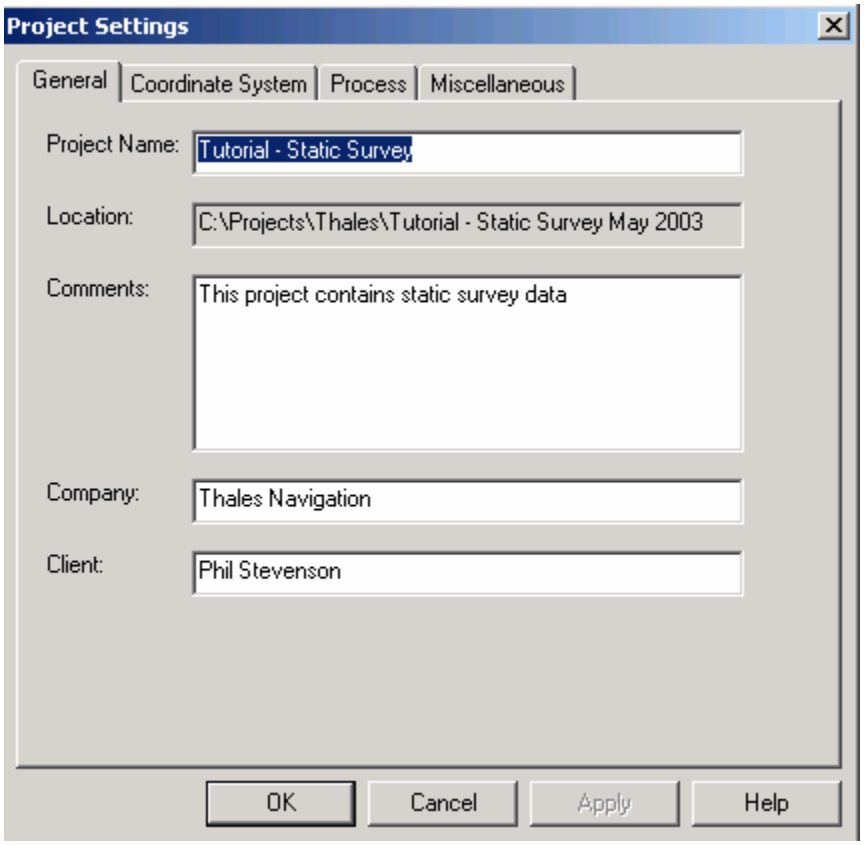
Ashtech Solutions: Data Cleaning Part One

In any survey project there lies a potential for mistakes made in the field work that will need to be cleaned up. Sometimes the fix is easy and sometimes not. This tutorial addresses some common mistakes and illustrates how they can be overcome.

Cleaning up field data

The first task that will save many headaches is to create a project that can be found again. This is best achieved by choosing a project name and creating a file folder that will accurately describe the project, thus making it easier to locate again. This is done in the Project Settings Menu under the General Tab as illustrated in screen shot 1.



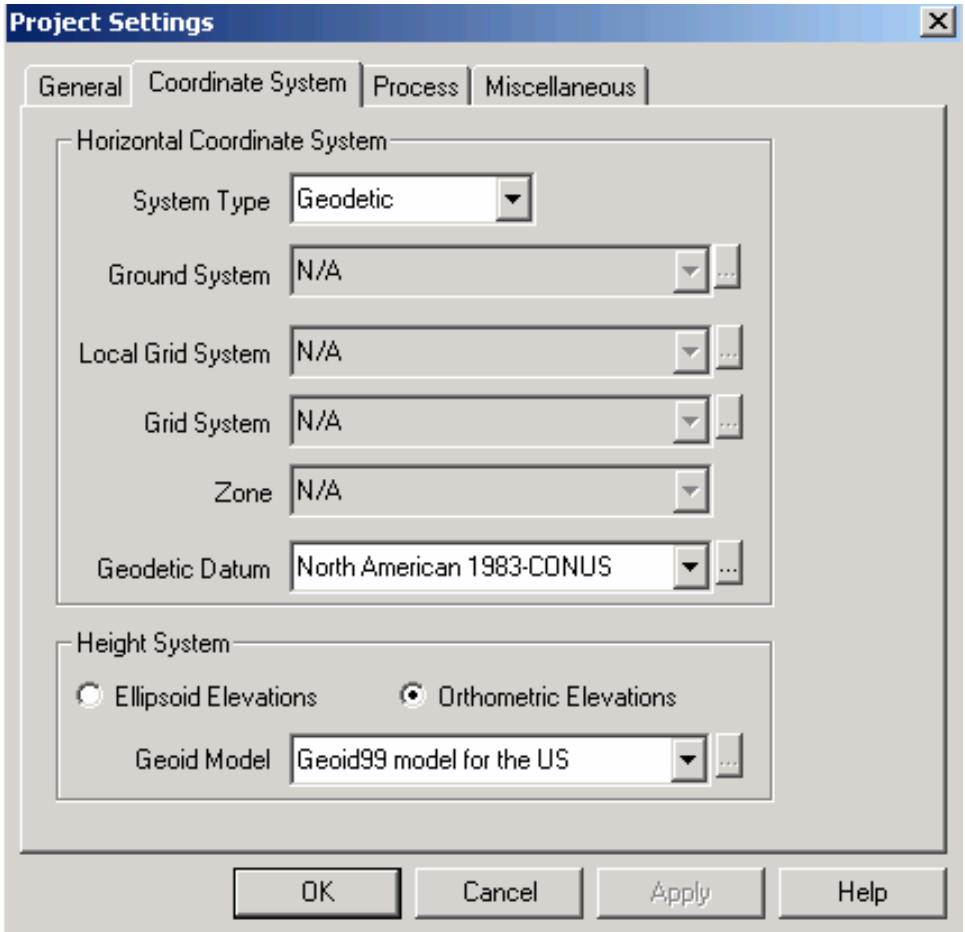
Screen shot 1

Notice in screen shot 1 under Project Name: *Tutorial – Static Survey*. This will help as a reminder of what this project was for and make it easy to find, especially if there are not any other projects with this same name.

Under Location: *C:\Projects\Thales\Tutorial – Static Survey May 2003* it is shown that the project is in a folder named Tutorial – Static Survey May 2003, which is a sub folder of Thales, which is a sub folder of Projects, which is a folder found on drive C.

Adding a brief description of the project under comments will also serve as a reminder of what the project entailed etc…

While in the Project Settings menu click on the Coordinate System tab (ref: screen shot 2).



Screen shot 2

It's always a good idea when setting up the coordinate system for a project to begin with something related to the National Spatial Reference System (NSRS).

When a ground or local grid coordinate system is used, the connection to the NSRS is broken and may make processing difficult. There is always time to convert to a local grid or ground coordinate system after the data processing and the minimally constrained adjustment are acceptable.

For more on the NSRS visit the following web site:

http://www.ngs.noaa.gov/PUBS_LIB/develop_NSRS.html

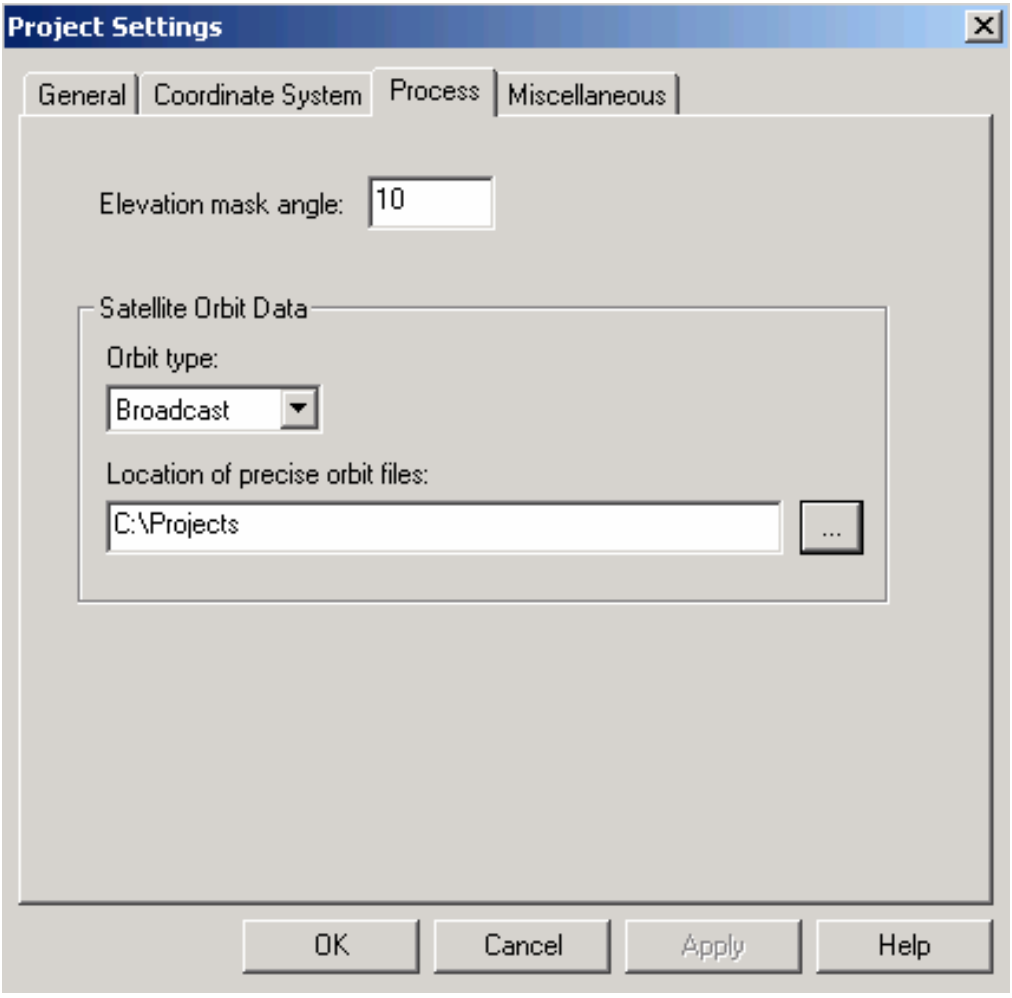
Notice in screen shot 2 that geodetic coordinates are to be used and that they are to be based on the North American Datum of 1983 and the Geoid99 model for the USA. This is shown in the boxes for System Type and Geodetic Datum. These choices were made because they match the control point data sheets obtained from the National Geodetic Survey

http://www.ngs.noaa.gov/cgi-bin/datasheet.prl

and they also match the coordinates for the position of the project control point that was determined using OPUS several months ago.

