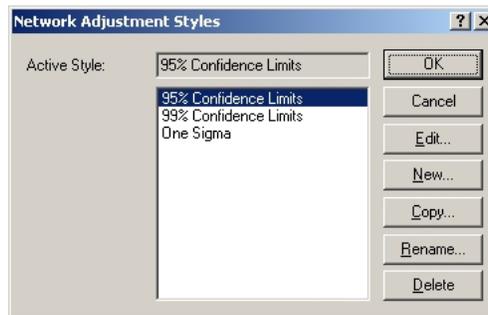




Location and Surveys

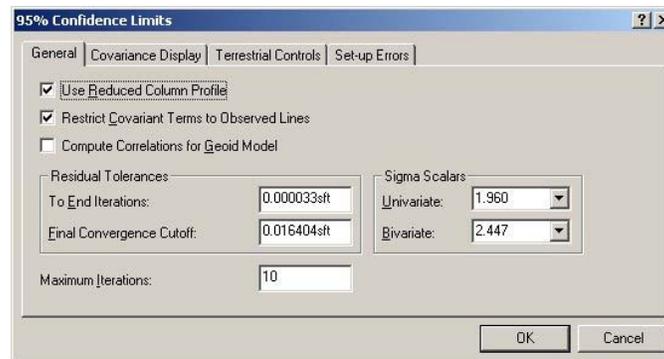
TGO Network Adjustment Minimally Constrained Adjustment

1. ADJUSTMENT / DATUM (default is WGS-84)
2. ADJUSTMENT / ADJUSTMENT STYLES – pick 95% Confidence Limits



Edit... to check defaults

- a. General Tab – Sigma Scalars Univariate 1.960 Bivariate 2.447





Location and Surveys

- b. Covariance Display 1.96 Horizontal 1.96 3 – Dimensional

95% Confidence Limits

General | Covariance Display | Terrestrial Controls | Set-up Errors

Horizontal

Express Precision as: Ratio Constant Term (C): 0.00000000sft

Propagated Linear Error (E): U.S. Scalar on Linear Error (S): 1.960

Three-Dimensional

Express Precision as: Ratio Constant Term (C): 0.00000000sft

Propagated Linear Error (E): U.S. Scalar on Linear Error (S): 1.960

Use Elevation errors if available

OK Cancel

- c. Set-Up Errors Error in Height of Antenna = 0.002 m or 0.007 sft Centering Error = 0.003 m or 0.010 sft
(You will need to add the Set-Up Error values the first time)

95% Confidence Limits

General | Covariance Display | Terrestrial Controls | Set-up Errors

GPS

Error in Height of Antenna: 0.007sft

Centering Error: 0.010sft

Terrestrial

Error in Height of Instrument: 0.000sft

Centering Error: 0.000sft

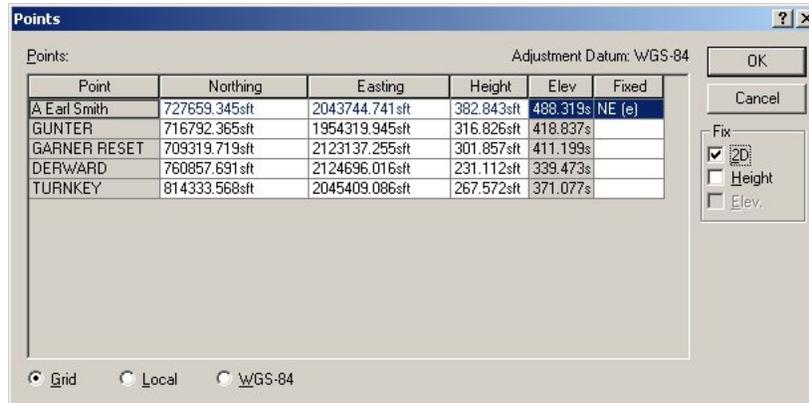
OK Cancel



Location and Surveys

3. Constraining One Control Point

- a. ADJUSTMENT / POINTS -- from the Points dialog box choose one of the control points to be held 2D by highlighting the control point and checking the 2D box to the right



