Office of Engineering
Division of Facilities & Transit

AEC APPLICATIONS

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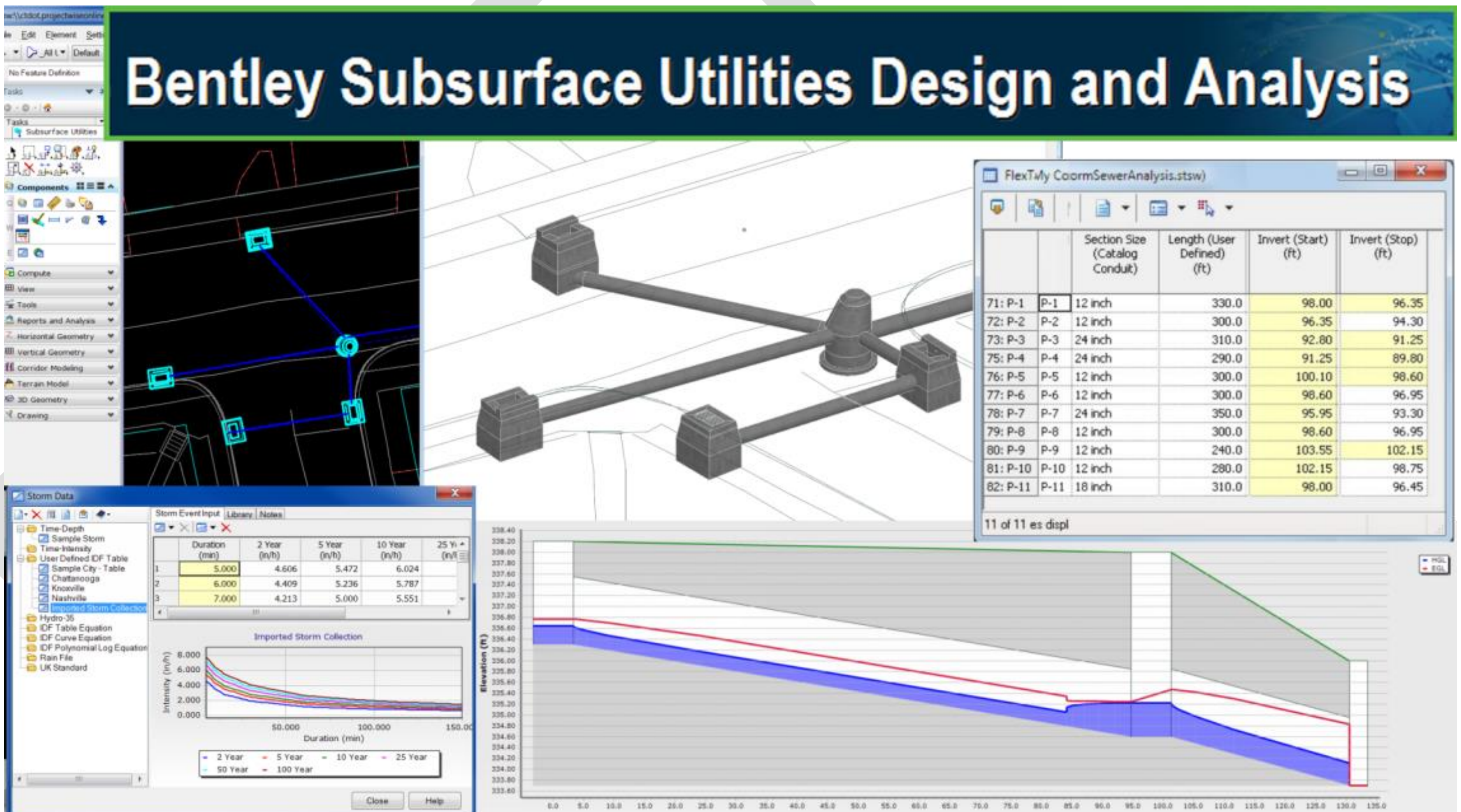

CTDOT *OPENROADS* SUDA MANUAL FOR DESIGNERS

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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 ***S***ubsurface ***U***tilities ***D***esign and ***A***nalysis 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

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.

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

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

Chapter 2. Storm Drainage Design & Analysis

The SUDA (<u>S</u>ubsurface <u>U</u>tilities <u>D</u>esign and <u>A</u>nalysis} platform consists of two license scopes; the storm drainage design and analysis (StormCAD for OpenRoads) and <u>S</u>ubsurface <u>U</u>tility <u>E</u>ngineering (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** <u>will not change</u> the physical characteristics of the storm drainage; **Design** <u>may change</u> 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 **<u>is in</u>** 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 **<u>one</u>** 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.

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.

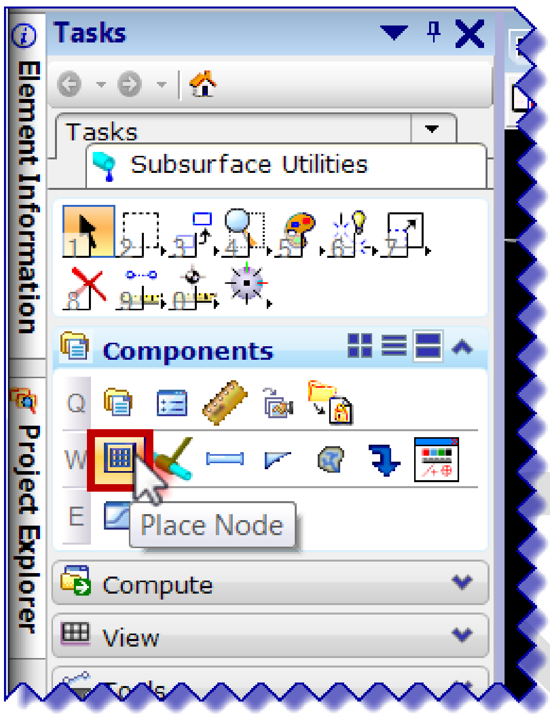
1.1.2. Layout of Drainage Structures (Nodes)

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.

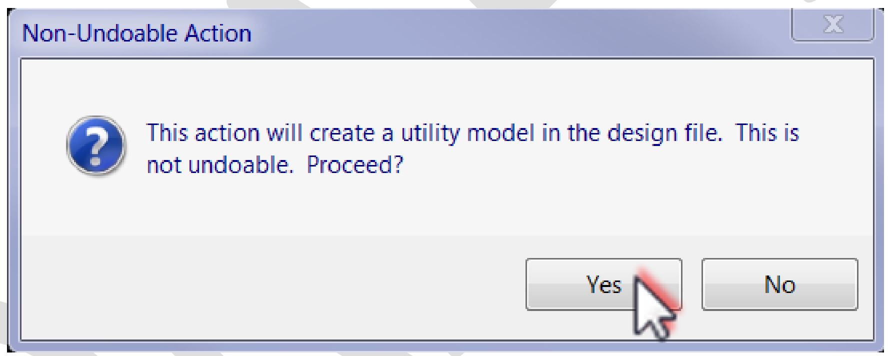
Quick Look: Laying Out of Inlets & Pipes	Laying Out Inlets At & Parallel to a Curb	Laying Out Pipes & Additional Inlets

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 <u>first time</u> in your file you will get a message box. "…will create a utility model…."

Click **"Yes".**

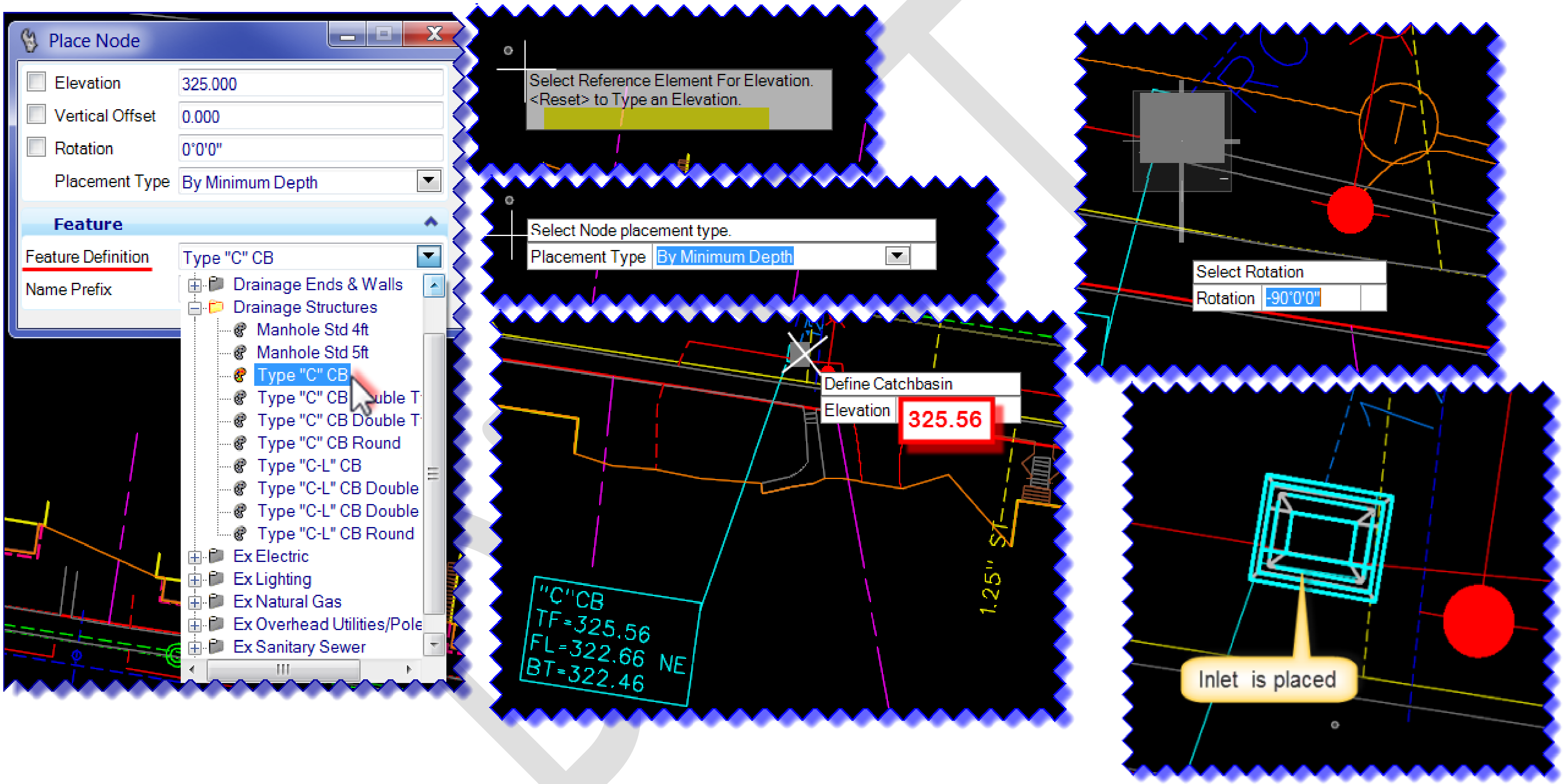


This will open and prepare the Subsurface Utility project in your MicroStation DGN file, some context menus will pop-up and disappear, wait until completed and your courser comes back.

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.

3. Prompt: Define Catchbasin and Elevation box {With this prompt you should see the structure (example: catch basin) on your courser}, 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.
4. 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

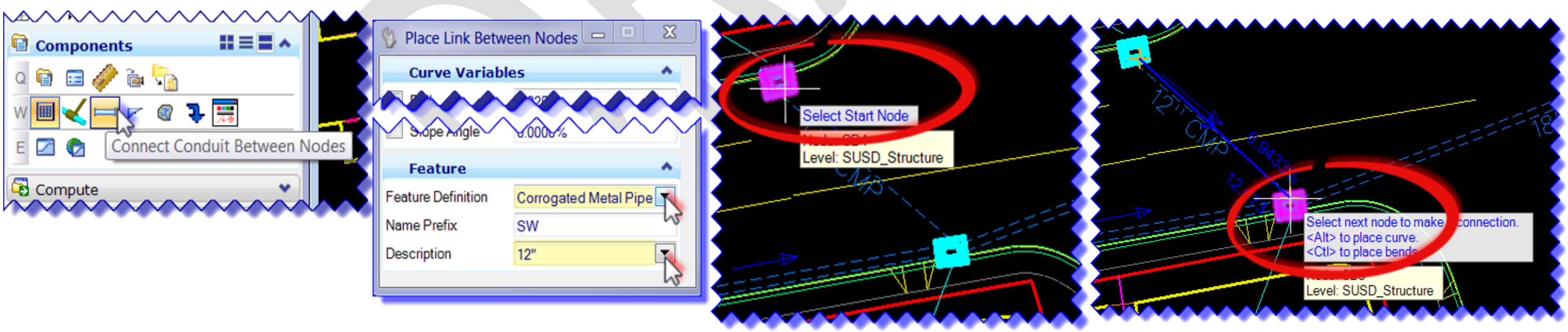
Locating a Low Point & Placing a Curb Inlet

Placing the last two Inlets

1.1.3. Place Conduits (Connect Conduit Between Nodes)

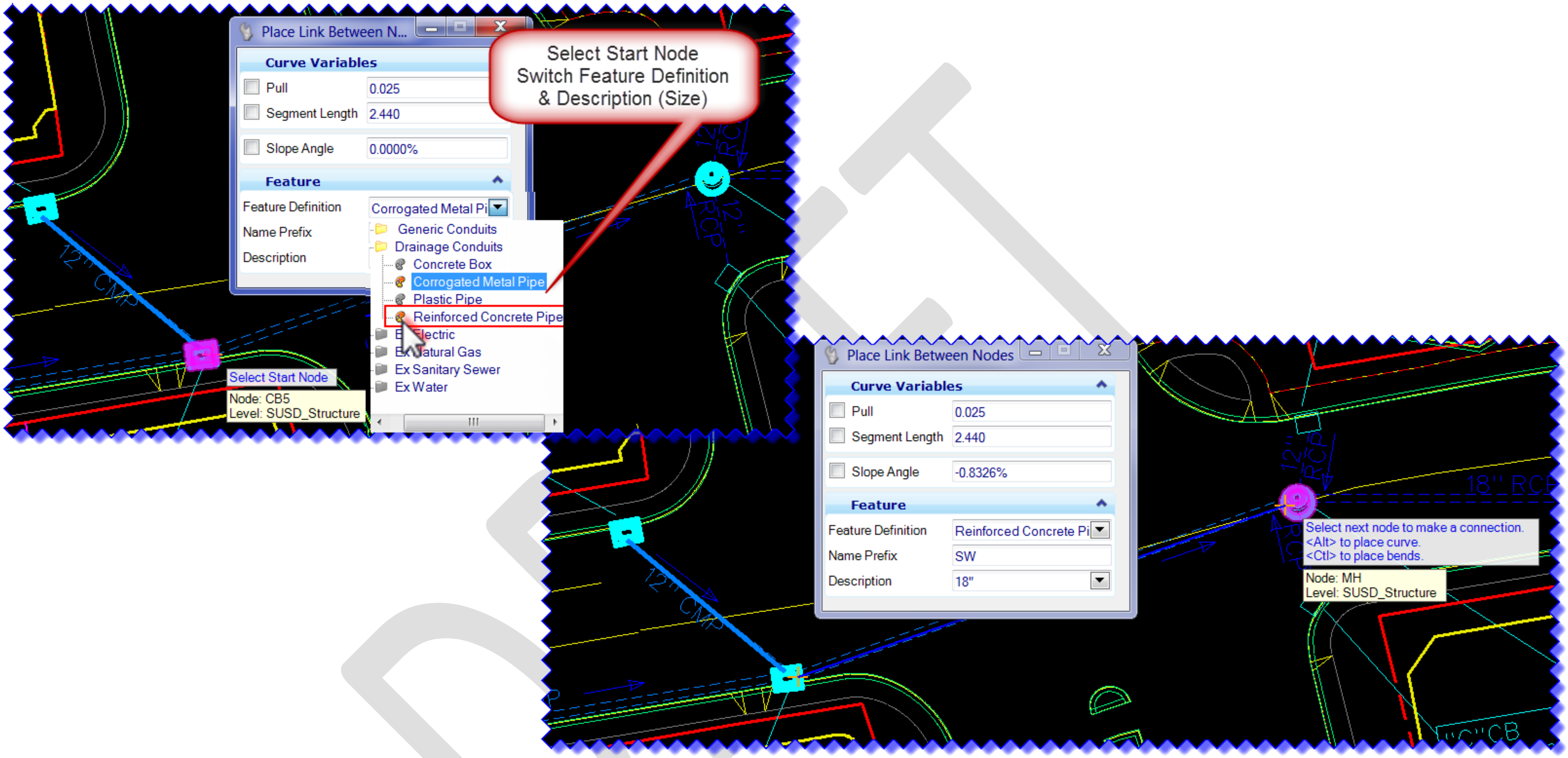
Conduits are placed between nodes such as catch basins, manholes and headwalls.

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 courser 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 courser 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.

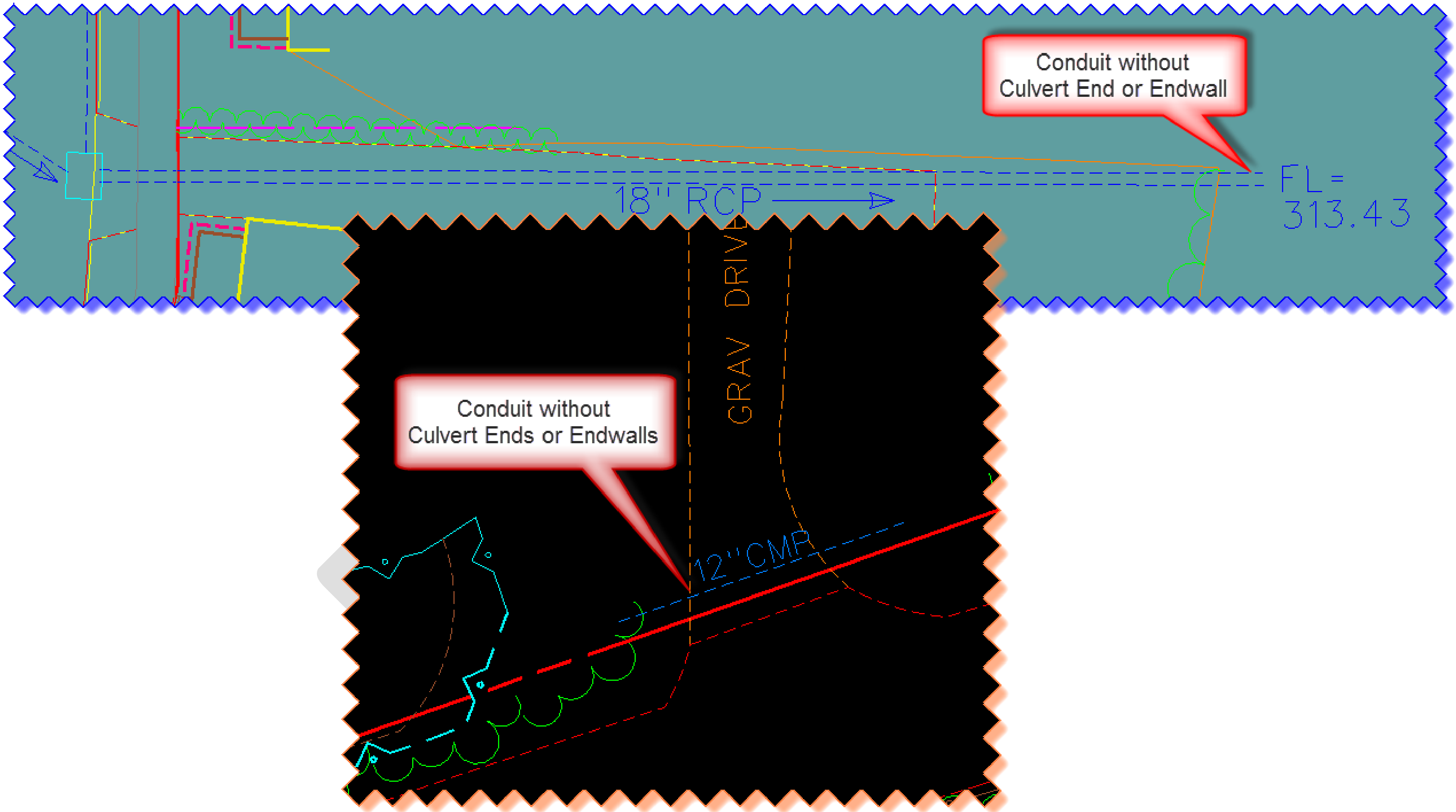


Placing the Pipes

Place Culvert between the Headwalls

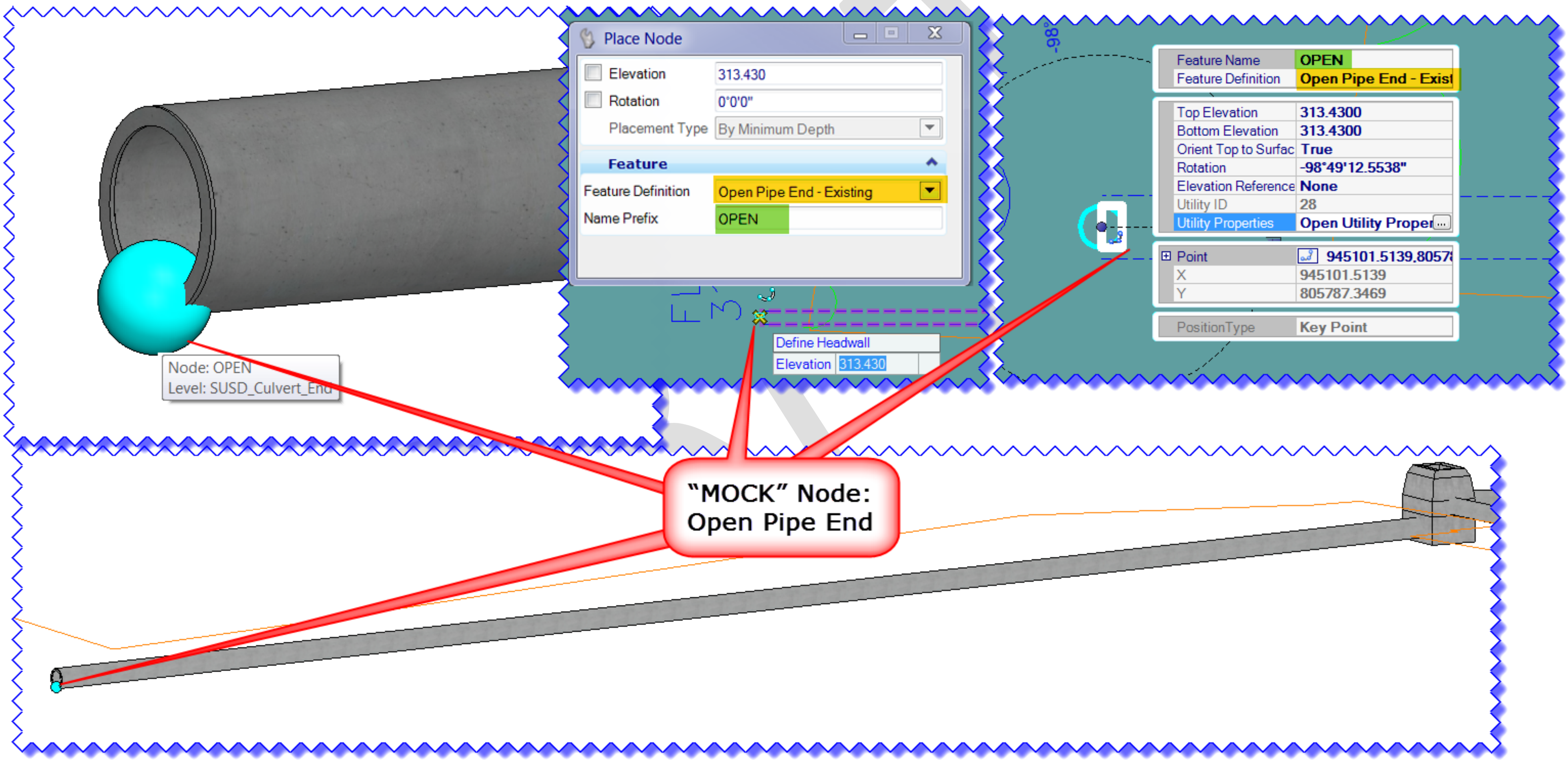
1.1.4. Special Drainage Item

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.

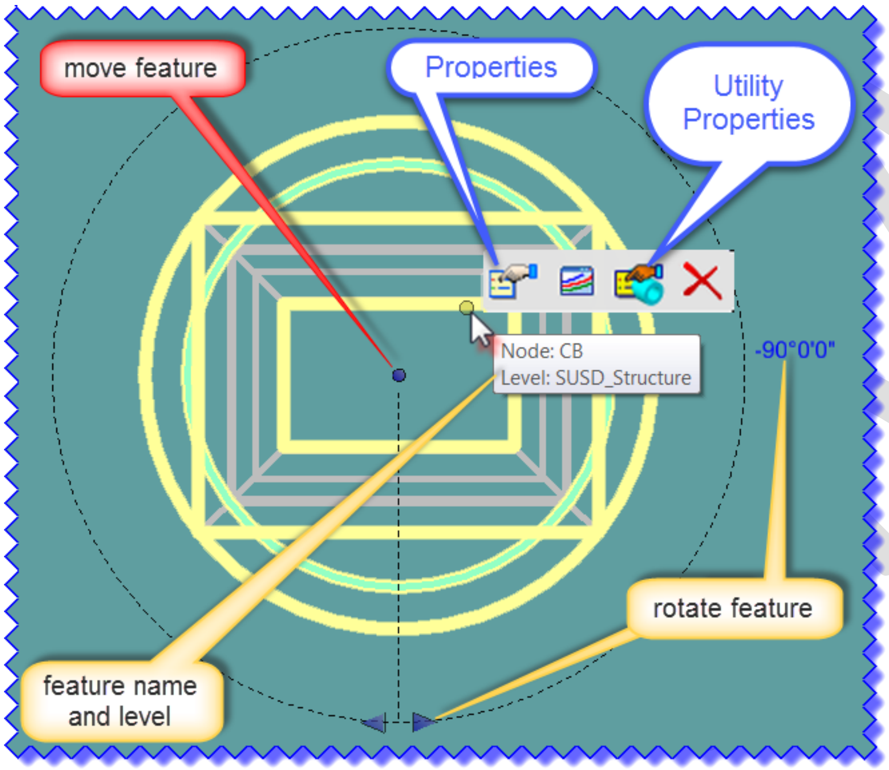


1.1.5. Input Invert Elevations

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).

