



Office of Engineering  
Division of Facilities & Transit

ARCHITECTURAL  
**A E C**  
ENGINEERING CONSTRUCTION  
APPLICATIONS

Version 1

5/3/2018

# Bentley Subsurface Utilities Design and Analysis

The screenshot displays the Bentley Subsurface Utilities Design and Analysis software interface. It features a 3D model of sewer pipes and manholes, a storm data table, and a storm intensity graph. The storm data table is as follows:

Section	Section Size (Catalog Conduit)	Length (User Defined) (ft)	Invert (Start) (ft)	Invert (Stop) (ft)
71: P-1	P-1 12 inch	330.0	98.00	96.35
72: P-2	P-2 12 inch	300.0	96.35	94.30
73: P-3	P-3 24 inch	310.0	92.80	91.25
75: P-4	P-4 24 inch	290.0	91.25	89.80
76: P-5	P-5 12 inch	300.0	100.10	98.60
77: P-6	P-6 12 inch	300.0	98.60	96.95
78: P-7	P-7 24 inch	350.0	95.95	93.30
79: P-8	P-8 12 inch	300.0	98.60	96.95
80: P-9	P-9 12 inch	240.0	103.55	102.15
81: P-10	P-10 12 inch	280.0	102.15	98.75
82: P-11	P-11 18 inch	310.0	98.00	96.45

The storm data table also includes a graph showing Intensity (in/h) versus Duration (min) for various return periods (2 Year, 5 Year, 10 Year, 25 Year, 50 Year, 100 Year).

**CTDOT OPENROADS SUDA MANUAL FOR DESIGNERS**

<b>CHAPTER 1. INTRODUCTION TO SUDA</b>	<b>4</b>
<b>CHAPTER 2. STORM DRAINAGE DESIGN &amp; ANALYSIS</b>	<b>6</b>
<b>Section 1.1 Laying Out Storm Drainage</b>	<b>6</b>
1.1.1. Terrain Model	6
1.1.2. Layout of Drainage Structures (Nodes)	7
1.1.3. Place Conduits (Connect Conduit Between Nodes)	10
1.1.4. Special Drainage Item	12
1.1.5. Input Invert Elevations	14
1.1.6. Defined Drainage Areas	19
Runoff Coefficients	19
Time of Concentration Types	20
Tc Data Collection	21
Catchment Areas	22
1.1.7. Displaying Gutters	26
1.1.8. Defining Storm Events	29
A. Create IDF-Table by importing CSV-file (preferred option)	33
B. Create IDF-Table Adding Return Periods and Durations (quick & dirty)	36
<b>Section 2.1 Preparation to Compute</b>	<b>39</b>
2.1.1. Setting Properties – Defaults - Constraints –Prototypes	39
Project Defaults	40
Default Design Constraints	40
Prototypes	41
2.1.2. Setting Global Storm Events and Alternatives	44
2.1.3. Validate	48
2.1.4. Compute and Result Formats	52
A. Compute	52
B. Flextables	54
C. Profiles	58
➤ Open Profile Model (single pipe):	58
➤ Create Profile Run	59
➤ Auto Create Profile Run	60
➤ Open Profile Model	61
➤ Open Analysis Profile	62
➤ Open Engineering Profile	63

<b>Section 3.1</b>	<b>Existing Storm Drainage Analysis</b>	<b>65</b>
<b>Section 4.1</b>	<b>Proposed Storm Drainage Design and Analysis</b>	<b>65</b>
<b>Section 5.1</b>	<b>Plans Production</b>	<b>66</b>
5.1.1.	Plan Sheet	66
5.1.2.	Profile Sheet	68
5.1.3.	Cross Sections	74
<b>CHAPTER 3.</b>	<b>SUBSURFACE UTILITY ENGINEERING (<i>SUE</i>)</b>	<b>76</b>

---

DRAFT

# Chapter 1. Introduction to SUDA

---

*The engineer should have a fundamental understanding of drainage calculations and the Rational Method that is used throughout StormCAD for OpenRoads.*

This manual is to introduce CTDOT users to the latest Subsurface Utilities Design and Analysis for OpenRoads (*SUDA*) which includes modeling Subsurface Utilities (*SUE*) and performing hydraulic analysis (OpenRoads for StormCAD). AEC Applications provides an OpenRoads Managed Workspace through the use of ProjectWise to provide the standardization users will need to prepare their design. All OpenRoads projects will be done in the ProjectWise (PW) document management system environment and will use Managed Workspaces to implement the latest CTDOT CADD Standards.

Bentley ProjectWise (PW) is a collaborative environment which allows all parties involved in the project to use live data and to make real time decisions. It also allows CAD support to more efficiently update or edit any necessary Workspace resource. All CTDOT employees should have a ProjectWise account. If you do not, or if you experience difficulties logging in, please contact Julie Annino via email: [Julie.Annino@ct.gov](mailto:Julie.Annino@ct.gov)

When starting a new OpenRoads Project do not copy or open any DGN files that were used on the Network drive (X-Drive), these files do not use the correct settings. You may reference them in as needed but using them and running OpenRoads will cause problems.

Selecting the Bentley Institute Icon throughout this manual will link users to training videos on the Bentley LEARNserver. These videos are part of the [4-Subsurface Utility Design and Analysis](#) Recommended Learning Paths.

**State Employees** will need a Bentley Select ID to access the Bentley LEARNserver, should you need an ID, or have difficulties logging in, please contact Samantha Scharpf via email: [Samantha.Scharpf@ct.gov](mailto:Samantha.Scharpf@ct.gov).

**Consultant Engineering firms** need to purchase their own training subscriptions directly through Bentley.

If you have questions regarding this manual or *SUDA* preferences, please contact: [Gabriele.Hallock@ct.gov](mailto:Gabriele.Hallock@ct.gov)

Before getting started AEC recommends viewing these first 2 videos from the [Drainage Design using StormCAD for OpenRoads series](#) to get acclimated with the SUDA application and the terms used throughout this guide.



Creating Utility Database



Getting Ready – Exploring the Data

DRAFT

# Chapter 2. Storm Drainage Design & Analysis

---

The SUDA (Subsurface Utilities Design and Analysis} platform consists of two license scopes; the storm drainage design and analysis (StormCAD for OpenRoads) and Subsurface Utility Engineering (SUE) with capabilities to include Conflict Detection and non-drainage utility attribution. StormCAD for OpenRoads provides comprehensive 2D & 3D modeling for the design and analysis of storm water systems, while SUE extends the OpenRoads technology by including 2D & 3D feature-based models of the other utilities (water, electric, gas, etc.) within the project site to evaluate and detect conflicts between all utilities within a project site. StormCAD for OpenRoads has two calculation options: Analysis and Design. Analysis will not change the physical characteristics of the storm drainage; Design may change the physical characteristics.

*It is the designer's responsibility to adhere to the CTDOT Drainage Manual, CTDOT Hydraulics & Drainage Directives and Standards*

## Section 1.1 Laying Out Storm Drainage

It is assumed the designer is familiar with the OpenRoads technology and its interface, such as using Tool Settings dialog, Heads-Up Prompt and the 2D & 3D model duality. The designer should have a working knowledge calculating and laying out storm drainage systems.

### 1.1.1. Terrain Model

SUDA uses the terrain model referenced into a DGN file to display the storm drainage and other utilities in 2D and 3D. Drainage structures and conduits are fully-integrated in graphic and database functions. The data is in the graphics within the design file (\*.dgn file).

The designer should be aware that StormCAD for OpenRoads can use the elevations from the active terrain, also StormCAD for OpenRoads can only work with one terrain; this makes it necessary to merge terrains such as existing, LIDAR, point clouds and/or proposed.

To merge two or more terrains review the Bentley OpenRoads Technology - Fundamentals Learning Path - "Terrain Modeling" to help with merging existing terrain with the proposed terrains and others.



## Terrain Modeling Complex Terrain Models

This “**drainage terrain**” is in its own MicroStation DGN file and is referenced into the “drainage” MicroStation DGN file.

The [CTDOT OpenRoads Manual for Designers](#) should be followed and applied:

Chapter 1: ProjectWise Set Up;

Chapter 2: Project Start Up → Step 1 - Verify Correct Project Workspace,

Step 2 - Copy Resource Files from the Workspace to your project,

Step 3 - Create a Document (MicroStation DGN File),

Step 4 - Open a MicroStation DGN file.

If this is the first time creating a MicroStation DGN file complete Step 5 & 6 also.

Create a *Drainage MicroStation DGN file* exclusively for the drainage analysis/design, reference in the existing survey and proposed design (if doing proposed drainage), reference in the existing drainage terrain or proposed drainage terrain (if doing proposed drainage). When finished with the drainage, reference into your OpenRoads design file.

Depending on what the designer will use SUDA for will determine the steps to follow using SUDA:

- A. Analyze the existing storm drainage for a project site, a single system or multiple, or
- B. Analyze the existing storm drainage and upgrade for a project site as needed/required or
- C. Analyze and/or design proposed storm drainage system(s) for a project site and
- D. Analyze conflicts between existing utilities and proposed drainage.

### 1.1.2. Layout of Drainage Structures (Nodes)

**Open** your Drainage MicroStation DGN file and **reference** in the terrain; either the existing, proposed and/or the existing/proposed drainage terrain.

AEC recommends viewing these three videos from the [Drainage Design using StormCAD for OpenRoads](#) series to learn how to layout the drainage network system with SUDA.



Quick Look: Laying Out  
of Inlets & Pipes

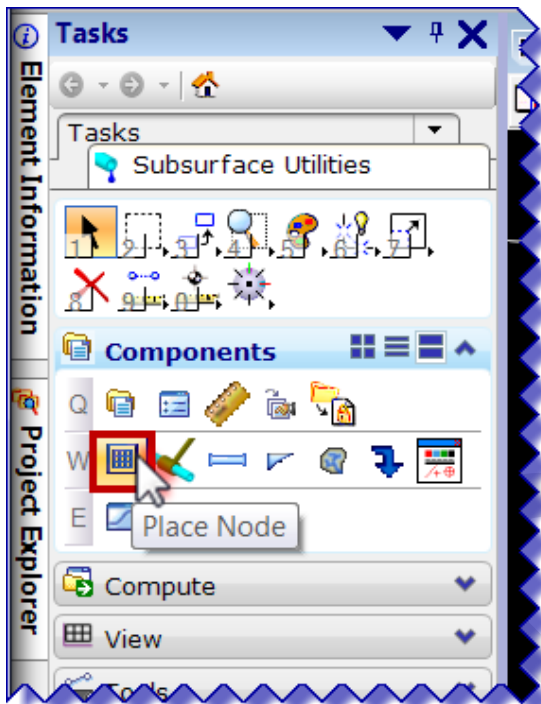


Laying Out Inlets At  
& Parallel to a Curb



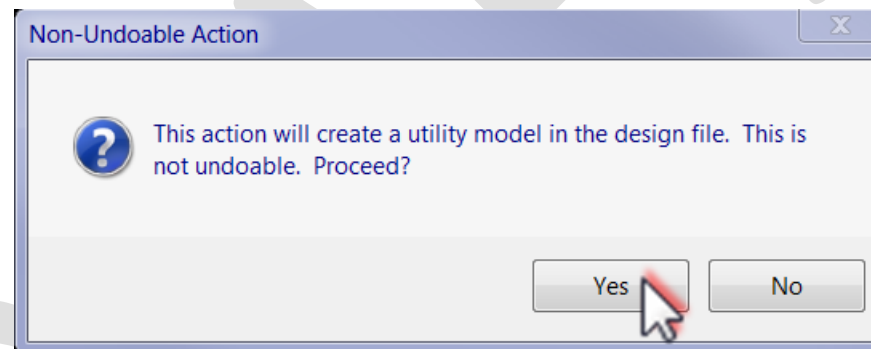
Laying Out Pipes &  
Additional Inlets

From the Subsurface Utilities tasks open **Components** tool box and select the **'Place Node'** command and place all catch basins for your system/project. (Usually inlets are placed up-stream to down-stream)



When you use any one Subsurface Utilities command for the first time in your file you will get a message box. "...will create a utility model..."

Click **"Yes"**.



This will open and prepare the Subsurface Utility project in your MicroStation DGN file, some context menus will pop-up and disappear, wait until completed and your cursor comes back.

Activate the **Place Node** command again, select as **Feature Definition** - the drainage structure you want to place such a Type "C" Catch Basin or Manhole. Follow the pop-up prompts:

1. Prompt: **Select Reference Element For Elevation**, <Reset> to Type an Elevation. Select the active terrain (referenced in) or click Reset (right mouse button) to enter an elevation.
2. Prompt: **Select Node Placement type**. Placement Type: By Minimum Depth → **Accept** (left mouse button). There are other options to place nodes, but are not covered at this time.



- Prompt: **Define Catchbasin and Elevation box** {With this prompt you should see the structure (example: catch basin) on your cursor}, here enter the TF (Top of Frame) Elevation and data point (left click) to the location you want the structure (catch basin) to be placed. Or Define Catchbasin and Vertical Offset box, enter and offset or type in 0.00 > enter; **data point** to the location you want to place the structure.
- Prompt: **Select Rotation**, rotate to the position/rotation, data point (left click) to accept.



To only see the outline of the structure (catch basin, etc.) turn off the "Fill" in the view attributes.

If you have more structures (catch basins or manholes) to place continue placing. After you placed the last structure, right click once more and select the Element Selection tool to end the Place Node command.

**Note:** Please be aware, if you delete a structure you also delete any conduit connected to the structure.

Additional Bentley Institute LearnServer training videos recommended by AEC:



Locating & Placing an On-Grade Curb Inlet



Locating a Low Point & Placing a Curb Inlet

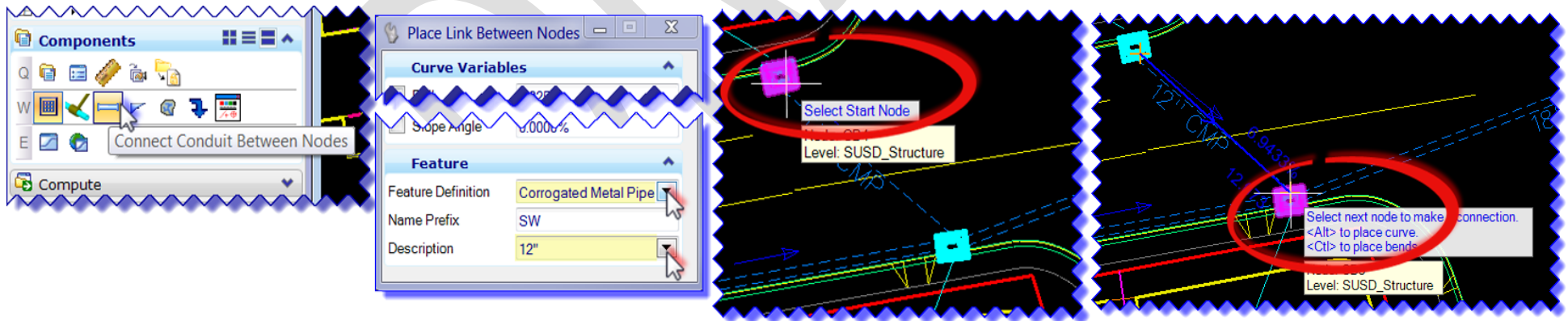


Placing the last two Inlets

### 1.1.3. Place Conduits (Connect Conduit Between Nodes)

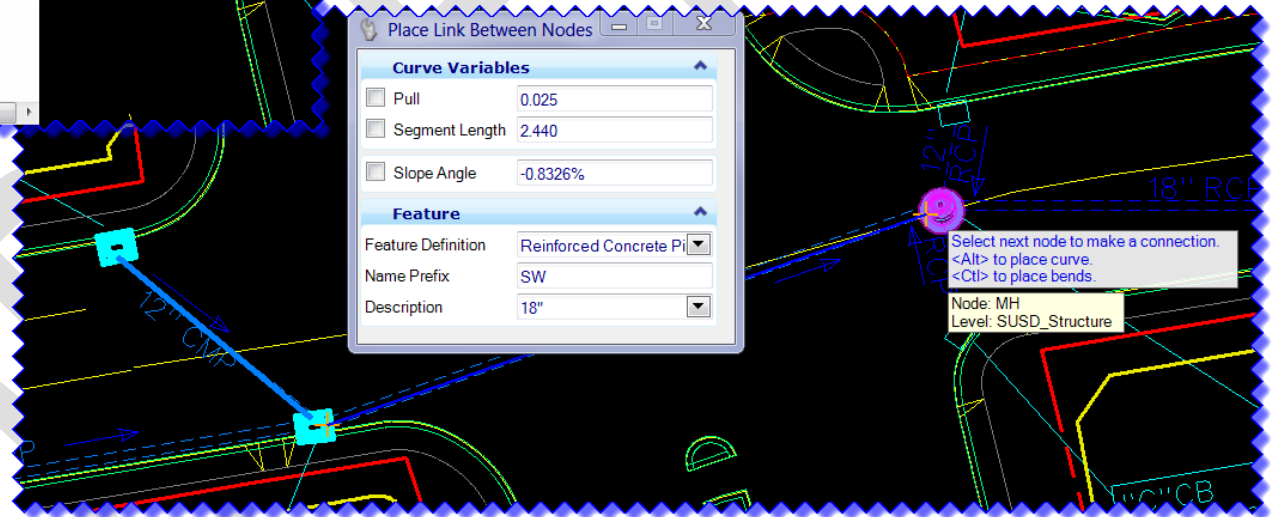
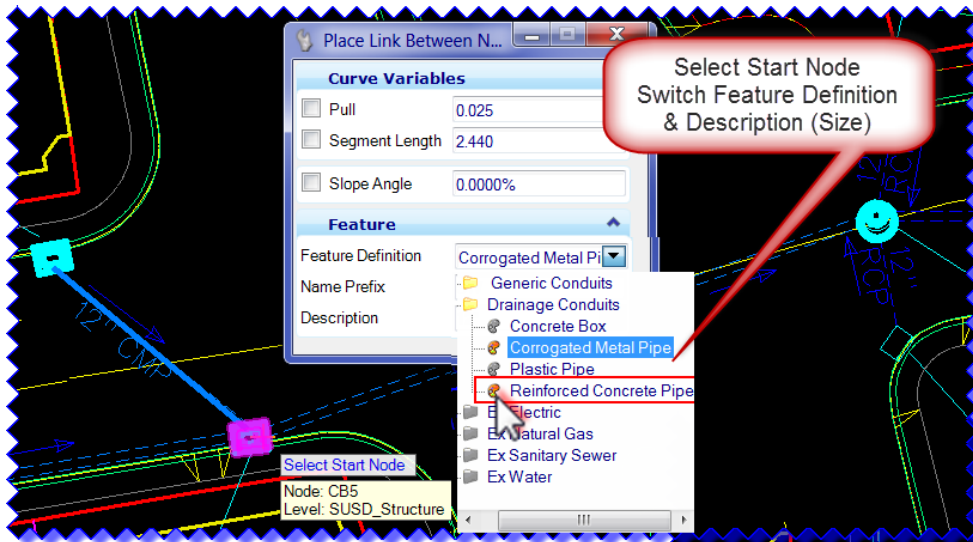
Conduits are placed between nodes such as catch basins, manholes and headwalls.

1. Activate the **Connect Conduit Between Nodes** command and select the **Feature Definition** for the pipe you want to place (example Corrugated Metal Pipe), the Name Prefix is set by default to SW (Storm Water), under Description click on the down arrow to select the pipe size (example 12").
2. **Select Start Node**, in the drawing hover your cursor close to the first inlet (node i.e. catch basin), it will snap to the node where the conduit can connect. **Accept** (left click).
3. **Select next node** to make a connection. Again hover your cursor close to the inlet to connect the conduit to (second node i.e. catch basin). **Accept** (left click)



You can place more conduits, using the **Connect Conduit Between Nodes** command. **Select Start Node** first then select the Feature Definition and Description (conduit size), follow the pop-up prompts.

When all conduits are placed right click and select the **Element Selection** tool to end the Connect Conduit Between Nodes command.



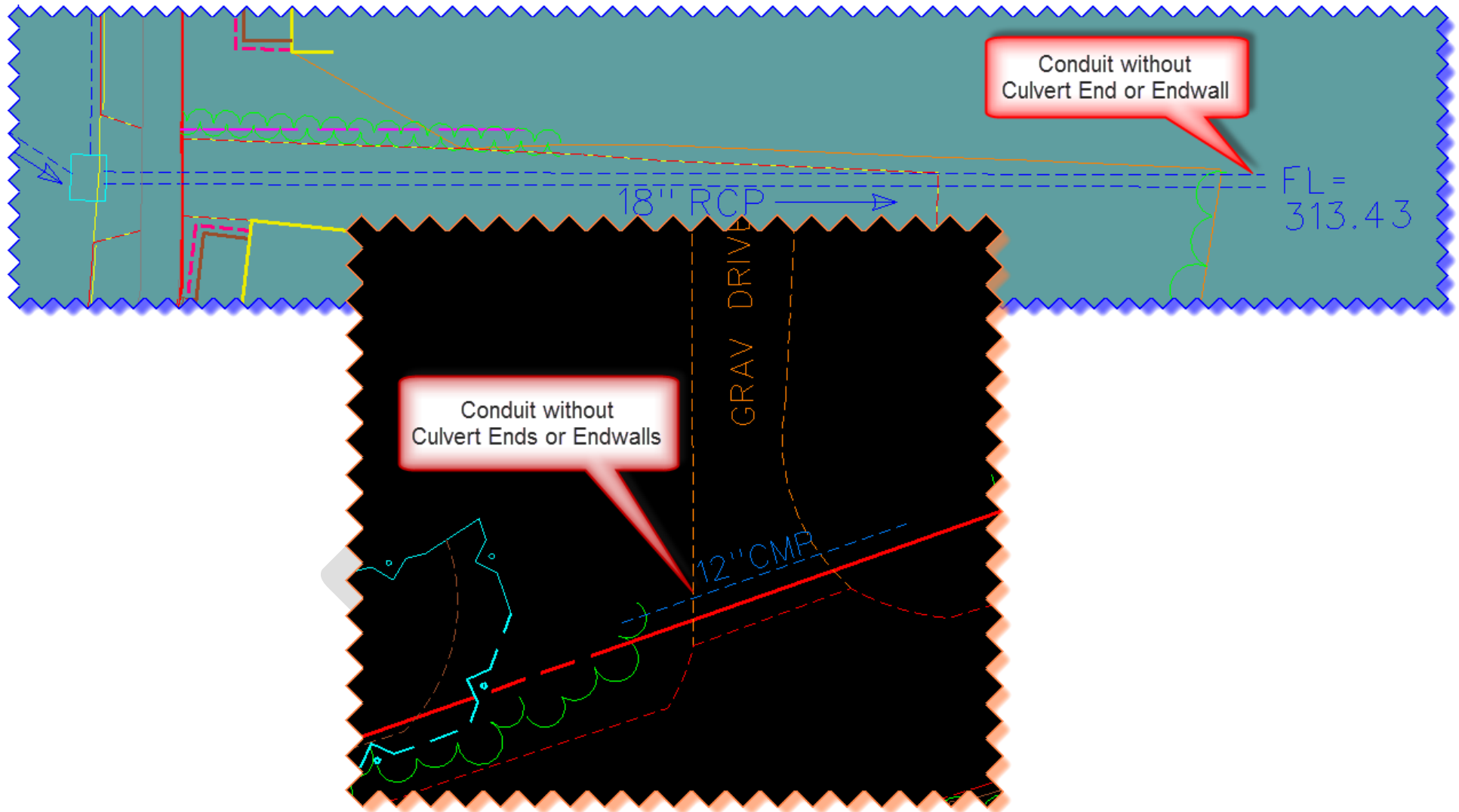
Placing the Pipes



Place Culvert between  
the Headwalls

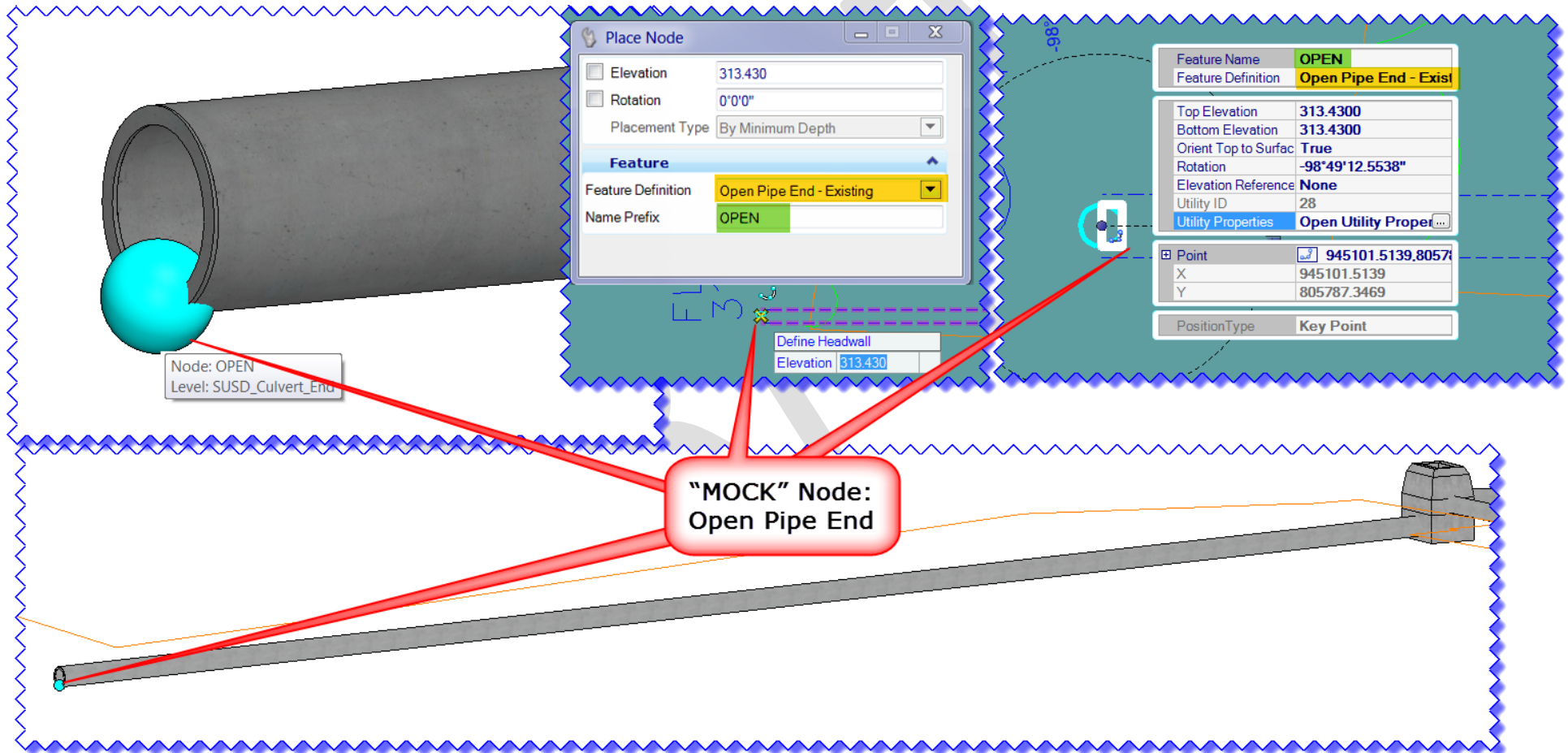
### 1.1.4. Special Drainage Item

Such as a pipe without a culvert end or endwall, a pipe below the driveway that conveys a swale/ditch. Since conduits connect between two nodes a "mock" node(s) is (are) placed at the outfall (and inlet) elevation(s).



1. Select the **Place Node** tool; in the pop-up menu for **Feature Definition** select → **Drainage Ends & Walls** → **Open Pipe End – Existing**. Follow the prompts.

2. *Prompt:* **Select Reference Element For Elevation**, <Reset> to Type an Elevation. **Click Reset** (right mouse button)
3. *Prompt:* **Select Node Placement type**. Placement Type: By Minimum Depth. **Accept** (left mouse button)
4. *Prompt:* **Define Headwall, Elevation**; here enter the FL (Flow Line) Elevation and **data point** (left click) to the location you want the node to be placed, you can snap to the end of the existing pipe in the survey dgn file.
5. *Prompt:* **Select Rotation**, rotate to the position/rotation, data point (left click) to accept.

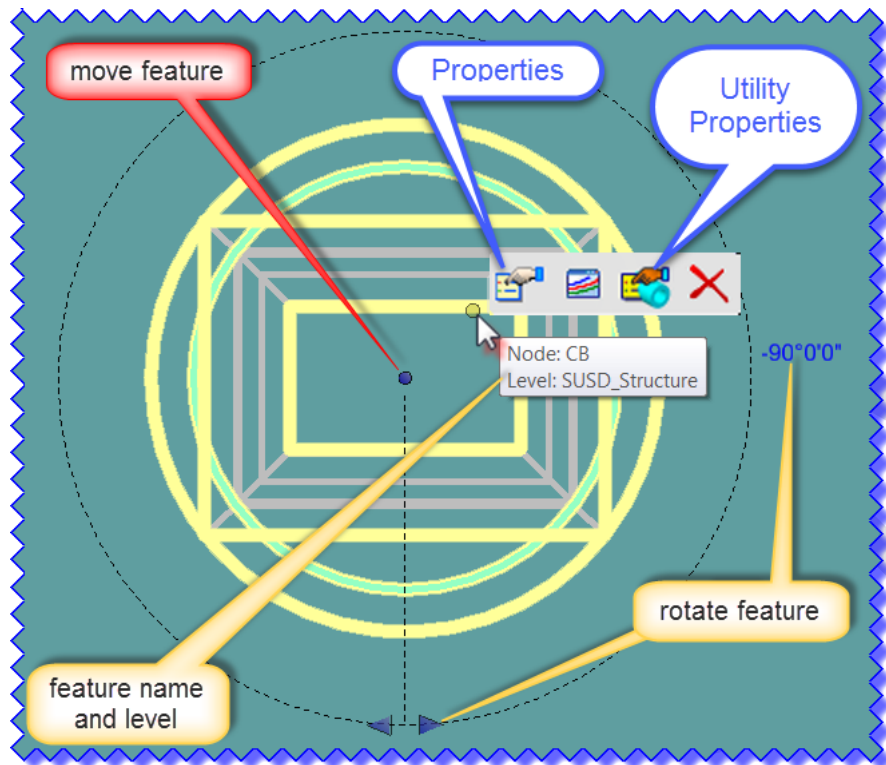


## 1.1.5. Input Invert Elevations

After you completed the layout for the drainage structures and conduits you will enter the elevations for the start and stop inverts for the conduits, SUDA sets conduit inverts at the bottom of the structures by default.

