in the control input/output file include HRU files listed in the subbasin general input (.sub) file, reservoir and point source input files listed in the watershed configuration (.fig) file and "unique" files which contain input for uncommon or specialized processes not typically simulated.

The control input/output file can be divided into a number of different sections. Figure 32.1 illustrates the different groupings of files within file.cio.

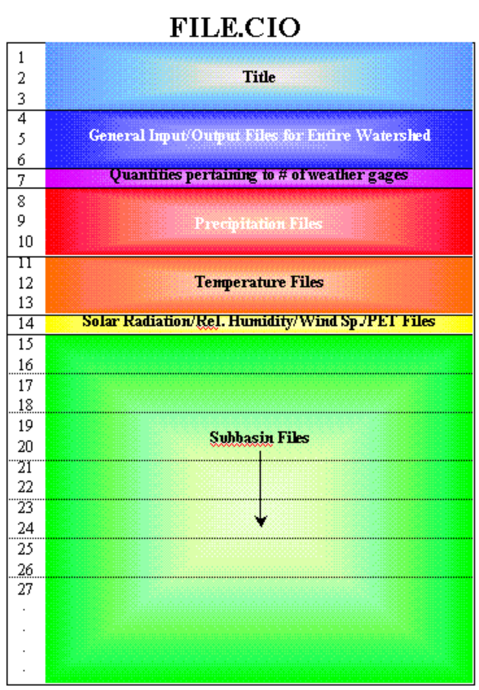

Figure 32.1: General organization of control input/output files

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

32.1.1 TITLE SECTION (FILE.CIO)

Variable name	Definition
TITLE	The first three lines of 'file.cio' are reserved for a description of the simulation run. The description may take up to 80 spaces per line. The title given in file.cio is printed to every output file. (optional)

32.1.2 GENERAL INPUT/OUTPUT SECTION (FILE.CIO)

Variable name	Definition
BIGSUB	Name of subbasin output file (**.bsb**). Loadings to the reach (water, sediment and nutrients) are summarized for each subbasin.
SBSOUT	Name of hydrologic response unit (HRU) output file (**.sbs**). Loadings to the reach (water, sediment and nutrients) and crop growth are summarized for each HRU.
RCHOUT	Name of main channel, or reach, output file (**.rch**). Summarizes the amount of water, sediment and pollutants entering and leaving the reach and provides data on in-steam processes (e.g. sediment deposition, evaporation occurring in the channel)
RSVOUT	Name of reservoir output file (**.rsv**). Summarizes the amount of water, sediment and pollutants entering and leaving the reservoir and quantifies processes occurring in the reservoir (e.g. sediment deposition).
WTROUT	Name of HRU impoundment output file (**.wtr**). Summarizes the amount of water, sediment and pollutants entering and leaving ponds, wetlands and depressional areas (potholes) and quantifies processes occurring in the different impoundments.

Variable name	Definition
PESTOUT	Name of pesticide output file (**.pso**). The movement and transformation of the different pesticides used in the simulation are summarized for each HRU.
EVENT	Name of event output file (**.eve**). When very large basins are being simulated, it is often easier to split them into several SWAT runs. This file writes daily output which can be read into a different SWAT run.
ROUTIN	Name of watershed configuration file (**.fig**). Contains the commands to add and route flows through the watershed.
CODEDAT	Name of input control code file (**.cod**). The input control code file summarizes information that affects the operation of SWAT (e.g. print codes, weather generator codes, number of years being simulated, number of subbasins being simulated)
BASNDAT	Name of basin input file (**.bsn**). Contains inputs for processes modeled at the watershed level.
WATQAL	Name of watershed water quality input file (**.wwq**)
CROPDB	Name of land cover/plant growth database file (**crop.dat**). This file contains growth parameters for the different land covers.
TILLDAT	Name of tillage database file (**till.dat**). This file contains mixing efficiencies for different tillage implements.
PESTIDAT	Name of pesticide database file (**pest.dat**). This file contains parameters governing movement and degradation of pesticides.
FERTDAT	Name of fertilizer/manure database file (**fert.dat**). This file contains nutrient content data for fertilizers.
URBDAT	Name of urban land type database file (**urban.dat**). This file contains data required to model build-up/wash-off in urban areas.

32.1.3 CLIMATE INPUT SECTION (FILE.CIO)

Variable name	Definition
NRGAGE	Number of precipitation gage (.pcp) files used in the simulation. Up to 18 files may be used.
NTGAGE	Number of temperature gage (.tmp) files used in the simulation. Up to 18 files may be used.
NRTOT	Total number of precipitation gage records used in the simulation. If each .pcp file contains only one precipitation gage record, NRTOT = NRGAGE. Otherwise, NRTOT > NRGAGE. A maximum of 5400 precipitation gage records may be used in a simulation.
NTTOT	Total number of temperature gage records used in the simulation. If each .tmp file contains only one temperature gage record, NTTOT = NTGAGE. Otherwise, NTTOT > NTGAGE. A maximum of 2700 temperature gage records may be used in a simulation.
NRGFIL	Number of precipitation gage records within each .pcp file. A maximum of 300 precipitation gage records may be placed in each .pcp file.
NTGFIL	Number of temperature gage records within each .tmp file. a maximum of 150 temperature gage records may be placed in each .tmp file
NSTOT	Number of solar radiation records within the .slr file. A maximum of 300 solar radiation records may be placed in the .slr file.
NHTOT	Number of relative humidity records within the .hmd file. A maximum of 300 relative humidity records may be placed in the .hmd file.
NWTOT	Number of wind speed records within the .wnd file. A maximum of 300 wind speed records may be placed in the .wnd file.
RFILE(1)	Name of measured precipitation input file #1 (**.pcp**).
RFILE(2)	Name of measured precipitation input file #2 (**.pcp**).
RFILE(3)	Name of measured precipitation input file #3 (**.pcp**).
RFILE(4)	Name of measured precipitation input file #4 (**.pcp**).
RFILE(5)	Name of measured precipitation input file #5 (**.pcp**).

Variable name	**Definition**
RFILE(6)	Name of measured precipitation input file #6 (**.pcp**).
RFILE(7)	Name of measured precipitation input file #7 (**.pcp**).
RFILE(8)	Name of measured precipitation input file #8 (**.pcp**).
RFILE(9)	Name of measured precipitation input file #9 (**.pcp**).
RFILE(10)	Name of measured precipitation input file #10 (**.pcp**).
RFILE(11)	Name of measured precipitation input file #11 (**.pcp**).
RFILE(12)	Name of measured precipitation input file #12 (**.pcp**).
RFILE(13)	Name of measured precipitation input file #13 (**.pcp**).
RFILE(14)	Name of measured precipitation input file #14 (**.pcp**).
RFILE(15)	Name of measured precipitation input file #15 (**.pcp**).
RFILE(16)	Name of measured precipitation input file #16 (**.pcp**).
RFILE(17)	Name of measured precipitation input file #17 (**.pcp**).
RFILE(18)	Name of measured precipitation input file #18 (**.pcp**).
TFILE(1)	Name of measured temperature input file #1 (**.tmp**).
TFILE(2)	Name of measured temperature input file #2 (**.tmp**).
TFILE(3)	Name of measured temperature input file #3 (**.tmp**).
TFILE(4)	Name of measured temperature input file #4 (**.tmp**).
TFILE(5)	Name of measured temperature input file #5 (**.tmp**).
TFILE(6)	Name of measured temperature input file #6 (**.tmp**).
TFILE(7)	Name of measured temperature input file #7 (**.tmp**).
TFILE(8)	Name of measured temperature input file #8 (**.tmp**).
TFILE(9)	Name of measured temperature input file #9 (**.tmp**).
TFILE(10)	Name of measured temperature input file #10 (**.tmp**).
TFILE(11)	Name of measured temperature input file #11 (**.tmp**).
TFILE(12)	Name of measured temperature input file #12 (**.tmp**).
TFILE(13)	Name of measured temperature input file #13 (**.tmp**).
TFILE(14)	Name of measured temperature input file #14 (**.tmp**).
TFILE(15)	Name of measured temperature input file #15 (**.tmp**).
TFILE(16)	Name of measured temperature input file #16 (**.tmp**).
TFILE(17)	Name of measured temperature input file #17 (**.tmp**).

Variable name	Definition
TFILE(18)	Name of measured temperature input file #18 (**.tmp**).
SLRFILE	Name of measured solar radiation input file (**.slr**).
RHFILE	Name of measured relative humidity input file (**.hmd**).
WNDFILE	Name of measured wind speed input file (**.wnd**).
PETFILE	Name of potential evapotranspiration input file (**.pet**).

32.1.4 SUBBASIN INPUT SECTION (FILE.CIO)

Variable name	Definition
ISB	Subbasin number. This number is present to assist the user—the model ignores this number. Input files for the different subbasins must be listed consecutively in the subbasin input section.
SUBDAT	Name of subbasin general input data file (**.sub**).
RTEDAT	Name of subbasin routing input data file (**.rte**). This file contains parameters for the main channel.
PNDDAT	Name of subbasin pond input data file (**.pnd**).
WUSDAT	Name of subbasin water use management data file (**.wus**).
WGNDAT	Name of subbasin weather generator data file (**.wgn**).
SWQDAT	Name of subbasin stream water quality data file (**.swq**).
IRGAGE	Number of the measured precipitation record used within subbasin. Optional.
ITGAGE	Number of the measured temperature record used within the subbasin. Optional.
ISGAGE	Number of the solar radiation record used within the subbasin. Optional.
IHGAGE	Number of the relative humidity record used within the subbasin. Optional.
IWGAGE	Number of the wind speed record used within the subbasin. Optional.

32.1.5 FILE FORMAT (FILE.CIO)

Variable name	Line #	Position	Format	F90 Format
TITLE	1-3	space 1-80	character	a80
BIGSUB	4	space 1-13	character	a13
SBSOUT	4	space 14-26	character	a13
RCHOUT	4	space 27-39	character	a13
RSVOUT	4	space 40-52	character	a13
empty location	4	space 53-65	character	a13
WTROUT	4	space 66-78	character	a13
PESTOUT	5	space 1-13	character	a13
EVENT	5	space 14-26	character	a13
ROUTIN	5	space 27-39	character	a13
CODEDAT	5	space 40-52	character	a13
BASNDAT	5	space 53-65	character	a13
WATQAL	5	space 66-78	character	a13
CROPDB	6	space 1-13	character	a13
TILLDAT	6	space 14-26	character	a13
PESTIDAT	6	space 27-39	character	a13
FERTDAT	6	space 40-52	character	a13
URBDAT	6	space 53-65	character	a13
NRGAGE	7	space 1-4	integer	i4
NTGAGE	7	space 5-8	integer	i4
NRTOT	7	space 9-12	integer	i4
NTTOT	7	space 13-16	integer	i4
NRGFIL	7	space 17-20	integer	i4
NTGFIL	7	space 21-24	integer	i4
NSTOT	7	space 25-28	integer	i4
NHTOT	7	space 29-32	integer	i4
NWTOT	7	space 33-36	integer	i4
RFILE(1)	8	space 1-13	character	a13
RFILE(2)	8	space 14-26	character	a13
RFILE(3)	8	space 27-39	character	a13
RFILE(4)	8	space 40-52	character	a13
RFILE(5)	8	space 53-65	character	a13

Variable name	Line #	Position	Format	F90 Format
RFILE(6)	8	space 66-78	character	a13
RFILE(7)	9	space 1-13	character	a13
RFILE(8)	9	space 14-26	character	a13
RFILE(9)	9	space 27-39	character	a13
RFILE(10)	9	space 40-52	character	a13
RFILE(11)	9	space 53-65	character	a13
RFILE(12)	9	space 66-78	character	a13
RFILE(13)	10	space 1-13	character	a13
RFILE(14)	10	space 14-26	character	a13
RFILE(15)	10	space 27-39	character	a13
RFILE(16)	10	space 40-52	character	a13
RFILE(17)	10	space 53-65	character	a13
RFILE(18)	10	space 66-78	character	a13
TFILE(1)	11	space 1-13	character	a13
TFILE(2)	11	space 14-26	character	a13
TFILE(3)	11	space 27-39	character	a13
TFILE(4)	11	space 40-52	character	a13
TFILE(5)	11	space 53-65	character	a13
TFILE(6)	11	space 66-78	character	a13
TFILE(7)	12	space 1-13	character	a13
TFILE(8)	12	space 14-26	character	a13
TFILE(9)	12	space 27-39	character	a13
TFILE(10)	12	space 40-52	character	a13
TFILE(11)	12	space 53-65	character	a13
TFILE(12)	12	space 66-78	character	a13
TFILE(13)	13	space 1-13	character	a13
TFILE(14)	13	space 14-26	character	a13
TFILE(15)	13	space 27-39	character	a13
TFILE(16)	13	space 40-52	character	a13
TFILE(17)	13	space 53-65	character	a13
TFILE(18)	13	space 66-78	character	a13
SLRFILE	14	space 1-13	character	a13
RHFILE	14	space 14-26	character	a13
WNDFILE	14	space 27-39	character	a13
PETFILE	14	space 40-52	character	a13

Variable name	Line #	Position	Format	F90 Format
The remaining lines provide input data for all of the subbasins. Two lines are devoted to each subbasin's input data. In the equation for the line number, *i* is the subbasin number.				
ISB	13 + 2*i*	space 1-5	integer	i5
SUBDAT	13 + 2*i*	space 7-19	character	a13
RTEDAT	13 + 2*i*	space 21-33	character	a13
PNDDAT	13 + 2*i*	space 35-47	character	a13
WUSDAT	13 + 2*i*	space 49-61	character	a13
WGNDAT	14 + 2*i*	space 7-19	character	a13
SWQDAT	14 + 2*i*	space 21-33	character	a13
IRGAGE	14 + 2*i*	space 49-52	integer	i4
ITGAGE	14 + 2*i*	space 53-56	integer	i4
ISGAGE	14 + 2*i*	space 57-60	integer	i4
IHGAGE	14 + 2*i*	space 61-64	integer	i4
IWGAGE	14 + 2*i*	space 65-68	integer	i4

32.2 INPUT CONTROL CODE FILE (.COD)

The input control code file regulates the general operation of SWAT. In addition to setting output file formats, the input control code file defines which processes are/are not modeled in the SWAT simulation.

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

Variable name	Definition
TITLE	The first line of the .cod file is reserved for user comments. The comments may take up to 80 spaces. (optional)
NBYR	Number of calendar years simulated. The number of years simulated in a SWAT run can vary from 1 to 9,999 years. If a simulation is begun on August 1st of the year 1995 and ends July 30th of the year 1997, the model will be simulating 3 calendar years (1995, 1996 and 1997).
IYR	Beginning year of simulation (for example, 1980). The value entered for this variable is not important unless measured data (e.g. weather) is used in the run. When measured data is used, the model uses this variable to locate the beginning year within the data file.
IDAF	Beginning julian day of simulation. With this variable, SWAT is able to begin a simulation at any time of the year. If the variable is left blank or set to zero, the model starts the simulation on January 1st.
IDAL	Ending julian day of simulation. With this variable, SWAT will end the simulation on the date specified. If the variable is left blank or set to zero, the model ends the simulation on December 31st.

