



## FUGRO GEOSPATIAL, INC.

### Accuracy Report

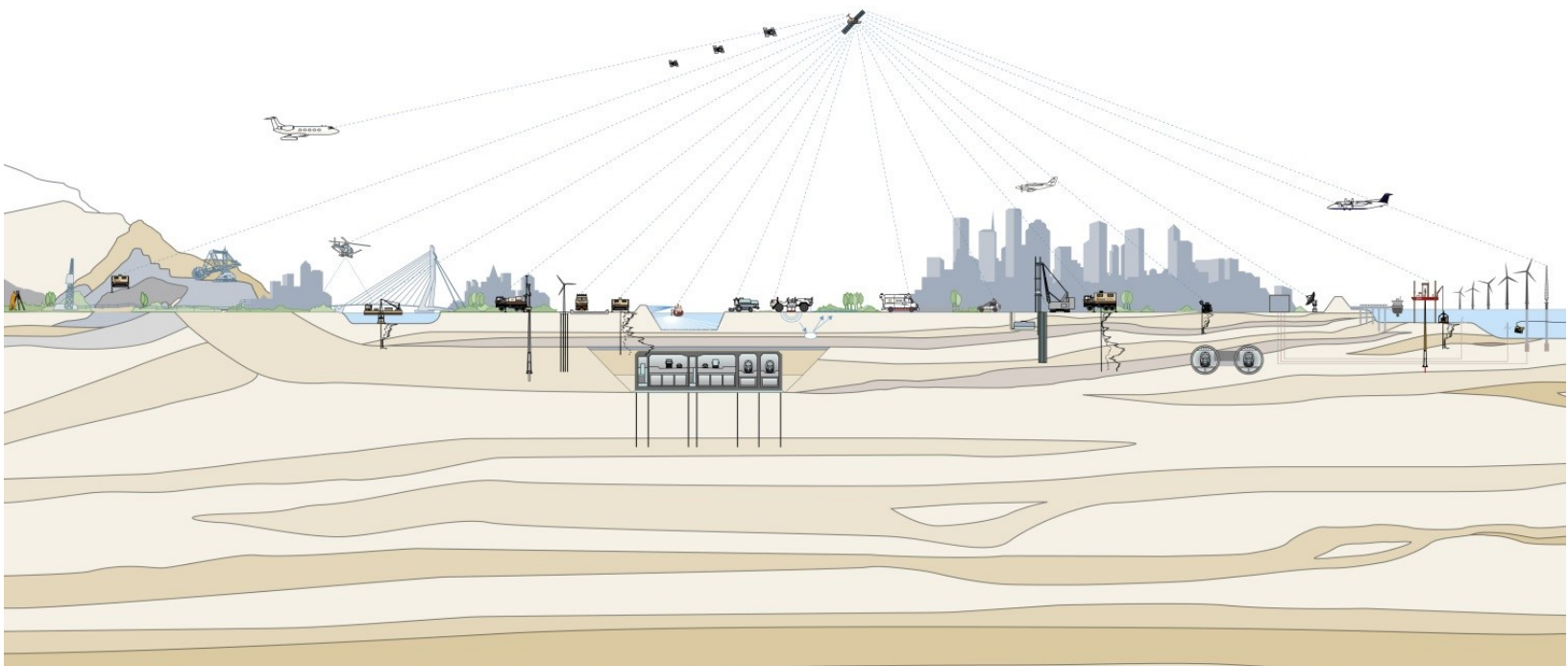
SD\_Southwest\_NRCS\_2018\_D18

Prepared for:

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**1. ACCURACY REPORTING**

Data collected under this Task Order meets the National Standard for Spatial Database Accuracy (NSSDA) accuracy standards. The NSSDA standards specify that vertical accuracy be reported at the 95 percent confidence level for data tested by an independent source of higher accuracy.

**1.1 Positional Accuracy**

Before classification and development of derivative products from the point cloud, the absolute and relative vertical accuracies of the point cloud were verified.

**1.2 Absolute Vertical Accuracy**

**Unclassified Lidar Point Cloud Data:** The Non-Vegetated Vertical Accuracy (NVA) of the Lidar Point Cloud data was calculated against TINs derived from the final calibrated and controlled swath data. The required accuracy ( $ACC_z$ ) is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on  $RMSE_z$  of 10 cm in the “open terrain” and/or “Urban” land cover categories. This is a required accuracy. Please refer to the table below for the achieved accuracies. The raw swath point cloud data met the required accuracy levels before point cloud classification and derivative product generation.