http://www.ngs.noaa.gov/OPUS/index.html

Next look under the Process tab in the Project Settings menu (ref: screen shot 3).



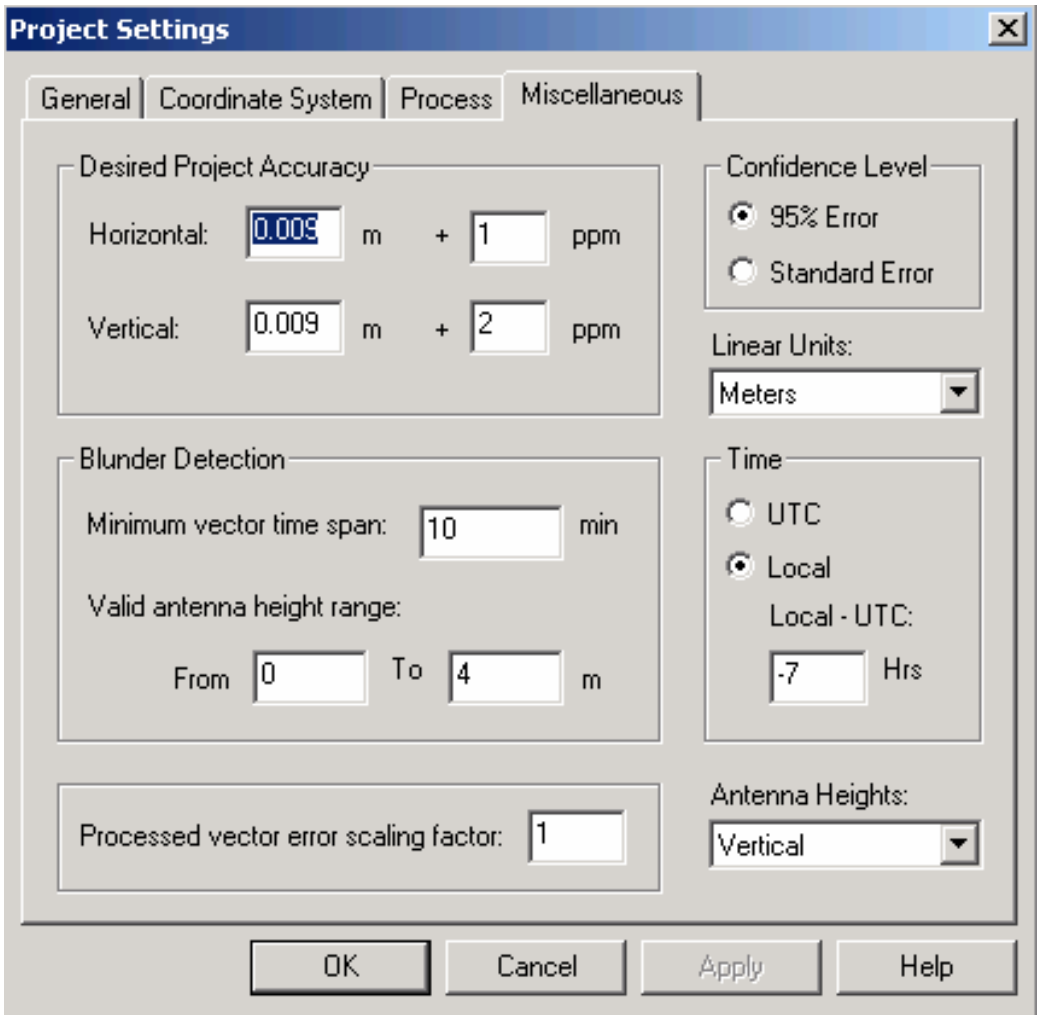
Screen shot 3

The vectors on the Tutorial – Static Survey project are short. This makes an elevation mask of 10 degrees and use of the broadcast orbits appropriate for this project.

When is it time to use precise orbits or a higher elevation mask?

When doing so gives better results.

Finally while still in the Project Setting Menu click the Miscellaneous tab (ref: screen shot 4).



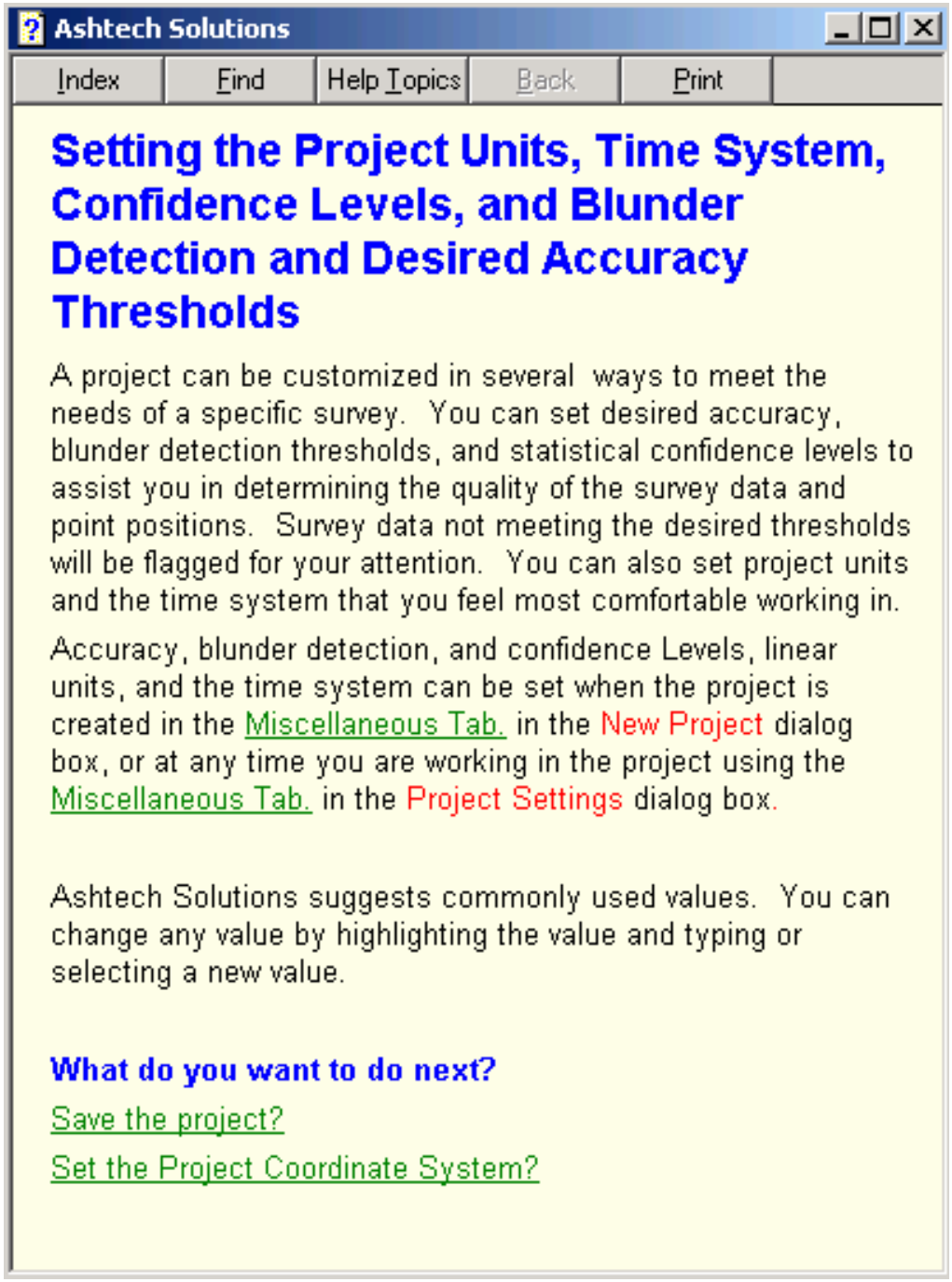
Screen shot 4

One of the user settings is for desired project accuracy. One of the questions to answer is whether the project will be done for the purpose of meeting that project accuracy. What is set will not change the data processing. However, it will affect what is reported as a QA failure. For now leave it at 0.009 meters and decide later whether less stringent settings, that still meet project expectations, will eliminate some of the red vectors.

