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# TECHNICAL PROJECT REPORT

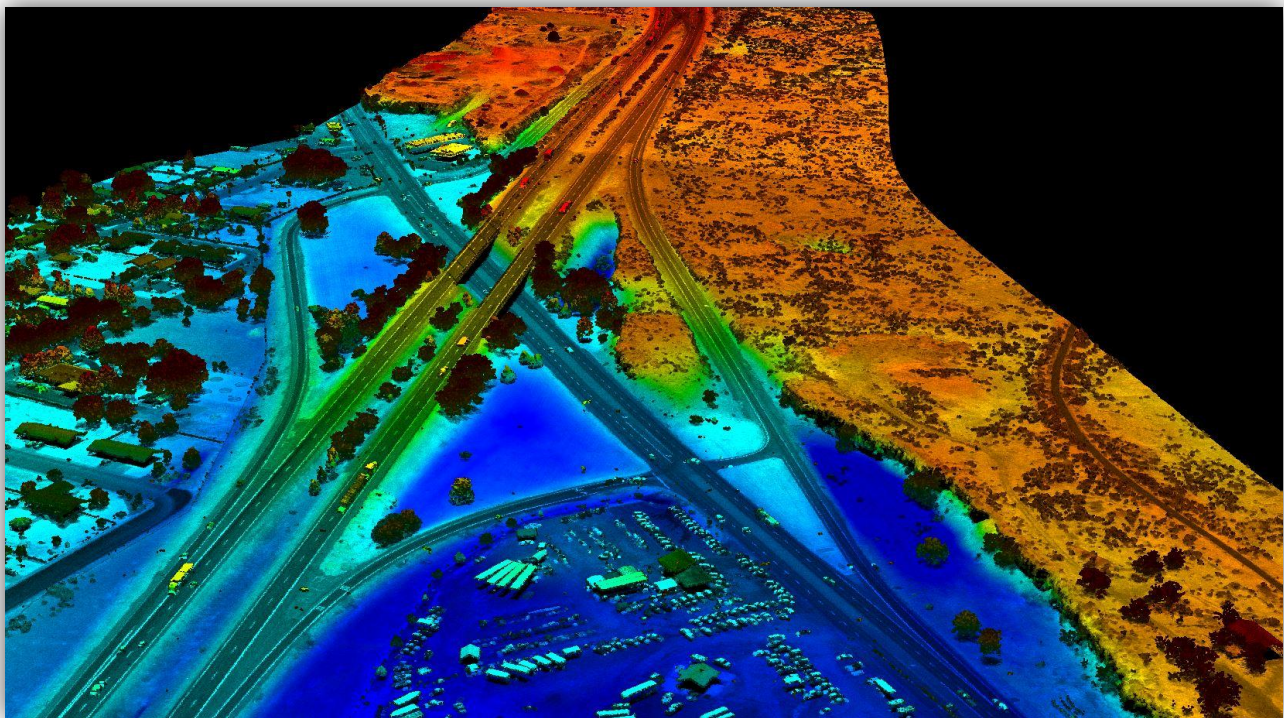
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## D5 AERIAL PHOTOGRAPHY AND LIDAR

Project Nos. A014(008), A014(009)

and Key Nos. 14008, 14009

**April 2016-August 2017**



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# Technical Project Report

## D5 Aerial Photography and LiDAR

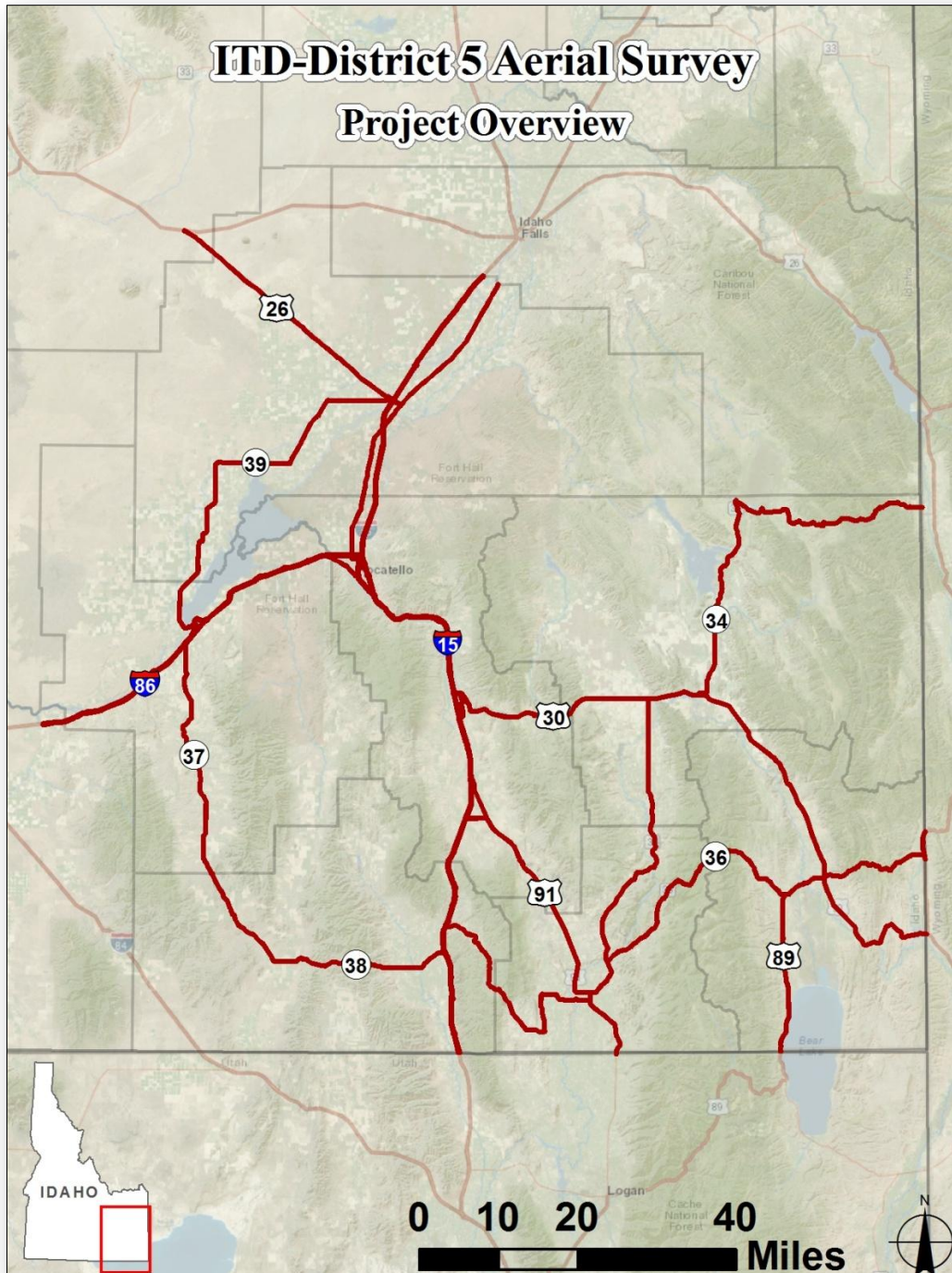
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# 1. Overview

This project entails aerial photography/LiDAR acquisition and mapping for the District 5 – District Wide Aerial Mapping Project and Avery Parcels located in Bannock, Bear Lake, Bingham, Caribou, Franklin, Oneida, and Power Counties in southeastern Idaho. The LiDAR and imagery data were acquired between April 7 and October 12, 2016.

**Exhibit 1:** D5 Aerial Photography and LiDAR project overview



## 2. Acquisition

### 2.1 LiDAR and Imagery Acquisition – Equipment and Methodology

LiDAR and imagery acquisition for the D5 project was performed simultaneously with an Optech ALTM Orion H300 LiDAR sensor and an Optech CS-10000 aerial camera system. The LiDAR sensor and the aerial camera were paired in a customized mount to minimize error and increase accuracy between datasets. Aero-Graphics flew at an average altitude of 3,300 ft AGL (above ground level) and made appropriate adjustments to compensate for topographic relief. The imagery was acquired at a 0.25' (7.5cm) ground sampling distance with 30% overlap, collecting 6,788 images over 411 flightlines. LiDAR acquisition was performed with 30% overlap and yielded an average 9.6 points per square meter throughout the project area. The PRF (pulse rate frequency) used for collection was 225 kHz, scan frequency 68.7 Hz, and scan angle +/- 14.5° from the nadir position (full scan angle 29°).

**Exhibit 2:** Summary of planned flight parameters

Altitude (ft AGL)	Overlap (%)	Speed (kts)	PRF (kHz)	Scan Freq (Hz)	Scan Angle ° (full)
3,300	30	115	225	68.7	29

PPM <sup>2</sup> (mean)	Post spacing Cross Track (m)	Post Spacing Down Track (m)	Swath Width (m)	# Flightlines	# Images
7.28	0.43	0.43	522.41	411	6,788

The Orion H300 can send/receive up to 300,000 pulses per second and is capable of receiving up to four range measurements, including 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, and last returns for every pulse sent from the system. The Orion H300 features roll compensation that adjusts the mirror to maintain the full scan angle integrity in relation to nadir, even when less than perfect weather conditions push the sensor off nadir. It is also equipped with a GPS/IMU unit that continually records the XYZ position and roll, pitch and yaw attitude of the plane throughout the flight. This information allows us to correct laser return data positions that may have been thrown off by the plane's natural movement.