Variable name	Definition
IPD	Print code. This variable governs the frequency that model results are printed to output files. There are three options: 0 monthly 1 daily 2 annually If you choose to print results on a daily basis, the number of years simulated should be limited and/or the variables printed to the output file should be restricted. If these precautions are not taken, the output files will be too large to view.
NYSKIP	Number of years to ***not*** print output. The options are 0 print output for all years of the simulation 1 print output after the first year of simulation 2 print output after the second year of simulation ⇣ nbyr no output will be printed If initial conditions are not well known, a warm-up or equilibration period may be needed to get the values of soil water, residue, etc. to representative amounts. NYSKIP defines the duration of the equilibration period. In addition to not writing data to the output files, annual averages are not computed for the skipped years. Averages for the entire simulation period will also exclude data from the skipped years. The default value for NYSKIP is 0.
IPRN	Print code for input.std file. There are two options: 0 entire input.std file is printed 1 condensed version of input.std file is printed
ILOG	Streamflow print code. This variable allows the user to take the $\log_{10}$ of the flow prior to printing streamflow values to the .rch file. There are two options: 0 print streamflow in .rch file 1 print log of streamflow in .rch file In large basins (for example, the Mississippi River basin), streamflow values printed to the .rch file may exceed the range allowed by the file format statements. This variable will eliminate print errors caused by very large values.

Variable name	Definition
IPRP	Print code for .pso file. There are two options: 0 do not print pesticide output (.pso file will be empty) 1 print pesticide output
IGN	Random generator seed code. A set of random numbers is needed by SWAT to generate weather data. SWAT has a set of default random numbers embedded in the code. To use the default random numbers, the user should set IGN = 0. This is the default value for IGN. In some situations, a user may wish to vary the weather sequence between runs. This is done by setting IGN to a different number every time the model is run. This code will activate a random number generator, which will replace the default set of random numbers with a new set. The value to which IGN is set determines the number of times the random number generator is cycled before the simulation begins. The seeds produced by the random number generator are then utilized by the weather generator instead of the default values. Measured weather data read into the model is not affected by this variable. However, if the measured data contains missing values, the weather generator is activated to produce data to replace the missing values. The data produced to replace missing values will be affected by this variable.
PCPSIM	Rainfall input code. This variable identifies the method the model will use to process rainfall data. There are two options: 1 measured data read for each subbasin 2 rainfall generated for each subbasin
IDT	Time step used to report measured rainfall data (minutes). Required if IEVENT = 2 or 3. One of the following should be chosen: 1 min, 2 min, 3 min, 4 min, 5 min, 6 min, 10 min, 12 min, 15 min, 20 min, 30 min.
IDIST	Rainfall distribution code. There are two options: 0 skewed distribution 1 mixed exponential distribution

Variable name	Definition
REXP	Value of exponent for mixed exponential rainfall distribution. A value for REXP must be entered if IDIST = 1. The model will set REXP = 1.3 if no value is entered.
TMPSIM	Temperature input code. This variable identifies the method the model will use to process temperature data. There are two options: 1 measured date read for each subbasin 2 daily max/min generated for each subbasin
SLRSIM	Solar radiation input code. This variable identifies the method the model will use to process solar radiation data. There are two options: 1 measured data read for each subbasin 2 solar radiation generated for each subbasin
RHSIM	Relative humidity input code. This variable identifies the method the model will use to process relative humidity data. There are two options: 1 measured data read for each subbasin 2 relative humidity generated for each subbasin
WNDSIM	Wind speed input code. This variable identifies the method the model will use to process wind speed data. There are two options: 1 measured data read for each subbasin 2 wind speed generated for each subbasin
IPET	Potential evapotranspiration method. There are four options for potential ET calculations: 0 Priestley-Taylor method 1 Penman/Monteith method 2 Hargreaves method 3 read in potential ET values

Variable name	Definition
IEVENT	Rainfall/runoff/routing option: 0 daily rainfall/curve number runoff/daily routing 1 daily rainfall/Green & Ampt runoff/daily routing (sub-hourly rainfall required for Green & Ampt is generated from daily) *this option not yet operational* 2 sub-hourly rainfall/Green & Ampt runoff/daily routing 3 sub-hourly rainfall/Green & Ampt runoff/hourly routing Option 0 was the only active option in prior versions of the model and is the default.
ICRK	Crack flow code. There are two options: 0 do not model crack flow in soil 1 model crack flow in soil The default option is ICRK=0.
IRTE	Channel water routing method: 0 variable storage method 1 Muskingum method The default option is IRTE=0. The Muskingum method is a new option available with SWAT2000. The user must be careful to define MSK_CO1, MSK_CO2 and MSK_X (in .bsn) when the Muskingum method is chosen.
IDEG	Channel degradation code. There are two options: 0 channel dimensions are not updated as a result of degradation (the dimensions remain constant for the entire simulation) 1 channel dimensions are updated as a result of degradation Channel degradation refers to the downcutting and widening of the channel with time and is always calculated. The default option is IDEG=0 (the channel width and depth remain constant).

Variable name	Definition
IRESQ	Lake water quality code. The variable identifies whether or not lake water quality is simulated in the reservoirs. There are two options: 0 do not model lake water quality 1 model lake water quality The default option is IRESQ=0.
IWQ	In-stream water quality code. The variable identifies whether in-stream transformation of nutrients is allowed to occur. 0 do not model in-stream nutrient transformations 1 model in-stream nutrient transformations The default option is IWQ=0.
ISPROJ	Special project flag. SWAT includes sections of code specific to particular projects. This variable flags the code used in the particular simulation. There are three options: 0 not a special project 1 HUMUS project 2 Missouri River climate change project A user will set this variable to something other than zero only if the SWAT programmers have told him to do so.

For long runs, the output files can get so large that the user may have difficulty in opening the files to look at output. The user has the option of customizing the output printed to the output files. Lines of the .cod file are used to specify the variables to be printed to the reach output file (.rch), the subbasin output file (.bsb), and the HRU output file (.sbs). If these lines contain only zeros, the model will print all the output variables to the file.

Variable name	Definition
IPDVAR(:)	Output variables printed to the .rch file. (up to 20 variables may be chosen in customized output.) The codes for the output variables are: 1 FLOW_IN: Average daily streamflow into reach (m^3/s) 2 FLOW_OUT: Average daily streamflow out of reach (m^3/s)

Variable name	Definition
	continued from previous page: 3 EVAP: Average daily loss of water from reach by evaporation (m^3/s) 4 TLOSS: Average daily loss of water from reach by transmission (m^3/s) 5 SED_IN: Sediment transported with water into reach (metric tons) 6 SED_OUT: Sediment transported with water out of reach (metric tons) 7 SEDCONC: Concentration of sediment in reach (mg/L) 8 ORGN_IN: Organic nitrogen transported with water into reach (kg N) 9 ORGN_OUT: Organic nitrogen transported with water out of reach (kg N) 10 ORGP_IN: Organic phosphorus transported with water into reach (kg P) 11 ORGP_OUT: Organic phosphorus transported with water out of reach (kg P) 12 NO3_IN: Nitrate transported with water into reach (kg N) 13 NO3_OUT: Nitrate transported with water out of reach (kg N) 14 NH4_IN: Ammonium transported with water into reach (kg N) 15 NH4_OUT: Ammonium transported with water out of reach (kg N) 16 NO2_IN: Nitrite transported with water into reach (kg N) 17 NO2_OUT: Nitrite transported with water out of reach (kg N) 18 MINP_IN: Mineral phosphorus transported with water into reach (kg P) 19 MINP_OUT: Mineral phosphorus transported with water out of reach (kg P) 20 CHLA_IN: Chlorophyll-a transported with water into reach (kg) 21 CHLA_OUT: Chlorophyll-a transported with water out of reach (kg) 22 CBOD_IN: Carbonaceous biochemical oxygen demand transported into reach (kg O_2) 23 CBOD_OUT: Carbonaceous biochemical oxygen demand transported out of reach (kg O_2) 24 DISOX_IN: Dissolved oxygen transported into reach (kg O_2) 25 DISOX_OUT: Dissolved oxygen transported out of reach (kg O_2) 26 SOLPST_IN: Soluble pesticide transported with water into reach (mg a.i.) 27 SOLPST_OUT: Soluble pesticide transported with water out of reach (mg a.i.) 28 SORPST_IN: Pesticide sorbed to sediment transported with water into reach (mg a.i.) 29 SORPST_OUT: Pesticide sorbed to sediment transported with water out of reach (mg a.i.) 30 REACTPST: Loss of pesticide from water by reaction (mg a.i.) 31 VOLPST: Loss of pesticide from water by volatilization (mg a.i.) 32 SETTLPST: Transfer of pesticide from water to river bed sediment by settling (mg a.i.) 33 RESUSP_PST: Transfer of pesticide from river bed sediment to water by resuspension (mg a.i.) 34 DIFFUSEPST: Transfer of pesticide from water to river bed sediment by diffusion (mg a.i.)

Variable name	Definition
	continued from previous page: 35 REACBEDPST: Loss of pesticide from river bed sediment by reaction (mg a.i.) 36 BURYPST: Loss of pesticide from river bed sediment by burial (mg a.i.) 37 BED_PST: Pesticide in river bed sediment (mg a.i.) 38 BACTP_OUT: Number of persistent bacteria transported out of reach 39 BACTLP_OUT: Number of less persistent bacteria transported out of reach 40 CMETAL#1: Conservative metal #1 transported out of reach (kg) 41 CMETAL#2: Conservative metal #2 transported out of reach (kg) 42 CMETAL#3: Conservative metal #3 transported out of reach (kg)
IPDVAB(:)	Output variables printed to the .bsb file (up to 15 variables may be chosen in customized output.) The codes for the output variables are: 1 PRECIP: Average total precipitation on subbasin (mm H_2O) 2 SNOMELT: Snow melt (mm H_2O) 3 PET: Potential evapotranspiration (mm H_2O) 4 ET: Actual evapotranspiration (mm H_2O) 5 SW: Soil water content (mm H_2O) 6 PERC: Amount of water percolating out of root zone (mm H_2O) 7 SURQ: Surface runoff (mm H_2O) 8 GW_Q: Groundwater discharge into reach (mm H_2O) 9 WYLD: Net water yield to reach (mm H_2O) 10 SYLD: Sediment yield (metric tons/ha) 11 ORGN: Organic N released into reach (kg/ha) 12 ORGP: Organic P released into reach (kg/ha) 13 NSURQ: Nitrate released into reach (kg/ha) 14 SOLP: Soluble P released into reach (kg/ha) 15 SEDP: Mineral P attached to sediment released into reach (kg/ha)
IPDVAS(:)	Output variables printed to the .sbs file (up to 20 variables may be chosen in customized output.) The codes for the output variables are: 1 PRECIP: Total precipitation on HRU (mm H_2O) 2 SNOFALL: Precipitation falling as snow, sleet, or freezing rain (mm H_2O) 3 SNOMELT: Amount of snow or ice melting (mm H_2O) 4 IRR: Amount of irrigation water applied to HRU (mm H_2O) 5 PET: Potential evapotranspiration (mm H_2O) 6 ET: Amount of water removed by evapotranspiration (mm H_2O) 7 SW: Soil water content at end of time period (mm H_2O) 8 PERC: Amount of water percolating out of the root zone (mm H_2O) 9 GW_RCHG: Amount of water entering both aquifers (mm H_2O) 10 DA_RCHG: Amount of water entering deep aquifer from root zone (mm H_2O) 11 REVAP: Water in shallow aquifer returning to root zone (mm H_2O)

Variable name	Definition
	continued from previous page: 12 SA_IRR: Amount of water removed from shallow aquifer for irrigation (mm H_2O) 13 DA_IRR: Amount of water removed from deep aquifer for irrigation (mm H_2O) 14 SA_ST: Amount of water in shallow groundwater storage at end of time period (mm H_2O) 15 DA_ST: Amount of water in deep groundwater storage at end of time period (mm H_2O) 16 SURQ: Surface runoff contribution to reach (mm H_2O) 17 TLOSS: Amount of water removed from tributary channels by transmission (mm H_2O) 18 LATQ: Lateral flow contribution to reach (mm H_2O) 19 GW_Q: Groundwater discharge into reach (mm H_2O) 20 WYLD: Net amount of water contributed by the HRU to the reach (mm H_2O) 21 SYLD: Amount of sediment contributed by the HRU to the reach (metric tons/ha) 22 USLE: USLE soil loss (metric tons/ha) 23 N_APP: Amount of N fertilizer applied (kg N/ha) 24 P_APP: Amount of P fertilizer applied (kg P/ha) 25 NAUTO: Amount of N fertilizer applied automatically (kg N/ha) 26 PAUTO: Amount of P fertilizer applied automatically (kg P/ha) 27 NGRZ: Nitrogen applied to HRU in grazing operation during time step (kg N/ha) 28 PGRZ: Phosphorus applied to HRU in grazing operation during time step (kg P/ha) 29 NRAIN: Nitrate added in rainfall (kg N/ha) 30 NFIX: Amount of N fixed by legumes (kg N/ha) 31 F-MN: Transformation of N from fresh organic to mineral pool (kg N/ha) 32 A-MN: Transformation of N from active organic to mineral pool (kg N/ha) 33 A-SN: Transformation of N from active organic to stable organic pool (kg N/ha) 34 F-MP: Transformation of P from fresh organic to mineral pool (kg P/ha) 35 AO-LP: Transformation of P from organic to labile pool (kg P/ha) 36 L-AP: Transformation of P from labile to active mineral pool (kg P/ha) 37 A-SP: Transformation of P from active mineral to stable mineral pool (kg P/ha) 38 DNIT: Amount of N removed from soil by denitrification (kg N/ha) 39 NUP: Nitrogen uptake by plants (kg N/ha) 40 PUP: Phosphorus uptake by plants (kg P/ha) 41 ORGN: Organic N contributed by HRU to reach (kg N/ha) 42 ORGP: Organic P contributed by HRU to reach (kg P/ha) 43 SEDP: Mineral P attached to sediment contributed by HRU to reach (kg P/ha) 44 NSURQ: NO_3 contributed by HRU in surface runoff to reach (kg N/ha)

