FUGRO AERIAL & MOBILE MAPPING, INC.

FLI-MAP®

FUGRO AERIAL & MOBILE MAPPING INC.

GCMRC

FLI-MAP SURVEY CONTROL REPORT

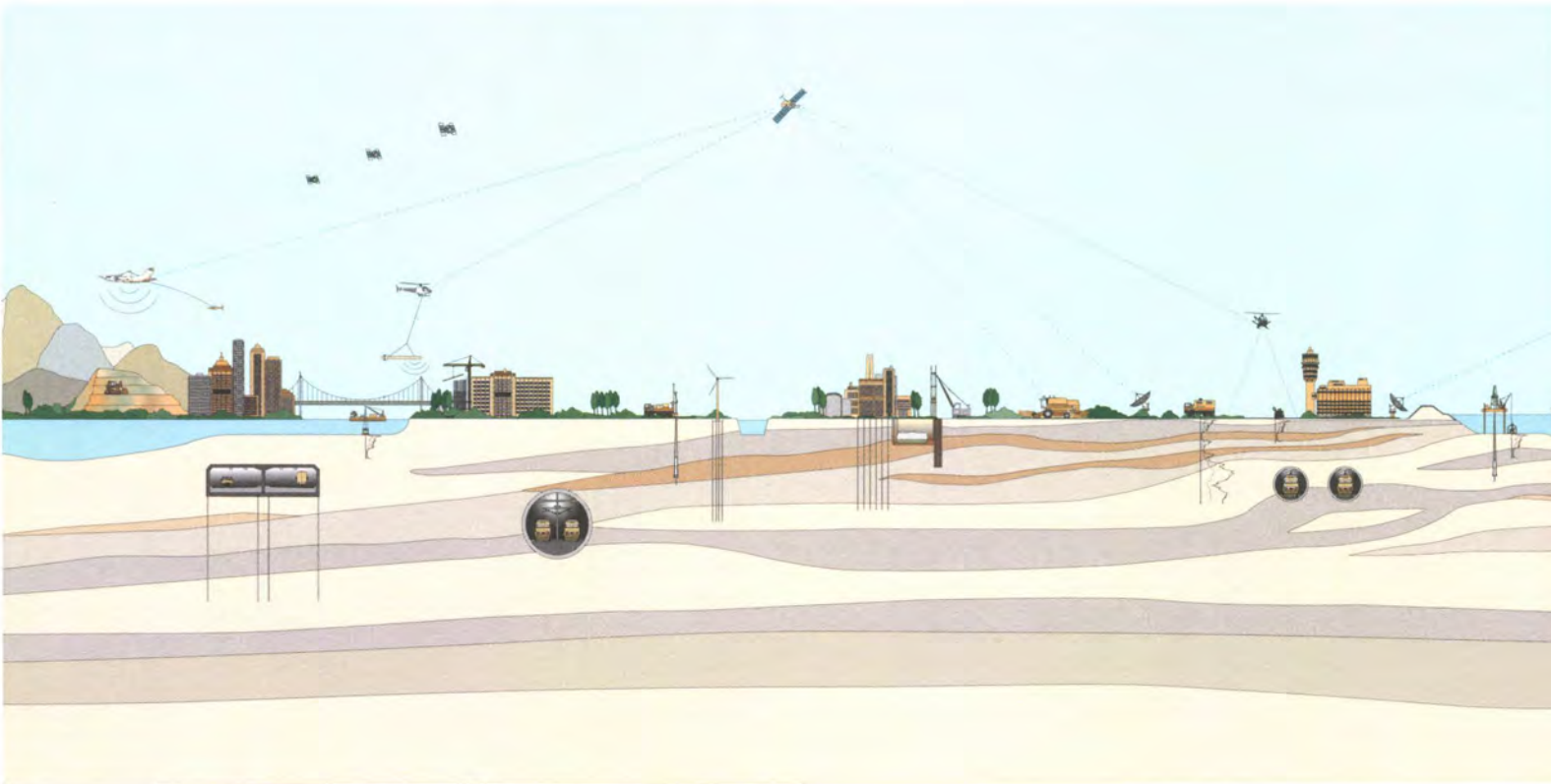
SITES OF CULTURAL SIGNIFICANCE SURVEY

GLEN CANYON, AZ

FM400-006

FAMM JOB # 503513.00039.00

JULY 2013



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1. FLI-MAP® SYSTEM DESCRIPTION

Fugro Aerial & Mobile Mapping, Inc.

FLI-MAP®

The following is a brief description of how FLI-MAP ® integrates the use of LiDAR technology and GPS to meet the challenge for a fast and accurate means of aerial surveying. The mobile FLI-MAP ® system is designed, built and operated by Fugro Aerial & Mobile Mapping, Inc., part of the Fugro group of companies. The system description will be for the latest mobile FLI-MAP 400® system, which can be attached to several types of helicopters.

System description FLI-MAP®

The basic concept is that a helicopter flies over the corridor to be surveyed, collecting precise GPS measurements, platform attitude, laser ranges, and imagery data.

The LiDAR sensor scans the terrain and objects directly below the helicopter at a rate of 150, 000, 200,000, or 250,000 points per second. The scan width is 1.15 times the helicopter height above the ground. The terrain directly below and forward of the aircraft is imaged with high-resolution digital video and still cameras. All images are recorded with a digital time stamp for integration with the LiDAR data. Figure 1 is a graphical presentation of FLI-MAP® system operation.

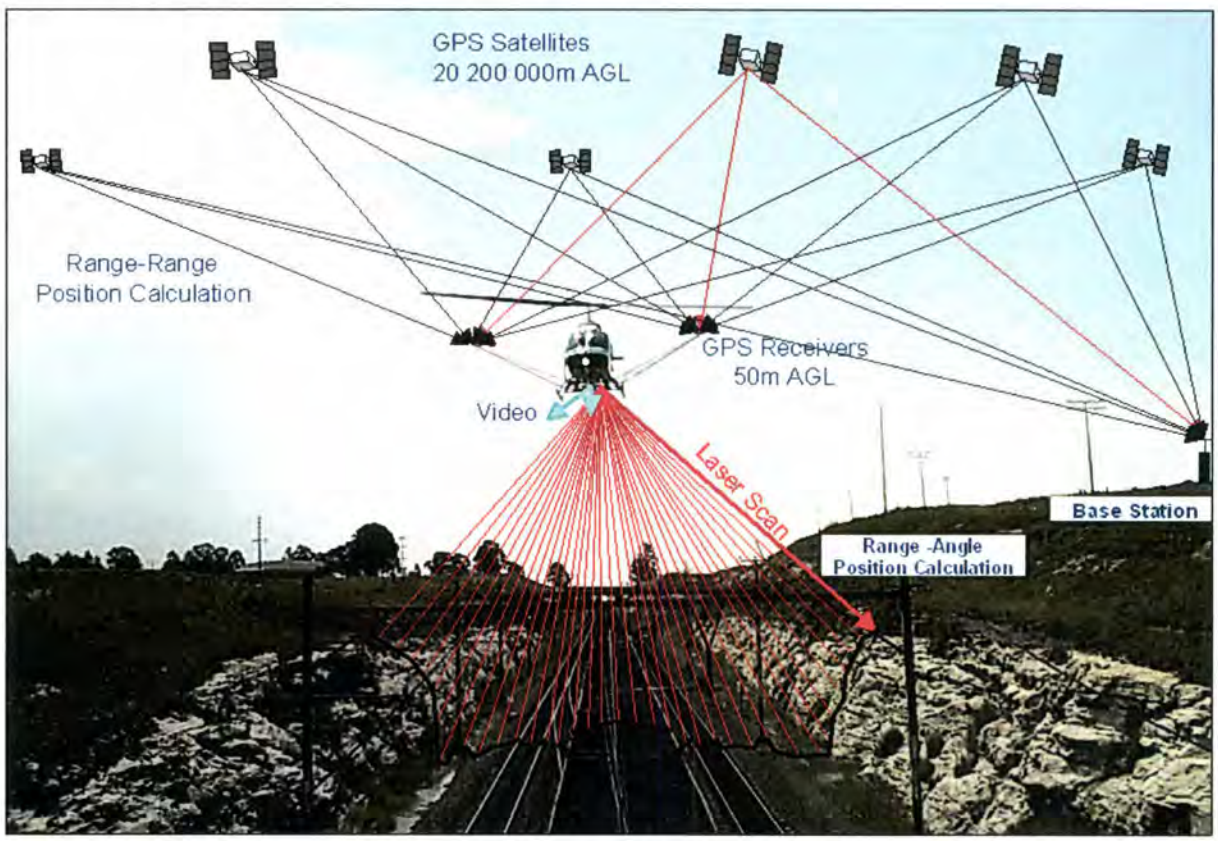


Figure 1 – System Operation

The final post processed output, including the video from the FLI-MAP system, includes XYZ positions of the laser returns. The data density that is required to differentiate infrastructure components such as rails, mile posts, signals, switches, electrification wires, masts, etc. is at least 10 points per m^2. These infrastructure components are identified by patterns of points with spatial relationships. Thus, the FLI-MAP® system integrates several main systems into a high-tech survey tool and the various subsystems are described below:

Positioning System

FLI-MAP® incorporates two rover (moving) GPS receivers (dual frequency L1/L2 & Omnistar®) integrated with a full inertial navigation system to provide a sub-meter accurate position of the helicopter for real-time pilot navigation. A higher level of accuracy and reliability of the position (< 10cm) is calculated in post processing utilizing multiple ground reference GPS receivers. These GPS receivers, both moving and ground reference, record the dual frequency carrier phase and pseudo range measurements from each satellite. The two airborne moving receivers (with separate antennas) provide a redundancy check on the post-processed kinematic DGPS aircraft position. Figure 2 shows the two moving GPS receivers mounted on the helicopter.

Figure 2: Moving GPS Receivers

Attitude System

A solid state Inertial Measurement Unit (IMU) is used to measure instantaneous pitch, roll and heading, as well as accelerations of the platform in three dimensions. These measurements are used by the integrated Inertial Navigation System (INS) to calculate accurate attitude of the helicopter at every sampling location.

Laser System

The scanning laser is a custom designed eye safe, reflectorless rangefinder using Infrared light and is capable of measuring multiple return ranges from 20 - 1000 meters.

Figure 3: Laser Scanner

Figure 4: Laser Scanner Mounted in Pod

Every scan contains 1000 distance and signal strength (intensity) measurements and has a field of view of 60 degrees. Each scan record also contains referencing, timing, laser altitude, data verification and error detection information. The intensity information can be used to produce an active infrared image. The rotating polygon contains 4 faces. Two direct the laser beams to scan directly below the helicopter (Nadir view), one directs the laser beams to scan 7 degrees forward of nadir, and one directs the laser beams to scan 7 degrees aft of nadir. Operationally, the polygon can rotate at 3 different speeds; 37.5, 50.0, and 62.5 times per second, which results in a total of 150,000; 200,000; and 250,000 points per second respectively. Each laser pulse is capable of recording up to 4 returns per pulse, giving additional processing options when working in areas of dense vegetation.

Video System

FLI-MAP is equipped with two Standard resolution Video Cameras and two HD Cameras. The Standard resolution Video Cameras, broadcast quality, color video cameras, recording directly to hard drives in MPEG4 format are used to aid the pilot with navigation. The HD Cameras are in 1080p MPEG4 format, recording to solid state hard drives. The down looking Standard camera records approximately the same area that is laser scanned and has a zoom factor of approximately x1. The forward-looking Standard camera, mounted in an oblique position, has a fixed focal length with a zoom factor of approximately x1.5. The down looking HD camera records approximately the same area that is laser scanned and has a zoom factor of approximately x1.2. The forward-looking HD camera, mounted in an oblique position, has a fixed focal length with a zoom factor of approximately x1.2. The precise UTC time is encoded on each frame of video, allowing for accurate correlation with the laser data. All pilot / operator communications and voice notes are recorded on the audio track of the MPEG recorder for archiving and aiding in data interpretation.

Digital Still System

FLI-MAP is also equipped with two digital, high-resolution (29 Mega pixel) still cameras set in the down and forward-looking perspectives. Both cameras incorporate a Gigabit Ethernet interface, capturing approximately 1 frame every 1.5 seconds per camera, depending on helicopter forward speed and altitude. The down looking camera has a zoom factor of x1 and the forward-looking camera has a zoom factor of approximately x1.5. At a typical flight altitude of 50 meters, the down looking camera delivers images with a resolution of under 2 centimeters per pixel.

Line Scan System

A fifth camera is embedded within the laser sensor and collects true color and is applied in real time to each laser point collected, aiding in the interpretation of the laser data.