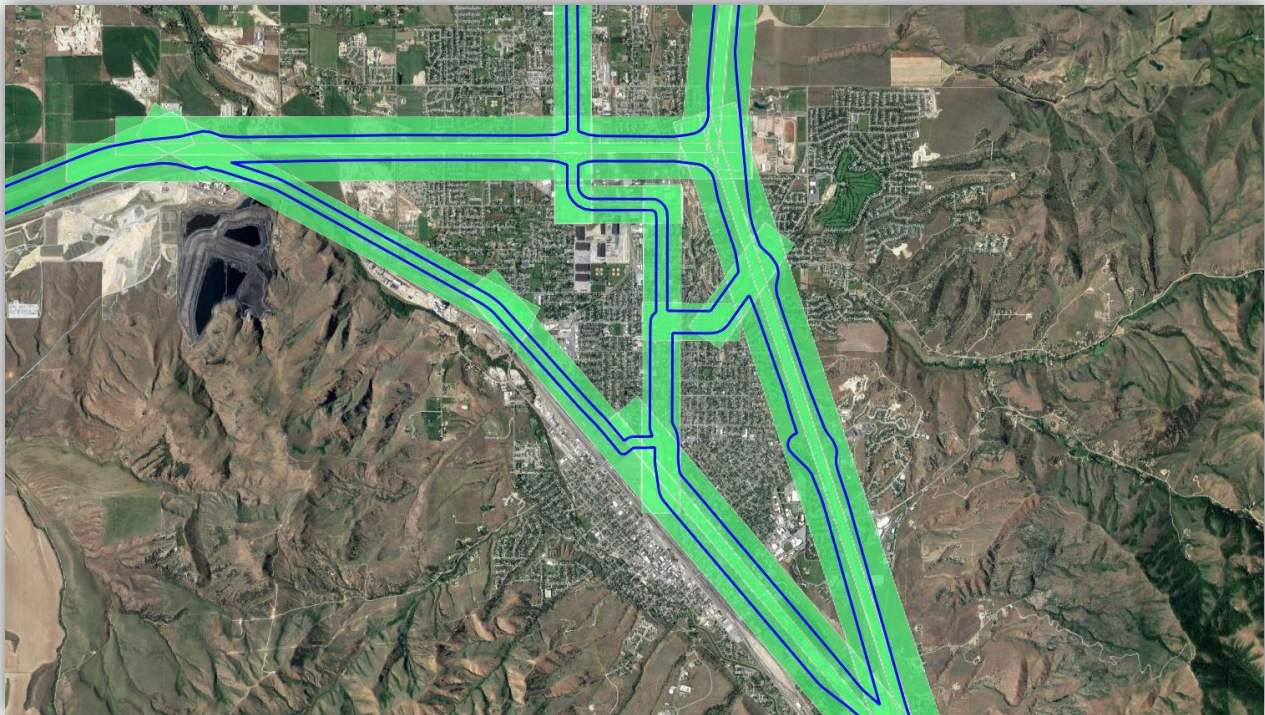
**Exhibit 3:** The acquisition platform for the D5 Aerial Photography and LiDAR project was a turbocharged Cessna 206. Our 206 has been customized for LiDAR and other airborne sensors with an upgraded power system and avionics. The stability of the Cessna 206 is ideal for LiDAR collection



The ALTM Orion H300 LiDAR sensor is equipped with FMS Planner Flight Management System Software, which is the latest release from Optech. Aero-Graphics utilizes FMS Planner to both plan the flight and guide the airborne mission while in flight. This smooth transition from flight planning to aerial operations eliminates discrepancies between the flight plan and the actual airborne mission. The use of FMS Planner helps ensure an accurate and consistent acquisition mission with real-time quality assurance while still airborne. The system operator can monitor the point density and swath during the mission to confirm adequate coverage within the area of interest, as shown in **Exhibit 4**.



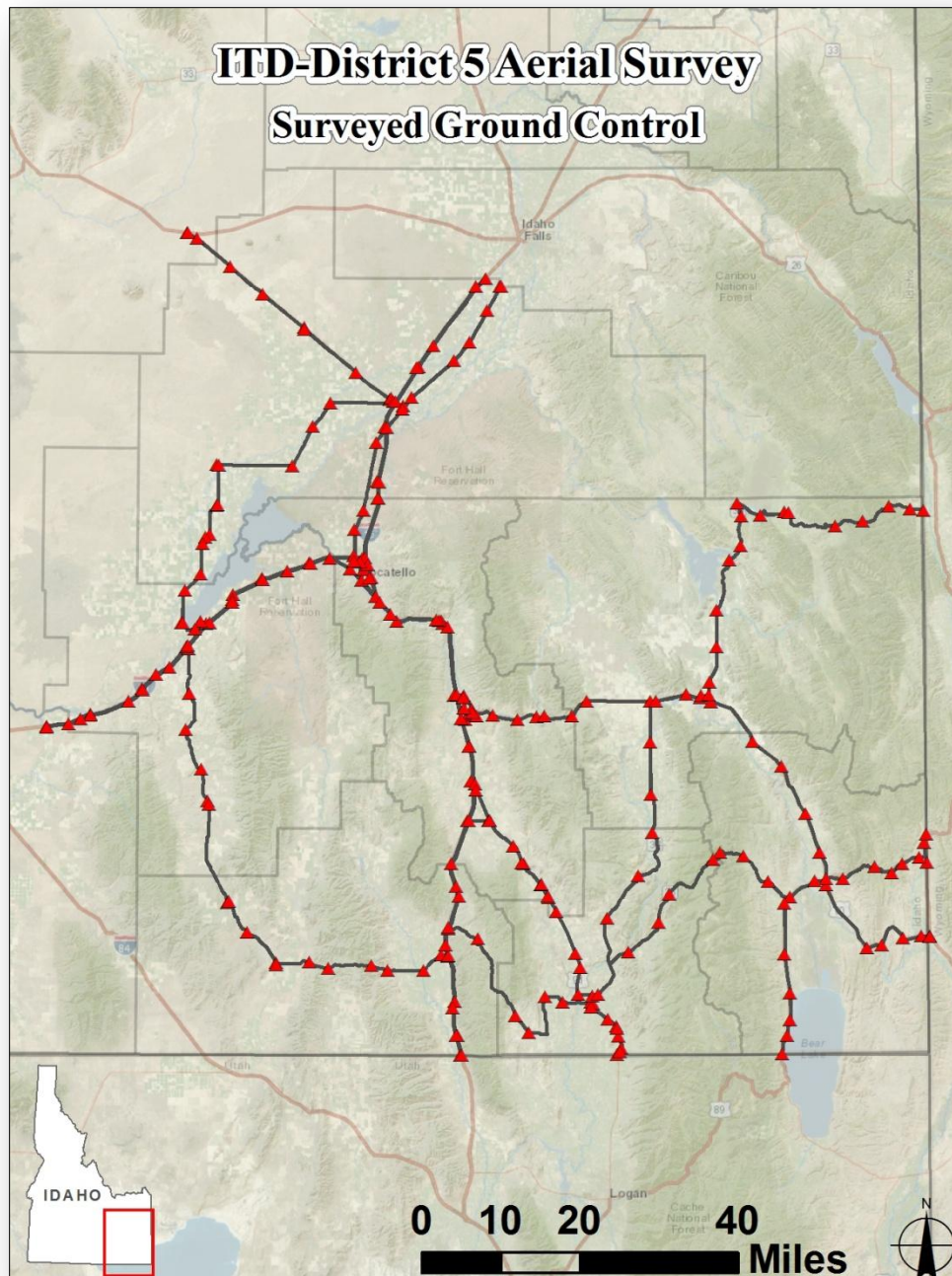
**Exhibit 4:** Swath data for the D5 Aerial Photography and LiDAR project was recorded and viewed real-time by the operator.



## 2.2 Ground Survey – Equipment and Methodology

Aero-Graphics used CORS base stations and statically-collected survey data at strategic points throughout the project area to ensure that the LiDAR and imagery data maintained its true geographic integrity. Single-base and SmartBase solutions were used to differentially correct the aircraft’s trajectory data. Control point and base station coordinates can be found in Appendix A. LiDAR positional accuracy can be found in section 4.2.

**Exhibit 5:** Static ground control for the D5 Aerial Photography and LiDAR project



### 3. LiDAR Processing Workflow

- a. **Absolute Sensor Calibration.** Our absolute sensor calibration adjusted for the difference in roll, pitch, heading, and scale between the raw laser point cloud from the sensor and surveyed control points on the ground.
- b. **Kinematic Air Point Processing.** Differentially corrected the 1-second airborne GPS positions with ground base station; combined and refined the GPS positions with 1/200-second IMU (roll-pitch-yaw) data through development of a smoothed best estimate of trajectory (SBET).
- c. **Raw LiDAR Point Processing (Calibration).** Combined SBET with raw LiDAR range data; solved real-world position for each laser point; produced point cloud data by flight strip in ASPRS v1.2 .LAS format; output in local coordinate system.
- d. **Relative Calibration.** Performed relative calibration by correcting for roll, pitch, heading, and scale discrepancies between adjacent flightlines; tested resulting relative accuracy. Results presented in Section 4.1.
- e. **Vertical Accuracy Assessment.** Performed comparative tests that showed Z-differences between each static survey point and the laser point surface. Results presented in Sect. 4.2.
- f. **Tiling & Long/Short Filtering.** Cut data into project-specified tiles and filtered out grossly long and short returns.
- g. **Classification & QA/QC.** Ran classification algorithms on points in each tile; separated into the following classes: 1-Processed, but unclassified, 2-Bare Earth, 7-Low Noise, 9-Water, 17-Bridge Decks, 18-High Noise, 20-Ignored Ground ; revisited areas not completely classified automatically and manually corrected them.

## 4. Results

### 4.1 Relative Calibration Accuracy Results

*Between-swath* relative accuracy is defined as the elevation difference in overlapping areas between a given set of two adjacent flightlines. The statistics are based on the comparison of the flightlines and points listed below.

#### **ITD-District 5 project area: (419 flightlines, > 3 billion points)**

- Between-swath relative accuracy **average** of 0.058 foot

#### **Avery Parcels: (5 flightlines, > 15 million points)**

- Between-swath relative accuracy **average** of 0.048 foot

*Within-swath* relative accuracy is the amount of vertical separation, or “noise,” among a set of points on open, paved ground that should have the same elevation. The within-swath relative accuracy average is less than **0.026 foot**.

