



Under the Surface with Subsurface Utilities

Presented by:
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Under the Surface with Subsurface Utilities

Description: (per the agenda)

Building a drainage model is fast and easy, but a LOT happens under the surface when you click Subsurface Utilities buttons.

This presentation dives into how OpenRoads and StormCAD unite to provide a comprehensive drainage and utility solution.

- What happens when you click Place Node? or Place Conduit? or Compute?
- How do you confirm the results you got?
- Where did those newly designed pipe sizes come from?
- **How do you constrain the design to your needs?**

Join us as we answer these questions.

Introduction

- We have lots of “Kinesthetic” Training for Subsurface Utilities
- This presentation is about “going deeper” – into the calculations
- 1st: Link to Training
- 2nd: Dive into Workspace (Inlets)
- 3rd: Go over the details

Available Training

- Subsurface Utilities Training & Documentation
 - [4 Subsurface Utility Design and Analysis Learning Path](#)
 - SELECTseries 4
- OpenRoads Workspace Training & Documentation
 - [OpenRoads Designer - Subsurface Utilities Learning Path](#)
 - Includes Updates to many of the SELECTseries 4 classes
 - Adds the “deeper”
 - What Happens When You Place an Inlet
 - What Happens When You Place a Pipe
 - What Happens When You Hit Compute

Inlets – Filling in the blanks

- If you Bypass this, you'll be undersized
- What the HEC? 22!
- On Garde: Location is Sumptin' to Talk about
- Get your mind out of the gutter (and into the ***Inlet's*** gutter fields)

Inlet Genealogy

- Place Node
 - Physical Properties
 - Feature Definition
 - Feature Symbology (Plan, Profile, 3D)
 - Hydraulic Prototype
 - Inlet Location (On-Grade or In Sag)
 - Inlet Capture Type
 - Inlet Catalog
 - Design Sizes

OpenRoads: It Starts with the Feature Definition

<input type="checkbox"/> Elevation	1000.000
<input type="checkbox"/> Vertical Offset	0.000
<input type="checkbox"/> Rotation	N90°00'00.0"E
Placement Type	By Minimum Depth
Feature	
Feature Definition	Inlet Generic Combo
Name Prefix	CB-



Select Reference Element For Node Elevation.
<Reset> to Type an Elevation.

Inlet Feature Definition

- Symbology
- Hydraulic Prototype

The screenshot displays the 'OpenRoads Standards' interface. On the left, a tree view shows the hierarchy: Node > Storm Water > Inlets > Inlet Generic Combo. On the right, the 'Properties (OpenRoads Standards)' window is open, showing the configuration for the selected 'Inlet Generic Combo' feature. The 'Hydraulic Prototype' and 'Symbology' sections are highlighted with red boxes.

