

2009 Roads and Bridges Conference

IW-3

Using InRoads Storm & Sanitary V8i

Presenter: Jeff Martin, PE, Bentley Systems, Inc./Senior Training Materials Specialist

Get hands-on experience in the InRoads Storm & Sanitary V8i session that teaches the basics of creating models, displaying cross sections and profiles, detecting clashes visually, and importing data into StormCAD.

Bentley Systems, Incorporated
685 Stockton Drive
Exton, PA 19341
www.bentley.com

Lesson Name: Launching and Loading

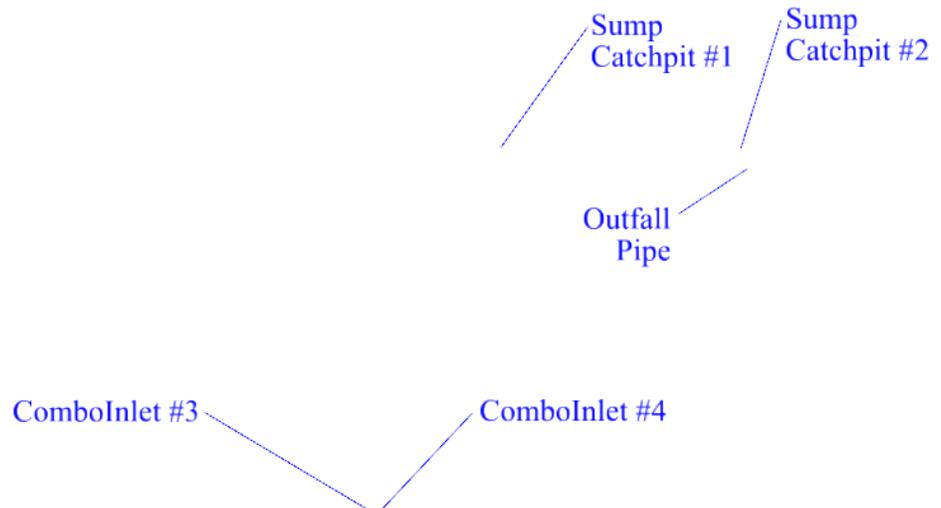
LESSON OBJECTIVE:

In this lesson the student will launch InRoads Storm & Sanitary and load the project data.

EXERCISE: LAUNCH AND LOAD

This exercise will guide you through the steps to launch the software and load the data.

1. Go to **Start > Programs > Bentley > InRoads Group v8i > InRoads Suite**.
2. When the MicroStation Manager appears browse to the **C:\2009 RBC\IW-3\DATA** folder, select the file named **IW-3_Drainage.dgn** and click **Open** button.



3. When the InRoads Explorer appears, select **InRoads >File > Project Defaults**.
4. When the **Set Project Defaults** dialog appears select **2009 RBC IW-3 Drainage** from the **Configuration Name** list.
This tells InRoads what settings files to use and the starting directories in the various File Open and File Save As... dialogs.
5. Click **Apply**.
6. **Close** the Set Project Defaults dialog.
7. In the InRoads Explorer, select **InRoads>File > Open**.
8. When the Open dialog appears select **Files of Type: Project (*.rwk)**.
9. Select the InRoads project file:

C:\2009 RBC\IW-3\DATA\IW-3 Drainage.rwk and press **Open**.

10. Click **Cancel** to close the **Open** dialog.

EXERCISE: VERIFY THE LOADED DATA AND SETTINGS

1. This exercise will reviews the loaded data and settings.

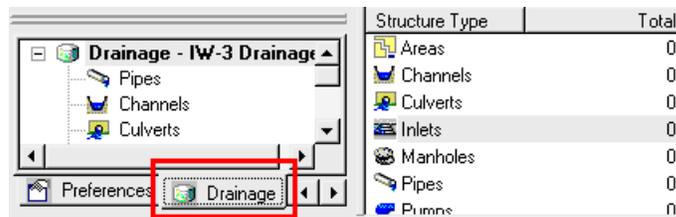
Opening the *RWK* project file opens the following files:

Drainage	IW-3 Drainage
Surface	design
Geometry	IW-3 Drainage
Preference	Bentley Training IW-3

These steps should be performed by the user:

1. Display Contours (Select **InRoads > Surface > View > Contours**).

2. Optional but useful step: in the InRoads Explorer click on the **Drainage** workspace tab. This provides some additional feedback when laying out drainage structures



The following steps should already have been done as part of the class setup:

1. Verify that the MicroStation Key in field is visible (**MicroStation > Utilities > Key-in**).
2. Verify that the **InRoads Style Lock** is ON (**InRoads > Tools > Locks > Style**).
3. Verify that a Cell Library is loaded (**MicroStation > Element > Cell**).
4. Verify that the Callouts Reference file Display is ON.
5. Verify the Cell Scale Factor is 1 (**InRoads > Tools > Options >> Factors**).
6. Verify that the Hydrology and Hydraulics Application Add-In is enabled (**InRoads > Evaluation > Hydrology and Hydraulics**). If not, select via **InRoads > Tools > Application Add-In**.

Lesson Name: Using the Lay Out dialog

LESSON OBJECTIVE:

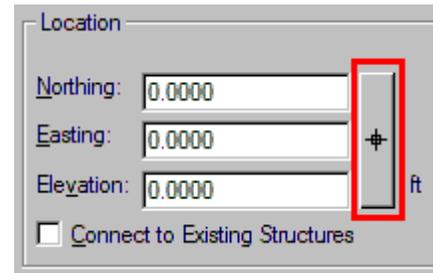
Lay Out some (random?) Inlets and a (random?) Pipe and Review their Settings.

EXERCISE: LAY OUT TWO INLETS IN LOCATIONS

This exercise will guide you through the steps to Lay Out two Catchpit inlets in sump locations

Click **InRoads > Drainage > Lay Out**.

1. Select the **Inlet** tab.
2. Click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
3. Snap to the end of the **Sump Catchpit 1** leader.



4. Click **Apply**.

Note that graphics for the inlet are placed and the form resets for the next inlet.

5. Click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
6. Snap to the end of the **Sump Catchpit 2** leader.
7. Click Apply.

Note that graphics for the inlet are placed and the form resets for the next inlet.

EXERCISE: LAY OUT A PIPE

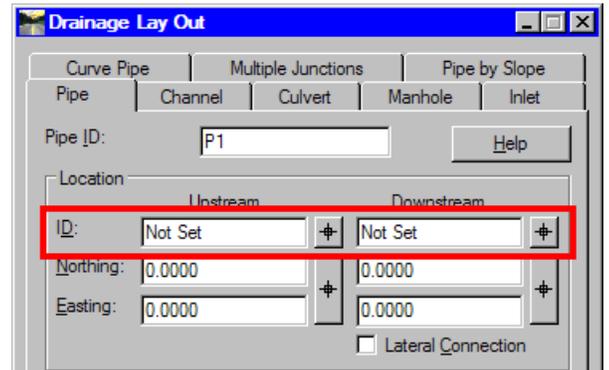
This exercise will guide you through the steps to Lay Out a pipe between the two Catchpits.

1. Select **InRoads > Drainage > Lay Out**.
2. Select the **Pipe** tab.

A pipe has two ends: the **Upstream** and **Downstream** end. This is the sole determinant of what direction the pipe flows.

Each end of a pipe can be either attached to a structure or be unattached in free space.

In this exercise we will be connecting each end of the pipe to an inlet. Be sure to select the Graphic Locators next to the **ID** fields.



3. Click on the Graphic Locator button to the right of the **Upstream ID** field.
4. Click on the eastern catchpit (**IN1**). A “snap” is not necessary.
5. Click on the Graphic Locator button to the right of the **Downstream ID** field.
6. Click on the western catchpit (**IN2**). A “snap” is not necessary.
7. The **Upstream** and **Downstream ID** fields should read **IN1** and **IN2**, respectively.
8. Click **Apply**.

Note that graphics for the pipe are placed and the form anticipates that the Downstream Inlet will be the Upstream Inlet for the next pipe.

9. **Close** the Drainage Lay Out dialog

EXERCISE: REVIEW THE STRUCTURES

This exercise will guide you through the steps to review the structures just placed.

1. Select **InRoads > Drainage > Edit/Review**.
2. At the “Key in ID or identify structure” prompt select the first inlet.

The Edit/Review Inlet dialog shows the attributes in the Inlet database record. Some of the fields are editable, others are selectable, others are read-only. Note the Type, Class, and size of the Inlet. The data is segregated by functional categories by Tabs across the top of the form.

3. Click the **Edit Down** button, which will review the data of the structure (the pipe) attached downstream of the current inlet.
4. Click **Close** when done.

EXERCISE: DELETE THE STRUCTURES

This exercise will guide you through the steps to delete the structures we just placed.

