

# **AVALIAÇÃO DO SWMM COMO FERRAMENTA PARA A SIMULAÇÃO DE TÉCNICAS DE LID (LOW IMPACT DEVELOPMENT) EM PEQUENAS BACIAS URBANAS**

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# SWMM (Storm Water Management Model)

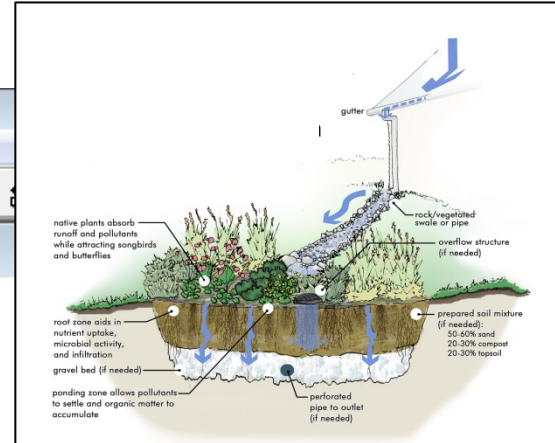
- O SWMM mundialmente empregado para o planejamento, análises e projetos relacionados ao escoamento das águas pluviais, esgotamento sanitário e outros sistemas de drenagem em áreas urbanas.
- Permite Modelagem hidrológica, hidráulica e de qualidade da água, podendo ser utilizado para eventos simples, ou para simulação contínua.
- Versão (5.0) apresenta com extensão adicional da modelagem hidrológica - LID (Low Impact Development).

# LID – SWMM (Storm Water Management Model)

The screenshot shows the SWMM 5 software interface with the LID Control Editor dialog box open. The dialog box has the following fields and options:

- Control Name: [Empty text box]
- LID Type: Bio-Retention Cell (selected in a dropdown menu)
- Process Layers: Surface (selected), Soil, Stor.
- Storage Depth (in. or mm): 0.0
- Vegetation Volume Fraction: 0.0
- Surface Roughness (Mannings n): 0.1
- Surface Slope (percent): 1.0

Buttons at the bottom of the dialog: OK, Cancel, Help.



# LID – SWMM (Storm Water Management Model)

The screenshot displays the SWMM 5 software interface. The main window shows a project titled "SWMM 5 - lid.inp" with a menu bar (File, Edit, View, Project, Report) and a toolbar. On the left, a "Data" panel is visible with a tree view containing "Options", "Climatology", "Hydrology", "Rain Gages", "Subcatchments", "Aquifers", "Snow Packs", "Unit Hydrograph", "LID Controls", and "Hydraulics". The "LID Controls" folder is expanded, and a "LID Control Editor" dialog box is open in the foreground.

The "LID Control Editor" dialog box has the following fields and options:

- Control Name: [Empty text box]
- LID Type: [Bio-Retention Cell (selected)]
- Process Layers: [Surface | Soil | Storage] (Surface is selected)
- Storage Depth (in. or mm): 0.0
- Vegetation Volume Fraction: 0.0
- Surface Roughness (Mannings n): 0.1
- Surface Slope (percent): 1.0

Buttons at the bottom of the dialog are "OK", "Cancel", and "Help".

To the right of the dialog, a cross-section diagram of a bio-retention cell is shown. The diagram includes the following components and labels:

- OPTIONAL TOPSOIL AND SOIL ON TOP OF PEA GRAVEL
- METAL CAP WITH LOCK
- SS < 5%
- PEA GRAVEL OR RIVER STONE
- PROTECTIVE LAYER OF FILTER FABRIC
- CLEAN, AGGREGATE WITH MAX. DIAMETER OF 3.5 IN. AND A MIN. DIAMETER OF 1.5 IN.
- SAND FILTER 6 - 8" DEEP (OR FABRIC EQUIVALENT)
- 4 - 6 IN. PERFORATED PIPE
- FOOT PLATE
- UNDISTURBED MATERIAL

Below the diagram is a photograph of a bio-retention cell installed in a landscape, showing a row of rocks with a metal cap and a perforated pipe, surrounded by grass and a tree.

The bottom status bar of the software shows: "Auto-Length: Off", "Offsets: Depth", "Flow Units: CFS", "Zoom Level: 100%", and "X,Y: -4726.841, 5700.713".

# LID – SWMM (Storm Water Management Model)

The image displays the SWMM 5 software interface with the LID Control Editor dialog box open. The dialog box is titled "LID Control Editor" and contains the following fields and options:

- Control Name: [Empty text box]
- LID Type: **Bio-Retention Cell** (selected in a dropdown menu)
- Process Layers: Surface, Soil, Stor. (tabs)
- Storage Depth (in. or mm): 0.0
- Vegetation Volume Fraction: 0.0
- Surface Roughness (Mannings n): 0.1
- Surface Slope (percent): 1.0

At the bottom of the dialog box are buttons for "OK", "Cancel", and "Help".