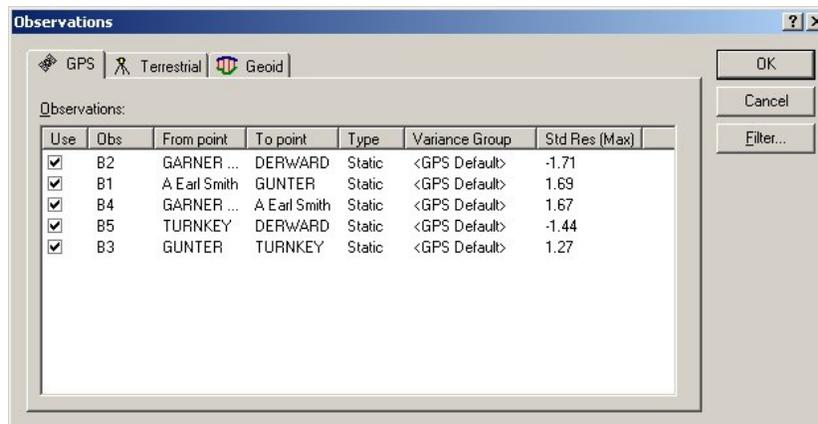
- b. ADJUST NETWORK -- select ADJUSTMENT / ADJUST
-- choose the ADJUST icon from the project bar (on left)
- c. Review and Evaluate Minimally Constrained Results
 - REPORTS / NETWORK ADJUSTMENT REPORT
 - Statistical summary – global statistics – FAIL?
 - Adjusted observations
 - Histogram of standardized residuals -- OUTLIERS?
 - Point error ellipses
- d. Do we have any OUTLIERS?
 - If YES, make note of the baseline number and continue to Step 4
 - If NO, go to Step 6.



Location and Surveys

Take a good look at the residuals of each Outlier. On occasion you may find that one bad observation throws several observations out as outliers. By disabling the worst outlier and readjusting, you may find that the other observations work. Do not remove observations from your adjustment without first looking at how the removal will affect the network configuration. At times, the residuals of these outliers are so small that they do not significantly effect the Network and can be left in the adjustment.

4. ADJUSTMENT / OBSERVATIONS / GPS Tab (uncheck baseline # of the outlier)



5. Return to Step 3b

6. DOES NETWORK PASS CHI-SQUARE TEST?

Review and Evaluate Minimally Constrained Results (See 3c)

If YES, go to Step 12

If NO, go to Step 7



Location and Surveys

7. ADJUSTMENT / WEIGHTING STRATEGIES / GPS Tab

Set scalar type to ALTERNATIVE

Obs	From point	To point	Next Scalar	Type	Variance Group
B1	A Earl Smith	GUNTER	0.49	Static	<GPS Default>
B2	GARNER ...	DERWARD	0.49	Static	<GPS Default>
B3	GUNTER	TURNKEY	0.49	Static	<GPS Default>
B4	GARNER ...	A Earl Smith	0.49	Static	<GPS Default>
B5	TURNKEY	DERWARD	0.49	Static	<GPS Default>

8. ADJUST NETWORK

Repeat Steps 6 and 8 until network passes CHI-SQUARE TEST, then go to Step 9.

9. REPORTS/ NETWORK ADJUSTMENT REPORT/ STATISTICAL SUMMARY/ WEIGHTING/ STRATEGIES / GPS OBSERVATIONS

Check to see what scalar was applied in order for the Network to pass the CHI-SQUARE TEST

