KTF software
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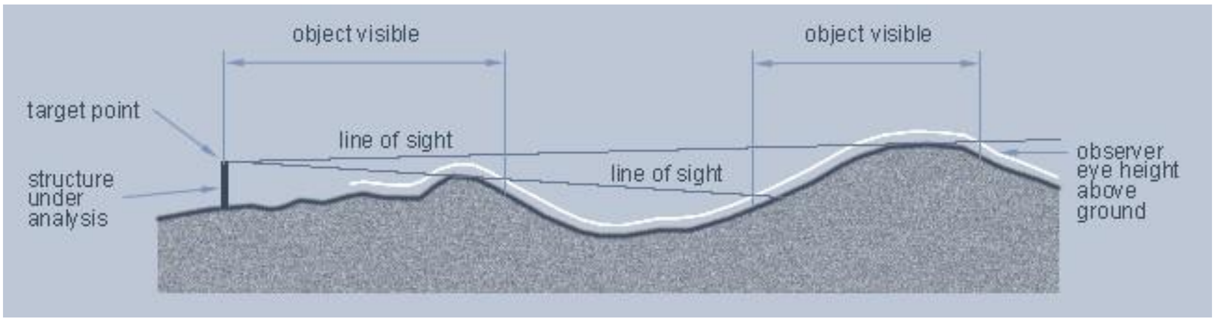
Ground Modelling, Road Design and Land Survey software for Civil Engineering, Environmental and Landscape applications working within CAD.

ZTV (Zones of Theoretical Visibility)

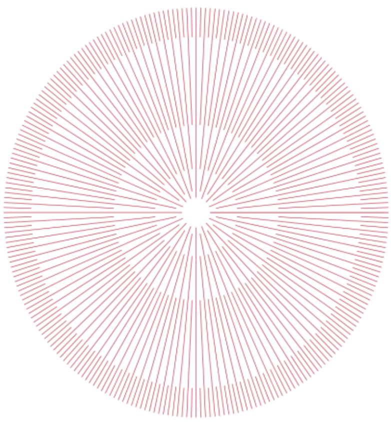
Introduction

The purpose of this module is to provide a powerful analysis and presentation tool to assist with visibility studies. Previously called ZVI (Zones of Visual Impact) the idea is to illustrate where one or more targets are visible from within a study area by calculating a large number of “line of sight” calculations. Suitable 3D data must exist for the study area so that a ground model can be created. Advanced features including Field of view and Shadow Flicker analysis are documented in KTF_advanced_ZTV.pdf.



Examples of applications that this module is suitable for include studies for the impact of residential or industrial developments, roads, cranes, quarries, spoil heaps and of course wind farms. A ZTV analysis may have just one target (target point in the above diagram) e.g. a chimney or mast but the majority of projects involve multiple targets organised to represent a number of wind turbines, roof tops, a length of road or an area of landfill for example. Note that in the case of a mast it can be represented as four targets, one at the top, one a quarter of the way down, one at halfway and one three quarters of the way down so the result is more meaningful than just “who can see the top?”.

ZTV is a specialist program and not a standard component of KTF. The basic principal works by a series of rays radiating out from the target or targets and it may help to consider this as many hundreds or thousands of sections being calculated automatically.



Rays for a single target

Terminology

Elevation	Z value of target (or visual barrier).
Extent distance	Distance from target to analysis end e.g. 7000 metres
Height	The height of a target above the ground.
Observer height	Eye height above ground of the observer/receptor.
ODE	Optimal Density Expansion. This is set "on" for typical use to ensure that the lateral spacing between adjacent rays will never exceed the ray resolution value. Has the effect of making "sub rays" as shown in the illustration above.
Ray (or radial)	Line from target over study area (or line of site). One analysis may have many thousands.
Ray resolution	Maximum distance between rays – the smaller this distance the higher the resolution with an increase in the number of rays and calculation time.
Receptor	Observer (person receiving the view).
Sector	Defines a sector only for analysis – default is 360 degrees.
.sky file	Input and analysis parameters are saved in a .sky file.
Start distance	Distance from target point before analysis starts e.g. 500 metres.
Study area	Area surrounding the target(s) over which the analysis takes place and where there is model coverage. May be the whole modelled area or restricted to within a closed 2D Polyline (faster as only calculating in the defined study area – only available when using 3D Polyline targets).
Target	Point to be studied e.g. top of mast, half way up a mast, point on roof etc.
Target Polyline	3D Polyline representing linear features (e.g. roof tops) from which multiple targets will be generated. Note that a mast or chimney may be represented as a vertical 3D Polyline with vertices at top and middle for example.
Visibility Models	These are the results from visibility analysis from multiple targets (e.g. where there are a number of turbines etc.) or from field of view analysis. The model consists of square cells whose size is related to the ray resolution. A cell will have a positive integer value indicating how many targets are visible to an observer standing within it or a negative value relating to how far below a line of sight the observer is. In the case of a field of view visibility model the values assigned to each cell relate to the subtended horizontal angle from visible target extents in degrees. Visibility models are represented using menu item *Ground Modelling, Analysis and Colour mapping, Z value*.
Visual barrier	An open 2D Polyline represents an existing or proposed feature such as a wall, hedge or line of trees etc. A closed 2D Polyline represents a wooded area for example with the whole area raised above the ground. A 3D Polyline can represent roof tops for example.

