

Survey Pro's Roads Module

User Guide

From Survey Pro v6.6



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2.4.3. You agree to use all reasonable efforts to prevent unauthorized use and disclosure of the Software.

2.5. Evaluation Software. Subject to the terms and conditions of this Agreement and during its term, we may, in our discretion, provide You with pre-release, beta or other software on an evaluation basis ("**Evaluation Software**"). You may use Evaluation Software solely for internal evaluation purposes for thirty (30) days from receipt of the Evaluation Software (unless otherwise agreed with us in writing) (the "**Evaluation Period**"). Unless You pay the applicable license fee for the Software, the Evaluation Software may become inoperable and, in any event, your right to use the Evaluation Software automatically expires at the end of the Evaluation Period. Evaluation Software shall be subject to all restrictions on

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7. Professional Services. Our Supplier shall provide the number of person-days, if any, of professional consulting services ("**Professional Services**") purchased in the applicable Order Form and related statement of work. If we are providing Professional Services, unless agreed in a separate written agreement, all Professional Services shall be provided pursuant to our standard service terms which are available upon request to us. If your Order Form is with our Supplier other than us, that party (and not us) is solely responsible for providing Professional Services and we, not being a contracting party, have no liability related to such services.

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8.4. The Parties agree that the limitations specified in this Section 8 will survive and apply even if any limited remedy specified in this Agreement is found to have failed of its essential purpose.

9. Confidential Information. Any software, Documentation or technical information provided by us (or our suppliers and agents) shall be deemed our "Confidential Information" without any marking or further designation. Except as expressly authorized herein, You will hold in confidence and not use or disclose any of our Confidential Information. Without limiting the foregoing, You acknowledge that the Software constitutes the valuable confidential information and trade secrets of us and, accordingly, You shall at all times, both during the term of this Agreement and thereafter keep in trust and confidence all the Software, and shall not disclose the same to any third party without our prior written consent. You acknowledge that disclosure of our Confidential Information would cause substantial harm to us that could not be remedied by the payment of damages alone and therefore that upon any such disclosure by You, we shall be entitled to appropriate equitable relief in addition to whatever remedies we might have at law.

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11. General.

11.1. Assignment. This Agreement will bind and inure to the benefit of each Party's permitted successors and assigns. We may assign this Agreement to any Affiliate or in connection with a merger, reorganization, acquisition or other transfer of all or substantially all of our assets or voting securities. You may not assign or transfer this Agreement, in whole or in part, without our written consent. Any attempt to transfer or assign this Agreement without such written consent will be null and void. If You obtain such written consent from us, You shall permanently assign or transfer all of your rights under this Agreement, provided You retain no copies and You transfer all of the Software (including all component parts, the media and printed materials, any upgrades, and this Agreement), and the recipient agrees to the terms of this Agreement. If the Software portion is an upgrade, any assignment or transfer must include all prior versions of the Software.

11.2. Partial Invalidity. If any provision of this Agreement is held to be invalid, illegal or unenforceable to any extent, that provision shall, if possible, be construed as though more narrowly drawn, if a narrower construction would avoid such invalidity, illegality or unenforceability, or, if that is not possible, such provision shall, to the extent of such invalidity, illegality or unenforceability, be severed, and the remaining provisions of this Agreement shall remain in effect, provided, however, that the court shall have authority and jurisdiction to, and

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11.3. Governing Law; Jurisdiction and Venue.

11.3.1. If You obtained this Software in the U.S., this Agreement is governed by the laws of the State of California (state where Trimble Inc. is located) and the U.S. without regard to conflicts of laws provisions thereof, and without regard to the United Nations Convention on the International Sale of Goods ("UNCISG"). In such case the jurisdiction and venue for actions related to the subject matter hereof are the State of California and U.S. federal courts located in Santa Clara County, California, and both Parties hereby submit to the personal jurisdiction of such courts.

11.3.2. If You obtained this Software outside the U.S., this Agreement is governed by the laws of The Netherlands (country where Trimble Europe B.V. is located), excluding its rules governing conflicts of laws and without regard to the UNCISG. In such case each jurisdiction and venue for actions related to the subject matter hereof are the Dutch courts of the District of Oost-Brabant, The Netherlands, and both Parties hereby submit to the personal jurisdiction of such courts.

11.4. Attorneys' Fees and Costs. The prevailing Party in any action to enforce this Agreement will be entitled to recover its attorneys' fees and costs in connection with such action.

11.5. Notices and Reports. Any notice or report hereunder shall be in writing. If to us, such notice or report shall be sent to the attention of "General Counsel – Legal Notice – Spectra Products" to "Trimble Inc., 935 Stewart Drive, Sunnyvale, California 94085, U.S.A.". If to You, such notice or report shall be sent to the address You provided upon placing your order or at the time the Software has been first made available to You. Notices and reports shall be deemed given: (a) upon receipt if by personal delivery; (b) upon receipt if sent by certified or registered U.S. mail (return receipt requested); or (c) three (3) business days after being sent by a reputable international courier requiring signature for receipt, addresses to the Party at its notice address. Either Party may change its notice address by written notice to the other.

11.6. Amendments; Waivers. No supplement, modification, or amendment of this Agreement shall be binding, unless executed in writing by a duly authorized representative of each Party to this Agreement. No waiver will be implied from conduct or failure to enforce or exercise rights under this Agreement, nor will any waiver be effective unless in a writing signed by a duly authorized representative on behalf of the Party claimed to have waived.

11.7. Entire Agreement. This Agreement is the complete and exclusive statement of the mutual understanding of the Parties and supersedes and cancels all previous written and oral agreements and communications relating to the subject matter of this Agreement. No provision of any purchase order or in any other business form employed by You will supersede the terms and conditions of this Agreement, and any such document issued by a Party hereto relating to this Agreement shall be for administrative purposes only and shall have no legal effect. **Notwithstanding the foregoing, if You have entered into a separate written license agreement signed by us for use of the Software, the terms and conditions of such other agreement shall prevail over any conflicting terms or conditions in this Agreement.**

11.8. Independent Contractors. The Parties to this Agreement are independent contractors. There is no relationship of partnership, joint venture, employment, franchise or agency created hereby between the Parties. Neither Party will have the power to bind the other or incur obligations on the other Party's behalf without the other Party's prior written consent.

11.9. Force Majeure. Neither Party shall be liable to the other for any delay or failure to perform any obligation under this Agreement (except for a failure to pay fees) if the delay or failure is due to unforeseen events, which occur after the signing of this Agreement and which are beyond the reasonable control of the Parties, such as strikes, blockade, war, terrorism, riots, natural disasters, refusal of license by the government or other governmental agencies, in so far as such an event prevents or delays the affected Party from fulfilling its obligations and such Party is not able to prevent or remove the force majeure at reasonable cost.

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11.11. Third-Party Software. If designated in the Documentation, the Software may contain or be provided with certain Third-Party Software (including software which may be made available to You in source code form). Such Third-Party Software is not licensed hereunder and is licensed pursuant to the terms and conditions indicated in the Documentation and/or on the Third-Party Software conditions (“**Third-Party License**”). Except as may be set forth in the Third-Party License, neither we nor our Suppliers offer any warranty in connection with any Third-Party Software and neither we nor our Suppliers shall be liable to You for such Third-Party Software.

11.12. Official Language. The official language of this Agreement is English. For purposes of interpretation, or in the event of a conflict between English and versions of this Agreement in any other language, the English language version shall be controlling.

11.13. Reservation of Rights. We reserve all rights not expressly granted by this Agreement.

If an executed agreement exists between You and us at any time regarding the Software, the terms of that agreement shall supersede the terms of this Agreement in its entirety. Thus, if You enter into a separate written agreement with us regarding the Software, that agreement (not this one) will control your use of the Software; and further if that agreement is terminated, You will not have the right to use the Software under the terms of this Agreement after termination. Notwithstanding the foregoing, pre-printed terms and conditions on your Order form shall not supersede this Agreement.

Data Collector Warranty Program

Spectra would like to make you aware of the warranty program. A new data collector that has been purchased and is still under the one year factory warranty or under an extended warranty will be authorized for software updates. Data collectors that are not currently under a warranty plan are eligible to purchase an extended warranty. There are Survey Pro software only warranties that will authorize the data collector for software updates, and there are warranties that cover both the data collector hardware and Survey Pro software. The extended warranties are a good way to protect your investment in your equipment.

The Survey Pro installation program will use your internet connection to compare the data collector's serial number against a data base that contains the warranty status on all units. If the unit is under a valid warranty, the installation will proceed. If the unit is not covered under warranty, then a message will be displayed informing you of this and the installation will stop.

To receive Survey Pro minor improvement releases, identified by the version numbering system, you only need to be on the current version of the latest minor update. In other words, if you have version 5.0.x you are authorized for a version 5.0.5 improvement release automatically. For minor updates, 5.0 to 5.1 for example, it is now required that the data collector or Survey Pro software be on a current warranty plan.

The warranty plans are listed on Spectra price lists. Data collector serial numbers are required in order to generate the proper registration codes for your unit and to log the warranty plan into the database.

Changes to this User Guide from Survey Pro v6.5 to v6.6

Cut slopes and fill slopes can now be expressed as ratios.

Table of Contents

Introducing Survey Pro's Roads Module	1
Purpose	1
Road Projects	1
Block Diagram	1
Parameters Defining a Road	2
Importing a Road File From Third-Party Software	3
Import Rules	3
Rules Applying to Imported Roads	3
Valid LandXML Roads	3
Creating a Road	4
Slope Staking	8
Introduction	8
Step-by-Step Instructions	9
Staking out a Road	14
Introduction	14
Step-by-Step Instructions	15
Show Station Function	17
Generating Reports	19
Alignments	21
Introduction	21
Definitions	22
Horizontal Alignment	22
Vertical Alignment	23
Entering Angles and Distances	23
Creating an Alignment	26
Editing an Alignment	28
Deleting an Alignment	28
Templates	29
Definition	29
Using Templates	30
Polylines	32
Introduction	32
Creating a Polyline	32
1st Method	33
2nd Method	34
Editing a Polyline	35
Appendix	37
Abbreviations Used	37
Calculator	37
Road Definition Rules	39
Station Equations and Additional Points	40
Understanding Station Equations	42
First Example: Two Roads Meet, One Ends and One Starts	42
Second Example: Two Roads Meet, Both End	43

Introducing Survey Pro's Roads Module

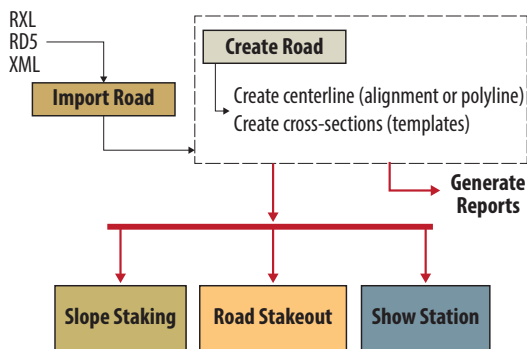
- Purpose** Survey Pro's Roads module allows you to do the following:
- "Slope stake" a road, based on various slopes and hinge points (**Slope Staking** function).
 - Stake a road project at any segment on any station (**Road Stakeout** function).
 - Perform grade check and quality control using dynamic surface information (**Show Station** function).
 - Generate reports.

