User Manual

Program version 3.0.27

DW Consulting

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This application has been developed using Borland Delphi version XE3.

TerraSurveyor makes extensive use of the following components and programs:

- LMD tools (www.lmdinnovative.com)
- JEDI components (www.delphi-jedi.org)
- SDL Component Suite (www.lohninger.com)
- Matrix Software Protection System (www.matrixlock.de)
- Enigma Protector (www.enigmaprotector.com/en/home.html)
- SurGe Data Interpolation system (mujweb.atlas.cz/www/SurGe)
- ZipForge (www.componentace.com)
- GLScene – OpenGL for Delphi (glscene.sourceforge.net)
- Tcad – drawing components (www.codeidea.com)
- TMS Components (www.tmssoftware.com)

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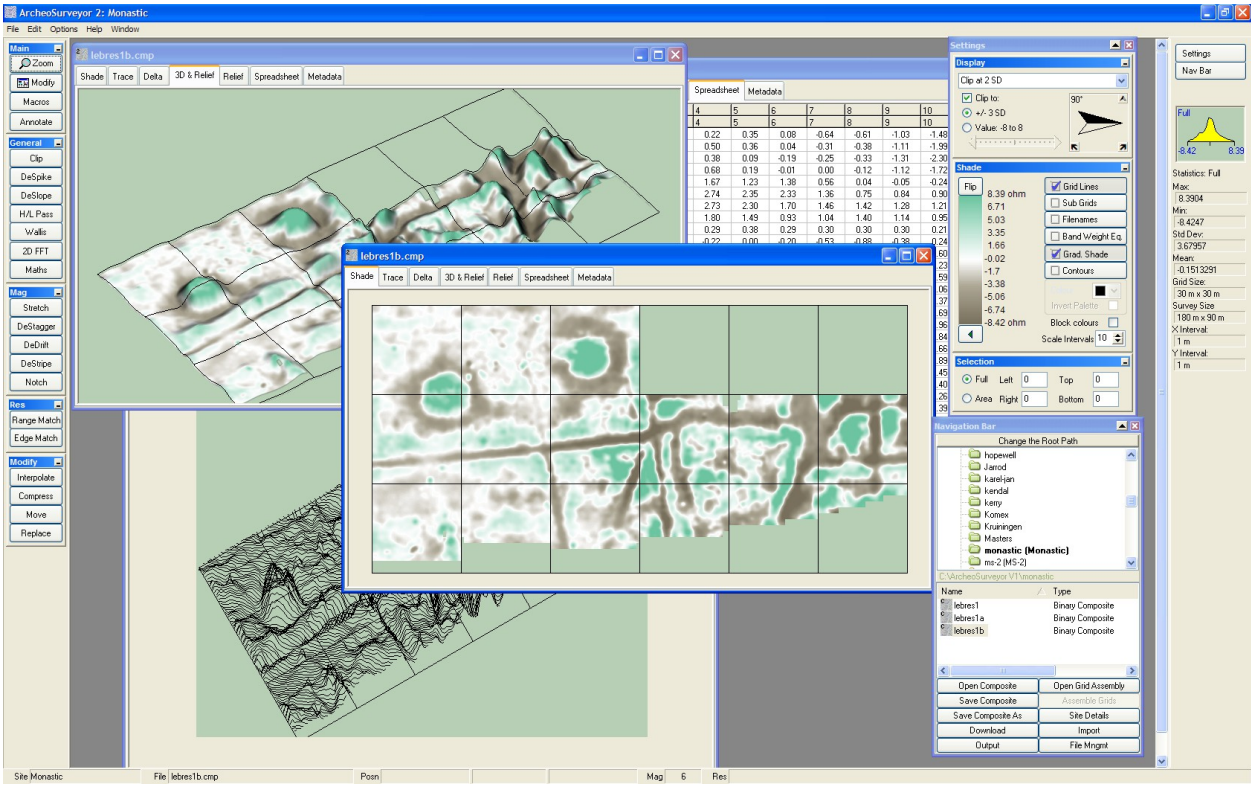
1 INTRODUCTION

1.1 OVERVIEW

TerraSurveyor is specifically designed to acquire, assemble, process and visualize 2 dimensional archaeological data gathered with Geophysical Instruments such as Resistivity Meters and Magnetometers. It makes full use of the capabilities of Windows Vista/7/8 and the OpenGL advanced 3D graphics system when the hardware supports it.



1.1.1.1 DATA ARRANGEMENT

TerraSurveyor primarily uses a **site** based metaphor for arranging and storing the data collected and generated. Each site is normally stored within a dedicated folder, containing specific sub-folders and all the various files related to that site. However, this is not essential as composite files can be stored and opened outside of the site structure.

1.1.2 GRIDS & COMPOSITES

Data can be downloaded or logged either directly from a variety of Geophysics instruments or imported from a range of common and special formats. TerraSurveyor recognizes two main categories of data: Grids and Composites. Grids are relatively small blocks of data points typically collected by hand-held instruments in a very structured manner. All datapoints in the grid are an exact interval apart in both X & Y axes. The grids are then assembled into a larger Composite, still using the same X & Y intervals. More modern or automated instruments may gather all the data in one dataset that does not need to be assembled and, in the case of GPS based systems, may not use specific X & Y axes or regular intervals. TerraSurveyor is therefore able to import these datasets directly to Composites. In the case of the GPS based systems, the GPS positioned datapoints are maintained as the source in their original format.

In all cases, the data is converted into an XML based format specific to TerraSurveyor and stored in the Grids or Comps folder of a Site. The format contains the actual source data, either copied from the grids or the source file, references to all source data as applicable and a complete record of all processes applied to the data.

1.1.3 PROCESSES

A wide range of Processes are provided, allowing the data to be manipulated to produce the best possible interpretation. Because the composite file maintains a record of all layers created as the result of a process being applied, the sequence and parameters of all layers can be fine-tuned or completely changed without any loss of data integrity.

1.1.4 VIEWS

The processed data can be viewed in a number of ways, the most common being the shade, trace and 3D views. All views are drawn directly from the current dataset to ensure then best possible accuracy. Other views are provided to support the data in various ways. There is a Delta view which shows the difference between any 2 layers, a Spreadsheet view to allow inspection and editing of individual datapoints and a Metadata view giving access to ancillary data associated with the Composite.

Multiple composites may be open at the same time, each in it's own child window within TerraSurveyor.

1.1.5 PUBLISHING

Processed views can be integrated with text, supporting graphics and other design elements to produce a final publication quality page. The text and supporting elements are linked to the composite and site information so that if values change (because of changes to the processing, etc.) the text and supporting elements are redrawn accordingly. This view uses vector drawing methods wherever possible to retain quality at any size.

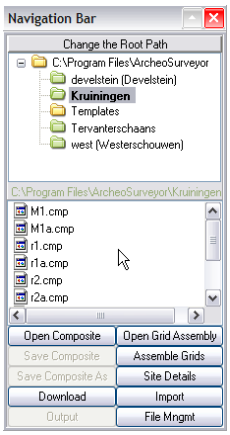
1.1.6 SAVING

The data generated can be saved to disc in a variety of text and graphic formats. Direct printing to paper is also possible.

2 Folders and Files

2.1 Sites

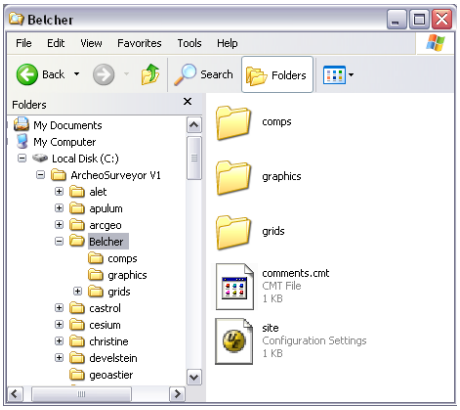
TerraSurveyor normally stores all related data in a single folder. This folder is referred to within the program and this manual as a **Site**. This is intended to reflect the traditional archaeological site which is seen as the most common way data will be grouped. When first started, the default installation will show 3 example sites in the TerraSurveyor folder (C:\Program Files\TerraSurveyor). This is only an example and need not be where you keep your own data. The example sites can also be deleted if you wish.



A Site Folder in the NavBar

Each Site folder is given the name specified for the site when it is created and normally just contains one special file. TerraSurveyor uses a file called SITE.INI to recognize the folder as being a site. This contains the data seen in the **File|Open** dialog fields. There will also be 3 standard subfolders named **\Grids**, **\Comps** and **\Graphics**. These are where TerraSurveyor stores the grid files, the generated composites and any graphics that are created. Additionally a 4th folder named **\Export** may be present. This is where exported data - either from grids or composites - will normally be stored. This folder is created the first time data is exported.

The **\Grids** folder may also contain subfolders. These folders can be created during the download or import process. They can be used for 2 purposes. The first is if grids of different sizes are being used on the same site. The **Assemble Grids** window can display and assemble grids that are not the same size, but this is not recommended. Ideally only grids of the same size should be stored in a folder (i.e. the Grid length, width, traverse interval and measurement interval are all the same). If they are not, perhaps because different instruments are being used on the same site or because certain areas are being surveyed at a different resolution to the rest of the site, sub folders should be created to separate the different grid types.



A Site Folder in My Computer

This facility can also be used to separate grids into different areas of a site. For example, perhaps a site consists of a North field and a South field. By creating 2 subfolders called North and South, the grids for these areas can be easily administered. However, note that only grids within the same folder can be combined into a single composite.

The Site folder is a normal Windows folder and can be used to hold any other folders or files of your choosing. For example, a **\Source** folder could be added to store the source files for imported data, survey reports could be kept in the site folder itself or a **\Maps** folder could hold AutoCAD drawing files. You can do anything you like as long as the SITE.INI file is present.

> Note: Site folders must not contain other site folders, if this does occur (perhaps because site folders have been moved or created by other means) TerraSurveyor will be unable to see or navigate to the lower level site.

Composite files can be opened even when not contained in a site structure. Just double-click on the composite file in any file manager and it will be opened in TerraSurveyor. Note that if the composite being opened is not in a site structure, some facilities such as modify grids will not be available as the program does not know where the grids are.

2.2 Files

2.2.1 Grids

The term "Grid" is used by TerraSurveyor to refer to the data measured within a rectangular area on a Site. The grid file is generated either by directly downloading data from an instrument or by importing the data from a plain text file generated by some other means. Either process creates a special file containing the basic data from the survey, plus some additional information. This extra information is extracted either directly from the instrument during the download process or from user- supplied data filled in prior to the download/import being started. The grid files must then be assembled into a Composite to recreate the full data set from the surveyed area.

2.2.2 Composites

The term "Composite" is used in TerraSurveyor to refer to the file type used to process and display a surveyed area. The name evolved in the days when all surveys were carried out with hand-held instruments that generated grids that then had to be merged into a single composite. Nowadays many modern surveying systems gather data in a single, large file which is converted straight into a composite. Thus "Composite" is used in TerraSurveyor to refer to a set of grid files assembled into a single unit or imported from a single, complete survey dataset. In the case of grids, they are assembled in their correct relative positions in the Grid Assembly window. All subsequent processing actions are carried out in the Main window.

When saved as a file, a composite contains just the source data from all the grids or source file, some metadata (names, dates, comments, etc) and a list of applied processes. Once the file is loaded into TerraSurveyor this list of processes is used to re-create a set of layers, each layer containing a copy of the previous layer but modified by the applicable process. In this way, any layer can be displayed at any time and processes can be modified, have their sequence changed, be deleted or added to. The 'top' layer always reflects the result of applying the full list of processes to the source data.

2.2.3 File Types

Both Grids and Composites are saved as plain ASCII XML files. They can also be stored in compressed form. The default format can be selected in **Preferences**.

Grid files have the extension .xgd for the uncompressed XML version and .zgd for the compressed XML. Composites use a similar scheme: .xcp for XML and .zcp for compressed XML.

The XML files use a plain ASCII format and so can be viewed (and even edited or created) in any text editor. This provides a level of retrieval security in that even if TerraSurveyor is not available for some reason, the data can still be recovered. The downside is that the data can be changed very easily – perhaps making it unreadable to TerraSurveyor. The program expects certain elements and attributes (the names for the structures in an XML file) to be present and with certain values. If these are not present, are in different positions or have unexpected content, the read process will probably fail. In order to minimize the chance of this and also reduce the size of the files, the second format: compressed XML is available. This is in reality just a zipped copy of the XML file. In fact, if you change the extension of the file name to .zip, you will be able to extract the XML grid or composite within it using any ZIP management program. By default, files will be saved as plain XML, this can be changed by selecting the compressed format in the Save dialogs or by changing a setting in **Preferences**.

3 USING THE PROGRAM

The TerraSurveyor program consists of a number of windows and areas. In addition to the normal menus at the top, the main window has buttons for all the processes running down the left side and displays some statistical data for the currently selected composite on the right. Normally there will be a floating control panel called **Settings** visible. This, and the optional **NavBar** are described in detail below. Finally, the main part of the window can contain any number of open Composites (within the memory limitations of your PC).

> Note: Because all operations such as downloading, importing and opening composites must be done within the context of a site, many of the menu items will be disabled (greyed out) when the program is first started. You need to select or create a site to enable the menu items. See section 3.1.1 & 3.1.2 below on how to create and navigate Sites.

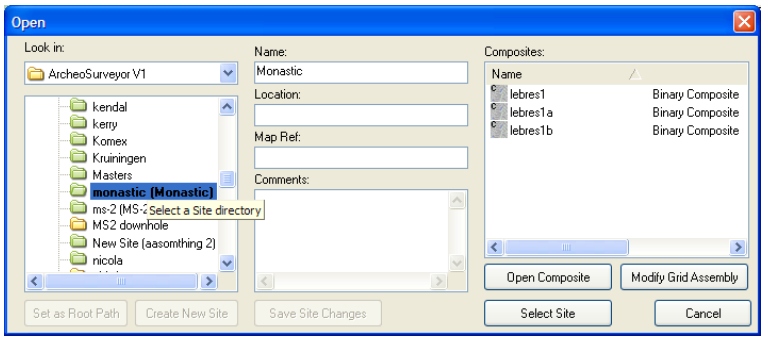
3.1 NAVIGATION

There are two main methods available to navigate from Site to Site and select Composites within a Site: the **NavBar** and **Menus**. Use the **Preferences | Navigation** setting to switch between methods.

In addition is is possible to open Composites by drag-and-drop or double-clicking them from a file management program (such as My Computer or My Documents in WinXP). By selecting one or more composites in the file management program and dragging it/them onto TerraSurveyor, the composite(s) will be opened and the composite's site selected. Double-clicking a composite (or composites) will open a new copy of TerraSurveyor with the selection opened and the composite's site selected. Note that this method will only work with composites, not grids.

3.1.1 MENUS

The layout and use of the menu system used in TerraSurveyor is similar in most respects to any other Windows application. However, the site based layout of the folders does result in some differences. The principal difference is that the **Open** Dialog box has a dual function as in order to open a composite, you must first select a site. The Open dialog therefore contains special controls to navigate the drives and recognize the TerraSurveyor site folders. Once a site has been selected, all - and only - the composites are shown on the Composites list. The Composites can then be opened, either as Shade Views or as Master Grid assemblies (to change the grids used to create the composite). The Open dialog also displays supporting 'metadata' about each site. Furthermore, it can be used to create new sites (the button 2nd from left) and set the default path to be shown in the dialog in the future.



Once a site has been selected in the **Open** dialog, the **New** menu item will be enabled. This item is only for creating a new composite from a set of grids.

The other main items on the **File** menu are only enabled when a composite is open. The **Graphics** item provides access to a dialog box to either save the current composite as an image or print it to paper.

3.1.1.1 FILE MANAGEMENT

The **File Mngmt** menu gives access to some basic file management functions: **Rename**, **Copy to**, **Move to**, **Merge** and **Delete**. Note that these actions cannot be performed on the currently open composite. The **Merge** function allows multiple GPS based composites to be merged into a single file. Selecting this menu item will show a file selection dialog. The selected composites will be used to create a new composite containing just the source (position & value) data from the selected composites. All composites must be in the same folder; be GPS based data and within 1 deg (lat/long) or 10Km of each other to be merged.

Complete Sites can also be copied, moved, deleted or archived to a zip file from this menu.

3.1.2 NAVIGATION BAR

The **NavBar** is a floating control panel and is the alternative method used to navigate and access sites. It is designed to provide a clear and handy overview of the available sites and composites, however it can take up a large amount of the screen.

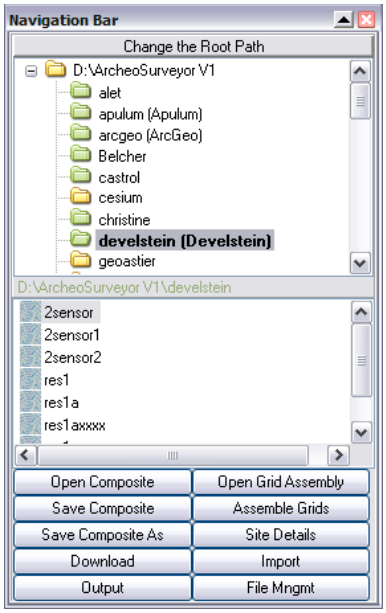
By default the **NavBar** is positioned near the top-right corner of the screen however, it will remember where you last positioned it and will re-appear there next time you open TerraSurveyor.

In order to be as unobtrusive as possible, but still readily available, the **NavBar** is a "roll-up" window. Click on the small Up or Down arrow in the top right corner of the Bar to see this in action. The Bar can be repositioned by dragging within the title bar, the width can be set by dragging the right hand edge and the height by dragging the bottom edge.

To further reduce it's presence, it can be closed completely by clicking on the red X or on the button marked NavBar. Clicking the button again will restore it to it's previous position.

The Bar itself contains 4 main areas:
The top area labeled **Change the Root Path** is a button that opens a **Browse to Folder** window. This window sets the path used in the main tree view below it. On startup this path will be set to the value set in **Preferences** for the **Site Root** folder or the last folder visited via this button. When changing the Root Path from the **NavBar or in Preferences** make sure you select the parent folder for a site, Not the site folder itself.

The Main Tree view shows the folders (and subfolders) within the currently selected **Site Root**. Folders that are Sites are shown with green icons with the Description of the site in brackets after the folder name (if the two are different). Also, the currently selected Site is shown in Bold. Non-site folders can be opened by clicking on their yellow folder icon. Site folders cannot be opened – they are the end of the tree as far as TerraSurveyor is concerned.



The bottom list shows the composite files available within the currently selected site. A composite can be opened into the main composite view by double-clicking it from this list. To revise the assembly of Grids, select it and use the button **Open Grid Assembly**.

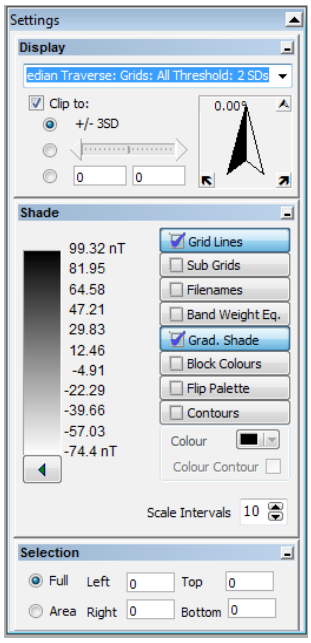
The buttons at the bottom of the Bar can be used to perform all the main functions associated with Sites, Grids and Composites:

- **Open Composite** : Open a selected composite for processing,
- **Open Grid Assembly** : Open a selected composite to revise the Assembly of Grids,
- **Assemble Grids**: Assemble a new Composite from available Grids,
- **Save Composite & Save Composite As** : Save the current Composite with either the current name or a new name
- **New Site / Site Details** : Convert the current folder into a site or view (and edit) the details of the current site.
- **Download & Import :** Data from an Instrument or other file.
- **Output** : Save, Print or Export an image or survey.
- **DataLogging** : Activate datalogging functions if enabled for your license.

When a Site is selected the **New Site** button will change to **Site Details**. To create a new site, select a non-site folder such as the parent of the current site. The button will be re-named **New Site.**

3.2 SETTINGS

The main floating control panel is called the **Settings** panel. It behaves exactly the same as the NavBar and can rolled up or hidden using the control buttons in the title bar at the top of the panel. The panel is subdivided into 3 sections, each of which can also be rolled up within the Settings panel to further reduce the size. Click the button in the top right corner to roll or unroll the section. These sections are labeled **Display** at the top and **Selection** at the bottom. The center section will change depending on the view selected in the currently active composite.



3.2.1 DISPLAY

In this panel you can:

- Select the layer to show in the current composite
- Set the display clipping parameters. These can be used to limit the range of values used to compute colors/hight range in the shade, trace and 3D views. These clipping values override (if tighter than) those set in the clipping process. They are primarily intended to aid in the initial assessment of the data prior to any other processes being applied. Either +/- a preset SD range, a slider set range or typed absolute values can be used.
- See the direction of North relative to the data. In all views the data is always (initially) oriented so that the first traverse is at the top of the screen and the direction of the first traverse when the data was collected runs from left to right. The Shade and Trace views can be rotated to any angle by dragging the compass arrow, the 3D view by dragging the actual image (the 3D view has an arrow at the rear of the survey to indicate north).

Note: The value for North is initially set during download or import of data. The value stored with a composite can be changed in the **Metadata** view**.** Changing this value does not affect the values stored with each source grid.

3.2.2 SELECTION

This section can be used to set a selection area (in intervals) on the composite or fine-tune an area selected with the mouse. If no selection has been made all the boxes will show zero. Clicking the **Full** box will clear any selection.

3.2.3 VIEW-SPECIFIC OPTIONS

Other options or information applicable to the currently selected view will be displayed on the **Settings** panel. These will be described in the applicable View description (see section 4).

3.3 Views

The central area of TerraSurveyor window can contain any number of Composite windows. Each composite window will show a single composite. This window is where the current data set for a composite is shown, modified by the applied processes and displayed in a number of different ways.

Each Composite window has a Tab bar at the top for selecting display modes and a main area where the data is displayed.
TerraSurveyor is able to display the data in a number of different ways:

- Shade
- Trace
- Delta
- 3D & Relief
- Relief (different method to that used in 3D view)
- Spreadsheet
- Metadata
- Publish

Each view can be selected by clicking on the tab at the top of the view window.

See section 4 for details of each view.

Note: It is important to remember that these views are just that - views - of the data. A view at any magnification is generated from the applicable data and all processes are applied to the data, not the image displayed on screen.

3.4 Processes

This is the generic term for all manipulations that can be applied to a Composite. They can be accessed from the Process menu or via the buttons running down the left side of the window. Application of any process results in the addition of a new layer to the Composite. The results of any new layer being created are displayed in the current view. The majority of processes can only be applied when the Shade, Trace or Data view is selected.

The buttons on the left side of the window have been grouped into functional sets. Each set can be closed or opened by clicking on the small button in the set's title bar. Note that this grouping is purely to aid in locating particular processes. In the case of the Magnetometer and Resitivity sets, it does not mean that a process can only be applied to that type of data, it is merely the most common data type for that process. Any process can be applied to any data type. The buttons in the set's title block allows the set to be closed or opened, thus also reducing the clutter and required height of the main window.

A simple 'Delete last Process' function is provided via the Edit menu and the **Ctrl-U** keyboard shortcut. This only and always deletes the last process, it does not undo any changes made to a process by Modify, etc.

Full details of each process can be found in section 5. An overview is provided below.

3.4.1 Main Processes

(menu & keyboard only)

Cut - Copy all datapoints within the selected area. Replace them with the dummy value. Keyboard: **Ctrl-X**

Copy - Copy all datapoints within the selected area. Keyboard: **Ctrl-C**

Copy Image - copy the currently displayed image (in the Shade, Trace, Delta, 3D and Relief views) to the clipboard. Note that this will make an exact copy of the screen image, at the current magnification. The cursor position label will be copied if visible and large surveys using graduated shade may show previously undisplayed areas as block shaded. Keyboard: **Ctrl-I**

Paste - Insert the data cut/copied by the previous commands into the Base Layer. The location of the mouse click sets the top-left corner of the paste area. Any data that would extend beyond the boundaries of the current survey is lost. See Cut, Copy & Paste for details. Keyboard: **Ctrl-V**

(menu & buttons)

Clip - Replace all values in the current layer outside a specified minimum and maximum with those values. Min and Max can be specified in absolute values or +/- SDs.

Interpolate – Increase or decrease the resolution of the data.

Despike - Scans the composite using a uniform weighted window looking for datapoints that exceed the mean of the window by a specified threshold amount. When found, the point is replaced by either the mean or threshold.

Stretch - Compensate for data collection errors caused by the operator walking too slow or fast. Stretches (and/or compresses) each traverse by a specified number of intervals.

DeStagger - Compensate for data collection errors caused by the operator starting recording each traverse too soon or too late. Shifts each traverse forwards (and/or backwards) by a specified number of Intervals.

DeDrift - Compensate for data collection errors caused by drift or sudden changes in an instrument's zero position. See De-Drift for details.

DeSlope – Compensates for excessive 'slopes' in source data caused by non-archaeological influences such as pipelines or fences within or close to the survey area.

Wallis – Applies a locally adaptive contrast enhancement filter to the survey or selection.

DeStripe - Determines the mean/mode/median of each grid or traverse and then subtracts that value from each datapoint in the current layer. Used to remove the striping effect within a grid or patchwork effect between grids caused by directional effects, operator habits, instrument setup, drift, etc.

Edge Match - Calculates the mean of the 2 lines (rows or columns) of data either side of the edge to match. Subtracts the difference between the means from all datapoints in the selected area.

Range Match – Similar to Edge Match. However Range Match also spreads the data values in the area to be matched so that the Min and Max values also match.

Periphery Match – Calculates a 2D surface for each grid and subtracts that surface from each value. The shape of the surface is determined by the average of the grid's edge values and their neighbours in adjacent grids.

H/L Pass (High / Low pass filter) - Uses either a uniformly or Gaussian weighted window to remove high or low frequency components in a survey.

2D FFT - Uses FFT techniques to remove any underlying frequency at any angle from a survey.

Notch – Similar to the 2D FFT described above but focuses on narrow frequencies only occurring along the traverses.

Maths – Apply basic maths (add, multiply, power & absolute) processes to the survey or selection.

Mask – Prevent the application of subsequent processes to an arbitrary area.

Compress - Apply a compression algorithm to the current layer.

Normalize – Convert all values in the selection area or individual grids to a value between 0 and 1.

Replace - Search the current layer for any value (including the Dummy value) between a Max and Min (max and Min can be the same to replace a specific value). Replace that value with a specified replacement value.

Move - Move the select area a specified distance Left/Right and Up/Down.

Delete - Replace all datapoints within the selected area with the dummy value. Does not activate the Paste command.

Annotate – Adds a special Annotation layer to the survey. This layer displays a set of symbols at specified X & Y locations over the survey.

3.4.2 GPS Processes

These processes are only applicable to Source data gathered with GPS based systems. The processes are applied directly to the source data which is then (re)interpolated to create a normal base layer. This base layer is then used to create the displayed image and can be further processed by most of the above mentioned processes.

Clip - Replace all values in the current layer outside a specified minimum and maximum with those values. Min and Max can be specified in absolute values or +/- SDs.

DeStripe - Determines the median of each transect and then subtracts that value from each datapoint in the transect. May be used to remove the striping effect seen within a survey caused by directional effects, operator habits, instrument setup, drift, etc.

Despike - Scans the transect using a one dimensional, uniform weighted window looking for datapoints that exceed the mean/median of the window by a specified threshold amount. When found, the point is replaced by either the mean/median or threshold.

H/L Pass (High / Low pass filter) - Uses either a uniformly or Gaussian weighted window to remove high or low frequency components in a survey. Applied in one dimension along the transects/source data.

Straighten – Corrects sudden changes in X&Y positions that may be caused by changing GPS satellite constellations.

Reduce Points – Uses the Douglas-Peucker polyline simplification algorithm to reduce the number of datapoints passed to subsequent GPS processes.

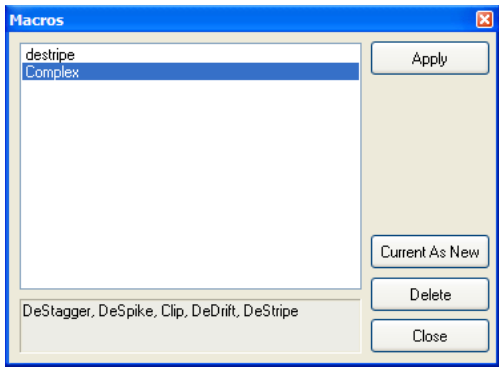
3.5 MACROS

The Macro button allows you to save the set of processes applied to the currently selected composite. This set can then be applied to a different composite with the click of a button. This can be useful in a number of situations, for example:

- When a large number of composites are created for the same site, it may be desirable to apply exactly the same processing to all of them.
- For quick and simple processing in the field by inexperienced operators.

Warning: Macros must be used with care and an understanding of their limitations. To obtain the best results from TerraSurveyor, each composite should be processed individually. Full regard must be given to the features and anomalies present in the composite, the geology of the site and characteristics of the instrument.

To create a Macro, open or create a composite with the desired processes in the correct order. Open the Macro dialog by pressing the **Macro** button on the left hand button panel. Press the **Current as New** button. Give the macro a simple descriptive name. Press OK and the macro will be created from the processes in the current composite. A secondary description will be created for the macro as a list of each process name in the macro. This will be shown below the list as a macro is selected.



To apply a macro, open the dialog, select the required macro from the list and press **Apply**. The processes recorded in the macro will be applied to the currently selected composite in the same order and with the same parameter values.

Notes regarding Macros:

- All parameters in each process - except those indicating selections - will be stored in the macro. Any selection data will be ignored so that when the macro is applied to a different composite, the process will affect the entire composite. A warning will be given for each process that has a selection as the macro is created.
- Processes that can only be applied to selections (such as Range Match and Move) cannot be included in Marcos and will be ignored.
- Processes that apply absolute values as their parameters should be used carefully. For example the Clipping process can be applied as actual values. This may be suitable for one dataset but if applied to a dataset with a range outside these values will result in no useable data. Instead the +/- SD values should be set as the actual clipping values are then calculated from the current data.
- The processes stored in the macro are simply added on top of any existing processes. This allows you to stack macros and/or individual processes.
- Once the macro has been applied, the processes can be edited, reordered and deleted just like any other processes. The composite does not store information regarding the macros, just the processes the macro created.

3.6 Download

Data can be downloaded directly from many common Geophysics instruments. TerraSurveyor can communicate directly with a range of instruments allowing data to be read directly into it's own Grid format.

Instruments currently supported are:

- Bartington Grad 601 & 601-2 Magnetometer (single & dual sensor pairs)
- GeoScan FM-36 & FM-256 Magnetometer
- GeoScan RM-15 Resistivity meter + MPX15 multiplexer
- TR/CIA Resistivity meter
- Arc-Geo Datalogger

First, connect the instrument to the computer using the cable supplied by the instrument manufacturer.

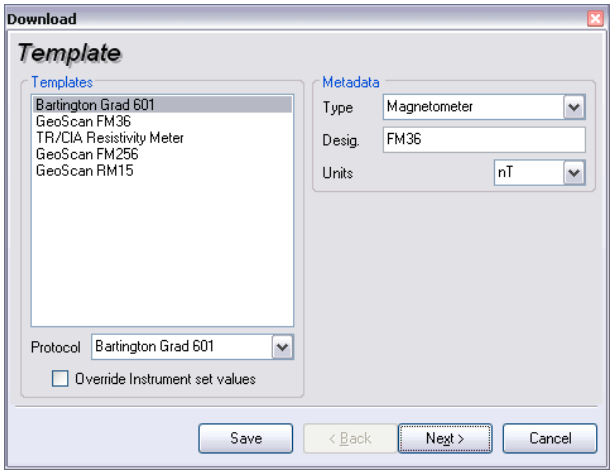
Select **Download** from the **File** menu or the **NavBar**.

The download system uses a 'Wizard'. Each step of the download is covered by a dialog page. Once the necessary data has been entered on each page, press the **Next>** button to move on. The download process consists of up to 6 pages, however only those pages relevant to the selected protocol are shown so that for most instruments, there will be less pages to go through. For many instruments this will be just the Template, Output Files and Progress pages.

3.6.1 Important:

TerraSurveyor provides download processes for a wide variety of data formats generated by the different instruments. Each of which must have it's own specific process. This makes it impractical to provide comprehensive error checking and handling for all instruments and conditions. We therefore suggest that you maintain the download software supplied by the manufacturer of the instruments alongside TerraSurveyor. In case of problems, use the manufacturer's software to download the data, export it to a standard format and then import it into TerraSurveyor.

3.6.2 TEMPLATE:



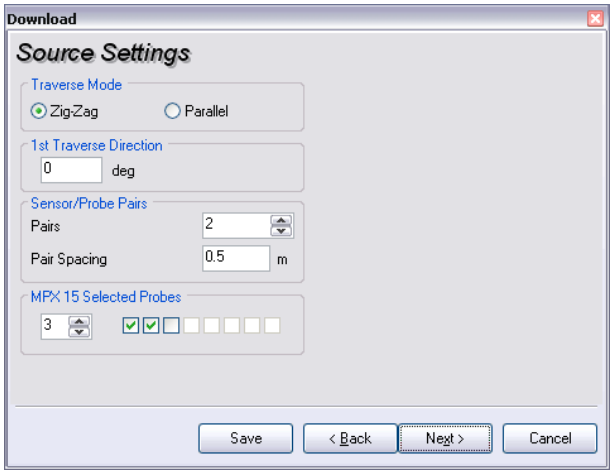
Select the applicable template from the List. Each Instrument type may have more that one entry in the list when that instrument can have different settings, such as **Grid Size** or **Intervals**. The basic instrument for a template must be selected from the **Protocol** list at the bottom.

