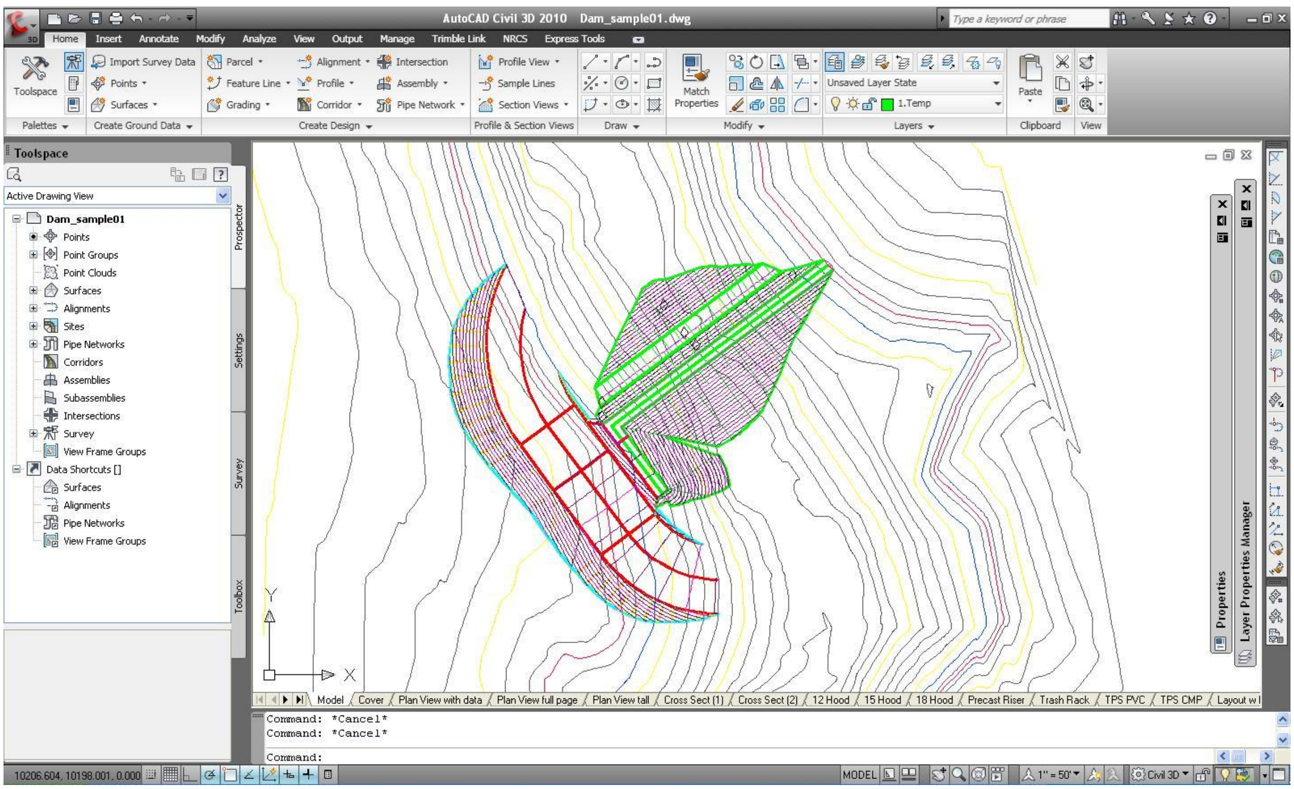
SOUTH DAKOTA NRCS CIVIL 3D 2010 DRAFTING NOTE

DAM – STAGE-STORAGE

DETERMINE THE STORAGE VOLUME OF THE POOL

In this example, the storage volume of the pool area upstream of a dam is evaluated and a report is created with the elevation, area, and volume of storage. The volume is calculated by two different methods, the end area method and the conic approximation method. The dam and auxiliary spillway were created using the drafting note titled, "Dam – Grading." Figure 1 shows the created surfaces from the previous drafting notes.

