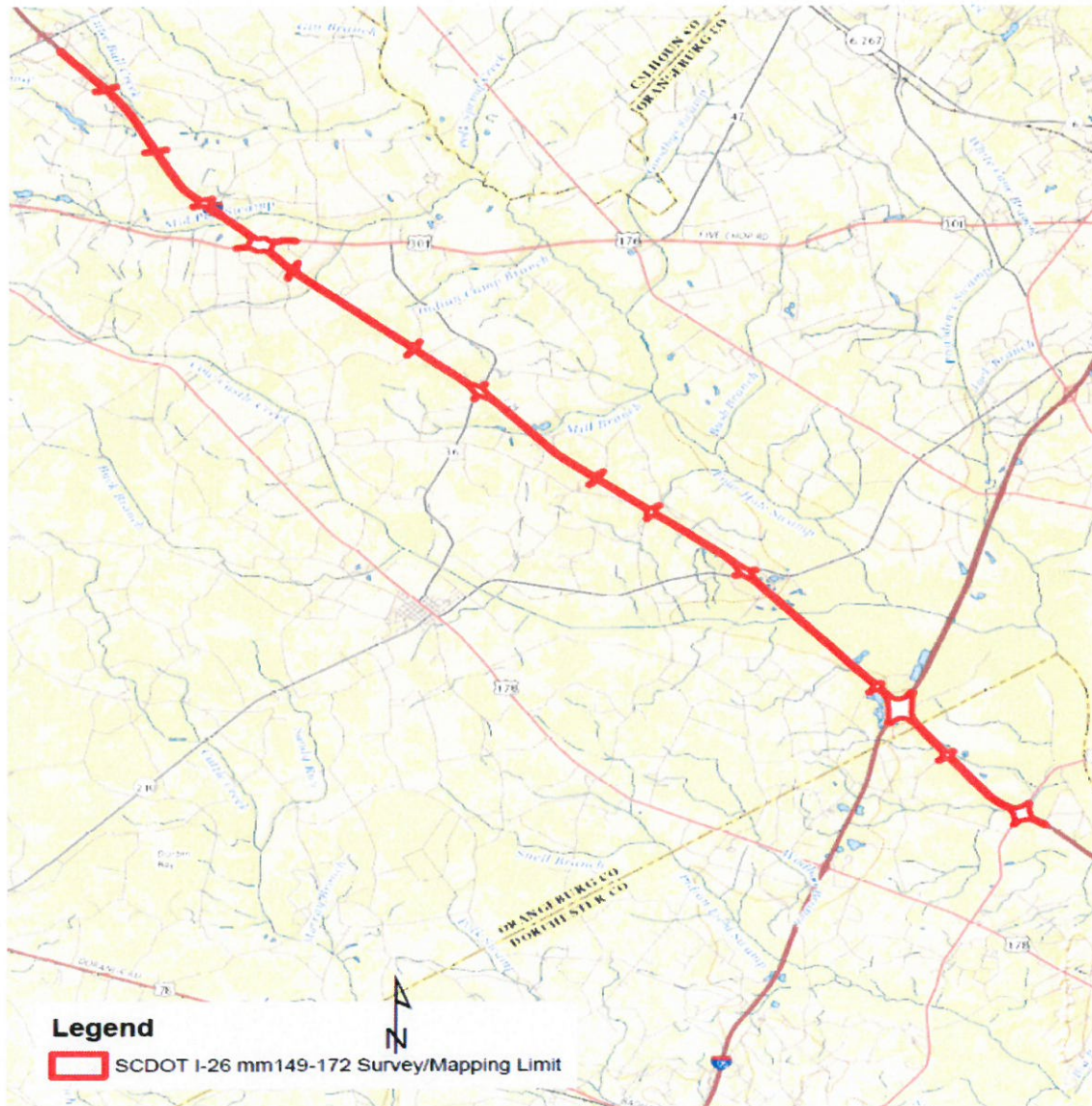
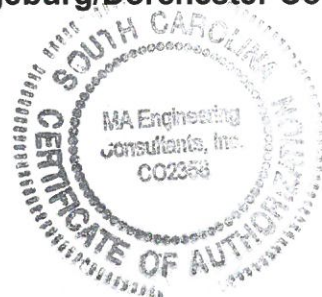


Aerial Triangulation and Survey Control Report

Photogrammetric Mapping, LiDAR and Imagery Services



P029938: I-26 mm149-mm172 Reconstruction
Orangeburg/Dorchester Counties, SC



April 14, 2017

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SC PLS Statement

I, M. H. Weatherford PE,PLS,CFM, a Professional Land Surveyor in the State of South Carolina, certify that this aerial triangulation task was performed by an ASPRS Certified Photogrammetrist in the employment of M A Engineering Consultants, Inc. (MAEC) for SCDOT aerial mapping project **P029938: I-26 mm149-mm172 Reconstruction – Orangeburg/Dorchester Counties, SC**; that MAEC performed the photo control survey with conventional leveling under my direct supervision; that the aerial triangulation measurements, adjustment, and analysis based on GPS-based Control were completed on November 7, 2016 and aerial topographic/LiDAR mapping completed on March 2, 2017; The aerial imagery airborne GPS/IMU and LiDAR data and all coordinates are based on SC State Plane Coordinates, NAD83(2011) horizontal datum and NAVD88 vertical datum in the international foot units.

Witness by my hand and seal on this 18 day of APRIL, 2017.

Professional Seal

M. H. Weatherford, PLS



Aero-Triangulation Report

Task Order	Project#	County	Description
3	P029263	Orangeburg/Dorchester	I-26 Reconstruction mm149-172, SC

Submitting Organization

MA Engineering Consultants, Inc.

598 E. Chatham Street, Suite 137

Cary, NC 27511

877-623-2123 or 919-297-0220 (Office) 919-291-0221 (Fax)

Steven Bailey, PLS; Project Manager sbailey@maec.com

Matthew W. Elious, CP; Geospatial/GIS Manager melious@maec.com

Hart Weatherford, PE, PLS; SC Professional Land Surveyor in Responsible Charge hweatherford@maec.com

Introduction

Under contract with SCDOT, MA Engineering Consultants, Inc. (MAEC) is providing photogrammetric services for 1"=50' Mapping, Digital Terrain Modeling with LiDAR and Digital Ortho-Imagery for the abovementioned project in conformance with the scope of work for same dated July 11, 2016.

The intent of this document is to present a Control Report detailing the results of the softcopy Aero-Triangulation task performed for this project in conformance with *the scope of work*. A cover statement signed and sealed by a South Carolina PLS accompanies this report.

Summary of Aero-Triangulation Results

The aero-triangulation was performed by a Certified Photogrammetrist using Intergraph's ImageStation Automatic Triangulation (ISAT) software, version 6.1 for manual and automatic measurements and for least squares bundle adjustment processing.

The project area was flown with an UltraCAM fp at a flying height of approximately 2800ft above MSL. The camera focal length is 100.5 mm with a resolution of 6 microns.

