EPA STORM WATER MANAGEMENT MODEL (SWMM), VERSIONS 4.31 & 4.4

DESCRIPTION

SWMM is a dynamic rainfall-runoff simulation model, primarily but not exclusively for urban areas, for single-event or long-term (continuous) simulation. Flow routing is performed for surface and sub-surface conveyance and groundwater systems, including the option of fully dynamic hydraulic routing in the Extran Block. Nonpoint source runoff quality and routing may also be simulated, as well as storage, treatment and other best management practices (BMPs). Version 4.3 (May 1994) contains corrections and enhancements to Version 4.20 (June 1992), including a new Transport flow divider, revised hydraulic radius calculations for natural channels in Extran and Transport (to agree with the HEC-2 method), multiple land use options in Runoff, additional sewer infiltration options, improved manipulation of long-term rainfall data (especially 15-min data), a linkage to WASP4 from Transport, additional statistical output from Runoff and many other corrections and enhancements to various program options. Version 4.4 contains many more improvements and options and modifications, as described below. The latest edition of Version 4.4, currently Version 4.4h, is the recommended version for all users. However, EPA SWMM5 is a completely revised an official release of SWMM, now available (November 2004). It is recommended for new users, except that SWMM5 may not be not fully functional in terms of all SWMM4 capabilities (e.g., plug flow in treatment objects). See further information below.

The SWMM4.4h executable program and the Fortran code may be downloaded from this Web site (see later instructions), and this is the recommendation in order to have the most recent code changes. The 1994 version 4.3 is also available from the EPA CEAM. The OSU code and EPA CEAM code is DOS-based and runs in a window under Windows 95/98/NT/2000/XP. Although it will run under DOS with a 486 processor, a Pentium is recommended. Program storage requires about 5 Mb of hard disk space. Also included with the OSU and EPA releases is the Fortran source code, program documentation (but not the users manuals, as explained below), and several sample input files. See this and the EPA CEAM Web site for details.

State-of-the-art graphical user interfaces are available from third-party venders listed later in this Web site. Most of these GUIs are constructed around the core Fortran code of the OSU model version.

AVAILABILITY

We recommend using SWMM5 (see below) or Version 4.4h, downloadable at this site. However, Version 4.31 is available at this site and from the EPA CEAM. Contact:

Center for Exposure Assessment Modeling (CEAM)
National Exposure Research Laboratory - Ecosystems Research Division
Office of Research and Development (ORD)
U.S. Environmental Protection Agency (U.S. EPA)
960 College Station Road
Athens, Georgia (GA) 30605-2700
Voice phone: (706) 355-8400
Web:http://www.epa.gov/ceampubl/

The program may be downloaded directly from the CEAM web page. Additional EPA programs are also available on the CEAM web site, beginning at: http://www.epa.gov/ceampubl/

SWMM 4.4h FEBRUARY 2001 and March 2002 and October 2005

An updated version of SWMM, version 44H, has been placed on the OSU Web/FTP site during February 2001 and updated several times, most recently October 25, 2005. This replaces the last posted version of swmm44gu, September 2000. (These versions are periodically updated. Look for the date on the 44hexe.zip file.) Version 4.4gu included many enhancements provided by Camp, Dresser and McKee. Version 44H includes still more enhancements by OSU and CDM as well as contributions from users. See the file 44README.TXT for a guide to documentation and file 44GUCHNG.TXT for a list of all changes.

We (OSU and CDM) are calling the new version 4.4h instead of 4.4gu to reflect the significant changes to the Runoff Block that have occurred since the last release, in September 2000. We have resisted calling it "version 4.5" or "version 5" in order to try to avoid difficulties in getting agency approval for the various SWMM versions. That is, this is done so as not to confuse agencies who approve SWMM usage. The primary changes included in the February 2001 4.4h release relate to new options for overland flow routing in the Runoff Block. Overland flow may be routed from one subarea of a subcatchment to another, e.g., to simulate runoff from a roof flowing over a lawn, or flow from non-directly connected impervious areas. Runoff from one subcatchment may also be directed to another subcatchment, instead of having to flow into a channel/pipe or inlet. In this way riparian zone and overland flow BMPs may be simulated. Other new options include removal mechanisms in Runoff Block channel/pipes and much general cleanup. See file 44GUCHNG.TXT for a list of all changes.