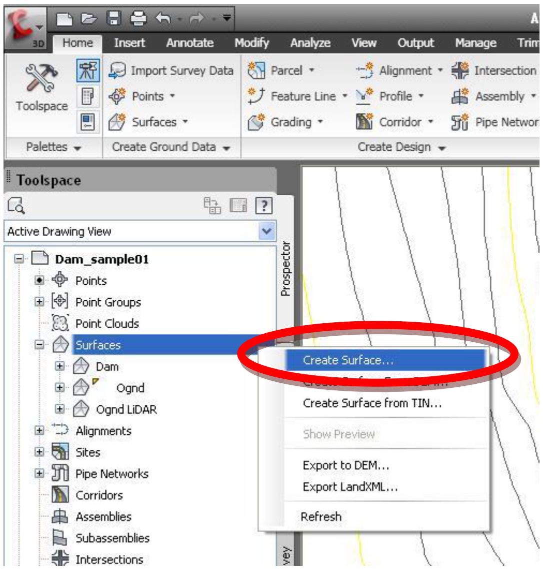
Figure 1: The original ground surface, Ognd and the embankment dam surface, Dam.



Create a Surface and Merge the Ognd Surface and Dam Surface

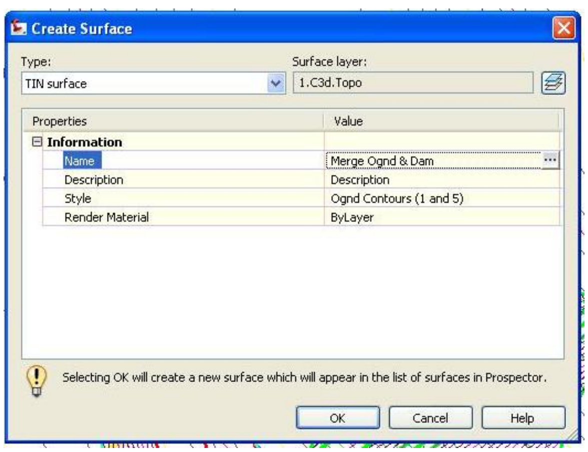
The first step is to create a new surface. The new surface will merge the Ognd surface or the original ground from the survey and the Dam surface, which is a previously created surface of the new dam. Right click on Surfaces in Toolspace and select Create Surface, as shown in Figure 2.

Figure 2: Create a new surface.



Change the name of the surface and select the style of the surface in the Create Surface window as shown in Figure 3.

Figure 3: The Create Surface window.



In Toolspace, under surfaces, expand the new surface, Merge Ognd & Dam. Expand Definition, right click on Edits, and select paste surface. Paste the Ognd surface and then the Dam surface. It is also helpful to set the surface styles of the existing layers to None so that the merged surface is the only one visible.

Figure 4: Paste Ognd and Dam surfaces to the Merge Ognd & Dam surface.