- Road Projects** Road projects supported by Survey Pro can be created in two different ways:
- Either they are created in CAD software and then exported in one of the following formats, and then imported to Survey Pro:
 - RXL (RoadXML files)
 - RD5 (Road files)
 - XML (LandXML files)
 - Or they are created directly within Survey Pro. Creating a road project in Survey Pro implies:
 - Creating an alignment (or a polyline) describing the road centerline.
 - Creating templates describing the road's cross section at different locations (called *stations*) along the road centerline.
 - Defining the start point (POB).

See also *page 2* for more details.

NOTE: Imported road projects may be edited (modified) in Survey Pro. Restrictions exist however when editing imported roads (see *page 3*).

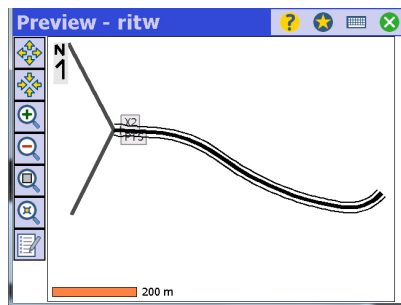
Block Diagram



Parameters Defining a Road



In Survey Pro, a road is defined by the following parameters:

1. An *alignment*, which consists of:
 - A *horizontal alignment (HAL)*, which defines the layout of the road in the horizontal plane. It can be made up of a series of straight, curved and spiral segments. Generally the HAL coincides with the centerline of a road, but this is not an absolute requirement.
Note that the horizontal layout of a road may be also be defined from a *polyline* (see page 32) although this won't usually be the preferred procedure.
 - A *vertical alignment (VAL)*, which defines the layout of the road in the vertical plane (road's vertical profile). It can be made up of grades and parabolic curves.
2. *Templates*, which contain the road's cross section information. Templates are assigned to different locations, called *stations*, along the road centerline. Templates are broken down into segments. Each segment contains a specified length and a slope (or change in elevation).
3. A *POB (Point Of Beginning)*, which designates the location in the current job where the road starts. The POB can be defined by an existing point or specified coordinates and can be changed at any time. The VAL's start station elevation will be set from the POB.



Importing a Road File From Third-Party Software

After opening a job in Survey Pro, do the following:

- From the main menu, select **Roads**, then **Manage Roads**.
- Tap **Add**, then **Import**.
- Select the source folder, the format (RXL, RD5 or XML) and the name of the file to import.
- Tap . The road is then imported into the open job. The road name appears in the list of existing roads, along with a graphic representation of its horizontal and vertical alignments.
- Tap  to close the window and return to the **Roads** menu. You are now ready to modify or stake out your road project.

Import Rules

- Survey Pro does not support RXL files containing widening definition elements, superelevation definition elements, or road scale and will not import these files. Widenings and superelevations are fully supported in the template definitions and for all staking routines (see *page 40* for more details).
- Survey Pro will convert RD5 road files to be compatible with Survey Pro and save them as **.survey* files. Any super elevations and widenings present in an RD5 road definition will create new templates to apply their effects in the resulting imported road.

Rules Applying to Imported Roads

An imported road is not-editable – and will be read only – if it contains the following elements:


- Non-clothoid spirals
- Spirals that transition between two curves, i.e. a spiral where both the entry and exit radiuses are non-infinite.
- Vertical circular arcs.

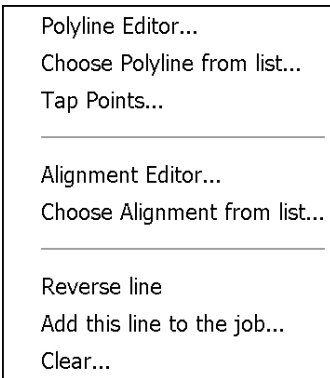
Valid LandXML Roads

- Survey Pro only supports LandXML roads defined by "CrossSectSurf" elements. The cross-section is assumed to be defined by offset and elevation pairs.
- If there are multiple cross section surfaces defined in the LandXML file for a given road, then each surface will be imported as a separate road into Survey Pro.

Creating a Road



After opening a job in Survey Pro, do the following:

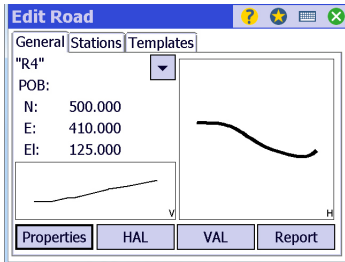
1. From the main menu, select **Roads**, then **Manage Roads**.
2. Tap **Add**, then **Create New**. Survey Pro then asks you to enter the following parameters:
 - **Road name**
 - **Station interval**: Distance increment along the road centerline which defines the level of detail to show when displaying the various review maps and when producing reports.
Too much detail with a station interval set too low will cause the program to run slowly. Only reduce this value below 10 meters if the level of detail is required. Often, 50 to 100 meters or more is sufficient for showing enough detail on the maps and in reports since the reports always generate data for changes in templates, grades, or alignment.
Station intervals for staking can be set in the individual staking routines.
3. Tap  to open the scroll-down list. Select the option that suits best to define the road centerline:
 - **Polyline Editor**: Opens the polyline editor so you can now define the polyline you want to use as the road centerline. For more information, refer to *Polylines on page 32*.
NOTE: Survey Pro will convert any polyline you will select for use in a road project as an alignment.
 - **Choose polyline from list**: Displays the list of existing polylines stored in the job so you can choose one to become the road centerline.
 - **Tap Points**: Lets you build a polyline by successively selecting different points stored in the job.
 - **Alignment Editor**: Opens the alignment editor so you can now define the alignment you want to use as the road centerline. For more information, refer to *Alignments on page 21*.
 - **Choose Alignment from list**: Displays the list of existing alignments/roads stored in the job so you can choose one to become the road centerline. This may be the centerline of an existing road, in which case you will select the name of this road to select its centerline.
 - **Reverse line**: Reverses the direction in which the selected alignment or polyline will be used (start point becomes end point).
 - **Add this line to the job**: Select this option if you want to save a polyline you have manually defined through the above **Tap Points** option to the job (or using the **To/From** button; see below).




- **Clear:** Dissociates the alignment or polyline you have just selected from the road project (you no longer want it to be used as the road centerline).

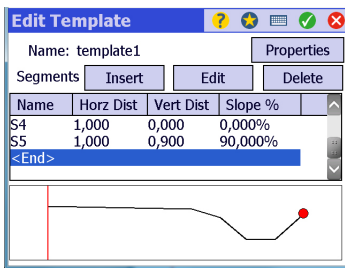
Additionally, you may select an existing polyline by tapping **Tap Line** and selecting it on the map, or you can build a polyline by keying in its point names (e.g. 20-30) using the **To/From** button.

4. Once the centerline has been defined, tap  to create the road.
5. Tap  again. At this stage the road editor tools and road viewers are presented (see below).



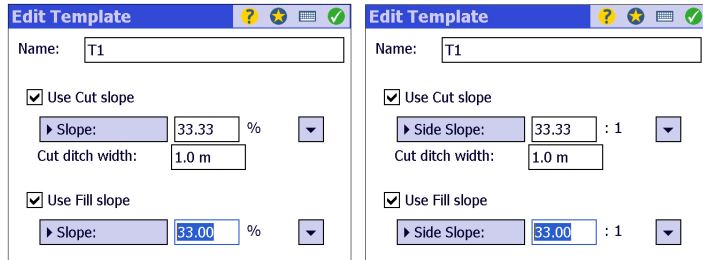
6. Open the **Templates** tab, then tap **Add** to create your first template. For more information about templates, see *page 29*.
7. Tap **Insert** to define the first segment. The slope of the segment may be entered either as a rising or falling vertical offset, or as a positive or negative grade in % (slope is defined as "rise over run" or percent slope for template definitions).
8. Tap  to save the segment. This takes you to the previous screen where you can see the newly created segment (a red spot appears at the end of this segment).
9. Repeat the previous two steps until all the segments have been added. To append a segment to the outside of the previous one, you must first select **<End>** and then tap **Insert**.

The screenshot below shows a template with 5 segments.



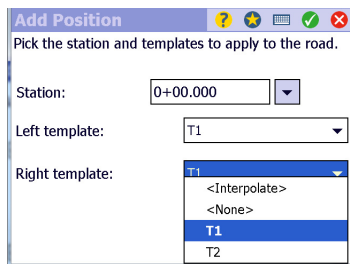
A new segment can be inserted BEFORE any existing segment: Just select that segment in the list (the red spot appears where the segment will be inserted), then tap **Insert** and define the new segment.

- Then tap **Properties**, enter the name of the template and define the cut slope and fill slope to use with the template (more explanations on page 29). These two slopes may be entered either as a percentage or a ratio:



To toggle from percentage to ratio – or the other way round – just tap on the field name. The field is labeled **Slope** for a percentage, **Side Slope** for a ratio.

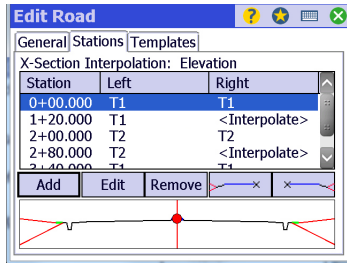
- Tap to return to the screen showing the current list of segments in your template.
- Tap again to save the template and return to the **Templates** tab.
- Repeat the previous six steps as many times as necessary to create all the templates you need in your road project.
- Then open the **Stations** tab to assign templates to the required stations along the alignment.
- Tap **Add**. Enter a station value and then choose a right template and a left template from the list of available templates:





Remember you can also use the **<Interpolate>** or **<None>** option. See page 30 for details).

- Tap to save the station and return to the **Stations** tab.

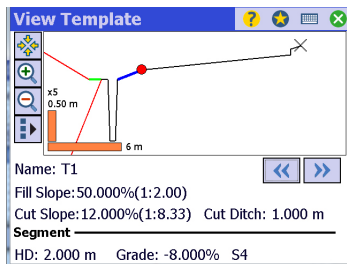
17. Resume the previous two steps as many times as necessary to create all the stations you need in your road project. When you are finished, the **Stations** tab may look like this:





You may use the following two buttons to get a detailed view of each of the segments in the selected templates

- : Displays a detailed view of the right template.
- : Displays a detailed view of the left template.



Example:



Use the following buttons to explore the different segments of the template, starting from the centerline (shown as a thin black cross):

- : Highlights the next segment.
- : Highlights the previous segment.

A red spot is shown at the beginning of the highlighted segment, which appears as a thick blue line. Its full properties are displayed at the bottom of the screen.

18. Go back to the **Stations** tab by tapping .
19. Tap  again twice to return to the **Roads** menu. You are now ready to stake out your road project.

