

ODOT User Guide for StormCAD

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Disclaimer

The ODOT StormCAD Standards provided do not exempt the professional from performing responsible engineering. This document along with the ODOT custom seed files are for public use, however no ODOT support will be provided. There are no expressed or implied warranties concerning the accuracy, completeness, reliability or usability of this information. Further, ODOT assumes no responsibility for any incorrect results or damage resulting from the use of this information. All users shall expressly hold ODOT harmless from any liability or loss due to any computer or software generated problems associated with this product. The professional shall have final responsibility for the accuracy of all input and output of computer-based applications and any technical issues or questions that may arise.

Introduction

What Is StormCAD and Why Do We Want to Use It?

Bentley StormCAD is a software product that allows the user to design a new storm sewer system or analyze an existing system. As an alternative to the ODOT CDSS storm sewer modules, StormCAD is customizable and supports ODOT drainage design criteria (see Location and Design Manual, Volume 2). It also performs pavement spread, inlet bypass and open channel flow calculations, but this document focuses on the storm sewer applications.

With the StormCAD graphical interface, the designer creates either a schematic network or storm sewer system drawn to scale. StormCAD for MicroStation operates in the familiar CADD environment, uses standard ODOT levels and line styles, and supports drainage basemap development.

StormCAD for MicroStation is featured in this document. It is interoperable with the standalone mode and provides the same functionality, computations and reporting capabilities. The steps presented for hydraulic design and analysis are also applicable to the standalone mode, and most of the tools, icons and dialog boxes are identical.

Additional Resources

Bentley StormCAD Help (StormCAD Help Menu) – includes quick start lessons plus comprehensive guidelines for creating a project, calculating the model, presenting results, engineering theory, and features of the MicroStation workspace environment. This information is also available in .pdf format as the *StormCAD V8i User's Guide* (installed with program on the hard drive).

Bentley Technical Support (<http://selectservices.bentley.com/en-US/>) – for StormCAD technical support, it is recommended that you take advantage of the Bentley Knowledge Base or Service Request Manager. You will need to sign in, and you can contact your CADD administrator if you need assistance with setting up a Bentley account.

Bentley Learn Server (<http://learn.bentley.com>) – has extensive on-demand training with lectures and hands-on exercises (Storm Sewer Design and Modeling using StormCAD Learning Path). The StormCAD standalone version is featured. Please see your CADD administrator for help with getting started.

Software Versions

This user guide was developed using the following software versions:

StormCAD V8i (SELECTseries 3) v08.11.03.83

MicroStation V8i (SELECTseries 3) v08.11.09.459

StormCAD SELECTseries 3 is compatible with MicroStation SELECTseries 2 and does not require an upgrade to MicroStation SELECTseries 3. If MicroStation is already on the machine when you install StormCAD, it should integrate automatically.

Important: StormCAD V8i (SELECTseries 3) v08.11.03.83 is not compatible with GEOPAK SELECTseries 3. There is a new release of StormCAD, version 08.11.03.84, that was released after this documentation was complete. This version resolves the compatibility issue with GEOPAK SELECTseries 3. Although StormCAD for MicroStation and GEOPAK are not intended to be integrated products, they share the MicroStation interface.

Installation

Before You Start

StormCAD V8i (SELECTseries 3) works best when installed on a system with MicroStation V8i (SELECTseries 3). If GEOPAK Suite V8i (SELECTseries 3) is installed, then StormCAD V8i (SELECTseries 3) v08.11.03.84 must be used.

You must also make sure that you have the ODOT Standard StormCAD sub-directory in your *ODOTstd\V8istd* directory. For an ODOT installation, verify that you have an I:\ODOTstd\V8istd\StormCAD folder. If not, please ask your CADD Administrator to update ODOTstd from the Central Office site. This directory contains ODOT's Engineering Libraries, StormCAD project seed file, FlexTables and Properties settings, and this documentation. The I:\ODOTstd\V8istd directory includes three additional StormCAD for MicroStation files: *stm.cel*, *stormcad.ucf* and *StormCADSeed.dgn*, found in the *cell*, *config* and *seed* folders, respectively.

Installation

You must have administrator privileges to perform the installation.

For a typical ODOT installation, the StormCAD software is found in:

\\itcfs007\support1\Win7Software - PC\Bentley\StormCAD\stmc08110383en\. Run *Setup.msi* and accept the defaults. After installation, run:

\\itcfs007\support1\Win7Software - PC\Bentley\StormCAD\sewergems08110383en.exe to install the latest patch.

The desktop shortcut for the standalone version probably needs to be modified. The target should be "C:\Program Files (x86)\Bentley\StormCAD8\StormCAD.exe". There is a separate *StormCAD.exe* file in the *x64* subdirectory that creates error messages if launched.

User Configuration Setup

Each user will need to copy the MicroStation User Configuration File for StormCAD (*stormcad.ucf*), from I:\ODOTstd\V8istd\config to the user's home drive location. For an ODOT installation the location will be W:\BentleySS3.

The final step is optional but recommended. Copy the following FlexTables and Properties files located in the *ODOTstd\V8istd\StormCAD* directory, and then replace the default files installed by StormCAD in the C:\Users\username\AppData\Local\Bentley\StormCAD\8 directory:

- AttributeFlexTables.xml
- FlexTables.xml
- PredefinedFlexTables.xml
- SharedWorkspaces.xml

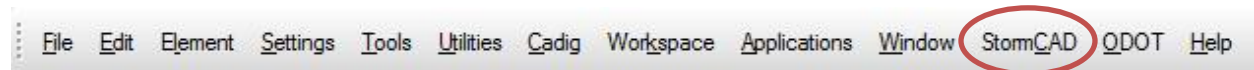
These settings affect information display (shared and predefined FlexTables and Properties).

Note: The first time you use StormCAD for MicroStation, you may notice that your individualized MicroStation environment and workspace preferences (e.g., toolbars, dual monitors, etc.) have reverted to default settings. Find the familiar toolbars (Tools > Tool Boxes) and adjust the workspace preferences as desired.

Activation and Settings

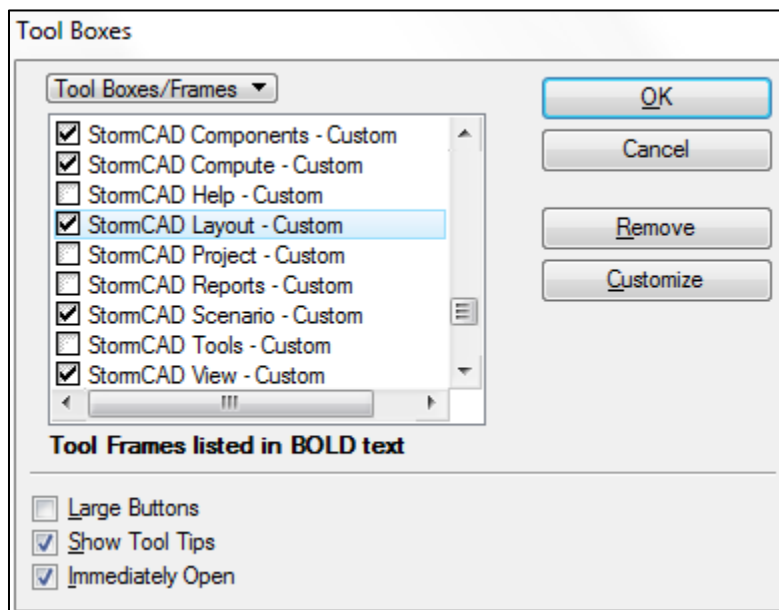
StormCAD for MicroStation

When StormCAD for MicroStation is launched, the MicroStation File Open dialog box appears. The User should be set to stormcad and the Project should be ODOTV8iSS3. After a .dgn file is opened, the StormCAD pull-down menu appears on the main toolbar. This menu contains some features that are not accessible in the StormCAD toolbars.



StormCAD Toolbars

In MicroStation mode, the StormCAD toolbars (e.g., View, Layout, Compute, etc.) are found under the MicroStation Tools Menu (Tools > Tool Boxes). They are also located in the Tasks Dialog. The StormCAD toolbars and dialog boxes are dockable and can be pinned if desired. This document covers the tools and icons most frequently used. Full explanations can be found in Bentley StormCAD Help.



ODOT Standards

The StormCAD project seed file (StormCADSeed.stws) incorporates ODOT standards with the following customized features: Engineering Libraries, Catalogs, Storm Data, Default Design Criteria, User Data Extensions, Element Symbology, Prototypes, Project FlexTables and Reports, Property Grid Customization, Alternatives, Calculation Options, Scenarios and Project Options.

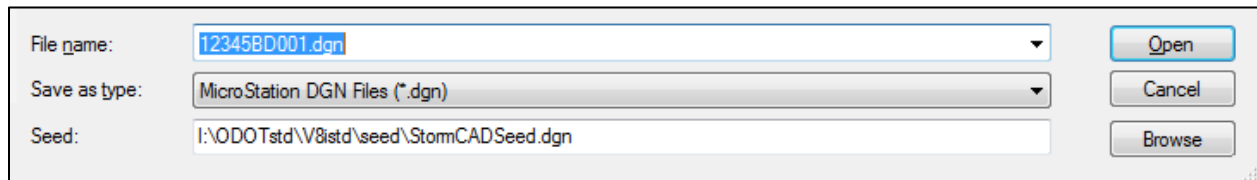
The MicroStation seed file (StormCADSeed.dgn) affects placement of new StormCAD elements on ODOT standard levels (StormCAD for MicroStation Element Levels feature).

Using StormCAD

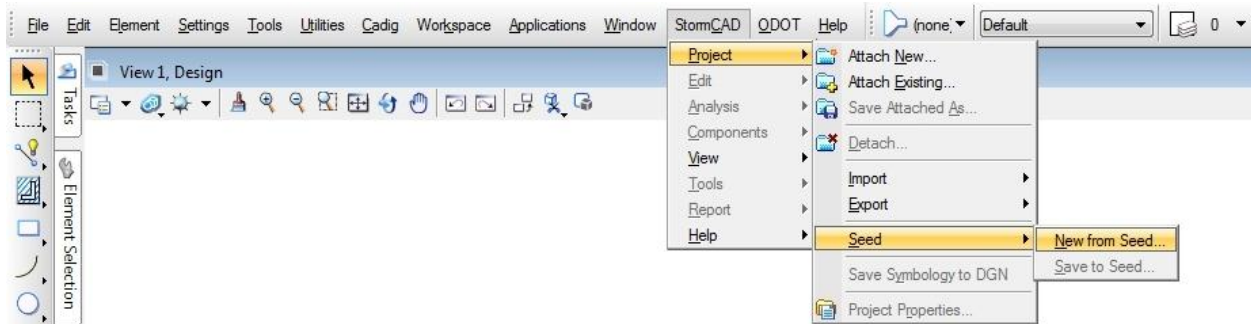
Starting a New Project

A StormCAD for MicroStation project requires three files – one MicroStation .dgn file attached to two StormCAD project files (.stws, .mdb). Starting a new project requires three steps.

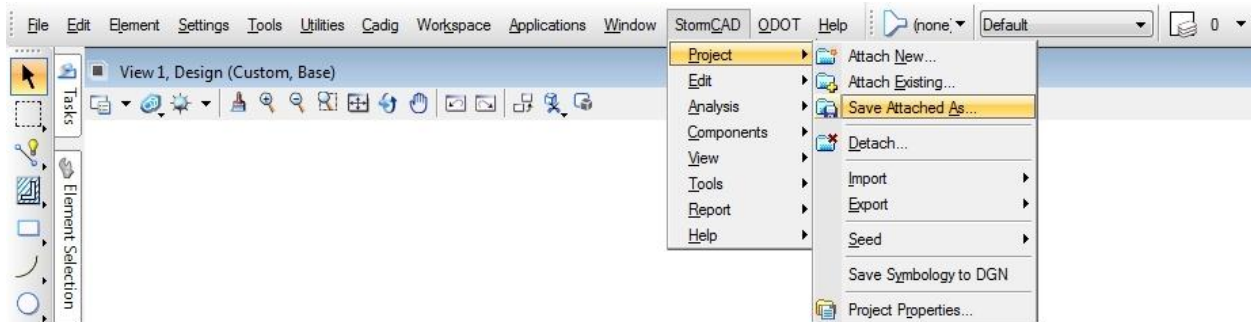
1. **Create new .dgn file from seed** (*ODOTstd\V8istd\seed\StormCADSeed.dgn*). If starting with the StormCAD standalone version, the project can be attached to a .dgn file later if desired.



2. **Attach new StormCAD project file from seed** (StormCAD > Project > Seed > New from Seed). Navigate to *ODOTstd\V8istd\StormCAD\seed\StormCADSeed.sews*. The seed file creates multiple untitled StormCAD project files at the default location on the user hard drive (*C:\Users\username\AppData\Local\Temp\Bentley\StormCAD*). The ODOT customized settings outlined in this document are dependent on these seed files.



3. **Save attached project file to the appropriate directory** (StormCAD > Project > Save Attached As). The default file name is the .dgn file name with the .stws extension. Navigate to the appropriate project directory (the default prompt is *W:\MyDocuments\Bentley\StormCAD*).



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Notes:

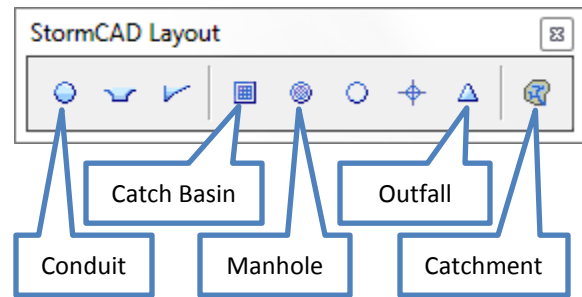
- A new StormCAD project can also be attached to an existing .dgn file (e.g., drainage basemap). You can lay out a StormCAD system on top of features previously drawn on drainage levels. In this case, it would probably be best to use the StormCAD levels so that duplicate/overlapping elements can be turned off when plotting construction plans. See the Element Levels section of this document to change the default levels for placing new StormCAD elements.
- It is a good idea to edit the **Project Properties**. (StormCAD > Project > Project Properties). All report headings include the Project Title, which defaults to the project file name (.stsw) if left blank. The Project Inventory Report also includes the additional fields (Engineer, Date, etc.).
- StormCAD for MicroStation autosaves as you go. The standalone mode requires manual saves.
- Sharing a StormCAD project with another user requires both the .stws and .mdb files. The .dgn file is not necessary for non-MicroStation users.
- You might get a pop-up message, "About to compact database." This is not necessary, and if desired, this feature can be turned off (StormCAD > Tools > Options > Global).