The March 2002 update includes corrections to the continuity checks for subcatchment-to-subcatchment flow routing and corrections to several other errors, including metric input of natural channel data in the Transport Block. Also included is a highly preliminary Transport Block linked DO-BOD-NOD water quality routine, in the manner of the modified Streeter-Phelps routines that are included in the EPA WASP model. See documentation in TRANSWQ.ZIP, including a small program to test the reaeration routines.

The November 2003 version includes minor corrections made since earlier releases. See file 44guchng.txt.

The November 2004 version includes a Rain Block option for reading comma-delimited hourly rainfall and numerous minor error corrections.

The October 25, 2005 version includes changes to allow the S/T block to read alphanumeric input correctly, to allow BMP removal from Runoff dummy channels, to read air temperature data correctly, and other minor changes. With the likely exception of repair of other small errors, this is probably the last significant modification of version 4.4h. Please try SWMM5!

The first release of version 4.4gu replaced the August 1997 earlier version 4.4. That version included many of the enhancements mentioned on the swmm-users discussion group during the past several years. We are grateful to Camp Dresser & McKee for donation of so much of the code. However, SWMM4.4h will never be an "official" EPA release, since it has been superseded by SWMM5 (see below).

NEW OBJECT-ORIENTED EPA SWMM5 AVAILABLE NOW! (November 2004)

The Cincinnati Lab of EPA and Camp Dresser & McKee have now completed an official release of SWMM5, a complete revision of SWMM that includes a graphical user interface. The new version uses object-oriented C code. A translation program to convert SWMM4 input files to SWMM5 input files is included with the distribution. Feedback is invited via an e-mail address provided by the EPA and through the swmm-users Internet discussion group. Please see the EPA web site for the free download and much more information: http://www.epa.gov/ednnrmrl/models/swmm/index.htm   The final release includes almost all of the SWMM4.4h functionality; exceptions include plug flow and sedimentation theory in treatment units, erosion off subcatchments, and scour-deposition in channels and conduits. The SWMM5 engine is designed to link easily to proprietary GUIs (listed below) that will eventually provide more functionality than the wonderful, but more limited GUI provided directly by the EPA, particularly in the area of GIS and CAD interfacing.

SWMM AND Y2K

Is SWMM Y2K compliant? Yes!

If you cross the 12/99 - 1/00 boundary during a single event or continuous simulation there will not be a problem, since the dates are only labels. Dates are mostly requested with 4-digit years. In places where two-digit years are allowed, years are automatically assumed to begin with 1900. E.g., if 98 is entered as a year, it will be changed to 1998. If 01 is entered as a year, it will be changed to 1901. No version, new or old will harm your computer if you inadvertently put in 01 for 2001.

Chuck Moore of CDM has made changes to all computational blocks for version 4.4 that take care of the century boundary crossing issue for all simulations. WCH has tested all these corrections with interface files that span the date transition.

The Rain Block has been corrected to read and pre-process data for dates that cross the 12/99 - 1/00 boundary. Be aware that the NOAA National Climatic Data Center has discontinued their "Release B Condensed" data format, since they only have 3-digit years, not 4-digit. Only the NCDC-format (TD 3240 and TD 3260) formats will be Y2K compliant, although SWMM will run pre-2000 data in all historic formats. Current Canadian precipitation data (HLY03, HLY21, FIF21) from the Canadian Meteorological Centre may also be read and processed in the Rain Block and are Y2K compliant. Full details are in the revised documentation file, RAIN.DOC. Two new new files have been added for downloading (Y2KTEST.ZIP, CANADATA.ZIP) that document all tests.