Variable name	Definition
	continued from previous page: 45 NLATQ: NO_3 contributed by HRU in lateral flow to reach (kg N/ha) 46 NO3L: NO_3 leached below the soil profile (kg N/ha) 47 NO3GW: NO_3 contributed by HRU in groundwater flow to reach (kg N/ha) 48 SOLP: Soluble phosphorus contributed by HRU in surface runoff to reach (kg P/ha) 49 P_GW: Soluble phosphorus contributed by HRU in groundwater flow to reach (kg P/ha) 50 W_STRS: Number of water stress days. 51 TMP_STRS: Number of temperature stress days 52 N_STRS: Number of nitrogen stress days. 53 P_STRS: Number of phosphorus stress days. 54 BIOM: Total plant biomass (metric tons/ha) 55 LAI: Leaf area index 56 YLD: Harvested yield (metric tons/ha) 57 BACTP: Number of persistent bacteria in surface runoff (count) 58 BACTLP: Number of less persistent bacteria in surface runoff (count)

The input control code 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
NBYR	2	integer	free
IYR	3	integer	free
IDAF	4	integer	free
IDAL	5	integer	free
IPD	6	integer	free
NYSKIP	7	integer	free
IPRN	8	integer	free
ILOG	9	integer	free
IPRP	10	integer	free
IGN	11	integer	free
PCPSIM	12	integer	free
IDT	13	integer	free
IDIST	14	integer	free
REXP	15	real	free
TMPSIM	16	integer	free

Variable name	Line #	Format	F90 Format
SLRSIM	17	integer	free
RHSIM	18	integer	free
WNDSIM	19	integer	free
IPET	20	integer	free
IEVENT	21	integer	free
ICRK	22	integer	free
IRTE	23	integer	free
IDEG	24	integer	free
IRESQ	25	integer	free
IWQ	26	integer	free
ISPROJ	27	integer	free
COMMENT LINE	28	character	a80
IPDVAR(1)	29	integer	free
IPDVAR(2)	29	integer	free
IPDVAR(3)	29	integer	free
IPDVAR(4)	29	integer	free
IPDVAR(5)	29	integer	free
IPDVAR(6)	29	integer	free
IPDVAR(7)	29	integer	free
IPDVAR(8)	29	integer	free
IPDVAR(9)	29	integer	free
IPDVAR(10)	29	integer	free
IPDVAR(11)	29	integer	free
IPDVAR(12)	29	integer	free
IPDVAR(13)	29	integer	free
IPDVAR(14)	29	integer	free
IPDVAR(15)	29	integer	free
IPDVAR(16)	29	integer	free
IPDVAR(17)	29	integer	free
IPDVAR(18)	29	integer	free
IPDVAR(19)	29	integer	free
IPDVAR(20)	29	integer	free
COMMENT LINE	30	character	a80
IPDVAB(1)	31	integer	free
IPDVAB(2)	31	integer	free

Variable name	Line #	Format	F90 Format
IPDVAB(3)	31	integer	free
IPDVAB(4)	31	integer	free
IPDVAB(5)	31	integer	free
IPDVAB(6)	31	integer	free
IPDVAB(7)	31	integer	free
IPDVAB(8)	31	integer	free
IPDVAB(9)	31	integer	free
IPDVAB(10)	31	integer	free
IPDVAB(11)	31	integer	free
IPDVAB(12)	31	integer	free
IPDVAB(13)	31	integer	free
IPDVAB(14)	31	integer	free
IPDVAB(15)	31	integer	free
COMMENT LINE	32	character	a80
IPDVAS(1)	33	integer	free
IPDVAS(2)	33	integer	free
IPDVAS(3)	33	integer	free
IPDVAS(4)	33	integer	free
IPDVAS(5)	33	integer	free
IPDVAS(6)	33	integer	free
IPDVAS(7)	33	integer	free
IPDVAS(8)	33	integer	free
IPDVAS(9)	33	integer	free
IPDVAS(10)	33	integer	free
IPDVAS(11)	33	integer	free
IPDVAS(12)	33	integer	free
IPDVAS(13)	33	integer	free
IPDVAS(14)	33	integer	free
IPDVAS(15)	33	integer	free
IPDVAS(16)	33	integer	free
IPDVAS(17)	33	integer	free
IPDVAS(18)	33	integer	free
IPDVAS(19)	33	integer	free
IPDVAS(20)	33	integer	free

CHAPTER 33

SWAT INPUT DATA:
GENERAL WATERSHED ATTRIBUTES

General watershed attributes are defined in the basin input file. These attributes control physical processes at the watershed level. Other than the variable DA_KM, the area of the watershed, the variables in this file are calibration variables or variables normally modified only for advanced or research applications.

33.1 BASIN INPUT FILE (.BSN)

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

Variable name	Definition
TITLE	The first line is reserved for a description. The description may take up to 80 spaces. Optional.
DA_KM	Area of the watershed (km^2)
DT	*Variable not currently used.*
SFTMP	Snowfall temperature (ºC). Mean air temperature at which precipitation is equally likely to be rain as snow/freezing rain. The snowfall temperature should be between –5 ºC and 5 ºC. A default recommended for this variable is SFTMP = 1.0. Optional.
SMTMP	Snow melt base temperature (ºC). Snow pack temperature above which snow melt will occur. The snow melt base temperature should be between –5 ºC and 5 ºC. A default recommended for this variable is SMTMP = 0.50. Optional.
SMFMX	Melt factor for snow on June 21 (mm H_2O/ºC-day). If the watershed is in the Northern Hemisphere, SMFMX will be the maximum melt factor. If the watershed is in the Southern Hemisphere, SMFMX will be the minimum melt factor. SMFMX and SMFMN allow the rate of snow melt to vary through the year. The variables account for the impact of snow pack density on snow melt. If no value for SMFMX is entered, the model will set SMFMX = 4.5. Optional.
SMFMN	Melt factor for snow on December 21 (mm H_2O/ºC-day). If the watershed is in the Northern Hemisphere, SMFMN will be the minimum melt factor. If the watershed is in the Southern Hemisphere, SMFMN will be the maximum melt factor. SMFMX and SMFMN allow the rate of snow melt to vary through the year. The variables account for the impact of snow pack density on snow melt. If no value for SMFMN is entered, the model will set SMFMN = 4.5. Optional.

Variable name	Definition
TIMP	Snow pack temperature lag factor. This parameter controls the impact of the current day's air temperature on the snow pack temperature. TIMP can vary between 0.01 and 1.0. When TIMP=1.0 there is no lag, i.e. the snow pack temperature is the same as the current day's air temperature. As TIMP goes to zero, the snow pack's temperature will be less influenced by the current day's air temperature. If no value for TIMP is entered, the model will set TIMP = 1.0. Optional.
SNOCOVMX	Minimum snow water content that corresponds to 100% snow cover (mm H_2O). If the snow water content is less than SNOCOVMX, then a certain percentage of ground cover will be bare. If no value for SNOCOVMX is entered, the model will set SNOCOVMX = 1.00. Optional.
SNO50COV	Fraction of snow volume represented by SNOCOVMX that corresponds to 50% snow cover. SWAT assumes a nonlinear relationship between snow water and snow cover. SNO50COV can vary between 0.01 and 0.99. If no value for SNO50COV is entered, the model will set SNO50COV = 0.50, i.e. 50% of SNOCOVMX. Optional.
RCN	Concentration of nitrogen in rainfall (mg N/L). If no value for RCN is entered, the model will set RCN = 1.0. Optional.
SURLAG	Surface runoff lag coefficient. This parameter is needed in subbasins where the time of concentration is greater than 1 day. SURLAG is used to create a "storage" for surface runoff to allow runoff to take longer than one day to reach the subbasin outlet. If no value for SURLAG is entered, the model will set SURLAG = 4.0. Optional.
APM	Peak rate adjustment factor for sediment routing in the *subbasin (tributary channels)*. Sediment routing is a function of peak flow rate and mean daily flow. Because SWAT can not directly calculate the sub-daily hydrograph due to the use of precipitation summarized on a daily basis, this variable was incorporated to allow adjustment for the effect of the peak flow rate on sediment routing. This factor is used in the MUSLE equation and impacts the amount of erosion generated in the HRUs. If no value for APM is entered, the model will set APM=1.0. Optional.

Variable name	Definition
PRF	Peak rate adjustment factor for sediment routing in the *main channel*. Sediment routing is a function of peak flow rate and mean daily flow. Because SWAT can not directly calculate the sub-daily hydrograph, this variable was incorporated to allow adjustment for the effect of the peak flow rate on sediment routing. This variable impacts channel degradation. If no value for PRF is entered, the model will set PRF = 1.0. Optional.
SPCON	Linear parameter for calculating the maximum amount of sediment that can be reentrained during channel sediment routing ($DEG_r = SPCON \times (V_c)^{SPEXP}$ where DEG_r is the amount of sediment reentrained and V_c is stream velocity in the channel). SPCON should be between 0.0001 and 0.01. If no value for SPCON is entered, the model will set SPCON = 0.0001. Optional.
SPEXP	Exponent parameter for calculating sediment reentrained in channel sediment routing ($DEG_r = SPCON \times (V_c)^{SPEXP}$ where DEG_r is the amount of sediment reentrained and V_c is stream velocity in the channel). SPEXP should be between 1.0 and 1.5. If no value for SPEXP is entered, the model will set SPEXP = 1.0. Optional.
EVRCH	Reach evaporation adjustment factor. If no value for EVRCH is entered, the model will set EVRCH = 1.00. Optional
EVLAI	Leaf area index at which no evaporation occurs from water surface. EVLAI is used in HRUs where a plant is growing in a ponded environment (e.g. rice). Evaporation from the water surface is allowed until the leaf area of the plant reaches the value specified for EVLAI. EVLAI should be between 0.0 and 10.0. If no value for EVLAI is entered, the model will set EVLAI = 3.0. Optional.
FFCB	Initial soil water storage expressed as a fraction of field capacity water content. All soils in the watershed will be initialized to the same fraction. If FFCB is not set to a value, the model will calculate it as a function of average annual precipitation. FFCB should be between 0.0 and 1.0. The default method is to allow the model to calculate FFCB (set FFCB = 0.0). Optional.
CMN	Rate factor for humus mineralization of active organic nutrients (N and P). If no value for CMN is specified, the model will set CMN = 0.0003. Optional.

Variable name	Definition
UBN	Nitrogen uptake distribution parameter. This parameter controls the amount of nitrogen removed from the different soil layers by the plant. In particular, this parameter controls the amount of nitrogen removed from the surface layer via plant uptake. While the relationship between UBN and nitrogen removed from the surface layer is affected by the depth of the soil profile, in general as UBN increases the amount of N removed from the surface layer relative to the amount removed from the entire profile increases. If no value for UBN is entered, the model will set UBN = 20.0. Optional.
UBP	Phosphorus uptake distribution parameter. This parameter controls plant uptake of phosphorus from the different soil horizons in the same way that UBN controls nitrogen uptake. If no value for UBP is entered, the model will set UBP = 20.0. Optional.
NPERCO	Nitrate percolation coefficient. NPERCO controls the amount of nitrate removed from the surface layer in runoff relative to the amount removed via percolation. The value of NPERCO can range from 0.01 to 1.0. As NPERCO → 0.0, the concentration of nitrate in the runoff approaches 0. As NPERCO → 1.0, surface runoff has the same concentration of nitrate as the percolate. If no value for NPERCO is entered, the model will set NPERCO = 0.20. Optional.
PPERCO	Phosphorus percolation coefficient (10 m^3/Mg). The phosphorus percolation coefficient is the ratio of the solution phosphorus concentration in the surface 10 mm of soil to the concentration of phosphorus in percolate. The value of PPERCO can range from 10.0 to 17.5 If no value for PPERCO is entered, the model will set PPERCO = 10.0. Optional.
PHOSKD	Phosphorus soil partitioning coefficient (m^3/Mg). The phosphorus soil partitioning coefficient is the ratio of the soluble phosphorus concentration in the surface 10 mm of soil to the concentration of soluble phosphorus in surface runoff. If no value for PHOSKD is entered, the model will set PHOSKD = 175.0. Optional.
PSP	Phosphorus availability index. The fraction of mineral phosphorus remaining in solution after initial rapid sorption to soil. If no value for PSP is entered, the model will set PSP = 0.40. Optional.

Variable name	Definition
RSDCO	Residue decomposition coefficient. The fraction of residue which will decompose in a day assuming optimal moisture, temperature, C:N ratio and C:P ratio. If no value for RSDCO is entered, the model will set RSDCO = 0.05. Optional.
PERCOP	Pesticide percolation coefficient. PERCOP controls the amount of pesticide removed from the surface layer in runoff relative to the amount removed via percolation. The value of PERCOP can range from 0.01 to 1.0. As PERCOP → 0.0, the concentration of pesticide in the runoff approaches 0. As PERCOP → 1.0, surface runoff has the same concentration of pesticide as the percolate. If no value for PERCOP is entered, the model will set PERCOP = 0.50. Optional.
IRTPEST	Number of pesticide to be routed through the watershed channel network. This is the pesticide ID number from the pesticide database. While more than one type of pesticide may be applied to the HRUs, the model will monitor the movement of only one pesticide through the channel network. Optional.
WDPQ	Die-off factor for persistent bacteria in soil solution. (1/day) Optional.
WGPQ	Growth factor for persistent bacteria in soil solution. (1/day) Optional.
WDLPQ	Die-off factor for less persistent bacteria in soil solution. (1/day) Optional.
WGLPQ	Growth factor for less persistent bacteria in soil solution. (1/day) Optional.
WDPS	Die-off factor for persistent bacteria adsorbed to soil particles. (1/day) Optional.
WGPS	Growth factor for persistent bacteria adsorbed to soil particles. (1/day) Optional.
WDLPS	Die-off factor for less persistent bacteria adsorbed to soil particles. (1/day) Optional.
WGLPS	Growth factor for less persistent bacteria adsorbed to soil particles. (1/day) Optional.
BACTKDQ	Bacteria partition coefficient. Partition coefficient for bacteria between soluble and sorbed phase in surface runoff. If no value for BACTKDQ is entered, the model will set BACTKDQ = 175.0. Optional.

Variable name	Definition
THBACT	Temperature adjustment factor for bacteria die-off/growth. If no value for THBACT is entered, the model will set THBACT = 1.07. Optional.
MSK_CO1	Calibration coefficient used to control impact of the storage time constant (K_m) for normal flow (where normal flow is when river is at bankfull depth) upon the K_m value calculated for the reach. Required only if IRTE = 1 in .cod file.
MSK_CO2	Calibration coefficient used to control impact of the storage time constant (K_m) for low flow (where low flow is when river is at 0.1 bankfull depth) upon the K_m value calculated for the reach. Required only if IRTE = 1 in .cod file.
MSK_X	Weighting factor controlling relative importance of inflow rate and outflow rate in determining water storage in reach segment. The values for MSK_X can range from 0.01 - 0.30. If no value for MSK_X is entered, the model will set MSK_X = 0.2. Required only if IRTE = 1 in .cod file.
ESCO	Soil evaporation compensation factor. This factor adjusts the depth distribution for evaporation from the soil to account for the effect of capillary action, crusting and cracks. ESCO must be between 0.01 and 1.0. If no value for ESCO is entered, the model will set ESCO = 0.95. The value for ESCO may be set at the watershed or HRU level (ESCO in .hru).
EPCO	Plant uptake compensation factor. This factor adjusts the depth distribution for plant uptake of water from the soil to account for the variation in root density with depth. EPCO must be between 0.01 and 1.0. If no value for EPCO is entered, the model will set EPCO = 1.0. The value for EPCO may be set at the watershed or HRU level (EPCO in .hru).

