Survey Engineering Tool (SET)

Version 2.1

User Documentation

June, 2009

EFT - Engineering Field Tools

Survey Engineering Tool
Version 2.1

June, 2009

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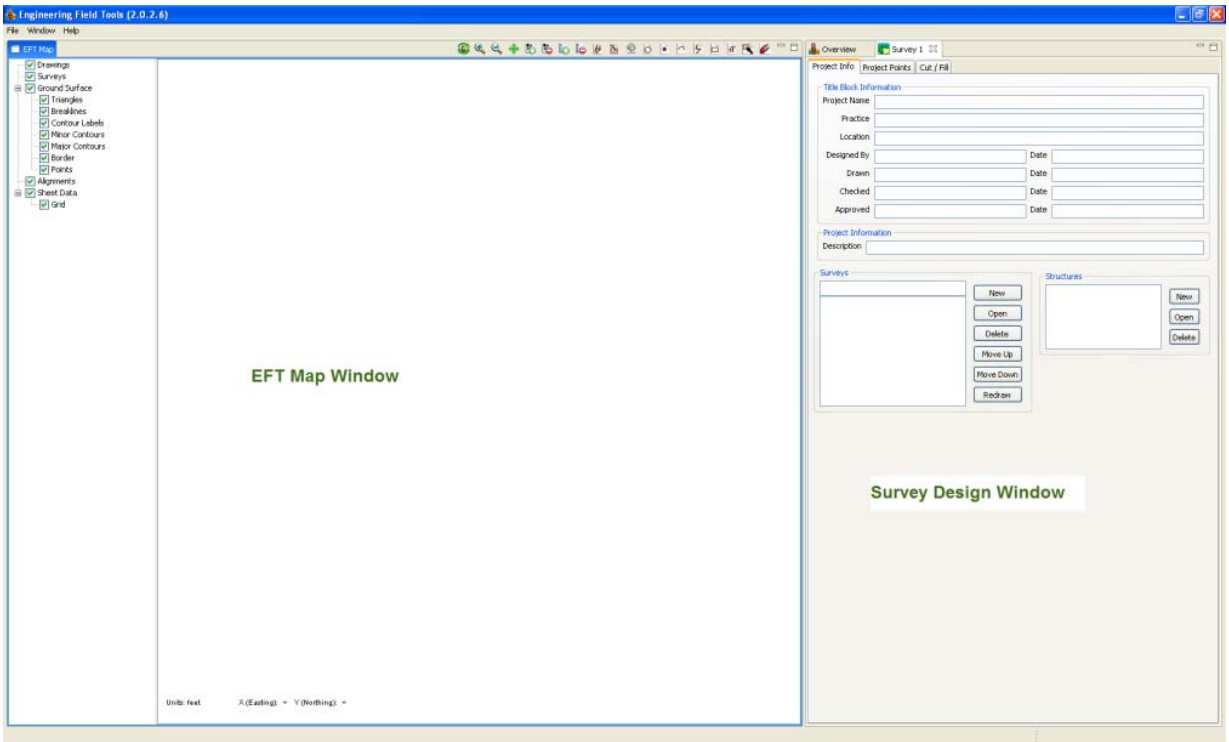
1. Opening Screen

Note

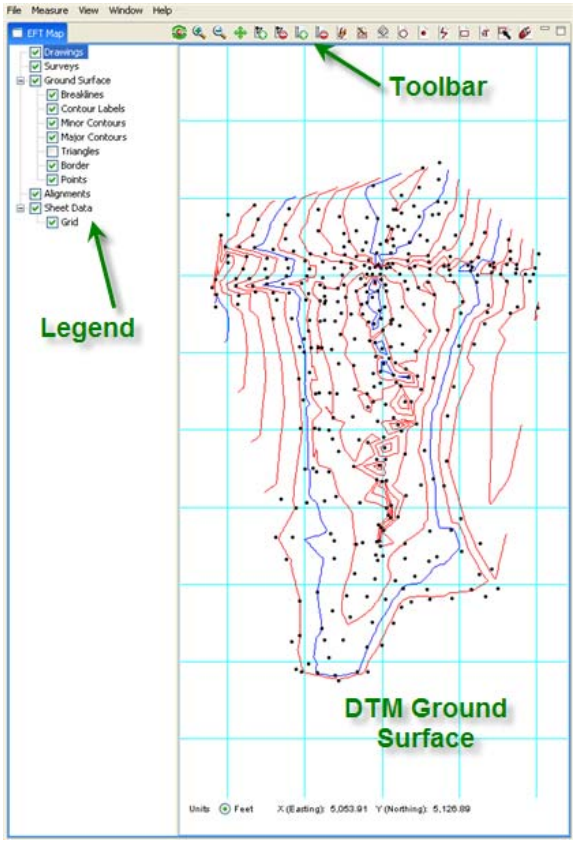
This section of the user manual begins at the point when a new Survey Manager is created. Please refer to the Engineering Field Tools Framework section of the Help system for assistance in adding Customers, adding Projects, and adding a new Survey Design.

When a new Survey Design is started, the following opening screen is displayed. The left window is the EFT Map window, and the right window is the Survey Design window.



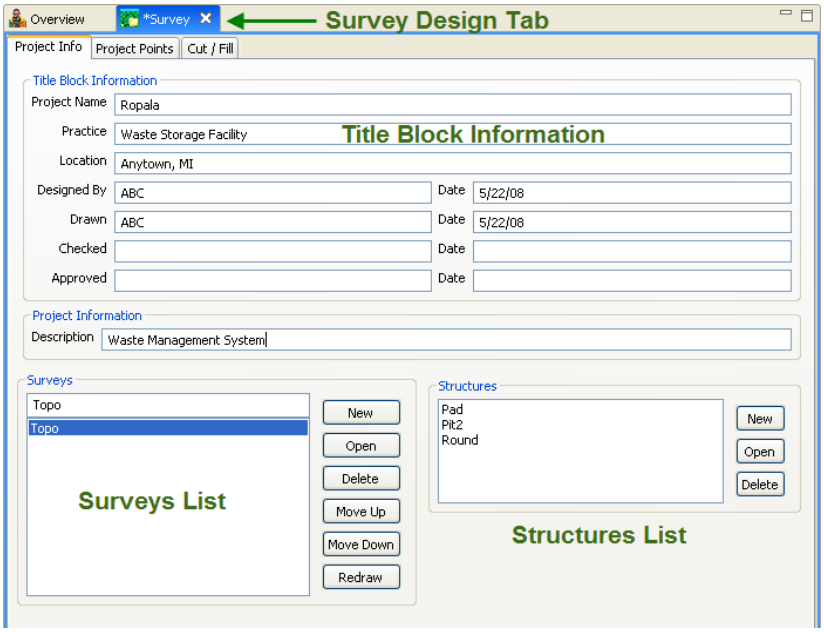
1.1. EFT Map Window

Below is a sample of a DTM displayed on the Map window. Note the Legend on the left and the Toolbar along the top. The Legend allows the user to turn on and off different map features to be displayed. The Toolbar allows the user to change the view, modify the DTM, perform measurements, and add drawing objects to the map.



1.2. Survey Design Window

Below is an example of what is presented in the Survey Design window. The tabs at the top level are the Overview tab, which gives you access to the customer and project management functions, and the currently opened survey design.



1.3. Project Information tab

As shown above, the Project Information tab contains the project name and description, as well as information that will be placed in the title block of printed drawings. Refer to the Map Sheets section for more detailed information about the title block.

Also, the **Surveys List** is shown. This contains all of the various surveys that make up the current survey design. Individual surveys can be started (new), opened, and deleted.

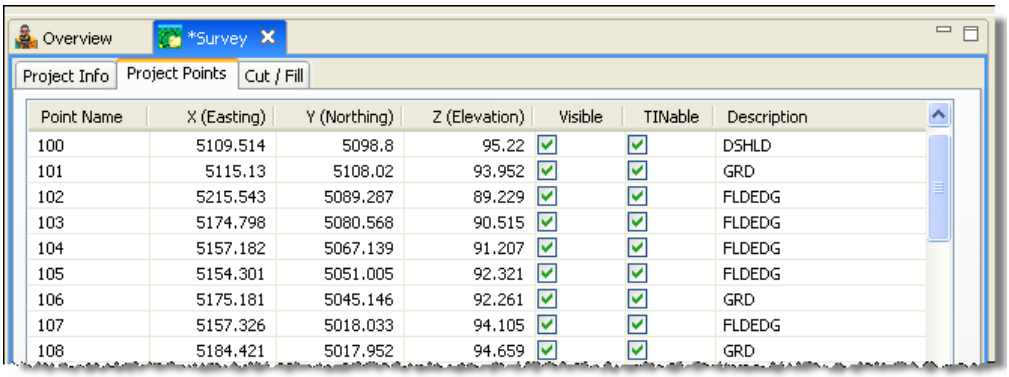
Finally, the **Structures List** is shown, which contains all of the user defined structures for this survey design.

1.4. Project Points tab

The second tab over is the project points tab, which presents a table of all of the combined points from the surveys in the survey list. Point data in the project point table cannot be edited from within the table; the survey from which the points were entered must be opened to edit the points.

Each point has a point name, X, Y, and Z coordinates and point description from the imported file. Note that the imported file may not have point names and/or descriptions as these are optional. Use the scroll bar to view all of the data. You can also use the scroll wheel on your mouse, if available.

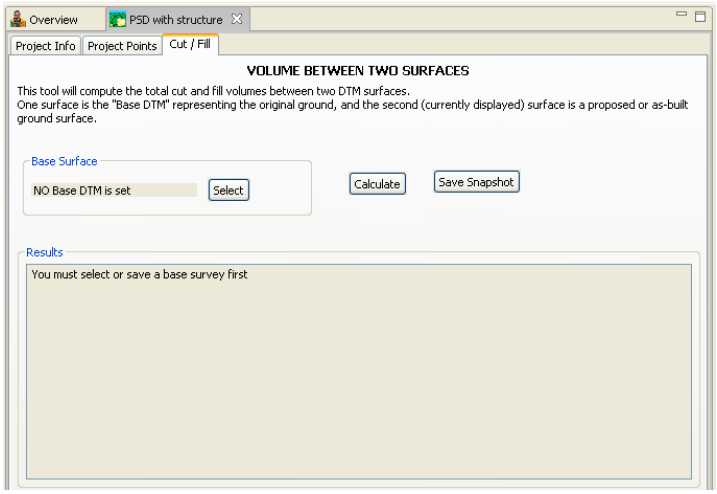
Functions you can perform in this table are sorting the points, making points invisible on the map, excluding points from the DTM, and displaying only certain points (isolate points). See the Project Points Table section for a description of these functions.



Point Name	X (Easting)	Y (Northing)	Z (Elevation)	Visible	TINable	Description
100	5109.514	5098.8	95.22	✓	✓	DSHLD
101	5115.13	5108.02	93.952	✓	✓	GRD
102	5215.543	5089.287	89.229	✓	✓	FLDEDG
103	5174.798	5080.568	90.515	✓	✓	FLDEDG
104	5157.182	5067.139	91.207	✓	✓	FLDEDG
105	5154.301	5051.005	92.321	✓	✓	FLDEDG
106	5175.181	5045.146	92.261	✓	✓	GRD
107	5157.326	5018.033	94.105	✓	✓	FLDEDG
108	5184.421	5017.952	94.659	✓	✓	GRD

1.5. Cut/Fill tab

The Cut/Fill tab computes the volumes of cut and fill between two DTM surfaces. The process compares the opened surface with another previously saved surface. For more information, refer to the Volume Between 2 Surfaces section under Ground Surface Map in this user manual.



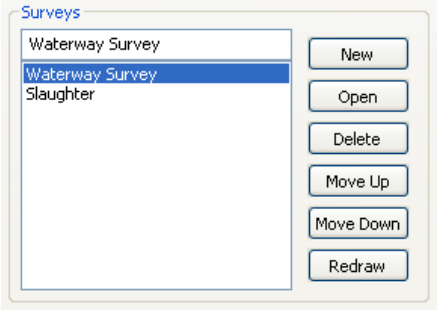
1.6. Surveys List

The Survey List contains all of the various surveys that make up the current survey design project. Surveys can be in XYZ format (rectangular coordinates), Station/Offset (profile and cross sections), or Radial (transit surveys).

Start new surveys by clicking the NEW button. Existing surveys can be displayed for editing by clicking the OPEN button. Surveys can be removed from the survey project by clicking the DELETE button.

Survey names can be reordered in the list by highlighting the survey and pressing the Move Up and Move Down buttons.

Refer to the DTM Basics section on the use of the Redraw button.



2. Survey Input

Survey data is entered in one of three formats, depending on how the survey is collected in the field:

Note

Before you can input a survey, you must first create a customer, then a project for that customer. Within the project, you will define a new Survey Tool Design. Refer to the EFT Framework Help file for assistance in working with Customers, Projects, and Design Tools.

1. **XYZ format**

   This type of survey has rectangular coordinates (X, Y, and Z or Northing, Easting, and Elevation). This type of data comes from total station survey instruments, GPS, and LIDAR. Grid style surveys can also be entered as an XYZ survey type. This survey data can be imported from an existing file or can be manually entered.

2. **Station-Offset**

   This survey is typically done by defining an alignment (a profile) and cross-sections perpendicular to the alignment. Stations are defined along the alignment, and offset shots define the cross-sections at user defined stations. Two kinds of alignments can be defined in SET: Simple Alignments and User Defined Alignments. Simple alignments need not be defined prior to entering cross-sections. Simple alignments are limited to straight lines pointing north and starting at station 0+00. User defined alignments allow all other possibilities, that include deflections and curves. Refer to the sections below that describe alignments.

3. **Radial**

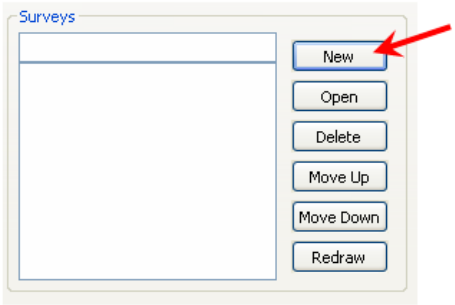
   This type of survey is collected using transits and theodolites. Points are defined by horizontal angle and distance, with an elevation. Various types of instrument moves are supported by SET when the survey requires more than one instrument point. This Radial input routine replaces the SSRP program within the Ohio suite of engineering programs.

2.1. XYZ Survey Input

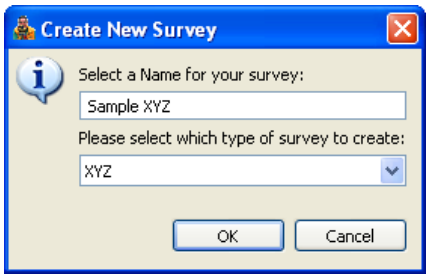
XYZ survey data can be manually entered or imported. To start an XYZ survey, you must first create a new survey in the opened survey design.

2.1.1. Create a New XYZ Survey

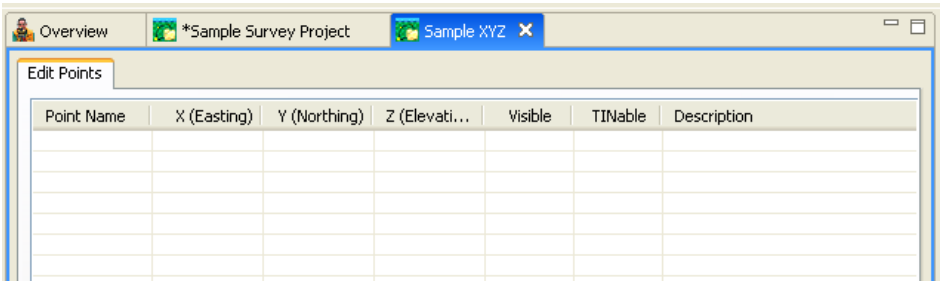
1. On the Project Info tab of a new or open survey design, press the NEW button next to the Surveys List



2. Enter the name of this XYZ survey in the popup window, and be sure XYZ is shown in the Survey type drop-down list. XYZ is the default selection. Click OK and the XYZ Input Editor will open.

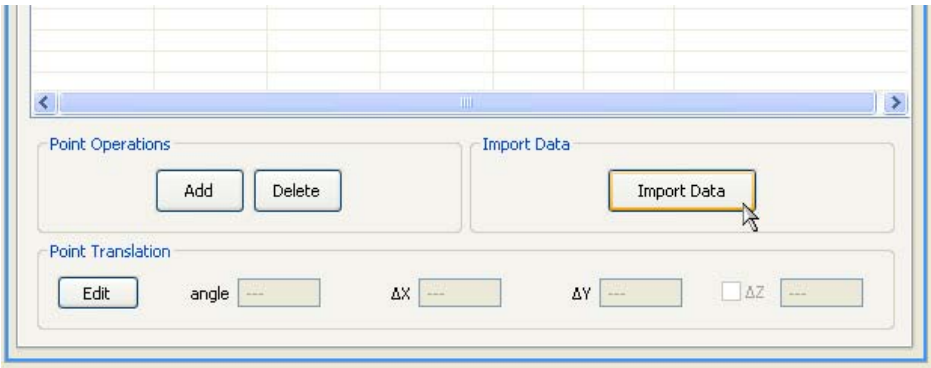


3. When a new XYZ survey is created, a blank Input Editor screen will display as shown below.



2.1.2. Importing XYZ Data

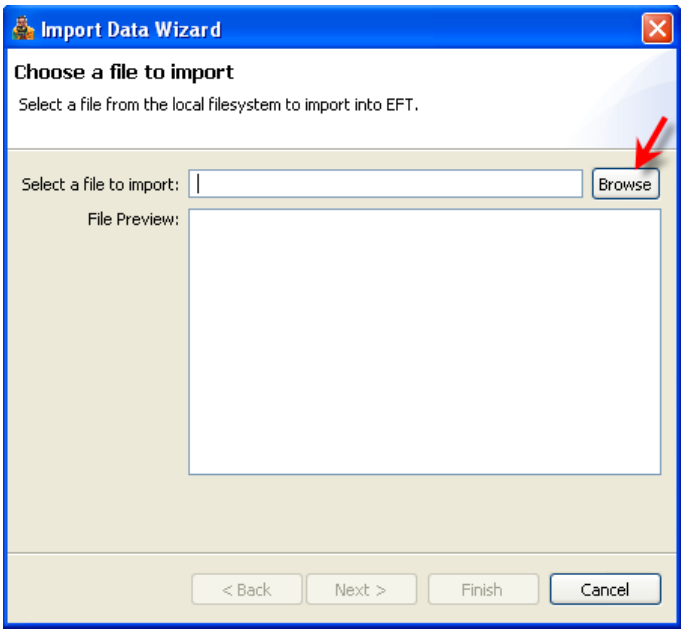
1. To import an existing XYZ data file into SET, press the IMPORT DATA button.

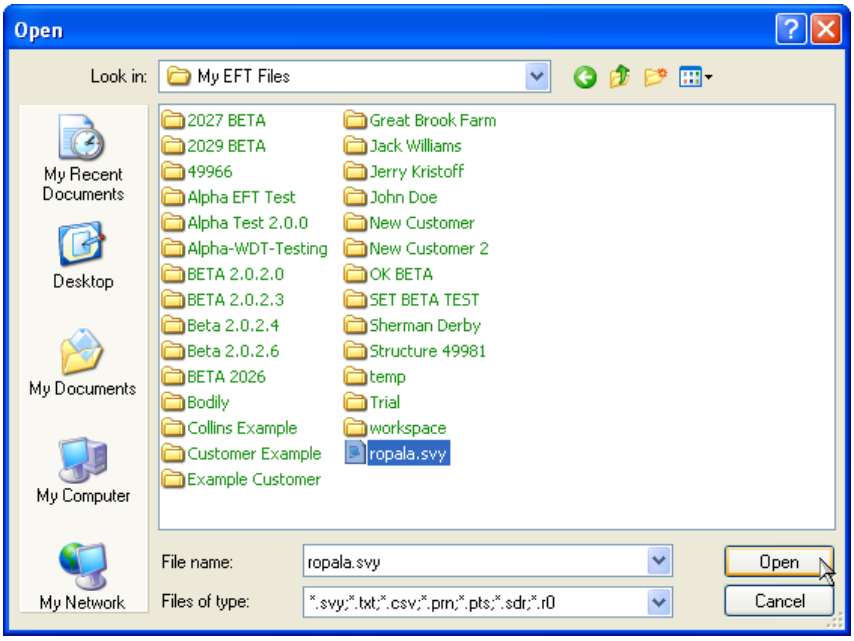


2. The Import Data Wizard screen will appear. Press the **BROWSE** button to navigate to the file containing your XYZ survey data. SET will look in My Documents\ My EFT Files by default. Highlight the file to be imported and press **OPEN**.

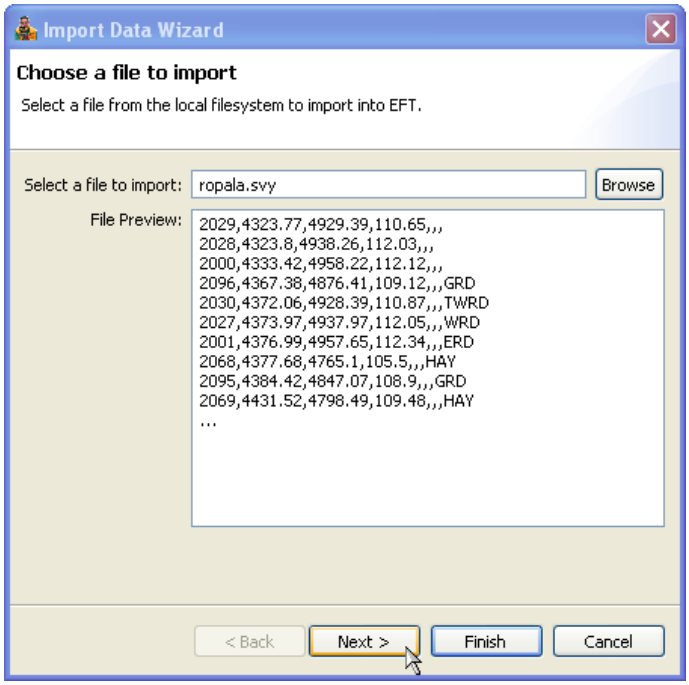
Tip

Refer to the Preferences section to see how you can redefine the default location for SET to find your imported data files.

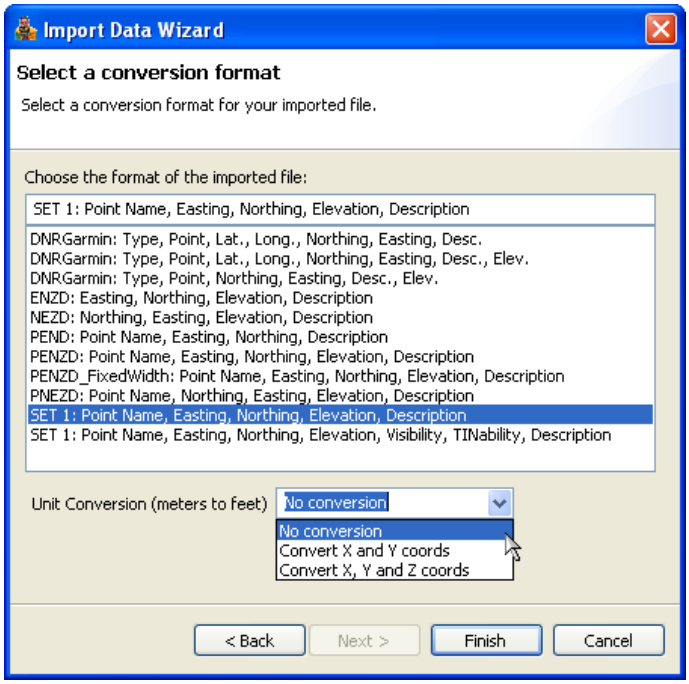




3. When the file to be imported is opened, the Import Wizard will display the file name, and preview some of the points to help determine the format of the data. Press the **NEXT** button.



4. The Conversion Format window will appear, where you must select the format of the data in the imported file. After selecting the format, press **FINISH**. Press the **BACK** button if you need to review the points in the file. You can define the default conversion format by changing the setting in the Preferences section. Refer to the **Preferences** section of this user manual for more assistance.

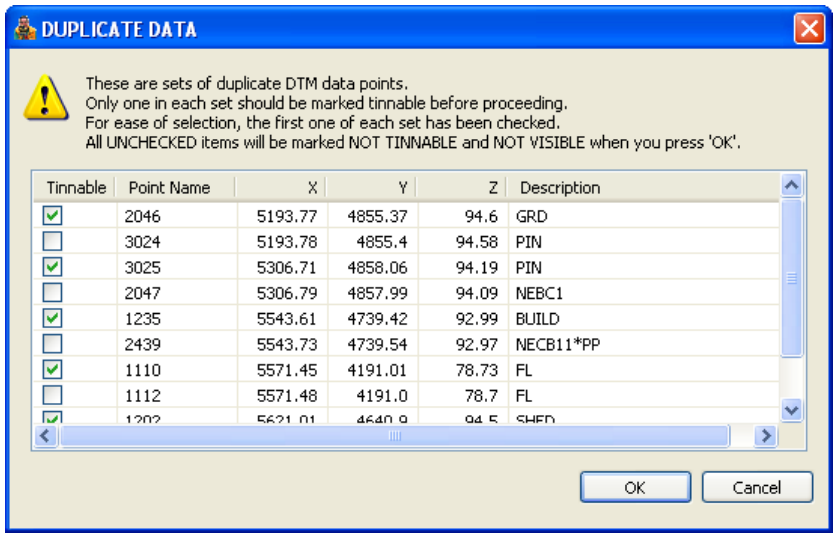


5. **Unit Conversion (meters to feet)** - If the survey file to be imported has metric units, then you can convert to feet by changing the Unit Conversion setting. Note that SET only works in feet (computed distances and areas are based in feet). You can choose to convert only the X & Y coordinates into feet (elevations already in feet), or choose to convert all 3 coordinates to feet.

Note

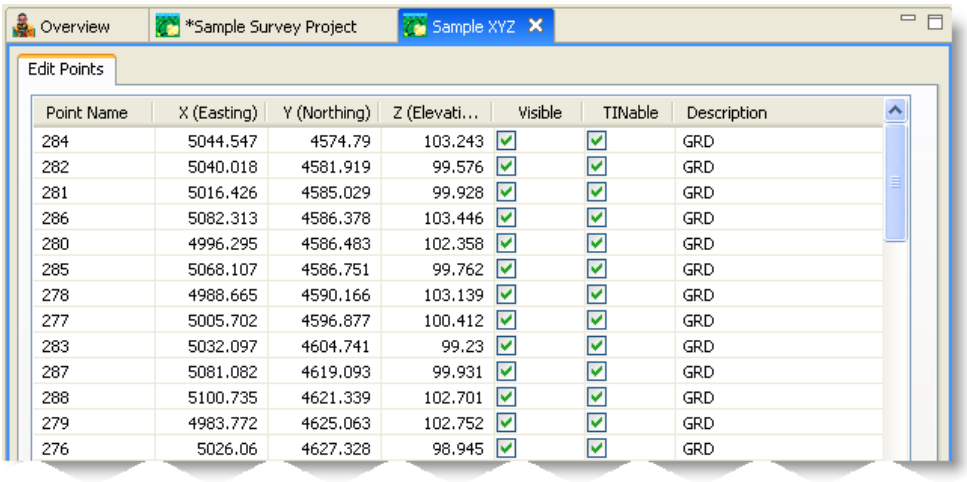
The conversion used in SET will convert meters to US Survey Feet.

6. **Duplicate Points** - If the file contains duplicate points, then they will be listed. Each set of duplicate points will be listed. Select the point that you wish to remain on the DTM by checking the box (the first point in each duplicate set is the default point to remain on the DTM). The other non-checked points will be marked invisible and untinnable (will not be a part of the DTM). The program considers points to be duplicates if the **horizontal** distance (elevation is not considered) between the points is less than 0.2 ft. The point name and description are also not considered in this test.



Tinnable	Point Name	X	Y	Z	Description
☑	2046	5193.77	4855.37	94.6	GRD
☐	3024	5193.78	4855.4	94.58	PIN
☑	3025	5306.71	4858.06	94.19	PIN
☐	2047	5306.79	4857.99	94.09	NEBC1
☑	1235	5543.61	4739.42	92.99	BUILD
☐	2439	5543.73	4739.54	92.97	NECB11*PP
☑	1110	5571.45	4191.01	78.73	FL
☐	1112	5571.48	4191.0	78.7	FL
☑	1202	5621.01	4640.9	94.5	SHED

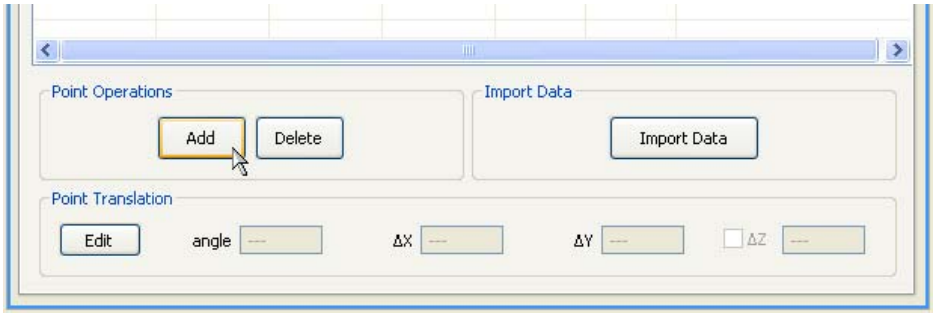
7. Click OK, and the XYZ data points will be displayed in the XYZ point table.



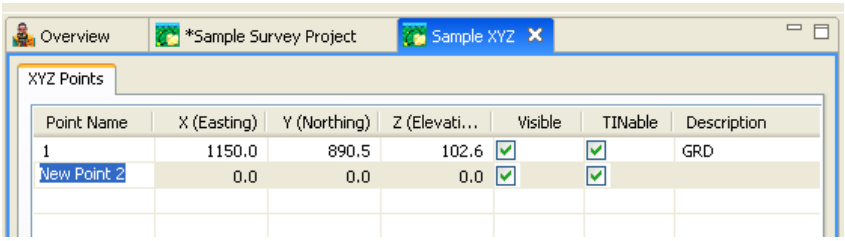
Point Name	X (Easting)	Y (Northing)	Z (Elevati...	Visible	TINable	Description
284	5044.547	4574.79	103.243	☑	☑	GRD
282	5040.018	4581.919	99.576	☑	☑	GRD
281	5016.426	4585.029	99.928	☑	☑	GRD
286	5082.313	4586.378	103.446	☑	☑	GRD
280	4996.295	4586.483	102.358	☑	☑	GRD
285	5068.107	4586.751	99.762	☑	☑	GRD
278	4988.665	4590.166	103.139	☑	☑	GRD
277	5005.702	4596.877	100.412	☑	☑	GRD
283	5032.097	4604.741	99.23	☑	☑	GRD
287	5081.082	4619.093	99.931	☑	☑	GRD
288	5100.735	4621.339	102.701	☑	☑	GRD
279	4983.772	4625.063	102.752	☑	☑	GRD
276	5026.06	4627.328	98.945	☑	☑	GRD

2.1.3. Manual entry

1. Click on the ADD button in the Point Operations portion of the Input Editor Screen.



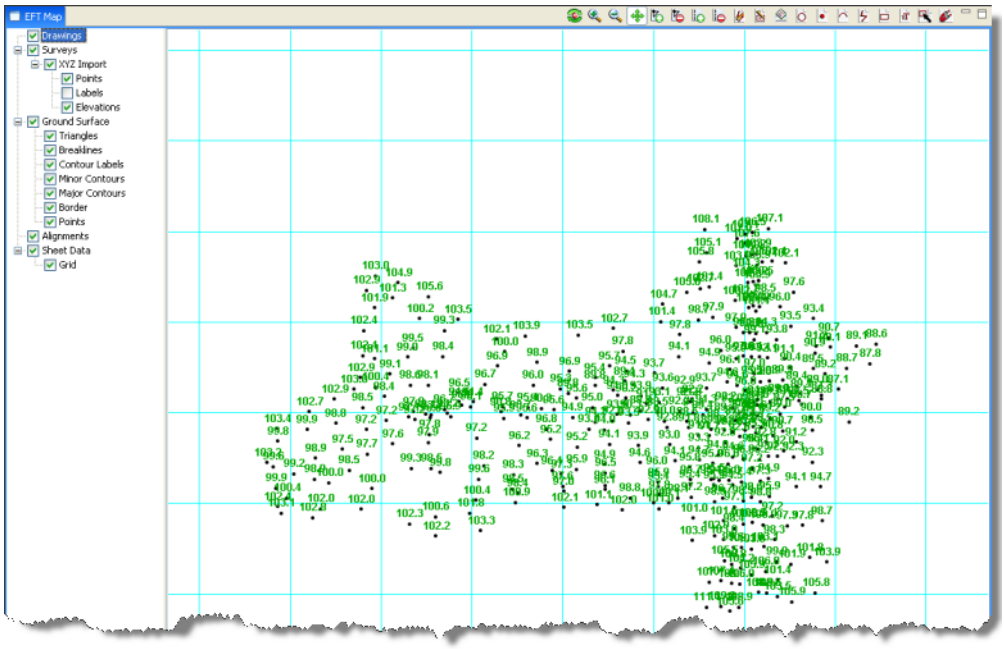
2. The first row is highlighted so you may enter the point information. Enter the point coordinates and the description. The points will be Visible and TINable by default. You may change either of these by unchecking the box.



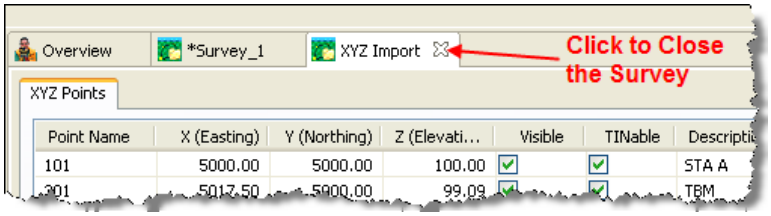
3. Continue adding points for your entire survey by repeating steps 1 and 2.

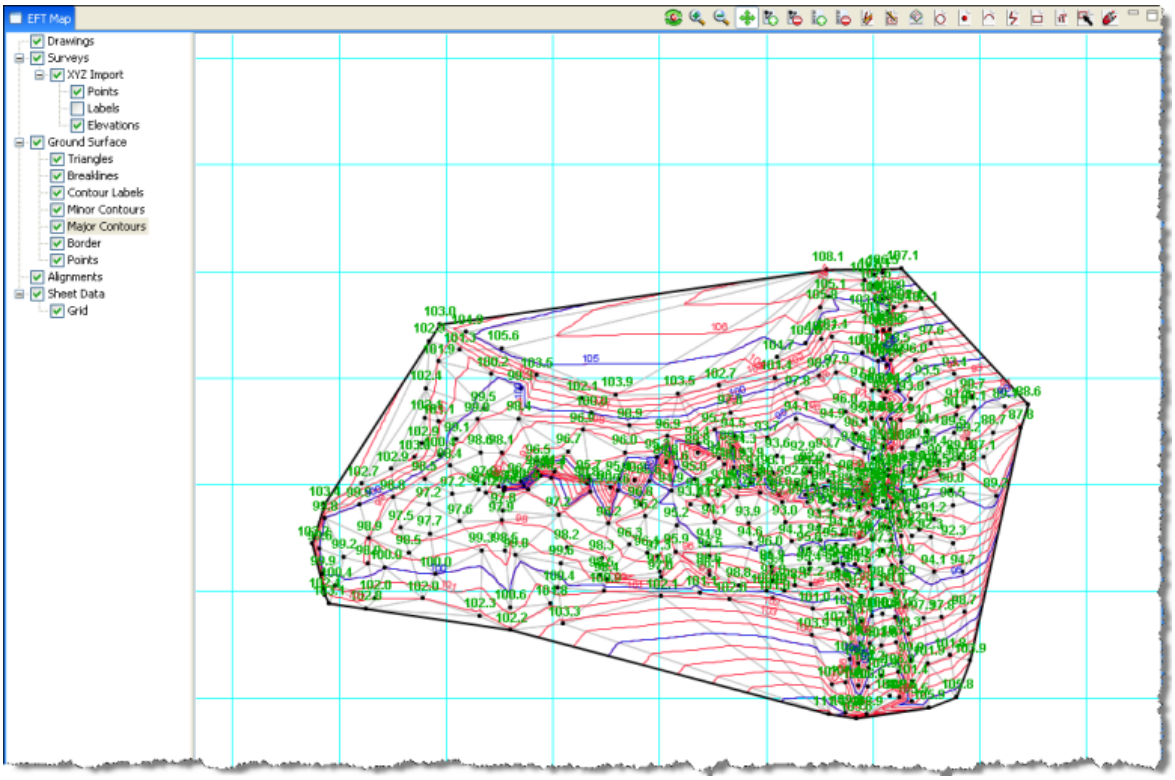
2.1.4. Survey Map

As the XYZ survey is entered or after it is imported, the points are displayed on the map. Note that you may need to press the **FULL EXTENT** button first to see the points on the map. **While the XYZ survey input screen is open, the DTM will not be processed (no contours will be displayed)**.



To process the DTM and create contours, the survey must be closed. Do this by clicking the "X" on the Survey Input screen tab. Then, the DTM (border, triangles and contour lines) will be displayed on the map as shown below.





2.1.5. Visible and TINable options

This option changes how the point affects the DTM. If a point is marked unTINable, then it will still remain on the map, but will not influence the DTM (see the DTM Basics section under Ground Surface Map of this user manual for more information). Examples are TBMs and other survey shots taken that are not on the ground surface and would affect how the contours of the ground surface would look. If a point is marked invisible, then that point would be excluded from the DTM and would not be visible on the map. Examples are duplicate check shots on TBMs or other points. They remain in the survey, but are not visible on the map.

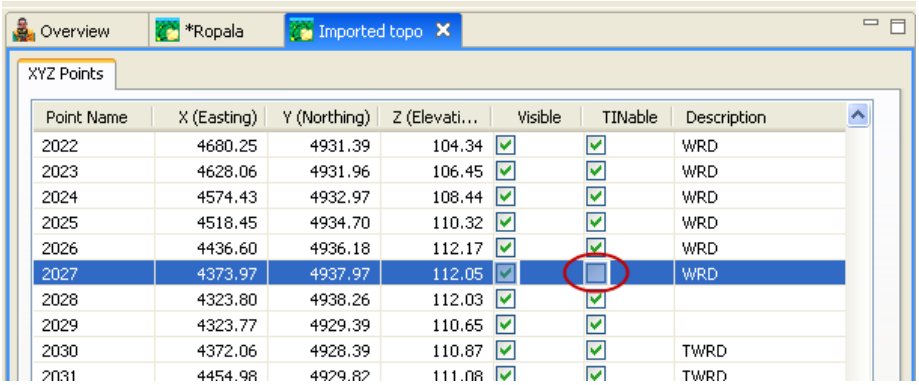
To make a point invisible on the survey map, uncheck the Visible checkbox for the point. Note that invisible points are also excluded from the DTM (the TINable checkbox is automatically unchecked).

To exclude a point only from the DTM, uncheck the TINable checkbox for the point.

Close the survey editor to update the DTM on the surface map.

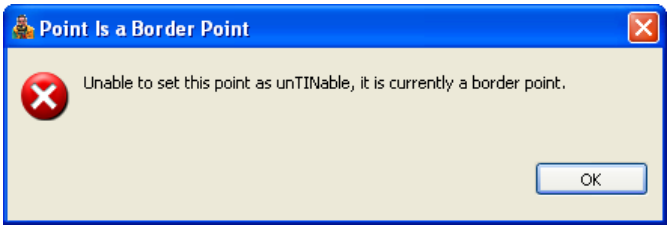
Tip

It's recommended to mark points unTINable or invisible in the original XYZ survey editor, and not the project points table.



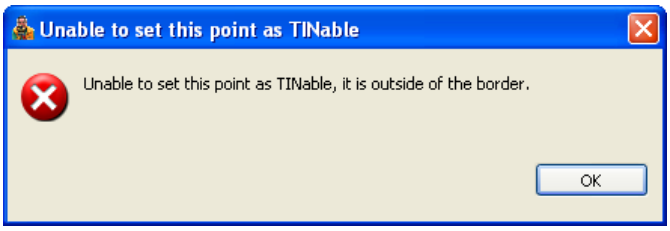
Point Name	X (Easting)	Y (Northing)	Z (Elevati...	Visible	TINable	Description
2022	4680.25	4931.39	104.34	✓	✓	WRD
2023	4628.06	4931.96	106.45	✓	✓	WRD
2024	4574.43	4932.97	108.44	✓	✓	WRD
2025	4518.45	4934.70	110.32	✓	✓	WRD
2026	4436.60	4936.18	112.17	✓	✓	WRD
2027	4373.97	4937.97	112.05	✓	☐	WRD
2028	4323.80	4938.26	112.03	✓	✓	
2029	4323.77	4929.39	110.65	✓	✓	
2030	4372.06	4928.39	110.87	✓	✓	TWRD
2031	4454.98	4929.82	111.08	✓	✓	TWRD

Note that you cannot make a point that is a border point unTINable. That is, all border points must lie on the DTM. If you try, an error message will display as shown below. To remove a border point from the DTM, the point must first be deleted as a border node (See section on Borders). Then you may make the point unTINable.



Remember that you will also get this error message if you try to make a border point invisible because making a point invisible also makes the point unTINable.

Also note that you cannot make a point that lies outside of the border a TINable point, since all points on a DTM must be within the defined border. An error message will be displayed, as shown below.



2.1.6. Translation and Rotation of XYZ Surveys

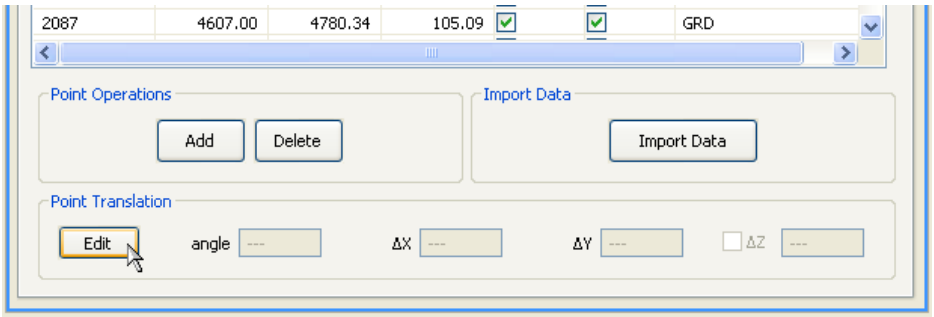
XYZ surveys can be translated (moved horizontally and vertically) and/or rotated to different coordinates by using the Point Translation routines. There are three methods available as described below. To begin the Point Translation process, you must open the XYZ survey editor of the survey to be translated. The Point Translation control is located at the bottom of the input screen. This area shows the current translation in effect (the boxes will be blank when no translation is in effect). To begin the point translation, or edit one in effect, click the **EDIT** button.

Note

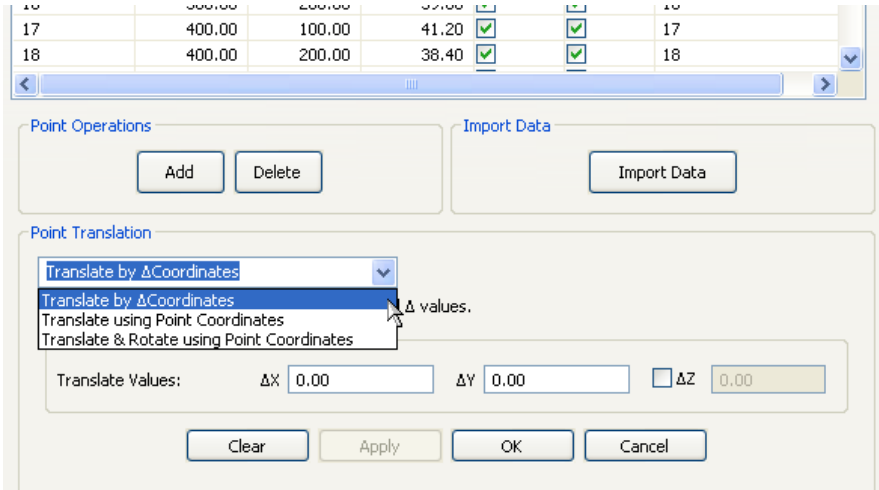
Radial and Station/Offset surveys can affectively be translated and/or rotated by modifying the Initial Instrument Setup (for Radial) or the Alignment (for Station/Offset).

Note

Since translation and rotation will require that new convex hull borders be created, any border edits previously made will be lost. Therefore, it's suggested to perform any translation and rotation operations before making border edits.



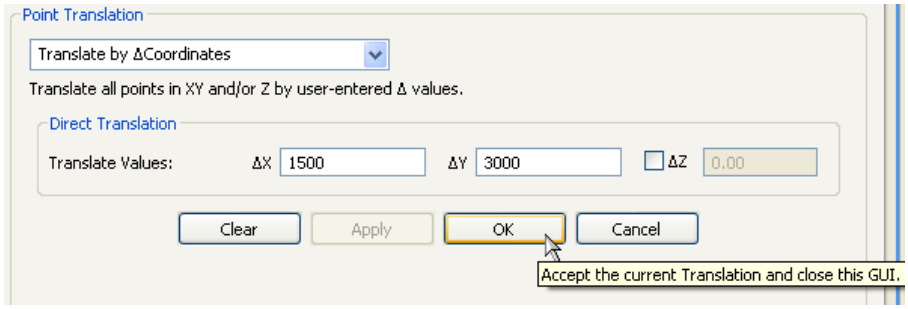
When the EDIT button is pressed, the Point Translation area of the screen expands to show the methods and the input fields. There are three methods of translation; the Translate by Δ Coordinates is the default method. Choose the appropriate method from the drop-down box and follow the procedures in the applicable section below. Pop-up hints appear as you move your cursor over most of the input field headers.



2.1.6.1. Translate by Delta (Δ) Coordinates

Translating by Δ coordinates is the simplest method and does not rely on other SET surveys in the current design. However, you must first know the amount of translation that will be applied to each of the coordinates.

1. Begin by bringing up the Point Translation editor as described above. The xyz survey can be translated in any combination of X, Y and/or Z. Enter the ΔX and/or ΔY distances in the appropriate boxes. If you wish to translate by the elevation, you must first check the ΔZ checkbox and enter the difference in elevation to translate. In the example below, the distances to be translated were entered in the ΔX and ΔY fields. Press the OK button to accept the inputs and close the translation input screen.

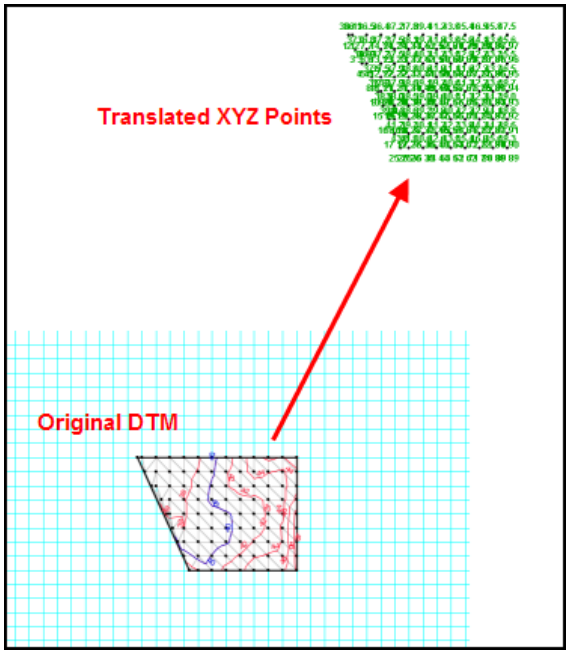


2. When the OK button is pressed, the xyz points will be translated by the distances entered. The translation results are displayed at the bottom of the input screen.

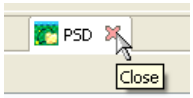
Note

The coordinates shown in the survey editor of the translated survey will show the original coordinates (not translated). The translated coordinates will show on the Project Points table, and will be printed in the Project Points report.