Slope Staking

Introduction

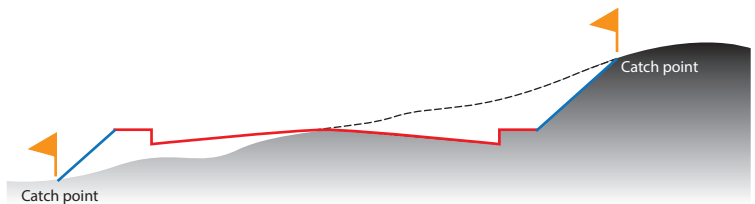
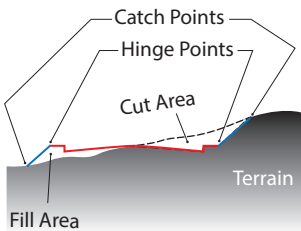
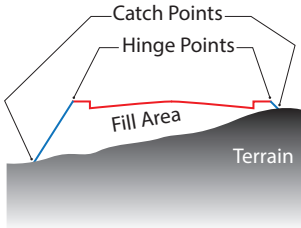
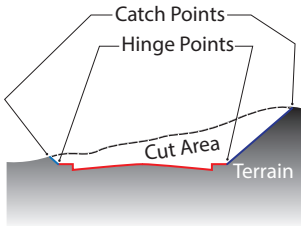
Slope staking is about locating where the outer slopes of a predefined roadway intersect with the surface of the terrain. Through this routine, intersecting points are determined at various stations. These points, called *catch points*, or sometimes *daylight points*, are where a cut or a fill begins.

The *side slope* of a road's cross section (see definition on *page 29*) has either a specified positive slope or a specified negative slope, which ends at the catch point. The side slope attaches to the edge of the road at what is called the *hinge point*.

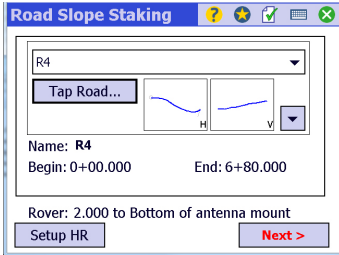
Slope Staking can automatically determine if the side slope should be a cut or fill depending on the existing terrain. The type of slope to use is determined by your first shot off the side of the road surface area and is based on if you are above or below the hinge point design elevation.

Survey Pro has three settings with regards to which side slope value is used. These settings are found on the main slope staking screen.

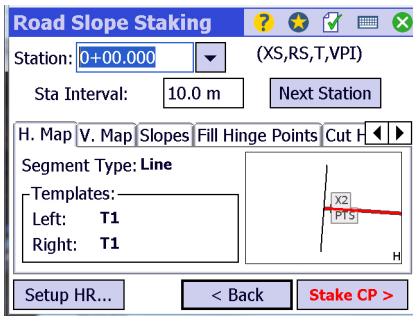
- **Automatic:** Survey Pro determines the correct side slope value to use based on the measurement to the rod. If the computed elevation for the measurement is above the cut hinge point, then Survey Pro determines that you are in a cut zone and will use the cut slope value and hinge point. If the elevation is below the fill hinge point, then Survey Pro will use the fill slope value and hinge point.
- **Force Cut Slope, or Force Fill Slope:** In certain conditions, the results of the comparison between the measurement elevation and the road design can be ambiguous to the software. In those cases, the surveyor has full control and can choose which side slope value to use by selecting either Force Cut or Force Fill. Survey Pro will then use that slope value to accomplish the slope staking.



Step-by-Step Instructions

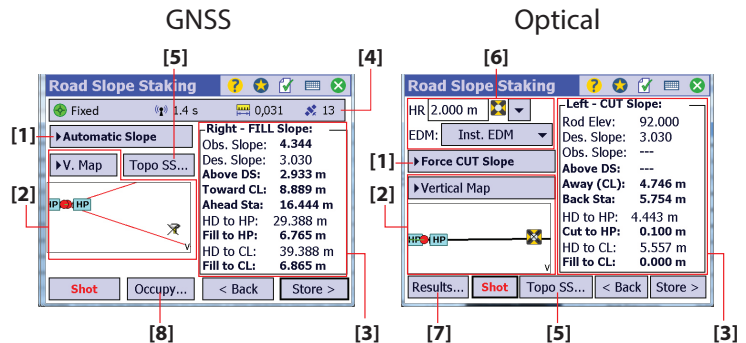


- From the main menu, select **Roads**, then **Slope Staking**.
- Select the road you are working on. This can be done either by picking a name from the scroll-down list, or by selecting the road on the map (first tap **Tap Road**). As a result, the screen shows a view of the road's horizontal and vertical alignments, recalls the name of the selected road and indicates the values of start station and end station.
- Depending on the equipment used (optical or GNSS) and unless already done, make the additional settings to get ready (backsight setting or GNSS antenna setting respectively). See GNSS screen example in the left column.
- Tap **Next >**. The screen that now appears allows you to prepare for slope staking the selected road:



- Select the station where to start. You may use the **Next Station** button to increment the station, based on the value entered in the **Sta Interval** field.
NOTE: The value of **Sta Interval** may be positive or negative.
- Go through the five different tabs shown on this screen:
 1. The **H. Map** tab (default) provides the names of the templates used on the left and right side of the road cross section at the selected station. The reported segment type can be "line", "curve" or "spiral" (current segment of the alignment).
A graphic view represents the road centerline (in red) as well as the position of the current station with a thin line perpendicular to the road centerline. You may tap on this graphic to get a larger view of the road centerline.
 2. The **V. Map** tab provides a view of the entire road cross section. Hinge points are shown as red spots and labeled "HP" (for Hinge Points).

3. The **Slopes** tab allows you to change the cut and fill slopes for both sides of the rod cross section. By default, the value assigned to all these slopes is the one you chose when defining the side slope of the cross section (see the definition of this extra segment on *page 6* and *page 29*). If you want different values for the left or right side of the road cross section, check the corresponding boxes and enter the desired ratio (run/rise ratio, e.g. 3:1).
 4. The **Fill Hinge Points** tab allows you to select the segment on the right or left side of the road that you want to use for the fill hinge point.
 5. The **Cut Hinge Points** tab allows you to select the segment on the right or left side of the road that you want to use for the cut hinge point.
- Tap **Stake CP >**. Survey Pro now shows the Road Slope Staking screen (see examples below). Using this screen, you will be guided to stake out the catch point you are looking for. Please read all the details about the information displayed on this screen in what follows.



[1] (GNSS/Optical): Selects the type of slope that will be used between the catch point and hinge point:

- **Automatic Slope:** Selects the slope based on the current position. If the position elevation is above the hinge point, a cut slope is computed. If the position elevation is below the hinge point, a fill slope is computed.
- **Force CUT Slope:** Forces all computations to be based on the preset cut slope.
- **Force FILL Slope:** Forces all computations to be based on the preset fill slope.

[2] (GNSS/Optical): Selects the type of guidance you wish to use to find the catch point:

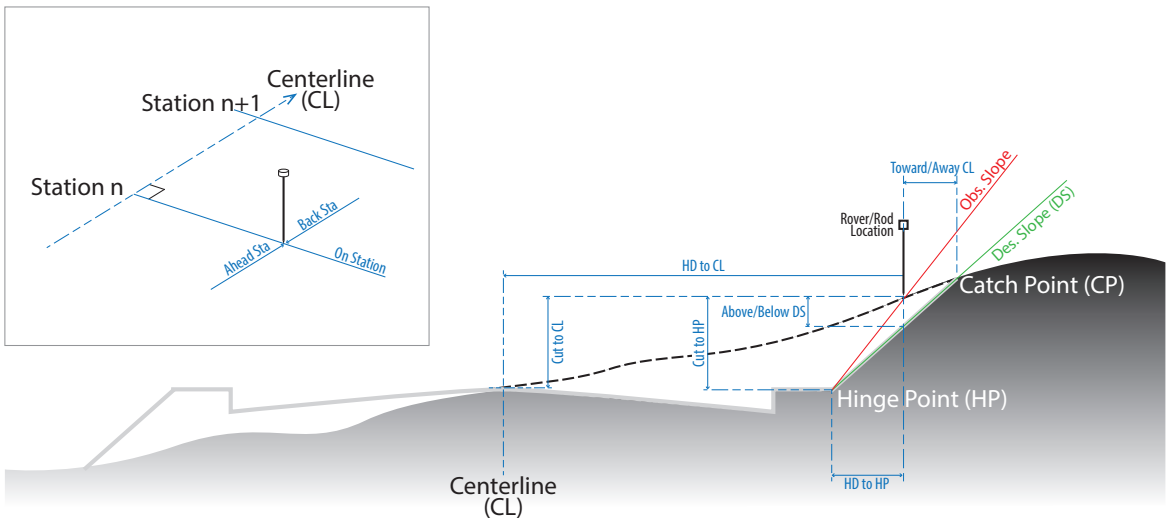
- **Vertical Map (V. Map):** Displays a view of the road cross section at the current station. The vertical map will show an "X" at the location of each previous slot.

- **Horizontal Map (H. Map):** Displays an overhead view of the job (portion of the horizontal alignment).
- **N,E,Z (GNSS) or Shot Data (Optical):** Displays the measurements made when last tapping the **Shot** button.

NOTE 1: The correct procedure for slope staking in GNSS or robotic mode is to use the graphic portion of the screen (**H. Map** or **V. Map**) to locate the catch point as closely as possible and press **Shot**. Once the position is satisfactory, you can determine if the rover needs to be moved again.

NOTE 2: The horizontal and vertical maps are continuously updated whereas the measurements listed in area **[3]** are not updated until you tap the **Shot** button.

[3] (GNSS/Optical): Shows measurements made for the current rover/rod location the moment you tap the **Shot** button (the top title indicates which side of the road you are on and whether a cut or fill slope is required from the point where you currently stand). These measurements are described and illustrated below:



- **Rod Elev** (Optical only): Current elevation of the rod location.
- **Obs. Slope:** Observed (computed) cut or fill slope based on the last shot and the corresponding hinge point.
- **Des.Slope:** Design cut or fill slope.
- **Above DS/Below DS:** Cut or fill required respectively for the current rover/rod location to be positioned on the design slope.
- **Toward CL/Away CL:** Computed horizontal distance that the rover/rod must move either toward the centerline or away from it respectively,

before it is positioned at the catch point. This distance is based on the observed terrain computed from the last two shots. If only one shot has been taken, it is assumed that the terrain is level when computing this value.

- **On Station/Back Sta/Ahead Sta:** Tells whether the rover/rod is on the station being staked, or otherwise the distance it must move (parallel to the centerline), back or ahead, to be on the correct station.
- **HD to HP:** Horizontal distance from the rover/rod to the hinge point.
- **Fill to HP/Cut to HP:** Vertical distance from the rover/rod to the hinge point.
- **HD to CL:** Horizontal Distance to the centerline.
- **Fill to CL/Cut to CL:** Vertical distance from the rover/rod to the centerline.

[4] (GNSS only): GNSS status bar: Displays the current values of solution type (should be "Fixed"), age of corrections, horizontal precision and number of satellites used. You may tap on this bar to open the detailed GNSS Status screen.

[5]: Topo SS: Use this button to store the last shot taken as an instantaneous (non-averaged) position (GNSS) or a sideshot (Optical).

[6] (Optical only):

- **HR:** Rod height
- Type of prism used
- **EDM:** This button can be toggled to shoot in various EDM modes. The options available depend on the total station being used. Consult the total station's documentation for more information on the EDM modes that it supports.

