Localization & Grid to Ground Scale Factors in SurvCE

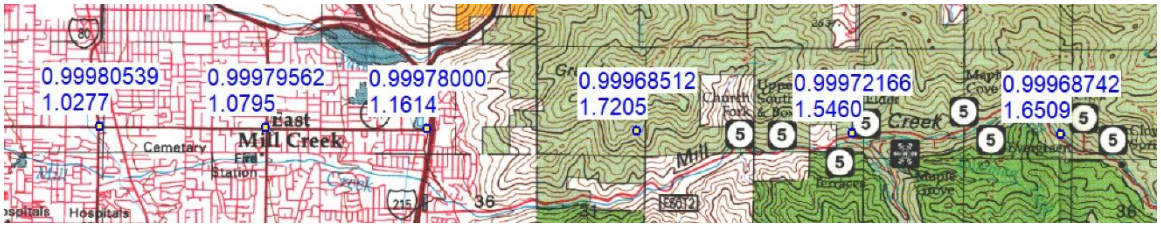
Mark Silver, ms@igage.com, +1-801-412-0011 x16, blog.ashgps.com

Grid-to-Ground

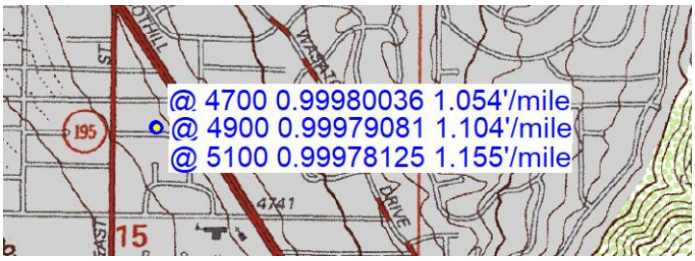
CSF is function of:

Latitude, Elevation and Projection

Difficult to choose a single reasonable CSF for a large project:



Especially if you have moderate elevation changes. Here is an example of the change of 400' elevation at my house:

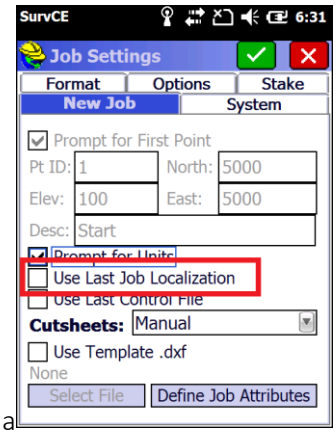


Localizations

A localization (or calibration) allows you to best match an existing survey or to start a new survey at ground and control the basis of bearings.

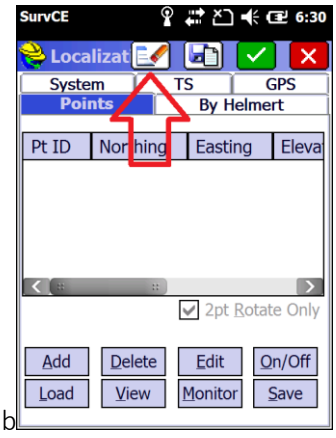
Reusing last localization? Clean slate!

File: Job Settings:



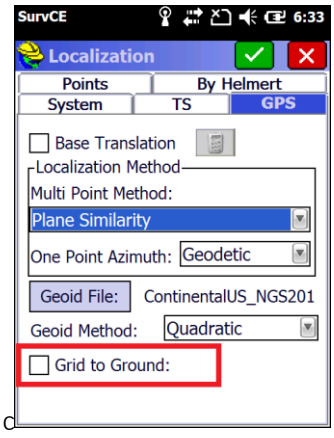
a

Equip: Localization: Points



b

Equip: Loc..: GPS



c

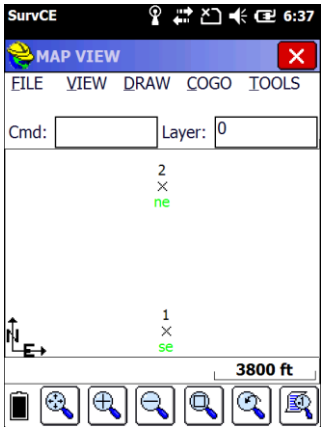
If you work at a mine and reuse the localization on every job, you might want to check 'Use Last Job Localization' (a), otherwise probably not.

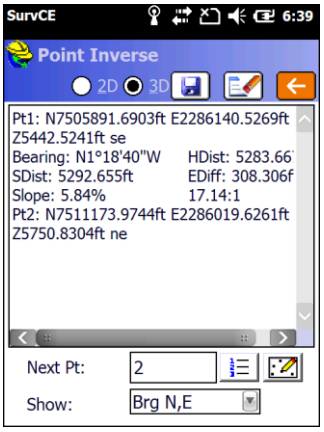
The 'Clear Localizaiton' (b) disassociates the .loc file from your job. But it does not delete it, so you can always get back.

Be careful with Grid to Ground and Azimuth (c); always (almost) have a GEOID file loaded in the background.

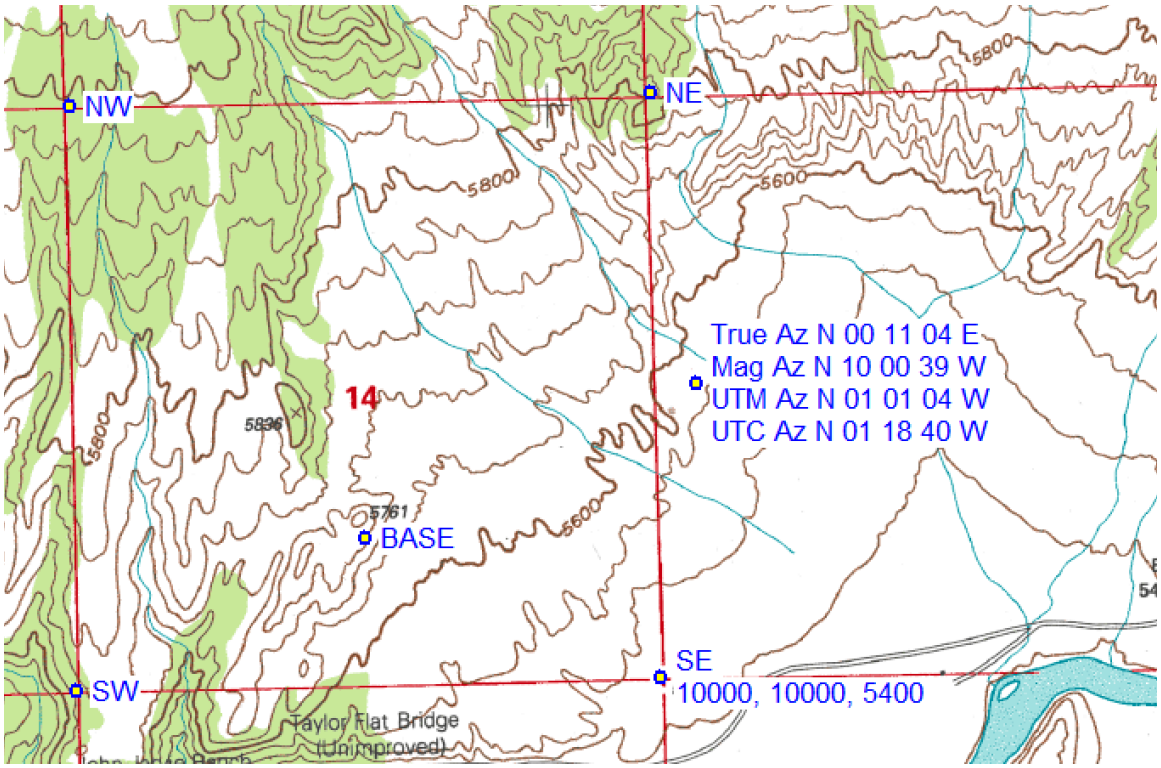
001 Start a new job at 10,000, 10,000; use Geodetic North at Ground based at a chosen parcel corner.

At Grid





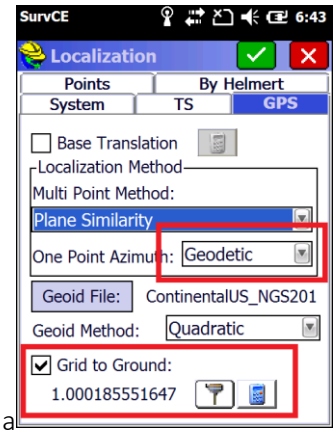

```
Pt1: N7505891.6903ft E2286140.5269ft
Z5442.5241ft se
Bearing: N1°18'40"W   HDist: 5283.667ft
SDist: 5292.655ft     EDiff: 308.306ft
Slope: 5.84%     17.14:1
Pt2: N7511173.9744ft E2286019.6261ft
Z5750.8304ft ne
```



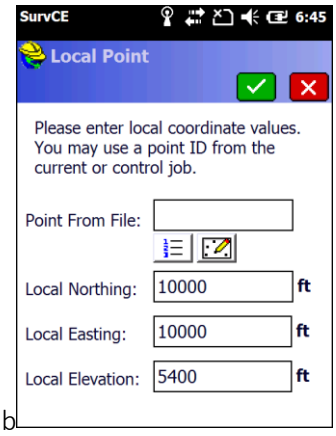
Occupy SE, compute combined scale factor, translate to 10000,10000 with GeoN Basis of Bearing (BOB).

Verify the resulting ground distance and bearing (a), enter a starting point (b):

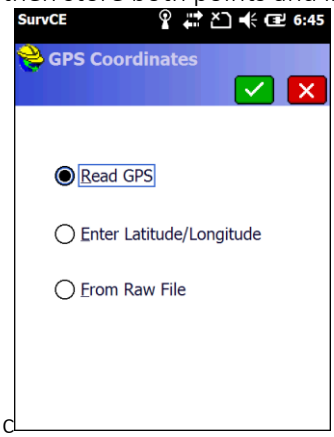
a



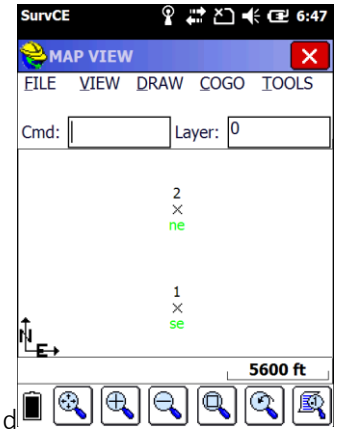
b



Do single point localization from 'Equip: Localization: Points: Add', read the GPS (occupying SE mark), then store both points and inverse:



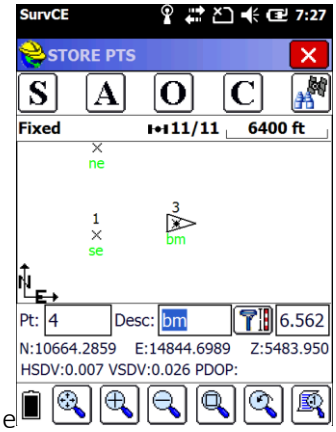
c



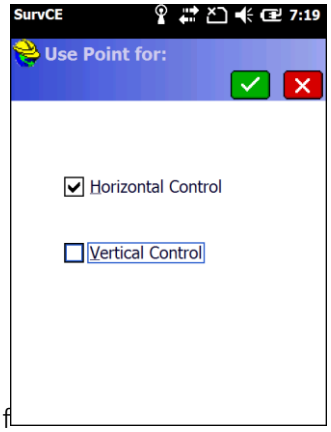
d

```
Pt1: N10000.0004ft E9999.9999ft
Z5400.0042ft se
Bearing: N0°11'07"E   Ground: 5284.654ft    Grid: 5283.673ft
SDist: 5293.639ft     EDiff: 308.306ft
Slope: 5.83%     17.14:1
Pt2: N15284.6263ft E10017.0834ft
Z5708.3105ft ne
```

Now, let's pick up a local benchmark for elevation, store VBM (e), turn off vertical on exiting point (f):

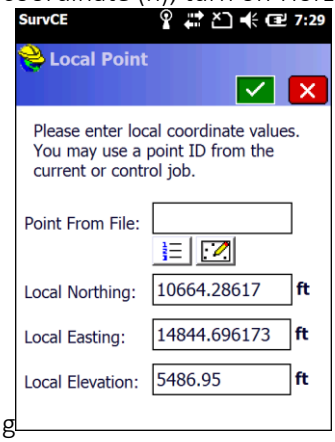


e

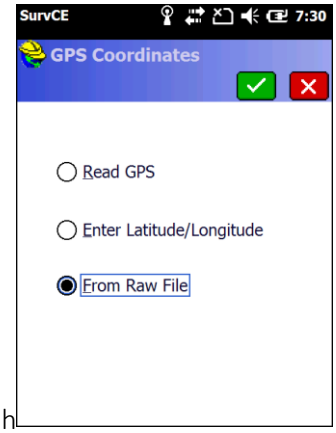


f

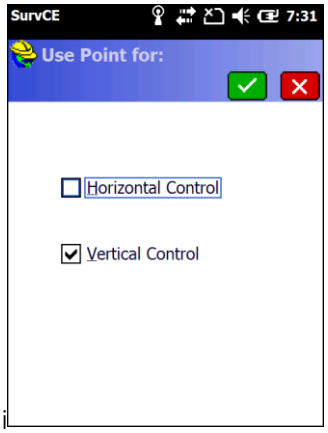
Add new point by recalling point 3, then editing elevation to match VBM (g), use Raw File for GPS coordinate (h), turn off Horz on VBM:



g



h

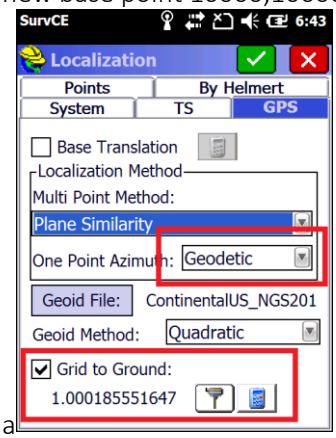


i

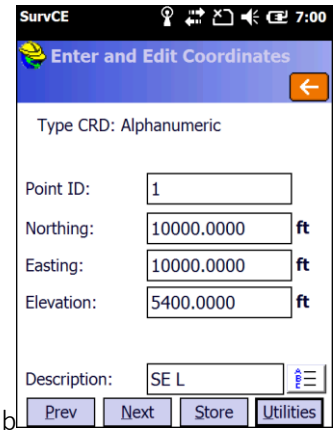
Then reprocess, finally verify that the VBM has the correct elevation.

002 Stat a new job, following a historic plat, matching the original basis-of-bearing but holding exact ground measurements.

