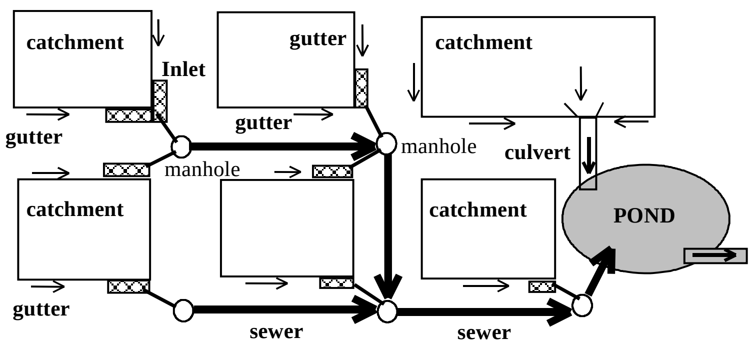
Culvert and Sewer Systems in SWMM

James C.Y. Guo, Professor and Director, P.E.,
Department of Civil Engineering
U. of Colorado Denver

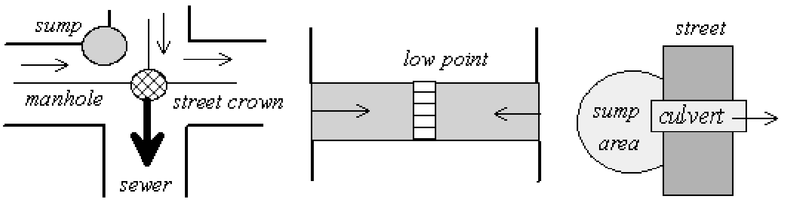
Street and Sewer

1. A sewer system consists of sewers and manholes. A manhole collects the inlet flows collected at a street intersection.
2. A sewer often designed to pass 2 to 5-yr minor event
3. Street and sewer are jointly to pass 100-yr major event



Street Sump and Storage Capacity

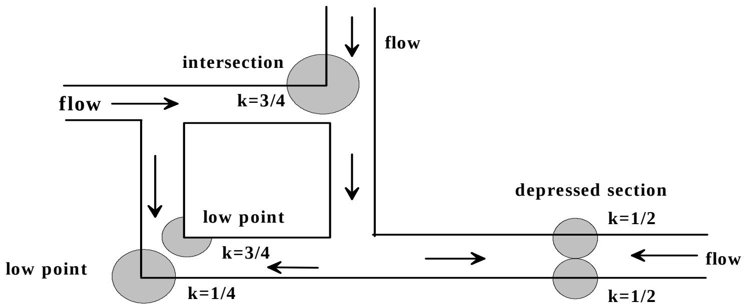
When a manhole or culvert is surcharged, the excess storm water will fill up the sump areas. Sumps are created by
(1)street crowns at an intersection
(2) sags on the street vertical profile, and
(3) road embankment.



Intersection   Depressed Street   Culvert and Embankment

Sump Storage = Node Storage Volume

Surface storage area = K * circular area
Radius of circle= max depth in gutter/transverse slope=0.5/0.02=25 ft

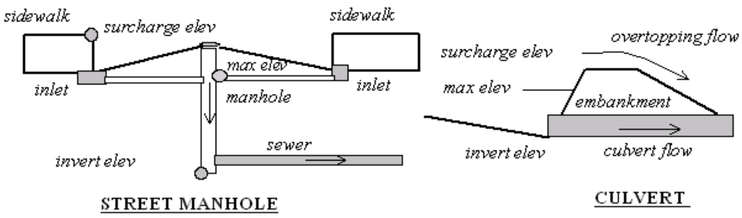


Guo, James C.Y. (2000). "*Street Storm Water Conveyance Capacity*." ASCE J. of Irrigation and Drainage Engineering, Vol 126, No. 2, Mar/Apr.

Guo, James C.Y. (2000). "*Street Storm Water Storage Capacity* " Water Environmental Research Journal, Vol 72, No. 5, September/October.

