# A Preview of the Next SWMM 5 Update

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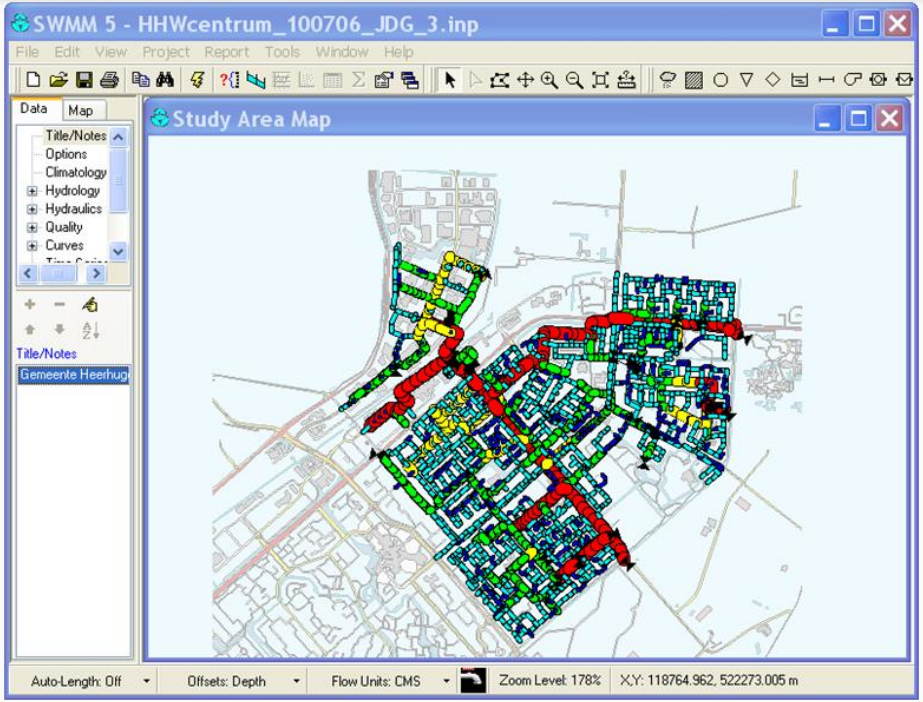
# The EPA Stormwater Management Model (SWMM)

- 5th generation Hydrologic, Hydraulic and Water Quality model
- Used in thousands of stormwater studies around the world
- Adopted by several commercial products
- Supported by US EPA since 1970
- Now accepting code contributions via its Open Source initiative



# New Features Added to EPA SWMM

- HEC-22 Inlet Analysis
- Control Rule Extensions
- Variable Speed Pumps
- Functional Storage Shapes

# HEC-22 Inlet Analysis

- Inlets convey runoff from street pavements into below ground storm sewers.
- Inlet type, sizing and spacing chosen to meet limits on spread & depth of water on pavement.
- FHWA “Urban Drainage Design Manual” (HEC-22) is the de facto standard for inlet analysis.

# Factors Affecting Inlet Flow Capture

**On-Grade Grates:**

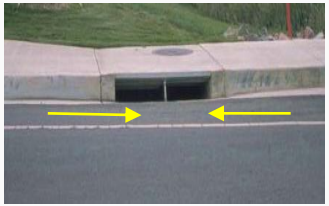
- Approach flow rate, velocity & spread
- Street cross slope & curb depression
- Grate width & length

**On-Grade Curb Openings:**

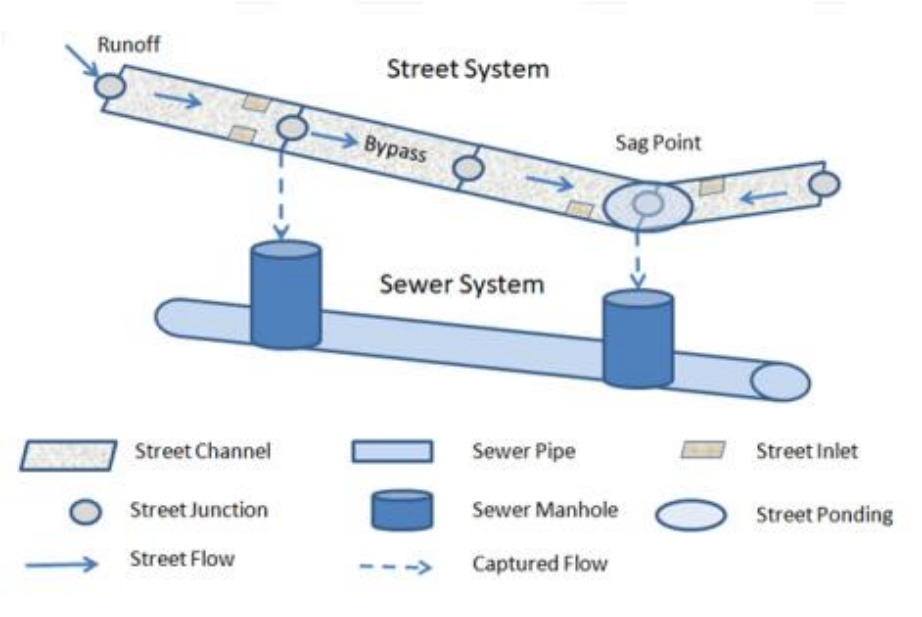
- Approach flow rate
- Street slope, cross slope, roughness & curb depression
- Opening length

**On-Sag Inlets:**

- Depth of water at curb
- Grate width, length & area of openings
- Curb opening length & height



