Southern Nevada Water Authority (SNWA)
Las Vegas, Nevada

SNWA LiDAR Digital Elevation Data
LiDAR Mapping Report

Prepare for and submitted to:

SOUTHERN NEVADA WATER AUTHORITY
A NOT-FOR-PROFIT WATER AGENCY

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Prepared by:

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SUMMARY

Merrick & Company (Merrick) was contracted by Southern Nevada Water Authority (SNWA) to provide LiDAR (**Li**ght **D**etection **A**nd **R**anging) terrain mapping to SNWA for a portion of the greater Las Vegas, NV region. The total project area encompasses approximately 1,161.62 square miles consisting of approximately 606.21 square miles of Quality Level Two (QL2) LiDAR and approximately 555.42 square miles of Quality Level Two (QL2) LiDAR*. The purpose of the project is to produce accurate high-resolution LiDAR data to support mapping, planning, analysis, and mangament of the region's water resources and develop solutions that will ensure adequate future water supplies for the Las Vegas Valley.

Unless otherwise stated, the LiDAR mapping requirements and deliverables will meet standards as outlined in the *USGS-NGP Lidar Base Specifications, Techniques and Methods 11–B4, Version 1.2, November 2014* (TM11-B4) (http://pubs.usgs.gov/tm/11b4/pdf/tm11-B4.pdf).

The vertical accuracy requirements of the LiDAR data will meet or exceed the following:

- Vertical accuracy (absolute for the Non-vegetated Vertical Accuracy [NVA])
  - ≤10cm RMSEz
  - ≤19.6cm at the 95% confidence level ($Accuracy_Z$)
- Relative accuracy
  - ≤6cm Smooth surface repeatability
  - ≤8cm RMSDz
  - ±16cm maximum difference

* QL1 LiDAR specifications suggest a point density of greater than or equal to eoight points per square meter (≥8ppsm), or less than or equal to thirty-five hundredths of a meter (≤0.35m) Aggregate Nominal Pulse Density (ANPD).QL2 LiDAR specifications suggest a point density of greater than or equal to two points per square meter (≥2ppsm), or less than or equal to seven-tenths of a meter (≤0.71m) Aggregate Nominal Pulse Density (ANPD).

CONTACT INFORMATION

Questions regarding this report should be addressed to:

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Project Completion Report

The contents of this report summarize the methods used to establish the GPS base station network, perform the LiDAR data collection and the survey data collection, the post-processing as well as the results of these methods for the SNWA project.

Duration/Time Period

One LiDAR aircraft, a Cessna 402C (tail number N4661N) was used to collect LiDAR Data. The Cessna 402C arrived on site April 20, 2016 and the LiDAR data collection was accomplished April 21, 2016 thru May 16, 2016. The North Las Vegas Airport (KVGT) was used as the airport of operation.

Mission Parameters for QL1 Sensor 12SEN314 (7,500 & 9,500 Feet MSL)

LiDAR Sensor	Optech Sensor 12SEN314
Nominal Ground Sample Distance	0.42 meters (7,500) 0.41 meters (9,500)
Average Altitudes (MSL in feet)	7,500 & 9,500 Feet
Average Groundspeed	170 Knots
Scan Rate	81 Hertz
Scan FOV (scan angle)	34 Deg.
Pulse Rate	500,000 Hertz

Mission Parameters for QL2 Sensor 12SEN314 (8,500 & 11,500 Feet MSL)

LiDAR Sensor	Optech Sensor 12SEN314
Nominal Ground Sample Distance	0.57 meters
Average Altitudes (MSL in feet)	8,500 & 11,500 Feet
Average Groundspeed	170 Knots
Scan Rate	61 Hertz
Scan FOV (scan angle)	40 Deg.
Pulse Rate	350,000 Hertz

Mission Parameters for QL2 Sensor 12SEN314 (9,200 Feet MSL)

LiDAR Sensor	Optech Sensor 12SEN314
Nominal Ground Sample Distance	0.60 meters
Average Altitudes (MSL in feet)	9,200 Feet
Average Groundspeed	170 Knots
Scan Rate	58 Hertz
Scan FOV (scan angle)	35 Deg.
Pulse Rate	300,000 Hertz

Flight Mission Date and Times

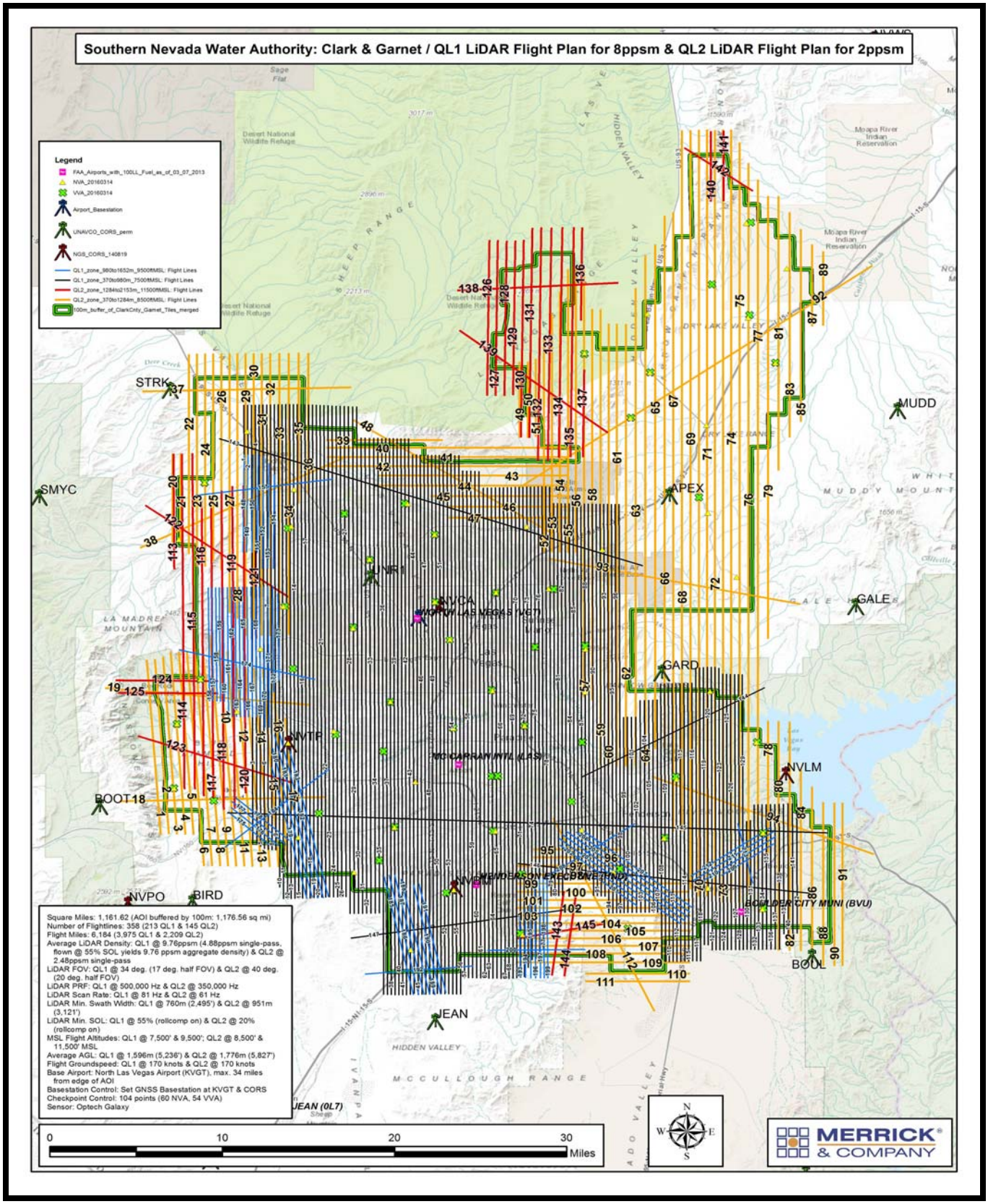
Mission	Date	Plane	Sensor SN	Start Time GPS sec.	End Time GPS sec.	Number of GNSS Solution Records
160421_A	April 21, 2016	N4661N-402C	12SEN314	457085.0	476186.0	19102
160424_A	April 24, 2016	N4661N-402C	12SEN314	24741.0	39671.0	14931
160425_A	April 25, 2016	N4661N-402C	12SEN314	111822.0	117485.0	5664
160426_A	April 26, 2016	N4661N-402C	12SEN314	196404.0	204774.0	8371
160427_A	April 27, 2016	N4661N-402C	12SEN314	282931.0	299608.0	16678
160429_A	April 29, 2016	N4661N-402C	12SEN314	455459.0	471392.0	15934
160430_A	April 30, 2016	N4661N-402C	12SEN314	542479.0	551505.0	9027
160501_A	May 01, 2016	N4661N-402C	12SEN314	23588.0	40524.0	16937
160502_A	May 02, 2016	N4661N-402C	12SEN314	109802.0	125139.0	15338
160503_A	May 03, 2016	N4661N-402C	12SEN314	196359.0	211739.0	15381
160503_B	May 03, 2016	N4661N-402C	12SEN314	282925.0	300714.0	17790
160504_A	May 04, 2016	N4661N-402C	12SEN314	369711.0	386013.0	16303
160505_A	May 05, 2016	N4661N-402C	12SEN314	455622.0	475807.0	20186
160508_A	May 08, 2016	N4661N-402C	12SEN314	109629.0	129746.0	20118
160509_A	May 09, 2016	N4661N-402C	12SEN314	196488.0	215404.0	18917
160510_A	May 10, 2016	N4661N-402C	12SEN314	282855.0	297528.0	14674
160511_A	May 11, 2016	N4661N-402C	12SEN314	368963.0	384584.0	15622
160516_A	May 16, 2016	N4661N-402C	12SEN314	196838.0	196838.00	10280

Field Work / Procedures

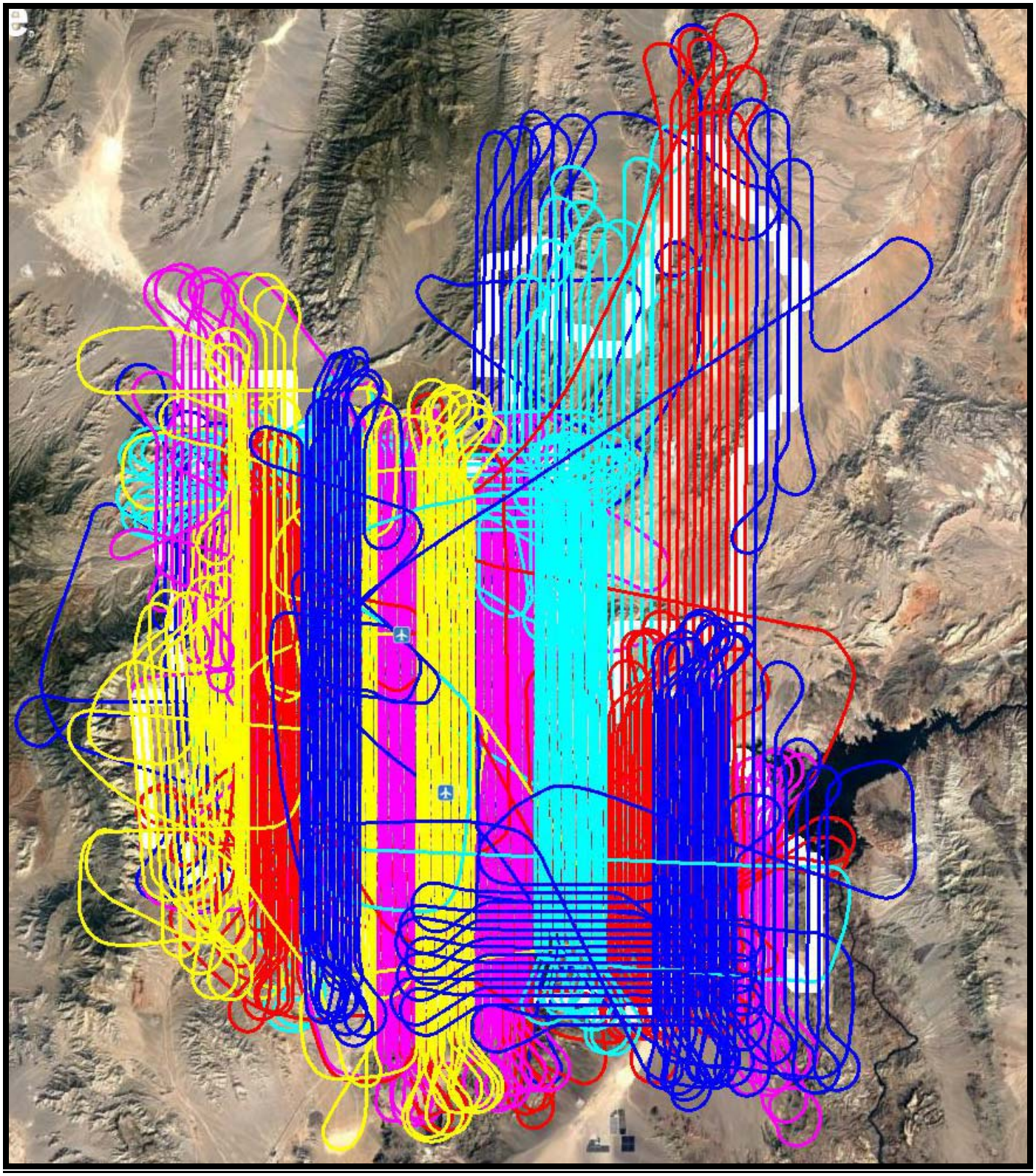
One ground GPS Base Stations was set up at the airport of operation for the LiDAR data collection (Base_KVGT). In addition CORS (Continually Operating Reference Stations) were used for processing verification.

Pre-flight checks such as cleaning the sensor head glass are performed. A five minute INS initialization is conducted on the ground, with the aircraft engines running, prior to flight, to establish fine-alignment of the INS. GPS ambiguities are resolved by flying within ten kilometers of the base stations. During the data collection, the operator recorded information on log sheets which includes weather conditions, LiDAR operation parameters, and flight line statistics. Near the end of the mission, GPS ambiguities were again resolved by flying within ten kilometers of the base stations to aid in post-processing. Data was sent back to the main office and preliminary data processing was performed for quality control of GPS data and to ensure sufficient overlap between flight lines. Any problematic data could then be reflown immediately as required. Final data processing was completed in the Greenwood Village, Colorado office.

Planned Flight Line Diagram

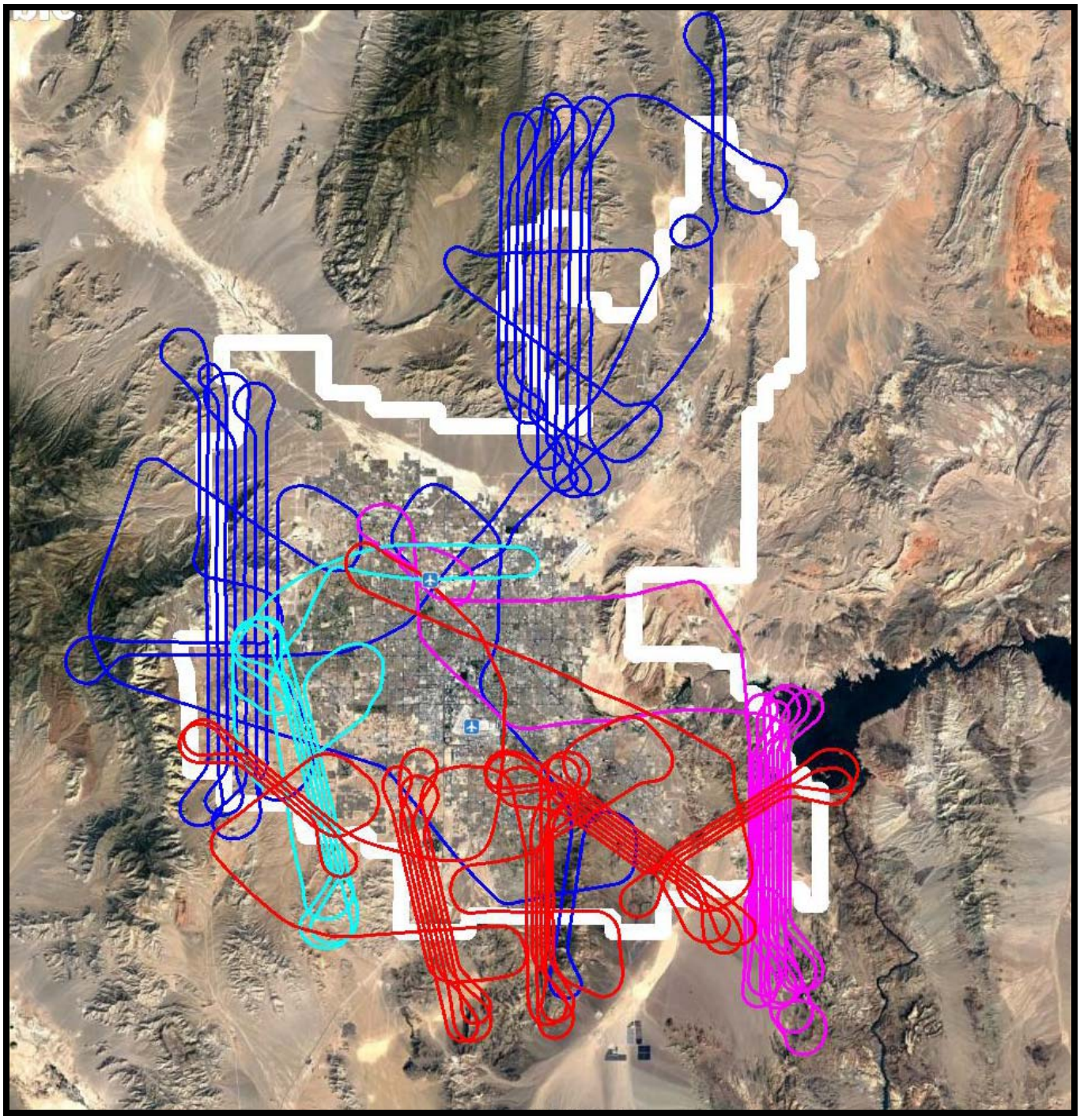


Actual Flight Lines Colored Mission by Mission – Showing All Flight Lines



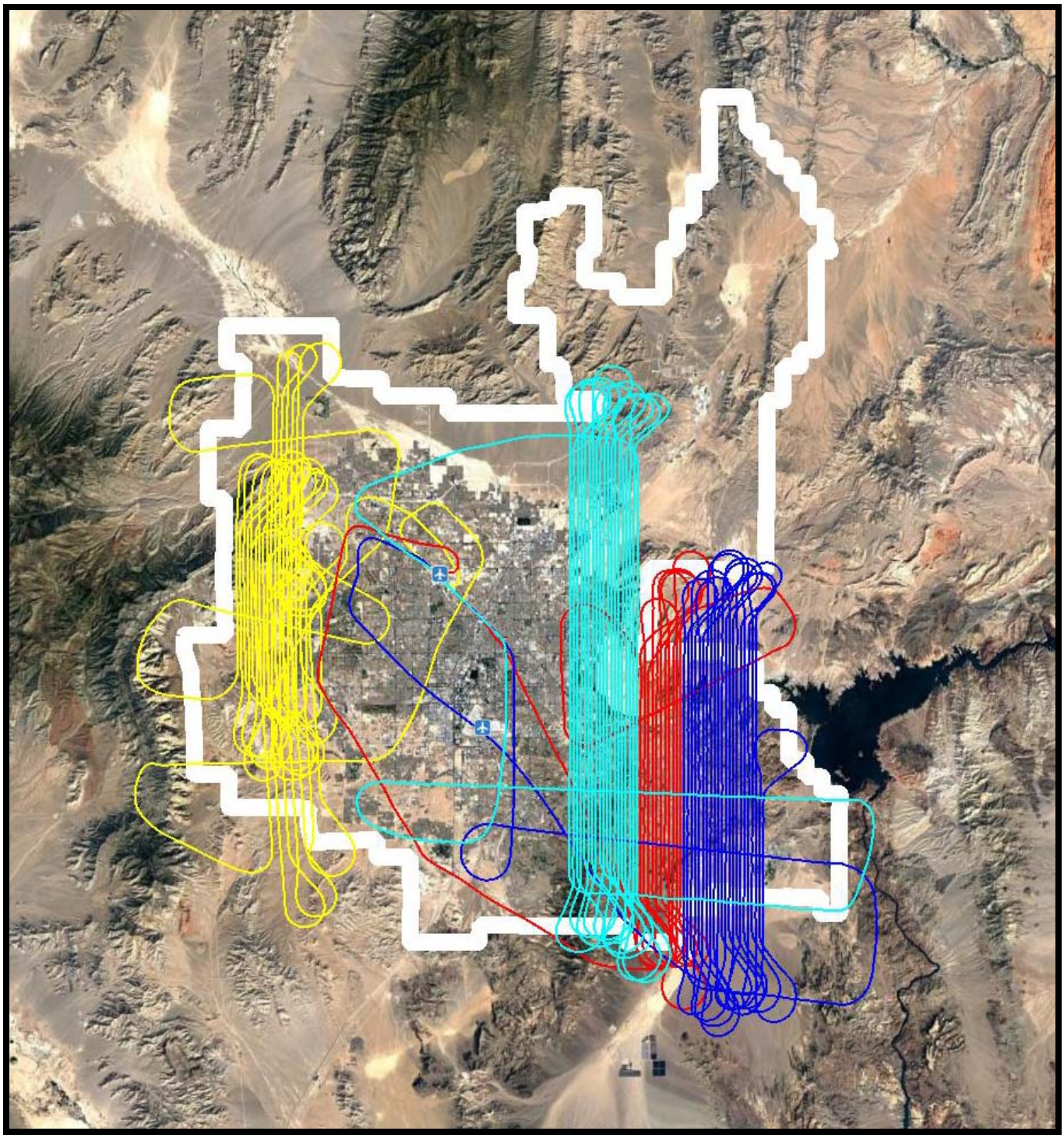
Actual Flight Lines Colored Mission by Mission

Mission	Date	Color	Mission	Date	Color
160421_A	April 21, 2016	**Blue**	160425_A	April 25, 2016	**Cyan**
160424_A	April 24, 2016	**Red**	160426_A	April 26, 2016	**Magenta**



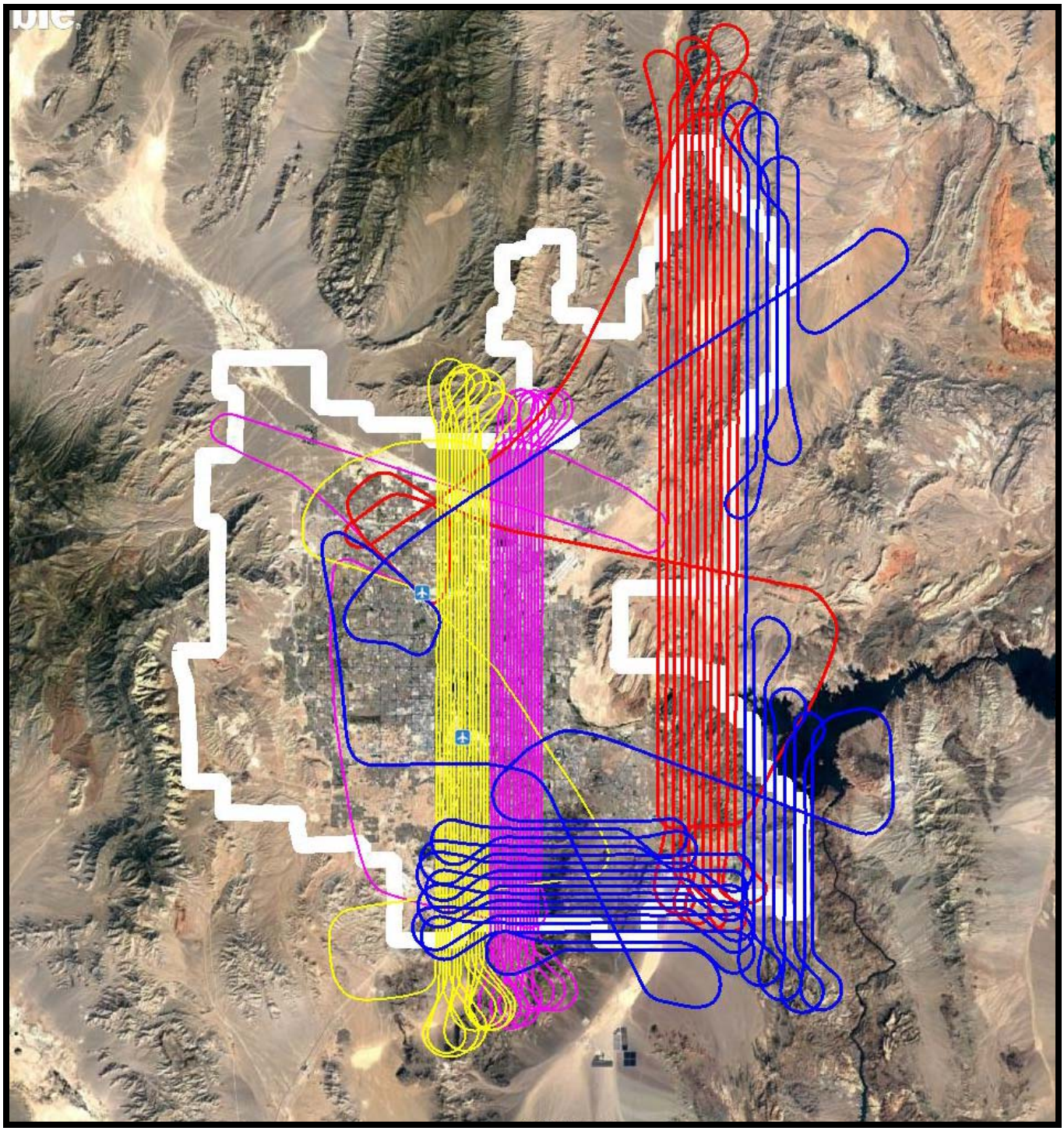
Actual Flight Lines Colored Mission by Mission

Mission	Date	Color	Mission	Date	Color
160427_A	April 27, 2016	**Yellow**	160430_A	April 30, 2016	**Red**
160429_A	April 29, 2016	**Blue**	160501_A	May 01, 2016	**Cyan**



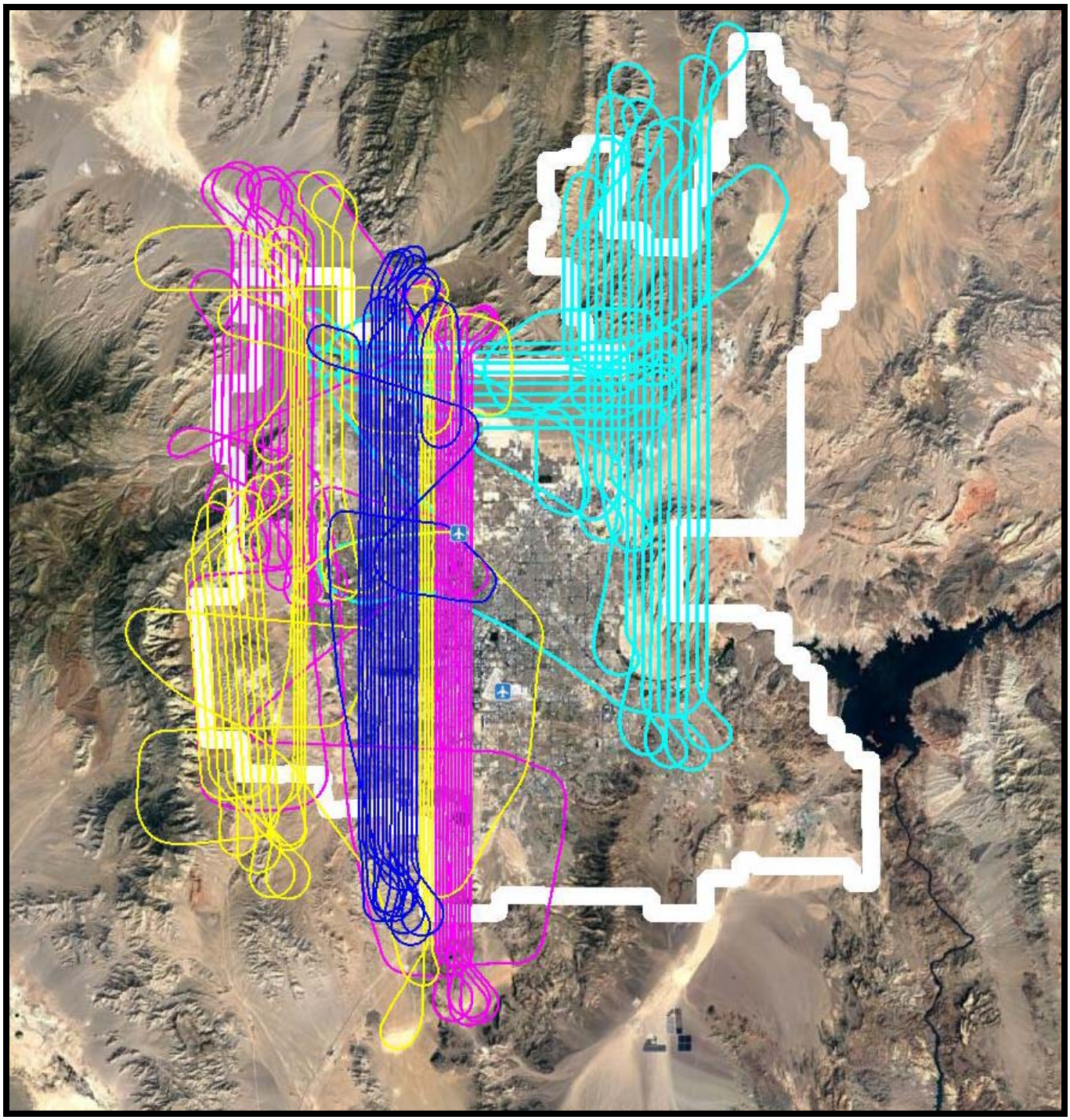
Actual Flight Lines Colored Mission by Mission

Mission	Date	Color	Mission	Date	Color
160502_A	May 02, 2016	**Magenta**	160503_B	May 03, 2016	**Blue**
160503_A	May 03, 2016	**Yellow**	160504_A	May 04, 2016	**Red**



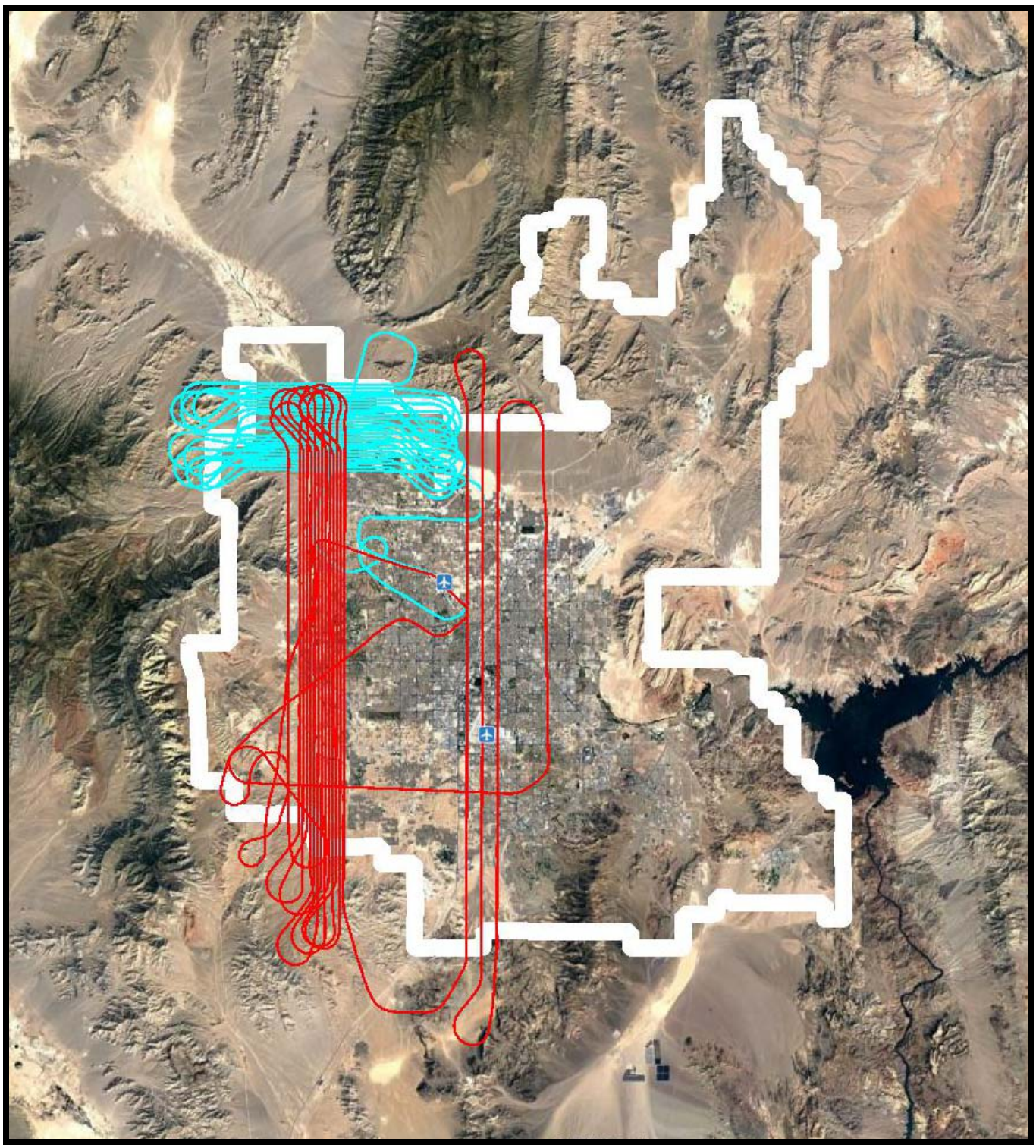
Actual Flight Lines Colored Mission by Mission

Mission	Date	Color	Mission	Date	Color
160505_A	May 05, 2016	**Cyan**	160509_A	May 09, 2016	**Yellow**
160508_A	May 08, 2016	**Magenta**	160510_A	May 10, 2016	**Blue**



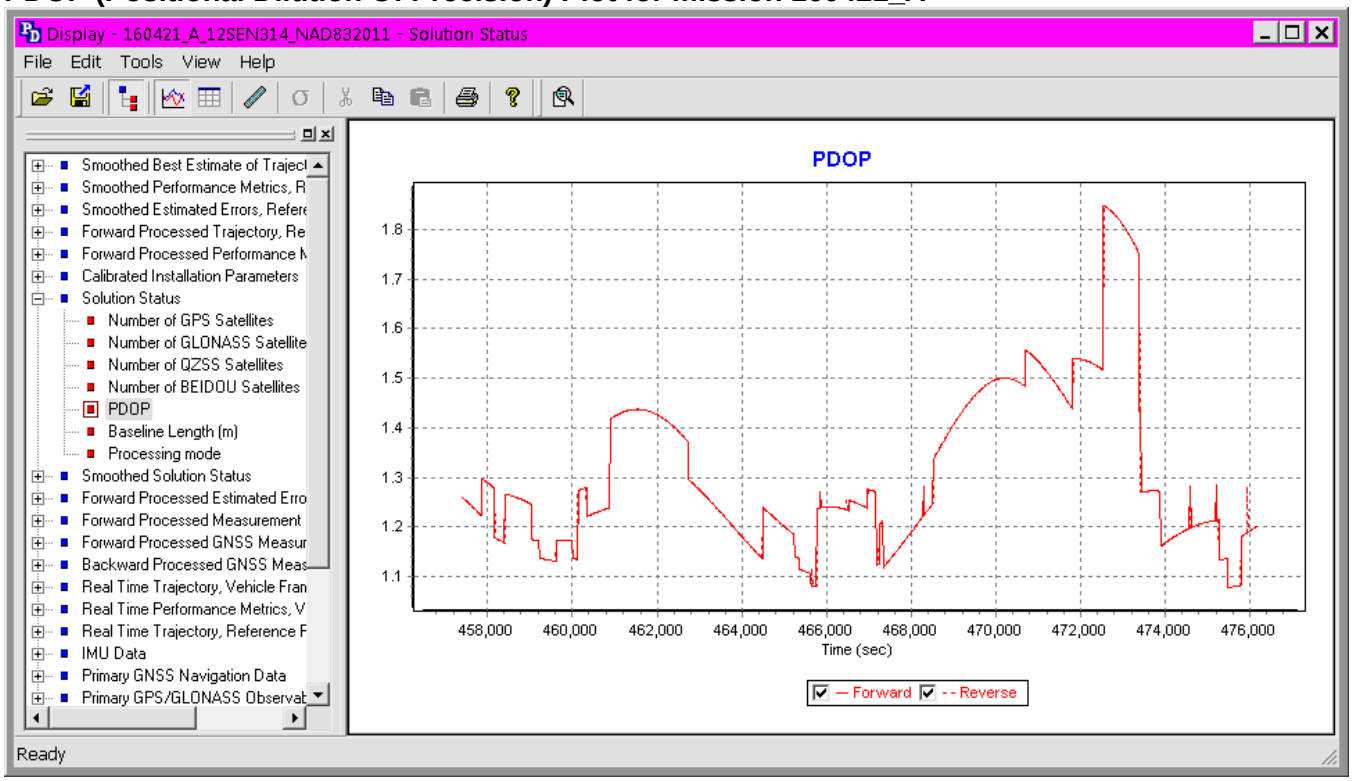
Actual Flight Lines Colored Mission by Mission

Mission	Date	Color	Mission	Date	Color
160511_A	May 11, 2016	**Red**	160516_A	May 16, 2016	**Cyan**

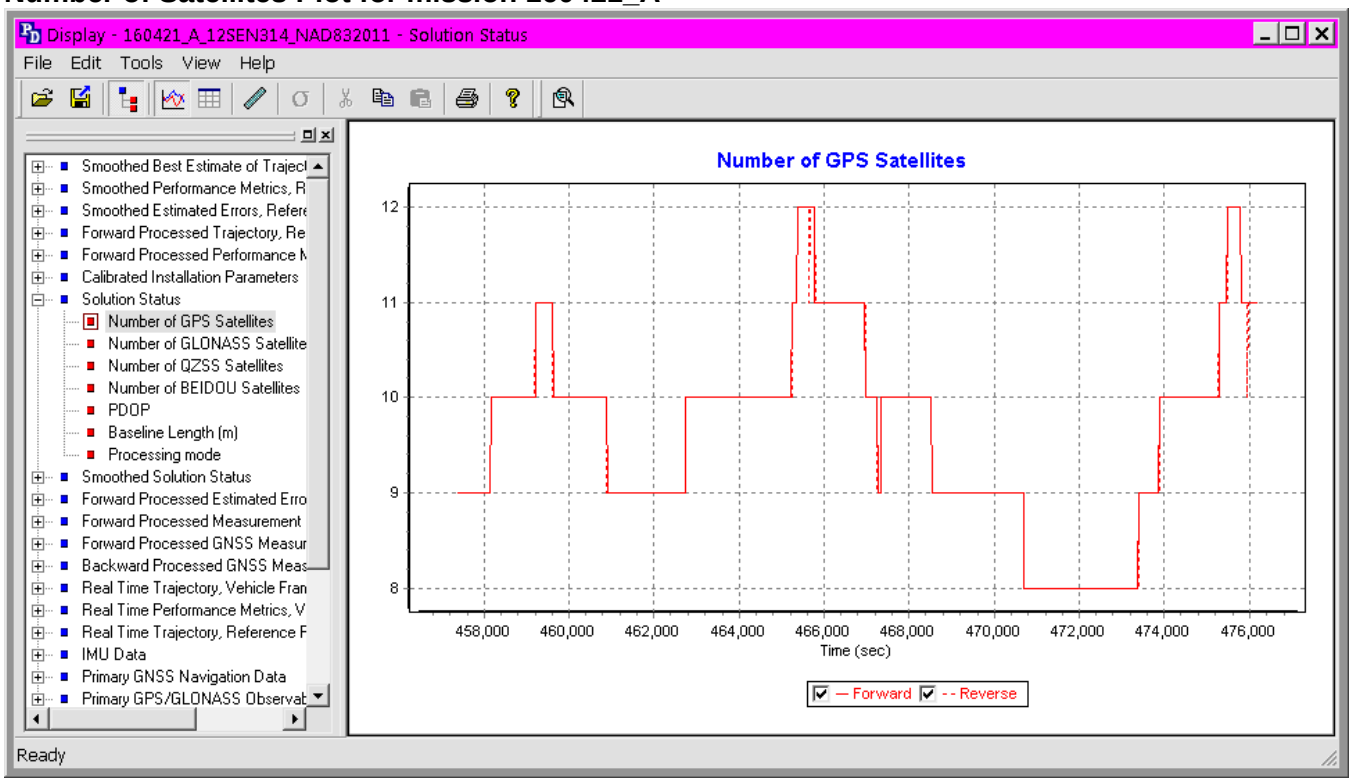


The following graphs show the GPS PDOP (Positional Dilution Of Precision) Plot and Number of Satellites Plot