1. Select **InRoads > Drainage > Structure > Delete**.
2. At the “Identify item to delete” prompt, select the eastern inlet (**IN1**).
3. Accept the selection with a datapoint
4. At the “Identify item to delete” prompt, select the western inlet (**IN2**).
5. Accept the selection with a datapoint
6. At the “Identify item to delete” prompt, select the pipe.
7. Accept the selection with a datapoint
8. At the “Identify item to delete” prompt, right-click (Reset) to exit the command.

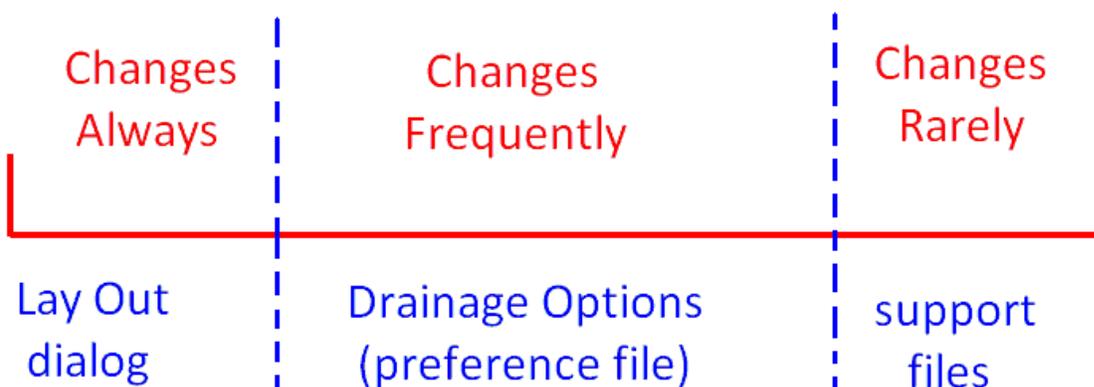
Lesson Name: Lay Out structures with intentional settings

LESSON OBJECTIVE:

Learn how settings are defined and how to set them. Lay Out structures with proper settings.

The Drainage database stores a great deal of data for each drainage structure types it models. Pipes, for example, have over 70 storable attributes, inlets over sixty, plus user-definable fields. Laying Out structures would be a very slow process if the user had to answer fifty questions per structure.

There is a spectrum of “volatility” in the information used to define structures.



At one end of the spectrum is information that changes for every structure. These are the settings available on the Lay Out dialog. At the other end of the spectrum is information that seldom changes or changes only

between different geographic or regulatory regions. This information is located in files that the user can select, but seldom needs to edit.

In between the most dynamic and the most static information is the information that varies less than always but more than seldom. S&S groups most of the settings in the **Drainage Options** dialog.

Any information required to place a structure, which is not specifically asked for on the Lay Out dialog, is taken from the Drainage Options settings or from support files.

EXERCISE: LAY OUT TWO CATCHPIT INLETS IN THE PREVIOUS SUMP LOCATIONS

This exercise will guide you through the steps to Lay Out two Catchpit inlets in sump locations, this time making sure that we are using proper settings.

1. Select **InRoads > Drainage > Lay Out**.
2. Select the **Inlet** tab.
3. Click the **Options** button.
4. The **Drainage Options** dialog opens to the **Inlet** tab. There are many settings the user may adjust here. To streamline the processes of defining and retrieving (Saving and Loading) settings most InRoads dialogs have a Preferences button.
5. Click the **Preferences** button.
6. The **Preferences** dialog lists the pre-defined Preferences for the parent dialog, Drainage Options. Controls allow Loading, Saving, and Deleting the command's Preferences.
7. Select the **IW-3 CatchpitSump3x3** preference, Click **Load** and then **Close** the Preferences dialog.
8. Review the Inlet settings.
9. Click on the **Pipe** tab to review the pipe settings that were also loaded as part of the **IW-3 CatchpitSump3x3** preference.
10. Review the settings under the other tabs.
11. Click **Apply** and **Close** the **Drainage Options** form.
12. In the Drainage Lay Out form click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
13. Snap to the end of the **Sump Catchpit 1** leader.
14. Click Apply.
Note that graphics for the inlet are placed and the form resets for the next inlet.
15. Click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
16. Snap to the end of the **Sump Catchpit 2** leader.

17. Click **Apply**.
18. Note that graphics for the inlet are placed and the form resets for the next inlet.
19. Select the **Pipe** tab of the Drainage Lay Out dialog.
20. Click on the Graphic Locator button to the right of the **Upstream ID** field.
21. Click on the eastern catchpit (**IN1**). A “snap” is not necessary.
22. Click on the Graphic Locator button to the right of the **Downstream ID** field.
23. Click on the western catchpit (**IN2**). A “snap” is not necessary.
24. The **Upstream** and **Downstream ID** fields should read **IN1** and **IN2**, respectively.
25. Click **Apply**.

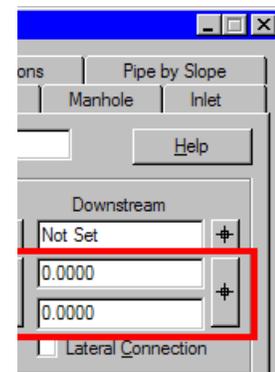
Note that graphics for the pipe are placed and the form anticipates that the Downstream Inlet will be the Upstream Inlet for the next pipe.

We will now place a free-exit outfall pipe discharging into the ditch next to the road.

26. Click on the Graphic Locator button to the right of the **Downstream Northing** and **Easting** fields.
27. Click on the “Outfall Pipe” leader.

The **Upstream** and **Downstream ID** fields should read **IN2** and **FREE_EXT**, respectively. The Slope field is negative, indicating that the pipe is going uphill (but still *downstream*).

28. Key in **0.5%** for the **Slope**.
29. Click **Apply**.



30. The graphics for the pipe are placed and the form anticipates that the Downstream Inlet will be the Upstream Inlet for the next pipe.
31. **Close** the Drainage Lay Out dialog.
32. Save your results in the drainage database by clicking **InRoads > Save > Drainage Data**. It is a good idea to save the database whenever you’ve completed and verified any significant amount of work (there is no Auto-Save).

Lesson Name: Displaying and Annotating Structures

LESSON OBJECTIVE:

Learn how to Display and Annotate Structures.

EXERCISE: DISPLAY THE DRAINAGE STRUCTURES

All the information necessary to display the Storm & Sanitary structures is contained in the database. The graphics are created from the database and not primary sources of information. As such, they can be deleted or otherwise manipulated with CAD commands with no effect on the information in the database. Manipulating the database information can only be accomplished using Storm & Sanitary commands.

The InRoads Style Lock (InRoads > Tools > Locks > Style) affects how the structures are displayed. For structure display we will limit our discussion to the Style Lock being ON.

1. Window in to the Storm & Sanitary structures.
2. Select **MicroStation > Edit > Select All**.
3. Click the **MicroStation Delete** tool (or hit the **Delete** key). This deletes all the graphics, but note that the InRoads Explorer still shows 2 Inlets and 1 Pipe (if the Drainage workspace tab is selected).
4. Select **InRoads > Drainage > View > Drainage**.

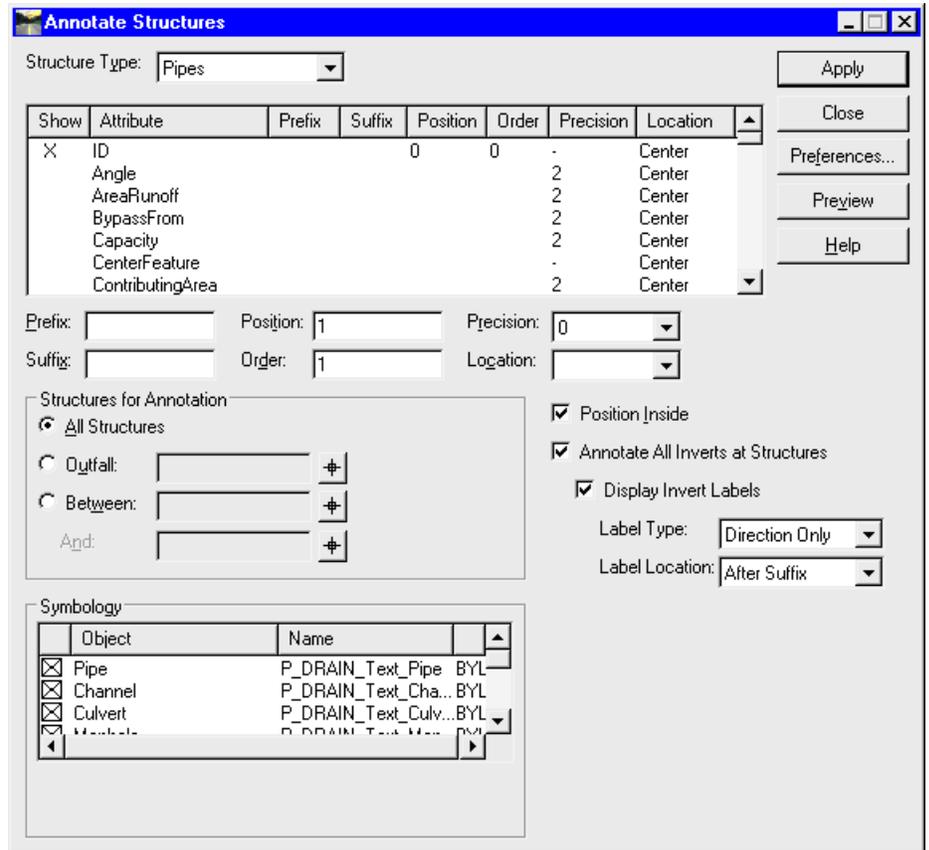
The structure graphics are displayed (or re-displayed) from information in the database. If the View Drainage dialog appears the Style Lock is OFF. Close the dialog, turn the Style Lock ON and then select Drainage > View > Drainage again.