For this project the plan was for short sessions with as little as twenty minutes of common data. Therefore, meeting a 0.009 meter accuracy may be too much to expect from the collected field data.

What is the meaning of all these fields?

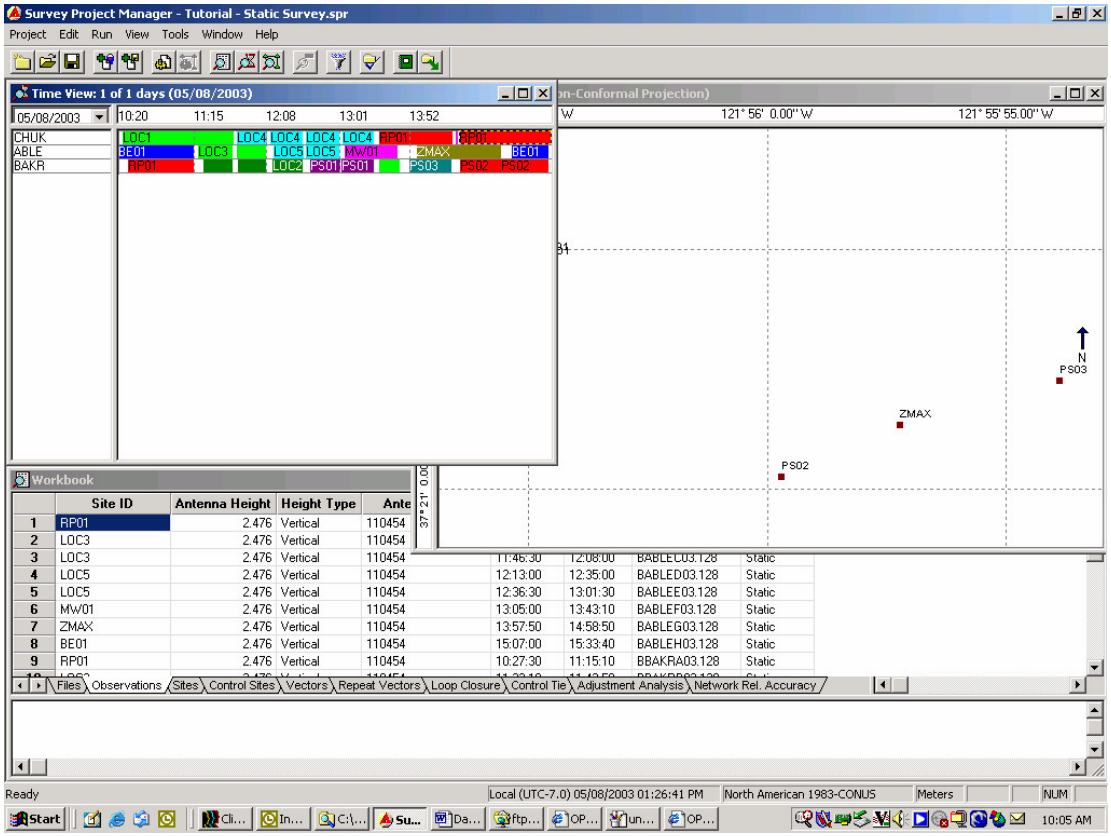
Go to the help button. It often provides useful information about the purpose or function of each choice in any of the Ashtech Solutions menus. A click on the help button for the menu illustrated in screen shot 4 brings up this help information.



After closing the help window and adding data files to the project there is a chance to view the work from the field.

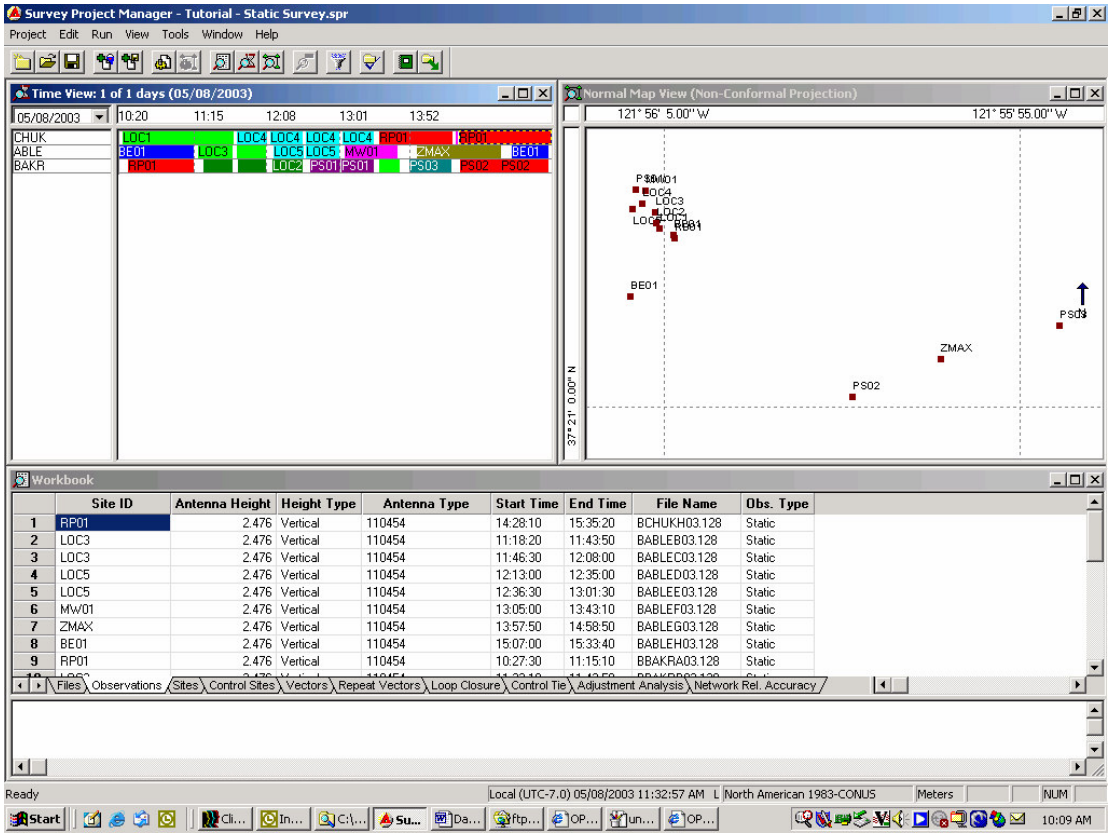
The files have been downloaded and are ready to process.

Sometimes it is a little difficult to see everything at once



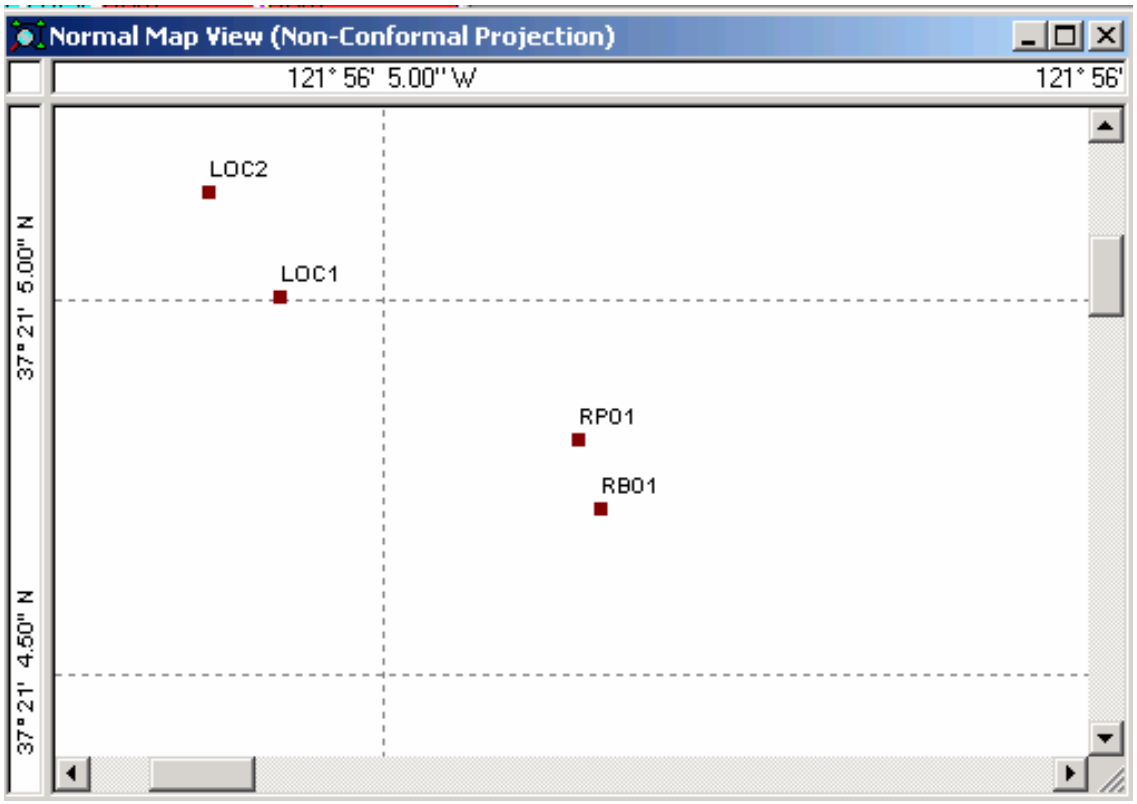
Screen shot 5

but a click on Window at the top of the screen and then Tile Workspace and the project is organized for the beginning of data processing.



