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# Storm Water Management Model (SWMM)

*An application that helps predict the quantity and quality of runoff in future long-term runoff events within urban areas*

Stormwater discharges continue to cause impairment of our Nation's waterbodies. Regulations that require the retention and/or treatment of frequent, small storms that dominate runoff volumes and pollutant loads are becoming more common. The U.S. Environmental Protection Agency (EPA) developed the Storm Water Management Model (SWMM) to help support local, state, and national stormwater management objectives to reduce runoff through infiltration and retention. SWMM was first developed in 1971 and has undergone several major upgrades since then.

## Application

SWMM is used widely throughout the world for large-scale planning, analysis, and design related to stormwater runoff, combined and sanitary sewers, and other drainage systems in urban areas – although there are many applications for drainage systems in non-urban areas as well. Running under Windows® operating systems, SWMM provides an integrated environment for editing study area input data, running hydrologic, hydraulic and water quality simulations, and viewing the results in a variety of formats. These include color-coded drainage area and conveyance system maps, time series graphs and tables, profile plots, and statistical frequency analyses. Typical applications of SWMM:

- Designing and sizing of drainage system components for flood control.
- Sizing detention facilities and their appurtenances for flood control and water quality protection.
- Mapping flood plains of natural channel systems – *SWMM 5 is a FEMA-approved model for National Flood Insurance Program studies.*
- Designing control strategies for minimizing combined sewer overflows.
- Evaluating the impact of inflow and infiltration on sanitary sewer overflows.
- Generating nonpoint source pollutant loadings for waste load allocation.
- Controlling site runoff using eight green infrastructure practices, which are types of low impact development (LID) controls (see page 2 for details).
- Evaluating the effectiveness of best management practices for reducing wet weather pollutant loadings.

## Modeling Capabilities

SWMM accounts for various hydrologic processes that produce runoff from urban areas:

- Runoff reduction via green infrastructure practices
- Time-varying rainfall (precipitation) and evaporation of standing surface water
- Snow accumulation and melting
- Rainfall interception from depression storage
- Infiltration of rainfall into unsaturated soil layers
- Percolation of infiltrated water into groundwater layers
- Interflow between groundwater and the drainage system
- Nonlinear reservoir routing of overland flow

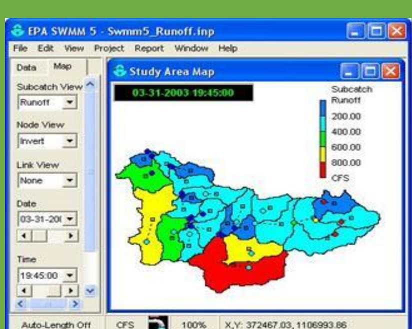
## Add-in Tool for Climate Projections

SWMM was recently updated to include a software utility that allows future climate change projections to be incorporated into modeling. The SWMM Climate Adjustment Tool (SWMM-CAT) provides a set of location-specific adjustments derived from World Climate Research Programme global climate change models. SWMM-CAT accepts monthly adjustment factors for climate-related variables that could represent the potential impact of future climate changes.

(1) Green Infrastructure

(2) Traditional Grey Infrastructure

The Storm Water Management Model (SWMM) is a simulation model used for single event or long-term simulation of water runoff quantity and quality in primarily urban areas. It includes the application of green infrastructure practices that promote the natural movement of water within an ecosystem, instead of allowing it to run across paved surfaces and down storm drains. Green infrastructure, such as the bioretention cell shown in the image (1) above, allows runoff to infiltrate into the ground instead of allowing it to wash away into drains, as shown in the traditional grey infrastructure image (2) above.




**Download and Additional Material:**
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## Green Infrastructure Practices

SWMM allows engineers and planners to represent combinations of green infrastructure practices to determine their effectiveness in managing runoff. Although some of these practices can also provide significant pollutant reduction benefits, at this time, SWMM only models the reduction in runoff mass load resulting from the reduction in runoff flow volume. SWMM can explicitly model eight different generic green infrastructure practices:

**Rain Gardens.** A depressed area in the landscape, planted with grasses, flowers, and other plants, that collects rain water from a roof, driveway, or street and allows it to infiltrate into the ground. Rain gardens can also help filter out pollutants in runoff and provide food and shelter for butterflies, song birds and other wildlife. More complex rain gardens with drainage systems and amended soils are often referred to as bioretention cells.

**Bioretention Cells (or Bioswales).** Depressions that contain vegetation grown in an engineered soil mixture placed above a gravel drainage bed which slow, infiltrate, and filter runoff. They provide storage, infiltration, and evaporation of both direct rainfall and runoff captured from surrounding areas. As linear features, bioretention cells are particularly well suited to being placed along streets and parking lots.

**Vegetative Swales.** Channels or depressed areas with sloping sides covered with grass and other vegetation. They slow down the conveyance of collected runoff and allow it more time to infiltrate the native soil beneath it.

**Infiltration Trenches.** Narrow ditches filled with gravel that intercept runoff from upslope impervious areas. They provide storage volume and additional time for captured runoff to infiltrate the native soil below.

**Green Roofs.** A variation of a bioretention cell, green roofs have a soil layer laying atop a special drainage mat material that conveys excess percolated rainfall off of the roof. They contain vegetation that enable rainfall infiltration and evapotranspiration of stored water. Green roofs are particularly cost-effective in dense urban areas where land values are high and on large industrial or office buildings where stormwater management costs are likely to be high.

**Rooftop (Downspout) Disconnection.** This practice allows rooftop rainwater to discharge to pervious landscaped areas and lawns instead of directly into storm drains. You can use it to store stormwater and/or allow stormwater to infiltrate into the soil. Downspout disconnection could be especially beneficial to cities with combined sewer systems. SWMM can also model roofs with directly connected drains that overflow onto pervious areas.

**Rain Barrels or Cisterns (Rainwater Harvesting).** Containers that collect roof runoff during storm events and can either release or re-use the rainwater during dry periods. Cisterns may be located above or below ground and have a greater storage capacity than a rain barrel.

**Continuous Permeable Pavement Systems.** Excavated areas filled with gravel that are paved over with a porous concrete or asphalt mix. Normally, rainfall will immediately pass through the pavement into the gravel storage layer below where it can infiltrate at natural rates into the site's native soil. Block Paver systems consist of impervious paver blocks placed on a sand or pea gravel bed with a gravel storage layer below. Rainfall is captured in the open spaces between the blocks and conveyed to the storage zone and native soil below.