To the right of the dialog box is a diagram illustrating the cross-section of a Bio-Retention Cell. The diagram shows the following layers from top to bottom:

- Rain (indicated by downward arrows)
- Porous pavers (top layer)
- Sand/gravel (middle layer)
- Geotextile fabric (separating sand/gravel from coarse gravel)
- Retention trench (coarse gravel) (bottom layer)
- Geotextile fabric (separating coarse gravel from subsoil)
- Infiltration to subsoil (indicated by downward arrows)

An "Overflow pipe" is shown on the left side of the diagram, with an arrow pointing left. A photograph of a real-world Bio-Retention Cell is shown in the bottom right corner of the diagram area.

The background shows the SWMM 5 main window with a project named "SWMM 5 - lid.inp". The interface includes a menu bar (File, Edit, View, Project, Report), a toolbar, a Data/Map view, and a project tree on the left. The status bar at the bottom indicates "Auto-Length: Off", "Offsets: Depth", "Flow Units: CFS", "Zoom Level: 100%", and "X,Y: -4726.841, 5700.713".

# LID – SWMM (Storm Water Management Model)

The screenshot displays the SWMM 5 software interface with the LID Control Editor dialog box open. The dialog box is titled "LID Control Editor" and contains the following fields and options:

- Control Name: [Empty text box]
- LID Type: Bio-Retention Cell (selected in a dropdown menu)
- Process Layers: Surface, Soil, Stor. (radio buttons)
- Storage Depth (in. or mm): 0.0
- Vegetation Volume Fraction: 0.0
- Surface Roughness (Mannings n): 0.1
- Surface Slope (percent): 1.0

At the bottom of the dialog box are buttons for "OK", "Cancel", and "Help".

An inset image shows three blue rain barrels on a wooden pallet, illustrating a rain barrel system. The barrels are positioned against a brick wall, and the pallet is placed on a grassy area.

The background shows the SWMM 5 main window with a menu bar (File, Edit, View, Project, Report) and a toolbar. The left sidebar contains a tree view with categories like Options, Climatology, Hydrology, and LID Controls. The bottom status bar displays "Auto-Length: Off", "Offsets: Depth", "Flow Units: CFS", "Zoom Level: 100%", and "X,Y: -4726.841, 5700.713".



# LID – SWMM (Storm Water Management Model)

The image shows a screenshot of the SWMM 5 software interface. The main window is titled "SWMM 5 - lid.inp" and displays a project tree on the left with categories like Options, Climatology, Hydrology, and Hydraulics. The "LID Controls" section is expanded. A dialog box titled "LID Control Editor" is open in the center, showing the configuration for a "Bio-Retention Cell". The dialog box includes fields for Control Name, LID Type (set to Bio-Retention Cell), Process Layers (Surface, Soil, Storage), Storage Depth (0.0), Vegetation Volume Fraction (0.0), Surface Roughness (Mannings n) (0.1), and Surface Slope (percent) (1.0). Buttons for OK, Cancel, and Help are at the bottom of the dialog. To the right of the dialog box is a photograph of a bio-retention cell, which is a long, narrow, grassy area with a black metal grate at the bottom, used for stormwater management. The background of the software window shows a map view of the project area.

SWMM 5 - lid.inp

File Edit View Project Report

Data Map

Options  
Climatology  
Hydrology  
Rain Gages  
Subcatchments  
Aquifers  
Snow Packs  
Unit Hydrograph  
LID Controls  
Hydraulics

LID Controls

LID Control Editor

Control Name:

LID Type: **Bio-Retention Cell**

Process Layers: Surface Soil Storage

Storage Depth (in. or mm)

Vegetation Volume Fraction

Surface Roughness (Mannings n)

Surface Slope (percent)

OK Cancel Help

Auto-Length: Off Offsets: Depth Flow Units: CFS Zoom Level: 100% X,Y: -4726.841, 5700.713

# LID – SWMM (Storm Water Management Model)

The screenshot displays the SWMM 5 software interface. The main window is titled "SWMM 5 - Simulacao.inp - [Study Area Map]". The menu bar includes File, Edit, View, Project, Report, Tools, Window, and Help. The toolbar contains various icons for file operations and navigation. The left sidebar shows a tree view of the project structure, with "Subcatchments" expanded to show "S36". The main workspace shows a map of the study area. A dialog box titled "LID Controls for Subcatchment S36" is open, displaying a table of LID controls. The table has the following data:

Control Name	LID Type	% of Area	% From Imperv	Report File
MR110	Rain Barrel	2.500	100	

The dialog box also includes buttons for "Add", "Edit", "Delete", "OK", "Cancel", and "Help". The status bar at the bottom shows "Auto-Length: Off", "Offsets: Depth", and coordinates "707.248, 6680.275". A timestamp "03/06/2014 00:01:00" is displayed in the top right corner of the main window.