The Storm & Sanitary junction structure (Inlets and Manholes) display is composed of a vault and an optional cell. The inlets show inside and outside vault walls and a cell representing the inlet grate. The Cell Scale Factor (InRoads > Tools > Options > Factors) is currently set at 1.0, which provides a true-scale representation of the grate. For large scale plots or projects it is often desirable to make the Cells much larger by increasing the Cell Scale Factor. The vaults are always shown true-scale.

EXERCISE: ANNOTATE THE DRAINAGE STRUCTURES

This exercise shows the user how to display Structure information using the Annotate Structures tool and pre-defined Preferences.

This command is for bulk annotation and is excellent for getting necessary information very quickly. For final sheet callouts the InRoads Drafting Notes functionality is fully integrated with the Storm & Sanitary graphics and database. Both methodologies can annotate any attribute in the database, including custom data fields.



Note: the Style Lock can affect Annotation symbology. With Style Lock ON Storm & Sanitary reads the Style field in each data record and uses that definition for the structure's annotation symbology; With Style Lock OFF all structures display according to the symbology as defined in the Symbology frame of the Annotation Structures dialog. The content does not change though the level, text style, size and orientation may.

The text created by this command is typical MicroStation text. It can be manipulated by the typical CAD commands. The text size defined in the symbology is, like all InRoads text, multiplied by the Global Text Scale factor (InRoads>Tools>Options>>Factors). It honors the InRoads Pencil/Ink toggle and the Delete Ink lock.

Each structure's text is a single Multi-Line Text node. All structure annotation created by a single click of the Apply button is a graphic group. When moving text around to minimize overlaps turn the Graphic Group Lock OFF.

1. Window in to the Storm & Sanitary structures.
2. Select **Drainage > View > Annotate Structures**.
3. Click **Apply**.

The Structures are annotated according to whatever Annotate Structures Preference is active.

Everything in the database may be annotated. Because there are literally tens of thousands of combinations of attributes, suffixes, prefixes, etc., using Preferences is the only efficient way to use this command. If you edit the settings to something you would like to use in the future **Save** them as a new Preference.

4. Click the **Preferences** button.
5. **Load** the **Type and Size** preference.
6. **Close** the **Preferences** dialog.
7. Click **Apply**.

This Preference shows some structural information that can help determine if the structures you placed are the proper Type and Size. You can use InRoads > Drainage >Edit/Review to make changes if necessary. Change the Global Text Scale factor (InRoads>Tools>Options>>Factors) as necessary (make sure you leave the Cell Scale factor at zero).

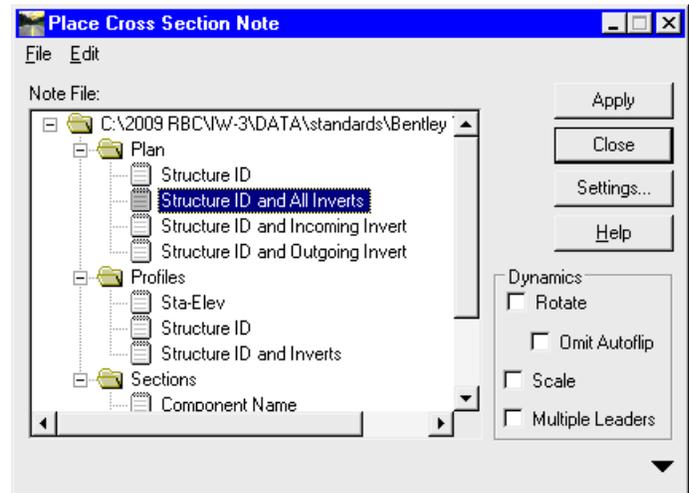
EXERCISE: USE INROADS DRAFTING NOTES FOR INDIVIDUAL STRUCTURE CALLOUTS

This exercise shows how the Storm & Sanitary database is integrated into the InRoads Drafting Notes functionality. Notes provide “final sheeting” callouts, including frames and leaders with or without terminators . Unlike the Annotate Structures tool, which is One-Click-Many-Structures, Drafting Notes requires a click or two per structure.

1. Window in to the Storm & Sanitary structures.
2. Select **InRoads > Drafting > Place Plan Note**.

The Drafting Notes definitions are stored in a .dft file, that has been specified as part of the InRoads Project Configuration. Plan, Profile and Cross Section Notes all behave similarly, but due to slight variations in their respective dialogs, they are launched via separate menu items.

The **Note File** list shows the contents of the active Drafting Definition file (*.dft).



3. In the **Note File** list expand the file to the subfolders Plan, Profiles, and Sections.
4. Expand the **Plan** folder.
5. Select **Structure ID and All Inverts** Note.
6. Click **Apply**.

7. At the “Identify element” prompt click the long pipe and Accept it.

MicroStation prompts “Identify Note Location” for the note, which is “attached” to the cursor with a leader starting at the point where the pipe was selected.

8. Place the note with a datapoint.

9. At the “Identify element” prompt click the upstream inlet and Accept it.

10. MicroStation prompts “Identify Note Location” for the note. Notice that since the inlet’s Invert In field is blank (it is the uppermost structure in the network) the note’s “INVERT EL IN =” is followed by “{InvertIn}”, indicating that that field is blank.

11. Right-click to cancel the note placement and right-click again to return to the Place Plan Note dialog.

12. Place a note at the inlet using the **Structure ID and Outgoing Invert** note.

Lesson Name: Laying Out On-Grade Combination Inlets and Pipes

LESSON OBJECTIVE:

Lay Out Combination Inlets On Grade.

EXERCISE: LAY OUT TWO COMBO GRATE INLETS IN ON-GRADE LOCATIONS

This exercise will guide you through the steps to Lay Out two Curb Grate inlets in On-Grade locations.

1. Adjust the CAD view so that the ComboInlet callouts are visible.
2. Select **InRoads > Drainage > Lay Out**.
3. Select the **Inlet** tab.
4. Click the **Options** button.
5. The **Drainage Options** dialog opens to the **Inlet** tab. There are many settings the user may adjust here. To streamline the processes of defining and retrieving (Saving and Loading) settings most InRoads dialogs have a Preferences button.
6. Click the **Preferences** button.
7. Select the **IW-3 ComboInletOn-Grade6x3** preference, select **Load** and then **Close** the form.
8. Review the settings under the **Inlet** tab.
9. Click on the **Pipe** tab to review the settings that were also loaded as part of the **IW-3 ComboInletOn-Grade6x3** preference.
10. Click on the **Gutter** tab to review the gutter settings that were also loaded as part of the preference.

An important drainage design limit in gutter spread. Storm & Sanitary calculates the spread at each inlet assuming that all surface flow runs through a gutter whose dimensions were defined from the Gutter dimensions active at Lay Out. The gutter flow spread, depth, and velocity, as well as the size and geometry of the grate determine the amount of flow captured by the inlet.

11. Click **Apply** and **Close** the **Drainage Options** form.
12. In the **Drainage Lay Out** form click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
13. Snap to the end of the **ComboGrate #3** leader, which ends at the gutter flow line of the road
14. Click Apply.

Note that graphics for the inlet are placed and the form resets for the next inlet. The grate should be aligned with the curb. One of the active Drainage Option settings aligns the inlet parallel to the active horizontal alignment. If the North-South road is not the active alignment,

the Orientation may not align with the curb. The **Edit/Review** tool can be used to change the inlet Orientation if necessary.

15. Click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
16. Snap to the end of the **ComboGrate #4** leader.
17. Click Apply.

Note that curb is rotated automatically so that the grate is in the road.

