

SWMM: Storm Water Management Model

Contact Information

SWMM 4.4 and previous versions:

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SWMM version 5:

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Download Information

Availability: Nonproprietary
 SWMM 4.4: <http://ccee.oregonstate.edu/swmm>
 SWMM 5 (available for beta testing): <http://www.epa.gov/ednrmrl/swmm/index.htm>
 Cost: N/A

Model Overview/Abstract

SWMM is a dynamic rainfall-runoff simulation model developed by EPA. It is applied primarily to urban areas and for single-event or long-term (continuous) simulation using various timesteps (Huber and Dickinson, 1988). It was developed for the analysis of surface runoff and flow routing through complex urban sewer systems. The latest official version of SWMM is 4.4h, which is recommended for all users. EPA SWMM5 is a completely revised and updated release of SWMM. The first beta test version SWMM5 was released in June 2003. However, SWMM5 is still under development, with additional functions being incorporated and released over time. In SWMM, flow routing is performed for surface and sub-surface conveyance and groundwater systems, including the options of nonlinear reservoir channel routing and fully dynamic hydraulic flow routing. In the fully dynamic hydraulic flow routing option, SWMM simulates backwater, surcharging, pressure flow, and looped connections. SWMM has a variety of options for quality simulation, including traditional buildup and washoff formulation as well as rating curves and regression techniques. Universal Soil Loss Equation (USLE) is included to simulate soil erosion. SWMM incorporates first order decay and particle settling mechanism in pollutant transport simulations and includes an option of simple scour-deposition routine. Storage, treatment, and other BMPs can also be simulated.

Model Features

- Watershed hydrology and water quality
- Stream/conduit transport

- Urban stormwater and sewage systems

Model Areas Supported

Watershed	High
Receiving Water	Medium
Ecological	None
Air	None
Groundwater	Low

Model Capabilities

Conceptual Basis

The basic spatial unit for SWMM is the subcatchment into which the modeled watershed is subdivided. Multiple small subwatersheds and representative streams may be networked together to represent a larger watershed drainage area.

Scientific Detail

Infiltration is calculated using the Horton or Green-Ampt methods, at the user's choice. A version of Manning's equation is used to estimate flow rate from the subcatchment area based on a conceptual model of the subcatchment as a "nonlinear reservoir." The lumped storage scheme is applied for soil/groundwater modeling. For impervious areas, a linear formulation is used to compute daily/hourly increases in particle accumulation. For pervious areas, a modified USLE determines sediment load. The concept of potency factors is applied to simulate pollutants other than sediment.

The Transport block has kinematic wave routing of flow and quality, base flow generation, and infiltration capabilities and it routes flow through user-defined system ranges from natural channel to concrete pipes. The EXTRAN block carries out a numerical solution of the complete St. Venant equations for urban drainageways and conduits, by modeling the network as a link-node system. SWMM can be directly interfaced with EPA's WASP receiving water quality model.

Model Framework

- Subwatersheds and watershed
- Channel/pipe network
- One-dimensional flow and pollutant routing

Scale

Spatial Scale

- Subwatershed of flexible size

Temporal Scale

- User-defined timestep, typically minutes to hourly

Assumptions

- The model performs best in urbanized areas with impervious drainage, although it has been widely used elsewhere.
- Model parameters for quantity and quality simulations are developed such that the model will be calibrated to enhance its capability.
- Water table elevation is assumed to be fixed.
- All the pollutants entering the waterbodies are sediment adsorbed.

Model Strengths

- Fully dynamic hydraulic routing
- Hydraulic structure (manhole, weir, orifice, etc.) simulation
- Overland flow routing between pervious and impervious areas within a subcatchment (latest version)
- Various options for quality simulation, including buildup and washoff, rating curves, and regression techniques

Model Limitations

- Only considers settling and first-order decay in in-stream pollutant routing and transformation
- Weak groundwater simulation capability

Application History

SWMM has been applied to urban hydrologic quantity/quality problems in scores of U.S. cities as well as extensively in Canada, Europe, and Australia (Donigian and Huber, 1991; Huber, 1992). The model has been used for very complex hydraulic analysis for combined sewer overflow mitigation, as well as for many stormwater management planning studies and pollution abatement projects (Huber, 1992). Warwick and Tadepalli (1991) describe calibration and verification of SWMM on a 10-square-mile urbanized watershed in Dallas, Texas. Tsihrintzis, et al., (1995) describe SWMM applications to four watersheds in South Florida representing high- and low-density residential, commercial, and highway land uses.