# LID – SWMM (Storm Water Management Model)

- LID - subunidades das bacias hidrográficas
- O modelo não permite o controle do resultado em diferentes escalas de análise => resposta de cada LID individualmente
- Apenas um hidrograma final no exutório da bacia hidrográfica

## **TRABALHO EXPLORATÓRIO:**

1. Investigar capacidade do SWMM na modelagem de LID (barris de chuva – microrreservatório)
2. Comparar com modelagem considerando a unidade de armazenamento (storage unit)

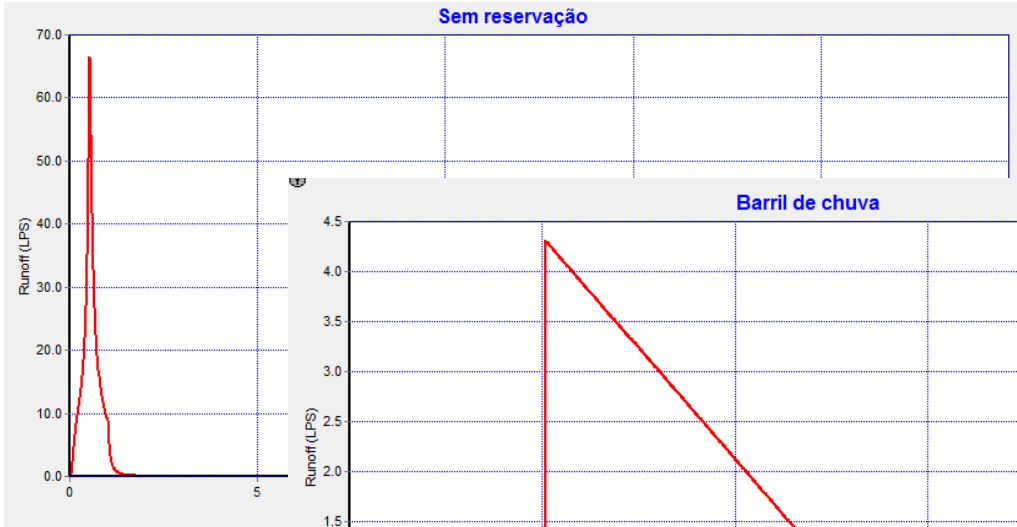
# LID – SWMM (Storm Water Management Model)

## Simulações conduzidas:

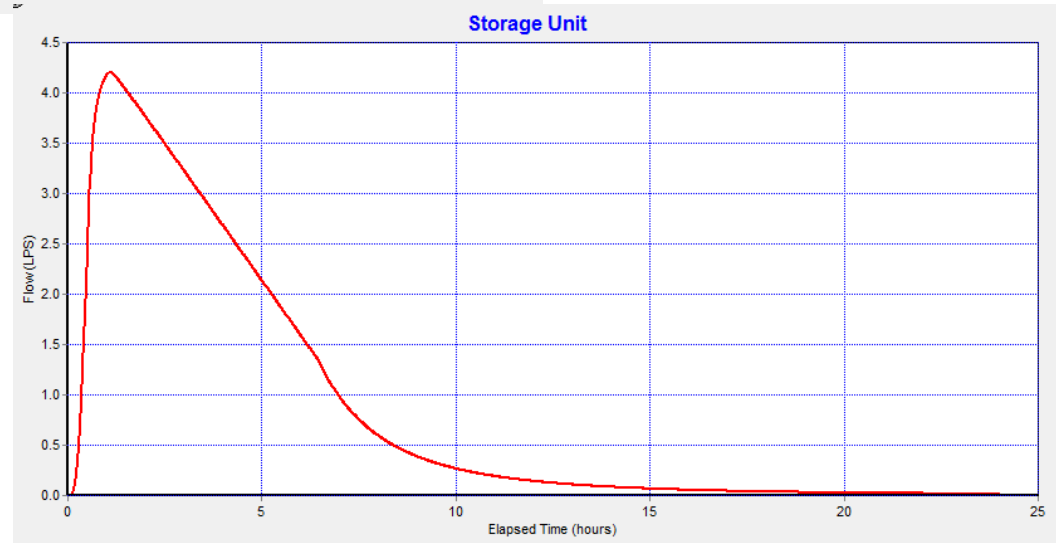
- Lote de 2000 m<sup>2</sup> - 100% impermeável
- Aplicadas as restrições do DM N<sup>o</sup> 15.371 – POA
- Vazão de restrição de 4,2 l.s<sup>-1</sup>
- 6 simulações (LID e Reservatório) – 3 volumes
- Mesmo hidrograma (1hora,  $\Delta t = 1\text{min}$ )  $\approx 73\text{m}^3$