18. Select the **Pipe** tab of the Drainage Lay Out dialog.
19. Click on the Graphic Locator button to the right of the **Upstream ID** field.
20. Click on the eastern combo inlet (**IN3**). A “snap” is not necessary.
21. Click on the Graphic Locator button to the right of the **Downstream ID** field.
22. Click on the western combo inlet (**IN4**). A “snap” is not necessary.
23. The **Upstream** and **Downstream ID** fields should read **IN3** and **IN4**, respectively.
24. Click **Apply**.

Note that graphics for the pipe are placed and the form anticipates that the Downstream Inlet will be the Upstream Inlet for the next pipe.

EXERCISE: LAY OUT TWO COMBO INLETS USING PRECISION INPUT

This exercise will guide you through the steps to Lay Out two Curb Grate inlets in On-Grade locations using Precision Input.

1. Select **InRoads > Drainage > Lay Out**.
2. Select the **Inlet** tab.
3. Click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
4. When the form disappears, key in “**so=1800,-14**” in the MicroStation key in field and hit return.
The Drainage Lay Out dialog returns with the Northing Easting and Elevations values from that station offset location.
5. Click **Apply**.
The graphics for the combo inlet are placed.
6. Click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
7. When the form disappears, key in “**so=1800,14**” in the MicroStation key in field and hit return.
The Drainage Lay Out dialog returns with the Northing Easting and Elevations values from that station offset location.

8. Click **Apply**.
The graphics for the combo inlet are placed.
9. Select the **Pipe** tab of the Drainage Lay Out dialog.
10. Click on the Graphic Locator button to the right of the **Upstream ID** field.
11. Click on the ComboInlet #4 (**IN4**). A “snap” is not necessary.
12. Click on the Graphic Locator button to the right of the **Downstream ID** field.
13. Click on the right-side inlet to the south (**IN6**). A “snap” is not necessary.
14. The **Upstream** and **Downstream ID** fields should read **IN4** and **IN6**, respectively.
15. Click **Apply**.
16. Click on the Graphic Locator button to the right of the **Upstream ID** field.
17. Click on the left-side ComboInlet at station 18+00, -14 (**IN5**). A “snap” is not necessary.
18. Click on the Graphic Locator button to the right of the **Downstream ID** field.
19. Click on the right-side inlet at station 18+00, 14 (**IN6**). A “snap” is not necessary.
20. The **Upstream** and **Downstream ID** fields should read **IN5** and **IN6**, respectively.
21. Click **Apply**.

Note that graphics for the pipe are placed and the form anticipates that the Downstream Inlet will be the Upstream Inlet for the next pipe.

Lesson Name: Using some Hydrology and Hydraulics Tools

LESSON OBJECTIVE:

Use some of the Hydrology and Hydraulics tools to establish inlet locations.

EXERCISE: USE THE TRICKLE COMMAND TO LOCATE SUMP LOCATIONS

This exercise will guide you through the steps to use the Trickle command to locate sump locations.

1. Display the road features by displaying the Surface Features (InRoads > Surface > View > Features) or turn on the Display of the RoadFeatures reference file.
2. Select **InRoads > Evaluation > Hydrology and Hydraulics > Trickle**.
3. Ensure that the **Surface** is set to **design**, **Direction** is set to **Down**, and the **Dynamics** check box is enabled.

Our area to be evaluated is the north-south road south of the east-west road. The road is curbed and crowned with a low point. We are looking for two sump locations for inlets.
4. Click **Apply** and drag the cursor over the North-South road.

There should be two sump locations south of the east-west road, one on either side of the centerline.

5. Place a data point to create a flow line on either side of the centerline.

We will use the downstream ends of these lines to place sump inlets in the next section. These sump locations are at the gutter flowlines at station 12+00.

Lesson Name: Laying Out Curb Grates in Sump Locations

LESSON OBJECTIVE:

Lay Out Curb Grate Inlets in the Sump Locations.

EXERCISE: LAY OUT TWO COMBO GRATE INLETS IN ON-GRADE LOCATIONS

This exercise will guide you through the steps to Lay Out two Curb Grate inlets in On-Grade locations.

1. Select **InRoads > Drainage > Lay Out**.
2. Click the **Options** button.
3. Click the **Preferences** button.
4. Select the **IW-3 CurbGrateSump6x3**.
5. Click **Apply** and **Close** the **Drainage Options** dialog.
6. Click on the Graphic Locator button to the left of the Northing Easting and Elevation fields.
7. Snap to the end of the left side trickle line.
8. Click **Apply**.

The graphics for the combo inlet are placed as well as a pipe between it and the previous inlet.

9. Clear the **Add Connecting Pipe** check box. Click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
10. Snap to the end of the right side trickle line.
The Drainage Lay Out dialog returns with the Northing Easting and Elevations values from that station offset location.
11. Click **Apply**.

The graphics for the combo inlet are placed.

EXERCISE: CONNECT THE INLETS

This exercise will guide you through the steps to connect the disconnected inlets.

1. In the **Drainage Lay Out** dialog select the **Pipe** tab.
2. Click on the Graphic Locator button to the right of the **Upstream ID** field.
3. Click on the right-side inlet at station 18+00, 14 (**IN6**)..
4. Click on the Graphic Locator button to the right of the **Downstream ID** field.
5. Click on the right-side sump inlet at (**IN8**).
6. Click **Apply**.
7. The graphics for the pipe are placed.
8. Click on the Graphic Locator button to the right of the **Upstream ID** field.
9. Select the left sump inlet (**IN7**).
10. Click on the Graphic Locator button to the right of the **Downstream ID** field.
11. Select the right sump inlet (**IN8**)
12. Click **Apply**.
13. The graphics for the pipe are placed.

EXERCISE: ADJUST THE RIGHT SIDE COMBO INLETS

This exercise will guide you through the steps to changing the right side combo inlets so that the curb openings are on the upside of the grate.

Each type and size of Inlet has a specific style defined in the Drainage Structures file. Often there are left and right versions of the same type and size inlet. By changing from the default Style for the inlet to its “mirror” the curb opening graphic is corrected.

1. Select **InRoads > Drainage > Edit/Review**.
2. Select one of the Combo Inlets on the right side of the North-South road.
3. In the Edit/Review dialog, select the Styles tab.
4. In the Point listbox, select the Style **P_DRAIN_Combol_6.0x3.0**.
5. Click Apply.

Note that the opening is now to the north of the grate.

6. Select the other right-side combination inlet and change its Point Style to **P_DRAIN_Combol_6.0x3.0**.

Lesson Name: Adding Flows

LESSON OBJECTIVE:

Attach flows to the network.

EXERCISE: COMPUTE THE RUNOFFS FROM TWO DRAINAGE SHAPES

This exercise will guide you through the steps to calculate the runoff from two drainage shapes and attach them to the drainage network.

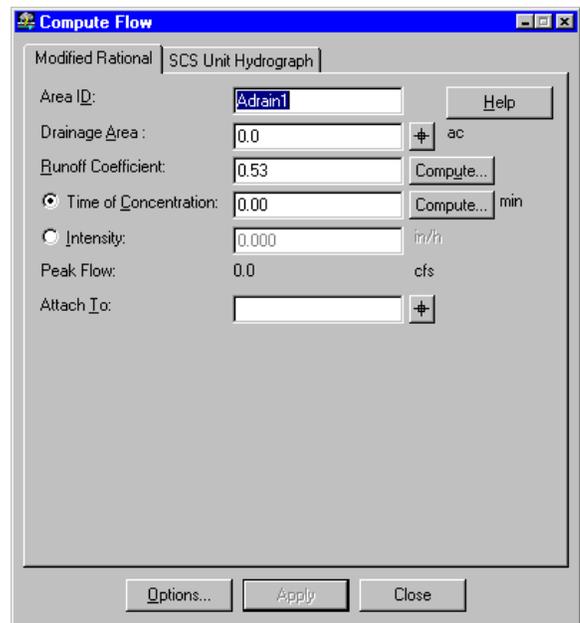
Any CAD shape can be selected and its area calculated. The Hydrology and Hydraulics tools can be used to determine flowpaths, ridges and valleys and source areas. Once the various limits of a drainage basin is found the individual components can be merged using the Create Complex Shape command or by using the Place Shape command, snapping to the relevant points. If the area is already known, that value can be keyed in; a shape is not necessary (this can save time when inlets are uniformly spaced with identical drainage areas).

The Compute Flow command calculates a Peak Flow value using the Modified Rational or SCS Unit Hydrograph methods.

In the Modified Rational method, Runoff Coefficients can be keyed in or a weighted-average can be computed using the active Runoff Coefficient table. The Time of Concentration can be keyed in or calculated using built-in Kirpich, FAA, or Overland Flow calculators.

A known or required intensity can be keyed in instead of being computed via Time of Concentration.

Once enough of the data is defined so that a Peak Flow can be calculated, the Area can be attached to a drainage structure.