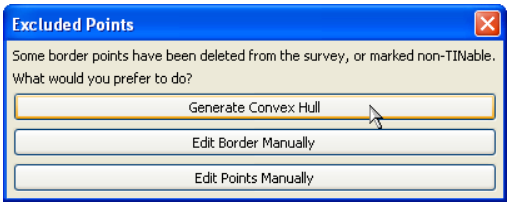
3. On the survey map, the points will move (likely off the screen - press the Full Extents button to see them again), but the DTM will not yet be moved. This is because the XYZ Survey editor is still open.



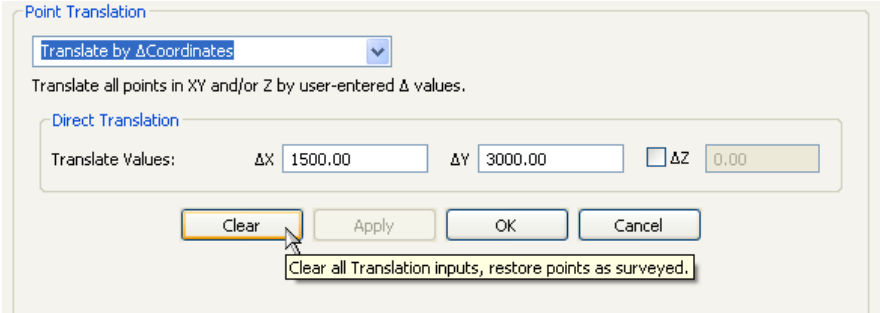
4. If the translation appears correct, then close the survey editor for this XYZ survey.



5. Since the border of the original DTM no longer contains the translated survey points, the Excluded Points error message displays, prompting you to fix the border. Choose the **Generate Convex Hull** option. A revised DTM of the translated points will be processed. Press the Full Extents button again to bring the survey map to the new DTM.



6. To remove all translation from the survey and return to the original coordinates, open the translated XYZ survey, press the **EDIT** button on the survey editor screen, then press the **CLEAR** button on the translation editor. You will need to generate a convex hull border to correct the DTM when you close the survey editor. The **CANCEL** button closes the translation editor without saving changes.

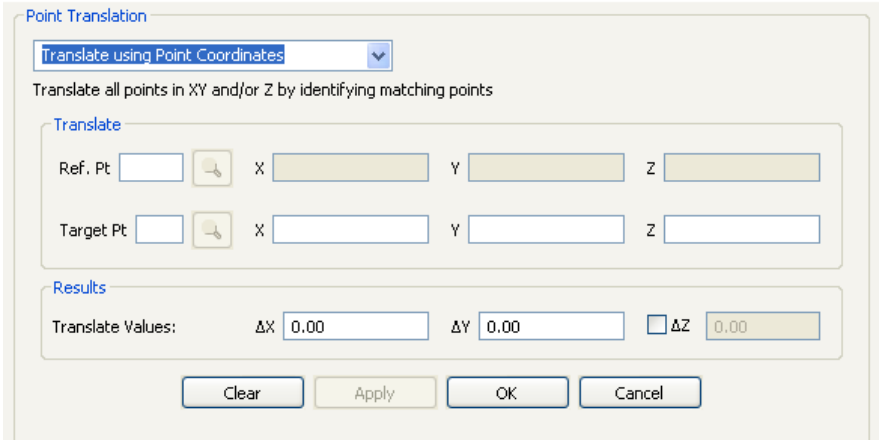


2.1.6.2. Translate Using Point Coordinates

Translating using point coordinates will translate all the points of one survey based on the coordinates of one point in another survey in the same design. A **reference point** is selected in the first survey, that will be translated to a **target point** in the second survey. The delta coordinates are computed and applied to all the points in the first survey.

1. Begin by bringing up the Point Translation editor as described above.

2. Choose the Translate using Point Coordinates method from the drop-down box. You must enter the reference point and target point to compute the translation values.



3. First, enter the point name of the Reference Point in the survey that is to be translated (call this Survey 1). Press the ENTER key or click on the Look-up button to retrieve the coordinates of the reference point. Next, enter the point name of the Target Point from a second survey (Survey 2). Again, press ENTER or click the Look-up button to retrieve the coordinates of the target point.

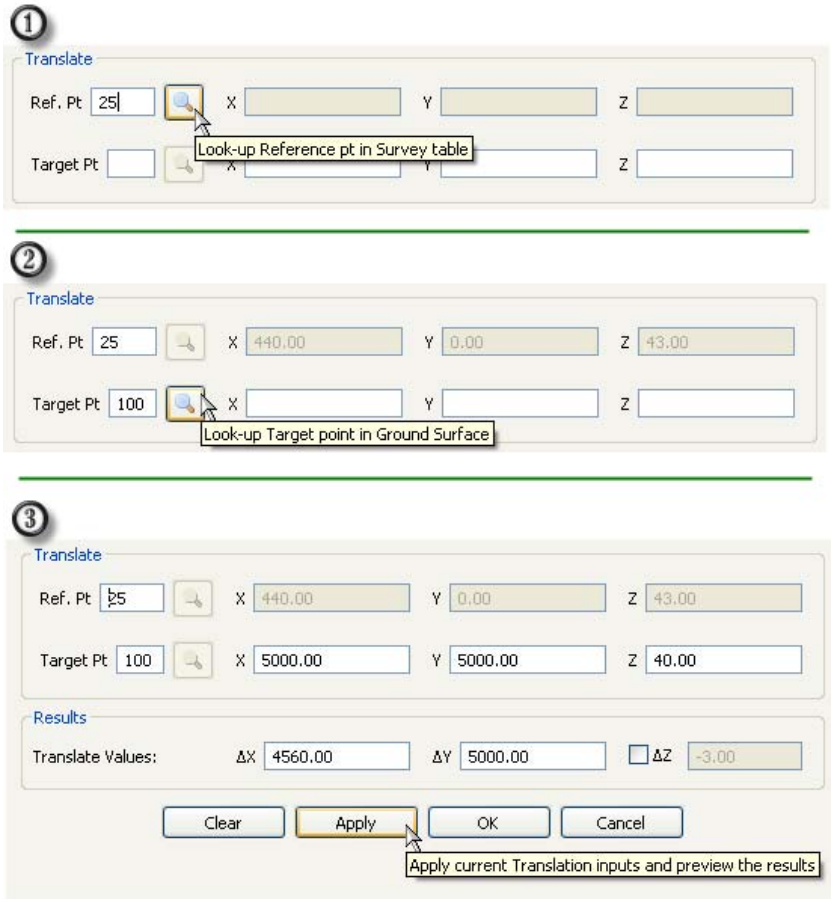
Note

Survey 2 (that contains the target point) does not need to be entered into SET. If you know the coordinates of the target point, you can simply enter them manually. To use the Look-up feature, however, Survey 2 must be entered into SET in the current design.

The translation results based on these points will be computed and displayed in the Results area. The change in elevation will be computed, but a vertical translation will not be performed unless the ΔZ checkbox is checked. You can click the **APPLY** button to view the translation without closing the translation editor. You can make changes in the inputs if needed. When done, click the **OK** button to apply the results and close the editor.

Note

The translation and rotation values in the results area can be manually edited. If edited, the reference and target point names and coordinates will be erased.

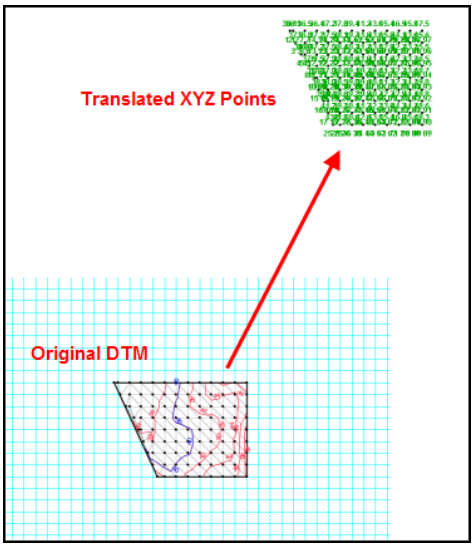


4. When the **OK** button is pressed, all of the xyz points in Survey 1 will be translated by the computed delta distances. The translation results are displayed at the bottom of the input screen.

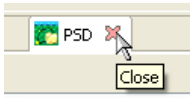
Note

The coordinates shown in the survey editor of the translated survey will show the original coordinates (not translated). The translated coordinates will show on the Project Points table, and will be printed in the Project Points report.

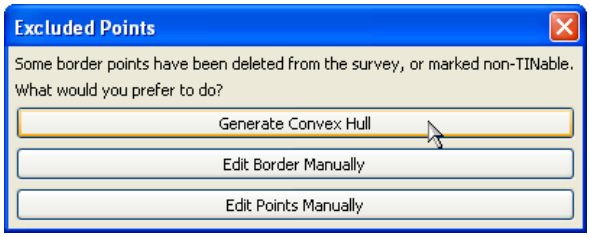
5. On the survey map, the points will move (likely off the screen - press the Full Extents button to see them again), but the DTM will not yet be moved. This is because the XYZ Survey editor is still open.



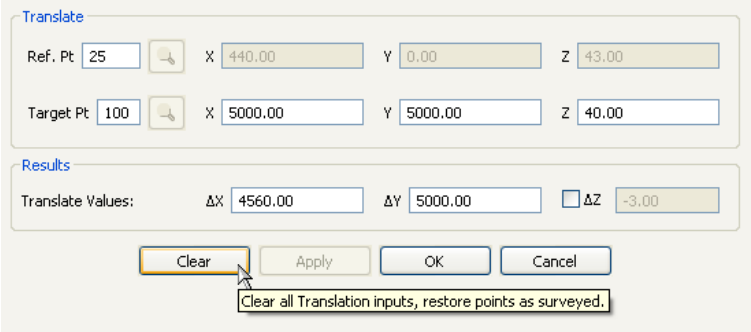
6. If the translation appears correct, then close the survey editor for this XYZ survey.



7. Since the border of the original DTM no longer contains the translated survey points, the Excluded Points error message displays, prompting you to fix the border. Choose the **Generate Convex Hull** option. A revised DTM of the translated points will be processed. Press the Full Extents button again to bring the survey map to the new DTM.



8. You may edit the translation by pressing the **EDIT** key on the survey editor and make the necessary changes. To remove all translation from the survey and return to the original coordinates, open the translated XYZ survey, press the **EDIT** button on the survey editor screen, then press the **CLEAR** button on the translation editor. After you edit or clear the translation, you will need to generate a convex hull border to correct the DTM after you close the survey editor. The **CANCEL** button closes the translation editor without saving changes.

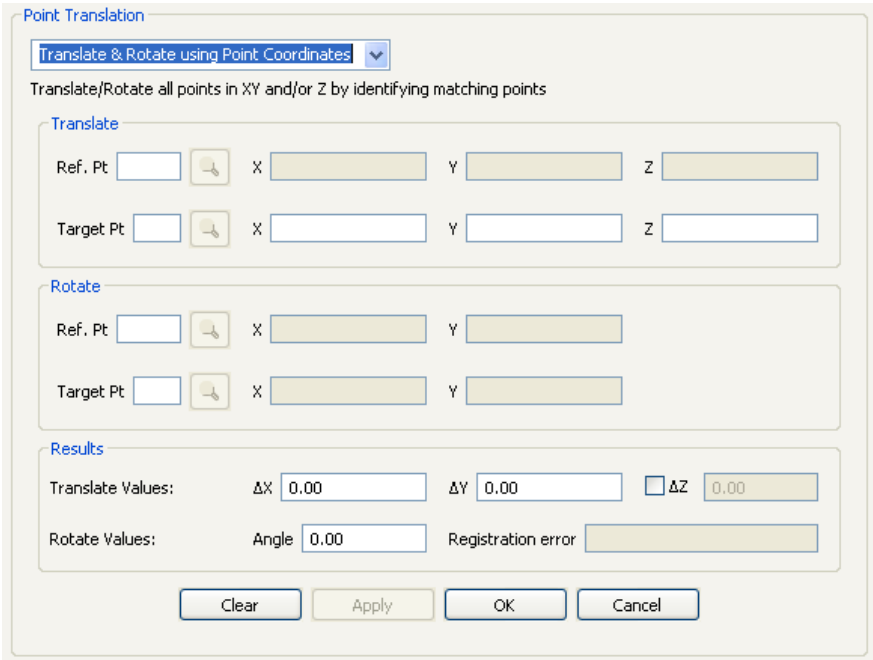


2.1.6.3. Translate and Rotate Using Point Coordinates

Translating and Rotating using point coordinates requires the use of two sets of reference points and target points. The first set is used to define the translation, and the second set to compute the rotation angle.

1. Begin by bringing up the Point Translation editor as described above.

2. Choose the Translate and Rotate using Point Coordinates method from the drop-down box. Enter the reference points and target points to compute the translation and rotation values.



3. Follow the steps below to translate and rotate an XYZ survey using point coordinates.

   1) First, define the translation to be applied to the survey. Enter the point name of the Reference Point in the survey that is to be translated (call this Survey 1). Press the ENTER key or click on the Look-up button to retrieve the coordinates of the reference point. **Note that this point is the pivot point for the rotation of the survey.** See below.

   2) Enter the point name of the Target Point from a second survey (Survey 2). Again, press ENTER or click the Look-up button to retrieve the coordinates of the target point. The translation distances will be computed and show in the Results area. The change in elevation will be computed, but a vertical translation will not be performed unless the ΔZ checkbox is checked.

      Note

      Survey 2 (that contains the target point) does not need to be entered into SET. If you know the coordinates of the target point for translation, you can simply enter them manually. To use the Look-up feature, however, Survey 2 must be entered into SET in the current design.

   3) Now, define the basis for rotating the survey. Note that the rotation will be about the **reference point of the translation** (point 25 is the pivot point in the example shown below). Enter the point name of the Reference Point from Survey 1 for the rotation and press ENTER or click the Look-up button to retrieve the coordinates.

   4) Enter the point name of the Target Point from a second survey (Survey 2). Again, press ENTER or click the Look-up button to retrieve the coordinates of the target point. The rotation angle and registration error will be computed and show in the Results area.

5) Again, the rotation process will rotate all the points in Survey 1 about the reference point of the translation. In the example below, all of the points in Survey 1 will be rotated 13.00 degrees around point 25.

The registration error is computed and displayed when the rotation angle is computed. The registration error is the difference of the distances between the Translation reference and target points and the Rotation reference and target points. In the example, the Registration error = (Distance between points 25 and 100) - (Distance between points 27 and 101). This gives you feedback whether you used the correct reference and target points.

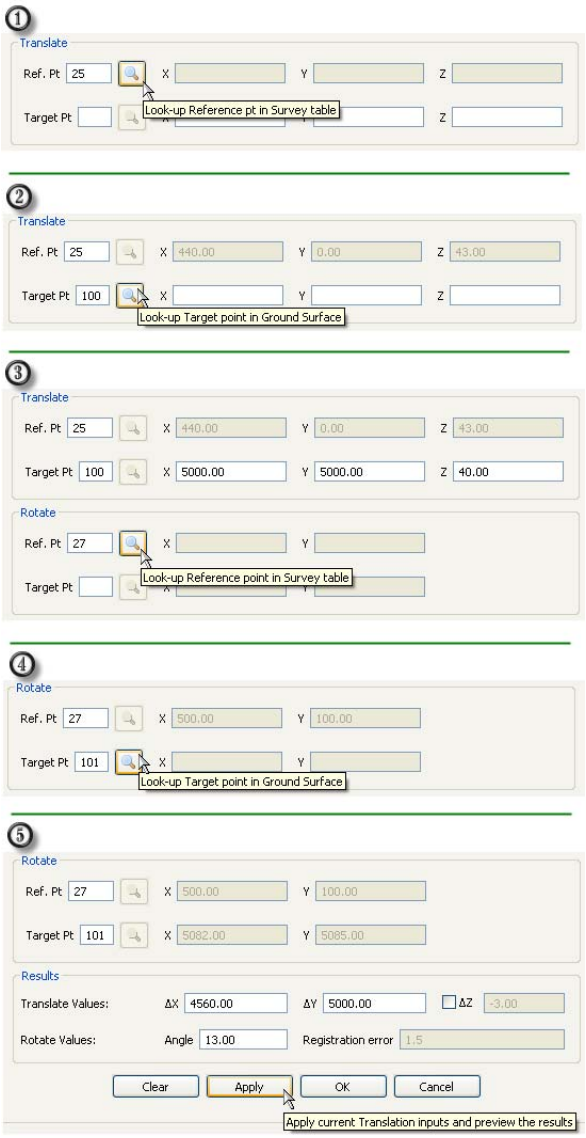
Note

Survey 2 (that contains the target point) does not need to be entered into SET. If you know the coordinates of the target point for rotation, you can simply enter them manually. To use the Look-up feature, however, Survey 2 must be entered into SET in the current design.

Note

The translation and rotation values in the results area can be manually edited. If edited, the reference and target point names and coordinates will be erased.

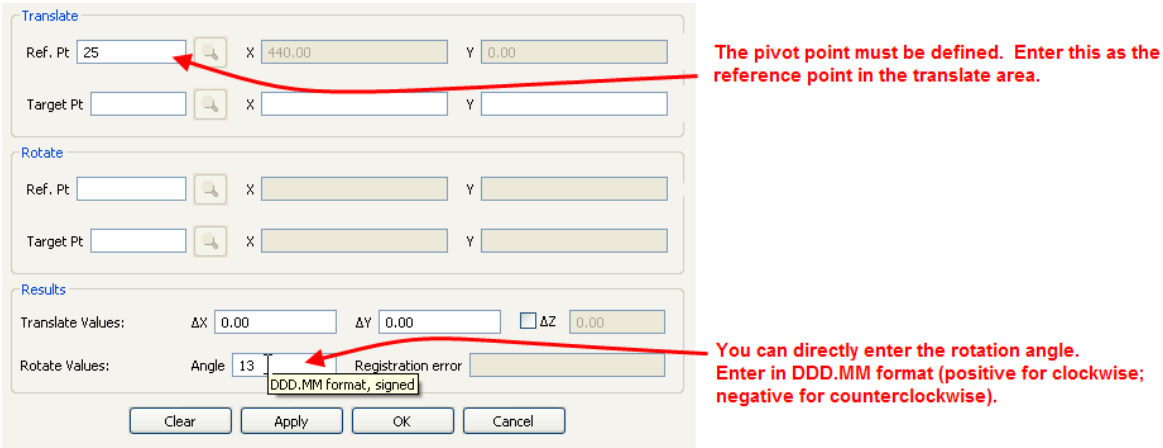
You can click the APPLY button to view the translation and rotation without closing the translation editor. You can make changes in the inputs if needed. When done, click the OK button to apply the results and close the editor.



4. You can manually rotate a survey about a point by following these steps:

   1) The pivot point for the rotation must first be defined. The rotation is always about the Translate reference point (even if a translation is not performed). Therefore, enter the point name of the pivot point in the Translate reference point entry box and press ENTER or click the Look-up button to retrieve the coordinates.

   2) Manually enter the rotation angle, using the DDD.MM format. A positive value will rotate clockwise; a negative value rotates counter-clockwise.

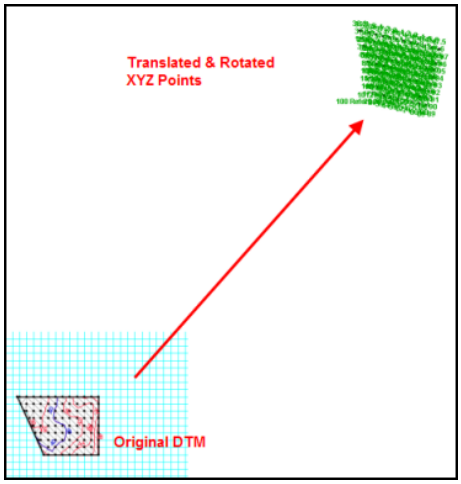


   3) When the OK button is pressed, all of the xyz points in Survey 1 will be translated by the computed delta distances and rotated about the pivot point. The translation and rotation results are displayed at the bottom of the input screen.

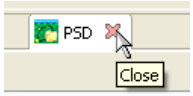
Note

The coordinates shown in the survey editor of the translated survey will show the original coordinates (not translated). The translated coordinates will show on the Project Points table, and will be printed in the Project Points report.

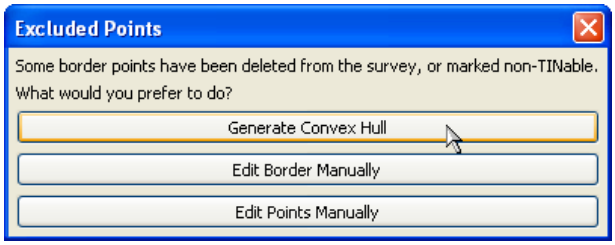
5. On the survey map, the points will move (likely off the screen - press the Full Extents button to see them again), but the DTM will not yet be moved. This is because the XYZ Survey editor is still open.



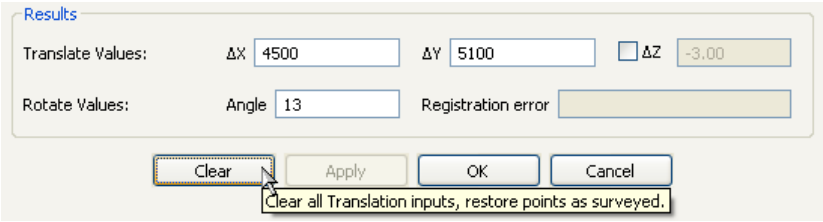
6. If the translation appears correct, then close the survey editor for this XYZ survey.



7. Since the border of the original DTM no longer contains the translated survey points, the Excluded Points error message displays, prompting you to fix the border. Choose the **Generate Convex Hull** option. A revised DTM of the translated points will be processed. Press the Full Extents button again to bring the survey map to the new DTM.



8. You may edit the translation by pressing the **EDIT** key on the survey editor and make the necessary changes. To remove all translation and rotation from the survey and return to the original coordinates, open the translated XYZ survey, press the **EDIT** button on the survey editor screen, then press the **CLEAR** button on the translation editor. After you edit or clear the translation, you will need to generate a convex hull border to correct the DTM after you close the survey editor. The **CANCEL** button closes the translation editor without saving changes.

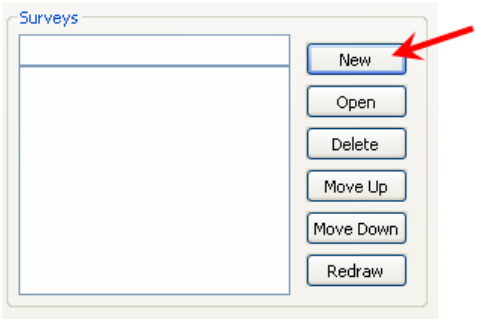


2.2. Station Offset Survey Input

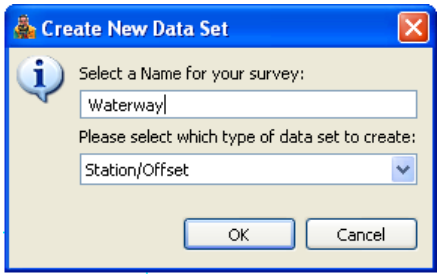
Station offset surveys are entered manually as cross sections along a defined alignment.

2.2.1. Create a New Station Offset Survey

1. On the Project Info tab, press the NEW button next to the Surveys List.

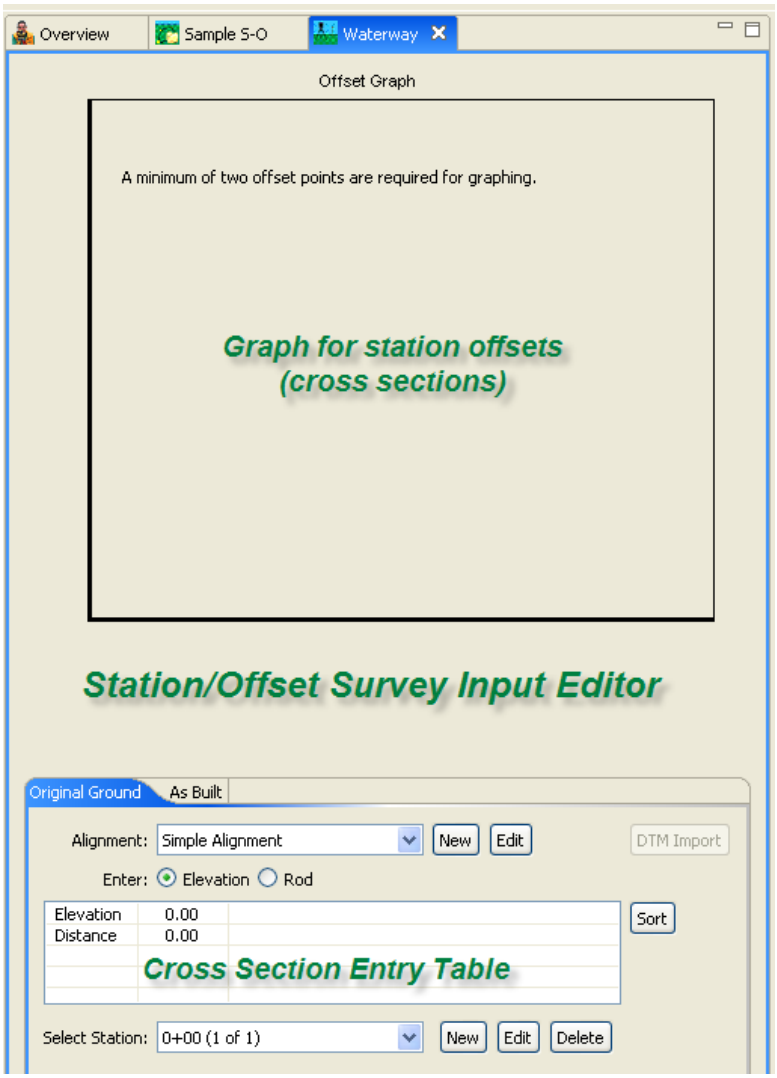


2. Enter the name of this survey in the popup window, and be sure Station Offset is shown in the Survey type drop-down list. Click OK and the Station Offset Input Editor will open.



2.2.2. Station-Offset Survey Input Editor

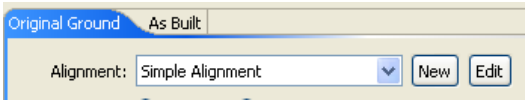
The Station Offset Survey Input Editor opens with the Offset graph at the top and the cross section (offset) entry table at the bottom, as shown below. Before sections are entered, an alignment is needed, as described in the next section.



2.2.3. Alignments

There are two types of alignments in SET: **Simple alignment** and **User-defined alignment**.

Simple Alignment



When a new station-offset survey is opened, a simple alignment is assumed. The properties of a simple alignment are as follows.

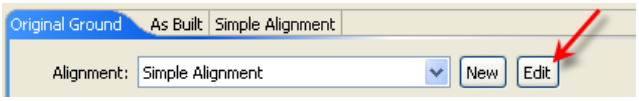
- Starting station = 0+00
- Increasing stations oriented towards the North (zero degrees azimuth)
- Straight alignment, without deflections or curves
- Beginning station centerline coordinates of X=0 and Y=0

If a simple alignment can be used, then you can simply begin entering cross-section data (see ‘‘Entering Offset Data” below). However, if any of the above properties do not apply to your alignment, then you must define an alignment.

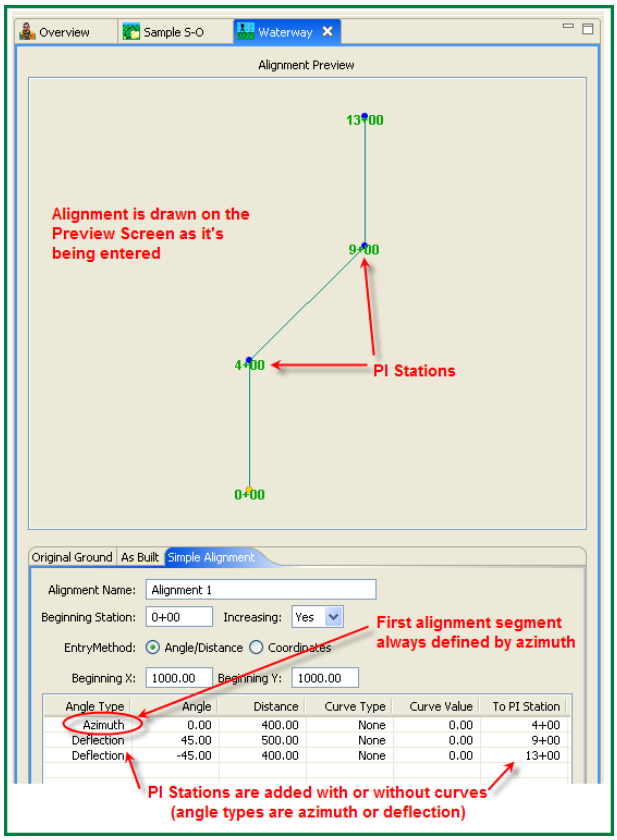
User Defined Alignment

User defined alignments give full flexibility in defining the alignment, including defining the starting station, beginning X & Y coordinates, and the ability to defined alignments with deflections or curves at any azimuth.

To begin an alignment, click on the **Edit** button. This will replace the Simple Alignment rather than add another alignment to it.



An Alignment Editor Screen will appear to allow entry of the parameters to define the alignment.



Enter the following information as it applies to your new alignment:

1. Enter a new name for you alignment. The program will not allow you use the name **`Simple Alignment`**.

2. Enter a starting station for your alignment. Do not add the **`"+"`** symbol to the station; the program will do this.

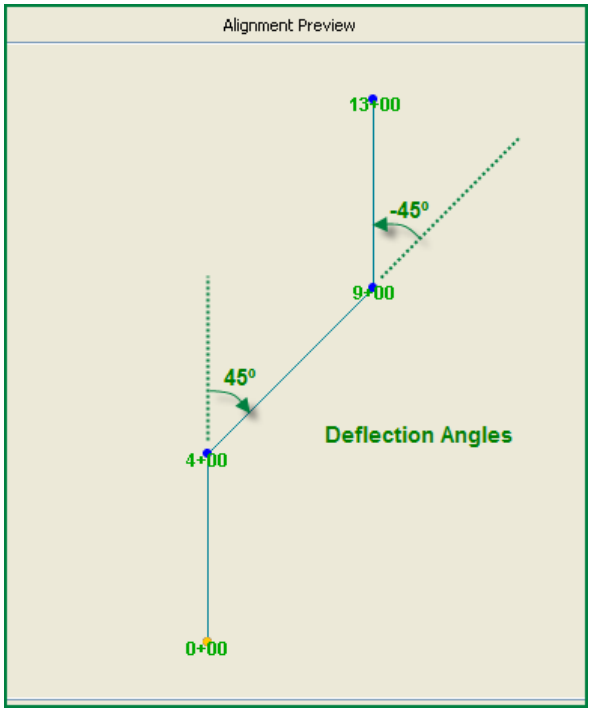
3. Choose whether stations will be increasing or decreasing. They will be increasing by default (YES). If decreasing, choose NO.

4. Choose whether you will be defining your PI stations with angles and deflections from the starting station, or by entering X & Y coordinates. Angle/Distance is the default.

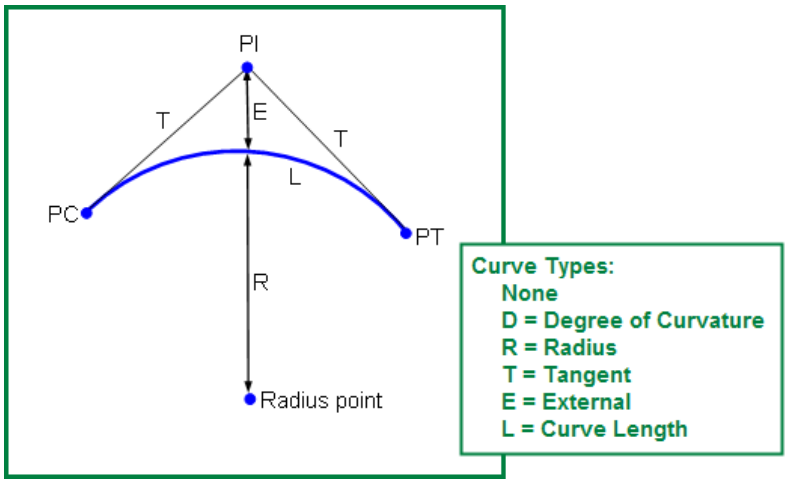
5. Enter the X & Y coordinates of the beginning of the alignment, if other than zero.

6. Begin defining the alignment by entering the parameters that will define the next PI station. Note that the first segment of the alignment must be defined by entering a starting azimuth (zero being north). Enter the azimuth angle and the distance to the next PI station. No curves are allowed on the first segment of the alignment. Note that angles are to entered in DD.MMSS format (for example, an angle of 45 degrees, 35 minutes would be entered as 45.35)

7. Continue adding data to define subsequent points in the alignment. Angles can be either azimuth or deflection. Deflection is the default angle type for the subsequent PI stations. The figure below illustrates deflection angles.

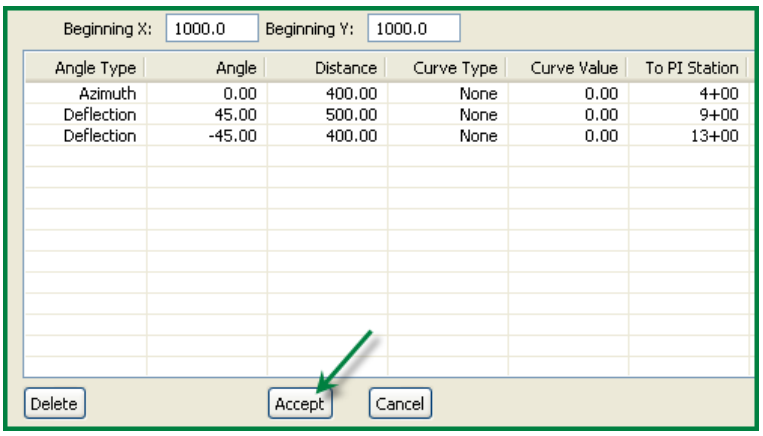


Curves. Alignments can have straight line segments, or can be defined by curve data. Each curve may be defined in one of several parameters; all of the other parameters will be computed. Note that the Arc Method is used to define the curves in SET. Refer to the Engineering Field Handbook, Chapter 1 for definitions and a full explanation of horizontal curves.



- **None** - no curve is simply a straight alignment to the next PI station
- **Degree of Curvature** - enter the degree of curve subtended by a chord of 100 feet.
- **Radius** - enter the radius of the circle that describes the curve (in feet)
- **Tangent** - enter the distance from the PC to the PI (in feet)
- **External** - enter the external distance from the mid-point of the curve to the PI
- **Curve Length** - enter the distance along the curve from the PC to the PT

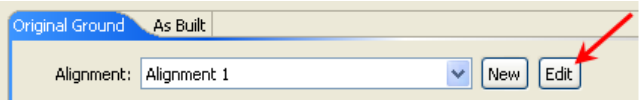
Once the alignment is entered, press the Accept button to save the alignment and return to the Input Editor.



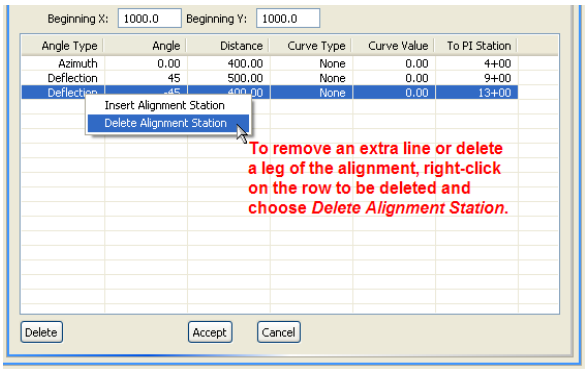
Angle Type	Angle	Distance	Curve Type	Curve Value	To PI Station
Azimuth	0.00	400.00	None	0.00	4+00
Deflection	45.00	500.00	None	0.00	9+00
Deflection	-45.00	400.00	None	0.00	13+00

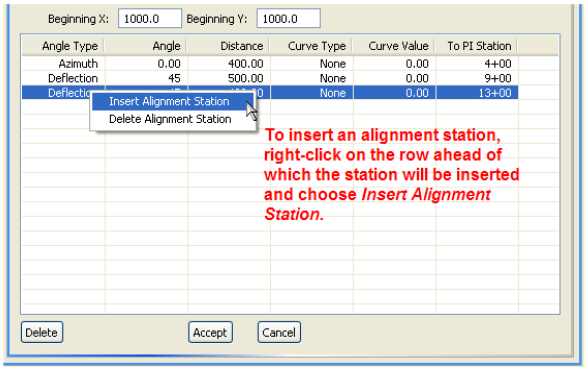
Editing and Deleting Alignments

To edit an existing alignment, choose it from the drop-down box and press the **Edit** button.

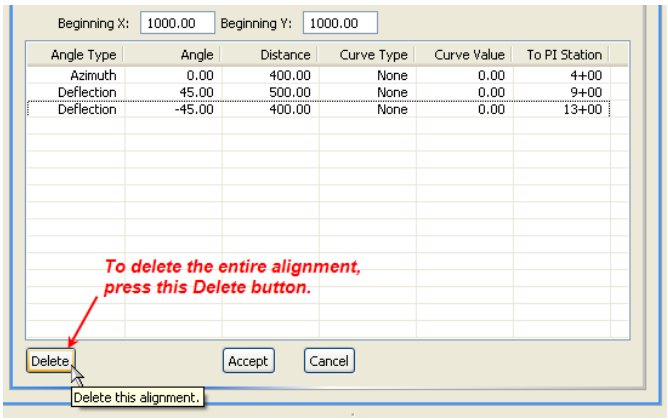


You may edit the alignment by changing the values directly in the table. To remove a segment of the alignment (or to remove an extra row of data in the alignment screen), right-click and select **Delete Alignment Station**. Insert an alignment station by right-clicking the row where the station is to be inserted, and select **Insert Alignment Station**. A blank row will open in front of the highlighted row where you can add the alignment information for the inserted station. Press the ***Accept*** button to save the changes, or the ***Cancel*** button to go back to the Offset Data screen without saving any changes.



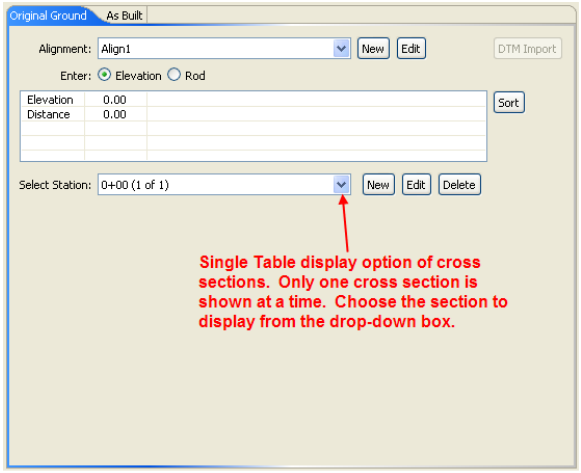


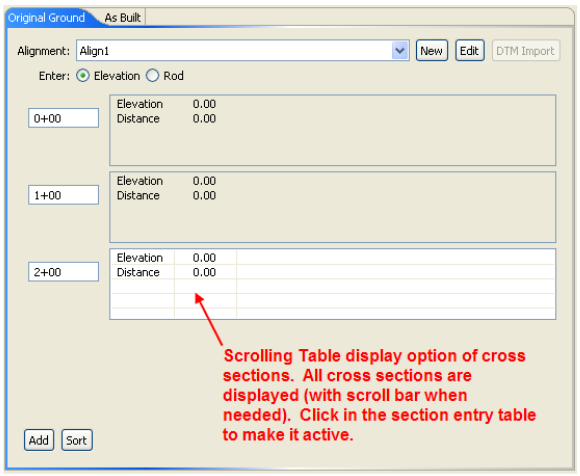
To delete the entire alignment, press the Delete button.



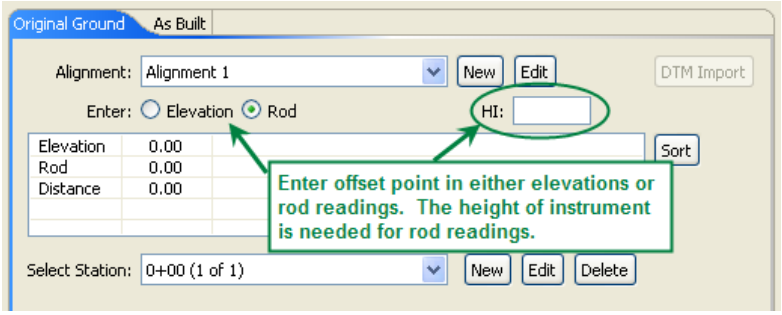
2.2.4. Entering offset data

You have the option of displaying the cross sections in a single table, where only one section is displayed at a time, or in a scrolling table that shows all the sections. The scrolling table is the default, but you can change this default in the Station/Offset Survey section in Preferences. See the **Preferences** section in this user manual. The two types are displayed below. The remaining screen shots and instructions show the Single Table method, with comments added when using the Scrolling Tables.

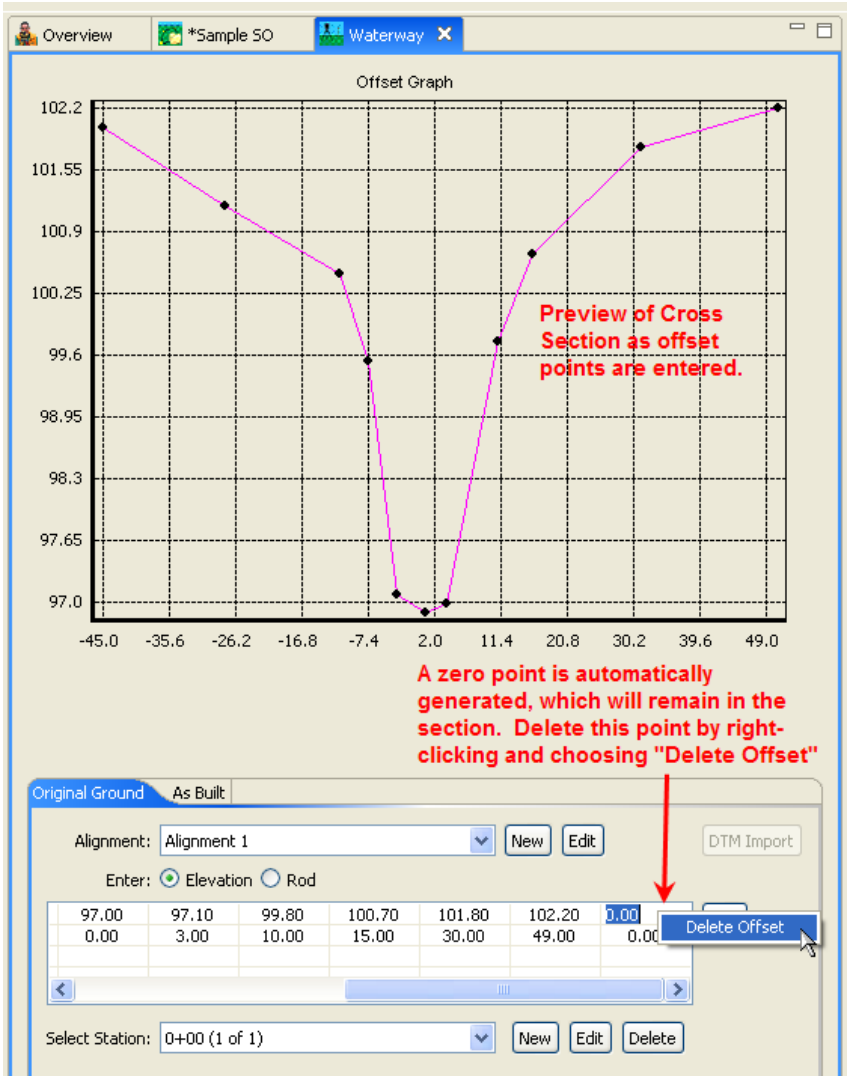




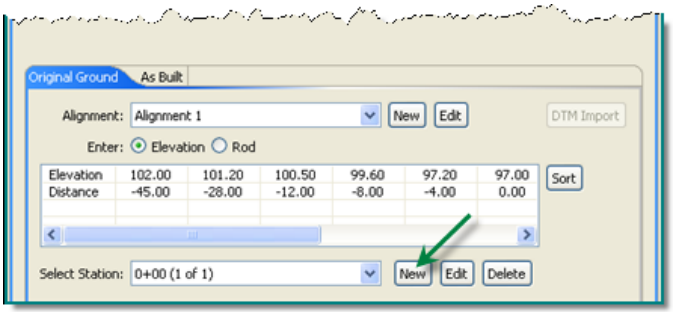
Once the alignment is defined (or the simple alignment is used), begin entering cross section (offset) points. Enter your point data using rod readings or elevations. Enter an HI elevation to compute cross section elevations from rod readings. Use the Enter or Tab keys to advance through the table.



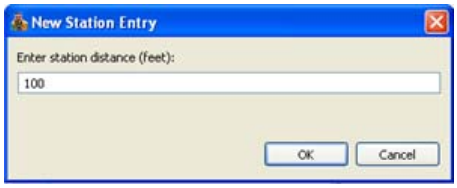
As you enter the offset data, the Offset graph will show the cross section. Note that a zero point is created after each point is entered. You must delete this point when you are done with the section. Do this by right clicking on the point (with either field active), and choose Delete Offset. The graph will now look correct.



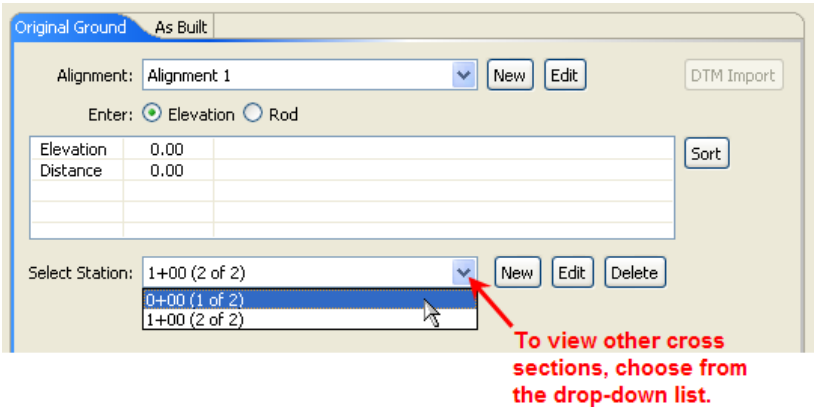
To enter the next cross section, press the **New** button to the right of the Select Station field. (for the Scrolling Table option, press the **Add** button which will create a new table to the scrolling list).



Fill in the station of the next cross section. Do not add the **"+"** symbol to the station; the program will do this.

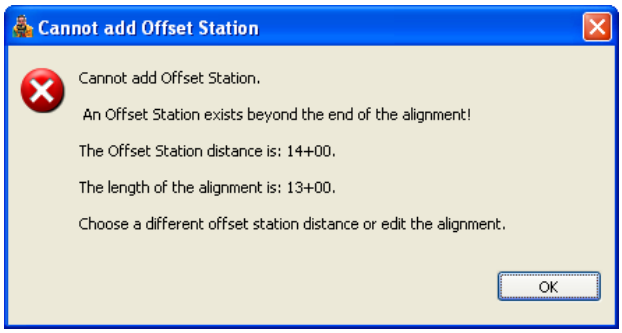


Continue entering cross sections. You can view each entered section by choosing the station from the drop-down box.

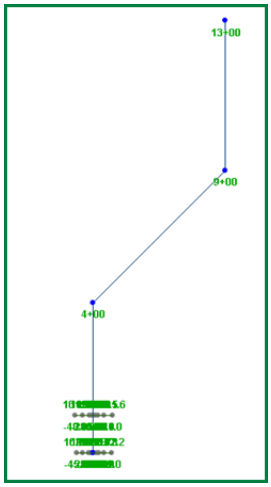


Note

If you are using the Simple Alignment, the alignment will extend automatically to accommodate the station distance. However, if you have defined an alignment, new cross section stations must be in the range between the beginning and ending station (as defined in the Alignment Editor). Otherwise, an error message will be displayed (sample message below). If you need to enter a station that is before the beginning station or beyond the ending station of an existing alignment, then you must first edit the alignment to lengthen it.