The basin input 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
DA_KM	2	real	free
DT	3	real	free
SFTMP	4	real	free

Variable name	Line #	Format	F90 Format
SMTMP	5	real	free
SMFMX	6	real	free
SMFMN	7	real	free
TIMP	8	real	free
SNOCOVMX	9	real	free
SNO50COV	10	real	free
RCN	11	real	free
SURLAG	12	real	free
APM	13	real	free
PRF	14	real	free
SPCON	15	real	free
SPEXP	16	real	free
BLANK LINE	17	real	free
BLANK LINE	18	real	free
BLANK LINE	19	real	free
BLANK LINE	20	real	free
BLANK LINE	21	real	free
EVRCH	22	real	free
EVLAI	23	real	free
FFCB	24	real	free
CMN	25	real	free
UBN	26	real	free
UBP	27	real	free
NPERCO	28	real	free
PPERCO	29	real	free
PHOSKD	30	real	free
PSP	31	real	free
RSDCO	32	real	free
PERCOP	33	real	free
IRTPEST	34	integer	free
WDPQ	35	real	free
WGPQ	36	real	free
WDLPQ	37	real	free
WGLPQ	38	real	free
WDPS	39	real	free

Variable name	Line #	Format	F90 Format
WGPS	40	real	free
WDLPS	41	real	free
WGLPS	42	real	free
BACTKDQ	43	real	free
THBACT	44	real	free
MSK_CO1	45	real	free
MSK_CO2	46	real	free
MSK_X	47	real	free
ESCO	48	real	free
EPCO	49	real	free

CHAPTER 34

SWAT INPUT DATA: CLIMATE

SWAT requires daily precipitation, maximum/minimum air temperature, solar radiation, wind speed and relative humidity. Values for all these parameters may be read from records of observed data or they may be generated.

Seven types of files store the climatic data required by SWAT—the weather generator input file (.wgn), the measured precipitation file (.pcp), the measured temperature file (.tmp), the solar radiation input file (.slr), the wind speed input file (.wnd), the relative humidity input file (.hmd), and the potential evapotranspiration input file (.pet). Up to 18 precipitation files and 18 temperature files may be utilized in a simulation. The precipitation and temperature files are able to hold records for more than one gage, so there is not a limitation on the number of gages that can be used in a simulation. One solar radiation file, wind speed file and relative humidity input file may be used in a simulation. These files are able to hold records for more than one gage, so there is not a limitation on the number of gages that can be used in a simulation. The potential evapotranspiration file holds only one record that is used for the entire watershed.

34.1 WEATHER GENERATOR INPUT FILE (.WGN)

The weather generator input file contains the statistical data needed to generate representative daily climate data for the subbasins. Climatic data will be generated in two instances: when the user specifies that simulated weather will be used or when measured data is missing.

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

Variable name	Definition
TITLE	The first line of the .wgn file is reserved for user comments. The comments may take up to 80 spaces. (optional)
WLATITUDE	Latitude of weather station used to create statistical parameters (degrees). The latitude is expressed as a real number with minutes and seconds converted to fractions of a degree. Optional.
WLONGITUDE	Longitude of weather station (degrees). This variable is not used by the model. Optional.
WELEV	Elevation of weather station (m). Optional.
RAIN_YRS	The number of years of maximum monthly 0.5 h rainfall data used to define values for RAIN_HHMX(1,:) - RAIN_HHMX(12,:).
TMPMX(mon)	Average daily maximum air temperature for month (ºC).
TMPMN(mon)	Average daily minimum air temperature for month (ºC).
TMPSTDMX(mon)	Standard deviation for daily maximum air temperature in month (ºC).

Variable name	Definition
TMPSTDMN(mon)	Standard deviation for daily minimum air temperature in month (ºC).
PCPMM(mon)	Average amount of precipitation falling in month (mm H_2O).
PCPSTD(mon)	Standard deviation for daily precipitation in month (mm H_2O/day).
PCPSKW(mon)	Skew coefficient for daily precipitation in month.
PR_W(1,mon)	Probability of a wet day following a dry day in the month.
PR_W(2,mon)	Probability of a wet day following a wet day in the month.
PCPD(mon)	Average number of days of precipitation in month.
RAINHHMX(mon)	Maximum 0.5 hour rainfall in entire period of record for month (mm).
SOLARAV(mon)	Average daily solar radiation for month (MJ/m^2/day).
DEWPT(mon)	Average daily dew point temperature in month (ºC).
WNDAV(mon)	Average daily wind speed in month (m/s).

The format of the weather generator input file is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	space 1-80	character	a80
WLATITUDE	2	space 13-19	decimal(xxxx.xx)	f7.2
WLONGITUDE	2	space 32-38	decimal(xxxx.xx)	f7.2
WELEV	3	space 13-19	decimal(xxxx.xx)	f7.2
RAIN_YRS	4	space 13-19	decimal(xxxx.xx)	f7.2
TMPMX(1)	5	space 1-6	decimal(xxx.xx)	f6.2
TMPMX(2)	5	space 7-12	decimal(xxx.xx)	f6.2
TMPMX(3)	5	space 13-18	decimal(xxx.xx)	f6.2
TMPMX(4)	5	space 19-24	decimal(xxx.xx)	f6.2
TMPMX(5)	5	space 25-30	decimal(xxx.xx)	f6.2
TMPMX(6)	5	space 31-36	decimal(xxx.xx)	f6.2
TMPMX(7)	5	space 37-42	decimal(xxx.xx)	f6.2
TMPMX(8)	5	space 43-48	decimal(xxx.xx)	f6.2
TMPMX(9)	5	space 49-54	decimal(xxx.xx)	f6.2
TMPMX(10)	5	space 55-60	decimal(xxx.xx)	f6.2

Variable name	Line #	Position	Format	F90 Format
TMPMX(11)	5	space 61-66	decimal(xxx.xx)	f6.2
TMPMX(12)	5	space 67-72	decimal(xxx.xx)	f6.2
TMPMN(1)	6	space 1-6	decimal(xxx.xx)	f6.2
TMPMN(2)	6	space 7-12	decimal(xxx.xx)	f6.2
TMPMN(3)	6	space 13-18	decimal(xxx.xx)	f6.2
TMPMN(4)	6	space 19-24	decimal(xxx.xx)	f6.2
TMPMN(5)	6	space 25-30	decimal(xxx.xx)	f6.2
TMPMN(6)	6	space 31-36	decimal(xxx.xx)	f6.2
TMPMN(7)	6	space 37-42	decimal(xxx.xx)	f6.2
TMPMN(8)	6	space 43-48	decimal(xxx.xx)	f6.2
TMPMN(9)	6	space 49-54	decimal(xxx.xx)	f6.2
TMPMN(10)	6	space 55-60	decimal(xxx.xx)	f6.2
TMPMN(11)	6	space 61-66	decimal(xxx.xx)	f6.2
TMPMN(12)	6	space 67-72	decimal(xxx.xx)	f6.2
TMPSTDMX(1)	7	space 1-6	decimal(xxx.xx)	f6.2
TMPSTDMX(2)	7	space 7-12	decimal(xxx.xx)	f6.2
TMPSTDMX(3)	7	space 13-18	decimal(xxx.xx)	f6.2
TMPSTDMX(4)	7	space 19-24	decimal(xxx.xx)	f6.2
TMPSTDMX(5)	7	space 25-30	decimal(xxx.xx)	f6.2
TMPSTDMX(6)	7	space 31-36	decimal(xxx.xx)	f6.2
TMPSTDMX(7)	7	space 37-42	decimal(xxx.xx)	f6.2
TMPSTDMX(8)	7	space 43-48	decimal(xxx.xx)	f6.2
TMPSTDMX(9)	7	space 49-54	decimal(xxx.xx)	f6.2
TMPSTDMX(10)	7	space 55-60	decimal(xxx.xx)	f6.2
TMPSTDMX(11)	7	space 61-66	decimal(xxx.xx)	f6.2
TMPSTDMX(12)	7	space 67-72	decimal(xxx.xx)	f6.2
TMPSTDMN(1)	8	space 1-6	decimal(xxx.xx)	f6.2
TMPSTDMN(2)	8	space 7-12	decimal(xxx.xx)	f6.2
TMPSTDMN(3)	8	space 13-18	decimal(xxx.xx)	f6.2
TMPSTDMN(4)	8	space 19-24	decimal(xxx.xx)	f6.2
TMPSTDMN(5)	8	space 25-30	decimal(xxx.xx)	f6.2
TMPSTDMN(6)	8	space 31-36	decimal(xxx.xx)	f6.2
TMPSTDMN(7)	8	space 37-42	decimal(xxx.xx)	f6.2
TMPSTDMN(8)	8	space 43-48	decimal(xxx.xx)	f6.2
TMPSTDMN(9)	8	space 49-54	decimal(xxx.xx)	f6.2

Variable name	Line #	Position	Format	F90 Format
TMPSTDMN(10)	8	space 55-60	decimal(xxx.xx)	f6.2
TMPSTDMN(11)	8	space 61-66	decimal(xxx.xx)	f6.2
TMPSTDMN(12)	8	space 67-72	decimal(xxx.xx)	f6.2
PCPMM(1)	9	space 1-6	decimal(xxx.xx)	f6.2
PCPMM(2)	9	space 7-12	decimal(xxx.xx)	f6.2
PCPMM(3)	9	space 13-18	decimal(xxx.xx)	f6.2
PCPMM(4)	9	space 19-24	decimal(xxx.xx)	f6.2
PCPMM(5)	9	space 25-30	decimal(xxx.xx)	f6.2
PCPMM(6)	9	space 31-36	decimal(xxx.xx)	f6.2
PCPMM(7)	9	space 37-42	decimal(xxx.xx)	f6.2
PCPMM(8)	9	space 43-48	decimal(xxx.xx)	f6.2
PCPMM(9)	9	space 49-54	decimal(xxx.xx)	f6.2
PCPMM(10)	9	space 55-60	decimal(xxx.xx)	f6.2
PCPMM(11)	9	space 61-66	decimal(xxx.xx)	f6.2
PCPMM(12)	9	space 67-72	decimal(xxx.xx)	f6.2
PCPSTD(1)	10	space 1-6	decimal(xxx.xx)	f6.2
PCPSTD(2)	10	space 7-12	decimal(xxx.xx)	f6.2
PCPSTD(3)	10	space 13-18	decimal(xxx.xx)	f6.2
PCPSTD(4)	10	space 19-24	decimal(xxx.xx)	f6.2
PCPSTD(5)	10	space 25-30	decimal(xxx.xx)	f6.2
PCPSTD(6)	10	space 31-36	decimal(xxx.xx)	f6.2
PCPSTD(7)	10	space 37-42	decimal(xxx.xx)	f6.2
PCPSTD(8)	10	space 43-48	decimal(xxx.xx)	f6.2
PCPSTD(9)	10	space 49-54	decimal(xxx.xx)	f6.2
PCPSTD(10)	10	space 55-60	decimal(xxx.xx)	f6.2
PCPSTD(11)	10	space 61-66	decimal(xxx.xx)	f6.2
PCPSTD(12)	10	space 67-72	decimal(xxx.xx)	f6.2
PCPSKW(1)	11	space 1-6	decimal(xxx.xx)	f6.2
PCPSKW(2)	11	space 7-12	decimal(xxx.xx)	f6.2
PCPSKW(3)	11	space 13-18	decimal(xxx.xx)	f6.2
PCPSKW(4)	11	space 19-24	decimal(xxx.xx)	f6.2
PCPSKW(5)	11	space 25-30	decimal(xxx.xx)	f6.2
PCPSKW(6)	11	space 31-36	decimal(xxx.xx)	f6.2
PCPSKW(7)	11	space 37-42	decimal(xxx.xx)	f6.2
PCPSKW(8)	11	space 43-48	decimal(xxx.xx)	f6.2

Variable name	Line #	Position	Format	F90 Format
PCPSKW(9)	11	space 49-54	decimal(xxx.xx)	f6.2
PCPSKW(10)	11	space 55-60	decimal(xxx.xx)	f6.2
PCPSKW(11)	11	space 61-66	decimal(xxx.xx)	f6.2
PCPSKW(12)	11	space 67-72	decimal(xxx.xx)	f6.2
PR_W(1,1)	12	space 1-6	decimal(xxx.xx)	f6.2
PR_W(1,2)	12	space 7-12	decimal(xxx.xx)	f6.2
PR_W(1,3)	12	space 13-18	decimal(xxx.xx)	f6.2
PR_W(1,4)	12	space 19-24	decimal(xxx.xx)	f6.2
PR_W(1,5)	12	space 25-30	decimal(xxx.xx)	f6.2
PR_W(1,6)	12	space 31-36	decimal(xxx.xx)	f6.2
PR_W(1,7)	12	space 37-42	decimal(xxx.xx)	f6.2
PR_W(1,8)	12	space 43-48	decimal(xxx.xx)	f6.2
PR_W(1,9)	12	space 49-54	decimal(xxx.xx)	f6.2
PR_W(1,10)	12	space 55-60	decimal(xxx.xx)	f6.2
PR_W(1,11)	12	space 61-66	decimal(xxx.xx)	f6.2
PR_W(1,12)	12	space 67-72	decimal(xxx.xx)	f6.2
PR_W(2,1)	13	space 1-6	decimal(xxx.xx)	f6.2
PR_W(2,2)	13	space 7-12	decimal(xxx.xx)	f6.2
PR_W(2,3)	13	space 13-18	decimal(xxx.xx)	f6.2
PR_W(2,4)	13	space 19-24	decimal(xxx.xx)	f6.2
PR_W(2,5)	13	space 25-30	decimal(xxx.xx)	f6.2
PR_W(2,6)	13	space 31-36	decimal(xxx.xx)	f6.2
PR_W(2,7)	13	space 37-42	decimal(xxx.xx)	f6.2
PR_W(2,8)	13	space 43-48	decimal(xxx.xx)	f6.2
PR_W(2,9)	13	space 49-54	decimal(xxx.xx)	f6.2
PR_W(2,10)	13	space 55-60	decimal(xxx.xx)	f6.2
PR_W(2,11)	13	space 61-66	decimal(xxx.xx)	f6.2
PR_W(2,12)	13	space 67-72	decimal(xxx.xx)	f6.2
PCPD(1)	14	space 1-6	decimal(xxx.xx)	f6.2
PCPD(2)	14	space 7-12	decimal(xxx.xx)	f6.2
PCPD(3)	14	space 13-18	decimal(xxx.xx)	f6.2
PCPD(4)	14	space 19-24	decimal(xxx.xx)	f6.2
PCPD(5)	14	space 25-30	decimal(xxx.xx)	f6.2
PCPD(6)	14	space 31-36	decimal(xxx.xx)	f6.2
PCPD(7)	14	space 37-42	decimal(xxx.xx)	f6.2