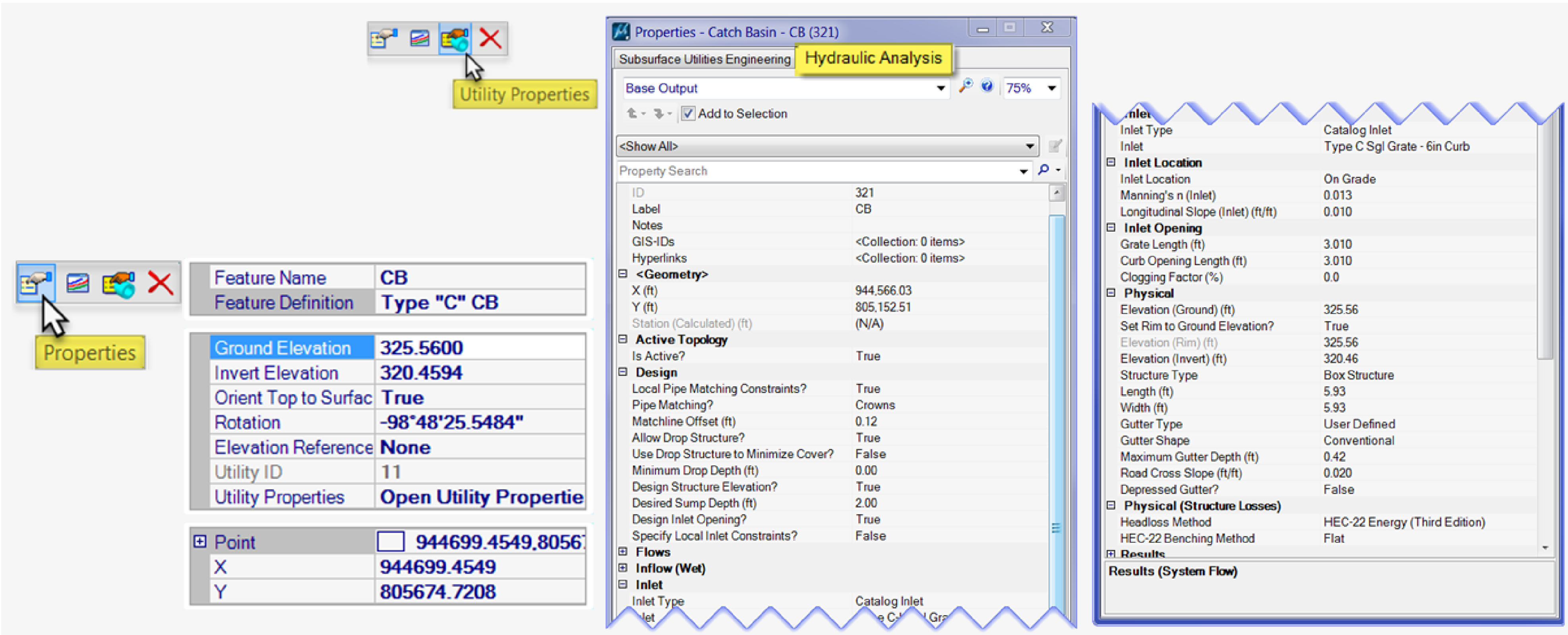
When you select a placed utility feature in OpenRoads, some feature properties can be edited/rotated/moved in the graphic (just as with other OpenRoads tools), it shows the label and level; also the *context toolbox* displays and offers two options to input/edit utility information: Properties and Utility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

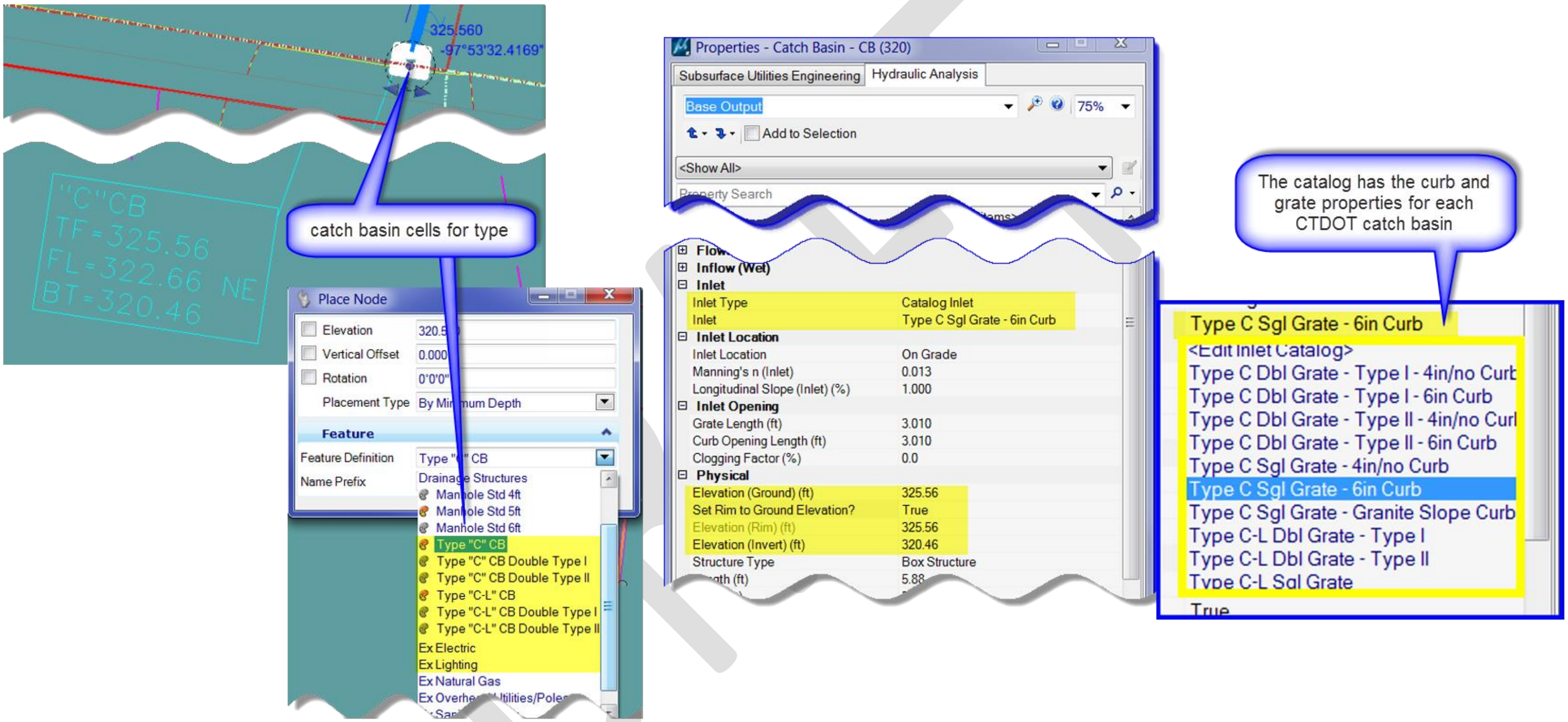
The reason for two property panels is because SUDA tools represent the merger of two diverse technologies. OpenRoads builds the 3D models of the utilities, but Bentley's Haestad technology (StormCAD) executes the analytic modeling for hydraulics and Subsurface Utility Engineering.



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:

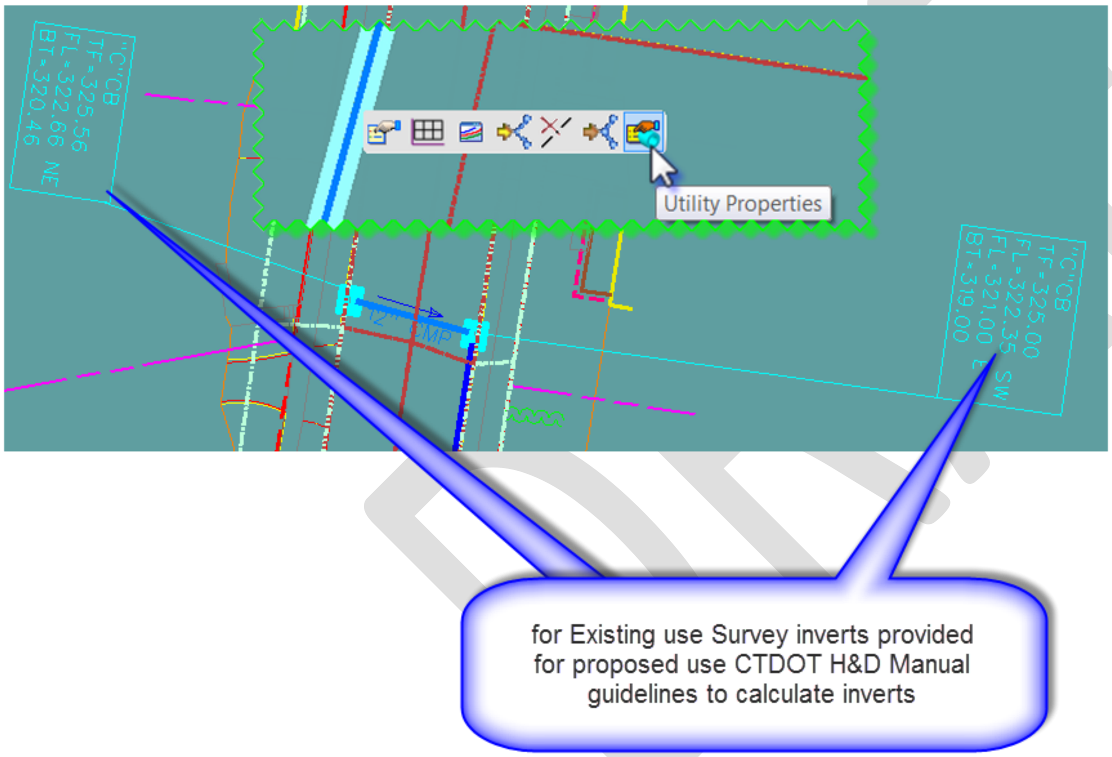
- Inlet Type: set to Catalog Inlet and
- Inlet: Click the down arrow and select the catch basin of your choice.
- Other items will be edited later.

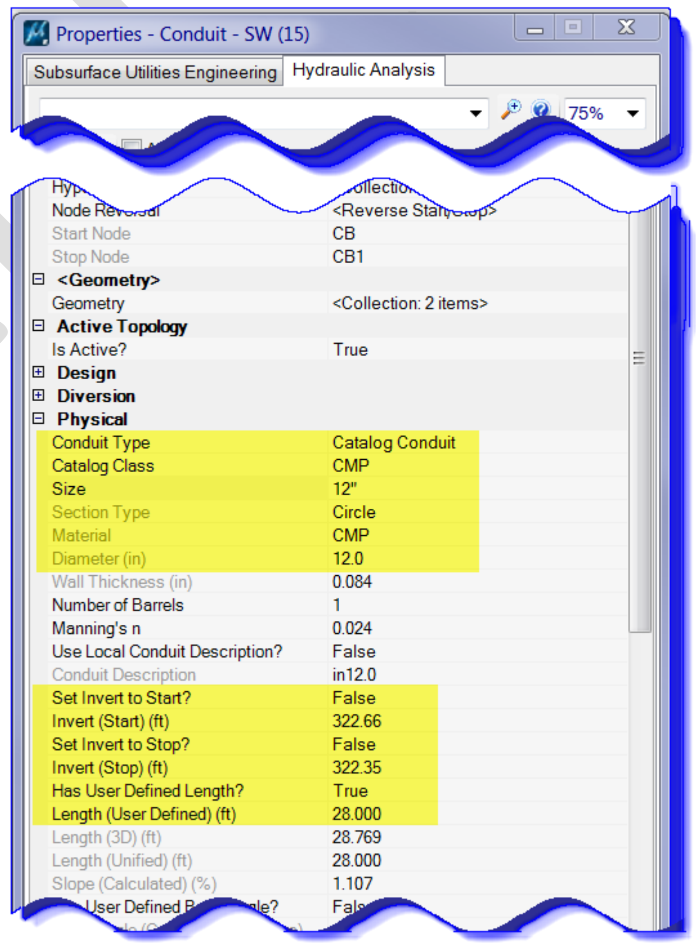


3. Click and hover over the conduit, in the pop-up menu select Utility Properties, in the properties box click on the Hydraulic Analysis tab.
4. Check and edit as needed the Physical Properties for the conduits:

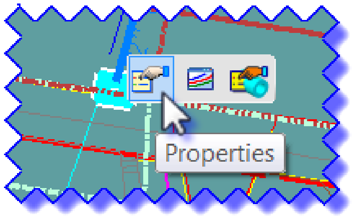
   - Conduit Type: Catalog conduit,

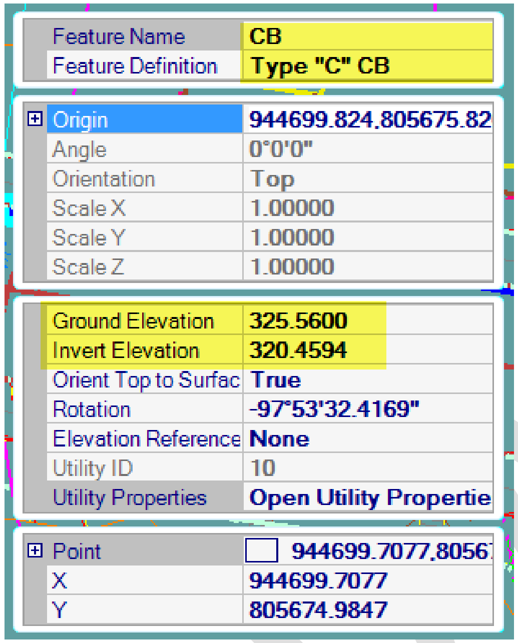
- Catalog Class: click the down arrow and select >Concrete, PVC, CMP;
- Size: click down arrow and select size.
- Invert (Start): enter elevation
- Invert (Stop): enter elevation.
- Has User Defined Length? True (default) or False
- Length (user Defined) enter length.
- Other items will be edited later.

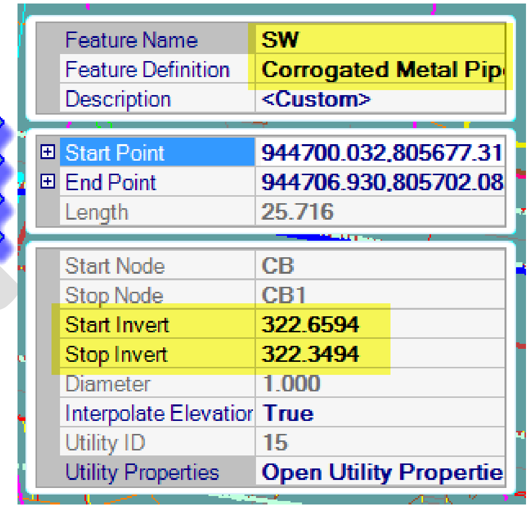




Input the elevations using ‘Properties’.







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.

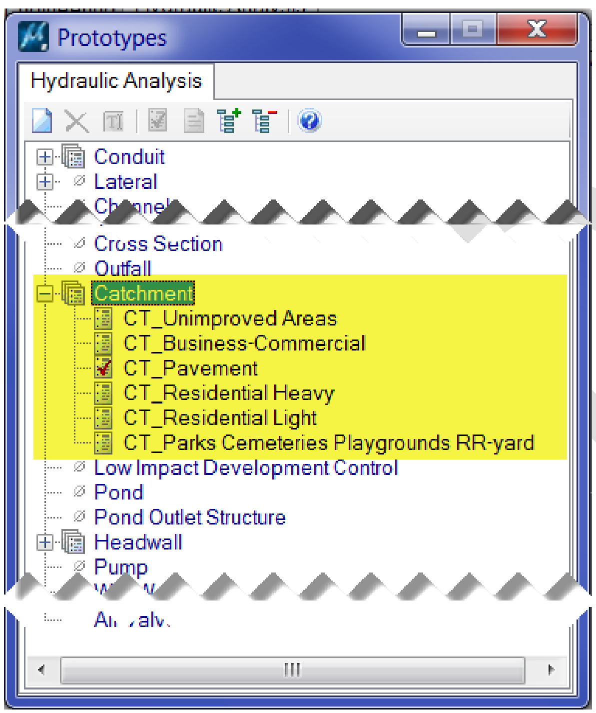
Bentley Institute
Place Catchments by Picking Shapes

Bentley Institute
Place Catchment by Picking Points

Bentley Institute
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.



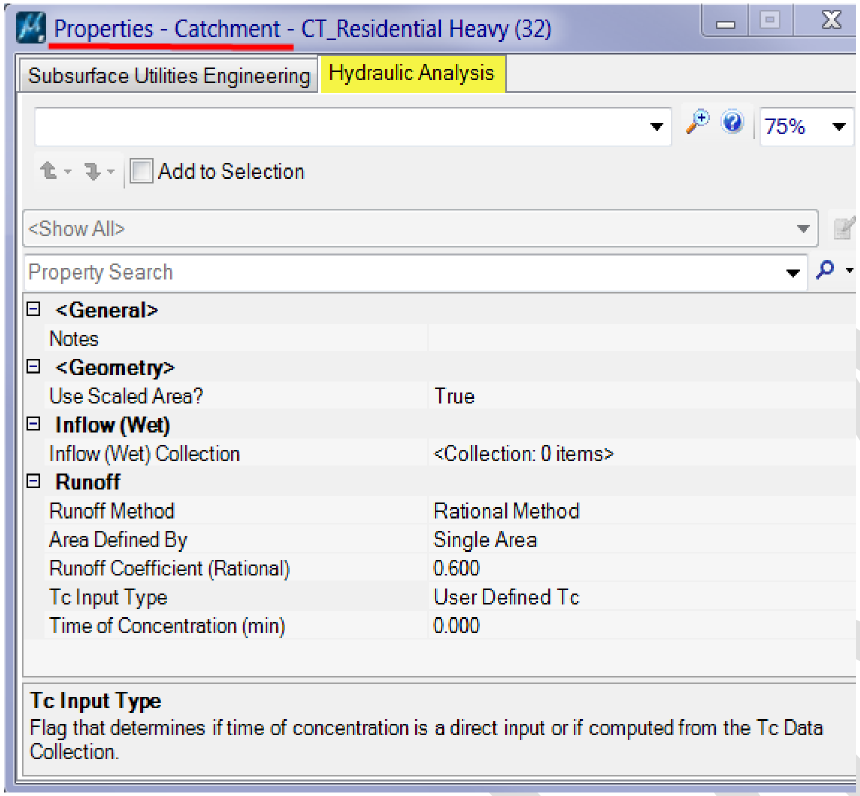
Rational Method	
Catchment Area Type	Runoff Coefficient
CT_Unimproved Areas	0.2
CT_Business-Commercial	0.75
CT_Pavement	0.9
CT_Residential Heavy	0.6
CT_Residential Light	0.4
CT_Parks Cemeteries Playgrounds RR-Yard	0.35

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

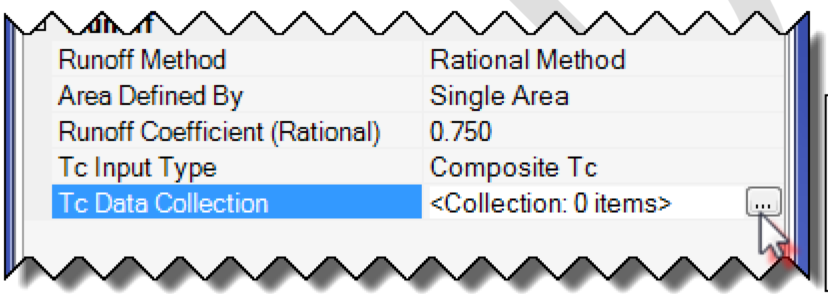
Runoff Method – SUDA uses the *Rational Method*

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

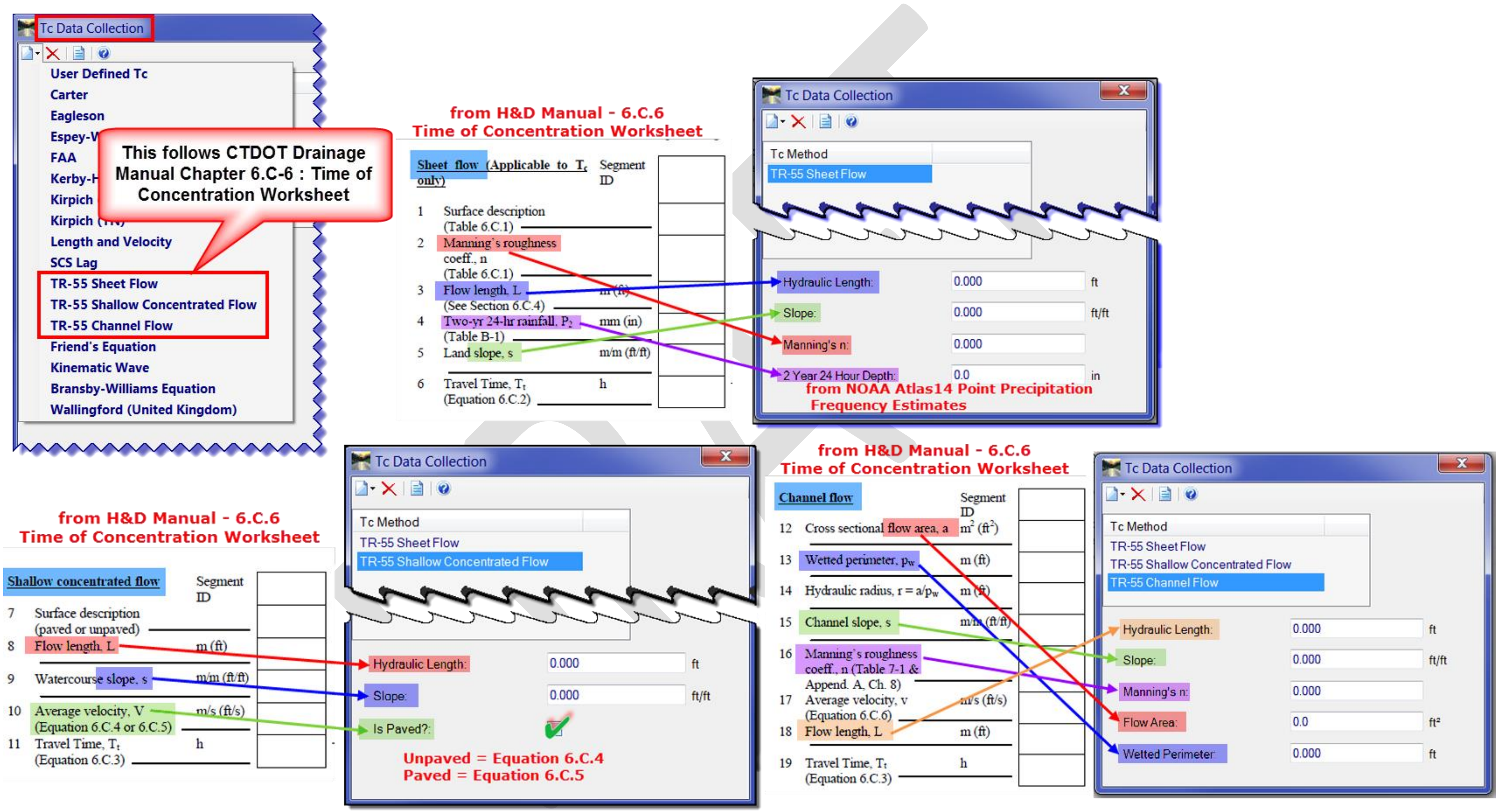


Tc Input Type –Composite Tc

Tc Data Collection – <Collection: 0 items> […]

C. Tc Data Collection

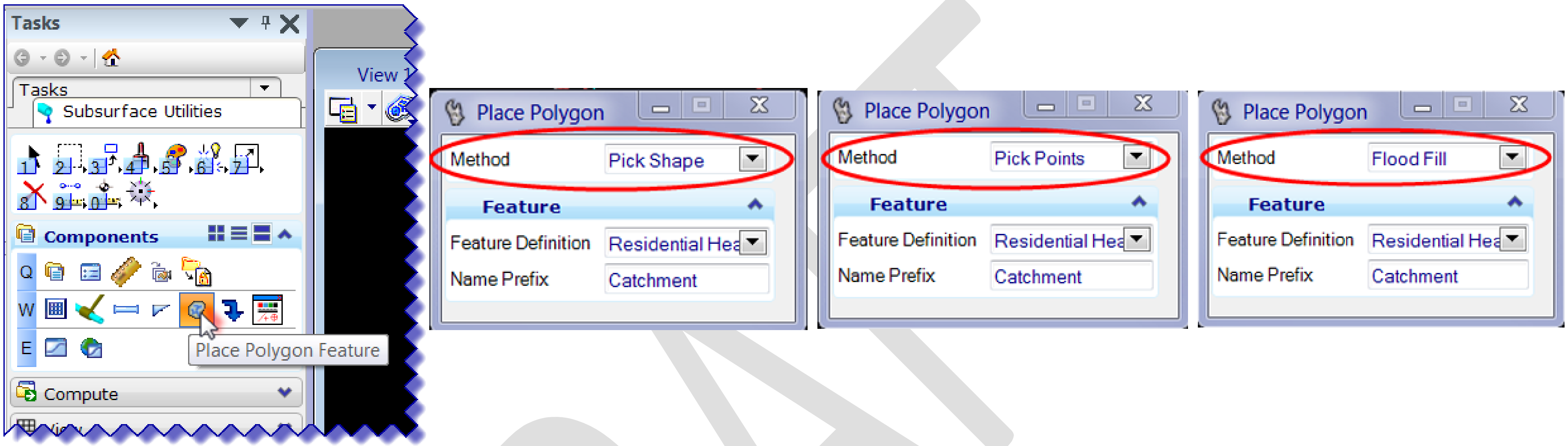
use the TR-55 Sheet Flow, Shallow Concentrated Flow and Chanel Flow.



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.

Bentley Institute

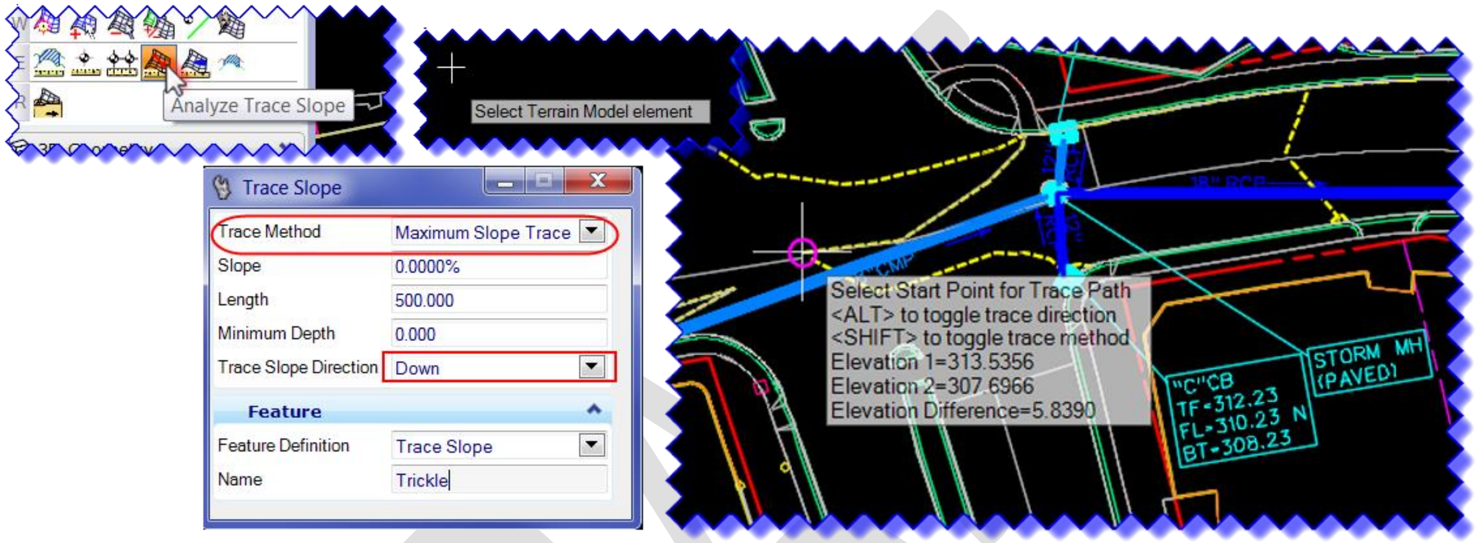
The Analyze Trace Slope Tool

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

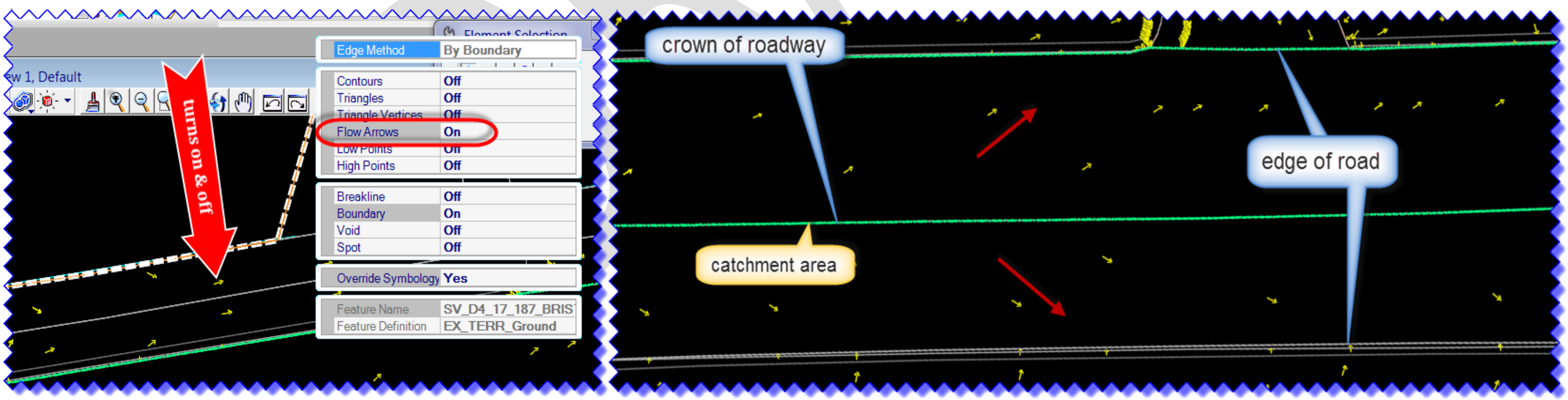
Use the Analyze Trace Slope command from the terrain tools to determine catchment areas for inlets. You should do this in the *drainage terrain* file.

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.

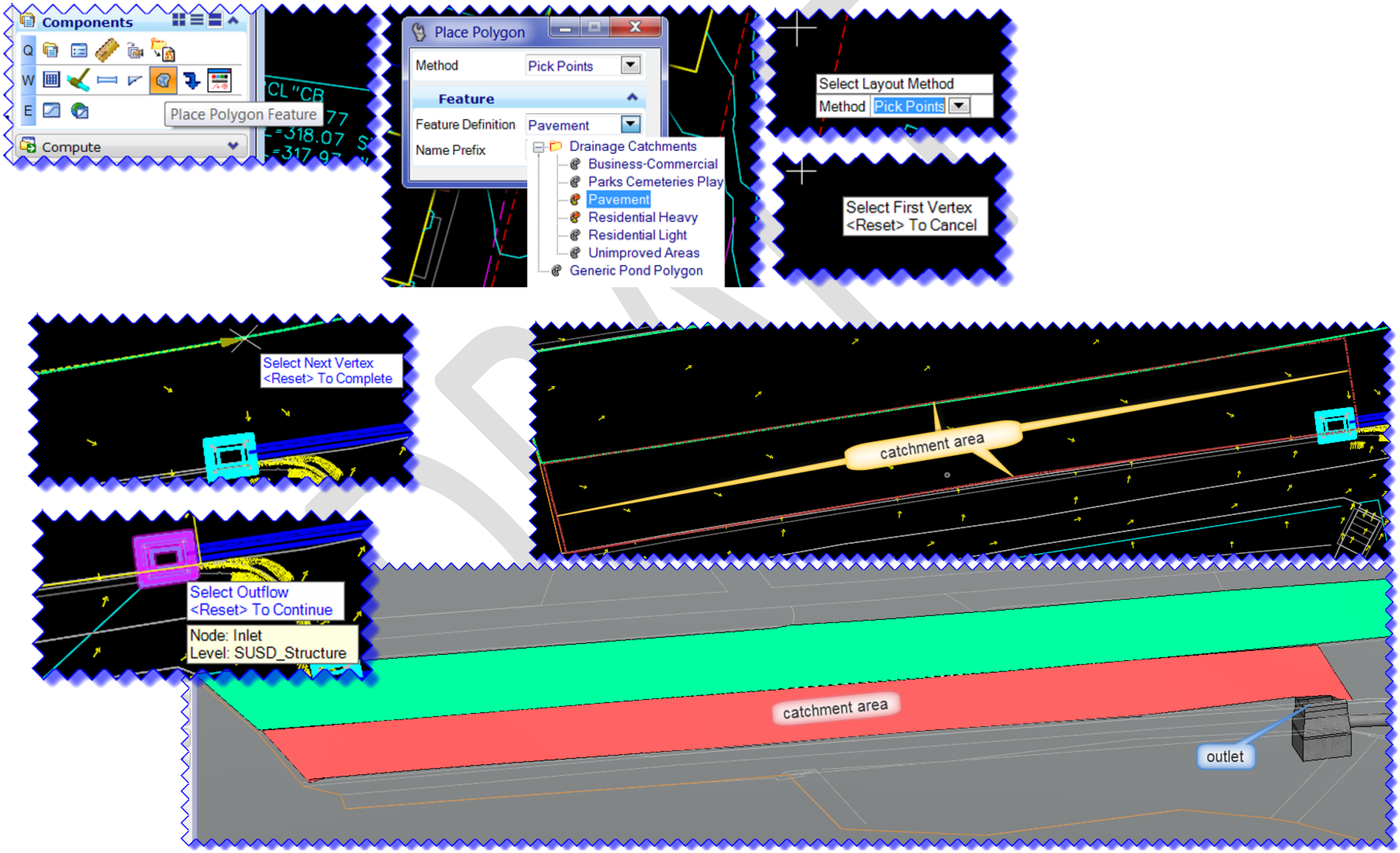


Another option is to *turn on* the Flow Arrows in the drainage terrain. This will show the direction storm water flows within the terrain.

