Final Project Report

For Project #14060013
Nueces County, Texas

November 22, 2006

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PROJECT APPROACH

Project Name and Location
MAPVI-URS Corporation Nueces County, Texas

Dates of Data Acquisition
June 19, 22, 23, 24, 25, 27, & 28, 2006
July 16 & 17, 2006

Dates of Data Processing
June 19 – October 2, 2006

The results of the Quality Inspection within the project area indicate that the data exceeds the FEMA requirement for 2-foot contours or 18.5 cm RMSE. The data as tested had a final RMSE 9.668 cm (.3172 ft) in the Nueces County, Texas project area.

General
Spectrum Mapping was tasked by MAPVI – URS Corporation, Albuquerque, to provide airborne Light Detection and Ranging (LIDAR) of approximately 620 square miles around Nueces County, Texas. Spectrum followed data collection and processing procedures for Federal Emergency Management Agency (FEMA) Guidelines and Specifications Appendix A. Data product deliverables included LIDAR to support 2-ft contours. Spectrum's acquisition division collected the LIDAR data on June 19, 22, 23, 24, 25, 27 & 28 and July 16 & 17, 2006. The project was collected with a Rams ALS50 Lidar sensor, including an inertial measurement unit (IMU) and a dual frequency Global Positioning System (GPS) receiver and antenna.

Project Area
Spectrum ensures that the geographic extent of the project area is collected using the correct mission profiles for the desired products. This is accomplished using TRACK'AIR, a digital mission-planning tool.

Mission planning consists of several steps that ensure proper flight preparation. First the project boundary for the site is acquired from our customer and imported into our flight planning software. Following this, available information such as elevation data, vegetation coverage and cultural feature extents are reviewed and general assessments are made by our Photogrammetrists to determine proper LIDAR system settings, such as field of view (FOV) and ground sample distance (GSD). All LIDAR flight lines are flown with a minimum of 30% side overlap. Having set the previous parameters, the flight plan is prepared in digital form using our proprietary software. The existing elevation data is then imported and queried to calculate the flight altitudes for each flight line. Once flight planning is complete, waypoints in latitude/longitude and ellipsoid height are output to our flight management system.

GPS differential correction is required for our process. GPS planning software is used to predict positional dilution of precision (PDOP… i.e. GPS quality) greater than 3.0. Should this condition occur, laser data acquisition is suspended until the satellite geometry improves. Spectrum's base stations are full wave, dual frequency, GPS receivers that

record data at 1 second intervals. All base station data is recorded to 1 gigabyte (GB) flash memory cards for immediate use after the mission.

Acquisition Systems

Flight data was logged digitally to a 150 GB removable hard drive array on board the aircraft. GPS base station data was logged to flash memory cards. This allowed for rapid file transfer since tape systems have been eliminated from the process. Drives were downloaded daily, processed, and archived immediately following collection, yielding basic laser data within hours of data collection. Field checks of the data were performed each day to ensure complete coverage of the area flown that day.

Data Acquisition

Our flight crew, comprised of a pilot and a system operator, mobilized to the project site on June 18, 2006 ferrying all equipment and digital information required. Recovery of GPS base stations and coordination with the project ground control team were completed to identify correct base station and calibration site information.

National Geodetic Survey (NGS) points were chosen prior to collection for base station locations. The points were chosen based on their proximity to the airport and their accuracy ratings according to the NGS. Frontier Surveying was engaged to set a calibration site at the airport, as well as setting approx. 36 ground control points in the project area. Before each mission, the pilot acquired data over the calibration site.

The flight crew was guided by a GPS controlled flight management system, which displays the flightplan; including altitude, heading, cross track deviation and PDOP. The system operator monitors flight management data in addition to laser information. During flight the crew monitors all functions in system operation and guidance ensuring a successful mission.

GPS/IMU Processing

Position and orientation data must be processed first in order to resolve laser data and verify flight coverage. All aircraft trajectory parameters are generated during this process. Both horizontal and vertical project coordinate computations are accomplished at this stage. This processing takes approximately twice the actual flight time of the mission.

Raw Laser Data Processing

Laser data is then processed to resolve the range finder, scan angle, and position and orientation system data, using Spectrum's post-processing software. All returns are sorted to best reflect the vegetated and bare earth surfaces. Data are transformed from raw binary format to laser return file (LAS) file format for filtering and custom projection. The most current NGS models are an integral part of the post-processing software, with custom projection options available.

Laser data are thinned for quick projection of swath coverage. Spectrum's LIDIMAGE™ software is also used at this stage for a rudimentary test of the data validity. LIDIMAGE™

is a fast-generating bitmap utility for rapid viewing of the digital elevation model (DEM) data. Any seams, holes, or other unwanted artifacts could be quickly identified for potential re-flight areas.

Bare Earth Data Filtering

The LIDAR system collects elevation and position information from all reflective surfaces. The task is to identify and remove those features that do not describe the bare earth. Spectrum houses all laser points in a database LAS that retains information about flight day and time, return number, laser scan angle, and other proprietary information. This data is displayed and manipulated using our proprietary tools and software. The database is reviewed and areas of like characteristics are delineated and flagged. A laser processing group, will determine which type of filtering technique(s) need to be applied to each type of area, to best portray a bare earth surface. Factors that affect this decision are slope, vegetation and cultural features. Each project has unique characteristics that can only be assessed after the data is collected. The data is flagged in the LAS format and as part of the QC process with the imagery, reviewed to ensure correct surface depiction.

Data voids may occur from several different causes, including the following:

Natural

- LIDAR pulses may be naturally absorbed by water bodies or areas recently covered with asphalt. Such voids are normally considered to be unavoidable.

Operational

- The LIDAR system may have malfunctioned for some reason.
- Heavy winds, flight navigation system (FNS) error or pilot error may have caused "holidays" between flight lines.

Procedural

- Data points may be un-intentionally removed as part of the bare-earth post-processing to delete points that impinged on the tops of manmade structures or failed to penetrate dense vegetation.

Data voids caused by removal of LIDAR data points on manmade structures are acceptable.

As part of the field Quality Control (QC) process, data voids caused by operational constraints are re-collected if required. No data voids were identified in the Nueces County project.

Artifacts are regions of anomalous elevations or oscillations and ripples within the DEM data resulting from systematic errors, environmental conditions, or incomplete post-processing.

Quality Assurance

A rigorous quality assurance program insures that the final data products meet all requirements prior to delivery to the customer. Quality Assurance / Quality Control (QA/QC) is embedded into the overall data acquisition and processing steps we use. Quality assurance is inherent in developing the project plan, acquisition, verifying data and

processing, and assuring that the final products meet all of FEMA requirements in accordance with the contract. Spectrum Mapping's quality assurance procedures follow the "FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A: Guidance for Aerial Mapping and Surveying" for use of LIDAR mapping technology.

DATA PROCESSING PROCEDURES

Data Processing Procedures

Data was delivered to Spectrum Mapping's Albuquerque office from the field on external hard drives. The data is cataloged and copied onto the processing computer disk drives. The data is then re-verified for coverage and quality, at which point it is ready to be calibrated. Once the data is calibrated it is prepared for post processing. The first step in the LIDAR data processing is to produce the x, y, and z laser return files (LAS) using Leica Geosystems ALS Post Processor v2.63d, georeferencing each point to Texas State Plane Coordinates – South Zone NAD83/NAVD88 – US Survey Feet. The ellipsoid to orthometric height conversion used the NGS Geoid 99.

The next step uses Spectrum's proprietary Lidar Project Developer (LPD) Software to combine the flight line LAS files in a merge process called "Tiling", which extracts and crops data according to the tiling scheme developed for the client (5000 ft x 5000 ft), resulting in more manageable files. These tiles contain all available data from the source files and are processed using analytical algorithms to classify data based on spatial and attribute properties for each X,Y,Z point.