## 4.2 Vertical Accuracy

The following exhibits display the Non-vegetated Vertical Accuracy (NVA) results for the ITD-District 5 and Avery Parcels project areas. NVA is defined as the elevation difference between the LiDAR surface and ground surveyed static points collected in open terrain (bare soil, sand, rocks, and short grass) as well as urban terrain (asphalt and concrete surfaces). VVA is defined as the elevation difference between the LiDAR surface and ground surveyed static points collected in all vegetated land cover categories combined, including tall weeds and crops, brush lands, and lightly- to fully-forested land cover categories.

**Exhibit 6:** *Non-vegetated Vertical Accuracy (NVA) of the ITD-District 5 overall project area*

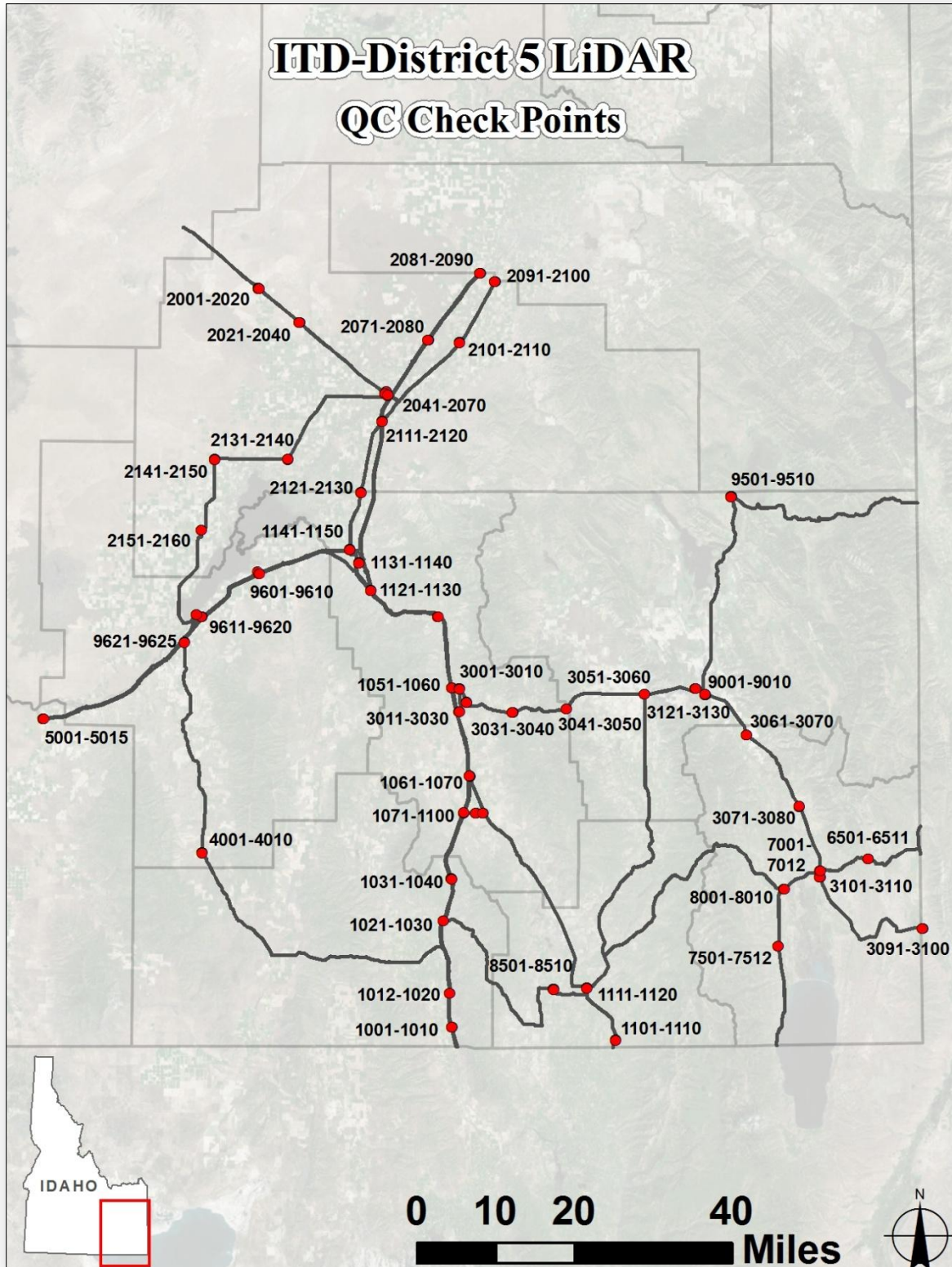
<b>Accuracy<sub>z</sub>: Tested 0.202 feet Non-vegetated Vertical Accuracy (NVA) at 95 percent confidence level in all open and non-vegetated land cover categories combined using RMSE<sub>z</sub> x 1.96.</b>	
<b>Average Error = -0.002 ft</b>	<b>RMSE = 0.103 ft</b>
<b>Minimum Error = -0.285 ft</b>	<b><math>\sigma</math> = 0.103 ft</b>
<b>Maximum Error = 0.419 ft</b>	<b>2<math>\sigma</math> = 0.206 ft</b>
<b>Survey Sample Size: n = 545</b>	

**Exhibit 7:** *Non-vegetated Vertical Accuracy (NVA) of the Avery Parcels project area*

<b>Accuracy<sub>z</sub>: Tested 0.047 feet Non-vegetated Vertical Accuracy (NVA) at 95 percent confidence level in all open and non-vegetated land cover categories combined using RMSE<sub>z</sub> x 1.96.</b>	
<b>Average Error = -0.011 ft</b>	<b>RMSE = 0.024 ft</b>
<b>Minimum Error = -0.046 ft</b>	<b><math>\sigma</math> = 0.022 ft</b>
<b>Maximum Error = 0.036 ft</b>	<b>2<math>\sigma</math> = 0.044 ft</b>
<b>Survey Sample Size: n = 10</b>	



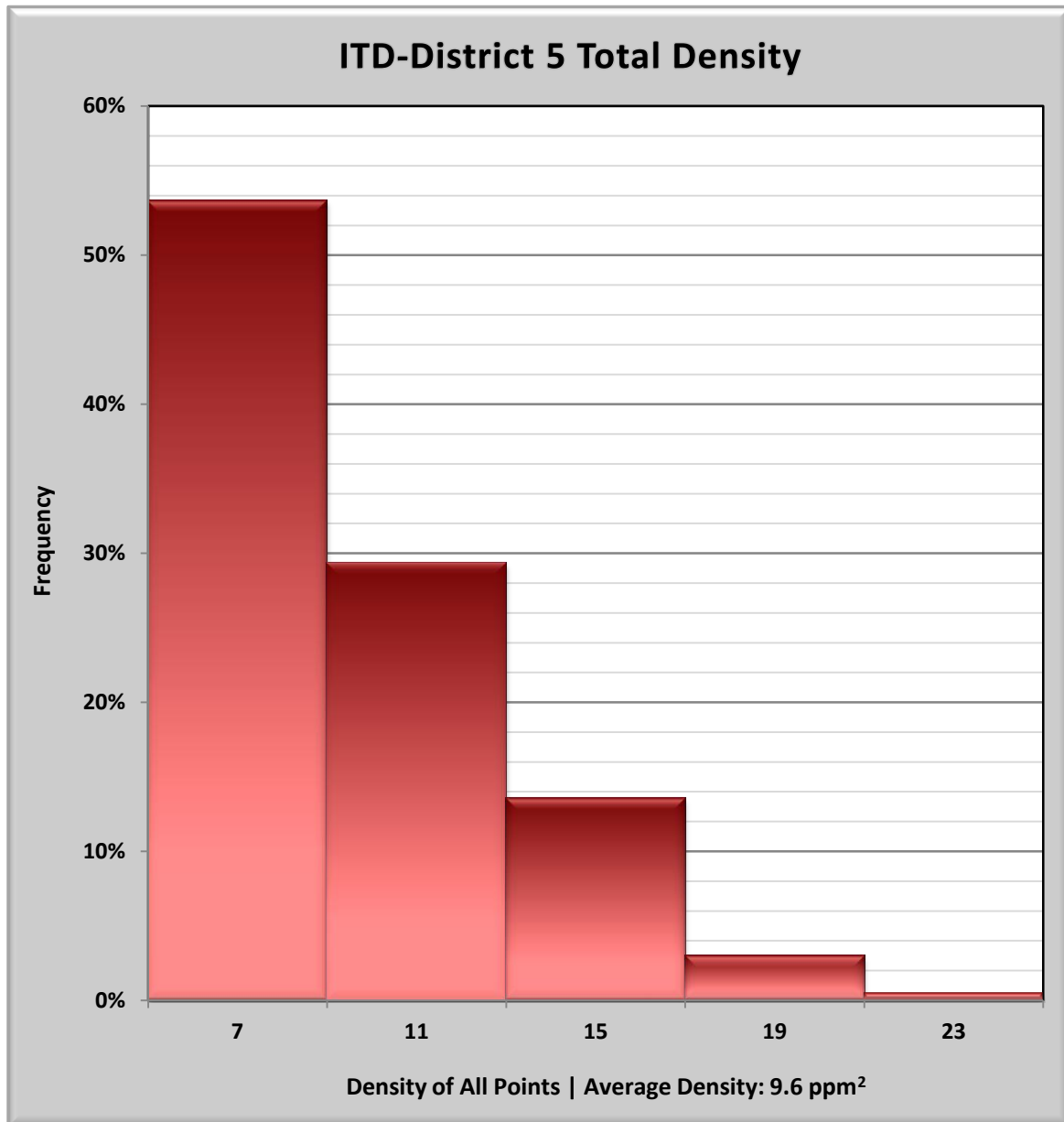
**Exhibit 8:** LiDAR checkpoints used for the NVA assessment