3D data

The initial requirement before starting a ZVI project is to source suitable height data. The most common suitable product for projects in Great Britain is the OS Land-Form PROFILE DTM (Digital Terrain Model). Do NOT purchase as contours.

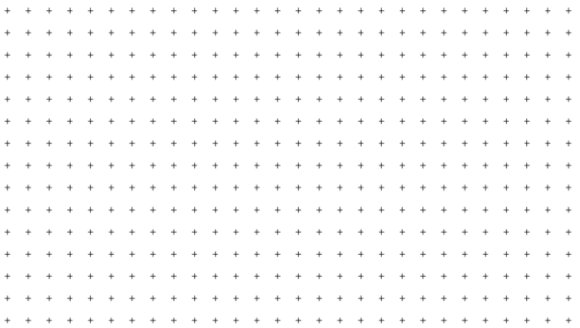
The data is also available from the Ordnance Survey but in NTF format in 5,000 x 5,000 metre tiles that will need converting by KTF into .xyz files and then merging into one large .xyz file. Menu item *Translators, OS, OS Land-Form PROFILE, PROFILE to .xyz* Menu item *File utilities, .xyz Co-ordinate files, Merge.*

If data has been supplied as a number of DXF files and is thousands of Point entities with Z values convert this data in the drawing to .xyz files with menu item *File utilities, .xyz Co-ordinate files, Output from 3D Points* and then *File utilities, .xyz Co-ordinate files, Merge and Extract.*
A low resolution (50 metre grid) is available at no/low cost from Ordnance Survey as their OS OpenData, LandForm PANORAMA product. This data needs to be converted to .xyz files with menu item *Translators, OS, OS OpenData, OS Land-Form PANORAMA to .xyz* and if more than one file *File utilities, .xyz Co-ordinate files, Merge and Extract.*

If you have contour data this is generally not a good start but please contact us for help!

For most projects the ground model is created from an .xyz file and not from drawing entities. These .xyz files can very big e.g. 10 million points but the KTF Gridding method has been designed to make them usable for model creation.