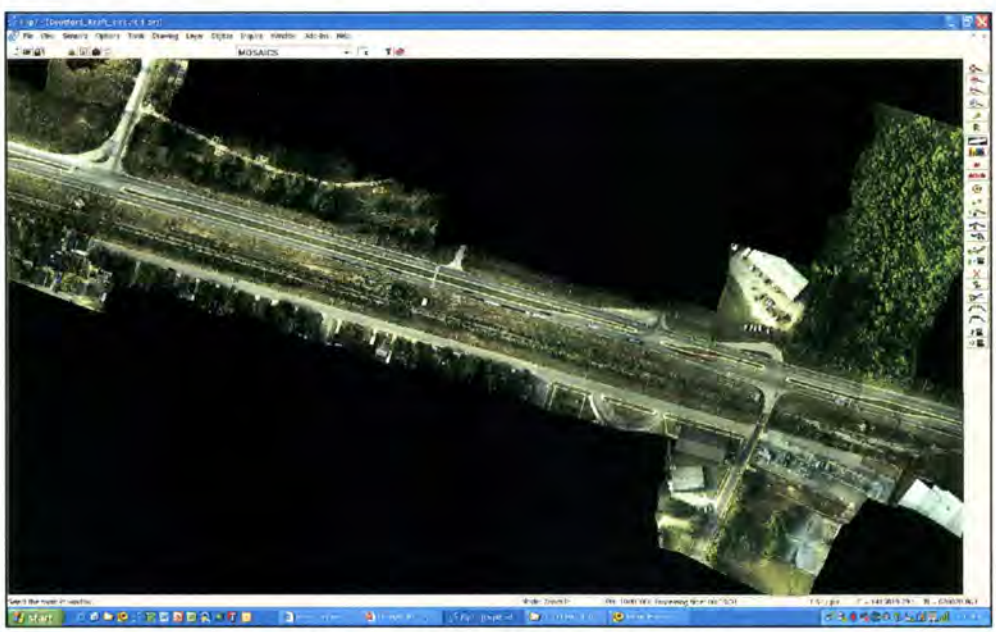


Figure 5: Laser Data Colored by Line Scan

Display and Acquisition System

The FLI-MAP® system can direct and guide the pilot along predetermined survey flight lines, using a light bar to indicate course deviation, both horizontally and vertically. The horizontal course is determined by the navigation and positioning systems and the scanning laser Above Ground Level (AGL) feature provides the vertical course. The pilot and operator can view both the down-looking and forward-looking video on a flat screen color display, while the operator has a dedicated laptop for control and status monitoring of the system during operations.

The airborne processing system is a multiple Intel-based PC, which provides airborne data management, sensor control, and navigation processing. The measurements such as GPS pseudo ranges and carrier phase, laser scan records, and the real-time differential and INS solutions, are stored on removable PC cards and Solid State Hard Drives.

Aircraft Integration

As the FLI-MAP® system is a modular design; it can be mounted to various types of helicopters. For this purpose the system is divided into two main parts, the sensor platform and the Electronic Control Unit (ECU). The sensor platform is mounted to standard cargo connection points below the helicopter. This platform contains the laser, IMU, cameras and two specially designed extensions on which the GPS antennas are mounted. The ECU contains all the necessary data collecting and processing equipment. The box (19 in.) is fixed inside the helicopter and is connected to the sensor platform by means of an 'umbilical cord'.

Figure 6: Pilot Display & Light Bar (Update Pic)

Figure 7: Electronic Control Unit (Update Pic)

Figure 8: FLI-MAP System Mounted to Bell 206-L3

Air Weather Data Probe

The ADP, Air Data Probe, provides real-time measurement of mean winds and RMS turbulence metrics, temperature, humidity, and pressure data. The data is logged internally to a USB device.

System Specifications

FLI-MAP 400 JOHN CHANCE LAND SURVEYS	
Laser Pulse Rate	150,000; 200,000; & 250,000 pulses per second
Multiple Return Capability	Yes - Maximum of 4 returns per pulse
Intensity Measurement for Each Return	Yes
Laser Eye Safety	Certified as Class 1 laser Eye safe at the aperture
Laser Point Density	Based on ground speed and altitude above the ground Approx 60 points per square meter @ 100m altitude Approx 20 points per square meter @ 300m altitude
Laser Ranging Accuracy	1 cm
Laser Swath Angle	60 degrees – Swath width approximates to flying height
Laser Look Angles	Nadir Forward looking (7 degrees) Rear looking (7 degrees)
Maximum Operating Height	1000 meters
Total System Accuracy (absolute)	15 cm horizontal @ 2 sigma (95% confidence level) 10 cm vertical @ 2 sigma (95% confidence level)
Digital Video Imagery	1080P - MPEG 4 format (Avi) – 1920 x 1080 pixel Forward and down looking perspectives Can be viewed directly in PLS-CADD using JCLS's DV Controller software plug-in
Digital Still Imagery	29.0 Mega pixel Forward and down looking perspectives Approx 1 frame per second for each camera
Line scan Imagery	Yes – Integrated line scan camera embedded inside laser scanner to collect real time RGB
GPS/INS Positioning Rate	200 Hz
Air Data Probe	Yes – wind speed and direction, temperature, and pressure

2. DATA COLLECTION SUMMARY

2.0 Data Collection Summary

The following are daily reports of the field activities during data collection. Further detailed information about the data collection flights can be found in section 4.3 "Flight Logs".

Sunday, July 7, 2013: FLI-MAP crew departs Lafayette and begins mobilization to Page, AZ. Crew is comprised of Marc Yost, Chris Fought, and Ron Bertucci.

Monday, July 8, 2013: FLI-MAP crew completes mobilization, arriving in Page, AZ. Adam Mills arrives by commercial flight. Helicopter arrives on site. Marc recovers the station LFRG, within a road repaving work zone, and coordinates with the road paving project supervisor to access the site during flights.

Tuesday, July 9, 2013: Crew recovers the remaining two control stations, L404 and E078. Crew goes to airport and installs the system, and a test flight is conducted over the canyon for safety and within the canyon for camera settings.

Wednesday, July 10, 2013: 2 flights today completing the collection for this project. Each flight contains the entire project, with additional passes, to ensure enough usable images due to sun reflection off the river and the potential excessive shadowing at the bottom of the canyon. Data is GPS processed and verified for completeness.

Thursday, July 11, 2013: System is removed from the helicopter. Helicopter departs the job site back to Shawnee. Crew departs the job site, and begins the demobilization back to Lafayette.

Friday, July 12, 2013: Crew completes the demobilization, arriving in Lafayette.

FIELD PERSONNEL		
[redacted]	[redacted]	[redacted]
Sr. Field Project Supervisor	**Marc Yost**	**Fugro Aerial & Mobile Mapping, Inc.**
System operator	**Chris Fought**	**Fugro Aerial & Mobile Mapping, Inc.**
Data Processor	**Adam Mills**	**Fugro Aerial & Mobile Mapping, Inc.**
Base Station	**Ron Bertucci**	**Fugro Aerial & Mobile Mapping, Inc.**
Pilot	**Ken Carroll**	**Airflite, Inc**

3. DATA PROCESSING REPORT

3.0 Data Processing Report

Control Network Field Processing:

- During FLI-MAP® data collection three (3) control stations were occupied simultaneously with Trimble R7 GNSS receivers. These 3 FLI-MAP® base stations have published coordinate values in the NGS database and were recommended by the GCMRC.
- The three stations occupied were E 78 (GP0104), L 404 (GP0283) and LFRG (DG5953). Station "E 78" was designated as the vertical reference station for this project.
- A static GPS survey was performed to validate the horizontal and vertical position of each FLI-MAP® control station monument. The GPS data was processed and adjusted utilizing Trimble's TBC software package.
- CORS station AZPG was downloaded and added to this network.
- A least squares adjustment was performed on the static GPS data collected by constraining to the published latitude, longitude and ellipsoidal height of the vertical reference station (E 78), as well as, the published latitude and longitude of L404 & LFRG.
- The adjusted coordinates were differenced from the published coordinates for each of these stations producing the following results:

Values shown are control coordinates minus adjusted coordinates.

Point ID	ΔEasting (Meter)	ΔNorthing (Meter)	ΔElevation (Meter)	ΔHeight (Meter)
AZPG	0.001	-0.005	?	-0.009
L404	?	?	?	0.023
LFRG	?	?	?	0.007

- The favorable results above validate the published values of the three FLI-MAP® base stations. This validation led to the decision to utilize the published NGS coordinates (latitude, longitude & ellipsoidal height) for the three FLI-MAP® base stations to process the position of the FLI-MAP® airborne platform in the Applanix POSPAC software (GPS & inertial processing).

Initial Field Processing: FLI-MAP® field processing consists of merging the GPS data collected at the control stations with the GPS, INS, and laser data collected with the FLI-MAP® system during the flight. The processing of this information produces XYZ coordinates in the Flip7® software developed by Fugro Aerial & Mobile Mapping, Inc., which allows for viewing, evaluation, and manipulation of the FLI-MAP® data. The sequential steps are:

- GPS and INS data are "unpacked" from the format in which they are collected in the helicopter and are placed in the appropriate data tree structure which separates the data recorded from the two helicopter receivers and the real-time inertial data recorded by the IMU sensor mounted atop the laser.
- Once the laser, GPS, and IMU data are placed in the correct directories, GPS data from the ground control stations and the two helicopter receivers are post-processed using POSPAC's - POSGNSS software to produce a best fit location of the two FLI-MAP® GPS antennas at each epoch (1 second).
- For this project, the POSGNSS "Multi-Base" approach was utilized to compute the horizontal position and ellipsoidal height of FLI-MAP's two GPS navigation antennas (each antenna location is computed independently). The "Multi-Base" approach allows the POSGNSS software to utilize multiple GPS base stations simultaneously (in this case three) to compute the location of each FLI-MAP® antenna.
- Position vectors are calculated between the two FLI-MAP® antennas and the CRP (common reference point) located in the laser using lever arm offsets and real-time IMU data for 3D-angle orientation.
- The aircraft position and attitude data is then merged with the laser information in FAMM's Flip7® software package to produce XYZ data sets and perform orthometric height modeling.
- The ellipsoidal heights for each of the laser points are reduced to orthometric heights as part of the processing of the laser data by applying the GEOID12A model which is incorporated into Flip7®.

Utilizing Flip7®, the data is processed to produce the following:

- A complete XYZ data set by computing a XYZ coordinate for 100% of the laser returns. This file represents all physical features detected by the laser.
- Each laser point has a northing, easting, and elevation assigned to it as well as an intensity value and UTC time. Flip7® can then link the laser points with the corresponding time on the video so that the digital image (laser data) and color video of an object in question can be viewed easily.

Typical Field Data QC Process:

- Debrief with the system operator and communicate any issues that occurred during data collection that would need additional review.
- Copy data from the helicopter's drives to duplicate external hard drives and verify that the number of files and their sizes are correct.
- Open and play video and view image files to verify audio and image quality.
- Create the FLI-MAP® system's raw position file to bring into FLIP7.
- Import flight lines, boundaries, routes, etc... from the field supervisor to establish collection areas.
- Generate raster boxes and images to verify coverage with the collection areas.
- Generate thumbnail images/footprints and verify coverage.
- Run the image QC tool to flag time gaps and missing events.
- Post- process the GPS files to create the final position file for the flight. Described in "Initial Field Processing".
- Verify the accuracy of the LiDAR data. First check over any base passes to get the delta difference. Then check the quality of the data over structures and overlapping passes. If there is an accuracy issue, reprocess the GPS data and begin the LiDAR quality check again.
- If there are multiple flights, compare the position of the overlapping structures and ground between flights. If they match move on, if not, reprocess the GPS data and repeat the verification process.
- If at any point there is a discrepancy, contact the system operator and the field supervisor to review the data and designate areas that need to be recollected (if applicable).

Note: FLI-MAP® data processing is started in the field to ensure coverage, accuracy, and quality of the data before de-mobilization can occur. All raw data and field processed data is transferred onto removable hard drives for shipment/transportation back to the office. Identical duplicate copies are made in the field.

FLI-Map data processing.

The ASCII file was written out for all 4 flight passes over project area. The format for these 4 files are x coordinate, y coordinate, z (elevation) , laser return number, intensity, red value, green value, blue value. It is a comma delimited file. The only editing of the files was to remove minor sparkles far above the main data set and sun glint anomalies that occurred from reflections off the water surface. The data was written out in State plane Zone 202, NAD83, metric units and using Geoid12A orthometric elevations for delivery. The data was also written out in State Plane Zone 202, NAD83, metric units with ellipsoid elevations.

Ortho-Rectified Mosaic Imagery.

The ortho-rectified mosaic imagery is created in FLIP7 and OrthoVista using a series of filters and tools. These orthos are created at 0.25 feet per pixel.

FLIP7
In FLIP7 a series of filters and tools are executed to generate DEM files. We then Ortho-rectify the still imagery onto the DEM surface. Next we export the Ortho-rectified imagery along with final tile boundaries.

OrthoVista
Next we import the orthos and blend the overlap.
Finally we create and export files in a Tiff format.

FLIP7
Last is the review of these final TIFF images. Then they are exported for delivery.