The apriori precision of image coordinates assigned was 4 microns. The overall post adjustment precision of the block was 1.2 microns

One hundred eighty-eight (188) survey panel points were used in the adjustment including **twenty-nine (29)** paneled check points that were used to QC the LiDAR bare-earth classification for accuracy analysis. For A. T. processing, the survey control points were assigned standard deviations of 0.1ft in Easting, 0.1ft in Northing and 0.1ft Elevation. The final block adjustment RMS at the control:

Final AT Results (all units in International Feet)				
Point Type	No. Points	RMSE (X)	RMSE (Y)	RMSE (Z)
Control	188	0.04	0.04	0.02

Signed 
Matthew W. Elious, CP #R1007

Aero-Triangulation Methodology

The imagery, control and airborne GPS/IMU (ABGPS/IMU) data for this project were acquired by MAEC. The supplied images were further processed by MAEC using ImageStation Raster Utility (ISRU) to generate a full set of overviews for each image.

Once the project parameters and camera file were defined in ISAT, the images and their folder location were established using ISAT Strip Wizard. Following this, the localized control coordinates and ABGPS/IMU were imported into ISAT and reviewed for verification using the Footprint Viewer.

Once the visual display of the imagery superimposed on the control were verified, the block was processed without control constraints (free net adjustment) by ISAT automatic correlation to obtain preliminary stereo restitution to aid in the manual measurements of pass points.

Using the multi-photo process, pass points were then measured (with y-parallax removal where required) in a 5-point regular pattern as much as possible for the entire block. The block was then processed, reviewed and image measurements refined/re-measured where necessary. This process was repeated until all images were determined to be clean of errors (i.e. the pass points residual errors were 5 microns or less). Also, using MAEC in-house Graph AT display software, all autocorrelation 2-ray pass points were deleted from the block except for 2-ray pass points in the first and last models of the block. This ensures that all pass points were imaged on 3 successive photos (3-ray points) except for pass points in the first and last models of the block or in highly dense “Von Gruber” locations where 3-photo pass points was not optimal. Following this process, the control panel locations were measured and a least squares solution processed while constraining the control only. ABGPS and IMU data were not constrained in the bundle block adjustment for this project.

Once all control points were measured and processed to yield satisfactory block-wise RMS values (not > than 2 times a priori RMS), the block control was “densified” to transform all pass-point image coordinates to corresponding analytical ground coordinates.

As a further quality control step, a bulk orientation process was run on the block to compute “absolute orientation” parameters of each stereo model. The models with the largest residuals were reviewed in stereo to display and examine the maximum absolute errors in the individual stereo-model points. An occasional high residual point may trigger the need to re-measure the pass point. It was however not necessary for this project block.

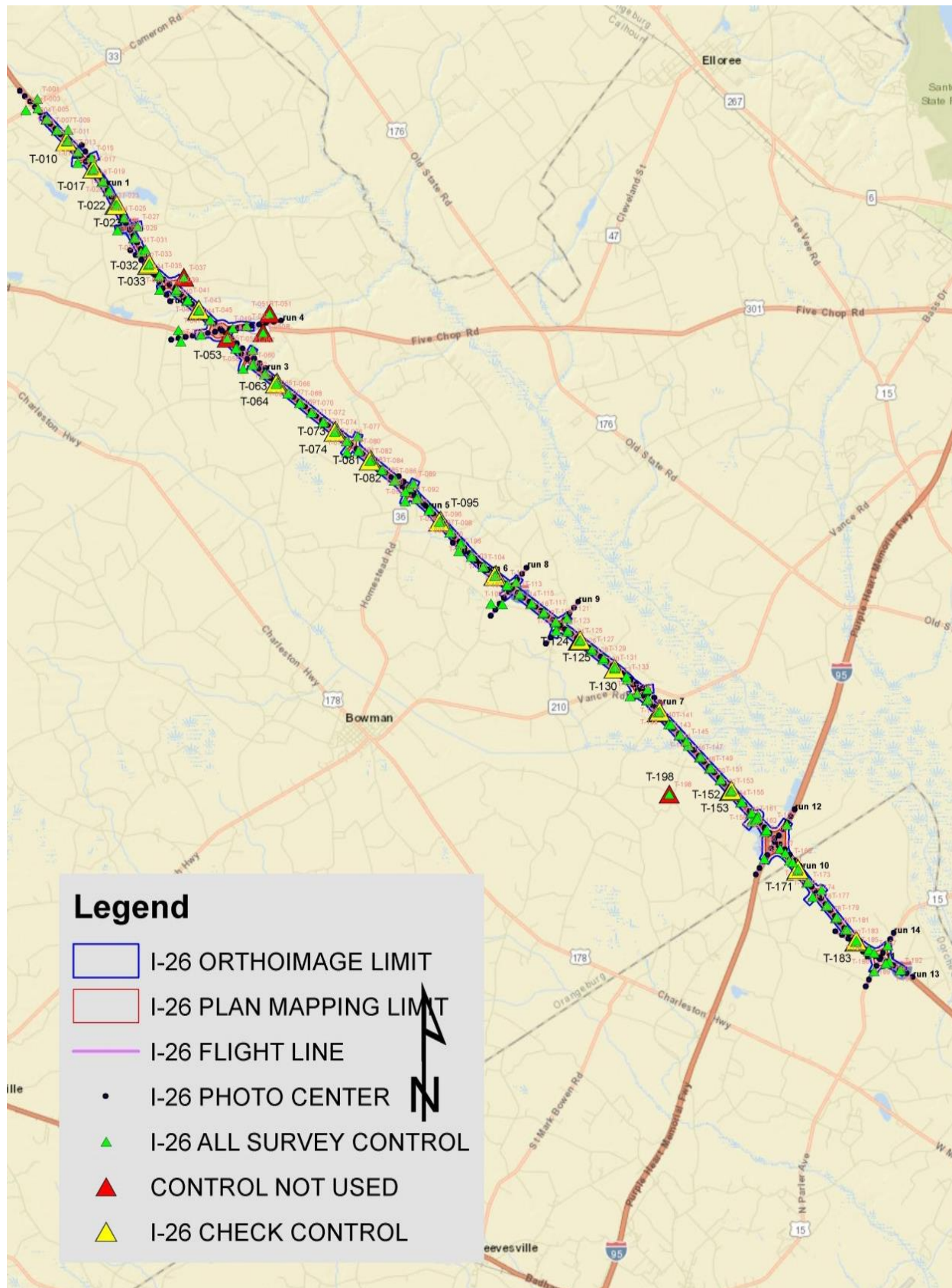


Figure 1 Imagery Flight/Control Index (14 flight lines, 283 exposures, Check Points in "Yellow")

Photogrammetric Aero-Triangulation Results

Photography Data

Project: I-26 (mm149-172)
 State: South Carolina
 OOP: 10/18/2016
 Exposures: 001-283
 Camera: UCFp OTA1 (6-micron resolution)
 Calibration Date: March 2, 2015
 Focal Length: 100.5mm

