Dewberry®

PROJECT REPORT

For the

USGS Grand Lake, OK LiDAR Project

USGS Contract:

G10PC00013

Task Order Number:

G11PD00916

Prepared for:
USGS

Prepared by:
Dewberry
1000 Ashley Blvd., Suite 801
Tampa, Florida 33602-3718

Report Date: November 7, 2011

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Executive Summary

The primary purpose of this project was to develop a consistent and accurate surface elevation dataset derived from high-accuracy Light Detection and Ranging (LiDAR) technology for the USGS Grand Lake, OK project area. Grand Lake was flown as part of a larger FEMA LiDAR project. All data for this FEMA project was flown together and calibrated to a single geodetic network.

The LiDAR data were processed to a bare-earth digital terrain model (DTM). Detailed breaklines, bare-earth DEMs, and 1-foot contours were produced for the project area. Data was formatted according to tiles with each tile covering an area of 5000 ft by 5000 ft. A total of 631 tiles were produced for the project encompassing an area of approximately 348 sq. miles.

The Project Team

Dewberry served as the prime contractor for the project. In addition to project management, Dewberry was responsible for breakline production, Digital Elevation Model (DEM) and contour production, quality assurance, and the final LAS classification of the data.

Laser Mapping Specialists Inc. (LMSI) completed LiDAR data acquisition, data calibration, and initial LAS classification for the Grand Lake project area.

Survey Area

The project area addressed by this report falls mainly within Oklahoma with small portions extending into Kansas and Missouri. Oklahoma counties include Craig, Ottawa, Delaware, and Mayes. Kansas counties include Labette and Cherokee. Missouri counties include McDonald.

Date of Survey

The LiDAR aerial acquisition was conducted from December 3, 2010 thru December 29, 2010.

Datum Reference

Data produced for the project were delivered in the following reference system.

Horizontal Datum: The horizontal datum for the project is North American Datum of 1983 (NAD 83) HARN
Vertical Datum: The Vertical datum for the project is North American Vertical Datum of 1988 (NAVD88)
Coordinate System: Oklahoma State Plane Coordinate System, North Zone
Units: Horizontal units are in US Survey Feet, Vertical units are in Feet.
Geiod Model: Geoid09 (Geoid 09 was used to convert ellipsoid heights to orthometric heights).

LiDAR Vertical Accuracy

Grand Lake was flown as part of a larger FEMA LiDAR project. All data for this FEMA project was flown together and calibrated to a single geodetic network. Checkpoints were established for the larger FEMA project, but none of these checkpoints fall within the Grand Lake boundary. The vertical accuracy for the FEMA project is detailed in the provided report titled "RAMPP QA OttawaDelaware_07062011.pdf." The FEMA project vertical accuracy is summarized in section 4 of this report.

Project Deliverables

The deliverables for the project are listed below.

1. Raw Point Cloud Data (Swaths)
2. Classified Point Cloud Data (Tiled)
3. Bare Earth Surface (Raster DEM – GRID Format)
4. Metadata
5. Project Report (Acquisition, Processing, QC)
6. Project Extents Derived from LiDAR Deliverable
7. Breakline Data (File GDB and shapefiles)
8. Contours (1-FT in shapefile format)
9. Intensity Imagery (1-FT pixels in TIFF format)

1 Project Tiling Footprint

Six hundred and thirty-one (631) tiles were delivered for the project. Each tile's extent is 5000 feet by 5000 feet.

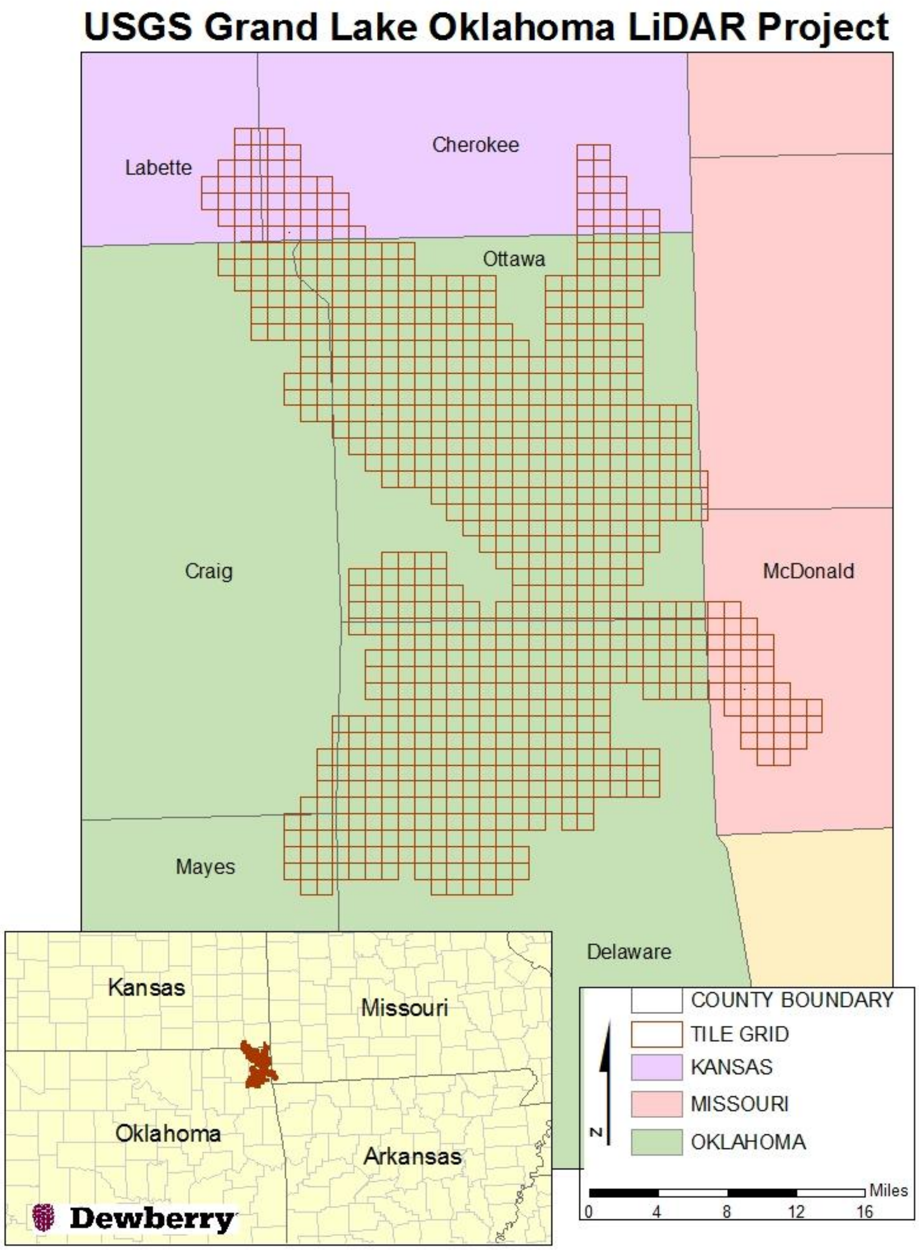

Figure 1: Project Map

1.1 List of delivered tiles (631):

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2 LiDAR Acquisition Report

Laser Mapping Specialists, Inc.

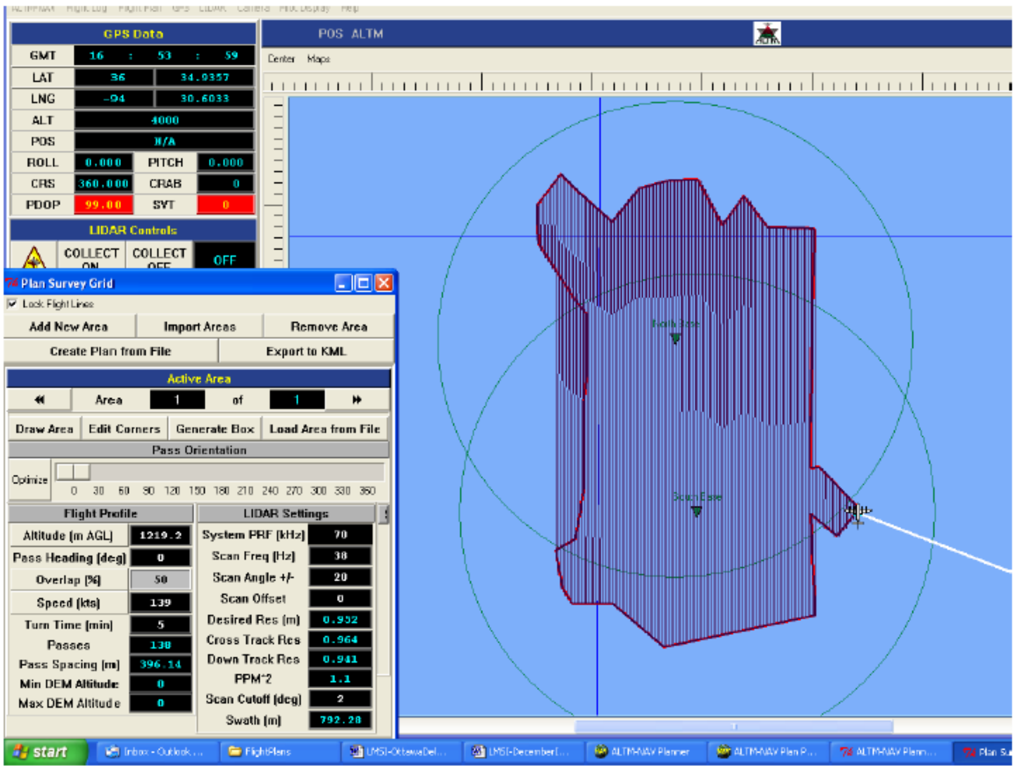
Mapping at the speed of li

RAMP Project #: 50036726-E0040410 (Ottawa & Deleware, OK)
Acquisition Report
2/23/2011
LMSI IDIQ SUBCONTRACT # HSFEHQ-09-D-0363-U005

LIDAR Surveys

LIDAR acquisition began on December 3, 2010 (julian day 337) and was completed on December 29, 2010 (julian da 363). A total of 19 survey missions were flown to complete the project. LMSI utilized an Optech ALTM3100EA for acquisition. The flight plan was flown as planned with no modifications. There were no unusual occurances during tl acquisition and the sensor performed within specifications. There were 138 flight lines required to complete the proje The flight plan is shown below.

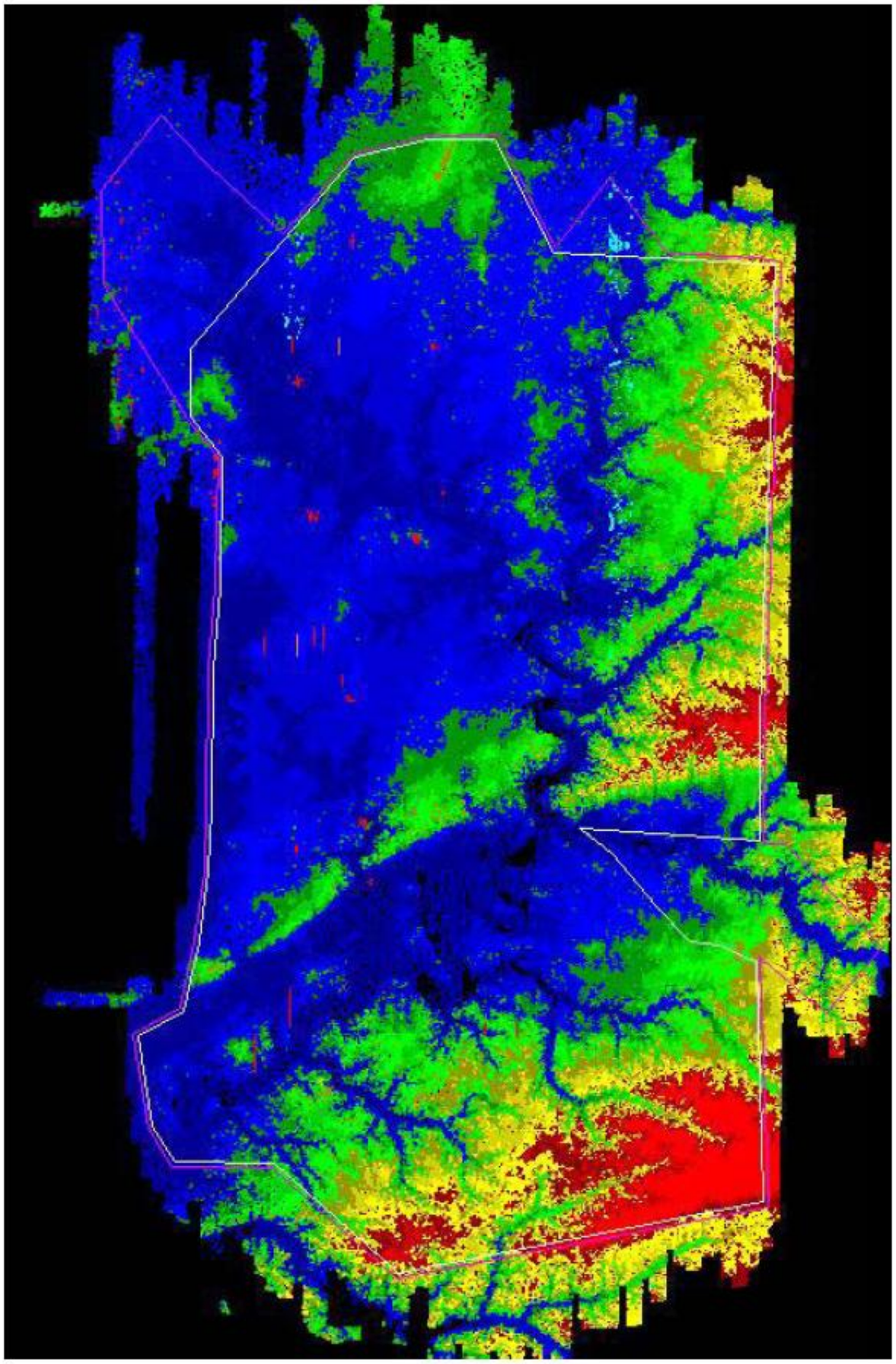
Flight Layout



LIDAR Flight Parameters

Laser Firing Rate:	70000
Altitude (mtr. AGL):	1220
Swath Overlap (%):	50
Approx. Ground Speed (knts):	139
Scan Rate (Hz):	38
Scan Angle (°±):	20
Computed Along Track Spacing (mtr):	0.95
Computed Cross track Spacing (mtr.):	0.95
Average Raw Point Spacing (mtr.)	0.67
Computed Swath Width (mtr.):	3555
Number of Lines Req'd:	138
Line Spacing (mtr.)	792

FEMA LIDAR Surveys – Ottawa-Delaware Counties, OK



LIDAR project coverage map

LIDAR Survey Coverage Check
Project coverage was checked on site with no data gaps except for water features.