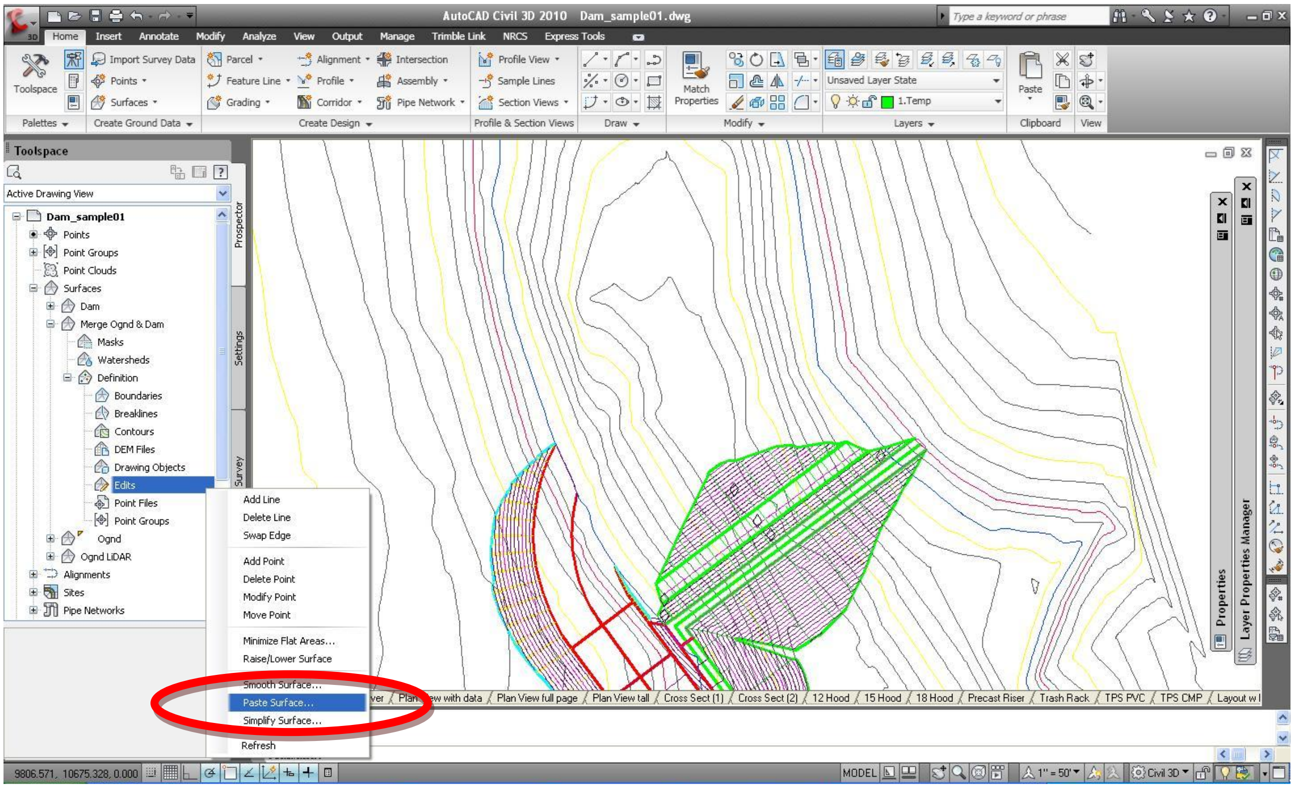