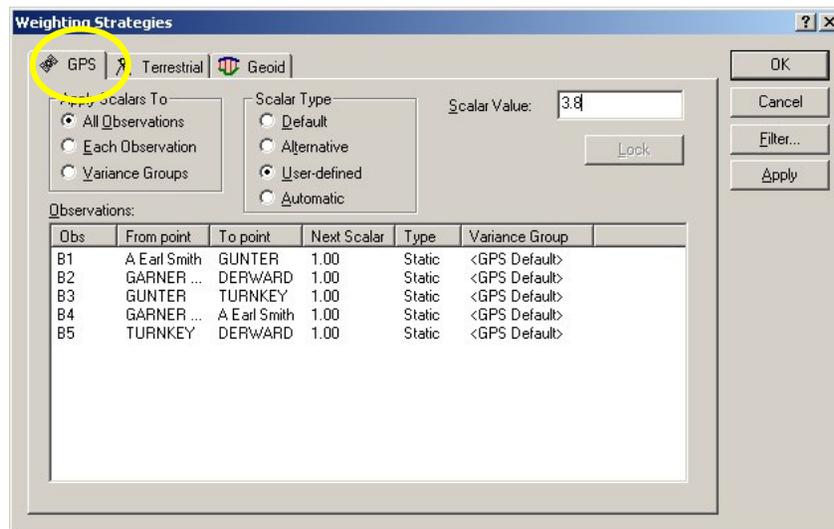


Location and Surveys

10. ADJUSTMENT / WEIGHTING STRATEGIES /GPS Change scalar type to USER DEFINED

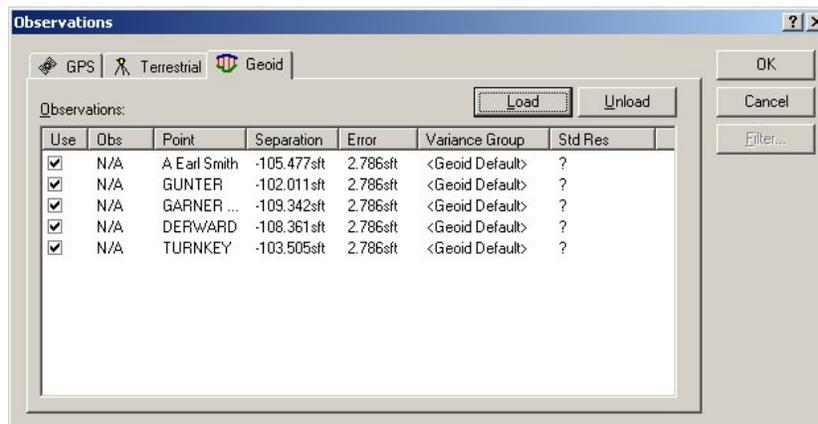
Take the scalar that was applied in the Network Adjustment Report and round up to the nearest tenth.

Example: If the scalar was 3.71, Use 3.80



11. ADJUST NETWORK

12. LOAD THE GEOID MODEL --- ADJUSTMENT / OBSERVATIONS / Geoid Tab / Load





Location and Surveys

13. ADJUSTMENT / POINTS

Make sure the original control point is highlighted, Check the Elev. Box to the right. You are now holding this control point Horizontally and Vertically

Point	Northing	Easting	Height	Elev	Fixed
A Earl Smith	727659.345sft	2043744.741sft	382.588sft	488.319s	NEe
GUNTER	716792.370sft	1954319.945sft	316.570sft	418.581s	
GARNER RESET	709321.894sft	2123146.236sft	302.240sft	411.582s	
DERWARD	760857.707sft	2124696.016sft	231.496sft	339.858s	
TURNKEY	814333.578sft	2045409.087sft	267.315sft	370.820s	

14. ADJUST NETWORK

Note – When controlling Preliminary Mapping step 15 can be omitted since a calibration is not needed.

15. ADJUSTMENT/ CALIBRATION COORDINATES/ Save...

Use the second option “New points with suffix”. Leave suffix as _GPS.

This will create New points inside your Project to be used in the calibration that have a _GPS suffix.

Save coordinates for calibration

Existing points

New points with suffix:



Location and Surveys

Fully Constrained Adjustment

At this time, decisions have to be made whether the control can be used or if there is any control points that do not agree and may introduce error into your network. If you have used HARN and CORS stations exclusively in your network your control should agree. If you are mixing Horizontal and/or Vertical control stations from non GPS network adjusted points you may find the control points may not work.

The Adjustment should be done as a continuous operation until completed. If you have to stop and get out of your project part way through the adjustment you may have to adjust it a couple of time to get back to the point you were at before you exited.

16. CHANGE DATUMS -- ADJUSTMENT / DATUM – Select NAD 83

17. ADJUSTMENT / WEIGHTING STRATEGIES / Geoid Tab
Set scalar type to ALTERNATIVE

Obs	Point	Next Scalar	Separation	Error	Variance Group
G17	NCRD	1.00	-33.231m	0.776m	<Geoid Default>
G18	NCLI	1.00	-33.012m	0.776m	<Geoid Default>
G19	NCFA	1.00	-33.517m	0.776m	<Geoid Default>
G20	NCKN	1.00	-35.749m	0.776m	<Geoid Default>
G21	b4951-1	1.00	-33.773m	0.776m	<Geoid Default>
G22	b4951-4	1.00	-33.816m	0.776m	<Geoid Default>
G23	b4951-2	1.00	-33.784m	0.776m	<Geoid Default>
G24	b4951-3	1.00	-33.813m	0.776m	<Geoid Default>



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18. View the NETWORK ADJUSTMENT REPORT / Control Coordinate Comparisons and find the station that agrees the best in horizontal and vertical. Go under POINTS in the ADJUSTMENT MENU and check the 2d and Elev. Block of the point you want to hold.

a. ADJUST the network

At this time you can see how this affects the network by going back to the NETWORK ADJUSTMENT REPORT / Control Coordinate Comparisons and see if remaining control points continue to move closer to their published values.