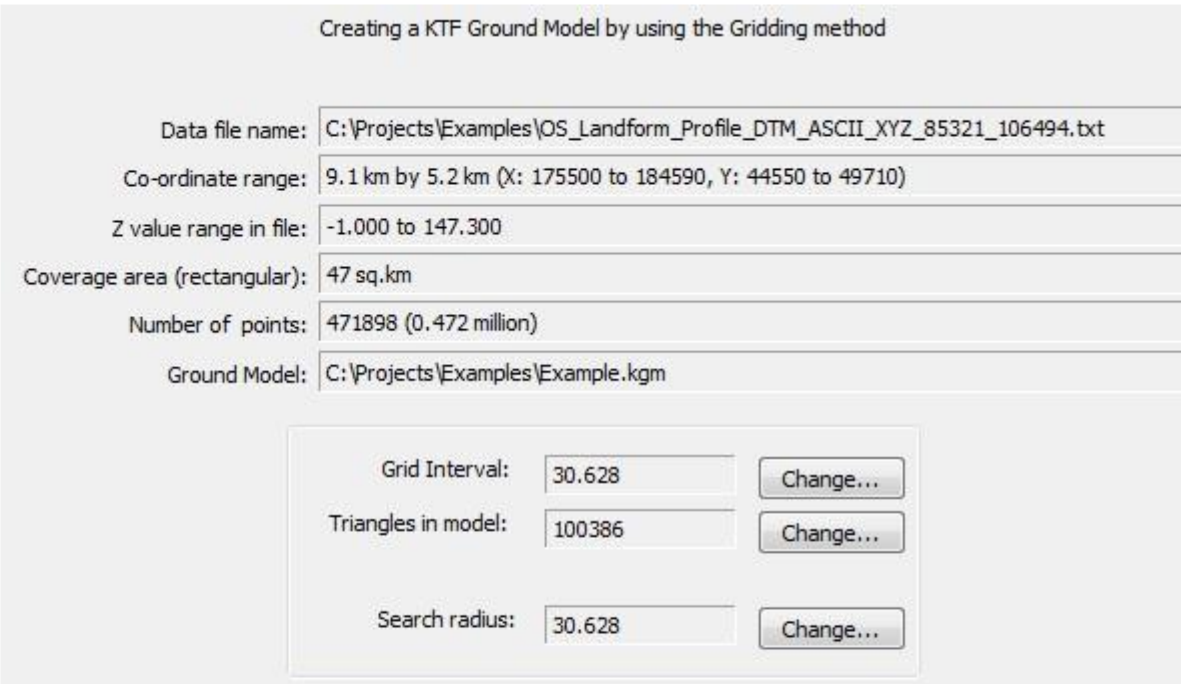
LIDAR data that represents tree and building tops is NOT suitable as the base ground model this would assume that the observer has climbed to the top of the tree or is standing on the office roof and is not on the real "landform". However, such data can be used to define visual barriers automatically (see visual barriers section below).



Representation of square grid data

Creating the ground model

The model covering the study area will normally be created from an .xyz file using the Gridding method. However if the data is a square grid with up to 250,000 points use menu item *Create Model, from .xyz file Square grid data* to create the model directly from the data. In most cases the files will be much larger so use menu item *Ground Modelling, Create Model, from .xyz file Gridding*.



Initial dialogue

After changing the Grid interval to 20.000

Setting the grid interval to make between 150,000 and 1,000,000 triangles in the model should be a reasonable number. While the absolute upper limit is related to hardware and the amount of memory etc. in practice a model exceeding 10,000,000 triangles will be too big.

Representing the target(s)

1. Individual targets (and how to group a number of individual targets)

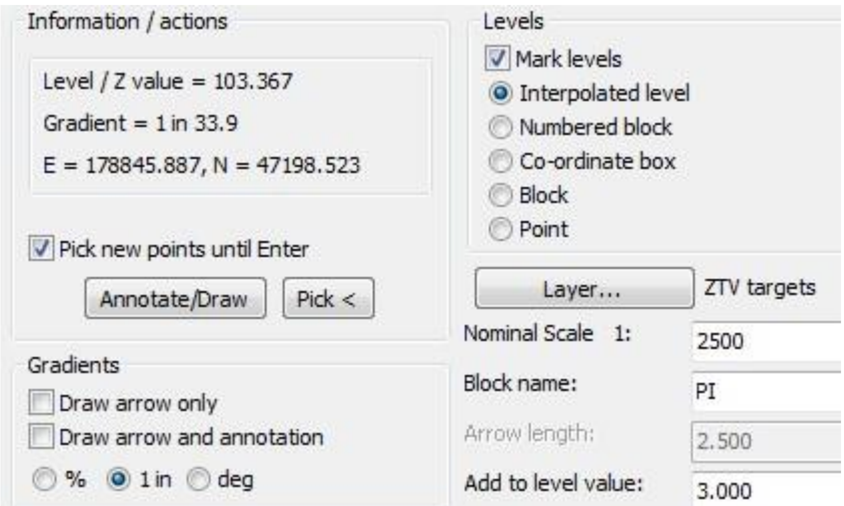
If there is a single target or just two or three, the plan location(s) may be represented in the drawing as a Circle, Block or Point etc. When adding individual items to the target list by clicking the Add < button in the main ZTV dialogue the following will be prompted for :-

Target location	Pick a 2D location and then enter the target height from the ground.
or	Pick a 3D location to define the target elevation. ↲ to accept the elevation.
Target description	E.g. Turbine 1
Start Distance	↲ to accept default, enter alternative or drag to define the distance.
Extent Distance	↲ to accept default, enter alternative or drag to define the distance.
Ray Resolution	↲ to accept default or enter alternative.
Analyse Sector or 360	↲ to accept 360 degree analysis around the target. Enter “S” to save time if the study area can be defined as a sector, pick a start and then move clockwise to fix the end.