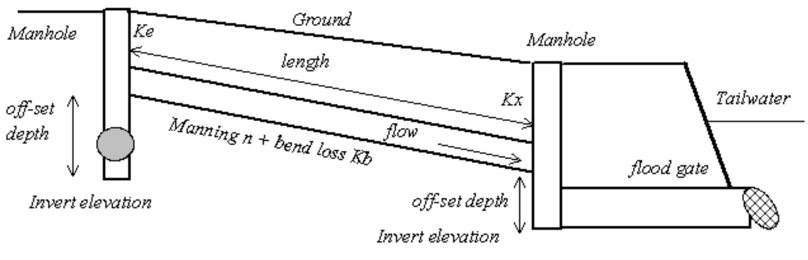
Elevations at Entrance

Elevation	Manhole on Street	Culvert and Embankment
Invert	bottom of manhole	invert of the culvert entrance
Max	gutter flow line or flow depth	1.5 time culvert diameter
Surcharge	top of side walk or	top of the roadway
	12-inch water in gutter	



Culvert and Sewer Profiles

A sewer is prescribed using: (1) length (2) x-section (3) offset depths (4) roughness (5) loss coefficients (6) base and maximum water depth (7) ponding area (8) floodgate at exit



The maximum depth and ponding area at a node are sensitive to a DW model, but not to a KW model. A DW model will store the excess water according to these two parameters or release the excess water out of the system (like what KW does) if these two parameters are not specified.

Sewer System Modeling

1. Sewer and Manhole System
a. Node = manhole collecting inflows
b. Link = sewer between two manholes
c. Outlet = system exit required by Dynamic wave simulation

2. Flow Simulation
a. Kinematic wave for preliminary design that ignores the tailwater.
b. Dynamic wave for final design that calculates HGL and EGL according to the tailwater specified.
c. Tailwater prescribed by the low and high tides
d. Flood gate used to open and close the system

Minor flood simulation = 5-yr event for “manhole-sewer-outlet” = node +link + outlet **using KW or DW**
Major flood simulation = 100 yr event for “manhole-street-sewer” = node +divider + overflow link + link **using KW only**

Sewer system and flow simulation by j. Guo

Hydro modification model – Channels and Streets

Your tasks are:
(1) Build a Channel-flow model
a) Build a Channel-flow model for pre-development condition
b) Build a Channel-flow model for post-development condition
All conveyance elements are channels that should be designed to pass the 100-yr peak flows with a trapezoidal section defined as: bottom width B=2 ft, size slope Z=4, and max water depth Y-max=3 feet.

(2) Build a Channel-street gutter for Catchment 3
Street gutters have an irregular section as shown in Figure 2. The street width is 35 feet with a side slope of 2% and max gutter flow depth<0.5 ft.

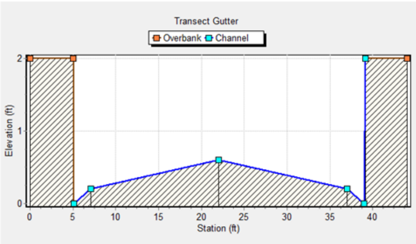
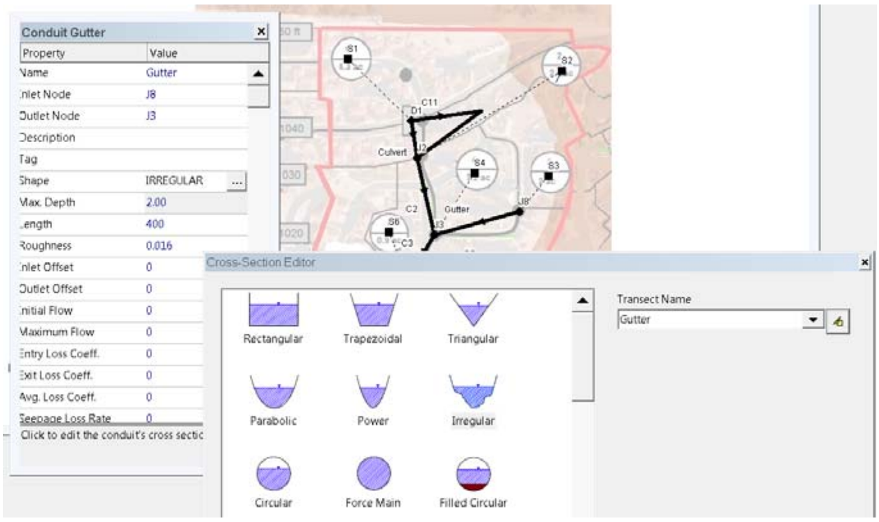


Figure 2. Street gutter cross section.

