United Sates
Environmental Protection
Agency

Office of Water
(4305)

EPA-823-B-95-008
September 1995

EPA

SWMM Windows Interface User's Manual

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FOREWORD

Water quality standards are implemented through a process of developing Waste Load Allocations (WLAs) for point sources, Load Allocations (LAs) for nonpoint sources and natural backgrounds, and Total Maximum Daily Loads (TMDLs) for the watershed. Ultimately permit limits are developed based on these WLAs, LAs and TMDLs. Many of the required calculations are preformed with computer simulation models. Either steady-state or dynamic modeling techniques may be used.

The Office of Science and Technology develops and maintains analytical tools, such as the Storm Water Management Model (SWMM), to assist in performing analysis of water quality problems and developing TMDLs. The Windows interface developed for the SWMM model will help users prepare input files more efficiently. Calibration routines and plotting capabilities facilitate interpreting the model's results and calibrating the model. There are many useful features included in the SWMM Windows interface. Different screens or parts of screens will be active or inactive depending on the input. This feature reduces the potential for making mistakes during data entry.

This document is an Agency software user's manual. It does not establish or affect legal rights or obligations. It does not establish binding requirements. This document is expected to be revised periodically to reflect changes in this rapidly evolving area. Comments from users will be welcomed. Send comments to U.S. EPA, Office of Water, Office of Science and Technology, Standards and Applied Science Division (4305), 401 M Street SW, Washington, DC 20460.

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ACKNOWLEDGMENTS

The SWMM Windows Interface software and this user's manual were written by Mohammed Lahlou, Ph.D., and Sayedul H. Chcudhury of Tetra Tech, Inc. and Yin Wu, Ph.D., and Kirk Baldwin of General Science Corporation, under the direction of D. King Boynton of EPA's Office of Science and Technology. The authors would like to thank Gerald LaVeck, and Russell Kinerson of the Office of Science and Technology for their contribution and assistance in the successful completion of this project.

DISCLAIMER

The information contained in this user's manual is intended to assist in using the Windows™ interface for the SWMM model, developed by the U.S. Environmental Protection Agency's Office of Science and Technology. This user's manual is not a substitute for *Storm Water Management Model, Version 4: User's Manual* developed by Wayne C. Huber and Rober E. Dickinson (EPA/600/3-88/001a) which addresses the model theory, and provides more specific guidance on applications.

TRADEMARKS

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1. INTRODUCTION

The EPA's Storm Water Management Model (SWMM) is a large, complex model capable of simulating the movement of precipitation and pollutants from the ground surface through pipe and channel networks, storage/treatment units, and finally to receiving waters. Both single-event and continuous simulation may be performed on catchments having storm sewers, combined sewers, and natural drainage, for prediction of flows, stages, and pollutant concentrations.

The model may be used for both planning and design. The planning model is used for an overall assessment of the urban runoff problem and proposed abatement options. This model is typified by continuous simulation for several years using long-term precipitation data. Catchment schematization is usually "coarse" in keeping with the planning level of analysis. A design-level, event simulation also may be run using a detailed catchment schematization and shorter time steps for precipitation input.

The SWMM Windows interface was developed to assist the user in data input and model execution and to make a complex model user-friendly. The Windows interface was developed for the Office of Science and Technology, Standards and Applied Sciences Division of the U.S. Environmental Protection Agency to assist them with the Total Maximum Daily Load (TMDL) program. This user's guide provides guidance on the use of the SWMM interface and illustrates its use with four example runs. The Windows interface integrates the SWMM model and data handling needs to make the model implementation user friendly. A brief description of the SWMM model structure is presented in order to facilitate subsequent discussions.

This guide is divided into seven sections. Section 2 gives you a technical summary of the SWMM model, as well as the model structure, the interaction between the various blocks of SWMM, the input requirements, and the output. Section 3 describes the Windows Implementation of the blocks, including descriptions of the screens sequences, the corresponding blocks, changes made for ease of use, and limitations of the implementation. Section 4 provides minimum hardware requirements and installation information for the Windows SWMM. Section 5 provides the information necessary to use the SWMM interface, including:

- Accessing an Existing File or Opening a New File
- File-Naming Conventions
- Saving Input Files
- Setting Up a Default Editor for Viewing Output Files
- SWMM Windows Interface Commands and Function Keys
- Submitting an Input File to the Model
- Import File Option in SWMM
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- Using the Manual Run Option

Section 6 contains four example runs that highlight user entry and model output. Section 7 describes the SWMM post-processor capabilities, which allows the user to display tabulated summary information and graphical representations of the modeling results. Appendices provide the screen structure and variable descriptions for the Windows interface blocks.

2 TECHNICAL SUMMARY AND BACKGROUND

2.1 Overview of SWMM 4.3

SWMM simulates most quantity and quality processes in the urban hydrologic cycle on the basis of rainfall (hyetograph) and other meteorological inputs and system characterization (catchment, conveyance, storage/treatment). Storm sewers, combined sewers, and natural drainage systems can be simulated as well.

2.2 Model Structure and Description of Blocks

SWMM is constructed in the form of "blocks" as follows:

Computational Blocks:	Runoff, Transport, Extran, Storage/Treatment
Services Blocks:	Executive, Rain, Temp, Graph, Statistics, Combine

Each block has a specific function, and the results of each block are entered on working storage devices to be used as part of the input to other blocks. A typical run usually involves only one or two computational blocks together with the Executive Block. A summary of the four computational blocks in SWMM are shown in Table 2.1. This table explains the model capability, flow routing characteristics, and quality by block.

The Runoff Block is a critical block to the SWMM simulation. This block receives meteorological data from either Rain and/or Temp Blocks or user defined hyetographs (rainfall intensity vs. time) and then simulates the rainfall-runoff process using a nonlinear reservoir approach, with an option for snowmelt simulation. Groundwater and unsaturated zone flow and outflow are included using a simple lumped storage scheme. At the end, the Runoff Block produces hydrographs and pollutographs at inlet locations. This block may be run for periods ranging from minutes to years. Simulations less than a few weeks will henceforth be called single event mode and longer simulations will be called continuous mode. With the slight exception of snowmelt, all computations are done identically for the two cases (Huber and Dickinson, 1988). Quality processes in the Runoff Block include generation of surface runoff constituent loads through a variety of options: 1) build-up of constituents during dry weather and wash-off during wet weather, 2) "rating curve" approach in which load is proportional to flow rate to a power, 3) constant concentration (including precipitation loads), and/or 4) Universal Soil Loss Equation (Donigian and Huber, 1991). The overall catchment may be divided into a maximum of 200 subcatchments and 200 channel/pipes plus inlets. The Runoff Block transfers hydrographs and pollutographs for as many as 200 inlets and 10 constituents through an assigned interface file to other SWMM blocks.

The Transport block is one of the subsequent blocks and performs the detailed flow and pollutant routing through the sewer system. In the Transport Block, flow routing is accomplished using the kinematic wave method, while quality processes include first-order decay and simulating scour and deposition within the sewer system based on Shiled's criterion for initiation of motion, and generation of dry-weather flow and quality. The Transport Block uses inlet hydrographs and pollutographs generated either from the Runoff Block via the interface file or from the user defined option as the input, then determines the quantity and quality of dry weather flow, the system infiltration, pollutant loadings for each channel/pipe, and study area.

The Storage/Treatment (S/T) Block is a special type of element of the Transport Block. The S/T Block simulates the routing of flows and up to three pollutants through a dry- or wet-weather S/T tank containing up to five units or processes. It also simulates removal in S/T devices by 1) first-order decay coupled with complete mixing or plug flow, 2) removal functions (e.g., solids deposition as a function of detention time), or 3) sedimentation dynamics. Additionally, capital cost and operation and maintenance cost can be estimated for each unit.

The Extended Transport (EXTRAN) Block provides the SWMM with dynamic wave simulation capability (Roesner, L.A. et al, 1988). The EXTRAN Block is

Table 2.1 Summary of Computational Blocks in SWMM

Block	Capability			Flow Routing Characteristics		Quality
	Description	Quantity (inlets)	Quality (pollutants)	Method	Backwater Effects	Method
Runoff	simulate quantity and quality runoff of a drainage basin, route flows and pollutants to major sewer lines, produce hydrographs and pollutographs at inlet locations	200	10	Non-linear reservoir, cascade of conduits	No	1) build-up/wash-off; 2) rating curve approach; 3) const. concentration; 4) USLE.
Transport	routes flow and pollutant through the sewer system, determine quantity and quality of dry-weather flow, calculate system infiltration, land, capital, operation and maintenance costs of two internal storage tanks	200	4	Kinematic wave, cascade of conduits	No	Shield's criterion for initiation of motion, and generation of simulation of dry-weather flow and quality.
Extran	routes flow through the sewer system, simulate backwater profiles (flows) in open channel and/or closed conduit systems, a drainage system can be represented as links and nodes, looped pipe networks, weirs, orifices, pumps, and system surcharges	200	0	Dynamic wave, complete equations, interactive conduit network	Yes	No water quality simulation
Storage/ Treatment	characterize the effects of control devices upon flow and quality, simulate removal in S/T devices, calculate costs	5 units or processes	3	Storage routing		1) first order decay; 2) removal functions; 3) sedimentation dynamics.

the most comprehensive simulation program available in the public domain for a drainage system hydraulics and simulates branched or looped networks; backwater resulting from tidal or nontidal conditions; free-surface flow; pressurized flow or surcharges; flow reversals; flow transfer by weirs, orifice; and pumping facilities; and storage at on-line or off-line facilities. EXTRAN uses a link-node description of the sewer system that facilitates the discrete representation of the physical prototype. The conduit system is idealized as a series of links and channels/conduits, which are connected as nodes or junctions. Links and nodes have well-defined properties which, taken together, permit representation of the entire pipe network. Links permit flow from node to node. Nodes are the storage elements of the system and correspond to manholes or pipe junctions in the physical system. Inflows, such as inlet hydrographs, and outflows, such as weir diversions, take place at the nodes of the idealized sewer system.

These four computational blocks can be run either independently or in any sequence. Additionally, service blocks are available for supporting the computational blocks. They are statistical analysis of the output time series (Statistics Block), input and manipulation of precipitation, evaporation, and temperature time series (Rain and Temp Blocks), line printer graphics (Graph Block), and output time series manipulation (Combine Block).

2.3 Data Requirements

Depending upon the simulation objective, input data requirements can range from minimal to extensive. For simulation of a complete drainage network, data collection can be accomplished within a few days, but reducing the data for input to the model may take up to 3 person-weeks for a large area (e.g., greater than 2000 acres). For an EXTRAN simulation of sewer hydraulics, expensive and time-consuming field verification of sewer invert elevations is often required. On an optimistic note, however, most data reduction, i.e., tabulation of slopes, lengths, and diameters, is straightforward (Ambrose and Barnwell, 1989).

Categories of Data:

1) Weather Data: hourly or daily precipitation; daily or monthly evaporation rates. Snowmelt: daily max - min temperatures, monthly wind speeds, melt coefficients and base temperatures, snow distribution fractions and areal depletion curves (continuous only), and other melt parameters.

2) Surface quantity: area, imperviousness, slope, width, depression storage and Manning's roughness for pervious and impervious areas; Horton or Green-Ampt infiltration parameters.

3) Subsurface quantity: Porosity, field capacity, wilting point, hydraulic conductivity, initial water table elevation, ET parameters; coefficients for groundwater outflow as function of stage and tail water elevations.

4) Channel/pipe quantity: linkages, shape, slope, length, Manning's roughness. EXTRAN transport also requires invert and ground elevation, storage volumes at manholes and other structures; geometric and hydraulic parameters for weirs, pumps, orifices, storage, etc.; infiltration rate into conduits.

5) Storage/sedimentation quantity: stage-area-volume-outflow relationship, hydraulic characteristics of outflows.

6) Surface quality: land use; total curb length; catchbasin volume and initial pollutant concentrations; street sweeping interval, efficiency and availability factor; dry days prior to initial precipitation; dust/dirt and/or pollutant fraction parameters for each land use, or pollutant rating curve coefficients; concentrations in precipitation; erosion parameters for Universal Soil Loss Equation, if simulated.

7) Dry-weather flow constant or on basis of diurnal and daily quantity/quality variations, population density, other demographic parameters.

8) Particle size distribution, Shields parameter decay coefficients for channel/pipe quality routing and scour/deposition routine (optional).

9) Storage/treatment: parameters defining pollutant removal equation; parameters for individual treatment options such as particle size distribution, maximum flow rates, size of unit, outflow characteristics; optional dry-weather flow data when using continuous simulation.

10) Storage/treatment cost: parameters for capital and operation and maintenance costs as function of flows, volumes and operating time.

In order to create SWMM input files, the users have to follow certain sequences within one particular block or between blocks. In the Runoff Block, for example, the Group Identifiers, i.e., SWMM ID, are defined as the order of input data and are characterized into five sections: general input and control data, meteorological data, surface quantity, surface quality, and print control. Each section may be divided into subsections, e.g., meteorological data include snow data, precipitation data, and evaporation data. Many individual parameters are entered in those data categories.

2.4 Output

SWMM produces a time history of flow, stage and constituent concentration at any point in the watershed for Runoff, Transport, Storage/Treatment Blocks. Seasonal and annual summaries are also produced, along with continuity checks and other summary output. Simulation output in the Extran takes the form of water surface elevations and discharges at selected system locations.

3 TECHNICAL DESCRIPTION OF THE SWMM IMPLEMENTATION IN WINDOWS

The SWMM Windows interface is designed to be as user-friendly as possible. The SWMM Windows interface consists of five interface blocks: METeorological data (MET), RUNOFF, USEr defined Hydrographs and Pollutographs (USEHP), TRANSPORT, and EXTRAN. Basically, the MET function acts as the Rain and Temp blocks. The RUNOFF, TRANSPORT, and EXTRAN interface blocks perform the same functions as the Runoff, Transport, and EXTRAN Blocks do in SWMM 4.3. The USEHP function allows the user to define time series of flows and concentrations at desired inlets.

A key feature of the design of a "Windows" user interface for SWMM 4.3 is the separation of meteorological data from the Runoff Block of user input. Users will access the MET interface to create and edit meteorological data. Selection of meteorological data for use in a RUNOFF run will occur as part of the RUNOFF function. The goal of this function is to consolidate user interaction and input of meteorological data in SWMM into one separate module. From a user's perspective, all meteorological data will be accessed unambiguously by a single file name. This therefore, eliminates meteorological data entry in the RUNOFF input file. Similar consideration made in the TRANSPORT and EXTRAN functions is the separation of user defined hydrographs and pollutographs from the TRANSPORT and EXTRAN user input. The *USEHP function was developed to handle all user-supplied flows and concentrations.*

The normal execution sequence for the SWMM Windows interface is indicated by an arrow symbol as shown in the screen in Figure 3.1. Usually, MET should be executed first to create interface files that are required input to the Runoff Block. Likewise, RUNOFF creates an interface file that is required input to the Transport and EXTRAN Blocks. USEHP serves the same function for input to the Transport and EXTRAN Blocks as the runoff interface file does. TRANSPORT or EXTRAN can be executed independently when either a Runoff interface file or a USEHP file exists.

NOTE: In order to differentiate the Windows Interface blocks from the actual SWMM blocks (even if they are practically the same thing in some instances), the Windows Interface Blocks will be in capital letters and will be identified as an "interface block".

3.1 MET

As mentioned earlier, MET allows the user to create and edit meteorological data. Input data in MET consists of three data components: general meteorological parameters, precipitation and evaporation, and snow data. Those three elements take a total of six screens (see Table 3.1). The first screen describes the control variables in MET, such as the types of meteorological data and units associated with the MET data. The selections on the first screen determines which subsequent screens are accessible. The next two screens contain raingage stations and precipitation data. The fifth screen defines monthly average evaporation and/or wind speed. Air temperatures are stored on the fourth screen for continuous snowmelt simulation, and on the last screen for single event snow melt simulation. RAIN (precipitation) and evaporation data are always required in MET. Wind speed and temperature data are needed when the snowmelt is simulated .

Precipitation data are the single most important group of hydrologic data required by SWMM. SWMM requires a hyetograph of rainfall intensities versus time for the period of simulation. For single event simulation, this is usually a single storm, and data for up to ten raingages may be entered. For continuous simulation, hourly, daily or other continuous data from at least one gage are required. RAIN data can be selected from a NOAA data file, an existing user-created file, or a new file. NOAA data files are obtained from the EPA Environmental Research Lab in Athens, Georgia. They contain 35-year daily weather data for all NOAA first order stations in the United States. Please note that at present only one raingage is available when the user selects the NOAA

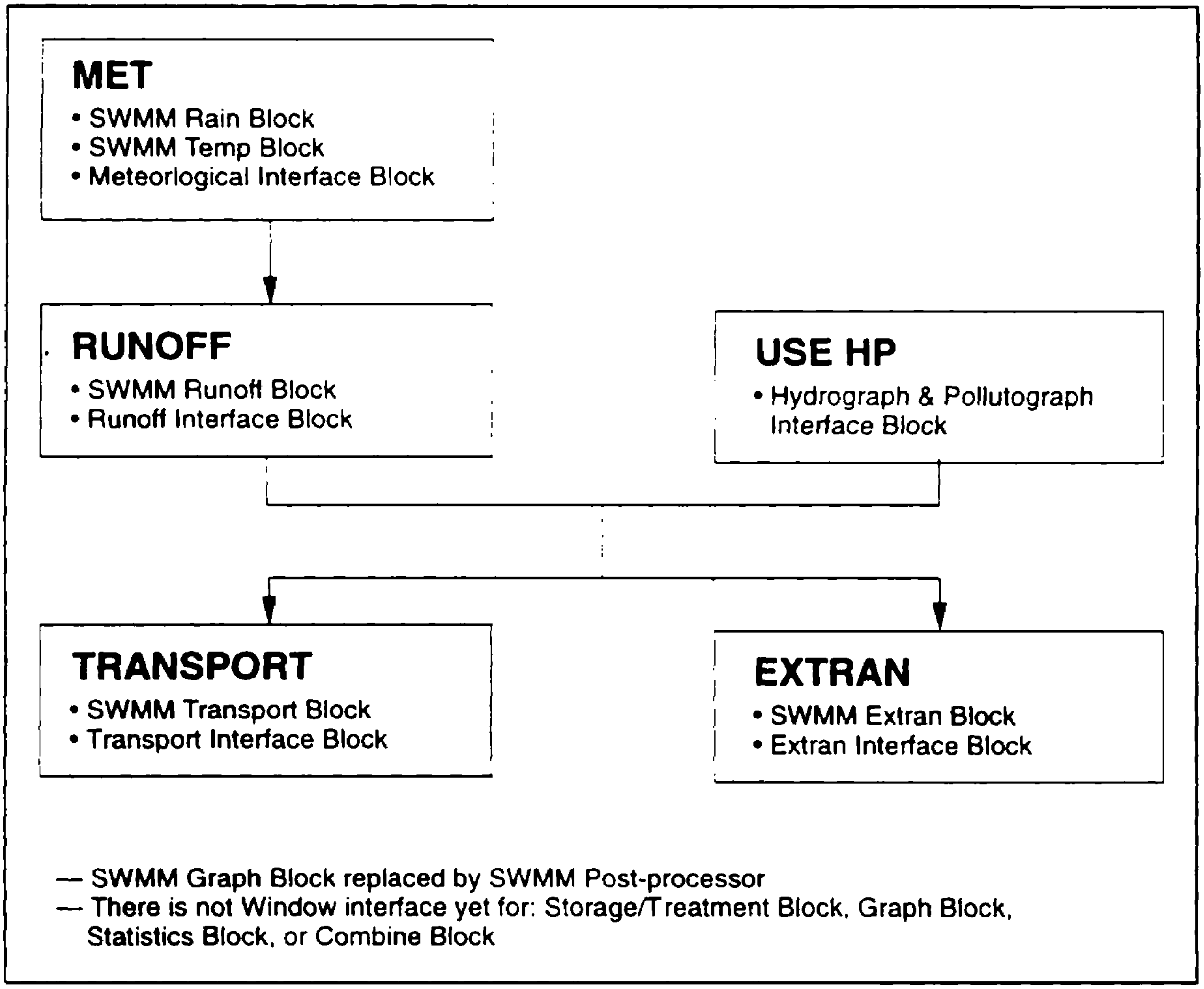


Figure 3.1 SWMM Windows Interface Functions.

data option from our meteorological database. The RAIN data should be entered in the Rain Data Table on Screen No. 3. Input variables for this screen are listed in Table A.1. The format used in Rain Data Table is the same one stored in the Rain Block interface file of SWMM, which is an unformatted binary file. Thus, the RAIN data can be handled through the Rain Data Table instead of using the Rain Block and E1-E3 data groups in Runoff Block.

