

# The CEDRA Corporation's COMMAND OF THE MONTH

A monthly information bulletin

July 2012

FEATURED COMMAND  
Well Pad Elevation  
Determination



## Application Description

A while ago an application was described to us that caught our interest. The application involved computing an elevation value for a well pad such that the cut and fill volumes for the earthwork were balanced.

A well pad is an area of constant elevation and known size. The well pad area does not have to be square or rectangular but rather could be an irregular shaped polygon. To tie the well pad to the existing ground surface, sides slopes of fixed slope are used. Depending upon the soil conditions different slopes are used.

Using this information, the designer's task is to determine an elevation value for the well pad such that the cut and fill earthwork volumes are within a desired tolerance. So that, the process is to guess an initial elevation value, compute the earthwork volumes, see if they are equal, if not try another elevation value.

It doesn't take much to see that this is a highly computational process and one that is ideally suited for some sort of an automated process.

## The CEDRA Solution

To handle this application, the [Set Pad Elevation] command located within the CEDRA-AVland-CrossSections Toolbar, see Figure 1 was developed. In addition to this new command other modifications were incorporated to accommodate the application. The first of

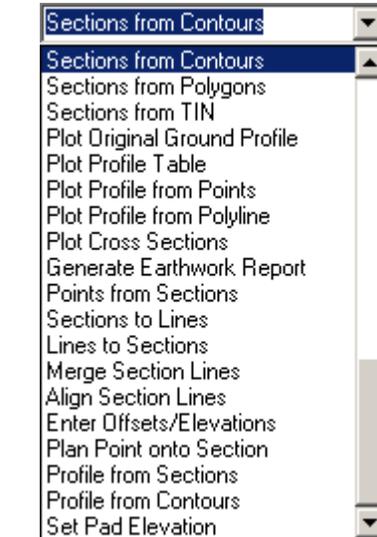


Figure 1  
CEDRA-AVland-CrossSections  
Toolbar

these modifications was the addition of the [Polygons from Slope Lines] command located within the CEDRA-AVland-ContouringMenus toolbar, see Figure 2.

### Command Of The Month bulletin

*This month's issue discusses how to determine the elevation of a well pad such that the cut and fill earthwork volumes are identical.*

Additionally, the Create 3D Triangle and Intersect Line w/ 3D Polygons tools were added to the CEDRA-AVland-Contouring Tools toolbar. These are the left-most and right-most tools in the toolbar respectively, see Figure 3.

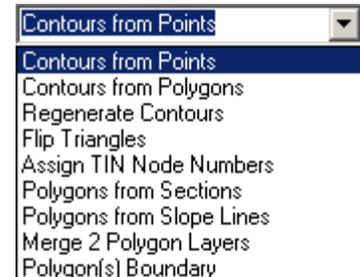


Figure 2  
CEDRA-AVland-ContouringMenus  
Toolbar

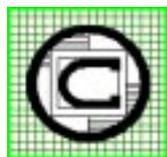


Figure 3  
CEDRA-AVland-ContouringTools  
Toolbar

## Set Pad Elevation Overview

The premise behind the [Set Pad Elevation] command is that the user first develops a series of triangles denoting the well pad footprint. The Create 3D Triangle tool can be used to accomplish this task. The triangles created by this tool are stored as polygon features.

Once this is complete, the user defines a series of lines of fixed slope and length that emanate from user-specified vertices of the well pad surface towards the existing ground surface, see Figure 4. These lines are referred to as slope lines and indicate the desired slope at a point along the well pad perimeter. There is no limit to the number of slope lines that can be created. The Intersect Line w/ 3D Polygons tool can be used to create the slope lines.



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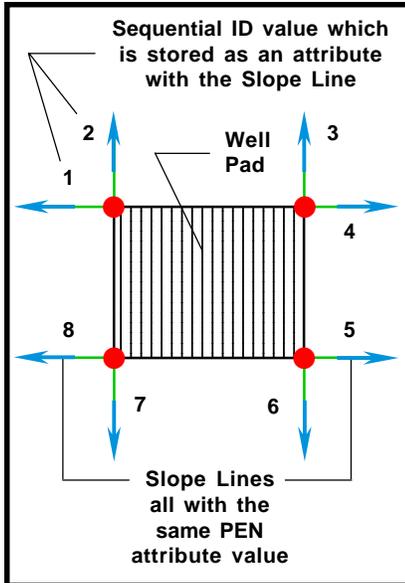


Figure 4  
Well Pad Layout and associated  
Slope Lines

When processing the slope lines, in order to properly create triangles around the perimeter of the well pad, an attribute value is used to control the sequence of the slope lines. As such, the slope lines do not need to be created in sequence but a value must be assigned to a slope line indicating the sequence of the slope line (1, 2, 3, 4, etc.), see Figure 4.

In addition to the sequential value, the user also assigns a PEN attribute value. This value is used to associate the slope line with a well pad. In so doing, the user is able to have multiple well pads with the slope lines of each well pad assigned a different PEN attribute value.

To execute the [Set Pad Elevation] command, the user must have: (a) an existing ground 3D polygon layer, (b) a well pad 3D polygon layer and (c) a slope line layer. Upon activation of the command, a multi-input dialog box will be presented from which the user specifies the pertinent information.

If the OK button is selected, the command begins an iterative process of changing the well pad elevation, developing new polygons around the perimeter of the well pad, computing cut and

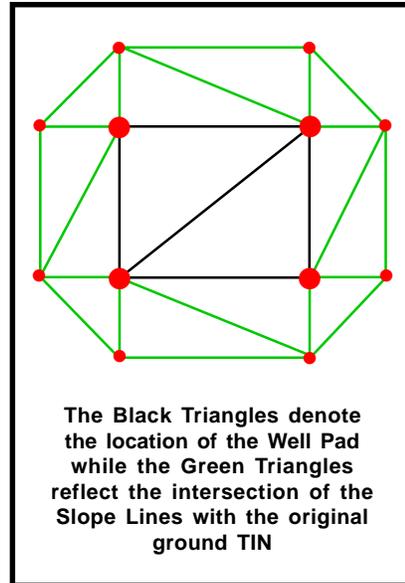


Figure 5  
Polygons created using  
Polygons from Slope Lines

fill volumes and determining if the cut and fill volumes are within a user-specified tolerance.