Initial classification separates anomalous noise and overlapping returns. Additional classification algorithms are then applied to remove between 90-95% of vegetation and most other prominent, above-ground features from the data. The classified tiles are then manually inspected and edited using Spectrum's Lidar Project Viewer (LPV) along with proprietary filtering tools to isolate and define the bare earth surface.

Following extensive review and Quality Assurance, the final tiles contain all returns, minus the overlapping and noise points. These files serve as a record of All Returns and have the bare earth class of data extracted to individual Bare Earth LAS tiles.

The bare earth files were merged with existing (2001) Nueces LAS mapping using LPD to produce complete bare earth hybrid (2001/2006) tiles. These hybrids were then "gridded" to provide a regular DEM in LAS format. The All Return (ARL), Bare Earth (BE) and Gridded (DEM_8) LAS files were delivered along with ASCII format X,Y,Z files of the same data. All data was processed and delivered in Texas State Plane, South. Horizontal reference is NAD83. Vertical control reference datum is NAVD88-Geoid99. Units of measurement are in US Survey Feet.

Editing Methodologies

Step 1: The (raw data set) tiles will first have automated classification algorithms run which are designed to detect and isolate points which meet certain specific criteria and conclude by assigning targeted points with a separate classification value. All points begin on Class 1 (Surface) and will have a series of filters performed which assign points to Classes 2, 3, 4, etc. Ideally, what points remain on Class 1 will eventually be considered the Bare Earth data.

There are a number of common filtering methods used, including Triangulated Irregular Network (TIN) filters (comparing elevations of each point with its neighboring points), Polynomial filters (comparing a point's residual elevation difference with a mathematically

derived, polynomial-based surface curve which is “fit” to that point’s regional neighbors), Property filters (using a non-spatial attribute to isolate specific points, such as scan angle, file ID, classification value, etc.) and Proximity filters (comparing a point’s spatial distance, horizontally or vertically, to it’s neighbors).

The (raw data set) tiles are first analyzed to detect and classify anomalous returns which are considered noise (caused by refracted Lidar pulses). A second classification is performed on each tile to remove overlapping regions (edge matching). This allows a seamless data set without redundancies. Successive classifications are performed on each tile which analyze each point’s spatial relationship with its neighbors, removing vegetation and artificial structures from the bare earth class. Some of the classifications may scour away valid bare earth data (ridgelines or peaks, roads, levees, ledges, hilltops, etc.) along with the undesired features.

Automatic filtering macros are developed which best address the terrain and vegetation conditions of the data. These are performed over each tile in a batch process. The automatically classified tiles are deemed ready for manual review and editing by a trained editor.

Step 2: The editor will open a tile for inspection using the LPV (Viewer) and perform restorative edits (manually classifying feature definition back to the bare earth class). This includes restoring road edges, hilltops, escarpments and other natural/artificial land forms which may have been eroded by automatic filtering. The converse of filter erosion includes areas which were not filtered enough by the automatic algorithms. These include low-frequency vegetation (tops of agricultural fields/crops) and miscellaneous “artifacts” which require removal from the bare earth class. The editor can define polygon masks over areas which require additional classification and perform automated filtering over those areas only. Final edits are performed by manually classifying small pits or bumps which are judged to be non-surface artifacts.

Step 3: Once a tile has been edited, it is passed to a QA editor who checks the tile for completeness, conformity and consistency. If problems are detected, such as failure to restore an over-filtered area as Surface or failure to remove artifacts detrimental to the bare earth definition, the tile is sent back to the editing phase for reiterative analysis. These tiles will be filtered or edited until they pass the QA phase.

Step 4: A set of shaded-relief images is generated for tiles which have passed the QA phase. These are viewed and compared for completeness and consistency across the job.

Step 5: Finished QA of tiles, which are then exported to exclude the overlapping flightline class and noise points. The resulting tiles are considered finished and used to create bare-earth source tiles and subsequent products.

Map Coordinate System and Datum:
Texas State Plane – South (FIPS Zone 4205), NAD83, NAVD88, US Survey Feet

GEOID Used:
GEOID99

Quality Control Procedures
Spectrum has many control procedures in place to provide quality assurance through each step of data processing.
Step 1 - Verify project boundaries and data deliverables with customer prior to flight.

Step 2 - QA of data after collection to verify complete coverage, data then goes to calibration.

Step 3 - QA of data after calibration to verify solution before data processing.

Step 4 -QA/QC of automated vegetation filter iterations, data may go through many different iterations of automated filters, data then goes to manual editing.

Step 5 -QA/QC of manual edits.

Step 6 - QA/QC of final deliverables. All LIDAR DEM data are converted into hillshades and reviewed for artifact removal, proper datum and coordinate systems, data voids or anomalies, and edge matching.

Step 7 - Delivery media are verified and checked for completeness before delivery.

PROJECT SUMMARY

Project Summary

Approximately 620 square miles of data was collected around Nueces County, in Texas. The LIDAR data was collected on June 19, 22, 23, 24, 25, 27 & 28 and July 16 & 17, 2006. No major problems were encountered during the acquisition and post processing of this project.

The processed LIDAR data exceeds contracted FEMA specification of 18.5 cm RMSE.

The tested root-mean square error (RMSE) in the project area was 9.668 cm (.3172 ft) Spectrum used 36 checkpoints provided by Frontier Surveying.

LIDAR SYSTEM DATA REPORT

Summary of Lidar Quality Assessment for Nueces County 2006 Mapping, Spectrum Mapping

MAPVI obtained several submittals of static GPS observations from Frontier Surveying in Corpus Christi, TX in order to measure the nominal quality of the data which served as the source of the mapping data. A cluster of control points was established at the Robstown Airport (these were called a "Bowtie" and numbered 7 total). Another 29 points were supplied which were generally distributed across the county in a wide pattern, providing 36 points for quality assessment. Spectrum Mapping used this control to assess the quality of the mapping, prior to tiling and editing the bare-earth products.

The 36 points were projected to Texas State Plane – South Zone – NAD83/NAVD88 (Geoid 99) as U.S. Survey feet. Table 1 lists the points measured against source flight lines LAS data.

Table 1. Points measured against source flight lines LAS data.

Point ID	SPX-NAD83-ft	SPY-NAD83-ft	Z-NAVD88-ft (Geoid 99)
0002	1246544.45	17173109.88	76.13
1004	1302761.33	17187217.29	37.98
1006	1268070.37	17203146.67	80.77
1009	1215682.20	17215570.39	74.55
1010	1210127.55	17182519.79	83.11
1016	1198767.22	17121451.55	77.50
1017	1218427.06	17115441.70	67.26
1018	1227386.93	17135028.20	59.26
1019	1175766.26	17150082.81	117.14
1020	1174147.31	17128653.23	104.97
1021	1177797.44	17174044.14	119.60
1022	1180784.11	17204834.47	107.15
1023	1194999.31	17211373.74	105.02
1203	1258374.74	17158694.32	67.69
1204	1262057.70	17185906.21	74.34
1205	1261613.92	17226035.40	16.78
1206	1219015.43	17235120.61	39.02
1207	1185614.79	17228474.51	117.64
1210	1448510.94	17193658.23	5.01
1211	1408180.88	17128168.09	4.39
1212	1368249.05	17149274.39	7.39
1213	1341782.30	17176275.78	11.85
1214	1342331.41	17188177.70	3.20
1215	1394777.81	17109702.02	6.75
1304	1333558.06	17103584.37	20.27
1305	1307162.92	17103219.79	38.06
1306	1263380.38	17099078.19	35.33
1307	1255060.23	17110758.56	41.18

Point ID	SPX-NAD83-ft	SPY-NAD83-ft	Z-NAVD88-ft (Geoid 99)
1311	1279997.59	17129921.45	51.21
BT_1	1245752.75	17173402.33	76.42
BT_2	1246544.45	17173109.88	76.13
BT_3	1246195.69	17173737.27	76.37
BT_4	1246315.72	17173732.49	77.60
BT_5	1245455.82	17174406.87	77.88
BT_6	1243920.04	17174445.18	77.78
BT_7	1244041.82	17174423.90	78.57

Listing of Control Measured Against LAS Flight Lines

With the exception of the bowtie survey control points, the locations of the control points were distributed throughout the project, though not necessarily within the project limits to be mapped (Figure 1). Each control point's X,Y location allowed an interpolated derivation of the elevation comprised of 3 surrounding LAS points, triangulated as a plane. The difference in elevation between the Control Point Z and the TIN LAS points was compiled in a table and a statistical evaluation was performed.