[7]: Results (Optical only): Displays the following additional cut, fill and location information:

- Type of slope (e.g. left/right, cut/fill)
- Design and observed slope ratios (run over rise)
- Design and actual stations
- HD and Cut/Fill to Hinge Point
- HD and Cut/Fill to centerline
- If applicable, HD and Cut/Fill to edge of pavement and edge of curb
- Name of segment and HD and Cut/Fill to that segment extremity (Road Slope Stake only).

[8]: Occupy (GNSS only): Use this button to compute the current position of the rover over a certain number of epochs. This puts the receiver into a mode where a more accurate static position can be computed. When you think enough measurements have been made, tap **Accept**.

- Walk in the field where you think you can start slope staking and then take a shot. Read the measurements (see **[3]** above), then move the rod/rover accordingly. Take a new shot, read the measurements again, move, etc. until you find the accurate position of the catch point. Mark this point in the field.
- Tap **Store**.

You may need to store a point for the staked catch point. To store the point, first give that point a name and a description, then tap **Store CP**.

You may also want to stake out points (reference points) at some distance from the catch point and at the same station: Key in an offset from the catch point, away from the centerline, and then press **Stake** (GNSS) or **Solve** (Optical). Then follow the usual instructions to stake out a point. (See *Survey Pro User Guide* for more details.)

Additionally, the summary of the results described above in **[7]** may also be displayed from this screen by tapping on the **Results** button.

- Once you have stored the catch point, or if you want to move on without storing the point in the file, tap **Next CP** to resume the above procedure for the next catch point required.

Staking out a Road

Introduction

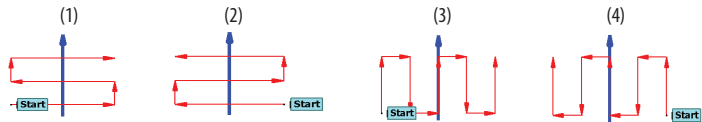
The **Road Stakeout** function is used to stake subgrades and road surfaces after the road centerline has been rough staked and the slope staking has been done using Survey Pro's **Slope Staking** function.

Before you start staking out a road, be aware you can choose the way Survey Pro will take you to each of the road's significant points (outer edge of each segment). Two modes are possible:

- *Manual Mode*: At any given station, you will select manually each of the points you want to stake. After completing this task, you will select the next station to continue.

Use this mode if you want full control of which points you really want to stake, or if you are interested in only staking some particular points, and not all of them. This mode requires that you go back to the cross section view every time you want to select the next point to go to.

- *Auto-Advancement*: You ask Survey Pro to guide you automatically to each and every of the significant points, starting at a specified station and ending at another given station. In this mode you will never have to select the next point to go to as Survey Pro will automatically select it once you are done with the current one.

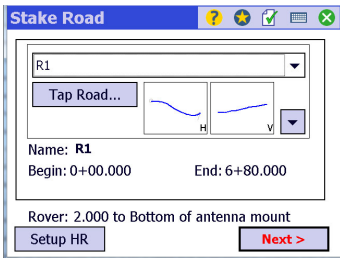


Four different auto-advancement modes are available:

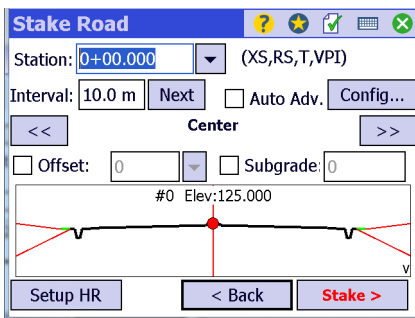
- Starting from left to right along a cross section, one station after the other (1)
- Starting from right to left along the cross section, one station after the other (2)
- Switching between two adjacent stations, from left to right (3)
- Switching between two adjacent stations, from right to left (4)

Also remember each point you stake may optionally be saved to the job for further processing.

Step-by-Step Instructions



- From the main menu, select **Roads**, then **Road Stakeout**.
- Select the road you are working on. This can be done either by picking a name from the scroll-down list, or by selecting the road on the map (first tap **Tap Road**). As a result, the screen shows a view of the road's horizontal and vertical alignments, recalls the name of the selected road and indicates the values of begin and end stations.
- Depending on the equipment used (optical or GNSS) and unless already done, make the additional procedures to get ready (backsight setting or GNSS antenna setting respectively). See GNSS screen example in the left column.
- Tap **Next >**. The screen that now appears allows you to prepare for staking out the selected road:



The lower part of the screen shows the cross section of the road at the entered station. The red spot indicates the point you want to stake out (by default the road centerline).

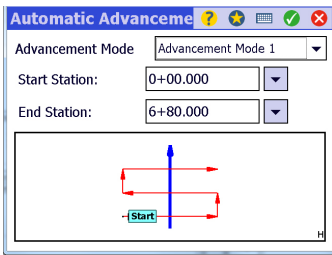
You may use the **<<** and **>>** buttons to move the red spot on the different segments of the cross section, respectively to the right or to the left. After tapping any of these buttons, the red spot is moved to the end of the next segment.

NOTE: The side (center, left or right), rank (#1, #2, etc.) and name of the segment on which the red spot is currently located are displayed between these two buttons.

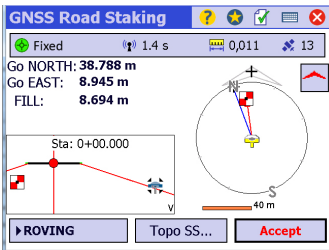
This screen also contains important information allowing you to control the way you want to carry out the stakeout routine:

- **Station:** Station value (by default the road start station), followed by a number of abbreviated terms between brackets describing that particular station. See list of abbreviations used on *page 37*.
- **Interval:** Interval of distance along the road centerline at which you want to advance when you tap the **Next** button.

- **Next** button: Increments the **Station value** by the value given in **Interval**. (To come back to a lower value of **Station**, temporarily change the **Interval** parameter to a negative value so you can come back to this lower value by tapping the **Next** button.)
- **Auto Adv.** (for automatic advancement): You may choose to select manually each point you want to stake out at the current station, in which case you will disable this option, or you may ask Survey Pro to follow an advancement mode taking you automatically to the different points you have to stake out from a specified station to another specified station. For more information, see *page 14*.



- **Config** button: When **Auto Adv.** is enabled, this button allows you to choose the advancement mode you wish to use. Choose one of the available four modes and then specify the range of stations (**Start Station** and **End Station**) within which you want Survey Pro to guide you automatically to the useful points (see screen example in the left column).
- **Offset**: Enable this option if you wish to stake out points at some horizontal distance from their real positions. Positive values will offset away from the centerline and negative values will offset toward the centerline.
- **Subgrade** (vertical offset): Enable this option if you wish to stake out your points at some vertical distance from their real positions. Then enter a positive distance for a vertical offset below real positions, or a negative distance for a vertical offset above real positions. For no subgrade, just clear this button.



- Tap **Stake >**. The screen then displays the guidance information you usually get from Survey Pro for single point stakeout and for the selected type of instrument (optical or GNSS). See screenshot example in the left column or refer to *Survey Pro User Guide* for more details.
- Head for the target following the guidance instructions given by Survey Pro.
- When the position is located, tap **Accept**. You may store the position of the point if you wish by tapping **Store**. Tap **Stake Next** to configure for the next point by advancing stations or selecting a new segment.
- In Auto Advancement mode, tap **Stake Next** to proceed directly with the next point.
- Resume the previous four steps until you are finished with staking out the road.

See the Survey Pro User Guide for more detailed information on how the basic staking screens work as they are almost identical to the operation of the road staking screens.

Show Station Function

While you are using the Road Stakeout function, there will be times when you perform grade checking, "blue topping", and other types of quality control checking.

The **Show Station** function allows you to spot some locations of interest, or to qualify some existing locations, in reference to your road project. Through this function, Survey Pro will describe the location your rod/rover is currently occupying compared to the road alignment and the corresponding cross section.

- Stand on a location with your rod/rover.
- From the main menu, select **Roads > Show Station**.
- Select the name of the road you are working on.
- Tap **Next**. Survey Pro displays a three-tab screen fully describing the location with respect to the road project (see screens below for GNSS and optical).

In GNSS, Survey Pro will continuously update the content of the three tabs regardless of whether you are walking or keeping static. The position may be computed in ROVING or OCCUPYING mode.

In Robotic mode, Survey Pro will continuously update the contents of the three tabs if "Tracking" or similar continuous EDM modes are in use. Otherwise, the **Shot** button must be tapped in order to update the data.

When using a mechanical optical station, tap the **Shot** button every time you move the rod to a new location if you want Survey Pro to provide measurements for this location.

GNSS

Road Station and Offset

Fixed 1.4 s 0,011 13

Rover: 2.000 to Bottom of antenna mount

Alignment | Cross-Section | Shot Data

Station: 1+83.051 Left of Arc

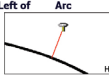
Template: T1

Segment: ---

Elev: 85.852 m

Offset Dist: 26.409 m

ROVING < Back Accept



Road Station and Offset

Fixed 1.4 s 0,011 13

Rover: 2.000 to Bottom of antenna mount

Alignment | Cross-Section | Shot Data

Station: 1+83.041 Segment: ---

Template: T1


Cut\Fill: ---

Fill to CL: 4.296 m

Fill to Edge: 4.046 m

%Slp. to CL: 16.29

ROVING < Back Accept



Road Station and Offset

Fixed 1.4 s 0,011 13

Rover: 2.000 to Bottom of antenna mount

Alignment | Cross-Section | Shot Data

Northing: 6,243,045.026

Easting: 1,359,190.277

Elevation: 86.370

ROVING < Back Accept

Optical

Road Station and Offset

HR 2.000 m EDM: Inst. EDM

Alignment | Cross-Section | Shot Data

Station: 1+90.674 Left of Arc

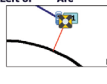
Template: T1

Segment: ---

Elev: 89.000 m

Offset Dist: -65.700 m

Shot < Back Store...



Road Station and Offset

HR 2.000 m EDM: Inst. EDM

Alignment | Cross-Section | Shot Data

Station: 1+90.674 Segment: ---

Template: T1

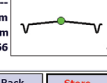
Cut\Fill: ---

Fill to CL: 1.746 m

Fill to Edge: 1.496 m

%Slp. to CL: 2.66

Shot < Back Store...



Road Station and Offset

HR 2.000 m EDM: Inst. EDM

Alignment | Cross-Section | Shot Data

Angle Right: 178°00'00"

Zenith: 90°00'00"

Slope Dist.: 15.000

N: 6,243,077.959

E: 1,359,213.243

EI: 89.000

Shot < Back Store...

- Tap **Accept** (GNSS) or **Store** (Optical) to save the position of that location.




Generating Reports

- From the main menu, select **Roads > Manage Roads**.
- From the list of road names displayed, select the one for which you want to generate a report
- Tap **Edit**, then tap **Report**. Let Survey Pro generate the report. This report provides the coordinates of each of the useful points in the road cross section for every station you defined along the road centerline. Survey Pro then displays the resulting report.