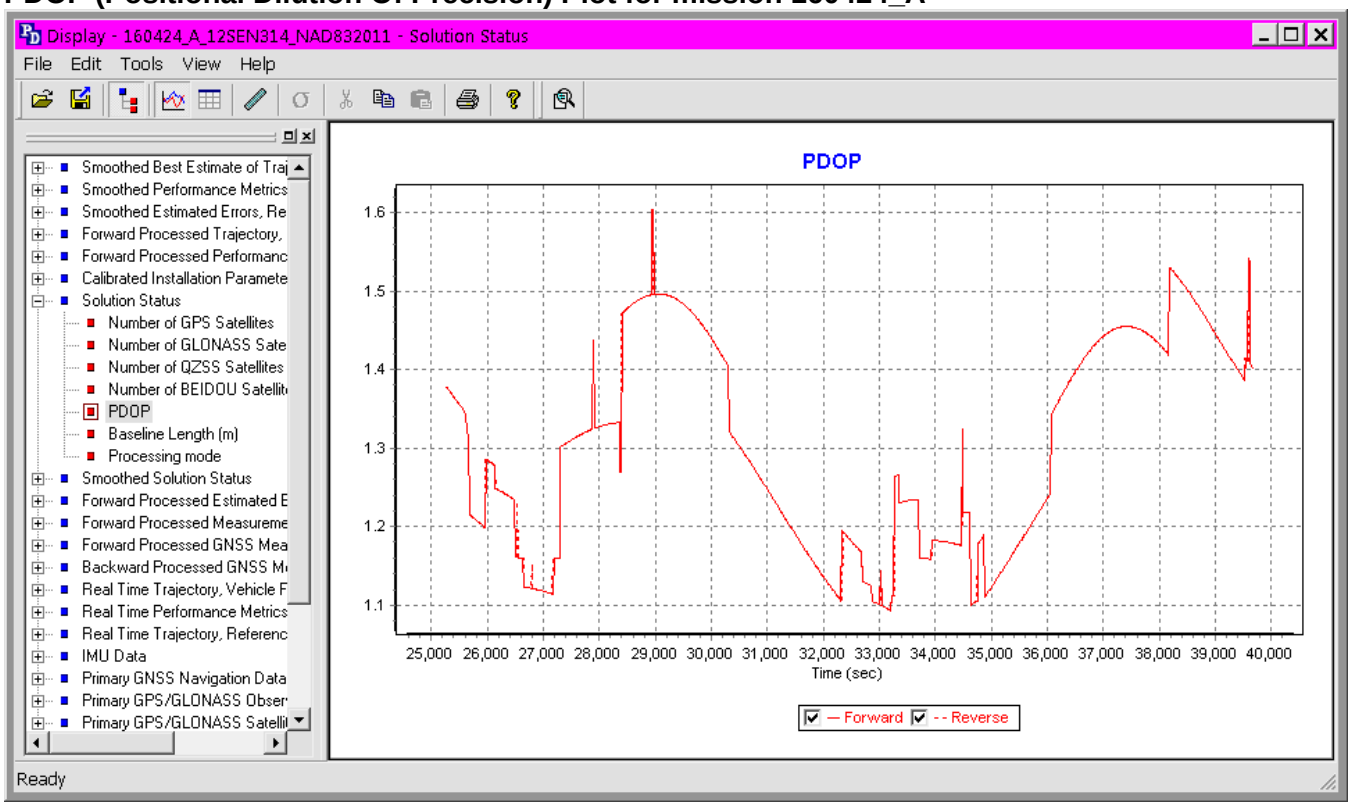
PDOP (Positional Dilution Of Precision) Plot for mission 160421_A



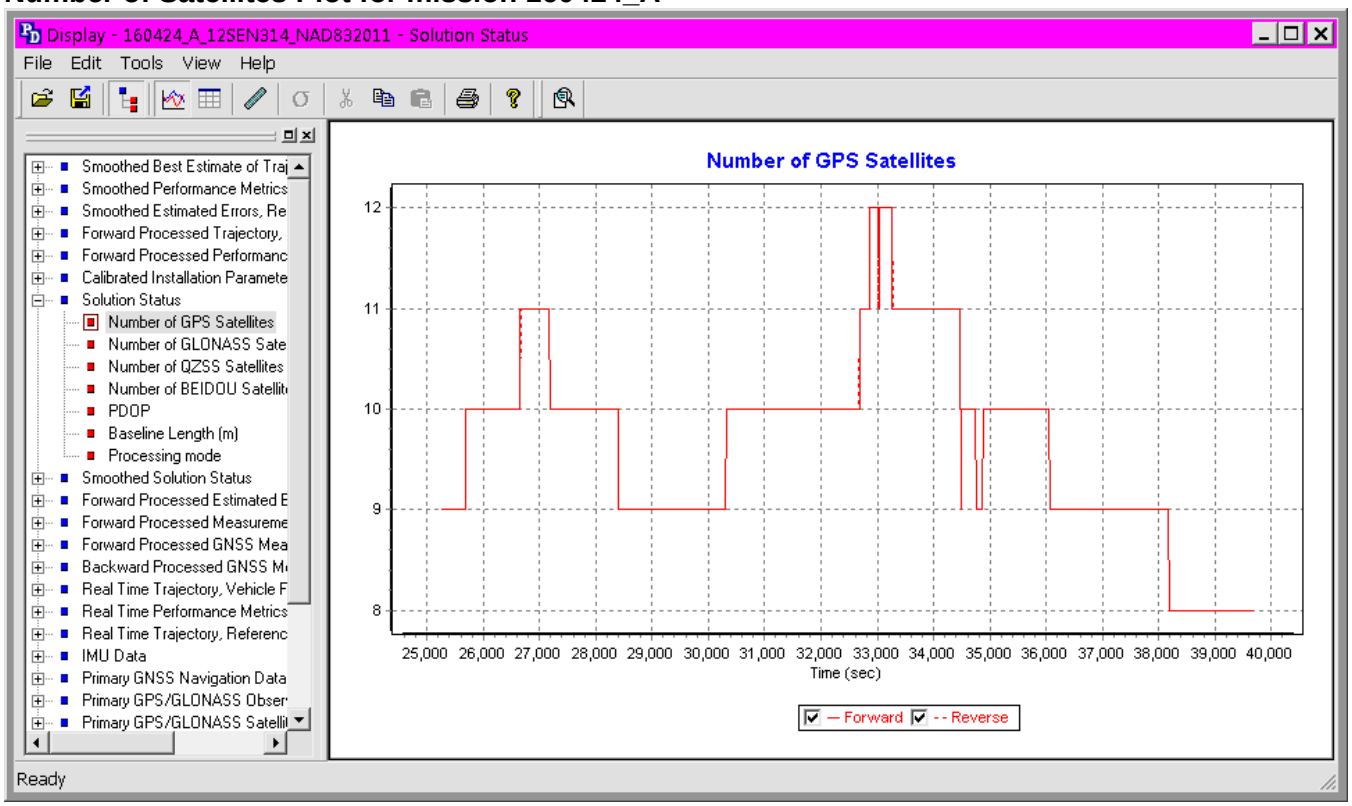
Number of Satellites Plot for mission 160421_A



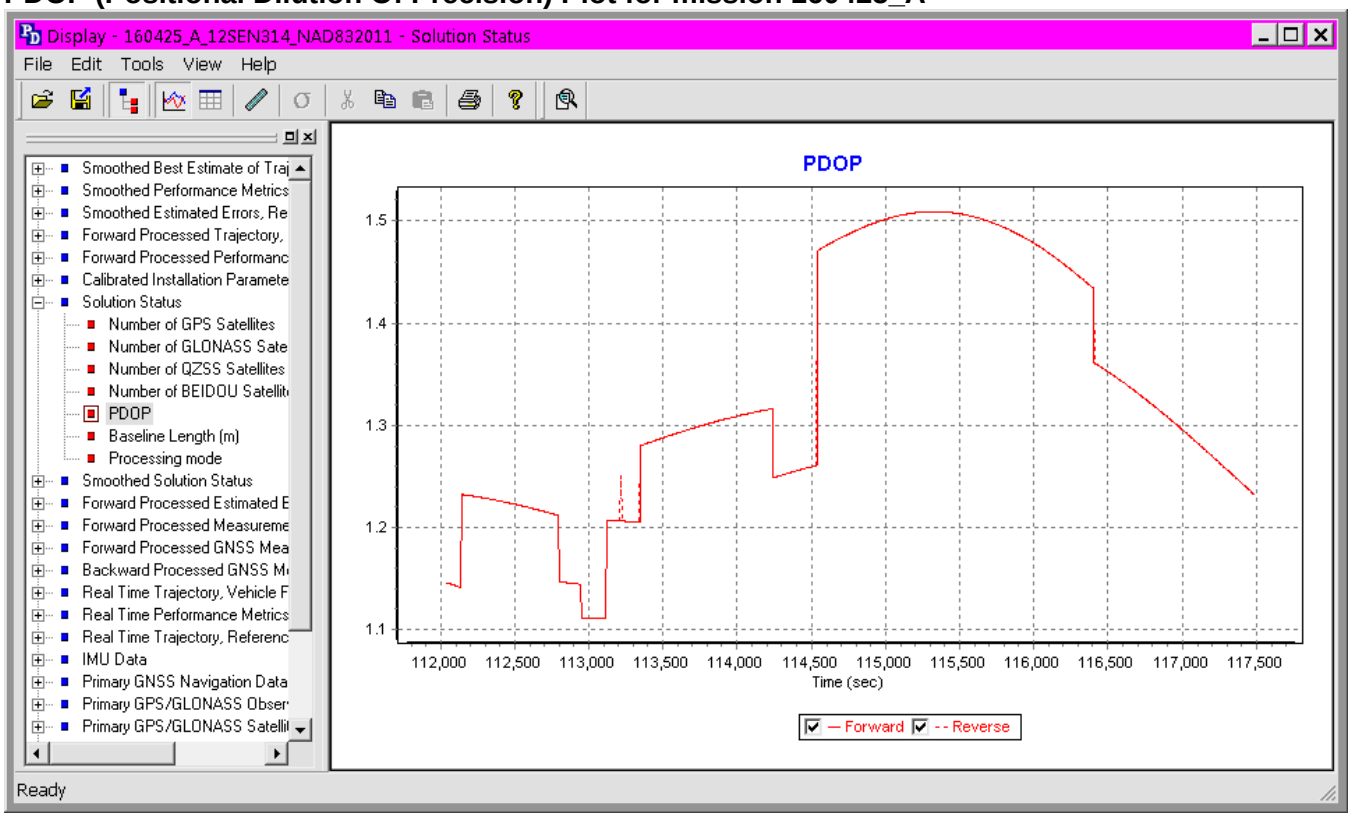
PDOP (Positional Dilution Of Precision) Plot for mission 160424_A



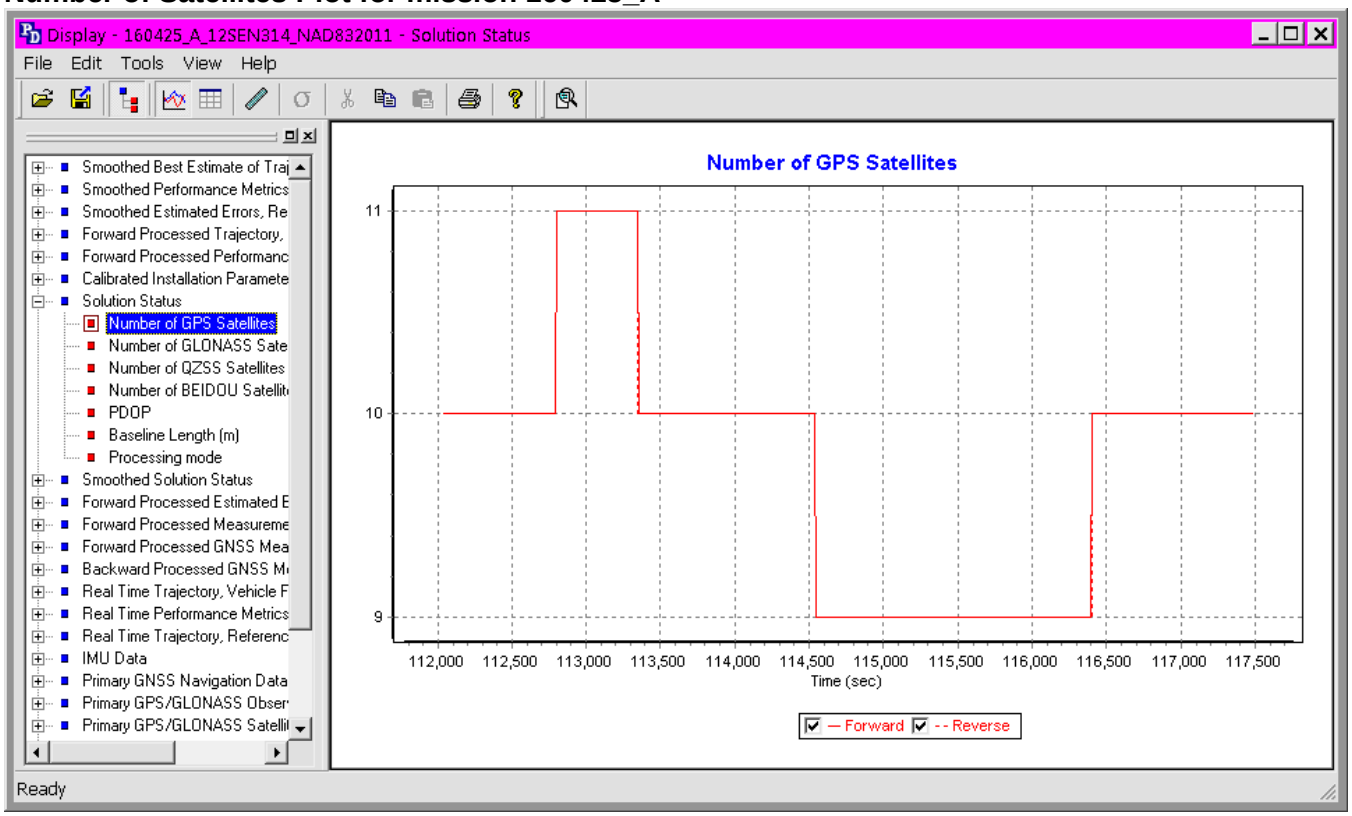
Number of Satellites Plot for mission 160424_A



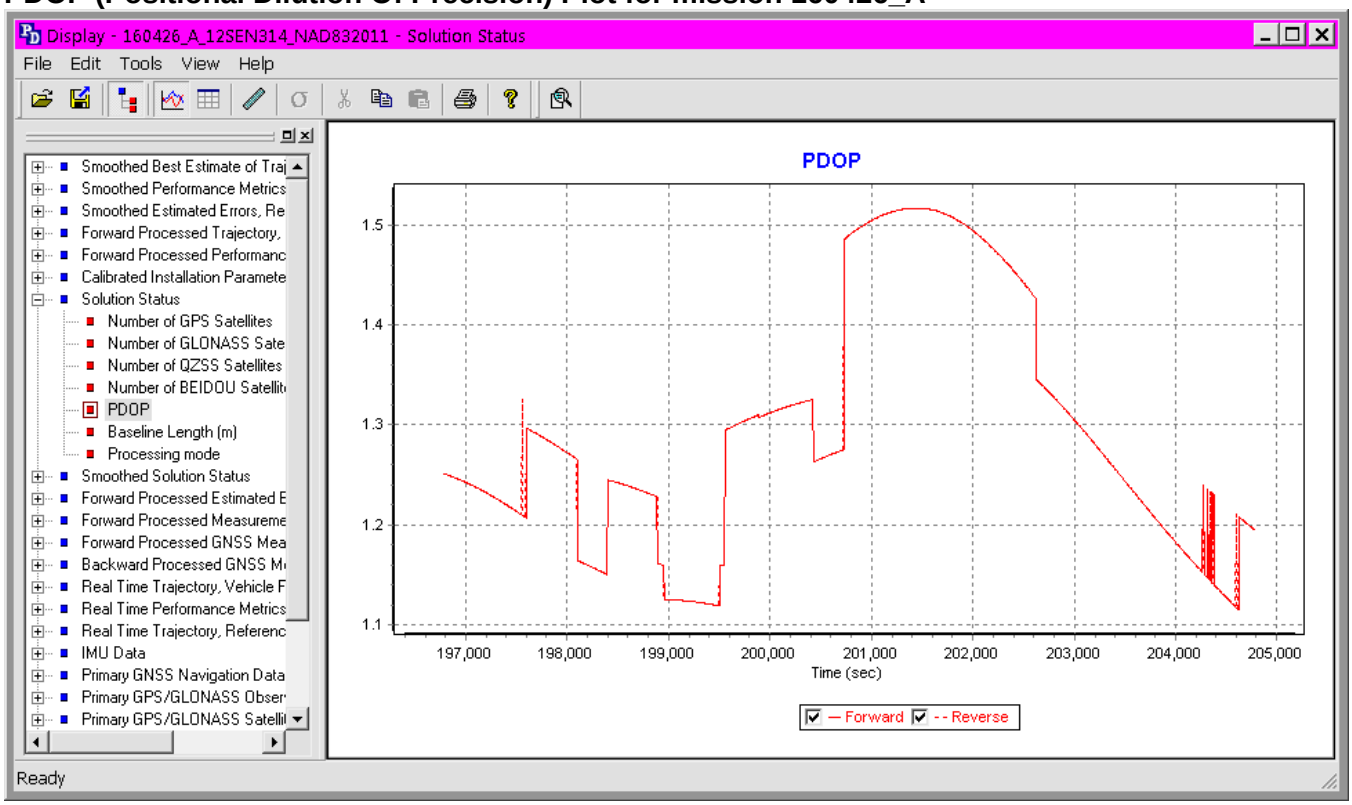
PDOP (Positional Dilution Of Precision) Plot for mission 160425_A



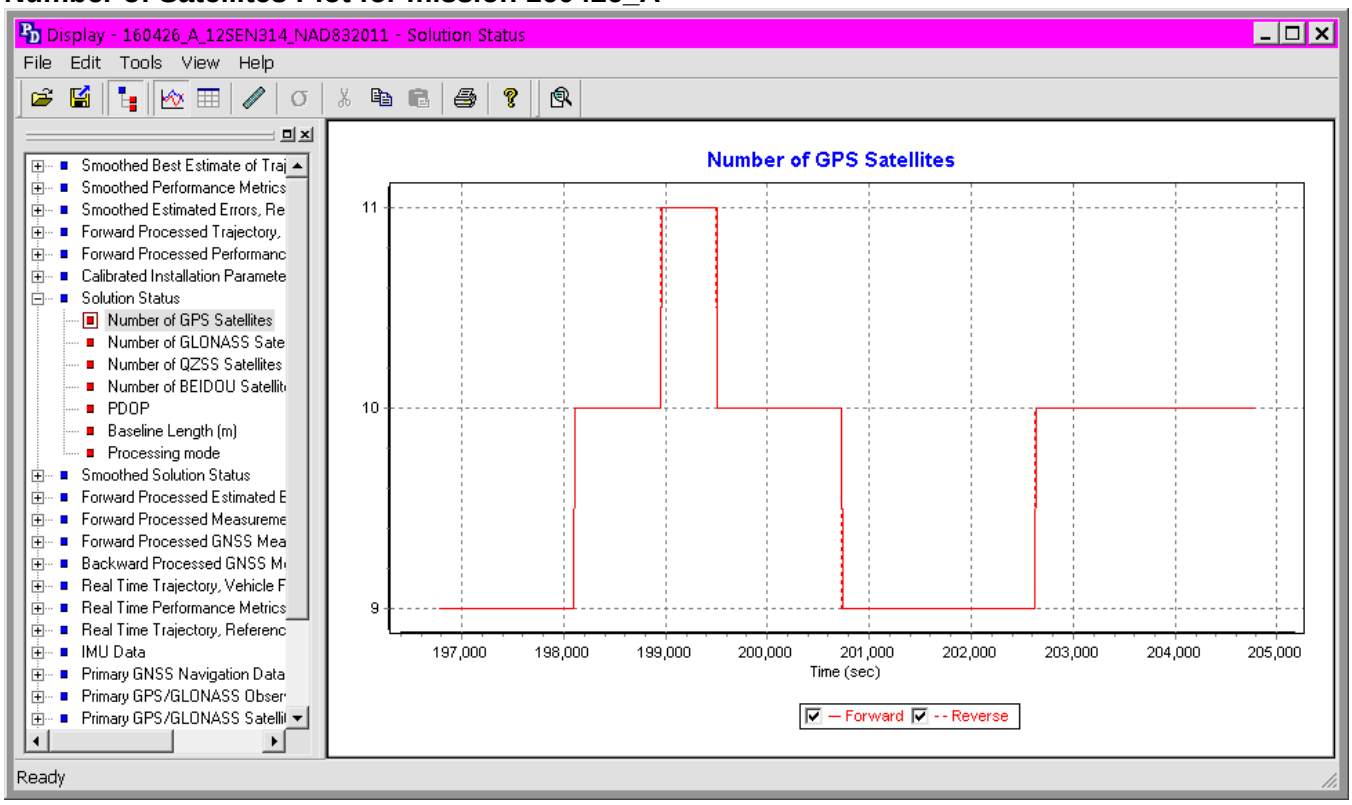
Number of Satellites Plot for mission 160425_A



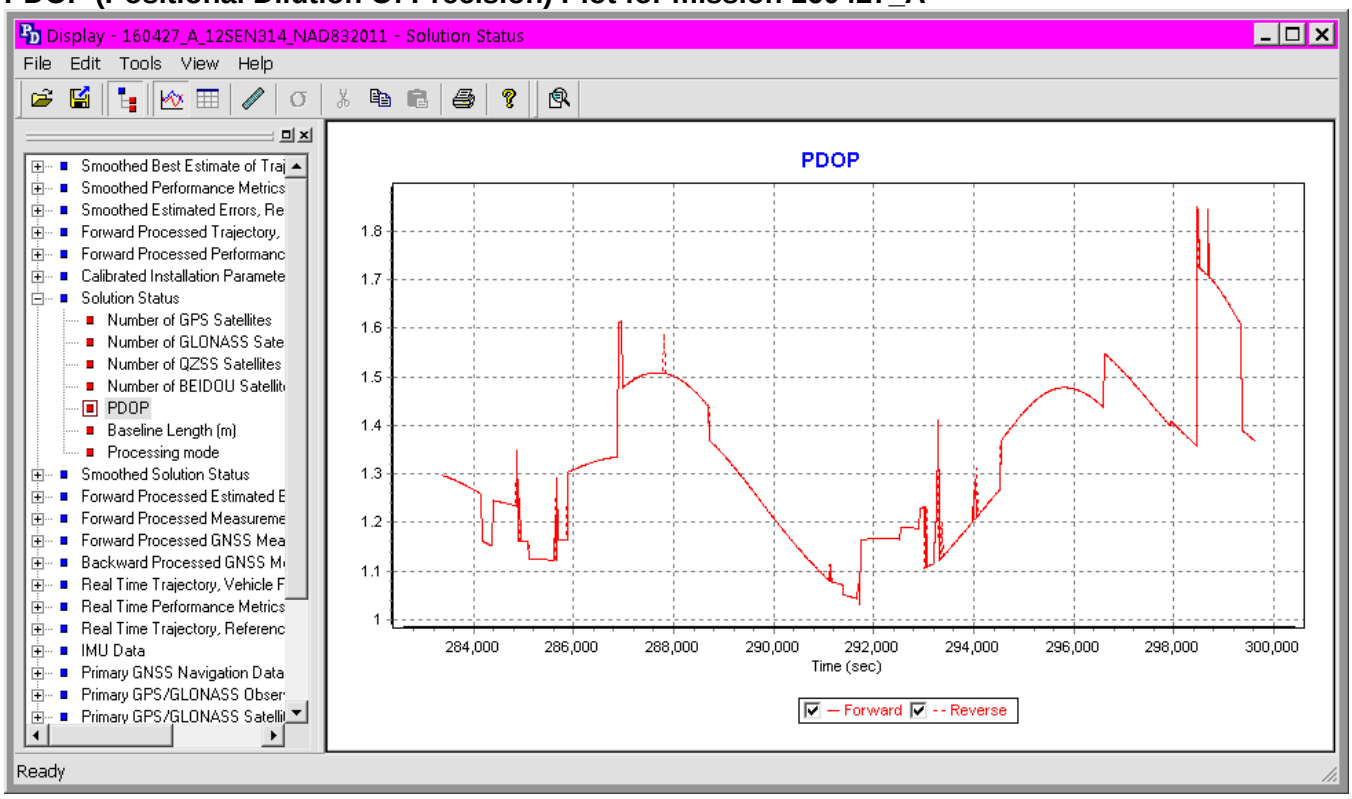
PDOP (Positional Dilution Of Precision) Plot for mission 160426_A



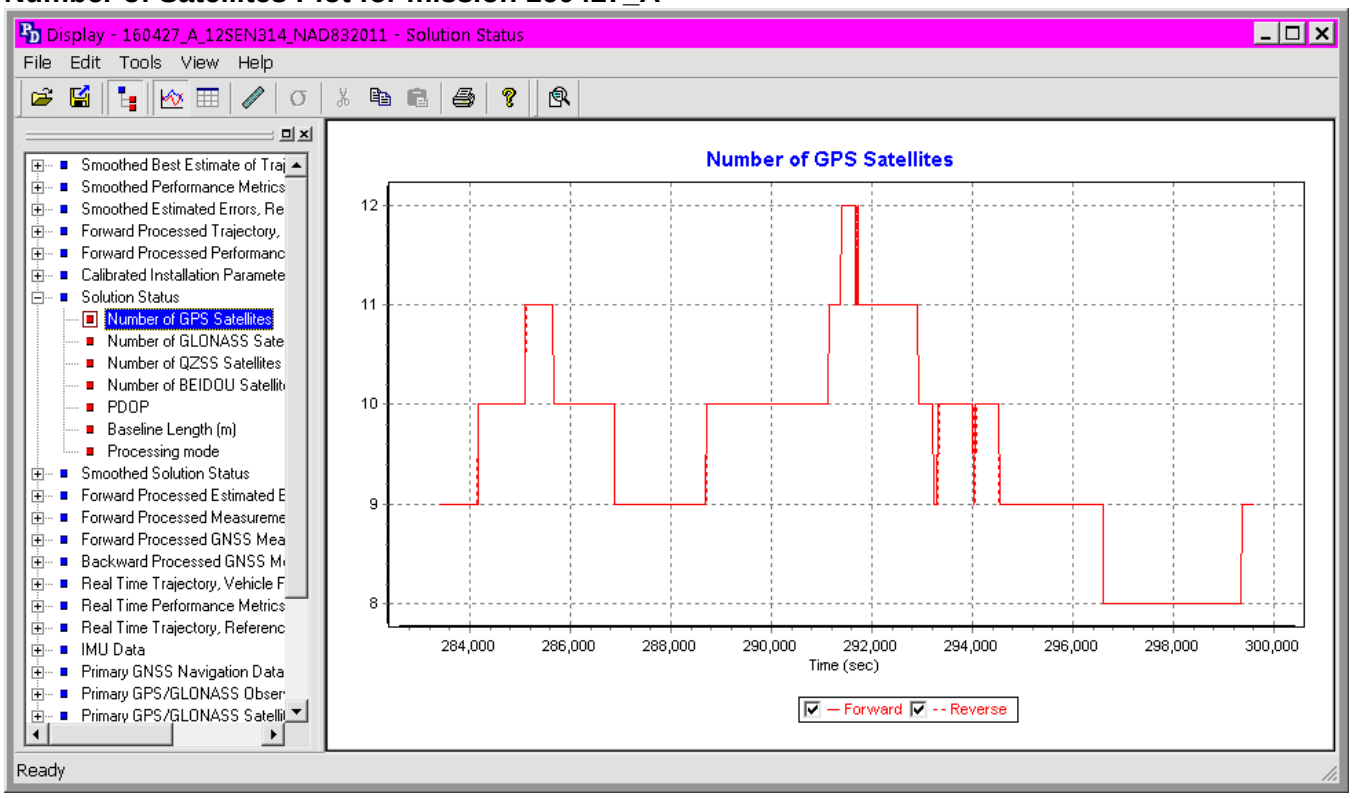
Number of Satellites Plot for mission 160426_A



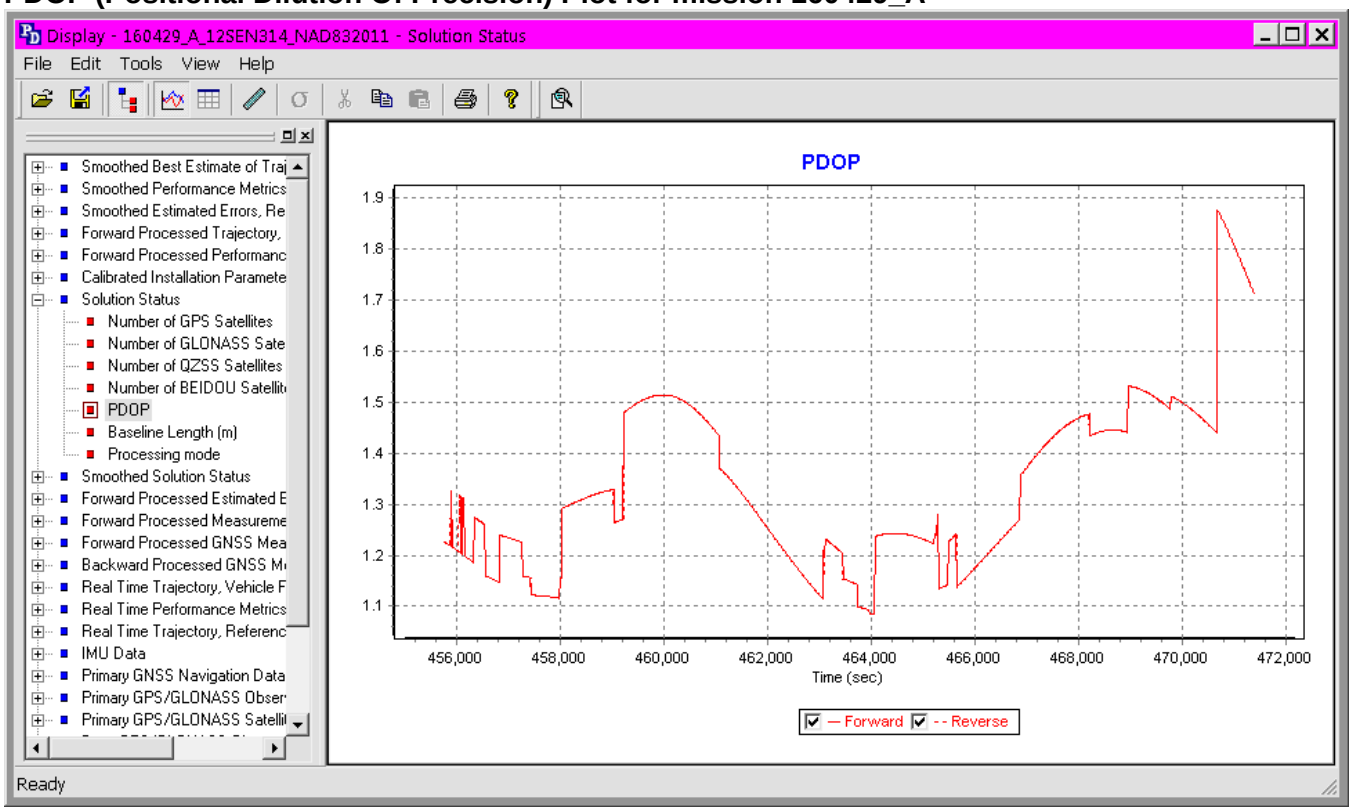
PDOP (Positional Dilution Of Precision) Plot for mission 160427_A



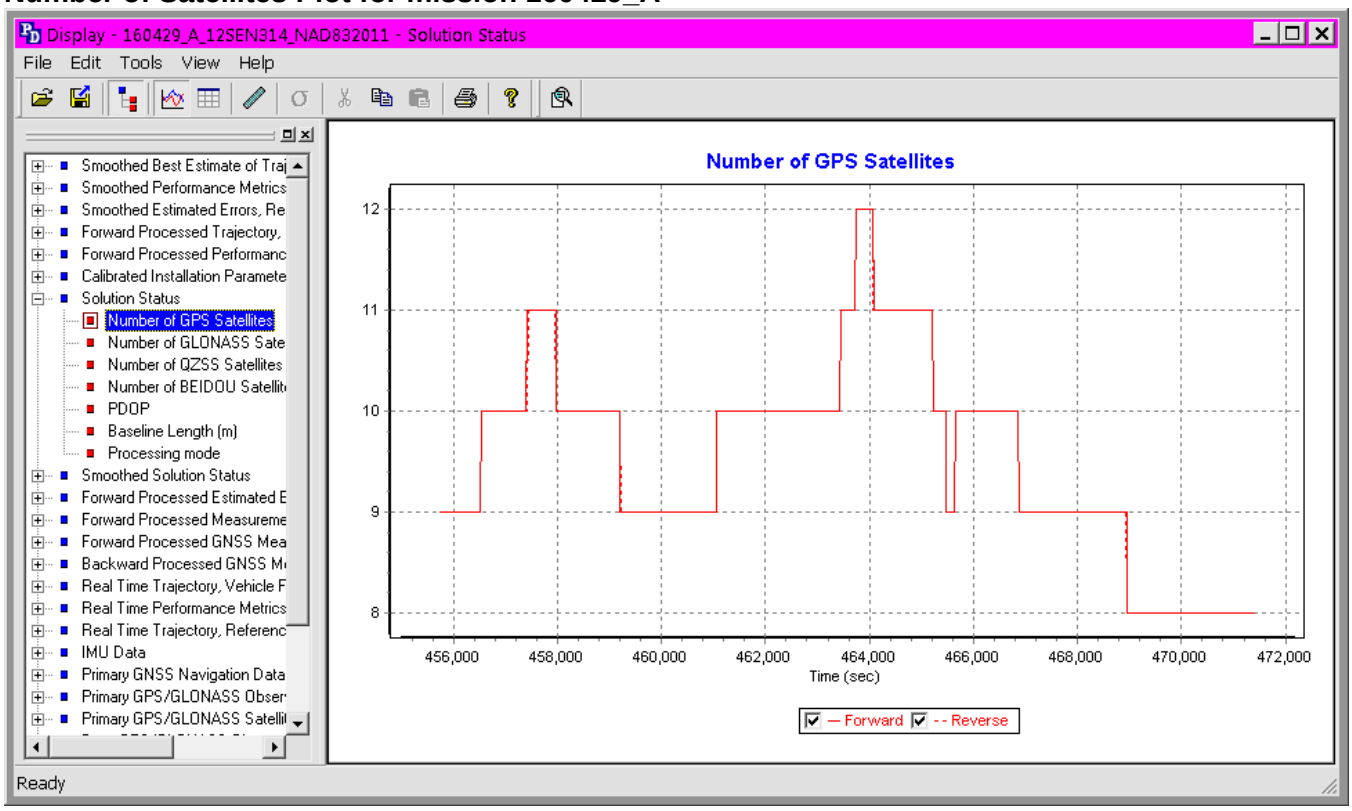
Number of Satellites Plot for mission 160427_A



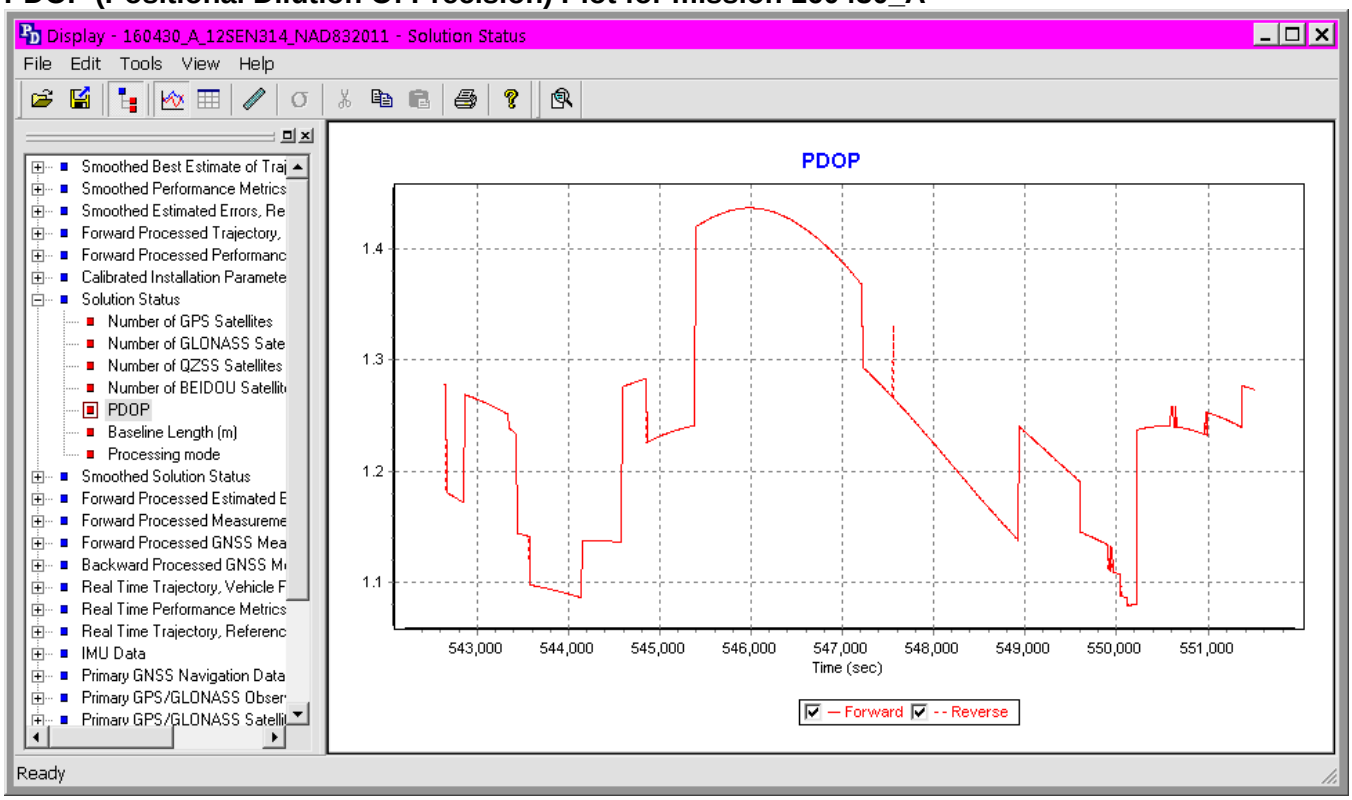
PDOP (Positional Dilution Of Precision) Plot for mission 160429_A