Once the cut and fill volumes are within the tolerance or the maximum number of trials has been exceeded, the process terminates.

Shown in Figure 5 are two triangles in the center of the figure denoting the location and size of a sample well pad area. In this example, the well pad is rectangular although this does not have to be the case.

The green triangles around the perimeter of the well pad indicate the intersection of the well pad side slopes with the original ground surface. The slope lines shown in Figure 4 are used to compute the intersections with the original ground surface.

As the well pad elevation is altered, new intersections with the original ground surface are computed using the same side slopes as when the process was initially begun. That is to say, the slope of the slope line is maintained throughout the process.

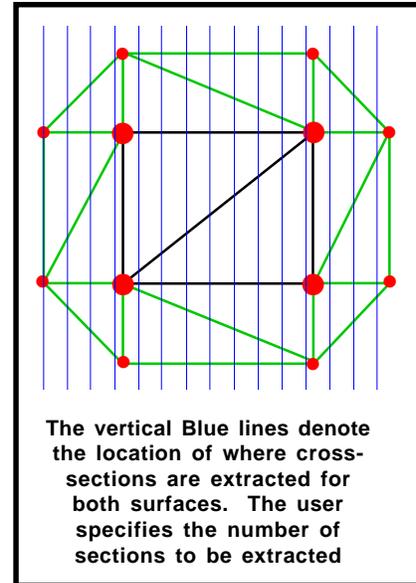


Figure 6  
Extraction of Cross-Sections for  
determining Cut/Fill Volumes

After all of the slope lines have been processed and the new side slope triangles created, the command extracts a series of cross-sections for the original ground surface and the well pad surface, see Figure 6. These cross-sections are used to determine the cut and fill earthwork volumes.

The number of cross-sections that are extracted is specified by the user. It is reasonable to conclude that the larger the number of cross-sections specified by the user, the more accurate the volumes will be since the spacing between the cross-sections is smaller.

However, there is a point of diminishing return where too large a number of cross-sections does not result in that much more of an accurate volume calculation.

After the cross-sections have been extracted, the command determines the cut and fill volumes. Based upon the difference between the values, the command will either raise or lower the well pad elevation.

The above process repeats until the cut and fill volumes are within a user-specified tolerance.

## Create 3D Triangle Operation

The first step in the process is the establishment of the well pad triangles. The Create 3D Triangle tool can be used to perform this task. The polygons which are created by this command have a Z value assigned to their vertices. That is to say, the tool creates PolygonZ features. Additionally, the polygons are stored in the current active layer. As such, if an existing layer is to be used for storing the polygons, this layer must be able to accommodate PolygonZ features.

To create a 3D triangle, which is stored as a polygon feature, the following steps can be performed

- **1** Scroll down in the **CEDRA commands** menu combo box, and **select** the [Set Working Directory] command. **Navigate** to the folder where any new data is to be stored and then **click** the **OK** button.
- **2** Scroll down in the **CEDRA commands** menu combo box, and **select** the [Set Active Layer] command. If the polygons to be created are to be stored in an existing layer, **select** the Picking Existing Layer option, followed by clicking the **OK** button. **Select** the layer from the list, then **click** the **OK** button.

If a new layer is to be created, **select** the Entering New Layer Name option, followed by **clicking** the **OK** button. **Enter** the desired new layer name, then **click** the **OK** button.

- **3** **Click** on the Create 3D Triangle,  tool to activate the tool.
- **4** **Make** a single-click in the map area to denote the first point comprising the triangle.
- **5** **Make** a single-click in the map area to denote the second point comprising the triangle.

- **6** **Make** a double-click in the map area to denote the last point comprising the triangle.

The tool will then create a PolygonZ feature and store the polygon in the current active layer. The command remains active so that Steps 4 through 6 can be repeated for each triangle that is to comprise the well pad triangles.

If the polygons are to be stored in a new layer, the reader is referred to **Note i**, which appears at the end of this publication.

## Intersect Line w/ 3D Polygons Operation

Having created the well pad triangles, the user is now able to establish the slope lines. A slope line must have its start point match a vertex of a well pad triangle and its orientation or direction must point outwards from the well pad surface towards the original ground surface.

In defining a slope line, the user will specify a direction and a distance. The direction can be explicitly entered as a Cartesian direction (a value between 0 and 360 with positive being counter-clockwise from the x axis), or the direction can be defined by making two picks in the map area.

The slope line buffer distance represents the maximum distance from the well pad footprint that is allowable. This value is entered in Display Units.

To use this command, the user must activate in the Table of Contents the original ground surface layer. This must be a 3D polygon layer (a layer that contains PolygonZ features). If a PolygonZ layer is not active or if more than 1 layer is active, an appropriate warning message will be displayed.

To create a slope line, which is stored in the current active layer, the following steps can be performed



Figure 7  
3D Polygon Layer not Active  
Warning Message

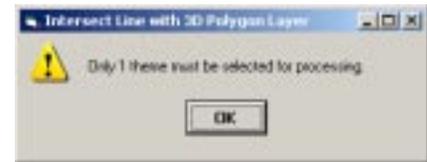


Figure 8  
More than 1 Layer Active  
Warning Message

- **1** Scroll down in the **Table of Contents** area, and **select** the layer that contains the PolygonZ features to be processed. This layer represents the original ground surface.
- **2** **Click** on the Intersect Line w/ 3D Polygons, , tool to activate the tool.
- **3** **Make** a pick in the map area on top of a vertex of a well pad triangle to denote the start point of the slope line. If a 3D polygon layer is not active or if more than 1 layer is active, an appropriate warning message will be displayed, see Figures 7 and 8.

Following the definition of the slope line start point, the multi-input dialog box shown in Figure 9 will appear.