# Modeling a Dual Drainage System



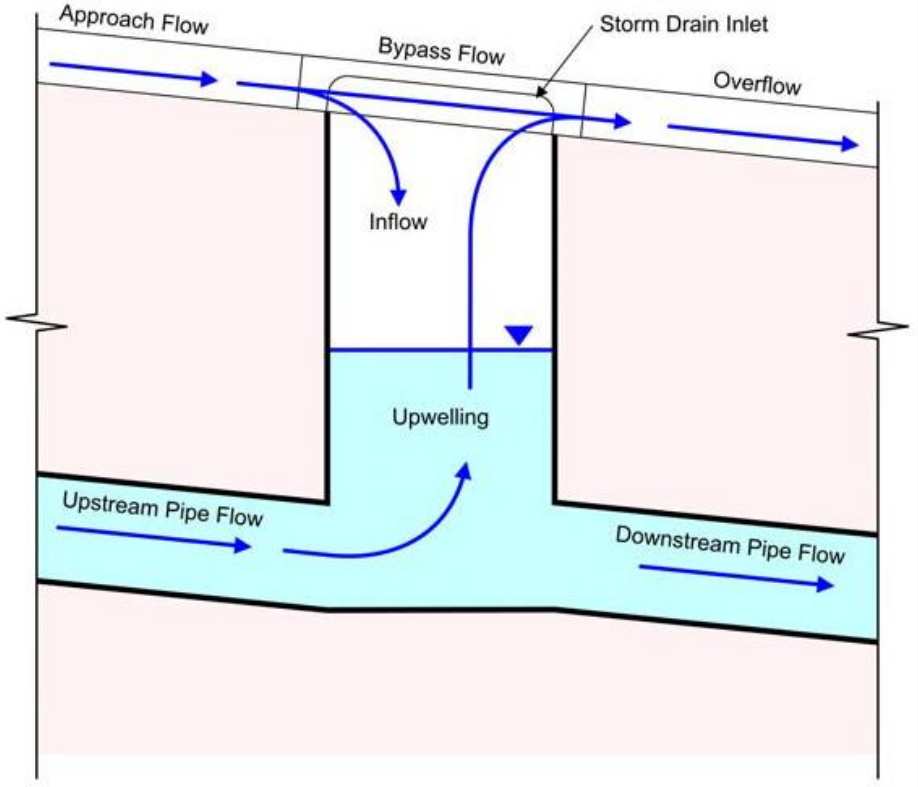

Methods for Modeling Dual Drainage Systems

- Flow divider nodes
- Shared nodes with offset
- Orifice or outlet links
- Lateral flow adjustment

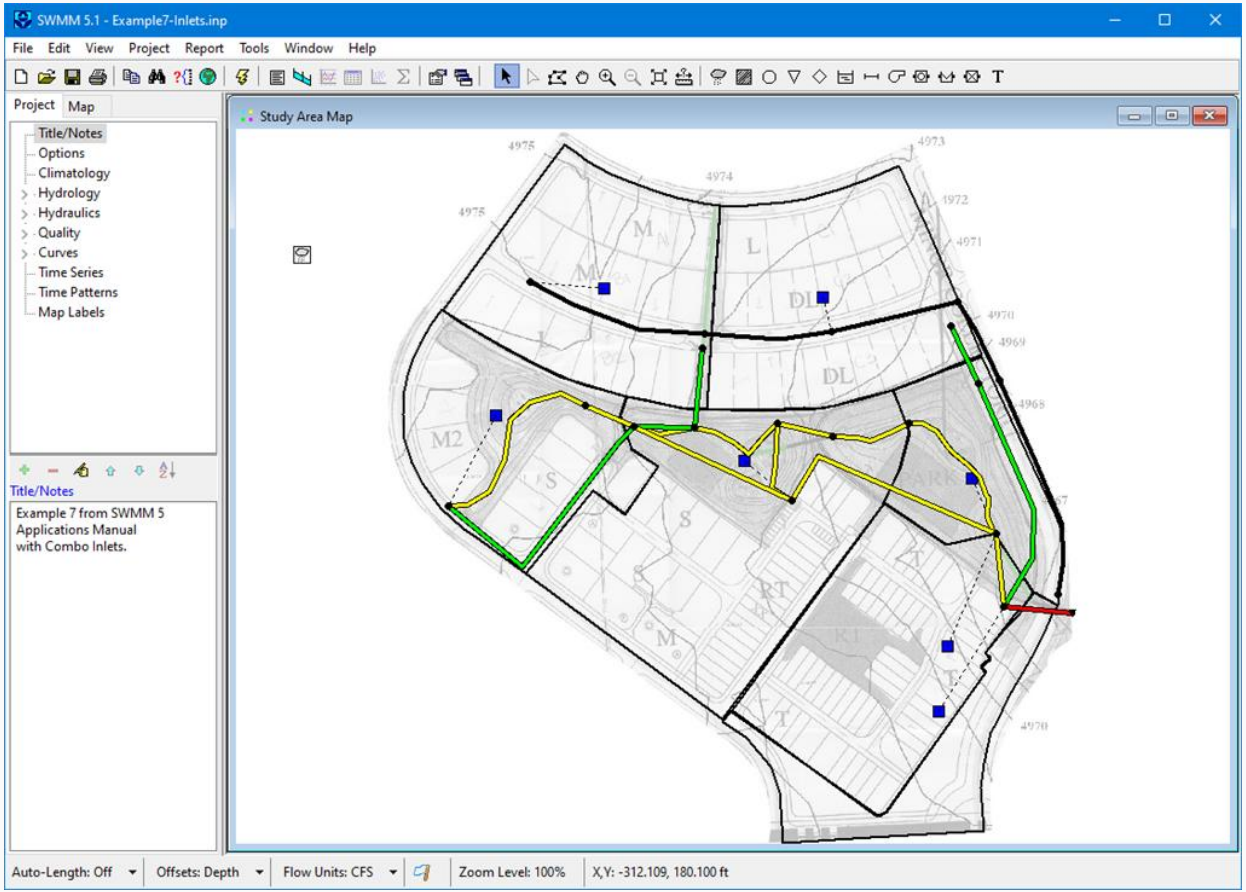
# Inlet Analysis Using Lateral Flow Adjustment

At each flow routing time step:

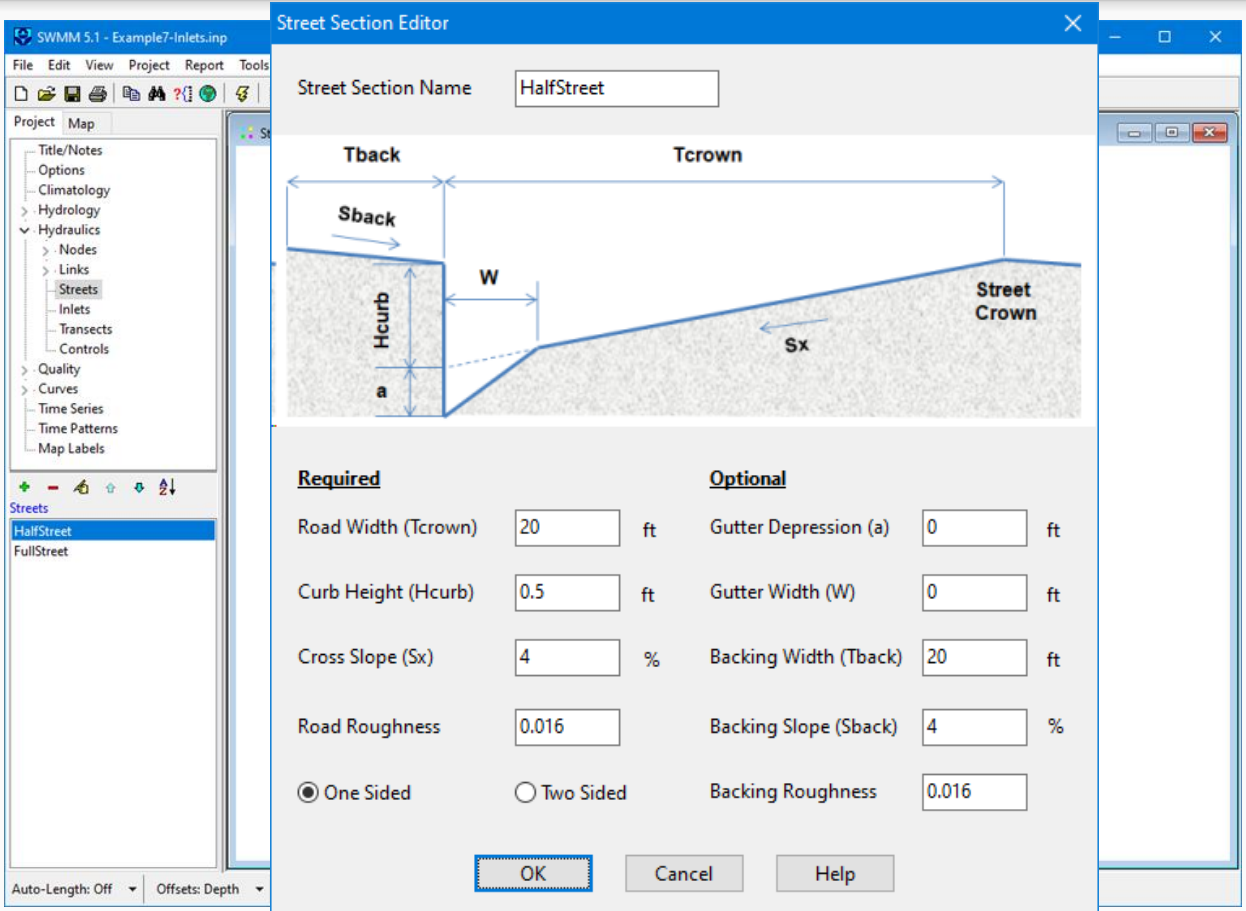
- Compute each inlet's flow capture (Qc) using HEC-22 methods
- Add Qc to sewer node's lateral inflow
- Subtract Qc from lateral inflow to inlet's street node
- Add any sewer node overflow to street node's lateral inflow
- Apply usual flow routing procedure



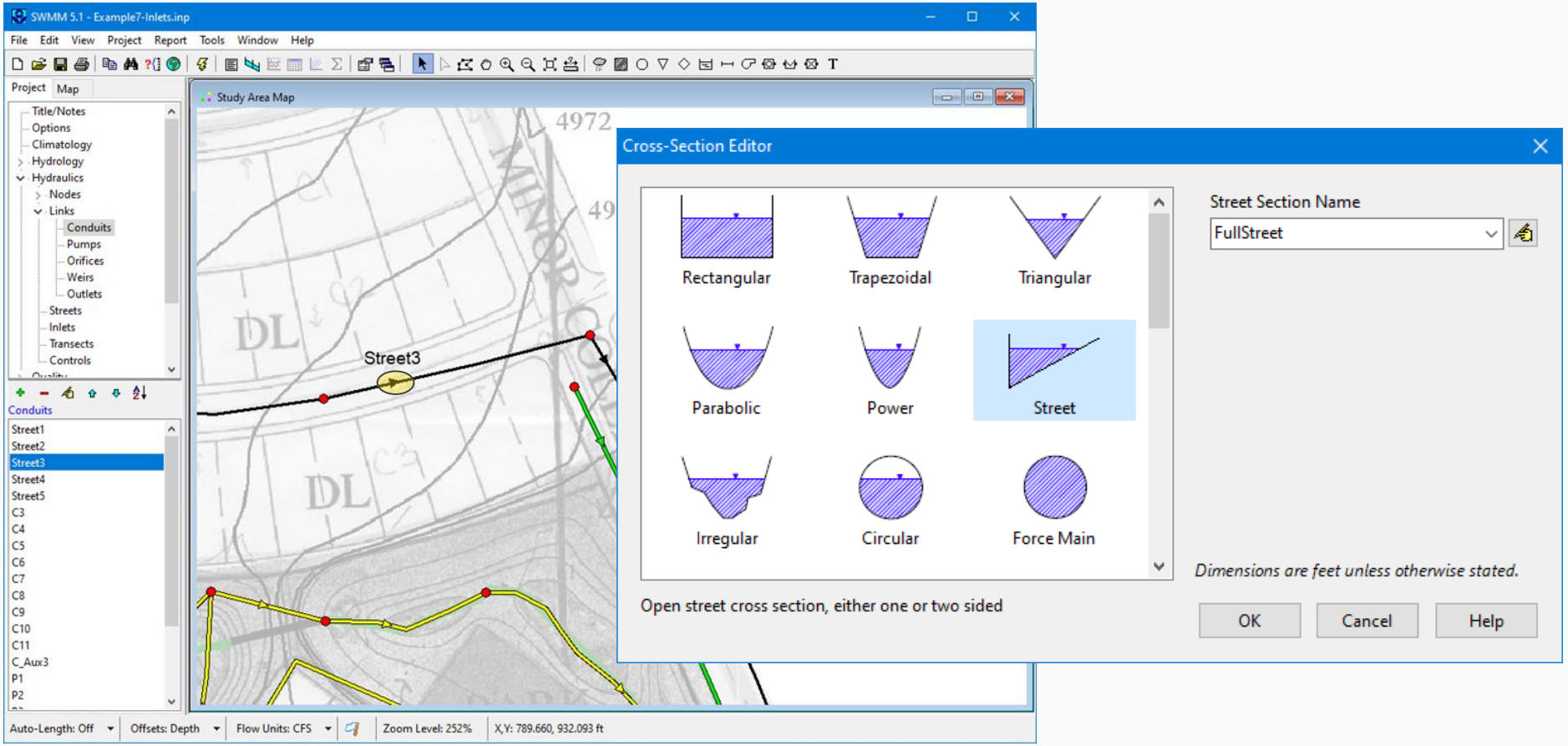
# Step 1 - Layout the street and sewer networks