NWS precipitation data can be also read into the MET function. The data include: 1) hourly and 15-min precipitation data for NWS Release B Condensed (IFORM=4 in the Rain Block), and 2) hourly precipitation data for NWS Card Deck 488 file (IFORM=2 in the Rain Block).

Evaporation can be input either by entering monthly average rates or using default rates that are internally supplied in the SWMM model. Wind speed and temperature data are needed, if snowmelt simulations are included. Similar to evaporation rates, a monthly average wind speed should be provided. When a daily NOAA data file is selected, MET will automatically compute monthly values for evaporation and wind speed.

Air temperature can be entered on either Screen No.4 or Screen No. 6 based upon the types of snowmelt simulation. Continuous snowmelt simulation requires

Table 3.1 Data Category and Screen Input in MET interface

<table>
<tr><th>Data Element</th><th colspan="3">Category</th><th>Screen Title</th><th>Data Requirement</th><th>Screen No.</th></tr>
<tr><td>1</td><td colspan="4">General Meteorological Parameters</td><td>Units, control variables</td><td>1</td></tr>
<tr><td rowspan="4">2</td><td colspan="3" rowspan="2">Precipitation</td><td>Station Table</td><td>Raingage station number (max=10)</td><td>2</td></tr>
<tr><td>Rain Data Table</td><td>Hourly, daily, and any time step precip. values</td><td>3</td></tr>
<tr><td colspan="3" rowspan="2">Evaporation</td><td rowspan="3">Avg. EVAP & WINDSPEED Table</td><td>Default evap. rates</td><td>1</td></tr>
<tr><td>Monthly evap. rates</td><td>5</td></tr>
<tr><td rowspan="3">3</td><td rowspan="3">SNOW</td><td colspan="2">Windspeed</td><td>Monthly windspeed rates</td><td>5</td></tr>
<tr><td rowspan="2">Temp</td><td>Single Event</td><td>Single Event Snow Melt Air Temp. Table</td><td>Time interval, air temp values</td><td>6</td></tr>
<tr><td>Continuous</td><td>TEMP Data Table</td><td>Daily Max & Min temp. data</td><td>4</td></tr>
</table>

a complete time history of daily maximum and minimum temperatures on Screen No. 4. These maximum/minimum temperatures are supplied in the NOAA data file. A single event snowmelt simulation receives air temperatures from Screen No. 6 for a given time step entered on the first screen. The temperatures are constant over the time interval.

After all the data are entered, MET will generate four MET interface files: a RAIN data interface file, a TEMP data interface file, an evaporation and wind speed file (EVAWIND), and a single event snow melt temperature file (SINAIR). The first two interface files are the SWMM scratch files processed during the execution of the Runoff block. The other two files would be processed into the Runoff Block input file. The evaporation and wind speed data from the EVAWIND file will be placed on F1 and C2 data group lines in the RUNOFF input file, respectively. The air temperature from the SINAIR file will be input to C5 data group line.

3.2 RUNOFF

The RUNOFF interface block assist in creating the Runoff input file and call the SWMM Runoff Block for execution. It is designed to closely follow the input representation order in the Runoff Block. Input data in RUNOFF are divided into five data elements: general control parameter, meteorological data, water quality, description of a drainage system, and print control. The general control parameter includes identifying a MET file, unit, simulation length, starting date, time step, and type of simulations. These selections determine whether subsequent screens or controls are accessible. The meteorological data include precipitation, evaporation, temperature, and wind speed, which should be generated through the MET function. Water quality simulation requires the user to specify up to ten pollutants and appropriate parameters to buildup and washoff mechanisms, and up to five land uses to characterize different subcatchments. Erosion and groundwater simulations are optional. A drainage system can be described as number of subcatchments (subwatersheds connected with channels/pipes. Necessary inputs associated with subcatchment are surface area, width, ground slope, Manning's roughness coefficient, and infiltration rates. Channel descriptions are the length, Manning's roughness coefficient, invert slope, diameter for pipes, and cross-sectional dimensions of the channel. Other inputs are discussed in Section 2.1.

There are a total of twenty-three screens in the RUNOFF interface. The screen input sequence (see Table 3.2) reflects the overall structure of the Runoff

Table 3.2. Screen Input Sequence in RUNOFF Interface

Data El.	Category	Content			SWMM ID	Screen No.
1	General Control Parameter	Titles			A1	1
		Units			B1	2
		Simulation	Starting, ending time, time step		B1, B3	1
		Simulation Type: Groundwater Flow & Quality (J1)				2
2	Meteorologic Data (B1)	Precipitation (D1)	hyetographs (1-10)		E1-E3	2
			RAIN (database)			
		Evaporation	default rates		F1	
			monthly rates			
			TEMP (database)			
		Snow (B1)	no		C1-C5	2,3,4,5
			single event			
			continuous			
3	Water Quality	Pollutants (1-10)			J3	6 & 7
		Land uses & fractions			J2 & J4	8 & 9
		Groundwater Concentration			J5	10
4	Description of a Drainage System	Channel/Pipe	#,inlet #, length,slope, Manning's n		G1-G2	11
		Watershed/ Subcatchment	Surface Water	#, inlet	H1	12 & 13
				infiltration		
			Groundwater	physical	H2-H4	14
				empirical		
			Snow		I1-I2	15 & 16
			Erosion		K1	17
			Quality		L1-L2	18
5	Print control	SWMM output, Inlet hydrographs, pollutographs, inflows, outflows, channel depths.			B2, M1-M3	19-23

Block. Screen numbers are assigned corresponding to the data elements and to cover all the input requirements. Table 3.2 also shows the relationship between the screen numbers in the RUNOFF interface and SWMM ID (Group Identifiers) in a RUNOFF input file. Furthermore, a spreadsheet (see Table A.2) is generated to identify the controls (variables) for each screen. This table defines the following for RUNOFF:

1. variable name in the Runoff Block,
2. the description of the variable,
3. SWMM ID in the Runoff Block (SID),
4. screen number (SCR),
5. control number (CS),
6. control type (CT), item, range, default, and unit.

Each variable in the Runoff Block for SWMM 4.3 has a unique control number on a particular screen in the RUNOFF interface. For example, if you refer to the first page of Table A.2, a variable WET in SWMM 4.3 is interpreted as Wet time step (sec), which is the eighth control on the first screen in the RUNOFF Windows interface.

For WET, the SID (SWMM ID) should be under Group B3, the type is floating, the range must be equal or greater than one, the default should be 3600.0 seconds, and the unit is in seconds. The relationship between variables of SWMM 4.3 and controls of SWMM interface can be easily checked in Table A.2.

3.3 USEHP

The USEHP function is designed to create and edit user-defined inlet flows and concentrations. This option is preferable to the RUNOFF interface file option for those users who wish mainly to use the Transport Block or the EXTRAN Block. For EXTRAN, the user should provide only inlet hydrographs in USEHP since EXTRAN is not capable of simulating water quality. Any quality information that is input to EXTRAN is ignored by the program.

There are a total of five screens in the USEHP interface block and input requirements are listed in Table 3.3. USEHP will generate four USEHP files (see Table 5.1) as input to the Transport and Extran Blocks. As shown in Table 3.3, the values stored in USEHP correspond to the variables and data group lines in either a Transport Block input or an EXTRAN Block input. For a Transport input file, two variables, (i.e., NINPUT and NCNTRL) and two data lines (i.e., I1 and R1) are used for inlet hydrographs; and a variable (NPOLL) and two data lines (i.e., F1 and R1) are used for inlet pollutographs. Similarly, for an EXTRAN input a variable, NJSW, and K1-K3 data lines are used for the inlet hydrographs.

3.4 TRANSPORT

The Transport Block was implemented following the same procedure as used for the Runoff Block. Table 3.4 indicates the screen input sequence in the TRANSPORT interface as compared to in the SWMM model. The TRANSPORT interface is characterized into six data components, namely TRANSPORT simulation control, sewer system description, water quality, infiltration and dry-weather flow, study area description, and print control. TRANSPORT simulation control defines an inlet hydrograph and pollutograph file, computational parameters, units, and types of simulation. Sewer system description provides the physical characteristics of the conveyance system. Quality data identify pollutants to be routed and their characteristics. Infiltration and Dry-Weather Flow (DWF) data describe the necessary drainage area characteristics to permit the computation of the respective inflow quantities and qualities. Print control reports a time history of inlet hydrographs and pollutographs, and a time history of channel depths.

Table 3.3 Screen Input Sequence in USEHP interface

Data Element	Category	Data Requirement	Transport Block	Extran Block	Screen No.
1	General Control Parameters	Units, # of inlets, # of pollutants, # of data points	NINPUT NPOLL	NJSW	1
2	List of Inlet Numbers	Inlet number	I1	K2	2
	Pollutant Name Table	Pollutant name, input and output unit	F1	No	3
	Time of day	Time in hours	R1	K1,K3	4
	Hydrograph/Pollutograph Table	Time series of flows and concentrations			5

Table 3.4 Screen Input Sequence in TRANSPORT Interface

Data Element	Category	Content		SWMM ID	Screen No.
1	TRANSPORT Simulation Control	Title		A1	1
		Inlet Hydrographs and Pollutographs		B3	
		Computational Control		B1,B3	
		Simulation Type	Simulation Type	B3	2
			Unit	B1	
			# of Constituents	B1	
2	Sewer System Description	Sewer System Table		E1	3
		Special Types of Sewer Element	Storage Tank	G1-G5	
			New Shapes	C1,D1-D9	
			Natural Channel (HEC-2 format)	E2-E4	
3	Water Quality			F1	4
4	Infiltration and Dry-Weather Flow			K1,K2,L1-L3, M1-M4	5,6,7,8
5	Study Area Description	Study Area Parameters		N1,O1,O2	9 & 10
		Process Flow Characteristics		P1	11
		Categorized Study Area		Q1	12
6	Print Control	Printed non-conduit elements for hydrograph & pollutograph	Transferred to Graph Block	B1,C1,H1	13 & 14
			Input	J1	15
			Output	J2	16
		Printed conduit elements for depths		I2	17

The physical representation of the sewer system is a key input to the TRANSPORT simulation. The sewer system is classified as a certain type of "element." All elements in combination form in a manner similar to that of links and nodes (Huber and Dickinson, 1988). Elements in a real system can be described as a network of conduits (e.g., channels/pipes) joined with non-conduits such as manholes. Conduits themselves may be of different element types depending upon their geometrical cross-section. Non-conduits must be located at points corresponding to inlet points for hydrographs generated by either the Runoff Block or USEHP. According to SWMM documentation, there is a total of twenty-five types of elements that are available for use in Transport Block (See Table 3.5). Eighteen of them are conduit elements and seven are non-conduit elements. For the elements with regular shapes, data requirements are usually the tabulation of shape, dimension, slope, and roughness parameters. While for the elements with irregular shapes, supplemental data are required, such as flow-area and depth-area relationships of the elements. The irregular shapes are new shapes and natural channels with HEC-2 format for conduit elements and storage tanks for non-conduit elements.

Only up to four pollutants can be handled for water quality simulation in the Transport Block. Pollutants may be introduced to the sewer system by either the RUNOFF interface or USEHP using the data group I1 and R1 in the Transport input file.

The TRANSPORT interface contains a total of seventeen screens. The data components associated with screen numbers in the interface and SWMM ID in SWMM 4.3 are presented in Table 3.4. Table A.4 contains a description of the TRANSPORT data requirements including variable definitions, SWMM ID, screen number, control number, control type, control item, type, range, default, and units. This table was designed to assist in assembling data for implementing WINDOWS processes of SWMM and give a clear picture of identifying the variables used in TRANSPORT interface as compared to SWMM 4.3.

The TRANSPORT interface reads the data for conduit and non-conduit elements from the Sewer System Table on Screen No. 3. Different element types supplied with the TRANSPORT block and corresponding element names used in the TRANSPORT interface are listed in Table 3.5. Three irregular shapes of elements are a natural channel, a user-supplied shape, and a storage unit. They are treated as special elements and have to be separate functions in the TRANSPORT interface. Currently, the TRANSPORT allows the user to specify three types of files, which correspond to three types of sewer elements. They are defined as follows:

Special Elements	SWMM Data Groups in Transport Block	File Name Used in TRANSPORT interface
HEC-2 format	E2-E3	XHEC2*.PIP
User supplied	C1, D1-D9	XSHAP*.PIP
Storage unit	G1-G5	XTANK*.PIP

The files must contain the input parameters and data group lines required by the TRANSPORT input. The three types of files are XHEC2### PIP for a natural channel, XSHAP### PIP for a user supplied shape, and XTANK###.PIP for a storage unit. For example, you define a non-conduit element as a storage tank, you need to prepare a data file containing G1-G5 data group lines using any text editor outside of the Windows interface. You should save this file as

XTANK*.PIP. Next, go to the fourth column under TYPE on Screen 3 in the TRANSPORT interface and specify the file that you created. Table 5.1 presents files created by TRANSPORT

3.5 EXTRAN

There are three data components included in the Extran Block: EXTRAN simulation control, sewer system description, and output print and plot. The EXTRAN simulation control defines the simulation, an inlet hydrograph file, computational control, and simulation methods. Like the TRANSPORT interface, EXTRAN gets inlet flows from either a RUNOFF interface file or a USEHP file. Therefore, the user must run either RUNOFF or USEHP before proceeding with EXTRAN. The sewer system description is divided into two sections: identification of channels/conduits and junctions. The cross sections of channels/conduits can be regular or irregular. For regular channels, input data are relatively simple. For irregular channels, however, data are complex and a detailed description to define cross sections for each channel is needed. Junction data can be described as regular junctions and special flow devices that divert sanitary sewage out of a combined sewer system or relieve the storm load on sanitary interceptors. The five types of junctions are storage, orifice, weir, pump, and outfall. Like irregular channels, those special junctions may require detailed input describing a time-history curve for stage, volume, flow, etc. Output print and plot determine number junctions and channels for printing and plotting of heads and flows.

There are twenty-three screens for the EXTRAN interface, as shown in Table 3.6. Sixteen of these screens are for inputs for channels and junctions. Two looping screens are developed to handle large input depending upon the type of channel or junction. Variable input sequences on each screen are given in

Table A.5, which defines the variable name, the description of variable, SWMM ID, screen number, control number, and the variable's usage

Screens No. 4 and 5 are designed to store the data for natural channels, which use the same format as used in the HEC-2 model.

3.6 Limitations of The SWMM Windows Interface

The SWMM Windows Interface has several limitations. These limitations are summarized below:

1. In the RUNOFF Windows interface, the maximum number of watersheds and channels allowed is 100. For the SWMM Model 4.3, the maximum number allowed is 200. In the TRANSPORT and EXTRAN Interfaces, the maximum number of inlets and channels allowed is 100, while the maximum number of inlets and channels allowed in the SWMM model is 200.

2. Due to problems with the subcatchment number variable, which would not accept names, all IDs in all the Windows interfaces have to be integers instead of characters. You cannot enter a name for pipes, subcatchments, inlet numbers.

3. Due to problems encountered with the snow melt simulation and with the conversion of the pan evaporation data, daily evaporation rate and wind speed data from the MET interface for continuous snowmelt simulation will be converted to monthly data.

Table 3.5 Different Element Types in Transport Block

NTYPE	Transport Block	TRANSPORT interface
	CONDUIT ELEMENTS	
1	Circular	Circular
2	Rectangular	Rectangular
3	Phillips standard egg shape	Egg shape
4	Boston horseshoe	Horseshoe
5	Gothic	Gothic
6	Catenary	Catenary
7	Louisville semielliptic	Semielliptic
8	Basket-handle	Baslet-Handle
9	Semi-circular	Semi-circular
10	Modified basket-handle	Modified B-H
11	Rectangular, triangular bottom	R + tri bottom
12	Rectangular, round bottom	R + round bottom
13	Trapezoid	Trapezoid
14	Parabolic	Parabolic
15	Power Function	Power F
16	HEC-2 Format - Natural Channel	XHEC2###.PIP
17, 18	User supplied	XSHAP###.PIP
	NON-CONDUIT ELEMENTS	
19	Manhole	Manhole
20	Lift station	Lift station
21	Flow divider	Flow divider
22	Storage unit	XTANK###.PIP
23	Flow divider - weir	Flow divider-weir
24	Flow divider	Flow divider
25	Backwater element	Backwater

Table 3.6 Screen Input Sequence in EXTRAN Interface

Data Element	Category	Content		SWMM ID	Screen No.
1	EXTRAN Simulation Control	Title		A1	1
		Inlet Hydrographs		B3,K1,K2,K3 (if USEHP is selected)	
		Computational Control and Unit		B1,B3,B2	
		Simulation and print control	Solution technique, flow condition, and conduit elevation	B0,BB	2
			Print cycle	B1	
2	Sewer System Description	Channels/Conduits	Channels/Conduits Table	C1	3
			Natural Channel (HEC-2 format)	C2-C4	4-5
		Junctions	Regular Junction	D1,I1,I2,J1	6
			Storage Junction	E1,E2	7-8
			Orifice	F1,F2	9-12
			Weir	G1	13-14
			Pump	H1	15-16
			Outfall	J2-J4	17-18
3	Output print and plot	Printed and plotted Junctions for elevations		B4,B6	19,21
		Printed and plotted channels for flows and velocities		B5,B7	20,22
		Plotted channels for US/DS elevations		B8	23

4 MINIMUM SYSTEM REQUIREMENTS AND SOFTWARE INSTALLATION

4.1 Minimum System Requirements

The system runs under Microsoft® Windows. The minimum system requirements are provided below:

- Windows Version 3.1
- 80386 Processor
- 4 Megabytes RAM
- 10 Megabytes hard disk space

NOTE: A math co-processor is recommended but not required.