GPS Surveys

Base Stations

Two base stations were utilized for all but the last survey mission. The base station in the north portion of the project was named N_Base and the base station on the south portion of the project was named S_Base. An offset base point was set for the last mission from the south base and designated S_Base2. The base staion coordinates are set forth below:

N_Base	Latitude:	N36 50 39.57657
	Longitude:	W94 51 19.96588
	Ellipsoid Height:	217.6815m
	Orthometric Height:	246.9993m
S_Base	Latitude:	N36 34 59.92262
	Longitude:	W94 48 47.42050
	Ellipsoid Height:	220.9840m
	Orthometric Height:	249.9642m
S_Base 2	Latitude:	N36 34 59.85846
	Longitude:	W94 48 47.05486
	Ellipsoid Height:	220.8141m
	Orthometric Height:	249.7942m

Ground Control/QC Check Points

Six kinematic cross sections and 15 static points were surveyed at various locations throughout the project to be utilized for quality control and adjustment of the LIDAR data.

Airborne GPS Trajectories

All airborne GPS trajectories were processed and checked on site. All trajectories were very high quality with forward/reverse separation between 2cm-4cm.

Acquisition Summary

All equipment performed within specifications with no unusual occurances or anamolies. All data was of a very high quality and the project was executed as planned.

Daily Flight Log

Julian Date:	337	Aircraft Tail #:	4351+
Local Date:	03-Dec 2010	Pilot:	John Pitts
Local Time:	07:22	Airport ID:	MIO
Time Zone:	Central	Operator:	Mike Rovrero

Hobbs Beg:	Hobbs End:
2044.1	

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
0253	020@3	10	clr	30 F	26 F	30.13

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
ottawa Delaware	Fema		20	38	1219	150
ok						

POS/AV File Name
337A
ALTM-Logfile Name
377 A

Ground Station Data

Begin Static 1	757 am
End Static 1	807 am
Begin Static 2	1240
End Static 2	1250
Temp/Pressure (GND)	/

POS/AV File Transfers

1st File	Last File

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
1434	1434	NA	154	1000	1.42	10	96	test fire
1440	1440	NA	164	932	1.42	10	124	test fire
1456	1458	1	179.2	1258	1.63	9	126	
1502	1503	2	360	1330	1.78	8	152	
1508	1510	3	180	1260	1.46	10	134	
1514	1516	4	360	1257	1.49	10	156	
1520	1523	5	180	1277	1.51	10	131	
1527	1530	6	360	1270	1.51	10	157	
1535	1538	7	180	1256	1.59	9	135	
1542	1544	8	360	1219	1.87	8	159	
1550	1554	9	180	1240	2.35	7	133	
1559	1602	10	360	1219	2.06	8	152	
1608	1611	11	180	1242	1.59	9	123	
1615	1618	12	360	1271	1.67	9	162	
1623	1627	13	180	1300	1.79	9	131	
1631	1634	14	360	1350	1.79	9	168	
1639	1643	15	180	1271	1.81	9	127	
1641	1649	16	360	1226	1.79	9	163	
1655	1657	17	180	1269	1.73	9	127	
1204	1206	18	360	1221	2.2	8	167	
1718	1735	24	180	1219	2.2	9	125	

Daily Activity/Comments

337A Page 1

Check-off When Completed

- [x] Power up ALTM Laser System
- [x] Boot Laptop/Open Programs:
- [x] POS/AV
- [x] ALTM/NAV
- [ ] Internet Explorer FTP:/
- [x] Delete old POS/AV files from PC Card
- [x] Achieve fine alignment
- [x] Start logging to pc card
- [x] Collect 5-min Static
- [x] Configure ALTM
- [x] Verify Full NAV
- [x] Shutters open at 2000ft AGL
- [x] Two 10-second Test Fires
- [ ] Roll Comp Line
- [x] Flight-lines flown
- [ ] Roll Comp Line
- [ ] Copy all but last 2 POS/AV to C drive
- [x] Close Shutters
- [ ] Collect 5 min. Static
- [ ] Stop Logging to PC Card
- [ ] Copy Remaining POS/AV Files to C Drive
- [x] Power-down ALTM System

Daily [illegible]ht Log

Julian Date:	337	Aircraft Tail #:	435 JA	Hobbs Beg:	2044.1
Local Date:	03-Dec 2010	Pilot:	John Pitts		
Local Time:		Airport ID:	MEO	Hobbs End:	
Time Zone:	Central	Operator:	Mike Borrero		

POS/AV File Name
337
ALTM-Logfile Name
337

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
0253	070@3KTS	10	CLR	30 F	26 F	30.13

Ground Station Data

Begin Static 1
757 cm
End Static 1
807 cm
Begin Static 2
1240
End Static 2
1250
Temp/Pressure (GND)
/

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
Ottawa Delaware	Fenny		20	38	1219	150
OK						

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
1741	1754	20	360	1236	1.63	9	172	
1819	1821	Crossline	90	1283	1.70	8	163	Crossline

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- [ ] Power up ALTM Laser System
- [ ] Boot Laptop/Open Programs:
- [ ] POS/AV
- [ ] ALTM/NAV
- [ ] Internet Explorer FTP:/
- [ ] Delete old POS/AV files from PC Card
- [ ] Achieve fine alignment
- [ ] Start logging to pc card
- [ ] Collect 5-min Static
- [ ] Configure ALTM
- [ ] Verify Full NAV
- [ ] Shutters open at 2000ft AGL
- [ ] Two 10-second Test Fires
- [ ] Roll Comp Line
- [ ] Flight-lines flown
- [ ] Roll Comp Line
- [ ] Copy all but last 2 POS/AV to C drive
- [ ] Close Shutters
- [ ] Collect 5 min. Static
- [ ] Stop Logging to PC Card
- [ ] Copy Remaining POS/AV Files to C Drive
- [ ] Power-down ALTM System

Daily Activity/Comments

337 Page 2

Daily Flight Log

Julian Date:	10343A	Aircraft Tail #:	4354	Hobbs Beg:	2058.7
Local Date:	1733	Pilot:	John Pitts		
Local Time:	Central	Airport ID:	UTO	Hobbs End:	
Time Zone:	9 Dec 2010	Operator:	Mike Borrero		2063.7

POS/AV File Name
10343A
ALTM-Logfile Name
10343A

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
1821	200 Calm kts	10 SM	CLR	51 °F	33 °F	29.99

Ground Station Data

Begin Static 1
1744
End Static 1
1754
Begin Static 2
2220
End Static 2
2230
Temp/Pressure (GND)
/

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
Ottawa Delaware OK	FEMA		26	38	1215	150

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
0000	0005	Test fire						
0033	0049	21	180	1225	2.11	10	149	
0055	0110	22	360	1265	.99	10	150	
0115	0131	23	180	1260	1.69	10	148	
0137	0153	24	360	1218	1.67	9	151	
0156	0212	25	180	1224	1.47	9	148	
0218	0224	26	360	1211	1.36	10	143	
0239	0253	27	180	1291	1.41	10	162	
0254	316	28	360	1243	1.88	8	134	
0329	342	29	180	1230	1.64	6	160	
357	359	cross line	90	1306	1.96	8	163	

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- ✓ Power-up ALTM Laser System
- ✓ Boot Laptop/Open Programs:
- ✓ POS/AV
- ✓ ALTM/NAV
- ✓ Internet Explorer FTP:/
- ✓ Delete old POS/AV files from PC Card
- ✓ Achieve fine alignment
- ✓ Start logging to pc card
- ✓ Collect 5-min Static
- ✓ Configure ALTM
- ✓ Verify Full NAV
- ✓ Shutters open at 2000ft AGL
- ✓ Two 10-second Test Fires
- ✓ Roll Comp Line
- ✓ Flight-lines flown
- ✓ Roll Comp Line
- ✓ Copy all but last 2 POS/AV to C drive
- ✓ Close Shutters
- ✓ Collect 5 min. Static
- Stop Logging to PC Card
- Copy Remaining POS/AV Files to C Drive
- Power-down ALTM System

Daily Activity/Comments

Pos 142.4.202.40

Daily Flight Log

Julian Date:	10344A	Aircraft Tail #:	435H	Hobbs Beg:	2063.7
Local Date:	10 Dec 2010	Pilot:	John Pitts	Hobbs End:	2070.6
Local Time:	1000	Airport ID:	MJO		
Time Zone:	central	Operator:	Mike Burrero		

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
951	calm	5.0	CLR	39°F	35°F	30.07
central						

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
ottowa Delaware OK FEMA			20	38	1215	150

POS/AV File Name	ALTM-Logfile Name
10344A	10344A

Ground Station Data

Begin Static 1	[illegible] 13:33
End Static 1	[illegible] 1349
Begin Static 2	1804
End Static 2	1809
Temp/Pressure (GND)	45°F / 37°F

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
1950	2007	Test fires						
MMM 2016	2030	30	360	1168	1.74	10	157	
2037	2053	31	180	1182	1.54	11	146	
2054	2119	32	360	1288	1.52	4	164	
2118	2135	33	180	1215	1.71	4	146	
2140	2154	34	360	1262	2.56	7	169	
2214	2231	35	180	1221	1.62	8	139	
2237	2251	36	360	1246	1.39	10	162	
2256	2314	37	180	1241	1.65	9	138	
2319	0040	38	360	1235	1.54	10	165	(laser cut off restart)
2352	2354	cross line	90	1250	1.85	10	164	

Daily Activity/Comments

POS/AV File Transfers

1st File	Last File

Check-off When Completed

✓	Power up ALTM Laser System
✓	Boot Laptop/Open Programs:
✓	POS/AV
✓	ALTM/NAV
✓	Internet Explorer FTP:/
✓	Delete old POS/AV files from PC Card
✓	Achieve fine alignment
✓	Start logging to pc card
✓	Collect 5-min Static
✓	Configure ALTM
✓	Verify Full NAV
	Shutters open at 2000ft AGL
	Two 10-second Test Fires
	Roll Comp Line
	Flight-lines flown
	Roll Comp Line
	Copy all but last 2 POS/AV to C drive
	Close Shutters
	Collect 5 min. Static
	Stop Logging to PC Card
	Copy Remaining POS/AV Files to C Drive
	Power-down ALTM System

Daily Flight Log

Julian Date:	10344C	Aircraft Tail #:	435H	Hobbs Beg:	2070.6
Local Date:	10 Dec 2010	Pilot:	John Pitts	Hobbs End:	2073.3
Local Time:	2000	Airport ID:	435H		
Time Zone:	Central	Operator:	Mika Barrero		

POS/AV File Name
10344C
ALTM-Logfile Name

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
2000	Calm 170 @ 4 Kts	10 SM	BKN 12000	45F	37°F	29.89

Ground Station Data

Begin Static 1
2005
End Static 1
2018
Begin Static 2
2221
End Static 2
2231
Temp/Pressure (GND)
51°F / 1/2°F

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
Ottawa Orleans Farms		20	38		1219	150
OK						

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
		[illegible]	BLANK					
0226	0252	Testfire						Temps Dew
0301	317	38	360	1241	1.82	9	183 72	03 °C Temp 03°C Dew
0319	334	39	180	1287	1.62	10	117	03°C 03°C
0344	0358	40	360	1214	1.65	10	170	63°C 03°C
0405	0405	crosshire	90	977	1.76	10	176	03°C 03°C

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- Power up ALTM Laser System
- Boot Laptop/Open Programs:
- POS/AV
- ALTM/NAV
- Internet Explorer FTP:/
- Delete old POS/AV files from PC Card
- Achieve fine alignment
- Start logging to pc card
- Collect 5-min Static
- Configure ALTM
- Verify Full NAV
- Shutters open at 2000ft AGL
- Two 10-second Test Fires
- Roll Comp Line
- Flight-lines flown
- Roll Comp Line
- Copy all but last 2 POS/AV to C drive
- Close Shutters
- Collect 5 min. Static
- Stop Logging to PC Card
- Copy Remaining POS/AV Files to C Drive
- Power-down ALTM System

Daily Activity/Comments

Daily Flight Log

Julian Date:	10347	Aircraft Tail #:	435M	Hobbs Beg:	2074.9	Temp (gnd):	19°
Local Date:	13 Dec 2010	Pilot:	Mike B	Hobbs End:	2080.3		
Local Time:	1033	Airport ID:	KMTO	BEG. STATIC:	10:44	Pressure (gnd):	30.35
Time Zone:	Central	Operator:	VickeBonn	END STATIC:	16 54		30.35

