AutoCAD®
Civil 3D® 2008

Using Hydraflow Storm Sewers Extension with AutoCAD Civil 3D 2008: A Recommended Workflow

The ability to perform storm water hydrology and hydraulic (H&H) tasks is crucial to civil and environmental engineers. Currently, most H&H tasks are accomplished using Microsoft® Excel® program, or other third-party applications, with no direct connection to civil engineering design and construction documentation software. As a result, engineers are forced to transfer data between various programs, which results in increased time, inefficiency, and a higher risk of error. To better accommodate engineers working on these tasks, Civil 3D subscribers now have access to Hydraflow Storm Sewers Extension for AutoCAD® Civil 3D® 2008 software.

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Introduction

Hydrologic and hydraulic (H&H) engineering has often been considered a subset of civil and environmental engineering in which engineers focus solely on H&H analysis and design. Engineers who work on H&H tasks deal with issues involving the flow and storage of water, including drainage, reducing the effects of floods and droughts, and water quality.

Some basic H&H tasks include, but are not limited to:

- Watershed runoff analysis
- Channel analysis, including water surface elevations and floodplain delineation
- Sedimentation and erosion analysis
- Storm water management and urban drainage
- Reservoir system simulation and analysis
- Computational hydraulics
- Culvert design
- Detention pond design

This white paper provides a recommended workflow for storm sewer design and analysis using Civil 3D 2008 pipe networks and Hydraflow Storm Sewers Extension.

Civil 3D Layout

Civil 3D Surfaces

Typically, the first step in the H&H design process is to develop a base map that contains all the surface information. Using the surface analysis tools in Civil 3D, you can gather topographic information about the site with which you are working. This helps you with finalizing the site design.

Some useful surface analysis tools include the following:

- Slope labels, slope arrows, and spot elevations
- Legend tables
- Water drop
- Quick ground profiles
- Contour-based slope analysis

The result of the analysis and design of the surface is a combined surface derived from existing (predevelopment) and proposed (post development) surface data. This surface should include any corridor surfaces for roadways or paved areas and grading objects for other site properties.

While analyzing the surface, you can also create subcatchment boundaries (drainage areas). This can be done by reviewing the topography and delineating areas either by hand or using Civil 3D to create parcels or polylines. The data from these subcatchment boundaries can be used to perform hydrologic analyses. You should also gather the following data that is specific to the area in which the project is located:

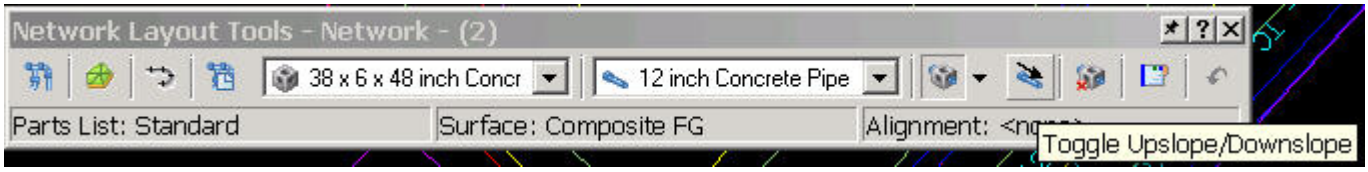
- Soil hydrologic group data
- Cover type and other subsurface data
- Floodplain data
- Coefficient of runoff (C) values for catchment areas

Civil 3D Pipe Networks

To begin the stormwater pipe design and analysis, create a preliminary pipe network in Civil 3D. At this point, you should already have developed your surface and established any alignments and profiles for your site.

To create a preliminary pipe network:

1. From the Pipes menu, choose Create Pipe Network by Layout.
2. In the Create Pipe Network dialog box, enter network name and use the pull-down menus to select the following:
   - Parts list
   - Surface
   - Alignment
   - Pipe and structure labels (these can also be added later)
3. On the Network Layout Tools toolbar, select the structure, pipe type, and pipe size.
4. Click the Upslope/Downslope button, if necessary, so that the slope corresponds with your layout.

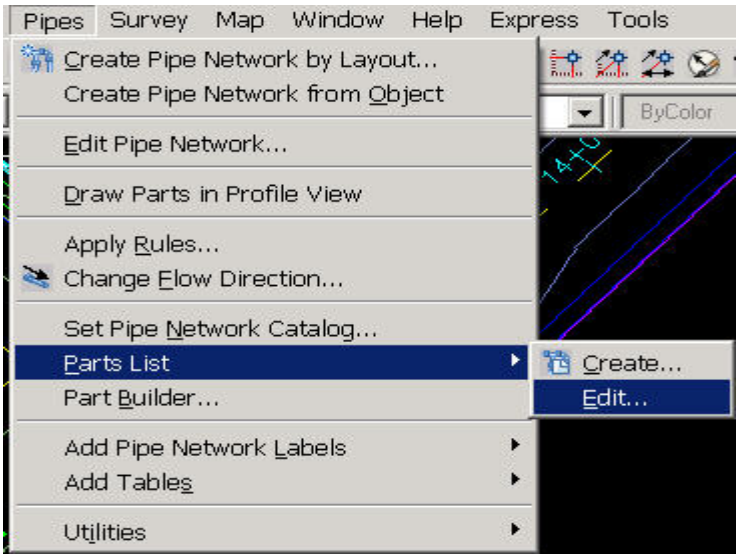


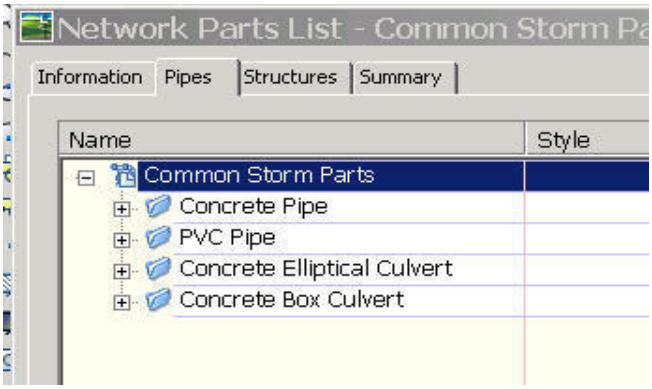
When creating a network, you can use a combination of storm drain manholes and catch basins connected by pipes selected from the Pipe list. For a preliminary layout, you are generally laying out the pipes so that they follow the slope of the proposed road surface. You can adjust this during the analysis, but this gives you something to work from. It is recommended that pipes be drawn in the direction of flow and that there are an equal number of pipes to structures. This helps ensure successful import into Hydraflow Storm Sewers Extension.

This example assumes that the parts list has already been established. For details on using a parts list and parts catalog, refer to “Best Practices with Pipe Network Parts Catalogs” at
http://images.autodesk.com/adsk/files/civil3d_2008_pipe_networks_best_practice.pdf

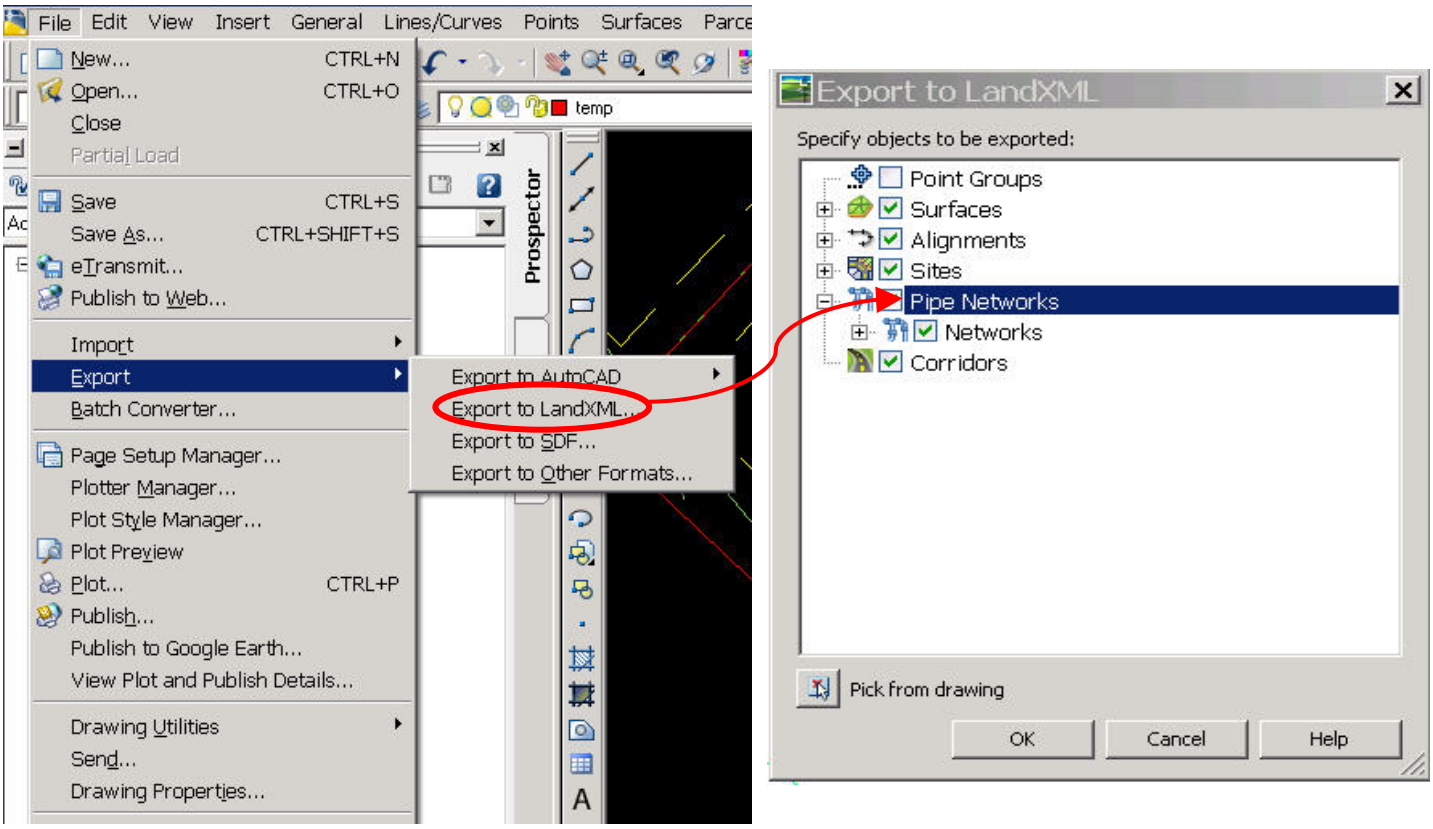
To simply add or change the parts list:

1. From Pipes menu, choose Parts List>Edit. Select the list you want to edit, and add or delete pipes and structures as needed.