When designing the proposed drainage, you can also let SUDA calculate the pipe inverts when you use the *Base Design Scenario* in the Hydraulic Analysis (when using this, make sure the Default Design Constraints are set for the project as required).

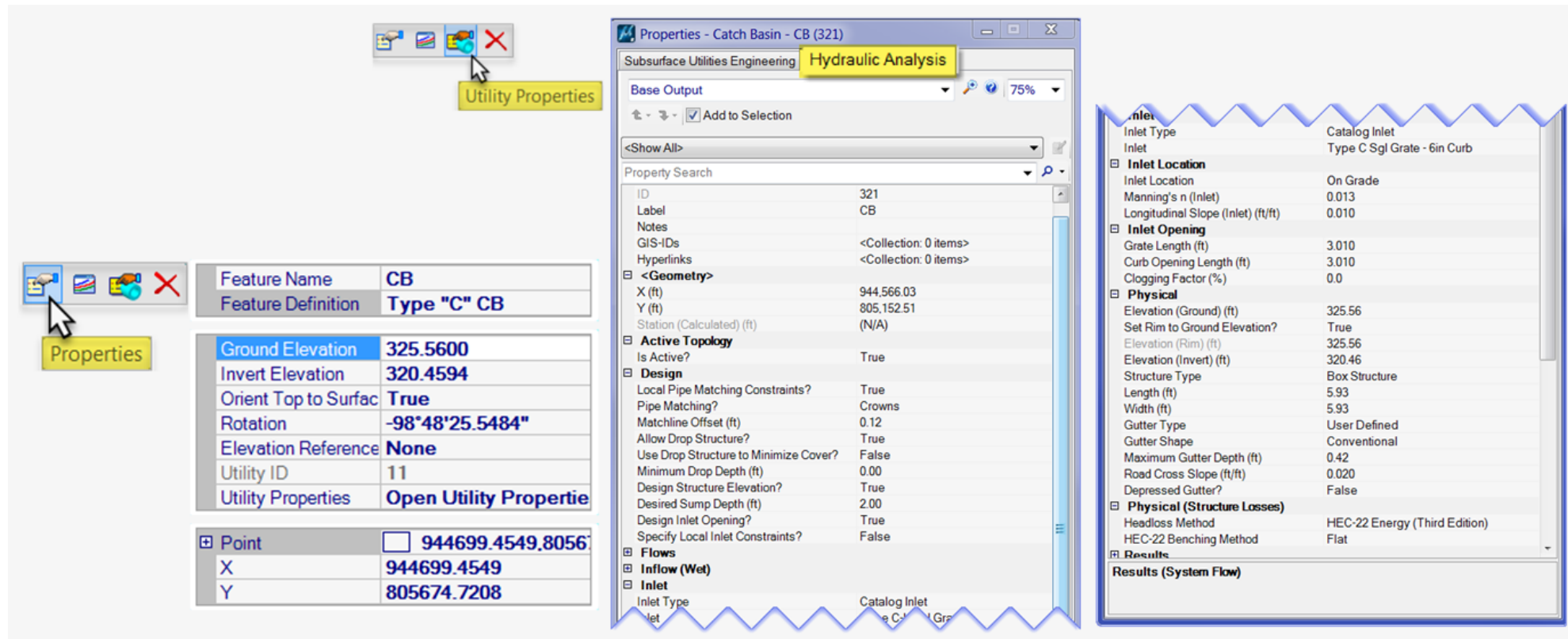
When you select a placed utility feature in OpenRoads, some feature properties can be edited/rotated/moved in the graphic (just as with other OpenRoads tools), it shows the label and level; also the *context toolbox* displays and offers two options to input/edit utility information: **Properties** and **Utility Properties**.



'**Properties**' lists the CADD properties such as level, color, feature, feature definition etc.;

'**Utility Properties**' lists every available hydraulic property including user customized properties.

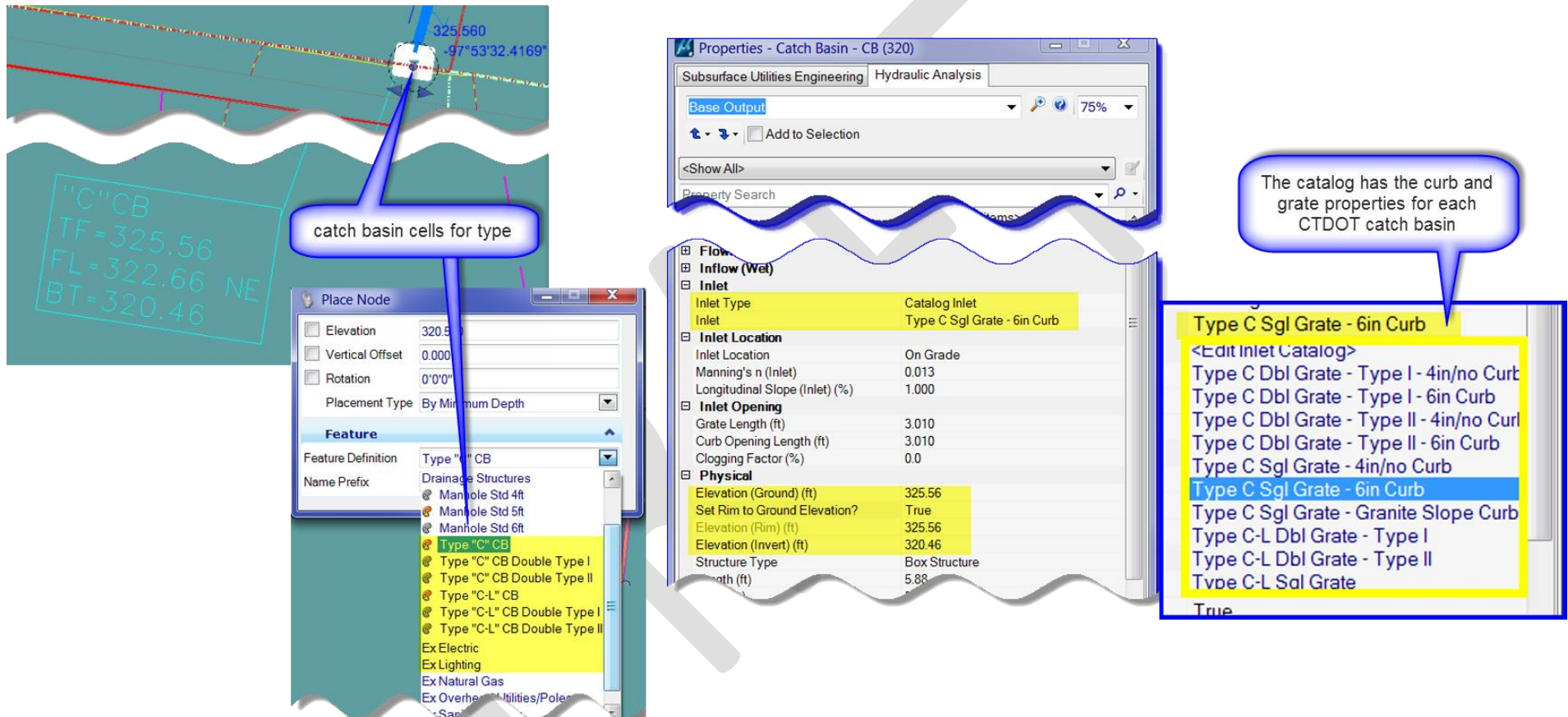
The reason for two property panels is because SUDA tools represent the merger of two diverse technologies. OpenRoads builds the 3D models of the utilities, but Bentley's Haestad technology (StormCAD) executes the analytic modeling for hydraulics and Subsurface Utility Engineering.



1. **Click and hover** over a node (catch basin or manhole), in the pop-up menu select **Utility Properties**, in the properties box click on the **Hydraulic Analysis** tab.
2. **Check and edit** as needed the Physical Properties for the nodes:
  - Elevation (Ground),
  - Set Rim to Ground Elevation?, Elevation (Rim),
  - Elevation (Invert) (= bottom of node).

You can also update the Inlet properties:

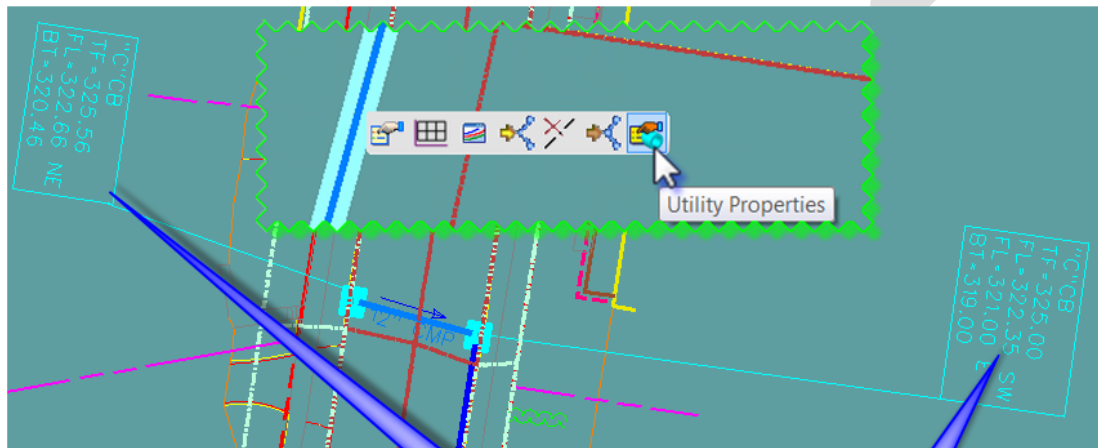
- Inlet Type: set to Catalog Inlet and
- Inlet: Click the down arrow and select the catch basin of your choice.
- Other items will be edited later.



3. Click and hover over the conduit, in the pop-up menu select **Utility Properties**, in the properties box click on the **Hydraulic Analysis** tab.
4. Check and edit as needed the Physical Properties for the conduits:
  - Conduit Type: Catalog conduit,



- Catalog Class: click the down arrow and select >Concrete, PVC, CMP;
- Size: click down arrow and select size.
- Invert (Start): enter elevation
- Invert (Stop): enter elevation.
- Has User Defined Length? True (default) or False
- Length (user Defined) enter length.
- Other items will be edited later.



for Existing use Survey inverts provided  
for proposed use CTDOT H&D Manual  
guidelines to calculate inverts

Properties - Conduit - SW (15)

Subsurface Utilities Engineering Hydraulic Analysis

75%

Hydraulic Collector  
Node Reversed <Reverse Start/Stop>  
Start Node CB  
Stop Node CB1

<Geometry>  
Geometry <Collection: 2 items>

Active Topology  
Is Active? True

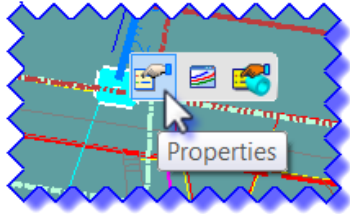
Design

Diversion

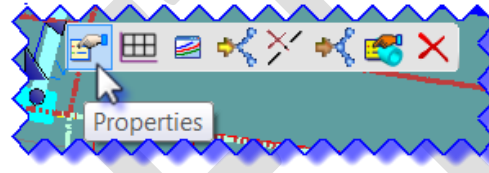
Physical

Conduit Type	Catalog Conduit
Catalog Class	CMP
Size	12"
Section Type	Circle
Material	CMP
Diameter (in)	12.0
Wall Thickness (in)	0.084
Number of Barrels	1
Manning's n	0.024
Use Local Conduit Description?	False
Conduit Description	in12.0
Set Invert to Start?	False
Invert (Start) (ft)	322.66
Set Invert to Stop?	False
Invert (Stop) (ft)	322.35
Has User Defined Length?	True
Length (User Defined) (ft)	28.000
Length (3D) (ft)	28.769
Length (Unified) (ft)	28.000
Slope (Calculated) (%)	1.107
User Defined Pipe Slope?	False

Input the elevations using 'Properties'.



Feature Name	CB
Feature Definition	Type "C" CB
Origin	944699.824,805675.82
Angle	0°0'0"
Orientation	Top
Scale X	1.00000
Scale Y	1.00000
Scale Z	1.00000
Ground Elevation	325.5600
Invert Elevation	320.4594
Orient Top to Surface	True
Rotation	-97°53'32.4169"
Elevation Reference	None
Utility ID	10
Utility Properties	Open Utility Propertie
Point	944699.7077,805674.9847
X	944699.7077
Y	805674.9847



Feature Name	SW
Feature Definition	Corrogated Metal Pip
Description	<Custom>
Start Point	944700.032,805677.31
End Point	944706.930,805702.08
Length	25.716
Start Node	CB
Stop Node	CB1
Start Invert	322.6594
Stop Invert	322.3494
Diameter	1.000
Interpolate Elevation	True
Utility ID	15
Utility Properties	Open Utility Propertie

## 1.1.6. Defined Drainage Areas

The designer has several options to configure drainage areas (catchment areas). Catchment properties include: runoff coefficient, time of concentration types, time of concentration and catchment area. Below are suggested videos to familiarize the designer with placing catchment areas.



Place Catchments  
by Picking Shapes



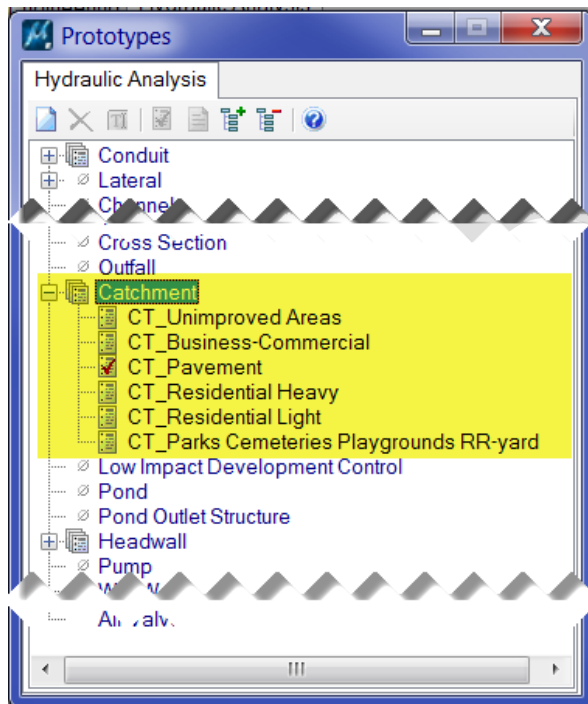
Place Catchment by  
Picking Points



Place Catchments  
by Flood Fill

### A. Runoff Coefficients

have been defined as prototypes following the CTDOT Drainage Manual. Runoff coefficients are composites from Table 6-4 Recommended Coefficient of Runoff Values for Various Selected Land Uses and Table 6-5 Coefficients for Composite Runoff Analysis, Chapter 6 of the CTDOT Drainage Manual.



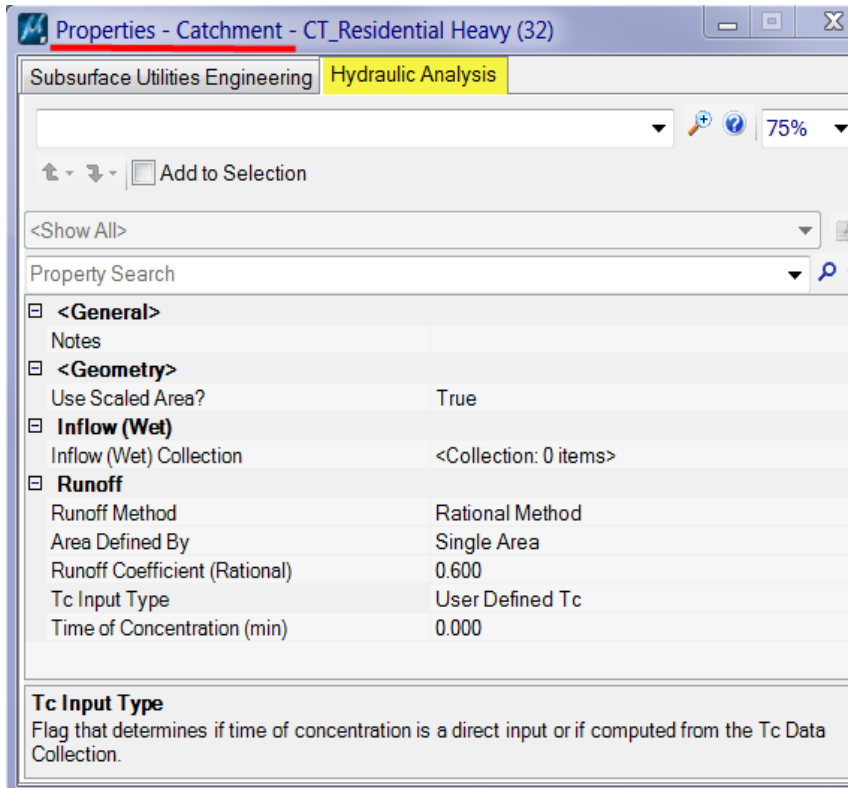
Rational Method	
Catchment Area Type	Runoff Coefficient
CT_Unimproved Areas	0.2
CT_Business-Commercial	0.75
CT_Pavement	0.9
CT_Residential Heavy	0.6
CT_Residential Light	0.4
CT_Parks Cemeteries Playgrounds RR-Yard	0.35

More *Catchment* types can be added or the coefficients can be changed specific to the project if needed.

## B. Time of Concentration Types

are the Tc Input Types: *User Defined Tc* - where the user inputs minutes for Tc or

*Composite Tc* - where the user inputs a data collection of Tc's.



**Notes** - here the user can enter project specific data/notes

**Use Scaled Area** - True or False - default is set to TRUE - if set to False: user inputs area

**Inflow (Wet) Collection** - Set up a list of inflows directly injected into the system at the node

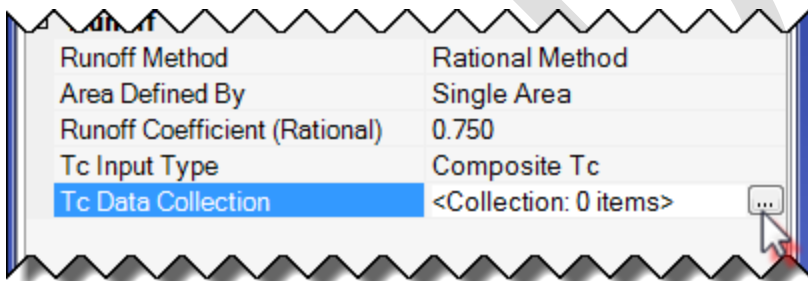
**Runoff Method** - SUDA uses the *Rational Method*

**Area Defined By** - Single Area or Multiple Subareas

**Runoff Coefficient** - value from CTDOT H&D Manual

**Tc Input Type** - User Defined Tc

**Time of Concentration** - measured in minutes is either for a 'Single Area' or a Composite with a collection of data



**Tc Input Type** - Composite Tc

**Tc Data Collection** - <Collection: 0 items> [...]

## C. Tc Data Collection

use the TR-55 Sheet Flow, Shallow Concentrated Flow and Channel Flow.

Tc Data Collection

User Defined Tc

- Carter
- Eagleson
- Espey-V
- FAA
- Kerby-H
- Kirpich
- Kirpich (1922)
- Length and Velocity
- SCS Lag
- TR-55 Sheet Flow
- TR-55 Shallow Concentrated Flow
- TR-55 Channel Flow
- Friend's Equation
- Kinematic Wave
- Bransby-Williams Equation
- Wallingford (United Kingdom)

This follows CTDOT Drainage Manual Chapter 6.C-6 : Time of Concentration Worksheet

### from H&D Manual - 6.C.6 Time of Concentration Worksheet

Sheet flow (Applicable to T <sub>c</sub> only)	Segment ID
1 Surface description (Table 6.C.1)	
2 Manning's roughness coeff., n (Table 6.C.1)	
3 Flow length, L (See Section 6.C.4)	m (ft)
4 Two-yr 24-hr rainfall, P <sub>2</sub> (Table B-1)	mm (in)
5 Land slope, s	m/m (ft/ft)
6 Travel Time, T <sub>t</sub> (Equation 6.C.2)	h

Tc Data Collection

Tc Method  
TR-55 Sheet Flow

Hydraulic Length: 0.000 ft

Slope: 0.000 ft/ft

Manning's n: 0.000

2 Year 24 Hour Depth: 0.0 in

from NOAA Atlas 14 Point Precipitation Frequency Estimates

### from H&D Manual - 6.C.6 Time of Concentration Worksheet

Shallow concentrated flow	Segment ID
7 Surface description (paved or unpaved)	
8 Flow length, L	m (ft)
9 Watercourse slope, s	m/m (ft/ft)
10 Average velocity, V (Equation 6.C.4 or 6.C.5)	m/s (ft/s)
11 Travel Time, T <sub>t</sub> (Equation 6.C.3)	h

Tc Data Collection

Tc Method  
TR-55 Sheet Flow  
TR-55 Shallow Concentrated Flow

Hydraulic Length: 0.000 ft

Slope: 0.000 ft/ft

Is Paved?

Unpaved = Equation 6.C.4  
Paved = Equation 6.C.5

### from H&D Manual - 6.C.6 Time of Concentration Worksheet

Channel flow	Segment ID
12 Cross sectional flow area, a	m <sup>2</sup> (ft <sup>2</sup> )
13 Wetted perimeter, p <sub>w</sub>	m (ft)
14 Hydraulic radius, r = a/p <sub>w</sub>	m (ft)
15 Channel slope, s	m/m (ft/ft)
16 Manning's roughness coeff., n (Table 7-1 & Append. A, Ch. 8)	
17 Average velocity, v (Equation 6.C.6)	m/s (ft/s)
18 Flow length, L	m (ft)
19 Travel Time, T <sub>t</sub> (Equation 6.C.3)	h

Tc Data Collection

Tc Method  
TR-55 Sheet Flow  
TR-55 Shallow Concentrated Flow  
TR-55 Channel Flow

Hydraulic Length: 0.000 ft

Slope: 0.000 ft/ft

Manning's n: 0.000

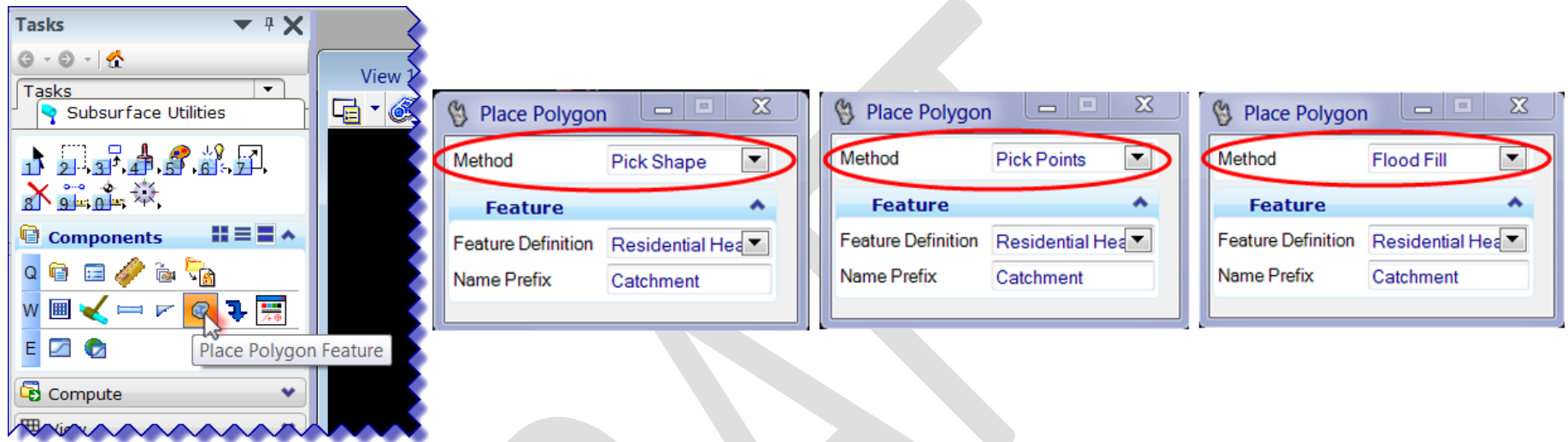
Flow Area: 0.0 ft<sup>2</sup>

Wetted Perimeter: 0.000 ft

## D. Catchment Areas

there are several methods (commands) available to configure drainage areas (as shown in previous videos):

### Pick Shape – Pick Points – Flood Fill



Try them all to see which one best fits your particular project site.

To define catchment areas OpenRoads has tools available to find the catchment areas, check out the following video and others within the Hydraulic Terrain Analysis series.



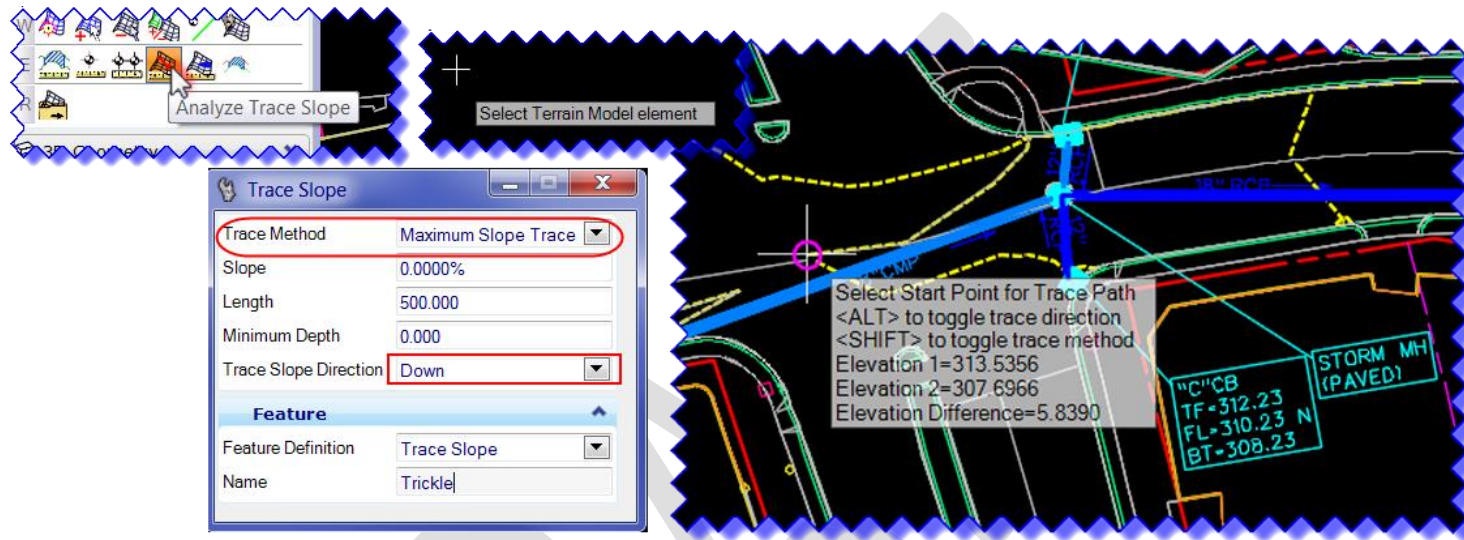
### The Analyze Trace Slope Tool

The Hydraulic Terrain Analysis tools help you evaluate a terrain's hydrologic patterns, including determining catchment boundaries using MicroStation and OpenRoads terrain tools.

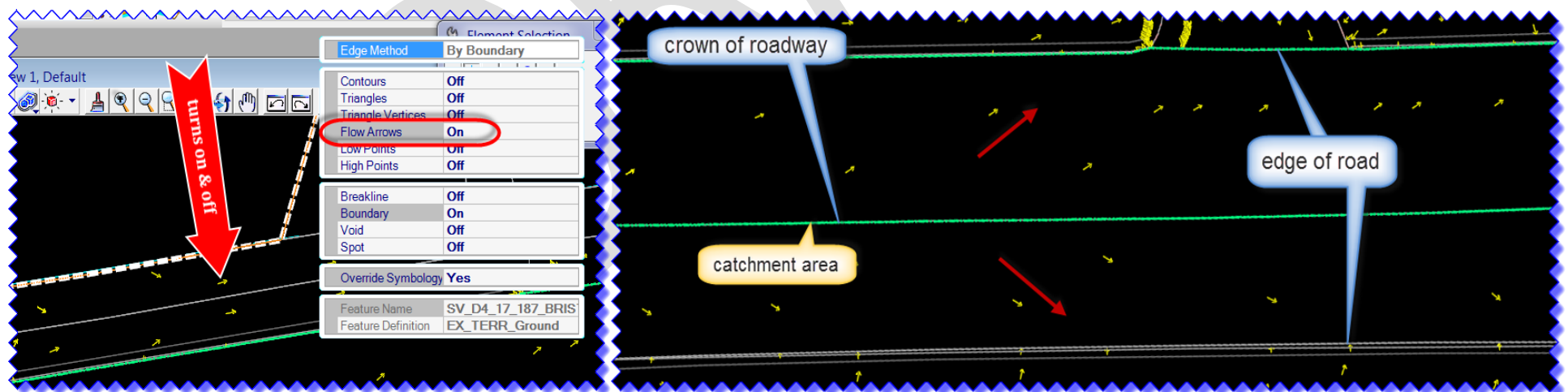
Use the **Analyze Trace Slope** command from the terrain tools to determine catchment areas for inlets. You should do this in the *drainage terrain* file.

This tool will analyze the terrain slope, trace the flow of storm water and show low points of the terrain.

From the Terrain Model tool box select: **Analyze Trace Slope**, select: Maximum Slope Trace, Trace Slope Direction is Down.