4. SURVEY CONTROL INFORMATION

4.1 GPS NETWORK SUMMARY AND MAP

GCMRC
Glen Canyon
FAMM Job # 503513.00039.00
July 2013

NAME	POSITION (NAD83)	ELLIP METERS	GPS NAVD 88 ELEV. METERS	GEOID 12A HEIGHT METERS	PUB. NAVD 88 ELEV. METERS	PUB. DELTA GPS METERS	NGS PID	DESCRIPTION	
AZPG	36 54 31.19200 N 111 27 45.63636 W	1302.753	1326.247	-23.494			DK8419	CITY OF PAGE CORS ARP	
E078	36 56 17.01087 N 111 28 45.51354 W	1134.864	1158.396	-23.532	1158.365	0.031	GP0104	E 78	
L404	36 51 58.31311 N 111 30 12.23436 W	1314.315	1337.775	-23.459	1337.778	-0.003	GP0283	L 404	
LFRG	36 51 40.44344 N 111 36 04.00591 W	968.916	992.406	-23.491	992.30	0.106	DG5953	LFRG	SEE NOTE BELOW

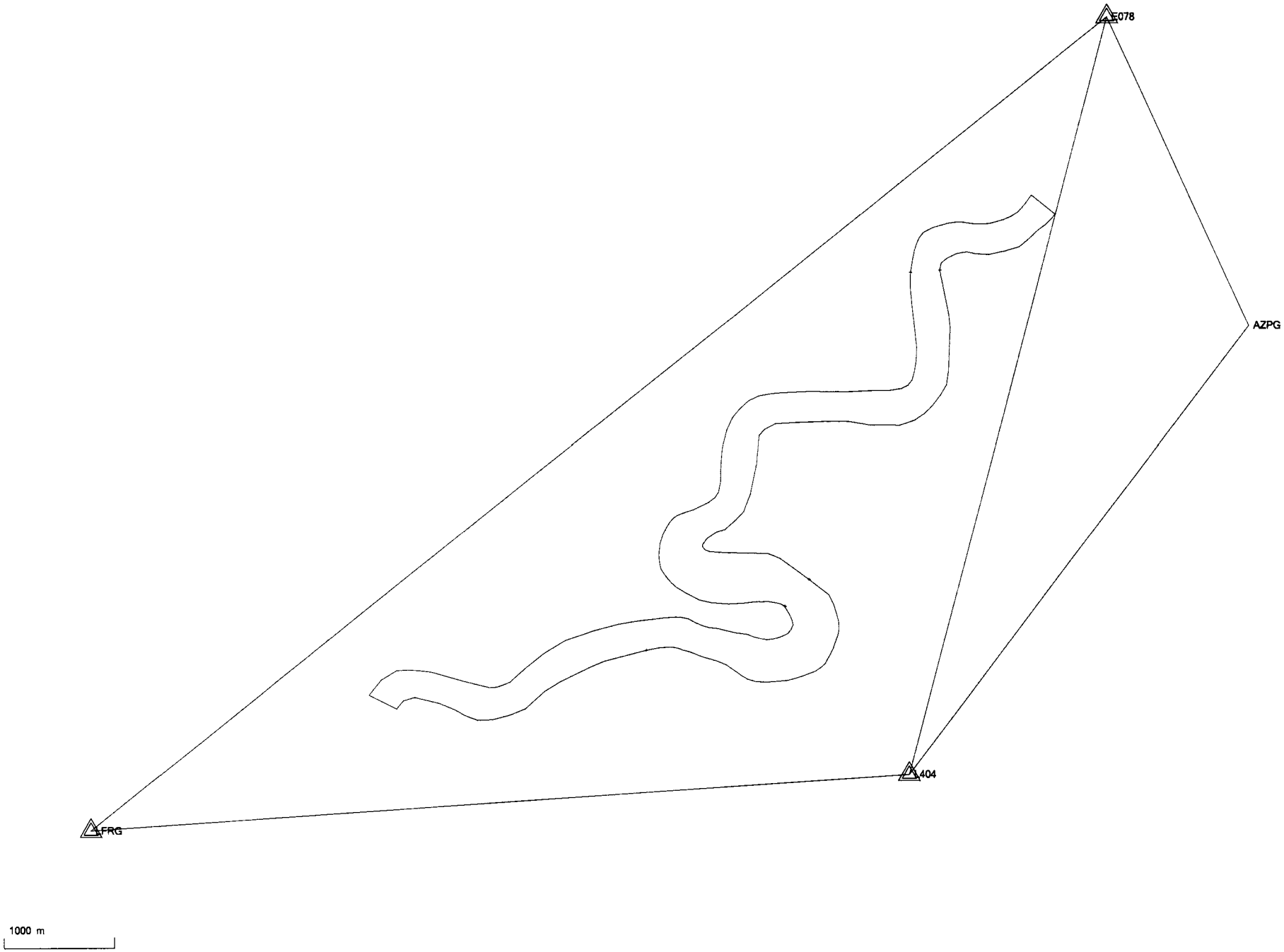
Note: The positions of the stations listed above are referenced to NAD83 (2011) (EPOCH 2010.0) position horizontally & NAVD88 vertically. These coordinates were used as control for the FLI-MAP survey performed in July 2013. FAMM utilized FM400-006 for data collection.

The horizontal positions were computed in a least squares adjustment of the GPS data by holding to the published NAD83 (2011) positions of: "E078", "L404", and "LFRG".

The vertical positions (ellipsoidal heights) were computed in a least squares adjustment of the GPS data by holding to the computed ellipsoidal height of E078". This ellipsoidal height was computed using GEOID12A and the published NAVD88 elevation of "E078"

The elevations listed above (in black) are published NAVD88 elevations.
The elevations listed above (in blue) are GPS derived elevations (orthometric heights) referenced to NAVD88.

Note: The published NAVD88 elevation for station "LFRG" is 992.30 meters. This published NAVD88 elevation was determined with GPS observation & GEOID09. The difference between GEOID09 (-23.36m) and GEOID12A (-23.49m) is 0.13m. The difference between these two geoid models at this station account for the decimeter level error highlighted above in yellow. It is important to note that the adjusted ellipsoidal height for "LFRG" aboves compares favorably (0.007m) to this stations NGS published ellipsoidal height.


E078
AZPG
404
FRG
1000 m

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[redacted]		[redacted]	
Name:	D:\Data\Trimble Business Center\Projects\2013\Glen Canyon.vce	Name:	US State Plane 1983
Size:	189 KB	Datum:	NAD 1983 (Conus)
Modified:	7/10/2013 4:03:26 PM (UTC:-7)	Zone:	Arizona Central 0202
Time zone:	Mountain Standard Time	Geoid:	GEOID12A (Conus)
Reference number:	503513.00039.00	Vertical datum:	
Description:	Glen Canyon		

Network Adjustment Report

Adjustment Settings

Set-Up Errors

GNSS

Error in Height of Antenna: 0.001 m

Centering Error: 0.001 m

Covariance Display

Horizontal:

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 m

Scale on Linear Error [S]: 1.960

Three-Dimensional

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 m

Scale on Linear Error [S]: 1.960

Adjustment Statistics

Number of Iterations for Successful Adjustment:	2
Network Reference Factor:	1.21
Chi Square Test (95%):	Passed
Precision Confidence Level:	95%
Degrees of Freedom:	23

Post Processed Vector Statistics

Reference Factor:	1.21
Redundancy Number:	23.00
A Priori Scalar:	1.40

Control Coordinate Comparisons

Values shown are control coordinates minus adjusted coordinates.

Point ID	ΔEasting (Meter)	ΔNorthing (Meter)	ΔElevation (Meter)	ΔHeight (Meter)
AZPG	0.001	-0.005	?	-0.009
L404	?	?	?	0.023
LFRG	?	?	?	0.007

Control Point Constraints

Point ID	Type	East σ (Meter)	North σ (Meter)	Height σ (Meter)	Elevation σ (Meter)
E078	Local	Fixed	Fixed	Fixed	
L404	Local	Fixed	Fixed		
LFRG	Local	Fixed	Fixed		
Fixed = 0.000001(Meter)					

Adjusted Grid Coordinates

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Constraint
AZPG	253814.757	0.003	655431.237	0.003	1326.247	0.013	
E078	252317.675	?	658686.063	?	1158.396	?	LLh
L404	250206.458	?	650702.454	?	1337.775	0.013	LL
LFRG	241496.168	?	650118.405	?	992.406	0.016	LL

Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (Meter)	Height Error (Meter)	Constraint
AZPG	N36°54'31.19200"	W111°27'45.63636"	1302.753	0.013	
E078	N36°56'17.01087"	W111°28'45.51354"	1134.864	?	LLh
L404	N36°51'58.31311"	W111°30'12.23436"	1314.315	0.013	LL
LFRG	N36°51'40.44344"	W111°36'04.00591"	968.916	0.016	LL

Adjusted ECEF Coordinates

Point ID	X (Meter)	X Error (Meter)	Y (Meter)	Y Error (Meter)	Z (Meter)	Z Error (Meter)	3D Error (Meter)	Constraint
AZPG	-1868673.069	0.005	-4752980.281	0.010	3810075.588	0.008	0.013	
E078	-1869285.902	?	-4750488.808	?	3812583.041	?	?	LLh
L404	-1873091.183	?	-4754292.003	?	3806312.436	?	?	LL
LFRG	-1881216.546	?	-4751141.032	?	3805664.425	?	?	LL

Error Ellipse Components

Point ID	Semi-major axis (Meter)	Semi-minor axis (Meter)	Azimuth
AZPG	0.004	0.004	11°

Adjusted GPS Observations

Transformation Parameters

Azimuth Rotation: 0.103 sec **(95%)** 0.053 sec

Scale Factor: 1.00000026 **(95%)** 0.00000026

Observation ID		Observation	A-posteriori Error	Residual	Standardized Residual
L404 --> AZPG (PV9)	**Az.**	37°35'36.76817"	0.115 sec	-0.040 sec	-0.368
	ΔHt.	-11.563 m	0.014 m	-0.020 m	-1.888
	Ellip Dist.	5948.694 m	0.004 m	0.002 m	0.632
L404 --> LFRG (PV8)	**Az.**	266°24'42.69224"	0.053 sec	0.147 sec	1.625
	ΔHt.	-345.400 m	0.016 m	-0.021 m	-1.783
	Ellip Dist.	8730.606 m	0.002 m	0.004 m	1.175
L404 --> E078 (PV4)	**Az.**	15°03'38.27964"	0.053 sec	-0.074 sec	-0.984
	ΔHt.	-179.451 m	0.013 m	0.022 m	1.646
	Ellip Dist.	8258.719 m	0.002 m	-0.001 m	-0.381
AZPG --> E078 (PV12)	**Az.**	335°34'20.41787"	0.188 sec	-0.002 sec	-0.013
	ΔHt.	-167.889 m	0.013 m	-0.012 m	-1.421
	Ellip Dist.	3582.905 m	0.003 m	0.003 m	1.160

LFRG --> E078 (PV11)	**Az.**	51°49'11.90957"	0.053 sec	0.035 sec	0.685
	ΔHt.	165.948 m	0.016 m	-0.012 m	-1.043
	Ellip Dist.	13803.712 m	0.004 m	-0.004 m	-1.379
L404 --> LFRG (PV2)	**Az.**	266°24'42.69224"	0.053 sec	0.022 sec	0.255
	ΔHt.	-345.400 m	0.016 m	0.015 m	1.160
	Ellip Dist.	8730.606 m	0.002 m	0.004 m	1.278
L404 --> AZPG (PV3)	**Az.**	37°35'36.76817"	0.115 sec	-0.079 sec	-0.881
	ΔHt.	-11.563 m	0.014 m	0.012 m	1.061
	Ellip Dist.	5948.694 m	0.004 m	0.000 m	-0.049
L404 --> E078 (PV10)	**Az.**	15°03'38.27964"	0.053 sec	-0.089 sec	-1.031
	ΔHt.	-179.451 m	0.013 m	-0.004 m	-0.363
	Ellip Dist.	8258.719 m	0.002 m	0.001 m	0.259
LFRG --> E078 (PV5)	**Az.**	51°49'11.90957"	0.053 sec	0.022 sec	0.510
	ΔHt.	165.948 m	0.016 m	0.010 m	0.831
	Ellip Dist.	13803.712 m	0.004 m	-0.003 m	-0.896
AZPG --> E078 (PV6)	**Az.**	335°34'20.41787"	0.188 sec	-0.019 sec	-0.132
	ΔHt.	-167.889 m	0.013 m	0.006 m	0.707
	Ellip Dist.	3582.905 m	0.003 m	0.000 m	0.112

Covariance Terms

From Point	To Point		Components	A-posteriori Error	Horiz. Precision (Ratio)	3D Precision (Ratio)
AZPG	E078	**Az.**	335°34'20.31489"	0.184 sec	1 : 1079563	1 : 1052713
		ΔHt.	-167.889 m	0.013 m		
		ΔElev.	-167.851 m	0.013 m		
		Ellip Dist.	3582.906 m	0.003 m		
AZPG	L404	**Az.**	217°37'04.65988"	0.109 sec	1 : 1762397	1 : 1762092
		ΔHt.	11.563 m	0.014 m		
		ΔElev.	11.528 m	0.014 m		
		Ellip Dist.	5948.696 m	0.003 m		
L404	E078	**Az.**	15°03'38.17666"	0.000 sec	1 : 0	1 : 28506379
		ΔHt.	-179.451 m	0.013 m		
		ΔElev.	-179.378 m	0.013 m		
		Ellip Dist.	8258.721 m	0.000 m		
LFRG	E078	**Az.**	51°49'11.80660"	0.000 sec	1 : 0	1 : 73503482
		ΔHt.	165.948 m	0.016 m		
		ΔElev.	165.990 m	0.016 m		
		Ellip Dist.	13803.715 m	0.000 m		
LFRG	L404	**Az.**	86°21'11.55667"	0.000 sec	1 : 0	1 : 14150528
		ΔHt.	345.400 m	0.016 m		
		ΔElev.	345.369 m	0.016 m		
		Ellip Dist.	8730.608 m	0.000 m		

4.2 STATION DESCRIPTIONS

FAMM Job No.: 13-00039

FLI-MAP®
FUGRO AERIAL & MOBILE MAPPING INC.

FUGRO

STATION NAME: "CITY OF PAGE CORS ARP"
PID: DK8419
CORS IDENTIFIER: "AZPG"
FAMM IDENTIFIER: "AZPG"

1:48,000
0 0.25 0.5 1 Miles

MONUMENT DESCRIPTION: Described by the National Geodetic Survey, the Station is a GPS CORS. The latest information, including the Positions and Velocities are available in the coordinate and log files accessible by anonymous FTP or the worldwide web at:

FTP CORS.NGS.NOAA.GOV: CORS/COORD and CORS/STATION log
HTTP://WWW.NGS.NOAA.GOV under products and services

PUBLISHED NAD83 (2011) (EPOCH 2010.0) :
Lat. N. 36 54 31.19183
Long. W. 111 27 45.63634
Ellipsoid Height = 1,302.744

ADJUSTED NAD83 (2011) (EPOCH 2010.0):
Lat. N. 36 54 31.19200
Long. W. 111 27 45.63636
Ellipsoid Height = 1,302.753

ADJUSTED NAVD88 (METERS):
Elevation = 1,326.247

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IGS 08

CITY OF PAGE (**AZPG**), ARIZONA

Created on 31Aug2011 at 10:01:40.