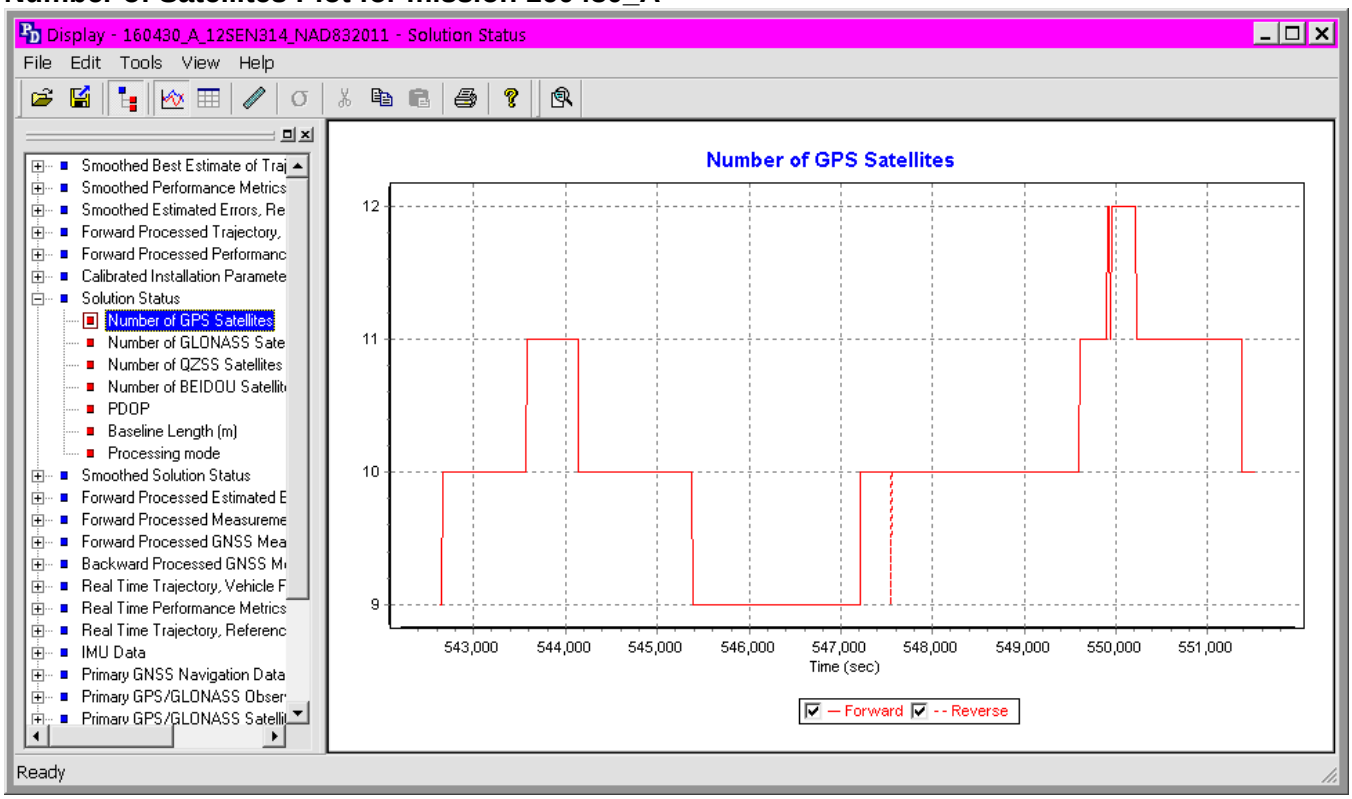
Number of Satellites Plot for mission 160429_A



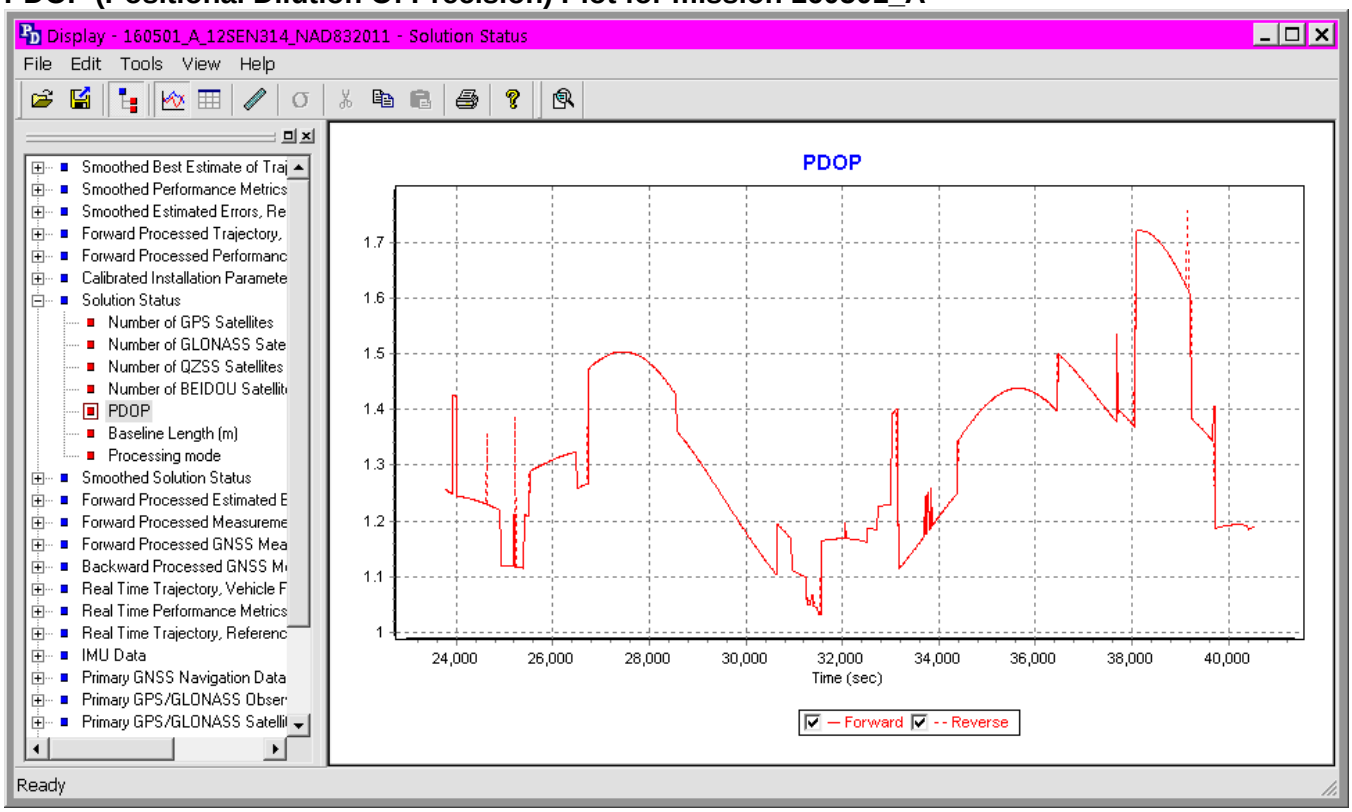
PDOP (Positional Dilution Of Precision) Plot for mission 160430_A



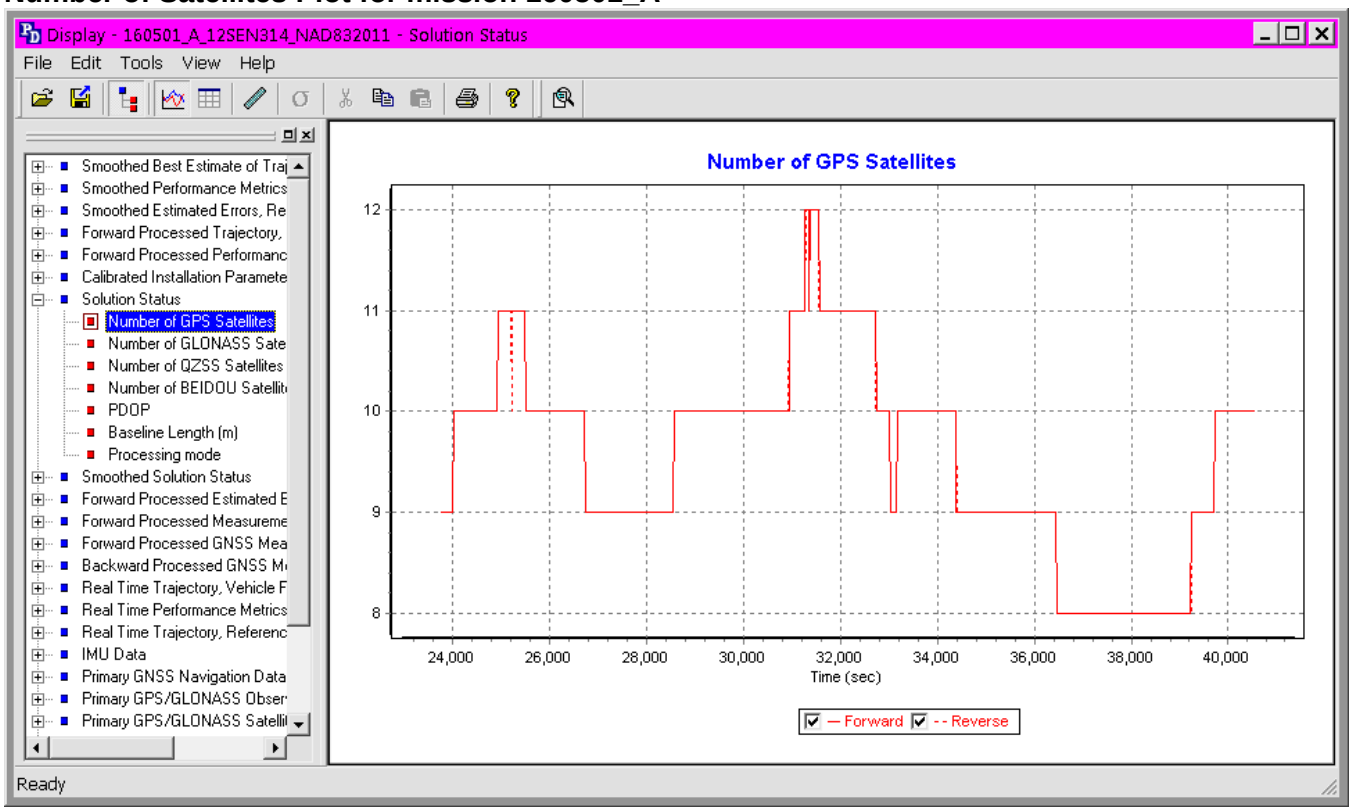
Number of Satellites Plot for mission 160430_A



PDOP (Positional Dilution Of Precision) Plot for mission 160501_A



Number of Satellites Plot for mission 160501_A



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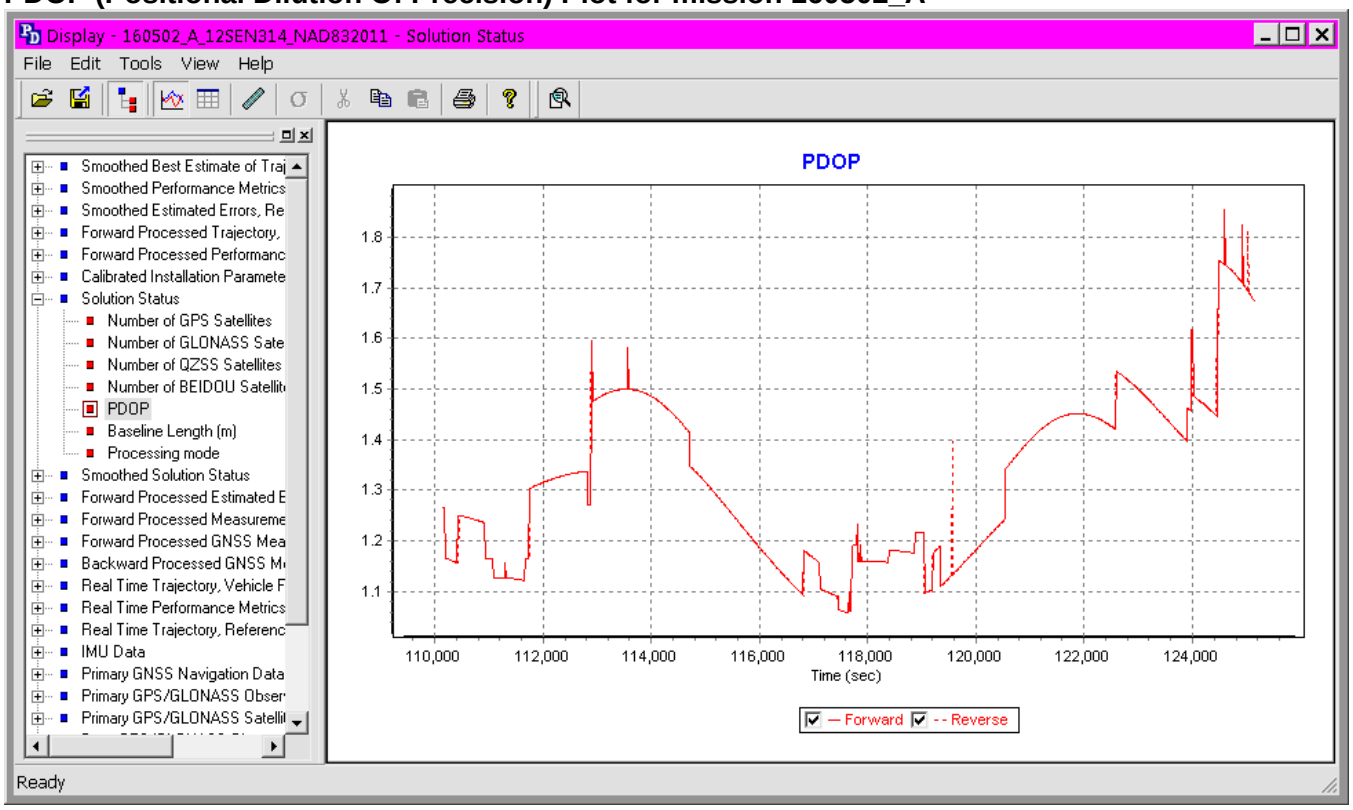
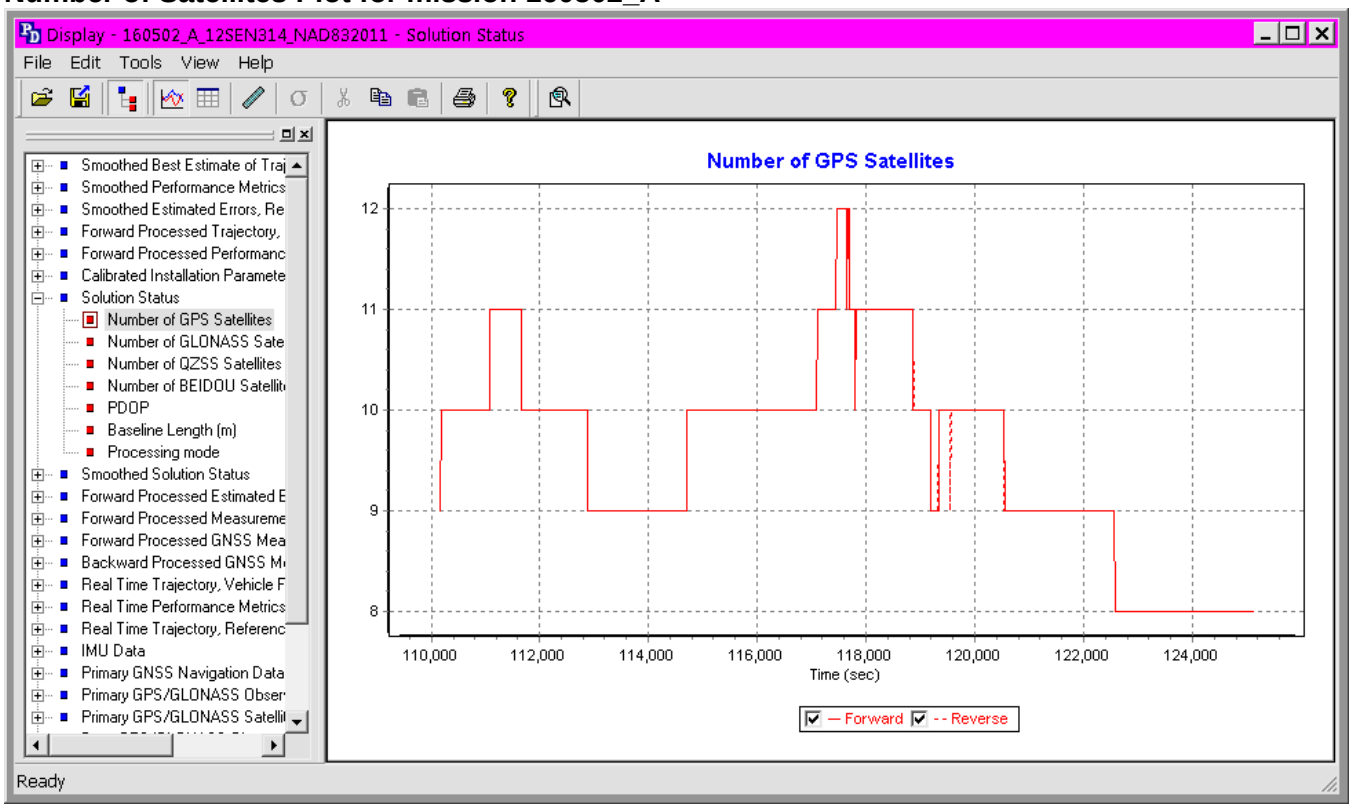


Number of Satellites Plot for mission 160502_A



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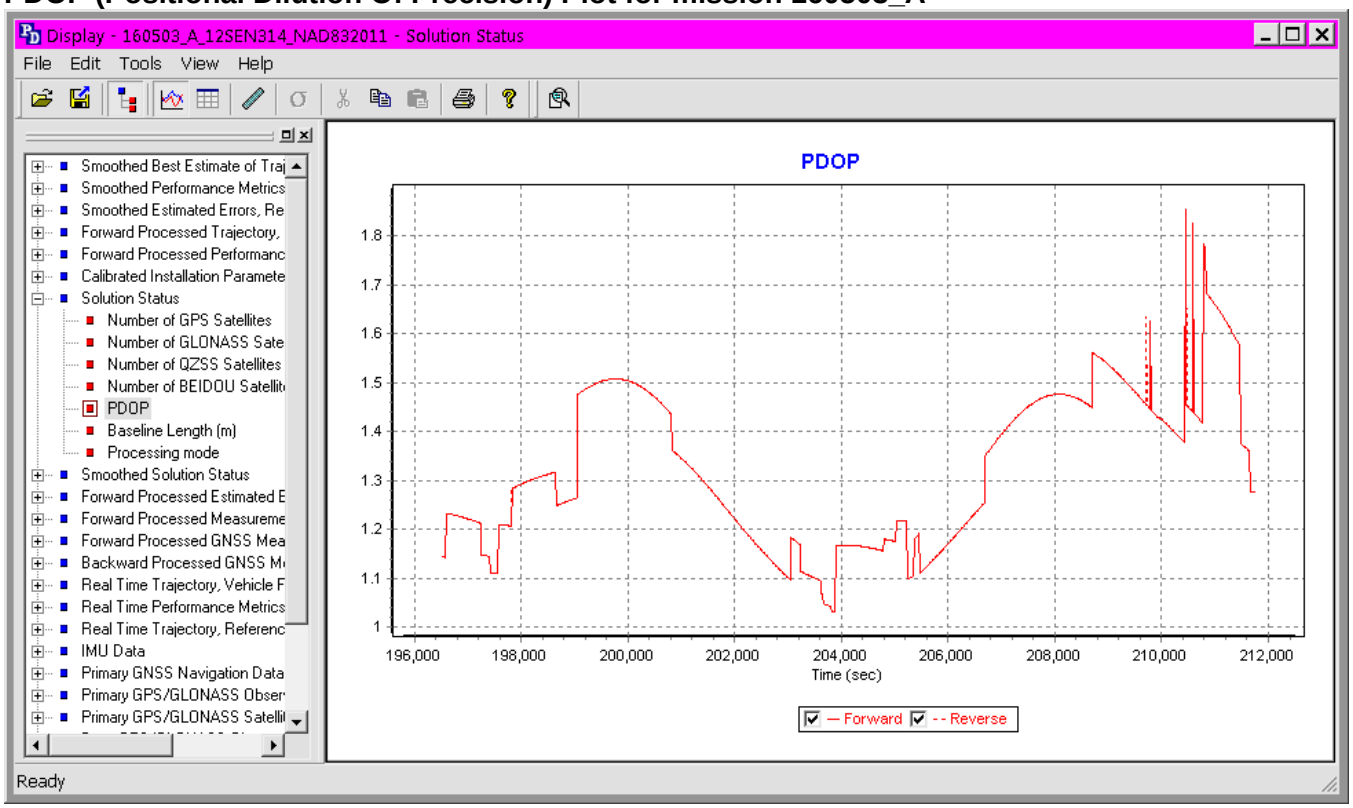
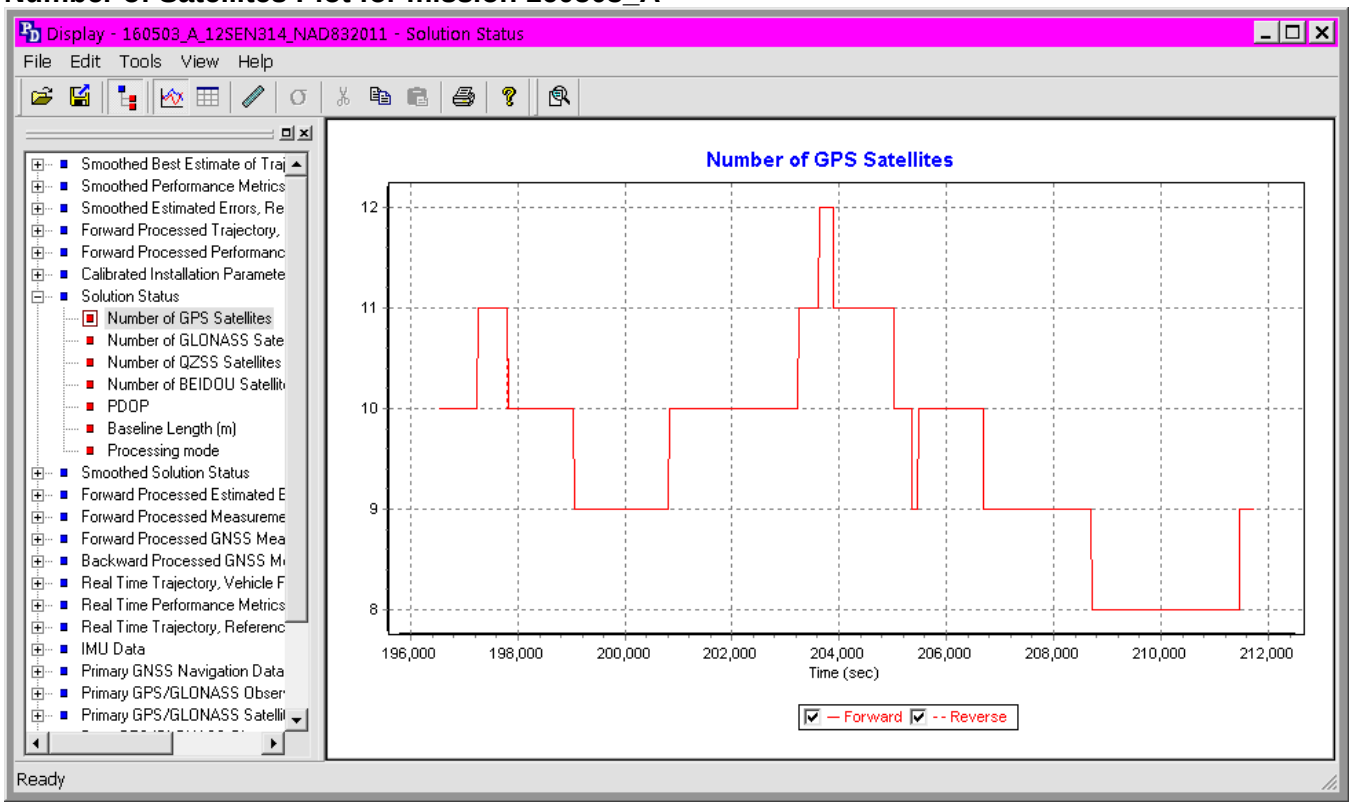


Number of Satellites Plot for mission 160503_A



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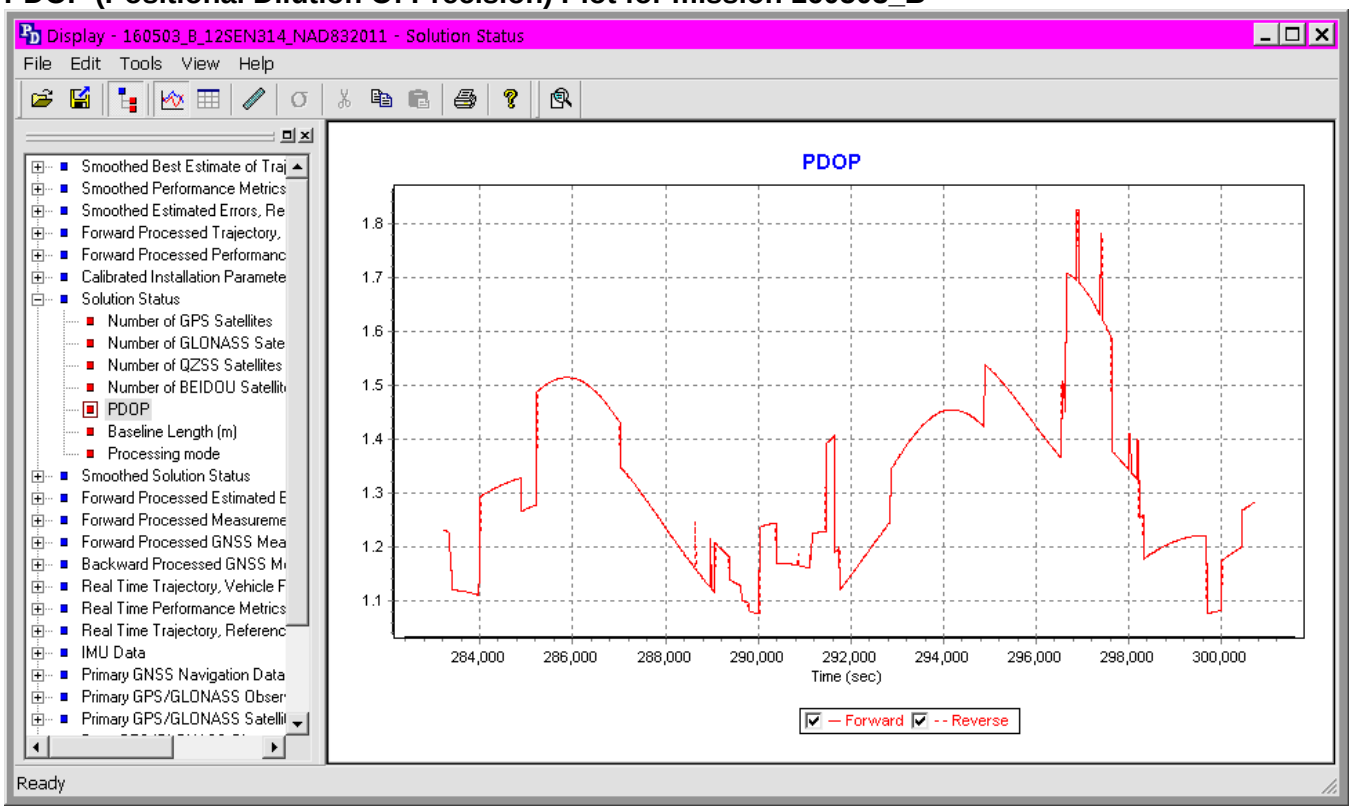
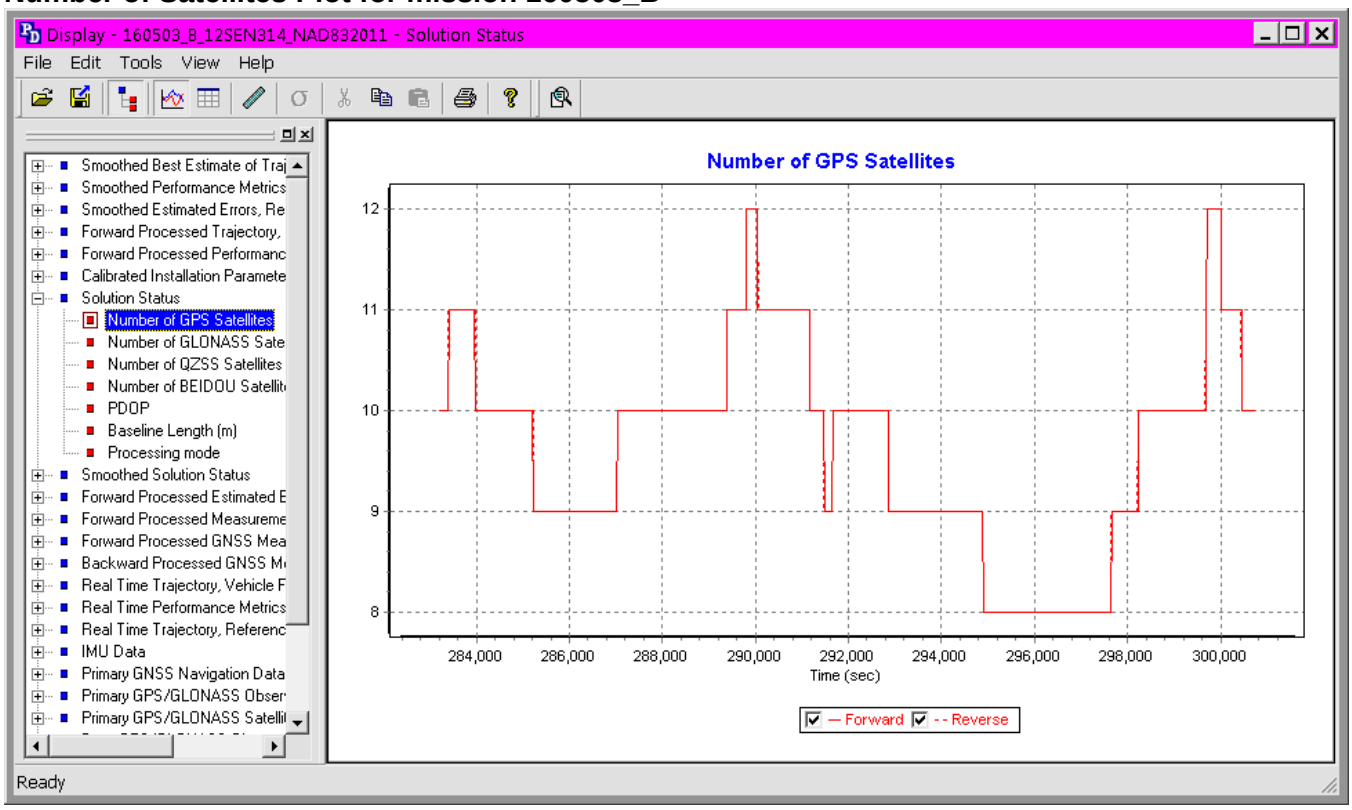


Number of Satellites Plot for mission 160503_B



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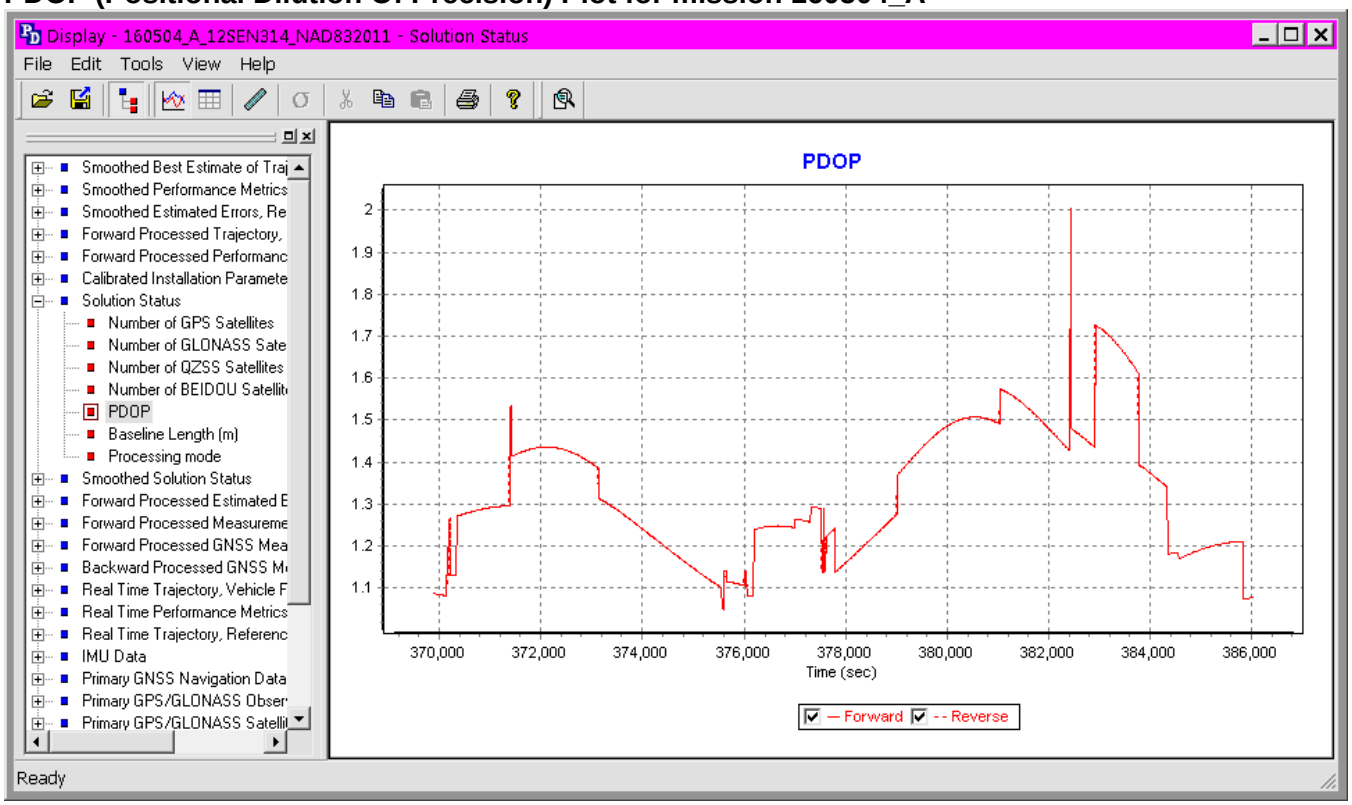
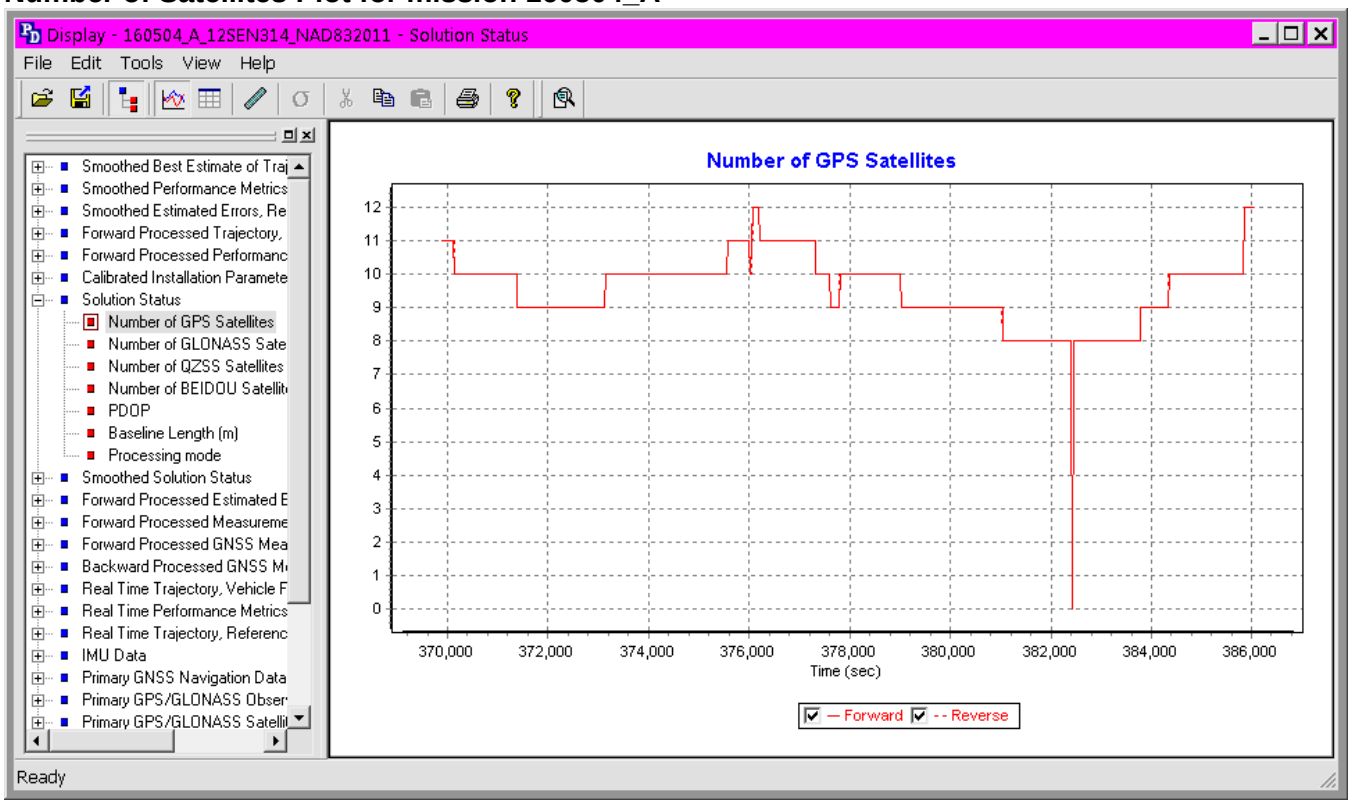
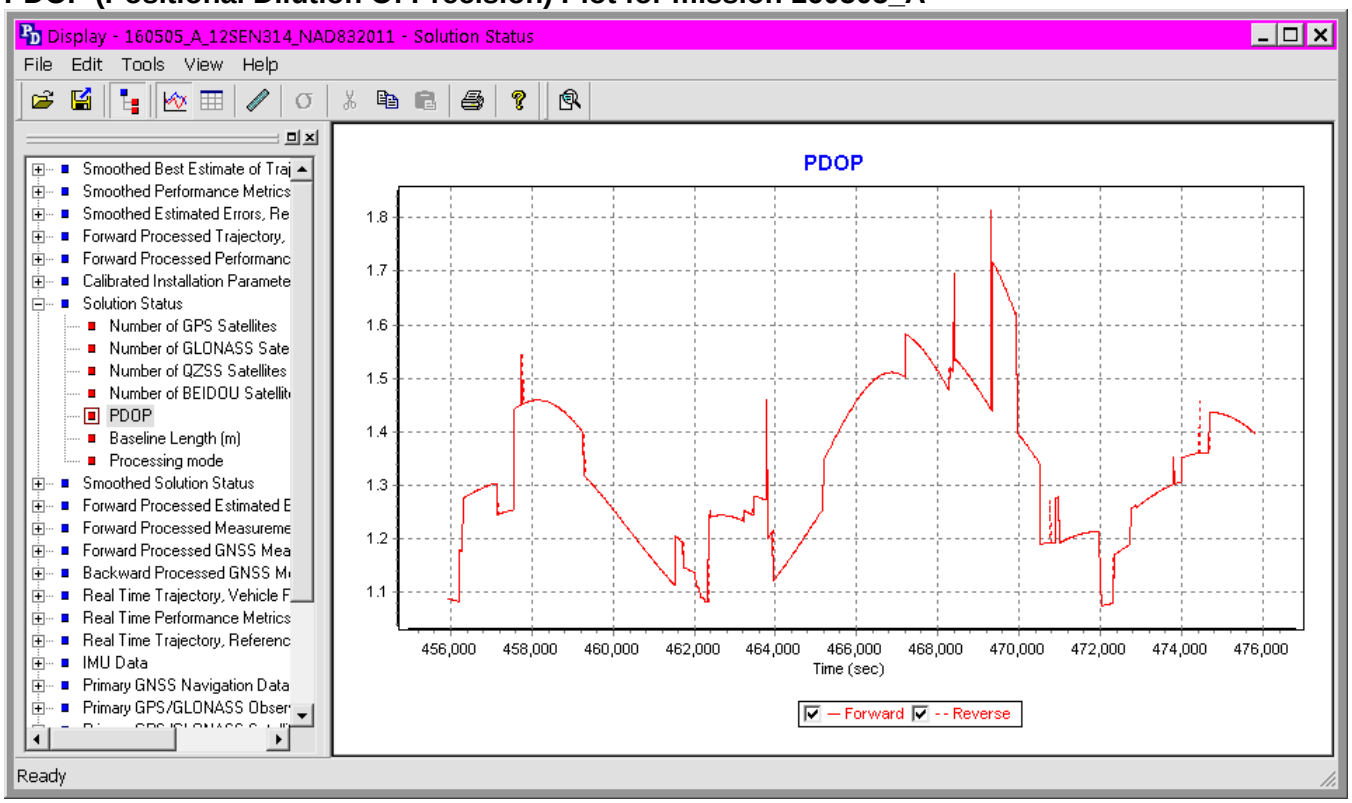