Many instruments provide all necessary sizes, intervals, etc. within the header of the downloaded data. In these cases, the download process omits the pages that allow you to set these values. However it may be that the you have used different values (for the grid size perhaps) than those recorded in the header. In these cases, you can choose to show all the pages and override the header values manually. This is done by by checking the **Override Instrument set values** checkbox.

If a new template is needed, select the most similar template available for that instrument, make the necessary changes in the other pages and then click **Save**. You can also change an existing template by the same means. All the settings on all pages will be saved with the template. A template can be deleted by selecting it and then pushing the Delete key.

Set the **Metadata** applicable to the instrument. This data is for reference only. It is stored with the Grids and Composite created from the grids and can be seen in the Metadata view.

3.6.3 SOURCE SETTINGS



This page will normally only be displayed for instruments that do not supply header data in the download, primarily the GeoScan instruments.

Traverse mode describes the method used to walk the grid. Zig-zag means that each traverse starts at the end that the previous one ended. Parallel means that all traverses start from the same side of the grid.

Direction of 1st traverse in degrees. This sets the direction of the North arrow on the main display.

Sensors/Probe Pairs. The sensor count is used by some processes, such as DeStagger and Stretch Traverse, to correctly modify the data. This setting is only applicable to systems that generate multiple readings at each interval such as a Bartington Grad 601-2 or GeoScan RM15 + MPX15 multi-probe array. For all other systems this value should be left at 1.

Notes:
For a gradiometer, one sensor is a pair of magnetometers (i.e. A single Bartington Grad 601 or FM36 is considered one sensor for the purposes of downloading).

The spacing value is for reference only and is not used in any computations. Use it to record the horizontal distance between probes for a resistivity system or the vertical separation for gradiometers.

The presence and contents of the last panel on this page will depend on the instrument selected. For most instruments there will be no other panel showing.

For the GeoScan FM36/256 a checkbox for **Drift Correction** will be shown.

For the MPX15 a panel giving control of the probe configurations will show:
MPX 15 Selected Probes. The MPX 15 allows you to log data from a number of probes, connected in various configurations. Each probe pair reading may therefore be at a different spacing (equating to different depths). However, to fit the TerraSurveyor method of handling data, each spacing must be downloaded into a separate grid. To do this TerraSurveyor allows you to set the number of probe pairs read at each measurement point and then specify which readings taken at that point are to be recorded. By doing *multiple downloads* of the same data but selecting different readings from the datastream each time, each spacing set can be read into different grids.

For example:
If you have 4 probes on the frame at 0.5m spacings you could define the MPX 15 configuration as 2 x 0.5m readings in parallel (probe 1 & 2 + probe 3 & 4) + 1 x 1.5m reading (probe 1 & 4). This would output 3 values at each measurement point. To download this data you would do two complete downloads from the instrument, each download creating a different grid from the logged data. The downloads would use the following settings:

- Sensor Probe Pairs : 2 @ 0.5m, Selected Probes : 3 with checkboxes 1 & 2 checked.
- Sensor Probe Pairs : 1 @ 1.5m, Selected Probes : 3 with checkbox 3 checked.

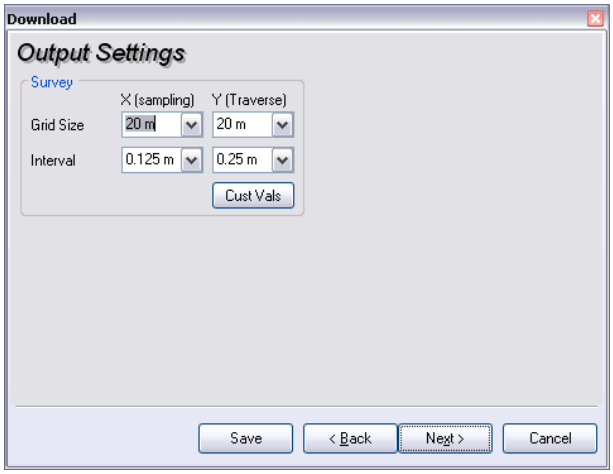
Remember that the Grid Size & Intervals must also be set differently for each download and that each set of grids should be saved in separate grid subfolders.

Each setup can be saved as a different template.

3.6.4 OUTPUT SETTINGS

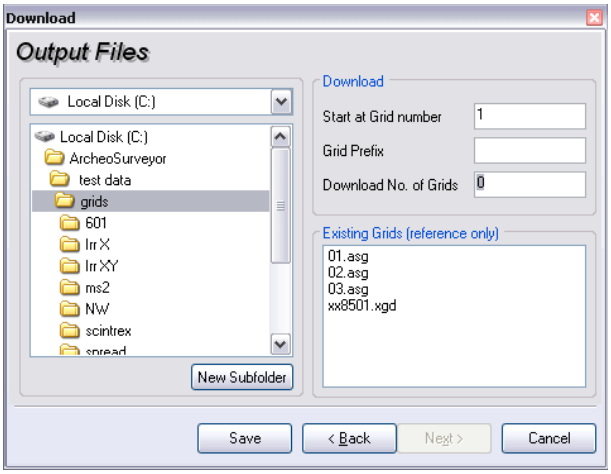
Covers the parameters of the grids to be created. Set the **Grid Size**, and **Intervals** to the appropriate values. Non-standard sizes can be set using the **Cust Vals** button. This will turn all 4 drop-down lists into edit boxes. In this case, all 4 values will have to be entered by hand.

Remember that the X axis in TerraSurveyor is along the line of the traverse and will be the axis going across the screen in normal use. The Y axis is the distance between each traverse and will go from the top to the bottom of the screen.



3.6.5 OUTPUT FILES

The output path is shown for reference. It is set at the pre-defined \Grids folder of the site, however additional subfolders may be created within the \Grids folder (click **New Folder**). This is useful for separating Grids, for example by instrument or area within a site. Note that Grids of different size (or X/Y Intervals) should not be mixed in a subfolder. The Grid Assembly window can show and assemble Grids with different sizes, however this is not recommended (the thumbnail height and width will be set to the largest dimension of all the grids in the folder).



Set the **Start at Grid Number** and **Grid Prefix** if required. **Start at Grid Number** can be any whole number. **Grid Prefix** can be any string. Use these fields to differentiate between grids downloaded on different days, site areas, etc.

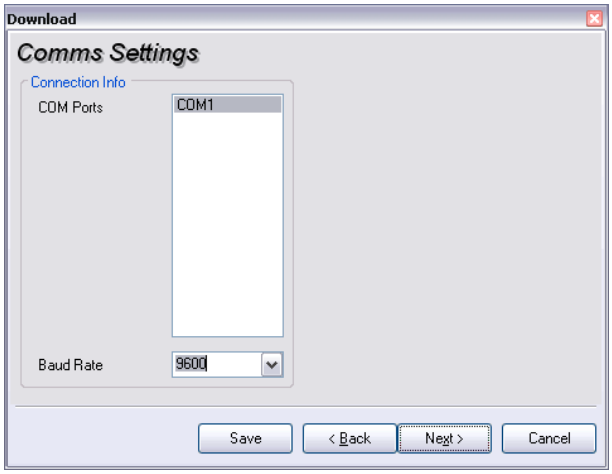
The **Start at Grid Number** will be added to the download sequence of the grid. Sequence numbers below 10 are padded with a leading zero (i.e. 01, 02, etc.). Most instruments number all grids in their memory from 1. Please note that it does not affect which grids are downloaded, only the names created for them.

By using a **Grid Prefix** string, grids could be renumbered A01, A02, A03 on day 1; B01, B02, B03 on day 2 etc. Similarly, using a different **Start at Grid Number** value could create grids 01, 02, 03 on day 1; 04, 05, 06 on day 2, etc.

For GeoScan instruments, set the **Download No. of Grids** to the appropriate value. All other instruments will determine this value from information in the downloaded data and so this field is disabled for them. For GeoScan downloads, the **Next>** button will be disabled until a number of grids to download has been specified.

3.6.6 COMMS SETTINGS

All downloads are carried out using serial cables. Many modern computers - especially laptops - do not have a serial port (also known as an RS232 port). In this case you can use a USB to Serial adapter cable/box to connect the two. If this method is used, the COM port should not be set in **Preferences** because the port number is assigned dynamically, depending on the other units connected to the USB ports. The download process will therefore scan all the available serial ports in turn and attempt to establish communications with the instrument. Once the instrument has been found, the download will automatically start.



However, this does not work for a few instruments, notably the GeoScan machines, which do not wait for TerraSurveyor to initiate the download. In the case of these machines the COM port must be set on this page. The list shows all the currently active COM ports and is continually refreshed. The best way to determine which port the cable is connected to is therefore to leave the cable unplugged. When this page is reached make a note of the listed COM ports then plug the cable in. Wait a moment (it may take the PC a second or two to recognize the cable) then select the new entry on the list.

There is one other circumstance which may cause problems: when other serial devices are also sending signals to the PC. The most common of these is a GPS receiver. As TerraSurveyor only checks for the presence of data - any data - on a COM port, a GPS receiver (which generates data continuously) connected to a port number lower than that used by the Instrument will be assumed to be the download instrument. In this case, either turn off the device or determine the COM port the instrument is connected to and set the COM port explicitly in Preferences.

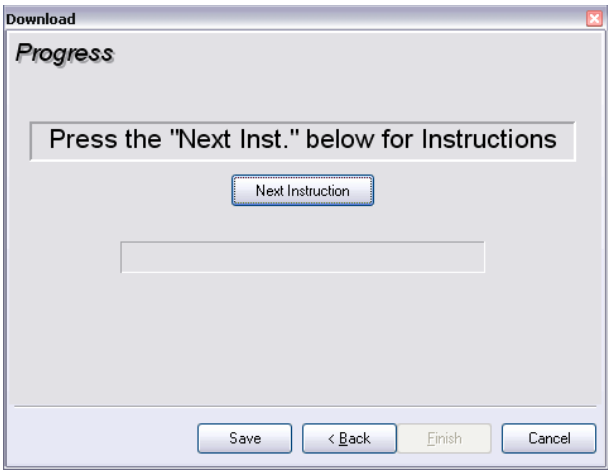
The **Baud Rate** can be changed from that specified in the Template for those instruments that support different baud rates (currently only the GeoScan machines)

3.6.7 PROGRESS

Follow the directions given on the large panel at the top of this page. The messages are specific to each Instrument. Click on the **Next Instruction** button to advance to the next message and finally start the actual download procedure.

Progress or Error messages appropriate to the Instrument and the data it provides will be displayed in the large panel and a bar will show progress (when this can be computed).

Once downloading has been successfully completed, a message box will show the number of grids created. Click **OK** and then **Finish** to continue to the **Grid Assembly** Window.



3.7 Import

Data can be imported from a range of standard format data files generated by software such as that supplied with other Geophysics instruments. A number of special formats created by specific instruments or software programs are also supported.

Generic Formats:

- XYZ
- Z
- Spreadsheet
- Irregular X
- Gridded GPS
- Irregular X & Y

Special Formats:

- GSSI Profiler
- Surfer ASCII, version 6 & 7 binary
- Scintrex
- GeoPlot binary Grid & Composites
- Geonics G38
- GeoMetrics G858
- InSite Grids & Grid assemblies (limited)
- Blank Composite

Data is normally imported into grids the same as those created by the download process. However data can also be imported directly to a composite when the layout dictates.

3.7.1 Generic Formats

TerraSurveyor can read the following generic ASCII formats:

3.7.1.1 XYZ :

In this format each line of the file represents a single cell in the grid (or composite). The line must contain at least 3 entries; the column (X), row (Y) and value (Z). Any column may be selected from the file to fill each of these values, the column order and method used to select them is defined in the File Layout page.

Empty values may be omitted, entries that exceed the range specified in the import dialog will be ignored. Lines that do not yield valid numbers in all three specified columns or do not start with digits will also be ignored.

3.7.1.2 Z :

Each line of the file contains just a single entry for the value. The position of each value is assumed from it's sequence. The first value is typically placed in the top-left corner cell of the grid, the second in the cell to it's right and so on. The file must therefore contain a value for every cell in the grid, empty values must be represented by the dummy value. The traverses is always assumed to go from left to right (as viewed from the startpoint of a grid when gathering the data). The position of the origin (corner of the first value) can be set to any corner.

3.7.1.3 Spreadsheet :

Each line of the file represents a complete row of the grid (or composite). Values may be separated by a tab, space or comma. As with the XYZ format, care must be taken when using data with PCs that use the comma as the decimal separator. Empty values may be omitted as long as the separator is present.

TerraSurveyor assumes by default that all imported data is arranged with the origin (position 0,0) in the Top-Left corner. The position of the origin can however be set to any corner.

3.7.1.4 Irregular X:

The basic layout of the file must be similar to the basic XYZ file (i.e. at least 3 columns, containing the X distance, Y distance and Z measurement value). However, this format allows one of the distance axes to have irregular intervals. The irregular intervals will be converted into regular intervals (at a spacing set in the import dialog) by an interpolation process.

As the format name implies, the interpolated axis will always be the X axis when displayed in TerraSurveyor. This may seem to imply that the format cannot be used for certain files. However, the column used for the X axis does not have to be called the X axis by the file. Simply specify whatever column contains the irregularly spaced data as the X axis and then rotate of flip the resulting data as necessary to re-orientate the final data.

Note that any data rows with values outside the range specified by the import dialogs will be ignored, as will any lines in the file that do not contain valid numbers in the defined columns.

3.7.1.5 IRREGULAR X & Y:

This format is typically intended for use with data gathered with GPS positioning data. Using this method, the data does not need to conform to a classic grid system. However, for best coverage and results from the available GPS processes, it is suggested that a regular, grid-like approach is used when gathering data: the lines need not be oriented in any particular direction but they should be fairly straight, parallel and regularly spaced.

The basic layout of the file must be similar to the basic XYZ file (i.e. an ASSCII file of at least 3 columns, containing the X distance, Y distance and Z measurement value). Each row may contain multiple X, Y & Z sets. The source values will be interpolated to generate appropriate values at the closest regular grid points. The interpolation process can use any interval for the X & Y axis. Interpolated points will be generated for a specified radius around each point. This is to ensure that complete ground coverage is provided for each traverse or track of source data – and also limit the interpolation to a statistically valid distance from the available data.

Because of the nature of the data, grids have no meaning. Therefore Irregular X & Y data is always interpolated straight to a composite. The composite will be sized to fit the full extent of the source data, plus allowing for the width of the track as specified in the **Irregular X & Y** panel.

To import more than one file to a single composite, join the source files into a single text file (using an external text editor or word processor) prior to importing.

The source data can contain markers to define the start and end of traverses. The markers can be almost any text embedded in the file. The import process uses either (user defined) Regular Expressions to recognize the marker (see 3.7.3.5 for details) or a value in a specific column that changes to trigger a new traverse. The regular expression can be a separate line of text in the file or a particular string within a line of data, the trigger column must be part of a normal row in the data. The regular expressions or Change column will be saved in the template.

If both start and end markers are present, data between each start and end mark will not be used in the interpolation process (nor will datapoints before the first start and after the last end). Just start markers can also be used.

X & Y positions can be in either Lat/Long, Deg/Min/Sec format (or variations on this) or UTM meters. In the case of the former, the data will be stored in the composite file using the source format but will be converted to UTM values when opened. If the data is imported from UTM, a UTM zone can be specified however this is not required. If the data is not geo-referenced then the UTM format should be used. A geoid can also be specified for GPS data, this will be stored in the composite. If no Geoid is selected, the Geoid set in Preferences will be used.

Note that any lines in the file that do not contain valid numbers in all the defined columns will be ignored.

Survey systems are increasingly mounting multiple sensors together on a single machine such as towed cart. Some of the dataloggers associated with such systems output each sensor's position and value as a single line of data, however some place all the data for all the sensors at a single measurement event on the same line. TerraSurveyor can handle either file layout. If multiple sensors are defined in each row, the X, Y & Z for each sensor must be a separate column in the file. The file will be read from beginning to end for each sensor specified and the data for that sensor appended to the end of the composite.

3.7.2 Special Formats

A number of special formats can also be imported or created. These formats are specific to particular instruments or software packages. By providing direct import facilities, full advantage can be taken of the special processing abilities provided by TerraSurveyor.

3.7.2.1 GSSI Profiler :

An ASCII format created by the GSSI Profiler datalogger. The data file (extension *.emi) contains some standard header lines followed by data in a comma separated XYZ format. The data lines may also contain GPS positioning data if the datalogger is suitably equipped (and the appropriate logging mode is selected). If GPS data is present the file is imported directly to composites, non-GPS data is imported as grids that must then be assembled into composites. The import process reads the header data in the .emi file and sets all the appropriate parameters accordingly. Thus there are almost no settings to be made in the import dialogs apart from the source file to be imported and destination. The only settings that can be filled in are **Direction of First Traverse** (this is not available in the header data and is not required for GPS based data) and for GPS based data: **Track Radius**, **Interval** and **Use GPS**. **Track Radius** determines the number of interpolated datapoints that are kept around every source point. This ensures that interpolated data is only shown within a statistically valid range of the source data. **Interval** sets the density of interpolated data points. Both these values can be changed after import. The **Use GPS** switch allows the GPS data to be ignored in which case all data will imported to grids.

3.7.2.2 Surfer :

TerraSurveyor can handle three types of files created by the program "Surfer" from Golden Software: the plain ASCII files and the version 6 & 7 binary files.

In Surfer files the first line of the data represents the bottom row of the grid, the grid is therefore automatically flipped vertically during import. The X & Y Grid size and intervals are calculated from the values specified in the header.

Note that Surfer files consider datapoints to be placed at the intersection of intervals. See section 3.7.3.1. for a detailed explanation of this factor.

The size of the Grid/Composite specified in the Import wizard will override the size defined in the Surfer file header. Data outside the specified area will be ignored. The size should therefore be set to a value equal to, or greater than the actual size to ensure data is not lost.

3.7.2.3 Scintrex:

An ASCII format produced by the Scintrex SmartMag or NavMag software. TerraSurveyor can import grids gathered from instruments used in both the vertical and horizontal orientations. Grids gathered in the vertical mode can be imported as either Upper, Lower (total field) or Gradiometer (difference between upper and lower). By selecting the sensor mode "Twin", grids can be imported where the Field 1 column becomes the even-numbered rows and Field 2 the odd-numbered rows (assuming the first row is number zero). When used in this mode, ensure that the instrument is not rotated at the end of rows and that the correct sensor is on the left/right.

Note that the Scintrex files use X for the traverses whereas TerraSurveyor considers the Y axis to be traverses. The grid is therefore rotated 90° to the orientation indicated in the source import file.

Because of the way Scintrex grid data is collected, there is no fixed sampling interval (this is equivalent to the Irregular X format described above). The import function creates fixed intervals by interpolating between the variable Scintrex Y intervals. The TerraSurveyor X (sampling) interval can therefore be set to any value, we would suggest that a value close to the average Scintrex sampling value be selected. The actual interpolated value is taken from the mid-point of the interval, e.g. With an X interval of 0.5m, the data is interpolated at 0.25, 0.75, 1.25, etc.

There is also a significant delay inherent in the Scintrex datalogging system so De-stagger aways has to be applied to the grid. However, the datalogger has the advantage of being able to log data both before the start and after the end of a line. This enables the import function to apply the de-stagger during import and fill the line ends with true, recorded data instead of the adjacent averages as used in the Main view De-stagger process. However, it can only be done during the import process; if not done correctly the whole import

process will have to be repeated to correct it. To take full advantage of this facility, the operator should ensure that logging starts and ends at least 1m either side of the row. The de-stagger values can be set in Intervals or centimeters (or a combination of both). Negative values pull the data back towards the start of the line (normally the required correction).

The Scintrex import function expects the NavMag data to be in 7 (space and sometimes comma separated) columns:

```
          0      -4.85294  48826.67  48828.95  10.748667  0    -4.55
```

SmartMag data is in this form:

```
  0.00000,          *, 48255.33, 48255.15,   -0.00,  10.78000
```

In the case of SmartMag data, the Y position (column 2) will be interpolated between available "Marker" lines or the start and end of the row (based on changes in the X position in column 1). Lines beginning with a '/' character will be ignored.

3.7.2.4 GeoPlot:

TerraSurveyor can import the grid and composite files created by the program "GeoPlot" from GeoScan Research. The grids and composites are actually stored in pairs of files: Grids as a xxx.grd and xxx.dat pair and composites as a xxx.cmd and xxx.cmp pair (where xxx is the 'name' of the grid or composite). The grd and cmd files are ASCII header files describe the grid or composite's size, shape, etc. The dat and cmp files are the actual values in binary format. The import process will only show the header files but the pair of files must be present in the same folder in order for the import to work. All data regarding the size and shape will be extracted from the header file, therefore the Source and Output Settings pages of the Import wizard are not shown. Grids will be converted to TerraSurveyor grid files and composites to TerraSurveyor composites.

3.7.2.5 Geonics

The Geonics format is a common file format created by the Geonics Mapper software after downloading data from their EM31 & EM38 instruments. Both Gridded and GPS modes are supported. Gridded covers both the Auto and Manual modes defined by Geonics. Files that use variable X intervals will be imported in the same way as the generic Irregular X method.

In 'Grid' mode the file uses a variant of the XYZ file layout however the Y (traverse line) is only given once at the start of each block X values. Note that the Geonics datapoints are recorded at the intersections of intervals. This difference is ignored in the import process resulting an offset of data position of ½ an interval in both axes. See 3.7.3.1 for further information.

Note: The Geonics file format is extremely flexible, particularly in the use of line labels. In fact, the line label can mean just about anything the user wishes. However there is no means of describing that meaning in the file. The import process therefore only attempts to handle the simplest and most straightforward variations. Warnings are given if more complex labels are found, however it may be that an apparently simple label is actually used in a complex and unsupported manner.

As there is no fixed value for the X & Y origin, this can be set in the Import Wizard. Set the value **X & Y Origin starts at:** to the value that the first X & Y value in the file will have. THis value will then be subtracted from each X and Y position to match the zero-based standard in TerraSurveyor. Note that the Wizard assumes that both the X & Y axes will use the same start value and therefore the same correction.

In GPS mode, the grid based X & Y positions are still present but are virtually irrelevant, instead the X & Y position of each point is interpolated from the GPS records inserted into the file at one second itervals. The interpolation is based on a simple straight line between the last and next GPS point, using the high accuracy time to determine the distance along the line. GPS mode files always convert straight to Composites.

3.7.2.6 GeoMetrics G858

This import process currently only supports the G858 Grid based files, not the GPS versions.

This format is an ASCII format created by the GeoMetrics MagMapper software when used with the G858 magnetometer. The *.stn files that TerraSurveyor can read are a variation on the Irregular X format and handled as such. This means that the (regular) X values are interpolated from the irregular source data.

3.7.2.7 UXO (VALLON)

An ASCII XYZ format common to the UXO (unexploded ordnance) community. The current import process is based on examples exclusively from Vallon which may contain manufacturer specific features.

3.7.2.8 SENSYS ASC

ASCII files created by the SenSys Magneto or DLMGPS programs. Note that these programs have a range of export formats and options, it is important that you set 'Save type as' to ASCII (*.asc) and deselect 'Automatic Track Compensation' (under Options).

3.7.2.9 INSITE GRIDS & GRID ASSEMBLIES

InSite is another geophysical data processing program, however it is no longer generally available. A number of operators still use it and a large body of data exists in it's format.

> Note: There is no published description of the InSite data format and experimentation with a variety of samples indicates that the format is at the same time both simplistic and very complicated. The grid files are simple Z files with some header lines. However the Grid assembly files which show how a set of grids are arranged, allow the grids to be oriented in a multitude of ways but the parameters that control this orientation do not operate consistently between different surveys. It has therefore been impossible to develop an import process that can handle all available example files in a satisfactory manner.
> Therefore it is recommended that if you have InSite files, extreme care is taken when using this import process. We suggest contacting DW Consulting if you have any doubts about the accuracy of the process and the resulting data.

The basic Grid import process works well with all available samples and should be used as the basis for any import work. The Composite import process that reads the Grid.Inf files *may* succeed but more probably will only show distorted grids in their correct positions (and may fail completely). In this case, we recommend you import the grids separately and use the position information extracted from the Grid.Inf file to create a new composite from scratch.

3.7.2.10 BLANK COMPOSITES

One further special import format is possible which will generate blank composites - i.e. a composite where all the cells contain the Dummy value. This can then be used for a number of purposes such as inputing data by hand via the Data View. Select the File Type **Blank Composite**. The **Type** box will be automatically set to Composite, the **Composite X & Y** boxes will be shown - with default values of 1. Set the values for the Grid intervals and the size of the Composite (in Grids). Specify a name for the Composite file then click on **Finish**. The new blank composite will be listed with all the normal composites in the site folder. Grids will be given dummy filenames in the form "B[X,Y]" where X and Y are the Column and Row.

To enter values in the Composite, see the **Manual Data Entry** section below.

> Note: Composites created from a blank cannot be modified by the **Open Grid Assembly** window. They can however be exported as grids and then re-assembled as a new Composite.

3.7.3 Import Process

Select **Import** from the **File** menu or **NavBar** (these will be disabled until a site has been opened).

The import system uses a 'Wizard'. Each step of the import is covered by a dialog page. Once the necessary data has been entered on each page, press the **Next>** button to move on. The import process consists of up to 6 pages, however only those pages relevant to the selected file format are shown so that often there will be less pages to go through. In some cases this will be just the Template, Input Files, Output Files and Progress pages.

3.7.3.1 Measurement point position

Some data formats & instruments, such as the Geonics data and Surfer files, consider datapoints to be placed at the intersection of intervals. This differs from the TerraSurveyor perspective where datapoints are considered to be at the center of (half way between) each interval. This has significant implications for the import process. In the Surfer/Geonics world a grid that is 20m x 20m at 1m intervals would contain 21 rows and columns. The first row and column datapoint being measured at 0m x0m and the last at 20m x 20m. The same grid in the TerraSurveyor world would have only 20 rows and columns. It would consider the first point to be measured at 0.5m x 0.5m and the last at 19.5m x 19.5m. The import process takes a simplistic approach to handling this offset, it ignores it. The first datapoint from the Surfer file is stored in the first datapoint of the TerraSurveyor Grid/Composite. In practice it has been found that this is sufficient for normal purposes. In most cases the offset is insignificant relative to the overall size of the survey and and other sources of error such as magnetic dip. The offset can easily be corrected on the ground if required. Attempts to interpolate values for the true X & Y positions degrade the data too much. This approach also has the advantage of preserving the true measured values.

3.7.3.2 Important

Importing Composites

In order to support the grid-oriented processes such as Stretch Traverse and De-stagger, dummy filenames are generated for any grid that contains data. These filenames are in the form "I[X,Y]" where X and Y are the Column and Row.

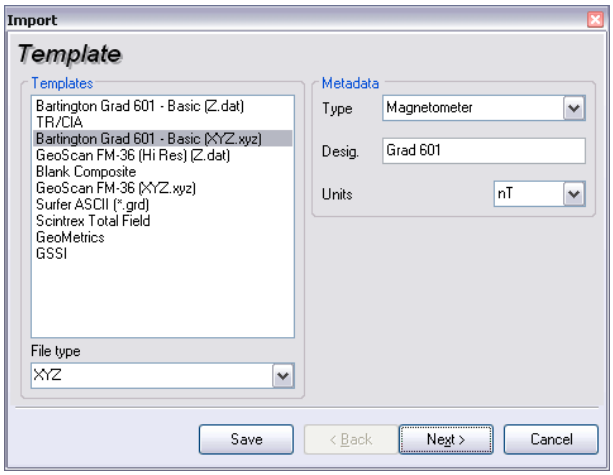
Header Files

TerraSurveyor does not generally support generic files with “headers”, i.e. Information before the actual measured data describing instrument settings. This data should be deleted in a text editor prior to importing. Special formats such as Surfer ASCII files which specify header info in a particular layout are catered for.

Mismatched data and parameters

As many checks as possible for the specific type of data are carried out during the import process to ensure that the data matches the specified parameters. However there are situations where the correctness of the data cannot be confirmed programmatically. The most common of these occurs with XYZ data when the X and/or Y interval is set smaller than the data's actual interval. In this case the data will be imported but the grid thumbnails will appear blank as every data point is surrounded by (and in effect 'swamped' by) dummy values. If this occurs, check the X and Y Intervals and re-import the data.

3.7.3.3 TEMPLATE:



Select the applicable template from the List. Each Instrument type may have more that one entry in the list when that instrument can have different settings, such as **Grid Size** or **Intervals**. The data format for a template must be selected from the **File Type** list at the bottom.

Some formats provide all necessary sizes, intervals, etc. within the header of the file. In these cases, the import process omits the pages that have you to set these values.

If a new template is needed, select the most similar template available for that file type, make the necessary changes in the other pages and then click **Save**. You can also change an existing template by the same means. All the settings on all pages will be saved with the template. A template can be deleted by selecting it and then pushing the Delete key.

The **Instrument type, Designation** and **Units** can be set but have no effect on the actual data. The values are for reference only and are only displayed in the Metadata view (and the Palette/Vertical scale in the case of Units).

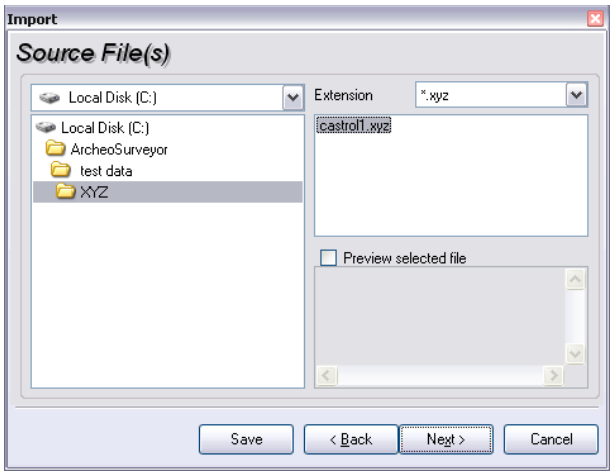
3.7.3.4 Source Files

The Drive & Folder list set and show the directory the source files will be found in. The site path is shown by default. This can be changed to any folder.

Set the **extension** of the input file if necessary (this may have been preset by the template).

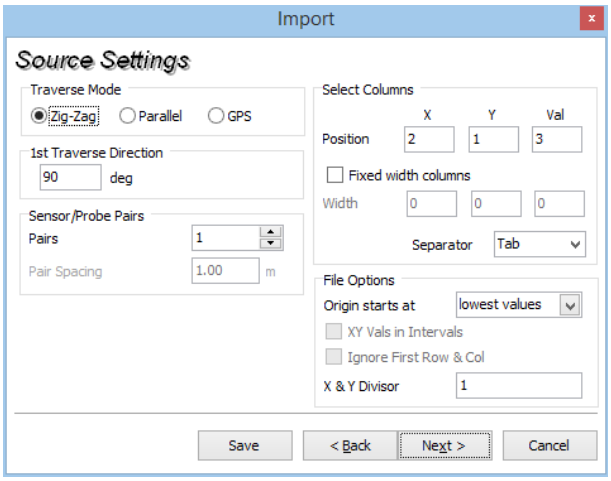
> Note: Different programs may produce very different files with the same extension. Just selecting the extension in this list does not guarantee that the import process will work. In fact, this list has no effect on the import process at all, it just determines the files that will be shown in the file list. The correct import format *must* be set by the File Type list on the Template page.

Select the file(s) to be imported. If a composite is to be imported, only one file may be selected. By checking the **Preview selected file** box, the first few lines of the file can be viewed to ensure the selected file type is correct.



3.7.3.5 Source Settings

The fields shown and options available on this page of the Wizard will differ depending on the file type selected. The screenshot gives an example of what you will see. All the various fields are described below.



Set **Traverse mode**. This information is used by some of the processes, such as DeStagger and Stretch Traverse, to correctly modify the data and is also important when the data is in Z format (i.e. no X and Y information is supplied).

Set the **Direction of 1st traverse** in degrees (this may be a decimal value however in most cases just the integer value will be used in any calculations or processes).

Many of the import formats use vertical columns to store the data. The **Select Columns** panel controls how these columns are read and processed (Irregular X&Y data uses a slightly different panel – see below for details). Columns can be defined either in terms of absolute position or column number. In the first case you must specify the start position and width in characters of each column. In the second you must specify the column number (starting from 1) and the character used to separate each column. This can be either a space, tab or comma. Commas should not be used if the PC is set to use commas as the decimal separator (such as in most European countries) as this will result in apparent extra columns. In this case use the tab or space as the column separator. Multiple spaces may be used to separate columns and may also surround commas. However only a single comma or tab character may be used between each column.

Check the **X & Y Values in Intervals** checkbox if the X & Y positions are given in interval counts rather that measured values (meters or ft).

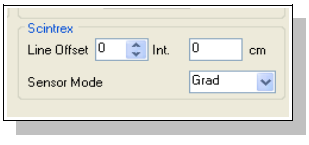
For the spreadsheet format use the **Ignore First Row & Col** checkbox if the file uses these to show the position rather than values.

Sensors/Probe Pairs. The sensor count is used by some processes, such as DeStagger and Stretch Traverse, to correctly modify the data. This setting is only applicable to systems that generate multiple readings at each interval such as a Bartington Grad 601-2 or GeoScan RM15 + MPX15 multi-probe array. For all other systems this value should be left at 1.

> Notes:
> For a gradiometer, one sensor is a pair of magnetometers (i.e. A single Bartington Grad 601 or FM36 is considered one sensor for the purposes of downloading).

The spacing value is for reference only and is not used in any computations. Use it to record the horizontal distance between probes for a resistivity system or the vertical separation for gradiometers.

For **Scintrex** files:



Set the **Sensor Mode** so that either the Gradient, Upper or Lower sensor data column is imported.