First occupy the SE corner and compute a valid CSF (a). The record BOB is North 1 deg 5 min East. Add a new base point 10000,10000 (b):

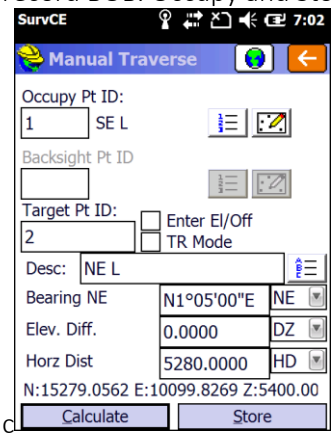


a

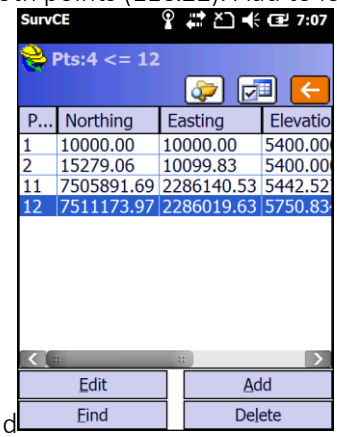


b

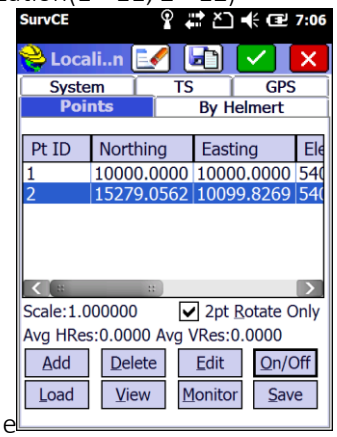
COGO: 9. Manual Traverse (a), compute a coordinate, based on 1 for some point about 1 mile north on record BOB. Occupy and Store both points (11&22). Add to localization(1->11; 2->12)



c



d



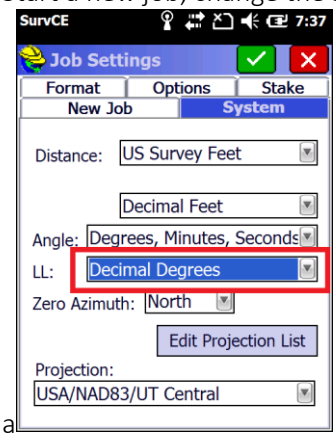
e

Check the '2pt Rotate Only' box, we don't want to honor the original distance as it was slope chained. Reprocess when prompted. Inverse when complete:

```
Pt11: N10000.0000ft E10000.0000ft
Z5089.4188ft se m
Bearing: N1°05'00"E   Ground: 5284.648ft    Grid: 5283.668ft
SDist: 5293.634ft     EDiff: 308.306ft
Slope: 5.83%     17.14:1
Pt12: N15283.7033ft E10099.9148ft
Z5397.7251ft ne m
```

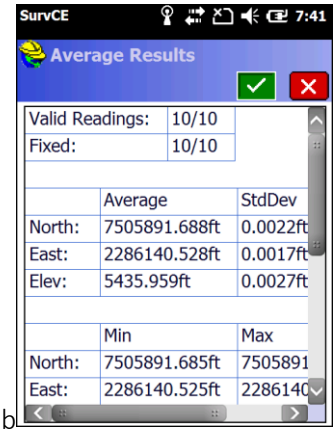
003 Start a new job, using a custom Low Distortion Projection, based at a central location at the job. Choose the correct projection scale factor so that distances are ground.

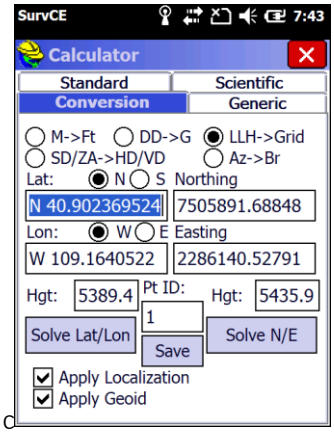
Start a new job, change the System option for LL display to decimal degrees:



a

Occupy the point that you want to use for the project datum. Store a 30-second average as point #1; then COGO: Calculator: Conversion and recall point 1, then click on 'Solve Lat/Lon':

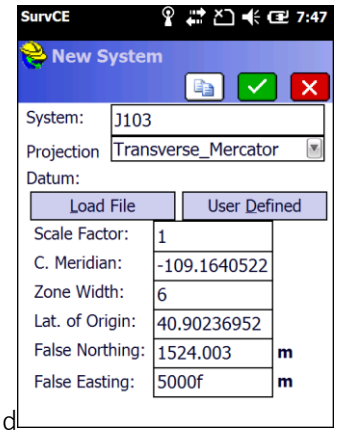
b 

c 

Note the Lat and Lon:

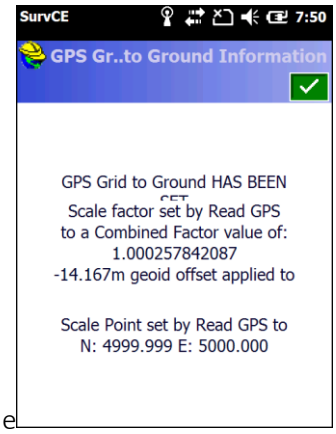
```
N 40.9023695246 W 109.1640522309
```

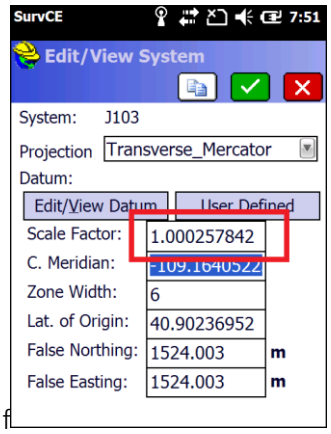
Navigate to Equip: Localization: System, edit the projection list and choose Add User Defined

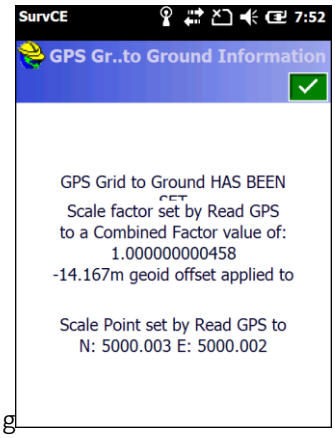
d 

Set the 'C. Meridian' to the longitude (make sure negative!) of the point; the Lat of Origin to the latitude. Set the False N & E to what you wan the point to be (5000f will automatically translate to 1524.003 meters).

Navigate back to Localization: GPS and use the Grid to Ground to find a reasonable scale factor (e):

e 

f 

g 

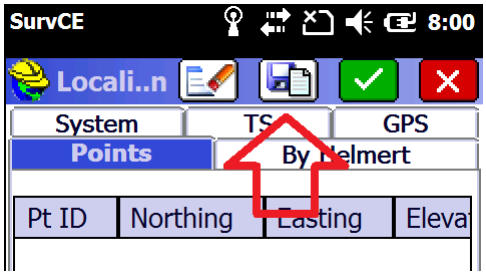
Then go back to the coordinate system definitation and change the scale factor to the computed scale factor (f); finally return to the Grid to Ground computation and verify that the CSF is nearly 1.0.

Change the Lat/Lon display back to DMS.

Next store the SE and NE corner and inverse between them:

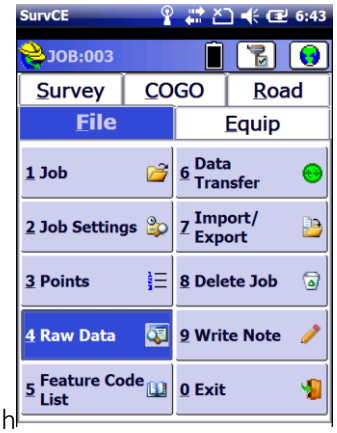
```
Pt2: N5000.0003ft E5000.0022ft
Z5435.9592ft se
Bearing: N0°11'07"E   HDist: 5284.640ft
SDist: 5293.626ft     EDiff: 308.313ft
Slope: 5.83%     17.14:1
Pt3: N10284.6125ft E5017.0823ft
Z5744.2720ft ne
```

Save the system description to an HTM file for later use as job metadata:

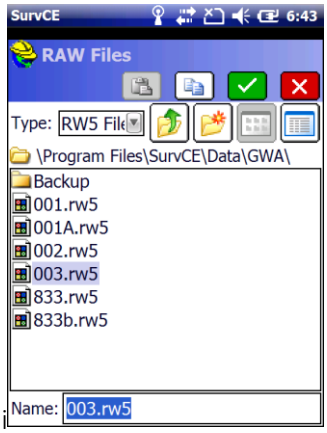


Reprocess the job so that the stored point is localized to match the local datum point, here are the EXACT steps:

From the ‘File’ menu (h) click on ‘Raw Data’, then (i) accept the current job’s RW5 file, (j) click on ‘Process GPS’:



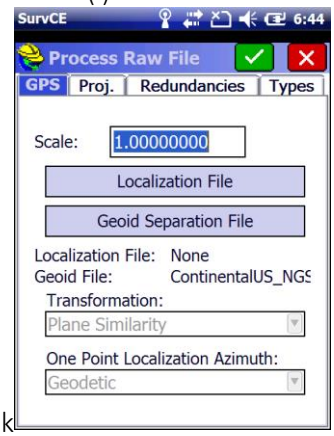
h



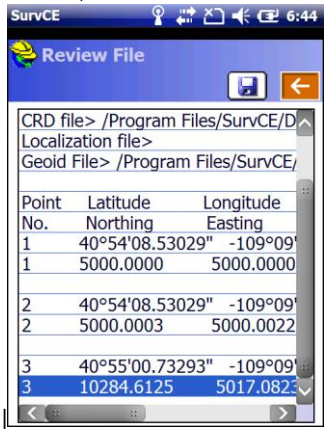
i

j

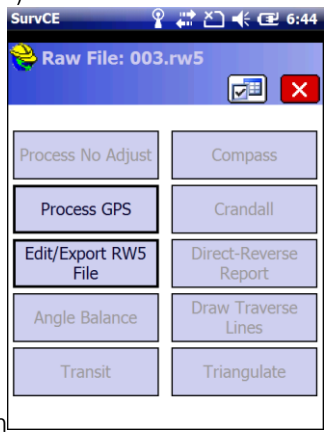
Accept the defaults (k) (sometimes you will need to enter 1/jobCSF but not in the LDP case); look at the results (l) and save to text file if desired; click the red check mark (m):



k

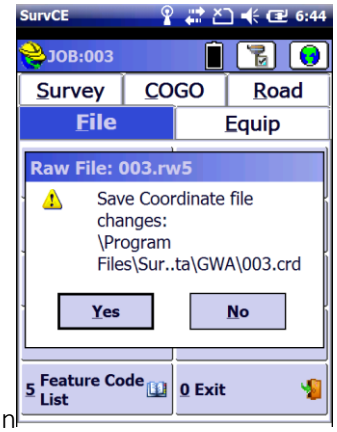


l

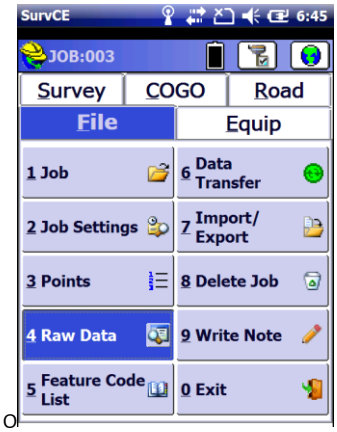


m

Click ‘Yes’ (n); then you are back at the main menu (o); check out the point list (p):



n



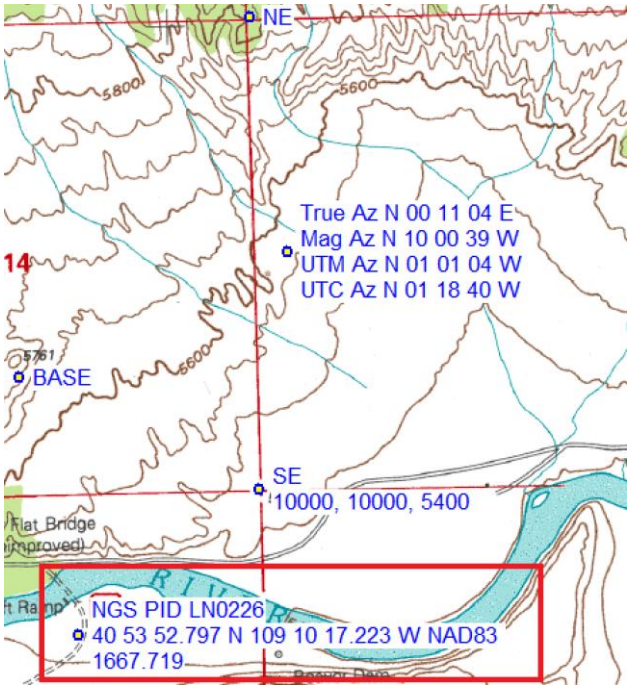
o

p

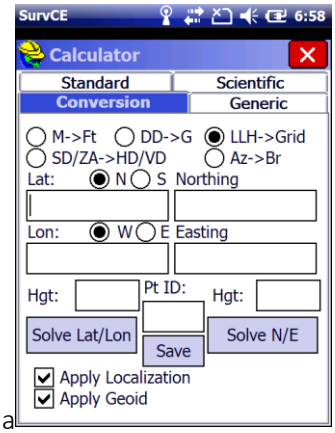
It worked!

004 Using the previous job, with LDP geodetic basis of bearings and ground distances (10,000, 10,000.) Hand enter a couple of NGS Control Points using the published geodetic positions.