Screen shot 6

From this view it can be seen that something is not quite right with the field work. Some of the points are so close together that it is really hard to see what's what. By zooming in on the map view objects are made clearer (screen shot 7).



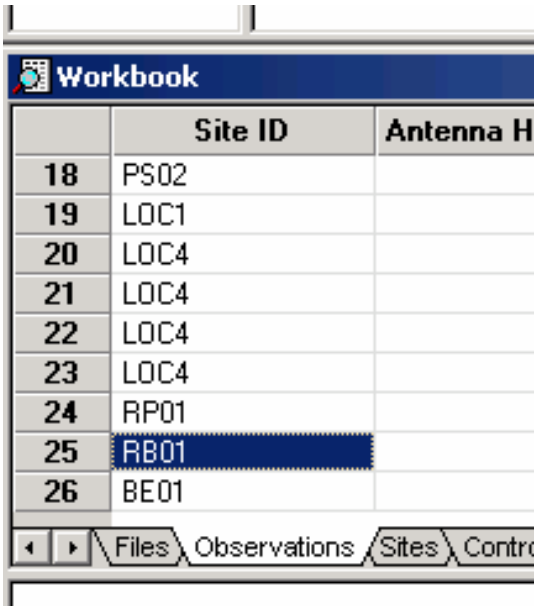
Screen shot 7

Now the problem is revealed. One of the site id's is wrong. There is not a Site called RB01 on this project. RP01 is the control point and there was more than one session scheduled on this point. A field error like this can result in connectivity errors, errors in the adjustment, and two sets of coordinates for the same point on the ground. The first thing to do is check the session plan and the field log. Where was that receiver supposed to be when data was recorded as being on a Site called RB01?

A quick look at what was done confirms suspicions based on what the map view indicates. RB01 should have been named RP01.

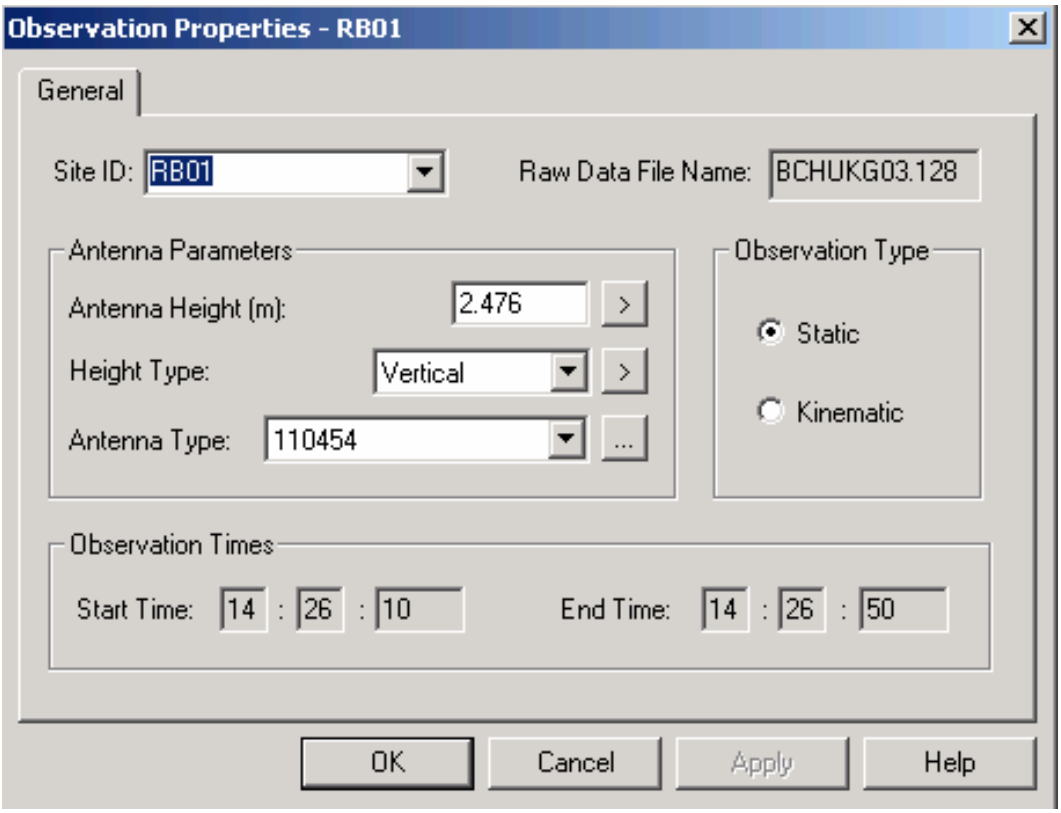
This is easy to fix!

Find RB01 on the Occupations tab in the workbook (screen shot 8).



Screen shot 8

Right click on the RB01 under the Site ID to bring up the Observation Properties dialog box (screen shot 9).

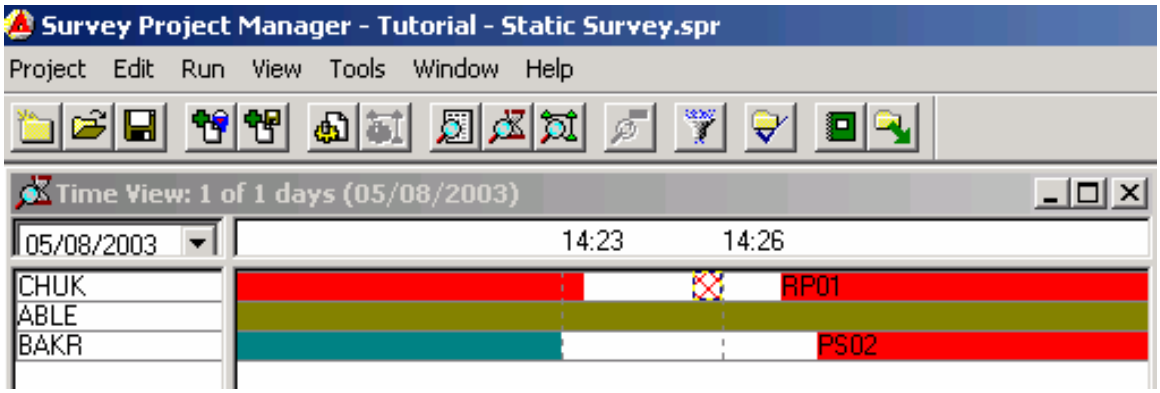


Screen shot 9

With RB01 highlighted change the Site ID to RP01 and click OK. The workbook, map, and time view are all updated with the change.

Now something looks a little odd on the time view.

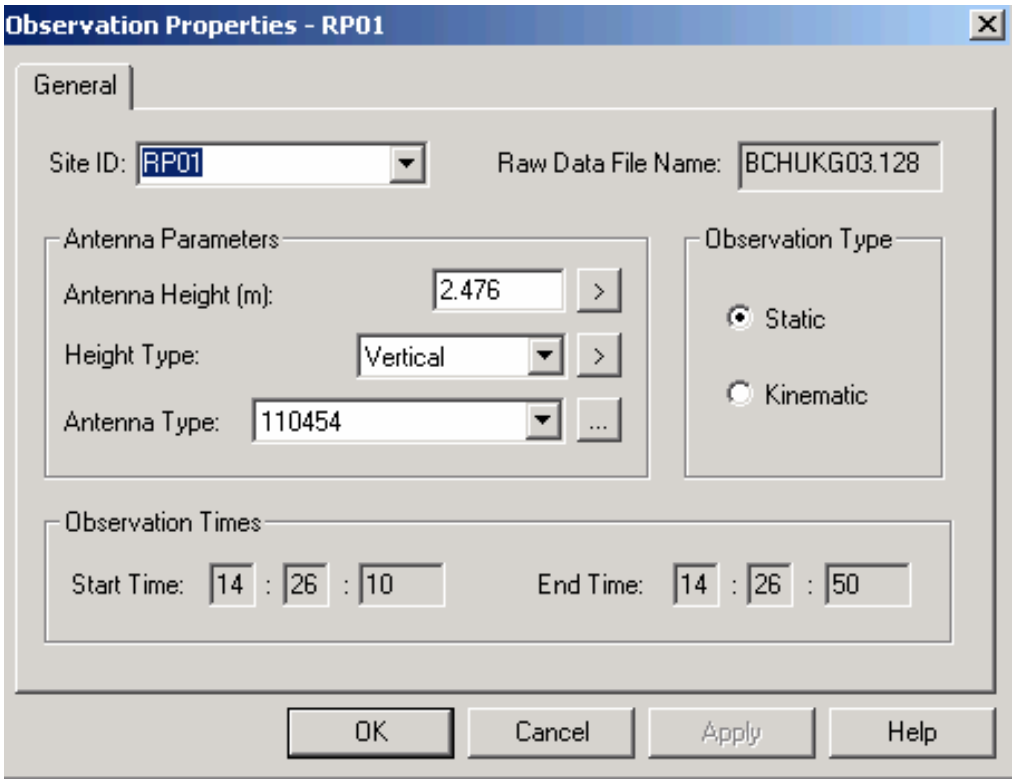
Zoom in on the time view and a false start with one of the GPS receivers is revealed (screen shot 10).



