Aligning a System to Two Points at Ground

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Thesis

We have two points in the centerline of a roadway that runs generally East-West. We would like to build a local system based on the West point and use a 'generally accepted' truncated State Plane coordinate for this Western point. The Eastern point is an unknown distance from the Western point, we would like to build a Ground System with the Eastern Point at the Cardinal N90E direction. In this case, the Eastern point will be used for Bearing only. The computed Grid to Ground scale factor will be used for the new system.

Western Point:

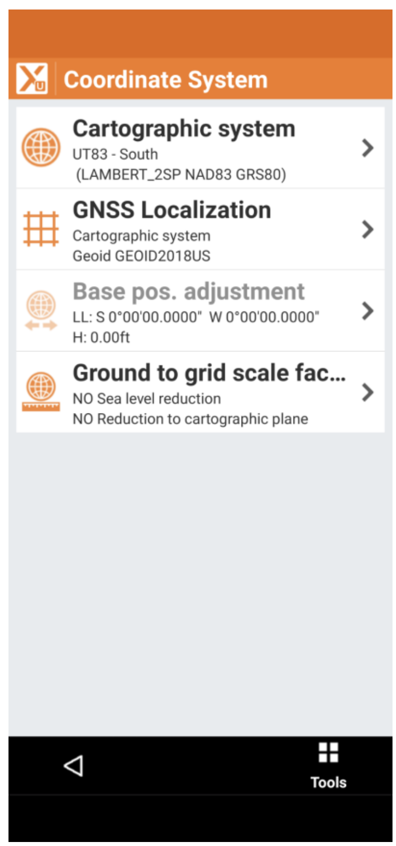
Lat Lon Ellipsoid:	**37 7 48.88043** N **113 30 35.44965** W NAD8
	2786.82 Ft Ellipsoid
UT South SPC (sFeet):	1,054,514.467 SFEET E 10,017,594.041 SFEET N UTS NAD83
Truncated Local Coord:	**54,514.467** SFEET E **17,594.041** SFEET N

Eastern Point:

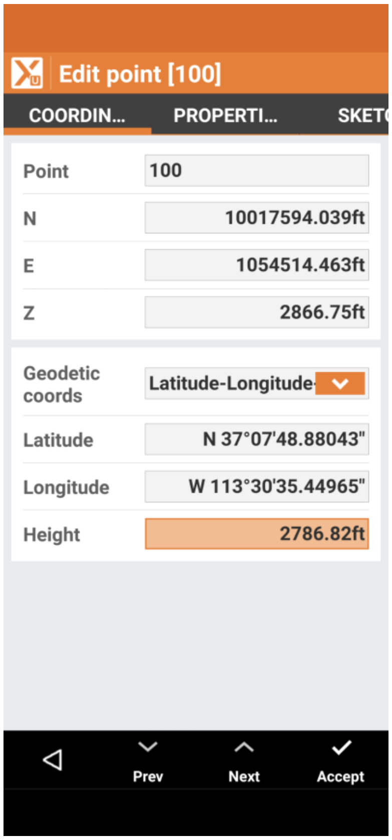
Lat Lon Ellipsoid:	**37 7 48.57847** N **113 30 0.41208** W NAD83
	2804.71 Ft Ellipsoid

Solution

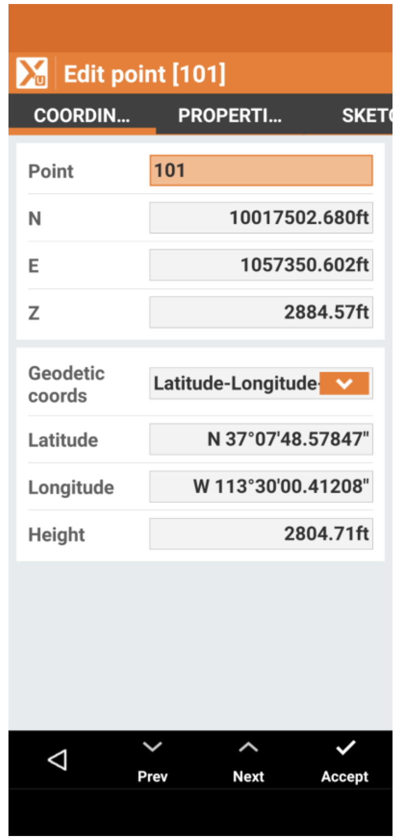
Make a new job, the initial coordinate system does not matter, so we will use the underlying nominal SPC zone 'Utah South NAD83' with GEOID18 loaded:



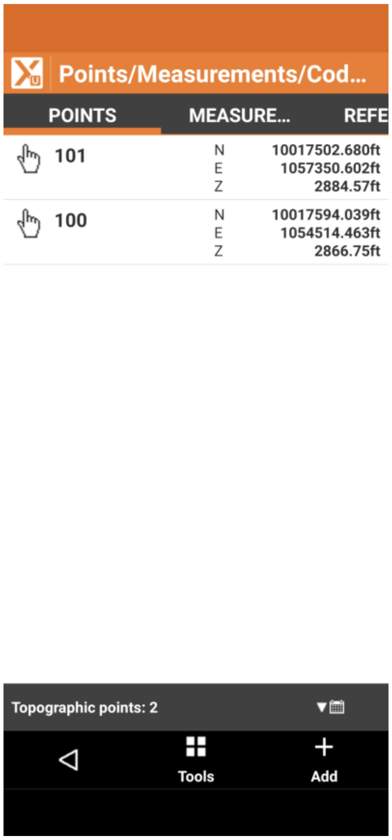
From the **Main Menu**, **JOB** (tab) click on **Points/Measurements/Codes**, then click on **+Add**, then enter Point 100 using Lat/Lon/EllipH:



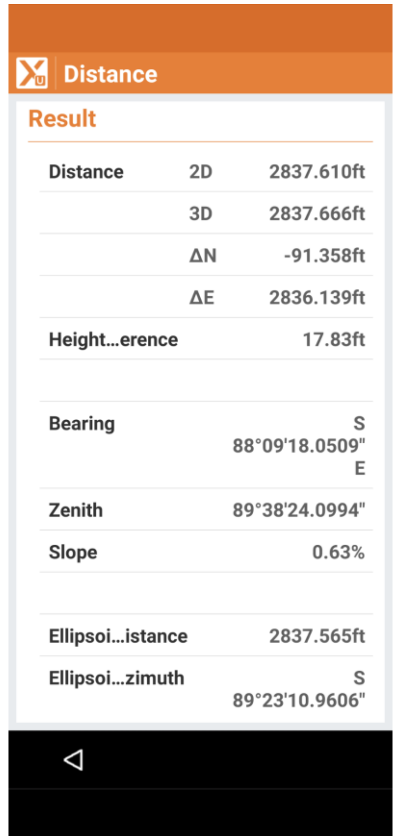
Click **Accept**, then add the Eastern Point using Lat/Lon/EllipH as Point 101:



We now have two points defined in our point list:



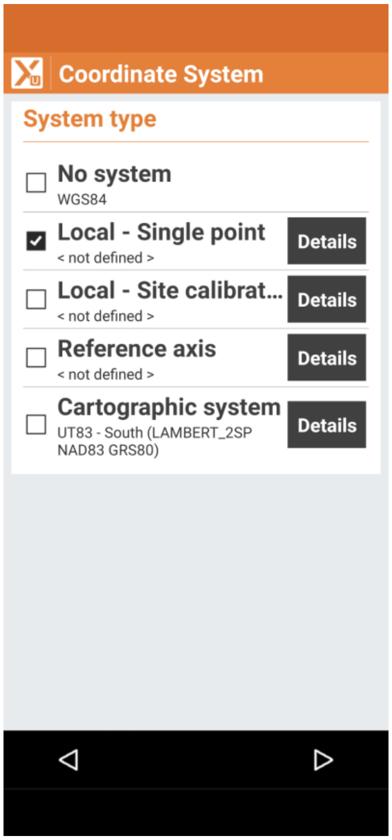
We can use the **CAD**, **Info**, **Distance** tool to compute the Grid distance between 100 -> 101:



The Grid distance is 2837.610 USFeet. We don't need this distance, but it will be useful for comparison in the next step.