There are two shapes in the locked **Temp_Area** level. Let us unlock the level and use the shapes for the Compute Flow tool.

1. Isolate the shapes in the Temp_Area level by turning off the Reference file Displays and/or Surface Features display.
2. In the MicroStation Key-in field, key in "level set lock off Temp_Area"
3. Select **InRoads > Drainage > Compute Flow**.
4. Click on the Graphic Locator button to the right of the **Drainage Area** field.
5. Click on the upper shape.
6. The Drainage Area is computed to be 8400 sq. ft. The default Runoff Coefficient is 0.9, which is acceptable for this all-pavement area. The Time of Concentration of 5 minutes is also acceptable. A peak flow of 1.038 cfs is calculated from this information
7. Click on the Graphic Locator button to the right of the **Attach To** field.
8. This area drains to the northernmost left-side inlet (**IN3**). Click on it and Accept with a data point.
9. Click **Apply**.

An Area database record is created, the shape is displayed according to the Symbology defined for Drainage Areas, and the dialog resets for the next shape.

The next shape is the left-side sump shape.
10. Click on the Graphic Locator button to the right of the **Drainage Area** field.
11. Click on the lower shape.
12. The Drainage Area is computed to be 10500 sq. ft. The default Runoff Coefficient is 0.9, which is acceptable for this all-pavement area. The Time of Concentration of 5 minutes is also acceptable. A peak flow of 1.297 cfs is calculated from this information
13. Click on the Graphic Locator button to the right of the **Attach To** field.
14. This area drains to the left-side sump inlet (IN7). Click on it and Accept with a data point.
15. Click **Apply**.

An Area database record is created, the shape is displayed according to the Symbology defined for Drainage Areas, and the dialog resets for the next shape.

EXERCISE: USE THE COMPUTED ACREAGES FOR INLETS WITH THE SAME LAYOUTS

The left-side and right-side drainage basins are symmetric. Additionally the combo inlets all have identically-sized drainage areas. Rather than define shapes for each, we will save time by simply keying in the acreage for each.

1. Select **InRoads > Drainage > Compute Flow**.

The three combo inlets without attached areas drain 8400 sq. ft. They each have a Runoff Coefficient of 0.9 and a Time of Concentration of 5 minutes.

2. In the **Drainage Area** field key in **8400**.
3. Verify a Runoff Coefficient of 0.9 and a Time of Concentration of 5 minutes.
A peak flow of 1.038 cfs is calculated from this information
4. Click on the Graphic Locator button to the right of the **Attach To** field.
5. This area drains to the northernmost right-side inlet (IN4). Click on it and Accept with a data point.
6. Click **Apply**.
7. An Area database record is created and the dialog resets for the next shape.
8. Repeat the above steps to create Drainage Areas for the other two ComboInlets.
9. The right-side sump Curb Grate drains the same amount as the left-side sump Curb Grate, 10500. Create a Drainage Area for this inlet.
10. Verify that there are drainage areas for each curb grate and combo inlet, by double-clicking the Areas Structure Type in the InRoads Explorer (the workspace tab must be set to Drainage). The headers in the list are sortable.
11. Save the Drainage File (**InRoads > File > Save > Drainage Data**).

Lesson Name: Designing the Network

LESSON OBJECTIVE:

Use the Network Design command to perform a Hydraulic Design on the Network.

Overview

Given a physical network model and a hydrologic model linked to the physical model, network hydraulic modeling can now take place.

Methodology

A detailed breakdown of the S&S design calculation procedures can be found at **InRoads > Help > Supplemental Information > Storm & Sanitary > Storm & Sanitary Design Procedures**. Most of S&S methodology, including Inlet capture methodology and Hydraulic and Energy Grade Line analysis, use as a foundation the Urban Drainage Design Manual, Hydraulic Engineering Circular No. 22.

Fixed/Resize

Every Network Structure (as opposed to a Storm Area, Sanitary Zone, or a Utility) in its database record has a field called "Status". The value is either Fixed or Resize. It is this toggle that tells S&S whether to upsize structures to meet design criteria. Our structure defaults were set to Fixed. We can change the status using the **InRoads > Drainage > Structure > Modify Status** command; a fence can be used for bulk changes.

EXERCISE: USE THE NETWORK DESIGN COMMAND TO PERFORM A HYDRAULIC DESIGN ON THE NETWORK

We are going to perform a design of the North-South road network.

1. Select **InRoads > Drainage > Network > Design**.

2. Click on the Graphic Locator button to the right of the **Tree Network Containing** field.

3. Select any structure in the North-South network.

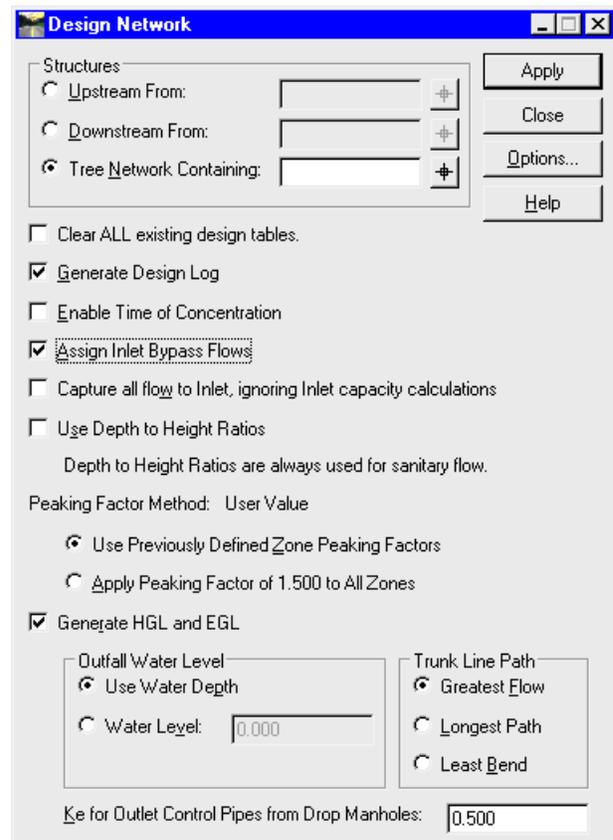
4. Accept the structure with a data point.

For information on the individual controls click the **Help** button.

5. Ensure that the following check boxes are enabled:

- Generate Design Log
- Assign Inlet Bypass Flows
- Generate HGL and EGL

6. Click **Apply**.



The Design Log provides design values and messages on each structure in the sequence it was designed. Violations of design constraints are noted here. If the HGL and EGL check box is enabled the end of the log should be two HGL tables. If the network processing halts at a structure due to some error the log typically explains why. It is good technique to always scroll to the bottom of the log to verify successful completion.

7. Now that the database is updated with design values the Drainage Annotation Design Results preference provides useful feedback.

8. Save the Drainage File (**InRoads > File > Save > Drainage Data**).

Lesson Name: Generating Drainage Profiles

LESSON OBJECTIVE:

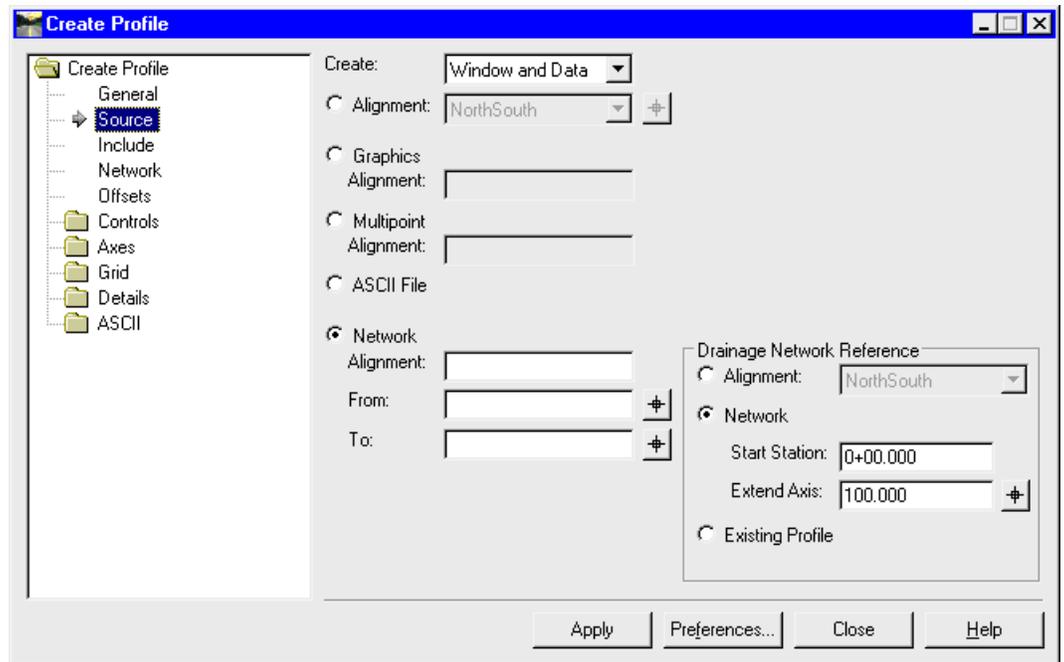
Generate Drainage Profiles.