Set the **Offset** to allow for datalogger delay. Each reading's position will be corrected by the specified amount in Intervals and/or cm. Positive values 'pull back' the data by the specified amount.

For **Irregular X** files:

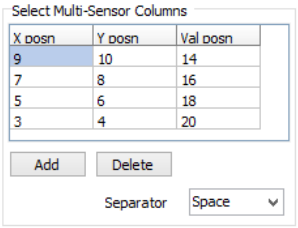
Set **Origin starts at** to 0, 1, ½ Int or Lowest Values. Because TerraSurveyor uses an origin of 0,0 for all grids and composites, imported data with explicit X & Y values may need to be repositioned. This setting determines the value to be subtracted from every X & Y value. This should be set to **0** for *all* cases except for XYZ or Irregular X data. If the X & Y values are in intervals and start at 1,1, select **1**. If the X & Y values indicate the center of the measurement 'box' (e.g. 0.25 & 0.5 for X & Y intervals of 0.5 & 1) select **½ Int**. If

other values, such as Easting and Northing are used for the X & Y position, select **Lowest Values**. This will scan the data and subtract the lowest found value from every value.

X & Y Divisor will divide the value in the file by the given value. This can be used when the X & Y values are not recorded in the units required for the survey, for example if they are in Ft or millimeters when the survey needs to be Meters.

For **Irregular X&Y** files:

Because the Irregular X&Y format supports multiple sensors per row, the Select Columns panel for this format is different. The X, Y and Z (val) column for each sensor is listed in a short table. This table can be extended or reduced with the Add & Delete buttons. Fixed positions are not supported, positions can only be defined in terms of columns delineated by either spaces, tabs or commas.



The File options panel is also not shown with this format as all it's settings are redundant.

3.7.3.6 FORMAT SETTINGS

For **Irregular X&Y** files:

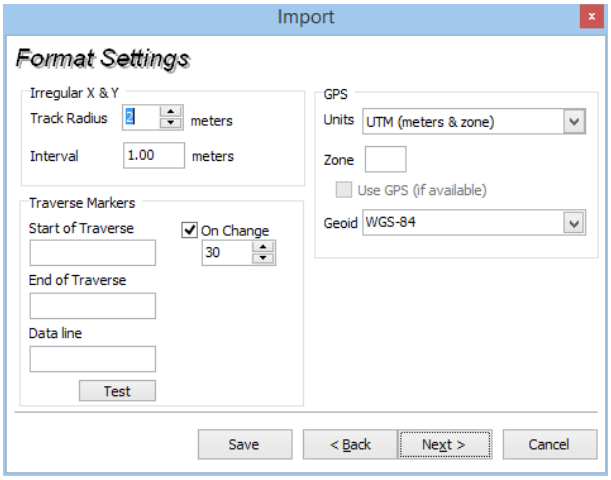
The **Track Radius** determines the number of interpolated datapoints that are kept around the interpolated point closest to each source point. The value is the width of a square area, so that 7 will keep all interpolated values in a rectangle 7 'x' intervals wide by 7 'y' intervals high around the center interpolated value.

The Interval determines the level of interpolation applied to the data. Care should be taken when setting this value to avoid excessively large composites.

Both the Track radius and Interval can be changed when viewing the results.

Regular Expressions are used to find Datalines and Traverse Start & End markers. These are set and can be tested in this panel. See http://www.regular-expressions.info/reference.html for further information on Regular Expressions.

As an alternative to the regular expressions, a column in the file can be monitored and a Traverse end/start triggered when the value in this column changes. Note that this method does not support gaps between the end and start of traverses.

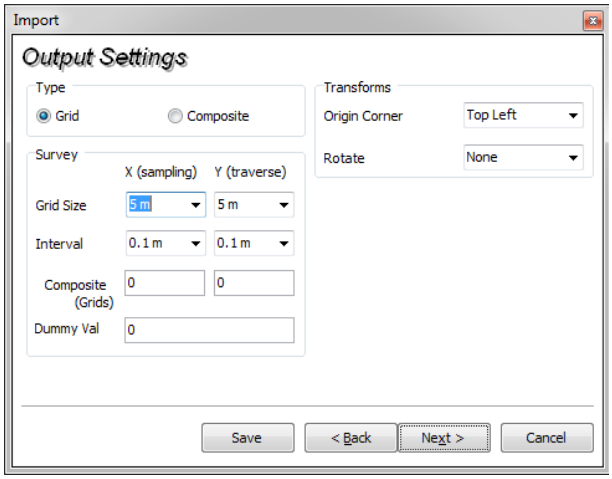


Set the **Geoid** to be used to convert the GPS Lat/Long position to Northings & Easthings.

Use GPS is only applicable to GSSI data.

3.7.3.7 Output Settings

In the **Type** panel, select whether the files are to imported as individual **Grids** or a single complete **Composite**.



In the Survey panel, set the **Grid Size**, and **Intervals**. If the correct grid size for the source data is not listed select the next bigger size. This will result in grids bigger than the original and thus give empty borders round the data. This can however be fixed later by selecting and moving the data into place. Non-standard sizes can also be entered in these fields. Remember that TerraSurveyor cannot combine different sized grids into a composite (at least, not very well). It is therefore highly recommended that you choose one grid size for all the files that will be assembled into a composite. Usually it is simpler to import different sized files into a standard big grid and move the data around later.

If the type is set to **Composite,** the width and height of the Composite (in Grids) must also be specified.

The **Dummy Value** will determine which datapoints from the imported files will be marked as non-values (e.g. Areas within a grid that could not be surveyed because of ground obstacles, etc.). All data points with this value will be displayed in the 'background' colour and will not be modified or used by the various processes. All processes are aware of this value and will not use then in computations or generate values that equal the Dummy Value. If necessary, the generated value will be offset by a small amount to avoid this value.

For **Irregular X&Y** and **Gridded GPS** files only the X Interval value can be set. The Composite size is set by the source file and the Y interval is always set to the same as the X.

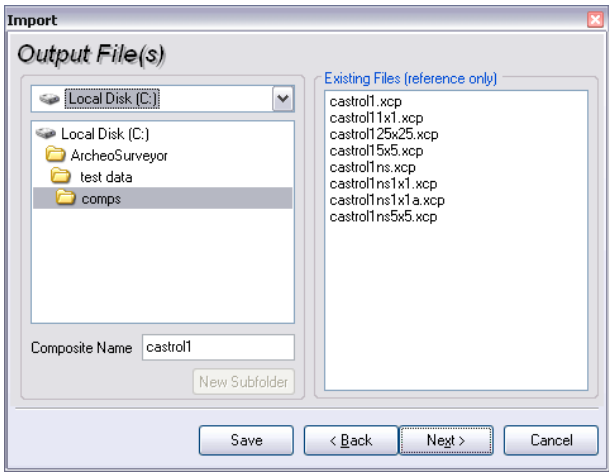
Change the **Origin** corner if necessary. TerraSurveyor assumes the imported data starts (or has a 0,0 position) at the top-left corner. If this is not so for the imported data, the resulting images will be flipped in the X and/or Y axis. The default is Top-Left but any corner can be selected. Changing the corner will flip the data of each grid or the complete composite top-to-bottom and/or left-to-right prior to it being saved.

Or change the **Rotation** if necessary (only the origin or the rotation can be changed, not both).
If the source data is not oriented the same way as is expected by TerraSurveyor, the grids can be modified automatically during import. Set the corner used by the source data as it's origin (0,0 position) to rotate the the grid in 90 degree increments.

3.7.3.8 Output Files

If the import Type is set to Grids, the output path can be selected in this folder list. It will default to the pre-defined **Grids** folder of the site, however additional subfolders may be created within this folder (click **New Folder**). This can be useful for separating Grids, for example by instrument or area within a site.

Note that Grids of different size (or X/Y Intervals) should not be mixed in a subfolder. The Grid Assembly window can show Grids with different sizes, however this is not recommended (the thumbnail height and width will be set to the largest dimension of all the grids in the folder).

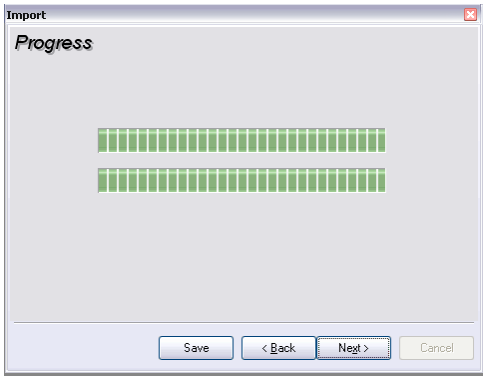


Specify a **prefix** for each imported grid file name if required.

Imported Composites will always be saved direct to the **\Comps** folder of the current site and so in this case the list is disabled. As only single composites can be imported, the Name of the new composite can be specified in the box below the Folder list. The default is the name of the source file. Clicking any existing composite name in the **Existing Files** list will place the name of that composite in the **Composite Name** box.

3.7.3.9 PROGRESS

Click **Next** to begin the actual import process. Some indication of import progress will be shown though the exact format and data shown will depend on the type and number of files to be imported.

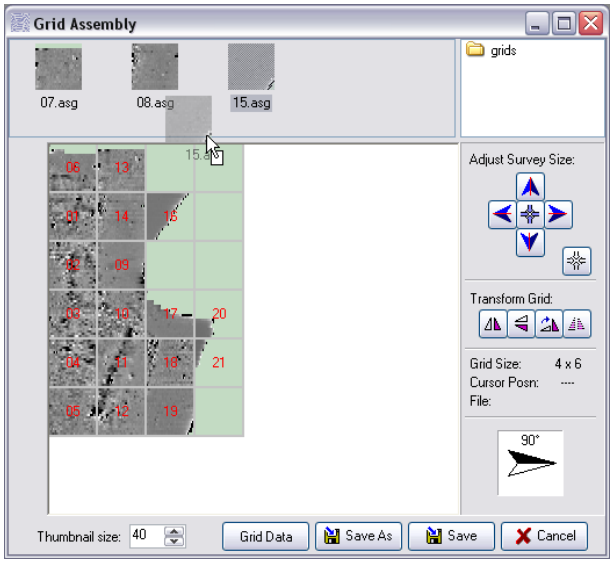


On successful completion, a message will be displayed showing the number of imported grid files.

Click **Finish** to close the Import Wizard.

3.8 Grid Assembly

Once the grids from a survey have been imported or downloaded directly from an Instrument, they are stored in the **Grids** folder of the site. The **Grid Assembly** dialog allows these grids to be assembled into a composite.



All the available grids in the current Site's **Grid** folder or sub-folder will be shown at the top of the dialog box. Each grid is shown as a small greyscale thumbnail of the data in that grid. The sub-folders of the Grids folder (if any) are shown in the list to the right. The window can be resized and the splitter bar between the top and bottom areas moved to allow more thumbnails to be displayed.

The direction of North (taken from data stored in the *first* grid in the folder) is shown for reference. The size of the thumbnails and the grid squares can be changed (from 10 to 100 pixels wide in 10 pixel increments).

3.8.1 Assemble Grids

Below the thumbnails is a grid of squares. This is where the grids are assembled into a composite. Initially this grid is 5 x 5 but the size can be changed by using the 4 arrow buttons on the Adjust Survey Size panel. Each button click will add a blank row or column in that direction. The grid can be also be shrunk from any side. Press the 4-way arrow in the center of the group to toggle the direction of the arrows (or by pressing the **shift** key and the relevant arrow button). The arrows will change to indicate in which direction the grid will shrink. Finally, the entire grid can shrunk to fit the placed grids in one go by clicking the Shrink button.

To assemble the composite, click on and drag each thumbnail to it's the correct position on the grid. Any thumbnail can be repositioned by dragging it to another position or back to the thumbnail list. Dropping a thumbnail on top of another will return the covered one to the list.

3.8.2 Transform Grid

Once a thumbnail is in it's correct position some adjustments can be made to the data (if necessary). A grid thumbnail can be selected by clicking on it and then by using the buttons on the option panel, it can be rotated (in either 90 deg steps for grids with equal X and Y increments or 180 deg) or flipped top-to-bottom or left-to-right.

For more complex transformations click on the **Fix Grids** button: . This will open a dialog allowing complex transformations to grids to be carried out. A short list of example transforms is included, more can be added by the user as required. The basis of the transform is that a repeating pattern or set of line swaps are defined. Each line can also be reversed. For example, a simple pattern of 1 > 2, 2 > 1 would swap each pair of lines, moving line 1 to line 2, line 2 to line 1, line 3 to line 4, line 4 to line 3, etc. The transform can be applied to any or all grids in the current folder.

3.8.3 Merge Grids

A simple merge can be performed by dragging a grid thumbnail and dropping it onto another grid thumbnail on the top panel. If the 2 grids are compatible (have the same size and intervals), a new grid will be created that contains all the datapoints from both the dragged and dropped-on grids. This new grid will be called "name1+name2" where name1 and name2 are the names for the 2 grids.

This technique is specifically designed for those situations where an obstacle such as a wall transects a grid. Rather than trying to climb over the wall on every traverse, it is simpler to survey the grid as two grids, one for one side of the obstacle on one for the other.

3.8.4 SAVE GRID

The combined grids can then be saved as a composite file, which stores not only the assembled data but also details of each grid (including any adjustments) used to create the composite.

On saving a composite with modified source grids, you will be asked if the modifications are to be saved to Grid files as well. You can save the modified grids as new files or overwrite the originals. If the modified grids are saved as new files, the composite will be saved with references to the new files. Whatever is done with the grids, the modified data is stored in the saved composite.

A composite can be opened in the Assemble Grid dialog at any time to add new grids or otherwise modify the layout. When the composite is re-opened all Processes will be re-applied to the new data and layout. Selections in Processes are corrected to allow for changes in position.

Note: Imported and Blank Composites cannot be opened in the Grid Assembly dialog.

3.9 Manual Data Entry

Besides the automatic data acquisition methods of Download and Import, TerraSurveyor can also be used to input data manually.

To do this a blank composite of the required size must first be created:

- Select the Site required and click on **Import**.
- Select the **Blank Composite** template from the list and set the various parameters (X & Y intervals, X & Y length, Composite size [in Grids], etc.).
- Click on the **Create Blank Composite** button and then **Finish**.

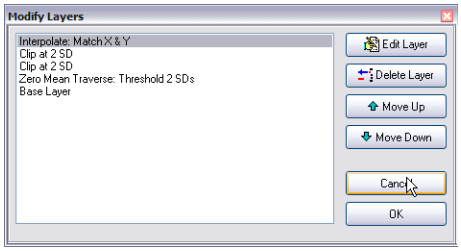
Once the blank composite has been created, open it as normal and select the **Spreadsheet** view. Initially all cells will contain just a '-' signifying that the underlying data is the Dummy value. Make sure that the **Edit Cells** button is down and then select a cell. Type the new value in it and use the cursor, tab or arrow keys to move to the next cell. To set a cell to the dummy value type any non-number (such as '-') in it.

Note: Composites created from a blank cannot be modified by the **Open Grid Assembly** window. They can however be exported as grids and then re-assembled as a new Composite.

Note: Cell values can only be edited when they form part of the Base Layer. This is because only the base layer and the Processes are saved in the composite file. All the other layers are re-created from the Base Layer and the Processes. The **Edit Cells** button will be disabled when any layer other than the Base Layer is selected.

3.10 Modify Layers

The Modify Layers dialog box shows a complete history of all layers created from the source data and provides the means to change them. Clicking the top button will display the dialog box appropriate for the currently selected process. By using the other buttons you can delete or change the sequence layers are applied in. Once the box is closed (with **OK**), all the layers are recalculated and the top layer with it's new dataset is displayed.



This dialog can also be opened by pressing **Ctrl-M**.

Note: The 4 buttons can usually be used in any combination any number of times (move a layer, change it's parameters, move it again, etc.) before closing the box to recalculate the layers. However, complex operations such as this *may* cause errors, especially when a combination of Interpolate layers and Selected areas are involved. We suggest that you only move *or* edit Interpolate layers and then close the box. Re-opening it will allow you to apply other changes without risk of errors occurring.

3.10.1 GPS Modify

The GPS Modify Layers dialog is identical to the main Modify dialog and provides the same functionality for the GPS proceses.

3.11 MOVING DATAPOINTS

A number of methods for moving datapoints are provided, each having different strengths and weaknesses.

The primary method for moving data *within* a composite should always be via the Grid Assembly window when the data to be moved forms complete grids. This retains the most information and is the most robust.

However, it is possible that only a portion of a grid needs to be moved, in which case the **Move** command can be used. This displaces the selected area by a specified number of intervals, both Left/Right and Up/Down. The **Delete** command replaces all datapoints within the selected area with the current dummy value. Both these methods are stored as processes and are thus saved with the composite and can be edited.

To transfer datapoints from one composite to another, the **Copy** and **Paste** commands should be used. These are only available from the **Process** menu. Remember that the operation and result of these commands is different to **Move** and **Delete**. **Copy** and **Paste** can be carried out in either the **Shade** or **Spreadsheet** views.

Copy transfers the currently selected area (or the complete survey if no selection has been made) to the clipboard as plain text. The text consists of a number of header rows and the selected data as tab separated columns, each row on one line. The header data is used by TerraSurveyor to recognise and format the data during the paste operation. Though the data is intended to be pasted into TerraSurveyor, the layout is straightforward enough that it could be used for transferring data to a spreadsheet for example (see the Export section for an example of the file). Copy can be activated by selecting the area to be copied and then choosing **Copy** from the **Edit** menu or pressing **Ctrl-C**.

The **copy** command can copy data from any layer, just select the required layer from the drop-down list prior to selecting and copying the data.

The **Paste** command however *always* places it's data into the base layer of the target composite. This is necessary as the saved composite file does not save the intermediate layers, only the base layer. All data must therefore be placed in the base layer to be retained. When the Paste command is active (either by selecting **Paste** from the **Edit** menu or pressing **Ctrl-V** – and valid data is on the clipboard) the cursor will change shape (a small dotted line box will appear below the cursor arrow). When active, the first mouse click will set the top-left corner of where the data will be positioned. Any data that would extend beyond the boundaries of the destination survey will be lost. In order to support the grid-oriented processes such as Stretch Traverse and De-stagger, dummy filenames are generated for any grid square which contains (only) pasted data. These filenames are in the form "P[X,Y].pasteddata" where X and Y are the Column and Row.

The basic **Ctrl-V** paste method will replace all the underlying data with the new data, so that (for example) dummy values in the pasted data will replace data values in the destination area. By selecting other Paste options from the Paste submenu other effects can be obtained:

- Replace (All with Data)
- Replace (Data with Data)
- Replace (All with All)
- Sum
- Difference
- Product

The first three differ in how dummy values (non-data) are handled. The last three combine the data values (only, dummies are ignored) in different ways. These may be useful to compare or combine the results from different survey types of the same area.

The basic Paste method is intended to be used to merge portions of composites, especially when the data is only available as composites for import and not as grids:

- Import and save the composites to be merged. Do not process the data in any way.

- Select which is to become the main composite.
- In Grid Assembly enlarge the Grid area of the selected composite sufficiently and in the correct direction to hold the other composite(s).
- Open a second copy of TerraSurveyor.
- Open the composite that is to be merged into the main one in the second copy of TerraSurveyor.
- Select the complete Survey area.
- Copy it to the clipboard.
- Switch to the enlarged composite.
- Paste the data into the main survey at the appropriate point.
- Save the data and continue as normal.

If this is the case, consideration should also be given to **exporting** the data as TerraSurveyor grids and then reassembling the grids into a new composite.

It is possible to paste copied data into the same survey, i.e. the source and target may be the same composite. However, this is not recommended. Move is the preferred method in this case.

Care should be taken when copying and pasting data to ensure that the range and scale of the source and target match. A warning will be given if the scale (i.e. the X & Y Intervals) do not match but it is up to you to ensure the range of the data is compatible. Use of the **Interpolate**, **Add**, **Mult** and **DeStripe** functions may help to correct any differences.

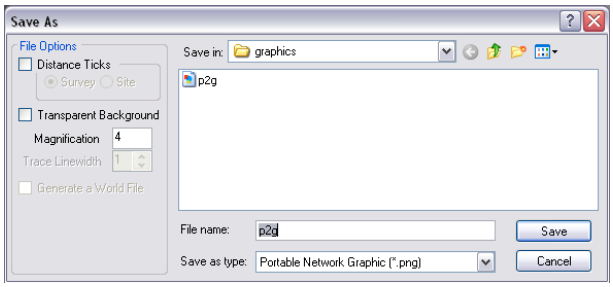
3.12 Output

The current view can be saved as an image or printed direct to paper.

3.12.1 Image

The Image Save As is opened via the **NavBar Output** button or the main **File|Save Image** menu. Depending on the currently selected view and file format, various options will be available next to the normal Save As dialog. These allow you to choose:

- Distance Ticks (drawn along the top and left edges of the survey)
- Transparent background (when the file format supports it)
- Magnification (determines the size of the image and the relative fineness of the lines)
- Trace line width (for Trace View)
- World File generation (all Shade view formats)



To maintain the best possible image, BMP, PNG and TIF image formats are recommended. The BMP is an exact copy of the displayed layer but at a high resolution more suitable for printing. This does however produce extremely large files. The PNG (Portable Network Graphics) format uses a lossless compression scheme to maintain the same level of data accuracy but with much smaller files. Compressed TIFFs are also supported, as these are often suitable for import into CAD programs. JPG is also provided but a high quality value (low compression) should be used. The default is 100% (no compression).

When saving a page from the **Publish** view, the WMF format will also be on the list, however only the Transparent background option is available (distance ticks, WLD files, etc. are not applicable to Publish).

When saving or printing **Shade** and **Trace** views, no matter what portion of the layer is shown on screen, the complete survey area is saved or printed. The **3D** view only saves or prints the same view as on screen but at a higher magnification. For technical reasons this magnification is fixed.

3.12.1.1 Transparent Background

When set, dummy values (the background colour) become transparent. This can be especially useful when overlaying the survey results on other maps. This option works for Shade, Trace and 3D images saved as PNG files ONLY (BMP, JPG and TIF formats do not support transparency).

3.12.1.2 Distance Ticks

Draws 'tick' marks with distance indication on the top and left sides. Ticks are placed at the smallest regular interval possible (in the sequence 1m, 2m, ¼ grid, ½ grid, 1 grid, 2 grids, 4 grids, etc.) that will allow all the text to show without overrunning it's neighbour. The Values can be either based on the Survey origin showing a the distance from the top left corner, or the Site in which case they are modified based on the Survey's Position relative to the Site Origin and the Direction of 1st Traverse. The intervals will be prefixed with N,S,E or W as appropriate.

3.12.1.3 Magnification

To obtain clear images and text, the image saved to a file or printed often needs to be much bigger than the image seen on the screen as the screen resolution is always lower than that of a printer. The magnification level for saved graphics can therefore be set independently of the screen magnification. However, large surveys at high magnifications can exceed the memory capacities of a PC. The actual magnification will therefore be reduced to the maximum possible for the available memory.

Increasing the magnification may also increase the number of Distance Ticks shown along the edge as the size of each Tick's text remains the same.

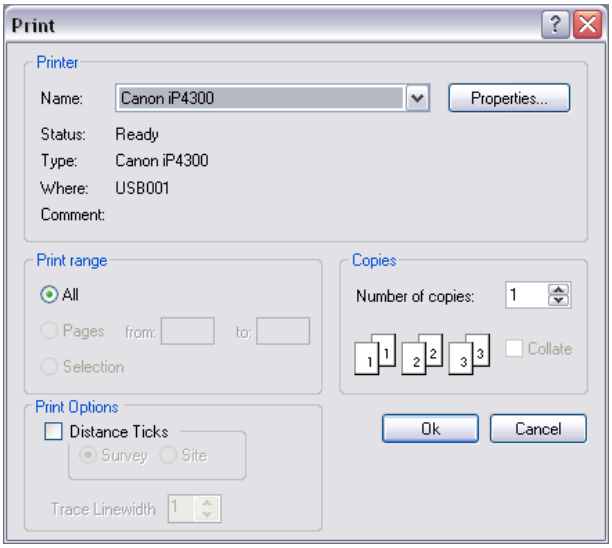
3.12.1.4 Generate a World File

Checking this box will create a small text file with the same name and path as the main graphic file but with a modified extension. This text file is a standard format used to convey GeoReferencing data about the image. This file is readable by many GIS programs and enable them to correctly position and scale the image.

Note: This option cannot be used with Distance Ticks as the extra data around the survey image will invalidate the position information.

3.12.2 Print

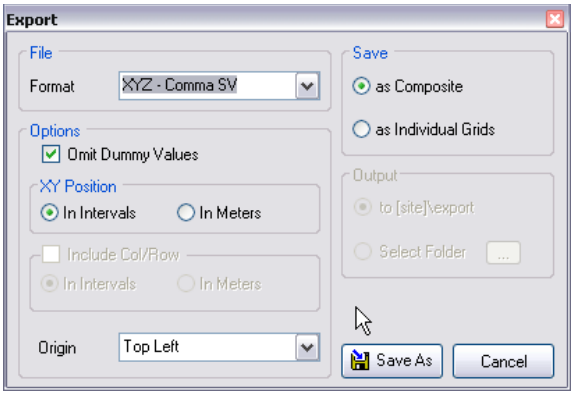
The Print dialog is opened via the **NavBar Output** button or the main **File|Print** menu. Depending on the currently selected view and file format, various options will be available next to the normal printer options such as printer and paper size.



3.13 EXPORT

Export the *Current* Layer in a variety of formats suitable for transferring data to other programs.

A number of options are provided by the dialog box. The primary one being the format. Seven major formats are supported:



- XYZ (comma, space or tab delimited)
- Z
- Spreadsheet (comma or tab delimited)
- Surfer ASCII
- TerraSurveyor Grids
- TerraSurveyor Composite
- ESRI ASCII Grid file (Actually exports a composite)

The extension to be used for the export file(s) can be selected from a list (if applicable).

Depending on the format selected, different options will be available. These include omitting dummy values and adding a border to spreadsheet data marking off columns and rows.

The Origin of the data can be set to any of the 4 corners (when this is not fixed by the export format). Row and column numbers will always increase from the origin corner to the opposite corner. The default origin or start corner for TerraSurveyor data is top left. The origin will either start at 0,0 or 1,1 depending on the settings of the source composite. Data is always exported by Row then Column (row 1: col 1, col 2, ... col N, row 2: col 1, col 2, ... col N, etc.).

The default is to export the data to a specially created sub-folder of the site called \Export within the current site. This would therefore appear next to the standard folders of \Grids, \Comps and \Graphics. Alternatively a specific path to export the data to can be set.

Finally a choice can be made as to whether the data is exported as a single large composite or as individual grid files matching the source data. The exported file will be given the same name as the source composite (in the case of a single file) or each exported file will be given the name of the source grid file (for individual grids).

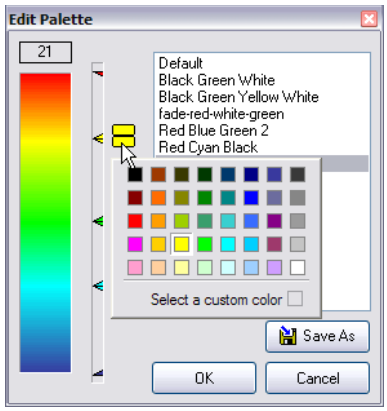
Exporting as a single file can be useful when surveys of different sized grids need to be combined: Assemble the 2 areas as separate composites, export the one that does not match the required grid size as a single composite and then re-import it using the correct grid size. Expand the Grid Assembly area of one of the resulting Composites enough to accommodate both and then copy one to the other.

Exporting as TerraSurveyor grids may sound odd but can be useful. Surveys created in a blank composite cannot be added to, however, by exporting the composite as grids, the grids can be re-assembled with other 'real' grids. Grids can also be modified and then exported, the new grid contains the result of any processes as the new base layer. This may be useful in certain circumstances but must be used with caution as the accountability trail is lost.

The export XML Composite is similar to the Export AS Grids as unlike the normal XML composites, this option saves the currently selected layer, not the base layer. This means that the current layer becomes the Base layer when re-opened. It also replaces the processes with a 'History' section that details the processes in plain text form. A single, BaseLayer process is included to allow TerraSurveyor to read the file.

3.14 PALETTES

The shade plot uses a range of colours to indicate relative signal strength for each datapoint. The colours used are defined in a Palette. A number of predefined palettes are supplied with TerraSurveyor but you can also define your own in **Options | Palettes**.



The list on the right of the window allows you to select any existing palettes to use as a basis.

On the left, an example of how the current palette will look is displayed.

To the right of the example palette is a vertical bar with a number of small triangles or 'bugs' in it. These represent the points in the palette at which colour transitions occur. The top and bottom bugs are single triangles, the remainder are double.

Add a new bug by clicking on an empty portion of the bar. Move an existing bug by dragging it. Right clicking the bug will delete it.

To change the colour of a bug, select it by clicking on it and then click on the larger coloured square that will appear next to it. This will pop up a window showing all the system colours available. Select a colour and the square and bug will change to that colour. The portion of the palette between that bug and it's neighbour will transition between their 2 colours. If both bugs (above and below an area) have the same colour, there will be a solid colour in that portion of the palette.

When finished, either **Save As** a new palette or **Save** to replace the currently selected palette.

3.14.1 PALETTE MANAGEMENT

The palette files are copied from the installation directory to the current user's **Application Data** directory the first time you runs TerraSurveyor. If making changes to these files by hand, make sure that you are looking at the correct set of files for the OS and User.

To assist in Palette file management, there is a tab in Preferences called Support Files. Here you will see a list of all available Palettes. Right-clicking on the file list will pop up a menu giving access to basic file management processes (Rename, Copy to, Copy from and Delete).

3.15 Preferences

A range of values, colours and other settings can be pre-set to your preference. This can be done in Preferences (under the **Options** menu). There are a number of panels devoted to different aspects of the program. Each panel can be selected by clicking on the list on the left.

General View: This panel deals mainly with default colours and options for the main views. You can set the colours for most features to anything you like, these values are the default – the value used at startup. Many of them can be changed from the view directly. A few deserve special mention.

Current Palette overrules Composite Palette. Each composite is saved with the name of the palette in use at the time of the save. If you would prefer to always use the current palette when you open any composite, turn this option on.

Site Root Directory. Displays the path to the directory used by the Navbar. This can be changed here or from the NavBar. Make sure when selecting a directory that you select the parent of the Site folders you want to see. Selecting the site folder itself will not work – the NavBar will try to look inside the folder for other sites and find none.

Disable 3D Plot The 3D plot view is extremely processor intensive, generating a view of even a medium sized survey can take minutes. For this reason you will always be asked if you want to generate the view when the 3D view tab is selected. In addition, for very slow machines, you have the option to remove all temptation by removing the tab entirely using this checkbox.

Process Defaults: Sets the default values for a number of processes.

Files & Graphics: Set the default file formats, colours and options for saving and printing images.

General: Set units of measurement and mapping coordinate systems.

Default Linear Units: TerraSurveyor primarily works in meters, however some users in the USA require surveys to be in feet. Selecting this option 'cheats' in that it really only changes the on-screen labels used for a survey, it does not actually change the scale of anything. It does however rescale some export formats that require meters.

Map Coord system: No matter what the source of the data, ultimately it will be converted to a meter (or feet) based system for display. The default is the UTM system however 2 other gridding systems are also supported: OSGB36 for Great Britain and RD for The Netherlands. If either of these systems is selected here, the user will have the option of selecting them for the display of a survey in the main screen Status bar. The OSGB36 conversion is built-in however this is a low accuracy (+/- 10m), mathematical conversion only. For the highest (sub-meter) accuracy, an extra file is required which performs a conversion to the OSTN02 standard. This file is essentially a database of correction factors that vary over the whole of the UK. The file is available on request from DW Consulting.

Default UTM Zone: Only really required for certain imported file types that are UTM based but do not contain UTM zone information.

Interpolation: TerraSurveyor uses an interpolation system called ABOS implemented via an external program called SurgeF (see www.surgeweb.sweb.cz/surgemain.htm). The various parameters used by this program are set here. We strongly suggest they be left at their default values unless you have experience with SurgeF and good reasons for changing them.

Download/Import: Set various options for Downloading and Importing data. In particular:

Scan All Ports: All Download operations take place via the serial (RS232) port. On most laptop computers there are no serial ports anymore so the only way to connect the instrument is via a USB to Serial adapter. The problem with this is that the PC will often assign a different Serial or COM port number each time the adapter is connected. The program therefore cannot be certain on which COM port to look for the data. To solve this, if this option is turned on (the default) TerraSurveyor will scan each available COM port in turn 'looking' for data to download. Once it finds a port with data the download process will begin. Instruments

that cannot support this method (primarily the GeoScan instruments) will ask you to choose a COM port from a list prior to starting the download.

Grids:

Padded Filename length: determines the number of leading zeros for downloaded grid filenames. The leading zeros ensure that the grids are listed in numerical order. For example if you download 20 grids into a folder and use a padded length of 3, the files will be named 001, 002, … 009, 010, etc.

Intervals, Sizes & Units: Lists the values seen in the X & Y Grid & Interval dropdown lists in the Import & Download dialog. The list can be edited to add or remove values so that custom sizes and intervals can be supported. Also allows the list of measurement units (nT, Ohm, etc.) to be changed (note that only normal characters can be used, no Greek symbols such as Ω or other special characters may be used).

Palettes & Title Blocks: Because the Shade Palette files and Title Block templates are saved in the Users Application Data folder, they can be difficult to find. This panel provides basic file management options for these files.

Annotation Symbols: The Annotation layers allow you to select symbols from a list of symbol sets. This panel allows you to manage those sets. Sets can be added, deleted, renamed and modified. All the symbols in a set must come from the same font (any font can be used though symbol fonts such as WingDings are the best candidates). Each set can contain a maximum of 20 symbols.