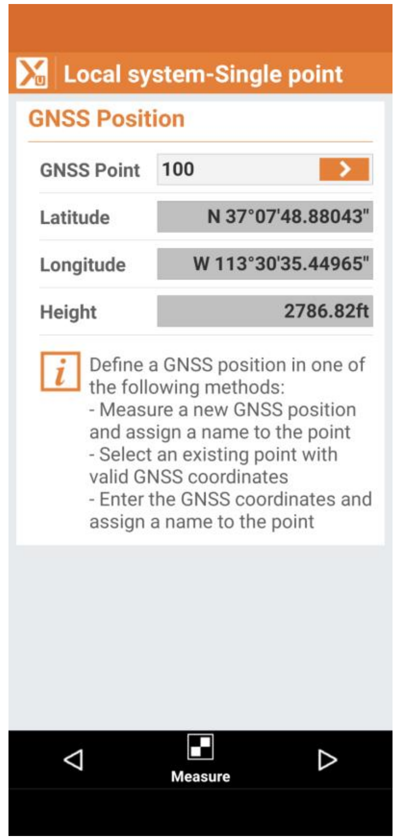
Now, let's build a Single Point Ground system and compute the Ground distance between these two points. Go back to the **Main Menu**, **JOB** tab, then click on **GNSS Localization** then

Local – Single point:



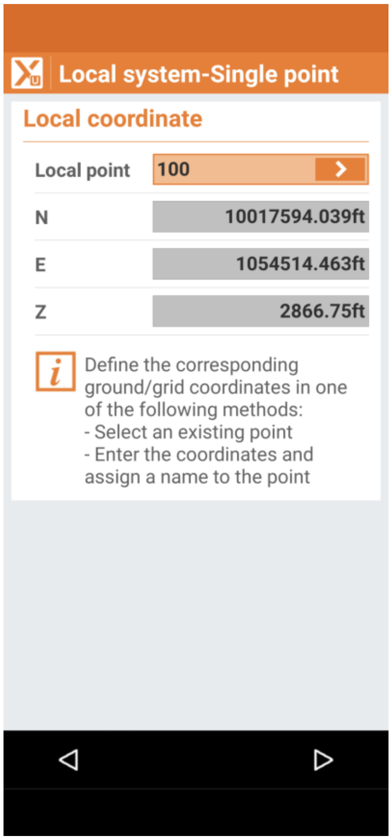
Click on the black **Details** button to the right of **Local – Single Point**. X-PAD will ask for the **Local system – Single point** geographic position. Use the **>** button to the right of **GNSS Point** to recall

Point 100:



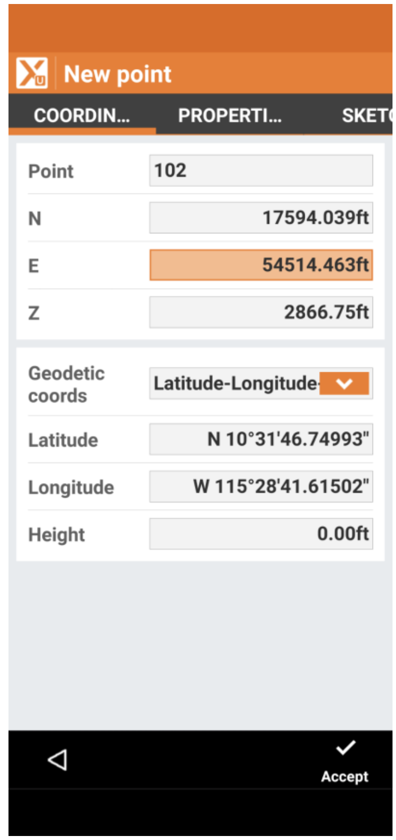
Click on the **Next** (right arrow) at the bottom. X-PAD will show the computed State Plane

Coordinates for Point 100.:



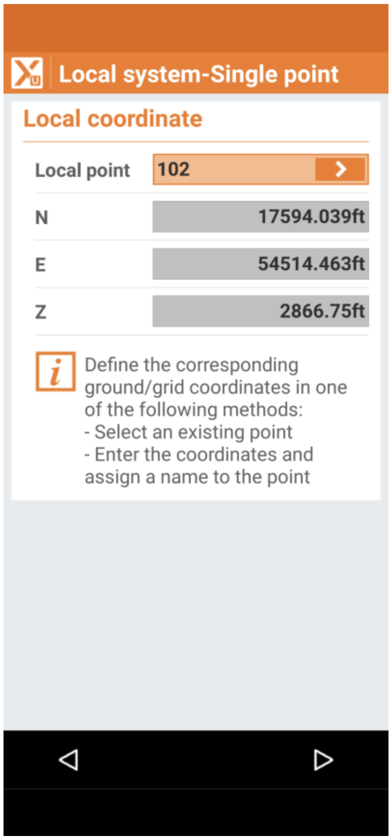
We want to truncate the SPC position such that only 5 significant places to the left of the decimal-point remain.