- b. Continue to fix the control stations one at a time and adjust (step 17a) in the order of the precision.

19. ADJUSTMENT / WEIGHTING STRATEGIES / Geoid Tab
Change scalar type to USER DEFINED

Take the [Geoid Scalar](#) that was applied in the Network Adjustment Report
Example: If the scalar was 0.11, Use 0.11

The screenshot shows the 'Weighting Strategies' dialog box with the 'Geoid' tab selected. The 'Apply Scalars To' section has 'All Observations' selected. The 'Scalar Type' section has 'User-defined' selected. The 'Scalar Value' field contains '.11'. The 'Observations' table is as follows:

Obs	Point	Next Scalar	Separation	Error	Variance Group
G17	NCRD	1.00	-33.231m	0.776m	<Geoid Default>
G18	NCLI	1.00	-33.012m	0.776m	<Geoid Default>
G19	NCFA	1.00	-33.517m	0.776m	<Geoid Default>
G20	NCKN	1.00	-35.749m	0.776m	<Geoid Default>
G21	b4951-1	1.00	-33.773m	0.776m	<Geoid Default>
G22	b4951-4	1.00	-33.816m	0.776m	<Geoid Default>
G23	b4951-2	1.00	-33.784m	0.776m	<Geoid Default>
G24	b4951-3	1.00	-33.813m	0.776m	<Geoid Default>



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The adjustment is now complete, although there are a few checks yet to do.

20. Make sure to CHECK --- REPORTS / NETWORK ADJUSTMENT REPORT

Does network pass CHI-SQUARE TEST?

If NO, you may have to go back to ADJUSTMENT / WEIGHTING STRATEGIES / [GPS](#) SCALAR type and change to ALTERNATIVE and ADJUST NETWORK until your network passes the CHI-SQUARE TEST.

If YES, check REPORTS / NETWORK ADJUSTMENT REPORT / ADJUSTED OBSERVATIONS to see what kind of value you have for the deflection in longitude (a value over 10 seconds may indicate a problem in vertical)



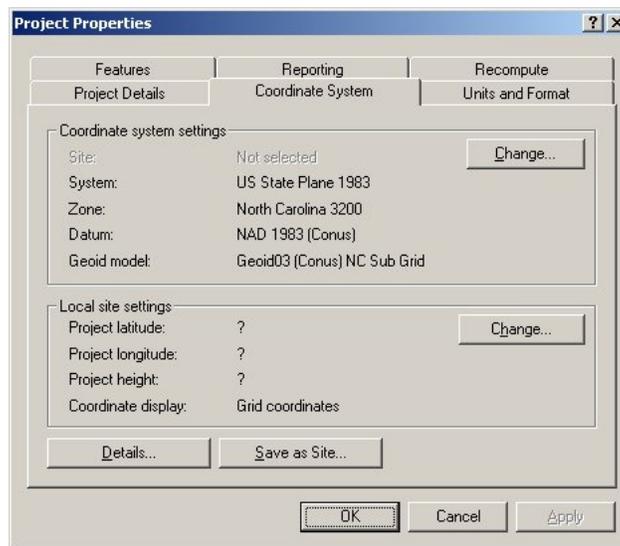
Location and Surveys

Localizing the Project

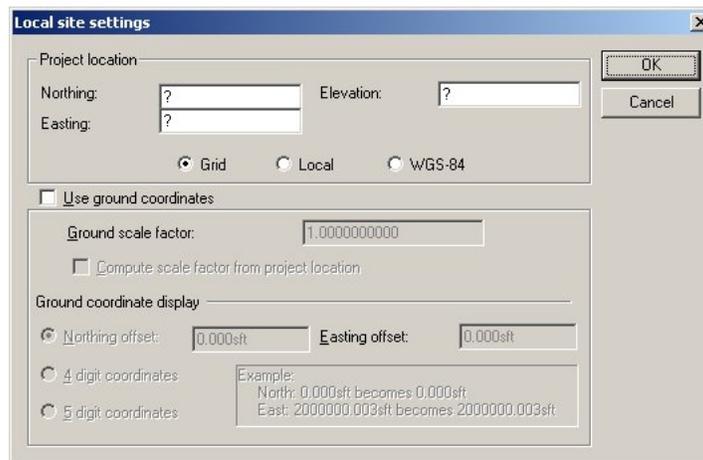
Note – When controlling Preliminary Mapping steps 19 and 20 can be omitted since a calibration is not needed.