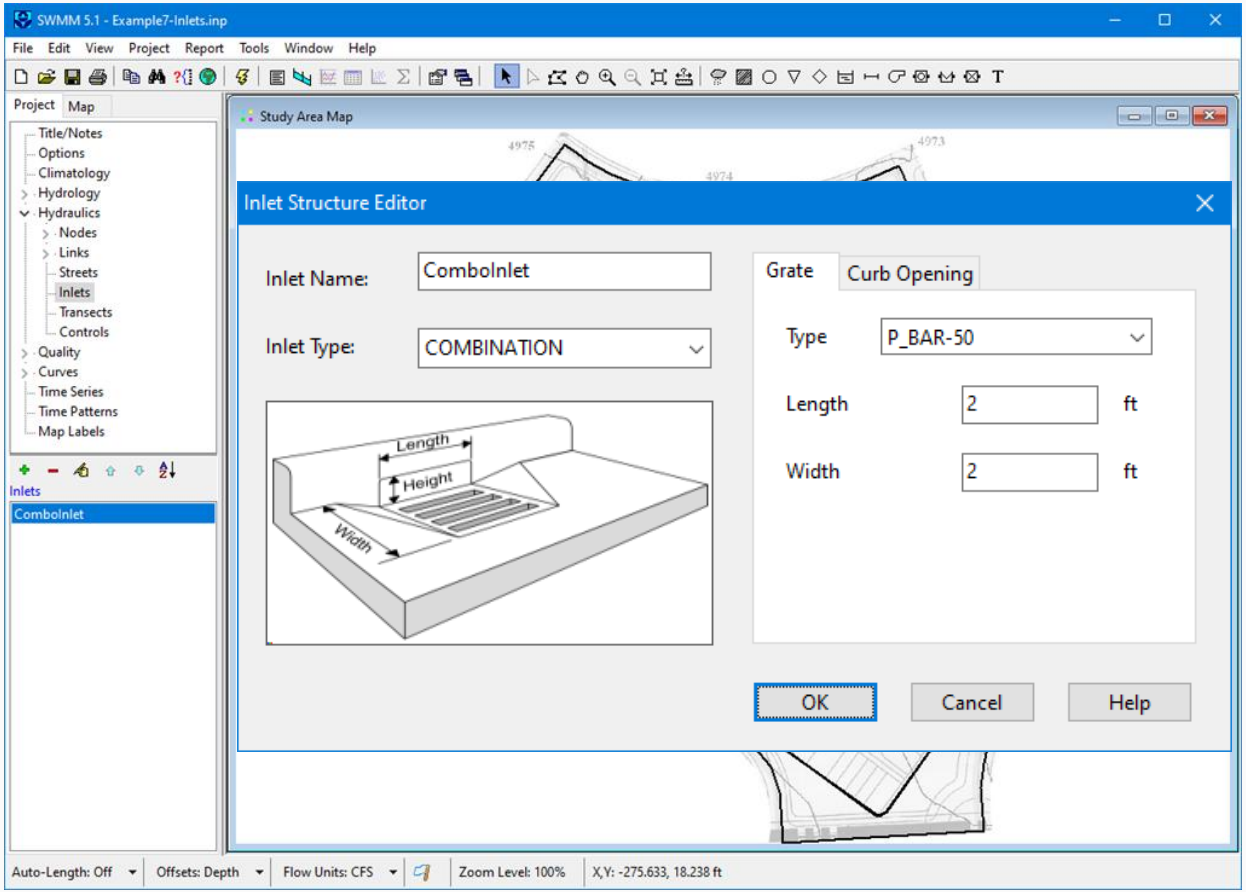
# Step 2 - Create a collection of Street cross-sections