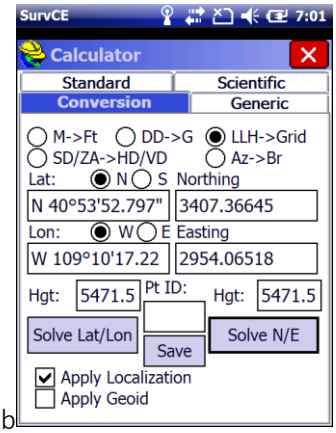
So, if we are working in a modified SPC or in an LDP, how can we export Lat/Lon's or import Lat/Lons? In this example, we have Geodetic coordinates for a NGS Control Monument with Orthometric height:



How can we enter this Lat/Lon coordinate with Ortho height into our LDP job?



a

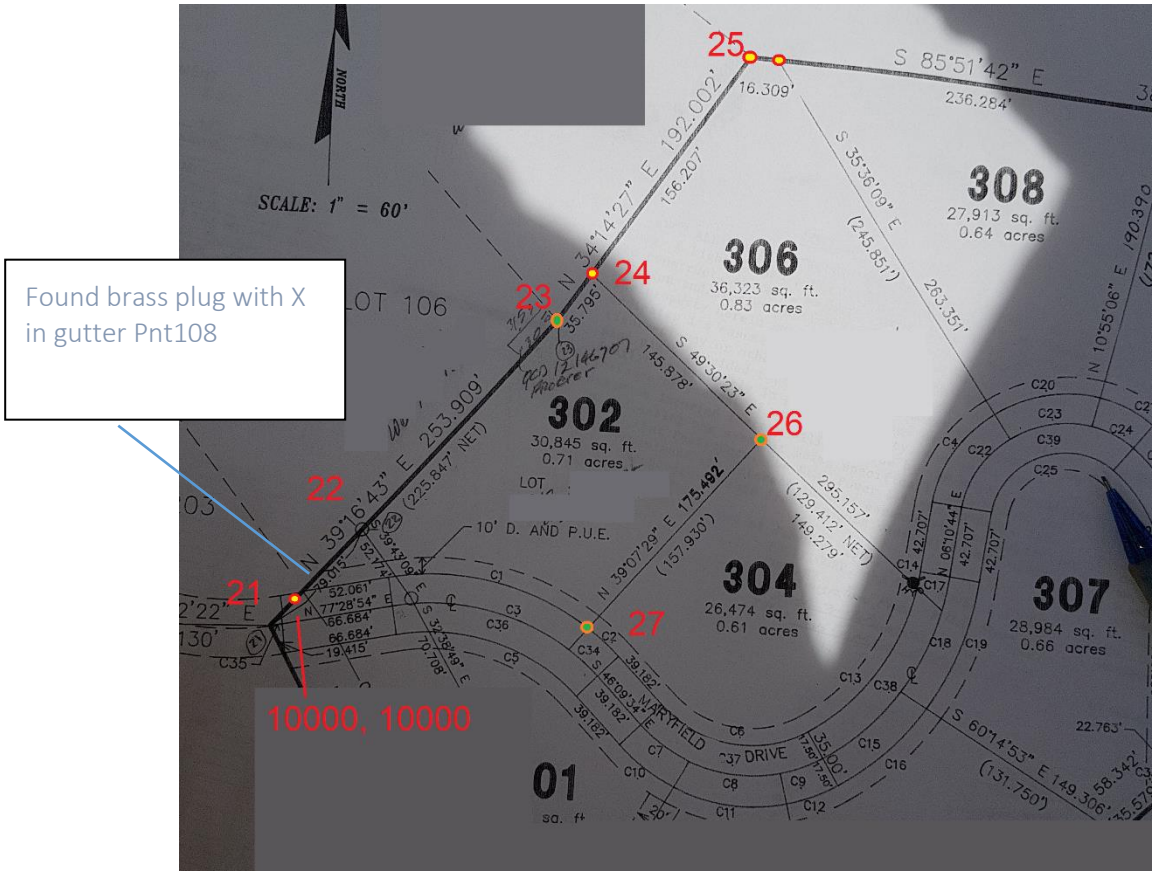


b

COGO: Calculator: Conversion: LLH->Grid (a)

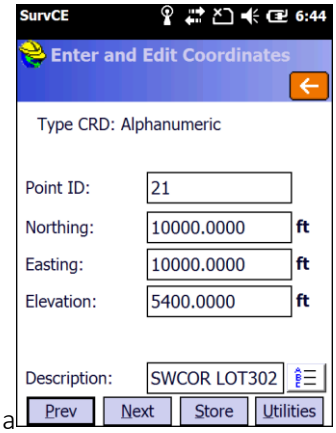
Show how to enter a point AND explain 'Apply Localization' and 'Apply Geoid'.

005 Start a new job, retracing an existing survey. Initially use a few points to 'get on the system' then after finding the remaining corners, do a multipoint calibration looking for blunders.

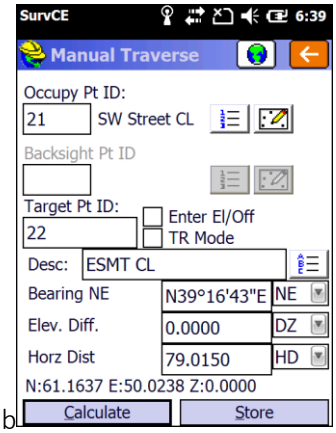


Begin by entering point 21 as 10000,10000,5800 (a) then project 22 (b) and continue to 23, 24, 25, 26 and 27:

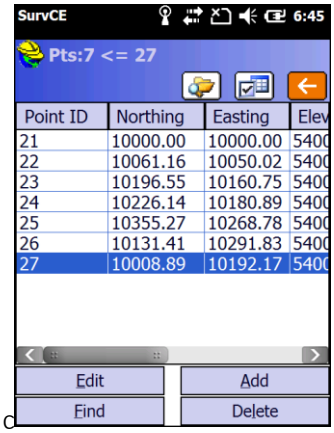
a



b

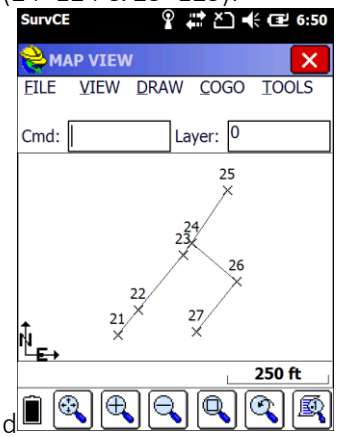


c

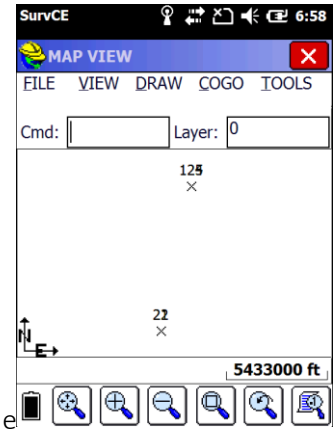


Points 24 and 25 have found 5RBC with reputable surveyor's license number. 21, 22, 23, 26 and 27 are missing, in heavy shrubs and under 1' of snow.

Draw parcel boundary (MapView: Draw Polyline 2D) d, then occupy and store the points that we found (24=124 & 25=125):



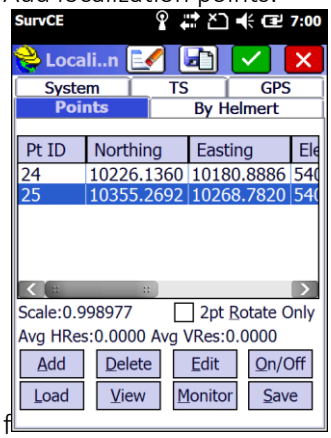
d



e

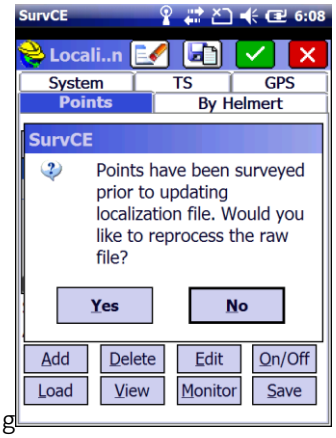
We have both local and Utah Central SPC points in our job at this point (e).

Add localization points:

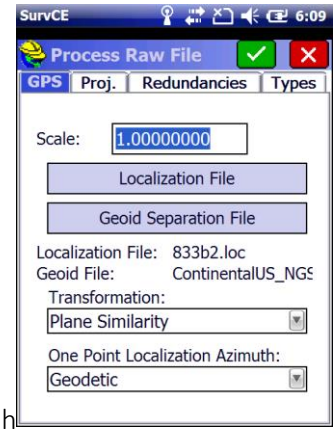


f

Click on Save to store the localization and then Reprocess the Raw File when prompted. Here are the EXACT Steps:



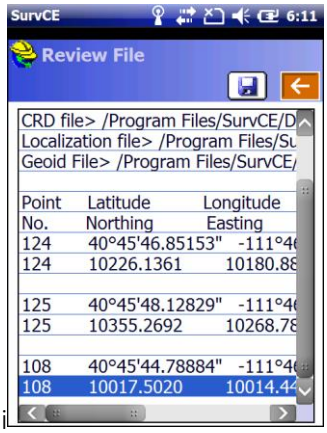
g



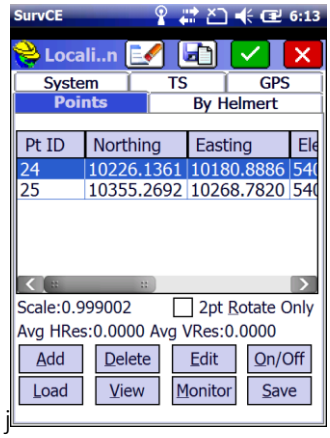
h

Click on Yes (g), (h) scale does not matter, we will honor the two points, 'One Point Loca…' does not matter as this is a two (and will become more) point.

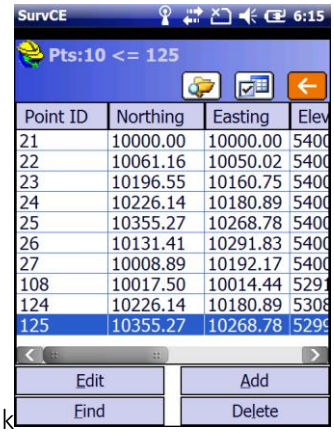
Click on the green checkmark, the full results are shown in a text file. You can click the disk button if you would like to save to a text file.



i



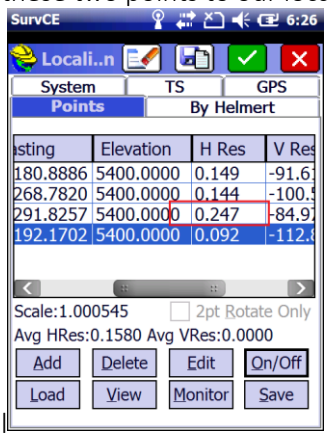
j



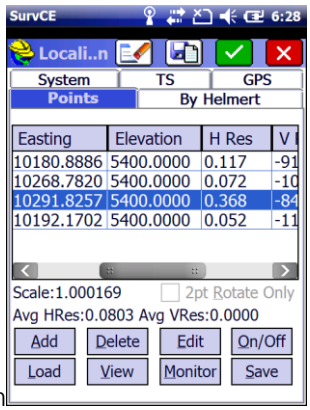
k

(j) Click on the red back button to return to the points tab, then click the green check mark to return to the Equip menu. Look at the point list (k), all of the occupations are now local coordinates.

Now stake the un-found points. We were able to find 26 and 27 fully buried, within 0.5' of the staked values. #26 is a 5RBC but there is sprinkler construction next to it and it appears to be leaning. Let's add these two points to our localization:



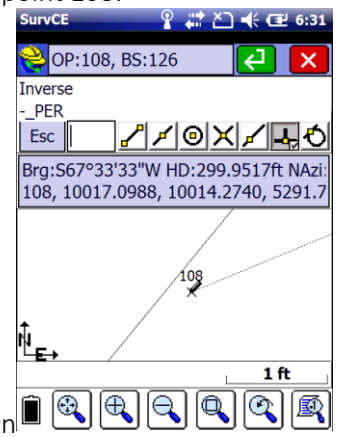
l



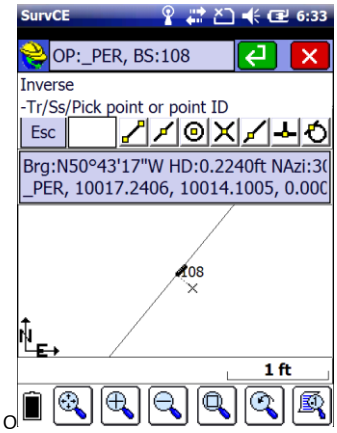
m

Sure enough, #26 appears to have a horizontal issue (l). Turn #26 off (m). Reprocess with point 27 included and point 26 removed.

Let's check out that brass plug in the gutter. From map view, zoom in and select Inverse then enter point 108:



n



o

Click on the snap perpendicular button (n), then click on the line (o): 0.22' is amazing considering where this 1982 survey is, the terrain and the ground stability!

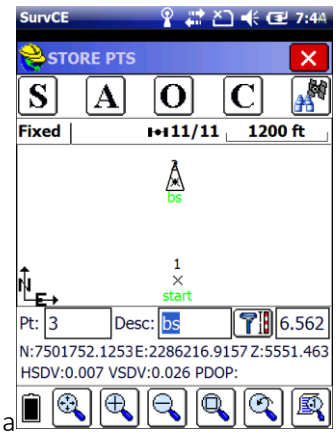
--

With this existing job, show how to enter a state plane coordinate (for a subdivision control point), convert to Lat/Lon and then convert to the local coordinates. Use this UTC USFeet coordinate:

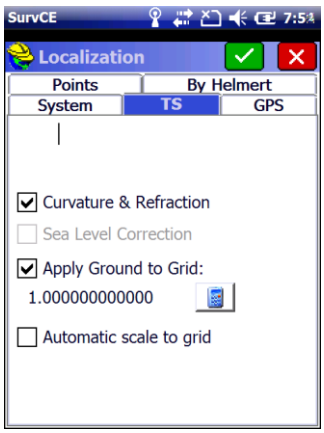
```
7447599.30 N  1563871.41  5300.10 Ortho
```

006 Mix total station shots with GPS measurements at Grid.

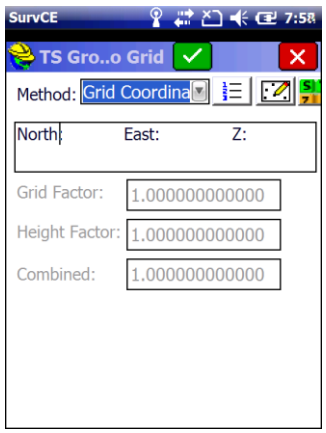
Start a new job, shoot two GPS points, a starting point and a backsight point. Set the TS up on start and backsight BS. In Equip: Localization: TS check the 'Apply Ground to Grid' checkbox (b). Click on the calculator button and chose 'Method: Grid Coordinates':



a

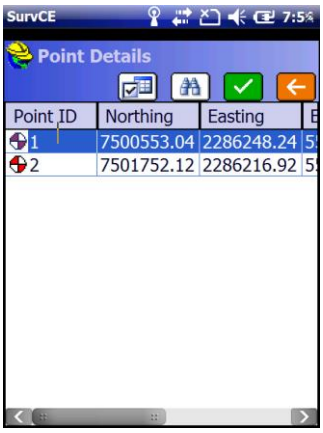


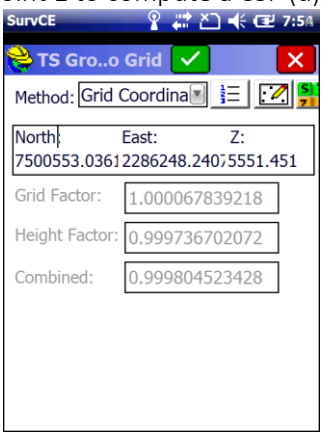
b

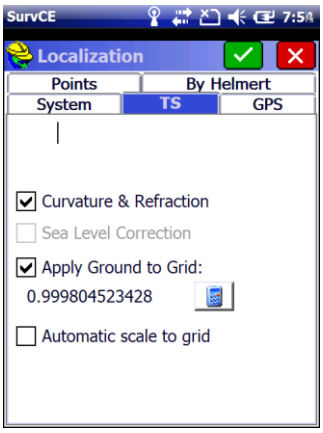


c

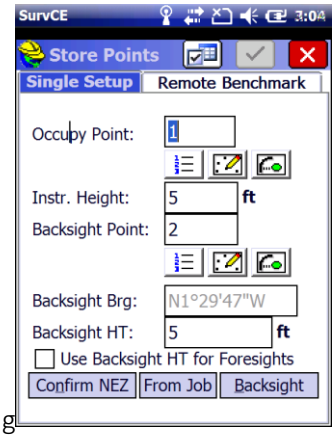
Click the 123 button and choose point 1 to compute a CSF (d).