Input Data	X(omega)	Y(phi)	Z(kappa)
Ground Control Weights (ift):	0.1	0.1	0.1
Camera Position Weights (ift):	0.33	0.33	0.33
Camera Attitude (decimal degrees):	0.015	0.015	0.040
Image Coordinate Weights:	4 microns for both x & y		

Output Data	X(omega)	Y(phi)	Z(kappa)
RMS Ground Control (ift):	0.038	0.035	0.016
RMS Camera Position Control (ift):			
RMS Camera Attitude (decimal degrees):			
Overall Adjustment Sigma:	1.2 microns		

Control Points excluded from Aero-Triangulation

All values ift:

Point ID	Class	delta X	delta Y	delta Z	
T-050	XYZ	-0.247	0.197	-.304	poor fit
T-051	XYZ	-.306	-0.208	-0.861	poor fit
T-053	Seems target paved over (not seen in imagery)				
T-037	Target outside photo coverage				
T-198	Target outside photo coverage				

Table 1 Aero-Triangulation Results Summary

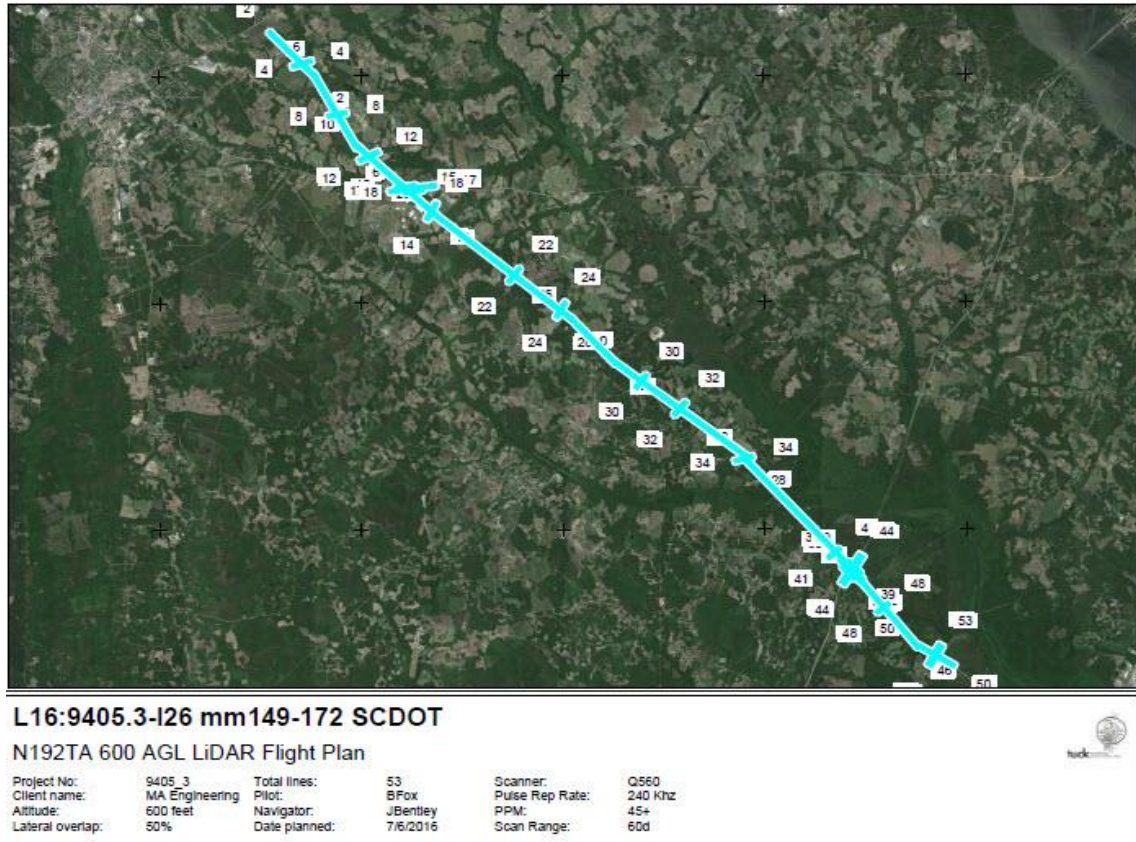


Figure 2 LiDAR Flight Index of 53 flight lines, 600' AGL

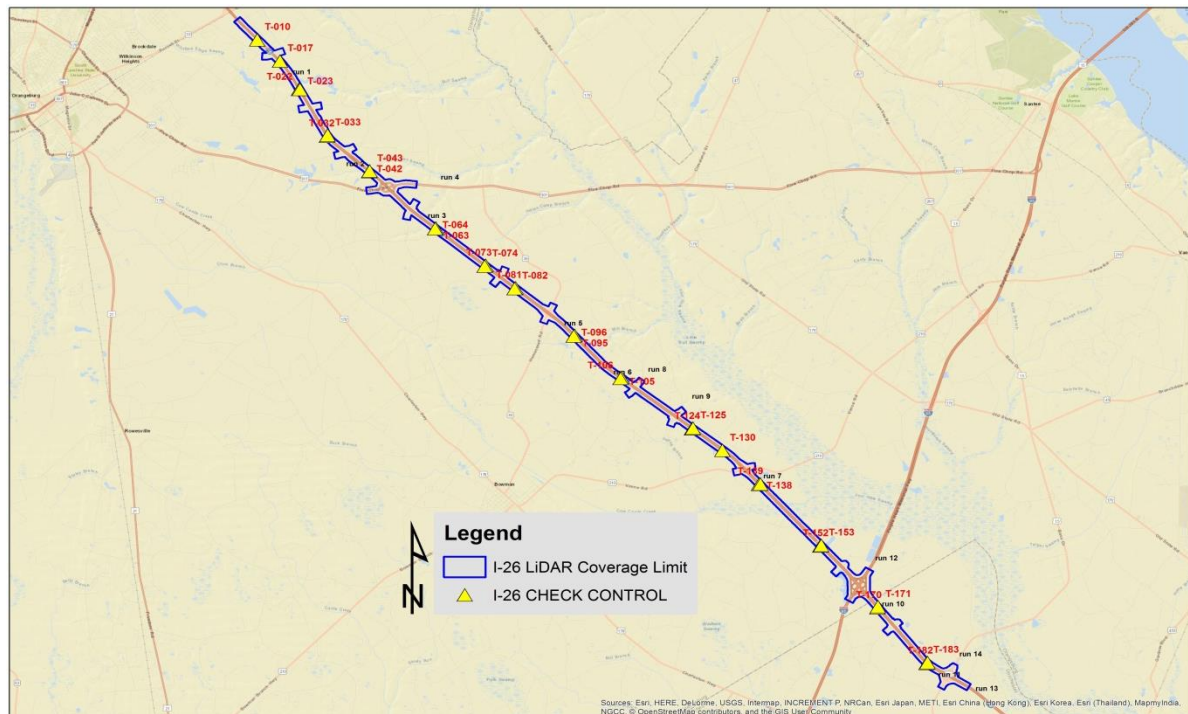


Figure 3 LiDAR Coverage and Check Points Index

LiDAR Control Results Summary

Project File	MA Engineering LiDAR Control Report, I-26 MM 149 - 172 Rehabilitation - Orangeburg and Dorchester Counties, SC
Project Unit	NAD83 - State Plane Coordinate System South Carolina - NAVD88 - International Feet
Requirement Type	RMSE(z)
RMSE(z) Objective	0.05-0.1 ft.
Control Points in Report	29
Elevation Calculation Method	Interpolated from TIN
Control Points with LiDAR Coverage	29
Average Control Error Reported	-0.006586207
Maximum (highest) Control Error Reported	0.11
Median Control Error Reported	-0.013
Minimum (lowest) Control Error Reported	-0.095
Standard deviation (sigma) of Error for sample	0.048391644
RMSE of Error for sample (RMSE(z))	0.048003951
NSSDA Achievable Contour Interval	0.2
ASPRS Class 1 Achievable Contour Interval	0.2
NMAS Achievable Contour Interval	0.2

Table 2 LiDAR Control Summary

LiDAR Control RMSE & Accuracy Results

	ΔZ^2
Sum:	0.066827
Average:	0.002304379
RMSE:	0.048003951
Accuracy at 95% confidence:	0.094087744

Table 3 LiDAR RMSE & Accuracy Results

Lidar Control Residuals Results

PID	Y control	X control	Control Point Z	Z from LiDAR	Z Error	ΔZ^2
T-183	530903.08	2146204.04	88.84	88.83	0.012	0.0001440
T-182	530776.94	2146115.06	90.04	90.05	-0.010	0.0001000
T-171	537999.56	2140357.38	99.13	99.09	0.035	0.0012250
T-170	537838.41	2140290.36	99.14	99.16	-0.023	0.0005290
T-153	2133661.76	545792.47	104.29	104.22	0.068	0.0046240
T-152	2133541.49	545696.05	104.30	104.19	0.110	0.0121000
T-139	553561.32	2126446.57	107.30	107.28	0.017	0.0002890
T-138	553521.67	2126274.88	107.44	107.37	0.067	0.0044890
T-130	557839.08	2121960.94	119.98	119.97	0.007	0.0000490
T-124	560586.74	2118348.93	129.38	129.32	0.060	0.0036000
T-125	560678.63	2118481.68	129.42	129.40	0.019	0.0003610
T-106	567000.36	2109904.48	142.42	142.40	0.017	0.0002890
T-105	567103.96	2110023.05	142.43	142.48	-0.053	0.0028090
T-042	593257.83	2080167.29	152.28	152.37	-0.095	0.0090250
T-043	593332.62	2080232.25	152.42	152.46	-0.037	0.0013690
T-095	572453.08	2104495.50	156.67	156.65	0.021	0.0004410
T-096	572358.72	2104373.56	156.83	156.78	0.053	0.0028090
T-022	603704.75	2071870.80	162.23	162.26	-0.028	0.0007840
T-023	603699.56	2071987.00	162.81	162.82	-0.013	0.0001690
T-064	586001.38	2087962.10	164.49	164.57	-0.082	0.0067240
T-063	586097.59	2088069.80	164.64	164.68	-0.037	0.0013690
T-082	578401.42	2097386.89	166.11	166.12	-0.007	0.0000490