As you enter sections in the Input Editor, the survey map will display the alignment and offset data, along with the point information (you may need to press the **FULL EXTENTS** button to show the points on the map. Note that this is not the DTM. The DTM will be generated when the input editor is closed for the survey.

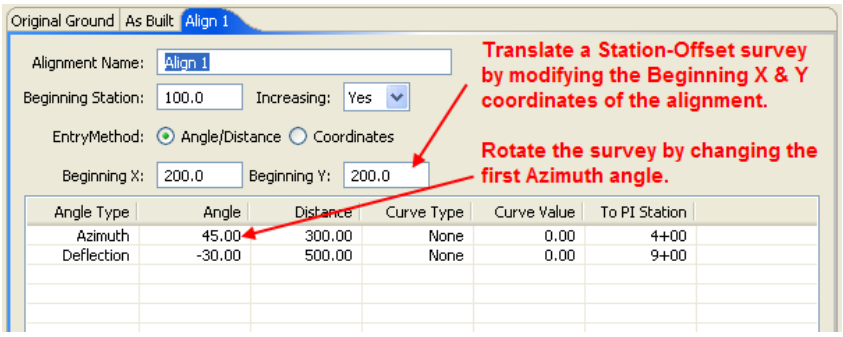


2.2.5. Translation and Rotation of Station-Offset Surveys (with user defined Alignments)

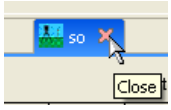
1. Station-Offset surveys can effectively be translated by modifying the Beginning X and Y coordinates of a user defined Alignment . The survey can be rotated by changing the first Azimuth angle.

Note

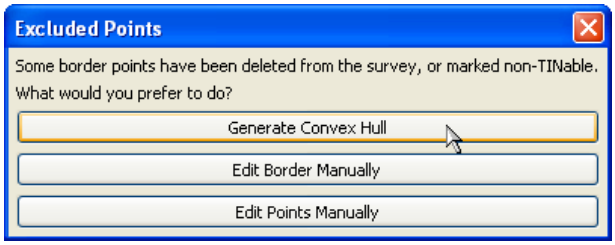
Simple alignments cannot be translated or rotated. They, by definition, begin at coordinate 0,0 and always have a zero azimuth.



2. If the translation appears correct, then close the survey editor for this Station-Offset survey.



3. Since the border of the original DTM no longer contains the translated survey points, the Excluded Points error message displays, prompting you to fix the border. Choose the **Generate Convex Hull** option. A revised DTM of the translated points will be processed. Press the Full Extents button again to bring the survey map to the new DTM.

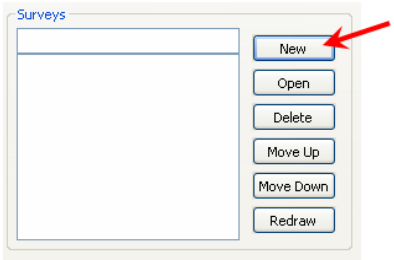


2.3. Radial Survey Input

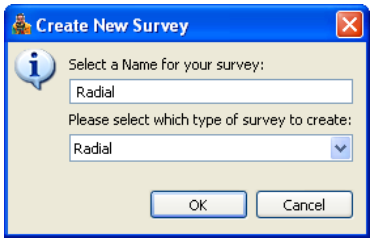
Radial surveys are entered manually into the radial survey editor.

2.3.1. Create a New Radial Survey

1. On the Project Info tab, press the NEW button next to the Surveys List.

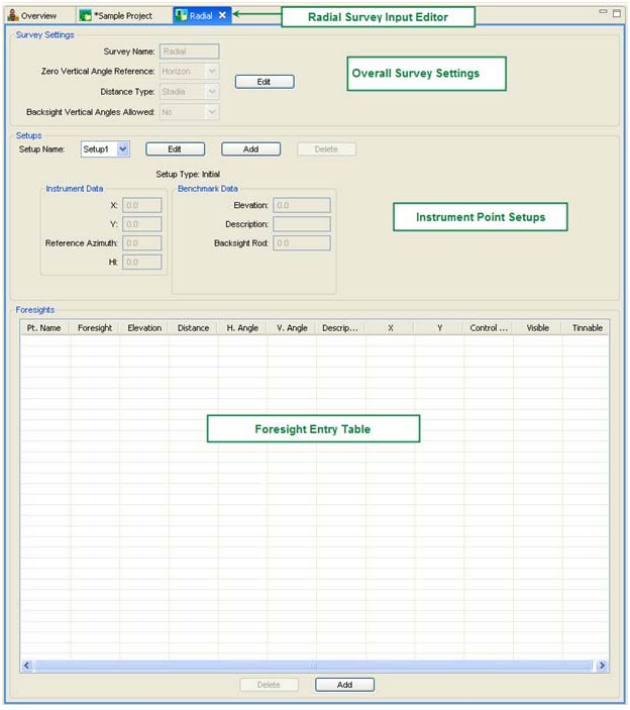


2. Enter the name of this survey in the popup window, and be sure Radial is shown in the Survey type drop-down list. Click OK and the Station Offset Input Editor will open.



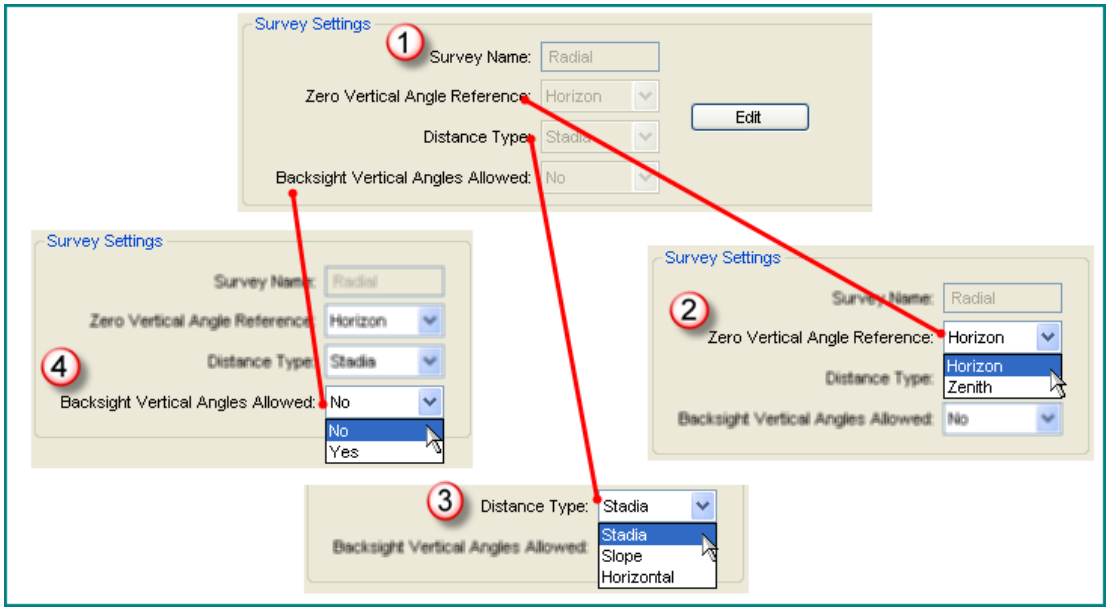
2.3.2. Radial Survey Input Editor

The Radial Survey Input Editor opens as shown below. The Survey Settings for the entire survey are shown at the top. In the center section is where the Instrument Setup data is entered. The bottom section is where the Foresights are entered.



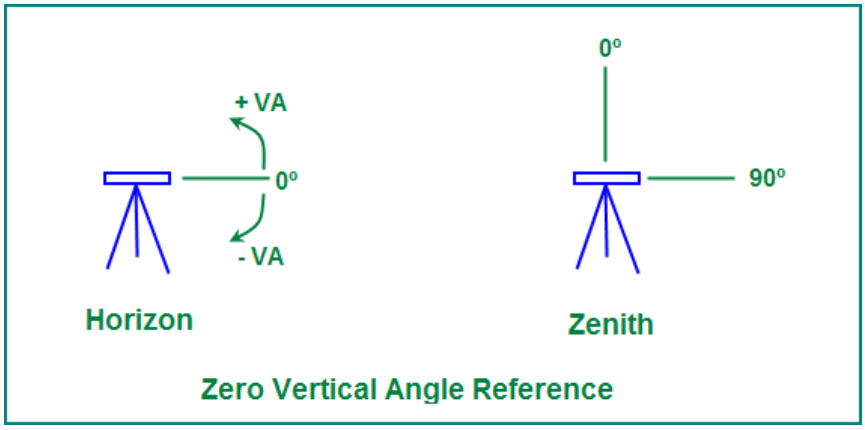
Survey Settings

The survey settings affect the entire radial survey. The setting choices are shown and described below:



1. **Survey Name** is as entered when creating the survey. The name cannot be changed here.

2. **Zero Vertical Angle Reference** refers to whether the zero degree reference for vertical angles points on the horizon or points straight up (Zenith). Horizon is the default reference. Vertical angles are entered differently depending on the reference chosen, as shown in the following schematic. Note that the default condition can be changed in the Radial Survey section in Preferences. Refer to the **Preferences** section of this user manual.

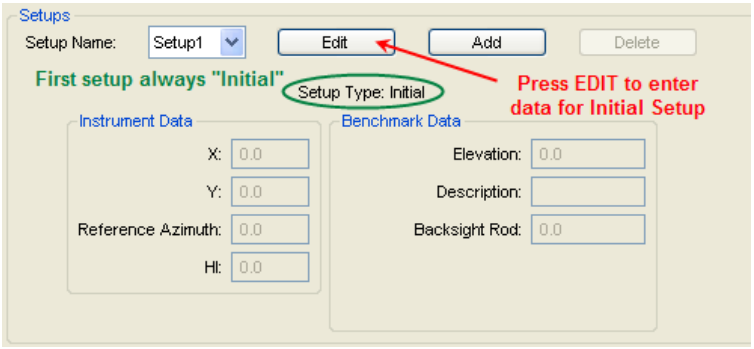


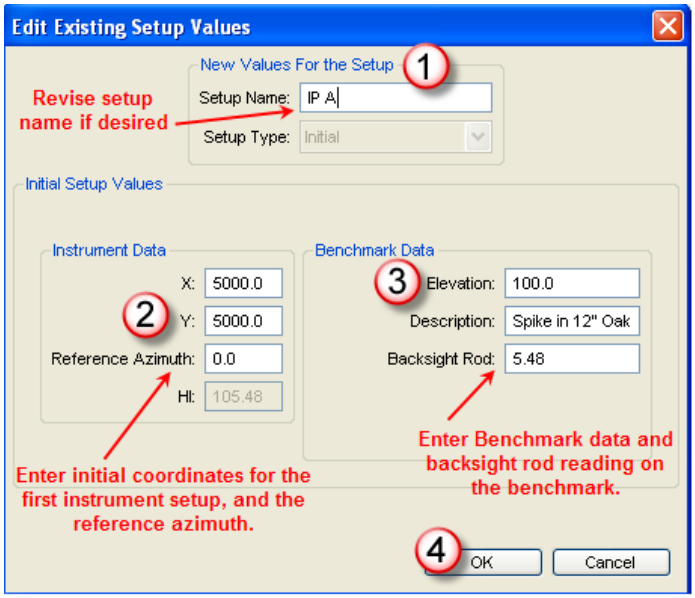
3. **Distance Type** refers to how the distance measurements are taken. The most common is Stadia distance, and is the default. If the slope distance or horizontal distances were measured, then choose the appropriate type. Note that the default condition can be changed in the Radial Survey section in Preferences. Refer to the **Preferences** section of this user manual.

4. **Backsight Vertical Angles Allowed** asks the user whether or not vertical angles were taken on backsight shots from TBMs or TPs. Using vertical angles on backsight shots is not normally good survey practice, but is sometimes necessary. The default is No. Note that the default condition can be changed in the Radial Survey section in Preferences. Refer to the **Preferences** section of this user manual.

Initial Setup

The name of the first instrument setup type in a radial survey is always called the `Initial` setup. To enter the specific instrument data and backsight data for the initial setup, press the `Edit` key.





1. You may change the name of the initial setup if you wish.

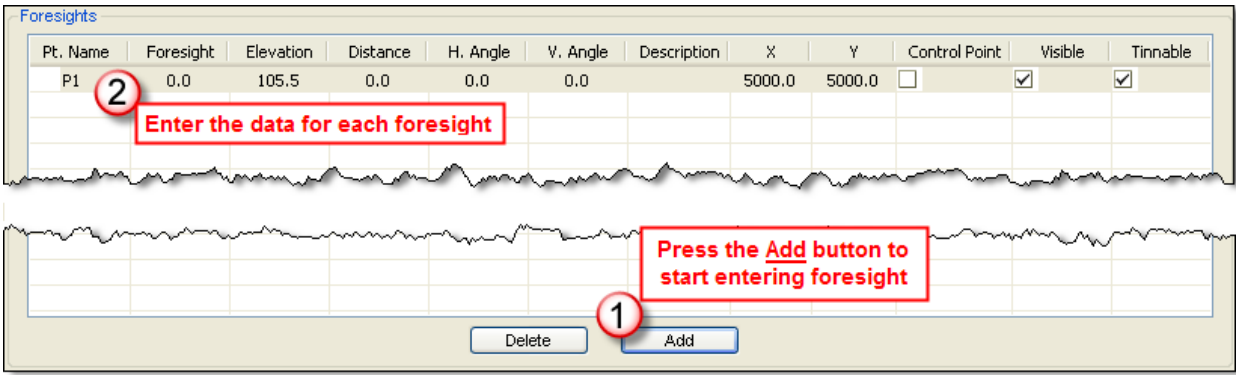
2. Enter the X & Y coordinates of the instrument, and the reference azimuth. For instance, if you set the zero azimuth of the instrument to magnetic north, then enter zero degrees as the reference azimuth.

3. Enter the Benchmark Data: the elevation and description of the benchmark, and the rod reading of the Backsight shot taken on the benchmark.

4. Press OK to accept the Setup values for the Initial Instrument Setup.

Foresights table

Now, you are ready to enter foresights taken from the first instrument point. First, press the ***Add*** button, then enter the foresight data. The point name is automatically incremented (P1, P2, etc), but you can overwrite the name if you wish. Pressing the Tab key or the Enter key will advance the cursor to the next field. The elevation and X & Y coordinates of each shot are computed as the data is entered.

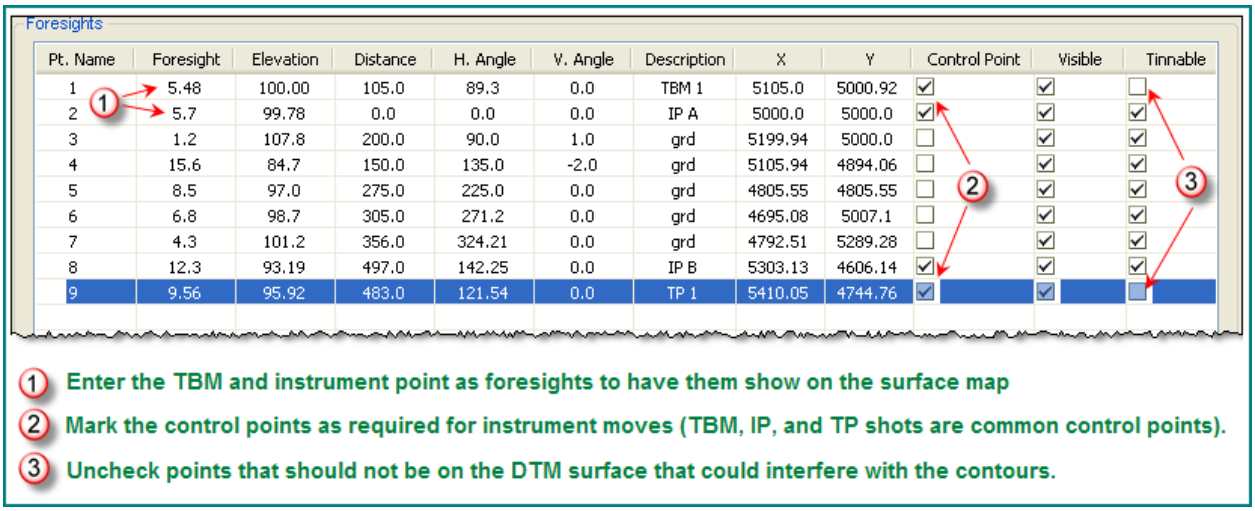


Point Attribute Checkboxes

1. **Including Benchmark and Instrument Points on the Map** - To include the initial benchmark and instrument point on the map, you will need to enter them as foresight shots as shown below.

2. **Control Points** - If the survey involves more than one instrument point, then certain foresights will need to be marked as control points. Control points are those locations that will be sighted from future instrument points for either vertical or horizontal control. Examples are benchmarks, turning points, and instrument points. Simply click the control point checkbox to mark points as control points. Uncheck the box to unmark them.

3. **Visible and Tinnable Points** - You have the option to exclude certain points from the surface map by making them invisible. An example might be a check shot on a benchmark that might clutter the map. You also can make points untinnable, which means that they will be visible but will not be included on the DTM. Examples are benchmarks and turning points that are not on the ground and could bias the contour map. Uncheck the checkboxes to mark the points. Note that invisible points are automatically mark untinnable, and conversely tinnable points must be visible.



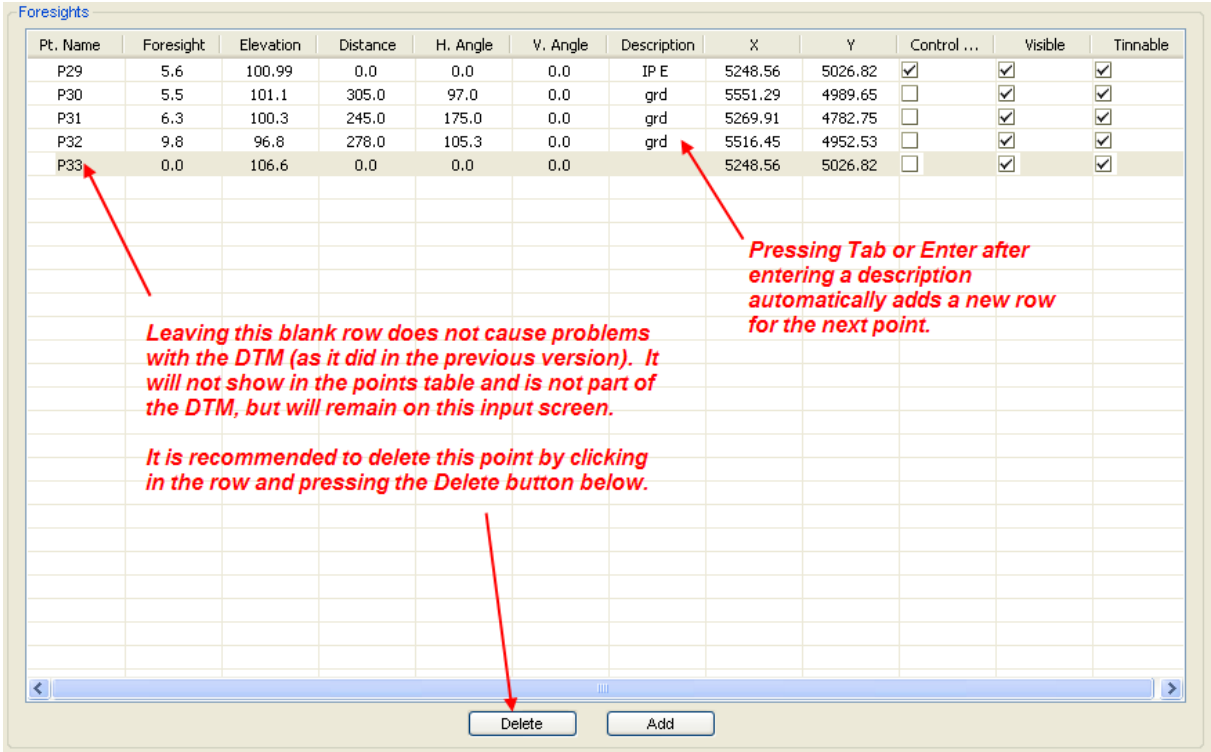
Deleting Foresights

To delete foresight shots, simply click on the row containing the foresight entry and press the Delete key.

Note

As you enter foresight shots, a new row is automatically generated with the next available point number and with zero entries. If the previously entered foresight was the last to be entered in the table, then this blank row should be deleted. This blank point will not show on the map or in the project points list, but will remain on this input screen. Again, to delete this foresight, click on the row and

press the Delete key. In the example below, if point P32 is the last point to be entered in this table, then the blank foresight should be deleted.



2.3.3. Instrument Move Types

Four types of instrument moves are supported by SET. With all of these methods, the horizontal orientation is maintained throughout the survey.

1. **North at Point** The most common method is when the surveyor shoots a new point to where the instrument will be moved. First, a turning point is shot to transfer elevation. Then the next instrument point is shot, and the inner base plate of the instrument (horizontal orientation) is locked. The instrument is then moved to the new point. By plunging the scope and aligning the outer base plate on the previous point the original reference position for horizontal angles is maintained throughout the survey. The surveyor will then lock the outer baseplate, unlock the inner baseplate, replunge the scope, then backsight on the turning point to establish the height of instrument (HI) at the new instrument point. Now the instrument is ready to shoot additional points (foresights). For those who are familiar with the Ohio SSRP program, this instrument move was called "Orient on North from Predetermined Point (plunge)."

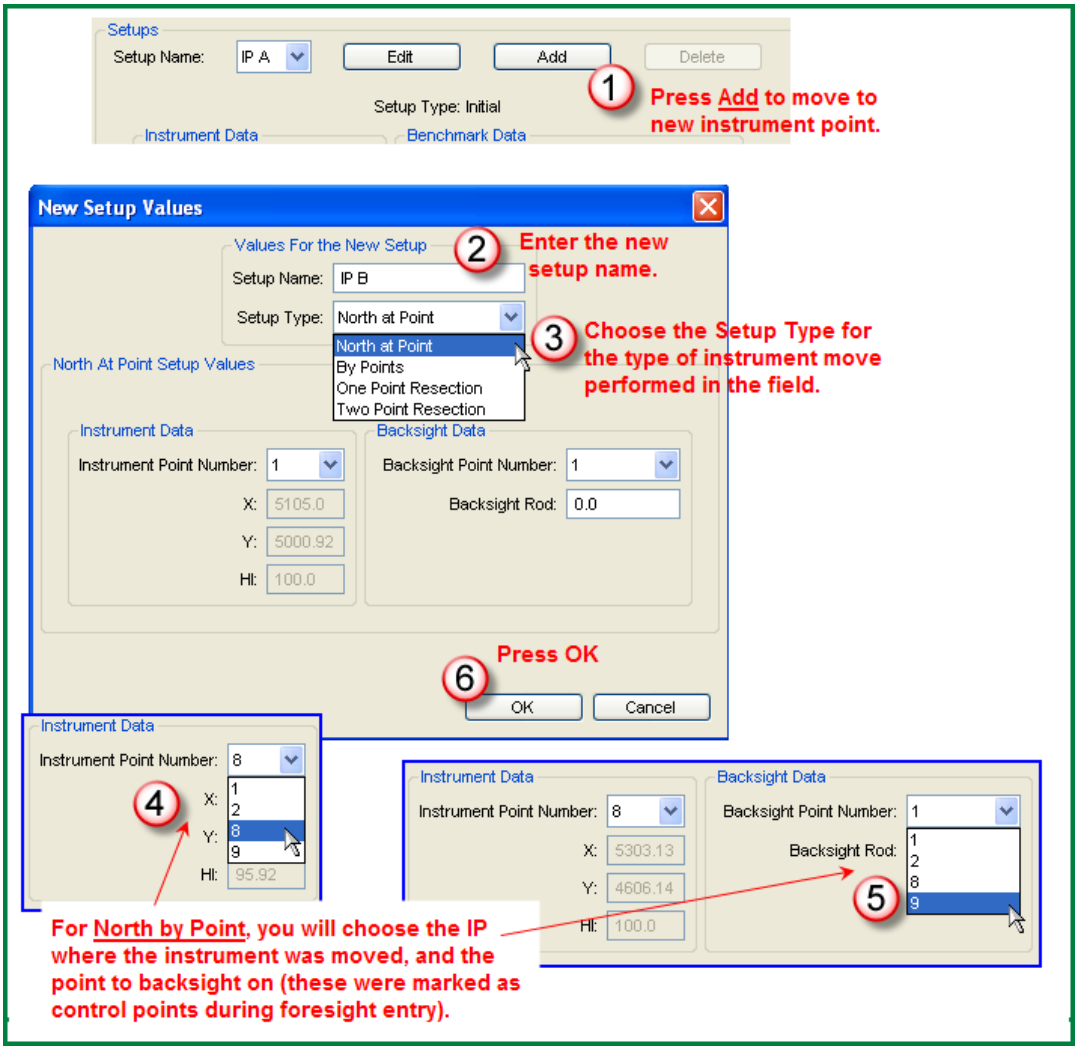
2. **By Points** This is similar to the previous method (instrument is moved to a previously surveyed point), but instead of plunging the scope, the user may Zero the reference position on any existing point. In this case the measured horizontal angle is not the typical north azimuth angle. In SSRP this was called "Previously Surveyed Point with a New Orientation."

3. **One Point Resection** This is where the instrument is set up on a random unknown point. The horizontal reference angle is set via the compass to magnetic north. Then a known point is shot (horizontal angle and distance). This provides the position of the instrument. The same point also serves as the turning point for elevation, so shooting this point is treated as a backsight. In SSRP this method was called "North Orientation with Instrument at a Random Point."

4. **Two Point Orientation** This last method is similar to One Point Resection, except that distance and angle are measured to two known points. The position of the new point and reference orientation are calculated from these two points. Note that the second point is treated as a backsight so that the elevation can be computed. In SSRP this method was called "2 Point Orientation with Instrument at a Random Point".

Adding Instrument Setups (Moves)

To add a new instrument setup, follow the steps below:



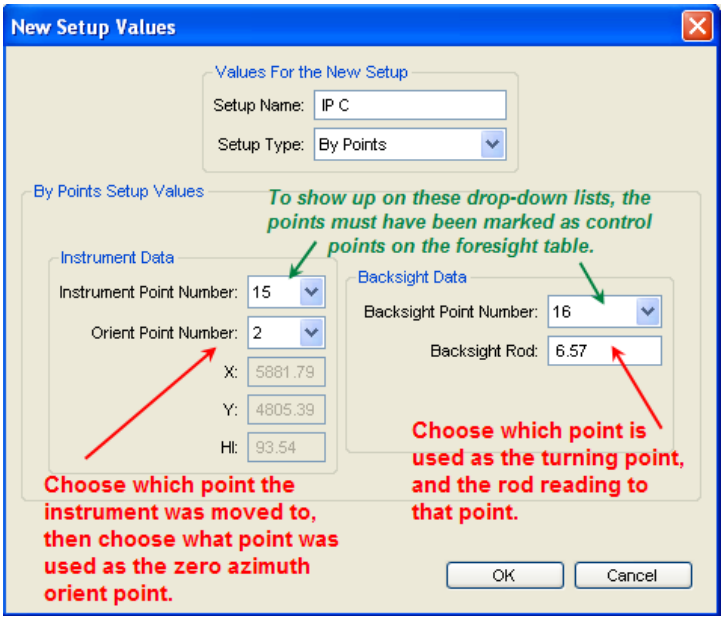
1. Press the Add button in the Setups section of the Radial survey editor. The New Setup Values window will display.

2. Enter a new setup name or accept the default name presented.

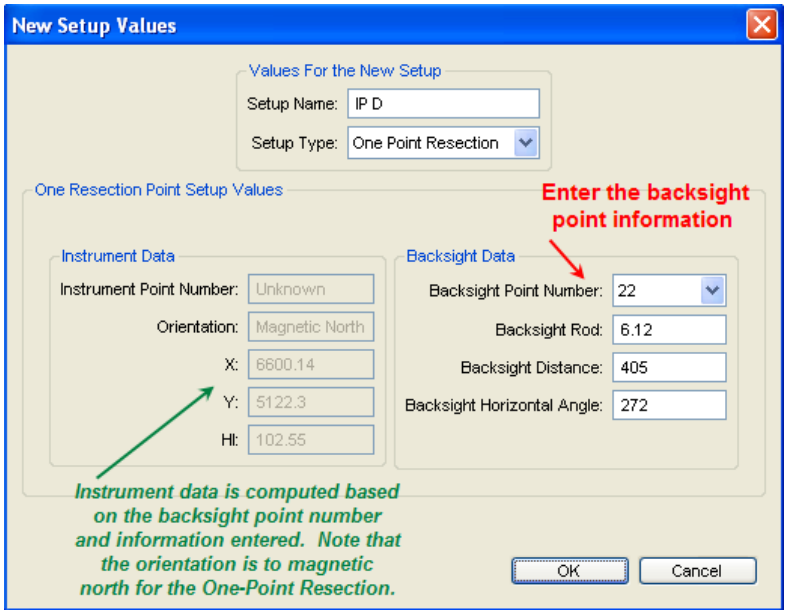
3. Choose the Setup Type that represents the method of moving the instrument performed in the field. The Instrument and Backsight data to be entered will depend on the type of instrument move:

   a) **North at Point** (shown above) - choose the point number that the instrument was moved to from the drop-down list. This point was surveyed from the previous instrument location. Note that to be listed on this drop-down list, the point must be marked as a control point in the foresight table when the point was entered. Next, choose the Backsight point number, and the backsight rod reading. Then press OK. A new Foresight table will be shown.

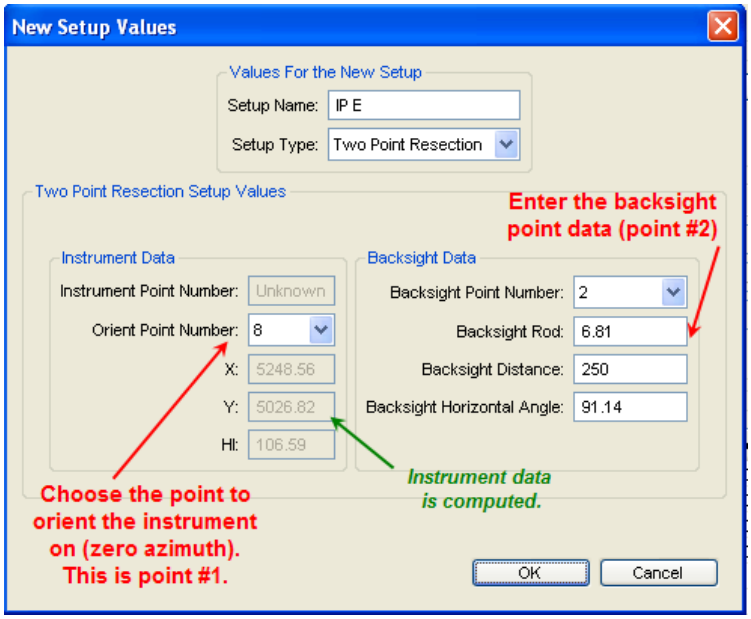
b) **By Points** - for this instrument move, choose the point number that the instrument was moved to from the drop-down list. Also, choose the Orient point number (where the instrument was set to zero azimuth). Next, choose the Backsight point number, and the backsight rod reading. Then press OK. A new Foresight table will be shown.



c) **One Point Resection** - For this move, the instrument is set up at an unknown location, which will be computed. You must choose the backsight point number from the drop-down list, then provide the rod reading, distance, and horizontal angle from the instrument to the backsight point. Note that the zero azimuth reference angle is assumed to be pointed to magnetic north for this instrument setup type. Then press OK. A new Foresight table will be shown.

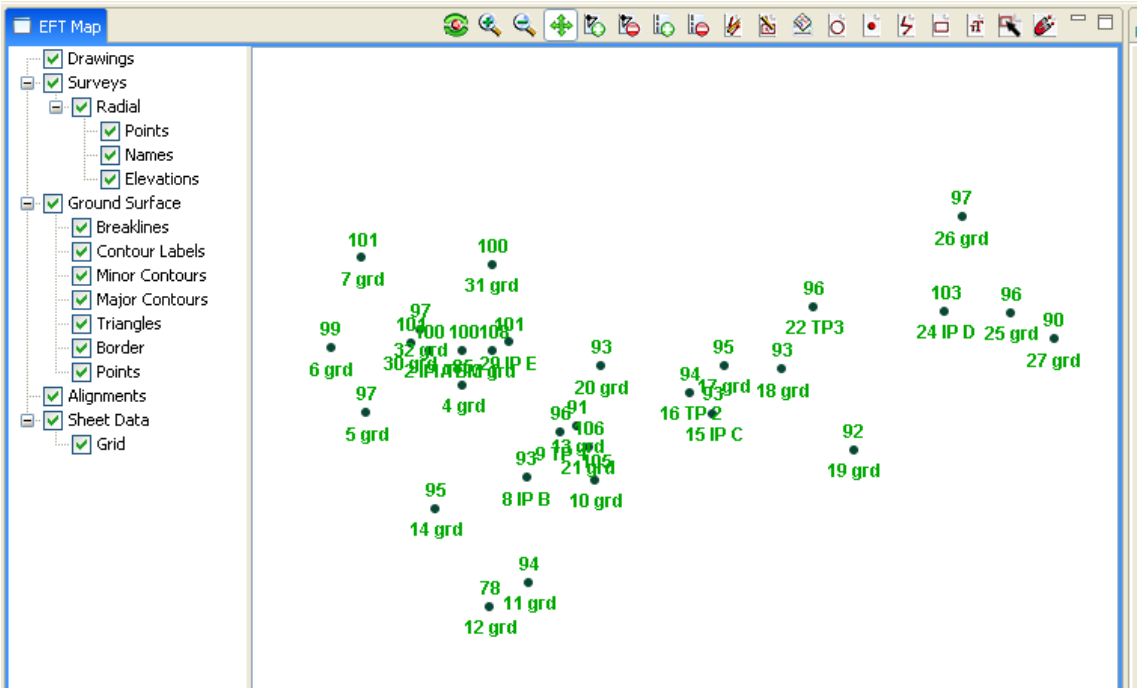


d) **Two Point Resection** - Like the one point resection, the instrument is set up at an unknown location which will be computed. The difference is that the instrument is oriented (zero azimuth) on a known point instead of magnetic north. Choose this orient point from the drop-down box. Then, choose the backsight point number from the drop-down list and provide the rod reading, distance, and horizontal angle from the instrument to the backsight point. Then press OK. A new Foresight table will be shown.

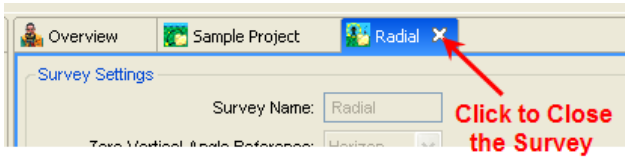


2.3.4. Survey Map

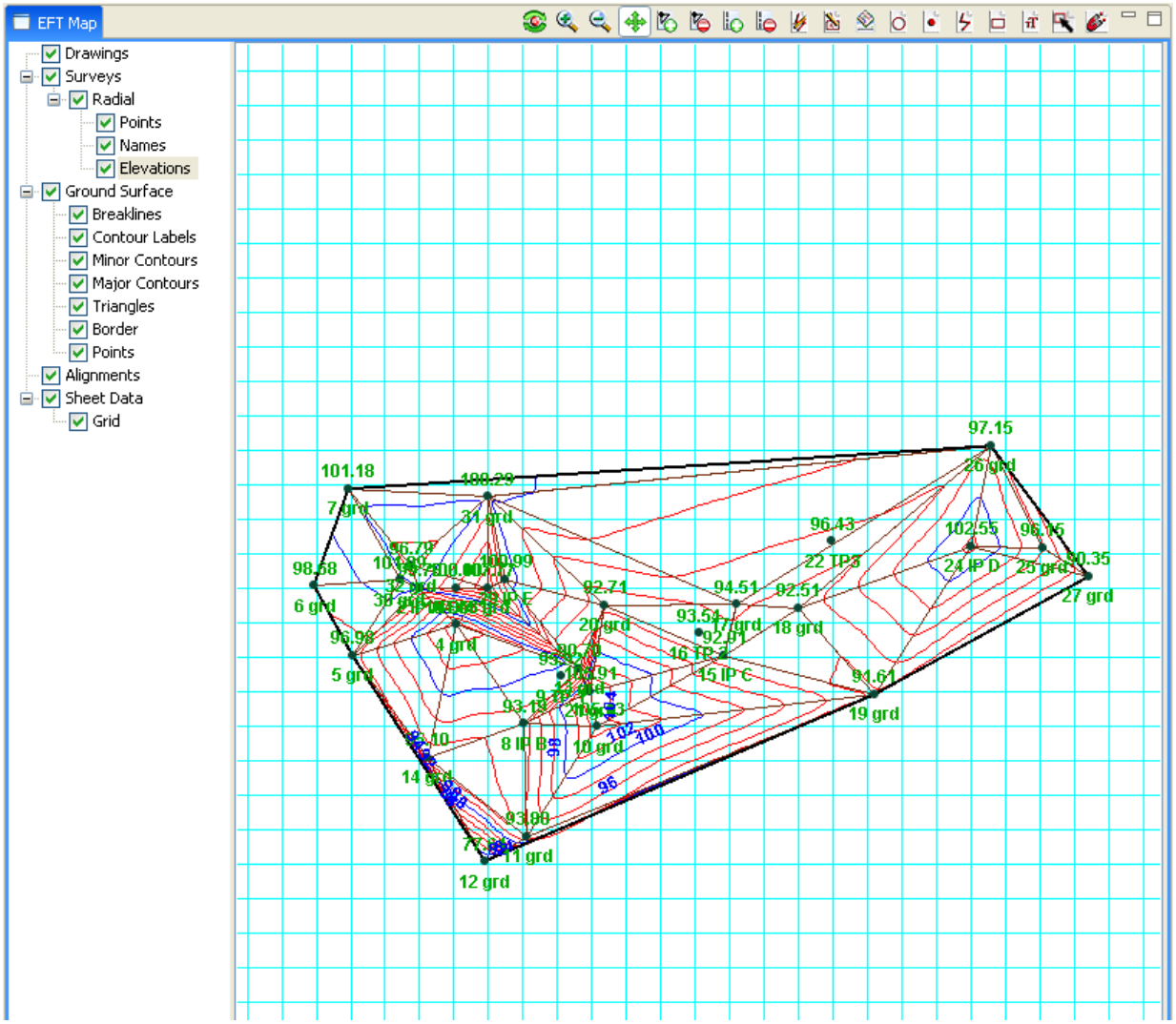
As the radial survey is entered, the points are displayed on the map. While the radial survey is open, the DTM is not displayed. You may need to press the **FULL EXTENTS** button to see the survey.



To close the survey and display the contour map, click on the X on the survey name tab.



Now, the survey map screen will display the DTM of the radial survey.



Also, you can view the project points in X,Y,Z format by choosing the Project Points tab.

Overview | Sample Project

Project Info | Project Points | Cut / Fill

Point Name	X (Easting)	Y (Northing)	Z (Elevati...	Visible	TINable	Description
6	4695.08	5007.1	98.68	☑	☑	grd
7	4792.51	5289.28	101.18	☑	☑	grd
5	4805.55	4805.55	96.98	☑	☑	grd
30	4943.57	5024.78	101.09	☑	☑	grd
32	4973.34	5066.07	96.79	☑	☑	grd
2	5000.0	5000.0	99.78	☑	☑	IP A
14	5021.37	4509.12	95.1	☑	☑	grd
1	5105.0	5000.92	100.0	☑	☐	TBM 1
4	5105.94	4894.06	84.65	☑	☑	grd
12	5188.5	4206.38	77.64	☑	☑	grd
31	5196.02	5266.12	100.29	☑	☑	grd
3	5199.94	5000.0	107.77	☑	☑	grd
29	5248.56	5026.82	100.99	☑	☑	IP E
8	5303.13	4606.14	93.19	☑	☑	IP B
11	5311.19	4280.24	93.8	☑	☑	grd
9	5410.05	4744.76	95.92	☑	☐	TP 1
13	5461.54	4767.33	90.7	☑	☑	grd
21	5494.66	4701.3	105.91	☑	☑	grd
10	5515.76	4599.33	105.13	☑	☑	grd
20	5536.47	4951.61	92.71	☑	☑	grd
16	5810.5	4870.26	93.54	☑	☐	TP 2
15	5881.79	4805.39	92.91	☑	☑	IP C
17	5917.14	4953.22	94.51	☑	☑	grd
18	6096.74	4942.59	92.51	☑	☑	grd
22	6195.39	5136.43	96.43	☑	☐	TP 3
19	6318.19	4691.58	91.61	☑	☑	grd
24	6600.14	5122.3	102.55	☑	☑	IP D
26	6655.96	5414.01	97.15	☑	☑	grd
25	6806.08	5117.21	96.15	☑	☑	grd
27	6938.99	5034.67	90.35	☑	☑	grd

2.3.5. Visible and TINable Point Options

You have the option to exclude certain points from the surface map by making them invisible. An example might be a check shot on a benchmark that might clutter the map. You also can make points untinnable, which means that they will be visible on the map, but will not be included on the DTM. Examples are benchmarks and turning points that are not on the ground and could bias the contour map. Uncheck the checkboxes to mark the points invisible or unTINable. Note that invisible points are automatically mark untinnable, and conversely tinnable points must be visible.

Foresights

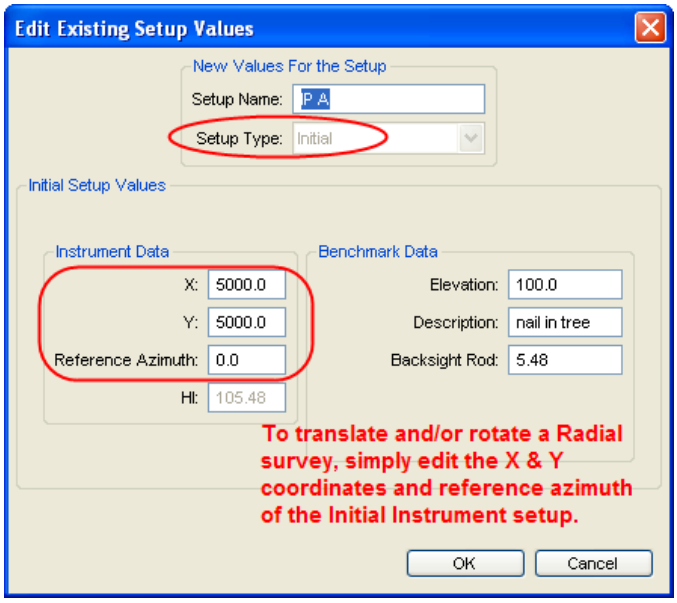
Pt. Name	Foresight	Elevation	Distance	H. Angle	V. Angle	Descri...	X	Y	Contro...	Visible	Tinnable
1	5.48	100.00	105.0	89.3	0.0	TBM1	5105.0	5000.92	☑	☑	☐
2	5.7	99.78	0.0	0.0	0.0	IP A	5000.0	5000.0	☑	☑	☑
3	1.2	107.8	200.0	90.0	1.0	grd	5199.94	5000.0	☐	☑	☑
4	15.6	84.7	150.0	135.0	-2.0	grd	5105.94	4894.06	☐	☑	☑
5	8.5	97.0	275.0	225.0	0.0	grd	4805.55	4805.55	☐	☑	☑
6	6.8	98.7	305.0	271.2	0.0	grd	4695.08	5007.1	☐	☑	☑
7	4.3	101.2	356.0	324.21	0.0	grd	4792.51	5289.28	☐	☑	☑
8	12.3	93.19	497.0	142.25	0.0	IP B	5303.13	4606.14	☑	☑	☑
9	9.56	95.92	483.0	121.54	0.0	TP 1	5410.05	4744.76	☑	☑	☐

Tip

It's recommended to mark points unTINable or invisible in the original Radial survey editor, and not the project points table.

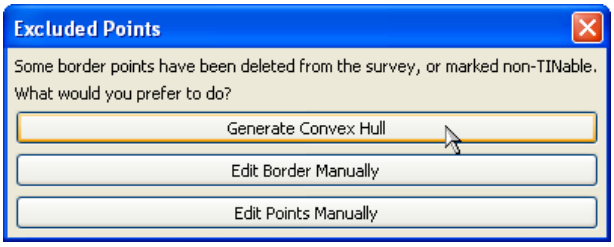
2.3.6. Translation and Rotation of Radial Surveys

1. Radial surveys can effectively be translated by modifying the X and Y coordinates of the Initial Instrument setup. A Radial survey can be rotated by modifying the reference azimuth.



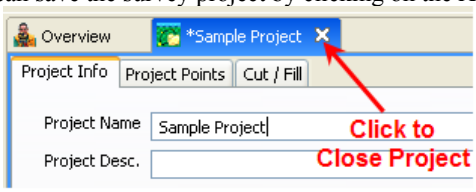
2. If the translation appears correct, then close the survey editor for this Radial survey.

3. Since the border of the original DTM no longer contains the translated survey points, the Excluded Points error message displays, prompting you to fix the border. Choose the **Generate Convex Hull** option. A revised DTM of the translated points will be processed. Press the Full Extents button again to bring the survey map to the new DTM.

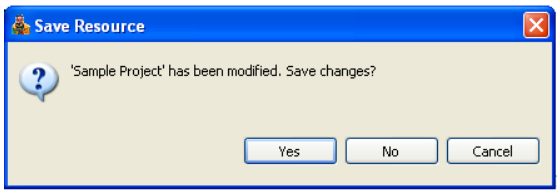


2.4. Saving Survey Projects

After the survey is closed, you can save the survey project by clicking on the X on the Survey Design tab.



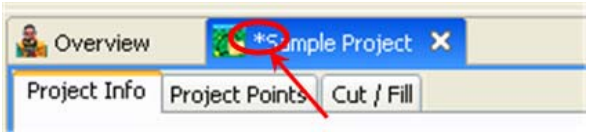
You will be prompted to save the Survey Design.



The survey design is saved as an XML file using the name of the survey design when it was created. In the example above, the Survey Design would be saved as *Sample Project.xml*.

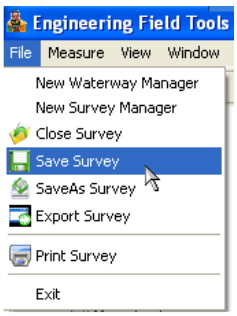
Note

If you make changes to an existing survey, the change should trigger a flag that will prompt you to save the changes when the project is closed. This flag is noted by a small asterisk next to the project name on the Project Tab.



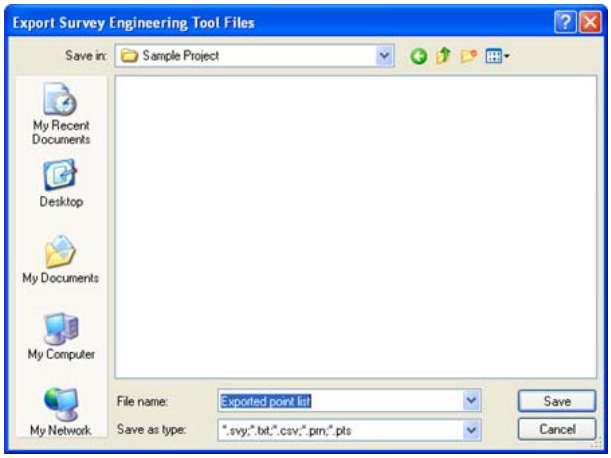
The program will also save the settings in the Legend (see the `Legend Layer Properties` section below).

If you make changes that you wish to save, and the asterisk does not display, then be sure to save the file before closing the project by choosing Save from the File menu (click on the Survey Design Tab first to activate the File menu).



2.5. Exporting Survey Projects

You can export the project points with one of five file extensions (.svy, .txt, .csv, .prn, or .pts). All formats include the Point Name, X, Y, and Z coordinates, and the Description. All files are in the PENZD format. The **svy** format is the SET standard point file format and includes the Tinnable and Visible data (true or false). Note that if no file extension is provided, then the file will be saved as a .svy file.



3. Project Points Table

The Project points tab contains the project points table. The table compiles all of the points from all surveys in the survey list for the current design. Radial and Station-Offset surveys are converted to X, Y, and Z coordinates. Point data in the project point table cannot be edited from within the table; the survey from which the points were entered must be opened to edit the points.