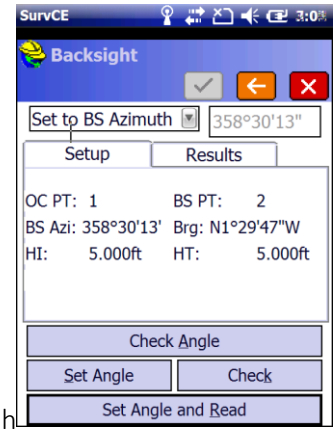
d 

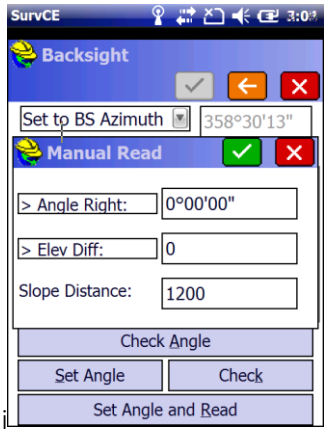
e 

f 

Click the green check mark and go to 'Survey: Store Points' (g); setup and click 'Backsight'

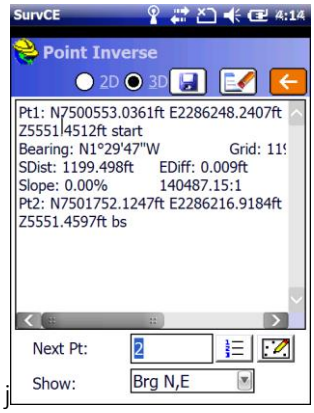
g 

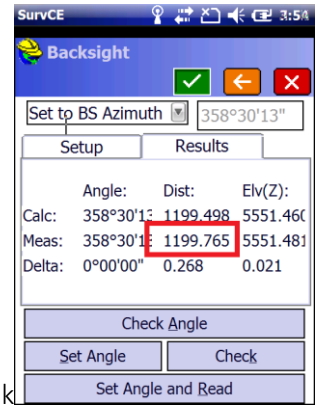
h 

i 

SurvCE applies the single computed CSF to reduce each ground measurement (shot with TS) to grid:

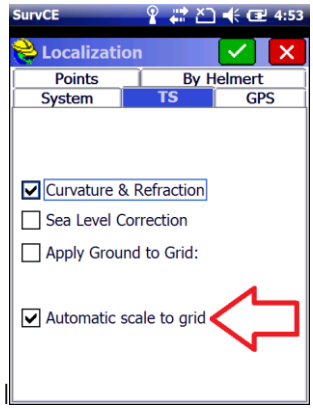
1200.00 * 0.999804523 = 1199.7654

j 

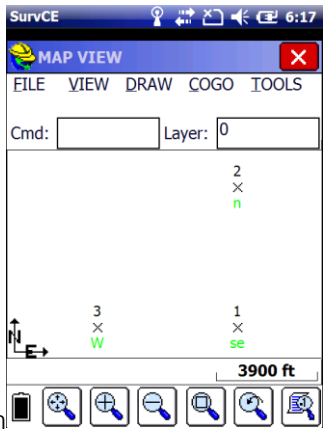
k 

Alternatively, you can choose 'Automatic scale to grid' which computes a scale factor for every vector independently: the CSF at both ends of the total station shot are applied to the measured ground

distance.



l



m

Consider (m) where 3 is 5280 W of 1 and 2 is 5280 N of 1. If we shoot from 1 to 2:

Meas: 0°00'00" 5279.035 5436.537 SF = 0.999817234848484 8

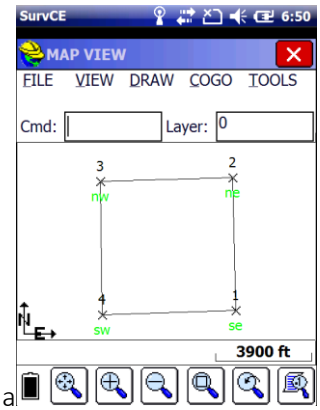
However if we shoot from 1 to 3:

Meas: 270°00'0(5279.022 5436.537 SF = 0.999814772727272 7

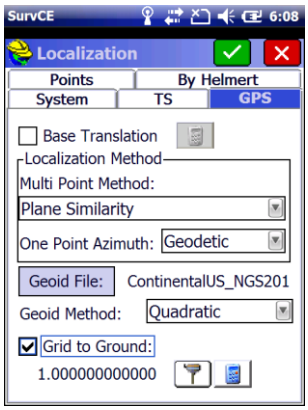
For large projects, this is a very accurate method for combining traditional and GPS measurements.

007 Choose an appropriate Combined Scale Factor based on Job corners. Set a Geodetic (True North) BOB system at the job center. (Tricky because you need raw data at Job Center.)

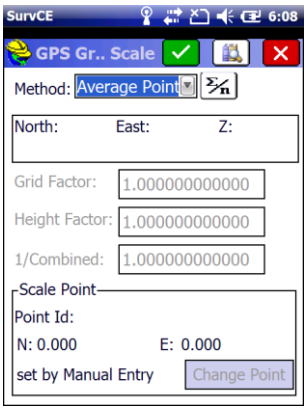
Store the 4 corners of a job (a). Equip: Localization: GPS (tab), check Grid to Ground (b). Select 'Average Points' (c)



a



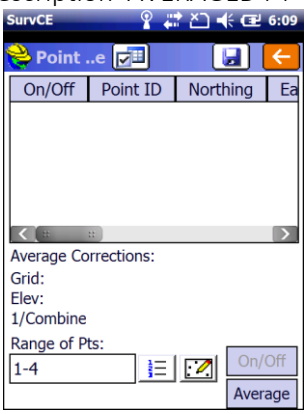
b

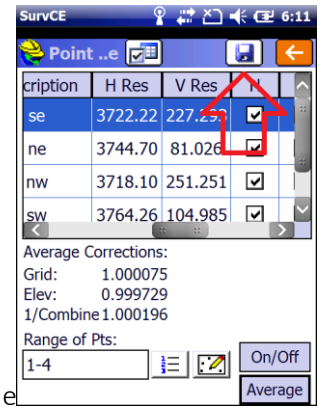


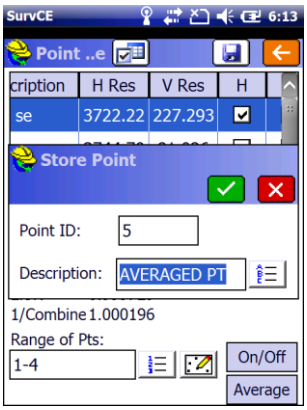
c

Enter the point range (d), then click 'Average', note the scale factor (looks about right) (e) and then click the store point button (looks like a diskette). The next available point is automatically selected with the

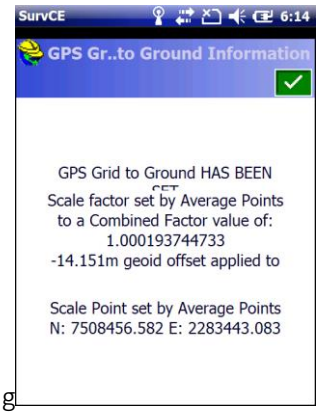
description ‘AVERAGED PT’ (f):

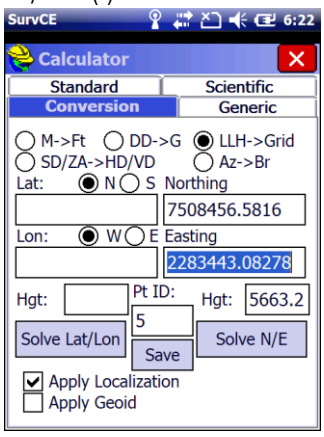
d 

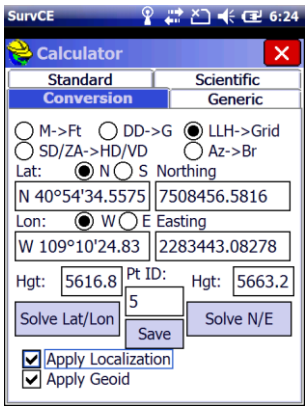
e 

f 

Red back then green check mark back, SurvCE will choose the average point for the scale point and register the new scale factor (g). Exit all the way back to the Equip menu. You will not be prompted to reprocess the raw file. Go to COGO: Calculator: Converstion and recall point 5 (h). Mark sure ‘Apply Geoid’ is check and click on Solve Lat/Lon (i):

g 

h 

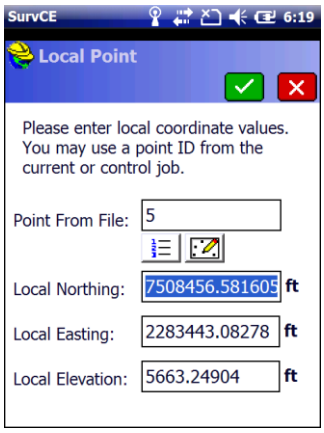
i 

Make a note of the Lat, Lon and Ellipsoid Height:

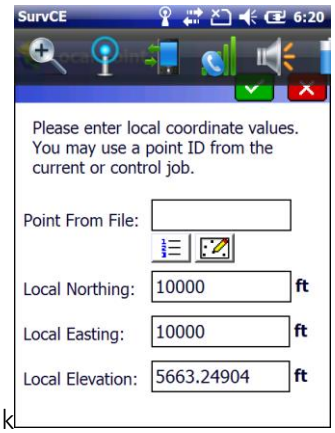
N 40°54'34.557508" W 109°10'24.832991" 5616.824

Re-enter the Localization menu, make sure the ‘One Point Azimuth’ is set to Geodetic, then select the Points tab and add a new point. Choose point 5 to be the ‘Local Point’ (this loads the measured elevation) (j); then change the Northing and Easting to rounded values (k). Choose to enter the Lat/Lon

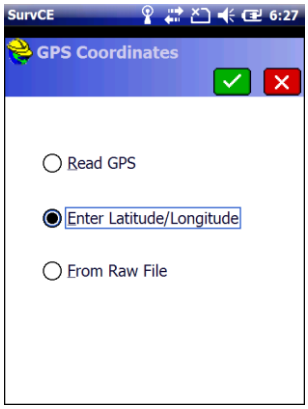
for the GPS coordinates:



j

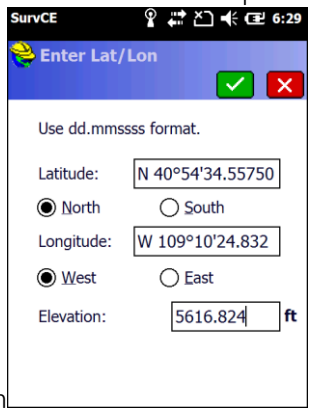


k

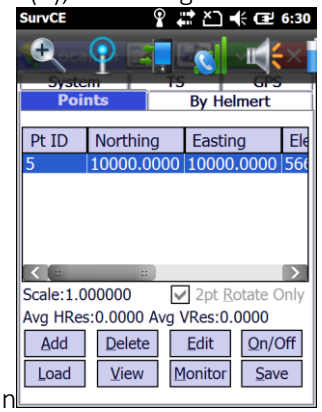


l

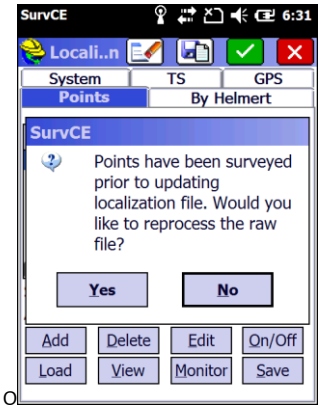
Click the green check mark, then enter the saved Lat, Lon and Ellipsoid Height (m). Clcik the green check mark to return to the points menu (n), click the green check mark and then save the localization



m

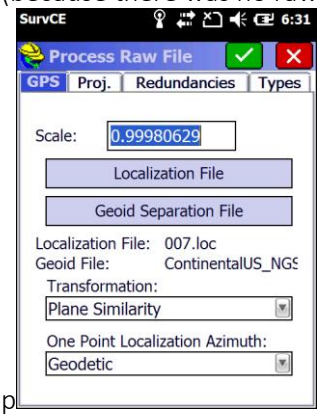


n

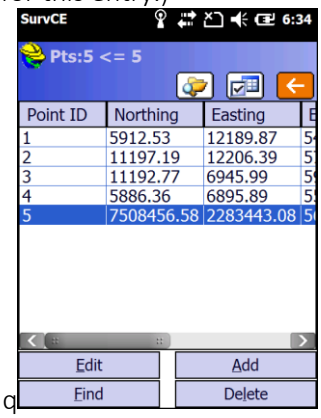


o

Choose Yes to reprocess the raw file (o) Notice that the scale is set to the inverse of the CSF (p), click the green check mark, the then red X, then the red X. Notice that (q) point 5 has not been recomputed (because there was no raw data for this entry.)