4.2 Installing the Software

STEP 1. Insert the SWMM Setup Disk (i.e., SWMM - DISK 1), into drive A: or B:

NOTE: You must have 10 Megabytes of space on the hard disk drive on which you are installing SWMM for Windows. **Also close all open applications including FILE MANAGER before you start the SETUP program.**

STEP 2. Start Windows and, at the Program Manager, choose File Run.

STEP 3: Type A:SETUP.EXE ("B:" if the disk is on the B: drive) and press ENTER.

STEP 4: You will be asked to enter the path of the directory where you would like SWMM to be installed. When you accept the default path or enter a new directory path, the installation will begin.

Please note that the SWMM Windows interface consists of three disks.

STEP 5. You are now ready to use SWMM.

The executable for which the SETUP program has already created an icon is described below.

Executable	**Description**
SWMM.EXE	The main SWMM executable. This executable allows you access to the two SWMM options:

The Windows Interface Option:
This option calls up all the windows implementations of the various blocks of SWMM as explained in Section 3.

Manual Run Option:
For experienced users of SWMM and those familiar with the structure of the input files, this option allows you to edit input files directly using a data editor.

NOTE: The working directory option should be the one containing the executables since SWMM requires certain table files in order to create the input files.

5 USING THE SWMM WINDOWS INTERFACE

Once you have finished installing the software, you will be ready to access the SWMM Windows Interface and Manual Run option. When you select the Windows Interface option, you will see a flow-chart that is shown in Figure 3.1 that shows the various interface blocks that are available and the sequence you should follow in accessing them. All the interface blocks share certain characteristics since they are all in Windows. This section details how to use the capabilities available in the various interface blocks in SWMM. In addition, it will detail the Manual Run option as well. This section describes the following:

- Accessing An Existing File or Opening a New File
- SWMM File-Naming Conventions
- Saving Input Files
- Setting Up a Default Editor for Viewing Output Files
- Submitting an Input File to the Model
- SWMM Windows Interface Commands and Function Keys
- Import File Option in SWMM
- Export Function
- Array Screen Capabilities
- Using the Manual Run option

5.1 Accessing an Existing File or Opening a New File

When you first enter any of the Windows SWMM Blocks, you will be automatically assigned a new file. The new file name and number will appear at the top of the screen in parentheses.

To **access an existing file**, click on the **FILE** option on the very top line, select the **OPEN** option and select the file that you want from the list that appears.

NOTE: The input files must be in the same location as the *.EXE files (the SWMM executable files). If you elect to read in an existing file from a different directory, the directory that the file is in becomes the default directory for SWMM. All the data files for SWMM must exist in the default directory. So we strongly recommend that you do not save input files in any location other than the SWMM directory.

If you selected an existing file to edit, when you choose to save the file, the existing file will be rewritten with the new values unless you choose the SAVE AS option and assign a new file name. Please remember, if you are assigning a new name to a file, to follow the naming conventions followed by SWMM explained in the next subsection.

5.2 SWMM File Naming Conventions

The naming convention of files in SWMM is as follows: the first four characters are the interface block name, the next three digits are sequentially assigned numbers that indicate the number of the input file that you are currently creating, and the file extension indicates the file type. Table 5.1 summarizes naming conventions of the SWMM interface for each function. There are three file extensions in the MET input files. The first extension is .MET which indicates user defined meteorological data, the second one is .DAT that contains hourly precipitation data, and the last one is .ATH that indicates long term meteorological data obtained from the EPA Athens Lab. The file extensions in the RUNOFF and TRANSPORT interfaces are also standardized. For instance, *.INP is the input file and *.OUT is the output file.

Additional files for RUNOFF and TRANSPORT are post-processor files, which include the Tables, Graphics, and Calibration files. They are defined below:

Table 5.1 Naming Conventions of SWMM Interface

Interface Blocks	File Name	File Type (Fmt)[1]	Content
METeorological data editor (MET)	SMET###.MET	Input (A)	MET Windows interface input.
	*.DAT	Input (A)	Hourly precipitation data.
	*.ATH	Input (A)	Daily meteorological data for NOAA first order stations in the U.S. Provided by the EPA in Athens, GA.
	SMET###.MT1	Output/Input (B)	A Rain interface file that contains precipitation data. An input file to the Runoff Block.
	SMET###.MT2		A Temp interface file that contains maximum and minimum temperatures. This is an input file to the Runoff Block.
	SMET###.MT3		An monthly evaporation and wind speed file. To be placed in F1 and C2 lines in a Runoff input file.
	SMET###.MT4		A air temp data file for single snow melt simulation. To be placed in C5 line in a Runoff input file.
RUNOFF	RNOFF###.INP	Input (A)	RUNOFF Windows interface input.
	RNOFF###.RUN	Input (A)	RUNOFF run file which can be executed under DOS.
	RNOFF###.OUT	Output (A)	Runoff output generated by SWMM.
	RNOFF###.INT	Output (B)	Runoff interface file generated by SWMM.
USEr defined Hydrographs and Pollutographs (USEHP)	USEHP###.HP	Input (A)	USEHP Windows interface input.
	USEHP###.HP1	Output/Input (A)	An inlet hydrograph and/or pollutograph file. To be placed in the NINPUT, NPOLL, F1, I1, and R1 lines in a Transport input file.
	USEHP###.HP2		
	USEHP###.HP3		
	USEHP###.HP4		An inlet hydrograph file to be placed in K1-K3 lines and NJSW in EXTRAN input file.
TRANSPORT	TRANS###.INP	Input (A)	TRANSPORT Windows interface input.
	XTANK###.PIP		Storage tank data file defined by the user.
	XSHAP###.PIP		New shapes data file defined by the user.
	XHEC2###.PIP		Natural channel (HEC-2 format) file defined by the user.
	TRANS###.RUN		TRANSPORT run file which can be executed under DOS.
	TRANS###.OUT	Output (A)	Transport output generated by SWMM
	TRANS###.INT	Output (B)	Transport interface file generated by SWMM
EXTRAN	EXTRN###.INP	Input (A)	EXTRAN Windows Interface input
	EXTRN###.RUN		EXTRAN run file which can be executed under DOS
	EXTRN###.OUT	Output (A)	Extran output generated by SWMM
	EXTRN###.INT	Output (B)	Extran interface file, can be used for subsequent blocks.

[1]File format can be either ASCII (A) or Binary (B)

The RUNOFF Interface

SWRPP*.INP	Tables file based on RNOFF*.INT
SWRGR*.INP	Graphics file based on RNOFF*.INT
SWRCA*.INP	Calibration file based on RNOFF*.INT

The TRANSPORT Interface:

SWTPP*.INP	Tables file based on TRANS*.INT
SWTGR*.INP	Graphics file based on TRANS*.INT
SWTCA*.INP	Calibration file based on TRANS*.INT

5.3 Saving Input Files

SWMM will ask you whether you wish to save the input file when you exit an interface block or when you reach the last screen of an interface function. However, if you have accessed an existing file and made all the changes before reaching the last screen, you may save the input file by proceeding to the FILE option and selecting the SAVE option. Once you have completed an input file, you may submit it to the SWMM model for execution. When you submit the input file to the model, the input file will be validated by the Windows interface. If any errors are detected during the validation, you will be informed of them and brought to the incorrect entry so that you might effect the change immediately.

5.4 Setting Up a Default Editor for Viewing Output Files

The default editor for viewing and editing SWMM output files is the WRITE program in Windows. However, users may choose any other data editor (e.g., EDIT.EXE) for viewing the output by selecting the Utilities menu on the top line of the screen and using the Setup Output File Viewer option. The path and executable name of the output file editor should be specified under this option.

This output viewer is automatically activated each time a SWMM run is completed. To view the model output (rather than submitting a SWMM model run), the editor can be used outside the SWMM Windows interface. Using the appropriate file manipulations of the editor, the SWMM output file can be opened, edited, and saved.

5.5 Submitting an Input File to the Model

When you have completed the input file for the interface that you are in, select the RUN button to run the model with the input file you created. When you select the RUN option, all the entries in the file will be validated. If any errors are detected during the validation, SWMM will put up a message informing you of the type of error detected and will then take you to the prompt that is incorrect. Once all the values are valid, the file is submitted to the appropriate block for execution. An icon will appear at the bottom of the screen for those blocks for which the SWMM model is called. When the processing of the input file is complete and the output results, SWMM will ask whether you wish to view them. If you indicated that you did wish to view the output file, SWMM will show them using a data editor allowing you to annotate the results if you so choose. To exit from the Data File Editor, press the ALT and F4 function keys simultaneously. You will be returned to the interface block that you were in previously.

5.6 SWMM Windows Interface Commands and Function Keys

The Windows Interface options all have a series of "buttons" designed to make using the system as easy as possible. These buttons and the commands they represent are accessible in three ways: (1) click on the button with the mouse key to access the function that button represents, (2) press the ALT along with the underlined letter in the button title (e.g. ALT/H for Help), or (3) select the TOOL option and select the option under there from the list presented.

The buttons and the commands they represent are explained below.

The NEXT Button This option allows you to move to the next screen in the interface. If there are incorrect values on the screen that you are in currently and you attempt to move to another screen, SWMM will inform you of the error and allow you the option of going back (and correcting the error at a later time) or correcting the error. The cursor will blink at the prompt with the incorrect entry, if you elect to correct the error before moving on.

The BACK button This button allows you to move back one screen. If there are incorrect values on the screen that you are in currently and you attempt to move to another screen, SWMM will inform you of the error and allow you the option of going back (and correcting the error at a later time) or correcting the error. The cursor will blink at the prompt with the incorrect entry, if you elect to correct the error before moving on.

The INDEX Function Instead of moving backwards and forwards through the screens, you may use the INDEX feature to hop back and forth between screens. To access this feature, move your cursor over the INDEX button and click with the mouse button, or enter ALT, I. All the screens available in this option will be displayed with the screen title and the screen numbers. **Certain screens will be grayed out. This indicates that these screens are not accessible due to selections made on other screens. The screen that you were in when you selected the INDEX button will be highlighted in blue text**

If you wish to see the prompts that appear on each screen, press the EXPAND button at the bottom of the INDEX screen. The screen names and numbers will then include all the prompts contained in the screens. You may contract the screen again to the normal display of just the screen names and number by clicking on the CONTRACT button

To move to the screen that you want, move your cursor over the screen number of any non-gray screen and click the left mouse button. You are taken immediately to that screen. To exit the INDEX screen and return to the previous screen, click on the CANCEL button.

The HELP Button This option allows you access help information on that interface. You have two different types of help: **Prompt-Level Help** which contains information on the specific prompt that your cursor is on or on which you are entering data and **General Help** which contains a general description of the SWMM system.

To access **General Help**, move your cursor to the tool bar and the select the HELP option, or enter ALT, H from the keyboard. A menu will appear. Select the HELP INDEX option or enter I from the key board.

To access **Prompt-Level Help**, move your cursor over to the prompt on which you would like information and press either the **F1** function key or move your cursor over to the HELP button and click.

A window will appear in either case displaying broad help or prompt-specific help. **If you are accessing prompt-specific help, you may browse through the helps for all the additional prompts that are related to the prompt you are on by accessing the forward and backward BROWSE keys.**

All words or sentences that are in green and underlined have further information on them. Move your cursor over the phrase on which you would like further information and click. You will be taken to that option.

There is a search function within the HELP functions that allows you to type in a word and find all the help available on the word that you typed. To access this, select the SEARCH key in the HELP window and follow instructions.

When you are through viewing help, exit the help window by either entering ALT, F4 from the keyboard or by moving the cursor over to the icon on the top left corner of the window and double clicking the left mouse button. You will be returned to the screen that you were in previously.

The CALC Button This option allows you to access the Calculator Function within Windows, should you require the use of a calculator at any screen in SWMM.

The TOP Button This option allows you to move to the first screen in SWMM from any screen without having to use the INDEX function.

The RUN Button This option allows you to submit an input file that you have created to the SWMM model for execution. If you have incorrect entries in the file when you click on this button, SWMM will inform you that you have incorrect values and take you to the appropriate prompt so that you may correct the value and resubmit the file.

The RESTORE Button This option allows you to restore the default values that were in the file before you started making changes for this screen. This is an option that allows you to start again without having to exit the system or go back to every variable that you changed.

The TABLES Button This option allows you to tabulate the SWMM output results. The Tables function presents the user with two types of tables: Summary table and Event Mean Concentrations (EMCs) table.

The GRAPHICS Button This option allows you to graph the SWMM output results. There are six different types of graphs available: hydrograph, pollutograph, loadograph, flow volume, mass, and land use.

The CALIBRATION Button This option allows you to perform the calibration based on the SWMM results. You can use this option to compare simulated results with observed data. Two types of graphs and one statistical table are generated at the end of the calibration. Refer to Accessing The Calibration Routine for details (Section 7.3).

5.7 Import File Option in SWMM

The import file option allows the user to access existing input files that are generated from other model runs. The SWMM interface can import three types of files: NWS rainfall data can be imported into the MET interface for the Rain Block, an existing runoff input file can be imported into the Windows interface for the RUNOFF block and existing transport input files can be imported into the Windows interface for the TRANSPORT block.

Procedure for Using the Import Functions

The Import option is selected from the main menu bar at the top of MET, RUNOFF, or TRANSPORT interfaces. When the import option is selected, the Runoff file will appear as an option. Select this option.

A window will appear with a list of Runoff Input file that are in the SWMM directory. To see a list of files with extensions other than .DAT extension, select the List Files of Type option at the bottom of the window. The second option will be to see a list of all the files in the directory. To import a file from the list, bring the cursor to the file that you would like to import and click twice in quick succession or click on the OK button when the cursor is on the file. A description line, which consists of the top line of the file (i.e., the A1 card in the Runoff input), is provided to help you identify the file when the cursor is on the file name.

The SWMM interface currently supports the SWMM 4.2 version, although the SWMM 4.3 execution file (05/25/94) is used. Not all the SWMM input cards in the SWMM blocks can be read into the interfaces. For example, the L2 card in the Runoff Block cannot be imported to the RUNOFF interface. To find a list of the SWMM ID cards and variables that can be read into the interface refer to Appendix B. A message will be displayed on the screen when reading the new SWMM cards.

The weather data handled in SWMM interface is different from the Runoff Block of the SWMM model. The interface allows the user to enter all the weather data in MET while the Runoff Block lets the user enter the rainfall data either in the Rain Block or in the Runoff input itself. When importing an existing Runoff input file, the RUNOFF interface reads most of the data lines except E1-E3, D1, and F1 lines in the Runoff input file (see SWMM manual by Huber, W.C. and Dickinson, R.E., 1988, for explanation of data lines). Those rainfall and evaporation data should be entered in the MET interface. In other word, the user should interpret E1-E3, D1, and F1 lines and generate a new SMET*.MET file. A complete runoff interface file must include a MET file.

Existing input files can contain only one data block. Multiple blocks are not allowed. The interface Import function can read existing input files containing single block information, although the SWMM model allows the user to put more than one data block in one input file.

5.8 Export Function

The Export function is a function available under the Tables option that allows you to export Summary data or EMCs tables to another file for export into a spreadsheet program or another analytical or graphical program. The Export function is available under the Edit option at the top of the screen.

Using the Export Function

STEP 1. Highlight the block of data (either rows or columns or both) that you want to export. To select a block that is larger or wider than a screen, proceed to the cell that will begin your block and click with the left mouse button. Next move to the last cell in the block that you want and press the SHIFT key and the left mouse button simultaneously.

STEP 2. Select Edit at the top line of the window screen (ALT, E). Next, select Export. An Export screen will appear. You have two options for storing the data: table delimited or comma delimited. The table-delimited option will save the data in fixed columns, which is appropriate for a word processor. The comma-delimited option will separate the variables using commas, this option is appropriate for database and spreadsheet programs. After selecting the file format, provide a file name and hit the OK button. The highlighted block of data will be written into the file that you specified.

5.9 Array Screen Capabilities in SWMM

There are many array screens (the screens where the same variable requires a row of entries) in SWMM, such as hydraulic data, initial conditions, etc. At these screens, you have two additional capabilities that are not available on regular screens in SWMM.

1. EDIT: Copy and Paste

This option is available from the menu bar at the top of the Window (ALT, E). You may use this capability to select a block of data (either rows or columns or both) and paste it to another area if the same data is to be duplicated or copy data from a spreadsheet program where you may have climatological data, for instance, and copy it for use by SWMM. The first cell selected will be highlighted rather than in reverse video as are the remaining cells in the area that you have selected.

To select a block that is larger or wider than a screen, proceed to the cell that will begin your block and click with the left mouse button. Next move to the last cell in the block that you want and press the SHIFT key and the left mouse button simultaneously. This will highlight the area that you want.

To paste the block that you just copied, move to the area that you want to copy the block to and select the paste option from EDIT. You will see a message advising you that any data existing in the area that you selected will overwritten.

2. ARITHMETIC BOX

One of key features with the SWMM Windows interface is to provide mathematical calculations in columns so that the user can easily change a row of values in an array screen. This is because input values of variables in several groups or cards (e.g., G1 card) of the SWMM input may require "-1" or "-2" indicate a multiply ratio or a default value. This feature is selected by clicking on the variable title in any array, for instance, WIDTH (of subcatchment). A window will appear allowing you to do arithmetic operations for that column for a user-specified number of rows. You will be able to access an arithmetic function that allows you to add, subtract, multiply or divide any single or range of values for that variable. You may also set default values for a variable in any array screen. For example, you may choose to multiply all the values in the rainfall intensity when you perform sensitivity analyses.

5.10 Manual Run Option

This option is one of two main options available to you in the SWMM main menu. This option allows you to edit input files and submit the appropriate ones to the model. Table 5.1 gives you a summary of all the input and output files generated by SWMM and their file formats. Refer to it if you have any questions about any of the files. You may only edit ASCII files. This option requires some expertise in SWMM, so we recommend that you use the Windows interface option to familiarize yourself with the SWMM Model prior to using this option. To change the default file editor, select the Utilities option at the top of the screen. Click on Setup Output File Viewer. You will then be required to enter the location and executable name of the output file editor when you select this option.