The Create Profile dialog has many controls to provide completely customizable results. The Help button provides full details on all the options; we will explore two “leaves” important to drainage: the Source leaf and the Network leaf.

The **Source** leaf is used to define the horizontal path of the profile “slice.”

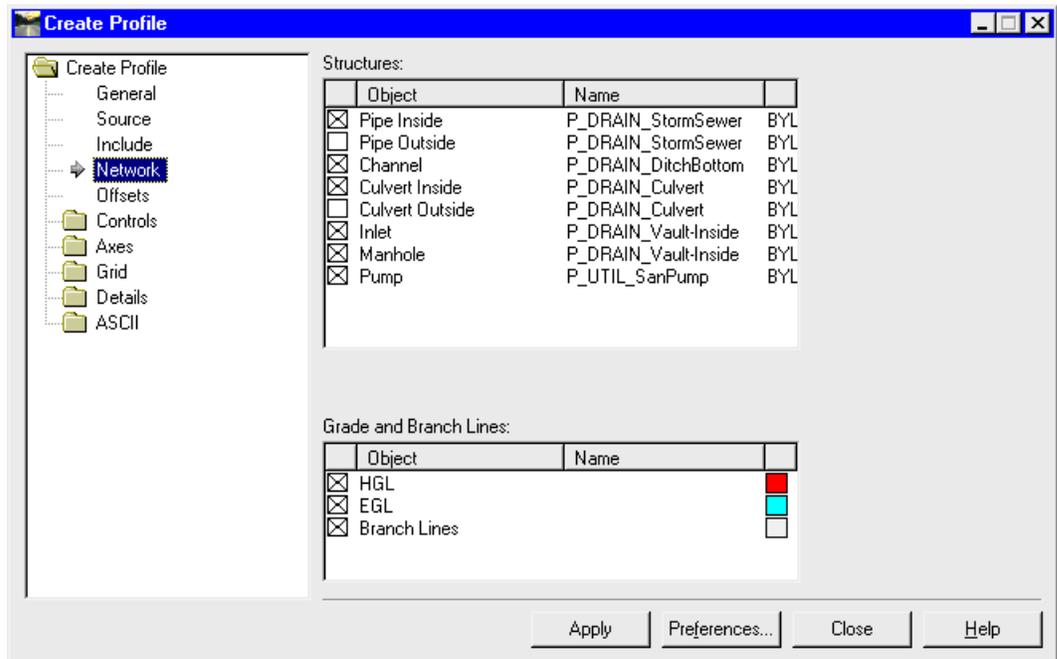
For Drainage Structures to show, the **Network Alignment** radio button must be selected.

To cut the profile along the structures select the **Network** radio button in the Drainage Network Reference frame.



To cut along the active alignment and project the structures onto it, select the **Alignment** radio button. The Existing Profile button projects drainage structures onto profiles that have already been created.

The **Network** leaf is where the symbology is set for the drainage structures and HGL, EGL and Branch Lines. When the InRoads Style Lock is ON the Symbology of Structures is derived from the individual structure record's Style attribute.

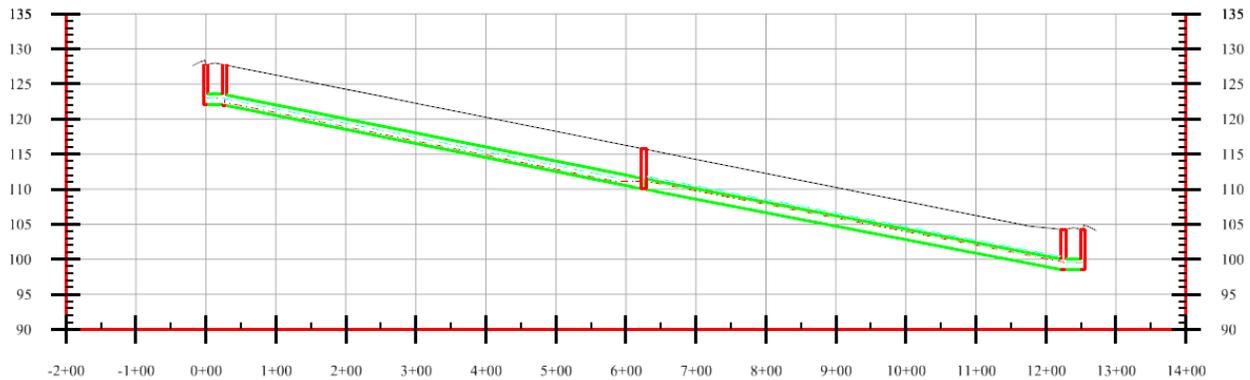


EXERCISE: GENERATE DRAINAGE PROFILES

This exercise will guide you through the steps to create drainage profiles.

1. Select **InRoads > Evaluation > View > Profile > Create Profile**.
2. Turn the Style Lock OFF (InRoads > Tools > Locks > Style).
3. In the **General** leaf ensure that the **design** surface check box is selected.
4. Select the **Source** leaf.
5. Ensure that the **Create** listbox reads **Window and Data**.
6. Select the **Network** radio button.
7. A drainage profile can be created between any two structures in the same network.
8. Click on the Graphic Locator button to the right of the **From** field. Select the northernmost left-side Combo Inlet (**IN3**).
9. Click on the Graphic Locator button to the right of the **To** field. Select the right-side Curb Gate sump (**IN8**).
10. Ensure that the radio button in the Drainage Network Reference frame is set to **Network**.
11. Click **Apply**.

12. At the “Identify Location” prompt place a data point for the location of the lower left corner for the profile. Place it to the right of the graphics.



EXERCISE: ANNOTATE DRAINAGE PROFILE

This exercise will guide you through the steps to annotate drainage profiles.

1. Select **InRoads > Evaluation > Profile > Annotate Drainage Profile**.

The Annotate Drainage Profile dialog looks and behaves similarly to the Annotate Structure dialog with a specific difference: the **Set List** control. Drainage profiles are annotated one at a time. Use the Set List or the Graphic Locator button to its right to select the Profile to Annotate.

2. Click **Apply**. Verify that the Profile Structures were Annotated.
3. **Close** the dialog.

Structure Notes can be placed in profile using the **InRoads > Drafting > Place Profile Note** tool in a manner similar to the **Place Plan Note** tool.

Lesson Name: Rapid Layout

LESSON OBJECTIVE:

This exercise has two objectives: (1) show how fast a network can be placed and (2) add additional structures for future interference checking.

EXERCISE: LAY OUT SANITARY MANHOLES AND PIPES

This exercise will guide you through the steps to lay out sanitary manholes simultaneously with pipes. Our goal here is to place a manholes and pipes within the limits of the NorthSouth road as an interference opportunity – not necessarily as good design.

1. Select **InRoads > Drainage > Lay Out**.
2. Click on the **Manhole** tab.
3. Click on the **Options** button.
4. Click on the **Preferences** button.
5. Select the **IW-3 Sanitary** Preference.
6. Click **Load** and **Close** the Preferences dialog.
7. Review the Settings under the **Manhole, Pipe** and **Structure IDs** tab.
Note that the Prefixes for the Manholes and Pipes include “san”. This is for our tracking purposes only. Storm & Sanitary does not distinguish between “sanitary” structures and “drainage” structures: it had fields for both flows in each database record.
8. **Close** the **Preferences** dialog.
9. In the **Drainage Lay Out** dialog, **Manhole** tab, enable the “**Add Connecting Pipes**” check box.
10. Select the **By Elevation** radio button. This places the invert at the active minimum pipe depth.
11. Click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
12. Place a data point within the NorthSouth road, somewhere near the north end.
13. Click **Apply**. The manhole is placed.
14. Click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
15. Place a data point within the NorthSouth road, somewhere near the middle.
16. Click **Apply**. The manhole and the pipe between it and the previous manhole is placed.
17. Click on the Graphic Locator button to the right of the Northing Easting and Elevation fields.
18. Place a data point within the NorthSouth road, somewhere near the south end.
19. Click **Apply**. The manhole and the pipe between it and the previous manhole is placed.

20. **Close** the dialog.