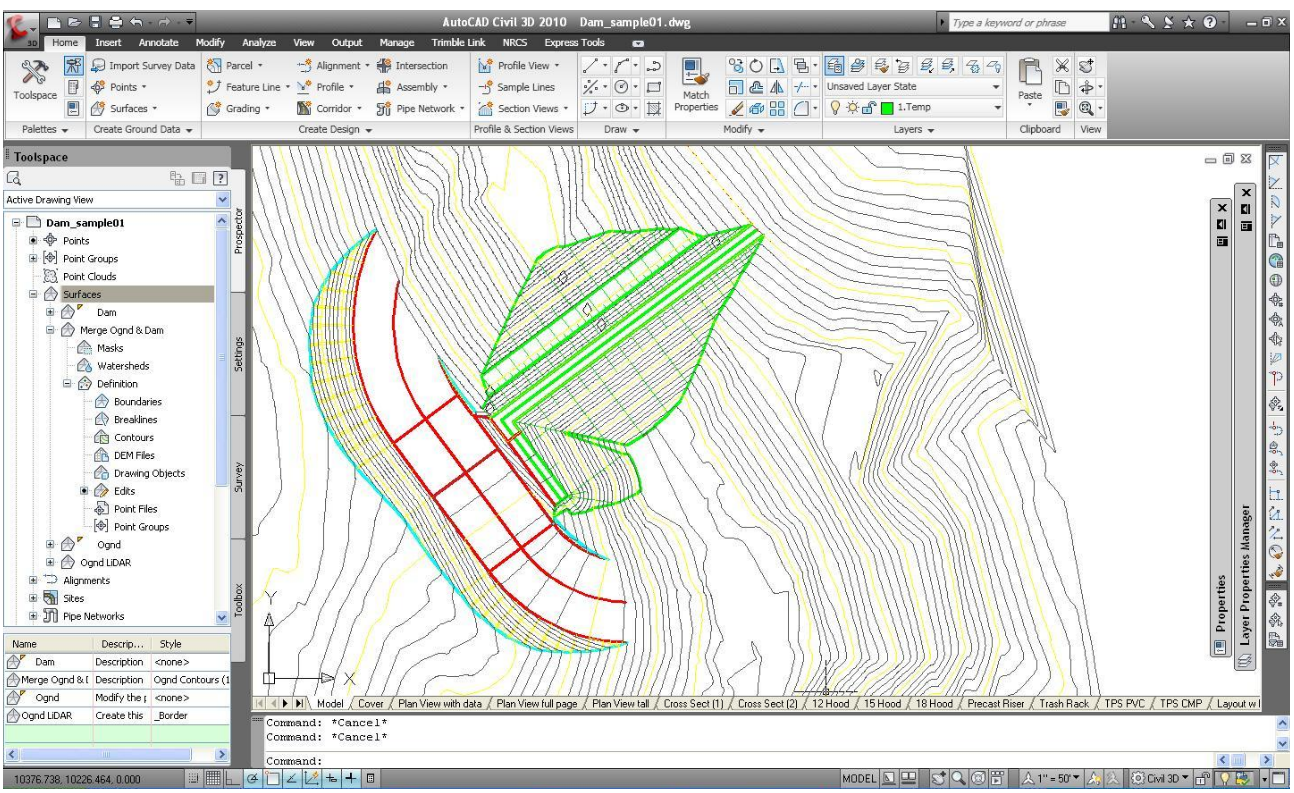