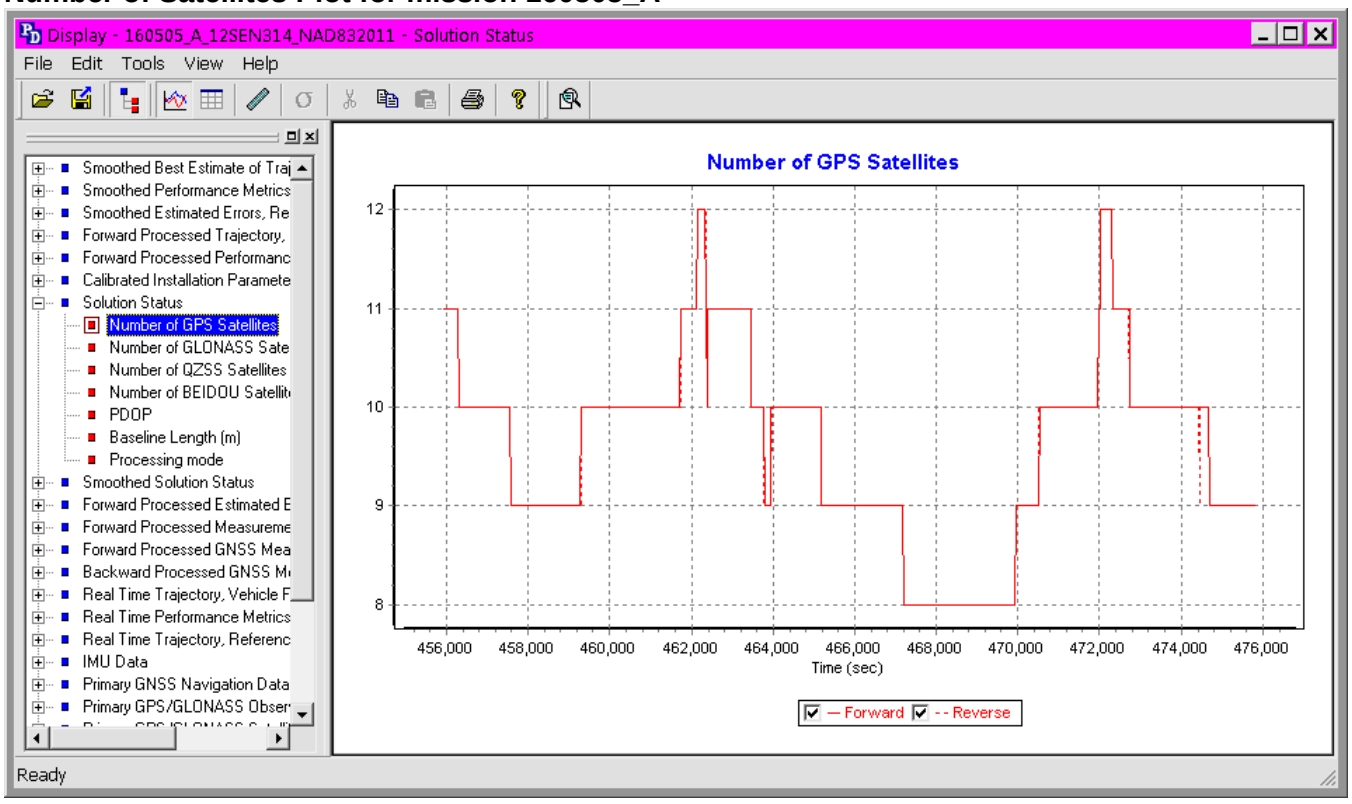
Number of Satellites Plot for mission 160504_A



PDOP (Positional Dilution Of Precision) Plot for mission 160505_A



Number of Satellites Plot for mission 160505_A



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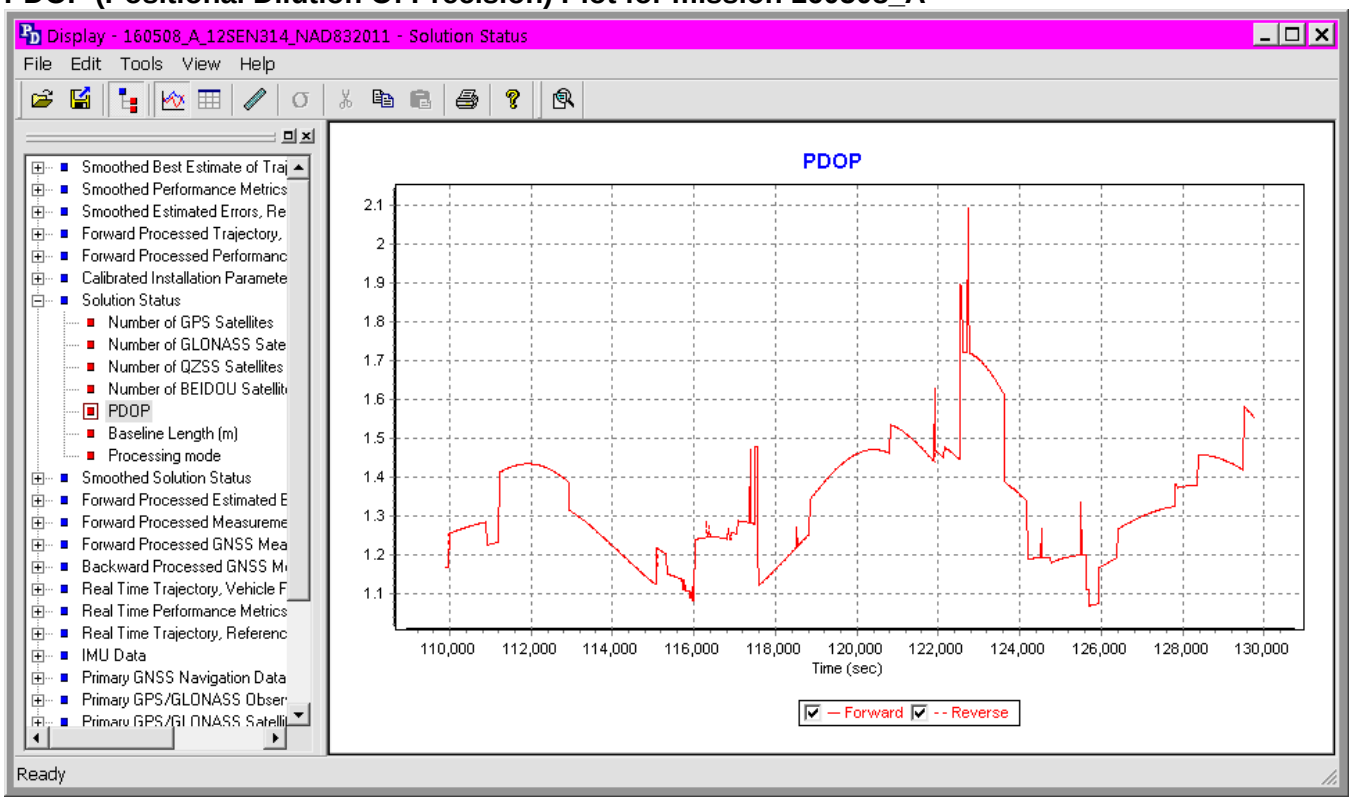
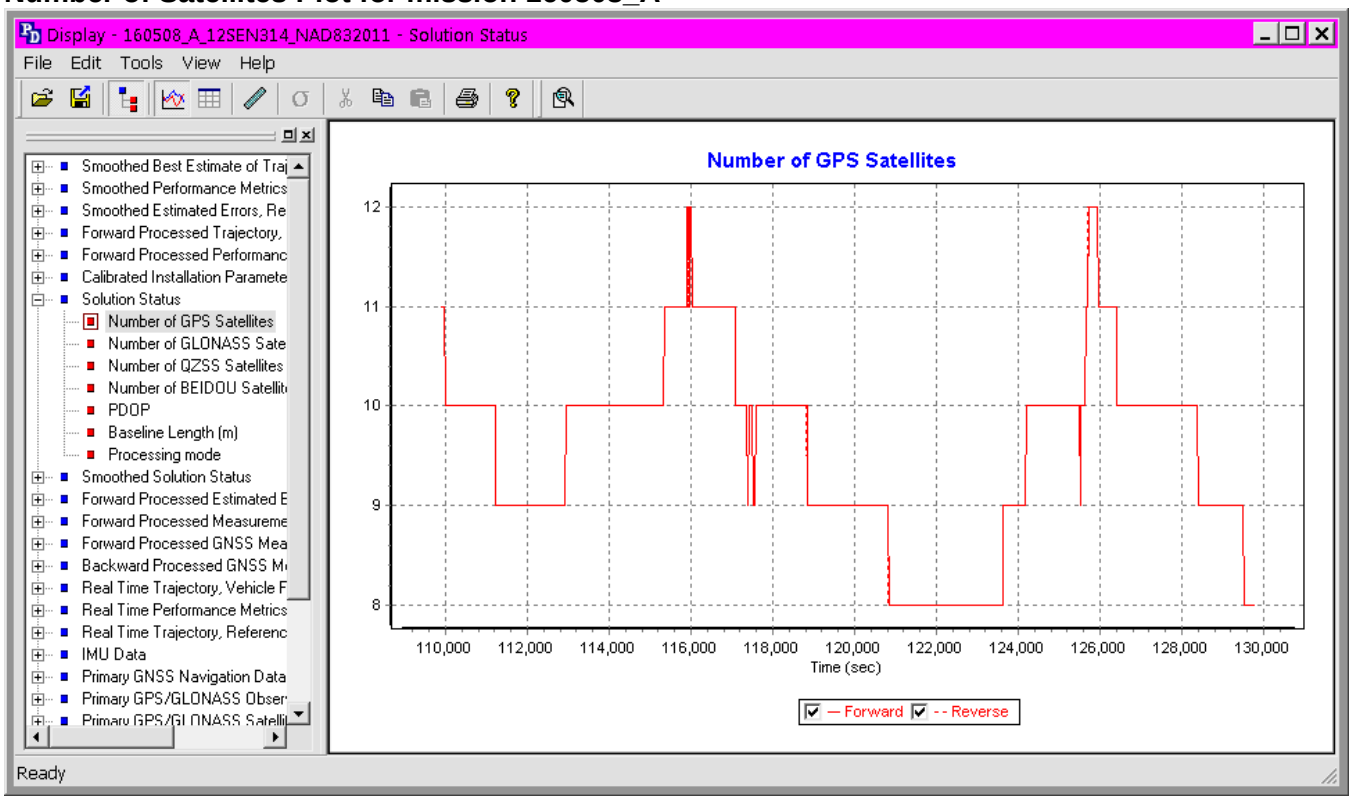
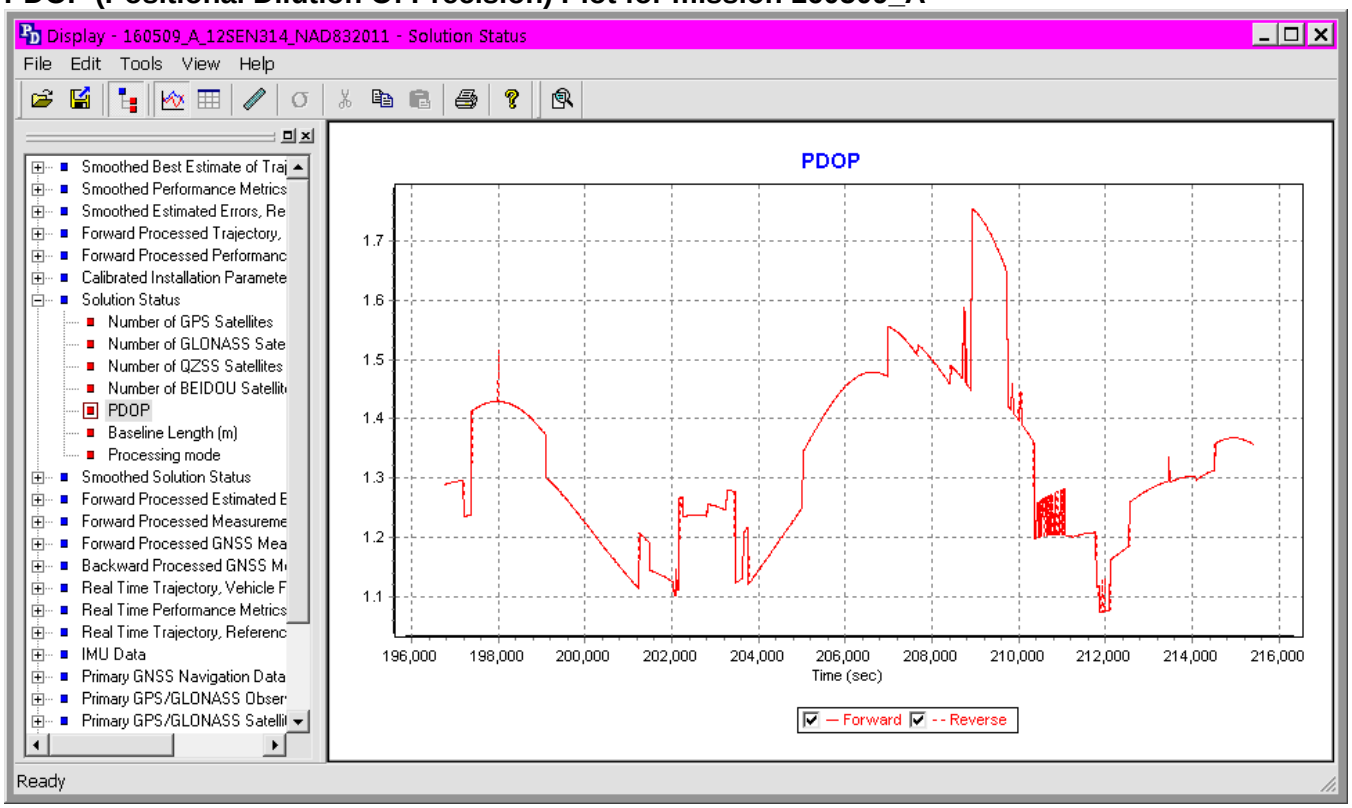


Number of Satellites Plot for mission 160508_A



PDOP (Positional Dilution Of Precision) Plot for mission 160509_A



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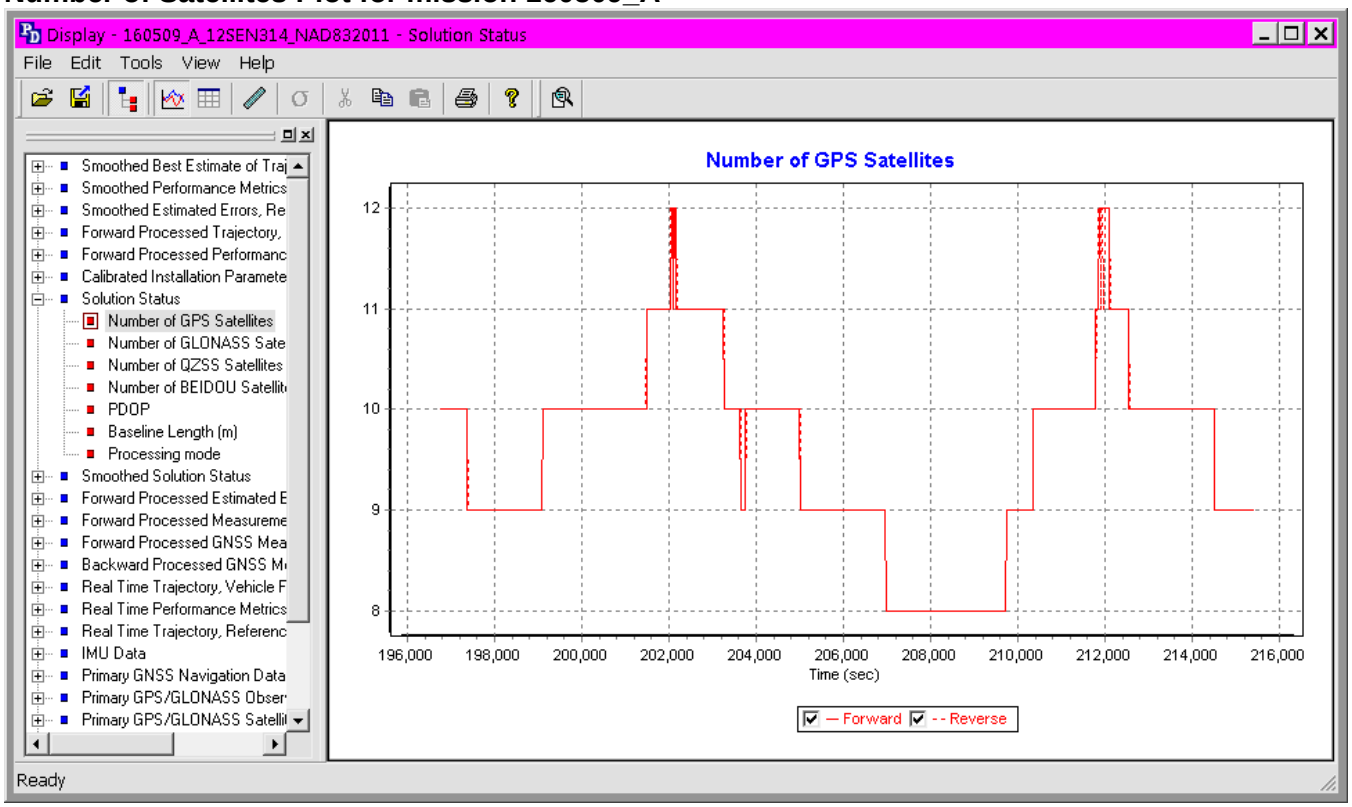

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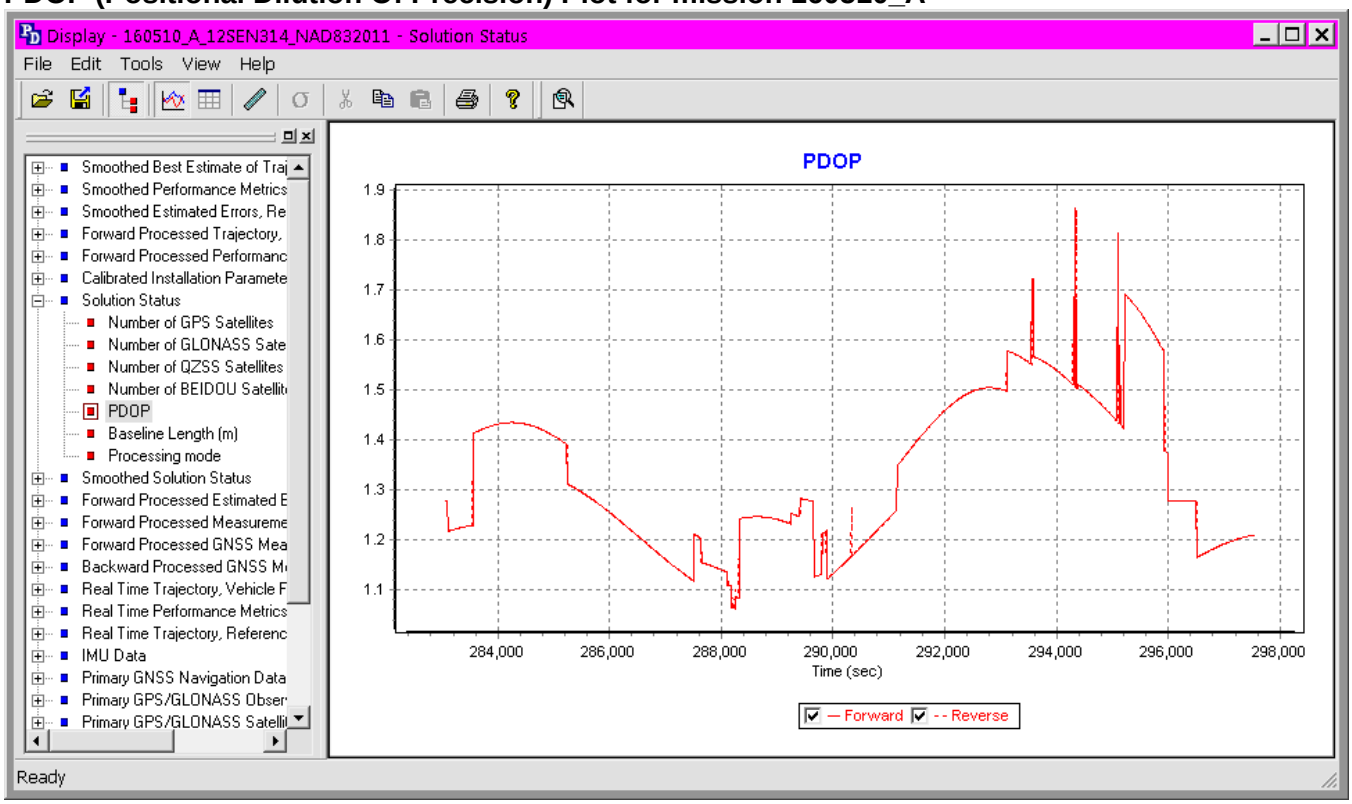
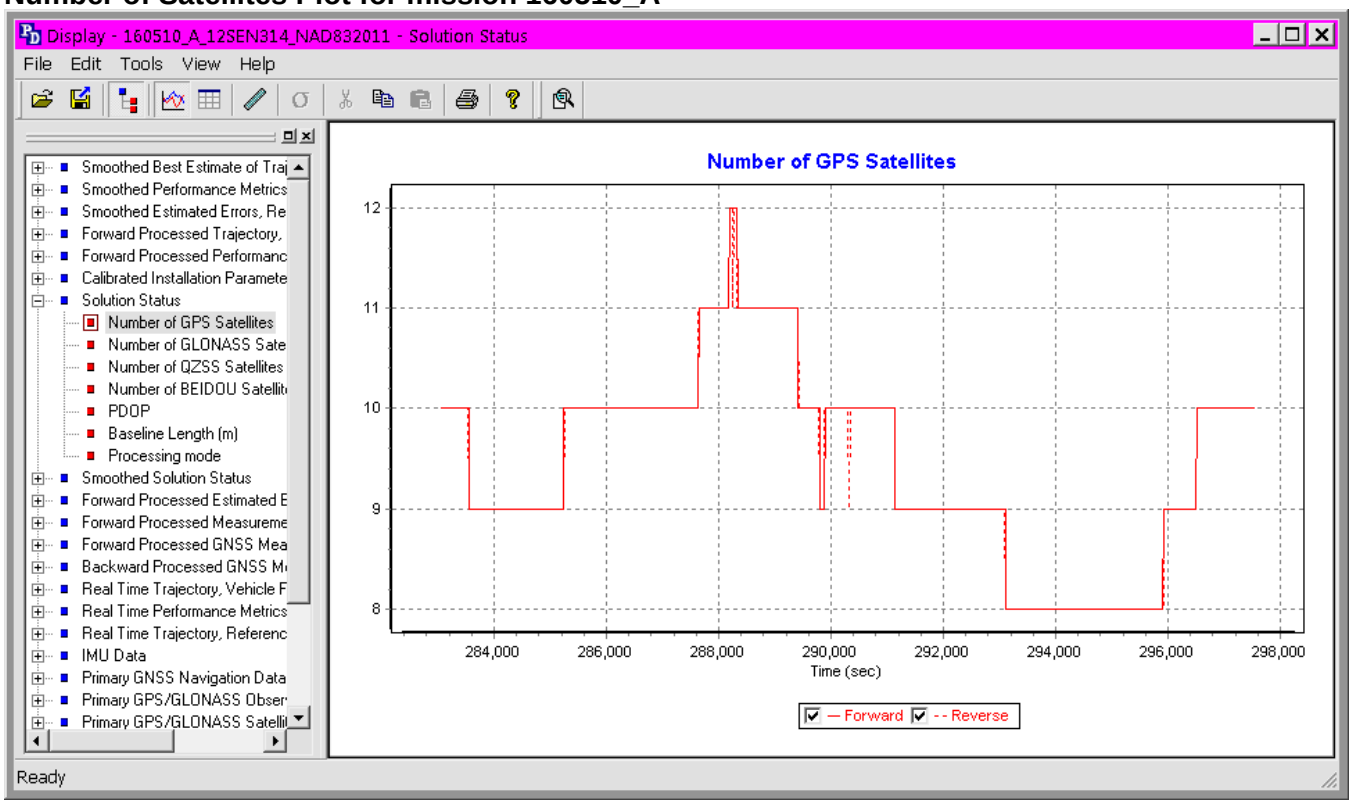
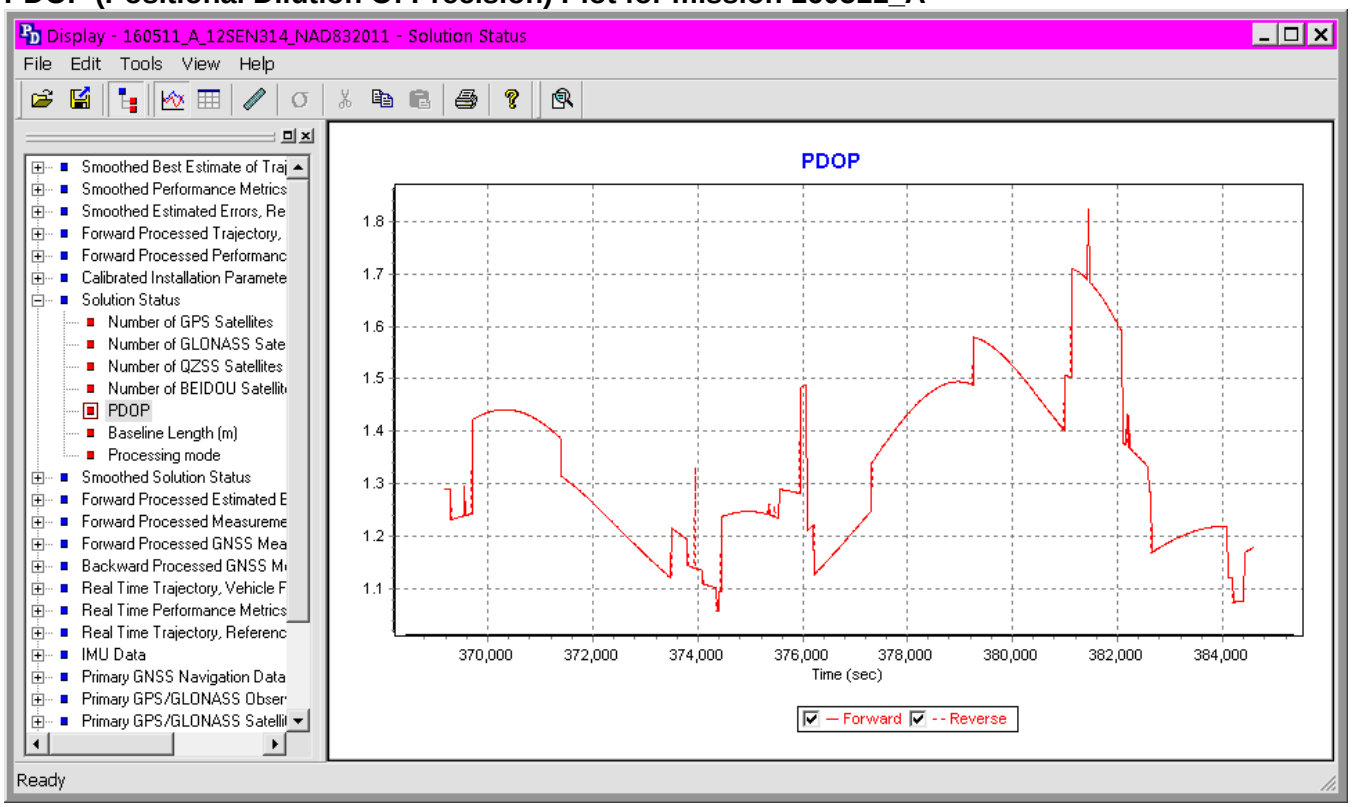


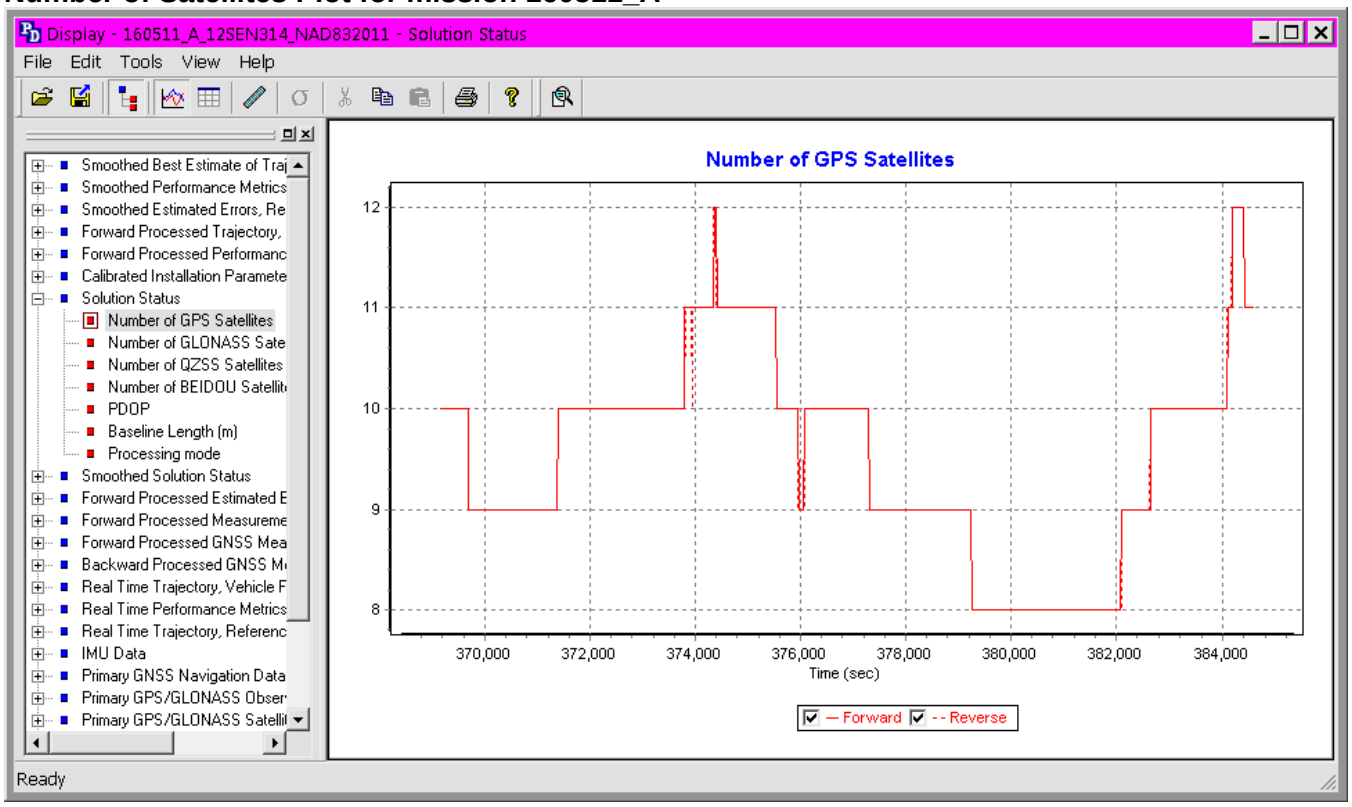
Number of Satellites Plot for mission 160510_A



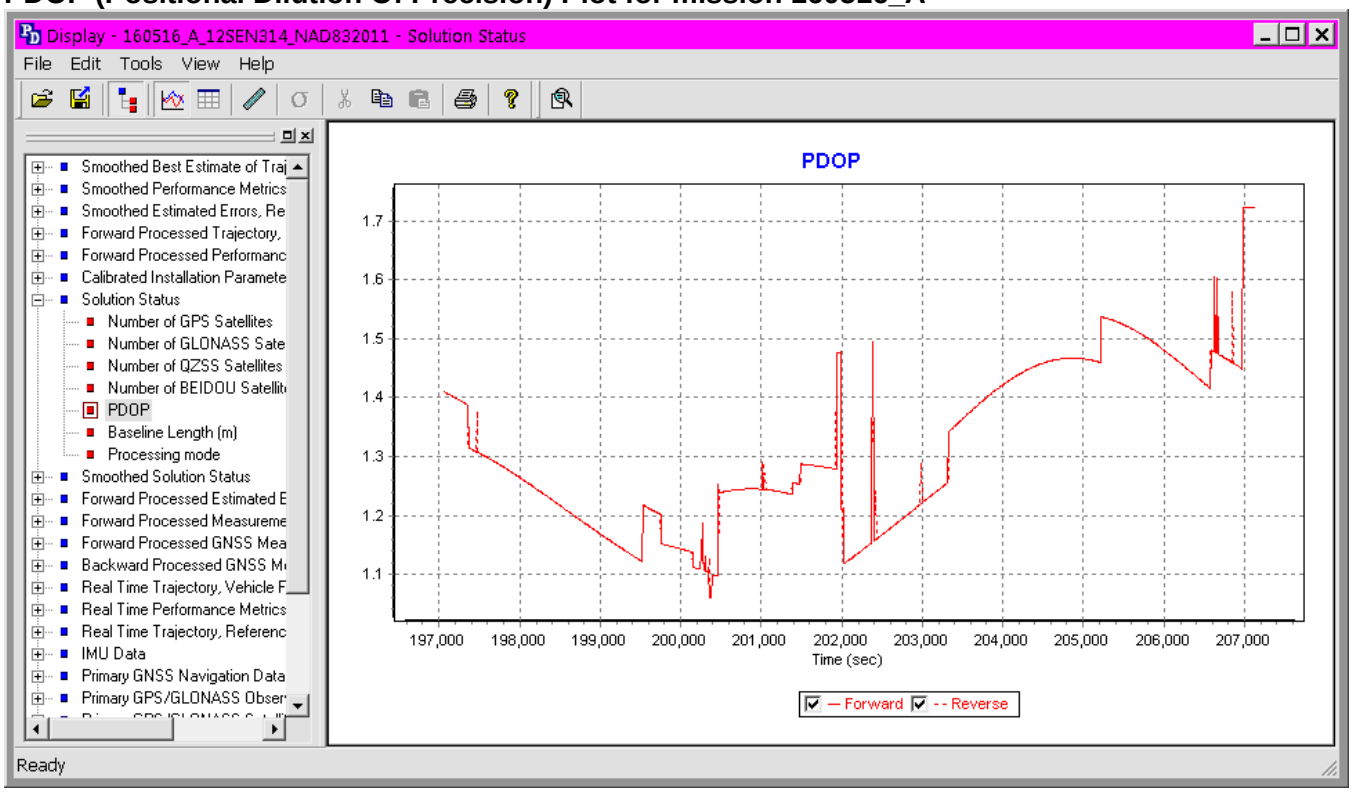
PDOP (Positional Dilution Of Precision) Plot for mission 160511_A



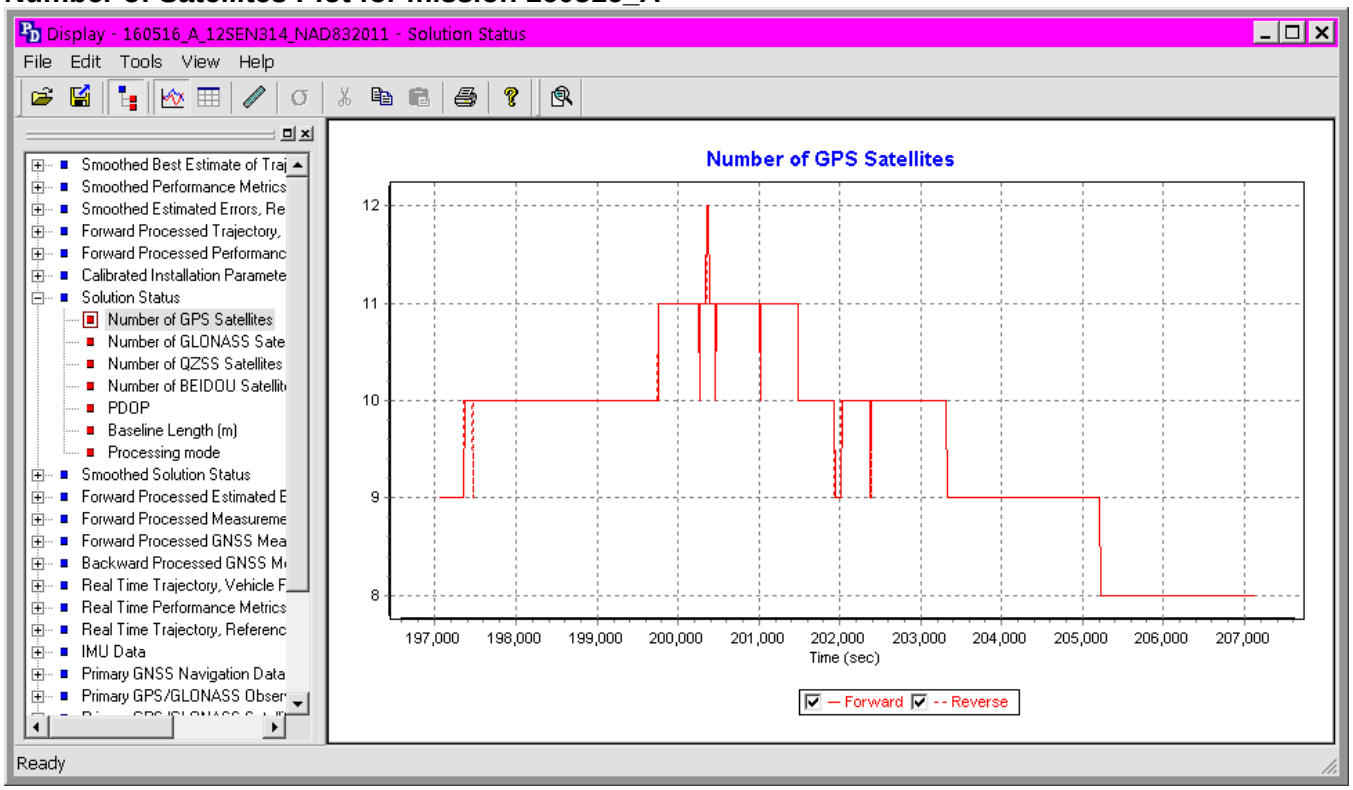
Number of Satellites Plot for mission 160511_A



PDOP (Positional Dilution Of Precision) Plot for mission 160516_A



Number of Satellites Plot for mission 160516_A



LiDAR Data Processing

The airborne GPS data was post-processed using Applanix POSPac Mobile Mapping Suite version 7.1 Service Pack 2. A fixed-bias carrier phase solution was computed in both the forward and reverse chronological directions. Whenever practical, LiDAR acquisition was limited to periods when the PDOP (**P**ositional **D**ilution **O**f **P**recision) was less than 4.0. PDOP indicates satellite geometry relating to position. Generally PDOP's of 4.0 or less result in a good quality solution, however PDOP's between 4.0 and 5.0 can still yield good results most of the time. PDOP's over 6.0 are of questionable results and PDOP's of over 7.0 usually result in a poor solution. Usually as the number of satellites increase the PDOP decreases. Other quality control checks used for the GPS include analyzing the combined separation of the forward and reverse GPS processing from one base station and the results of the combined separation when processed from two different base stations. Basically this is the difference between the two trajectories. An analysis of the number of satellites, present during the flight and data collection times, is also performed.