21. Save the Drainage File (**InRoads > File > Save > Drainage Data**).

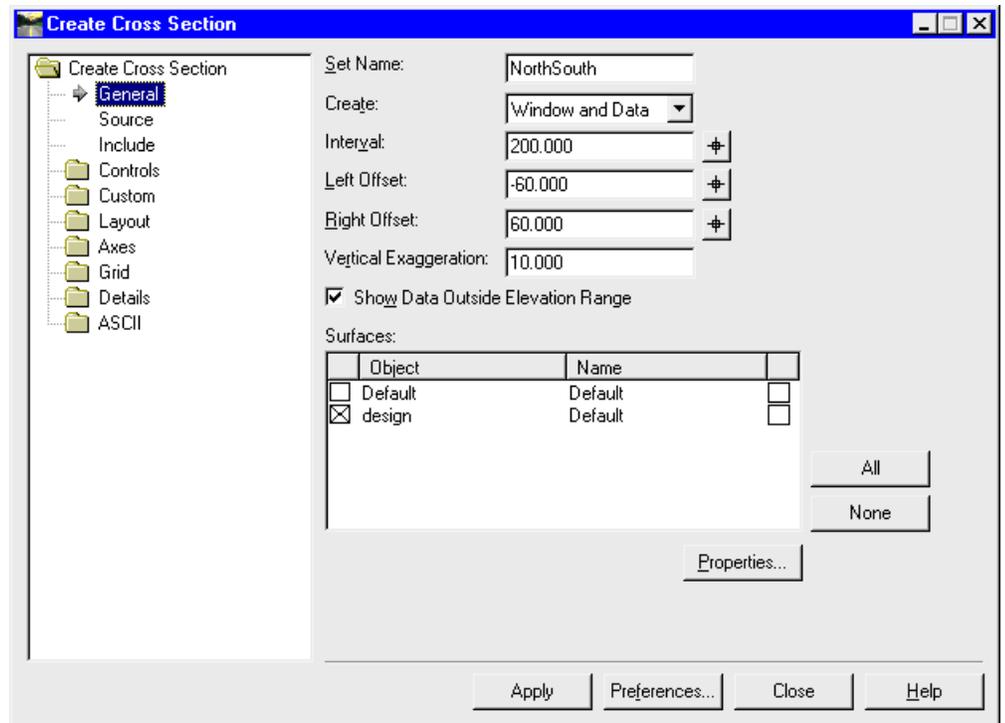
Lesson Name: Generating Cross Sections

LESSON OBJECTIVE:

Generate Cross Sections with Drainage Structures

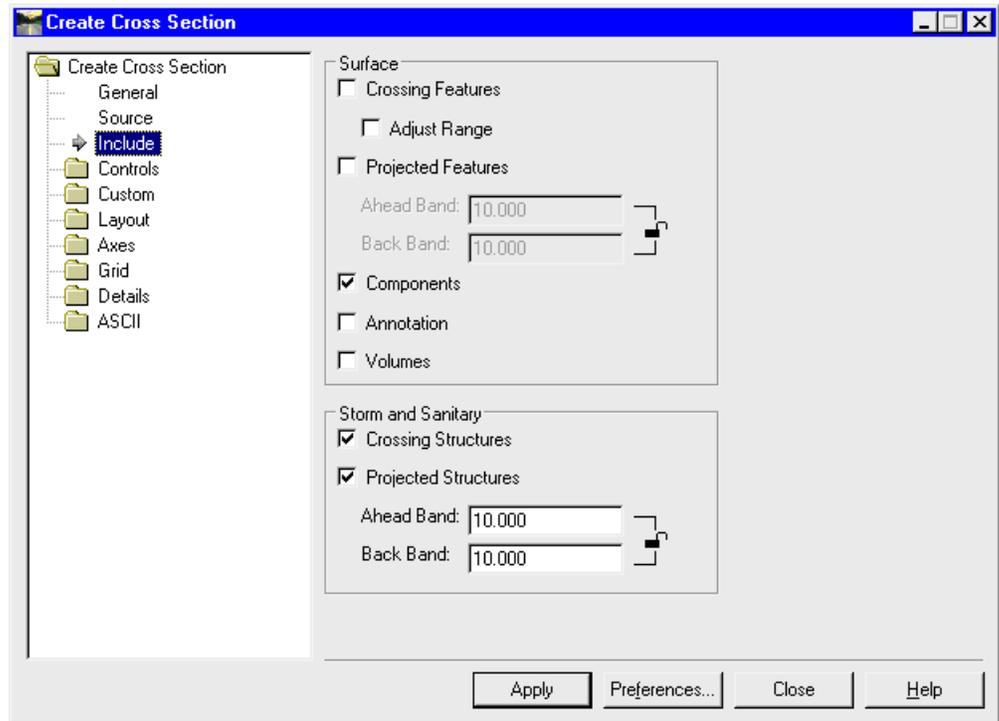
Like Profiles, Create Cross Sections involves many settings. See the on-line Help for full details.

The **General** leaf sets the interval and width for regular sections along the horizontal path, which is set in the Source leaf. The Set Name reflects the name of the active source.



Structures are included in Cross Sections via controls in the Storm and Sanitary frame of the **Include** leaf.

Setting **Ahead** and **Back Bands** will limit the range within which Drainage Structures are projected.



EXERCISE: CREATE CROSS SECTIONS WITH DRAINAGE

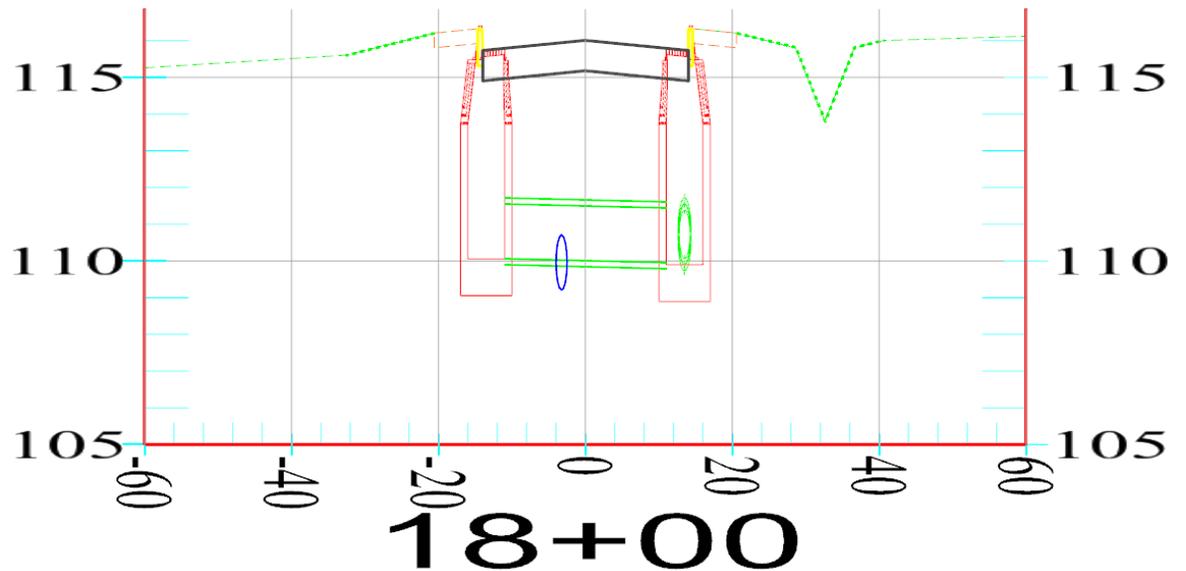
This exercise will guide you through the steps to Create Cross Sections with Drainage Structures.

1. Select **InRoads > Evaluation > Cross Section > Create Cross Section**.
2. In the **General** leaf ensure that the **design** surface check box is selected.
3. Select the **Source** leaf and ensure that the **NorthSouth Alignment** is the active Source.
4. Select the Include leaf enable the **Crossing Structures** and **Projected Structures** check boxes.
5. Key in **10** for the **Ahead Band** and for the **Back Band**.
6. Click Apply.
7. At the "Identify location" prompt, place a data point to the upper right of the other graphics in the CAD file (so that the cross sections do not overlap anything).
8. **Close** the dialog.

EXERCISE: CREATE CROSS SECTIONS WITH DRAINAGE

This exercise will guide you through the steps to View Cross Sections using the Cross Section Viewer. The Cross Sections are normal MicroStation graphics. The Viewer simply facilitates scrolling from one section to the next.

1. Select **InRoads > Evaluation > Cross Section > Cross Section Viewer**.
2. Select the first station in the **Cross Sections** list.
3. Select the down arrow (↓) to move to the next section. Repeat as interested.
4. The screenshot shows the section at Station 18+00.



5. **Close** the dialog.

Note the apparent conflict at the crossing pipe. Depending on where you placed the Sanitary Manholes your Sanitary pipe location may differ.

Cross Section structures can be annotated using the **InRoads > Drafting > Place Cross Section Note** tool.

Lesson Name: Visual Class Detection

LESSON OBJECTIVE:

Detect Structure Interference Visually.