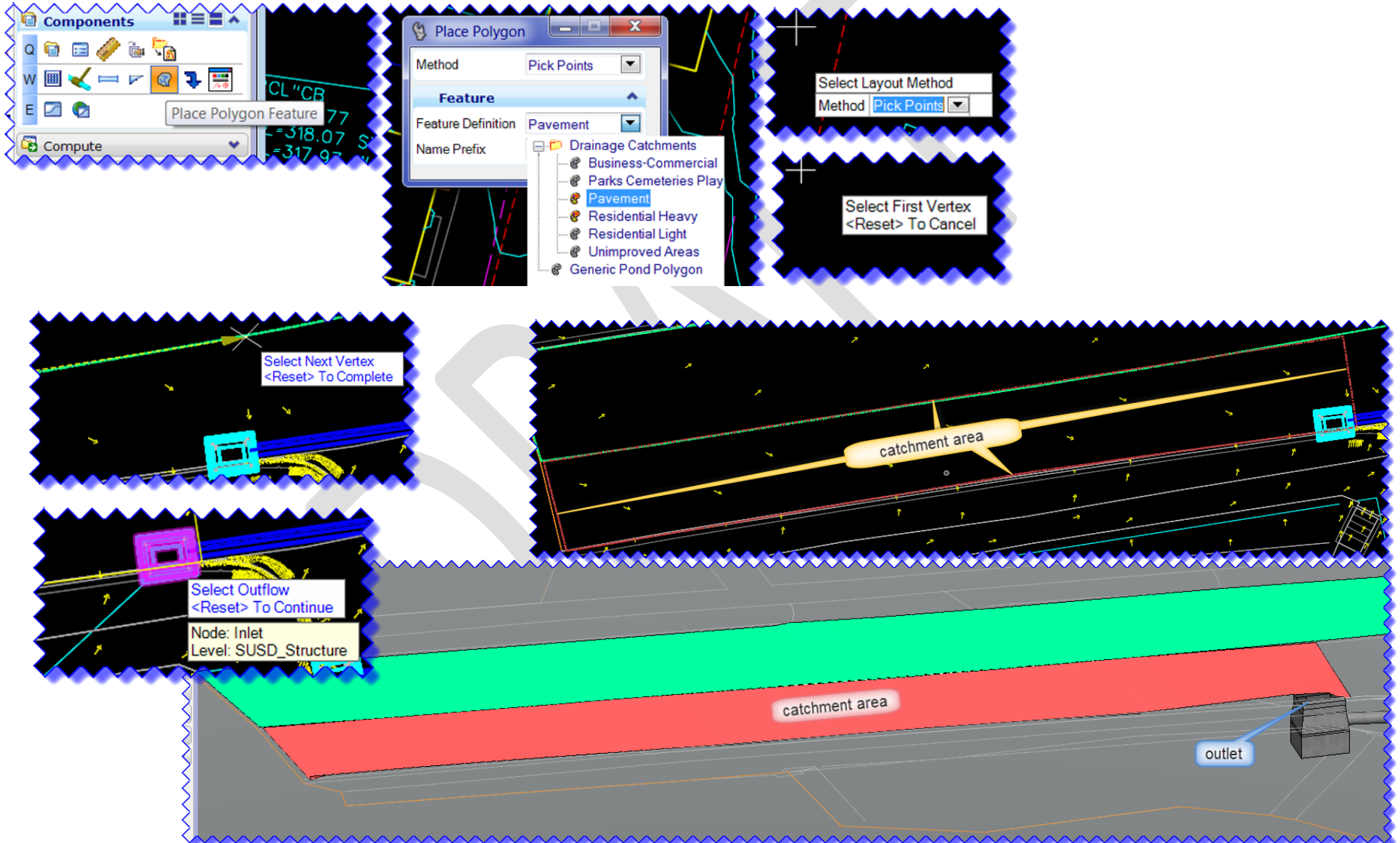


Another option is to **turn on** the Flow Arrows in the drainage terrain. This will show the direction storm water flows within the terrain.



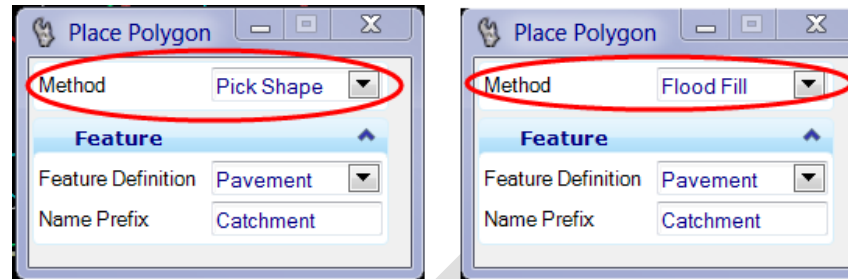
Define the catchment areas in the "Drainage" MicroStation DGN file using the **Place Polygon Feature** tool using the "Pick Points" Method. Pick the *Feature Definition* of the drainage catchment you are defining, pavement etc.

Follow the prompts: **Select Layout Method**, **Select First Vertex**, **Select Next Vertex** <Reset> To Complete, **Select Outflow**, Select reference surface.

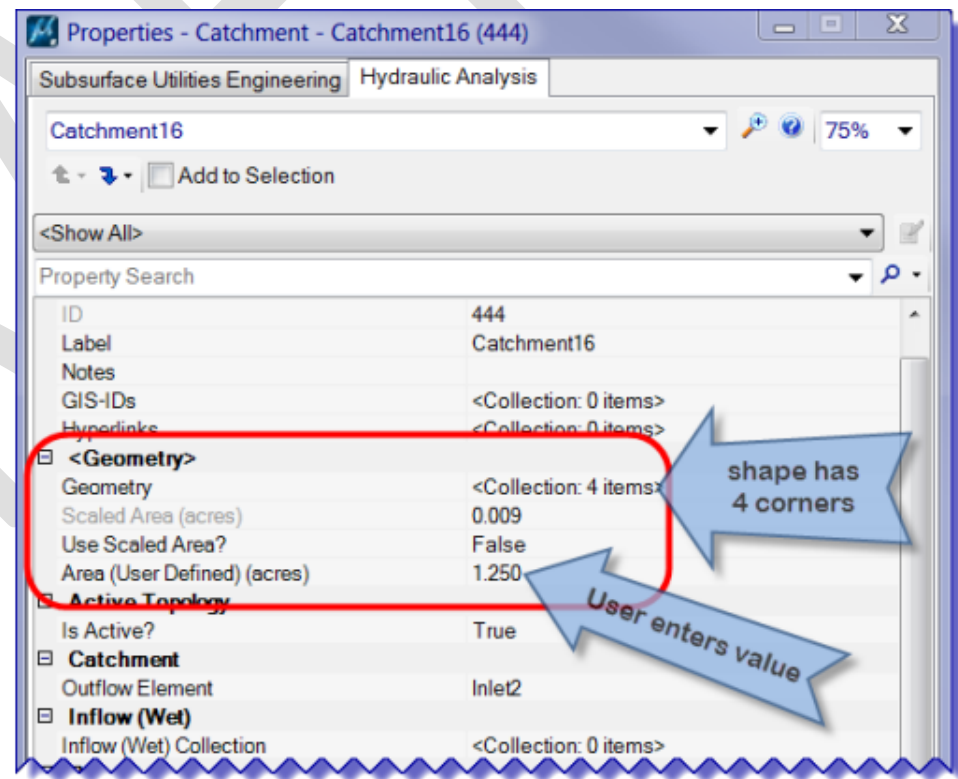
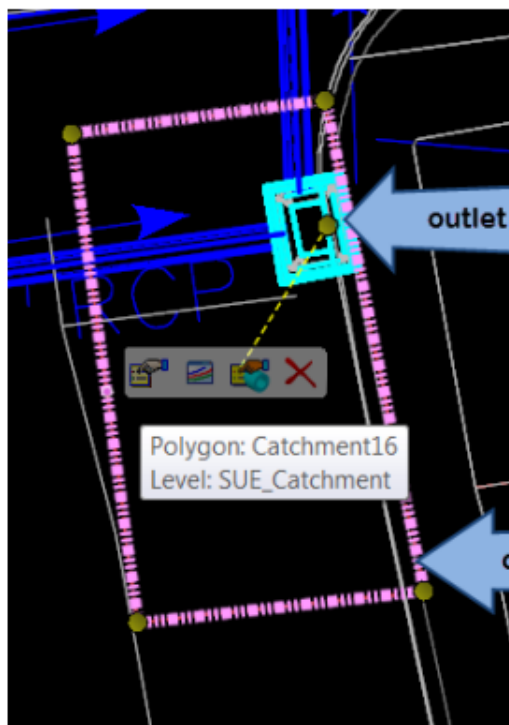




To: **Place Polygon by Method** → **Pick Shape** and **Flood Fill**, see the previously mentioned videos on the Bentley Institutes SUDA Learning Path.



Another option, the user can also place any type of shape, and input the drainage areas into the Hydraulic Analysis tab.



## 1.1.7. Displaying Gutters

Gutters are the method by which a catch basin bypass flow is assigned to a downhill catch basin. Gutters only represent the hydraulic relationship between the inlets and are not accurate 2D or 3D models.

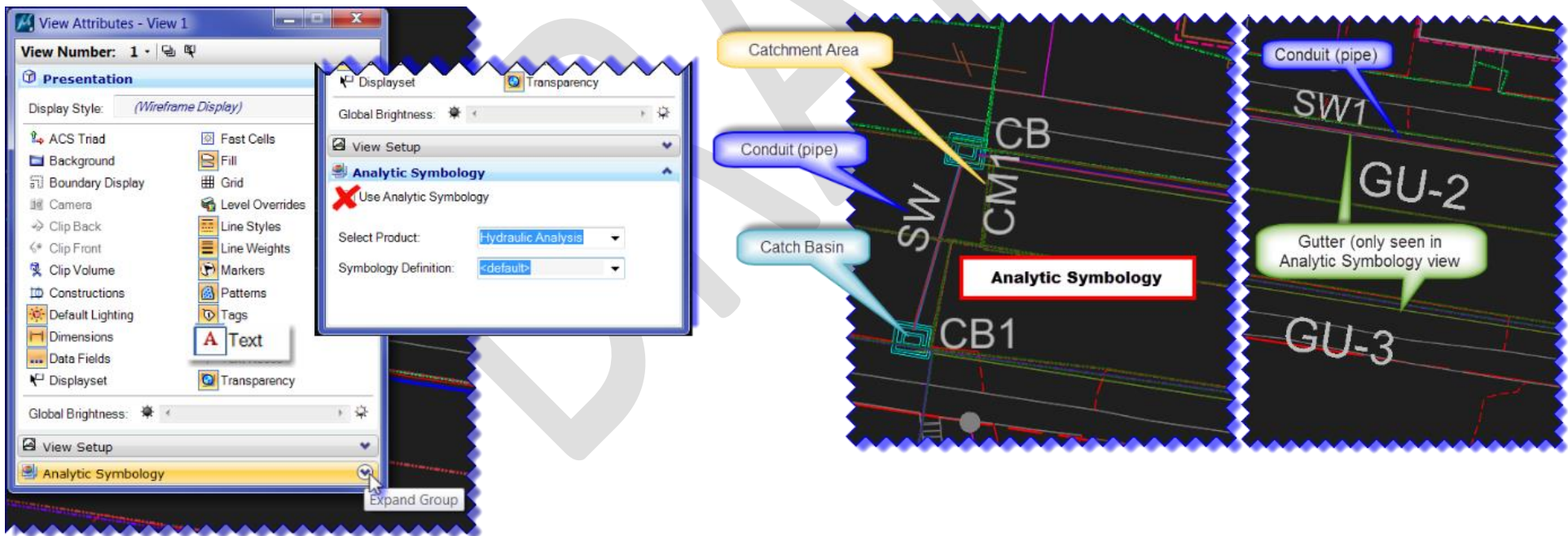
The following video is recommended:



Viewing Gutters with Analytic Symbology

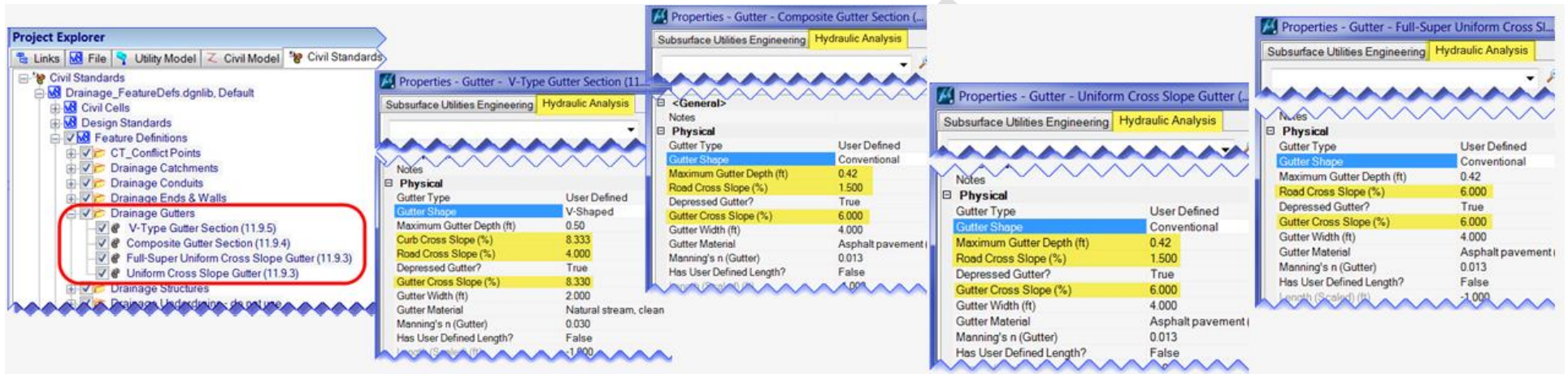
To display and add gutters to a drainage system the display in the 2D view has to be changed to Use Analytic Symbology.

In View 1 (2D view) click on **View Attributes**, in the View Attributes box – View 1, check off 'Text' under Presentation, then expand the Analytic Symbology (if not expanded) and check on "Use Analytic Symbology".

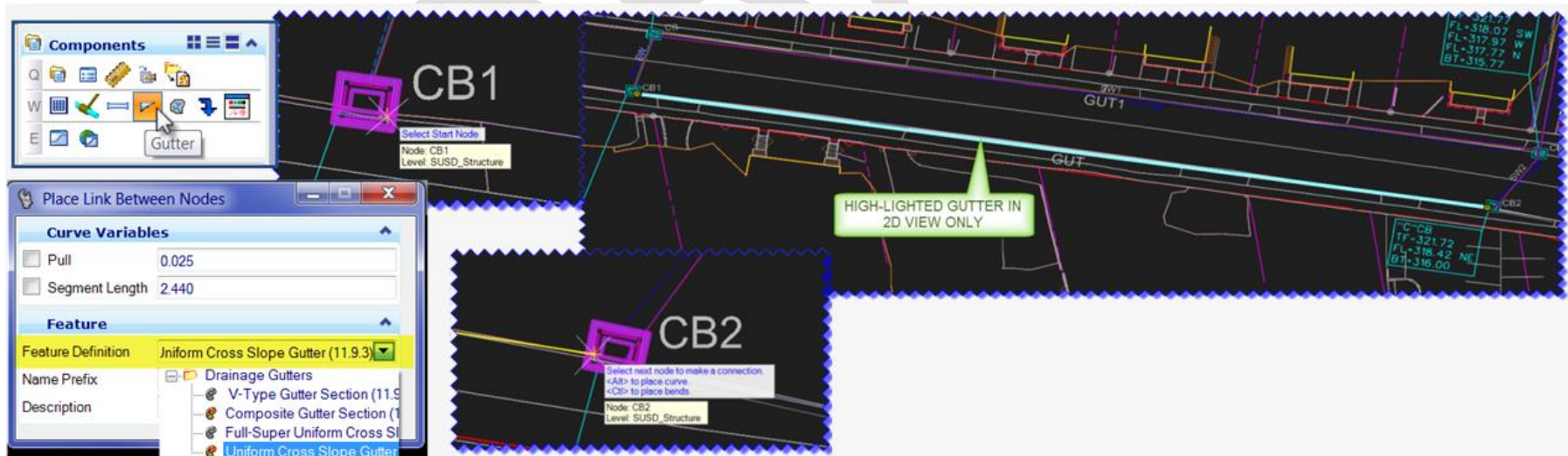


This will turn on "labels" in the plan view (2D view – Default). If the labels do not show, refresh the view.

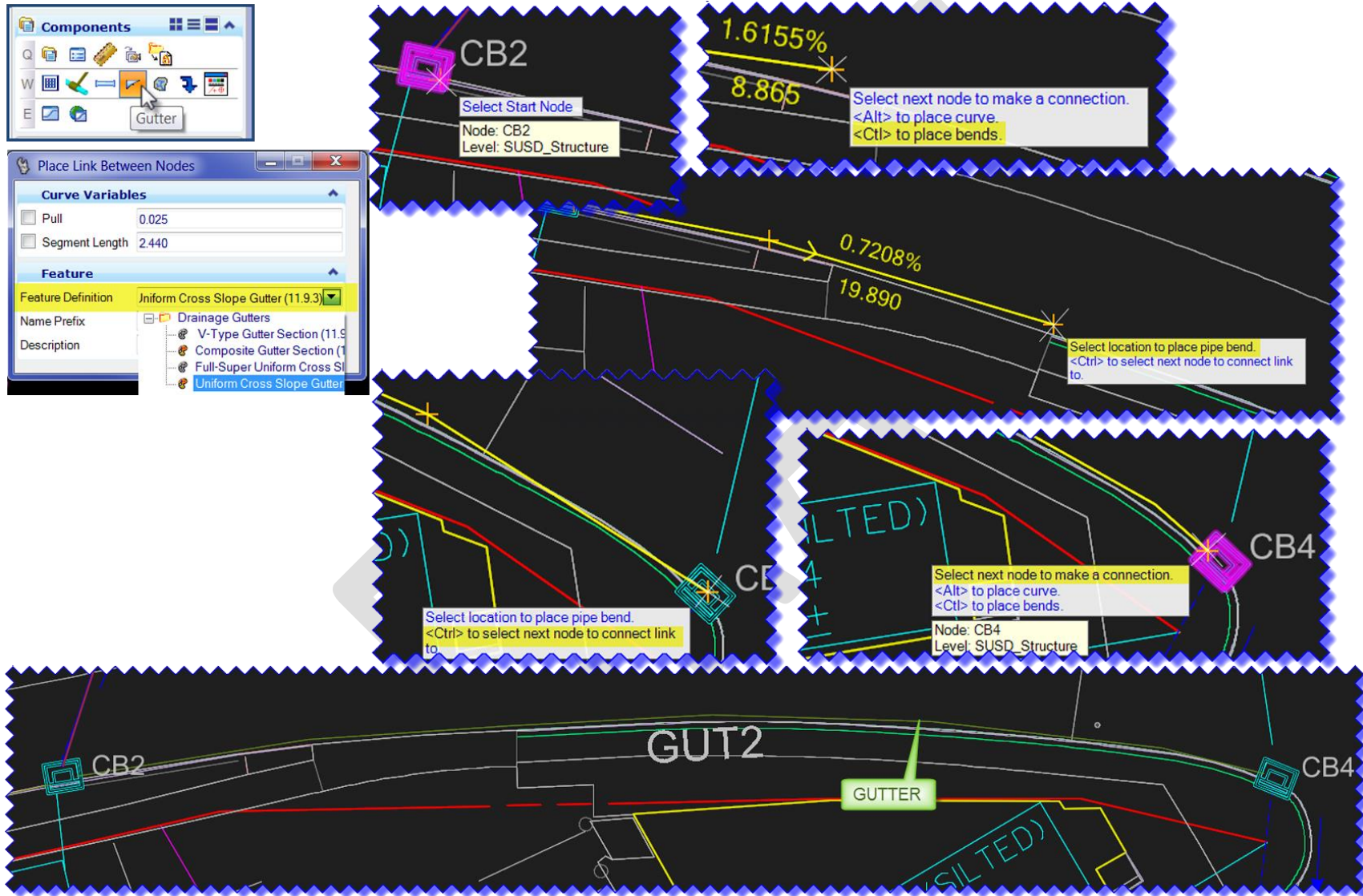
There are four (4) gutters available that correspond to the CTDOT Drainage Manual, Chapter 11 – Storm Drainage Systems, 11.9 Gutter Flow Calculations; 11.9.3 Uniform Cross Slope Procedure; 11.9.4 Composite Gutter Sections Procedure and 11.9.5 V-Type Gutter Sections Procedures. The engineer (user) has to decide which gutter best fits their project and edit as needed.



Click on the **Gutter** tool, in the **Place Link between Nodes** tool box select the gutter needed under Feature Definition. This will prompt you to **Select Start Node** → select the start catch basin, prompt: **Select next node to make connection** → select the next catch basin where the bypass flow for the first catch basin will go to.



If the gutter is around a curve/bend use the **Gutter** tool, picking the start catch basin, then instead of picking the next catch basin, press the **<Ctrl> key** (Control key) and pick (select) the location to place the "pipe" bend (gutter bend), then to change back to the place node command press the **<Ctrl>** again to select next node to make a connection; **reset** (click left mouse button) to end command.



## 1.1.8. Defining Storm Events

The Department's Hydraulic and Drainage Unit advises the designer to use the NOAA Atlas 14 Data, which can be accessed through the [NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES](#) webpage in conjunction with the CTDOT Drainage Manual.

Follow the direction on the *NOAA Atlas 14* webpage and directions given by *CTDOT H&D unit* on how to develop the Point Precipitation Frequency (PF) Estimates, which can be downloaded in CSV-format and opened with Excel. The data in the PF tabular format will be used for Storm Data to create a *User Defined IDF Table*.

NOAA's National Weather Service  
Hydrometeorological Design Studies Center  
Precipitation Frequency Data Server (PFDS)

Home Site Map News Organization

NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: CT

**Data description**

Data type:  Units:  Time series type:

1) Manually:

a) By location (decimal degrees, use "-" for S and W): Latitude:  Longitude:  Submit

b) By station (list of CT stations):

c) By address

2) Use map (if ESRI interactive map is not loading, try adding the host: <https://js.arcgis.com/> to the firewall, or contact us at [hdsc.questions@noaa.gov](mailto:hdsc.questions@noaa.gov)):

Map  Terrain

Name: Rocky Hill, Connecticut, USA\*  
Latitude: 41.6600\*  
Longitude: -72.6600\*  
Elevation: 188.8 ft\*\*

\* Source: ESRI Maps  
\*\* Source: USGS

move to project area

description of project area

a) Select location  
Move crosshair or double click

b) Click on station icon  
Show stations on map

Scroll down the webpage, making sure CSV format is set to: **Precipitation Frequency Estimates** and click **Submit**.

**POINT PRECIPITATION FREQUENCY (PF) ESTIMATES**

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION  
NOAA Atlas 14, Volume 10, Version 2

YEARS

PF tabular

PF graphical

Supplementary information

Print page

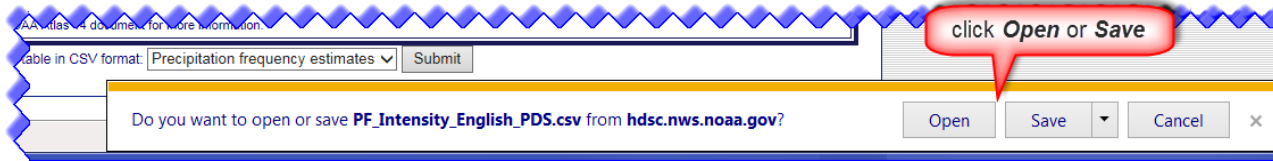
**PDS-based precipitation frequency estimates with 90% confidence intervals (in inches/hour)<sup>1</sup>**

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	3.98 (3.17-4.94)	4.86 (3.86-6.04)	6.29 (4.98-7.85)	7.48 (5.88-9.40)	9.11 (6.91-12.0)	10.4 (7.69-14.0)	11.6 (8.35-16.3)	13.2 (8.94-19.0)	15.3 (9.91-22.8)	16.8 (10.7-25.7)
10-min	2.82 (2.24-3.50)	3.44 (2.73-4.28)	4.45 (3.53-5.56)	5.30 (4.16-6.65)	6.46 (4.90-8.51)	7.35 (5.45-9.91)	8.24 (5.92-11.6)	9.35 (6.33-13.4)	10.8 (7.02-16.2)	11.9 (7.54-18.2)
15-min	2.21 (1.76-2.75)	2.70 (2.14-3.36)	3.49 (2.76-4.36)	4.15 (3.27-5.22)	5.06 (3.84-6.67)	5.76 (4.28-7.77)	6.46 (4.64-9.06)	7.33 (4.97-10.5)	8.48 (5.51-12.7)	9.35 (5.92-14.3)
30-min	1.50 (1.19-1.86)	1.82 (1.45-2.27)	2.36 (1.87-2.95)	2.80 (2.21-3.52)	3.41 (2.59-4.50)	3.89 (2.88-5.24)	4.36 (3.13-6.11)	4.94 (3.35-7.11)	5.72 (3.71-8.54)	6.30 (3.99-9.62)
60-min	0.944 (0.751-1.17)	1.15 (0.913-1.43)	1.49 (1.18-1.86)	1.77 (1.39-2.22)	2.15 (1.63-2.83)	2.44 (1.81-3.30)	2.74 (1.97-3.85)	3.11 (2.11-4.47)	3.60 (2.34-5.37)	3.96 (2.51-6.05)
2-hr	0.621 (0.498-0.766)	0.751 (0.601-0.928)	0.963 (0.768-1.19)	1.14 (0.902-1.42)	1.38 (1.06-1.81)	1.57 (1.17-2.11)	1.76 (1.27-2.46)	2.01 (1.37-2.87)	2.35 (1.53-3.48)	2.60 (1.65-3.95)
3-hr	0.480 (0.386-0.589)	0.579 (0.465-0.712)	0.741 (0.593-0.915)	0.875 (0.697-1.09)	1.06 (0.816-1.39)	1.20 (0.905-1.61)	1.35 (0.983-1.89)	1.55 (1.06-2.21)	1.82 (1.19-2.69)	2.02 (1.29-3.05)
6-hr	0.302 (0.245-0.369)	0.366 (0.296-0.447)	0.469 (0.378-0.575)	0.555 (0.444-0.685)	0.673 (0.521-0.875)	0.764 (0.578-1.02)	0.855 (0.628-1.19)	0.988 (0.676-1.40)	1.16 (0.762-1.71)	1.30 (0.828-1.95)
MIN. - HR. - DAY	0.270	0.270	0.288 (0.234-0.351)	0.343 (0.276-0.420)	0.417 (0.325-0.539)	0.475 (0.362-0.629)	0.532 (0.394-0.738)	0.617 (0.424-0.867)	0.730 (0.479-1.06)	0.815 (0.521-1.21)
24-hr	0.107 (0.088-0.129)	0.133 (0.109-0.160)	0.174 (0.143-0.211)	0.209 (0.170-0.254)	0.256 (0.201-0.329)	0.292 (0.225-0.386)	0.329 (0.246-0.456)	0.386 (0.266-0.539)	0.461 (0.304-0.668)	0.519 (0.333-0.766)
45-day	0.011 (0.008-0.011)	0.011 (0.009-0.013)	0.013 (0.011-0.015)	0.014 (0.012-0.016)	0.016 (0.013-0.020)	0.018 (0.014-0.022)	0.019 (0.014-0.025)	0.021 (0.015-0.028)	0.023 (0.015-0.032)	0.024 (0.016-0.035)
60-day	0.009 (0.007-0.010)	0.009 (0.008-0.011)	0.011 (0.009-0.013)	0.012 (0.010-0.014)	0.014 (0.011-0.016)	0.015 (0.012-0.018)	0.016 (0.012-0.020)	0.017 (0.012-0.023)	0.018 (0.012-0.025)	0.019 (0.013-0.028)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

Estimates from the table in CSV format: **Precipitation frequency estimates** Submit

Either select **Open**, **Save** or **Save As**, (save to Project directory).



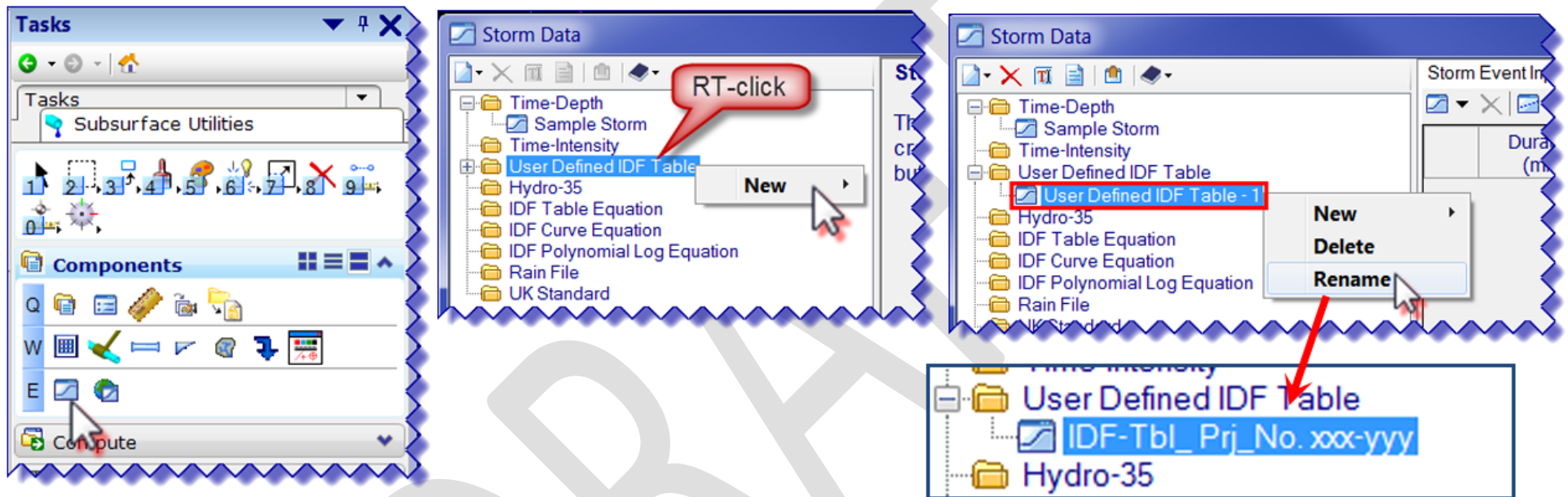
The Excel file will be used to create an IDF-Table for SUDA.

A screenshot of Microsoft Excel showing a CSV file named "PF\_Intensity\_English\_PDS.csv". The spreadsheet contains the following data:

1	Point precipitation frequency estimates (inches/hour)										
2	NOAA Atlas 14 Volume 10 Version 2										
3	Data type: Precipitation intensity										
4	Time series type: Partial duration										
5	Project area: Northeastern States										
6	Location n Connecticut USA										
7	Station Name: -										
8	Latitude: 41.6679°										
9	Longitude: -72.6353°										
10	Elevation (USGS): 119.88 ft										
11											
12											
13	PRECIPITATION FREQUENCY ESTIMATES										
14	by duration:	1	2	5	10	25	50	100	200	500	1000
15	5-min:	3.98	4.86	6.29	7.48	9.11	10.4	11.6	13.2	15.3	16.8
16	10-min:	2.82	3.44	4.45	5.3	6.46	7.35	8.24	9.35	10.8	11.9
17	15-min:	2.21	2.7	3.49	4.15	5.06	5.76	6.46	7.33	8.48	9.35
18	30-min:	1.5	1.82	2.36	2.8	3.41	3.89	4.36	4.94	5.72	6.3
19	60-min:	0.944	1.15	1.49	1.77	2.15	2.45	2.74	3.11	3.6	3.96
20	2-hr:	0.621	0.751	0.963	1.14	1.38	1.57	1.76	2.01	2.35	2.6
21	3-hr:	0.48	0.579	0.741	0.875	1.06	1.2	1.35	1.55	1.82	2.02
22	6-hr:	0.302	0.366	0.469	0.555	0.673	0.764	0.855	0.988	1.16	1.3
23	12-hr:	0.183	0.223	0.288	0.343	0.417	0.475	0.532	0.617	0.73	0.815
24	24-hr:	0.107	0.133	0.174	0.209	0.256	0.292	0.329	0.386	0.461	0.519
25	2-day:	0.061	0.077	0.102	0.123	0.153	0.175	0.198	0.236	0.287	0.326

A "Save As" dialog box is open over the spreadsheet, showing the file name "PF\_Intensity\_English\_PDS-Prj\_No.csv" and the save location "Hallock, Gabriele Desktop". The "Save" button is highlighted with a mouse cursor.