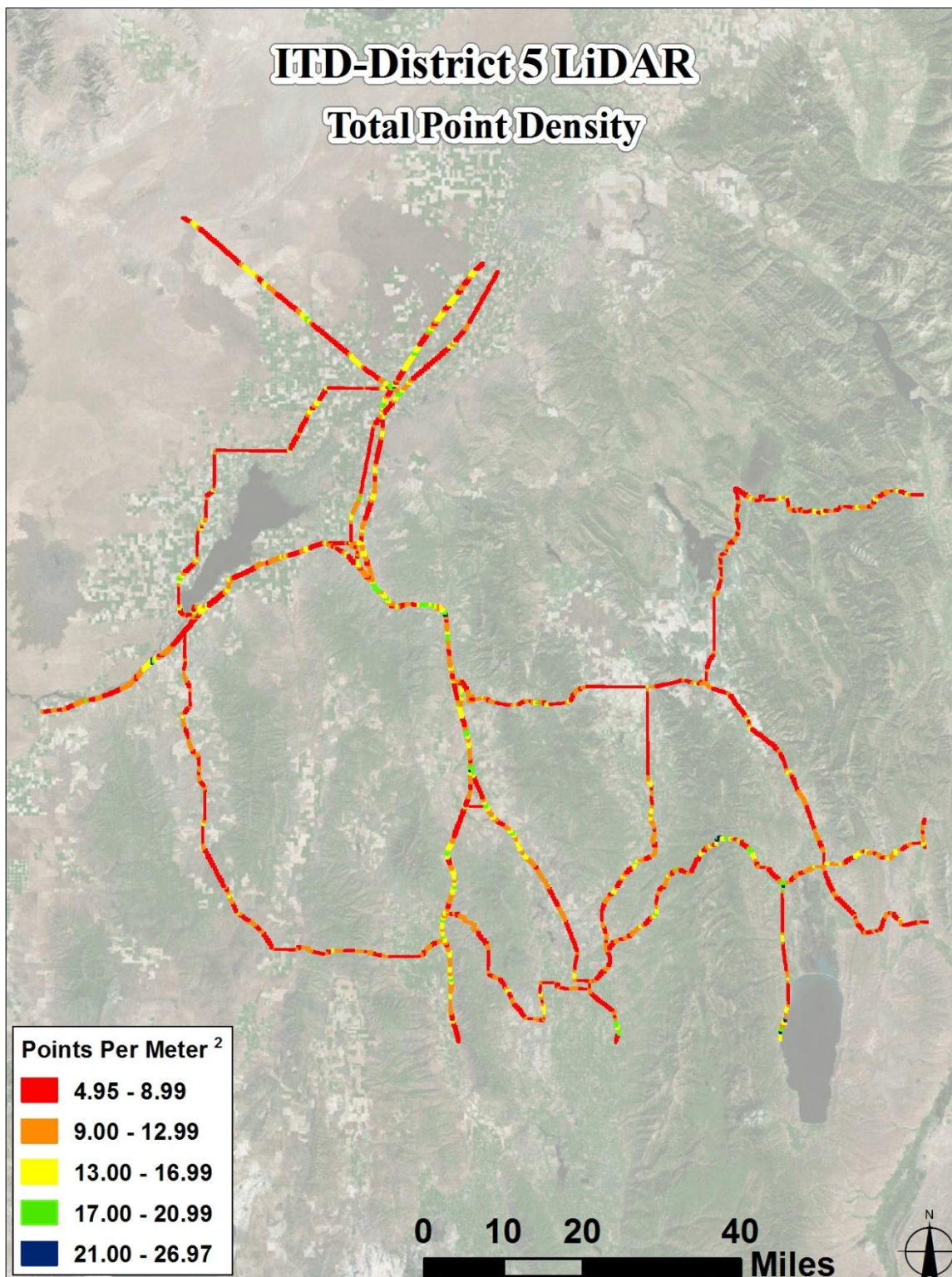
### 4.3 Data Density

The goal for this project was to achieve a LiDAR point density of **4.0** points per square meter. The acquisition mission achieved an actual average of **9.6** points per square meter. The following two exhibits show the density of **all collected points**.

**Exhibit 9: ITD-District 5 – All returns Laser Point Density by Frequency, points/m<sup>2</sup>.** Demonstrates the percentage of project tiles with points in a given density range