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
1031	calm	10.0	overcast	19°F	0°F	30.35
			Good			

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
Altown	FEMA		70	38	1219	150
Delaware OK						

POS/AV File Name
10347A
ALTM-Logfile Name
10347A
static Beg 1542
static end

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments	
1704	1750							Test fires	
								Temp	Dew
1729	1744	41	180	1146	1.71	8	163	21°F	0°F
1749	1807	42	360	1154	2.06	7	136	21°F	0F
~~1812~~		~~43~~	~~180~~		~~2.75~~	~~7~~	~~161~~		
1835	1850	43	180	1220	2.46	8	163	24°F	0°F
1855	1912	47	360	1204	2.85	7	138	27°F	0F
1916	1932	45	180	1208	1.58	9	160	26°F	0F
1936	1954	46	360	1221	1.71	10	152	26°F	0F
1959	2016	47	180	1264	1.72	10	156	26°F	0F
2020	2038	48	360	1257	1.56	11	141	30°F	-2°F
2042	2058	49	180	1209	1.96	7	153	30°F	-2°F
2103	21:21	50	360	1234	1.72	8	144	30°F	-5°F
2131	2133	Crossline	90	1300	2.41	6	162	30	-5°F

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- [x] Power up ALTM Laser System
- [x] Boot Laptop/Open Programs:
- [x] POS/AV
- [x] ALTM/NAV
- [x] Internet Explorer FTP:/
- [x] Delete old POS/AV files from PC Card
- [x] Achieve fine alignment
- [x] Start logging to pc card
- [x] Collect 5-min Static
- [x] Configure ALTM
- [x] Verify Full NAV
- [ ] Shutters open at 2000ft AGL
- [ ] Two 10-second Test Fires
- [ ] Roll Comp Line
- [ ] Flight-lines flown
- [ ] Roll Comp Line
- [ ] Copy all but last 2 POS/AV to C drive
- [ ] Close Shutters
- [ ] Collect 5 min. Static
- [ ] Stop Logging to PC Card
- [ ] Copy Remaining POS/AV Files to C Drive
- [ ] Power-down ALTM System

Daily Activity/Comments

line 43 Pdop over 3
44

FedEx Tracking #:

Daily Flight Log

Julian Date:	10347	Aircraft Tail #:	4351t	Hobbs Beg:	2080.5
Local Date:	13 Dec 2010	Pilot:	John Pitts		
Local Time:	1701	Airport ID:	M20	Hobbs End:	2082.6
Time Zone:	Central	Operator:	Mike Burrard		

POS/AV File Name
10347B
ALTM-Logfile Name
16347B

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
1652	100	CLR	10 SM	30°F	-5°F	30.25
	3 Kts					

Ground Station Data

Begin Static 1	1720
End Static 1	1730
Begin Static 2	1902
End Static 2	
Temp/Pressure (GND)	/

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
Oklahoma	FEMA		20	38	1219	150
Delaware OK						

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments	
2358	2347	Test lines						Temp	Dew
0000	0017	51	180	1291	1.97	10	150	30°F	-5°F
0021	0034	52	360	1212	2.14	10	151	26°F	0°F
		53	180						

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- [x] Power up ALTM Laser System
- [x] Boot Laptop/Open Programs:
- [x] POS/AV
- [x] ALTM/NAV
- [x] Internet Explorer FTP:/
- [x] Delete old POS/AV files from PC Card
- [x] Achieve fine alignment
- [x] Start logging to pc card
- [x] Collect 5-min Static
- [x] Configure ALTM
- [x] Verify Full NAV
- [x] Shutters open at 2000ft AGL
- [ ] Two 10-second Test Fires
- [ ] Roll Comp Line
- [ ] Flight-lines flown
- [ ] Roll Comp Line
- [ ] Copy all but last 2 POS/AV to C drive
- [ ] Close Shutters
- [ ] Collect 5 min. Static
- [ ] Stop Logging to PC Card
- [ ] Copy Remaining POS/AV Files to C Drive
- [ ] Power-down ALTM System

Daily Activity/Comments

Daily Flight Log

Julian Date:	0350	Aircraft Tail #:	435H	Hobbs Beg:	2083.8	Temp (gnd):	[illegible]
Local Date:	Dec 16	Pilot:	Jon Potts	Hobbs End:	2088.4	Pressure (gnd):	30.01
Local Time:	15:22	Airport ID:	MZO	BEG. STATIC:	1550		
Time Zone:	Central	Operator:	Mike B	END STATIC:	1660		

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
1524	350C 8KTS	10 miles	CLR	44°F	28°F	30.01

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
Ottawa Delaware OK	FEMA		20	38	1219	150

POS/AV File Name
10350A
ALTM-Logfile Name
10350A
Ending static start 2032
Ending static End 2042

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments (Temp)	Comments (Dew)
		Test fires						Temp	Dew
2206	2229	[illegible]	[illegible]						
2240	2255	53	180	1203	1.51	10	181.06	44°F	28°F
2302	2324	54	360	1303	1.44	11	114	41°F	28°F
2329	2341	55	180	1273	1.87	10	167	41°F	28°F
2350	0011	56	360	1265	1.92	10	121	37°F	26°F
0037	0052	57	180	1240	1.83	10	162	37°F	26°F
0057	0119	58	360	1272	1.73	9	125	37°F	26°F
0127	0132	54	180	1220	1.50	9	171	37°F	28°F
0143	0203	60	360	1201	1.33	10	130	37°F	28°F
0210	0213	crossline	0270	1231	1.41	10	175	37°F	28°F

Daily Activity/Comments

FedEx Tracking #:

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- [x] Power up ALTM Laser System
- [x] Boot Laptop/Open Programs:
- [x] POS/AV
- [x] ALTM/NAV
- [x] Internet Explorer FTP:/
- [x] Delete old POS/AV files from PC Card
- [x] Achieve fine alignment
- [x] Start logging to pc card
- [x] Collect 5-min Static
- [x] Configure ALTM
- [x] Verify Full NAV
- [x] Shutters open at 2000ft AGL
- [ ] Two 10-second Test Fires
- [ ] Roll Comp Line
- [ ] Flight-lines flown
- [ ] Roll Comp Line
- [ ] Copy all but last 2 POS/AV to C drive
- [ ] Close Shutters
- [ ] Collect 5 min. Static
- [ ] Stop Logging to PC Card
- [ ] Copy Remaining POS/AV Files to C Drive
- [ ] Power-down ALTM System

Daily Flight Log

Julian Date:	10351 A	Aircraft Tail #:	435H	Hobbs Beg:	2088.4
Local Date:	Dec 17 2010	Pilot:	John Tilts		
Local Time:	800	Airport ID:	M20	Hobbs End:	
Time Zone:	Central	Operator:	Mike Borrero		2093.6

POS/AV File Name
10351A
ALTM-Logfile Name
10351A

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
712	calm	7 miles	BKN 1000	32°F	28°F	3019

Ground Station Data

Begin Static 1	813
End Static 1	823
Begin Static 2	1300
End Static 2	1310
Temp/Pressure (GND)	42°F / 28°F 30.21 in

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
ottown	FEMA		20	38	1214	150
Delaware ok						

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments	
1428	1452	Test fires						Temp	Dew
1502	1518	61	180	1237	2.12	8	163	32°F	28°F
1523	1543	62	360	1235	2.16	8	132	35°F	30°F
1547	1600	63	180	1201	2.52	8	161	35°F	30°F
1607	1627	64	360	1217	2.73	7	138	35°F	31°F
1640	1656	65	180	1204	1.72	8	160	35°F	30°F
1701	1720	66	360	1284	1.49	8	135	35°F	30°F
1819	1827	67	180	1237	2.50	7	161	35°F	30°F
1844	1847	Crossline	90	1226	2.06	7	165	42°F	28°F

Daily Activity/Comments

Circled base cause of low Space Vechicles

POS/AV File Transfers

1st File	Last File

Check-off When Completed

✓	Power up ALTM Laser System
✓	Boot Laptop/Open Programs:
✓	POS/AV
✓	ALTM/NAV
✓	Internet Explorer FTP:/
✓	Delete old POS/AV files from PC Card
✓	Achieve fine alignment
✓	Start logging to pc card
✓	Collect 5-min Static
✓	Configure ALTM
✓	Verify Full NAV
✓	Shutters open at 2000ft AGL
✓	Two 10-second Test Fires
✓	Roll Comp Line
✓	Flight-lines flown
✓	Roll Comp Line
	Copy all but last 2 POS/AV to C drive
	Close Shutters
	Collect 5 min. Static
	Stop Logging to PC Card
	Copy Remaining POS/AV Files to C Drive
	Power-down ALTM System

Daily Flight Log

Julian Date:	10351	Aircraft Tail #:	4354	Hobbs Beg:	2093.6
Local Date:	17 Dec 2010	Pilot:	John Pitts	Hobbs End:	
Local Time:	1428	Airport ID:	UIZO		
Time Zone:	central	Operator:	Mike Barrero		

POS/AV File Name
103517B
ALTM-Logfile Name
103517B

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
1429	calm	10SM	scatter 8000 BKN 10000	44°F	26°F	30.19

Ground Station Data

Begin Static 1	14:35
End Static 1	14:45
Begin Static 2	1935
End Static 2	1945
Temp/Pressure (GND)	39°F / 3022

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
Ottowa	FEMA		20	38	1219	150
Delaware						
OK						

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
2053	2058	Test fires						
2112	2120	67	180 [struck through]	[struck through] 1223	2.46	8	160	44°F 26°F
2124	2154	68	360	1225 [struck through]	2.24	7	138	44°F 26°F
2200	2217	69	180	1154	1.46	9	158	44°F 26°F
2222	2242	70	360	1213	1.61	9	145	6°C -2°C
2246	2303	71	180	1245	1.54	10	172	6°C -2°C
2307	2327	72	360	1222	1.43	11	150	6°C -2°C
2340	2355	73	180	1250	2.14	9	168	6°C -2°C
0002	0023	74	360	1277	2.14	10	130	39°F 30°F
0027	0049	75	180	1226	1.91	10	160	39°F 30°F
0052	0110	76	360	1215	1.52	10	132	39°F 29°F
0112	0119	crossline	270	1123	1.50	9	152	39°F 29°F

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- [ ] Power up ALTM Laser System
- [ ] Boot Laptop/Open Programs:
- [ ] POS/AV
- [ ] ALTM/NAV
- [ ] Internet Explorer FTP:/
- [ ] Delete old POS/AV files from PC Card
- [ ] Achieve fine alignment
- [ ] Start logging to pc card
- [ ] Collect 5-min Static
- [ ] Configure ALTM
- [ ] Verify Full NAV
- [ ] Shutters open at 2000ft AGL
- [ ] Two 10-second Test Fires
- [ ] Roll Comp Line
- [ ] Flight-lines flown
- [ ] Roll Comp Line
- [ ] Copy all but last 2 POS/AV to C drive
- [ ] Close Shutters
- [ ] Collect 5 min. Static
- [ ] Stop Logging to PC Card
- [ ] Copy Remaining POS/AV Files to C Drive
- [ ] Power-down ALTM System

Daily Activity/Comments

Aztec Sea Natty Port Melissa Jem — Music — Inverce X-mas — WSAD

Daily Flight Log

Julian Date:	10352	Aircraft Tail #:	4354	Hobbs Beg:	2088.0
Local Date:	Dec 18 2010	Pilot:	John Pitts	Hobbs End:	
Local Time:	1400	Airport ID:	VHJO		
Time Zone:	Central	Operator:	Mike Barnard		

POS/AV File Name
10352A
ALTM-Logfile Name
10352A

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
3:0	calm	4 miles	CLR	28°F	26°F	3921

Ground Station Data

Begin Static 1	935
End Static 1	945
Begin Static 2	1436
End Static 2	1446
Temp/Pressure (GND)	/

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
ottawa	FEMA		20	28	1219	150
Delaware OK						

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
1611	1630	72	180	1218	2.13	8	143	28°F 26°F
1635	1653	78	360	1238	1.61	8	142	33°F 30°F
1657	1716	79	180	1213	1.65	9	144	35°F 30°F
1722	1734	80	360	1178	2.05	7	147	33°F 30°F
~~1745~~	~~1755~~	~~81~~	~~180~~	~~1169~~	~~1.65~~	~~8~~	~~143~~	~~33°F 30°F~~
~~1814~~		~~81~~	~~180~~		~~2.27~~	~~7~~	~~146~~	
1846	1849	138	360	1281	1.93	8	144	31°F 28°F
1838	1837	crossline	270	1291	2.73	7	137	Ground 77-80
1854	1857	137	180	1252	2.09	8	146	34°F 30°F
1910	1914	136	360	1165	1.46	10	145	39°F 30°F
1918	1922	135	180	1240	1.49	10	141	34°F 30°F
1927	1932	134	360	1267	1.63	10	151	34°F 30°F
1936	1941	1383	180	1206	1.17	10	140	39°F 30°F
1945	1950	132	360	1201	1.68	10	150	30°F 30°F
1954	1959	131	180	1224	1.64	10	143	39°F 30°F
2003	2004	130	360	1191	1.51	11	148	39°F 30°F
2012	2014	crossline	90	1261	1.44	9	158	39°F 30°F

POS/AV File Transfers

1st File	Last File

Check-off When Completed

C	Power up ALTM Laser System
C	Boot Laptop/Open Programs:
✓	POS/AV
✓	ALTM/NAV
✓	Internet Explorer FTP:/
✓	Delete old POS/AV files from PC Card
✓	Achieve fine alignment
	Start logging to pc card
	Collect 5-min Static
	Configure ALTM
	Verify Full NAV
	Shutters open at 2000ft AGL
	Two 10-second Test Fires
	Roll Comp Line
	Flight-lines flown
	Roll Comp Line
	Copy all but last 2 POS/AV to C drive
	Close Shutters
/	Collect 5 min. Static
/	Stop Logging to PC Card
	Copy Remaining POS/AV Files to C Drive
	Power-down ALTM System

