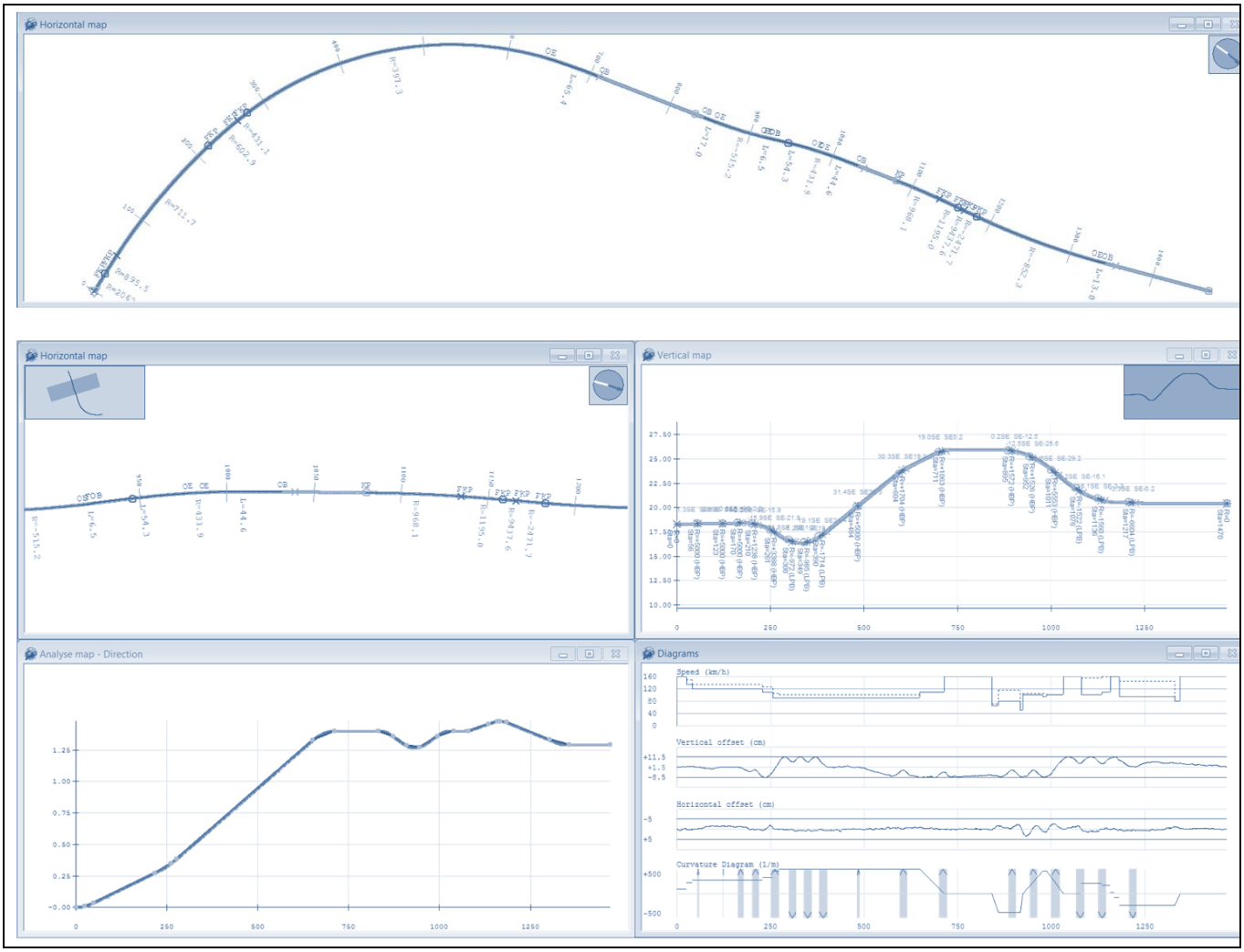
User manual

GEDO NovaTrack



Version 2.0.1
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Trimble

This is the September 2019 release of the **TRIMBLE GEDO NovaTrack User Manual**, English language version v2.0.1.
It applies to the TRIMBLE GEDO NovaTrack software and GEDO CE 2.0 track measurement systems.

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Contacting Trimble Track Survey & Scanning Support

If you cannot find the information you need in this manual, submit an inquiry to Trimble Track Survey & Scanning Support.

1. Go to www.trimble-railway.com/en/contact/trimble-railway-gmbh/
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3. Click the **Submit** link

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CONTENTS

1 General information

- Introduction
- Updating this manual
- Related documentation

This manual is a user reference guide for end users who have completed training courses and have been certified at Trimble Track Survey & Scanning Training Centers or at designated Dealer Training facilities. It describes how to manipulate and operate track measurement data using Trimble GEDO track systems.

1.1 Introduction

Training on the GEDO NovaTrack software is required, in order to understand measurement data processing workflows and make correct calculation result interpretation.

The technical documentation and the recommendations within are intended solely as a complement to the skills acquired through training. They can never replace theoretical and practical training provided in accordance with good practice. If the operator does not feel capable of providing personnel with this training, Trimble Track Survey & Scanning or designated Dealer organizations can be consulted concerning the training program.

The training must cover the explanation of the different functions of the material, instructions for its use and maintenance, and the safety rules to respect, as well as practical exercises.

1.2 Updating this manual

Photographs, illustrations, specifications and other details in this manual were up to date when the manual was released. Any changes that may be needed will be issued as supplementary or replacement pages, via a Product Bulletin, other service information, or as a new revision to this manual.

1.3 Related documentation

You can download the latest version of this manual, as well as all Product Bulletins, User Guides, and any Declaration of Conformity relevant to the TRIMBLE GEDO CE 2.0 trolley or TRIMBLE GEDO NovaTrack product group from the Trimble Track Survey & Scanning Support site (requires active Extended Warranty software agreement and user registration). The files are in Adobe Portable Document Format (PDF).

Important!

Read all relevant Product Bulletins before you start operating TRIMBLE GEDO NovaTrack software product.

To download an operating instruction for Trimble GEDO NovaTrack software products:

1. Go to the Trimble Track Survey & Scanning Support website at http://www.trimble-railway.com/download
2. Enter your username and password and then click Login.
3. In the folder structure, select Subject and required Product
4. Select the item that you want to download.

2 About the software

GEDO NovaTrack is a software tool for optimization, adjustment and alignment calculation of existing railway lines.

Track re-alignment tasks are placing high demands on the precision of the alignment calculation. Whilst within the track re-alignment phase, GEDO NovaTrack software continuously streams horizontal and vertical offsets between existing track and newly calculated alignment.

Trimble GEDO NovaTrack software enables the automatic reverse calculation of alignment elements in an absolute coordinate system based on track survey data from the Trimble GEDO systems. In this way, the alignment elements with optimal parameters and absolute positions are estimated to best fit the current track position. This software functionality enables seamless design alignment data delivery within project areas where track design information is absent or out of date.

GEDO NovaTrack – other areas of use:

- Adjustment of existing alignments.
- Analyzing the deviation between two alignments.
- Calculation of horizontal and vertical distances between alignment and fixed objects.
- Identifying chainage information for structural elements along the track alignment, for example, catenary masts.

Overview of TRIMBLE GEDO NovaTrack

GEDO NovaTrack analyses rail measured points taken from the GEDO CE track measurement systems and generates optimal positions for both horizontal and vertical alignments through theses points. The quality of the calculated alignment is compared to the measured points and illustrated using offset diagrams. In the alignment editing phase, these diagrams are used for reviewing the alignment elements.

GEDO NovaTrack uses the .GDT file format (centreline) to import measured track data. Additionally, the software supports other measurement data formats, from ASCII file formats (column separated data).

The calculation accuracy is dependent on the distances between the measured points and the measurement accuracy. The minimum required distance between points dependent on the geometry of the railway track and its quality. Small radii and complicated transitions between alignment elements with many consecutive curves requires shorter distances between the measured points.

A distance of 3.0 m between measured points will generally give a good result with most tracks. If the geometry is less complicated, the distance between points can be extended up to 5.0 - 10.0 m. Further increased distances between points is not recommended.

GEDO NovaTrack is using following abbreviations for horizontal and vertical alignment elements:

S - Long fall gradient. Slope of the vertical alignment element in per-mil

SE - End of Slope. Marks the transition between gradient and vertical curve element.

HBP - High Break Point. Vertical intersection point where the slope decreases.

LBP - Vertical Intersection Point. IP where the slope increases.

STA - Chainage. Distance in metres along the track from a given reference point.

Pr - Chainage mark in metres.

Km - Kilometre. Similar to chainage, but the unit is in kilometres.

L - Straight element length. Used for horizontal elements. Unit in metres.

R - Radius for circular elements. Used for horizontal and vertical elements, in metres.

A - Transition curve (clothoid/spiral) A-parameter. Used for transition curve elements.

3 Installation and licensing

This chapter describes the relevant information related to system requirements for software installation, license activation and configuration.

In order to operate TRIMBLE GEDO NovaTrack, the computer requirements are as follows:

- Microsoft Windows® 7 (32-bit OS), 8.1 and 10.
- Processor: 1.2 GHz or higher
- RAM: minimum 1 GB

3.1 Download TRIMBLE GEDO NovaTrack

To download the latest version of TRIMBLE GEDO NovaTrack software, please follow the link and instructions:

1. Go to the Trimble Track Survey & Scanning Support website at http://www.trimble-railway.com/download .
2. Enter your username and password and then click Login
3. In the folder structure, select Subject and required Product (GEDO NovaTrack)
4. Select the installation package to download.

3.2 Install TRIMBLE GEDO NovaTrack

This paragraph provides information on how the TRIMBLE GEDO NovaTrack software can be installed on a Microsoft Windows® based PC computer.

- Copy GedoNovaTrack_vX.X.exe installation package to a temporary PC folder.
- Start GedoNovaTrack_vX.X.exe and follow the instructions on the screen.
- After installation is completed, a GEDO NovaTrack shortcut will be created on the desktop.
  - In order to run software in US Feet units, please edit GEDO NovaTrack shortcut by changing ´Target´ setting with command string:

    NovaTrackG.exe -USFEET
- To run the program, double click the GEDO NovaTrack shortcut icon.
- Create a folder for all GEDO NovaTrack project related data (f.e. C:\Gedo NovaTrack\Data).

3.3 Software licensing

In order to use all of TRIMBLE GEDO NovaTrack's functionalities, a software dongle license is required. With a dongle license, the program can be installed on several PC's but it can be started and used only on the PC where the USB dongle (or SD card) is plugged in. A dongle license requires the additional installation of the Wibu Codemeter software.

4 Typical workflow

4.1 Alignment calculation using automatic smoothing

Trimble GEDO NovaTrack provides a functionality for automatic processing of measured track data into horizontal alignment elements, using ´ NovaTrack 3.0´ method.

The automatic processing workflow:

Step 1. Import track measurement data by clicking *Open -> (.GTD format file).*

Step 2. From the list select appropriate calculation profile (e.g. ´Adjustment new track´).

Step 3. If required, adjust Main Calculation Constants (depending on track and measurement quality): ´*Min.straight line length*´, ´*Minimum uplift*´ and ´*Number of iterations*´[1].

Step 4. Press ´*OK-Analyze*´ to compute alignment.

Step 5. Review calculated offsets. If required, adjust scale for horizontal and vertical offset in *Tools -> Options*.

Step 6. Adjust individual horizontal alignment elements where offsets are beyond set tolerances.

Step 7. Adjust gradient lines and PVI from the *Vertical layout*, so vertical alignment elements are within the limits of minimum uplift and upper tolerance.

Step 8. If required, adjust calculated cant/speed values. Double click Cant Diagram. In the Speed/Cant table change ´h1´, ´h2´ and ´v´ fields. Select checkbox ´K´ to lock edited values.

Step 9. Export alignment to GEDO Office file format by selecting *File -> Save As.. -> All GEDO Office files format*. The alignment data will be stored into three separate file formats: *.TDT, .HDT and .UDT.*

[1 – In the NovaTrack 3.0 method it is recommended to adjust number of iteration between 1 and 20. Larger amount than 20 iterations will not have effect on final alignment result.

4.2 Alignment calculation using semi-automatic method

In the semi-automatic processing workflow, initial alignment measurement processing is done using ´Regression with Transition Curves´ method. Further, using the Analysis Diagram tools, horizontal alignment elements are enhanced by extrapolating them based on track measurements. Semi-automatic workflow applies for tracks with poor geometry:

The processing workflow using Analysis tools:

Step 1. Import track measurement data by selecting Open -> .GTD format file

Step 2. From the list select appropriate calculation profile (e.g. ´TR_Heavy_Re-alignment´).

Step 3. If required, adjust Main Calculation Constants (depending on track quality): ´Error tolerance´´[1, ´Min.straight line length´, ´Min.radius for transition curves´, ´Number of iterations´´[2.

Step 4. Press ´OK-Analyze´ button to compute alignment.

Step 5. Review calculated offsets. If required, adjust scale for horizontal and vertical offset in Tools -> Options.

Step 6. Continue with further alignment adjustment in the Analysis Diagram. Depending on a track configuration, select Curvature 7 or Direction diagram .

Step 7. In Analysis diagram activate continues calculation mode by selecting ´Calculate automatically. Alignment/offsets will be updated continuously while editing split points.

Step 8. Adjust split point position by adding or removing redundant split points (e.g to minimize offsets).

Step 9. Switch to Horizontal layout. If the horizontal offset values are still exceeding set limits, adjust individual horizontal alignment elements using element editing tools. Double-click element and adjust geometry parameters by observing offset trend.

Step 10. Adjust gradient lines and PVI from the Vertical layout, so vertical alignment elements are within the limits of minimum uplift and upper tolerance.

Step 11. If required, adjust calculated cant/speed values. Double click Cant Diagram. In the Speed/Cant table change ´h1´, ´h2´ and ´v´ fields. Select checkbox ´K´ to lock edited values.

Step 12. Export alignment to GEDO Office file format by selecting File -> Save As.. -> All GEDO Office files format. The alignment data will be stored into three separate file formats: .TDT, .HDT and .UDT.

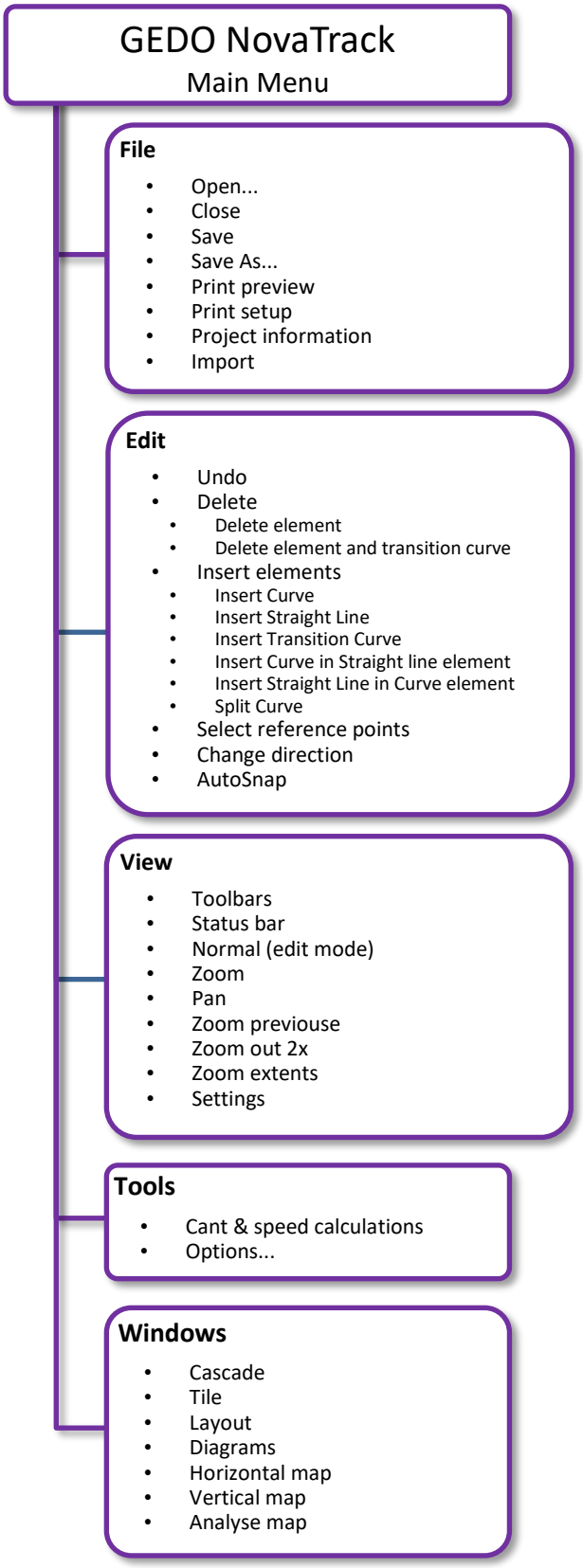
[1 – In the ´Regression with Transition Curves´ method it is recommended to adjust ´Error tolerance´ based on track geometry quality. The higher tolerance generates less precise alignment solution. It is recommended to use tolerance range between 0.5 and 30 meters.

[2 – Setting ´Number of iterations´ is directly related to ´Error tolerance´ setting and defines with what step increment ´Error tolerance´ will be increase. Calculation always starts with error tolerance 0.0 m and runs till it reaches maximum set value. At the end of the iteration process, software selects alignment solution which has smallest ´Sum of offset´ value.

The higher iteration number can have effect on more precise alignment fitting.

5 Menu structure and user interface

5.1 GEDO NovaTrack menu structure



GEDO NovaTrack software menu structure

5.2 Toolbar items

GEDO NovaTrack has six different toolbars that gives access to the most frequently used command/functions. Holding the cursor on a toolbar button, a short description of the command is displayed. From the View menu, it is possible to choose which toolbars should be displayed, see Toolbars / Status line.

The toolbar buttons have colour codes; blue is Horizontal window, green is Vertical window, grey is the Diagram window and red square symbol is the Analysis window. The predefined layout makes it easy to move the window to desired position.

The toolbars can be moved as required.

5.2.1 Standard toolbar

Icon	Function description
	Open existing project in .SPW or import new measurement data from GEDO .GDT file format
	Save project to .SPW or export data to GEDO Office alignment file format (.TDT, .HDT, .UDT)
	Alignment re-calculation based user selected settings and setting profile
	The Undo tool reverts back changes made in the process of calculation or editing. Undo function is affecting data changes made both in horizontal/vertical views, analysis diagrams and alignment changes due to recalculation process.
	The Redo tool reverts forward changes made in the process of calculation or editing. Redo function is affecting data changes made both in horizontal/vertical views, analysis diagrams and alignment changes due to recalculation process.
	Show Result File. Provides detail summary of alignment data input and calculation results.
	Print. Using this tool, it is possible to print out the data in the Horizontal, Vertical and Schematic windows. The data for the active window view will be printed. The information defined in the function 'Project Information' will be used for the printout headers.
	Help. Opens the GEDO NovaTrack help file.

5.2.2 View toolbar

Icon	Function description
	Normal (Edit Mode). Switching from zoom or pan mode to Edit mode. The Normal (Edit mode) is the standard mode and gives access to editing and pointing functions.
	Pan. Moves the zoomed area by pressing the left mouse button and dragging the zoomed area into place.
	Zoom Window. Zooms in an area between the chainages. The area is defined by clicking at the 'from chainage' and at the 'to chainage'.
	Zoom Previous. Zooms to the previous view.

5.2.3 Mode toolbar

Icon	Function description
	Mode Line (Not yet implemented)
	Mode Point (Not yet implemented)
	Left to Right Drawing. Rotates the drawing and the coordinate system so that the horizontal alignment is shown from left to right. By default this option is activated. When the option is not checked, the drawing is shown with the x-axis direction upwards. Left to right drawing can also be switched on or off from the toolbar.
	AutoSnap. Function is affecting element editing in horizontal, vertical and analysis diagram views. During element editing, when dragging existing tangent points or creating new, the function will automatically lock tangent point to a measured point.
	Change Horizontal Direction. When importing measurement data, the program will automatically start the chainage at the lowest X-coordinate, with increasing chainage northwards. This direction can be reversed using this tool.

5.2.4 Edit toolbar

Icon	Function description
	Delete measure point (Not yet Implemented)
	Delete Intersection Point. The function deletes the active vertical curve, and its initial and final straight lines (grades) are joined into one element.
	Insert Intersection Point. Inserts curve in vertical alignment. The program prompts for the position of curve and element radius.
	Delete Element Only. First active element is marked with a thicker line within the horizontal window. Then active element is deleted. - Before activating this tool, make sure that the correct element is selected by clicking on it in the window 'Horizontal Map'.
	Delete Element and Transition Curves. Deletes active element along with the transition curves. - If the calculation fails ('Calc Not Ok' on status bar), the horizontal alignment has to be edited by the user until the calculation is successful. - Before activating this tool, make sure that the correct element is selected by clicking on it in the 'Horizontal Map' window.
	Insert Transition Curve. Inserts a transition curve (TC) after the active element. - If the calculation fails ('Calc Not Ok' at status bar), the horizontal alignment has to be edited by the user until the calculation is successful. - Choose 'Undo' to revert back to the last line calculation.
	Insert Curve. Inserts a curve (C) after the active element. - If the calculation fails ('Calc Not Ok' at status bar), the horizontal alignment has to be edited by the user until the calculation is successful. - Choose 'Undo' to bringing back the last line calculation.
	Insert Straight Line. Inserts a straight line (SL) after the active element. - If the calculation fails ('Calc Not Ok' at status bar), the horizontal alignment has to be edited by the user until the calculation is successful. - Choose 'Undo' to bringing back the last line calculation.
	Insert Curve in Straight Line Element. Inserts a curve (C) along with transition curves (TC) at either ends of the active straight line element. - If the calculation fails ('Calc Not Ok' at status bar), the horizontal alignment is to be edited by the user until the calculation is successful. - Choose 'Undo' to bringing back the last line calculation.
	Insert Straight Line in Curve Element. Inserts a straight line (SL) along with Transition curves (TC) at either ends in the active curve element.

	- If the calculation fails ('Calc Not Ok' at status bar), the horizontal alignment is to be edited by the user until the calculation is successful. - Choose 'Undo' to bringing back the last line calculation.
	Split Curve. Splits the active curve element. The old curve is split and two new curves are calculated from the measured data.
	Select Reference Point. The current start chainage reference point is replaced with a new reference point from the measurement data.

5.2.5 Layout toolbar

Icon	Function description
	Horizontal Map Diagram. Positions the Horizontal window above and the Schematic window below
	Vertical Map Diagram. Positions the Vertical window above and the Schematic window below.
	Vertical Map Horizontal Diagram. Positions the Vertical window to the left, Horizontal window to the bottom right and the Schematic window to the top right.
	Horizontal Map Vertical Diagram. Positions the Horizontal window to the left, Vertical window to the bottom right and the Schematic window to the top right.
	Hmap Vmap Diagram. Positions the Horizontal window above, the Vertical window in the middle and the Schematic window below.
	Vmap Hmap Diagram. Positions the Vertical window above, the Horizontal window in the middle and the Schematic window below.

5.2.6 Analysis toolbar

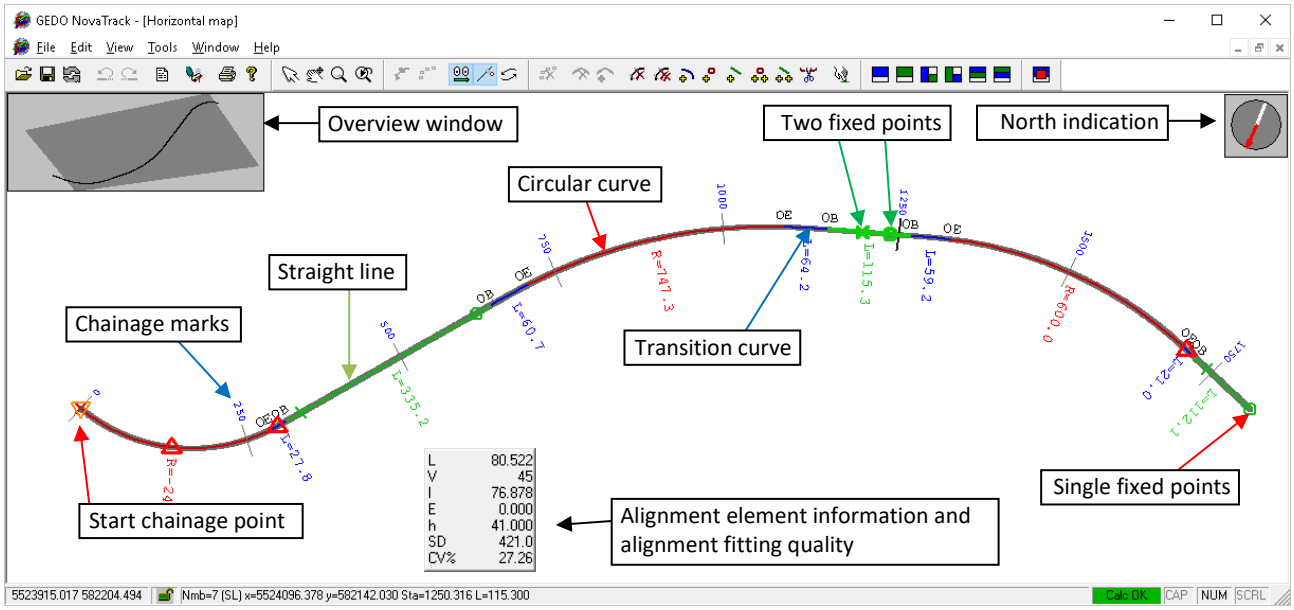
Icon	Function description
	Analysis Diagram. Opens new Analysis diagram window. Use mouse right-click to select appropriate measured point visualization method: Curvature 3, Curvature 7 or Direction.

5.3 Graphical User interface

GEDO NovaTrack uses three movable and re-sizeable windows: Horizontal Map, Vertical Map, and Analysis diagram windows. These windows can be arranged within the user's preferences. GEDO NovaTrack also has pre-defined Layouts for these three windows.

5.3.1 Horizontal map view

The Horizontal window shows the Project's horizontal alignment (current line calculation). The alignment can be shown in either a left-to-right direction, or orientated with the North direction pointing upwards on the screen depending upon the current view settings (see View ▸ Settings).



The horizontal alignment elements are colour coded:

- green colour for straight line;
- blue colour for transition curves or spirals;
- red colour for circular curves;
- chainage is marked with a blue ticks.