Feature Definition	
Name	Inlet Generic Combo
Description	
Name Seed	CB-

Item Type	
Item Type	No Item Type

Hydraulic Prototype	
Prototype	Inlet Generic Combo

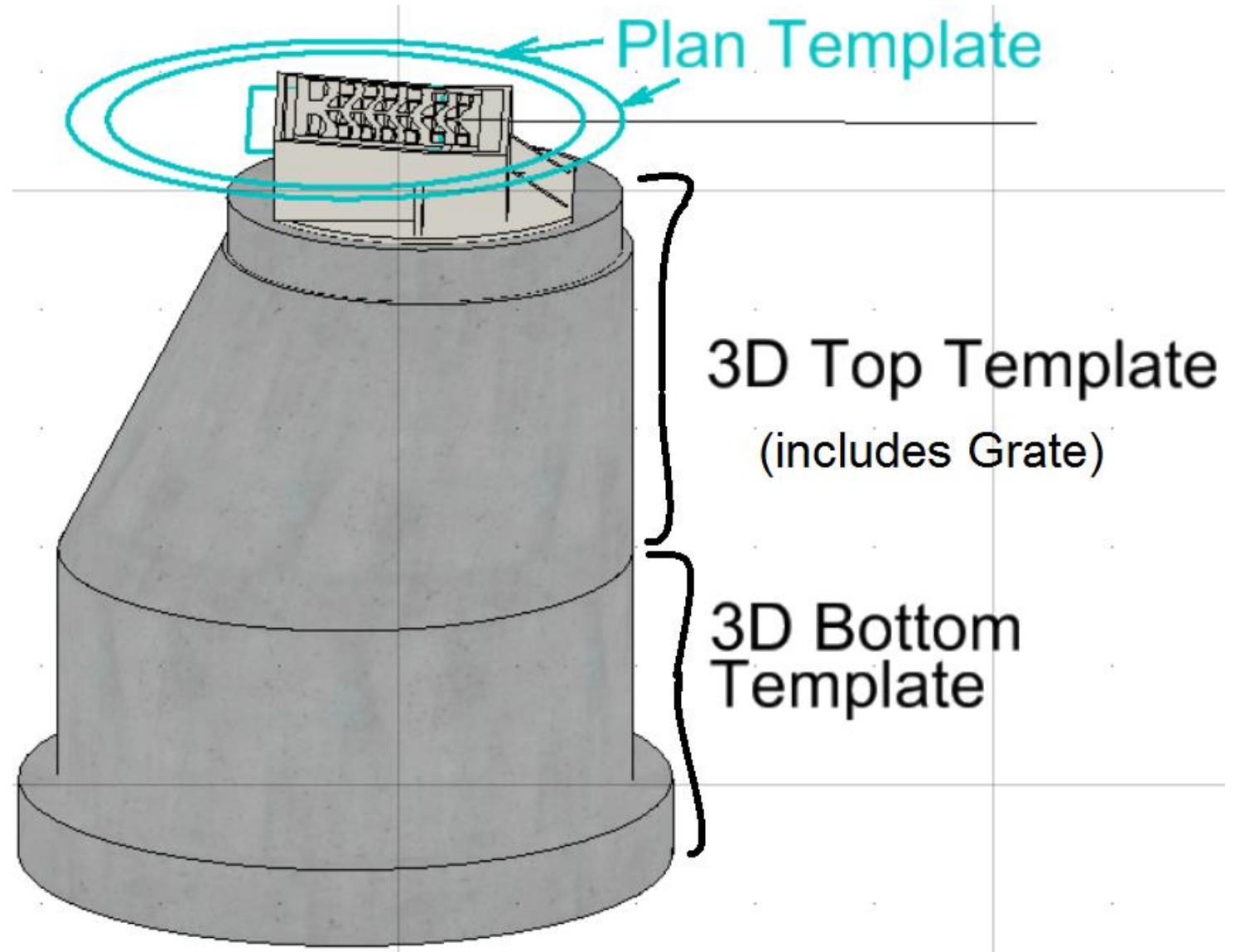
User Data Extensions	
User Data Extensions	<Collection: 0 Items>

Symbology	
Point Feature Symbology	Inlet Generic Combo
Profile Feature Symbology	Storm Water (Node)
Solid Feature Symbology	Inlet Generic Combo

Node	
Default Height	5.0000
Use Slope of Surface	True
Structure Type	Inlet Combined
Network Type	Storm Water Only

Inlet Symbology

Symbology	
Point Feature Symbology	Inlet Generic Combo
Profile Feature Symbology	Storm Water (Node)
Solid Feature Symbology	Inlet Generic Combo



Inlet Physical Properties (at Layout)