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Layout

After starting a project, the first step is to create the system using the graphical interface and StormCAD Layout tools. The StormCAD Layout toolbar includes links, nodes and catchments, and the tools are similar to using MicroStation Place Line, Place Active Cell, and Place Shape, respectively.

Before placing new elements, however, it is a good idea to review a few settings.

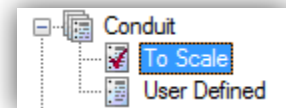


Default Settings

The StormCAD for MicroStation **Element Levels** feature (StormCAD > View > Element Levels) controls the default MicroStation levels on which new items and annotations will be placed. The levels can be changed later with normal MicroStation tools if necessary (Change Element Attribute, etc.).

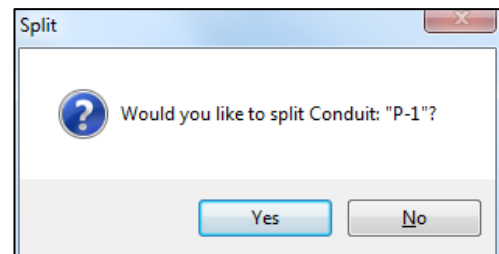
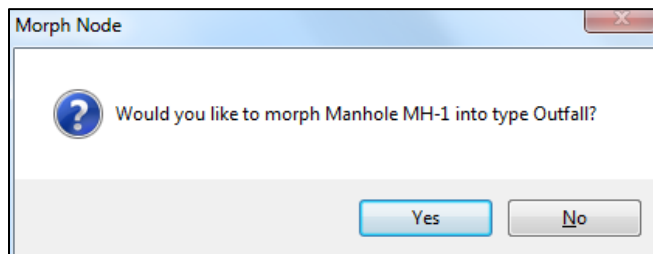
	Element Level	Annotation Level
Conduit	DR_P_Stom_Sewer	DR_P_StomCAD_Annotatio
Catch Basin	DR_P_Cells	DR_P_StomCAD_Annotatio
Manhole	DR_P_Cells	DR_P_StomCAD_Annotatio
Outfall	DR_P_Cells	DR_P_StomCAD_Annotatio
Catchment	DR_P_Drainage_Area	DR_P_StomCAD_Annotatio

The **Prototypes** feature (StormCAD > View > Prototypes) controls the default StormCAD attributes (e.g., catch basin type, conduit length to scale, etc.) of new elements placed. Later the elements are edited with FlexTables or the Properties dialog. For more details about Element Levels and Prototypes, see the View section of this document.



Nodes

The Layout toolbar includes the following node elements: catch basin, manhole, transition, cross section and outfall (every system requires an outlet node). The cell library (stm.cel) includes only one cell for each type of element (e.g., a square symbol for all catch basins). Click on the icon to activate the layout tool or use the dropdown menu (StormCAD > Tools > Layout). You may prefer to place the cell features on the fly while laying out conduit (see Links), but nodes can also be placed first using MicroStation precision placement tools (e.g., Snaps, AccuDraw, etc.). StormCAD permits node morphing or link splitting when you place a node on top of an existing element.



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Links

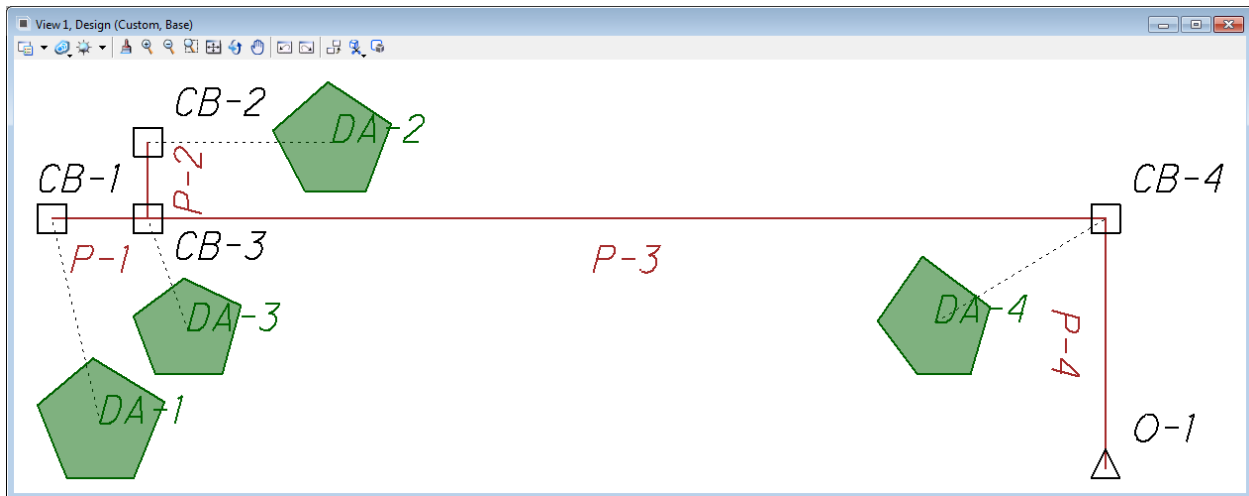
The Layout toolbar includes the following link elements: conduit, channel and gutter. For storm sewer systems, connect the nodes with conduits. If you want to place nodes on the fly, a manhole is the default conduit end. This can be set to catch basin in the Layout Conduit tool dialog. Alternately, you can take advantage of the morph node feature for elements that have already been placed.

Links require a node on both ends. If you delete a node, any attached links will also be deleted. If you move a node, the link geometry is automatically modified.

StormCAD is capable of performing culvert inlet control equations for open-ended storm sewers. From the Properties dialog, edit the Physical (Culvert) attributes (e.g., Is Culvert? True). You can use a “transition” node at the inlet end in lieu of a catch basin. In general, however, StormCAD should not be used for culvert calculations (HY-8, the FHWA Culvert Analysis Program is an excellent alternative to the ODOT CDSS culvert analysis modules).

Catchments

The Layout toolbar includes a catchment element. Drainage areas are represented as polygons, and they can be drawn to scale if desired. The catchment layout tool is slightly different than the normal MicroStation Place Shape. Click to place the vertices and then finish with a right click.



You will use **FlexTables** or the **Properties** dialog to connect the drainage areas to nodes and edit the StormCAD attributes for all elements. For more details, see the View section of this document.

Note: A StormCAD model generally requires catchments as well as an outfall.

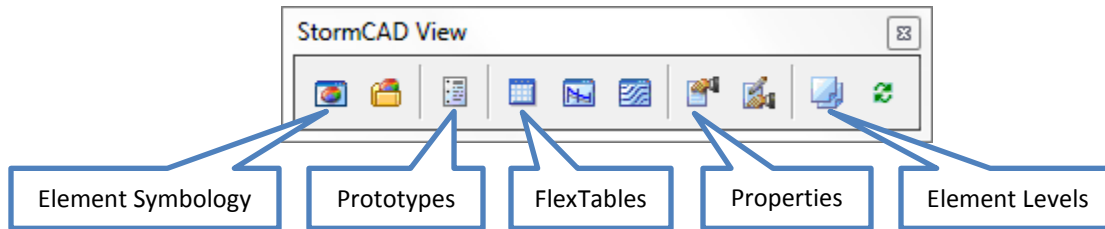
Labels

The label prefix and numbering is controlled by StormCAD **Options** (StormCAD > Tools > Options > Labeling). System elements should generally be placed in order from upstream to downstream for the best results when reviewing tabulated data. **Element Symbology** (StormCAD > View > Element Symbology) affects label placement and annotation properties as well as the element appearance (e.g., red lines for conduits).

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View

The View menu (StormCAD > View) includes several key StormCAD features.



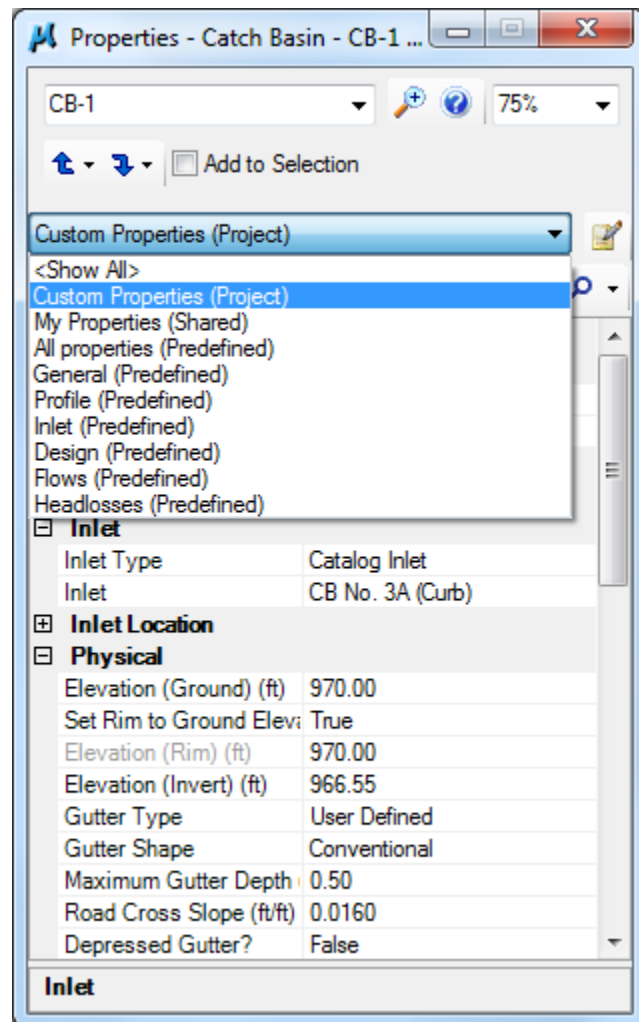
Properties

The StormCAD Property Editor dialog box is similar to MicroStation Element Information – it is used for viewing and editing information for elements and prototypes, and it is also used for scenarios and calculation options.

Click on an element in the drawing view to activate the Properties dialog, or use the search box/dropdown menu at the top to select an element. The dialog also includes buttons to Navigate Upstream/Downstream.

The number of element attributes can be overwhelming. The element attributes are organized by category. Use the plus/minus button next to the heading to expand/contract a category. The default profile is <Show All>. Select **Custom Properties (Project)** from the dropdown menu to hide some attributes and categories (advanced users might want to use the **Propertygrid Customizations** feature to create or edit a Shared profile).

The fastest way to edit text or data is to click on the label to the left of the field and start typing. Calculated values and results are represented with gray text. Some calculated values, such as conduit slope, are automatically generated. Results are visible after a scenario is run.

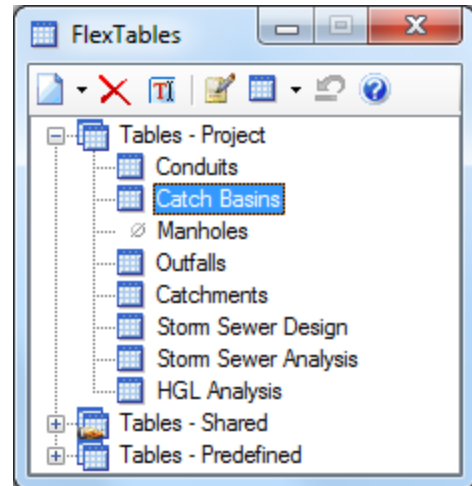


FlexTables

Use StormCAD FlexTables to enter information for multiple elements quickly, view calculated results and generate reports. As an alternative to the Property Editor, a FlexTable accesses the same element attributes and displays the same information. By default, a FlexTable may not display all of the fields shown in the Property Editor, but all FlexTables can be modified if desired by adding or deleting fields, changing column widths, editing labels, etc. Elements can also be sorted or filtered by attribute.

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The FlexTable manager shows three categories: Project, Shared and Predefined. The Project FlexTables are included with the StormCAD project file. Changes made to the Shared and Predefined FlexTables are stored on the user hard drive.



The Storm Sewer Design and Analysis FlexTables are types of conduit tables that include calculated result fields (indicated with yellow columns). The HGL Analysis FlexTable conveys the same information as the Storm Sewer Analysis using a two-row format. These FlexTables are intended to be used to generate reports after a scenario is computed.

Hint – use **Global Edit** to save time with FlexTables. Right click on a column heading to take advantage of this feature.

Catch Basins – the same inlets are used with both storm sewer and pavement drainage calculations (the FlexTable below shows only the data fields needed for storm sewer calculations – additional attributes are accessible through the Properties dialog). Select the ODOT inlet from the dropdown menu. For storm sewer calculations, the Inlet Location should be In Sag to capture all inflow (alternately, set the Inlet Type to Full Capture or the Catalog Inlet to Generic Default 100%). Enter the ground and invert elevations for existing analysis. For a new system design, only the ground elevation is necessary.

	Label	Roadway Station (ft)	Side	Inlet Type	Inlet	Inlet Location	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Notes
310: CB-1	CB-1	715+00	Left	Catalog Inlet	CB No. 3A (Curb)	In Sag	970.00	0.00	
311: CB-2	CB-2	715+20	Left	Catalog Inlet	CB No. 2-3	In Sag	968.30	0.00	
312: CB-3	CB-3	715+20	Left	Catalog Inlet	CB No. 3A (Curb)	In Sag	969.80	0.00	
314: CB-4	CB-4	717+20	Left	Catalog Inlet	Generic Default 100%	In Sag	968.30	0.00	

4 of 4 elements displayed

Conduits – review and modify the section size (diameter), invert elevations and length if needed. By default, StormCAD adjusts the inverts as well as size when it runs a design scenario. If using length to scale and inverts that match the start and stop nodes, no initial data entry may be needed.