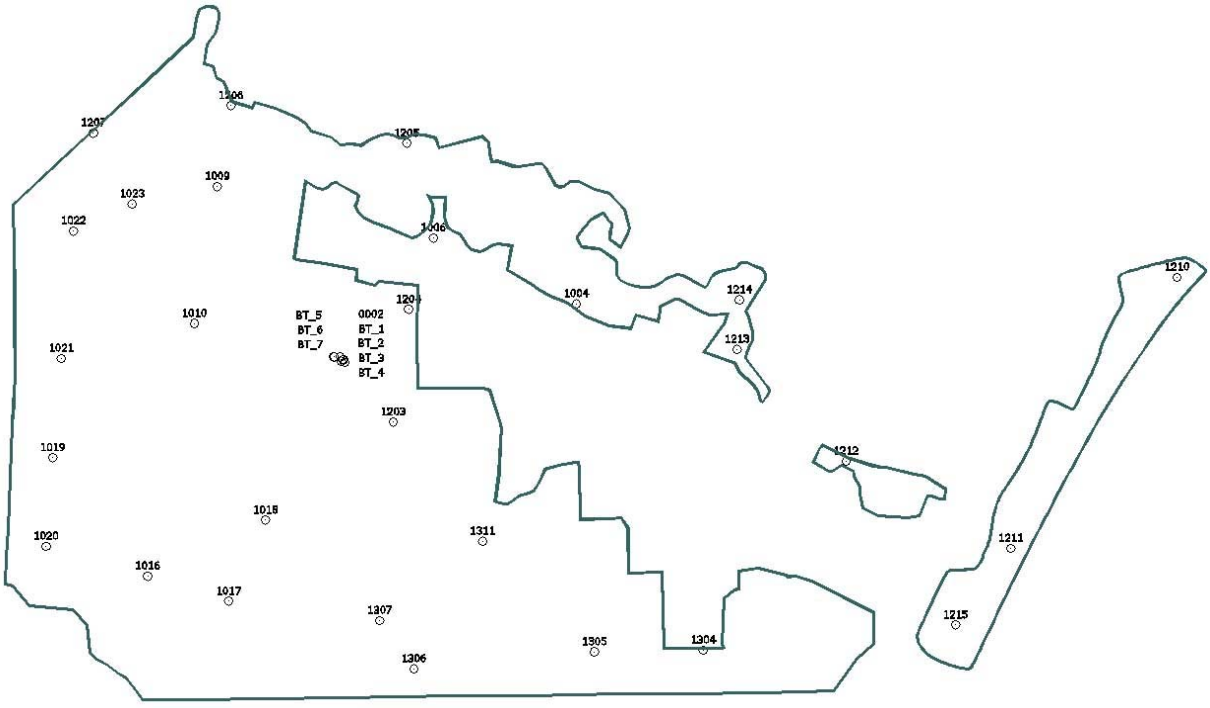

Figure 1. Control point locations.

Control points would often intersect more than one LAS flightline, as those files overlap on each side with neighboring flightlines. Though there were 36 Control Points for

measuring, the derived elevation differences were drawn from 53 samples, due to more than one file intersecting the control point location. Since this operation was intended to measure the overall conformity to mapping standards, outlying differences were weighed against independent measurements between flight lines. Put differently, though some differences measured were slightly more than desired, measurements between neighboring flightlines suggested the flightline in question should not be adjusted in elevation, despite what the quality report implied.

Using the table of differences, Spectrum Mapping determined an average elevation difference of **-0.15 feet**, with a Standard Deviation of 0.282 and an RMSEz of **0.3172 feet**. A 95 percentile value of **0.6218** was compared to the difference table to determine stability across the set of samples. 50 of 53 (94%) samples were within the acceptance test, though one of those which failed was within a portion of the flightline (Mission 14 / Line 70) which was not included in the project mapping (due to overlap removal during the mapping process). With that outlier excluded, 50 of 52 (96%) of the comparisons were within the desired range of variance.

Tested 0.6218 feet vertical accuracy at 95-percent confidence level using RMSEz x 1.960. Based on these first-run measurements (prior to tiling and editing), the Lidar was found to **meet the following standards for 2-foot contours: United States National Map Accuracy Standards (NMAS), American Society for Photogrammetry and Remote Sensing (ASPRS) Class 1, and National Standard for Spatial Data Accuracy (NSSDA).**

Table 2 lists the breakdown of measurements against source flightline LAS data.

Table 2. Measurements of flightlines against source flightline LAS data.

Point ID	Mission / Line Name (LAS)	SPX-83 (ft)	SPY-83 (ft)	Z-88 (ft-G99)	LAS TIN Elev (ft)	Z-Difference (ft)	Squared	Z Difference < 1.96 RMSE (95.Percentile)
2	m16_line045_1	1246544.45	17173109.88	76.13	75.65	-0.48	0.2304	T
2	m16_line046_2	1246544.45	17173109.88	76.13	75.95	-0.18	0.0324	T
1004	m5_line028_2	1302761.33	17187217.29	37.98	37.72	-0.26	0.0676	T
1006	m5_line027_1	1268070.37	17203146.67	80.77	80.84	0.07	0.0049	T
1006	m5_line028_2	1268070.37	17203146.67	80.77	80.71	-0.06	0.0036	T
1009	m10_line041_3	1215682.20	17215570.39	74.55	74.44	-0.11	0.0121	T
1010	m12_line058_2	1210127.55	17182519.79	83.11	83.16	0.05	0.0025	T
1016	m2_line089	1198767.22	17121451.55	77.50	77.17	-0.33	0.1089	T
1016	m2_line090	1198767.22	17121451.55	77.50	77.21	-0.29	0.0841	T
1017	m3_line083_2	1218427.06	17115441.70	67.26	66.89	-0.37	0.1369	T
1018	m14_line070_2	1227386.93	17135028.20	59.26	58.31	-0.95	0.9025	F (edge of line)
1018	m9_line071_2	1227386.93	17135028.20	59.26	59.08	-0.18	0.0324	T
1019	m2_line087	1175766.26	17150082.81	117.14	116.80	-0.34	0.1156	T
1019	m2_line088	1175766.26	17150082.81	117.14	116.79	-0.35	0.1225	T
1020	m2_line097	1174147.31	17128653.23	104.97	105.46	0.49	0.2401	T
1020	m2_line098	1174147.31	17128653.23	104.97	105.30	0.33	0.1089	T