Daily Activity/Comments

church guitar
Invoice music John Xmas

FedEx Tracking #:

Daily Flight Log

Julian Date:	10353	Aircraft Tail #:	N135H	Hobbs Beg:	2104.8
Local Date:	14 Dec 2010	Pilot:	John Pitts	Hobbs End:	
Local Time:	9:13	Airport ID:	MID		
Time Zone:	central	Operator:	Mike B		

POS/AV File Name
10353A
ALTM-Logfile Name
035314

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
920	calm	5sm	CLR	37°F	33°F	30.06

Ground Station Data

Begin Static 1	End Static 1	Begin Static 2	End Static 2	Temp/Pressure (GND)
0923	0933	1235		/

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
ottawa	FEMA		20	38	1219	150
Delaware						
OK						

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
1540	1547	Test	fires					
1557	1618	81	180	1220	1.67	9	130	37°F 33°F
1622	1640	82	360	1226	2.30	8	167	44°F 33°F
1644	1704	83	180	1217	1.604	9	143	44°F 34
1709	1725	84	360	1278	1.70	8	163	44°F 33°F
1731	1751	85	180	1232	2.02	7	137	48°F 34°F
		86	360					
1822	1824	crossline	270	1250	3.07	7	151	45°F 37°F

Daily Activity/Comments

Tattoo Galaxies (Tests) Indoor Xmas music ATP Discovery flying wild

FedEx Tracking #:

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- ✓ Power up ALTM Laser System
- ✓ Boot Laptop/Open Programs:
- ✓ POS/AV
- ✓ ALTM/NAV
- ✓ Internet Explorer FTP:/
- ✓ Delete old POS/AV files from PC Card
- ✓ Achieve fine alignment
- ✓ Start logging to pc card
- ✓ Collect 5-min Static
- ✓ Configure ALTM
- ✓ Verify Full NAV
- Shutters open at 2000ft AGL
- Two 10-second Test Fires
- Roll Comp Line
- Flight-lines flown
- Roll Comp Line
- Copy all but last 2 POS/AV to C drive
- Close Shutters
- Collect 5 min. Static
- Stop Logging to PC Card
- Copy Remaining POS/AV Files to C Drive
- Power-down ALTM System

Daily Flight Log

Julian Date:	10353	Aircraft Tail #:	435H
Local Date:	10 Dec 2010	Pilot:	John Kitts
Local Time:	1901	Airport ID:	WTO
Time Zone:	central	Operator:	Mike B

Hobbs Beg:	2108.5
Hobbs End:	2113.5

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
1335 central	190 9Kts	10 sm	CLR	53°F	26°F	29.98

Ground Station Data

POS/AV File Name
10353 B
ALTM-Logfile Name
10353 B
Begin Static 1
1415
End Static 1
1425
Begin Static 2
1859
End Static 2
1904
Temp/Pressure (GND)
/

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
ottawa	FEMA		20	38	1219	150
Delaware						
OK						

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
2036	2044	Test	fires					
2059	2115	86	360	1260	2.62	7	164	53°F 26°F
2121	2142	87	180	1171	2.22	8	136	53°F 26°F
2142	2201	88	360	1308	1.67	8	166	53°F 26°F
2207	2224	89	180	1222	1.42	10	130	50°F 27°F
2234	2250	90	360	1287	1.53	10	166	50°C 27°F
2255	2317	91	180	1251	1.43	11	132	50°F 27°F
2323	2339	92	360	1081	2.13	9	161	8°C -2°C
2344	0005	93	180	1302	2.04	10	127	8°C -2°C
0008	0024	94	360	1142	2.07	10	167	8°C -2°C
0028	0130	crossline	90	1216	1.72	10	165	5°C -2°C

Daily Activity/Comments

Alfred hichcox
tule sod erypt

FedEx Tracking #:

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- [ ] Power up ALTM Laser System
- [ ] Boot Laptop/Open Programs:
- [ ] POS/AV
- [ ] ALTM/NAV
- [ ] Internet Explorer FTP:/
- [ ] Delete old POS/AV files from PC Card
- [ ] Achieve fine alignment
- [ ] Start logging to pc card
- [ ] Collect 5-min Static
- [ ] Configure ALTM
- [ ] Verify Full NAV
- [ ] Shutters open at 2000ft AGL
- [ ] Two 10-second Test Fires
- [ ] Roll Comp Line
- [ ] Flight-lines flown
- [ ] Roll Comp Line
- [ ] Copy all but last 2 POS/AV to C drive
- [ ] Close Shutters
- [ ] Collect 5 min. Static
- [ ] Stop Logging to PC Card
- [ ] Copy Remaining POS/AV Files to C Drive
- [ ] Power-down ALTM System

Daily Flight Log

Julian Date:	10356	Aircraft Tail #:	N455H
Local Date:	Dec 22 2010	Pilot:	John Ditls
Local Time:	9:30	Airport ID:	MIO
Time Zone:	Central	Operator:	Mike Bouvero

Hobbs Beg:	2113.5
Hobbs End:	2119.1

POS/AV File Name
10356 H
ALTM-Logfile Name
10356 H

Ground Station Data

Begin Static 1	948
End Static 1	958
Begin Static 2	1445
End Static 2	1459
Temp/Pressure (GND)	41°F / 30.39

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
912	020	10.0	CLR	28°F	19°F	30.40
	6 KTS	SM				

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
other	FEMA		20	38	1214	150
Balance ok						

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
1607	1630	Test fires						Temp Dew
1640	1657	95	180	1204	1.64	9	152	28°F 19°F
1702	1721	96	360	1231	1.65	8	123	28°F 19°F
1728	1745	97	180	1203	2.57	7	154	30°F 18°F
1822	1849	98	360	1213	1.86	8	127	30°F 19°F
1849	1905	99	180	1215	1.62	9	160	30°F 18°F
1911	1931	100	360	1245	1.57	10	121	30°F 18°F
1941	1956	101	180	1253	1.60	10	158	30°F 18°F
2001	2020	102	360	1273	1.43	9	126	30°F 18°F
2024	2027	crossline	90	1263	1.72	9	132	30°F 18°F

Daily Activity/Comments

FedEx Tracking #:

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- [x] Power up ALTM Laser System
- [x] Boot Laptop/Open Programs:
- [x] POS/AV
- [x] ALTM/NAV
- [x] Internet Explorer FTP:/
- [x] Delete old POS/AV files from PC Card
- [x] Achieve fine alignment
- [x] Start logging to pc card
- [x] Collect 5-min Static
- [x] Configure ALTM
- [x] Verify Full NAV
- [x] Shutters open at 2000ft AGL
- [x] Two 10-second Test Fires
- [ ] Roll Comp Line
- [ ] Flight-lines flown
- [ ] Roll Comp Line
- [ ] Copy all but last 2 POS/AV to C drive
- [ ] Close Shutters
- [ ] Collect 5 min. Static
- [ ] Stop Logging to PC Card
- [ ] Copy Remaining POS/AV Files to C Drive
- [ ] Power-down ALTM System

Daily Flight Log

Julian Date:	10356	Aircraft Tail #:	N435 1t	Hobbs Beg:	2114.3
Local Date:	22 Dec 2010	Pilot:	John Pitts	Hobbs End:	
Local Time:	17:30	Airport ID:	MIO		
Time Zone:	Central	Operator:	Mike Borrero		2123.7

POS/AV File Name
10356B
ALTM-Logfile Name
10356B

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
1722	Calm	10	CLR	34	21	30.42

Ground Station Data

Begin Static 1
1717
End Static 1
1727
Begin Static 2
2132
End Static 2
2142
Temp/Pressure (GND)
/

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
Ottawa	FEMA		20	38	1219	150
Delware						
OK						

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
2328	2348	Test fires						Temp Dew
0007	0022	103	180	1272	1.91	10	154	36 21
0026	0045	104	360	1173	1.62	10	139	37 21
0050	0105	105	180	1263	1.60	9	148	37 21
0110	0127	106	360	1250	1.42	9	144	34 21
0145	0200	107	180	1286	1.41	10	155	30 21
0205	0221	108	360	1254	1.76	9	143	30 21
0226	0242	109	180	1257	1.92	9	148	30 21
0247	0303	110	360	1199	1.61	10	146	30 21
0308	0310	Crossline	90	1202	1.64	10	139	30 21

Daily Activity/Comments

FedEx Tracking #:

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- [ ] Power up ALTM Laser System
- [ ] Boot Laptop/Open Programs:
- [ ] POS/AV
- [ ] ALTM/NAV
- [ ] Internet Explorer FTP:/
- [ ] Delete old POS/AV files from PC Card
- [ ] Achieve fine alignment
- [ ] Start logging to pc card
- [ ] Collect 5-min Static
- [ ] Configure ALTM
- [ ] Verify Full NAV
- [ ] Shutters open at 2000ft AGL
- [ ] Two 10-second Test Fires
- [ ] Roll Comp Line
- [ ] Flight-lines flown
- [ ] Roll Comp Line
- [ ] Copy all but last 2 POS/AV to C drive
- [ ] Close Shutters
- [ ] Collect 5 min. Static
- [ ] Stop Logging to PC Card
- [ ] Copy Remaining POS/AV Files to C Drive
- [ ] Power-down ALTM System

Daily Flight Log

Julian Date:	10361	Aircraft Tail #:	N435?T	Hobbs Beg:	2129.7
Local Date:	Dec 27 2010	Pilot:	Rusty Miller	Hobbs End:	2132.5
Local Time:	1745	Airport ID:	MJD		
Time Zone:	central	Operator:	Mike Bozrag		

POS/AV File Name	ALTM-Logfile Name
10361	10361

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
1731	150 7	10	CLR	35°F	19°F	30.21

Ground Station Data

Begin Static 1	1756
End Static 1	1806
Begin Static 2	2029
End Static 2	2039
Temp/Pressure (GND)	/

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
[illegible] [illegible] OK	FEMA		20	98	1219	150

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
0120	0138	111	180	1117	1.40	10	142	35°F 19°F
0145	0159	112	360	1239	1.72	9	166	35°F 19°F
0210	0211	crossline	90	1183	1.92	9	166	35°F 19°F

Daily Activity/Comments

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- Power up ALTM Laser System
- Boot Laptop/Open Programs:
- POS/AV
- ALTM/NAV
- Internet Explorer FTP:/
- Delete old POS/AV files from PC Card
- Achieve fine alignment
- Start logging to pc card
- Collect 5-min Static
- Configure ALTM
- Verify Full NAV
- Shutters open at 2000ft AGL
- Two 10-second Test Fires
- Roll Comp Line
- Flight-lines flown
- Roll Comp Line
- Copy all but last 2 POS/AV to C drive
- Close Shutters
- Collect 5 min. Static
- Stop Logging to PC Card
- Copy Remaining POS/AV Files to C Drive
- Power-down ALTM System

Daily Flight Log

Julian Date:	10362	Aircraft Tail #:	435H	Hobbs Beg:	2132.7
Local Date:	28 Dec 2010	Pilot:	CRASH	Hobbs End:	2136.9
Local Time:	753	Airport ID:	MTO		
Time Zone:	Central	Operator:	Mike Borrero		

POS/AV File Name
10362A
ALTM-Logfile Name
10362A

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
731	Calm	10 [illegible]	CLR	26°F	23°F	30.21

Ground Station Data

Begin Static 1	0759
End Static 1	0809
Begin Static 2	1142
End Static 2	
Temp/Pressure (GND)	/

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
Alltown	FEMA		20	38	1219	150
Delaware						
OK						

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
1440	1457	113	180	1187	1.77	8	153	26°F 23°F
1502	1518	114	360	1287	1.83	9	162	26°F 23°F
1524	1540	115	180	1231	2.15	8	146	-1 -4 2 miles
1549	1602	116	360	1230	2.34	8	162	-1 -4 3 miles
1627	1639	129	180	1227	1.91	8	144	N 2 -4
1648	1657	128	360	1261	2.06	7	152	N 2 -4
1705	1710	127	180	1231	2.61	7	134	N 2 -4
1715	1721	126	360	1232	2.91	7	157	N 2 -4
1724	1731	Crossline	90	1231	2.91	7	153	2 -4

Daily Activity/Comments

POS/AV File Transfers

1st File	Last File
turn off	
[illegible]	2 miles out

Check-off When Completed

- Power up ALTM Laser System
- Boot Laptop/Open Programs:
- POS/AV
- ALTM/NAV
- Internet Explorer FTP:/
- Delete old POS/AV files from PC Card
- Achieve fine alignment
- Start logging to pc card
- Collect 5-min Static
- Configure ALTM
- Verify Full NAV
- Shutters open at 2000ft AGL
- Two 10-second Test Fires
- Roll Comp Line
- Flight-lines flown
- Roll Comp Line
- Copy all but last 2 POS/AV to C drive
- Close Shutters
- Collect 5 min. Static
- Stop Logging to PC Card
- Copy Remaining POS/AV Files to C Drive
- Power-down ALTM System

Daily Flight Log

Julian Date:	10 362	Aircraft Tail #:	N435??	Hobbs Beg:	2136.9
Local Date:	12-28-2010	Pilot:	Crash	Hobbs End:	2139.2
Local Time:	1314	Airport ID:	MJO		
Time Zone:	Central	Operator:	Mike Bonino		

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
~~[illegible]~~ 1313	180 6	10	2300	46F	35F	3013

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
Ottawa Dilwood OK	FEMA		20	38	1219	150