Cross marks and circle marks are fixed points (tangent points), necessary for the alignment calculation. The fixed point position can be modified in the graphical interface. However, fixed points cannot be deleted or created, since they are connected to the alignment elements.

The fixed points are colour coded, marked with different symbols and have the following meaning:

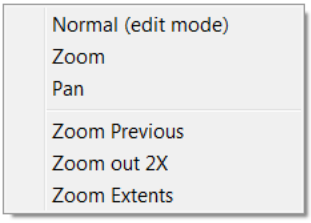
- green fixed points belong to elements which are locked with two fix points. The first point is a cross and the second is a circle;
- red fix points are locking the elements at one fixed position only.

For a description on calculation methods, see *7. Definition of calculation methods*. For a description on editing the alignment calculation, see *9. Alignment data calculation and editing*.

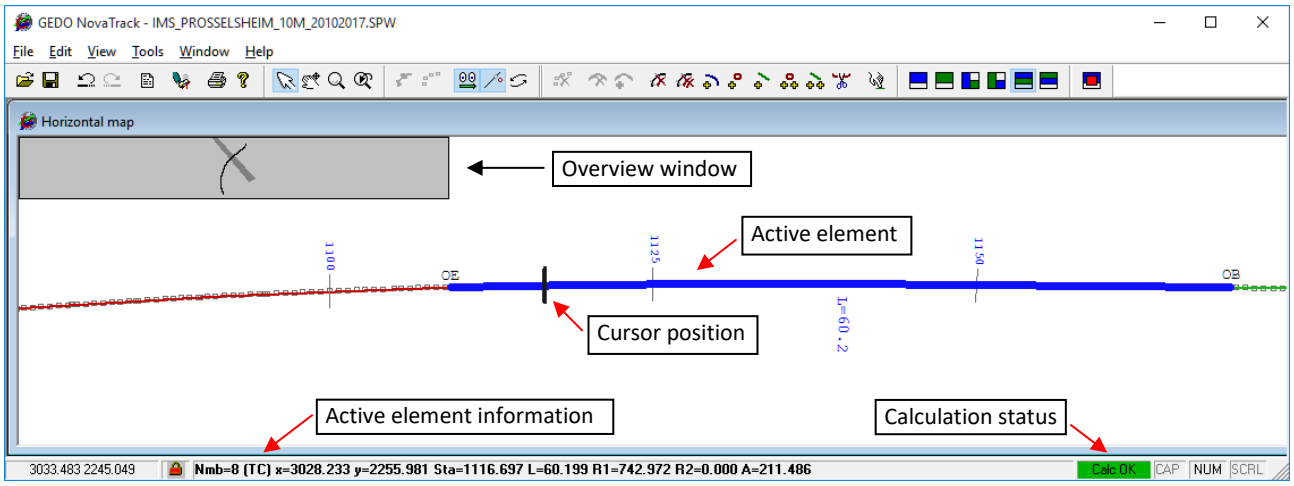
In the top left hand corner of the *Horizontal* window, an aerial overview window of the complete alignment is shown, with the active view window marked in a darker colour.

In the top right hand corner, a north arrow is shown. (Only when viewed in left-to-right mode)

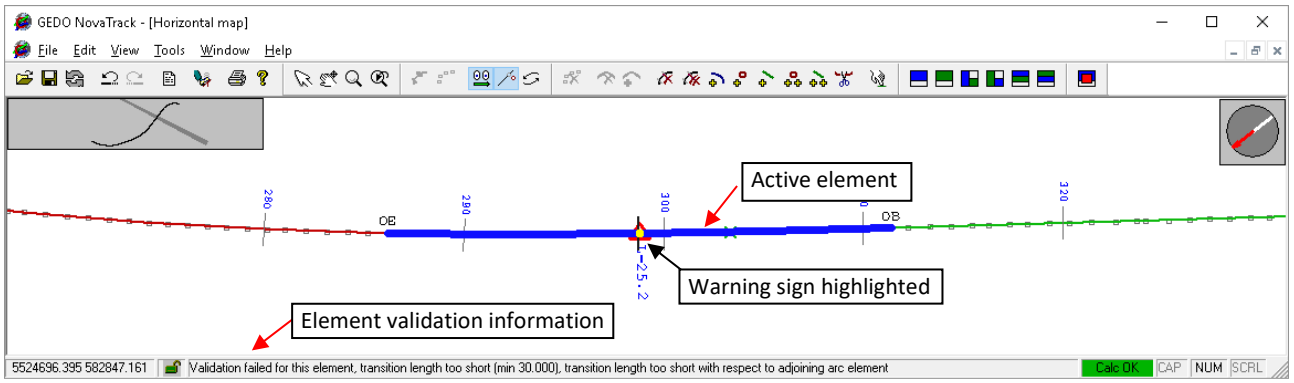
For viewing basic alignment element information, point the element using mouse left-click. A double left-click opens the element Editing dialog (see *9.3.1 Workflow for manual horizontal alignment and offsets adjustment*). A right-click opens a quick menu with appropriate commands:



When the cursor is moved along the alignment, the chainage marker is shown at the cursor's position. The active element is displayed using a bolder colour. When the cursor is pointed at a fixed point, the fixed point is marked with a filled, yellow circle.

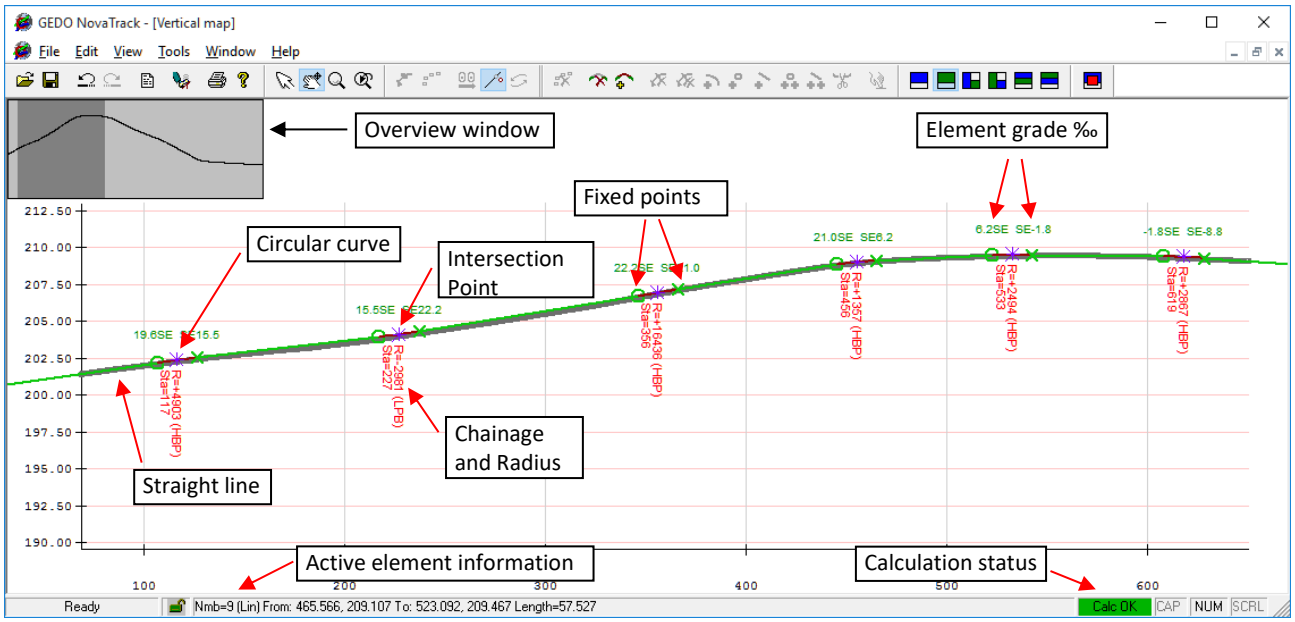


All calculated alignment elements which are outside the limits set in the selected user profile, are marked with a warning sign (triangle symbol) ⚠. When the mouse pointer is moved over the warning sign, the symbol is highlighted ⚠ and the status prompts ⚠ with element validation information.



5.3.2 Vertical map view

In the *Vertical Map* layout window, the vertical alignment of the project is shown. The alignment is shown as a graph with the chainage on the X-axis and the height (elevation, Z-value) on the Y-axis. The alignment is colour coded: straight elements are green and circular curves are marked in red.



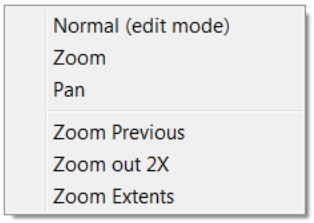
Cross marks and circles are fixed points necessary for the line calculation.

Green fixed points belong to straight elements, where the first fixed point is a cross, and the second is a circle. Blue crosses represent the vertical angular points for the circular curves.

For a description on editing the vertical alignment, please refer to chapter *9.3.3. Workflow for manual vertical alignment and offsets adjustment*.

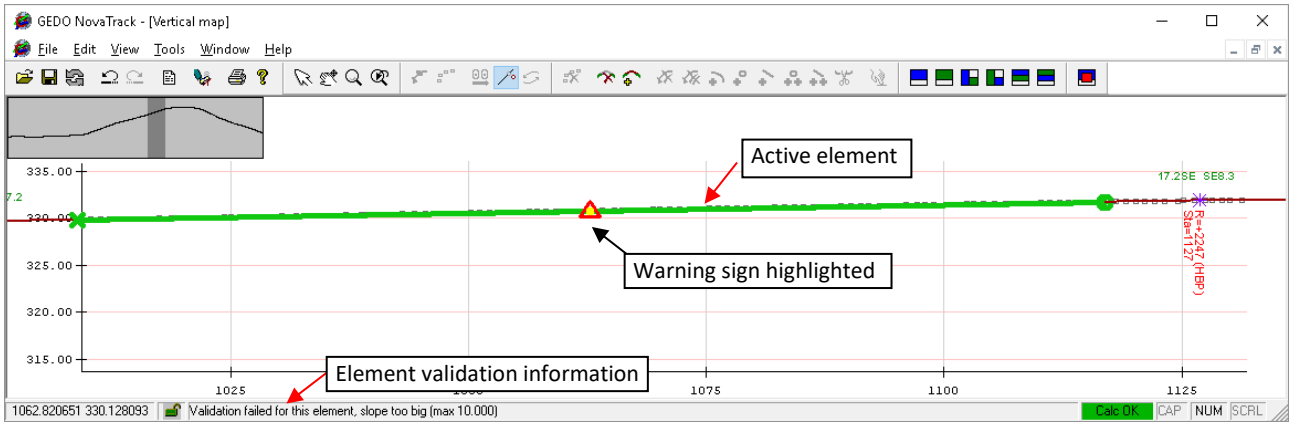
In the top left hand corner of the Vertical window, a view over the complete vertical alignment is shown, with the current view marked in a darker colour.

The user chooses an active element by clicking on it. Double-clicking an element opens the edit element dialogue box. A right-click opens a quick menu with appropriate commands:



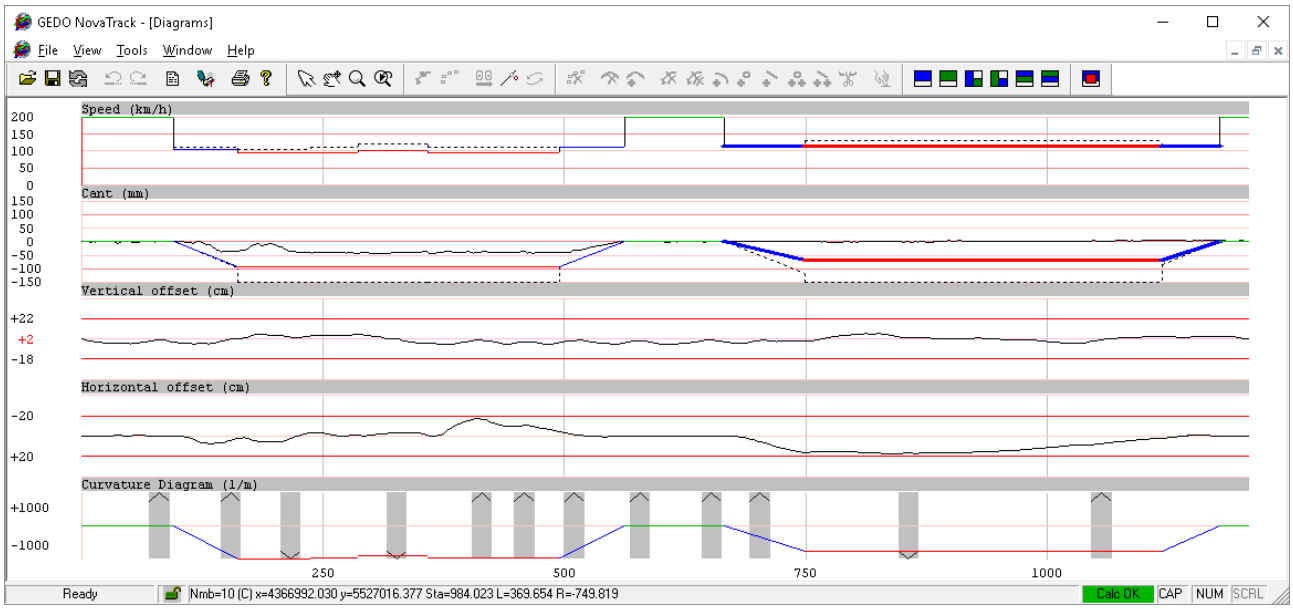
All calculated alignment elements which are outside the limits set in the selected user profile, are marked with a warning sign ⚠ (triangle symbol).

When the mouse pointer is moved over the warning sign , the ⚠ symbol is highlighted and the status prompts with element validation information.



5.3.3 Diagram view

The Diagram window displays information about the calculated/set speed, measured/calculated cant, vertical offsets, horizontal offsets and horizontal/vertical alignment curvature.



- The Speed diagram (in km/h) shows calculated speed at each horizontal alignment element. The speed indication lines has different marking, which is dependent on element type (separated by colours) and calculated speed values (separated by line type).

———————	Calculated Vmax speed for individual element (colour coded)
----------	Calculated Vmax speed for individual element, considering neighbouring element speed (colour coded)
▬▬▬▬▬▬▬	User set Vmax speed for individual elements (colour coded)

The speed calculation regulations can be set or edited in the *Calculation profile*.

Calculation profiles can be accessed from the toolbar, by selecting function *Re-analyse* or from the main menu Tools -> Options -> Calc.set. Use the same dialog to dedine new or edit existing profile.

Vmax values are calculated based on calculation profile table and can be overridden with user define speed settings, in the *Tools -> Cant and Speed calculations – Speed*.

- The Cant diagram (in millimeters) shows measured and calculated Cant values. Additionally, depending on alignment element type, calculated Cant values are coloured accordingly. The maximum scale for calculated Cant is set in the *Calculation Profile* settings (variable *hmax*). The calculated Cant values for the whole alignment can be access for editing by double-clicking on Cant graph.

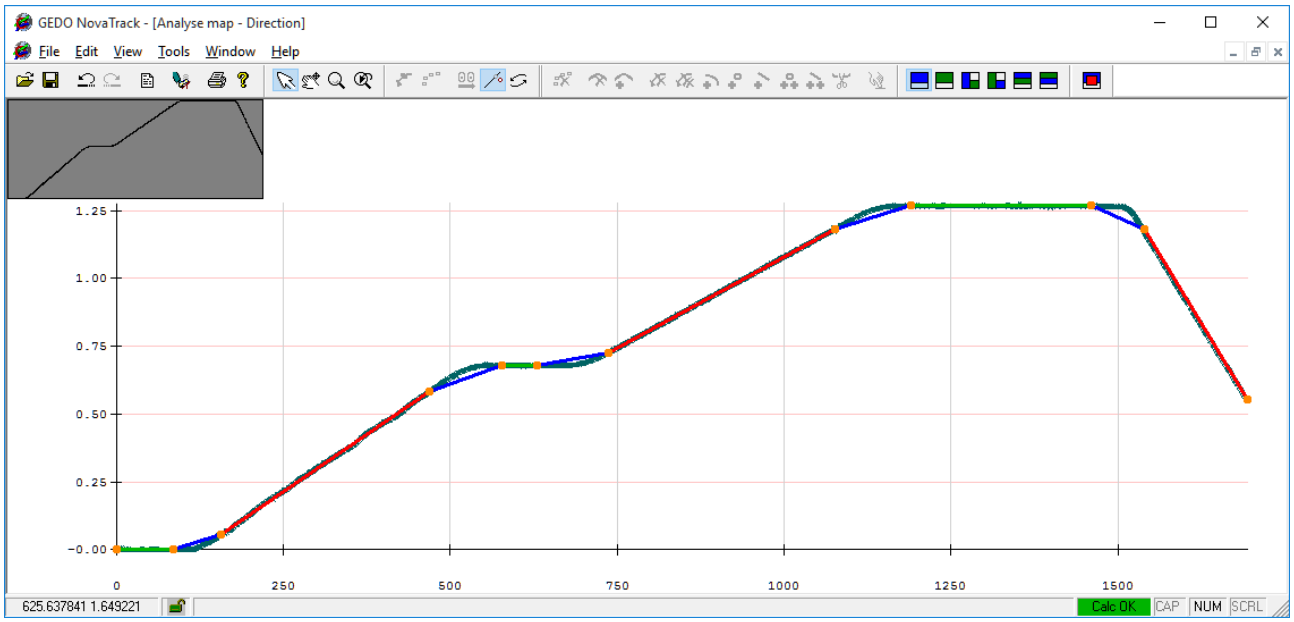
  For editing of *Calculation profile*, please refer to chapter *6.4 Calculation profiles* and *Appendix 2. Calculation profile definition*.

	Measured Cant (black colour)
	Calculated Cant for individual element (black colour)
	Calculated Cant for individual element, considering neighbouring element speed and Cant according Calculation profile (colour coded depending on element type)
	Overridden Cant by user (bolded, colour coded depending on element type)

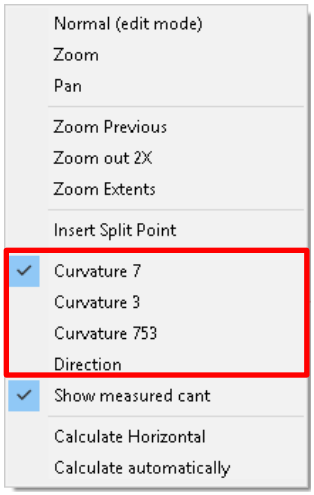
- The Vertical offset diagram (in centimetres) shows the offset between measured points and the vertical alignment calculation. Where the calculated line is above the measured point, the vertical offset is shown as above the *0-level* (positive offset). The scaling of the vertical offset diagram can be set in *Tools -> Options -> Project*.
- The Horizontal offset diagram (in centimetres) shows the offset between measured points and the horizontal line calculation. Where the calculated alignment is always following the 0-level, and measured points as the continuous black line are displayed on both side of 0-level axis. Offsets on the left side *0-level* axis are ´positive´, and on the right side - ´negative`. The scale of the horizontal offset diagram can be adjusted in *Tools -> Options-> Project* settings.
- The Curvature diagram (1/R) shows the curvature of the horizontal alignment. If measured point view "*Show 3 (and/or 7-) point radius*" (in *View -> Settings* dialog) is activated, these calculated points are visible in the *Curvature diagram*. The diagram also shows the vertical alignment, with its Intersection Points and vertical radii indicated with grey fields and arrowheads.
- At the bottom of the *Diagram* window, the chainage information is displayed.

5.3.4 Analysis diagram view

The *Analysis* window is used for semi-automatic analysis of the measured track data. Based on the measured points, the program calculates horizontal track curvature as *1 / Radius* and *Direction* changes. Calculated values are displayed along the chainage axis in the form of diagram.



To switch between available Analysis diagram visualization modes, in the *Analysis diagram* view use mouse *right-click* and select appropriate data visualization mode from short-cut menu:



Analysis diagram mode	**Comment**
Curvature 7	Invers radius curvature diagram, 7 point radius
Curvature 3	Invers radius curvature diagram, 3 point radius
Curvature 753	Invers radius curvature diagram, average of 7, 5 and 3 point radius
Direction	Directional diagram based on direction change along the measured point

Important!

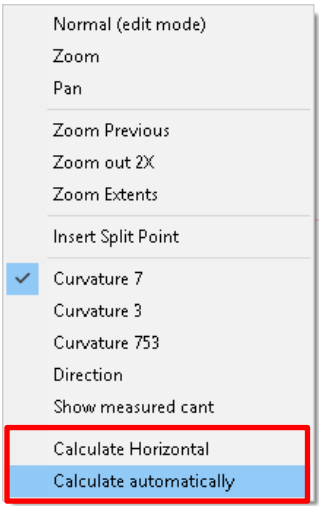
Analysis function only calculates horizontal alignment geometry. If the *Manual* or *Automatic* calculation function is activated, the available alignment geometry in the *Horizontal view* window will be replaced with the calculated alignment from *Analysis diagram*.

The *Analysis* calculation engine is relying on the user defined "*split*" points (in the *Analysis diagram*) which are representing a preliminary locations for element tangent point.

Each "*split*" point is connected with an horizontal alignment element and these elements are presented in the diagram view as preliminary guidelines for horizontal alignment calculation. The colour of the alignment elements has the following meaning:

Color	Element type
Green	Straight line
Red	Circular curve
Blue	Clothoid/Spiral (transition curve)
Grey	No element inserted between split points

After the positions for the elements are identified and alignment is calculated in the diagram view, the result is automatically is synchronized with Horizontal view. Diagram recalculation and synchronization with horizontal view can be set in Manual or Automatic mode. To switch between the modes in the Analysis diagram view *right-click* and select/deselect calculation mode to *Calculate automatically*:



Important!

No element will be inserted between two *´split´* points that have fewer than 3 measured points between them.

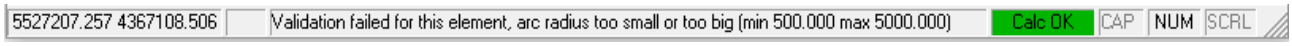
If the diagram elements between the split points are coloured in ´magenta´, it means that an alignment has an errors and therefore it can´t be calculated.

5.3.5 Status bar

The Status bar shows information about the position of the cursor, active element and calculation status. The type of visible information varies depending on what windows are open and the type of active element. When the user is editing an element, a brief description of what the user should do is displayed.

- To the left, the coordinates of the cursor are shown. When the cursor is in the *Horizontal* window, the coordinates are East-North. When in the Vertical window, the coordinates are Chainage-Elevation.
- The following symbol is a *Padlock*. The lock is green when there is no element selected for editing. When an element is activated for editing, by clicking on it, the padlock changes to red.
- To the right of the *Padlock*, information about the current element is displayed - *Element number*, *Element type*, *Coordinates*, *Chainage*, *Length* and *Radius* (*Transitions* are displayed with Start and End radius). Displayed information about elements in the vertical alignment are *Element number*, *Element type*, *Chainage* for start and end, and *Element length*.
- Further to the right, the status of the line calculation is displayed. When the calculation is successful, the text ''*Calc Ok*' is shown in green. When the calculation is not successful, the text ''*Calc not Ok*' is shown in red. Double-clicking this field opens the result text-file.
- Furthest to the right of the Status bar shows the current status for Caps Lock, Num Lock and Scroll Lock.

When the specific element warning sign ⚠ is selected in the Horizontal or Vertical view, a status bar prompts with element validation information.



6 Settings and options

Settings and parameters in the GEDO NovaTrack software are grouped into the following groups:

- Project settings
- General settings
- Grid and Map settings
- Calculation profiles

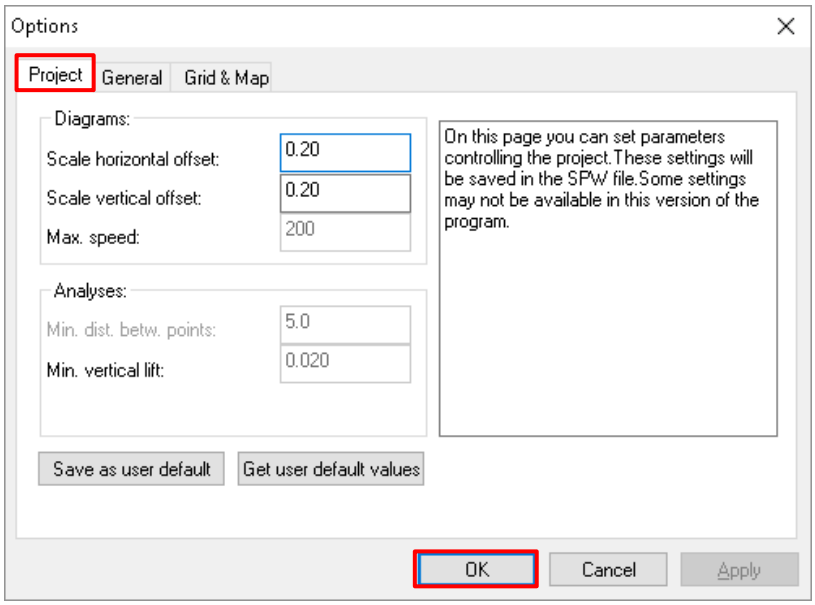
Important!

These settings are stored on a software configuration level and within the project .SPW files. Settings covering calculation profiles are stored in ´Profiles.ini´ file (located in GEDO NovaTrack installation folder).

6.1 Project settings

To access the Project setting group:

- from the main menu select *Tools -> Options*
- select the *Project* tab.
- confirm changes by pressing *OK* button.



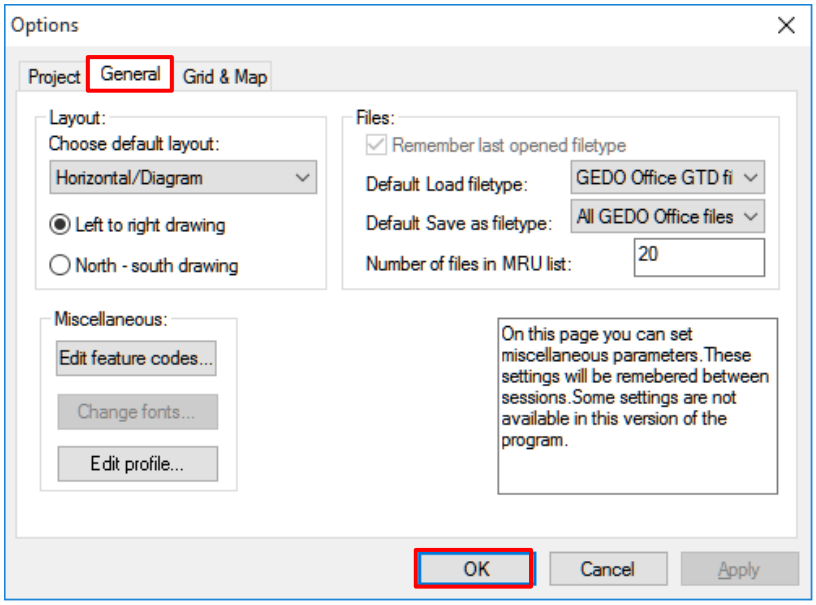
Settings	Comment
Scale horizontal offset	Scale for the Horizontal offset diagram values. Unit is metres
Scale vertical offset	Scale for the Vertical offset diagram values. Unit is metres
Save as user default	Saves as default settings.