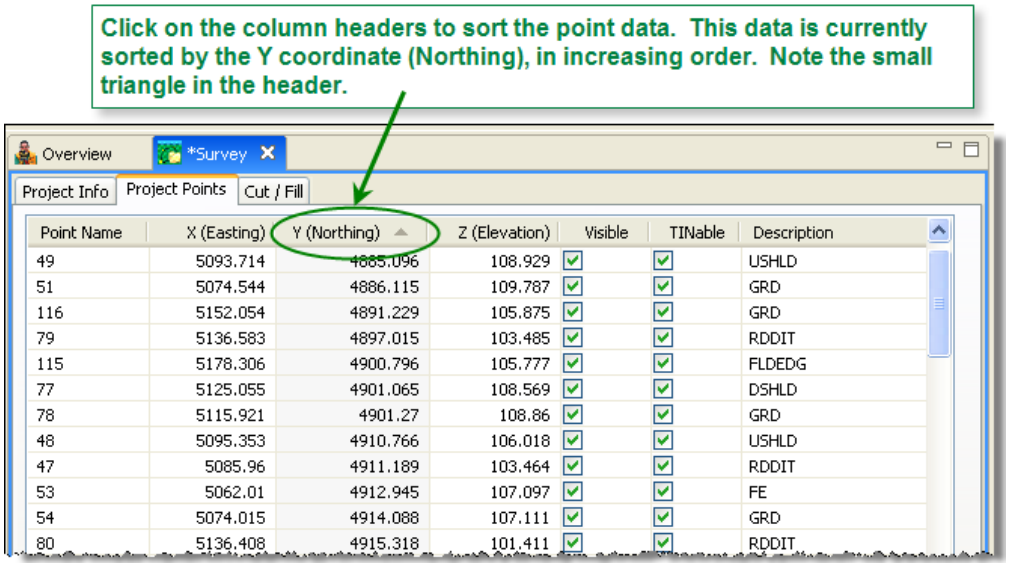
3.1. Table operations

Points in the table can be sorted, and points can be isolated to find them easier on the map when performing other functions, like drawing lines, measuring, or adding breaklines.

3.1.1. Sorting

When a survey is entered or imported, the points are sorted in the same order as they were entered. The points may be sorted by any of the fields by clicking on the column header. For example, clicking on the Y column will sort the points in order of the Northing coordinate, from lowest to highest value. Clicking on the same column again will sort the points the opposite way, from highest to lowest. Clicking a third time will return to the default sort order (order of entry).

Upon reopening a survey design, after it has been saved and closed, the points in the project points table will be sorted by the Point Name using an alphabetical sort.



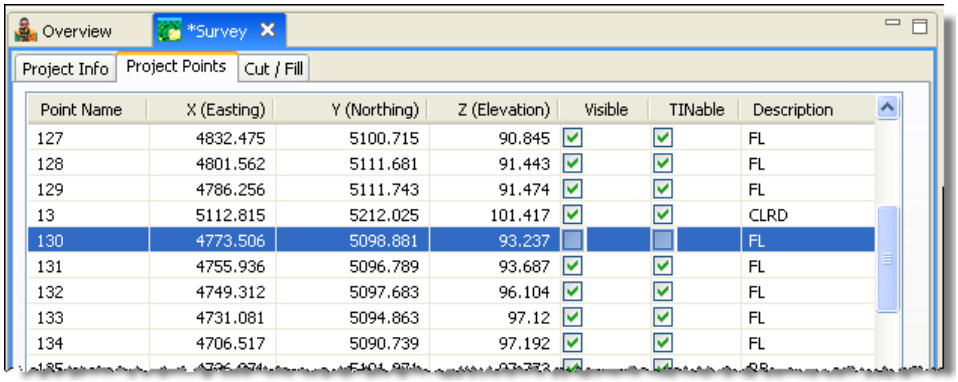
3.1.2. Visible and TINable options

Note

Although you can exclude points from the DTM within the project points table, the changes will not be saved. You must exclude the points using the survey editor where the point was entered. However, excluding points in the project points table gives you immediate feedback on the surface map, and is handy for trial and error situations where you need to see which points need to be excluded to make the ground surface look correct. Once you find the points to exclude, go to the corresponding survey input editor to mark the points unTINable or invisible.

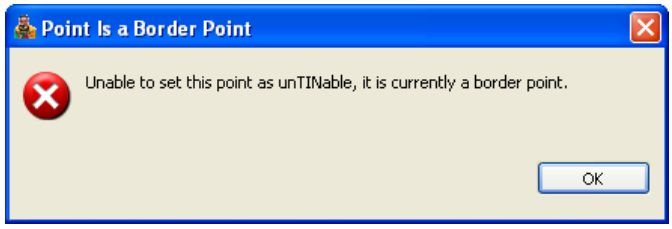
To make a point invisible on the survey map, uncheck the Visible checkbox for the point. Note that invisible points are also excluded from the DTM (the TINable checkbox is automatically unchecked).

To exclude a point only from the DTM, uncheck the TINable checkbox for the point. The point will remain on the survey map, but will not influence how the contours are drawn. It is common to exclude points that are not on the ground (TBMs, for example) that would improperly influence the contours.



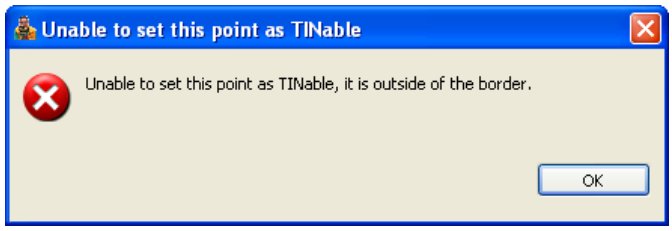
Point Name	X (Easting)	Y (Northing)	Z (Elevation)	Visible	TINable	Description
127	4832.475	5100.715	90.845	✓	✓	FL
128	4801.562	5111.681	91.443	✓	✓	FL
129	4786.256	5111.743	91.474	✓	✓	FL
13	5112.815	5212.025	101.417	✓	✓	CLRD
130	4773.506	5098.881	93.237			FL
131	4755.936	5096.789	93.687	✓	✓	FL
132	4749.312	5097.683	96.104	✓	✓	FL
133	4731.081	5094.863	97.12	✓	✓	FL
134	4706.517	5090.739	97.192	✓	✓	FL

Note that you cannot make a point that is a border point unTINable. That is, all border points must lie on the DTM. If you try, an error message will display as shown below. To remove a border point from the DTM, the point must first be deleted as a border node (See section on Borders). Then you may make the point unTINable.



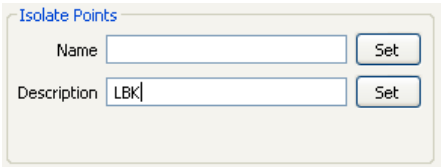
Remember that you will also get this error message if you try to make a border point invisible because making a point invisible also makes the point unTINable.

Also note that you cannot make a point that lies outside of the border a TINable point, since all points on a DTM must be within the defined border. An error message will be displayed, as shown below.



3.1.3. Isolate

You can selectively show certain points on the surface map that have the same Point Name or Point Description, turning all others off. This can aid in creating borders, breaklines, and adding drawing elements. For example, if you describe all survey shots taken of the left bank of a stream with an LBK description, then you can isolate and only display those points. In this way, it is easier to connect these points to form a breakline.



To isolate points:

1. Enter the Point Name or Description by which to isolate the points. The isolate function will only work on the Name or the Description, not a combination of both.

2. Click the **Set** button next to the corresponding entry to cause the map to display only the points with the entered name or description. Be sure the points are turned on in the Legend.

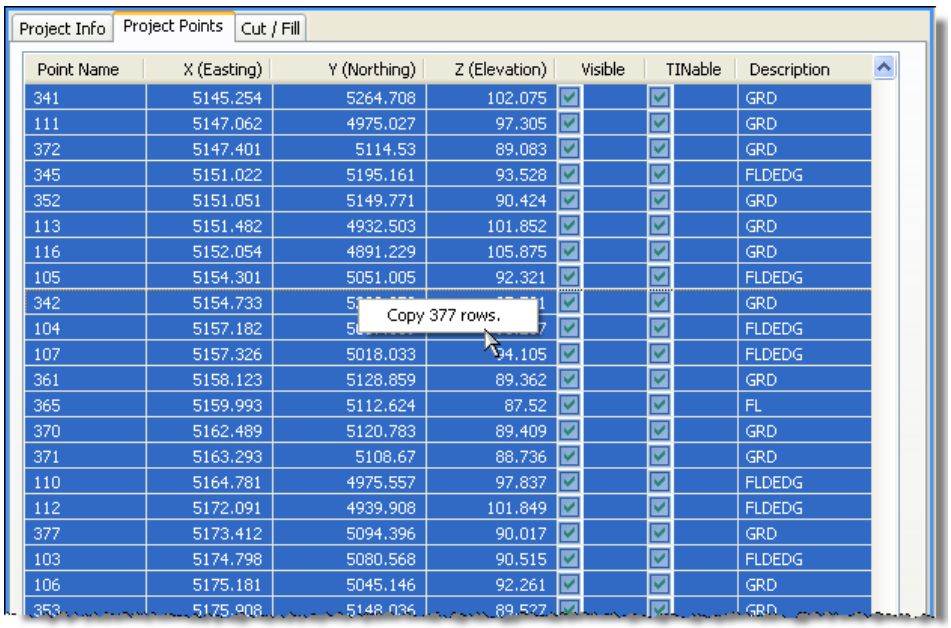
3. All points that contain the string of letters entered will be displayed. For example, if the user isolates by simply entering "L" as the description, all points that have an L in the description will be displayed (LBK, LANE, FL, INLET, etc)

4. To again show all points on the survey map, clear the entry box for the Point name or Description (highlight the entry and press the Delete key) and press the Set button again.

3.1.4. Copying Points in the Points Table

There is a Project Points report that lists all the points in the survey design. See the Reporting section for details. However, you can also copy and paste all or selected rows by following the instructions below:

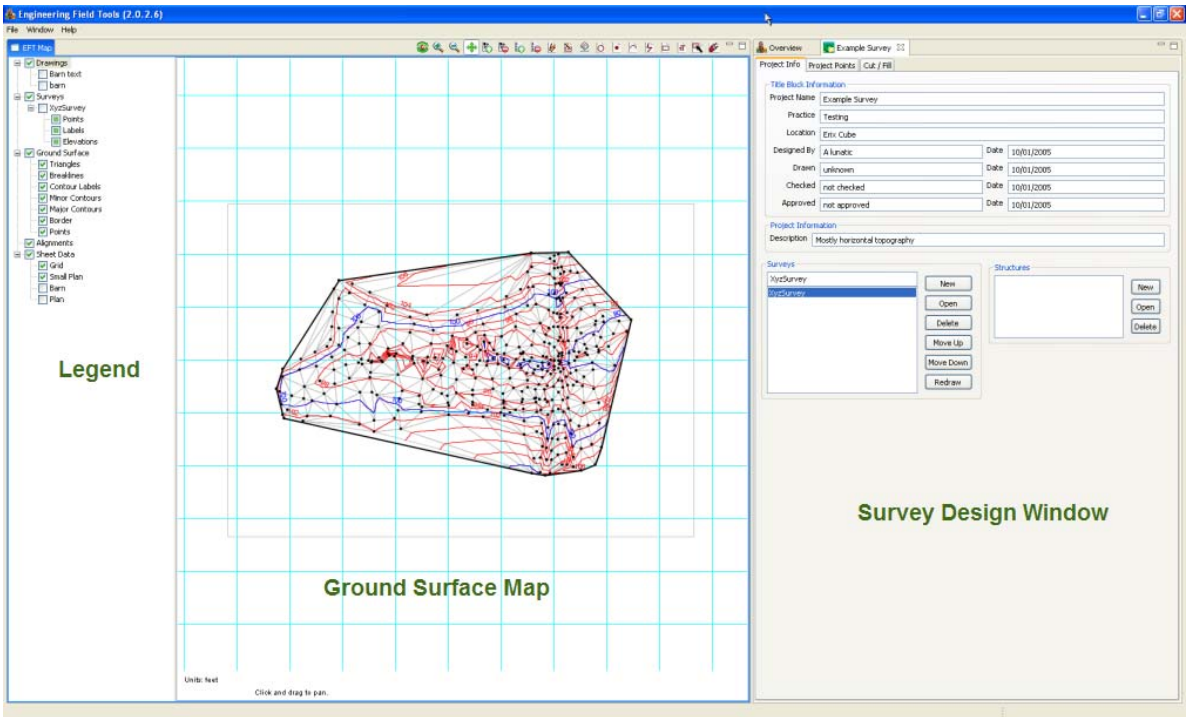
Highlight the points you want printed, then copy and paste into another program to print the list. Do this by highlighting the first point you wish to include, then hold the **Shift** key and click on the last point to be included (you may also selectively include points by using the **Crtl** key). Then, right-click within a highlighted area and choose **Copy xx rows**. You can then paste into Excel or a text editor and print the list.



Point Name	X (Easting)	Y (Northing)	Z (Elevation)	Visible	TINable	Description
341	5145.254	5264.708	102.075	✓	✓	GRD
111	5147.062	4975.027	97.305	✓	✓	GRD
372	5147.401	5114.53	89.083	✓	✓	GRD
345	5151.022	5195.161	93.528	✓	✓	FLDEDG
352	5151.051	5149.771	90.424	✓	✓	GRD
113	5151.482	4932.503	101.852	✓	✓	GRD
116	5152.054	4891.229	105.875	✓	✓	GRD
105	5154.301	5051.005	92.321	✓	✓	FLDEDG
342	5154.733	[illegible]	[illegible]	✓	✓	GRD
104	5157.182	[illegible]	[illegible]	✓	✓	FLDEDG
107	5157.326	5018.033	[illegible]94.105	✓	✓	FLDEDG
361	5158.123	5128.859	89.362	✓	✓	GRD
365	5159.993	5112.624	87.52	✓	✓	FL
370	5162.489	5120.783	89.409	✓	✓	GRD
371	5163.293	5108.67	88.736	✓	✓	GRD
110	5164.781	4975.557	97.837	✓	✓	FLDEDG
112	5172.091	4939.908	101.849	✓	✓	FLDEDG
377	5173.412	5094.396	90.017	✓	✓	GRD
103	5174.798	5080.568	90.515	✓	✓	FLDEDG
106	5175.181	5045.146	92.261	✓	✓	GRD
353	5175.908	5148.036	89.527	✓	✓	GRD

4. Ground Surface Map

The ground surface is a composite Digital Terrain Model (DTM) of all of the surveys in the survey manager. **The DTM is generated when the survey(s) are closed within the survey manager.** You can change the display of the map by turning layers on and off in the legend and by changing layer properties. You can also edit the DTM by adding or deleting border nodes, and by adding breaklines. However, you must open the original survey to edit any of the point data. Refer to the following sections for editing the ground surface map display and for making adjustments to the DTM.



4.1. DTM Basics

The following sections will introduce the concepts of the Digital Terrain Model and related terms to understand how SET represents the ground surface from a collection of points.

4.1.1. Concepts

A **Digital Terrain Model** (DTM) is a representation of a surface consisting of point data – the ground surface in this case. The DTM is based on the construction of a TIN, or **Triangular Irregular Network** The TIN is a mesh of irregularly shaped, non-overlapping adjacent triangles connecting all points in the survey that are to be included in the DTM (what are referred to as **TINable** points in the program). Surveyed points that are not actually on the ground should be marked not TINable. Three neighboring TINable points connected to form a triangle represent one triangular face on the DTM surface. **Contours** are calculated by interpolating between each pair of points in each triangular face.

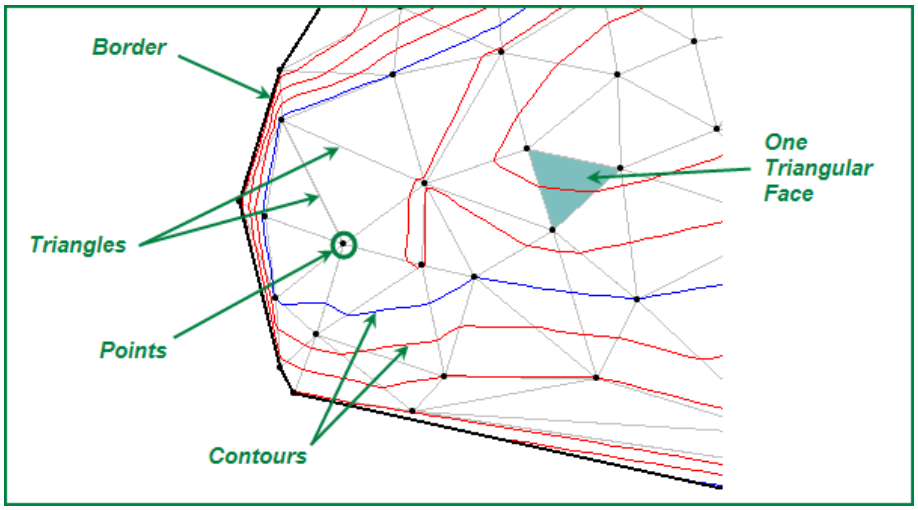
The DTM engine within SET first creates a default border around the TINable points. This default border is referred to as a **Convex Hull** border which is the shortest path around all the points. It is as if a lasso was thrown around all the points and the rope was pulled tightly. All the adjacent points around the outside of the survey that the rope touches are joined by straight-line segments to form the convex hull border. This border might include areas in which the surface is undefined (not included in the TIN triangles). Therefore, after the convex hull is computed, the border is processed further to pull the border inward until all area within the border is contained within the TIN triangles. To summarize, the DTM shown on the map display consists of a border that contains all of the TINable points, a triangular network (the TIN) that connects all of the TINable points, and the contour lines.

There are two **Rules** that must be followed before the DTM engine can process the map:

- There can be no duplicate TINable points
- All TINable points must be contained within the currently defined border (this also means that all border points must also be TINable points).

4.1.2. Default DTM

When a survey is entered or imported for the first time, the program will check for duplicate points (two or more points with the same or nearly the same horizontal coordinates). Points are considered duplicate if the horizontal distance between them is less than 0.2 ft. Only the X and Y coordinates are considered when making this test. If there are duplicate points in the survey, an error message will display the sets of duplicate points and give you the chance to mark which point is to remain TINable while the others are marked invisible (and not TINable). Next, the default Convex Hull border will be generated automatically. Finally, the TIN triangles and contour lines are generated and displayed. The default ground surface has now been created. A portion of an example DTM is shown below:



4.1.3. Modifications to the DTM

There are two types of modifications to the ground surface DTM:

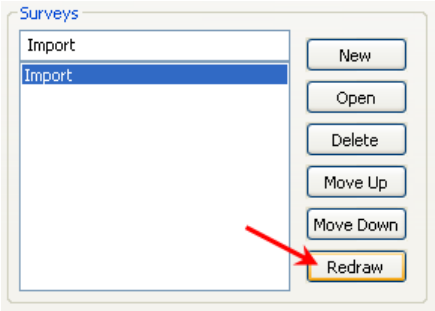
- The first is not really modifying the DTM itself, but simply how the DTM is displayed on the screen and on the plot of the map. Examples are whether to display the triangles, point elevations or descriptions, the contour line interval, and the border among many other settings. These are each displayed on their own map layer and are controlled in the Legend. Refer to the Legend section of this user manual for information on how to control the layers.
- The DTM itself can be modified so that it better represents the actual ground surface. The DTM engine makes certain assumptions when it first creates the border and TIN, which may not be a true representation of the ground. Examples of changes that can be made to modify the DTM are adjusting the border to avoid contouring areas not part of the survey, adding breaklines to change the triangulation to follow actual slope breaks, and excluding non-ground points from the DTM. Editing Borders and Adding or deleting breaklines are covered in the Map Toolbar items under Ground Surface Map section of this user manual. Refer to the Survey Input section of this user manual for excluding individual points from the DTM.

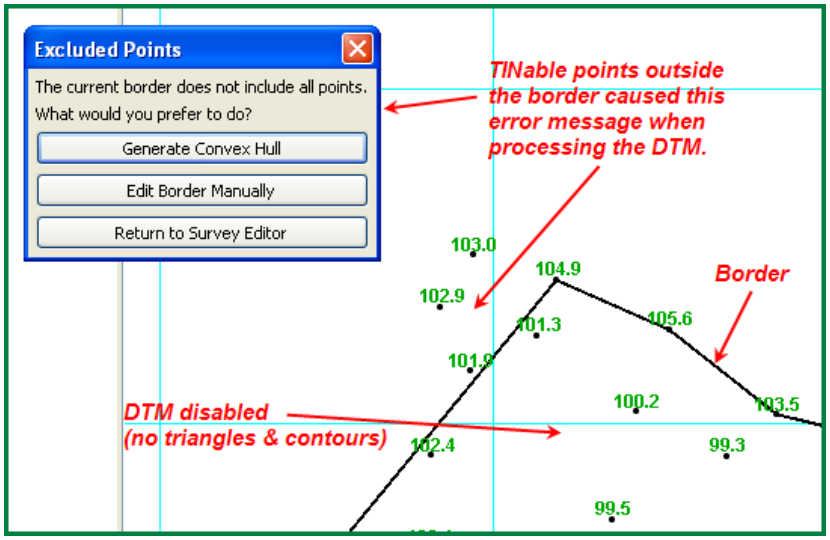
As modifications are made to the DTM, it is updated automatically. However, if changes are made that causes TINable points to lie outside of the border, then the DTM engine is disabled until the errors are corrected. When the DTM engine is disabled, triangles and contour lines are not displayed. Two of the most common changes that will disable the DTM engine are:

- Adding or deleting border nodes that cause points to be outside of the modified border.
- Marking points TINable that lie outside of the current border.

4.1.4. Correcting DTM Errors

If the DTM is disabled (the triangles and contour lines do not display on the map), then you must correct the error that caused the problem. This involves either modifying the border to include all TINable points, or marking points outside of the border as not TINable. If it's not obvious to you what caused the problem, then you can press the REDRAW button to force the DTM to process and the following error message will appear.





You are given three choices:

1. **Generate Convex Hull**: This will delete the current border and create a new convex hull border around all TINable points. The TIN will be created and the contours drawn.

2. **Edit the Border**: This gives you the opportunity to modify the border by adding or deleting border nodes. Pressing the REDRAW button again will check the border edits to determine if a valid DTM can be generated.

3. **Edit the Survey**: This gives you the chance to mark TINable points that lie outside the border as not TINable. Pressing the REDRAW button again will check the point edits to determine if a valid DTM can be generated.

If repeated attempts of editing the border do not result in a valid DTM, it is best to start over by choosing the Convex Hull option. When you edit the border from a valid condition, you will receive immediate notice if the edit would result in a point being outside of the new border. Changing the border in small steps should help you to find the offending point.

4.2. Map Toolbar

The Map Toolbar is the horizontal strip above the map window that, when activated, provide various tools to view the map, measure features, modify the DTM, and add drawings. Refer to the following explanations for each toolbar button function.

4.2.1. Map Viewing Toolbar Buttons

This section describes the four methods to view the survey map.

4.2.1.1. Full Extent

The survey map can be reset to its full extent to show all the points by pressing the Full Extent button on the toolbar. The survey map will be centered in the map display area of the screen.

Note that if map sheets are defined, the full extents button will include all the map sheets in the map display, whether the map sheets are turned on or not.

The full extents will include a buffer area between the edge of the map and the edges of the map screen. The default buffer area is set at 10%. This buffer area can be increased or decreased in the Mapping section of Preferences.

4.2.1.2. Zoom In

You can zoom in to a smaller area of the survey to show more detail by clicking the Zoom In button on the toolbar. The Zoom In function will remain active until the button is clicked again, or if the Zoom Out or Pan functions are activated. You may press the Full Extent button at any time while the Zoom In function is active to reset the survey map without leaving the Zoom In function. You can zoom in using two methods:

- Clicking once with the left mouse button will zoom in a predetermined amount and will center the map on the cursor location when the button was clicked.
- You may define the zoomed area by drawing a zoom window. Click and hold the left mouse button, then drag the cursor in any direction to draw the zoom window. When you release the mouse button, the survey map will be zoomed to the window.

Note

You can also use the mouse's scroll wheel to zoom in by simply scrolling the wheel towards the screen. Note that a toolbar button must be clicked before the wheel scroll will become active.

4.2.1.3. Zoom Out

You can zoom out to show more of the survey map by pressing the Zoom Out button on the toolbar, then clicking on the survey map with the left mouse button. The map will zoom out a predetermined amount, centered on the cursor location. The Zoom Out function will remain active until the button is clicked again, or if the Zoom In or Pan functions are activated. You may press the Full Extent button at any time while the Zoom Out function is active to reset the survey map without leaving the Zoom Out function.

Note

You can also use the mouse's scroll wheel to zoom out by simply scrolling the wheel away from the screen. Note that a toolbar button must be clicked before the wheel scroll will become active.

4.2.1.4. Pan

Selecting the Pan button from the toolbar will allow you to move the survey around on the display. To pan, click and hold with the left mouse button, then drag the survey to the desired position and release the mouse button. The pan function will remain active until the button is clicked again, or if a zoom function is activated. You may press the Full Extent button at any time the Pan function is active to reset the survey map without leaving the Pan function.

The survey map will automatically pan in any of the four directions. When the cursor is placed close to a map edge, the survey map will start panning after a short delay.

> **Note**
>
> You can use the mouse's scroll wheel to zoom in and out while the Pan button is active. Do this by simply scrolling the wheel towards and away from the screen. The map will scroll in or out using the current location of the mouse pointer as the center of zooming action.

4.2.2. Border Toolbar Buttons

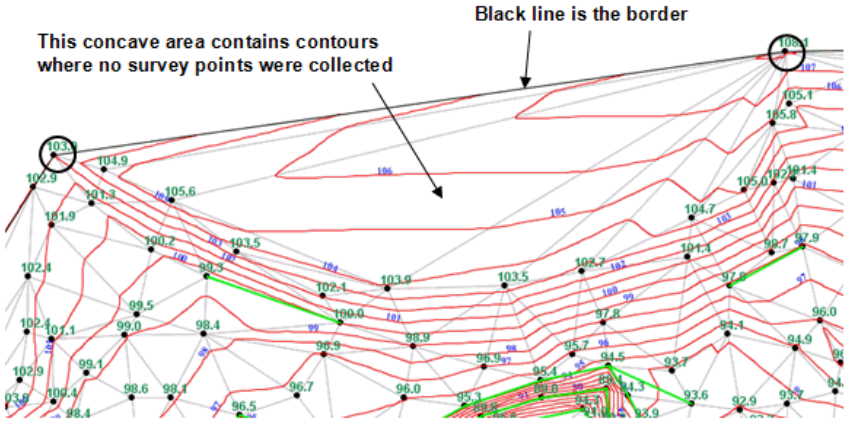
The border tools allow the user to add and delete border nodes from the border, most commonly to prevent the program from contouring areas that were not surveyed.

4.2.2.1. About borders

The border is defined as the outer extent of a DTM. All points contributing to the DTM (TINable points) must be within the border. When a survey is brought into the program, a default border is assigned to the survey. This default is called a "convex hull" border which is the shortest path around all the points. It is as if a lasso was thrown around all the points and the rope was pulled tightly. All the adjacent points around the outside of the survey that the rope touches are joined by straight-line segments to form the convex hull border. This border might include areas in which the surface is undefined (not included in the TIN triangles). Therefore, after the convex hull is computed, the border is processed further to pull the border inward until all area within the border is contained within the TIN triangles. By default, the border is shown as a black line around the perimeter of the survey. You can change the color or weight of the border in the Drawing Properties window.

Due to the convex hull approach, there are instances when the shape of the area surveyed contains concave areas that were not actually surveyed, but are included in the border and therefore contain contours. In the example below, a large concave area contains contours where no survey data was collected, so these contours are most likely not accurate. This is due to the default convex hull border that connects the outside points with straight lines. The two circled points are border points in the default border for this survey.

To eliminate these erroneous contours, the border must be modified by adding border points between the two circled points that were selected automatically by the program. As a result, no triangles will be drawn beyond the border, therefore the contours will be eliminated.



4.2.2.2. Add border nodes

To add a border node:

1. Zoom to the area so all of the proposed border nodes to be added are visible. Pressing the Pan or Zoom buttons will interrupt the process of adding border nodes.

2. Click the Add Border Point button. Note: The snap-to-point function will turn on automatically.

3. Border points must be added between two existing adjacent border points. Existing border points will have a red dot when they are highlighted by the cursor. Move the mouse to locate the first border point.

4. Click on the first existing border point. It will change from red to green.

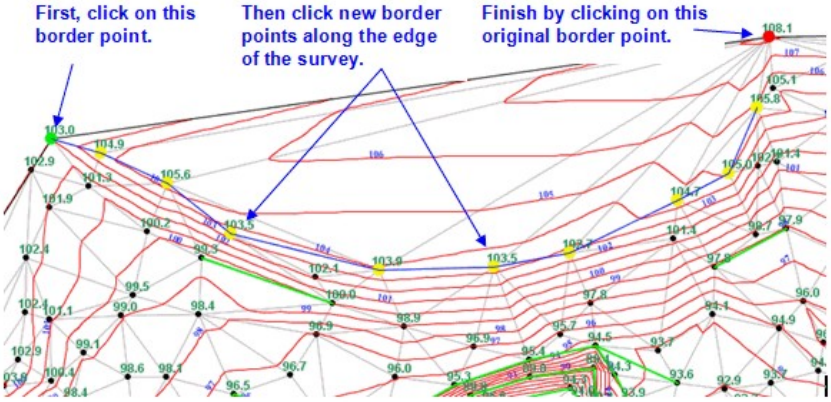
5. Click on points that should be included in the new border. (Refer to image.) As you add points, yellow dots will appear at the new proposed border points, and the proposed new border will show as a blue line.

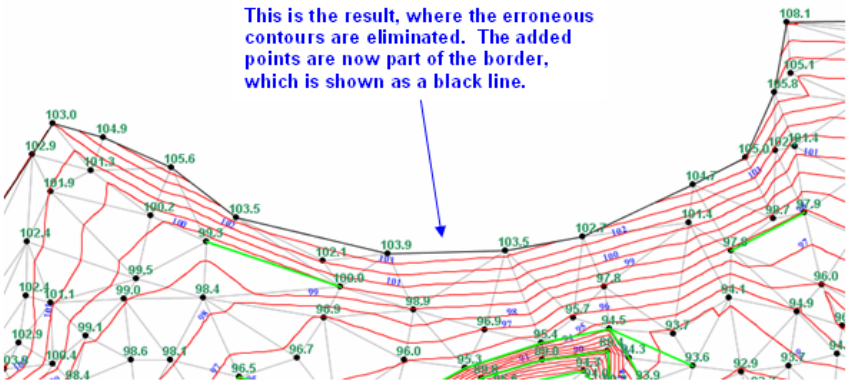
6. Finish by clicking on the second existing border point (adjacent to the first existing border point). The second existing border will highlight in red. The program will process the new border.

7. Click on the Add Border Point button again to stop adding border nodes.

Note

The program will pan in any of the four directions. When the cursor is placed close to a map edge, the survey map will start panning after a short delay. You can also use the mouse scroll wheel to zoom in and out to aid in adding the border nodes. And, you can change the size of the map window by sliding the divider on either side without interrupting the border edits.



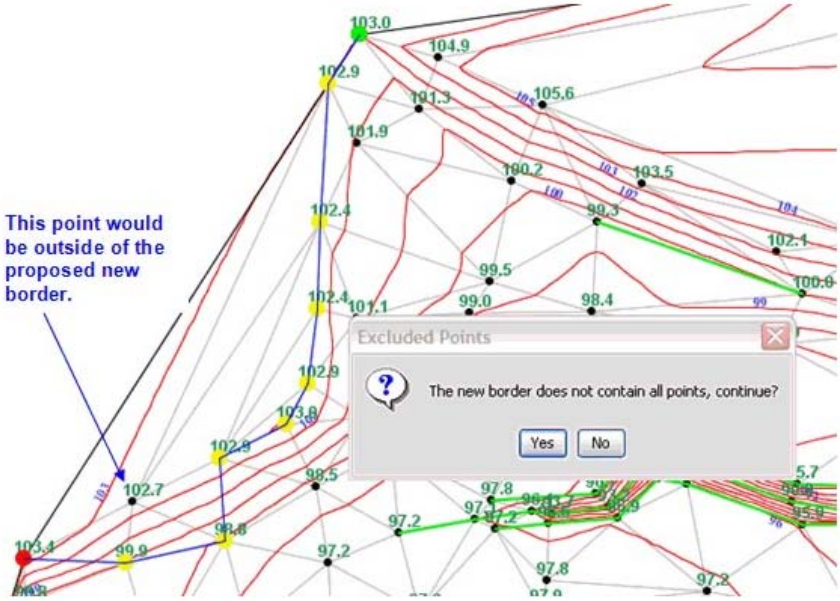


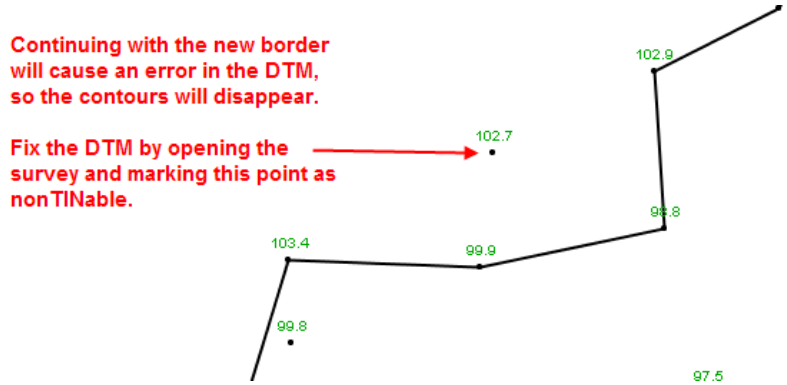
The program will verify that you inserted the new border points between two original adjacent border points. If not, an error message will appear.

Also, the program will let you know with a warning message if any survey points would lie outside of the newly proposed border. Ordinarily, you would not want to leave points outside of the border because those points will not be part of the DTM. If you want to be sure those points are included in the DTM, answer No to the warning message and start over. The program will allow you to exclude these points from the DTM if you choose (answer Yes to the Excluded Points warning message). However, the DTM will be disabled and the triangles and contour lines will not display. In order to fix the DTM, you must open the survey editor and mark the points outside of the border as nonTINable. Closing the survey and pressing the **REDRAW** button next to the surveys list will check the point edits to determine if a valid DTM can be generated. Refer to the Correcting DTM Errors portion of the Ground Surface Map section of this user manual.

You can include points outside of the border into the DTM again by adding them as border point.

If no errors are detected, or if you have chosen to exclude points outside of the border from the DTM, then the survey map will be updated to eliminate all triangles and contours outside of the new border.





4.2.2.3. Delete border nodes

Border points can also be removed. This is usually caused by accidentally adding the wrong point as a border node.

To delete a border node:

1. Click the Delete Border Point button. Note: The snap-to-point function will turn on automatically.

2. Move the cursor to the border point that you wish to remove. Note that existing border points will have a red dot when they are highlighted by the cursor.

3. Click on the point to delete it from the border. The program will adjust the border and revise the DTM. The program will connect the closest two border points on either side from the border point being deleted. Ensure that the resulting border is correct for your survey. You may need to adjust the border further by adding and/or deleting other border points.

4. Click on the Delete Border Point button again to stop removing border points. : The program will pan in any of the four directions. When the cursor is placed close to a map edge, the survey map will start panning after a short delay. Zooming will interrupt the deletion of border points.

> **Note**
>
> The program will pan in any of the four directions. When the cursor is placed close to a map edge, the survey map will start panning after a short delay. You can also use the mouse scroll wheel to zoom in and out to aid in adding the border nodes. And, you can change the size of the map window by sliding the divider on either side without interrupting the border edits.

4.2.3. Breakline Toolbar Buttons

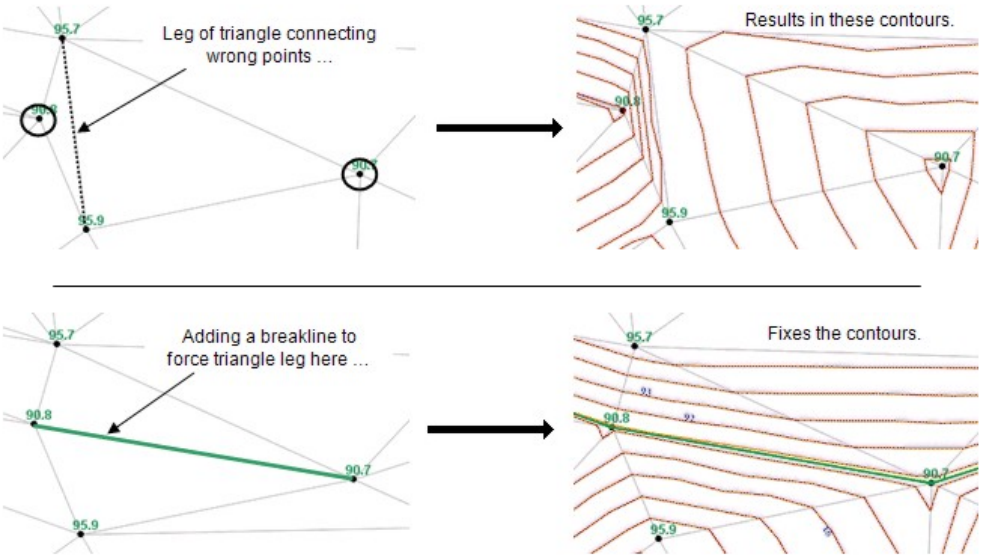
The Breakline tools allow the user to control the way the program contours the points on the map by adding breaklines at breaks in slope.

4.2.3.1. About breaklines

Breaklines are lines added to the surface model to control how the triangles will be drawn, and therefore how the contours are represented. Breaklines are used to indicate discontinuity and to show a break in the slope.

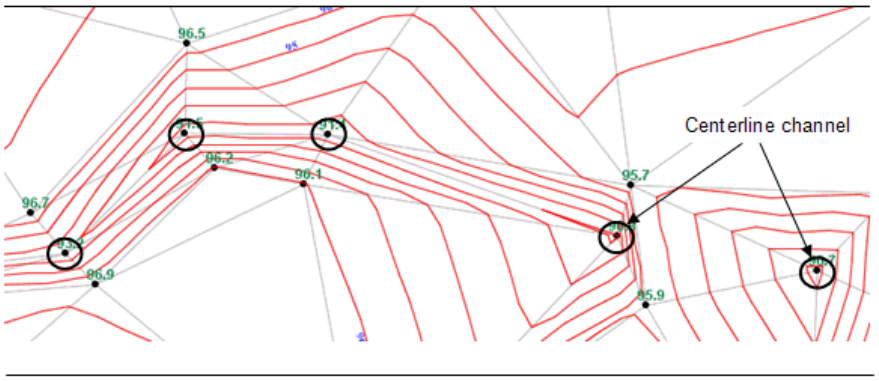
Four points will form two adjacent triangles, which can be joined in two ways. Sometimes, the program will create the two triangles that result in contours that do not properly represent the actual field.

In the example below, four points are shown with triangles. The two circled points represent channel centerline points. The program did not connect the centerline points, rather it connected points across the channel, resulting in contours that do not make sense for this area. (The program will generally choose the shorter length to connect the four points to form two triangles). To fix this situation, add a breakline that connects the two channel points. Breaklines force the program to place the leg of the triangle on the breakline. Triangles can never cross breaklines. The second set of diagrams below show the corrected contours as a result of the added breakline.

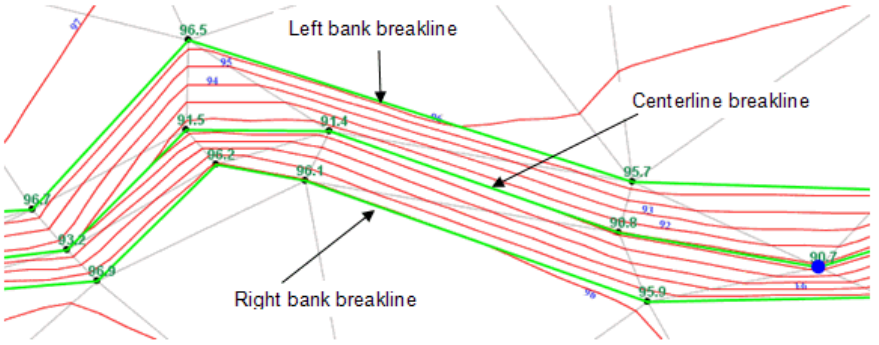


The example below is the same survey, but showing more area. The first diagram shows the triangles and contours as assumed by the program. The circled points are the channel centerline points. In the second diagram, breaklines were drawn to connect all the centerline points. Also, breaklines were drawn to connect the left bank points and to connect the right bank points. The resulting contours better represent the actual ground surface.

Before...



After...



It's important that survey shots be taken in the field at abrupt changes in slope. These points can then be used to create breaklines at those locations where the program incorrectly draws the triangles.

4.2.3.2. Add breaklines

To add a breakline:

1. Click on the Add Breakline button on the toolbar. Note: The snap-to-point feature will be turned on automatically.

2. Click the first point to begin adding the first breakline segment.

3. Click the second point. The added breakline will be drawn in the color set in the Drawing Properties for breaklines (default is green).

4. Click additional points to add segments to the breakline. The triangles and contours will be updated as segments are added.

5. Double-click the final point to end the breakline.

6. Repeat steps 2-5 for additional breaklines. Be careful not to cross breaklines. This will generate an error message.

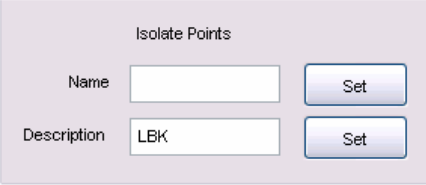
7. Click the Add Breakline button on the toolbar to stop adding breaklines.

Note

The program will pan in any of the four directions. When the cursor is placed close to a map edge, the survey map will start panning after a short delay. You can also use the mouse scroll wheel to zoom in and out to aid in adding the border nodes. And, you can change the size of the map window by sliding the divider on either side without interrupting the breakline edits.

Tip

The Isolate function can aid in creating breaklines. You can have the program only display (isolate) points that have the same Point Name or Point Description. For example, if you describe all survey shots taken of the left bank of a stream with an LBK description, then you can isolate and only display those points. In this way, it's easier to connect these points to form a breakline. To isolate points, choose Edit Points from the Edit menu. The lower left portion of the Survey Data window is where you can enter the point name or description.



In this example, LBK is entered as the description to isolate points by. Clicking the **Set** button next to the entry will cause the map to display only the points with an LBK description. Be sure Point Markers are turned on in the Features Visibility window. To show all of the points again, clear the Isolate Points entry boxes (highlight the entry and press the Delete key) and press the corresponding **Set** button again.

4.2.3.3. Delete breaklines

To delete breaklines:

1. Click on the Delete Breakline button on the toolbar, or choose Delete from the Breakline menu. Note: The snap-to-point feature will be turned on automatically.

2. Move the cursor close to one of the points that are part of the breakline, and any breakline segments connected to that point will be highlighted in red.

3. Click a highlighted segment to delete it. The triangles and contours will be updated with each deletion.

4. Repeat steps 2-3 to delete additional breaklines.

5. Click the Delete Breakline button again to stop deleting breaklines.

> **Note**
>
> The program will pan in any of the four directions. When the cursor is placed close to a map edge, the survey map will start panning after a short delay. You can also use the mouse scroll wheel to zoom in and out to aid in adding the border nodes. And, you can change the size of the map window by sliding the divider on either side without interrupting the breakline edits.

4.2.4. Measurement Toolbar Buttons

There are 3 measurement tools in SET:

- Measure Line Tool - a tool to measure distances between two or more points
- Measure Area Tool - a tool to measure the area of a user defined polygon
- Stage Storage Tool - a tool to compute a stage storage table of a set of contours that represent the pool area of a dam or dike

4.2.4.1. Measure Line Tool

The Measure Line tool will determine distances between two points or multiple points selected in a series. **To measure between surveyed points, turn on the Snap-To-Point function**.

To measure a line:

1. First, zoom to the area of interest on the map display where distances will be measured. Pressing the Pan or Zoom buttons will interrupt the measurement tool.

2. Click on the Measure Line button on the toolbar. The Snap-to-Points feature may be turned on or off during the measurement process without disrupting the measurement.

3. Click once on the left mouse button to start the line. Move the cursor to draw the first line segment.

4. Click at the desired location to complete the first measurement line segment.

5. Click at additional locations to add more segments. You can measure along a series of points. As you draw the line segments on the screen, the Status Bar at the bottom of the screen will display the total straight line distance measurement in feet.

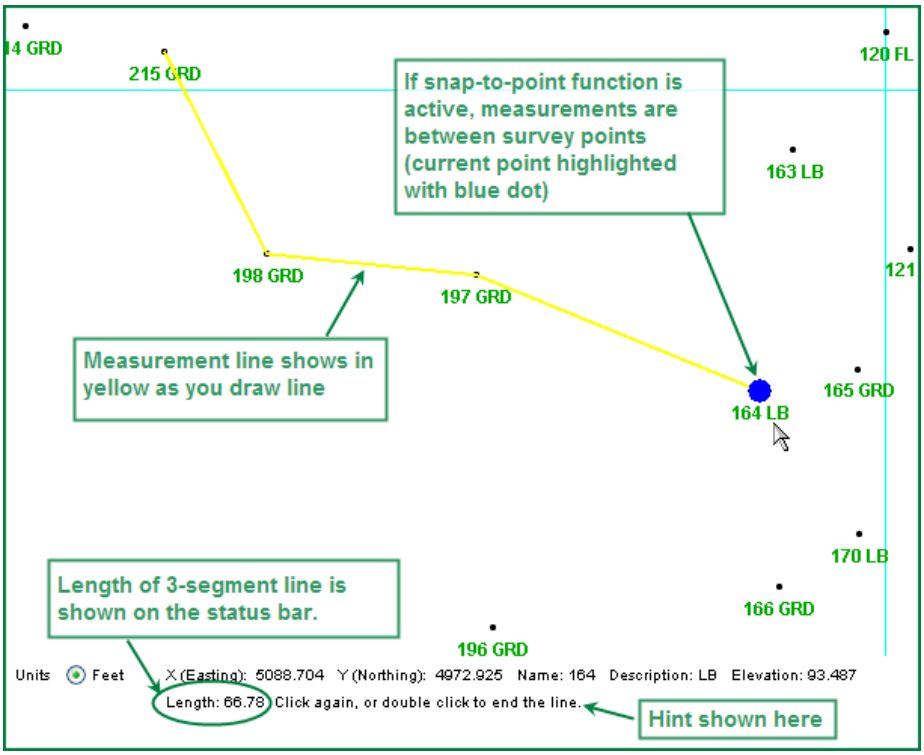
6. Double-click on the last measurement point to end the measurement. The total line length will be displayed on the Status Bar.

7. Repeat steps 3-6 to measure another line.

8. Click the Measure Line button to exit the Measure Line tool.

Note

The program will pan in any of the four directions. When the cursor is placed close to a map edge, the survey map will start panning after a short delay. You can also use the mouse scroll wheel to zoom in and out to aid in adding the border nodes. And, you can change the size of the map window by sliding the divider on either side without interrupting the measurement.



4.2.4.2. Measure Area Tool

The Measure Area tool will determine the area of a polygon described by at least 3 points. To measure the area defined by surveyed points, turn on the Snap-To-Point function.

To measure area:

1. First, zoom to the area of interest on the map display where areas will be measured. Pressing the Pan or Zoom buttons will interrupt the measurement tool.

2. Click the Measure Area button on the toolbar. The Snap-to-Points feature may be turned on or off during the measurement process without disrupting the measurement.

3. At the starting point for the measurement, click once with the left mouse button to start the area.

4. Click to add straight line segments to the polygon. A closed polygon is measured with each click.

5. As you draw the polygon on the screen, the Status Bar at the bottom of the screen will display the total area measurement in square feet.