Road Cross-sections Report					
Alignment Name:	R5				
Alignment Code:	Neters				
Units:	Meters				
Road Cross-section Points					
Offset	North	East	Elevation	Station	Notes
Station = 0+00.000					
-10.000	624094.574	359280.698	51.960	S1	
0.000	624095.380	359280.000	52.000	CL	
10.000	624095.824	359195.262	51.960	S1	
Station = 0+10.000					
-10.000	624094.278	359210.673	51.960	S1	
0.000	624094.282	359189.976	52.000	CL	
10.000	624094.327	359189.278	51.960	S1	
Station = 0+20.000					
-10.000	624093.281	359120.689	51.960	S1	
0.000	624093.485	359121.951	52.000	CL	

Hold down a stylus or your finger on the screen to scroll the content of the report up or down.

NOTE: The **Station Interval** value set in the Road Properties will dictate how detailed the report will be. If a low number is set for the interval, and the road is very long, then the report will take time to generate. Consider increasing the interval for longer roads. The report will always generate data for when the alignment or templates change so important details will not be lost.

- Tap  then . Survey Pro asks you if you want to save the report.
- Tap **Yes** if this is what you want to do.
- Select a folder and key in a name for the report file (an html file with default name "<road_name>.htm").
- Tap .
- After Survey Pro reports that the file has been saved, tap **OK**.

The file can be downloaded to a computer and viewed in a local web browser.

Road Cross-sections Report

Alignment Name: R4
 Alignment Code:
 Units: Meters

Road Cross-section Points

	Offset	North	East	Elevation	String name
Station = 0+00.000					
	-12.000	6244116.371	1359278.837	19.760	S1
	0.000	6244116.000	1359278.000	20.000	CL
	12.000	6244093.029	1359277.163	19.760	S1
Station = 0+10.000					
	-14.333	6244118.601	1359288.975	19.773	
	-13.667	6244117.936	1359288.929	19.760	
	-13.000	6244117.271	1359288.882	19.227	
	-12.667	6244116.938	1359288.859	19.227	
	-12.000	6244116.273	1359288.813	19.760	S1
	0.000	6244104.302	1359287.976	20.000	CL
	12.000	6244092.332	1359287.139	19.760	S1
	12.667	6244091.667	1359287.092	19.227	
	13.000	6244091.334	1359287.069	19.227	
	13.667	6244090.669	1359287.022	19.760	
	14.333	6244090.004	1359286.976	19.773	
Station = 0+15.000					

Alignments

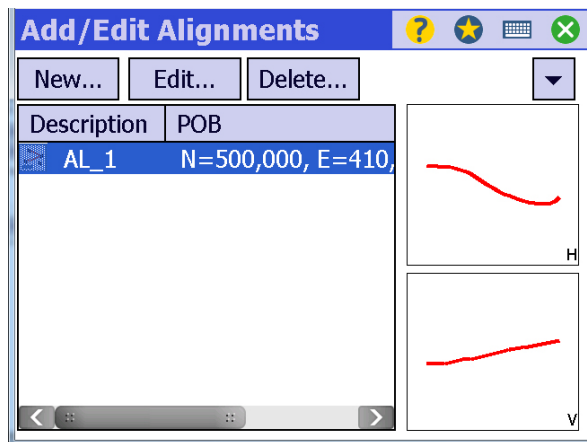
Introduction Much like polylines, alignments represent 3-D paths made up of different portions connected together (i.e. one after the other). These portions – called *segments* in Survey Pro – may be straight lines or curves.

As opposed to polylines, alignments do not rely on existing points, but just on the shape you define for each of their segments. You will, however, need to define a start point for an alignment. This point is called POB (for “Point Of Beginning”). The point where a new segment connects to the previous one is called a *node*.

Also as opposed to polylines, the three-dimensional feature of alignments is not implicit, but is obtained by defining separately:

- An alignment in the horizontal plane. This alignment is called “horizontal alignment” and is abbreviated “HAL”.
- An alignment in the vertical plane. This alignment is called “vertical alignment” and is abbreviated “VAL”.

Survey Pro will then combine the pair of horizontal and vertical alignments to create a single alignment with unique horizontal and vertical characteristics. The alignment will be anchored geographically through the POB (the alignment’s start point). If the POB is changed, the road will retain its geometry with no changes. Only the start location will change.



Definitions Horizontal Alignment

NOTE: There is always an option to make a segment tangent to the previous segment. This means that the outgoing azimuth from the previous segment will be used for the starting azimuth for the new segment. This is typically the method used. If not, then if adjustments are made early in an alignment, later segments will no longer be tangent and there will be irregular deviations.

The segments of a horizontal alignment may be:

- *Line* segments. A line is defined by a length and an azimuth at the segment's start point. When the line is not the first segment in the alignment, you may prefer to make it tangent to the previous segment rather than enter an azimuth for the line. Survey Pro allows you to make that choice.
- *Arc* segments. An arc may be defined in many different ways by combining two parameters, one from each of the following two lists below:

List 1:

1. **Radius:** The distance from the radius point to the curve.
2. **Delta:** The internal angle from center to tangent points (i.e. to the start point and end point of the arc).
3. **Degree Arc:** The internal angle equivalent to a 100-foot arc length.
4. **Degree Chord:** The internal angle equivalent to a 100-foot chord length.

List 2:

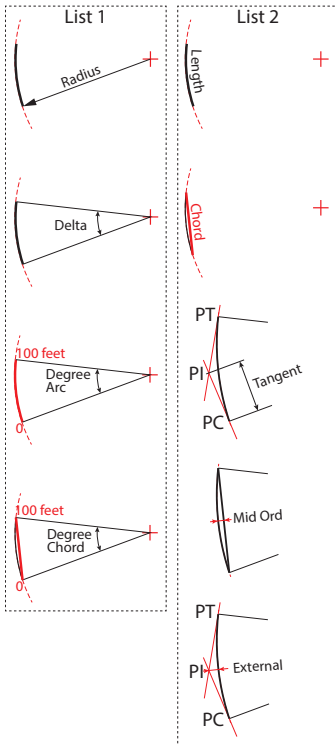
1. **Length:** The arc length.
2. **Chord:** The chord length.
3. **Tangent:** The distance from the point of curvature (PC) or point of tangent (PT) to the point of inflection (PI).

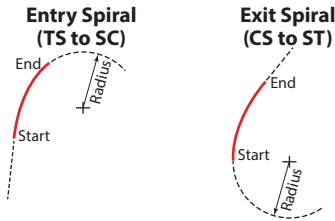
NOTE: The point of curvature (PC) is the first point of the arc segment. The point of tangent (PT) is the last point of the arc segment. The point of inflection (PI) is the intersection point of the tangent lines from PC and PI.

4. **Mid Ord:** The distance between the curve and the chord at the center of the curve's length.
5. **External:** The distance between the point of inflection (PI) and the arc.

Additionally, you should choose a turn for the arc (oriented to the left or right) and an azimuth at the segment's start point. When the arc is not the first segment in the alignment, you may prefer to make it tangent to the previous segment rather than enter an azimuth for the arc. Survey Pro allows you to make that choice.

NOTE: Survey Pro will show a preview of the resulting arc after you have chosen values for the two selected parameters. If these values are not compatible with each other, Survey Pro will show a blank preview meaning you need to correct the submitted values to get a valid arc.





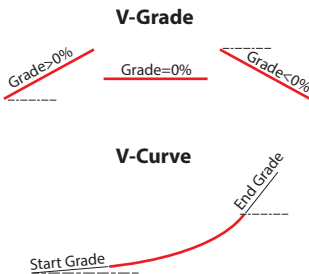
- **Spiral segments.** Two types of spiral segments may be defined:
 - **Entry spiral**, describing a curve providing a transition from a straight line to an arc. In Survey Pro, entry spirals are designated as "TS to SC", meaning "Tangent to Spiral" to "Spiral to Curve".
 - **Exit spiral**, describing a curve providing a transition from an arc to a straight line. In Survey Pro, exit spirals are designated as "CS to ST", meaning "Curve to Spiral" to "Spiral to Tangent".

A spiral is therefore defined by a radius, a length, a turn (to the left or right), a type (entry or exit spiral) and an azimuth at the spiral's start point.

When the spiral is not the first segment in the alignment, you may prefer to make it tangent to the previous segment rather than enter an azimuth for the spiral. Survey Pro allows you to make that choice.

Vertical Alignment

The segments of a vertical alignment may be:



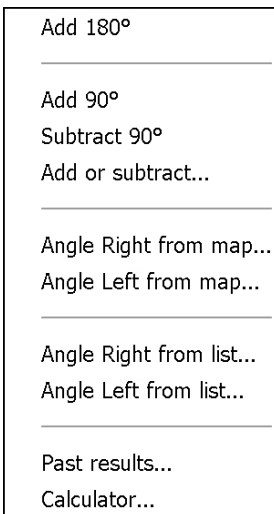
- **Line segments (V. Grade).** A line is defined by a length and a grade (in percent). If the line is not the first segment in the alignment, you may easily read the grade value of the previous segment for a smooth transition between the two segments.
- **Curved segments (V. Curve).** A parabolic curve is defined by a length, a start grade and an end grade. If the curve is not the first segment in the alignment, you may easily read the grade value of the previous segment for a smooth transition between the two segments.

Entering Angles and Distances

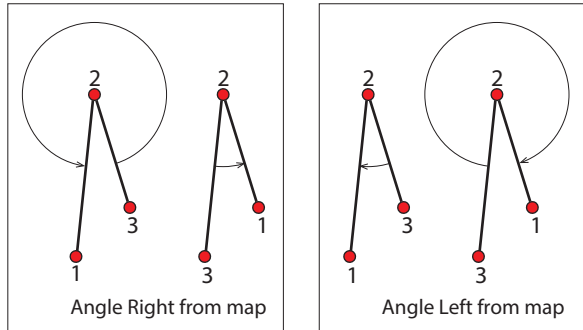
When defining the segments of an alignment, you can directly enter the requested values of angle and distance, if you know them. If you don't, Survey Pro may assist you in determining these values. This is explained below.

When an angle is requested, you may open the power menu (a scroll-down list) next to the concerned field, and select one of the following options (If the field is initially blank, Survey Pro will assume it contains the value "0"):

- **Add 180°, Add 90°:** Adds respectively 180° or 90° to the currently keyed-in value and then replaces this value with the result of the addition.
- **Subtract 90°:** Subtracts 90° to the currently keyed-in value and then replaces this value with the result of the subtraction.
- **Add or subtract:** Adds the angle value you specify to the currently keyed-in value and then replaces this value with the result of the calculation. If the specified value is positive, an addition is performed and if it's negative, a subtraction is performed.

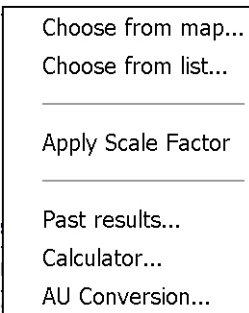


- **Angle Right from map, Angle Left from map:** Asks you to select three points stored in the job. Survey Pro will calculate and enter the angle value resulting from the selected points, from the chosen option (right or left), and from the order in which the points were selected on the map (see diagram below).



