

# LAB 8 - Evaluating Bridge Design Surfaces

In this lab you will evaluate the excavation and backfill surfaces you created in the previous lab by computing cut and fill volumes. InRoads provides different methods for computing volumes. In this lab, you will work with three different methods.

## Chapter Objectives:

- Learn how to compute Triangle volumes.
- Learn how to set default XSL style sheets to format InRoads reports.
- Learn how to compute Grid volumes as a check for the triangle volumes.
- Learn how the grid interval affects grid volume results.
- Learn how to compute End Area Volumes from cross section graphics.

The following files are used in this lab:

- C:\Projects\12345\Bridge\Working \CU12345BRDG\_Model.dgn
- C:\Workspace\Workspace-CDOT\_XM\Standards-Global\InRoads\Preferences\CDOT\_Civil.xin
- C:\Projects\12345\Design\InRoads\12345 SH119
- C:\Projects\12345\Design\InRoads\12345 SH119 SH52 Interchange.alg
- C:\Projects\12345\ROW\_Survey\InRoads\DTM\12345 existing ground for interchange

**Note:** The following files were created in the previous lab “*Feature Based Modeling.*” If these files don’t exist in the location identified below then they can also be copied from the directory *C:\Projects\12345\Miscellaneous\BRDG-08*

- C:\Projects\12345\Bridge\InRoads\12345 backfill for pier footer
- C:\Projects\12345\Bridge\InRoads\ 12345 excavation for pier footer

## Lab 8.1 - Open Data Files

1. Open MicroStation and InRoads using the *C:\Projects\12345\Bridge\Working \CU12345BRDG\_Model.dgn* file.
2. Verify the correct *XIN* file is loaded.
3. Select **File > Open** from the InRoads menu.
4. Open *C:\Projects\12345\Design\InRoads\12345 SH119*, *12345 backfill for pier footer*, *12345 excavation for pier footer*, and *12345 SH119 SH52 interchange.alg*.
5. Open *C:\Projects\12345\ROW\_Survey\InRoads\DTM\12345 existing ground for interchange*.

## Lab 8.2 - Compute the Pier Excavation Volume

The triangle is the most accurate method of computing volumes in InRoads. It compares existing and design surfaces to compute cut, fill and net volume between the surfaces. Since you have created an excavation surface for the pier footer, you can use the triangle method to compare this surface to the existing ground surface and compute the amount of cut needed for the excavation of the footer.

The grid method provides a quick check against other volume methods to ensure volume accuracy. The smaller you set the grid interval, the more accurate the volume results. You'll use the grid method to check your triangle volume.

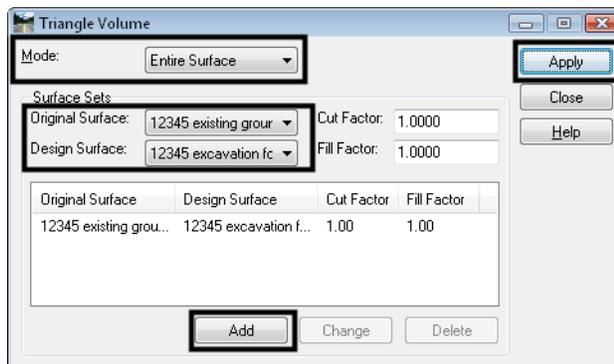
1. **Delete** any MicroStation graphics currently in the design file.
2. Select **Evaluation > Volumes > Triangle Volume**.
3. Set **Mode** to *Entire Surface*.

**Note:** You have the option to compute volumes on a portion of the surface using a MicroStation fence or shape. Areas outside of the smaller of the two surfaces are ignored.

4. Set **Original Surface** to *12345 existing ground for interchange*.
5. Set **Design Surface** to *12345 excavation for pier footer*.

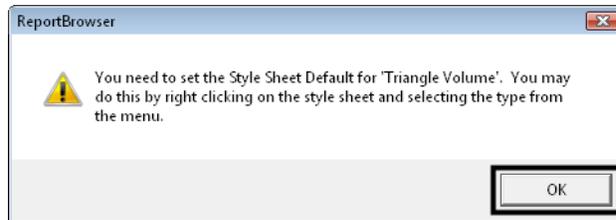
Note: **Cut** and **Fill Factors** are swell and shrinkage factors that you can apply to the volumes depending on the classification of material.

6. <D> **Add**.