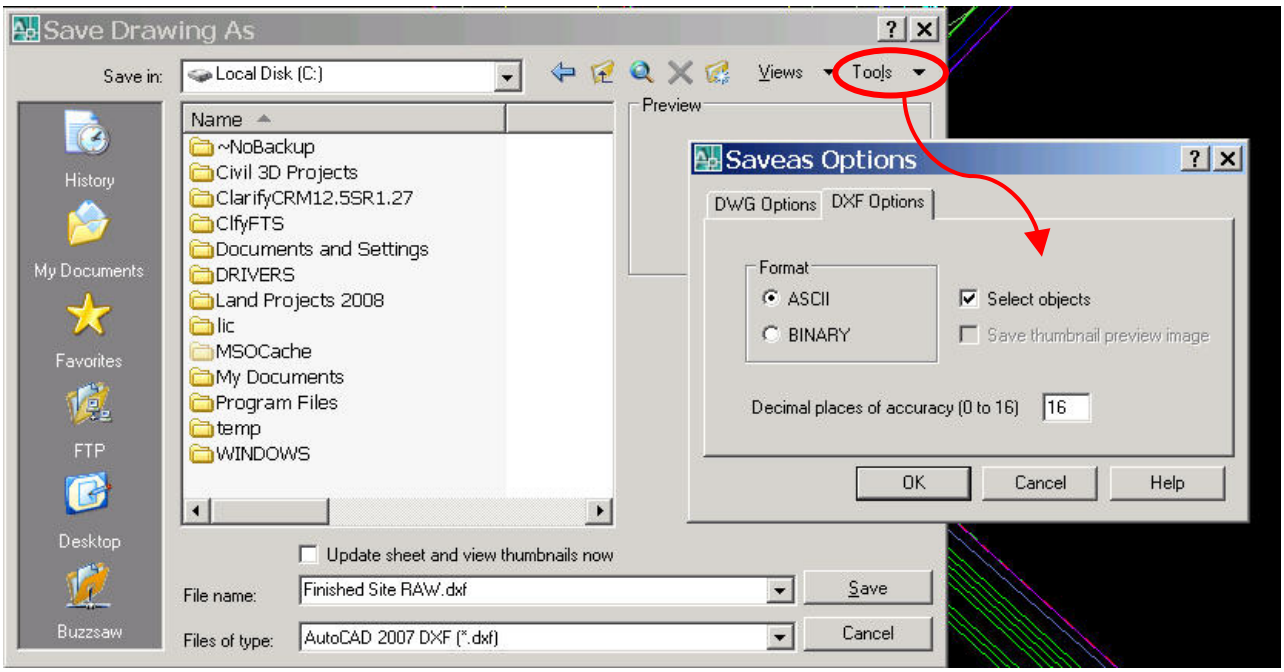




2. Once the preliminary layout is complete, export the pipe layout using the Export to Land XML command.



You can also create a DXF™ file that can be used as a background image in Hydraflow Storm Sewers Extension. To create a DXF file of only certain objects, such as parcels or surface data, use the Save As command and from the Tools menu choose Options.

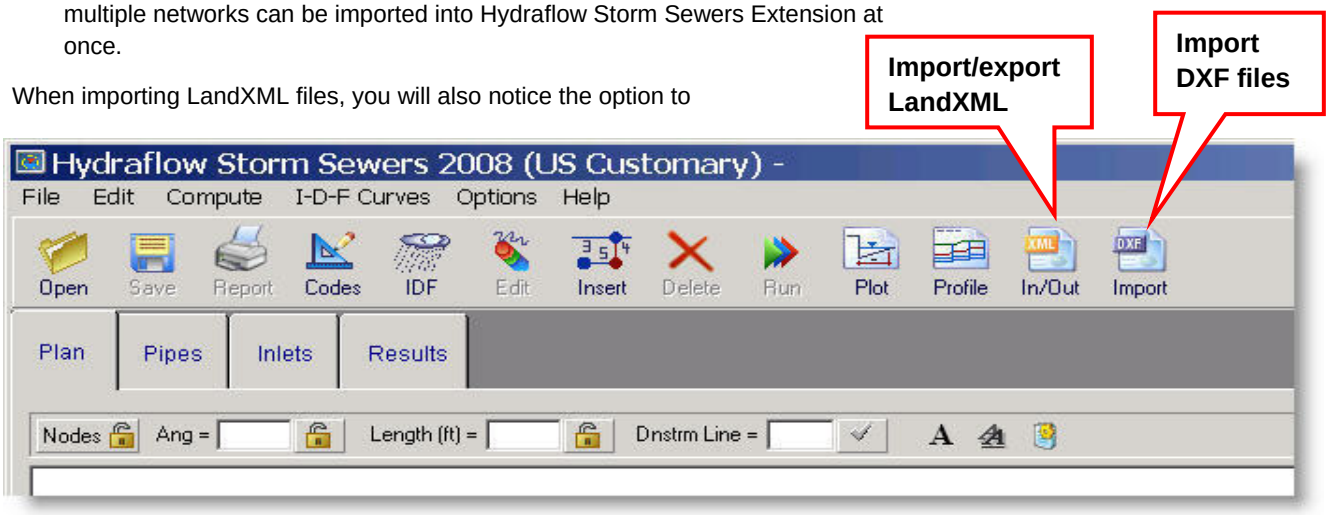


Hydraflow Storm Sewers Extension

When you launch Hydraflow Storm Sewers Extension, a new storm sewers project opens automatically. Notice the options available for quick importing and exporting.

- To import a DXF file to use as your background image, click the Import button.
- To import a LandXML file from Civil 3D, click the In/Out button, and when the dialog box appears, make sure you are on the Import tab. Browse to your LandXML file, and click Open. You will notice that any pipe networks contained in the LandXML file are listed under Available Pipe Networks. Highlight the network, use the check boxes to select the import options, and click Import. Note that multiple networks can be imported into Hydraflow Storm Sewers Extension at once.

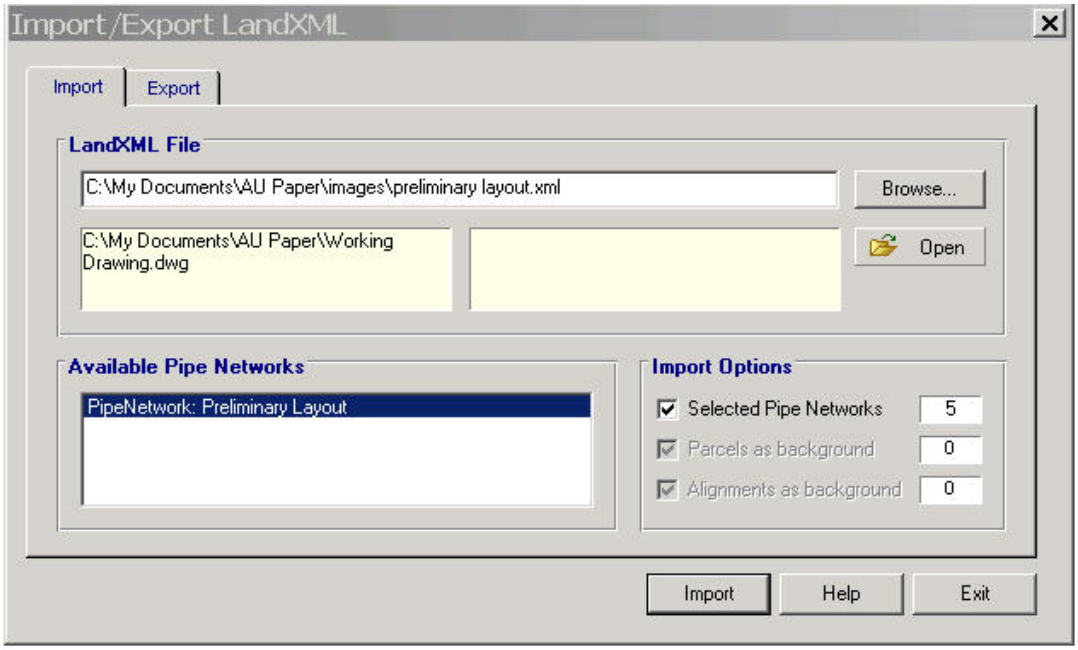
When importing LandXML files, you will also notice the option to