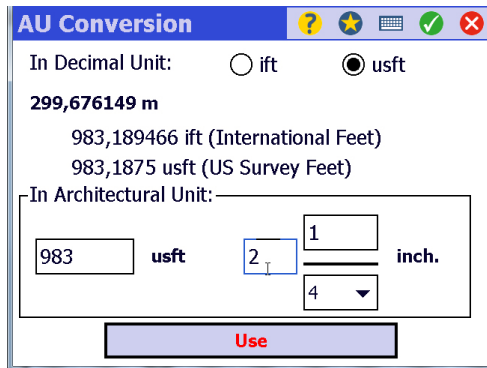
- **Angle Right from list, Angle Left from list:** Same as the above two options, except that you select the points one after the other from the job's list of points, and not from the map.
- **Past results:** Use this option to enter an angle value that was computed previously within the software (i.e. using the calculator, the COGO function, etc.). Select one from the list.
- **Calculator:** Gives access to an on-screen calculator allowing you to make all kinds of calculation you need to do at this stage to determine the value of angle you need. For more information, refer to *page 37*.

When a distance is requested, you may open a scroll-down list next to the concerned field, and select one of the following options:



- **Choose from map:** Asks you to select two points on the map. The points are necessarily part of the job. Survey Pro will compute the distance between these two points and will enter the resulting value in the field.
- **Choose from list:** Same as the above option except that you select the points one after the other from the job's list of points, and not from the map.
- **Apply scale factor:** Multiplies the job's scale factor to the keyed-in distance value and replaces this value with the result of the multiplication.
- **Past results:** Use this option to enter a distance value that was computed previously within the software (i.e. using the calculator, the COGO function, etc.). Select one from the list.
- **Calculator:** Gives access to an on-screen calculator allowing you to make all kinds of calculation you need to do at this stage to determine the value of distance you need. For more information, refer to *page 37*.

- **AU Conversion** (AU= Architectural Unit): Allows you to convert feet and fractional inches (e.g 2' 1 1/4") to decimal units (see screen below).



The value displayed in bold characters is expressed in the currently set default unit in Survey Pro.

NOTE: The result of AU conversion is typically one of the results available from **Past results**.

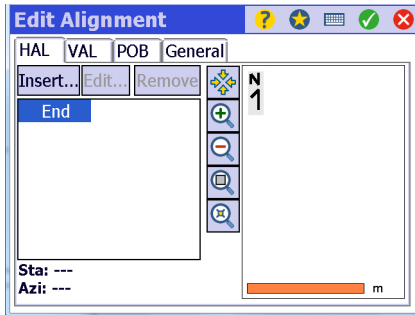
When opening the window, first select the unit in which the distance you want to convert is currently expressed (**ift** or **usft**), then enter this distance in the lower part of the window (in feet and inches).


The result of the conversion appears instantly in the upper part of the screen (in meters).

Tap **Use** if you want the converted distance to be used in the distance field defining the segment.

Creating an Alignment

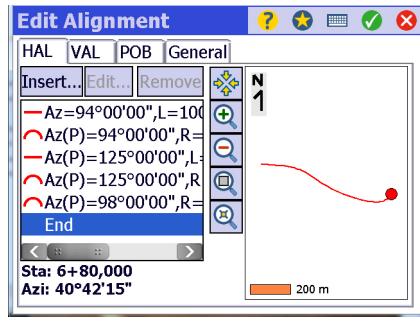
- From the main menu, select **Roads** then **Manage Roads**. Tap successively **Add** and **Create New**. Then from the scroll-down list, select the **Alignment Editor** option to access the screen below. Survey Pro prompts you to create a new horizontal alignment (**HAL** tab displayed). (Outside of the Roads module, you can also access the same screen to create an alignment by selecting **Job > Edit Alignments** from the main menu. Then tap **New**.)




- Tap **Insert**. Survey Pro suggests that you create the first segment of the horizontal alignment.
- Tap on the tab corresponding to the first segment you want to insert. This may be a line (straight line), an arc or a spiral.
- Define the distances and/or angles for this segment (see all the details on *page 22* and *page 23*).
- Tap  to create the segment. The screen then shows the shape of the segment. The end of the segment is represented by a big red spot. You may use the zoom buttons to change the map scale.
- Resume the previous four steps to create the second segment, and then the next ones. Each time, the map is updated to show all the segments of the alignment. The big red spot always indicates the end of the last segment entered.

Starting from the second segment, you may prefer to activate the **Make this segment tangent to previous** option rather than enter an azimuth or bearing

angle for the beginning of the segment. This is to make sure a smooth transition is achieved between that segment and the previous one.



- After you are done with the horizontal alignment, tap on the **VAL** tab to create the vertical alignment.
- Follow the same instructions as above to create the vertical alignment. The **Get Previous Grade** option allows you to read the grade value of the previous segment so you can define a grade value that makes sense for the segment you are defining.
- When you are done with the vertical alignment, tap on the **POB** tab to define the point of beginning. This may be an existing point or any location for which you need to provide the three coordinates. Enter a value for the start station according to the type of format selected in **Job > Settings > Format**.
- Tap on the **General** tab to enter a name for the alignment and possibly select a layer where to store it.
- Tap  to return to the list of alignments. The newly created alignment is now visible in the list.

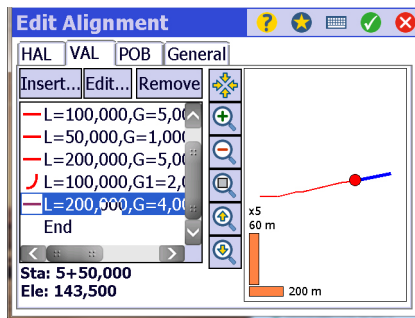
Editing an Alignment

- From the main menu, select **Job > Edit Alignments**. The screen now lists all the existing alignments.
- Select the alignment you want to modify and then tap **Edit**.
For both the horizontal and vertical alignments, you can select a segment and then:
 - Modify the definition of the segment by tapping **Edit**.
 - Remove the segment by tapping **Remove**.
 - Insert a new segment BEFORE this segment by tapping **Insert**. To add a segment at the end of the alignment, tap **END** in the list, then **Insert**, then define the new segment.

NOTE 1: Whatever the change you do, all remaining segments with the **Make this segment tangent to previous** option active will be impacted by the change.

NOTE 2: When selecting a segment in the alignment, the map shows the selected segment in blue and the red spot is moved to the beginning of that segment.

NOTE 3: If an alignment has already been used in a road definition, changes made in the alignment editor will not be reflected in the road definition. To update the road, simply edit the road definition and select the updated alignment.

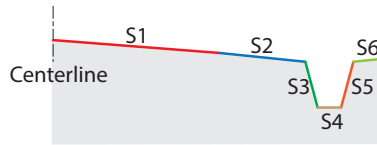


Deleting an Alignment

- From the main menu, select **Job > Edit Alignments**. The screen now lists all the existing alignments.
- Select the alignment you want to delete and then tap **Delete**.

Templates

Definition A template describes the half cross section (or half profile) of a road at a given station. It is made up of several segments (Sx):



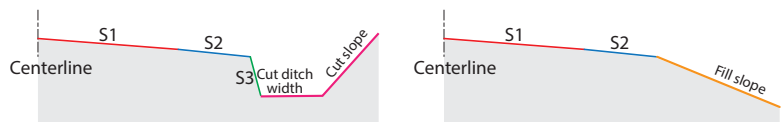
Survey Pro always asks you to define a template to the right of –and starting from– the centerline. Be aware you will be able to use a template to describe the left-hand side of the road as well. This is explained on [page 30](#).

Each segment of a template is defined by:

- A name (roadbed, curb face, top of curb, ditch, etc.)
- A horizontal distance
- A slope, which may be expressed either as a rising or falling vertical offset, in meters, or a grade (a positive or negative rise/run).

In addition, you may define a *side slope* allowing smooth insertion of the roadway into the terrain. The side slope is defined by one of the following sets of parameters:

- **Cut slope** and **Cut ditch width**: Used if the surface of the terrain is at a higher elevation compared to the road project. **Cut slope** then represents the slope (positive) from the defined hinge point to the daylight or catch point. It may be expressed either as a percentage or a ratio. This slope is typically defined using various parameters including material type and right of way width. **Cut ditch width** represents the length of an additional, horizontal segment that you may insert between the edge of the road and the beginning of the cut slope (see below left). **Cut ditch width** may be ignored or zeroed.
- **Fill slope**: Used if the surface of the terrain is at a lower elevation compared to the road project. **Fill slope** then represents the slope (negative) of the side slope (see below right). Likewise, this parameter may be expressed as a percentage or a ratio.



NOTE 1: The end of the last segment in a template is often the *hinge point* (see also [page 8](#)), but not always. The hinge point can be any segment on the template. Survey Pro uses the last segment as the only option when editing

the template. This includes the cut ditch segment for cut side slopes. However, within the **Slope Staking** function, you can change the hinge point node.

NOTE 2: For both slopes, key in "1.55" for a slope of 1.55% (which represents a rise of 1.55 m rise for every 100 m horizontal). This is known as "rise over run" or a grade.

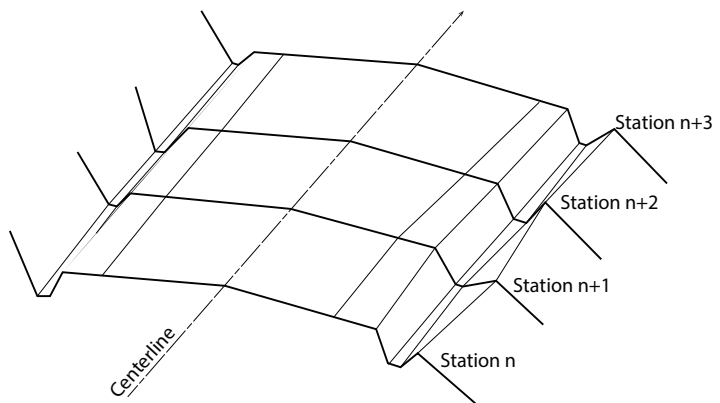
GOOD TO KNOW:

1. A template must have at least one segment defined to be valid.
2. You may define a segment with a zero distance provided it's not the first one in the template.
3. Both a cut slope and a fill slope may be defined in a template to make sure the template deals with all cases of terrain.

Using Templates

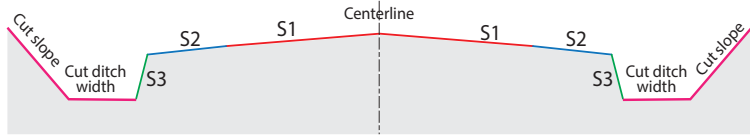
Because the cross section of a road is not usually the same everywhere, you will usually need to create several templates for a road project.

After you have defined all your templates, you will assign these templates to particular locations (stations) along the road centerline.



In addition, for each station you define, you will choose a template for the half cross section located to the right of the centerline (**Right template**), and one for the other half cross section, located to the left (**Left template**).

As already mentioned, the same template may be applied to both the right and left sides of a road, in which case the road's entire cross section will be symmetrical with respect to a vertical line passing through the centerline:



You may need to create stations for which there is no particular change to the cross section. In this case, you will choose to "interpolate" the cross section at these stations. That means Survey Pro will look at the two surrounding templates (the last one used at a previous station and the next one used at a further station) to calculate the road cross section at these stations through linear interpolation. In this case, choose the **<Interpolate>** option when building the road stations.

You may also choose to not assign a template (right and left) to a station because that station is on the centerline, but before the road starts, or after the road ends, for example. In that case you will choose the **<None>** option.