The screenshot displays the 'Properties - Storm Water Node - CB-1' window. The 'General' section includes ID (154), Label (CB-1), Notes, GIS-IDs, Hyperlinks, and Feature Definition. The 'Geometry' section lists X (ft) as 11,041.38, Y (ft) as 13,231.57, Station (Calculated) (ft) as N/A, and Node Rotation (degrees) as -49.72. The 'Active Topology' section is expanded to show 'Design' properties such as Local Pipe Matching Constraints (True), Pipe Matching (Inverts), Matchline Offset (0.12), Allow Drop Structure (True), Use Drop Structure to Minimize Cover (False), Minimum Drop Depth (0.00), Design Structure Elevation (True), Desired Sump Depth (0.00), Design Inlet Opening (True), and Specify Local Inlet Constraints (False). The 'Flows' section shows Flow (Additional Subsurface) (0.00), Flow (Known) (0.00), Flow (Additional Carryover) (0.00), External CA (0.000), and External Tc (0.000). The 'Inflow (Wet)' section shows Inflow (Wet) Collection (<Collection: 0 items>). The 'Inlet' section shows Inlet Type (Catalog Inlet) and Inlet (Inlet Generic Combo). The 'Inlet Location' section shows Inlet Location (On Grade), Manning's n (0.013), and Longitudinal Slope (0.000). The 'Inlet Opening' section shows Grate Length (2.000), Curb Opening Length (3.000), and Clogging Factor (0.0). The 'Physical' section shows Elevation (Ground) (1,000.00), Set Rim to Ground Elevation? (True), Elevation (Rim) (1,000.00), Elevation (Invert) (983.60), Structure Type (Box Structure), Length (4.00), Width (3.00), Gutter Type (User Defined), Gutter Shape (Conventional), Maximum Gutter Depth (0.50), Road Cross Slope (0.020), Depressed Gutter? (True), Gutter Cross Slope (0.083), and Gutter Width (2.000). The 'Physical (Structure Losses)' section is partially visible at the bottom. Annotations include 'User' pointing to the 'Feature Definition' field, 'Input' pointing to the 'Node Rotation' field, and a vertical 'PROTOTYPE' label on the right side.

Inlet Hydraulic Prototype

Properties (no selection)

Subsurface Utilities Engineering Hydraulic Analysis

Pipe-1

75%

<Show All>

Property Search

External Tc (hours)	0.000
Inflow (Sanitary Loading)	
Sanitary Loads	<Collection: 0 items>
Inflow (Wet)	
Inflow (Wet) Collection	<Collection: 0 items>
Inlet	
Inlet Type	Catalog Inlet
Inlet	Inlet Generic Combo
Inlet Location	
Inlet Location	On Grade
Manning's n (inlet)	0.013
Longitudinal Slope (Inlet) (ft/ft)	0.020
Inlet Opening	
Grate Length (ft)	2.000
Curb Opening Length (ft)	3.000
Clogging Factor (%)	0.0
Physical	
Elevation (Ground) (ft)	0.00
Set Rim to Ground Elevation?	True
Elevation (Rim) (ft)	0.00
Elevation (Invert) (ft)	0.00
Structure Type	Box Structure
Length (ft)	4.00
Width (ft)	3.00
Gutter Type	User Defined
Gutter Shape	Conventional
Maximum Gutter Depth (ft)	0.50
Road Cross Slope (ft/ft)	0.020
Depressed Gutter?	True
Gutter Cross Slope (ft/ft)	0.083
Gutter Width (ft)	2.000
Physical (Structure Losses)	
Headloss Method	Standard

Notes
Additional information about this element.

Prototype
-Combo

Calculation
Type

A Design may
update Grate
or Opening
Length only

The Catalog lists
Structure L & W, but
they are never used

Catalog contains
no Gutter info,
only Depression
depth and width

Inlet Catalogs

The screenshot shows the 'Inlet Catalog' window with the 'Inlet' tab selected. The window is divided into three main sections: General, Curb, and Grate. Each section contains several configuration parameters with input fields and dropdown menus.

General Section:

- Inlet Type: Combination
- Structure Width: 3.000 ft
- Structure Length: 4.000 ft

Curb Section:

- Curb Opening Height: 6.000 in
- Default Curb Opening Length: 3.000 ft
- Local Depression: 0.000 in
- Depression Width: 0.000 in
- Throat Type: Horizontal
- Throat Angle: 90.00 degrees

Grate Section:

- Grate Type: Curved Vane
- Grate Width: 1.833 ft
- Default Grate Length: 3.000 ft

Buttons for 'Close' and 'Help' are visible at the bottom right of the window.