You have two options for the SWMM Input files:

EDIT You may edit two types of files using this option: *.RUN, which are the files generated by the RUNOFF, TRANSPORT, and EXTRAN interfaces for input to SWMM or *.DAT files, which are the traditional files created for the DOS model version of SWMM that you may have created previously or came with the SWMM model (the example runs that are provided, see Section 5).

RUN Once you have edited either the *.RUN files or the *.DAT files, you may submit them for processing by the SWMM model by selecting this button.

6. EXAMPLE RUNS

This section contains four example runs to illustrate how to best use the SWMM Windows interface. The example runs are selected in an attempt to exercise the major portions of the SWMM interface. A matrix of SWMM interface with the various runs is shown in Table 6.1. The SWMM interface contains five blocks: MET, RUNOFF, USEHP, TRANSPORT, and EXTRAN. Each block has its own components, and each component may be divided into sections if applicable. Five SWMM interface blocks and their subdivisions are listed in the first column. The four example runs are given on the top row of Table 6.1. For a given example, two or more blocks may be used depending on the level of complexity of the simulation. Example 2 shown in Table 6.1, for instance, illustrates the combination of three blocks: MET, RUNOFF, and TRANSPORT. It includes the applications on 1) how to generate precipitation data for a single event simulation using MET; 2) how to describe a drainage system with channels and subwatersheds and simulate runoff and water quality using RUNOFF; and 3) how to apply TRANSPORT to a sewer system for the simulations of infiltration, dry weather, and water quality.

These examples were obtained from the EPA and demonstrated the applications on the Rain, Temp, Runoff, Transport, and Extran Blocks in the SWMM model. The interface runs can be checked using the input files supplied by EPA along with the distribution package for SWMM. The example input files prepared for testing the SWMM Windows interface and corresponding ones used for SWMM 4.3 are listed in Table 6.2. This table indicates the relationship between blocks used in the SWMM interface and Blocks in SWMM 4.3 for each example run. The first example is a screening level example: the rainfall-runoff was simulated through a single watershed. The first run shows the use of the MET and RUNOFF blocks, while the second one presents a user-supplied hyetograph utilizing MET, RUNOFF, and TRANSPORT. The sequence of running the SWMM Windows interface is given in the FUNCTION column of Table 6.2. In example 1, MET produces an input file called SMET001.MET, and further generates a Rain interface file after a RUN button is selected. This is equivalent to running the Rain Block using two input files: RAIN8.DAT and USRN4.DAT. A RUNOFF input file, RNOFF001.INP, generated by the interface can be checked with a Runoff Block input file, RUNOFF36.DAT.

6.1 Example 1—A User-Defined Hyetograph (A Screening-Level Example)

This is an example of a user-defined time series of rainfall with a total precipitation of 28.0 mm. A user defined hyetograph is shown in Table 6.3. The format (see Table 6.3) required by MET is the same one used in Rain Block interface file. A single catchment with a total drainage area of 300 hectares receives rainfall through an inlet. The catchment characteristics are 20% of impervious area, 100 meters long for catchment width, and 0.001 for ground slope. The total simulation length lasts 3 days.

This example is there to show you how to use MET and RUNOFF together to perform a Runoff Block Run. Only hydrologic simulation is involved.

The steps that you must follow for this screening-level example are explained in detail below:

STEP 1. Select the SWMM Windows Interface option from the main SWMM menu. Next, select the MET Block, which is the first option in the flow chart, by clicking on the option.

STEP 2. Select the example MET data that has been created for you by clicking on the FILE option, followed by the OPEN option. Select the first file listed: SMET001.MET. The file will be loaded into the MET interface. Move through the screens and familiarize yourself with the MET option. Use the HELP button to answer any questions you may have. Compare the input to Table 6.3 to make sure that it is the right file.

STEP 3. Next, click on the RUN button. MET will then generate a Rain Block interface file.

Table 6.1 Example Run Matrix for SWMM Windows Interface

BLOCKS	EXAMPLE RUN 1	2	3	4
MET				
Precipitation	•	•		
Rain gage - Single	•	•		
- Multi				
Evaporation - Default rates		•		
- Monthly rates	•			
Snow - Wind Speed				
- Temp - Single Event				
- Continuous				
RUNOFF				
Drainage System				
- Channels/Pipes		•		
- Watersheds/ Subcatchments	•	•		
Snow - Single Event				
- Continuous				
Groundwater				
Water Quality		•		
Erosion				
USEHP				
Inlet - Single			•	
Multi				•
Flow			•	•
Pollutant			•	
TRANSPORT				
Sewer System		•	•	
- Storage Tank				
- New Shape				
- Natural Channel				
Infiltration Inflow		•		
Dry Weather Inflow		•		
Water Quality		•	•	
- RUNOFF Interface		•		
- USEHP			•	
EXTRAN				
Sewer System				
- Channels				•
- Junctions (one free outfall) Boundary Conditions				•
Inlet Hydrographs				
- RUNOFF Interface				
- USEHP				•

Table 6.2 Example Input files with SWMM Windows and SWMM 4.3

Example	SWMM Windows Interface		SWMM 4.3	
	Block	Input File	Block	Input File
1	MET	SMET001.MET	Rain	RAIN8.DAT USRN4.DAT
	RUNOFF	RNOFF001.INP	Runoff	RUNOFF36.DAT
2	MET	SMET002.MET	Runoff	RUNOFF3.DAT
	RUNOFF	RNOFF002.INP		
	TRANSPORT	TRANS001.INP	Transport	TRANS1.DAT
3	USEHP	USEHP002.HP	Transport	TRANS35.DAT
	TRANSPORT	TRANS002.INP		
10	USEHP	USEHP001.HP	Extran	EXAM1.DAT
	EXTRAN	EXTRN001.INP		

Table 6.3 A User-Defined Hyetograph in MET

Julian Date	Hour[1] (second)	Time Interval THISTO (second)	Rainfall Intensity (mm/hr)
88001	3600	300	12
88001	7200	300	24
88001	10800	300	0
88001	25200	300	12
88001	26100	300	12
88001	27900	300	12
88001	30600	300	24
88001	34000	300	42
88002	37800	300	54
88002	41400	300	66
88002	45000	300	78

[1]Daytime (starting storm) hour in seconds from midnight

You must have used the RUN button before you proceed to the next block in SWMM.

STEP 4 Exit the MET option by pressing the ALT key and F4 function key. You will be returned to the SWMM Windows Interface menu. Select the RUNOFF option.

STEP 5. Click on the FILE option, select the OPEN File option. A list of Runoff Input Files will appear. Select the RNOFF001.INP file for this example run. Once you select this option, the parameters for this example run will be entered from the file. The first screen for the RUNOFF block also allows you to enter the Meteorological Input file. If the file that you created for the MET option does not show in the input option for the file name, click on the arrow key to the right of the option. A list of existing meteorological file names will appear. Select SMET001.MET. **Please note that, if you did not use the RUN button from the MET interface, you will not be able to use the MET data since the interface file will not exist. You will be informed by the interface that the input file could not be read if you did not create the Rain Block Interface file in MET.**

STEP 6. Familiarize yourself with the screens in the RUNOFF option by moving through the screens using either the NEXT, BACK or INDEX options. Refer to Section 5 for more information on these buttons. Certain important screens are detailed below.

Screens 1 and 2:

The hydrologic simulation starts at January

1, 1988 and the simulation length is three days. Three time steps should be entered. Screen 2 in RUNOFF determines the complexity of the simulation. In this case, snowmelt is not included; default evaporation rates are used; and metric units are selected. Screens 3 through 8 are grayed because no snowmelt is simulated.

Screen 10:
This screen gives you the physical representation of the watershed. For this example, you have a single watershed without a connecting channel. One inlet is defined as a raingage station in MET for this watershed. Please note that the raingage station in MET must match the hyetograph number in RUNOFF. For this example, raingage station number is 1.

Screen 12:
You will notice that two infiltration equations are available to you in this screen: (1) the Horton and (2) the modified Green-Ampt equation. The Horton model is empirical and is perhaps the best known of the infiltration equations. Many hydrologists have a "feel" for the best values for its three parameters despite the fact that little published information is available.

The Green-Ampt equation is a physically-based model that can give you a good description of the infiltration process. The Mein-Larson (1973) formulation of the Green-Ampt equation is a two-stage model. The first step predicts the volume of water, which will infiltrate before the surface becomes saturated. From this point onwards, infiltration capacity is predicted directly by the Green-Ampt equation. This equation is applicable also if the rainfall intensity is less than the infiltration capacity at the beginning of the storm. New data have been published to help users evaluate the parameter values (e.g. Carlisle et al. 1981). Both equations require three different coefficients. The user will be required to enter these coefficients in Screen 13. The Windows interface has an additional function to help users with these coefficients. Depending on the equation selected by the user, definitions of each of these coefficient will appear when the user clicks on the appropriate variable.

For this example, the Green-Ampt equation has been selected. The three coefficients are 4.0 for the average capillary suction of water, 1.0 for the saturated hydraulic conductivity of soil, and 0.34 for the initial moisture deficit for soil.

STEP 7. Submit the RUNOFF input file to the SWMM model for execution by clicking on the RUN button. An icon will appear on the bottom of the screen with the words SWMM MODEL EXECUTION on the icon. When the processing is complete, the output will be shown in the default output file viewer. View the output carefully and see how the SWMM model blocks in this screening level example. Press the ALT/F4 sequence to exit when you are through. You will be returned to the RUNOFF block. Press the ALT/F4 sequence again until you are back at the SWMM main menu.

6.2 Example 2—Steven's Avenue Drainage District in Lancaster, PA (MET, RUNOFF, and TRANSPORT)

The 67 hectare Stevens Avenue Drainage District in Lancaster, Pennsylvania is a relatively steep (average slope = 0.046) combined sewered catchment with its overflow tributary to Conestoga Creek. It has been the site of intermittent monitoring activity since 1972 due to its selection as the location of a swirl concentrator from an EPA demonstration grant. Although several storms were monitored prior to construction activities, the measurement technique used the Manning's equation to develop a rating curve in a supercritical flow pipe section ("manhole 51" of SWMM schematization). As a result measured flows (at 1.5 minute intervals) are very "flashy" and erratic; 6-min averages have been used in the SWMM calibration using the storm of November 28, 1973, taken from the EPA Urban Rainfall-Runoff-Quality Data Base (Huber et al., 1981). Further information about the catchment and sampling is given in the Data Base report and by Heaney et al. (1975). Quality concentration data have also been used for SS, BOD5, and COD calibrations using the same storm. Artificially high COD values are input at selected manholes to produce dry-weather flow COD values since the dry-weather flow generated by subroutine FILTH cannot generate any COD (see SWMM manual by Huber, W.C. and Dickinson, R.E., 1988, for explanation).

This watershed is a complex drainage system and is divided into 29 subwatersheds and 35 channels. There are 15 inlets in the drainage system. Seven pollutants are included for water quality simulations: (1) Total Solids (TS), (2) Total Suspended Solids (TSS), (3) BOD-5, (4) COD, (5) Total Coliform, (6) Ammonia nitrogen (NH_3-N), and (7) Total Phosphate (T-PO_4-P). Each subcatchment supplies one of five land uses: single family residential, multi-family residential, commercial, school, and parkland. The storm of November 28, 1975 with a rainfall duration of 40 minutes is used in the simulation. This example shows you the use of MET, RUNOFF, and TRANSPORT.

The steps and the sequence of blocks that you must go through for this example run are explained below:

STEP 1. Select the SWMM Windows Interface option from the main SWMM menu and select the MET option.

STEP 2. Select the example MET data that has been created for you by clicking on the FILE option, followed by the OPEN option. Select the second file listed: SMET002.MET. The file will be loaded into the MET interface. Move through the screens and familiarize yourself with the MET option. Use the help information available to you through the HELP button to answer any questions you may have about any prompts. Next, click on the RUN button. MET will then generate a Rain Block interface file. You must have used the RUN button before you may proceed to the next block in SWMM.

STEP 3. Exit the MET option by pressing the ALT key and F4 function key. You will be returned to the SWMM Windows Interface menu. Select the RUNOFF option.

STEP 4. Click on the FILE option, select the OPEN File option. A list of Runoff Input Files will appear. Select the RNOFF002.INP file for this example run. Once you select this option, the parameters for this example run will be entered from the file.. The first screen for the RUNOFF interface also allows you to enter the Meteorological Input file. If the file that you created for the MET option does not show in the input option for the file name, click on the arrow key to the right of the option. A list of existing meteorological file names will appear. Select SMET002.MET. **Please note that, if you did not use the RUN button from the MET interface, you will not be able to use the MET data since the interface file will not exist. You will be informed by the interface that the input file could not be read if you did not create the Rain Block Interface file in MET.**

STEP 5. Familiarize yourself with this input file and the screens in the RUNOFF option by moving through the screens using either the NEXT, BACK or INDEX options. Refer to Section 5 for more information on these buttons.

Screens Six through Eight and Eighteen are controlled by the selection of water quality simulation and will become available for data entry when you select the water quality simulation option on Screen 2. You will be required to enter all the input values related to the water quality simulation. For water quality variable estimates, the user should read the file called README.2ND that is supplied with the SWMM 4.3 model released by the EPA (it will be in the SWMM directory). This file has more information on the sample data files.

You may easily change a row of values in an array screen using a feature available within array screens (screens where the same variable requires a row of entries). If you click on the variable name in these screens, you will be able to access the row arithmetic function that allows you to add, subtract, multiply or divide for any single or range of values for this variable. You may therefore change all zero values for a variable to a single default by adding the default value that you want to all the zero values in the array.

STEP 6. Submit the RUNOFF input file to the SWMM model for execution by clicking on the RUN button. An icon will appear on the bottom of the screen with the words SWMM MODEL EXECUTION on it. If you click on this option, you will see the processing of the DOS SWMM model 4.3. When the processing is complete, the output will be shown in the default output file viewer. View the output carefully. The Runoff Block has generated 15 inlet hydrographs in a file named RNOFF002.INT. This file is used as the hydrograph and pollutograph input file for the Transport Block. You are now ready to move to the next and final block in this sequence, the **TRANSPORT** interface.

STEP 7. Exit from RUNOFF by pressing the ALT key and F4 function key simultaneously. Select the TRANSPORT interface from the SWMM Windows Interface Menu. You will be taken to the Transport Block.

STEP 8. Select the transport input file for this example by clicking on the FILE option, followed by the OPEN option. Select the TRANS001.INP file. The first screen in the TRANSPORT interface also contains the option for the selection of the Inlet Hydrograph file. RNOFF002.INT, which is the file that you just created in the RUNOFF Block, should be the default file. Please note that, if you did not use the RUN button in the RUNOFF interface, you will not be able to use the data since the interface file, i.e., RNOFF002.INT will not exist. You will be informed by TRANSPORT that the input file could not be read, if you did not have a RUNOFF interface run. In this file, seven constituents (pollutants) have been simulated. However, since the TRANSPORT is limited to a maximum of four constituents, we have selected only BOD5, TSS, Total Coliform and COD for this run (see screen 4). Please note that the CUNIT and TYPE UNIT variables on Screen 4 have been grayed since both units will be the same as that entered earlier in the RUNOFF block.

Sewer infiltration inflow and dry-weather sewage inflow are simulated in this example. You have to enter the number of pollutants in Screen 2 only if the RUNOFF interface file has been selected, as is the case for this example.

Please note that Screen 3 is a critical screen in this block since it contains the parameters necessary for describing a complete sewer system. The process of describing a complex sewer system can be difficult. The process can be simplified by using the following structured approach. First, identify the non-conduit elements such as manholes and conduit elements, e.g., channel/pipes. Next, assign a number to each non-conduit and conduit element. For this example, the sewer system contains 25 manholes, one lift station, one flow divider, and 24 channels. Manhole 50 is an outfall.

STEP 9 Use the NEXT, BACK and INDEX buttons along with the HELP button to move through the screens and familiarize yourself with both the TRANSPORT block and with this input file. When you have done so, submit this input file by pressing the RUN button. The SWMM model icon will appear in the bottom of the screen with the title SWMM model execution. When the processing is complete, you will be asked whether you wish to see the output file that has been created. If you indicate YES, you will view the output file using the Output File Editor. Examine the output file carefully and press the ALT/F4 sequence to exit when you are through. You will be returned to the TRANSPORT block. Press the ALT/F4 sequence again until you are back at the SWMM main menu.

6.3 Example 3—Simulation of a Simple One-Pipe System with Two Manholes (USEHP & TRANSPORT)

We are simulating a simple one-pipe system with a small slope and water quality for a Transport run. The one-pipe system has two manholes. The first manhole is specified through the USEHP interface. The constituents TSS and BOD5 with decay are simulated without scour/deposition. A user-supplied hydrograph and two pollutographs for inlet number 1000 are shown in Table 6.4 below.

The steps that you must follow for this screening-level example are explained in detail below:

STEP 1. Select the SWMM Windows Interface option from the main SWMM menu. Next, select the USEHP option.

STEP 2. Select the example USEHP file that has been created for you by clicking on the FILE option, followed by the OPEN option. Select the second file listed: USEHP002.HP. The file will be loaded into the USEHP Interface. Move through the screens and familiarize yourself with this option. Use the help information available to you through the HELP button to answer any questions you may have about any prompts. Compare the input to Table 6.4 above to make sure that it is the right file.

STEP 3. Next, click on the RUN button. USEHP will then generate the USEHP interface files as input to the Transport Block. You must have used the RUN button before you may proceed to the next block in SWMM.

Table 6.4 User-Defined Hydrograph and Pollutographs in USEHP

Time (hr)	Flow (cfs)	TSS (mg/L)	BOD (mg/L)
0	1.0	10.0	10.0
1.0	100.0	100.0	100.0
2.0	1.0	10.0	10.0
3.0	1.0	10.0	10.0
24.0	1.0	10.0	10.0

STEP 4. Exit this option by pressing the ALT key and F4 function key. You will be returned to the SWMM Windows Interface menu. Select the TRANSPORT option.

STEP 5. Click on the FILE option, select the OPEN File option. A list of Transport Input Files will appear. Select the TRANS002.INP file for this example run. Once you select this option, the parameters for this example run will be entered from the file. The first screen for this interface also allows you to select the USEHP file created before. As explained in the introduction to this example, this is a simple system containing one pipe and two manholes. The first manhole is the inlet that was specified in the USEHP002.INP file. The sequence of entering this system is to start with an inlet, then follow the channel and end with a manhole, i.e., an outfall. There are a total of nine screens available to you in this example.

STEP 6. Familiarize yourself with the screens in this option by moving through the screens using either the NEXT, BACK or INDEX options. Refer to Section 5 for more information on these buttons. Also use the HELP buttons for any questions that you might have on any prompt. When you have completed your run-through, submit the input file to the SWMM model by clicking on the RUN button. The output file will be displayed to you when it is ready.