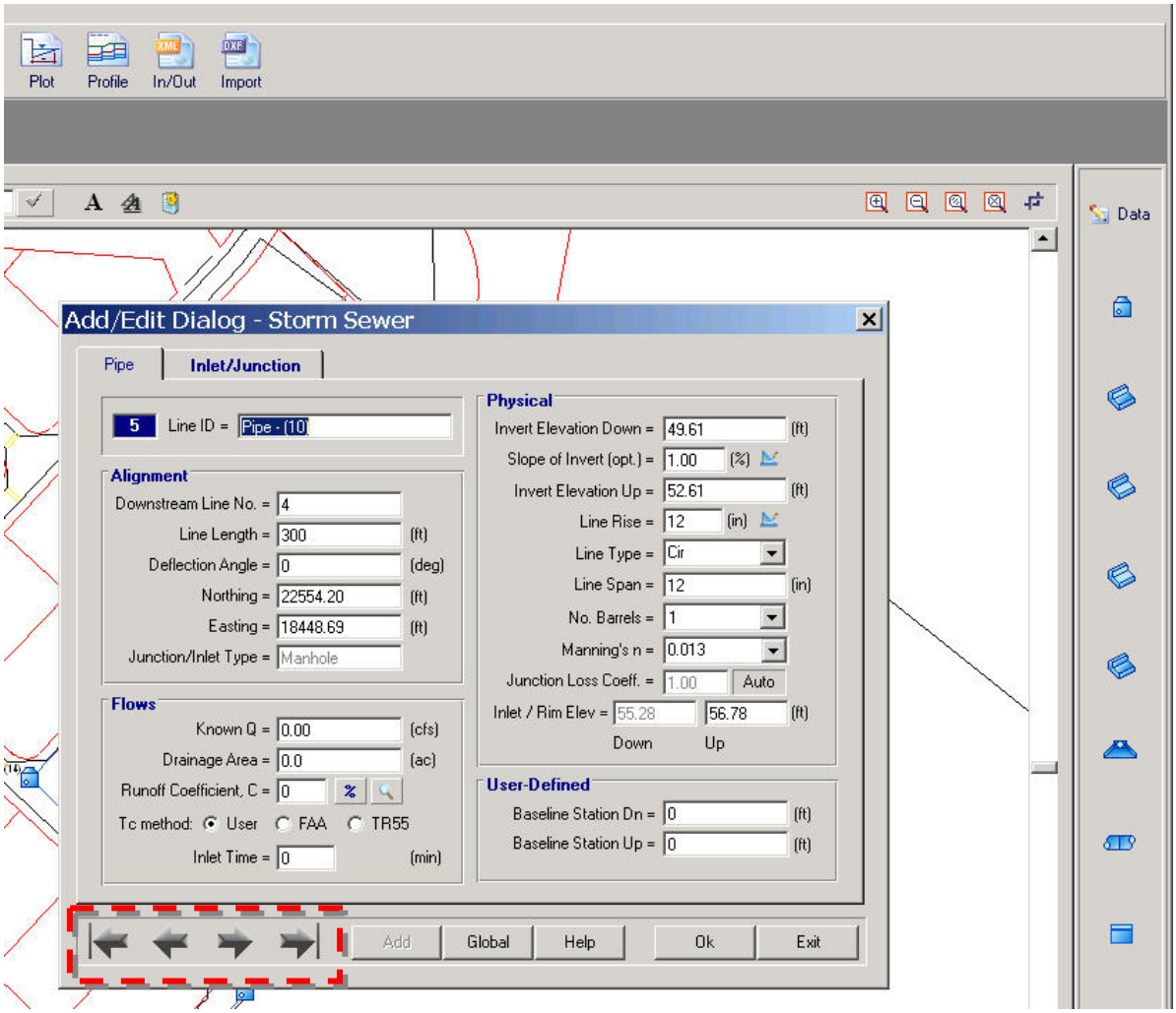
import alignments and parcels as a background. This may be an alternative to importing a DXF image.

Once the networks and DXF background image have been imported, you can add known data into the current pipe layout before moving on to the calculations. The known data may include flow values, existing pipe sizes, existing inverts, and so forth.

Select and highlight the pipes or manhole/inlet structures that you want to add data to. Click the Data button or double-click the



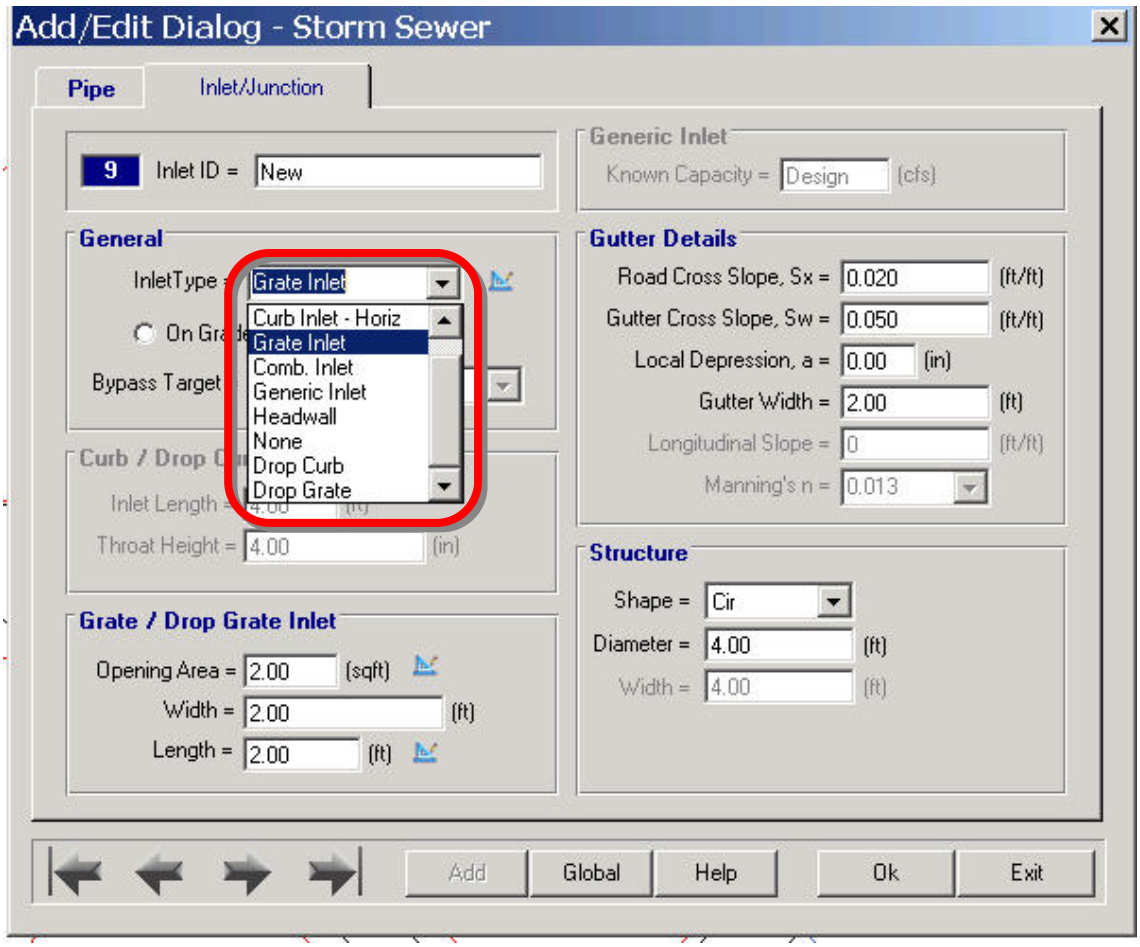
component to open the Add/Edit dialog box. This dialog box contains the properties of the pipe and inlet/junction, including length, size, inverts, and n-values.



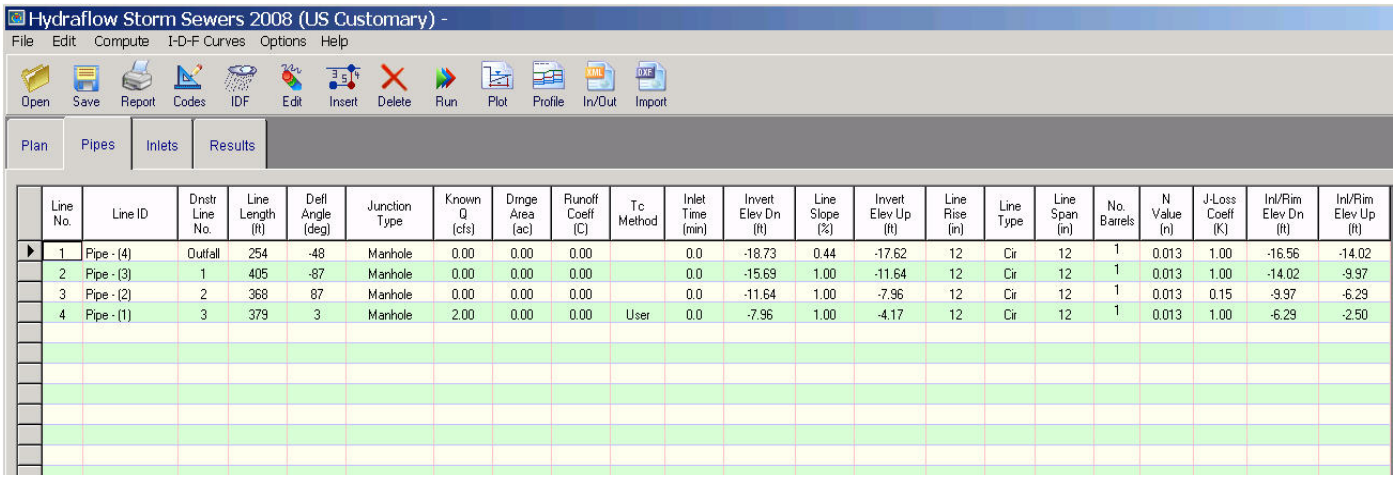
After each edit, click OK. You can then use the arrows at the lower left to move through the remaining pipes and structures in the network. When you are finished, click Exit to return to the main screen.