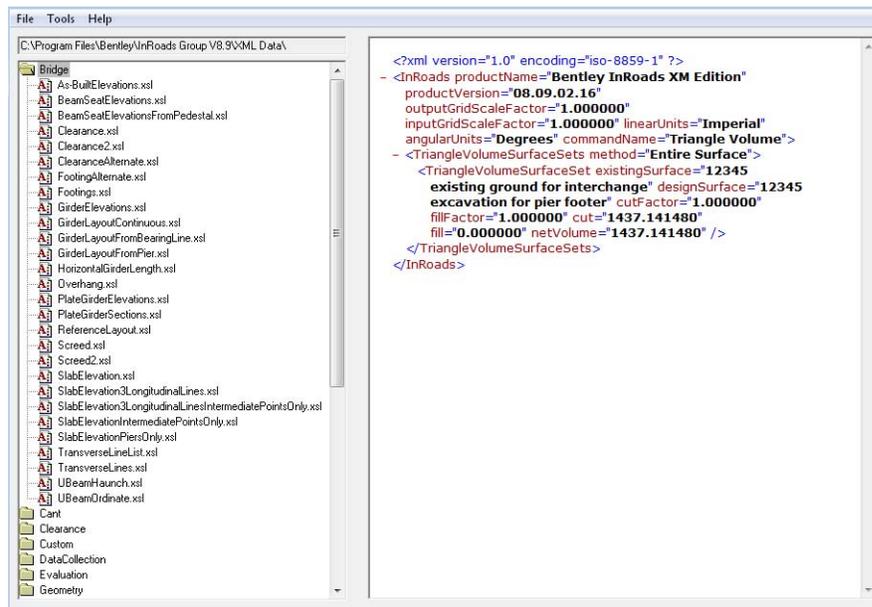


7. <D> **Apply**.

- If you receive a warning message that a default style sheet has not been selected for the **Triangle Volume** report, select **OK** after receiving this message. You will set a default style sheet in this lab.

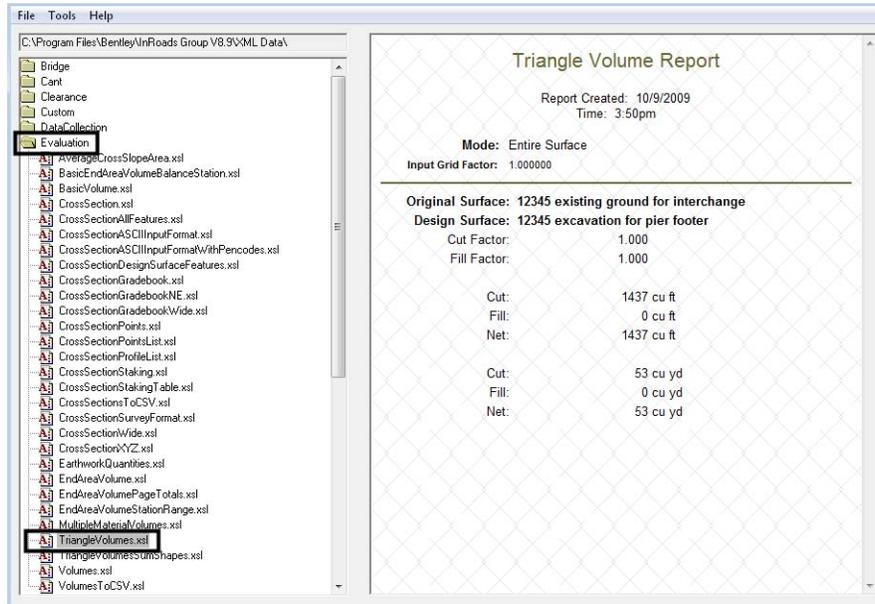


**Note:** The *Bentley InRoads Report Browser* automatically starts, allowing you to select a style sheet (i.e. a report template) to format the report. All available report style sheets are organized in folders and listed on the left-hand side of the report browser. The right-hand side shows the report *XML* data.



- In the *Report Browser*, select the *Evaluation* folder.

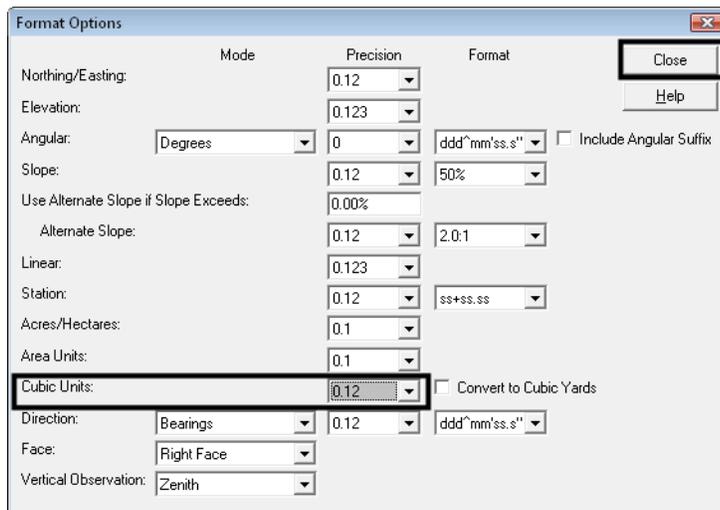
10. Select the *TriangleVolumes.xml* style sheet.