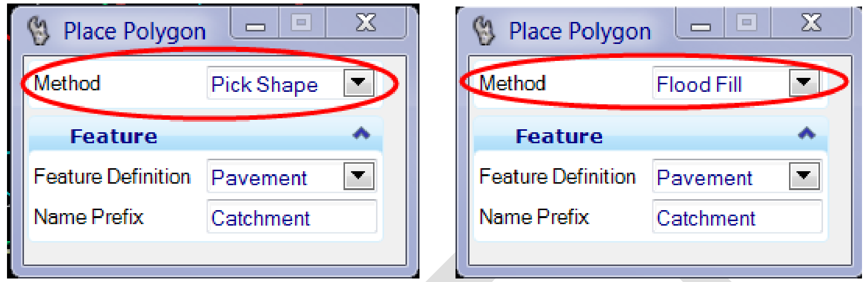


Define the catchment areas in the "Drainage" MicroStation DGN file using the **Place Polygon Feature** tool using the "**Pick Points**" Method. Pick the *Feature Definition* of the drainage catchment you are defining, pavement etc.

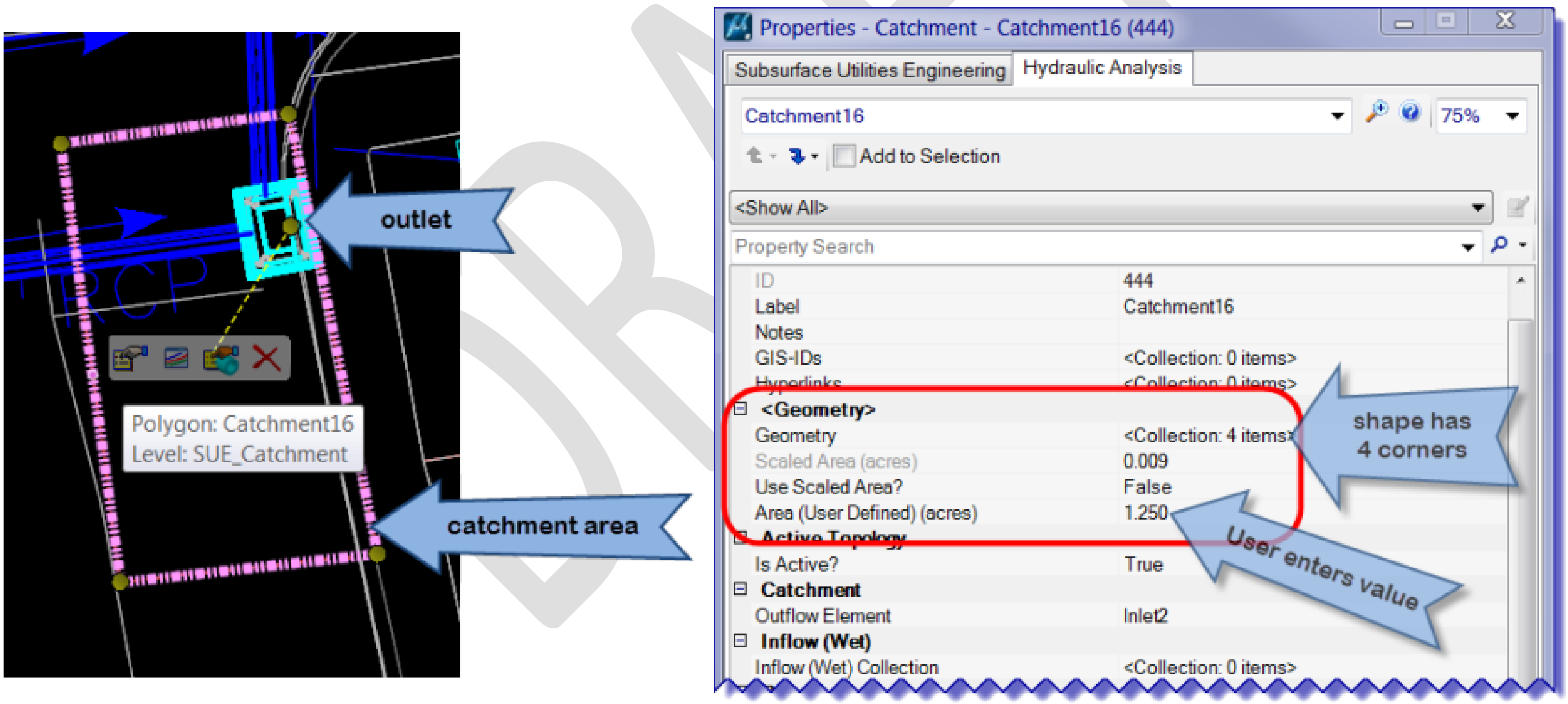
Follow the prompts: **Select Layout Method**, **Select First Vertex**, **Select Next Vertex** <Reset> To Complete, **Select Outflow**, Select reference surface.



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

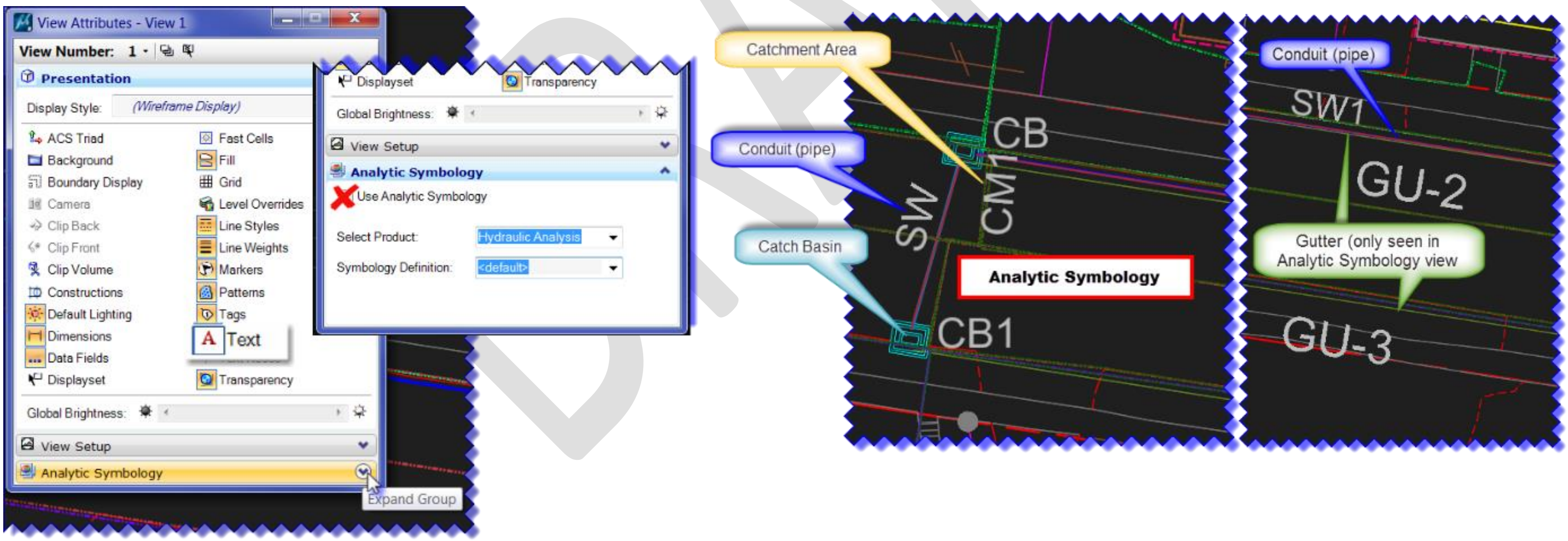
Gutters are the method by which a catch basin bypass flow is assigned to a downhill catch basin. Gutters only represent the hydraulic relationship between the inlets and are not accurate 2D or 3D models.

The following video is recommended:

Viewing Gutters with Analytic Symbology

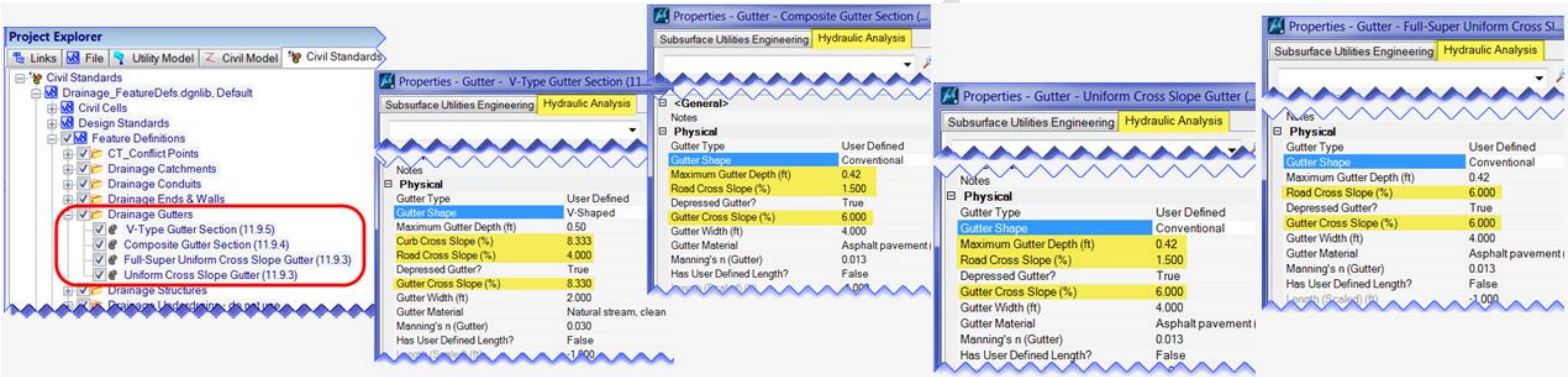
To display and add gutters to a drainage system the display in the 2D view has to be changed to Use **Analytic Symbology.**

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".

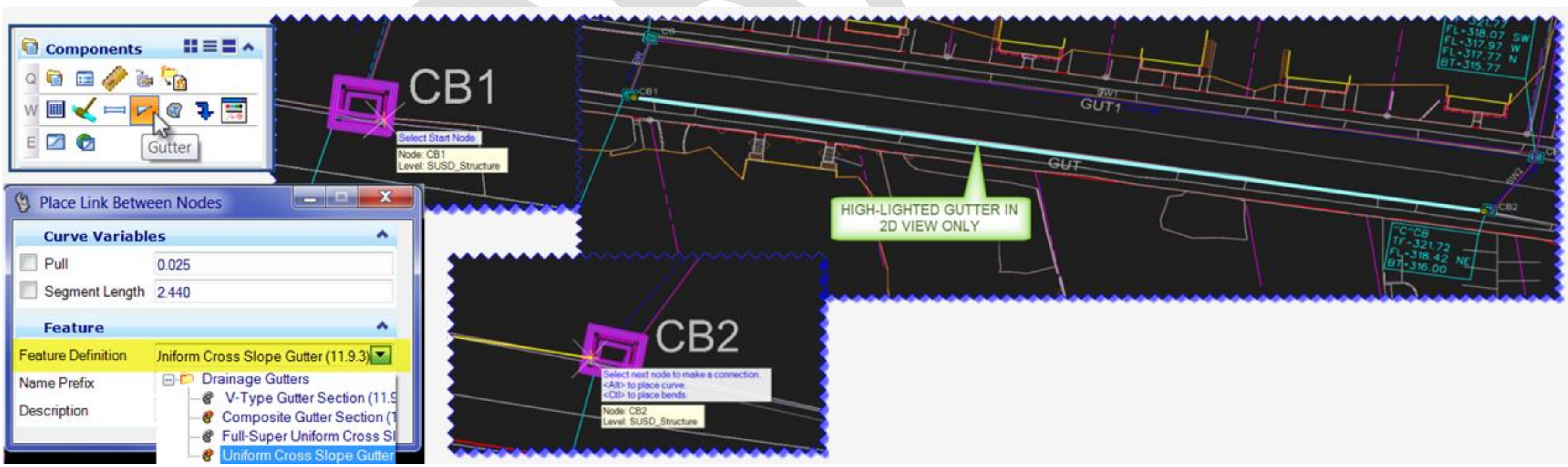


This will turn on "labels" in the plan view (2D view – Default). If the labels do not show, refresh the view.

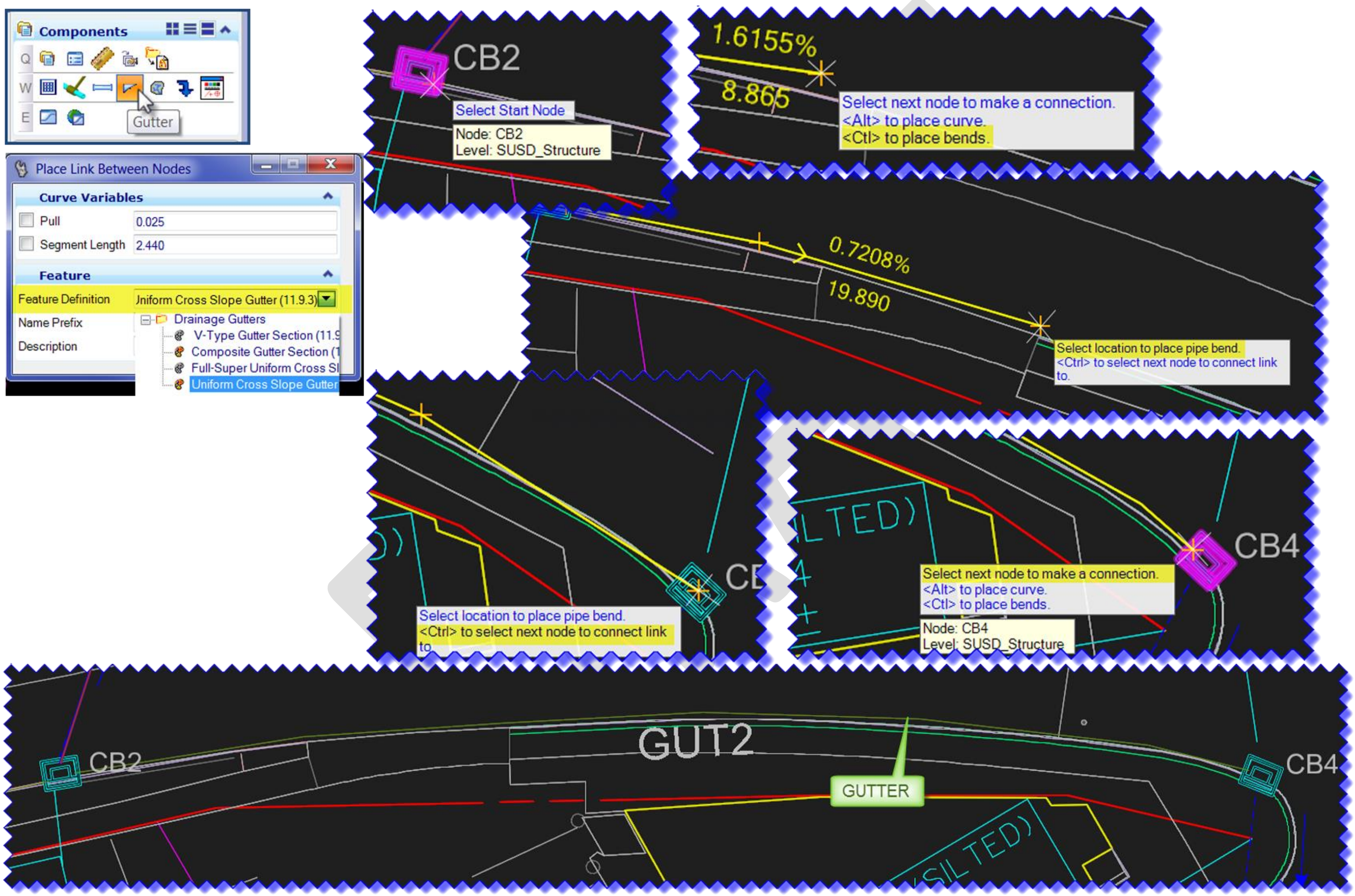
There are four (4) gutters available that correspond to the CTDOT Drainage Manual, Chapter 11 – Storm Drainage Systems, 11.9 Gutter Flow Calculations; 11.9.3 Uniform Cross Slope Procedure; 11.9.4 Composite Gutter Sections Procedure and 11.9.5 V-Type Gutter Sections Procedures. The engineer (user) has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



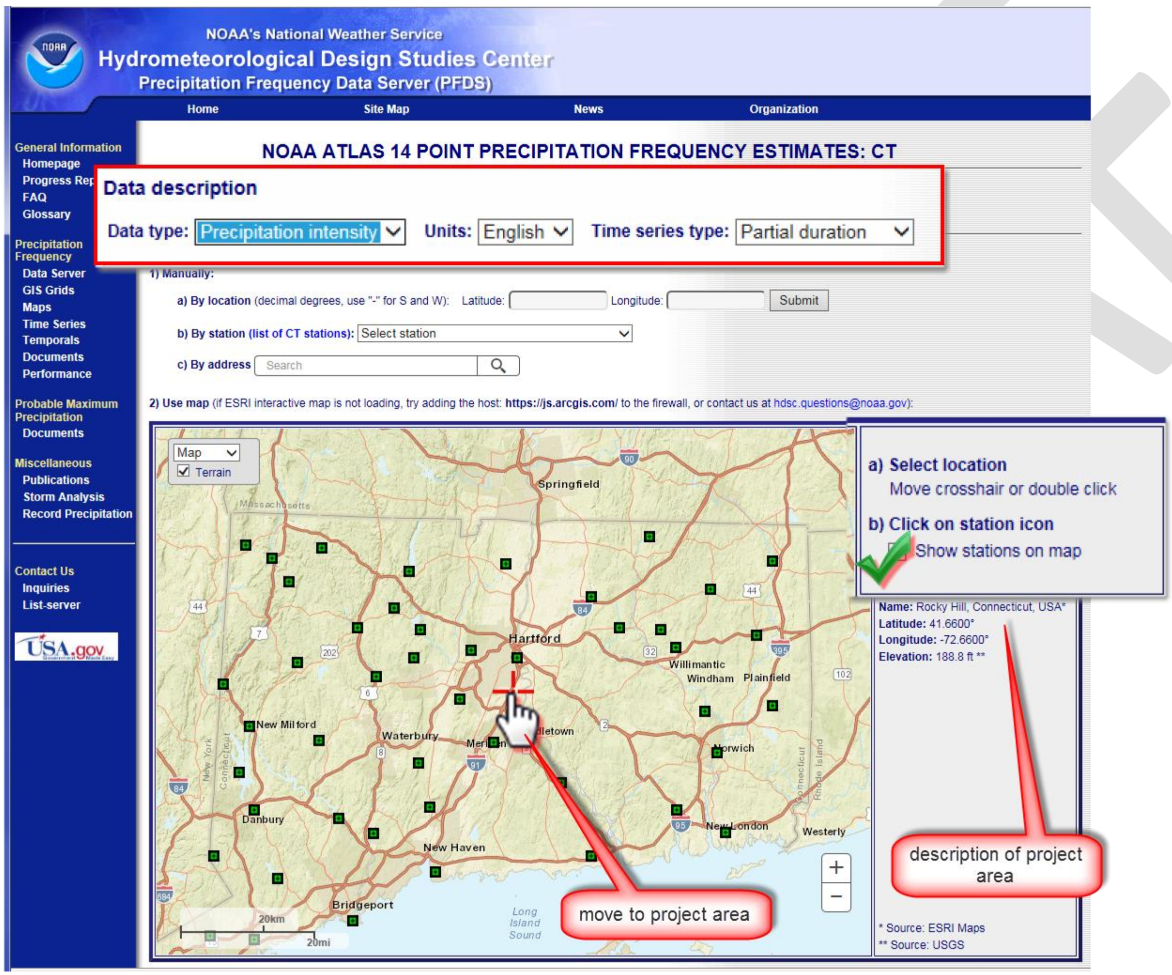
If the gutter is around a curve/bend use the Gutter tool, picking the start catch basin, then instead of picking the next catch basin, press the <Ctrl> key (Control key) and pick (select) the location to place the "pipe" bend (gutter bend), then to change back to the place node command press the <Ctrl>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



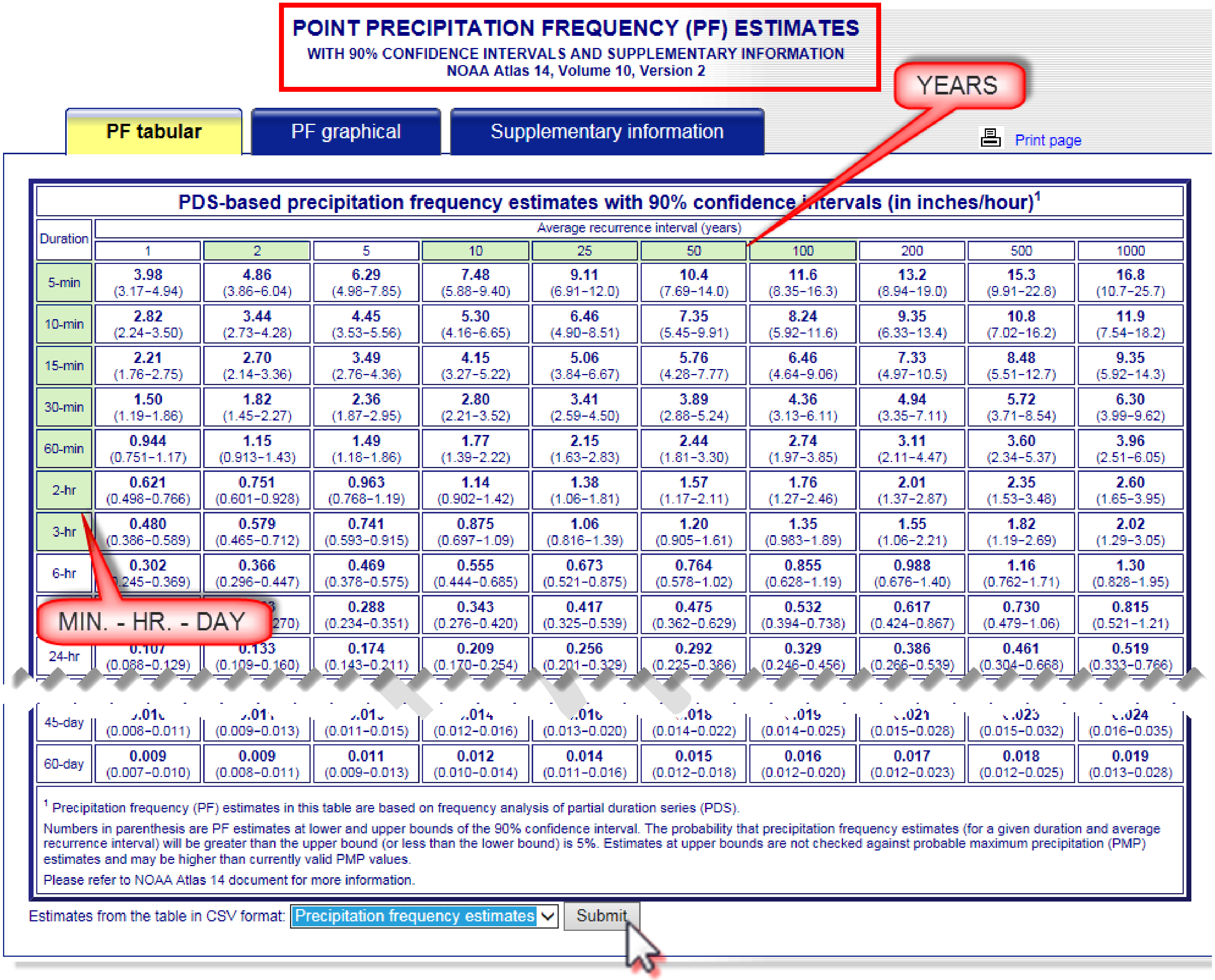
1.1.8. Defining Storm Events

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*.



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



PDS-based precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

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 ([illegible]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)
[illegible]	[illegible]	[illegible]	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	[illegible] (0.008-0.011)	[illegible] (0.009-0.013)	[illegible] (0.011-0.015)	[illegible] (0.012-0.016)	[illegible] (0.013-0.020)	[illegible] (0.014-0.022)	[illegible] (0.014-0.025)	[illegible] (0.015-0.028)	[illegible] (0.015-0.032)	[illegible] (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)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

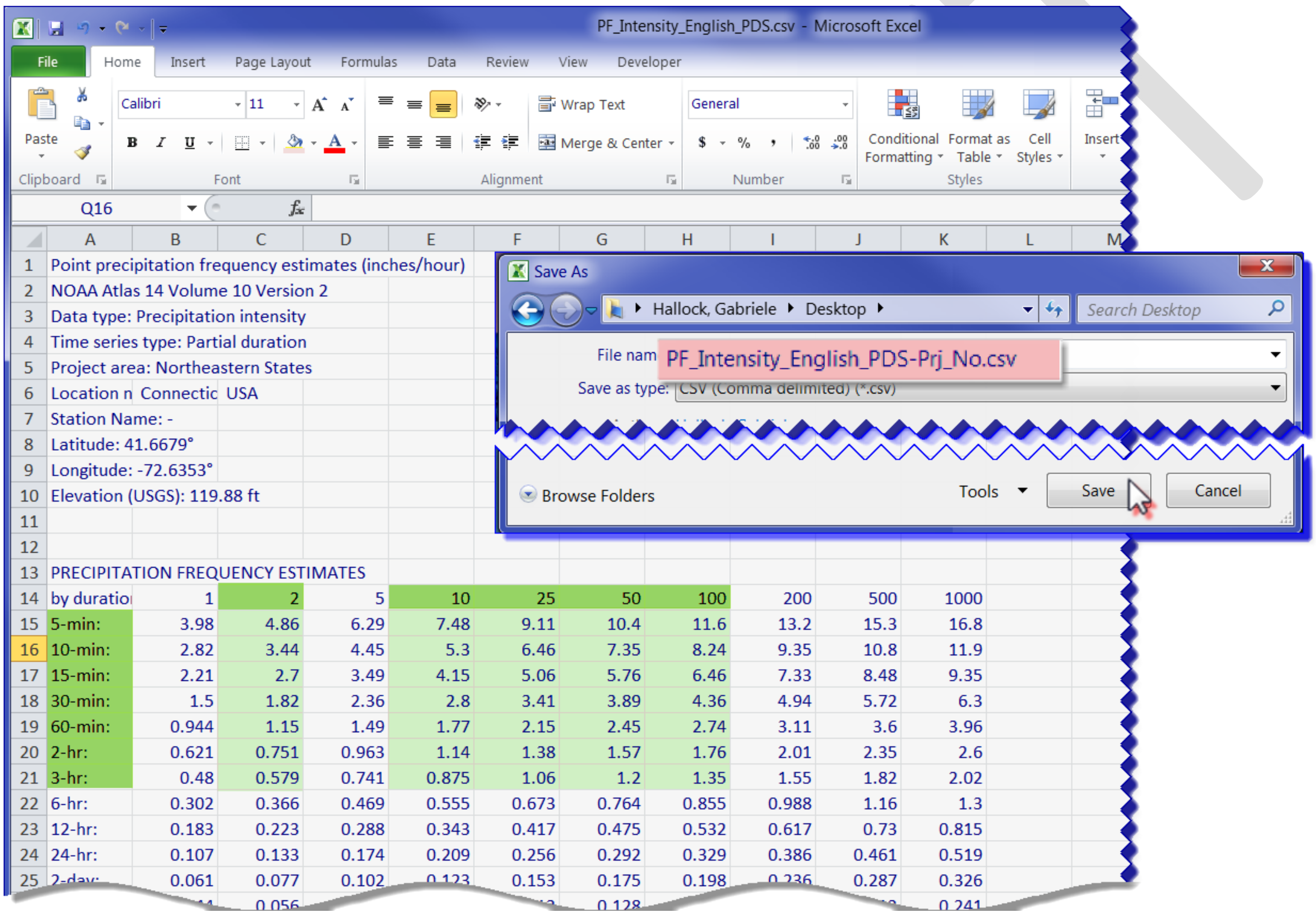
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper 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.