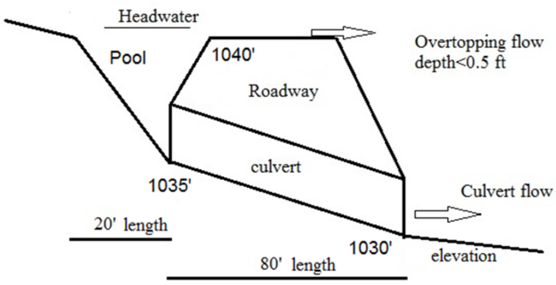
Irregular and Regular X-section for Conduits



Project: Design of Culvert and Pool

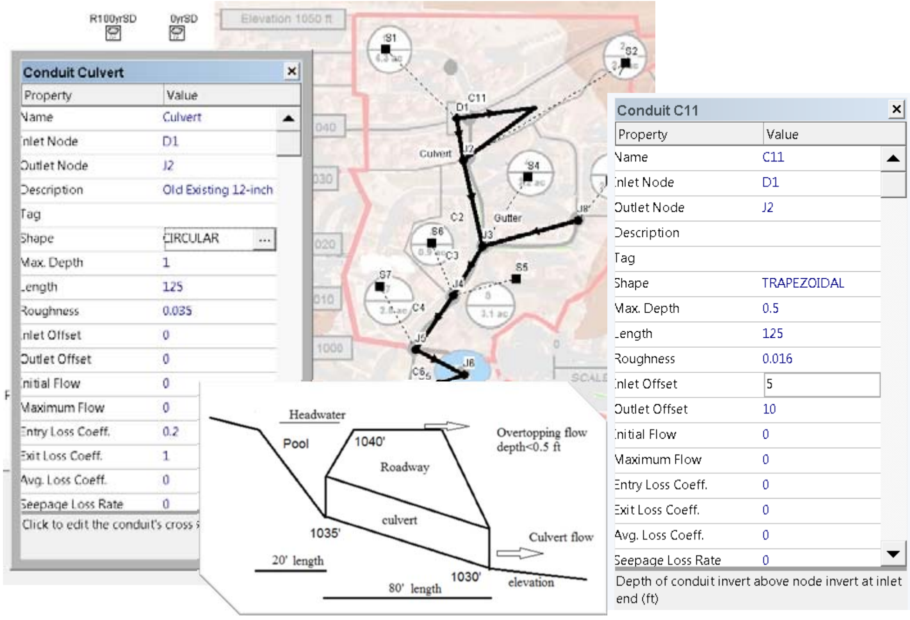
(1) Build a Channel-gutter-culvert (CGC)model for Catchment 1

All culverts are designed to use multiple 18-inch circular pipes (1, 2, or 3 barrels) to pass the 100-yr flow. According to the following profile, the roadway overtopping flow is modeled with a 5-ft weir with a depth< 0.5 ft. Add an entrance loss coefficient of 0.5 and exit loss coefficient of 1.0.



Test on what if a 12-inch old corrugate pipe is used for this case. (N=0.035)

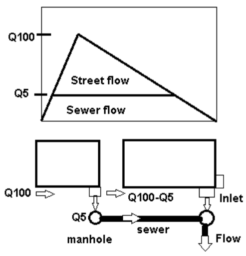
Culvert and Overtopping Flow



Flow Diversion at Street Inlet

FOR KW ROUTING – Let user define the flow diversion

- Convert the node to "Divider Node"
- Set a cutoff to be Q5,
- Choose the option of "overflow"
- Provide a table to split the inflow as:

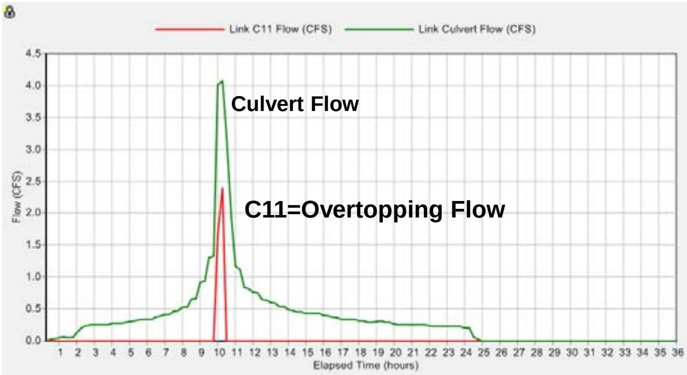


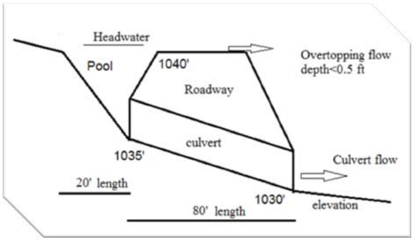
Inflow	1	Q5	Q5+1	Q100
Diverted	1	Q5	Q5+1	Q5

- Q5 = 5-yr peak runoff
  Q100= 100-yr peak runoff

- Choose a Side Weir = mini flow + max height + weir coefficient
  set Q5 to be minimum flow to begin flow diversion
  set a vertical height of the assigned weir width
  enter weir coefficient *weir length

FOR DW ROUTING: - Let EGL and HGL work on flow.