The Temp Block, Combine Block and Graph Block are all compatible.

DOCUMENTATION

The two users manuals below may still be purchased and are changed only slightly from those for the original Version 4.0 in 1988. (It is not necessary to update version 4 manuals.) W.C. Huber recommends purchasing revised and more readable documentation from William James at CHI. His two hard-bound manuals incorporate most of the additions to the model since 1988 as well as much useful modeling guidance and an index.

Please note that the dynamic .DOC or documentation files (text files that can be used as example input files and as templates for user-generated input files) included with the SWMM4 distribution files also serve as partial documentation of modifications made during the 1990s.

Huber, W.C. and R.E. Dickinson, *Storm Water Management Model User's Manual, Version 4*, EPA/600/3-88/001a (NTIS PB88-236641/AS), Environmental Protection Agency, Athens, GA, 1988, 595 pp.

Roesner, L.A., Aldrich, J.A. and R.E. Dickinson, *Storm Water Management Model User's Manual, Version 4: Addendum I, EXTRAN*, EPA/600/3-88/001b (NTIS PB88236658/AS), Environmental Protection Agency, Athens, GA, 1988, 203 pp.

Changes in input formats and options for each SWMM block can be found in "documentation" files (.DOC) on the distribution disks in the form of current annotated example input files. The manuals can be obtained from three sources:

- *National Technical Information Service (NTIS)*
  5285 Port Royal Road
  Springfield, Virginia 22161
  (703) 487-4650
  Contact NTIS for charges, and include the NTIS numbers listed above.

- *Dr. William James*   (Recommended vendor for updated manuals.)
  Computational Hydraulics International
  36 Stuart St.
  Guelph, Ontario N1E 4S5

Phone: (519) 767-0197 FAX: (519) 767-2770
e-mail:bill@computationalhydraulics.com
(Contact CHI for prices.)

Note: William James has his own version of SWMM users manuals that are superior in most respects to the "official" EPA manuals. Contact him or CHI for more information.

The executable program, Fortran code and documentation files are also available on the Internet via anonymous FTP at OSU at: ftp://ftp.engr.orst.edu/pub/swmm/pc. See later instructions -- **or simply access from this Web page, later**.

The program available from OSU (and CHI) includes all corrections and enhancements completed at the time of an order (listed near the end of the SWMMRDME file), plus updated .DOC (input format) files. Version 4.31 of SWMM uses the same Lahey compiler and similar array sizes. Version 4.4 is compiled using Digital Visual Fortran 6 (or Compaq Visual Fortran 6).

Web Source for Manuals

BOSS International has converted the EPA SWMM manuals to an Adobe Acrobat (.pdf) format for downloading off the Web. The 798 pages for the two manuals may be accessed at:
www.bossintl.com/products/download/item/MIKE+SWMM.html
Several other documents related to stormwater hydraulics and hydrology may also be accessed at this site.

SWMM BIBLIOGRAPHY

Current bibliographic information is available as part of stormwater modeling conference proceedings from Dr. William James. Contact CHI for information on how to purchase this set of very useful proceedings. Bibiographic information is also included as part of PCSWMM.

SUPPORT

Technical support for installation and computer compatibility problems is available from the EPA. Limited technical support regarding program operation is available by telephone from Dr. Huber or from Dr. James (only if the program is purchased from him). Infrequent workshops on model operation are conducted as well. Contact Dr. Huber or Dr. James for information.

The most useful support is obtained from other users, as well as model developers, on the swmm-users internet discussion group, discussed below.