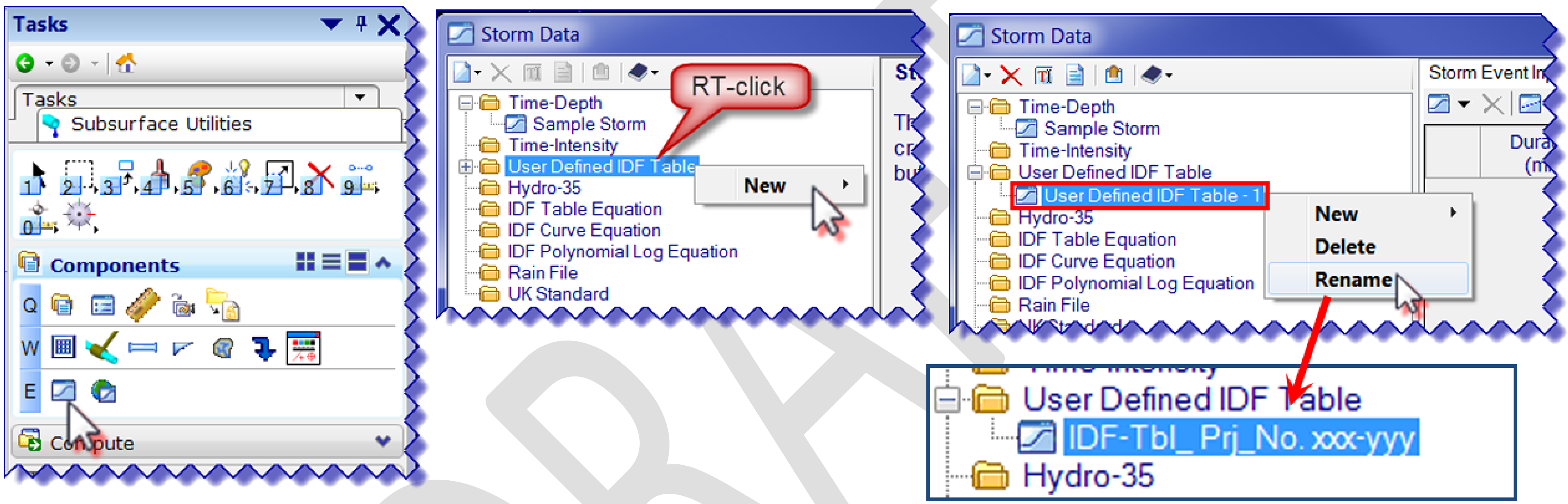
Estimates from the table in CSV format: Precipitation frequency estimates | Submit

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

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



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.**

Bentley Institute

Importing an IDF Table from a File

Bentley Institute

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.

A1 — Point precipitation frequency estimates (inches/hour)

saved from NOAA Atlas 14

	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 Connectic 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 duratio	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

A1 — by duration for ARI (years):

NOAA Atlas 14 edited & saved

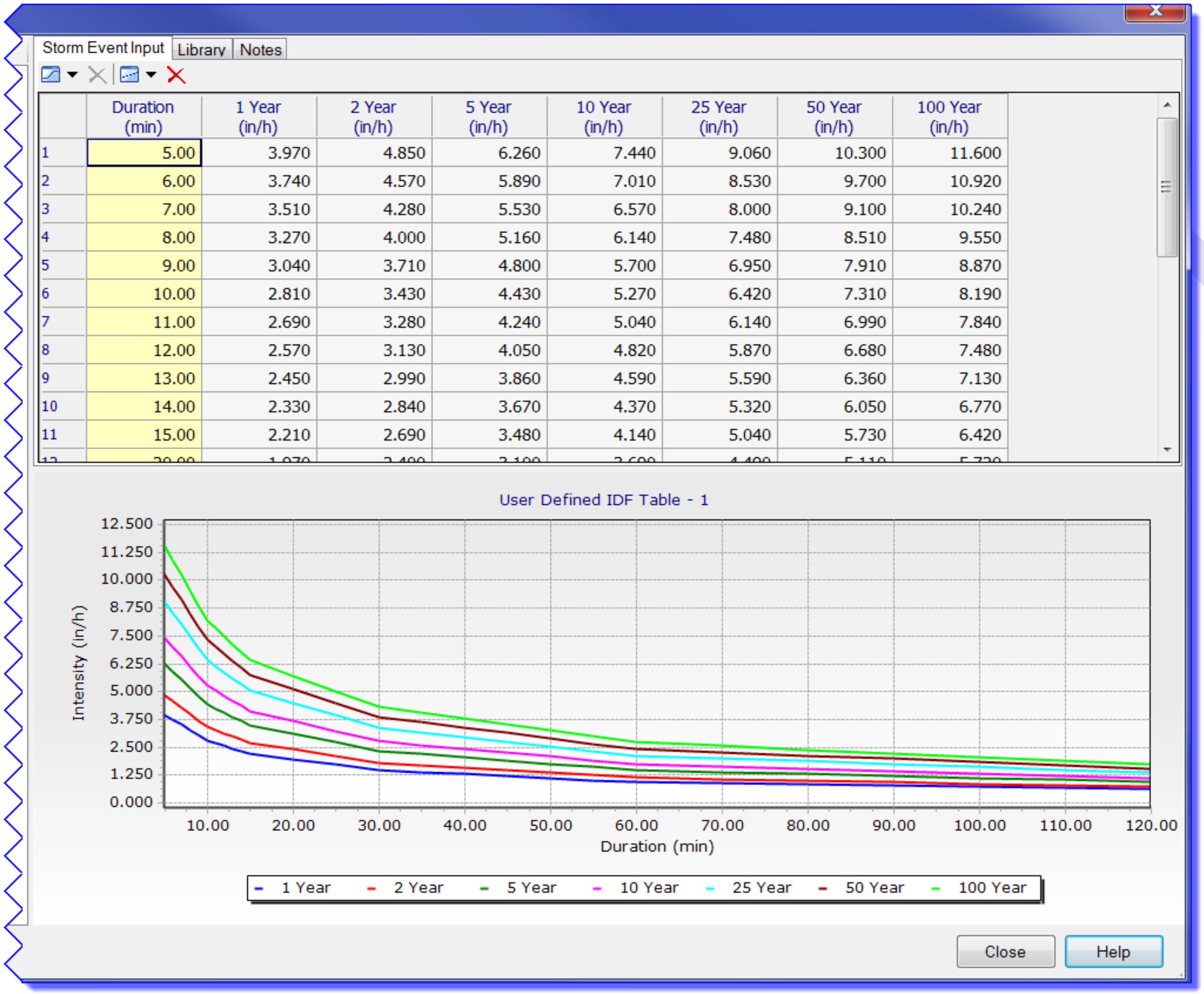
	A	B	C	D	E	F	G	H
1	by duratio	1	2	5	10	25	50	100
2	5	3.97	4.85	6.26	7.44	9.06	10.3	11.6
3	10	2.81	3.43	4.43	5.27	6.42	7.31	8.19
4	15	2.21	2.69	3.48	4.14	5.04	5.73	6.42
5	30	1.48	1.81	2.34	2.78	3.39	3.86	4.32
6	60	0.93	1.14	1.47	1.75	2.13	2.42	2.72
7	120	0.608	0.738	0.949	1.12	1.37	1.55	1.74
8	180	0.468	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 edit, interpolated & saved

	A	B	C	D	E	F	G	H
1	by duratio	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	[illegible]	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	[illegible]	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	2.34	2.78	3.39	3.86	4.32
16	35	1.39	[illegible]	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

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.

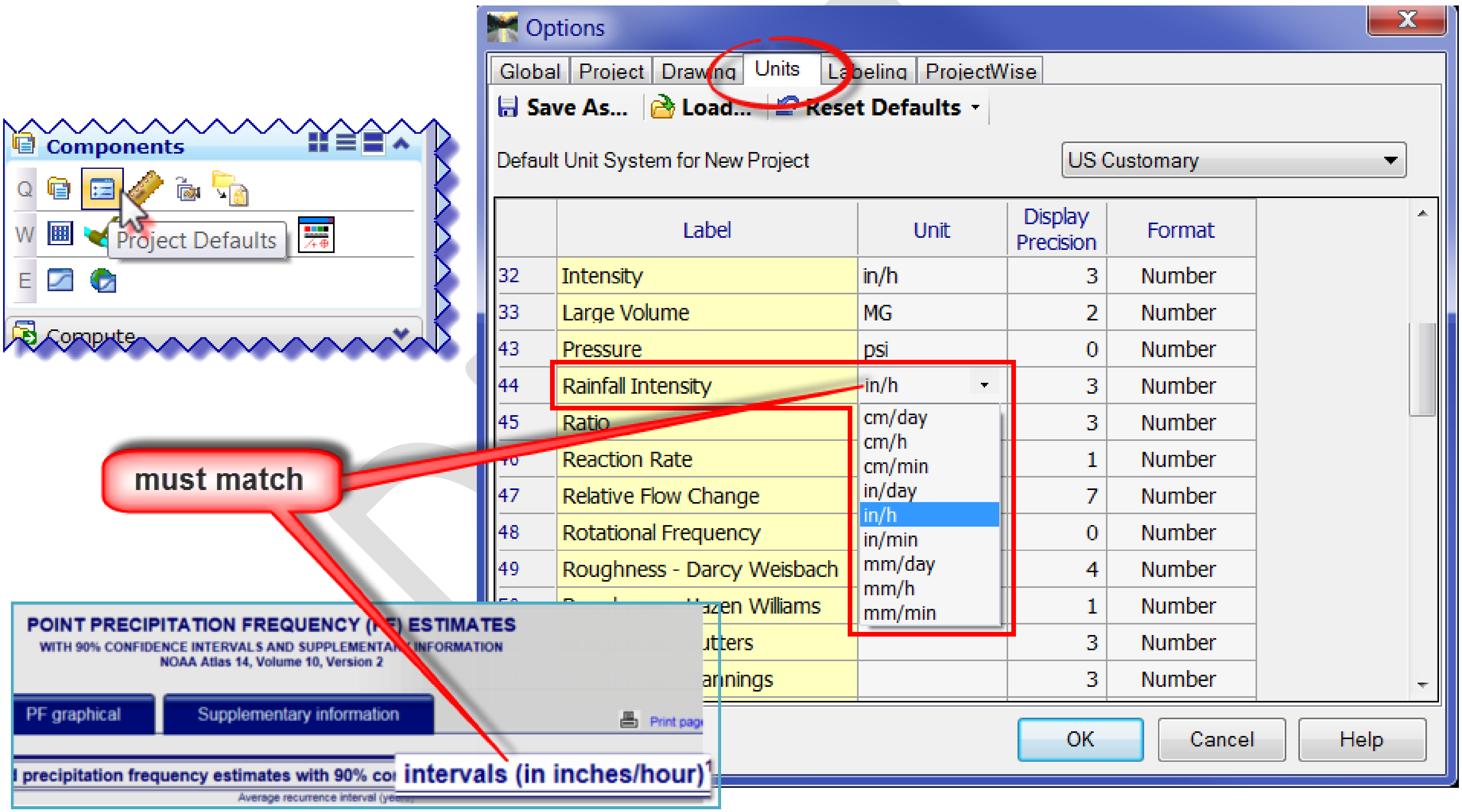
Your finished Storm Data for your project should look similar to this:



	Duration (min)	1 Year (in/h)	2 Year (in/h)	5 Year (in/h)	10 Year (in/h)	25 Year (in/h)	50 Year (in/h)	100 Year (in/h)
1	5.00	3.970	4.850	6.260	7.440	9.060	10.300	11.600
2	6.00	3.740	4.570	5.890	7.010	8.530	9.700	10.920
3	7.00	3.510	4.280	5.530	6.570	8.000	9.100	10.240
4	8.00	3.270	4.000	5.160	6.140	7.480	8.510	9.550
5	9.00	3.040	3.710	4.800	5.700	6.950	7.910	8.870
6	10.00	2.810	3.430	4.430	5.270	6.420	7.310	8.190
7	11.00	2.690	3.280	4.240	5.040	6.140	6.990	7.840
8	12.00	2.570	3.130	4.050	4.820	5.870	6.680	7.480
9	13.00	2.450	2.990	3.860	4.590	5.590	6.360	7.130
10	14.00	2.330	2.840	3.670	4.370	5.320	6.050	6.770
11	15.00	2.210	2.690	3.480	4.140	5.040	5.730	6.420

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.

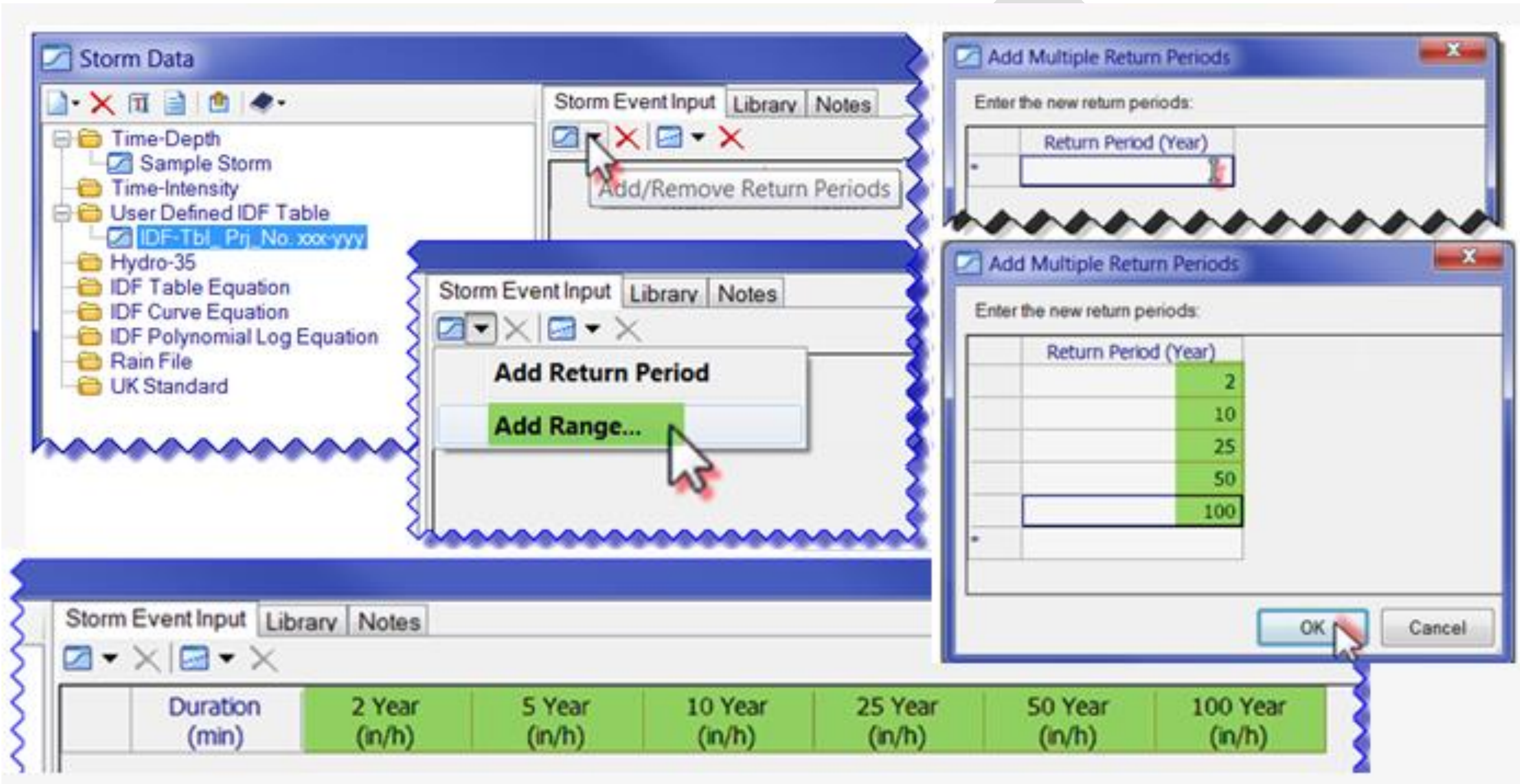
Click on Project Defaults icon, in the Components box, click on the Units tab. Scroll down to the Rainfall Intensity and ensure that it matches the units in the IDF file. Click OK.



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.

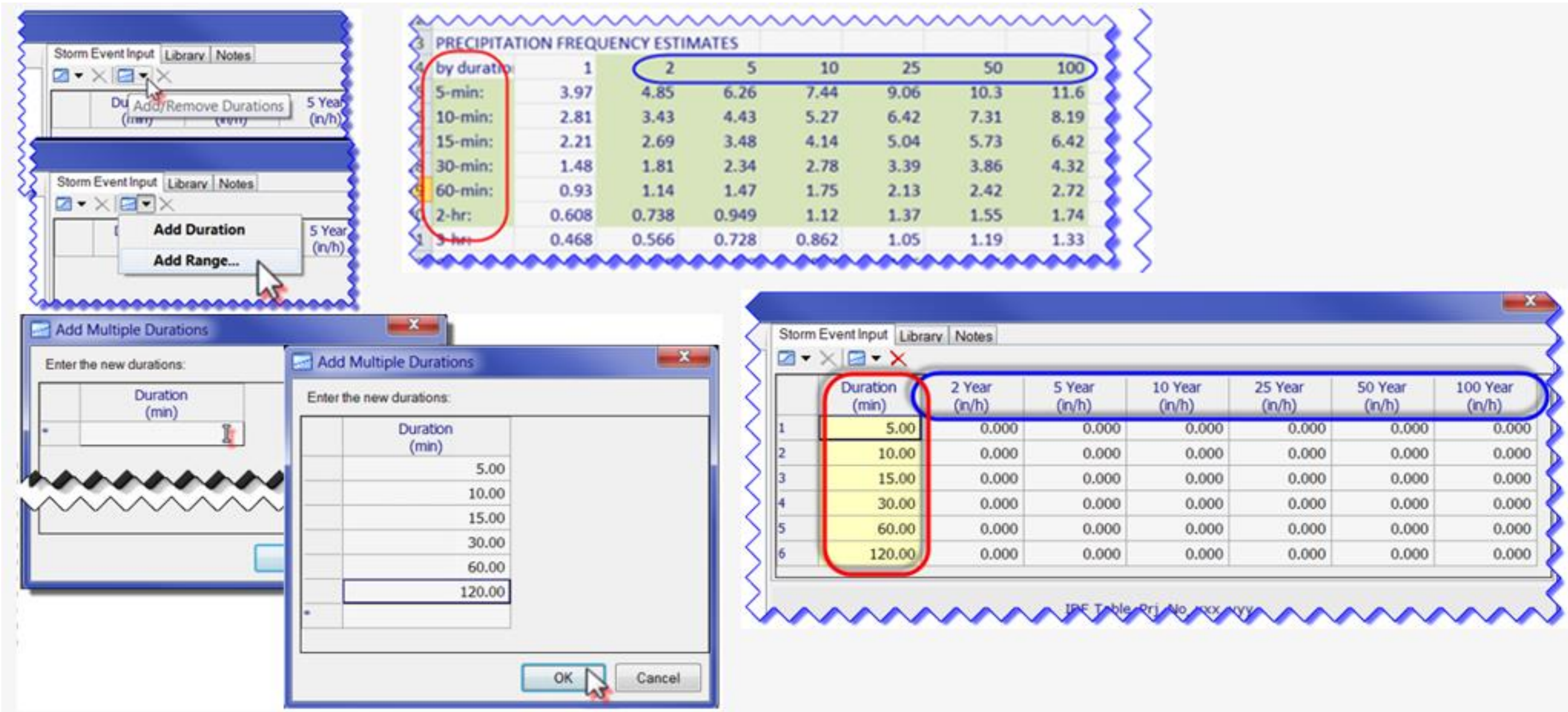
Open the saved *PF_Intensity_English_PDS.csv* file with Excel.



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.

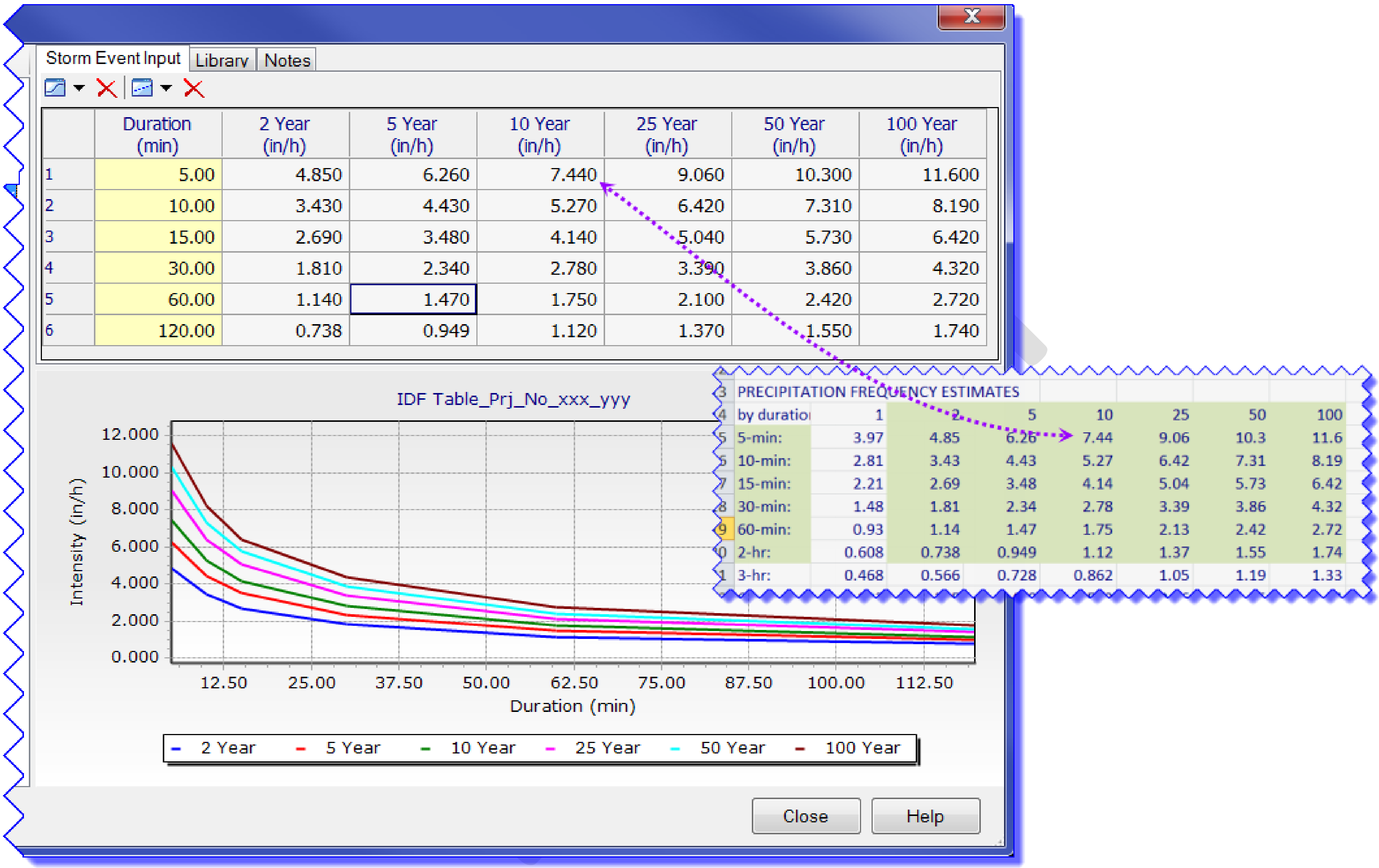
Click OK.



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:



	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)
1	5.00	4.850	6.260	7.440	9.060	10.300	11.600
2	10.00	3.430	4.430	5.270	6.420	7.310	8.190
3	15.00	2.690	3.480	4.140	5.040	5.730	6.420
4	30.00	1.810	2.340	2.780	3.390	3.860	4.320
5	60.00	1.140	1.470	1.750	2.100	2.420	2.720
6	120.00	0.738	0.949	1.120	1.370	1.550	1.740

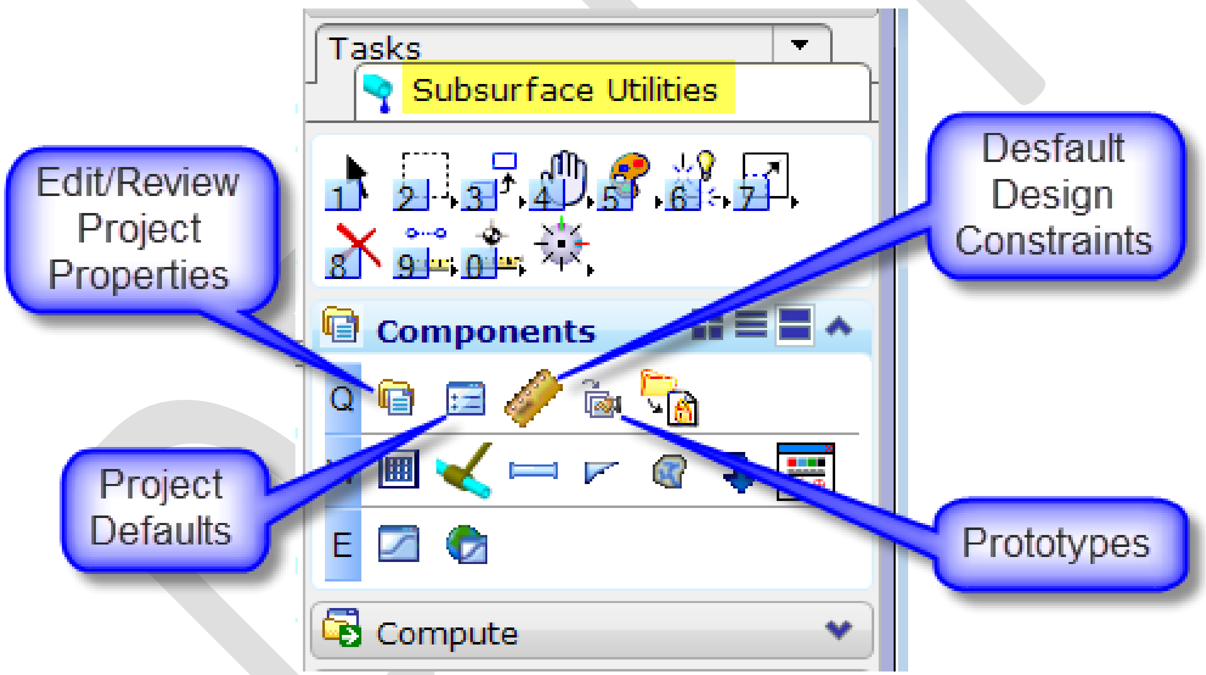
PRECIPITATION FREQUENCY ESTIMATES							
by duratio	1	2	5	10	25	50	100
5-min:	3.97	4.85	6.26	7.44	9.06	10.3	11.6
10-min:	2.81	3.43	4.43	5.27	6.42	7.31	8.19
15-min:	2.21	2.69	3.48	4.14	5.04	5.73	6.42
30-min:	1.48	1.81	2.34	2.78	3.39	3.86	4.32
60-min:	0.93	1.14	1.47	1.75	2.13	2.42	2.72
2-hr:	0.608	0.738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

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

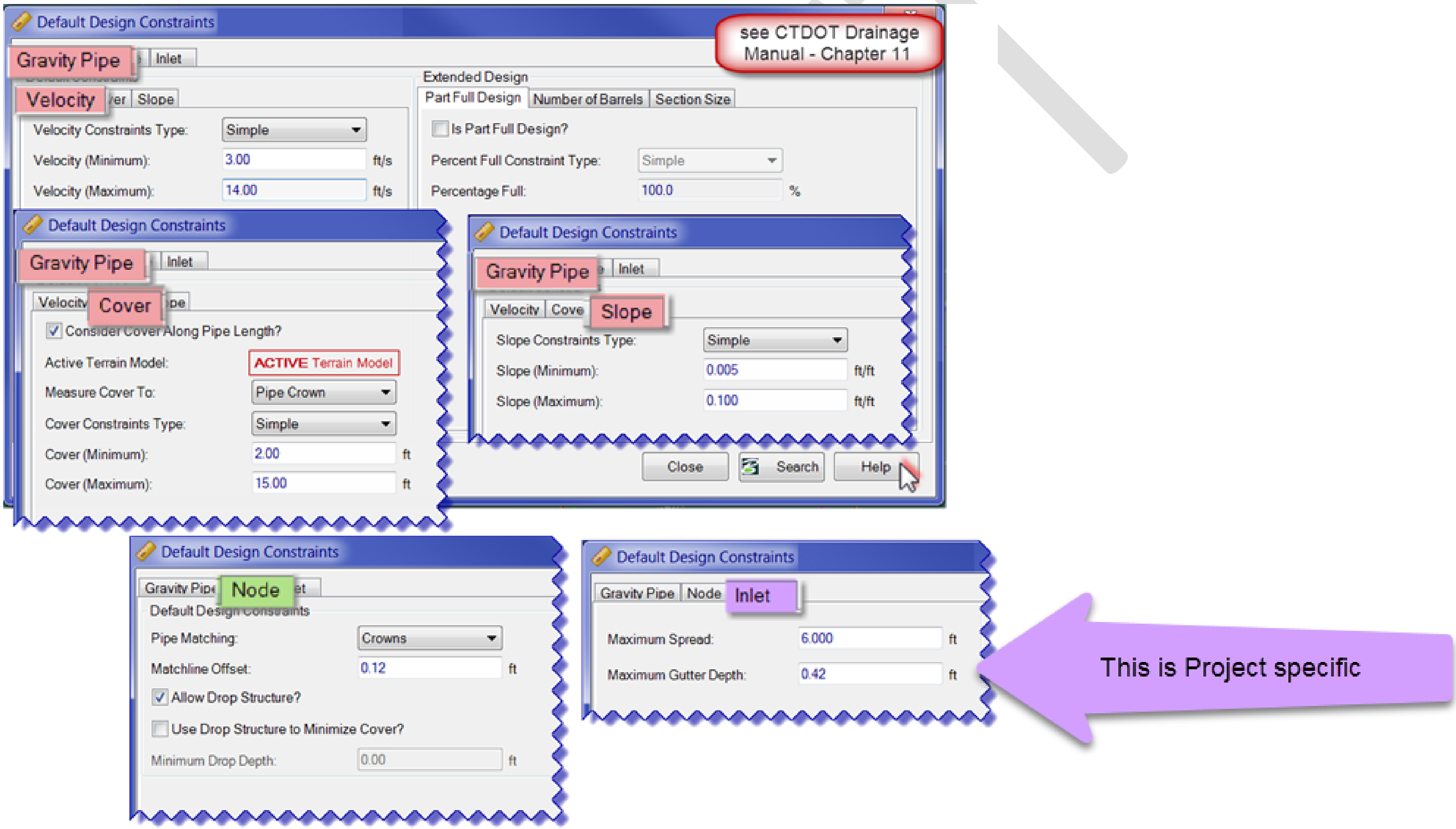
Under Components the engineer will set project properties, defaults, design constraints and prototypes specific to the project. The most common data has been set to follow the *CTDOT Drainage Manual*, but it is important the engineer reviews and edits these to fit project needs. See the Help menu for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



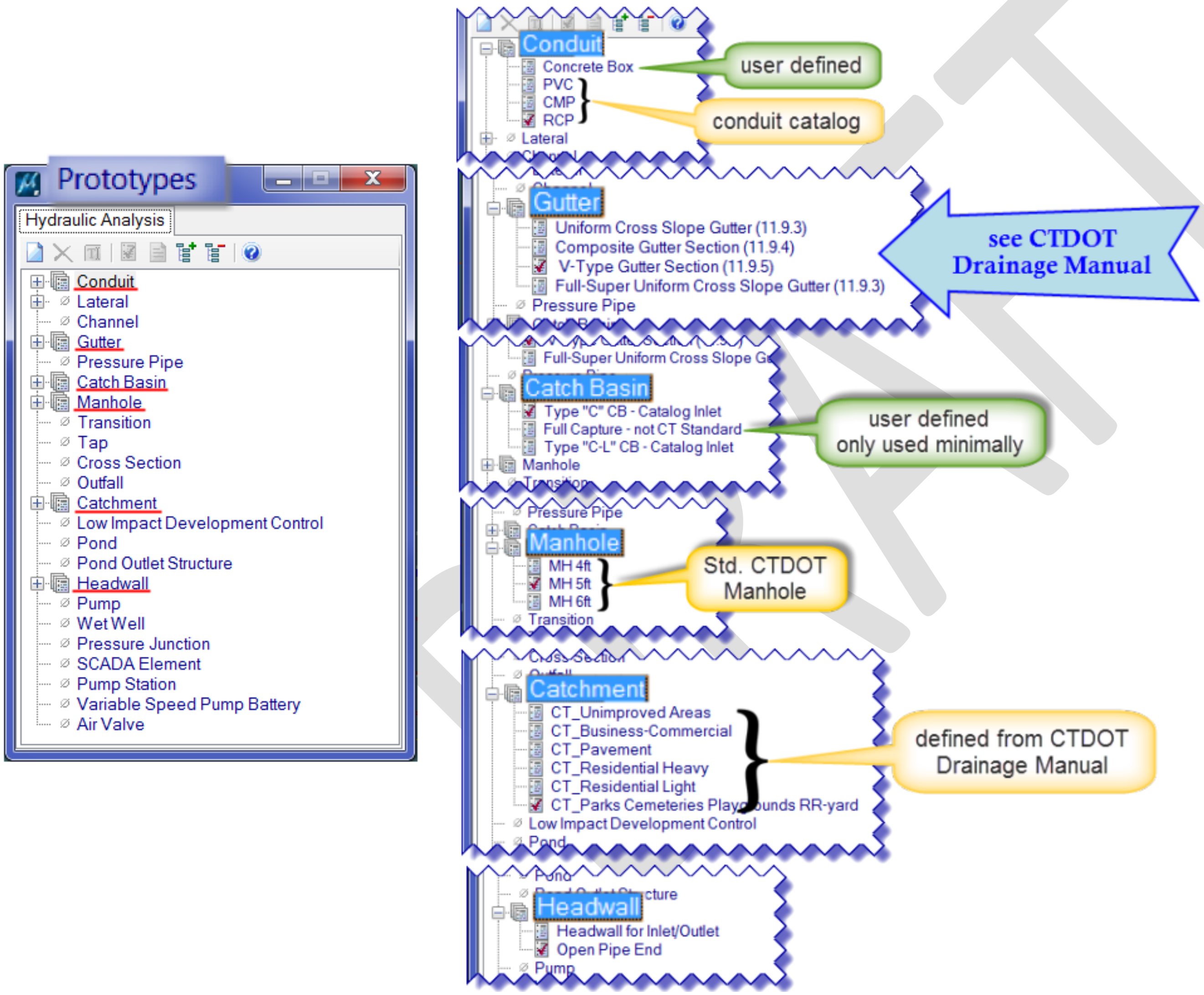
Edit/Review Project Properties - enter information for your project and system; such as: project number, project title, project engineer, project designer, location, systems, station to station, year storm(s) used and assumptions made.