Figure 5: The merged surface Merge Ognd and Dam with the other surfaces turned off.



Extract Objects from the Merged Surface

The next step is to create polylines of the contour lines in the pool area. The polylines will be extracted from the Merge Ognd & Dam surface. To extract the polylines, go to the Modify Ribbon and select Surface under the Ground Data panel and this will display the Surface ribbon. On the Surface ribbon, select extract objects. This will bring up the Select Objects from Surface window as shown in Figure 8. In this example, select from drawing the major and minor contour lines in the pool area. When you click on the green boxes on the right, this will allow one to select the contour lines. The contour lines range from elevation 1725 feet to 1742 feet. The contour lines selected will now be polylines and will have an area associated with them.

Figure 6: The Modify ribbon.

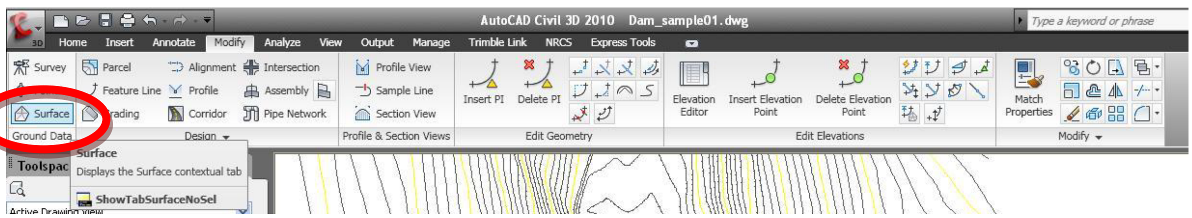


Figure 7: Extract objects icon on the Surface Ribbon.