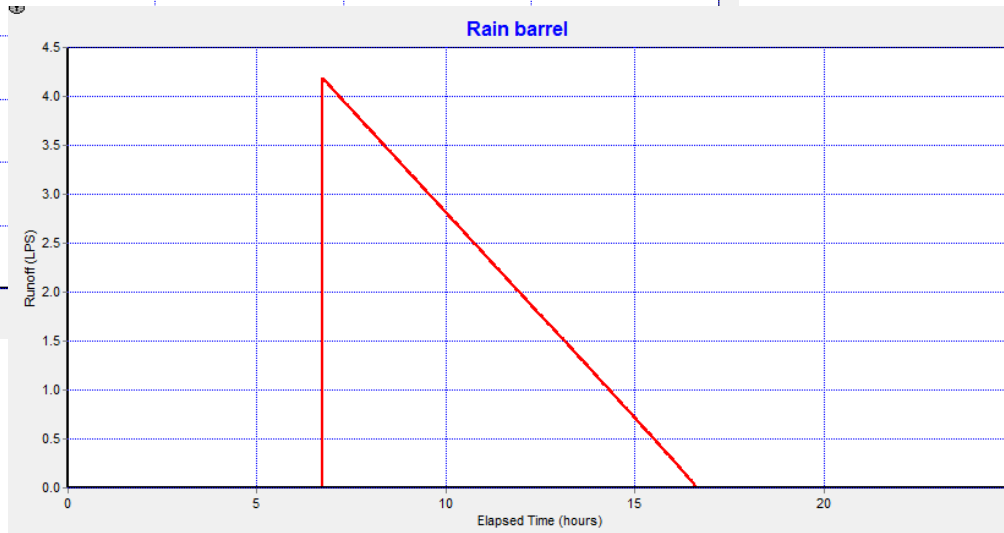
# Resultados: LID – SWMM



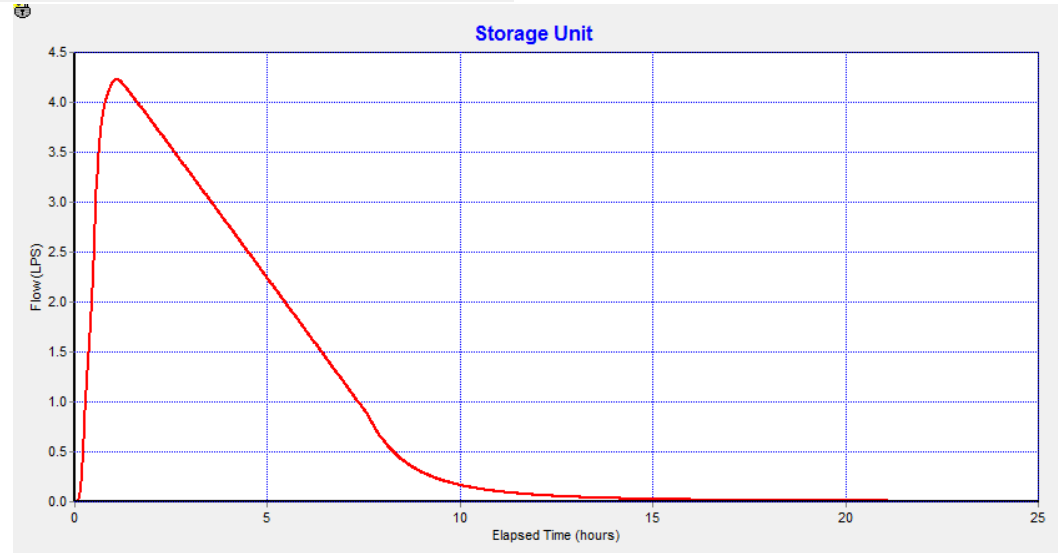
Volume 1: 10%AS



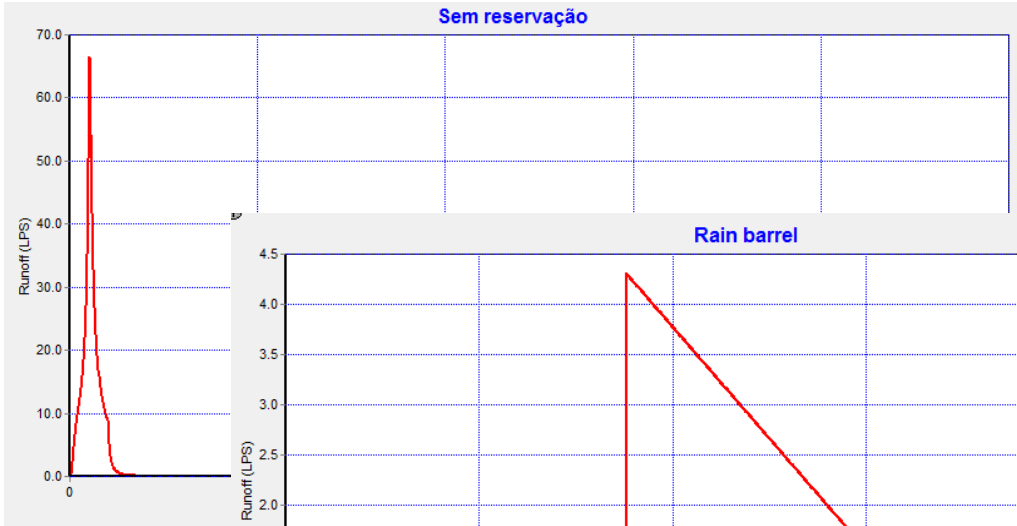
# Resultados: LID – SWMM



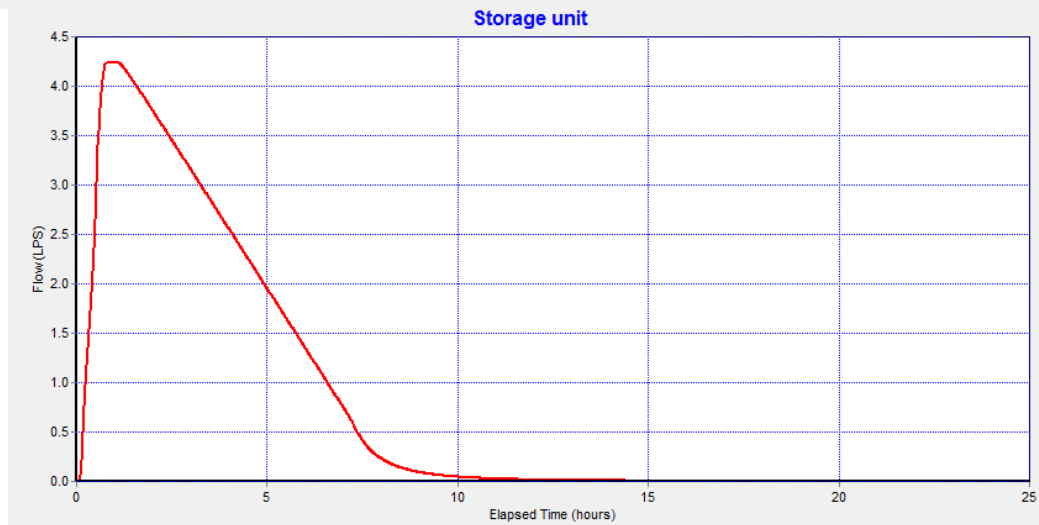
Volume 2: 5%AS



# Resultados: LID – SWMM



Volume 3: 2,5%AS



# Resultados: LID – SWMM

<b>Simulação</b>	<b>RES 2,5%A</b>	<b>BC 2,5%A</b>	<b>RES 5% A</b>	<b>BC 5% A</b>	<b>RES 10% A</b>	<b>BC 10%A</b>
<b>Volume Escoado (m<sup>3</sup>)</b>	69,95	75	75,09	75,25	74,5	75
<b>Tempo de Pico no hidrograma de saída</b>	00:48	08:48	01:04	06:44	01:04	05:05
<b>Escoamento Máximo (l.s-1)</b>	4,2	4,2	4,2	4,2	4,2	4,2

- Sem problemas de continuidade
- Tempo de ocorrência de pico mal representado
- Vazão de restrição mantida com alteração das estruturas de descarga



# Considerações: LID – SWMM

- Dificuldade no entendimento dos processos realizados no módulo LID
- Não é possível avaliar separadamente os escoamentos gerados na unidade de bacia com e sem LID
- Comparação com propagação em reservatório convencional – SU
- Forma de hidrograma e tempo de ocorrência de pico mal representado
- Falta de um manual detalhado – usar com cuidado