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.

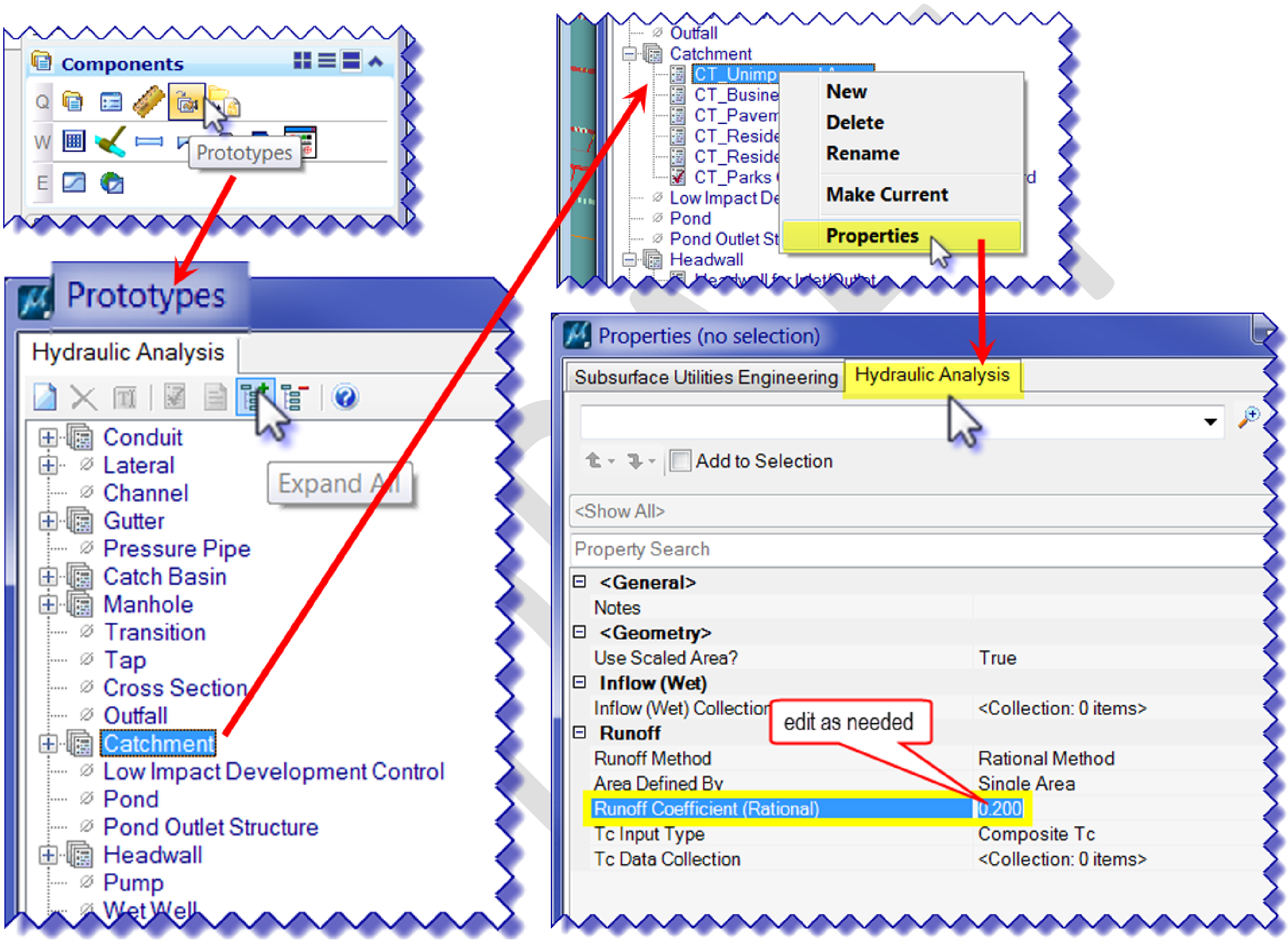


Prototypes – are used to *define the hydraulic properties of features*. A prototype works in cooperation with element templates and feature definitions to define the characteristics of a drainage feature. The most widely used conduits, gutters, catch basins, manholes, catchments and headwalls have been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

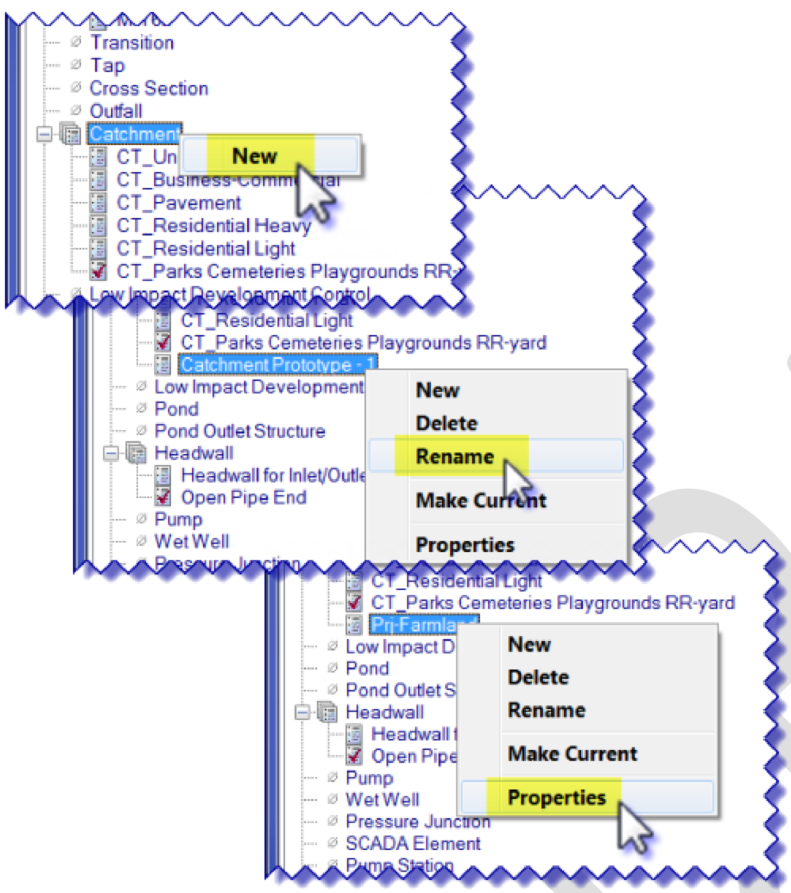


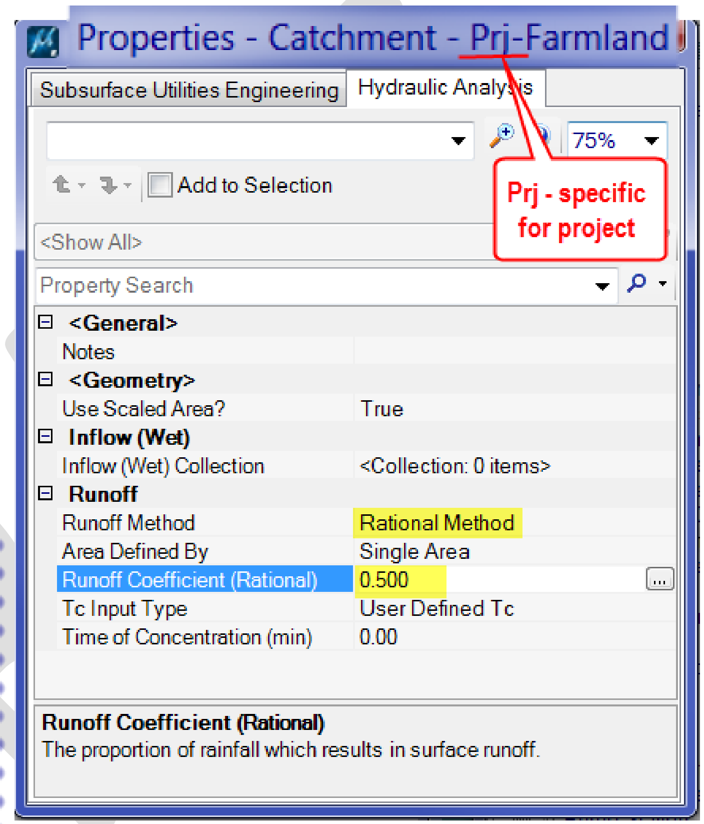
<u>Conduits</u> and <u>Catch Basins</u> have the hydraulic data tabulated in catalogs and are selected as needed within the Hydraulic Analysis window.

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:

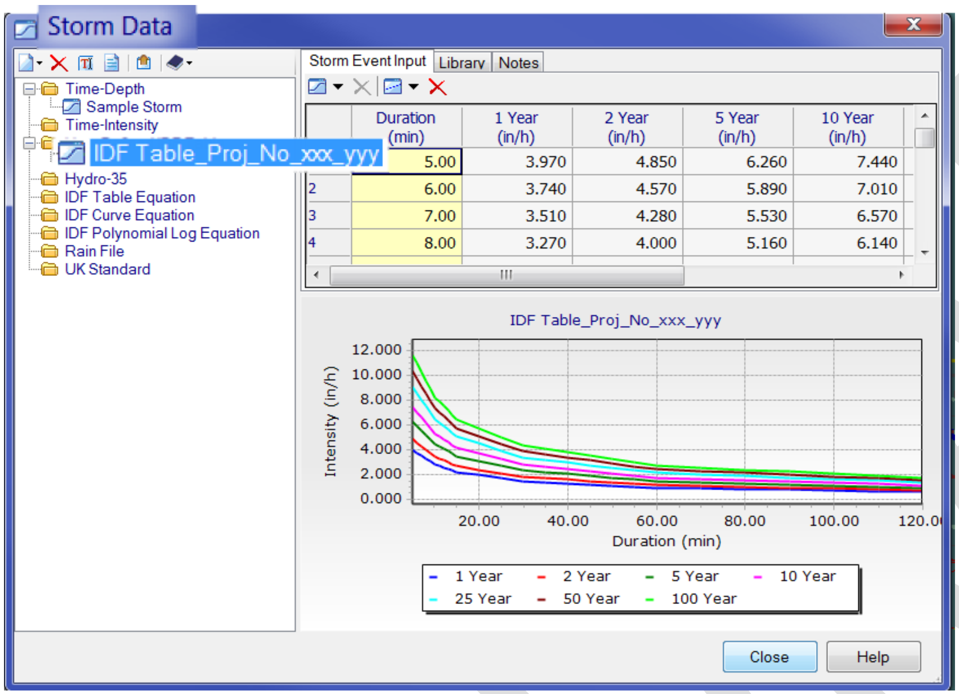
Reviewing a Catchment Feature Definition

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:

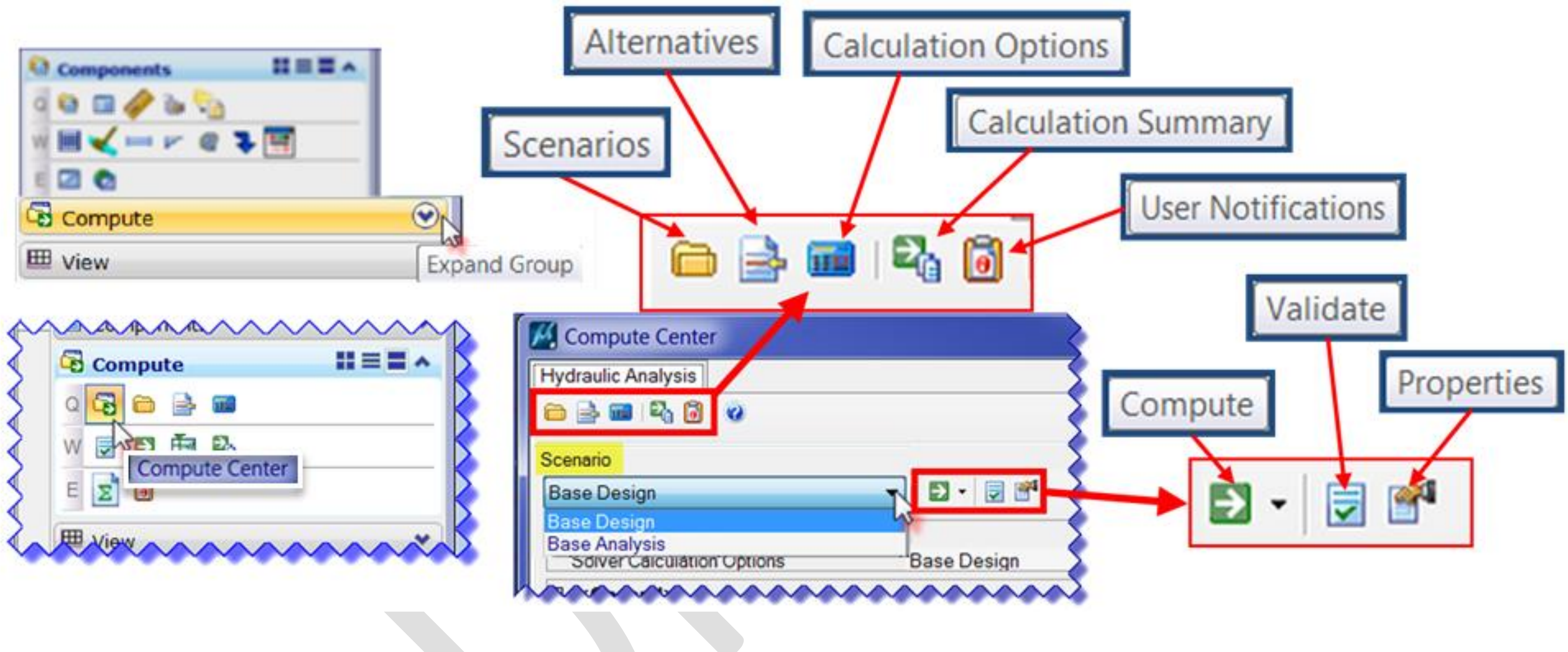
- 2-year for water handling;
- 10-year for the drainage system and
- 25-year for sag condition

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

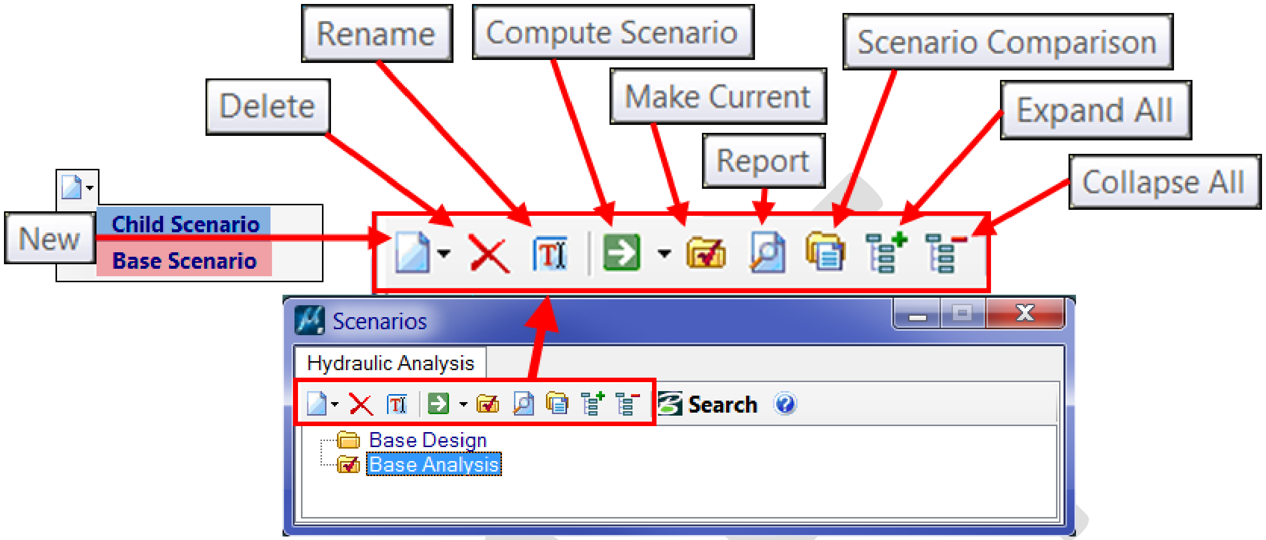
Click on Global Storm Events icon, you should see one Alternative, Base Rainfall Runoff for Sample Storm, when you first open the Global Storm Runoff. This will change after project alternatives are set-up. Close.

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 <u>will</u> resize pipes, change inverts to Default Design Constraints. Base Analysis <u>will not</u> 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.



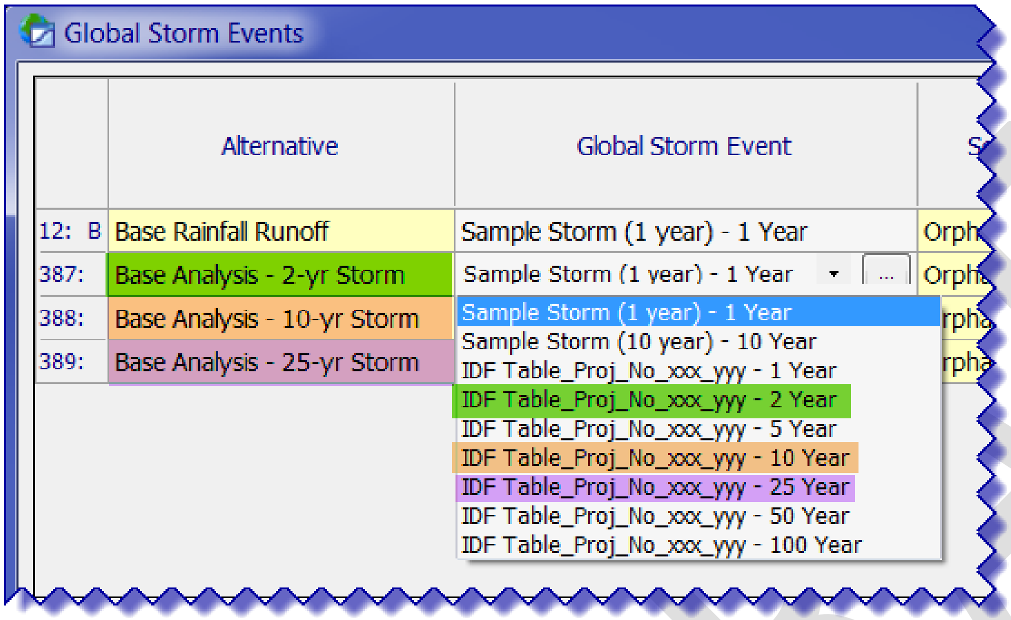
Right-click on Base Analysis and click on Properties, click on the Hydraulic Analysis tab in properties. Here all available Alternatives are shown. Click on Rainfall Runoff, the default shows **Base Rainfall Runoff** and there is a down arrow, click there and you can select <New…>. In the Create New 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:

Bentley Institute
Managing Scenarios – Introduction and Overview

Bentley Institute
Reviewing Calculation Options and Scenario Properties

Bentley Institute
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:

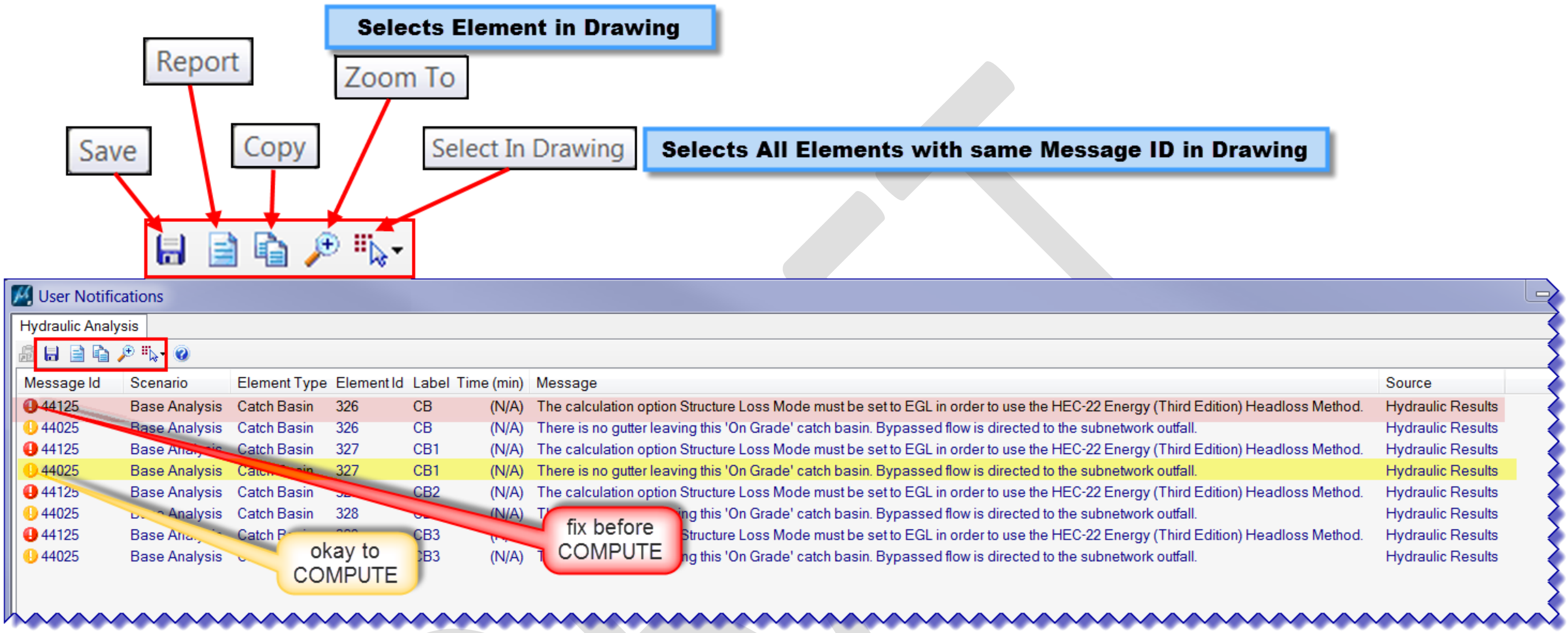
Validating a Scenario

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

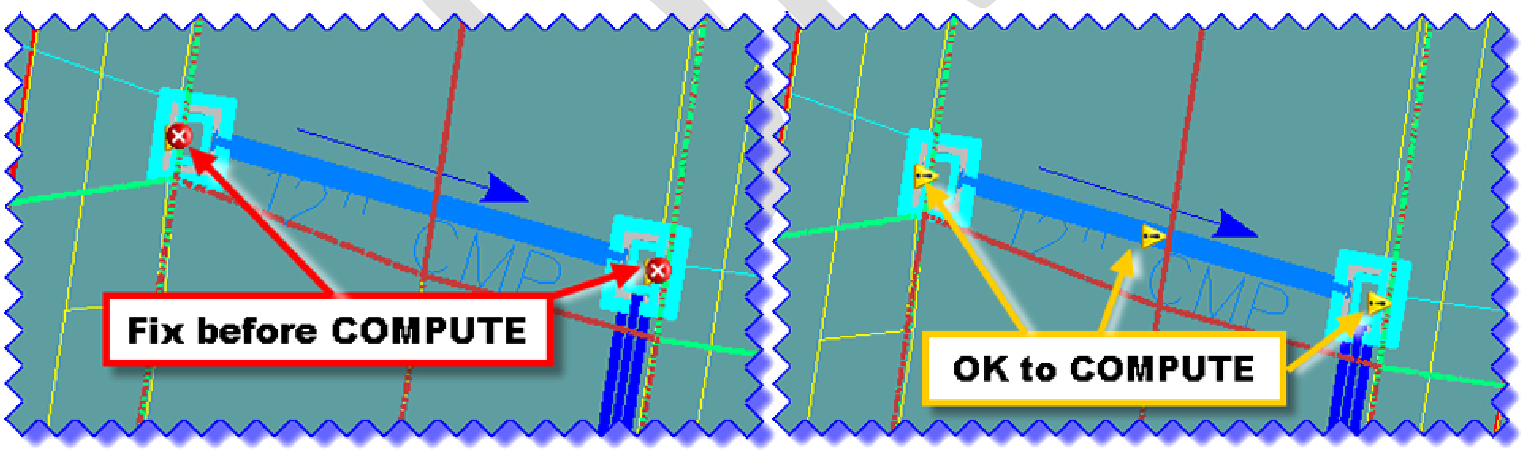
Click on User Notification icon: the notifications window will come up displaying a list of warnings generated during the validation process. There are two types:

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

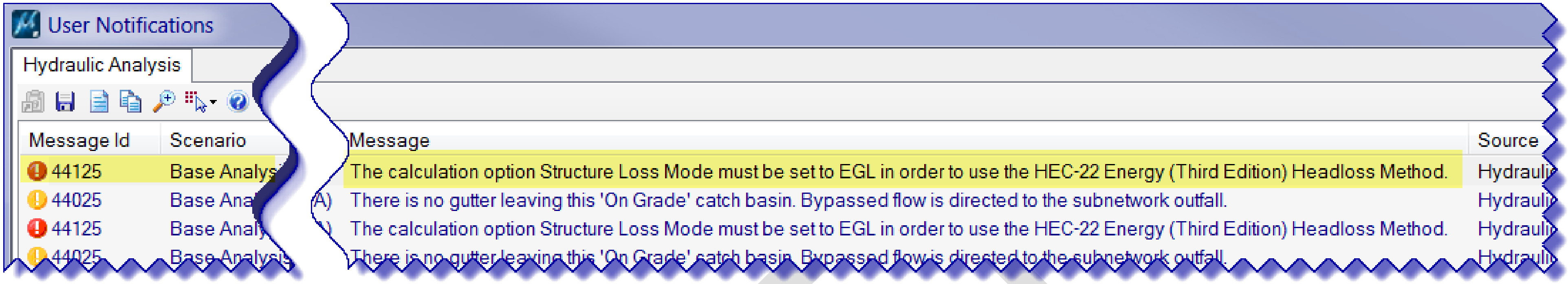
In the User Notification box, you will see Messages with the RED and/or Yellow icon as well as a tool box (see below).