- **4** **Enter** in the *Cartesian Direction*: data field the desired direction value,  
or  
**enter** the keyword **pi** to denote that the direction is to be specified by two picks in the map area.

If the **pi** keyword is specified, perform the following.

- **4a** **Click** at the **OK** button.

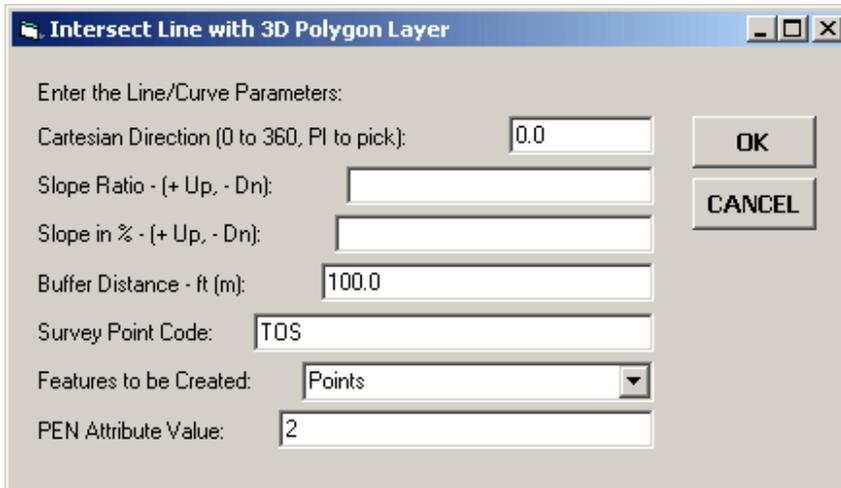


Figure 9  
Intersect Line w/ 3D Polygon Layer Dialog Box

- **4b** Make a pick in the map area to denote the start point of an implied direction.

- **4c** Make a pick in the map area to denote the end point of an implied direction.

The tool will then re-display the multi-input dialog box of Figure 9 displaying the computed direction as the default value.

- **5a** Enter in the Slope Ratio: data field the desired slope ratio. The slope ratio is comprised of two numbers separated by the : character. For example, 3:1 or 4:1.

- **5b** Enter in the Slope in %: data field the desired percent slope. This is a single nonzero value such as 2, 5, 10, 20, etc.

Note, the user should enter either the Slope Ratio or the Slope in %, not both.

- **6** Enter in the Buffer Distance: data field the maximum distance from the perimeter of the well pad that is allowable.

- **7** Enter in the Survey Point Code: data field the point code that should be stored with point features that are created. This value

is stored under the PTCODE attribute.

- **8** Scroll down in the *Features to be Created*: data field, and select the appropriate of the following options:

- **Points**, to indicate that a point feature is to be created.
- **Lines**, to indicate a line feature is to be created.

- **9** Enter in the *PEN Attribute Value*: data field the value that should be stored in the PEN attribute.

- **10** Click at the **OK** button to create the appropriate feature, or click at the **Cancel** button to abort the command.

If the tool is unable to compute an intersection with the original ground surface, the warning message shown in Figure 10 will be displayed.

Following the computation the tool re-displays the multi-input dialog box of Figure 9 using the previous values as the current default values. The user is then able to establish another slope line using the same start point.

If another start point is to be used, click the Cancel button and make a pick in the map area on top of the appropriate well pad triangle vertex.



Figure 10  
No Intersection Computed  
Warning Message

The current active layer is used to store the point or line feature. Additionally, both of these feature types will be assigned a Z value. That is to say, the tool creates PointZ and PolylineZ features. As such, these features can be displayed in the ArcScene program, if desired.

### Set Pad Elevation Operation

Once the well pad triangles and slope lines have been established, the user is at a point where the [Set Pad Elevation] command can be used.

- **1** Scroll down in the {CEDRA-AVland-CrossSections} menu combo box, and select the [Set Pad Elevation] command. At this point the multi-input dialog box shown in Figure 11 will be displayed.

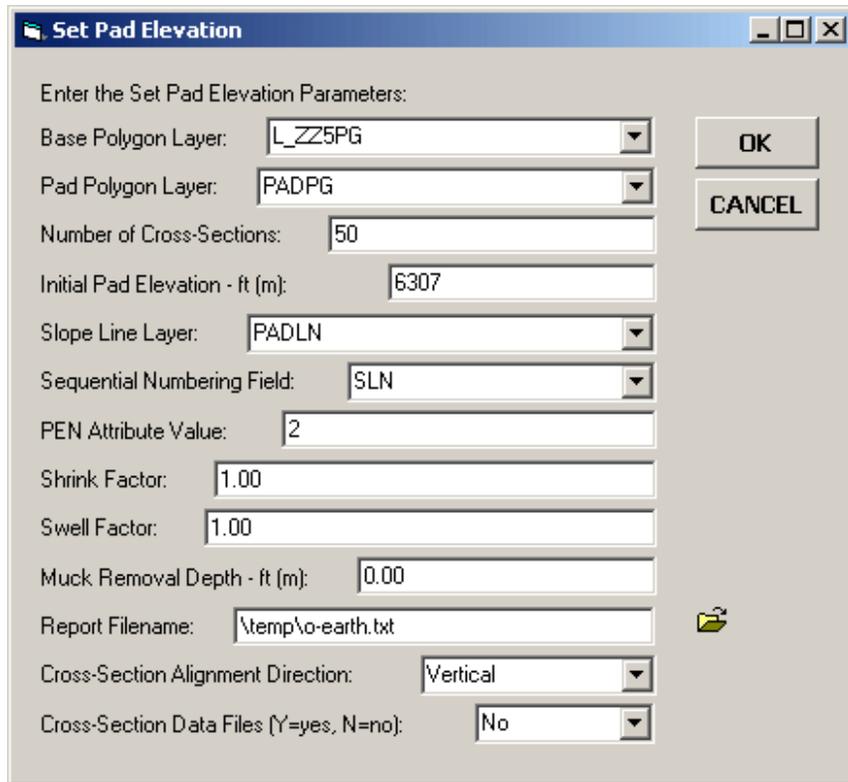
- **2** Scroll down in the *Base Polygon Layer*: data field, and select the layer that represents the original ground surface.