Screen shot 10

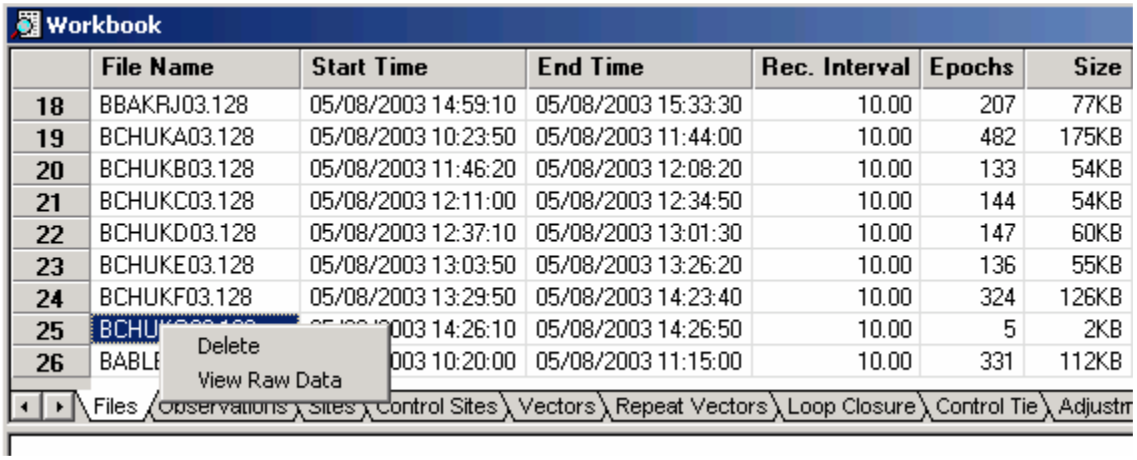
Because the minimum vector time span was set to ten minutes in the Project Settings this short file is ignored. The crosshatched pattern in the time bar means it will not be processed. This file serves no useful purpose in the project so it can safely be deleted.

A right click on the bar in the time view will permit viewing of the Observation Properties for this point (screen shot 11). The name of the raw data file is BCHUKG03.128. Under Observation Times the start time and the end time show that this file contains only 40 seconds of data.



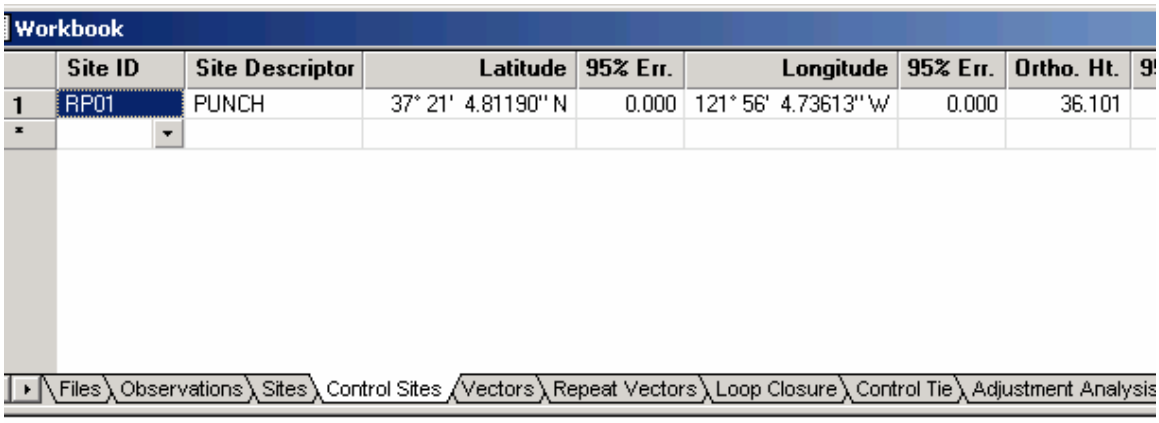
Screen shot 11

To delete this file go to the Files tab in the workbook and right click on the raw data file name, verify that it is the small file, then click on Delete to remove the file from the project (screen shot 12).



Screen shot 12

Now is the time to seed the project with the control point coordinates that will be used as a basis for the data processing.



Screen shot 13

A raw GPS coordinate can easily be 50 feet off in the horizontal location and 100 feet off vertically (ref: screen shot 7). For many projects this is close enough for the purpose of the survey. For this project coordinates determined using OPUS will be used as the control point seed values.

The first test is for reasonableness. Are the raw coordinates of the control point a close match for the OPUS control coordinates? (Screen shot 13.)

Data from the OPUS report:

REF FRAME: NAD83(CORS96) (EPOCH:2002.0000)
LAT: 37°21'04.77521"
W LON: 121°56'04.71600"
EL HGT: -12.187(m)
ORTHO HGT: 20.426(m) [Geoid99 NAVD88]

A rough method of calculating distances from latitude and longitude is that a second is approximately equal to 100 feet. That makes the latitude miss by five feet, the longitude misses by 2 feet, and the elevation misses the OPUS results by about 51 feet. These are reasonable numbers that indicate the project will process successfully after the control site is edited.

One method of editing the coordinates is to double click on the present value then use the arrow keys to highlight the value that needs to be changed. (Screen shot 14.)

GPS is three dimensional so this point will be used to constrain the horizontal and vertical position of the project.

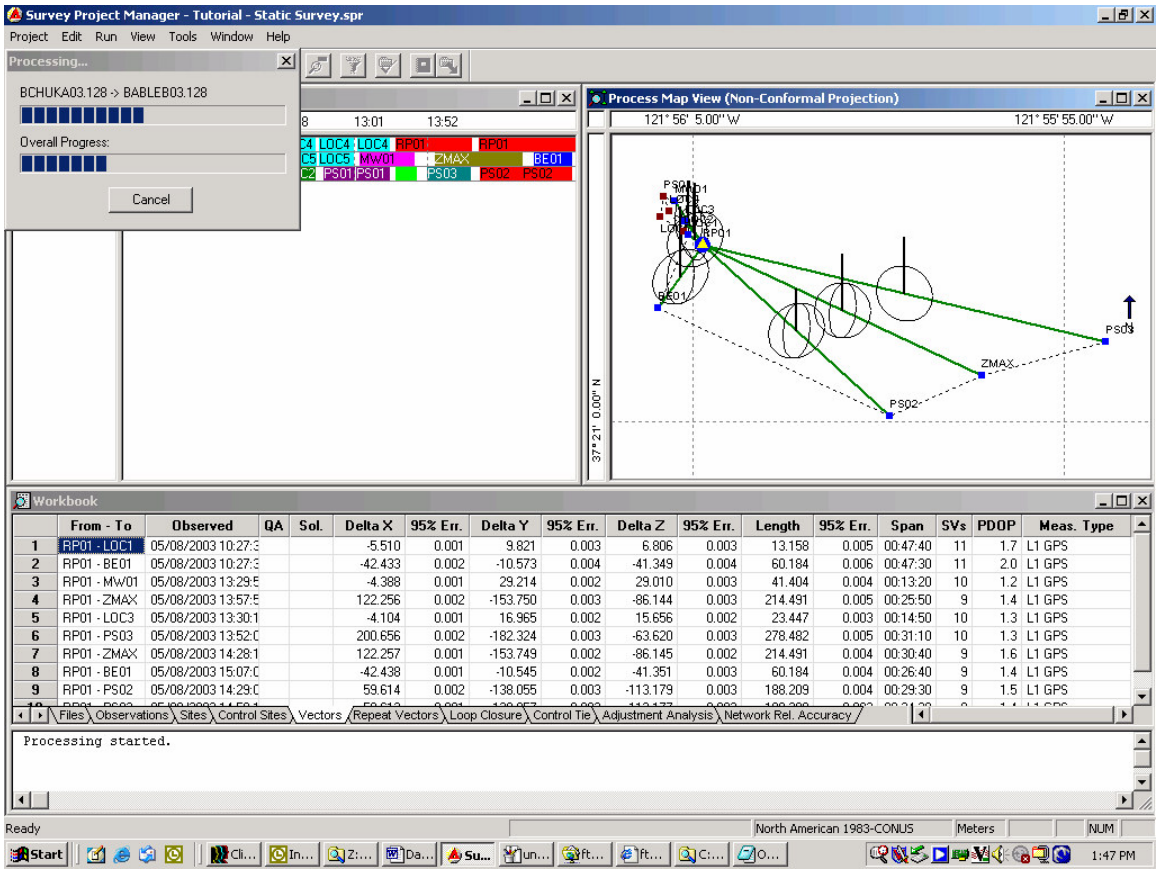
If the project included multiple known horizontal and/or vertical control points the known values would be entered on the control sites tab with the type identified as horizontal or vertical or both. For the initial processing and minimally constrained adjustment, only one horizontal and one vertical control point should be held fixed. The remaining control points should be set to Fixed – None so closing errors for the control sites will be computed and can be displayed on the Control Tie tab.