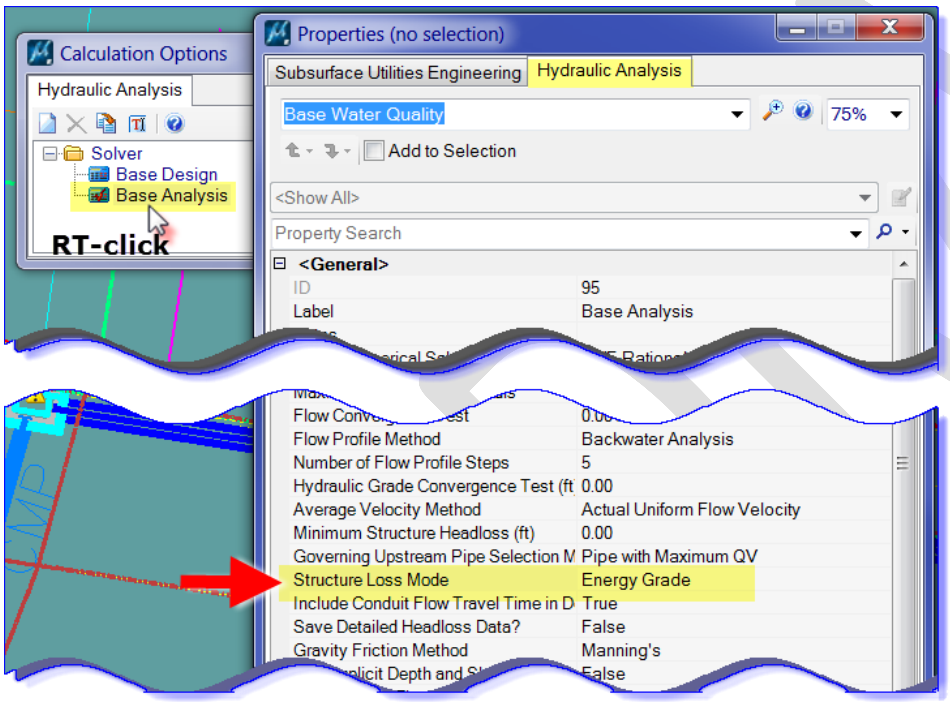
Errors look like this in drawing/screen.

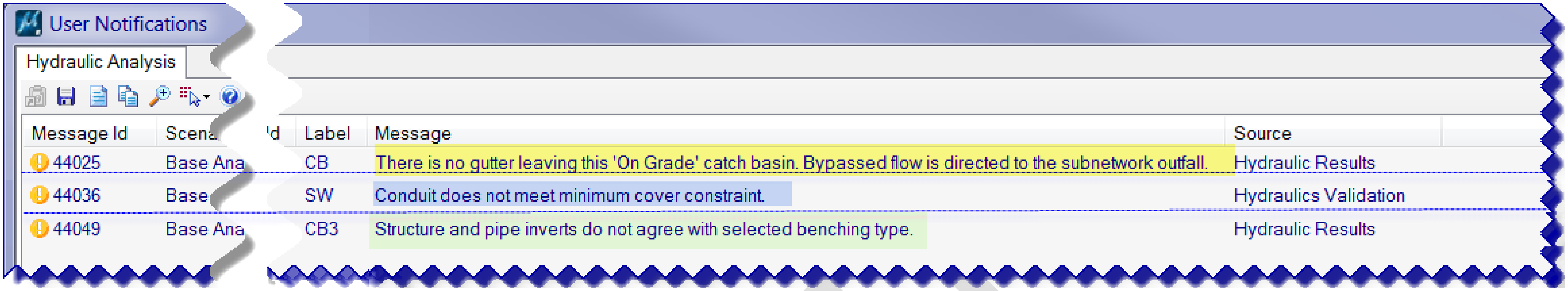


Examples of User Notifications:



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





<u>Meaning:</u>

→ 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.

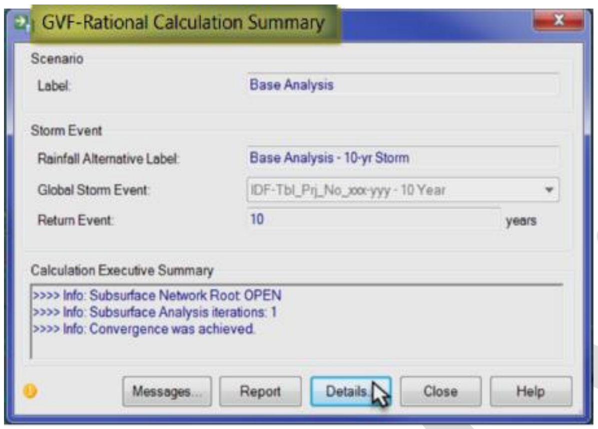
→ benching method is set to HEC-22 Benching Method = Flat in accordance to the CTDOT Drainage Manual.

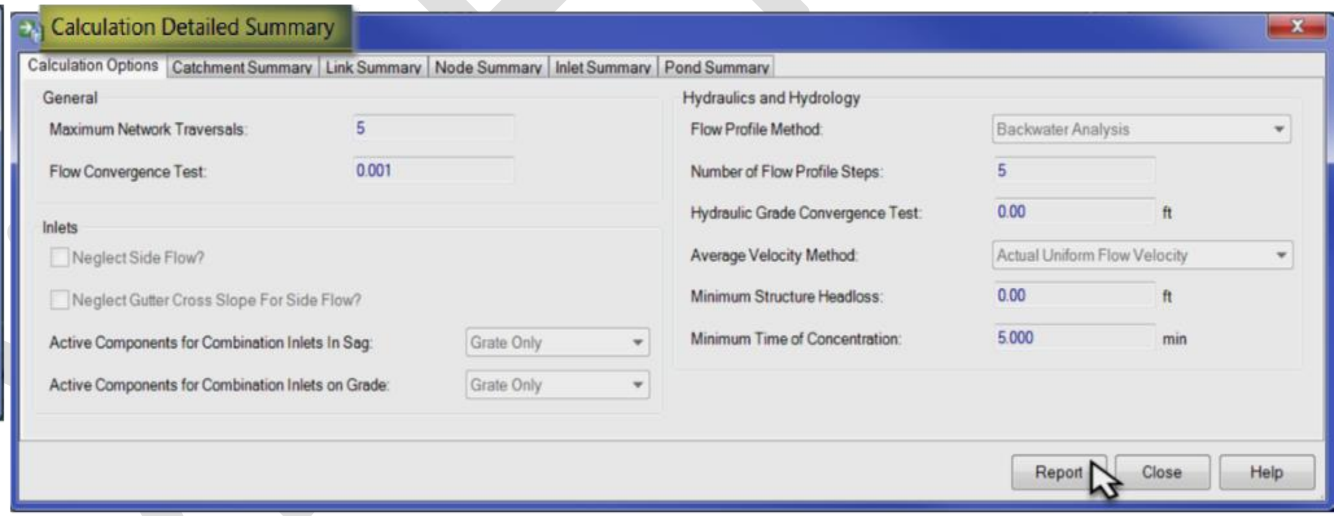
2.1.4. Compute and Result Formats

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

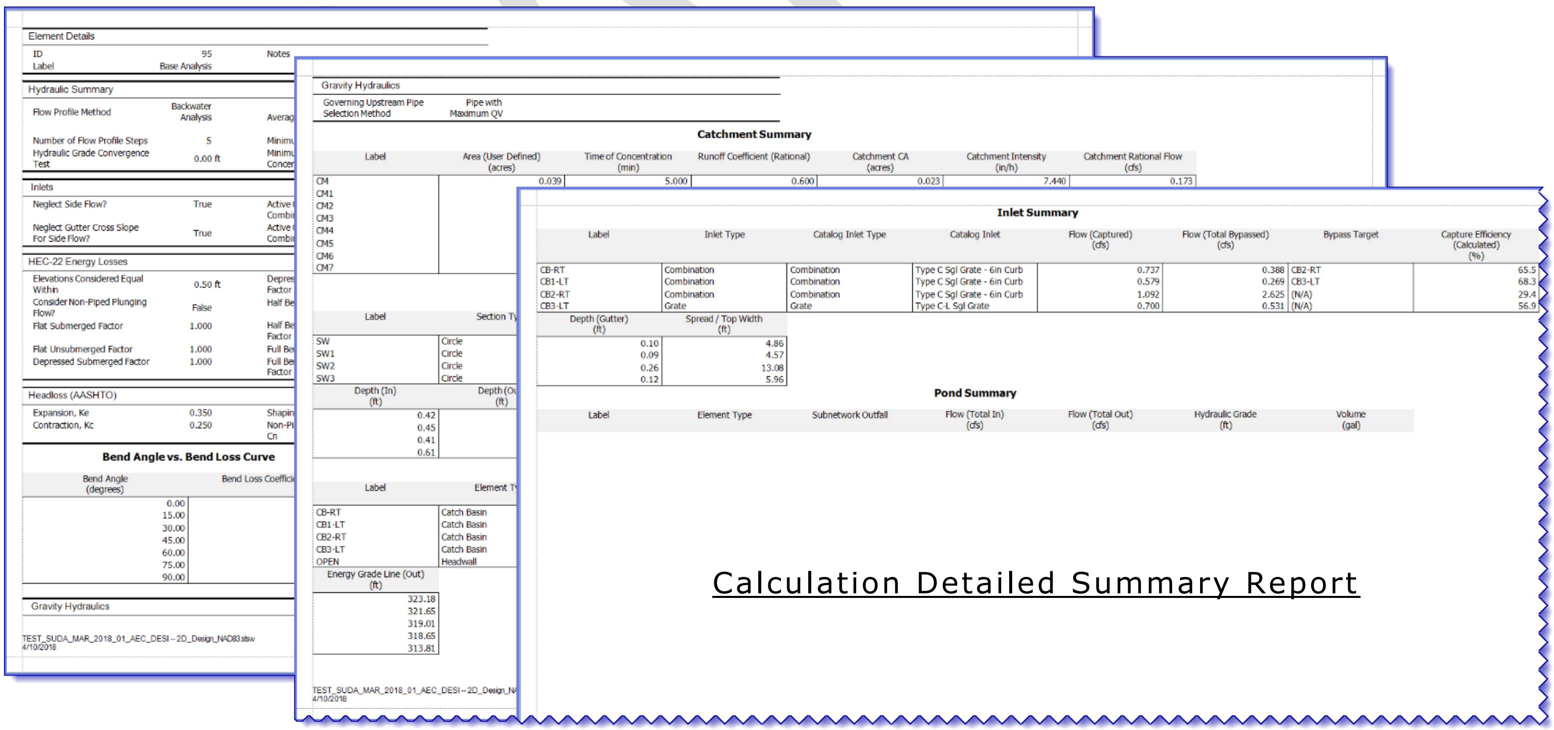
Label	Element Type	Subnetwork Outfall	Flow (Total In) (cfs)	Flow (Total Out) (cfs)	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)
CB	Catch Basin	OPEN	0.86	0.86	325.56	320.46	323.23	323.23

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

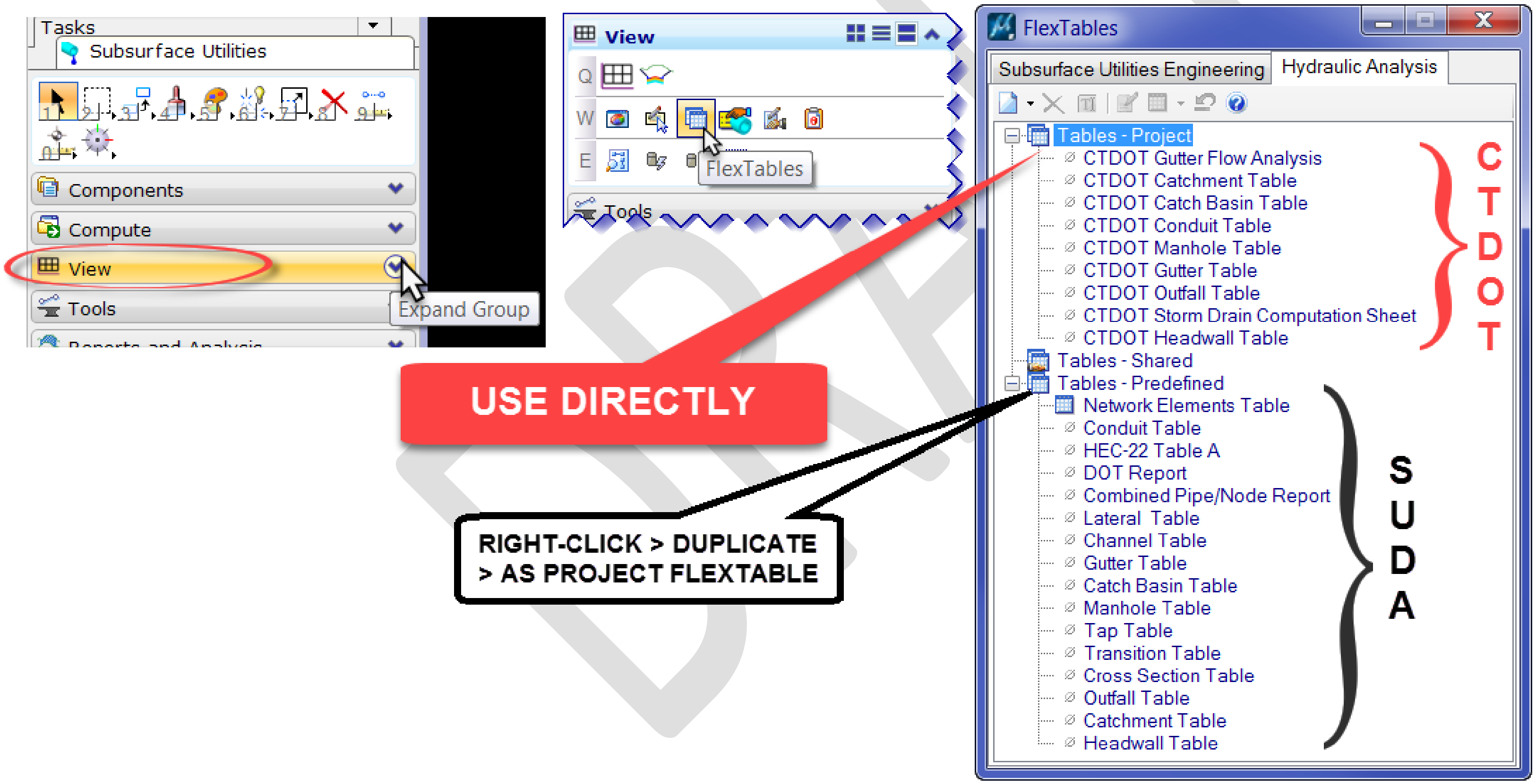


<u>Calculation Detailed Summary Report</u>

B. Flextables

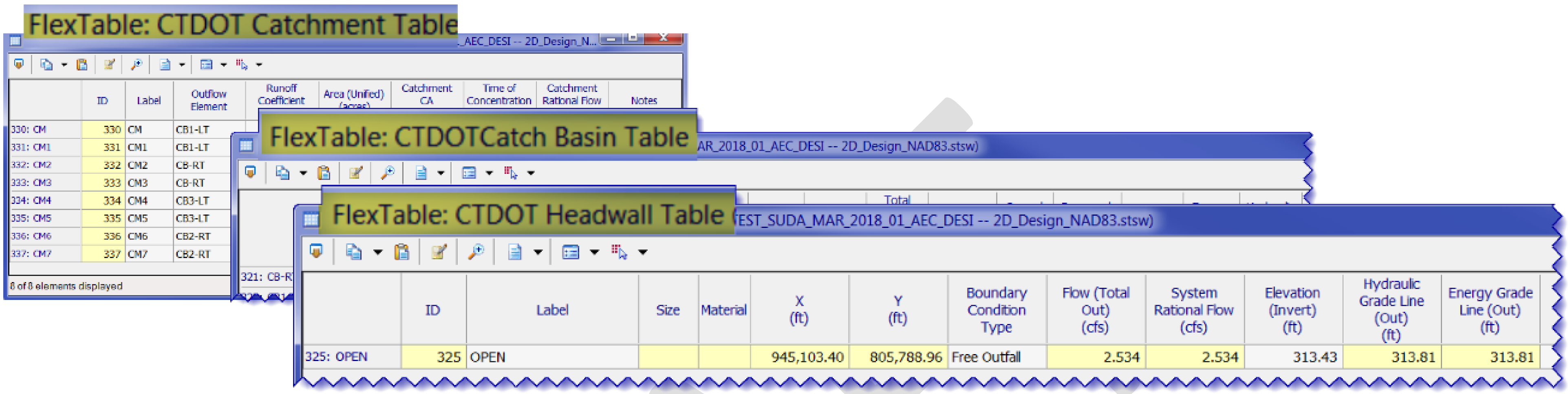
With Flextables SUDA shows the engineering data in tabular format. Any FlexTable can be edited to best fit the project. The designer should use the drainage manual as a guide to determine the information needed to represent the drainage system.

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)

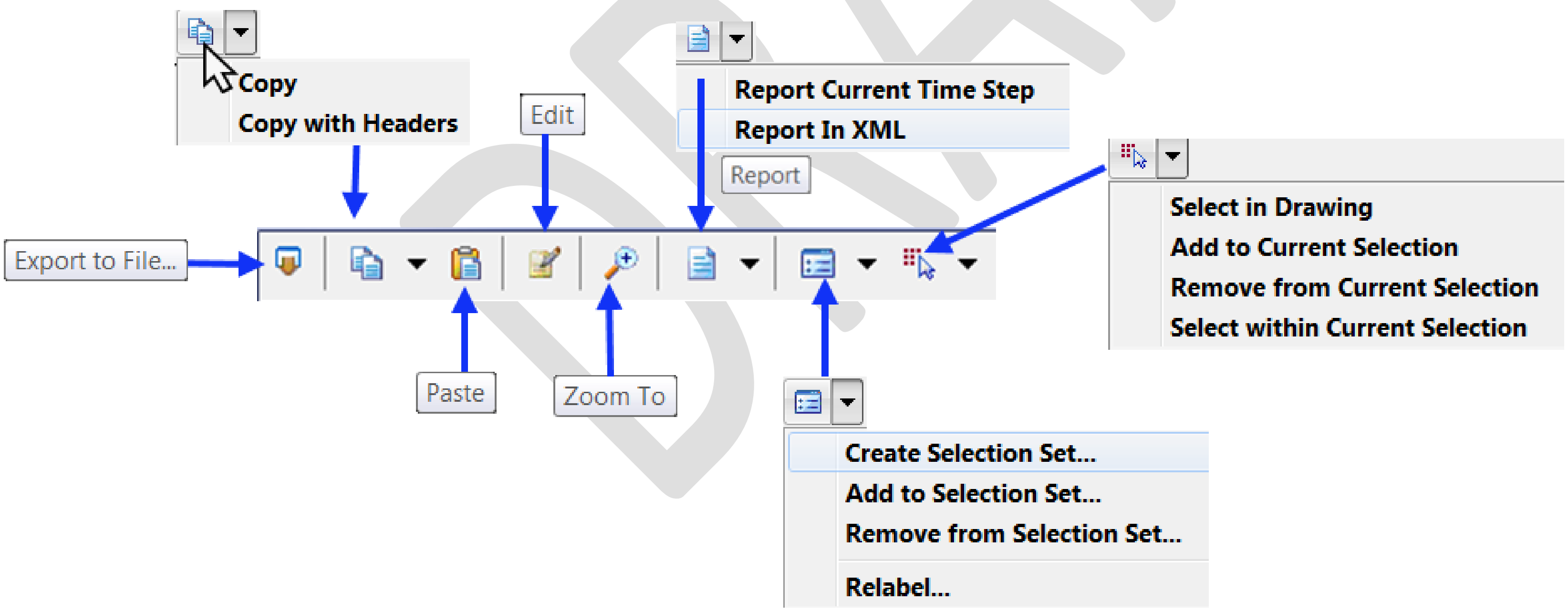


Bentley Institute

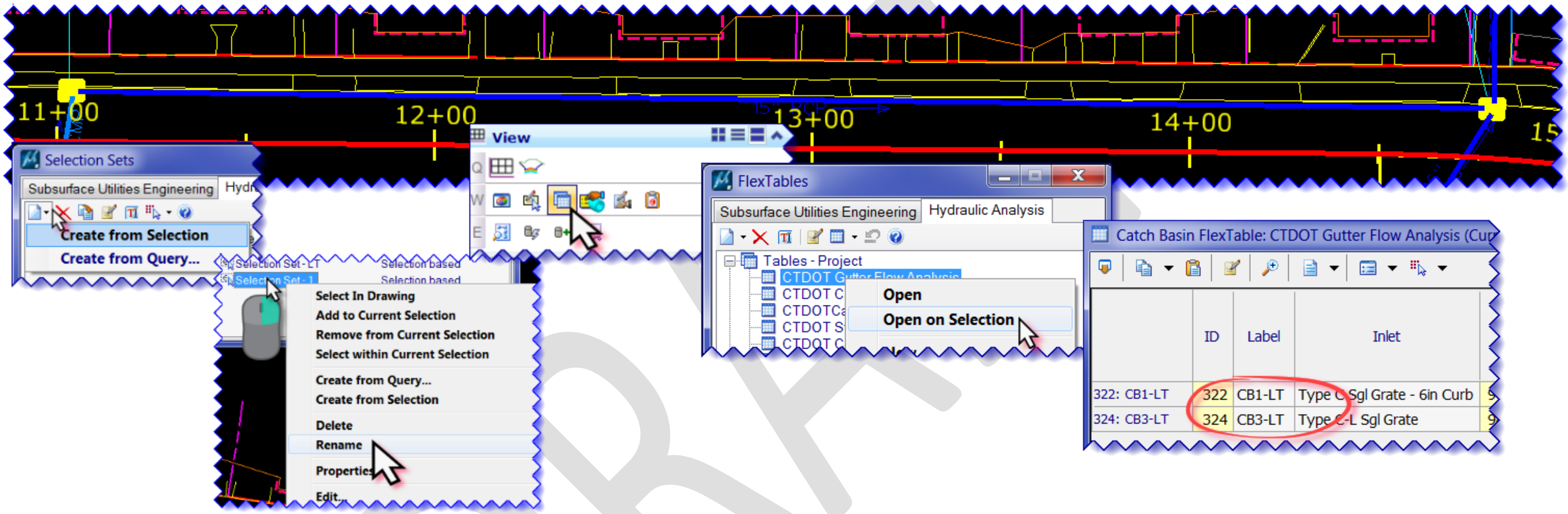
FlexTables: Using, Customizing and Reporting



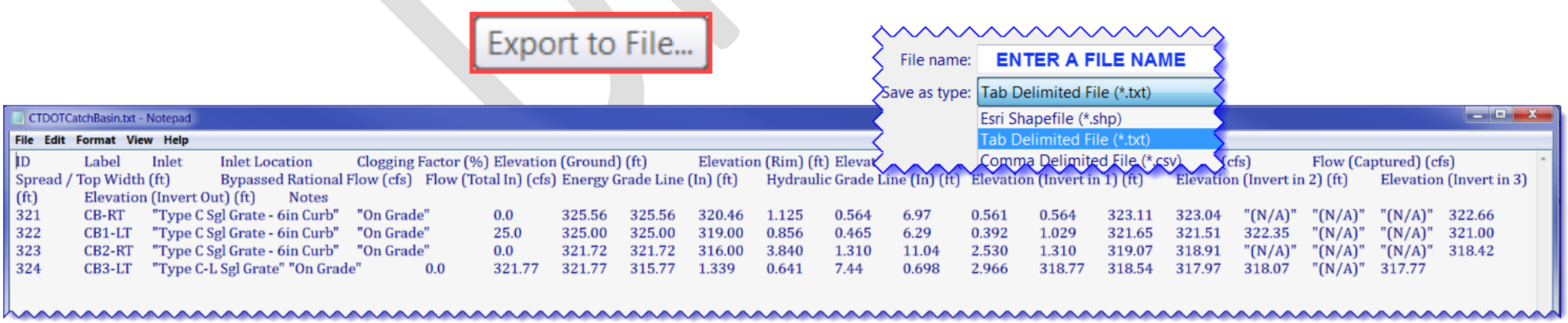
Double-click on any of the flextables to open it. Each table has various tools such as: export, copy, paste, edit, zoom to, report, options and select in drawing.



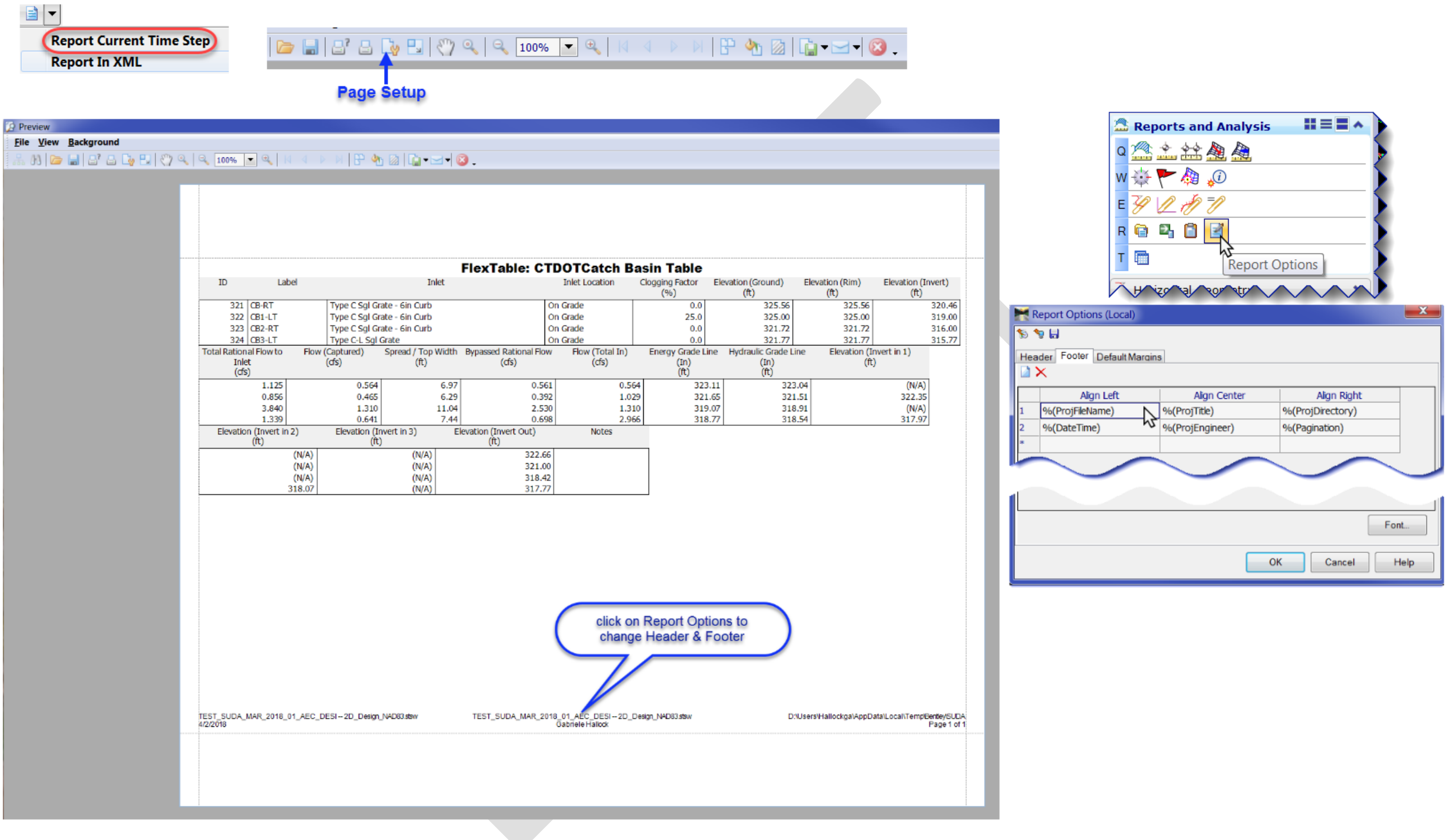
Create Selection Set … to split up the drainage data into left and right side of the roadway. First select all the nodes (catch basins, manholes etc.) on one side using the Element Selection tool, next click on 'Selection Sets' icon in the View Task menu. In the Selection Sets menu click the down arrow 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.



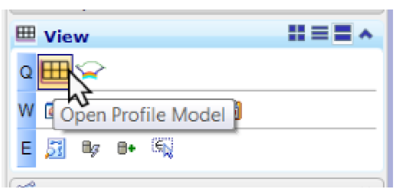
Using Page Setup you can change the paper size, margins layout to what best fits for your project.

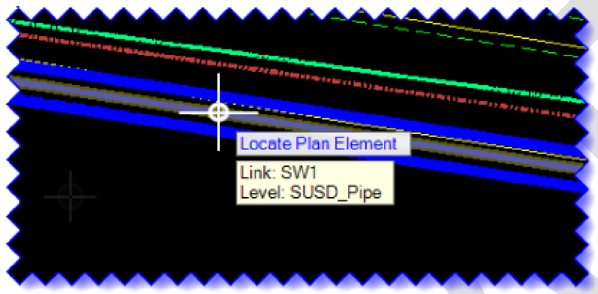
C. Profiles

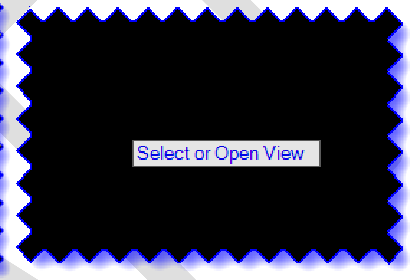
There are various profiles available that show the drainage data in different concepts and views.