- **3** Scroll down in the *Pad Polygon Layer*: data field, and select the layer that represents the well pad layer.

- **4** Enter in the *Number of Cross-Sections*: data field the desired number of cross-sections to be extracted.

- **5** Enter in the *Initial Pad Elevation*: data field the current elevation assigned to the well pad triangles.

- **6** Scroll down in the *Slope Line Layer*: data field, and select the layer that contains the slope lines.



Enter the Set Pad Elevation Parameters:

Base Polygon Layer: L\_ZZ5PG

Pad Polygon Layer: PADPG

Number of Cross-Sections: 50

Initial Pad Elevation - ft (m): 6307

Slope Line Layer: PADLN

Sequential Numbering Field: SLN

PEN Attribute Value: 2

Shrink Factor: 1.00

Swell Factor: 1.00

Muck Removal Depth - ft (m): 0.00

Report Filename: \temp\o-earth.txt

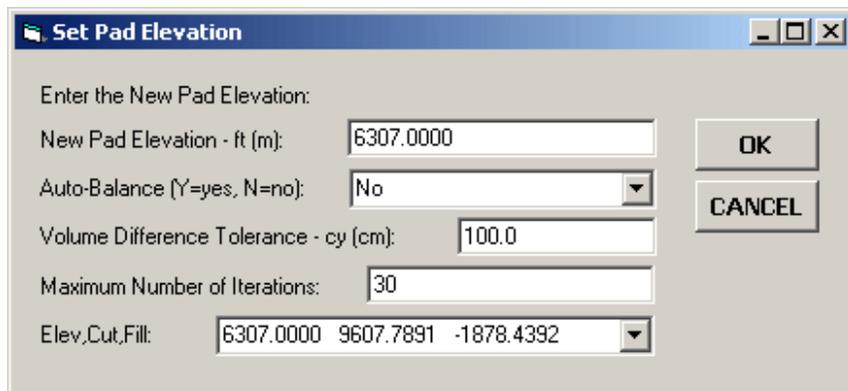
Cross-Section Alignment Direction: Vertical

Cross-Section Data Files (Y=yes, N=no): No

OK

CANCEL

Figure 11  
Set Pad Elevation Dialog Box



Enter the New Pad Elevation:

New Pad Elevation - ft (m): 6307.0000

Auto-Balance (Y=yes, N=no): No

Volume Difference Tolerance - cu (cm): 100.0

Maximum Number of Iterations: 30

Elev.,Cut,Fill: 6307.0000 9607.7891 -1878.4392

OK

CANCEL

Figure 12  
Cut/Fill Earthwork Volume Display Dialog Box

- **7** Scroll down in the *Sequential Numbering Field*: data field, and **select** the attribute that contains the sequential number values for the slope lines that are associated with the well pad.
- **8** Enter in the *PEN Attribute Value*: data field the value that is assigned to the slope lines which are associated with the well pad.
- **9** Enter in the *Shrink Factor*: data field a **multiplier** by which cut volumes are to be multiplied. This should be a value of less than or equal to 1.0.
- **10** Enter in the *Swell Factor*: data field a **multiplier** by which fill volumes are to be multiplied. This should be a value greater than or equal to 1.0.

- **11** Enter in the *Muck Removal Depth - ft (m)*: data field a **depth** in feet (meters) of unsuitable material to be removed from the original ground surface before the earthwork quantities are determined. This should not be a negative value.

- **12** Enter in the *Report Filename*: data field the name of the text file that will contain a formal report of the earthwork calculations. Alternatively, **click** on the folder icon on the right side of the parameter to display the traditional Windows file navigation dialog box where the filename can be entered or an existing file selected.

- **13** Scroll down in the *Cross-Section Alignment Direction*: data field, and **select** the appropriate of the following options:

- **Vertical**, to indicate cross-sections are to be extracted in a north-south direction.
- **Horizontal**, to indicate that the cross-sections are to be extracted in a east-west direction.

- **14** Scroll down in the *Cross-Section Data Files*: data field, and **select** the appropriate of the following options:

- **No**, to indicate cross-section data files are not to be created.
- **Yes**, to indicate that cross-section data files are to be created.

- **15** Click at the **OK** button to continue,  
or  
**click** at the **Cancel** button to abort the command.

Having clicked at the *OK* button, the command extracts cross-sections from the original ground and well pad layers to determine initial earthwork cut and fill volumes. These results are then presented in the multi-input dialog shown in Figure 12.



Figure 13  
Same Pad Elevation Specified  
Warning Message

Using this dialog box, the user specifies: (a) a new well pad elevation, (b) whether auto-balancing should be performed or not, (c) the volume tolerance value and (d) the maximum number of trials when auto-balancing is performed.

Since this is an iterative process, the last parameter in the dialog box is a drop-down list that will contain the elevation value and the associated cut and fill volumes for each specific elevation that is analyzed. This drop-down list is for view only purposes.

- **1** **Enter** in the *New Pad Elevation*: data field another elevation that should be used. If the user enters the same elevation value, the warning message shown in Figure 13 will be displayed.
- **2** **Scroll** down in the *Auto-Balance*: data field, and **select** the appropriate of the following options:
  - **No**, to indicate that the user will be entering different elevation values manually.
  - **Yes**, to indicate that the user wishes the command to begin a loop to determine the elevation value where the cut and fill volumes are within the specified volume tolerance.
- **3** **Enter** in the *Volume Difference Tolerance*: data field the desired value where the difference between the cut and fill values is considered acceptable.
- **4** **Enter** in the *Maximum Number of Iterations*: data field the maximum number of trials that should be performed.