Settings	Comment
Get user default values	Restores saved user default values for this dialog box

6.2 General settings

To access the General setting group:

- from the main menu select *Tools -> Options*
- select the *General* tab.
- confirm changes by pressing *OK* button.



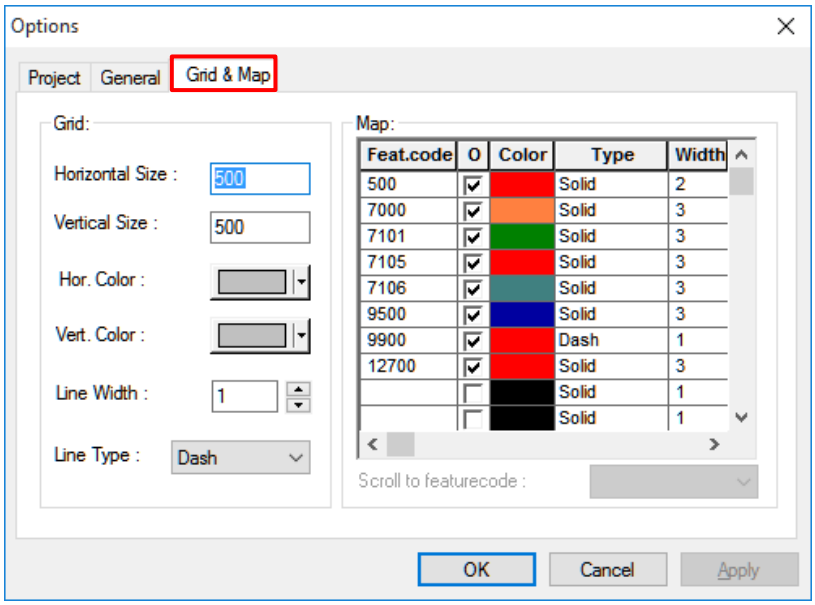
Settings	Comment
Layout	
Choose default layout	Sets the default layout window from the Predefined Window Layouts.
Left to right drawing	Sets the default orientation for the horizontal alignment from the left-to-right
North-south drawing	Sets the default orientation for the horizontal alignment from according to the coordinate grid
Files	
Remember last opened file type	Not implemented in this version.
Default load file type	Sets the default file type for opening a project.
Default Save as file type	Sets the default file type for saving a project.
Number of files in MRU list	Sets the number of recently used files shown in the File menu.

Settings	Comment
Miscellaneous	
Edit feature codes	Is used for changing or predefining feature codes for track centres or rails in in-data files.
Change fonts	Not implemented in this version.
Edit profile…	Create and edit calculation profiles

6.3 Grid and map settings

To access the Grid and Map setting group:

- from the main menu select *Tools -> Options*
- select the *Grid & Map* tab.



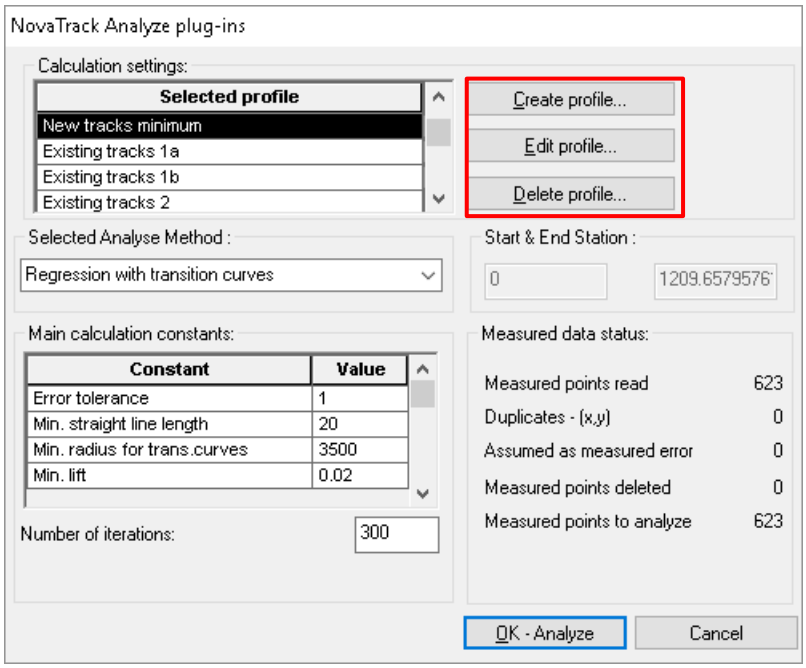
Settings	Comment
Grid	
Horizontal Size/Vertical Size	Sets the size of the grid. Unit is metres.
Horizontal Colour/Vertical Colour	Sets the colour of the grid. Choose from the colour box.
Line Width	Sets the grid line width. Change to arrow-up or arrow-down.
Line Type	Sets the grid line-type. Choose available line-types from the drop-down list.
Map	

Settings	Comment
Feature code	Lists feature codes in the imported map. The feature codes can be edited, but it is not possible to join feature codes into one.
On	Sets the feature code display status on/off.
Color	Sets the feature entity display colour.
Type	Sets the feature entity display line-type.
Width	Sets the feature entity display line-type width.

6.4 Calculation profiles

There are two possibilities to access the Calculation profile settings:

a) from the main toolbar, select *Re-analise*



b) from the main menu, select *Tools -> Options -> General*

- press ´*Edit profile…*´ button to view or edit calculation profiles.
- to delete selected profile, press ´ *Delete current profile* ´ button.
- To create new profile, press ´ *New (copy from existing)* ´ button. The new profile will be always created based on a selected profile values.

Important !

Detail description of constants used in calculation profiles is listed in the *Appendix 2. Calculation profile* definition.

For the alignment re-calculation process, some of the most important constants are directly accessible from Re-analyze dialog:

Settings	**Comment**
Selected Analyze method	Regression method: - Novatrack 3.0: for track with good geometry quality - Regression with transition curves: for track with low-avarage geometry quality - Regression without transition curves: for track with low geometry quality. Transition curves will not be used in alignment approximation.
Error tolerance	Setting affecting precision for alignment element approximation. The less value, more ´constrained´ element fitting to the measured points. The error tolerance is iterated from zero to set error tolerance value.
Min. straight line length	Minimum length for the straight elements. The software will iterate the length from the set minimum length.
Min. radius for transition curve	Minimum radius for the transition curves. The software will iterate with transition elements (length, radius) starting from set radius value.
Min. lift	Applied minimum average vertical lift for vertical alignment elements
Number of iterations	Number of iterations for fitting horizontal alignment elements

7 Definition of calculation methods

GEDO NovaTrack software contains two main methods for automatic alignment fitting with measured points. Each method has its own features and individual requirements for the measurement data.

7.1 Alignment smoothing using the NovaTrack 3.0 method

Horizontal alignment

The method is based on the analysis of the track measurement data in a curvature diagram, instead of trying to compute the elements (straights, curves and transition curves) directly from the coordinates of the measured data. In the diagram, the software assembles the points into groups of seven and transforms the coordinates, from X-Y to Chainage – Curvature. In a curvature diagram, all the elements that are straight lines or curves are represented as straight lines (constant curvature has parallel offset to the R axis), and the transition curves have linear increasing or decreasing functions. The elements are dissolved from a regression analysis to find best-fit lines. When the elements are identified, they are transformed back to X-Y coordinates and the result can be calculated.

Vertical alignment

The gradient lines are found by assuming a "corridor" either side of the straight line and then the software will compute how far the straight line can be extended without crossing the corridor with set vertical offset tolerance *´error_tolerance_vertical´*. The vertical intersection points are inserted at the intersection between straight lines. The radii are then calculated as having a tangent length of 20.0m.

Demands on track measurement data

The method is sensitive to the quality of the track measured data, but compared to the other methods, uses a more powerful algorithm for line calculation. With high quality on both track and measured data, the analysis will be capable of handling relatively complicated geometry.

Important !

Detail description of ´Novatrack 3.0´ method specific calculation constants is listed in the *Appendix 2. Calculation profile* definition.

7.2 Alignment smoothing using ´Regression with transition curves´ method

Horizontal geometry

This Analysis method is using the least squares method to find the straight lines in the alignment from the track measured coordinates and within user defined tolerances. Method is using measured data to calculate the “best” radius between straight elements. If a radius cannot be calculated, or calculated value exceeding 25000.0 meters, the radius is set to 10.0 m or 25000.0 meters.

Vertical geometry

Regarding vertical geometry, the least squares method is also used for establishing straight lines from the measured points, within the user given tolerance. From the measured data, software calculates the “best” radius between straight elements. If a radius cannot be calculated, or calculated to more than 50000.0m, the radius is set to 50000.0m.

Demands on track measurement data

The ´Regression with transition curves´ analysis is less sensitive in detecting S-curves and combined curves, especially when the minimum straight line length is set too long. In those cases, connecting straight lines in between the S-curve are not detected.

The calculation of the transition curve parameter is also a relatively simple procedure and is done after the calculation of radii smaller than the radius given by the user. The analysis starts with the parameter A set to A = R/3, the length is reduced where there is no room for transition curves.

The ´Regression with transition curves´ analysis has lower demands on the quality of the measured data, compared to the Novatrack 3.0, and will in most cases be able to find the straight lines. It is then up to the user to edit the geometry until a satisfying result is reached. The analysis will on the other hand have trouble with more complicated geometry, such as S-curves and combining spirals.

In most cases the ´Regression with transition curves´ analysis will generate alignment geometry which can later be used for further optimization and adjustment.

Note.

Detail description of ´Regression with transition curves´ method specific calculation constants is listed in the *Appendix 2. Calculation profile* definition.

7.3 Alignment smoothing using Analysis Diagram tools

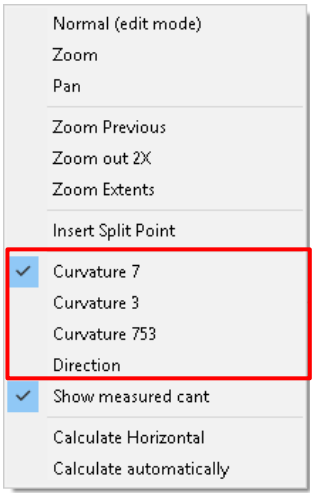
7.3.1 Analysis Diagram introduction

The Analysis diagram tool is used to manually or semi-automatically adjust horizontal alignment elements and overall horizontal alignment quality based on the track measured points.

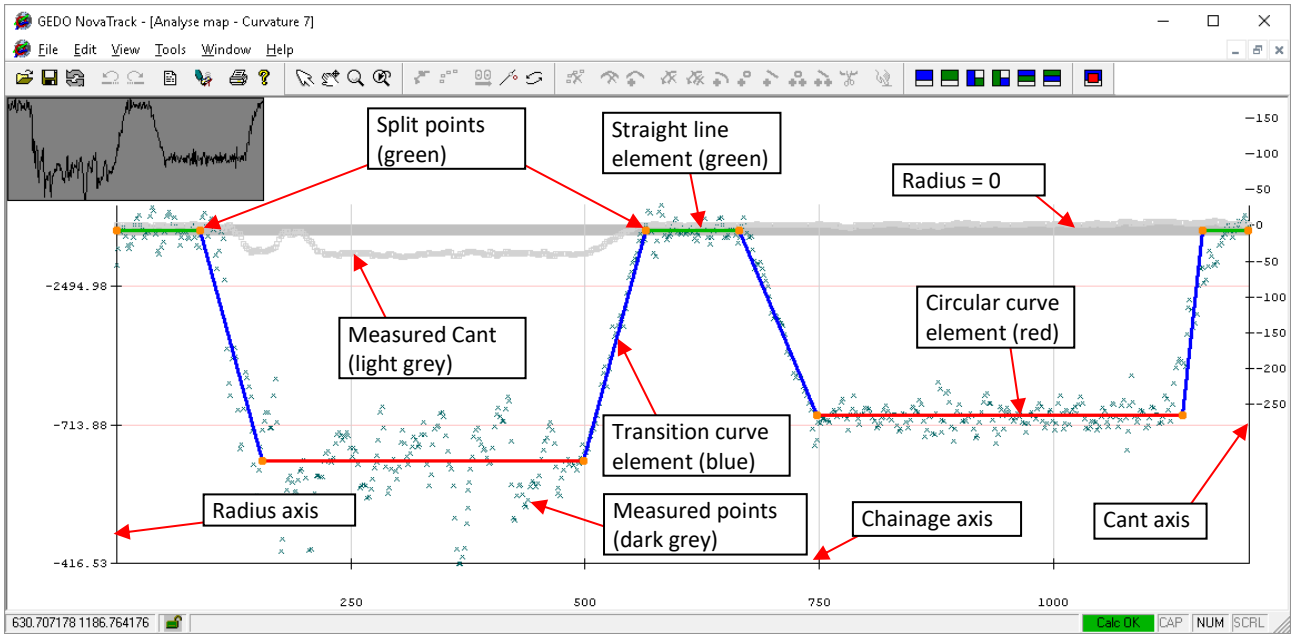
Once measured points are automatically processed within set number of iterations, using `Novatrack 3.0` or ´Regression with transition curves´ methods, elements can manually or semi-automatically be further adjusted in these two primary Analysis diagrams:

- Curvature 7 (measured data is shown as 1/Radius, using 7 points)
- Direction (measured data is shown as direction change)

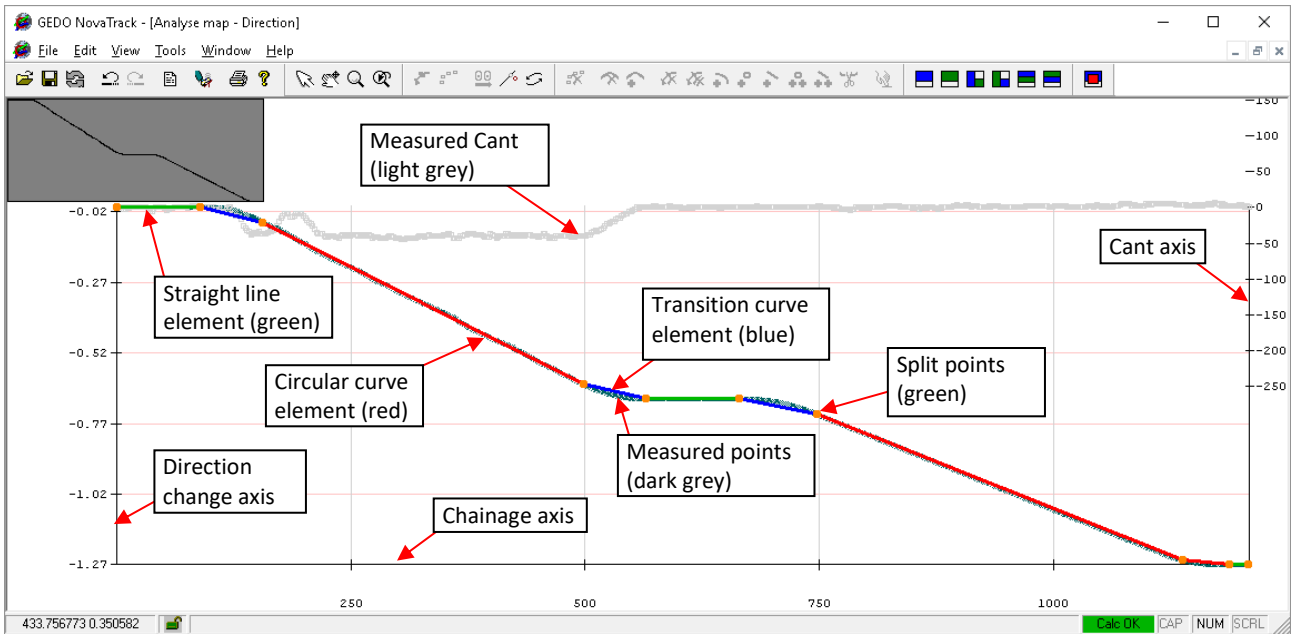
To switch between the available Analysis modes, in the Analysis diagram use mouse right-click to switch between Analysis mode:



Analysis mode	Comment
Curvature 7	Curvature diagram, based on 7 point radius - Diagram recommended to analyse track curvature with moderate-good geometry quality.
Curvature 3	Curvature diagram, based on 3 point radius - Diagram recommended to analyse track curvature with good geometry quality.
Curvature 753	Curvature diagram, based on average of 7, 5 and 3 point radius - Diagram recommended to analyse track curvature with good-very good geometry quality.
Direction	Direction diagram, based on measured points direction vector changes in a chainage direction: - Diagram recommended to analyze track curvature with low-very good geometry. The Diagram is very efficient to analyze track geometry on a long straight and radii stretches. Direction diagram is also highly supportive when curvature pattern can´t be recognized by Curvature 7, 3 or 753 analysis mode.



Analysis diagram - Curvature 7



Analysis diagram - Direction

Important!

Analysis diagram function calculates only horizontal alignment geometry. If the alignment is recalculated in *Automatic* mode, alignment geometry in the *Analysis diagram* will be overridden with new alignment result.

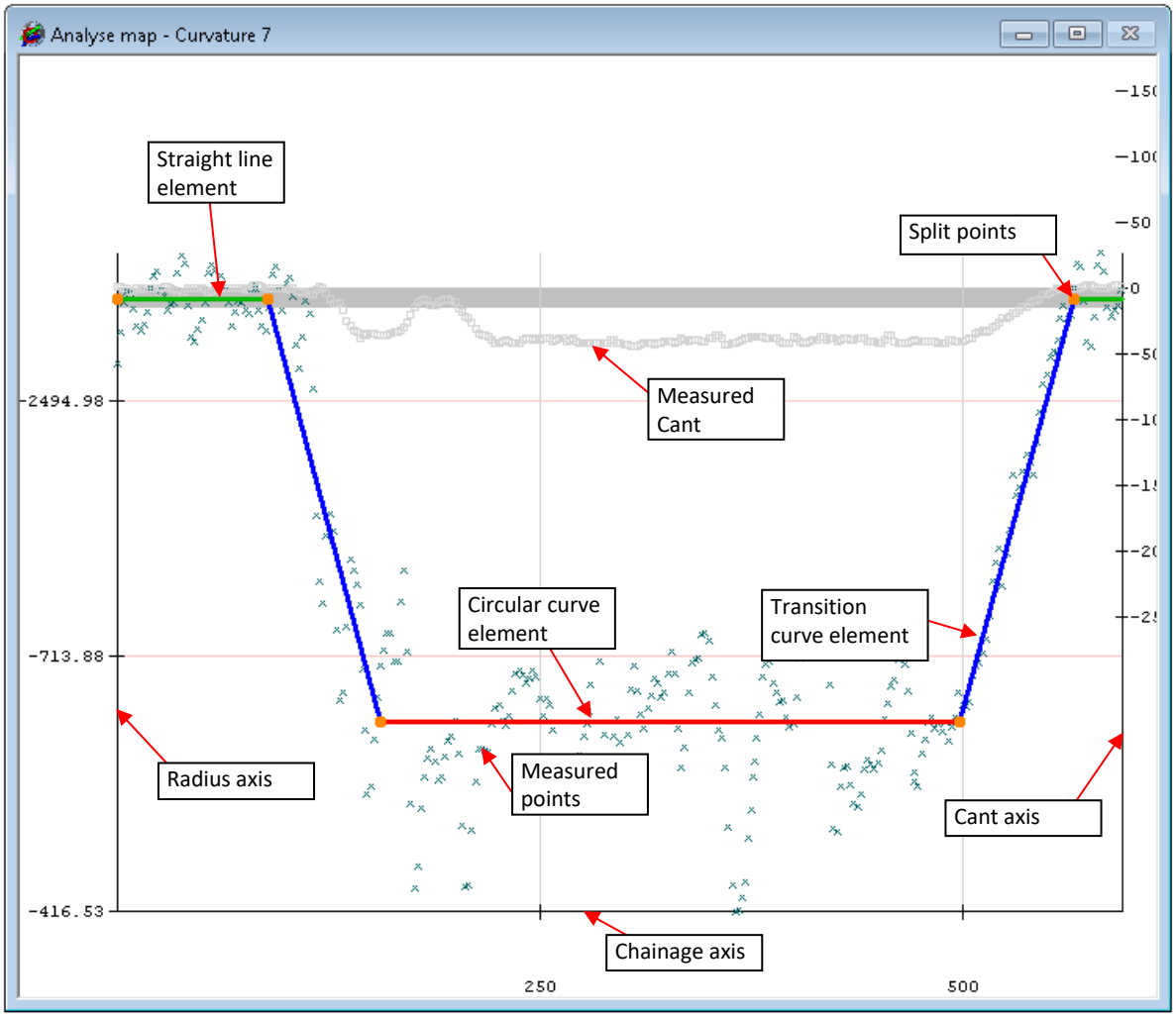
7.3.2 Analysis diagram editing and calculation

In the *Analysis diagram* view, calculation of horizontal alignment can be done in following ways:

- right-click and select *Calculate Automatically* (continues real-time calculation)
- right-click and select *Calculate Horizontal* (single calculation)
- pressing *C key* (single manual calculation)
- pressing *V key* (single manual calculation, just visible part of alignment)

In the *Curvature 7* , *Curvature 3* and *Curvature 753* diagram the following rules apply:

- straight elements always follow the measured points along the chainage, with R = 0
- circular curve elements are parallel to chainage axis, with constant R offset
- transition curves are linearly ascending or descending relatively to R and Chainage axis.
- split points are inserted at diagram locations, where the point sequence is starting to change the Radius.



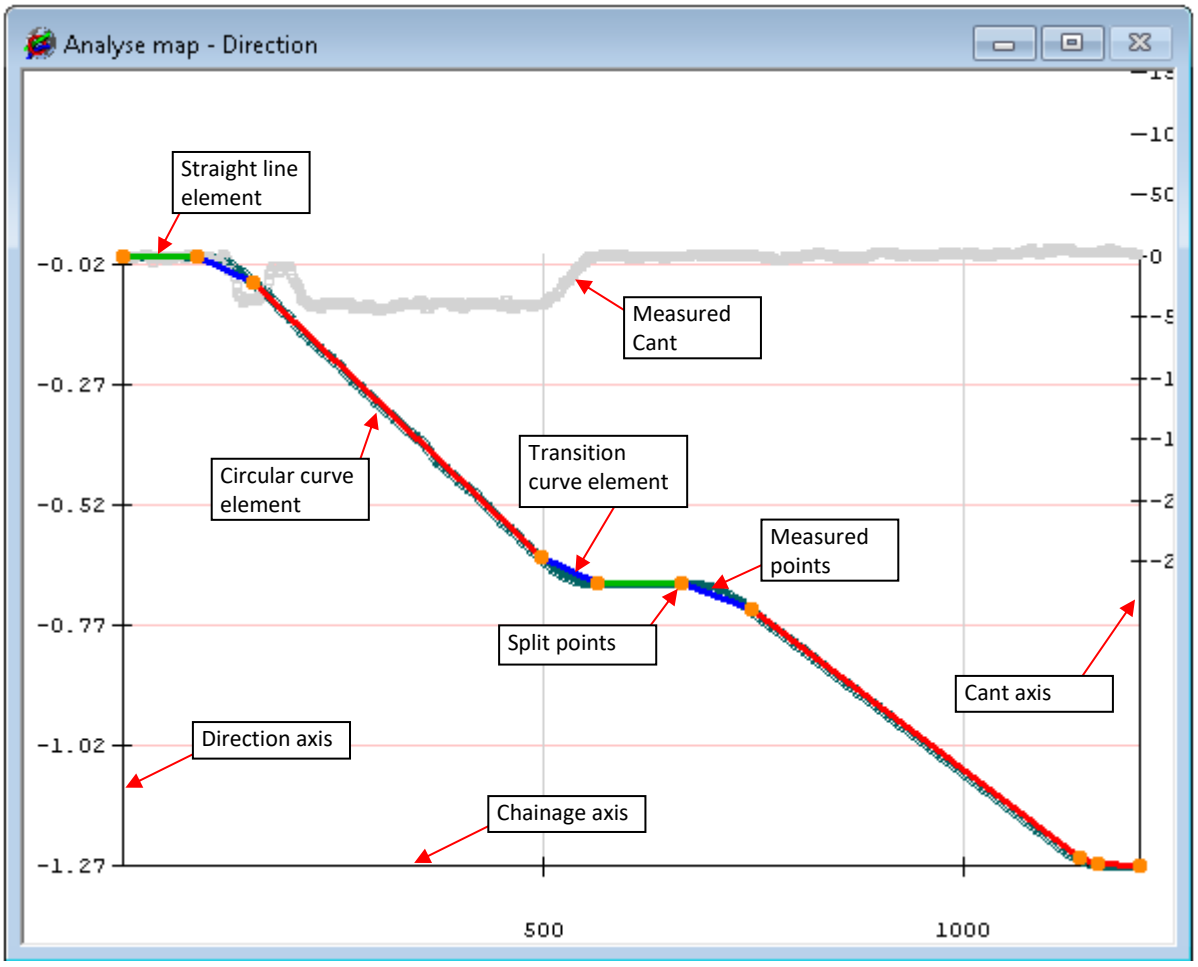
Split point positioning within Curvature 7 and Curvature 3 analysis diagram

Important!

Split points just indicates the preliminary position for element tangent points, however the precise position will be determined after element precise approximation process is completed.

In a *Direction diagram* the following rules apply:

- straight elements are always parallel to the Chainage axis, with Direction change = 0.
- circular curve elements are ascending or descending along measured points, relative to the Direction and Chainage axis.
- transition curves are established at diagram segments, where the direction of measured points starts to transition from `0 deg. to constant angle´ or from ´constant angle to 0 deg.´.
- split points are inserted at the diagram locations, where the measured point sequence starts to change the Direction angle.