**Note:** The XML data is formatted using this report style sheet.

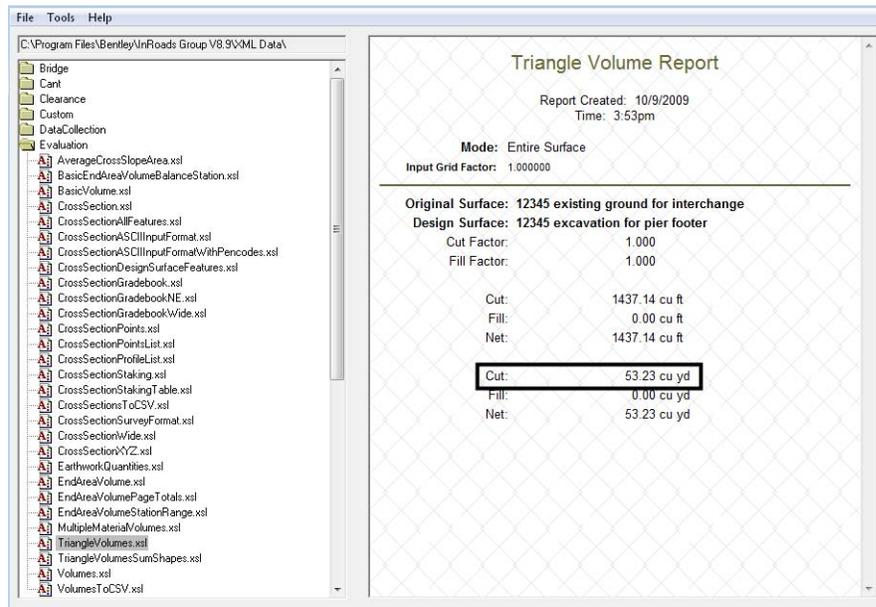
11. In the *Report Browser* window, select **Tools > Format Options**.

12. In the *Format Options* dialog box, set *Cubic Units* to **0.12** precision.



13. <D> Close.

**Note:** The report automatically updates with the new formatting.



14. Record your results:

Cut: \_\_\_\_\_ cu yd.

**Note:** Any fill that is listed should be negligible.

15. Right-click on the *Triangle Volumes.xml* style sheet and select *Set Default Triangle Volume*.

**Note:** The next time you run the *Triangle Volume* command, InRoads will automatically use this style sheet without you having to select it. You can always select another style sheet from the *Report Browser* to change the report formatting at any time.

16. Close the *Triangle Volume Report* by select the *X* in the upper right corner of the *Report Browser*.

17. In the *Triangle Volume* command, <D> Close.

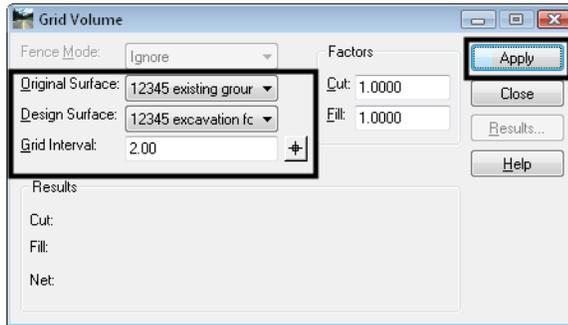
Next, you will check your triangle volumes by computing grid volumes.

18. Select **Evaluation > Volumes > Grid Volume**.

19. Set *Original Surface* to *12345 existing ground for interchange*.

20. Set *Design Surface* to *12345 excavation for pier footer*.

21. For **Grid Interval Key in 2.0**.



22. <D> **Apply**.

**Note:** For this command, the volume results appear in the dialog box instead of a report.

23. Record your results in the table below.

24. For **Grid Interval Key in 1.0**.

25. <D> **Apply**.

26. Record your results in the table below.

27. For **Grid Interval Key in 0.5**.

28. <D> **Apply**.

29. Record your results in the table below.

	Interval = 2.0	Interval = 1.0	Interval = 0.5
<b>Cut Volume</b>	cu yd.	cu yd.	cu yd.

**Note:** As you decrease the size of the grid interval, your grid volume should approach the triangle volume results with increased accuracy. If your **0.5** grid interval volume does not compare favorably to your triangle volume, see your instructor.

30. <D> **Close** on the **Grid Volume** dialog box.

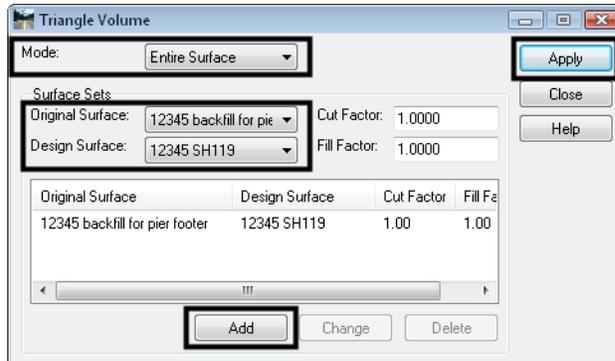
### Lab 8.3 - Compute the Pier Backfill Volume

In this section, you will use the same volume commands to compute your backfill quantities.

1. Select **Evaluation > Volumes > Triangle Volume**.
2. Set **Mode** to **Entire Surface**.
3. Set **Original Surface** to **12345 backfill for pier footer**.
4. Set **Design Surface** to **12345 SH119**.