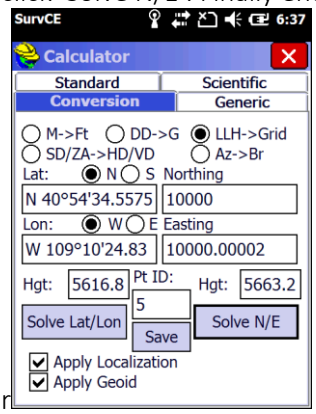
p



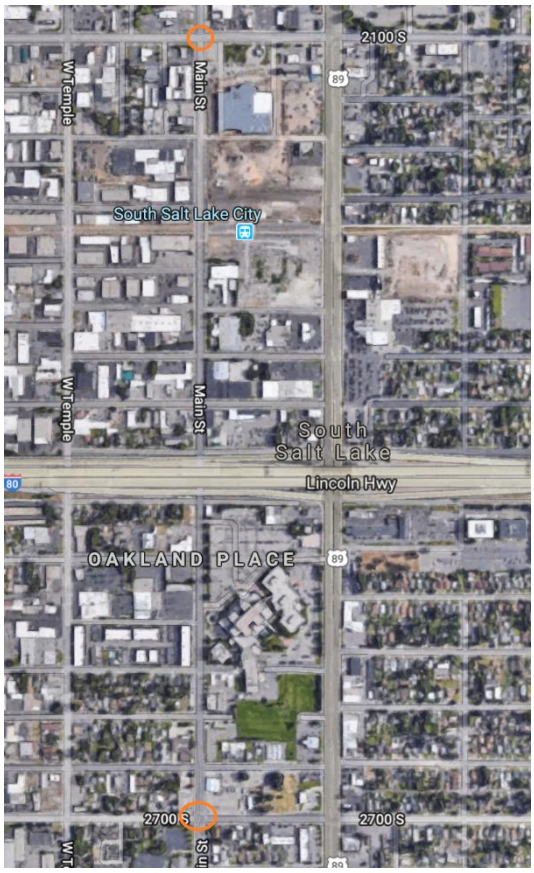
q

If you would like to have a point at this location you can use COGO: Calculator: Conversion.

Uncheck ‘Apply Localization’ then recall point 5 (a). Solve for Lat/Lon. Check ‘Apply Localization’ then click ‘Solve N/E’. Finally enter a new point ID 6 and click ‘Save’



008 Network Leveraging of Localization



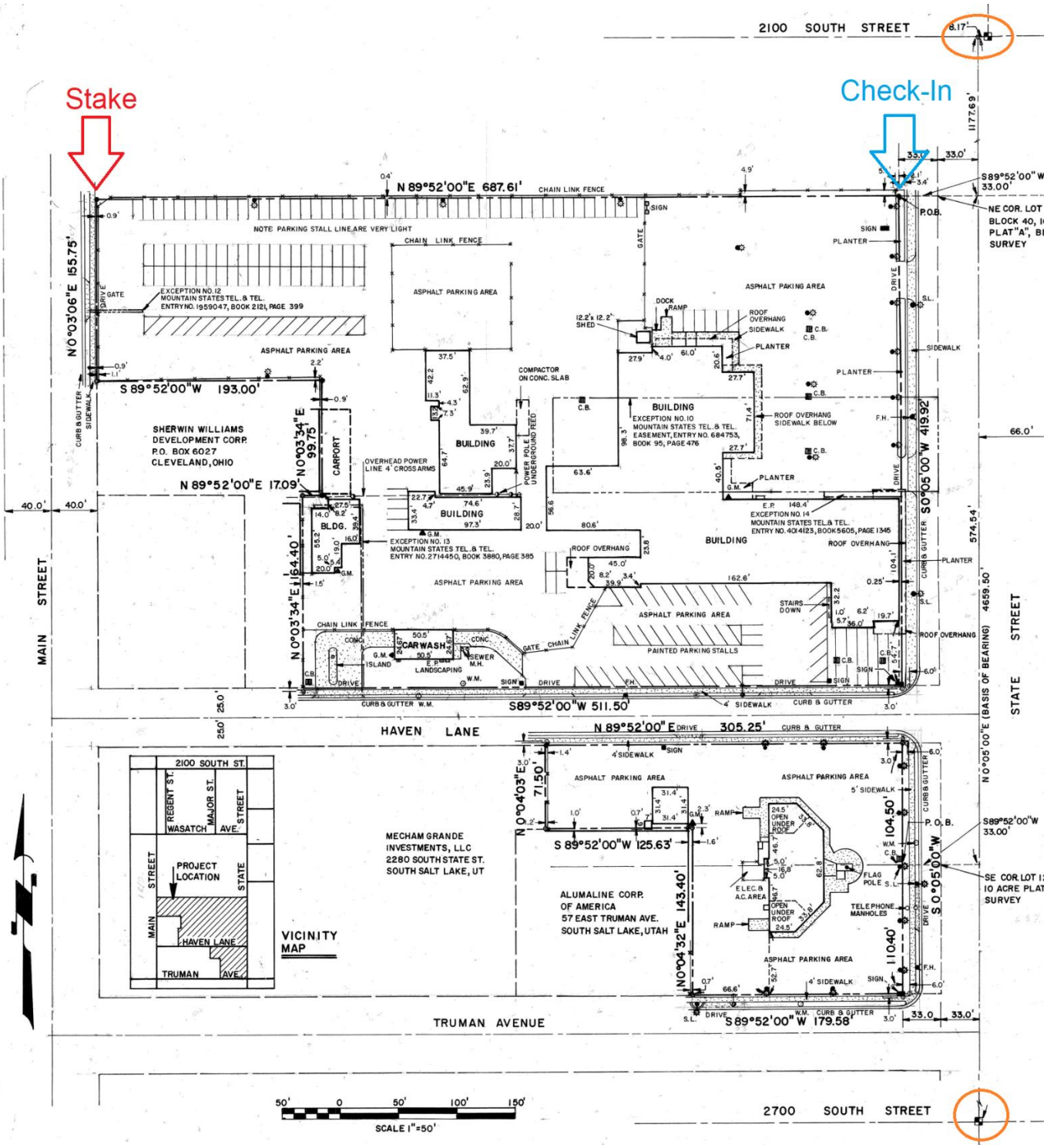
Construction has obliterated the North West corner of a parcel in Salt Lake City. The current owners are replacing the fence, repaving a parking area and setting landscaping.

We want to match an existing survey which is based on street monuments in two busy intersections in Utah (2700 S & Main Street, 2100 S and Main Street).

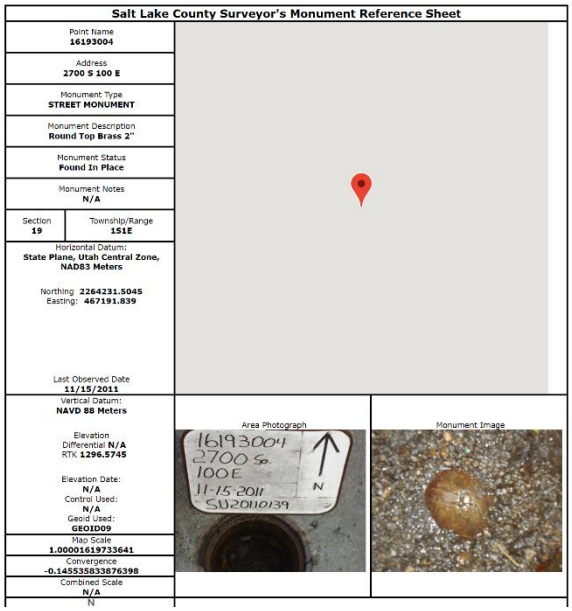
We are NOT going to occupy these two points.

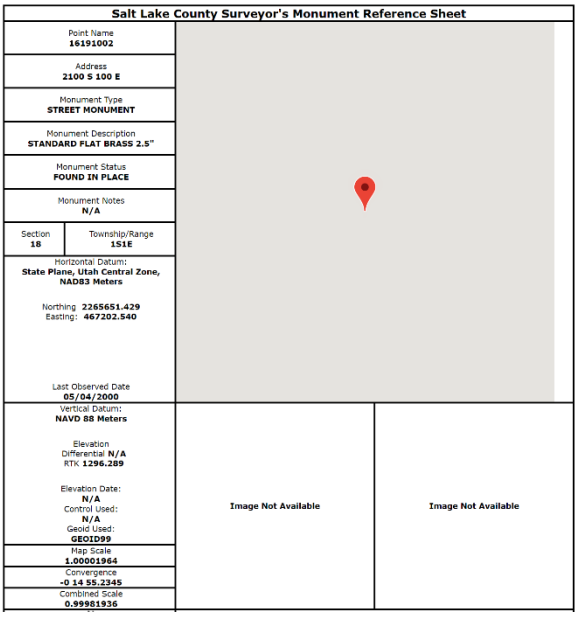
We know from experience checking in on similar monuments in the area that the County Tie Sheets are always within a couple of hundredths of RTK solutions using the local ‘TURN’ network.

Our goal is to use the two street monuments, without occupying them, but checking in on the previous survey POB as a check point and then resetting the NW corner.

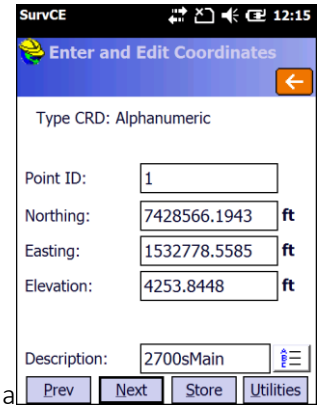


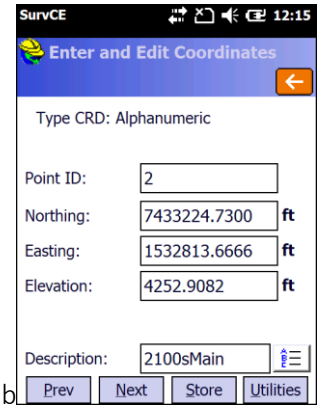
Enter the two street monuments (a 2700 S) (b 2100 S) as points 1 and 2:

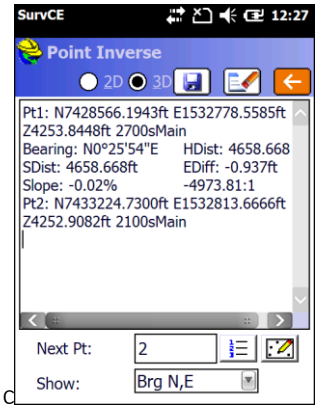




The tie sheets are in meters so you need to enter 'M' after each distance:

a 

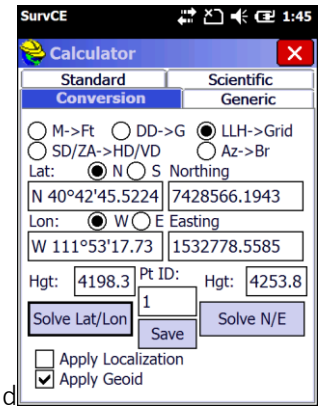
b 

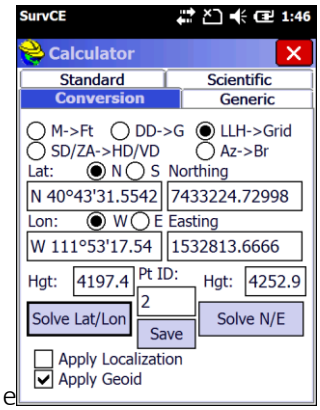
c 

Inversing (c):

```
RECORD:  N0 05 00 E        4659.500 (1/CSF 1.000178592)
Bearing: N0°25'54"E   HDist: 4658.668ft
SDist: 4658.668ft     EDiff: -0.937ft
Slope: -0.02%    -4973.81:1
```

Use COGO: Calculator: Conversion to compute the Lat/Lon/Ellipsoid height at these monuments:

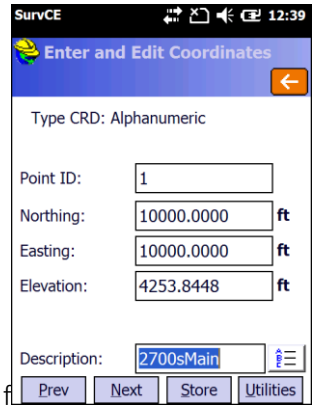
d 

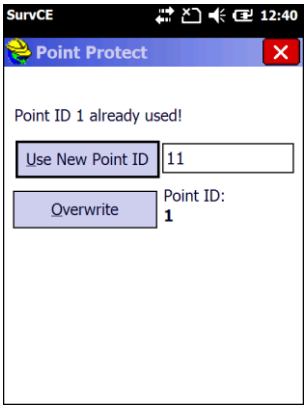
e 

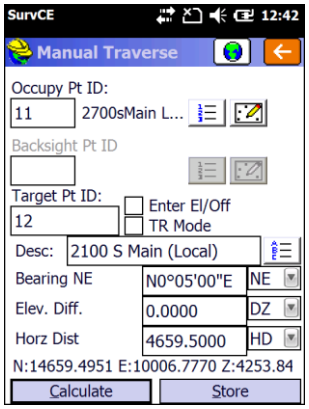
N 40°42'45.522485"
W 111°53'17.733773"
4198.313 (ellips)

N 40°43'31.554234"
W 111°53'17.540435"
4197.441 (ellips)

Now that we have geographic coordinates (Lat,Lon,Height) for these two controlling monuments, we can create a local coordinate system. Let's start at the South control point and call it 10,000, 10,000 with the elevation from point 1. In COGO: Keyboard Input, recall point 1 then set Northing and Easting to 10,000, when prompted to overwrite change the PID to 11, next project a point (at ground) the record bearing and distance from 11 (use COGO: Manual Traverse) (h):

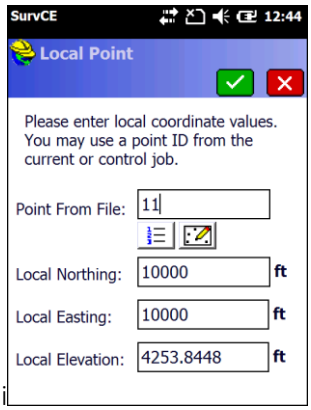
f 

g 

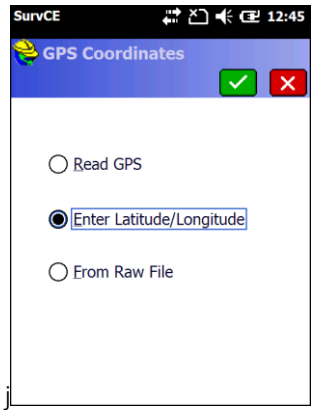
h 

Now create ground system that matches the plat. From Equip: Localization use point 11 as the first control point's local value (i), you will have to hand enter the Lat/Lon/Height (j,k), since the local point's elevation exactly matches the control point leave Elevation enabled (l):