ADDITIONAL SWMM VENDORS AND INFORMATION

PCSWMM

A menu-driven interface for running the model and providing hydro/pollutographs and animated hydraulic gradelines, plus sensitivity
analysis and GIS options. The distribution disk also includes bibliographic data. Charge: about US$600.
Contact:

Dr. William James or Mr. Rob James or Ms. Lyn James
Computational Hydraulics International (CHI)
36 Stuart St.
Guelph, Ontario N1E 4S5
Phone: (519) 767-0197 * FAX: (519) 767-2770
e-mail:bill@computationalhydraulics.com
Web:http://www.computationalhydraulics.com/

MTVE - Model Turbo-View

Mainly a post-processor for Extran (MTVE) and Runoff (MTVR), including the ability to show the dynamic movement of the hydraulic grade line and display Extran and Runoff Block networks. Charge: <$1,000. Contact:

10 Brooks Software
c/o Mark TenBroek
3744 West Huron River Drive
Suite 200
Ann Arbor, Michigan 48103
Phone or fax: (734) 761-1511
Email: 10brooks@mediaone.net
Web:people.mw.mediaone.net/10brooks

XP-SWMM or Visual SWMM

A complete graphical user interface and post-processor for SWMM. Charge: varies but upwards of $5,000. Contact:

XP Software
2000 NE 42 Ave., Suite 214
Portland, Oregon 97213
Phone: (888) 554-5022
FAX: (888) 554-5122
e-mail: info@xpsoftware.com

Also offered as Visual SWMM or Visual Hydro through:
CAiCE Software Corporation
410 Ware Blvd., Suite 1200
Tampa, Florida 33619-9019
Phone: (800) 883-3487 or (813) 620-1444
FAX: (813) 620-9019
e-mail: sales@caice.com

MIKE-SWMM

The Danish Hydraulic Institute has a general GUI for the Runoff and Extran Blocks, called MIKE-SWMM, based on the DHI MOUSE model interface. Price upwards of $5,000. Contact:
DHI Inc. Portland Office:

David Wood - President
319 SW Washington St.
Suite 614
Portland, Oregon 97204
Tel: 503-827-5900
Fax: 503-827-5905
E-mail: dhi-or@dhigroup.com
Web: http://www.mikeswmm.com/

SWMM - ArcView Link - CDM

Camp, Dresser and McKee has developed a link of Runoff and Extran Block input/output routines with the GIS program ArcView. These tools are now available to SWMM users. SWMMTools is an ArcView extension that allows users of the EPA version of SWMM (e.g., Version 4.4gu) to visualize a SWMM model in conjunction with existing GIS data. The scripts permit viewing of model input and output summary data within ArcView. Contact Mitch Heineman for more information. The routines may be downloaded at the following site:

SWMM - ArcView Link - MWH Soft

Another SWMM-GIS link is available from MWH Soft. InfoSWMM provides a complete integration of EPA's SWMM 5 engine into an easy-to-learn and use ArcGIS/ArcView extension. H$_2$OMAP SWMM is a stand-alone geospatial version of the same interface that provides the same functionality but without requiring ArcGIS. Further information is available from the MWH Soft web site or from:

Erick Heath, P.E.
(626) 568-6855
Erick.heath@mwhsoft.com

SewerCAT, with Extran DLL

Sewer Computer Analysis Tools (SewerCAT^{TM}) is a PC-based software product that has been designed primarily for the modeling
of flows and heads within sewer networks. In 1999, an Extran engine was added to SewerCAT. This work was partially funded by the City of Philadelphia Water Department. The Extran code from SWMM version 4.4h has been taken and modified so that the purely computational aspects of the model are encapsulated into a DLL (Dynamic Link Library). The DLL conforms to the input and output required by SewerCAT of its hydraulic engines. Information about SewerCAT and the Extran DLL may be obtained from:

David T. Mears
SewerCAT Maintainer
Earth Tech
Bellevue, Washington
SewerCatDev@hotmail.com
Phone: (206) 300-7873
www.sewermodel.com

No support is available for the following two programs, and they are mentioned here only for informational purposes:

SwmmDuet

An interactive ArcInfo pre-processor (and limited post-processor) for SWMM was developed in 1992-93 by Dr. T. Gray Curtis. It couples the ArcInfo GIS with SWMM. No charge for beta version. However, this program is based on the 1993 Version 4.2 of SWMM, developed and is not current. A better choice for interactive SWMM-GIS activity is to use one of three GUIs discussed above: PCSWMM, XP-SWMM, or Visual SWMM.