Click on the >, choose **New point** and enter point 102 with the new local coordinates:



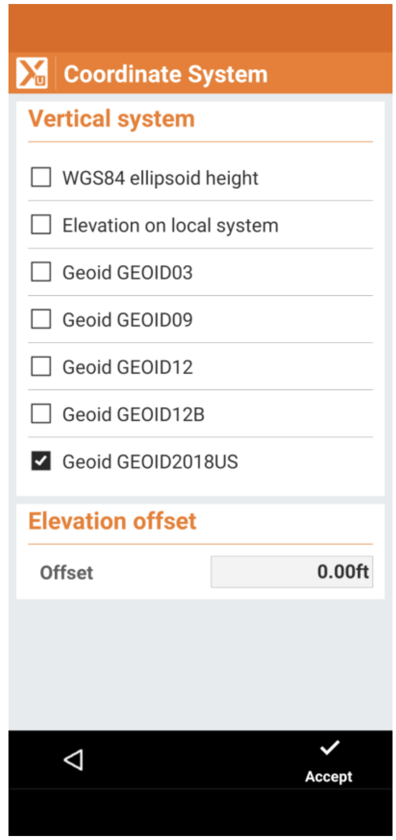
Click on **Accept**.

The truncated **Local Coordinate** will be shown:



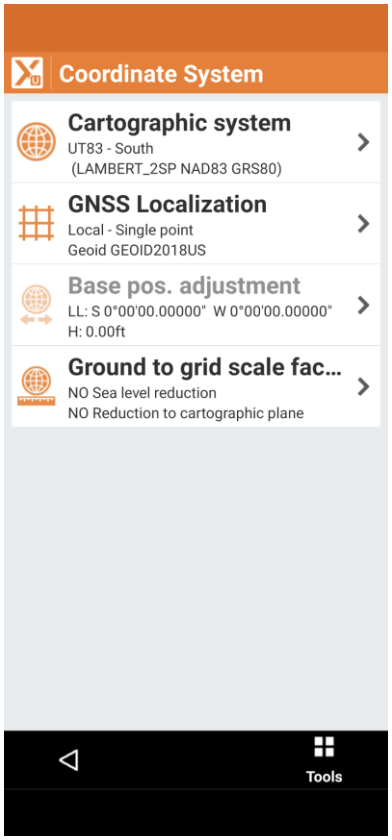
Click the **Next** (right-arrow button) at the bottom.

Select an appropriate GEOID:

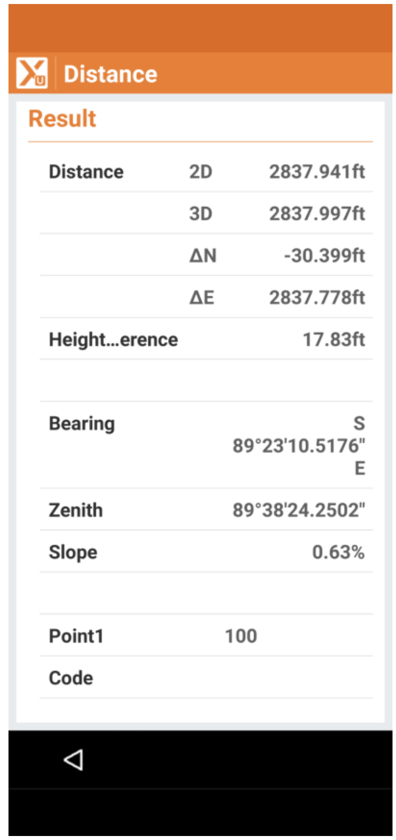


Then click **Accept**.

X-PAD will show that the **GNSS Localization** is **Local Single Point** with the selected GEOID:



Return to **CAD**, **Info**, **Distance** and compute the distance from 100 to 101:



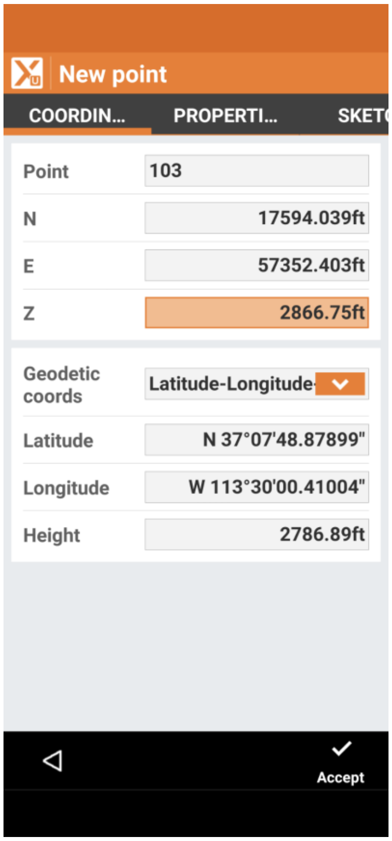
The Ground distance is **2837.94** USFeet, the Grid distance was **2837.610** USFeet. This is correct for this elevation and grid location.