6.4 Example 4—Basic Pipe System (USEHP and EXTRAN)

This example is obtained from the EXTRAN user's manual (Roesner et al. 1988) described as Example 1: Basic pipe system. Figure 6.1 below shows a typical sewer system of conduits conveying stormwater flow. The system consists of nine channels and ten junctions with one free outfall. In this example, conduits are designated with four-digit numbers, while junctions have been given five-digit numbers. There are three junctions or inlets that receive inflows, which will be defined using the USEHP interface. The total simulation length is eight hours.

Two SWMM interfaces are used in running Example 4. First, the user should select the USEHP block to specify three inlet hydrographs. The user then should access EXTRAN in order to select an inlet hydrograph file that has been just generated by USEHP, and to enter a drainage system and simulation information for a EXTRAN run. A USEHP001.HP file and an EXTRN001.INP file are the input files for this example.

The steps in this example are explained below.

STEP 1. Select the SWMM Windows Interface option from the main SWMM menu. Next, select the USEHP option.

STEP 2. Select the example USEHP data that has been created for you by clicking on the FILE option, followed by the OPEN option. Select the first file listed: USEHP001.HP. The file will be loaded into the USEHP interface. Move through the screens and familiarize yourself with this option. Use the help information available to you through the HELP button to answer any questions you may have about any prompts. Next, click on the RUN button. USEHP will then generate four USEHP interface files. You must have used the RUN button before you may proceed to the next block in SWMM.

STEP 3. Exit the USEHP option by pressing the ALT key and F4 function key. You will be returned to the SWMM Windows Interface menu. Select the EXTRAN option.

STEP 4. Click on the FILE option, select the OPEN File option. A list of EXTRAN Input Files will appear. Select the EXTRN001.INP file for this example run. Once you select this file, the parameters for this example run will be entered from the file. The first screen for this interface also allows you to enter the USEHP file. **Please note that, if you did not use the RUN button in the USEHP interface, you will not be able to use the data since the interface files will not exist. You will be informed by the interface that the input file could not be read if you did not create the USEHP Interface file.**

STEP 5. Use the NEXT, BACK and INDEX buttons along with the HELP button to move through the screens and familiarize yourself with both the EXTRAN block and with this input file. When you have done so, submit this input file to the RUN button. The SWMM model icon will appear in the bottom of the screen with the title SWMM MODEL EXECUTION. When the processing is complete, you will be asked whether you wish to see the output file that has been created. If you indicate YES, you will view the output file using the Output File Editor. Examine the output file carefully and press the ALT/F4 sequence to exit when you are through. You will be returned to the EXTRAN block. Press the ALT/F4 sequence again until you are back at the SWMM main menu.

Summary of output from EXTRAN:

The first section is an echo of the input data and a listing of conduits created internally by EXTRAN to represent outfalls and diversions caused by weirs, orifices, and pumps.

The next section of the output is the intermediate printout. This lists system inflows as they are read

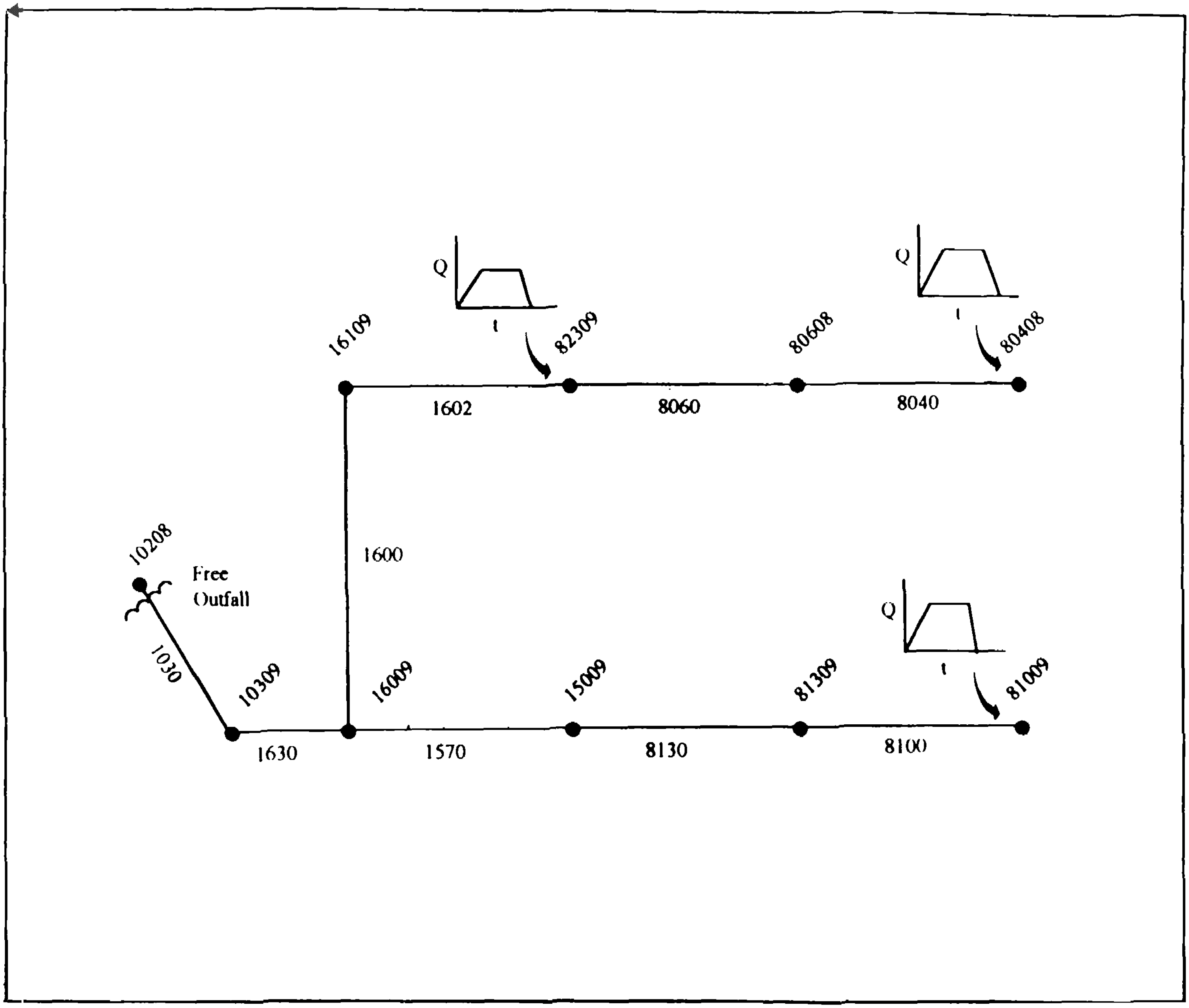


Figure 6.1 **Basic System with Free Outfall. (After Camp. Dresser, and McKee, 1988.)**

by EXTRAN and gives the depth at each junction and flow in each conduit in the system at a user-input time interval. A junction in surcharge is indicated by printing an asterisk beside its depth. An asterisk beside a conduit flow indicates that the flow is set at the normal flow value for the conduit. The intermediate printout ends with the printing of a continuity balance of the water passing through the system during the simulation. Printed outflows from junctions not designated as outfalls in the input data set are junctions which have flooded.

The final section of the output gives the time history of depths and flows for those junctions and conduits input by the user, as well as a summary requested plots of junctions heads and conduit flows.

7 SWMM POST-PROCESSOR

The SWMM Post-Processor consists of three parts:

- Summary Tables
- Graphics
- Calibration

Figure 7.1 shows the SWMM post-processor structure. The Summary Tables function presents flow rate (or volume) and pollutant concentrations (or loads) for desired inlets. The Tables function presents the user with two different types of tables: the summary table and the Event Mean Concentration (EMCs) table. The Graphics routine displays six different types of graphs: hydrograph, pollutograph, loadograph, flow volume, mass, and land use. The Calibration routine allows the user to compare observed data and predicted values.

These three functions are available from the RUNOFF interface and the TRANSPORT interface blocks. The results (Tables or Graphs) presented in the three functions are based on the values stored in either a RUNOFF interface file (RNOFF*.INT) or a TRANSPORT interface file (TRANS*.INT). Therefore, the user must provide a SWMM interface file.

The functions are accessible through three special buttons on the third line of each screen in RUNOFF and TRANSPORT.

7.1 The Tables Routine

The table function presents the user with two different types of tables:

- **The Summary Table**

The summary table presents flow rate (or volume) and pollutant concentrations (or loads) for desired inlets. There are four time increments given for this option: Event, Daily, Monthly, and Annual. Usually, Event may be applied to single-event simulations where the instantaneous flow rate and pollutant concentrations will be displayed in the summary table, while Daily, Monthly, or Annual may be used for continuous simulations where the flow volume and pollutant loads can be tabulated.

The Event Mean Concentrations (EMCs) Table.

The EMCs table reports flow volume, duration, EMCs, and Loads for each storm event. Two parameters are required to be specified: minimum interevent time and base flow. The minimum interevent time indicates the minimum number of dry hours (or fractional hours) that will constitute an interevent. The baseflow or cutoff flow is used to separate the events. Flows greater than the baseflow are part of the event, conversely flows less than or equal to the baseflow are part of the interevent period. The default value of the baseflow may be set to zero.

The event mean concentrations are defined as the total pollutant mass divided by the total runoff volume for storm events. Separation of the data into events depends on the unique series of zero and non-zero instantaneous flow values found at each inlet location within the system being simulated. The results of the analyses would be expected to vary from location to location. The Statistics Block can analyze only one location at a time. However, the Windows post-processor can analyze multiple locations (the maximum inlets specified in the interface file).

Procedure for Generating a Table

STEP 1. The table option is accessible through a TABLES button on the third line of the screen, with the other button options available in RUNOFF and TRANSPORT. It is also accessible under the Utilities option in the main menu bar (ALT U, G).

STEP 2. The table program screen will appear. You must first select a Runoff or Transport interface file (depending on the module from where you selected graphics). To see a list of the files that exist in your default directory, click on the arrow to the right of the input cell asking you for the file name.

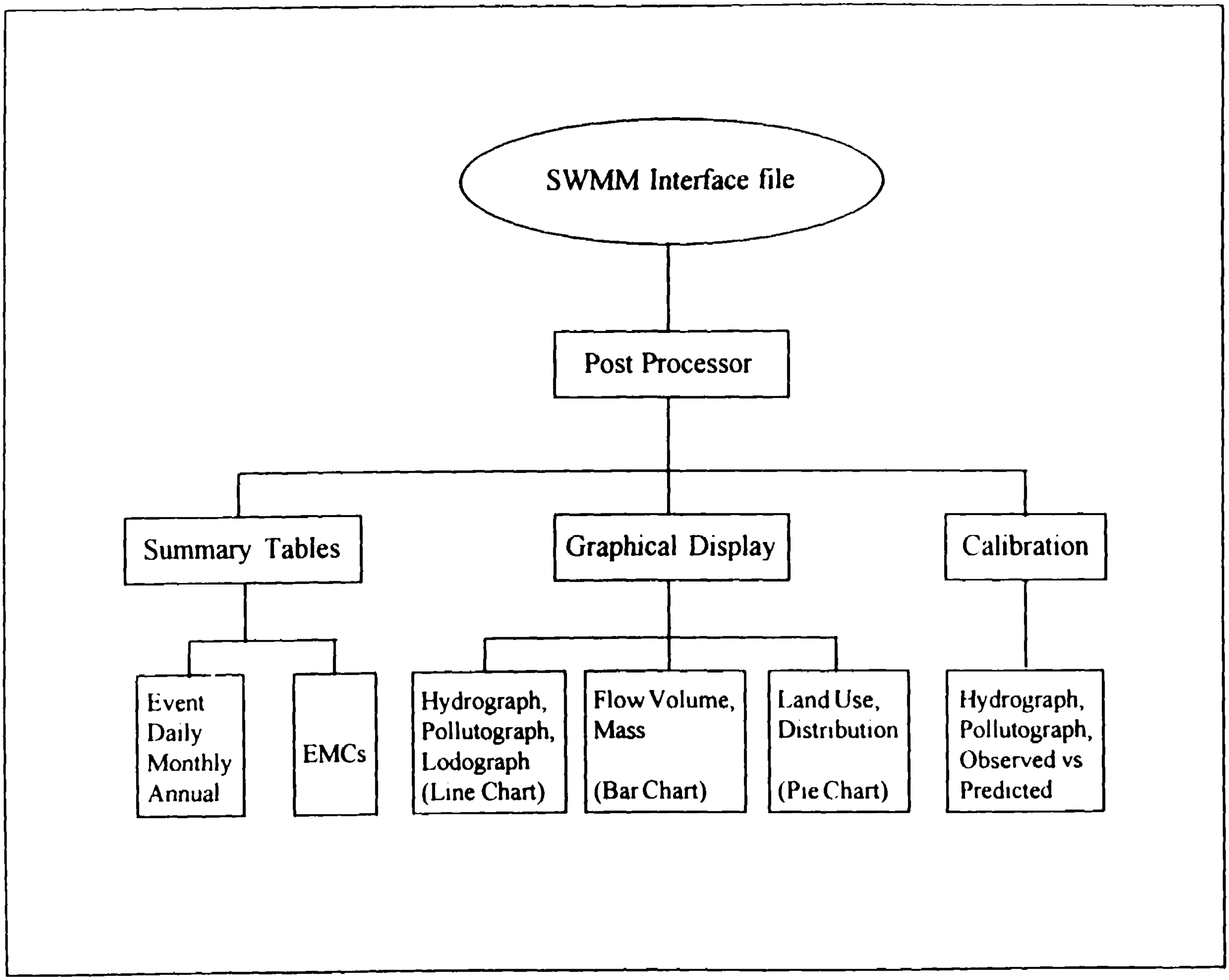


Figure 7.1 SWMM Post-Processing Structure.

Select the file that you would like to tabulate the model results for the tables.

STEP 3. Select the type of table that you like to have. Specify inlets of interest or the duration for the summary table.

STEP 4. Hit the NEXT button when you have completed the selections that you wish. The tables will loop through the number of inlets specified. One table represents the model results for a specified location (inlet).

STEP 5. Use the Export function to export summary data and EMCs tables to another file in either table delimited or comma delimited format.

7.2 The Graphics Routine

The Graphics option in SWMM provides access to six different type of graphs: hydrograph, pollutograph, loadograph, flow volume, mass, and land use. It is available from the RUNOFF module and the TRANSPORT module. The graphics option is provided to allow the user to represent the results in easy-to-understand graphs.

Accessing the Graphics Program

STEP 1. The graphics option is accessible through a GRAPHICS button on the third line of the screen, with the other button options available in RUNOFF and TRANSPORT. It is also accessible under the Utilities option in the main menu bar (ALT U, G).

STEP 2. The graphics program screen will appear. You must first select a Runoff or Transport interface file (depending on the module from where you selected graphics). To see a list of the files that exist in your default directory, click on the Arrow to the right of the parameter asking you for the file name. Select the file that you would like to use as input for the graphics.

STEP 3. Select the type of graph from the list provided. Please note that depending on the input file that you selected, certain graphs such as pollutographs may not be available since the data in the file does not support that graph. The options that are unavailable to you will be grayed out. A list of inlet IDs will be presented when you select an input file. You may select between one and three inlets to represent on the graph. For the Flow Volume and Mass Graph, you will be required to select the Time Increment that you would like: daily, monthly, or annual. You will then be required to enter the period for which you would like to have for the graph. Please note that the period shown when you select the Runoff file automatically shows the beginning and ending dates of the data contained in the file. You may only select a period with the dates shown if you wish to change the defaults.

STEP 4. Hit the RUN button when you have completed the selections that you wish. You will see a box informing you that the selections that you made will be saved under the filename shown at the top of the screen.

STEP 5. Next you will see a list of files in a box with the title of GRAPHIC SELECTION. The file that was just generated will be selected. You may select up to four graphs from the list presented. Hit the OK button to draw the graphs.

STEP 6. The graphs that you selected will be drawn on the screen. Once drawn, you have two options:

PRINT: To print the graph(s) that appear on the screen, select the GRAPH option at the top of the screen and select PRINT. The file will be printed to the default Windows printer.

EDIT: This option allows you to copy the image and transport it to any Windows program through the Cut and Paste option available with that program. To do this, select EDIT at the top of the screen, and select COPY.

Figure 7.2 displays four graphs from the first two example results.

Features and Limitations of the Graphics Program

- The graphics routine can draw up to three inlets or pollutants for one graph. It can display two inlets or pollutants with two Y-axes for one graph.

- To draw land use distribution, you must have two files: a Runoff interface file (RNOFF*.INT) and a RUNOFF windows interface file (RNOFF*.INP). The land use distribution is computed based on the data stored in the RNOFF*.INP file. This means that two interface files must be available when the user selects the land use option.

- You can display up to four graphs at a time. To create four different graphs at one session, you must loop through the graphics option screen using a different graphics input file name each time (this is the file name shown at the top of the screen: SWTGR*.INP for TRANSPORT graphs, and SWRGR*.INP for the RUNOFF graphs). If you do not select a new file name, then when you hit the RUN button, it will overwrite the graph that you just created since the graphs are organized by file names.

7.3 The Calibration Routine

The calibration routine can be accessed by clicking on the Calibration button with the mouse. A window similar to the Graphics Routine will appear. There are only two types of graphics available: hydrograph and pollutograph. The procedures to generate the graphs in the calibration routine are similar to the ones used in the graphics routine, except for observed data. Like the graphics routine, you should select a Runoff interface (i.e., RNOFF*.INT) file and specify the type of graph, the inlet number(s), time increment, beginning and ending time, and number of observed points. You then should provide observed data on Screen 3. You have options either to enter the data on Screen 3 or to import the observed data that are stored in a separate file. Refer to the How to Import Observed Data option in details. Click Run to view the calibration graphs.

The calibration routine produces two types of graphs and one statistical table. The first graph draws two sets of values over time: predicted values obtained from a RNOFF*.INT file for a continuous plot and observed data from the user input on Screen 3 for a scatter plot. The second graph shows observed data vs. predicted values and a best fit line, which is automatically generated by the calibration routine. The table displays several important parameters for predicted values and observed data. For a hydrograph, flow volume, peak flow, time to peak, and duration are reported. For a pollutograph, pollutant mass, peak concentration, Event Mean Concentration (EMC), time to peak, and duration are presented. Figure 7.3 presents the total solids calibration graphs from a RNOFF002.INT file.

- **Importing Observed Data**

If you have observed data stored in either a spreadsheet or an ASCII file, you can import the data directly to the observed data screen. The format in the data file should be consistent with the format defined on the observed data screen (Screen 3 in the calibration routine). Check the file format before importing the data. Select Edit at the top line of the observed data screen and select the Import option. Then, give a file name that contains the observed data. Click on OK. The data will be entered into the screen.