The 1993 Unix version of SwmmDuet may be downloaded via ftp at ftp.engr.orst.edu/pub/swmm/workstation at Oregon St. University.

Support is unavailable.

EPA Windows SWMM

This program was developed by the EPA Office of Science and Technology in 1994 as a Windows-based, menu-driven interface for parts of SWMM. It has been useful as a training tool, but is too limited in capabilities to be a useful production tool. This version is not recommended by W. Huber for other than simple or learning simulations on the basis of numerous small errors that have never been corrected. (Use EPA SWMM5 instead, described earlier.) Support for the program by the EPA Office of Water has been discontinued as of November 1999 and the program is no longer available. For further information, contact Russ Kinerson, (202) 260-1330.

DOWNLOADING THE OSU VERSION OF SWMM

Sixteen SWMM files are in the SWMM anonymous ftp location at OSU:
ftp://ftp.engr.orst.edu/pub/swmm/pc.
"Click" on this location to download SWMM.

Note: Version 44h contains the most recent updates and is recommended for use. Version 4.31 will continue to be distributed until version 44h has complete acceptance.

Version 4.31 (7 files) (not recommended)

SWMMRDME

> - read-me file describing recent changes to the code (ASCII). After going to the ftp site, this may be read by "clicking" on the title. Read it to find out what's new. The date at the top usually corresponds to the most current version of the model, and the most recent changes can be found in the numerical listing, near the end of the file.

SWMMEXE.ZIP

> - pkzipped executable (binary)

SWMMCODE.ZIP

> - pkzipped Fortran code (binary)

SWMMREAD.ZIP

> - pkzipped read-me and document (.DOC) files (binary)

SWMMXMP1.ZIP

> - pkzipped first set of SWMM examples, partially described in SWMMRDME (binary)

SWMMXMP2.ZIP

> - pkzipped second set of SWMM examples, partially described in SWMMRDME (binary)

SWMMXMPC.ZIP

> - pkzipped continuous SWMM example for Miami (binary)

Version 4.4H (10 files) (recommended). Latest posted version: October 25, 2005.

44README.TXT = description of the files.

44hexe.zip = win-zipped executable (swmm44h.exe)

44hcode.zip = win-zipped Fortran code

old-doc.zip = zipped data/document files (text files) for each block. These are old .DOC files from version 4.31 but should execute with version 4.4gu. However, changes (documentation) for version 4.4 are contained in .DOC files in file 44-doc.zip, below.

44-doc.zip = zipped data/document files (text files) for each block that contain documentation of changes for version 4.4g. These document files (.doc) are text files, not Word files and may be used as program

input files. In addition, there are five <u>Word</u> files (44a.doc, 44f.doc, 44g.doc, cdm-extran-report.doc, cdm9-8-00.doc) that describe all the changes implemented by Chuck Moore for various versions of SWMM 4.4g. An additional file, shapes.doc.txt, describes the geometries of Extran ellipse and arch conduits, KLASS 9, 10, and 11. (Sorry for the confusion with file extensions.)

44guchng.txt = text file that documents any changes to various version 4.4 releases since the "base" version was released on September 28, 1999.

overland.zip = zipped data and output files illustrating February 2001 overland flow options.

transwq.zip = zipped documentation and sample data files for linked DO-BOD-NOD water quality simulation in the Transport Block.

y2ktest.zip = zipped data files for testing of continuous simulations that span the century boundary.

canadata.zip = zipped data files for testing current Canadian hourly and 15-minute precipitation formats in the Rain Block.