We now would like to build a 2-point localization where the Eastern point has the same Northing, but the Easting is 2837.94 larger than the Western point.

54514.463 + 2837.94 = **57352.403**

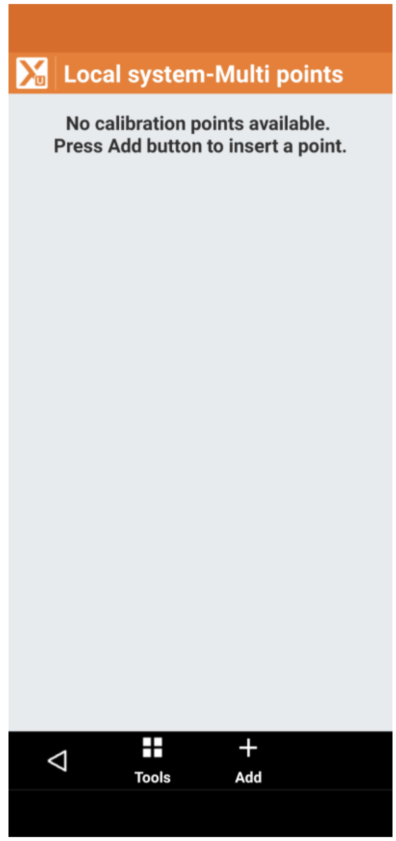
Go to the **Main Menu**, **JOB** (tab), **Points, Measurements, Codes** and add a fourth point

103:



Click Accept.

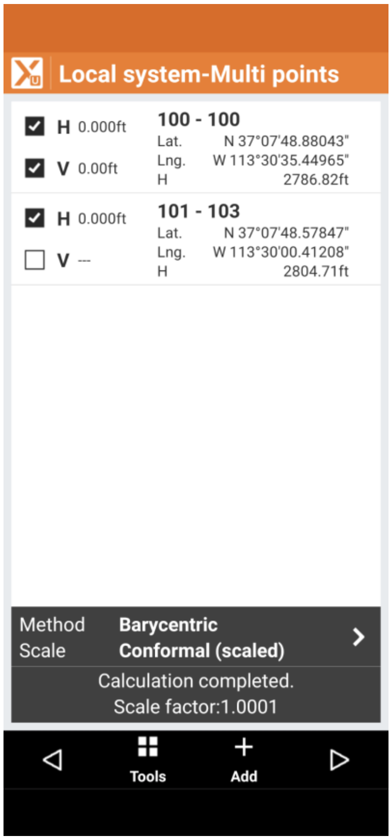
We now have two Geographic Coordinates and two projected points to build a complete system with. Return to the **Main Menu**, **Coordinate System**, **GNSS Localization** and select **Local – Site calibration**, then click the black **Details** button. The **Local system-Multi points** dialog is shown:



Add two points:

GNSS Position 1	100
Local Coordinate 1:	100
GNSS Position 2:	101
Local Coordinate 2:	103

The **Local system-Multi points** dialog will reflect these selections and show a Scale factor: 1.0001:



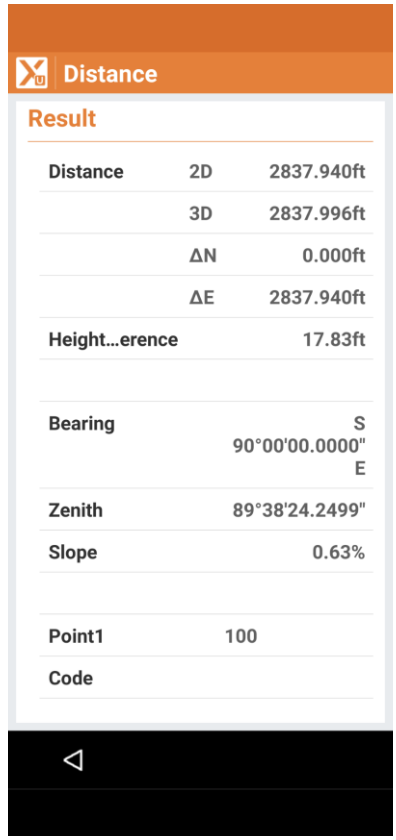
Uncheck the second point-pair's **Vertical checkbox** to prevent building a tilted-plane system.