# Step 3 - Assign Street cross-sections to street conduits

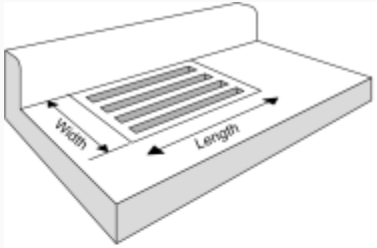


# Step 4 - Create a collection of Inlet designs

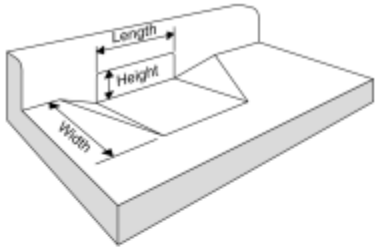


# Supported Inlet Types

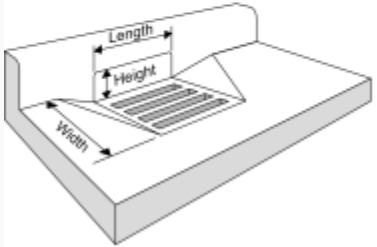
## Curb & Gutter Inlets



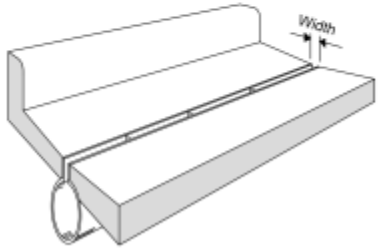

Grated Inlet




Curb-Opening Inlet

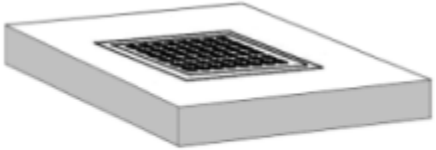



Combination Inlet