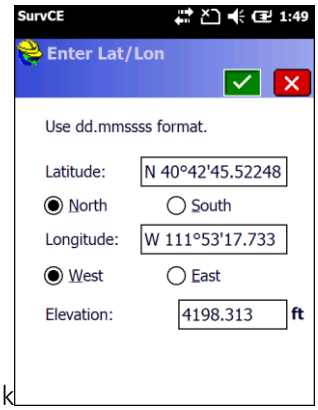
i



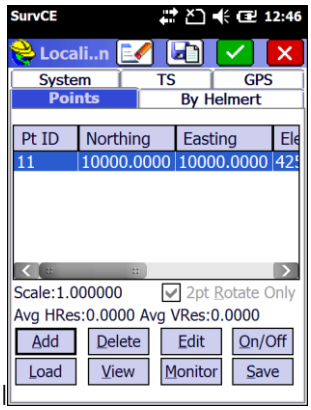
j



k

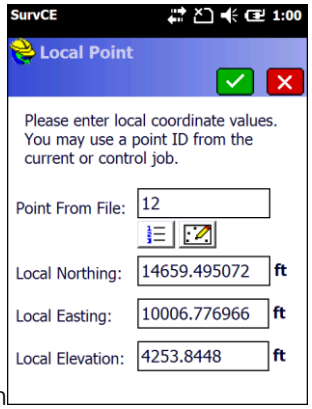


l

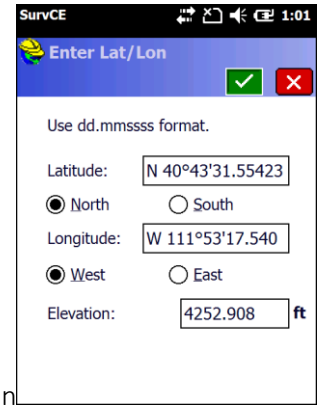


Next enter the second control point 12. Use point 12 for local coordinates (m), then hand enter the Lat/Lon/Height (n), turn off vertical (o):

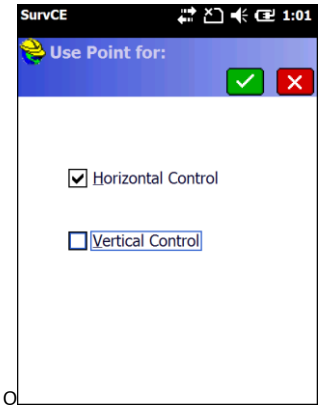
m



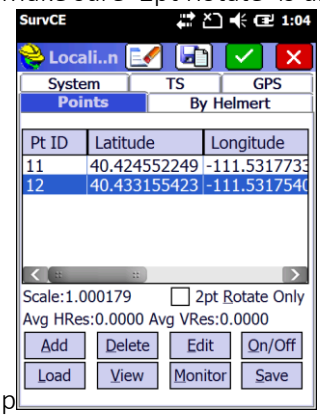
n



o



Make sure '2pt Rotate' is unchecked, notice that the scale is exactly what we calculated earlier:



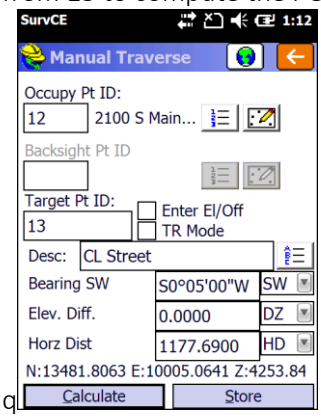
p

There are is no raw data (all of the points so far are SP's) so SurvCE does not offer to reprocess the raw file.

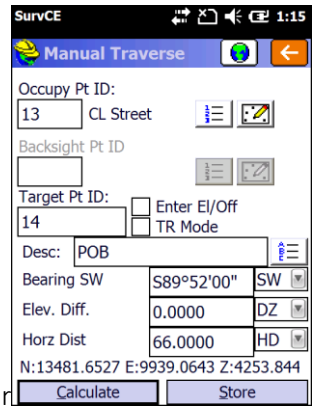
Now let's use the ALTA survey to compute local coordinates from the 2100 S Main control point back to the POB:

S 0 5 0 W 1177.69 to CLStreet [13], thence
S 89 52 0 W 66.00' to POB [14], thence
S 89 52 0 W 687.61 to the NorthWest corner that we want to stake [15]

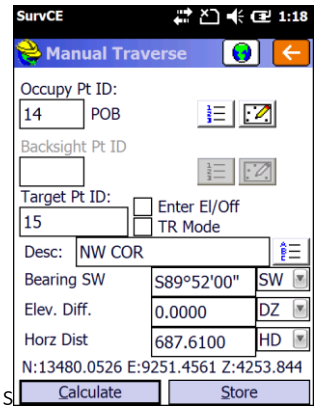
Starting at PID 12, use COGO: Manual Traverse to compute PID13 (q) the street CL, then continue West from 13 to compute the POB (r), then continue from PID 14 the POB west to the NW corner 15 (s):



q

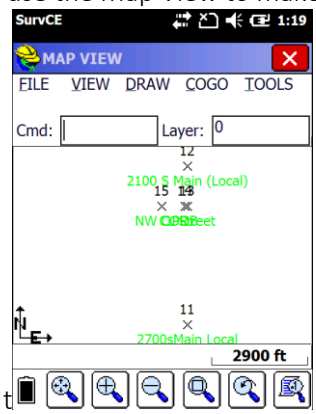


r



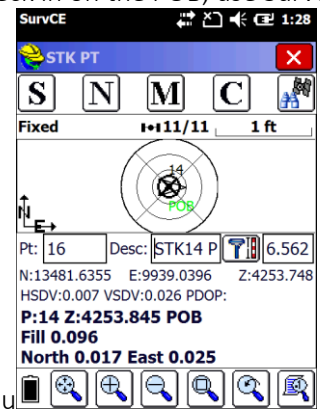
s

You can use the Map View to make sure that we are on track (t):



t

Now check in on the POB, use Survey: Stake Points and target the POB [14](u):



u

Considering how we got here, a couple hundredths in Northing and Easting is okay.

Now we can stake the North West lot corner with confidence that we are on the previous survey. (Actually, we checked in on two additional points hitting them within a couple of hundredths.)

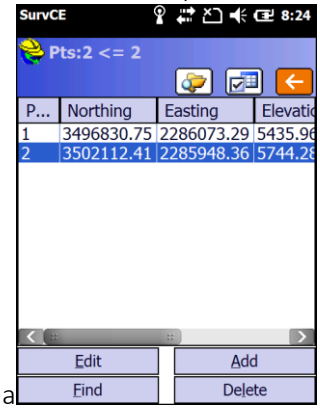
SURVCE / GNSS: FIXING MISTAKES

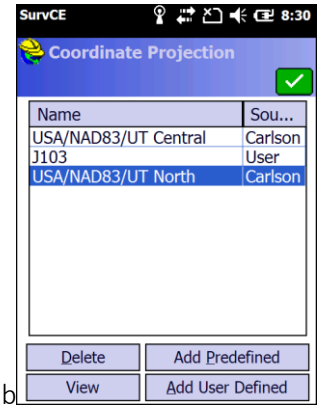
Mark Silver | Tuesday 10:00 -11:30 am / Bay

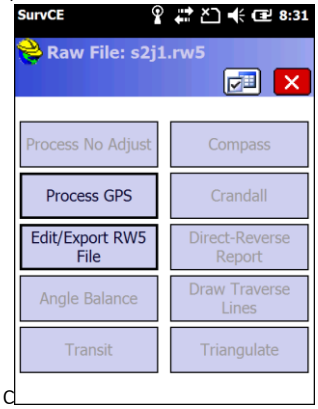
01:: I just collected 1,200 GPS field shots in the wrong state plane zone!

Ouch! That hurts, but it is no big deal. Just reprocess the raw file.

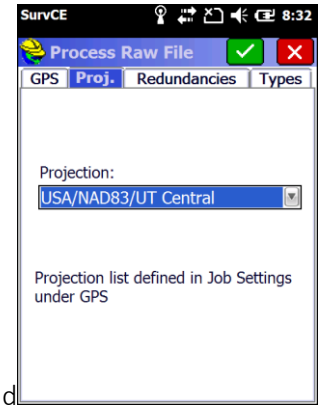
Here are some points that were collected in Utah North NAD83 (a):

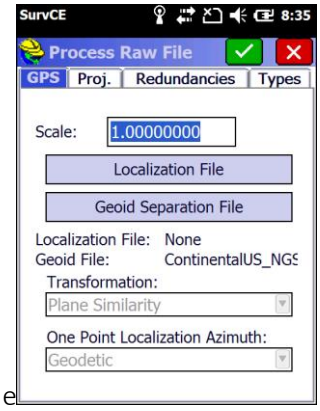
a 

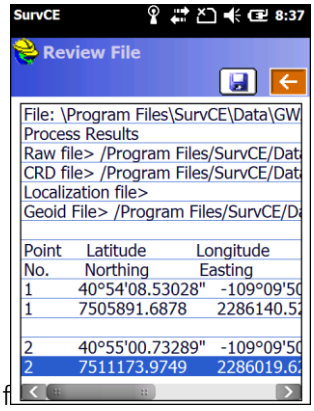
b 

c 

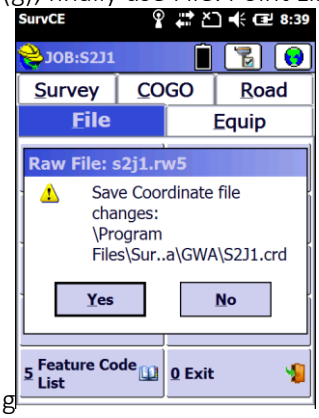
To reprocess, first make sure that the target projection is available in the Projection List, (File: Job Settings: System (tab)) (b) MAKE SURE YOU SELECT THE DESIRED PROJECTION HERE (because you want additional points to have the desired projection); then File: Raw Data; choose the current job raw file (c). Click on 'Process GPS' then choose the desired projection on the 'Proj.' tab (d), on the GPS tab make sure the localization file is empty and a Geoid file is selected (e) click the green check mark, a review of the newly projected points is displayed (f) which you can save with the disk button. Click on the red back arrow.

d 

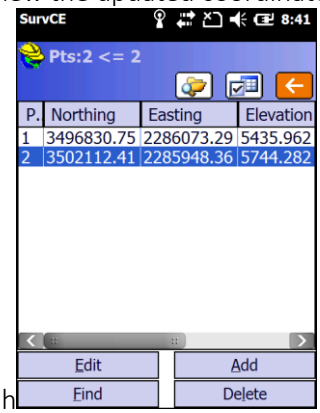
e 

f 

Then click on the Red X to exit the Raw File tool. Click on 'Yes' when prompted to save the coordinates (g); finally use File: Point List to view the updated coordinates:



g



h

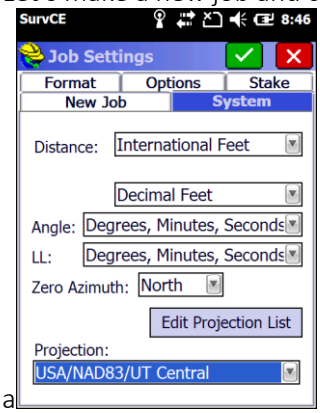
Process GPS in Raw File ONLY works for points that have GNSS underlying data. Stored Points (SP) won't be reprojected.

The only way to get GNSS data is to setup a base OR to store a GNSS derived point.

02:: I just collected a ton of GPS data in international feet, it should have been US Survey Feet!

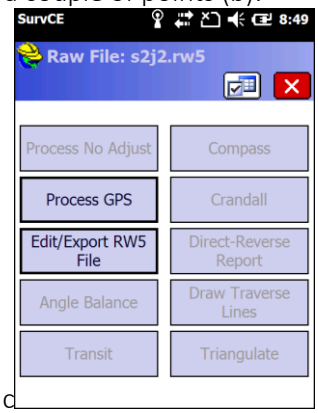
This is a very common issue and it is harder to fix than you might expect.

Let's make a new job and choose International Feet (a) and store a couple of points (b):



a

b

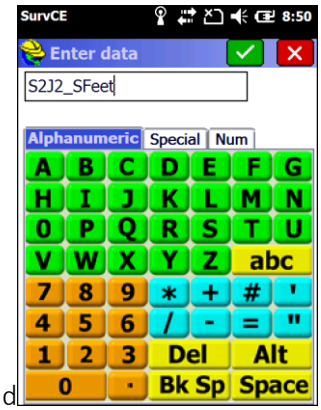


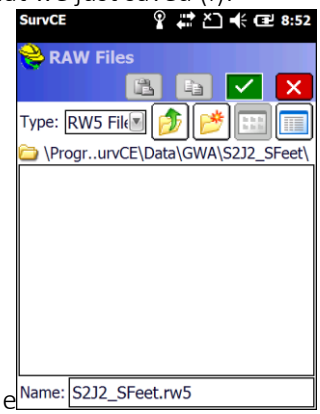
c

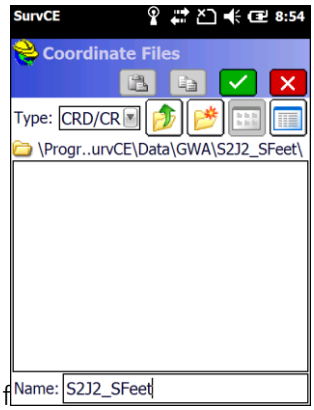
The best thing is to store the Raw Data file in a new folder: choose File: Raw Data, select he current file and then click on 'Edit/Export RW5 File' (c), then push the 'Save' button:

Make a new folder with the new units as part of the name (d); enter the folder and store the job with a filename that matches the folder (e); return to the File menu and open a new job in the new folder with

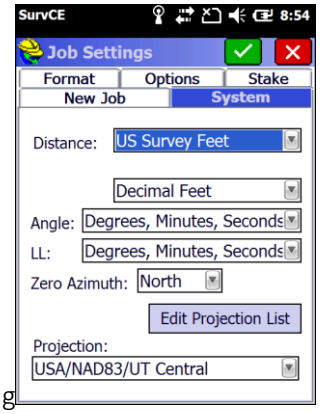
the same name as the raw file that we just saved (f):

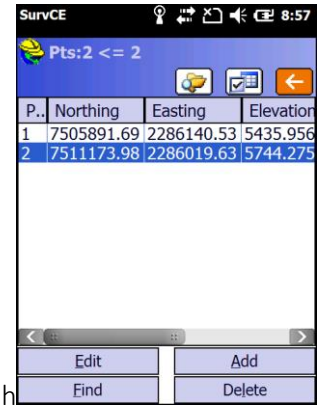
d 

e 

f 

When prompted, select 'Survey Feet' (g). Go to File: Raw File and then click on Process GPS, then green check mark, then red back, then Yes. Check the final coordinates in File: Points, they should be in the selected units:

g 

h 

03:: I collected a day's worth of data using an autonomous base position, I would like to convert it to a true base position.