Entering the above for more than two or three targets will become very repetitive with a chance of typing errors so a better method to represent the targets and get them into the target list is this :-

Stage 1

Menu item *Ground Modelling, Interpolated Levels, Picked Points (and gradients)*



The settings above would be suitable if the target was the top of a solar panel for example and is 3.0 metres above the ground (note the Add to level value: setting).
Note that Pick new points until Enter should only be "on" only if the addition is the same for all locations. Click Annotate/Draw to pick a series of locations to represent the targets.

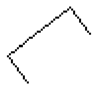
Stage 2
When all the targets (interpolated level PI blocks) are in the drawing join them together with menu item *3D Polylines, from picking Levels* (the order does not matter as only the vertices will be used as targets and it does not need to be closed).

Stage 3
Menu item *Ground Modelling, Analysis and Colour mapping, ZTV*
In the Targets panel click 3D Polylines <, pick the 3D Polyline and accept the default of using the Vertices.

2. <u>Multiple targets</u>

Where targets are the tops of buildings for example draw these as 3D Polylines where the vertices will represent the roof corners/ ridge lines for typical use. A proposed road centre or top of a designed bund for example should also be drawn as a 3D Polyline and target points can be interpolated at specified regular intervals.

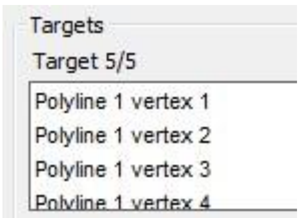
For example the top of a rectangular warehouse with a known height above a known slab level should be represented by a 3D Polyline drawn by menu item *3D Polylines, from 2D locations*. Note that this should have four vertices to represent the four corners i.e. not closed.



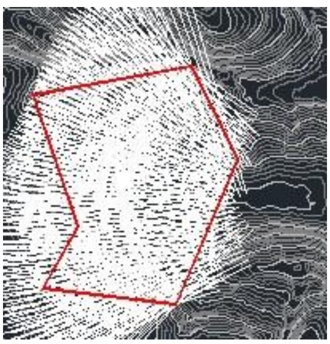
Multiple targets are added to the list of targets by clicking 3D Polylines < Pick one or more 3D Polylines.
↵ to accept the use of Vertices or enter "C" if working with linear targets like proposed roads.

↵ to accept default of not using a defined Study area for typical use or assuming that a closed 2D Polyline has been drawn to represent a defined study area enter "Y" and pick the closed 2D Polyline.

Enter the Start distance
Enter the Extent distance
Enter the Ray resolution



Target list from one 3D Polyline with five vertices



Note that if using a defined study area start and extent distances are not prompted for. This method will be faster because calculations only take place over the relevant area

Rays located by Study area defined by 2D Polyline

The targets are now all numbered and added to the list. The initially entered values appear in the Target details panel where they may be edited. <u>Click the Save As button to save the target data to a .sky file</u>.

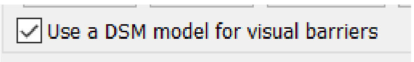
Representing visual barriers

Manual method

These need to exist in the drawing as 2D (open or closed) or 3D Polylines. These barriers may be existing or proposed features. Visual barriers will have the effect of “stopping” a visible ray assuming that the barrier is high enough. One use is to enable the user to experiment on a “what if” basis to see what effect screen planting at a certain location and with a defined height will have on the visibility of the target(s). Visual barrier information is stored and retrieved with other parameters in the .sky file. Add Visual Barriers to the list by clicking the Add < button in the Visual Barriers panel.

Linear barrier(s)	Pick one or more open 2D Polylines. Enter a description (e.g. proposed screen planting) Enter Start height and ↵ to accept default End height for typical use.
Area barrier	Pick one or more closed 2D Polylines. Enter a description (e.g. existing wooded area) Enter height and ↵ to accept default End height for typical use.
Wire frame e.g. roof	Pick one or more 3D Polylines. Enter a description (e.g. Roof tops existing houses) ↵ to use the 3D Polyline for typical use (or enter a Start Elevation if “over-riding” the Z values of the vertices and fixing start and end elevations).