- Inlet (Type C)
- Inlet (Type E)
- Inlet (Type G)
- Inlet Generic Combo**
- Inlet Generic Curb Grate
- Inlet Generic Curb Opening
- Inlet Generic Ditch

The screenshot shows the 'Design' tab of the 'Inlet Catalog' window. It features a table with a column for 'Design Length (ft)' and a list of inlet types. The table contains five rows of data, with the last row marked with an asterisk (*).

	Design Length (ft)
1	3.000
2	4.000
3	5.000
4	8.000
5	12.000
*	

Buttons for 'Close' and 'Help' are visible at the bottom right of the window.

Inlet Calc Results

Properties - Storm Water Node - CB-1 ...

Subsurface Utilities Engineering Hydraulic Analysis

Pipe-1 75%

<Show All>

Property Search

Inlet Generic Combo	
Inlet Location	
Inlet Location	On Grade
Manning's n (Inlet)	0.013
Longitudinal Slope (Inlet) (ft/ft)	0.000
Inlet Opening	
Grate Length (ft)	2.000
Curb Opening Length (ft)	3.000
Clogging Factor (%)	0.0
Physical	
Elevation (Ground) (ft)	1,000.00
Set Rim to Ground Elevation?	True
Elevation (Rim) (ft)	1,000.00
Elevation (Invert) (ft)	983.60
Structure Type	Box Structure
Length (ft)	4.00
Width (ft)	3.00
Gutter Type	User Defined
Gutter Shape	Conventional
Maximum Gutter Depth (ft)	0.50
Road Cross Slope (ft/ft)	0.020
Depressed Gutter?	True
Gutter Cross Slope (ft/ft)	0.083
Gutter Width (ft)	2.000
Physical (Structure Losses)	
Headloss Method	Standard
Headloss Coefficient (Standard)	0.500
Results	
> Results (Carryover Flow)	
> Results (Engine Parsing)	
Results (Flow)	
Flow (Local Surface) (cfs)	(N/A)
Flow (Total Out) (cfs)	(N/A)
Local Inflow?	<None>
Flow (Local from Inflow Collection) (cfs)	(N/A)
Flow (Local In) (cfs)	(N/A)
> Results (Hydraulic Summary)	
> Results (Hydraulic)	
> Results (Inlet Bypassed Flows)	
> Results (Inlet Capture)	
> Results (Inlet Surface Flows)	
> Results (Intercepted Flow)	
> Results (Local Flows)	
> Results (Misc)	
> Results (Profile)	
> Results (System Flow)	

Results (Flow)

Updated from
Catalog values
on **DESIGN**
Calculations
Only

Results
Updated
on All
Computes

Feature Definitions → Properties

- (note: changing Feature Definitions in the Properties dialog is not recommended for structures)

Inlet Genealogy

- Demo

Pipe Genealogy

- Place Conduit
 - Physical Properties
 - Feature Definition
 - Feature Symbology (Plan, Profile, 3D)
 - Hydraulic Prototype
 - User-Defined Size or Catalog?
 - Conduit Catalog
 - Design Sizes

Pipe Feature Definition

The image shows two panels from a Bentley software interface. The left panel is the 'Feature Definitions' tree, and the right panel is the 'Properties (OpenRoads Standards)' dialog.