Point ID	Mission / Line Name (LAS)	SPX-83 (ft)	SPY-83 (ft)	Z-88 (ft-G99)	LAS TIN Elev (ft)	Z-Difference (ft)	Squared	Z Difference < 1.96 RMSE (95.Percentile)
1021	m4_line076_2	1177797.44	17174044.14	119.60	119.73	0.13	0.0169	T
1022	m13_line061_1	1180784.11	17204834.47	107.15	107.25	0.10	0.0100	T
1022	m13_line062_2	1180784.11	17204834.47	107.15	107.36	0.21	0.0441	T
1023	m12_line052_2	1194999.31	17211373.74	105.02	104.83	-0.19	0.0361	T
1203	m16_line046_1	1258374.74	17158694.32	67.69	67.26	-0.43	0.1849	T
1204	m9_line032_3	1262057.70	17185906.21	74.34	74.26	-0.08	0.0064	T
1204	m9_line033_1	1262057.70	17185906.21	74.34	74.53	0.19	0.0361	T
1205	m15_line016	1261613.92	17226035.40	16.78	16.64	-0.14	0.0196	T
1205	m15_line017	1261613.92	17226035.40	16.78	16.60	-0.18	0.0324	T
1206	m15_line022_2	1219015.43	17235120.61	39.02	39.05	0.03	0.0009	T
1207	m16_line049_1	1185614.79	17228474.51	117.64	117.54	-0.10	0.0100	T
1210	m8_line137	1448510.94	17193658.23	5.01	4.99	-0.02	0.0004	T
1210	m8_swline067	1448510.94	17193658.23	5.01	4.90	-0.11	0.0121	T
1211	m8_line134	1408180.88	17128168.09	4.39	4.35	-0.04	0.0016	T
1211	m8_line135	1408180.88	17128168.09	4.39	4.16	-0.23	0.0529	T
1212	m5_swline043	1368249.05	17149274.39	7.39	7.42	0.03	0.0009	T
1213	m6_swline024	1341782.30	17176275.78	11.85	11.76	-0.09	0.0081	T
1213	m6_swline025	1341782.30	17176275.78	11.85	11.61	-0.24	0.0576	T
1213	m6_swline040	1341782.30	17176275.78	11.85	12.22	0.37	0.1369	T
1214	m6_swline012	1342331.41	17188177.70	3.19	3.17	-0.02	0.0004	T
1215	m7_swline079	1394777.81	17109702.02	6.75	6.54	-0.21	0.0441	T
1215	m7_swline080	1394777.81	17109702.02	6.75	6.61	-0.14	0.0196	T
1304	m10_line036_2	1333558.06	17103584.37	20.27	20.08	-0.19	0.0361	T
1305	m16_line048_1	1307162.92	17103219.79	38.06	38.06	0.00	0.0000	T
1306	m14_line070_2	1263380.38	17099078.19	35.33	34.69	-0.64	0.4096	F
1307	m13_line068_1	1255060.23	17110758.56	41.18	41.17	-0.01	0.0001	T
1307	m13_line069_2	1255060.23	17110758.56	41.18	41.06	-0.12	0.0144	T
1311	m16_line049_2	1279997.59	17129921.45	51.21	50.98	-0.23	0.0529	T
BT_1	m16_line045_1	1245752.75	17173402.33	76.42	76.50	0.08	0.0064	T
BT_1	m16_line046_2	1245752.75	17173402.33	76.42	76.61	0.19	0.0361	T
BT_2	m16_line045_1	1246544.45	17173109.88	76.13	75.65	-0.48	0.2304	T
BT_2	m16_line046_2	1246544.45	17173109.88	76.13	75.95	-0.18	0.0324	T
BT_3	m16_line045_1	1246195.69	17173737.27	76.37	76.16	-0.21	0.0441	T
BT_4	m16_line045_1	1246315.72	17173732.49	77.59	77.10	-0.49	0.2401	T
BT_5	m16_line045_1	1245455.82	17174406.87	77.88	77.29	-0.59	0.3481	T
BT_6	m16_line046_2	1243920.04	17174445.18	77.78	77.53	-0.25	0.0625	T
BT_7	m16_line046_2	1244041.82	17174423.90	78.57	77.63	-0.94	0.8836	F
					TOTAL	-8.18	5.3342	

Point ID	Mission / Line Name (LAS)	SPX-83 (ft)	SPY-83 (ft)	Z-88 (ft-G99)	LAS TIN Elev (ft)	Z-Difference (ft)	Squared	Z Difference < 1.96 RMSE (95.Percentile)
					Avg Error	**-0.15**	**0.1006**	
					# Samples	**53**	**0.3172**	**RMSE**
					NSSDA		**0.6218**	**95.Percentile**

Figure 2 shows the tile layout for Nueces County, while Figure 3 shows the flight plan used for Nueces County.

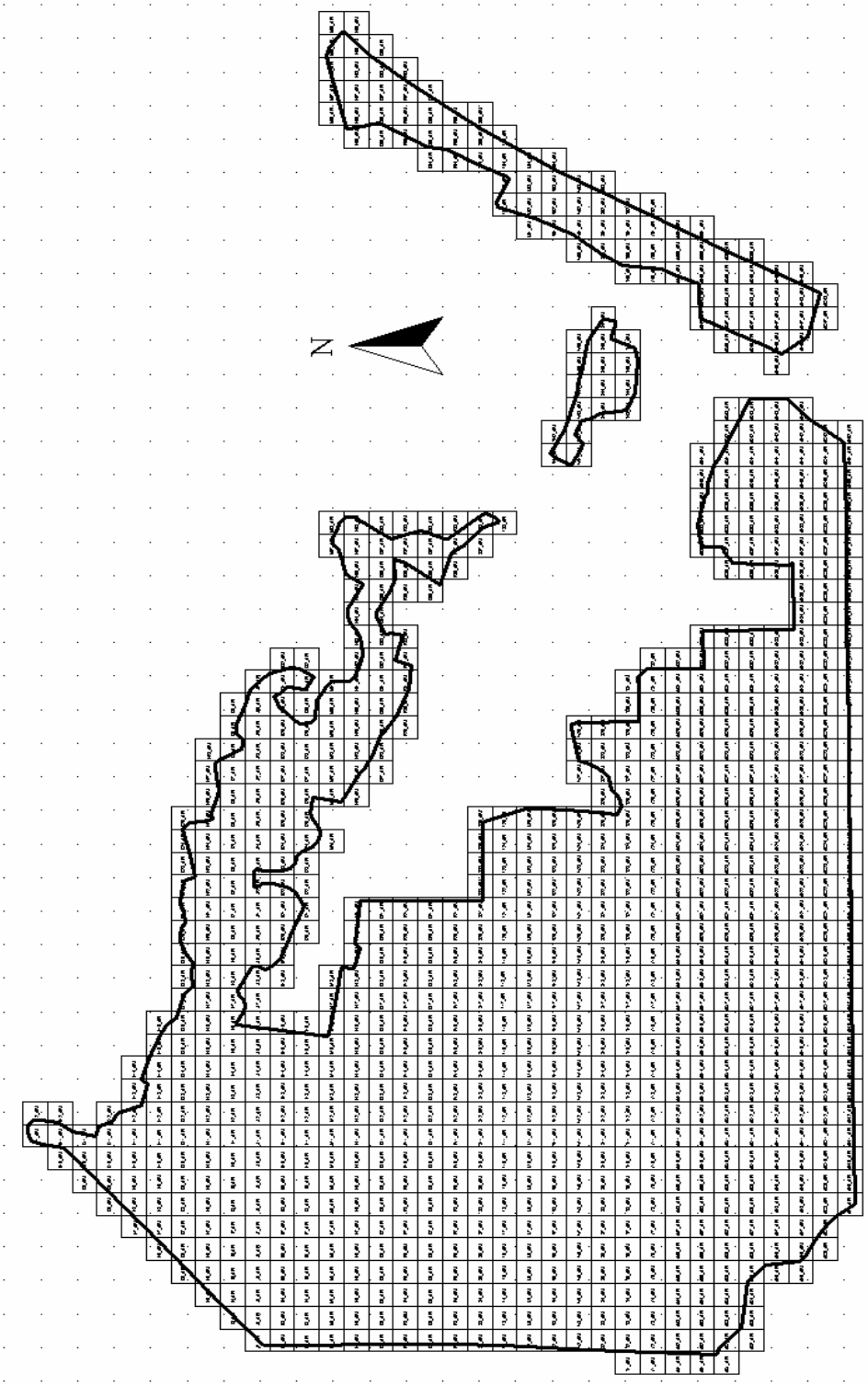

Figure 2. Nueces County, TX Tile Layout.