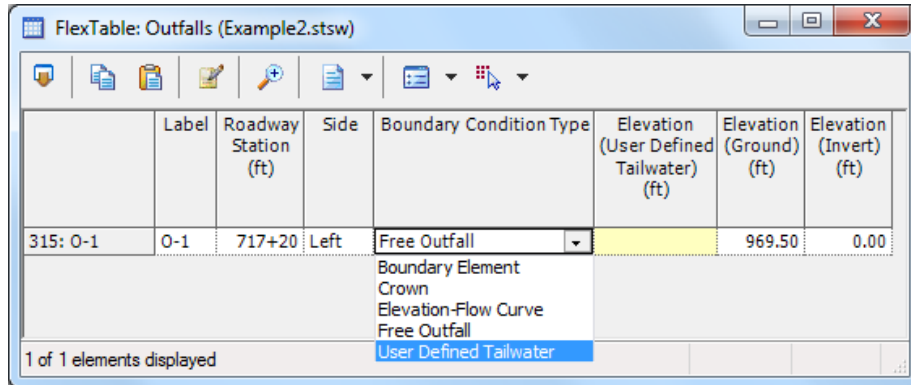
	Start Node	Stop Node	Begin Station (ft)	End Station (ft)	Section Size	Manning's n	Match Start Node Invert?	Invert (Start) (ft)	Match Stop Node Invert?	Invert (Stop) (ft)	Has User Defined Length?	Length (User Defined) (ft)	Length (Scaled) (ft)	Slope (Calculated) (ft/ft)
317: P-1	CB-1	CB-3	715+00	715+20	12 in.	0.015	<input checked="" type="checkbox"/>	0.00	<input checked="" type="checkbox"/>	0.00	<input type="checkbox"/>		20.0	0.0000
318: P-2	CB-2	CB-3	715+20	715+20	12 in.	0.015	<input checked="" type="checkbox"/>	0.00	<input checked="" type="checkbox"/>	0.00	<input type="checkbox"/>		16.0	0.0000
319: P-3	CB-3	CB-4	715+20	717+20	12 in.	0.015	<input checked="" type="checkbox"/>	0.00	<input checked="" type="checkbox"/>	0.00	<input type="checkbox"/>		200.0	0.0000
320: P-4	CB-4	O-1	717+20	717+20	12 in.	0.015	<input checked="" type="checkbox"/>	0.00	<input checked="" type="checkbox"/>	0.00	<input type="checkbox"/>		80.0	0.0000

4 of 4 elements displayed

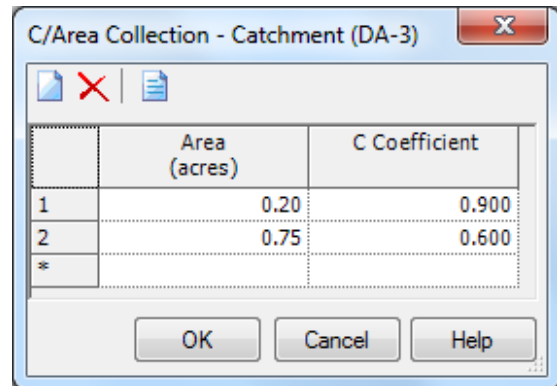
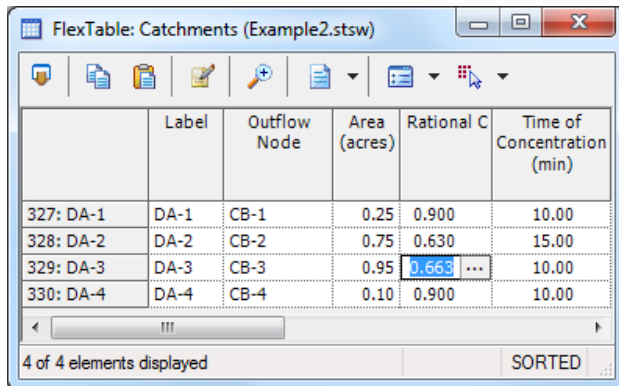
SORTED

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Outfalls – enter the ground and invert elevations. For the Boundary Condition Type, Free Outfall is appropriate for design mode. For hydraulic grade line analysis, enter a User Defined Tailwater.



Catchments – specify the Outflow Node by using the dropdown menu (select from drawing). Enter the area, rational coefficient and time of concentration. Multiple subareas can be incorporated.

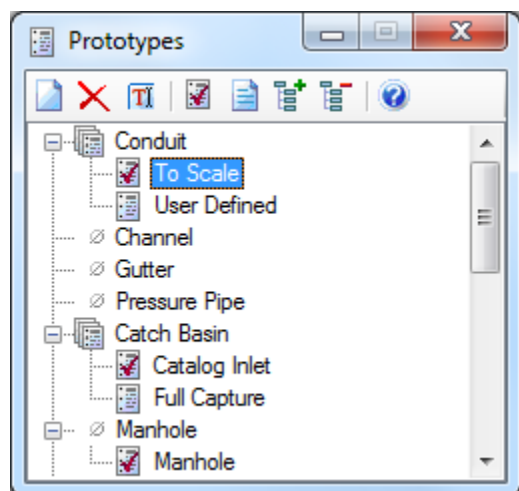


Hydrology Note: StormCAD can also accommodate fixed flows (e.g., peak flow obtained from USGS regression equations). Use the **Properties** dialog to edit the **Inflow (Wet) Collection**.

Prototypes

Prototypes affect new elements placed. They can save time by automatically populating various attribute fields. It is a good idea to review the prototypes prior to laying out a new system. Later the attribute values can be edited as needed with FlexTables or the Property Editor.

Prototypes are viewed and edited using the Properties dialog. The active conduit here (To Scale) has a 12 inch section size, with length to scale and invert elevations that match the start and stop nodes. By default, both size and invert elevations will be affected in design mode. For a quick schematic or existing system analysis, consider the User Defined conduit prototype (Make Current).

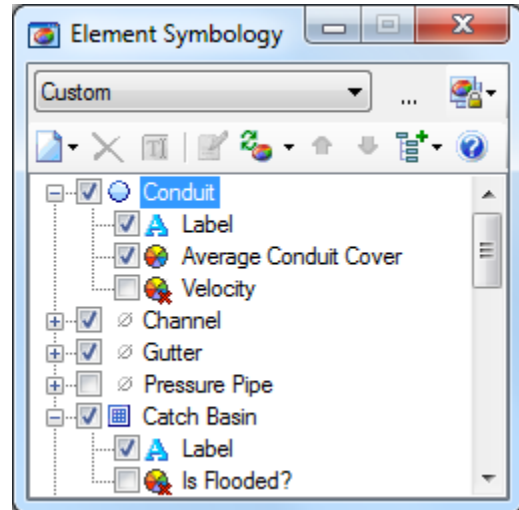


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Element Symbology

Use the Element Symbology dialog to manage the appearance of elements and labels. The checkboxes control visibility of annotations and color coding as well as the elements themselves.

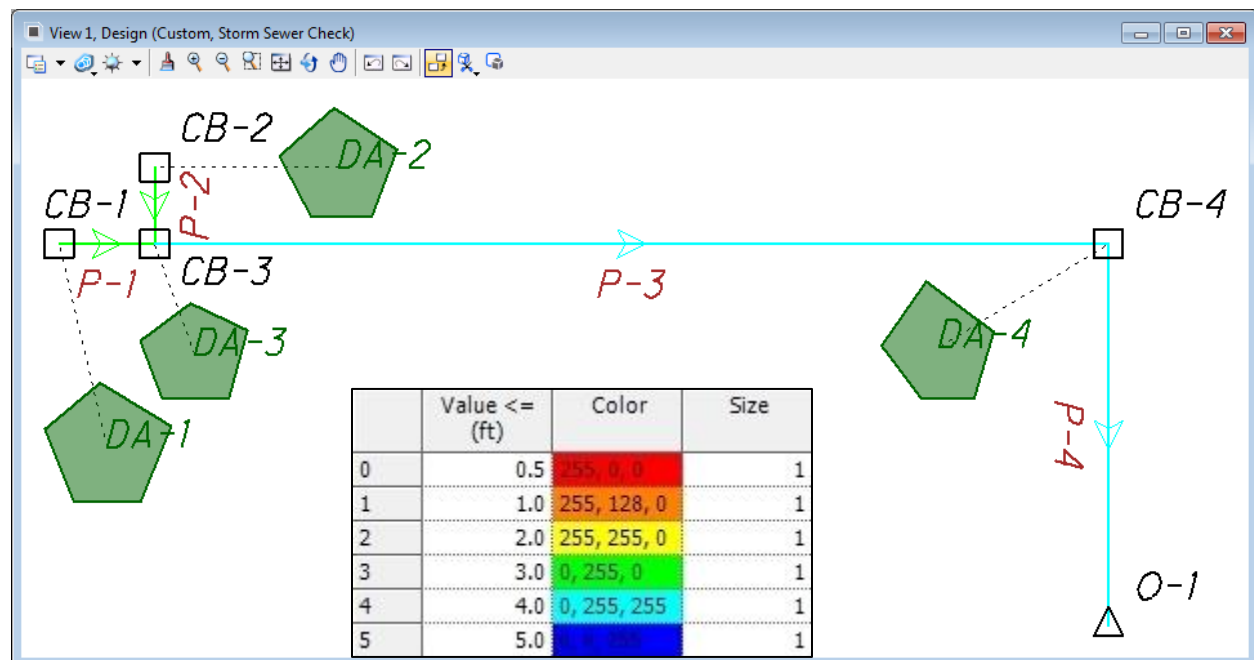
Annotations, or labels, are placed at fixed offsets, and the default text height is 5.6 (40 scale). Labels can include attribute fields like conduit length or diameter. StormCAD Options also affect the label scale, prefixes and numbering (StormCAD > Tools > Options). Avoid overlapping labels, because all annotations are visible in the .dgn file when StormCAD is not active. StormCAD text is not influenced by the MicroStation model annotation scale.



<General>	
Label	Conduit
Display	
Default Color	Color [A=255, R=165, G=42, B=42]
Symbol Size Multiplier	1.000
Line Width Multiplier	3.000
Show Flow Arrows	True

Selecting an element category (e.g., Conduit) activates the **Properties** dialog as shown here. Element appearance is controlled by StormCAD settings (e.g., red conduits) that override the MicroStation color and line weight. For issues related to ODOT CADD standards, see the Drainage Basemap section of this document.

Color Coding is a feature that affects element color, size or line width only when its box is checked in the Element Symbology manager. It visually represents ranges of attribute values or calculated results. For example, the color coding below symbolizes the average conduit cover. A quick glance shows you where the depth might be problematic. Here, the upstream pipes (green) are a little bit shallower than the downstream ones (cyan), but no pipes are too shallow (red or orange).

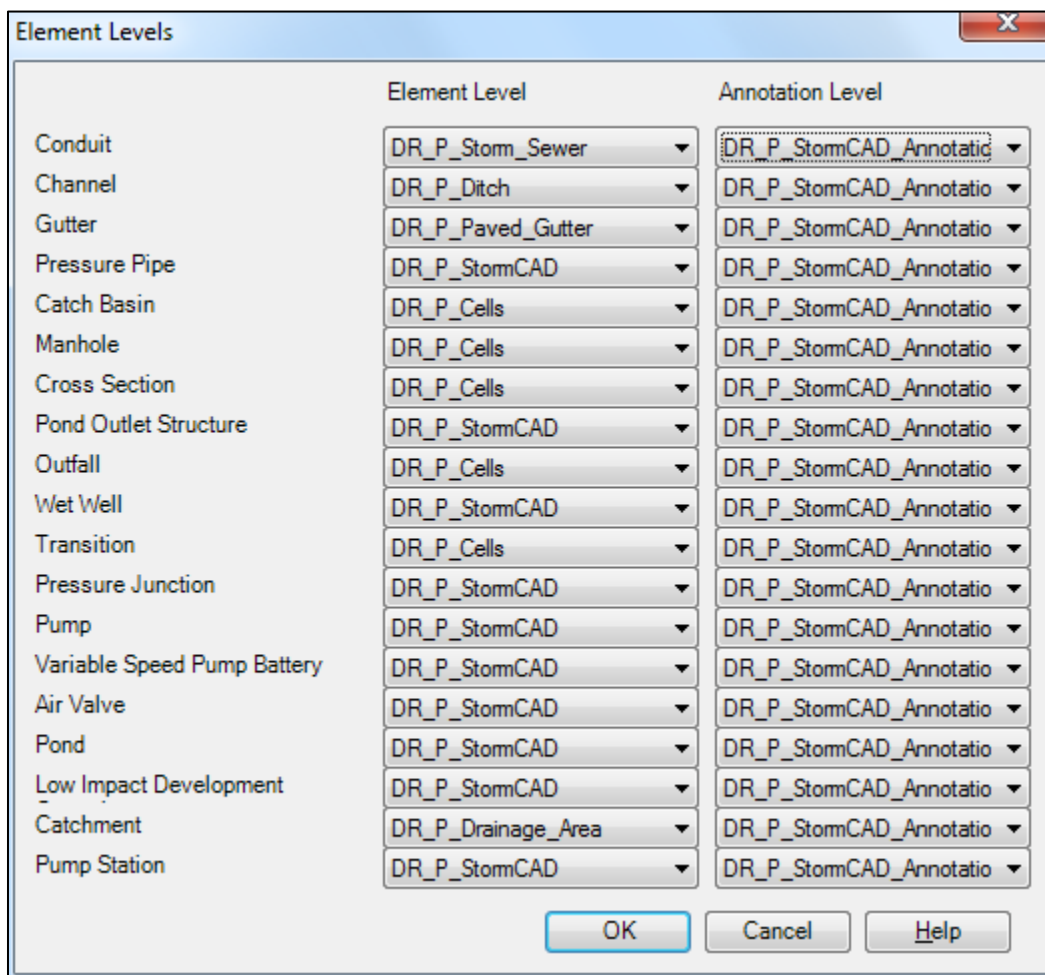


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Element Levels

The StormCAD for MicroStation **Element Levels** feature controls the default MicroStation levels on which new items and annotations will be placed. Use the dropdown menu to change the default level or specify the active level prior to placing elements. Changing the Element Levels selections does not affect previously created StormCAD elements, for which it is necessary to use the normal MicroStation selection and attribute tools. Element Levels are attached to the .dgn file, and the settings shown below are part of the ODOTStormCAD.dgn seed file. Otherwise, levels are not available in the dropdown selection unless they have already been used in the drawing.

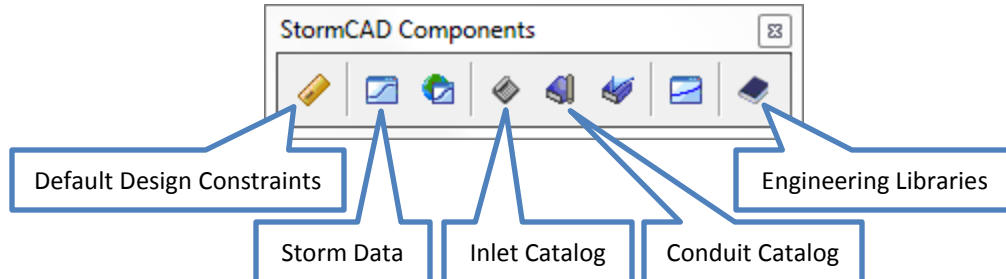
To add a level to the dropdown list, you can draw a scratch line on the desired level and then delete it (this is how the StormCADSeed.dgn file was created), or change an existing MicroStation or StormCAD element to the desired level. The levels in the dropdown list are arranged in the order in which they were placed, with the newest additions at the bottom – not necessarily alphabetically.