Automatic method



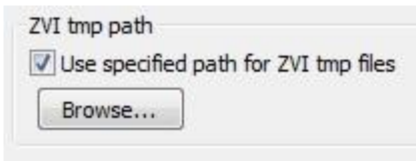
You can use a DSM (Digital Surface Model) to automatically generate the visual barriers. Please refer to a separate document “ZTV automatic visual barriers”

Click Save As to save the barrier data to a .sky file.

Running a ZTV analysis

Assuming that the Ground Model has been created from suitable data, Target locations are known and any visual barriers drawn as Polylines the analysis can start.

Note that running a large ZVI analysis can mean calculations involving millions of points and create very large temporary files which are normally stored in the project folder. If the project directory is on the network a considerable time saving may be made by setting a temporary file directory on the local hard drive before running the analysis. To do this click menu item *Help, Configure* and then Ground Modelling settings, browse to specify a local folder.



Menu item *Ground Modelling, Analysis and Colour mapping, ZTV.* The whole operation is controlled by the main dialogue with initial input of target and barrier data from the command line prompt. Select the ground model, the dialogue displays two empty lists, one for Targets and one for Visual Barriers.

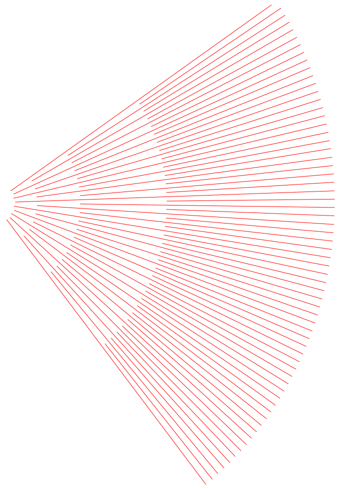
<u>Targets</u>

Click Add < in the Targets panel.
Follow the prompts as described on page 4

Show — Preview to show coverage of rays.
Delete — To remove highlighted lines from the target list.
Clear — To remove all lines from the target list.
Clone a target — To duplicate a highlighted target line. This is intended for a vertical feature where two or more targets are required. Edit the heights for the cloned points.

Note that if after specifying a single Target an Elevation is prompted for this will be due to that Target being outside of the modelled area.

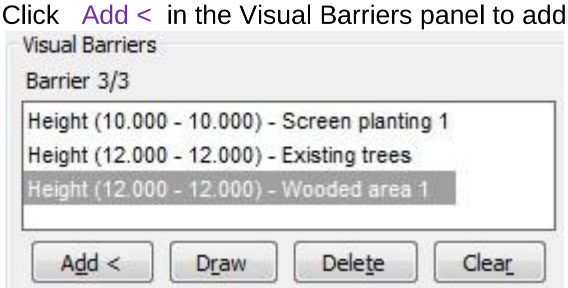
If Analyse Sector was chosen the rays from the Show button will look like this :-



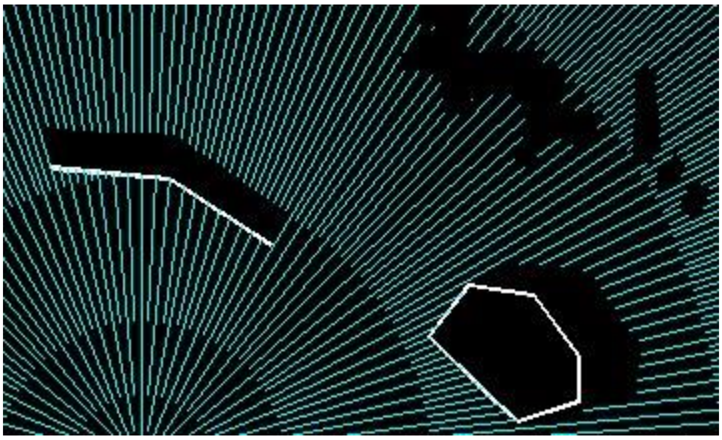
Individual targets can be added to the list as above but a faster method is to click the From 3D Polylines< button as described on pages 4 and 5.

<u>Visual Barriers</u>

Click Add < in the Visual Barriers panel to add to the Visual Barriers and pick the Polylines.