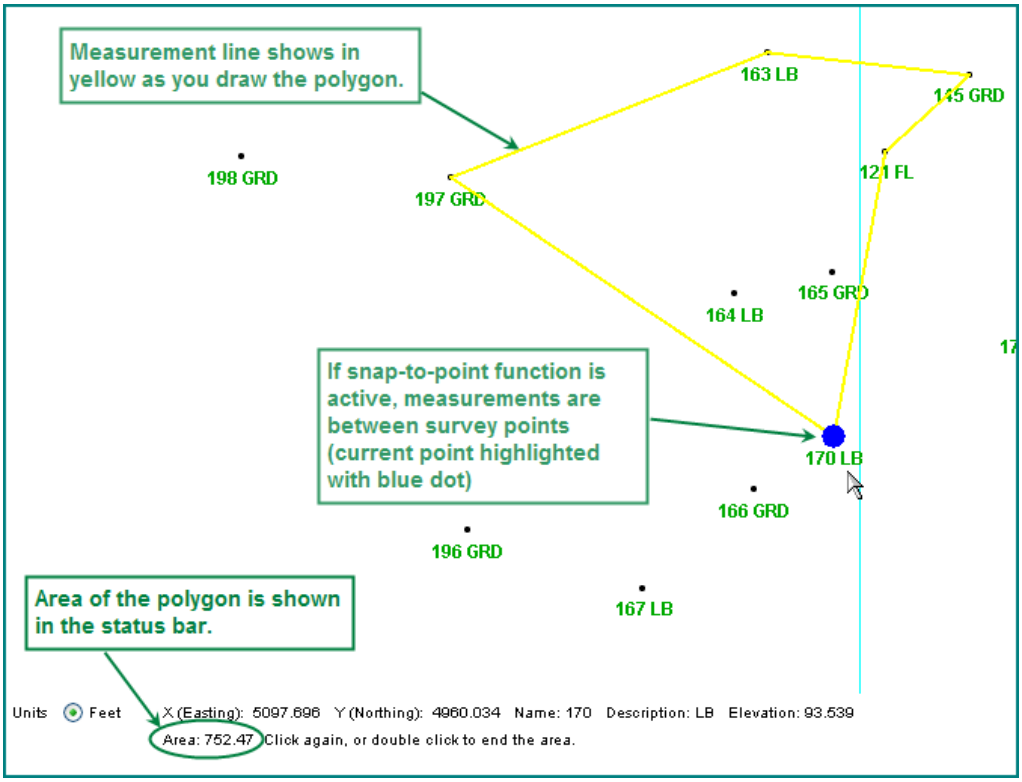
6. Double-click on the last measurement point to end the measurement. Note the final area of the polygon in the status bar.

7. Repeat steps 3-6 to measure another area.

8. Click the Measure Area button again to exit the measure tool.

Note

- The program will pan in any of the four directions. When the cursor is placed close to a map edge, the survey map will start panning after a short delay. You can also use the mouse scroll wheel to zoom in and out to aid in adding the border nodes. And, you can change the size of the map window by sliding the divider on either side without interrupting the measurement.
- Take care not to cross lines defining the polygon; unpredictable measurements will result.



4.2.4.3. Stage Storage Tool

The Stage Storage tool can compute a table of surface areas and volumes of storage for a set of contours that represent the pool area of a dam or dike.

Perform the following steps to perform a stage storage computation:

1. First, you should draw a polyline to mark the centerline of the dam or dike ("cutline"). This will help in identifying where the centerline is while you perform the operation and afterwards. Enlarge the map display and zoom in or out to display the entire area for computation. Using the zoom or pan controls will cancel the operation. You should also turn off layers that might clutter the map display. Be sure contour lines and labels are turned on and that your contour interval is what you wish it to be. Only visible contours will be included in the computation.

2. To start, click on the Stage Storage button on the toolbar. When you do, the status bar at the bottom of the map screen will guide you with hints.

3. First, define one end of the "cutline". This is the centerline of your dam, and the contours will be "cut off" at this line to compute areas. Be sure that you start the cutline high enough to be above the highest contour line to be included in the computation. Click on the start of the cutline.

4. Now, click on the other end of the cutline. Again, be sure to be high enough to include the highest contour line. After you click this second point, the cutline will show in purple.

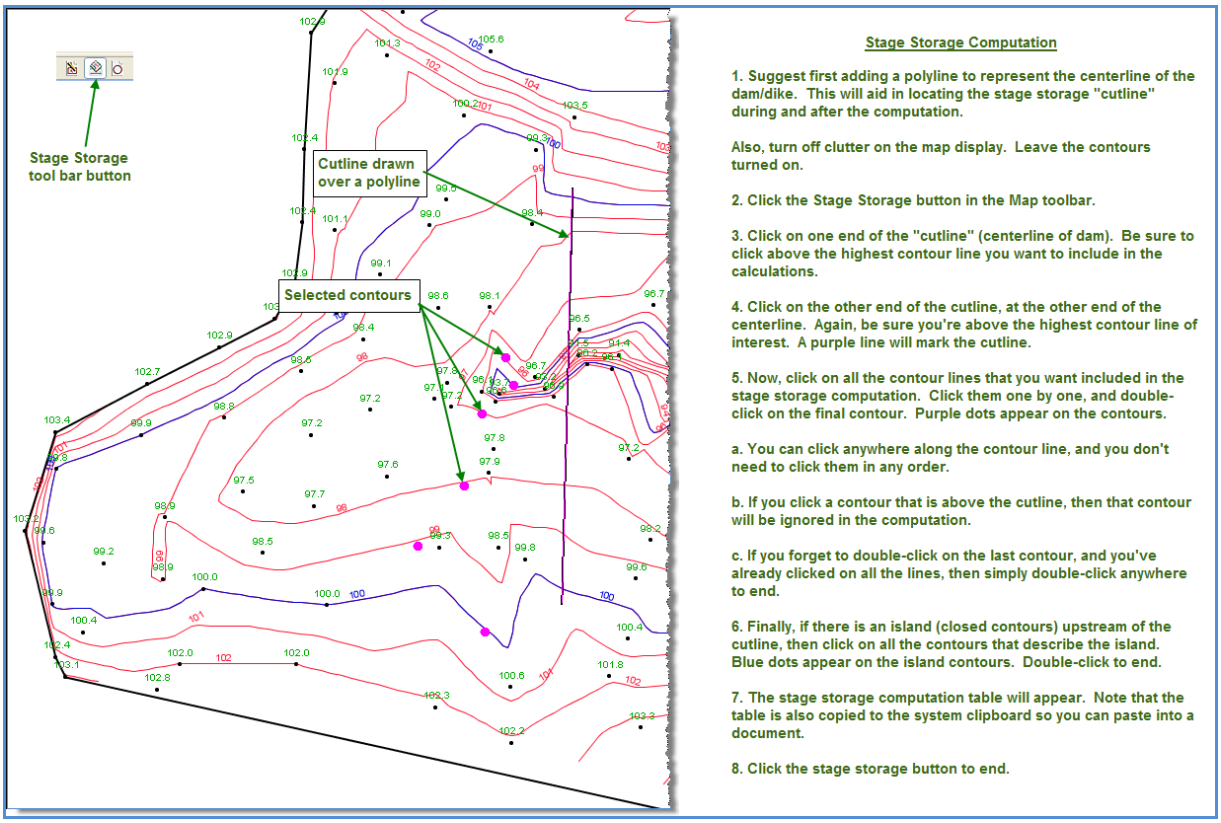
5. Now, click on all the contour lines that you want to be included in the stage storage computation. **Be sure to click the contours on the upstream side of the cutline**. As you click on the lines, purple dots will appear. If they're not exactly on the line, that's okay.

   - You can click anywhere on each contour line (again, upstream of the cutline)
   - You don't need to click on the contour lines in order. If you miss one, just go back and click it.
   - If you click a contour that is above the cutline, it will be ignored in the computation.
   - Double click on the last contour line. If you already picked your last line to be included, then double-click anywhere to end this step.

6. The process now prompts you to define islands on the upstream side of the cutline. Islands are depicted by closed contours. Islands will reduce the available storage in a pool area. If you have closed contours, then click on all the contour lines that define the island. Island contours will show as a blue dot. Double-click to end. If you do not have closed contours, then double-click anywhere to end the computation.

7. The stage storage computation results show as a pop-up window. The stage storage table is also copied to your system clipboard so you can paste into a document. At present, there is no Stage Storage Report within SET.

8. Click on the Stage Storage toolbar button again to end the feature.

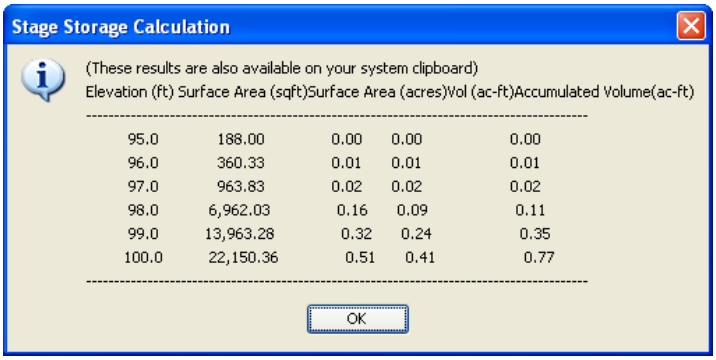


The resulting stage storage computations show as a table in a pop-up window, and are copied to the system clipboard. Press the **OK** button to close the window.

Note

If you accidentally click too many times, and the calculation window disappears, it is still on your desktop, but is just under the SET program window. Simply minimize SET and you will see the

calculation window. You must close this window to continue, so if it disappears and you try to do something else in SET, it seems as though SET is locked up. Instead, it is just waiting for you to click the OK button, but it is hidden under the SET program window.

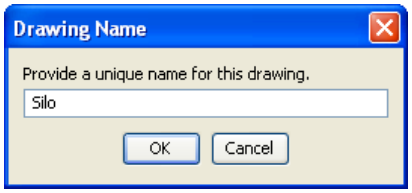


4.2.5. Draw Toolbar Buttons

There are 6 tools to draw features on the survey map. You can draw circles, points, arcs, lines, rectangles, and add text. There is also a "Draw Select" button to select and move existing drawings on the map.

4.2.5.1. Adding and Naming Drawings

Add drawing items to the map by using the drawing tools which are accessible on the drawing toolbar. Each drawing must have a unique name. Once drawn, a dialog box will pop up to name the drawing. Refer to the description of each drawing object below for instructions on how to draw the objects.

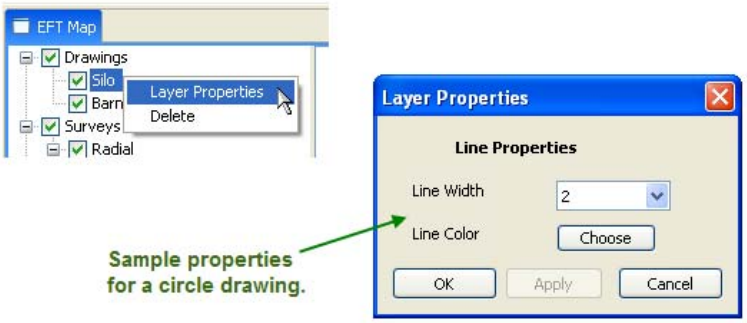


Note

You may use the snap-to-point function to connect drawing objects to surveyed points.

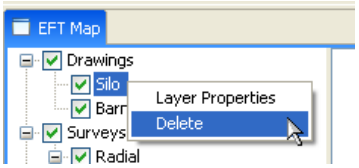
4.2.5.2. Change Drawing Properties

To change the properties of a drawing, right-click on the name of the drawing in the legend underneath the Drawings heading and select **Properties**. Refer to the descriptions below for each drawing for a description of their associated properties.



4.2.5.3. Deleting Drawings

To delete a drawing, right-click on the name of the drawing in the legend underneath the Drawings heading and select **Delete**.



4.2.5.4. Draw Circle

Circles are drawn from the center, outwards. To draw a circle, select the Draw Circle tool so that it is highlighted then move the mouse cursor onto the map surface. Click once (and release) at the center of your desired circle and move the mouse outward to the desired radius length. Click again to draw the circle. The save drawing dialog box will come up to allow you to enter a drawing name. The circle drawing object will be added as a layer on the map legend. You can turn on the Snap-to-Point tool to use surveyed points to define the circle.

Properties that you can adjust for a circle include the line width and choose a line color. The default line width is `2` and the default color is black.

4.2.5.5. Draw Point

Points are also known as symbols. The default point symbol is a filled in circle of size 5. To draw a point, select the Draw Point tool so that it's highlighted then click anywhere on the map area. A dialog box asking you to name the point will appear. The point drawing object will be added as a layer on the map legend. You can turn on the Snap-to-Point tool to use surveyed points to define the location of the point drawing.

Point properties include Size (default is 5), Color (default is black), and Style (default is `Circle`). Other point styles include: Square, Triangle, Cross, and Star.

4.2.5.6. Draw Arc

The Arc tool draws circular arcs (portions of a circle). Arcs are drawn by first defining two points on the circle, then defining the size of the arc. Start by selecting the Arc tool. Click on the arc starting point, then click on the arc ending point. A temporary line will be drawn on the screen to mark these point locations. To finish the arc, you move the cursor on one side or the other of the temporary line to define how large the circular arc will be and click the last point. The arc will be drawn and the save drawing dialog box will display to allow you to enter the drawing name. The arc drawing object will be added as a layer on the map legend. If the arc doesn't look correct when the dialog box appears, just press Cancel and start again.

You can turn on the Snap-to-Point tool in order to use surveyed points to define the three arc points. Properties that you can adjust for a circle include the line width and choose a line color. The default line width is 2 and the default color is black.

4.2.5.7. Draw Polyline

To draw a line or polyline, select the Draw Polyline tool and move the mouse pointer to where you would like to start the line. Click the mouse button and move to where you want the line to be drawn. Repeat this as necessary to get a polyline. Double-click to have the line end. A dialog box will then appear to name the drawing. The polyline drawing object will be added as a layer on the map legend. You can turn on the Snap-to-Point tool to use surveyed points to define the polyline nodes.

Properties for a polyline include line width (default is 2) and line color (default is black).

4.2.5.8. Draw Rectangle

To draw a rectangle, select the Draw Rectangle tool, then click your mouse once where you would like the rectangle's start corner to be, then move the mouse to the end corner of the rectangle and click the mouse again. A dialog box will appear asking you to name the rectangle. You can turn on the Snap-to-Point tool to use surveyed points to define the rectangle corners. The rectangle drawing object will be added as a layer on the map legend.

Properties for a rectangle include line width (default is 2) and color (default is black).

4.2.5.9. Draw Text

Draw Text by selecting the Draw Text tool, then click your mouse to locate where the text will be located on the map. The entered text will be centered on the clicked location. Type in your text, then press the Enter key to end the entry. A dialog box will appear to enter the name of the text object. The text object will be added as a layer on the map legend.

4.2.5.10. Select drawing

Draw Select allows you to move an existing drawing. Select the Draw Select tool then click on an existing drawing element to highlight and move it. **Do not delete drawings by pressing the Delete key while the drawing is selected.** See above to properly delete drawing objects.

4.2.6. Snap to Point Toolbar Button

The Snap to Point feature performs two major functions: to display point information on the status line, and to perform measurements or add drawings that are based on surveyed points. This function is toggled on and off by pressing the Snap to Point button on the toolbar.

Snap to Point active: When Snap to Point is turned on, a larger blue dot will be displayed on the survey point that is closest to the cursor. The status bar will show the information for the currently highlighted point as shown below:

```
Units: feet        X (Easting): 4890.64  Y (Northing): 5102.65  Name: 1170  Description: LB  Elevation: 95.64
                   Click and drag to pan.
```

Snap to Point inactive: When Snap to Point is turned off, the cursor moves freely about the survey map. The status bar will show the Northing and Easting coordinates at the location of the cursor as shown in the following example:

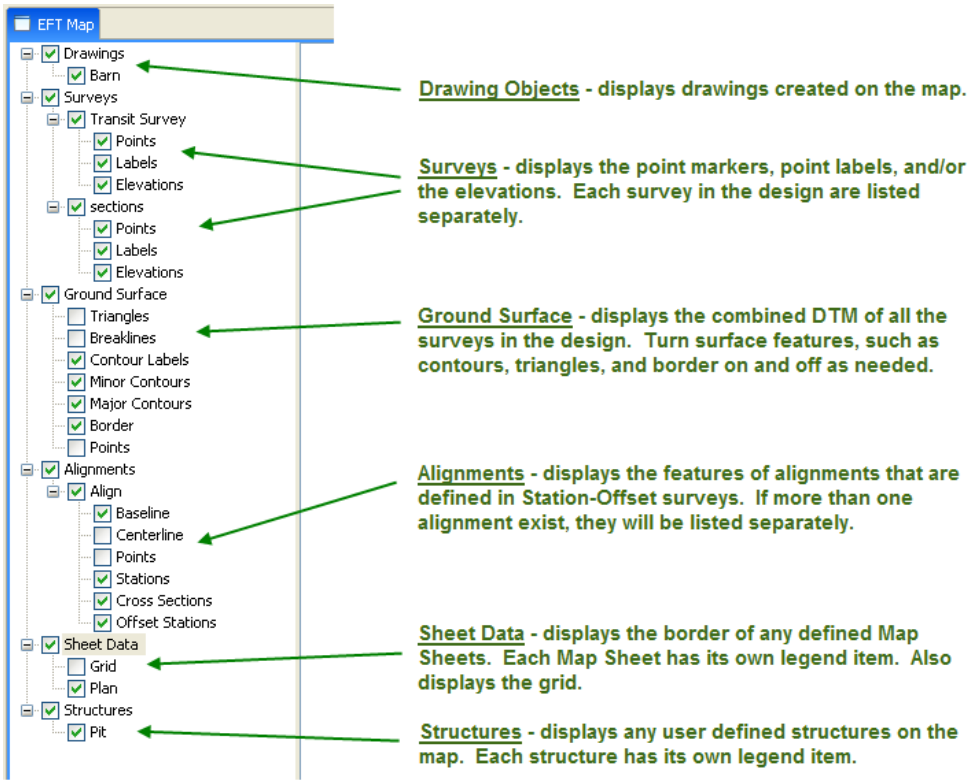
```
Units: feet        X (Easting): 5,197.94  Y (Northing): 5,402.89
                   Click and drag to pan.
```

Turning snap to point on makes it easier to perform other functions within the program, such as measuring lines or areas and drawing, when you need to use the exact locations of the points, and for annotating the map with drawing objects that were surveyed in the field.

Note that the snap to point function is activated automatically when adding or deleting breaklines, or when adding or deleting border nodes since these functions only work with surveyed points on the DTM.

4.3 Legend

The map legend will allow you to turn layers on and off to control the display the information for the ground surface map. An example is shown below:



4.3.1. Legend Items

The following describes the basic features of each legend item. Not all legend items will be shown on every survey. It will depend on what type of survey it is and if certain features have been created.

Drawings

Drawings that you create are each given a different name that you specify. Each drawing object creates a new layer using that drawing name. You can turn drawing layers on or off by checking and unchecking the drawing name box, or turn them all off by unchecking the Drawings checkbox. You can also control the layer properties for each drawing. See the layer properties discussion below. Drawings can be deleted directly from the legend. Just right-click on the drawing name and select DELETE.

Surveys

Each survey listed in the Survey table (on the Project Info tab) has its own legend item. Each survey legend item contains a Points, Labels, and Elevation layer that you can control separately. If you wish to turn a survey layer off, just uncheck the box next to the Survey name. To turn all Surveys off, uncheck the box next to Surveys. You can also control the layer properties for each layer. See the Layer Properties discussion below. Also, point labels and elevation have data settings that can be modified. Refer to the Data Settings discussion below.

Surveys cannot be deleted directly from the legend. Surveys must be deleted from the Survey table on the Project Info tab.

Ground Surface

The ground surface legend item contains many layers to help interpret the ground surface on the map and for map plots. Turn layers on and off as you need to best relate the information. Note that the Points layer is a second points symbol layer in addition to the point layer in the Surveys. This is so that if the Survey layer is turned off, the point symbols would still be visible. You can also control the layer properties for each layer.

See the Layer Properties discussion below. Also, contour labels and major contours have data settings that can be modified. Refer to the Data Settings section below.

Alignments

Alignments are defined in Station-Offset surveys. Each created alignment will have its own legend item. Each alignment will contain several layers to control what is shown on the surface map and the map plot. If you wish to turn an alignment layer off, just uncheck the box next to the Alignment name. To turn all Alignments off, uncheck the box next to Alignments. You can also control the layer properties for each layer. See the Layer Properties section below.

Alignment cannot be deleted directly from the legend. Alignments must be deleted from the Station-Offset survey.

Sheet Data

Sheet data contains the Grid layer and the Map Sheets. You can turn the grid layer on and off by checking and unchecking the box. Change the grid appearance in its layer properties, and the spacing of the grid in its data settings. Refer to the Layer Properties and Data Settings sections below.

Map Sheets provide the capability to plot SET surveys on a number of sheets. The user controls the number of sheets, at what size, the print scale, and which map layers are to be visible on each sheet. The border of the sheet is represented by a rectangular viewport to show what portion of the map will be plotted to the sheet and where it will be placed on the sheet.

Refer to the MAP SHEETS section of this user manual for detailed information on creating, modifying, deleting, and printing map sheets.

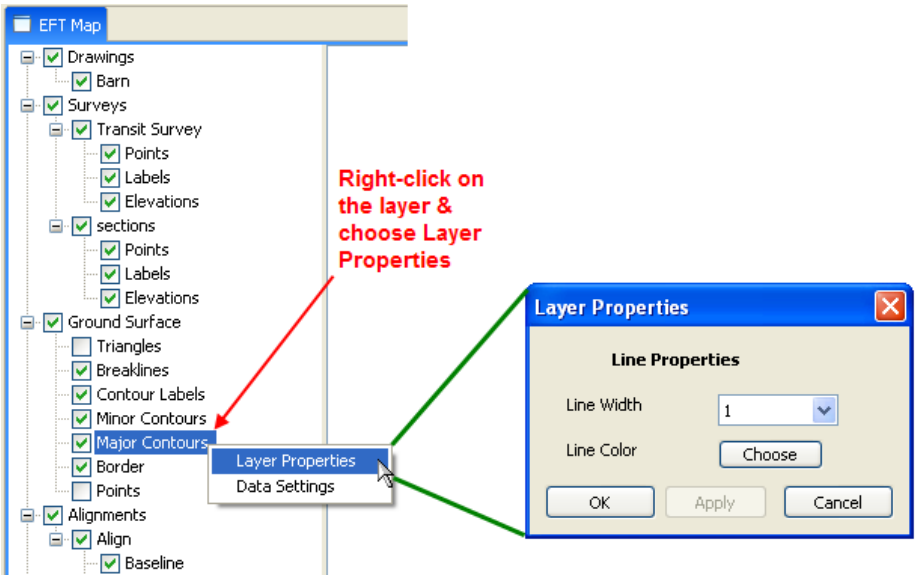
Structures

Structures designed by the user each have its own legend layer. You can check and uncheck each layer's checkbox to turn the structure layer on and off. Each layer has its own layer properties and data settings. Refer to the Layer Properties and Data Settings sections below.

Structures cannot be deleted directly from the legend. Structures are deleted from the Structures table on the Project Info tab.

4.3.1. Legend Layer Properties

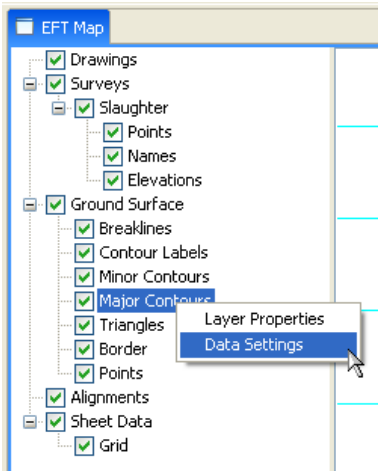
Layer properties can be changed for each of the legend items. Properties include such items as Line Width, Color, and Text Style depending on the layer. Saving projects will also save the legend settings for the survey manager project. To change the properties for a layer item, right-click the Layer name, and choose Layer Properties. A window will appear where you can change the properties.



Make the desired changes and press Apply to see the results without closing the layer properties window. Pressing OK will apply the changes and close the layer properties window. Pressing Cancel before pressing Apply or OK will cancel the operation.

4.3.2. Legend Data Settings

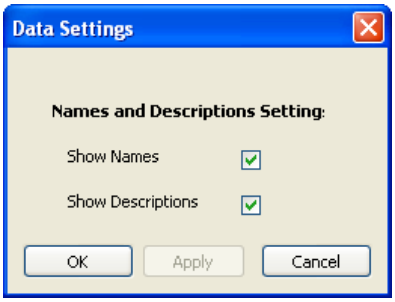
Some of the layers also contain Data Settings that may be changed. To access the data settings, right-click on the layer and select **Data Settings**.



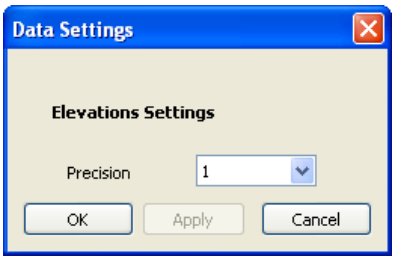
The layers that contain data settings are explained as follows:

1. **SURVEYS**

   a) **POINT LABELS -** The data settings are simply to choose whether point names, point descriptions, or both are displayed on the map when the Labels box is checked in the legend.



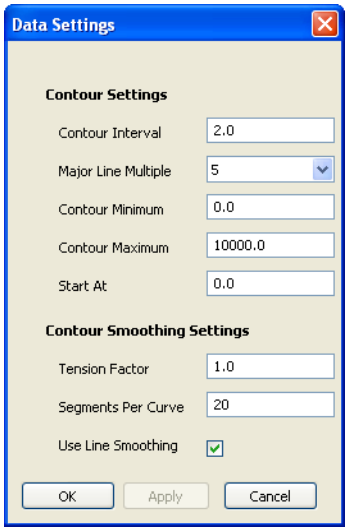
   b) **POINT ELEVATIONS -** The only data setting for elevations is for the precision of the elevation label to be displayed. Precision is the number of decimal points displayed.



2. **GROUND SURFACE**

a) **CONTOUR LABELS** - Here, you can change the precision of the contour labels (number of decimal places) and the frequency of the labels along the contour lines. The default precision is 0 (whole numbers) with a frequency of 5. You can also choose whether or not to label the minor contour lines by checking or unchecking the box.

b) **MAJOR CONTOURS** - These data settings will affect both the major and minor contour lines. Note that you can save default preferences for the contour interval and multiple for all future jobs. Refer to the Preferences section of this user manual for more information.



1) **Contour Settings**

a) **Contour Interval**: the interval between all minor contours. The default value is 2 feet between contours.

b) **Major Line Multiple**: the number of minor contour intervals between major contours. The major contour interval is equal to the contour interval times the major line multiple. For example, if the contour interval is 2 feet with a major line multiple equal to 5, then the major contour interval will be 10 feet on the map.

c) **Contour Minimum & Contour Maximum**: The lowest and highest contour elevations that will be displayed on the map. You can change these entries to control the range of contours that will be displayed.

d) **Start at**: The beginning contour that will be displayed.

2) **Contour Smoothing Settings**

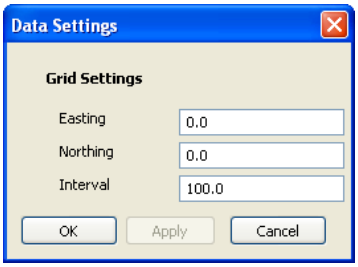
a) **Tension Factor**: This factor, along with the segments per curve, determine the smoothness of the contour lines. Without smoothing, the contours will show as straight-line segments without curves. The effective range of tension is 0 to 10, with 0 have no tension (broad corners) and 10 having high tension (tight corners)

b) **Segments per Curve**: Along with the tension factor, this affects how smooth the contours will appear on the map. To make a curved contour line, it must be made up of shorter segments. The more segments, the smoother the curve. The effective range is about 3 to 100 segments per curve.

c) **Use Line Smoothing** checkbox: You can quickly turn line smoothing on and off with this checkbox.

3. SHEET DATA

a) GRID - You can change the way the grid is displayed on the map by using these settings. Note that you may need to press the REDRAW button in the Survey Manager section of the screen to see the changes made to the grid.



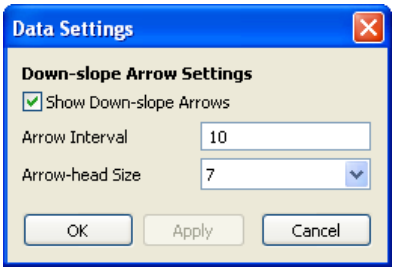
1) **Easting** - This defines the easting coordinate of the first vertical grid line (starting grid line).

2) **Northing** - This defines the northing coordinate of the first horizontal grid line (Starting grid line).

3) **Interval** - Defines the interval for all easting and northing grid lines on the surface map.

4. STRUCTURES –

The data settings for structures allows you to turn down-slope arrows on or off. Slope arrows assist the user to interpret the direction of slope for cut and fill surfaces on structures. You can also control the frequency and size of the arrows. Refer to the Structures section of the user manual for more information.



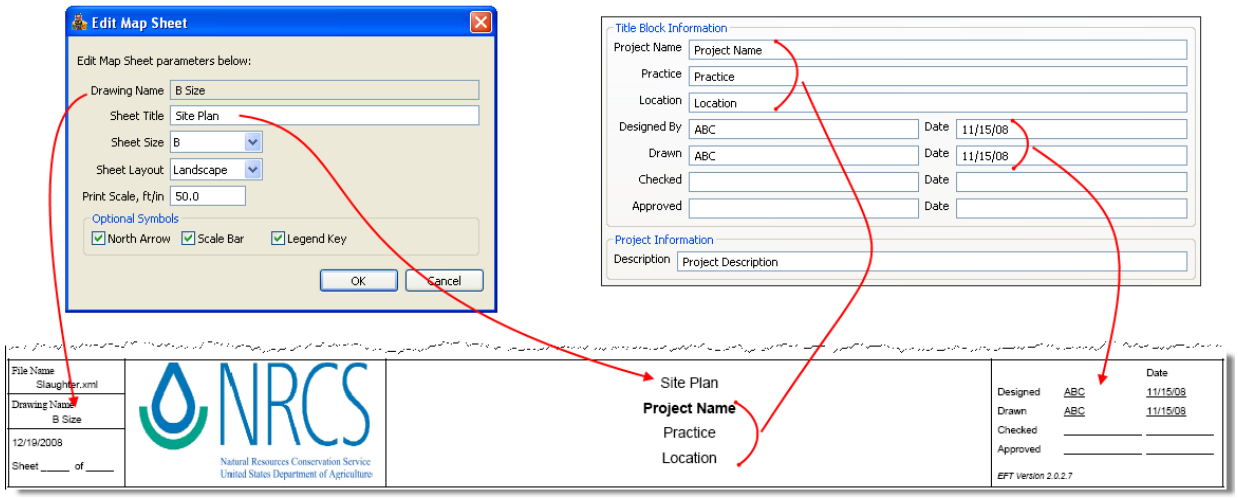
4.4 Map Sheets

Map Sheets provide the capability to plot SET surveys on one or more sheets. The user can control the number of sheets, of what size, the print scale, and which map layers will be plotted. The following sections describe how to create and manage map sheets.

4.4.1. Title Block Information

A title block is printed on every map sheet. The image below shows the sources of the information that will appear in the title block. Most of the title block information comes from the Project Info tab. Note there is a limitation of 40 characters for the Sheet Title, Project Name, Practice, and Location fields. The Designed By, Drawn, Checked, and Approved fields are limited to 15 characters. This is so they will print properly on the map sheets.

Also note that there is a "Sheet ___ of ___" box printed on every title block. This is provided for the user to fill in the appropriate sheet numbers by hand on the printed copies. No automatic sheet numbering is provided in this field. This box also includes the date that the map sheet was created. The EFT program version number is printed in the signature block, and the survey project file name is printed in its own box.

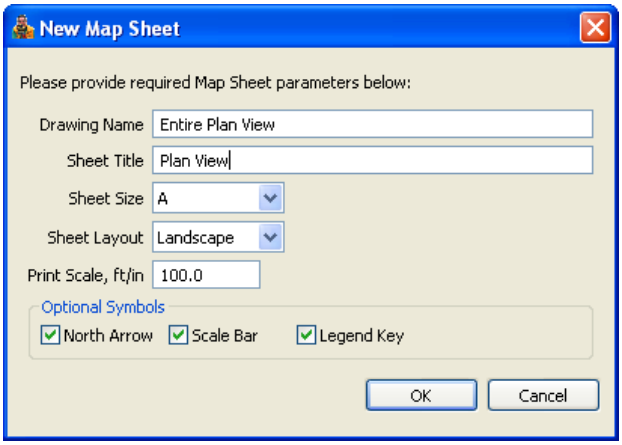


4.4.2. Creating a Map Sheet

To create a map sheet, follow the steps below:

1. First, modify the survey map to display the area of interest that will be plotted. Zoom in and out as needed. Also, only turn on those layers that you wish to appear on the map sheet. Whatever layers are active when the sheet is created will be displayed on the map sheet. Then, right-click on the Sheet Data legend item and choose New Map Sheet.

2. The Map Sheet dialog will open, where you will enter the map sheet parameters



a) Enter the Drawing Name. This is the name that will be used for the map sheet layer in the legend

b) Enter a Sheet Title. The sheet title will be plotted on the drawing on the first line of the title block .

c) Define the Sheet Size from the drop-down. The available sheet sizes are A (8 1/2" x 11"), B (11" x 17"), and D (22" x 34"). Size A is generally referred to as Letter size, and size B as Ledger or Tabloid. You must ensure that your printing device will support the size chosen.

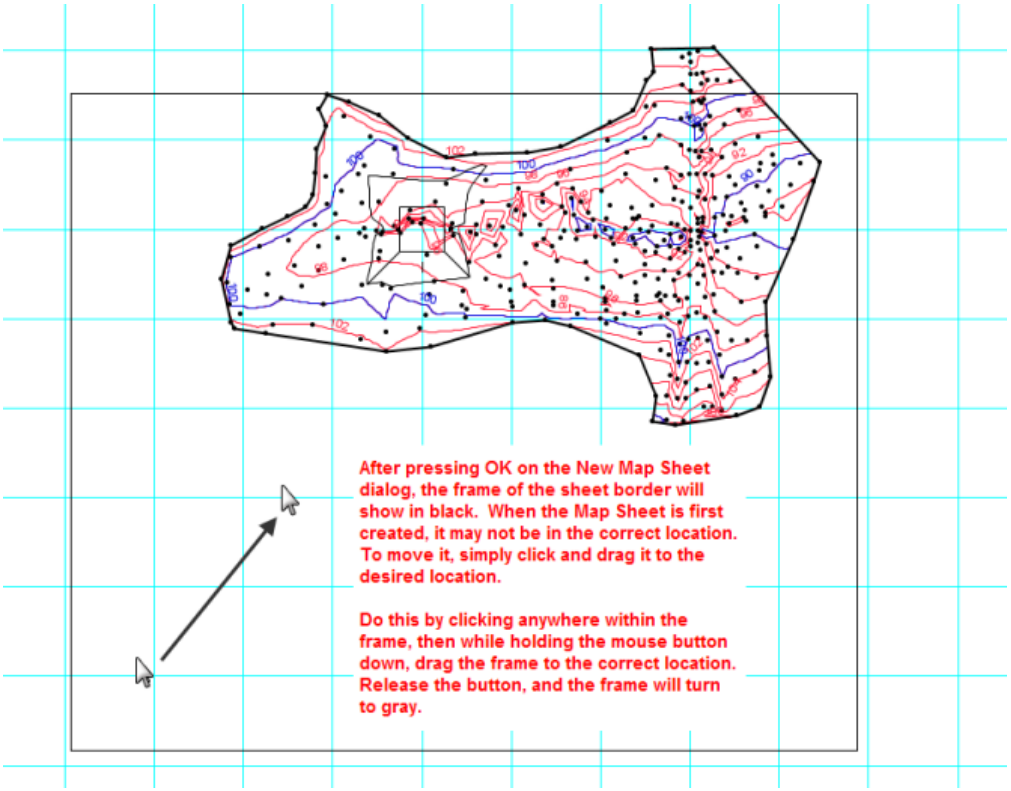
d) Choose whether the layout of the sheet will be Portrait or Landscape from the drop-down.

e) Enter a print scale, in feet per inch. For example, an entry of 100 would mean 1inch on the plotted paper represents 100 feet on the ground.

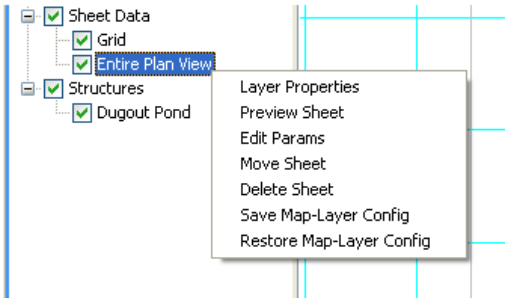
f) Choose which of the optional symbols you wish to show on the plotted map. The north arrow will be plotted in the upper left corner of the plotted sheet; the legend will plot in the upper right corner; and the scale will plot in the lower right corner. The symbols are selected by default; uncheck the symbols you do not want to appear on the map sheet.

g) Press the OK button to create the map sheet on the Survey Map screen. The map sheet will appear in the Legend under the Sheet Data item, named with the Drawing name entered in the dialog box.

3. When you press the OK button, the map sheet border (viewport) will show in black. It may not appear in the correct location. So, using the left mouse button, click anywhere in the viewport **and while holding the mouse button** drag the viewport to its proper location. Release the button and the viewport will lock in that location. If you drop the map sheet in the wrong location, just Move the map sheet as described in the section below. If the viewport is too small or too large, then modify the sheet size, orientation, and/or scale in the Map Sheet parameters as described below.

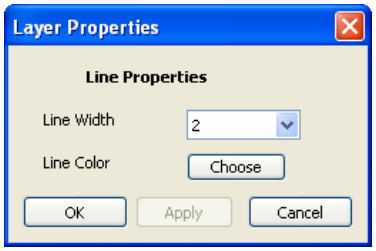


4. Once the map sheet layer appears in the Legend, you can control it and modify its properties by right-clicking on the Map Sheet layer name. You will see the following options. Refer to the sections below for more information.



4.4.3. Map Sheet Layer Properties

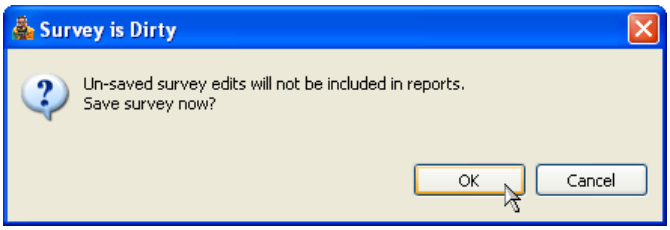
You can control the line size and color of the border around the viewport by right-clicking on the Map Sheet layer name and choosing **Layer Properties**.



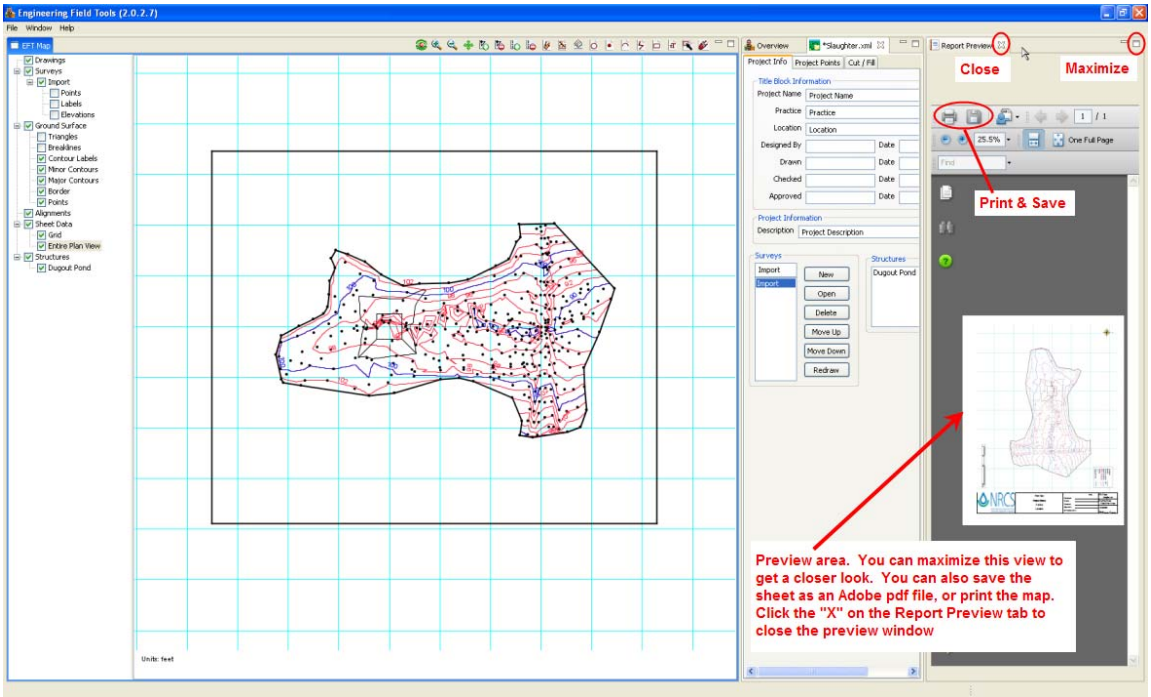
4.4.4. Previewing a Map Sheet

The Preview Sheet option allows you to preview what will be plotted. This allows you to see if the map looks correct before plotting. It also allows you to quickly get an individual plot of a map sheet without going through the Survey Reports routine. Also, **the preview sheet plot will not contain any page numbers**. If you wish to print several sheets at once, then print using the Survey Reports function (see Reports and Printing in this user manual).

To preview a map sheet, just right click the Map Sheet layer name and choose **Preview Sheet**. If changes have been made to the survey file that haven't yet been saved, then a message will be displayed prompting you to save the file. If so, press OK and the map will be displayed on the right side of the EFT window.



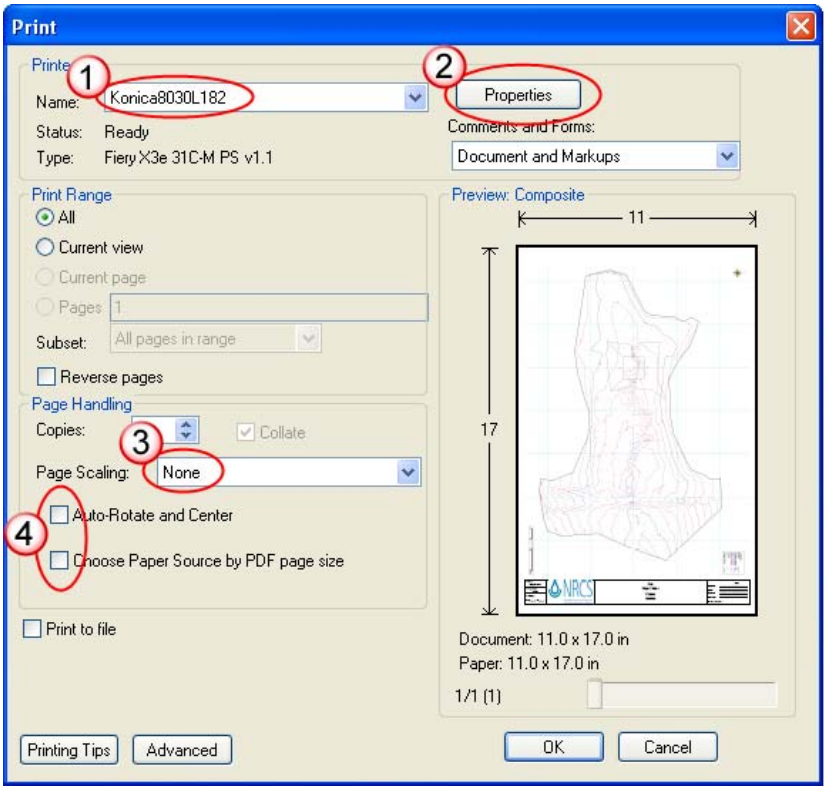
The map sheet will be brought up in a PDF viewer. Maximize the view if needed to get a closer look at the results. You can save the sheet as a file, print the sheet, or cancel. **If you maximize the view, be sure to close the report preview by clicking the X on the preview tab, and NOT the X in the upper right corner, which will close EFT.**



4.4.4.1. Print Settings using Adobe Reader

Below is a screen shot of the print dialog box after pressing the Print button in the preview window. The settings below generally work for many printers. You may need to change some settings depending on the printer or plotter you are using. The example below is for printing a B size sheet (11" x 17").

> **Note**
> If you find that the printed output is not scale accurate, you can adjust the "Map-Sheet Print Scale Factor" in the Mapping section in the program preferences. Refer to the Preferences section of this user manual for more information. A good way to test this is to print a map with the grid lines turned on.



Depending on your printer or plotter, you may need to use different settings, but generally these settings work:

1. Make sure you choose the correct printer or plotter that supports the size of the map sheet to be printed.

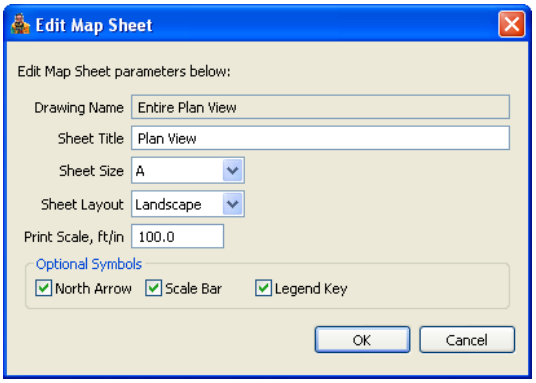
2. Click the properties button to open the printer properties, and choose the correct paper size. (the "choose paper source by PDF page size" checkbox does not always work).

3. To ensure the printout is scale accurate, be sure Page Scaling is set to NONE.

4. Normally, these checkboxes can be left unchecked. Just check the preview composite to see if the page looks correct before pressing OK.

4.4.5. Editing Map Sheet Parameters

A map sheet can be modified by editing its parameters. You can change any parameter except the Drawing Name, which is the layer name on the legend. To modify the sheet parameters, right click the Map Sheet layer name and choose **Edit Params.**



When you press OK, the map sheet viewport will be updated on the survey map. If the sheet size, layout or print scale were changed, then the viewport size will be resized while retaining the same reference point (lower-left corner of the viewport).

4.4.6. Moving a Map Sheet

To move a defined map sheet, right click on the Map Sheet layer name and choose **Move Sheet**. The border of the map sheet's viewport will turn black. To move the sheet, click anywhere within the viewport and while holding the mouse button down, drag the viewport to the new location. Release the mouse button to drop the sheet in its new location. Together with the Edit Params operation, this allows the user to change the scale of the map sheet and relocated it to suit.

4.4.7. Deleting a Map Sheet

A map sheet can be deleted by right-clicking on the Map Sheet layer name and choosing **Delete Sheet**.

4.4.8. Saving the Map Layer Configurations

When a map sheet is printed, it will show the same layers that were displayed on the survey map display at the time the sheet was created. To change the way a defined map sheet is printed, you must make the desired changes on the survey map display, then right-click on the Map Sheet layer name and choose **Save Map-Layer Config**. For instance, you add a structure to a design. A previously defined map sheet did not include this structure. To plot the structure on this map sheet, make sure the structure layer is turned on, then select Save Map-Layer Config.

If many changes to the map display have been made between the time the map sheet was created to the time the structure was added, then it may be more efficient to restore the map to the way it looked when the map sheet was created, and then make the modifications. Use the Restore Map-Layer Config operation described below.