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Components

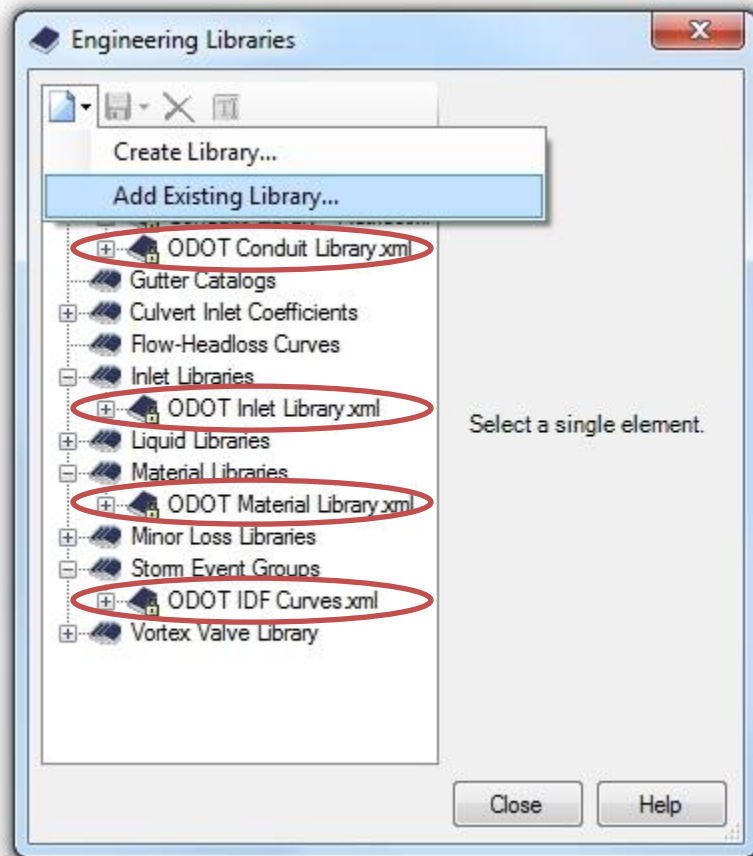
The StormCAD Components menu (StormCAD > Components) provides access to a number of ODOT customized features.



Engineering Libraries

Engineering Libraries are external to a StormCAD project file, and StormCAD installation includes some Bentley default libraries that are not used for ODOT purposes. The first time you use StormCAD, you will need to add the ODOT Engineering Libraries that are shown here at right (navigate to *ODOTstd\V8istd\StormCAD\EngineeringLibraries*).

The Storm Data, Inlet Catalog and Conduit Catalog found on the Components menu have elements and properties imported from the engineering libraries, and these components are included with the StormCAD project seed file. The ODOT Material Library does not have a corresponding catalog, but it is necessary to specify the conduit material when running StormCAD in design mode.



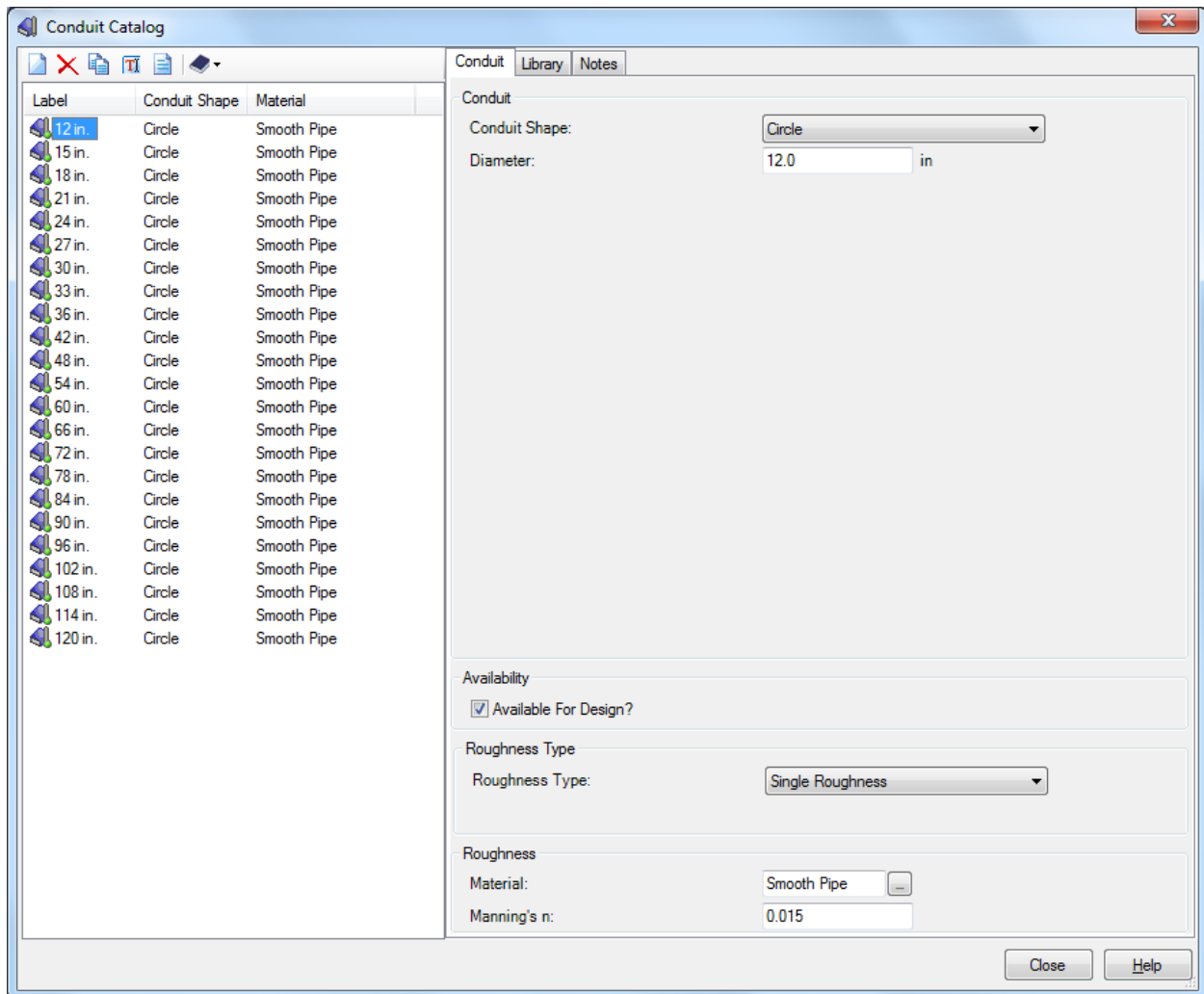
Note: Engineering Library updates are not automatically pushed to existing catalogs.

Catalogs

The **Conduit Catalog** includes elements imported from the ODOT Conduit Engineering Library. The Material should be Smooth Pipe from the ODOT Material Engineering Library. The Manning's "n" value is based on diameter as per the Location and Design Manual, Volume 2 (for ODOT purposes, this is not the same as the basic "n" value for smooth pipe). When using a conduit FlexTable or the Properties dialog,

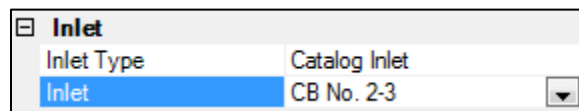
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the Section Size (Conduit Catalog) field has a dropdown selection menu with all of the Conduit Catalog elements. The alternative to a Catalog Conduit is a User Defined Conduit, but StormCAD design mode requires use of catalog conduits. The default conduit Prototype is a 12 in. catalog conduit.



The **Inlet Catalog** includes elements imported from the ODOT Inlet Engineering Library and which correspond to the ODOT Standard Construction Drawings. The catalog also includes a generic full capture inlet (Generic Default 100%). These same inlets are used for both storm sewer nodes and pavement spread calculations, and many of the catalog data fields are not pertinent to storm sewers (e.g., grate and curb window dimensions). For example, the difference between CB No. 3A (Curb & Gutter) and CB No. 3A (Curb) is irrelevant for storm sewer calculations. The “Dummy Node” with no captured flow is only intended for use with certain pavement spread calculations.

The Properties dialog and catch basin FlexTables have an Inlet Type field. The Full Capture type is suitable for storm sewer calculations, but selecting Catalog Inlet provides access to the Inlet pulldown menu.



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The Inlet Catalog manager has another Inlet Type dropdown menu. Flow to Inlet vs. Flow Captured is used for catch basins in ditches and Generic Default 100%, because it allows the designer to model full capture with a catalog inlet. The Ditch Inlet Type should not be used for ODOT purposes, because it requires additional channel section elements. For Gutter, Curb and Combination Inlets, bypass calculations are performed for inlets located on grade. Setting the inlet location to in sag for these inlets ensures that all flow is captured for purposes of storm sewer calculations.

	Flow to Inlet (cfs)	Flow Captured (cfs)
1	0.00	0.00
2	1.00	1.00
*		

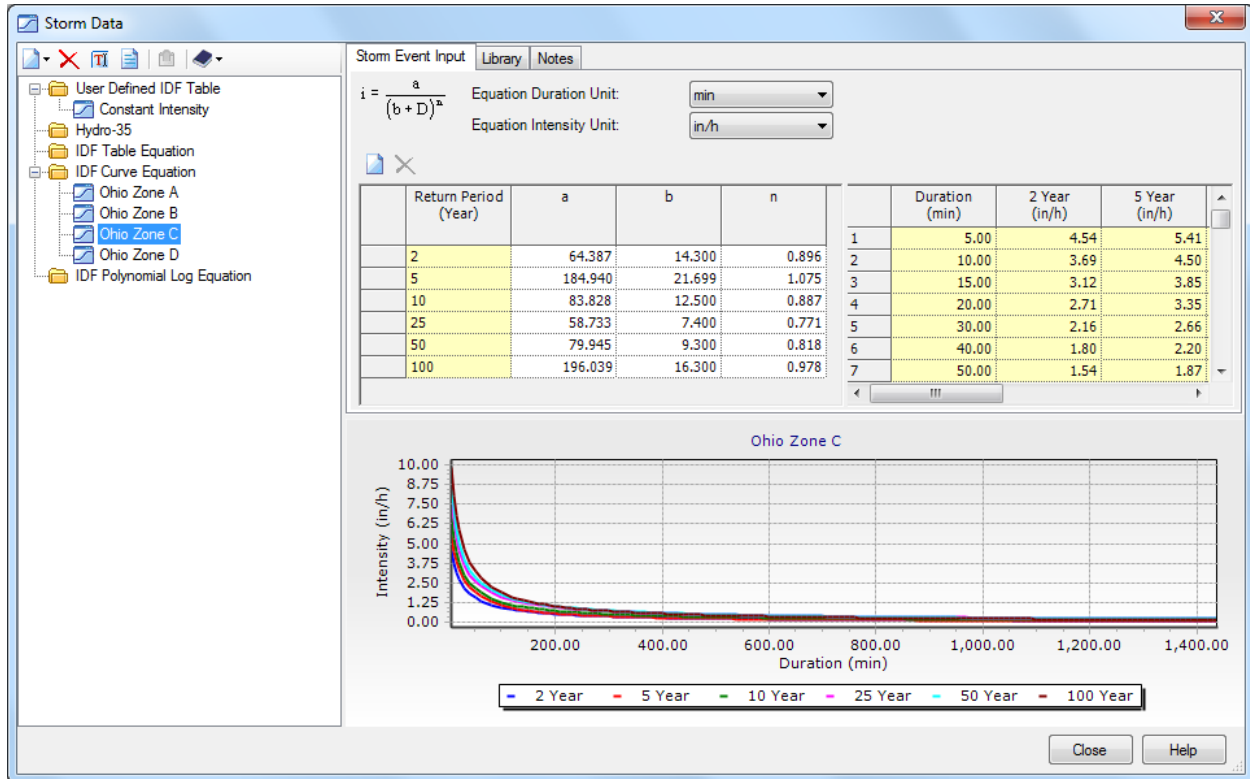
Note: StormCAD uses FHWA grate types (e.g., 30° tilt bar), not ODOT standard Neenah grates. The ODOT Inlet Library uses the closest approximation for modeling purposes. For details about the FHWA grate types, see the NHI Urban Drainage Design Manual (HEC-22).

Storm Data

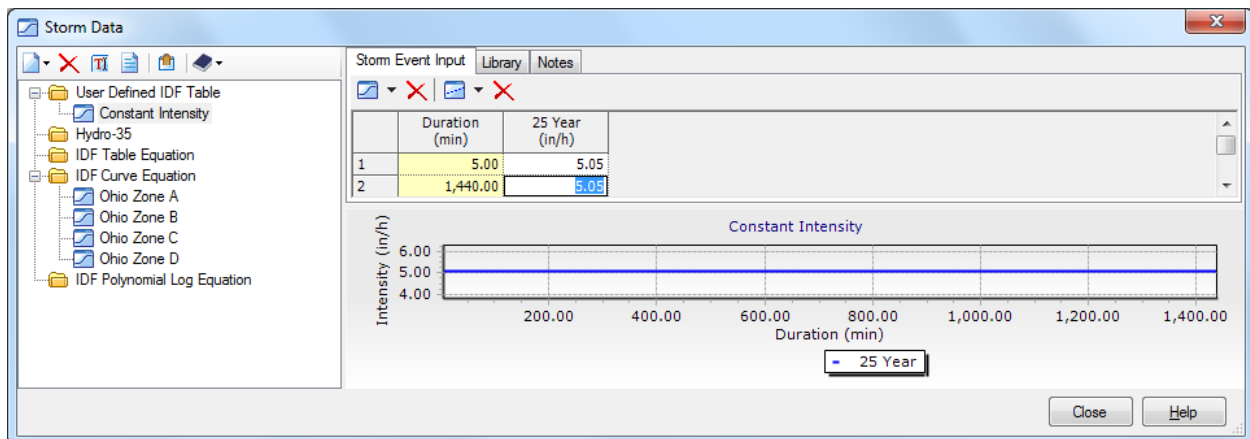
The Storm Data components include the rainfall intensity-duration-frequency curves for Ohio geographic areas as given in the Location and Design Manual, Volume 2. Similar to a catalog, these

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components are attached to the StormCAD project seed file. The original storm data can be imported from the ODOT IDF Curves Engineering Library (ensure that the equation duration and intensity units are selected). The **Global Storm Events** manager is a separate feature accessible through the Components menu. It is used for defining Rainfall Runoff Alternatives after storm events have been imported from an engineering library.