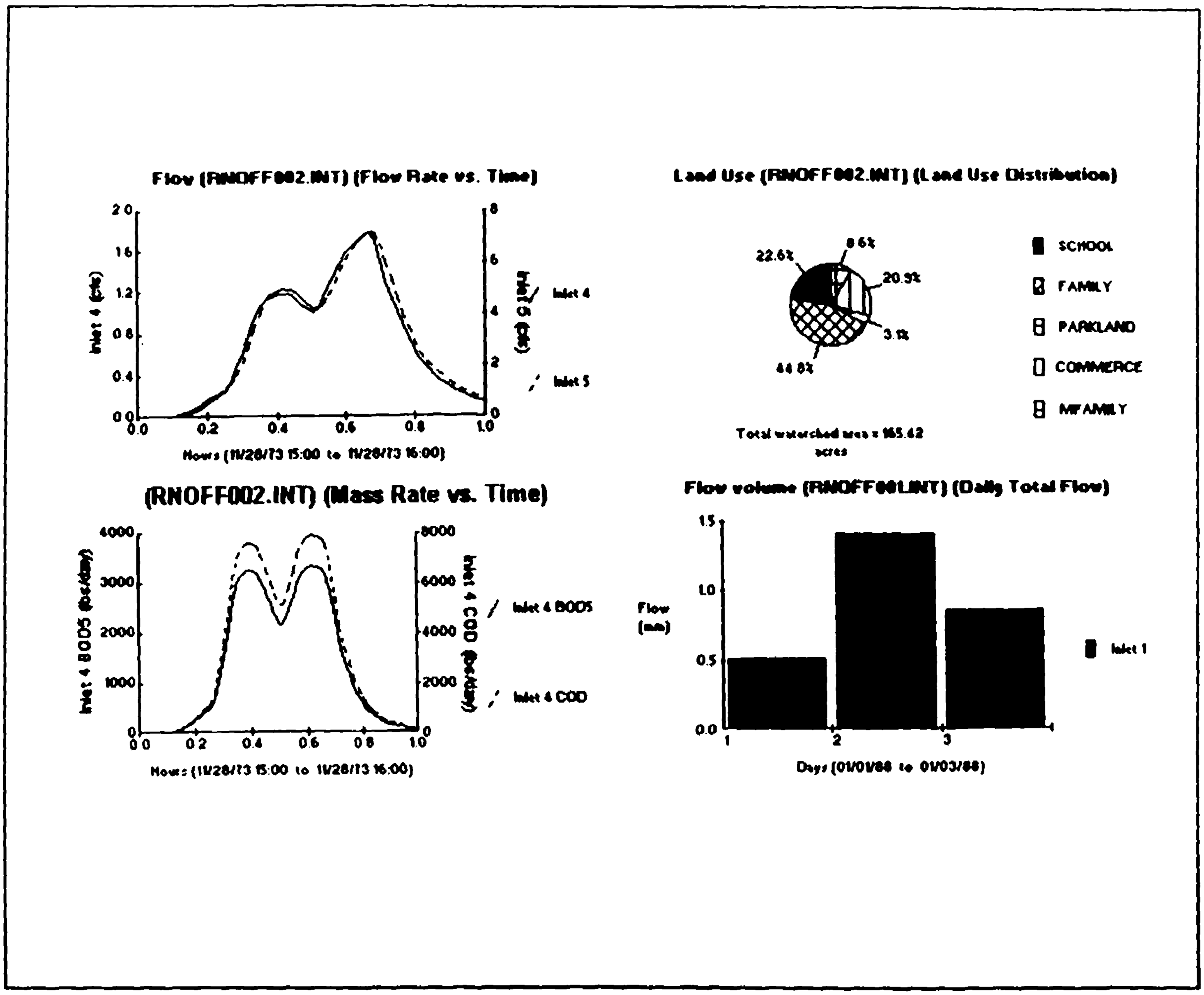
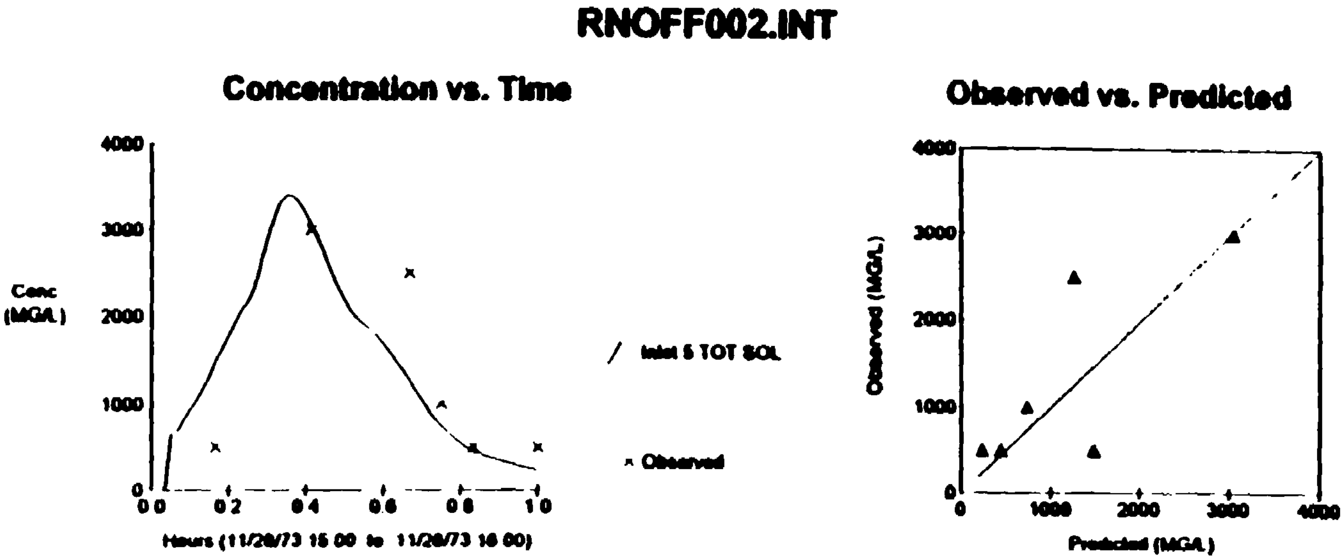


Figure 7.2 RUNOFF Graphics



	Mass (lb)	Peak Conc (MG/L)	Event Mean Conc (MG/L)	Time to Peak (hours)	Duration (hours)
Predicted	1156.82	3387.23	1767.88	0.36	1.00
Observed	1080.72	3000.00	1783.88	0.42	0.83

Figure 7.3 Total Solids Concentrations

APPENDIX A: SWMM WINDOWS INTERFACE DESIGN

This appendix contains the structures and variables for the five window interface portions of SWMM. There are five tables in this appendix:

Table A.1	Input Variables and Screen Sequence in MET
Table A.2.	Input Variables and Screen Sequence in RUNOFF
Table A.3	Input Variables and Screen Sequence in USEHP
Table A.4	Input Variables and Screen Sequence in TRANSPORT
Table A.5	Input Variables and Screen Sequence in EXTRAN

The screen design for the interfaces that are the same as the SWMM Model 4.3 blocks (RUNOFF, TRANSPORT and EXTRAN) provide the following information:

1. The variable name for the model block in SWMM (if there is one),
2. the description of the variable
3. SWMM ID (SID)
4. screen number (SCR)
5. control number (CS)
6. control type (CT), item, range, default, and unit.

You are therefore able to match the Windows Interface variable name with the SWMM Model Variable names, see where it occurs in the interface, read a description, see what type of variable, the unit type and the range, all by referring to the table for the block in which you are interested.

For those for which there are no corresponding blocks in SWMM (MET and USEHP), the following is provided:

1. Screen Number
2. Variable Name
3. Definition of the variable
4. Unit Type

This will give you all the information about each variable in the interface. Please refer to Sections 2 and 3 for more general information about SWMM and the Windows implementation.

Table A.1 Input Variables and Screen Sequence in MET

Screen No.	Variables	Definition	Unit
1	Description	Description of this run	
	UNITS	Input meteorological data units either in U.S. units or [Metric units]	
	Number of rain gages	Number of raingage stations	
	Number of rain data values	Number of data values for precipitation on Screen No. 3	
	Time interval in hours	Time interval for single event snowmelt simulation	
	Number of air temperatures	Number of values for air temperature on Screen No. 6	
	Number of TEMP data values	Number of data values for TEMP Data Table on Screen No. 4	
2	STATION	An integer (1-10) for raingage station number	
3	JUL.DATE	An integer for the Julian date in the format YYDDD	
	HOUR	A real number for the daytime hour from midnight	second
	THISTO	A real number for the time interval between precipitation data values (A variable time interval is allowed)	second
	PRECIP(i)	A real number for rainfall intensity with the its raingage number (i - raingage, max=10)	in/hr [mm/hr]
4	JUL.DATE	An integer for the Julian date in the format YYDDD	
	MAX TEMP.	A real number for maximum temperature for the date	°F [°C]
	MIN TEMP.	A real number for minimum temperature for the date	
5	EVAP	A real number for monthly average evaporation rate	in/day [mm/day]
	WINDSPEED	A real number for monthly average wind speed rate	mile/hr [km/hour]
6	TAIR	A real number for air temperature for single event snowmelt simulation	°F [°C]

Table A.2 Input Variables and Screen Sequence in RUNOFF

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
	RUNOFF Simulation Time Control									
TITLE	Description of this run	A1	1	1	1		C160			
	Meteorologic Data		1	2	1		C40			
	Simulation Time Period		1		5					
NHR	Starting time of the storm hr	B1	1	3	1		I	0-24	0	
NMN	min	B1	1	4	1		I	0-60	0	
NDAY	Day storm starts (mm/dd/yy)	B1	1	5	1		I	0-31		
MONTH		B1	1	5	1		I	0-12		
IYRSTR		B1	1	5	1		I	00-99	42	
LONG	Simulation Length	B3	1	6	1		F			
LUNIT	Units of simulation length	B3	1	7	3		C11			
	Seconds		1		9	1			0	
	Minutes		1		9	2			1	
	Hours		1		9	3			2	
	Days		1		9	4			3	
	Ending Date		1		9	5			4	
WET	Wet time step (sec)	B3	1	8	1		F	> = 1	3600.0	second
WETDRY	Transition time step (sec)	B3	1	9	1		F		7200.0	second
DRY	Dry time step (sec)	B3	1	10	1		F		86400.0	second
	Simulation Control Parameters		2							
	Simulation Type		2		5					
	Groundwater Flow		2	1	4		I	0,1		
KWALTY	Quality Simlation	B1	2	2	4		I	0,1	1	
ISNOW	Snowmelt Simulation	B1	2	3	5		I	0-2	0	
ISNOW	Not simulated	B1	2	4	6		I	0		
ISNOW	Single event	B1	2	5	6		I	1		
ISNOW	Continuous	B1	2	6	6		I	2		
IVAP	Evaporation	B1	2	7	5			0,>0	>0	
	Evaporation data from met. data file		2	8	6					
	Default evaporation rate		2	9	6				0	
METRIC	UNIT	B1	2	10	5		C15	0,1	0	
	U. S. units		2	11	6			0		
	Metric units		2	12	6			1		

Table A.2—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
	Snow Melt		3							
ELEV	Average watershed elevation	C1	3	1	1		F		0.0	ft [m]
FWFRAC(1)	Ratio of free water holding capacity to snow depth on snow covered impervious area	C1	3	2	1		F		0.0	w.e. in [mm]
FWFRAC(2)	Ratio of free water holding capacity to snow depth on snow covered pervious area	C1	3	3	1		F		0.0	w.e. in [mm]
FWFRAC(3)	Ratio of free water holding capacity to snow depth for snow on normally bare impervious area	C1	3	4	1		F		0.0	w.e. in [mm]
SNOTMP	Dividing temp. between snow and rain	C1	3	5	1		F		0.0	F [C]
SCF	Snow gage correction factor	C1	3	6	1		F		1.0	
TIPM	Weight used to compute antecedent temp. index	C1	3	7	1		F	0.0-1.0	0.0	
RNM	Ratio of negative melt coeff. to melt coeff.	C1	3	8	1		F		0.6	
ANGLAT	Average latitude of watershed (degree north)	C1	3	9	1		F		0.0	
DTLONG	Longitude correction	C1	3	10	1		F		0.0	min
	Areal Depletion Curve for Impervious Area (%)		4					0.0-1.0		
ADCI(1)	ADCI (1-10)	C3	4	1	1		F		0.0	
	Aeral Depletion Curve for Pervious Area (%)		5					0.0-1.0		
ADCP(1)	ADCP (1-10)	C4	5	1	1		F		0.0	
	Water Quality		6							
NQS	Number of constituents (1-9)	J1	6	1	1		I	1-9		
JLAND	Number of land uses (1-5)	J1	6	2	1		I	1-5	0	
DRYDAY	Number of dry days prior to storm	J1	6	3	1		F	>0.0	0.0	days
CBVOL	Average catchbasin storage volume	J1	6	4	1		F		0.0	ft3 [m3]
DRYBSN	Dry days required to recharge to catchbasin	J1	6	5	1		F	>0.0	1.0	days
IROS	Erosion Simulation	J1	6	6	4		I		0	
IROSAD	Erosion added to constituent number	J1	6	7	1		I		0	
RAINIT	Higest average 30-minute rainfall intensity	J1	6	8	1		F		0.0	in/hr [mm/hr]
	Groundwater Quality		6	9	4					
	Street Sweeping Parameters				5					

Table A.2—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
REFFDD	Street sweeping efficiency for "dust and dirt"	J1	6	10	1		F		0.0	
KLNBGN	Day of year on which street sweeping begins	J1	6	11	1		I		0	
KLNEND	Day of year on which street sweeping ends	J1	6	12	1		I		367	
	Constituent Table	J3	7							
PNAME(K)	CNAME	J3	7	1	1		C			
PUNIT(K)	CUNIT	J3	7	2	1		C			
NDIM(K)	TYPE UNIT	J3	7	3	2		C	0-2	0	
	mg/l		7			1		0		
	MPN/l		7			2		1		
	OTHER		7			3		2		
KALC(K)	BUILDUP	J3	7	4	2		C	0-4	0	
	Fraction		7			1		0		
	Power-linear		7			2		1		
	Exponential		7			3		2		
	Mich-Men		7			4		3		
	No buildup		7			5		4		
KWASH(K)	WHSHOFF	J3	7	5	2		C	0-2	0	
	Power-Exp		7			1		0		
	R. Curve/N		7			2		1		
	R. Curve/B		7			3		2		
KACGUT(K)	FUNCTION	J3	7	6	2		C	0-2	0	
	F(gutter len)		7			1		0		
	F(area)		7			2		1		
	Constant		7			3		2		
LINKUP(K)	LINK-SNOW	J3	7	7	2		C	0,1	0	
	No		7			1		0		
	Yes		7			2		1		
QFACT(1,K)*	LIMIT	J3	7	8	1		F		0.0	
QFACT(2,K)*	POWER	J3	7	9	1		F		0.0	
QFACT(3,K)*	COEFF	J3	7	10	1		F		0.0	
QFACT(4,K)*	FOURTH	J3	7	11	1		F		0.0	
QFACT(5,K)*	FIFTH	J3	7	12	1		F		0.0	
WASHPO(K)*	POWERW	J3	7	13	1		F		0.0	

Table A.2—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
RCOEF(K)*	COEFFW	J3	7	14	1		F		0.0	
CBFACT(K)*	INICON	J3	7	15	1		F		0.0	8(3)
CONCRN(K)*	CONPRE	J3	7	16	1		F		0.0	8(3)
REFF(K)*	EFFI	J3	7	17	1		F		0.0	
	Land Use Table		8							
LNAME(J)	LNAME	J2	8	1	1		C			
METHOD(J)	METHOD	J2	8	2	3		C	-2,-1,0-2	0	
	New values		8			1		-2		
	New Ratio		8			2		-1		
	Power-linear		8			3		0		
	Exponential		8			4		1		
	Michaelis-Menton		8			5		2		
JACGUT(J)	FUNCTION	J2	8	3	3		C	0-2	0	
	F(gutter len)		8			1		0		
	F(area)		8			2		1		
	Constant		8			3		2		
DDLIM(J)*	LIMIT	J2	8	4	1		I		10	
DDPOW(J)*	POWER	J2	8	5	1		F		0.0	
DDFACT(J)*	COEFF	J2	8	6	1		F		0.0	
CLFREQ(J)*	DAYS1	J2	8	7	1		F		0.0	days
AVSWP(J)*	FRACTION	J2	8	8	1		F		0.0	
DSLCL(J)*	DAYS2	J2	8	9	1		F		0.0	days
	Fractional Constituent Table	J4	9							
KTO	CNAME1	J4	9	1	1		I		0	
KFROM	CNAME2	J4	9	2	1		I		0	
F1(KTO,KFROM)	FRACTION	J4	9	3	1		F		0.0	
	Groundwater Concentration	J5	10							
	GCONC(1-10)				1		F		0.0	8(3)
	*** Array									

Table A.2—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
PCTZER	Percent of impervious area with zero detention	B4	12	4	1		F		25	%
	Subcatchment Surface Water Table		13							
JK	HYETO #	H1	13	1	1		I		1	
NAMEW	NAMEW	H1	13	2	1		C			
NGTO	CHA/INLET #	H1	13	3	1		C			
WW(1)*	WIDTH	H1	13	4	1		F		0.0	ft (m)
WAREA*	AREA	H1	13	5	1		F		0.0	area (ha)
WW(3)*	% IAREA	H1	13	6	1		F		0.0	%
WSLOPE*	SLOPE	H1	13	7	1		F		0.0	ft/ft
WW(5)*	IMP 'n'	H1	13	8	1		F		0.0	
WW(6)*	PER 'n'	H1	13	9	1		F		0.0	
WSTORE1*	ISTORE	H1	13	10	1		F		0.0	in (mm)
WSTORE2*	PSTORE	H1	13	11	1		F		0.0	in (mm)
WLMAX*	COEFF1	H1	13	12	1		F		0.0	
WLMIN*	COEFF2	H1	13	13	1		F		0.0	
DECAY*	COEFF3	H1	13	14	1		F		0.0	
	Subcatchment Groundwtaer Table	H2	14							
NMSUB	NAMEW	H2	14	1	1		C		0.0	
NGWGW	CHA/INLET #	H2	14	2	1		C		0.0	
ISFPF	GPRINT	H2	14	3	3		I	0,1	0	
	Yes					1	I	0		
	No					2	I	1		
ISFGF	GGRAPH	H2	14	4	3		I	0,1	0	
	Yes					1	I	0		
	No					2	I	1		
BELEV	BELEV	H2	14	5	1		F		0.0	ft (m)
GRELEV	GELEV	H2	14	6	1		F		0.0	ft (m)
STG	IELEV	H2	14	7	1		F		0.0	ft (m)
BC	CB/TS ELV	H2	14	8	1		F		0.0	ft (m)
TW	TW	H2	14	9	1		F		0.0	
A1*	GCOEFF	H3	14	10	1		F		0.0	in/hr-ft
			14							(mm/hr-m)