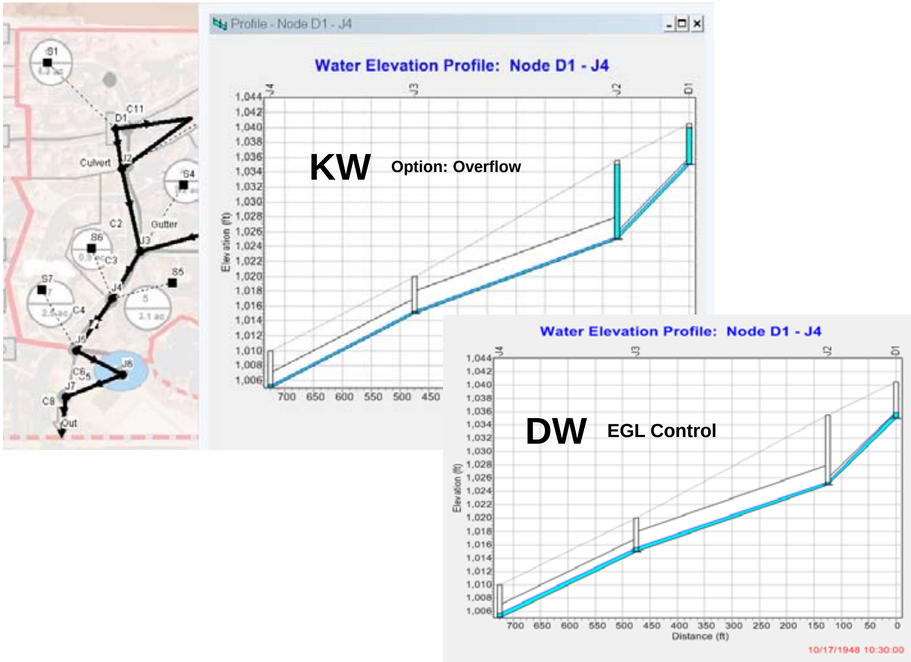




SWMM USER Discussion

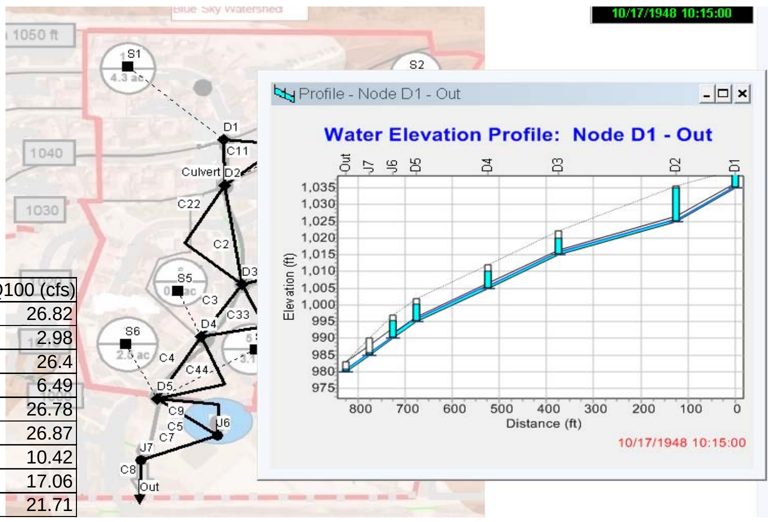
For more complicated systems and flow patterns the dynamic wave routing option must be used. With such systems, the key issue is how to represent the connection between the street system and the drainage system. Directly connecting a wide, shallow "street conduit" to the top of a manhole junction seems to produce large continuity errors and instabilities. A better option is to use an orifice for the connection.

The "water elevation" line (solid blue) depicted in a Profile Plot is the hydraulic grade line (HGL). The ground line is drawn through the node's max. depth. The HGL that will be drawn above the ground line if surcharge occurs.



Project: Profiles of Sewer Line

Design the sewer line for Q5 ➔ using 18-inch circular pipes
Test if the street and sewer system can pass the 100-yr event.



Node	Q100 (cfs)
J7	26.82
J8	2.98
J5	26.4
J1	6.49
J6	26.78
Out	26.87
D2	10.42
D3	17.06
D4	21.71

Q and A Session

FOR MORE INFORMATION

James.Guo@UCDenver.edu
WWW.UCDENVER.EDU/~Jguo -- Website
WWW.UDFCD.ORG -- Free Software
WWW.URBANWATERSHEDS.ORG – Training Classes

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