aero-graphics
GEOSPATIAL SERVICES

February 18, 2016

Ryen Johnson, MBA, P.L.S.
District Location Land Surveyor
Idaho Transportation Department
5151 S 5th Ave.
Pocatello, ID 82304-2202

Subject: District 5 - District-Wide Aerial Mapping Project
Key Numbers 14008 & 14009

Reference: Initial Scope of Work received January 27, 2016

Dear Ryen,

I have prepared the following detailed Scope of Work covering aerial photography/LiDAR acquisition and mapping for the above referenced project located in Bannock, Bear Lake, Bingham, Caribou, Franklin, Oneida, and Power Counties in southeastern Idaho.

SCOPE OF SERVICES

Aero-Graphics will provide the following products and services:

1. Digital aerial photography acquisition at a ground sample distance (GSD) of 7.5cm.
2. LiDAR data acquisition at a nominal point spacing (NPS) of 0.5m. (4 points per square meter).
3. Raw and bare-earth classified LiDAR data in LAS v1.2 format.
4. 2' contours and planimetric data furnished in MicroStation V8i .DGN format at 1"=100'.
5. DTM files consisting of break lines and mass points in ASCII and InRoads .DTM formats.
6. DEM data at a 2' cell size provided in ESRI Grid raster format.
7. Color orthorectified imagery in .TIF, .SID and .HMR formats with a pixel resolution of 0.25'.
8. One accuracy assessment report of surveyed spot elevations compared to the DTM.
9. One full license of Leica Cyclone 3D point cloud processing software with three year's support.

TECHNICAL APPROACH

Definition of Mapping Area

This project entails aerial mapping for all Interstates and Highways within the confines of District 5. Some portions of I-86 and US-26 will extend beyond District/County borders. The following routes are included:

A) US-30 (91 miles)	B) US-91 & SH-40 (85 miles)	C) I-15 (112 miles)
D) SH-39 (51 miles)	E) US-89 & SH-61 (48 miles)	F) SH-36 (67 miles)
G) US-26 (35 miles)	H) I-86 (from MP 14.8, 48 miles)	I) SH-38 (24 miles)
J) SH-37 (32 miles)	K) SH-34 (99 miles)	

The following business loops will also be included:

I-86B American Falls (5 miles)	I-15B Blackfoot (6 miles)
I-15B Inkom (1 mile)	I-15B McCammon (4 miles)
I-15B Pocatello (8 miles)	US-30B Lava Hot Springs (0.4 miles)

Orthorectified imagery will extend 500' each side of centerline of all Interstate roadways and 250' on each side from the centerline of all other routes. Topographic and planimetric data will extend 200' on each side of centerline of all Interstate roadways and 100' on each side from the centerline of all other routes. The total area for LiDAR and imagery coverage is approximately 78 square miles.

Aerial Control Survey

Prior to photography, Aero-Graphics project surveyors will target and survey approximately 133 aerial control points shown in RED and GREEN in the attached .KMZ file. Horizontal and vertical control for all targets will be accurate to within ± 5cm. Aero-Graphics will provide a digital control listing to ITD in .XLS format with the following information included:

POINT #	WGS84 LATITUDE	WGS84 LONGITUDE	EASTING	NORTHING	GROUND ELEV.

Horizontal coordinates will tie to NAD 83, Idaho State Plane coordinates, East Zone in US Survey Foot. Vertical coordinates will tie to the NAVD 88 datum in US Survey Foot. An average elevation of 4,900' will be used to determine one overall Combined Adjustment Factor for conversion to true ground distances across the entire project.

Targets will be 1' x 12' crosses (6' arms). They will be in contrast with the ground and clearly visible from the air. Monuments will be flush with the ground. Where recoverable, some targets will be placed on NGS stations as indicated by the GREEN points in the KMZ file. Aero-Graphics will make all owner contacts prior to placing aerial targets on private property and will remove all aerial targets placed on private property when no longer needed.

In accordance with ASPRS standards and for vertical accuracy assessment purposes on the LiDAR data, Aero-Graphics will collect robotic total station check shots on hard surfaces within a 1000' radius surrounding the 19 lidar base station points shown in YELLOW in the attached KMZ file.