Feature Definitions Panel:

- Feature Definitions
 - Alignment
 - Terrain
 - Corridor
 - Superelevation
 - Linear Template
 - Surface Template
 - Linear
 - Point
 - Mesh
 - Node
 - Conduit
 - Communications
 - Electrical
 - Gas
 - Generic Conduit
 - Petroleum
 - Storm Water
 - Circular
 - Storm Water (Concr)
 - Storm Water (HDPE)
 - Storm Water (Metal)
 - Storm Water (PVC)**
 - Thermal
 - Waste Water

Properties (OpenRoads Standards) Panel:

Selection (1)
Storm Water (PVC)

Feature Definition

Name	Storm Water (PVC)
Description	
Name Seed	Pipe-

Item Type

Item Type	No Item Type
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Conduit

Trench Template	Components\Trench\Utility Trench
Function	Trunk Line
Network Type	Storm Water Only
Conduit Type	Conduit
Shape	Circle
Shape Orientation	Invert
Conduit Table	<Collection: 10 Items>

Hydraulic Prototype

Prototype	PVC
-----------	-----

User Data Extensions

User Data Extensions	<Collection: 0 Items>
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Symbology

Linear Feature Symbology	Storm Water (PVC)
Profile Feature Symbology	Storm Water (Conduit)
Solid Feature Symbology	Storm Water (PVC)

Pipe Prototype

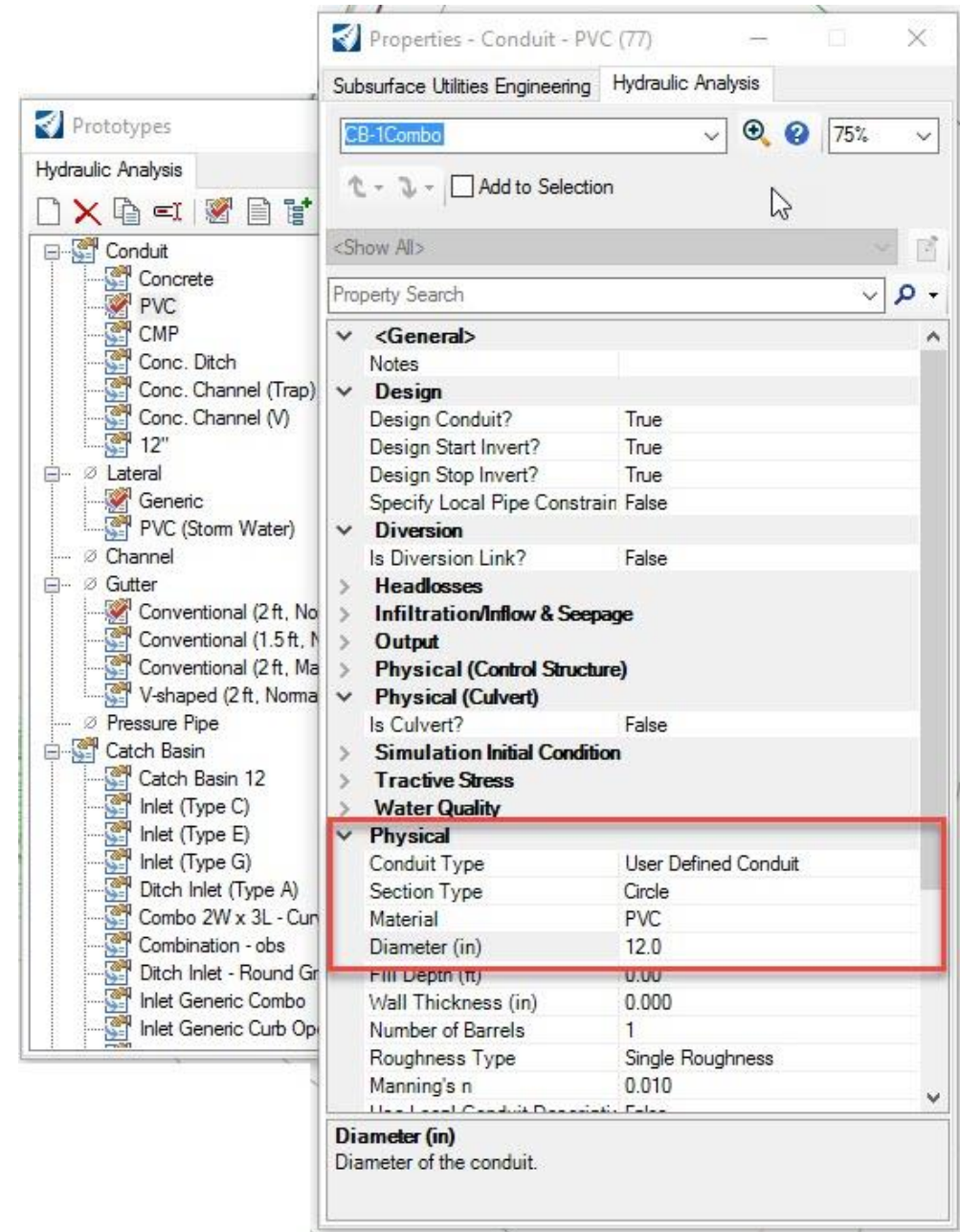
For calculations, a pivotal Prototype setting is the *Conduit Type*. There are two types:

User Defined

Catalog Conduit

The Physical Properties as defined in a *User Defined* Prototype are static: a single shape and size.

A Design Calculation CANNOT resize a *User-Defined* pipe.



Pipe Catalog

Conduit Catalog

Conduit Library Notes

Conduit Shape: Circle

Catalog Conduit Class Sizes

	Label	Available for Design	Inside Diameter (in)	Manning's n	Kutter's n	Darcy-Weisbach e (ft)	Hazen-Williams C	Wall Width (in)	Minimum Bend Radius (ft)	Joint Deflection (degrees)	Unit Length (ft)
1	4 inch	<input checked="" type="checkbox"/>	4.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000
2	6 inch	<input checked="" type="checkbox"/>	6.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000
3	8 inch	<input checked="" type="checkbox"/>	8.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000
4	10 inch	<input checked="" type="checkbox"/>	10.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000
5	12 inch	<input checked="" type="checkbox"/>	12.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000
6	15 inch	<input checked="" type="checkbox"/>	15.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000
7	18 inch	<input checked="" type="checkbox"/>	18.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000
8	24 inch	<input checked="" type="checkbox"/>	24.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000
9	30 inch	<input checked="" type="checkbox"/>	30.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000
10	36 inch	<input checked="" type="checkbox"/>	36.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000
11	42 inch	<input checked="" type="checkbox"/>	42.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000
12	48 inch	<input checked="" type="checkbox"/>	48.0	0.010	0.010	0.0004	150.0	0.000	0.000	0.00	0.000