Adjusting Data Stored with an Autonomous Base to an OPUS Position

Often when you first visit a site, you will use '**Read GPS**' to initialize your base position. The resulting position will be within 6 feet of the True position for the base point, but it will not be exact. The stored / broadcast base location will have some ΔNorthing ΔEasting ΔHeight from the True NAD83_2011 Epoch 2010.0 framed coordinate for my base.

Every point that you store will include this positional offset: the vectors between the Base and the Rover points will all be exact, but the entire job will be 3D shifted around the true positions by the ΔNorthing ΔEasting ΔHeight.

This section details a workflow to adjust your autonomous day's work to exactly match an OPUS position.

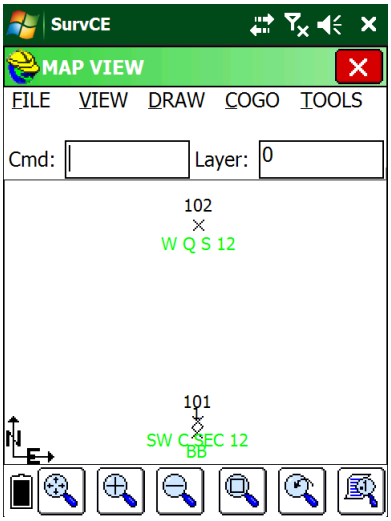
For this example:

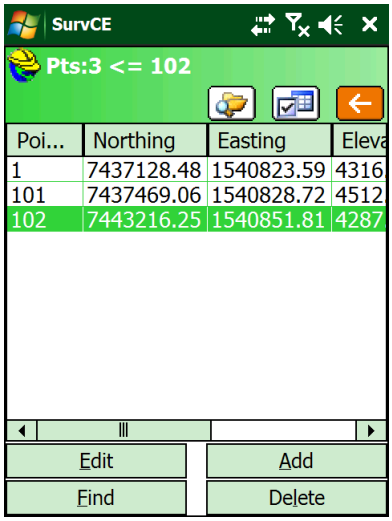
A hub and tack have been set at a random point south of a PLS job site

The Base was initialized using '**Read GPS**' as point ID 1 with description of '**BB**' as shown in the

previous section

Two points: the South West Corner Pt 101 and West Quarter of Section 12 Pt 102 have been stored:





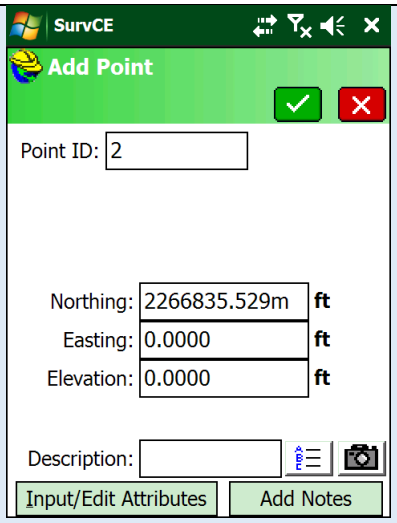
The Static Occupation file from the Base was downloaded and submitted it to OPUS using the tools and procedures described in the 'Downloading, Processing and Archiving Static Data' section found on page **Error! Bookmark not defined.**.

NGS's OPUS returned a OPUS report which is partially shown below:

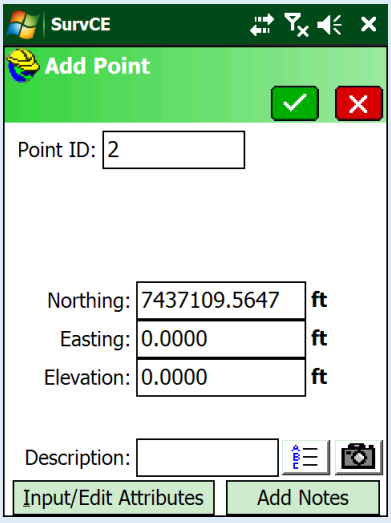
```
REF FRAME: NAD_83(2011)(EPOCH:2010.0000)              IGS08 (EPOCH:2017.6624)

         X:     -1802337.501(m)    0.013(m)          -1802338.395(m)    0.013(m)
         Y:     -4492708.224(m)    0.013(m)          -4492706.940(m)    0.013(m)
         Z:      4141119.504(m)    0.007(m)           4141119.412(m)    0.007(m)

       LAT:    40 44 10.27259      0.007(m)        40 44 10.28846      0.007(m)
     E LON:   248  8 27.05615      0.007(m)       248  8 27.00042      0.007(m)
     W LON:   111 51 32.94385      0.007(m)       111 51 32.99958      0.007(m)
    EL HGT:          1304.150(m)    0.017(m)             1303.439(m)    0.017(m)
 ORTHO HGT:          1320.877(m)    0.032(m) [NAVD88 (Computed using GEOID12B)]

                        UTM COORDINATES     STATE PLANE COORDINATES
                         UTM (Zone 12)          SPC (4302 UT C)
Northing (Y) [meters]     4509826.918          2266835.529
Easting (X)  [meters]      427456.339           469661.993
Convergence  [degrees]    -0.56068672          -0.23006449
Point Scale                0.99966477           1.00002259
Combined Factor            0.99946031           0.99981805
```

The method for entering a new point, #2 differs depending on if the projection (the coordinate system) is the State Plane projection returned in the OPUS solution, or a Localized Coordinate System:

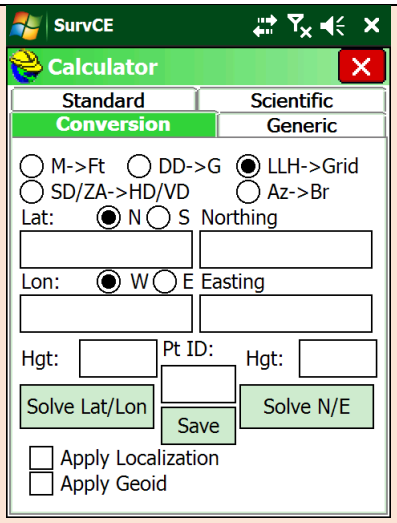
State Plane Coordinate System	Localized Coordinate System
Enter a new pointe '2' from the '**File**: **Points**' by pressing '**Add**':	Go to the '**COGO**' tab and click on the '**8 Calculator**' button, then select the '**Conversion**' tab and click the '**LLH->Grid**' button:



Enter the Northing from the OPUS result with a 'm' after the number, when you click to the Easting the coordinate will automatically change to US Survey Feet:

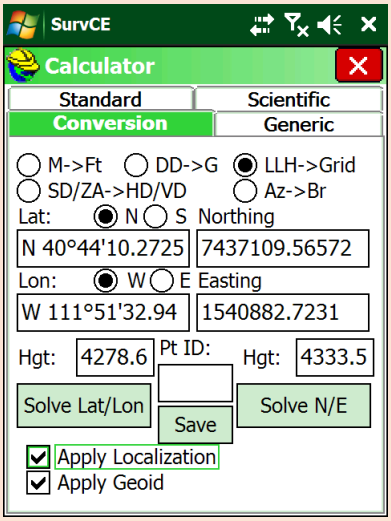


Do the same for the Easting and **Orthometric** elevation, don't forget to enter a 'm' after each:

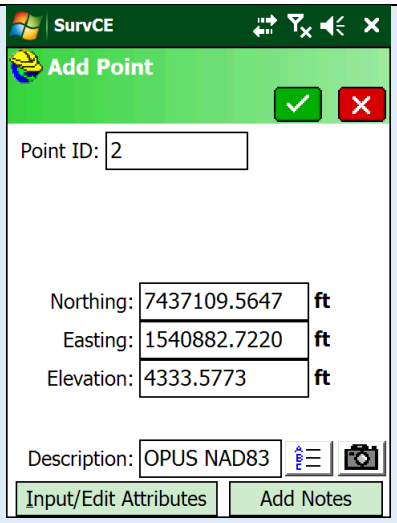


Click the '**Apply Localization**' and '**Apply Geoid**' checkboxes.

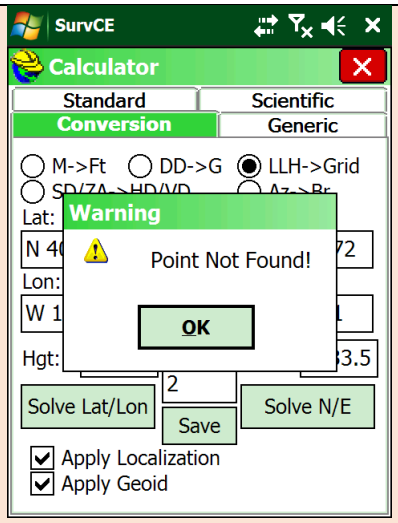
Enter the NAD83 Latitude, Longitude, and Ellipsoid Height on the left side. Be sure to put an 'm' after the metric ellipsoid height:



Click the 'Solve N/E' button on the right, then enter 2 (or any unused point ID) in the 'Pt ID:' box:'

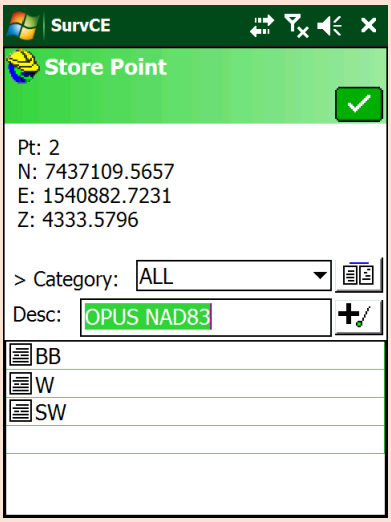


Click the green check mark to accept the new point.



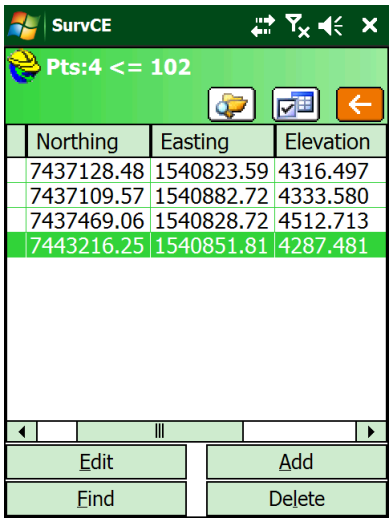
SurvCE will note that point #2 does not exist, click OK,

then click the 'Save' button:



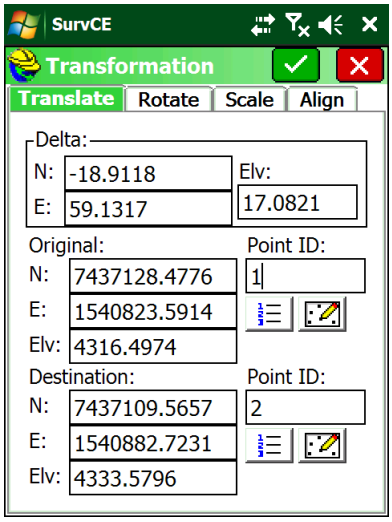
Enter a reasonable description as shown above and click the green check mark.

If you return to the 'File: Points' list you can view the offset from the OPUS result to the autonomous base:

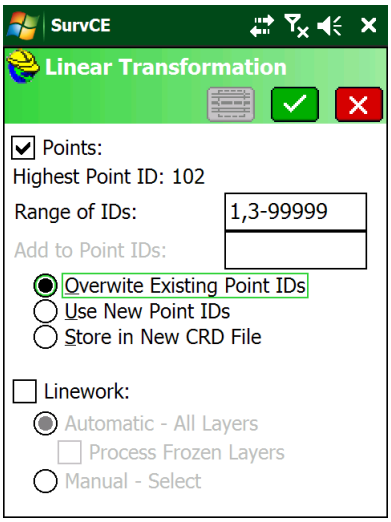


Click the red back button to return to the main menu.

Go to the '**COGO**: **7 Transformation**' tool from the main menu. Enter the '**Original Point ID:**' as '**1**' and the '**Destination Point ID**' as '**2**':

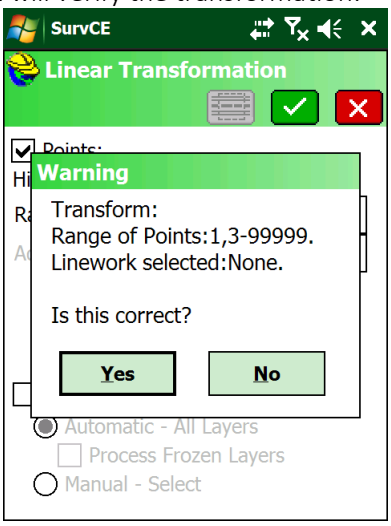


SurvCE will automatically calculate the ΔNorthing ΔEasting ΔHeight between the two points as shown above. Click the green check mark:



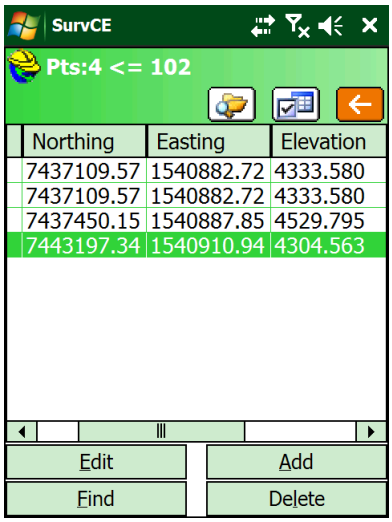
Change the '**Range of IDs**' to **NOT** include the OPUS point #2 that we just hand entered (as shown above), then click the green check mark.

SurveCE will verify the transformation:



Click 'Yes'. The adjustment will be completed and the job coordinates will be modified to match the OPUS solution.

You can verify that it was successful by returning to the 'File: Points' list:



Points 1 and 2 are now identical and points 101 and 102 have been adjusted.