4.4.9. Restoring the Map Layer Configurations

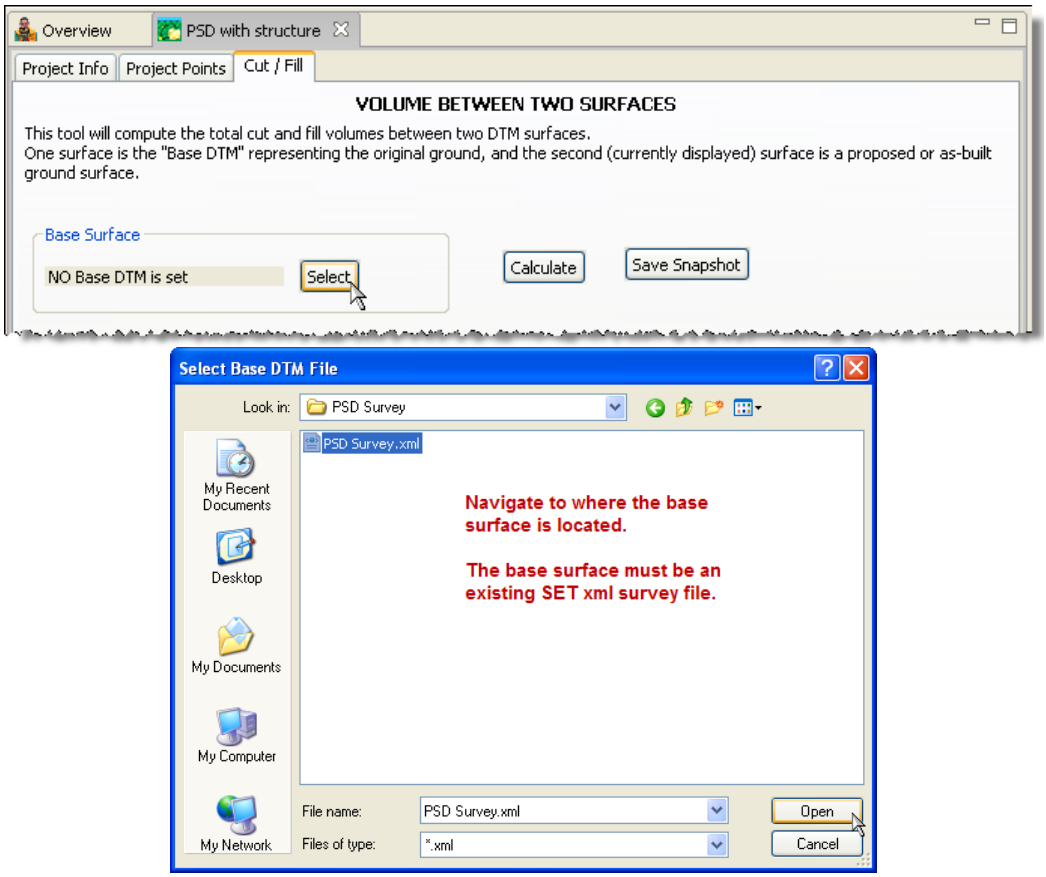
After you create a map sheet with certain layers turned on, you will likely continue to change the settings and layers as you work with the design. Should you wish to return to the way the map display looked when you created a map sheet, you can easily do this by right-clicking on the Map Sheet layer name and choosing **Restore Map-Layer Config.** The map display will revert back to the settings used when that map sheet was created or last saved.

> **Tip**
>
> The ability of the Map Sheet to save a complex map layer configuration make them a handy tool to control the EFT Map display. The user can define map sheets which are never meant to be printed; just to use them to store a map presentation setup for later recall. The user can use the Restore Map-Layer Config operation of a particular map sheet to recall those settings. This allows are user to switch rapidly between very different map configurations.

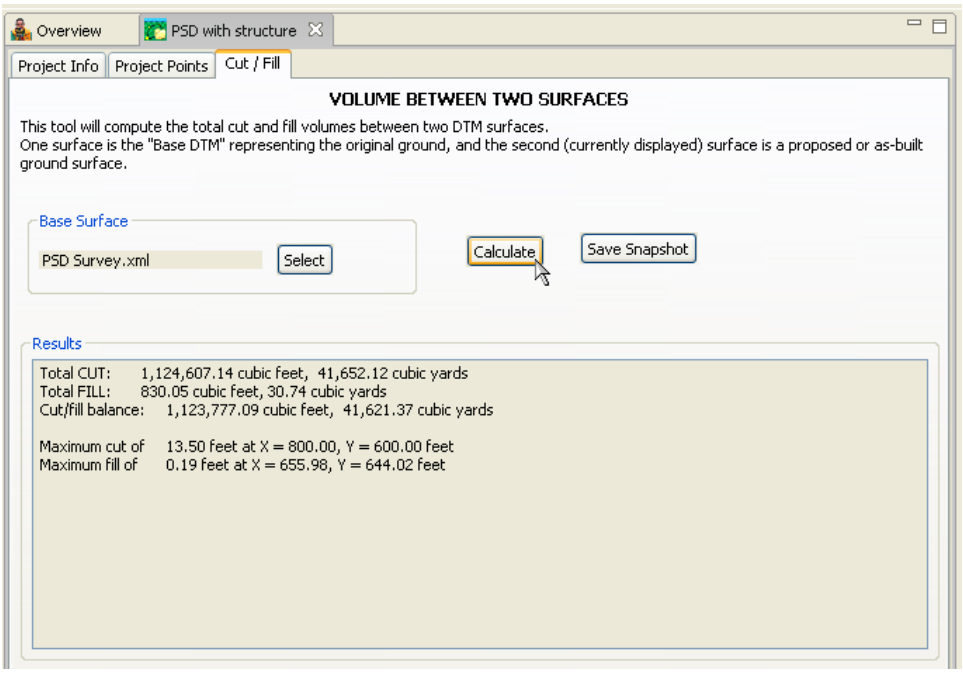
4.5. Volume Between 2 Surfaces

The volume between two DTM surfaces can be computed in the Cut / Fill tab of the open survey design. This feature will compare the currently opened survey with another existing survey created and saved with SET. An example application would be computing the difference in earthwork volume between an as-built survey and the original survey of the same area.

To begin, open the first survey design (for example, the as-built survey) and click on the Cut / Fill tab. Then, load the base surface by clicking the **Select** button, navigating to where the base surface survey file is located, and pressing **Open**. Note that this base surface must have been previously created and saved in SET; it will have an XML file extension.



When the base surface file name is displayed, press the **Calculate** button to compute the volumes of cut and fill between the two surfaces. **Note that the results will be copied to the system clipboard, to allow you to paste the results in another document if desired.** ***There is no separate report to print these results.***



Note

Commonly, this tool will be used to compare two surfaces that were created at different times such as an original survey (the base survey) and an as-built survey taken after the project is completed. Therefore, the method described above would be used, where the user would open the as-built survey and navigate to the location of the base survey.

However, there is a provision for comparing two surfaces using the same opened survey. When you get the currently opened survey to the point where you wish to consider it a base surface for volume computation, you can save it as a base survey by using the **Save Snapshot** button. Give the surface a new name when prompted and press Save. Then, you can continue making changes to the survey to the point where you wish to compute the volume difference between it and the base surface you took the snapshot of. At that point, save the current survey design (File, Save) then press the Select button on the Cut/Fill tab and select the snapshot file. Then press Calculate to compute the volume between the current surface and the snapshot surface.

5. Structures

Structures in SET are predefined templates that can be placed onto the ground surface. The user defines the size, slopes and location of the structure. The cut and/or fill slopes are extended to the ground surface and quantities of storage volume and earthwork volumes can be computed.

5.1. Structure Types

Structure properties are defined by the user. Once it's size and it's location on the surface map are defined, then the side slopes are extended to intersect the ground surface and the volumes of earthwork and storage can be computed. You can choose from five structure types, as follows:

1. **Rectangular Pit**

   A rectangular pit is an excavated pit that is entirely in the ground and contains only cut slopes. If a dike is needed to contain the desired amount of storage, then you must use the Diked Pit structure. The pit's width and length are entered. The structure assumes a level bottom at a user specified elevation. The side slopes can be uniform, or each side slope can be defined individually.

2. **Round Pit**

   A round pit is also an excavated pit that is entirely in the ground and contains only cut slopes. There is no diked pit alternative to the round pit. The structure assumes a level bottom at a user specified elevation. One cut slope can be entered.

3. **Diked Pit**

   A diked pit is a rectangular shaped pit that is a combination of excavation and earthfill to contain the desired storage. The pit width and length are defined, as well as the dike width, the inside slopes, the cut slopes, and the fill slopes. The structure assumes a level bottom at a user specified elevation, or the user can define the pit depth. The program will compute the earthwork balance and the cut:fill ratio.

4. **Pad**

   A pad structure is a flat, level, rectangular surface of a specified width, length, and elevation. The user also defines the cut and fill slopes. The program will compute the earthwork balance and the cut:fill ratio.

5. **Land Leveling**

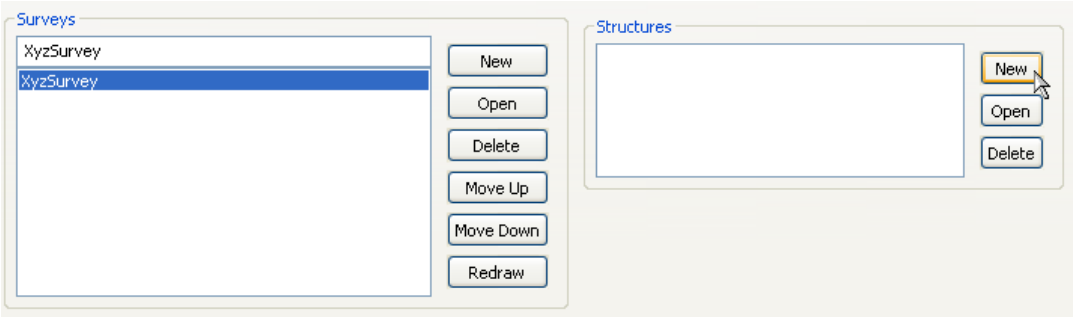
   A land leveling structure is a single plane at specified slopes and elevation on the whole field or part of the field. The user first designates whether the design covers the whole field or part of the field. There are buttons to return the coordinates of the centroid and the slopes for the plane of best fit. These values may be edited for the design. The program will adjust the base elevation to achieve the desired cut:fill ratio and calculate the resulting earthwork quantities.

5.2. Adding Structures to the DTM Surface

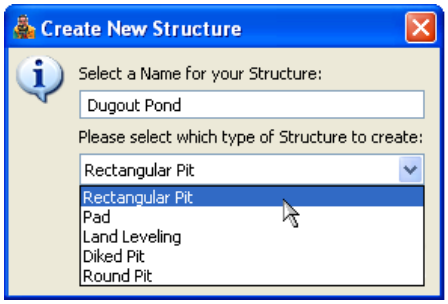
Structures are added to the ground surface by performing the following steps. Start on the Project Info Tab of the currently open survey design.

5.2.1. Creating a New Structure

After you have entered or imported a survey, the DTM has been processed (contour lines have been created), and you are satisfied that the contour lines represent the actual ground, then you can add a structure. Do this by clicking the **NEW** button next to the Structures Table on the Project Info tab.



In the Create New Structure dialog window, enter a name for your structure, and choose the type of structure. A Structure Input screen will open that is specific to the type of structure selected.



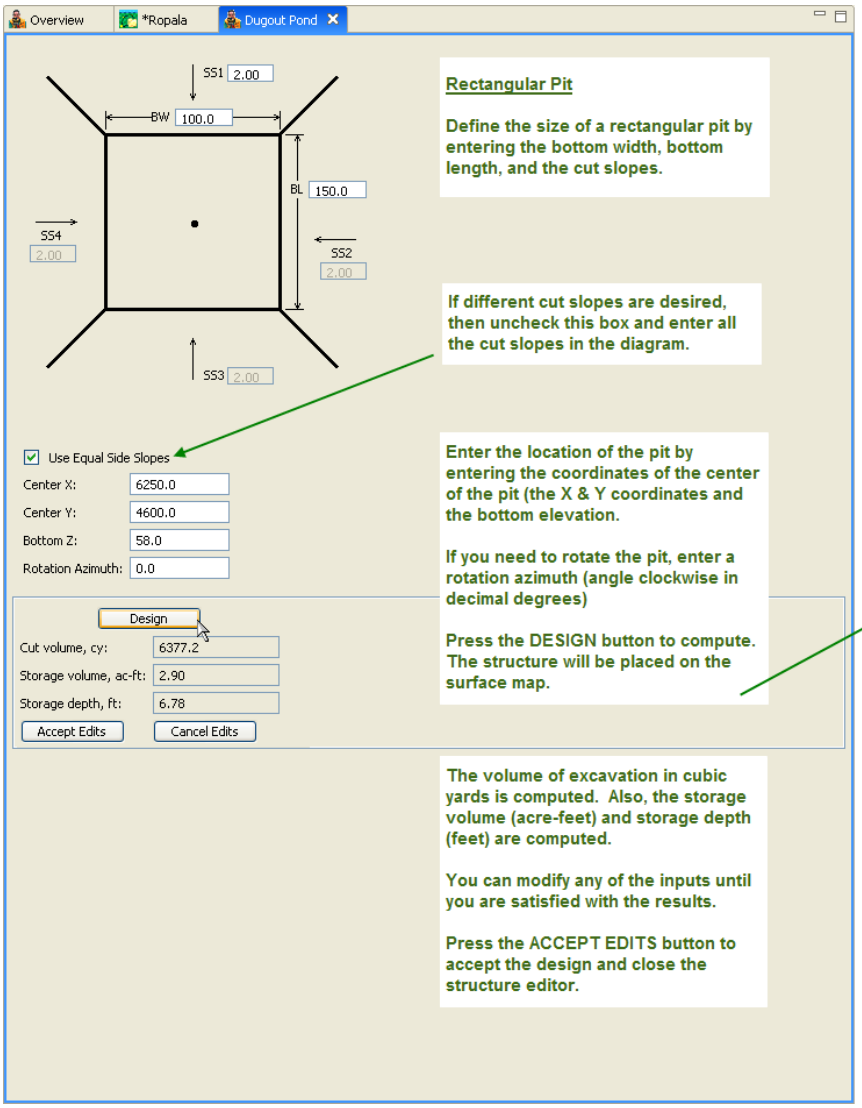
Enter a name for your structure, and choose the structure type from the drop-down list.

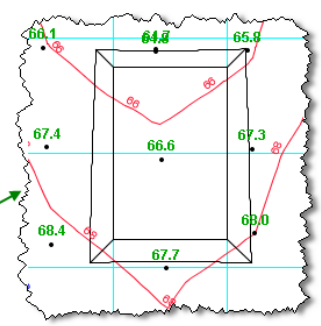
5.2.2. Structure Input Screens

The following sections describe the specific input screen for the different structures.

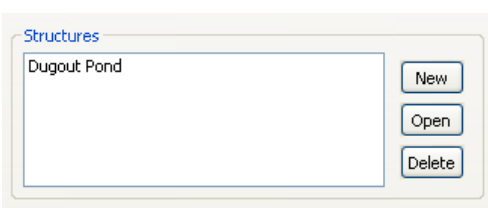
5.2.2.1. Rectangular Pit

If a Rectangular Pit structure type is chosen, the Rectangular Pit Input Screen will open so you can define the pit parameters. A rectangular pit is an excavated pit that is entirely in the ground and contains only cut slopes. If a dike is needed to contain the desired amount of storage, then you must use the Diked Pit structure. The pit's width and length are entered. The structure assumes a level bottom at a user specified elevation. The side slopes can be uniform, or each side slope can be defined individually.





Rectangular pit displayed on the map.

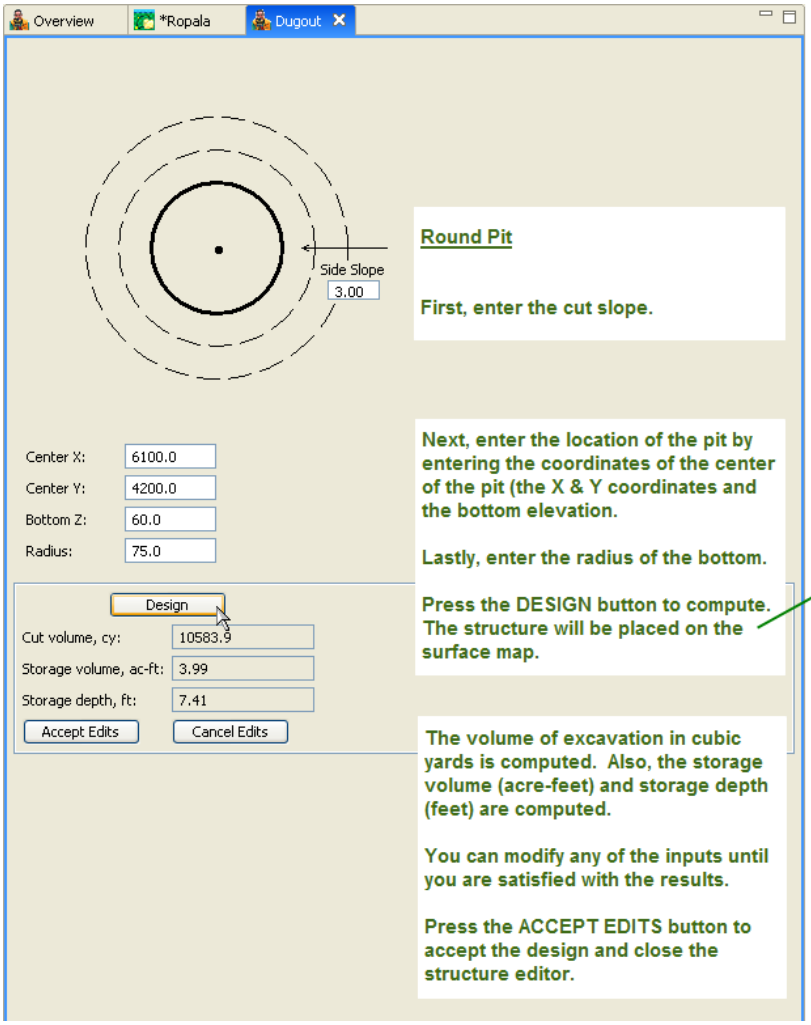


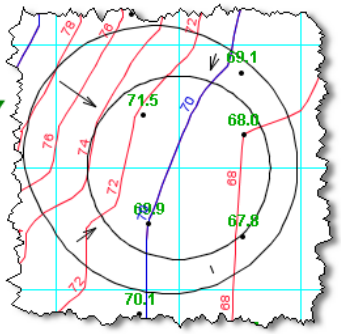
Added structures are listed in the Structures table, where you can OPEN them for editing, or DELETE them.

You can also add NEW structures.

5.2.2.2. Round Pit

If a Round Pit structure type is chosen, the Round Pit Input Screen will open so you can define the pit parameters. A round pit is an excavated pit that is entirely in the ground and contains only cut slopes. There is no diked pit alternative to the round pit. The structure assumes a level bottom at a user specified elevation. One cut slope can be entered.

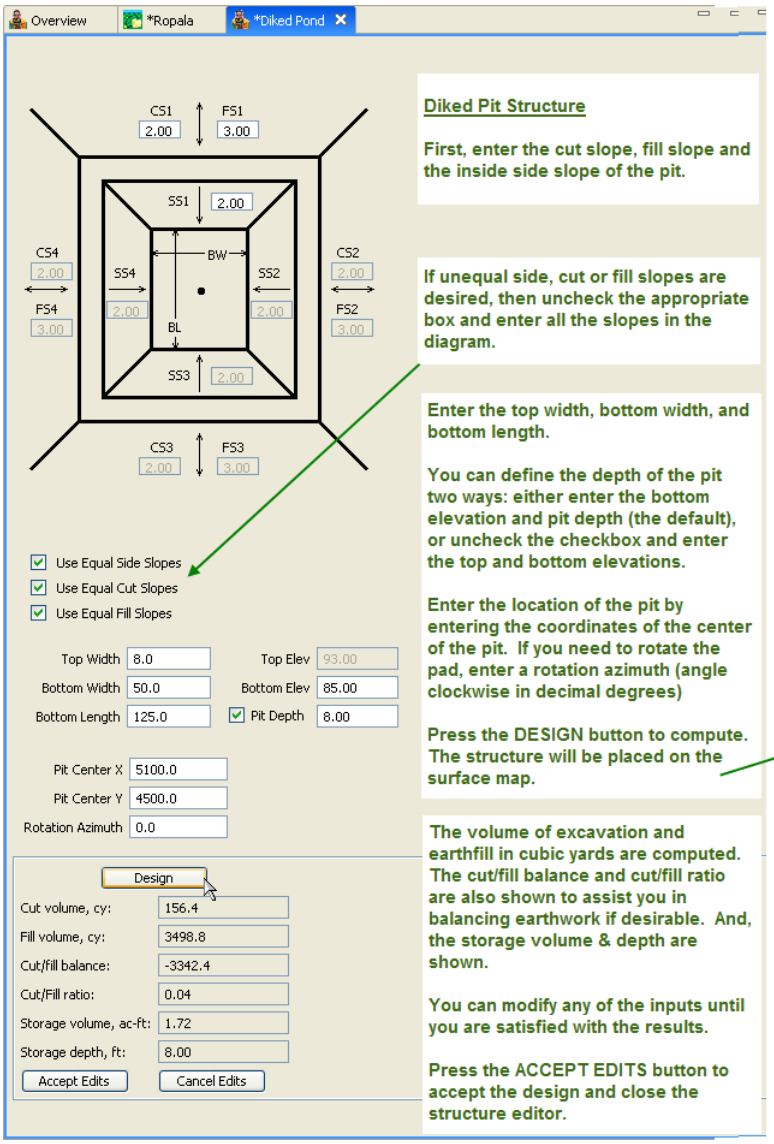




Round pit displayed on the map.

5.2.2.3. Diked Pit

If a Diked Pit structure type is chosen, the Diked Pit Input Screen will open so you can define the pit parameters. A diked pit is a rectangular shaped pit that is a combination of excavation and earthfill to contain the desired storage. The pit width and length are defined, as well as the dike width, the inside slopes, the cut slopes, and the fill slopes. The structure assumes a level bottom at a user specified elevation, or the user can define the pit depth. The program will compute the earthwork balance and the cut:fill ratio.



Diked Pit Structure

First, enter the cut slope, fill slope and the inside side slope of the pit.

If unequal side, cut or fill slopes are desired, then uncheck the appropriate box and enter all the slopes in the diagram.

Enter the top width, bottom width, and bottom length.

You can define the depth of the pit two ways: either enter the bottom elevation and pit depth (the default), or uncheck the checkbox and enter the top and bottom elevations.

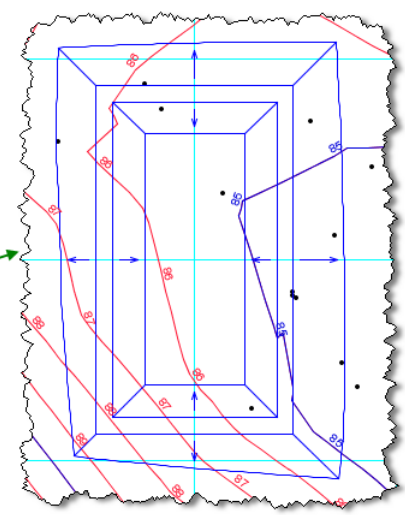
Enter the location of the pit by entering the coordinates of the center of the pit. If you need to rotate the pad, enter a rotation azimuth (angle clockwise in decimal degrees)

Press the DESIGN button to compute. The structure will be placed on the surface map.

The volume of excavation and earthfill in cubic yards are computed. The cut/fill balance and cut/fill ratio are also shown to assist you in balancing earthwork if desirable. And, the storage volume & depth are shown.

You can modify any of the inputs until you are satisfied with the results.

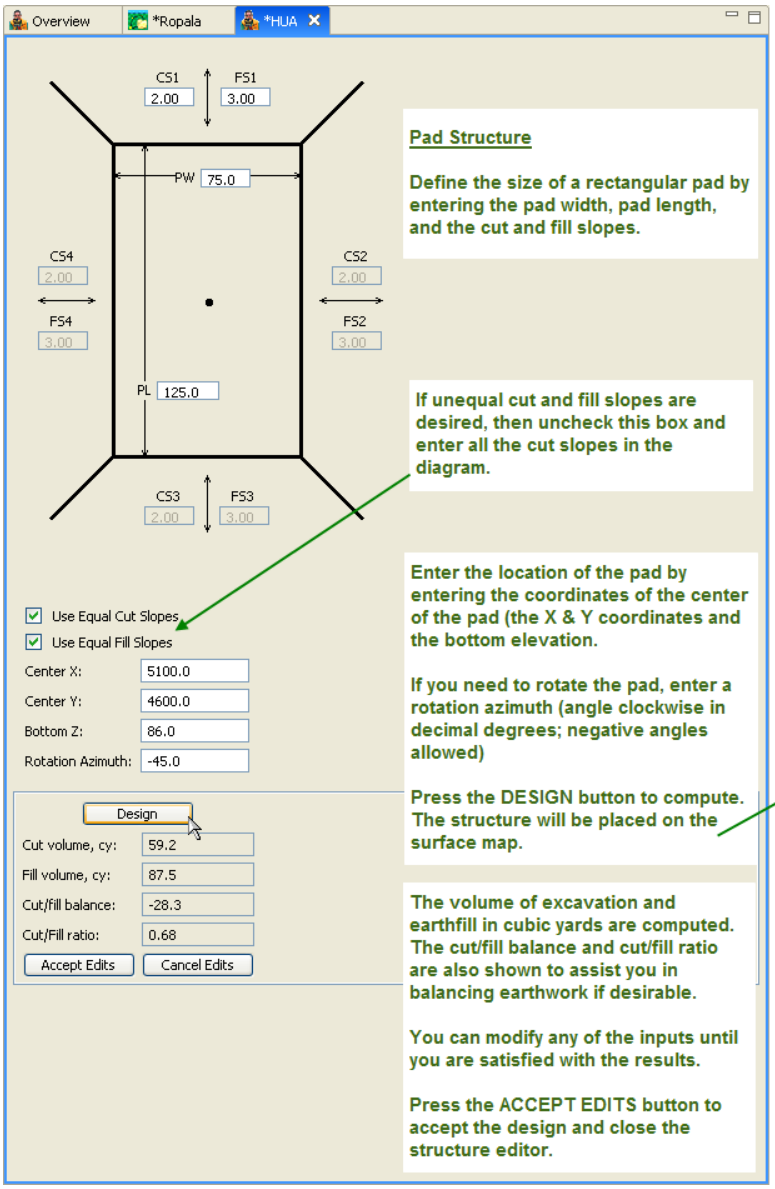
Press the ACCEPT EDITS button to accept the design and close the structure editor.

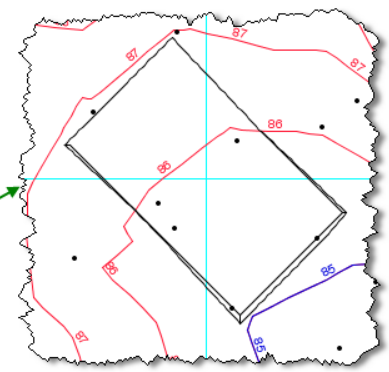


Diked pit displayed on the map.

5.2.2.4. Pad Structure

If a Pad structure type is chosen, the Pad Input Screen will open so you can define the pad parameters. A pad structure is a flat, level, rectangular surface of a specified width, length, and elevation. The user also defines the cut and fill slopes. The program will compute the earthwork balance and the cut:fill ratio.

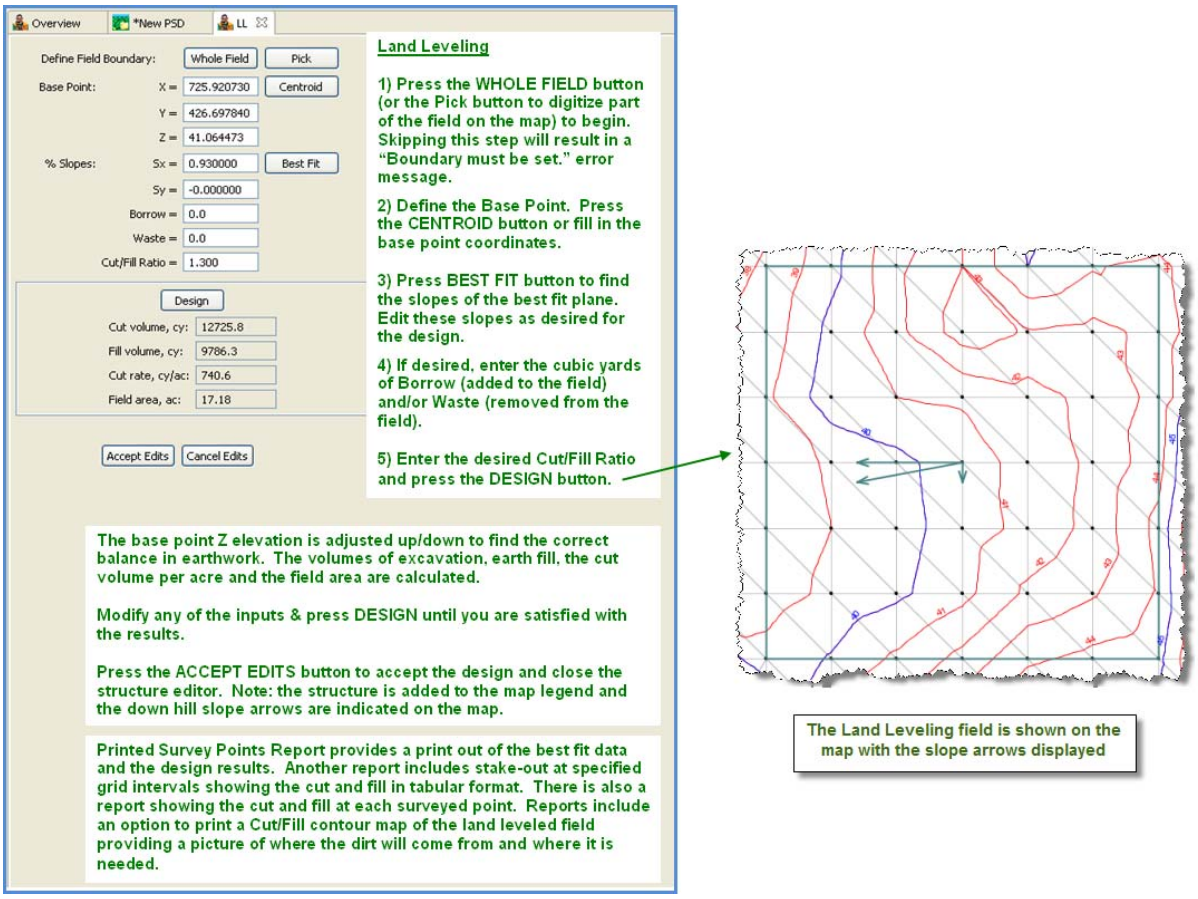




Pad is displayed on the map.

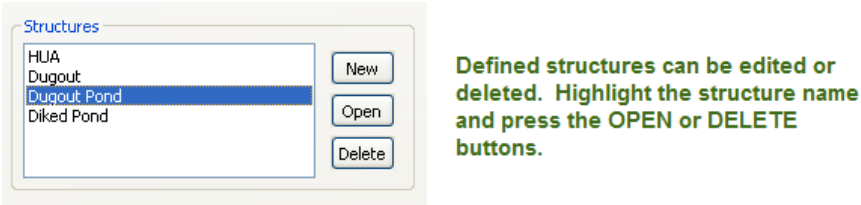
5.2.2.5. Land Leveling

If a Land Leveling structure type is chosen, the Land Leveling Input Screen will open so you can define the plane parameters. A land leveling structure is a single plane at specified slopes and elevation on the whole field or part of the field. The user first designates whether the design covers the whole field or part of the field. There are buttons to return the coordinates of the centroid and the slopes for the plane of best fit. These values may be edited for the design. The program will adjust the base elevation to achieve the desired cut:fill ratio and calculate the resulting earthwork quantities.



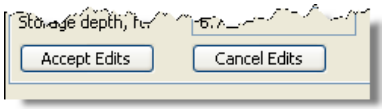
5.3. Opening Existing Structures for Editing or Deleting

Structures previously defined in a design file can be opened for editing and deleting. Simply highlight the structure to edit or delete and press the appropriate button.



To edit a structure press **OPEN**. The structure input screen for the type of structure will open with the previous input values and volume results. Make modifications as needed, pressing **DESIGN** to compute the new results.

When you edit a structure, be sure to press **ACCEPT EDITS** to save the changes. If you start editing a structure and wish to close the edits without saving them, then press the **CANCEL EDITS** button in the Structure Input screen.

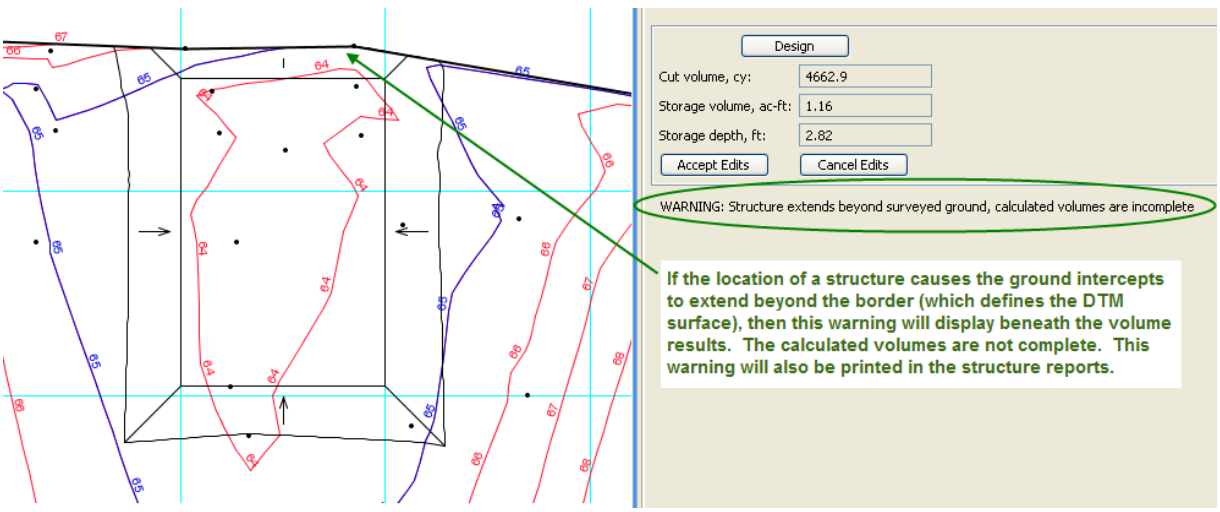


5.4. Warning and Error Messages when Working with Structures

When working with structures on the ground surface, you may run into user warning and error messages. Three of the more common messages are:

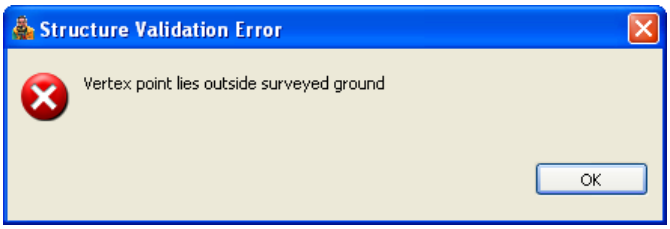
5.4.1. Incomplete Volumes Warning

If the structure is located so that the ground intercepts would extend beyond the surveyed ground (defined by the border), then the volumes will still be computed, but the following warning message is displayed and printed in the reports. You need to evaluate whether more survey data is needed. Note that this condition is only a warning and not an error condition. SET will still be able to map the structure.



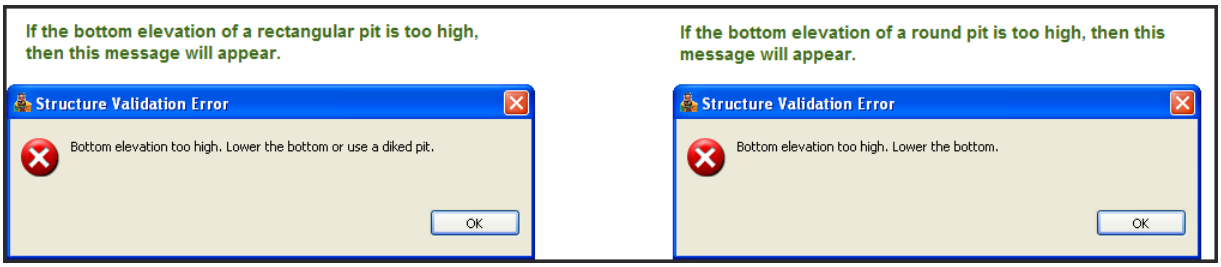
5.4.2. Vertex Points Outside of Border Error

If the structure is located so that one of the vertex points that defines the structure (corners of the pit bottom, for instance), then the program will display the following error message. In this case, you must move the structure so all vertex points lie within the border, or add survey data. SET will not be able to map the structure until you move the structure so all vertex points are within the boundary of the survey.



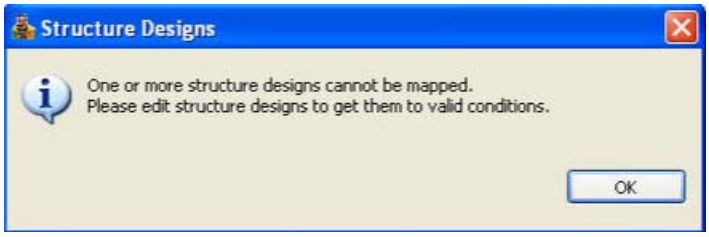
5.4.3. Bottom Elevation too High for Rectangular and Round Pit Errors

Since rectangular and round pits are excavation only, their entire bottom must lie below the ground surface. If any portion of the bottom lies above the ground surface, then the following message appears. You need to lower the bottom elevation, move the pit to another location on the ground surface, or use a diked pit. The only diked pit offered in SET is a rectangular diked pit. SET will not be able to map the structure until you lower the bottom elevation.

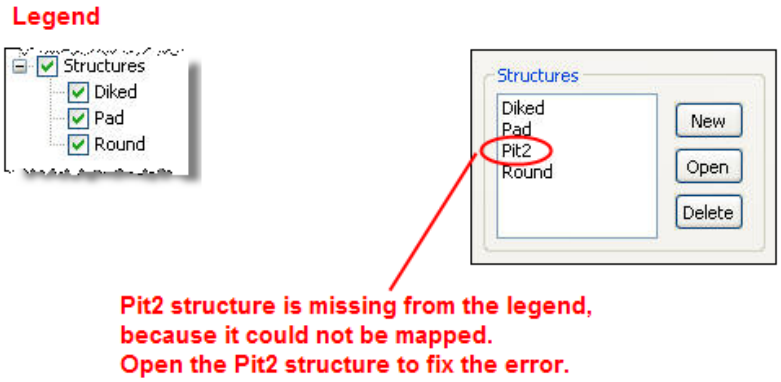


5.4.4. Structure Mapping Error

If you save a structure that has an error (you save by closing the structure input screen or choosing **Accept Edits**), SET will not be able to add the structure to the map. Also, the structure name will not be added to the legend. You will see the following warning message to alert you to this condition. This message will also appear if you open a survey design that has one or more structures that have an error condition.



To solve this problem, simply open the offending structure and revise its location or elevation. You can determine which structure(s) have problems by comparing the structure legend items with the list of structures. The structure(s) missing from the legend have an error condition.

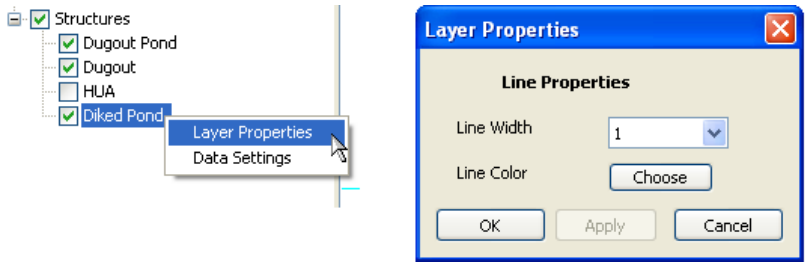


5.5. Structure Legend Items

When a structure is defined, it is added to the legend for the surface map. Each defined structure will have its own legend item. The user can control each structure item: turn structures on and off on the map, change the layer properties, and change the data settings.

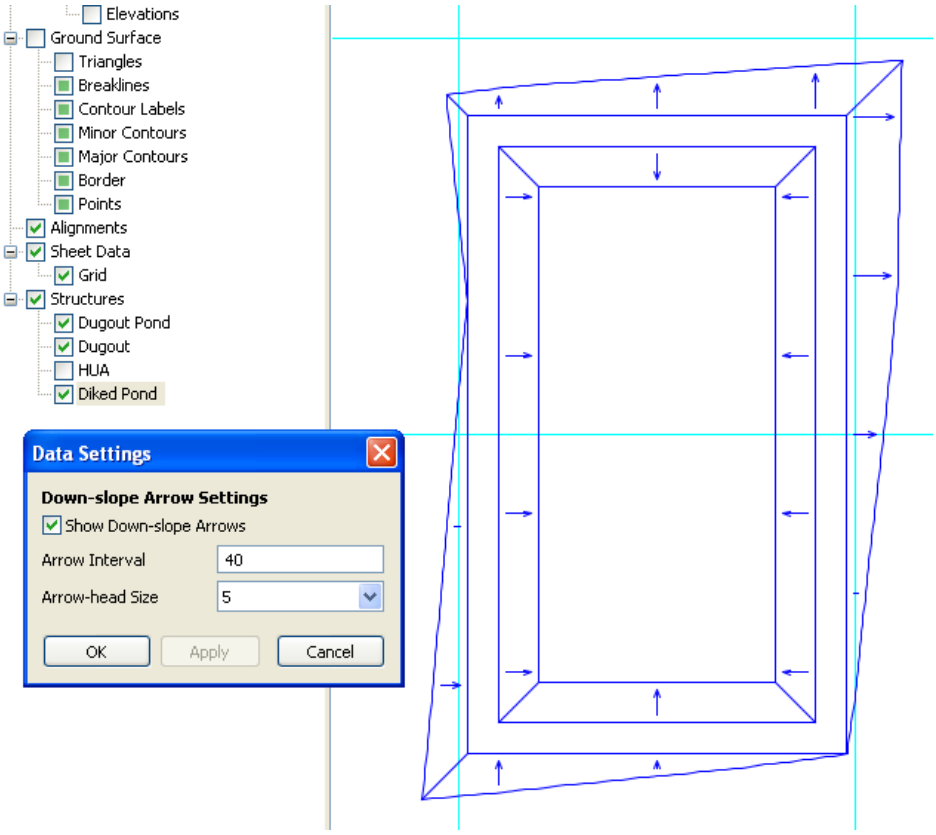
5.5.1. Structure Layer Properties

The line weight and color of the lines that define the structure can be changed in the Layer Properties. Right-click on the structure to be changed and click Layer Properties.



5.5.2. Structure Data Settings

Access the Data Settings dialog by right-clicking on the structure name in the legend. The structure data settings allow the user to control whether slope arrows are displayed, how often the slope arrows are displayed, and the size of the arrows. Slope arrows always point downhill, and can aid in the interpretation of the slopes of a structure. The setting you use will depend on the zoom level of the map. If you do not wish for the arrows to show, then uncheck the box. You can change the default values for these settings in the Structures section in Preferences. Refer to the **Preferences** section of this user manual.



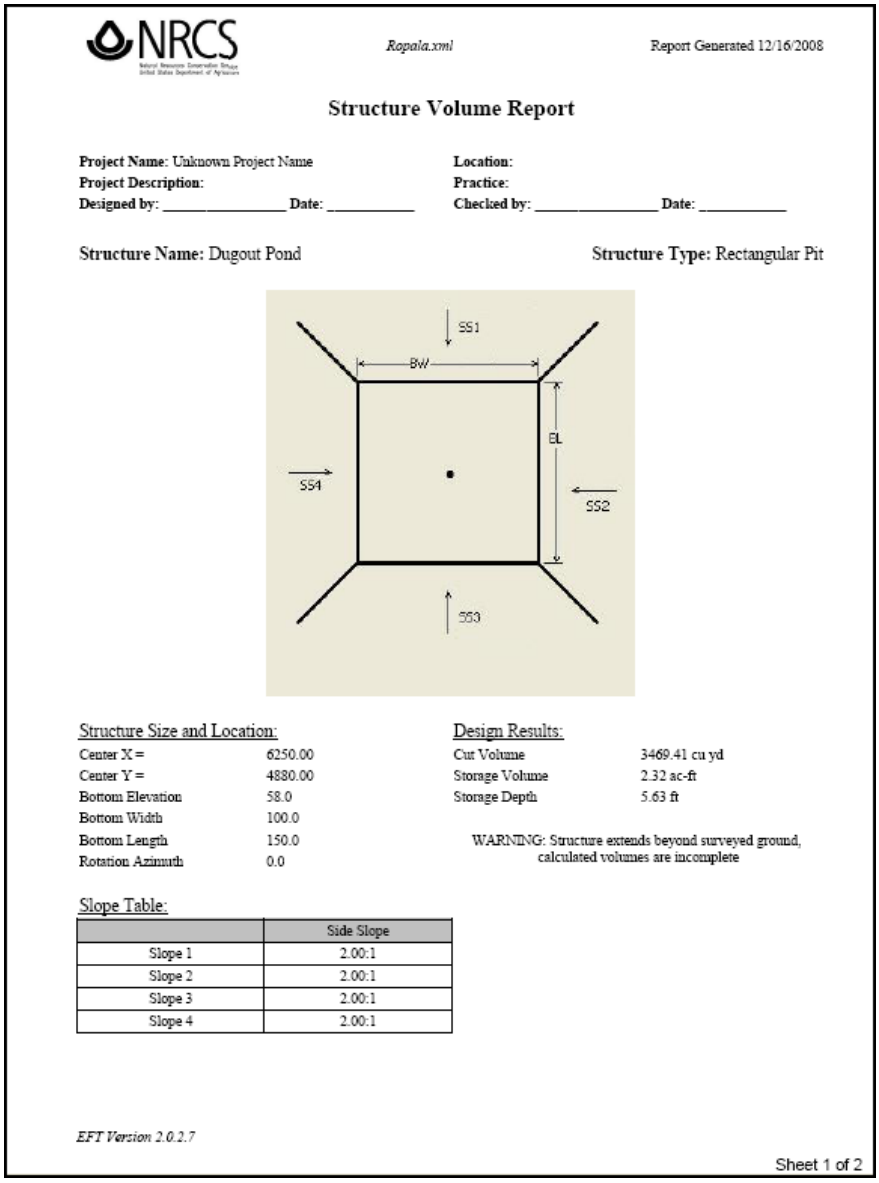
5.6. Structure Reports

There are two different structure reports available. Refer to the Reports and Printing section of this user manual for a more detailed explanation of how to generate structure reports. This section explains what each report offers.

For the Land Leveling reports, refer to the Reports and Printing section of this user manual.

5.6.1. Structure Design/Volume Report

This report documents the parameters that defined the structure and the resulting quantities. The structure sizes, slopes, location, and rotation are printed as well as the storage depth and volume, cut and/or fill volumes, cut/fill balance, and cut/fill ratio, as applicable for the structure type. If the location of the structure causes any of the slope intercepts to extend beyond the border, then a warning message is printed on the report. An example of the design/volume report for a rectangular pit is shown below.



NRCS

Ropala.xml Report Generated 12/16/2008

Structure Volume Report

Project Name: Unknown Project Name
Project Description:
Designed by: _____ **Date:** _____

Location:
Practice:
Checked by: _____ **Date:** _____

Structure Name: Dugout Pond **Structure Type:** Rectangular Pit

Structure Size and Location:

Center X =	6250.00
Center Y =	4880.00
Bottom Elevation	58.0
Bottom Width	100.0
Bottom Length	150.0
Rotation Azimuth	0.0

Design Results:

Cut Volume	3469.41 cu yd
Storage Volume	2.32 ac-ft
Storage Depth	5.63 ft

WARNING: Structure extends beyond surveyed ground, calculated volumes are incomplete

Slope Table:

	Side Slope
Slope 1	2.00:1
Slope 2	2.00:1
Slope 3	2.00:1
Slope 4	2.00:1

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Sheet 1 of 2

5.6.2. Structure Stakeout Report

This report documents the parameters that defined the structure and the coordinates and the cut/fill at key points to layout the structure on the ground. Each structure type has its own set of key points, which are shown on the report. If the location of the structure causes any of the slope intercepts to extend beyond the border, then a message is printed in the stakeout table, and the coordinates are given where the slope intercept meets the border of the survey along with the cut or fill at that point. Ordinarily, the cut and fill at the ground intercept is zero. An example stakeout report for a rectangular pit is shown below. This structure has two slope intercepts that extend beyond the border for illustration.