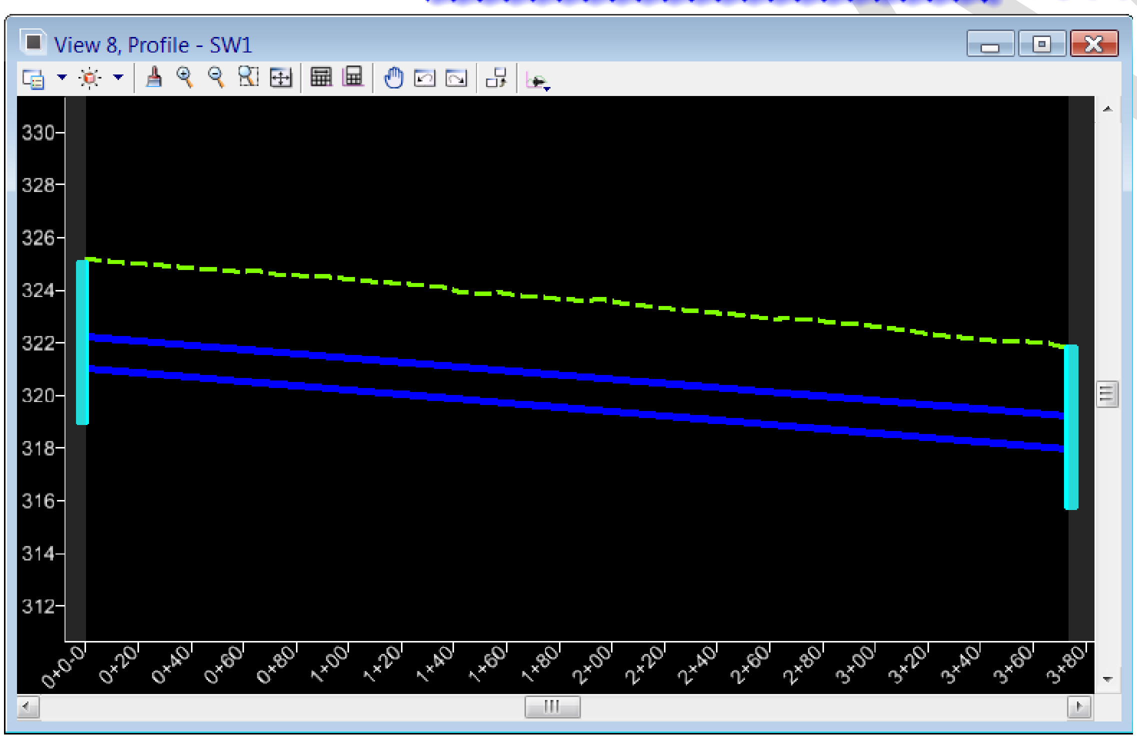
➢ Open Profile Model (single pipe):

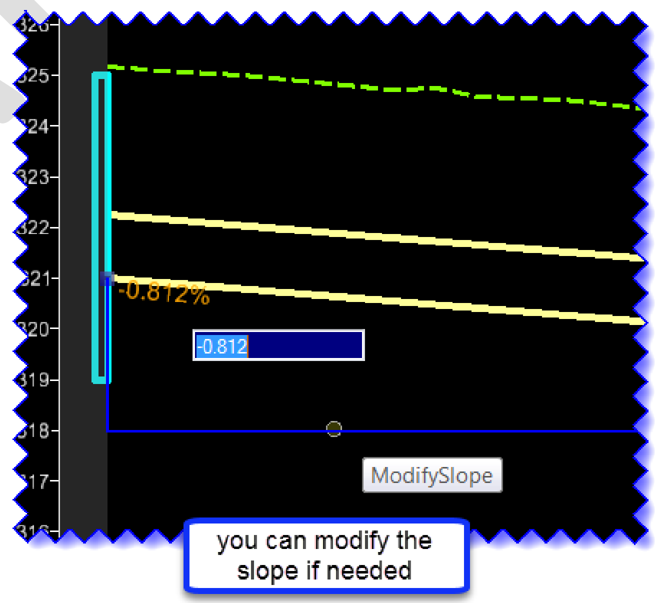
Click on the Open Profile Model task in the View task menu. Follow the pop-up commands → Locate Plan Element, pick the pipe you want to see a profile of → Select or Open View, click in the view window you want the profile to be displayed. You can view a profile of the individual pipes as needed.





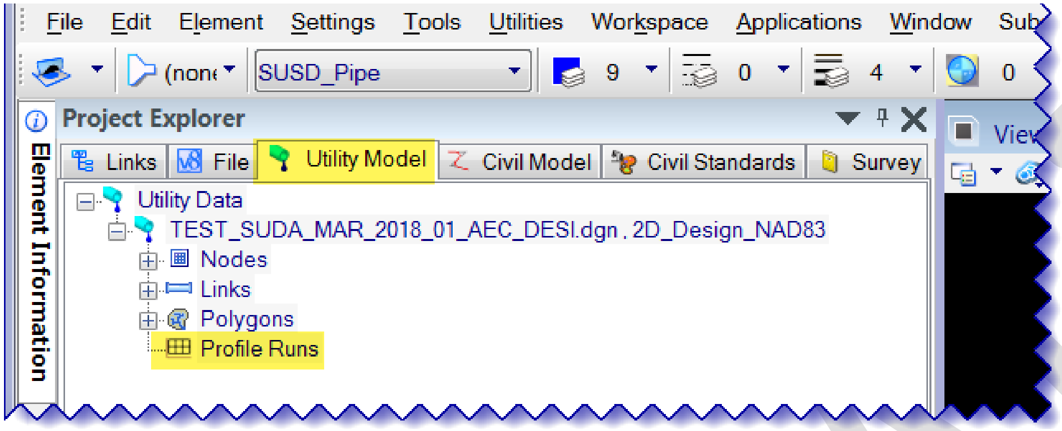




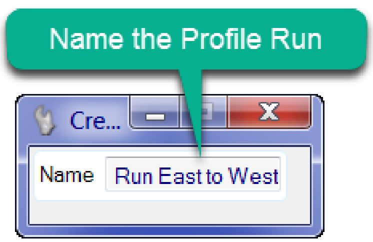


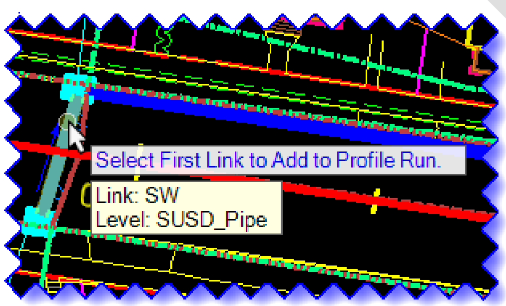
➢ Create Profile Run

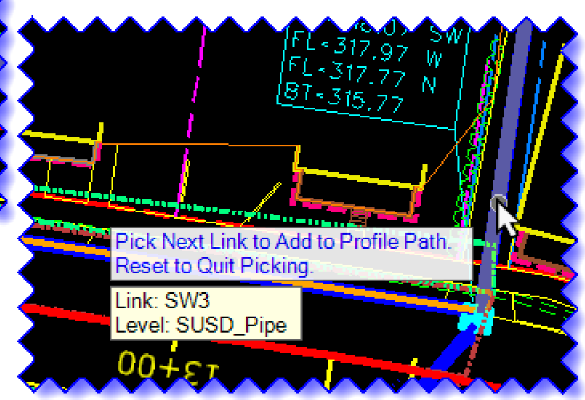
Click on/Open **Project Explorer**, click the **Utility Model** tab and expand your 2D MicroStation file so you see **Profile Runs**. Right-click select **Create Profile Run** or **Auto Create Profile Run** → follow the pop-up commands.

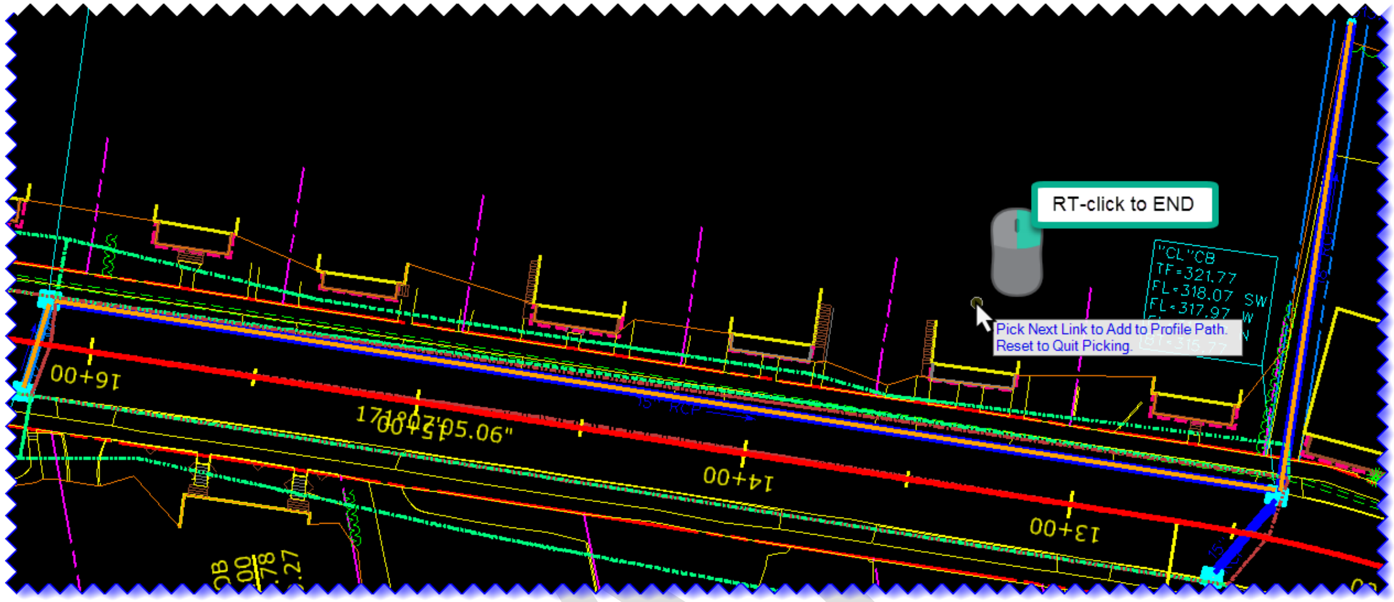


Create Profile Run → Name the Profile Run → Select First Link to Add to Profile Run → Pick Next Link to Add to Profile Path. Reset to Quit Picking. This will create a profile that can be displayed in three (3) different ways = Profile Model, Analysis Profile and Engineering Profile.



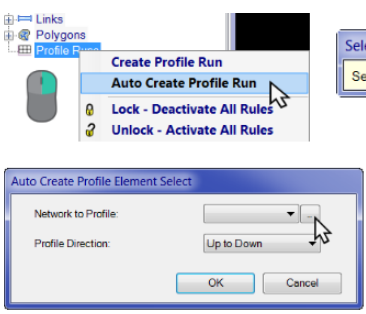


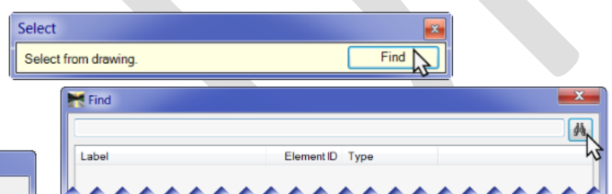


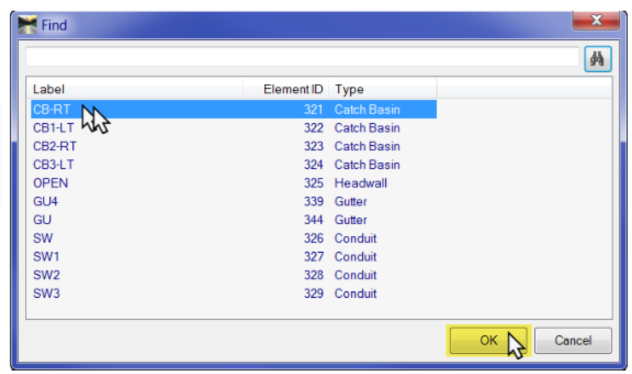


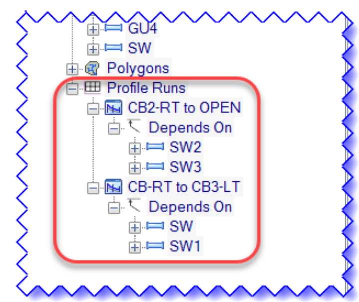
➢ Auto Create Profile Run

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.



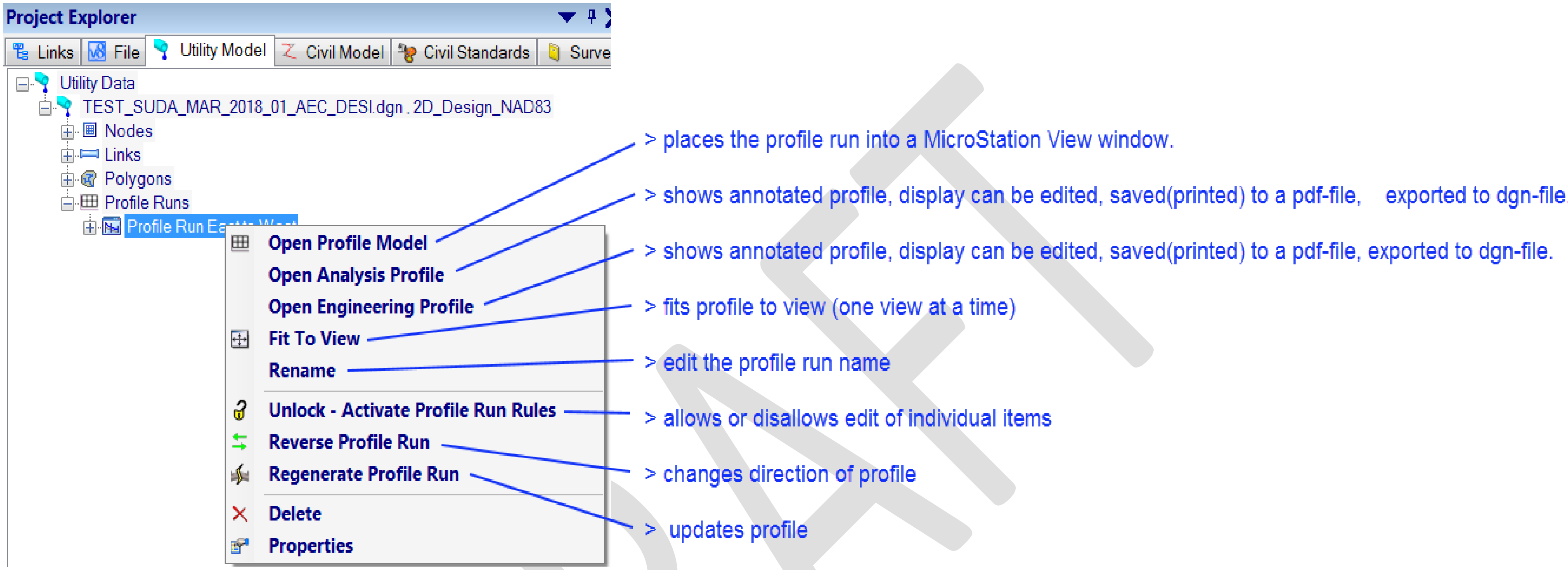






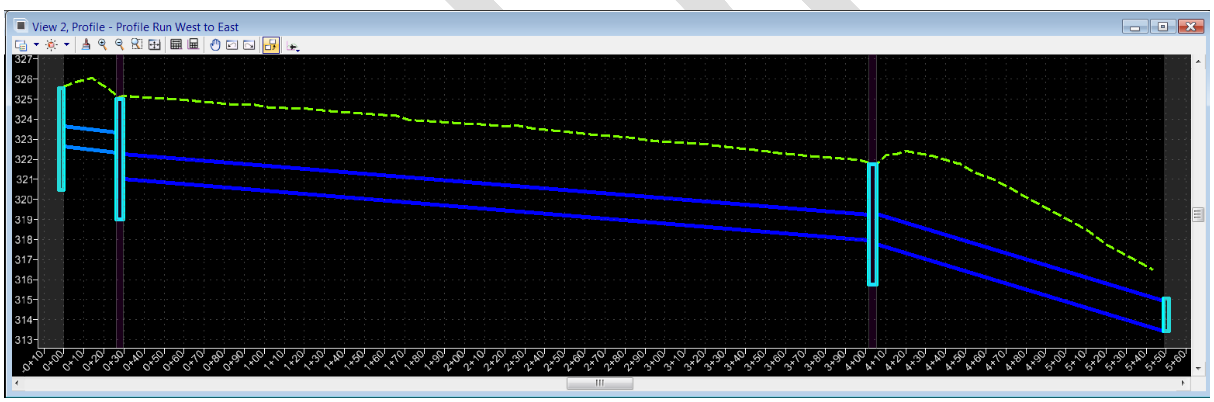
Note: You may not get exactly what you are looking for.

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.



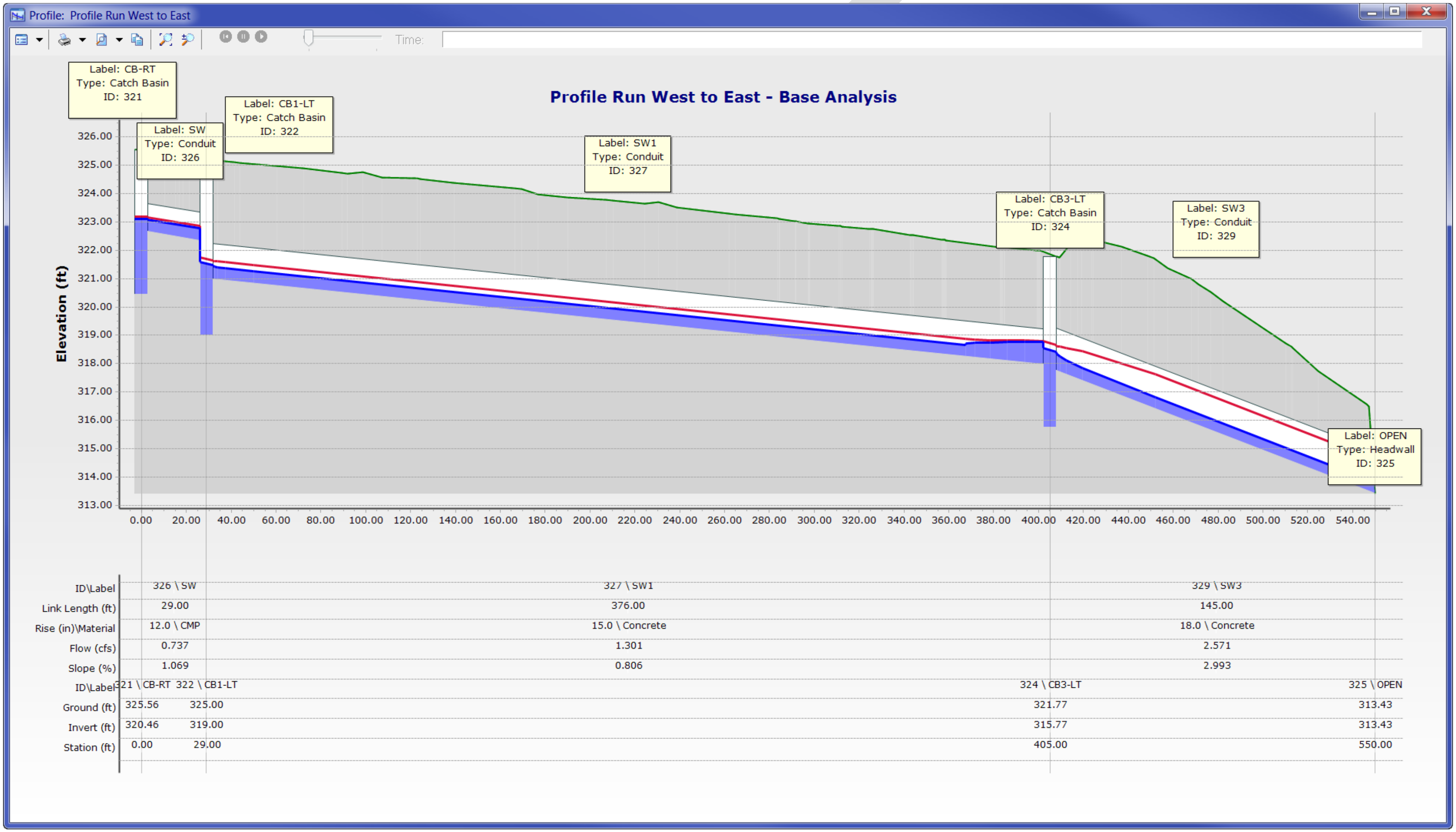
➢ Open Profile Model

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



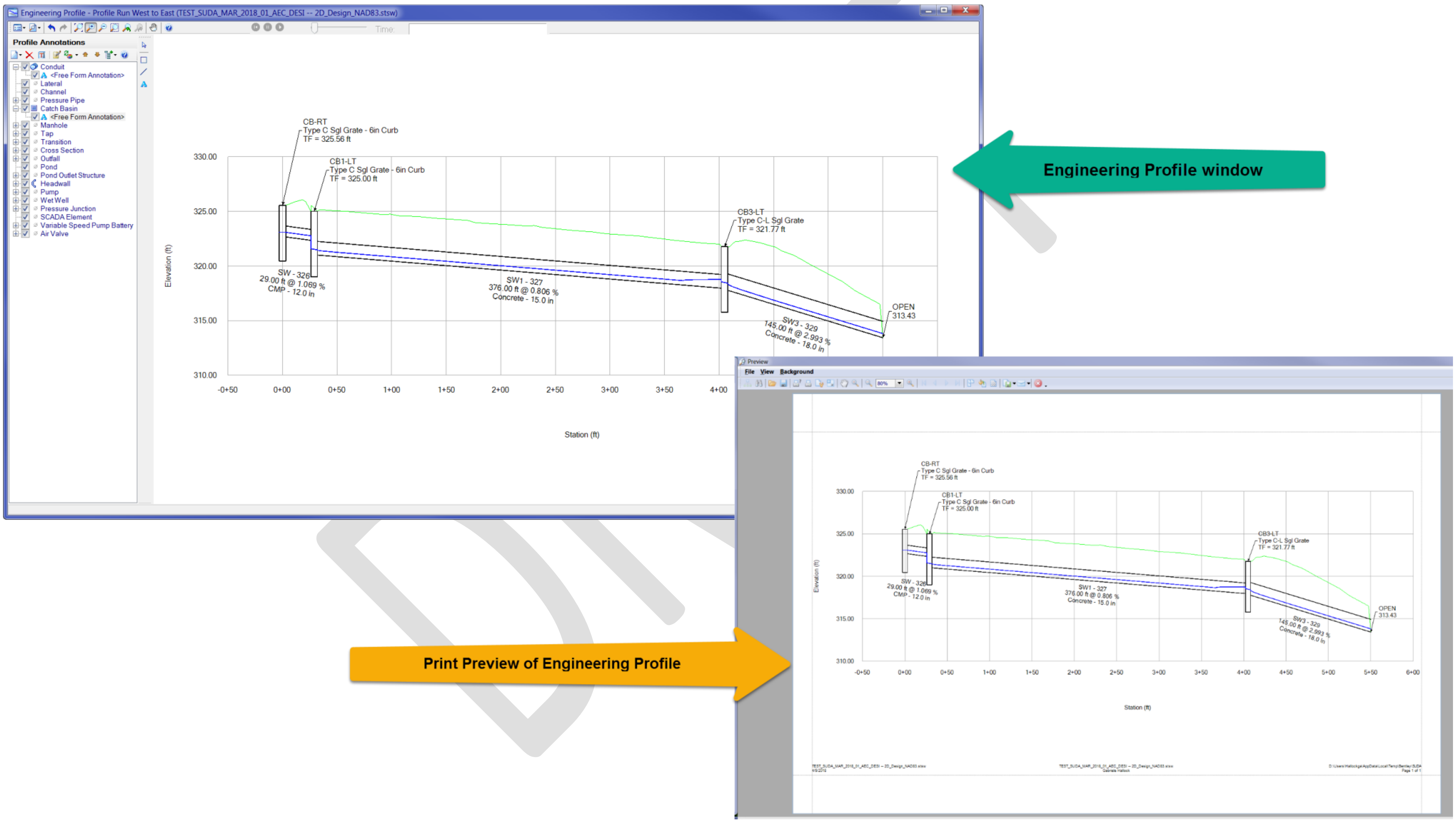
➢ Open Analysis Profile

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.



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

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

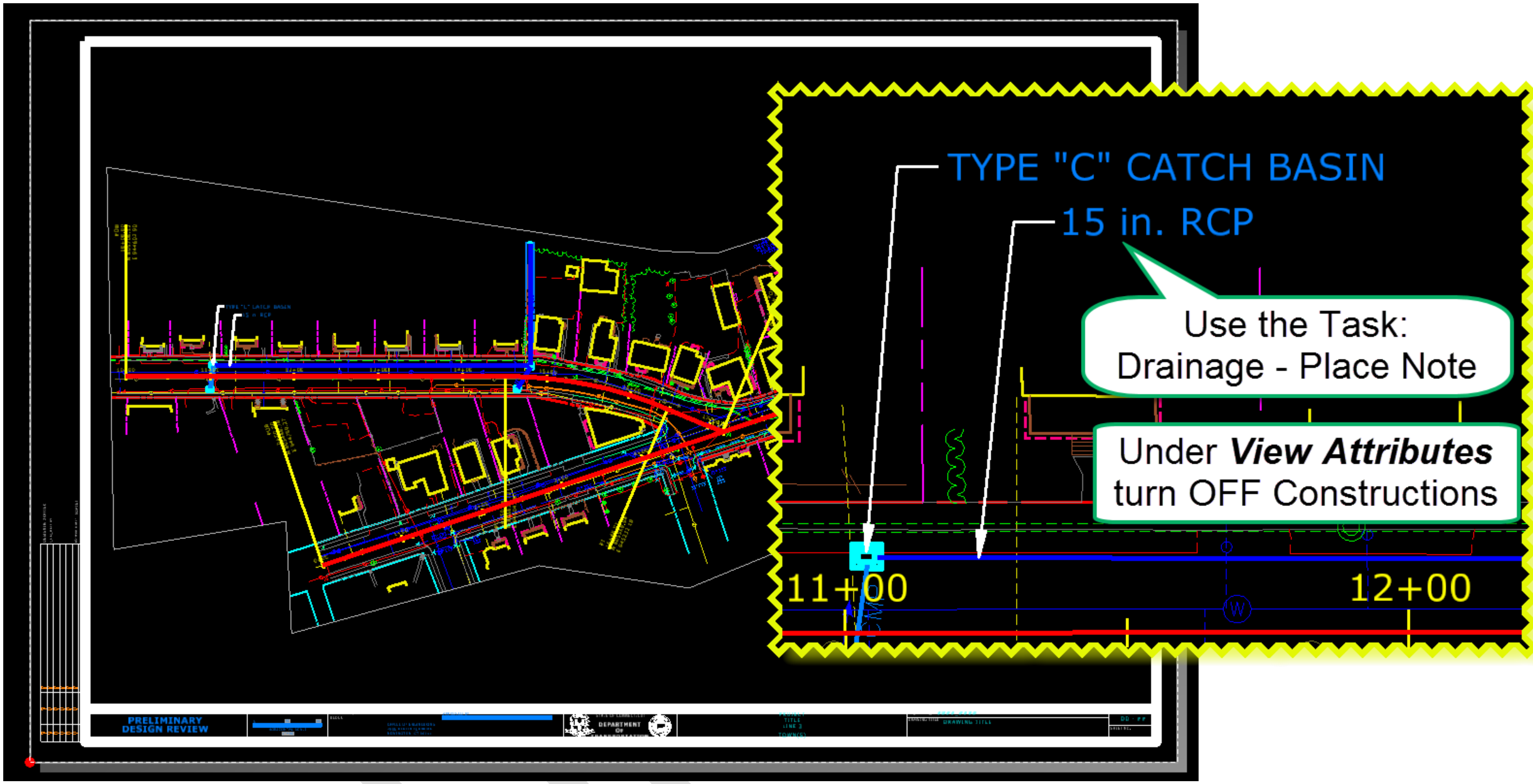
Make sure you follow Chapter 8 of the CTDOT OpenRoads Manual for Designers.

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).

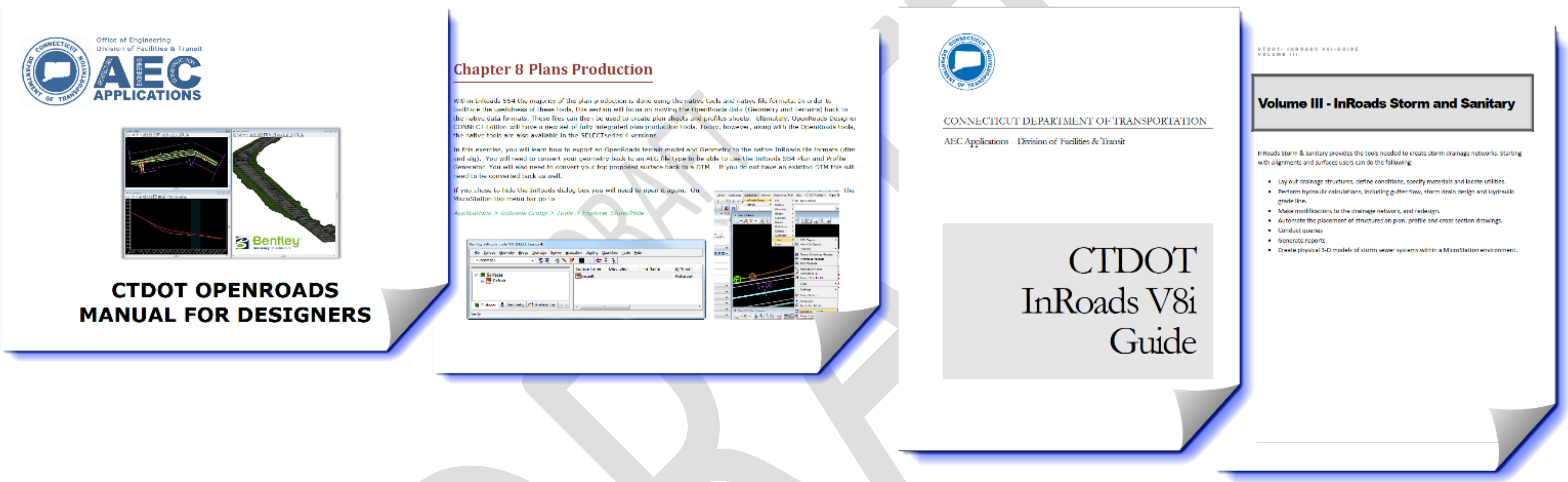
8.2.2 Option 2 – InRoads Plan and Profile Generator: make sure you open the main modeling DGN file not the drainage file. Follow through with the Plan and Profile Generator, for Step 6. Make sure you include the *Drainage Model file* as a needed Model Files…


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

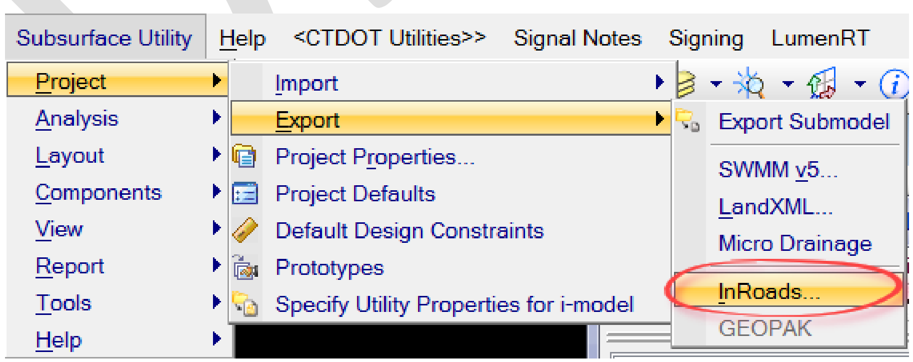
5.1.2. Profile Sheet

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**.