From the Subsurface Utilities Components tasks → click on the **Storm Data** icon. There are several methods for specifying storm data; we will discuss the User Defined IDF Table. In the Storm Data dialog box right-click on **User Defined IDF Table** → click **New**. A *User Defined IDF Table-1* is created, right-click and click **Rename**. Rename the IDF-table to a project specific name; example: IDF-Table\_Prj\_No\_xxx\_yyy.



You have two (2) options for the precipitation frequency estimates to be used or imported in SUDA.

See the following videos from the [4-SUBSURFACE UTILITY DESIGN AND ANALYSIS](#) Recommended Learning Path: **DEFINING RAINFALL RUNOFF WITH IDF.**



Importing an IDF Table from a File



Creating a New IDF Table using the Dialog



## A. Create IDF-Table by importing CSV-file (preferred option)

Open the saved PF\_Intensity\_English\_PDS.csv file with Excel. You need to **edit** the file to only show the *columns for durations* and *the rows for minutes*. It is recommended to edit further by **adding/interpolating** the data for more minutes.

Point precipitation frequency estimates (inches/hour)

	A	B	C	D	E	F	G	H
1	Point precipitation frequency estimates (inches/hour)							
2	NOAA Atlas 14 Volume 10 Version 2							
3	Data type: Precipitation intensity							
4	Time series type: Partial duration							
5	Project area: Northeastern States							
6	Location n Connecticut USA							
7	Station Name: HARTFORD BRAINARD FLD							
8	Latitude: 41.7291°							
9	Longitude: -72.6435°							
10	Elevation (USGS): 20 ft							
11								
12								
13	PRECIPITATION FREQUENCY ESTIMATES							
14	by duration	1	2	5	10	25	50	100
15	5-min:	3.97	4.85	6.26	7.44	9.06	10.3	11.6
16	10-min:	2.81	3.43	4.43	5.27	6.42	7.31	8.19
17	15-min:	2.21	2.69	3.48	4.14	5.04	5.73	6.42
18	30-min:	1.48	1.81	2.34	2.78	3.39	3.86	4.32
19	60-min:	0.93	1.14	1.47	1.75	2.13	2.42	2.72
20	2-hr:	0.608	0.738	0.949	1.12	1.37	1.55	1.74
21	3-hr:	0.468	0.566	0.728	0.862	1.05	1.19	1.33

saved from NOAA Atlas 14


by duration for ARI (years):

	A	B	C	D	E	F	G	H
1	by duration	1	2	5	10	25	50	100
2	5	3.97	4.85	6.26	7.44	9.06	10.3	11.6
3	10	2.81	3.43	4.43	5.27	6.42	7.31	8.19
4	15	2.21	2.69	3.48	4.14	5.04	5.73	6.42
5	30	1.48	1.81	2.34	2.78	3.39	3.86	4.32
6	60	0.93	1.14	1.47	1.75	2.13	2.42	2.72
7	120	0.608	0.738	0.949	1.12	1.37	1.55	1.74
8	180	0.468	0.566	0.728	0.862	1.05	1.19	1.33
9	360	0.293	0.355	0.458	0.543	0.66	0.75	0.84

NOAA Atlas 14 edited & saved

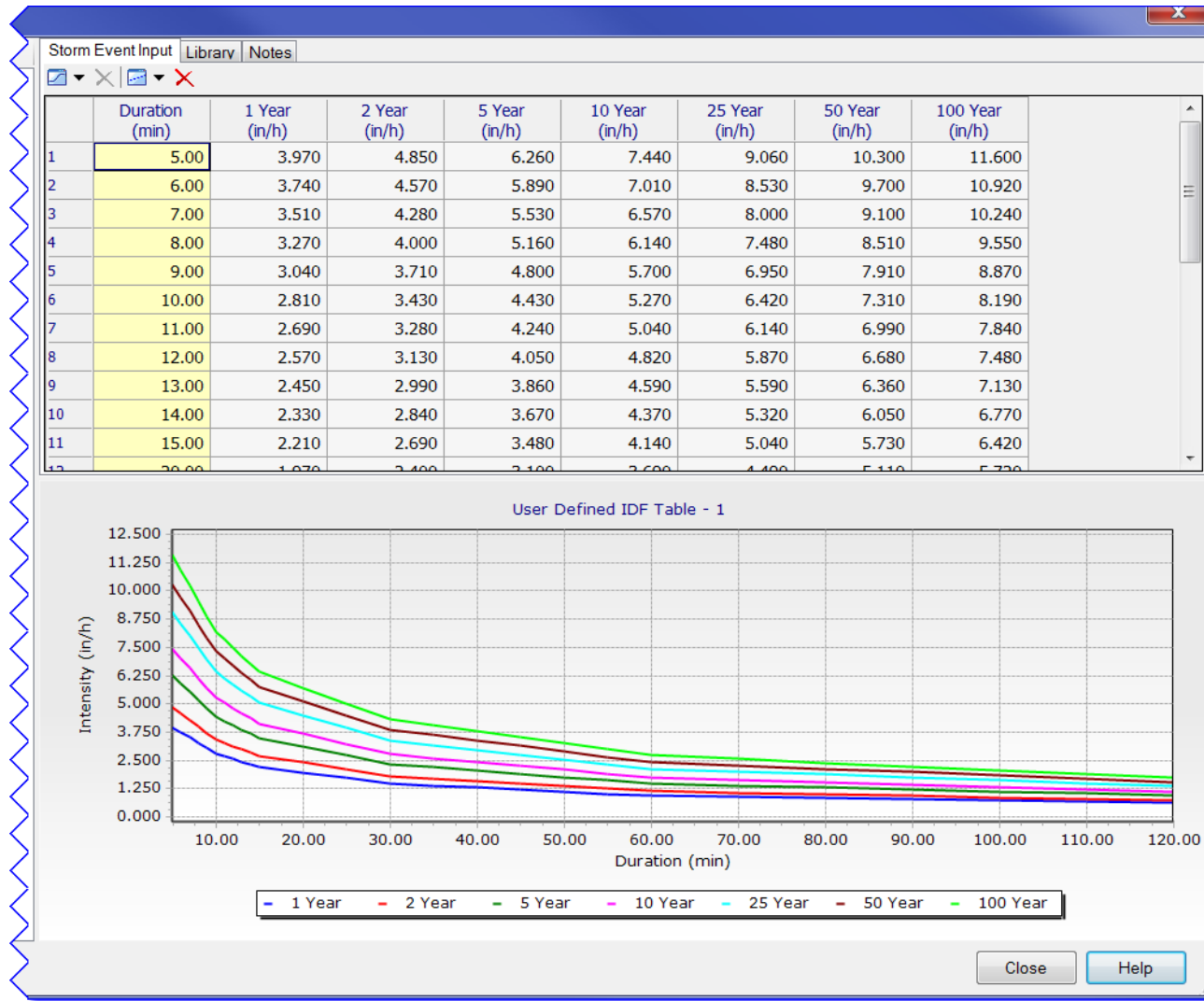
	A	B	C	D	E	F	G	H
1	by duration	1	2	5	10	25	50	100
2	5	3.97	4.85	6.26	7.44	9.06	10.3	11.6
3	6	3.74	4.57	5.89	7.01	8.53	9.7	10.92
4	7	3.51	4.28	5.53	6.57	8	9.1	10.24
5	8	3.27	4	5.16	6.14	7.48	8.51	9.55
6	9	3.04	3.71	4.8	5.7	6.95	7.91	8.87
7	10	2.81	3.43	4.43	5.27	6.42	7.31	8.19
8	11	2.69	3.28	4.24	5.04	6.14	6.99	7.84
9	12	2.57	3.13	4.05	4.82	5.87	6.68	7.48
10	13	2.45	2.99	3.86	4.59	5.55	6.36	7.13
11	14	2.33	2.84	3.67	4.37	5.32	6.05	6.77
12	15	2.21	2.69	3.48	4.14	5.04	5.73	6.42
13	20	1.97	2.4	3.13	3.69	4.49	5.11	5.72
14	25	1.72	2.1	2.72	3.23	3.94	4.48	5.02
15	30	1.48	1.81	2.28	2.78	3.39	3.86	4.32
16	35	1.39	1.7	2.2	2.61	3.18	3.62	4.05
17	40	1.3	1.59	2.05	2.44	2.97	3.38	3.79
18	45	1.21	1.48	1.91	2.27	2.76	3.14	3.52
19	50	1.11	1.36	1.76	2.09	2.55	2.9	3.25
20	55	1.02	1.25	1.62	1.92	2.34	2.66	2.99
21	60	0.93	1.14	1.47	1.75	2.13	2.42	2.72
22	70	0.88	1.07	1.38	1.65	2	2.28	2.56
23	80	0.82	1.01	1.3	1.54	1.88	2.13	2.39
24	90	0.77	0.94	1.21	1.44	1.75	1.99	2.23
25	100	0.72	0.87	1.12	1.33	1.62	1.84	2.07
26	110	0.66	0.81	1.04	1.23	1.5	1.7	1.9
27	120	0.608	0.738	0.949	1.12	1.37	1.55	1.74

NOAA Atlas 14 edit, interpolated & saved

In the Storm Data box select the User Defined IDF Table (IDF Table\_Prj\_No\_xxx\_yyy) created earlier and click on the **Import** icon . A Warning will come up (Import IDF Data?) click **Yes**. In the Explorer **select** the

saved and edited CSV-file, click **Open**. SUDA will populate the rows and columns with the data from the chosen CSV file.

Your finished Storm Data for your project should look similar to this:



To import an IDF table the data has to be in either the CSV-format or in a TXT-format. **Close** the Storm Data box.

Click on **Project Defaults** icon, in the Components box, click on the **Units** tab. Scroll down to **the Rainfall Intensity** and ensure that it matches the units in the IDF file. Click **OK**.

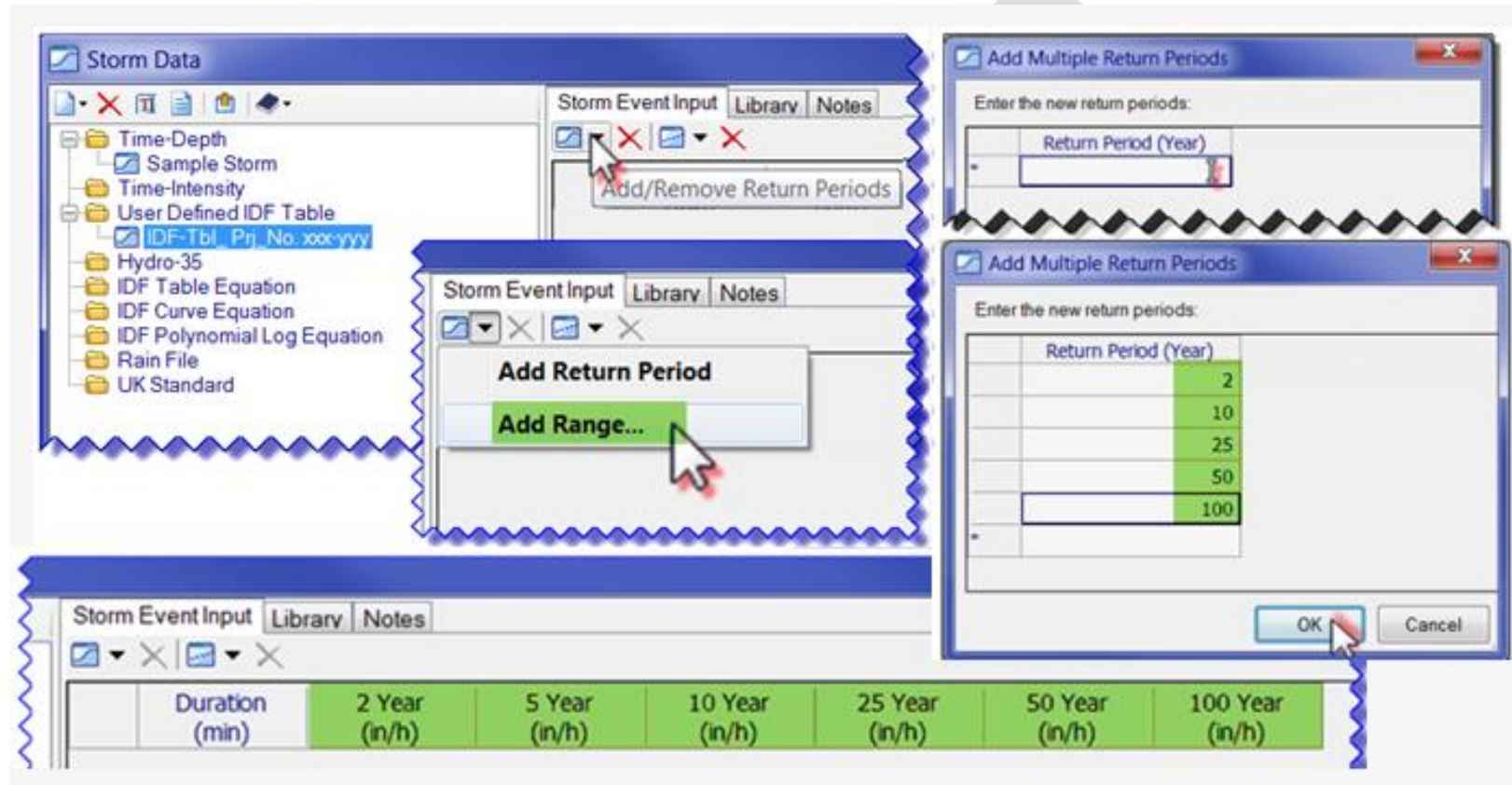
The image shows a software interface with a 'Components' sidebar on the left containing a 'Project Defaults' icon. The main window is the 'Options' dialog box, with the 'Units' tab selected and circled in red. The 'Default Unit System for New Project' is set to 'US Customary'. A table lists various parameters and their units. The 'Rainfall Intensity' row (row 44) is highlighted with a red box, and its unit dropdown menu is open, showing 'in/h' selected. A red callout bubble with the text 'must match' points to the 'in/h' unit. An inset window shows a document snippet titled 'POINT PRECIPITATION FREQUENCY (PF) ESTIMATES' with the text 'precipitation frequency estimates with 90% confidence intervals (in inches/hour)'. The 'Options' dialog box has 'OK', 'Cancel', and 'Help' buttons at the bottom.

	Label	Unit	Display Precision	Format
32	Intensity	in/h	3	Number
33	Large Volume	MG	2	Number
43	Pressure	psi	0	Number
44	Rainfall Intensity	in/h	3	Number
45	Ratio	cm/day cm/h cm/min	3	Number
46	Reaction Rate	in/day in/h	1	Number
47	Relative Flow Change	in/min	7	Number
48	Rotational Frequency	mm/day mm/h mm/min	0	Number
49	Roughness - Darcy Weisbach		4	Number
50	...		1	Number
...	...		3	Number
...	...		3	Number

## B. Create IDF-Table Adding Return Periods and Durations (quick & dirty)

**Note:** Merriam-Webster's Definition of quick and dirty:  
Expedient and effective, but not without flaws or unwanted side effects.

Open the saved *PF\_Intensity\_English\_PDS.csv* file with Excel.



In the Storm Data box under the **Storm Event Input** tab, click on the down arrow for **Add/Remove Return Periods**.

Click on **Add Range ...**, bring your cursor into the box for **Return Period (Year)**, **add the years** needed for your project; example 2, 10, 25, 50, 100 years.

Click **OK**.

The image displays a software interface for configuring storm event input. It includes a 'PRECIPITATION FREQUENCY ESTIMATES' table, an 'Add Multiple Durations' dialog box, and a 'Storm Event Input' data table.

**PRECIPITATION FREQUENCY ESTIMATES**

by duration	1	2	5	10	25	50	100
5-min:	3.97	4.85	6.26	7.44	9.06	10.3	11.6
10-min:	2.81	3.43	4.43	5.27	6.42	7.31	8.19
15-min:	2.21	2.69	3.48	4.14	5.04	5.73	6.42
30-min:	1.48	1.81	2.34	2.78	3.39	3.86	4.32
60-min:	0.93	1.14	1.47	1.75	2.13	2.42	2.72
2-hr:	0.608	0.738	0.949	1.12	1.37	1.55	1.74
5-hr:	0.468	0.566	0.728	0.862	1.05	1.19	1.33

**Add Multiple Durations**

Enter the new durations:

Duration (min)
5.00
10.00
15.00
30.00
60.00
120.00

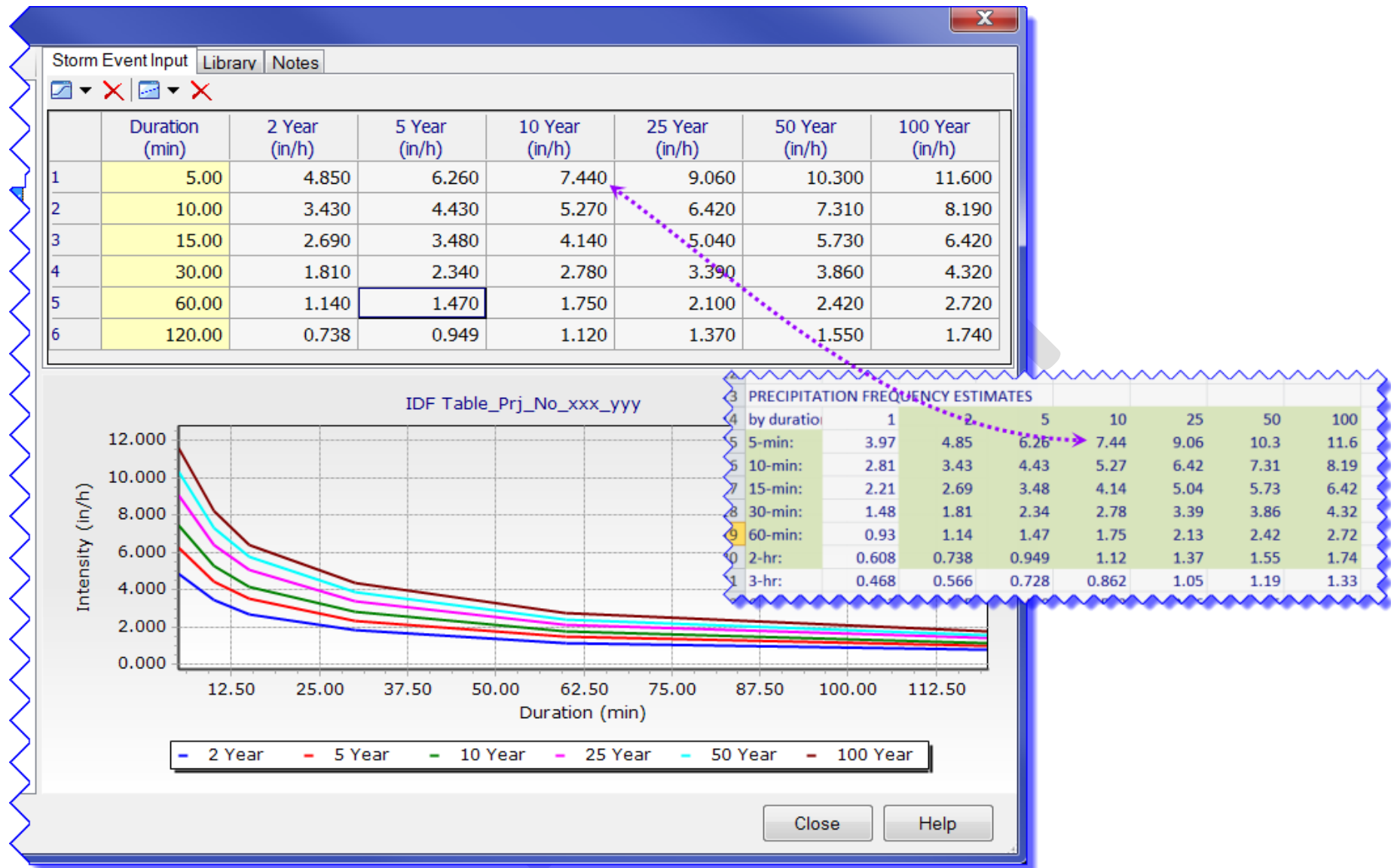
**Storm Event Input**

Duration (min)	2 Year (in/h)	5 Year (in/h)	10 Year (in/h)	25 Year (in/h)	50 Year (in/h)	100 Year (in/h)
5.00	0.000	0.000	0.000	0.000	0.000	0.000
10.00	0.000	0.000	0.000	0.000	0.000	0.000
15.00	0.000	0.000	0.000	0.000	0.000	0.000
30.00	0.000	0.000	0.000	0.000	0.000	0.000
60.00	0.000	0.000	0.000	0.000	0.000	0.000
120.00	0.000	0.000	0.000	0.000	0.000	0.000

Next, in the Storm Data box under the **Storm Event Input** tab, click on the down arrow for **Add/Remove Durations**. Click on **Add Range ...**, bring your cursor into the box for Duration (min), add the minutes needed for your project; example 5, 10, 15, 30, 60, 120 minutes. Click **OK**.

Now you can input the data from the saved PF\_Intensity\_English\_PDS.csv file. Start in the first column, enter the data, tab to the next column, and enter the data and so on.

Your finished Storm Data for your project similar to this:

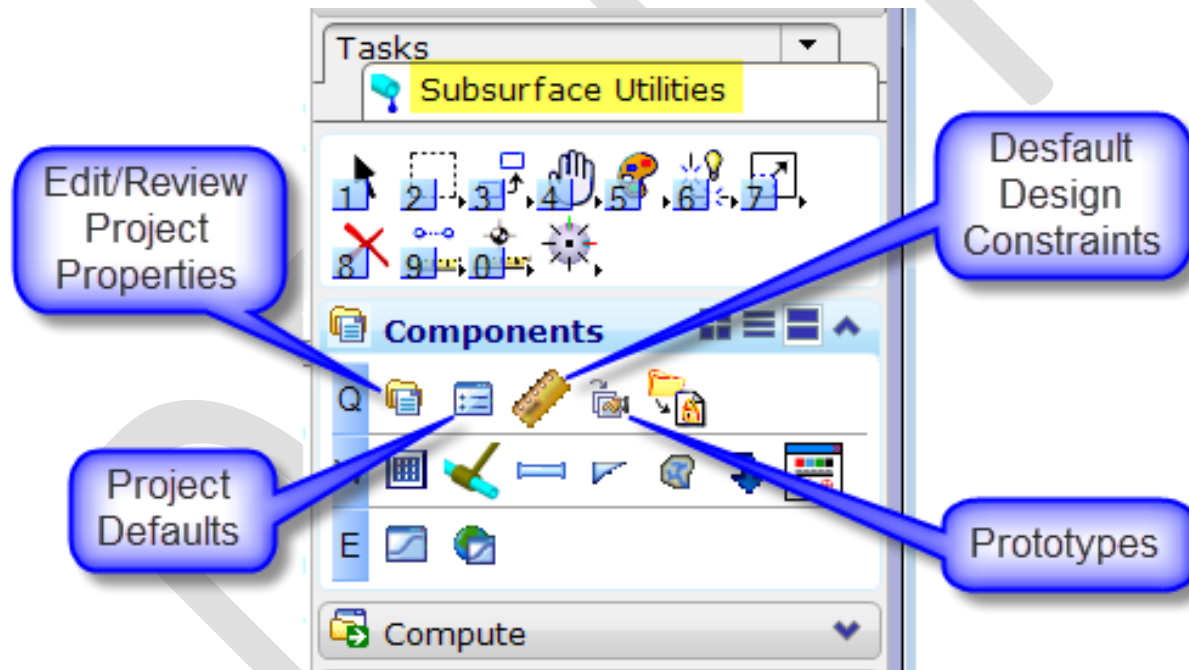


## Section 2.1 Preparation to Compute

Before the drainage system can be analyzed and/or computed some settings need to be added, edited and/or checked.

### 2.1.1. Setting Properties - Defaults - Constraints - Prototypes

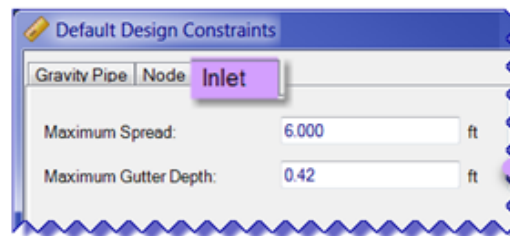
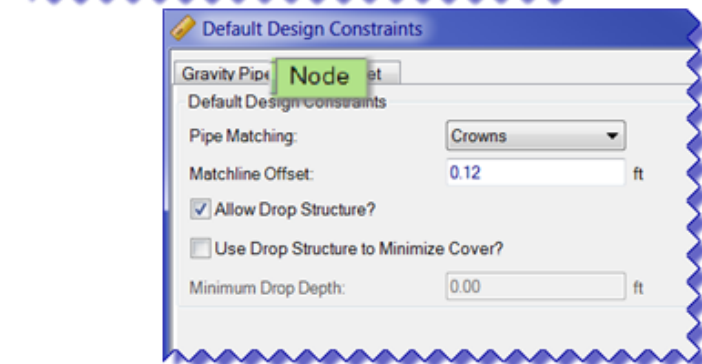
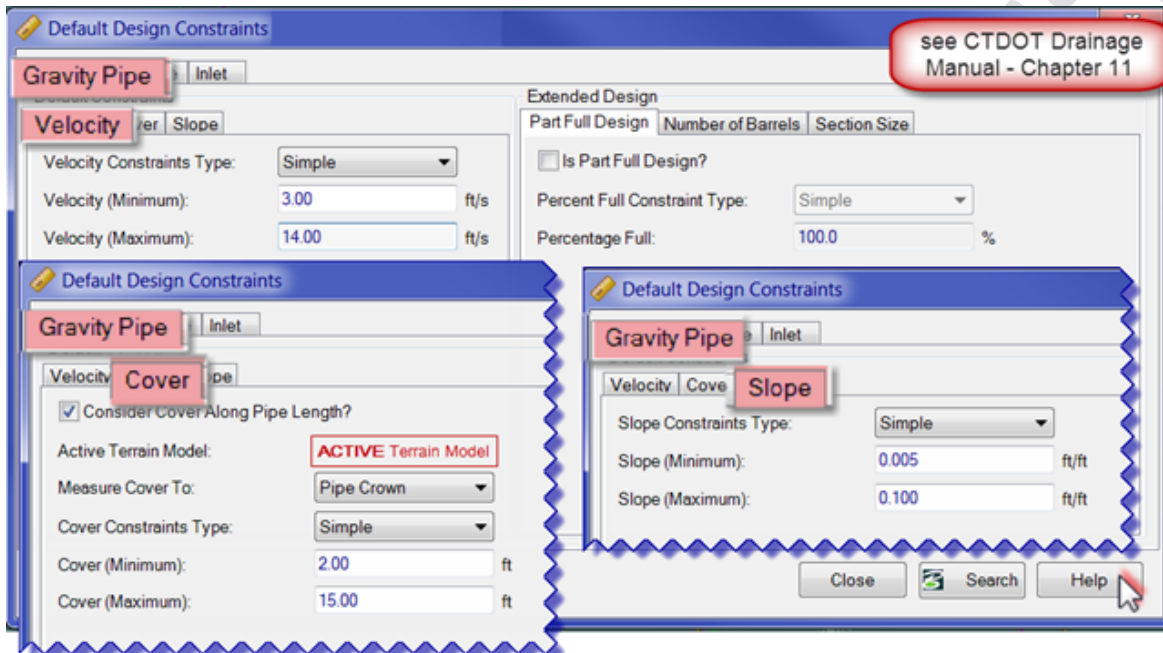
Under Components the engineer will set project properties, defaults, design constraints and prototypes specific to the project. The most common data has been set to follow the *CTDOT Drainage Manual*, but it is important the engineer **reviews** and **edits** these to fit project needs. See the Help menu for further explanation of the settings.



**Edit/Review Project Properties** - enter information for your project and system; such as: project number, project title, project engineer, project designer, location, systems, station to station, year storm(s) used and assumptions made.

**Project Defaults** - the Option box opens. *Project* tab: Pipe Length – Use 3D Length? → is unchecked; *Drawing* tab: make sure *Drawing Mode* is set to **Scaled**, *Plot scale factor* **1in. = 40.000 ft**; *Units* tab: Default Unit System for New Project is set to: **US Customary**, make sure all units are set correctly.