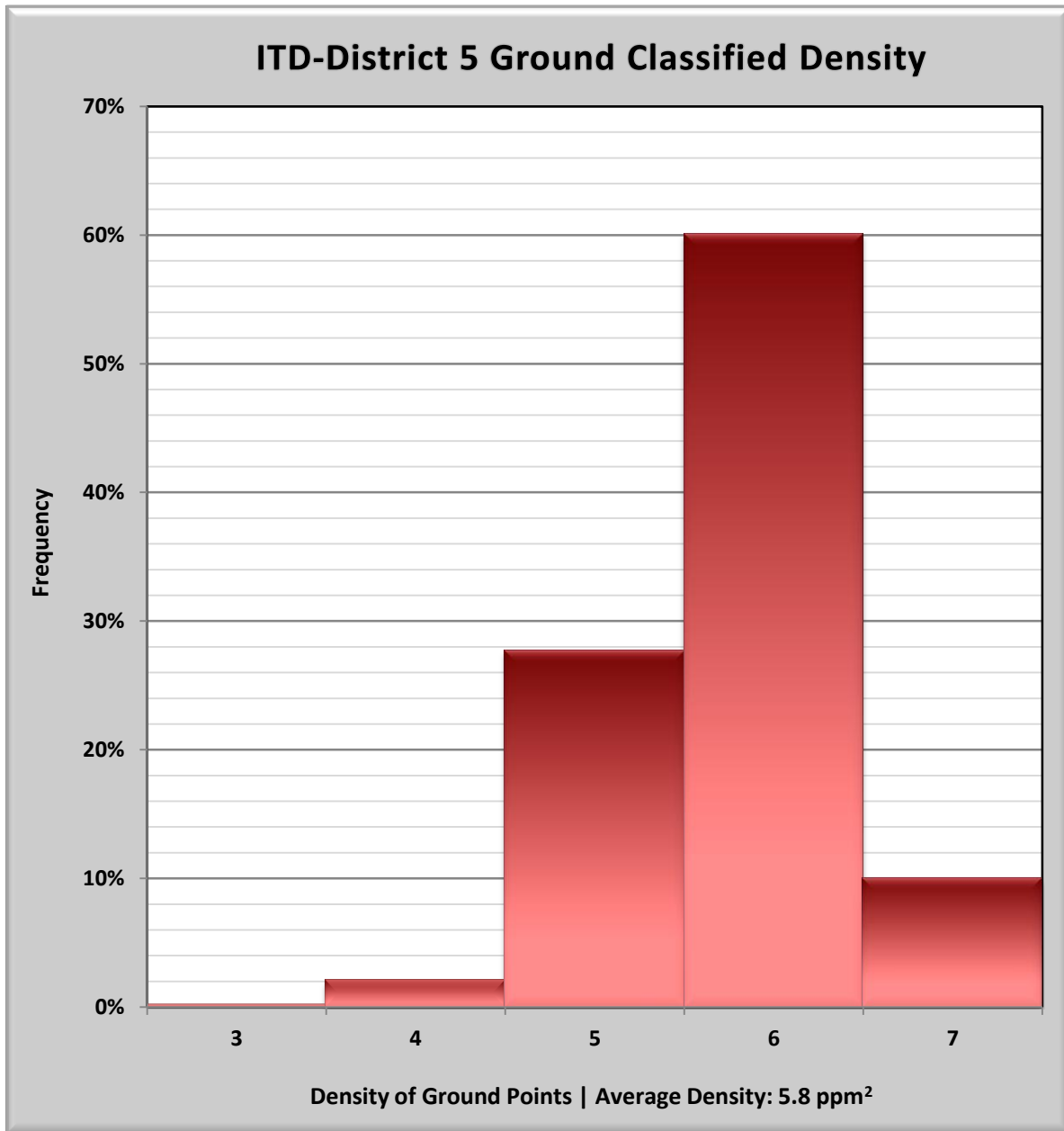


**Exhibit 10:** Laser Point Density of All Returns by Tile, points/m<sup>2</sup>

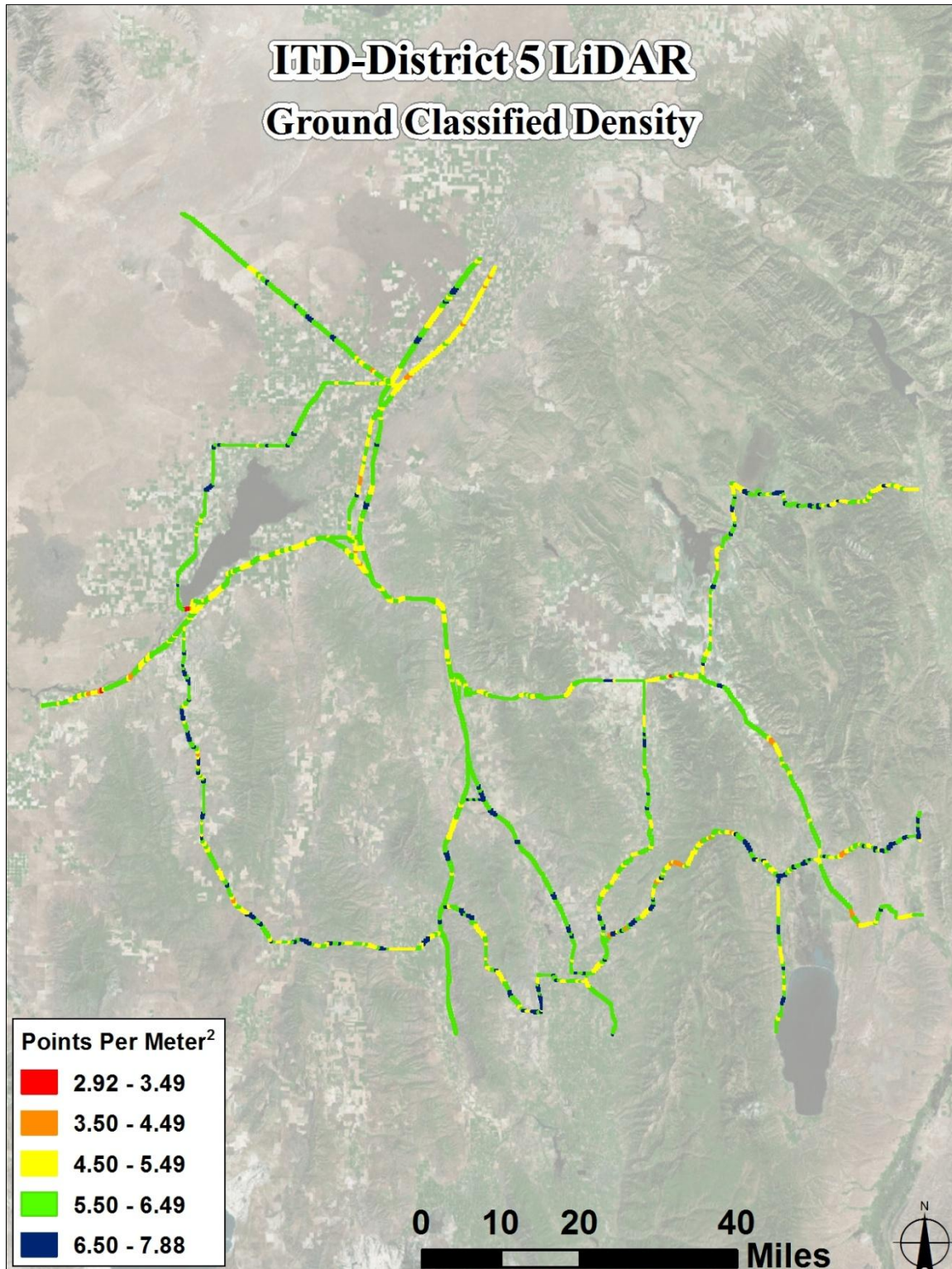


The following two exhibits show the density of **ground classified points**. Factors such as vegetation, water, and buildings will reduce the density of points classified to the ground. For the ITD-District 5 project, an average of **5.8** ground classified points per square meter was achieved.

**Exhibit 11: ITD-District 5 - Ground Classified Laser Point Density by Frequency, points/m<sup>2</sup>.**  
*Demonstrates the percentage of project tiles with points in a given density range*



**Exhibit 12:** Ground Classified Laser Point Density by Tile, points/m<sup>2</sup>



#### 4.4 Data Density Summary

ITD-District 5 & Avery Parcels	Goal	Actual (mean)
<b>Total Point Density:</b>	4.0 points/m <sup>2</sup>	9.6 points/m <sup>2</sup>
<b>Ground Classified Point Density:</b>	-----	5.8 points/m <sup>2</sup>

#### 4.5 Projection, Datum, and Units

<b>Projection:</b>		Idaho State Plane East Zone (Modified) CAF: 0.999715090
<b>Datum</b>	<b>Vertical:</b>	NAVD88
	<b>Horizontal:</b>	NAD83
<b>Units:</b>		US Feet

### 5. Deliverables

<b>LiDAR Point Data:</b>	<ul style="list-style-type: none"> <li>Classified LiDAR point data in .LAS v1.2 format</li> </ul>
<b>Raster Data:</b>	<ul style="list-style-type: none"> <li>3-band orthorectified imagery in .TIF, .SID, and .HMR formats at a pixel resolution of 0.2' (Avery Parcels) and 0.25' (interstates and highways)</li> <li>DEM data at a 2' cell size in ESRI Grid raster format</li> </ul>
<b>Vector Data:</b>	<ul style="list-style-type: none"> <li>2' (interstates and highways) and 1' (Avery Parcels) contours and planimetric data in MicroStation V8i .DGN format at 1"=100'</li> <li>DTM files consisting of break lines and mass points in ASCII and InRoads .DTM formats</li> </ul>
<b>Report of Survey:</b>	<ul style="list-style-type: none"> <li>Technical Project Report</li> </ul>

## Appendix A – Surveyed Ground Control

Survey Point	NAD83 State Plane Idaho East Zone (Modified)		NAVD88
	Northing (usft)	Easting (usft)	Elevation (usft)
101	667754.536	470764.605	4919.880
103	608406.818	542583.187	4744.042
104	606862.069	542642.630	4728.232
105	560247.320	599787.690	4482.509
106	561130.759	600606.975	4482.380
107	558610.718	601963.329	4486.568
108	558855.249	603419.939	4487.711
109	555724.949	608772.511	4499.554
110	553637.618	608291.591	4499.542
111	640996.307	663923.465	4644.983
112	635712.194	657298.443	4633.388
113	635610.789	673239.138	4650.377
114	635624.237	674272.415	4653.318
115	596255.980	629060.172	4560.090
117	505313.213	591240.446	4429.957
118	504730.702	592378.377	4434.095
119	541828.765	596409.914	4481.082
120	541352.238	597664.298	4479.776
122	455652.888	575584.806	4479.731
124	453855.443	581366.462	4569.571
125	454547.745	583305.612	4619.341
126	446430.723	582352.253	4522.601
127	439052.523	580624.071	4461.635
128	428196.320	590169.495	4508.231
129	424397.914	592868.815	4545.090
130	440793.874	514376.195	4432.631
132	410587.122	476691.110	4417.991
133	410842.522	479220.218	4472.456
134	411863.070	473092.777	4398.495
135	406642.625	469438.233	4361.991
136	393390.120	465016.402	4467.501
137	394749.175	463473.928	4405.771
138	410875.789	460395.181	4394.108
139	410828.354	461258.803	4396.570
140	469801.119	479090.415	4403.055
141	468286.026	476447.974	4399.775
142	516732.642	484150.780	4471.676
143	516028.209	485513.617	4470.140
144	515898.218	534442.747	4435.409
146	342032.829	370054.047	4245.440

Survey Point	Northing (usft)	Easting (usft)	Elevation (usft)
147	340976.983	370335.989	4240.553
148	291971.201	477829.777	4909.235
149	289512.501	478603.947	4951.846
150	223919.386	491263.399	5266.942
151	224879.900	492032.427	5312.358
152	339513.980	463180.328	4616.506
153	410397.217	635187.280	4529.061
154	412514.061	634164.513	4547.607
155	362439.999	642862.048	4712.862
156	362552.228	644730.265	4725.891
157	362185.346	649456.309	4785.296
158	360621.302	648698.961	4767.494
159	345961.732	650105.366	4790.032
160	304964.334	654040.748	4791.675
161	303285.290	656807.234	4806.445
162	298871.471	657520.757	4816.111
163	278852.536	666795.564	4859.912
164	278522.058	665648.630	4848.027
165	278511.586	651516.536	4759.307
166	278543.002	666331.618	4850.594
167	234643.315	644243.466	5340.259
168	228197.093	645829.551	5106.721
170	206151.387	638791.843	4875.597
171	188816.787	634249.385	4536.927
172	188033.846	638268.132	4640.528
173	183710.398	667820.588	5686.866
174	164493.590	671375.361	5487.045
175	135682.425	701973.670	4826.146
176	136299.462	704903.622	4783.980
177	157762.687	643127.635	4618.836
178	121971.834	646955.321	4432.904
179	135125.091	644830.703	4567.229
180	178571.466	598036.913	4856.315
181	179720.563	558565.939	5170.996
182	183493.711	523494.332	4779.333
183	182275.852	523750.911	4778.516
184	160379.934	712896.455	4735.319
185	157457.927	734389.030	4714.173
186	156278.734	735780.418	4710.080
187	154052.394	734457.763	4712.288
188	126407.193	754595.906	4507.833
189	122363.642	751973.704	4509.109
190	161405.104	735039.999	4729.591



Survey Point	Northing (usft)	Easting (usft)	Elevation (usft)
192	162340.034	725720.407	4681.043
193	226932.008	705964.256	4772.890
194	228010.719	705689.288	4774.022
195	175886.620	749243.245	4893.606
196	182680.780	746792.527	4555.018
197	185122.304	745709.690	4668.503
198	192236.507	746801.074	4958.526
199	241808.693	765949.800	5128.529
200	296176.109	774214.107	5307.724
201	358566.256	773905.590	5695.086
202	358596.862	777706.434	5735.002
203	348558.794	721534.103	6048.296
204	345979.471	685318.556	4981.489
205	361006.060	807365.446	5776.076
206	362255.706	808030.023	5773.474
207	358098.873	814737.630	5842.602
208	419314.154	818218.123	6156.014
209	462605.987	834407.112	6241.213
210	490952.979	832024.982	6371.121
211	484938.376	863795.172	6405.269
212	484636.643	866774.983	6424.724
213	478872.036	916151.052	6205.655
214	486829.340	948027.707	5790.563
215	486059.446	956781.613	5763.663
216	229469.871	786640.318	5547.246
217	257302.637	820886.606	7295.736
218	227649.083	867567.849	5930.893
219	223326.537	863712.854	5953.136
220	189422.045	863797.547	5961.692
221	145341.592	867494.494	5971.338
222	134934.480	865573.239	5950.565
223	122841.521	862402.147	5951.658
224	235689.758	891774.950	5964.817
225	240090.461	891786.887	5989.576
226	331348.533	842245.947	5938.810
227	283207.750	877901.048	6060.651
228	243708.327	935604.680	6821.038
229	264026.339	957330.442	6251.516
230	269523.991	958703.943	6263.825
231	193646.199	918814.778	6040.163
232	201617.085	955485.783	6065.810
233	201529.979	961016.607	6115.275
501	353095.328	654508.805	4837.464