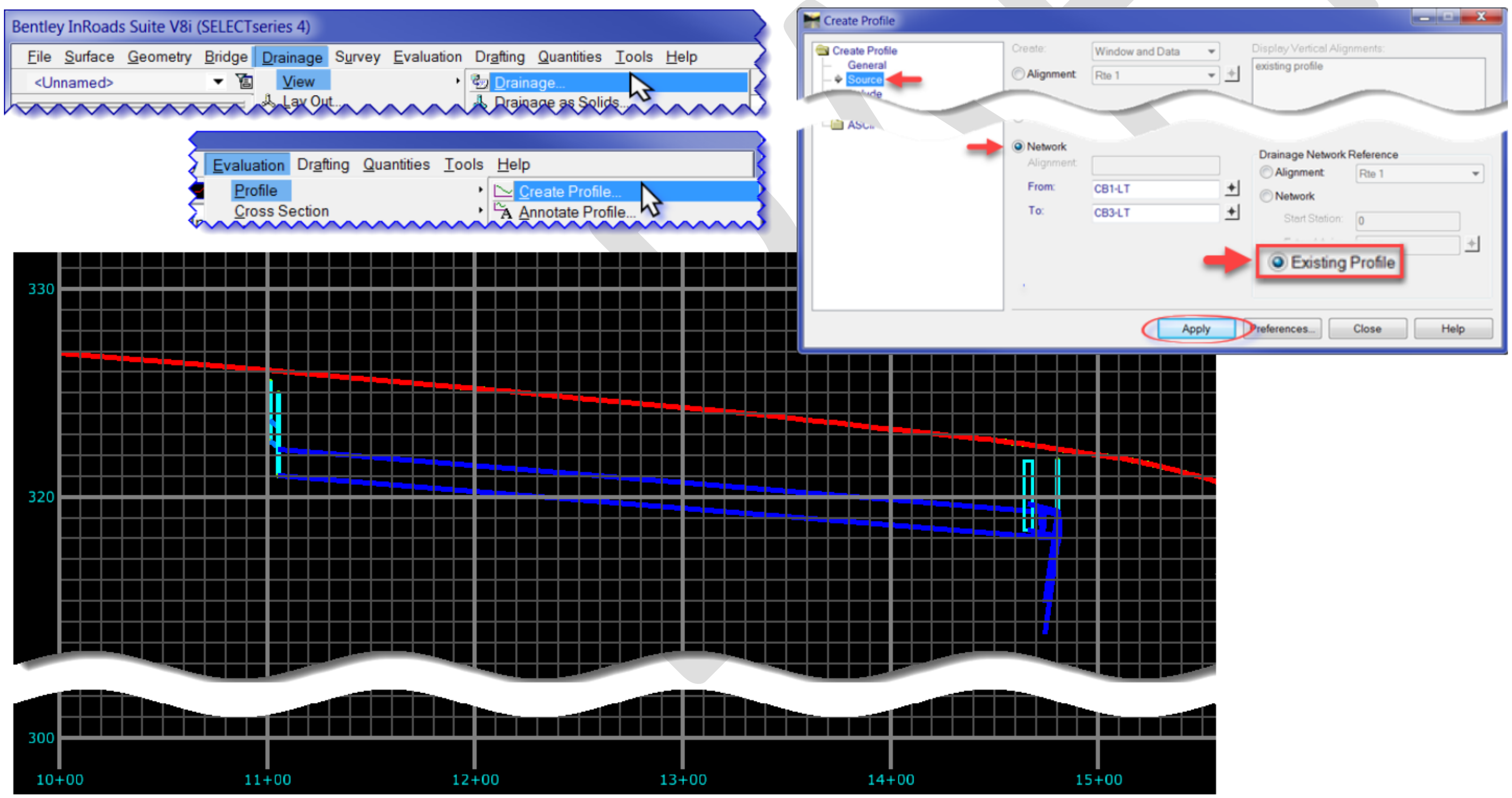
In the SUDA Drainage DGN file go from the Menu bar, select Subsurface Utility → Project → Export → InRoads… using the Advanced Wizard, giving it a unique name ending with *.sdb (Export_SUDA_IR_Drainage.sdb) save the Drainage Database to the project folder in ProjectWise.



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

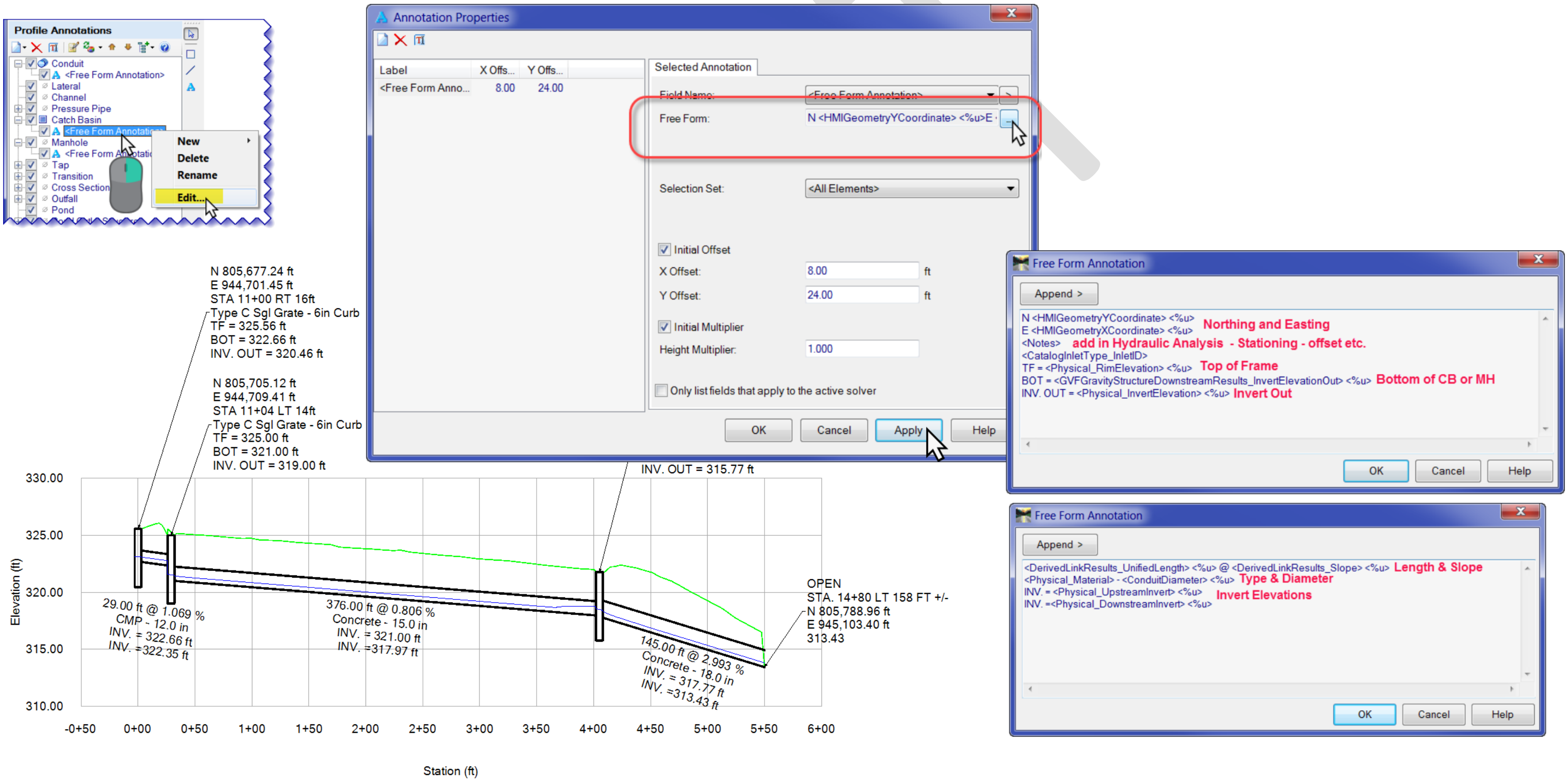
After you completed the profile sheets, go back to the **2D Design Model DGN file** that houses the *Profile(s) and Profile grids(s)*. Here you will place the drainage profile(s) following the steps of *Section 15 Storm and Sanitary Final Annotation*.

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.

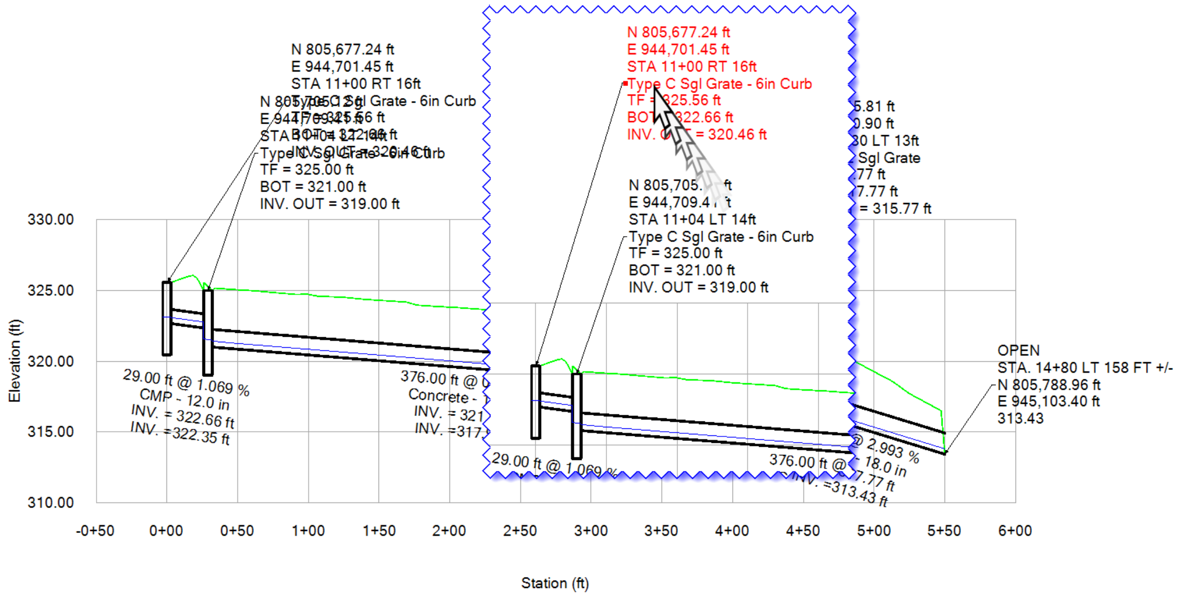


The designer can also incorporate the Engineering Profile (see Section 2 – Step 4 – C. f.) on a plan sheet.

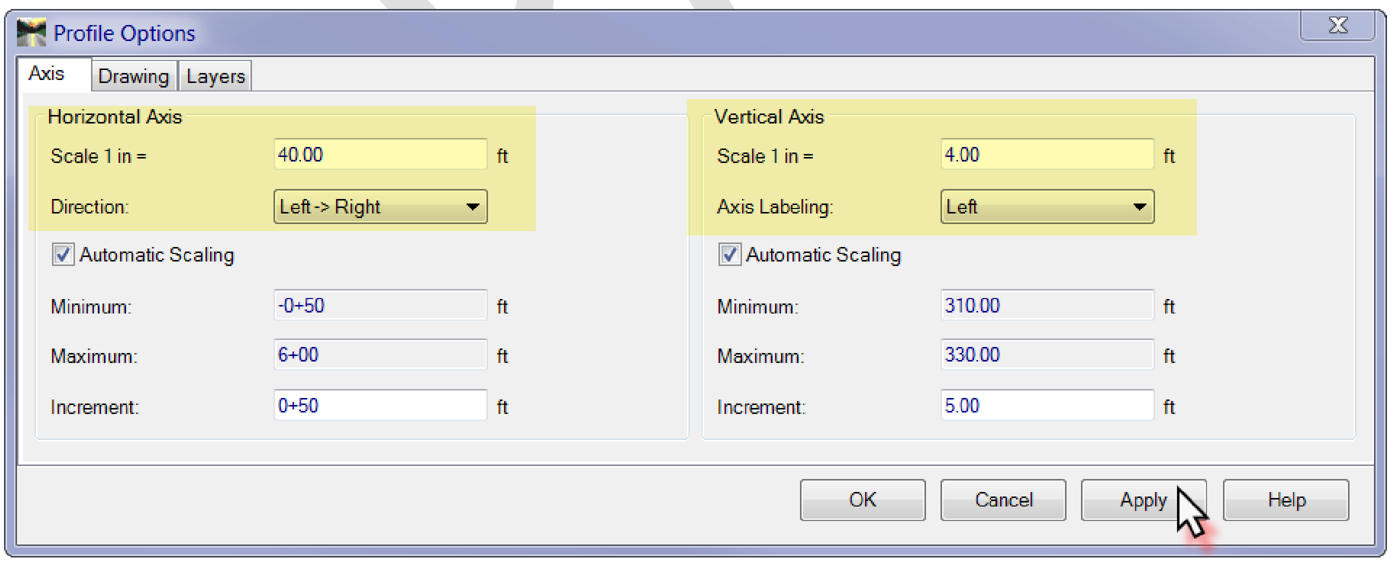
From the **Project Explorer**, select **Utility Model → Profile Runs →** select the profile run and right-click and select **Open Engineering Profile**. In the Engineering Profile box to the left is Profile Annotations, here the designer can modify/add any annotation for the profile. The Engineering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



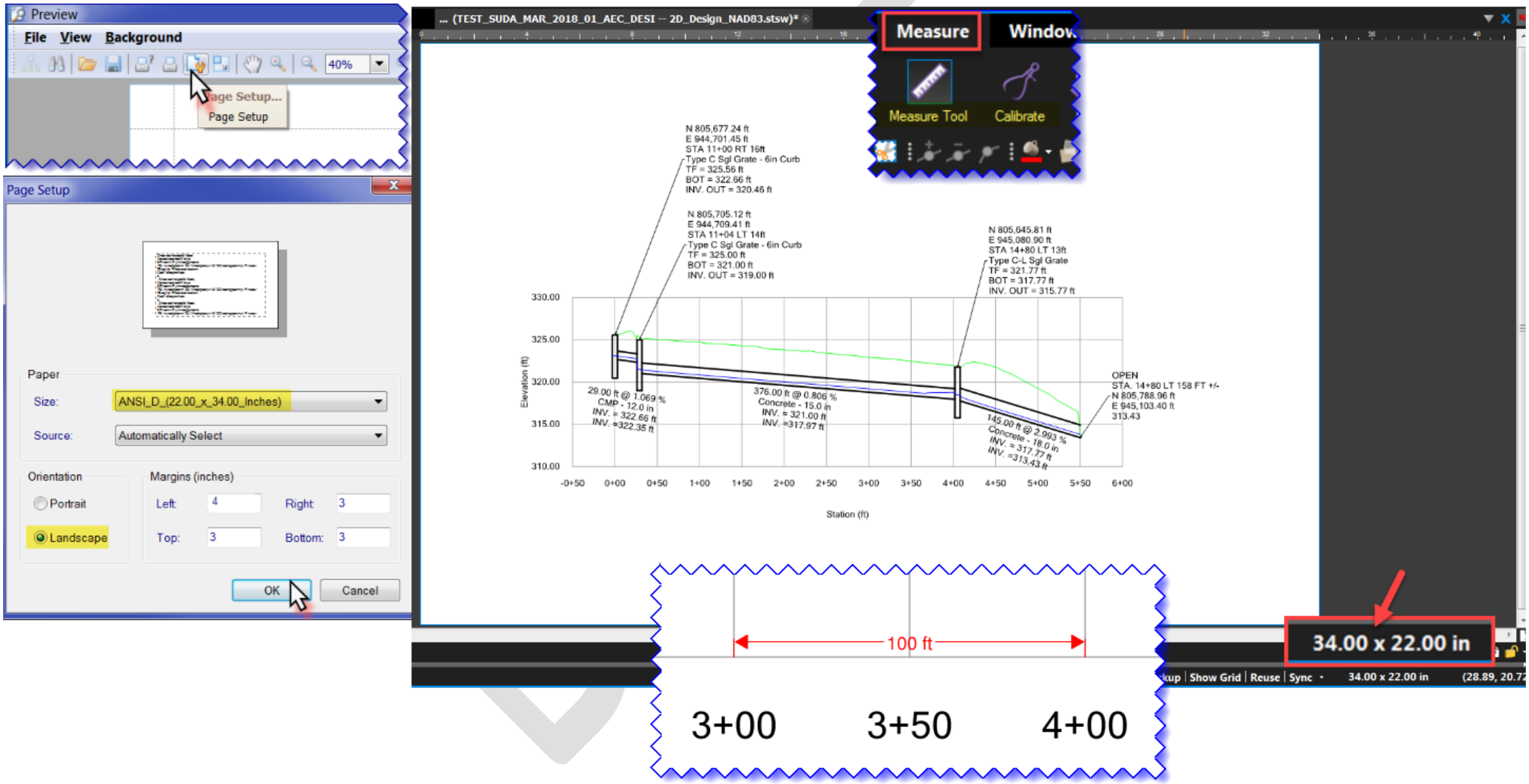
Click once on the call-out and you can move it.



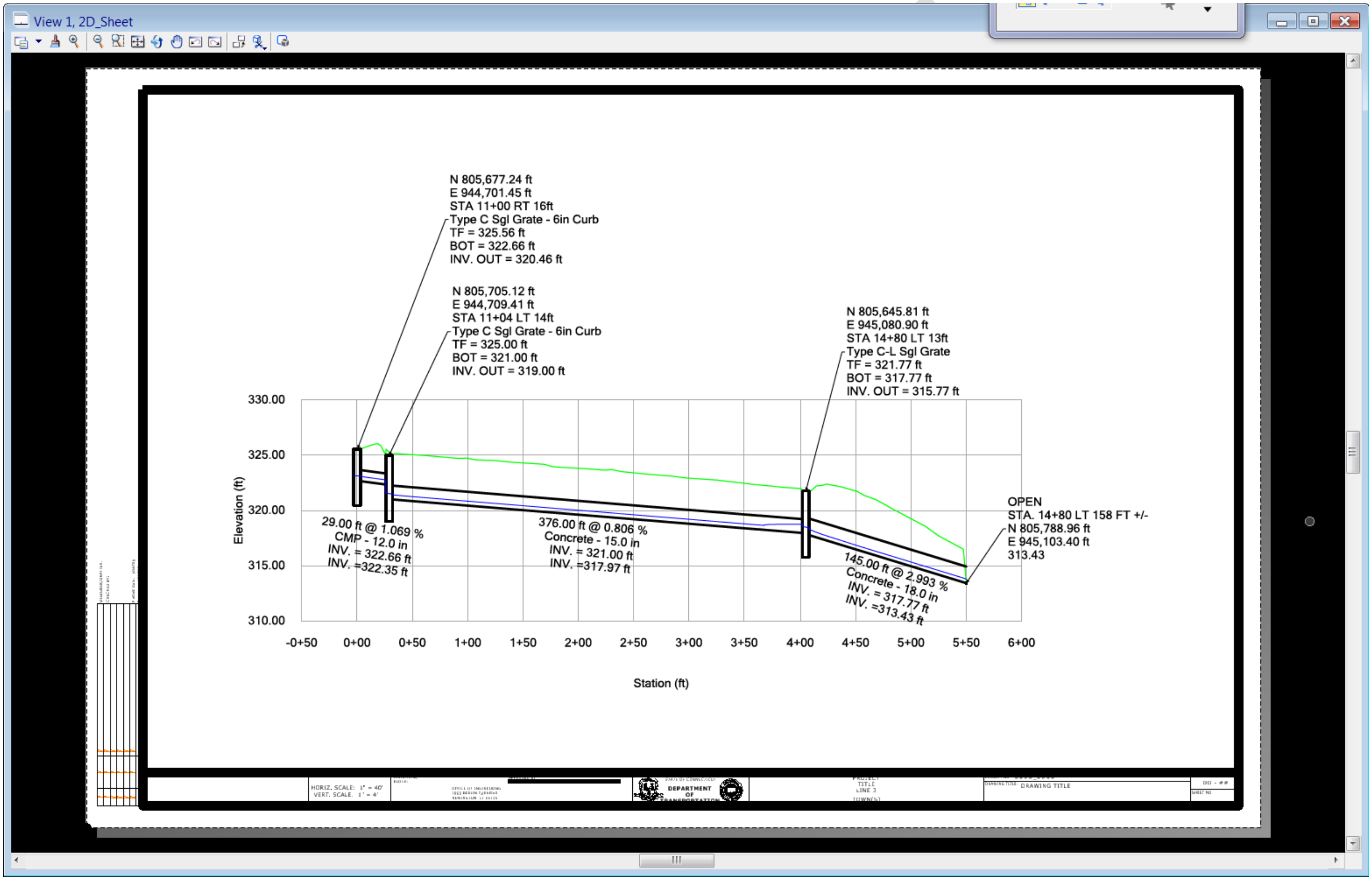
Click on the Tools command and select Options. Profile Options should have settings as below, click Apply and OK.



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.



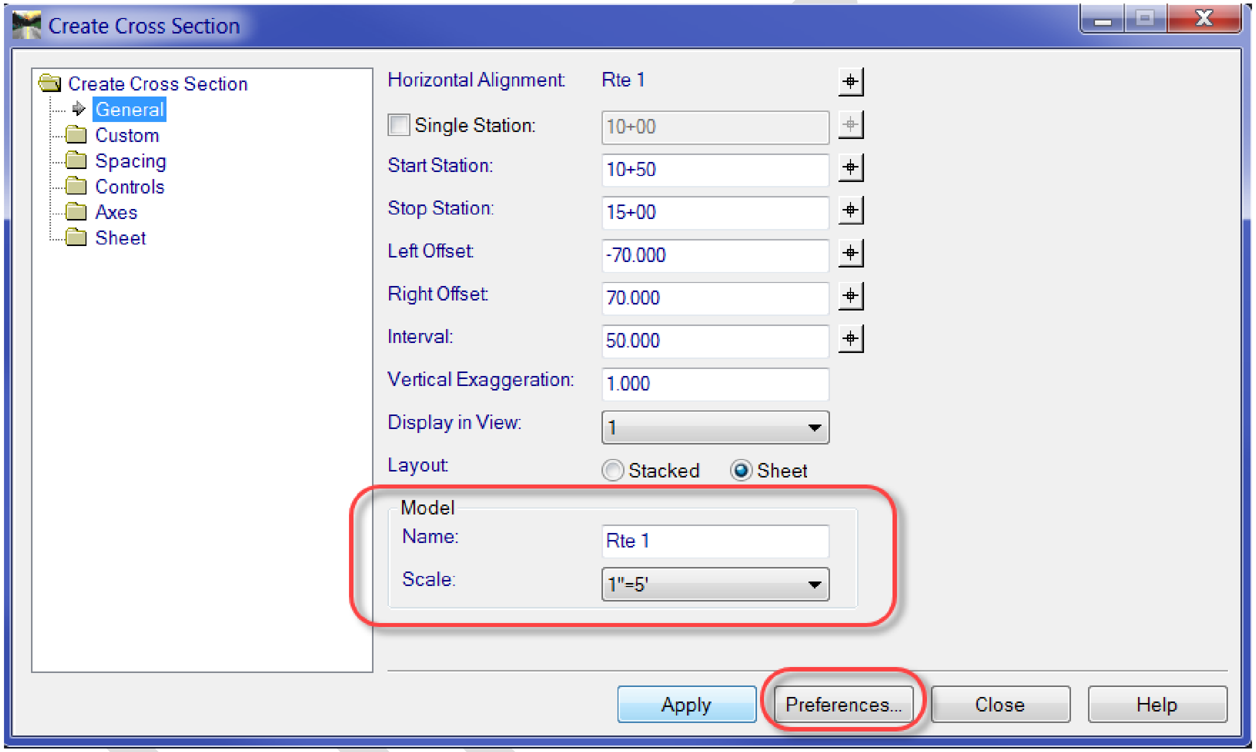
In MicroStation create a new sheet file, using the ProjectWise Advanced Wizard, use the 2D_SheetSeed.dgn as seed. Attach the Engineering Profile pdf using Raster Manager. Place a border cell, you may need to change the color to black, label the border as needed, include a horizontal and vertical scale;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

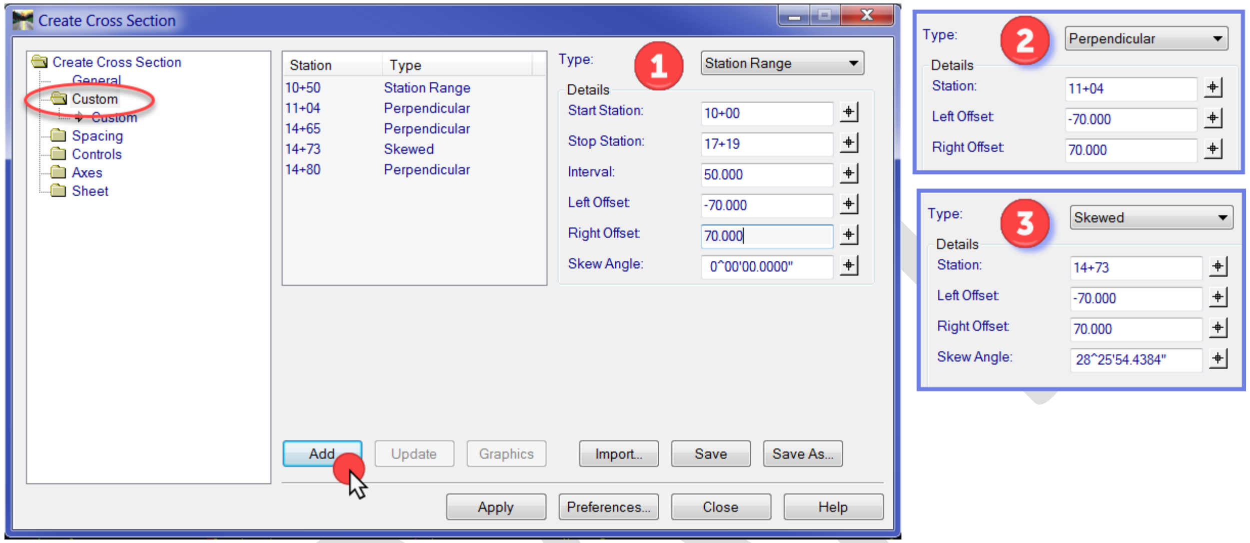


If you want cross sections at each drainage structures (CB's & MH's) select Custom;

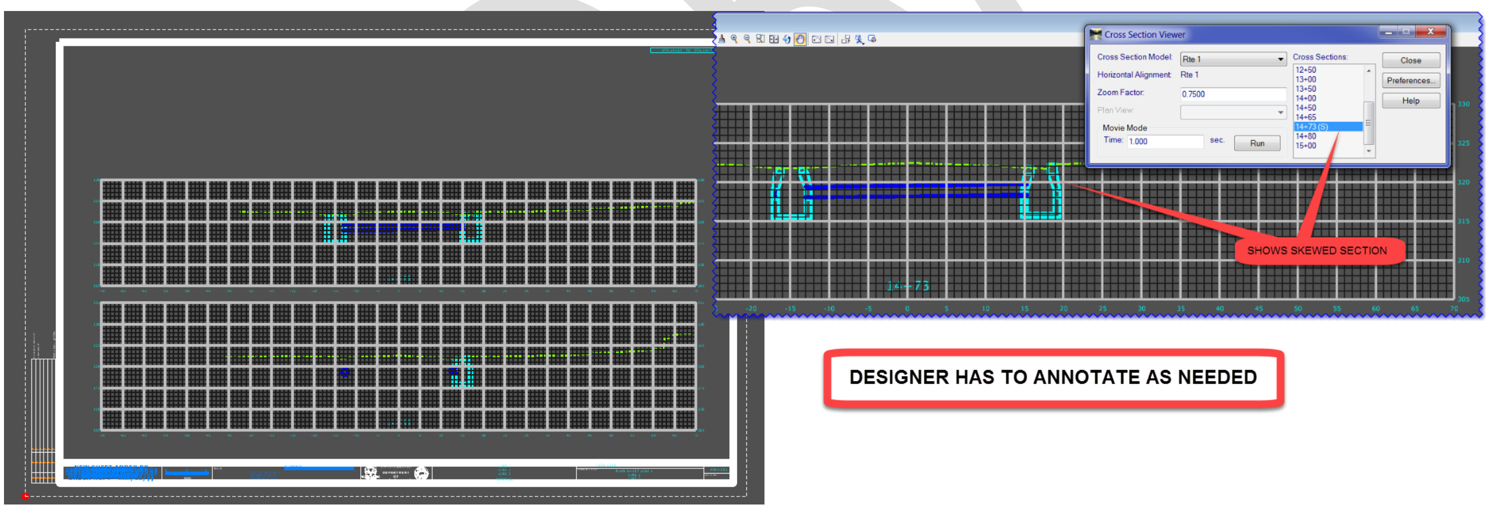
1. Add Station Range as Type, input Start Station, Stop Station, Interval (50.00), and set Left Offset to -70.00, Right Offset to 70.00, Skew Angle to 0. Click Add.

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