T-081	578499.68	2097492.47	166.25	166.29	-0.037	0.0013690
T-073	581350.96	2093956.34	170.60	170.63	-0.034	0.0011560
T-074	581254.19	2093848.47	170.77	170.84	-0.067	0.0044890
T-017	607307.63	2069640.11	177.61	177.66	-0.052	0.0027040
T-033	597891.60	2075266.94	179.40	179.45	-0.047	0.0022090
T-032	597768.82	2075166.75	182.34	182.37	-0.032	0.0010240
T-010	610010.54	2066943.21	190.88	190.90	-0.023	0.0005290

Table 4 LiDAR Residuals

Survey Control Methodology

The Survey Control Network developed for this project based on South Carolina State Plane Grid coordinates with the horizontal values based on NAD 83/2011 and the vertical based on NAVD 88. Horizontal coordinates were established using the SC Virtual Reference Network (SCVRN) GPS system which allows for real-time corrected GPS locations. Each target and check point was observed for a minimum of three minutes. Vertical elevation values were established from the NGS monument PID: AA4238 with a published elevation of 205.23 (ft). Each target was elevated using differential leveling methods.

NGS Monument Details

```
AA4238 *****
AA4238 DESIGNATION - 38 001
AA4238 PID - AA4238
AA4238 STATE/COUNTY- SC/ORANGEBURG
AA4238 COUNTRY - US
AA4238 USGS QUAD - ORANGEBURG NORTH (1987)
AA4238
AA4238 *CURRENT SURVEY CONTROL
AA4238
AA4238* NAD 83(2011) POSITION- 33 31 02.59476(N) 080 47 44.98544(W) ADJUSTED
AA4238* NAD 83(2011) ELLIP HT- 31.150 (meters) (06/27/12) ADJUSTED
AA4238* NAD 83(2011) EPOCH - 2010.00
AA4238* NAVD 88 ORTHO HEIGHT - 62.555 (meters) 205.23 (feet) ADJUSTED
AA4238
```

Summary of Survey Control Results

The table shows the results of the SCVRN GPS and leveling surveys:

Desc	PDOP	H. Prec (95%)	Sat #	Epochs (1")	Easting	Northing	Leveled Elev
T-003	1.3	0.05	14	181	2064064.99	613273.57	232.33
T-004	1.1	0.05	9	180	2064871.96	612171.05	202.43
T-006	1.5	0.06	13	183	2065904.84	611083.98	196.34
T-007	1.3	0.09	13	181	2065984.70	611145.13	196.27
T-010	1.5	0.11	14	182	2066943.16	610010.51	190.88
T-011	1.3	0.04	15	181	2067044.77	610048.68	190.70
T-012	1.5	0.08	11	183	2067991.58	608926.76	185.51
T-013	1.3	0.16	14	181	2068075.73	608982.54	185.22
T-017	1.3	0.06	14	181	2069640.11	607307.63	177.61
T-018	1.7	0.04	12	183	2070480.92	605994.98	168.80
T-019	1.3	0.06	12	181	2070571.61	606086.50	170.92
T-020	1.8	0.04	12	184	2071122.70	605034.90	164.90
T-022	1.9	0.12	11	179	2071870.85	603704.90	162.23
T-023	1.3	0.04		188	2071987.00	603699.56	162.81
T-024	1.5	0.06	13	180	2072598.60	602389.92	176.66
T-025	1.6	0.04	11	181	2072686.43	602435.66	176.57
T-028	1.6	0.10	14	179	2073687.55	600397.24	183.46
T-029	1.5	0.04		62	2073801.04	600470.07	182.88
T-030	1.4	0.11	15	180	2074408.07	599072.53	182.37
T-032	1.3	0.04	15	179	2075166.75	597768.82	182.34
T-033	1.4	0.03	12	181	2075266.94	597891.60	179.40
T-034	1.3	0.05	13	180	2076169.44	596667.01	176.26
T-035	1.2	0.04	14	181	2076277.63	596761.82	175.28
T-038	1.3	0.08	14	180	2077827.88	595179.54	167.57
T-039	1.4	0.04	14	181	2077984.87	595327.59	167.81
T-040	1.3	0.06	13	179	2078982.20	594213.94	153.86
T-041	1.4	0.03	13	181	2079114.22	594335.21	153.66
T-042	1.6	0.10	14	181	2080167.29	593257.83	152.28
T-043	1.6	0.04	10	181	2080232.25	593332.62	152.42
T-044	1.9	0.03	11	179	2081263.19	592277.81	158.70
T-045	1.4	0.03		185	2081359.62	592349.77	160.67
T-056	1.4	0.03	13	179	2083929.94	589498.34	169.20
T-059	1.5	0.06	14	182	2085696.16	588013.28	166.13
T-060	1.6	0.04	13	179	2085611.29	587897.64	166.21