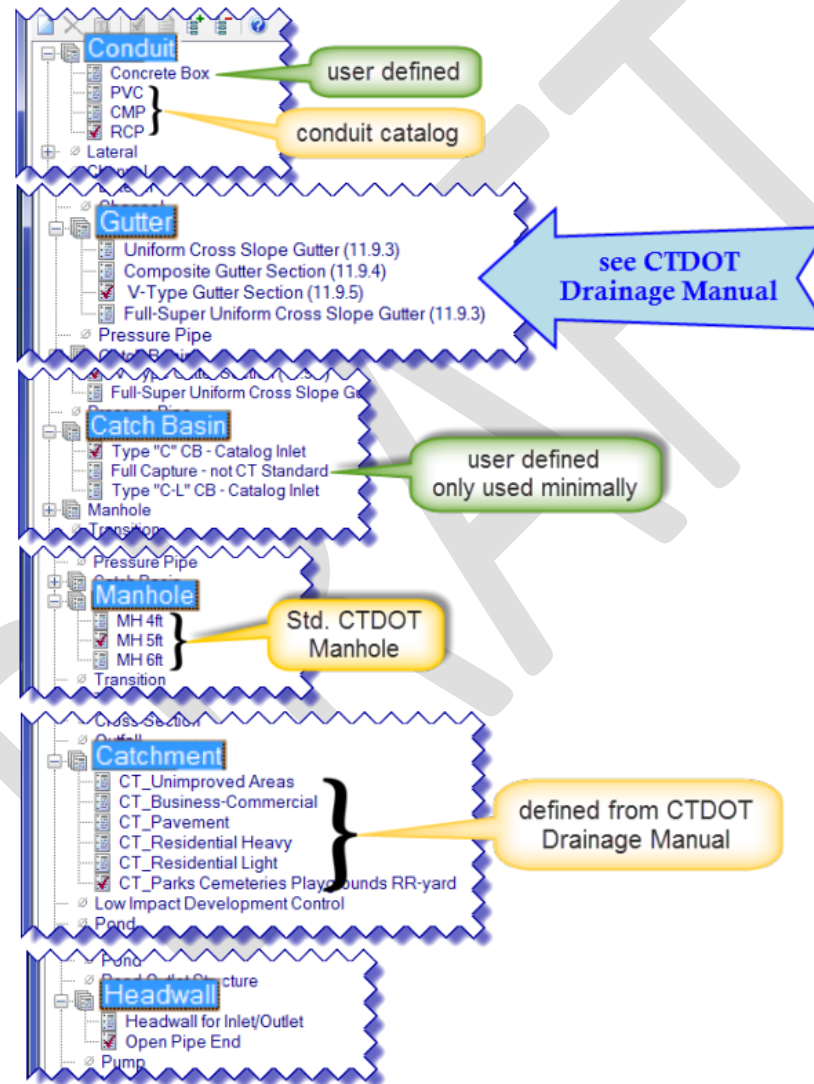
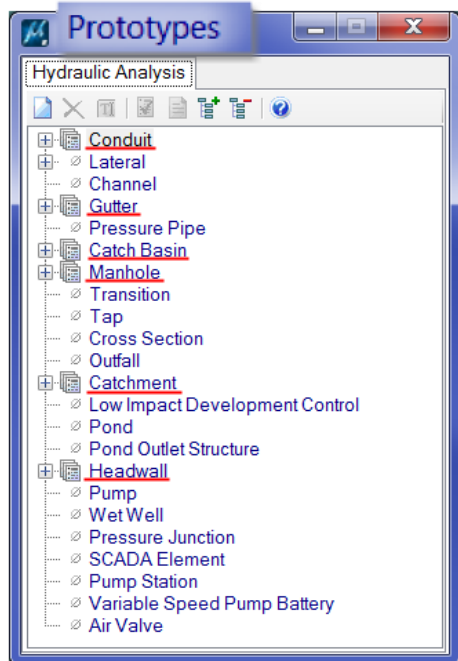
**Default Design Constraints** – have been set to CTDOT Drainage Manual where possible. If you want **SUDA to design** your drainage system, it is especially important to review, edit and make changes to follow design standards for the individual project, such as maximum spread. The SUDA Help menu should be used for each specific explanation of the Default Design Constraints topic.



This is Project specific

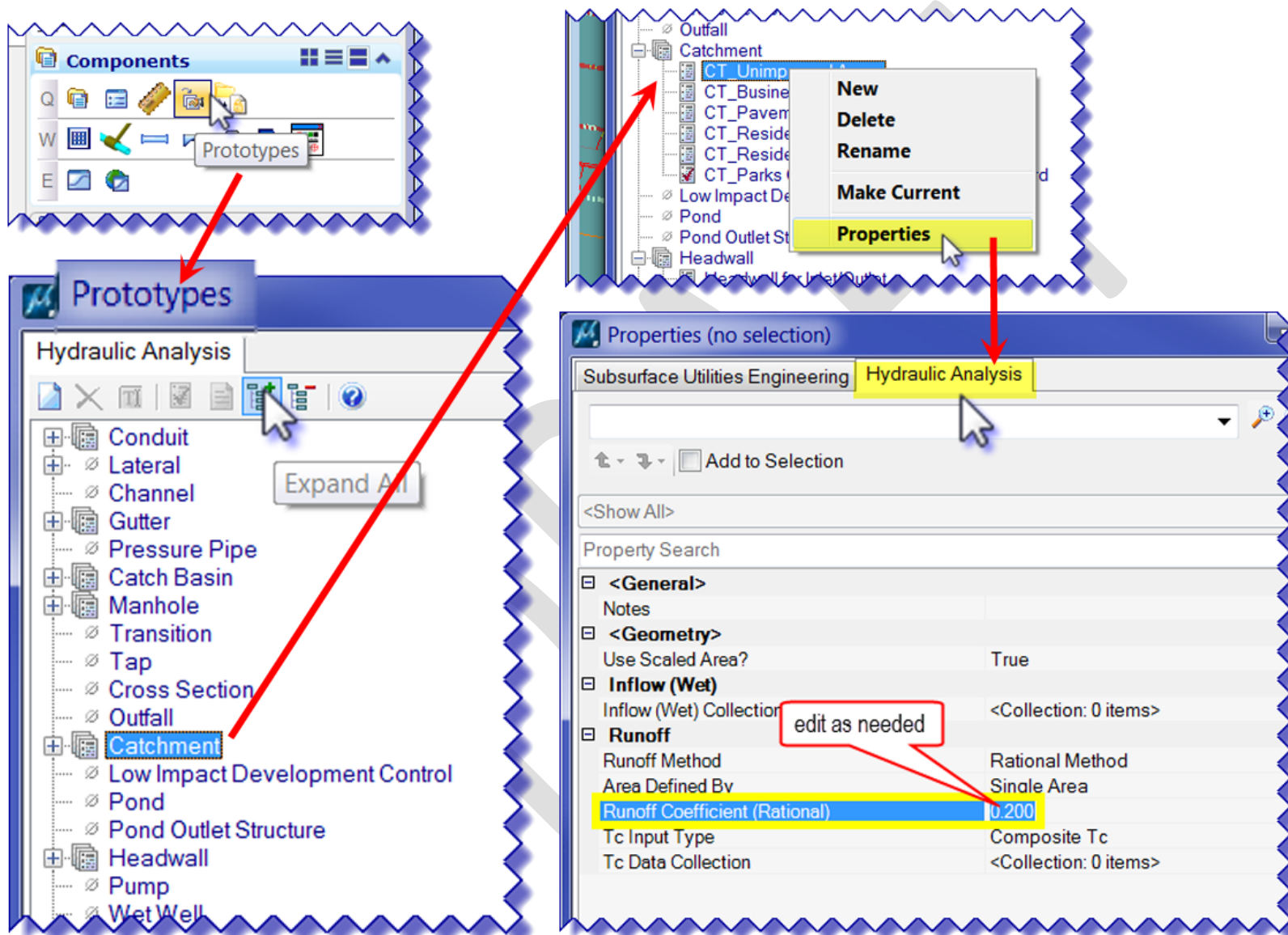


**Prototypes** – are used to *define the hydraulic properties of features*. A prototype works in cooperation with element templates and feature definitions to define the characteristics of a drainage feature. The most widely used conduits, gutters, catch basins, manholes, catchments and headwalls have been set to CTDOT Standards. Some properties are project specific and should be edited as an individual item within the items Hydraulic Analysis.

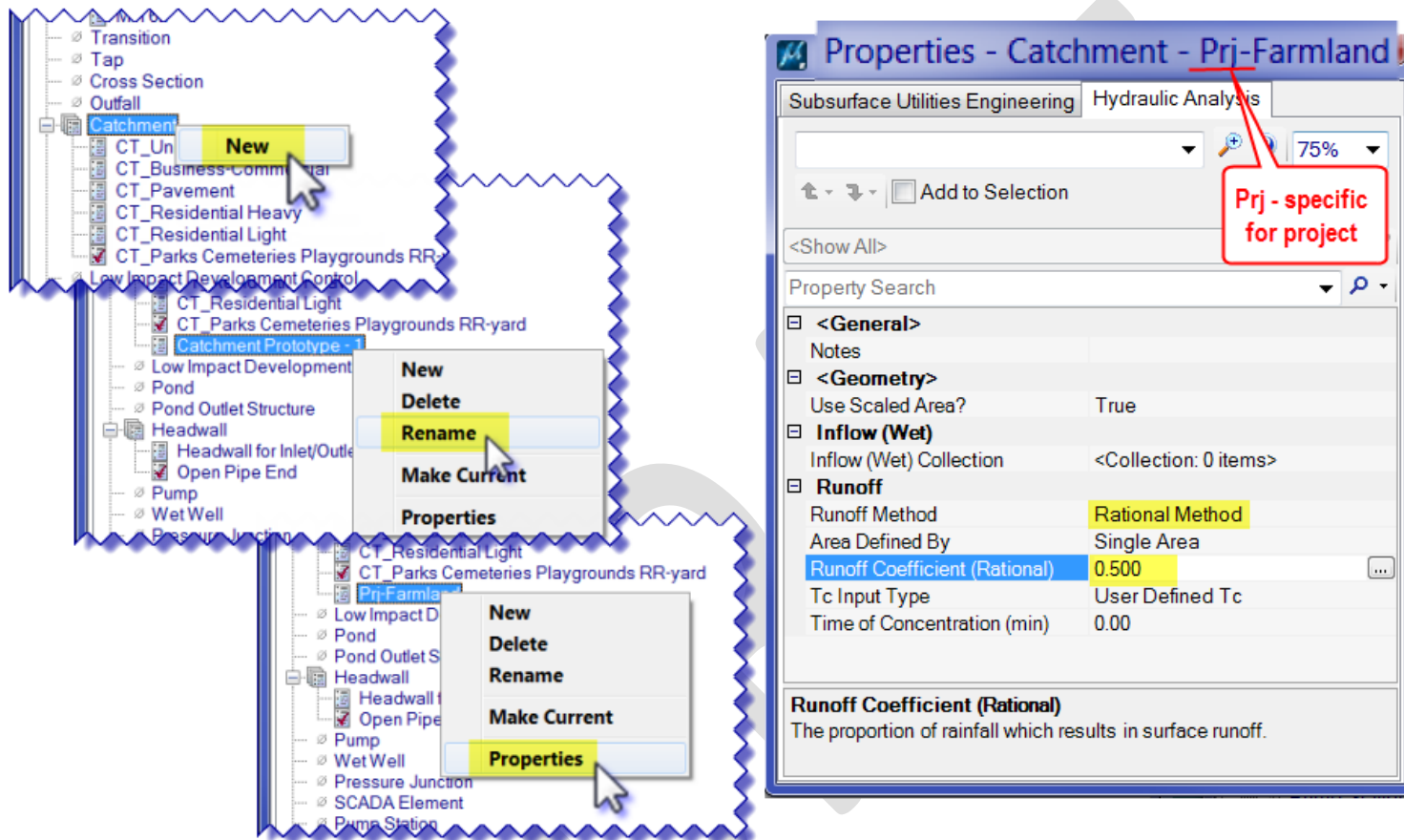


Conduits and Catch Basins have the hydraulic data tabulated in catalogs and are selected as needed within the Hydraulic Analysis window.

The engineer can add or edit a prototype if needed for the project. As example - edit the Runoff Coefficient for a catchment. Click on the **Prototypes icon**, in the Prototypes box, click on **Expand All**, under Catchment right-click on the **item** you want to **edit**, select **Properties**, click on the **Hydraulic Analysis tab**; **edit** the Runoff Coefficient to the value you want.



As example – Add a catchment prototype. Click on the **Prototypes** icon, in the Prototypes box, click on **Expand All**, right-click on **Catchment**, click on **New**, right-click on the **New Catchment Prototype – 1** and select **Rename**; rename to description of catchment (ie. Prj-Farmland); right-click and select **Properties**; click on the **Hydraulic Analysis tab**, input/edit the data as needed.



For further explanations and help see the following videos:



Reviewing a Catchment Feature Definition



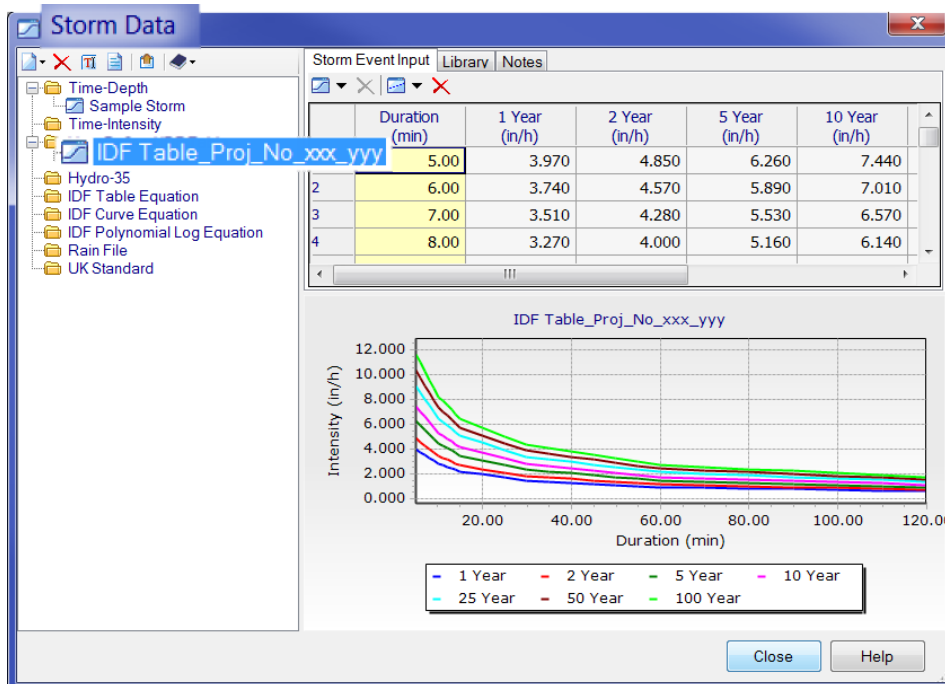
Reviewing a Catchment Hydraulic Prototype



Creating a New Catchment Type

## 2.1.2. Setting Global Storm Events and Alternatives

SUDA's drainage calculations are run on groups of settings called *Scenarios*, which have distinct subgroups of settings focused on aspects of drainage design or analysis. The subgroups are called *Alternatives* and include scopes as Physical Alternative, Design Option Alternatives and *Rainfall Runoff Alternatives* (focus here). Each Rainfall Runoff Alternative points to a *Storm Event* selected from the Storm Data collection (the IDF-Table imported previously).



In this workflow see *Section 1: Laying Out Storm Drainage, Step 8. Defining Storm Events*

To learn more about Scenarios and Alternatives, please watch these videos from the [4-SUBSURFACE UTILITY DESIGN AND ANALYSIS](#) Recommended Learning Path.



Analyze the System  
and Review Hydraulic  
Profiles



Introducing  
Alternatives and  
Scenarios

Scenarios will be discussed in more detail later in this workflow.

**Storm Events** used for analysis/design for storm drainage systems are usually:

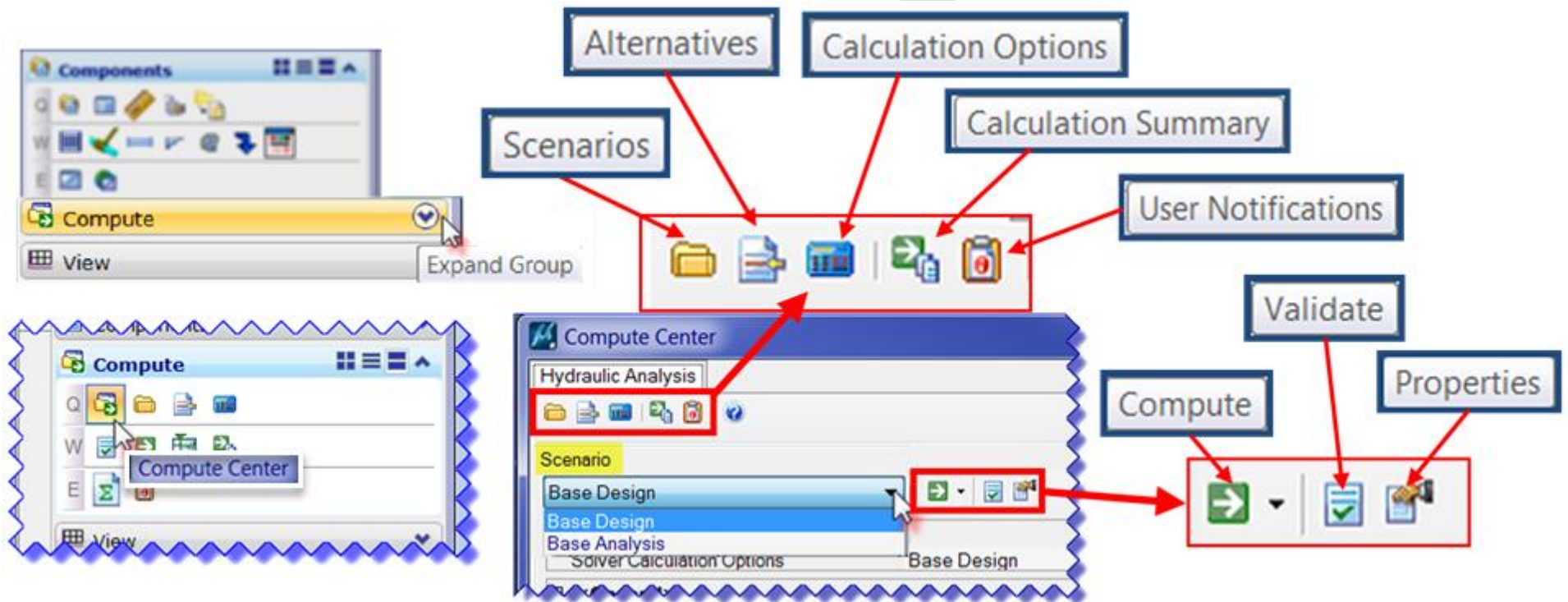
- 2-year for water handling;
- 10-year for the drainage system and
- 25-year for sag condition

(see Table 11-2 Pavement Drainage Design Criteria, Chapter 11 – CTDOT Drainage Manual)

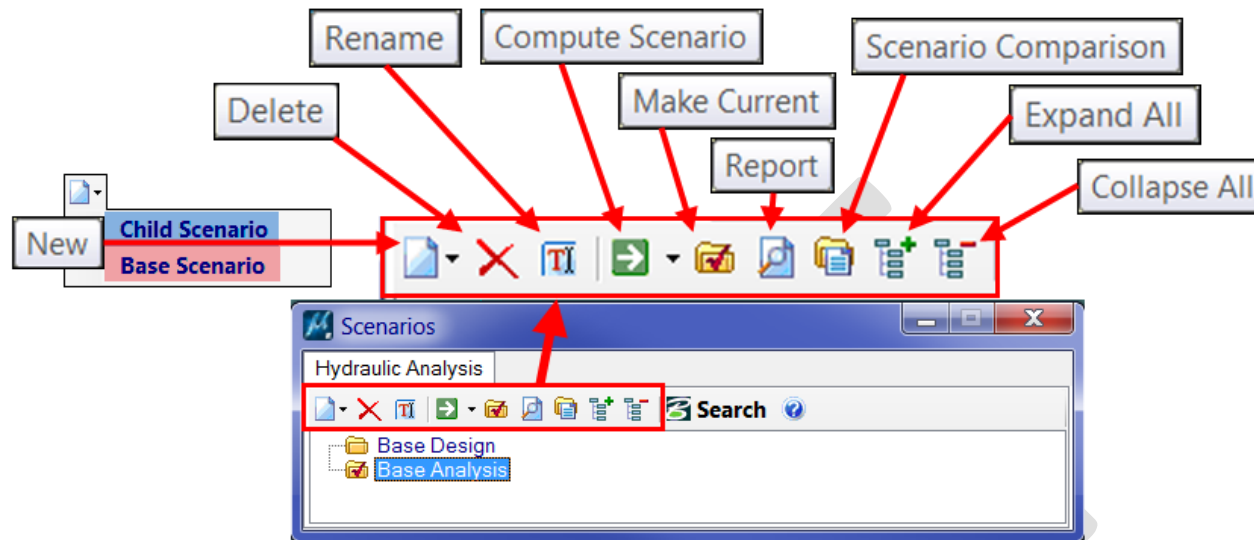
Click on **Global Storm Events** icon, you should see one Alternative, Base Rainfall Runoff for Sample Storm, when you first open the Global Storm Runoff. This will change after project alternatives are set-up. **Close**.

Click on the down arrow in the **Compute** task menu to expand the group.

The first icon is the **Compute Center**; this has most of the tasks within the Compute task menu.



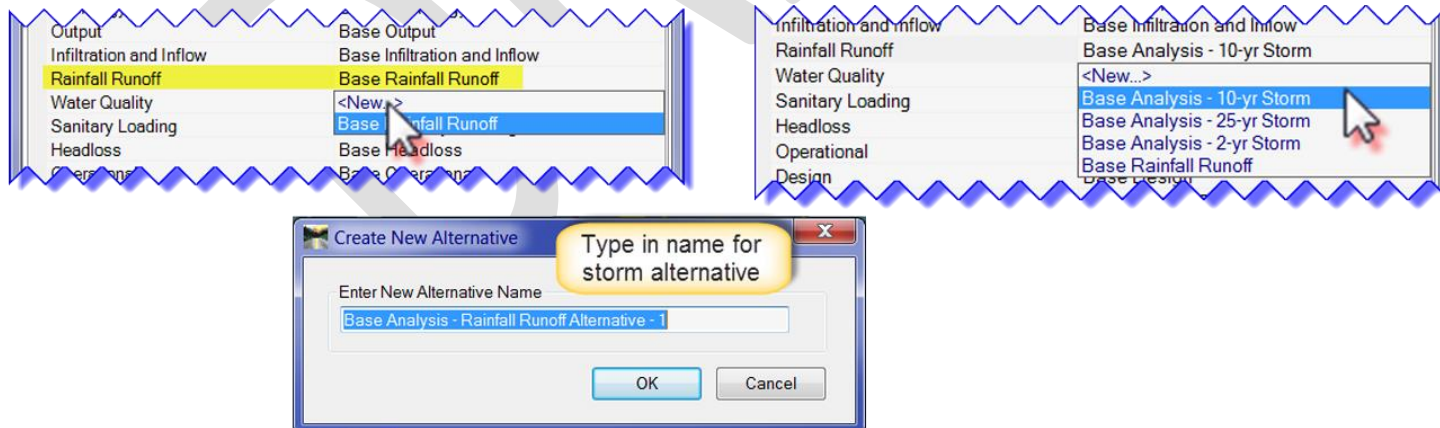
Click on the down arrow for **Scenarios**, there are two Scenarios: **Base Design** and **Base Analysis**. Base Design will resize pipes, change inverts to Default Design Constraints. Base Analysis will not resize pipes or change inverts, but will check if pipes and inverts conform to Default Design Constraints. Any discrepancies will be shown in 'User Notifications' after computed. Click on the Scenarios button and the Scenarios box will open.



Right-click on **Base Analysis** and click on **Properties**, click on the **Hydraulic Analysis tab** in properties. Here all available Alternatives are shown. Click on **Rainfall Runoff**, the default shows **Base Rainfall Runoff** and there is a down arrow, click there and you can select **<New...>**. In the Create New Alternative **enter** a new rainfall alternative for your Project, click **OK**. Select New again for more Rainfall Alternatives.

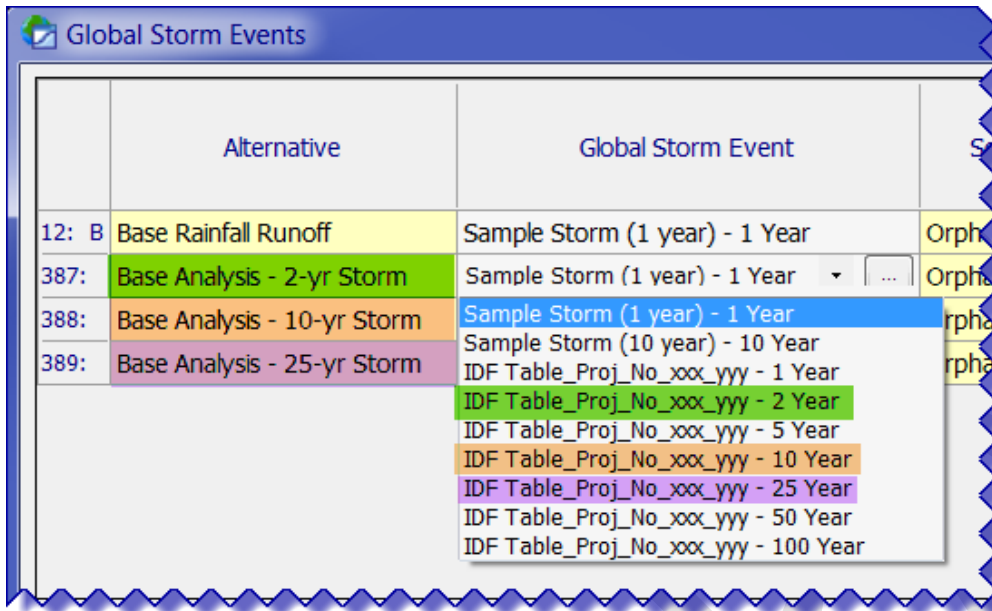
Examples: Base Analysis – 2-yr Storm, or Base Analysis – 10-yr Storm, Base Analysis – 25-yr Storm.

Make any one active by selecting the storm of your choice. **Close** the properties box.



Go back to [Components](#), click on [Global Storm Events](#).

There are now additional alternatives; [select](#) a new alternative and [change](#) the [Global Storm Event](#) to your projects corresponding event storm. Example: Base Analysis – 2-yr Storm [click](#) on down arrow and select IDF Table\_Prj\_No\_xxx\_yyy – 2 Year. Do this for the others also.



In the Scenarios box right-click on Base Design and select Properties. [Click](#) on the Hydraulic Analysis tab, [change](#) the Rainfall Runoff to the Base Analysis as previously for analysis. (Example – 10-yr storm). Close properties box.

This is the minimum preparation needed to **'Compute'** the storm drainage system(s) for a project.

Recommended videos to view:



Managing Scenarios –  
Introduction and Overview



Reviewing Calculation Options  
and Scenario Properties



Creating a New Scenario &  
Alternative 100-yr Storm

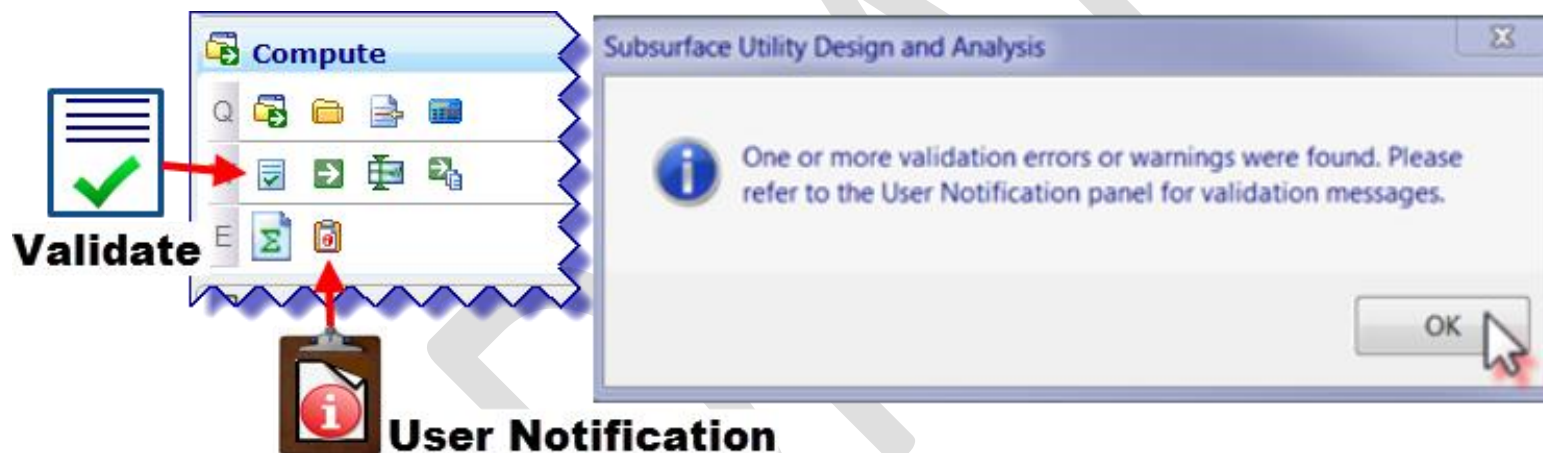
### 2.1.3. Validate

The Validate command is in the Compute task bar and within the Compute Center menu box. The Validate command will run a diagnostic check on the network data (drainage system) and alert you to possible problems that could be encountered during the calculations. It is a good idea to check the drainage system to see if there are any input data errors or missing items/data especially when there is a large system. View the following video:





Validating a Scenario

Click on the **Validate** command, you may get a message for errors or warnings: Click **OK**.



Click on **User Notification** icon: the notifications window will come up displaying a list of warnings generated during the validation process. There are two types:

-  Red → error must be corrected before the model (system) can be computed
-  Yellow → does not prevent successful calculation of the model, but element does not meet certain criteria.



In the User Notification box, you will see Messages with the RED and/or Yellow icon as well as a tool box (see below).

The screenshot shows the 'User Notifications' dialog box for a 'Hydraulic Analysis'. A toolbar at the top contains icons for Save, Report, Copy, Zoom To, and Select In Drawing. Callouts identify these icons: 'Save', 'Report', 'Copy', 'Zoom To', and 'Select In Drawing'. A larger callout box labeled 'Selects All Elements with same Message ID in Drawing' points to the 'Select In Drawing' icon. The main area is a table of messages:

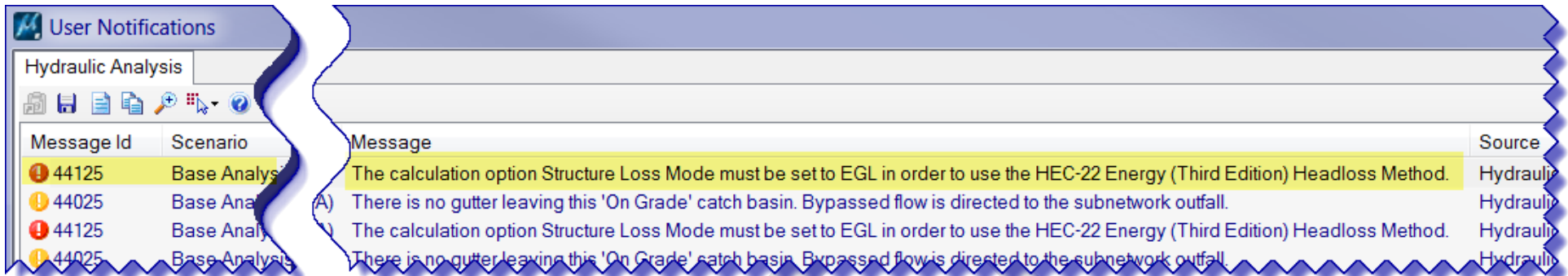
Message Id	Scenario	Element Type	Element Id	Label	Time (min)	Message	Source
44125	Base Analysis	Catch Basin	326	CB	(N/A)	The calculation option Structure Loss Mode must be set to EGL in order to use the HEC-22 Energy (Third Edition) Headloss Method.	Hydraulic Results
44025	Base Analysis	Catch Basin	326	CB	(N/A)	There is no gutter leaving this 'On Grade' catch basin. Bypassed flow is directed to the subnetwork outfall.	Hydraulic Results
44125	Base Analysis	Catch Basin	327	CB1	(N/A)	The calculation option Structure Loss Mode must be set to EGL in order to use the HEC-22 Energy (Third Edition) Headloss Method.	Hydraulic Results
44025	Base Analysis	Catch Basin	327	CB1	(N/A)	There is no gutter leaving this 'On Grade' catch basin. Bypassed flow is directed to the subnetwork outfall.	Hydraulic Results
44125	Base Analysis	Catch Basin	328	CB2	(N/A)	The calculation option Structure Loss Mode must be set to EGL in order to use the HEC-22 Energy (Third Edition) Headloss Method.	Hydraulic Results
44025	Base Analysis	Catch Basin	328	CB2	(N/A)	There is no gutter leaving this 'On Grade' catch basin. Bypassed flow is directed to the subnetwork outfall.	Hydraulic Results
44125	Base Analysis	Catch Basin	329	CB3	(N/A)	The calculation option Structure Loss Mode must be set to EGL in order to use the HEC-22 Energy (Third Edition) Headloss Method.	Hydraulic Results
44025	Base Analysis	Catch Basin	329	CB3	(N/A)	There is no gutter leaving this 'On Grade' catch basin. Bypassed flow is directed to the subnetwork outfall.	Hydraulic Results

Callouts on the table indicate: 'fix before COMPUTE' pointing to red error messages (44125) and 'okay to COMPUTE' pointing to yellow warning messages (44025).