Variable name	Line #	Position	Format	F90 Format
PCPD(8)	14	space 43-48	decimal(xxx.xx)	f6.2
PCPD(9)	14	space 49-54	decimal(xxx.xx)	f6.2
PCPD(10)	14	space 55-60	decimal(xxx.xx)	f6.2
PCPD(11)	14	space 61-66	decimal(xxx.xx)	f6.2
PCPD(12)	14	space 67-72	decimal(xxx.xx)	f6.2
RAINHHMX(1)	15	space 1-6	decimal(xxx.xx)	f6.2
RAINHHMX(2)	15	space 7-12	decimal(xxx.xx)	f6.2
RAINHHMX(3)	15	space 13-18	decimal(xxx.xx)	f6.2
RAINHHMX(4)	15	space 19-24	decimal(xxx.xx)	f6.2
RAINHHMX(5)	15	space 25-30	decimal(xxx.xx)	f6.2
RAINHHMX(6)	15	space 31-36	decimal(xxx.xx)	f6.2
RAINHHMX(7)	15	space 37-42	decimal(xxx.xx)	f6.2
RAINHHMX(8)	15	space 43-48	decimal(xxx.xx)	f6.2
RAINHHMX(9)	15	space 49-54	decimal(xxx.xx)	f6.2
RAINHHMX(10)	15	space 55-60	decimal(xxx.xx)	f6.2
RAINHHMX(11)	15	space 61-66	decimal(xxx.xx)	f6.2
RAINHHMX(12)	15	space 67-72	decimal(xxx.xx)	f6.2
SOLARAV(1)	16	space 1-6	decimal(xxx.xx)	f6.2
SOLARAV(2)	16	space 7-12	decimal(xxx.xx)	f6.2
SOLARAV(3)	16	space 13-18	decimal(xxx.xx)	f6.2
SOLARAV(4)	16	space 19-24	decimal(xxx.xx)	f6.2
SOLARAV(5)	16	space 25-30	decimal(xxx.xx)	f6.2
SOLARAV(6)	16	space 31-36	decimal(xxx.xx)	f6.2
SOLARAV(7)	16	space 37-42	decimal(xxx.xx)	f6.2
SOLARAV(8)	16	space 43-48	decimal(xxx.xx)	f6.2
SOLARAV(9)	16	space 49-54	decimal(xxx.xx)	f6.2
SOLARAV(10)	16	space 55-60	decimal(xxx.xx)	f6.2
SOLARAV(11)	16	space 61-66	decimal(xxx.xx)	f6.2
SOLARAV(12)	16	space 67-72	decimal(xxx.xx)	f6.2
DEWPT(1)	17	space 1-6	decimal(xxx.xx)	f6.2
DEWPT(2)	17	space 7-12	decimal(xxx.xx)	f6.2
DEWPT(3)	17	space 13-18	decimal(xxx.xx)	f6.2
DEWPT(4)	17	space 19-24	decimal(xxx.xx)	f6.2
DEWPT(5)	17	space 25-30	decimal(xxx.xx)	f6.2
DEWPT(6)	17	space 31-36	decimal(xxx.xx)	f6.2

Variable name	Line #	Position	Format	F90 Format
DEWPT(7)	17	space 37-42	decimal(xxx.xx)	f6.2
DEWPT(8)	17	space 43-48	decimal(xxx.xx)	f6.2
DEWPT(9)	17	space 49-54	decimal(xxx.xx)	f6.2
DEWPT(10)	17	space 55-60	decimal(xxx.xx)	f6.2
DEWPT(11)	17	space 61-66	decimal(xxx.xx)	f6.2
DEWPT(12)	17	space 67-72	decimal(xxx.xx)	f6.2
WNDAV(1)	18	space 1-6	decimal(xxx.xx)	f6.2
WNDAV(2)	18	space 7-12	decimal(xxx.xx)	f6.2
WNDAV(3)	18	space 13-18	decimal(xxx.xx)	f6.2
WNDAV(4)	18	space 19-24	decimal(xxx.xx)	f6.2
WNDAV(5)	18	space 25-30	decimal(xxx.xx)	f6.2
WNDAV(6)	18	space 31-36	decimal(xxx.xx)	f6.2
WNDAV(7)	18	space 37-42	decimal(xxx.xx)	f6.2
WNDAV(8)	18	space 43-48	decimal(xxx.xx)	f6.2
WNDAV(9)	18	space 49-54	decimal(xxx.xx)	f6.2
WNDAV(10)	18	space 55-60	decimal(xxx.xx)	f6.2
WNDAV(11)	18	space 61-66	decimal(xxx.xx)	f6.2
WNDAV(12)	18	space 67-72	decimal(xxx.xx)	f6.2

34.2 PRECIPITATION INPUT FILE (.PCP)

Measured precipitation data is read into the model from the .pcp file. The precipitation data may be read into the model in daily or sub-daily time increments. The following sections describe the format for a daily and a subdaily precipitation file.

34.2.1 DAILY PRECIPITATION DATA

Daily precipitation data is used when the SCS curve number method is chosen to model surface runoff (Set by IEVENT in the .cod file).

While the input file must contain data for the entire period of simulation, the record does not have to begin with the first day of simulation. SWAT is able to search for the beginning date in the file, saving editing time on the user's part. Once SWAT locates the record for the beginning day of simulation, it no longer processes the year and date. Because it does not check the subsequent dates, it is very important that the data for the remaining days in the simulation are listed sequentially. (If no year and date are entered for any of the records, the model assumes the first line data corresponds to the first day of simulation.)

A negative 99.0 (-99.0) should be inserted for missing data. This value tells SWAT to generate precipitation for that day.

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

Variable name	Definition
TITLE	The first line of the precipitation file is reserved for comments.
LATITUDE	Latitude of precipitation recording gage location. This value is not used by the model.
LONGITUDE	Longitude of precipitation recording gage location. This value is not used by the model.
ELEVATION	Elevation of precipitation recording gage station (m). Precipitation values are adjusted for elevation in subbasins where elevation bands are defined.
YEAR	Year (4-digit)
DATE	Julian date
PRECIPITATION	Amount of precipitation falling in the time period (mm)

The format of the daily precipitation file with one record is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	unrestricted	character	unrestricted
LATITUDE	2	space 8-12	free	unrestricted
LONGITUDE	3	space 8-12	free	unrestricted
ELEVATION	4	space 8-12	integer	i5
YEAR	5-END	space 1-4	integer	i4
DATE	5-END	space 5-7	integer	i3
PRECIPITATION	5-END	space 8-12	decimal(xxx.x)	f5.1

To place more than one data record within the .pcp file, repeat the original formatting for the recorded data to the right of the existing data. Simulations have been run with 200 records placed in the precipitation files.

For example, assume there are records for six different rain gages stored in the daily .pcp. The formatting of the .pcp file is

Gage	Variable name	Line #	Position	Format	F90 Format
ALL	TITLE	1	unrestricted	character	unrestricted
1	LATITUDE	2	space 8-12	free	unrestricted
2	LATITUDE	2	space 13-17	free	unrestricted
3	LATITUDE	2	space 18-22	free	unrestricted
4	LATITUDE	2	space 23-27	free	unrestricted
5	LATITUDE	2	space 28-32	free	unrestricted
6	LATITUDE	2	space 33-37	free	unrestricted
1	LONGITUDE	3	space 8-12	free	unrestricted
2	LONGITUDE	3	space 13-17	free	unrestricted
3	LONGITUDE	3	space 18-22	free	unrestricted
4	LONGITUDE	3	space 23-27	free	unrestricted
5	LONGITUDE	3	space 28-32	free	unrestricted
6	LONGITUDE	3	space 33-37	free	unrestricted
1	ELEVATION	4	space 8-12	integer	i5
2	ELEVATION	4	space 13-17	integer	i5
3	ELEVATION	4	space 18-22	integer	i5
4	ELEVATION	4	space 23-27	integer	i5
5	ELEVATION	4	space 28-32	integer	i5
6	ELEVATION	4	space 33-37	integer	i5
ALL	YEAR	5-END	space 1-4	4-digit integer	i4
ALL	DATE	5-END	space 5-7	3-digit integer	i3
1	PRECIPITATION	5-END	space 8-12	decimal(xxx.x)	f5.1
2	PRECIPITATION	5-END	space 13-17	decimal(xxx.x)	f5.1
3	PRECIPITATION	5-END	space 18-22	decimal(xxx.x)	f5.1
4	PRECIPITATION	5-END	space 23-27	decimal(xxx.x)	f5.1
5	PRECIPITATION	5-END	space 28-32	decimal(xxx.x)	f5.1
6	PRECIPITATION	5-END	space 33-37	decimal(xxx.x)	f5.1

34.2.2 SUB-DAILY PRECIPITATION

Sub-daily precipitation data is required if the Green & Ampt infiltration method is being used (Set by IEVENT in the .cod file). When the Green & Ampt infiltration method is used to calculate surface runoff, SWAT is unable to generate precipitation data. Because of this, PCPSIM in the .cod file must be set to 1 and negative 99.0 (-99.0) should ***not*** be inserted for missing data. An independent weather generator or extrapolation from adjacent weather stations should be used to fill in missing data.

While the input file must contain data for the entire period of simulation, the record does not have to begin with the first day of simulation. SWAT is able to search for the beginning date in the file, saving editing time on the user's part. Unlike the daily precipitation data, SWAT verifies that the date is correct on all lines. If the model reads in an incorrect date, it will print an error message to the *input.std* file stating the day and year in the precipitation record where the inconsistency is located and the program will stop.

The number of lines of precipitation data per day is governed by the time step used (IDT in the .cod file). To save space, only one line is required for days with no rain at all. When SWAT reads a blank for the delimiter (see variable list below), it knows that all time steps on the day have no precipitation and that there are no more lines of precipitation data for that day.

Following is a brief description of the variables in the sub-daily precipitation input file. They are listed in the order they appear within the file.

Variable name	Definition
TITLE	The first line of the precipitation file is reserved for comments.
LATITUDE	Latitude of precipitation recording gage location. This value is not used by the model.
LONGITUDE	Longitude of precipitation recording gage location. This value is not used by the model.

Variable name	Definition
ELEVATION	Elevation of precipitation recording gage station (m). Precipitation values are adjusted for elevation in subbasins where elevation bands are defined.
YEAR	Year (4-digit)
DATE	Julian date
HOUR	Hour of day (0-23). The hour and minute are at the end of the time step.
DELIMITER	Space is allowed on the line for a colon to separate the hour and minute readings. The delimiter is used by the model to identify days where there is no rain and only one line is present for the day in the .pcp file. If a blank space is inserted instead of the colon, the model will assign zero precipitation to all time steps on the day.
MINUTE	Minute of hour (0-59). The hour and minute are at the end of the time step.
PRECIPITATION	Amount of precipitation falling in the time period (mm)

The format of the sub-daily precipitation file with one record is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	unrestricted	character	unrestricted
LATITUDE	2	space 13-17	free	unrestricted
LONGITUDE	3	space 13-17	free	unrestricted
ELEVATION	4	space 13-17	integer	i5
YEAR	5-END	space 1-4	integer	i4
DATE	5-END	space 5-7	integer	i3
HOUR	5-END	space 8-9	integer	i2
DELIMITER	5-END	space 10	character	a1
MINUTE	5-END	space 11-12	integer	i2
PRECIPITATION	5-END	space 13-17	decimal(xxx.x)	f5.1

To place more than one data record within the .pcp file, repeat the original formatting for the recorded data to the right of the existing data. Simulations have been run with 200 records placed in the precipitation files.

For example, assume there are records for six different rain gages stored in the sub-daily .pcp. The formatting of the .pcp file is

Gage	Variable name	Line #	Position	Format	F90 Format
ALL	TITLE	1	unrestricted	character	unrestricted
1	LATITUDE	2	space 13-17	free	unrestricted
2	LATITUDE	2	space 18-22	free	unrestricted
3	LATITUDE	2	space 23-27	free	unrestricted
4	LATITUDE	2	space 28-32	free	unrestricted
5	LATITUDE	2	space 33-37	free	unrestricted
6	LATITUDE	2	space 38-42	free	unrestricted
1	LONGITUDE	3	space 13-17	free	unrestricted
2	LONGITUDE	3	space 18-22	free	unrestricted
3	LONGITUDE	3	space 23-27	free	unrestricted
4	LONGITUDE	3	space 28-32	free	unrestricted
5	LONGITUDE	3	space 33-37	free	unrestricted
6	LONGITUDE	3	space 38-42	free	unrestricted
1	ELEVATION	4	space 13-17	integer	i5
2	ELEVATION	4	space 18-22	integer	i5
3	ELEVATION	4	space 23-27	integer	i5
4	ELEVATION	4	space 28-32	integer	i5
5	ELEVATION	4	space 33-37	integer	i5
6	ELEVATION	4	space 38-42	integer	i5
ALL	YEAR	5-END	space 1-4	4-digit integer	i4
ALL	DATE	5-END	space 5-7	3-digit integer	i3
ALL	HOUR	5-END	space 8-9	integer	i2
ALL	DELIMITER	5-END	space 10	character	a1
ALL	MINUTE	5-END	space 11-12	integer	i2
1	PRECIPITATION	5-END	space 13-17	decimal(xxx.x)	f5.1
2	PRECIPITATION	5-END	space 18-22	decimal(xxx.x)	f5.1
3	PRECIPITATION	5-END	space 23-27	decimal(xxx.x)	f5.1
4	PRECIPITATION	5-END	space 28-32	decimal(xxx.x)	f5.1
5	PRECIPITATION	5-END	space 33-37	decimal(xxx.x)	f5.1
6	PRECIPITATION	5-END	space 38-42	decimal(xxx.x)	f5.1

34.3 TEMPERATURE INPUT FILE (.TMP)

Measured temperature data is read into the model from the .tmp file. A negative 99.0 (-99.0) should be inserted for missing maximum or minimum temperatures. This value tells SWAT to generate the missing value(s).

As with the precipitation file, the record in the temperature input file does not have to begin with the first day of simulation. SWAT is able to search for the beginning date in the temperature file and all the comments made for this feature in the discussion of the precipitation file pertain to the temperature file as well.