**Table 1: Accuracy of the Lidar Point Cloud Data**

Raw Flight Lines	$RMSE_z$ (non-vegetated)	NVA at 95-percent confidence level
Specification (cm)	$\leq 10$	$\leq 19.6$
Calculated Values (cm)	5.5	10.8
<i>Specification (m)</i>	$\leq 0.100$	$\leq 0.196$
<i>Calculated Values (m)</i>	0.055	0.108
Number of points	39	39

**Bare Earth Surface:** The accuracy ( $ACC_z$ ) of the derived DEM was calculated and is being reported in three (3) ways:

- $RMSE_z$  (Non-Vegetated):** The required  $RMSE_z$  is  $\leq 10$  cm.
- Non-Vegetated Vertical Accuracy (NVA):** The required NVA is:  $\leq 19.6$  cm at a 95% confidence level, derived according to NSSDA, i.e., based on  $RMSE_z$  of 10 cm in the “open terrain” and/or “Urban” land cover categories. This is a required accuracy.
- Vegetated Vertical Accuracy (VVA):** The required VVA is:  $\leq 29.4$  cm at a 95<sup>th</sup> percentile level, derived according to ASPRS Guidelines, Vertical Accuracy for Reporting LiDAR Data, i.e. based on the 95<sup>th</sup> percentile error in Vegetated land cover categories combined (Tall Grass, Brush, Forested Areas). This is a required accuracy.

Please refer to the table below for the achieved accuracies.

**Table 2: Accuracy of the Derived DEM**



DEM	RMSE <sub>z</sub> (non-vegetated)	NVA at 95-percent confidence level	VVA at 95th percentiles
Specification (cm)	≤ 10	≤ 19.6	≤ 29.4
Calculated Values (cm)	5.7	11.2	15.4
<i>Specification (m)</i>	<i>≤ 0.100</i>	<i>≤ 0.196</i>	<i>≤ 0.294</i>
<i>Calculated Values (m)</i>	<i>0.057</i>	<i>0.112</i>	<i>0.154</i>
Number of points	39	39	39

### 1.3 Relative Accuracy

**Smooth Surface Repeatability:** In ideal theoretical conditions, smooth surface repeatability is a measure of variations documented on a surface that would be expected to be flat and without variation. Users of lidar technology commonly refer to these variations as “noise.” Single-swath data was assessed using only single returns in non-vegetated areas. Repeatability was evaluated by measuring departures from planarity of single returns from hard planar surfaces, normalizing for actual variation in the surface elevation. Repeatability of only single returns was then assessed at multiple locations within hard surfaced areas (for example, parking lots or large rooftops).

Each sample area was evaluated using a signed difference raster (maximum elevation – minimum elevation) at a cell size equal to twice the ANPS, rounded up to the next integer. Sample areas were approximately 50 square meters (m<sup>2</sup>). The maximum acceptable variations within sample areas for this project is 6 cm. Isolated noise is expected within the sample areas and was disregarded.

The evaluation was done on 32 flat open sample areas over the Delivery 1 area. The results are shown in the table below, please also refer to

*USGS\_SD\_2018\_Delivery\_1\_Smooth\_Surface\_Repeatability.shp*

**Table 3: Relative Accuracy, Smooth Surface Repeatability**

Max_DZ (m)	Area (sq m)
0.049	79
0.052	66
0.043	131
0.048	169
0.043	104
0.053	242
0.052	929
0.046	171
0.044	290
0.035	280
0.038	250
0.038	175
0.038	143



0.039	138
0.027	239
0.031	124
0.044	275
0.055	224
0.033	192
0.048	261
0.051	234
0.049	274
0.043	163
0.046	70
0.048	220
0.039	149
0.057	153
0.032	55
0.035	77
0.042	162
0.034	100
0.055	74

**Overlap Consistency:** Overlap consistency is a measure of geometric alignment of two overlapping swaths; the principles used with swaths can be applied to overlapping lifts and projects as well. Overlap consistency is the fundamental measure of the quality of the calibration or boresight adjustment of the data from each lift, and is of particular importance as the match between the swaths of a single lift is a strong indicator of the overall geometric quality of the data, establishing the quality and accuracy limits of all downstream data and products.