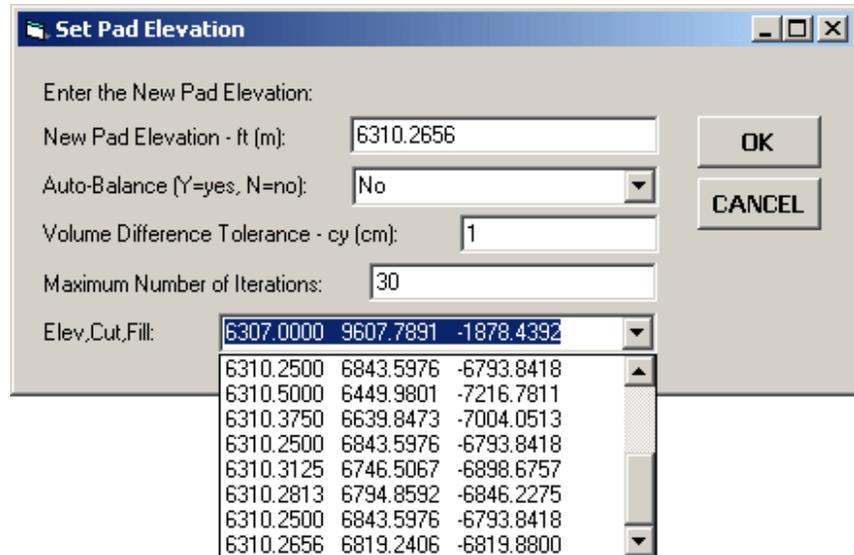


Figure 14  
History of Elevation, Cut and Fill Volume Values Display

- **5** **Click** at the **OK** button to continue,  
or  
**click** at the **Cancel** button to abort the command.

Having clicked at the *OK* button, the command: (a) adjusts the elevations of the well pad triangles, (b) deletes the triangles around the perimeter of the well pad footprint, (c) creates new ones using the new pad elevation along with the appropriate slope lines in the slope layer, (d) extracts new cross-sections and (e) computes new earthwork values.

If the auto-balance option is not active, the command re-displays the dialog box shown in Figure 12 with the exception that the drop-down list for the last parameter in the dialog box will contain the results for the specified elevation. The user can view the results in the drop-down list and then make a decision as to enter a new pad elevation or click the *Cancel* button to terminate the command.

If the auto-balance option is active, the command checks if the cut and fill volumes are within the user-specified volume tolerance. If not, the command determines another pad elevation and repeats the process. This continues until the cut and fill volumes are within the tolerance or the maximum number of

trials has been exceeded. Depending upon the number of cross-sections to be extracted and the size of the well pad surface, this can process can take some time.

Once the auto-balance operation is complete, the dialog box of Figure 12 is re-displayed. Shown in Figure 14 is a sample of what the drop-down list for the last parameter will contain. As can be seen, a list of all of the elevation values that were specified and the associated cut and fill volumes for the elevation value will appear in the drop-down list.

At this point, the user can enter another pad elevation or select the *Cancel* button to terminate the command.

Shown in Figure 15 is a sample earthwork report file that is created by this command. The values shown in bold are the values that are checked for equality.

Shown in Figure 16 is an ArcScene display of the original ground and well pad polygons. The polygons in the baby blue color are the original ground polygons while the other polygons are the well pad polygons. On the right side of the figure the fill area is quite apparent, while on the left the cut area is also noticeable.

