Storm Water Management Model (SWMM 2D Integration)

What's Changed

Previously, GISpipe provided three separate model menus: Water Distribution Network Model, Storm Water Management Model, and Surface Runoff Model. In this update, the Surface Runoff Model has been integrated into the Storm Water Management Model.

Previous Configuration	Updated Configuration
Water Distribution Network Model Storm Water Management Model Surface Runoff Model	Water Distribution Network Model Storm Water Management Model (SWMM 2D Integration)

SWMM 2D System Requirements

Item	Minimum	Recommended
OS	Windows 10 64bit	Windows 10/11 64bit
CPU	4 cores	8 cores or more
RAM	8 GB	16 GB or more
GPU	OpenCL 1.2 supported	NVIDIA GTX 1060 or higher
Disk	1 GB free space	SSD 10 GB or more

Note: SWMM 2D can run in CPU mode without a GPU. Using a GPU provides approximately 10–30x faster performance.

SWMM 2D Overview

SWMM 2D is an integrated analysis model that bidirectionally couples EPA SWMM 1D pipe network analysis with a 2D Shallow Water Equations (SWE) solver to simulate flooding based on DEM data.

Key Features:

- 1D: SWMM pipe network analysis (sewers, internal flow in manholes)
- 2D: HLLC Riemann solver-based surface flooding (includes rainfall, infiltration, evaporation)
- 1D-2D bidirectional coupling
    - 1D overflow → flows to 2D surface through manholes
    - 2D surface → flows back into 1D network through manholes
- DEM is used directly as the 2D computation grid (no separate mesh generation required)
- Subcatchments are not used — the 2D DEM replaces the role of subcatchments

- Coupling points = manholes (junctions)
- Standalone junctions + inflow can simulate surface runoff even without rainfall

SWMM Network Layer Composition:

Layer	Description
SWMM Network	1D network data (sewers, manholes, etc.)
Surface DEM	Terrain elevation (including buildings)
Roughness (Manning's n) DEM	Manning's n values based on land use
Infiltration DEM	Infiltration code values based on soil type

Analysis Results:

- Water depth (including flood extent) — displayed by colour
- Velocity and flow direction — displayed by colour and arrows

Results are visualized over time on the DEM as images.

[Figure 1: SWMM 2D Concept - 1D-2D Bidirectional Coupling - Screenshot to be added]

Quick Start

The simplest way to test SWMM 2D. You can run a 2D analysis with just a surface DEM and rainfall data, without roughness (Manning's n) or infiltration DEMs.

Step 1: Add Empty Network Layer

Add an empty SWMM network layer in the Storm Water Management Model.

[Figure Q1: Adding empty network layer - Screenshot to be added]

Step 2: Create Rainfall Data (Huff Curve)

In Settings > Time Series, generate rainfall data using Huff Curve values.

[Figure Q2: Time Series - Huff Curve rainfall data generation - Screenshot to be added]

Step 3: Add Rain Gauge and Link Time Series

In Edit, add a Rain Gauge and link it to the generated time series rainfall data.

[Figure Q3: Rain Gauge addition and time series linking - Screenshot to be added]

Step 4: Add 2D Layer (Surface Only)

In Add 2D Layer, add only the surface DEM. Roughness (Manning's n) and infiltration DEMs are not required for the analysis to run.

[Figure Q4: Add 2D Layer - Surface only selected - Screenshot to be added]

Step 5: Run Analysis and View Results

Click the Run Analysis button to immediately view results.

[Figure Q5: Quick Start analysis results - Screenshot to be added]

Tip: This method allows you to quickly verify SWMM 2D basic operation. For more accurate analysis, refer to the 10-step guide in the following section.

SWMM 2D Usage Guide (10 Steps)

The following is the step-by-step workflow for performing a detailed SWMM 2D integrated analysis.

Step 1: Prepare DEM Surface Data

Prepare the DEM (Digital Elevation Model) data that forms the basis of 2D analysis. High-resolution DEM is required for urban flood analysis.

Method A: Import DEM File

- Import a high-resolution DEM file (e.g., airborne LiDAR) by clicking the Import button on the left Layer Panel.

Method B: Generate DEM from Contour Data

- Import contour data, then use the Generate DEM function in the Tools menu to create the DEM.

[Figure 2: DEM Import / DEM Generation screen - Screenshot to be added]

Step 2: Import Building Data

Import building data. Buildings serve two roles in 2D analysis:

- Obstacles that water cannot pass through — affects flow paths
- Rainfall distribution on building rooftops

Import building polygon data (ESRI ShapeFile) by clicking the Import button on the left Layer Panel.

[Figure 3: Building data import - Screenshot to be added]

Step 3: Import Land Use / Soil Maps

Import land use and soil maps for roughness (Manning's n) and infiltration parameter estimation.

Import land use and soil maps in ESRI ShapeFile format by clicking the Import button on the left Layer Panel.

- Land use → Roughness (Manning's n) estimation (roads, green areas, buildings, and other surface characteristics)
- Soil map → Infiltration and evaporation parameter estimation

[Figure 4: Land use / Soil map import - Screenshot to be added]

Step 4: Generate Basin & Stream

Use the Generate Basin & Stream function in the Tools menu to analyse the DEM surface.