Workbook

	Site ID	Site Descriptor	Latitude	95% Err.	Longitude	95% Err.	Ortho. Ht.
1	RP01	PUNCH	37° 21' 4.77521" N	0.000	121° 56' 4.71600" W	0.000	20.426
*							

Screen shot 14

With the control point editing done it is time to save the project and process the vectors.



Screen shot 15

As each vector is processed the map view changes and the vector results are added to the Vectors tab in the Workbook (screen shot 15). The results are assessed quickly by clicking on the column headings. For help in understanding what information is available and how to make use of it read the section in the Ashtech Solutions manual called Post-Processing Data Analysis. While you are reading go ahead and read to the end of the chapter for a more complete understanding of processing results.

In the help file there are additional resources that describe the processing and the results of the processing.

The first column to evaluate is the Sol (Solution). Partial or float solutions are indicators of problems. With a left mouse click on the column heading the toggle will sort the data from best to worst or worst to best. Read more about partial and float solutions in your Ashtech Solutions manual.

Partial or float solutions can be used effectively in a project if you will take the time to make the necessary redundant measurements for verification of the results. Do not rely on the vector statistics for a partial or float solution.

If the project contains partial or float solutions the first option is to clean up the vector.

The QA will show what vectors did not meet the standards that were set in the desired project accuracy. A QA fail does not mean the vector is bad. It only means it did not meet the QA setting. Data cleaning tools are there to be used. By left clicking on the QA column heading the toggle will sort the QA failures to the top or bottom of the list.

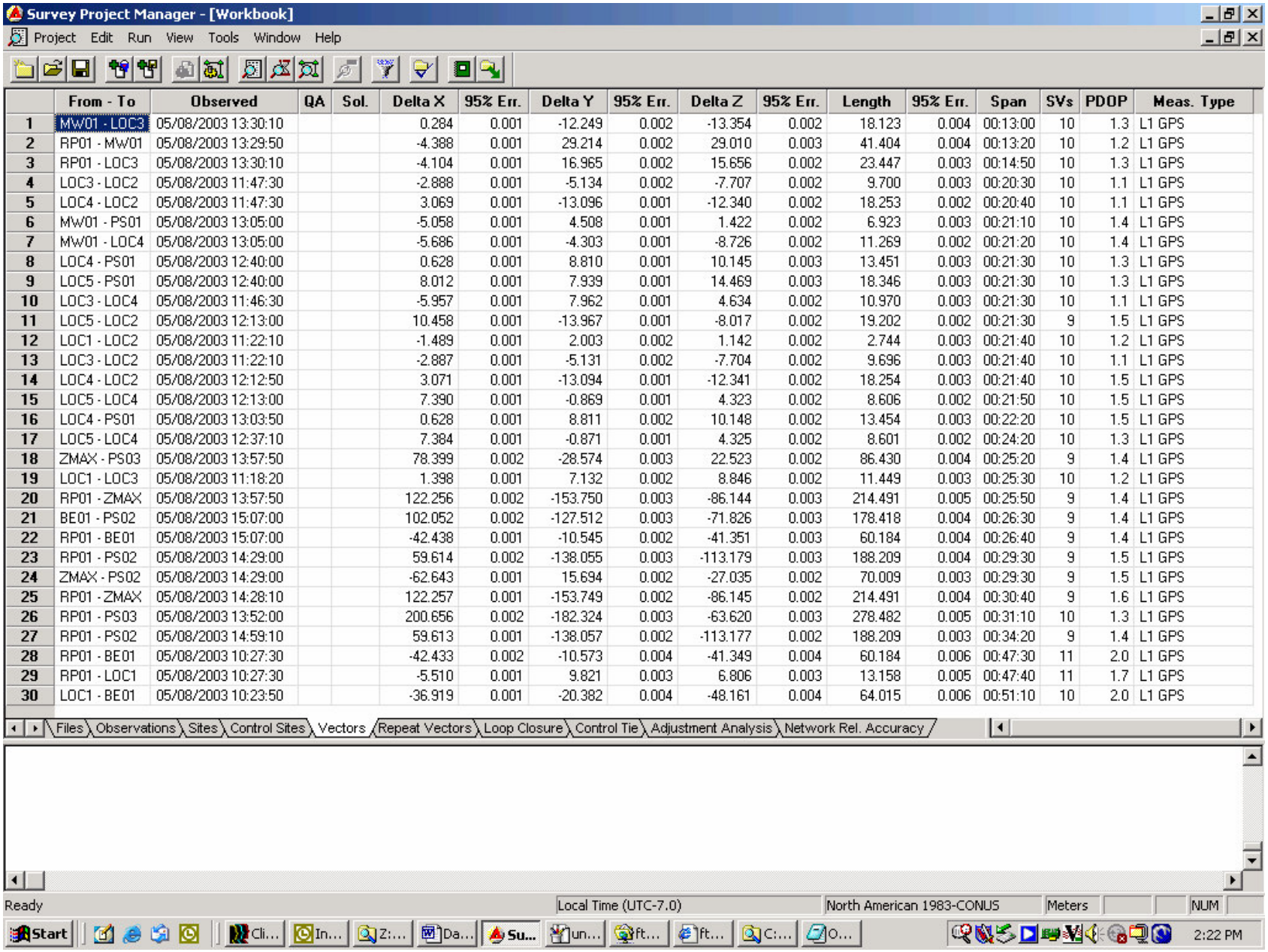
There is a tendency by some to want to compare total station measurements with the vector length. This is usually a fruitless exercise. The best way to compare GPS measurements with total station measurements is to inverse between adjusted coordinates, apply grid and elevation scale factors as appropriate, and then make the comparison. Do not assume that the total station represents the standard. The total station should be checked on an EDM base line where the GPS tools can also be checked. Please note that the inverse between coordinates should be done after the network adjustment. Since this project has not been adjusted as yet, there is no value in comparing measurements at this time.

Fortunately this project contains no Sol or QA problems. By left clicking on the 95% error just to the right of length the potential for three dimensional error in the vector processing can be toggle sorted from best to worst, or worst to best.

In the list illustrated in screen shot 16, the vectors have been sorted according to span going from the least common data to the most common data. At the top is a vector with 13 minutes of data, the shortest session. With the longest set of common data being just over 51 minutes it is obvious that there is an advantage to having nine or more SV's with a PDOP not more than 2.0.

The vectors appear to be very good so it is time for a minimally constrained adjustment.