Errors look like this in drawing/screen.

The image shows two side-by-side screenshots of a drawing. The left screenshot shows two catch basins with red 'X' error icons. A callout box labeled 'Fix before COMPUTE' points to these errors. The right screenshot shows the same two catch basins, but now with yellow 'Y' warning icons. A callout box labeled 'OK to COMPUTE' points to these warnings.

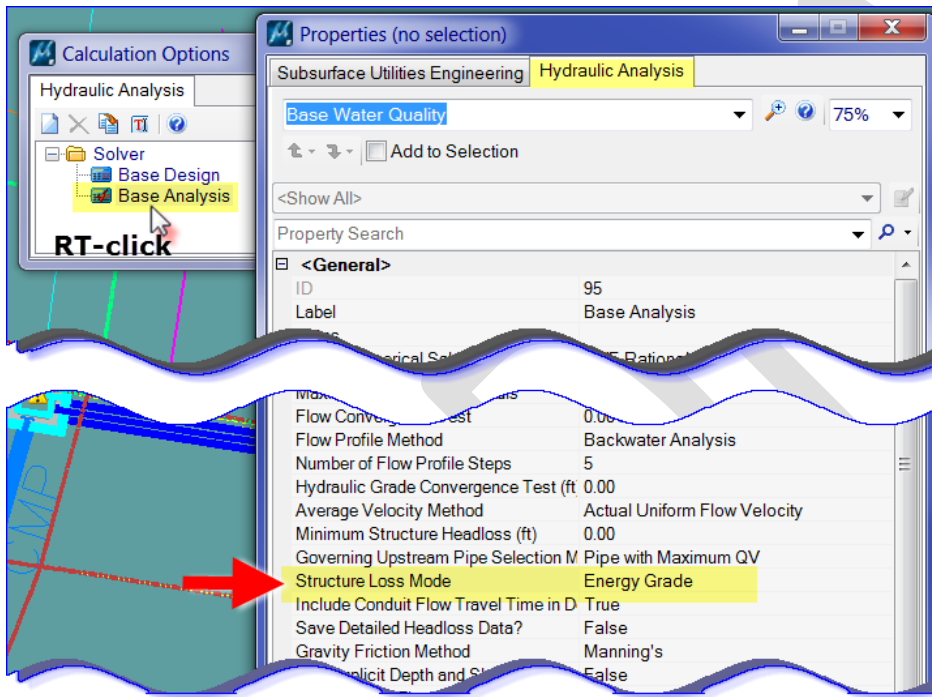
## Examples of User Notifications:



The screenshot shows the 'User Notifications' window. On the left, a table lists messages with their IDs and scenarios. On the right, a detailed view of a message is shown.

Message Id	Scenario	Message	Source
44125	Base Analysis	The calculation option Structure Loss Mode must be set to EGL in order to use the HEC-22 Energy (Third Edition) Headloss Method.	Hydraulic
44025	Base Analysis	A) There is no gutter leaving this 'On Grade' catch basin. Bypassed flow is directed to the subnetwork outfall.	Hydraulic
44125	Base Analysis	A) The calculation option Structure Loss Mode must be set to EGL in order to use the HEC-22 Energy (Third Edition) Headloss Method.	Hydraulic
44025	Base Analysis	There is no gutter leaving this 'On Grade' catch basin. Bypassed flow is directed to the subnetwork outfall.	Hydraulic

**Meaning:** Inlet calculations use the Headloss Method: HEC-22 Energy (3<sup>rd</sup> Edition) to use this, the Structure Loss mode must be set to the Energy Grade Line (EGL) in the Calculation Options.



The screenshot shows two windows from the software. The 'Calculation Options' window on the left has a red arrow pointing to the 'Base Analysis' option with the text 'RT-click'. The 'Properties (no selection)' window on the right shows the 'Structure Loss Mode' property set to 'Energy Grade'.

Property	Value
ID	95
Label	Base Analysis
Structure Loss Mode	Energy Grade
Include Conduit Flow Travel Time in D	True
Save Detailed Headloss Data?	False
Gravity Friction Method	Manning's
Implicit Depth and St	False

User Notifications					
Hydraulic Analysis					
Message Id	Scenario	Id	Label	Message	Source
44025	Base Ana		CB	There is no gutter leaving this 'On Grade' catch basin. Bypassed flow is directed to the subnetwork outfall.	Hydraulic Results
44036	Base		SW	Conduit does not meet minimum cover constraint.	Hydraulics Validation
44049	Base Ana		CB3	Structure and pipe inverts do not agree with selected benching type.	Hydraulic Results


### Meaning:

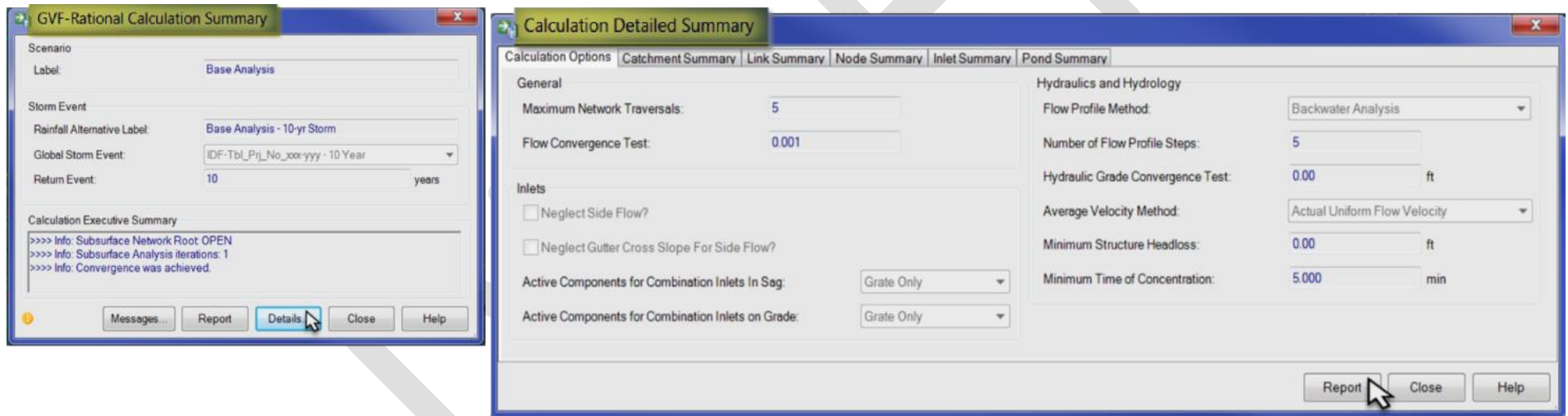
- catch basin doesn't have a gutter attached, open analytical view and place gutter to direct flow to next catch basin or system.
- min. cover set in default design constraints is not met; change pipe class, inverts, or size or add barrel.
- benching method is set to HEC-22 Benching Method = Flat in accordance to the CTDOT Drainage Manual.

## 2.1.4. Compute and Result Formats

### A. Compute

You are ready to compute after all **RED** issues are resolved and all **YELLOW** issues are modified or considered.

Click the **Compute** icon . A GVF-Rational Calculation Summary box will open. Click on **Messages...** to see the newest User Notifications; click on **Report** and get Scenario Summary preview, this can be printed; click **Details...** the Calculation Detailed Summary box will open showing Calculation Options and Summaries for Catchment, Link, Node, Inlet and Pond. Click the **Report** to get one combined report to review/print/save. For individual and more complex reports use FlexTables.



View the following video:



Computing the Scenario and  
Reviewing the Results

Label	Area (User Defined) (acres)	Time of Concentration	Runoff Coefficient (Rational)	Catchment CA (acres)	Catchment Intensity (in/h)	Catchment Rational Flow (cfs)
CM	0.100	5.000	0.900	0.090	9.554	0.87

Label	Section Type	Branch ID	Subnetwork Outfall	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Depth (In) (ft)	Depth (Out) (ft)
SW	Circle	2	OPEN	0.86	2.45	323.12	322.81	0.46	0.46

Label	Element Type	Subnetwork Outfall	Flow (Total In) (cfs)	Flow (Total Out) (cfs)	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)
CB	Catch Basin	OPEN	0.86	0.86	325.56	320.46	323.23	323.23

Label	Inlet Type	Catalog Inlet Type	Catalog Inlet	Flow (Captured) (cfs)	Flow (Total Bypassed) (cfs)	Bypass Target	Capture Efficiency (Calculated) (%)	Depth (Gutter) (ft)	Spread / Top Width (ft)
CB	Catalog Inlet	Combination	Type C Sgl Grate - 6in Curb	0.86	0.58	(N/A)	59.8	0.15	7.655

Label	Element Type	Subnetwork Outfall	Flow (Total In) (cfs)	Flow (Total Out) (cfs)	Hydraulic Grade (ft)	Volume (gal)
-------	--------------	--------------------	-----------------------	------------------------	----------------------	--------------

### Calculation Detailed Summary Tabs:

- Catchment Summary
- Link Summary
- Node Summary
- Inlet Summary
- Pond Summary

Element Details		ID		Notes	
Label	95	Base Analysis			

Hydraulic Summary	
Flow Profile Method	Backwater Analysis
Number of Flow Profile Steps	5
Hydraulic grade convergence	0.00 ft

Inlets	
Neglect Side Flow?	True
Neglect Gutter Cross Slope For Side Flow?	True

HEC-22 Energy Losses	
Elevations Considered Equal Within	0.50 ft
Consider Non-Piped Plunging Flow?	False
Flat Submerged Factor	1.000
Flat Unsubmerged Factor	1.000
Depressed Submerged Factor	1.000

Headloss (AASHTO)	
Expansion, Kc	0.250
Contraction, Kc	0.250

Bend Angle vs. Bend Loss Curve	
Bend Angle (degrees)	Bend Loss Coefficient
0.00	
15.00	
30.00	
45.00	
60.00	
75.00	
90.00	

Gravty Hydraulics	
Governing Upstream Pipe Selection Method	Pipe with Maximum QV

Catchment Summary						
Label	Area (User Defined) (acres)	Time of Concentration (min)	Runoff Coefficient (Rational)	Catchment CA (acres)	Catchment Intensity (in/h)	Catchment Rational Flow (cfs)
CM	0.090	5.000	0.600	0.023	7.440	0.173

Inlet Summary								
Label	Inlet Type	Catalog Inlet Type	Catalog Inlet	Flow (Captured) (cfs)	Flow (Total Bypassed) (cfs)	Bypass Target	Capture Efficiency (Calculated) (%)	
CB-RT	Combination	Combination	Type C Sgl Grate - 6in Curb	0.737	0.386	CB2-RT	65.5	
CB1-LT	Combination	Combination	Type C Sgl Grate - 6in Curb	0.579	0.269	CB3-LT	68.3	
CB2-RT	Combination	Combination	Type C Sgl Grate - 6in Curb	1.092	2.625	(N/A)	29.4	
CB3-LT	Combination	Combination	Type C.L Sgl Grate	0.700	0.531	(N/A)	56.9	

Depth (Gutter) (ft)		Spread / Top Width (%)	
0.10	4.86		
0.09	4.57		
0.26	13.08		
0.12	5.96		

Pond Summary					
Label	Element Type	Subnetwork Outfall	Flow (Total In) (cfs)	Flow (Total Out) (cfs)	Volume (gal)

Label	Element Type	Energy Grade Line (Out) (ft)
CB-RT	Catch Basin	323.18
CB1-LT	Catch Basin	321.65
CB2-RT	Catch Basin	319.01
CB3-LT	Catch Basin	318.65
OPEN	Headwall	313.81

Calculation Detailed Summary Report

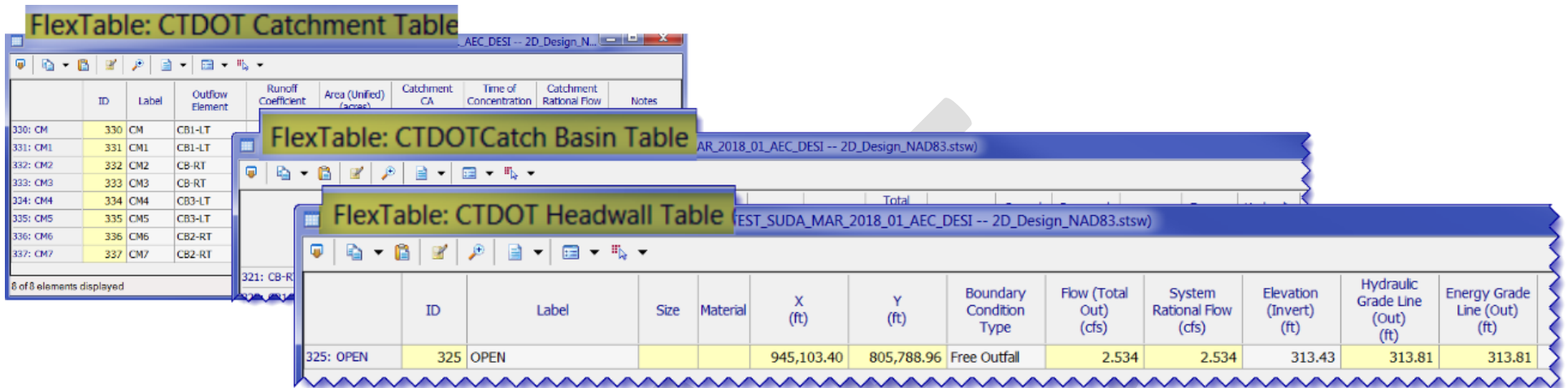
## B. Flextables

With FlexTables SUDA shows the engineering data in tabular format. Any FlexTable can be edited to best fit the project. The designer should use the drainage manual as a guide to determine the information needed to represent the drainage system.

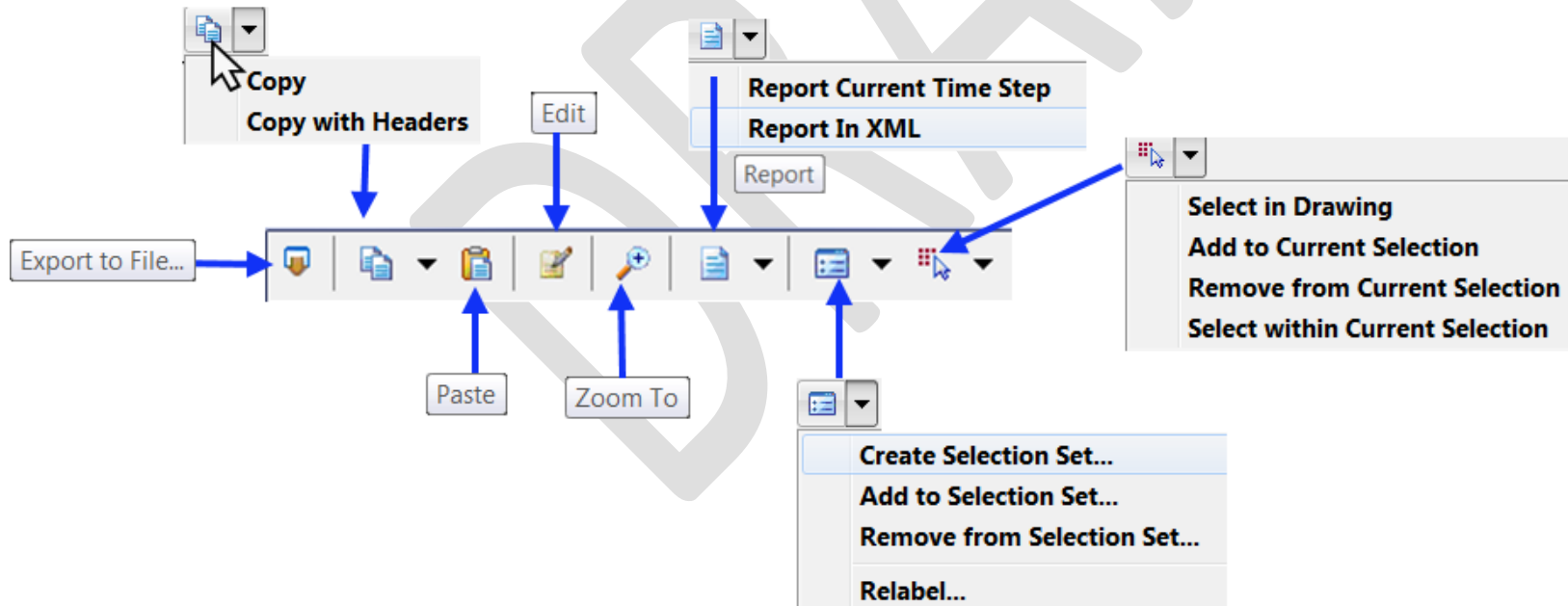
**Expand** the View taskbar, click on the **FlexTables** icon, in the FlexTables box click on the **Hydraulic Analysis** tab. Tables are characterized into **Project - Shared - Predefined**. SUDA has predefined tables' set-up that can be edited as needed. Expand the **Tables - Project** folder and **CTDOT FlexTables** are available for use and are edited to reflect information/data needed for the drainage computations, they still can be edited as needed specific to the project. (Copy and rename project specific)

The image shows a screenshot of the Bentley SUDA software interface. On the left, the 'Tasks' pane is visible with the 'View' taskbar selected and circled in red. A red arrow points from the 'View' taskbar to the 'FlexTables' icon in the 'View' taskbar. Another red arrow points from the 'FlexTables' icon to the 'FlexTables' window. The 'FlexTables' window is open to the 'Hydraulic Analysis' tab, showing a tree view of tables. The 'Tables - Project' folder is expanded, showing a list of tables: CTDOT Gutter Flow Analysis, CTDOT Catchment Table, CTDOT Catch Basin Table, CTDOT Conduit Table, CTDOT Manhole Table, CTDOT Gutter Table, CTDOT Outfall Table, CTDOT Storm Drain Computation Sheet, and CTDOT Headwall Table. A red bracket on the right side of this list is labeled 'CTDOT'. Below this, the 'Tables - Shared' and 'Tables - Predefined' folders are expanded, showing a list of tables: Network Elements Table, Conduit Table, HEC-22 Table A, DOT Report, Combined Pipe/Node Report, Lateral Table, Channel Table, Gutter Table, Catch Basin Table, Manhole Table, Tap Table, Transition Table, Cross Section Table, Outfall Table, Catchment Table, and Headwall Table. A black bracket on the right side of this list is labeled 'SUDA'. A red callout box with the text 'USE DIRECTLY' points to the 'Tables - Project' folder. A black callout box with the text 'RIGHT-CLICK > DUPLICATE > AS PROJECT FLEXTABLE' points to the 'Tables - Predefined' folder.

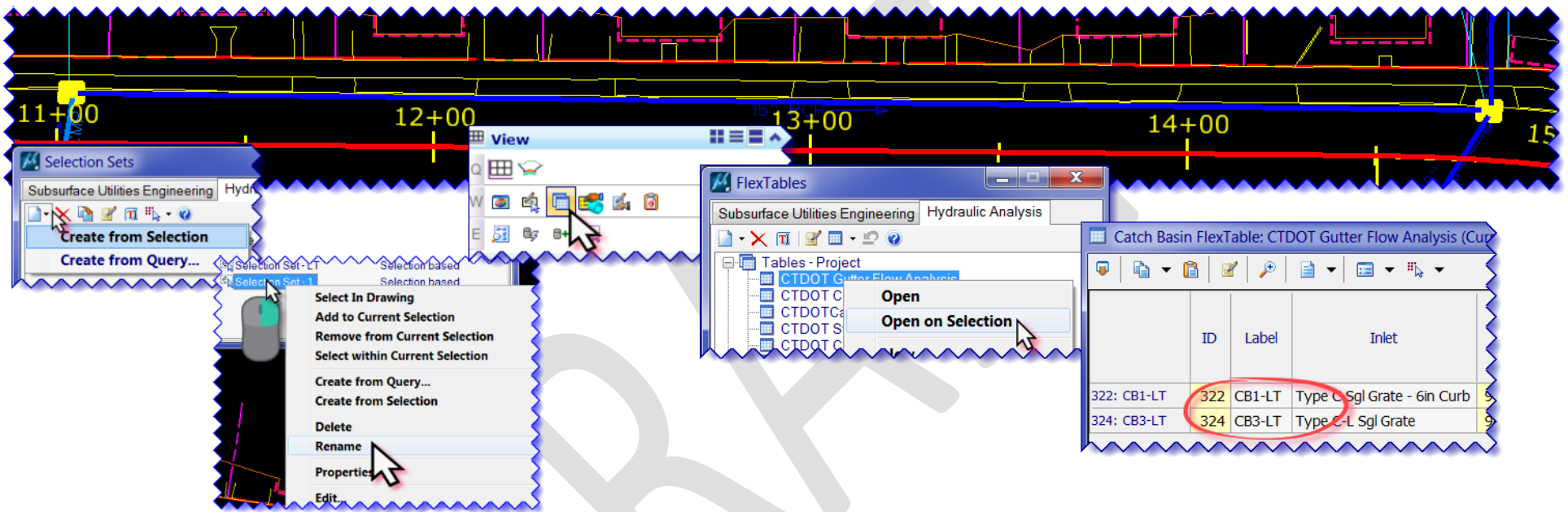




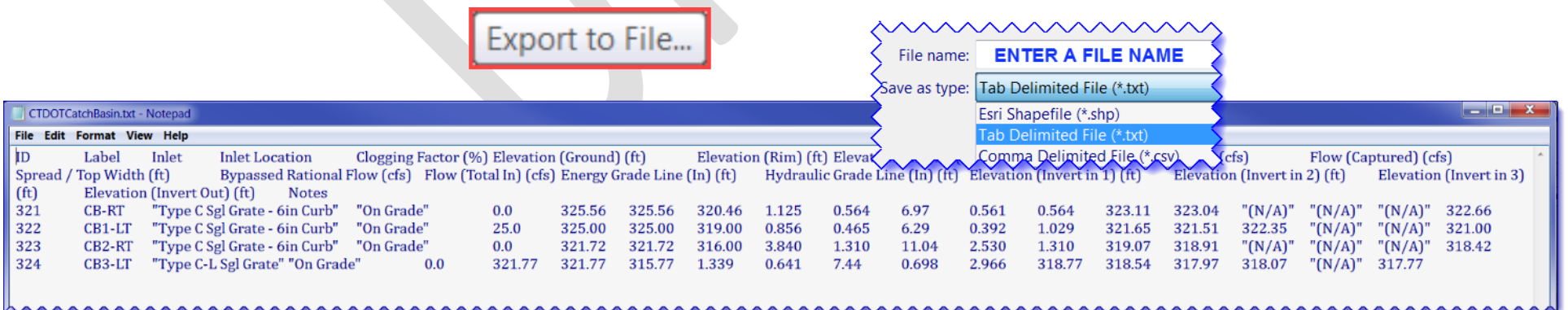
Double-click on any of the flextables to open it. Each table has various tools such as: export, copy, paste, edit, zoom to, report, options and select in drawing.



**Create Selection Set ...** to split up the drainage data into left and right side of the roadway. First select all the nodes (catch basins, manholes etc.) on one side using the **Element Selection tool**, next click on 'Selection Sets' icon in the View Task menu. In the Selection Sets menu click the down arrow to select **Create from Selection**, Right-click on **Rename**. Type in a name "Route 1 - LT" or similar. Click on the "Select in Drawing" icon to select the set to display in the FlexTables. Within the FlexTables menu right-click on your choice and click on 'Open on Selection'; only the selected item will be shown in the FlexTables.



**Export to File...** → lets you create a text file which can be imported to Excel with some editing.





The **Report Current Time Step** shows the data in a landscape letter format that can be saved in pdf-format.

The screenshot displays a software interface with a report preview window and two configuration windows. The report preview window shows a table titled "FlexTable: CTDOTcatch Basin Table" with columns for ID, Label, Inlet, Inlet Location, Clogging Factor, Elevation (Ground), Elevation (Rim), and Elevation (Invert). The table contains data for four inlets (CB-RT, CB1-LT, CB2-RT, CB3-LT) and their respective flow and elevation values. The report options window shows a table for header and footer content, with columns for Align Left, Align Center, and Align Right. The report options window also has tabs for Header, Footer, and Default Margins, and buttons for Font, OK, Cancel, and Help.

**Report Current Time Step**  
Report In XML

Page Setup

**FlexTable: CTDOTcatch Basin Table**

ID	Label	Inlet	Inlet Location	Clogging Factor (%)	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert) (ft)
321	CB-RT	Type C Sgl Grate - 6in Curb	On Grade	0.0	325.56	325.56	320.46
322	CB1-LT	Type C Sgl Grate - 6in Curb	On Grade	25.0	325.00	325.00	319.00
323	CB2-RT	Type C Sgl Grate - 6in Curb	On Grade	0.0	321.72	321.72	316.00
324	CB3-LT	Type C-L Sgl Grate	On Grade	0.0	321.77	321.77	315.77

Total Rational Flow to Inlet (cfs)	Flow (Captured) (cfs)	Spread / Top Width (ft)	Bypassed Rational Flow (cfs)	Flow (Total In) (cfs)	Energy Grade Line (In) (ft)	Hydraulic Grade Line (In) (ft)	Elevation (Invert in 1) (ft)
1.125	0.564	6.97	0.561	0.564	323.11	323.04	(N/A)
0.856	0.465	6.29	0.392	1.029	321.65	321.51	322.35
3.840	1.310	11.04	2.530	1.310	319.07	318.91	(N/A)
1.339	0.641	7.44	0.698	2.966	318.77	318.54	317.97

Elevation (Invert in 2) (ft)	Elevation (Invert in 3) (ft)	Elevation (Invert Out) (ft)	Notes
(N/A)	(N/A)	322.66	
(N/A)	(N/A)	321.00	
(N/A)	(N/A)	318.42	
318.07	(N/A)	317.77	

click on Report Options to change Header & Footer

TEST\_SUDA\_MAR\_2018\_01\_AEC\_DESI-2D\_Design\_NAD03.stw 4/2/2018  
TEST\_SUDA\_MAR\_2018\_01\_AEC\_DESI-2D\_Design\_NAD03.stw Gabriele Hallock  
D:\Users\Hallowqa\AppData\Local\Temp\Bentley\SUDA Page 1 of 1

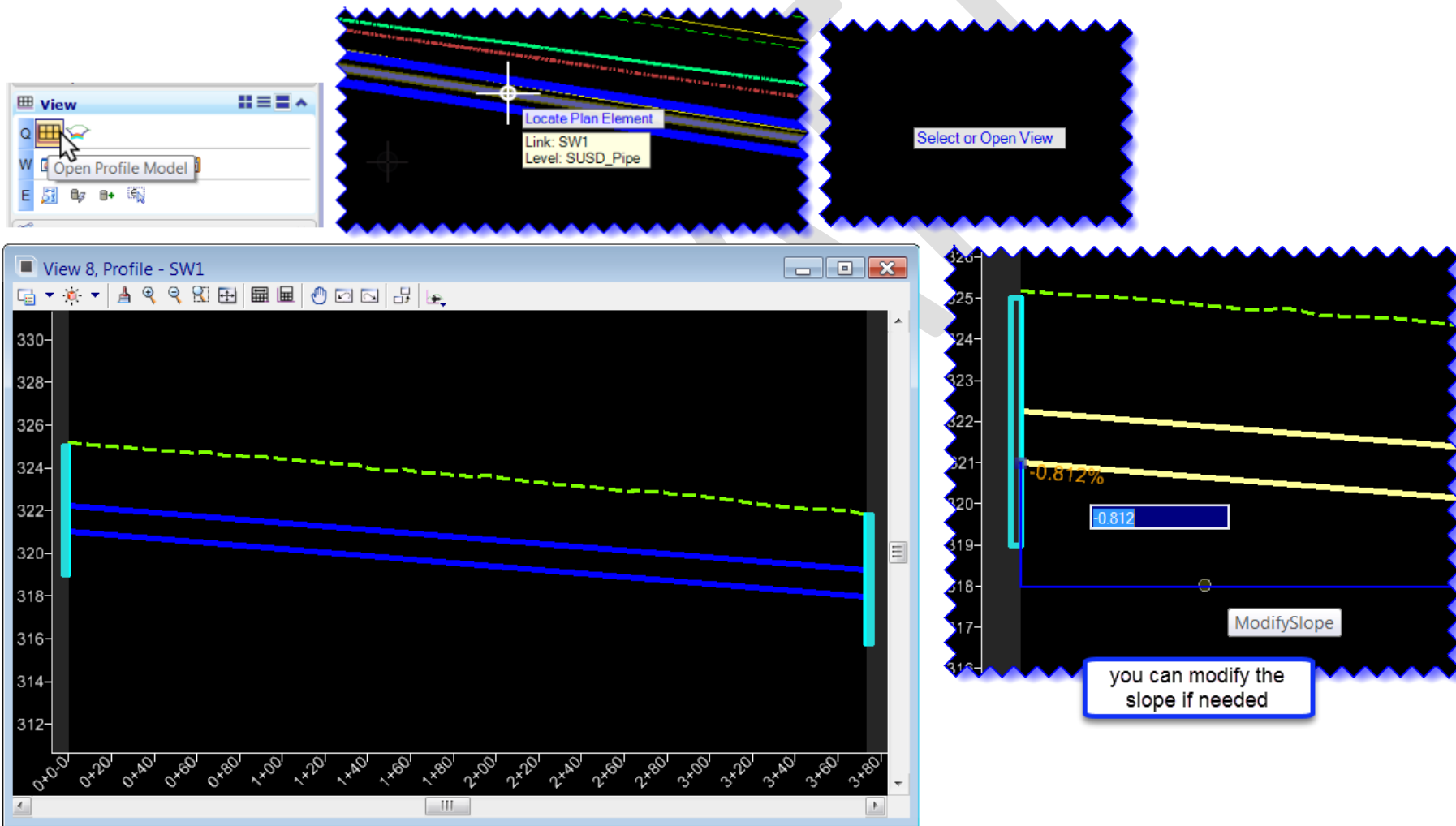
Using Page Setup you can change the paper size, margins layout to what best fits for your project.