03B:: How to read a GNSS Raw File

GNSS Base

The following discussion explains what is going on for when you setup a base in SurvCE, what gets loaded in the receiver and what entries are made in the .CRD, .REF and .RW5 files:

.CRD	Job 'Card' file. May also have a .CRDB extension (new style)
.REF	Base Reference file

Information you may need when looking at this discussion and example:

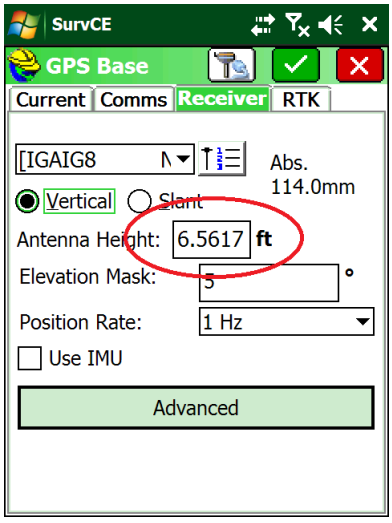
iG8	Receiver Type	IGAIG8	
PC	1301.0562 m = 4268.5489 sFeet	Electrical Phase Center of GNSS antenna element	
HR	6.9357 = 6.5617 + 0.3740	HR = (HI + L1) ; Distance from GM to PC	
L1	0.1140 m = 0.3740 sFeet	L1 Offset (distance from ARP to PC)	
HI	2.0000 m = 6.5617 sFeet	Vertical distance from GM to ARP	
SHMP	0.0839 m	Slant Height Measurement Point (distance from ARP) at bottom of receiver to the slant measurement point	
ARP	2.000 m higher than GM	Antenna Reference Point (bottom of receiver)	
GM	4261.6129 sFeet = 1298.9422 m 4316.4974 sFeet = 1315.6710 m Ortho	Ellip	Ground Mark (the point at the tip of the rod)
GEOID	-16.728 m = -54.8818 sFeet	GEOID12B separation at the GM	
R		radius of receiver at the SHMP	

SurvCE Job is set to Utah Central NAD83, US Survey Feet

The base position for this example is:

40 44 10.457107	-111 51 33.712948	DMS: DD MM SS.ssssss
40.7362380852	-111.8593647077	Decimal Deg: DDD.ddddddddddd

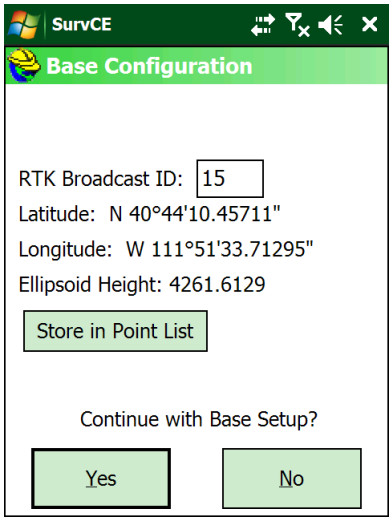
When you setup a base, the HI is entered on the Receiver tab.



In this example the base is on a fixed height 2-meter rod so the Antenna Height is:

HI	2.0000 m = 6.5617 sFeet	Vertical distance from GM to ARP

After configuring the 'RTK' tab, and then doing a 10 point average, this is what the '**Base Configuration**' screen looks like:



The displayed Ellipsoid height (4261.6129) is the Ground Mark (GM) ellipsoid elevation in job distance units (US Survey Feet.)

Ground Mark (GM) 4261.6129 sFeet = 1298.9422 m Ellipsoid

When you click on the '**Store in Point List**' button, the point is stored in the .RW5 file with raw data (it is not just a Stored Point (SP)).

Here is a snippet showing the two lines that '**Store in Point List**' generates:

```
GPS,PN1,LA40.441045710682,LN-111.513371294781,EL1301.056221,--BB
--GS,PN1,N 7437128.4776,E 1540823.5914,EL4316.4974,--BB
```

Discussion:

This 'GPS,' line has the base position in DD.MMSSssssss, the height is the ellipsoid height of the PC in meters. This is the 'raw' data for the base point.

This '--GS line' is the grid coordinates and Orthometric Height of the Ground Mark in SFeet and the orthometric elevation. Note that 4316.4974 = 4261.6129 – (-54.8818) Ortho = Ellipsoid - Geoid

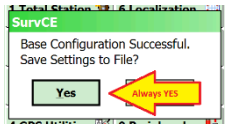
the point list entry (**File**: **Points**) looks like this:

Northing	Easting	Elevation
7437128.48	1540823.59	4316.497

This point matches the --GS line in the raw file. Note that the elevation is the orthometric height of the Ground Mark. This is the same point that an OPUS solution references.

.REF File Description

When you finish setting up the base, SurvCE prompts you to 'Save Settings to File':



You always should click on '**Yes**'.

This is the .REF file that is generated:

```
VERSION2
40.7362380852
-111.8593647077
1298.9422109783

15
```

Note that the .REF file has the decimal (DD.ddddddddd) for Lat, Lon; and the Ellipsoid Height of the GM in meters. The '15' on the last line is the 'RTK Broadcast ID' entered by the user.

The .REF file is extremely useful for setting the base on the same Ground Mark on subsequent days, you only need to supply the antenna height and the base can be loaded with coordinates that result in identical Rover points.

.RW5 Base File Description

The file below shows the raw file entries for the example base setup. Each section is color coded to match the description lines which follow:

```
--Entered Base HR: 6.5617 ft, Vertical
LS,HR6.9357
GPS,PN1,LA40.441045710682,LN-111.513371294781,EL1301.056221,--BB
--GS,PN1,N 7437128.4776,E 1540823.5914,EL4316.4974,--BB
--Base Configuration by Reading GPS Position
--DT02-03-2015
--TM00:57:26
--Entered Base HR: 6.5617 ft, Vertical
--Antenna Type: [IGAIG8          NONE],RA0.0676m,SHMP0.0839m,L10.1140m,L20.0911m,--L1/L2 Internal Antenna
BP,PN15,LA40.441045710682,LN-111.513371294781,EL1301.0562,AG2.0000,PA0.1140,ATAPC,SRBASE,--
--GS,PN15,N 7437128.4776,E 1540823.5914,EL4316.4974,--Base
--GT,PN15,SW1964,ST310997000,EW1964,ET310997000
```

A comment that details the HI (GM to ARP) height entered by the user.

LS is the HI + L1 (6.9357 = 6.5617 + 0.3740) in the Distance units (SFeet)

The following two lines were stored by pressing **Store in Point List:**

'GPS' The base position in DD.MMSSssssss, the height is the ellipsoid height of the PC in meters.

'--GS' The grid coordinates and Orthometric Height of the Ground Mark in SFeet
4316.4974 = 4261.6129 – (-54.8818) Ortho = Ellipsoid – Geoid

The red section is the final Base Configuration entry. It details the method, the date (DT), the time (TM). The HR (Receiver Height) is shown with the measurement method: Vertical or Slant.
The `--Antenna Type` message includes everything needed to compute the PC from the GM for Vertical and Slant measurements:

- The 20-character antenna name: `[IGAIG8          NONE]`
- the receiver radius at the SHMP: `RA0.0676m`
- the distance from the ARP to the SHMP: `SHMP0.0839m`
- the L1 offset (distance from the ARP to the L1 PC): `L10.1140m`
- the L1 offset (distance from the ARP to the L2 PC): `L20.0911m`

The final three lines include a BP (Base Point) 3-record set which includes

BP record:

PN	Point ID
LA	Latitude in DD.MMSSssssssss
LN	Longitude in DDD.MMSSssssssss formant
EL	Elevation of PC in meters
AG	Antenna-Ground, HI (GM to ARP), Instrument Height in meters
PA	Phase Center to Antenna: L1 Offset in meters
ATAPC	broadcast point Phase Center: broadcast coordinate is for PC

A --GS comment record:

PN	Point ID
N	Projected Northing
W	Projected Easting
EL	Orthometric Elevation of the Ground Mark in job units
--	Description 'Base'

A – GT comment record (included if 'Store GPS Accuracy' is enabled)

PN	Point ID
SW	Start Week
ST	Start Time
EW	End Week
ET	End Time

04:: I did not store the base position as a point when I did a 'Read GPS', can I extract the base position from the raw file (.RW5) or the ref file (.ref)?

```
VERSION2
40.7362380852
-111.8593647077
1298.9422109783

15
```

Notice that the .REF file has the Ground Mark with Ellipsoid Height. You can convert the Lat and Lon to DMS and use the COGO: Calculator to convert to Grid Coordinates and add them to the job. You must add in the HI and L1 offset.

Or, you can look in the .RW5 file:

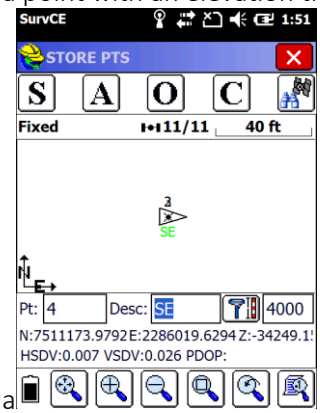
```
--Entered Base HR: 6.5617 ft, Vertical
LS,HR6.9357
GPS,PN1,LA40.441045710682,LN-111.513371294781,EL1301.056221,--BB
--GS,PN1,N 7437128.4776,E 1540823.5914,EL4316.4974,--BB
--Base Configuration by Reading GPS Position
--DT02-03-2015
--TM00:57:26
--Entered Base HR: 6.5617 ft, Vertical
--Antenna Type: [IGAIG8          NONE],RA0.0676m,SHMP0.0839m,L10.1140m,L20.0911m,--L1/L2 Internal Antenna
BP,PN15,LA40.441045710682,LN-111.513371294781,EL1301.0562,AG2.0000,PA0.1140,ATAPC,SRBASE,--
```

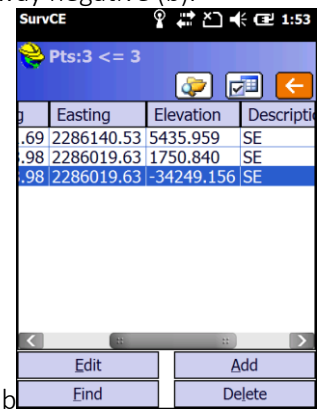
05:: I localized on two points at this job and stored a ton of existing features. Now I realize that one of my control points was actually an offset. How do I save my work?

Edit the point on the Points tab, save the localization and reprocess the raw file.

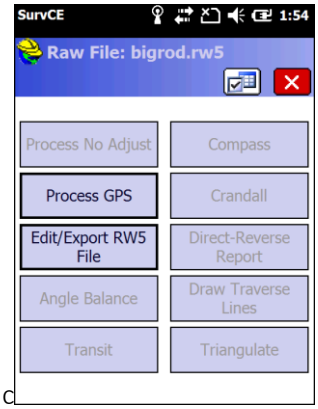
06:: I just stored a shot with a 40000 foot HI!

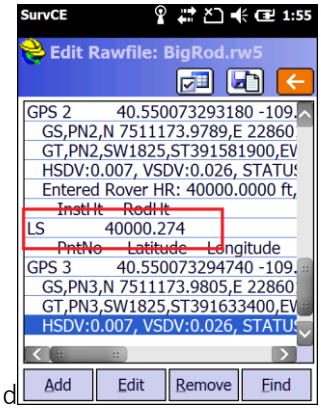
(Why does SurvCE let you do this?) You accidently store a point with an HI of 40000 feet (a). This makes a point with an elevation that is way negative (b).

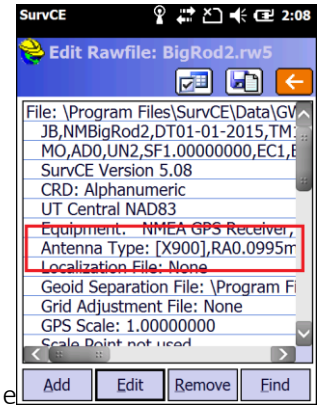
a 

b 

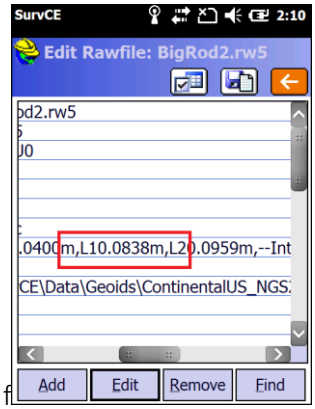
From the File menu: Raw Data (c), then Edit/Export RW5 File (d). Find the errant LS line (d) that can't be good! Before we edit it, drag to the top of the file and find the Antenna Type comment (e):

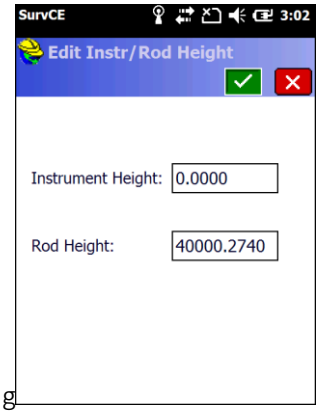
c 

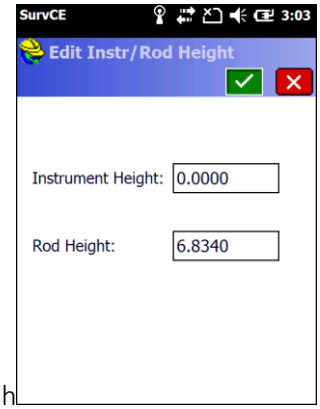
d 

e 

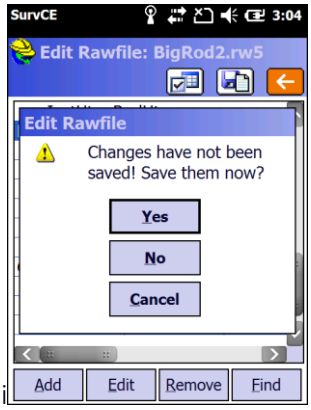
Drag to the right side (f) to find the L1 (phase offset) – 0.0838m; then go back to the LS line, highlight it and click on Edit (g) change the Rod Height to '2.0838m' (h)

f 

g 

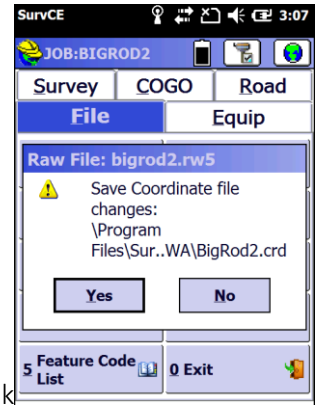
h 

Click the green check mark and then click the red back button. Click Yes (i) to save the changes; replace the file when prompted. Next click on 'Process GPS' (j); click on the green check mark, red back arrow, then red X, finally save the raw file (k).



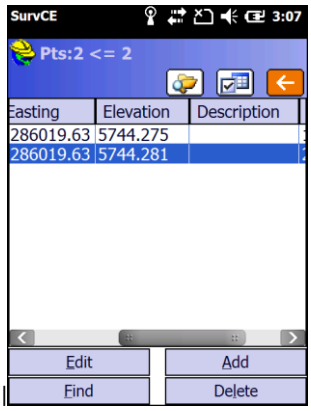
i

j



k

Click on Points to verify that the elevation has been fixed (l)



l