The GPS trajectory was combined with the raw IMU data and post-processed using POSPac Mobile Mapping Suite version 7.1 Service Pack 2. The Smoothed Best Estimated Trajectory (SBET) and refined attitude data are then utilized in the LMS Post Processor to compute the laser point-positions – the trajectory is combined with the attitude data and laser range measurements to produce the 3-dimensional coordinates of the mass points. Up to four return values are produced within the Optech LiDAR Mapping Suite (LMS) processor software for each pulse which ensures the greatest chance of ground returns in a heavily forested area.

Laser point classification was completed using Merrick Advanced Remote Sensing (MARS®) LiDAR processing and modeling software. Several algorithms are used when comparing points to determine the best automatic ground solution. Each filter is built based on the projects terrain and land cover to provide a surface that is 90% free of anomalies and artifacts. After the auto filter has been completed the data sets are then reviewed by an operator utilizing MARS® to remove any other anomalies or artifacts not resolved by the automated filter process. During these final steps the operator also verifies that the data sets are consistent and complete with no data voids.

GPS Controls

One ground GNSS Base Stations was set up at the airport of operation for the LiDAR data collection (Base_KVGT). In addition CORS (Continually Operating Reference Stations) were used for processing verification.

The ground GNSS Base Station (Base_KVGT) was post processing using Trimble Business Center Software version 2.60 and checked with OPUS solutions from NGS (National Geodetic Survey).

See the following spreadsheet for ground GNSS Base Station information:

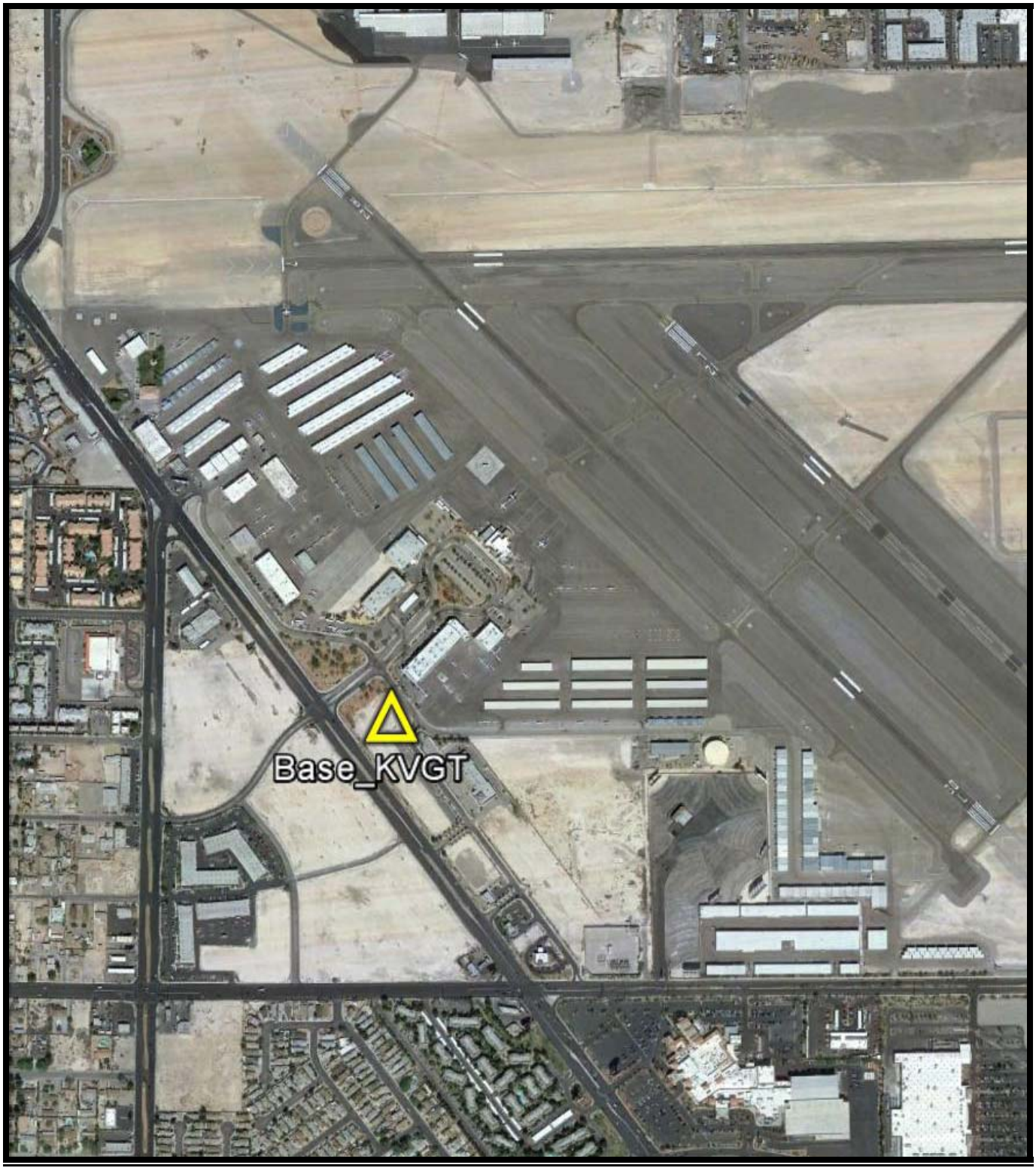
Project: SNWA
Job#: 65219059
Date: Aug. 2016

Coordinate System: NAD83(2011) NV East
Zone: Nevada East
Project Datum: NAD 1983(2011)
Vertical Datum: NAVD88
Units: USFeet

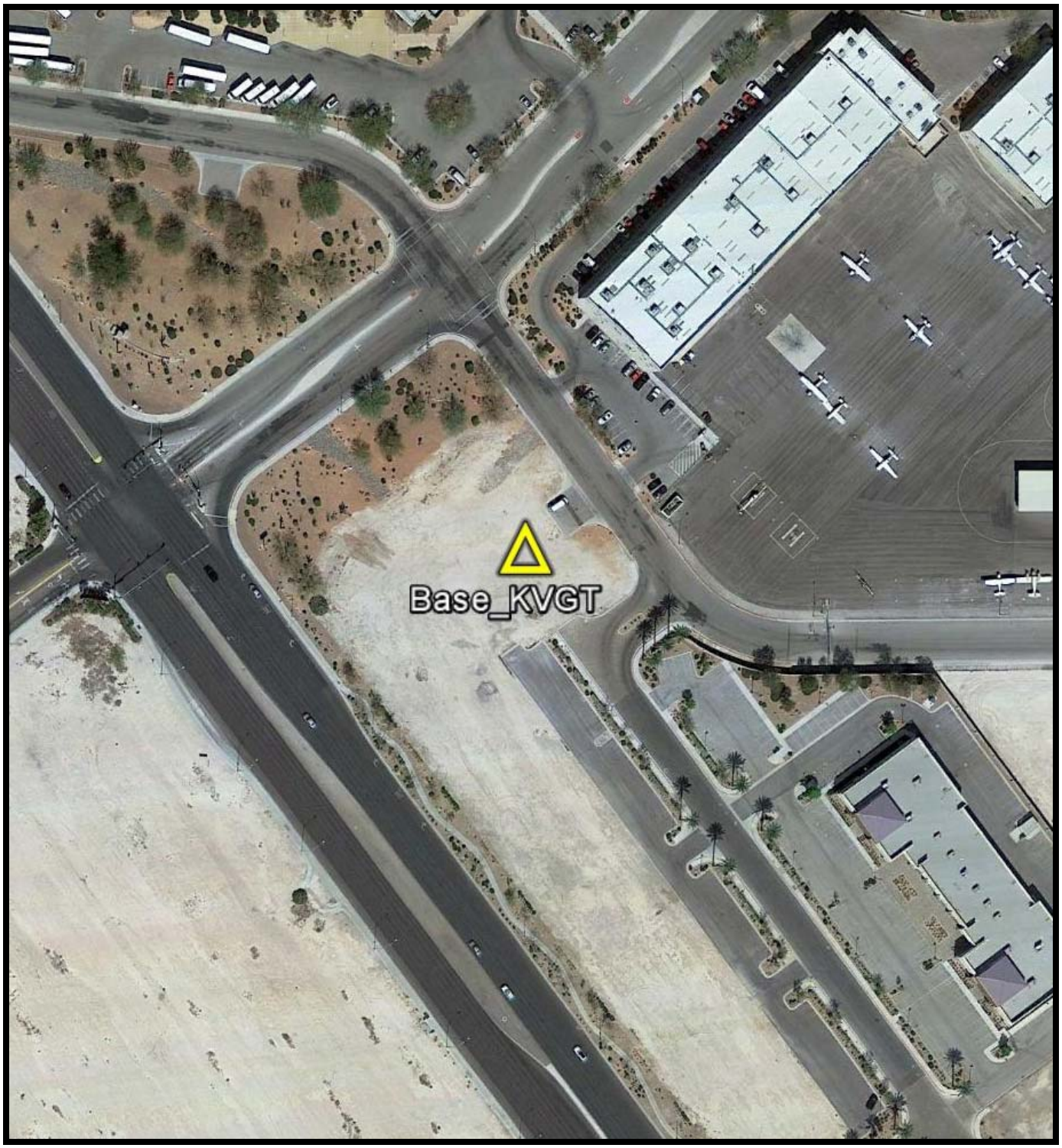
Pt#	Geodetic NAD83(2011)		Ellipsoid	Description
Name	Latitude	Longitude	Height	
	North	West		
	Deg Min Sec	Deg Min Sec	USFeet	
Base_KVGT	N36°12'24.30698"	W115°12'05.07827"	2104.17	Airport Base

Pt#	NAD83(2011) NVEast Zone		NAVD88	Description
Name	Northing	Easting	Elevation	
	Y	X	Z	
	USFeet	USFeet	USFeet	
Base_KVGT	26777102.53	768837.35	2195.66	Airport Base

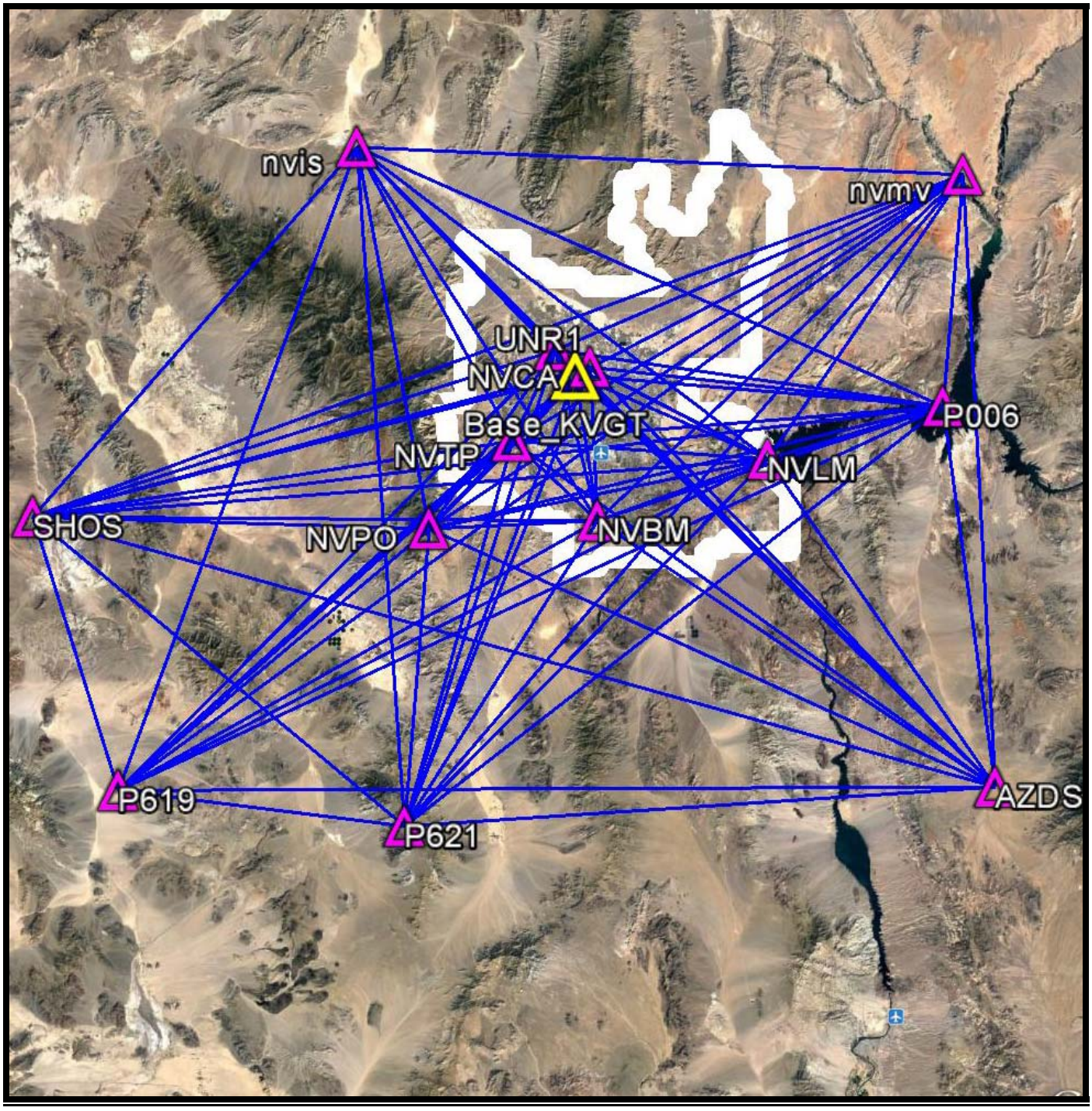
Base Station used to control the Flight Data



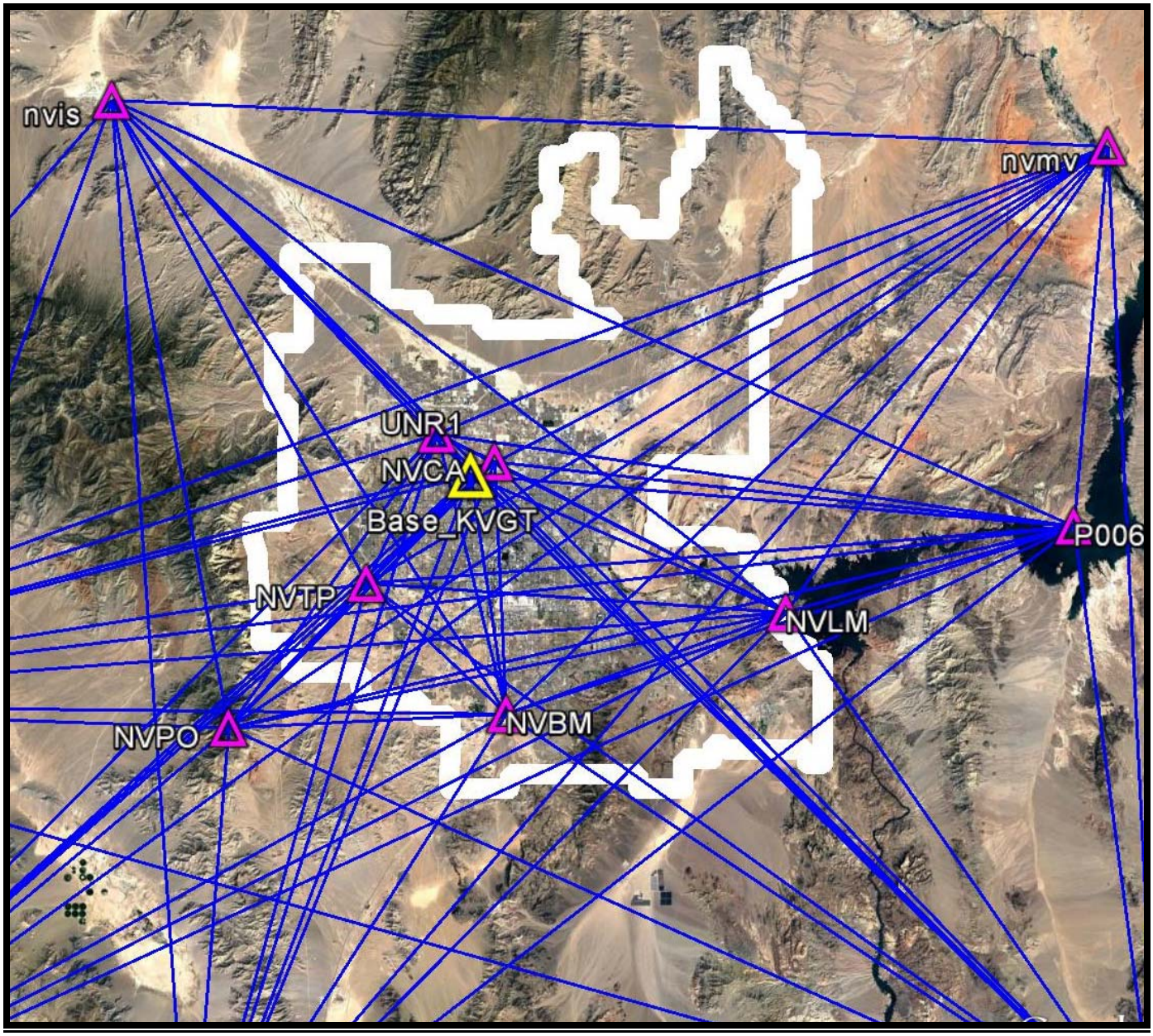
Base Station used to control the Flight Data (Detail)



Base Station and CORS used to control the Flight Data.



Base Station and CORS used to control the Flight Data (Detail)



Survey Report

Ground GNSS Survey

The following listings show the ground survey points that were established as Control Points (lipt), surveyed by Merrick & Company. These control points are used in the calibration of the LiDAR point cloud.

Ground Control Points are shown in Grid values (State Plane, NAVD88) and Latitude, Longitude and Ellipsoid Height.

Ground Point Parameters

Coordinate System: Nevada State Plane Coordinate System, East Zone.
Horizontal Datum: The horizontal datum for the project is North American Datum of 1983, adjusted to the National Spatial Reference System of 2011 (NAD83 /2011).
Vertical Datum: The Vertical datum for the project is North American Vertical Datum of 1988 (NAVD88).
Geiod Model: Geoid12A (Geoid12A will be used to convert ellipsoid heights to orthometric heights).
Units: Horizontal units are in US Survey Feet, Vertical units are in US Survey Feet.

Ground Control Points

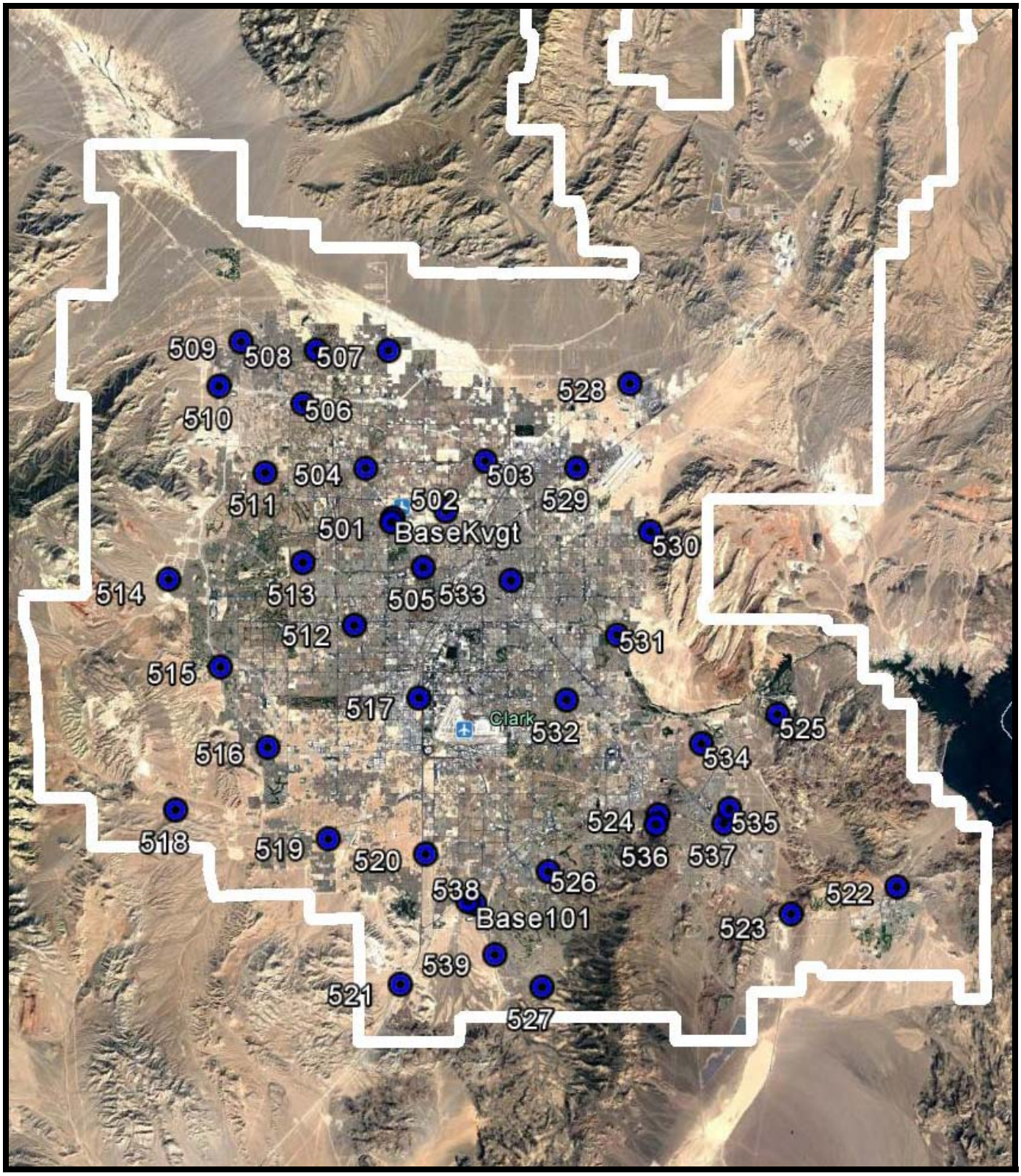
Name	NorthUSF_NVEast	EastUSF_NVEast	ElevUSF_NAVD88	Code
BaseKVGT	26777102.53	768837.35	2195.66	LIPT
Base101	26693968.04	786944.04	2396.59	LIPT
501	26776216.13	768498.44	2199.92	lipt
502	26778707.43	780245.79	2093.25	lipt
503	26789560.43	788696.89	1974.69	lipt
504	26787823.52	762876.69	2248.93	lipt
505	26766479.93	775418.39	2091.46	lipt
506	26801673.75	749246.41	2417.48	lipt
507	26813286.78	767693.78	2321.15	lipt
508	26813294.54	752077.41	2407.39	lipt
509	26814930.03	735882.31	2826.48	lipt
510	26805301.07	731259.59	2954.20	lipt
511	26786716.83	741200.87	2506.80	lipt
512	26753907.24	760614.48	2310.57	lipt
513	26767373.16	749469.93	2524.31	lipt
514	26763618.64	720728.02	3399.06	lipt
515	26744754.91	731839.18	2831.00	lipt
516	26727470.75	742144.93	2581.73	lipt
517	26738249.08	774621.28	2153.10	lipt
518	26714061.99	722683.67	3169.48	lipt
519	26707841.92	755351.82	2575.28	lipt
520	26704606.41	776297.13	2268.87	lipt

521	26676619.97	771053.83	2715.03	lipt
522	26697912.12	878298.50	2275.55	lipt
523	26691914.59	855408.46	2302.16	lipt
524	26713263.50	826516.62	1909.78	lipt
525	26735124.56	852249.36	1915.10	lipt
526	26700943.06	802815.96	2430.65	lipt
527	26676087.29	801579.58	3018.64	lipt
528	26806459.68	819881.99	2060.21	lipt
529	26788166.73	808492.73	1862.92	lipt
530	26774463.84	824479.06	2101.10	lipt
531	26752076.60	817460.77	1695.53	lipt
532	26737973.91	806548.23	1764.59	lipt
533	26763792.05	794382.14	1840.21	lipt
534	26728646.87	835813.90	1640.03	lipt_intpt
535	26714664.35	841927.86	1936.27	lipt_intpt
536	26711134.61	826066.36	1955.08	lipt
537	26711460.40	840749.33	2009.22	lipt_intpt
538	26694480.10	785461.92	2374.03	lipt
539	26683044.85	791369.37	2592.94	lipt_intpt

Name	Latitude	Longitude	EllipUSF	Code
BaseKVGT	36°12'24.30698"	-115°12'05.07827"	2104.17	LIPT
Base101	35°58'41.37684"	-115°08'28.73810"	2304.51	LIPT
501	36°12'15.55411"	-115°12'09.25643"	2108.43	lipt
502	36°12'39.71184"	-115°09'45.77925"	2001.45	lipt
503	36°14'26.66649"	-115°08'02.03366"	1882.95	lipt
504	36°14'10.55822"	-115°13'17.32668"	2157.78	lipt
505	36°10'38.99098"	-115°10'45.31135"	1999.67	lipt
506	36°16'28.00108"	-115°16'03.16623"	2327.07	lipt
507	36°18'22.19276"	-115°12'17.30784"	2230.58	lipt
508	36°18'22.83129"	-115°15'28.11289"	2317.17	lipt
509	36°18'39.49867"	-115°18'45.93494"	2736.99	lipt
510	36°17'04.39750"	-115°19'42.73029"	2864.85	lipt
511	36°14'00.33253"	-115°17'41.97328"	2416.66	lipt
512	36°08'35.22358"	-115°13'46.45185"	2219.29	lipt
513	36°10'48.77678"	-115°16'01.80242"	2433.63	lipt
514	36°10'12.42907"	-115°21'52.52263"	3310.02	lipt
515	36°07'05.60293"	-115°19'37.60401"	2740.94	lipt
516	36°04'14.37942"	-115°17'32.61552"	2490.94	lipt
517	36°05'59.83206"	-115°10'56.45601"	2061.29	lipt

518	36°02'02.27833"	-115°21'30.06755"	3079.33	lipt
519	36°00'59.83324"	-115°14'52.55564"	2483.89	lipt
520	36°00'27.04636"	-115°10'37.74439"	2176.94	lipt
521	35°55'50.47492"	-115°11'42.92091"	2623.06	lipt
522	35°59'14.85608"	-114°49'56.86162"	2182.75	lipt
523	35°58'17.19747"	-114°54'35.89779"	2209.15	lipt
524	36°01'50.15835"	-115°00'25.86173"	1817.02	lipt
525	36°05'24.73004"	-114°55'10.74910"	1822.59	lipt
526	35°59'49.60328"	-115°05'15.18769"	2338.36	lipt
527	35°55'43.84745"	-115°05'31.75768"	2926.41	lipt
528	36°17'12.18753"	-115°01'40.14856"	1969.24	lipt
529	36°14'11.90819"	-115°04'00.45932"	1771.14	lipt
530	36°11'55.51061"	-115°00'46.29648"	2009.47	lipt
531	36°08'14.51530"	-115°02'13.46517"	1603.18	lipt
532	36°05'55.63331"	-115°04'27.40895"	1672.04	lipt
533	36°10'11.56651"	-115°06'54.14727"	1748.00	lipt
534	36°04'21.73231"	-114°58'31.49634"	1547.26	lipt_intpt
535	36°02'03.06959"	-114°57'18.11803"	1843.47	lipt_LiDAR Pt. Check
536	36°01'29.13094"	-115°00'31.49656"	1862.37	lipt
537	36°01'31.45930"	-114°57'32.71738"	1916.40	lipt_intpt
538	35°58'46.50707"	-115°08'46.74376"	2281.95	lipt
539	35°56'53.14689"	-115°07'35.51574"	2500.81	lipt_intpt

Ground Control Points



Ground Points (LiDAR checkpoints)

The following listings show the ground survey points that were established as the Non-vegetated Vertical Accuracy (NVA) and Vegetated Vertical Accuracy (VVA) LiDAR checkpoints that were established and surveyed by SNWA surveyors.

Name	NorthUSF_NVEast	EastUSF_NVEast	ElevUSF_NAVD88	ID_Code	ACC_TYPE
1	26743681.57	803733.30	1831.84	GHV060 AERIAL TARGET	NVA
2	26839375.53	718636.87	2956.01	HP044 AERIAL TARGET	NVA
3	26775355.49	751171.77	2419.81	HP045 AERIAL TARGET	NVA
4	26808495.35	732311.13	2959.06	HP047 AERIAL TARGET	NVA
5	26815838.10	767887.20	2337.76	HP048 AERIAL TARGET	NVA
6	26783976.40	776211.97	2170.29	HP049 AERIAL TARGET	NVA
7	26808444.21	804377.26	2147.99	HP050 AERIAL TARGET	NVA
8	26800920.50	827588.74	1983.82	HP051 AERIAL TARGET	NVA
9	26768595.73	822534.55	1990.70	HP052 AERIAL TARGET	NVA
10	26820495.56	733155.02	2902.44	HP054 AERIAL TARGET	NVA
11	26754875.81	860631.71	1396.85	HP063 AERIAL TARGET	NVA
12	26822712.61	705653.59	3691.98	HP080 AERIAL TARGET	NVA
13	26725511.13	770303.88	2309.60	HV029 AERIAL TARGET	NVA
14	26768680.94	722890.65	3421.28	HV046 AERIAL TARGET	NVA
15	26738057.60	731305.43	2853.81	HV053 AERIAL TARGET	NVA
16	26726259.36	850320.16	1937.31	HV061 AERIAL TARGET	NVA
17	26709953.39	821275.56	2102.18	HV062 AERIAL TARGET	NVA
18	26696248.06	831092.06	2616.86	HV067 AERIAL TARGET	NVA
19	26690415.03	782133.21	2420.78	HV068 AERIAL TARGET	NVA
20	26675799.34	803132.26	3099.96	HV069 AERIAL TARGET	NVA
21	26670938.14	768910.13	2821.59	HV070 AERIAL TARGET	NVA
22	26707446.63	734371.11	2966.79	HV082 AERIAL TARGET	NVA
23	26758789.24	704397.69	3708.94	HV1047 AERIAL TARGET	NVA
24	26812871.65	859996.78	2485.64	HV1056 AERIAL TARGET	NVA
25	26744261.87	697269.85	3828.80	HV200 AERIAL TARGET	NVA
26	26684080.69	876702.20	2220.24	HV66 AERIAL TARGET	NVA
27	26815875.26	844802.74	2356.05	HV78 AERIAL TARGET	NVA
28	26790125.68	869705.39	2009.23	HP1040 AERIAL TARGET	NVA
29	26725710.63	699819.48	3544.09	HV81 AERIAL TARGET	NVA
30	26677359.06	894264.79	2120.67	HV1059 AERIAL TARGET	NVA
31	26752024.38	821846.56	1804.49	HV1057 AERIAL TARGET	NVA
32	26804112.67	697499.37	4465.86	HP1048 AERIAL TARGET	NVA No Cover
33	26696026.78	750598.76	2689.55	HV1044 AERIAL TARGET	NVA
34	26841381.82	859545.76	2201.70	GVAHV005_0 AERIAL TARGET	NVA
35	26861582.06	880656.10	2279.04	GVAHV008_0 AERIAL TARGET	NVA
36	26876242.71	872291.27	2012.80	GVAHV011_0 AERIAL TARGET	NVA

37	26906957.72	871739.45	2607.83	GVAHV015_0 AERIAL TARGET	NVA
38	26892253.51	884169.44	2247.72	GVAHV016_0 AERIAL TARGET	NVA
42	26877544.72	841493.81	2746.24	GVAHV10_02 AERIAL TARGET	NVA
1001	26738521.31	822561.31	1623.31	LVW21 NG TRAIL	VVA
1002	26738499.81	822537.94	1623.04	LVW21 NG TRAIL	VVA
1003	26738524.88	822538.70	1623.04	LVW21 NG REED	VVA
1004	26738529.31	822562.72	1623.52	LVW21 NG QB	VVA
1005	26737613.68	823329.94	1604.40	LVW23 NG DIRT	VVA
1006	26737654.76	823359.24	1604.60	LVW23 NG DIRT	VVA
1007	26737667.64	823413.48	1604.78	LVW23 NG REED	VVA
1008	26736865.61	822722.06	1600.45	LVW22 NG DIRT	VVA
1009	26736902.59	822680.54	1601.23	LVW22 NG SB	VVA
1010	26734542.49	827915.71	1570.67	LVW20 NG TAM	VVA
1011	26734532.24	827929.24	1570.57	LVW20 NG SAC	VVA
1012	26734517.53	827919.58	1570.64	LVW20 NG SAC	VVA
1013	26733854.85	828251.50	1569.32	LVW19 NG HM	VVA
1013	26733854.85	828251.50	1569.32	LVW19 NG HM	VVA
1014	26733848.23	828237.70	1569.56	LVW19 NG 4W	VVA
1015	26733849.55	828352.64	1568.61	LVW19 NG BAC	VVA
1016	26733861.78	828369.60	1568.09	LVW19 NG DIRT	VVA
1017	26734030.34	831481.03	1545.73	LVW18 NG BASA	VVA
1018	26733964.84	831488.97	1545.06	LVW18 NG TAM	VVA
1019	26734065.67	831488.86	1545.56	LVW18 NG ROAD	VVA
1020	26733862.82	832973.57	1534.23	LVW17 NG DIRT	VVA
1021	26733891.53	832994.59	1534.65	LVW17 NG CREO	VVA
1022	26733901.87	833008.96	1534.63	LVW17 NG HM	VVA
1023	26733952.08	832992.81	1534.26	LVW17 NG DW	VVA
1024	26733973.73	833018.18	1530.62	LVW17 NG GW	VVA
1025	26734023.86	833994.82	1527.81	LVW15 NG CW	VVA
1026	26734014.66	833958.22	1527.69	LVW15 NG DIRT	VVA
1027	26734084.38	833827.31	1529.99	LVW15 NG ASH	VVA
1028	26734043.88	833796.77	1527.29	LVW15 NG DIRT	VVA
1029	26734190.97	835504.65	1544.96	LVW14 NG CREO	VVA
1030	26734175.70	835364.90	1532.12	LVW14 NG 4W	VVA
1031	26734151.31	835361.18	1532.89	LVW14 NG 4W	VVA
1032	26734932.96	836744.45	1512.17	LVW12 NG DIRT	VVA
1034	26734946.06	836742.75	1512.64	LVW12 NG BAC	VVA
1035	26735103.32	836909.87	1512.28	LVW12 NG GW	VVA
1036	26735107.07	836969.59	1510.41	LVW12 NG DIRT	VVA
1037	26734901.93	836746.48	1513.73	LVW12 NG QB	VVA
1038	26735354.18	837589.36	1510.37	LVW10 NG REED	VVA
1039	26735287.12	837570.99	1509.82	LVW10 NG DIRT	VVA

1040	26735285.66	837548.39	1510.14	LVW10 NG TAM	VVA
1041	26735257.24	837547.87	1510.10	LVW10 NG QB	VVA
1042	26735372.23	837700.54	1508.01	LVW10 NG BAC	VVA
1043	26735355.90	838101.53	1505.94	LVW09 NG HM	VVA
1045	26735395.42	838127.06	1495.70	LVW09 NG CW	VVA
1046	26735367.63	838136.00	1503.45	LVW09 NG DIRT	VVA
1047	26735452.79	838163.19	1494.32	LVW09 NG WILL	VVA
1048	26736259.44	840470.88	1485.18	LVW08 NG DIRT	VVA
1049	26736265.05	840460.05	1485.11	LVW08 NG WILL	VVA
1050	26736273.75	840462.74	1485.41	LVW08 NG WILL	VVA
1051	26737887.89	844913.50	1473.73	LVW07 NG DIRT	VVA
1052	26737908.29	844926.59	1472.01	LVW07 NG TAM	VVA
1053	26737997.38	844908.53	1469.21	LVW07 NG TAM	VVA
1054	26738039.31	844842.93	1468.06	LVW07 NG TAM	VVA Not Used
1055	26739572.76	846239.81	1438.54	LVW06 NG QB	VVA
1056	26739612.91	846294.73	1436.99	LVW06 NG QB	VVA
1056	26739612.91	846294.73	1436.99	LVW06 NG QB	VVA
1057	26739633.64	846261.77	1438.12	LVW06 NG BUSH	VVA
1058	26739611.17	846197.88	1438.36	LVW06 NG HM	VVA
1059	26735999.81	837603.92	1509.53	LVW05 NG WILL	VVA
1060	26736019.67	837570.35	1514.18	LVW05 NG CW	VVA
1061	26736015.26	837561.75	1513.98	LVW05 NG HM	VVA
1062	26736001.00	837506.62	1514.59	LVW05 NG CW	VVA
1063	26735127.90	834963.41	1524.30	LVW04 NG DIRT	VVA
1064	26735125.27	834888.33	1523.13	LVW04 NG BASA	VVA
1065	26734903.93	834782.77	1528.86	LVW03 NG HM	VVA
1066	26734911.34	834700.71	1525.96	LVW03 NG DIRT	VVA
1067	26734928.15	834664.66	1522.92	LVW03 NG CW	VVA
1068	26734712.56	833729.44	1529.58	LVW02 NG DIRT	VVA
1069	26734732.58	833717.96	1530.60	LVW02 NG HM	VVA
1070	26734721.83	833755.48	1529.01	LVW02 NG SB	VVA
1071	26734557.76	832781.20	1536.06	LVW01 NG DIRT	VVA
1072	26734547.87	832756.54	1536.10	LVW01 NG WILL	VVA
1073	26734533.40	832732.50	1536.86	LVW01 NG REED	VVA
1074	26734457.78	832612.78	1537.70	LVW01 NG DIRT	VVA
1075	26734437.61	832587.04	1538.16	LVW01 NG WILL	VVA
1076	26734410.82	832534.81	1537.87	LVW01 NG WILL	VVA Not Used
1077	26734374.11	832590.06	1538.18	LVW01 NG REED	VVA
2101	26771645.65	780665.76	2055.82	NVA50 MAG	NVA
2102	26771683.07	780675.15	2055.54	VVA17 NG BUSH	VVA
2103	26771674.53	780716.17	2055.28	VVA17 NG TREE	VVA
2105	26783984.51	776423.79	2169.30	VVA02 NG TREE	VVA