SHRINKAGE FACTOR = 1.00		EXPANSION FACTOR = 1.00				TOP SOIL DEPTH = 0.00 FEET					
BASELINE STATION	CENTERLINE STATION	T. G. ELEVATION	SECTION CUT (SF)	SECTION AREA FILL (SF)	SECTION CUT (CY)	VOLUME FILL (CY)	CUMULATIVE CUT (CY)	VOLUME FILL (CY)	MASS HAUL (CY)	SURF AREA (SY)	VOLUME CUMULTV (CY)
0+36.35	0+36.35	6301.36	0.01	-135.09	0.00	0.00	0.00	0.00	0.00	0.00	0.0
0+43.62	0+43.62	6303.78	0.07	-620.23	0.01	-101.69	0.01	-101.69	-101.68	167.9	167.9
0+50.89	0+50.89	6306.20	0.03	-1152.47	0.01	-238.66	0.02	-340.35	-340.32	214.3	382.2
0+58.16	0+58.16	6308.63	0.01	-1686.01	0.01	-382.14	0.03	-722.49	-722.46	224.7	606.9
0+65.43	0+65.43	6310.27	0.04	-1979.65	0.01	-493.51	0.04	-1216.00	-1215.96	233.0	839.9
0+72.70	0+72.70	6310.27	0.26	-1936.02	0.04	-527.17	0.08	-1743.16	-1743.08	239.2	1079.1
0+79.97	0+79.97	6310.27	0.38	-1877.72	0.09	-513.44	0.16	-2256.60	-2256.44	245.0	1324.1
0+87.24	0+87.24	6310.27	1.89	-1809.46	0.31	-496.40	0.47	-2753.01	-2752.54	249.9	1574.0
0+94.51	0+94.51	6310.27	3.69	-1737.95	0.75	-477.59	1.22	-3230.60	-3229.38	253.1	1827.0
1+01.78	1+01.78	6310.27	4.71	-1638.77	1.13	-454.61	2.35	-3685.20	-3682.85	255.3	2082.4
1+09.05	1+09.05	6310.27	8.41	-1529.86	1.77	-426.59	4.12	-4111.80	-4107.68	257.6	2340.0
1+16.32	1+16.32	6310.27	12.78	-1418.16	2.85	-396.89	6.97	-4508.69	-4501.72	260.3	2600.3
1+23.59	1+23.59	6310.27	16.73	-1304.42	3.97	-366.54	10.94	-4875.23	-4864.29	263.5	2863.8
1+30.86	1+30.86	6310.27	24.19	-1188.32	5.51	-335.60	16.45	-5210.83	-5194.38	266.9	3130.7
1+38.13	1+38.13	6310.27	40.93	-1057.51	8.77	-302.36	25.22	-5513.18	-5487.96	268.9	3399.7
1+45.40	1+45.40	6310.27	61.22	-924.91	13.75	-266.89	38.97	-5780.07	-5741.10	269.2	3668.9
1+52.67	1+52.67	6310.27	87.06	-799.36	19.96	-232.14	58.93	-6012.21	-5953.28	266.8	3935.8
1+59.94	1+59.94	6310.27	115.88	-684.34	27.32	-199.75	86.26	-6211.96	-6125.71	263.9	4199.6
1+67.21	1+67.21	6310.27	156.08	-573.89	36.61	-169.40	122.87	-6381.36	-6258.49	262.7	4462.3
1+74.48	1+74.48	6310.27	203.70	-466.09	48.44	-140.01	171.31	-6521.37	-6350.06	261.4	4723.7
1+81.75	1+81.75	6310.27	265.06	-357.94	63.11	-110.94	234.42	-6632.31	-6397.89	260.3	4984.0
1+89.02	1+89.02	6310.27	346.83	-252.64	82.38	-82.20	316.80	-6714.51	-6397.72	260.4	5244.3
1+96.29	1+96.29	6310.27	450.36	-158.57	107.33	-55.36	424.12	-6769.87	-6345.75	261.3	5505.6
2+03.56	2+03.56	6310.27	564.39	-75.07	136.62	-31.45	560.74	-6801.33	-6240.59	280.7	5786.4
2+10.83	2+10.83	6310.27	709.73	-22.32	171.54	-13.11	732.27	-6814.44	-6082.17	281.5	6067.8
2+18.10	2+18.10	6310.27	900.45	-1.32	216.78	-3.18	949.05	-6817.62	-5868.57	263.7	6331.5
2+25.37	2+25.37	6310.27	1115.65	0.00	271.43	-0.18	1220.48	-6817.80	-5597.32	264.9	6596.4
2+32.64	2+32.64	6310.27	1332.10	-0.24	329.54	-0.03	1550.02	-6817.83	-5267.81	265.1	6861.5
2+39.91	2+39.91	6310.27	1555.49	-0.28	388.76	-0.07	1938.78	-6817.90	-4879.13	265.1	7126.6
2+47.18	2+47.18	6310.27	1741.26	0.00	443.84	-0.04	2382.62	-6817.94	-4435.32	265.2	7391.8
2+54.45	2+54.45	6310.27	1870.00	0.00	486.18	0.00	2868.80	-6817.94	-3949.14	264.9	7656.7
2+61.72	2+61.72	6310.27	2000.05	0.00	521.02	0.00	3389.82	-6817.94	-3428.12	264.4	7921.1
2+68.99	2+68.99	6310.27	2129.16	0.00	555.91	0.00	3945.74	-6817.94	-2872.20	263.6	8184.6
2+76.26	2+76.26	6310.27	2171.10	0.00	578.94	0.00	4524.68	-6817.94	-2293.26	263.2	8447.8
2+83.53	2+83.53	6310.27	2154.42	0.00	582.34	0.00	5107.03	-6817.94	-1710.91	263.9	8711.7
2+90.80	2+90.80	6310.27	2113.33	0.00	574.57	0.00	5681.59	-6817.94	-1136.35	265.7	8977.4
2+98.07	2+98.07	6311.95	1557.59	0.00	494.21	0.00	6175.81	-6817.94	-642.13	263.6	9240.9
3+05.34	3+05.34	6314.37	838.57	-7.17	322.59	-0.97	6498.40	-6818.90	-320.51	224.5	9465.4
3+12.61	3+12.61	0.00	465.93	0.00	175.62	-0.96	6774.02	-6819.87	-145.85	155.5	9620.9
3+19.88	3+19.88	0.00	222.64	-0.04	92.70	-0.01	6766.72	-6819.87	-53.15	102.4	9723.3
3+27.15	3+27.15	0.00	83.63	0.00	41.23	-0.01	6807.96	-6819.88	-11.92	62.6	9785.9
3+34.42	3+34.42	0.00	0.17	0.00	11.28	0.00	<b>6819.24</b>	<b>-6819.88</b>	-0.64	23.0	9808.9

Figure 15  
Sample Earthwork Volume Report File - Values in Bold are the one which are checked for Equality



Figure 16  
ArcScene Display of the Original Ground and Well Pad Polygons

It should be noted that the utilization of the ArcScene program truly enhances the visualization of the surfaces and is a powerful asset when making presentations.

### Polygons from Slope Lines Operation

The [Polygons from Slope Lines] command is actually incorporated in the [Set Pad Elevation] command. So that, if the user is simply interested in using the [Set Pad Elevation] command, the [Polygons from Slope Lines] command does not have to be activated.

However, if there is a need to use the functionality of the [Polygons from Slope Lines] command, it is available as a stand-alone command.

The [Polygons from Slope Lines] command will create polygons using an original ground polygon layer and a slope line layer.

The slope line layer contains line features whose endpoints indicate a direction and slope. This line is then intersected with the polygons in the original ground polygon layer. Since there can be many intersections, the command uses the intersection that is closest to the start point of the slope line. The intersection point will then become a vertex in a polygon created by the command.

The original ground polygon layer is simply a layer that contains PolygonZ features. There is no specific order in which the polygons should appear in this layer.

Prior to activating the command, the user selects the lines in the slope line layer that are to be processed. If no line features are selected, a warning message to this effect will be displayed.

Also prior to activating the command, the user activates in the Table of Con-

tents the original ground polygon layer and the slope line layer to be processed. If these layers are not active or if more than two layers are active, an appropriate warning message will be displayed.

Upon activation, the command displays a multi-input dialog box from which the user specifies the attribute which contains the sequential ID values and the PEN attribute value to be assigned to the newly created polygons.

If the OK button is selected, the command processes the slope lines in an order controlled by the sequential ID value. The coordinates of the line's endpoints are extracted and a direction and slope are computed. This information is then used in the intersection process with the original ground polygons.

As the slope lines are processed, triangles are formed and stored as polygon features in the current active layer.