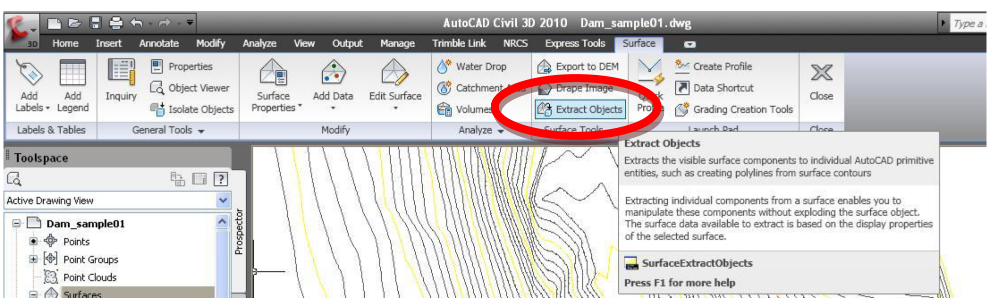
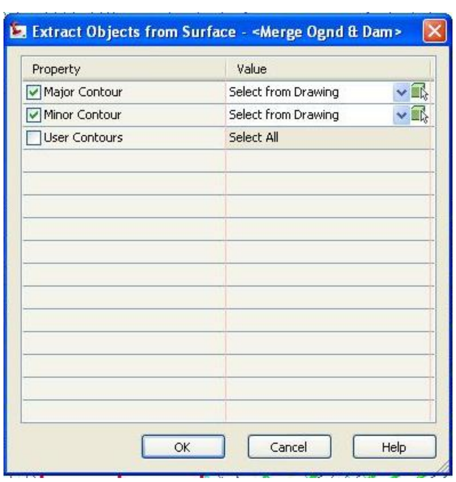


Figure 8: Extract objects from Surface



Stage Storage Extension

The stage storage extension is used to create a report with the elevations, areas and volumes for the pool. On the Toolbox tab in Toolspace, expand the Stage Storage Extension and right click on Stage Storage. This will open the window in Figure 10.

Figure 9: Stage Storage Extension in the Toolbox in the Toolspace.

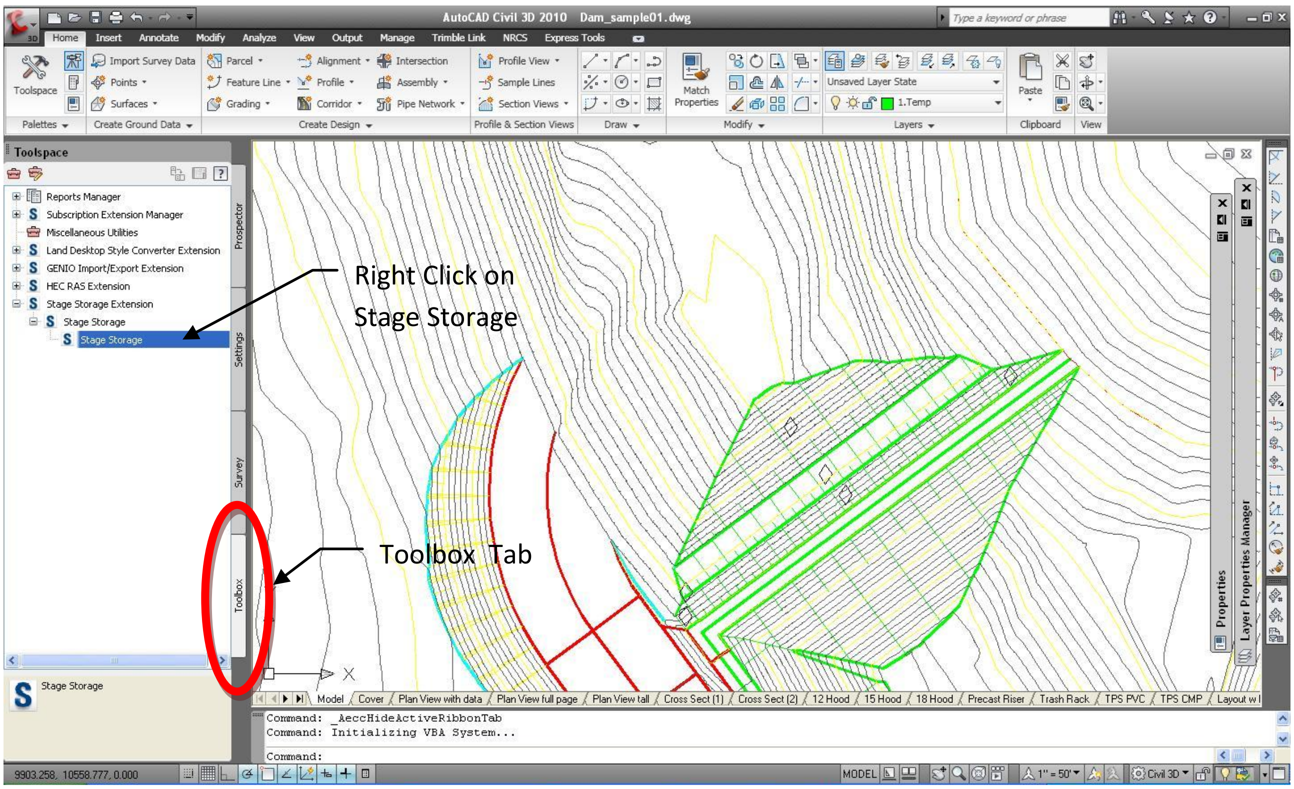
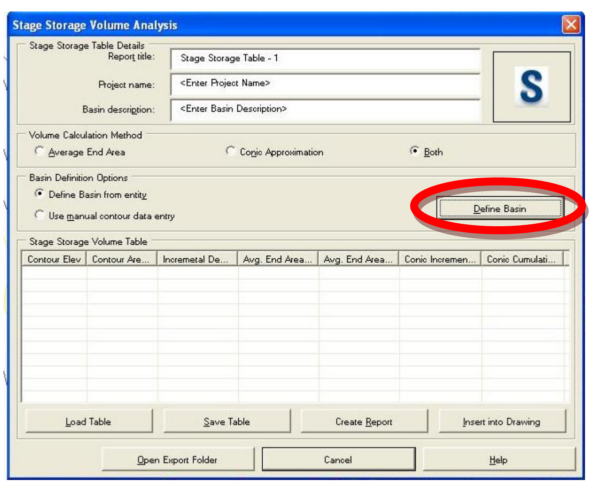