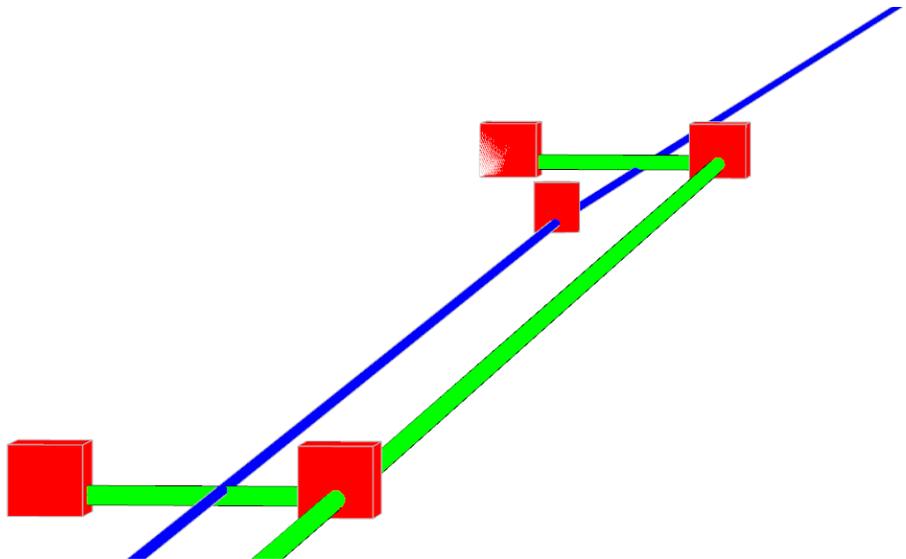
EXERCISE: DISPLAY DRAINAGE AS SOLIDS

This exercise will guide you through the steps to Display Drainage As Solids

1. Place a fence around the structures.
2. Select the MicroStation Delete Fence Contents command.
3. Delete the network.
4. Turn off the display of any Reference files.
5. Select **InRoads > Drainage > View > Drainage as Solids**.
6. In the View Drainage As Solids dialog click **Apply**.
7. In the MicroStation Key-in field, key in “**view clash_hiddenfill**”.
8. At “Saved View > Select view” prompt, place a data point in the view.

This is a saved view with a close perspective on the interferences and the Display Style set to Filled Hidden Line.

9. Use view controls (Fit View, Window Area, Rotate View, etc.) to check other interferences.
10. When done key in “**view drain_top**” and place a data point in the view to return to the normal top view.



Lesson Name: Importing Storm & Sanitary data into StormCAD

LESSON OBJECTIVE:

Learn how to Import Storm & Sanitary into StormCAD.

Note: we will not be performing these steps in class.

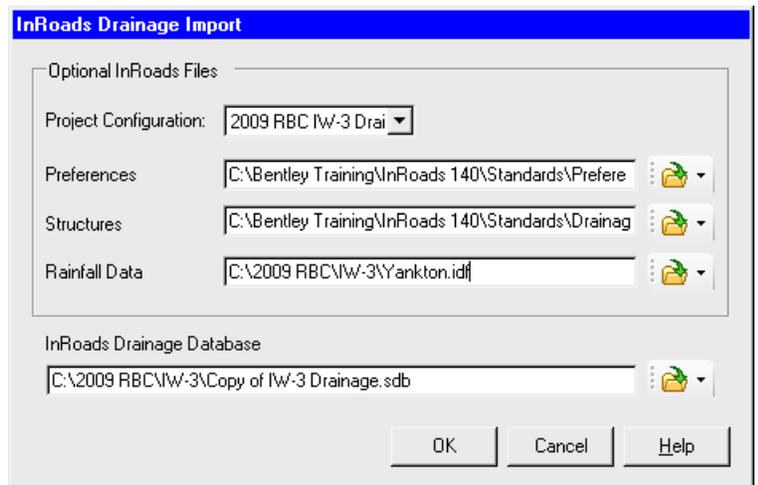
No “export” or translation in InRoads/Storm & Sanitary is necessary. From within StormCAD, the Drainage Data file, the *.sdb file, can be imported into StormCAD.

From within Bentley StormCAD V8i, select Project > Import > InRoads. The Drainage Database must, of course, be specified.

There are three other files StormCAD needs to successfully import the Drainage data:

- The InRoads Preference file
- The S&S Drainage Structures file
- The rainfall Intensity-Duration-Frequency file

These three files can be specified automatically if the Project Configuration files are available (they are machine- and Windows user-specific.)



Lesson Name: Manipulating Structures and Areas

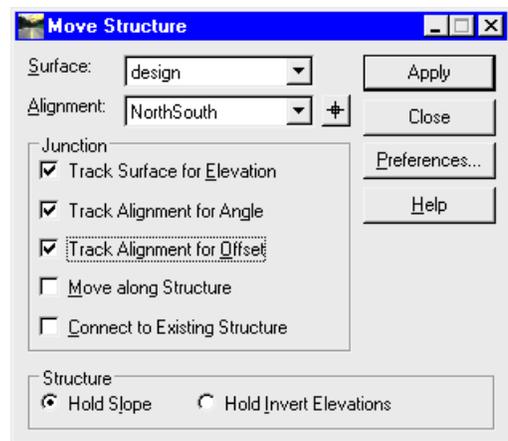
LESSON OBJECTIVE:

Learn how to adjust placed structures and areas.

As you have seen it is easy to Lay Out drainage structures and areas. There are many tools in Storm & Sanitary to modify structures and networks already in the database. Individual structures can be moved horizontally using the Structure > Move tool and vertically using the Structure > Move in Profile tool. Inlets and Manholes can be inserted onto pipes (breaking the pipe in two) using the Structure > Insert and the Structure > Insert in Profile tools.

Entire networks can be moved horizontally or have its elevations adjusted to a new surface using the Network > Move tool. The Network > Adjust tool is used to move pipes to meet minimum cover requirements and to perform crown matching.

If you noticed the results in the Design Log the spread at the inlets exceeded the Allowable spread, indicating the inlet spacing was too large. An engineering solution would be to decrease the spacing between inlets. The Drainage > Structure > Move Structures tool has a number of different options to meet the designer's specific needs when moving a structure.



When moving Drainage Inlets, Drainage Areas also change. The Drainage Area graphics can be edited using standard CAD tools, such as Modify Element. Once the graphic shape is edited selecting the area with the Compute Flow will update the area value (acreage) while maintaining its other previously-defined values.

EXERCISE: MOVE THE COMBO INLETS NORTH

This exercise will guide you through the steps to decrease the inlet spacing.

1. Select **InRoads > Drainage > Structure > Move**.
2. Ensure that the following checkboxes are set:
 - Track Surface for Elevation
 - Track Alignment for Angle
 - Track Alignment for Offset
 - Hold Slope
3. Click **Apply**.
4. Select the upper left combo inlet (**IN3**).
5. You will get a warning that the junction is fixed. Click **OK** to continue.
6. Move the cursor. Note that the inlet retains its offset.
7. Place the inlet further north than its current position.
8. Use the MicroStation Modify Element tool to move the shape vertex north to the new location of the inlet.
9. Select **InRoads > Drainage > Flows > Compute Flows**.
10. Select the Graphic Locator button to the right of the **Drainage Area** field.
11. Select the drainage area shape.
12. The **Compute** Flow dialog returns with a square footage that should be less than the original 8400 sq. ft.
13. Click **Apply** and **Close** the dialog.
14. Re-Design the network to check the spread value (**InRoads > Drainage > Network > Design**).

If the spread value for IN3 is still excessive the steps should be repeated until the spread value is allowable.

Alternatively, we could assume that we will have to add an additional inlet. We could recalculate the interval based on an additional inlet and move all the inlets to an even interval. The left additional inlet could be placed normally. The new right inlet can be placed using the Structure > Insert tool. Don't forget to adjust all the drainage acreages.

EXERCISE: MOVE THE SANITARY PIPES IN PROFILE

There may have been some interference between different structures. The interfering pipes can be moved in profile, maintaining slope or holding an invert using the Drainage > Structure > Move in Profile.

This exercise will guide you through the steps to move the Sanitary Pipes to avoid conflict with the crossing storm pipes.

Note: it is a very good idea to save and archive the Drainage file prior to doing major changes to a network.

1. Create a Drainage Profile along the Sanitary network.
2. Select **InRoads > Drainage > Structure > Move in Profile**.
3. At the “Identify structure” prompt select a pipe. Note: selecting a pipe in the middle third will hold the pipe’s slope constant; selecting an upper or lower third will lock the other invert, the “free” invert can be set with a data point or an elevation key-in.
4. In order for the hydraulics to be re-designed and the HGL and EGL lines to be updated, a Network Design must be performed as well as a Drainage Profile Update (**InRoads > Evaluation > Profile > Update Drainage Profile**).