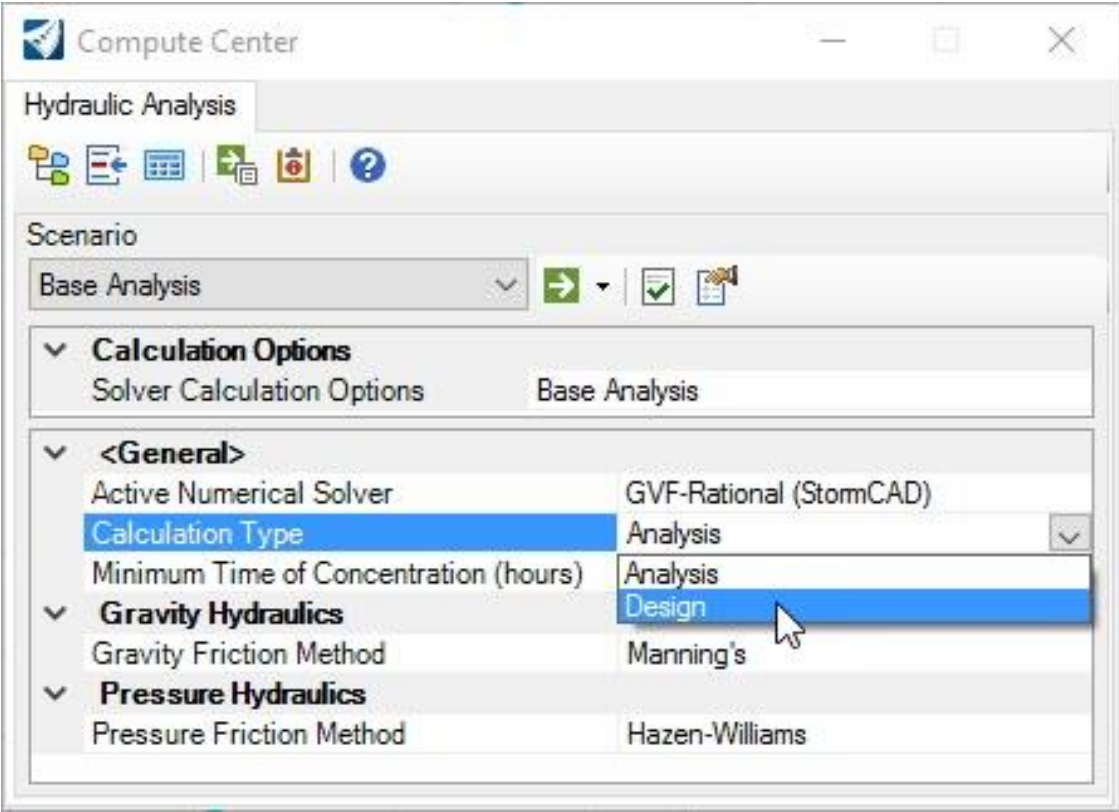
Class Availability

Available For Design?

Roughness

Material: PVC

Before you Hit Compute



Computation Settings

The screenshot shows the 'Properties (no selection)' dialog box with the 'Hydraulic Analysis' tab selected. The 'Pipe-2' element is selected, and the '75%' zoom level is indicated. The 'Property Search' field is empty. The settings are organized into several sections:

- <General>**
 - ID: 110
 - Label: Base Analysis
 - Notes:
 - Active Numerical Solver: GVF-Rational (StormCAD)
 - Calculation Type: Analysis
 - Minimum Time of Concentration (hours): 0.083
- Gravity Hydraulics**
 - Maximum Network Traversals: 5
 - Flow Convergence Test: 0.001
 - Flow Profile Method: Backwater Analysis
 - Number of Flow Profile Steps: 5
 - Hydraulic Grade Convergence Test (ft): 0.00
 - Average Velocity Method: Actual Uniform Flow Velocity
 - Minimum Structure Headloss (ft): 0.00
 - Governing Upstream Pipe Selection Method: Pipe with Maximum QV
 - Structure Loss Mode: Hydraulic Grade
 - Include Conduit Flow Travel Time in Design: True
 - Save Detailed Headloss Data?: False
 - Gravity Friction Method: Manning's
 - Use Explicit Depth and Slope Equations?: False
 - Ignore Travel Time in Carrier Pipes?: False
 - Correct for Partial Area Effects?: False
- Inlets**
 - Active Components for Combination Inlets on Grade: Grate and Curb
 - Active Components for Combination Inlets In Sag: Grate and Curb
 - Neglect Gutter Cross Slope For Side Flow?: False
 - Neglect Side Flow?: False
 - Grating Parameters (United Kingdom): <Collection: 5 items>
- Pressure Hydraulics**
 - Liquid Label: Water at 20C(68F)
 - Pressure Friction Method: Hazen-Williams
- Rational Method**
 - Use Rational Method Frequency Factors: False
 - Allow Runoff Coefficient to Exceed 1.0?: False
 - Carryover Modeling Method: As CA (Traditional)
- Headloss (AASHTO)**
 - Bend Angle vs. Bend Loss Curve: <Collection: 7 items>
 - Expansion, Ke: 0.350
 - Contraction, Kc: 0.250

At the bottom, the 'ID' section states: 'Unique identifier assigned to this element.'