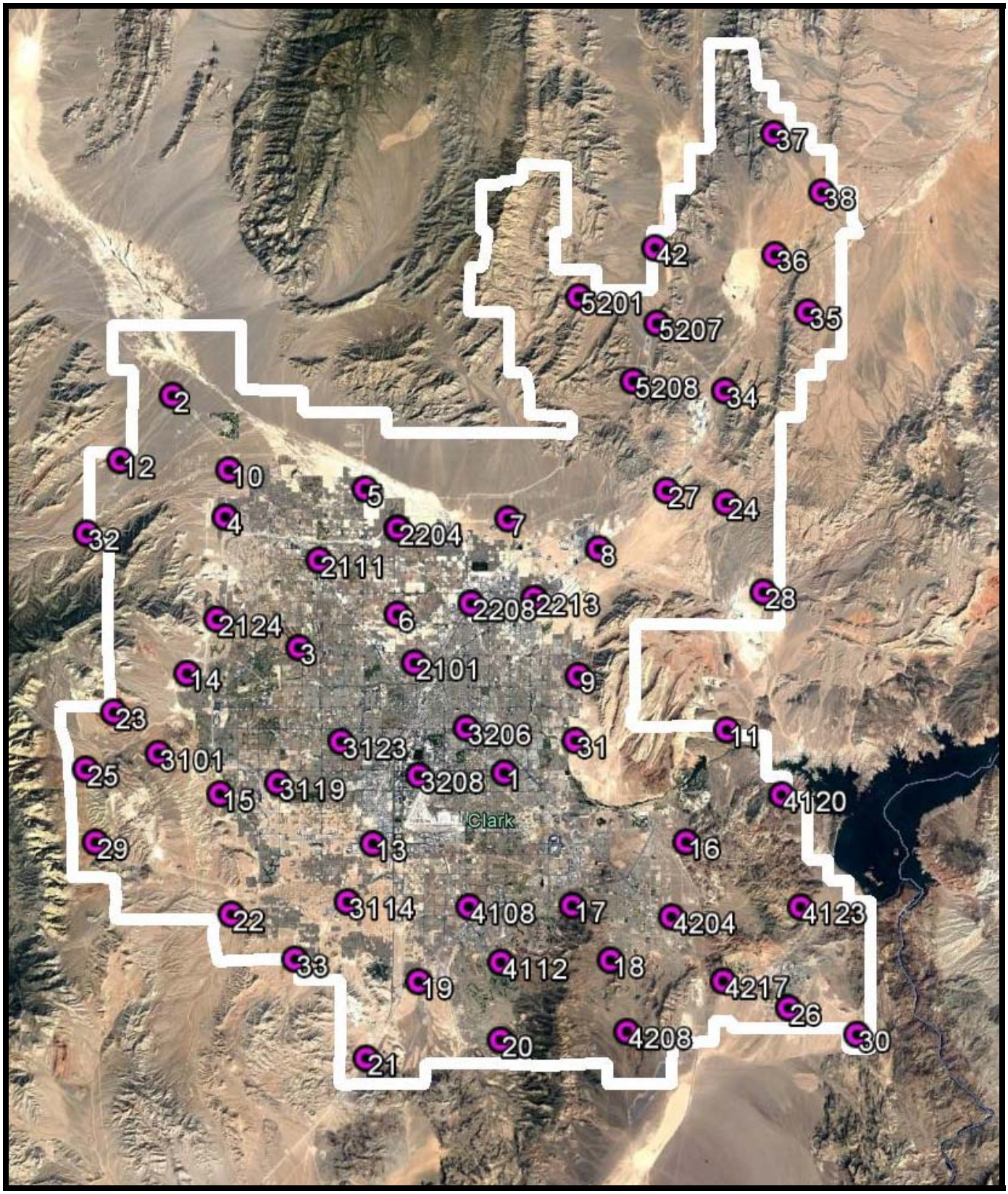
2106	26784005.22	776436.73	2169.00	VVA02 NG TREE	VVA
2109	26783984.52	776423.77	2169.44	VVA02 NG TREE	VVA
2110	26784005.24	776436.68	2169.03	VVA02 NG TREE	VVA
2111	26797674.92	756191.53	2329.12	NVA47 NV	NVA
2112	26797673.10	756240.99	2329.09	VVA15 NG BUSH	VVA
2113	26797737.41	756264.59	2328.75	VVA15 NG TREE	VVA
2114	26797686.01	756309.88	2327.42	VVA15 NG TREE	VVA
2115	26812671.83	748481.51	2479.20	VVA29 NG TREE	VVA
2116	26812577.82	748451.15	2481.19	VVA29 NG TREE	VVA
2117	26808117.34	731198.72	2999.44	VVA09 NG BUSH	VVA
2118	26807982.10	731212.37	2998.13	VVA09 NG BUSH	VVA
2119	26808001.32	731250.54	2996.80	VVA09 NG BUSH	VVA
2121	26822704.67	705643.48	3692.99	VVA33 NG BUSH	VVA
2122	26822693.42	705626.14	3692.82	VVA33 NG BUSH	VVA
2123	26822795.83	705678.58	3684.00	VVA33 NG YUC	VVA
2124	26782494.33	730328.18	2923.52	NVA51 MAG	NVA
2125	26782521.37	730158.99	2929.99	VVA18 NG TREE	VVA
2126	26782527.34	730116.59	2930.91	VVA18 NG BUSH	VVA
2127	26782439.22	730075.16	2935.25	VVA18 NG TREE	VVA
2128	26762273.98	732663.71	2976.14	VVA26 NG TREE	VVA
2129	26762278.64	732669.21	2976.13	VVA26 NG TREE	VVA
2130	26762388.43	732641.19	2975.73	VVA26 NG BUSH	VVA
2132	26775809.55	751206.89	2410.96	VVA01 NG TREE	VVA
2133	26775814.19	751213.55	2410.38	VVA01 NG TREE	VVA
2134	26775803.55	751154.51	2412.40	VVA01 NG TREE	VVA
2201	26815975.93	766921.06	2339.48	VVA10 NG BUSH	VVA
2202	26815984.76	766929.67	2340.08	VVA10 NG BUSH	VVA
2203	26815985.70	766903.16	2341.08	VVA10 NG DEC	VVA
2204	26805872.25	776185.95	2241.73	NVA46 MH CTR	NVA
2205	26805823.20	776169.15	2241.78	NVA46 MAG PS	NVA
2206	26805768.44	776220.01	2243.41	VVA14 NG EVER	VVA
2207	26805856.78	776167.05	2241.89	VVA14 NG DEC	VVA
2208	26786889.96	795058.66	1911.58	NVA48 BC AP	NVA
2210	26786924.79	795019.14	1910.83	VVA16 NG EVER	VVA
2211	26786942.99	795003.17	1910.51	VVA16 NG DEC	VVA
2212	26786895.71	795062.97	1910.68	VVA16 NG BUSH	VVA
2213	26788244.54	811148.08	1865.99	NVA49 MAG XWALK	NVA
2214	26787443.39	812776.56	1859.78	VVA40 NG BUSH	VVA
2215	26787353.56	812774.16	1858.85	VVA40 NG DEC	VVA
2216	26769277.43	805127.32	1786.73	VVA27 NG BUSH	VVA
2217	26769275.92	805105.37	1786.66	VVA27 NG DEC	VVA
3101	26748285.19	715670.09	3362.47	NVA64 NG 60D	NVA

3103	26725689.08	699908.04	3539.21	VVA32 NG TREE	VVA
3104	26725729.41	699871.98	3540.08	VVA32 NG BUSH	VVA
3105	26719358.54	708443.48	3378.71	VVA39 NG TREE	VVA
3106	26719381.56	708453.58	3378.12	VVA39 NG TREE	VVA
3107	26719042.00	708397.54	3385.77	VVA39 NG TREE	VVA
3108	26715238.69	740687.99	2820.78	VVA31 NG TREE	VVA
3109	26715236.63	740582.67	2822.63	VVA31 NG TREE	VVA
3110	26715254.17	740576.67	2822.87	VVA31 NG TREE	VVA
3111	26699919.02	759280.88	2528.27	VVA11 NG TREE	VVA
3112	26699922.26	759270.31	2529.55	VVA11 NG TREE	VVA
3113	26699946.72	759225.72	2530.83	VVA11 NG TREE	VVA
3114	26710639.21	763865.40	2433.52	NVA56 MAG	NVA
3115	26710804.12	763919.81	2434.16	VVA23 NG TREE	VVA
3116	26710801.31	763935.06	2433.87	VVA23 NG TREE	VVA
3117	26735240.17	760656.82	2341.22	VVA44 NG TREE	VVA
3118	26735393.34	760650.93	2340.95	VVA44 NG BUSH	VVA
3119	26740889.07	745961.69	2532.07	NVA55 MAG	NVA
3120	26740933.74	745889.98	2535.99	VVA22 NG TREE	VVA
3121	26740942.56	745876.01	2536.43	VVA22 NG TREE	VVA
3122	26740926.48	745867.31	2533.19	VVA22 NG TREE	VVA
3123	26751468.45	762020.06	2290.55	NVA52 MAG	NVA
3124	26751616.65	762182.69	2287.59	VVA19 NG TREE	VVA
3125	26751615.87	762148.38	2288.21	VVA19 NG TREE	VVA
3126	26751618.57	762115.44	2288.16	VVA19 NG TREE	VVA
3127	26689279.83	779729.84	2458.12	VVA30 NG BUSH	VVA
3128	26689266.47	779741.99	2458.23	VVA30 NG TREE	VVA
3129	26689276.20	779746.88	2458.08	VVA30 NG BUSH	VVA
3201	26769930.52	822180.06	1947.56	VVA8 NG DEC	VVA
3202	26769987.94	822239.64	1951.10	VVA8 NG EVER	VVA
3203	26769727.25	822104.32	1947.97	VVA8 NG BUSH	VVA
3204	26755196.96	793727.13	1881.50	VVA20 NG DEC	VVA
3205	26755400.60	793672.56	1883.84	VVA20 NG EVER	VVA
3206	26755068.03	793951.25	1877.33	NVA53 MAG PS	NVA
3208	26742925.64	781879.17	2062.69	NVA54 MAG PS	NVA
3209	26742939.24	781896.98	2062.66	VVA21 NG DEC AC	VVA
3210	26743066.78	781887.67	2061.97	VVA21 NG PALM	VVA
3211	26742897.79	781927.05	2063.03	VVA21 NG BUSH	VVA
3212	26726906.39	793819.11	2024.17	VVA42 NG DEC	VVA
3213	26726978.36	793579.96	2026.59	VVA42 NG EVER	VVA
3214	26726921.19	793562.70	2028.61	VVA42 NG BUSH	VVA
3215	26727348.18	795193.30	2006.73	VVA43 NG PALM	VVA
3216	26727336.00	795310.65	2005.04	VVA43 NG EVER	VVA

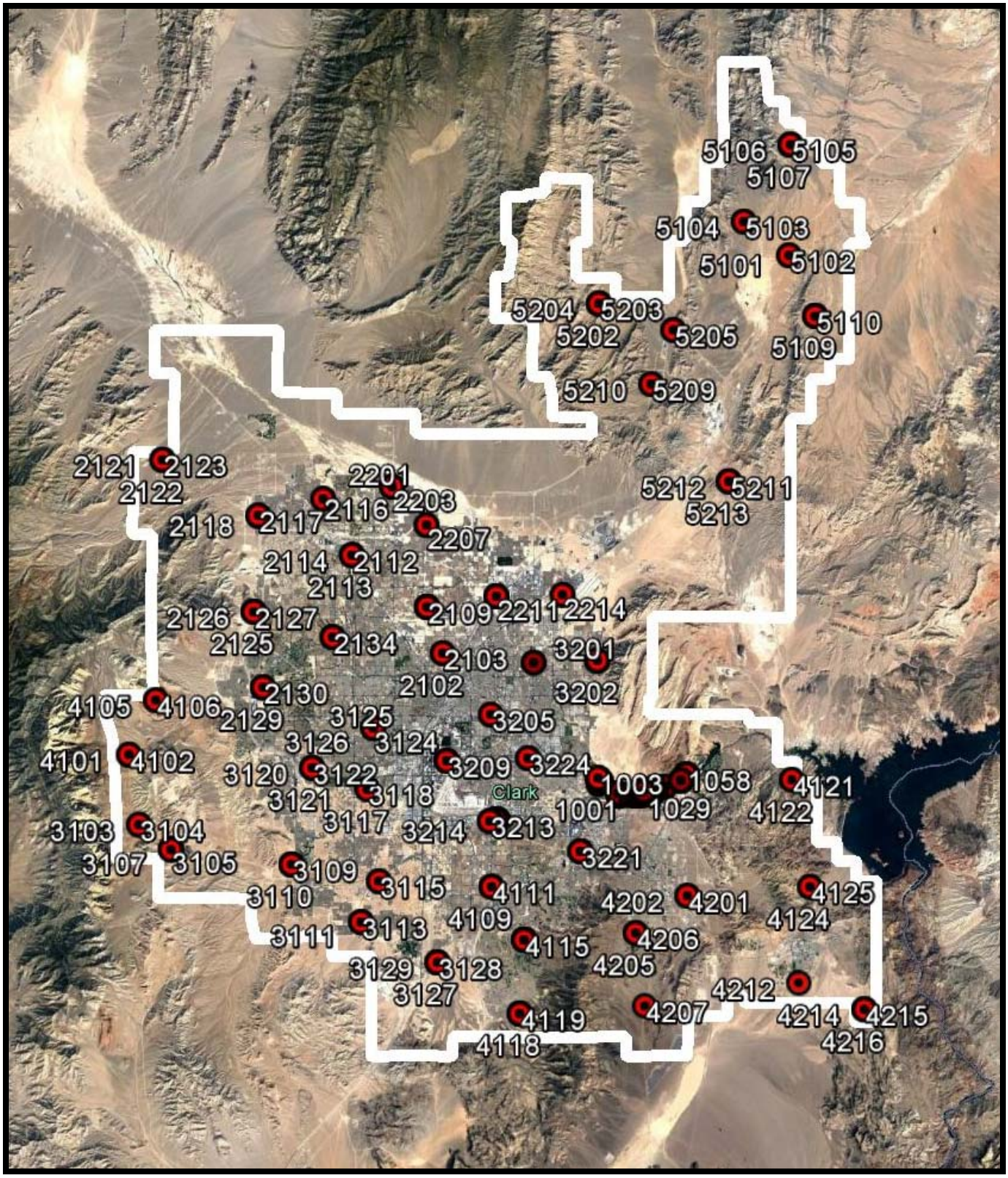
3217	26727389.61	795251.89	2006.28	VVA43 NG DEC	VVA
3218	26727304.88	795666.28	2001.31	VVA47 NG DEC	VVA
3219	26727328.99	795745.78	2000.36	VVA47 NG EVER	VVA
3220	26727247.10	795713.89	2002.11	VVA47 NG BUSH	VVA
3221	26718952.37	817868.86	1817.05	VVA28 NG EVER	VVA
3222	26718965.17	817943.79	1814.78	VVA28 NG DEC	VVA
3223	26719028.24	817965.67	1813.57	VVA28 NG DEC	VVA
3224	26743764.85	803650.47	1829.45	VVA7 NG BUSH	VVA
3225	26743735.61	803813.71	1826.85	VVA7 NG DEC	VVA
4101	26744319.44	697156.72	3832.74	VVA41 NG TREE	VVA
4102	26744291.17	697142.72	3832.75	VVA41 NG TREE	VVA
4105	26758858.44	704353.26	3712.64	VVA34 NG BUSH	VVA
4106	26758868.83	704331.18	3713.64	VVA34 NG BUSH	VVA
4108	26709503.86	794917.50	2162.14	NVA58 MAG	NVA
4109	26709456.35	794171.77	2160.67	VVA12 NG BUSH	VVA
4110	26709459.39	794193.99	2161.10	VVA12 NG BUSH	VVA
4111	26709451.55	794133.86	2160.86	VVA12 NG TREE	VVA
4112	26695479.96	803120.08	2555.98	NVA59 MAG	NVA
4113	26695595.73	803001.67	2555.92	VVA25 NG TREE	VVA
4114	26695577.62	803030.78	2557.48	VVA25 NG BUSH	VVA
4115	26695488.34	802936.59	2552.09	VVA25 NG TREE	VVA
4116	26695531.18	802934.91	2553.06	VVA25 NG TREE	VVA
4117	26676063.03	801963.65	3046.31	VVA03 NG TREE	VVA
4118	26676071.60	801934.64	3044.19	VVA03 NG TREE	VVA
4119	26676031.20	801929.48	3047.38	VVA03 NG TREE	VVA
4120	26738346.79	874797.00	1469.07	NVA63 MAG	NVA
4121	26738292.69	874733.32	1472.37	VVA38 NG BUSH	VVA
4122	26738299.41	874725.93	1472.32	VVA38 NG BUSH	VVA
4123	26709878.94	879645.33	1970.00	NVA61 6OD NAIL	NVA
4124	26709824.81	879625.51	1972.40	VVA36 NG BUSH	VVA
4125	26709843.85	879611.89	1973.25	VVA36 NG GRASS	VVA
4201	26707311.82	846723.05	2092.29	VVA24 NG DEC	VVA
4202	26707345.48	846642.84	2092.00	VVA24 NG BUSH	VVA
4204	26707188.83	846680.92	2090.35	NVA57 MAG PS	NVA
4205	26697379.59	832873.42	2524.55	VVA5 NG DEC	VVA
4206	26697412.68	832869.93	2523.56	VVA5 NG BUSH	VVA
4207	26677940.71	835414.64	2374.24	VVA37 NG BUSH	VVA
4208	26677899.05	835406.41	2374.10	NVA62 HUB	NVA
4212	26684149.17	876759.18	2222.76	VVA4 NG EVER	VVA
4214	26677177.76	894437.32	2111.14	VVA35 NG BUSH	VVA
4215	26677187.84	894444.96	2111.34	VVA35 NG BUSH	VVA
4216	26677132.05	894469.97	2111.55	VVA35 NG BUSH	VVA

4217	26690873.91	859982.13	2341.77	NVA60 CON AP	NVA
5101	26878395.11	873109.09	2028.03	VVA56 NG BUSH	VVA
5102	26878427.95	873090.23	2028.52	VVA56 NG BUSH	VVA
5103	26887297.36	860845.12	2056.24	VV050 NG TREE	VVA
5104	26887276.96	860883.04	2057.36	VVA50 NG BUSH	VVA
5105	26907779.70	873224.01	2588.55	VVA49 NG BUSH	VVA
5106	26907707.54	873225.79	2588.59	VVA49 NG BUSH	VVA
5107	26907699.73	873192.88	2589.68	VVA49 NG BUSH	VVA
5108	26862285.18	880232.21	2274.32	VVA52 NG BUSH	VVA
5109	26862270.67	880162.91	2276.12	VVA52 NG BUSH	VVA
5110	26862174.33	880158.54	2275.40	VVA52 NG GRASS	VVA
5201	26864798.08	822123.65	3568.05	GVA09 ALCAP	NVA
5202	26864797.04	822048.82	3569.51	VVA54 NG JOSH	VVA
5203	26864823.87	822055.93	3570.96	VVA54 NG BUSH	VVA
5204	26864805.38	822114.06	3568.83	VVA54 NG YUCCA	VVA
5205	26858160.13	842046.72	2576.45	VVA53 NG YUCCA	VVA
5206	26858182.24	842060.78	2576.24	VVA53 NG BUSH	VVA
5207	26858440.25	842148.54	2577.84	GVA07 MAG NAIL	NVA
5208	26843658.72	836148.11	2556.58	GVA04 60D NAIL	NVA
5209	26843708.25	836195.81	2553.79	VVA57 NG BUSH	VVA
5210	26843679.16	836255.87	2551.42	VVA57 NG YUCCA	VVA
5211	26817863.73	857216.27	2571.81	VVA51 NG TAM	VVA
5212	26817900.64	857167.97	2571.98	VVA51 NG TAM	VVA
5213	26817900.00	857187.47	2572.53	VVA51 NG BUSH	VVA

NVA Checkpoints

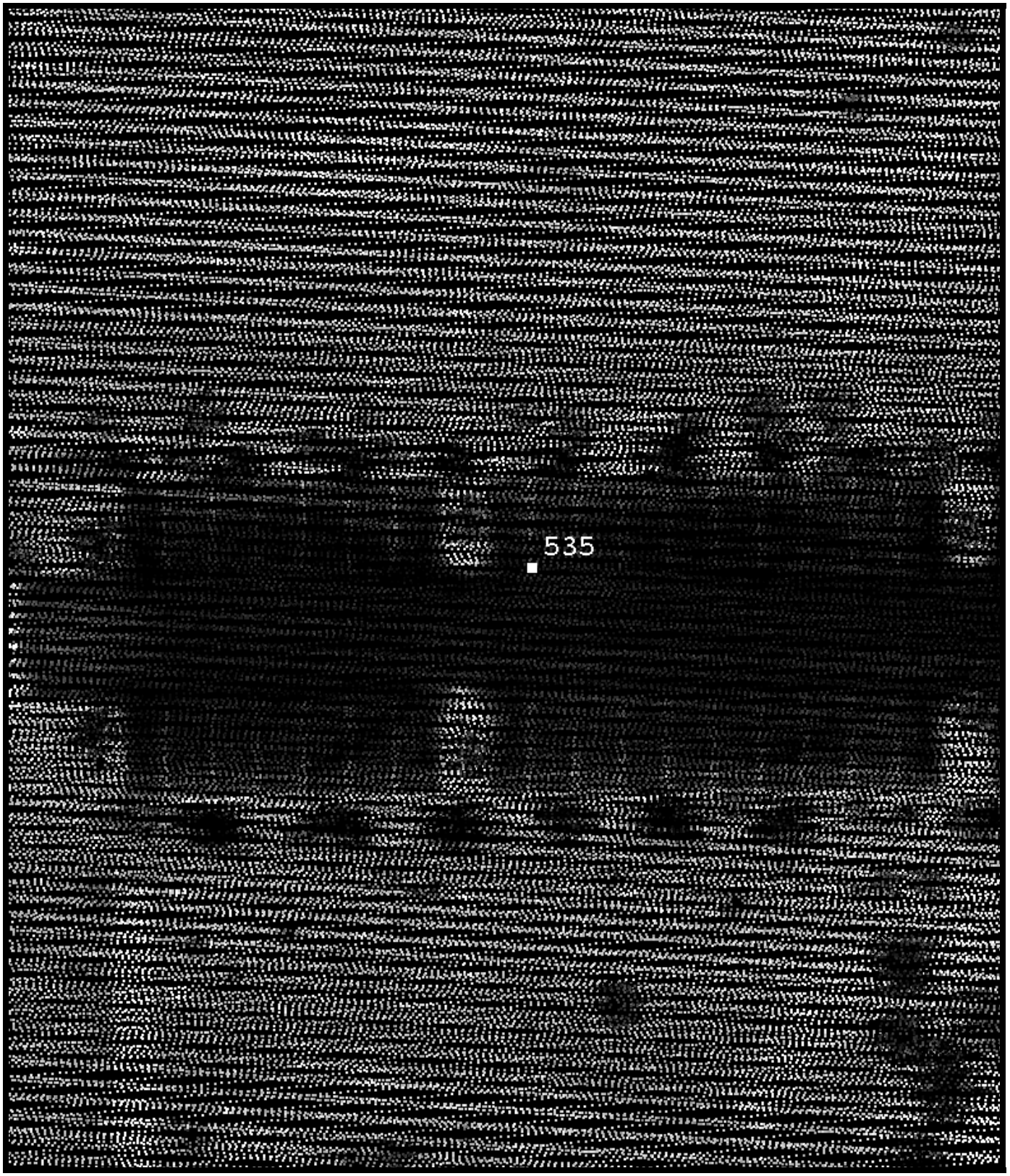


NVA Checkpoints

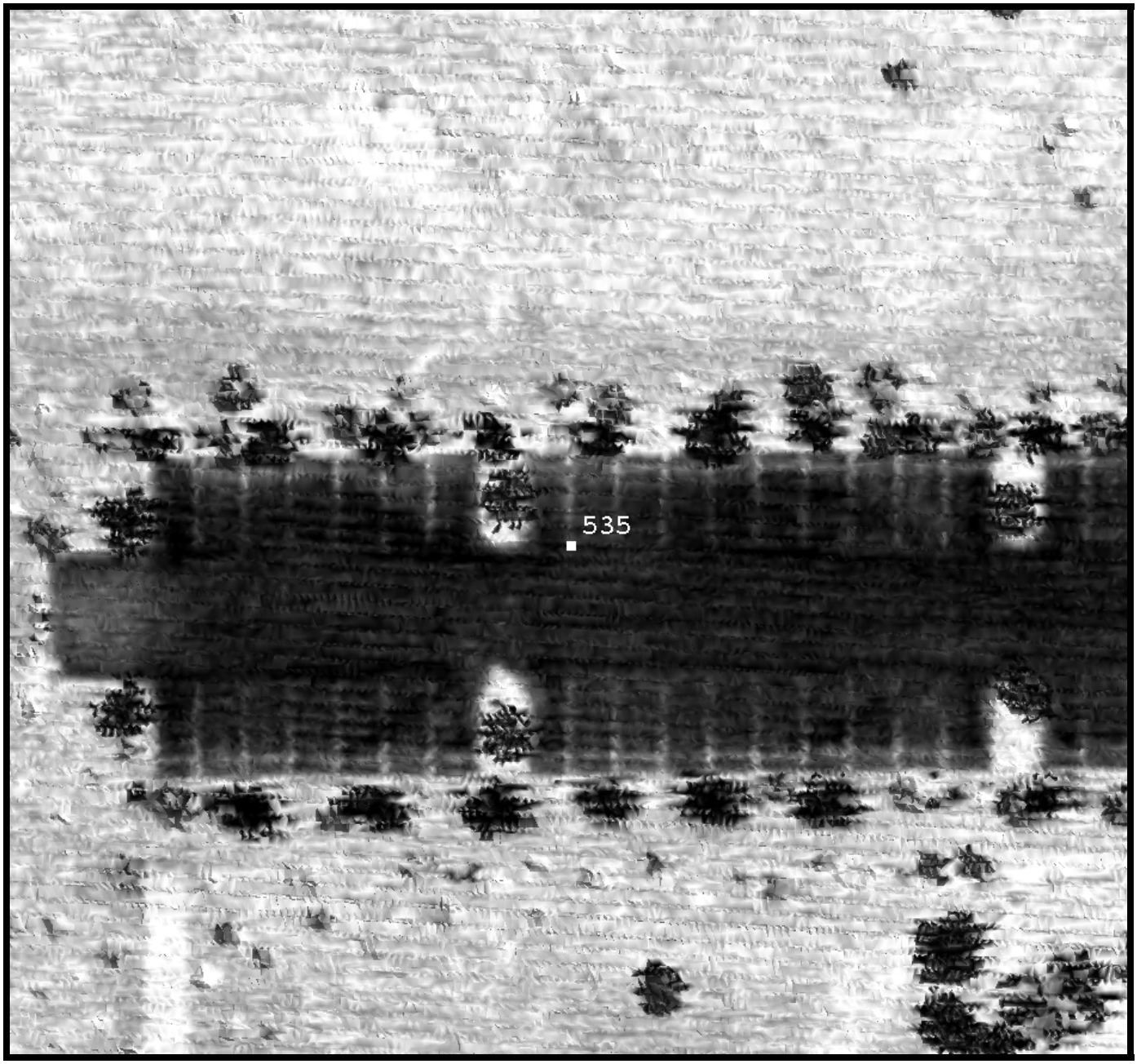


Horizontal Check for Ground Point 535 matching LiDAR control points
Picture of point 535

Horizontal Check for Ground Point 535 matching LiDAR control points



Horizontal Check for Ground Point 535 matching LiDAR control points (Detail TIN)



LiDAR Checkpoint Report

This LiDAR data set was tested to meet ASPRS Positional Accuracy Standards for Digital Geospatial Data (2014) for a 10.0 cm RMSEz Vertical Accuracy Class. Actual NVA accuracy was found to be RMSEz = 4.1 cm, equating to +/- 8.0 cm at 95% confidence level. Actual VVA accuracy was found to be +/- 26.6 cm at the 95th percentile.

Filtered Checkpoint Report for NVA and VVA Points

The following table illustrates the results of the LiDAR data compared to the LiDAR checkpoints (NVA and VVA). The listing is sorted by the **Z Error** column showing, in ascending order, the vertical difference between the LiDAR points and the surveyed ground points.Points are grouped by NVA and VVA

Project Data Unit: U.S. Survey Foot
Vertical Accuracy Class tested: 10.0-cm
Elevation Calculation Method: Interpolated from TIN
LiDAR Classifications Included: 2
Check Points in Report: 266
Check Points with LiDAR Coverage: 265
Check Points (NVA): 61
Check Points (VVA): 204
Average Vertical Error Reported: -0.074 U.S. Survey Foot
Maximum (highest) Vertical Error Reported: 0.129 U.S. Survey Foot
Median Vertical Error Reported: -0.062 U.S. Survey Foot
Minimum (lowest) Vertical Error Reported: -0.437 U.S. Survey Foot
Standard deviation of Vertical Error: 0.113 U.S. Survey Foot
Skewness of Vertical Error: -0.438
Kurtosis of Vertical Error: 0.352
Non-vegetated Vertical Accuracy (NVA) RMSE(z): 4.097cm PASS
Non-vegetated Vertical Accuracy (NVA) at the 95% Confidence Level +/-: 8.031cm PASS
Vegetated Vertical Accuracy (VVA) at the 95th Percentile +/-: 26.585cm PASS
FGDC/NSSDA Vertical Accuracy at the 95% Confidence Level +/-: 8.031cm
This data set was tested to meet ASPRS Positional Accuracy Standard for Digital Geospatial Data (2014) for a 10.0 cm RMSEz Vertical Accuracy Class. Actual NVA accuracy was found to be RMSEz = 4.097 cm equating to +/- 8.031cm at the 95% confidence level. Actual VVA accuracy was found to be +/- 26.585cm at the 95th percentile.

Control	Control Pt	Control Pt	Cover	Control Pt	Z from	NVA	**Z Error**	Min.	Median	Max.
Point Id	X (East)	Y (North)		Z (Elev)	LiDAR	or		Z	Z	Z
	USFeet	USFeet		USFeet	USFeet	VVA	**USFeet**	USFeet	USFeet	USFeet
2208	795058.66	26786889.96	Yes	1911.58	1911.14	NVA	**-0.44**	1911.12	1911.21	1911.21
4208	835406.41	26677899.05	Yes	2374.10	2373.83	NVA	**-0.28**	2373.75	2373.82	2373.84
22	734371.11	26707446.63	Yes	2966.79	2966.55	NVA	**-0.24**	2966.55	2966.55	2966.58
29	699819.48	26725710.63	Yes	3544.09	3543.85	NVA	**-0.24**	3543.77	3543.80	3543.92
14	722890.65	26768680.94	Yes	3421.28	3421.04	NVA	**-0.24**	3421.00	3421.05	3421.13
4108	794917.50	26709503.86	Yes	2162.14	2161.92	NVA	**-0.23**	2161.86	2161.88	2161.99
4112	803120.08	26695479.96	Yes	2555.98	2555.76	NVA	**-0.22**	2555.75	2555.78	2555.79
18	831092.06	26696248.06	Yes	2616.86	2616.65	NVA	**-0.21**	2616.54	2616.68	2616.70

12	705653.59	26822712.61	Yes	3691.98	3691.78	NVA	**-0.21**	3691.75	3691.75	3691.80
4217	859982.13	26690873.91	Yes	2341.77	2341.57	NVA	**-0.20**	2341.45	2341.46	2341.61
20	803132.26	26675799.34	Yes	3099.96	3099.76	NVA	**-0.20**	3099.75	3099.75	3099.76
15	731305.43	26738057.60	Yes	2853.81	2853.64	NVA	**-0.17**	2853.62	2853.63	2853.70
7	804377.26	26808444.21	Yes	2147.99	2147.82	NVA	**-0.17**	2147.81	2147.82	2147.84
10	733155.02	26820495.56	Yes	2902.44	2902.28	NVA	**-0.16**	2902.26	2902.28	2902.29
21	768910.13	26670938.14	Yes	2821.59	2821.43	NVA	**-0.16**	2821.41	2821.43	2821.44
4204	846680.92	26707188.83	Yes	2090.35	2090.19	NVA	**-0.16**	2090.15	2090.22	2090.22
3	751171.77	26775355.49	Yes	2419.81	2419.66	NVA	**-0.15**	2419.63	2419.69	2419.69
3206	793951.25	26755068.03	Yes	1877.33	1877.19	NVA	**-0.14**	1877.05	1877.11	1877.30
33	750598.76	26696026.78	Yes	2689.55	2689.43	NVA	**-0.12**	2689.35	2689.44	2689.45
30	894264.79	26677359.06	Yes	2120.67	2120.55	NVA	**-0.12**	2120.47	2120.58	2120.62
2204	776185.95	26805872.25	Yes	2241.73	2241.63	NVA	**-0.10**	2241.61	2241.62	2241.66
8	827588.74	26800920.50	Yes	1983.82	1983.72	NVA	**-0.10**	1983.68	1983.74	1983.76
23	704397.69	26758789.24	Yes	3708.94	3708.84	NVA	**-0.10**	3708.84	3708.84	3708.89
31	821846.56	26752024.38	Yes	1804.49	1804.39	NVA	**-0.10**	1804.38	1804.41	1804.43
2111	756191.53	26797674.92	Yes	2329.12	2329.03	NVA	**-0.10**	2329.02	2329.03	2329.06
17	821275.56	26709953.39	Yes	2102.18	2102.09	NVA	**-0.09**	2102.03	2102.10	2102.18
4	732311.13	26808495.35	Yes	2959.06	2958.98	NVA	**-0.08**	2958.94	2959.00	2959.02
6	776211.97	26783976.40	Yes	2170.29	2170.22	NVA	**-0.07**	2170.21	2170.24	2170.26
2213	811148.08	26788244.54	Yes	1865.99	1865.92	NVA	**-0.07**	1865.83	1865.91	1865.93
3208	781879.17	26742925.64	Yes	2062.69	2062.62	NVA	**-0.07**	2062.55	2062.61	2062.63
13	770303.88	26725511.13	Yes	2309.60	2309.54	NVA	**-0.06**	2309.48	2309.59	2309.65
5	767887.20	26815838.10	Yes	2337.76	2337.70	NVA	**-0.06**	2337.69	2337.70	2337.70
1	803733.30	26743681.57	Yes	1831.84	1831.78	NVA	**-0.06**	1831.75	1831.76	1831.80
19	782133.21	26690415.03	Yes	2420.78	2420.73	NVA	**-0.06**	2420.71	2420.74	2420.77
9	822534.55	26768595.73	Yes	1990.70	1990.65	NVA	**-0.05**	1990.61	1990.65	1990.65
2205	776169.15	26805823.20	Yes	2241.78	2241.73	NVA	**-0.05**	2241.72	2241.72	2241.75
3123	762020.06	26751468.45	Yes	2290.55	2290.50	NVA	**-0.05**	2290.46	2290.54	2290.66
3101	715670.09	26748285.19	Yes	3362.47	3362.42	NVA	**-0.05**	3362.39	3362.40	3362.44
16	850320.16	26726259.36	Yes	1937.31	1937.27	NVA	**-0.04**	1937.27	1937.27	1937.29
2101	780665.76	26771645.65	Yes	2055.82	2055.78	NVA	**-0.04**	2055.67	2055.79	2055.80
5208	836148.11	26843658.72	Yes	2556.58	2556.55	NVA	**-0.03**	2556.52	2556.55	2556.56
26	876702.20	26684080.69	Yes	2220.24	2220.21	NVA	**-0.03**	2220.18	2220.21	2220.27
35	880656.10	26861582.06	Yes	2279.04	2279.01	NVA	**-0.03**	2279.01	2279.01	2279.08
25	697269.85	26744261.87	Yes	3828.80	3828.78	NVA	**-0.02**	3828.75	3828.77	3828.81
28	869705.39	26790125.68	Yes	2009.23	2009.23	NVA	**0.00**	2009.16	2009.25	2009.35
3114	763865.40	26710639.21	Yes	2433.52	2433.53	NVA	**0.01**	2433.52	2433.52	2433.54
5207	842148.54	26858440.25	Yes	2577.84	2577.85	NVA	**0.01**	2577.73	2577.86	2577.87
11	860631.71	26754875.81	Yes	1396.85	1396.88	NVA	**0.03**	1396.86	1396.89	1396.98
4120	874797.00	26738346.79	Yes	1469.07	1469.10	NVA	**0.03**	1468.96	1469.09	1469.11
2	718636.87	26839375.53	Yes	2956.01	2956.05	NVA	**0.04**	2956.01	2956.05	2956.05