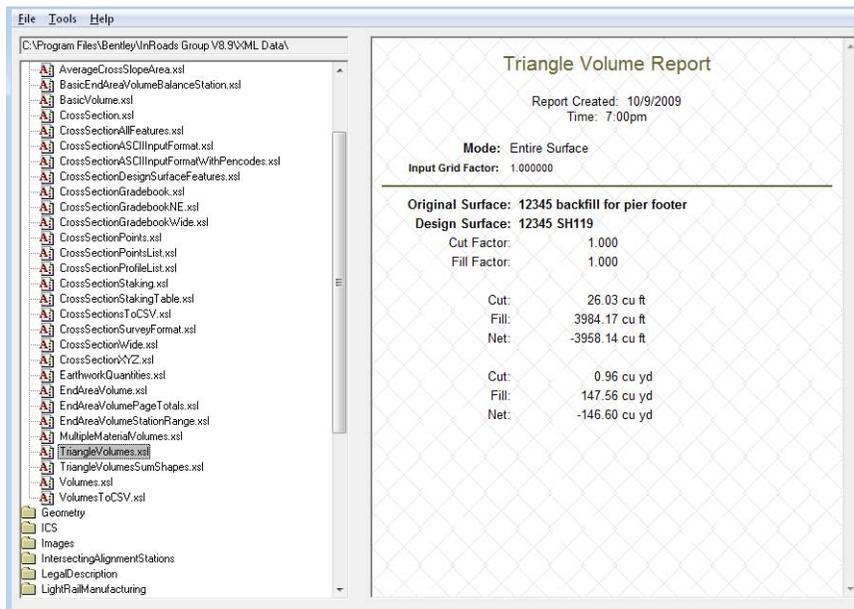
**Note:** The backfill surface is set as the *original surface* in order for the results to display as a “fill” volume.

5. <D> Add.



6. <D> Apply.

**Note:** Since you previously selected a default style sheet for this command, you do not get the warning message and the report is automatically generated using the *TriangleVolumes.xml* style sheet.



7. Record your results:

Fill: \_\_\_\_\_ cu yd.

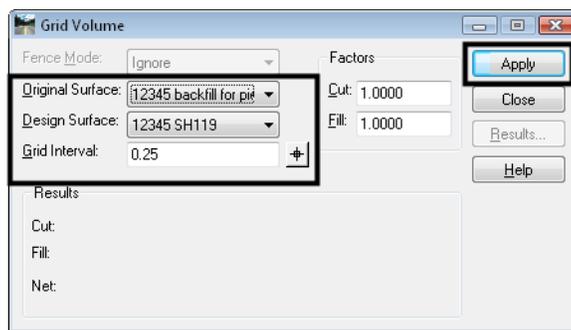
8. Close the *Triangle Volume Report* by select the **X** in the upper right corner of the *Report Browser*.

9. In the *Triangle Volume* dialog box, <D> Close.

Next, you will check your triangle volumes by computing grid volumes.

10. Select **Evaluation > Volumes > Grid Volume**.
11. Set **Original Surface** to *12345 backfill for pier footer*.
12. Set **Design Surface** to *12345 SH119*.
13. For **Grid Interval** key in *0.25*.

**Note:** An acceptable grid interval depends on the size of your surfaces, the variation and relief in your surfaces, whether or not your surfaces were surveyed, how they were surveyed, etc. You may need to try a few grid intervals based on these variables before converging on a good net number. For our two surfaces, an interval of *0.25* should provide accurate results.



14. <D> **Apply**.
15. Record your results:  
Fill: \_\_\_\_\_ cu yd.

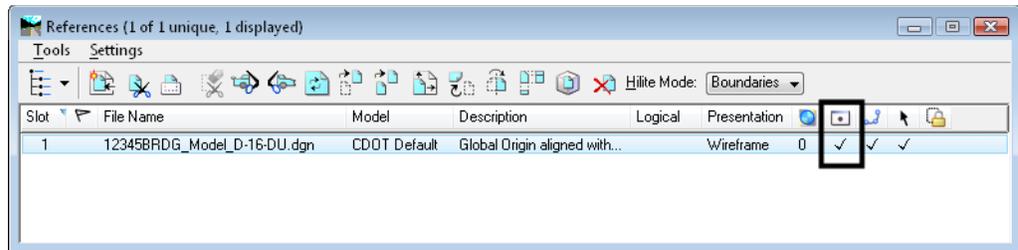
**Note:** Your grid volume results should compare favorably to your triangle volume results. If not, see your instructor.