In order to force the road surface to remain constant until a specific station where a transition to a new template needs to start, simply place the same template twice. Once at the start station for that section of road, and then again when that section ends. If you add templates on the opposite side of the road in between these stations, then either **<Interpolate>** or the original template can be used.

Polylines

Introduction Polylines represent 3-D paths made up of different portions connected together (i.e. one after the other). These portions –called *segments* in Survey Pro – may be straight lines or curves.

Polylines are built on existing points. The line segments between points will contain grades if the two points that bound the segment are 3-D points with elevations. If the points are 2-D, then the line segment will have no elevation or grade.

Creating a Polyline All the points used in a polyline should have first been created in, or imported into the job.

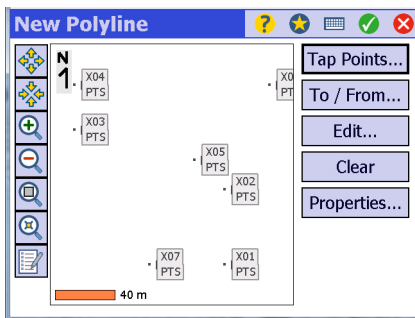
Two methods exist to create a polyline:

- 1st Method (visual): You use the map view of the job to tap successively on each of the points making up the polyline. This method is very simple but only allows you to create straight segments. Transforming a straight segment into an arc (curved segment) can only be done by editing the polyline after saving it.
- 2nd Method (algebraic): You specify the name of each of the points making up the polyline. This method is faster and more powerful: you can create a polyline instantly by specifying the range of constitutive points, and you can create curved segments directly.

After all the required points have been added to the job, do the following:

- From the main menu, select **Roads** then **Manage Roads**. Tap successively **Add** and **Create New**. Then from the scroll-down list, select the **Polyline Editor** option to access the screen below. Survey Pro shows a map of all the points stored in the job.

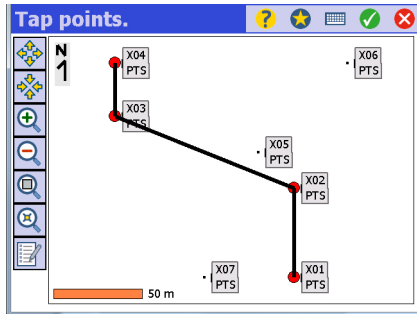
(Outside of the Roads module, you can also access the same screen to create a polyline by selecting **Job > Edit Polylines**. Then tap **New** and **Edit**.)






- Use the first or second method to create a polyline (see below).

1st Method

- Tap **Tap Points**. Survey Pro uses the whole screen to display a larger view of the map.
- Tap on the point where the polyline starts. The point then appears as a big red spot.
- Tap on the second point of the polyline. The point also appears as a large red spot, plus a black segment is drawn from the first to the second point.
- Tap successively on all the points until you reach the end of the polyline.

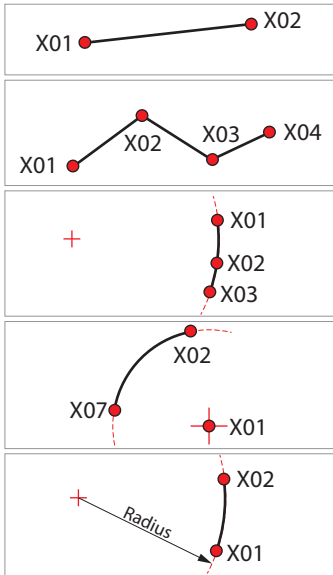


NOTE: To transform a straight segment into an arc, see *Editing a Polyline on page 35*.

- Tap  to end the polyline.
- Tap  again to name the polyline (fill in the **Description** field).
- Tap  again to save the polyline. This takes you back to the first screen where you can now see the newly created polyline being highlighted in the list of existing polylines. The shape of this polyline in the horizontal plane is shown in the top-right chart, and its shape in the vertical plane in the bottom-right chart.

2nd Method

- Tap **To / From**. Survey Pro displays a text box in which you can write the algebraic expression of the polyline. The syntax you should use to build this expression is briefly described underneath the text box and detailed in the examples below:



Example of a single straight segment: X01,X02

Survey Pro will create a straight segment between point X01 and point X02 (comma used as separator).

Example of a series of straight segments: X01-X04

Survey Pro will create a series of straight segments starting from point X01 up to point X04, passing through point X02 and point X03 (hyphen used as separator).

Example of a single curve passing through three points: X01(X02)X03

Survey Pro will create an arc of a circle starting at point X01, ending at point X03 and passing through point X02 (brackets used to indicate the point somewhere on the curve).

Example of an arc defined by the center of the circle and its two ends: X07(X01,R)X02

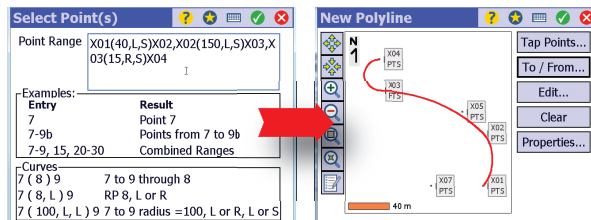
Survey Pro will create an arc starting at point X07 and ending at point X02. The center of the circle from which the arc originates is point X01. Seen from X01, the arc will start from X07, going to the right (R) towards point X02.

Example of an arc of known radius and connecting two known points: X01(40,L,S)X02

Survey Pro will create an arc starting at point X01 and ending at point X02. The center of the circle from which the arc originates is located to the left (L) of the oriented segment X01 to X02. The circle radius is 40 m (40) and the chosen portion of arc is the shorter one (S).

Example of a series of curves: X01(40,L,S)X02,X02(150,L,S)X03,X03(15,R,S)X04

In the expression, adjacent segments are separated by a comma. See the resulting polyline on the screenshot below right.



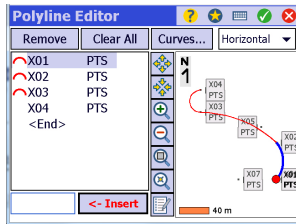
- Type in the expression describing the polyline you want to create.
- Tap to name the polyline (default: "Defined by: <expression>"). You may enter another name of your choice.
- Tap again to save the polyline. This takes you back to the first screen where you can now see the newly created polyline being highlighted in the list of existing polylines. The shape of this polyline in the horizontal plane is

shown in the top-right chart, and its shape in the vertical plane in the bottom-right chart.

Editing a Polyline

Changes can be made to polylines after they have been saved in Survey Pro. To edit a polyline, do the following:

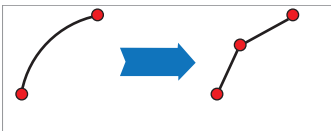
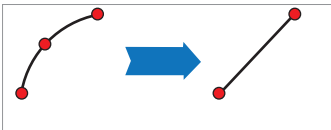
- From the main menu, select **Job > Edit Polyline**
- Select the polyline you want to edit from the list of existing polylines.
- Tap **Edit**. Survey Pro shows the shape of the selected polyline in the horizontal plane.
- Tap on the **Edit** button. Survey Pro shows all the details of the polyline in the horizontal plane:

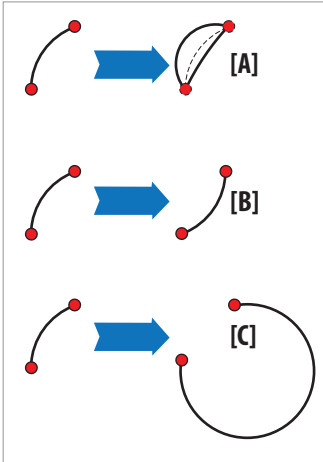


NOTE: You may want to switch to the vertical plane to make your changes. In that case, just select **Vertical** in the drop-down list on the right.

The following changes can be made to a polyline:

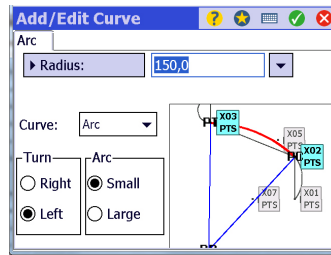
- **Removing a point:**
 - In the list of points of the polyline, select the point you wish to remove.
 - Tap **Remove**. The shape of the polyline is instantly updated to reflect the change. Note that the two segments adjacent to the deleted point are replaced by one single straight segment connecting the preceding point to the next point.
- **Inserting a new point** between any two existing points (this will cause the curved or straight segment between these two points to be broken into two straight segments):
 - In the list of points of the polyline, select the point that will follow the point you are about to insert.
 - Use the text box located in the lower-left corner to enter the name of the point you want to insert (this point must be stored in the job).
 - Tap **<- Insert**. The shape of the polyline is instantly updated to reflect the change.





- **Changing the radius and/or shape of a curved segment.**

- In the list of points of the polyline, select the start point of the segment you wish to modify. The map then highlights the segment corresponding to your selection.
- Tap **Curves**. From there, you can change the value of radius (**[A]**), change the orientation of the arc (to the right or to the left) (**[B]**) or change the portion of arc used, i.e. the longer one or the shorter one (**[C]**). See also screenshot below.



- **Changing a curved segment into a straight segment.**

- In the list of points of the polyline, select the start point of the segment you wish to modify. The map then highlights the segment corresponding to your selection.
- Tap **Curves**. Select **None** from the **Curve** drop-down list.

- **Changing a straight segment into a curved segment.**

- In the list of points of the polyline, select the start point of the segment you wish to modify. The map then highlights the segment corresponding to your selection.
- Tap **Curves**. Select **Arc** from the **Curve** drop-down list, then set the **Radius** value and the desired orientation and portion of arc.

- **Removing all the points:** Use the **Clear** button.

- **Renaming the polyline** and/or assigning the polyline to a different layer: Use the **Properties** button.

- After you've made your change, tap to make that change effective and then tap twice again on this button to return to the list of polylines.

REMINDER: Adding or removing a point affects the polyline both in the horizontal and vertical plane, regardless of the plane in which you make the change.

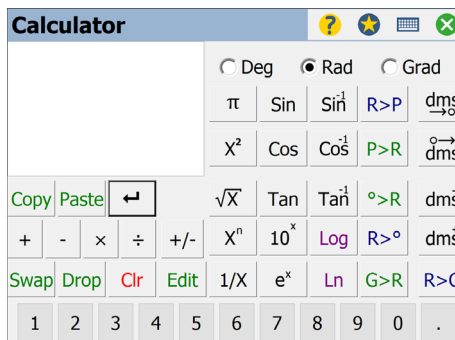



Appendix

Abbreviations Used

Abbreviation	Meaning
CL	Centerline
CP	Catch Point
Des. Slope	Design cut or fill slope
DS	Design Slope
HD	Horizontal Distance
Hi	Vertical Curve High Point
HP	Hinge Point
Lo	Vertical Curve Low Point
Obs. slope	Observed cut or fill slope
PT	Point of Tangent (Curve to Tangent)
RE	Road End
RS	Road Start
SC	Transition Curve
STEQ	Station Equation
T	Template assignment (any station with a template)
VCE	Vertical Curve End
VCS	Vertical Curve Start
VPI	Vertical Point of Intersection
XS	Regular Sections

Calculator The Calculator screen consists of a stack that can contain any number of values and buttons that perform various operations.