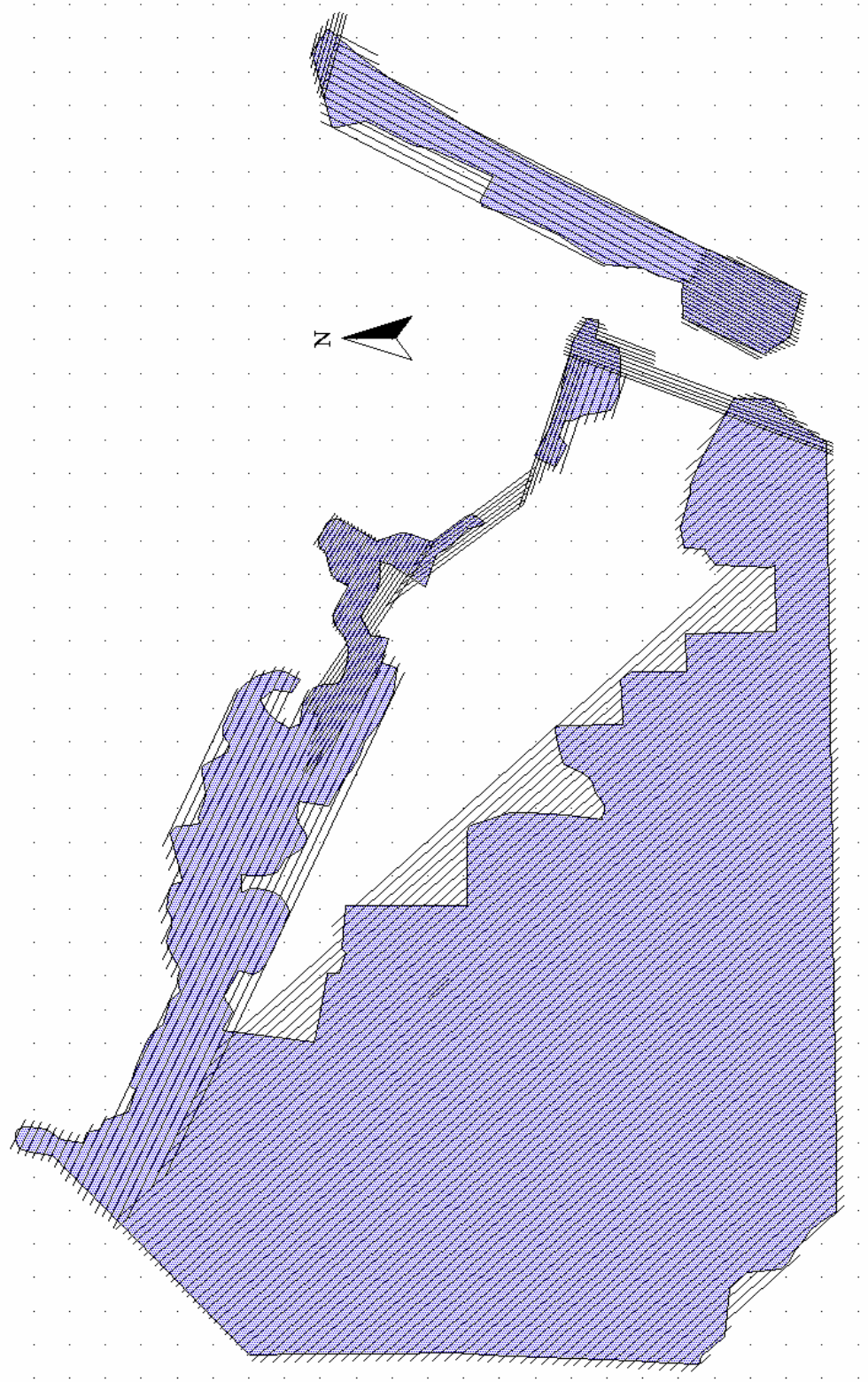

Figure 3. Nueces County, TX Flight Plan.

GROUND CONTROL REPORT

GPS Control

The base station at the airport was one of the contracted surveyors surveyed ground points for calibration of the data at the project areas.

Base Station Information

The base station used was #T53 B This base station was used in conjunction with the NGS point AB 3207, the information for which is listed below.

The NGS Data SheetSee file dsdata.txt for more information about the datasheet.DATABASE = Sybase ,PROGRAM = datasheet, VERSION = 7.42
1 National Geodetic Survey, Retrieval Date = NOVEMBER 17, 2006
AB3207 *
AB3207 PACS - This is a Primary Airport Control Station.
AB3207 DESIGNATION - T53 B
AB3207 PID - AB3207
AB3207 STATE/COUNTY- TX/NUECES
AB3207 USGS QUAD - ROBSTOWN (1975)
AB3207
AB3207 *CURRENT SURVEY CONTROL
AB3207 _____
AB3207* NAD 83(1993)- 27 46 45.38802(N) 097 41 25.86446(W) ADJUSTED
AB3207* NAVD 88 - 23.35 (meters) 76.6 (feet) GPS OBS
AB3207 _____
AB3207 X - -755,715.114 (meters) COMP
AB3207 Y - -5,596,364.647 (meters) COMP
AB3207 Z - 2,954,884.541 (meters) COMP
AB3207 LAPLACE CORR- 0.39 (seconds) DEFLEC99
AB3207 ELLIP HEIGHT- -3.25 (meters) (10/23/00) GPS OBS
AB3207 GEOID HEIGHT- -26.55 (meters) GEOID03
AB3207
AB3207 HORZ ORDER - B
AB3207 ELLP ORDER - FOURTH CLASS II
AB3207
AB3207.This mark is at Nueces Co (T53) Airport (T53)
AB3207
AB3207.The horizontal coordinates were established by GPS observations
AB3207.and adjusted by the National Geodetic Survey in February 1996..
AB3207
AB3207.The orthometric height was determined by GPS observations and a
AB3207.high-resolution geoid model.
AB3207
AB3207.GPS derived orthometric heights for airport stations designated as
AB3207.PACS or SACS are published to 2 decimal places. This maintains
AB3207.centimeter relative accuracy between the PACS and SACS. It does
AB3207.not indicate centimeter accuracy relative to other marks which are
AB3207.part of the NAVD 88 network.
AB3207
AB3207.The X, Y, and Z were computed from the position and the ellipsoidal ht.
AB3207**