2124	730328.18	26782494.33	Yes	2923.52	2923.58	NVA	**0.06**	2923.55	2923.61	2923.62
3119	745961.69	26740889.07	Yes	2532.07	2532.13	NVA	**0.06**	2532.08	2532.15	2532.16
36	872291.27	26876242.71	Yes	2012.80	2012.86	NVA	**0.06**	2012.82	2012.89	2012.90
4123	879645.33	26709878.94	Yes	1970.00	1970.07	NVA	**0.07**	1970.01	1970.01	1970.08
38	884169.44	26892253.51	Yes	2247.72	2247.79	NVA	**0.07**	2247.77	2247.80	2247.81
34	859545.76	26841381.82	Yes	2201.70	2201.77	NVA	**0.07**	2201.76	2201.82	2201.83
37	871739.45	26906957.72	Yes	2607.83	2607.90	NVA	**0.07**	2607.84	2607.87	2607.94
42	841493.81	26877544.72	Yes	2746.24	2746.31	NVA	**0.07**	2746.30	2746.31	2746.52
5201	822123.65	26864798.08	Yes	3568.05	3568.18	NVA	**0.13**	3568.08	3568.13	3568.27
24	859996.78	26812871.65	Yes	2485.64	2485.77	NVA	**0.13**	2485.69	2485.78	2485.82
27	844802.74	26815875.26	Yes	2356.05	2356.18	NVA	**0.13**	2356.16	2356.18	2356.18
32	697499.37	26804112.67	No	4465.86		NVA				
3214	793562.70	26726921.19	Yes	2028.61	2027.85	VVA	**-0.76**	2027.73	2027.85	2027.89
1017	831481.03	26734030.34	Yes	1545.73	1545.01	VVA	**-0.72**	1544.99	1545.06	1545.18
1035	836909.87	26735103.32	Yes	1512.28	1511.59	VVA	**-0.69**	1511.22	1511.33	1511.70
1042	837700.54	26735372.23	Yes	1508.01	1507.37	VVA	**-0.64**	1506.96	1507.36	1507.88
4111	794133.86	26709451.55	Yes	2160.86	2160.40	VVA	**-0.46**	2160.35	2160.44	2160.55
3221	817868.86	26718952.37	Yes	1817.05	1816.61	VVA	**-0.44**	1816.59	1816.59	1816.69
3105	708443.48	26719358.54	Yes	3378.71	3378.31	VVA	**-0.41**	3378.12	3378.34	3378.37
4110	794193.99	26709459.39	Yes	2161.10	2160.75	VVA	**-0.35**	2160.70	2160.72	2160.80
3203	822104.32	26769727.25	Yes	1947.97	1947.62	VVA	**-0.35**	1947.36	1947.89	1948.54
3107	708397.54	26719042.00	Yes	3385.77	3385.45	VVA	**-0.32**	3385.41	3385.45	3385.45
2123	705678.58	26822795.83	Yes	3684.00	3683.68	VVA	**-0.32**	3682.15	3683.59	3683.77
3209	781896.98	26742939.24	Yes	2062.66	2062.40	VVA	**-0.26**	2062.30	2062.34	2062.77
4206	832869.93	26697412.68	Yes	2523.56	2523.30	VVA	**-0.26**	2523.10	2523.36	2523.43
3225	803813.71	26743735.61	Yes	1826.85	1826.59	VVA	**-0.26**	1826.30	1826.53	1826.72
3103	699908.04	26725689.08	Yes	3539.21	3538.96	VVA	**-0.26**	3538.93	3538.94	3539.37
2117	731198.72	26808117.34	Yes	2999.44	2999.19	VVA	**-0.25**	2998.88	2999.20	2999.37
2216	805127.32	26769277.43	Yes	1786.73	1786.49	VVA	**-0.24**	1786.47	1786.50	1786.59
3112	759270.31	26699922.26	Yes	2529.55	2529.31	VVA	**-0.24**	2529.24	2529.27	2529.45
4116	802934.91	26695531.18	Yes	2553.06	2552.82	VVA	**-0.24**	2552.78	2552.78	2552.86
1075	832587.04	26734437.61	Yes	1538.16	1537.95	VVA	**-0.21**	1537.94	1537.95	1538.01
3111	759280.88	26699919.02	Yes	2528.27	2528.07	VVA	**-0.21**	2527.81	2528.26	2528.45
3202	822239.64	26769987.94	Yes	1951.10	1950.91	VVA	**-0.19**	1950.85	1950.95	1950.96
3212	793819.11	26726906.39	Yes	2024.17	2023.99	VVA	**-0.19**	2023.80	2023.85	2024.03
1019	831488.86	26734065.67	Yes	1545.56	1545.38	VVA	**-0.18**	1545.27	1545.28	1545.42
1025	833994.82	26734023.86	Yes	1527.81	1527.64	VVA	**-0.17**	1526.89	1527.79	1527.96
1006	823359.24	26737654.76	Yes	1604.60	1604.43	VVA	**-0.17**	1604.41	1604.46	1604.49
1018	831488.97	26733964.84	Yes	1545.06	1544.90	VVA	**-0.16**	1544.85	1545.03	1545.27
2116	748451.15	26812577.82	Yes	2481.19	2481.03	VVA	**-0.16**	2480.73	2481.07	2481.11
1023	832992.81	26733952.08	Yes	1534.26	1534.11	VVA	**-0.15**	1534.04	1534.12	1534.15

4215	894444.96	26677187.84	Yes	2111.34	2111.20	VVA	**-0.14**	2111.11	2111.12	2111.35
1026	833958.22	26734014.66	Yes	1527.69	1527.55	VVA	**-0.14**	1527.51	1527.56	1527.56
3201	822180.06	26769930.52	Yes	1947.56	1947.42	VVA	**-0.14**	1947.19	1947.39	1947.55
4113	803001.67	26695595.73	Yes	2555.92	2555.80	VVA	**-0.12**	2555.78	2555.80	2556.30
3222	817943.79	26718965.17	Yes	1814.78	1814.66	VVA	**-0.12**	1814.46	1814.64	1814.78
1001	822561.31	26738521.31	Yes	1623.31	1623.20	VVA	**-0.12**	1623.06	1623.20	1623.29
3223	817965.67	26719028.24	Yes	1813.57	1813.46	VVA	**-0.11**	1813.39	1813.42	1813.58
2114	756309.88	26797686.01	Yes	2327.42	2327.31	VVA	**-0.11**	2327.18	2327.24	2327.35
1071	832781.20	26734557.76	Yes	1536.06	1535.97	VVA	**-0.09**	1535.84	1535.86	1536.37
1005	823329.94	26737613.68	Yes	1604.40	1604.31	VVA	**-0.09**	1604.25	1604.31	1604.36
1066	834700.71	26734911.34	Yes	1525.96	1525.87	VVA	**-0.09**	1525.82	1525.87	1525.95
2211	795003.17	26786942.99	Yes	1910.51	1910.42	VVA	**-0.09**	1910.38	1910.45	1910.46
1008	822722.06	26736865.61	Yes	1600.45	1600.36	VVA	**-0.09**	1600.33	1600.36	1600.38
3220	795713.89	26727247.10	Yes	2002.11	2002.04	VVA	**-0.08**	2001.78	2002.23	2002.32
1070	833755.48	26734721.83	Yes	1529.01	1528.94	VVA	**-0.08**	1528.80	1529.03	1529.18
4212	876759.18	26684149.17	Yes	2222.76	2222.69	VVA	**-0.08**	2222.66	2222.72	2222.76
3210	781887.67	26743066.78	Yes	2061.97	2061.90	VVA	**-0.07**	2061.83	2061.88	2061.95
3216	795310.65	26727336.00	Yes	2005.04	2004.98	VVA	**-0.06**	2004.78	2005.06	2005.13
5102	873090.23	26878427.95	Yes	2028.52	2028.46	VVA	**-0.06**	2028.38	2028.49	2028.61
4201	846723.05	26707311.82	Yes	2092.29	2092.24	VVA	**-0.05**	2092.19	2092.25	2092.30
1032	836744.45	26734932.96	Yes	1512.17	1512.12	VVA	**-0.05**	1512.09	1512.12	1512.13
1040	837548.39	26735285.66	Yes	1510.14	1510.09	VVA	**-0.05**	1510.04	1510.07	1510.48
1064	834888.33	26735125.27	Yes	1523.13	1523.08	VVA	**-0.05**	1522.76	1523.02	1523.16
3104	699871.98	26725729.41	Yes	3540.08	3540.03	VVA	**-0.05**	3539.78	3540.07	3540.39
4125	879611.89	26709843.85	Yes	1973.25	1973.21	VVA	**-0.04**	1973.14	1973.19	1973.25
1020	832973.57	26733862.82	Yes	1534.23	1534.20	VVA	**-0.03**	1534.19	1534.19	1534.21
2203	766903.16	26815985.70	Yes	2341.08	2341.05	VVA	**-0.03**	2340.70	2341.15	2341.17
2210	795019.14	26786924.79	Yes	1910.83	1910.80	VVA	**-0.03**	1910.52	1911.00	1911.02
1037	836746.48	26734901.93	Yes	1513.73	1513.70	VVA	**-0.03**	1513.37	1513.58	1513.71
3128	779741.99	26689266.47	Yes	2458.23	2458.20	VVA	**-0.03**	2458.18	2458.22	2458.24
2121	705643.48	26822704.67	Yes	3692.99	3692.96	VVA	**-0.03**	3692.87	3692.90	3693.03
3125	762148.38	26751615.87	Yes	2288.21	2288.19	VVA	**-0.02**	2288.18	2288.20	2288.37
4115	802936.59	26695488.34	Yes	2552.09	2552.07	VVA	**-0.02**	2551.93	2551.94	2552.28
2103	780716.17	26771674.53	Yes	2055.28	2055.26	VVA	**-0.02**	2055.22	2055.27	2055.32
4118	801934.64	26676071.60	Yes	3044.19	3044.17	VVA	**-0.02**	3043.95	3044.19	3044.20
1051	844913.50	26737887.89	Yes	1473.73	1473.71	VVA	**-0.02**	1473.67	1473.69	1473.83
2207	776167.05	26805856.78	Yes	2241.89	2241.88	VVA	**-0.01**	2241.80	2241.82	2241.89
1028	833796.77	26734043.88	Yes	1527.29	1527.28	VVA	**-0.01**	1527.25	1527.25	1527.44
2212	795062.97	26786895.71	Yes	1910.68	1910.67	VVA	**-0.01**	1910.23	1910.79	1910.80
1034	836742.75	26734946.06	Yes	1512.64	1512.63	VVA	**-0.01**	1512.50	1512.61	1512.67
3215	795193.30	26727348.18	Yes	2006.73	2006.73	VVA	**-0.01**	2006.69	2006.73	2006.77
3116	763935.06	26710801.31	Yes	2433.87	2433.87	VVA	**-0.01**	2433.82	2433.89	2433.96

2129	732669.21	26762278.64	Yes	2976.13	2976.13	VVA	**0.00**	2976.05	2976.11	2976.27
3108	740687.99	26715238.69	Yes	2820.78	2820.78	VVA	**0.00**	2820.73	2820.75	2821.01
1069	833717.96	26734732.58	Yes	1530.60	1530.60	VVA	**0.00**	1530.24	1530.50	1530.81
1068	833729.44	26734712.56	Yes	1529.58	1529.59	VVA	**0.01**	1529.55	1529.57	1529.65
3213	793579.96	26726978.36	Yes	2026.59	2026.60	VVA	**0.01**	2026.58	2026.78	2027.15
4106	704331.18	26758868.83	Yes	3713.64	3713.65	VVA	**0.01**	3713.62	3713.68	3713.73
1046	838136.00	26735367.63	Yes	1503.45	1503.46	VVA	**0.01**	1503.28	1503.51	1503.55
3115	763919.81	26710804.12	Yes	2434.16	2434.17	VVA	**0.01**	2433.91	2434.52	2434.65
2128	732663.71	26762273.98	Yes	2976.14	2976.15	VVA	**0.01**	2976.07	2976.16	2976.17
2133	751213.55	26775814.19	Yes	2410.38	2410.40	VVA	**0.02**	2410.14	2410.37	2410.50
2113	756264.59	26797737.41	Yes	2328.75	2328.77	VVA	**0.02**	2328.71	2328.78	2328.79
1022	833008.96	26733901.87	Yes	1534.63	1534.66	VVA	**0.03**	1534.55	1534.71	1534.71
3217	795251.89	26727389.61	Yes	2006.28	2006.31	VVA	**0.03**	2006.27	2006.31	2006.34
3124	762182.69	26751616.65	Yes	2287.59	2287.64	VVA	**0.05**	2287.60	2287.60	2287.69
3109	740582.67	26715236.63	Yes	2822.63	2822.69	VVA	**0.06**	2822.66	2822.70	2822.76
3113	759225.72	26699946.72	Yes	2530.83	2530.90	VVA	**0.07**	2530.70	2531.05	2531.27
5210	836255.87	26843679.16	Yes	2551.42	2551.49	VVA	**0.07**	2551.13	2551.52	2551.73
2109	776423.77	26783984.52	Yes	2169.44	2169.51	VVA	**0.07**	2169.22	2169.84	2170.19
3204	793727.13	26755196.96	Yes	1881.50	1881.58	VVA	**0.08**	1881.49	1881.55	1881.61
4105	704353.26	26758858.44	Yes	3712.64	3712.72	VVA	**0.08**	3712.51	3712.66	3712.85
5107	873192.88	26907699.73	Yes	2589.68	2589.77	VVA	**0.09**	2589.70	2589.85	2589.88
1007	823413.48	26737667.64	Yes	1604.78	1604.87	VVA	**0.09**	1604.77	1604.87	1605.08
3120	745889.98	26740933.74	Yes	2535.99	2536.08	VVA	**0.09**	2536.03	2536.06	2536.50
1050	840462.74	26736273.75	Yes	1485.41	1485.50	VVA	**0.09**	1485.28	1485.56	1485.63
3219	795745.78	26727328.99	Yes	2000.36	2000.46	VVA	**0.10**	2000.38	2000.47	2000.63
1029	835504.65	26734190.97	Yes	1544.96	1545.07	VVA	**0.11**	1544.75	1545.42	1545.45
2130	732641.19	26762388.43	Yes	2975.73	2975.84	VVA	**0.11**	2975.82	2975.87	2975.87
3205	793672.56	26755400.60	Yes	1883.84	1883.95	VVA	**0.11**	1883.93	1883.97	1883.99
5205	842046.72	26858160.13	Yes	2576.45	2576.57	VVA	**0.12**	2576.41	2576.47	2577.05
4109	794171.77	26709456.35	Yes	2160.67	2160.79	VVA	**0.12**	2160.69	2160.87	2160.94
5101	873109.09	26878395.11	Yes	2028.03	2028.16	VVA	**0.13**	2028.04	2028.15	2028.22
2125	730158.99	26782521.37	Yes	2929.99	2930.12	VVA	**0.13**	2930.05	2930.12	2930.15
4122	874725.93	26738299.41	Yes	1472.32	1472.45	VVA	**0.13**	1471.99	1472.32	1472.52
4117	801963.65	26676063.03	Yes	3046.31	3046.45	VVA	**0.14**	3046.13	3046.45	3046.50
2119	731250.54	26808001.32	Yes	2996.80	2996.94	VVA	**0.14**	2996.84	2996.93	2996.95
5202	822048.82	26864797.04	Yes	3569.51	3569.65	VVA	**0.14**	3569.42	3569.51	3569.80
3218	795666.28	26727304.88	Yes	2001.31	2001.45	VVA	**0.14**	2001.39	2001.50	2001.58
3110	740576.67	26715254.17	Yes	2822.87	2823.02	VVA	**0.15**	2822.91	2822.94	2823.13
1048	840470.88	26736259.44	Yes	1485.18	1485.33	VVA	**0.15**	1485.17	1485.33	1485.34
5106	873225.79	26907707.54	Yes	2588.59	2588.74	VVA	**0.15**	2588.66	2588.76	2589.09
1024	833018.18	26733973.73	Yes	1530.62	1530.78	VVA	**0.16**	1530.60	1530.82	1532.08
1063	834963.41	26735127.90	Yes	1524.30	1524.46	VVA	**0.16**	1524.21	1524.44	1524.53

1074	832612.78	26734457.78	Yes	1537.70	1537.87	VVA	**0.17**	1537.78	1537.94	1538.02
2217	805105.37	26769275.92	Yes	1786.66	1786.83	VVA	**0.17**	1786.52	1786.71	1787.31
3211	781927.05	26742897.79	Yes	2063.03	2063.20	VVA	**0.17**	2062.99	2063.18	2063.22
2115	748481.51	26812671.83	Yes	2479.20	2479.37	VVA	**0.17**	2479.18	2479.27	2479.43
2206	776220.01	26805768.44	Yes	2243.41	2243.59	VVA	**0.18**	2243.47	2243.58	2243.69
2126	730116.59	26782527.34	Yes	2930.91	2931.09	VVA	**0.18**	2930.62	2931.17	2931.24
2202	766929.67	26815984.76	Yes	2340.08	2340.26	VVA	**0.18**	2340.22	2340.32	2340.35
4102	697142.72	26744291.17	Yes	3832.75	3832.94	VVA	**0.19**	3832.73	3832.91	3833.02
4214	894437.32	26677177.76	Yes	2111.14	2111.33	VVA	**0.19**	2110.53	2110.89	2112.23
1041	837547.87	26735257.24	Yes	1510.10	1510.30	VVA	**0.20**	1510.10	1510.47	1510.60
2132	751206.89	26775809.55	Yes	2410.96	2411.16	VVA	**0.20**	2410.67	2411.20	2411.25
4216	894469.97	26677132.05	Yes	2111.55	2111.75	VVA	**0.20**	2111.26	2111.79	2111.87
3106	708453.58	26719381.56	Yes	3378.12	3378.32	VVA	**0.20**	3377.58	3378.32	3378.36
1031	835361.18	26734151.31	Yes	1532.89	1533.10	VVA	**0.21**	1532.89	1533.27	1533.28
2105	776423.79	26783984.51	Yes	2169.30	2169.51	VVA	**0.21**	2169.22	2169.84	2170.19
3224	803650.47	26743764.85	Yes	1829.45	1829.66	VVA	**0.21**	1829.61	1829.68	1829.68
5104	860883.04	26887276.96	Yes	2057.36	2057.57	VVA	**0.21**	2056.98	2057.72	2058.14
1065	834782.77	26734903.93	Yes	1528.86	1529.08	VVA	**0.22**	1529.03	1529.07	1529.21
2215	812774.16	26787353.56	Yes	1858.85	1859.07	VVA	**0.22**	1859.04	1859.08	1859.11
4205	832873.42	26697379.59	Yes	2524.55	2524.78	VVA	**0.23**	2524.63	2524.87	2524.87
4207	835414.64	26677940.71	Yes	2374.24	2374.47	VVA	**0.23**	2374.45	2374.58	2374.69
2214	812776.56	26787443.39	Yes	1859.78	1860.01	VVA	**0.23**	1859.80	1860.01	1860.19
5204	822114.06	26864805.38	Yes	3568.83	3569.06	VVA	**0.23**	3569.00	3569.03	3569.42
1009	822680.54	26736902.59	Yes	1601.23	1601.47	VVA	**0.24**	1601.27	1601.52	1601.65
1039	837570.99	26735287.12	Yes	1509.82	1510.06	VVA	**0.24**	1509.94	1510.09	1510.16
1014	828237.70	26733848.23	Yes	1569.56	1569.80	VVA	**0.24**	1569.73	1569.87	1569.93
3117	760656.82	26735240.17	Yes	2341.22	2341.46	VVA	**0.24**	2341.03	2341.18	2341.52
2134	751154.51	26775803.55	Yes	2412.40	2412.66	VVA	**0.26**	2412.54	2412.56	2417.15
1016	828369.60	26733861.78	Yes	1568.09	1568.36	VVA	**0.27**	1568.23	1568.48	1568.49
2110	776436.68	26784005.24	Yes	2169.03	2169.31	VVA	**0.28**	2168.99	2169.30	2169.58
3122	745867.31	26740926.48	Yes	2533.19	2533.47	VVA	**0.28**	2533.37	2533.48	2533.69
2122	705626.14	26822693.42	Yes	3692.82	3693.10	VVA	**0.28**	3692.73	3692.90	3693.28
4114	803030.78	26695577.62	Yes	2557.48	2557.76	VVA	**0.28**	2557.59	2557.63	2558.37
3121	745876.01	26740942.56	Yes	2536.43	2536.71	VVA	**0.28**	2536.43	2536.78	2537.01
4119	801929.48	26676031.20	Yes	3047.38	3047.67	VVA	**0.29**	3047.52	3047.68	3047.70
1049	840460.05	26736265.05	Yes	1485.11	1485.40	VVA	**0.29**	1485.28	1485.49	1485.56
5108	880232.21	26862285.18	Yes	2274.32	2274.61	VVA	**0.29**	2274.11	2274.15	2275.14
5105	873224.01	26907779.70	Yes	2588.55	2588.84	VVA	**0.29**	2588.65	2588.87	2589.00
1062	837506.62	26736001.00	Yes	1514.59	1514.89	VVA	**0.30**	1514.83	1514.96	1515.01
4124	879625.51	26709824.81	Yes	1972.40	1972.70	VVA	**0.30**	1972.64	1972.65	1972.78
1067	834664.66	26734928.15	Yes	1522.92	1523.22	VVA	**0.30**	1523.11	1523.30	1523.31
1021	832994.59	26733891.53	Yes	1534.65	1534.96	VVA	**0.31**	1534.85	1534.94	1535.03

2106	776436.73	26784005.22	Yes	2169.00	2169.31	VVA	**0.31**	2168.99	2169.30	2169.58
1043	838101.53	26735355.90	Yes	1505.94	1506.26	VVA	**0.32**	1505.43	1505.60	1506.41
5206	842060.78	26858182.24	Yes	2576.24	2576.56	VVA	**0.32**	2576.43	2576.62	2576.79
5203	822055.93	26864823.87	Yes	3570.96	3571.29	VVA	**0.33**	3571.24	3571.25	3571.37
4101	697156.72	26744319.44	Yes	3832.74	3833.07	VVA	**0.33**	3832.89	3833.07	3833.23
5209	836195.81	26843708.25	Yes	2553.79	2554.13	VVA	**0.34**	2554.10	2554.12	2554.16
5109	880162.91	26862270.67	Yes	2276.12	2276.46	VVA	**0.34**	2276.32	2276.35	2276.64
3118	760650.93	26735393.34	Yes	2340.95	2341.30	VVA	**0.35**	2340.89	2341.32	2341.79
1056	846294.73	26739612.91	Yes	1436.99	1437.37	VVA	**0.38**	1437.36	1437.37	1438.00
5213	857187.47	26817900.00	Yes	2572.53	2572.91	VVA	**0.38**	2572.85	2572.96	2573.02
1058	846197.88	26739611.17	Yes	1438.36	1438.77	VVA	**0.41**	1438.66	1438.70	1438.81
3126	762115.44	26751618.57	Yes	2288.16	2288.57	VVA	**0.41**	2288.49	2288.51	2288.64
1027	833827.31	26734084.38	Yes	1529.99	1530.41	VVA	**0.42**	1528.91	1530.17	1531.11
3127	779729.84	26689279.83	Yes	2458.12	2458.57	VVA	**0.45**	2458.52	2458.55	2458.57
2112	756240.99	26797673.10	Yes	2329.09	2329.55	VVA	**0.46**	2329.37	2329.45	2329.77
1002	822537.94	26738499.81	Yes	1623.04	1623.52	VVA	**0.48**	1623.25	1623.61	1623.80
4121	874733.32	26738292.69	Yes	1472.37	1472.85	VVA	**0.48**	1472.52	1472.91	1472.95
4202	846642.84	26707345.48	Yes	2092.00	2092.50	VVA	**0.50**	2092.07	2092.42	2092.62
1015	828352.64	26733849.55	Yes	1568.61	1569.11	VVA	**0.50**	1568.75	1569.10	1569.44
3129	779746.88	26689276.20	Yes	2458.08	2458.60	VVA	**0.52**	2458.59	2458.60	2458.62
1057	846261.77	26739633.64	Yes	1438.12	1438.65	VVA	**0.53**	1438.27	1438.87	1439.42
1073	832732.50	26734533.40	Yes	1536.86	1537.39	VVA	**0.53**	1537.24	1537.44	1537.48
1061	837561.75	26736015.26	Yes	1513.98	1514.52	VVA	**0.54**	1514.36	1514.75	1514.79
5110	880158.54	26862174.33	Yes	2275.40	2275.95	VVA	**0.55**	2275.57	2275.66	2276.53
2127	730075.16	26782439.22	Yes	2935.25	2935.82	VVA	**0.57**	2935.74	2935.80	2935.86
5212	857167.97	26817900.64	Yes	2571.98	2572.57	VVA	**0.59**	2572.50	2572.65	2572.78
1004	822562.72	26738529.31	Yes	1623.52	1624.11	VVA	**0.59**	1623.70	1623.95	1624.62
2201	766921.06	26815975.93	Yes	2339.48	2340.08	VVA	**0.60**	2339.21	2340.06	2340.12
1013	828251.50	26733854.85	Yes	1569.32	1569.93	VVA	**0.61**	1569.66	1570.02	1570.02
1030	835364.90	26734175.70	Yes	1532.12	1532.74	VVA	**0.62**	1532.27	1532.41	1533.47
5211	857216.27	26817863.73	Yes	2571.81	2572.53	VVA	**0.72**	2572.27	2572.59	2572.61
1045	838127.06	26735395.42	Yes	1495.70	1496.42	VVA	**0.72**	1495.70	1496.36	1496.43
1012	827919.58	26734517.53	Yes	1570.64	1571.36	VVA	**0.72**	1571.23	1571.34	1571.39
1055	846239.81	26739572.76	Yes	1438.54	1439.27	VVA	**0.73**	1439.09	1439.30	1439.44
1052	844926.59	26737908.29	Yes	1472.01	1472.75	VVA	**0.74**	1472.65	1472.92	1472.99
1047	838163.19	26735452.79	Yes	1494.32	1495.09	VVA	**0.77**	1494.93	1495.24	1495.69
1003	822538.70	26738524.88	Yes	1623.04	1623.86	VVA	**0.82**	1623.76	1623.82	1623.97
2118	731212.37	26807982.10	Yes	2998.13	2998.96	VVA	**0.83**	2998.78	2999.00	2999.05
1010	827915.71	26734542.49	Yes	1570.67	1571.55	VVA	**0.88**	1571.43	1571.56	1571.57
1011	827929.24	26734532.24	Yes	1570.57	1571.47	VVA	**0.90**	1571.46	1571.56	1571.59
1053	844908.53	26737997.38	Yes	1469.21	1470.22	VVA	**1.01**	1469.68	1470.47	1470.61
1072	832756.54	26734547.87	Yes	1536.10	1537.16	VVA	**1.06**	1536.36	1536.43	1537.89

1036	836969.59	26735107.07	Yes	1510.41	1511.49	VVA	**1.08**	1511.34	1511.63	1511.71
5103	860845.12	26887297.36	Yes	2056.24	2057.41	VVA	**1.17**	2056.94	2057.44	2057.73
1038	837589.36	26735354.18	Yes	1510.37	1511.58	VVA	**1.21**	1511.21	1511.46	1511.72
1060	837570.35	26736019.67	Yes	1514.18	1515.42	VVA	**1.24**	1514.98	1515.05	1516.27
1059	837603.92	26735999.81	Yes	1509.53	1510.81	VVA	**1.28**	1509.39	1510.26	1514.82
1077	832590.06	26734374.11	Yes	1538.18	1539.64	VVA	**1.46**	1539.44	1539.48	1539.87
2102	780675.15	26771683.07	Yes	2055.54	2057.97	VVA	**2.43**	2056.92	2057.80	2058.01

LiDAR CALIBRATION and BLOCK LAS OUTPUT with the Galaxy LiDAR SENSOR

Note: All figures represented on the following pages are for general illustration purposes, and are not examples derived from actual SNWA project data.

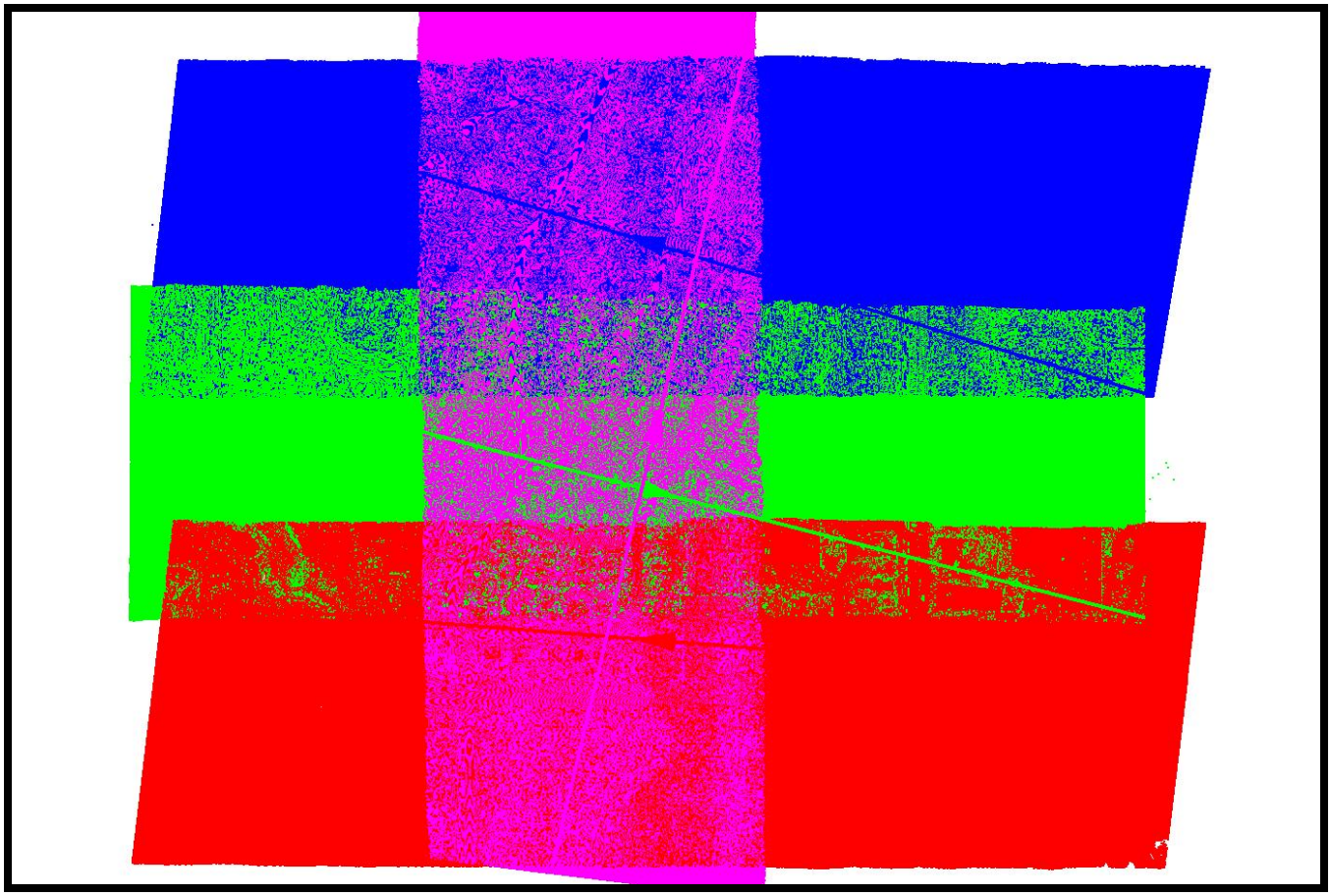
Introduction

LiDAR data is output as LAS point data using Optech's Lidar Mapping Suite (LMS). LMS matches ground and roof planes plus roof lines to self-calibrate and correct system biases. These biases occur within the hardware of the laser scanning systems, within the inertial measurement unit (IMU,) and because of environmental conditions which affect the refraction of light. The systemic biases that are corrected for include scale, roll, pitch, and heading.

In addition to the self-calibration mode LMS runs a "production" mode which applies the self-calibration parameters and then analyzes each individual flight line and applies small adjustments to each line to tie overlapping LiDAR points even more tightly together.

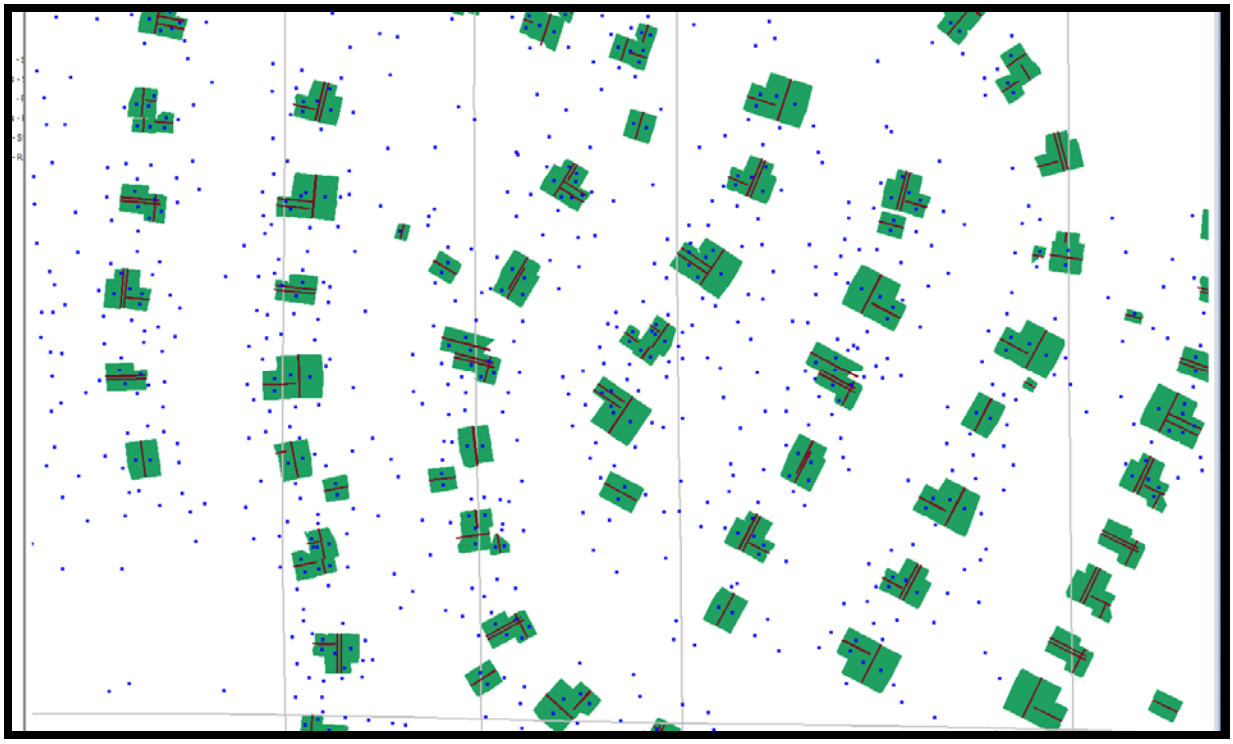
Boresight Self-Calibration Processing Procedures

An LMS boresight calibration is performed on an as-needed basis to correct scale, roll, pitch and heading biases. A minimum of three overlapping flights are flown in opposing directions with one cross flight.



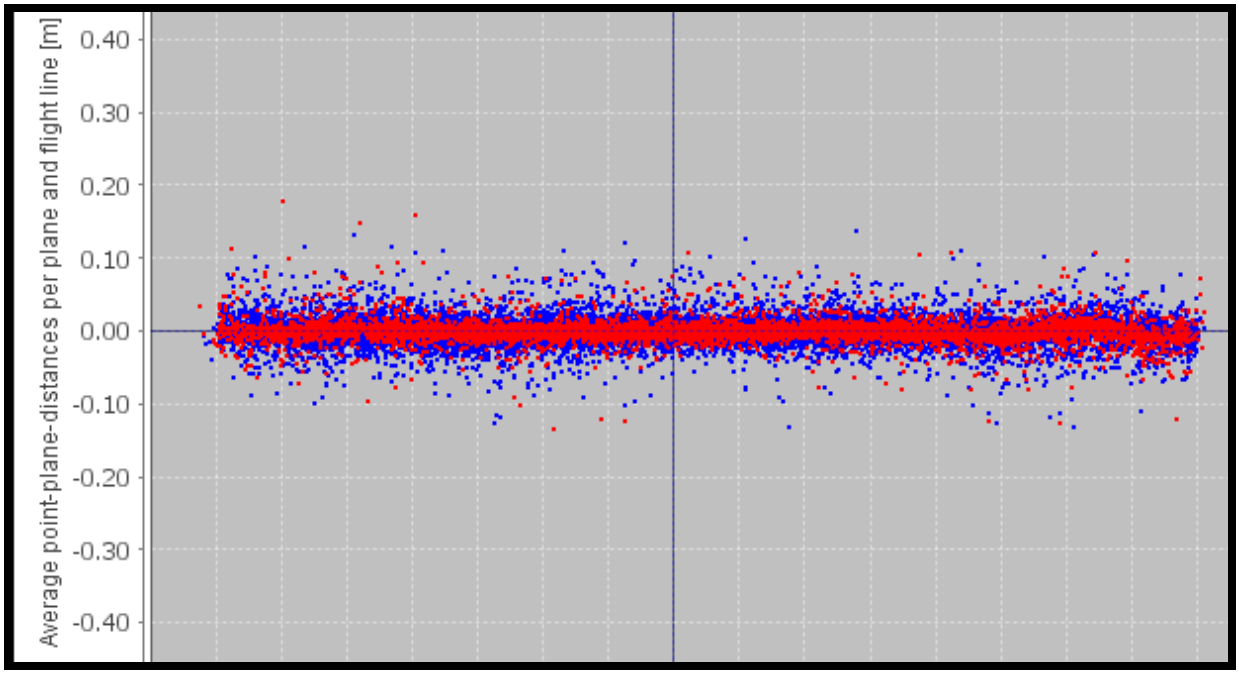
The Boresighting module frees scan angle scale, scan angle lag, XYZ boresight corrections and elevation position corrections while locking scan angle offset and XY position corrections.

The picked calibration site will have a good distribution of buildings for the self-calibration software to match ground planes, roof planes and roof lines.

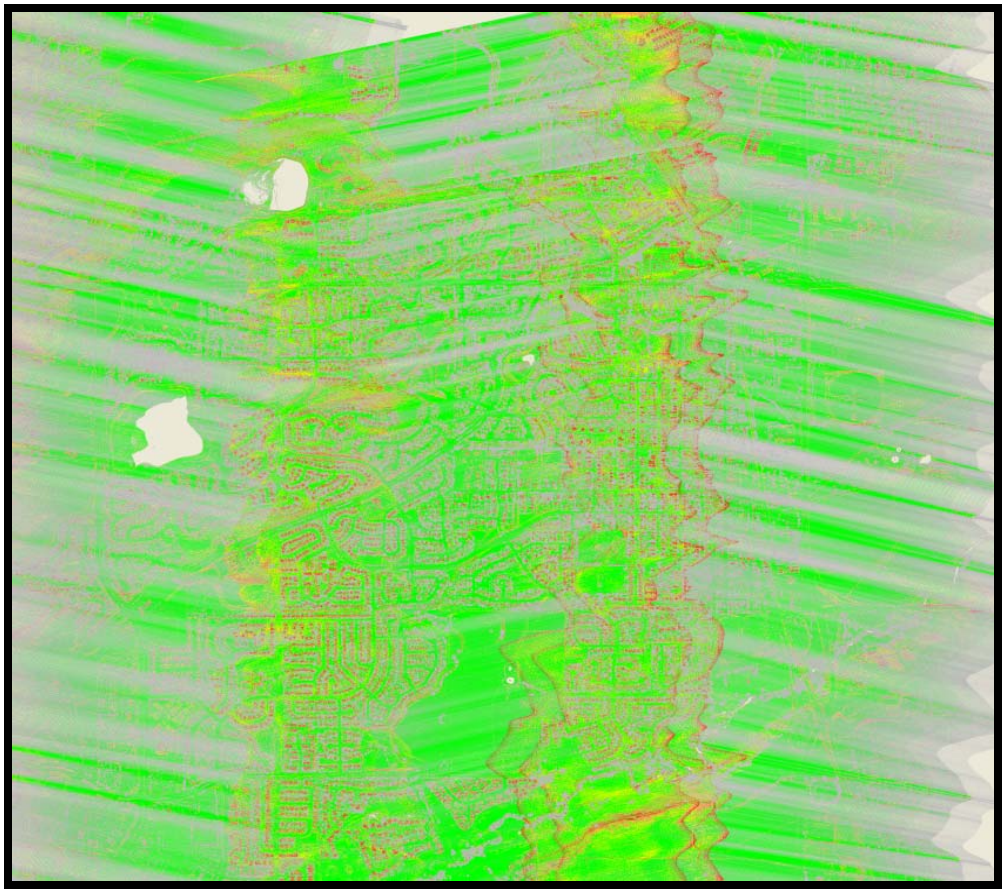


At the conclusion of the self-calibration run the data is quality checked with LMS plots.