Click the **Next** button (right-arrow), the **Coordinate System**, **System Type** will be shown, click the **Next** button at the bottom again and choose an appropriate Geoid, finally click **Accept**.

Note: If you don't continue through by clicking the right-arrow, then click on **Accept** your changes will not be kept!

If you think that you might want to reuse this system, click on **Tools**, then **Save current system** and give the new system a reasonable name.

Finally, return to the **CAD** screen and compute the distance from Point 100 to Point 101:



The distance is Ground (**2837.940 USFeet**) and the bearing is cardinal East as we desired.

Now that we have the desired Ground System defined from point 100, we can still use background maps:

Coordinate System Report

You can write a Coordinate System report from **Main Menu**, **JOB** (tab), **Coordinate System**, **Tools**, **Report**:

Coordinate

Job Demo2.gfd4 **Date:** 04-10-21 **Time:** 13:15

System type: **Cartographic**

Name **UT83 - South**
Projection **LAMBERT_2SP**

DATUM

Name	NAD83
Shift.X	0.000000ft
Shift.Y	0.000000ft
Shift.Z	0.000000ft
Rot.X	0.000000000
Rot.Y	0.000000000
Rot.Z	0.000000000
Scale	1-0.000ppm

ELLIPSOID

Name	GRS80
A	20925604.474ft
Inv.Flat.	298.257222101

System type: **Multiple points**
Transformation: **Conformal (with scale variation)**

Name	Use H V	WGS84 / ETRS89 Latitude ECEF X	Longitude ECEF Y	Height ECEF Z	N	UT83 - South E Calculated Reference Difference	Z
100	Yes	N 37°07'48.88043"	W	2786.82ft	17594.039ft	54514.463ft	2866.75ft
	Yes	-6664081.705ft	-15319138.251ft	12563753.72ft	17594.039ft 0.000ft	54514.463ft 0.000ft	2866.75ft 0.00ft
101	Yes	N 37°07'48.57847"	W	2804.71ft	17594.039ft	57352.403ft	2884.64ft
	No	-6661492.433ft	-15320300.025ft	12563740.17ft	17594.039ft 0.000ft	57352.403ft 0.000ft	2866.75ft ! 17.89ft

Shift.X	-677584.749284ft
Shift.Y	-10028139.986454ft
Rot.X	1°50'42.391908584"

04-10-2021 13:16:04
Pag.1

Scale	1+116.965ppm

Barycenter
N0 10045734.025ft
E0 733518.182ft

Elevations:	**Geoid**
Geoid:	**GEOID2018US**

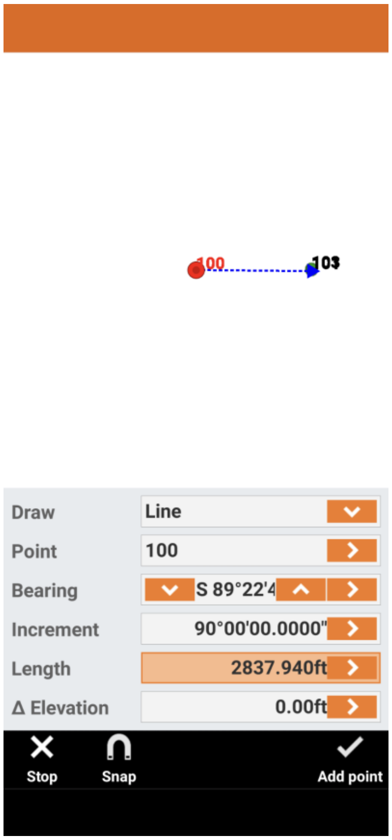
04-10-2021 13:16:04
Pag.2

Hint: Non-Cardinal Bearings

In the previous example, we computed the Easting coordinate of the second local point by adding the desired Ground distance to the Easting coordinate of the first point.

What if we wanted to have that bearing actually be some other, non-cardinal, bearing?

You can use the CAD, Draw, Layout drawing tool to add a new point at some distance – bearing from the first point (100):



After clicking **Add point**, a new point the desired Ground distance at the entered bearing (S 89 22 44 E above) can then be used as the 2nd point's Local Coordinate.