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

Variable name	Definition
TITLE	The first line of the temperature file is reserved for comments.
LATITUDE	Latitude of temperature recording gage location. This value is not used by the model.
LONGITUDE	Longitude of temperature recording gage location. This value is not used by the model.
ELEVATION	Elevation of temperature recording gage station (m). Temperature values are adjusted for elevation in subbasins where elevation bands are defined.
YEAR	Year (4-digit)
DATE	Julian date
MAX TEMP	Daily maximum temperature (ºC).
MIN TEMP	Daily minimum temperature (ºC).

The format of the temperature file with one record is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	unrestricted	character	unrestricted
LATITUDE	2	space 8-17	free	
LONGITUDE	3	space 8-17	free	
ELEVATION	4	space 8-17	integer	i10
YEAR	5-END	space 1-4	4-digit integer	i4
DATE	5-END	space 5-7	3-digit integer	i3
MAX TEMP	5-END	space 8-12	decimal(xxx.x)	f5.1
MIN TEMP	5-END	space 13-17	decimal(xxx.x)	f5.1

To place more than one data record within the .tmp file, repeat the original formatting for the recorded data to the right of the existing data. Simulations have been run with 150 records placed in the temperature files.

For example, assume there are records for three different temperature gages stored in the .tmp. The formatting of the .tmp file is

Gage	Variable name	Line #	Position	Format	F90 Format
ALL	TITLE	1	unrestricted	character	unrestricted
1	LATITUDE	2	space 8-17	free	unrestricted
2	LATITUDE	2	space 18-27	free	unrestricted
3	LATITUDE	2	space 28-37	free	unrestricted
1	LONGITUDE	3	space 8-17	free	unrestricted
2	LONGITUDE	3	space 18-27	free	unrestricted
3	LONGITUDE	3	space 28-37	free	unrestricted
1	ELEVATION	4	space 8-17	integer	i10
2	ELEVATION	4	space 18-27	integer	i10
3	ELEVATION	4	space 28-37	integer	i10
ALL	YEAR	5-END	space 1-4	4-digit integer	i4
ALL	DATE	5-END	space 5-7	3-digit integer	i3
1	MAX TEMP	5-END	space 8-12	decimal(xxx.x)	f5.1
1	MIN TEMP	5-END	space 13-17	decimal(xxx.x)	f5.1
2	MAX TEMP	5-END	space 18-22	decimal(xxx.x)	f5.1
2	MIN TEMP	5-END	space 23-27	decimal(xxx.x)	f5.1
3	MAX TEMP	5-END	space 28-32	decimal(xxx.x)	f5.1
3	MIN TEMP	5-END	space 33-37	decimal(xxx.x)	f5.1

34.4 SOLAR RADIATION INPUT FILE (.SLR)

Measured solar radiation data is read into the model from the .slr file. A negative 99.0 (-99.0) should be inserted for missing radiation values. This value tells SWAT to generate the missing value(s).

As with the precipitation file, the record in the solar radiation input file does not have to begin with the first day of simulation. SWAT is able to search for the beginning date in the solar radiation file and all the comments made for this feature in the discussion of the precipitation file pertain to the solar radiation file as well.

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

Variable name	Definition
TITLE	The first line of the solar radiation file is reserved for comments.
YEAR	Year (4-digit)
DATE	Julian date
SOL_RAD	Daily total solar radiation (MJ/m^2).

The format of the solar radiation input file with one record is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	unrestricted	character	unrestricted
YEAR	2-END	space 1-4	4-digit integer	i4
DATE	2-END	space 5-7	3-digit integer	i3
SOL_RAD	2-END	space 8-15	decimal(xxxx.xxx)	f8.3

To place more than one data record within the .slr file, repeat the original formatting for the recorded data to the right of the existing data.

For example, assume there are records for ten different solar radiation gages stored in the .slr. The formatting of the .slr file is

Gage	Variable name	Line #	Position	Format	F90 Format
ALL	TITLE	1	unrestricted	character	unrestricted
ALL	YEAR	2-END	space 1-4	4-digit integer	i4
ALL	DATE	2-END	space 5-7	3-digit integer	i3
1	SOL_RAD	2-END	space 8-15	decimal(xxxx.xxx)	f8.3
2	SOL_RAD	2-END	space 16-23	decimal(xxxx.xxx)	f8.3
3	SOL_RAD	2-END	space 24-31	decimal(xxxx.xxx)	f8.3
4	SOL_RAD	2-END	space 32-39	decimal(xxxx.xxx)	f8.3
5	SOL_RAD	2-END	space 40-47	decimal(xxxx.xxx)	f8.3
6	SOL_RAD	2-END	space 48-55	decimal(xxxx.xxx)	f8.3
7	SOL_RAD	2-END	space 56-63	decimal(xxxx.xxx)	f8.3
8	SOL_RAD	2-END	space 64-71	decimal(xxxx.xxx)	f8.3
9	SOL_RAD	2-END	space 72-79	decimal(xxxx.xxx)	f8.3
10	SOL_RAD	2-END	space 80-87	decimal(xxxx.xxx)	f8.3

34.5 WIND SPEED INPUT FILE (.WND)

Measured wind speed data is read into the model from the .wnd file. A negative 99.0 (-99.0) should be inserted for missing wind speed values. This value tells SWAT to generate the missing value(s).

As with the precipitation file, the record in the wind speed input file does not have to begin with the first day of simulation. SWAT is able to search for the beginning date in the wind speed file and all the comments made for this feature in the discussion of the precipitation file pertain to the wind speed file as well.

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

Variable name	Definition
TITLE	The first line of the wind speed radiation file is reserved for comments.
YEAR	Year (4-digit)
DATE	Julian date
WND_SP	Daily average wind speed (m/s).

The format of the wind speed input file with one record is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	unrestricted	character	unrestricted
YEAR	2-END	space 1-4	4-digit integer	i4
DATE	2-END	space 5-7	3-digit integer	i3
WND_SP	2-END	space 8-15	decimal(xxxx.xxx)	f8.3

To place more than one data record within the .wnd file, repeat the original formatting for the recorded data to the right of the existing data.

For example, assume there are records for ten different wind speed gages stored in the .wnd. The formatting of the .wnd file is

Gage	Variable name	Line #	Position	Format	F90 Format
ALL	TITLE	1	unrestricted	character	unrestricted
ALL	YEAR	2-END	space 1-4	4-digit integer	i4
ALL	DATE	2-END	space 5-7	3-digit integer	i3
1	WND_SP	2-END	space 8-15	decimal(xxxx.xxx)	f8.3
2	WND_SP	2-END	space 16-23	decimal(xxxx.xxx)	f8.3
3	WND_SP	2-END	space 24-31	decimal(xxxx.xxx)	f8.3
4	WND_SP	2-END	space 32-39	decimal(xxxx.xxx)	f8.3
5	WND_SP	2-END	space 40-47	decimal(xxxx.xxx)	f8.3
6	WND_SP	2-END	space 48-55	decimal(xxxx.xxx)	f8.3
7	WND_SP	2-END	space 56-63	decimal(xxxx.xxx)	f8.3
8	WND_SP	2-END	space 64-71	decimal(xxxx.xxx)	f8.3
9	WND_SP	2-END	space 72-79	decimal(xxxx.xxx)	f8.3
10	WND_SP	2-END	space 80-87	decimal(xxxx.xxx)	f8.3

34.6 RELATIVE HUMIDITY INPUT FILE (.HMD)

Measured relative humidity data is read into the model from the .hmd file. A negative 99.0 (-99.0) should be inserted for missing relative humidity values. This value tells SWAT to generate the missing value(s).

As with the precipitation file, the record in the relative humidity input file does not have to begin with the first day of simulation. SWAT is able to search for the beginning date in the relative humidity file and all the comments made for this feature in the discussion of the precipitation file pertain to the relative humidity file as well.

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

Variable name	Definition
TITLE	The first line of the wind speed radiation file is reserved for comments.
YEAR	Year (4-digit)
DATE	Julian date
RHD	Daily average relative humidity expressed as a fraction.

The format of the relative humidity input file with one record is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	unrestricted	character	unrestricted
YEAR	2-END	space 1-4	4-digit integer	i4
DATE	2-END	space 5-7	3-digit integer	i3
RHD	2-END	space 8-15	decimal(xxxx.xxx)	f8.3

To place more than one data record within the .hmd file, repeat the original formatting for the recorded data to the right of the existing data.

For example, assume there are records for seven different relative humidity gages stored in the .hmd. The formatting of the .hmd file is

Gage	Variable name	Line #	Position	Format	F90 Format
ALL	TITLE	1	unrestricted	character	unrestricted
ALL	YEAR	2-END	space 1-4	4-digit integer	i4
ALL	DATE	2-END	space 5-7	3-digit integer	i3
1	RHD	2-END	space 8-15	decimal(xxxx.xxx)	f8.3
2	RHD	2-END	space 16-23	decimal(xxxx.xxx)	f8.3
3	RHD	2-END	space 24-31	decimal(xxxx.xxx)	f8.3
4	RHD	2-END	space 32-39	decimal(xxxx.xxx)	f8.3
5	RHD	2-END	space 40-47	decimal(xxxx.xxx)	f8.3
6	RHD	2-END	space 48-55	decimal(xxxx.xxx)	f8.3
7	RHD	2-END	space 56-63	decimal(xxxx.xxx)	f8.3

34.7 POTENTIAL EVAPOTRANSPIRATION INPUT FILE (.PET)

Daily potential evapotranspiration data is read into the model from the .pet file. As with the precipitation file, the record in the potential evapotranspiration input file does not have to begin with the first day of simulation. SWAT is able to search for the beginning date in the potential evapotranspiration input file and all the comments made for this feature in the discussion of the precipitation file pertain to the potential evapotranspiration file as well.

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

Variable name	Definition
TITLE	The first line of the wind speed radiation file is reserved for comments.
YEAR	Year (4-digit)
DATE	Julian date
PETMEAS	Daily potential evapotranspiration for watershed (mm H_2O).

The format of the potential evapotranspiration input file is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	unrestricted	character	unrestricted
YEAR	2-END	space 1-4	4-digit integer	i4
DATE	2-END	space 5-7	3-digit integer	i3
PETMEAS	2-END	space 8-12	decimal(xxx.x)	f5.1

34.8 MULTIPLE RECORDS IN CLIMATE FILES

Multiple records may be placed in all measured climatic data files except the potential evapotranspiration file. To assign the different gages to the subbasins in file.cio, a gage number is specified on the subbasin input lines for each type of measured climate data file used in the simulation. Unique gage numbers are assigned to the individual records in the following manner:

Using the precipitation files as an example, numbering is begun in the file assigned to RFILE(1). If ten gages are present in this file, they are numbered from left to right: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. Moving to the next precipitation file which also contains 10 files, RFILE(2), the gages are numbered from left to right beginning where the previous file left off: 11, 12, 13, 14, 15, 16, 17, 18, 19, 20. In the same manner, the gages in RFILE(3), RFILE(4), RFILE(5), RFILE(6), etc. will be processed.

CHAPTER 35

SWAT INPUT DATA: GENERAL ATTRIBUTES

The subbasin and HRU general input files contain information related to a diversity of features within the HRU and its subbasin. Data contained in the subbasin input file can be grouped into the following categories: properties of tributary channels within the subbasin, the amount of topographic relief within the subbasin and its impact on the climate, variables related to climate change, the number of HRUs in the subbasin and the names of HRU input files. Data contained in the HRU input file can be grouped into the following categories: area contained in HRU, parameters affecting surface and subsurface water flow, parameters affecting erosion and management inputs related to the simulation of urban areas, irrigation, tile drains and potholes.

35.1 SUBBASIN GENERAL INPUT FILE (.SUB)

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

Variable name	Definition
TITLE	The first line of the .sub file is reserved for user comments. The comments may take up to 80 spaces. Optional.
HRUTOT	Total number of HRUs modeled in the subbasin.
LATITUDE	Latitude of subbasin (degrees). The latitude is expressed as a real number with minutes and seconds converted to fractions of a degree.
ELEV	Elevation of subbasin (m).
ELEVB(band)	Elevation at the center of the elevation band (m). Up to 10 zones may be specified. Optional.
ELEVB_FR(band)	Fraction of subbasin area within the elevation band. Values for ELEVB_FR should be between 0.0 and 1.0. Optional.
SNOEB(band)	Initial snow water content in elevation band (mm H_2O). Optional.
PLAPS	Precipitation lapse rate (mm H_2O/km). A positive value denotes an increase in precipitation with an increase in elevation while a negative value denotes a decrease in precipitation with an increase in elevation. The lapse rate is used to adjust precipitation for elevation bands in the subbasin. If no elevation bands are defined, the precipitation generated or read in from the .pcp file is used for the subbasin with no adjustment. To adjust the precipitation, the elevation of the recording station or the weather station is compared to the elevation specified for the elevation band. Optional.

Variable name	Definition
TLAPS	Temperature lapse rate (ºC/km). A positive value denotes an increase in temperature with an increase in elevation while a negative value denotes a decrease in temperature with an increase in elevation. If no value is entered for TLAPS, the model sets TLAPS = -6 ºC/km. The lapse rate is used to adjust temperature for elevation bands in the subbasin. If no elevation bands are defined, the temperature generated or read in from the .tmp file is used for the subbasin with no adjustment. To adjust the temperature, the elevation of the recording station or the weather station is compared to the elevation specified for the elevation band. Optional.
SNO_SUB	Initial snow water content (mm H_2O). This value is not needed if the subbasin is divided into elevation bands (see variables ELEVB, ELEVB_FR and SNOEB in this file). Optional.
CH_L(1)	Longest tributary channel length in subbasin (km). The channel length is the distance along the channel from the subbasin outlet to the most distant point in the subbasin.
CH_S(1)	Average slope of tributary channels (m/m). The average channel slope is computed by taking the difference in elevation between the subbasin outlet and the most distant point in the subbasin and dividing by CH_L.
CH_W(1)	Average width of tributary channels (m).
CH_K(1)	Effective hydraulic conductivity in tributary channel alluvium (mm/hr).
CH_N(1)	Manning's "n" value for the tributary channels.
CO2	Carbon dioxide concentration (ppmv). If no value for CO2 is entered the model will set CO2 = 330 ppmv (ambient CO_2 concentration). (Optional—used in climate change studies only)
RFINC(mon)	Rainfall adjustment (% change). (Optional—used in climate change studies only). Daily rainfall within the month is adjusted by the specified percentage. For example, setting RFINC = 10 will make rainfall equal to 110% of the original value.