On the Inlet/Junction tab of the Add/Edit dialog box, you can easily change the inlet type. All the properties for that inlet or junction are available from in this dialog box. (Dimmed options cannot be edited in this dialog box.) The type of inlet or junction can be changed as shown here or by selecting an icon to the right of the main screen. Each icon relates to an inlet or junction type.

Hydraflow Storm Sewers Extension provides the option to disregard inlets. However, if an inlet is specified, a flow must be specified (using known flow or calculating with Rational method data).

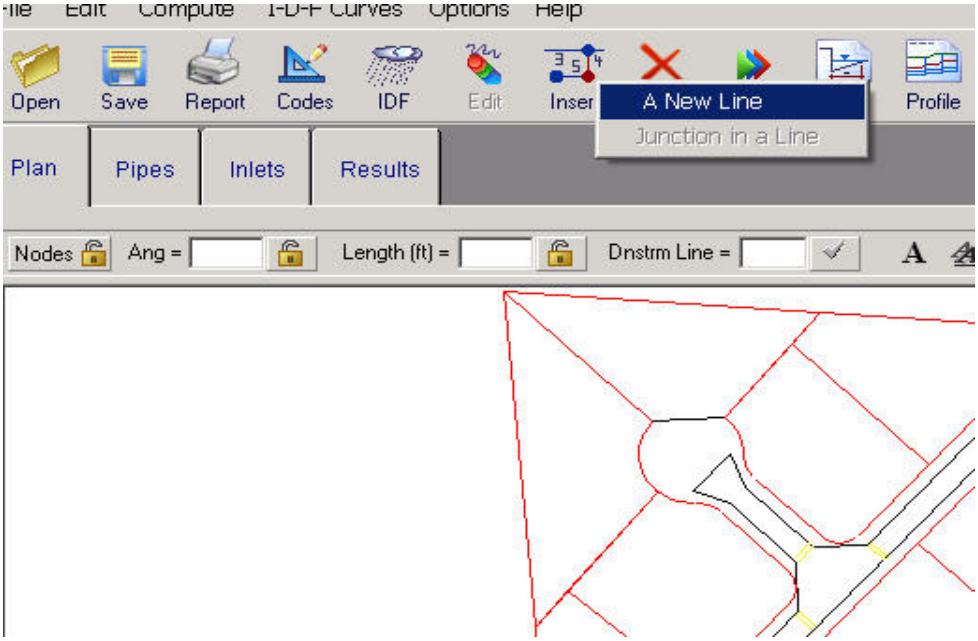


Data for the pipes and inlet can also be added or edited in table format. Clicking the Pipes or Inlets tab at the top of the main screen takes you to a table in which you can edit values as necessary.



Line No.	Line ID	Dnstr Line No.	Line Length (ft)	Defl Angle (deg)	Junction Type	Known Q (cfs)	Drnge Area (ac)	Runoff Coeff (C)	Tc Method	Inlet Time (min)	Invert Elev Dn (ft)	Line Slope (%)	Invert Elev Up (ft)	Line Rise (in)	Line Type	Line Span (in)	No. Barrels	N Value (n)	J-Loss Coeff (K)	Inl/Rim Elev Dn (ft)	Inl/Rim Elev Up (ft)
1	Pipe - (4)	Outfall	254	-48	Manhole	0.00	0.00	0.00		0.0	-18.73	0.44	-17.62	12	Cir	12	1	0.013	1.00	-16.56	-14.02
2	Pipe - (3)	1	405	-87	Manhole	0.00	0.00	0.00		0.0	-15.69	1.00	-11.64	12	Cir	12	1	0.013	1.00	-14.02	-9.97
3	Pipe - (2)	2	368	87	Manhole	0.00	0.00	0.00		0.0	-11.64	1.00	-7.96	12	Cir	12	1	0.013	0.15	-9.97	-6.29
4	Pipe - (1)	3	379	3	Manhole	2.00	0.00	0.00	User	0.0	-7.96	1.00	-4.17	12	Cir	12	1	0.013	1.00	-6.29	-2.50

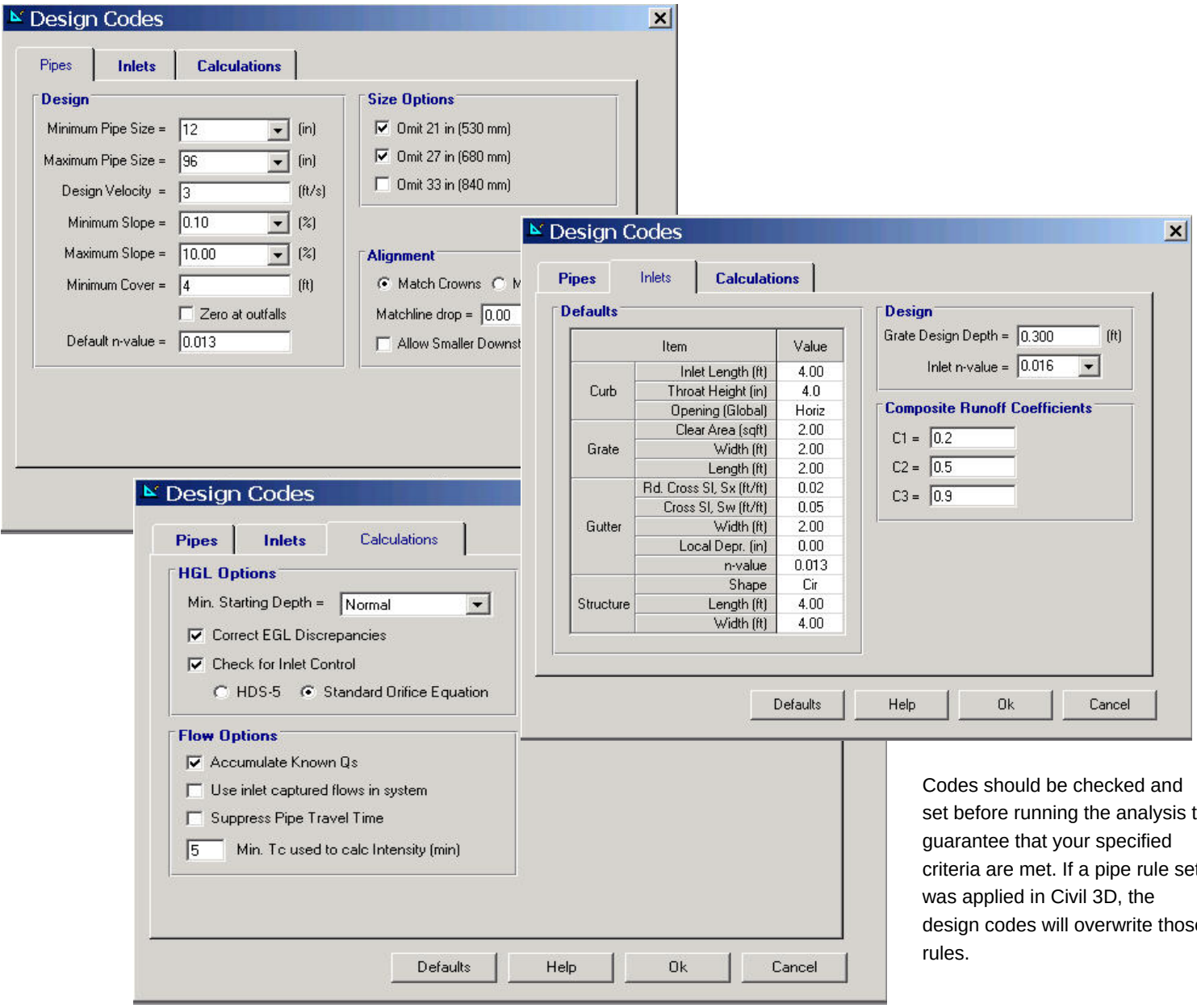
If new pipelines or inlets are needed, you can add them in the table or on the Plan View screen as shown here.



Inserting lines between existing lines in your layout can be done on the Plan view by clicking the Insert button and selecting A New Line. When adding new lines or renumbering lines, check that the lines are flowing in the correct direction.