Physical Alternative

Physical : Base Physical (_Drainage_Design -- Default.stsw)

Conduit Lateral Channel Gutter Pressure Pipe Catch Basin Manhole Property Connection Tap Transition Cross Section Outfall

ID	Structure	Diameter (in)	Culvert Equation Form	Arch Data Type	Fill Depth (ft)	Slope Correction Factor	Has Stop Control Structure?	Rise (ft)	C	Stop Control Structure	Span (ft)	Sidewalls Removed	M	Wall Thickness (in)	Ellipse Orientation	K	Y
130:	Px-1	12.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	0.156		0.0000	0.0000
131:	Px-2	12.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	0.000		0.0000	0.0000
132:	Px-3	12.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	0.000		0.0000	0.0000
133:	Px-4	12.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	0.000		0.0000	0.0000
134:	Px-5	12.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	0.000		0.0000	0.0000
135:	Px-6	12.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	0.000		0.0000	0.0000
136:	Px-7	12.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	0.000		0.0000	0.0000
137:	Pout	24.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	0.234		0.0000	0.0000
143:	PL-1	21.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	2.496		0.0000	0.0000
144:	PL-2	18.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	2.250		0.0000	0.0000
145:	PL-3	15.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	2.250		0.0000	0.0000
146:	PL-4	15.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	2.004		0.0000	0.0000
147:	PL-5	15.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	2.004		0.0000	0.0000
148:	PL-6	15.0	Form 1		0.00	-0.500	<input type="checkbox"/>		0.0000				0.0000	1.872		0.0000	0.0000

* = Base data = Local data = Inherited data

Inlet Capture Results

Properties - Storm Water...
 Subsurface Utilities Engineering Hydraulic Analysis
 75%
 Add to Selection
 <Show All>
 Property Search

- > <General>
- > <Geometry>
- > Active Topology Local Q adds
- > Design
- > Flows
 - Flow (Additional Subsurface) (cfs) 0.00
 - Flow (Known) (cfs) 0.80
 - Flow (Additional Carryover) (cfs) 4.00
 - External CA (acres) 0.000
 - External Tc (hours) 0.000
- > Inflow (Wet)
 - Inflow (Wet) Collection <Collection>

Gutter Flow
 Flow in vault

Properties - Catch Basin - IN-R4 (125)
 Subsurface Utilities Hydraulic Analysis
 75%
 Add to Selection
 <Show All>
 Property Search

Specific Energy (In) (ft)	3.66
Specific Energy (Out) (ft)	3.65
Results (Hydraulic)	
Velocity Head (In-Governing) (ft)	0.00
Results (Inlet Bypassed Flows)	
Bypassed CA (acres)	0.449
Bypassed Tc (min)	5.00
Bypassed Intensity (in/h)	6.503
Bypassed Rational Flow (cfs)	2.95
Bypassed Additional Carryover Flow (cfs)	0.00
Bypassed Fixed Flow (cfs)	0.00
Bypassed Known Flow (cfs)	0.00
Flow (Total Bypassed) (cfs)	2.95
Bypass Target	IN-R3
Results (Inlet Capture)	
Capacity (Gutter) (cfs)	6.19
Capacity (Inlet) (cfs)	0.54
Efficiency (At Design Spread) (%)	8.0
Spread / Top Width (ft)	3.739
Depth (Gutter) (in)	2.417
Flow (Captured) (cfs)	0.54
Capture Efficiency (Calculated) (%)	15.5
Results (Inlet Surface Flows)	
Total Inlet CA (acres)	0.532
Total Inlet Tc (min)	5.00

Flow (Captured) (cfs)
 Amount of surface flow captured by inlet. A negative captured flow implies an overflow condition.

Pipe Genealogy

- Demo

What happens when you hit compute

- Lots of calculations
- But not too much to think about
- You do need to consider...
 1. Do you want to **calculate** pipe sizes, or just **use** the sizes you have?
 2. If you **calculate** sizes, do you want to store a new set of results?
 3. If you want to **use** the sizes, **how** do you want to analyse?

Compute

- Demo



Under the Surface with Subsurface Utilities

Thank You