Figure 10: The stage storage Volume Analysis window.



On the Stage Storage Volume Analysis window, Figure 10, click Define Basin. This will open another window, Define Basin from Entities, shown in Figure 11. Since the polylines are already created, select Define Basin from Polylines and select Define. Now select the polyline contour lines for the pool.

Figure 11: The define basin window.

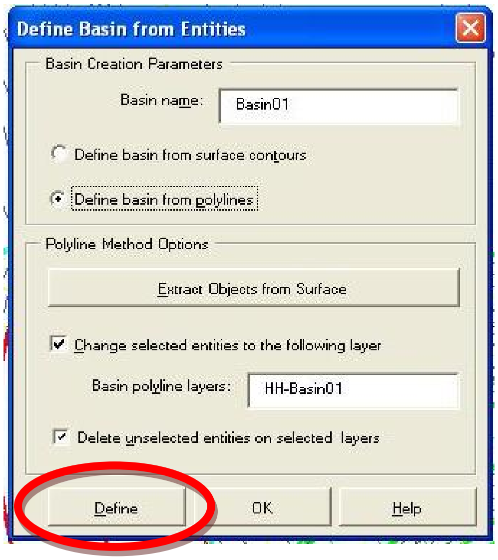
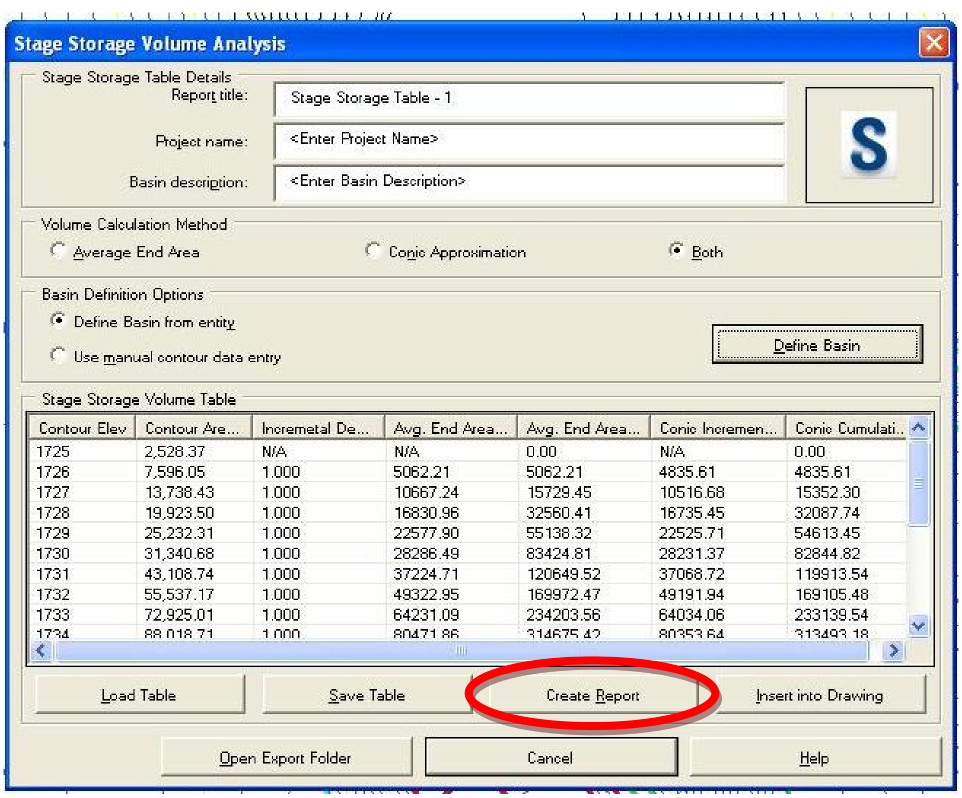
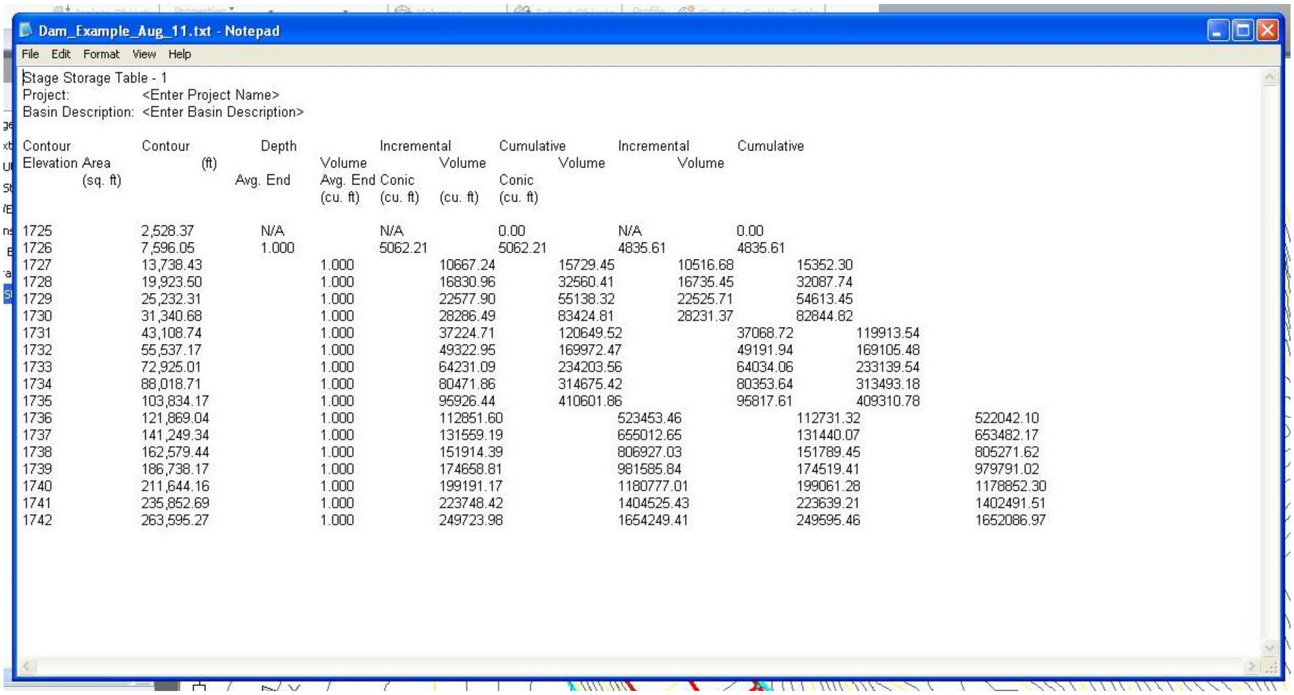