Antenna Reference Point(ARP): **CITY OF PAGE CORS ARP**

PID = **DK8419**

IGS08 POSITION (EPOCH 2005.0)
Computed in Aug 2011 using data through gpswk 1631.

X =	-1868673.756 m	latitude	= 36 54 31.20957 N
Y =	-4752978.961 m	longitude	= 111 27 45.68169 W
Z =	3810075.531 m	ellipsoid height	= 1301.938 m

IGS08 VELOCITY
Predicted with HTDP_3.1.2 Aug 2011.

VX =	-0.0140 m/yr	northward	= -0.0078 m/yr
VY =	0.0005 m/yr	eastward	= -0.0132 m/yr
VZ =	-0.0063 m/yr	upward	= -0.0001 m/yr

NAD_83 (2011) POSITION (EPOCH 2010.0)
Transformed from IGS08 (epoch 2005.0) position in Aug 2011.

X =	-1868673.067 m	latitude	= **36 54 31.19183 N**
Y =	-4752980.277 m	longitude	= **111 27 45.63634 W**
Z =	3810075.578 m	ellipsoid height	= **1302.744 m**

NAD_83 (2011) VELOCITY
Transformed from IGS08 velocity in Aug 2011.

VX =	0.0022 m/yr	northward	= 0.0015 m/yr
VY =	0.0012 m/yr	eastward	= 0.0016 m/yr
VZ =	0.0004 m/yr	upward	= -0.0013 m/yr

L1 Phase Center of the current GPS antenna: CITY OF PAGE CORS L1 PC C

The External geodetic antenna L1/L2, SmartTr antenna
(Antenna Code = LEIAX1202GG NONE) was installed on 04Mar2008.
The L2 phase center is 0.001 m below the L1 phase center.

PID = DK8420

IGS08 POSITION (EPOCH 2005.0)
Computed in Aug 2011 using data through gpswk 1631.

X =	-1868673.775 m	latitude	= 36 54 31.20962 N
Y =	-4752979.007 m	longitude	= 111 27 45.68171 W
Z =	3810075.571 m	ellipsoid height	= 1302.001 m

The IGS08 VELOCITY of the L1 PC is the same as that for the ARP.

NAD_83 (2011) POSITION (EPOCH 2010.0)
Transformed from IGS08 (epoch 2005.0) position in Aug 2011.

X =	-1868673.086 m	latitude	= 36 54 31.19188 N
Y =	-4752980.323 m	longitude	= 111 27 45.63636 W
Z =	3810075.618 m	ellipsoid height	= 1302.807 m

The NAD_83 (2011) VELOCITY of the L1 PC is the same as that for the ARP.

```
**********************************************************************
 HT_MOD       -  This is a Height Modernization Survey Station.
 CORS         -  This is a GPS Continuously Operating Reference Station.
 DESIGNATION -  CITY OF PAGE CORS ARP     =     "AZPG"
 CORS_ID      -  AZPG
 PID          -  DK8419
 STATE/COUNTY-  AZ/COCONINO
 COUNTRY      -  US
 USGS QUAD    -  PAGE (1985)

                        *CURRENT SURVEY CONTROL

 ___________________________________________________________________
 NAD 83(2011) POSITION- 36 54 31.19183(N) 111 27 45.63634(W)   ADJUSTED
 NAD 83(2011) ELLIP HT-  1302.744 (meters)        (08/??/11)   ADJUSTED
 NAD 83(2011) EPOCH   -  2010.00
 NAVD 88 ORTHO HEIGHT -  1326.18   (meters)    4351.0   (feet) GPS OBS
 ___________________________________________________________________
 NAVD 88 orthometric height was determined with geoid model    GEOID09
 GEOID HEIGHT    -        -23.43  (meters)                     GEOID09
 GEOID HEIGHT    -        -23.50  (meters)                     GEOID12A
 NAD 83(2011) X  - -1,868,673.067 (meters)                     COMP
 NAD 83(2011) Y  - -4,752,980.277 (meters)                     COMP
 NAD 83(2011) Z  -  3,810,075.578 (meters)                     COMP
 HORZ ORDER      -  SPECIAL (CORS)
 ELLP ORDER      -  SPECIAL (CORS)
```

Formal positional accuracy estimates are not available for this CORS because its coordinates were determined in part using modeled velocities. Approximate one-sigma accuracies for latitude, longitude, and ellipsoid height can be obtained from the short-term time series. Additional information regarding modeled velocities is available on the CORS Coordinates and Multi-Year CORS Solution FAQ web pages. The coordinates were established by GPS observations and adjusted by the National Geodetic Survey in August 2011. NAD 83(2011) refers to NAD 83 coordinates where the reference frame has been affixed to the stable North American Tectonic Plate. The coordinates are valid at the epoch date displayed above which is a decimal equivalence of Year/Month/Day.

The orthometric height was determined by GPS observations and a high-resolution geoid model using precise GPS observation and processing techniques. The XYZ, and position/ellipsoidal ht. are equivalent. The ellipsoidal height was determined by GPS observations and is referenced to NAD 83.

```
 The following values were computed from the NAD 83(2011) position.
                     North          East      Units Scale Factor Converg.
SPC AZ C      -   655,431.232   253,814.757   MT  0.99992016   +0 16 21.5
SPC AZ C      - 2,150,364.93    832,725.58   iFT  0.99992016   +0 16 21.5

              -  Elev Factor  x  Scale Factor =   Combined Factor
SPC AZ C      -   0.99979560  x   0.99992016  =   0.99971577

                        SUPERSEDED SURVEY CONTROL
 NAD 83(CORS)-  36 54 31.19168(N)    111 27 45.63643(W) AD(2002.00) c
 ELLIP H (02/??/09) 1302.735  (m)                       GP(2002.00) c c

U.S. NATIONAL GRID SPATIAL ADDRESS: 12SVF5878384840(NAD 83)
MARKER: STATION IS THE ANTENNA REFERENCE POINT OF THE GPS ANTENNA
```

FAMM Job No.: 13-00039

FLI-MAP®
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FUGRO

STATION NAME: "E 78"
PID: GP0104
FAMM IDENTIFIER: "E078"

1:48,000
0 0.25 0.5 1 Miles

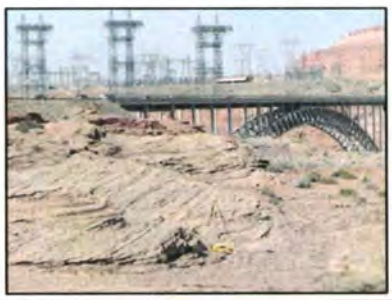
MONUMENT LOCATION:
To reach the station from the intersection of US-89 and N Lake Powell Blvd in Page, AZ, travel NW on US-89 for 0.6 miles to a graveled road, right. Turn right and travel NW on the dirt road for 0.2 miles to a "T" intersection. Turn left and travel W then NW for an additional 0.2 miles to a dirt pull off on the left (park here) and the station on the left. The station is a Bureau of Reclamation BM disk set into a sandstone outcrop. The station is located 204.0' NE of centerline of the dam access road (gated), 229.0' SW of centerline of the graveled road, and 229.0' E of the T-junction of the gate and fence for the dam access road.

PUBLISHED NAD83 (2011) (EPOCH 2010.0):
Lat. N. 36 56 17.01087
Long. W. 111 28 45.51354

PUBLISHED NAVD88 (METERS):
Elevation = 1,158.365

ADJUSTED NAD83 (2011) (EPOCH 2010.0):
Lat. N. 36 56 17.01087
Long. W. 111 28 45.51354

ADJUSTED NAVD88 (METERS):
Elevation = 1,158.396



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****

DESIGNATION - E 78 = "E078"
PID - GP0104
STATE/COUNTY- AZ/COCONINO
COUNTRY - US
USGS QUAD - PAGE (1985)

*CURRENT SURVEY CONTROL

NAD 83(2011) POSITION-	36 56 17.01087(N) 111 28 45.51354(W)			ADJUSTED
NAD 83(2011) ELLIP HT-	1134.864 (meters)	(06/27/12)		ADJUSTED
NAD 83(2011) EPOCH -	2010.00			
NAVD 88 ORTHO HEIGHT -	1158.365 (meters)	3800.40	(feet)	ADJUSTED
NAD 83(2011) X -	-1,869,285.902 (meters)			COMP
NAD 83(2011) Y -	-4,750,488.808 (meters)			COMP
NAD 83(2011) Z -	3,812,583.041 (meters)			COMP
LAPLACE CORR -	1.39 (seconds)			DEFLEC12A
GEOID HEIGHT -	-23.53 (meters)			GEOID12A
DYNAMIC HEIGHT -	1157.056 (meters)	3796.11	(feet)	COMP
MODELED GRAVITY -	979,462.7 (mgal)			NAVD 88

VERT ORDER - FIRST CLASS II

FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)

Type	Horiz	Ellip	Dist(km)
NETWORK	0.46	0.80	
MEDIAN LOCAL ACCURACY AND DIST (023 points)	0.51	0.94	104.45

The horizontal coordinates were established by GPS observations and adjusted by the National Geodetic Survey in June 2012. NAD 83(2011) refers to NAD 83 coordinates where the reference frame has been affixed to the stable North American tectonic plate. See NA2011 for more information. The horizontal coordinates are valid at the epoch date displayed above which is a decimal equivalence of Year/Month/Day.

The orthometric height was determined by differential leveling and adjusted by the NATIONAL GEODETIC SURVEY in June 1991. WARNING-Repeat measurements at this control monument indicate possible vertical movement. The X, Y, and Z were computed from the position and the ellipsoidal ht. The Laplace correction was computed from DEFLEC12A derived deflections. The ellipsoidal height was determined by GPS observations and is referenced to NAD 83. The dynamic height is computed by dividing the NAVD 88 geopotential number by the normal gravity value computed on the Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45 degrees latitude (g = 980.6199 gals.). The modeled gravity was interpolated from observed gravity values.

The following values were computed from the NAD 83(2011) position.

	North	East	Units	Scale Factor	Converg.
SPC AZ C -	658,686.063	252,317.675	MT	0.99991869	+0 15 46.2
SPC AZ C -	2,161,043.51	827,813.89	iFT	0.99991869	+0 15 46.2
UTM 12 -	4,088,108.331	457,318.234	MT	0.99962244	-0 17 17.0

	Elev Factor	x	Scale Factor	=	Combined Factor
SPC AZ C -	0.99982193	x	0.99991869	=	0.99974064
UTM 12 -	0.99982193	x	0.99962244	=	0.99944444

SUPERSEDED SURVEY CONTROL

NAD 83(2007)-	36 56 17.01027(N)	111 28 45.51376(W)		AD(2007.00)	0
ELLIP H (02/10/07)	1134.888 (m)			GP(2007.00)	
NAD 83(1992)-	36 56 17.01019(N)	111 28 45.51351(W)		AD( )	B
ELLIP H (08/22/05)	1134.892 (m)			GP( )	3 1
NAVD 88 (08/22/05)	1158.37 (m)	3800.4	(f)	LEVELING	3
NGVD 29 (??/??/92)	1157.498 (m)	3797.56	(f)	ADJ UNCH	1 2

U.S. NATIONAL GRID SPATIAL ADDRESS: 12SVF5731888108(NAD 83)
MARKER: DD = SURVEY DISK
SETTING: 66 = SET IN ROCK OUTCROP
SP_SET: SANDSTONE OUTCROP
STAMPING: BM E 78 1957
MARK LOGO: BOR
MAGNETIC: O = OTHER; SEE DESCRIPTION
STABILITY: A = MOST RELIABLE AND EXPECTED TO HOLD
STABILITY: POSITION/ELEVATION WELL
SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
SATELLITE: SATELLITE OBSERVATIONS - April 01, 2005

HISTORY	- Date	Condition	Report By
HISTORY	- 1957	MONUMENTED	BOR
HISTORY	- 1962	GOOD	CGS
HISTORY	- 1983	GOOD	NGS
HISTORY	- 20050401	GOOD	NGS

STATION DESCRIPTION

DESCRIBED BY COAST AND GEODETIC SURVEY 1962 0.6 MI NE FROM PAGE. ABOUT 0.25 MILE SOUTHEAST ALONG U.S. HIGHWAY 89 FROM THE NORTHEAST END OF THE GLEN CANYON BRIDGE AT PAGE, TO A BLINKING LIGHT. THENCE 0.15 MILE NORTH-NORTHEAST ALONG A GRAVELED ROAD TO A GUARD GATE. THENCE 0.1 MILE WEST ALONG A PAVED ROAD. THENCE 0.1 MILE NORTH ALONG A GRAVELED ROAD ALONG THE SOUTHWEST SIDE OF A STEEL MESH FENCE. 163 FEET SOUTHWEST OF THE CENTER LINE OF THE ROAD, SET IN THE TOP OF A SANDSTONE OUTCROP WHICH IS ABOUT 8 FEET BELOW THE LEVEL OF THE ROAD, 174 FEET SOUTHWEST AND ACROSS THE ROAD FROM THE STEEL MESH FENCE, 107 FEET NORTH-NORTHEAST OF POWER POLE NUMBER 18-12, 77 FEET WEST OF THE WEST SIDE OF A MUSHROOM SHAPED SANDSTONE FORMATION, AND BETWEEN TWO 2-INCH METAL PIPES WHICH SUPPORT A 2X4-INCH BOARD WHICH PROTECTS THE MARK.