Overlap consistency was assessed at multiple locations within overlap in non-vegetated areas of only single returns.

Each overlap area was evaluated using a signed difference raster with a cell size equal to twice the ANPS, rounded up to the next integer. The difference rasters are visually examined using a bicolor ramp from the negative acceptable limit to the positive acceptable limit. Although isolated excursions beyond the limits are expected and accepted, differences in the overlaps shall not exceed the following limits:

1. Swath overlap difference,  $RMSDz \leq 8$  cm
2. Swath overlap difference, maximum  $\pm 16$  cm

The difference rasters are also statistically summarized to verify that root mean square difference in z (RMSDz) values do not exceed the project specifications. Consideration will be given for the effect of the expected isolated excursions over limits.

The result of the evaluation over 68 samples throughout the Delivery 1 area is shown in the table below, please also refer to also refer to:

*USGS\_SD\_2018\_Delivery\_1\_Relative\_Accuracy\_Flightline\_Overlap.shp*

**Table 4: Relative Accuracy, Overlap Consistency**

RMS_DZ (m)	Max_DZ (m)	Min_DZ (m)	Area (sq m)
0.0167	0.0549	-0.0512	523
0.0195	0.0387	-0.0815	585
0.0208	0.0508	-0.0171	835
0.0479	0.1239	-0.0204	667
0.0199	0.0517	-0.0352	766
0.0356	0.0189	-0.0703	761
0.0247	0.1458	-0.0609	846
0.0281	0.0251	-0.0851	691
0.0665	-0.0129	-0.1067	1181
0.0477	0.0865	0.0099	685
0.0326	0.081	-0.0801	1138
0.0213	0.0693	-0.064	1300
0.0322	0.1212	-0.0474	830
0.0069	0.0243	-0.021	761
0.0291	0.0505	0.0025	766
0.0377	0.1165	-0.0815	446
0.0183	0.0591	-0.0589	653
0.0574	-0.0279	-0.1053	947
0.0363	0.0958	-0.032	1410
0.0219	0.0724	-0.0289	1737
0.0179	0.0887	-0.0826	1473
0.0289	0.031	-0.0643	1335
0.0234	0.0507	-0.004	896
0.0198	0.0532	-0.0528	1520
0.0467	-0.0053	-0.0921	1045
0.047	0.0194	-0.1322	1635
0.0104	0.04	-0.0457	1025
0.0393	0.1001	-0.0203	1097
0.0637	0.1153	0.0056	893

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0.0647	0.0991	0.0232	1228
0.0111	0.0375	-0.0258	696
0.0116	0.0693	-0.0463	972
0.0285	0.122	-0.1226	496
0.0445	0.0836	0.0103	462
0.0169	0.061	-0.0306	973
0.0414	-0.0083	-0.095	543
0.0139	0.0444	-0.0504	683
0.0617	0.1389	0.0174	887
0.0345	0.0815	-0.0225	887
0.0711	0.1263	-0.0062	935
0.0491	0.1072	-0.0133	544
0.0101	0.0389	-0.0342	983
0.0297	0.1357	-0.1447	871
0.0343	0.071	-0.0095	962
0.0368	0.067	-0.0021	676
0.0136	0.051	-0.041	867
0.049	-0.0097	-0.0907	569
0.0126	0.0295	-0.0461	905
0.0207	0.0437	-0.0061	602
0.0304	0.0966	-0.1461	678
0.016	0.0592	-0.0692	813
0.035	0.1005	-0.0299	673
0.0202	0.0109	-0.0568	517
0.0755	-0.0355	-0.1099	583
0.0168	0.0607	-0.0248	477
0.0483	0.0183	-0.1017	700
0.028	0.0927	-0.0389	713
0.0159	0.0438	-0.0443	807
0.0301	0.1099	-0.0956	1311
0.0247	0.064	-0.0135	1412
0.0117	0.03	-0.0441	872
0.0127	0.0523	-0.0576	1050
0.0363	0.0106	-0.0961	1176
0.0546	0.0207	-0.1367	1269
0.0215	0.0701	-0.0411	599
0.037	0.005	-0.0709	512
0.0206	0.0369	-0.0693	485
0.0121	0.0228	-0.037	522