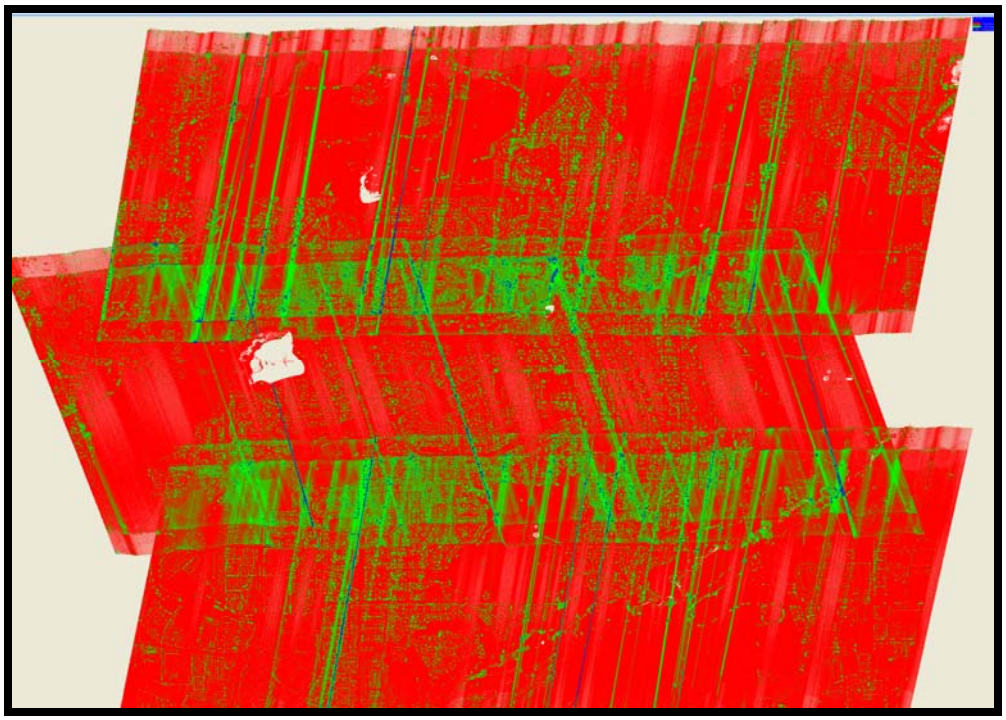
Plot of plane vertical distances from datum plane.



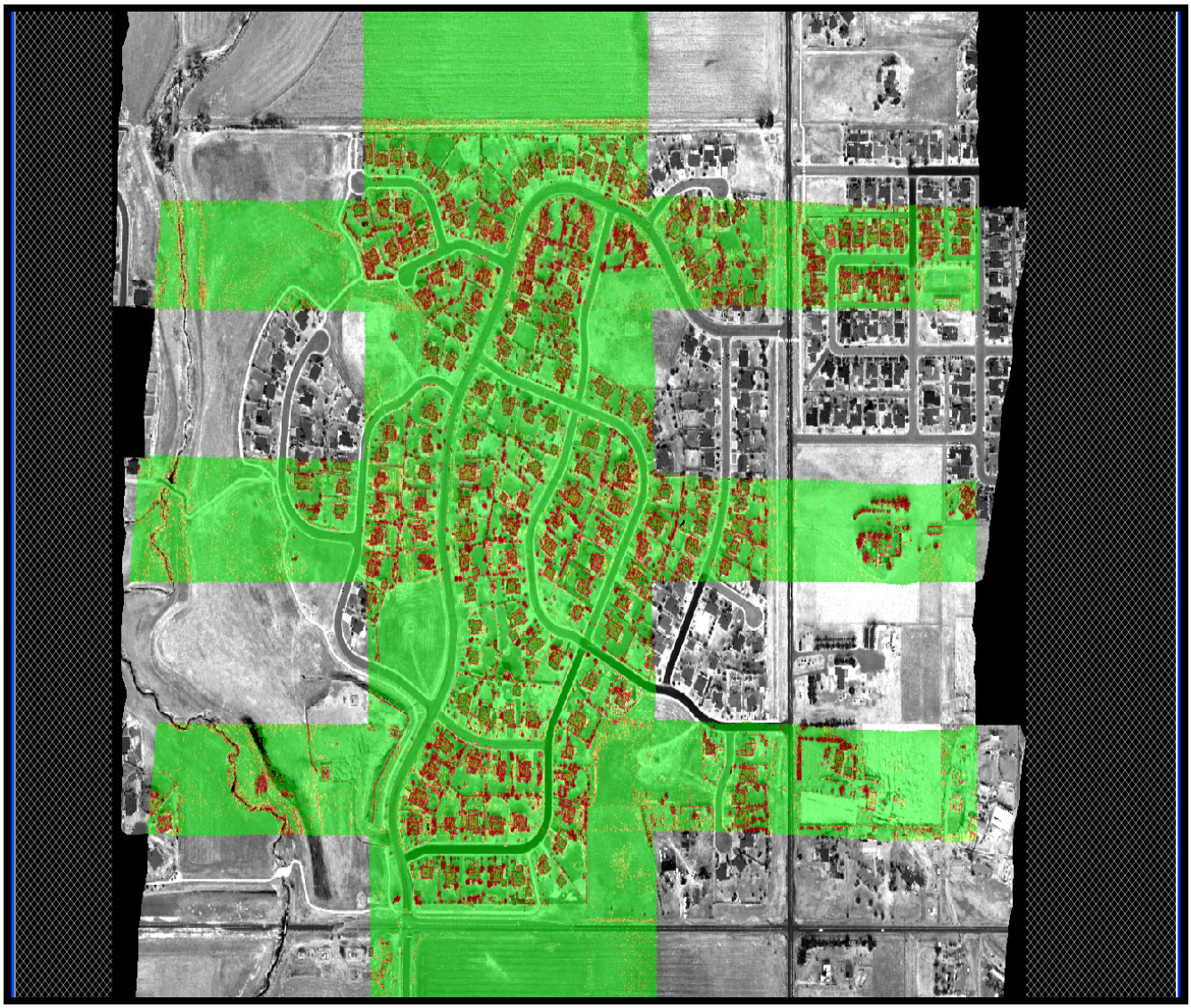
Plot of height differenced between flight lines. (Green=less than 5cm).



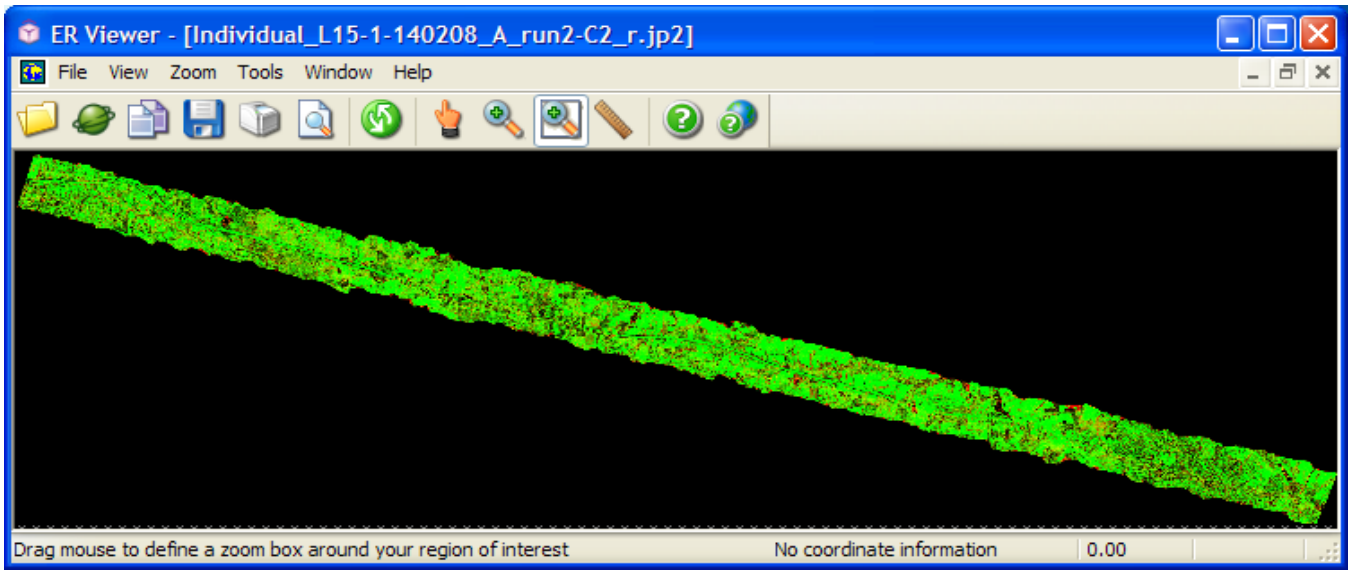
Plot of point densities. (Red=5-9 points per cell, green 10+ points per cell).



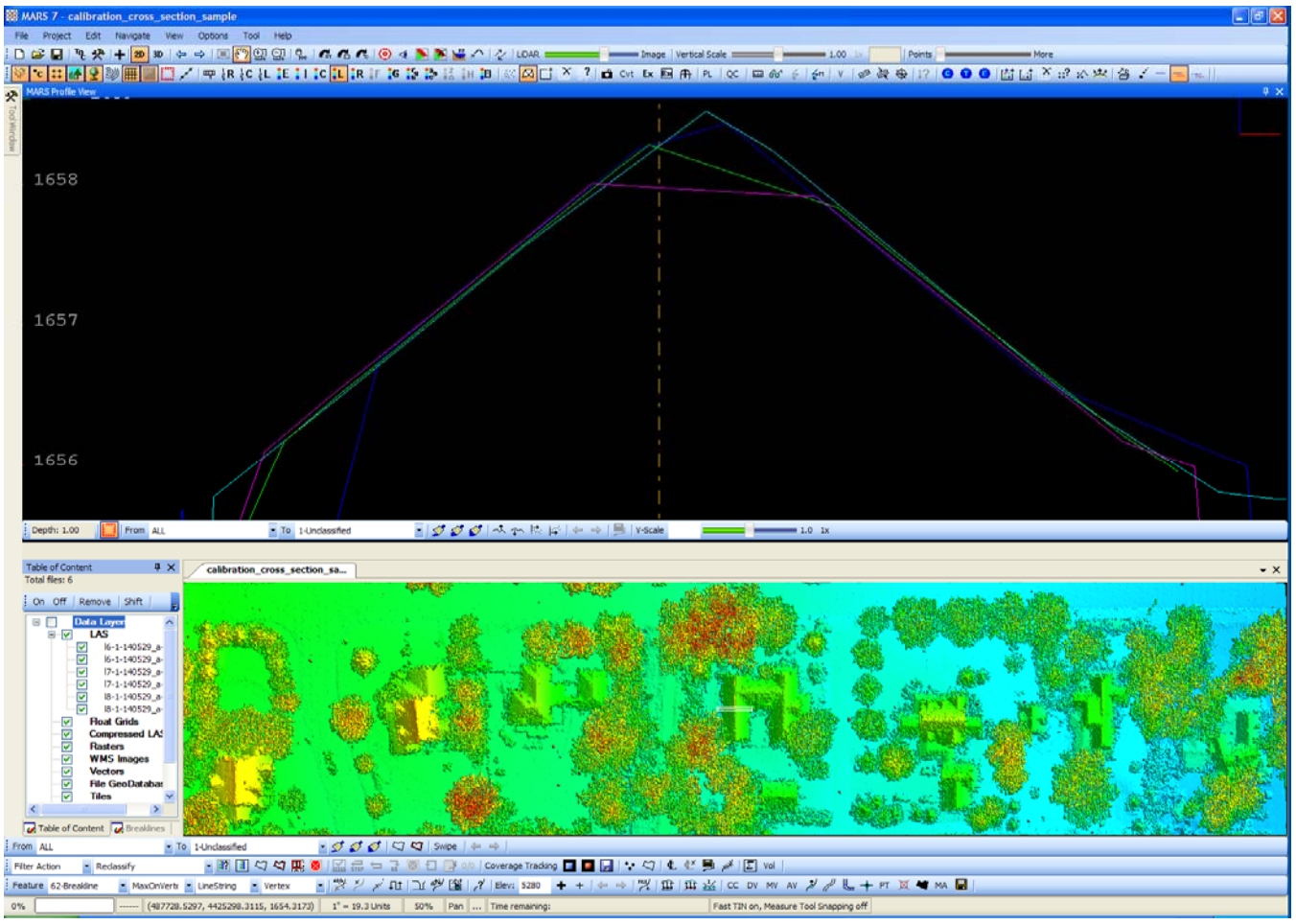
A Flight Line Separation Raster image is generated in MARS®, in this example ground returns from multiple flight lines that are fitting within 3 centimeters is colored green.



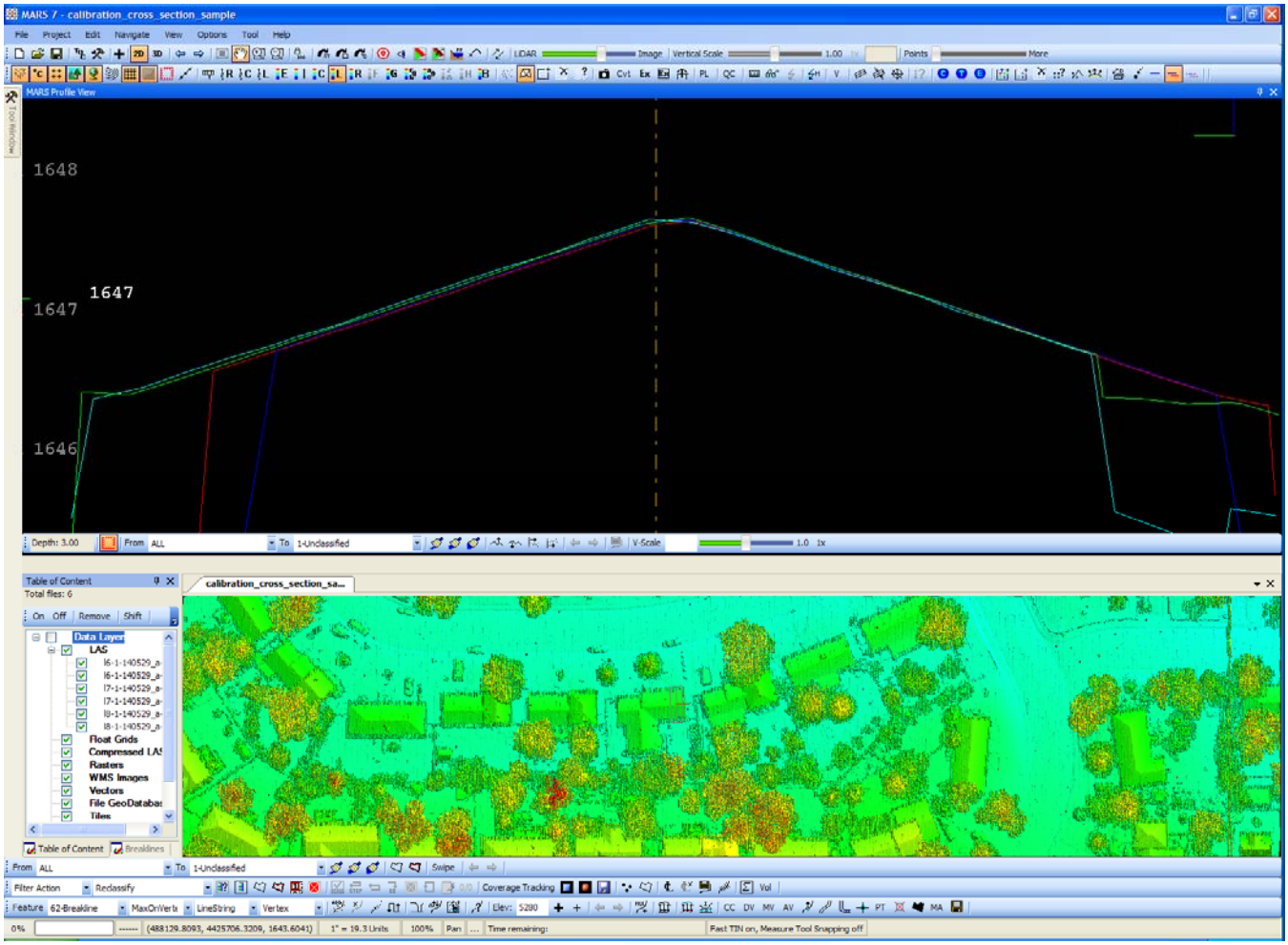
MARS® tests for internal relative vertical accuracy using inbound and outbound scan values. Again Green is showing inbound and outbound scan data fitting to 3 centimeters.



Building cross sections are checked for good alignment. Pitch and heading are checked on roof planes parallel to the flight direction.



Roll and scale are checked on roof planes perpendicular to the flight direction.

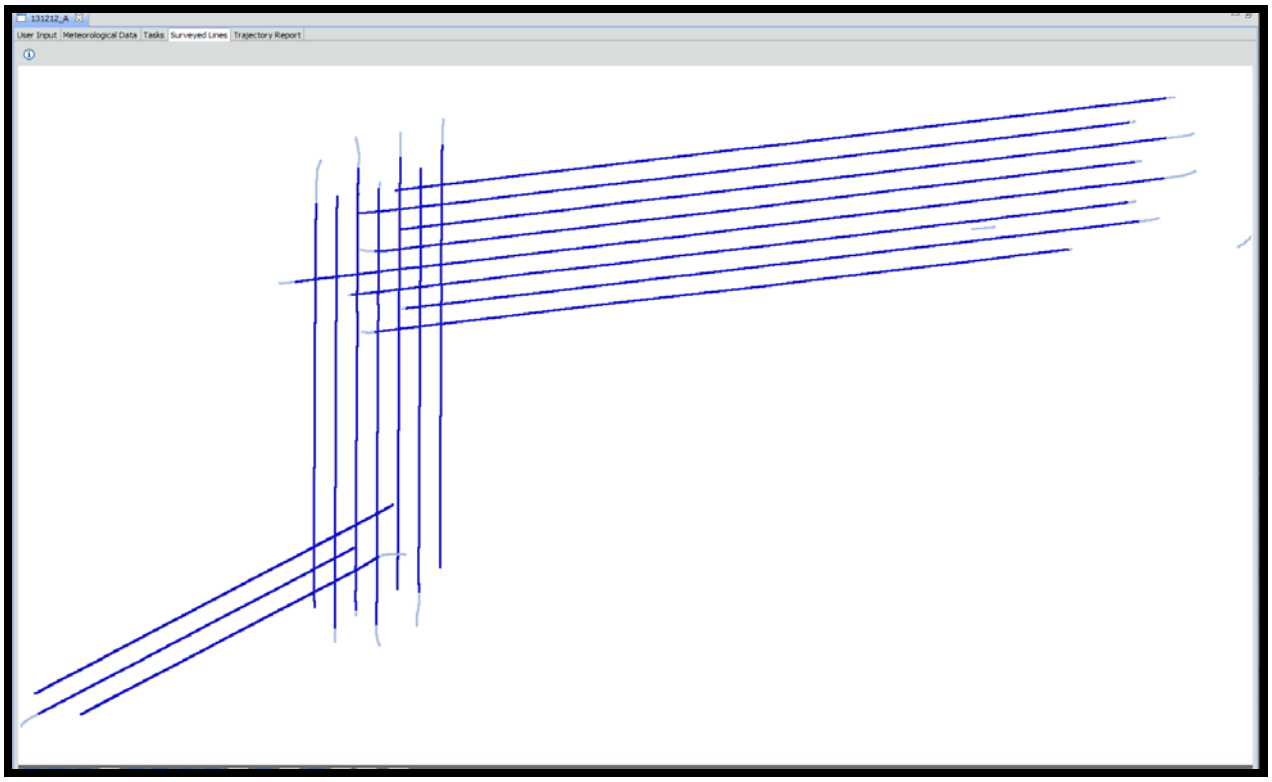


The LMS program outputs a "LCP" file with all the correction parameters. The calibration process may be run several times until the boresight adjustments are acceptable. When the boresight solution is acceptable the LCP file adjustments are saved and also applied to subsequent projects. Each new project is again analyzed and when the adjustment biases show too much drift a new boresight calibration is run. The LCP file may hold calibration tolerances for several projects.

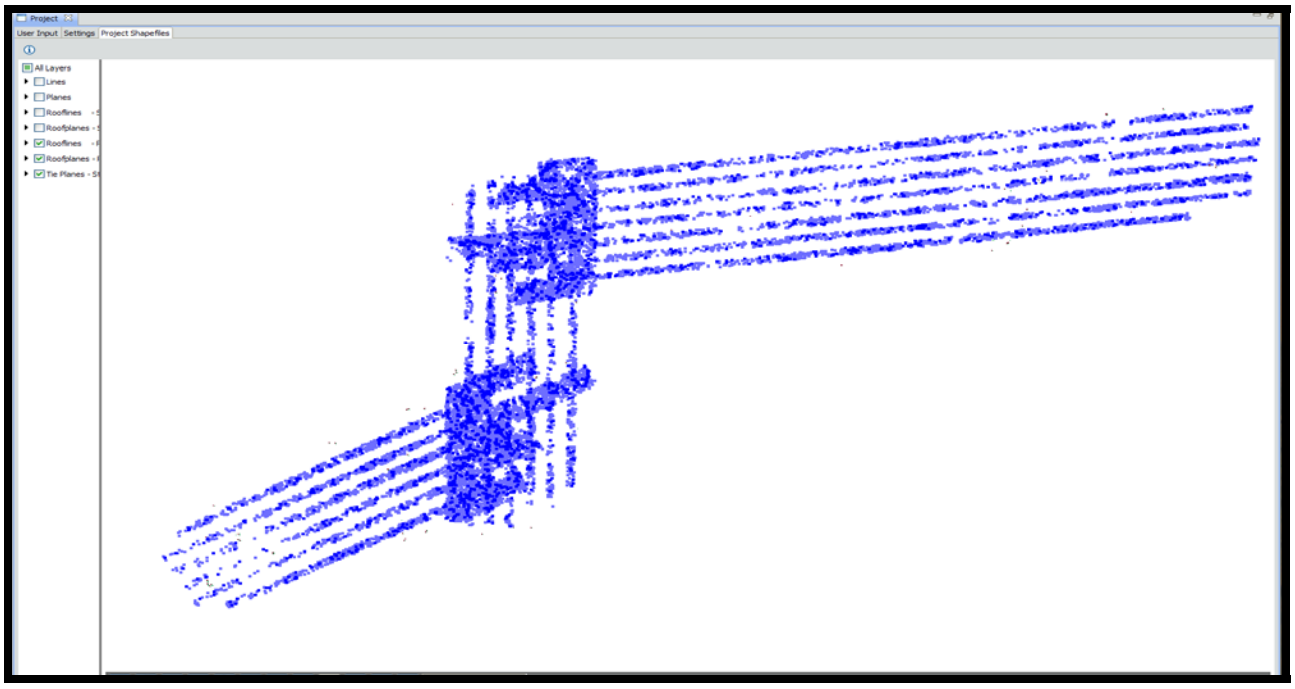
BLOCK LAS Production Processing Procedures

The LMS production mode is run on each flight line to further tie the final LiDAR LAS flight line files tightly together. Production settings allow scan angle scale, scan angle lag to float and allows elevation to move slightly during flight line to flight line comparison thus further tying flight lines together. A cross flight with locked elevation data is used for controlling flight line elevations.

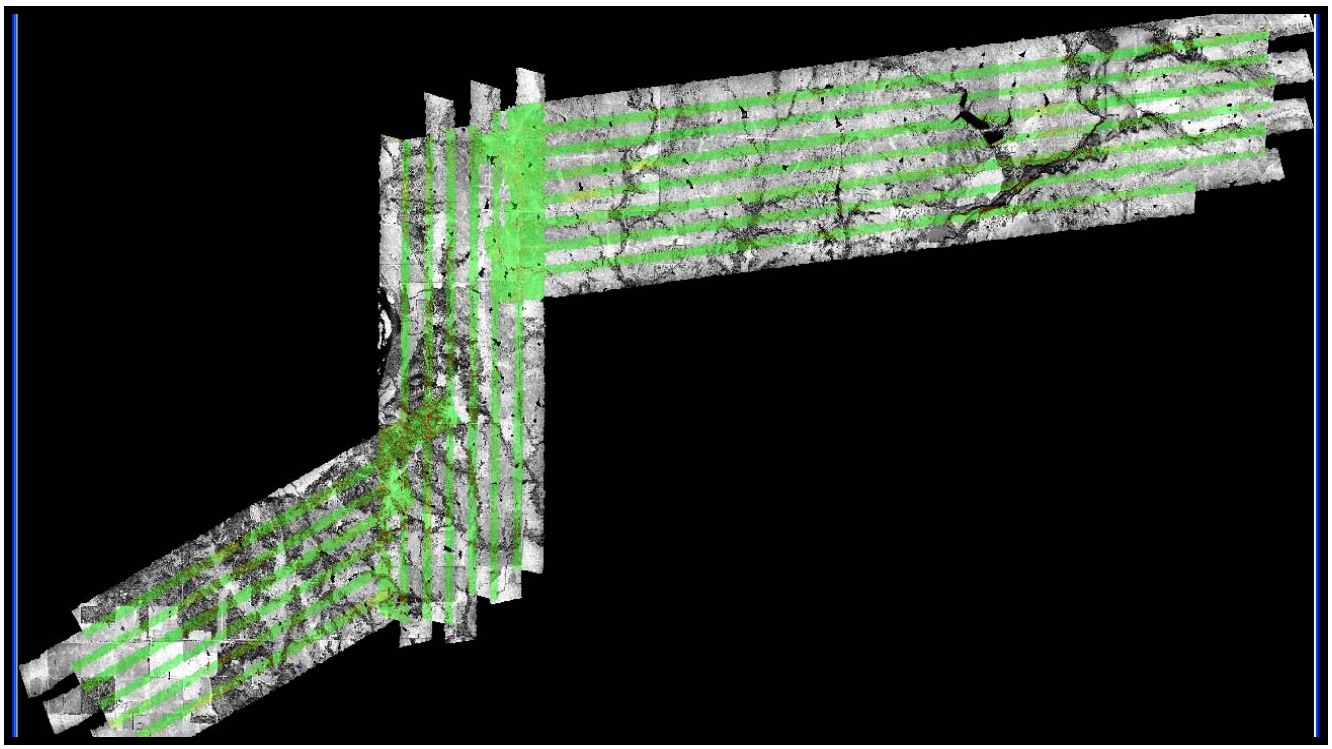
A block of data is selected to process with LMS production settings. Data collected during turns at the ends of flight lines is deselected (light blue lines).



As in self-calibration the LMS production program analyses ground, roof planes and rooflines. One cross flight is locked in elevation and all other lines are adjusted to it. Unlike the calibration site the distribution of roof planes is usually much less dense. Here matched ground tie planes are blue.

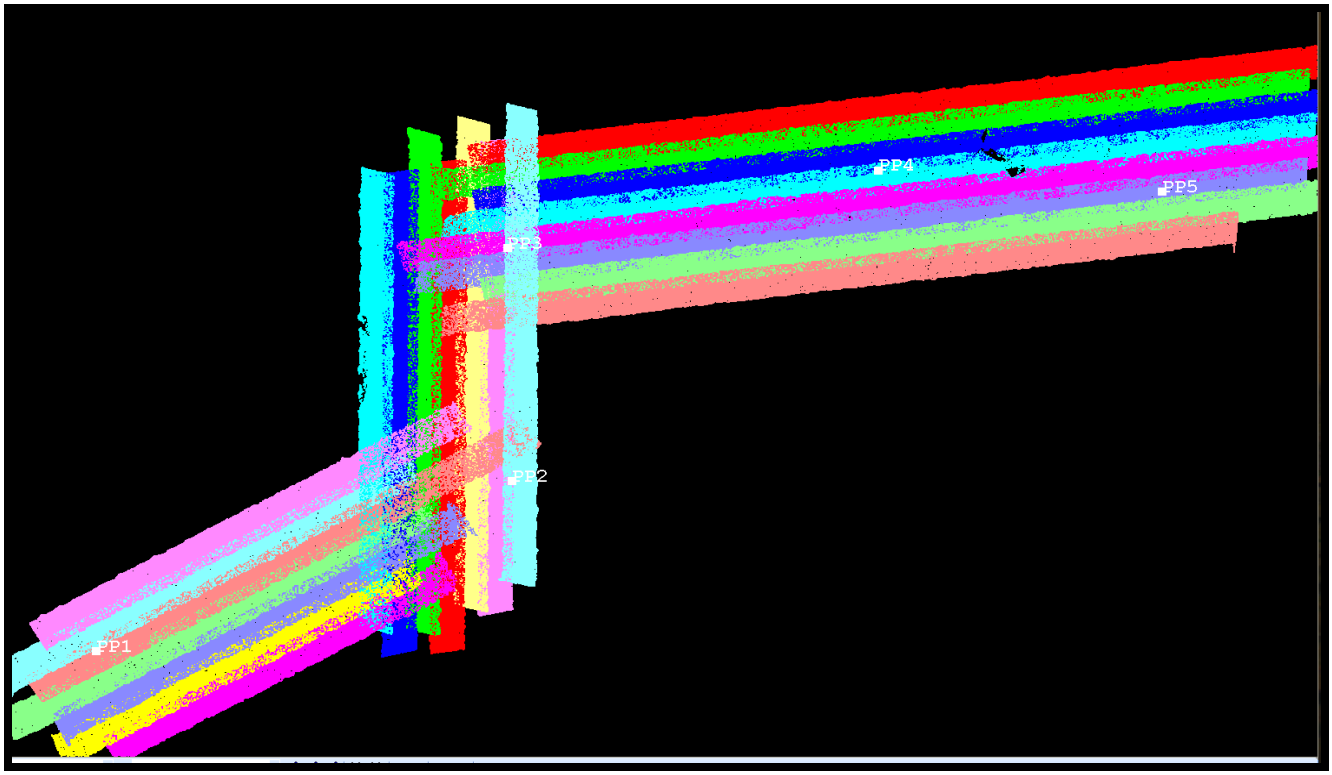


The same quality control outputs used to check self-calibrations are available to analyze the production run. Output plots are again available in LMS and cross sections plus a Flight Line Separation Raster are generated in MARS® to check coverage and quality.

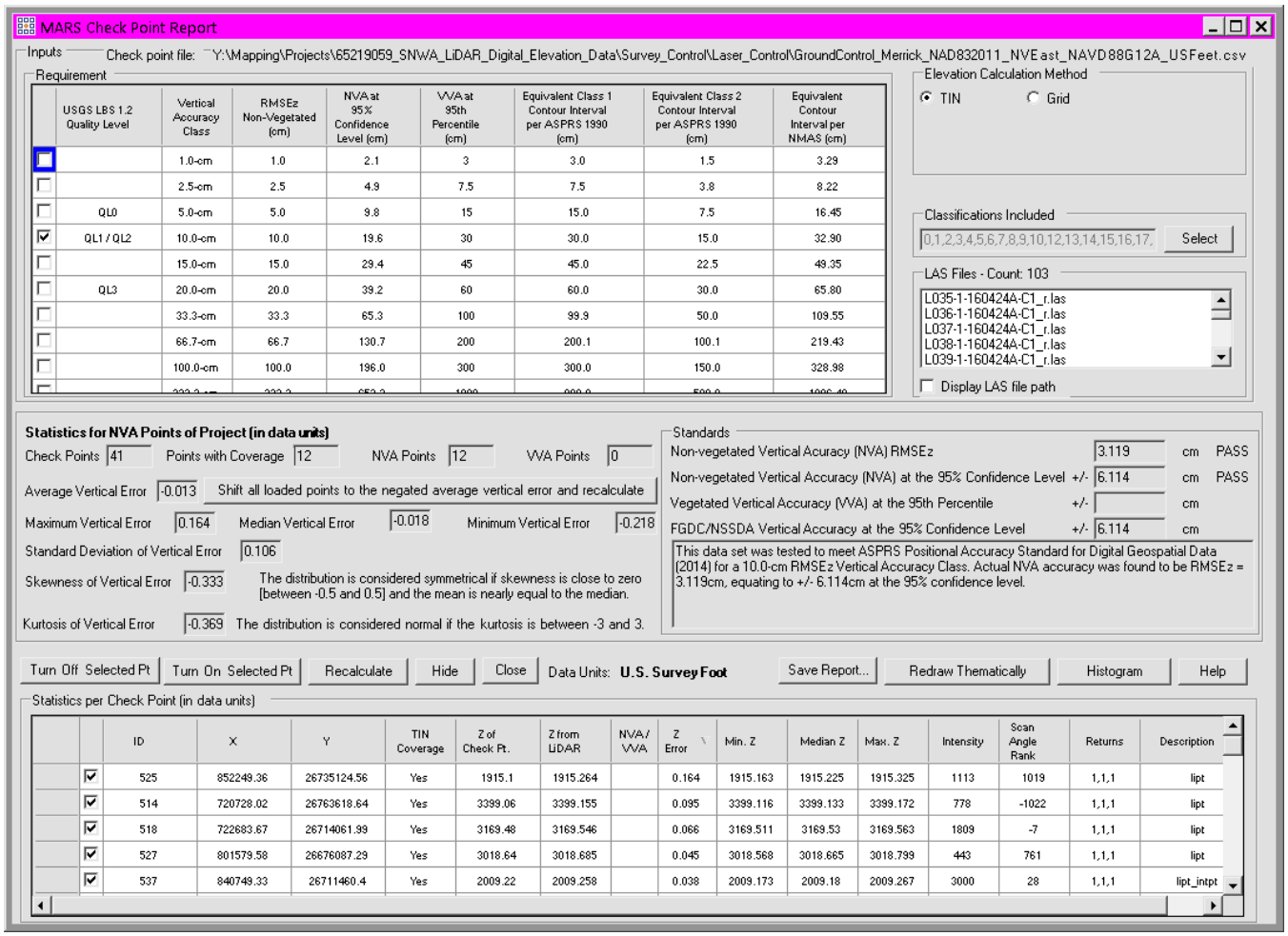


Correcting the Final Elevation

After all the lines are tied together a ground control network is imported into MARS®. The ground control network may be pre-existing or collected by a licensed surveyor.



The next step is to compare the ground control elevations to the LiDAR data set. A Check Point Report is run and the data set is shifted slightly to zero out the average elevation error and points checked for quality.



The final step before boresighted, leveled LAS files are ready for filtering is to run the MARS® QC Module on the block data. The Boresighted LiDAR QC Report outputs individual reports on Point Density, Nominal Pulse Spacing, Data Voids, Spatial Distribution, Scan Angles, Control Report, Flight Line Separation, Flight Line Overlap, Buffered Boundary, LAS Formats, Datums and Coordinates. These reports are checked with the required specifications in the Project Management Plan.

LIDAR CLASSIFICATION

Auto-Filter (automated)

Merrick uses customizable software to classify an automated bare-earth (i.e., ground / Class 2) solution from the LiDAR point cloud. The software uses several different algorithms combined in a macro to determine the classification for each point. Filter parameters are adjusted based on the terrain and land cover for each project to produce the best ground result and to minimize hand-filter. Merrick's automated filters typically classify 85- to 90-percent of the ground.

Hand-Filter (manual editing)

The remaining 10- to 15-percent of the points resulting from the automated filtering techniques are possibly misclassified and require final editing. Using the MARS® software, Merrick has several manual edit tools which allow us to re-classify these features to the appropriate class. All the data within the project extent is viewed by an operator to ensure all artifacts are removed, and that we are meeting project specifications. Once it is deemed the best ground solution is met, Merrick performs a final auto-filter to classify all points to meet the ASPRS LAS 1.4 specification. During this process all non-ground points are classified to Class 1 (Unclassified), and following this is a height-from-surface auto-filter is run to re-class noise to Classes 7 and 18.

The following table represents the ASPRS LAS 1.4 classifications used:

- Class 1 = Unclassified
- Class 2 = Bare-earth Ground
- Class 7 = Low point (noise)
- Class 9 = Water
- Class 10 = Ignored ground (near a breakline)
- Class 17 = Bridge decks
- Class 18 = High noise

* Withheld flags set

Hydro-enforcing breaklines are captured by Merrick compilers. These features are appropriately turned in to polygons and are used in MARS® to reclassify ground points in water to Water (Class 9). The LiDAR points around the breaklines are reclassified to Ignored Ground (Class 10) based on predetermined buffer.

HYDRO-FLATTENING BREAKLINE COLLECTION (per the USGS National Geospatial Program Lidar Base Specification Version 1.2)

Linear hydrographic features

Merrick uses a methodology that directly interacts with the LiDAR bare-earth data to collect drainage breaklines. To determine the alignment of a drainageway, the technician first views the area as a TIN of bare-earth points using a color ramp to depict varying elevations. In areas of extremely flat terrain, the technician may need to determine the direction of flow based on measuring LiDAR bare-earth points at each end of the drain. The operator will then use the color ramped TIN to digitize the drainage in 2D with the elevation being attributed directly from the bare-earth .LAS data. Merrick's proprietary MARS® software has the capability of "flipping" views between the elevationTIN, Intensity and imagery, as necessary, to further assist in the determination of the drainage. All drainage breaklines are collected in a downhill direction. For each point collected, the software uses a five-foot (5') search radius to identify the lowest point within that proximity. Within each radius, if a bare-earth point is not found that is lower than the previous point, the elevation for subsequent point remains the same as the

previous point. This forces the drain to always flow in a downhill direction. Waterbodies that are embedded along a drainageway are validated to ensure consistency with the downhill direction of flow.

This methodology may differ from those of other vendors in that Merrick relies on the bare-earth data to attribute breakline elevations. As a result of our methodology, there is no mismatch between LiDAR bare-earth data and breaklines that might otherwise be collected in stereo 3D as a separate process. This is particularly important in densely vegetated areas where breaklines collected in 3D from imagery will most likely not match (either horizontally or vertically), the more reliable LiDAR bare-earth data.

Merrick has the capability of "draping" 2D breaklines to a bare-earth elevation model to attribute the "z" as opposed to the forced downhill attribution methodology described above. However, the problem with this process is the "pooling "effect or depressions along the drainageway caused by a lack of consistent penetration in densely vegetated areas.

Criteria of linear hydrographic breaklines are as follows:

- Linear hydrographic features (e.g., visible streams, rivers, shorelines, canals, etc.) greater than one hundred feet (100') wide will be captured as a double-lined polygon
  - linear hydrographic features must be flat and level bank-to-bank (perpendicular to the apparent flow centerline) with gradient following the immediately surrounding terrain
  - water surface edge must be at or just below the immediately surrounding terrain
  - streams should break at road crossings (e.g., culverts), and streams and rivers should not break at bridges

Waterbodies

Waterbodies are digitized from the color ramped TIN, similar to the process described above. The elevation attribute is determined as the technitian collects the hydro feature by using the lowest bare-earth point within the polygon.

Criteria of waterbody breaklines are as follows:

- Waterbodies (e.g., lakes, ponds, reservoirs) greater than two (2) acres in size are surrounded by a water breakline (i.e., closed polygon)
  - waterbodies must be flat and level with a single elevation for every bank vertex
  - water surface edge must be at or just below the immediately surrounding terrain
  - long impoundments, such as reservoirs or inlets, whose water surface elevations drop when moving downstream should be treated as rivers

DIGITAL ELEVATION MODEL (DEM)

Merrick exports the hydro-flattening breakline enforced Class 2 (ground) LiDAR points to 2' (QL2) or 1' (QL1) cell size Esri floatgrids (.flt/.hdr) using MARS®. The floatgrids are imported and converted to Esri grids (1' or 2' resolution as appropriate). The result is a seamless* DEM in ArcGIS (i.e., Esri grid) 32-bit floating point format; later converted to ERDAS Imagine (IMG) format for client delivery. Projection information is applied that reflects the classified LAS / project requirements.

These DEMs are exported to the project tiling scheme prior to delivery.

* PLSS formatted tiles will require minimal amounts of overlap (i.e., non-rectangular tiles).