Variable name	Definition
TMPINC(mon)	Temperature adjustment (ºC). (Optional—used in climate change studies only). Daily maximum and minimum temperatures within the month are raised or lowered by the specified amount.
RADINC(mon)	Radiation adjustment (MJ/m^2-day). (Optional—used in climate change studies only). Daily radiation within the month is raised or lowered by the specified amount.
HUMINC(mon)	Humidity adjustment. (Optional—used in climate change studies only). Daily values for relative humidity within the month are raised or lowered by the specified amount. The relative humidity in SWAT is reported as a fraction.
HRUDAT	Name of HRU general input data file (**.hru**).
MGTDAT	Name of HRU land use management data file (**.mgt**).
SOILDAT	Name of HRU soil data file (**.sol**).
CHEMDAT	Name of HRU soil chemical data file (**.chm**).
GWDAT	Name of HRU groundwater data file (**.gw**).

The subbasin general input file is partially free format and partially fixed format. The variables that are free format will have *free* listed in the **F90Format** column and will not have a position defined. The variables that are fixed format will have a FORTRAN format and position specified.

The free format 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 fixed format variables must be entered using the specified format and positioning on the line in order for the model to read them properly.

The format for the subbasin general input file is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	space 1-80	character	a80
HRUTOT	2		integer	free
LATITUDE	3		real	free
ELEV	4		real	free
COMMENT LINE	5	space 1-80	character	a80
ELEVB(1)	6	space 1-8	decimal (xxxx.xxx)	f8.3
ELEVB(2)	6	space 9-16	decimal (xxxx.xxx)	f8.3
ELEVB(3)	6	space 17-24	decimal (xxxx.xxx)	f8.3
ELEVB(4)	6	space 25-32	decimal (xxxx.xxx)	f8.3
ELEVB(5)	6	space 33-40	decimal (xxxx.xxx)	f8.3
ELEVB(6)	6	space 41-48	decimal (xxxx.xxx)	f8.3
ELEVB(7)	6	space 49-56	decimal (xxxx.xxx)	f8.3
ELEVB(8)	6	space 57-64	decimal (xxxx.xxx)	f8.3
ELEVB(9)	6	space 65-72	decimal (xxxx.xxx)	f8.3
ELEVB(10)	6	space 73-80	decimal (xxxx.xxx)	f8.3
COMMENT LINE	7	space 1-80	character	a80
ELEVB_FR(1)	8	space 1-8	decimal (xxxx.xxx)	f8.3
ELEVB_FR(2)	8	space 9-16	decimal (xxxx.xxx)	f8.3
ELEVB_FR(3)	8	space 17-24	decimal (xxxx.xxx)	f8.3
ELEVB_FR(4)	8	space 25-32	decimal (xxxx.xxx)	f8.3
ELEVB_FR(5)	8	space 33-40	decimal (xxxx.xxx)	f8.3
ELEVB_FR(6)	8	space 41-48	decimal (xxxx.xxx)	f8.3
ELEVB_FR(7)	8	space 49-56	decimal (xxxx.xxx)	f8.3
ELEVB_FR(8)	8	space 57-64	decimal (xxxx.xxx)	f8.3
ELEVB_FR(9)	8	space 65-72	decimal (xxxx.xxx)	f8.3
ELEVB_FR(10)	8	space 73-80	decimal (xxxx.xxx)	f8.3
COMMENT LINE	9	space 1-80	character	a80
SNOEB(1)	10	space 1-8	decimal (xxxx.xxx)	f8.3
SNOEB(2)	10	space 9-16	decimal (xxxx.xxx)	f8.3
SNOEB(3)	10	space 17-24	decimal (xxxx.xxx)	f8.3
SNOEB(4)	10	space 25-32	decimal (xxxx.xxx)	f8.3
SNOEB(5)	10	space 33-40	decimal (xxxx.xxx)	f8.3

Variable name	Line #	Position	Format	F90 Format
SNOEB(6)	10	space 41-48	decimal (xxxx.xxx)	f8.3
SNOEB(7)	10	space 49-56	decimal (xxxx.xxx)	f8.3
SNOEB(8)	10	space 57-64	decimal (xxxx.xxx)	f8.3
SNOEB(9)	10	space 65-72	decimal (xxxx.xxx)	f8.3
SNOEB(10)	10	space 73-80	decimal (xxxx.xxx)	f8.3
PLAPS	11		real	free
TLAPS	12		real	free
SNO_SUB	13		real	free
CH_L(1)	14		real	free
CH_S(1)	15		real	free
CH_W(1)	16		real	free
CH_K(1)	17		real	free
CH_N(1)	18		real	free
CO2	19		real	free
COMMENT LINE	20	space 1-80	character	a80
RFINC(1)	21	space 1-8	decimal (xxxx.xxx)	f8.3
RFINC(2)	21	space 9-16	decimal (xxxx.xxx)	f8.3
RFINC(3)	21	space 17-24	decimal (xxxx.xxx)	f8.3
RFINC(4)	21	space 25-32	decimal (xxxx.xxx)	f8.3
RFINC(5)	21	space 33-40	decimal (xxxx.xxx)	f8.3
RFINC(6)	21	space 41-48	decimal (xxxx.xxx)	f8.3
COMMENT LINE	22	space 1-80	character	a80
RFINC(7)	23	space 1-8	decimal (xxxx.xxx)	f8.3
RFINC(8)	23	space 9-16	decimal (xxxx.xxx)	f8.3
RFINC(9)	23	space 17-24	decimal (xxxx.xxx)	f8.3
RFINC(10)	23	space 25-32	decimal (xxxx.xxx)	f8.3
RFINC(11)	23	space 33-40	decimal (xxxx.xxx)	f8.3
RFINC(12)	23	space 41-48	decimal (xxxx.xxx)	f8.3
COMMENT LINE	24	space 1-80	character	a80
TMPINC(1)	25	space 1-8	decimal (xxxx.xxx)	f8.3
TMPINC(2)	25	space 9-16	decimal (xxxx.xxx)	f8.3
TMPINC(3)	25	space 17-24	decimal (xxxx.xxx)	f8.3
TMPINC(4)	25	space 25-32	decimal (xxxx.xxx)	f8.3
TMPINC(5)	25	space 33-40	decimal (xxxx.xxx)	f8.3
TMPINC(6)	25	space 41-48	decimal (xxxx.xxx)	f8.3

Variable name	Line #	Position	Format	F90 Format
COMMENT LINE	26	space 1-80	character	a80
TMPINC(7)	27	space 1-8	decimal (xxxx.xxx)	f8.3
TMPINC(8)	27	space 9-16	decimal (xxxx.xxx)	f8.3
TMPINC(9)	27	space 17-24	decimal (xxxx.xxx)	f8.3
TMPINC(10)	27	space 25-32	decimal (xxxx.xxx)	f8.3
TMPINC(11)	27	space 33-40	decimal (xxxx.xxx)	f8.3
TMPINC(12)	27	space 41-48	decimal (xxxx.xxx)	f8.3
COMMENT LINE	28	space 1-80	character	a80
RADINC(1)	29	space 1-8	decimal (xxxx.xxx)	f8.3
RADINC(2)	29	space 9-16	decimal (xxxx.xxx)	f8.3
RADINC(3)	29	space 17-24	decimal (xxxx.xxx)	f8.3
RADINC(4)	29	space 25-32	decimal (xxxx.xxx)	f8.3
RADINC(5)	29	space 33-40	decimal (xxxx.xxx)	f8.3
RADINC(6)	29	space 41-48	decimal (xxxx.xxx)	f8.3
COMMENT LINE	30	space 1-80	character	a80
RADINC(7)	31	space 1-8	decimal (xxxx.xxx)	f8.3
RADINC(8)	31	space 9-16	decimal (xxxx.xxx)	f8.3
RADINC(9)	31	space 17-24	decimal (xxxx.xxx)	f8.3
RADINC(10)	31	space 25-32	decimal (xxxx.xxx)	f8.3
RADINC(11)	31	space 33-40	decimal (xxxx.xxx)	f8.3
RADINC(12)	31	space 41-48	decimal (xxxx.xxx)	f8.3
COMMENT LINE	32	space 1-80	character	a80
HUMINC(1)	33	space 1-8	decimal (xxxx.xxx)	f8.3
HUMINC(2)	33	space 9-16	decimal (xxxx.xxx)	f8.3
HUMINC(3)	33	space 17-24	decimal (xxxx.xxx)	f8.3
HUMINC(4)	33	space 25-32	decimal (xxxx.xxx)	f8.3
HUMINC(5)	33	space 33-40	decimal (xxxx.xxx)	f8.3
HUMINC(6)	33	space 41-48	decimal (xxxx.xxx)	f8.3
COMMENT LINE	34	space 1-80	character	a80
HUMINC(7)	35	space 1-8	decimal (xxxx.xxx)	f8.3
HUMINC(8)	35	space 9-16	decimal (xxxx.xxx)	f8.3
HUMINC(9)	35	space 17-24	decimal (xxxx.xxx)	f8.3
HUMINC(10)	35	space 25-32	decimal (xxxx.xxx)	f8.3
HUMINC(11)	35	space 33-40	decimal (xxxx.xxx)	f8.3
HUMINC(12)	35	space 41-48	decimal (xxxx.xxx)	f8.3

Variable name	Line #	Position	Format	F90 Format
COMMENT LINE	36	space 1-80	character	a80
HRUDAT	37-END	space 1-13	character	a13
MGTDAT	37-END	space 14-26	character	a13
SOILDAT	37-END	space 27-39	character	a13
CHEMDAT	37-END	space 40-52	character	a13
GWDAT	37-END	space 53-65	character	a13

35.2 HRU GENERAL INPUT FILE (.HRU)

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

Variable name	Definition
TITLE	The first line of the .hru file is reserved for user comments. The comments may take up to 80 spaces. (optional)
HRU_FR	Fraction of total watershed area contained in HRU (km^2/km^2). If no value for HRU_FR is entered, the model will set HRU_FR = 0.0000001.
SLSUBBSN	Average slope length (m). If no value for SLSUBBSN is entered, the model will set SLSUBBSN = 50. The GIS interfaces will assign the same value to this variable for all HRUs within a subbasin. However, some users like to vary this value by soil type and land cover.
SLOPE	Average slope steepness (m/m). The GIS interfaces will assign the same value to this variable for all HRUs within a subbasin. However, some users like to vary this value by soil type and land cover.
OV_N	Manning's "n" value for overland flow.
LAT_TTIME	Lateral flow travel time (days). Setting LAT_TTIME = 0.0 will allow the model to calculate the travel time based on soil hydraulic properties. This variable should be set to a specific value only by hydrologists familiar with the base flow characteristics of the watershed.
LAT_SED	Sediment concentration in lateral and groundwater flow (mg/L). Sediment concentration in lateral and groundwater flow is usually very low and does not contribute significantly to total sediment yields unless return flow is very high.
SLSOIL	Slope length for lateral subsurface flow (m). If no value is entered for SLSOIL, the model sets SLSOIL = SLSUBBSN. The GIS interfaces will assign the same value to this variable for all HRUs within a subbasin. However, some users like to vary this value by soil type and land cover.

Variable name	**Definition**
CANMX	Maximum canopy storage (mm H_2O). (Optional)
ESCO	Soil evaporation compensation factor. This factor adjusts the depth distribution for evaporation from the soil to account for the effect of capillary action, crusting and cracks. ESCO must be between 0.0 and 1.0. If no value for ESCO is entered, the model will set ESCO = 0.95. The value for ESCO may be set at the watershed or HRU level (ESCO in .bsn).
EPCO	Plant uptake compensation factor. This factor adjusts the depth distribution for plant uptake of water from the soil to account for the variation in root density with depth. EPCO must be between 0.0 and 1.0. If no value for EPCO is entered, the model will set EPCO = 1.0. The value for EPCO may be set at the watershed or HRU level (EPCO in .bsn).
RSDIN	Initial residue cover (kg/ha). (Optional)
ERORGN	Organic N enrichment ratio. If the value for ERORGN is set to zero, the model will calculate an enrichment ratio for every storm event. The default option is to allow the model to calculate the enrichment ratio.
ERORGP	Organic P enrichment ratio. If the value for ERORGP is set to zero, the model will calculate an enrichment ratio for every storm event. The default option is to allow the model to calculate the enrichment ratio.
FILTERW	Width of edge-of-field filter strip.
IURBAN	Urban simulation code: 0 no urban sections in HRU 1 urban sections in HRU, simulate using USGS regression equations 2 urban sections in HRU, simulate using build up/wash off algorithm.
URBLU	Urban land type identification number from urban.dat.

Variable name	Definition
IRR	Irrigation code. This variable, along with IRRNO, specifies the source of irrigation water applied in the HRU. Irrigation water may be diverted from anywhere in the watershed or outside the watershed. IRR tells the model what type of water body the irrigation water is being diverted from. The options are: 0 no irrigation 1 divert water from reach 2 divert water from reservoir 3 divert water from shallow aquifer 4 divert water from deep aquifer 5 divert water from unlimited source outside watershed
IRRNO	Irrigation source location. The definition of this variable depends on the setting of IRR. If IRR = 1, IRRNO is the number of the reach that water is removed from. If IRR = 2, IRRNO is the number of the reservoir that water is removed from. If IRR = 3 or 4, IRRNO is the number of the subbasin that water is removed from. If IRR = 0 or 5, this variable is not used.
FLOWMIN	Minimum in-stream flow for irrigation diversions (m^3/s). If irrigation water being applied in the HRU is from a reach (IRR = 1), a threshhold level of streamflow can be specified. Irrigation water will be diverted from the reach only if flow in the reach is at or above FLOWMIN.
DIVMAX	Maximum daily irrigation diversion from the reach (if value entered for DIVMAX is positive the units are mm, if the value entered for DIVMAX is negative the units are 10^4 m^3). If irrigation water being applied in the HRU is from a reach (IRR = 1), a value can be defined which specifies the maximum amount of water that can be removed from the reach and applied to the HRU on any one day.
FLOWFR	Fraction of available flow (total flow in reach – FLOWMIN) that is allowed to be applied to the HRU. If FLOWMIN is left at zero, the fraction of available flow becomes the fraction of total flow in reach that is allowed to be applied to the reach. The value for FLOWFR should be between 0.0 and 1.0. The model will default FLOWFR = 1.0 if no value is entered. Used only if IRR = 1.

Variable name	**Definition**
DDRAIN	Depth to subsurface drain (mm). If drainage tiles are installed in the HRU, the depth to the tiles is needed (optional).
TDRAIN	Time to drain soil to field capacity (hours). If tile drainage is installed in the HRU, the time required to drain the soil from saturation to field capacity is needed (optional).
GDRAIN	Drain tile lag time (hours). The amount of time between the transfer of water from the soil to the drain tile and the release of the water from the drain tile to the reach (optional).
IPOT	Number of HRU (must be located in subbasin) that is ponding water, i.e. the number of the HRU into which surface runoff from the current HRU drains. This variable identifies closed depressional areas or impounded areas used to grow plants in water (e.g. rice paddies). These areas are commonly referred to as potholes. Optional.
POT_FR	Fraction of HRU area that drains into the pothole. Required if IPOT is set to a number other than zero.
POT_TILE	Average daily outflow to main channel from tile flow if drainage tiles are installed in the pothole (m^3/s). Required only for the HRU that is ponding water (IPOT = current HRU number).
POT_VOLX	Maximum volume of water stored in the pothole (10^4 m^3 H_2O). Required only for the HRU that is ponding water (IPOT = current HRU number).
POT_VOL	Initial volume of water stored in the pothole (10^4 m^3 H_2O). Required only for the HRU that is ponding water (IPOT = current HRU number).
POT_NSED	Normal sediment concentration in pothole (mg/L). Required only for the HRU that is ponding water (IPOT = current HRU number).
POT_NO3L	*Not currently active*. Nitrate decay rate in pothole (1/day). Required only for the HRU that is ponding water (IPOT = current HRU number).