21. Localize Project – FILE/ Project Properties

Select the Coordinate System Tab



Select [Change...] for Local site settings





Location and Surveys

Input Coordinate for Localization Point

Toggle to use ground coordinates

Enter Scale Factor*

Local site settings

Project location

Northing: 66494.459m Elevation: 8.910m

Easting: 712835.351m

Grid Local WGS-84

Use ground coordinates

Ground scale factor: 1.0001814

Compute scale factor from project location

Ground coordinate display

Northing offset: 0.000m Easting offset: 0.000m

4 digit coordinates

5 digit coordinates

Example:
North: 66494.459m becomes 66494.459m
East: 712835.351m becomes 712835.351m

OK Cancel

* Take Note that the Scale Factor is the inverse of the Combined Grid Factor used to localize the Project

Press **[OK]**. Project has now been Localized.



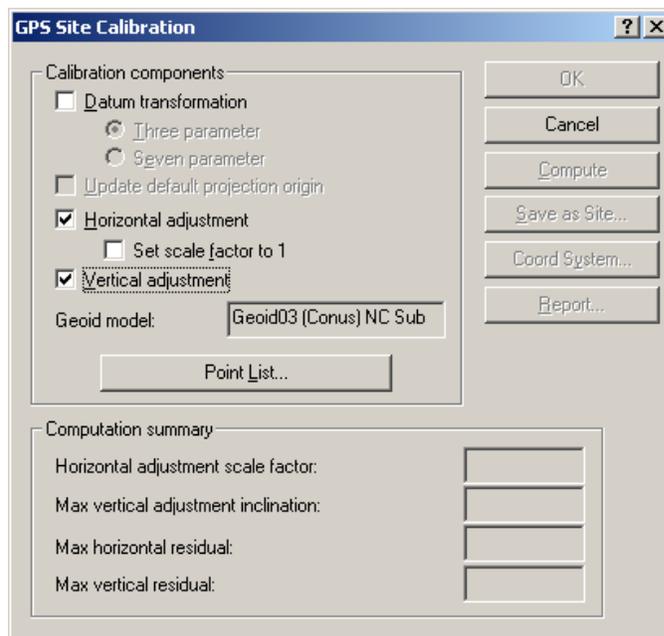
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GPS Site Calibration

Note that calibrating will remove the Network Adjustment. However copies of the Network Adjustment reports are in the REPORTS/NETADJUST folder under the project.

22. Calibrate Project - SURVEY/ GPS SITE CALIBRATION

- a. Check Horizontal and Vertical Adjustment as shown in the following figure.

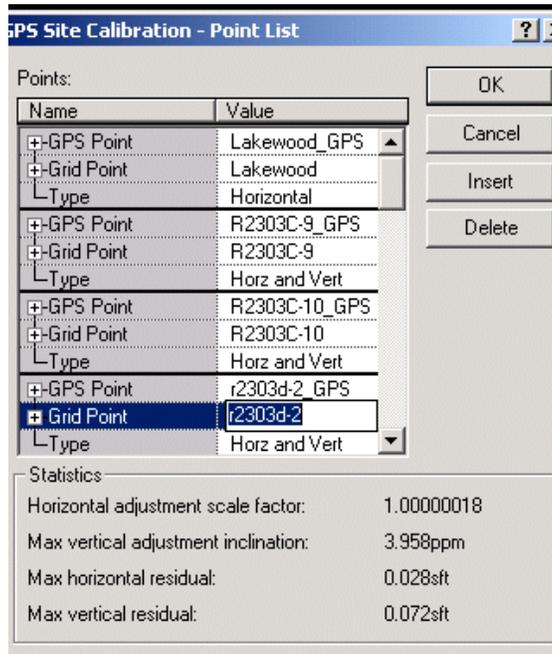


- b. Select **POINT LIST**



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- c. Under **POINT LIST** match the points w/ the _GPS suffix as the wgs84 reference positions and the points without the suffix as the Local values.