4 Views

4.1 Overview

Any number of composites may open simultaneously in the central area of TerraSurveyor. Each data contained in a composite can be viewed in a number of different ways. These views can be selected using the tabs at the top of the composite window.

Note: It is important to remember that views are just that - views - of the data. A view at any magnification is generated directly from the base data plus all the applicable processes. No view modes, processes or magnifications are created by manipulating the image displayed on screen.

4.1.1 North

Normally the data is oriented so that the first traverse is at the top of the screen and the direction of the first traverse when the data was collected runs from left to right. The direction of North relative to the composite is shown by the compass in the top right corner of the **Settings** panel. The Shade and Trace views can be rotated to any angle by clicking and dragging the point of the compass arrow to a new 'first traverse' position. When released the survey will be re-drawn at the selected angle. The rotated view uses interpolation techniques to generate pseudo-traverses at right angles to the selected angle. These pseudo-traverses are only used to generate the view - they have no effect on the actual data stored in the composite.

The value for North is initially set during download or import of data. The value stored with a composite can be changed in the **MetaData** view**.** This does not affect the values stored with each source grid.

4.1.2 Current Layer

The currently displayed layer can be changed to any layer in the composite using the dropdown list in the **Settings** control panel. The default is to display the last generated layer. The current displayed layer also determines the layer saved to graphics or printed.

4.1.3 Status Bar

The status bar at the bottom of the window displays information about the site, composite and mouse position. The fields show from left to right:

- The name of the site
- The name of the current composite
- One of the following position displays (click the button next to it to cycle through the displays). Each position is followed by the value of the datapoint at that position:
  - The position of the cursor in Intervals.
  - The X/Y position of the cursor. This position is in meters/ft and is only relative to the top/left corner of the survey and is not adjusted for the orientation of the survey.
  - The East/West and North/South position of the cursor. Also in meters/ft, it is calculated relative to the Composite Origin, taking the Direction of 1st traverse into account. This position can therefore be directly related to the map reference of the cursor.
- The current magnification factor. A magnification of 1 means 1 pixel is equal to 1m.
- Res (Resources). This field will only normally only show on older operating systems. Indicates the system memory available for operations. It has no purpose in WinXP or Vista because of the different way in which memory is managed.

4.1.4 Zoom

The Shade and Trace views can be zoomed by selecting the **Zoom** button on the Side toolbar (top left) or **Ctrl-Z** to toggle zooming on or off. This will change the cursor to a small magnifying glass. Then either **Left-Click** (to zoom in) or **Right-click** (to zoom out) on any point in the survey. The survey will be zoomed in to

(or out from) the point of the click. **Ctrl-Left-click** doubles (or **Ctrl-Right-click** halves) the magnification level. A specific area can be selected by **Click-dragging** over it when in Zoom mode (not available when the view is rotated). When the mouse is released, the survey will be magnified to show the selected area. Finally, the survey can be zoomed out so that the whole survey fits in the current window. Use the **Edit|Fit to Window** menu item or press **Ctrl-W**. The magnification level is shown on the status bar at the bottom of the screen. The initial magnification level is set to the maximum possible to display the whole survey area in the area available.

4.1.5 Window management

Use the Window menu to manage any open composites. Two particularly useful shortcuts are **Shift+Del** to close the currently selected composite and **Ctrl+Tab** to cycle through all the open composites.

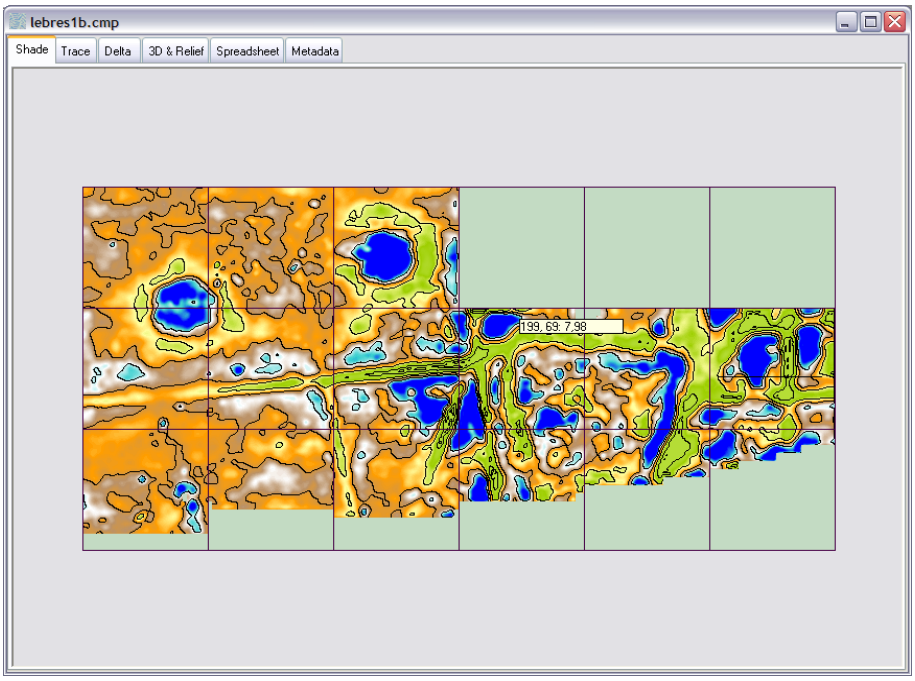
4.1.6 Options

Other options or information applicable to the currently selected view will be displayed on the **Settings** Control Panel.

Any areas where no measurements were made, and all backgrounds are indicated by a separate 'dummy' colour. This colour can be set in **Options | Preferences (General)**.

4.2 Shade

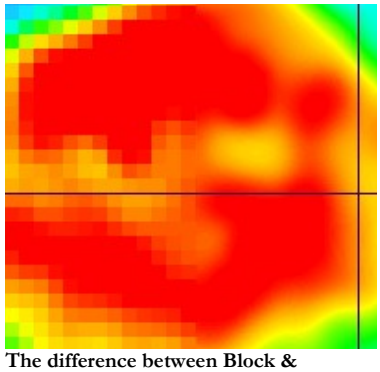
The primary display method for the data. It presents the data as a 'shaded map' of the survey area using colours or greyscales to indicate the relative strength of the signal at each measurement point.



4.2.1 Modes

Two shading modes are possible:

- **Block** (default) each measurement point colours a rectangular block whose size is determined by the measurement intervals.
- **Graduated shade** calculates a continuously interpolated value for every pixel. Each pixel value is calculated by generating cubic spline curves from all the data points in both the X and Y axes. This mode also allows the generation of accurate contour lines.



The difference between Block & Graduated shading

Note: Graduated Shading is very processor intensive. Generating this view, especially at high magnifications, can be slow. Enabling the Contour option will also add considerably to the time.

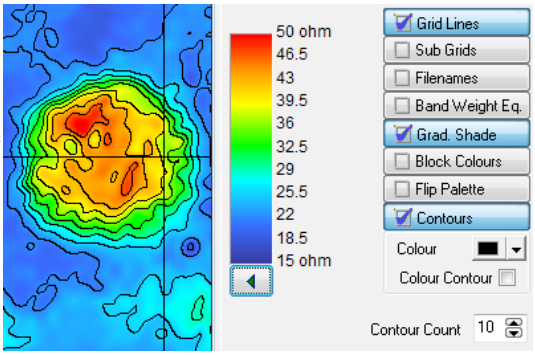
Remember that Graduated Shading is just a view of the data, it does not change or 'improve' the accuracy of the underlying data in any way.

4.2.2 Band Weight Equalisation

In addition to the 2 main modes, an option called **Band Weight Equalisation** can be applied to the data in either mode. This option re-distributes the assignment of palette shades or colours amongst the dataset. This re-distribution equalises the datapoints per palette shade or band, enhancing the visible detail within the most predominant values.

4.2.3 PALETTE

The palette of colours used in both block and graduated modes can be changed by clicking on the arrow below the palette colour bar (Settings panel). This will display all the currently defined palettes. Click on one to change the palette used with the composite. A scale indicating the value each colour equates to is shown to the right of the bar.



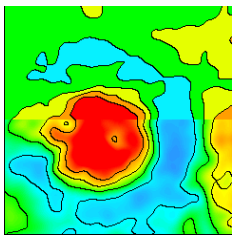
The number of values listed in the scale can be changed by changing the Scale Intervals (which will be labeled Contour Count if Contours are on).

The Palette can be inverted using the Flip Palette button. Note that this option is only in effect for the current palette and is not saved with the composite.

4.2.4 CONTOURS

Contours can only be displayed when Graduated Shade is active. Contours are drawn at regular, equally spaced levels within the range of the current layer. You can set the number of contour levels and the colour the contour lines will be drawn in. You can also colour the contour; this will draw the contour in the palette color that would have been covered by the contour and the remainder will be drawn in the colour normally defined for the contour. So by setting the contour colour to white and choosing a palette with no white in it, you can produce coloured contours.

By checking Block colours, the palette will be resampled to just use the center value of the colours between each contour line. This will create solid bands or blocks of colours, even though Graduated Shading is on. Changing the number of contours will also change the colour used for each band.



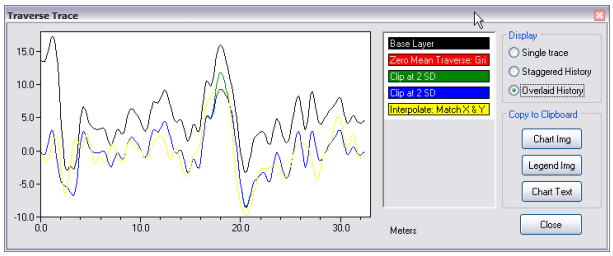
With and without Block Colours

4.2.5 X, Y AND Z

A continuous, on-screen display of the mouse's current X-Y position (in Intervals) and the data value at that position is provided. This can be turned on or off in Preferences. The mouse position is also shown in either Intervals or Meters (from the survey or site origin) in the status bar at the bottom of the screen.

4.2.6 LOCAL TRACE

A pop-up window can be displayed and set to show a variety of 'trace' views related to a line drawn on the survey. Hold down the **Alt** key and click on any point of the survey. Drag the mouse to the other end of the the line to be examined. The line can go in any direction. When the mouse is released a window will open displaying the data under the drawn line as a trace.



Use the buttons to the right of the graph to set the display to show:

- just the selected traverse
- a 'history' of the selected traverse (every layer in the composite)*.
- a 'history' (as above) with each layer offset by a small amount so that all layers can be seen.

For both history modes, a legend is also displayed showing the title of the layer drawn in the colour used for that layer.

Layers are shown in a sequence of colors (black for the base layer then red, green, blue, yellow, teal, lime, aqua, fuchsia, maroon, navy, purple, silver, light grey, grey, dark grey).

The graph, legend and actual data can all be copied to the clipboard for pasting into other applications by using the buttons at the bottom of the window.

4.2.7 Measure

The distance and angle between two points on a survey can be measured. Hold down both the **Shift** and **Alt** keys and click on any point of the survey. Drag the mouse to the other end of the the line to be measured. When the mouse is released a dialog will show the length of the line is meters (or feet) and the angle from true north.

4.2.8 Grid, Sub-Grid and File

Buttons toggle the display of Grid lines, Sub-Grid intersections and (Source grid) filenames. Various colours and options for the Grid lines, Sub-Grid crosses and File names can be set in Preferences | Shade & Trace.

4.2.9 Selection

Most processes can be applied to either the full survey area or just a selected area. The Shade and Spreadsheet views are the only views that allow selection of an area.

To select an area, **Left-click** and drag from one corner to the opposite corner.

To select a complete grid, **Right-click** anywhere inside the grid square.

To select a block of grids, **Right-click** on the grid in one corner of the block and then **Shift-Right-click** on the grid in the opposite corner.

To deselect an area, **Left-click** and release anywhere in the survey area.

A selected area can be 'fine tuned' by modifying the numbers in the **Selection** box. This is located to the right of the view area. Select the tab Selection and change the values for the Top, Left, Bottom or Right of the selection area. These values are shown in Intervals, not meters.

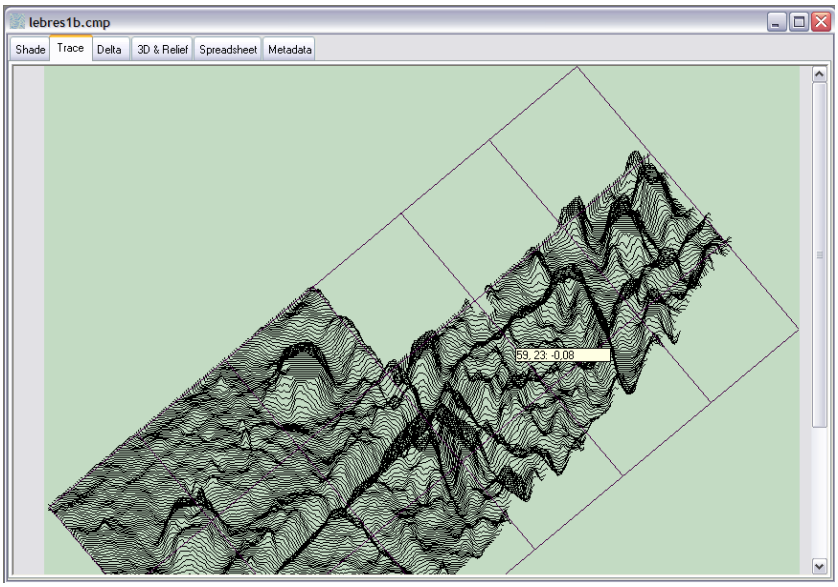
Note that any selection will be lost when the Layer changes (a layer is added or deleted).

Certain process (**DeStripe, DeStagger, DeDrift & Stretch**) can only be applied to complete grids. The selection method for these processes is therefore slightly different. No selection should be made before opening the dialog for these processes. Instead, once the dialog is open, **Left-click** in the grid that you wish to apply the process to. As a grid is selected, a ✓ will appear in the grid. **Left-click** on it again to deselect it. A block of grids can be selected in one go by **Right-click** in one grid and then **Shift-Right-click** in the opposite corner grid. As **DeDrift** can only be applied to a single grid, the **Right-Click** does not work for this process and **Left-click**ing a grid will deselect any other selected grid.

4.3 Trace

The alternate main display method for the data. It presents the data as a trace or graph line for each traverse. Each traverse is displaced down the screen to provide a 3D- like visualisation of the survey area.

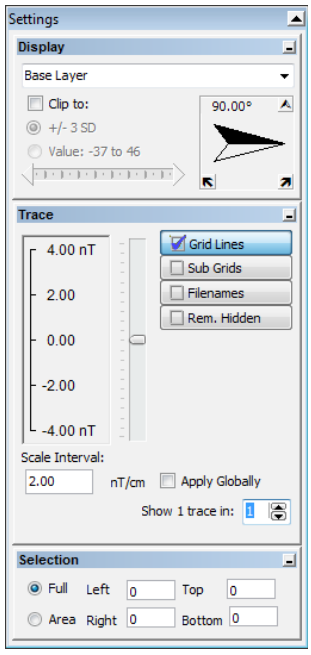
Most processes can be applied from this view, however, no selections can be made so processes can only be applied to the whole survey.



4.3.1 Vertical Scale

The Vertical scaling Factor of the display can be altered using the slider control in the Settings panel. This allows you to set the best scale to reveal details in the data. The Scale above the slider gives an indication of the range of the data. The scale is in Units (nT, Ohms, etc.). On screen each 'tick' is approximately 1 cm however this may not be the case once the survey has been saved as a graphic.

4.3.2 Grid, Sub-Grid and File



Buttons toggle the display of Grid lines, Sub-Grid intersections and (Source grid) filenames. Various colours and options for the Grid lines Sub-Grid crosses and File names can be set in Preferences | Shade & Trace.

4.3.3 Hidden Lines

A toggle button on the panel turns hidden line removal on and off.

4.3.4 Scale Interval

The scale interval is set to a default value based on 5 steps to cover the Minimum to Maximum values. This can however be changed to use more convenient values. The scale and survey will be redrawn accordingly.

4.3.5 Apply Globally

Applies the current Scale interval to all open composites. This allows different composites to be compared using equal settings.

4.3.6 Show 1 trace in X

Omits every trace except multiples of X. Allows large, dense surveys to display visible traces, albeit at reduced data density.

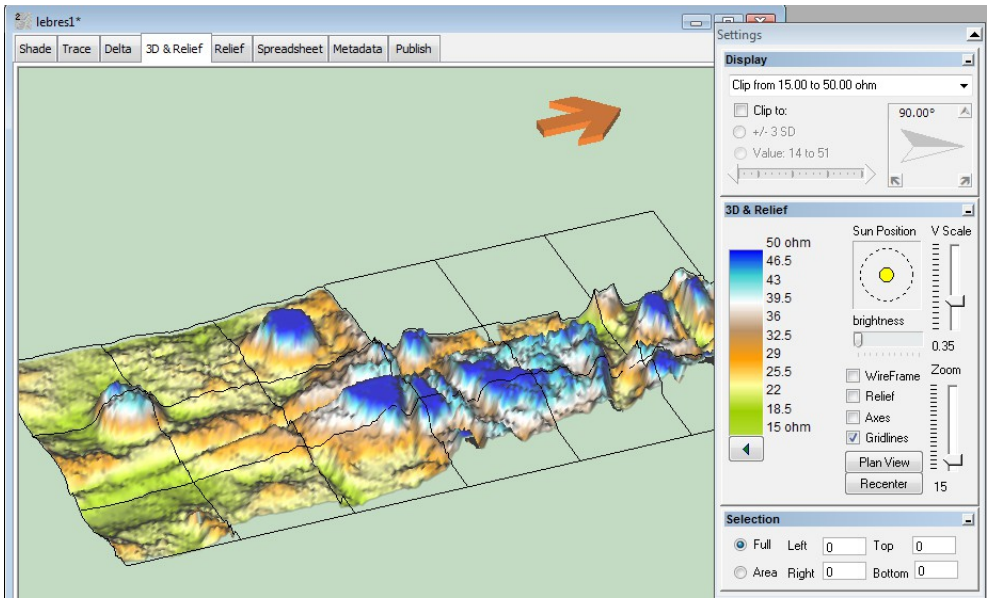
4.4 3D & Relief

This view displays the survey area as a rotateable 3D 'skin'. Because of the 3D representation of the data, neither the equivalent position of the mouse or the data value at that point is displayed.

Note: This function makes use of a system called OpenGL to draw the graphics. This system may not be available on some older PCs. The program will check the PC at startup and warn you if a suitable version of OpenGL is not supported.

Generation of the underlying data model used to display this view is processor intensive and will take a few seconds. However, once rendering is completed all functions described below are extremely fast.

The 3D model is based on a framework which joins each datapoint's center location. This means that there will be an empty band around the edge of the survey ½ interval wide.



The 3D model converts the values in the current layer into relative heights. The median value for the layer is used as the zero line. A graduated shade image of the survey (the same as would be seen in the shade view) is then draped over the height model. Dummy values are not shown. North is indicated by an arrow fixed above the top edge of the survey model.

4.4.1 Rotation

The model can be spun and rotated in any direction by clicking and dragging on the model with the mouse. You can move the model vertically and horizontally with **Right-Click**.

Note: Vertical and horizontal position changes are in relation to the front view of the model. So if the model has been spun 180° the apparent movement will be opposite to the movement of the mouse.

4.4.2 Vertical Scale

The vertical height can be set by the **V Scale** slider on the settings panel.

4.4.3 Zoom

The zoom level can be changed with the **Zoom** slider on the Settings panel. The model can also be zoomed with the mouse wheel (if present).

4.4.4 Brightness

The brightness of the lighting used to illuminate the 3D model can be reduced. This can enhance the colour shading.

4.4.5 Palettes

Any of the palettes can be selected in the Settings panel, just as in the Shade view.

4.4.6 Relief

The 'sun' illuminating the 3D model can be moved to cast shadows. Drag the yellow sun disc in the Settings panel to change the illumination. The sun is always moved with the model so that rotating the model will keep the same illumination.

To change the 3D model to a pure relief model, check the Relief box. This will replace the current palette with a single gray colour.

> Note: Because of the way the 3D view generates height maps (which are used to create the relief effect), some smoothing of features does occur. If this is unacceptable you should use the Relief view which uses a different computational model to generate it's image. See the following section for details.

4.4.7 Wireframe

The 3D model can be changed to display just the lines connecting the points by checking the **Wireframe** checkbox in the settings panel.

4.4.8 Axes

X, Y and Z axes showing distance (for X & Y) and value (Z) can be turned on with the **Axes** checkbox.

4.4.9 Plan

Clicking the **Plan View** button on the control panel sets the rotation about the X and Y axes so that an exact plan view (i.e. the same view as seen in the Shade view) is displayed. This can be useful for viewing a pure relief view and comparison purposes.

4.4.10 Recenter

The **Recenter** button resets all viewing factors to their default values. This is primarily for use in case the 3D model has been 'lost' due to rotation and/or sideways movement.

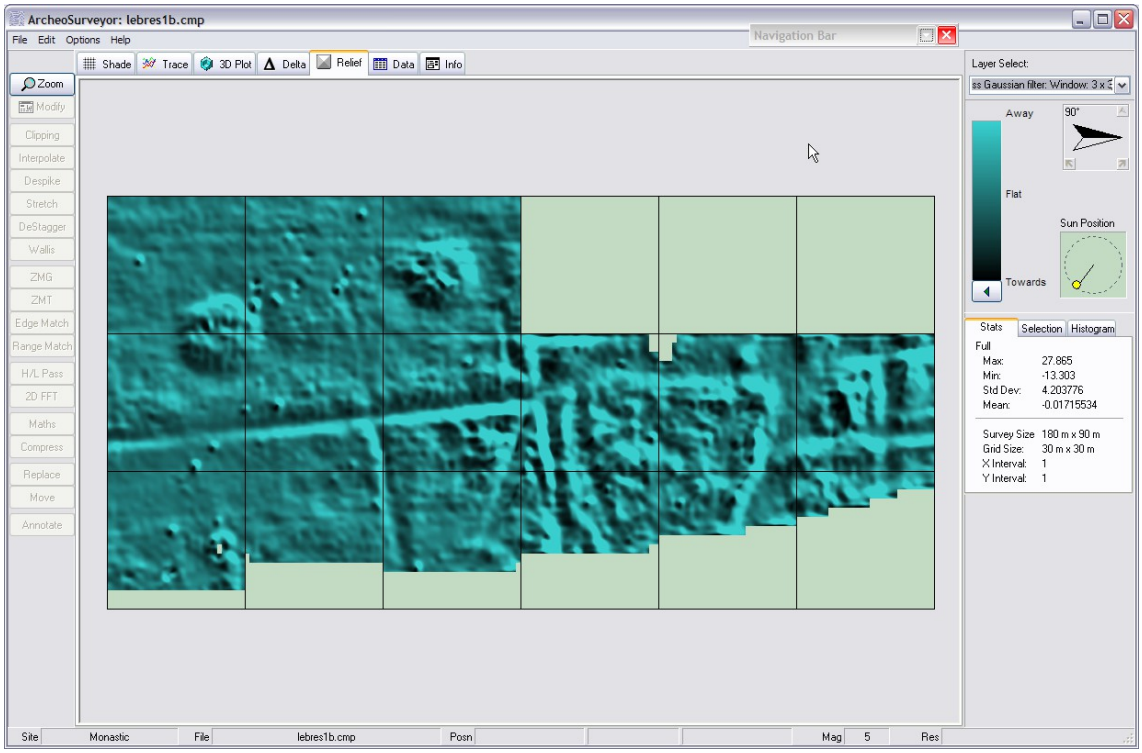
4.5 Relief

Note: This view is not displayed in the default installation. It can be turned on in Preferences (in which case the 3D & Relief tab will be renamed 3D).

It's result is identical in function to that provided in the 3D view. However, because of the way in which the 3D view generates it's hight map, some smoothing occurs which can diminish it's effectiveness. This view has therefore been made available to supplement the 3D relief view.

This view is quite processor intensive and can be slow to display.

Displays the survey as if it was a 3D surface lit from an angle. This presentation can be effective for highlighting features in a survey which has a changing background signal level or 'slope'. This view calculates a continuously interpolated value for every pixel. Each pixel value is calculated by generating cubic spline curves from all the data points in both the X and Y axes. This is similar to the technique used for the Graduated Shade view, but in this case the method is always used.



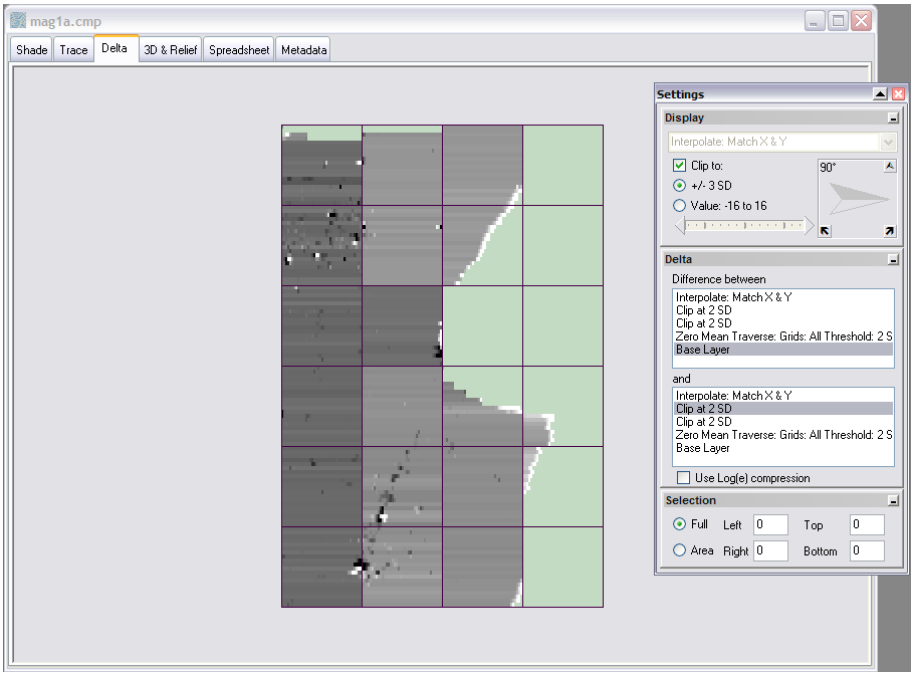
4.5.1 Sun

Set the position of the 'sun' by clicking and dragging the sun symbol (the yellow circle) around in the box. The view will be updated when the sun is released.

4.6 Delta

This view displays the difference between any 2 layers as a basic shade plot using the colour palette currently selected in the Shade view.

When initially selected, this view will show the Delta (difference) between the top 2 layers. Selecting any layer from the 2 lists will redisplay the Delta. A shade plot of the difference between every point in the 2 layers will be displayed in the center area. When the differences between 2 layers contain extremes, such as is often the case with an initial clip process, the differences can be enhanced by checking the **Use Log(e) compression** box.



4.6.1 Usage:

This view is specifically designed to highlight possible over-processing of the data. By comparing 2 layers, the result of a process or set of processes can be seen. It is often easier in this way to see when archaeology is being removed by a process or setting.

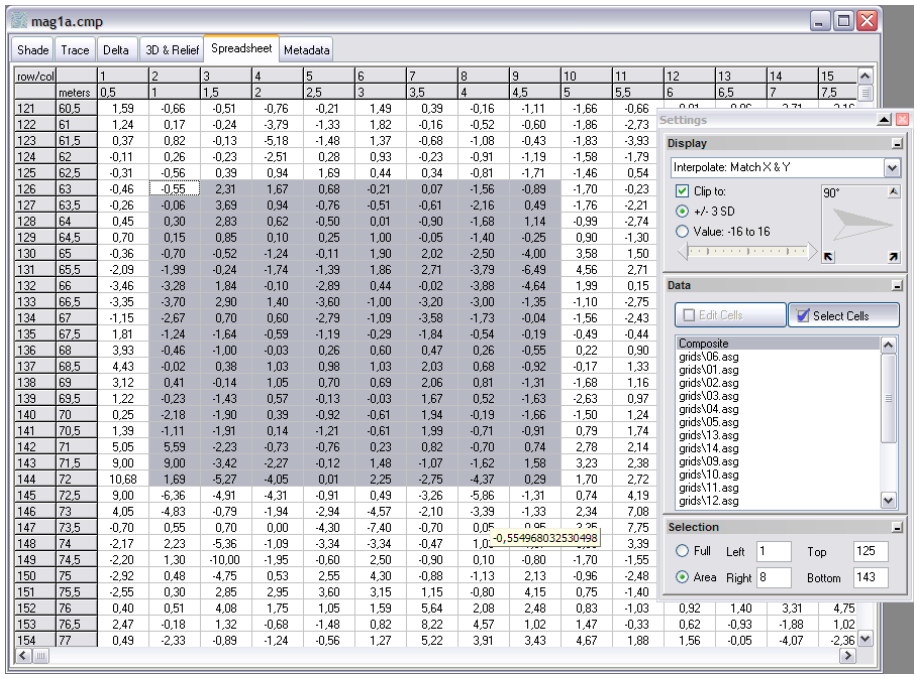
The example screenshot shows the effect of applying DeStripe. This striping result is quite normal for this process. In this case it clearly shows 2 areas surveyed with a differently setup instrument. It also shows that possible archaeology has been removed (the linear feature at the bottom) and the effect of a metal fence (the white fringe on the right).

Note: Only layers with the same intervals can be compared. Thus an Interpolation layer will prevent comparison of layers above and below it.

4.7 SPREADSHEET

Displays a spreadsheet- type grid of the data allowing individual values in all layers to be inspected (and to an extent edited). The top 2 rows and left 2 columns display the Row/Column in Intervals and Meters. For the sake of readability all values are shown rounded to 2 decimal places but the true data value can be seen by selecting a cell and waiting a moment for the hint to appear. Dummy values are displayed as '-'.

Either the whole Layer or just one Grid can be displayed by selecting either 'Composite' or a grid filename from the list in the information panel.



Most process can be applied to the data while in this view. The buttons of those that cannot be used will be disabled.

Use the two buttons in the Settings panel **Select Cells** and **Edit Cells** to switch between the following modes:

4.7.1 EDIT CELLS

This option will only be active if the Current Layer is the Base Layer.

Data can be edited directly by typing in the applicable cell. On leaving the view you will be asked to confirm that the changed data should be transferred to the Composite.

> Note: Changes made by Editing Cells are not immediately saved to the Composite file, but just transferred from the spreadsheet view to the Base layer of the composite.

To save the changes to the file, the Composite as a whole must be explicitly saved. Any value that is not a valid number (such as '-') will be replaced by the Dummy value.

4.7.2 SELECT CELLS

Data can also be selected and copied for pasting into other applications. Select by click and dragging over the area required. The area can also be set by using the Selection fields in the settings panel. Copy the selection with **Ctrl-C.** The Area can then be pasted into any application that supports plain text such as Excel or

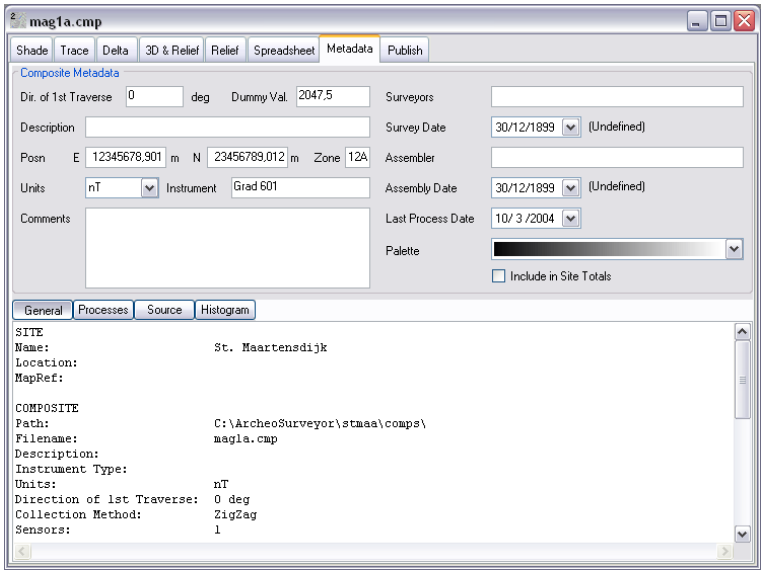
Word. The data can also be pasted into other composites where it will be correctly integrated into the existing data. See Moving Datapoints for more information on the various options for pasting data.

Note: You will be warned and ask to continue or cancel if the destination composite and copied data do not have the same interval parameters.

4.8 METADATA

In addition to the actual survey data and processes, a range of metadata is saved with the composite. This metadata contains information about the survey that either cannot be collected automatically by the download or import process or data that contributes to the image but is not part of it.

The top portion of the view contains a number of fields that can be changed or filled by the user. Below this is an area which contains all the information relevant to a composite formatted as a text file.



4.8.1 METADATA FIELDS

The editable fields are:

Dir. of 1st traverse: This value determines the direction in which the North arrow points. Remember that surveys are normally shown with the first traverse at the top, running from left to right. A value of 90 will therefore result in a North arrow pointing up the screen. This value will be set initially by the Dir of 1st traverse value set in the download or import dialog for the first grid in the composite. This will have in turn been set by the instrument (in the case of downloads where the instrument logs this value). The value can be set in 1° increments.

Dummy Val: Sets the dummy value for the composite. Changing this value will change ALL dummy values in the composite to the new value. This can be useful when combining composites from different sources.

Description: A simple text field for a short name or description for the composite. This will be shown after the filename in the status bar.

Posn: Defines the position of the Top Left corner of the composite relative to any fixed location. Using these values, the position of the composite can be specified relative to a known point on the site or georeferenced as a UTM location. The values are specified in Easting and Northing meters (or feet). These values will be added to the E/W & N/S distances shown on the status bar (3rd posn panel). The values will also be used to position Annotations and set applicable parameters if the survey is exported as a file that supports georeferencing. If the Default Linear Units are Meters then a UTM zone may be specified.