## Lab 8.4 - Compute End Area Volumes

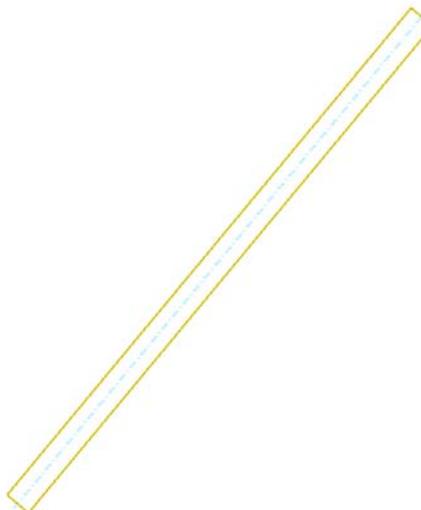
You may also want to use the **End Area Volumes** command as another check of your triangle volumes or if your contractor requires end area volumes for his work. The **End Area** method requires that you have a set of cross sections cut showing the surfaces from which you want to compute volumes. The volumes are calculated from the cross section graphics instead of comparing DTM data, as with the **Triangle** and **Grid** methods.

In this section you will compute the end area volume for your pier footer backfill. In order to do so, you must first cut a set of cross sections along the pier. You can either cut cross sections on a graphic or an alignment, so you will copy the pier centerline element from the reference file into the active bridge model file.

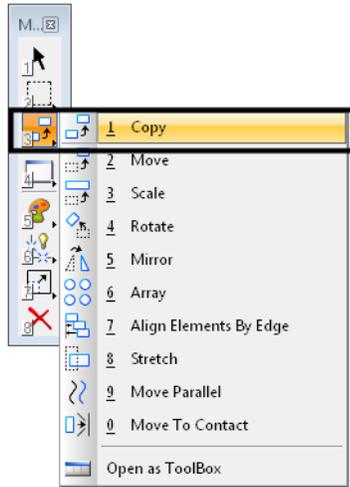
1. If your reference file is not turned on, select **File > Reference** and toggle on the display of the *12345BRDG\_Model\_D-16-DU* file.



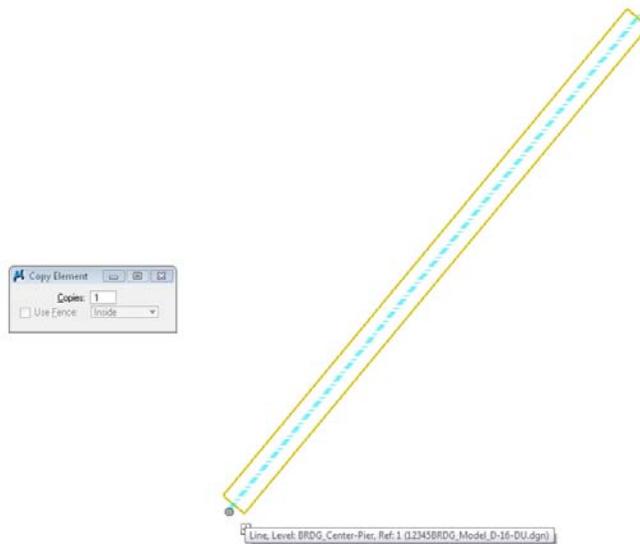
2. Window in on the pier centerline.



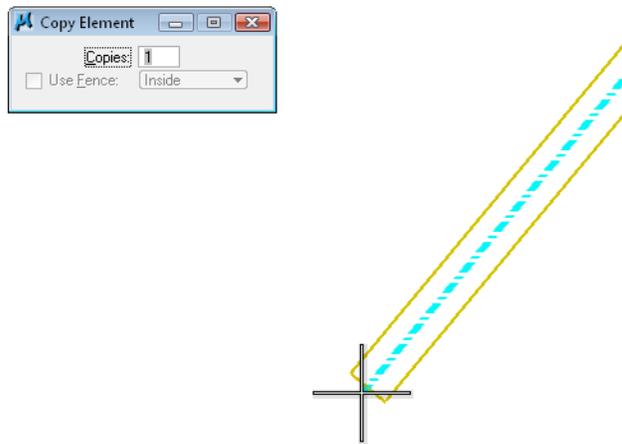
3. Select MicroStation's **Copy** command.



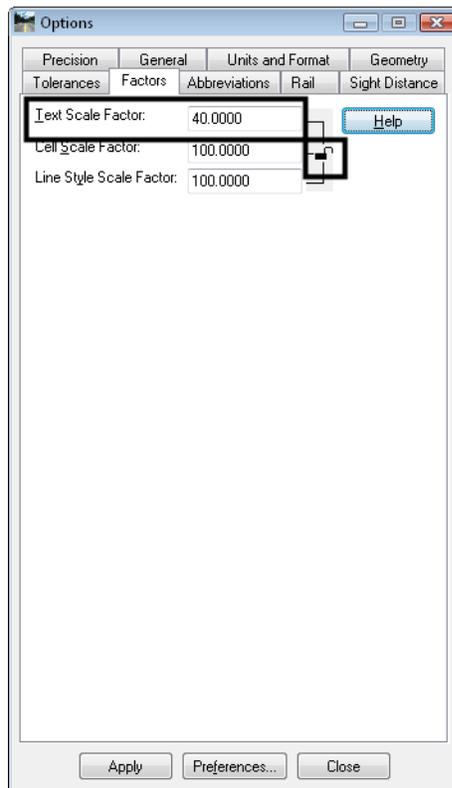
4. Snap to the end of the line to identify it to copy.