Digital Imagery and LiDAR Data Acquisition

A turbocharged Cessna T206 aircraft, equipped with an Optech Orion H300 LiDAR sensor and CS-10000 medium format camera, will be used to collect elevation data and digital imagery throughout the project area shown in the attached .KMZ file. The project requires a flying height of 3,300' above mean terrain, a pulse repetition frequency of 225 kHz and a 29-degree scan angle. The sensor will collect data at a of 0.5m nominal point spacing (4 points per square meter). Imagery will be collected at a ground sample distance (GSD) of 7.5cm. 405 flight lines and 6,728 exposures are required for full coverage.

Imagery and LiDAR data will be acquired when skies are clear and free from smog, smoke, snow, sleet, rain, clouds, cloud shadow, excessive haze, and dust, and when visibility is at least ten miles. Acquisition will not occur if snow is on the ground. Acquisition will take place when the sun angle is equal to or greater than 30° in order to minimize shadows.

Aero-Graphics will occupy 19 LiDAR base stations during the flights as shown at locations shown by the YELLOW points in the attached KMZ. GPS base-line lengths will not exceed 24km in any direction.

Digital Mapping Standards

Digital files will reflect the latest MicroStation V8i and InRoads CAD standards as downloaded from ITD's Roadway Design CADD Files website.

Relative LiDAR Swath Calibration

Using TerraMatch/TerraScan software, Aero-Graphics will perform relative calibration on the LiDAR data by correcting for roll, pitch, heading, and scale discrepancies between adjacent flight lines and test the resulting relative accuracy to ensure interswath overlap consistencies ≤ 8cm RMSDz and ≤ 16cm max. Relative vertical accuracy is also assessed by smooth surface repeatability in a single swath over hard, flat surfaces. Repeatability will not exceed 6cm.

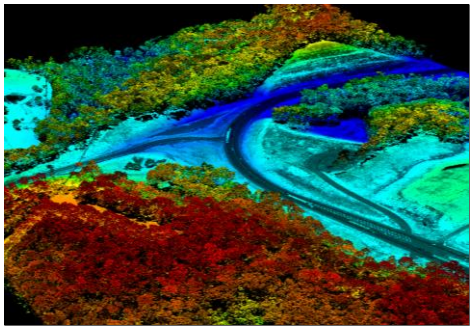
Accuracy Assessment

In accordance with NSSDA and ASPRS Positional Accuracy Standards for the 20cm Vertical Accuracy Class, Aero-Graphics will conduct an accuracy assessment on the lidar point cloud using the robotic total station check shots. The unclassified point cloud will meet non-vegetated area (NVA) requirements (20cm RMSEz and 39.2cm at the 95% confidence level) prior to further classification and processing as calculated between check points and a TIN consisting of all single return LiDAR points falling nearest the surveyed check points.

LiDAR Data Classification

Once the relative calibration and accuracy assessment is completed, the LiDAR points are classified to the minimum USGS point cloud classification scheme:

Code	Description
1	Processed, but unclassfied
2	Bare earth
7	Low noise
9	Water
10	Ignored ground (near a breakline)
17	Bridge Decks
18	High noise



This is accomplished by using a series of classification algorithms in TerraScan. The algorithm parameters will be fine-tuned to yield the best results for the terrain encountered in the project

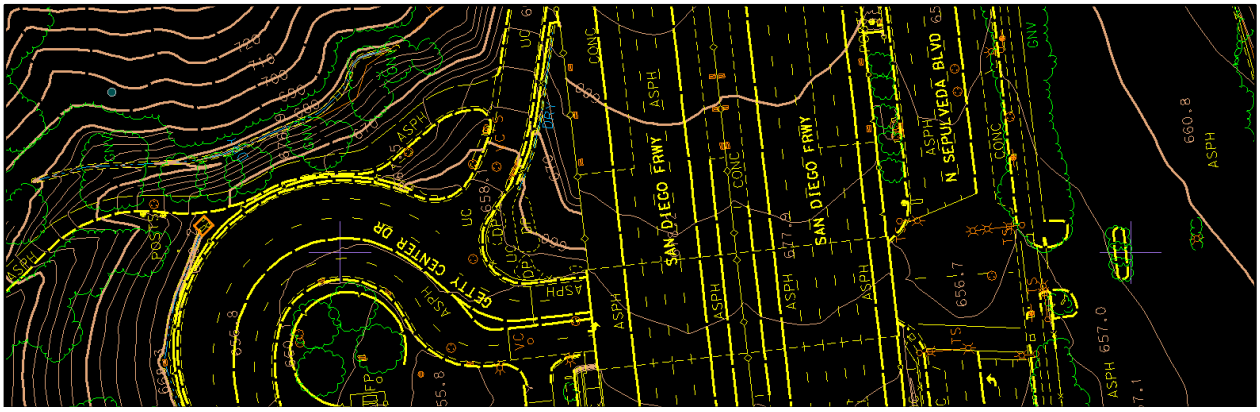
area. This data will then be put through a rigorous QA/QC of bare-earth classification, conducted manually to ensure accuracy. Both raw and classified point cloud data, with embedded flight line information, will be delivered in .LAS v1.2 format.