Ground Station Data

POS/AV File Name	
10362B	
ALTM-Logfile Name	10362B
Begin Static 1	1314
End Static 1	1329
Begin Static 2	1529
End Static 2	1539
Temp/Pressure (GND)	/

POS/AV File Transfers

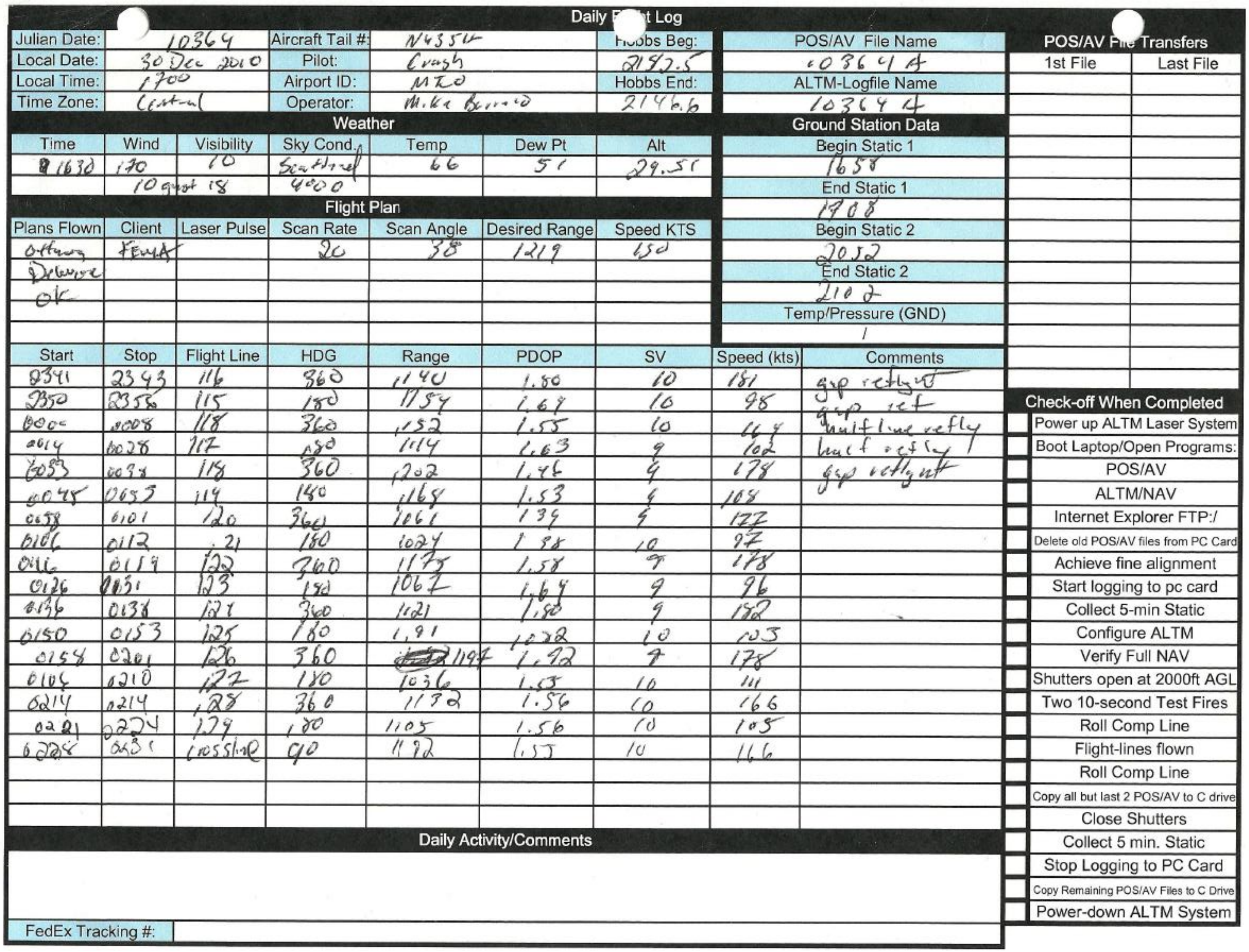
1st File	Last File

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
1955	2000	119	180	1223	1.74	9	131	46°F 35°F
2006	2011	120	360	1198	1.64	9	141	46°F 35°F
2018	2024	121	180	1211	2.60	7	133	46°F 35°F
2032	2037	122	360	1214	2.44	8	145	46°F 35°F
2043	2048	123	180	1203	2.36	8	128	46°F 35°F
2056	2057	Crossline	90	1241	1.38	10	146	46°F 35°F
2331	2332	122	360	1193	2.08	10	157	
2339	2342	123	180	1146	1.48	10	140	44 35 Did not
2348	2353	124	360	1114	1.53	10	158	44 35 run
2359	0005	125	180	1270	1.67	10	141	44 35
0010	0011	Crossline	90	1236	1.58	10	161	44 35
		~~115~~	~~180~~					
		~~116~~	~~360~~					
		~~118~~	~~360~~					
0058	0101	117	180	1212	1.51	9	140	44 35 half
0114	0121	118	360	1235	1.42	9	156	44 35 half
0129	0130	127	180	1200	1.56	9	136	gap reflight
0136	0132	128	360	1266	1.[illegible]	9	149	gap reflight
0142	0144	112	180	1184	1.80	8	136	gap reflight

Check-off When Completed

- Power up ALTM Laser System
- Boot Laptop/Open Programs:
- POS/AV
- ALTM/NAV
- Internet Explorer FTP:/
- Delete old POS/AV files from PC Card
- Achieve fine alignment
- Start logging to pc card
- Collect 5-min Static
- Configure ALTM
- Verify Full NAV
- Shutters open at 2000ft AGL
- Two 10-second Test Fires
- Roll Comp Line
- Flight-lines flown
- Roll Comp Line
- Copy all but last 2 POS/AV to C drive
- Close Shutters
- Collect 5 min. Static
- Stop Logging to PC Card
- Copy Remaining POS/AV Files to C Drive
- Power-down ALTM System

Daily Activity/Comments



Daily Flight Log

Julian Date:	10364	Aircraft Tail #:	N435U	Hobbs Beg:	2192.5
Local Date:	30 Dec 2010	Pilot:	Crash	Hobbs End:	2146.6
Local Time:	1700	Airport ID:	MZO		
Time Zone:	Central	Operator:	Mike Berard		

POS/AV File Name	ALTM-Logfile Name
10364 A	10364 A

Weather

Time	Wind	Visibility	Sky Cond.	Temp	Dew Pt	Alt
1630	170	10	Scattered	66	51	29.51
	10 gust 18		4000			

Ground Station Data

Begin Static 1	1658
End Static 1	1908
Begin Static 2	2052
End Static 2	2102
Temp/Pressure (GND)	/

Flight Plan

Plans Flown	Client	Laser Pulse	Scan Rate	Scan Angle	Desired Range	Speed KTS
Offtime Delivered ok	FEMA		20	38	1219	150

Start	Stop	Flight Line	HDG	Range	PDOP	SV	Speed (kts)	Comments
2341	2343	116	360	1140	1.80	10	181	gap refly
2350	2356	115	180	1154	1.67	10	98	gap ref
0000	0008	118	360	1152	1.55	10	64	half line refly
0014	0028	117	180	1114	1.63	9	102	half refly
0053	0038	118	360	1202	1.46	9	178	gap refly not
0048	0053	119	180	1168	1.53	9	108	
0058	0101	120	360	1061	1.39	9	122	
0106	0112	121	180	1024	1.38	10	97	
0116	0119	122	360	1173	1.58	9	178	
0126	0131	123	180	1067	1.64	9	96	
0136	0138	124	360	1121	1.80	9	182	
0150	0153	125	180	1191	1.038	10	103	
0154	0201	126	360	1194	1.92	9	178	
0104	0210	127	180	1036	1.53	10	111	
0214	0214	128	360	1132	1.56	10	166	
0221	0224	129	180	1105	1.56	10	105	
0228	0231	crossline	90	1192	1.55	10	166	

Daily Activity/Comments

FedEx Tracking #:

POS/AV File Transfers

1st File	Last File

Check-off When Completed

- Power up ALTM Laser System
- Boot Laptop/Open Programs:
- POS/AV
- ALTM/NAV
- Internet Explorer FTP:/
- Delete old POS/AV files from PC Card
- Achieve fine alignment
- Start logging to pc card
- Collect 5-min Static
- Configure ALTM
- Verify Full NAV
- Shutters open at 2000ft AGL
- Two 10-second Test Fires
- Roll Comp Line
- Flight-lines flown
- Roll Comp Line
- Copy all but last 2 POS/AV to C drive
- Close Shutters
- Collect 5 min. Static
- Stop Logging to PC Card
- Copy Remaining POS/AV Files to C Drive
- Power-down ALTM System

LIDAR DATA CALIBRATION REPORT

Grand Lake, OK
Originally submitted: 8-22-11

Submitted by:

LMSI

Submitted to:

DEWBERRY

EXECUTIVE SUMMARY

This LiDAR project was to provide high accuracy, calibrated multiple return LiDAR for the Grand Lake, OK area. Data was collected and delivered in compliance with the "U.S. Geological Survey National Geospatial Program Base LiDAR Specifications, Version 13 – ILMF 2010".

This report concerns the Grand Lake, OK area, the primary deliverable product was classified LiDAR data in tiled format.

The elevation data was verified internally prior to delivery to ensure it met fundamental accuracy requirements (vertical accuracy NSSDA RMSEZ = 9.25cm (NSSDA AccuracyZ 95% = 18 cm) or better; in open, non-vegetated terrain) when compared to kinematic and static GPS checkpoints. Below is the summary for both tests:

- The LiDAR dataset was tested to 0.043m vertical accuracy at 95% confidence level based on consolidated $RMSE_z$ (0.022m x 1.960) when compared to 10 GPS static check points.
- The LiDAR dataset was tested to 0.16m vertical accuracy at 95% confidence level based on consolidated $RMSE_z$ (0.083m x 1.960) when compared to 6 GPS kinematic cross sections.

All data delivered meets or exceeds LMSI's deliverable product requirements.

INTRODUCTION

LiDAR data is remotely sensed high-resolution elevation data collected by an airborne collection platform. By positioning laser range finding with the use of 1 second GPS with 200 Hz inertial measurement unit corrections; LMSI's LiDAR instruments are able to make highly detailed geospatial elevation products of the ground, man-made structures and vegetation.

The purpose of this LiDAR data was to produce high accuracy 3D terrain geospatial products for flood mapping and other applications.

This report covers the LiDAR processing methods and deliverable products. A GPS Validation Report has been included as an appendix.

Please note that this report focuses solely on the LMSI activities pertaining to the LiDAR data processing component of this project.

1. LiDAR Data Processing

1.1. Airborne GPS Kinematic

Airborne GPS kinematic data was processed on-site using GrafNav kinematic On-The-Fly (OTF) software. Flights were flown with a minimum of 6 satellites in view (13° above the horizon) and with a PDOP of better than 4. Distances from base station to aircraft were kept to a maximum of 40km.

For all flights, the GPS data can be classified as excellent, with GPS residuals of 3cm average or better but no larger than 10cm being recorded.

1.2. Generation and Calibration of Laser Points (raw data)

The initial step of calibration is to verify availability and status of all needed GPS and Laser data against field notes and compile any data if not complete.

Subsequently the mission points are output using Optech's Dashmap, initially with default values from Optech or the last mission calibrated for system. The initial point generation for each mission calibration is verified within Microstation/Terrascan for calibration errors. If a calibration error greater than specification is observed within the mission, the roll pitch and scanner scale corrections that need to be applied are calculated. The missions with the new calibration values are regenerated and validated internally once again to ensure quality.

All missions are validated against the adjoining missions for relative vertical biases and collected GPS kinematic validation points for absolute vertical accuracy purposes.

On a project level, a supplementary coverage check is carried out, to ensure no data voids unreported by Field Operations are present.

1.3. Vertical Bias Resolution

When the LiDAR data was compared to the GPS kinematic and static points, a bias was detected. Hence the following corrections were applied:

Mission	Total Vertical Adjustment (m)
10337	0.29
10343	0.29
10344	0.35
10345	0.4
10347a	0.4
10347b	0.35
10350	0.3
10351a	0.2
10351b	0.15
10352	0.1
10353a	0.15
10353b	0.2
10356a	0.2
10356b	0.15
10361	0.2
10362a	0.2
10362b	0.25
10362c	0.2
10364	0.2

1.4. Deliverable Product Generation

The classified LiDAR data was delivered in a tiled dataset conforming to the tiling scheme set forth. The LiDAR header is populated with the projection information and the withheld angles (+/-2deg) are classified onto the Withheld class.

All products were delivered in Oklahoma North SPCS US survey feet, NAD83(HARN), NAVD88(Geoid03).

2. Quality Control for Data Processing LiDAR Calibration

Quality assurance and quality control procedures for the raw LiDAR data are performed in an iterative fashion through the entire data processing cycle.

The following list provides a step-by-step explanation of the process used by LMSI to review the data prior to customer delivery.

2.1. Calibration Setup and Data Inventory

Data collected by the LiDAR unit is reviewed for completeness, acceptable density and to make sure all data is captured without errors or corrupted values. In addition, all GPS, aircraft trajectory, mission information, and ground control files are reviewed and logged into a database.

2.2. Boresight and Relative accuracy

The initial points for each mission calibration are inspected for flight line errors, flight line overlap, slivers or gaps in the data, point data minimums, or issues with the LiDAR unit or GPS. Roll, pitch and scanner scale are optimized during the calibration process until the relative accuracy is met.