NRCS

Ropala.xml Report Generated 12/16/2008

Structure Stakeout Report

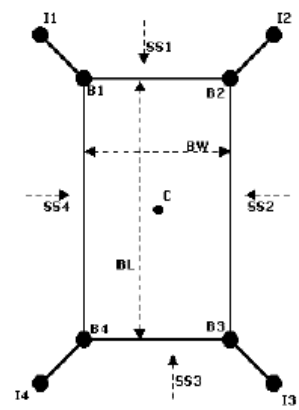
Project Name: Unknown Project Name
Project Description:
Designed by: _____ **Date:** _____

Location:
Practice:
Checked by: _____ **Date:** _____

Structure Name: Dugout Pond **Structure Type:** Rectangular Pit

Structure Properties

BW	100.0
BL	150.0
SS 1	2.00:1
SS 2	2.00:1
SS 3	2.00:1
SS 4	2.00:1
Bottom Elev.	58.0
Rotation	0.0



Stakeout Table

Pt. Name	Description	X	Y	Z	Cut
C	Center	6250.00	4880.00	58.0	C 5.8
B1	Bottom 1	6200.00	4955.00	58.0	C 6.8
B2	Bottom 2	6300.00	4955.00	58.0	C 6.6
B3	Bottom 3	6300.00	4805.00	58.0	C 6.5
B4	Bottom 4	6200.00	4805.00	58.0	C 6.2
I1	No valid Ground Intercept	6185.10	4969.90	65.5	C 0.6
I2	No valid Ground Intercept	6311.26	4966.26	63.6	C 1.0
I3	Corner Intercept 3	6313.38	4791.63	64.7	0
I4	Corner Intercept 4	6186.88	4791.88	64.6	0

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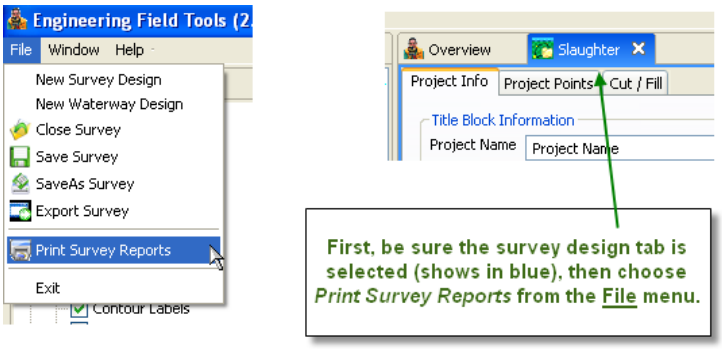
Sheet 2 of 2

6. Reports and Printing

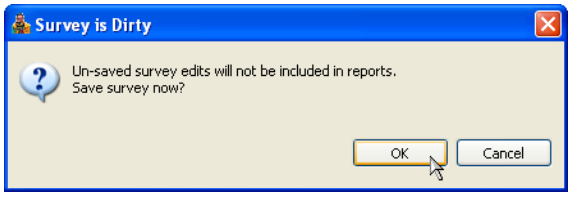
The EFT Framework includes a reporting subsystem which generates output documenting the designs prepared with the various conservation engineering design tools. This is useful for preparing internal documentation reports for NRCS records, and for preparing design documentation packages to be provided to contractors. Moreover, the reporting framework is used for preparing both map graphics reports, called Map Sheets, and for preparing the text documents detailing the designs. This chapter documents the operations and use of the reporting framework to print maps and text reports.

6.1. Generating a Report

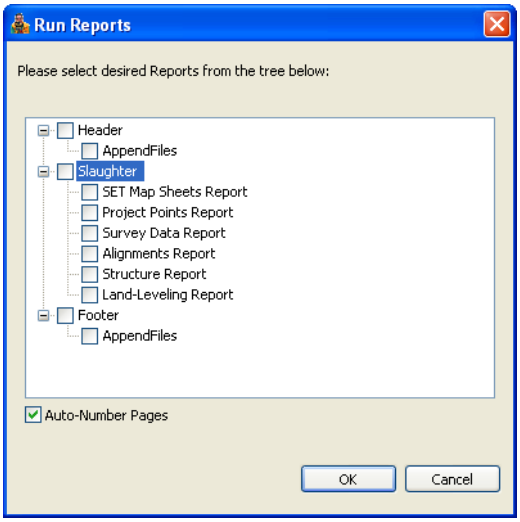
To start a report, ensure that the survey design tab is selected (it's highlighted in blue), then access the Reports from the File menu.



If changes have been made to the survey file that haven't yet been saved, then a message will be displayed prompting you to save the file. If so, press OK and the map will be displayed on the right side of the EFT window.



The **Run Reports** window will open to list the reports available for this survey design in a tree fashion. Indicate whether you wish the pages to be numbered. The default is checked (pages numbered), but you can change this default setting in the Preferences section under Reporting Services. Select the reports to run and press OK. The individual reports are described in the sections below.



The Report system provides some special features to support batched packages of reports.

Saved package configuration:

When the report package is run, the full package configuration - which reports were selected, and all the parameters provided through the wizards - is saved for later reuse. The next time the user selects the "Print Reports" menu item, the complete saved state will be retrieved and displayed in the Run Reports Window. From this starting point, the user can re-run the same package of reports with the same configuration as before just by clicking Finish. This allows the user to re-print a package later, if needed.

This can save a lot of trouble if one report out of a package was configured wrong. In this case, the user would select the "Print Reports" item again, and the Run Reports Window would come up with the same configuration it had before. The user can un-check the one report that was configured wrong, and then check it again. The wizard will be presented again, allowing the user to enter correct configuration for that one report. Then a click on the "Finish" button will print the whole report package, with the error corrected. This is much simpler than having to reconfigure every report in the package from scratch.

Page Numbering:

Note the "Auto-Number Pages" check-box, in the Run Reports Window beneath the actual tree view. If checked, the total set of reports in the package will be page-numbered together in a continuous sequence. This is a quality-assurance feature, letting a contractor check a hard-copy package to make sure he has all the pages of the construction plans. Similarly, an NRCS staffer can be sure he has all pages of a documentation report. The user can turn this off when needed, e.g., when he would prefer to hand-number a set of large map sheets.

Header/Footer Reports:

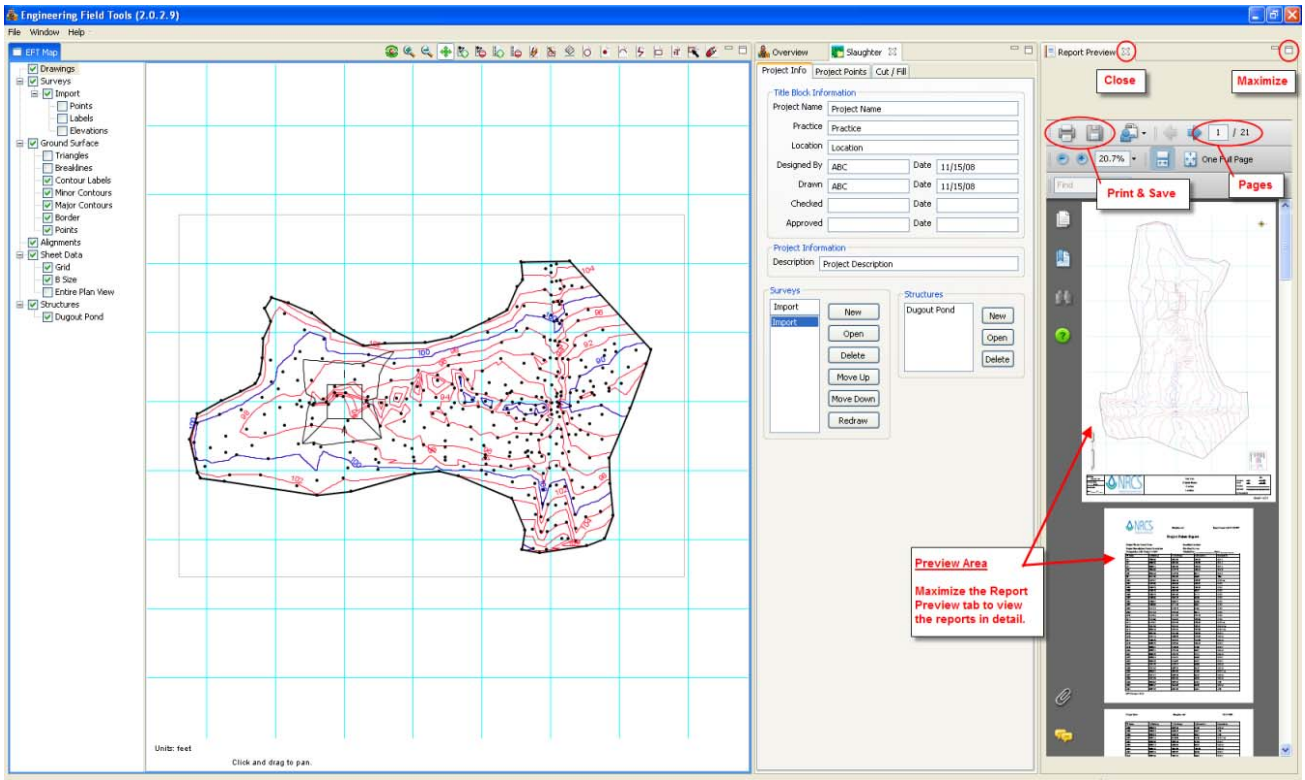
The Header and Footer sections of the Run Reports Window allow the user to add cover sheets or standard "boiler-plate" documents to the overall report package. These come out numbered together with all the other reports into one complete package. In the snapshot above, the Header and Footer sections include the AppendFiles report. The AppendFiles report lets the user add external files (files outside the EFT files directory, which must be PDFs or image files at this time) as part of the overall report package, on the fly at report launch time.

The AppendFiles report tool is a "dynamic" tool, which has to be configured at report launch time. The configuration of the AppendFiles report is not included in the saved package configuration (because EFT can't count on the external files being available for a later run). Therefore, to re-create a package which used the AppendFiles tool, the user has to check the AppendFiles tool and select the same files again.

For some uses, such as state-wide standards drawings or other "boilerplate" maintenance specs, this control pattern is not a good fit. Therefore, in addition to the AppendFiles report tool, EFT also supports adding "static" boilerplate reports, which are kept in the report tree and available for use as a header or footer report just by clicking the check-box. See the Preferences section of the EFT Framework Help file for a description of how to add these "static" header/footer items.

6.2. Report Preview

Once the reports are selected from the Run Reports window and OK is pressed, the reports will be generated. It may take a little time to run the reports, but once finished, the Report Preview tab will open.



If you need to examine the reports more closely, click the Maximize button. You can use the usual Adobe toolbar buttons to zoom into the report as needed. You can rotate the image by right-clicking on the page and select Rotate Clockwise.

If you are satisfied with the report, click the print button to print the reports. You can also save the report as an Adobe document. If you need to make changes to the report, then click the X on the preview tab to close.

Close the report preview by clicking on the X on the tab. **If you maximize the view, be sure to close the report preview by clicking the X on the preview tab, and NOT the X in the upper right corner, which will close EFT**.

6.2.1. Print Settings using Adobe Reader

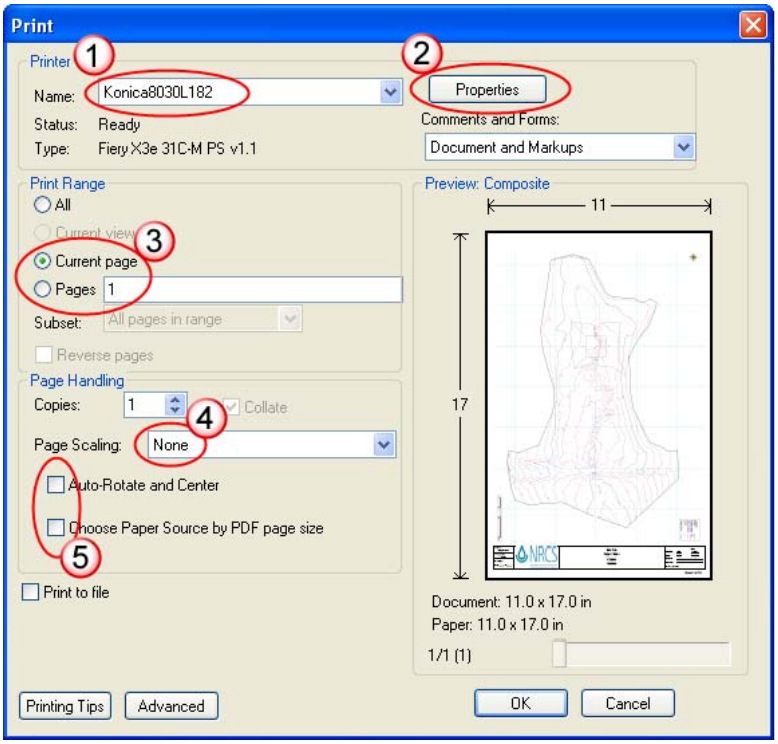
If you included map sheets larger than A size (8.5"x 11") in the list of reports that you selected, you will likely need to print the map sheets separately. Mixing print sizes is generally only desirable if you wish the page numbers to be included on the map sheets. Otherwise, it may be easier to simply generate the map sheets separately using the report system or the map sheet preview function discussed above.

6.2.1.1. Printing Map Sheets

Below is a screen shot of the print dialog box after pressing the Print button in the preview window. This example has a 21 page report, page one of which is a Map Sheet. The settings below generally work for many printers. You may need to change some settings depending on the printer or plotter you are using. The example below is for printing a B size sheet (11" x 17").

Note

If you find that the printed output is not scale accurate, you can adjust the "Map-Sheet Print Scale Factor" in the Mapping section in the program preferences. Refer to the Preferences section of this user manual for more information. A good way to test this is to print a map with the grid lines turned on. This should be a rare occurence. The default scale factor works well with most printers.



Depending on your printer or plotter, you may need to use different settings, but generally these settings work:

1. Make sure you choose the correct printer or plotter that supports the size of the map sheet to be printed.

2. Click the properties button to open the printer properties, and choose the correct paper size. (the "choose paper source by PDF page size" checkbox does not always work).

3. Choose the page numbers of the map sheets to print (or current page if only one sheet)

4. To ensure the printout is scale accurate, be sure Page Scaling is set to None.

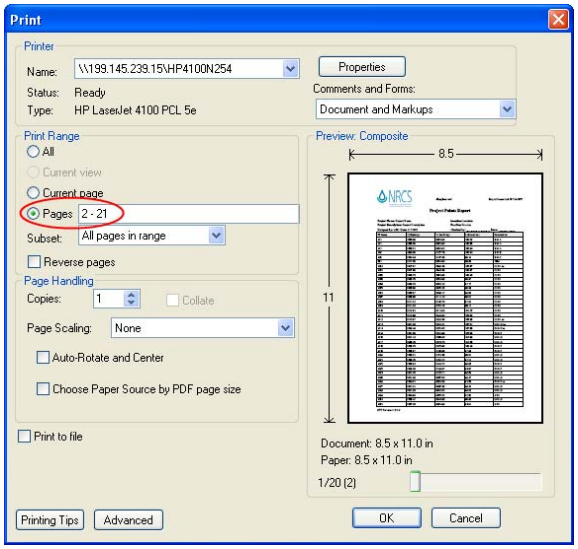
5. Normally, these checkboxes can be left unchecked. Just check the preview composite to see if the page looks correct before pressing OK.

Note

If the above Print window appears, but disappears quickly, it "went behind" the SET window. Simply minimize SET to view the Print window again.

6.2.1.2. Printing Other Reports

For the other 8.5" x 11" reports, you can likely print to your default printer. You may need to select the pages if the report package contains large map sheets. In this example, the remaining 20 pages of a 21 page report will be printed.

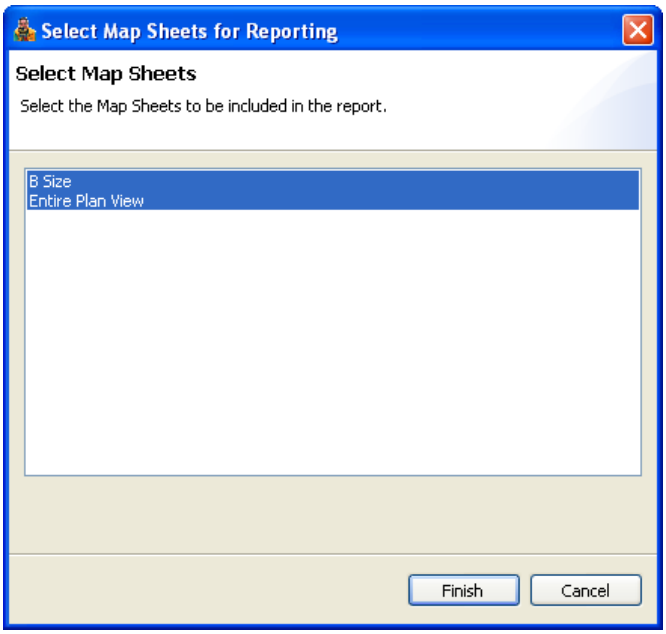


6.3. SET Map Sheets Report

User defined Map Sheets can be printed alone or with other reports. Refer to the Map Sheets section under Ground Surface Map for help in defining and modifying map sheets. When the Map Sheets checkbox is checked, a pop-up window will appear for you to select which of the defined map sheets are to be printed. They are all highlighted by default. Choose the sheet(s) to print and click **Finish**.

Note

You can print a single map sheet, without pagination, using the Preview function in the Legend menu for any defined Map Sheet. Refer to **Previewing a Map Sheet** in the Ground Surface Map, Map Sheets section for help.



Note

The program remembers the map sheets that were chosen for a report request. So, if you wish to print different map sheets, then you must uncheck the SET Map Sheets Report checkbox and then check the box again to force the Selection window to appear again.

6.4. Project Points Report

To generate this report, check the Project Points Report on the Run Reports window. The project points report lists all the points from all surveys that have been entered into this project manager file. Note that Radial survey points and Station-Offset survey points will be converted to XYZ coordinates in this report. To see these survey points in their original format (as entered into SET), see the next section on Survey Data Reports. The points in the Project Points report are sorted by point name. Below is an example report.

NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Ropala.xml Report Generated 01/09/2009

Project Points Report

Project Name: Unknown Project Name **Location:**
Project Description: **Practice:**
Designed by: _____ **Date:** _____ **Checked by:** _____ **Date:** _____

Pt Name	X (Easting)	Y (Northing)	Z (Elevation)	Description
201	10676.32	4229.26	80.67	TH
202	10777.00	4213.36	81.30	TH
203	10883.90	4200.86	80.27	TH
204	10881.78	4071.84	74.58	TH
205	10772.26	4113.28	75.63	TH
206	10657.58	4156.50	77.43	TH
207	10636.58	4081.57	78.82	TH
208	10758.53	4016.12	76.64	TH
209	10877.85	3947.56	73.59	TH
210	10856.04	3972.49	74.85	TH
221	10797.20	3875.68	77.28	TH
222	10781.45	3751.76	77.99	TH
517	10909.86	3663.03	72.68	PIN
1013	9658.25	[illegible]	105.57	
1014	9682.12	4911.59	101.32	FE
1015	9768.77	4942.11	102.01	
1016	9789.82	4923.84	97.73	CM
1017	9864.94	4941.19	100.81	
1018	9866.25	4907.11	95.98	FE
1019	9967.66	4940.19	100.32	

EFT Version 2.0.2.9

Sheet 1 of 47

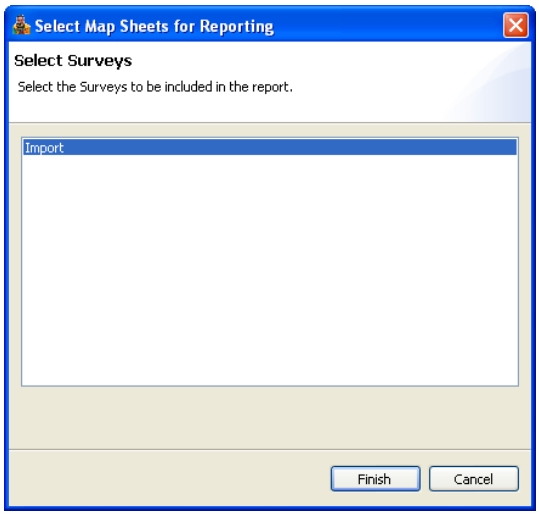
At the end of the project point report is a separate table that lists the sources of the points, that is, the names and types of surveys making up the project. Also, XYZ type surveys will show whether any translation or rotation modifications have been made. Note that the coordinates in the project points report reflect any translation and rotation that the user has made. The survey data report for the xyz survey will reflect the original coordinates without modifications due to translation or rotation. See the next section for survey data reports.

This Project Points data was compiled from the following surveys entered into SET:

Survey		Survey Translation				
Name	Type	Mode	Rotation	Delta X	Delta Y	Delta Z
Import	XyzSurvey	By Deltas	---	5000.0	0.0	---

6.5. Survey Data Report

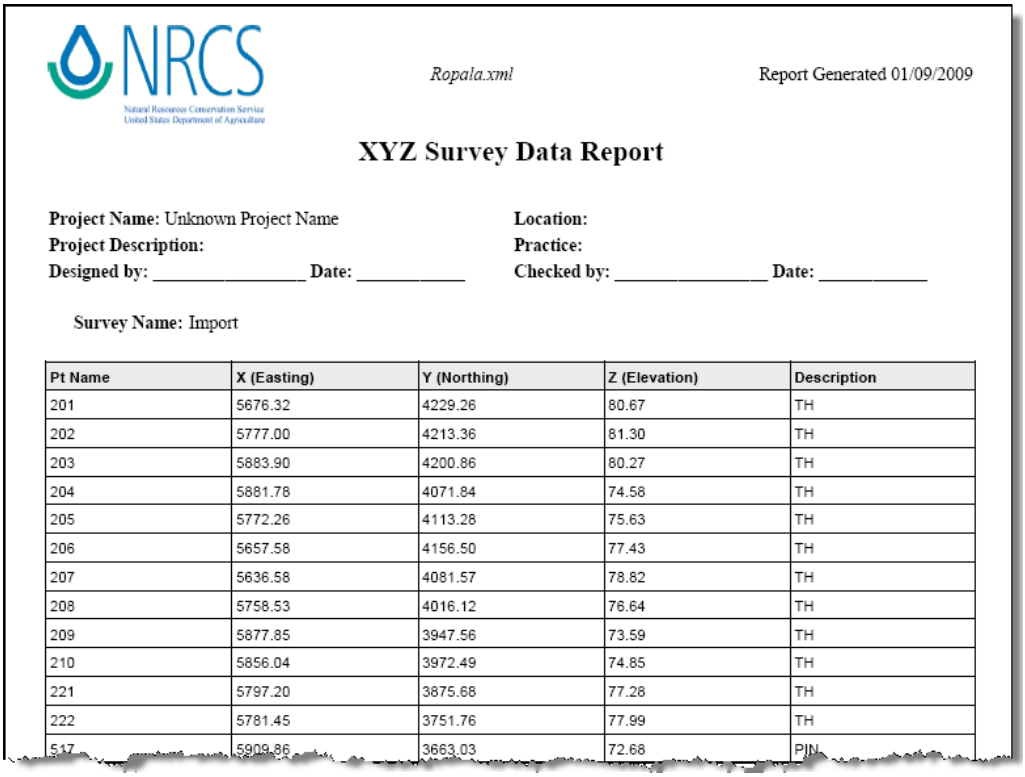
Survey Data reports serve to document the original survey information in the same format as was entered in the program. For instance, the Radial survey data report will show the survey points in the format as entered into SET. This is compared to the Project Points report that would show those same points but converted to XYZ coordinates. To generate these reports, check the Survey Data Reports checkbox on the Run Reports window. When this box is checked, a pop-up window will appear to select which surveys to include in the report. All are highlighted by default. Make your selection and press **FINISH**.



Below are examples for each of the three survey types.

1. **XYZ Survey Data Report**

   The survey data report for XYZ surveys shows the points with their original coordinates, without translation or rotation applied. To print the translated coordinates, you must request the Project Points report. See that section above.



Ropala.xml Report Generated 01/09/2009

XYZ Survey Data Report

Project Name: Unknown Project Name **Location:**
Project Description: **Practice:**
Designed by: _____ **Date:** _____ **Checked by:** _____ **Date:** _____

Survey Name: Import

Pt Name	X (Easting)	Y (Northing)	Z (Elevation)	Description
201	5676.32	4229.26	80.67	TH
202	5777.00	4213.36	81.30	TH
203	5883.90	4200.86	80.27	TH
204	5881.78	4071.84	74.58	TH
205	5772.26	4113.28	75.63	TH
206	5657.58	4156.50	77.43	TH
207	5636.58	4081.57	78.82	TH
208	5758.53	4016.12	76.64	TH
209	5877.85	3947.56	73.59	TH
210	5856.04	3972.49	74.85	TH
221	5797.20	3875.68	77.28	TH
222	5781.45	3751.76	77.99	TH
517	5909.86	3663.03	72.68	PIN

2. **Radial Survey Data Report**

This report shows the points in their original radial format. Note that the points are "reduced", that is, the elevations have been computed and the X&Y coordinates are shown for each point. A table at the end of the report lists the control points that were assigned during survey entry. Refer to the Radial Survey Input section of this user manual for more information.

Radial Survey.xml Report Generated 01/09/2009

Reduced Radial Survey Data Report

Project Name: Example Project
Project Description: Ground Topo
Designed by: DLN **Date:** 9/10/08

Location: Pittsfield, MA
Practice: Prescribed Grazing
Checked by: _____ **Date:** _____

Survey Name: Radial

Survey Settings
Zero Vertical Angle Reference: Horizon
Distance Type: Stadia
Backsight Vertical Angles Allowed: No

Setup Name: IP A
Setup Type: Initial
Instrument Location:
X: 5000.00 Y: 5000.00 HI: 105.48 Reference Azimuth: 0.00
Benchmark Information:
BM Elevation: 100.00 BS Rod: 5.48 Description: nail in tree
BS VA: 0.00 BS Distance: 0.00

Point Name	Foresight	Elevation	Distance	Horizontal Angle	Vertical Angle	X	Y	Description
1	5.48	100.00	105.00	89.30	0.00	5105.00	5000.92	TBM1
2	5.70	99.78	0.00	0.00	0.00	5000.00	5000.00	IP A
3	1.20	107.77	200.00	90.00	1.00	5199.94	5000.00	grd
4	15.60	84.65	150.00	135.00	-2.00	5105.94	4894.06	grd
5	8.50	96.98	275.00	225.00	0.00	4805.55	4805.55	grd
6	6.80	98.68	305.00	271.20	0.00	4695.08	5007.10	grd
7	4.30	101.18	356.00	324.21	0.00	4792.51	5289.28	grd
8	12.30	93.19	497.00	142.25	0.00	5303.13	4606.14	IP B
9	9.56	95.92	483.00	121.54	0.00	5410.05	4744.76	TP 1

Control Points:

Point Name	Foresight	Elevation	Distance	Horizontal Angle	Vertical Angle	X	Y	Description
1	5.48	100.00	105.00	89.30	0.00	5105.00	5000.92	TBM1
2	5.70	99.78	0.00	0.00	0.00	5000.00	5000.00	IP A
8	12.30	93.19	497.00	142.25	0.00	5303.13	4606.14	IP B
9	9.56	95.92	483.00	121.54	0.00	5410.05	4744.76	TP 1
15	6.30	92.91	612.00	71.00	0.00	5881.79	4805.39	IP C
16	5.67	93.54	572.00	62.30	0.00	5810.50	4870.26	TP 2
22	3.68	96.43	456.00	121.00	0.00	6195.39	5136.43	TP 3
24	0.00	102.55	0.00	0.00	0.00	6600.14	5122.30	IP D
P29	5.60	100.99	0.00	0.00	0.00	5248.56	5026.82	IP E

3. **Station-Offset Data Report**

   This report lists the cross section data as entered into the SET. The report is organized by Alignments. The points are "reduced", that is, the elevations X&Y coordinates are computed and displayed.

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Smith Waterway.xml Report Generated 01/09/2009

Reduced Station-Offset Survey Data Report

Project Name: Unknown Project Name **Location:**
Project Description: **Practice:**
Designed by: _____ **Date:** _____ **Checked by:** _____ **Date:** _____

Survey Name: SO 2

Alignment Name: Align 1

Station: 1+00

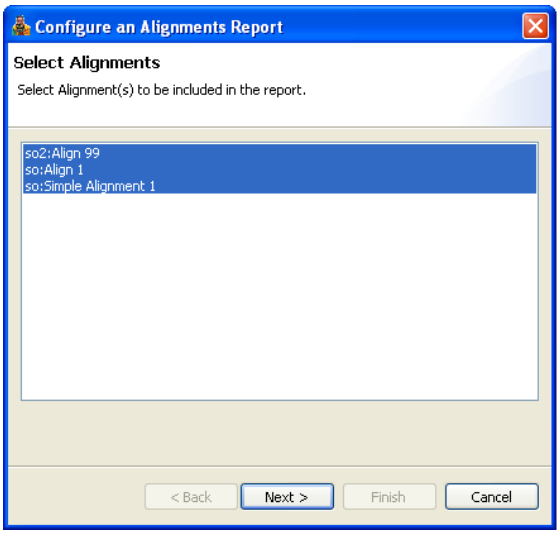
Distance	Elevation	X Coordinate	Y Coordinate
-150	100.0	150.0	300.0
-100	95.0	200.0	300.0
-50	92.0	250.0	300.0
-10	90.0	290.0	300.0
0	89.0	300.0	300.0
8	90.0	308.0	300.0
20	95.0	320.0	300.0
50	98.0	350.0	300.0

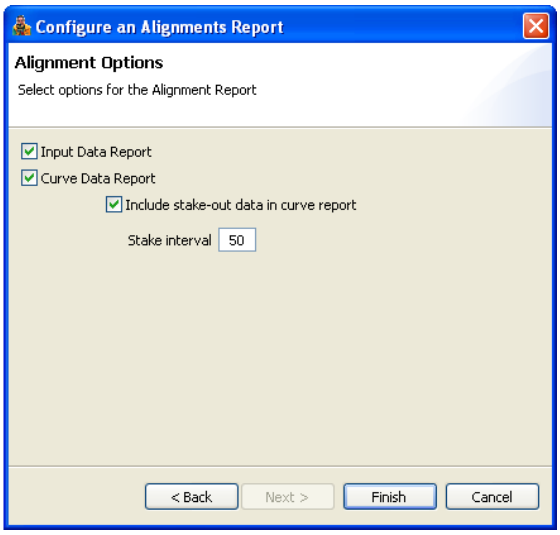
Station: 2+00

Distance	Elevation	X Coordinate	Y Coordinate
-50	102.0	250.0	400.0
-10	100.0	290.0	400.0
0	98.0	300.0	400.0
20	100.0	320.0	400.0
40	102.0	340.0	400.0

6.6. Alignments Report

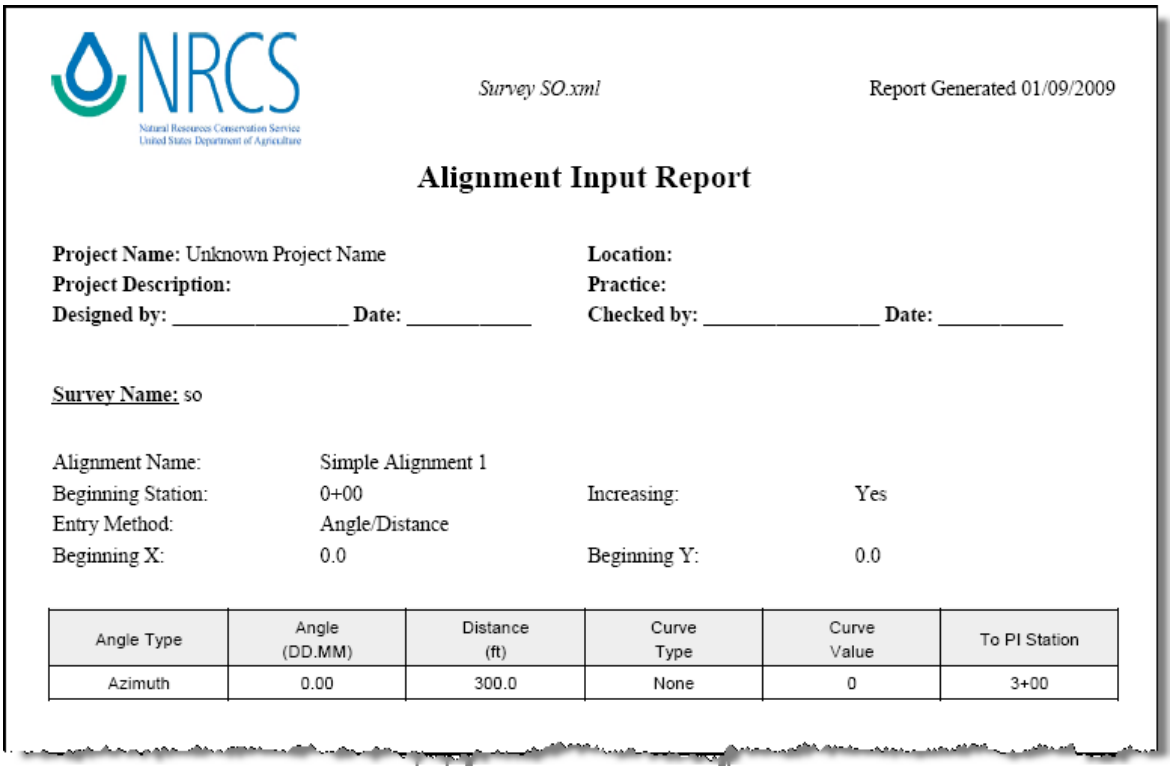
The Alignments report prints the point data that was used to define alignments for Station Offset surveys. After checking the Alignments Report checkbox in the Run Reports window, a pop-up window appears for the user to select which alignments are to be included in the report. Select the Alignment names and press **Next**. A second window will appear to select which reports to generate. The Input Data Report simply lists the alignment points that define the alignment in the same format as was entered in the Station Offset survey. If the alignment has curve data, then you can print the curve data report. And, you have the option to include a stake-out table in the curve data report, and can set the station interval for the stake-out. Make your selections and press **Finish**.





1. **Alignment Input Data Report**

   First is an example of an alignment report for a **Simple Alignment**.



NRCS
Natural Resources Conservation Service
United States Department of Agriculture

Survey SO.xml

Report Generated 01/09/2009

Alignment Input Report

Project Name: Unknown Project Name
Project Description:
Designed by: _____ **Date:** _____

Location:
Practice:
Checked by: _____ **Date:** _____

Survey Name: so

Alignment Name:	Simple Alignment 1		
Beginning Station:	0+00	Increasing:	Yes
Entry Method:	Angle/Distance		
Beginning X:	0.0	Beginning Y:	0.0

Angle Type	Angle (DD.MM)	Distance (ft)	Curve Type	Curve Value	To PI Station
Azimuth	0.00	300.0	None	0	3+00

Next is an example of a **user-defined alignment** defined with a starting azimuth and deflections. This alignment has no curve data entered.

Alignment Input Report

Project Name: Sample Farm
Project Description:
Designed by: ABC **Date:** 9/15/08

Location: Water Tower, IA
Practice: Grassed Waterway
Checked by: _____ **Date:** _____

Survey Name: SO

Alignment Name:	Align 2		
Beginning Station:	60+00.0	Increasing:	Yes
Entry Method:	Angle/Distance		
Beginning X:	100.0	Beginning Y:	100.0

Angle Type	Angle (DD.MM)	Distance (ft)	Curve Type	Curve Value	To PI Station
Azimuth	0.00	3000.0	None	0	90+00
Deflection	15.00	2000.0	None	0	110+00

Lastly is an example of a **user-defined alignment that contains curve data**. Note the table mimics the entry table contained in the Station Offset Alignment definition screen.

Alignment Input Report

Project Name: Sample Farm
Project Description:
Designed by: ABC **Date:** 9/15/08

Location: Water Tower, IA
Practice: Grassed Waterway
Checked by: _____ **Date:** _____

Survey Name: SO

Alignment Name:	Example 2		
Beginning Station:	10+00.0	Increasing:	Yes
Entry Method:	Angle/Distance		
Beginning X:	5000.0	Beginning Y:	5000.0

Angle Type	Angle (DD.MM)	Distance (ft)	Curve Type	Curve Value	To PI Station
Azimuth	115.00	450.0	None	0	14+50.0
Deflection	30.45	375.0	Tangent	100	18+20.2
Deflection	-15.31	250.0	Curve Length	100	20+69.6
Deflection	1.45	668.0	None	0	27+37.6
Deflection	75.18	800.0	Degree of Curvature	8	33+73.7
Deflection	44.27	618.0	External	44	39+69.0
Deflection	-17.00	700.0	None	0	46+69.0

2. **Alignment Curve Data and Stakeout Report**

The Curve data report lists the curve data for each alignment organized in a more typical arrangement. The first table shows the curve data assigned to each PI station. The second table lists the coordinates of the PC, PI, PT, and Radius point of each PI station in the alignment.

And, if requested, a Stakeout table is generated that prints the coordinates of the alignment (along the centerline of the curve), at the station interval specified when this report was requested.

Note that a stakeout report can be requested even if the alignment has no curves in order to lay out an alignment that has deflection angles.

Alignment Curve & Stakeout Report

Project Name: Sample Farm
Project Description:
Designed by: ABC **Date:** 9/15/08

Location: Water Tower, IA
Practice: Grassed Waterway
Checked by: _____ **Date:** _____

Survey Name: SO

Alignment Name: Example 2

Curve Data

P.I. Number	P.I. Station	Internal Angle (I, DD.MM)	Radius (R)	Degree of Curvature (D)	Tangent (T)	External (E)	Curve Length (L)	P.C. Station	P.T. Station
1	10+00								
2	14+50.0	30.45	363.67	15.75	100.00	13.50	195.18	13+50.0	15+45.2
3	18+20.2	-15.32	368.86	15.53	50.31	3.41	100.00	17+69.9	18+69.9
4	20+69.6								
5	27+37.6	75.18	716.20	8.00	552.54	188.37	941.25	21+85.0	31+26.3
6	33+73.7	44.27	548.24	10.45	224.01	44.00	425.32	31+49.7	35+75.0
7	39+69.0								
8	46+69.0								

Curve Data Coordinates

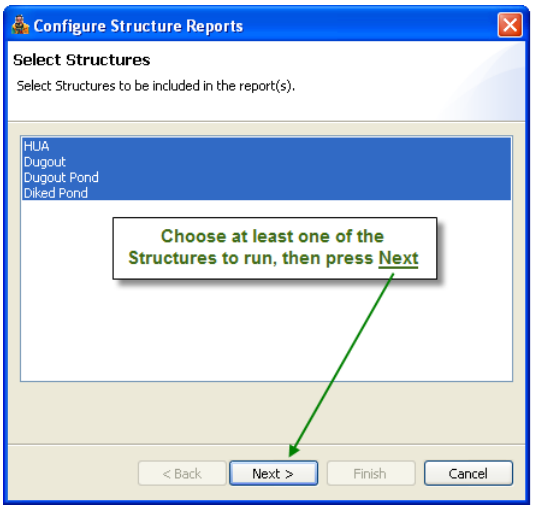
P.I. Number	P.I. Coordinates		P.C. Coordinates		P.T. Coordinates		Radius Point Coordinates	
	X	Y	X	Y	X	Y	X	Y
1	5000.00	5000.00						
2	5407.84	4809.82	5317.21	4852.08	5464.12	4727.16	5163.52	4522.49
3	5618.89	4499.85	5590.58	4541.44	5657.31	4467.37	5895.47	4749.03
4	5809.79	4338.43						
5	6306.47	3891.74	5895.64	4261.22	6053.34	3400.59	5416.72	3728.71
6	5939.97	3180.63	6042.59	3379.75	5727.26	3110.36	5555.27	3630.92
7	5353.17	2986.76						
8	4781.75	2582.42						

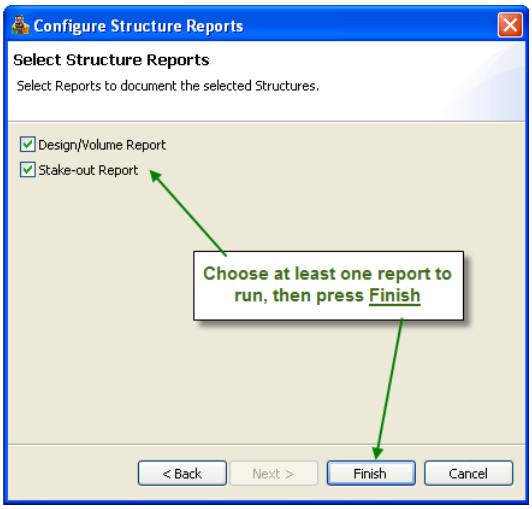
Alignment Stakeout Coordinates

Point ID	Station	X Coordinate	Y Coordinate
PI	10+00	5000.00	5000.00
	10+50.0	5045.32	4978.87
	11+00	5090.63	4957.74
	11+50.0	5135.95	4936.61
	12+00	5181.26	4915.48
	12+50.0	5226.58	4894.35
	13+00	5271.89	4873.21
PC	13+50.0	5317.21	4852.08
	14+00	5360.93	4827.91

6.7. Structure Report

To print Structure reports, check the Structure Report checkbox in the Run Reports window. When you do, the Configure Structure Reports window will open for you to select which structures to report on. Select the structure(s), and press the **Next** button to choose which report to run.





Note

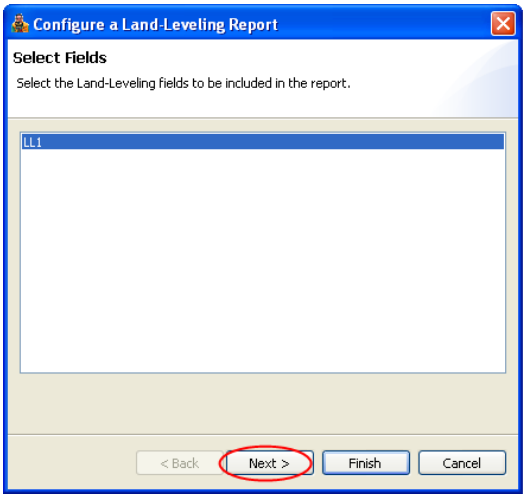
The program remembers the structures that were chosen for a report request. So, if you wish to print different structure reports, then you must uncheck the Structure Report checkbox and then check the box again to force the Selection window to appear again.

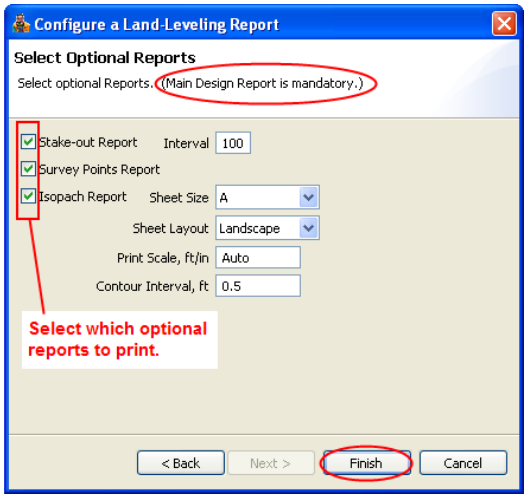
Two reports are offered: the Design/Volume report and the Stake-out report. **Examples are shown in the Structures section of this user manual**.

Even though Land Leveling is defined in SET with other structures, the reports for land leveling are explained in the next section.

6.8. Land Leveling Report

To generate the report, check the Land Leveling Report checkbox in the Run Reports window. A pop-up window then appears for the user to select which land leveling structures are to be included in the report (all will be highlighted by default). Select the structures names and press **Next**. A second window will appear to let the user select up to 3 optional reports. Note that there is a Land Leveling Design & Volume report (main design report) that is always printed, whether any boxes are checked in the optional reports window. Make your selection of optional reports and press **Finish**. The reports are discussed below with examples.





6.8.1. Land Leveling Design and Volume Report

This report is the main design report and is always printed, whether or not any of the optional reports were selected. This report documents the parameters that defined the land leveling plane and the resulting quantities. The parameters for both the plane of best fit and the design plane are listed. The elevations of two points are shown, the XYZ for the base (or centroid), and Eo (which is at coordinates X=0, Y=0). Eo is useful for calculating the elevation of any other XY point on the plane. The slopes in both the X and Y directions, the resultant slope and its azimuth angle of its down slope direction are listed. The field area, cut and fill volumes, cut/fill ratio, and cut/acre are given, as well as borrow and waste volumes, as appropriate. The depth and location for the maximum cut and fill points are also shown.

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New PSD.xml Report Generated 01/13/2009

Land Leveling Design and Volume Report

Project Name: My Land Leveling Project
Project Description:
Designed by: ok **Date:** 1/8/09

Location: NW 7, T123N, R234W
Practice: Irrigation Land Leveling (464)
Checked by: CET **Date:** 1/8/09

Structure Name: LL **Structure Type:** Land Leveling

Best Fit Results

Centroid:		Slopes:	
X =	725.92	Sx =	0.931538 %
Y =	426.70	Sy =	-0.037636 %
Z =	41.17	Eo =	34.569
Cut =	11332.59 cu yds	S =	-0.932298 %
Fill =	11332.60 cu yds	Slope Az. =	272

Design Results

Base Point:		Slopes:	
X =	725.92	Sx =	0.930000 %
Y =	426.70	Sy =	-0.000000 %
Z =	41.06	Eo =	34.313
		S =	-0.930000 %
		Slope Az. =	270

Areas:

Field =	17.18 ac

Earthwork:

Cut =	12721.57 cu yds	Waste =	0.00 cu yds
Fill =	9788.75 cu yds	Borrow =	0.00 cu yds
C/F Ratio =	1.300	Cut / Acre =	740.3 cy/ac

Max CUT =	4.59 ft at x = 440.00, Y = 0.00
Max FILL =	1.41 ft at x = 1000.00, Y = 400.00

6.8.2. Land Leveling Grid Stakeout Report

This is an optional report that documents the cut and fill depths at each grid location within the field. When the Stakeout Report is selected, the grid spacing may be entered. A grid spacing of 100 feet is the default. These points are interpolated when the design survey was not performed in a grid pattern.

New PSD.xml Report Generated 01/13/2009

Land Leveling Grid Stakeout Report

Project Name: My Land Leveling Project
Project Description:
Designed by: ok **Date:** 1/8/09

Location: NW 7, T123N, R234W
Practice: Irrigation Land Leveling (464)
Checked by: CET **Date:** 1/8/09

Structure Name: LL **Structure Type:** Land Leveling

INTERPOLATED GRID POINTS

xyGrid	100	200	300	400	500	600	700	800	900
800	0.86C	0.33C	0.70F	0.83F	1.16F	0.49F	0.38C	1.25C	2.72C
700	----	0.63C	0.10C	0.53F	0.86F	0.19F	0.98C	1.25C	2.32C
600	----	0.73C	0.10C	0.53F	0.56F	0.41C	0.88C	1.75C	0.22C
500	----	----	0.40C	0.13F	0.16F	0.71C	0.18C	0.65F	1.08F
400	----	----	0.70C	0.13F	0.36F	0.79F	1.12F	1.15F	1.38F
300	----	----	----	0.03F	0.46F	0.89F	1.22F	1.25F	1.38F
200	----	----	----	0.37C	0.36F	0.69F	1.02F	1.05F	0.48F
100	----	----	----	3.17C	0.34C	0.21C	0.38C	0.55C	1.12C
0	----	----	----	----	2.84C	0.71C	1.78C	1.75C	2.72C

6.8.3. Land Leveling Survey Data Report

This is an optional report that documents the X and Y location and elevation of each surveyed point. Additionally, the grade elevation on the plane, and the cut and fill depths are calculated for each surveyed point within the field.