Table A.2—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
	Channel /Pipe Table	G1	11							
NAMEG	NAME	G1	11	1	1		C			
NGTO	CHA/INLET #	G1	11	2	1		C			
NPG - NP	TYPE	G1	11	3	3		C	1-7		
	Trapezoidal		11			1		1		
	Circular		11			2		2		
	Dummy		11			3		3		
	Parabolic		11			4		4		
	Trap w/ weir		11			5		5		
	Cir w/weir		11			6		6		
	Par w/weir		11			7		7		
GWIDTH*	WIDTH	G1	11	4	1		F		0.0	ft (m)
GLEN*	LENGTH	G1	11	5	1		F		0.0	ft (m)
G3*	INV SLOPE	G1	11	6	1		F			ft/ft
GS1	L SLOPE	G1	11	7	1		F			ft/ft
GS2	R SLOPE	G1	11	8	1		F			ft/ft
G6*	Manning's n	G1	11	9	1		F		0.014	
DFULL*	DEPTH	G1	11	10	1		F			ft (m)
GDEPT*	INI DEPTH	G1	11	11	1		F			ft (m)
WTYPE	WTYPE	G2	11	12	3			0,1,2	0	
	B N weir		11			1	C	0		
	V N weir		11			2	C	1		
	Orifice		11			3	C	2		
WELEV	WELEV	G2	11	13	1		F		0.0	ft (m)
WDIS	COEEF	G2	11	14	1		F		3.3	ft1/2/s (m1/2/s)
SPILL	SPILL	G2	11	15	1		F		1.0	
	Watershed Parameters (subcatchments)		12							
	Number of subcatchments (1-100)		12	1	1		I			
INFILM	Infiltration Equation	B1	12	2	3		C	0	0	
	Horton		12			1		0		
	Green-Ampt		12			2		1		
REGEN	Regeneration coeff. using Horton Eq.	B4	12	3	1		F		0.01	

Table A.2—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
B1*	GEXPON	H3	14	11	1		F		0.0	
A2*	CHCOEFF	H3	14	12	1		F		0.0	in/hr-ft
			14							[mm/hr-m]
B2*	CEXPON	H3	14	13	1		F		0.0	
A3*	GCCOEFF	H3	14	14	1		F		0.0	in/hr-ft
			14							[mm/hr-m]
PRO*	PROSITY	H3	14	15	1		F		0.0	
WP*	WP	H3	14	16	1		F		0.0	
FC*	FC	H3	14	17	1		F		0.0	
HKSAT*	HKSAT	H3	14	18	1		F		0.0	in/hr [cm/hr]
TH1*	TH1	H3	14	19	1		F		0.0	
HCO*	HCO	H3	14	20	1		F		0.0	
PCO*	PCO	H4	14	21	1		F		0.0	/frac [m/frac]
CET*	CET	H4	14	22	1		F		0.0	
DP*	DP	H4	14	23	1		F		0.0	in/hr [cm/hr]
DET*	DET	H4	14	24	1		F		0.0	ft [m]
	Subcatchment Snow Melt Data		15							
JK1	NAMEW	I1	15	1	1		C			
SNN1	FRACIMP	I1	15	2	1		F		0.0	
SNCP(N)	FRACPER	I1	15	3	1		F		0.0	
WSNOW(N,1)	DEPIIMP	I1	15	4	1		F		0.0	.e. in [mm]
WSNOW(N,2)	DEPIPER	I1	15	5	1		F		0.0	.e. in [mm]
FW(N,1)	FWIMP	I1	15	6	1		F		0.0	in [mm]
FW(N,2)	FWPER	I1	15	7	1		F		0.0	in [mm]
DHMAX(N,1)*	MELTIMP	I1	15	8	1		F		0.0	in w.e./hr -F
									0.0	m w.e./hr -C
DHMAX(N,2)*	MELTPER	I1	15	9	1		F		0.0	in w.e./hr -F
									0.0	m w.e./hr -C
TBASE(N,1)*	TBASEIMP	I1	15	10	1		F		32.0	F [C]
TBASE(N,2)*	TBASEPER	I1	15	11	1		F		32.0	F [C]
	Subcatchment Snow Input for Continuous Simulation		16							
JK2	NAMEW	I2	16	1	1		C			

Table A.2—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
WSNOW(N,3)	DEPIMP	I2	16	2	1		F		0.0	in (mm)
FW(N,3)	WATIMP	I2	16	3	1		F		0.0	in (mm)
DHMAX(N,3)*	MAXCOE	I2	16	4	1		F		0.0	in w.e/hr-F (mm w.e./hr-C)
TBASE(N,3)*	TEMIMP	I2	16	5	1		F		32.0	F (C)
DHMIN(N,1)*	MINSIMP	I2	16	6	1		F		0.0	in w.e/hr-F (mm w.e./hr-C)
DHMIN(N,2)*	MINSPER	I2	16	7	1		F		0.0	in w.e/hr-F (mm w.e./hr-C)
DHMIN(N,3)*	MINBEAR	I2	16	8	1		F		0.0	in w.e/hr-F (mm w.e./hr-C)
SI(N,1)*	DEPSIMP	I2	16	9	1		F		0.0	w.e. in (mm)
SI(N,2)*	DEPSPER	I2	16	10	1		F		0.0	w.e. in (mm)
WEPLOW(N)	REDISTR	I2	16	11	1		F		0.0	w.e. in (mm)
SFRAC(N,1)	FRATIMP	I2	16	12	1		F	0.0-1.0	0.0	
SFRAC(N,2)	FRATPER	I2	16	13	1		F	0.0-1.0	0.0	
SFRAC(N,3)	FRATLAS	I2	16	14	1		F	0.0-1.0	0.0	
SFRAC(N,4)	FRATOUT	I2	16	15	1		F	0.0-1.0	0.0	
SFRAC(N,5)	FRACIMP	I2	16	16	1		F	0.0-1.0	0.0	
	Subcatchment Erosion Table		17							
NAMEW	NAMEW	K1	17	1	1		C			
ERODAR*	EAREA	K1	17	2	1		F		0.0	acres (ha)
ERLEN*	ELENG	K1	17	3	1		F		0.0	ft (m)
SOILF*	SOIL K	K1	17	4	1		F		0.0	
CROPMF*	CROP C	K1	17	5	1		F		0.0	
CONTPF*	CONT P	K1	17	6	1		F		0.0	
	Subcatchment Quality Table									
N - NAMEW	NAMEW	L1	18	1	1		C			
KL	LAND USE	L1	18	2	1		C			
BASIN(N)*	# CHACHBA	L1	18	3	1		F		0.0	
GQLEN(N)*	CURBL	L1	18	4	1		F		0.0	100 ft (km)

Table A.2—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
	*** number of constituents up to 10									
PSHED(1,N)	INI LOAD (1)	L1	18	5	1		F		0.0	
		L1	18		1		F		0.0	
PSHED(10,N)	INI LOAD (10)	L1	18	14	1		F		0.0	
	Print Control									
IPRN(1)	RUNOFF Input	B2	19	1	5		C21	0-7	0	
	Print all input data	B2	19	2	6	1		0		
	Control information	B2	19	3	6	2		1		
	Possible combinations	B2	19	4	6	3				
	Channel/Pipe	B2	19	5	4	4		2		
	Snowmelt	B2	19	6	4	5		3		
	Subchachment	B2	19	7	4	6		4		
	Water Quality	B2	19	8	4	7		5		
	RUNOFF Output									
IPRN(3)	SWMM output control	B2	19	9	5		C	0-2	0	
	Do not print totals		19	10	6	1		0		
	Monthly and annual totals only		19	11	6	2		1		
	Daily, monthly and annual totals		19	12	6	3		2		
IPRN(2)	Plot graphs	B2	19	13	4		I	0,1	0	
INTERV	Detailed print option	M1	19	14	5			0	0	
	statistical summary only		19	15	6	1	C	0		
	every time step		19	16	6	2		1		
	every K time steps		19	17	6	3		K		
	K =		19	18	1		I			
	*** provide starting and ending date Max = 10									
	Detailed Printout Periods (mm/dd/yy)									
STAPTP(1,NDET)	STARTING DATE (mm/dd/yy)	M2	20	1	1		I		0	
STOPPR(1,NDET)	ENDING DATE (mm/dd/yy)	M2	20	2	1		I		0	
NDET	Number of detailed printout periods	M2					I			
	Channel/Inlet Number for Printing Inflows and Concentrations									

Table A.2—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
IPRNT(1 NPRNT)	Channel/Inlet number	M3	21	1	7		I		0	
	Channel/Inlet Number for Printing Outflows and Concentrations									
IPRNT(1 NPRNT)	Channel/Inlet number	M3	22	1	7		I		0	
	Channel for Printing Depths		23							
KDEEP(1 MDEEP)	Channel number	M4	23	2	7		I		0	
NPRNT	Number of channels/inlets (for which non-zero fl to be printed	M1					I			
MDEEP	Number of depth locations for printout	M4					I			

Table A.3 Input Variables and Screen Sequence in USEHP

Screen No.	Variables	Definition	Unit
1	Description	Description of this run	
	UNITS	Units either in U.S. units or [Metric units]	
	Number of inlets	Number of inlets (non-conduit elements)	
	Number of pollutants	Number of pollutants (max=4)	
	Number of data points	Number of data points to define hydrographs and/or pollutographs	
2	INLET #	Inlet number	
3	POLLUTANT	Pollutant name (character field)	
	UNIT	Pollutant input unit (character filed)	
	TYPE UNIT	Pollutant output unit. Three options: mg/l, MPN/l, or others	
4	TEO	Time of day in decimal hour (e.g., 6:30 p.m.=18.5)	hour
5	INLET [TIME]	Inlet number supplied on Screen 2 [time of day provided on Screen 4]	[hour]
	FLOW	Input flow for the time step at the inlet	cfs [m^3/s]
	POLLUTANT [1]	Concentration for pollutant #1	unit supplied on Screen 3
	POLLUTANT [2]	Concentration for pollutant #2	unit supplied on Screen 3
	POLLUTANT [3]	Concentration for pollutant #3	unit supplied on Screen 3
	POLLUTANT (4)	Concentration for pollutant #4	unit supplied on Screen 3

Table A.4 Input Variables and Screen Sequence in TRANSPORT

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
	TRANSPORT Control Parameters									
TITLE	Description of this run	A1	1	1	1		C160			
	Inlet hydrographs and pollutographs file		1	2	3					
DWDAYS	Number of days prior to simulation	B2	1	3	1		F		0	
GNU	Kinematic viscosity of water	B2	1	4	1		F		10^-5	ft2/s
									10^-2	cm2/s
TRIBA	Total catchment area	B2	1	5	1		F		0.0	ac (ha)
	Computational Control		1		5					
IDATEZ	Starting date of strom (mm/dd/yy)	B1	1	6	1		C		000000	
TZERO	Starting time of the storm (hours)	B2	1	7	1		F		0	
NDT	Number of time steps	B1	1	8	1		I		0	
NITER	Number of iterations	B1	1	9	1		I		4	
DT	Time step (seconds)	B2	1	10	1		F		0	
EPSIL	Allowable error for convergence	B2	1	11	1		F		0.0001	
	Simulation Control		2							
	Simulation type		2		5		C25			
NINFIL	Sewer Infiltration Inflows	B3	2	1	4			0,1	0	
NFILTH	Dry-weather sewage inflow	B3	2	2	4			0,1	0	
NDESN	Hydraulic design	B3	2	3	4			0,1	0	
METRIC	Unit	B1	2	4	5			0,1	0	
	U. S. units		2	5	6	1	C15	0	0	
	Metric units		2	6	6	2	C15	1		
NPOLL	Number of constituents to be simulated	B1	2	7	1		I	0-4	0	
	*** Array (max = 100)									
	Sewer System Table		3							
NOE	CNAME	E1	3	1	1		C			
NUE(1)	1st U/P	E1	3	2	1		I		0	
NUE(2)	2nd U/P	E1	3	3	1		I		0	
NUE(3)	3nd U/P	E1	3	4	1		I		0	
NTYPE	TYPE	E1	3	5	3		C17	1-25	1	
	Circular	E1	3			1		1		

Table A.4—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
	Rectangular	E1	3			2		2		
	Egg shape	E1	3			3		3		
	Horseshore	E1	3			4		4		
	Gothic	E1	3			5		5		
	Catenary	E1	3			6		6		
	Semielliptic	E1	3			7		7		
	Baslet-Handle	E1	3			8		8		
	Semi-circular	E1	3			9		9		
	Modified B-H	E1	3			10		10		
	R + tri bottom	E1	3			11		11		
	R + round bottom	E1	3			12		12		
	Trapezoid	E1	3			13		13		
	Parabolic	E1	3			14		14		
	Power F	E1	3			15		15		
	Manhole	E1	3			16		19		
	Lift station	E1	3			17		20		
	Flow divider	E1	3			18		21		
	Flow divider/weir	E1	3			19		23		
	Flow divider	E1	3			20		24		
	Backwater	E1	3			21		25		
	XTANK001.DAT	G1-G5	3							
	XHEC2001.DAT	E2-E4	3							
	XSHAP001.DAT	D1-D9	3							
DIST*	LENGTH	E1	3	6	1		F		0.0	ft (m)
GEOM1*	GEOM1	E1	3	7	1		F		0.0	
SLOPE*	SLOPE	E1	3	8	1		F		0.0	
ROUGH*	MANNING'S n	E1	3	9	1		F		0.0	
GEOM2*	GEOM2	E1	3	10	1		F		0.0	
BARREL	BARREL	E1	3	11	1		F		1.0	
GEOM3*	GEOM3	E1	3	12	1		F		0.0	
	*** Array (max = 4)									
	Water Quality Table		4							
PNAME	POLLUTANT	F1	4	1	3		C8			

Table A.4—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
PUNIT	CUNIT	F1	4	2	1		C8			
NDIM	TYPE UNIT	F1	4	3	3		C11	0,1,2	0	
	mg/l					1		0		
	Other/l					2		1		
	Other units					3		2		
DECAY	DECAY	F1	4	4	1		F		0.0	1/day
SPG	GRAVITY	F1	4	5	1		F		0.0	
PSIZE(2)	SIZE (2)	F1	4	6	1		F		0.0	mm
PGR(2)	GR(2) %	F1	4	7	1		F		0.0	
PSIZE(3)	SIZE (3)	F1	4	8	1		F		0.0	mm
PGR(3)	GR(3) %	F1	4	9	1		F		0.0	
PSIZE(4)	SIZE (4)	F1	4	10	1		F		0.0	mm
PGR(4)	GR(4) %	F1	4	11	1		F		0.0	
PSIZE(5)	SIZE (5)	F1	4	12	1		F		0.0	mm
PGR(5)	GR (5) %	F1	4	13	1		F		0.0	
PSDWF	MAX SIZE	F1	4	14	1		F		0.0	mm
	Infiltration Inflows		5							
DINFIFL	Base dry weather infiltration	K1	5	1	1		F		0.0	cfs (m3/s)
GINFIL	Groundwater infiltration	K1	5	2	1		F		0.0	cfs (m3/s)
RINFIL	Rainwater infiltration	K1	5	3	1		F		0.0	cfs (m3/s)
RSMAX	Peak residual moisture	K1	5	4	1		F		0.0	cfs (m3/s)
CPINF(1)	Concentration of constituent #1	K1	5	5	1		F		0.0	
CPINF(2)	Concentration of constituent # 2	K1	5	6	1		F		0.0	
CPINF(3)	Concentration of constituent # 3	K1	5	7	1		F		0.0	
CPINF(4)	Concentration of constituent # 4	K1	5	8	1		F		0.0	
	*** Array (max = 12) Jan, Feb,.... ,Dec									
	Average Monthly Degree-Days		6							
	Month		6	1	1					
NDD(1-12)	Degree-Days	K2	6	2	1		F		0.0	F
	*** Array (max = 7) Sunday,..., Saturday									
	Daily Correction Factors for Flow and Concentrations		7							

Table A.4—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
	Day		7	1	1					
DVDWF(1-7)	SEWAGE FLOW	L1	7	2	1		F		1.0	
NVBOD(1-7)	BOD	L2	7	3	1		F		1.0	
DVSS(1-7)	SS	L3	7	4	1		F		1.0	
	*** Array (max = 24) 1 am, 2 am,..., 11 pm									
	Hourly Correction Factors for Flow and Concentration		8							
HVDWF(1-24)	SEWAGE FLOW	M1	8	1	1		F		1.0	
HVBOD(1)	BOD	M2	8	2	1		F		1.0	
HVSS(1)	SS	M3	8	3	1		F		1.0	
HVCOLI(1)	TOTAL COLIFORM	M4	8	4	1		F		1.0	
	Study Area Description		9							
KTNUM	Total number of subareas within a given stud	N1	9	1	1		I		1	
NPF	Number of process flows	N1	9	2	1		I		0	
KDAY	Day of the week begins simulation	N1	9	3	1		I		1	
CPI	Consumer price index	N1	9	4	1		F		125.0	
CCCI	Composite construction cost index	N1	9	5	1		F		110.0	
POPULA	Total population in all areas	N1	9	6	1		F		0.0	thousands
KASE	Estimate sewage quality from treatment plant	N1	9	7	4		I		0	
	Study Area Parameters		10							
	Total study area data		10							
ADWF	Sewage flow	O1	10	1	1		F		0.0	cfs (m3)
ABOD	BOD	O1	10	2	1		F		0.0	mg/l
ASUSO	SS	O1	10	3	1		F		0.0	mg/l
ACOLI	Coliform	O1	10	4	1		F		0.0	mg/l
	Categorized contributing Area									
TOTA	BOD and SS	O2	10	5	1		F		0.0	acre (ha)
TINA	Industrial	O2	10	6	1		F		0.0	acre (ha)
TCA	Commercial	O2	10	7	1		F		0.0	acre (ha)
	Residential area									
TRHA	High income	O2	10	8	1		F		0.0	acre (ha)
TRAA	Average income	O2	10	9	1		F		0.0	acre (ha)

Table A.4—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
TRLA	Low income	O2	10	10	1		F		0.0	acre (ha)
TRGGA	Additional waste	O2	10	11	1		F		0.0	acre (ha)
TPOA	Park and open area	O2	10	12	1		F		0.0	acre (ha)
	*** Array (max = NPF)									
	Process Flow Characteristics		11							
INPUT	MANHOLE #	P1	11	1	1		I		0	
QPF	FLOW	P1	11	2	1		F		0.0	cfs (m3/s)
BODPF	Q BOD	P1	11	3	1		F		0.0	mg/l
SUSPF	Q SS	P1	11	4	1		F		0.0	mg/l
	*** Array (max = KTNUM)									
	Categorized Study Area		12							
KNUM	KNUM	Q1	12	1	1		I		0	
INPUT	MANHOLE #	Q1	12	2	1		I		0	
KLAND	LAND	Q1	12	3	3		C15	1-5	5	
	Single-F R					1			1	
	Multi-F R					2			2	
	Commericial					3			3	
	Industrial					4			4	
	U/P lands					5			5	
METHOD	METHOD	Q1	12	4	3		C10		0	
	Metered					1			1	
	No metered					2			2	
KUNIT	UNIT	Q1	12	5	3		C15			
	Thousand gal/mo					1			0	
	Thousand cfs/mo					2			1	
	10^3 m3/mo					3			0	
MSUBT	PRINT	Q1	12	6	3		C3			
	No					1			0	
	Yes					2			1	
SAGPF	INDU Q	Q1	12	7	1		F		0.0	cfs (m3/s)
SABPF	BOD C	Q1	12	8	1		F		0.0	mg/l
SASPF	SS C	Q1	12	9	1		F		0.0	mg/l