STATION RECOVERY (1983)

RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1983 RECOVERED IN GOOD CONDITION. NEW DESCRIPTION FOLLOWS. 0.16 KM (0.1 MI) NORTHEAST ALONG US HIGHWAY 89 FROM THE NORTHEAST END OF THE GLEN CANYON BRIDGE IN PAGE, THENCE 0.16 KM (0.1 MI) NORTHWEST ALONG A PAVED ROAD, IN TOP OF AND 5.1 METERS (17 FT) SOUTHEAST OF THE NORTHWEST AND BOTTOM EDGE OF A SMALL SANDSTONE OUTCROP KNOLL ON THE NORTH END OF A MASSIVE SANDSTONE OUTCROP FORMATION, AT THE SOUTH END OF A GRADED CLEARING, 62.2 METERS (204 FT) NORTHEAST OF THE CENTER OF THE PAVED ROAD, 69.8 METERS (229 FT) EAST OF THE T-JUNCTION OF A CHAIN LINK FENCE FOR THE SECOND GATE ACROSS THE PAVED ROAD, 69.8 METERS (229 FT) SOUTHWEST OF THE CENTER OF A GRAVEL ROAD, 1.5 METERS (5 FT) ABOVE THE GRADED CLEARING. THE MARK IS 0.9 METERS SW FROM A WITNESS POST. THE MARK IS 1.8 M ABOVE THE PAVED ROAD.

STATION RECOVERY (2005)

RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 2005 RECOVERED AS DESCRIBED

FAMM Job No.: 13-00039

FLI-MAP®
FUGRO AERIAL & MOBILE MAPPING INC.

FUGRO

STATION NAME: "L 404"
PID: GP0283
FAMM IDENTIFIER: "L404"

1:84,000
0 0.5 1 2 Miles

MONUMENT LOCATION:
To reach the station from the intersection of US-89 and SR-98 on the S side of the town of Page, AZ, travel S on US-89 for 2.1 miles to a side road left and the station on the left, NE of the intersection. The station is a USC and GS disk set into a round concrete monument set 4" above grade, and is located 124.7' E of centerline of US-89, 21.3' E of the ROW fence, and 19.7' N of centerline of the dirt road.

PUBLISHED NAD83 (2011) (EPOCH 2010.0):
Lat. N. 36 51 58.31311
Long. W. 111 30 12.23436

PUBLISHED NAVD88 (METERS):
Elevation = 1,337.778

ADJUSTED NAD83 (2011) (EPOCH 2010.0):
Lat. N. 36 51 58.31311
Long. W. 111 30 12.23436

ADJUSTED NAVD88 (METERS):
Elevation = 1,337.775

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FBN - This is a Federal Base Network Control Station.
DESIGNATION - L 404 = "L404"
PID - GP0283
STATE/COUNTY- AZ/COCONINO
COUNTRY - US
USGS QUAD - LEES FERRY (1985)

*CURRENT SURVEY CONTROL

NAD 83(2011) POSITION-	36 51 58.31311(N) 111 30 12.23436(W)			ADJUSTED
NAD 83(2011) ELLIP HT-	1314.338 (meters)	(06/27/12)		ADJUSTED
NAD 83(2011) EPOCH -	2010.00			
NAVD 88 ORTHO HEIGHT -	1337.778 (meters)	4389.03	(feet)	ADJUSTED
NAD 83(2011) X -	-1,873,091.190 (meters)			COMP
NAD 83(2011) Y -	-4,754,292.020 (meters)			COMP
NAD 83(2011) Z -	3,806,312.450 (meters)			COMP
LAPLACE CORR -	2.53 (seconds)			DEFLEC12A
GEOID HEIGHT -	-23.46 (meters)			GEOID12A
DYNAMIC HEIGHT -	1336.228 (meters)	4383.94	(feet)	COMP
MODELED GRAVITY -	979,426.7 (mgal)			NAVD 88

VERT ORDER - FIRST CLASS II

FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)

Type	Horiz	Ellip	Dist(km)
NETWORK	0.25	0.57	
MEDIAN LOCAL ACCURACY AND DIST (110 points)	0.36	0.83	220.70

The horizontal coordinates were established by GPS observations and adjusted by the National Geodetic Survey in June 2012. NAD 83(2011) refers to NAD 83 coordinates where the reference frame has been affixed to the stable North American tectonic plate. See NA2011 for more information. The horizontal coordinates are valid at the epoch date displayed above which is a decimal equivalence of Year/Month/Day.

The orthometric height was determined by differential leveling and adjusted by the NATIONAL GEODETIC SURVEY in June 1991. The X, Y, and Z were computed from the position and the ellipsoidal ht. The Laplace correction was computed from DEFLEC12A derived deflections. The ellipsoidal height was determined by GPS observations and is referenced to NAD 83. The dynamic height is computed by dividing the NAVD 88 geopotential number by the normal gravity value computed on the Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45 degrees latitude (g = 980.6199 gals.). The modeled gravity was interpolated from observed gravity values.

The following values were computed from the NAD 83(2011) position.

	North	East	Units	Scale Factor	Converg.
SPC AZ C -	650,702.454	250,206.458	MT	0.99991672	+0 14 52.6
SPC AZ C -	2,134,850.57	820,887.33	iFT	0.99991672	+0 14 52.6
UTM 12 -	4,080,147.713	455,131.063	MT	0.99962480	-0 18 07.3

	Elev Factor	x	Scale Factor	=	Combined Factor
SPC AZ C -	0.99979378	x	0.99991672	=	0.99971051
UTM 12 -	0.99979378	x	0.99962480	=	0.99941866

SUPERSEDED SURVEY CONTROL

NAD 83(2007)-	36 51 58.31246(N)	111 30 12.23451(W)	AD(2007.00)	0
ELLIP H (02/10/07)	1314.377 (m)		GP(2007.00)	
ELLIP H (09/30/99)	1314.370 (m)		GP( )	3 1
NAD 83(1992)-	36 51 58.31358(N)	111 30 12.23214(W)	AD( )	B
NAD 83(1992)-	36 51 58.31254(N)	111 30 12.23396(W)	AD( )	A
ELLIP H (09/30/92)	1314.422 (m)		GP( )	2 1
NAVD 88 (09/30/92)	1337.78 (m)	4389.0 (f)	LEVELING	3

U.S. NATIONAL GRID SPATIAL ADDRESS: 12SVF5513180147(NAD 83)
MARKER: DB = BENCH MARK DISK
SETTING: 7 = SET IN TOP OF CONCRETE MONUMENT
SP_SET: CONCRETE POST
STAMPING: L 404 1962
MARK LOGO: NONE
MAGNETIC: N = NO MAGNETIC MATERIAL
STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
STABILITY: SURFACE MOTION
SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
SATELLITE: SATELLITE OBSERVATIONS - February 17, 2011

HISTORY	- Date	Condition	Report By
HISTORY	- 1962	MONUMENTED	CGS
HISTORY	- 1983	GOOD	NGS
HISTORY	- 19920203	GOOD	NGS
HISTORY	- 19951211	GOOD	CHANCE
HISTORY	- 19981119	GOOD	NGS
HISTORY	- 19981119	GOOD	NGS
HISTORY	- 19990426	GOOD	NGS
HISTORY	- 19990607	GOOD	NGS
HISTORY	- 20030524	GOOD	JCLS
HISTORY	- 20030529	GOOD	GRANCN
HISTORY	- 20040915	GOOD	NGS
HISTORY	- 20050401	GOOD	GRANCN
HISTORY	- 20110217	GOOD	BOR

STATION DESCRIPTION

DESCRIBED BY COAST AND GEODETIC SURVEY 1962 5.75 MI S FROM PAGE. ABOUT 5.75 MILES SOUTH ALONG U.S. HIGHWAY 89 FROM THE NORTHEAST END OF THE GLEN CANYON BRIDGE AT PAGE, ARIZONA. 239 FEET NORTHEAST OF HIGHWAY MILEPOST NUMBER 544, 125 FEET EAST OF THE CENTERLINE OF THE HIGHWAY, 20 FEET NORTH-NORTHWEST OF THE CENTERLINE OF A PRIVATE TRACK ROAD, 2.0 FEET EAST OF A METAL WITNESS POST, ABOUT 3 1/2 FEET ABOVE THE LEVEL OF THE HIGHWAY, AND SET IN THE TOP OF A CONCRETE POST PROJECTING 6 INCHES.

STATION RECOVERY (1983)

RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1983 RECOVERED IN GOOD CONDITION. ADD--6.5 METERS (21.5 FT) EAST OF THE RIGHT OF WAY FENCE.

STATION RECOVERY (1992)

RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1992 THE STATION IS LOCATED ABOUT 9.3 KM (5.8 MI) SOUTH OF THE GLEN CANYON BRIDGE LOCATED AT PAGE, 6.1 KM (3.8 MI) SOUTH OF THE JUNCTION OF U.S. HIGHWAY 89L LEADING EAST AND U.S. HIGHWAY 89 LEADING SOUTH NEAR THE SOUTHWEST EDGE OF PAGE, AT MILE POST 544, AND AT THE EAST SIDE OF THE EAST RIGHT-OF-WAY FENCE OF THE HIGHWAY. OWNERSHIP--PRESUMED TO BE THE NAVAJO NATION. TO REACH THE STATION FROM THE NORTHEAST END OF THE GLEN CANYON BRIDGE LOCATED NEAR THE NORTHWEST EDGE OF PAGE, GO

SOUTH ON HIGHWAY 89 FOR 9.3 KM (5.8 MI) TO MILE POST 544, THE STATION ON THE LEFT AND A NAVAJO INDIAN RESERVATION MARKER ON THE RIGHT. THE STATION IS A STANDARD DISK SET IN THE TOP OF A CONCRETE POST PROJECTING 7 CM ABOVE THE GROUND. LOCATED 73.0 M (239.5 FT) NORTHEAST OF MILE POST 544, 38.0 M (124.7 FT) EAST OF THE CENTERLINE OF THE HIGHWAY, 6.5 M (21.3 FT) EAST OF RIGHT-OF-WAY FENCELINE, 6.5 M (21.3 FT) EAST OF A FIBERGLASS WITNESS POST, 6 M (19.7 FT) NORTHEAST OF THE CENTER OF A DIM TRACK ROAD AND 0.91 M (2.99 FT) ABOVE THE LEVEL OF THE HIGHWAY.

STATION RECOVERY (1995)

RECOVERY NOTE BY JE CHANCE AND ASSOCIATES 1995 (MFY) RECOVERED AS DESCRIBED AND IN GOOD CONDITION THE WITNESS POST HAS BEEN MOVED IN LINE WITH FENCELINE

STATION RECOVERY (1998)

RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1998 (CSM) RECOVERED AS DESCRIBED. LOCATED 0.08 KM (0.05 MI) NORTHWEST OF US HIGHWAY 89 MILEPOST 544.

STATION RECOVERY (1998)

RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1998 RECOVERED IN GOOD CONDITION.

STATION RECOVERY (1999)

RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1999 (CSM) RECOVERED AS DESCRIBED.

STATION RECOVERY (1999)

RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 1999 (CSM) RECOVERED AS DESCRIBED.

STATION RECOVERY (2003)

RECOVERY NOTE BY JOHN CHANCE LAND SURVEYS INC 2003 RECOVERED IN GOOD CONDITION.

STATION RECOVERY (2003)

RECOVERY NOTE BY GRAND CANYON MONITORING AND RESEARCH 2003 RECOVERED AS DESCRIBED.

STATION RECOVERY (2004)

RECOVERY NOTE BY NATIONAL GEODETIC SURVEY 2004 RECOVERED AS DESCRIBED

STATION RECOVERY (2005)

RECOVERY NOTE BY GRAND CANYON MONITORING AND RESEARCH 2005 RECOVERED AS DESCRIBED.

STATION RECOVERY (2011)

RECOVERY NOTE BY US BUREAU OF RECLAMATION 2011 (SFL) RECOVERED IN GOOD CONDITION.

FAMM Job No.: 13-00039

FLI-MAP®
FUGRO AERIAL & MOBILE MAPPING INC.

FUGRO

STATION NAME: "LFRG"
PID: DG5953
FAMM IDENTIFIER: "LFRG"

1:48,000
0 0.25 0.5 1 Miles

MONUMENT LOCATION:
To reach the station from the intersection of Lee's Ferry Rd and US-89A in Marble Canyon, AZ, travel N on Lee's Ferry Rd for 4.4 miles to a road intersection, right. Proceed straight through the intersection for an additional 0.35 miles to a side road right, leading to the Park Employee residential area. Turn right and travel SE then SW to the dead end, and a dim dirt trail left, just S of the last house. Park on the dead end pavement and walk to the station. The station is a ½" rebar set into a round concrete base, covered by a rock cairn. The station is located 43m S of the SW fence corner.