Note, Winzip version 8.0 has been used for file compression.

In addition to the example files, the .DOC ("document") files contained in the 44-DOC.ZIP, OLD-DOC.ZIP, SWMMREAD.ZIP files and elsewhere are all executable and should be referenced in any case for the latest information on changes to SWMM input. The files are updated whenever there is a SWMM update. The latest date is the date at the beginning of the ASCII SWMMRDME file.

If there is a problem, please contact Wayne. Users should note that all code is eventually given to EPA CEAM at Athens, Georgia and is eventually incorporated into the "official" EPA SWMM release. The most recent CEAM release is dated May 1994 and differs from the OSU release in that the CEAM release *does not have* the most recent error corrections (listed at the end of the SWMMRDME file).

Both the OSU and CEAM versions use the same Lahey compiler and similar array sizes for Version 4.3 and 4.31. Version 4.4 is compiled using Compaq Digital Visual Fortran 6.6 (formerly Digital Visual Fortran). **When changes to the SWMM program are made, they will be announced on the SWMM Internet discussion group** on the list-server at the University of Guelph. To subscribe to this free service, send an Internet message to:

listserv@listserv.uoguelph.ca Leave the subject blank. The body of the message should contain only: **SUBSCRIBE SWMM-USERS followed by your NAME.** You will then receive copies of any messages sent to: swmm-users@listserv.uoguelph.ca

HINTS FOR SWMM PROBLEM SOLVING

1. Ask for help! Many problems have been encountered by others and already solved. See if a solution already exists.

2. Use the most recent SWMM version. This will be Version 4.4h. Although Version 4.31 (January 1997) is also provided, for continuity with the May 1994 Version 4.30 provided by EPA, Version 44h or whatever is most recent is recommended. The OSU version has corrections for most known errors but does not include all needed updates and modifications. The EPA CEAM Version 4.30 and OSU version 4.31 use the Lahey 5.20 compiler (utilizing extended memory and giving faster run times) and have larger array sizes than earlier OSU versions compiled with RM Fortran. Both versions require about 4 Mb of extended memory in which to execute. All error corrections are summarized in the SWMMRDME file in the OSU version, and errors corrected since the May 1994 EPA CEAM Version 4.30 release are identified. Version 44h is compiled with Compaq Digital Fortran 6.6 (formerly Digital Visual Fortran) and generally has very large array sizes (e.g., number of pipes allowable in an Extran simulation). These array limits are listed at the beginning of the SWMM output. As described earlier in this web page, Version 4.4h is based on modifications made by Camp Dresser & McKee and OSU and has the most corrections and options. It is the preferred option unless you have a special need for an earlier version.

3. Subscribe to newsletters (e.g., William James' *SWMM News and Notes*), review Internet conversations (e.g., swmm-users@listserv.uoguelph.ca), and attend user's group meetings. One users group meeting is always held each year in Toronto in February-March, sponsored by William James.

> *SWMM News and Notes*
> Dr. William James, ed.
> Computational Hydraulics International (CHI)
> 36 Stuart St.
> Guelph, Ontario N1E 4S5
> Tel. (519) 767-0197, Fax. (519) 767-2770
> Web: http://www.computationalhydraulics.com/

4. Join the Internet discussion group, hosted by Dr. William James at the University of Guelph. To join this free service, send an e-mail message to: listserv@listserv.uoguelph.ca Leave the subject blank. The body of the message should contain only: **SUBSCRIBE SWMM-USERS followed by your name**. You will then receive copies of any messages sent to: swmm-users@listserv.uoguelph.ca

Many SWMM errors, questions and problems are resolved within this busy discussion group, and changes to the OSU SWMM release are announced here.

Note that Dr. James operates similar list-servers for hec-users, hspf-users, and wasp-users. These may be joined in the same manner as for swmm-users.

5. Read this OSU SWMM Web page! New SWMM releases may be obtained here along with additional information about the model.