In addition to the ODOT IDF curves, there is a User Defined IDF Table for the hydraulic grade line check based on constant rainfall intensity, and it requires editing. The example shown below uses the 25-year outfall system intensity. For more details, see the Design & Analysis section of this document.

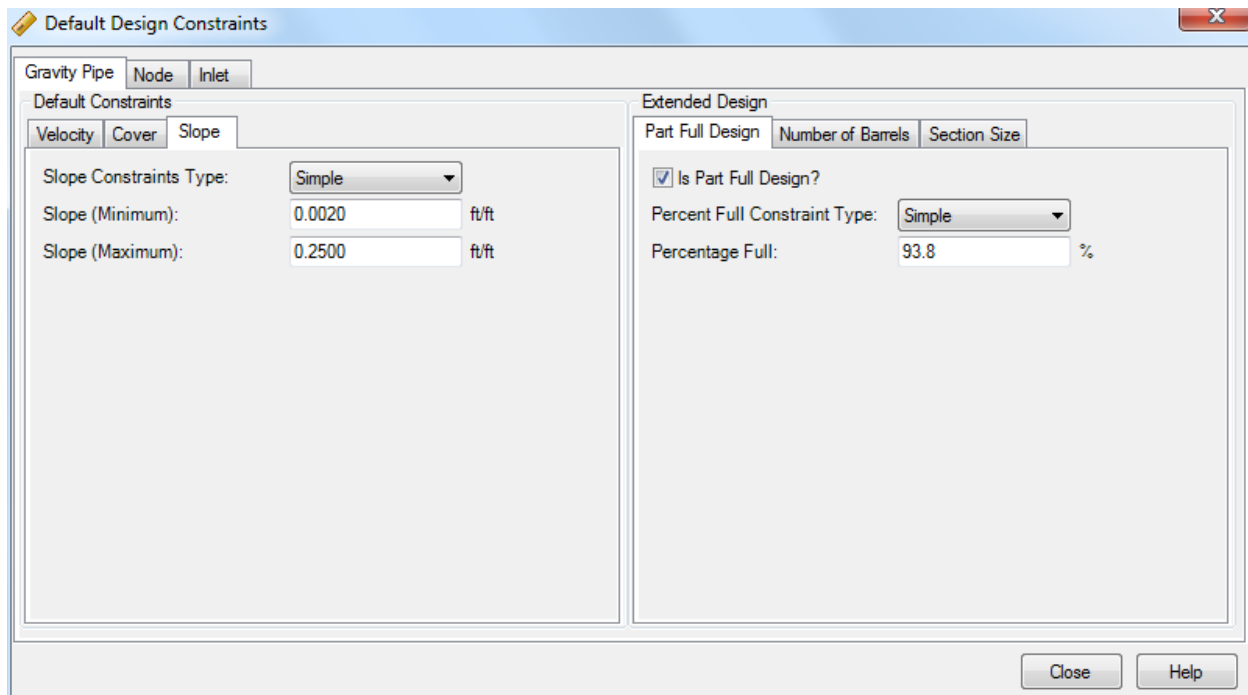


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Default Design Constraints

The Default Design Constraints incorporate ODOT design criteria for storm sewer velocity, cover, part full design and crown matching as per the Location and Design Manual, Volume 2. Taking advantage of the StormCAD minimum cover design constraint means that the designer is not required to provide pipe crown elevations prior to running a design scenario (minimum cover values include conduit wall thickness). The default inlet and conduit Prototypes include invert elevation design.

ODOT does not have minimum slope criteria, per se, but StormCAD assumes that the most economic storm sewer design is as shallow as possible. As a result, the minimum slope default design constraint directly impacts the size of automatically designed conduits, because StormCAD gives preference to meeting the minimum slope criteria first. The designer should understand that a smaller diameter pipe at a slightly steeper slope might also meet the just full design and minimum velocity constraints. If the conduit sizes generally seem too large, try increasing the minimum slope design constraint.

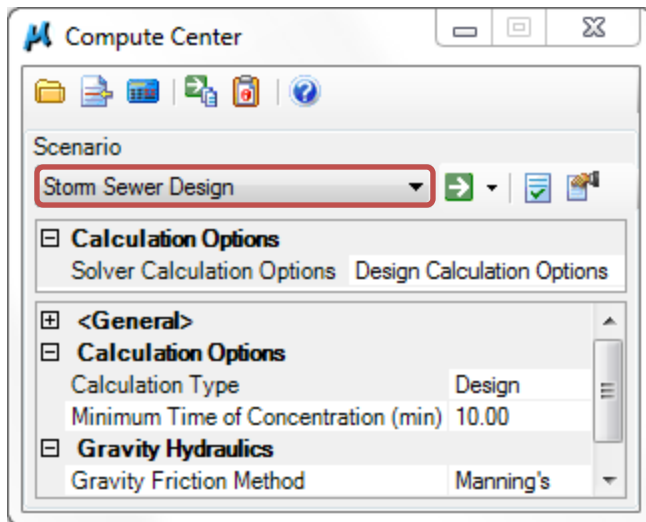
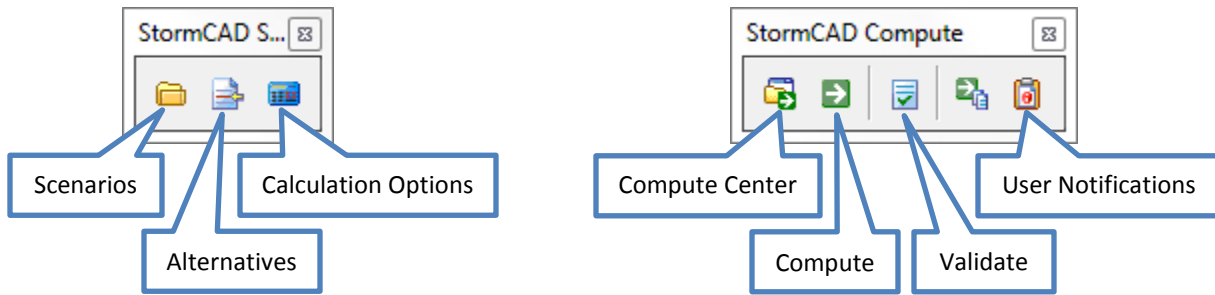


In the Default Design Constraints manager, the inlet tab is for designing the window opening length of a curb inlet based on efficiency or pavement spread – this feature is not used for ODOT purposes, and the default inlet Prototype excludes inlet opening design.

Local Constraints – some of the StormCAD conduit and inlet attributes in the design category refer to local constraints. These are design constraints for a given element that are not subject to the general default design constraints. By default the Prototypes do not specify local constraints, but this can be modified for any element using the Properties dialog.

The Default Design Constraints primarily affect the design mode outcomes, but User Notifications in the analysis mode may also include warnings when elements do not meet slope or cover restraints.

Design and Analysis



After laying out a system and editing the element attributes, the next step is to perform design and/or analysis computations. There are two toolbars (shown above) with features from the Analysis menu, and the **Compute Center** manager (StormCAD > Analysis > Compute Center) also provides access to these tools.

A typical ODOT storm sewer is sized to flow just full for the 10-year frequency storm, and the hydraulic grade line (HGL) is checked using the 25-year or 50-year frequency. The HGL analysis is influenced by the outlet tailwater elevation. To accomplish this, StormCAD uses **Scenarios**, **Alternatives** and **Calculation Options**.

Scenarios

A StormCAD Scenario is comprised of a group of Alternatives and Calculation Options. Some of the customized Scenarios, Alternatives and Calculation Options are featured in the table below. *Base* is the current scenario for a new project. To change this, right click on the selected scenario and use the popup menu or click the Make Current icon. Alternately, use the dropdown selection in the **Compute Center**. The scenario can be viewed or edited in the **Properties** dialog.

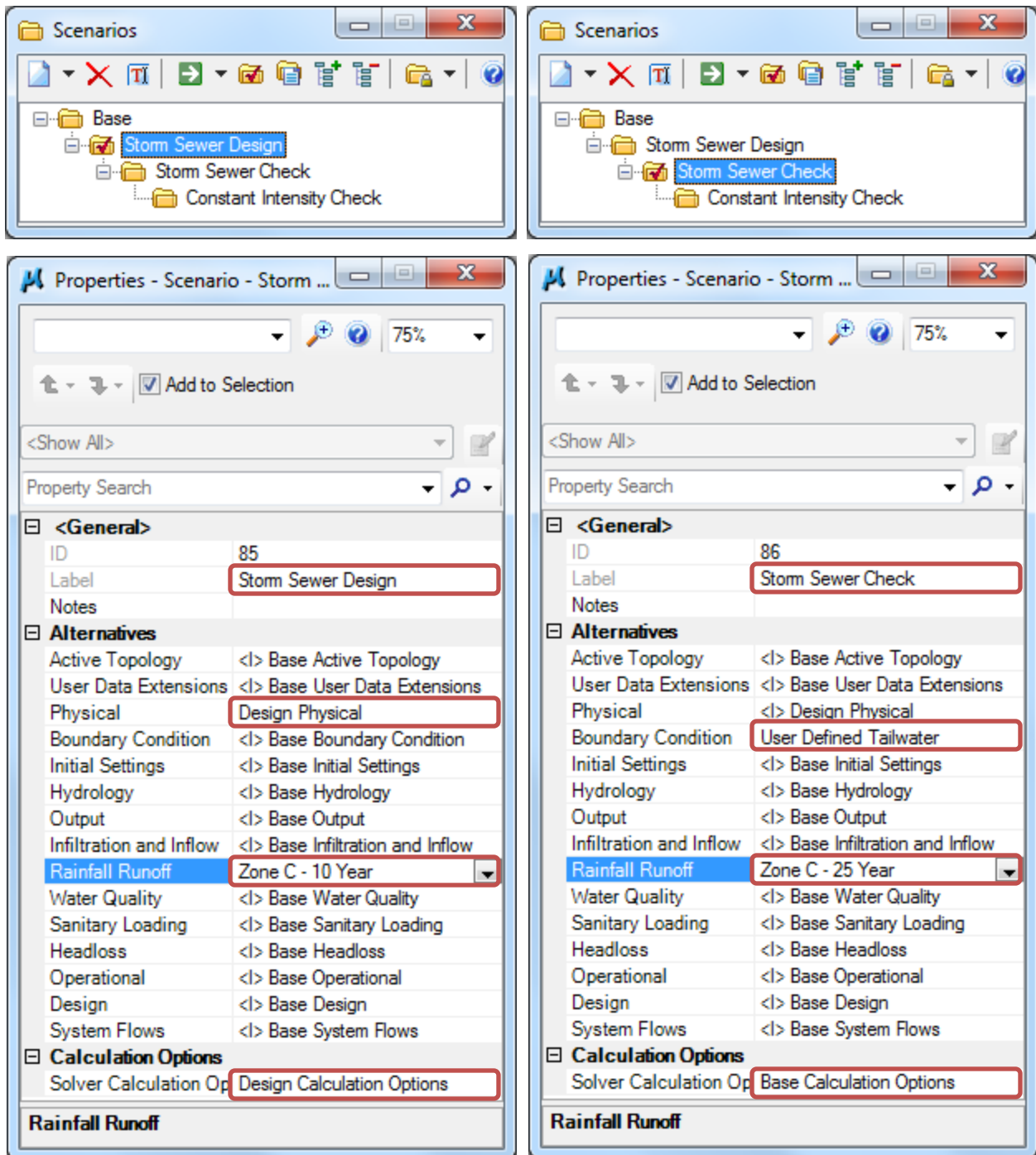


StormCAD Scenarios are subject to parent-child relationships, or inheritance, represented in the **Scenarios** manager tree view above (e.g., *Storm Sewer Check* is a child scenario of *Storm Sewer Design*).

	Base Scenario	Storm Sewer Design Scenario	Storm Sewer Check Scenario	Constant Intensity Check Scenario
Physical Alternative	Base	Design	< > Design	< > Design
Boundary Condition Alternative	Base	< > Base	User Defined Tailwater	< > User Defined Tailwater
Rainfall Runoff Alternative	Base	Design Storm (10-Year)	Check Storm (25-Year)	Constant Intensity Storm (25-Year)
Calculation Options	Analysis	Design	Analysis	< > Analysis

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For a child scenario, “inherited” Alternatives are indicated in the Properties dialog with <I> (see below). From the Properties dialog, the Alternatives are selected by using the dropdown choices. Pay particular attention to the Rainfall Runoff Alternative that must be specified before performing computations.



Alternatives

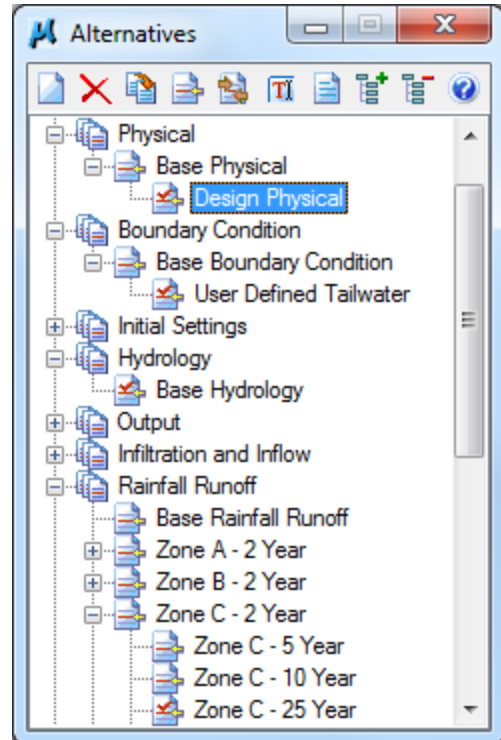
Most StormCAD Alternatives consist of data from the element attributes. For example, the *Physical Alternative* includes conduit sizes and invert elevations. The ground and invert elevations of an outlet are also part of the *Physical Alternative*, but the boundary condition (Free Outfall or User Defined

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Tailwater) is separate (*Boundary Condition Alternative*). For catchments, the area is included with the *Physical Alternative*, but the runoff coefficient and time of concentration are part of the *Hydrology Alternative*. The *Rainfall Runoff Alternative* (storm event) is independent of any element attributes. Some of the Alternatives are specific to sanitary or pressure flow systems and are irrelevant for ODOT purposes.