PUBLISHED NAD83 (2011) (EPOCH 2010.0):
Lat. N. 36 51 40.44344
Long. W. 111 36 04.00591

PUBLISHED NAVD88 (METERS):
Elevation = 992.30

ADJUSTED NAD83 (2011) (EPOCH 2010.0):
Lat. N. 36 51 40.44344
Long. W. 111 36 04.00591

ADJUSTED NAVD88 (METERS):
Elevation = 992.406

I:\GIS\MXD\Monument_Maps\503513.00039\LFRG_HandV.mxd, 7/22/2013, schexnider

```
**********************************************************************
 HT_MOD       -  This is a Height Modernization Survey Station.
 DESIGNATION -  LFRG     =      "LFRG"
 PID          -  DG5953
 STATE/COUNTY-  AZ/COCONINO
 COUNTRY      -  US
 USGS QUAD    -  LEES FERRY (1985)

                        *CURRENT SURVEY CONTROL

 ___________________________________________________________________
 NAD 83(2011) POSITION- 36 51 40.44344(N) 111 36 04.00591(W)   ADJUSTED
 NAD 83(2011) ELLIP HT-   968.923 (meters)        (06/27/12)   ADJUSTED
 NAD 83(2011) EPOCH   -  2010.00
 NAVD 88 ORTHO HEIGHT -   992.30   (meters)    3255.6   (feet) GPS OBS
 ___________________________________________________________________
 NAVD 88 orthometric height was determined with geoid model    GEOID09
 GEOID HEIGHT    -        -23.36  (meters)                     GEOID09
 GEOID HEIGHT    -        -23.49  (meters)                     GEOID12A
 NAD 83(2011) X  - -1,881,216.549 (meters)                     COMP
 NAD 83(2011) Y  - -4,751,141.037 (meters)                     COMP
 NAD 83(2011) Z  -  3,805,664.430 (meters)                     COMP
 LAPLACE CORR    -         -3.10  (seconds)                    DEFLEC12A

 FGDC Geospatial Positioning Accuracy Standards (95% confidence, cm)
 Type                                          Horiz  Ellip  Dist(km)
 ------------------------------------------------------------------
 NETWORK                                        0.29   0.65
 ------------------------------------------------------------------
 MEDIAN LOCAL ACCURACY AND DIST (053 points)    0.40   0.92    103.28
 ------------------------------------------------------------------
The horizontal coordinates were established by GPS observations and adjusted
by the National Geodetic Survey in June 2012. NAD 83(2011) refers to NAD 83
coordinates where the reference  frame has been affixed to the stable North
American tectonic plate. See  NA2011 for more information. The horizontal
coordinates are valid at the epoch date displayed above which is a decimal
equivalence of Year/Month/Day.

The orthometric height was determined by GPS observations and a high-
resolution geoid model using precise GPS observation and processing
techniques. The X, Y, and Z were computed from the position and the
ellipsoidal ht. The Laplace correction was computed from DEFLEC12A derived
deflections. The ellipsoidal height was determined by GPS observations and
is referenced to NAD 83.

 The following values were computed from the NAD 83(2011) position.
                     North          East     Units Scale Factor Converg.
SPC AZ C     -   650,118.405   241,496.168   MT  0.99990975   +0 11 21.5
SPC AZ C     - 2,132,934.40    792,310.26   iFT  0.99990975   +0 11 21.5
UTM  12      - 4,079,647.434   446,418.036   MT  0.99963537   -0 21 38.2

             -  Elev Factor  x  Scale Factor =   Combined Factor
SPC AZ C     -   0.99984797  x   0.99990975  =   0.99975773
UTM  12      -   0.99984797  x   0.99963537  =   0.99948339

                        SUPERSEDED SURVEY CONTROL
 NAD 83(2007)-  36 51 40.44284(N)    111 36 04.00613(W) AD(2007.00) 0
 ELLIP H (02/10/07)  968.944  (m)                       GP(2007.00)
 NAD 83(1992)-  36 51 40.44272(N)    111 36 04.00568(W) AD(       ) A
```

```
ELLIP H (05/31/05)  968.953  (m)                          GP(       ) 3 2
NAD 83(1992)-  36 51 40.44281(N)    111 36 04.00607(W) AD(       ) A
ELLIP H (06/28/04)  968.951  (m)                          GP(       ) 3 2
NAVD 88 (08/22/05)  992.30   (m)  UNKNOWN model used   GPS OBS
NAVD 88 (05/31/05)  992.29   (m)  UNKNOWN model used   GPS OBS
NAVD 88 (06/28/04)  992.3    (m)  GEOID03 model used   GPS OBS
```

U.S. NATIONAL GRID SPATIAL ADDRESS: 12SVF4641879647(NAD 83)
MARKER: DO = NOT SPECIFIED OR SEE DESCRIPTION
SETTING: 35 = SET IN A MAT FOUNDATION OR CONCRETE SLAB OTHER THAN
WITH SETTING: PAVEMENT
SP_SET: SPLINED REBAR
STAMPING: NO STAMPING
MAGNETIC: I = MARKER IS A STEEL ROD
STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO
STABILITY: SURFACE MOTION
SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR
SATELLITE: SATELLITE OBSERVATIONS - May 27, 2009

HISTORY	- Date	Condition	Report By
HISTORY	- 2003	MONUMENTED	GRANCN
HISTORY	- 20041115	GOOD	GRANCN
HISTORY	- 20050401	GOOD	GRANCN
HISTORY	- 20090527	GOOD	GRANCN

STATION DESCRIPTION

DESCRIBED BY GRAND CANYON MONITORING AND RESEARCH 2003 (FMG) FROM THE U.S. POST OFFICE IN MARBLE CANYON LODGE, FOLLOW THE ROAD TO LEE'S FERRY FOR 5 MILES TO THE RANGER STATION ON THE LEFT AT THE LARGE WATER TOWER. TURN RIGHT ON THE ROAD THAT LEADS TO THE RESIDENTIAL AREA FOR LEE'S FERRY PARK EMPLOYEES. FOLLOW ROAD TO ITS END ON THE SOUTH SIDE OF THE RESIDENTIAL AREA. THE STATION IS 43 METERS SOUTH OF THE SW FENCE CORNER AND 35 METERS SW OF THE NORTHERLY OF 2 MANHOLES. THE STATION IS A ONE-HALF INCH SPLINED REBAR WITH A 1-INCH STEEL CAP, CEMENTED TO A DEPTH OF 10 INCHES.

STATION RECOVERY (2004)

RECOVERY NOTE BY GRAND CANYON MONITORING AND RESEARCH 2004 RECOVERED AS DESCRIBED.

STATION RECOVERY (2005)

RECOVERY NOTE BY GRAND CANYON MONITORING AND RESEARCH 2005 RECOVERED AS DESCRIBED.

STATION RECOVERY (2009)

RECOVERY NOTE BY GRAND CANYON MONITORING AND RESEARCH 2009 (KAK) RECOVERED AS DESCRIBED.

4.3 FLIGHT LOGS

GCMRC

FLI-MAP
FUGRO AERIAL & MOBILE MAPPING INC.

JOB #	503513.00039.00	CLIENT	FEDI
FLIGHT #	13071011	TAIL #	N619

CREW

PILOT	Ken Carroll	OPERATOR	Chris Faught
		OBSERVER	

SYSTEM	LASER	FRAME
S/N	03	06

SETTINGS	TARGET ATT.	ALTITUDE (m)	SPEED (m/s)	LASER SPEED
	750	200	1820	150 kHz / 200 kHz / 250 kHz

STORAGE	NAV D	MPEG D	IMAGE D	LASER D	INS
DISK #	/	602D	607 608	611	603
	NAV E	MPEG E	IMAGE E	LASER E	
DISK #	/	605 6	609 610	612	

TIME	START	STOP
HOBBS (hrs)	3101.3	3103.6
SYSTEM (hrs)		
SURVEY (UTC)	163821	182712
VIDEO (UTC)	164927	182212
LASER (UTC)	165110	182025

WEATHER CONDITIONS		VIDEO Stop	VIDEO Start
TEMP (F)	40		
WIND (kts)	Calm		
SKY	clear		

REMARKS

608 - Laser Issue 35mm data
609 -
607 - Fed
610 - Dn

69.72 laser miles 32
3011
-62

LINE NAME	LASER START	LASER STOP	COMMENTS
L404	165110	165201	base
L404	165312	165354	base
GC003	165920	171256	170305 DNV Lines
GC001	171419	173058	171906 Fed 172848
GC002	173324	175014	174234 Sm 174236 DNV
GC004	175113	180521	175346 streaking 175830 Sm
extra	180611	181125	
extra	181241	181759	
extra	181836	182025	

Approved by Connie Landry, Manager, Field Operations, Fugro Aerial Mobile Mapping, 4/1/12
Note - To ensure that this is the latest version check the Electronic Master File

FLI-MAP
FUGRO AERIAL & MOBILE MAPPING INC.

JOB #	505513.40039.00	CLIENT	FEDI
FLIGHT #	130710F2	TAIL #	N619

CREW

PILOT	Ken Carroll	OPERATOR	Chris Fouquet
		OBSERVER	

SYSTEM

	LASER	FRAME
S/N	03	06

SETTINGS

TARGET ATT.	ALTITUDE (m)	SPEED (m/s)	LASER SPEED
750	200	18-20	150 kHz / 200 kHz / 250 kHz

STORAGE

	NAV D	MPEG D	IMAGE D	LASER D	INS
DISK #	—	602	615 616	611	603

	NAV E	MPEG E	IMAGE E	LASER E
DISK #	—	602	613 614	612

TIME

	START	STOP
HOBBS (hrs)	310.36	310.6.3
SYSTEM (hrs)		
SURVEY (UTC)	190821	212639
VIDEO (UTC)	191711	211931
LASER (UTC)	192059	212104

WEATHER CONDITIONS

		VIDEO Stop	VIDEO Start
TEMP (F)	103		
WIND (kts)	NE @ 5		
SKY	Clear		

REMARKS

cpu Image temp

613 - Fwd Vid
614 - Sm
615 - Dn Vid
616 - Fwd

92.53 laser miles

38
3607
-03

LINE NAME	LASER START	LASER STOP	COMMENTS
BC005	192058	193556	192151 Sm 192530 192520 192848
GC001	193731	196145	
GC002	195235	195600	pop 5.0
GC002	195750	201001	
GC004	201140	202531	202345 Fwd
extra	204139	204138	
extra	204228	204721	
extra	204904	205059	
"	205134	205250	
"	205347	205422	
"	205502	210231	
"	211041	211422	
C404	211656	211756	
C404	211851	211933	
extra	212039	212109	nose/tail

Approved by Connie Landry, Manager, Field Operations, Fugro Aerial Mobile Mapping, 4/1/12
Note - To ensure that this is the latest version check the Electronic Master File

4.4 ANTENNA HEIGHT LOG

130710f1	E078	R7-005	23001910.T02	Zephyr Geodetic 2 RoHS	Bottom of Antenna Mount	0852	1145	2.610	2.69546	ADAM
	L404	R7-006	21541910.T02	Zephyr Geodetic 2 RoHS	Bottom of Antenna Mount	0830	1145	1.8	1.88546	MARC
	LFRG	R7-013	17751910.T02	Zephyr Geodetic 2 RoHS	Bottom of Antenna Mount	0844	1145	2.0	2.08546	RON
130710f2	E078	R7-005	23001911.T02	Zephyr Geodetic 2 RoHS	Bottom of Antenna Mount	1155	1435	2.610	2.69546	ADAM
	L404	R7-006	21541911.T02	Zephyr Geodetic 2 RoHS	Bottom of Antenna Mount	1150	1435	1.8	1.88546	MARC
	LFRG	R7-013	17751911.T02	Zephyr Geodetic 2 RoHS	Bottom of Antenna Mount	1156	1435	2.0	2.08546	RON

5. COMMUNICATIONS

Yost, Marc

From: Mihata, Lindy <lindy_mihata@nps.gov>
Sent: Monday, June 10, 2013 5:25 PM
To: Sankey, Joel
Cc: Landry, Connie; Jordan, Becky [FEDI]; Timothy Saultz; Helen Fairley; Charles Kelly; Yost, Marc; McClellan, Richard [FEDI]; Brian Collins; Keith Kohl; Michael Peitz; John Spence
Subject: Re: Glen Canyon National Recreation Area flight coordinator

All:

Just to clarify.....the briefing will be with our park pilot, Tug Kangus not with me. Tug is located at the Page Airport. I can be contacted to coordinate the exchange of safety information.

Lindy

On Thu, Jun 6, 2013 at 9:08 AM, Sankey, Joel <jsankey@usgs.gov> wrote:
Hello Connie,

Thank you for the recap.

I would only add that Lindy Mihata and Mike Peitz have stated that each of their respective pre-flight briefings can take place over the telephone with your pilot Kenneth.

We appreciate that Lindy and Mike can handle the briefings in this manner to eliminate the need for Kenneth to otherwise have to travel from the Page airport for an in-person briefing.

Lindy and Mike, please reply if you have any additional concerns or questions with this arrangement for the briefings.

Thank you,
Joel

On Thu, Jun 6, 2013 at 8:51 AM, Landry, Connie <CLandry@fugro.com> wrote:

Joel,

Thank you for spending a few minutes with me on the phone this morning to explain the 2 flight coordinators and the necessary permits.

This is a recap of our conversation.

1) We understand that our pilot (Kenneth Carroll) will be required to speak to Lindy Mihata (flight coordinator for Glen Canyon NRA) for a pre-flight briefing the day prior to any flights. Lindy's contact info is attached below. I will also have our pilot contact Lindy Mihata prior to mobilization to discuss specifics about the project area including aerial obstructions.

2) We also understand that our pilot (Kenneth Carroll) will be required to speak to Michael Peitz (Interagency Aviation Officer - Grand Canyon NP and Kaibab NF) for a pre-flight briefing the day prior to any flights. Our pilot & I have already opened up a channel of communication with Mike to assist with the needed approval to work within the Grand Canyon National Park Special Flight Rules Area (GCNP-SFRA). We have Mike's contact information.

3) We understand that Michael Peitz will be working to acquire approval to utilize the existing DOI waiver to allow us to conduct the aerial data acquisition.

4) We understand that you are working with the NPS Science and Resource Management Personnel at Glen Canyon RA to acquire the necessary permit for us to conduct this mission.

All of these efforts are coordinated with the intention of having the data acquisition take place in the window between July 7th to July 13th.

Let me know if I have left anything out.

Regards,

Connie Landry Jr
Fugro Aerial and Mobile Mapping
Field Operations Manager
+1 (337) 268-3294 Work
+1 (337) 962-0161 Mobile
clandry@fugro.com
226 Dulles Drive
http://www.flimap.com

From: Sankey, Joel [mailto:jsankey@usgs.gov]
Sent: Wednesday, June 05, 2013 5:59 PM
To: Landry, Connie; Lindy Mihata
Cc: Jordan, Becky [FEDI]; Timothy Saultz; Helen Fairley; Charles Kelly; Yost, Marc; McClellan, Richard [FEDI]; Brian Collins; Keith Kohl

Subject: Glen Canyon National Recreation Area flight coordinator

Hello Connie,

Lindy Mihata is the flight coordinator for Glen Canyon NRA.