Figure 12: The Stage Storage Volume Analysis after the volumes are determined.



A report is created that includes all the data from the Stage Storage Volume Table in Figure 12 by clicking on Create Report. The report is a .txt text file, which can be used in Excel.

Figure 13: The .txt file for the stage storage.



Dam_Example_Aug_11.txt - Notepad

Stage Storage Table - 1
Project: <Enter Project Name>
Basin Description: <Enter Basin Description>

Contour Elevation	Contour Area (sq. ft)	Depth (ft)	Incremental Volume Avg. End (cu. ft)	Cumulative Volume Avg. End (cu. ft)	Incremental Volume Conic (cu. ft)	Cumulative Volume Conic (cu. ft)
1725	2,528.37	N/A	N/A	0.00	N/A	0.00
1726	7,596.05	1.000	5062.21	5062.21	4835.61	4835.61
1727	13,738.43	1.000	10667.24	15729.45	10516.68	15352.30
1728	19,923.50	1.000	16830.96	32560.41	16735.45	32087.74
1729	25,232.31	1.000	22577.90	55138.32	22525.71	54613.45
1730	31,340.68	1.000	28286.49	83424.81	28231.37	82844.82
1731	43,108.74	1.000	37224.71	120649.52	37068.72	119913.54
1732	55,537.17	1.000	49322.95	169972.47	49191.94	169105.48
1733	72,925.01	1.000	64231.09	234203.56	64034.06	233139.54
1734	88,018.71	1.000	80471.86	314675.42	80353.64	313493.18
1735	103,834.17	1.000	95926.44	410601.86	95817.61	409310.78
1736	121,869.04	1.000	112851.60	523453.46	112731.32	522042.10
1737	141,249.34	1.000	131559.19	655012.65	131440.07	653482.17
1738	162,579.44	1.000	151914.39	806927.03	151789.45	805271.62
1739	186,738.17	1.000	174658.81	981585.84	174519.41	979791.02
1740	211,644.16	1.000	199191.17	1180777.01	199061.28	1178852.30
1741	235,852.69	1.000	223748.42	1404525.43	223639.21	1402491.51
1742	263,595.27	1.000	249723.98	1654249.41	249595.46	1652086.97

Average End Area Method and Conic Approximation Method

The Average End Area method calculates the volume between two cross sections; the cross-sectional areas are averaged and multiplied by the distance between cross sections to determine the volume. The Average End Area method is expressed by the following equation:

$$V = \left(\frac{A_1 + A_2}{2}\right) L$$

where V is the volume, calculated from the two end areas A1 and A2, and the distance L between the two areas.

The Conic Approximation method calculates the volume between two sectional areas; the two areas being added along with the square root of their product and multiplied by a third of distance between the areas to determine the volume. The Conic Approximation method is expressed by the following equation:

$$V = \left(\frac{h}{3}\right)(A_1 + A_2 + \sqrt{A_1 A_2})$$

where V is the volume, calculated from the two areas A1 and A2, and the distance h between the two areas.