Table 5 Survey Control Results

Desc	PDOP	H. Prec (95%)	Sat #	Epochs (1")	Easting	Northing	Leveled Elev
T-061	1.6	0.04	14	181	2086892.44	587047.35	152.65
T-062	1.4	0.04	13	178	2086787.87	586948.92	152.76
T-063	1.5	0.09	13	181	2088069.80	586097.59	164.64
T-064	2.3	0.04	10	178	2087962.10	586001.38	164.49
T-065	1.7	0.08	12	181	2089243.34	585151.60	171.25
T-066	1.3	0.04	13	182	2089142.18	585049.46	171.31
T-067	1.5	0.05	13	181	2090419.81	584202.84	170.82
T-068	1.6	0.04	11	181	2090325.19	584094.95	170.84
T-069	1.6	0.05	13	181	2091602.92	583248.72	169.93
T-070	1.6	0.04	12	184	2091507.54	583141.16	170.06
T-071	1.5	0.07	13	181	2092781.32	582297.98	171.21
T-072	1.6	0.05	12	179	2092675.84	582198.93	171.19
T-073	1.8	0.05	12	181	2093956.34	581350.96	170.60
T-074	1.6	0.48	12	179	2093848.43	581254.20	170.77
T-075	1.8	0.04		126	2095131.27	580404.09	169.09
T-076	2.2	0.16	11	179	2095026.96	580303.43	169.13
T-079	1.3	0.06	13	181	2096315.17	579448.67	167.63
T-080	1.4	0.34	9	178	2096203.06	579355.25	167.59
T-081	1.3	0.05	14	181	2097492.47	578499.68	166.25
T-082	1.4	0.11	10	179	2097386.90	578401.46	166.11
T-083	1.9	0.04		185	2098666.56	577554.09	164.65
T-084	1.7	0.07	12	181	2098565.01	577451.27	164.56
T-085	1.5	0.04	11	181	2099966.20	576510.59	164.11
T-086	1.3	0.07	13	181	2099841.86	576421.92	163.97
T-091	1.5	0.02	11	181	2102221.47	574733.46	164.53
T-093	1.9	0.03		184	2103386.01	573639.68	162.59
T-094	1.2	0.06	14	181	2103329.14	573479.51	161.12
T-095	1.4	0.05	13	181	2104495.50	572453.08	156.67
T-096	1.3	0.08	14	181	2104373.56	572358.72	156.83
T-097	1.4	0.05		62	2105523.85	571350.70	142.52
T-098	1.5	0.09	12	181	2105402.66	571256.69	142.70
T-100	1.5	0.11	10	196	2106433.44	570150.14	137.10
T-101	1.3	0.04	15	181	2107584.98	569142.15	143.05
T-102	1.5	0.08	12	181	2107580.52	568925.10	144.01
T-103	1.1	0.06		62	2108820.63	568018.30	143.66
T-104	1.8	0.04	11	181	2108712.33	567908.04	144.46
T-105	1.2	0.05	13	181	2110023.05	567103.96	142.43
T-106	1.8	0.06	10	181	2109904.48	567000.36	142.42

Desc	PDOP	H. Prec (95%)	Sat #	Epochs (1")	Easting	Northing	Leveled Elev
T-107	1.7	0.07	11	181	2111230.28	566187.24	141.95
T-108	1.4	0.03	13	181	2111119.72	566078.10	141.55
T-112	1.5	0.04	11	181	2112333.86	565157.03	141.18
T-113	1.8	0.04	12	181	2112432.35	565275.52	141.21
T-114	1.5	0.04	12	181	2113529.02	564249.54	139.98
T-115	1.8	0.05	12	181	2113642.38	564357.42	139.95
T-116	1.4	0.05	12	181	2114739.01	563330.69	138.65
T-117	1.6	0.03	12	181	2114842.72	563445.21	138.69
T-118	1.6	0.06	12	181	2115966.26	562398.16	135.22
T-119	1.8	0.03	12	181	2116045.26	562531.31	135.32
T-122	1.6	0.06	12	181	2117149.81	561498.57	132.11
T-123	1.4	0.06	12	181	2117244.17	561619.82	132.20
T-124	1.8	0.06	12	181	2118348.93	560586.74	129.38
T-125	1.5	0.04	13	181	2118481.68	560678.63	129.42
T-126	1.9	0.05	12	181	2119560.43	559665.63	126.75
T-127	2	0.04	10	181	2119658.61	559784.03	126.78
T-128	1.6	0.08	11	181	2120758.91	558753.43	123.54
T-129	2	0.06	10	181	2120852.19	558875.94	123.57
T-130	1.6	0.18	13	181	2121960.95	557838.93	119.98
T-131	2	0.07	12	181	2121968.91	558026.26	120.28
T-132	1.3	0.11	14	181	2123234.30	556769.34	116.04
T-133	2	0.10	12	181	2123145.00	557065.29	117.55
T-136	1.5	0.04	14	181	2125144.92	554691.95	109.64
T-137	1.9	0.08	12	181	2125270.30	554828.73	110.59
T-138	1.5	0.12	14	186	2126274.83	553521.51	107.44
T-139	1.3	0.08	15	181	2126446.57	553561.32	107.30
T-140	1.5	0.03	13	181	2127364.50	552347.59	104.49
T-141	1.8	0.05	13	181	2127603.18	552316.33	104.18
T-142	1.3	0.08	16	181	2128397.98	551235.32	101.63
T-143	1.3	0.07	13	181	2128517.32	551329.52	101.72
T-144	1.4	0.09	13	181	2129355.58	550204.40	99.15
T-145	1.3	0.06	14	181	2129144.19	550656.14	99.88
T-146	1.3	0.04	15	181	2130443.31	549032.62	99.69
T-147	1.3	0.16	13	181	2130566.22	549126.15	99.74
T-148	1.5	0.05	11	181	2131471.04	547925.56	101.30
T-149	1.3	0.05	14	181	2131599.74	548011.11	101.34
T-150	1.7	0.05	10	181	2132534.35	546780.97	102.87
T-151	1.3	0.04	15	181	2132604.15	546930.80	102.83