Survey Point	Northing (usft)	Easting (usft)	Elevation (usft)
502	349109.714	654563.750	4825.287
503	350039.673	655971.473	4844.998
504	348542.456	657699.458	4847.732
505	350783.036	654958.728	4855.593
137A	395789.782	464599.769	4435.319
P101	124028.205	753589.640	4502.486
P102	134381.645	752514.707	4535.580
P103	141315.004	751086.494	4587.207
P104	140000.031	751693.859	4580.886
P105	145811.665	745706.699	4604.265
P106	162252.602	738788.168	4740.056
P107	180560.735	727101.428	4776.015
P109	189917.360	723779.515	4773.709
P110	217872.704	711018.536	4780.896
P111	235732.449	700662.168	4790.661
P112	235929.545	701122.037	4797.407
P113	249867.257	689305.101	4816.947
P114	250368.593	688171.310	4797.049
P115	261870.554	682514.299	4751.647
P116	121985.504	647702.929	4502.725
P117	134812.788	643842.712	4499.855
P118	153448.018	641653.165	4577.154
P120	188247.981	638761.576	4651.384
P122	195624.534	636894.977	4733.589
P123	207163.198	638712.742	4890.106
P124	249796.238	640590.063	5461.236
P125	278446.941	652719.043	4802.429
P126	328087.197	653268.651	4724.393
P127	328320.076	652559.759	4683.408
P128	346511.376	647332.158	4790.916
P129	353781.625	649271.036	4793.091
P131	408296.066	638420.336	4546.825
P132	412208.279	632947.277	4567.473
P133	412560.943	630775.628	4565.541
P135	411944.521	604327.113	4493.937
P137	416659.651	600038.918	4554.261
P138	441309.906	587519.258	4667.285
P139	440765.671	585948.684	4580.150
P140	446793.448	573272.352	4442.193
P141	449522.220	585140.203	4606.434
P142	451544.994	579784.669	4469.818
P143	452121.138	575561.968	4478.405
P144	454055.393	559358.354	4451.504

Survey Point	Northing (usft)	Easting (usft)	Elevation (usft)
P145	450819.326	545798.012	4463.020
P146	450355.485	546913.991	4462.914
P147	445466.426	531193.202	4436.354
P148	439745.682	514687.344	4437.435
P149	429747.334	494911.114	4409.776
P150	426311.687	494173.844	4416.662
P151	424492.890	494128.061	4433.317
P152	376549.088	443510.074	4363.594
P153	366755.398	433785.294	4235.135
P154	366125.420	434433.757	4258.298
P155	358516.747	425024.421	4271.831
P156	349759.053	399262.330	4228.714
P157	348923.039	399346.649	4234.981
P158	346811.667	392901.376	4414.527
P159	343224.205	384672.713	4418.902
P160	381209.179	452294.610	4408.437
P162	363449.625	465446.977	4866.720
P165	313185.127	473427.661	4773.050
P169	204195.129	504161.974	4926.239
P171	184201.756	545759.609	4955.601
P173	181772.223	587434.030	5270.346
P174	178551.268	622401.279	4465.430
P175	432699.861	462496.332	4415.323
P176	443538.627	473113.852	4401.349
P177	463730.857	474336.529	4407.473
P178	489283.516	483937.977	4439.872
P179	489955.085	484501.794	4440.528
P180	542327.829	548185.285	4461.533
P181	558041.472	559825.075	4467.367
P182	578353.622	576787.016	4473.877
P183	630714.404	514858.471	4821.465
P184	671481.902	464187.562	4934.450
P185	671704.062	464591.051	4939.068
P186	648908.680	492868.551	5021.030
P187	586095.145	642656.609	4569.903
P188	598517.568	653036.630	4572.264
P189	619780.000	664884.579	4623.163
P191	581750.436	619212.344	4521.696
P192	581440.004	617670.306	4527.916
P193	561554.748	614188.848	4512.735
P194	531333.254	590755.081	4467.035
P196	486241.744	582056.625	4470.060
P197	494176.402	592117.664	4499.270

Survey Point	Northing (usft)	Easting (usft)	Elevation (usft)
P198	494167.511	591543.446	4496.293
P200	473076.849	576264.163	4455.941
P201	349022.692	668758.787	4948.793
P202	348056.769	697809.488	5007.517
P203	348597.124	703323.843	5154.529
P204	358307.682	731538.822	5492.241
P205	363298.371	798180.305	5745.406
P206	331045.766	773889.117	5536.335
P208	270741.067	775436.704	4901.405
P212	213473.400	744951.686	5023.719
P217	315179.927	861838.787	6273.800
P219	257598.999	887200.236	5981.623
P221	195713.116	929000.541	6015.046
P223	200420.074	943013.846	6368.956
P224	201097.785	960979.510	6109.908
P225	201205.491	961005.711	6115.845
P303	199587.514	658676.333	5240.656
P306	148475.421	683591.654	5039.143
P307	136852.975	692819.071	4891.661
P311	161222.772	703390.672	4817.598
P312	157063.295	715277.755	4656.087
P313	190835.893	759543.596	4619.155
P314	210797.589	779602.200	5089.525
P316	252619.359	815978.722	7166.675
P317	255105.009	836192.699	6430.607
P320	237901.205	853086.753	5975.210
P322	163567.070	867359.745	5966.501
P325	238376.423	884134.909	5936.079
P327	239752.670	902895.164	6122.062
P330	247949.937	924046.731	6444.174
P332	249679.286	942769.612	6319.677
P333	250983.664	959077.688	6216.117
P334	254195.249	953988.240	6180.090
P336	362748.150	812966.998	5819.891
P337	371416.833	813618.310	5984.173
P338	394706.528	818140.400	6175.694
P341	452923.718	827014.851	6138.922
P342	482230.984	834824.051	6252.071
P343	482867.028	847494.149	6400.612
P347	475710.575	897737.439	6496.959
P350	488949.919	933841.407	5922.720

## QC Check Points

Check Point	NAD83 State Plane Idaho East Zone (Modified)		NAVD88
	Northing (usft)	Easting (usft)	Elevation (usft)
1001	135043.924	644810.996	4560.774
1002	135032.359	644769.347	4555.718
1003	135021.395	644726.980	4551.204
1004	135009.270	644682.443	4546.633
1005	135027.377	644520.095	4532.160
1006	135063.858	644495.278	4531.258
1007	135100.129	644469.891	4531.045
1008	135137.784	644443.506	4531.313
1009	135175.658	644416.717	4531.946
1010	135213.373	644390.077	4532.876
1012	157779.909	643090.758	4617.789
1013	157821.598	643089.871	4616.691
1014	157863.532	643088.972	4615.447
1015	157907.051	643088.138	4613.921
1016	157907.079	643074.228	4613.623
1017	157861.465	643075.191	4615.043
1018	157816.258	643076.132	4616.467
1019	157771.505	643077.162	4617.790
1020	157725.418	643078.210	4619.319
1021	206157.608	638784.293	4876.038
1022	206194.595	638811.817	4876.924
1023	206230.506	638839.372	4877.900
1024	206266.360	638867.897	4878.880
1025	206302.146	638897.442	4879.922
1026	206337.601	638927.599	4880.900
1027	206372.838	638957.766	4881.977
1028	206408.491	638988.847	4882.893
1029	206443.364	639019.458	4883.896
1030	206477.710	639049.965	4884.926
1031	234603.866	644263.046	5339.150
1032	234563.982	644282.987	5338.204
1033	234522.708	644303.553	5336.959
1034	234481.053	644324.411	5335.606
1035	234440.475	644344.700	5334.062
1036	234398.793	644365.707	5332.461
1037	234358.069	644386.264	5330.865
1038	234315.740	644407.652	5329.071
1039	234273.485	644429.037	5327.030
1040	234230.978	644450.435	5324.986
1041	410394.708	635143.165	4529.105

Point	Northing	Easting	Elevation
1042	410385.568	635100.184	4528.930
1043	410374.883	635056.407	4528.799
1044	410362.535	635013.366	4528.668
1045	410347.955	634969.465	4528.751
1046	410414.481	635183.811	4529.842
1047	410421.379	635228.362	4529.955
1048	410426.636	635272.489	4530.048
1049	410430.790	635318.228	4530.199
1050	410433.410	635365.058	4530.133
1051	362561.490	644814.868	4727.520
1052	362582.035	644775.343	4727.398
1053	362604.323	644735.157	4727.296
1054	362627.614	644695.858	4727.112
1055	362652.440	644657.822	4727.092
1056	362636.409	644600.760	4728.831
1057	362676.698	644578.166	4727.825
1058	362712.074	644549.781	4727.430
1059	362745.778	644518.265	4727.178
1060	362779.365	644485.622	4726.900
1061	303316.338	656776.490	4806.245
1062	303347.593	656745.306	4806.173
1063	303379.528	656713.492	4806.104
1064	303410.575	656682.691	4805.958
1065	303442.773	656650.613	4805.694
1066	303468.574	656607.913	4805.792
1067	303503.815	656574.428	4805.673
1068	303539.372	656542.559	4805.722
1069	303576.656	656511.672	4805.362
1070	303613.084	656483.376	4805.205
1071	278520.577	652726.367	4803.099
1072	278565.330	652724.199	4803.972
1073	278608.053	652717.927	4804.498
1074	278651.749	652710.796	4804.847
1075	278695.432	652703.702	4805.676
1076	278740.251	652696.247	4806.342
1077	278785.090	652688.728	4806.885
1078	278831.307	652681.069	4807.568
1079	278876.887	652673.633	4808.305
1080	278923.724	652666.024	4808.916
1081	278456.972	660892.755	4830.728
1082	278456.344	660844.745	4830.181
1083	278455.818	660797.729	4829.717
1084	278455.353	660751.705	4829.249