Design Codes

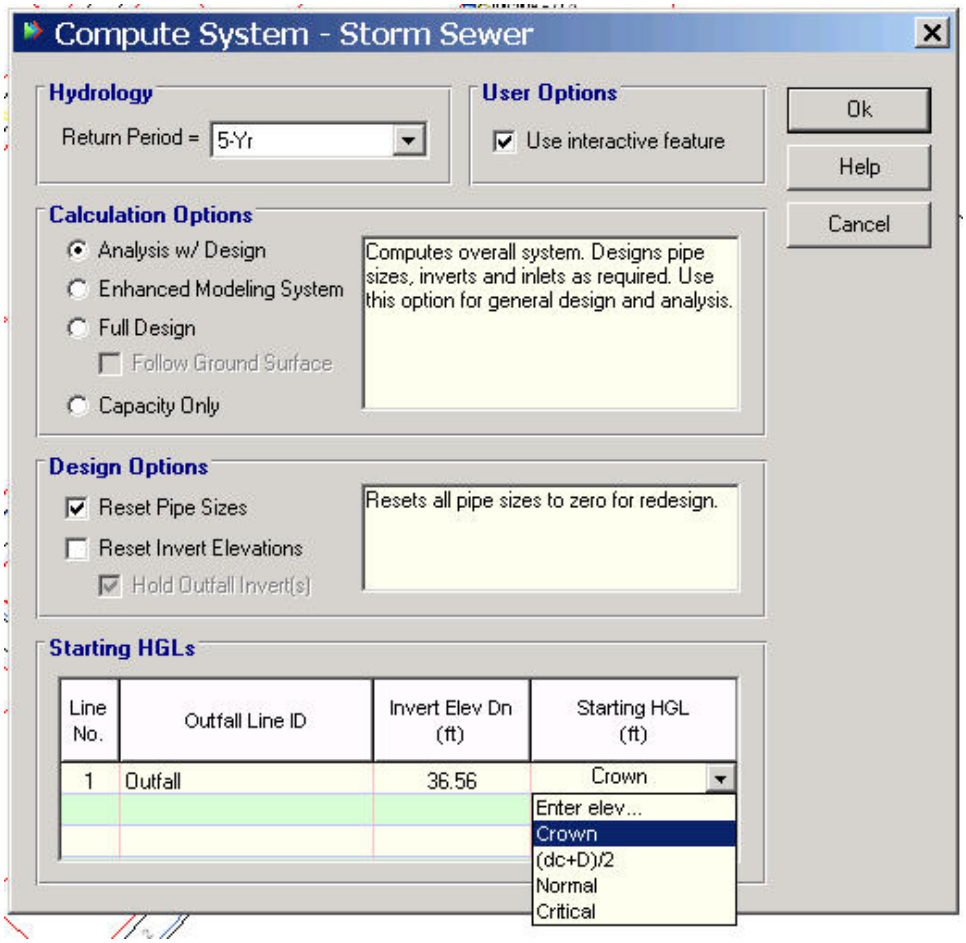
The Design Codes dialog box in Hydraflow Storm Sewers Extension enables you to specify certain design settings, which can then be saved to your storm sewers project. The three tabs in the Design Codes dialog box contain settings for pipes, inlets, and calculations.



Codes should be checked and set before running the analysis to guarantee that your specified criteria are met. If a pipe rule set was applied in Civil 3D, the design codes will overwrite those rules.

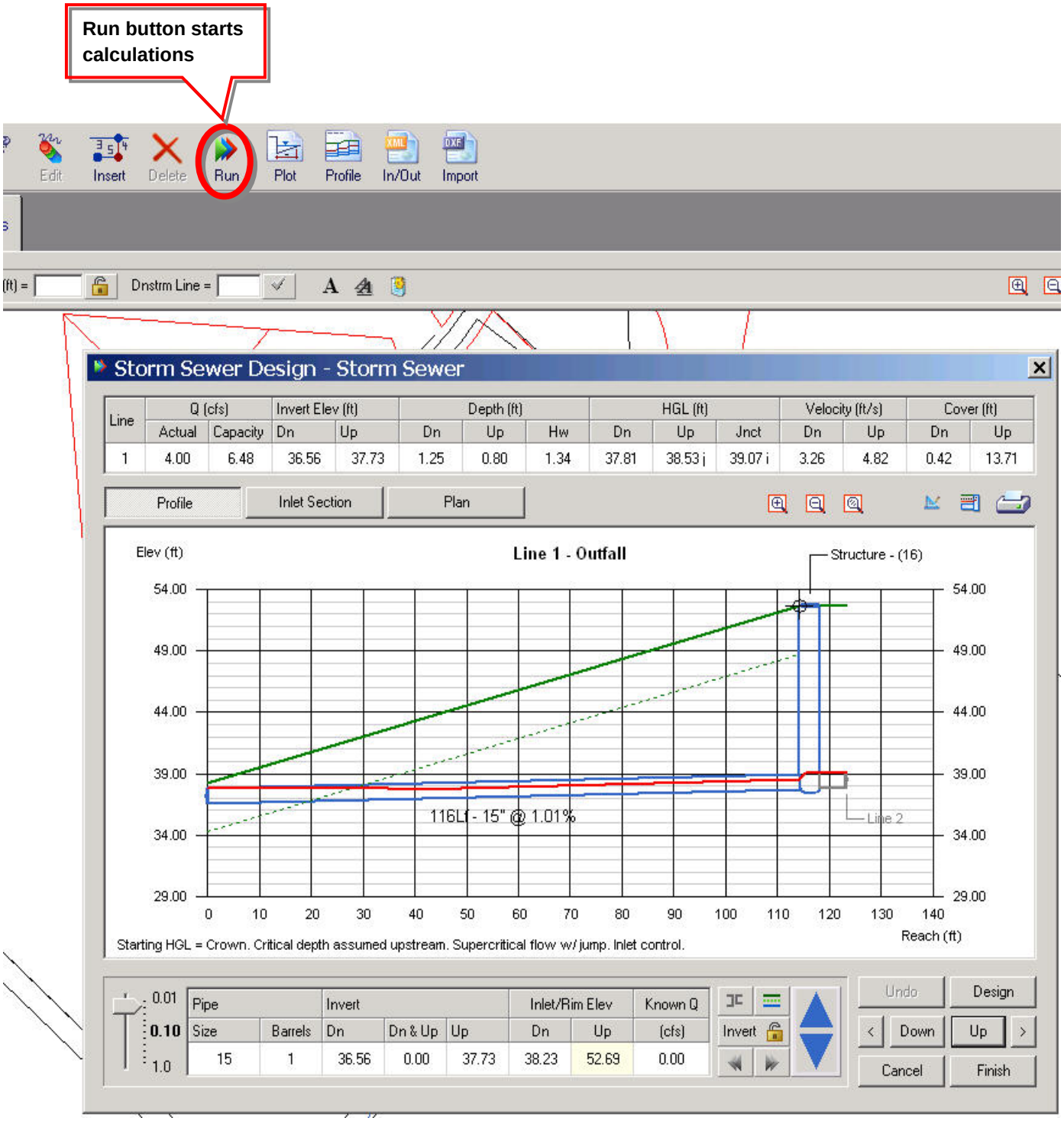
Calculation Options

Several different calculation scenarios are possible. The Compute System dialog box appears when you use the Run button to begin your calculations. As you can see, within Hydraflow Storm Sewers Extension four calculation options are available to help you distinguish between the varying conditions and possible results. The most commonly used option is Analysis w/ Design; it holds any data you choose to add and calculates any values that are not specified. This analysis starts at the downstream and works upstream.



However, say you are designing a new system and have only preliminary pipe sizes at this time. Based on your earlier hydrologic analysis of the area, you have defined the flow values (Q). To complete the calculations, in this case you would select the Full Design option, since you are primarily concerned with calculating the appropriate pipe sizes and maintaining a minimum depth of cover to reduce excavation costs. (If steeply sloped pipes are not a concern, select the Follow Ground Surface option.)

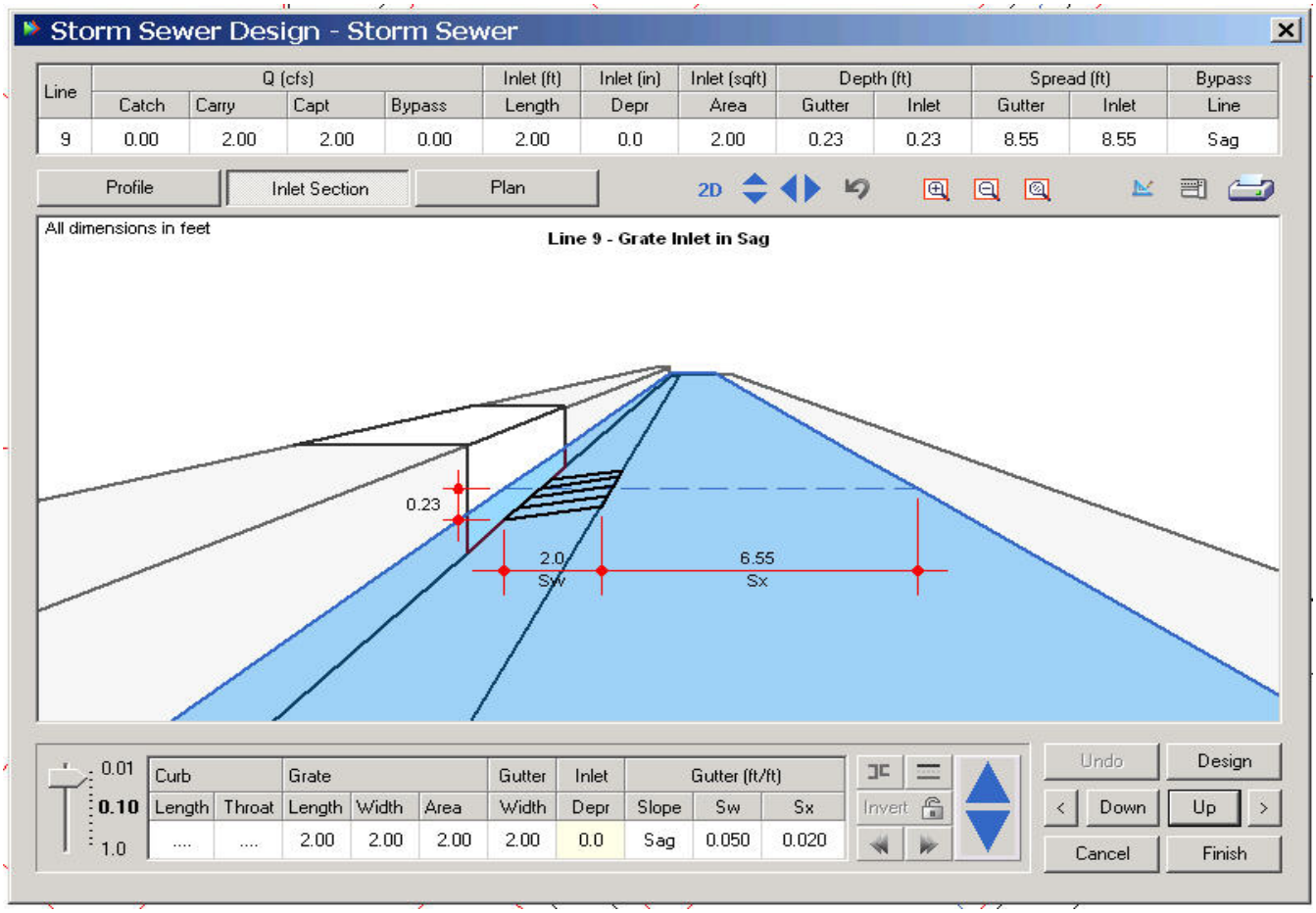
In addition, other options in the Compute System dialog box enable you to automatically reset all the current pipe sizes, invert elevations, or both. If you have a known starting hydraulic grade line (HGL), you can also enter that value here, or select one of the other options.