Split point positioning within Direction analysis diagram

Each "split" point is connected to an horizontal alignment element, and these elements are presented in the diagram as a ´guidelines´ for horizontal alignment calculation. The colour of the alignment elements has the following meaning:

Color	**Element type**
Green	Straight line
Red	Circular curve
Blue	Clothoid/spiral (transition curve)
Grey	Connection between elements without transition

When the elements are identified and an alignment solution is calculated, the alignment elements from the *Analysis diagram* are transformed back to X-Y coordinates.

Important!

No element will be inserted between two "split" points that have fewer than 3 measured points in between them.

If the grey colour line is drawn between split points, it means that an alignment elements will be connected without transition curve (SL – C or C-C).

Split points just indicates the preliminary position for element tangent points, however the precise position will be determined after element precise approximation process is completed.

7.3.3 Analysis diagram short cut tools

In order to accelerate work process with element adjustment process in the Analysis Map, the software provides a set of commands and tools.

7.3.3.1 *Commands and tools valid for Curvature and Direction analysis diagrams*

Short key	Command
Editing	
Left-click & drag	Pan diagram view along the chainage
Left-click ´split´ point	Snap to ´split´ and change position
Shift+ mouse cursor over ´measured point´	Snap to ´measured´ point. Status bar will indicate information about the selected point
Mouse cursor over ´split´ point + Delete	Deletes selects ´split´ point Important! - Always move mouse cursor over a split point (turns RED) and then activate function.
Shift + Left click over ´split´ point	Moves the split point to Radius = 0 and/or direction D = 0 Important!
Shift+ Delete	Delete selected measured point. Important! - Firstly, always move mouse pointed over measured point (turns into Circle). - While keeping the Shift key down and continue pressing Delete key, the function will continue to delete measured points, starting from the nearest to the previously deleted.
Ctrl-Z or 	Undo and redo changes
Double click or INS key	Inserts new split point by snapping to nearest measured point
A	Calculates element average radius to the next split point. Important! - Always move mouse cursor over first split point of the element (turns RED) and then press A key. - In the Curvature 7 and 3 diagrams the averaging function applies to straight and circular curve elements. - In the Direction diagram averaging function applies to straight elements only.
C	Calculates complete horizontal alignment
V	Calculates just visible horizontal alignment elements Important!

Short key	Command
	- Prior to activating this function, make sure that the alignment is in the window area and not starting or ending with a Clothoid element (transition curve).
D	Changes alignment direction
E	Erases all split points
S	Turns snap to the measured points On/Off
X	Turns split points in the diagram On/Off
3	Turn 1/Radius Curvature 3 On/Off
O	Filter out measurement bias in Curvature 3, 7 and 753 diagrams Important! - Filtering function can be applied in the Curvature 3, 7 and 753 diagrams only.

Note.

The function behind the *key Delete* require that the mouse pointer is placed over a "split" point and that the split point colour is changed to red. A red colour indicates that the point is selected and active.

7.3.3.2 *Commands and tools valid for Direction Analysis diagrams only*

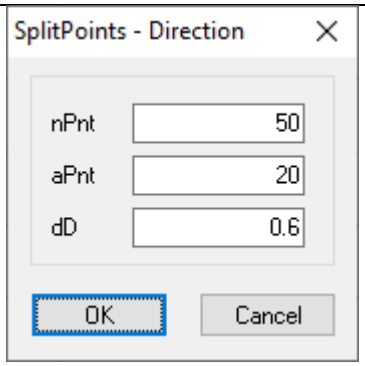
Semi-automatic measurement data Analysis in the Direction diagram can be done in the following ways. These three analysis methods help to identify split point locations.

Short key	Command
Split point accelerator	(Commands are only valid in the Direction Analysis Map)
L	Insert split points using direction change. Measured point analysis is based on a graphical directional change.
P	Insert split points using radius alteration. Measured point analysis is based on the change of radius along the graph.
O	Insert split points using direction line regression. Measured point analysis is based on the fact that elements in the graph are calculated according to line regression.
Q	Calculated of direction and measured point data displayed as Curvature

Important !

At any given point, a manual adjustment of the analysis split point locations and their quantities may be required to achieve an alignment solution.

Analysis based on directional change along the graph (*L key*):

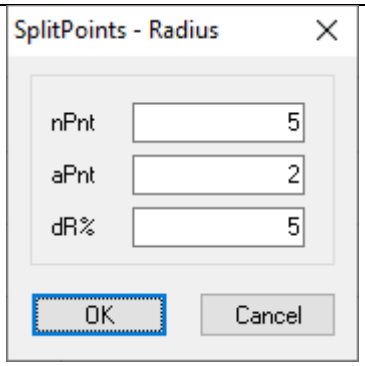


nPnt – number of points in a single analysis array
aPnt – number of points for calculating average direction
dD – maximum direction change between two vectors

The analysis assumes *nPnt* points at a time, calculates the average direction (y-value) at the first, middle and last *aPnt* point. These 3 values provide two directional vectors used to determine whether the graph changes direction. The parameter *dD* is the maximum directional change between the two vectors. The lower the *dD value*, the more exacting the analysis (will generate more split points).

A split point is automatically inserted when 3 subsequent calculations show the same directional change along the graph or if the directional change along the graph exceeds *dD*.

Analysis based on change of radius along the graph (*P key*):

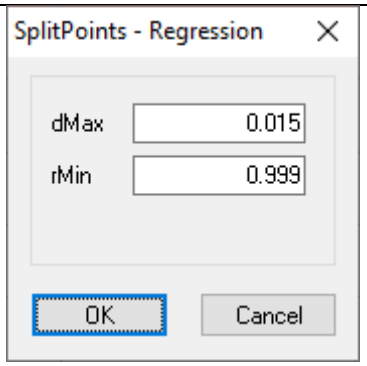


nPnt – number of points in a single analysis array
aPnt – number of points for calculating average direction
dR% – maximum radius change between two vectors

The analysis assumes *nPnt* point at a time, calculates the average direction (y-value) at the first, middle and last *aPnt* point. These 3 values provide two directional vectors used to calculate the radius at the beginning and at the end of these *nPnt*.

A split point is automatically placed when radians in 3 subsequent calculations show the same directional change along the graph or when the next radius deviates more than ±*dR%* percent of the previous calculated radius. The lower the *dR%*, the stricter the analysis (will generate more split points).

Analysis based on line regression along the graph (*O key*):



dMax – maximum difference between real direction and calculated direction
rMin – minimum regression coefficient (must be between 0 and 1)

Split points are automatically inserted by finding straight lines using line regression analysis.

The analysis starts by finding a line through the first 4 points. Based on the regression line cutting the y axis (direction axis) and the derivative line, one direction is calculated at each measured point. This value will probably differ from the real direction of the measured point, and this deviation is called delta. rMin is the least regression coefficient, and the greater rMin value, the tighter the analysis (will generate more split points).

As long as delta is less than *dMax* and the regression coefficient is less than *rMin*, the regression line is assumed to be acceptable and the next point will be included in the next regression. If not, the new line is assumed and a split point is placed at the end of the line.

Important!

The regression analysis is vulnerable to the measurement errors, and requires extremely good data.

8 Data import and export

GEDO NovaTrack software supports data interoperability with the following file formats:

Format	Read	Write	Description
SPW (.spw)	+	+	Native GEDO NovaTrack project file format
KOF05 (.kof)	+	+	Points, lines and alignment geometry (tabular, ASCII)
Lifting scheme (.lft)		+	Alignment geometry report (ASCII)
PXY (.pxy)	+ (1		Points and lines (tabular, ASCII)
GPS (.gps)	+		Points (tabular, ASCII)
Offset table (.alc)		+	Alignment offset report (tabular, ASCII)
Comma separated (.csv)		+	Alignment geometry report (tabular, ASCII)
NovaPoint (.tit)	+	+	Horizontal alignment geometry (ASCII)
Point file (.lin)	+	+	Alignment geometry (tabular, ASCII)
Intergraph (.dat)	+	+	Horizontal alignment geometry (tabular, ASCII)
NYPL (.nyl)	+	+	Horizontal alignment geometry (tabular, ASCII)
NADB (.ndb)	+	+	Alignment geometry (ASCII)
XRoad (.txt)	+	+	Alignment geometry (tabular, ASCII)
WinALC Geo (.geo)		+	Alignment geometry Plasser/Thuerer (ASCII)
WinALC Ver (.ver)		+	Alignment offsets Plasser/Thuerer (ASCII)
GEDO Office TDT (.tdt)	+	+	Horizontal alignment geometry (tabular, ASCII)
GEDO Office HDT (.hdt)	+	+	Vertical alignment geometry (tabular, ASCII)
GEDO Office UDT (.udt)	+	+	Cant alignment geometry (tabular, ASCII)
LandXML (.xml)	+ 2)	+	Points and horizontal/vertical alignment geometry

(1 - can be imported as background map data only

2) - import supports LandXML cgPoint elements only.

8.1 Import of GEDO measurement data

Track measurement data for alignment re-establishment is imported from the GEDO Office .GTD format files:

- From the main menu select *File -> Open*
- Select file type to *GEDO Office *.GTD*
- As part of the import process, a dialogue box *NovaTrack Analyze* will open. The dialogue box enables you to select already predefined *Calculation profile* for data analysis and alignment optimization.

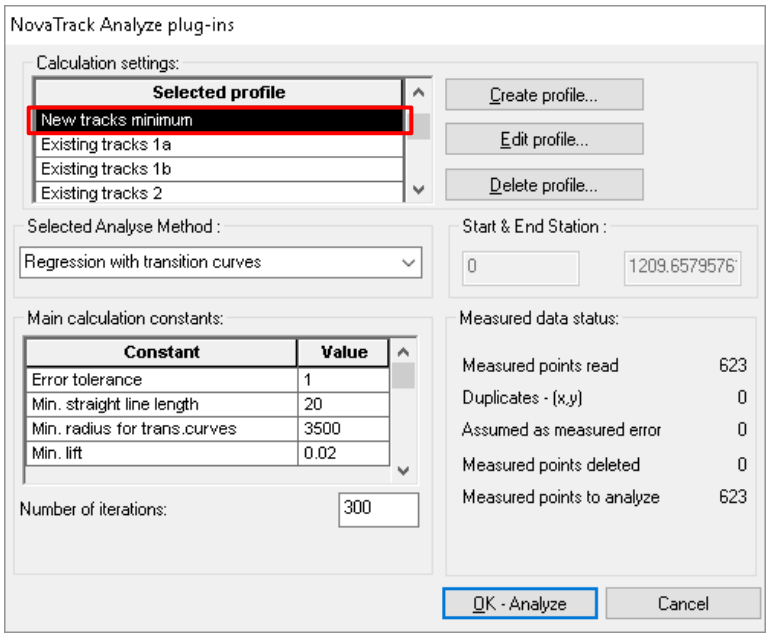
During the measured data import, the software will perform data check and error correction, including:

- data sorting
- duplicate point removal
- non-track related points removal
- estimate of measured track length

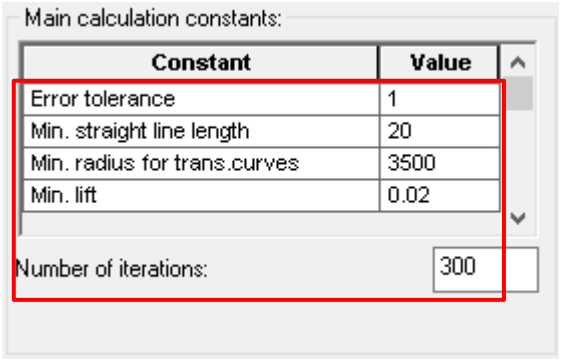
Status for the sorted data is shown in right hand side of the dialogue box.

- Choose existing calculation profile or create new. Calculation profile is linked with analysis method, so ´Selected Analyses Method´ option do not have to be selected separately.

Calculation profile contains both calculation constrains and alignment validation criteria's.

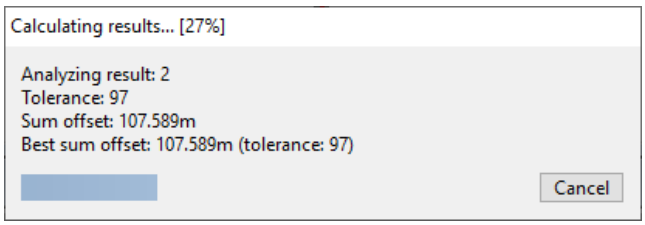


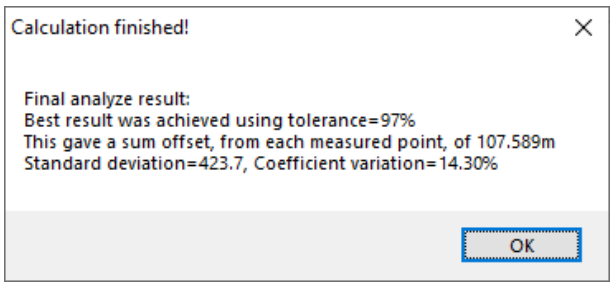
- Adjust main calculation constants, so they correspond with measured track quality and expected alignment result. The higher iteration number will produce smaller step with error tolerance



Setting	Comment
Error tolerance	Setting affecting precision for alignment element approximation. The less value, more ´constrained´ element fitting to the measured points. The error tolerance is iterated from zero to set error tolerance value.
Min. straight line length	Minimum length for the straight elements. The software will iterate the length from the set minimum length.
Min. radius for transition curve	Minimum radius for the transition curves. The software will iterate with transition elements (length, radius) starting from set radius value.
Min. lift	Applied minimum average vertical lift for vertical alignment elements
Number of iterations	Number of iterations for fitting horizontal alignment elements

- Press *Ok – Analyze* button to proceed with calculation.
- The software will run iteration process by evaluating alignment options for the best available solution within set constrains:





- At the end of the iteration process, software selects alignment solution which has smallest ´Sum of offset´ value.

Note.

If the alignment solution with particular measurement data cannot be calculated, it is recommended to re-adjust main constants.

Please refer to chapter 7.Definition of calculation methods for detailed method description and demands for measurement data.

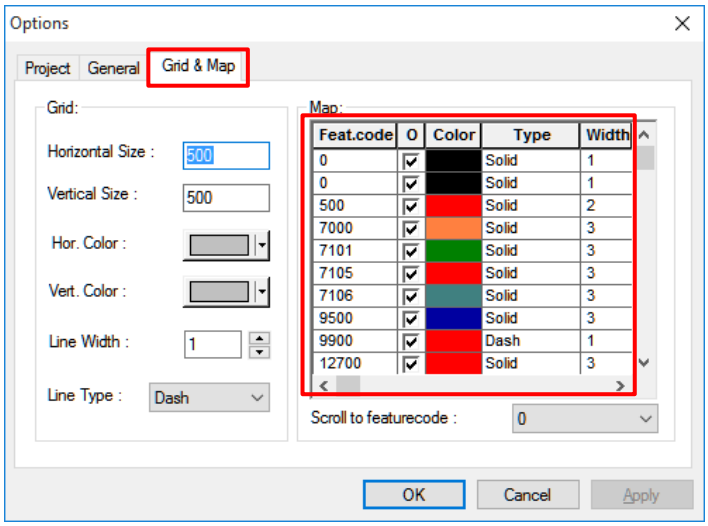
8.2 Import of background map data

For geographical orientation, track fix points and background maps can be imported as background map data sets from .KOF, .PXY or .GPS file formats:

- From the main menu, select *File –> Import Map…*
- From the drop down list select the suitable file format '*Files of Type*' of the dialog.

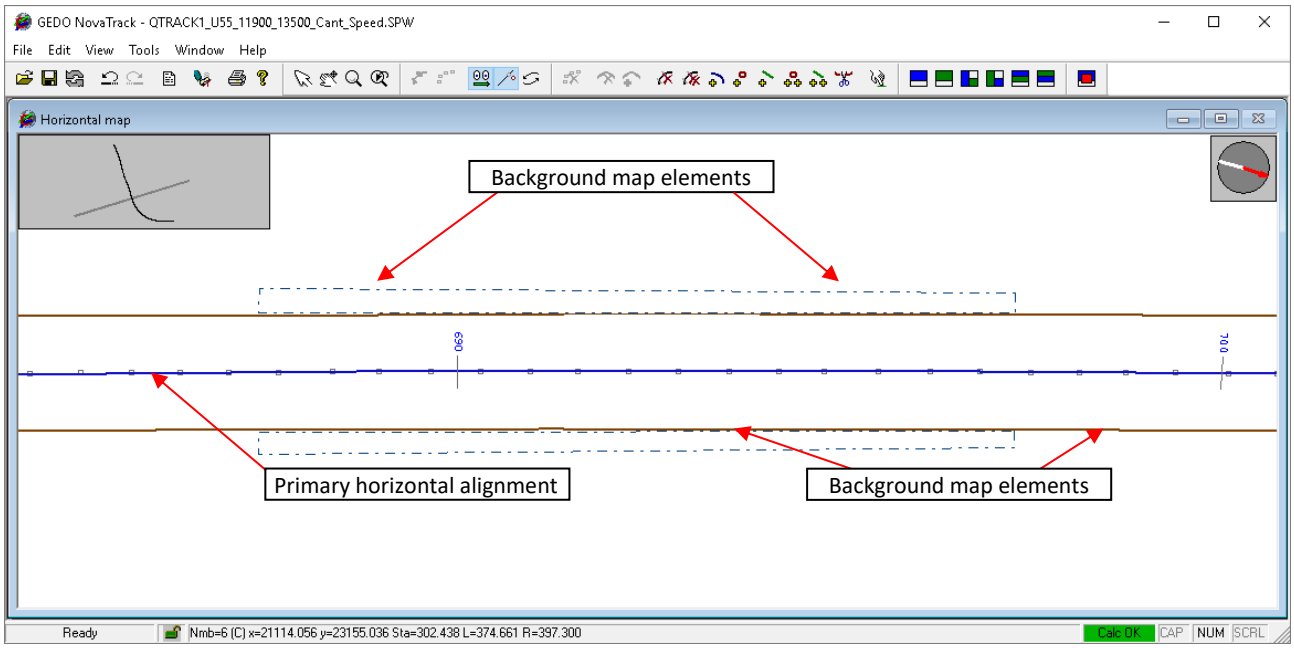
From the list select the file for the import and press *Open*.

- The dialogue '*Options*' with the tab '*Grid & Map*' will be opened.
- Check configuration of feature codes, colours and line-types. For a more detailed description of the settings please refer to section '*Grid and Map settings*'.



Press *OK* to accept grid and map settings.

- After the import, the background map data will be visible in the Horizontal Map layout, along with measured point information and design alignment elements.



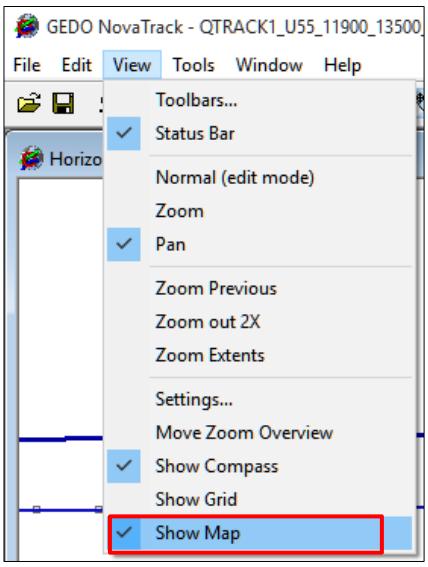
Background map data along with horizontal alignment

Important!

Background map elements are visible in the *Horizontal Map* view only.

The background map cannot be edited or stored in the GEDO NovaTrack project file (*.SPW).

To choose whether the background map should be visible or not, use the settings in the menu *File -> View -> Show Map*.



8.3 Alignment data export

GEDO NovaTrack software can export ('Save As') calculated alignment geometry and offset data to several file formats and reports. For more detail information on supported file formats please refer to chapter *8 Data import and export*.

To export complete alignment data for further use in GEDO Office software:

- From the main menu select *File -> Save As…*
- Select file format – *All GEDO Office files (*.*).* The alignment data will be exported into GEDO Office native alignment file formats:

  *.TDT - Horizontal Alignment data.

  *.HDT – Vertical Alignment data.

  *.UDT - Cant Alignment data.

Additionally, it is recommended to store processed measurement data and calculated alignment geometry in GEDO NovaTrack software (this will include measured points, analysis diagrams, cant data, design elements and speed information):

- From the main menu select *File -> Save As…*
- Select file format – *SPW file (*.SPW)*

8.4 Alignment data import and editing

GEDO NovaTrack software can import (‘*Import*’) calculated alignment geometry (horizontal, vertical and cant) from several file formats. For more detail information on supported file formats please refer to chapter *8 Data import and export*.

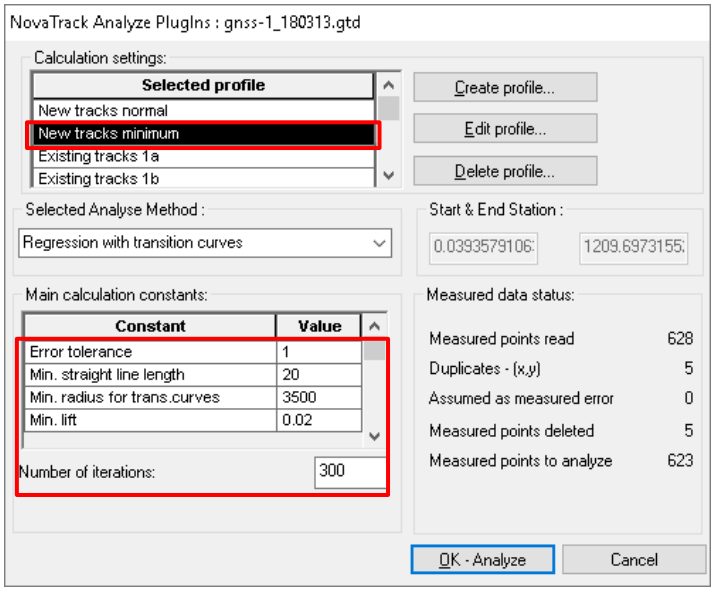
9 Alignment data calculation and editing

9.1 Automatic calculation of horizontal and vertical alignments

9.1.1 Automatic calculation of horizontal alignment

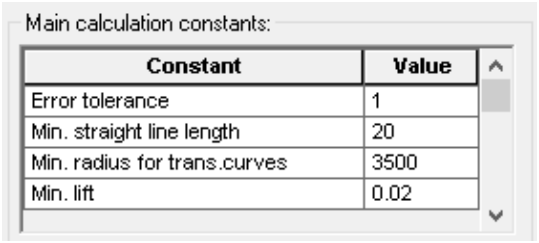
To continue with the automatic calculation of horizontal alignment elements, proceed with following steps:

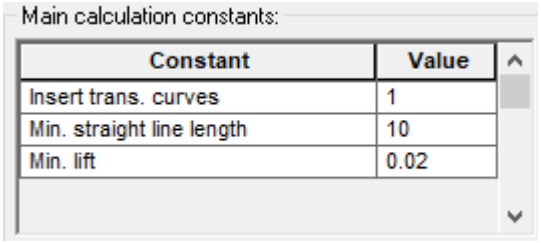
- From the main menu select *File -> Open* (select measurement data in *.GTD file format*)
- Select calculation profile based on ´*Regression with transitions curves*´ or ´*NovaTrack 3.0*´ method



- In the calculation method dialogue press *Configure* to set calculation constants:

´Regression with transition curves´

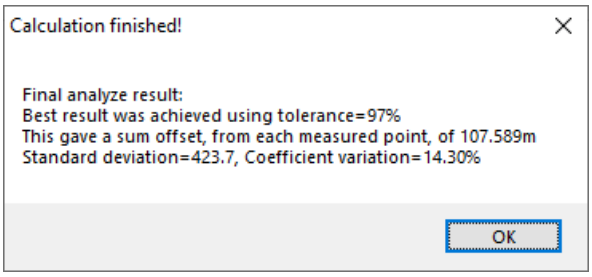




Recommended setting ´Regression with transition curves´	**Value**
Error tolerance	0.5 < ITERATIONS < 30
Min. straight line length	5 < L < 20 meters
Min. radius for transition curve	2500 < R < 4500
Number of iterations	50 < ITERATIONS < 200

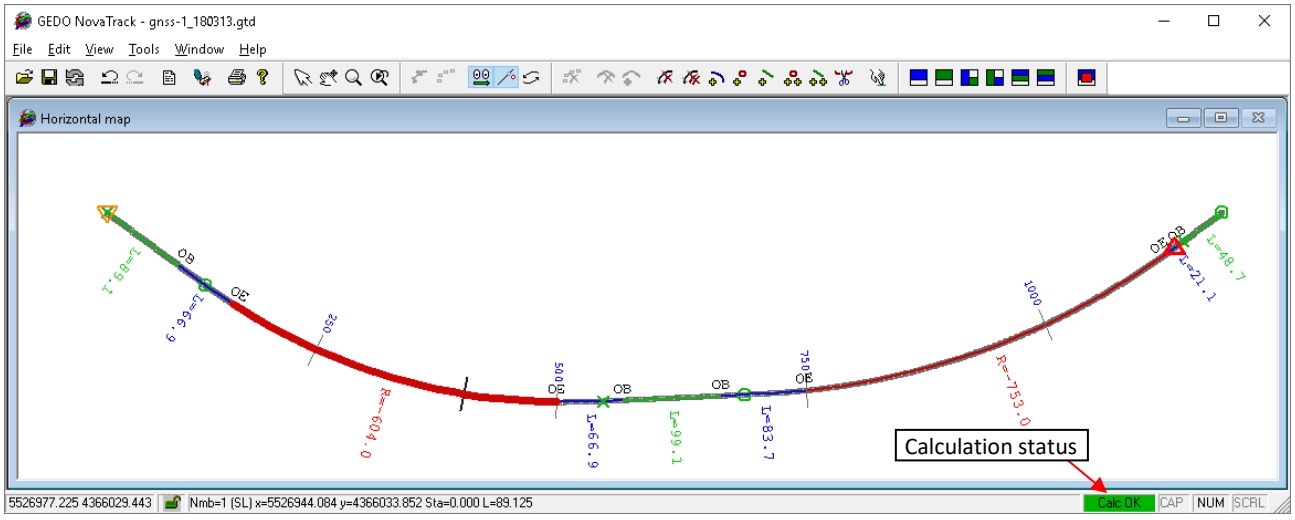
Recommended setting ´NOVATRACK 3.0´	**Value**
Min. straight line length	5 < L < 20 meters
Number of iterations	1 < ITERATIONS < 20

- Press *OK-Analyze* button to start calculation.
- After the calculation with set number of iterations is completed, software will prompt dialog with result summary:

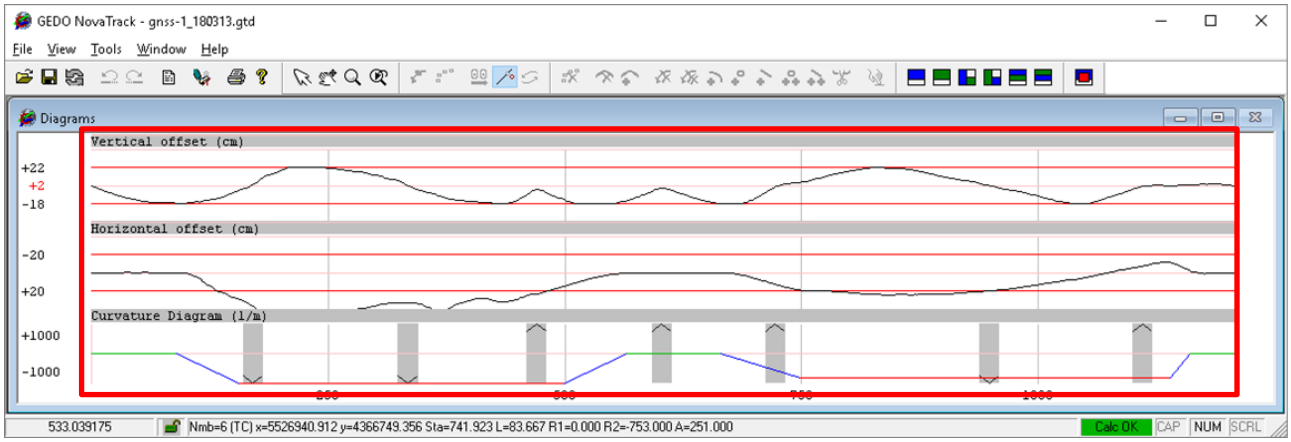


- Press *OK* button to confirm calculation result.