Photogrammetric Compilation

Digital workstations interfaced with Cardinal Systems VR software will be used to compile planimetry and DTM data consisting of break lines, mass points, and spot elevations, at a scale of 1"=100' for the mapping areas outlined in YELLOW and MAGNETA in the attached .KMZ file. Planimetry will include edges of roads; sidewalks; railroads; cattle guards, guard rails, building outlines; visible fences, signs, culverts, power and light poles; bridges; ditches; drainages; major vegetation outlines; and other features visible in the imagery and appropriate for 1"=100' scale mapping. 2' contours will be software-generated from bare-earth LiDAR data and supplemental break lines, with index contours every 10-feet. Data will be provided in the ground-adjusted coordinate system. Contours in areas obscured by dense vegetation, snow or other elements will be dashed to indicate questionable accuracy. A 5-inch coordinate grid will be included.

Final Editing and Translation

The contour and planimetric data will be delivered in MicroStation V8i .DGN format on CD. DTM data consisting of ground-classified LiDAR data, break lines and mass points/spot elevations will be furnished in .DTM and ASCII formats, suitable for InRoads software on CD. The full LiDAR data set (classified for ground and non-ground) will also be supplied in LAS 1.2 format on hard drive.



DEM Data

Aero-Graphics will provide bare-earth DEM data at a 2' cell size in ESRI Grid format for the corridors shown in BLUE in the attached KMZ file. Any water features such as ponds, lakes, rivers and streams that are collected within the photogrammetric mapping corridors will be used to hydro-flatten the DEM data.

Color Orthorectified Imagery

High-end Dell 64-bit workstations will be used to process the orthorectified imagery. To ensure horizontal accuracies commensurate with ASPRS Positional Accuracy Standards, the surface model used for rectification will be a combination of manually-collected break lines and the bare-earth LiDAR data set. Orthorectified imagery will cover the mapping areas shown in BLUE in the attached .KMZ file. Color ortho imagery will be furnished in .TIF, .SID and .HMR formats at a pixel resolution of 0.25' on portable hard drives. Imagery will be provided in the ground-adjusted coordinate system. Files will be no greater than 200 MB in size and will butt match with adjacent files. Files will be tone matched to optimize image quality throughout.

LiDAR Point Cloud Processing Software
Aero-Graphics will provide ITD with a license of Leica's Cyclone LiDAR processing software. This will include the Register and Survey modules. Software will be supplied with three years of technical support and updates (provided by Bonneville Blue).

ACCURACY DECLARATIONS

Based on accurate survey control, all work will meet or exceed ASPRS Class 1 Mapping Standards for 2' contours at a scale of 1"=100'.

SCHEDULE

Control survey (40%) ..... Completion by April 15, 2016
Photography/LiDAR acquisition (40%): ..... Completion by May 10, 2016
Control survey (remaining)..... Completion by September 1, 2016
Photography/LiDAR acquisition (remaining): ..... Completion by November 30, 2016
Mapping, LiDAR and imagery (40%): ..... Completion by December 31, 2016
Mapping, LiDAR and imagery (remaining): ..... Completion by July 31, 2017

Partial deliveries will be made according to the priorities listed in the Initial Scope of Work.

Should you have any questions or require further information, please call me at (801) 428-3102. Thank you for considering Aero-Graphics for this project.

Yours truly,

AERO-GRAPHICS, INC.

Kelly Francis, CP, PMP
President