Slotted Drain Inlet

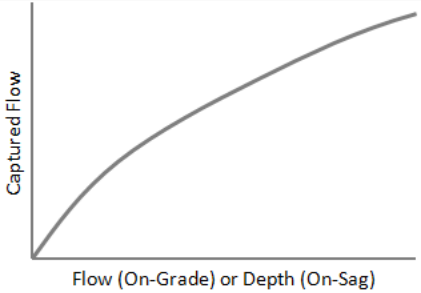
## Drop Inlets



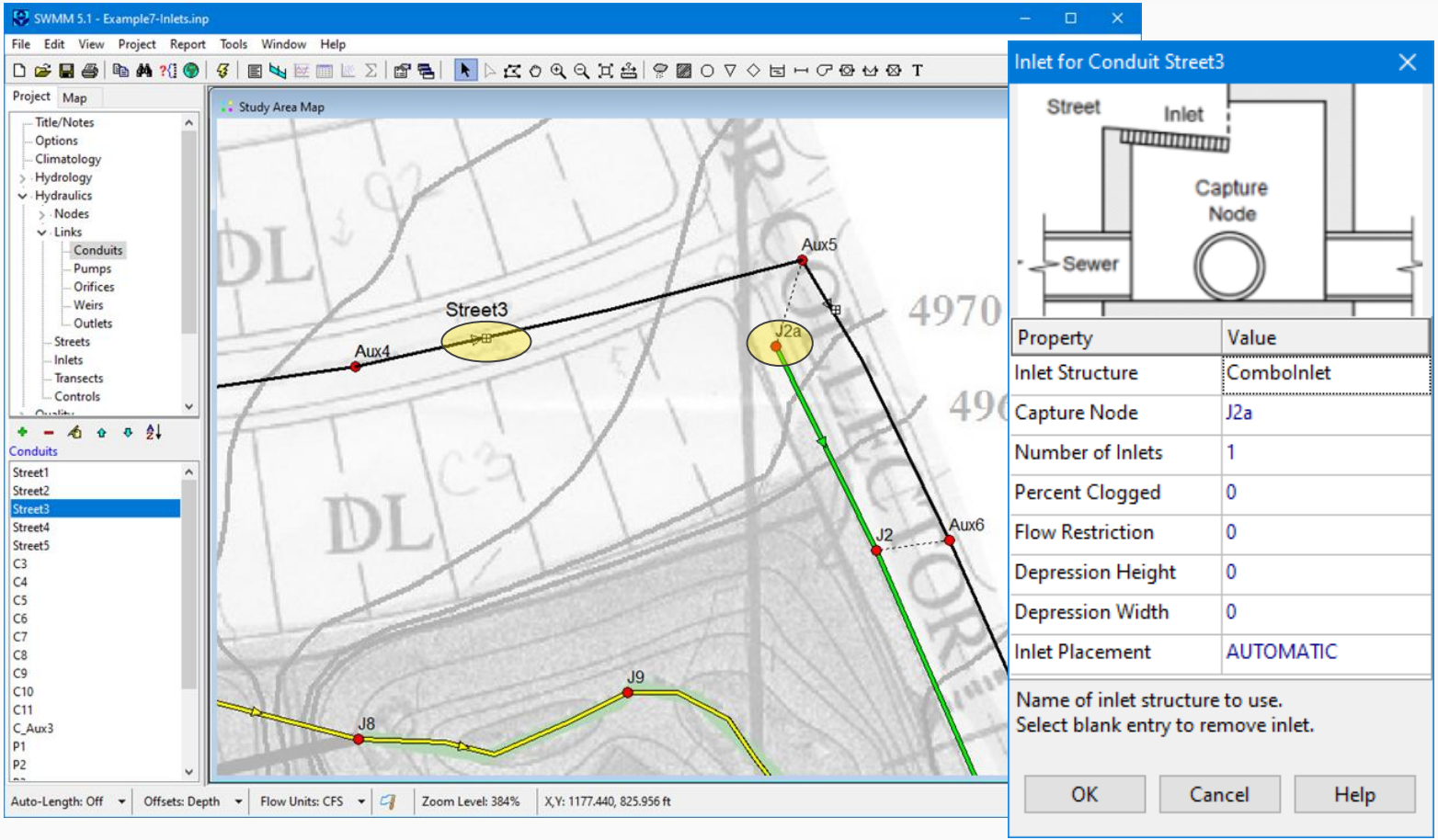
Drop Grate Inlet

Drop Curb Inlet

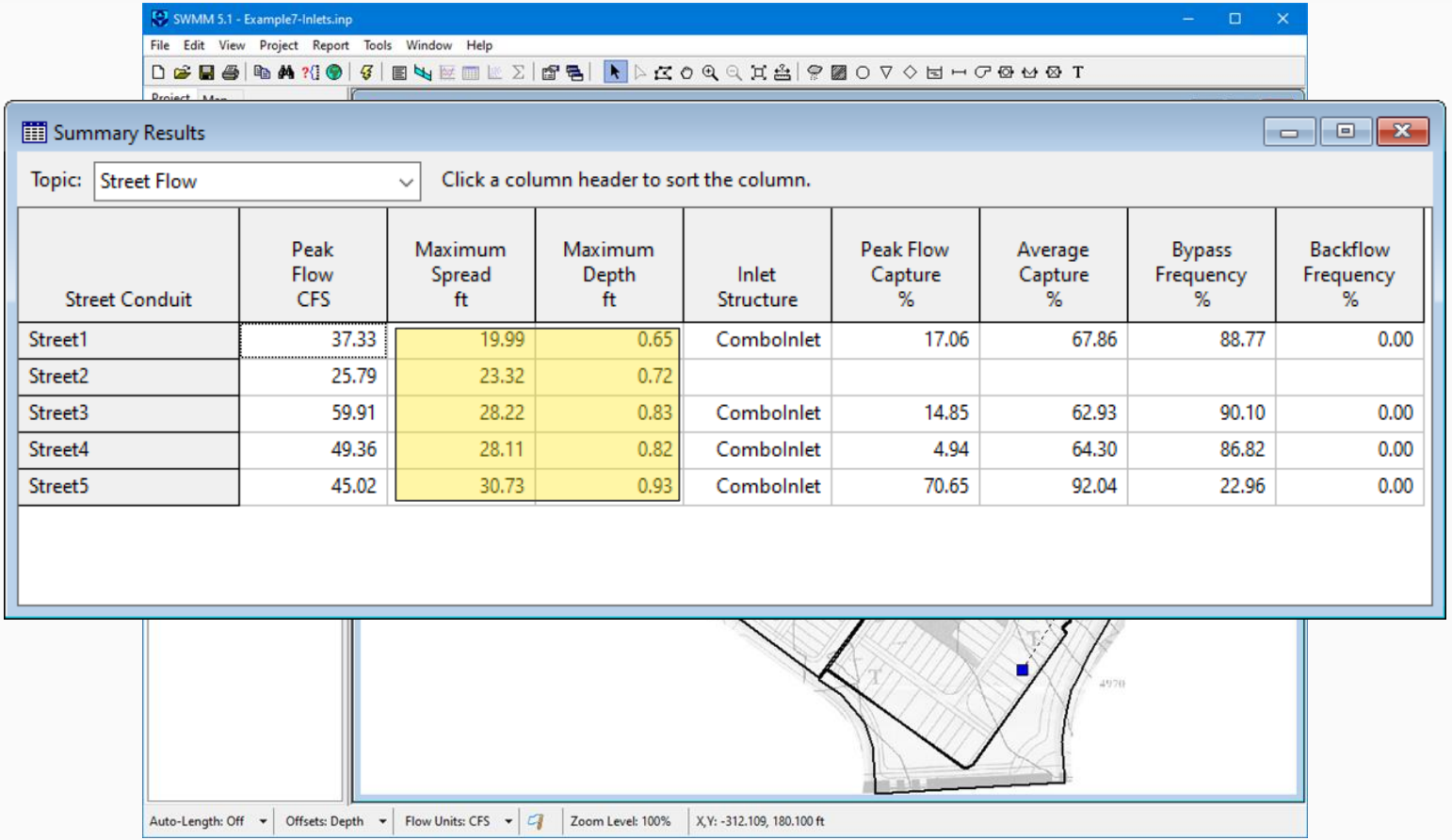
## Custom Inlet



# Step 5 - Assign Inlet designs to streets

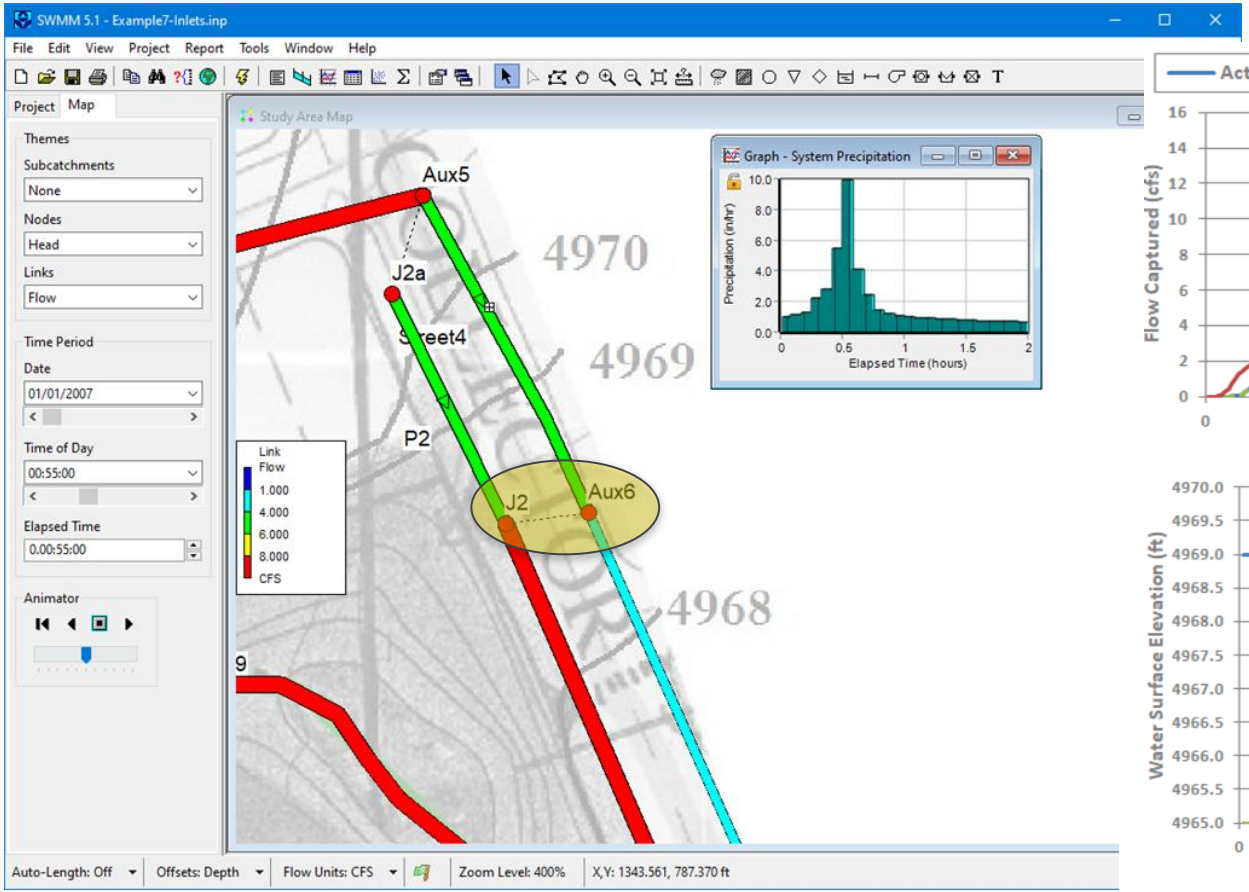


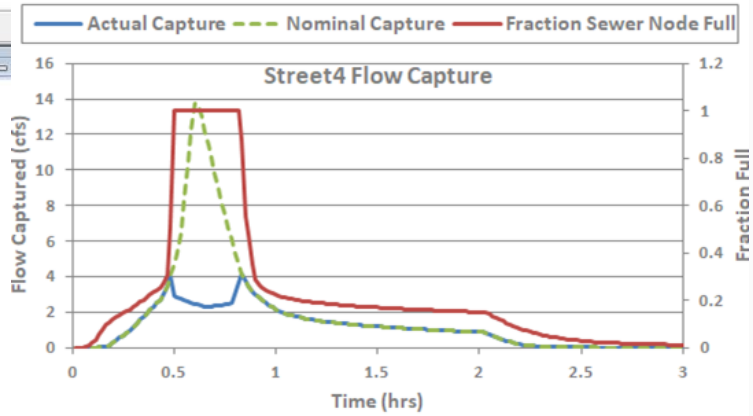
# Step 6 - Run an analysis and view the Street Flow Summary Report