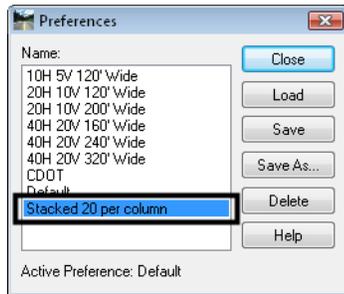
5. Snap to the same end to copy it to the active file in the exact same location.



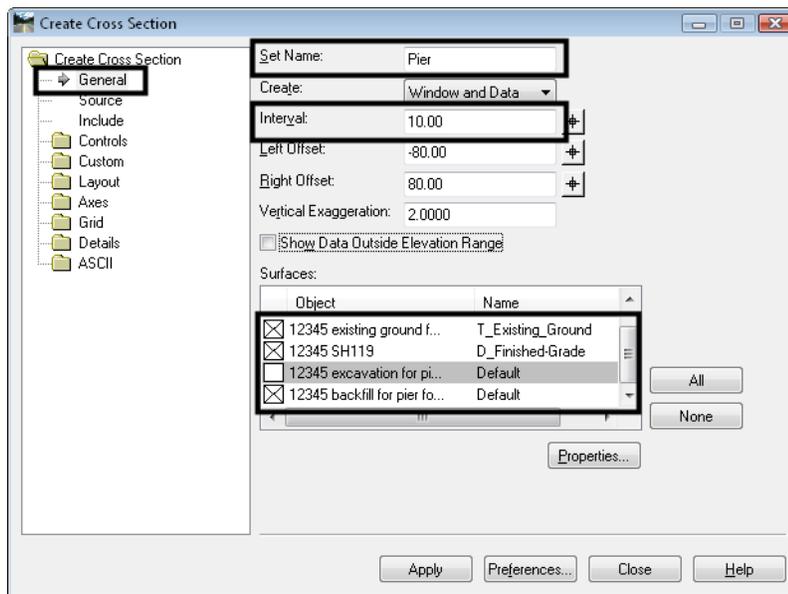
6. Turn off the display of the reference file.
  - Note:** Only the pier centerline element is now shown in the view.
7. Before cutting cross sections, set the text scale factor to be used for the cross section text. Select **Tools > Options**.
8. Select the **Factors** tab.
9. Unlock the three factors and for **Text Scale Factor** key in **40**.



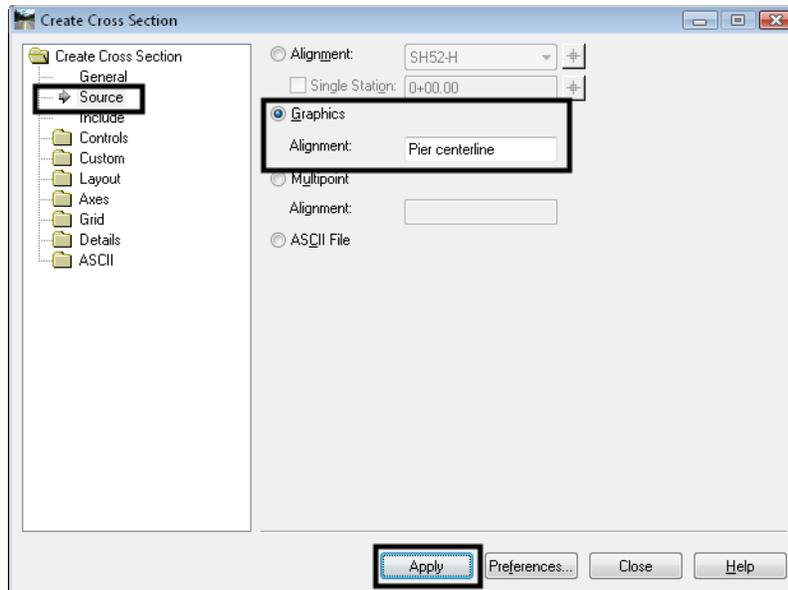
10. <D> **Apply**, then <D> **Close**.
11. Select **Evaluation > Cross Section > Create Cross Section**.
12. Select **Preferences** and select the **Stacked 20 per column** preference.



13. <D> **Load**, then <D> **Close**.
14. On the **General** branch, toggle off the **12345 excavation for pier footer** and **Default** surfaces. Make sure all other surfaces are toggled on.
15. For **Set Name**, key in **Pier**.
16. For **Interval**, key in **10**.