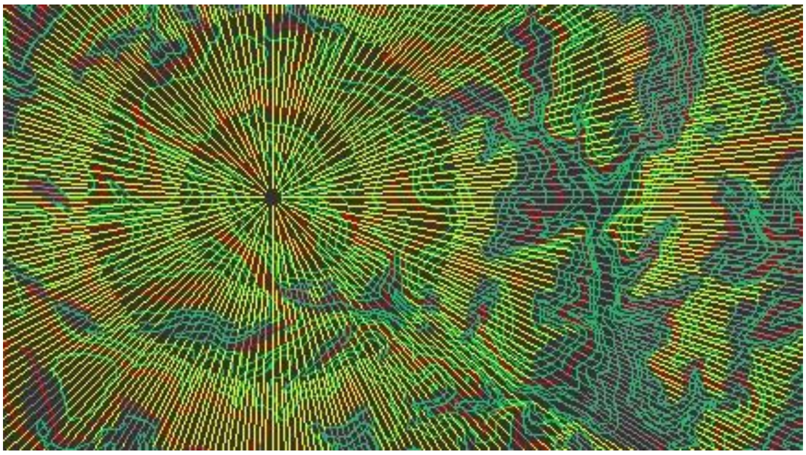
Draw — To draw one or all barriers (having opened an existing .sky file that includes them).
Delete — To remove highlighted lines from the barrier list.
Clear — To remove all lines from the target list.



The effect of visible rays being "stopped" by linear and area visual Barriers (invisible rays not drawn).

Settings

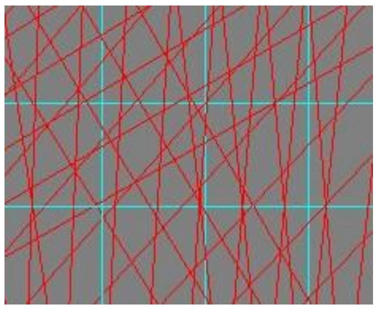
It is very important to confirm that the settings are correct before clicking the Start button. The settings on the right are only suitable for a single target analysis as the rays will be drawn and will provide a “hatch type” presentation of results :-



(Invisible rays drawn in grey)

Visibility model (number of targets)

To display the results of multiple target analysis the numbers of rays crossing a cell (the cell size is defined by the ray resolution) is counted and written to a visibility model (.kgm file). For example if there are six targets there may be cells where 1, 2, 3, 4, 5 or all 6 targets will be visible and these will correspond to z values in the visibility model of 1 to 6. Areas where no targets are visible have negative z values reflecting how much below seeing the target the observer is (how high to “jump” before seeing it).



Visible rays crossing cells

Settings for multiple target ZTV analysis.
Note that the rays are not drawn.

For advanced features including Field of view, Vertical view, Shadow flicker and Batch process please contact us.

Common area only
Should be “on” when the area covered by the targets is small compared to the whole study area. An example would be a local “clump” of wind farm turbines and say a 10Km X 10Km study area. An example where this setting should be “off” would be targets representing the centre of a road extending from say the south west to the north east of the study area. The common area is where all rays overlap. See appendix 1.

Trim to ground model edges
This will keep colour mapping results well within the “study area extents”.

Factor (for number of targets)
This enables the mapped Z values in the Number of targets visibility model to be multiplied by a factor to relate it to the length of a linear target or the area of an area target. For example if points are at intervals of 25 metres along a Polyline representing a road then by setting the factor to 25 the output Z values in the visibility model represent the length of road in metres that is visible at that location. If an area study is being made with defining points at an approximate grid of 25 metres by 25 metres then by setting the factor to 625 the Z value will represent the area of the target that is visible.