AB3207.The Laplace correction was computed from DEFLEC99 derived deflections.
AB3207
AB3207.The ellipsoidal height was determined by GPS observations
AB3207.and is referenced to NAD 83.
AB3207
AB3207.The geoid height was determined by GEOID03.
AB3207
AB3207; North East Units Scale Factor Converg.
AB3207;SPC TX S - 5,234,322.507 379,782.219 MT 0.99998676 +0 22 03.0
AB3207;SPC TX S -17,172,939.76 1,246,002.16 sFT 0.99998676 +0 22 03.0
AB3207;UTM 14 - 3,073,439.088 629,019.377 MT 0.99980546 +0 36 37.4
AB3207
AB3207! - Elev Factor x Scale Factor = Combined Factor
AB3207!SPC TX S - 1.00000051 x 0.99998676 = 0.99998727
AB3207!UTM 14 - 1.00000051 x 0.99980546 = 0.99980597
AB3207
AB3207: Primary Azimuth Mark Grid Az
AB3207:SPC TX S - T53 A 134 33 13.2
AB3207:UTM 14 - T53 A 134 18 38.8
AB3207
AB3207|--|
AB3207| PID Reference Object Distance Geod. Az |
AB3207| dddmmss.s |
AB3207| AC6062 T53 A APPROX. 0.5 KM 1345516.2 |
AB3207| AC6063 T53 C 362.001 METERS 31629 |
AB3207|--|
AB3207
AB3207 SUPERSEDED SURVEY CONTROL
AB3207
AB3207 ELLIP H (02/20/96) -3.14 (m) GP( ) 3 2
AB3207
AB3207.Superseded values are not recommended for survey control.
AB3207.NGS no longer adjusts projects to the NAD 27 or NGVD 29 datums.
AB3207.See file dsdata.txt to determine how the superseded data were derived.
AB3207
AB3207_U.S. NATIONAL GRID SPATIAL ADDRESS: 14RPR2901973439(NAD 83)
AB3207_MARKER: I = METAL ROD
AB3207_SETTING: 59 = STAINLESS STEEL ROD IN SLEEVE (10 FT.+)
AB3207_STAMPING: T53 B 1995
AB3207_MARK LOGO: NGS
AB3207_PROJECTION: FLUSH
AB3207_MAGNETIC: I = MARKER IS A STEEL ROD
AB3207_STABILITY: B = PROBABLY HOLD POSITION/ELEVATION WELL
AB3207_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
AB3207+SATELLITE: SATELLITE OBSERVATIONS - 1995
AB3207_ROD/PIPE-DEPTH: 8.6 meters
AB3207_SLEEVE-DEPTH : 1 meters
AB3207
AB3207 HISTORY - Date Condition Report By
AB3207 HISTORY - 1995 MONUMENTED NGS
AB3207 HISTORY - 19970310 GOOD NGS
AB3207
AB3207 STATION DESCRIPTION

AB3207
AB3207'DESCRIBED BY NATIONAL GEODETIC SURVEY 1995 (AJL)
AB3207'THE STATION IS LOCATED ABOUT 16.0 MI (25.7 KM) WEST OF CORPUS CHRISTI,
AB3207'10.0 MI (16.1 KM) NORTHEAST OF DRISCOLL, 1.5 MI (2.4 KM) SOUTHWEST OF
AB3207'ROBSTOWN AND AT THE NUECES COUNTY AIRPORT. OWNERSHIP--COUNTY OF
AB3207'NUECES, AIRPORT MANAGER IS MANUEL FLORES, RT 2 BOX 189A, ROBSTOWN,
TX.
AB3207'78380. PHONE (512) 387-1700. TO REACH THE STATION FROM THE JUNCTION
AB3207'OF US HIGHWAY 77 AND STATE HIGHWAY 44 EAST ON THE EAST SIDE OF
AB3207'ROBSTOWN, GO SOUTHERLY ON US HIGHWAY 77 FOR 1.2 MI (1.9 KM) TO THE
AB3207'INTERSECTION OF FARM ROAD 892 (LINCOLN AVENUE) , TURN RIGHT AND GO
AB3207'NORTH ON FARM ROAD 892 FOR 0.5 MI (0.8 KM) TO A PAVED ROAD LEFT, TURN
AB3207'LEFT AND GO WEST ON RUBEN CHAVEZ ROAD FOR 1.3 MI (2.1 KM) TO A PAVED
AB3207'ROAD LEFT, TURN LEFT AND GO SOUTH ON THE AIRPORT ENTRANCE ROAD
FOR
AB3207'0.25 MI (0.40 KM) TO THE APRON AHEAD AND THE OFFICE ON THE RIGHT, BEAR
AB3207'RIGHT AND GO SOUTHWEST ON THE APRON FOR 0.05 MI (0.08 KM) TO A
AB3207'CONNECTOR TAXIWAY AND THE STATION ON THE LEFT. THE STATION IS 190.0
AB3207'FT (57.9 M) NORTHEAST OF THE RUNWAY CENTER, 67.5 FT (20.6 M) SOUTHEAST
AB3207'OF THE CONNECTOR TAXIWAY CENTER, 58.0 FT (17.7 M) NORTH FROM A
AB3207'WINDSOCK POLE, 57.7 FT (17.6 M) NORTHWEST FROM THE WEST CORNER OF A
AB3207'SQUARE CONCRETE PAD FOR A UNDERGROUND TANK FILL, 12.8 FT (3.9 M)
AB3207'SOUTHWEST OF THE SOUTHWEST EDGE OF THE APRON PAVEMENT AND 2.0 FT
(0.6
AB3207'M) NORTHEAST OF A WITNESS POST. DRL. THIS IS A PAC STATION.
AB3207
AB3207 STATION RECOVERY (1997)
AB3207
AB3207'RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1997 (RWD)
AB3207'THE STATION WAS RECOVERED USING THE ORIGINAL DESCRIPTION, ALL
AB3207'DIRECTIONS AND DISTANCES CHECK.

SYSTEM CALIBRATION REPORT

System Calibration

The Spectrum RAMS LIDAR system uses multiple layers of system calibration. The initial instrument calibration is accomplished during the system fabrication. All critical components (IMU, LIDAR, Camera, and Scanner) are optically aligned to a common optical bench using NIST traceable optical collimators and optical flats. This alignment is initially carried out to 2 arc seconds. In addition to the optical bench calibration, the LIDAR system is operated against a series of known targets to determine both scale factor and bias accuracy. All system timing is derived from GPS.

On any aircraft installation the critical factor is location of the GPS antenna and IMU positioning with respect to the RAMS optical reference. This is accomplished through a differential GPS survey. After installation in the aircraft, the system is then flown against a ground test range that was developed using high accuracy GPS points from a licensed surveyor. The LIDAR system is checked using this control range established in Albuquerque, NM, at least twice a year or as otherwise required.

Spectrum's primary sensor calibration facility is located in an area surrounding University of New Mexico's basketball arena (Figures 4 and 5). This site was chosen for its large parking area that typically has few cars during daylight hours and its proximity to the airport. Spectrum maintains approximately 400 control points on this site, each accurate to 2-3 centimeters in X, Y and Z. All Spectrum sensors are calibrated here prior to their maiden flights and quarterly for verification. As of the latest quarterly calibration at this site on May 21, 2006 Spectrum's system is calibrated to .0268 RMSE.

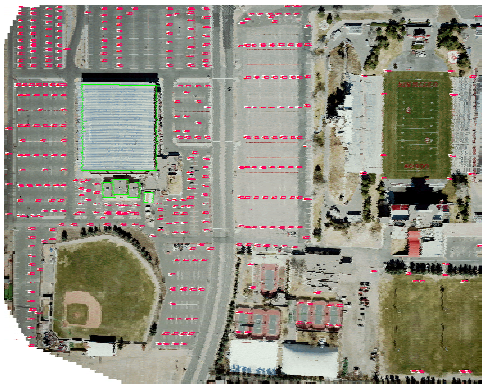

Figure 4. Entire In-situ Range at the Univ. NM PIT Control.

Figure 5. Enlargement of High Accuracy Photo-Identifiable Control.