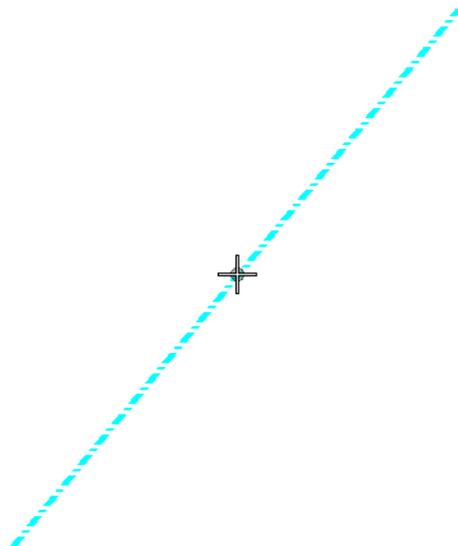


17. On the *Source* branch, toggle on *Graphics* and in the *Alignment* field, key in *Pier centerline*.



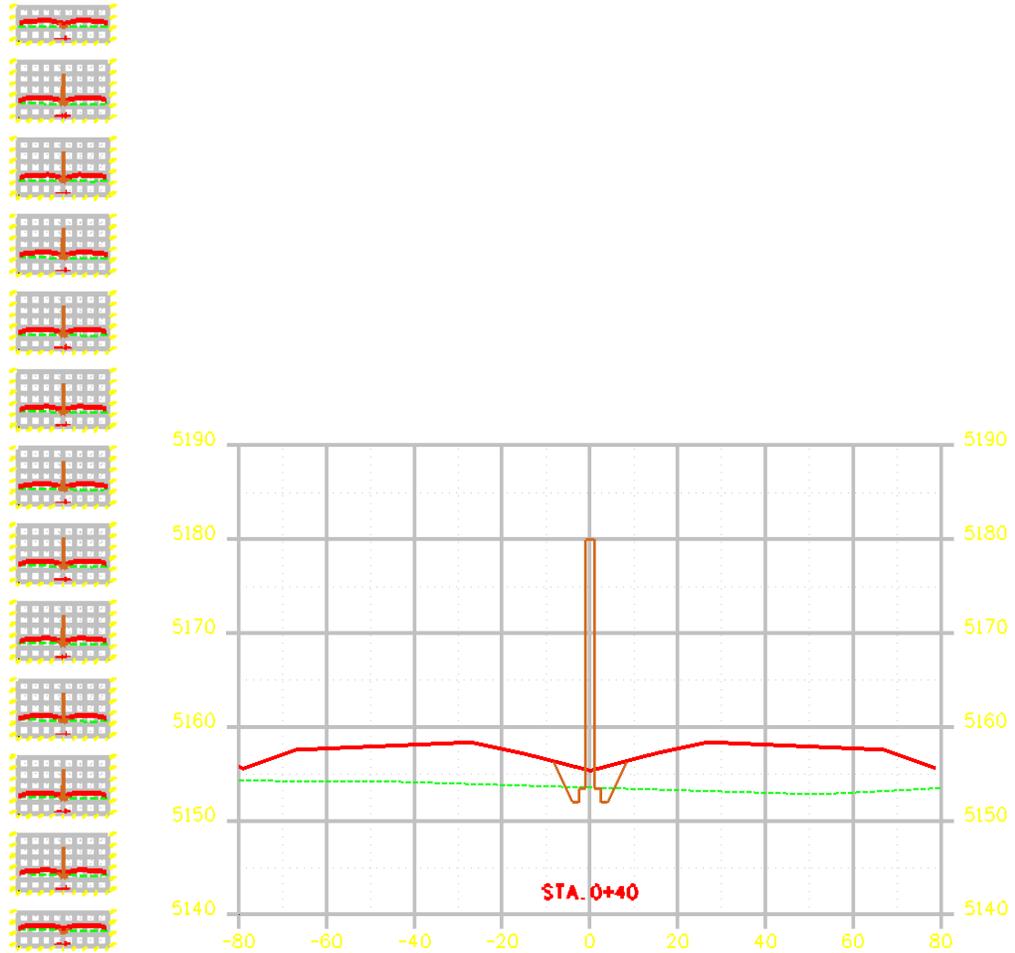
**Note:** The *End Area Volume* command requires an alignment in order to compute volumes. Specifying a name here will automatically create an alignment along the pier centerline element.

18. <D> **Apply**.
19. <D> the pier centerline.



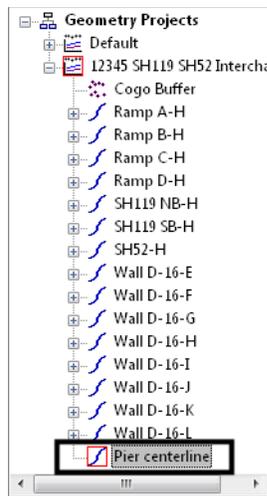
20. <D> to Accept.
21. <D> in a clear area for the lower left corner of the cross section set.