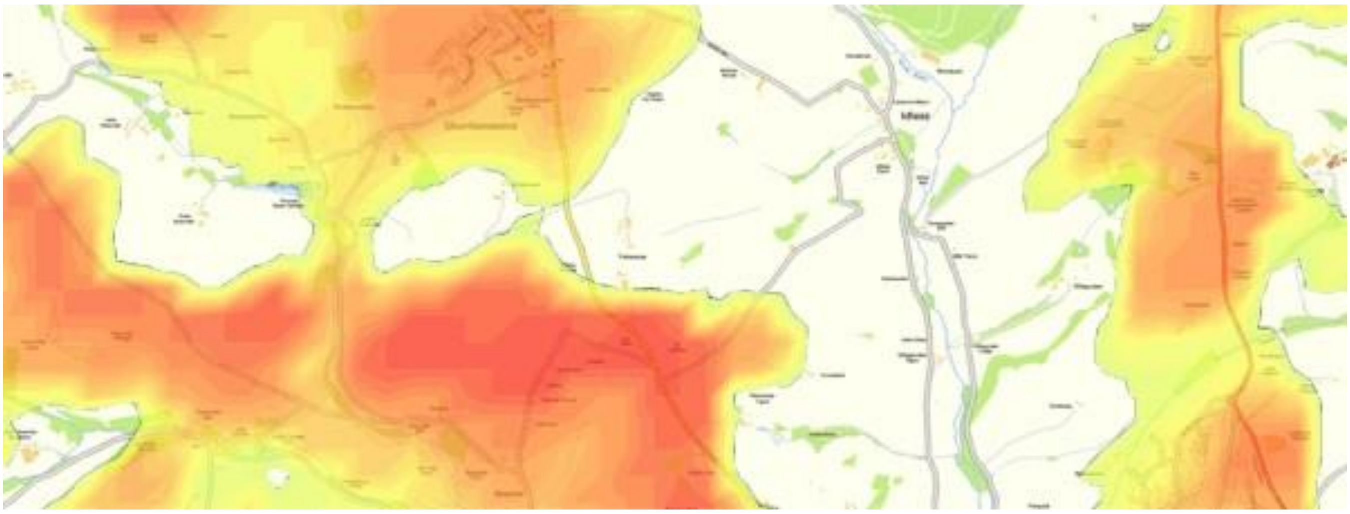
Observer Height
Eye height above ground level.
Use earth curvature correction
Should always be “on”. Accounts for approximately 2 metres over 5Km and 8 metres over 10Km.

Atmospheric Refraction correction
Using a coefficient of 0.075. When combined with curvature correction accounts for approximately 1.7 metres over 5Km and 6.7 metres over 10Km.

Graphical output

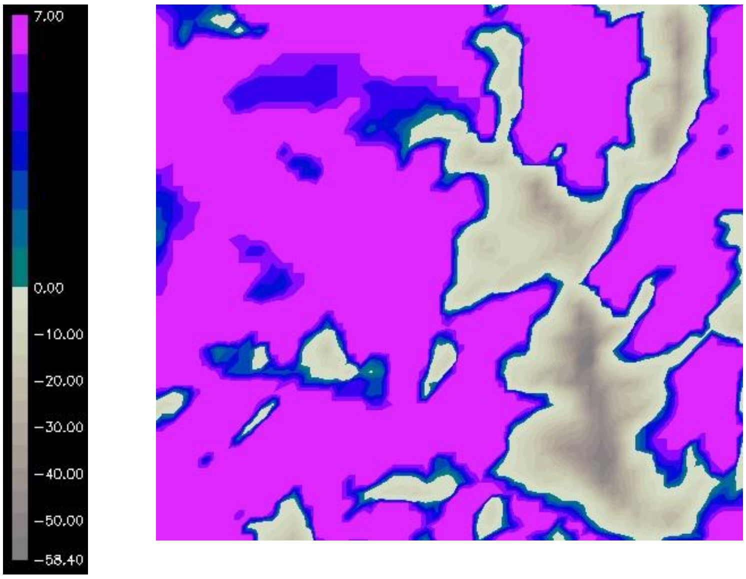
Multiple target ZTV results are written to a model (.kgm file). This is like any other ground model but the Z values relate to how many targets are visible in each cell that the model comprises (or how far below the line of sight if in an “invisible” area).

Use menu item *Ground Modelling, Analysis and Colour mapping, Z value* to present the results. Best presentation quality may be achieved when using the True colour option.



Colours in this map are based on visibility to a windfarm. In the coloured areas the turbines are visible, the deeper the red colour gets the more turbines are visible. Image produced from KTF ZVI results with raster image editing software.