Table A.4—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
WATER	WINTER USE	Q1	12	10	1		F		0.0	
PRICE	PRICE	Q1	12	11	1		F		0.0	/1000 gal cents/1000 m3
SEWAGE	SEWAGE	Q1	12	12	1		F		0.0	cfs (m3)
ASUB	AREA	Q1	12	13	1		F		0.0	acre (ha)
POPDEN	DENSITY	Q1	12	14	1		F		0.0	pers/ac pers (ha)
DWLNGS	DWELNGS	Q1	12	15	1		F		10.0/ac	
FAMILY	FAMILY	Q1	12	16	1		F		0.0	
VALUE	VALUE	Q1	12	17	1		F		20.0	$1000
PCGG	% GARBAGE	Q1	12	18	1		F		0.0	
XINCOM	INCOME	Q1	12	19	1		F		value/2.5	$1000/yr
	Print Control		13							
NPRINT	Error message suppressed	B1	13	1	4		I	0,1	0	
KPRINT	All shapes suppressed	C1	13	2	4		I	0,1	0	
INTPRT	Print interval	B1	13	3	1		I		0	
	List of Element Numbers for Hydrographs and Pollutographs to be Transferred		14							
JN(1-NOUTS)	Non-conduit element number	H1	14	1	7		I		0	
NOUTS	Number of non-conduit elements with transfe routed hydrographs and pollutographs placed interface file	B1					I		0	
	List of Element Numbers for Input Hydrographs and Pollutographs		15							
NYN(1-NNYN)	Non-conduit element number	J1	15	1	7		I		0	
NNYN	Number of non-conduit elements with input h and pollutographs printouts	B1					I			
	List of Element Numbers for Output Hydrographs		16							

Table A.4—continued

Variable	Description	SID	SCR	CS	CT	Item	Type	Range	Default	Units
	and Pollutographs									
NPE(1 NNPE)	Non-conduit element number	J2	16	1	7		I		0	
NNPE	Number of non-conduit elements with output and pollutographs printouts	B1					I		0	
	List the Conduit Elements for Which Depths to be Pri		17							
JSURF(1 NAURF)	Conduit number	I2	17	1	7		I		0	
NAURF	Number of conduit elements									
	*** Set NCNTRL = 0									
NCNTRL	Control parameter specifying means to be us transferring inlet hydrographs	B3					I	0,1	0	
	*** set NINPUT = 0									
NINPUT	Number of non-conduit elements with data in hydrographs and pollutographs on data group R1	B1					I	0,1	0	

Table A.5 Input Variables and Screen Sequence in EXTRAN

Variable	Description	SWID SW#Var	SCR	CS	CT	Item	Type	Range	Default	Units
	EXTRAN Simulation									
TITLE	Description of this run	A1	1	1	1		C160			
	Inlet hydrographs file		1	2	3					
REDO	Initial flows, heads, and velocities	B1#7	1	3	5		I	1-4	0	
	No		1	4	6			0		
	Read a hot-start file		1	5	6			1		
	Create a new hot-start file		1	6	6			2		
	Read old file and create a new hot-start file		1	7	6			3		
	Hot-start file	MM#2	1	8	3					
METRIC	Unit	B2#1	1	9	5		I	0,1	0	
	U.S. units			10	6	1		0		
	Metric units			11	6	2		1		
	Computational Control									
TZERO	Starting time of simulation (hour)	B1#3	1	12	1		F		0	
DELT	Time step (seconds)	B1	1	13	1		F		1.0	
NTCYC	Number of time steps	B1	1	14	1		I		1	
ITMAX	Number of iterations	B2	1	15	1		I			
SURTOL	Allowable error for convergence	B2	1	16	1		F			
	Simulation and Print Control		2							
	Number of channels/conduits in the system		2	1	1		I			
	Number of junctions in the system		2	2	1		I			
AMEN	Surface area for all manholes	B2	2	3	1		F		12.566	^2 (m^2)
NSTART	First time-step to begin print cycle	B1#4	2	4	1		I			
INTER	Print interval during simulation	B1	2	5	1		I			
JNTER	Print interval at end of simulation	B1	2	6	1		I			
NEQUAL	Modify short pipe lengths	B2	2	7	4		I			
ISOL	Solution technique	B0	2	8	3		I	0,1,2	0	
	Explicit	B0	2			1		0		
	Enhanced explicit	B0	2			2		1		
	Iterative explicit	B0	2			3		2		
KSUPER	Flow condition	B0	2	9	3		I	0,1	0	
	Normal and dynamic	B0	2			1		0		

Table A.5—continued

Variable	Description	SWID SW#Var	SCR	CS	CT	Item	Type	Range	Default	Units
	Normal	B0	2			2		1		
JELEV	Conduit elevation	BB	2	10	3		I	0,1	0	
	Depth	BB	2			1		0		
	Elevation	BB	2			2		1		
JDOWN	Water depth at outfall conduits	BB	2	11	3		I	0,1,2	0	
	Normal or critical	BB				1		0		
	Critical	BB				2		1		
	Normal	BB				3		2		
	*** 2(1) determines # of looping screens (3-5)									
	Channel/Conduit Data									
NCOND	Channel/conduit number	C1	3	1	1		I5		1	
NJUNC(1)	Junction number at upstream end of channel	C1	3	2	1		I		0	
NJUNC(2)	Junction number at downstream end of channel	C1	3	3	1		I		0	
QO	Initial flow	C1	3	4	1		F		0.0	s (m^3/s)
NKLASS	Type of channel shape	C1	3	5	5		I	1-8	1	
	Circular	C1	3			1		1		
	Rectangular	C1	3			2		2		
	Horseshoe	C1	3			3		3		
	Egg	C1	3			4		4		
	Baskethandle	C1	3			5		5		
	Trapezoid	C1	3			6		6		
	Parabolic	C1	3			7		7		
	HEC-2 format	C1	3			8		8		
AFULL	Cross section area	C1	3	6	1		F		0.0	^2 (m^2)
DEEP	Vertical depth	C1	3	7	1		F		0.0	^2 (m^2)
WIDE	Maximum width	C1	3	8	1		F		0.0	^2 (m^2)
LEN	Length	C1	3	9	1		F		0.0	^2 (m^2)
ZP(1)	UP distance of channel invert above junction inv	C1	3	10	1		F		0.0	^2 (m^2)
ZP(2)	DN distance of channel invert above junction inv	C1	3	11	1		F		0.0	^2 (m^2)
ROUGH	Manning'n coefficient	C1	3	12	1		F		0.0014	
	Trapezoid									
STHETA	Side Slope -1	C1	3	13	1		F		0.0	

Table A.5—continued

Variable	Description	SWID SW#Var	SCR	CS	CT	Item	Type	Range	Default	Units
SPHI	Side slope - 2	C1		14	1					
	HEC-2 format									
STHETA	Cross section ID	C1		15	1					
SPHI	Average slope	C1		16	1					
	Parabolic/power function									
STHETA	Exponent	C1		17	1					
	*** If NKLASS = 8 -> 4 & 5									
	Natural Channel (HEC-2 format)		4							
SECNO	Cross section ID	C3	4	1	?		I		1	
	Manning's n		4							
XNL	Left bank	C2	4	2	1		F		0.0	
XNR	Right bank	C2	4	3	1		F		0.0	
XNCH	Channel	C2	4	4	1		F		0.0	
NUMST	Number of elev/station points	C3	4	5	1		I		0-99	
	Station									
STCHL	Left bank of channel	C3	4	6	1		F		0.0	ft (m)
STCHR	Right bank of channel	C3	4	7	1		F		0.0	ft (m)
LEN	Channel length	C3	4	8	1		F		0.0	ft (m)
PXSECR	Factor - horizontal dimensions	C3	4	9	1		F		0.0	
PSXECE	Elevation increment	C3	4	10	1		F		0.0	
	*** Array screen									
	***NUMST determines # of rows									
	Cross Section Profile		5							
EL(1)	Elevation	C4	5	1		1			0.0	ft (m)
STA(1)	Station	C4	5	2		2			0.0	ft (m)
	*** looping screens per junction									
	*** Repeat Screens No. 6-18 for each junction									
	Junction Data									
JUN	Junction number	D1	6	1	1					

Table A.5—continued

Variable	Description	SWID SW#Var	SCR	CS	CT	Item	Type	Range	Default	Units
GRELEV	Ground elevation	D1	6	2	1				0.0	ft [m]
Z	Invert elevation	D1	6	3	1				0.0	ft [m]
QINST	Net constant flow into junction	D1	6	4	1				0.0	s [m^3/s]
YO	Initial depth above junction invert elevation	D1	6	5	1				0.0	ft [m]
JTYPE	Type of junction		6		5					
	Storage		6	6	4					
	Orifice - sump		6	7	4					
	Orifice - side outlet		6	8	4					
	Weir - transverse		6	9	4					
	Weir - side flow		6	10	4					
	Pump		6	11	4					
JFREE	Outfall without tide gate	I1	6	12	4					
JGATE	Outfall with tide gate	I2	6	13	4					
NTIDE	Type of boundary	J1	6	14	3					
	Free outfall		6			1		1		
	Constant elev		6			2		2		
	Tide coeff		6			3		3		
	Compute coeff		6			4		4		
	Stage-history		6			5		5		
	Storage Junction Data		7							
JSTORE	Junction Number	E1	7	1	?		I		0	
	Type of storage junction		7	2	5					
	Constant-area		7	3	6					
	Variable-area		7	4	6					
	Power function		7	5	6					
ZTOP	Crown Elevation	E1	7	6	1		F		0.0	ft [m]
ASTORE	Surface Area	E1	7	7	1		F		0.0	s [m^3/s]
NUMST	Number of stage/storage area points	E1	7	8	1		I	0-99		
	Power function		7							
QCURVE(1,1)	Coefficient	E2	7	9	1					
QCURVE(2,1)	Exponent	E2	7	10	1					

Table A.5—continued

Variable	Description	SWID SW#Var	SCR	CS	CT	Item	Type	Range	Default	Units
	*** NUMST determines # of rows (Array screen)									
	Variable-Area Storage Junction (Stage vs. Surface Area)									
QCURVE(1,1)	AREA (JUN #)	E2	8	1	1					acres (hec)
QCURVE(2,1)	DEPTH (JUN #)	E2	8	2	1					ft (m)
	*** Orifice (max = 60)									
	Orifice Data - Sump		9							
NJUNC(1)	Junction # containing orifice	F1	9	1	?		I			
NJUNC(2)	Junction # to which orifice discharges	F1	9	2	1		I			
NKLASS	Type of orifice	F1	9	3	3		I		1	
	Bottom outlet					1		2		
	T-H bottom					2		-2		
AORIF	Orifice area	F1	9	4	1		F			ft^2 (m^2)
CORIF	Orifice discharge coefficient	F1	9	5	1		F		1.0	
NTIME	Number of discharge coeff/area points	F2	9	6	1		I		0-50.	
	*** NTIME determines # of rows (Array screen)									
	Time-History Orifice Data		10							
VORIF(1,1)	TIME (JUN #)	F2	10	1	1		F			
VORIF(1,2)	FLOW COEFF	F2	10	2	1		F			
VORIF(1,3)	AREA	F2	10	3	1		F			ft^2 (m^2)
	*** Side Orifice									
	Orifice Data - Side Flow		11							
NJUNC(1)	Junction # containing orifice	F1	11	1	?		I			
NJUNC(2)	Junction # to which orifice discharges	F1	11	2	1		I			
NKLASS	Type of orifice	F1	11	3	3		I		1	
	Side outlet					1		1		
	T-H side					2		-1		
AORIF	Orifice area	F1	11	4	1		F			ft^2 (m^2)
CORIF	Orifice discharge coefficient	F1	11	5	1		F		1.0	

Table A.5—continued

Variable	Description	SWID SW#Var	SCR	CS	CT	Item	Type	Range	Default	Units
ZP	Distance of orifice invert above junction	F1	11	6	1		F			ft (m)
NTIME	Number of discharge coeff/area points	F2	11	7	1		I		0-50	
	*** NTIME determines # of rows (Array screen)									
	Time-History Orifice - Side Outlet		12							
VORIF(1,1)	TIME (JUN #)	F2	12	1	1		F			
VORIF(1,2)	FLOW COEFF	F2	12	2	1		F			
VORIF(1,3)	AREA	F2	12	3	1		F			ft^2 (m^2)
	*** Weir (max = 60)									
	Weir Data - Transverse									
NJUNC(1)	Junction # containing weir	G1	13	1	?		I			
NJUNC(2)	Junction # to which weir discharges	G1	13	2	2		I			
KWEIR	Type of weir	G1	13	3	3		I	1-4	1	
	Transverse		13			1		1		
	Trans w/ tide		13			2		2		
YCREST	Height of weir crest above invert	G1	13	4	1		F		0.0	ft (m)
YTOP	Heigth to top of weir opening above invert	G1	13	5	1		F		0.0	ft (m)
WLEN	Weir length	G1	13	6	1		F		0.0	ft (m)
COEF	Discharge coefficient	G1	13	7	1		F		1.0	
	Weir Data - Side Flow									
NJUNC(1)	Junction # containing weir	G1	14	1	?		I			
NJUNC(2)	Junction # to which weir discharges	G1	14	2	2		I			
KWEIR	Type of weir	G1	14	3	3		I	1-4	1	
	Side flow		14			1		3		
	Side flow w/ tide		14			2		4		
YCREST	Height of weir crest above invert	G1	14	4	1		F		0.0	ft (m)
YTOP	Heigth to top of weir opening above invert	G1	14	5	1		F		0.0	ft (m)
WLEN	Weir length	G1	14	6	1		F		0.0	ft (m)
COEF	Discharge coefficient	G1	14	7	1		F		1.0	
	*** Pump (max = 20)									

Table A.5—continued

Variable	Description	SWID SW#Var	SCR	CS	CT	Item	Type	Range	Default	Units
	Pump Data		15							
NJUNC(1)	Junction # being pumped	H1	15	1	?		I			
NJUNC(2)	Junction # which pumped discharge goes to	H1	15	2	1		I			
IPTYP	Type of pump	H1	15	3	3		I			
	Off-line	H1	15			1		1		
	In-line		15			2		2		
	Dynamic head		15			3		3		
PRATE(1)	Lower pumping rate	H1	15	4	1		F			ft^3/s (m^3/s)
PRATE(2)	Mid-pumping rate	H1	15	5	1		F			ft^3/s (m^3/s)
PRATE(3)	High pumping rate	H1	15	6	1		F			ft^3/s (m^3/s)
	Off-line pump volume									
VRATE(1)	Mid-rate pumps	H1	15	7	1		F			ft^3 (m^3)
VRATE(2)	High-rate pumps	H1	15	8	1		F			ft^3 (m^3)
VRATE(3)	Total wet well capacity	H1	15	9	1		F			ft^3 (m^3)
VWELL	Initial volume	H1	15	10	1		F			ft^3 (m^3)
	In-line pump depth									
VRATE(1)	Mid-rate pumps	H1	15	11	1		F			ft (m)
VRATE(2)	High-rate pumps	H1	15	12	1		F			ft (m)
	Dynamic head difference									
VRATE(1)	Lowest pumping rate	H1	15	13	1		F			ft (m)
VRATE(2)	Mid-poumping rate	H1	15	14	1		F			ft (m)
VRATE(3)	Highest pumping rate	H1	15	15	1		F			ft (m)
VWELL	Initial depth	H1	15	16	1		F			ft (m)
	*** Array screen (max = 20)									
	Depth in Pumping Inflow Junction									
PON	DEPTH ON (JUN #)	H1	16	1	1		F		0.0	ft (m)
ROFF	DEPTH OFF (JUN #)	H1	16	2	1		F		0.0	ft (m)
	Boundary Condition at Outfalls		17							
	Junction Number		17	1			I			
A1	First tide coeff	J2	17	2	1		F			ft (m)
W	Tide period (hours)	J2	17	3	1		F			hours

Table A.5—continued

Variable	Description	SWID SW#Var	SCR	CS	CT	Item	Type	Range	Default	Units
A2	Second tide coeff	J2	17	4	1		F			ft (m)
A3	Third tide coeff	J2	17	5	1		F			ft (m)
A4	Fourth tide coeff	J2	17	6	1		F			ft (m)
A5	Fifth tide coeff	J2	17	7	1		F			ft (m)
A6	Sixth tide coeff	J2	17	8	1		F			ft (m)
A7	Seventh tide coeff	J2	17	9	1		F			ft (m)
KO	Type of tide input	J3	17	10	3		I			
	Tidal height		17			1		0		
	High-low water values	J3	17			2		1		
NI	# of input points	J3	17	11	1		F			
DELTA	Convergence criterion	J3	17	12	1		F		0.0005	ft (m)
NCHTID	Print tidal input	J3	17	13	4					
	*** NI determines # of rows (Array screen)									
	Time-Stage Table									
TT	TIME	J4	18	1	1					Hours
YY	STAGE	J4	18	2	1					ft (m)
	*** 2(2) determines # of junction numbers									
	List of Junction Numbers for Heads to be printed		19							
JPRT(1 20)	Junction Number	B4	19	1	7					
NHPRT	Number of junctions for detailed printing of head	B3#1								
	*** 2(1) determines # of conduit numbers									
	List of Conduit Numbers for Flows to be printed		20							
CPRT(1 20)	Conduit Number	B5	20	1	7					
NQPRT	Number of conduits for detailed printing of flow	B3#2								
	*** 2(2) determines # of junction numbers									
	List of Junction Numbers for Heads to be Plotted		21							
JPLT(1 20)	Junction Number	B6	21	1	7					

Table A.5—continued

Variable	Description	SWID SW#Var	SCR	CS	CT	Item	Type	Range	Default	Units
NPLT	Number of junction heads to be plotted	B3#3								
	*** 2(1) determines # of conduit numbers									
	List of Concuit Numbers for Flows to be plotted		22							
KPLT(1 20)	Conduit Number	B7	22	1	7					
LPLT	Number of conduit flows to be plotted	B3#4								
	*** 2(1) determines # of conduit numbers									
	List of Concuit Numbers for US/DS elevations to be plotte		23							
JSURF(1 20)	Conduit Number	B8	23	1	7					
NSURF	Number of conduit upstream/downstream elevat to be plotted	B8#1								

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