928-608-6252 (office)

928-640-3114 (cell)

lindy_mihata@nps.gov

She is cc'd on this email. I spoke with her today and she confirmed that your pre-flight briefing with her could take place on the telephone the day prior to the flight.

--
Joel B. Sankey

Grand Canyon Monitoring and Research Center

US Geological Survey

2255 N. Gemini Dr.

Flagstaff, AZ 86001

928-556-7289

https://profile.usgs.gov/jsankey

--
Joel B. Sankey

Grand Canyon Monitoring and Research Center
US Geological Survey
2255 N. Gemini Dr.
Flagstaff, AZ 86001
928-556-7289

https://profile.usgs.gov/jsankey

--
Lindy Mihata
Assistant Chief Ranger
Glen Canyon National Recreation Area
928-608-6252

Task Order G13PD00454: GCMR 2013 LiDAR
Kickoff Meeting Notes

Tuesday – 4 June 2013
Teleconference

Agenda

12:00 – 12:05pm CST	Welcome and introductions
12:05 – 12:10pm CST	Project overview / GCMRC priorities
12:10 – 12:25pm CST	Scope of work – acquisition review
12:25 – 12:35pm CST	Scope of work – data production review
12:35 – 12:45pm CST	Project communications
12:45 – 12:50pm CST	Project deliverables review
12:50 – 12:55pm CST	Project schedule
12:55 – 1:00pm CST	Review of action items

In Attendance

USGS

- Robert Kelly
- Joel Sankey (GCMRC)
- Helen Fairley (GCMRC)
- Brian Collins (GCMRC)
- Keith Kohl (GCMRC)

Fugro

- Dave White
- Richard McClellan
- Becky Jordan
- Connie Landry (FAMM)
- Richard Davenport (FAMM)
- Morgan Reed (FAMM)
- Marc Yost (FAMM)

Scope of Work

- FAMM will provide LiDAR data collection for approximately 8.5 miles of the Colorado River corridor from river mile -6 to -14.5

Base Stations

- GCNRA and E78 are publically accessible; E78 might be more reliable
- LFRG is publically accessible but there is some construction on the road; may need to coordinate with the contractor, SBBI

Ground Control

- There are 16 panels from the ortho flight that are available. These panels are not needed for FAMM's purposes; however, they will be left for GCRMC as checkpoints

Flight Safety

- FAMM's Pilot took the NPS Flight Safety course on May 15, 2013
- GCMRC (Joel) to provide contact information for the Glen Canyon aviation coordinator
- FAMM to confirm with Mike Peitz from Grand Canyon that the planned flight lines fall outside of the Grand Canyon restricted area; GCMRC (Helen) to provide support if needed

Data Acquisition

- The most favorable GPS window is June 27 to July 13, 2013. Glen Canyon prefers that the collection occur in the beginning of July. Planned collection is scheduled to begin the week of July 7th; this does give FAMM enough time to complete acquisition by July 13th. GCMRC (Joel) to confirm window with Glen Canyon
- Mobilization and demobilization of equipment and personnel is expected to take 2 days each way
- Installation of the FLI-MAP equipment and survey control reconnaissance is expected to take 1 day
    - During the test flight FAMM will ensure all gear is working and will look for areas of concern that could impact data acquisition
- Data collection is expected to take 1 day, weather and flight restrictions permitting
- Requested flight crew briefing to take place in Page, AZ; GCMRC (Joel) believes that this is possible. Joel to also check and see if the briefing needs to be face to face or whether in could be held via a teleconference
- A representative of GCMRC is invited to fly in the helicopter during data collection, Joel is interested. USGS will need to need approval for a non-Fugro entity to be on board; Fugro (Rich) will submit a request to USGS
- FAMM's digital still camera is being upgraded from 11.0 Megapixel to 29.0 Megapixel; might be available for this project
- If the upgrades are complete and available video will also be collected as HD video; however, digital video imagery is not a deliverable for this project

Deliverables

The following table lists the project deliverables, the delivery of final products will be provided on a Firewire / USB hard drive:

	Deliverables
1.	Technical Kickoff Meeting
2.	Aerial acquisition
3.	Daily Acquisition Status Reports during acquisition
4.	Monthly Progress Reports
5.	Survey control report
6.	All LiDAR point data in ASCII format: ▪ XYZ ▪ RGB ▪ Intensity ▪ Return # **Note:** The LiDAR point data to be delivered as minimally processed raw data. IE: Fugro will process the data as to not remove vegetation, rocks, man-made features like cables, or create a bare earth dataset, etc. It is expected however, that the data would include removing any spurious LiDAR points that were atmospheric returns and not real data.
7.	ASCII data as separate flight lines
8.	Ortho images in tif/tfw format at 3" GSD
9.	Flight line index map as Arc/Info region coverages
10.	FGDC-compliant metadata developed using the metadata tool in Arc Catalog for each file delivered

- Completed LiDAR deliverables will reference the North American Datum 1983(NAD83) (NA2011), in Arizona State Plane (202 Arizona Central) projection and units in meters. For ellipsoidal heights, the NA2011 adjustment will be used. For orthometric heights, the vertical datum will be NAVD88 using GEOID 12A, on top of the ellipsoid

Communications

- Main POC for each stakeholder to provide Fugro (Rich) with contact information
- The following at GCMRC to be included on all communications: Joel Sankey, Helen Fairley, Brian Collins, and Keith Kohl
- USGS (Robert) indicated that the communication plan followed for the ortho project worked well, LiDAR project to follow same plan; see table below. Robert Kelly and Tim Saultz to be included on all communications. Phone conversations to be summarized and sent via email.
- Daily acquisition reporting requirements to be determined amongst Fugro a reported prior to the beginning of the project mobilization.

Communications Plan, Information Requirements

Stakeholder Name	*Stakeholder Position*	*Stakeholder Email*	*Stakeholder Phone*	*Information Needs*	*Comments*
Tim Saultz	Geospatial Products and Services Contract, Contracting Officer's Representative (GPSC-COR)	tsaultz@usgs.gov	(573) 308-3654	CC'd on all communications	
Robert Kelly	Geospatial Products and Services Contract (GPSC-POC)	ckelly@usgs.gov	(573) 308-3612	CC'd on all communications	
Joel Sankey	GCMRC Remote Sensing LiDAR Coordinator	jsankey@usgs.gov	(928) 556-7389	CC'd on all communications	Main GCMRC POC
Helen Fairley	Sociocultural Program Manager	hfairley@usgs.gov	(928) 556-7285	CC'd on all communications	
Brian Collins	Geology Scientist	bcollins@usgs.gov	(650) 329-5466	CC'd on all communications	
Keith Kohl	GCMRC Head Surveyor	kkohl@usgs.gov	(928) 556-7092	CC'd on all communications	POC for ground control communications
Dave White	Fugro VP Mapping Services	dwhite@fugro.com	(301) 948-8550 Ext:142	CC'd on all reports	
Becky Jordan	Fugro Project Manager	bjordan@fugro.com	(301) 948-8550 Ext:121	CC'd on all communications	
Richard McClellan	Fugro Task Order Manager	rmcclellan@fugro.com	(301) 948-8550 Ext:227	CC'd on all communications	Fugro's main POC. Communicates to all stakeholders
Robert McCarthy	Fugro SVP Mobile Mapping Services	RMcCarthy@fugro.com	(337) 268-3282	CC'd on all reports	Communicates through TO Manager or Field Operations Manager during acquisition
Connie Landry	Fugro Field Operations Manager	clandry@fugro.com	(337) 268-3294	CC'd on all acquisition communications	Communicates directly with GCMRC POC
Richard Davenport	Fugro Data Processing Manager	RDavenport@fugro.com	(337) 268-3363	CC'd on all production communications	Communicates through TO Manager or Field Operations Manager during acquisition

Morgan Reed	LiDAR Development Manager	MReed@fugro.com	(337) 268-3371	CC'd on all production communications	Communicates through Data Processing Manager
Marc Yost	Field Project Supervisor, data acquisition team lead	MYost@fugro.com	(337) 268-3287	CC'd on all acquisition communications	Communicates through Field Operations Manager

Action Items

Item	*Responsible*	*Due Date*	*Comments*
Coordinate with SBBI regarding access to LFRG, if necessary	Connie		
Provide contact information for the Glen Canyon aviation coordinator	Joel		Complete: Lindy Mihata Flight Coordinator for Glen Canyon NRA. 928-608-6252 (office) 928-640-3114 (cell) lindy_mihata@nps.gov
Confirm with Mike Peitz that the planned flight lines fall outside of the Grand Canyon restricted area	Connie		Helen to provide support as needed
Confirm with Glen Canyon that the acquisition window of July 7th to 13th is acceptable	Joel		Complete: Note from Joel Sankey email 6/6/13: The research permit, flight, and acquisition window of July 7th-13th have been approved by Glen Canyon NRA.
Confirm that flight crew briefing can take place in Page, AZ and/or via phone is acceptable	Joel		Complete: Note from Joel Sankey email 6/6/13: ... Lindy Mihata and Mike Peitz have stated that each of their respective pre-flight briefings can take place over the telephone with your pilot Kenneth.
Submit request to USGS regarding representative of GCMRC flying in the helicopter during data collection	Rich		Complete
Provide Rich with contact information	Main POC for each stakeholder		Complete

Follow communications plan within table above	All		
Determine daily acquisition reporting requirements	Rich/Connie		

6. SAFETY

FLI-MAP®

FUGRO AERIAL & MOBILE MAPPING INC.

Emergency Response Plan

Project Name: GCMRC - GLENN CANYON, AZ

FIRST RESPONSE: 911

Project #: 13-00039

HOSPITAL INFORMATION		
Address	City	Phone
Page Hospital	Page	(928) 645-2424
501 N. Navajo Drive		

Emergency response contacts			
Position	Name	Office #	Mobile #
Field Supervisor notifies:			
Emergency Services	Ambulance		-911
	Police		-911
	Fire Service		-911
	S&R / Air Traffic	Aviation Incident / Accident Response Guide	
Helicopter Company Emergency Contact	Mark White	(800) 234-7388	(405) 630-5000
Safety Manager	Jimmy Mizzi	(337) 268-3137	(337) 962-0188
Operations Manager	Connie Landry Jr	(337) 268-3294	(337) 962-0161
Operations Manager FLI-MAP notifies:			
Managing Director	Robert McCarthy	(337) 268-3282	(337) 962-0175

FIELD TEAM CONTACTS			
Position	Name	Mobile #	License - Vehicle ID
Field Supervisor	Marc Yost	(337) 962-0156	X514664 (SS42)
Data Processor	Adam Mills	(337) 962-0158	SNW679 (SS44)
Data Processor			
System Operator	Chris Fought	(337) 962-0152	
System Operator			
Base Operator	Ron Bertucci	(337) 371-0111	X514679 (SS41)
Base Operator			
Base Operator			
Base Operator			
Base Operator			
Base Operator			
Client Consultant			

AIRCRAFT INFORMATION			
Position	Name	Office #	Mobile #
Helicopter Company:	Air Flite, Inc.	(800) 234-7388	(405) 630-5000
Pilot:	Ken Carroll	(405) 275-4388	(417) 872-7685
Aircraft Engineer:	Duane Bodette	(405) 275-4388	(405) 200-5766
Chief Pilot / Emergency Contact:	Mark White	(405) 275-4388	(405) 630-5000
Make and Model: Bell L-3		Registration/Tail No: N619	
Colors and Markings: Black/White/Green/Red		Endurance: 3.0 Hrs	
Emergency Equipment: 406 ELT			

Fugro Aerial & Mobile Mapping
SAFETY MEETING FORM

FLI-MAP® FUGRO AERIAL & MOBILE MAPPING INC.

SUPERVISOR: M. Yost **JOB#:** 503513.00039.00 **DATE:** July 9, 2013

SYSTEM AND/OR LOCATION: FM400 – PAGE, AZ

SUBJECT DISCUSSED: HEAT EXHAUSTION & HEAT STROKE, SNAKE AVOIDANCE

ROSTER (PRINT NAME)	COMPANY	SIGNATURE
1) Adam Mills	FAMM	
2) Chris Faught	FAMM	
3) Ronald Bertucci	FAMM	
4) Marc [illegible]	FAMM	
5)		
6)		
7)		
8)		
9)		

JOB SAFETY AND ENVIRONMENTAL ANALYSIS
GPS BASE SETUP

Document #	**FAMM-JSEA-001**	CLIENT:	GCMRC
Associated Forms		DATE WORK DONE:	July 9, 2013
PERSON DOING JOB:	M. Yost	LOCATION OF ACTIVITY:	Page, AZ
JOB#	503513.00039.00		

Please Remember: All hazards are important. Make notice of all possible hazards. Detailed safe job procedures are necessary. Awareness, teamwork, communications, and alertness apply to every situation. Use complete recommendations to eliminate or reduce hazards. This JSEA is a compilation of potential physical and environmental hazards that should be expected on a similar work site. If actual work conditions or hazards require deviations from this JSEA the employee must take the appropriate safety measures and document any changes to the Sequence of basic job steps, potential accidents or hazards, and recommendations to eliminate or reduce potential hazards listed or not listed in this JSEA.

SAFETY EQUIPMENT REQUIRED TO DO THIS JOB:

☒	Hard Hats	☐	Fire Extinguisher	☒	Work Vest	☐	Dust Mask
☒	Safety Shoes	☒	Safety Glasses w/ Side Shields or Goggles	☐	Life Rings w/ 90' Floating Line	☐	Back Belts
☐	Hearing Protection	☐	Lockout/Tag out	☐	Tag Lines	☐	Face Shield
☒	Gloves	☐	Safety Harness	☐	Work Permit Required	☒	Traffic Cones

Comments: _____

Description of job specific hazards: _____

Note: All property damage, injury/illness, & environmental incidents are to be immediately reported to your supervisor and the HSE department. An incident report is to be completed and submitted along with a copy of the JSEA. The appropriate regulatory agency will be notified if applicable.