Point	Northing	Easting	Elevation
1086	278454.455	660658.497	4828.404
1087	278454.067	660612.014	4828.057
1088	278453.675	660565.584	4827.615
1089	278453.278	660518.067	4827.100
1090	278452.961	660470.458	4826.516
1091	278521.699	665603.731	4847.803
1092	278521.357	665557.935	4847.514
1093	278520.934	665512.609	4847.295
1094	278520.681	665466.926	4846.975
1095	278520.202	665419.698	4846.663
1096	278519.971	665373.762	4846.476
1097	278519.577	665326.359	4846.222
1098	278519.226	665279.772	4845.876
1099	278518.896	665231.054	4845.547
1100	278518.542	665184.095	4845.343
1101	126405.133	754648.772	4505.858
1102	126365.784	754628.574	4505.664
1103	126326.715	754606.409	4505.541
1104	126287.073	754583.391	4505.594
1105	126247.909	754559.760	4505.629
1106	126208.654	754534.417	4505.657
1107	126169.776	754508.696	4505.623
1108	126132.016	754483.473	4505.522
1109	126093.424	754457.027	4505.439
1110	126055.261	754431.748	4505.406
1111	161384.120	735040.015	4729.304
1112	161340.795	735053.587	4728.917
1113	161296.762	735062.486	4728.611
1114	161269.863	735022.362	4727.625
1115	161223.094	735027.652	4727.496
1116	161179.270	735032.458	4727.549
1117	161133.907	735034.949	4727.151
1118	161081.460	735035.450	4726.992
1119	161034.922	735035.701	4726.905
1120	160986.292	735036.084	4726.732
1121	428155.882	590192.279	4509.590
1122	428118.296	590218.724	4511.053
1123	428079.389	590246.169	4512.552
1124	428039.566	590273.764	4514.113
1125	428000.834	590301.512	4515.632
1126	427961.600	590330.645	4517.361
1127	427921.450	590358.425	4518.856
1128	427881.360	590387.194	4520.405

Point	Northing	Easting	Elevation
1129	427840.720	590415.936	4521.965
1130	427800.924	590444.365	4523.668
1131	446584.787	582430.277	4523.509
1132	446568.478	582385.854	4522.392
1133	446559.291	582340.318	4521.383
1134	446553.261	582292.470	4520.375
1135	446551.460	582244.611	4519.413
1136	446551.259	582194.044	4518.758
1137	446551.833	582148.268	4517.879
1138	446552.294	582099.814	4517.342
1139	446552.572	582051.702	4516.616
1140	446553.051	582003.845	4515.927
1141	455591.195	575935.691	4478.563
1142	455588.030	575981.769	4479.074
1143	455553.448	576010.992	4478.920
1144	455508.582	576010.987	4478.693
1145	455463.074	576011.135	4478.655
1146	455416.866	576010.888	4478.826
1147	455370.839	576010.907	4479.077
1148	455326.719	576022.717	4479.404
1149	455278.774	576022.767	4479.556
1150	455179.559	576022.560	4480.167
2001	630714.212	514858.351	4821.659
2002	630746.008	514825.926	4822.132
2003	630777.721	514793.463	4822.710
2004	630807.741	514762.559	4823.273
2005	630839.620	514729.843	4823.707
2006	630856.640	514747.495	4823.837
2007	630826.908	514778.097	4823.312
2008	630797.582	514808.230	4822.847
2009	630765.510	514841.138	4822.320
2010	630732.894	514874.593	4821.917
2011	630674.360	514934.687	4821.165
2012	630643.549	514966.442	4820.747
2013	630612.444	514998.402	4820.384
2014	630581.431	515030.241	4819.914
2015	630550.032	515062.566	4819.525
2016	630533.039	515045.003	4819.428
2017	630563.552	515013.565	4819.793
2018	630594.932	514981.332	4820.130
2019	630625.279	514949.822	4820.488
2020	630657.205	514916.921	4820.970
2021	607911.541	542246.700	4743.909



<b>Point</b>	<b>Northing</b>	<b>Easting</b>	<b>Elevation</b>
2022	607885.064	542279.009	4743.323
2023	607858.293	542311.743	4742.837
2024	607831.810	542344.211	4742.358
2025	607804.815	542377.434	4741.775
2026	607777.347	542411.191	4741.212
2027	607750.378	542444.261	4740.708
2028	607721.862	542479.083	4740.254
2029	607692.895	542514.491	4739.746
2030	607664.376	542549.222	4739.181
2031	607682.539	542565.725	4739.366
2032	607709.358	542532.947	4739.915
2033	607737.502	542498.321	4740.436
2034	607765.253	542464.461	4740.895
2035	607792.809	542430.651	4741.354
2036	607819.959	542397.391	4741.808
2037	607847.349	542363.801	4742.418
2038	607875.723	542329.010	4742.938
2039	607904.213	542294.114	4743.380
2040	607933.252	542258.570	4743.913
2041	561059.464	600581.171	4484.868
2042	561101.267	600581.587	4484.892
2043	561143.709	600581.802	4484.890
2044	561185.753	600581.934	4484.926
2045	561227.148	600581.917	4485.024
2046	561269.083	600581.456	4485.042
2047	561311.118	600582.044	4484.955
2048	561353.119	600581.799	4485.036
2049	561395.464	600582.089	4485.028
2050	561437.176	600582.657	4485.002
2051	560319.731	599473.487	4481.800
2052	560309.320	599516.317	4481.698
2053	560300.230	599558.705	4481.657
2054	560291.766	599601.769	4481.821
2055	560285.675	599646.256	4481.979
2056	560275.652	599687.935	4482.167
2057	560266.199	599729.522	4482.338
2058	560256.374	599773.627	4482.669
2059	560239.306	599815.549	4482.822
2060	560214.064	599852.690	4482.728
2061	558757.092	601644.557	4487.101
2062	558790.605	601615.798	4486.959
2063	558824.803	601586.783	4486.742
2064	558859.255	601557.275	4486.529

Point	Northing	Easting	Elevation
2065	558893.233	601527.683	4486.349
2066	558926.980	601498.293	4486.198
2067	558962.180	601467.617	4486.040
2068	558997.320	601436.603	4485.941
2069	559032.287	601405.417	4485.881
2070	559067.625	601373.943	4485.834
2071	596252.232	629000.614	4559.690
2072	596244.847	628955.799	4559.560
2073	596240.737	628909.371	4559.555
2074	596237.202	628862.618	4559.814
2075	596233.091	628815.892	4560.272
2076	596225.627	628769.289	4560.946
2077	596212.809	628724.469	4561.786
2078	596194.414	628680.877	4563.014
2079	596171.796	628640.318	4564.105
2080	596144.555	628599.170	4565.545
2081	640986.367	663764.803	4645.475
2082	640973.932	663719.444	4645.202
2083	640955.806	663676.367	4645.033
2084	640934.875	663634.813	4645.070
2085	640910.203	663595.357	4645.051
2086	640881.673	663558.154	4644.907
2087	640850.282	663521.613	4644.374
2088	640816.800	663485.425	4644.080
2089	640784.191	663450.187	4643.768
2090	640751.165	663415.238	4643.525
2091	635439.806	673663.387	4650.694
2092	635398.355	673640.490	4650.606
2093	635357.388	673617.040	4650.479
2094	635316.181	673593.820	4650.301
2095	635274.124	673570.651	4650.164
2096	635233.664	673548.072	4650.003
2097	635191.402	673524.258	4649.974
2098	635149.503	673500.596	4649.856
2099	635107.453	673476.968	4649.617
2100	635066.341	673454.117	4649.612
2101	594437.855	649642.580	4567.228
2102	594472.741	649671.704	4567.575
2103	594509.305	649701.768	4567.816
2104	594545.688	649732.093	4567.968
2105	594582.172	649762.096	4568.061

Point	Northing	Easting	Elevation
2106	594400.682	649611.713	4566.808
2107	594359.793	649586.206	4566.417
2108	594332.685	649622.976	4568.794
2109	594328.848	649669.974	4568.417
2110	594329.430	649716.596	4567.976
2111	541476.384	597754.538	4481.709
2112	541506.025	597719.227	4482.183
2113	541535.862	597683.603	4482.488
2114	541565.398	597647.820	4482.844
2115	541595.665	597611.187	4483.273
2116	541579.897	597597.563	4483.595
2117	541549.826	597633.853	4483.184
2118	541520.412	597669.516	4482.742
2119	541490.437	597705.980	4482.253
2120	541460.264	597742.431	4481.766
2121	493857.722	583717.164	4447.226
2122	493813.167	583708.447	4447.240
2123	493767.362	583699.572	4447.241
2124	493724.017	583691.170	4447.118
2125	493680.351	583682.615	4447.068
2126	493635.496	583673.929	4447.020
2127	493589.357	583665.184	4447.068
2128	493543.759	583656.282	4447.069
2129	493498.012	583647.301	4447.147
2130	493452.371	583639.037	4447.315
2131	515981.096	534366.574	4441.127
2132	515999.091	534408.384	4441.267
2133	516019.236	534450.020	4441.209
2134	516040.822	534491.018	4441.235
2135	516064.252	534531.568	4441.298
2136	516089.911	534570.226	4441.324
2137	516117.290	534609.049	4441.415
2138	516145.405	534646.429	4441.701
2139	516174.775	534682.404	4441.815
2140	516205.826	534717.487	4441.927
2141	516072.030	485426.631	4470.906
2142	516040.403	485392.980	4470.608
2143	516008.963	485361.758	4470.593
2144	515976.239	485329.885	4470.519
2145	515941.474	485297.832	4470.317
2146	515907.710	485268.062	4470.151
2147	515872.693	485238.372	4469.973
2148	515835.772	485208.773	4469.758

Point	Northing	Easting	Elevation
2149	515797.539	485180.256	4469.556
2150	515759.689	485152.872	4469.546
2151	468315.329	476382.875	4400.839
2152	468359.144	476393.810	4400.761
2153	468402.117	476408.693	4400.741
2154	468443.746	476425.795	4400.451
2155	468484.204	476445.107	4400.418
2156	468478.758	476508.493	4399.251
2157	468437.265	476493.367	4399.284
2158	468394.466	476479.132	4399.348
2159	468351.696	476466.085	4399.514
2160	468307.713	476454.348	4399.598
3001	362163.831	649495.269	4785.593
3002	362143.621	649535.678	4785.876
3003	362121.617	649575.339	4786.124
3004	362099.154	649614.788	4786.535
3005	362075.728	649653.575	4786.858
3006	362051.480	649692.974	4787.051
3007	362024.884	649732.238	4787.129
3008	361997.580	649770.516	4787.233
3009	361969.748	649808.038	4787.425
3010	361941.003	649844.863	4787.500
3011	353049.984	654512.527	4837.913
3012	353004.480	654517.110	4838.360
3013	352957.429	654521.628	4838.786
3014	352910.280	654525.916	4839.114
3015	352863.359	654530.521	4839.537
3016	352816.493	654535.394	4839.903
3017	352770.243	654539.855	4840.161
3018	352724.321	654544.316	4840.506
3019	352676.037	654548.844	4840.866
3020	352629.728	654553.713	4841.143
3021	346484.162	649687.504	4785.157
3022	346485.740	649642.059	4784.419
3023	346486.451	649596.152	4783.516
3024	346486.997	649548.899	4782.695
3025	346487.805	649502.876	4782.071
3026	346461.505	649502.588	4781.801
3027	346460.545	649548.504	4782.316
3028	346460.216	649594.628	4783.082
3029	346459.667	649641.173	4784.024
3030	346459.367	649686.107	4785.128
3031	346018.745	685348.853	4979.557