Relative accuracy and internal quality are checked using at least 3 regularly spaced QC blocks in which points from all lines are loaded and inspected. Vertical differences between ground surfaces of each line are displayed. Color scale is adjusted so that errors greater than the specifications are flagged. Cross sections are visually inspected across each block to validate point to point, flightline to flightline and mission to mission agreement. For this project the specifications used are as follow:
Relative accuracy <= 7cm RMSEZ within individual swaths and <=10 cm RMSEZ or within swath overlap (between adjacent swaths) .

A different set of QC blocks are generated for final review after all transformations have been applied.

2.3. Absolute accuracy

A preliminary $RMSE_z$ error check is performed at this stage of the project life cycle in the raw LiDAR dataset against GPS static and kinematic data and compared to $RMSE_z$ project specifications. The LiDAR data is examined in open, flat areas away from breaks. Lidar ground points for each flightline generated by an automatic classification routine are used.

Results:
Prior to delivery the elevation data was verified internally to ensure it met fundamental accuracy requirements of 18.5cm vertical accuracy at the 95% confidence level (2 sigma = RMSE * 1.96) in when compared to LMSI kinematic and static GPS checkpoints.

Data is compiled to meet 1m horizontal accuracy at the 95% confidence level (2 sigma = RMSE * 1.96)

- The LiDAR dataset was tested to 0.043m vertical accuracy at 95% confidence level based on consolidated $RMSE_z$ (0.022m x 1.960) when compared to 10 GPS static check points.

- The LiDAR dataset was tested to 0.16m vertical accuracy at 95% confidence level based on consolidated $RMSE_z$ (0.083m x 1.960) when compared to 6 GPS kinematic cross sections.

A detailed comparison is provided in Appendix A - GPS Validation.

3. Conclusion

Overall the LiDAR data products collected for Dewberry meet or exceed the requirements set out in the Statement of Work for this project. The quality control requirements of LMSI's Quality management program were adhered to throughout the acquisition stage of this project to ensure product quality.

Appendix A GPS Validation

Static GPS Validation

F:\Projects\Fema\Ok\control\FinalStaticGT.xyz

Number	Easting	Northing	Known Z	Laser Z	Dz
GCP_1	357714.955	4096169.592	321.684	321.690	+0.006
GCP_2	356109.626	4095713.990	313.876	313.820	-0.056
GCP_3	354516.430	4094246.993	296.337	296.350	+0.013
N_Base	334556.641	4079210.016	247.000	247.050	+0.050
S_Base	337787.084	4050179.436	249.964	249.950	-0.014
Sta_1	334887.846	4093406.416	251.801	251.800	-0.001
Stat_1	346030.691	4073131.052	231.513	231.510	-0.003
Static10	333362.708	4061532.751	274.957	274.970	+0.013
Static_8	314619.030	4095678.815	246.972	246.970	-0.002
Static9	349105.115	4091588.179	273.355	273.380	+0.025
Static_1	346870.561	4051570.668	253.095	253.100	+0.005
Static_2	319604.753	4055346.319	244.824	244.850	+0.026
Static_3	361740.756	4048384.132	310.061	310.050	-0.011
Static_4	348618.342	4081144.957	272.736	272.760	+0.024
Static_5	323313.600	4081087.841	248.381	248.380	-0.001
Static_6	333957.985	4040573.713	288.153	288.160	+0.007
Static_7	339625.222	4032517.956	323.693	323.720	+0.027
Static_8	319955.749	4038756.271	209.631	209.630	-0.001
Static_9	355194.994	4041499.677	306.394	306.400	+0.006

Average dz +0.006

Minimum dz -0.056

Maximum dz +0.050

Average magnitude 0.015

Root mean square 0.022

Std deviation 0.021

Kinematic GPS Validation

Sample Size	>10000	Points
RMSE	0.083	meters

KIN1: rms = 0.066cm

KIN2: rms = 0.091cm

KIN3: rms = 0.110cm

KIN4: rms = 0.090cm

KIN5: rms = 0.070cm

KIN6: rms = 0.074cm

3 LiDAR Processing & Qualitative Assessment

3.1 Data Classification and Editing

LiDAR mass points were produced to LAS 1.2 specifications, including the following LAS classification codes:

- Class 1 = Unclassified, and used for all other features that do not fit into the Classes 2, 7, 9, or 10, including vegetation, buildings, etc.
- Class 2 = Ground, includes accurate LiDAR points in overlapping flight lines
- Class 7 = Noise, low and high points
- Class 9 = Water, points located within collected breaklines
- Class 10 = Ignored Ground due to breakline proximity.
- Class 11 = Withheld points or points that exceed the maximum allowable scan angle.

The data was processed using GeoCue and TerraScan software. The initial step is the setup of the GeoCue project, which is done by importing project defined tile boundary index encompassing the entire project areas. The acquired 3D laser point clouds, in LAS binary format, were imported into the GeoCue project and divided into file size optimized tiles. Once tiled, the laser points were classified using a proprietary routine in TerraScan. This routine removes any obvious outliers from the dataset and moves points with scan angles that exceed the maximum allowable angle to class 11. Following this, the ground layer is extracted from the point cloud. The ground extraction process encompassed in this routine takes place by building an iterative surface model.

This surface model is generated using three main parameters: building size, iteration angle and iteration distance. The initial model is based on low points being selected by a "roaming window" with the assumption is that these are the ground points. The size of this roaming window is determined by the building size parameter. The low points are triangulated and the remaining points are evaluated and subsequently added to the model if they meet the iteration angle and distance constraints. This process is repeated until no additional points are added within iterations. A second critical parameter is the maximum terrain angle constraint, which determines the maximum terrain angle allowed within the classification model.

Once the data has been auto-classified the LAS are converted to LAS 1.2 Point Data Record Format 1 and converted to the required ASPRS classification scheme (1=Unclassified,2=ground,7=noise/flyers).

The following fields within the LAS files are populated to the following precision: GPS Time (0.000001 second precision), Easting (0.01 foot precision), Northing (0.01 foot precision), Elevation (0.01 foot precision), Intensity (integer value - 12 bit dynamic range), Number of Returns (integer - range of 1-4), Return number (integer range of 1-4), Scan Direction Flag (integer - range 0-1), Classification (integer), Scan Angle Rank (integer), Edge of flight line (integer, range 0-1), User bit field (integer - flight line information encoded). The LAS file also contains a Variable length record in the file header.

Dewberry utilizes a variety of software suites for data processing. The LAS dataset was received and imported into GeoCue task management software for processing in Terrascan. Each tile was imported into Terrascan and a surface model was created to examine the ground classification. Dewberry analysts visually reviewed the ground surface model and corrected errors in the ground classification such as vegetation, buildings, and bridges that were present following the initial processing conducted by LMSI. Dewberry analysts employ 3D visualization techniques to view the point cloud at multiple angles and in profile to ensure that non-ground points are removed from the ground classification. After the ground classification corrections were completed, the dataset was processed through a water classification routine that utilizes breaklines compiled by Dewberry to automatically classify hydro features. The water classification routine selects ground points within the breakline polygons and automatically classifies them as class 9, water. The final classification routine applied to the dataset selects ground points within a specified distance of the water breaklines and classifies them as class 10, ignored ground due to breakline proximity.

3.2 Qualitative Assessment

Dewberry qualitative assessment utilizes a combination of statistical analysis and interpretative methodology to assess the quality of the data for a bare-earth digital terrain model (DTM). This process looks for anomalies in the data and also identifies areas where man-made structures or vegetation points may not have been classified properly to produce a bare-earth model.

Within this review of the LiDAR data, two fundamental questions were addressed:

- Did the LiDAR system perform to specifications?
- Did the vegetation removal process yield desirable results for the intended bare-earth terrain product?

Mapping standards today address the quality of data by quantitative methods. If the data are tested and found to be within the desired accuracy standard, then the data set is typically accepted. Now with the proliferation of LiDAR, new issues arise due to the vast amount of data. Unlike photogrammetrically-derived DEMs where point spacing can be eight meters or more, LiDAR nominal point spacing for this project is 1 point per .7 square meters. The end result is that millions of elevation points are measured to a level of accuracy previously unseen for traditional elevation mapping technologies and vegetated areas are measured that would be nearly impossible to survey by other means. The downside is that with millions of points, the dataset is statistically bound to have some errors both in the measurement process and in the artifact removal process.

As previously stated, the quantitative analysis addresses the quality of the data based on absolute accuracy. This accuracy is directly tied to the comparison of the discreet measurement of the survey checkpoints and that of the interpolated value within the three closest LiDAR points that constitute the vertices of a three-dimensional triangular face of the TIN. Therefore, the end result is that only a small sample of the LiDAR data is actually tested. However there is an increased level of confidence with LiDAR data due to the relative accuracy. This relative accuracy in turn is based on how well one LiDAR point "fits" in comparison to the next contiguous LiDAR measurement. Once the absolute and relative accuracy has been ascertained, the next stage is to address the cleanliness of the data for a bare-earth DTM.

By using survey checkpoints to compare the data, the absolute accuracy is verified, but this also allows us to understand if the artifact removal process was performed correctly. To reiterate the quantitative approach, if the LiDAR sensor operated correctly over open terrain areas, then it most likely operated correctly over the vegetated areas. This does not mean that the entire bare-earth was measured; only that the elevations surveyed are most likely accurate (including elevations of treetops, rooftops, etc.). In the event that the LiDAR pulse filtered through the vegetation and was able to measure the true surface (as well as measurements on the surrounding vegetation) then the level of accuracy of the vegetation removal process can be tested as a by-product.

To fully address the data for overall accuracy and quality, the level of cleanliness (or removal of above-ground artifacts) is paramount. Since there are currently no effective automated testing procedures to measure cleanliness, Dewberry employs a combination of statistical and visualization processes. This includes creating pseudo image products such as LiDAR orthos produced from the intensity returns, Triangular Irregular Network (TIN)'s, Digital Elevation Models (DEM) and 3-dimensional models. By creating multiple images and using overlay techniques, not only can potential errors be found, but Dewberry can also find where the data meets and exceeds expectations. This report will present representative examples where the LiDAR and post processing had issues as well as examples of where the LiDAR performed well.

3.3 Analysis

Dewberry utilizes GeoCue software as the primary geospatial process management system. GeoCue is a three tier, multi-user architecture that uses .NET technology from Microsoft. .NET technology provides the real-time notification system that updates users with real-time project status, regardless of who makes changes to project entities. GeoCue uses database technology for sorting project metadata. Dewberry uses Microsoft SQL Server as the database of choice. Specific analysis is conducted in Terrascan and QT Modeler environments.

Following the completion of LiDAR point classification, the Dewberry qualitative assessment process flow for the USGS Eleven County Virginia LiDAR project incorporated the following reviews:

1. *Format:* The LAS files are verified to meet project specifications. The LAS files for the USGS Grand Lake Oklahoma LiDAR project conform to the specifications outlined below.

- Format, Echos, Intensity
    - LAS format 1.2, point data record format 1
    - Point data record format 1
    - Multiple returns (echos) per pulse
    - Intensity values populated for each point
- ASPRS classification scheme
    - Class 1 – unclassified
    - Class 2 – ground
    - Class 7 – Noise
    - Class 9 – Water
    - Class 10 – Ignored Ground due to breakline proximity
    - Class 11-Withheld points
- Projection
    - Datum – North American Datum 1983, HARN adjustment
    - Projected Coordinate System – State Plane Oklahoma North (3501)
    - Units – U.S. Survey Feet
    - Vertical Datum – North American Vertical Datum 1988, Geoid 09
    - Vertical Units - Feet
- LAS header information:
    - Class (Integer)
    - GPS Week Time (0.0001 seconds)
    - Easting (0.01 foot)

- Northing (0.01 foot)
- Elevation (0.01 foot)
- Echo Number (Integer 1 to 4)
- Echo (Integer 1 to 4)
- Intensity (8 bit integer)
- Flight Line (Integer)
- Scan Angle (Integer degree)

2. *Data density, data voids:* The LAS files are used to produce Digital Elevation Models using the commercial software package "QT Modeler" which creates a 3-dimensional data model derived from Class 2 (ground points) in the LAS files. Grid spacing is based on the project density deliverable requirement for un-obscured areas.

    a. Acceptable voids (areas with no LiDAR returns in the LAS files) that are present in the majority of LiDAR projects include voids caused by bodies of water. These are considered to be acceptable voids.

3. *Bare earth quality:* Dewberry reviewed the cleanliness of the bare earth to ensure the ground has correct definition, meets the project requirements, there is correct classification of points, and there are less than 5% residual artifacts. There were no major issues identified during the review of the data.

3.4 Conclusion

The dataset conforms to project specifications for format and header values. The spatial projection information and classification of points is correct. No major issues were identified during the qualitative review of the dataset.

4 Vertical Accuracy

Grand Lake was flown as part of a larger FEMA LiDAR project. All data for this FEMA project was flown together and calibrated to a single geodetic network. Checkpoints were established for the larger FEMA project, but none of these checkpoints fall within the Grand Lake boundary. There were a total of 48 checkpoints in the FEMA project area. The vertical accuracy for the FEMA project is detailed in the provided report titled "RAMPP QA OttawaDelaware_07062011.pdf." The tables below provide a quick overview of the vertical accuracy and are directly taken from the RAMPP report cited above.