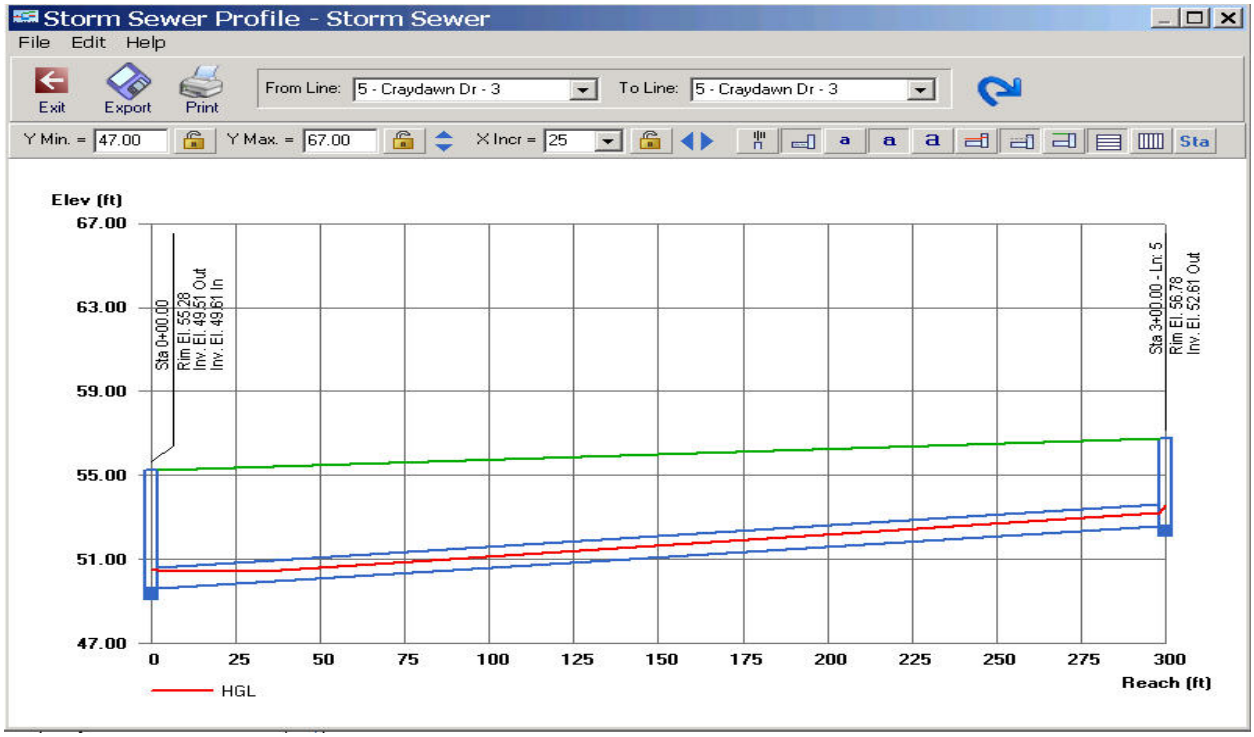
By highlighting one the contents of a box (such as the pipe size or an invert elevation) and using the blue up and down arrows, you change the value of the corresponding component. Use the scale in the bottom-left corner to set the increment.

After running the calculation, you can easily make additional adjustments to pipe sizes and inlets with the interactive design feature in Hydraflow Storm Sewers Extension. As shown in the preceding illustration, the default display is a profile view of the pipe. Using the controls, you can manipulate the slope, size, and even Q values. You can also scroll through multiple pipes to make changes along the entire network.

The interactive display has three different sections: Profile view, Plan view, and Inlet Section.

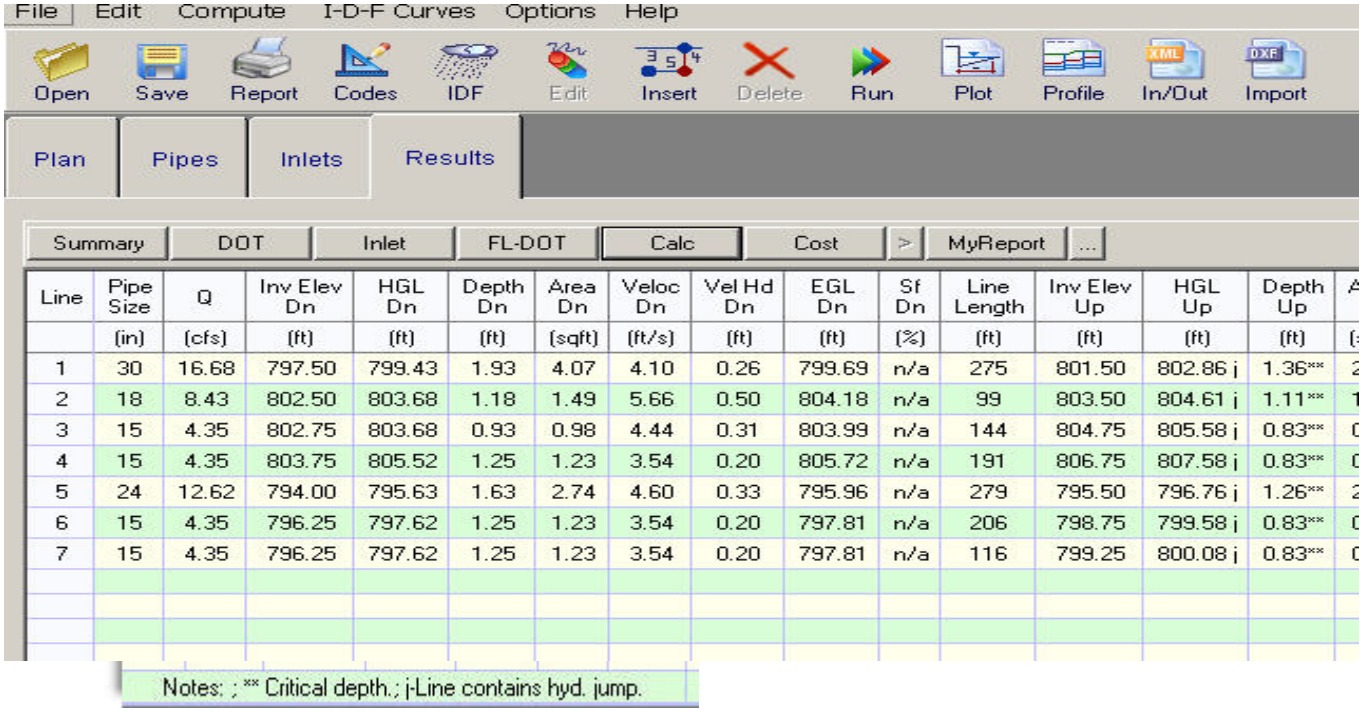


Hydraflow Storm Sewers Extension also has the ability to calculate the HGL and show it graphically in profile. With this application, you can export a profile with the HGL value as a DXF file that can be manipulated in Civil 3D. A profile would appear something like what you see here. The red line represents the HGL value, and the green line is the ground surface.



Review Results

The Results tab provides a series of forms that you can use to check calculations.