- Automatically generates basin boundaries and streams based on DEM.
- The generated basin polygons are used to define the analysis area in subsequent steps.

[Figure 5: Basin & Stream generation results - Screenshot to be added]

Step 5: Select Target Basin

Keep only the target basin for analysis and delete the remaining unnecessary basins.

[Figure 6: Target basin selection and unnecessary basin deletion - Screenshot to be added]

Step 6: Remove Outside Polygon Area

Use the "Remove Outside Polygon Area" function in the Edit menu.

Perform overlay operation using the target basin polygon to remove unnecessary areas outside the basin from each layer (DEM, buildings, land use, soil map, etc.).

[Figure 7: Remove Outside Polygon Area example - Screenshot to be added]

Step 7: Overlay Buildings onto DEM

Use the "Overlay Shape to Raster" (Overlay Operation) function in the Edit menu.

Add a height value (10m) to the DEM for building polygons to reflect buildings on the surface.

Setup Method:

1. Select the building layer in the Overlay Operation dialog
2. Input Type: Select "Direct Value Input"
3. Input Type: Select "Add to Existing Value"
4. Enter 10 for the value (10m)
5. Click the OK button

Note: 10m is set as a sufficient height for safety. Buildings become elevated above the DEM, acting as barriers that water cannot pass through in the 2D analysis.

[Figure 8: Overlay Operation dialog - Building height input - Screenshot to be added]

[Figure 9: DEM comparison before/after building overlay - Screenshot to be added]

Step 8: Create Roughness (Manning's n) DEM / Infiltration DEM

Copy the surface DEM to create the roughness (Manning's n) layer and infiltration layer.

Why copy the surface DEM: To maintain the same size (resolution, extent) and analysis area as the surface. Also, default values must be applied where no overlay is performed.

8-1. Create Roughness (Manning's n) Layer

1. Copy the surface DEM layer.
2. Use the land use polygons with the overlay operation to input roughness (Manning's n) values.
3. Default values are applied where no overlay is performed.

[Figure 10: Roughness (Manning's n) layer creation result - Screenshot to be added]

8-2. Create Infiltration Layer

1. Copy the surface DEM layer.
2. Use the land use/soil map polygons with the overlay operation to input infiltration code table Code values.
3. The infiltration layer stores code numbers (not actual infiltration values). During analysis, the Infiltration Table is referenced to apply actual

parameters.

Infiltration Table:

Code	Name	Horton f0	Green-Ampt Ks	Curve Number	Evap. Coeff.
0	Permeable	0.0000139	0.0000333	72	0.70
1	Impervious	0.0000000	0.0000000	98	0.30
3	Forest	0.0000278	0.0000067	55	0.90
7	Pavement	0.0000028	0.0000010	92	0.30
...	...	...	...	...	...

The full Infiltration Table can be viewed and edited in Storm Water Management Model > Model > Infiltration Code Table.

[Figure 11: Infiltration Code Table screen - Screenshot to be added]

[Figure 12: Infiltration layer creation result - Screenshot to be added]

Step 9: Add 2D Layers to SWMM Network

Add the three prepared DEM layers to the SWMM network layer.

How to Add:

1. Click Storm Water Management Model > Model > Add 2D Layer button
2. Select "Surface" from dropdown → specify the surface DEM layer
3. Select "Roughness (Manning's n)" from dropdown → specify the roughness (Manning's n) DEM layer
4. Select "Infiltration" from dropdown → specify the infiltration DEM layer

The SWMM network is already included in the existing SWMM layer.

Final SWMM Network Layer Composition:

Layer	Status
SWMM Network	Included in existing SWMM layer
Surface DEM	Registered via Add 2D Layer
Roughness (Manning's n) DEM	Registered via Add 2D Layer
Infiltration DEM	Registered via Add 2D Layer

[Figure 13: Add 2D Layer dropdown menu - Screenshot to be added]

[Figure 14: SWMM Network layer composition screen - Screenshot to be added]

Step 10: Run Analysis and View Results

Once all settings are complete, run the analysis.

Running the Analysis:

1. Click Storm Water Management Model > Run Analysis button
2. Monitor the simulation progress.
3. View results after completion.

Analysis Results:

Results are visualized as images on the DEM. You can observe the process of flooding spreading and receding over time.

Result Item	Description
Depth	Displayed by colour. Flood depth at each DEM cell. Area with depth > 0 = flood extent
Velocity	Displayed by colour and arrows. Velocity distribution and direction of surface flow

[Figure 15: Analysis results - Depth (flood extent) display - Screenshot to be added]

[Figure 16: Analysis results - Velocity distribution display - Screenshot to be added]

[Figure 17: Analysis results - Flood changes over time - Screenshot to be added]

Reference: Additional Usage

Surface Runoff Simulation Using Standalone Junctions

By entering an inflow value at a standalone junction not connected to any conduit, you can simulate the process of surface runoff from that point onto the 2D surface.

Use Cases:

- Discharge from a specific point
- Pump station outflow
- External inflow modelling

Note: Surface runoff simulation is possible even without rainfall.

** This document is a draft. Program screenshots will be added later.*

** [Figure X: ...] indicates screenshot insertion locations.*