> Note: The Composite origin is always considered to be the top left corner.

Units & Instruments: Specify the base unit for the measurements (nT, Ohm, etc.) and the designation of the instrument. The units will be used for vertical scale legends.

Comments: Any text may be saved with the composite.

Surveyors & Assembler: These fields (and the associated date fields) are intended to provide you with the ability to track the creation and processing of the composite. A name (or names) can be entered and dates set.

Palette: A shade palette can be specified for use with a composite. Note that this can be overridden by a setting in Preferences, in which case the composite will use the palette currently selected at the time the composite is opened.

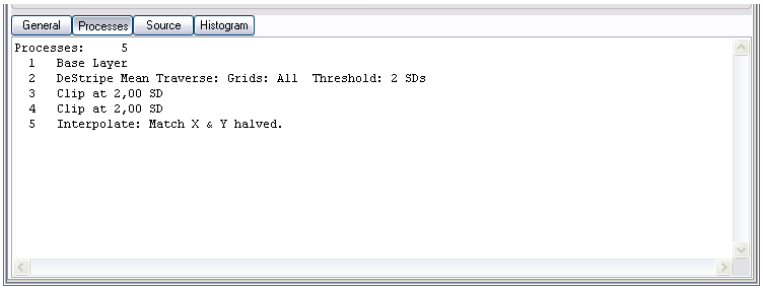
Include in Site Totals: If checked, the survey's total area (width * height of the complete survey) and surveyed area (number of non-dummy datapoints * X interval * Y interval) will be added to the **Site totals:** values shown at the top of the General Section of the metadata and will also be available as entities in the

Publish view. The Site totals will only be displayed for those composites that have had this item checked. The size data (along with some other useful information such as min, max, median, etc.) for all surveys that have this option checked are stored in an XLS spreadsheet in the Site folder. This file is always named "sitesummary.xls".

4.8.2 Composite Information

The bottom area of this view displays a plain text listing of all the attributes of the current Composite and Layer, including details of all Processes applied and Source grid files used. The data is divided into 4 sections for convenience: General, Source, Processes & Histogram (use the buttons to select the appropriate section). The Histogram section lists the bands and number of points per band used to draw the histogram (this can be used to create your own histograms externally).

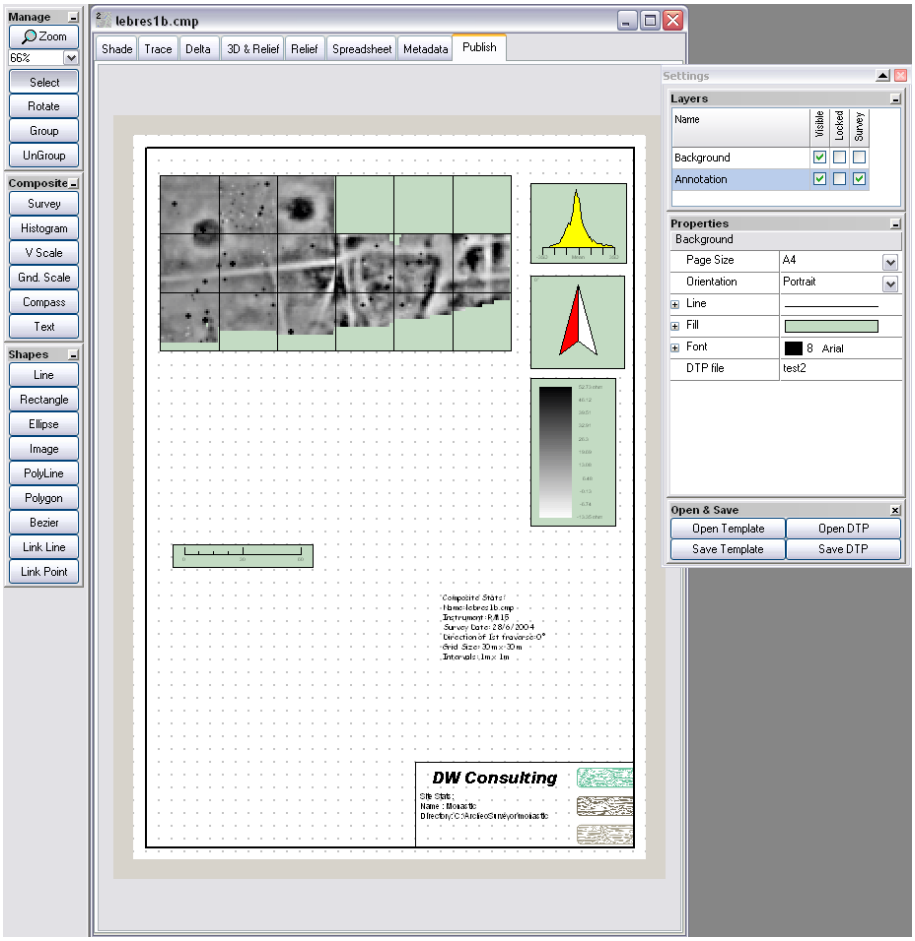
Any portion of the text can be selected and then copied to the clipboard (use **Ctrl-C**) for pasting into another application such as a word processor.



4.9 PUBLISH

The **Publish** view provides a "Desktop Publishing" (DTP) environment within TerraSurveyor. This allows the elements in the publish view such as the actual survey, associated text and support elements like the histogram, to be linked to the current data. As the data changes (because processes change or grids are added to the composite), the survey image, text and support elements will also change.

Note: The **Publish** view completely replaces and greatly expands upon the functionality formerly provided by the Title Block unit. However, the Publish view uses a completely different approach and file format. Existing Title Blocks therefore cannot be used with, or transferred to, this version of TerraSurveyor.



Important: When a Publish page is created and the Survey is copied from the Shade, Trace or other views to it, the settings used for most of the display options in the source view are also transferred to the Publish view, for example the Gridlines, Colour Palette, Contours, etc. are all used as the initial state for the Survey and other linked components. However, once the survey or other component has been place on the page, it becomes independent of the source. Only changes to the data (either because of changed processes, layer selection or grids) will affect the Publish view. Changes to the settings in the Publish view are also not returned to the Shade and other views. This allows the Publish page to be 'designed' while the main views are used for experimentation and research.

4.9.1 Use

The **Publish** view is used in a similar way to many DTP programs. It allows you to draw shapes and text on a page by selecting a type of shape and then clicking on the page where you want the shape to appear, the first click defines one corner, a second click defines the opposite corner. For most shapes, the **Line**, **Fill** and **Font** properties can be set in the **Settings** panel. Other properties applicable to the current shape will also be shown as appropriate. The Position and Size of any selected shape is shown in the status bar.

Changing to the **Publish** view will initially display a blank 'page' and will change the main window's **Process** buttons to a new set of buttons specific to the publishing functions. The **View Settings** panel also changes to show information about the layers in the page and attributes of the currently selected shape. If no shape is selected the attributes of the page itself are shown. The **Edit** menu is replaced by a **Publish** menu which duplicates the buttons. The menu also includes **Undo** and **Redo** items which are not on the buttons. These provide full undo and redo functions for (almost) all operations carried out while working on the page. The functions can also be called by pressing Ctrl-Alt-X or Ctrl-Alt-Y.

4.9.2 Manage Shapes

The top section of the left-hand toolbar is dedicated to managing the various shapes that can be drawn on the page.

4.9.2.1 Zooming

Because the functions available in this view are different to those in the Shade and other views, the zoom behaves quite differently. The zoom level can be set to a specific percentage from the dropdown list below the Zoom button. Clicking the Zoom button and then clicking on the page will increase the zoom by 50% of the current level. Shift-clicking will reduce it by 50%.

4.9.2.2 Select

Returns the cursor to the default mode of clicking to select shapes on the page. In this mode selected shapes can be moved around on the page by clicking and dragging them or manipulated in other ways by right-clicking on them and selecting an action from the menu. The selected shape(s) can be 'nudged' with the keyboard arrow keys. Each keypress will move the selection 1 screen pixel in that direction. Therefore the higher the zoom factor, the smaller the distance one keypress will move the selection on the page.

4.9.2.3 Rotate

Allows a shape or group of shapes to be freely rotated. Note that some elements (primarily the Histogram, Compass, and Scales) cannot be rotated. The selected shape's corners will change to blue circles, clicking and dragging one of these will rotate the shape. The shape can also be rotated to a specific angle by setting the Angle value in the shape's properties list.

4.9.2.4 Group & UnGroup

Any number of shapes can be grouped together to be moved, sized and otherwise act as one. Select the shapes to be grouped by Shift-clicking on each in turn (or Click-dragging over all the shapes). Once the shapes have been selected, click on **Group**. The attributes of a shape within a group cannot be changed unless the group is ungrouped first. Clicking **Ungroup** will split the group into it's constituent shapes.

4.9.2.5 Undo/Redo

Though not available from the buttons, two further commands are useful for managing the drawing: **Undo** and **Redo**. These provide full undo and redo functions for (almost) all operations carried out while working on the page. The functions can also be called by pressing **Ctrl-Alt-X** or **Ctrl-Alt-Y**. **Undo** is unlimited, i.e. it will undo all changes back to the very first one applied when the page was opened. **Redo** can only redo changes that have been undone until the next change occurs (this includes the smallest movement of any shape).

Limitations: For technical reasons, adding or deleting polyline & polygon nodes cannot be undone.

4.9.3 Composite

This section of the toolbar is concerned with predefined shapes that are linked to the contents of the current survey. Each shape will initially derive any applicable attributes from the last selected view. However all the

attributes can be changed in the **View Settings** panel. Once changed they will keep their values irrespective of any changes made to the main views. Changes to the *data* (as a result of added or changed processes or grids) will however change the shape (as applicable to the shape). For example, clipping the data will change the graph of the Histogram while changing the Direction of first traverse in the Metadata will change the direction the compass arrow points.

In the case of the Survey the shape will be drawn as a best fit within the selected area while maintaining the aspect ratio of the survey. The Compass will always be drawn as a square and the Vertical Scale, Palette and Ground Scale will be sized according to their own criteria. These criteria will override the size of the area drawn by the user.

4.9.3.1 Survey

Adds a shape containing the last selected view of the survey (either Shade, Trace, 3D or Relief). The shape will be sized to best fit the selected area while still maintaining the aspect ratio of the survey.

> Note: The View Clipping settings are NOT used when creating the Publish view. This may result in a difference between the appearance of the same survey in the Shade/Trace view and Publish view. You will be warned of this difference when adding a survey to the Publish view (this warning can be turned off).

The survey has all the properties available in the main View, plus a number of special ones only applicable to the Publish view. Those requiring special explanation are described in detail here:

Survey Type
Initially set to the type of survey last selected before Publish was chosen. Selecting a different view from the list sets the survey to either Shade, Trace, Relief or 3D.

The **Trace** view will have extra areas above and below the grids to accommodate the traces that exceed the area of the survey.

The **3D** view can only display the exact same image currently shown in the main 3D view, in effect a simple snapshot of the current view. No settings can be changed in Publish. Note that the 3D image is only created when the 3D view tab is selected. Therefore selecting this view in Publish before the main 3D view has been opened will result in an empty survey.

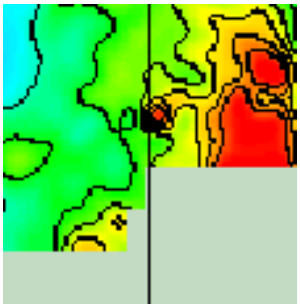
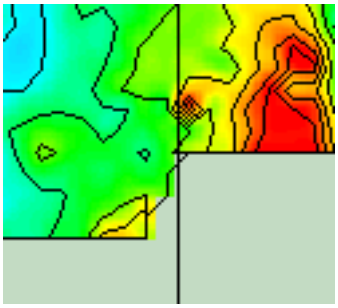
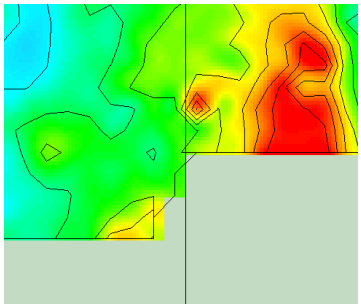
As changes to the data (via processes, etc.) are not automatically transferred to the 3D view, they are also not transferred to the 3D Publish view.

The Publish view endeavors to maintain the same size and correct aspect ratio for the survey. However as different main views have different sizing requirements, switching back-and-forth from one view to another may cause distortion and changes in scale to the survey.

Lock Aspect Ratio
Setting this property on ensures that the shape always keeps it's width/height ratio. This is of course very important for surveys but can also be useful for such things as keeping circles round.

Contours
Contours can be drawn using either a raster method (equivalent to the method used in the Shade View) or a vector method. The vector method draws the contours as actual lines between points whereas the raster method simply draws pixels that fall on a contour in a different colour. The vector method has two advantages over the raster method: the lines remain clear and sharp at any magnification, this is especially noticeable at higher magnification and, when saved as WMF the resulting contours remain editable lines over the underlying survey. However there is a disadvantage as well. Because of the way the lines are generated, there can be some odd effects at edges. In particular the outer edge of each contour is drawn ½ an interval in from the edge, this will be more noticeable on small surveys. Also note that the different calculation methods mean that contours from the two methods will not follow the exact same paths. This can be seen in the comparison below.

Because the Vector method only draws lines over the underlying (raster) survey and the vector and raster contours do not match exactly, the Block colouring option is not available with vector contours.

Raster contour	Vector Contour @ 200%	Vector Contour @ 750%
		

Rotate to North
By default, surveys are drawn with the same orientation as the default shade view: the first traverse runs left to right across the top. The survey can be automatically rotated so that North is shown towards the top of the page. This can be preset in **Preferences** or by the **Rotate to North** button on the Survey Properties once it has been added the the page (only shows if the current angle does not point north). The angle to rotate the survey is determined by the Direction of 1st Traverse which is set during download or import of the data, this value can also be changed in the Metadata view.

Hide Image
Hides the image of the survey shape leaving only the Grid lines, Subgrid lines and filenames showing. This option is intended to be used when annotating a survey. The annotations (in the form of text, polygons, lines, etc) can be drawn over the survey. Then, once the annotations are complete, the image can be hidden revealing only the annotations.

Hint: You may want to have both a survey image and annotated version next to each other. To do this while keeping the 2 surveys at the same scale: place just one survey on the layer, copy and paste it (from the right-click menu), move the new survey next to the old one, hide it's image, select both surveys and group them. Set the Group property **Lock Aspect Ratio** on and they can now be resized together.

Distance Ticks
Draws a scale along the top and down the left side of the survey. The distance between **Major** ticks (longer, normally with labels) and **Minor** ticks (shorter, without label) can be set in meters. The default is the grid width for major ticks (or 20m for non-gridded data) and 5m for minor ticks. The numbers shown at each major tick can also be turned off by setting **Label Ticks** to false. The numbers are always relative to the top-left corner of the survey and increase to the right and down. By setting the **Label Type** they can be either from the composite origin, the site origin or in intervals.

Grid Filenames
The Publish view provides more control over the formatting of the filenames than is available in the Shade/Trace views. The main difference is that the filenames do not rotate with the survey. Instead they remain horizontal no matter what angle the survey to turned to. Also the font (name, color, size, etc) can be set and the box colour can be changed or turned off entirely.

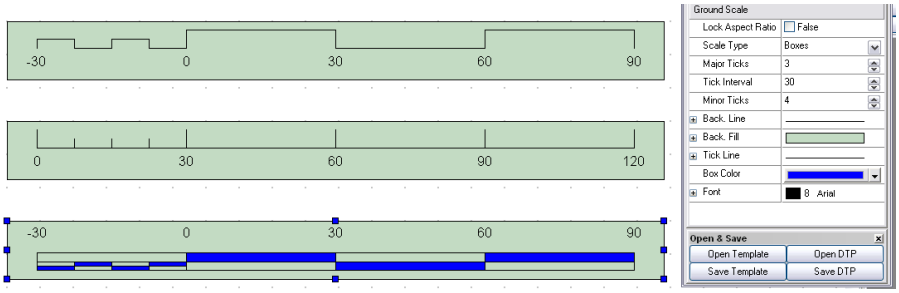
4.9.3.2 Histogram
Draws a histogram of the data. The layout is identical to that used on the Shade view.

4.9.3.3 Vertical Scale
Draws either a Palette with scale for the Shade view or a vertical scale for the Trace view. The height of the scale for a Trace view cannot be altered as it is linked to the scale of the Trace. The width is set by the font and the font's size. The width of the palette bar can be set via a property. The number of sections in the Vertical scale can be set. Each section is 1cm high.

4.9.3.4 Ground Scale

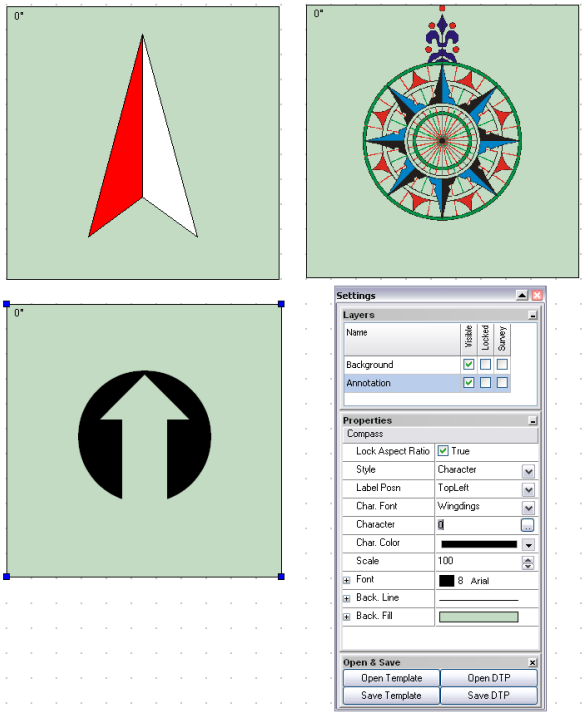
Draws a ground distance scale based on the size of the survey. The type of the scale and the numbers of major (numbered) and minor (unnumbered) ticks can be set. Currently 3 scale styles are defined: Zigzag, Ticks and Boxes. Though the basic style is fixed, the fonts, lines and fills for each style can be set to any value required in Properties. By default, the scale will be drawn with 4 major ticks, or 1 if the survey is only one grid wide.

Note that in order to preserve the scaling, the Ground scale cannot be resized directly. Changing the size of the survey will change the size of the scale as will changing the number of Major Ticks in the Properties. Changing the font and font size may also affect the height and width of the scale.



4.9.3.5 Compass

Draws a square box with a north arrow in it. The arrow indicates the direction of north relative to the survey on the same layer (or 'up' if no survey is present). The arrow can be either a simple drawing (as seen with the normal Shade view), a character from a font or an image. This allows the arrow to be customised to your requirements. The shape includes a numerical indication of the compass heading. This can be placed in any corner of the shape (or hidden) and can be set to any font & size.



Any character from any font can be used - though of course this will only make sense if the character is recognisable as an arrow. A number of characters from the WingDings fonts (standard in Windows) are suitable for this purpose. There are also specific geographical fonts available that may have suitable characters (if you have installed Golden Software's Surfer you will have a font called GSI North Arrows that consists entirely of such characters). Make sure that the selected character points upwards, the character will be rotated based on this assumption.

An image can also be used to provide an even more elaborate or custom compass arrow. You may have such an image available within your organisation as clipart, alternatively you could draw one yourself in a graphic package or download something from the internet. As with the character, North must be up to get the correct rotation. Note that the image is rotated around the center point of the image – which may not be the center of the compass.

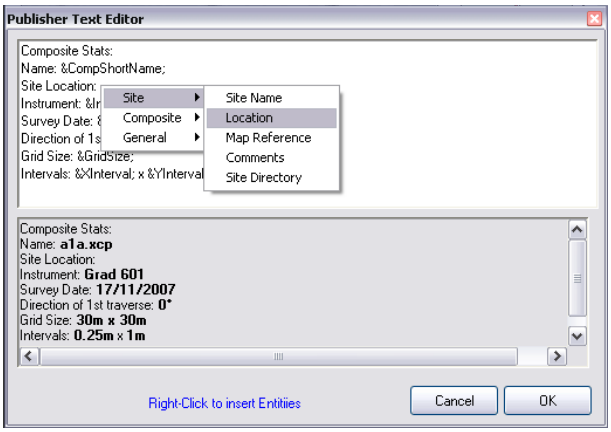
In the case of the character and image, there will be an additional property available. This scales the character or image to let you get the best fit to the background (if used). The example image shown above is scaled to 100% and so the top edge just touches the edge of the background.

4.9.3.6 TEXT

Places text on the page. This can be plain, fixed text or can include 'entities' or links to attributes of the survey. For example the name of the site or the dimensions of the survey can be included in the text. When these attributes change the text is changed accordingly.

The text edit box has 2 main areas, the top area is where the text is entered as in any text editor. The area below that shows an example of what the plain text will look like on screen (excluding font settings), the entities are shown in bold. To insert an entity right-click at the insertion point and choose the required one. The entities are divided into 3 lists: Site, Composite & General to aid selection.

Note: the list of available entities covers most aspects of the survey and site and is equivalent to the information available in the metadata view. However if you find a need for other entities please contact DW Consulting to discuss having them included in future versions of the program.

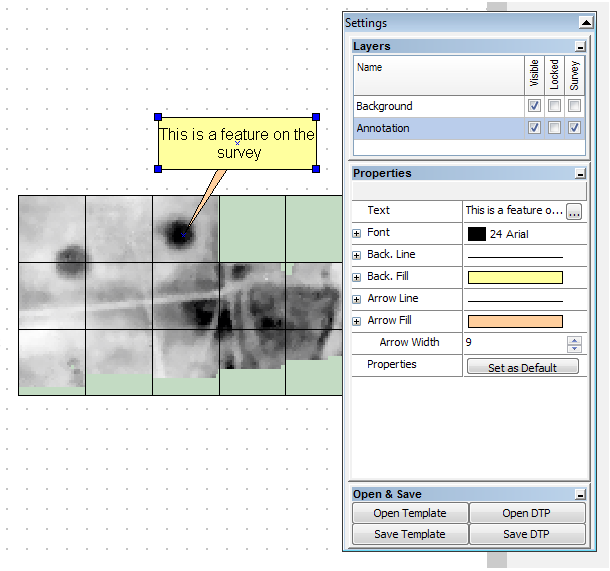


4.9.3.7 ANNOTATION

Adds a text box linked by an 'arrow' (triangular pointer) to a point on the page. The first click must be at the point the arrow is to point to, the second at the center of the point the text box will be drawn. Once the Annotation has been drawn, the text box can be moved around and resized and the arrow will follow it, always pointing to the same start point. If the start point of the arrow was on top of another object such as a survey image, the start point will be linked to that object and will also move with it.

To move the start point of the arrow relative to the object it is drawn on (and linked to), select the object and Ungroup it. The small dot at the point of the arrow will now be selectable and moveable. Move it to the desired position (the arrow will follow). Select the point and object (using Shift-click) and Group the objects. The arrow will probably be behind the object after grouping them, use the right-click menu Arrange to put the object behind the arrow again.

Note that the screen version of the annotation will have a small cross at the center of the text box. This will not be visible when the view is converted to an image or printed.



4.9.4 SHAPES

The final section of the toolbar provides generic drawing shapes. These can be used to annotate the survey, add support data around the survey or as simple drawing elements on the page.

4.9.4.1 LINE, RECTANGLE, ELLIPSE, ARC, POLYGON, POLYLINE, BEZIER

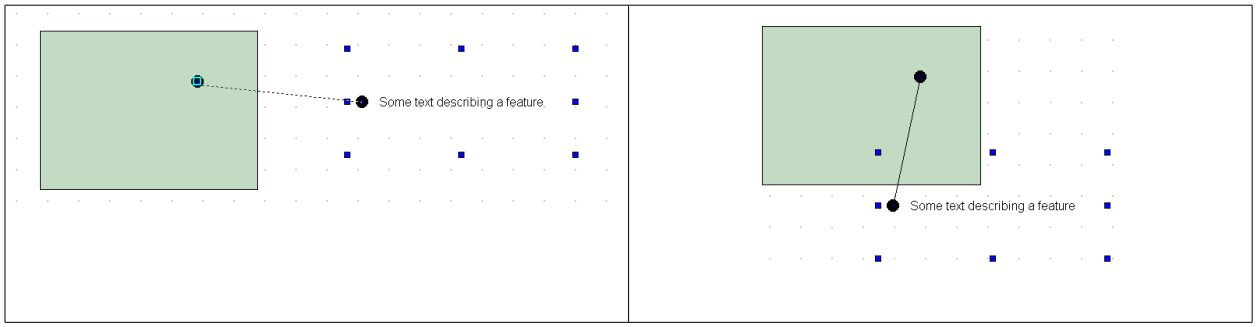
These are basic shapes and have no further functionality. The **Line** can have arrowheads at either or both ends. The **Polygon** & **Polyline** allow irregular lines and shapes to be drawn. The **Bezier** allows curved lines to be drawn, if the Fill of a **Bezier** curve is set to anything other than 'none', the first and last points are joined by a straight line and the shape filled. The **Arc** can be either a Line (simple curve), Chord (filled "D" shape), or Segment (filled Pie slice).

4.9.4.2 IMAGE

Allows an image to be placed on the page. Note that the image is stored in the publishing file and so need not be kept separately.

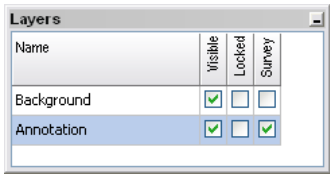
4.9.4.3 LINKLINE, LINKPOINT

The **Linkline** is a special version of the basic line. It can be drawn between 2 **Linkpoints** and when a **linkpoint** is moved, the line will follow it. For example, this can be used to link a block of text to a point on a survey. Place the survey and text block on the page. Place a **Linkpoint** on top of the survey at the point to be described and another **linkpoint** in the text block. Select the survey and it's **linkpoint** and **group** them. Do the same to the text block and it's **linkpoint**. Once they are grouped the **linkpoint** will move with the survey or text block. Then draw a **linkline** from the **linkpoint** on the text block to the **linkpoint** on the survey, As the cursor approaches a **linkpoint** it will be highlighted to show that the link has been made. Once the line is in place either group can be moved and the line will be re-drawn between them.



4.9.5 LAYERS

The shapes on a page can be assigned to different, user definable layers. Only the shapes on the currently selected layer can be selected, moved, etc. So for example a standard page border, company logo and address could be placed on one layer and the survey-related shapes on another. This would protect the standard items from being disturbed while working on the survey data.

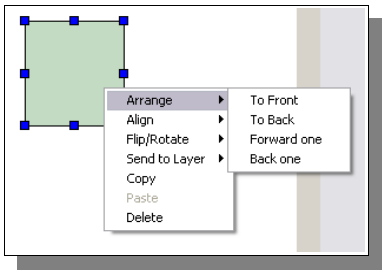


The layers are controlled by the **Layers** section on the **View Settings** panel. The default is 2 layers called Background and Annotation. Each layer can be hidden or locked by (un)checking the box next to the name. The 3rd box cannot be changed, it indicates whether a survey is on that layer. If a survey is on a layer and the layer is not locked, all and only the composite shapes on that layer will be linked to – and updated by – that survey.

Layers can be added, deleted or renamed by right-clicking on the layer name in **View Settings** list.

4.9.6 ARRANGING & EDITING SHAPES

Right clicking a shape will display a menu giving access to various options. These include arranging the order of shapes (which shapes are drawn in front or behind others) and aligning a number of selected shapes with respect to each other or the page. In addition the shape can be Flipped or turned, moved to a different layer, copied, deleted or (if shapes have been copied) pasted.



Two extra items: **Add** and **Delete Nodes** will be shown if the selected shape is a Polyline or Polygon (for technical reasons, Bezier line nodes cannot be edited. Also added or deleted nodes cannot be changed by **Undo**/**Redo**).

4.9.7 OPENING AND SAVING PUBLISH VIEWS

Publish views can be saved and reopened. The file format is however specific to TerraSurveyor's Publish mode and cannot be used by any other program. The files can either be saved as DTP files in any location (the default is in the current site /graphics folder) or as templates which are always stored in the application data folder. There is no difference between a file saved as DTP or template, only the location is different. When a template or DTP is opened it completely replaces any existing shapes and formatting on the page. The file contains all the data used for the page, including any images. When a file is opened it will always be updated to match the current survey, except for any locked layers which will continue to show the data as it was when locked and saved (including any survey images, histograms etc.).

The page can also be saved as an image, either in PNG, JPG, BMP or WMF format. This is done from the **Navbar Output** button, then select I**mage** from the dropdown menu or from the main **File|Save image** menu. Note that the WMF format is only available to licensed users (it is an editable vector format that would allow the trial period licensing restrictions to be bypassed). The saved image can be left at the original page size or trimmed down to just fit the shapes on the page, use the **Trim to Shapes** checkbox in Options to do this.

Note: The WMF format can be very useful as it is vector format that can be read by many common graphics programs. However, tests have shown that support for WMF files varies greatly between different programs. Though most will be able to handle the basic shapes, few have shown themselves able to handle such things as fill patterns (cross-hatch, etc.) or non- solid lines. Even high-end programs such as Adobe Illustrator have problems. Therefore if you see something different in your graphics program to what you created in TerraSurveyor, this is (probably) not the fault of TerraSurveyor!

5 Processes

All processes are mathematical modifications applied to the top-most layer of the composite. These modifications filter, enhance or move the data in some way. They are all designed to aid you in improving the appearance of any features present in the data, however applying lots of processes will not result in better data. The best results will always be obtained from good quality source data with careful and minimal application of the right processes. Experiment with the type, sequence and parameters of processes applied. In general your aim should always be to use the least amount of processes on a dataset.

The **Move** process is described in detail in section 3.12 Moving datapoints.

All processes (unless otherwise stated in the description) can be applied to any area, block of grids or the complete composite. See section 3.2.2 for full details on selecting areas and grids. If no specific selection has been made, the process will be applied to the complete composite.

GPS Processes

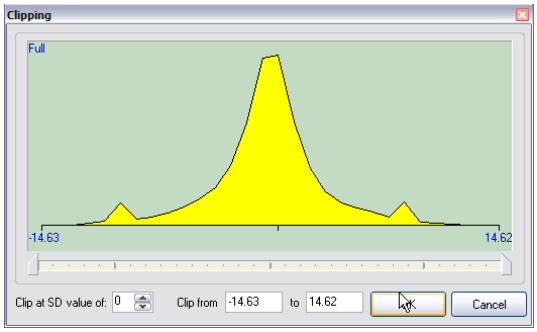
These processes are only applicable (and available) to source data gathered with GPS based systems. The processes are applied directly to the source data which is then interpolated to create a normal base layer. This base layer is then used to create the displayed image and can be further processed by most of the normal processes.

The available processes are described at the end of this chapter, there is also a Modify button that provides the same facilities for the GPS Processes as the main Modify button.

5.1 CLIPPING

Replace all values in the current layer outside a specified minimum and maximum with those values. Min and Max can be specified in absolute values or +/- SDs.

The dialog box for this process displays a histogram of the current layer's data. Use the Up/Down arrows next to the **Clip at SD Value** box to set the Min and Max cut-offs to 1,2 or 3 SDs above and below the Mean. Alternatively you can use the double sliders below the histogram to set the Min and Max to fixed values or set the values directly in the edit boxes.



Note: Use of either the sliders or edit boxes will set the **Clip at SD Value** to 0.

5.1.1 USAGE:

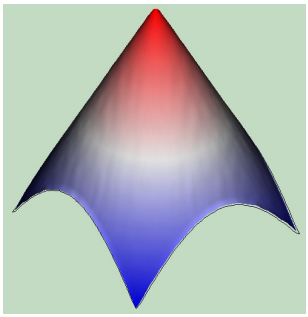
Use this process to remove extreme datapoint values. Extreme values will force the display to show all values in the center of the histogram in the same colour thus hiding fine details. Excluding these values will allow the details to show through.

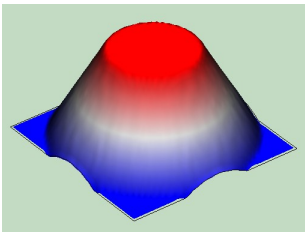
Note: Using the Band Weight Equalisation function will have a very similar effect but without actually changing the data. However, that will only be visible in the Shade view.
Note: The Settings panel Display box also contains Clipping values. Those values ONLY affect the display, NOT the underlying data.

Ideally the histogram should form a 'bell curve' with no empty areas at the edges.

It is preferable to use the SD values rather that setting the limits to specific values. This is because the SD values are calculated every time the data is processed from the mean of the current data. This means that the values will be correct, even if you change the sequence of the processes or change the overall data distribution by adding more grids to the composite.

The effect of clipping on artificial data

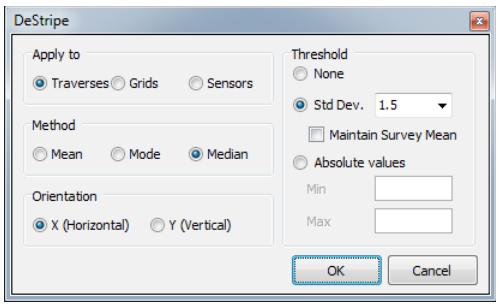




5.2 DeStripe

This process was formerly known as Zero Mean Traverse / Grid. However, with the introduction of the Mean/Median/Mode & Horizontal/Vertical options the name was no longer appropriate.

DeStripe calculates the Mean or Mode or Median of each Grid, Traverse or Sensor within a grid. The mean/mode/median is then subtracted from the grid/ traverse/sensor.