Point	Northing	Easting	Elevation
3032	346020.278	685395.060	4979.812
3033	346022.580	685439.967	4980.034
3034	346025.921	685486.134	4980.205
3035	346029.869	685532.692	4980.442
3036	346101.666	685523.998	4976.648
3037	346097.584	685476.115	4976.425
3038	346094.182	685427.979	4976.170
3039	346091.877	685380.222	4975.942
3040	346089.943	685334.281	4975.724
3041	348590.430	721561.668	6050.070
3042	348618.569	721599.103	6051.823
3043	348646.536	721635.585	6053.540
3044	348674.947	721671.767	6055.158
3045	348704.166	721708.764	6056.682
3046	348756.007	721672.585	6054.565
3047	348727.330	721635.072	6053.055
3048	348698.426	721598.513	6051.488
3049	348669.359	721560.614	6049.715
3050	348641.369	721522.715	6047.889
3051	358432.443	773873.658	5701.349
3052	358432.476	773919.522	5701.606
3053	358432.544	773966.100	5701.565
3054	358433.075	774012.719	5701.492
3055	358432.662	774059.198	5701.769
3056	358342.033	774099.928	5702.137
3057	358341.920	774055.665	5701.886
3058	358341.855	774009.366	5701.629
3059	358341.819	773960.464	5701.329
3060	358341.851	773908.657	5701.234
3061	331310.549	842270.867	5939.190
3062	331271.602	842296.599	5939.653
3063	331232.814	842322.475	5940.170
3064	331194.259	842348.815	5940.855
3065	331154.892	842376.036	5941.661
3066	331116.572	842403.182	5942.723
3067	331076.986	842431.726	5944.015
3068	331037.539	842460.529	5945.427
3069	330998.395	842489.714	5947.036
3070	330959.562	842519.166	5948.635
3071	283165.559	877924.030	6060.687
3072	283125.581	877946.175	6060.713
3073	283085.763	877968.239	6060.814
3074	283045.137	877990.977	6060.745

Point	Northing	Easting	Elevation
3075	283003.242	878013.872	6060.642
3076	282976.706	877957.766	6060.630
3077	283017.587	877935.521	6060.664
3078	283059.756	877911.785	6060.501
3079	283102.448	877888.107	6060.585
3080	283144.985	877864.334	6060.595
3091	201223.272	960853.341	6108.733
3092	201226.799	960808.994	6106.829
3093	201230.198	960764.500	6105.097
3094	201232.996	960721.435	6103.356
3095	201235.999	960676.736	6101.751
3096	201239.444	960631.932	6100.001
3097	201243.485	960586.334	6098.139
3098	201247.181	960540.504	6096.394
3099	201250.349	960495.141	6094.774
3100	201253.704	960450.836	6093.273
3101	235648.984	891783.608	5964.583
3102	235604.411	891793.192	5964.441
3103	235560.149	891803.567	5964.347
3104	235514.802	891815.183	5964.266
3105	235469.030	891827.617	5964.328
3106	235481.115	891870.289	5964.092
3107	235526.031	891857.721	5964.232
3108	235570.133	891845.639	5964.465
3109	235614.648	891833.462	5964.731
3110	235660.945	891820.879	5964.895
3121	358108.633	814893.055	5845.126
3122	358131.659	814851.114	5845.560
3123	358155.705	814810.980	5846.218
3124	358180.821	814770.493	5846.822
3125	358206.129	814730.312	5847.403
3126	358232.314	814690.445	5847.859
3127	358259.104	814649.514	5848.344
3128	358286.649	814610.234	5849.056
3129	358316.791	814571.380	5849.679
3130	358349.599	814535.763	5849.816
4001	252330.396	476846.079	5148.703
4002	252286.837	476845.792	5148.878
4003	252241.567	476845.800	5149.199
4004	252195.837	476846.397	5149.507
4005	252150.007	476847.462	5149.596
4006	252104.447	476849.691	5149.621
4007	252058.231	476854.236	5149.625

Point	Northing	Easting	Elevation
4008	252011.308	476861.081	5149.621
4009	251965.686	476870.610	5149.413
4010	251920.064	476882.591	5149.241
5001	341894.675	370088.243	4242.282
5002	341877.148	370049.880	4242.749
5003	341860.759	370009.196	4242.634
5004	341843.914	369968.002	4242.147
5005	341827.257	369928.455	4241.605
5006	341933.599	370156.342	4242.435
5007	341874.796	370166.711	4242.291
5008	341898.892	370200.240	4242.536
5009	341913.710	370199.345	4242.371
5010	341900.386	370220.751	4242.445
5011	341913.064	370221.622	4242.146
5012	341913.135	370266.782	4242.546
5013	341914.112	370310.583	4243.053
5014	341915.165	370354.807	4244.097
5015	341902.811	370354.739	4244.280
6001	440793.875	514376.194	4432.631
6501	247949.937	924046.731	6444.174
6502	247945.688	924065.769	6444.234
6503	247934.358	924108.403	6444.589
6504	247920.537	924151.429	6444.829
6505	247904.569	924194.468	6444.993
6506	247885.836	924237.333	6445.273
6507	247864.457	924226.113	6444.195
6508	247882.164	924184.547	6444.014
6509	247897.981	924142.515	6443.827
6510	247912.242	924097.527	6443.584
6511	247923.557	924053.807	6443.248
7001	240090.461	891786.887	5989.576
7002	240088.618	891961.573	5991.382
7003	240089.83	892143.584	5993.138
7004	240089.765	892099.619	5992.767
7005	240089.533	892052.024	5992.307
7006	240089.094	892005.223	5991.829
7007	240088.897	891955.46	5991.298
7008	240060.186	891911.009	5990.399
7009	240060.972	891955.859	5990.836
7010	240060.973	892001.079	5991.246
7011	240061.514	892048.084	5991.724
7012	240061.814	892095.922	5992.236
7501	189422.045	863797.547	5961.692

Point	Northing	Easting	Elevation
7502	189558.035	863799.071	5964.061
7503	189591.68	863816.148	5965.722
7504	189548.117	863817.325	5964.907
7505	189504.238	863819.124	5964.143
7506	189459.456	863821.69	5963.39
7507	189414.679	863824.845	5962.602
7508	189416.469	863852.308	5961.921
7509	189462.226	863849.466	5962.755
7510	189509.202	863846.884	5963.586
7511	189554.804	863844.779	5964.351
7512	189600.665	863843.012	5965.156
8001	227824.471	867789.715	5934.188
8002	227798.652	867751.971	5934.335
8003	227773.705	867713.386	5934.484
8004	227750.293	867673.728	5934.563
8005	227728.454	867633.508	5934.617
8006	227750.999	867623.756	5933.028
8007	227772.379	867663.087	5932.829
8008	227795.675	867702.534	5932.679
8009	227821.404	867742.418	5932.588
8010	227848.65	867781.874	5932.611
8501	160501.937	712784.411	4736.255
8502	160472.224	712816.545	4736.057
8503	160440.291	712847.475	4735.819
8504	160407.432	712877.184	4735.51
8505	160372.856	712906.105	4735.22
8506	160338.063	712932.795	4734.876
8507	160301.738	712958.426	4734.593
8508	160263.872	712983.941	4734.316
8509	160225.86	713008.985	4733.854
8510	160186.8	713033.249	4733.402
9001	362258.552	808267.469	5776.949
9002	362258.339	808220.712	5776.016
9003	362257.721	808174.295	5775.447
9004	362257.628	808129.194	5774.697
9005	362258.031	808082.485	5773.799
9006	362216.393	808079.908	5774.534
9007	362216.252	808125.377	5775.224
9008	362214.285	808171.104	5775.918
9009	362211.275	808217.291	5776.653
9010	362212.034	808265.461	5777.638
9501	491097.346	832355.921	6368.590
9502	491085.993	832312.286	6369.250



<b>Point</b>	<b>Northing</b>	<b>Easting</b>	<b>Elevation</b>
9503	491071.376	832268.029	6370.171
9504	491054.296	832225.975	6371.065
9505	491034.73	832185.003	6371.763
9506	491012.257	832144.312	6372.092
9507	490986.289	832104.605	6372.107
9508	490958.044	832067.796	6371.742
9509	490910.415	832016.852	6370.444
9510	490858.441	831972.198	6368.385
9601	439147.177	514996.919	4427.172
9602	439162.764	515037.766	4424.561
9603	439178.829	515078.734	4421.652
9604	439194.853	515119.505	4420.634
9605	439210.358	515158.774	4420.741
9606	439226.595	515199.951	4420.768
9607	439242.723	515240.536	4420.830
9608	439259.287	515282.66	4420.862
9609	439275.197	515322.841	4420.918
9610	439290.98	515362.774	4421.031
9611	410616.409	476746.886	4418.813
9612	410606.01	476705.249	4418.533
9613	410598.985	476661.681	4418.558
9614	410594.784	476616.243	4418.514
9615	410591.708	476570.801	4418.432
9616	411838.494	473127.081	4398.693
9617	411882.09	473130.344	4398.707
9618	411901.659	473168.302	4398.600
9619	411886.187	473210.176	4398.069
9620	411868.971	473252.171	4397.673
9621	393345.415	465015.844	4468.139
9622	393300.314	465015.531	4468.795
9623	393252.624	465015.161	4469.414
9624	393206.931	465014.943	4470.103
9625	393160.148	465014.586	4470.832