Line	Pipe Size	Q	Inv Elev Dn	HGL Dn	Depth Dn	Area Dn	Veloc Dn	Vel Hd Dn	EGL Dn	Sf Dn	Line Length	Inv Elev Up	HGL Up	Depth Up
	(in)	(cfs)	(ft)	(ft)	(ft)	(sqft)	(ft/s)	(ft)	(ft)	(%)	(ft)	(ft)	(ft)	(ft)
1	30	16.68	797.50	799.43	1.93	4.07	4.10	0.26	799.69	n/a	275	801.50	802.86 j	1.36**
2	18	8.43	802.50	803.68	1.18	1.49	5.66	0.50	804.18	n/a	99	803.50	804.61 j	1.11**
3	15	4.35	802.75	803.68	0.93	0.98	4.44	0.31	803.99	n/a	144	804.75	805.58 j	0.83**
4	15	4.35	803.75	805.52	1.25	1.23	3.54	0.20	805.72	n/a	191	806.75	807.58 j	0.83**
5	24	12.62	794.00	795.63	1.63	2.74	4.60	0.33	795.96	n/a	279	795.50	796.76 j	1.26**
6	15	4.35	796.25	797.62	1.25	1.23	3.54	0.20	797.81	n/a	206	798.75	799.58 j	0.83**
7	15	4.35	796.25	797.62	1.25	1.23	3.54	0.20	797.81	n/a	116	799.25	800.08 j	0.83**

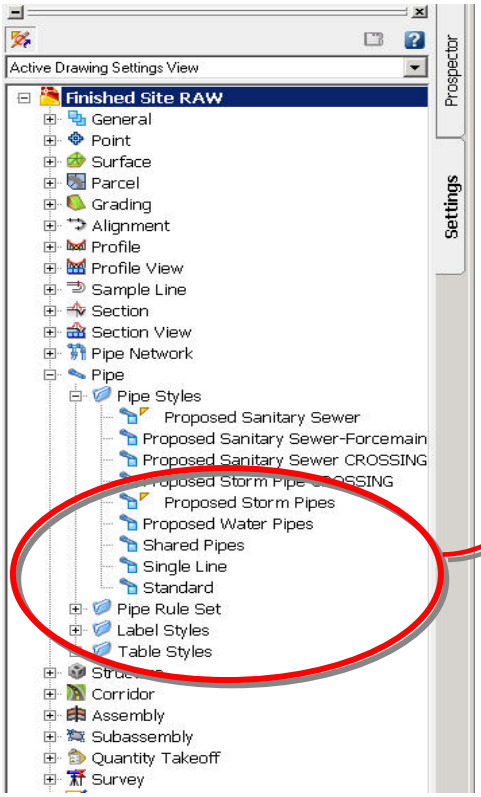
Exporting Hydraflow Storm Sewers Extension files to Civil 3D

When you are satisfied with your analysis, you can export the revised layout to LandXML by clicking the In/Out button you saw earlier. The Import/Export LandXML dialog box has a separate tab for Export. You can export LandXML as a new file or to update an existing XML file.

Then, when you are ready to import your design into Civil 3D, you use the Import LandXML command and select a new LandXML name (for a new file) or select the existing LandXML file that you are updating. If you import a new XML file, a second network is added to your drawing, so you will most likely want to delete the previous layout and replace it with the revised one.

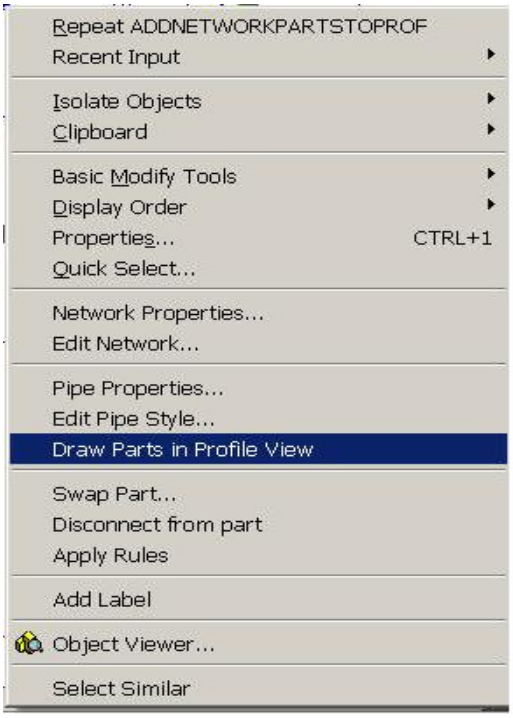
USING HYDRAFLOW STORM SEWERS EXTENSION WITH AUTOCAD CIVIL 3D 2008

After importing the layout back to Civil 3D, keep in mind that you may have to adjust styles and labels.

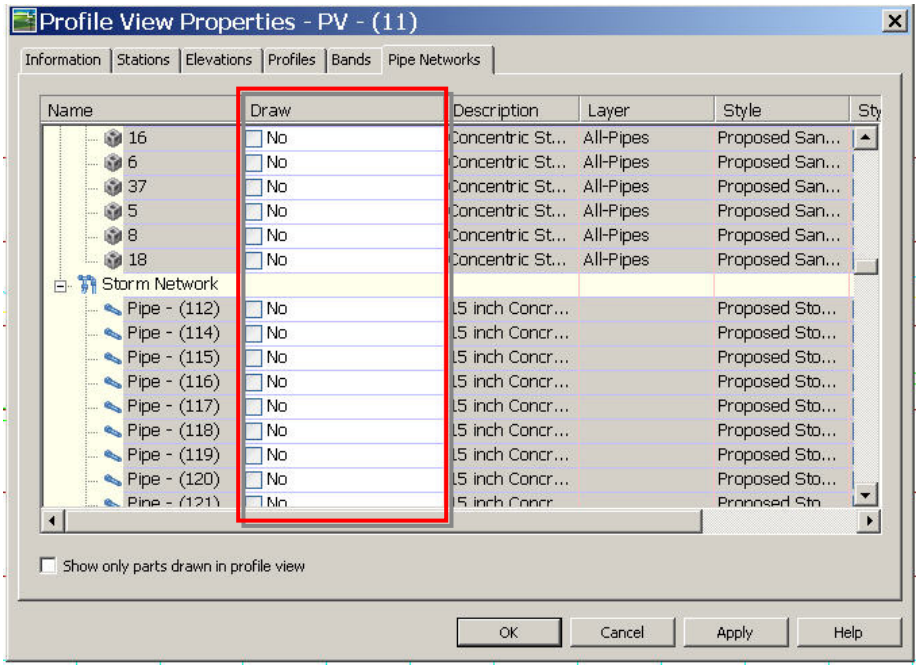


You can apply predefined labels and styles in Civil 3D to meet your needs.

After setting up the proper styles and labels for your pipes and structures, you can begin adding pipes to profile views. To do this, right-click Pipes and/or Structures, and choose Draw Parts in Profile View.



Alternatively, you can click a specified profile view and choose Profile View Properties. Use the check boxes in the Draw column to select the pipes and structures you want to show in that view.

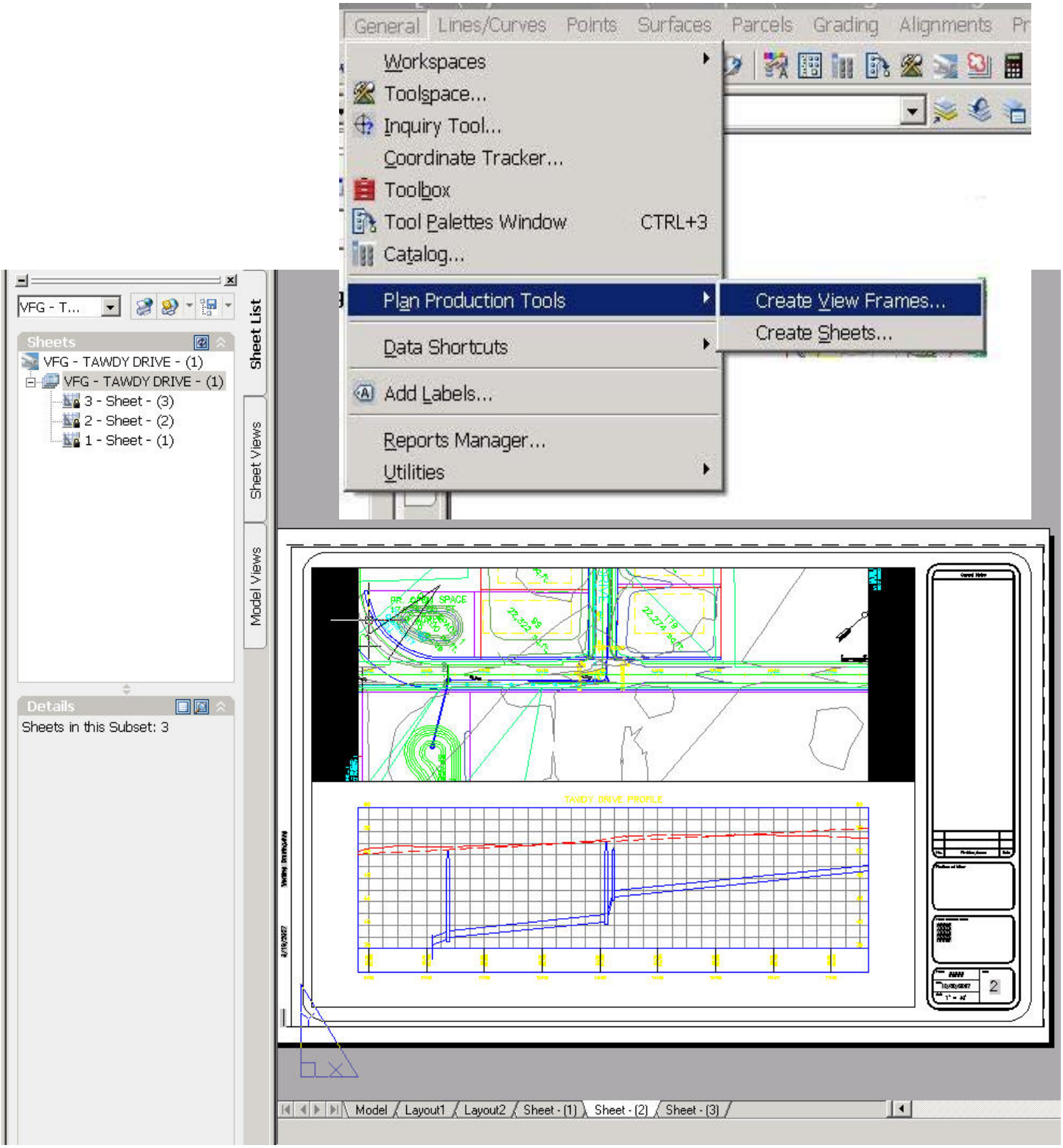


After adding pipes to profiles, you can use the DXF file of the profile that was created in Hydraflow Storm Sewers Extension and insert it as a block into your current drawing. The HGL line is simply an object in AutoCAD® software, and it can lay directly on top of the profiles you have created in Civil 3D.