DeStripe is a Grid-based process and so the selection procedure is slightly different than for most other processes. An area or block of grids can be selected as normal using the **Click-and-drag** or **Right-click** methods. However, any area selection will be expanded to cover all grids within that area. If no selection is made the process will be applied to all grids in the composite.

Set whether the correction is to be calculated for each traverse, the whole grid or all the traverses collected with the same sensor.

Optional **Thresholds** can be set for any method. These can be expressed in SDs or as absolute values. The Threshold determines which values will be included in the calculation of the Mean/Mode/Median value. If SDs are used, either a standard value can be selected from the list or a custom value typed over the standard value.

The **Median** and **Mode** methods do not generally require thresholds as they naturally exclude extreme datapoints, however thresholds can be used with these methods as it may be useful for cases with extreme disturbances in the data such as that caused by pipelines.

Normally the DeStripe is applied in the direction of the traverses – horizontally as seen on the views. However it can sometimes be useful to apply the process across the traverses. The orientation can therefore be set to Y (vertical) if required.

5.2.1 Usage:

The Destripe process is used to equalise underlying differences between grids. Differences can be caused by directional effects inherent in magnetic instruments, Instrument drift or orientation, delays between surveying adjacent grids, changes in the instrument set-up during a survey, etc.

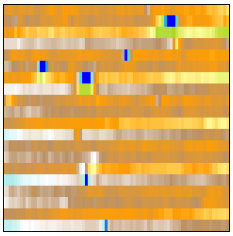
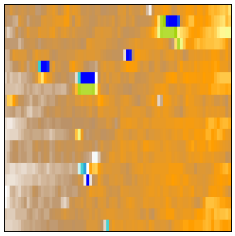
The Y (vertical) orientation can sometimes be used to remove some 'edge mismatch' errors remaining after the application of the more normal, horizontal direction.

The Sensor mode is particularly effective when linear features are present in the data that run parallel to the direction of traverse. In this case, normal Traverse based destriping will remove or severely reduce the linear feature as there is no way to determine that the average value of an individual traverse is due to a feature. By averaging all the traverses in a grid that were gathered with a particular sensor traveling in a particular direction, heading and sensor errors can be considered constant. The average for that set of traverses can therefore be considered the striping error value for all of them. Removing this value will destripe the data without affecting the linears that will now form only part of the traverse set.

Note that because the pattern of traverse interleaving varies between instruments and traverse separations, this mode uses hard-wired patterns for each instrument & separation combination. This mode can therefore only be applied to data that comes from certain instruments and is marked as such.

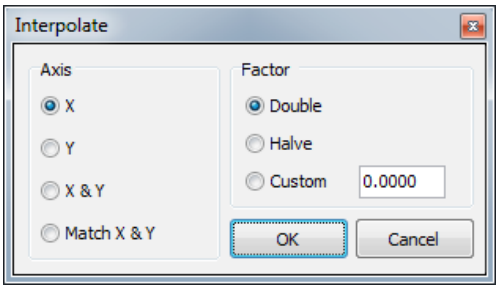
Normally this process will produce Bi-polar data with a center value close to zero. Because of this it is not recommended for use with Resistivity data. If the Mean mode is used with monopolar data – the normal result for Resistivity data, the **Maintain Mean** checkbox should be checked. This will add the mean of the source layer to all points in the processed layer after processing.

Note: Mean = average, Mode = most common value and Median = middle value (when all values are sorted into numerical sequence).

The effect of Destriping data using the Median method.	
	

5.3 INTERPOLATE

Increases or decreases the resolution of the survey. The values for the new datapoints are extrapolated using a cubic spline algorithm. This produces a smooth curve to fit the available source datapoints. This method is used for both increasing and decreasing the resolution.



Resolution can be changed to any value. For convenience and compatibility with previous versions of **TerraSurveyor**, single click 'double' and 'halve' values can also be selected. The custom factor can be any value with up to 4 decimal places. '2' and '0.5' will have the same result as the 'double' and 'halve' settings.

Three **axis** options are available to apply the factor to the X axis, the Y axis or both axes together.

The **Match** option changes the resolution of one axis to match the other. The Factor panel changes to show Increase or Decrease, so that either the lower resolution axis is increased to match the higher or visa-versa.

Notes:

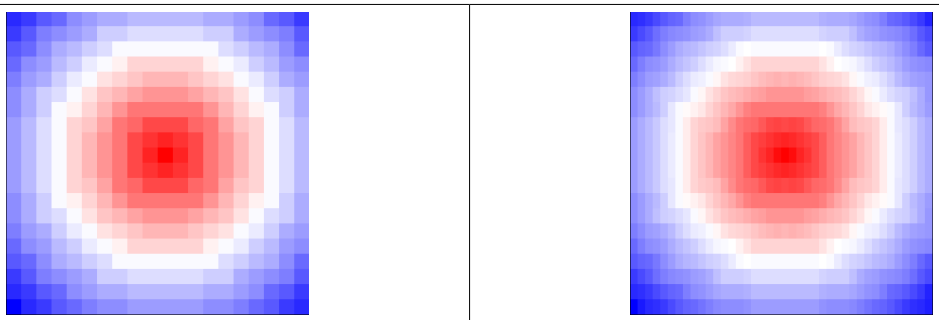
This process should only be used to allow different datasets to be matched, it should not be used to give the impression of enhanced data. Though it may appear to improve the data, any improvement is artificial. Excessive interpolation will eventually start to create artifacts that have no basis in the source data. Every doubling in any direction will also double the processing time for each subsequent process and prevent Delta View comparisons across the interpolated layer. Instead the view- based function Graduated Shade should be used. This produces the same (or better) result without modifying the actual data.

If Interpolate must be used, it should be carried out as late as possible in the sequence of processes as many processes (such as DeStagger and Stretch Traverse) depend on the original traverse data for their calculations.

Decreasing the resolution can be useful when a large survey at high resolution starts to overwhelm the PC. By reducing the resolution and then exporting the survey as a new composite, a much smaller and more manageable composite can be created.

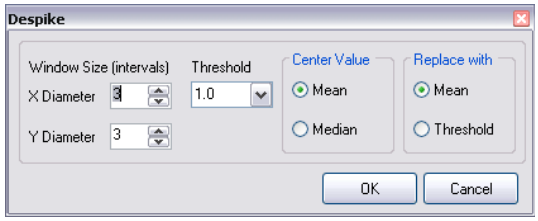
Though the process can handle any interval, artifacts may appear in the data when the start and end interval are not simple multiples of each other. This will be especially apparent when dummy value areas or the ends of traverses are involved as it may not be possible to fit the interpolated intervals exactly into the grid.

The effect of Interpolation on artificial data – doubling along the X axis.



5.4 DeSpike

Scans the composite using a uniform weighted window looking for datapoints that exceed the mean (or median) of the window by a specified threshold amount.
When found, the point is replaced by either the mean/median or threshold.



The size of the window used to calculate the mean can be set using the **X Diameter** and **Y Diameter** spin buttons. Diameter can be set to any (odd) number between 1 and 21 (i.e. a diameter of 3 = the center point plus one datapoint either side). A value of 1 means that the filter is not applied in that axis

Note: The size of the window is measured in Intervals - not meters.

Using the **Mean** value of the window to determine the threshold is the more traditional method, however the mean value is heavily influenced by the spike itself. Use of the **Median** value gives much better results.

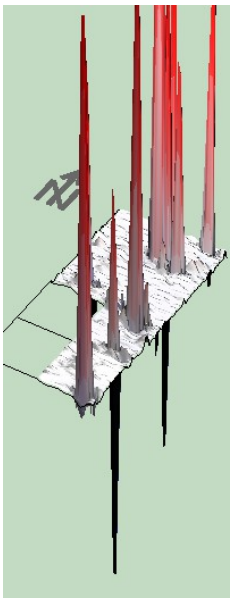
The **Threshold** value determines the point at which correction is applied. Correction is only applied when the center value exceeds the window mean by window SD * Threshold.

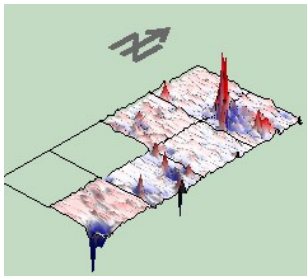
The center value can either be replaced with the **Mean/Median** or **Threshold** value.

5.4.1 Usage

The Despike filter is typically used with magnetometer data to remove spikes caused by small surface iron anomalies. These anomalies are generally the result of modern metal 'rubbish' in the topmost layers. These typically cause very strong but localised signals.

The effect of Desspiking data using the Median center value.

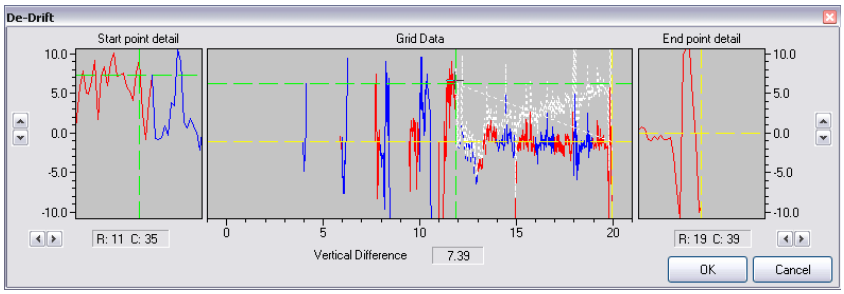




5.5 DeDrift

Corrects for drift in the readings taken by an instrument. The process applies a progressive correction to every datapoint within a range of points in a grid. Because of the source of the problem corrected by this process, it can only be applied to individual grids. Also note that the process can only be applied to data collected with single sensor instruments.

DeDrift is a Grid based process and so the selection procedure is slightly different than for most other processes. A single grid can be selected as normal using the Click-and-drag or Right-click methods. However, any area selection (or block of grids) will be reduced to cover just the top-left grid of the area.



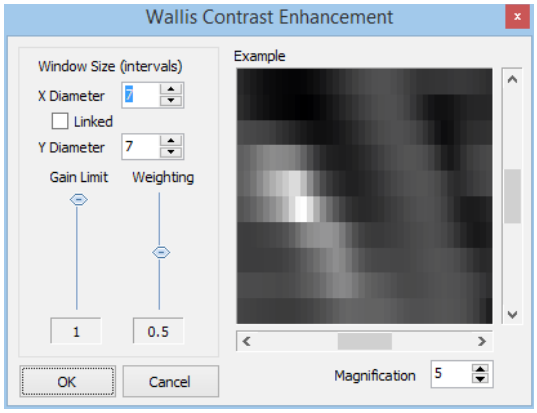
The main graph in the middle shows the data for the selected grid in the order it was recorded by the instrument, allowing for the type of recording methods specified in the grid file. The actual data values are however taken from the current layer. Alternate traverses are shown in blue and red to aid in locating the position. There are 2 crosshairs shown on the main graph. These crosshairs determine the range over which the process is applied and the magnitude of the correction. The green crosshair marks the start point and a yellow one the end point. As the crosshairs are moved (by clicking and dragging them), a white copy of the dataplot will show the result of applying the current crosshair positions to the grid data. The crosshairs can cross in the vertical axis but not in the horizontal (i.e. The end point can never be to the left of the start point).

To the left and right of the main graph are two larger scale graphs. These are centered around the start and end crosshair positions. These crosshairs cannot be moved directly with the mouse but can be precisely positioned by using the spin buttons. The buttons below the graphs move the points in measurement intervals and display the current start/end point in Row & Column values. The spin buttons beside the graphs change the Y values in increments of 1% of the data range. The difference between the start and end Y values is also shown below the center of the main graph.

The actual correction value is the difference between the start and end Y values divided by the number of datapoints between the start and end points. Each datapoint between the start and end point is then reduced by the correction value times it's distance from the start point (correctly allowing for zigzag or parallel data collection methods). All datapoints after the end point are reduced by the full difference.

5.6 Wallis

Note: The implementation of this process is completely revised (in version 3.0.25) compared to the original version. Only those parameters that have a direct correlation between the old and new implementation have been retained and even then the effect will be different. Composites that use the old implementation will show a warning when opened, asking the user to check the effect of this process. All new and changed composites will only use the new implementation.



A Wallis filter applies Locally Adaptive Contrast Enhancement to the layer or current selection. An example of the effect of this is shown as the parameters are changed to enable it to be fine-tuned.

Three values - Window Size, Weighting Factor and Gain - can be set in the filter's dialog. The window X & Y sizes can be linked so that they change in sync.

5.6.1 Usage:

This filter is particularly suited to surveys that display a pronounced slope across the area. This slope results in large portions of the survey being too 'dark' and other areas too 'light'. This slope can make it very difficult to further process the data without removing significant features. The Wallis Filter adjusts each datapoint so that the local mean and standard deviation (defined by the window) match the overall image mean and standard deviation. This enhancement produces good local contrast throughout the image, while reducing the overall contrast between bright and dark areas.

5.6.2 Implementation:

The implementation of the Wallis filter in TerraSurveyor is derived from "Beyer & Baltsavias" page 104: (http://www.igp.ethz.ch/photogrammetry/education/lehrveranstaltungen/RSGISFS2014/Exercises/wallis_theory.pdf)

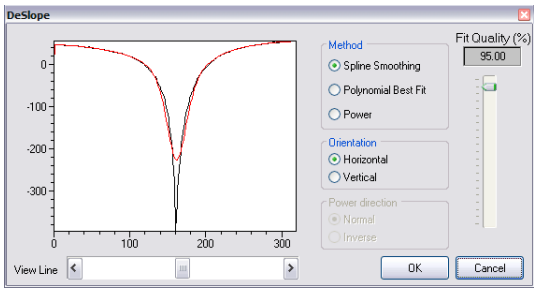
```
R0 = (IMm * Weight) + (WINm * (1 - Weight));
R1 = (Gain * IMsd) / ((Gain * WINsd) + ((1-Gain) * IMsd));
NewV = OldV - (OldV * R1) + R0;
```

where:

IMm	mean of the whole survey
WINm	mean of the window being sampled
IMsd	standard deviation of the whole survey
WINsd	standard deviation of the window being sampled
Gain & Weight	the two parameters (both values between 0 & 1)
OldV	Old value, the value at the center point of the window being sampled
NewV	New value: the old value minus the correction defined by the equation

5.7 DeSlope

Primarily intended to correct the 'waterfall' errors seen in Magnetometer data caused by large metal objects etc. near a survey area. The process calculates a curve (or straight line) for each row or column of data based on specified parameters. This curve is then subtracted from the actual data. Three different methods are provided to generate the correction curve. This process is not a magic fix, especially when the correction is extreme. However, if used with care and appreciation for the limitations, it can be used to salvage significantly distorted data.

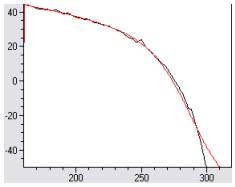


DeSlope is a selection based process. If no selection is made prior to stating the process, it is applied to the whole survey.

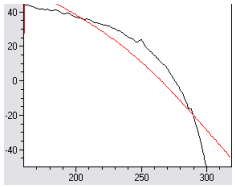
The dialog shows an example of the line of data to be corrected (each line in the selection can be viewed using the slider at the bottom). The black line shows the source data and the red line is the correction that will be applied.

There are 3 main methods available by the process:

Spline Smoothing: You can specify a 'Fit Quality', the hight the value (0 – 100%), the closer the curve fits the data. Too high a value may begin to smooth out archaeological features, too low will start to approach a straight line.

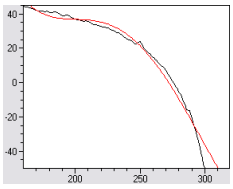


Spline Smoothing @ 95%



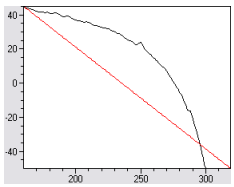
Spline smoothing @ 50%

Polynomial Best Fit: This method has no parameters, it is a pure mathematical function applied to the data. It generally provides the best results as the curve is fitted to each line of data.

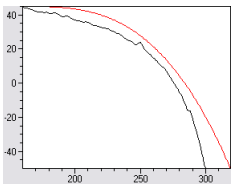


Polynomial Best Fit

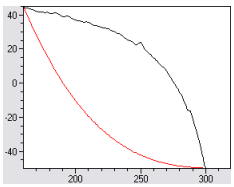
Power: A curve is generated based on the difference between the average start and end values of the selection (the left and right-most columns for a horizontal orientation and top and bottom rows for vertical). The method can have a power between 1 and 4 (1 being a straight line) and a normal or inverse direction.



Power of 1 (straight line)

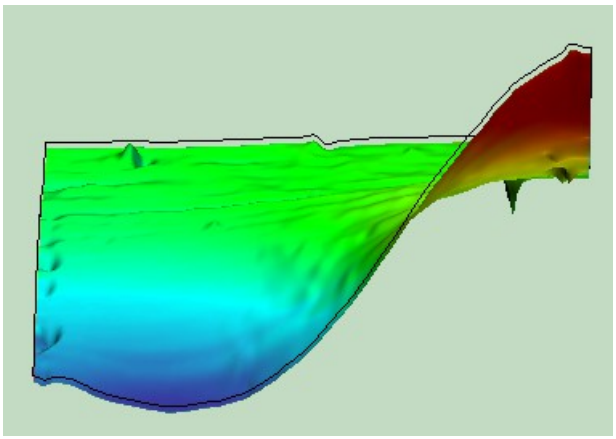


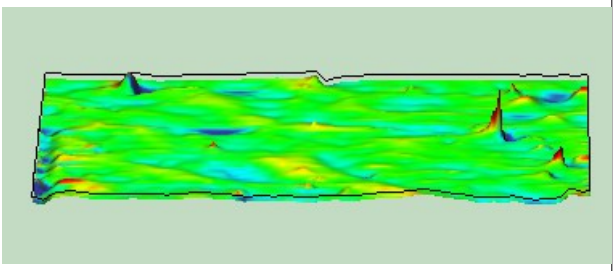
Cubic curve



Inverse Cubic Curve

The effect of Deslope data using the Polynomial Best Fit method.

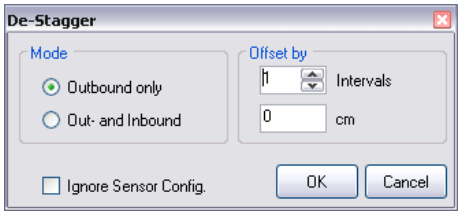




5.8 DeStagger

Compensates for data collection errors caused by the operator starting recording of each traverse too soon or too late. It shifts each traverse forwards (and/or backwards) by a specified number of Intervals.

The selection procedure for DeStagger is slightly different than for most other processes:



- A block of grids can be selected as normal using the **Right-click** methods.
- An area selection (using **Click & Drag**) that spans grids will be expanded to cover all grids within that area.
- An area selection that is completely within a single grid will be expanded to cover the full width of the grid and a number of rows determined by the sensor configuration. Because multi-sensor arrays are physically connected and also because of the complexities interlacing multi-sensor rows introduces, the rows will be expanded to cover all rows, both in- and outbound contained in a 'block' of multi-sensor and/or interlaced rows. This automatic selection area expansion can be overridden by checking **Ignore Sensor Config.** in the dialog box. In this case just the selected area will be shifted.
- If no selection is made the process will be applied to all grids in the composite.

The correction offset can be either be applied to just the **outbound** (i.e. 1st, 3rd, 5th, etc. traverse) or in **both** directions. Application in both directions is normally a better reflection of the source of the error but selecting **both** doubles the effect (it will normally create a minimum relative offset of 2 intervals). The **offset by** value determines how far the each datapoint is shifted. The new values for each datapoint is calculated using a cubic spline algorithm. This produces a smooth curve from the available datapoints. The offset value can be in whole intervals, cm or the sum of both.

This process correctly allows for multiple sensor arrays. Any number of sensors can be handled. The necessary information is extracted from the grid files. For example a 2 sensor array will shift the 1st and 2nd traverses in one direction, 3rd and 4th in the opposite, etc. Make sure that the Sensor count and Zig-Zag information is set correctly when downloading/importing the data.

If the data extends the full width of the grid, the missing datapoints at the start of each traverse are filled in by extrapolating the existing values in the traverse. Points at the end of the traverse will be discarded as they extend into adjacent grids or beyond the extent of the composite. If however a traverse starts and/or ends with dummy values, the dummy values will (in effect) also be moved with the data. This is specifically designed for data gathered with GPS-based positioning where there may be a large time lag in the datalogger. This can result in significant staggering. Note that recognition of these two 'modes' can sometimes conflict with each other when, for example grid based data has some blanks at the start or ends of lines or GPS based data comes close to the edge of a composite area. In this case originals of some readings may get 'left behind' when the line is shifted.

Because this process is dependent on sensor configuration and data collection patterns, it should be carried out prior to any interpolation.

Note: As each traverse is shifted forwards or backwards, datapoints at the end of the traverse are lost and an area at the start left uncovered. Datapoints in the uncovered area are replaced with values extrapolated from the preceding values in the same row. Data in adjacent grids is not used to create these replacement values.

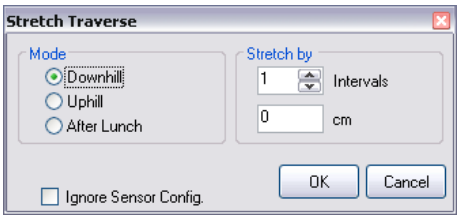
5.8.1 Usage:

Because of the presumed cause of this error, this process is really only applicable to Magnetometer data.

5.9 Stretch Traverse

Compensates for data collection errors caused by the operator walking too slow or fast. It stretches (and/or compresses) the end point of each traverse by a specified number of intervals, adjusting all the points in between by a proportional amount.

The selection procedure for Stretch Traverse is slightly different than for most other processes:



- A block of grids can be selected as normal using the **Right-click** methods.
- An area selection (using **Click & Drag**) that spans grids will be expanded to cover all grids within that area.
- An area selection that is completely within a single grid will be expanded to cover the full width of the grid and a number of rows determined by the sensor configuration. Because multi-sensor arrays are physically connected and also because of the complexities interlacing multi-sensor rows introduces, the rows will be expanded to cover all rows, both in- and outbound contained in a 'block' of multi-sensor and/or interlaced rows. This automatic selection area expansion can be overridden by checking **Ignore Sensor Config.** in the dialog box. In this case just the selected area will be stretched.

If no selection is made the process will be applied to all grids in the composite.This process can be applied in 3 different modes, referred to as: **Downhill**, **Uphill** and **After Lunch**. These describe the most common cause of stretching and compressing. **Downhill** means that the first traverse in the grid was walked too fast and the return traverse was too slow. **Uphill** is the reverse of this and **After Lunch** refers to the case when all traverses in both directions are walked too slow.

The value for **Stretch by** determines how far the last datapoint in each traverse is shifted. All intermediate datapoints are shifted a proportional value between zero (for the first point) and the selected value. The new values for the intermediate datapoints are calculated using a cubic spline algorithm. This produces a smooth curve from the available datapoints. The selected value can be in whole intervals, cm or the sum of both.

Note: Points that are left empty at the end of compressed traverses are filled with values extrapolated from the preceding values in the same row. Data in adjacent rows and grids is not considered.

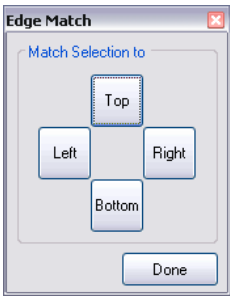
This process correctly allows for multiple sensor arrays. Any number of sensors can be handled. The necessary information is extracted from the grid files. For example a 2 sensor array with uphill correction will stretch the 1st and 2nd traverses, compress the 3rd and 4th, etc. Make sure that the Sensor count and Zig-Zag information is set correctly when downloading/importing the data.

Because this process is dependent on sensor configuration and data collection patterns, it should be carried out prior to any interpolation.

5.9.1 Usage:

Because of the presumed cause of this error, this process is really only applicable to Magnetometer data.

5.10 Edge Match



Calculates the mean of the 2 lines (rows or columns) of data either side of the edge to match. It then subtracts the difference between the means from all datapoints in the selected area.

Can only be applied to a selection. Selection may be a grid or any area. The selection must adjoin a valid area of data in the survey, i.e. not an area of dummy values or an edge. The dialog will stay open until **Done** is pressed so that a number of selections can be made one after the other.

Select the area to be matched *after* opening the dialog box. Then use one of the four buttons to choose the edge of the selection that is to serve as the reference.

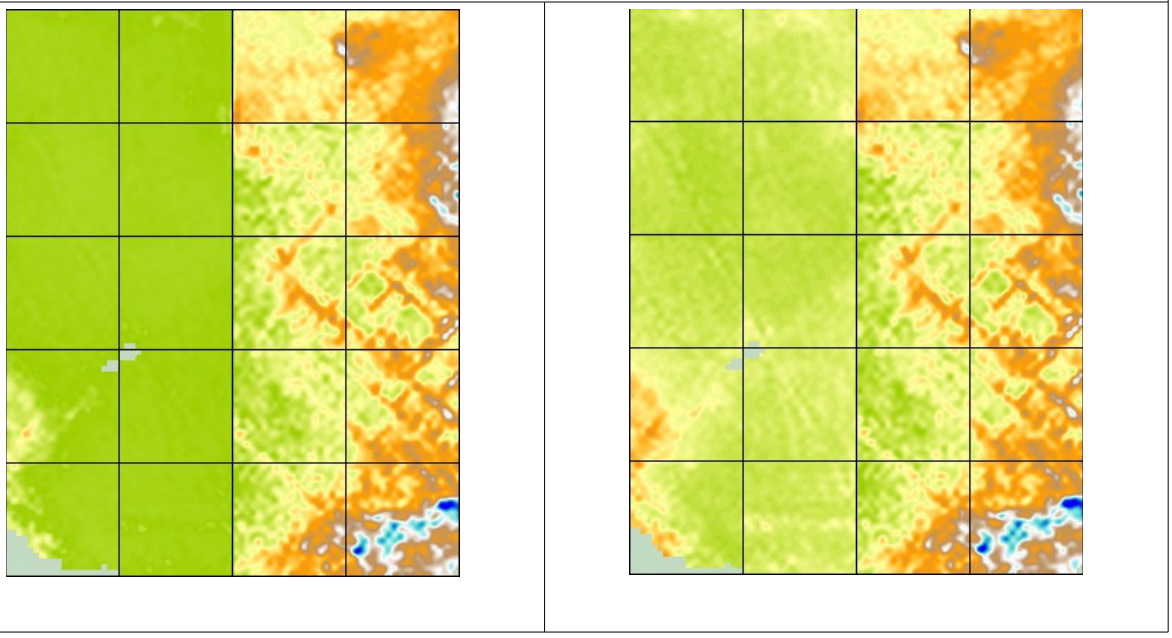
5.10.1 Usage:

Typically used with Resistivity data to correct for changes in the reference probes. These changes may be due to errors in transferring the probes to new positions or when a survey is spread over a period of time resulting in different conditions and probe locations. Because of the presumed source of this error, selections should normally be complete grids – use **Right-click** to select a complete grid.

5.10.2 Note:

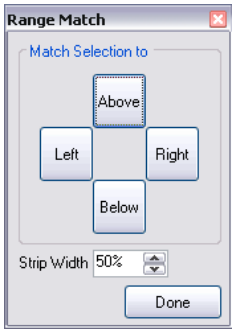
This process is best suited to matching areas that are already close, especially when the difference is just a different zero point. In cases of extreme differences the Range Match process may be a better choice.

The effect of Edge Match.



5.11 Range Match

Similar in effect to the Edge Match process but better able to handle widely differing data ranges and distributions. Range Match determines the minimum and maximum of a percentage of the (rows or columns) of data either side of the edge of the selection. It then calculates an offset and stretching factor to match the two datasets. The process then subtracts the offset from all datapoints in the selected area and multiplies them by the stretching factor. This can be particularly effective when matching resistivity grids that have been surveyed at different times.



Can only be applied to a selection. Selection may be a grid or any area. The selection must adjoin a valid area of data in the survey, i.e. not an area of dummy values or an edge. The dialog will stay open until **Done** is pressed so that a number of selections can be made one after the other.

Select the area to be matched *after* opening the dialog box. Then use one of the four buttons to choose the edge of the selection that is to serve as the reference.

Set the **Strip Width** to the percentage of the grid width that is to be used to determine the correction values.

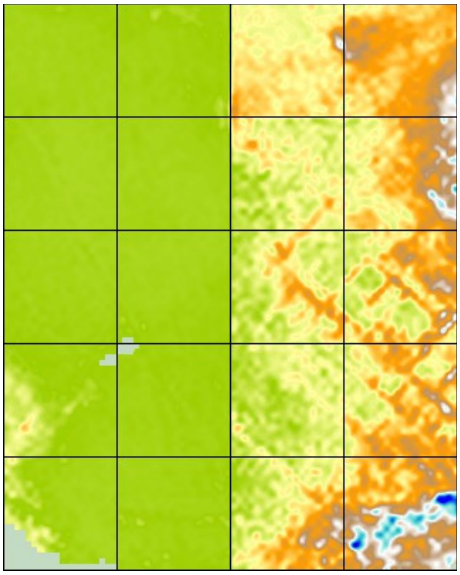
5.11.1 Usage:

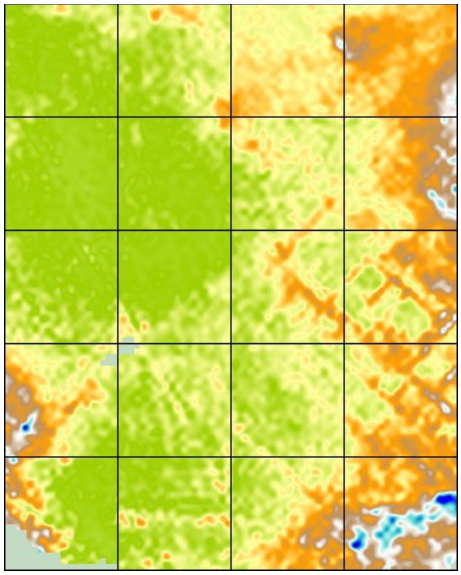
Typically used with Resistivity data to correct for changes in the reference probes. These changes may be due to errors in transferring the probes to new positions or when a survey is spread over a period of time resulting in different conditions and probe locations. Because of the presumed source of this error, selections should normally be complete grids – use **Right-click** to select a complete grid.

5.11.2 Note:

This process should not be used when the two areas to be matched are already close, especially when the difference is just a different zero point. Peaks in either the reference or changed area can dramatically skew the results. In this case the Edge Match process will often be a better choice. The Range Match process is better suited to situations where the differences are extreme - it will even handle the case where one area is inverted relative to the other.

The effect of Range Match.





5.12 Periphery Match

Calculates an underlying 2D surface for each grid and subtracts that surface from each value. The shape of the surface is interpolated from the grid's peripheral values averaged with their neighbours in adjacent grids.

Primarily intended for gridded Resistivity data, this process improves on the methods used in the Edge and Range Matching processes. Though both those processes worked reasonably well when just matching two adjacent grids, problems often occur when trying to match a block of grids. Because those processes apply a single, fixed correction value in just one axis, attempts to match grids in more than one axis will often result in worse results that before matching. The Periphery Match process addresses this problem by creating a 2D correction surface for each grid. The shape of this surface is interpolated from the average peripheral values of the grid and it's neighbouring grids. Each edge is therefore corrected by ½ the difference between it and it's neighbour, datapoints further in from the edges receive a similar but reduced correction.

This correction is applied to whole grids and is based on the premise that each grid is corrected by ½ the difference between itself and it's neighbour. Therefore the process has no parameters or selection criteria, it is always applied to all the grids in the survey. There is no dialog associated with the process however a progress dialog is shown while the grids are processed.

Source data (despiked)	After Periphery Match (preceded by Normalization)	Correction applied

5.12.1 Usage:

It is recommended that this process be proceeded by application of the DeSpike or Low Pass process as any spurious values on the periphery of a grid will seriously affect the results. This can clearly be seen in the example above, which has been despiked but still has sufficient anomalies on the edges to cause perturbations radiating across the grid edges. It may also be advantageous to apply the Normalization process before this process as this will smooth out large level changes such as seen in the example between the bottom-right grid and it's neighbours.

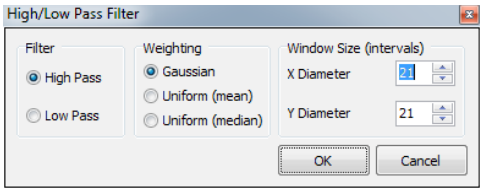
5.12.2 Note:

This process is quite slow!

The determination of each grid's 2D surface is done by the interpolation method normally used for processing GPS data. This method is handled by an external program(SurgeF.exe). The program itself is very fast for what is usually a very complex process involving perhaps millions of datapoints. However employing this method on a very small dataset is not efficient. It exposes the overhead involved in starting the program and reading the results many times. Each grid may take about 2 seconds to process (depending on your PC and the grid size).

5.13 High / Low Pass

Uses either a uniformly or Gaussian weighted window to remove high or low frequency components in a survey.



The size of the window used to calculate the mean can be set using the **X Diameter** and **Y Diameter** spin buttons. Diameter can be set to any (odd) number between 1 and 21 (i.e. a diameter of 3 = the center point plus one datapoint either side). A value of 1 means that the filter is not applied in that axis.

Selecting **High Pass** calculates the mean of all the values within the specified window and subtracts this mean from the center value.

Low Pass calculates the mean of all the values within the specified window and replaces the center value with the mean.

Uniform means that all values within the window are given equal weight, using either the mean or median value as the center.