Tables 1 and 2 summarize the vertical accuracy by fundamental, consolidated, and supplemental methods within each AOI:

AOI 1 - Vertical Accuracy at 95% Confidence Level and 95th Percentile				
Land Cover Category	**# of Points**	**Fundamental Vertical Accuracy (RMSEz x 1.9600) Spec = 0.245 m**	**Consolidated Vertical Accuracy (95th Percentile) Spec = 0.363 m**	**Supplemental Vertical Accuracy (95th Percentile) Spec = 0.365 m**
Consolidated			0.11	
BE & Low Grass	19	0.12		0.11
High Grass				
Brush				
Forest				
Urban				

Table 1 FVA, CVA, and SVA at the 95% confidence level for AOI 1

AOI 2 - Vertical Accuracy at 95% Confidence Level and 95th Percentile				
Land Cover Category	**# of Points**	**Fundamental Vertical Accuracy (RMSEz x 1.9600) Spec = 0.245 m**	**Consolidated Vertical Accuracy (95th Percentile) Spec = 0.363 m**	**Supplemental Vertical Accuracy (95th Percentile) Spec = 0.365 m**
Consolidated	29		0.14	
BE & Low Grass	5	0.15		0.11
High Grass	5			0.13
Brush	0			
Forested	8			0.13
Urban	11			0.15

Table 2 FVA, CVA, and SVA at the 95% confidence level for AOI 2

Tables 3 and 4 summarize the RMSEz and associated statistics for each land cover category within each AOI:

AOI 1 - Descriptive Statistics							
100% of Totals	Points	RMSE Spec=0.125 m	Mean Error (m)	Median Error (m)	SKEW	STDEV (m)	95th Percentile Spec=0.363 m
Consolidated	19	0.06	-0.01	-0.01	-0.22	0.06	0.11
BE & Low Grass	19	0.06	-0.01	-0.01	-0.22	0.06	0.11
High Grass							
Brush							
Forest							
Urban							

Table 3: Descriptive statistics for AOI 1

AOI 2 - Descriptive Statistics							
100% of Totals	Points	RMSE Spec=0.125 m	Mean Error (m)	Median Error (m)	SKEW	STDEV (m)	95th Percentile Spec=0.363 m
Consolidated	29	0.08	-0.01	-0.01	-0.04	0.08	0.14
BE & Low Grass	5	0.08	-0.02	0.00	-0.21	0.08	0.11
High Grass	5	0.08	0.03	0.05	-0.32	0.08	0.08
Forest	8	0.09	0.05	0.08	-0.44	0.08	0.13
Urban	11	0.08	-0.05	-0.02	0.07	0.07	0.15

Table 4: Descriptive statistics for AOI 2

5 Breakline Production & Qualitative Assessment Report

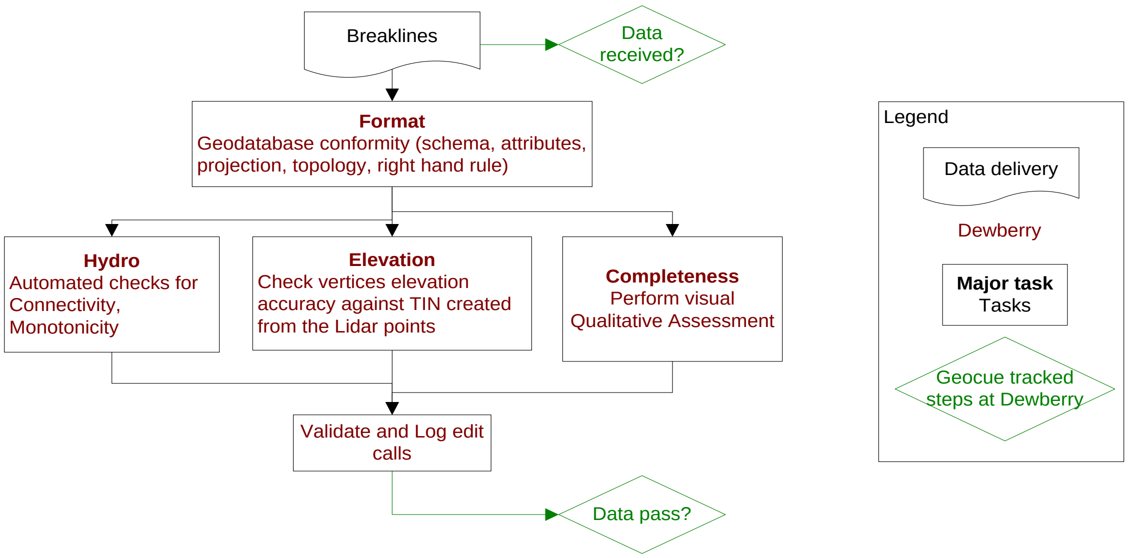
5.1 Breakline Production Methodology

Dewberry used GeoCue software to develop LiDAR stereo models of the USGS Grand Lake Oklahoma LiDAR Project area so the LiDAR derived data could be viewed in 3-D stereo using Socet Set softcopy photogrammetric software. Using LiDARgrammetry procedures with LiDAR intensity imagery, Dewberry stereo-compiled the two types of hard breaklines in accordance with the project's Data Dictionary.

All drainage breaklines are monotonically enforced to show downhill flow. Water bodies are reviewed in stereo and the lowest elevation is applied to the entire waterbody.

5.2 *Breakline Qualitative Assessment*

Dewberry completed breakline qualitative assessments according to a defined workflow. The following workflow diagram represents the steps taken by Dewberry to provide a thorough qualitative assessment of the breakline data.



5.3 *Breakline Topology Rules*

Automated checks are applied on hydro features to validate the 3D connectivity of the feature and the monotonicity of the hydrographic breaklines. Dewberry's major concern was that the hydrographic breaklines have a continuous flow downhill and that breaklines do not undulate. Error points are generated at each vertex not complying with the tested rules and these potential edit calls are then visually validated during the visual evaluation of the data. This step also helped validate that breakline vertices did not have excessive minimum or maximum elevations and that elevations are consistent with adjacent vertex elevations.

The next step is to compare the elevation of the breakline vertices against the elevation extracted from the ESRI Terrain built from the LiDAR ground points, keeping in mind that a discrepancy is expected because of the hydro-enforcement applied to the breaklines and because of the interpolated imagery used to acquire the breaklines. A given tolerance is used to validate if the elevations do not differ too much from the LiDAR.

Dewberry's final check for the breaklines was to perform a full qualitative analysis. Dewberry compared the breaklines against LiDAR intensity images to ensure breaklines were captured in the required locations. The quality control steps taken by Dewberry are outlined in the QA Checklist below.

5.4 Breakline QA/QC Checklist

Project Number/Description: USGS Grand Lake Oklahoma LiDAR

Date:______9/30/2011____

Overview

☒ All Feature Classes are present in GDB

☒ All features have been loaded into the geodatabase correctly. Ensure feature classes with subtypes are domained correctly.

☒ The breakline topology inside of the geodatabase has been validated. See Data Dictionary for specific rules

☒ Projection/coordinate system of GDB is accurate with project specifications

Perform Completeness check on breaklines using either intensity or ortho imagery

☒ Check entire dataset for missing features that were not captured, but should be to meet baseline specifications or for consistency (See Data Dictionary for specific collection rules). NHD data will be used to help evaluate completeness of collected hydrographic features. Features should be collected consistently across tile bounds within a dataset as well as be collected consistently between datasets.

☒ Check to make sure breaklines are compiled to correct tile grid boundary and there is full coverage without overlap

☒ Check to make sure breaklines are correctly edge-matched to adjoining datasets if applicable. Ensure breaklines from one dataset join breaklines from another dataset that are coded the same and all connecting vertices between the two datasets match in X,Y, and Z (elevation). There should be no breaklines abruptly ending at dataset boundaries and no discrepancies of Z-elevation in overlapping vertices between datasets.

Compare Breakline Z elevations to LiDAR elevations

☒ Using a terrain created from LiDAR ground points and water points and GeoFIRM tools, drape breaklines on terrain to compare Z values. Breakline elevations should be at or below the elevations of the immediately surrounding terrain. Z value differences should generally be limited to within 1 FT. This should be performed before other breakline checks are completed.

Perform automated data checks using PLTS

The following data checks are performed utilizing ESRI's PLTS extension. These checks allow automated validation of 100% of the data. Error records can either be written to a table for future correction, or browsed for immediate correction. PLTS checks should always be performed on the full dataset.

☒ Perform "adjacent vertex elevation change check" on the Inland Ponds feature class (Elevation Difference Tolerance=.001 feet). This check will return Waterbodies whose vertices are not all identical. This tool is found under "Z Value Checks."

☒ Perform "unnecessary polygon boundaries check" on Tidal Waters, Inland Ponds, and Inland Streams feature classes. This tool is found under "Topology Checks."

☒ Perform "duplicate geometry check" on (tidal waters to tidal waters), (inland streams to inland streams), (inland ponds to inland ponds), (tidal waters to inland streams), (tidal waters to inland ponds), (inland ponds to inland streams). Attributes do not need to be checked during this tool. This tool is found under "Duplicate Geometry Checks."

☒ Perform "geometry on geometry check" on (tidal waters to inland streams), (tidal waters to inland ponds), (inland ponds to inland streams). Spatial relationship is contains, attributes do not need to be checked. This tool is found under "Feature on Feature Checks."

☒ Perform "polygon overlap/gap is sliver check" on (tidal waters to tidal waters), (inland streams to inland streams), (inland ponds to inland ponds), (tidal waters to inland streams), (tidal waters to inland ponds), (inland ponds to inland streams). Maximum Polygon Area is not required. This tool is found under "Feature on Feature Checks."

Perform Dewberry Proprietary Tool Checks

☒ Perform monotonicity check on inland streams features using "A3_checkMonotonicityStreamLines." This tool looks at line direction as well as elevation. Features in the output shapefile attributed with a "d" are correct monotonically, but were compiled from low elevation to high elevation. These errors can be ignored. Features in the output shapefile attributed with an "m" are not correct monotonically and need elevations to be corrected. Input features for this tool need to be in a geodatabase. Z tolerance is .01 feet. Polygons need to be exported as lines for the monotonicity tool.

☒ Perform connectivity check between (tidal waters to inland streams), (tidal waters to inland ponds), (inland ponds to inland streams) using the tool "07_CheckConnectivityForHydro." The input for this tool needs to be in a geodatabase. The output is a shapefile showing the location of overlapping vertices from the polygon features and polyline features that are at different Z-elevation. The unnecessary polygon boundary check must be run and all errors fixed prior to performing connectivity check. If there are exceptions to the polygon boundary rule then that feature class must be checked against itself, i.e. inland streams to inland streams.

Metadata

☒ Each XML file (1 per feature class) is error free as determined by the USGS MP tool

☒ Metadata content contains sufficient detail and all pertinent information regarding source materials, projections, datums, processing steps, etc. Content should be consistent across all feature classes.

Completion Comments: **Complete – Approved**

5.5 Data Dictionary

LiDARgrammetry Data Dictionary & Stereo Compilation Rules

For the USGS Grand Lake Oklahoma LiDAR Project

Table of Contents

HORIZONTAL AND VERTICAL DATUM

The horizontal datum shall be North American Datum of 1983/HARN adjustment, Units in US survey feet. The vertical datum shall be referenced to the North American Vertical Datum of 1988 (NAVD 88), Units in Feet. Geoid09 shall be used to convert ellipsoidal heights to orthometric heights.

Coordinate System and Projection

All data shall be projected to Oklahoma State Plane North, Horizontal Units in Feet and Vertical Units in Feet.

Inland Streams and Rivers

Feature Dataset: BREAKLINES
Contains M Values: No
XY Resolution: Accept Default Setting
XY Tolerance: 0.003

Feature Class: STREAMS_AND_RIVERS
Contains Z Values: Yes
Z Resolution: Accept Default Setting
Z Tolerance: 0.001

Feature Type: Polygon
Annotation Subclass: None

Description

This polygon feature class will depict linear hydrographic features with a width greater than 100 feet.

Table Definition

Field Name	Data Type	Allow Null Values	Default Value	Domain	Precision	Scale	Length	Responsibility
OBJECTID	Object ID							Assigned by Software
SHAPE	Geometry							Assigned by Software
SHAPE_LENGTH	Double	Yes			0	0		Calculated by Software
SHAPE_AREA	Double	Yes			0	0		Calculated by Software

Feature Definition

Description	Definition	Capture Rules
Streams and Rivers	Linear hydrographic features such as streams, rivers, canals, etc. with an average width greater than 100 feet in length. In the case of embankments, if the feature forms a natural dual line channel, then capture it consistent with the capture rules. Other natural or manmade embankments will not qualify for this project.	Capture features showing dual line (one on each side of the feature). Average width shall be great than 100 feet to show as a double line. Each vertex placed should maintain vertical integrity and data is required to show "closed polygon". Generally both banks shall be collected to show consistent downhill flow. There are exceptions to this rule where a small branch or offshoot of the stream or river is present. The banks of the stream must be captured at the same elevation to ensure flatness of the water feature. If the elevation of the banks appears to be different see the task manager or PM for further guidance. Breaklines must be captured at or just below the elevations of the immediately surrounding terrain. Under no circumstances should a feature be elevated above the surrounding LiDAR points. Acceptable variance in the negative direction will be defined for each project individually. These instructions are only for docks or piers that follow the coastline or water's edge, not for

		docks or piers that extend perpendicular from the land into the water. If it can be reasonably determined where the edge of water most probably falls, beneath the dock or pier, then the edge of water will be collected at the elevation of the water where it can be directly measured. If there is a clearly-indicated headwall or bulkhead adjacent to the dock or pier and it is evident that the waterline is most probably adjacent to the headwall or bulkhead, then the water line will follow the headwall or bulkhead at the elevation of the water where it can be directly measured. If there is no clear indication of the location of the water's edge beneath the dock or pier, then the edge of water will follow the outer edge of the dock or pier as it is adjacent to the water, at the measured elevation of the water. Every effort should be made to avoid breaking a stream or river into segments. Dual line features shall break at road crossings (culverts). In areas where a bridge is present the dual line feature shall continue through the bridge. Islands: The double line stream shall be captured around an island if the features on either side of the island meet the criteria for capture. In this case a segmented polygon shall be used around the island in order to allow for the island feature to remain as a "hole" in the feature.