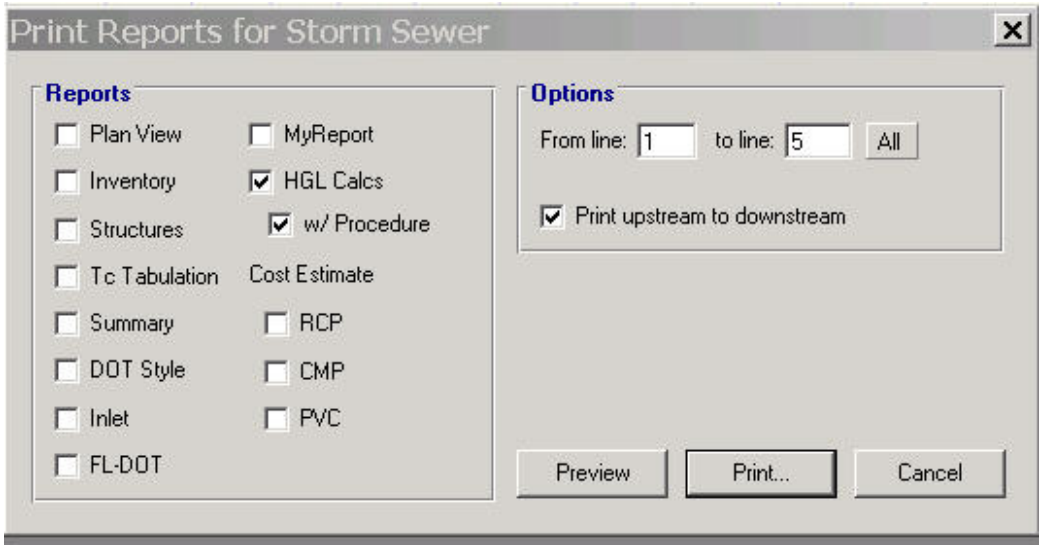
Creating Project Documents

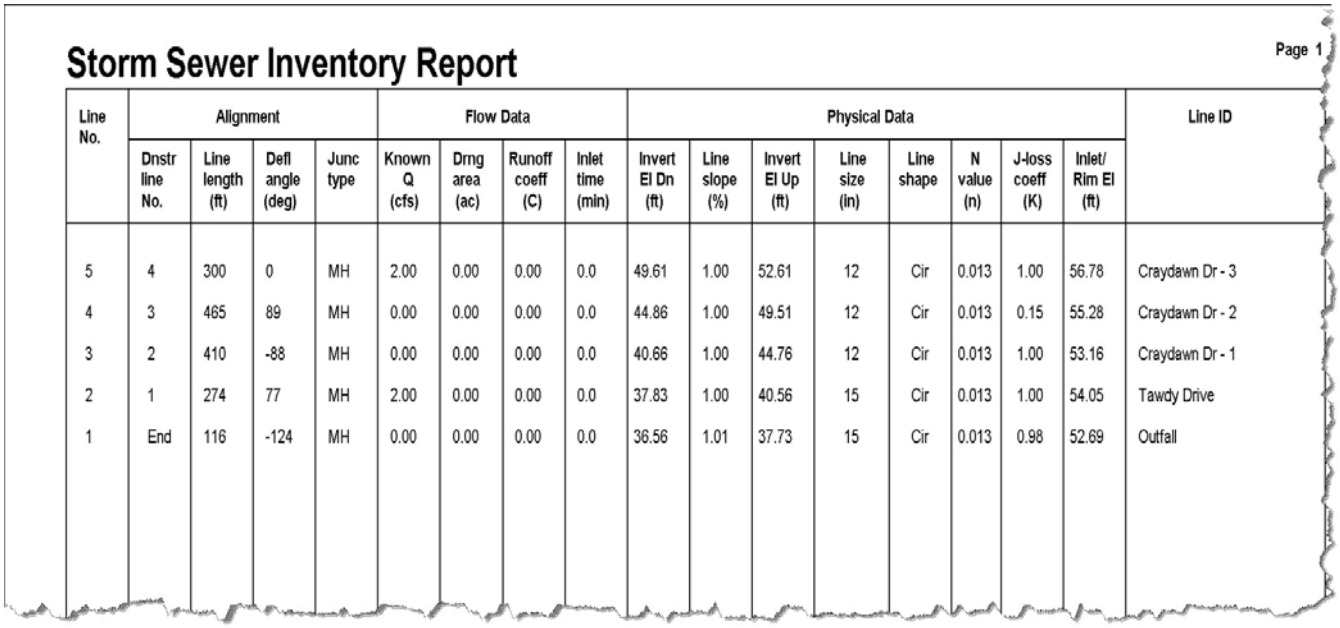
Once you have completed your analysis, finalized your design, and applied all the appropriate object and labels styles, the final task is to create production documents or submittals. These documents could include a set of construction plans, a design report, or simply an interim submittal to a client.

Plan or profile sheets are commonly used to show pipe size, slope, invert elevations, and crossings. In Civil 3D, you can use the Plan Production tools to customize and create your own plan and profile sheets.


General
Lines/Curves
Points
Surfaces
Parcels
Grading
Alignments
Workspaces
Toolspace...
Inquiry Tool...
Coordinate Tracker...
Toolbox
Tool Palettes Window CTRL+3
Catalog...
Plan Production Tools
Create View Frames...
Create Sheets...
Data Shortcuts
Add Labels...
Reports Manager...
Utilities
VFG - T...
Sheets
VFG - TAWDY DRIVE - (1)
VFG - TAWDY DRIVE - (1)
3 - Sheet - (3)
2 - Sheet - (2)
1 - Sheet - (1)
Details
Sheets in this Subset: 3
Sheet List
Sheet Views
Model Views
TAWDY DRIVE PROFILE
Model
Layout1
Layout2
Sheet - (1)
Sheet - (2)
Sheet - (3)

In addition to drawing sets, you may also be required to submit calculations in the context of a report. Hydraflow Storm Sewers Extension offers options for creating reports specific to the HGL calculations, inlets, Tc, and so forth. Results can also be exported as text files.





Storm Sewer Inventory Report Page 1

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr line No.	Line length (ft)	Defl angle (deg)	Junc type	Known Q (cfs)	Drng area (ac)	Runoff coeff (C)	Inlet time (min)	Invert El Dn (ft)	Line slope (%)	Invert El Up (ft)	Line size (in)	Line shape	N value (n)	J-loss coeff (K)	Inlet/ Rim El (ft)	
5	4	300	0	MH	2.00	0.00	0.00	0.0	49.61	1.00	52.61	12	Cir	0.013	1.00	56.78	Craydawn Dr - 3
4	3	465	89	MH	0.00	0.00	0.00	0.0	44.86	1.00	49.51	12	Cir	0.013	0.15	55.28	Craydawn Dr - 2
3	2	410	-88	MH	0.00	0.00	0.00	0.0	40.66	1.00	44.76	12	Cir	0.013	1.00	53.16	Craydawn Dr - 1
2	1	274	77	MH	2.00	0.00	0.00	0.0	37.83	1.00	40.56	15	Cir	0.013	1.00	54.05	Tawdy Drive
1	End	116	-124	MH	0.00	0.00	0.00	0.0	36.56	1.01	37.73	15	Cir	0.013	0.98	52.69	Outfall

Summary

As this paper shows, Hydraflow Storm Sewers Extension provides the capability to perform storm sewer design and analysis tasks that are necessary in civil and environmental engineering. The availability of this extension adds important technology to the Autodesk civil engineering solution that will enable Civil 3D customers to address a crucial part of their workflow as well as get higher value from design information for predicting project performance.

Hydraulic Grade Line Computations

Line	Size	Q	Downstream								Len		
	(in)	(cfs)	Invert elev (ft)	HGL elev (ft)	Depth (ft)	Area (sqft)	Vel (ft/s)	Vel head (ft)	EGL elev (ft)	Sf (%)	(ft)	Invert elev (ft)	HGL elev (ft)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
5	12	2.00	49.61	50.48	0.87	0.72	2.76	0.12	50.60	n/a	300	52.61	53.21 j
4	12	2.00	44.86	45.73	0.87	0.72	2.76	0.12	45.85	n/a	465	49.51	50.11 j
3	12	2.00	40.66	41.90	1.00	0.79	2.55	0.10	42.00	n/a	410	44.76	45.36 j
2	15	4.00	37.83	39.07	1.24	1.23	3.26	0.17	39.24	n/a	274	40.56	41.36 j
1	15	4.00	36.56	37.81	1.25	1.23	3.26	0.17	37.98	n/a	116	37.73	38.53 j

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