## C. Profiles

There are various profiles available that show the drainage data in different concepts and views.

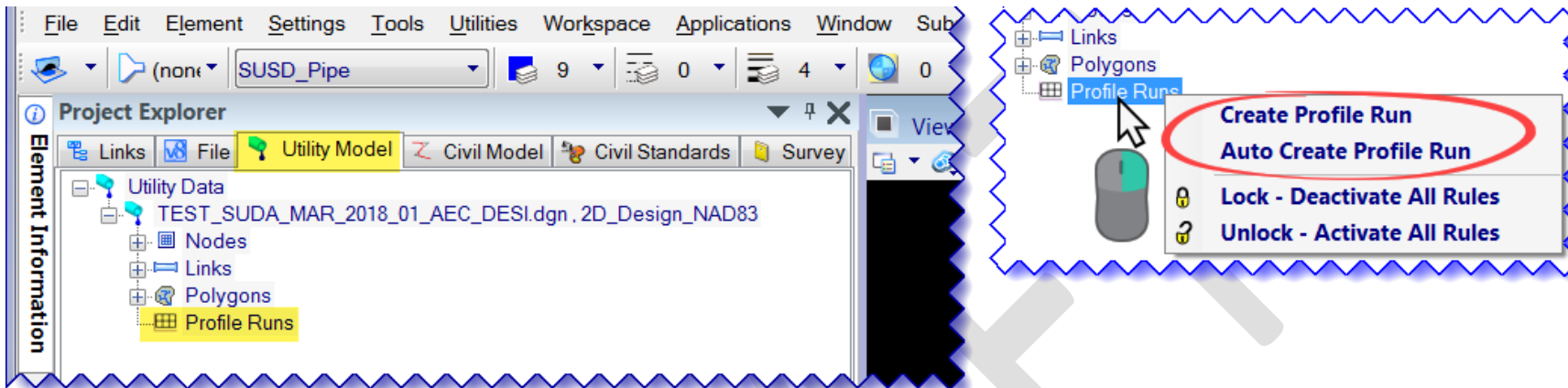
### ➤ Open Profile Model (single pipe):

Click on the **Open Profile Model** task in the View task menu. Follow the pop-up commands → **Locate Plan Element**, pick the pipe you want to see a profile of → **Select or Open View**, click in the view window you want the profile to be displayed. You can view a profile of the individual pipes as needed.

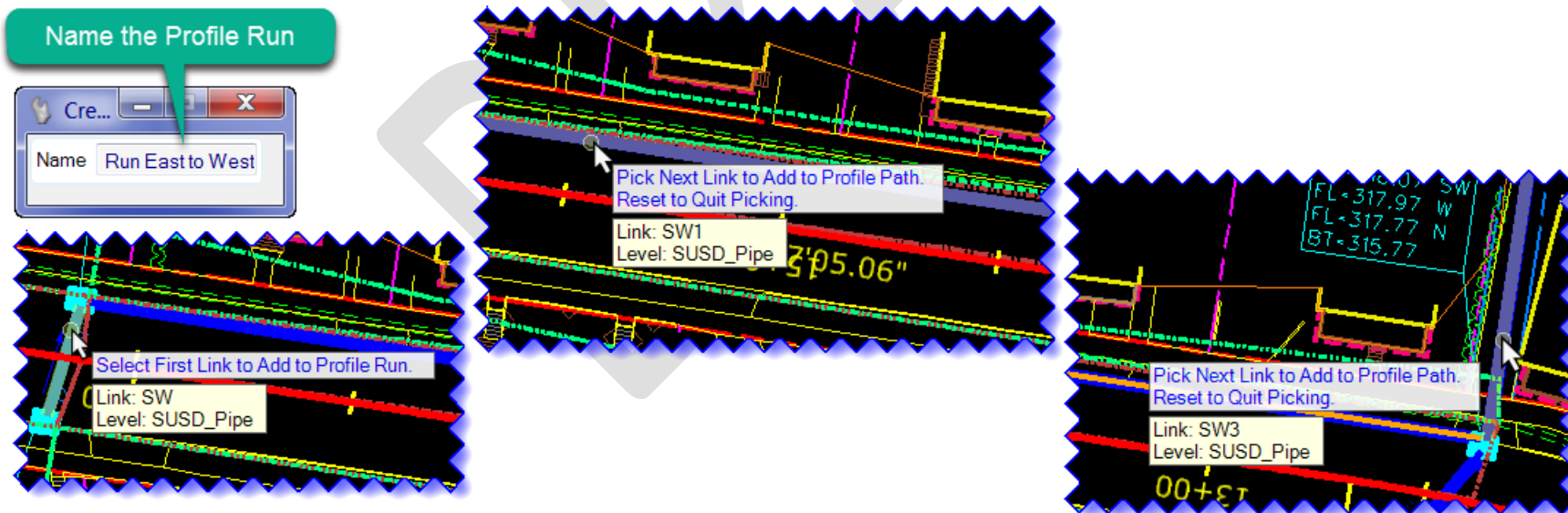


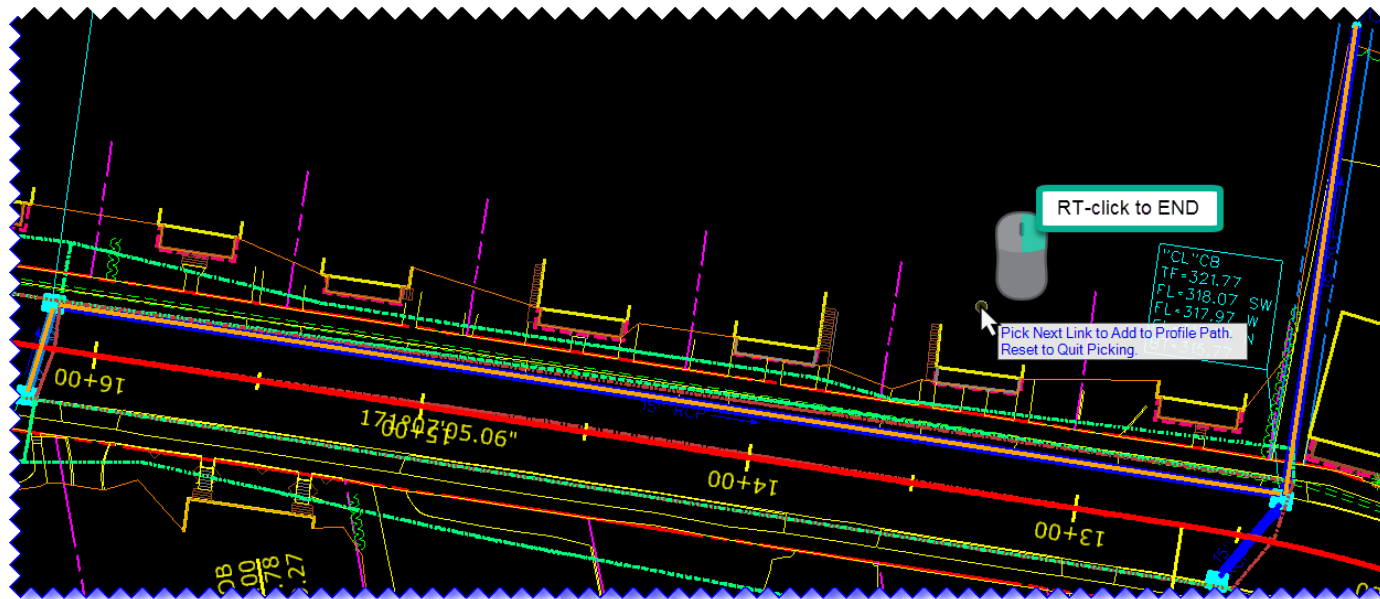
## ➤ Create Profile Run

Click on/Open **Project Explorer**, click the **Utility Model** tab and expand your 2D MicroStation file so you see **Profile Runs**. Right-click select **Create Profile Run** or **Auto Create Profile Run** → follow the pop-up commands.



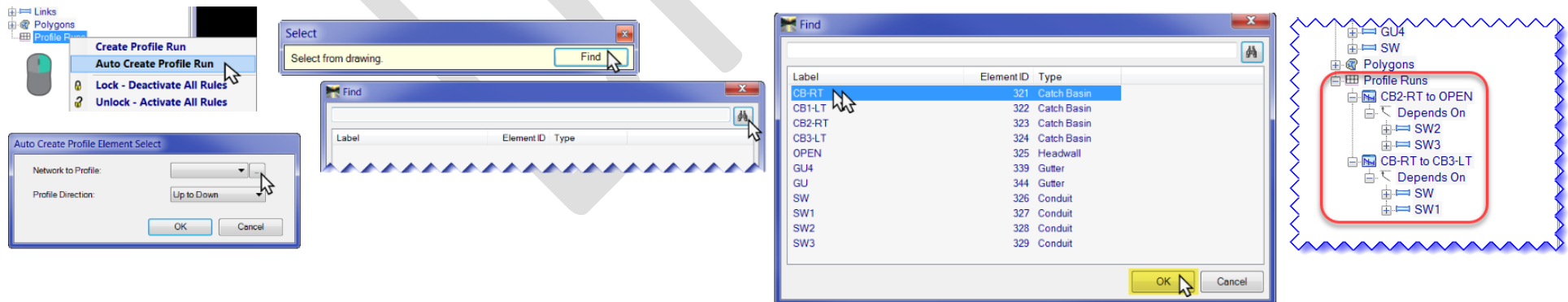
**Create Profile Run** → Name the Profile Run → Select First Link to Add to Profile Run → Pick Next Link to Add to Profile Path. Reset to Quit Picking. This will create a profile that can be displayed in three (3) different ways = Profile Model, Analysis Profile and Engineering Profile.





## ➤ Auto Create Profile Run

Right-click on Profile Runs → select **Auto Create Profile Run** → in the 'Auto Create Profile Element Select' box click on Ellipsis box (...) → in the 'Select' box click on 'Find' button → in the 'Find' click on the magnifying glass button → the Find box will populate → double-click on a catch basin and click Ok. In Project Explorer expand the Profile Runs. SUDA created profile runs for the project.



Note: You may not get exactly what you are looking for.

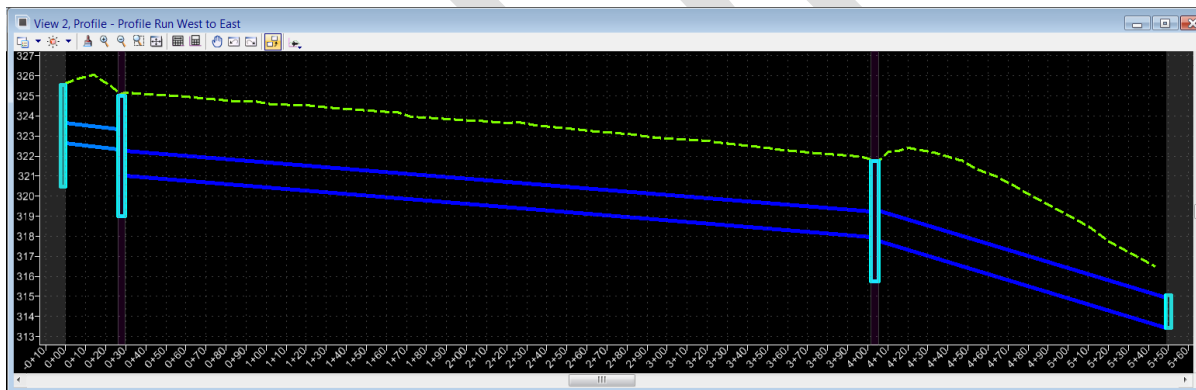
Back in **Project Explorer**, expand **Profile Runs** (click on the plus sign); the newly created profile run(s) is(are) now available to view. **Right-click** on the run to see all available options to view/edit the profile data.

The screenshot shows the Project Explorer window with the 'Profile Runs' folder expanded. A context menu is open over a profile run named 'Profile Run East to West'. The menu items and their descriptions are as follows:

- Open Profile Model**: > places the profile run into a MicroStation View window.
- Open Analysis Profile**: > shows annotated profile, display can be edited, saved(printed) to a pdf-file, exported to dgn-file.
- Open Engineering Profile**: > shows annotated profile, display can be edited, saved(printed) to a pdf-file, exported to dgn-file.
- Fit To View**: > fits profile to view (one view at a time)
- Rename**: > edit the profile run name
- Unlock - Activate Profile Run Rules**: > allows or disallows edit of individual items
- Reverse Profile Run**: > changes direction of profile
- Regenerate Profile Run**: > updates profile
- Delete**: > updates profile
- Properties**: > updates profile

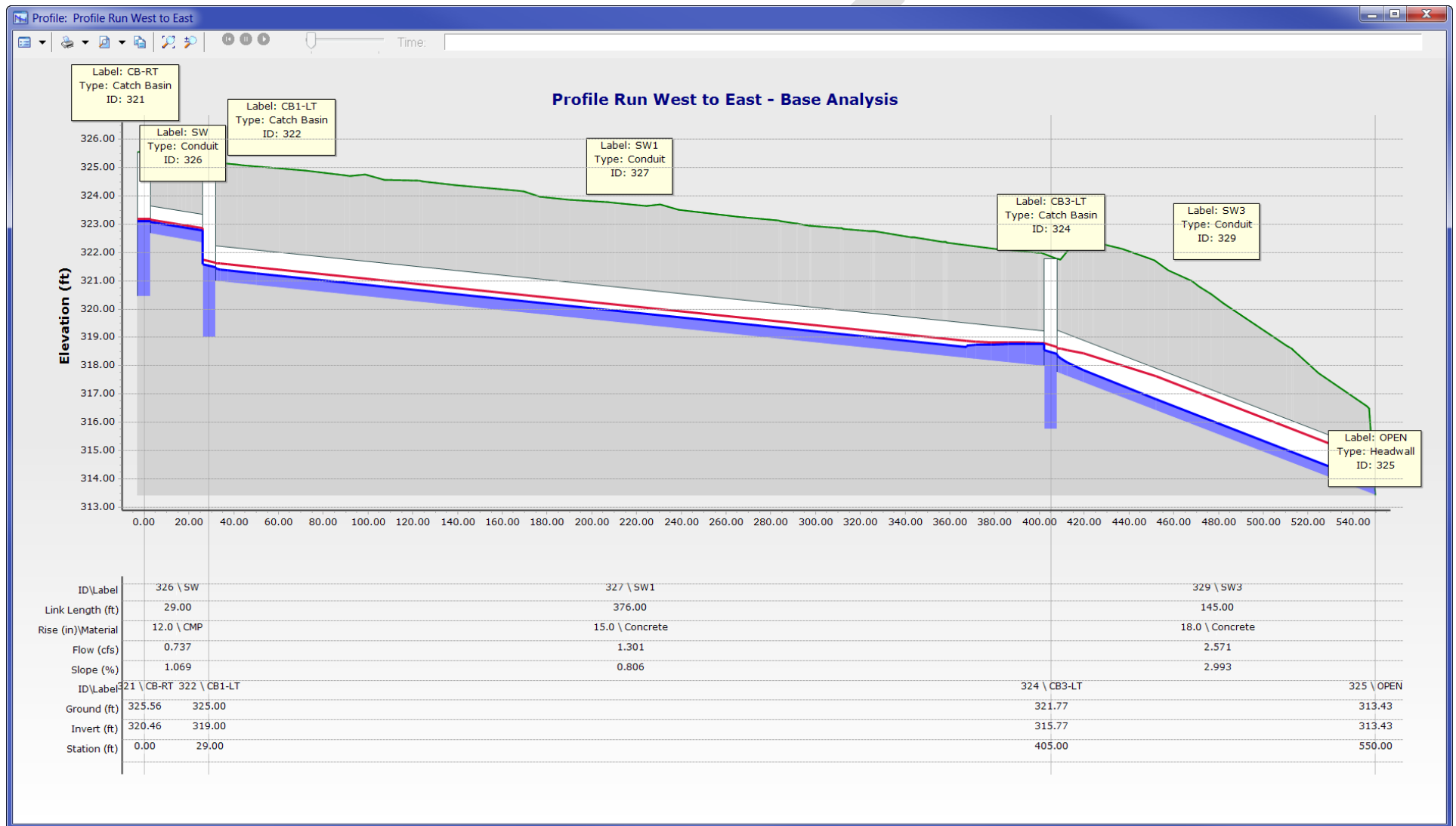
### ➤ Open Profile Model

Right-click on **Profile Run** → **Select Open Profile Model** → click in the view window to place the profile.



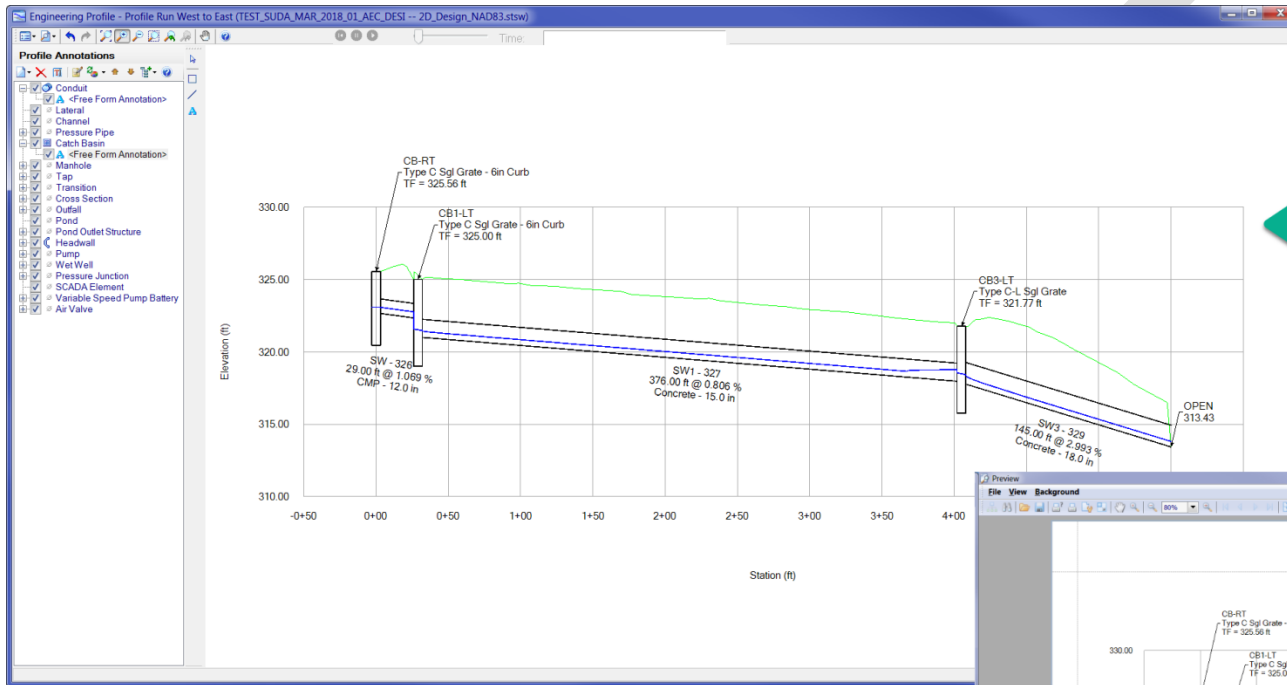
## ➤ Open Analysis Profile

Right-click on **Profile Run** → Select **Open Analysis Profile** → a window opens with the analysis profile. This can be modified to include Hydraulic Grade Line, Energy Grade Line, labels and table annotation and legend. The file can be exported to a drawing or can be printed.



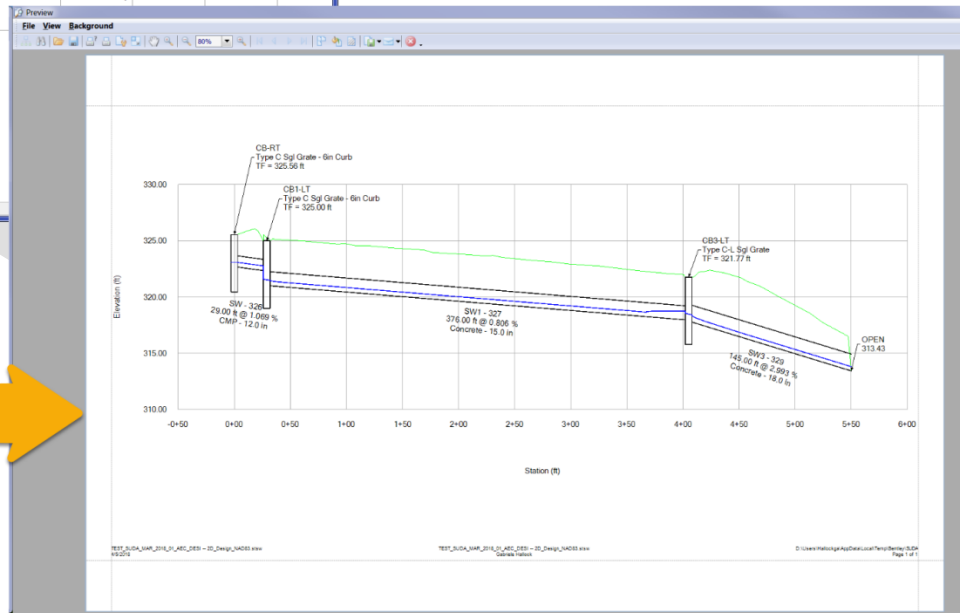
## ➤ Open Engineering Profile

Right-click on **Profile Run** → Select **Open Engineering Profile** → a window opens with the engineering profile. This can be modified to include inverts, slopes, types, length and more. The file can be exported to a drawing or can be printed and exported to a document.



Engineering Profile window

Print Preview of Engineering Profile



Videos to watch about Profiles:



Profiling and Labeling



Compute the Network

Additional videos to watch to help with computing, scenarios and comparing data:



Calculation Options  
Settings



Computing the Design  
Scenario and Reviewing  
the Results



Comparing the  
Analysis and Design  
Scenarios - Manually



Using the Scenario  
Comparison Tool

DRAFT



## Section 3.1 Existing Storm Drainage Analysis

COMING SOON

Use this workflow if you are analyzing the existing storm drainage systems for existing values and capacities.

If the existing survey terrain model is not enough for drainage evaluation use the Earth Exploration Toolset workflow to create an existing terrain model of the extended project area, and merge into one terrain model (existing drainage terrain) to reference into your Drainage MicroStation DGN file.

The designer will use the **existing terrain** model supplied by Survey to reference into a newly created MicroStation DGN file by following: Step 3 Create Document, "The **CTDOT OpenRoads Manual for Designers**", Chapter 2: Project Start Up.

## Section 4.1 Proposed Storm Drainage Design and Analysis

COMING SOON

Use this workflow if you are designing and analyzing the proposed storm drainage systems.

## Section 5.1 Plans Production

Within InRoads SS4 the majority of the plan production is done using the native tools and native file formats. Ultimately, OpenRoads Designer CONNECT Edition will have a new set of fully-integrated plan production tools.

Today, however, along with the OpenRoads tools, the native tools are also available in the SELECTseries 4 versions.

### 5.1.1. Plan Sheet

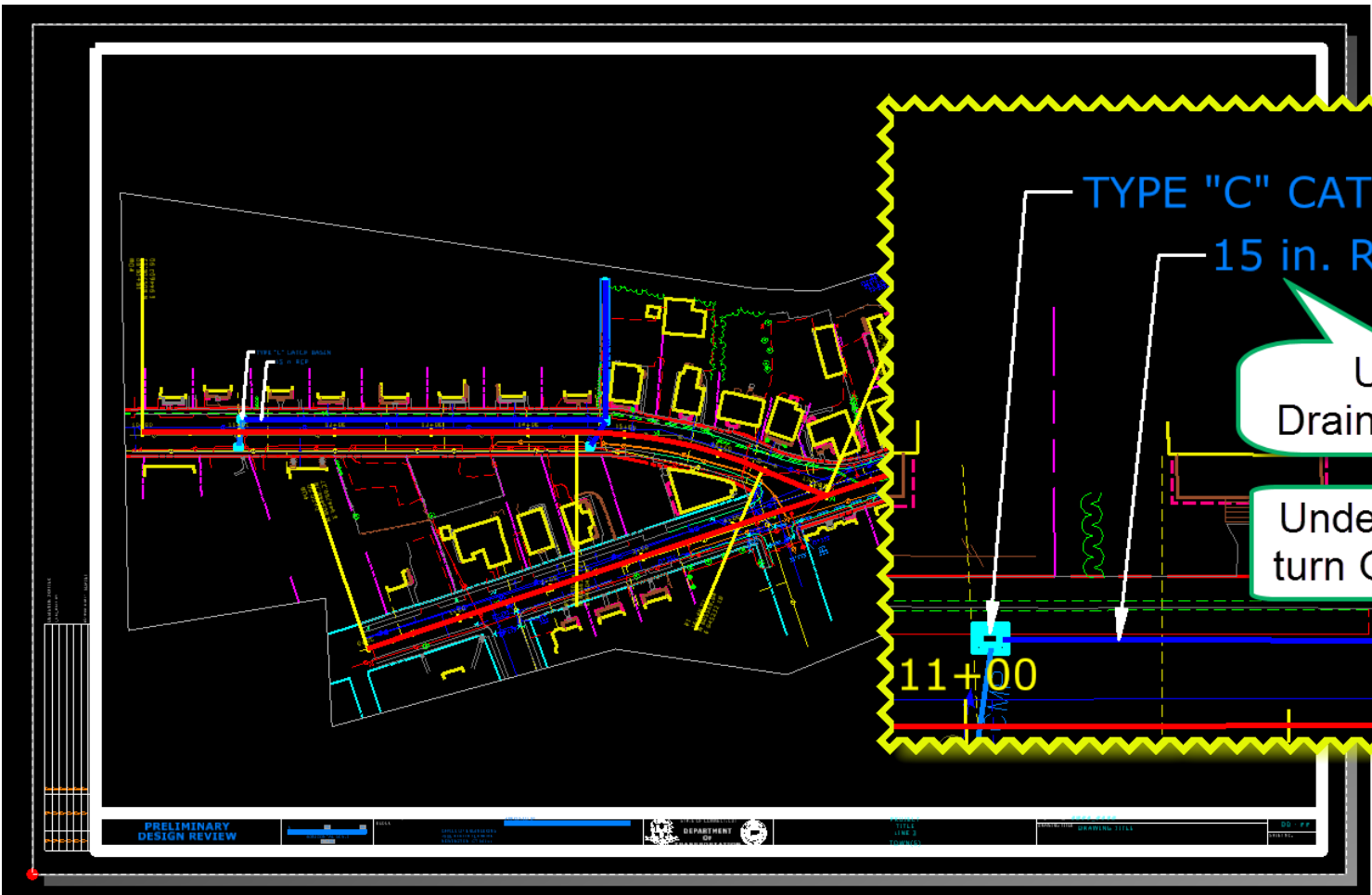
Make sure you follow [Chapter 8 of the CTDOT OpenRoads Manual for Designers](#).

Follow through with [Section 8.1 Exporting Data](#), **8.1.1 Export an ALG**; **8.1.2 Export to an Existing DTM and Export to a Proposed DTM**. You do not have to export the "Drainage Terrain" as a DTM, only graphical drainage items are used for plan production.

For [Section 8.2 Geo-Referenced Plan Cut Sheet](#) → you have to decide what option better fits your project.

**8.2.1 Option 1 – MicroStation Plan Sheet Creation:** follow through with creating a 2D\_OpenRoads\_Sheet file, reference in the required existing and proposed MicroStation DGN files including the Drainage MicroStation DGN file (2D Model).

**8.2.2 Option 2 – InRoads Plan and Profile Generator:** make sure you open the main modeling DGN file not the drainage file. Follow through with the Plan and Profile Generator, for Step 6. Make sure you include the *Drainage Model file* as a needed [Model Files...](#)



TYPE "C" CATCH BASIN  
15 in. RCP

Use the Task:  
Drainage - Place Note

Under **View Attributes**  
turn OFF Constructions

11+00

12+00

PRELIMINARY DESIGN REVIEW  
DEPARTMENT OF TRANSPORTATION  
TOWNSHIP OF ...

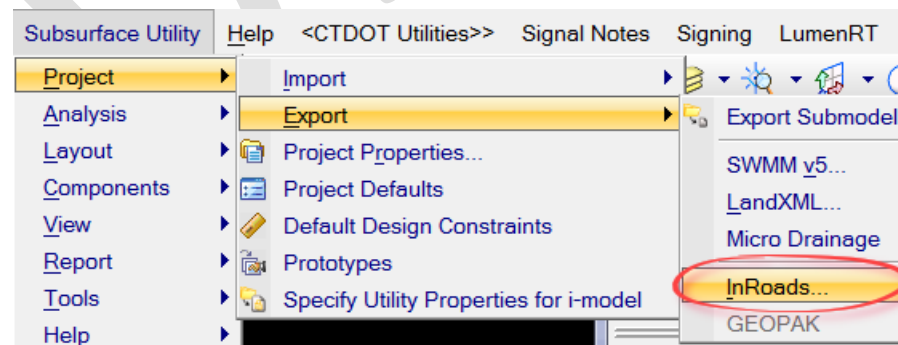
## 5.1.2. Profile Sheet

You can use either Option of [Section 8.3 Profile Cut Sheets](#) from [Chapter 8 of the CTDOT OpenRoads Manual for Designers](#).

You will have to Export the SUDA drainage model to InRoads Storm and Sanitary. Go to [Volume III – InRoads Storm and Sanitary of the CTDOT InRoads V8i Guide](#); *Section 15 Storm and Sanitary Final Annotation*; 15.1 Lab 26 Final Profile Drainage Display and Annotation.