The HRU general input 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 for the HRU general input file is:

Variable name	Line #	Format	F90 Format
TITLE	1	character	a80
HRU_FR	2	real	free
SLSUBBSN	3	real	free
SLOPE	4	real	free
OV_N	5	real	free
LAT_TTIME	6	real	free
LAT_SED	7	real	free
SLSOIL	8	real	free
CANMX	9	real	free
ESCO	10	real	free
EPCO	11	real	free
RSDIN	12	real	free
ERORGN	13	real	free
ERORGP	14	real	free
FILTERW	15	real	free
IURBAN	16	integer	free
URBLU	17	integer	free
IRR	18	integer	free
IRRNO	19	integer	free
FLOWMIN	20	real	free
DIVMAX	21	real	free
FLOWFR	22	real	free
DDRAIN	23	real	free
TDRAIN	24	real	free
GDRAIN	25	real	free
NO VARIABLE	26	free	free
IPOT	27	integer	free
POT_FR	28	real	free
POT_TILE	29	real	free

Variable name	Line #	Format	F90 Format
POT_VOLX	30	real	free
POT_VOL	31	real	free
POT_NSED	32	real	free
POT_NO3L	33	real	free

CHAPTER 36

SWAT INPUT DATA: SOIL

The soils data used by SWAT can be divided into two groups, physical characteristics and chemical characteristics. The physical properties of the soil govern the movement of water and air through the profile and have a major impact on the cycling of water within the HRU. Inputs for chemical characteristics are used to set initial levels of the different chemicals in the soil. While the physical properties are required, information on chemical properties is optional.

Two files, the soil input file (.sol) and the soil chemical input file (.chm), contain the soil properties used by SWAT. The soil input file defines the physical properties and initializes chemical quantities for all layers in the soil. The soil chemical input file initializes additional chemical quantities for the first soil layer.

36.1 SOIL INPUT FILE (.SOL)

Following is a brief description of the variables in the soil input file. They are listed in the order they appear within the file. The soil input file will hold data for up to 10 layers.

Variable name	Definition
TITLE/TEXT	The first line of the .sol file is reserved for user comments. The comments may take up to 80 spaces. (optional)
SNAM	Soil name. If given, the soil name is used in data summarization.
HYDGRP	Soil hydrologic group (A, B, C, or D (required by the SWAT ArcView interface) The criteria for placement in hydrologic groups are: A Minimum saturated hydraulic conductivity in the uppermost 0.5 m is > 110 mm/hr and internal free water occurrence is below 1.5 m. B Minimum saturated hydraulic conductivity in the uppermost 0.5 m is between 11 and 110 mm/hr and internal free water occurrence is below 1.0 m. C Minimum saturated hydraulic conductivity in the uppermost 0.5 m is between 1.1 and 11 mm/hr and internal free water occurrence is below 0.25 m. D Minimum saturated hydraulic conductivity in the uppermost 0.5 m is below 1.1 mm/hr and internal free water occurrence may be at any depth.
SOL_ZMX	Maximum rooting depth of soil profile (mm). If no depth is specified, the model assumes the roots can develop throughout the entire depth of the soil profile.
ANION_EXCL	Fraction of porosity (void space) from which anions are excluded. This parameter is currently used only in nitrate transport. If no value for ANION_EXCL is entered, the model will set ANION_EXCL = 0.50

Variable name	Definition
SOL_CRK	Crack volume potential of soil (optional)
TEXTURE	Texture of soil layer (optional). This data is not used by the model.
SOL_Z(layer #)	Depth from soil surface to bottom of layer (mm).
SOL_BD(layer #)	Moist bulk density (Mg/m^3 or g/cm^3). The soil bulk density expresses the ratio of the mass of solid particles to the total volume of the soil, $\rho_b = M_S / V_T$. In moist bulk density determinations, the mass of the soil is the oven dry weight and the total volume of the soil is determined when the soil is at or near field capacity. Bulk density values should fall between 1.1 and 1.9 Mg/m^3.
SOL_AWC(layer #)	Available water capacity of the soil layer (mm H_2O/mm soil). This is the volume of water that should be available to plants if the soil, inclusive of rock fragments, was at field capacity. Available water capacity is estimated by determining the amount of water released between in situ field capacity (the soil water content at soil matric potential of -0.033 MPa) and the permanent wilting point (the soil water content at soil matric potential of -1.5 MPa).
SOL_K(layer #)	Saturated hydraulic conductivity (mm/hr). The saturated hydraulic conductivity, K_{sat}, relates soil water flow rate (flux density) to the hydraulic gradient and is a measure of the ease of water movement through the soil. K_{sat} is the reciprocal of the resistance of the soil matrix to water flow.
SOL_CBN(layer #)	Organic carbon content (% soil weight). When defining by soil weight, the soil is the portion of the sample that passes through a 2 mm sieve.
CLAY(layer #)	Clay content (% soil weight). The percent of soil particles which are < 0.002 mm in equivalent diameter.
SILT(layer #)	Silt content (% soil weight). The percentage of soil particles which have an equivalent diameter between 0.05 and 0.002 mm.
SAND(layer #)	Sand content (% soil weight). The percentage of soil particles which have a diameter between 2.0 and 0.05 mm.

Variable name	Definition
ROCK(layer #)	Rock fragment content (% total weight). The percent of the sample which has a particle diameter > 2 mm, i.e. the percent of the sample which does not pass through a 2 mm sieve.
SOL_ALB(layer #)	Moist soil albedo. The ratio of the amount of solar radiation reflected by a body to the amount incident upon it, expressed as a fraction. The value for albedo should be reported when the soil is at or near field capacity.
USLE_K(layer #)	USLE equation soil erodibility (K) factor (units: 0.013 (metric ton m^2 hr)/(m^3-metric ton cm)). The units given are numerically equivalent to the traditional English units (0.01 (ton acre hr)/(acre ft-ton inch)). The values for the metric units will be exactly the same as those for the English units.
SOL_EC(layer #)	*Not currently active* Electrical conductivity (dS/m).

The format of the soil input file is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	space 1-80	character	a80
SNAM	2	space 13-28	character	a16
HYDGRP	3	space 25	character	a1
SOL_ZMX	4	space 29-35	decimal(xxxxxxxxx.xx)	f12.2
ANION_EXCL	5	space 52-56	decimal(x.xxx)	f5.3
SOL_CRK	6	space 34-38	decimal(x.xxx)	f5.3
COMMENT LINE	7	space 1-147	character	a80
SOL_Z(1)	8	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SOL_Z(2)	8	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SOL_Z(3)	8	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SOL_Z(4)	8	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SOL_Z(5)	8	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SOL_Z(6)	8	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
SOL_Z(7)	8	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SOL_Z(8)	8	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SOL_Z(9)	8	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SOL_Z(10)	8	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
SOL_BD(1)	9	space 28-39	decimal(xxxxxxxxx.xx)	f12.2

Variable name	Line #	Position	Format	F90 Format
SOL_BD(2)	9	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SOL_BD(3)	9	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SOL_BD(4)	9	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SOL_BD(5)	9	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SOL_BD(6)	9	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
SOL_BD(7)	9	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SOL_BD(8)	9	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SOL_BD(9)	9	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SOL_BD(10)	9	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
SOL_AWC(1)	10	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SOL_AWC(2)	10	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SOL_AWC(3)	10	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SOL_AWC(4)	10	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SOL_AWC(5)	10	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SOL_AWC(6)	10	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
SOL_AWC(7)	10	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SOL_AWC(8)	10	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SOL_AWC(9)	10	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SOL_AWC(10)	10	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
SOL_K(1)	11	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SOL_K(2)	11	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SOL_K(3)	11	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SOL_K(4)	11	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SOL_K(5)	11	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SOL_K(6)	11	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
SOL_K(7)	11	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SOL_K(8)	11	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SOL_K(9)	11	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SOL_K(10)	11	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
SOL_CBN(1)	12	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SOL_CBN(2)	12	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SOL_CBN(3)	12	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SOL_CBN(4)	12	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SOL_CBN(5)	12	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SOL_CBN(6)	12	space 88-99	decimal(xxxxxxxxx.xx)	f12.2

Variable name	Line #	Position	Format	F90 Format
SOL_CBN(7)	12	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SOL_CBN(8)	12	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SOL_CBN(9)	12	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SOL_CBN(10)	12	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
CLAY(1)	13	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
CLAY(2)	13	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
CLAY(3)	13	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
CLAY(4)	13	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
CLAY(5)	13	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
CLAY(6)	13	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
CLAY(7)	13	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
CLAY(8)	13	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
CLAY(9)	13	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
CLAY(10)	13	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
SILT(1)	14	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SILT(2)	14	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SILT(3)	14	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SILT(4)	14	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SILT(5)	14	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SILT(6)	14	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
SILT(7)	14	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SILT(8)	14	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SILT(9)	14	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SILT(10)	14	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
SAND(1)	15	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SAND(2)	15	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SAND(3)	15	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SAND(4)	15	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SAND(5)	15	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SAND(6)	15	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
SAND(7)	15	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SAND(8)	15	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SAND(9)	15	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SAND(10)	15	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
ROCK(1)	16	space 28-39	decimal(xxxxxxxxx.xx)	f12.2

Variable name	Line #	Position	Format	F90 Format
ROCK(2)	16	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
ROCK(3)	16	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
ROCK(4)	16	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
ROCK(5)	16	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
ROCK(6)	16	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
ROCK(7)	16	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
ROCK(8)	16	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
ROCK(9)	16	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
ROCK(10)	16	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
SOL_ALB(1)	17	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SOL_ALB(2)	17	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SOL_ALB(3)	17	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SOL_ALB(4)	17	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SOL_ALB(5)	17	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SOL_ALB(6)	17	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
SOL_ALB(7)	17	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SOL_ALB(8)	17	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SOL_ALB(9)	17	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SOL_ALB(10)	17	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
USLE_K(1)	18	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
USLE_K(2)	18	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
USLE_K(3)	18	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
USLE_K(4)	18	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
USLE_K(5)	18	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
USLE_K(6)	18	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
USLE_K(7)	18	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
USLE_K(8)	18	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
USLE_K(9)	18	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
USLE_K(10)	18	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
SOL_EC(1)	19	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SOL_EC(2)	19	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SOL_EC(3)	19	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SOL_EC(4)	19	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SOL_EC(5)	19	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SOL_EC(6)	19	space 88-99	decimal(xxxxxxxxx.xx)	f12.2

Variable name	Line #	Position	Format	F90 Format
SOL_EC(7)	19	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SOL_EC(8)	19	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SOL_EC(9)	19	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SOL_EC(10)	19	space 136-147	decimal(xxxxxxxxx.xx)	f12.2

36.2 SOIL CHEMICAL INPUT FILE (.CHM)

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

Variable name	Definition
TITLE	The first line of the .chm file is reserved for user comments. The comments may take up to 80 spaces. Optional.
NUTRIENT TITLE	The second line of the .chm file is reserved for the nutrient data title. This is not used by the model. Optional.
SOIL LAYER	Number of soil layer. This line in the .chm file is not used by the model and may be left blank.
SOL_NO3(layer #)	Initial NO_3 concentration (mg/kg) in the soil layer Optional.
SOL_ORGN(layer #)	Initial organic N concentration in the soil layer (mg/kg). Optional.
SOL_SOLP(layer #)	Initial soluble P concentration in soil layer (mg/kg). Optional.
SOL_ORGP(layer #)	Initial organic P concentration in soil layer (mg/kg). Optional.
PESTICIDE TITLE	Lines 8-11 are reserved for pesticide data titles. The data on these lines are not used by the model.
PESTNUM	Number of pesticide from pesticide database (pest.dat) Required if pesticide amounts are given.
PLTPST	Initial pesticide amount on foliage (kg/ha). Optional.
SOLPST	Initial pesticide amount in soil (mg/kg). The pesticide is assumed to be found at this concentration in all soil layers. Optional.
PSTENR	Enrichment ratio for pesticide in the soil. This is the ratio of the pesticide concentration on the sediment transported in surface runoff to the pesticide concentration in the soil. Optional.

The format of the soil chemical input file is:

Variable name	Line #	Position	Format	F90 Format
TITLE	1	space 1-80	character	a80
NUTRIENT TITLE	2	space 1-80	character	a80
SOIL LAYERS	3	space 1-80	character	a80
SOL_NO3(1)	4	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SOL_NO3(2)	4	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SOL_NO3(3)	4	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SOL_NO3(4)	4	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SOL_NO3(5)	4	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SOL_NO3(6)	4	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
SOL_NO3(7)	4	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SOL_NO3(8)	4	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SOL_NO3(9)	4	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SOL_NO3(10)	4	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGN(1)	5	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGN(2)	5	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGN(3)	5	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGN(4)	5	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGN(5)	5	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGN(6)	5	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGN(7)	5	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGN(8)	5	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGN(9)	5	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGN(10)	5	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
SOL_SOLP(1)	6	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SOL_SOLP(2)	6	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SOL_SOLP(3)	6	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SOL_SOLP(4)	6	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SOL_SOLP(5)	6	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SOL_SOLP(6)	6	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
SOL_SOLP(7)	6	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SOL_SOLP(8)	6	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SOL_SOLP(9)	6	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SOL_SOLP(10)	6	space 136-147	decimal(xxxxxxxxx.xx)	f12.2

Variable name	Line #	Position	Format	F90 Format
SOL_ORGP(1)	7	space 28-39	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGP(2)	7	space 40-51	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGP(3)	7	space 52-63	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGP(4)	7	space 64-75	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGP(5)	7	space 76-87	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGP(6)	7	space 88-99	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGP(7)	7	space 100-111	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGP(8)	7	space 112-123	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGP(9)	7	space 124-135	decimal(xxxxxxxxx.xx)	f12.2
SOL_ORGP(10)	7	space 136-147	decimal(xxxxxxxxx.xx)	f12.2
PESTICIDE TITLE	8-11	space 1-80	character	a80
PSTNUM	12-END		integer	free
PLTPST	12-END		real	free
SOLPST	12-END		real	free
PSTENR	12-END		real	free