In the **Alternatives** manager, each selected alternative associated with the current scenario has a red checkmark icon. To specify a different alternative for the current scenario, use the **Scenarios** manager and **Properties** dialog.

In the Rainfall Runoff Alternatives, *Base Rainfall Runoff*, *Storm Sewer Design Storm*, and *Storm Sewer Check Storm* are placeholders. From the **Scenarios** manager, select a scenario and use the **Properties** dialog dropdown choices to specify the actual storm event (e.g., Zone C – 10 Year).



As shown in the tree view, Alternatives are subject to “inherited” properties, similar to Scenarios. There are two ways to edit element properties for an alternative. To use the Alternatives dialog, double click on an alternative to open it (alternately, right click and select Open from the popup menu, or use the icon at the top of the **Alternatives** manager). In the example below, none of the data is inherited from *Base Physical*, even though it is the parent scenario. All of the physical conduit data is local data as indicated by the checkmark in the first column (see the key at the bottom of the dialog). Editing data in this dialog is similar to using a FlexTable. The tabs at the top are to select other element types.

Physical : Design Physical (Example2.stsw)

	Channel	Gutter	Pressure Pipe	Catch Basin	Manhole	Transition	Cross Section	Outfall	Pond	Pond Outlet			
	* Label	Conduit Type	Section Type	Material	Section Size (Catalog Conduit)	Diameter (in)	Manning's n	Set Invert to Start?	Invert (Start) (ft)	Set Invert to Stop?	Invert (Stop) (ft)	Has User Defined Length?	Length (User Defined) (ft)
317: P-1	<input checked="" type="checkbox"/> P-1	Catalog Conduit	Circle	Smooth Pipe	15 in.	15.0	0.015	<input type="checkbox"/>	966.55	<input type="checkbox"/>	964.79	<input type="checkbox"/>	
318: P-2	<input checked="" type="checkbox"/> P-2	Catalog Conduit	Circle	Smooth Pipe	15 in.	15.0	0.015	<input type="checkbox"/>	964.85	<input type="checkbox"/>	964.79	<input type="checkbox"/>	
319: P-3	<input checked="" type="checkbox"/> P-3	Catalog Conduit	Circle	Smooth Pipe	21 in.	21.0	0.015	<input type="checkbox"/>	964.29	<input type="checkbox"/>	963.86	<input type="checkbox"/>	
320: P-4	<input checked="" type="checkbox"/> P-4	Catalog Conduit	Circle	Smooth Pipe	21 in.	21.0	0.015	<input type="checkbox"/>	963.86	<input type="checkbox"/>	963.69	<input type="checkbox"/>	

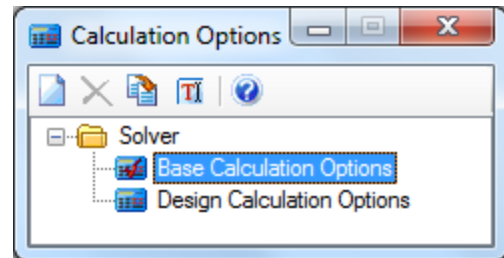
* = Base data = Local data = Inherited data

The other way to modify element data is to make sure the selected scenario is current (use the **Scenarios** manager or **Compute Center**) and then edit a **FlexTable** or use the **Properties** dialog. The advantages of this method are that you do not need to worry about the Alternatives manager, and the visible attribute fields are limited. When you change the current scenario, attributes in the FlexTables and Properties automatically switch to reflect the current Alternatives. Remember, though, that the various data fields in FlexTables (and Properties) may be parts of different categories of Alternatives.

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Calculation Options

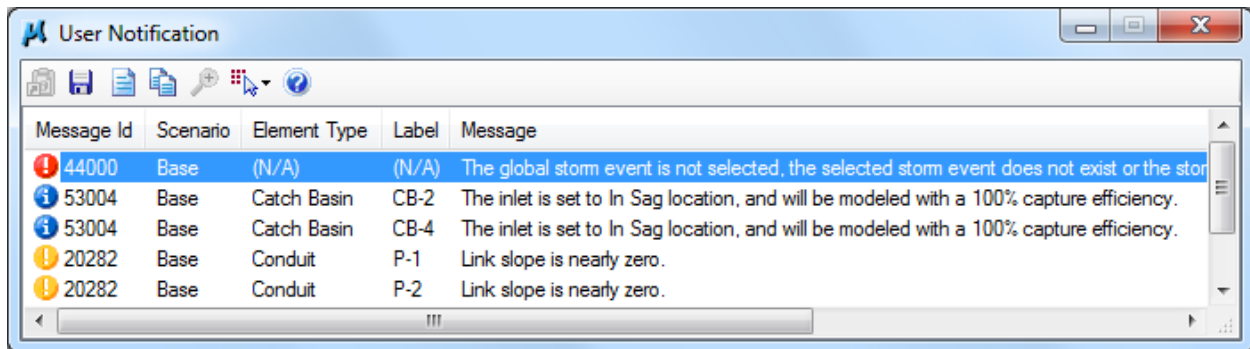
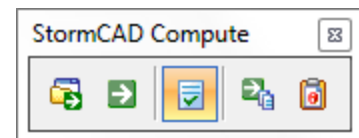
The StormCAD Calculation Options help to define a scenario, and the most important distinction is whether the computations will be performed in design or analysis mode. *Base Calculation Options* are for analysis. If *Design Calculations Options* are selected, then StormCAD will automatically size conduits and set invert elevations based on the Default Design Constraints.



The Calculation Options include the minimum time of concentration, and the default is 10 minutes. To edit the selected Calculation Options, use the **Properties** dialog.

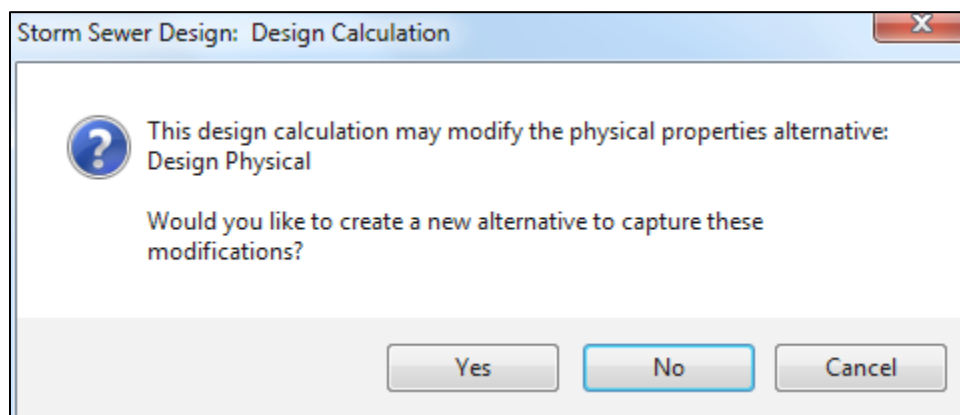
User Notifications

It is a good idea to validate input data prior to running a Scenario. Use the **Validate** tool (accessible through the **Compute Center** as well as the StormCAD Compute toolbar). If the **User Notification** manager appears, resolve any errors with **red** icons and review the other warnings.



Compute

After resolving User Notification errors, click Compute (accessible through the **Scenarios** manager and **Computer Center** as well as the StormCAD Compute toolbar). StormCAD runs the current scenario (it is also possible to perform a **Batch Run** with multiple scenarios). If the Calculation Options are set to design mode, there will be a popup query – it is not necessary to create a new physical alternative. If you click No, StormCAD will modify the current physical alternative.



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Putting It All Together (Storm Sewer System)

The following StormCAD steps and descriptions apply to a typical ODOT storm sewer project:

1. Begin

- a. Use *Base* scenario
 - Base Physical Alternative
- b. Layout system and edit element attributes

2. Design

- a. Change current scenario to *Storm Sewer Design*
 - Design Physical Alternative
 - Data inherited from Base Physical Alternative
 - Data modified by design computations
 - Free Outfall Boundary Condition Alternative
 - Design Calculation Options
- b. Select Rainfall Runoff Alternative (e.g., Zone C – 10 Year)
- c. Validate data , resolve errors and compute scenario
- d. Review results and create report

3. Analysis

- a. Change current scenario to *Storm Sewer Check*
 - Design Physical Alternative (inherited)
 - User Defined Tailwater Alternative
 - Analysis Calculation Options
- b. Verify the outlet tailwater elevation
- c. Select the Rainfall Runoff Alternative (e.g., Zone C- 25 Year)
- d. Validate data, resolve errors and compute scenario
- e. Review outfall system intensity

4. HGL Check

- a. Change current scenario to *Constant Intensity Check*
 - Design Physical Alternative (inherited)
 - User Defined Tailwater Alternative (inherited)
 - Analysis Calculation Options (inherited)
- b. Edit the *Constant Intensity Storm* in the Storm Data manager
 - Use outfall system intensity from *Storm Sewer Check*
- c. Validate data, resolve errors and compute scenario
- d. Review results, make profiles and create report

Notes:

- Use *Base Scenario* to **analyze an existing system** with a 10-year storm event. Use *Storm Sewer Check Scenario* and *Constant Intensity Check Scenario* to compute the 25-year HGL.
- ***Design Physical Alternative*** inherits data from the *Base Physical Alternative*. If *Storm Sewer Design Scenario* is not computed and the inherited data is not modified, then these two physical alternatives will be identical.

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- If you want to use your preferred design alternative for any other scenarios, simply make sure the Storm Sewer Design Physical Alternative is selected.
- **Design Structure Elevation?** This element attribute setting is irrelevant for analysis mode. In design mode, StormCAD sets the invert elevation of node elements (conduits are similar). This default setting can be changed to False using the Properties dialog. For example, the system outlet may have a fixed elevation.
- If you are running a design scenario for a system that includes an **existing drainage feature** or fixed physical data, make sure the corresponding design setting is False in the Properties dialog. This is also true if you are redesigning a system (e.g., with a different minimum slope) and want to keep certain portions of StormCAD's initial design.
- If you change any input data (e.g., conduit size, storm event, etc.), the hydraulic results do not automatically update. You need to compute the scenario again.
- **Is Active?** This attribute field is part of the *Active Topology Alternative*. Among other things, you could use this to model **multiple systems** in a single project, because it allows you to work on selected elements at a time without affecting any other systems.
- The StormCAD project seed file includes customized Scenarios and Alternatives to assist with standard ODOT design and analysis workflows. If it is necessary to create any new Alternatives or Scenarios, **StormCAD Help** provides additional guidance (StormCAD > Help > StormCAD Help > Contents > Scenarios and Alternatives).

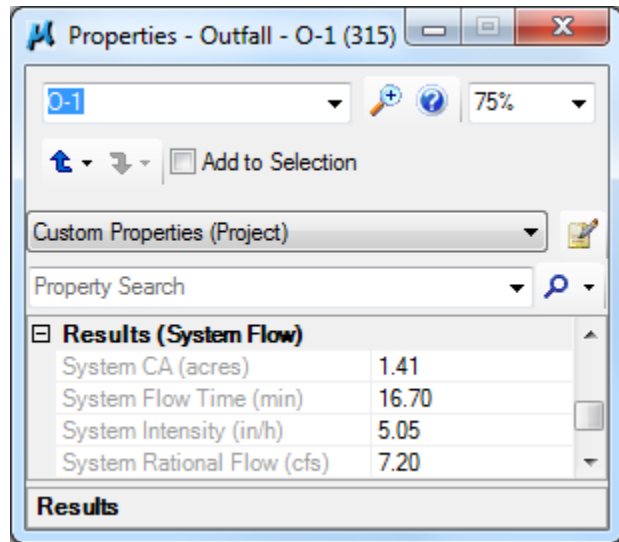
User Notifications:

- **Conduit discharge is above design discharge.** It is not unusual for this warning to appear after *Storm Sewer Check* or *Constant Intensity Check* is computed for a new storm sewer design – conduits are typically sized for a lower intensity storm, and then the HGL is checked for a higher intensity storm. Depending on the user defined outlet tailwater elevation, there may also be a velocity warning: **Conduit does not meet minimum velocity constraint.** These warnings should not be cause for concern with the *HGL Analysis*, provided that *Storm Sewer Design* does meet conduit discharge and minimum velocity design criteria.
- If there is a **global storm event** error, check the scenario properties and make sure the appropriate *Rainfall Runoff Alternative* has been selected. If the problem persists, open the Global Storm Events manager from the Components menu. Look for an alternative with an undefined storm event and use the dropdown selection list.

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Review Results

Properties – view results for individual elements. The calculated results are indicated with gray attribute field names, and they are found at the bottom of the Properties dialog.



Calculation Summary – is automatically generated when you compute a scenario. It allows you to view detailed results for all elements.

FlexTables – are convenient and customized for ODOT purposes. Use the Storm Sewer Design FlexTable when *Storm Sewer Design* is the current scenario. Use the Storm Sewer Analysis or HGL Analysis FlexTables when *Storm Sewer Check* or *Constant Intensity Check* is the current scenario.

	Flow (cfs)	Diameter (in)	Length (Unified) (ft)	Slope (ft/ft)	Invert (Start) (ft)	Invert (Stop) (ft)	Manning's n	Velocity (ft/s)	Capacity (Design) (cfs)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)	Cover (Start) (ft)	Cover (Stop) (ft)
317: P-1	1.20	12.0	20.0	0.0882	966.80	965.04	0.015	8.07	9.86	970.00	969.80	2.20	4.51
318: P-2	2.11	15.0	16.0	0.0040	964.85	964.79	0.015	3.00	3.79	968.30	969.80	2.20	4.26
319: P-3	5.90	21.0	200.0	0.0021	964.29	963.86	0.015	3.00	6.83	969.80	968.30	3.76	2.69
320: P-4	6.09	21.0	80.0	0.0021	963.86	963.69	0.015	3.00	6.81	968.30	969.50	2.69	4.06

The yellow cells hold calculated results. Input data in the white cells can be modified – compute the scenario to update hydraulic results.