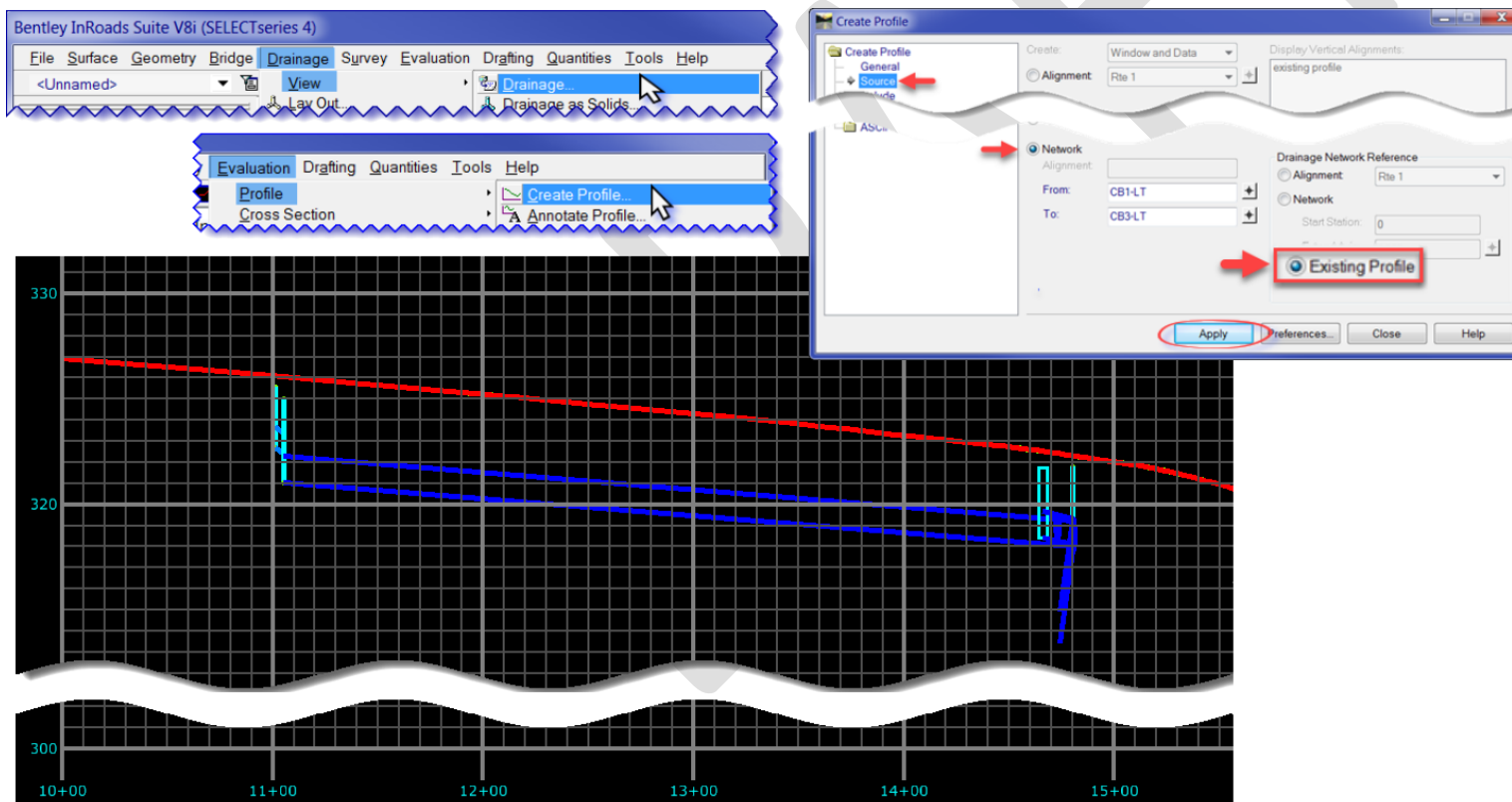
In the SUDA Drainage DGN file go from the Menu bar, select **Subsurface Utility** → **Project** → **Export** → **InRoads...** using the Advanced Wizard, giving it a unique name ending with \*.sdb (Export\_SUDA\_IR\_Drainage.sdb) save the Drainage Database to the project folder in ProjectWise.



In the InRoads dialog box make sure the ALG, Proposed/Existing DTM's and the drainage database \*.sdb are open.

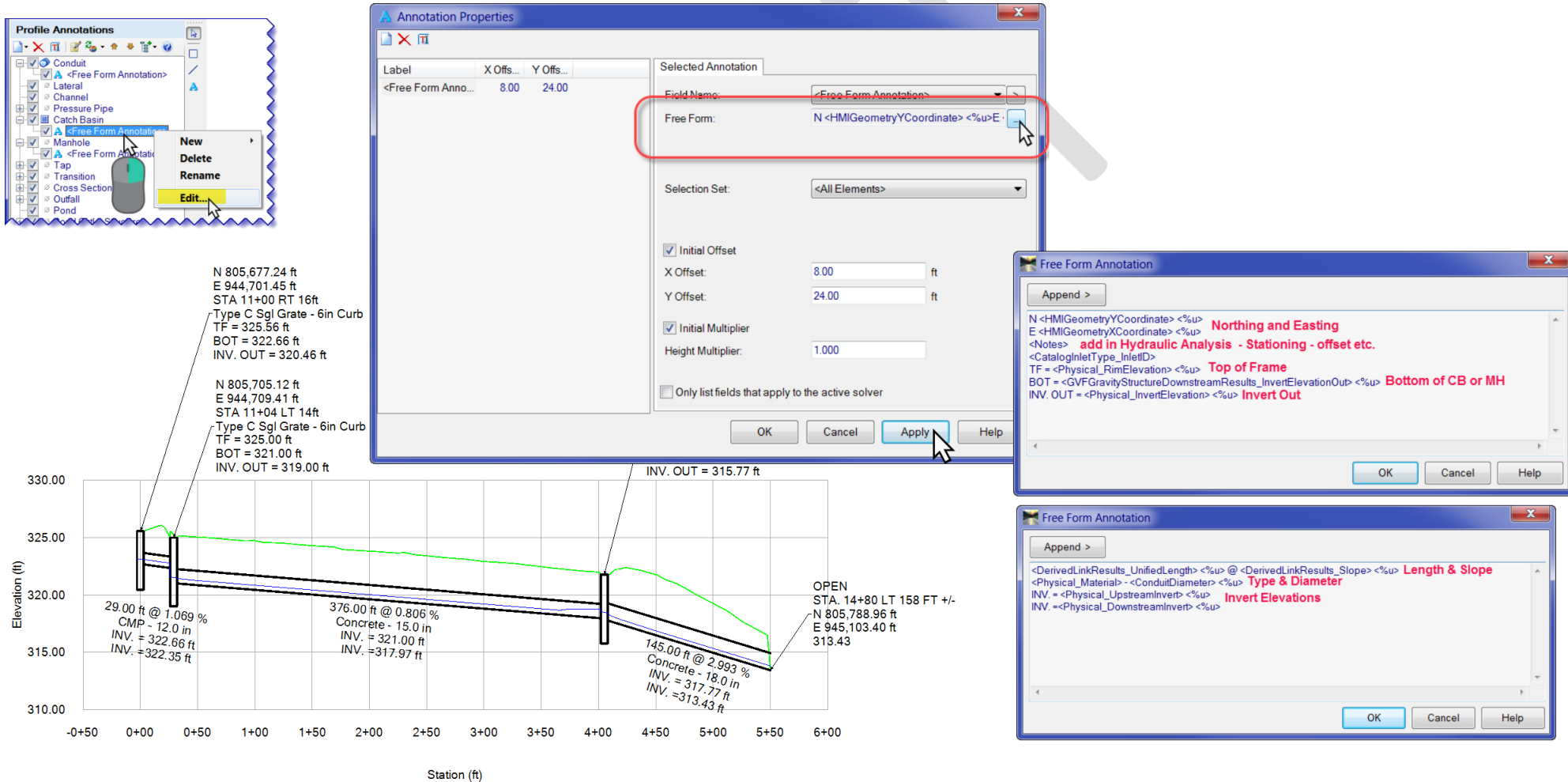
After you completed the profile sheets, go back to the **2D Design Model DGN** file that houses the *Profile(s) and Profile grids(s)*. Here you will place the drainage profile(s) following the steps of *Section 15 Storm and Sanitary Final Annotation*.

**Turn On** Style Lock. View the drainage, from the InRoads dialog box select **Drainage → View → Drainage**, and click **Apply** and **Close**. Using a separate view window zoom to the drainage plan view. From the InRoads dialog box select **Evaluation → Profile → Create Profile...**; now select **Source**, toggle on **Network** and use the pick buttons to select the profile run of your choice; toggle on **Existing Profile** and select **Apply**. **Close** the Create Profile dialog box. You may have to do some adjustments to the element attributes using MicroStation tools. Use available tools to annotate the drainage items.

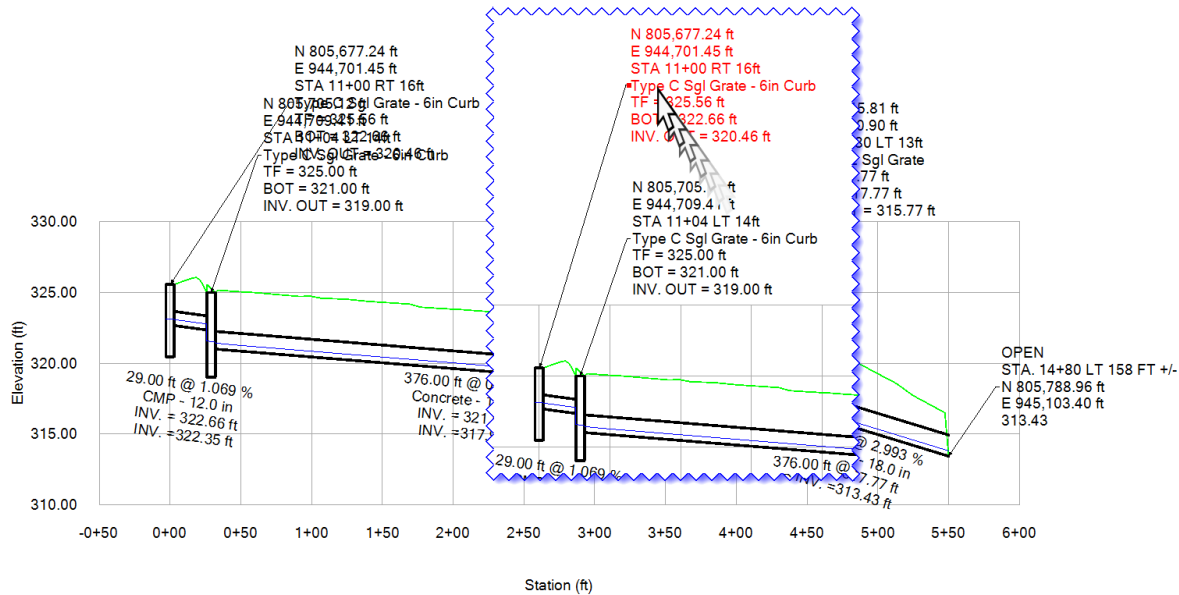


The designer can also incorporate the Engineering Profile (see [Section 2 – Step 4 – C. f.](#)) on a plan sheet.

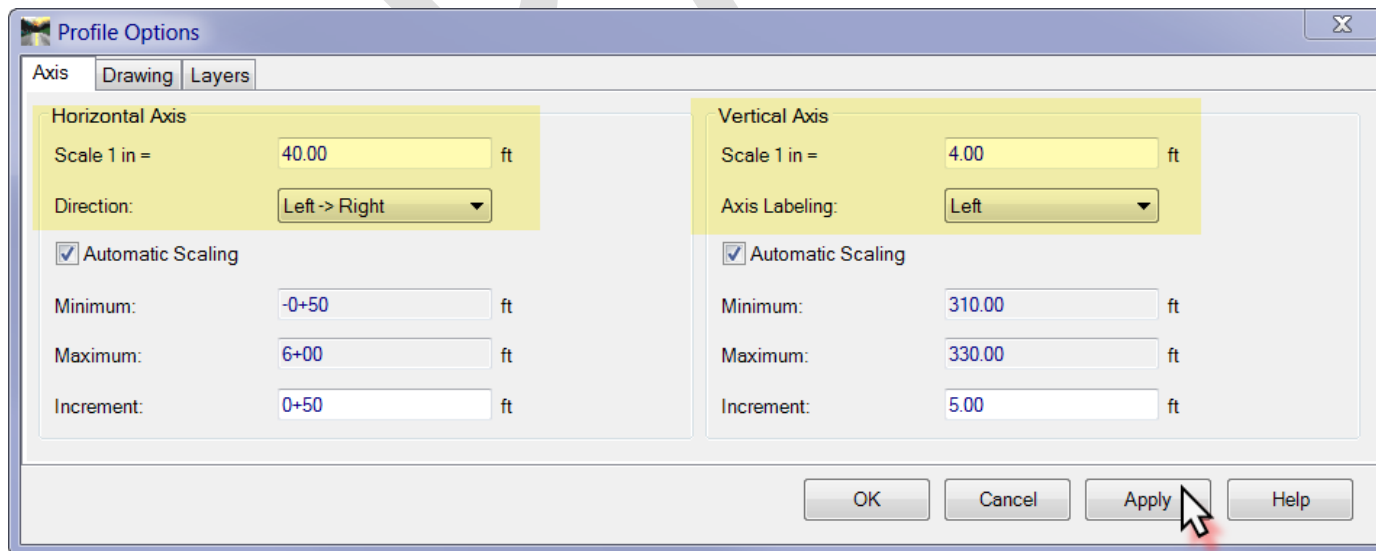
From the **Project Explorer**, select **Utility Model** → **Profile Runs** → select the profile run and right-click and select **Open Engineering Profile**. In the Engineering Profile box to the left is Profile Annotations, here the designer can modify/add any annotation for the profile. The Engineering Profile stationing is not the project stationing; it can be added in the Hydraulic Analysis under Notes and added to the annotation.



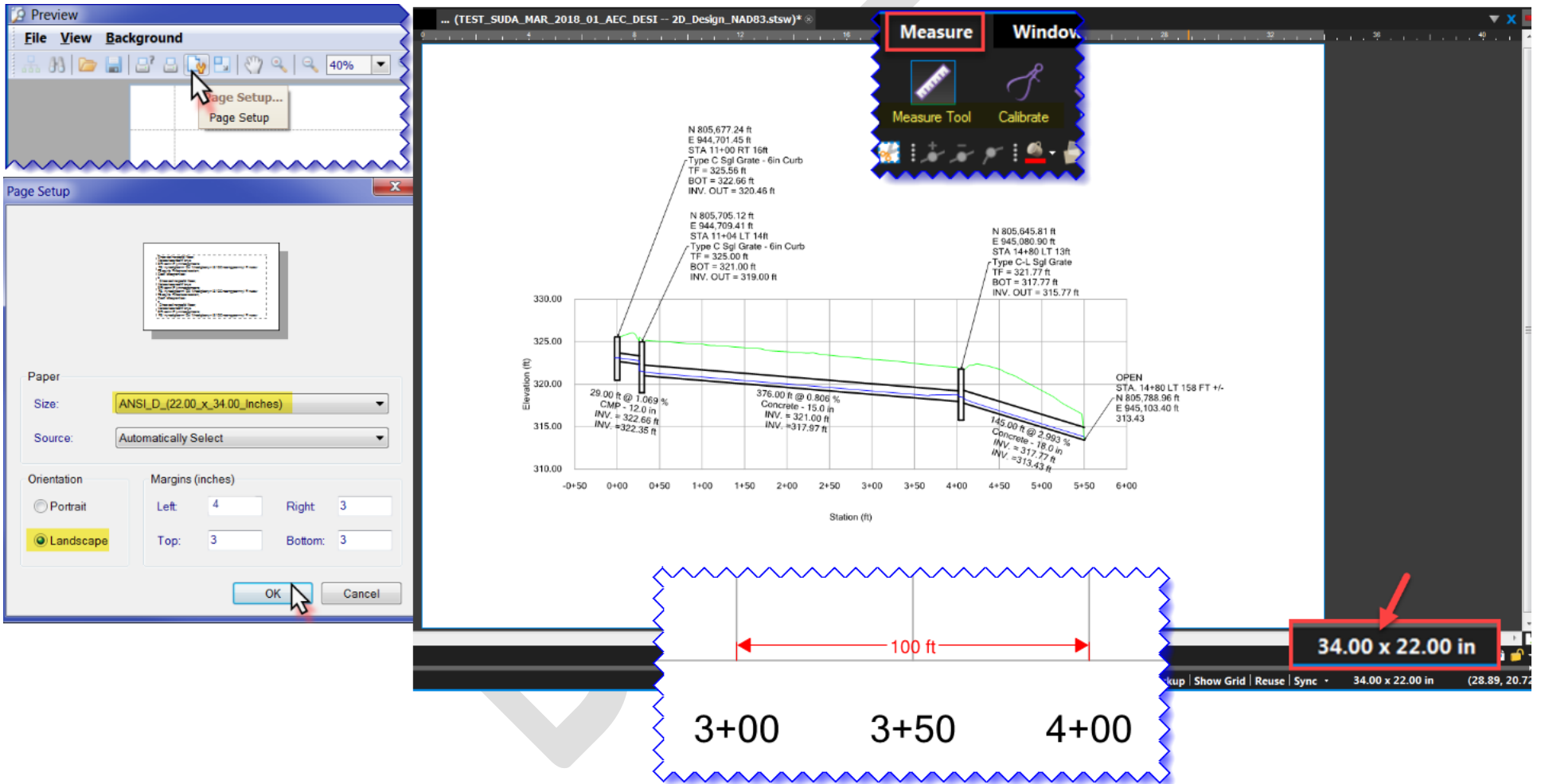
Click once on the call-out and you can move it.



Click on the Tools command and select Options. Profile Options should have settings as below, click **Apply** and **OK**.

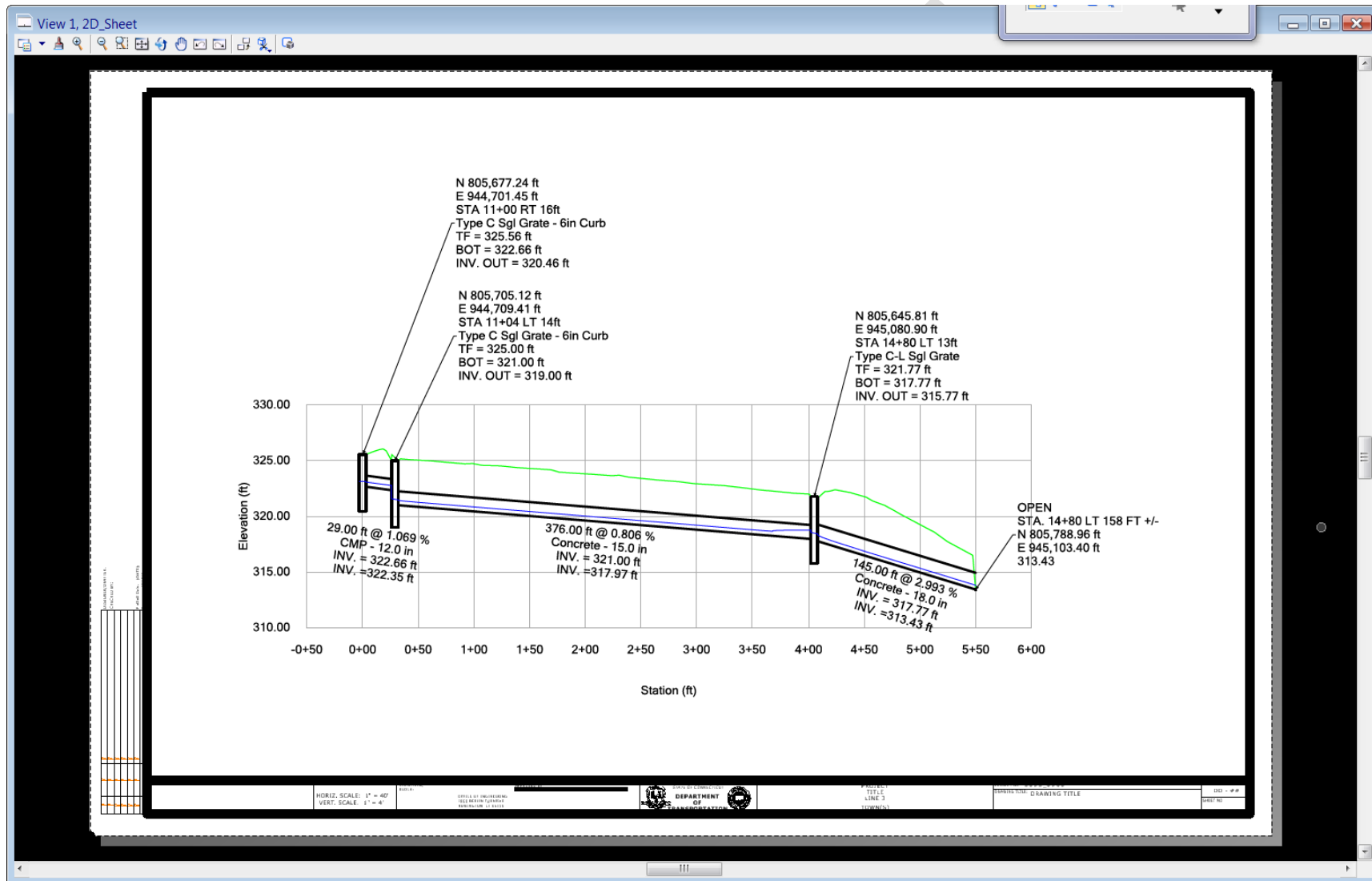


Next click on **Print Preview** tool select Fit To Page. In the Preview select Page Setup... Select the **Paper Size: ANSI\_D\_(22.00\_x\_34.00\_Inches)**, Orientation set to **Landscape**, set **Margins** (inches) to give enough room for the sheet border. Click on **File → Print**, name the pdf-file. Using the Measurement tools in BlueBeam, calibrate and measure the profile pdf, delete the footer. Save the pdf-file.





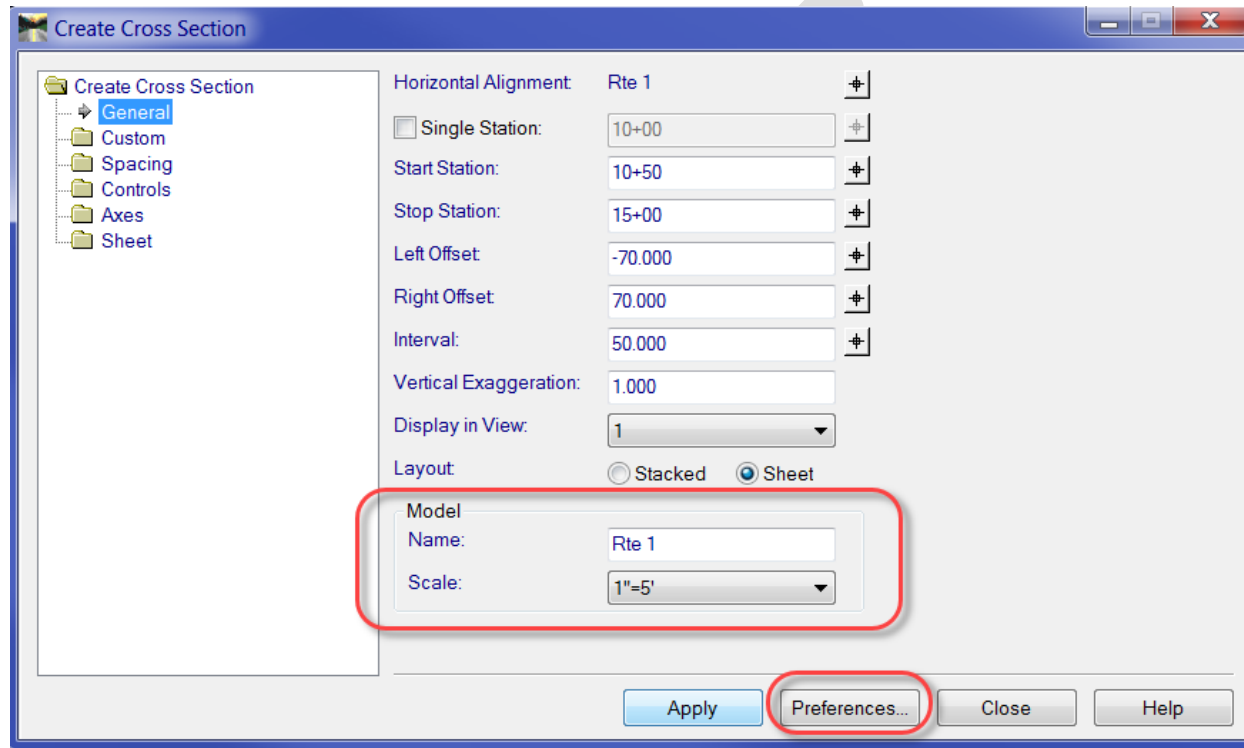
In MicroStation create a **new sheet** file, using the **ProjectWise Advanced Wizard**, use the 2D\_SheetSeed.dgn as seed. **Attach** the Engineering Profile pdf using Raster Manager. **Place** a border cell, you may need to change the color to black, label the border as needed, include a horizontal and vertical scale; turn off levels as needed, save the file.



Ready to publish.

### 5.1.3. Cross Sections

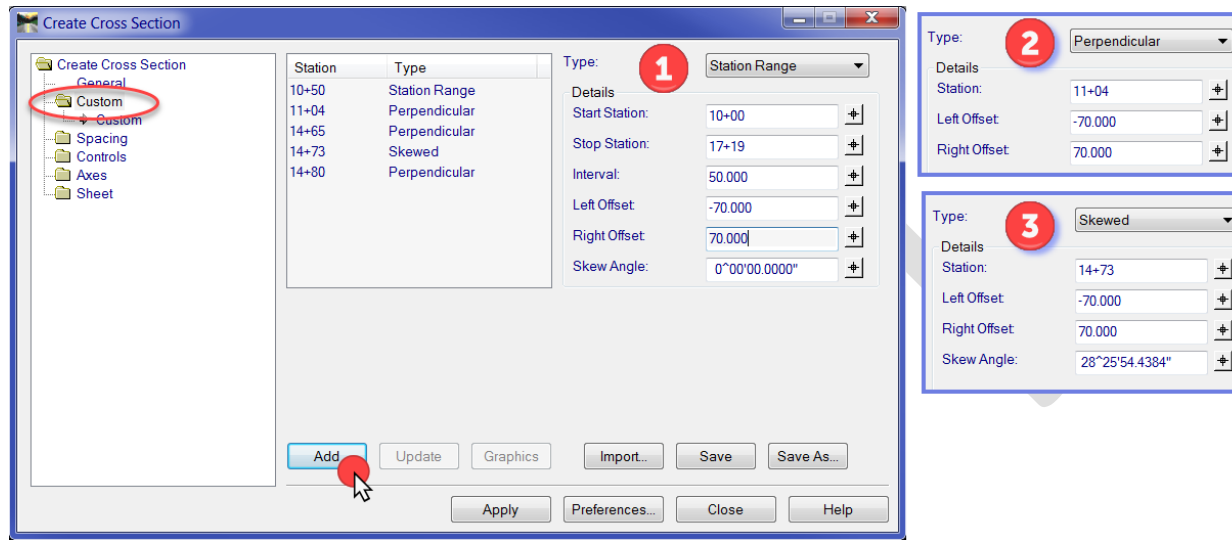
Follow **Section 8.4 Cross Sections** of the [Chapter 8 of the CTDOT OpenRoads Manual for Designers](#). If you create the cross sections after you completed your drainage placement, the structures and pipes will be displayed in the cross sections.



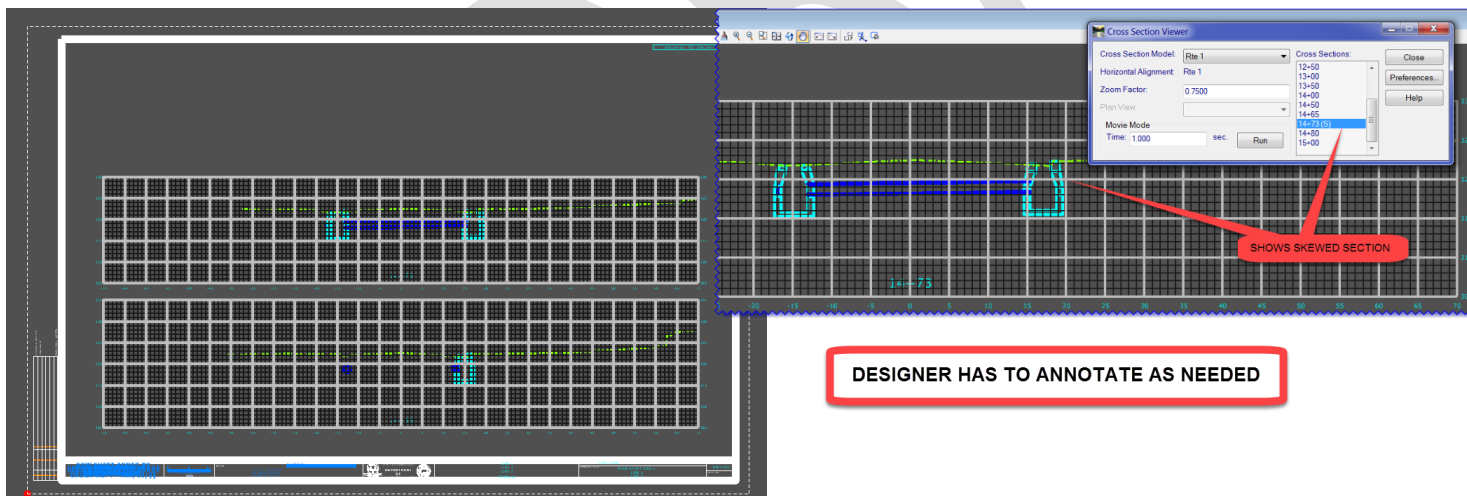
If you want cross sections at each drainage structures (CB's & MH's) select **Custom**;

1. Add **Station Range** as Type, input Start Station, Stop Station, Interval (50.00), and set Left Offset to -70.00, Right Offset to 70.00, Skew Angle to 0. Click Add.
2. Change Type to **Perpendicular**; Left Offset -70.00, Right Offset 70.00. Station: **click** on the pick button and in MicroStation **pick the structures** that are not on full and half stations. Click **Add**.

3. Change Type to **Skewed**; Left Offset -70.00, Right Offset 70.00. Station: **click** on the pick button and in MicroStation **pick the horizontal alignment** between to the structures. Skew Angle: **click** on the pick button and **follow the prompts** (click in the center of the structures). Click Add.



You can **Save/Save As** the Custom cross sections, ensure the Folder is pointing to the Project's PW-folder. Click **Apply**. **Close** the Create Cross Sections dialog. To view the cross sections follow **8.4.4 Viewing the Cross Sections**. The designer will have to annotate the storm drainage using MicroStation tasks.



# Chapter 3. Subsurface Utility Engineering (*SUE*)

---

COMING SOON

DRAFT