22. Window in on one of the cross sections to see the three surfaces.



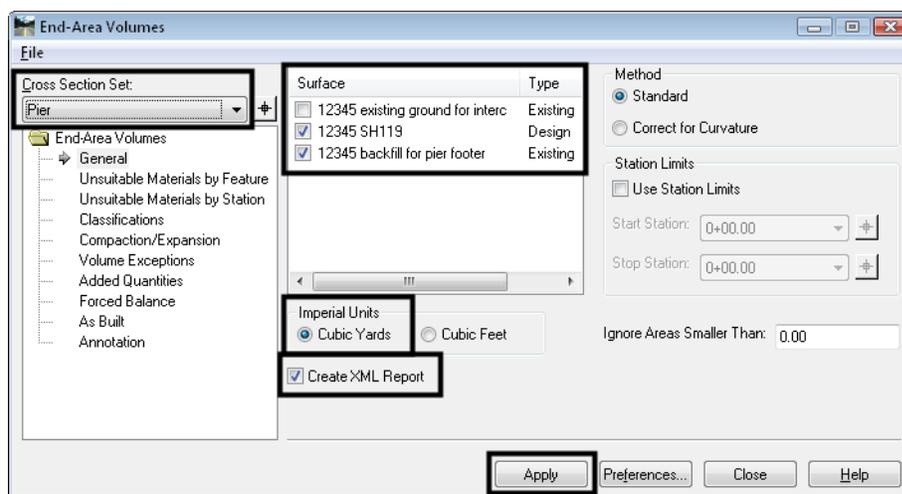
**Note:** Since you added the pier features to the backfill surface in the last lab, the pier and footer will be excluded from the backfill quantities, but the area of the pier that falls above the SH119 surface will be shown as cut and should be ignored.

23. Select the *InRoads Explorer Geometry* tab and note that you now have an active *Pier centerline* alignment created by the *Cross Section* command.



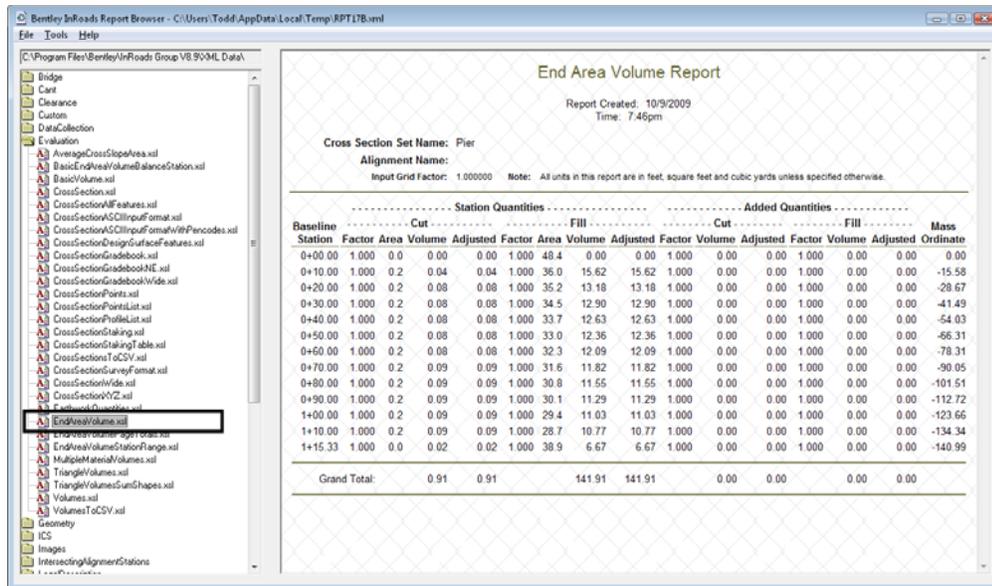
You're now ready to compute the end area volumes from the cross section graphics and new pier centerline alignment.

24. Select **Evaluation > Volumes > End Area Volumes**.
25. On the *General* branch, toggle off the *12345 existing ground for interchange surface* and make sure the *12345 SH119* and *12345 backfill for pier footer surfaces* are toggled on.
26. Set *Cross Section Set* to *Pier*.
27. Set *Imperial Units* to *Cubic Yards*.
28. Toggle on *Create XML Report*.



29. <D> Apply.
30. If you receive the *Report Browser* warning message, select **OK** since the *End Area Volume* command does not yet have a default style sheet set.

31. In the **Report Browser**, select the **EndAreaVolume.xml** style sheet under the **Evaluation** folder to format the report.



**Note:** If your report lists cubic feet, select **Tools > Format** options and toggle on **Convert to Cubic Yards**.

32. Read your fill volume from the Grand Total line of the report and record your results:

Fill: \_\_\_\_\_ cu yd.

**Note:** The **End Area Volume** results should compare favorably to your **Triangle Volume** results for backfill (within a few cubic yards). If not, see your instructor.

33. Close the **End Area Volume** report (click the **X** in the upper right corner).  
 34. <D> Close on the **End Area Volume** dialog box.

### Chapter Summary:

- **Triangle** volumes provide accurate cut and fill quantities.
- The **Triangle Volumes** command compares surfaces to compute volumes.
- The **Grid** method is useful to check triangle volumes.
- The accuracy of the **Grid Volumes** is controlled by the grid interval.
- Many factors affect the selection of an appropriate grid interval. Select an interval that converges on a net number favorable to the triangle results.
- The smaller the grid interval, the more accurate the grid volumes.
- **End Area Volumes** are computed from cross section graphics instead of comparing DTMs.
- The **End Area Volume** results should compare favorably to the **Triangle** volume results.