Desc	PDOP	H. Prec (95%)	Sat #	Epochs (1")	Easting	Northing	Leveled Elev
T-152	1.8	0.04	11	181	2133541.49	545696.05	104.30
T-153	1.3	0.05	14	181	2133661.76	545792.47	104.29
T-155	1.8	0.04	10	181	2134724.22	544648.04	104.25
T-156	1.2	0.04	12	181	2135593.34	543487.35	104.38
T-157	1.4	0.04	11	181	2135722.57	543573.93	104.28
T-160	1.3	0.05		184	2136104.59	542934.06	104.23
T-161	1.6	0.04	12	181	2136222.81	543030.21	104.29
T-163	1.3	0.03	12	181	2137211.79	541870.04	103.91
T-166	1.1	0.06	14	181	2138526.88	540006.72	102.20
T-167	1.4	0.03	12	181	2139085.34	539563.27	101.09
T-168	1.9	0.04	10	181	2139466.62	538830.70	100.00
T-169	1.4	0.03	13	181	2139802.88	538681.71	99.94
T-170	1.7	0.05	10	181	2140290.36	537838.41	99.14
T-171	1.3	0.03	13	185	2140357.52	537999.55	99.13
T-172	1.4	0.06	11	181	2141241.81	536667.51	97.98
T-173	1.4	0.03	13	181	2141366.71	536757.11	97.95
T-176	1.5	0.06	13	181	2143144.18	534325.93	95.63
T-177	1.5	0.04	13	181	2143278.73	534403.34	95.57
T-178	1.5	0.07	13	181	2144103.96	533146.01	94.33
T-179	1.5	0.05	12	181	2144226.69	533238.48	94.29
T-181	1.4	0.03	14	181	2145238.72	531993.07	91.97
T-182	1.3	0.04	15	181	2146115.06	530776.94	90.04
T-183	1.5	0.05	13	181	2146204.04	530903.08	88.84
T-184	1.3	0.05	15	181	2147389.59	529884.52	85.71
T-185	1.2	0.03	13	182	2147469.69	530029.55	85.65
T-187	1.2	0.04	14	181	2147978.90	529714.17	84.57
T-189	1.2	0.03	13	183	2149494.30	528818.81	86.45



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T-003	1.3	0.05	14	181	2064064.99	613273.57	232.33	Chevron
T-004	1.1	0.05	9	180	2064871.96	612171.05	202.43	Chevron
T-006	1.5	0.06	13	183	2065904.84	611083.98	196.34	Chevron
T-007	1.3	0.09	13	181	2065984.70	611145.13	196.27	Chevron
T-010	1.5	0.11	14	182	2066943.16	610010.51	190.88	Chevron
T-011	1.3	0.04	15	181	2067044.77	610048.68	190.70	Chevron
T-012	1.5	0.08	11	183	2067991.58	608926.76	185.51	Chevron
T-013	1.3	0.16	14	181	2068075.73	608982.54	185.22	Chevron
T-017	1.3	0.06	14	181	2069640.11	607307.63	177.61	Chevron
T-018	1.7	0.04	12	183	2070480.92	605994.98	168.80	Chevron
T-019	1.3	0.06	12	181	2070571.61	606086.50	170.92	Chevron
T-020	1.8	0.04	12	184	2071122.70	605034.90	164.90	Chevron
T-022	1.9	0.12	11	179	2071870.85	603704.90	162.23	Chevron
T-023	1.3	0.04	12	188	2071987.00	603699.56	162.81	Chevron
T-024	1.5	0.06	13	180	2072598.60	602389.92	176.66	Chevron
T-025	1.6	0.04	11	181	2072686.43	602435.66	176.57	Chevron
T-028	1.6	0.10	14	179	2073687.55	600397.24	183.46	Chevron
T-029	1.5	0.04	13	62	2073801.04	600470.07	182.88	Chevron
T-030	1.4	0.11	15	180	2074408.07	599072.53	182.37	Chevron
T-032	1.3	0.04	15	179	2075166.75	597768.82	182.34	Chevron
T-033	1.4	0.03	12	181	2075266.94	597891.60	179.40	Chevron
T-034	1.3	0.05	13	180	2076169.44	596667.01	176.26	Chevron
T-035	1.2	0.04	14	181	2076277.63	596761.82	175.28	Chevron
T-038	1.3	0.08	14	180	2077827.88	595179.54	167.57	Chevron
T-039	1.4	0.04	14	181	2077984.87	595327.59	167.81	Chevron
T-040	1.3	0.06	13	179	2078982.20	594213.94	153.86	Chevron
T-041	1.4	0.03	13	181	2079114.22	594335.21	153.66	Chevron
T-042	1.6	0.10	14	181	2080167.29	593257.83	152.28	Chevron
T-043	1.6	0.04	10	181	2080232.25	593332.62	152.42	Chevron
T-044	1.9	0.03	11	179	2081263.19	592277.81	158.70	Chevron
T-045	1.4	0.03	11	185	2081359.62	592349.77	160.67	Chevron
T-056	1.4	0.03	13	179	2083929.94	589498.34	169.20	Chevron
T-059	1.5	0.06	14	182	2085696.16	588013.28	166.13	Chevron
T-060	1.6	0.04	13	179	2085611.29	587897.64	166.21	Chevron
T-061	1.6	0.04	14	181	2086892.44	587047.35	152.65	Chevron
T-062	1.4	0.04	13	178	2086787.87	586948.92	152.76	Chevron
T-063	1.5	0.09	13	181	2088069.80	586097.59	164.64	Chevron
T-064	2.3	0.04	10	178	2087962.10	586001.38	164.49	Chevron
T-065	1.7	0.08	12	181	2089243.34	585151.60	171.25	Chevron