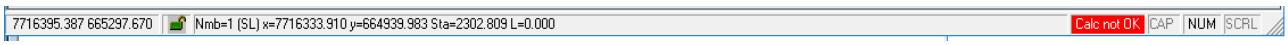
At the same time the status bar will indicate in a green message ´*CALC OK*´.



- Then also check the calculated offsets in the *Diagrams –> Horizontal Offset*.

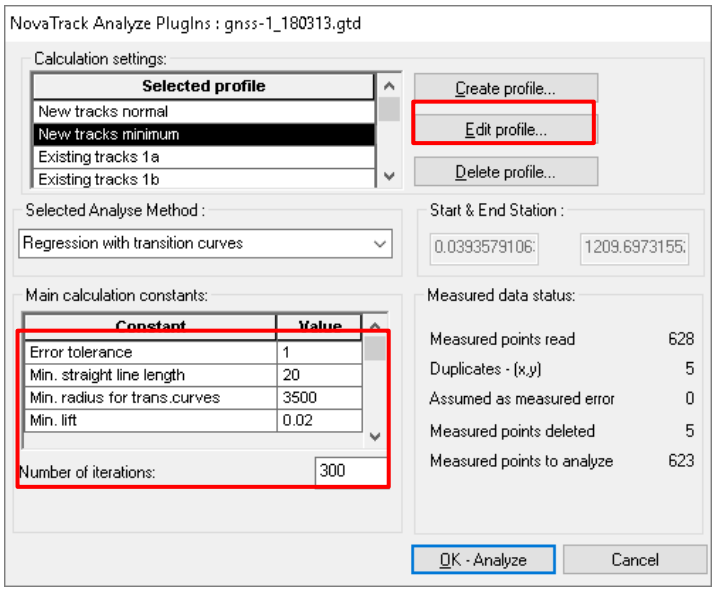


When software fails to find the alignment solution within set limitations, alignment status is indicated in red marking with the message ´*CALC not OK*´.



To re-calculate alignment with different settings (i.e. with smaller error tolerance):

- From the main toolbar select *Re-analyse* command.
- The command will open initial *NovaTrack Analyze* dialog. Adjust the settings by editing selected calculation profile ´*Edit profile*´ or by changing calculation profile ´*Main calculation constants*´ .
- Press ´*OK-Analyse*´ to recalculate the result.



- The new results will be directly updated on the screen.

Important !

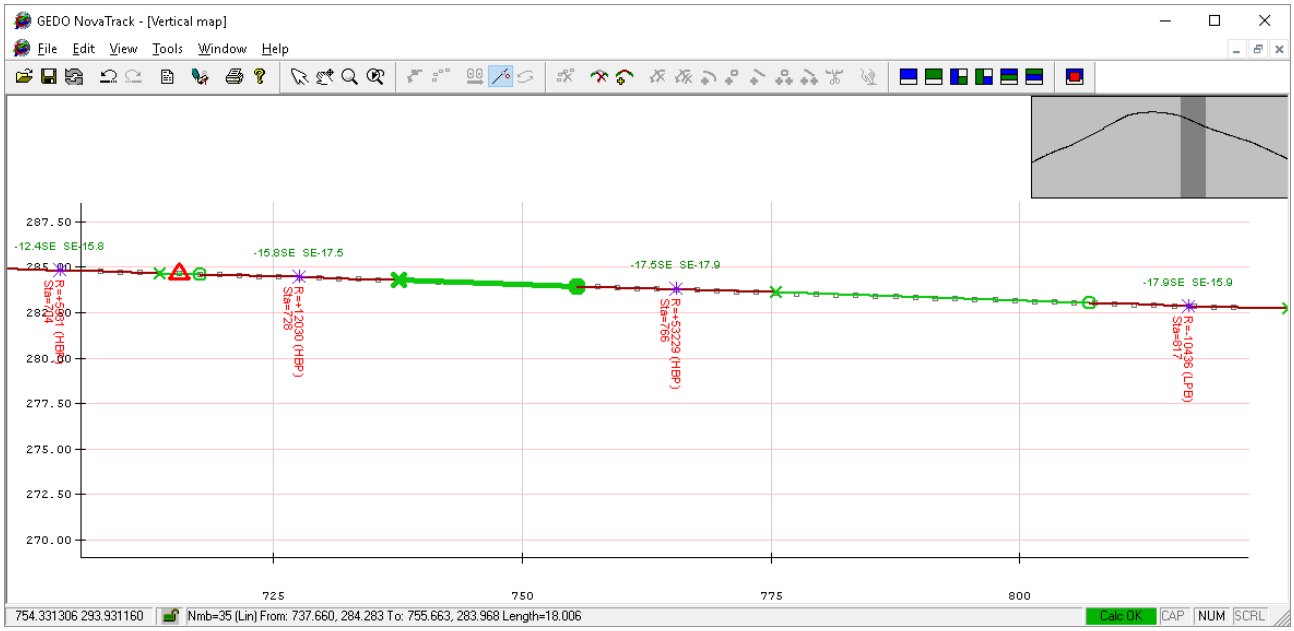
Re-calculation process will use last edited version of measured data. Thus, all measured points which were deleted before recalculation, will not be considered in the consecutive calculations.

Re-calculation process can be restored to previous versions using *UNDO* or *REDO* commands.

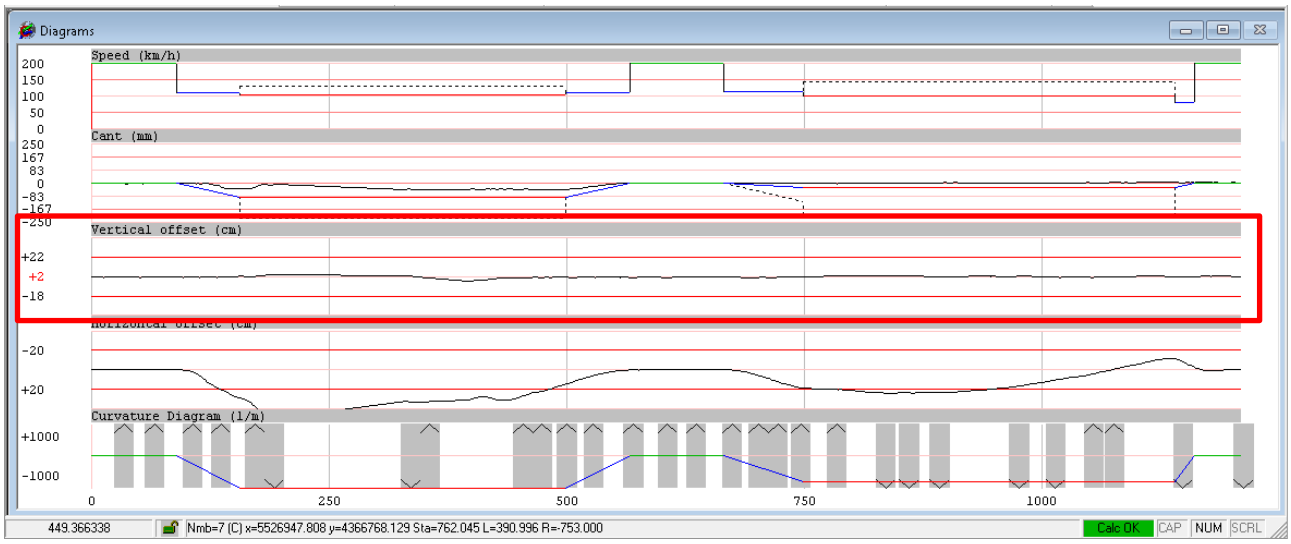
9.1.2 Automatic calculation of vertical alignment

Automatic calculation of vertical alignment uses same selected *Calculation profile* as horizontal alignment. Calculation for vertical alignment is completed simultaneously with the calculation of horizontal alignment. Vertical alignment smoothing is directly dependant on set *´error_tolerance_vertical´* value in the Calculation profile.

- To view and verify vertical alignment, switch the layout view to *Window -> Vertical Map*:



- In the *Diagram view*, check that the vertical alignment offsets (lifts) from measured points are within the set tolerance limits:



- If the vertical alignment offsets from the measured points are below the ´min. lift tolerance´ or above the maximum lift limits, adjust Vertical alignment approximation settings (*min_lift* and *error_tolerance_vertical*) in the Calculation profile and re-run calculation.

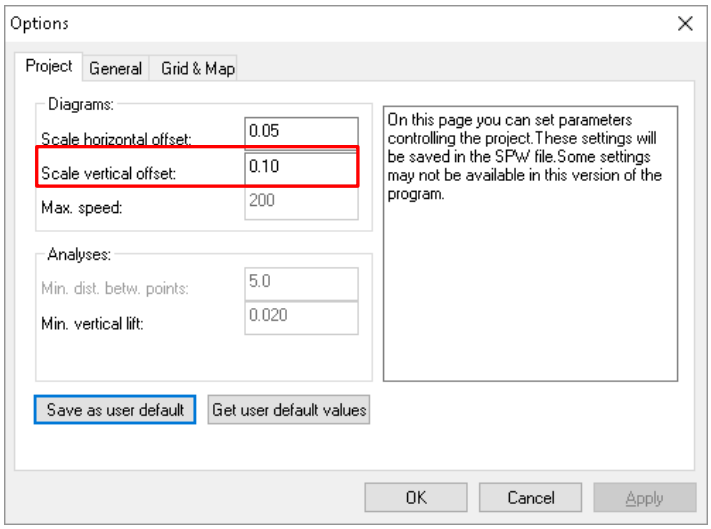
  If the new result is still outside requirements, continue with alignment manual editing and adjustment using manual editing tools, as described in chapter *9.3 Manual alignment editing and fine-tuning*.

Note.

Vertical alignment minimum vertical uplift can be adjusted in the Calculation profile (*min_lift*). The software will recalculate vertical gradients to fit new calculation settings.

Decreasing of Calculation setting ´*error_tolerance_vertical*´ will increase amount of gradient elements and decrease offsets between measured points.

To increase visibility of vertical offset value in the diagram vertical offset field, adjust ´*Scale vertical offset*´ parameter in the dialog *Tools -> Options -> Project*. Save values as User Default, so they can be recalled at any time.



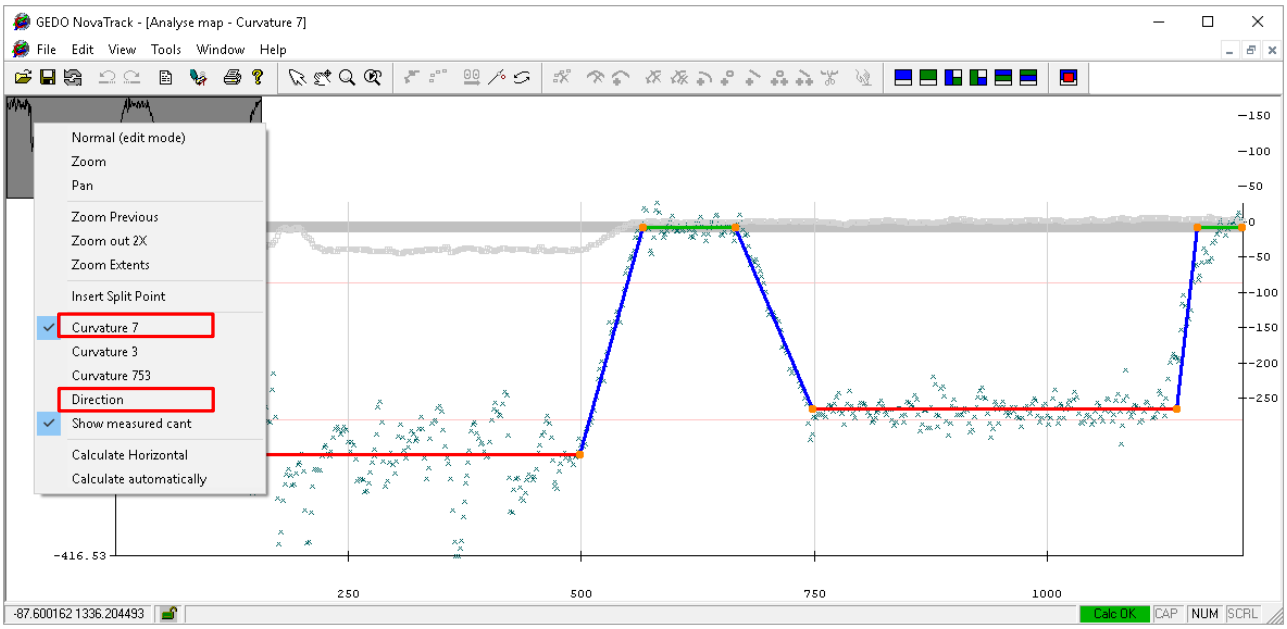
9.2 Calculation of horizontal alignment using the Analysis diagram

Measurement data from track with poor quality (geometry), can have a negative influence to automatic calculation results. This circumstance can prevent automatic process from finding right element configuration within set tolerance limits. As result, calculated alignment can have significant offsets, which are beyond set tolerance limits. To Overcome this issue, it is recommended with alignment editing in analysis diagram mode.

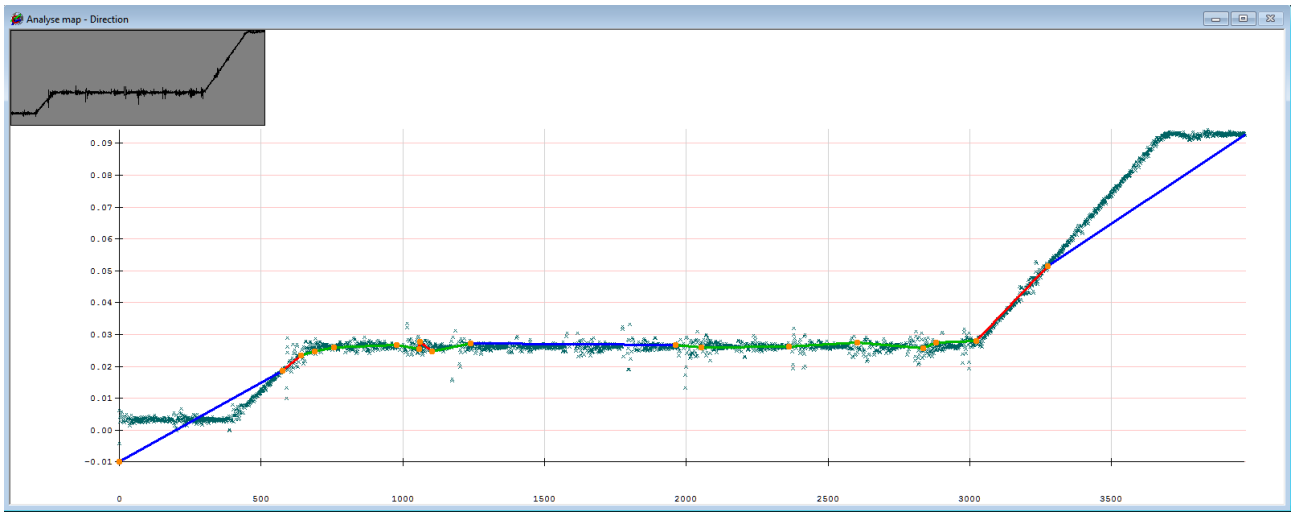
To switch to element analysis diagram mode:

Switch Layout view to Analysis Diagram, from menu selecting Window -> Analyse map.

- Right-click on the diagram and select diagram type: *Curvature 7* or *Direction.*
- To make sure that Analysis diagram has latest calculation result, in the *Horizontal view* press *´S´* key. The data between views will be synchronized.

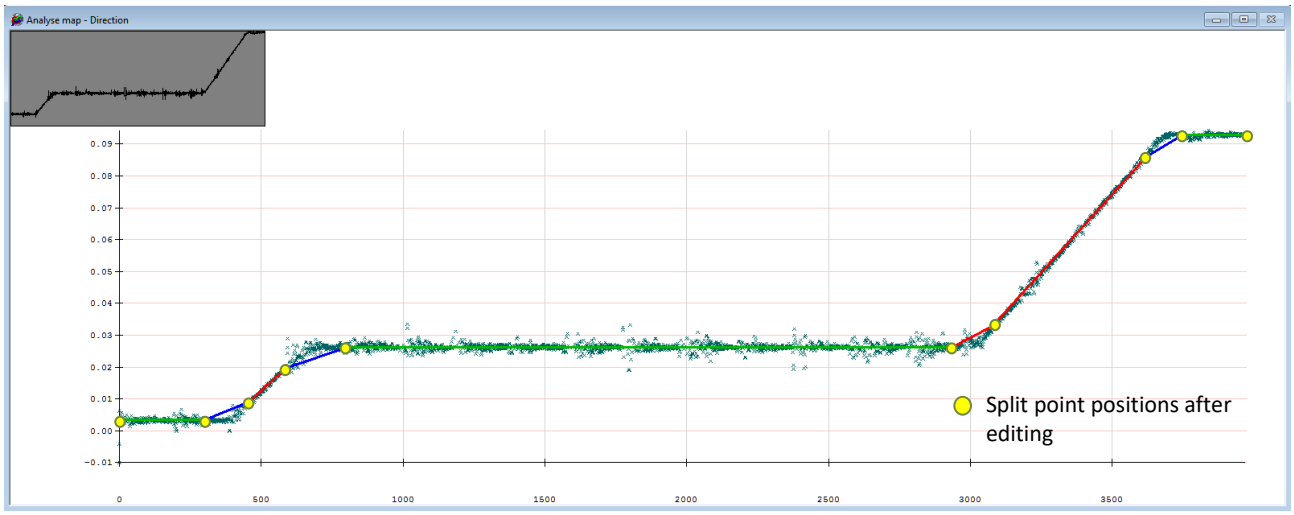


In the analysis diagram, each horizontal alignment element is limited by two split points.



Direction diagram. Before editing split points

- Adjust alignment elements by adding or removing split points. Check the chapter *7.3.2 Analysis diagram editing and calculation* for split point insertion rules.

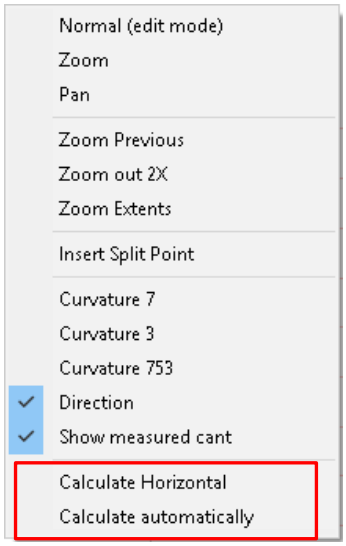


Direction diagram after editing

- Once the diagram editing is completed, re-calculate the alignment with new definitions.

To perform single alignment recalculation, press mouse *right-click* and from the short-cut menu select *Calculate Horizontal*.

Alternatively, from the short-cut menu select ´*Calculate automatically*´ to activate ´real-time´ recalculation option.



Note.

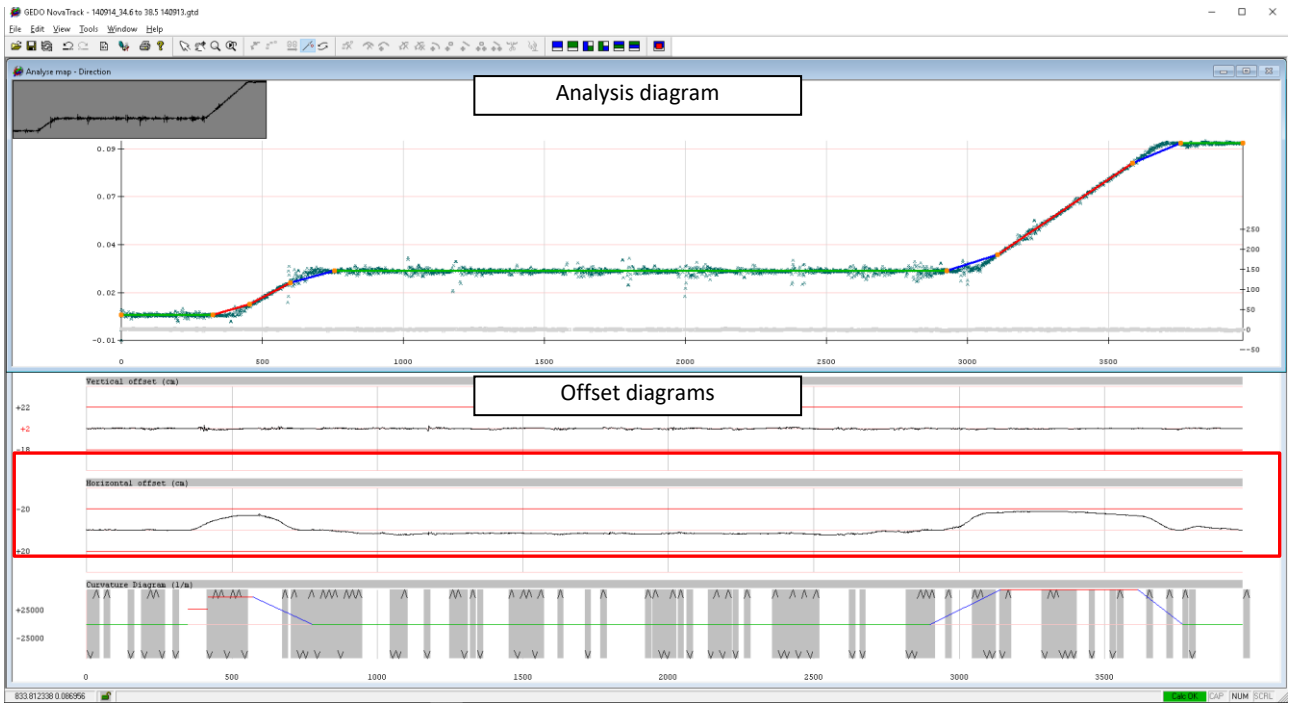
To insert new split point, double click with a mouse and new split point will be added.

To delete split point, move mouse cursor over the split point and press Delete key.

To move the split point, press left mouse key on the split point and drag the cursor.

To activate split point snap to measured point, in the main toolbar select button

As result, the elements from the analysis diagram are transformed to the absolute alignment position. To view horizontal alignment offsets while editing diagram, arrange the windows in the way that both analysis and offset diagrams are in the same view.



Note.

Scale for horizontal offsets can be adjusted in the *6.1 Project settings*.

Manual alignment element fine-tuning procedure is described in the chapter *9.3 Manual alignment editing and fine-tuning**Error! Reference source not found.***.

Important !

Editing of alignment elements in the analysis diagram can cause alignment calculation to fail because, element configuration and position is no longer mathematically solvable. This is then indicated on the status bar - Calc not OK.

To diagnose the calculation error or review calculation results in the numeric form, double-click the Calc OK/not OK indication. This will open the calculation protocol. The calculation report is updated with every new calculation. For more detail information about the calculation report, please refer to the chapter *10 Calculation report data*.

9.3 Manual alignment editing and fine-tuning

There alignment geometry editing tools are accessible from the Horizontal Map and Vertical Map views.