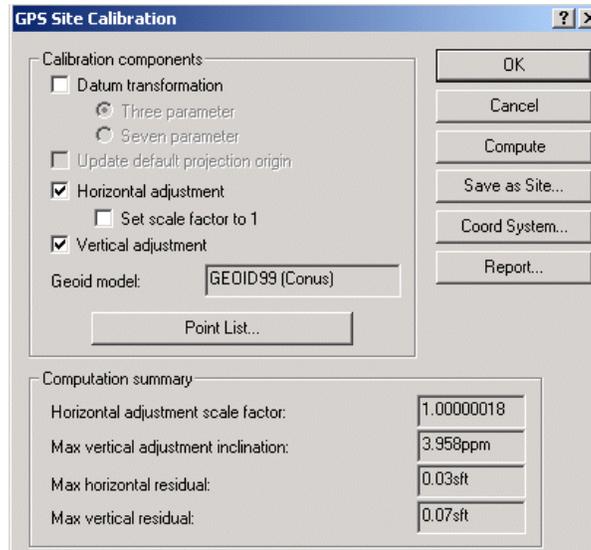


Watch the **Statistics** box to see how you calibration is working as you add points. You may have to make decisions on using some points as horizontal or vertical only if the point makes the residuals high.

- d. Select **OK** when you are satisfied with the points you have selected.



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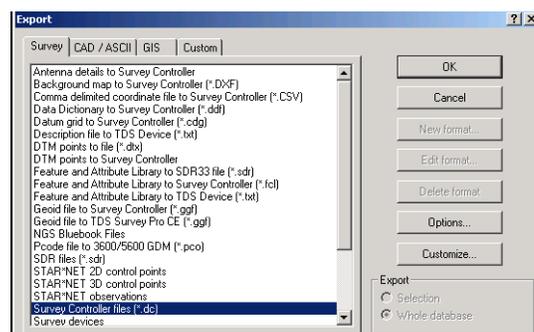


- e. Select **COMPUTE** and check the **COMPUTATION SUMMARY** for agreement.
- f. Select **Report** to create a Calibration Report to be used later for Plan Control Sheets. The file will be saved under the TGO project, Reports, Calibration directory.
- f. Select **OK** to accept Calibration.

Exporting Data from TGO

- 23. At this point in the project it is recommended to export “ Master “ files which will be the foundation for future surveys. In particular it is a good idea to export .DC and .CTL files. The .DC file can be put into your controllers and be used as template to make job files that work correctly for both GPS and Conventional methods.

Survey Control files (.dc): This export is under the **Survey** tab and creates a file for the controller.





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Most of the exports you need for DOT are under the **CAD/ASCII** tab.

- Geopak CTL :** Creates files for Geopak in .CTL format.
- Geopak INP file :** Creates files for Geopak input format.
- Geopak :** Creates an comma delimited ASCII files for Geopak as Point Number, X,Y,Z ,LCode PCode
- GPSRJxx.xls :** Creates files for input into the old GPSRJ spreadsheet.

L&S Survey Control Sheet – Adj. Coordinates :

L&S Survey Control Sheet – Ref. Coordinates :

Exports Localized and WGS84 points to be used to recreate the calibration. The **L&S Survey Control Sheet – Adj. Coordinates** should have only Localized points and the **L&S Survey Control Sheet – Ref. Coordinates** should have only **_GPS** points.

NCDOT Photogrammetry Export :

This file is in the proper format for Photogrammetric panels

24. Files that need to be saved for the future.

Calibration.html : The **Calibration.html** file, which is in the project directory under reports, needs to be saved for future use in the Survey Control Sheets. This file along with the **L&S Survey Control Sheet – Adj. Coordinates** and the **L&S Survey Control Sheet – Ref. Coordinates** file need to be sent in with the Control sheets. They will be used by Construction to recreate the Calibration.



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Appendix A

outlier

Outliers are observations which are identified by statistical analysis as having a residual too large for its estimated error. The term derives from the graphical position of an observation in a histogram.

residual

The correction, or adjustment, of an observation to achieve overall closure in a control network. Also, any difference between an observed quantity and a computed value for that quantity.

Chi-Square Test

This value lets you know how well the adjustment network fits together. If the reference factor is close to 1.0 and the degrees of freedom is acceptable, and the network is fitting together mathematically, and the Chi-square test passes.

When performing a successful least-squares adjustment, mathematical closure of the network is one important factor. Consider the Chi-square test to be your first indicator of mathematical closure.

tau (value)

A value computed from an internal frequency distribution based upon the number of observations, degrees of freedom, and a given probability percentage (95%). This value is used to determine if an observation is not fitting with the others in the adjustment. If an observations residual exceeds the tau, it is flagged as an outlier. Known as tau lines in the histogram of standardized residuals, vertical lines left and right of the center vertical line.