Vertical RMSE:

North RMSE	0.0231
South RMSE	0.0356
East RMSE	0.0248
West RMSE	0.024
Average	**0.026875 ft**

Horizontal RMSE:

North	0.499	0.4588
South	0.5354	0.4569
East	0.4374	0.5285
West	0.5779	0.5347
Average	**0.512425 ft**	**0.494725 ft**

The digital camera systems are flown over this site, control points are observed and a least squares bundle adjustment is performed. The LIDAR sensors are flown over the same site and surface comparisons are made using the laser data and the ground control points. In both the image and laser cases the angular differences between themselves and the IMU is calculated and used as constants in the final projection to project coordinates. These bore-sights are calculated upon initial installation of the sensors in an airborne platform and verified daily to insure integrity.

One of the benefits of a LIDAR system is that the calibration of the system is verified each time two or more flight lines are combined. This is a result of taking measurements on a common point from multiple locations (i.e. the ground point is fixed and each flight line that sees this is a different instrument location). When multiple flight lines can be combined with no artifacts then the calibration of the system is validated in terms of range and angular accuracies. Our standard practice requires that at least one flight line within the project be flown in both directions for calibration verification of range and angular accuracy.

Another important area of quality control is edge matching. All edge matching discrepancies in LIDAR DEM data occur between two flight lines. Identification of edge matching discrepancies is performed by overlaying either the contour or the shaded relief model representation of the original DEM. If edge artifacts are found in the overlap area between two flight lines then this represents an edge discrepancy. The GPS / IMU data is then reevaluated to check for any possible errors in the post processing or a spike in the PDOP at the time of data acquisition. Usually this type of problem is resolved by reprocessing the GPS / IMU.

For accuracy verification, static survey points are collected, using static benchmarks where available. These survey points within the project boundary are selected to allow a statistical absolute elevation verification of the data. This data set is then statistically compared to the project LIDAR DEM data after the combination of flight lines to verify accuracy both horizontal and vertical. The RMSE of the LIDAR DEM will be calculated using the ground GPS data to ensure that the vertical error is less than 0.15 m and the horizontal is less than 0.5 m.

GPS / Calibration Processing Summary

All GPS phase data was post-processed with continuous kinematic survey techniques using “On the Fly” (OTF) integer ambiguity resolution. The GPS data was processed with forward and reverse processing algorithms. The results from each process were combined to yield a single fixed integer phase differential solution of the aircraft trajectory. Plots of altitude and the forward and reverse GPS solution residuals (RMS and DOP) are attached for each day of flight. Spikes in the vertical component of these plots occur in turns and ferrying to and from collection sites, and do not affect the integrity of the solution. The RMS separation values (25%-75% weighting) for all flights are summarized below.

The Processing Summary provides statistics about the final solution. The processing summary includes details such as solution type, baseline distances, number of epochs in total, epochs not processed, and epochs with bad C/A code and L1 phase measurements.

Statistics such as RMS values of the C/A code, L1 phase, L1 Doppler measurements, quality number percentages, estimated position standard deviations calculated from the Kalman filtering, and percentages of epochs having double difference DOPs over 10, provide a quick, convenient method of assessing processed solutions. The forward/reverse separation RMSE values for Easting (E), Northing(N), and Height (H) are listed, and the forward/reverse separation RMSE values of E,N, and H for 25%-75% weighting.

The latter RMS values take into account the weighting of the forward/reverse combined solution only in the region of 25%-75% where the float solution has had time to converge to a lower value of error since the larger error values occur at the beginning of the processing direction. The same can be said for a Kinematic Ambiguity Resolution (KAR) fixed solution as well. The RMS values for the 25%-75% weighting of the combined solution are generally lower than the RMS values from the forward/reverse separation because if one solution has high error values, most of the weighting will go to the other processing direction.

The following is checked in the Processing Summary:

The forward/reverse separation RMS values of E,N, and H are generally low if a fixed integer solution has been obtained. The values should be less than 0.05 meters, but no greater than 0.10 meters.
The Quality Number Percentages should almost all be Quality 1. This number is typically close to 100%, with 1% in Quality 2 for a fixed integer solution.

Processing Summary Reports:

Processing Summary Information for July 16. 2006

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC16Jul06\GPS\NC16Jul06.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file:	30929
No processed position:	15468
Missing Fwd or Rev:	3
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0211 (m)
C/A Code:	1.22 (m)
L1 Doppler:	0.026 (m/s)

Fwd/Rev Separation RMS Values:

East:	0.024 (m)
North:	0.013 (m)
Height:	0.056 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (15452 occurrences):

East:	0.023 (m)
North:	0.012 (m)
Height:	0.055 (m)

Quality Number Percentages:

Q 1:	99.9 %
Q 2:	0.1 %
Q 3:	0.0 %
Q 4:	0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 100.0 %

0.10 - 0.30 m: 0.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 33.245 (km)

Minimum: 0.008 (km)

Average: 19.672 (km)

First Epoch: 0.014 (km)

Last Epoch: 0.015 (km)

Processing Summary Information for July 17, 2006

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC17Jul06\GPS\NC17Jul06.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 31695

No processed position: 15847

Missing Fwd or Rev: 3

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0246 (m)

C/A Code: 1.20 (m)

L1 Doppler: 0.026 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.026 (m)

North: 0.042 (m)

Height: 0.106 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (15842 occurrences):

East: 0.026 (m)

North: 0.042 (m)

Height: 0.106 (m)

Quality Number Percentages:

Q 1: 99.7 %

Q 2: 0.3 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 100.0 %

0.10 - 0.30 m: 0.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 39.170 (km)

Minimum: 0.011 (km)

Average: 17.792 (km)

First Epoch: 0.021 (km)

Last Epoch: 0.018 (km)

Processing Summary Information for June 19, 2006

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC19Jun06-2\GPS\NC19Jun06-2.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 31499

No processed position: 15752

Missing Fwd or Rev: 3

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0349 (m)

C/A Code: 1.18 (m)

L1 Doppler: 0.027 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.151 (m)

North: 0.031 (m)

Height: 0.139 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (15738 occurrences):

East: 0.151 (m)

North: 0.031 (m)

Height: 0.136 (m)

Quality Number Percentages:

Q 1: 96.2 %

Q 2: 3.8 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 100.0 %

0.10 - 0.30 m: 0.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 38.330 (km)

Minimum: 0.013 (km)

Average: 24.096 (km)

First Epoch: 0.023 (km)

Last Epoch: 0.013 (km)

Processing Summary Information for June 22, 2006 (Mission 1)

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC22Jun06-1\GPS\NC22Jun06-1.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 20283

No processed position: 10141

Missing Fwd or Rev: 3

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0283 (m)

C/A Code: 1.45 (m)

L1 Doppler: 0.029 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.012 (m)

North: 0.014 (m)

Height: 0.104 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (10136 occurrences):

East: 0.012 (m)

North: 0.014 (m)

Height: 0.104 (m)

Quality Number Percentages:

Q 1: 99.4 %

Q 2: 0.6 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 100.0 %

0.10 - 0.30 m: 0.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 31.738 (km)

Minimum: 0.013 (km)

Average: 19.152 (km)

First Epoch: 0.044 (km)

Last Epoch: 0.022 (km)

Processing Summary Information for June 22, 2006 (Mission 2)

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC22Jun06-2\GPS\NC22Jun06-2.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 20597

No processed position: 10298

Missing Fwd or Rev: 3

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0272 (m)

C/A Code: 1.16 (m)

L1 Doppler: 0.028 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.120 (m)

North: 0.047 (m)

Height: 0.051 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (10291 occurrences):

East: 0.120 (m)

North: 0.047 (m)

Height: 0.051 (m)

Quality Number Percentages:

Q 1: 99.0 %

Q 2: 1.0 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 100.0 %

0.10 - 0.30 m: 0.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 64.825 (km)

Minimum: 0.008 (km)

Average: 23.000 (km)

First Epoch: 0.022 (km)

Last Epoch: 0.008 (km)

Processing Summary Information for June 23, 2006 (Mission 1)

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC23Jun06-1\GPS\NC23Jun06-1.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 26448

No processed position: 13223

Missing Fwd or Rev: 3

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0395 (m)

C/A Code: 1.38 (m)

L1 Doppler: 0.028 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.018 (m)

North: 0.034 (m)

Height: 0.082 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (13218 occurrences):

East: 0.018 (m)

North: 0.034 (m)

Height: 0.082 (m)

Quality Number Percentages:

Q 1: 99.3 %

Q 2: 0.7 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 100.0 %

0.10 - 0.30 m: 0.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 48.955 (km)

Minimum: 0.011 (km)

Average: 20.553 (km)

First Epoch: 0.011 (km)

Last Epoch: 0.016 (km)

Processing Summary Information for June 23, 2006 (Mission 2)

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC23Jun06-2\GPS\NC23Jun06-2.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 25924

No processed position: 12957

Missing Fwd or Rev: 3

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0331 (m)

C/A Code: 1.15 (m)

L1 Doppler: 0.027 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.115 (m)

North: 0.067 (m)

Height: 0.126 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (12958 occurances):

East: 0.115 (m)

North: 0.067 (m)

Height: 0.126 (m)

Quality Number Percentages:

Q 1: 97.8 %

Q 2: 2.2 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 99.9 %

0.10 - 0.30 m: 0.1 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.1 %

Baseline Distances:

Maximum: 39.147 (km)

Minimum: 0.010 (km)

Average: 24.956 (km)

First Epoch: 0.014 (km)

Last Epoch: 0.011 (km)

Processing Summary Information for June 24, 2006 (Mission 1)

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC24Jun06-1\GPS\NC24Jun06-1.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 31078

No processed position: 15538

Missing Fwd or Rev: 2

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0474 (m)

C/A Code: 1.31 (m)

L1 Doppler: 0.027 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.093 (m)

North: 0.137 (m)

Height: 0.162 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (15529 occurrences):

East: 0.092 (m)

North: 0.136 (m)

Height: 0.161 (m)

Quality Number Percentages:

Q 1: 90.3 %

Q 2: 0.7 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 74.8 %

0.10 - 0.30 m: 25.1 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 52.450 (km)

Minimum: 0.010 (km)

Average: 41.127 (km)

First Epoch: 0.010 (km)

Last Epoch: 0.022 (km)

Processing Summary Information for June 24, 2006 (Mission 2)

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC24Jun06-2\GPS\NC24Jun06-2.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 26906

No processed position: 13452

Missing Fwd or Rev: 3

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0258 (m)

C/A Code: 1.31 (m)

L1 Doppler: 0.027 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.056 (m)

North: 0.023 (m)

Height: 0.086 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (13447 occurrences):

East: 0.056 (m)

North: 0.023 (m)

Height: 0.086 (m)

Quality Number Percentages:

Q 1: 99.8 %

Q 2: 0.2 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 100.0 %

0.10 - 0.30 m: 0.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 69.118 (km)

Minimum: 0.010 (km)

Average: 46.022 (km)

First Epoch: 0.012 (km)

Last Epoch: 0.010 (km)

Processing Summary Information for June 25, 2006 (Mission 1)

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC25Jun06-1\GPS\NC25Jun06-1.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 25396

No processed position: 12704

Missing Fwd or Rev: 3

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0314 (m)

C/A Code: 1.43 (m)

L1 Doppler: 0.027 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.023 (m)

North: 0.023 (m)

Height: 0.106 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (12374 occurrences):

East: 0.023 (m)

North: 0.023 (m)

Height: 0.106 (m)

Quality Number Percentages:

Q 1: 97.4 %

Q 2: 2.6 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 100.0 %

0.10 - 0.30 m: 0.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 47.586 (km)

Minimum: 0.010 (km)

Average: 24.506 (km)

First Epoch: 0.011 (km)

Last Epoch: 0.012 (km)

Processing Summary Information for June 25, 2006 (Mission 2)

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC25Jun06-2\GPS\NC25Jun06-2.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 28880

No processed position: 14438

Missing Fwd or Rev: 3

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0297 (m)

C/A Code: 1.15 (m)

L1 Doppler: 0.026 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.129 (m)

North: 0.068 (m)

Height: 0.154 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (14435 occurrences):

East: 0.129 (m)

North: 0.068 (m)

Height: 0.154 (m)

Quality Number Percentages:

Q 1: 98.1 %

Q 2: 1.9 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 100.0 %

0.10 - 0.30 m: 0.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 44.618 (km)

Minimum: 0.009 (km)

Average: 18.449 (km)

First Epoch: 0.012 (km)

Last Epoch: 0.010 (km)

Processing Summary Information for June 27, 2006 (Mission 1)

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC27Jun06-1\GPS\NC27Jun06-1.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 27498

No processed position: 13746

Missing Fwd or Rev: 3

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0202 (m)

C/A Code: 1.20 (m)

L1 Doppler: 0.027 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.008 (m)

North: 0.026 (m)

Height: 0.061 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (13745 occurrences):

East: 0.008 (m)

North: 0.026 (m)

Height: 0.061 (m)

Quality Number Percentages:

Q 1: 99.7 %

Q 2: 0.3 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 100.0 %

0.10 - 0.30 m: 0.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 39.622 (km)

Minimum: 0.013 (km)

Average: 17.115 (km)

First Epoch: 0.013 (km)

Last Epoch: 0.338 (km)

Processing Summary Information for June 27, 2006 (Mission 2)

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC27Jun06-2\GPS\NC27Jun06-2.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 26566

No processed position: 13464

Missing Fwd or Rev: 2

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0213 (m)

C/A Code: 1.08 (m)

L1 Doppler: 0.028 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.051 (m)

North: 0.037 (m)

Height: 0.046 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (13096 occurrences):

East: 0.051 (m)

North: 0.037 (m)

Height: 0.046 (m)

Quality Number Percentages:

Q 1: 99.6 %

Q 2: 0.4 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 69.2 %

0.10 - 0.30 m: 30.8 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 34.407 (km)

Minimum: 0.010 (km)

Average: 17.813 (km)

First Epoch: 0.012 (km)

Last Epoch: 0.011 (km)

Processing Summary Information for June 28, 2006

Program: POSGPS
Version: 4.11
Project: V:\Nueces_County\NC28Jun06\GPS\NC28Jun06.gnv

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 17558

No processed position: 8781

Missing Fwd or Rev: 3

With bad C/A code: 0

With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase:	0.0349 (m)
C/A Code:	1.34 (m)
L1 Doppler:	0.029 (m/s)

Fwd/Rev Separation RMS Values:

East:	0.015 (m)
North:	0.025 (m)
Height:	0.056 (m)

Fwd/Rev Sep. RMS for 25%-75% weighting (8771 occurrences):

East:	0.015 (m)
North:	0.025 (m)
Height:	0.056 (m)

Quality Number Percentages:

Q 1:	96.0 %
Q 2:	4.0 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %
Q 6:	0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m:	100.0 %
0.10 - 0.30 m:	0.0 %
0.30 - 1.00 m:	0.0 %
1.00 - 5.00 m:	0.0 %
5.00 m + over:	0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol:	0.0 %

Baseline Distances:

Maximum:	64.153 (km)

Minimum:	0.010 (km)
Average:	25.228 (km)
First Epoch:	0.015 (km)
Last Epoch:	0.012 (km)