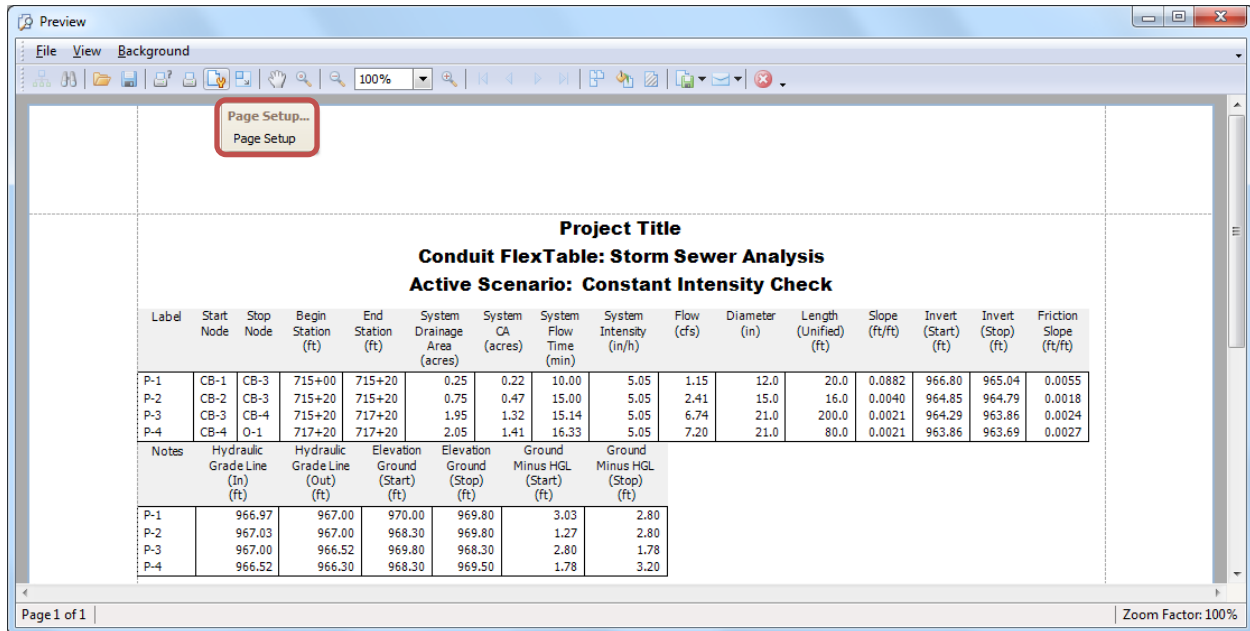
Reports

At least two storm sewer reports are necessary for typical ODOT purposes, because the design and analysis require more than one scenario. From any FlexTable, select the Report icon to generate a hard copy or save as a .pdf file.

	Diameter (in)	Length (Unified) (ft)	Report	Invert (Start) (ft)	Invert (Stop) (ft)	Friction Slope (ft/ft)	Notes	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)	Ground Minus HGL (Start) (ft)	Ground Minus HGL (Stop) (ft)
317: P-1	12.0	20.0	0.0882	966.80	965.04	0.0055	P-1	966.97	967.00	970.00	969.80	3.03	2.80
318: P-2	15.0	16.0	0.0040	964.85	964.79	0.0018	P-2	967.03	967.00	968.30	969.80	1.27	2.80
319: P-3	21.0	200.0	0.0021	964.29	963.86	0.0024	P-3	967.00	966.52	969.80	968.30	2.80	1.78
320: P-4	21.0	80.0	0.0021	963.86	963.69	0.0027	P-4	966.52	966.30	968.30	969.50	1.78	3.20

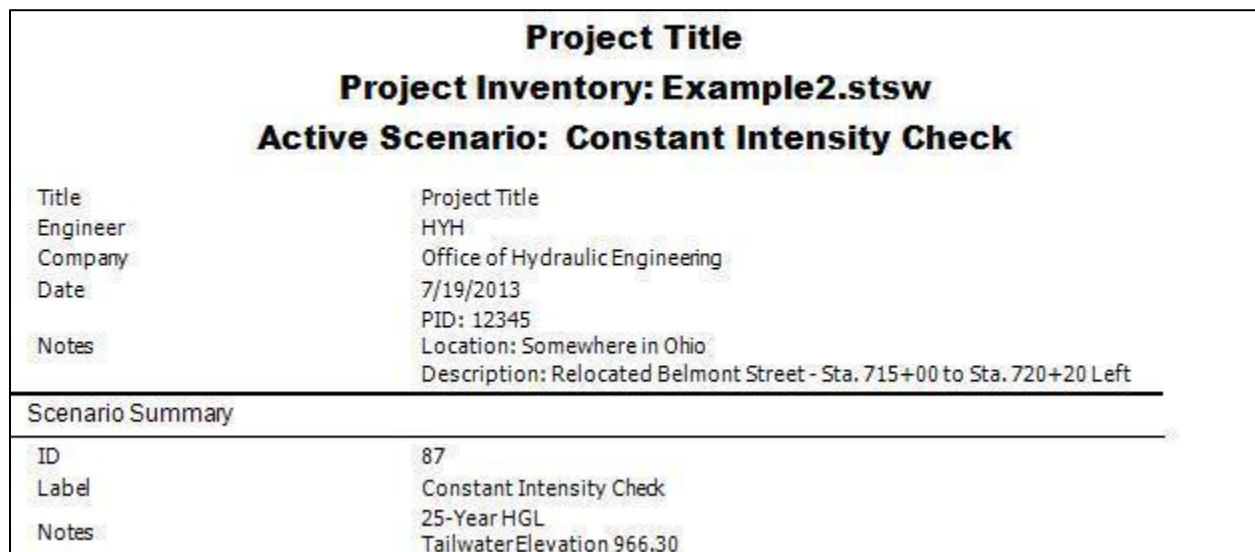
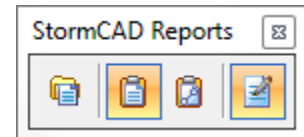
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From the Preview pane, use **Page Setup** to switch to landscape orientation if desired. In this example, the Notes attribute field is used to create duplicate labels for the second row. The FlexTable formats can be modified (column width, headings, etc.), but the final reports should include all the necessary information as per the Location & Design Manual, Volume 2 (see Form LD-34 in Appendix A).



The **Project Properties** (StormCAD > Project > Properties) include the project title. If this field is blank, the default title will be the name of the StormCAD project file (e.g., Example2.stsw). The report heading indicates the type of FlexTable as well as the active scenario.

The **StormCAD Reports** menu includes additional types of reports as well as **Report Options**. The **Project Inventory** includes all of the project properties plus a summary of the active scenario and all network elements.

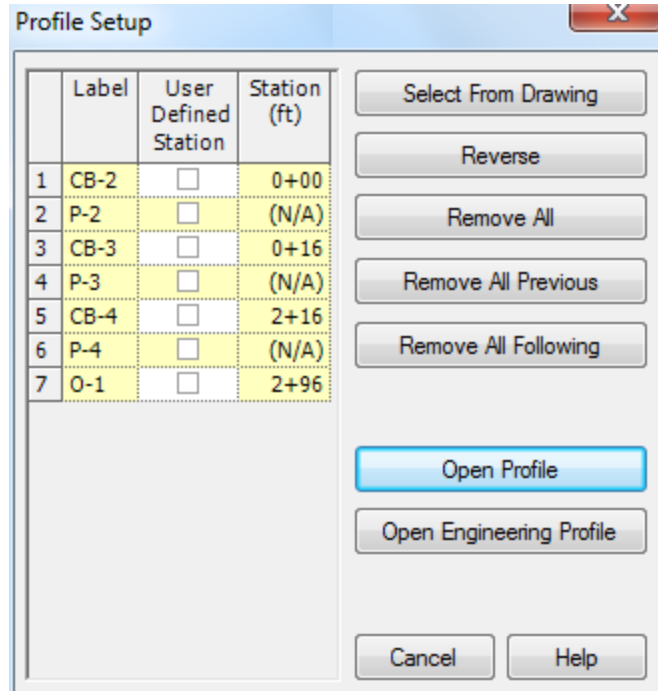
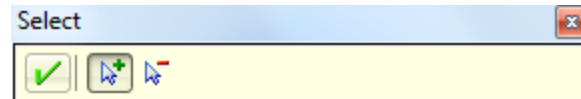
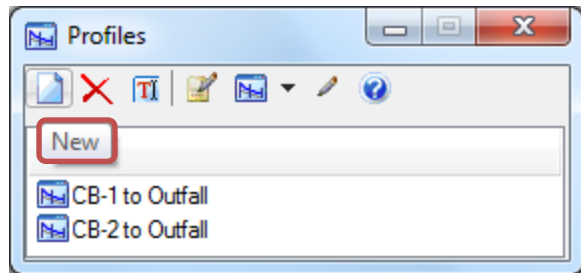
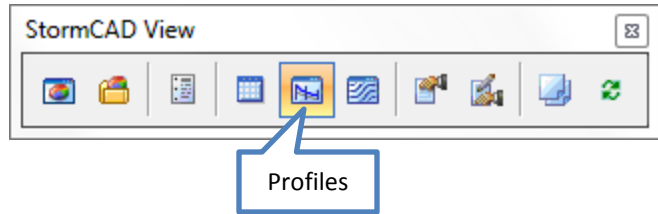


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Profiles

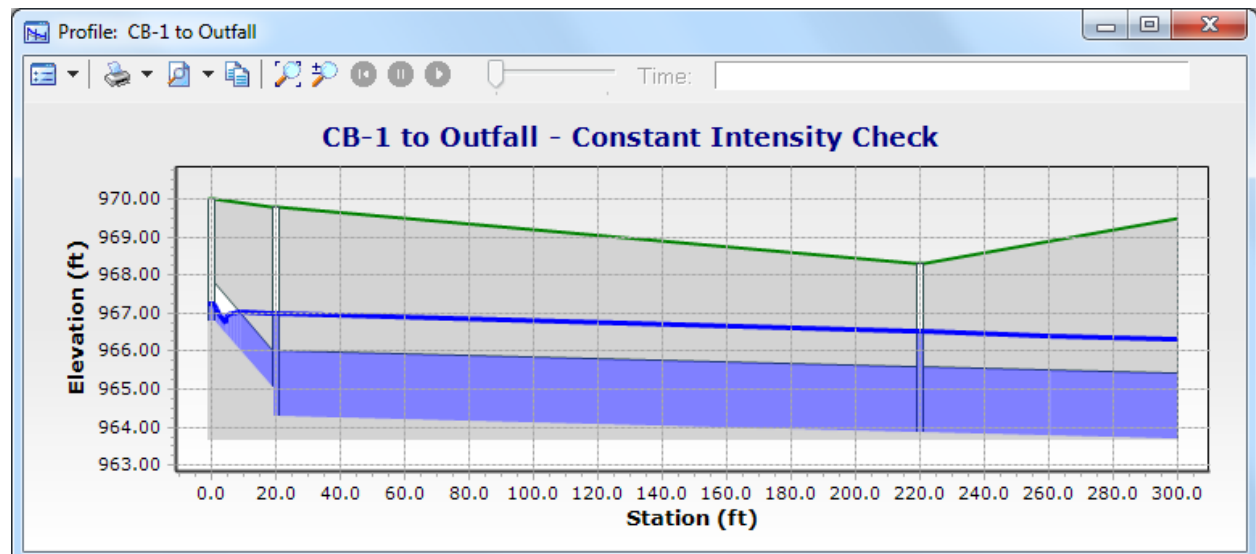
The Profiles tool is accessible from the **StormCAD View** menu. It is helpful for viewing the HGL when *Storm Sewer Check* or *Constant Intensity Check* is the current scenario.

To quickly create a profile from an inlet to the system outlet, select the beginning node from the drawing. Right click and hold, and then select *Create Profile* from the popup menu.



Alternately, use the **Profiles** manager to create a new profile. From the **Profile Setup**, use the **Select** tool to add the first and last nodes, and then click *Done*. Open the profile.

From the Profiles manager, right click on an existing profile to view it and create a printable report if desired. The default profile is shown below. The alternative engineering profile is drawn to scale. The stations here are referenced to the storm sewer system, not the roadway centerline.

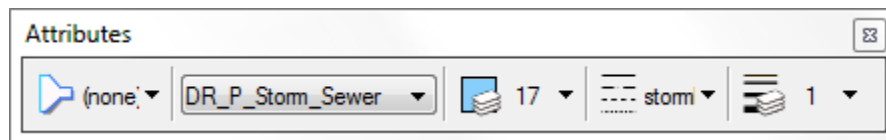


Drainage Basemap

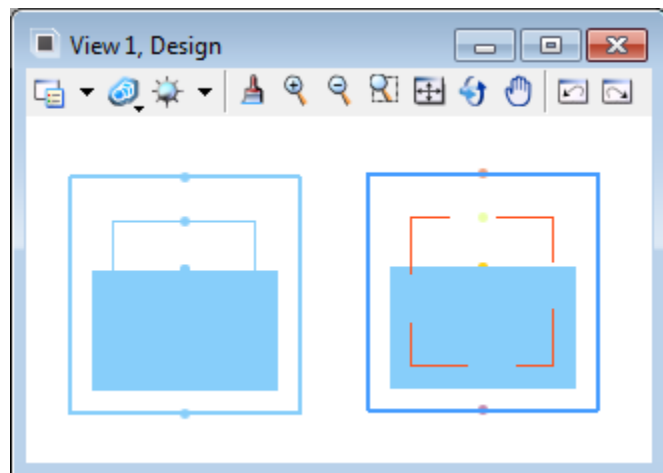
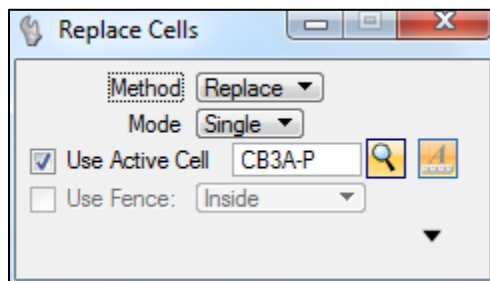
ODOT CADD Standards

StormCAD for MicroStation allows the designer to integrate hydraulic calculations with plan development by creating a storm sewer system plan view drawn to scale. It is best to have a drainage basemap file (e.g., 12345BD001.dgn) that contains only StormCAD elements with editing permission only for StormCAD users. The general roadway basemap (e.g., 12345BP001.dgn) can reference this file.

ByLevel Attributes – when opening the .dgn file with regular MicroStation, linear StormCAD elements (e.g., conduits) are displayed with standard ODOT levels, colors and styles. However, StormCAD for MicroStation sets the line weights to 0. Prior to plotting plan sets in regular MicroStation, you can correct the line weights using Element Selection and a tool like Change Element Attributes.



Standard ODOT Cells – the StormCAD cell library (stm.cel) includes only one cell for each type of element (e.g., a square symbol for all catch basins). The MicroStation Replace Cells tool can be used for the various ODOT catch basins, etc., with a few minor symbology differences. View 1 below shows proposed CB-3A cells. The Replace Cells tool was used on the left hand side to replace one of the generic StormCAD cells. The line weights are correct, but the cell component colors and line styles are ByLevel.