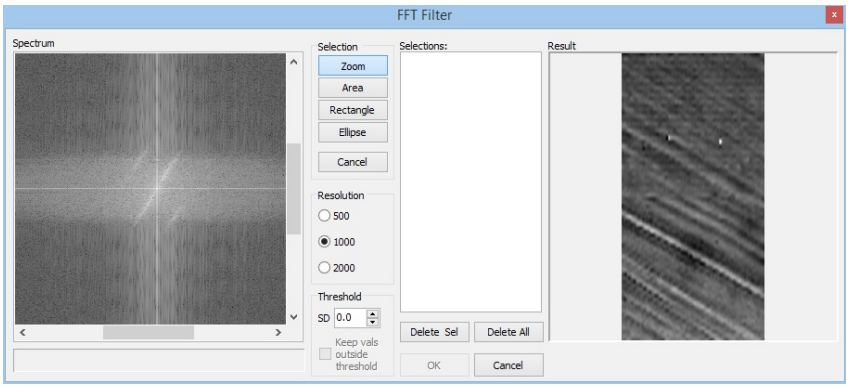
Gaussian means that the weight given to each value is higher the closer it is to the center point.

5.14 2D FFT

The 2 Dimensional Fast Fourier Transform converts the survey into a spectrum diagram that displays both frequency and direction. This diagram can be edited to remove certain areas. Once the diagram is converted back to a survey, the data these areas represent are removed. In this way, regularly repeating features such as plow marks can be filtered out.

> Note: Unlike all other filters used in TerraSurveyor, the 2D FFT filter manipulates an *image* of the survey rather than the underlying data. This is due to the graphical nature of the filter process. Once the filter is applied the result is converted back into a layer of data. This new layer is a good representation of the filtering process however there is no direct link between the before and after layer. This filter therefore lacks the accountability available with of all other processes. However the results achieved by this filter are potentially so useful, it is felt that this is an acceptable loss.

The dialog box for this filter has two main displays. The left-hand one is the frequency spectrum of the survey. This can be edited. The one on the right shows the result of the editing process. This is provided as an aid to the editing functions. It's appearance may be different to the main shade view, this is because the data is converted to a greyscale graduated shade image with no gridlines etc. It is this image that is edited and after editing, converted back into a data layer.



The frequency spectrum will normally consist of a dark background with a white cross in the center. In simple terms, the center of the cross contains or represents the 'real' data of the survey; the vertical arms result from the top and bottom edge of the survey and the horizontal arms are the left and right edge.

If there is a significant repeating pattern in the survey, this will normally be seen as a light coloured 'smudge' radiating out from the center of the image. The angle of a smudge to the center is at right-angles to the pattern seen on the survey. So a series of regular plough marks going from top-left to bottom-right will show as a smudge running from the center towards the top-right corner.

The length of the smudge relates to the regularity of the pattern; the more regular the pattern, the shorter and better defined the smudge will be. In severe cases 'echoes' or harmonics of the main pattern may be seen to the sides of the main smudge. This can be seen in the example here. These can be ignored as they should disappear when the main smudge is removed.

An operator induced error, such as that caused by a regular swing in the walking pattern, may show as a light spot on the vertical arm as this arm represents the direction of travel for the operator. However, in this case it may be better to use the **Notch Filter** described below. This filter is specially configured to deal with this type of error.

Areas of dummy values have sharp edges which would cause a faint checkerboard pattern in the spectrum. This has been avoided (to a large extent) by converting all dummy values to the survey Median. This does however mean that the Result image will show dummy values as a uniform gray. The dummy values are re-inserted when the process is applied back to the actual data layer. This edge effect will be very apparent with relatively small composites (single grids, etc.) as the edges of each datapoint become more significant in the overall dataset.

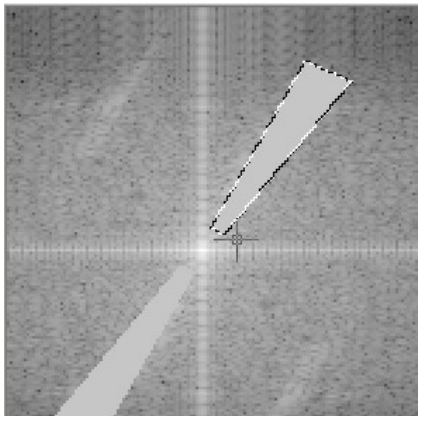
5.14.1 USAGE:

Both the spectrum and the survey images can be zoomed in and out. This is done by clicking (in) and right-clicking (out) on the image. For the spectrum, make sure that the Zoom button has been selected before doing this. The survey image is always in zoom mode.

To remove the patterns the smudge must be edited out. This is done by selecting an area on the spectrum with the mouse. Make sure the area to be selected is clearly visible (use the zoom function to do this). Select one of the 3 selection modes (area, rectangle or ellipse).

- **Area**: Click at the corners of an area in sequence round the area. Double-click to close the selection. For a very irregular area, you can also click and hold then draw round the area.
- **Rectangle**: Click and hold in one corner of the rectangle, drag to the opposite corner and release the mouse button.
- **Ellipse**: Click and hold at the center of the ellipse, drag outwards to the edge of the area to be selected.

When the mouse button is released, the area and the corresponding area mirrored about the center will be cleared - they will show as a plain grey. The Survey image will also be updated to deflect the result of clearing the selection. Note that this is just an indication of the result, dummy areas in particular may show features that will not appear in the final survey. If you start a selection but which to cancel it, press **Cancel Select**.



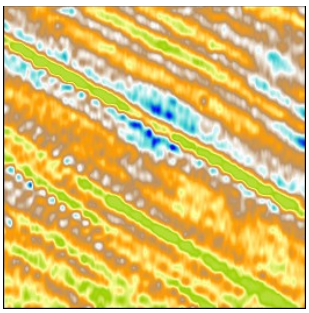
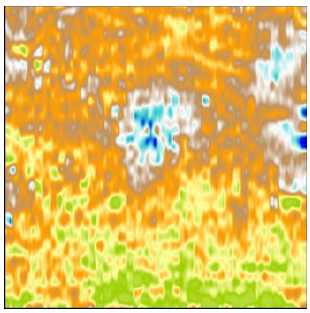
Make sure you do not clear the very center of the cross as this generally represents the 'real' data.

Multiple areas can be selected and cleared. All the deleted areas are shown in the list in the middle of the dialog box. You can delete any selection by clicking on it's entry in this list and clicking **Delete Sel**. at the bottom. All selections can be removed with the **Delete All** button.

The **Resolution** of the image used to calculate the 2D FFT can be set to a low (500x500 pixel), medium (1000x1000 pixel) or high (2000x2000 pixel) image. The default is 1000. Because the survey is converted to an image to perform the 2D FFT, some artifacts may be introduced in large or high resolution surveys. This effect can be reduced by using the high resolution image, however processing time will be increased.

A **Threshold** can be set to exclude out-lying values from the 2D FFT process. If the Threshold is set to any value greater than zero, the cut-off values will be set to the current layer median +/- the SD x the threshold value. Excluded datapoints will not be used to calculate the FFT (the cut-off value will be used instead) If the **Keep vals outside Threshold** checkbox is set, the excluded values will be used in the results layer rather than the calculated values.

Once you are satisfied with the result, click **OK** and the filter will be applied to the main composite.

The result of applying the 2D FFT process to data with heavy plough marks.	
	

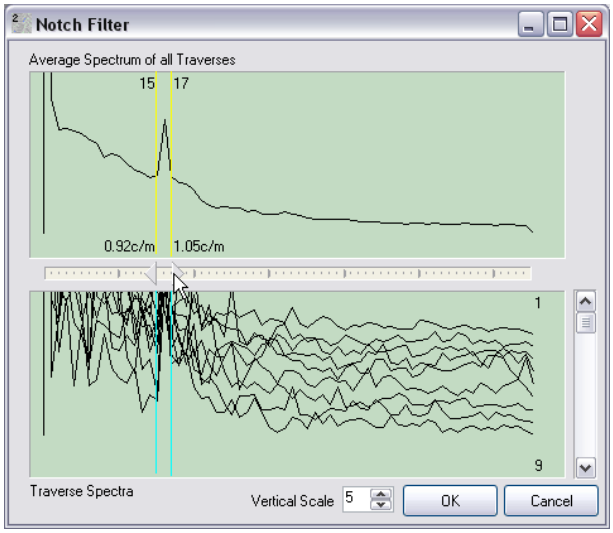
5.15 Notch Filter

The Notch, or Band-stop filter is used to remove or reduce a regular frequency background signal. Unlike the 2D FFT filter described above, the Notch filter only works along the traverses, i.e. in what is assumed to be the direction of travel for the operator. Its focus on one axis allows it to be far more precise in identifying and filtering errors in this axis than the 2D FFT can be.

> Note: This filter can only be applied to Bi-polar data. It is therefore not normally suitable for Resistivity data.

The Filter uses Fast Fourier Transforms to calculate the strength of every frequency present in each traverse (for the full width of the survey or a selected area). A particular frequency or range of frequencies can then be selected and reduced to zero.

The Notch filter Dialog box shows the average spectrum of the complete selection/survey in the top window and a scrollable, detailed spectrum of each traverse in the bottom. Use the slider bar between the two windows to set the upper and lower limits of the frequency to be filtered out. The vertical lines in each box will move with the slider to show the exact extent of the notch.



The vertical scale can be changed to improve the readability of the traces.

Because the signals are a product of the movement of the instrument, the frequency spectrum is in cycles per meter (c/m). The frequency is shown at the bottom of the upper window. The numbers at the top of the window refer to the Spectra as defined in the FFT.

The lowest frequencies are on the left, the highest on the right. The maximum frequency that can be measured by the instrument is determined by the sampling frequency, at 2 samples per meter the max frequency is 1 c/m, at 8 samples per meter it is 4 c/m.

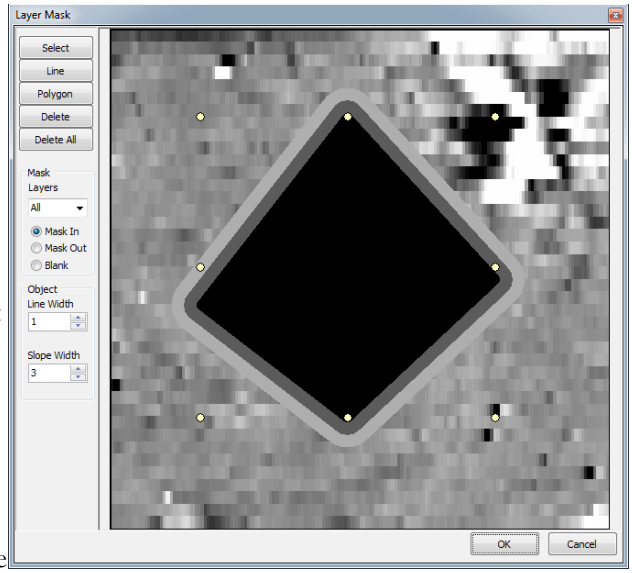
The 'real' archaeological data will effectively have a frequency of (virtually) zero as it is randomly distributed across a traverse. This will therefore form the bulk of the left-hand side of the graph. There will also be a flat region on the right. This is a natural result of the way in which FFTs work. , It will always be there but will change in size depending on the length of the traverse (i.e. width of the selection/survey). The point at which the trace goes flat corresponds to the maximum frequency in the data.

5.15.1 Usage:

The type of error the Notch filter can remove is limited to a regularly repeating cycle along the traverse. This is typically caused by the operator's walk having a constant 'beat' to it or other, operator or instrument problems. Generally, any errors will appear as narrow peaks in the central portion of the trace. To remove the peak set the max and min sliders to as close to either side of the peak as possible. You may find that repeated applications of the filter, slightly offset from previous applications, are necessary to remove all the peak.

Care must taken as the correction applied is a square, i.e. All data within the selection is reduced to the same level. Too wide a selection about a peak will reduce the top of the peak to the background level but will also reduce the sides of the peak below background level.

5.16 Mask



An ancillary process that prevents the application of subsequent processes to an arbitrary area or removes an area from subsequent processes.

All processes are normally applied to either the full survey or a rectangular selection. However this may not be sufficient for some processes and surveys. In this case the Mask process can be used to apply a process to a more precise area. The process works by allowing you to draw lines and/or polygons on the survey. The areas drawn will be ignored by subsequent processes. Either the data that is in the layer below the mask will be used or dummy values will be displayed instead.

To draw a line or polygon object, click on the appropriate button then click on each corner of the required line/area on the shown survey. The object may have as many points as you wish and there may be any number of objects on the mask. Double-click the last point to finish the line or close the polygon.

In either Mask mode (Mask in or Mask out) each object has 2 properties: **Line width** and **Slope width**. The line width simply sets the width of the object. The Slope width allows the object to have a more gradual effect, sloping or softening the edge of the shape. It does this by drawing 2 more objects around the outside of the main object at 2/3 and 1/3 intensity. The width of these objects is determined by the slope width property. The effect of this slope is to allow only 1/3 or 2/3 the difference between the two affected layers to actually be applied to the top layer. For example in a simple data set where all values are 100, applying a Math process to add 100 to all values would result in 200 outside the Mask, 100 inside the central black area, 133 in the dark grey band and 166 in the light grey band. The width properties are in meters (though due to the graphical nature of the mask process this is approximate).

In **Mask** mode, the Mask is be applied to all subsequent layers or just a number of layers (up to 9) after the mask. The mask can either apply to the data covered by the mask (Mask out) or all the data not covered by the mask (Mask in). In the latter case the mask will turn the colours of the object to white and have the effect that subsequent processes will only be applied to data covered by the objects, data outside the masked areas will not be processed.

In **Blank** mode all data points covered by the masked area are replaced by the survey's dummy value. The **Slope width** is fixed at zero for this mode.

Notes:

Slope & Line width are related to the survey interval (actually ½ * (X interval + Y interval))

The Mask itself does not affect the displayed data, it only affects the results of subsequent processes. This means that if you create a mask that blanks an area, there will initially be no change to the displayed data, it is only when other processes such as clipping, etc are applied that the blanked area will be shown as dummy values.

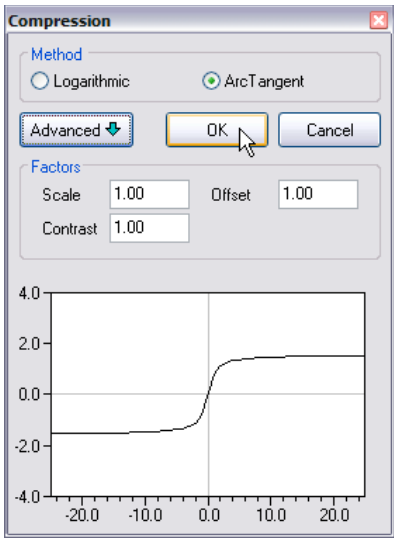
All processes are actually calculated for the whole survey area (or rectangular selection). The Mask process is then applied afterwards and unprocessed data 'floated' up from previous layers as required by the mask. This means that features (spikes, etc.) close to the edge of a mask with a wide effect may still show through even though they appear to have been masked off.

The survey will always be shown as a simple block shade view with the currently selected colour scheme, no matter what view or settings are selected for the survey.

5.17 Compression

Apply a compression algorithm to the current layer.

By default only the basic dialog box is shown. This allows a simple choice of **Logarithmic** or **ArcTangent** compression. The difference in effect can be seen in the plot shown at the bottom of the dialog box.



Clicking the **Advanced** button will show or hide the lower portion of the dialog box. Here you can vary the Factors (values) for **scale**, **contrast** and **offset** to tailor the curve of the algorithm to your requirements. The default values for these can be set in **Preferences**.

5.18 Normalize

Converts all values within a grid or selection to a value within the range 0 to 1 where 0 equates to the lowest value in the area and 1 the highest.

Can be applied to Grids (ignores current selection), selected area or the whole survey. These are the only parameters applicable to this process.

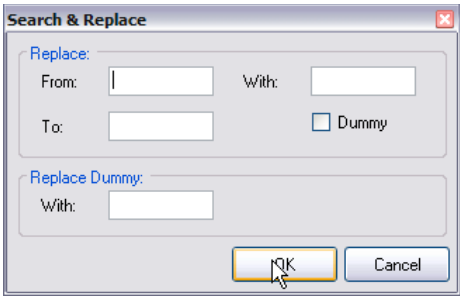
Primarily used to reduce differences between grids caused by instrument & environmental factors, most often seen with resistivity data. Particularly useful prior to the application of Periphery Matching (in which case it must be applied to Grids).

Note that once applied, the values are just numbers that fall within the range 0 – 1. Subsequent processes may well cause datapoints to move outside the 0 – 1 range.

5.19 Replace

Search for and Replace datapoint values with a specified value or the dummy. Can be for all the composite or a selection.

Two panels are provided: The main one allows a single value (set both the **From** and **To** to the same value) or range of values to be replaced by another value. Dummy values are ignored. Checking the **Dummy** box will replace the values in the input range with the current composite Dummy value. The second panel allows the dummy value to be changed to a new value.

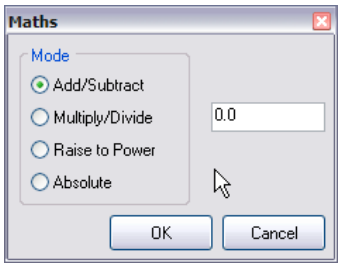


5.20 Basic Maths

A range of basic mathematical functions can be applied to the current layer or a selection. These are:

- Addition
- Multiplication
- Power
- Absolute

All functions are aware of the dummy value and will ignore it. If a calculation results in a value equal to the dummy value, a small offset will be added to the result to ensure the value is not mistaken for the dummy by the views or subsequent processes.



Add/Sub adds (or subtracts if negative) the specified value to every datapoint in the current layer or selection.

Mult/Div multiplies (or divides if less than 1) every datapoint in the current layer or selection by the specified value.

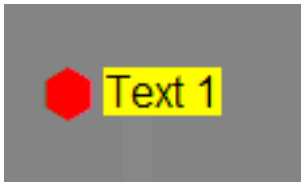
Power rasies every datapoint in the current layer or selection to the power of a specified value. Numbers less than 1 result in the root of the value (power of 0.5 is the same as the square root).

> **Note:** If the Layer contains negative values, all values are increased by the Minimum value prior to application of the Power function. The new values are then decreased by the same amount. This is necessary to prevent errors when raising negative numbers to a power.

Absolute makes every datapoint in the new layer positive (i.e. -1 becomes 1).

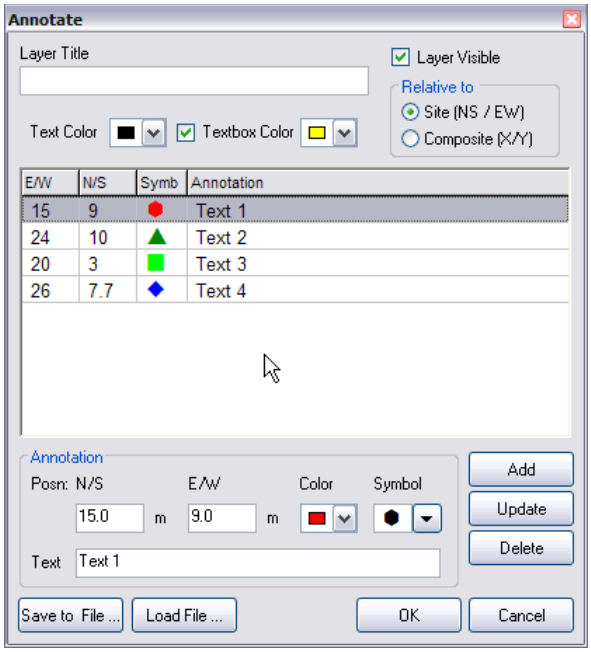
5.21 ANNOTATION

Create a layer of Text Annotations that appear over the Survey image.



Unlike the other processes, annotations are not directly related to the underlying data. Instead, they are symbols such as triangles, squares, etc. (optionally with some associated text) that are placed at a specific location over the survey. The annotations are either entered manually or can be imported from a simple text file. The annotations can be used to highlight points that are associated with the survey such as the location of surface finds, reference points, obstacles, etc.

Any number of annotation layers can be added to a composite and can be added at any position in the layer 'stack'. All annotation layers 'float' to the top and are drawn over the survey itself (unless they are set to invisible).



Each layer can have a number of attributes and parameters associated with it. These include:

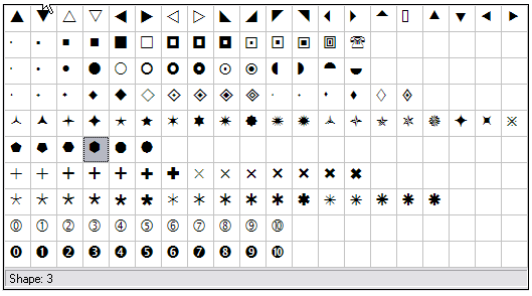
- a title
- whether the layer is visible
- whether position values are relative to the site (North/South, East/West) or composite origin (X & Y)
- a color for associated text
- use and color of associated text background

Each annotation has:

- an X & Y value in meters (relative to either the site origin or the composite origin)
- a symbol selected from a table of predefined symbols
- a color for the symbol
- some (optional) associated text for the annotation

Annotations can be added to a layer by two methods, either individually in the dialog box or by importing a text file. Once a file has been imported each entry can be modified individually. To add a new annotation, click on the **Add** button, fill in the relevant information and then click **Update**. To edit an existing entry, select the entry from the list at the top, edit the data and then click **Update**. A layer's entries can also be exported as a text file in the same format as the import file. Once an annotation layer has been created, all the necessary data is stored in the composite file. The import file (if used) is no longer required.

A range of predefined Symbols are provided, grouped into sets based on their basic shape. These sets are shown here and listed by name below. All the predefined symbols are taken from the standard Windows symbol fonts (Wingdings & Wingdings 2). The list of sets and/or the symbols in them can be modified in **Preferences**. Other symbols or complete sets can be added from other fonts (remember though that if composites are to be copied to other PCs, other users may not have these fonts installed).



The format for the external text file is a simple TAB separated ASCII file. Each line represents an entry. It must be in the form:

```
1       2     Shape     3    Red     Text 1
11      5     Round     5    Green   Text 2
13.3    7.5   Square    4    Lime    Text 3
14      13    Diamond   4    Blue    Text 4
```

The columns are:

- East/West or X value in meters
- North/South or Y value in meters
- Name of a symbol set
- Symbol seq number within the set
- Symbol Color
- Optional text associated with the symbol

Notes:

East & North are positive, West & South negative. X & Y values must always be positive and go downwards and right from the top-left corner of the composite.

The rotation of the Composite is taken into account when placing the Annotations.

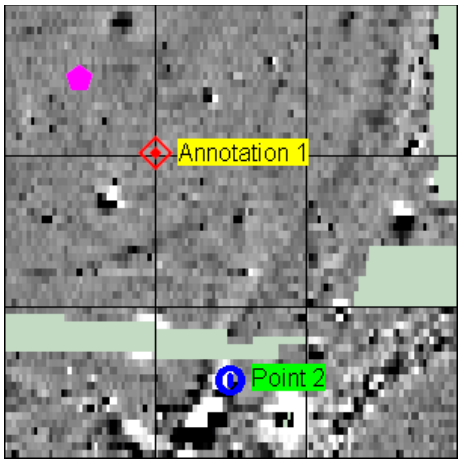
Predefined Symbol sets are : Triangle, Square, Round, Diamond, Star, Shape, Cross, Asterisk, Numeral and Numeral (filled). The sets can be changed to anything you like in **Preferences**.

Available colors are : Aqua, Black, Blue, Dark Gray, Fuchsia, Gray, Green, Lime, Light Gray, Maroon, Navy blue, Olive, Purple, Red ,Silver, Teal, White, Yellow (see below)

Colors in the import file may also be specified by number (1 = Aqua, 2 = Black, etc.) in the same order as the color names above. Exported files will always use the names.

Aqua	Black	Blue	Dk Gray	Fuchsia	Gray	Green	Lime	Lt Gray	Maroon	Navy Blue	Olive	Purple	Red	Silver	Teal	White	Yellow

Annotations in use.
Three different annotation layers are used to provide 3 different label styles.



5.22 GPS Clip

Only applicable to GPS datasets.

Replace all values in the current layer outside a specified minimum and maximum with those values. Min and Max can be specified in absolute values or +/- SDs.

Uses the same dialog box as the normal Clipping process (see 5.1Clipping for details).

5.23 GPS DeStripe

Only applicable to GPS datasets.

Determines the median of each transect or track and then subtracts that value from each datapoint in the transect. May be used to remove the striping effect seen within a survey caused by directional effects, operator habits, instrument setup, drift, etc.

Has most of the functionality of the main DeStripe process however the GPS version does not have the **Apply to** or **Orientation** checkboxes as these have no meaning here. DeStriping is always applied to transects.

Transects are defined by markers embedded in the source data. See the Import process description for details. If transects are not explicitly defined in the source data, they can be inferred by the **Remove Turns** process. (See 5.28.3 Remove Turns below)

5.24 GPS Despike

Only applicable to GPS datasets.

Scans the transect using a one dimensional, uniform weighted window looking for datapoints that exceed the mean/median of the window by a specified threshold amount. When found, the point is replaced by either the mean/median or threshold.

The dialog box for the GPS DeSpike is similar to that for the main DeSpike process, the only difference is that there is only one diameter for the window (along the transect).

Transects are defined by markers embedded in the source data. See the Import process description for details. If transects are not explicitly defined in the source data, they can be inferred by the **Remove Turns** process. (See 5.28.3 Remove Turns below)

5.25 GPS High / Low Pass

Only applicable to GPS datasets.

Uses either a uniformly or Gaussian weighted window to remove high or low frequency components in a survey. Applied in one dimension along the transects/source data.

The dialog box for the GPS H/L pass is similar to that for the main H/L Pass process, the only difference is that there is only one diameter for the window (along the transect).

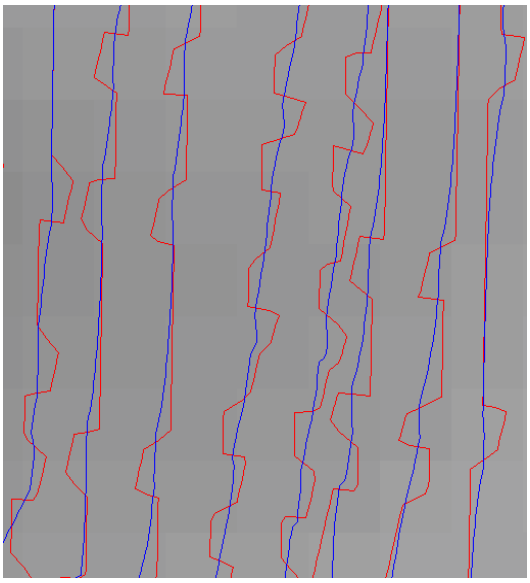
Transects are defined by markers embedded in the source data. See the Import process description for details. If transects are not explicitly defined in the source data, they can be inferred by the **Remove Turns** process. (See 5.28.3 Remove Turns below)

5.26 GPS Straighten

Only applicable to GPS datasets.

Corrects sudden changes in X&Y positions that may be caused by changing GPS satellite constellations. The process compares the distance between each point and the next to the median distance between points. If the distance is greater than 2x median, the next point is assumed to have jumped due to satellite constellation changes or other GPS error sources. The next point is moved to a point based on the distance and direction to the previous point. All subsequent points are also moved by the same amount (decreasing by 10% every point). The illustration shows the original track in red and the straightened result in blue.

Note that in cases of extreme changes, particularly if the track direction reverses, the straightened track can actually become worse. In this case it is recommended that the offending source points be deleted prior to application of the process. To deleted points, turn on the display of Current Points in the GPS Track button (View Settings). Then right-clicking on the relevant point and select Delete from the pop-up menu.



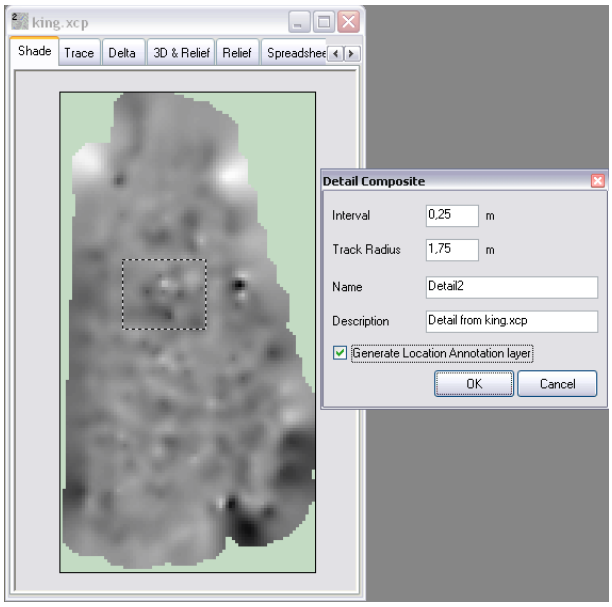
This process has no parameters and therefore no dialog box.

5.27 GPS Detail

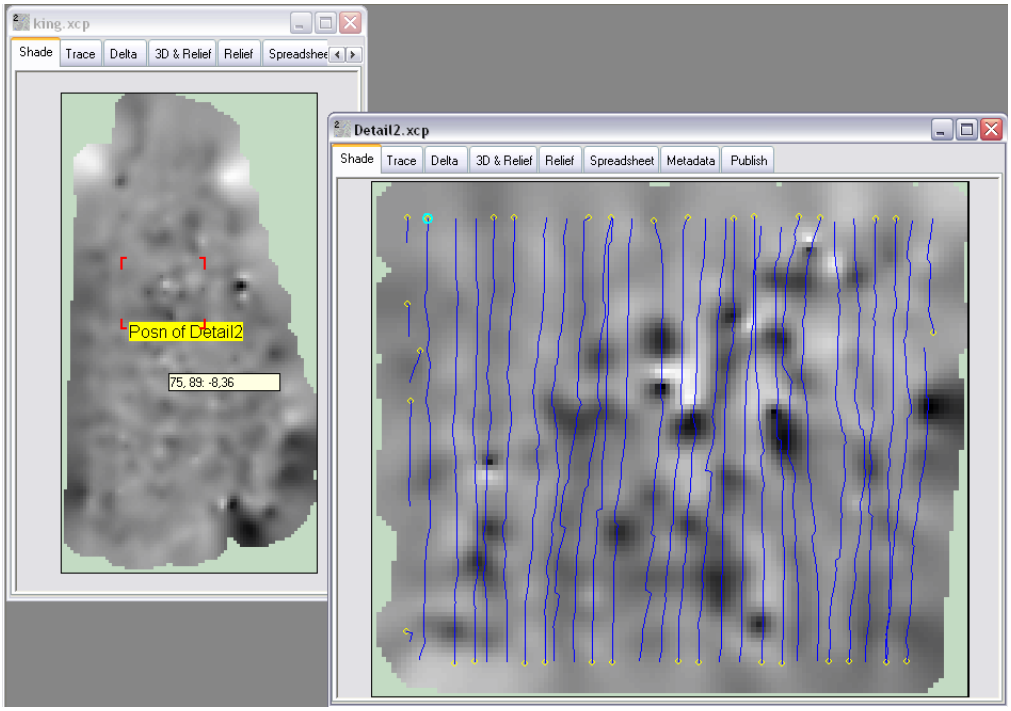
Only applicable to GPS datasets.

Because GPS source data may have a varying data density (the number of points within a certain area), it is often inefficient to interpolate a complete survey to the highest density available within the source (see **Interval** in GPS Base below). TerraSurveyor therefore provides a mechanism to select an area of a survey and extract that area out to a separate survey. Only source datapoints within the selected area are copied to the detail. This smaller detail survey is interpolated to a higher density (x2 the source by default) to make full use of the data available. Annotations can be generated in the source composite to show the area selected for the detail. Note that the annotations indicate the selection area, however because of the Track Radius the area covered by the detail will actually be bigger. Also the edges of the detail are generated from only the points in the selection so the edge will probably appear different to the source composite.

GPS Detail: Selected area and dialog box.



GPS Detail: Annotated source and detail composite (with track traces turned on).



5.28 GPS Base

Only applicable to GPS datasets.

5.28.1 Base Interpolation

A couple of settings are used by the interpolation process when converting the source data into a normal layer. These are initially set during the import process but can be changed via a dialog box associated with the GPS Base layer. The 2 settings are the **Interval** and **Track Radius**.

Interval sets the X & Y interval of the interpolated data (only square intervals are supported for this type of data). This value should be kept as large as possible relative to the area of data and number of source datapoints. For example: If the source data for a 1Ha survey is recorded at 0.1m intervals but with a track spacing of 2m, the average is about 50,000 points per Ha. However the using the recording interval as the interval for the whole survey a composite will have 1 million points to interpolate. In this case an X&Y interval of 0.5m would still give a resolution approximately equivalent to the source average but be about 25 times faster to process.

If higher resolution is required for certain areas of the survey, a GPS Detail can be selected and extracted to a separate composite.

Track Radius sets the area around each datapoint that is included in the interpolated result.

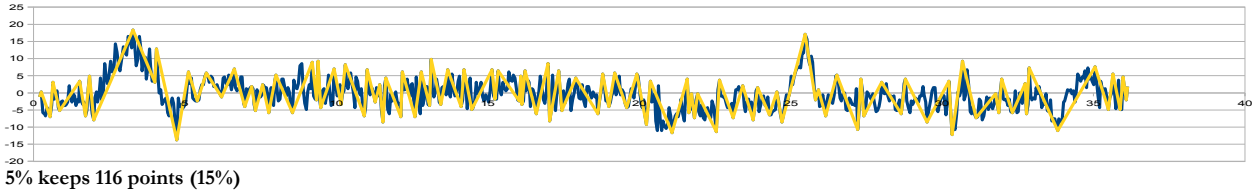
Tracks (or transects) are the lines of data gathered in one direction, they equate to the rows of data gathered by conventional griding methods. Though not essential with GPS data it is recommended that tracks be used to ensure complete and efficient coverage of a survey area. The distance between each track should be roughly constant and the Track Radius a little bigger than this distance. This will ensure that adjacent tracks will be displayed as a contiguous area while edges and unsurveyed areas will be displayed as dummy values.