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T-066	1.3	0.04	13	182	2089142.18	585049.46	171.31	Chevron
T-067	1.5	0.05	13	181	2090419.81	584202.84	170.82	Chevron
T-068	1.6	0.04	11	181	2090325.19	584094.95	170.84	Chevron
T-069	1.6	0.05	13	181	2091602.92	583248.72	169.93	Chevron
T-070	1.6	0.04	12	184	2091507.54	583141.16	170.06	Chevron
T-071	1.5	0.07	13	181	2092781.32	582297.98	171.21	Chevron
T-072	1.6	0.05	12	179	2092675.84	582198.93	171.19	Chevron
T-073	1.8	0.05	12	181	2093956.34	581350.96	170.60	Chevron
T-074	1.6	0.48	12	179	2093848.43	581254.20	170.77	Chevron
T-075	1.8	0.04	12	126	2095131.27	580404.09	169.09	Chevron
T-076	2.2	0.16	11	179	2095026.96	580303.43	169.13	Chevron
T-079	1.3	0.06	13	181	2096315.17	579448.67	167.63	Chevron
T-080	1.4	0.34	9	178	2096203.06	579355.25	167.59	Chevron
T-081	1.3	0.05	14	181	2097492.47	578499.68	166.25	Chevron
T-082	1.4	0.11	10	179	2097386.90	578401.46	166.11	Chevron
T-083	1.9	0.04	11	185	2098666.56	577554.09	164.65	Chevron
T-084	1.7	0.07	12	181	2098565.01	577451.27	164.56	Chevron
T-085	1.5	0.04	11	181	2099966.20	576510.59	164.11	Chevron
T-086	1.3	0.07	13	181	2099841.86	576421.92	163.97	Chevron
T-091	1.5	0.02	11	181	2102221.47	574733.46	164.53	Chevron
T-093	1.9	0.03	12	184	2103386.01	573639.68	162.59	Chevron
T-094	1.2	0.06	14	181	2103329.14	573479.51	161.12	Chevron
T-095	1.4	0.05	13	181	2104495.50	572453.08	156.67	Chevron
T-096	1.3	0.08	14	181	2104373.56	572358.72	156.83	Chevron
T-097	1.4	0.05	11	62	2105523.85	571350.70	142.52	Chevron
T-098	1.5	0.09	12	181	2105402.66	571256.69	142.70	Chevron
T-100	1.5	0.11	10	196	2106433.44	570150.14	137.10	Chevron
T-101	1.3	0.04	15	181	2107584.98	569142.15	143.05	Chevron
T-102	1.5	0.08	12	181	2107580.52	568925.10	144.01	Chevron
T-103	1.1	0.06	11	62	2108820.63	568018.30	143.66	Chevron
T-104	1.8	0.04	11	181	2108712.33	567908.04	144.46	Chevron
T-105	1.2	0.05	13	181	2110023.05	567103.96	142.43	Chevron
T-106	1.8	0.06	10	181	2109904.48	567000.36	142.42	Chevron
T-107	1.7	0.07	11	181	2111230.28	566187.24	141.95	Chevron
T-108	1.4	0.03	13	181	2111119.72	566078.10	141.55	Chevron
T-112	1.5	0.04	11	181	2112333.86	565157.03	141.18	Chevron
T-113	1.8	0.04	12	181	2112432.35	565275.52	141.21	Chevron
T-114	1.5	0.04	12	181	2113529.02	564249.54	139.98	Chevron
T-115	1.8	0.05	12	181	2113642.38	564357.42	139.95	Chevron



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T-116	1.4	0.05	12	181	2114739.01	563330.69	138.65	Chevron
T-117	1.6	0.03	12	181	2114842.72	563445.21	138.69	Chevron
T-118	1.6	0.06	12	181	2115966.26	562398.16	135.22	Chevron
T-119	1.8	0.03	12	181	2116045.26	562531.31	135.32	Chevron
T-122	1.6	0.06	12	181	2117149.81	561498.57	132.11	Chevron
T-123	1.4	0.06	12	181	2117244.17	561619.82	132.20	Chevron
T-124	1.8	0.06	12	181	2118348.93	560586.74	129.38	Chevron
T-125	1.5	0.04	13	181	2118481.68	560678.63	129.42	Chevron
T-126	1.9	0.05	12	181	2119560.43	559665.63	126.75	Chevron
T-127	2	0.04	10	181	2119658.61	559784.03	126.78	Chevron
T-128	1.6	0.08	11	181	2120758.91	558753.43	123.54	Chevron
T-129	2	0.06	10	181	2120852.19	558875.94	123.57	Chevron
T-130	1.6	0.18	13	181	2121960.95	557838.93	119.98	Chevron
T-131	2	0.07	12	181	2121968.91	558026.26	120.28	Chevron
T-132	1.3	0.11	14	181	2123234.30	556769.34	116.04	Chevron
T-133	2	0.10	12	181	2123145.00	557065.29	117.55	Chevron
T-136	1.5	0.04	14	181	2125144.92	554691.95	109.64	Chevron
T-137	1.9	0.08	12	181	2125270.30	554828.73	110.59	Chevron
T-138	1.5	0.12	14	186	2126274.83	553521.51	107.44	Chevron
T-139	1.3	0.08	15	181	2126446.57	553561.32	107.30	Chevron
T-140	1.5	0.03	13	181	2127364.50	552347.59	104.49	Chevron
T-141	1.8	0.05	13	181	2127603.18	552316.33	104.18	Chevron
T-142	1.3	0.08	16	181	2128397.98	551235.32	101.63	Chevron
T-143	1.3	0.07	13	181	2128517.32	551329.52	101.72	Chevron
T-144	1.4	0.09	13	181	2129355.58	550204.40	99.15	Chevron
T-145	1.3	0.06	14	181	2129144.19	550656.14	99.88	Chevron
T-146	1.3	0.04	15	181	2130443.31	549032.62	99.69	Chevron
T-147	1.3	0.16	13	181	2130566.22	549126.15	99.74	Chevron
T-148	1.5	0.05	11	181	2131471.04	547925.56	101.30	Chevron
T-149	1.3	0.05	14	181	2131599.74	548011.11	101.34	Chevron
T-150	1.7	0.05	10	181	2132534.35	546780.97	102.87	Chevron
T-151	1.3	0.04	15	181	2132604.15	546930.80	102.83	Chevron
T-152	1.8	0.04	11	181	2133541.49	545696.05	104.30	Chevron
T-153	1.3	0.05	14	181	2133661.76	545792.47	104.29	Chevron
T-155	1.8	0.04	10	181	2134724.22	544648.04	104.25	Chevron
T-156	1.2	0.04	12	181	2135593.34	543487.35	104.38	Chevron
T-157	1.4	0.04	11	181	2135722.57	543573.93	104.28	Chevron
T-160	1.3	0.05	11	184	2136104.59	542934.06	104.23	Chevron
T-161	1.6	0.04	12	181	2136222.81	543030.21	104.29	Chevron