Typical settings for colour mapping output

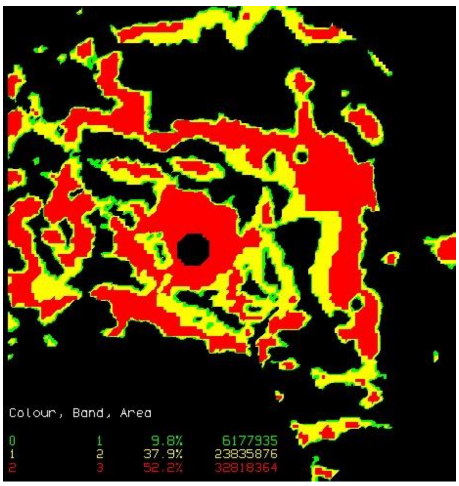


Colour mapping for 7 targets. A second run was made to show areas below a sight line (invisible) in grey shades.

Three targets at same plan location e.g. top of tower, third down and two thirds down.

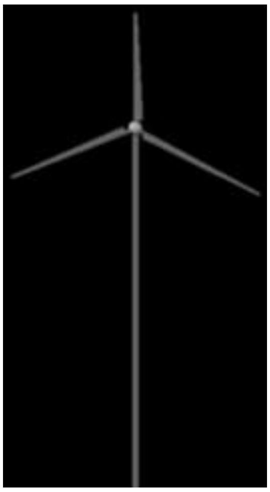
Add the three targets into the list in the normal way and run the analysis to write a visibility model.

Receptors in green area see the top only.
Receptors in yellow areas see middle & top. Receptors in red will see all three



% and areas relate to "total visible areas" and not total visibility model area.

3D Turbine representation



Menu item *Ground Modelling, Drape, Wind turbine* to locate a turbine with specified tower height and blade length.

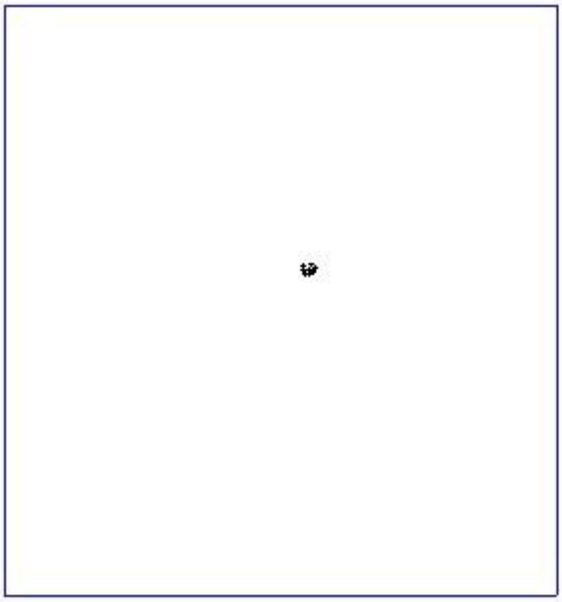
The DVIEW command for 3D views

This BricsCAD / AutoCAD command can help with generating a 3D view from a specified camera location to a target (e.g. top of a turbine blade).

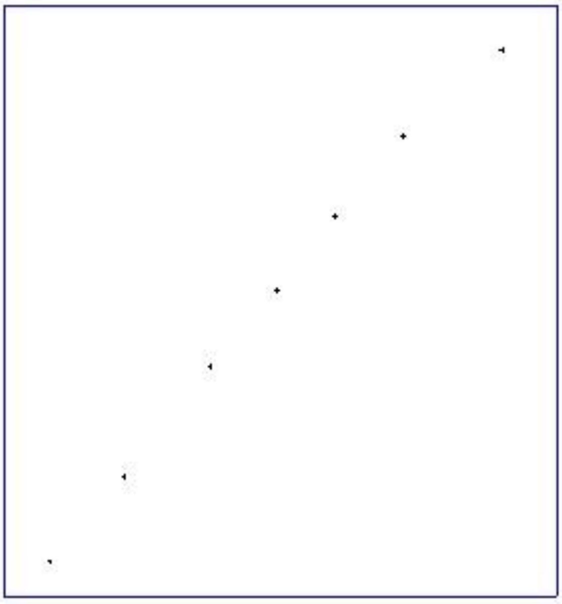
This is the basic sequence assuming that you are in the drawing with a suitable grid (drawn from the model by menu item *Ground Modelling, 3D Grid*) and the turbine for example :-

DVIEW
ALL (Return for an All selection set)
Return
PO   enter E,N,Level for the target.
Enter E,N,Level for camera location.
D
Return to accept default distance or enter alternative.

Appendix 1



Targets in small area compared to study area – Common area only should be "on".



Targets cover large area compared to study area – Common area only should be "off".