5.28.2 Reduce Points

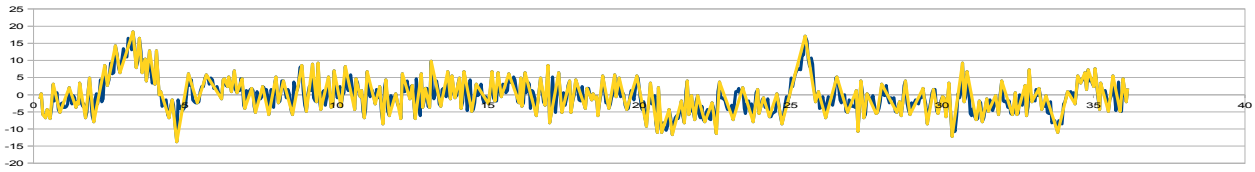
This function was previously implimented as a separate process. However, as it is primarily intended to reduce system memory requirements, it is best applied immediately the data is loaded. By making the function part of the Base layer, this can be achieved and controlled.

Uses the Douglas-Peucker polyline simplification algorithm to reduce the number of datapoints passed to subsequent GPS processes. The algorithm removes points in the source data that are not necessary to creating a good representation of the overall shape of the data. This reduces the amount of data that needs to be stored and processed by TerraSurveyor during subsequent operations. This can be a significant factor with very large (>10 million points) datasets. The tolerance of the algorithm can be set to control the accuracy of the reduced dataset's fit to the original. The lower the tolerance, the closer to the original. The tolerance is expressed in percent of the + & - 1 SD range of the source data, a value of 2% seems to provide good accuracy with a significant reduction in points. The default tolerance can be set in Preferences.

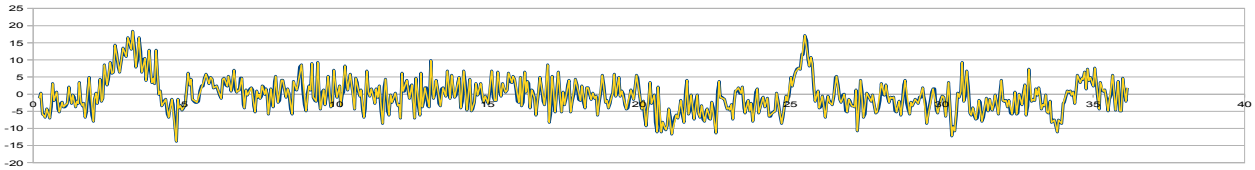
The following charts show the same sample data (40m long, 747 points) reduced with 5%, 2% and 0.5% tolerance (blue is source, yellow reduced):



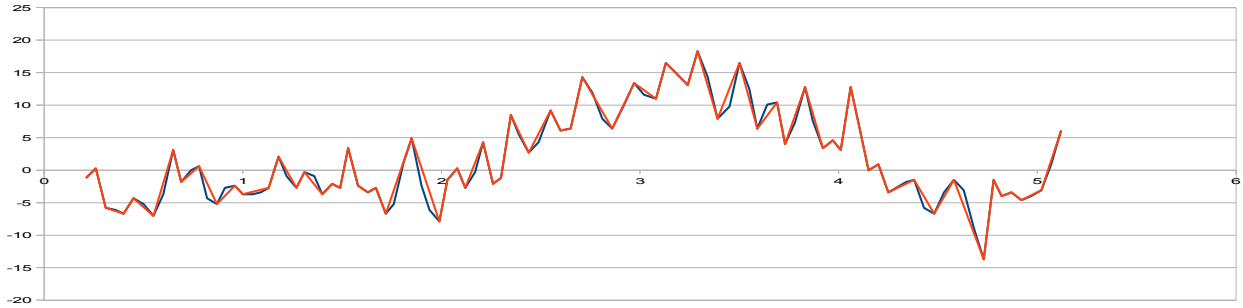
5% keeps 116 points (15%)



2% keeps 227 points (30%)



0.5% keeps 451 points (60%)



first 5m @ 0.5% tolerance in detail

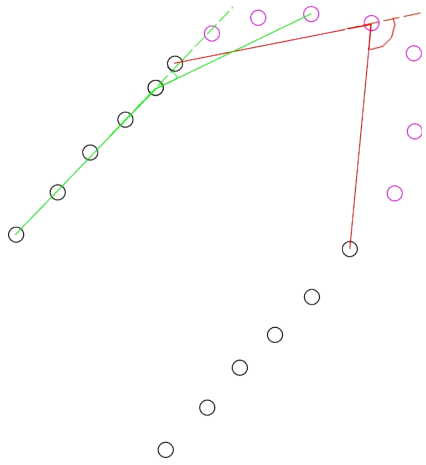
5.28.3 REMOVE TURNS

This function is implemented as part of the Base layer. As with Reduce Points, this function has to be applied to the data before any further processing – and in fact is applied to the data before Point Reduction (if used).

Used to cut tracks of data that do not have start and end traverse markers, such as that collected as a continuous stream with simple cart based systems. Many subsequent GPS based processes are ineffective without defined traverses (De-Stripe in particular).

As with many processes, the effectiveness of turn recognition will be influenced by many factors. Certain datasets or data collection methods may not lend themselves to turn recognition. Actions such as reversing or obstacle avoidance may well result in a turn being identified when a human would not see one. Conversely situations that appear to the user to be 'obvious' turns may not meet the processes criteria. Ultimately this process should always be seen as an aid to handling poor data, it should never be considered a standard, reliable tool for general use.

This function looks at the angle made from each point to another point a fixed number ahead and behind it. If the angle is greater (i.e. away from a straight line) than the defined threshold, it is assumed a turn has been started. The test continues on each point until the angle starts to decrease at which point the function assumes the apex of the turn has been reached (or just passed) and the cut is initiated. The cut marks a number of points either side of the turn apex as deleted and marks the last and first points either side of this as End and Start markers. The function has 3 parameters: Threshold angle (described above), Threshold length (the number of points in front and behind used to calculate the angle) and Cut Length (the number of meters in front and behind the apex that are marked as deleted).



A simplified example illustrating a threshold length of 4. The green line shows the Threshold angle has not been reached. The red line shows that the angle has been exceeded and the apex found. The magenta points either side of the apex are then marked as deleted to break the track into 2 straight, parallel traverses.

6 TUTORIAL

This tutorial gives a brief overview of the basic operations of TerraSurveyor. It assumes that the sample files have been loaded to the default installation folder (C:\Program Files\TerraSurveyor).

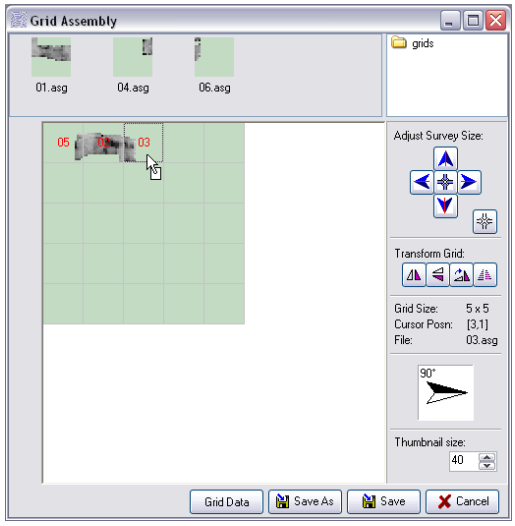
6.1 ASSEMBLE GRIDS INTO A COMPOSITE

- Go to **File | Open**
- Select the site "Develstein"
- Click **Select Site**
- Click **File | New**

OR

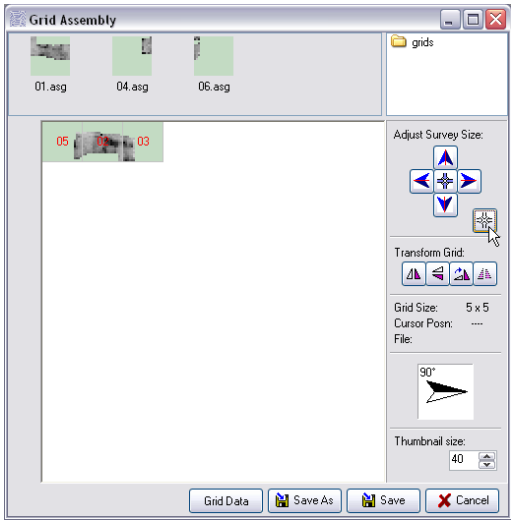
- Use the **NavBar** to select the site "Develstein"
- Click **Assemble New Grids** in the **NavBar**.

- The Application title and the **Site:** box in the status bar will show the name of the selected site.



- You will see a window showing a new, empty Grid Assembly area. The available Grids will be shown in the bar at the top as greyscale thumbnails of their data. There should be 6 of them (use the scroll bar or drag the line between the Assembly area and the thumbnails down to show them all)
- Click on the first thumbnail (02.asg) and drag it down onto the Assembly area. It belongs in the first row, second column.
- Click and drag two other thumbnails into position - 05.asg in the left corner and 03.asg to the right).
- Experiment with moving the thumbnails around, moving them back onto the bar and placing one on top of another. You will see that manipulating the thumbnails is very easy.
- Select one of the thumbnails by clicking on it (there will be a faint dotted line drawn round it). Then click on one of the four buttons to the right of the Assembly area. These will flip the data (left-right or top-bottom) or rotate it clockwise in increments of 90° (180° if the data is not symmetrical in X and Y). These transformations will be applied to the data as saved in the final Composite. You will also be asked if the changes are to be applied to the Grid files when you save the composite. If you say Yes, you will be asked for a name for the transformed grid file (by default '-a' will be added to the filename). To undo any changes made, just drag the grid back onto the top bar and then drag it back.
- Click the 4-way arrowhead at the center of the 4 arrow buttons. You will see that the four arrowheads swap direction. These arrowhead buttons allow you to change the size of the Assembly area. Click on the bottom button 4 times to shrink the Assembly area to the data. Do the same for the Right side. Experiment with these keys. You will see that warnings are given if grids containing data are going to be removed. Using these keys, an existing Composite can be expanded to add additional Grids at a later date.

Tip: Instead of clicking the center 4-way arrow, you can also just hold down the **shift** key. You can also click on the small, 4-way arrow button below and to the right of the main arrow buttons. This will shrink the Assembly area to fit the placed grids in one operation.



- Save the small composite you have created by clicking on **Save As**. Give it a name (test1) and close the Grid Assembly window.
- Reopen the Composite you just made: from the **NavBar** or **File | Open | Open as Grid Assembly**.
- Expand the Grid downwards by clicking on the Down Arrow button. This will add a blank row below the three existing grids.
- Select the other 3 grids from the bar to fill in this new row (in the order 04 - 01 - 06). You will notice that the 3 grids already on the Assembly area were not on the bar, only unused grids are shown here.
- Save the revised Composite (click on **Save**) and return to the main window.
- Take a look at the Composite you have just created by double clicking the entry in the **NavBar** comp list or in **File | Open**.

6.2 Process a Composite

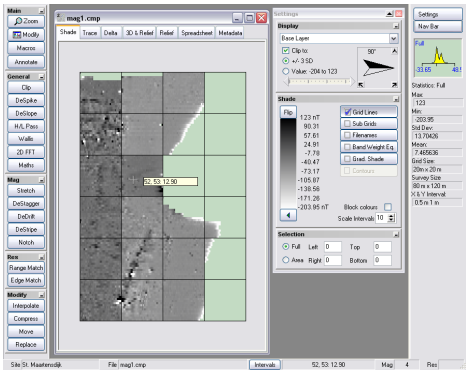
The processing for a Composite will be different in every case, however there are a number of common steps that often need to be taken.

- From menu **File|Open** select the Site "st maartensdijk".
- Open the Composite mag1.

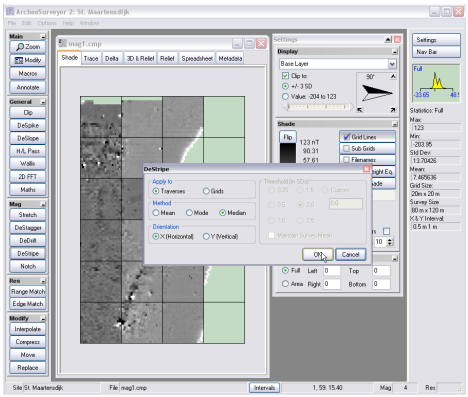
OR

- Use the **NavBar** to select the Site "st maartensdijk" (the folder name is stmaa but the full name is placed after it in brackets)
- Double-click mag1.cmp in the **NavBar** file list.

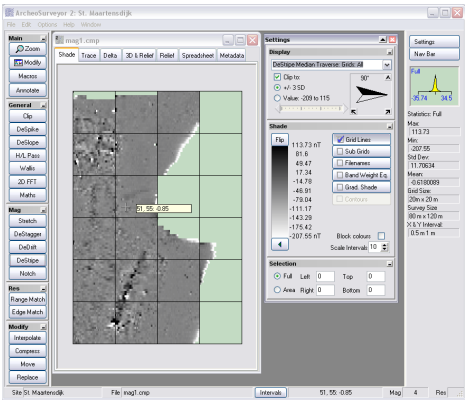
You will see that this is a single layer composite, the Layer Select list (top right corner) shows only the Base layer. It is obvious that there was a difference in the set-up of the instrument between the left column and one grid of the second column and the remainder of the grids. The 2 sets of grids have a clear difference in mean level, showing as a darker colour on the left. This can also be seen in the sidebar histogram as 2 distinct peaks. Our first task therefore is to remove this difference.



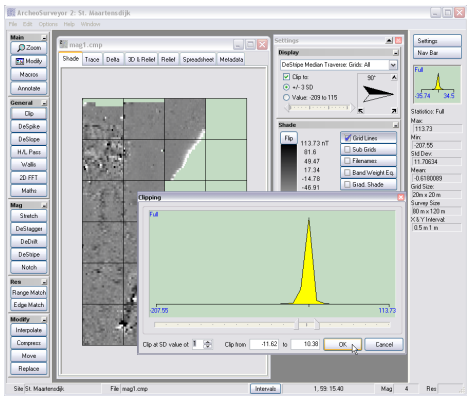
Click on the **DeStripe** button. Because no specific selection has been made, the process will automatically be applied to all the grids in the composite. Select Median mode (this usually gives the best results and is the simplest). Click OK.



You will see that the survey now has an even background colour. The histogram also now has just one peak. This peak is however very narrow. This shows that there is a small amount of data very far above and below the mean. These outlying data points squeeze the majority of the data into a narrow band in the center, which means that they all have about the same colour. This is the next thing to correct.

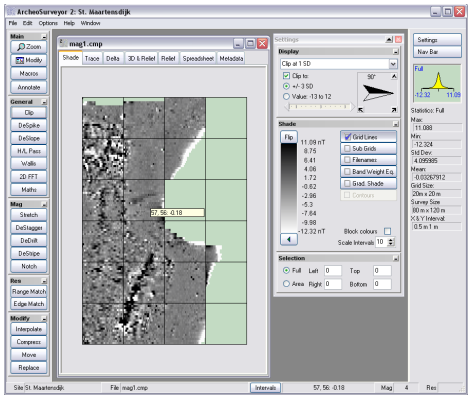


Click on **Clipping**. This will pop up a box showing the histogram again, but not clipped at +/- 3 as the one in the main window was. This shows the full range of the data (about -200 to +100 in this case). Use the spin button to set the clipping to +/- 1SD. This will move the sliders to values equal to 1 SD above and below the mean value. You can also move the sliders yourself to any value you like. Using the SD buttons is the better option though, especially if more grids might be added to the composite as then the process is applied to the new limits of the data, not those set for this set of data. Click OK to return to the main view.



You will see that the data has much more definition now.

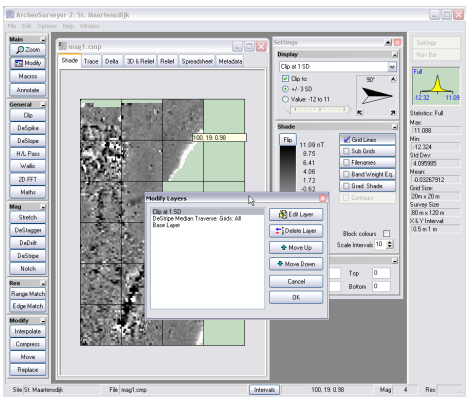
It might be necessary to apply the Clip process more than once if the data has some very extreme values.



Select the **Delta** Tab at the top of the window. Select the Base Layer in the bottom list and the Clipping layer in the top list. You will now see a shade view of the difference between these 2 layers. This can be very useful for spotting if filters and processes have been too aggressive and have started to remove important information.

In this case you can clearly see the effect of the DeStripe as a set of stripes – this is normal for this filter. You can also see a linear feature at the bottom of the survey. This is the result of the clipping and could be an indication that the process was too severe and is removing archaeological data.

Go back tot Shade view and click on **Modify**. The window will show a list of all the layers created in the composite. You can move, delete or edit the parameters of any of the layers and the view will be rebuilt from the base layer's data.



7 The Software

7.1 System Requirements

TerraSurveyor can be installed on any Windows-based PC from XP onwards (WinXP, WinNT, Win2000, Vista, Win7). The program *may* still run on Win 98 machines however this cannot be guaranteed and will depend on the user's specific hardware and software setup.

A USB port is required for the registration dongle (if used).

The 3D view makes use of a imaging system called OpenGL. This will be available automatically on any Windows PC However, older PCs may not support version 1.4 – which is the recommended minimum to run the features used in the 3D view. The program checks for this at startup and will warn you if the PC does not support 1.4 or above. The speed at which the 3D view is generated and manipulated will depend on the power of the video card or on-board drivers.

7.2 Installation

The software is provided as a single installation file called **ASv2-Setup.exe**. Make sure you are logged on as a User with Admin rights before installing the program. This is necessary to allow the installation process copy the files to the correct places and make some changes to the registry.

Start the **Setup** program **Asv2-Setup**. The wizard will take you through a number of steps to install the program and it's components. By default the program will be installed in C:\Program Files\TerraSurveyor. This is the path that will be assumed in this manual. The program, templates and example sites will be created in the installation directory. In addition, after the files have been copied, you will see a message that "INF file 'IWUSB.INF' was successful installed!" This indicates that the driver for the USB dongle was installed. This is necessary for all installations - including trial and machine code registrations that do not use the dongle.

Once the installation is complete, you will see a new TerraSurveyor icon on the Desktop and an entry under Start | programs.

The first time TerraSurveyor is started, all the templates will be copied to the current User's Application Data directory. This will normally be in:

C:\Documents and Settings\[user name]\Application Data\TerraSurveyor

but may vary for other versions of Windows and languages. It is your versions of the templates that are accessed by the program when running, *not* the versions in the installation \templates directory. This enables each user to have their own preferences, palettes, import and download settings.

7.3 Registration

The initial installation of TerraSurveyor will give you a 30-day trial period to evaluate the program. During this period Graphic Save functions and Direct Print will work but all images will be overprinted with the word TRIAL. After this period the program will continue to work, but ALL save, download, import and print functions will be disabled. This includes saving of Grids and Composites!

To register the program, please fill in the registration form at www.dwconsulting.nl

Or contact us at orders@dwconsulting.nl

Two methods are available to activate the program:
Machine Codes
Dongle

You will be asked to select which method you want to purchase when you place your order.

7.3.1 Machine Code

This method of registration locks a license to a particular PC. This is done by using certain serial numbers specific to the PC to form part of a digital 'key'. To create this key you will need to install the program, run it in trial mode and send the Machine Code (see Help | Registration) to us.

Once payment for the license(s) has been received, an Unlock code for each PC will be e-mailed to you. This code should be copied and pasted into the Unlock Code box in the Registration window. If you have more than one license make sure that each Unlock code is used with the correct PC.

7.3.2 Dongle

The Dongle is a small component that plugs into any USB port on a PC. The program regularly checks for the physical presence of the dongle. If the dongle is removed the program will revert to Trial mode, if the Trial period of 30 days has been passed ALL save, download and import functions will be disabled.

Once payment for the license(s) has been received, a dongle for each license will be sent to you in the post. TerraSurveyor can be installed on as many PCs as required but only a PC with a dongle plugged in will be able to download data, save graphics, etc.

7.3.3 Pros & Cons

Both methods have their advantages and disadvantages. The Dongles provide the greatest flexibility as they can be moved from PC to PC as required. You could, for example, have TerraSurveyor installed on a laptop for in the field and a PC in the office. You would however only need one dongle to operate them both (though not at the same time). Universities can invest in just a few dongles and issue them to students or faculty members as necessary for their work. Commercial companies could purchase a dongle to accompany each survey machine. You should only have to install the program (itself a simple matter) and plug in the dongle.

Disadvantages are that the dongle is a relatively small item that could be lost or stolen. Also, because it generally protrudes from the rear of a laptop, it is vulnerable and could be broken off or damaged.

The Machine code method is much quicker to implement - you don't have to wait for the dongle to arrive in the post. Once installed, it cannot be lost or broken but it also cannot be transferred.

We do understand that PCs are occasionally replaced and will be willing to provide new Unlock codes in this case. However, for obvious reasons this will not be done more often than once per year, per license and we reserve the right to deny the user new unlock codes if we feel that the service is being abused. Damaged dongles will be replaced for a small fee on return of the damaged unit. Lost dongles are however your responsibility!

7.4 APPENDIX: XML SCHEMAS

The Grids and Composites can be saved in XML format. The structure of the XML files is (currently) only defined in the program code. However, for good order, the following schemas define that structure in accordance with W3 standards. For more information on XML and Schemas refer to www.w3.org.

The philosophy behind the schemas is to define related aspects of the data in a single element. As far as possible, attributes are used to actually hold the values. This is more efficient and offers greater control over the format of the value. For example, the Date attributes are defined as xs:date. This means that their contents *must* be in the format "yyyy-mm-dd". Anything else - such as "yy/mm/dd" or "dd.mm.yy" is not permitted.

It is envisioned that in the future hardware will evolve from the current proprietary download streams to storing completed grid files in memory – hopefully in XML. The grid structure is therefore left flexible enough to allow for a range of measurement types. The Grid data is wrapped in a Data element that defines the type of data notation and the number of points. The basic type or mode is currently "XYV". This equated to the "XYZ" format already in common use. The Z axis is however reserved for the physical vertical axis, V is therefore used to indicate the measured value attribute. Other modes could be "V" which would equate to the common "Z" format, "XYZV" for multi-layer, 3 dimensional data, etc.

The Composite schema is specific to TerraSurveyor and so can be less flexible. The data in this case is always stored in a row by row, spreadsheet layout. Each row element has actual content: a set of space separated values. In order to minimise space requirements (and simplify the file somewhat) dummy values in a row can be replaced by "D". When read, each D will be converted to the specified dummy value.

7.4.1 XML SCHEMA FOR THE COMPOSITE FILE.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">

  <xs:element name="Composite">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="CompInfo"/>
        <xs:element ref="MetaInfo"/>
        <xs:element ref="Preferences"/>
        <xs:element ref="InstInfo"/>
        <xs:element ref="PositionInfo"/>
        <xs:element ref="GridInfo"/>
        <xs:element ref="SourceData"/>
        <xs:element ref="ProcessData"/>
        <xs:element ref="CompData"/>
      </xs:sequence>
      <xs:attribute name="ProgVer" use="required" type="xs:NMTOKEN"/>
      <xs:attribute name="Program" use="required" type="xs:NCName"/>
      <xs:attribute name="ver" use="required" type="xs:integer"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="CompInfo">
    <xs:complexType>
      <xs:attribute name="Desc" use="required" type="xs:NMTOKEN"/>
      <xs:attribute name="Name" use="required" type="xs:string"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="MetaInfo">
    <xs:complexType>
      <xs:attribute name="AssembleDate" use="required" type="xs:date"/>
      <xs:attribute name="SurveyDate" use="required" type="xs:date"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="Preferences">
```

```
  <xs:complexType>
    <xs:attribute name="PaletteName" use="required" type="xs:NCName"/>
    <xs:attribute name="ProcessTemplate" use="required" type="xs:NCName"/>
    <xs:attribute name="TemplateName" use="required" type="xs:NCName"/>
  </xs:complexType>
</xs:element>

<xs:element name="InstInfo">
  <xs:complexType>
    <xs:attribute name="Designation" use="required" type="xs:NCName"/>
    <xs:attribute name="Units" use="required" type="xs:NCName"/>
  </xs:complexType>
</xs:element>

<xs:element name="PositionInfo">
  <xs:complexType>
    <xs:attribute name="AbsXOrigin" use="required" type="xs:decimal"/>
    <xs:attribute name="AbsYOrigin" use="required" type="xs:decimal"/>
    <xs:attribute name="Origin" use="required" type="xs:integer"/>
    <xs:attribute name="Quadrant" use="required" type="xs:NCName"/>
    <xs:attribute name="TraverseDir" use="required" type="xs:decimal"/>
  </xs:complexType>
</xs:element>

<xs:element name="GridInfo">
  <xs:complexType>
    <xs:attribute name="Dummy" use="required" type="xs:decimal"/>
    <xs:attribute name="IntervalSep" use="required" type="xs:decimal"/>
    <xs:attribute name="Intervals" use="required" type="xs:decimal"/>
    <xs:attribute name="TraverseSep" use="required" type="xs:decimal"/>
    <xs:attribute name="Traverses" use="required" type="xs:decimal"/>
  </xs:complexType>
</xs:element>

<xs:element name="SourceData">
  <xs:complexType>
    <xs:sequence>
      <xs:element maxOccurs="unbounded" ref="SourceGrid"/>
    </xs:sequence>
    <xs:attribute name="RecordCount" use="required" type="xs:integer"/>
  </xs:complexType>
</xs:element>

<xs:element name="SourceGrid">
  <xs:complexType>
    <xs:attribute name="Mode" use="required" type="xs:NCName"/>
    <xs:attribute name="PosnX" use="required" type="xs:integer"/>
    <xs:attribute name="PosnY" use="required" type="xs:integer"/>
    <xs:attribute name="SensorSpacing" use="required" type="xs:decimal"/>
    <xs:attribute name="Sensors" use="required" type="xs:decimal"/>
    <xs:attribute name="name" use="required" type="xs:NCName"/>
  </xs:complexType>
</xs:element>

<xs:element name="ProcessData">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="Process"/>
    </xs:sequence>
    <xs:attribute name="RecordCount" use="required" type="xs:integer"/>
  </xs:complexType>
</xs:element>

<xs:element name="Process">
  <xs:complexType>
    <xs:sequence>
      <xs:element ref="Param"/>
      <xs:element ref="String"/>
    </xs:sequence>
    <xs:attribute name="Name" use="required" type="xs:NCName"/>
    <xs:attribute name="ParamCount" use="required" type="xs:integer"/>
    <xs:attribute name="SelectionBottom" use="required" type="xs:integer"/>
    <xs:attribute name="SelectionLeft" use="required" type="xs:integer"/>
    <xs:attribute name="SelectionRight" use="required" type="xs:integer"/>
```

```
      <xs:attribute name="SelectionTop" use="required" type="xs:integer"/>
      <xs:attribute name="SelectionType" use="required" type="xs:NCName"/>
      <xs:attribute name="StringCount" use="required" type="xs:integer"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="XYProcessData">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="XYProcess"/>
      </xs:sequence>
      <xs:attribute name="RecordCount" use="required" type="xs:integer"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="XYProcess">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="Param"/>
        <xs:element ref="String"/>
      </xs:sequence>
      <xs:attribute name="Name" use="required" type="xs:NCName"/>
      <xs:attribute name="ParamCount" use="required" type="xs:integer"/>
      <xs:attribute name="StringCount" use="required" type="xs:integer"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="Param">
    <xs:complexType>
      <xs:attribute name="Val" use="required" type="xs:decimal"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="String">
    <xs:complexType>
      <xs:attribute name="Val" use="required" type="xs:NCName"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="SourceXYData">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="XYV"/>
      </xs:sequence>
      <xs:attribute name="RecordCount" use="required" type="xs:integer"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="XYV">
    <xs:complexType>
      <xs:attribute name="X" use="required" type="xs:decimal"/>
      <xs:attribute name="Y" use="required" type="xs:decimal"/>
      <xs:attribute name="V" use="required" type="xs:decimal"/>
      <xs:attribute name="M" type="xs:NCName"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="CompData">
    <xs:complexType>
      <xs:sequence>
        <xs:element maxOccurs="unbounded" ref="Row"/>
      </xs:sequence>
      <xs:attribute name="Cols" use="required" type="xs:integer"/>
      <xs:attribute name="Max" use="required" type="xs:decimal"/>
      <xs:attribute name="Min" use="required" type="xs:decimal"/>
      <xs:attribute name="Rows" use="required" type="xs:integer"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="Row" type="xs:string"/>

</xs:schema>
```

7.4.2 XML Schema for the Grid file

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">

  <xs:element name="Grid">
    <xs:complexType>
      <xs:sequence>
        <xs:element ref="LoggingInfo"/>
        <xs:element ref="GridInfo"/>
        <xs:element ref="InstrumentInfo"/>
        <xs:element ref="PositionInfo"/>
        <xs:element ref="Data"/>
      </xs:sequence>
      <xs:attribute name="Site" use="required" type="xs:NCName"/>
      <xs:attribute name="ver" use="required" type="xs:integer"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="LoggingInfo">
    <xs:complexType>
      <xs:attribute name="Date" use="required" type="xs:date"/>
      <xs:attribute name="Mode" use="required" type="xs:NCName"/>
      <xs:attribute name="Time" use="required" type="xs:time"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="GridInfo">
    <xs:complexType>
      <xs:attribute name="Dummy" use="required" type="xs:decimal"/>
      <xs:attribute name="IntervalSep" use="required" type="xs:decimal"/>
      <xs:attribute name="Intervals" use="required" type="xs:integer"/>
      <xs:attribute name="TraverseSep" use="required" type="xs:decimal"/>
      <xs:attribute name="Traverses" use="required" type="xs:integer"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="InstrumentInfo">
    <xs:complexType>
      <xs:attribute name="Designation" use="required" type="xs:NCName"/>
      <xs:attribute name="SenSpacing" use="required" type="xs:decimal"/>
      <xs:attribute name="Sensors" use="required" type="xs:integer"/>
      <xs:attribute name="Units" use="required" type="xs:NCName"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="PositionInfo">
    <xs:complexType>
      <xs:attribute name="Origin" use="required" type="xs:integer"/>
      <xs:attribute name="Quadrant" use="required" type="xs:NCName"/>
      <xs:attribute name="TraverseDir" use="required" type="xs:decimal"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="Data">
    <xs:complexType>
      <xs:sequence>
        <xs:element maxOccurs="unbounded" ref="XYV"/>
      </xs:sequence>
      <xs:attribute name="datapoints" use="required" type="xs:integer"/>
      <xs:attribute name="mode" use="required" type="xs:NCName"/>
    </xs:complexType>
  </xs:element>

  <xs:element name="XYV">
    <xs:complexType>
      <xs:attribute name="V" use="required" type="xs:decimal"/>
      <xs:attribute name="X" use="required" type="xs:decimal"/>
      <xs:attribute name="Y" use="required" type="xs:decimal"/>
    </xs:complexType>
  </xs:element>

</xs:schema>
```

7.5 Appendix: Clipboard format

Selections can be copied to the clipboard, either from the Shade view or the Spreadsheet view, by selecting an area and selecting Copy from the Edit menu or clicking **Ctrl-C**. Once copied, the data is available in the normal Windows Clipboard. The data is prefixed with some information specifically designed to allow the data to be pasted into other composites thus retaining all relevant information regarding intervals, etc. The basic data is however plain ASCII in a tab separated grid format, suitable for pasting into a spreadsheet or word processor. The first line indicates the source of the data (TerraSurveyor). The next 10 lines contain the extra metadata, followed by the actual data.

7.5.1 Clipboard Example

```
TerraSurveyor Clipboard format
Layer  4
Dummy  2047.5
Xextent  6
Yextent  26
X Interval 0.5
Y Interval  0.5
Top  6
Left  3
Bottom  31
Right  8
Data
-11.82  -8.95  -4.51   4.86   3.97   7.54
-10.00  -5.29   2.16   5.16   5.41   7.31
 -5.49  -2.85   1.83   2.31   2.17   3.03
 -1.21  -1.71  -1.16  -0.86  -1.46  -1.11
  0.38  -1.04  -1.20  -1.49  -1.06  -1.17
  0.62  -0.08  -0.08  -0.68   0.92   0.52
  1.16   1.38  -0.40  -0.13   1.21   0.89
  0.99   1.54  -0.71   0.14  -0.01   0.24
 -0.68  -0.60   0.47   0.41  -1.48  -0.32
 -1.12  -0.82   0.43   0.43  -1.27  -0.02
  1.78   4.04  -2.97   0.07   1.67   1.38
  4.10   7.40  -5.55  -0.05   3.95   2.15
  1.99   3.25  -3.47   0.47   2.46   0.96
 -2.33  -2.68  -0.78   0.22  -0.43  -0.08
 -5.71  -4.00  -1.81  -1.84  -1.79   0.95
 -7.41  -3.36  -4.26  -3.41  -2.01   1.64
 -7.45  -4.28  -4.90  -2.34  -1.95  -0.40
 -6.65  -4.80  -3.55  -0.40  -1.25  -3.15
 -5.49  -2.39  -0.74   0.55   0.56  -4.02
 -2.31   2.24   3.04   2.29   2.99  -2.56
  3.73   7.17   6.98   6.26   5.24   0.58
  8.09   9.00   9.00   9.00   6.39   2.64
  6.69   5.71   7.85   7.37   5.75   1.46
  2.72   2.42   6.87   4.47   3.82  -0.58
  0.34   3.89   8.73   3.57   1.33  -0.97
  0.45   6.40   8.90   2.35  -1.35  -1.15
```