Inland Ponds and Lakes

Feature Dataset: BREAKLINES
Contains M Values: No
XY Resolution: Accept Default Setting
XY Tolerance: 0.003

Feature Class: PONDS_AND_LAKES
Contains Z Values: Yes
Z Resolution: Accept Default Setting
Z Tolerance: 0.001

Feature Type: Polygon
Annotation Subclass: None

Description

This polygon feature class will depict closed water body features that are at a constant elevation.

Table Definition

Field Name	Data Type	Allow Null Values	Default Value	Domain	Precision	Scale	Length	Responsibility
OBJECTID	Object ID							Assigned by Software
SHAPE	Geometry							Assigned by Software
SHAPE_LENGTH	Double	Yes			0	0		Calculated by Software
SHAPE_AREA	Double	Yes			0	0		Calculated by Software

Feature Definition

Description	Definition	Capture Rules
Ponds and Lakes	Land/Water boundaries of constant elevation water bodies such as lakes, reservoirs, ponds, etc. Features shall be defined as closed polygons and contain an elevation value that reflects the best estimate of the water elevation at the time of data capture. Water body features will be captured for features 2 acres in size or greater. "Donuts" will exist where there are islands within a closed water body feature greater than ½ acre in size.	Water bodies shall be captured as closed polygons with the water feature to the right. The compiler shall take care to ensure that the z-value remains consistent for all vertices placed on the water body. Breaklines must be captured at or just below the elevations of the immediately surrounding terrain. Under no circumstances should a feature be elevated above the surrounding LiDAR points. Acceptable variance in the negative direction will be defined for each project individually. An Island within a Closed Water Body Feature will also have a "donut polygon" compiled. These instructions are only for docks or piers that follow the coastline or water's edge, not for docks or piers that extend perpendicular from the land into the water. If it can be reasonably determined where the edge of water most probably falls, beneath the dock or

		pier, then the edge of water will be collected at the elevation of the water where it can be directly measured. If there is a clearly-indicated headwall or bulkhead adjacent to the dock or pier and it is evident that the waterline is most probably adjacent to the headwall or bulkhead, then the water line will follow the headwall or bulkhead at the elevation of the water where it can be directly measured. If there is no clear indication of the location of the water's edge beneath the dock or pier, then the edge of water will follow the outer edge of the dock or pier as it is adjacent to the water, at the measured elevation of the water.

Contact Information

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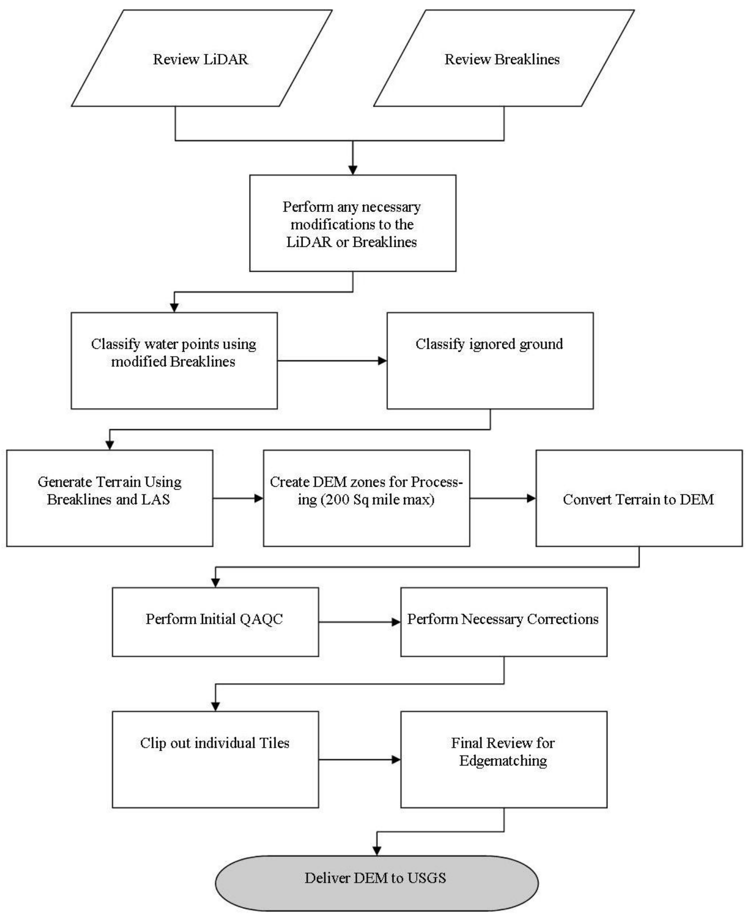
6 DEM Production & Qualitative Assessment

6.1 DEM Production Methodology

Dewberry's utilizes ESRI software and Global Mapper for the DEM production and QC process. ArcGIS software is used to generate the products and the QC is performed in both ArcGIS and Global Mapper.

Dewberry Hydro-Flattening Workflow



1. Classify Water Points: LAS point falling within hydrographic breaklines shall be classified to ASPRS class 9 using TerraScan. Breaklines must be prepared correctly prior to performing this task.
2. Classify Ignored Ground Points: Classify points in close proximity to the breaklines from Ground to class 10 (Ignored Ground). Close proximity will be defined as ½ the nominal point spacing on either side of the breakline. Breaklines will be buffered using this specification and the subsequent file will need to be prepared in the same manner as the water breaklines for classification. This process will be performed after the water points have been classified and only run on remaining ground points.

3. Terrain Processing: A Terrain will be generated using the Breaklines and LAS data that has been imported into Arc as a Multipoint File. If the final DEMs are to be clipped to a project boundary that boundary will be used during the generation of the Terrain.
4. Create DEM Zones for Processing: Create DEM Zones that are buffered around the edges. Zones should be created in a logical manner to minimize the number of zones without creating zones too large for processing. Dewberry will make zones no larger than 200 square miles (taking into account that a DEM will fill in the entire extent not just where LiDAR is present). Once the first zone is created it must be verified against the tile grid to ensure that the cells line up perfectly with the tile grid edge.
5. Convert Terrain to Raster: Convert Terrain to raster using the DEM Zones created in step 6. In the environmental properties set the extents of the raster to the buffered Zone. For each subsequent zone, the first DEM will be utilized as the snap raster to ensure that zones consistently snap to one another.
6. Perform Initial QAQC on Zones: During the initial QA process anomalies will be identified and corrective polygons will be created.
7. Correct Issues on Zones: Corrections on zones will be performed following Dewberry's in-house correction process.
8. Extract Individual Tiles: Individual Tiles will be extracted from the zones utilizing the Dewberry created tool.
9. Final QA: Final QA will be performed on the dataset to ensure that tile boundaries are seamless.

6.2 DEM Qualitative Assessment

Dewberry performed a comprehensive qualitative assessment of the DEM deliverables to ensure that all tiled DEM products were delivered with the proper extents, were free of processing artifacts, and contained the proper referencing information. This process was performed in ArcGIS software with the use of a tool set Dewberry has developed to verify that the raster extents match those of the tile grid and contain the correct projection information. The DEM data was reviewed at a scale of 1:5000 to review for artifacts caused by the DEM generation process and to review the hydro-flattened features. To perform this review Dewberry creates HillShade models and overlays a partially transparent colorized elevation model to review for these issues. Upon completion of this review the DEM data is loaded into Global Mapper to ensure that all files are readable and that no artifacts exist between tiles.

6.3 DEM QA/QC Checklist

Project Number/Description: USGS Grand Lake Oklahoma LiDAR
Date:______11/05/2011_____
Overview

- ☒ Correct number of files is delivered and all files are in ESRI GRID format
- ☒ Verify Raster Extents
- ☒ Verify Projection/Coordinate System

Review

- ☒ Manually review bare-earth DEMs with a hillshade to check for issues with hydro-enforcement process or any general anomalies that may be present. Specifically, water should be flowing downhill, water features should NOT be floating above surrounding terrain and bridges/box culverts should NOT be present in bare-earth DEM. Hydrologic breaklines should be overlaid during review of DEMs.

☒ Overlap points (in the event they are supplied to fill in gaps between adjacent flightlines) are not to be used to create the bare-earth DEMs

☒ DEM cell size is 2 feet

☒ Perform final overview in Global Mapper to ensure seamless product.

Metadata

☒ Project level DEM metadata XML file is error free as determined by the USGS MP tool

☒ Metadata content contains sufficient detail and all pertinent information regarding source materials, projections, datums, processing steps, etc.

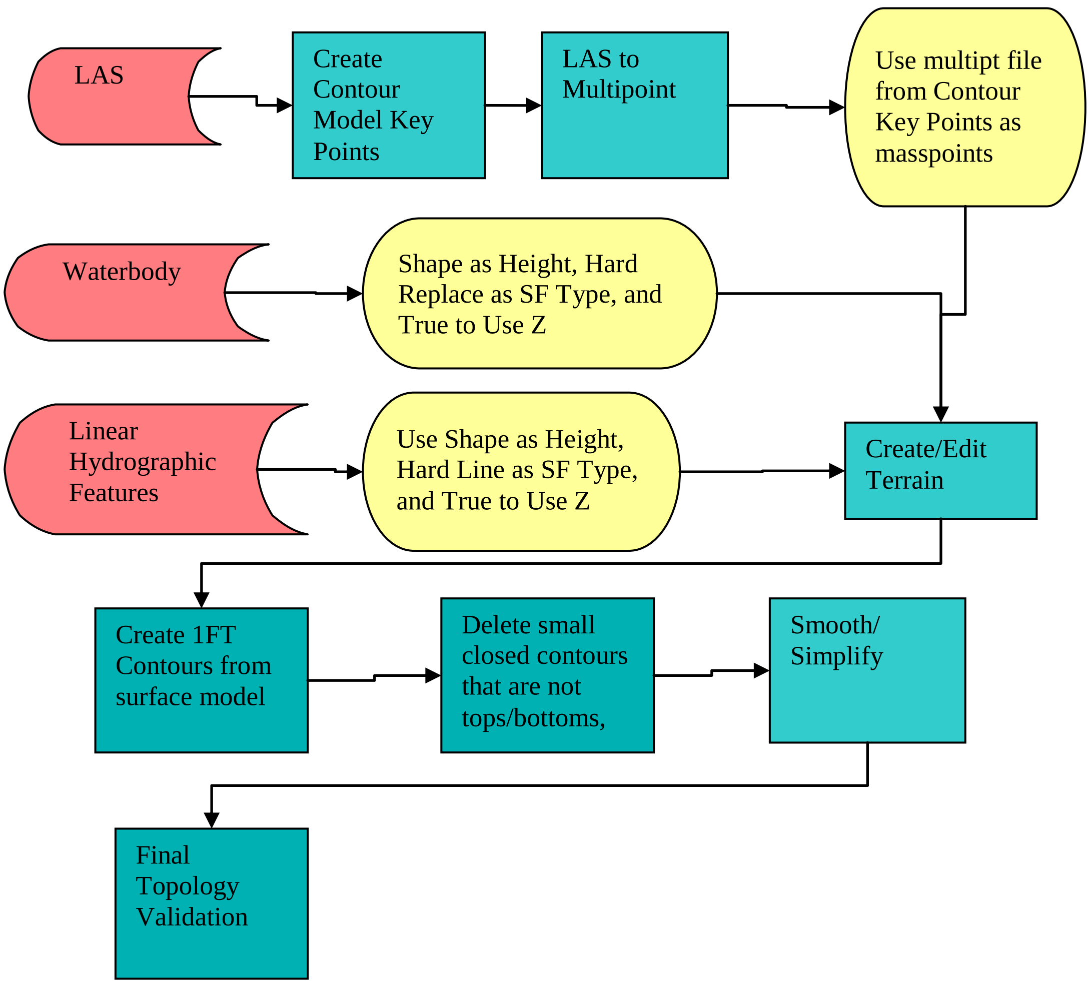
Completion Comments: Complete – Approved

7 Contour Production & Qualitative Assessment

7.1 Contour Production Methodology

Dewberry utilizes ESRI tools and proprietary tools to create contours.

Dewberry Contour Production Workflow



1. Create Contour Model Key Points: Model key points are created from the LAS. This intelligently thins the ground points to keep those necessary for surface definition while removing those that are redundant or unnecessary.
2. Create ESRI Terrain: The contour model key points are converted to multipoints. These are combined with the 3D breaklines collected for the project in an ESRI terrain. Breaklines at a constant elevation are used as a hard replace while all other 3D breaklines are used as a hard line.
3. Create Contours: Contours are generated from the surface model created in step 2. The contours are created to the desired interval (1-FT, 2-FT, etc). Index contours are defined during this step.

4. Edit Contours: Contours created from LiDAR data often contain large amounts of noise. This noise is reduced by using contour model key points. However, additional noise can be removed during this step.
5. Smooth Contours: Depending on the level of aesthetic quality specified for the project, the contours can be smoothed to varying degrees. Smoothing is accomplished in an ESRI environment with proprietary tools.
6. Topology: Topology is validated on the final contours to ensure data quality, integrity, and cleanliness.

7.2 Contours Qualitative Assessment

Dewberry ensures contour quality by reviewing all contours in ArcGIS software. The contours are reviewed for complete coverage, correct topology, and correct symbolization. The contours are reviewed in conjunction with the 3D breaklines to ensure all rules set during terrain generation were followed and were not compromised during the smoothing process. Any irregularities in the contours are reviewed with the DEMs to ensure all elevations are matching and errors have not been introduced during any step of the contour creation process.