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United States Department of Agriculture

New PSD.xml Report Generated 01/13/2009

Land Leveling Survey Data Report

Project Name: My Land Leveling Project
Project Description:
Designed by: ok **Date:** 1/8/09

Location: NW 7, T123N, R234W
Practice: Irrigation Land Leveling (464)
Checked by: CET **Date:** 1/8/09

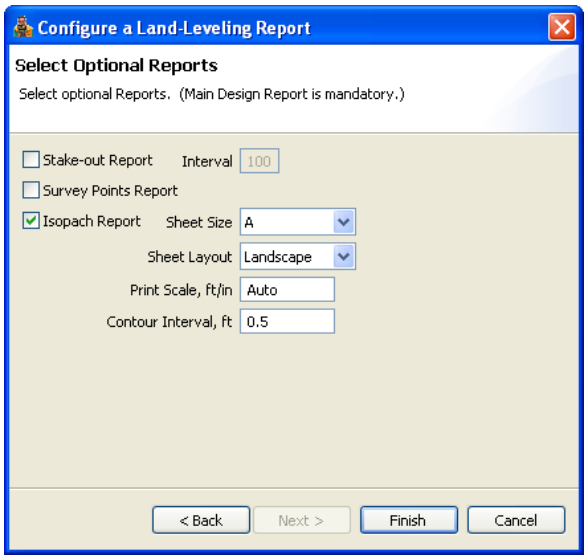
Structure Name: LL **Structure Type:** Land Leveling

Name	Description	X	Y	Z	GRADE	CUT	FILL
97	97(B)	1200.00	800.00	47.50	45.47	2.03C	
88	88(B)	1100.00	800.00	45.80	44.54	1.26C	
79	79(B)	1000.00	800.00	46.50	43.61	2.89C	
70	70(B)	900.00	800.00	45.40	42.68	2.72C	
61	61(B)	800.00	800.00	43.00	41.75	1.25C	
52	52(B)	700.00	800.00	41.20	40.82	0.38C	
43	43(B)	600.00	800.00	39.40	39.89		0.49F
34	34(B)	500.00	800.00	37.80	38.96		1.16F
24	24(B)	400.00	800.00	37.20	38.03		0.83F
14	14(B)	300.00	800.00	36.40	37.10		0.70F
7	7(B)	200.00	800.00	36.50	36.17	0.33C	
2	2(B)	100.00	800.00	36.10	35.24	0.86C	
1	1(B)	70.00	800.00	36.10	34.96	1.14C	
96	96(B)	1200.00	700.00	45.60	45.47	0.13C	
87	87	1100.00	700.00	43.60	44.54		0.94F
78	78	1000.00	700.00	44.10	43.61	0.49C	
69	69	900.00	700.00	45.00	42.68	2.32C	
60	60	800.00	700.00	43.00	41.75	1.25C	
51	51	700.00	700.00	41.80	40.82	0.98C	
42	42	600.00	700.00	39.70	39.89		0.19F
33	33	500.00	700.00	38.10	38.96		0.86F
23	23	400.00	700.00	37.50	38.03		0.53F
13	13	300.00	700.00	37.20	37.10	0.10C	
6	6	200.00	700.00	36.80	36.17	0.63C	
3	3(B)	120.00	700.00	37.00	35.43	1.57C	
95	95(B)	1200.00	600.00	45.50	45.47	0.03C	
86	86	1100.00	600.00	43.30	44.54		1.24F
77	77	1000.00	600.00	42.70	43.61		0.91F
68	68	900.00	600.00	42.90	42.68	0.22C	
59	59	800.00	600.00	43.50	41.75	1.75C	
50	50	700.00	600.00	41.70	40.82	0.88C	
41	41	600.00	600.00	40.30	39.89	0.41C	
32	32	500.00	600.00	38.40	38.96		0.56F
22	22	400.00	600.00	37.50	38.03		0.53F
12	12	300.00	600.00	37.20	37.10	0.10C	
5	5	200.00	600.00	36.90	36.17	0.73C	
4	4(B)	170.00	600.00	36.90	35.89	1.01C	

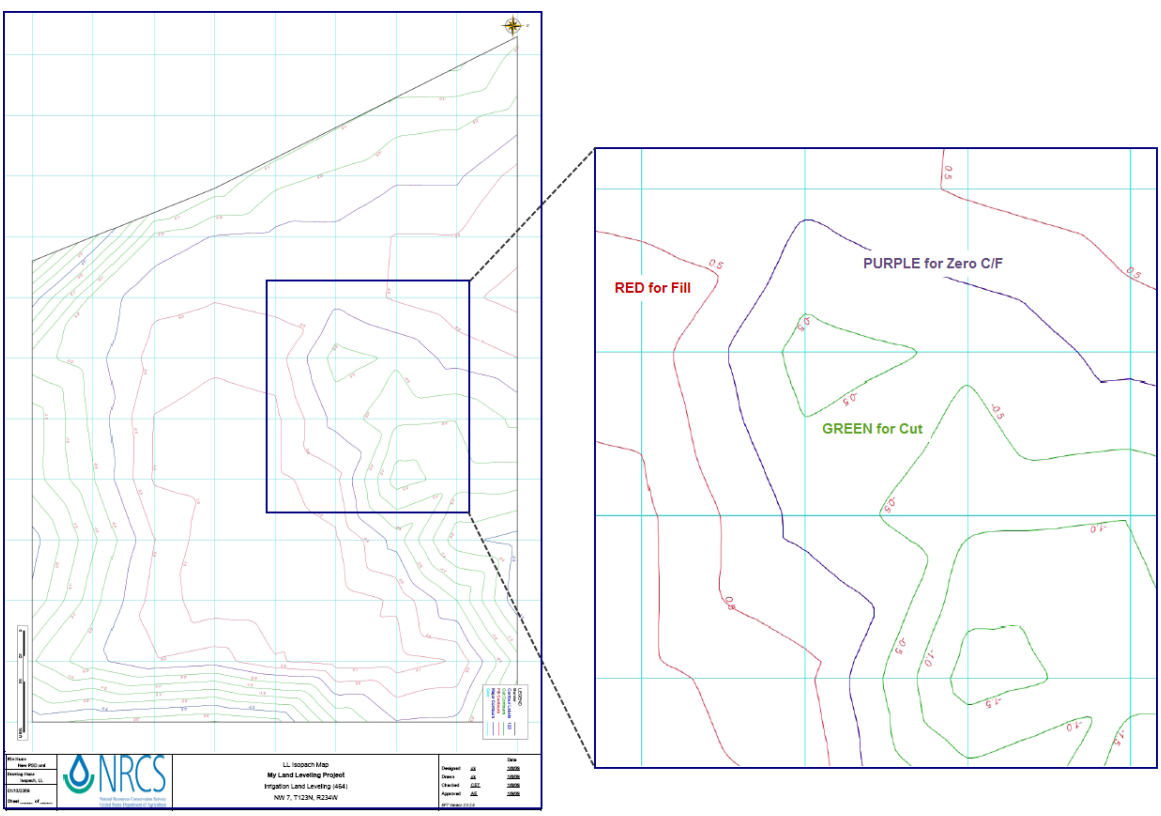
EFT Version 2.0.2.9

6.8.4. Land Leveling Isopach (Cut/Fill Contour Map) Report

Select the optional Isopach Report to get cut and fill contours for the field. Then, select the desired Sheet Size, Sheet Layout orientation, Print Scale, and Contour Interval. A print scale of Auto will fit the field onto the sheet. This is useful when scale is not important, or to help determine a more appropriate scale to choose. Deselect and reselect the Land Leveling Report to get the opportunity to change the scale in a subsequent report.

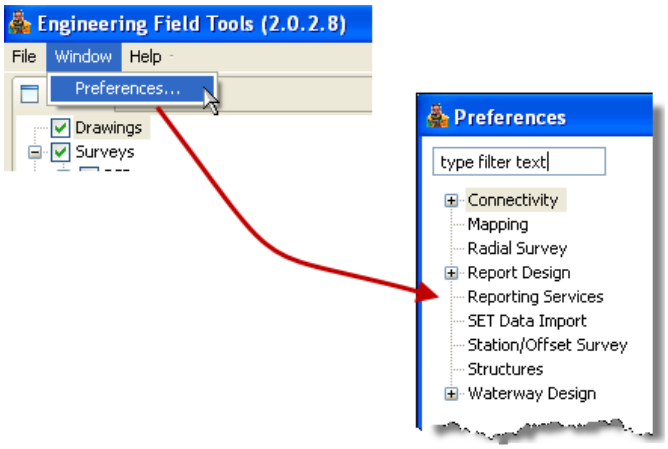


The contours on the map are color coded, with purple for zero cut/fill, green for cut depths and red for fill depths. This map provides a quick picture for the contractor to plan efficient travel routes without having to read all the stakes.



7. Preferences

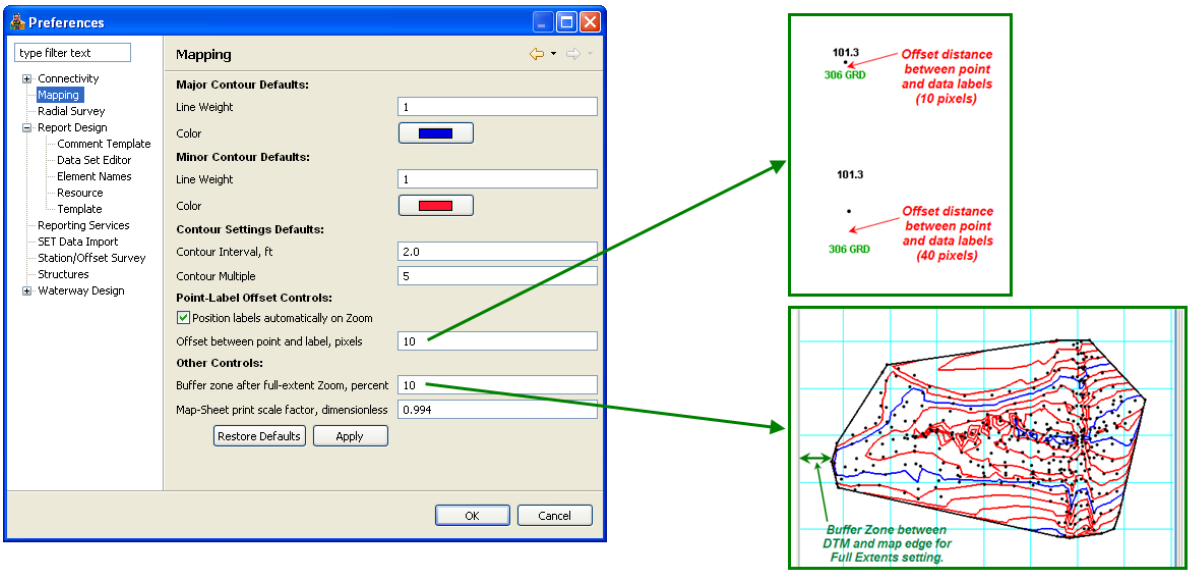
There are system preferences that can be changed to define many default conditions. Access the preferences by selecting **Preferences** from the Window menu.



The **Connectivity** section is not currently used by SET. The **Report Design** and **Reporting Services** sections are explained in the Reports section of the **EFT Framework** help file. And, refer to the Waterway program (WDT) for an explanation of the preferences for that program. The preferences relating to SET functions are described below:

7.1. Mapping Preferences

The mapping preferences define the default conditions of how the map is presented.



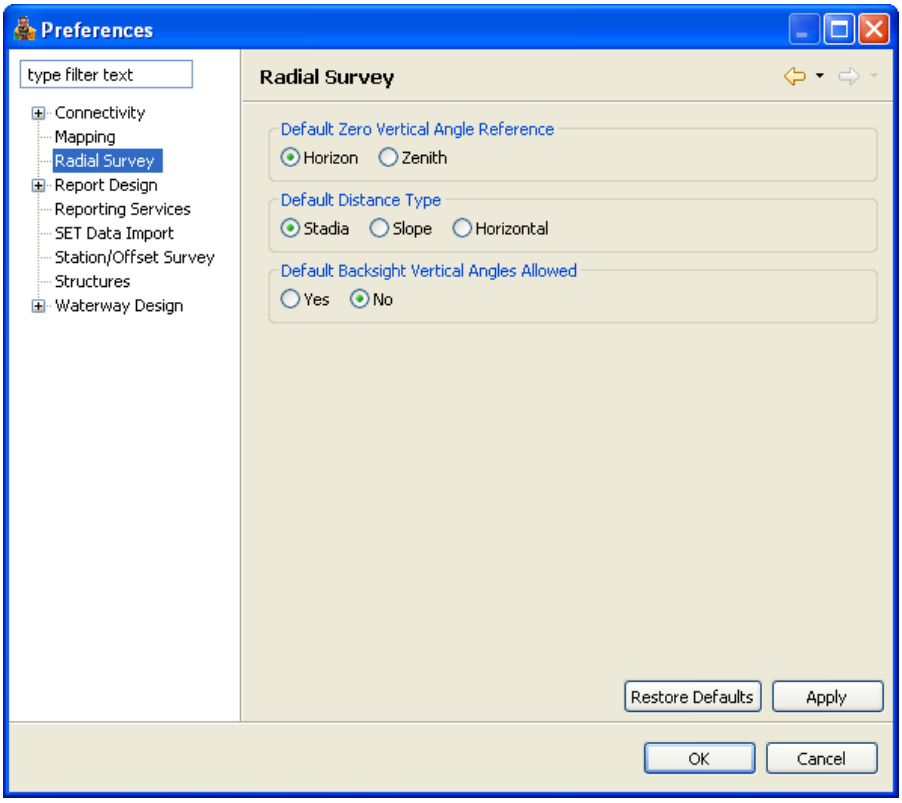
1. **Major and Minor Contour Defaults** - These settings will define the default line weight and color of the major and minor contour lines when a DTM is displayed.

2. **Contour Settings Defaults** - These settings will define the default contour interval and the default contour multiple when a DTM is displayed.

3. **Point-Label Offset Controls - These settings control how the point labels will appear on the surface map.**
   - Position labels automatically on Zoom - When this box is checked, the distance between the point marker and the point name & elevation labels will remain fixed at the number of pixels entered in item 3 below, regardless of the map Zoom level. If the box is unchecked, then the distance between the point marker and labels will increase as the Zoom level increases. This item is checked by default
   - Offset between point and label, pixels - This setting determines the distance, measured in pixels, between the point marker and the point labels. See the example above. The default distance is 10 pixels.
4. **Other Controls**
   - Buffer zone after full extent Zoom, percent- This setting determines the distance between the edge of the Ground Surface Map from the edges of the Map Screen, in percent of the Ground Surface Map. The default buffer zone is 10 percent. A higher percentage will increase the size of the blank area around the Ground Surface Map.
   - Map-Sheet print scale factor - This factor serves to give the user a means to adjust the plotting of a map to printers and plotters to make them scale accurate. Due to the possible variability between printers and plotters, it may be necessary to adjust this factor to achieve better scale accurate printouts (although this should be rare). The factor is applied equally in the vertical and horizontal directions.
5. Pressing the **Restore Defaults** button will restore the initial program defaults when SET was loaded. Press **OK** to save the default definitions, or **Cancel** to exit without saving changes.

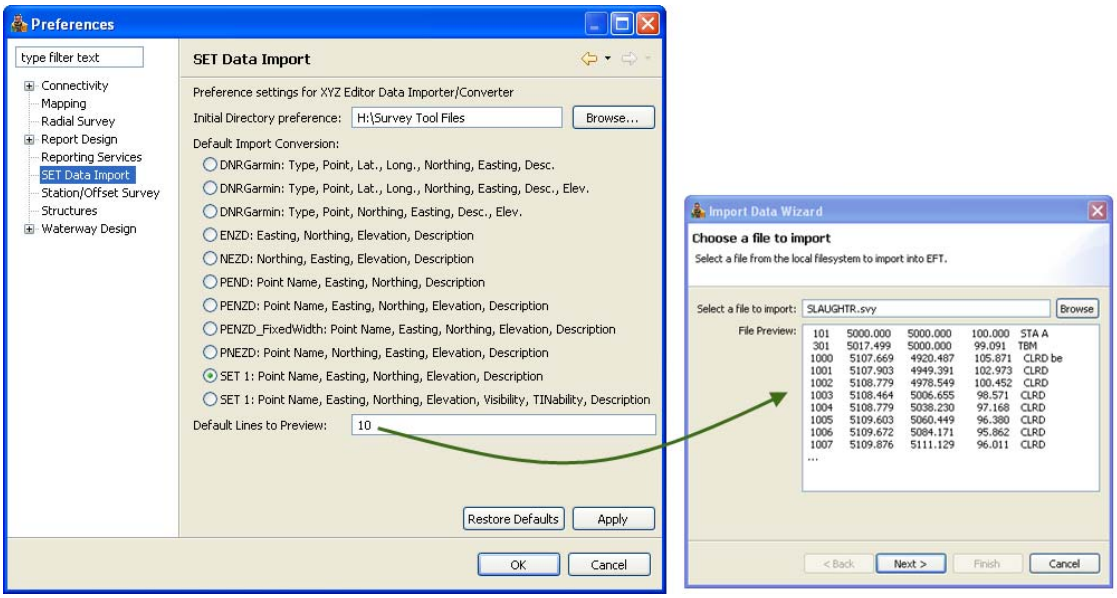
7.2. Radial Survey Preferences

These preference settings will determine the user preferences for the defaults in the Survey Settings section of the Radial Survey Input Editor. Refer to the Radial Survey Input section of this user manual for a full description of these settings.



7.3. SET Data Import Preferences

This section sets the preferences for the importing and conversion of XYZ datafiles into SET.



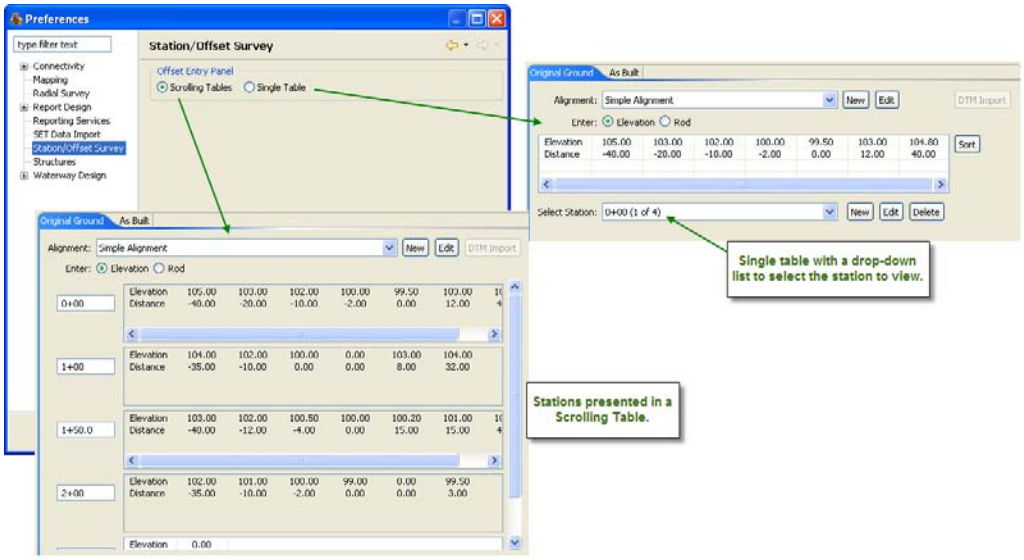
1. **Initial Directory Preference** - Press the **Browse** button to navigate to a default directory where you normally store files to import. Then, when you import surveys using the Import Data Wizard, the program will search for datafiles starting in this directory.

2. **Default Import Conversion** - This describes the default format presented in the Import Data Wizard for the imported file. You can change this to the format you most commonly import into SET.

3. **Default Lines to Preview** - This setting will allow you to change the number of lines previewed in the survey file to be imported when using the Import Data Wizard. The default is previewing the first 10 lines of survey.

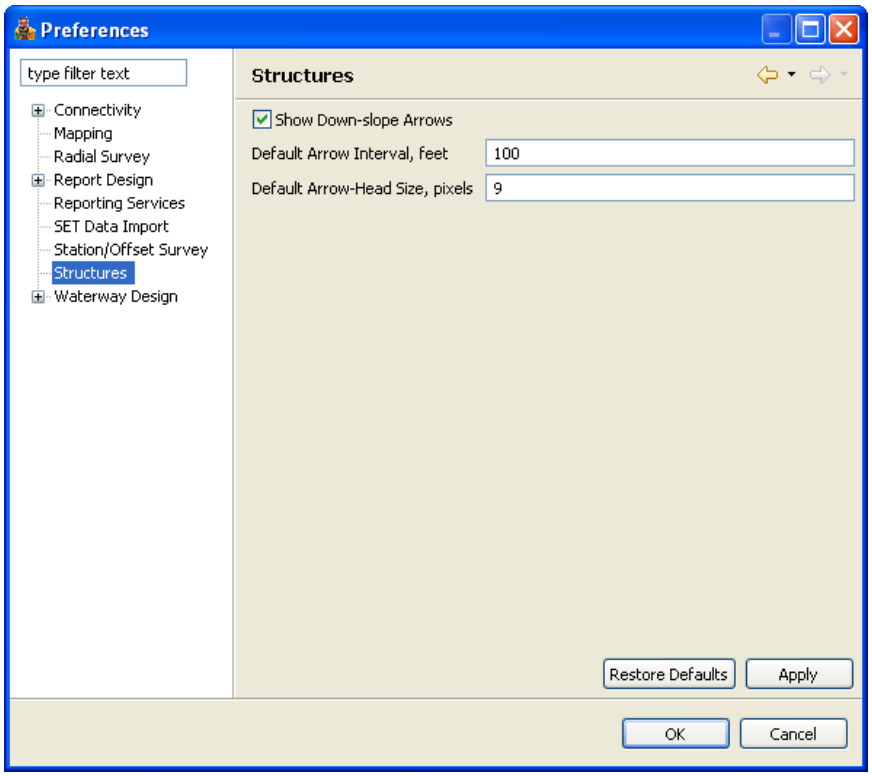
7.4. Station-Offset Surveys Preferences

This option allows you to select whether the cross-sections for offset stations in a Station-Offset survey will be presented in a scrolling table or in a single table. See examples below.



7.5. Structures Preferences

The structure preferences allow you to define whether the down-slope arrows are shown by default, their default interval (spacing between arrows), and size.



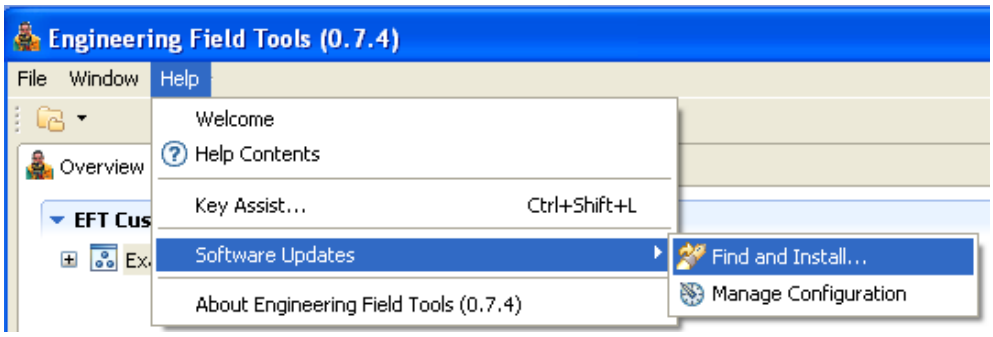
8. Help Menu

8.1. Software Updates

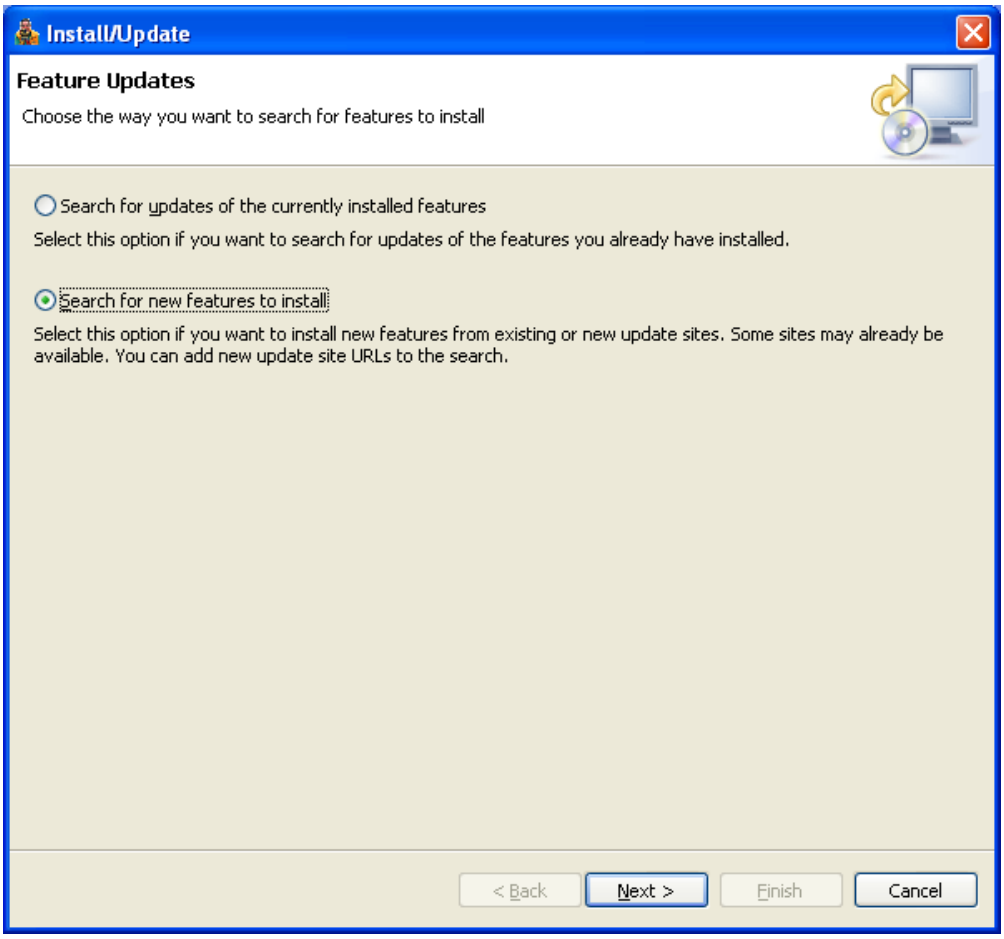
8.1.1. Checking for Available Updates

To access the update system:

1. Close all projects.
2. On the main menu at the top left side choose Help > Software Updates > Find and Install…, as shown in the figure below.



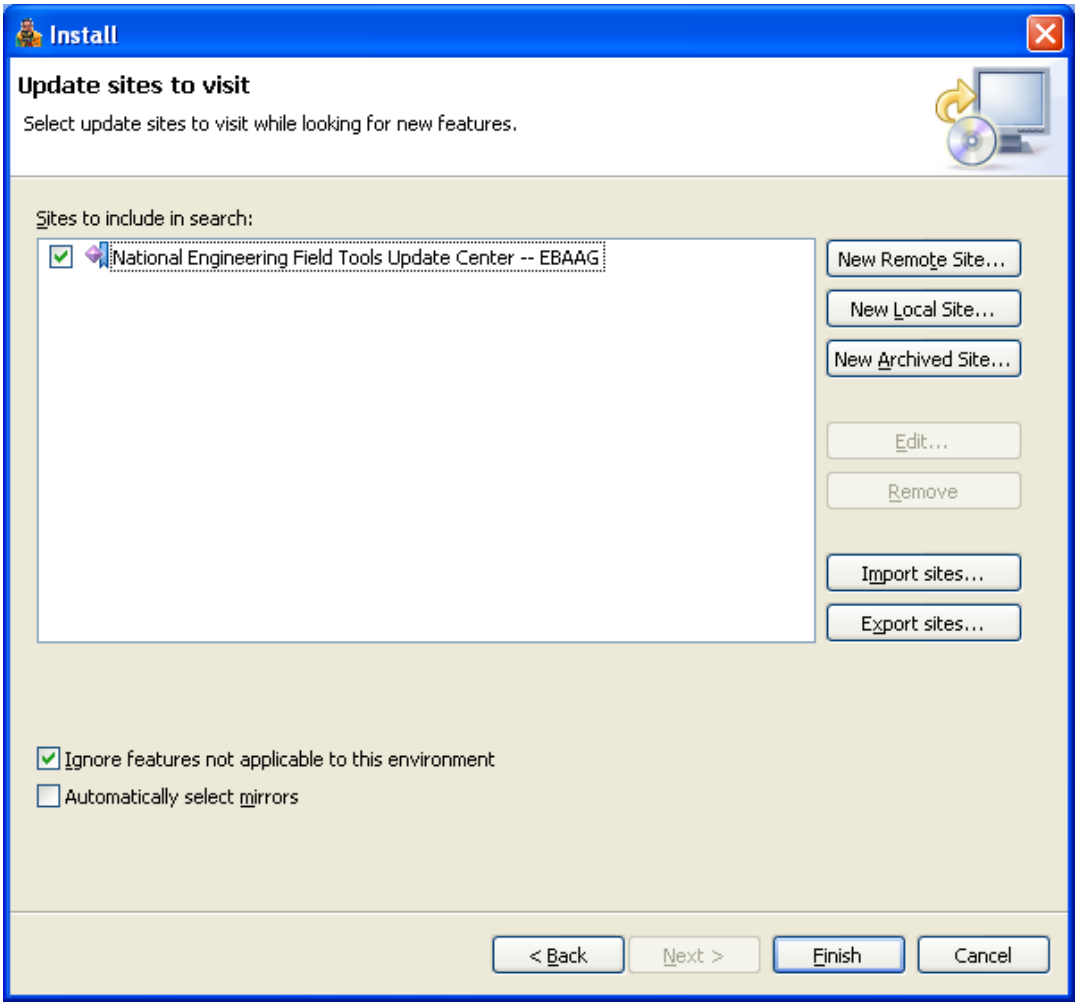
3. In the Install/Update wizard, select the `Search for new features to install` option as shown in the figure below. Then click Next.



4. In the Update site to visit page of the wizard, do the following (as shown in the figure below):

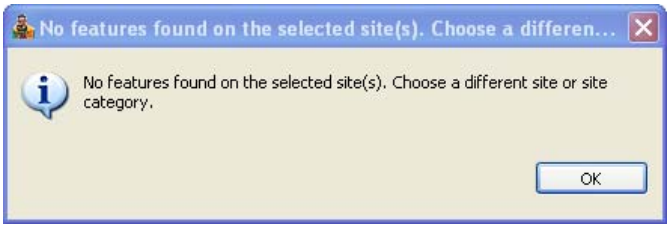
   a) click the check box next to the National Engineering Field Tools Update Center — EBAAG

   b) click the check box next to ignore features not applicable to this environment



5. Click **Finish**

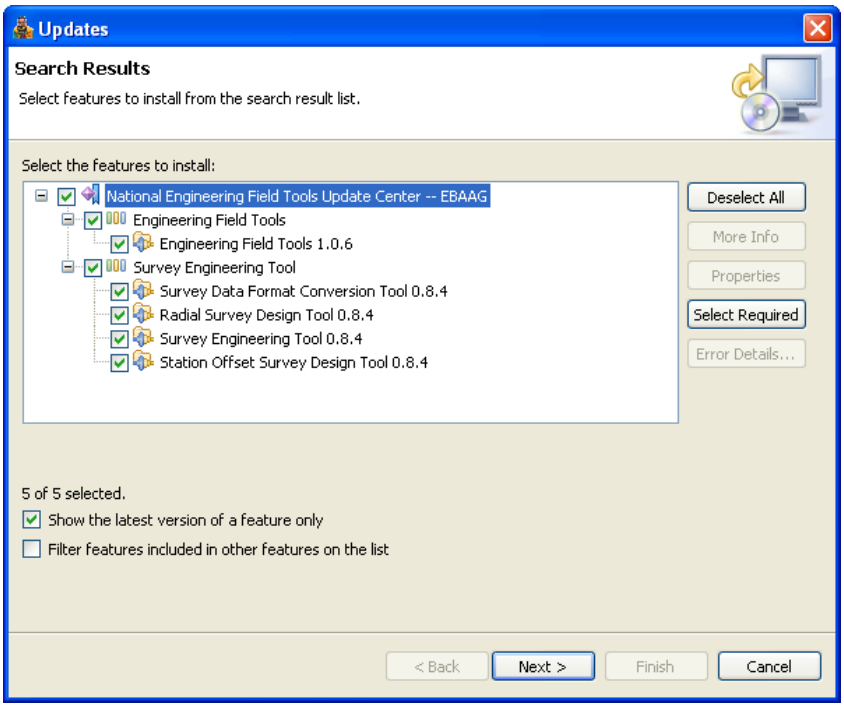
If you see the following message, then there are no updates available, and you have the latest version.



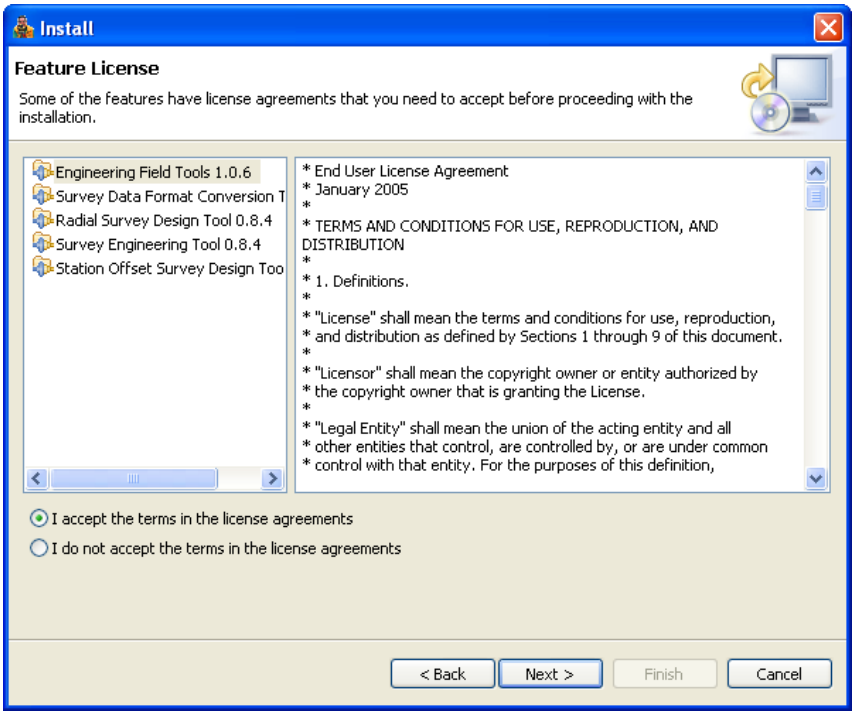
If you see available updates listed instead, proceed to the next section.

8.1.2. Updating

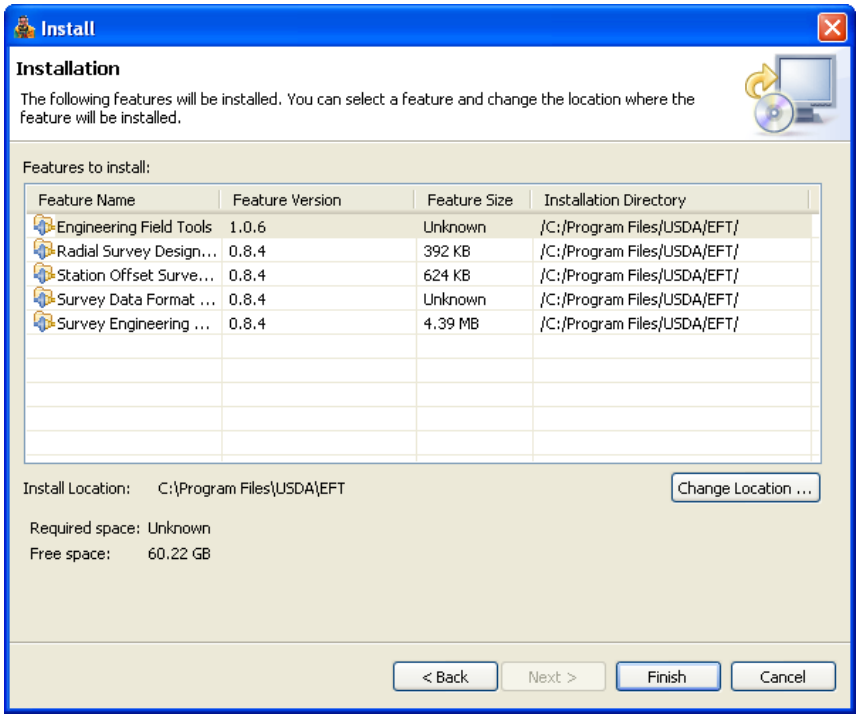
1. Shown in the figure below is an example list of what is available **(since individual updates will differ, you may see a different list)**. There is the update site name followed by feature categories followed by individual feature components (with the version numbers on the right). Select the topmost checkbox and all the lower checkboxes will be checked automatically.



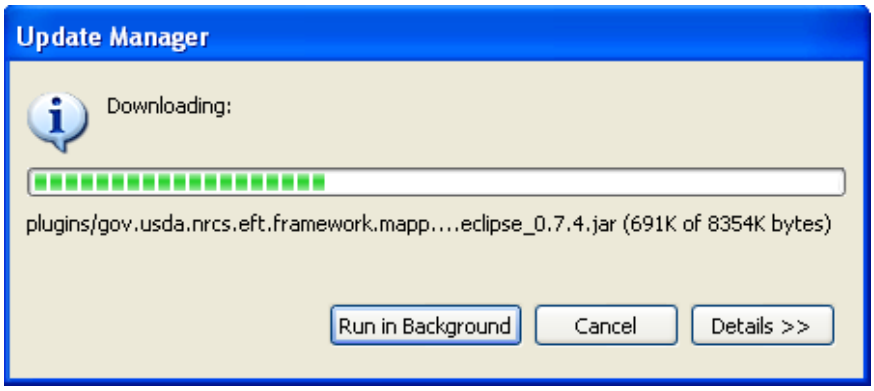
2. In the feature license screen you should check the I accept the terms in the license agreements and then Next.



3. In the feature location screen shows file size installation and disk space availability - **please do not change the installation directory location**.

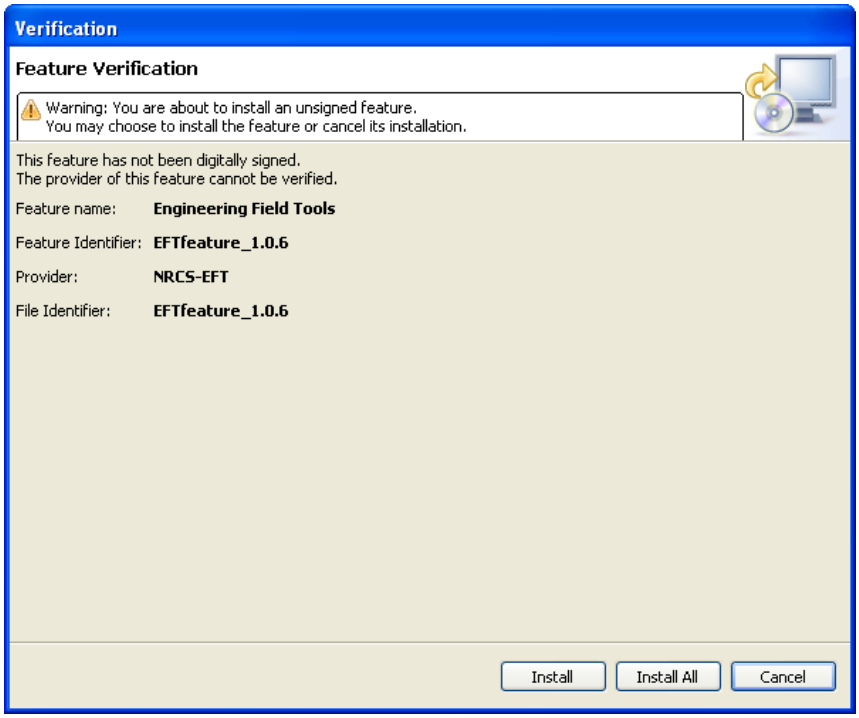


4. Click **Finish** The update wizard will now download the update. When finished, the Feature Verification screen will appear.

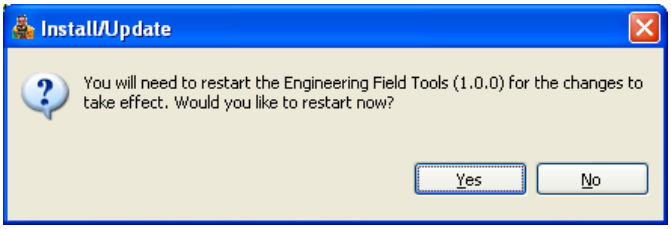


8.1.3. Installing the Update

1. When the updates finish downloading, you will see the Verification screen. On the feature verification screen verify that the provider is NRCS-EFT and install that feature; you can use the **Install_All** button.



2. You will see an installation progress window. When the installation is complete, EFT needs to be restarted to use the new features. Click **YES**.



3. EFT will then restart with additional features added.

9. Concepts & Definitions

Alignment

Alignments are used in station offset surveys. They represent the baseline of a series of cross sections, where stationing occurs along the alignment. Often, alignments also represent the centerline, as with a waterway. SET offers two types of alignments: a simple alignment and a user defined alignment.

Arc

An edge of a circle added to the survey map to identify the location of a natural or manmade formation that has an arc shape within the survey area.

Border

The border is defined as the outer extent of a DTM; it is made up of points (border nodes) along the outer extremities of the survey. All points contributing to the DTM must be within the border. The program develops a default border around all of the survey points. The user may modify this border as needed to better represent the surface being described by the DTM.

Border Node

A point along the border that is included in the border.

Breakline

Breaklines are lines added to the surface model to control how the triangles will be drawn, and therefore how the contours are represented. Breaklines are used to indicate discontinuity and to show a break in the slope. Triangles cannot cross breaklines, that is, a breakline will be one of the sides of the triangle between two adjacent triangles.

Contour

A line representing equal elevation on a DTM surface.

Contour Interval

The frequency in elevation at which contour lines are shown. This setting will define the interval between all contours.

Contour Major Line Multiple

This value will define how often major contours are displayed. Major contours are often shown in a different color and/or line weight than minor contours. This value and the Contour Interval value work together to determine how the contours will be displayed. For example, a Contour Interval of 2 with a Major Line Multiple of 5 will result in 2 foot minor contours with a major contour line at every 10 feet (contour interval of 2 multiplied by the major multiple of 5). Likewise, a Contour Interval of 5 with a Major Line Multiple of 10 will show 5 foot minor contours with a major contour line at every 50 feet.

Contour Smoothing Tension Factor

This factor, along with the Segments per Curve, determine how smooth the contours will appear on the map. Without smoothing, the contours would show as straight line segments, without curved corners. Higher tension factors cause the contours to have tight corners, while low factors will have more broad corners. The effective range of the tension is 0 to 10, with 0 having no tension (broad corners), and 10 having the most tension (tight corners).

Control Point

As used in the Radial survey type, points are designated by the user as control points so that SET can use these points to perform an instrument move. Designating points as control points makes it easier for the user to find the points in the drop down boxes in the input screens.

Convex Hull Border

The convex hull border is the default border created by SET to contain all the points that are to be included in the DTM. It is as if a lasso was thrown around all the points and the rope was pulled tightly. All the adjacent points around the outside of the survey that the rope touches are joined by straight-line segments to form the convex hull border.

Cut/Fill Balance

The cut/fill balance is used in earthwork computations to determine a deficit or surplus of earth in a computation. It is defined as the volume of cut minus the volume of fill. A positive balance indicates a surplus of earth, while a negative balance means more fill than cut (deficit of earth).

Cut/Fill Ratio

Like cut/fill balance, the ratio is used in earthwork computations. It is defined as the volume of cut divided by the volume of fill. A ratio greater than one reflects a surplus of earth, while a ratio of less than one reflects a deficit of earth.

DDD.MM

This represents the shorthand designation of how angles are entered in SET. Angles are entered and represented in SET as degrees and minutes, separated by a decimal point. For example, an angle of 45.29 represents an angle of 45 degrees and 29 minutes.

Digital Terrain Model (DTM)

A DTM is a representation, or model, of a surface consisting of coordinate point data. The DTM can be of the ground surface, or can be a planned surface of a structure like a pond or dam. The DTM is based on the construction of a TIN, or triangular irregular network. DTM is sometimes referred to as a DEM, or Digital Elevation Model.

Duplicate Points

Two or more points with the same or nearly the same horizontal coordinates. Points are considered duplicate if the horizontal distance between them is less than 0.2 ft. Only the X and Y coordinates are considered when making this test

Elevation

The distance relative to a vertical datum, generally an assumed datum, or sea level.

Isolate Points

A feature in SET where the user can enter a unique point name or point description that SET will use to filter the points that are displayed on the map. For example if FC was entered as a point description for fence in the isolate function, then only those points that contained FC in their description would be displayed on the surface map. This makes it easier to find points and to perform other functions like drawing breaklines, drawing objects, or for measuring.

Isopach

A land leveling contour map, where the contours represent cut and fill.

Map Sheet

Map sheets are user defined views of the surface map. Map sheets are generally defined to be printed. The user specifies the scale, orientation, and page size for the plotted page. Map sheets can also be defined and used to switch between views with different legend features turned on.

Point

A location in the survey that has a name, coordinates, and a description.

Point Data

Point data are representations of a point on the surface of the DTM. Each point has X, Y and Z coordinates along with a point name and a description. Normally, point data is entered or imported as survey points collected in the field. Points can also be added manually. By default, all imported survey points will be included on the DTM. Points can be individually excluded from the DTM and can be made invisible so they do not appear on the survey map.

Point Coordinates

All points need three point coordinates: X, Y, and Z coordinates. The X coordinate, also called the Easting, is the distance left and right (east and west) of a zero Easting datum. The Y coordinate, also called the Northing, is the distance north and south of the zero Northing datum. The Z coordinate is the elevation of the point. The three coordinates reference the point on the map in relation to other points that share the same datum.

Radial Survey

One of three types of surveys defined in SET. Radial surveys are performed with a transit or theodolite, where the surveyed points are measured and presented as distances and angles from the instrument.

Rotation

Surveys can be rotated about a single surveyed point. This is accomplished in the Translation routine of SET. To rotate a point, two common points are surveyed. One common point defines the pivot point and the second defines the amount of rotation. A rotation angle can also be entered manually. A user may wish to rotate a survey to adjust a survey based on magnetic north to true north as an example.

Segments per Curve (contour smoothing)

Along with the Contour Smoothing Tension Factor, this affects how smooth the contours appear on the

map. All contours are made up of straight line segments. To make a curve, it must be done with short segments. The more segments, the smoother the curve. Effective range is from about 3 to 100 segments per curve.

Stage Storage
Represents the amount of storage in acre-feet, at user defined elevations relative to a virtual dam. In SET the user selects multiple elevation bands that terminate at the virtual dam line and the program returns the area of each elevation band and the cumulative storage in acre-feet.

Station Offset Survey
One of three types of surveys defined in SET. A station offset survey involves cross sections taken at user defined stations along a defined alignment. Cross sections are taken perpendicular to the alignment. This type of survey is often performed using a level, rod, and tape measure.

Structure
In the SET program, structures are user defined templates that can be applied to a ground surface to compute volumes of storage and earthwork. The structures available in SET are rectangular pit, circular pit, diked pit, pad, and land leveling.

Translation
Moving a survey horizontally and/or vertically by recomputing the point coordinates based on the coordinates of a target point of another survey. Surveys are translated so that one survey can have the same reference point as another survey. SET offers several ways to translate a survey, and can also rotate a survey. To perform a translation, at least one common point must have been surveyed in both surveys (two common points are required for translation and rotation). Examples of when to translate a survey is to adjust the elevations of one survey to a different bench mark elevation; and adjust the x and y coordinates to match the UTM coordinates of a GPS device.

Triangular Irregular Network (TIN)
The TIN is a mesh of irregularly shaped, non-overlapping adjacent triangles connecting all points in the survey that are to be included in the DTM. Three neighboring points connected by a triangle represent a triangular face on the DTM surface. Contours are calculated by interpolating between each pair of points in each triangular face.

TINable
Refers to points that are part of the DTM. All TINable points must be contained within the defined border to create a DTM surface model.

unTINable
This term and nonTINable are mentioned throughout this user manual. It simply means that the point is marked not TINable, referring to points that are not assigned to the DTM surface model. If surveyed points are not on the ground, and would create a false surface model, the user must designate these points as not TINable, and the DTM engine will ignore them. SET will not automatically mark points "not TINable". Example of points that are commonly marked "not TINable" are bench marks. Points that exist outside of the defined border must be marked "not TINable" for the DTM to process the map. Note that points marked "not TINable" can be included in the DTM by marking them TINable again.

XYZ Survey
One of three types of surveys defined in SET. XYZ survey points are represented by coordinates (x, y, and z or northing, easting, and elevation). These are often performed using a total station, GPS, or from a LIDAR survey. XYZ surveys are generally imported into SET, but XYZ points can be manually entered into SET.