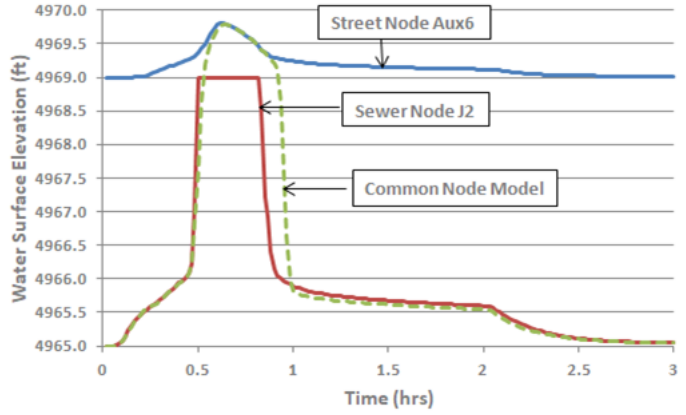



| Street Conduit | Peak Flow CFS | Maximum Spread ft | Maximum Depth ft | Inlet Structure | Peak Flow Capture % | Average Capture % | Bypass Frequency % | Backflow Frequency % |
|---|---|---|---|---|---|---|---|---|
| Street1 | 37.33 | 19.99 | 0.65 | ComboInlet | 17.06 | 67.86 | 88.77 | 0.00 |
| Street2 | 25.79 | 23.32 | 0.72 | | | | | |
| Street3 | 59.91 | 28.22 | 0.83 | ComboInlet | 14.85 | 62.93 | 90.10 | 0.00 |
| Street4 | 49.36 | 28.11 | 0.82 | ComboInlet | 4.94 | 64.30 | 86.82 | 0.00 |
| Street5 | 45.02 | 30.73 | 0.93 | ComboInlet | 70.65 | 92.04 | 22.96 | 0.00 |

# Reduced Capture Due to Full Manhole



# Control Rule Enhancements

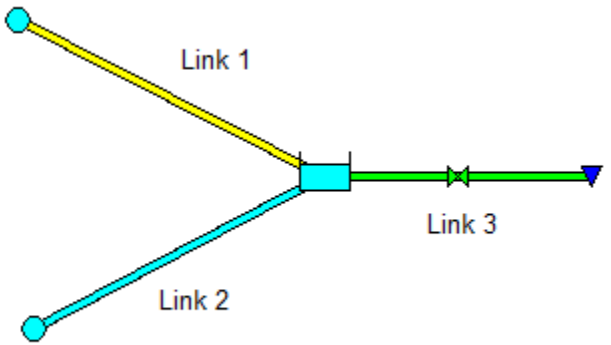
Control rule premise clauses expanded to include:

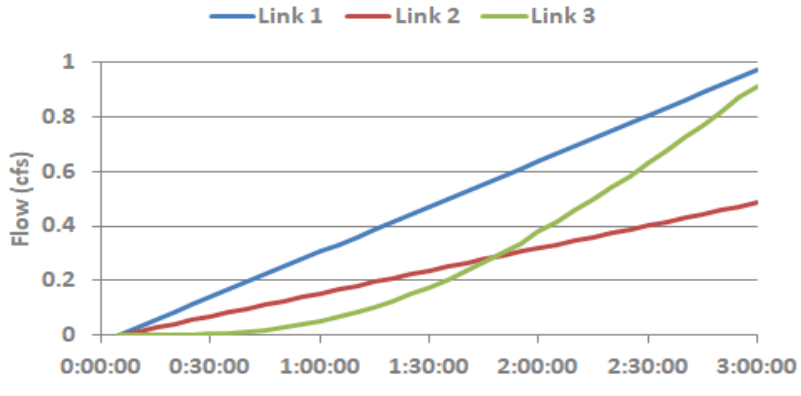
- additional control parameters
  - rain gage current rainfall & next rainfall
  - node full depth, volume, head
  - conduit length, slope, full depth, full flow, velocity
- named variables as aliases for Object - ID - Property

  `Variable N23 = Node 23 Depth`
- math expressions containing named variables

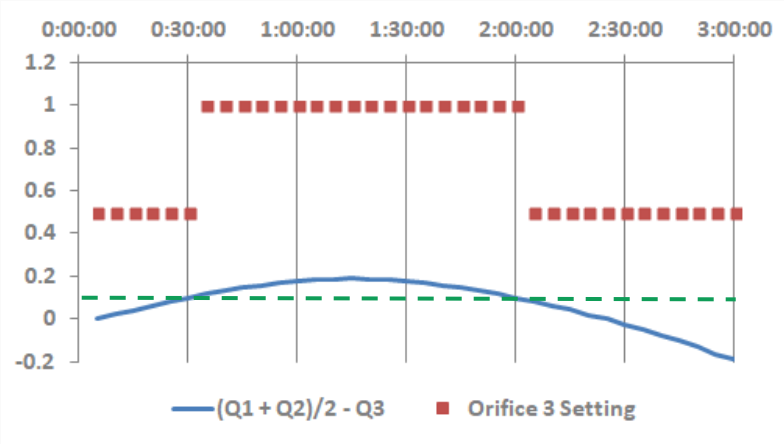
  `Expression HGL = abs(H23.1-H23.2)/L23`

# Example of Enhanced Control Rules



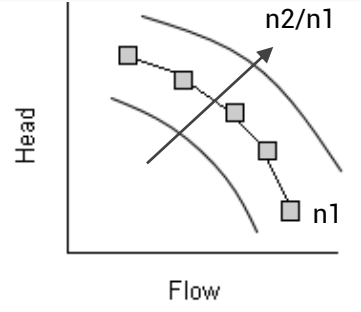

```
[RULES]
variable  Q1 = LINK 1 FLOW
variable  Q2 = LINK 2 FLOW
variable  Q3 = LINK 3 FLOW
expression Net_Inflow = (Q1 + Q2)/2 - Q3

rule 1
if Net_Inflow > 0.1
then ORIFICE 3 Setting = 1
else ORIFICE 3 Setting = 0.5
```



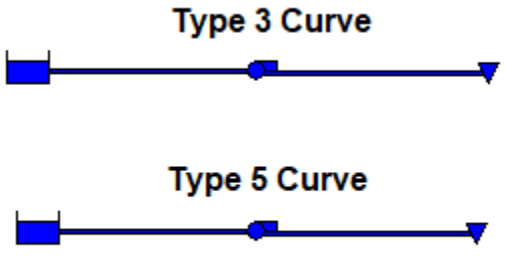
# Variable Speed Pumps

- Requires a Head (H) v. Flow (Q) performance curve that obeys the pump affinity laws:
  Q2/ Q1 = n2/ n1  H2/H1 = (n2/ n1)^2
- These determine how the curve shifts as impeller speed changes from a nominal value n1 to n2.