Screen shot 16



	From - To	Observed	QA	Sol.	Delta X	95% Err.	Delta Y	95% Err.	Delta Z	95% Err.	Length	95% Err.	Span	SVs	PDOP	Meas. Type
1	MW01 - LOC3	05/08/2003 13:30:10			0.284	0.001	-12.249	0.002	-13.354	0.002	18.123	0.004	00:13:00	10	1.3	L1 GPS
2	RP01 - MW01	05/08/2003 13:29:50			-4.388	0.001	29.214	0.002	29.010	0.003	41.404	0.004	00:13:20	10	1.2	L1 GPS
3	RP01 - LOC3	05/08/2003 13:30:10			-4.104	0.001	16.965	0.002	15.656	0.002	23.447	0.003	00:14:50	10	1.3	L1 GPS
4	LOC3 - LOC2	05/08/2003 11:47:30			-2.888	0.001	-5.134	0.002	-7.707	0.002	9.700	0.003	00:20:30	10	1.1	L1 GPS
5	LOC4 - LOC2	05/08/2003 11:47:30			3.069	0.001	-13.096	0.001	-12.340	0.002	18.253	0.002	00:20:40	10	1.1	L1 GPS
6	MW01 - PS01	05/08/2003 13:05:00			-5.058	0.001	4.508	0.001	1.422	0.002	6.923	0.003	00:21:10	10	1.4	L1 GPS
7	MW01 - LOC4	05/08/2003 13:05:00			-5.686	0.001	-4.303	0.001	-8.726	0.002	11.269	0.002	00:21:20	10	1.4	L1 GPS
8	LOC4 - PS01	05/08/2003 12:40:00			0.628	0.001	8.810	0.001	10.145	0.003	13.451	0.003	00:21:30	10	1.3	L1 GPS
9	LOC5 - PS01	05/08/2003 12:40:00			8.012	0.001	7.939	0.001	14.469	0.003	18.346	0.003	00:21:30	10	1.3	L1 GPS
10	LOC3 - LOC4	05/08/2003 11:46:30			-5.957	0.001	7.962	0.001	4.634	0.002	10.970	0.003	00:21:30	10	1.1	L1 GPS
11	LOC5 - LOC2	05/08/2003 12:13:00			10.458	0.001	-13.967	0.001	-8.017	0.002	19.202	0.002	00:21:30	9	1.5	L1 GPS
12	LOC1 - LOC2	05/08/2003 11:22:10			-1.489	0.001	2.003	0.002	1.142	0.002	2.744	0.003	00:21:40	10	1.2	L1 GPS
13	LOC3 - LOC2	05/08/2003 11:22:10			-2.887	0.001	-5.131	0.002	-7.704	0.002	9.696	0.003	00:21:40	10	1.1	L1 GPS
14	LOC4 - LOC2	05/08/2003 12:12:50			3.071	0.001	-13.094	0.001	-12.341	0.002	18.254	0.003	00:21:40	10	1.5	L1 GPS
15	LOC5 - LOC4	05/08/2003 12:13:00			7.390	0.001	-0.869	0.001	4.323	0.002	8.606	0.002	00:21:50	10	1.5	L1 GPS
16	LOC4 - PS01	05/08/2003 13:03:50			0.628	0.001	8.811	0.002	10.148	0.002	13.454	0.003	00:22:20	10	1.5	L1 GPS
17	LOC5 - LOC4	05/08/2003 12:37:10			7.384	0.001	-0.871	0.001	4.325	0.002	8.601	0.002	00:24:20	10	1.3	L1 GPS
18	ZMAX - PS03	05/08/2003 13:57:50			78.399	0.002	-28.574	0.003	22.523	0.002	86.430	0.004	00:25:20	9	1.4	L1 GPS
19	LOC1 - LOC3	05/08/2003 11:18:20			1.398	0.001	7.132	0.002	8.846	0.002	11.449	0.003	00:25:30	10	1.2	L1 GPS
20	RP01 - ZMAX	05/08/2003 13:57:50			122.256	0.002	-153.750	0.003	-86.144	0.003	214.491	0.005	00:25:50	9	1.4	L1 GPS
21	BE01 - PS02	05/08/2003 15:07:00			102.052	0.002	-127.512	0.003	-71.826	0.003	178.418	0.004	00:26:30	9	1.4	L1 GPS
22	RP01 - BE01	05/08/2003 15:07:00			-42.438	0.001	-10.545	0.002	-41.351	0.003	60.184	0.004	00:26:40	9	1.4	L1 GPS
23	RP01 - PS02	05/08/2003 14:29:00			59.614	0.002	-138.055	0.003	-113.179	0.003	188.209	0.004	00:29:30	9	1.5	L1 GPS
24	ZMAX - PS02	05/08/2003 14:29:00			-62.643	0.001	15.694	0.002	-27.035	0.002	70.009	0.003	00:29:30	9	1.5	L1 GPS
25	RP01 - ZMAX	05/08/2003 14:28:10			122.257	0.001	-153.749	0.002	-86.145	0.002	214.491	0.004	00:30:40	9	1.6	L1 GPS
26	RP01 - PS03	05/08/2003 13:52:00			200.656	0.002	-182.324	0.003	-63.620	0.003	278.482	0.005	00:31:10	10	1.3	L1 GPS
27	RP01 - PS02	05/08/2003 14:59:10			59.613	0.001	-138.057	0.002	-113.177	0.002	188.209	0.003	00:34:20	9	1.4	L1 GPS
28	RP01 - BE01	05/08/2003 10:27:30			-42.433	0.002	-10.573	0.004	-41.349	0.004	60.184	0.006	00:47:30	11	2.0	L1 GPS
29	RP01 - LOC1	05/08/2003 10:27:30			-5.510	0.001	9.821	0.003	6.806	0.003	13.158	0.005	00:47:40	11	1.7	L1 GPS
30	LOC1 - BE01	05/08/2003 10:23:50			-36.919	0.001	-20.382	0.004	-48.161	0.004	64.015	0.006	00:51:10	10	2.0	L1 GPS

When it comes to network adjustments spend some time reading the Adjustment chapter in the Ashtech Solutions manual. Also spend time gaining an understanding of what is in Appendix C of the manual.

Here it must be said that this author differs with the manual in one way by saying that a minimally constrained adjustment is appropriate, even when there is no redundancy, so coordinates will be computed outward from the control sites rather than potentially being computed from raw positions. It also provides for certainty regarding connectivity.

There are three words that guarantee GPS accuracy. Redundancy, *Redundancy.* **Redundancy**.

The following are some questions where yes answers will help guarantee accuracy.

Is there more than one set up on each of the Sites in the survey?

Is there more than one path to follow through the project to get from one point to another?

Were the shortest possible vectors measured?

Were antenna heights independently measured in feet and meters and then compared for accuracy?

If multiple control sites are used are they distributed around the project so it is balanced? Does the control make a box with the work inside the box?

With these questions in mind it is time to evaluate the work on this project.

By clicking on the QA column heading the three sites that do not meet the desired project accuracy are brought to the top of the Network Relative Accuracy table (screen shot 17). A decision must be made about whether or not to make more field measurements to get rid of an extra 0.001 meter of error in the project. For this project the settings will be modified instead of returning to the field. By changing the desired project accuracy in the project settings menu to 0.010 meters instead of the 0.009 that was originally set (screen shot 4) this project no longer has QA failures (screen shot 18).

Screen shot 17

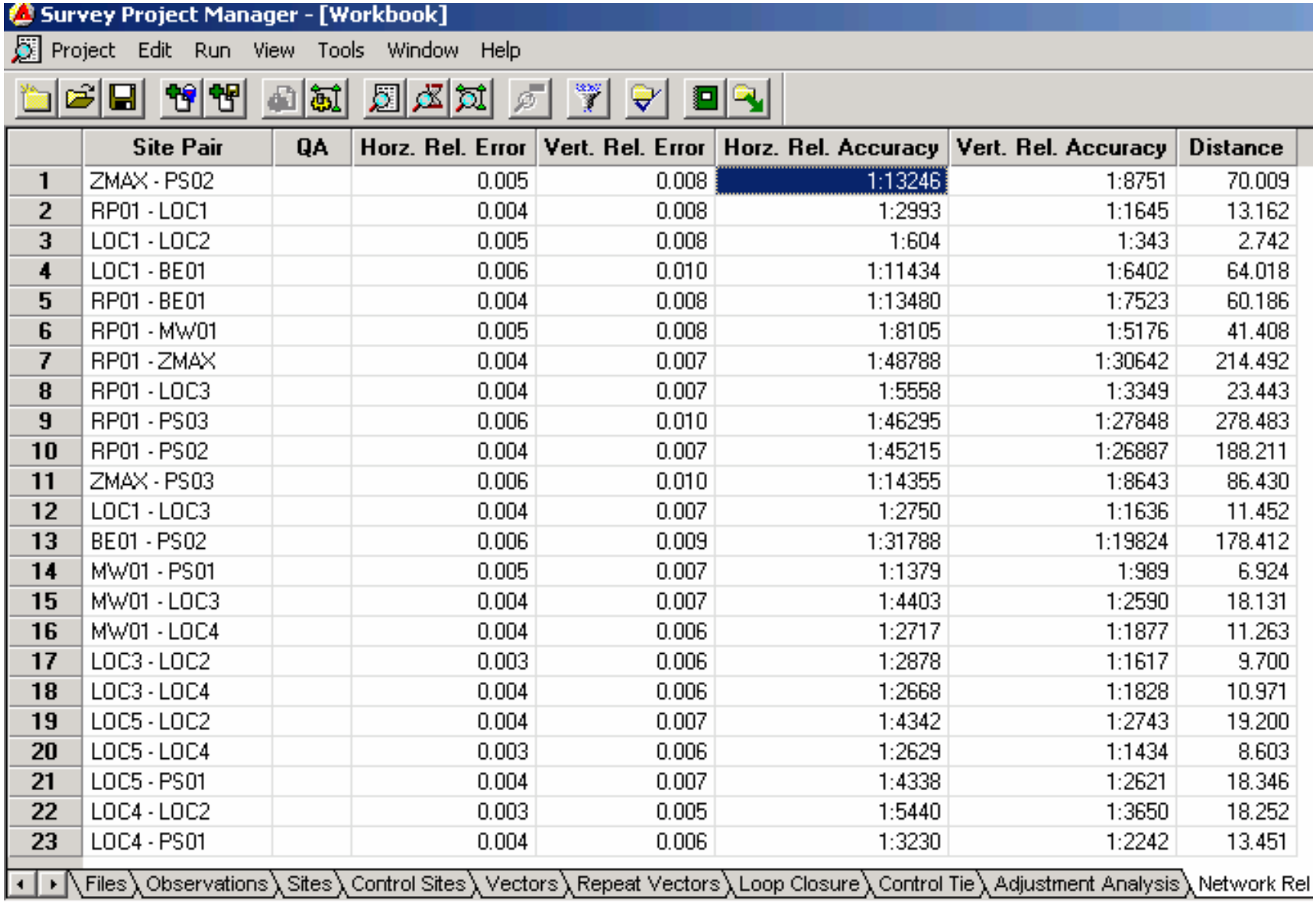
Survey Project Manager - [Workbook]