Alignment and geometry elements can be edited and fine-tuned in three different ways:

- by adjusting the position of fixed (tangent) points
- by adjusting the parameters of geometry elements
- by adding/splitting/deleting geometry elements
- by changing alignment chainage information

9.3.1 Workflow for manual horizontal alignment and offsets adjustment

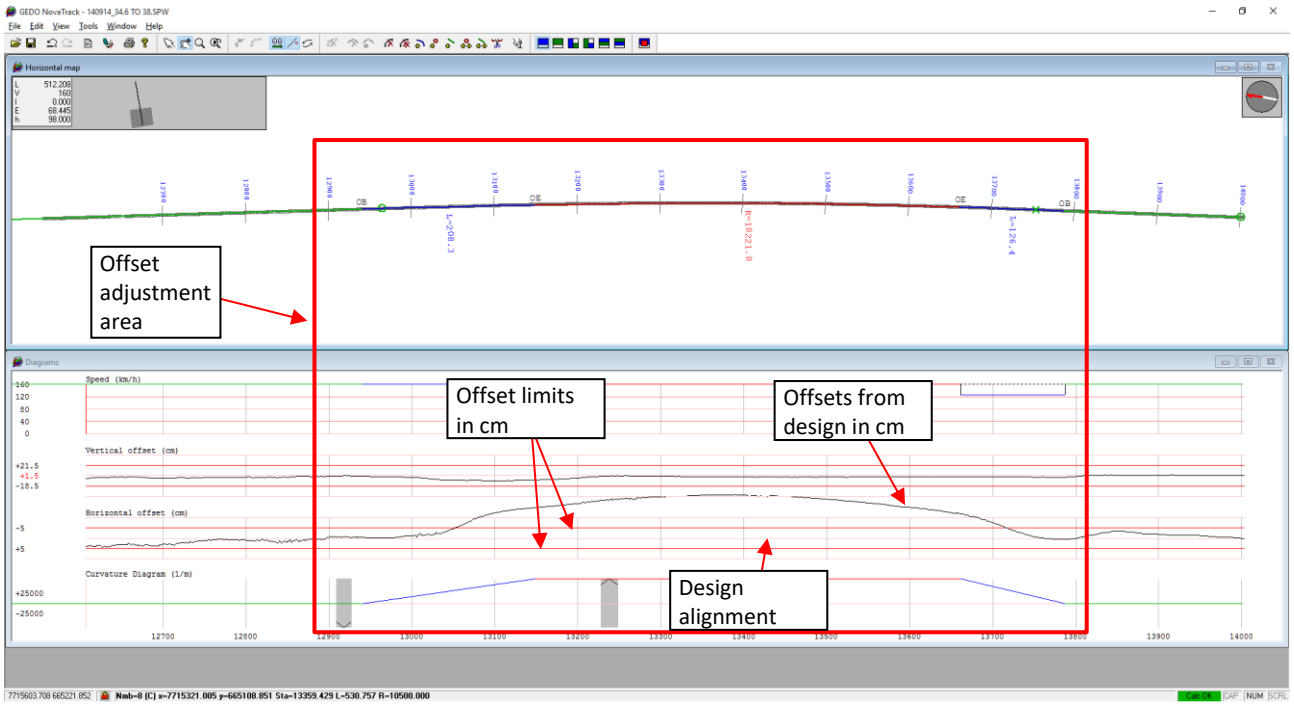
After the horizontal alignment calculation is completed using the automatic method or semi-automatic approach with the Analysis diagram, there still can be residual horizontal offsets, that are exceeding the maximum track tamping limit. Further precise adjustment of the offsets can be done directly by editing the parameters of the individual alignment elements:

- for straight line: fixed point coordinates (start, end);
- for transition curve: length and/or A-parameter;
- for circular curve: radius, length, start point coordinate (if element is Partly fixed).

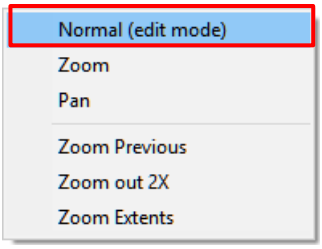
Each element position is controlled by maximum two fixed points. Depending on the element order, the software requires none (Approximate), one (Partial) or two (Fixed) fixed points per element. The software automatically determines how many fixed/tangent points are needed for each element. For the horizontal alignment fixed points are given with X- and Y- coordinates.

Manually to adjust horizontal offsets, proceed as follows:

- Identify alignment elements where the horizontal offsets are exceeding the pre-set limits.
- *Zoom in* to the *Diagram window* or *Horizontal Map* window, so the screen is covering principal element and two adjacent elements.



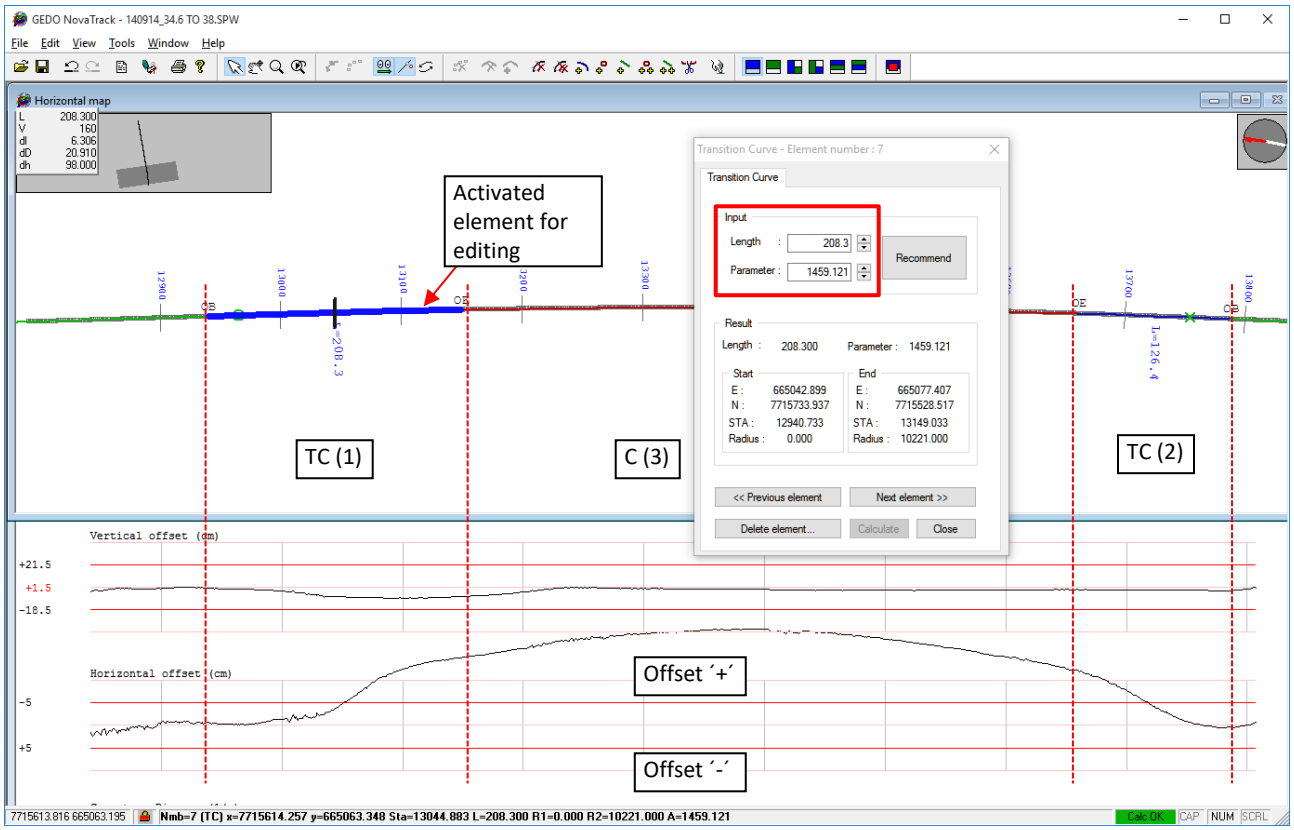
- *Right-click* on to the *Horizontal Map* layout. From the command list activate *Normal (edit mode)*. When *Normal (edit mode)* is activated, the mouse cursor follows the element geometry and allows them to be selected for detail editing.



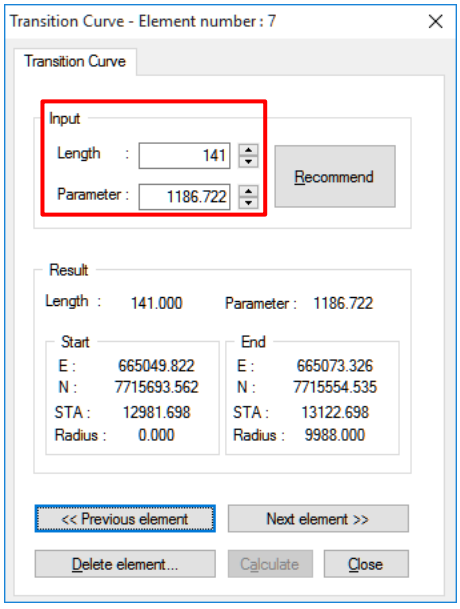
- Use the left mouse click to select the geometrical element for editing. Selected element information is displayed in the *Status bar*.

Note.

If the offset values at the Circular curve element are largest, it is recommended to start editing from the connected transition curve elements (*TC1*) and (*TC2*), and only after that switch to the circular curve (*C3*) editing.

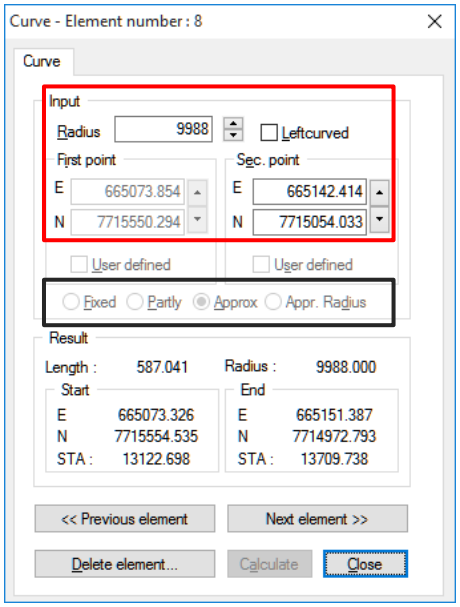


- Open the geometry editing dialogue box by making a double *left-click* on the activated element.



Transition curve dialogue box

Input data: length or A-parameter

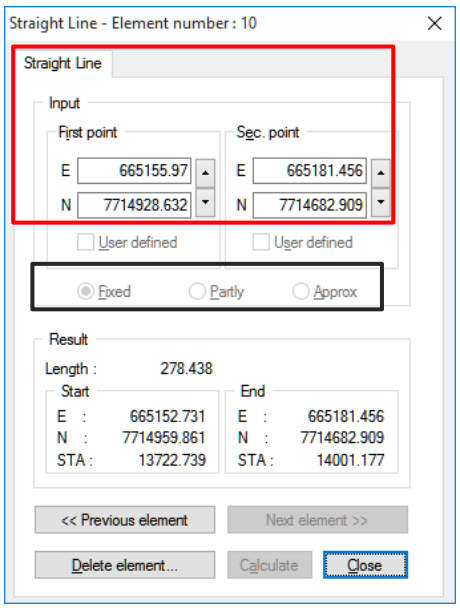


Circular curve dialogue box

Input data: radius and a

Fixed point status (auto selected): fixed, partly, approx., appr.radius

Greyed out fields cannot be edited and are selected by the software to automatically compute a best solution



Straight line dialogue box

Input data: Start and end fixed point coordinates

Fixed point status (auto selected): fixed, partly, approx.

Greyed out fields cannot be edited and are selected by the software to automatically compute a best solution

- Change an element´s parameters by using the up/down arrows for each field. During editing, the alignment and offsets are automatically updated. When values are entered directly, press ´*Calculate*´ to update geometry and offsets.

Note.

if an offset is positive ´+´ (on the left side of alignment), the element radius/length has to be decreased;

if an offset is negative ´-´ (on the right side of alignment), the element radius/length has to be increased;

by changing element coordinates using up/down arrows both ´X´ and ´Y´ coordinates are affected simultaneously, with a step of 7 cm;

by changing individual ´X´ or ´Y´ element coordinate, will have affect to element direction.

- If further editing required, switch to the next element by selecting ´*Next element*´ or double *left-click* on the element and the dialogue box information will be updated.

Important!

if the alignment solution cannot be calculated *Calc not Ok*, press the *Undo* key (Toolbar) to return the parameter value to its previous state;

redundant or faulty element can be deleted directly using element editing dialog, by selecting element and pressing ´*Delete element*´ button;

To diagnose the calculation error or review calculation results in the numeric form, double-click the Calc OK/not OK indication. This will open the calculation protocol. The calculation report is updated with every new calculation. For more detail information about the calculation report, please refer to the chapter *10 Calculation report data*.

9.3.2 Functions for horizontal alignment editing

9.3.2.1 Delete element only

Icon/Key	Function description
	To Delete Element Only: • Select alignment element using mouse *left-key* . Selected element will become a thicker line. • Press mouse *right-key* and choose *Delete*. • If the alignment calculation is '*Calc not Ok*', it has to be edited manually until the line calculation turns to '*Calc Ok*' or apply *UNDO* command to cancel changes.

9.3.2.2 Delete Element with Transition Curves

Icon	Function description
 DEL	To delete an element and the connected Transition Curves: • Select the alignment element using mouse *left-key*. Selected element will become a thicker line. • Press *DEL key* to delete the element. The activated element and connected transition curves will be deleted. If the alignment calculation is '*Calc not Ok*', it has to be edited manually until the line calculation turns to '*Calc Ok*' or apply *UNDO* command to cancel changes.

9.3.2.3 Insert Curve (Circular)

Icon	Function description
	To insert a Curve after the active element:

	• Use mouse *left-key* to mark the element after which you want to insert a circular curve element. Selected element will become a thicker line and marked with a red padlock symbol on the status bar. • Press *Insert Curve* icon to insert new element. If the alignment calculation is '*Calc not Ok*', it has to be edited manually until the line calculation turns to '*Calc Ok*' or apply *UNDO* command to cancel changes.

9.3.2.4 Insert Straight Line

Icon	Function description
	To insert a straight line after the active element: • Use mouse *left-key* to mark the element after which you want to insert a straight element. The selected element will contain thicker line and marked with red padlock on the status bar. • Press *Insert Straight line* icon to insert new element. A straight element cannot be inserted after a straight element and cannot be connected to another straight element. If the alignment calculation is '*Calc not Ok*', it has to be edited manually until the line calculation turns to '*Calc Ok*' or apply *UNDO* command to cancel changes.

9.3.2.5 Insert Transition Curve

Icon	Function description
	To insert a Transition Curve after the active element: • Use the mouse *left-key* to mark the element after which you wish to insert a transition curve element. Selected element will contain a thicker line and marked with red padlock on the status bar. • Press *Insert Transition Curve* icon to insert new element. If the alignment calculation is '*Calc not Ok*', it has to be edited manually until the line calculation turns to '*Calc Ok*' or apply *UNDO* command to cancel changes. Choose 'Undo' to revert back to the last line calculation.

9.3.2.6 *Insert Curve in Straight Line Element*

Icon	Function description
	To insert a Circular Curve element together with transition curves at either end into an active straight line element: • Use the mouse *left-key* to mark a straight line element, which will be split with the curve. • Run the function to insert a curve. • The program prompts for the location of a horizontal angular point of curvature (follow the messages in the status bar). • Pick the intersection /angular point. • By default, the program will insert a Circular Curve with a radius of 55.0 m and two transition curves at both ends with lengths of 15.0 m each. • When it is not possible to insert a Circular Curve inconjunction with transition curves, the transition curves will be discarded. When *AutoSnap* is active, the reference point will automatically snap to nearest measured point. *Autosnap* is switched on/off with the *key F9*. If the alignment calculation is '*Calc not Ok*', it has to be edited manually until the line calculation turns to '*Calc Ok*' or apply *UNDO* command to cancel changes. Choose 'Undo' to resort back the last line calculation.

9.3.2.7 *Insert a Straight Line in to Curve Element*

Icon	Function description
	To insert a Straight Line with Transition Curves into a Circular Curve Element: • Use the mouse *left-key* to mark the Circular Curve element, into which will be inserted a straight line and transition curves at both ends. • Run the function to insert a straight line. • The program prompts for two tangent points (end points) for the straight line element (follow the messages in the status bar). • Pick the end points of the straight line. The selected point coordinates are displayed on the status bar. • By default, the program will insert Straight line element and two transition curves at both ends with the length of 15.0 m each.

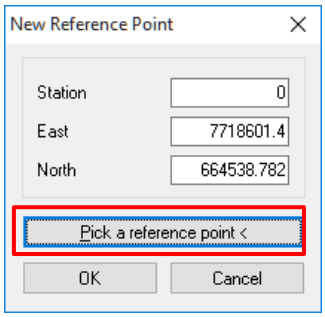
	• When it is not possible to insert a straight line with transition curves, the transition curves are discarded. When *AutoSnap* is active, the reference point will automatically snap to the nearest measured point. *Autosnap* is switched on/off with the *key F9*. If the alignment calculation is '*Calc not Ok*', it has to be edited manually until the line calculation turns to '*Calc Ok*' or apply *UNDO* command to cancel changes. Choose 'Undo' to revert back the last line calculation.

9.3.2.8 Split Curve

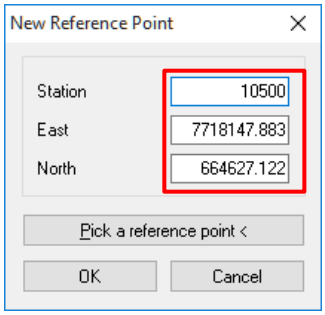
Icon	Function description
	To split the active Circular Curve element into two new Circular curves: • Use the mouse *left-key* to mark the Circular Curve element, which will be split. • Run the function to split the active curve. • The program prompts for two points (observe the status bar). One point is desired split point for the curve and the second point - fix point on one of the new curves. • The old circular curve is split and two new circular curves are calculated from the measured data. When *AutoSnap* is active, the reference point will automatically snap to nearest measured point. *Autosnap* is switched on/off with the *key F9*. If the alignment calculation is '*Calc not Ok*', it has to be edited manually until the line calculation turns to '*Calc Ok*' or apply *UNDO* command to cancel changes. Choose 'Undo' to bringing back the last line calculation.

9.3.2.9 Select Reference Point (change alignment chainage)

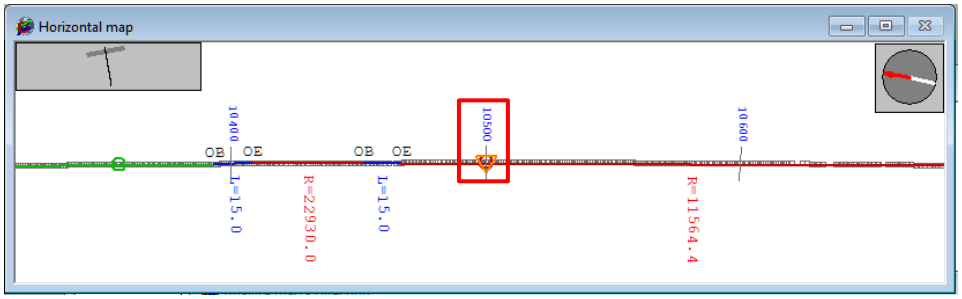
Icon	Function description
	To change chainage a reference point (start chainage): • From the toolbar run the function *Select Reference Point* • In the function dialogue box press the button ´*Pick a reference point*' and select the new reference point in the window '*Horizontal Map*'



- The function will read the current chainage and coordinates of selected point.
- Using the same dialogue box, type in the new chainage for selected point or alternatively, override the coordinates and chainage with known values.



- Press *OK* button to accept changes. In case changes were made to the reference point coordinates only, the overall alignment chainage will not be affected.
- The new reference point position will be marked with the a ´*triangle*´ symbol.



9.3.3 Workflow for manual vertical alignment and offsets adjustment

The vertical alignment is automatically calculated together with horizontal alignment, either during GEDO track measurement data imported or at the re-calculation. Further, precise adjustment of the offsets can be done directly by editing the parameters for individual alignment elements:

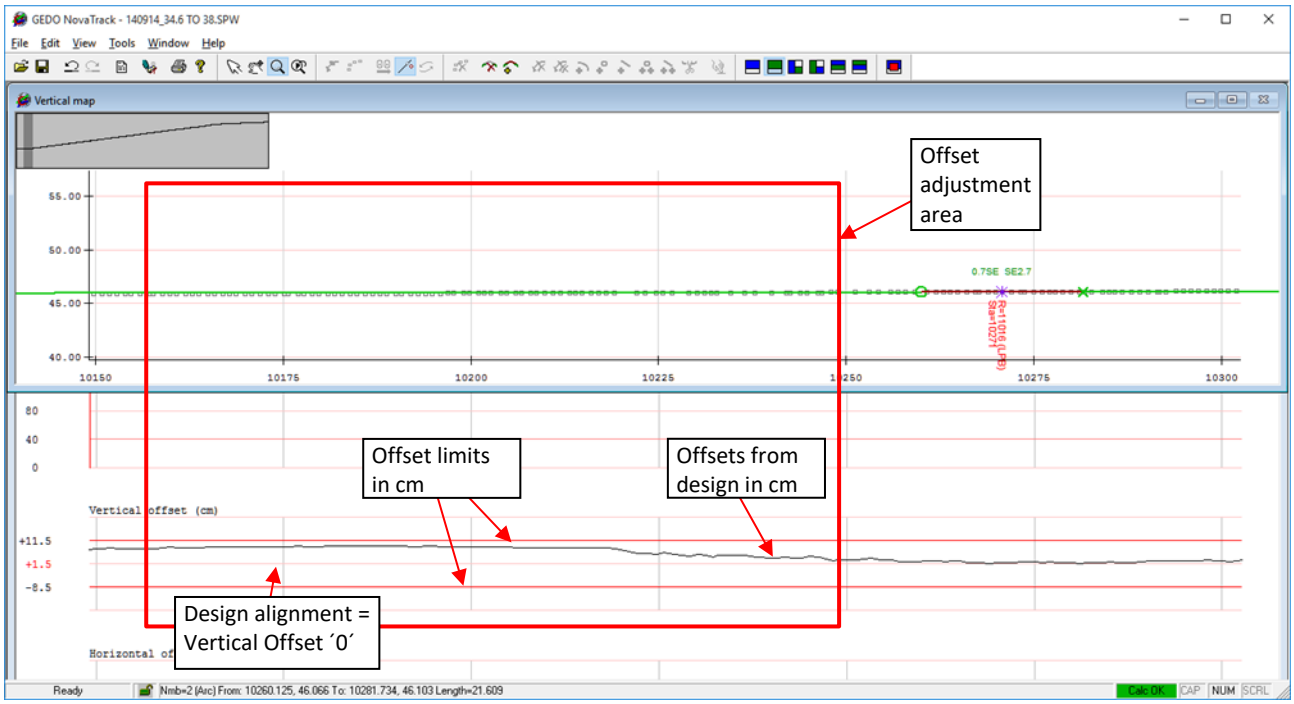
- for circular curve: radius, length, angular point elevation (PVI – point of vertical intersection), PVI chainage;
- for gradient line: start/end point chainage and elevation.

The vertical curve radius can be edited, either by changing the radius or its length. The correlation between curve radius R and length L is L=R*SD, where SD is change in grade along the vertical curve.

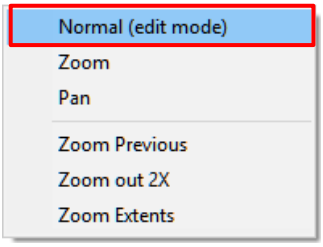
Alternatively, the fixed element and PVI position can be adjusted using the mouse cursor. It is recommended to use Snap (F9) function , so the mouse cursor is locked to the measured points.

Manually to adjust vertical elements and offsets, proceed as follows:

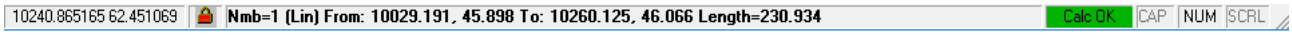
- Identify the alignment location (or elements) where the vertical offsets are exceeding set limits or element parameter is incorrect.
- *Zoom in* on the *Diagram window* or *Vertical Map window*, so the focus is over the area where vertical alignment offsets needs to be adjusted.



- In the *Vertical Map* layout use the mouse *right-click* to select *Normal (edit mode)* command. When *Normal (edit mode)* command is activated, the mouse cursor follows the alignment and enables to select individual elements for detail editing.



- Select element for editing by using the left mouse click. Selected element information is displayed in the *Status bar*.

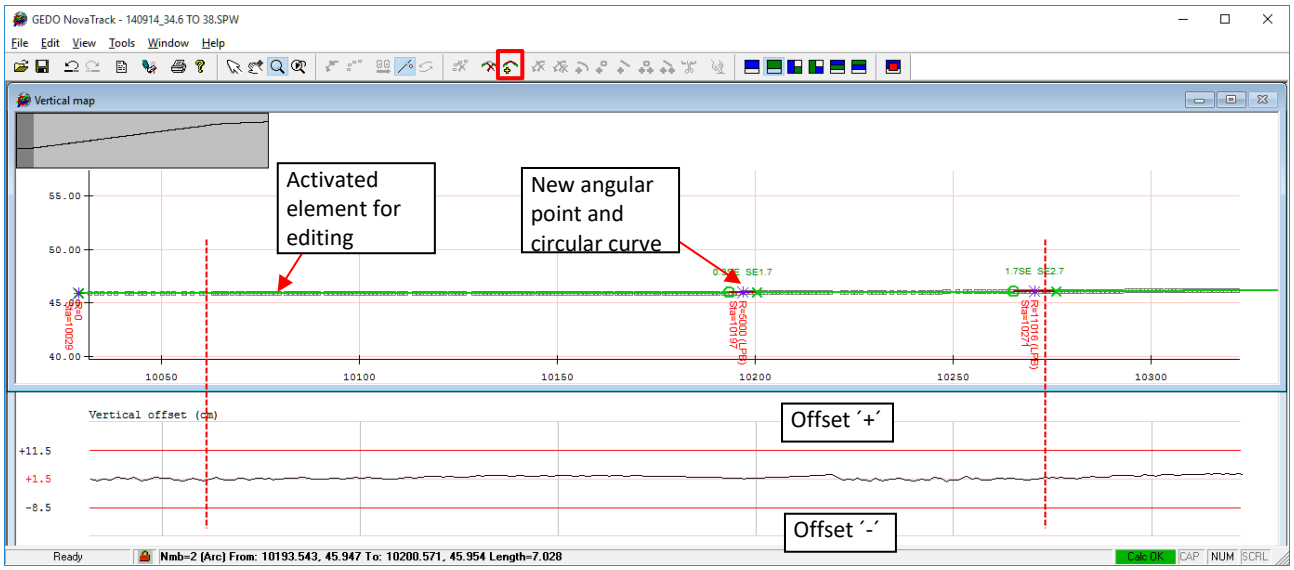


Note.

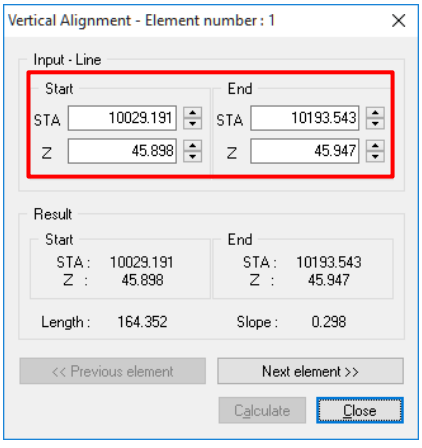
It is recommended to start the adjustment of vertical offsets at the chainages where offsets are at their peak (above or below) the design alignment.

- From the toolbar, select the function ´*Insert angular point*´ to insert an IP. Use the mouse *left-click* to select the element (chainage) where the angular (IP) point should be inserted.