The normal Place Active Cell tool was used on the right hand side. The differences are most noticeable with cells placed on the DR_X_Cells level, but for construction plans they are fairly insignificant. These variances are related to the Shared Cells used by StormCAD. Cells can be replaced as described here without adversely affecting StormCAD elements, but dropping a shared cell deletes a StormCAD node and any connected links.

Annotations – the StormCAD element labels are not subject to the MicroStation annotation scale, and the default size and element offset correspond to 40 scale. This should be adequate for creating a schematic drawing to accompany calculations and reports, but not necessarily for construction plan sets. All StormCAD annotations are visible when the file is opened with regular MicroStation, so it is recommended that you place StormCAD text on its own level. Also see Element Symbology.

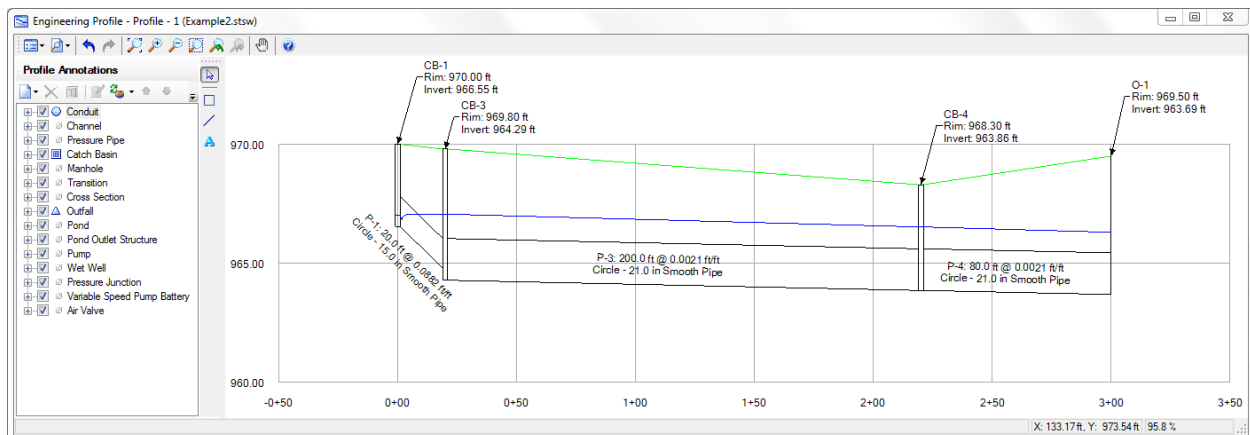
ODOT User Guide for StormCAD

StormCAD Modifications – deleting elements in StormCAD for MicroStation removes them from the StormCAD model. In fact, any MicroStation tool that deletes part of an element (e.g., IntelliTrim) will remove the entire element from the StormCAD model but not the .dgn file. You can safely move a node within StormCAD for MicroStation, and any connected link geometry will automatically update. Also remember that you can use the Node Morphing or Link Splitting features of the StormCAD Layout tools to add or change catch basins or manholes.

Drawing Modifications – when the file is opened in regular MicroStation, avoid manipulating, modifying or deleting StormCAD elements. These changes will not be reflected in the StormCAD model. If necessary, you can use the Synchronize Drawing tool (StormCAD > Tools > Database Utilities > Synchronize Drawing). This is helpful for inadvertent changes made in regular MicroStation. With this tool it is possible to delete all StormCAD elements when the file is opened with regular MicroStation and then recreate the system when the file is opened with StormCAD using the default StormCAD symbology (e.g., a single square for all catch basins, ByLevel line styles, etc.).

Roadway Profiles and Cross Sections – StormCAD does not support GEOPAK integration. While it can assist the designer with system layout and plan views, additional drafting is still needed for profiles and cross sections. Options include ODOT Drainage VBA applications and GEOPAK Road Draw Ancillary Features (VBA documentation and the GEOPAK Road Training Guide are found on the CADD website).

Although StormCAD does allow you to create an Engineering Profile that is drawn to scale, the stations do not correspond to the roadway centerline, and no additional pipe connections are shown in the catch basins and manholes. It might be possible to use this feature as a starting point for separate storm sewer profiles, however, if those plan sheets are necessary.



Bentley StormCAD Help – for additional details, see The MicroStation Environment Graphical Layout section (StormCAD > Help > StormCAD Help > Contents > Introducing the Workspace).

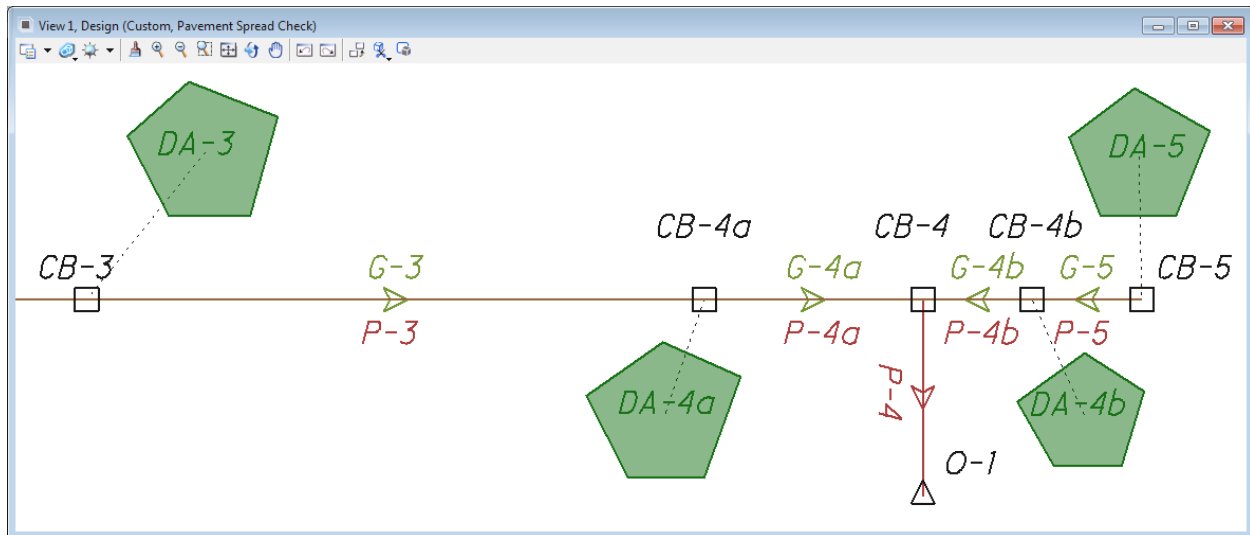
Additional StormCAD Capabilities

Pavement Drainage

StormCAD uses the same catch basin elements for inlet spacing and storm sewer calculations, reducing duplicate information. The additional system elements are gutter links. Keep in mind that models typically require all inlets to have subsurface outlets well as a system outfall. If needed, two inlets can be connected with both a gutter and a conduit, although the drawing will have line elements that coincide.

StormCAD follows the criteria outlined in the **FHWA Urban Drainage Design Manual (HEC-22)**. It is important to note that the grate types and inlet bypass calculations differ from ODOT standards and methodology. The local depression concept is also somewhat different, because it only affects curb opening inlets or combination inlets in a sag (i.e., not catch basin grate bypass calculations).

Calculating spread in a sag presents additional considerations. CDSS calculates spread for each of the incoming gutters as well as the combined flow at the inlet using a weir/orifice equation. It typically involves two separate drainage areas. StormCAD, however, performs only the weir/orifice analysis using a single drainage area. One workaround uses a “dummy node” on grade for each incoming gutter – it has a contributing catchment but is modeled with zero captured flow. In this scenario, the inlet in a sag does not have a separate catchment, but it receives all of the flow coming from both gutters. This approach allows the designer to check the maximum gutter spread on either side which might exceed the calculated spread at the inlet itself. Adding these dummy nodes to the model can be done fairly quickly with the Link Splitting feature of the Layout tool, which interpolates elevations. The model requires a conduit outlet even for a dummy inlet, but it will not carry any flow.



The StormCAD project seed file includes FlexTables for pavement inlets and gutter elements as well as a custom report. Keep in mind that the Pavement Inlet Table and storm sewer Catch Basin Table include identical elements, but different attribute fields are featured. In general, it is recommended that gutters use the upstream inlet cross section geometry to minimize data entry, and the Inlet Spread Report is based on the inlet elements. If StormCAD is used for inlet spacing analysis, reports should include all information as required by the Location & Design Manual, Volume 2 (see Form LD-40 in Appendix A, or use CDSS as a general guide).

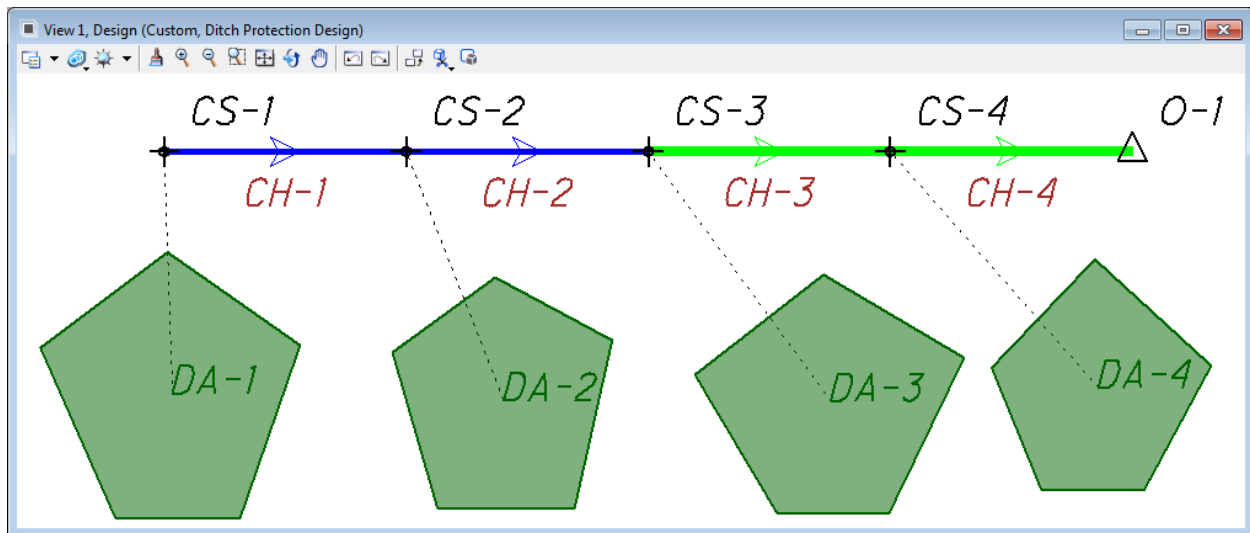
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Notes:

- Use the FlexTable **Global Edit** feature with caution, particularly when selecting the catalog inlet. It is recommended that you select each catch basin individually. Otherwise, the associated grate and curb inlet geometry might not automatically update, which could lead to incorrect bypass and spread results. You can use Properties or add FlexTable columns to view these fields.
- The inlet geometry requires a **longitudinal slope** attribute field for structures on grade. This value should generally match the calculated slope of the upstream gutter. StormCAD calculates the gutter slopes by using the inlet ground elevations and gutter length.

Ditch Design

StormCAD can perform open channel flow analysis using various material options. The custom ODOT Material Library includes the protective linings listed in the Location and Design Manual, Volume 2, and the StormCAD project seed file includes a shear stress element attribute. There are two seeded lining items corresponding to the CDSS approach, with the Manning's n value of 0.030 used for shear stress determination and 0.040 for depth determination (the ditch depth check scenario has its own physical and rainfall runoff alternatives). Compared to CDSS, the main difference is that StormCAD does not automatically select the ditch lining – the designer must manually select the lining type from the pulldown menu and ensure that drainage criteria are met. The Element Symbology feature of StormCAD can be used to visually identify channels with specific attributes (e.g., shear stress that exceeds 0.4 psf).



Ditch channels can be modeled as either conduit elements or channel elements, and cross sections are the node elements. The channel element characteristics are based on the cross sections, and they can interpolate changes between two sections. When using conduit elements to model ditches, the cross section geometry is ignored (transition elements are nodes that could be used in lieu of cross sections). StormCAD performs the same open channel flow calculations for both element types. The advantage of using conduits rather than channels to model ditches has to do with reports, which can include upstream/system drainage areas, times and intensities. Neither cross sections nor channels display these calculated result fields.

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Prior to laying out a system, select the appropriate conduit Prototype (e.g., Ditch To Scale) in order to minimize data entry (the red check mark indicates the current Prototype). It is also recommended that you change the labeling prefix for the open channel conduits prior to laying out the surface drainage system (StormCAD > Tools > Options > Labeling). For projects that combine enclosed storm sewers with open channel conduits, it may be necessary to use the FlexTable filter feature for the sake of clarity (e.g., right click on a column heading to create a custom filter based on section type). If StormCAD is used for ditch analysis, reports should include all information as required by the Location & Design Manual, Volume 2 (see Form LD-41 in Appendix A, or use CDSS as a general guide).

Advanced Features

StormCAD includes some additional features and tools beyond the scope of this document but still worth mentioning. For additional details see the StormCAD Help menu.

User Data Extensions – the ODOT StormCAD project seed file takes advantage of this feature to include additional element attribute fields that are not otherwise part of a typical StormCAD model. Examples include *Roadway Station* and *Side*, plus *Total Allowable Spread* and *Allowable Depth* for pavement drainage. These are for information only and intended to assist the reviewer. User Data Extensions can also be created using numeric formulas. Examples include *Ground Minus HGL*, *Total Inlet Surface Flow* (corresponds to CDSS Inlet Spacing Total Flow) and *Shear Stress* (necessary for ditch calculations).

ModelBuilder – StormCAD has a tool that can be used to import data to create or update a system. If you are starting with a .dgn file, however, it is first necessary to export elements to a .dxf file. This process is fairly complex, and you may encounter difficulties using ModelBuilder with StormCAD for MicroStation (it works fine with the standalone version).

If you have an existing system drawn using regular MicroStation tools, it might be most convenient to simply use this file as a background reference and place StormCAD elements in a separate drainage basemap by “tracing” over the existing drawing. Either way, you will have two overlapping systems, only one of which is linked to the StormCAD model.

TRex Terrain Extractor – this tool can be used to automatically assign elevation data to nodes (e.g., catch basin grates). The elevations used to calculate minimum conduit cover are based on the ground elevations at the nodes.