Project Edit Run View Tools Window Help

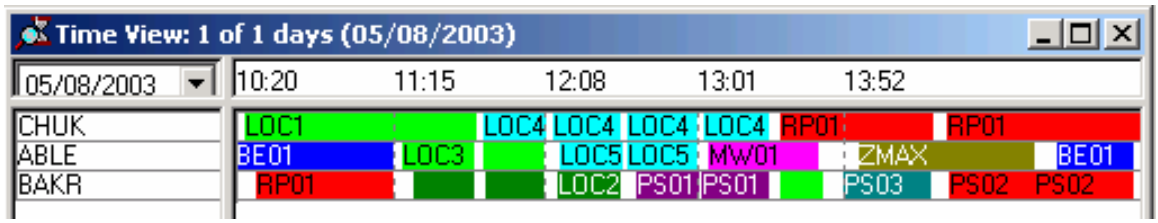
	Site Pair	QA	Horz. Rel. Error	Vert. Rel. Error	Horz. Rel. Accuracy	Vert. Rel. Accuracy	Distance
1	ZMAX - PS03	Fail	0.006	0.010	1:14355	1:8643	86.430
2	LOC1 - BE01	Fail	0.006	0.010	1:11434	1:6402	64.018
3	RP01 - PS03	Fail	0.006	0.010	1:46295	1:27848	278.483
4	RP01 - BE01		0.004	0.008	1:13480	1:7523	60.186
5	LOC1 - LOC2		0.005	0.008	1:604	1:343	2.742
6	RP01 - ZMAX		0.004	0.007	1:48788	1:30642	214.492
7	RP01 - LOC3		0.004	0.007	1:5558	1:3349	23.443
8	RP01 - LOC1		0.004	0.008	1:2993	1:1645	13.162
9	RP01 - MW01		0.005	0.008	1:8105	1:5176	41.408
10	RP01 - PS02		0.004	0.007	1:45215	1:26887	188.211
11	ZMAX - PS02		0.005	0.008	1:13246	1:8751	70.009
12	LOC1 - LOC3		0.004	0.007	1:2750	1:1636	11.452
13	BE01 - PS02		0.006	0.009	1:31788	1:19824	178.412
14	MW01 - PS01		0.005	0.007	1:1379	1:989	6.924
15	MW01 - LOC3		0.004	0.007	1:4403	1:2590	18.131
16	MW01 - LOC4		0.004	0.006	1:2717	1:1877	11.263
17	LOC3 - LOC2		0.003	0.006	1:2878	1:1617	9.700
18	LOC3 - LOC4		0.004	0.006	1:2668	1:1828	10.971
19	LOC5 - LOC2		0.004	0.007	1:4342	1:2743	19.200
20	LOC5 - LOC4		0.003	0.006	1:2629	1:1434	8.603
21	LOC5 - PS01		0.004	0.007	1:4338	1:2621	18.346
22	LOC4 - LOC2		0.003	0.005	1:5440	1:3650	18.252
23	LOC4 - PS01		0.004	0.006	1:3230	1:2242	13.451

Files | Observations | Sites | Control Sites | Vectors | Repeat Vectors | Loop Closure | Control Tie | Adjustment Analysis | Network Rel

Screen shot 18



	Site Pair	QA	Horz. Rel. Error	Vert. Rel. Error	Horz. Rel. Accuracy	Vert. Rel. Accuracy	Distance
1	ZMAX - PS02		0.005	0.008	1:13246	1:8751	70.009
2	RP01 - LOC1		0.004	0.008	1:2993	1:1645	13.162
3	LOC1 - LOC2		0.005	0.008	1:604	1:343	2.742
4	LOC1 - BE01		0.006	0.010	1:11434	1:6402	64.018
5	RP01 - BE01		0.004	0.008	1:13480	1:7523	60.186
6	RP01 - MW01		0.005	0.008	1:8105	1:5176	41.408
7	RP01 - ZMAX		0.004	0.007	1:48788	1:30642	214.492
8	RP01 - LOC3		0.004	0.007	1:5558	1:3349	23.443
9	RP01 - PS03		0.006	0.010	1:46295	1:27848	278.483
10	RP01 - PS02		0.004	0.007	1:45215	1:26887	188.211
11	ZMAX - PS03		0.006	0.010	1:14355	1:8643	86.430
12	LOC1 - LOC3		0.004	0.007	1:2750	1:1636	11.452
13	BE01 - PS02		0.006	0.009	1:31788	1:19824	178.412
14	MW01 - PS01		0.005	0.007	1:1379	1:989	6.924
15	MW01 - LOC3		0.004	0.007	1:4403	1:2590	18.131
16	MW01 - LOC4		0.004	0.006	1:2717	1:1877	11.263
17	LOC3 - LOC2		0.003	0.006	1:2878	1:1617	9.700
18	LOC3 - LOC4		0.004	0.006	1:2668	1:1828	10.971
19	LOC5 - LOC2		0.004	0.007	1:4342	1:2743	19.200
20	LOC5 - LOC4		0.003	0.006	1:2629	1:1434	8.603
21	LOC5 - PS01		0.004	0.007	1:4338	1:2621	18.346
22	LOC4 - LOC2		0.003	0.005	1:5440	1:3650	18.252
23	LOC4 - PS01		0.004	0.006	1:3230	1:2242	13.451



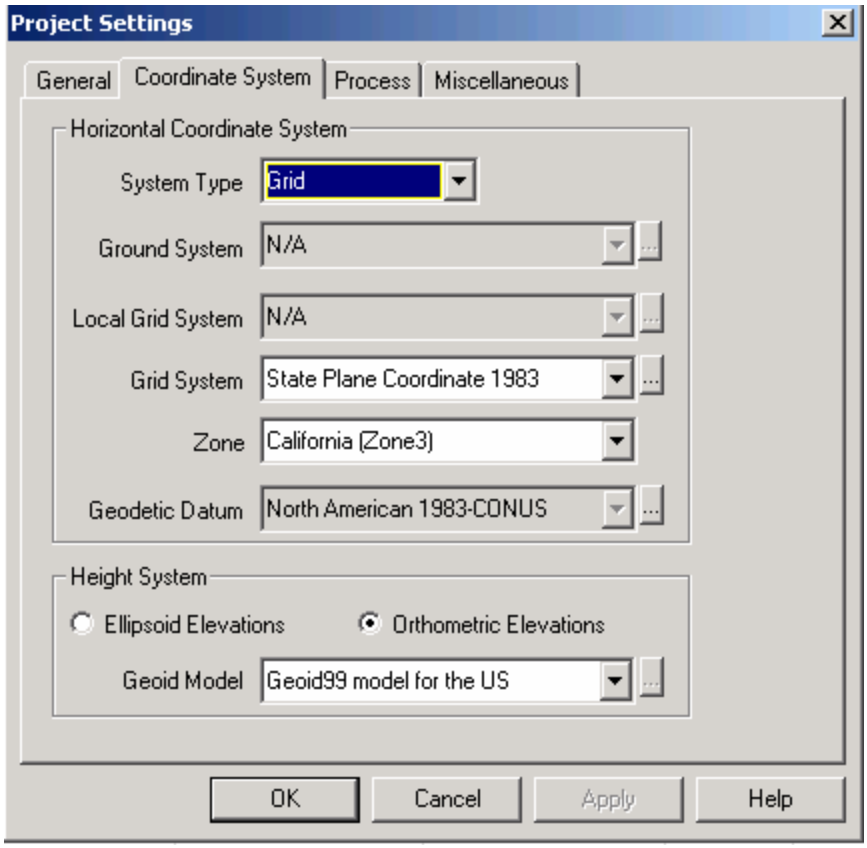
Screen shot 19

A close examination of the time view indicates that the project has some pivot points where a receiver was left running without making an independent set up. This was a decision made to allow two people to run three GPS receivers. It is a compromise and should be recognized as such.

This project worked so well that not all of the data cleaning tools available in Ashtech Solutions needed to be used. However, another trip to the project site for some redundant measurements using Stop&Go procedures might permit the use of some additional tools.

Before leaving this project it would be good to have some state plane coordinates in feet so comparisons with the Stop&Go survey work will be easy.

Remember the coordinate setting can now safely be changed to grid since the project data has already been processed. Ref: screen shot 2 and screen shot 20.



Screen shot 20

With a click on the Miscellaneous tab (ref: screen shot 4) notice that the linear units are now changed to US Feet and in screen shot 21 the Sites now have State Plane Coordinates in US Feet.

Screen shot 21

	Site ID	Site Descriptor	Status	Easting	95% Err.	Northing	95% Err.	Ortho. Ht.	95% Err.
1	RP01	PUNCH	Adjusted	6144675.503	0.000	1953589.058	0.000	67.014	0.000
2	LOC5	PK	Adjusted	6144583.181	0.019	1953657.302	0.018	65.792	0.031
3	MW01	PK	Adjusted	6144614.439	0.016	1953710.402	0.016	66.149	0.026
4	ZMAX	PK	Adjusted	6145277.169	0.012	1953224.141	0.014	67.196	0.023
5	BE01	PK	Adjusted	6144573.064	0.013	1953420.257	0.014	66.595	0.027
6	LOC3	PK	Adjusted	6144635.634	0.014	1953654.823	0.014	66.305	0.024
7	LOC2	PK	Adjusted	6144636.012	0.016	1953623.004	0.015	66.315	0.027
8	PS01	PK	Adjusted	6144592.627	0.019	1953716.745	0.019	65.971	0.031
9	PS03	PK	Adjusted	6145546.425	0.018	1953313.039	0.020	67.124	0.033
10	PS02	PK	Adjusted	6145073.869	0.011	1953117.296	0.014	65.065	0.022
11	LOC1	PK	Adjusted	6144643.551	0.015	1953618.098	0.013	66.420	0.027
12	LOC4	PK	Adjusted	6144605.525	0.016	1953674.542	0.016	66.135	0.028