Model Evaluation

The applications are primarily limited to urban areas.

Model Inputs

- Data requirements for hydrologic simulation include area, imperviousness, slope, roughness, width, depression storage, and infiltration parameters. Land use data are used to determine ground cover type for each model subarea.
- Depending on what options are set for the loading calculations, additional parameters are necessary (e.g., buildup coefficients would be needed for the dry weather buildup simulation).
- Additional data are necessary if the user intends to model subsurface drainage and interflow.
- Depending on the stormwater system, dimensions, slope, roughness coefficients, elevations, and storage are required.
- Continuous records of evapotranspiration, temperature, and solar intensity are required.

Users' Guide

- Huber, W.C. and R.E. Dickinson. 1988 *Storm Water Management Model User's Manual, Version 4*. EPA/600/3-88/001a (NTIS PB88-236641/AS). U.S. Environmental Protection Agency, Athens, GA, pp.595
- Roesner, L.A., J.A. Aldrich and R.E. Dickinson. 1988. *Storm Water Management Model User's Manual, Version 4: Addendum I, EXTRAN*. EPA/600/3-88/001b (NTIS PB88236658/AS). U.S. Environmental Protection Agency, Athens, GA. pp.203
- A revised and more readable User's Guide from William James at CHI can be purchased at <http://www.computationalhydraulics.com/Publications/Books/r219.html>

Cost: \$85

Technical Hardware/Software Requirements

Computer hardware:

- PC

Operating system:

- DOS and Windows

Programming language:

- FORTRAN (v4.4 and previous versions)
- C (v5)

Runtime estimates:

- Minutes

Linkages Supported

- SWMM can directly be interfaced with EPA's WASP receiving water quality model.

Related Systems

PCSWMM, XP-SWMM, MIKE-SWMM

Sensitivity/Uncertainty/Calibration

SWMM 4.4 includes a STATISTICS module, which performs simple statistical analyses on both quantity and quality parameters.

Model Interface Capabilities

- SWMM 5 includes a Graphical User Interface for input data preparation and output data display

References

Donigian, A.S., Jr., and W.C. Huber. 1991. *Modeling of Nonpoint Source Water Quality in Urban and Non-urban Areas*. EPA/600/3-91/039. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

Huber, W. C. 1992. Experience with the U.S. EPA SWMM Model for Analysis and Solution of Urban Drainage Problems. In *Proceedings, Inundaciones Y Redes De Drenaje Urbano*, ed. J. Dolz, M. Gomez, and J. P. Martin, eds., Colegio de Ingenieros de Caminos, Canales Y Puertos. Universitat Politecnica de Catalunya. Barcelona, Spain, pp. 199-220.

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James, W., W. C. Huber, R. E. Pitt, R. E. Dickinson, and R. C. James. 2002. *Water Systems Models [1]: Hydrology, User's guide to SWMM4 RUNOFF and Supporting Modules and to PCSWMM. Version 2.4.* Computational Hydraulics International, Guelph, Ontario, Canada. pp. 311.

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Tshihrintzis, V. A., R. Hamid, and H. R. Fuentes. 1995. Calibration and verification of watershed quality model SWMM in sub-tropical urban areas. In *Proceedings of the First International Conference - Water Resources Engineering*. American Society of Civil Engineers, San Antonio, TX. pp 373-377.

Tshihrintzis, V. and R. Hamid. 1998. *Runoff Quality Prediction from Small Urban Catchments using SWMM. Hydrological Processes*, 12 (2):311-329.

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