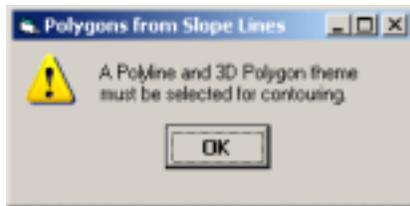


Figure 17  
Select Polyline and 3D Polygon Layers  
Warning Message



Figure 18  
More than 2 Layers Active  
Warning Message

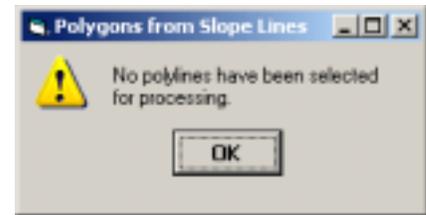


Figure 19  
No Polylines Selected  
Warning Message

Summarizing, the PEN attribute value is used to associate the newly created polygons with the well pad, while the sequential ID values indicate the order in which the slope lines are processed.

To use this command, the following steps can be performed

- **1** **Activate** in the Table of Contents the slope line layer to be processed.
- **2** **Select** the line features with the *Select Features from Active Layers*  tool, to be processed.
- **3** **Activate** in the Table of Contents the original ground polygon layer to be processed.
- **4** **Scroll** down in the {CEDRA-AVland-ContouringMenus} menu combo box, and **select** the [Polygons from Slope Lines] command. If the appropriate layers are not selected, one of the warning messages shown in Figures 17, 18 and 19 will be displayed. If the appropriate layers have been selected, the multi-input dialog box shown in Figure 20 will be displayed.
- **5** **Scroll** down in the *Sequential Numbering Field:* data field, and **select** the attribute that contains the sequential number values for the slope lines that are associated with the well pad.
- **6** **Enter** in the *PEN Attribute Value:* data field the value that is assigned to the slope lines which are associated with the well pad.

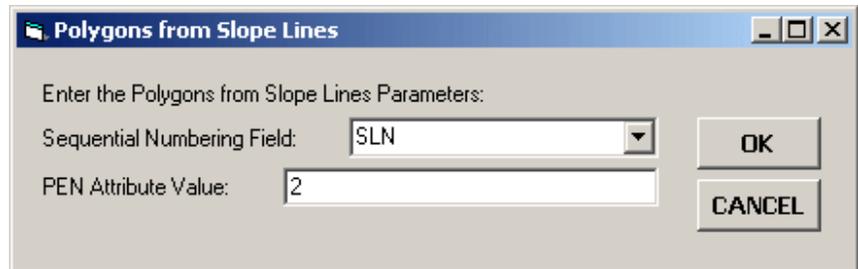


Figure 20  
Polygons from Slope Lines Dialog Box

- **7** **Click** at the **OK** button to begin the computations, or **click** at the **Cancel** button to abort the command.

Having clicked at the *OK* button, the command processes the slope lines in the order dictated by the values found in the sequential numbering field. The slope line is intersected with the original ground polygon layer, an intersection computed and triangles formed. The triangles are stored as polygon features in the current active layer.

#### Notes

- a. When using the Intersect Line w/ 3D Polygons tool, if a point feature is created the coordinates of the point reflect the intersection with the original ground surface. If a line feature is created, the start point coordinates of the line are those of the pick made by the user. The end point coordinates are computed using the slope and buffer distance specified by the user. As such, the end point of the line feature is not the intersection with the original ground surface.

- b. When using the Intersect Line w/ 3D Polygons tool, the buffer distance value defines the length of the line when a line feature is created. For point features it denotes the maximum distance an intersection will be considered.

- c. When using the Intersect Line w/ 3D Polygons tool, PEN attribute value is used to associate the slopes lines with a well pad.

- d. The SLN attribute is a good attribute to use as the sequential ID value for slope lines, although the user is able to use any other attribute. To populate the SLN attribute, the Edit Attributes of a Feature  tool, the Edit Feature Attributes  tool, within the CEDRA-DataEditor software, as well as native ArcMap functionality can be used to define the appropriate attribute value. The SLN attribute is populated as slopes lines are created. The modification of these values can be performed once all of the slope lines for a well pad have been established.

- e. When using the [Set Pad Elevation] command, the slope lines with the

specified PEN attribute value not only associate the slopes lines with a well pad, they also control the extent of the original ground surface that is examined. An enclosing rectangle is developed based upon the slope lines with the specified PEN attribute value, which is why specifying a proper buffer distance is important. The cross-sections are extracted along the horizontal or vertical midpoint of the enclosing rectangle, depending upon the user setting for the Cross-Section Alignment Direction parameter.

- f. The points and polygons created by the [Set Pad Elevation] command can be used by the [Contours from Polygons] command to generate final ground or proposed ground contours. The PEN attribute value that is specified in the multi-input dialog box, displayed by this command, will be assigned to the point and polygon features that are created. These features can then be processed by the [Contours from Polygons] command.
- g. The cross-section data files created by the [Set Pad Elevation] command are of the same form created by the [Sections from Contours], [Sections from Polygons] and [Sections from TIN] commands. In addition to the cross-section data files, profile data files will also be created. For the Base Polygon and Pad Polygon layers, the command will create a cross-section data file and a profile data file for each layer. As such, four data files will be created. The