- In the ´*New vertical point*´ dialogue box, chainage (*STA*) and elevation (*Z*) data is automatically extracted from the measured points. The default radius value is set to ´5000,0´ m. The circular curve length will be calculated based on the radius value and incoming/outgoing gradients.

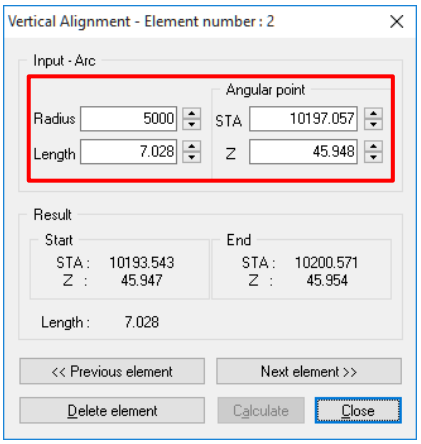


- Further, open the element editing dialogue by double clicking the element. Element editing dialog is transparent, so it´s stays active with selection of next element.



Gradient element dialogue box

Input data: fixed point chainage (STA) and elevation (Z)



Vertical curve dialogue box

Input data: element radius, length, PVI point chainage (STA) and elevation (Z)

- Adjust radius by typing manually between 3000 m and 5000 m, so the circular curve element is extended in length. Press ´*Calculate*´ to update changes.
- Press *Next element* to continue with the adjustment of neighbouring element. Modify elevation, chainage or radius using the up/down arrows for each field. Whilst editing, alignment recalculation and offset update is done automatically. When values are entered directly, press ´*Calculate*´ to update geometry and offsets.
- If there are still residual offsets, switch to neighbouring element by pressing ´*Next element*´ or ´*Previous element*´ button.
- First minimize offsets by adjusting the elevation Z value, and then adjust the chainage for further offset reduction.

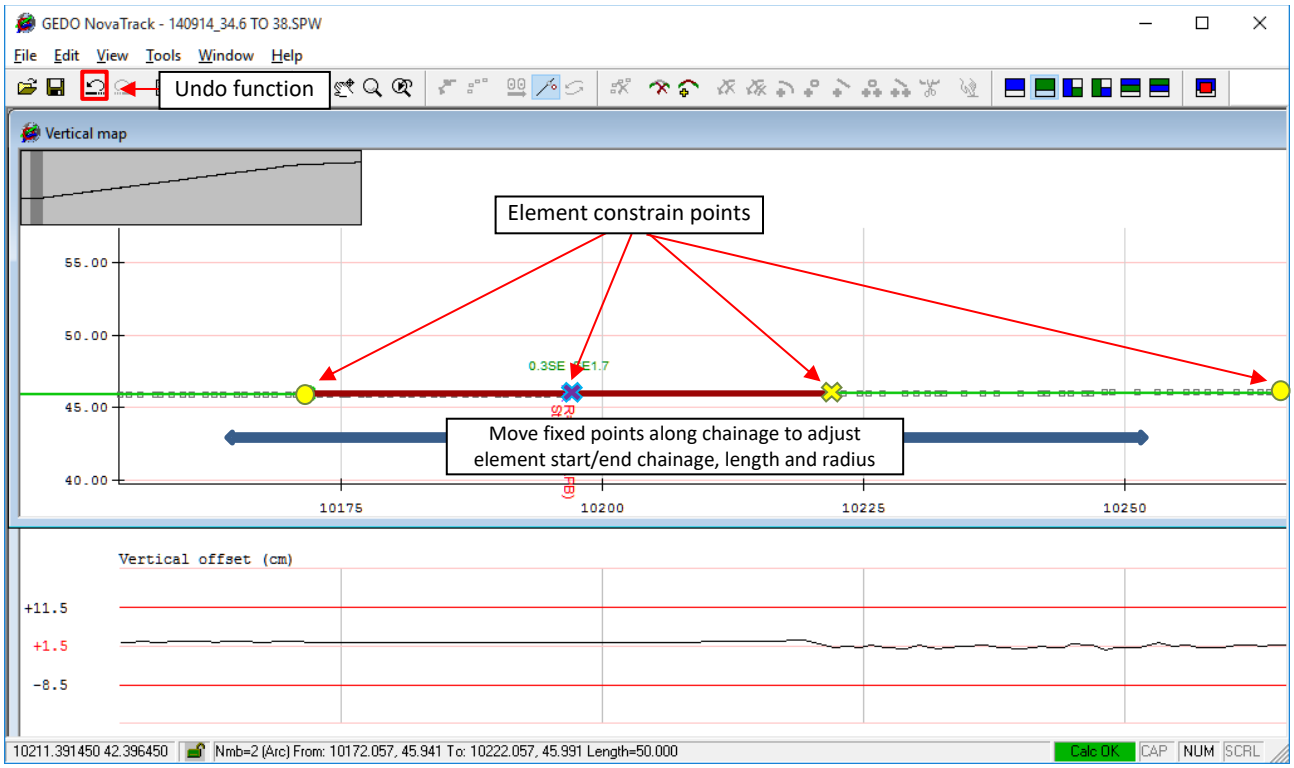
Note.

element radius/length modification has less of an impact to vertical offset;

first adjust the PVI elevation and then adjust the radius/length;

for Gradient – Gradient element connection use Radius of 1,0 meter;

to accelerate the editing of PVI (angular) and fixed point chainages, use the mouse *left key* to select a fixed point and move in a chainage direction. It is recommended to activate *AutoSnap (F9)*, so fixed points are following measured points. If *AutoSnap* is deactivated, fixed points can be moved unconstrained, in both chainage and elevation direction.



- When the PVI (angular) and fixed points are moved using mouse cursor, follow the status bar information about current point position and delta chainage/elevation from previous:

PVI (angular) point

Fixed point

Important!

the ´*Undo*´ function will undo all changes made after last project save;

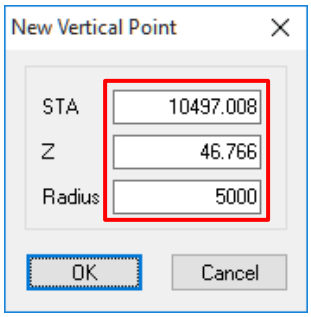
if an vertical alignment solution reports element overlap, press the ´*Undo*´ key to return parameter values to their previous state;

´Circular curve´ elements can be deleted directly from element editing dialog, by pressing ´*Delete element*´ button;

´Straight´ elements can be deleted from the Vertical Map view, by selecting element and pressing keyboard ´*DEL*´ key.

9.3.4 Functions for vertical alignment editing

9.3.4.1 Insert Vertical Angular Point (Intersection Point)

Icon	Function description
	To insert curves into a vertical alignment: • Activate the layout window '*Vertical Map*' • From the toolbar run the function *´Insert Angular Point´ (INS key)* • The program prompts for the curve insertion point. Use the mouse left-click to insert a point or alternatively use *´INS´* key • The program will prompt with the dialogue box '*New Vertical Point*' for the new curve settings (observe the status bar):  - Position of the vertical angular (IP) point (chainage). - Elevation of the curve. - Radius of curve. The default radius is 5000.0m. • Click the button *OK* to calculate the new vertical alignment. If the calculation fails, the vertical alignment is to be edited by the user until the calculation is successful.

9.3.4.2 Delete a Vertical Angular (Intersection Point) Point

Icon	Function description
	To delete a Vertical Angular (IP) Point. • Switch layout to *´Vertical Map´* • Select the vertical alignment angular element (curve) using mouse *left-key*. Selected element will be highlighted with a thicker line. • Press the *Delete* key to remove the marked element. • After deleting the angular element (curve), the start and end grading lines will be joined into one element.

	If the calculation fails after deleting a curve, the vertical alignment elements has to be edited until the calculation is successful.

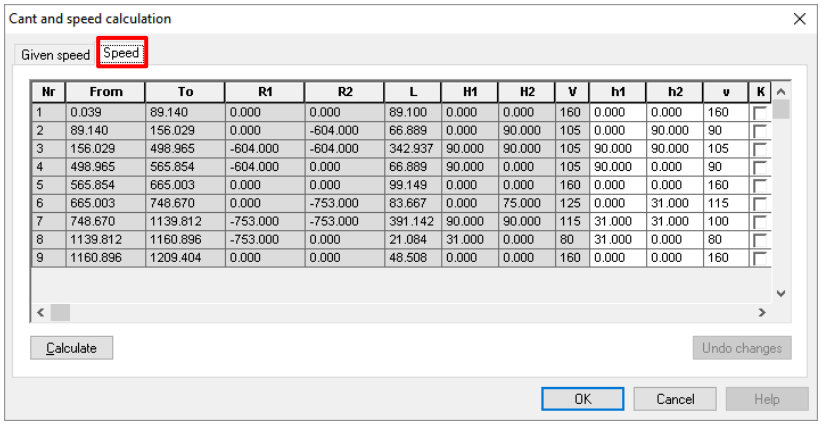
9.4 Calculation of cant and speed

Software functionality allows you to calculate the recommended Cant and Speed values, by evaluating the complete alignment geometry, individual alignment elements and settings in the *Calculation profile*.

Cant and speed values are recalculated automatically upon every change in the horizontal alignment and are shown in the table and diagram form.

To review calculated speed a cant in a table view, proceed as follows:

- From the main menu, select *Tools -> Cant and Speed calculations…* or double click *Cant Diagram*.
- The function will open a new dialogue box, containing two tabs:
  - Given speed – speed limit marking in the *Diagram* view.
  - Speed – cant and speed calculation



Nr	From	To	R1	R2	L	H1	H2	V	h1	h2	v	K
1	0.039	89.140	0.000	0.000	89.100	0.000	0.000	160	0.000	0.000	160	
2	89.140	156.029	0.000	-604.000	66.889	0.000	90.000	105	0.000	90.000	90	
3	156.029	498.965	-604.000	-604.000	342.937	90.000	90.000	105	90.000	90.000	105	
4	498.965	565.854	-604.000	0.000	66.889	90.000	0.000	105	90.000	0.000	90	
5	565.854	665.003	0.000	0.000	99.149	0.000	0.000	160	0.000	0.000	160	
6	665.003	748.670	0.000	-753.000	83.667	0.000	75.000	125	0.000	31.000	115	
7	748.670	1139.812	-753.000	-753.000	391.142	90.000	90.000	115	31.000	31.000	100	
8	1139.812	1160.896	-753.000	0.000	21.084	31.000	0.000	80	31.000	0.000	80	
9	1160.896	1209.404	0.000	0.000	48.508	0.000	0.000	160	0.000	0.000	160	

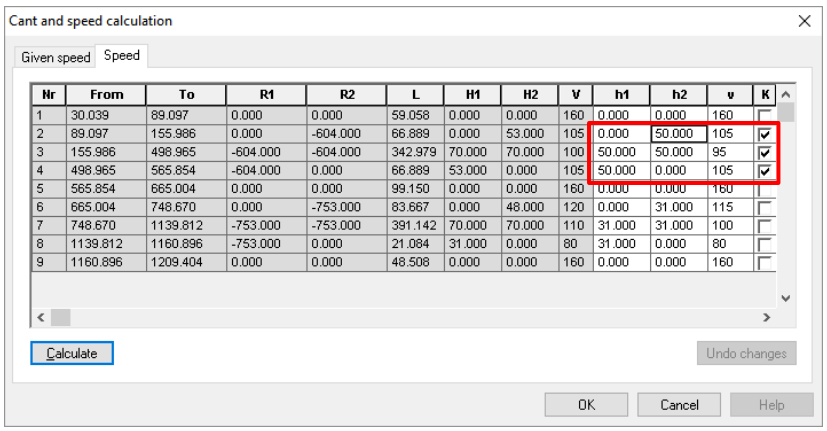
Note.

All settings for the speed and cant calculation are accessible from the main menu *Tools -> Options -> General -> Edit profile...*. Alternatively, the calculation settings and corresponding values can be edited in the *profiles.ini* file, located in the GEDO NovaTrack program directory. File format definition is listed in the *Appendix 1. File formats*.In the ´*Speed*´ tab, the ´*grey*´ and ´*white*´ fields are calculated automatically, however it is possible to override proposed values in the ´*white*´ fields.

The table columns have the following meaning:

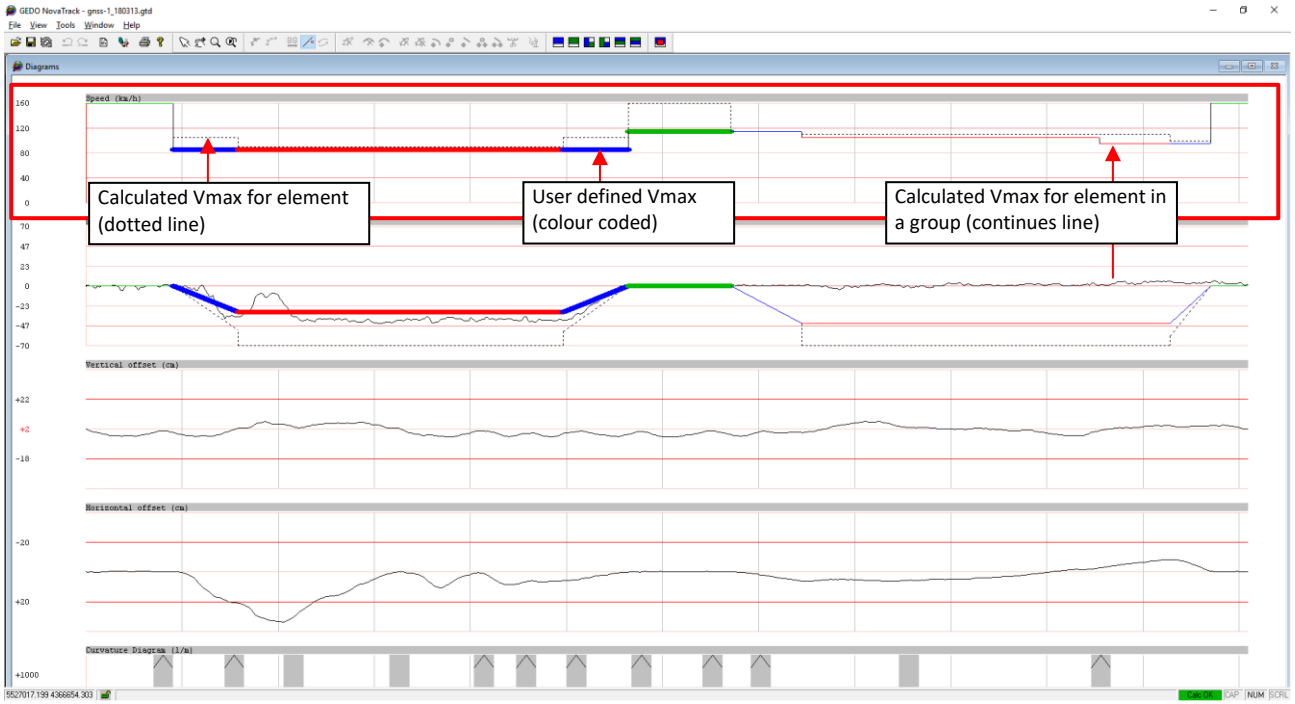
Name	Description	Name	Description
Nr.	Hor.alignment element number	*V*	Calc. Vmax speed based on element
From	Element start chainage	*h1*	Element start Cant. Based on element group
To	Element end chainage	*h2*	Element end Cant. Based on element group
R1	Element start radius	*v*	Calc. Vmax speed based on element group
R2	Element end radius	*K*	Select to override proposed values
L	Element length		
H1	Element start Cant value		
H2	Element end Cant value		

- To store user defined cant and speed values in the *´h1´*, *´h2´* and *´v´*, select the checkbox in the column *´K´*.



Nr	From	To	R1	R2	L	H1	H2	V	h1	h2	v	K
1	30.039	89.097	0.000	0.000	59.058	0.000	0.000	160	0.000	0.000	160	☐
2	89.097	155.986	0.000	-604.000	66.889	0.000	53.000	105	0.000	50.000	105	☑
3	155.986	498.965	-604.000	-604.000	342.979	70.000	70.000	100	50.000	50.000	95	☑
4	498.965	565.854	-604.000	0.000	66.889	53.000	0.000	105	50.000	0.000	105	☑
5	565.854	665.004	0.000	0.000	99.150	0.000	0.000	160	0.000	0.000	160	☐
6	665.004	748.670	0.000	-753.000	83.667	0.000	48.000	120	0.000	31.000	115	☐
7	748.670	1139.812	-753.000	-753.000	391.142	70.000	70.000	110	31.000	31.000	100	☐
8	1139.812	1160.896	-753.000	0.000	21.084	31.000	0.000	80	31.000	0.000	80	☐
9	1160.896	1209.404	0.000	0.000	48.508	0.000	0.000	160	0.000	0.000	160	☐

- Press *OK* to store settings.
- To evaluate speed calculations graphically, switch to the *Diagram* layout. Speed information is shown in the *Speed (km/h)* chart.

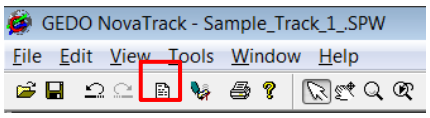


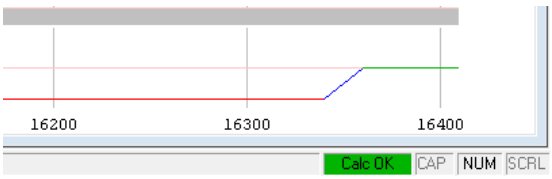
10 Calculation report data

The software produces calculation reports based on horizontal alignment input and output results. The calculation log is automatically updated each time the horizontal alignment geometry is affected or after manual element editing.

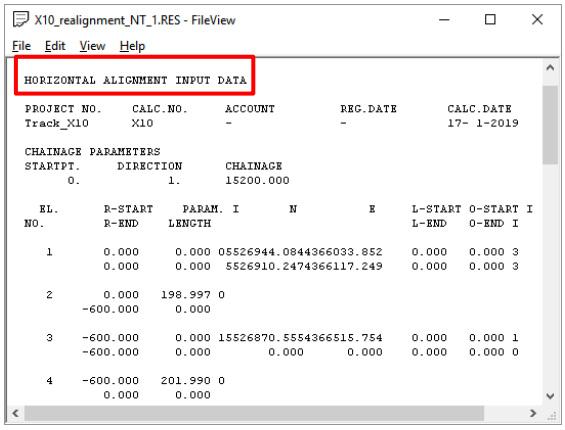
To access the calculation result log:

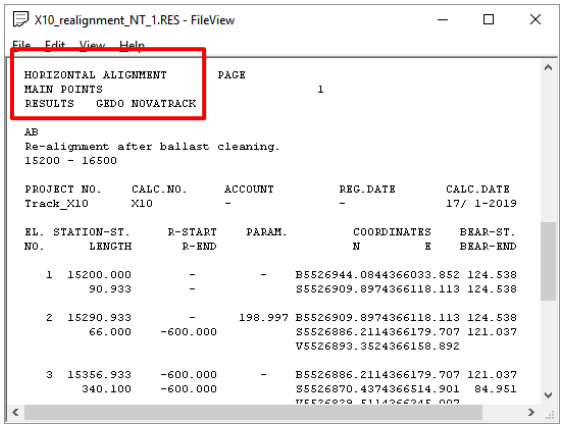
- From the toolbar select icon *Show Result File* or in the status bar double click message box '*Calc Ok*' / '*Calc not Ok*'.





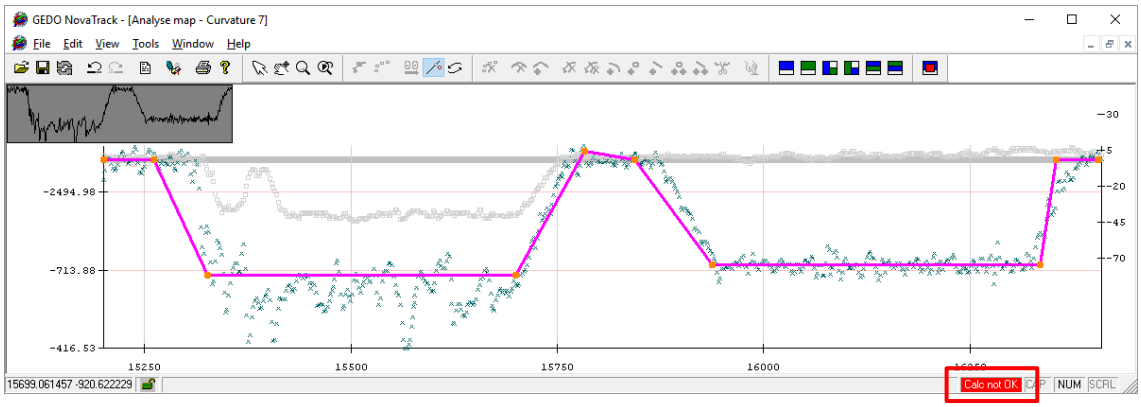
- The input and calculation result data will be separated by two individual headings - ´Horizontal Alignment Input Data´ and ´Horizontal Alignment Main Points - Result´.





Important!

In the case the solution for horizontal alignment cannot be found within set constrains, the status bar indicates ´*Calc not Ok*´and Analysis Diagram is coloured in ´*magenta*´. Please check calculation *Result file* for possible errors in element connection.

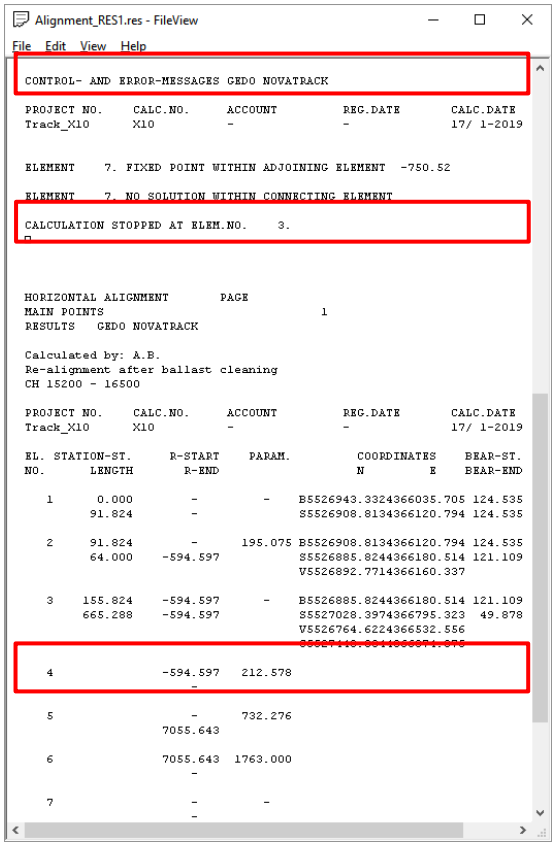


To check result file for errors:

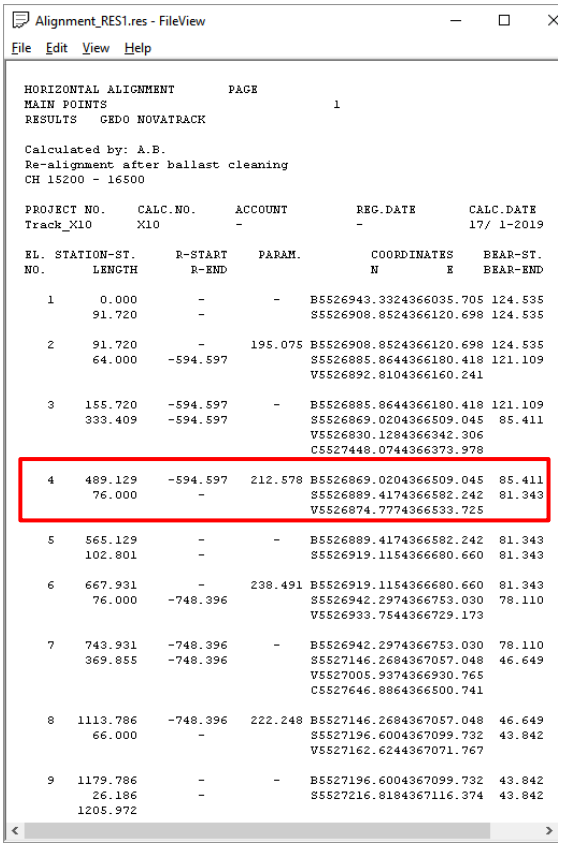
- Open result file and scroll to the header ´*Horizontal Alignment Main Points - Result*´.

  Each element causing an error in the element connectivity and therefore preventing an alignment solution, has only a few parameters listed. The parameters which cannot be calculated are marked with error codes or are not listed at all.

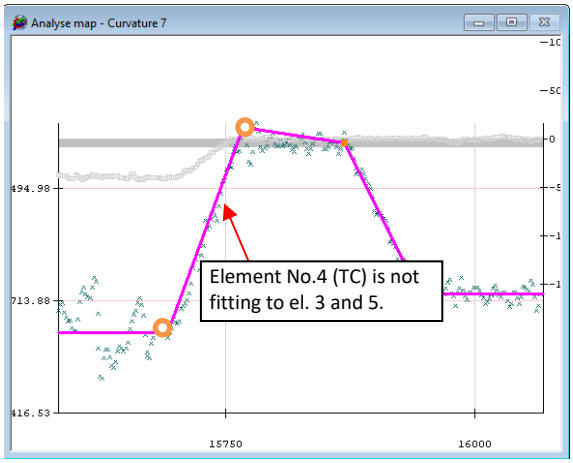
- Under the header ´Control and Error Messages´, check for the error records indicating faulty element and elements where calculation was aborted.



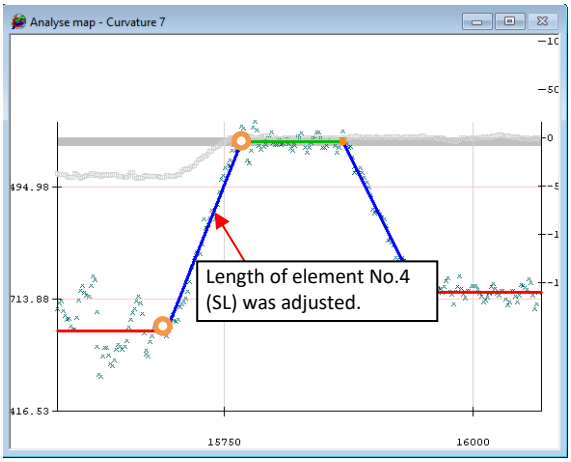
Result protocol.
Error detection in Element No.4



Result protocol.
Result after error in Element No.4 corrected.