- SWMM's Type 3 Pump uses a H-Q curve that only follows the flow affinity law as its speed setting is changed.
- A new Type 5 pump has been introduced that obeys both affinity laws.



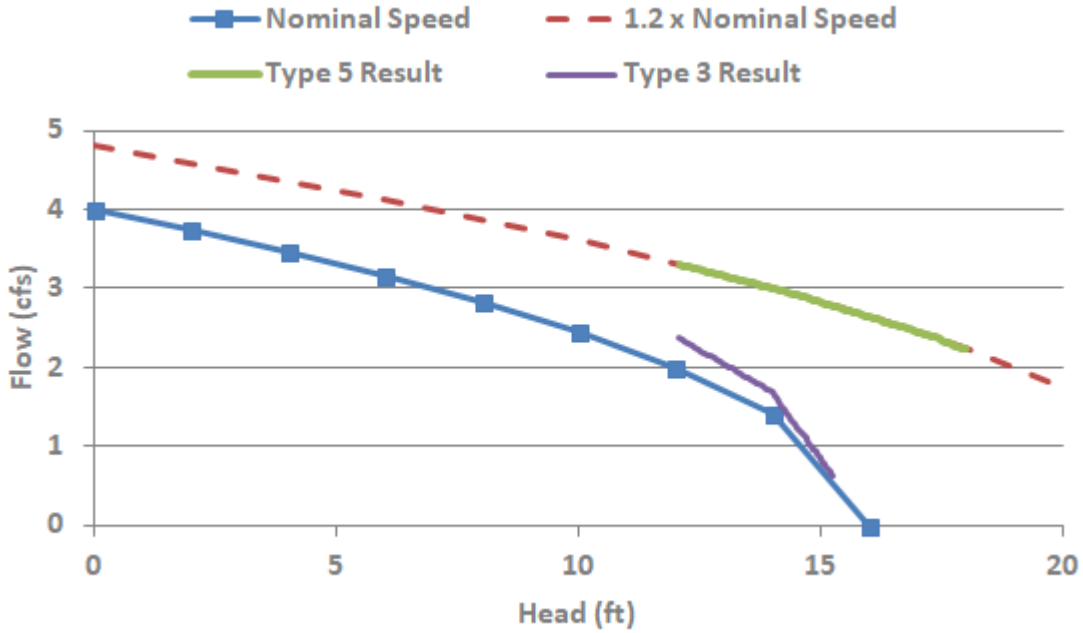
# New Type 5 Pump Curve v. Existing Type 3 Curve




If Simulation Time = 0

Then Pump Type3 Setting = 1.2

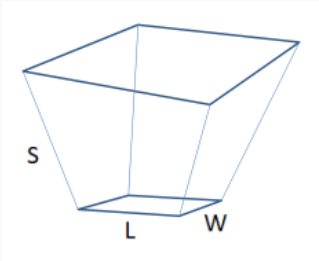
And Pump Type5 Setting = 1.2



# Storage Unit Curves

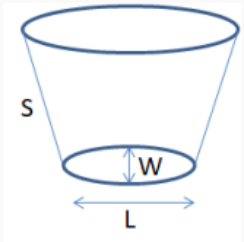
- SWMM represents storage unit shapes with a surface area v. depth curve.
- Either a tabular listing of area & depth points or a functional formula:
  Area = A0 + A1 * Depth^A2
  can be used.
- The functional option cannot represent common regular shapes where all sides are sloping (e.g. truncated pyramids).

# New Functional Storage Curves Added



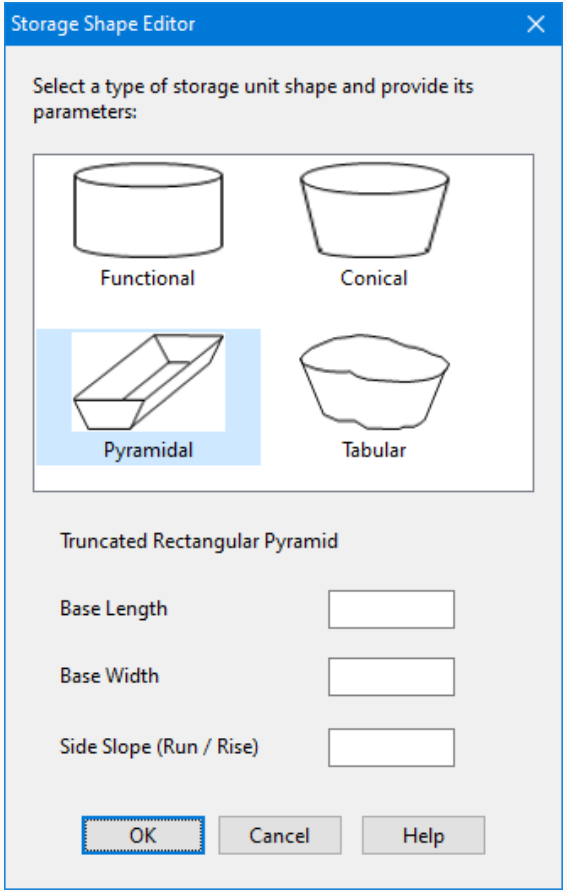

Truncated Rectangular Pyramid:

Area = L*W + 2*(L+W) * S*Depth + 4*(S*Depth)^2




Truncated Elliptical Cone:

Area = PI * (L*W + 2*W*S*Depth + (W/L)(S*Depth)^2)



# Current Status

This update is currently being reviewed and tested by both US EPA and several third parties and will hopefully be released shortly.