Figure 21  
CEDRA-Commands ComboBox

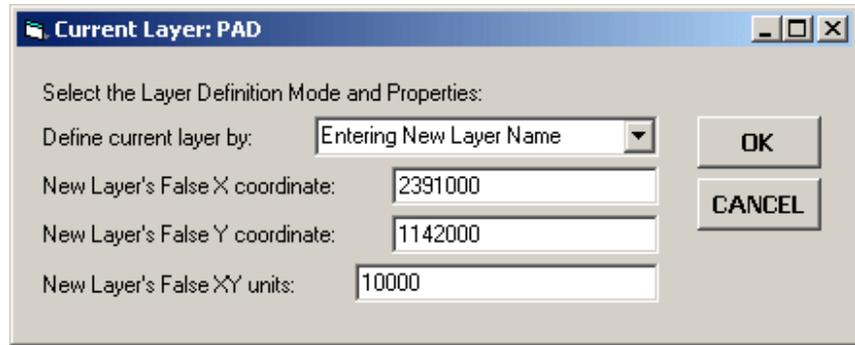


Figure 22  
Set Active Layer Dialog Box



Figure 23  
Enter New Layer Input Message Box

- h. In using the [Set Pad Elevation] command it is suggested that the well pad polygons and the slope line features be stored in the same geodatabase, be it file or personal.
  - data files are in actuality, tables. The names of the tables will be the name of the respective layer with the `_xsc` and `_pro` suffix. For example, if the Base Polygon layer is called A, two tables will be created called `A_XSC` and `A_PRO`. To generate a plot of the cross-sections, the [Plot Cross-Sections] command can be used.
  - list for the first parameter, see Figure 22.
  - **Enter** the appropriate **value** for the False X coordinate.
  - **Enter** the appropriate **value** for the False Y coordinate.
  - **Enter 10000** for the False XY units, then **click** the **OK** button.
  - **Enter** the appropriate **name** for the new layer to be created, see Figure 23, then **click** the **OK** button.
- i. To create a new personal geodatabase from within ArcMap using the CEDRA software, the following steps can be performed.
  - **Select** the [Set Active Layer] command from the CEDRA-Commands combo-box, see Figure 21.
  - **Select** the option Entering New Layer Name from the drop-down

The False X and False Y coordinates represent the low left corner coordinate of a rectangle that encompasses the entire area to be stored in the geodatabase. The False XY units value of 10000 ensures that enough precision will be stored in the geodatabase to handle large coordinate values such as state plane coordinates.

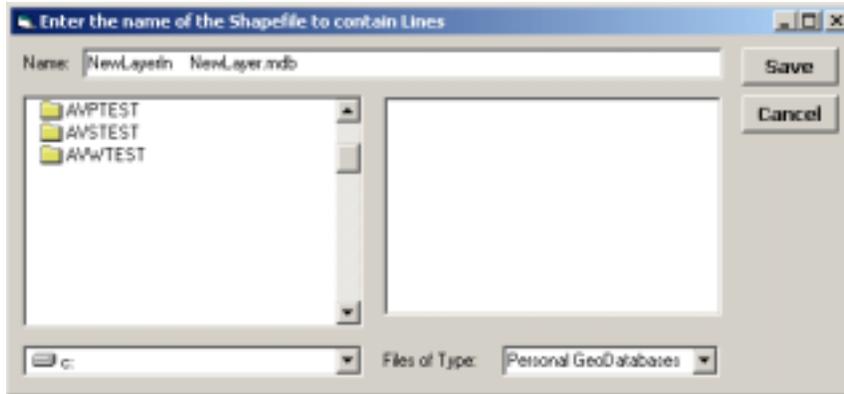


Figure 24  
New FeatureClass Specification Dialog Box

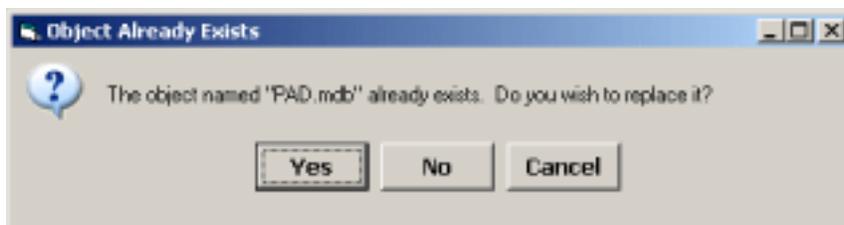


Figure 25  
GeoDatabase Overwrite or Append Query

At this point the new layer name has been specified. However, no new layer has been added to the Table of Contents. This only occurs when a new feature is created.

When a feature is created and stored in the current active layer, the program checks to see if the layer exists in the Table of Contents.

If the layer exists and can accommodate the feature type being created, the feature is stored in the layer.

If the layer does not exist or if the layer can not accommodate the feature type being created, the FeatureClass Specification dialog box shown in Figure 24 will appear.

The default will be to create a shapefile. To create a personal geodatabase, select the option Personal GeoDatabase from the Files of Type drop-down list.

After which, in the data field to the right of the label Name, the user can enter either two or three values.

If two values are specified, the first value represents the name of the feature class to be created (a dataset of the same name will also be created). The second value is the name of the personal geodatabase to be created.

If three values are specified, the first value is the name of the feature class to be created, followed by the name of the feature dataset and then finally, the name of the personal geodatabase to be created.

If the user specifies the name of a geodatabase that exists, the program will query the user as to if the geodatabase is to be overwritten (replaced) or appended to, see Figure 25. Selecting the Yes button results in the overwriting of the personal geodatabase. Selecting the

Cancel button aborts the creation of the feature, while selecting the No button results in the geodatabase being appended.

Selecting the No button enables the user to store multiple datasets in the same geodatabase.

Once all of the information has been entered, click the Save button to perform the appropriate action or the Cancel button to abort the command.

In specifying the name of a feature class, the following convention is used. The suffix **pn** is appended for Point features, **ln** for two-point line features, **pl** for polylines, **pg** for polygons and **tx** for annotation features.

For example, let us assume we wish to create two feature classes in a single personal geodatabase. The name of the personal database will be **test**. Following the naming convention mentioned above, the name of the Point feature class would be **testpn**, while the Line feature class would be **testln**.

## Summary

Although not a common GIS application, this issue demonstrates how GIS can be extended to accommodate a variety of different applications. The utilization of ArcScene truly helps in the visualization of the results of the [Set Pad Elevation] command. After all, looking at a plain ASCII text file doesn't really convey the amount of cut and fill to most people.

Note that this issue discusses the application of determining a well pad elevation. However, the same command can be applied to setting the elevation of a house or building pad.

The implementation of the [Set Pad Elevation] command as well as the other modifications discussed are recent ad-

ditions to the software. Users with a software support agreement should check with The CEDRA Corporation on how to obtain a software update so as to be able to utilize this new functionality.

As always, users who have a need for functionality that is not presently available in CEDRA software should feel free to forward these requests to CEDRA, as well as, any other comments or suggestions you may have.

*If you have a request for Command Of The Month, feel free to phone, fax or e-mail your request to The CEDRA Corporation.*