Analysis diagram.
Error detection in Element No.4



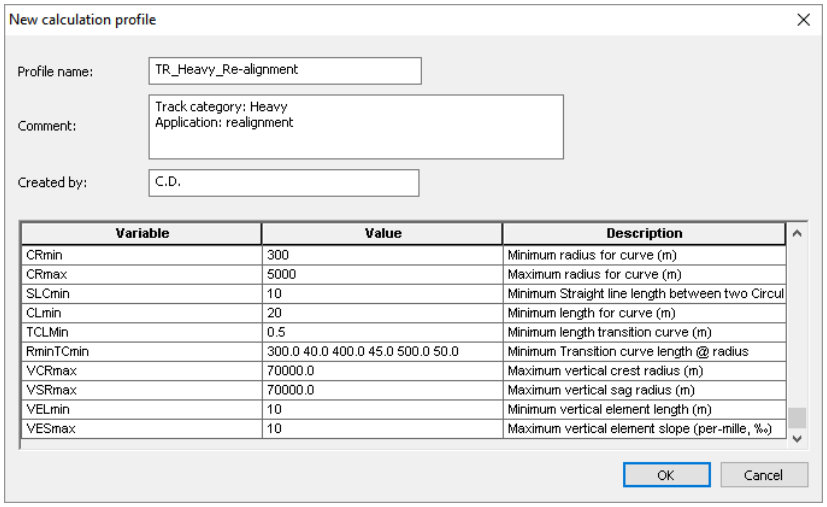
Analysis diagram.
Result after error in Element No.4 corrected.

11 Alignment geometry verification

Each alignment recalculation and editing activity is automatically followed by alignment element verification against user defined settings. Settings for alignment element verification are defined and stored in the same table as Calculation settings. Please refer to the chapter *Appendix 2. Calculation profile* definition for more detail information

To edit existing or to define new calculation profiles with alignment validation values, proceed as follows:

- From the menu select *Tools -> Option-> General* and press button *´Edit profile…´*.
- To edit existing profile, select profile and edit appropriate values.



- To delete profile, first select profile and then press ´Delete current profile´ button.
- To create new profile, first select reference profile and then press ´ New (copy from existing) ´ button. All variable values will be transferred from reference profile to new profile and can be adjusted.
- When profile editing is completed, press ´OK´ button to store changes.

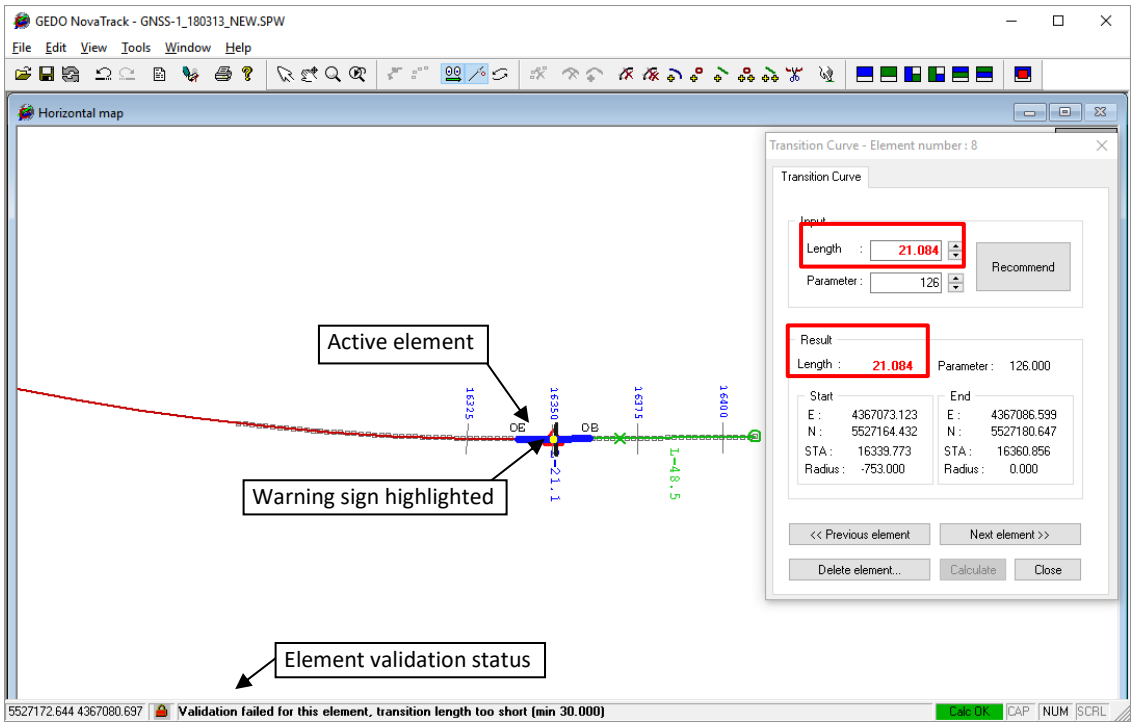
Note.

For the complete list of alignment verification variables, please refer to the chapter ´*Appendix 2. Calculation profile* definition ´.

- To apply new settings to active alignment and to run element validation, press ´Apply´ button. Validation process will be performed both for horizontal and vertical alignment.

  Alignment elements which do not correspond with set verification criteria are marked with warning symbol ⚠ .
- To get rough validation, move mouse over warning ⚠ symbol. The status bar line will show primary issue with an element.

- To get more precise information with validating issues, double click the element. The element editing dialog will show ´highlighted´ parameter which is beyond the set criterial limits.



- Once the element is adjusted (from the editing dialog or using Analysis Diagram) to comply with set requirements, warning information will be automatically removed.

Appendix 1. File formats

Trimble GEDO GTD file format (.gtd)*

Data: track trajectory, cant, gauge

Field delimiter: comma

Decimal separator: dot

Example:

```
[Header]
FormatVersion = 1.0                    ; file format version
Name = 34.6 to 38.5 140913             ; file name
ReferenceGauge = 1.435                 ; reference gauge
CantBase = 1.5096                      ; cant base
[TrackData]                            ; detail track data
[Point_no;;E-coord_C(m);N-coord_C(m);H-elev_C(m);Gauge(m);Incl(rads);Chainage(m);Prism_side;Ref_H_Rail]
34550R->34714L_1;;664538.782187441;7718601.40019557;45.8830243763602;1.434716544;-0.000818998017437332;34548.9312164998;Right;Left
34550R->34714L_2;;664538.889472634;7718600.88728717;45.8840264333605;1.434628768;-0.00108607569285843;34549.9164060877;Right;Left
34550R->34714L_3;;664539.108236682;7718599.73199802;45.8807265808121;1.434907288;-0.00118400417384616;34552.5435993232;Right;Left
34550R->34714L_4;;664539.335100111;7718598.56973668;45.8854532262065;1.43510816;-0.00168254916796553;34552.985992017;Right;Left
34550R->34714L_5;;664539.665681707;7718596.8885067;45.8919555278645;1.435060896;-0.00159352327615851;34553.919607927;Right;Left
34550R->34714L_6;;664539.911129619;7718595.6141894;45.8842067348748;1.4338506;-0.00147778961680936;34556.3216059077;Right;Left
34550R->34714L_7;;664540.305065043;7718593.62403868;45.8899238025968;1.434178072;-0.000925829087605769;34557.0148760155;Right;Left
34550R->34714L_8;;664540.576357108;7718592.19784344;45.880942453584;1.435855944;-0.000605335877100458;34560.5892768363;Right;Left
```

KOF file format (.kof)*

Data: points, lines, alignments

Field delimiter: space

Decimal separator: dot

Example:

```
-00 FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF *
-01 OOOOOOOOOOOO DDDDDDDDDDDD VVVVVVVVVVVV KKKKKKKKKKKK OOOO00000000 *
-02 SSSSSSSSSS KKKKKKKK NNNNNNNN TTTTTTTT TTTTTTTT II.III Bk MMMMMMM *
-03 TTTTTTTTTT KKKKKKKK HHH.HHHH VVV.VVVV AAAA.AAA SS.SSS Bk MMMMMMM *
-04 TTTTTTTTTT KKKKKKKK HHH.HHHH DDDD.DDD AAAA.AAA SS.SSS Bk MMMMMMM *
-05 PPPPPPPPPP KKKKKKKK XXXXXXXX.XXX YYYYYYY.YYY ZZZZ.ZZZ Bk MMMMMMM *
-06 PPPPPPPPPP KKKKKKKK PPPPPPPP.PPP AAAAAAA.AAA ZZZZ.ZZZ Bk MMMMMMM *
-09 FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFF Pi MMMMMMM *

-Pno   Chain. Fcode      N-coord.E-coord.     H-Elev.  0         *
 09_91
 05 300        12700     6595748.607  163951.272   11.548
 05 302        12700     6595748.473  163950.606   11.553
 05 303        12700     6595748.425  163950.361   11.554
 09_99
 09_91
 05 900        12701     6595749.483  163951.097   11.549
 05 904        12701     6595749.249  163949.928   11.557
 09_99
```

VER file format (.ver) (Plasser & Theuer, offsets for tamping)*

Data: chainages, horizontal and vertical offsets

Field delimiter: space

Decimal separator: dot

Example:

```
VerschHoehen          1.0Vorw___ ====EndOfFileHeader===
========= BeginOfTab =========
  15202.000  -1.062e+000   1.448e+001   0.000e+000
  15204.000  -7.132e-001   9.719e+000   0.000e+000
  15206.000  -5.048e-001   4.378e+000   0.000e+000
  15208.000  -1.076e+000   6.838e-001   0.000e+000
========== EndOfTab ==========
```

GEO file format (.geo) (Plasser & Theuer, alignment for tamping)*

Data: chainages, horizontal and vertical alignments

Field delimiter: space

Decimal separator: dot

Example:

```
SollGeom              1.0Vorw___ ====EndOfFileHeader===
========= BeginOfTab =========
  15200.000  -0.000e+000   0.000e+000  449  464
  15200.000  -0.000e+000   0.000e+000  449  464
  15289.523   6.600e+001   6.600e+001  451  465
  15355.523   6.040e+002   0.000e+000  450  464
  15698.343   6.800e+001   6.800e+001  451  465
  15766.343  -0.000e+000   0.000e+000  449  464
  15869.050   7.800e+001   7.800e+001  451  465
========== EndOfTab ==========
```

LIN file format (.lin)*

Data: horizontal alignment

Field delimiter: comma

Decimal separator: dot

Example:

```
6
1,5526944.08450,4366033.85216,  15200.00000,      0.00000,124.537926,      0.00000,      0.00000,     89.52254,
2,5526910.42692,4366116.80667,  15289.52254,      0.00000,124.537925,    199.65970,   -604.00000,     65.99999,
3,5526886.73403,4366178.39799,  15355.52253,   -604.00000,121.059705,      0.00000,   -604.00000,    342.82051,
4,5526870.83824,4366516.26160,  15698.34304,   -604.00000, 84.926209,    202.66226,      0.00000,     67.99999,
5,5526889.25546,4366581.71007,  15766.34303,      0.00000, 81.342589,      0.00000,      0.00000,    102.70668,
```

GPS file format (.gps)*

Data: points

Field delimiter: space

Decimal separator: comma

Example:

```
1       4366118,24909854    5526911,24741448    277,69031134
2       4366120,10299811    5526910,49704092    277,72766083
3       4366121,95690843    5526909,74669538    277,76451828
4       4366123,80934050    5526908,99271899    277,80215430
5       4366125,66213876    5526909,23962918    277,83786697
6       4366127,51624900    5526910,48978106    277,87329802
7       4366129,36890285    5526915,73633363    277,90791061
8       4366131,22185912    5526914,98364677    277,94311873
9       4366133,07479519    5526914,23088918    277,97703579
10      4366134,92729626    5526918,47707744    278,01101642
11      4366136,78144995    5526910,72732526    278,04613538
12      4366138,63572410    5526917,97787617    278,08146977
```

LandXML file format – Import (.xml)*

Data: points

Field delimiter: not applicable

Decimal separator: not applicable

Example:

```
<?xml version="1.0" encoding="utf-8"?>
<LandXML xmlns="http://www.landxml.org/schema/LandXML-1.2" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xsi:schemaLocation="http://www.landxml.org/schema/LandXML-1.2 http://www.landxml.org/schema/LandXML-1.2/LandXML-
1.2.xsd" version="1.2" date="2019-08-29" time="15:52:45" readOnly="false" language="English">
  <Project name="" desc="">
    <Feature name="projectExt">
      <Property label="id" value="8fd6e5a57b6e41ff9523b7a7f91a8342" />
    </Feature>
    <Feature code="trimbleLayers">
      <Feature code="trimbleLayer">
        <Property label="name" value="Points" />
        <Property label="color" value="255,255,255" />
        <Property label="lineStyleName" value="Solid" />
        <Property label="lineWeight" value="0" />
      </Feature>
    </Feature>
  </Project>
  <Units>
    <Metric linearUnit="meter" widthUnit="meter" heightUnit="meter" diameterUnit="meter" areaUnit="squareMeter"
volumeUnit="cubicMeter" temperatureUnit="celsius" pressureUnit="HPA" angularUnit="decimal degrees"
directionUnit="decimal degrees" />
  </Units>
  <Application name="Trimble Business Center" manufacturer="Trimble" version="31.0.7088.19172" timeStamp="2019-08-
29T15:52:45">
    <Author createdBy="Lmaciul" timeStamp="2019-08-29T15:52:45" />
  </Application>
  <CgPoints>
    <CgPoint name="IX_track_points_10m_2_1" featureRef="Points">5065125.54200 465821.32800 63.05700</CgPoint>
    <CgPoint name="IX_track_points_10m_2_2" featureRef="Points">5065115.08200 465821.26300 62.97800</CgPoint>
    <CgPoint name="IX_track_points_10m_2_3" featureRef="Points">5065135.82900 465821.24000 63.14100</CgPoint>
    <CgPoint name="IX_track_points_10m_2_4" featureRef="Points">5065108.57600 465821.15400 62.92700</CgPoint>
    <CgPoint name="IX_track_points_10m_2_5" featureRef="Points">5065145.90100 465821.00600 63.21300</CgPoint>
    <CgPoint name="IX_track_points_10m_2_6" featureRef="Points">5065098.38100 465820.83800 62.84500</CgPoint>
    <CgPoint name="IX_track_points_10m_2_7" featureRef="Points">5065156.38900 465820.65100 63.30200</CgPoint>
    <CgPoint name="IX_track_points_10m_2_8" featureRef="Points">5065088.34800 465820.38300 62.76500</CgPoint>
    <CgPoint name="IX_track_points_10m_2_9" featureRef="Points">5065166.22700 465820.22000 63.39100</CgPoint>
  </CgPoints>
</LandXML>
```

LandXML file format – Export (.xml)*

Data: horizontal/vertical alignment geometry

Field delimiter: not applicable

Decimal separator: not applicable

Example:

```
<?xml version="1.0" encoding="utf-8"?>
<LandXML xsi:schemaLocation="http://www.landxml.org/schema/LandXML-1.1 http://www.landxml.org/schema/LandXML-1.1/LandXML-1.1.xsd"
date="2019-08-29" time="13:54:43+02:00" version="1.1" xmlns="http://www.landxml.org/schema/LandXML-1.1"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
        <Units>
                <Metric areaUnit="squareMeter" linearUnit="meter" volumeUnit="cubicMeter" temperatureUnit="celsius"
pressureUnit="mmHG" angularUnit="radians" directionUnit="radians"/>
        </Units>
        <Application name="NovaTrack" manufacturer="Trimble Railway GmbH" version="2.0.1 (822)" manufacturerURL="www.trimble-
railway.com">
                <Author createdBy="User1"/>
        </Application>
        <Project name=""/>
        <Alignments name="">
                <Alignment name="From NovaTrack" staStart="0.000000" length="4551.273194">
                        <CoordGeom>
                                <Line staStart="0.000000" length="191.457445" dir="3.090229">
                                        <Start>6065346.847000 465808.873000</Start>
                                        <End>6065155.642053 465818.702624</End>
                                </Line>
                                <Spiral staStart="191.457445" constant="156.000" radiusStart="INF" radiusEnd="467.000000"
spiType="clothoid" length="52.111349" rot="cw" dirStart="3.089971" dirEnd="3.145764">
                                        <Start>6065155.642053 465818.702624</Start>
                                        <PI>6065120.941312 465820.486549</PI>
                                        <End>6065103.565881 465820.409574</End>
                                </Spiral>
                                <Curve staStart="243.568794" rot="cw" length="88.439274" radius="467.000000"
chord="88.307176" dirStart="3.145764" dirEnd="3.335981">
                                        <Start>6065103.565881 465820.409574</Start>
                                        <Center>6065105.634737 465353.414157</Center>
                                        <End>6065015.692139 465811.670994</End>
                                </Curve>
                                <Spiral staStart="332.008068" constant="78.000" radiusStart="467.000000" radiusEnd="INF"
spiType="clothoid" length="13.027837" rot="cw" dirStart="3.335981" dirEnd="3.349349">
                                        <Start>6065015.692139 465811.670994</Start>
                                        <PI>6065011.430749 465810.834606</PI>
                                        <End>6065002.932204 465809.043133</End>
                                </Spiral>
                                <Line staStart="345.035905" length="33.253699" dir="3.349349">
                                        <Start>6065002.932204 465809.043133</Start>
                                        <End>6064970.393585 465802.184069</End>
                                </Line>
                                <Spiral staStart="378.289604" constant="84.000" radiusStart="INF" radiusEnd="501.000000"
spiType="clothoid" length="14.083833" rot="cw" dirStart="3.348763" dirEnd="3.363404">
                                        <Start>6064970.393585 465802.184069</Start>
                                        <PI>6064961.206172 465800.247384</PI>
                                        <End>6064956.626491 465799.214563</End>
                                </Spiral>
                                <Curve staStart="392.373437" rot="cw" length="88.586484" radius="501.000000"
chord="88.471127" dirStart="3.363404" dirEnd="3.540481">
                                        <Start>6064956.626491 465799.214563</Start>
                                        <Center>6065066.845151 465310.488825</Center>
                                        <End>6064872.378444 465772.207029</End>
                                </Curve>
                                <Spiral staStart="480.959921" constant="167.000" radiusStart="501.000000" radiusEnd="INF"
spiType="clothoid" length="55.666667" rot="cw" dirStart="3.540481" dirEnd="3.595779">
                                        <Start>6064872.378444 465772.207029</Start>
                                        <PI>6064855.272741 465765.002440</PI>
                                        <End>6064821.918629 465748.717993</End>
                                </Spiral>
                                <Line staStart="536.626588" length="257.162205" dir="3.595779">
                                        <Start>6064821.918629 465748.717993</Start>
                                        <End>6064590.827995 465635.892824</End>
                                </Line>
                                <Spiral staStart="793.788793" constant="227.000" radiusStart="INF" radiusEnd="681.000000"
spiType="clothoid" length="75.666666" rot="ccw" dirStart="3.595779" dirEnd="3.540224">
                                        <Start>6064590.827995 465635.892824</Start>
                                        <PI>6064545.490370 465613.757677</PI>
                                        <End>6064522.238905 465603.964613</End>
                        </CoordGeom>
                        <Profile staStart="0.000000">
                                <ProfAlign name="From NovaTrack">
                                        <PVI>0.000000 64.327000</PVI>
                                        <CircCurve length="5803.772065" radius="19.999653">117.482044 63.868000</CircCurve>
                                        <CircCurve length="17619.465580" radius="19.999369">238.655032
62.977000</CircCurve>
                                        <CircCurve length="49377.012293" radius="19.999244">583.011244
60.054000</CircCurve>
                                        <CircCurve length="-9319.133311" radius="19.999377">758.759932
58.491000</CircCurve>
                                        <CircCurve length="-2894.169894" radius="19.999772">1085.862110
56.284000</CircCurve>
                                        <CircCurve length="-29449.176512" radius="19.999996">1349.032818
56.327000</CircCurve>
                                        <CircCurve length="-9677.417063" radius="19.999954">1927.054907
56.814000</CircCurve>
                                        <CircCurve length="-17774.090069" radius="19.999876">2056.987410
57.192000</CircCurve>
                                        <CircCurve length="7511.580248" radius="19.999909">2258.997610
58.007000</CircCurve>
```

```
                                                <CircCurve length="-3371.480888" radius="19.999724">2627.835957
58.513000</CircCurve>
                                                <CircCurve length="47250.286616" radius="19.999497">2893.577200
60.454000</CircCurve>
                                                <CircCurve length="4730.701206" radius="19.999728">2999.088210
61.180000</CircCurve>
                                                <CircCurve length="27378.521810" radius="19.999946">3445.752466
62.365000</CircCurve>
                                                <CircCurve length="-5547.843172" radius="19.999829">3741.201724
62.933000</CircCurve>
                                                <CircCurve length="3683.032329" radius="19.999847">4110.081210
64.972000</CircCurve>
                                                <CircCurve length="60998.297990" radius="20.000000">4521.605683
65.012000</CircCurve>
                                                <PVI>4551.950955 65.005000</PVI>
                                        </ProfAlign>
                                </Profile>
                        </Alignment>
                </Alignments>
</LandXML>
```

Appendix 2. Calculation profile definition

List of user defined calculation variables

Calculation profile header

[TRACK CAT 2]	Profile header (name)
description=Profile description	Profile description
created by=User1	Created by name or initials

HA Alignment regression variables

analyse_method=2	Selected analysis method
error_tolerance=5.0	Error tolerance for horizontal geometry (m)
error_tolerance_vertical=0.2	Error tolerance for vertical geometry (m)
error_tolerance_offset_pnts=85	Minimum % of measured points on resulting alignment (%)
nt3_remove_split=97	Initial percentage value for removing split points (%)
nt3_remove_split_step=3	Step size when iterating
nt3_remove_split_lines=7	Remove split point if less measure points than number since previous split point
nt3 merge split segments=0.2	Merge split points id tolerance is below value
min_straight_line=50.0	Minimum length of straight line in result alignment
min_radius_for_trans_curves=500.0	Minimum radius when inserting transition curves (m)
min_lift=0.100	Minimum vertical lift for vertical geometry (m)
number of iterations=1	Number of iterations. Set to 1 to disable.

VA Alignment calculation variables

error_tolerance_vertical=0.2	Error tolerance for vertical geometry (m)
min_lift=0.100	Minimum vertical lift for vertical geometry (m)

CANT and SPEED calculation variables

hmax=130	Maximum cant value (mm)
a=1.05	Minimum length for element with constant curvature (0.5V) (normal)
n=400	Maximum value for Cant change ratio (1:n)
Imax=9999999.0 160	Maximum values for Cant deficiency @ R
ImaxKP=100	Maximum Cant for circular curves
dImax=100	Maximum value for Cant variation
dDmax=9999999.0 69	Limit value for Cant ramp incline speed
Emax=600.0 90 9999999.0 110	Limit value for Cant Excess @ R
Vg=80	Maximum speed of the freight trains, km/h
b=0.5	Minimum length for element with constant curvature (0.25V) (minimum)
c=2.6	Coefficient for Rv calculation (2.6 normal, 3.6 minimum)
Vmax=200	Maximum speed (km/h)

GEOMETRY verification variables

CRmin=500	Minimum radius for curve (m)
CRmax=5000	Maximum radius for curve (m)
SLCmin=0.25	Minimum Straight line length between two Circular curves
CLmin=20	Minimum length for curve (m)
TCLMin=0.5	Minimum length transition curve (m)
RminTCmin=300.0 40.0 400.0 45.0 500.0 50.0	Minimum Transition curve length @ radius
VCRmax=70000.0	Maximum vertical crest radius (m)
VSRmax=70000.0	Maximum vertical sag radius (m)
VELmin=10	Minimum vertical element length (m)
VESmax=10	Maximum vertical element slope (per-mille, ‰)

Calculation profile settings(profiles.ini)

Example:

```
;************************************************************
 [New tracks smoothing]
 description=This is the description for new tracks
 created_by=AB
;Selected analyse method
 analyse_method=1
;Error tolerance for horizontal geometry (m)
 error_tolerance=5.000
;Error tolerance for vertical geometry (m)
 error_tolerance_vertical=0.2
;Minimum % of measured points on resulting alignment (%)
 error_tolerance_offset_pnts=85
;Initial percentage value for removing split points (%)
 nt3_remove_split=97
;Step size when iterating
 nt3_remove_split_step=3
;Remove split point if less measure points than number since previous split point
 nt3_remove_split_lines=7
;Merge split points id tolerance is below value
 nt3_merge_split_segments=0.2
;Minimum length of straight line in result alignment
 min_straight_line=10.000
;Minimum radius when inserting transition curves (m)
 min_radius_for_trans_curves=500.000
;Minimum vertical lift for vertical geometry (m)
 min_lift=0.100
;Number of iterations. Set to 1 to disable.
 number_of_iterations=1
;Maximum cant value (mm)
 hmax=150
;Minimum length for element with constant curvature (0.5V) (normal)
 a=0.5
;Maximum value for Cant change ratio (1:n)
 n=400
;Maximum values for Cant deficiency @ R
 Imax=600.0  80  9999999.0  100
;Maximum Cant for circular curves
 ImaxKP=100
;Maximum value for Cant variation
 dImax=25
;Limit value for Cant ramp incline speed
 dDmax=999999.0 28
;Limit value for Cant Excess @ R
 Emax=600.0  50  9999999.0  70
;Maximum speed of the freight trains, km/h
 Vg=80
;Minimum length for element with constant curvature (0.25V) (minimum)
 b=0.5
;Coefficient for Rv calculation (2.6 normal, 3.6 minimum)
 c=2.6
;Maximum speed (km/h)
 Vmax=200
;Minimum radius for curve (m)
 CRmin=500
;Maximum radius for curve (m)
 CRmax=5000
;Minimum Straight line length between two Circular curves
 SLCmin=0.25
;Minimum length for curve (m)
 CLmin=20
;Minimum length transition curve (m)
 TCLMin=0.5
;Minimum Transition curve length @ radius
 RminTCmin=300.0 40.0 400.0 45.0 500.0 50.0
```

```
;Maximum vertical crest radius (m)
 VCRmax=70000.0
;Maximum vertical sag radius (m)
 VSRmax=70000.0
;Minimum vertical element length (m)
 VELmin=10
;Maximum vertical element slope (per-mille, ‰)
 VESmax=10
;************************************************************
```

Document revisions

Rev. no.	Date	Latest changes	User
1.0.1.	15.01.2018	First release	LM
2.0.0.	01.03.2019	Second release	LM
2.0.1.	02.09.2019	Third release. Support for US Feet units.	LM

Notes.

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