When a value is being entered from the keypad, it is displayed in a special area called the active area. This value is then placed in Level 1 of the stack after tapping .

Tapping a button on the display performs the corresponding operation on either the last value in the display, or the last two values, depending on the operation. Each button is explained below where the value in Level 1 is x and the value in Level 2 is y .

- $+$: Adds x and y .
- \times : Multiplies x and y .
- $-$: Subtracts y from x .
- \div : Divides y by x .
- \leftarrow : Moves the active value to Level 1 of the stack, or duplicates Level 1 if there is no active value.
- $+/-$: Changes the sign of x .
-
- **Swap** : Swaps positions of x and y in the stack.
- **Drop** : Drops (removes) x from the stack.
- **Clr** : Clears the stack.
- **Edit** : Moves the value in Level 1 to the active area where it can be edited.
-
- π : Enters 3.141592654 to the stack.
- x^2 : Squares x .
- \sqrt{x} : Square root of x .
- x^n : Raises x to the power of n .
- $1/x$: Inverse of x .
- **Sin** : Sine of x .
- **Cos** : Cosine of x .
- **Tan** : Tangent of x .
- 10^x : Raises 10 to the power of x .
- e^x : Raises e (2.718281828) to the power of x .
- \sin^{-1} : Arc sine of x .

- Cos^{-1} : Arc cosine of x.
- Tan^{-1} : Arc tangent of x.
- Log : Common logarithm (base 10) of x.
- Ln : Natural logarithm (base e) of x.
- $\text{R}>\text{P}$: Converts the rectangular coordinates (y, x) to polar coordinates.
- $\text{P}>\text{R}$: Converts the polar coordinates (y, x) to rectangular coordinates.
- $^{\circ}>\text{R}$: Converts x, in decimal degrees to radians.
- $\text{R}>^{\circ}$: Converts x, in radians to decimal degrees.
- $\text{G}>\text{R}$: Converts x, in Grads to radians.
- $\frac{\text{dms}}{\circ}$: Converts x, in degrees.minutes-seconds to decimal degrees.
- $\frac{\circ}{\text{dms}}$: Converts x in decimal degrees to degrees.minutes-seconds.
- dms : Subtracts x in degrees.minutes-seconds from y in degrees.minutes-seconds.
- dms^{\dagger} : Adds x in degrees.minutes-seconds and y in degrees.minutes-seconds.
- $\text{R}>\text{G}$: Converts x, in radians to Grads.

Road Definition Rules

Definition rules are important to follow because they tell how each component, by reacting to the other components, affects the shape of the resulting road.

- A road does not require a template at the start station of an alignment. However, once a template is added on a side, then thereafter, both sides of the road must contain a template definition. That template can be a template created by the user, **<Interpolate>**, or **<None>**. Any of the three types is acceptable, but there MUST be one for each side of the road.

Example: The alignment starts at 0+00. You put your first template at 1+00. You must define both a left and right template at station 1+00. The program will not let you save the station until you do so.

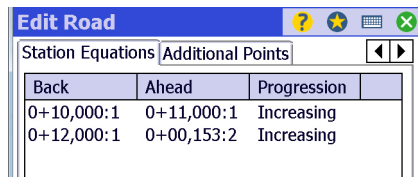
After that, you must have templates for the remainder of the alignment. If the road ends prior to the end of the alignment, then simply use **<None>** on both sides of the road at the station that defines the end of the road. Or, do nothing and let the last template run out for the length of the alignment. Either way is fine for the program. However, to avoid confusion, it's advisable to choose **<None>**.

- Understanding how to use **<Interpolate>**: If you need to change the template on the left side, but don't need to change the template on the right, then you can either reinsert the original right side template to keep any interpolation from happening, or you can use **<Interpolate>**. This completely depends on what you desire to happen.
For example, your road is going from two lanes down to one on the right side. You want the lanes to narrow linearly over the distance from the previous template to the new one. **<Interpolate>** is the perfect option for this. If, however, you want the road to remain constant, then just repeat the previous template on the right side. This is perfectly acceptable and guarantees nothing will wander.
- About alignments:
 - Both HAL and VAL alignments are required to define a road.
- About templates, for each side of the road:
 - All templates must have at least one segment
 - A template can contain one zero length segment making it effectively a blank segment, but the first segment must be greater than 0
 - All template stations must be within the station range for the alignment
 - Template segments must have a name. The template editor provides fields to enter the segment name.
- Only one template may occupy any station: As little as 0.001 units can be used to separate templates.

Station Equations and Additional Points

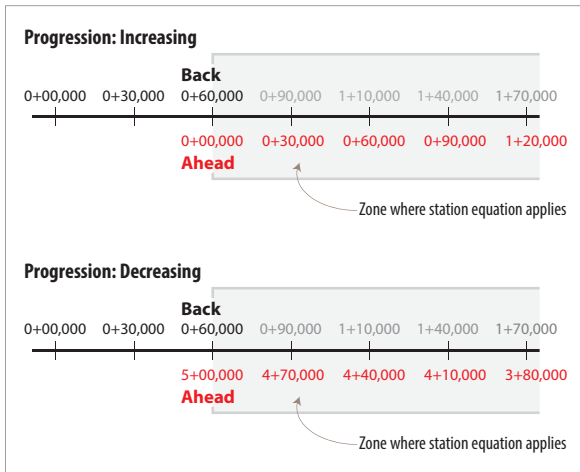
After importing an RXL road file, additional tabs may appear when editing the road if the initial RXL road definition included station equations and/or additional points. In this case and in addition to the usual **General**, **Stations** and **Templates** tabs, Survey Pro will also show the following tabs:

- **Station Equations:** Station equations define areas along the horizontal alignment where stations values should be, for practical reasons, other than those originally defined in the road project (more information on *page 42*). Below is an example of how Survey Pro shows station equations:

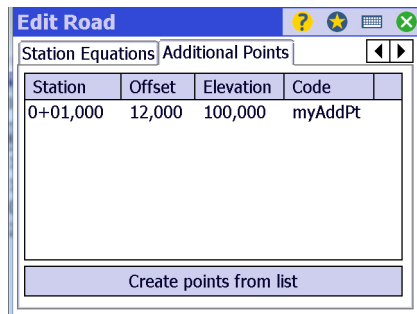


Each line provides the definition of a station equation:

- **Back** stand for the station value (as originally defined in the road definition) for which a new station value is requested. The station value is followed by “:n” where “n” is a number designating the area within which that particular station change should apply.
- **Ahead** is the new station value that you now wish to use at the specified **Back** station value.
- **Progression:** Indicates the direction of variation of the new station value, starting from the **Back** station value. New station values may increase (**Progression= Increasing**), or decrease (**Progression= Decreasing**) as you move forward along the road centerline (see diagram below).



- **Additional Points:** Individual locations along the road that are independent from the templates. These points are defined relative to the alignment. They represent such things as signage or man hole covers.



By pressing **Create points from list**, you can import these points into the job as real points. They can then be staked out or used for COGO or other survey operations.

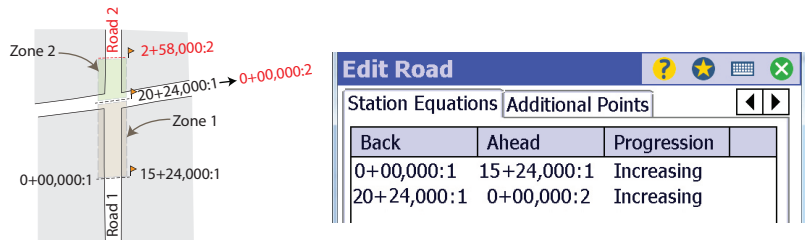
Understanding Station Equations

Station equations are used mostly when multiple roads cross, or where two roads merge. Each road has its own station values, and sometimes the work area crosses that boundary.

As earlier explained, a station equation – sometimes known as “equality” – defines a new station value at a specific station value. Typically, the new station values will increase from that point, but they may sometimes decrease. See examples in the two sub-sections below.

First Example: Two Roads Meet, One Ends and One Starts

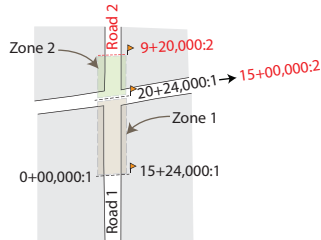
Your road project spans a portion of two formerly completed road projects connecting to each other at an intersection. The first of these older road projects ends at the intersection and the second one starts at this intersection. The former two road projects have their own station values, which do not necessarily match up. But while working on this road portion, you would like to read the old station values as you move forward. That’s where station equations come into play and make the use of these old station values possible.



At the beginning of zone 1, the station value is automatically changed from 0+0,000 to 15+24,000. As long as you work within zone 1, that change will apply and station values will increase as you move forward (toward the end of zone 1). When you reach the beginning of zone 2, a second change in station values is done. This new change takes effect, based on the station value resulting from the change requested by the first station equation (and not from the station value originally defined at this point in your road definition). So here when Survey Pro displays a station of 20+24,000, the second station equation comes into play and changes this value to 0+0.000. Station values will then increase as you move forward within zone 2.

Second Example: Two Roads Meet, Both End

This example is similar to the first one, except that here, because the second road also ends at the intersection, as does the first one, the station values resulting from the application of the second station equation will decrease as you move forward within zone 2.



Edit Road		
Station Equations		Additional Points
Back	Ahead	Progression
0+0,000:1	15+24,000:1	Increasing
20+24,000:1	15+00,000:2	Decreasing

Symbols*31, 39***A**Abbreviations *37*Additional points *41*Alignment *1, 2, 21*Alignment editor *4*Angles *23*Arcs *22*AU Conversion *25*Auto-advancement *14, 16*Automatic slope *10***B**Back (station equations) *41***C**Calculator *37*Catch point *8*Centerline *29, 30, 31*Cross sections *5*Cut ditch width *29*Cut hinge points *10*Cut slope *6, 29***D**Des. slope *11*Distances *23***E**Entry spirals *23*Exit spirals *23***F**Fill hinge points *10*Fill slope *6, 29*Force cut slope *8*Force fill slope *8***G**Get previous grade *27*Guidance data *10***H**H. Map *11*HAL *2, 21*Hinge point *8*Horizontal alignment *2, 22***I**Interpolate *6***L**LandXML *3*Leftt template *7, 30*Lines *22***M**Make this segment tangent to previous
*26, 28*Manual mode *14***N**Node *21*Non-clothoid spirals *3***O**Obs. slope *11*Occupy *13*Offset *16***P**Past results *24*POB *1, 2, 21, 27*Polyline *1, 2, 21*Polyline editor *4, 32*Progression *41***R**RD5 *1, 3*Reports *19*Right template *7, 30*Road scale *3*Road stakeout *1, 15*Rules *39*RXL *1, 3***S**Segments *21*Show Station *1, 17*Side slope *8*Slope Staking *1, 8*Solve *13*Spirals *23*Sta Interval *9*Stake *13*Start point *1*Station *5*Station equations *40*Station interval *4, 15*Subgrade *16*Superelevation *3***T**Template *1, 2, 5*Transitioning spirals *3***V**V. curve *23*V. grade *23*V. Map *9*VAL *2, 21*Vertical alignment *2, 23*Vertical circular arcs *3***W**Widening *3***X**XML *1, 3*