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T-163	1.3	0.03	12	181	2137211.79	541870.04	103.91	Chevron
T-166	1.1	0.06	14	181	2138526.88	540006.72	102.20	Chevron
T-167	1.4	0.03	12	181	2139085.34	539563.27	101.09	Chevron
T-168	1.9	0.04	10	181	2139466.62	538830.70	100.00	Chevron
T-169	1.4	0.03	13	181	2139802.88	538681.71	99.94	Chevron
T-170	1.7	0.05	10	181	2140290.36	537838.41	99.14	Chevron
T-171	1.3	0.03	13	185	2140357.52	537999.55	99.13	Chevron
T-172	1.4	0.06	11	181	2141241.81	536667.51	97.98	Chevron
T-173	1.4	0.03	13	181	2141366.71	536757.11	97.95	Chevron
T-176	1.5	0.06	13	181	2143144.18	534325.93	95.63	Chevron
T-177	1.5	0.04	13	181	2143278.73	534403.34	95.57	Chevron
T-178	1.5	0.07	13	181	2144103.96	533146.01	94.33	Chevron
T-179	1.5	0.05	12	181	2144226.69	533238.48	94.29	Chevron
T-181	1.4	0.03	14	181	2145238.72	531993.07	91.97	Chevron
T-182	1.3	0.04	15	181	2146115.06	530776.94	90.04	Chevron
T-183	1.5	0.05	13	181	2146204.04	530903.08	88.84	Chevron
T-184	1.3	0.05	15	181	2147389.59	529884.52	85.71	Chevron
T-185	1.2	0.03	13	182	2147469.69	530029.55	85.65	Chevron
T-187	1.2	0.04	14	181	2147978.90	529714.17	84.57	Chevron
T-189	1.2	0.03	13	183	2149494.30	528818.81	86.45	Chevron
600	1.8	0.017	13	180	613967.63	2064270.06	203.14	PSC
	1.2	0.023	15	182				
	1.2	0.021	15	181				
601	1.7	0.02	13	199	613168.12	2063100.81	206.10	PSC
	1.3	0.029	13	185				
	1.1	0.028	16	255				
602	1.7	0.018	12	180	610203.35	2066748.89	191.23	PSC
	1.3	0.072	12	179				
	1.9	0.025	11	179				
603	1.3	0.029	13	188	609139.14	2067931.10	185.57	PSC
604	1.3	0.035	12	221	605724.99	2070665.32	167.27	PSC
	1.8	0.022	11	180				
	1.3	0.021	13	205				
605	1.5	0.036	12	179	606260.09	2070456.73	171.61	PSC
606	1.4	0.033	13	183	601305.50	2072582.92	183.10	PSC
	1.2	0.041	15	180				
	1.5	0.038	14	226				
607	1.7	0.031	11	183	601544.09	2073915.09	178.68	PSC
	1.4	0.036	12	180				



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608	1.3	0.034	12	186	595474.29	2076800.45	172.14	PSC
	1.4	0.027	12	179				
	1.2	0.048	10	194				
	1.5	0.023	12	180				
609	1.4	0.024	13	183	596075.70	2077873.47	170.67	PSC
	1.4	0.027	12	181				
	1.4	0.028	13	180				
612	1.3	0.031	13	185	591124.73	2081654.39	172.00	PSC
	1.3	0.047	12	180				
	1.2	0.03	13	225				
	1.7	0.029	10	181				
	1.3	0.05	15	181				
613	2	0.014	11	240	591477.38	2083100.61	169.66	PSC
	1.2	0.028	13	180				
	1.6	0.018	12	188				
614	1.6	0.065	11	181	586520.30	2087555.36	157.11	PSC
	1.3	0.12	14	181				
615	1.4	0.129	12	186	585457.51	2088621.64	167.24	PSC
	2.2	0.027	10	180				
	1.5	0.022	11	181				
	1.3	0.037	12	181				
616	1.3	0.046	11	181	583278.08	2091577.01	169.49	PSC
	1.4	0.069	13	181				
617	1.5	0.044	11	180	582340.11	2092736.04	170.66	PSC
	1.4	0.047	13	181				
618	1.7	0.093	11	180	579886.56	2095780.58	167.93	PSC
	1.3	0.049	12	181				
	1.3	0.036	12	181				
619	1.3	0.035	12	181	578657.62	2097304.52	165.94	PSC
	1.2	0.159	11	185				
	1.3	0.048	14	182				
620	1.1	0.051	16	179	574611.84	2101061.62	167.28	PSC
	1.5	0.017	12	181				
	1.2	0.017	14	180				
	1.2	0.039	14	181				
	1.2	0.031	14	181				
621	1.1	0.033	17	180	576059.89	2101790.17	163.34	PSC
	1.4	0.04	12	180				
	1.3	0.057	14	182				



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	1.5	0.031	13	181				
	1.3	0.042	15	181				
622	1.5	0.049	13	182	572828.10	2103926.63	158.71	PSC
	1.7	0.033	11	179				
	1.6	0.03	11	182				
623	1.6	0.041	13	181	572167.53	2104769.35	152.71	PSC
	1.8	0.045	12	181				
624	1.4	0.02	10	198	569204.49	2107309.48	142.18	PSC
	1.4	0.097	12	179				
625	2.1	0.048	10	181	568179.50	2108629.71	143.27	PSC
	1.5	0.03	13	181				
628	1.7	0.031	10	181	562605.87	2115957.96	135.47	PSC
	1.3	0.025	14	181				
629	1.5	0.03	10	181	561658.32	2117203.71	132.06	PSC
	1.3	0.075	12	181				
630	2.4	0.035	10	181	559574.89	2119941.48	126.26	PSC
	1.5	0.045	12	181				
631	1.5	0.061	10	181	558667.03	2121133.71	122.57	PSC
	1.3	0.038	12	181				
632	1.3	0.019	15	180	555128.86	2123687.02	108.10	PSC
	1.3	0.035	14	180				
	1.2	0.014	14	179				
	1.5	0.018	13	181				
	1.5	0.019	13	181				
633	1.3	0.021	16	180	555755.06	2125299.38	110.27	PSC
	1.3	0.025	14	184				
	1.3	0.022	14	182				
	1.4	0.023	12	181				
	1.6	0.022	12	181				
634	1.8	0.028	12	181	552076.88	2127833.21	103.14	PSC
	1.3	0.028	14	181				
635	1.3	0.024	13	181	551291.68	2128337.33	101.29	PSC
	1.4	0.032	13	179				
	1.4	0.044	12	181				
	1.2	0.04	14	181				
636	1.4	0.043	11	181	548477.01	2131176.81	99.93	PSC
	1.2	0.049	14	181				
637	1.5	0.031	10	181	547372.50	2132202.63	101.71	PSC
	1.3	0.028	13	181				



M A Engineering Consultants, Inc.

Project: I-26 mm 149-172
MA Job No: 0935.001.10300

PCR

Date Begin Report:

*Project Control
Report*
June 14, 2017
**Final
Report**

Point ID	PDOP	95% Horiz. Prec (ft)	# of Sat's	Epochs (1 sec)	Northing	Easting	Elev	Point Desc
638	1.9	0.091	10	180	544849.87	2134319.42	103.71	PSC
	1.9	0.029	10	179				
	1.8	0.024	11	181				
	1.4	0.037	11	181				
640	1.2	0.034	14	180	540623.84	2138253.40	101.71	PSC
	1.7	0.018	11	181				
643	1.4	0.051	11	181	535690.71	2142027.71	96.06	PSC
	1.6	0.048	13	182				
646	1.4	0.048	14	179	529082.04	2149061.49	83.27	PSC
	1.3	0.025	11	180				
	1.7	0.03	12	181				