*****SWA: Employees have the responsibility & obligation to stop any work that they consider compromising to health, safety, & the environment.*****

Name(Print): Adam Mills	Signature: [signature]	Date 7-9-13
Name(Print): Chris Fogle	Signature: [signature]	Date 7-9-13
Name(Print): Marc Yost	Signature: [signature]	Date 7-9-13
Name(Print): Ronald Bertucci	Signature: [signature]	Date 7-9-13
Name(Print):	Signature:	Date
Name(Print):	Signature:	Date
Name(Print):	Signature:	Date
Name(Print):	Signature:	Date
Name(Print):	Signature:	Date
Name(Print):	Signature:	Date

JOB SAFETY AND ENVIRONMENTAL ANALYSIS
GPS BASE SETUP

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDATIONS TO ELIMINATE OR REDUCE POTENTIAL HAZARDS
1. Fueling vehicle	a. Personal injury b. Fuel Spillage c. Fire/Explosion	a. Ensure that gasoline doesn't get on you by holding nozzle away from your body. If gasoline does get on you, immediately wash area of contact with soap and water, as well as remove saturated clothing. No smoking, turn off vehicle and cell phone. b. Personnel are required to man the hose when fueling the vehicle. Never top off fuel tank. c. Do not smoke near flammable or combustible materials, turn off vehicle, and turn off cell phone while fueling the vehicle.
2. Drive to /Arriving at Base Station Location	a. Driving hazards (wreck, fatigue) b. Parking Hazards	a. Leave with plenty of time to arrive at the station: 1. Practice defensive driving by using the Smith System techniques. 2. Buckle up 4. Do not talk on cell phones or other communication devices while driving. 3. Pull over or let others drive if tired b. If parking on the shoulder of a road is necessary: 1. Use orange cones and orange safety light to alert other vehicles of your location. 2. Try to avoid backing if possible
3. Setting up Base Station at Point	a. Unsafe Surroundings (insects, animals, traffic, topography, plants, water, etc.) b. Strain/Sprain c. Slip/Trip/ Fall	a. Scout location before you bring equipment to actual point from your vehicle: 1. Wear orange safety vest if station is near roadside. 2. Have cutting tool to eliminate problem with bushes and small trees. 3. Have hardhat and safety shoes if necessary for location of station. For example, an electric substation. 4. Be aware of poisonous insects or dangerous animals. b. Watch footing and take your time. c. Watch footing and take your time.
4. Tearing Down Base Station	See potential hazards for Unsafe Surroundings listed above.	Refer to Mitigation for Setting up Base Station above.
5. Leaving Base Station	a. Traffic Accidents b. Site clean-up	Make sure all equipment is picked up and securely placed in the rear of the vehicle: a.) Make sure road is clear before departing and practice defensive driving while returning to the office. b.) Remove any trash from the site. Replace dirt/grass plug at survey control station. Leave the site in good condition.

JOB SAFETY AND ENVIRONMENTAL ANALYSIS
SETUP REMOTE FIELD PROCESSING OFFICE

Document #	**FAMM-JSEA-002**	CLIENT:	GCMRC
Associated Forms		DATE WORK DONE:	July 9, 2013
PERSON DOING JOB:	Adam Mills	LOCATION OF ACTIVITY:	Page, AZ
JOB#	503513.00039.00		

Please Remember: All hazards are important. Make notice of all possible hazards. Detailed safe job procedures are necessary. Awareness, teamwork, communications, and alertness apply to every situation. Use complete recommendations to eliminate or reduce hazards. This JSEA is a compilation of potential physical and environmental hazards that should be expected on a similar work site. If actual work conditions or hazards require deviations from this JSEA the employee must take the appropriate safety measures and document any changes to the Sequence of basic job steps, potential accidents or hazards, and recommendations to eliminate or reduce potential hazards listed or not listed in this JSEA.

SAFETY EQUIPMENT REQUIRED TO DO THIS JOB:

☐	Hard Hats	☐	Fire Extinguisher	☐	Work Vest	☐	Dust Mask
☒	Safety Shoes	☐	Safety Glasses w/ Side Shields or Goggles	☐	Life Rings w/ 90' Floating Line	☐	Back Belts
☐	Hearing Protection	☐	Lockout/Tag out	☐	Tag Lines	☐	Face Shield
☒	Gloves	☐	Safety Harness	☐	Work Permit Required	☒	Traffic Cones

Comments: _____

Description of job specific hazards: _____

Note: All property damage, injury/illness, & environmental incidents are to be immediately reported to your supervisor and the HSE department. An incident report is to be completed and submitted along with a copy of the JSEA. The appropriate regulatory agency will be notified if applicable.

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Name(Print): Adam Mills	Signature: Adam Mills	Date 7-9-13
Name(Print): Chris Fasht	Signature: Chris Fasht	Date 7-9-13
Name(Print): Ronald Bernucci	Signature: R Bernucci	Date 7-9-13
Name(Print): Marc Yost	Signature:	Date 7-9-13
Name(Print):	Signature:	Date
Name(Print):	Signature:	Date
Name(Print):	Signature:	Date
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Name(Print):	Signature:	Date
Name(Print):	Signature:	Date

JOB SAFETY AND ENVIRONMENTAL ANALYSIS
SETUP REMOTE FIELD PROCESSING OFFICE

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDATIONS TO ELIMINATE OR REDUCE POTENTIAL HAZARDS
1. Fueling vehicle	a. Personal injury	a. Ensure that gasoline doesn't get on you by holding nozzle away from your body. If gasoline does get on you, immediately wash area of contact with soap and water, as well as remove saturated clothing. No smoking, turn off vehicle and cell phone.
	b. Fuel Spillage	b. Personnel are required to man the hose when fueling the vehicle. Never top off fuel tank.
	c. Fire/Explosion	c. Do not smoke near flammable or combustible materials, turn off vehicle, and turn off cell phone while fueling the vehicle.
2. Drive to /Arriving at Remote Processing Office Site	a. Driving hazards (wreck, fatigue)	a. Leave with plenty of time to arrive at the station: 1. Practice defensive driving by using the Smith System techniques. 2. Buckle up (use your seatbelts) 4. Do not talk on cell phones or other communication devices while driving. 3. Pull over or let others drive if tired
	b. Parking Hazards	b. If parking on the shoulder of a road is necessary: 1. Use orange cones and orange safety light to alert other vehicles of your location. 2. Try to avoid backing if possible
3. Unload Gear	a. Strains, sprains	a. Assess the weight before lifting. Use proper lifting techniques by keeping body erect and lifting with your legs. Get help if load is too heavy.
	b. Slips/Trips/Falls	b. Wear shoes with non-slip soles. Watch where you walk. Use elevator if ground rooms are not available.
4. Mobilize Office	a. Strain/Sprain –associated with lifting.	a. Assess the weight before lifting. Use proper lifting techniques by keeping body erect and lifting with your legs. Get help if load is too heavy.
	b. Slips/Trips/Falls	b. Wear appropriate safety shoes. Watch where you walk. Go slow. Tape down exposed electrical cords or route so a trip hazard does not exist.
	c. Pinch points	c. Watch hand placement when lowering heavy objects. Wear gloves. Use equipment handles when possible.
	d. Electrical hazards	d. Check electrical circuits for correct voltage. Insure all electronic devices are off when plugging and unplugging. Use multi-strip or surge protectors.
	e. Hazards associated with office/ hotel environment. (Fire/smoke, Assault, Theft)	e. Smoke is usually the killer in hotel fires. Locate emergency exits and have an escape plan (smoke rises so stay near the floor and make your way out). Test smoke alarm in hotel room and/or bring a smoke detector since the ones in the hotels aren't always dependable. Never flash money around, keep doors locked, look over your shoulder often and be wary of suspicious looking persons. Report suspicious persons to hotel personnel. Keep vehicle and hotel/office doors locked. Never leave valuables lying around. Park in an area near lighting (if possible) or where heavy pedestrian traffic is expected (near main entrance).
5. Demobilization	Repack equipment - load into vehicles.	Refer to hazards and mitigations measures listed above (steps 3-4)

JOB SAFETY AND ENVIRONMENTAL ANALYSIS
FLI-MAP 400 SYSTEM INSTALL

Document #	**FAMM-JSEA-005**	CLIENT:	GCMRC
Associated Forms		DATE WORK DONE:	July 9, 2013
PERSON DOING JOB:	C. Faught	LOCATION OF ACTIVITY:	Page, AZ
JOB#	503513.00039.00		

Please Remember: All hazards are important. Make notice of all possible hazards. Detailed safe job procedures are necessary. Awareness, teamwork, communications, and alertness apply to every situation. Use complete recommendations to eliminate or reduce hazards. This JSEA is a compilation of potential physical and environmental hazards that should be expected on a similar work site. If actual work conditions or hazards require deviations from this JSEA the employee must take the appropriate safety measures and document any changes to the Sequence of basic job steps, potential accidents or hazards, and recommendations to eliminate or reduce potential hazards listed or not listed in this JSEA.

SAFETY EQUIPMENT REQUIRED TO DO THIS JOB:

☐	Hard Hats	☐	Fire Extinguisher	☐	Work Vest	☐	Dust Mask
☒	Safety Shoes	☐	Safety Glasses w/ Side Shields or Goggles	☐	Life Rings w/ 90' Floating Line	☐	Back Belts
☒	Hearing Protection	☐	Lockout/Tag out	☐	Tag Lines	☐	Face Shield
☒	Gloves	☐	Safety Harness	☐	Work Permit Required	☐	Floor Mat

Comments:

Description of job specific hazards:

Note: All property damage, injury/illness, & environmental incidents are to be immediately reported to your supervisor and the HSE department. An incident report is to be completed and submitted along with a copy of the JSEA. The appropriate regulatory agency will be notified if applicable.

*****SWA: Employees have the responsibility & obligation to stop any work that they consider compromising to health, safety, & the environment.*****

Name(Print): Adam Mills	Signature:	Date 7-9-13
Name(Print): Chris Faught	Signature:	Date 7-9-13
Name(Print): Ronald Bertucci	Signature:	Date 7-9-13
Name(Print): Marc Yoe	Signature:	Date 7-9-13
Name(Print):	Signature:	Date
Name(Print):	Signature:	Date
Name(Print):	Signature:	Date
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Name(Print):	Signature:	Date
Name(Print):	Signature:	Date

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDATIONS TO ELIMINATE OR REDUCE POTENTIAL HAZARDS
1. Initial loading of equipment: • Position pod frame box at rear of van in upright vertical position. • With one person on both sides of container, tilt the unit forward and rest it on the floor end of van; the long end of container must be on the floor (ie: long side upward). • Both men lift the unit into the van, pushing it forward until it is flush with the barrier located behind the van seats. • Repeat the process with the boom container so that both are side-by-side and both are vertical. never stack one on top of the other! • Two men lift the computer console into the van from the rear; place on driver side, behind the pod box. • Two men from rear lift the laser box up atop the computer console box adjusting so they lock into place. • Two men lift the monitor box into the van from the rear; place adjacent to console box, put monitor box on its side. • One man, from the rear of the van, place the spare CPU's box next to the monitor box standing up right. • One man, from the rear of the van, place the spare cables box in front of the computer console box on its side. • Place 3 safety cones, GPS unit, helicopter system cover, RECON supplies, tool box, supplies, system laptop, and hard drive box in the rear of the van. • At the side of van, place the GPU (ground power unit) aside the boom container as far back as possible. • The Airborne Weather Probe case should be secured inside the van behind the driver seat for safe keeping. • Driver's personal gear may go atop the boom container, on side of it, or in the rear so that movement of anything is hampered.	a. Heavy lifting (strain/sprain) b. Hand Injuries (pinch points/sharp edges) c. Slips/Trips/Falls	a. Assess the weight before lifting. Use proper lifting techniques, by keeping body erect and lifting with your legs. Get help if load is too heavy. Insure system battery is strapped into pod before loading pod box into vehicle. b. Watch where you place your hands, wear gloves, and use handles on containers whenever possible. c. Wear appropriate safety shoes. Watch where you walk. Go slow.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDATIONS TO ELIMINATE OR REDUCE POTENTIAL HAZARDS
1. Fueling vehicle	a. Personal injury	a. Ensure that gasoline doesn't get on you by holding nozzle away from your body. If gasoline does get on you, immediately wash area of contact with soap and water, as well as remove saturated clothing. No smoking, turn off vehicle and cell phone.
	b. Fuel Spillage	b. Personnel are required to man the hose when fueling the vehicle. Never top off fuel tank.
	c. Fire/Explosion	c. Do not smoke near flammable or combustible materials, turn off vehicle, and turn off cell phone while fueling the vehicle.
2. Drive to /Arriving at work site	a. Driving hazards (wreck, fatigue)	a. Leave with plenty of time to arrive at the station: 1. Practice defensive driving by using the Smith System techniques. 2. Buckle up 4. Do not talk on cell phones or other communication devices while driving. 3. Pull over or let others drive if tired
	b. Parking Hazards	b. If parking on the shoulder of a road is necessary: 1. Use orange cones and orange safety light to alert other vehicles of your location. 2. Try to avoid backing if possible **Note: Always acquire permission to enter airfield with personal and equipment**
3. Unloading equipment This task is essentially the reverse of loading but particular attention must be given to unloading the two large containers. From the rear of the van, off load all equipment, save the two containers having the booms and the pod. First slide the boom container to the rear and support it once the end passes the rear of the van (one person per side). When the end of the container can be lowered to the ground without catching on the top of the van, do so (use a piece of carpet on the deck if inside a hanger). Now lift the end of the container which is resting on the floor of the van upright. Lower the container from the top end to the deck where it now can be moved by more than two men. Repeat the procedure with the pod container, realizing that this unit weighs 375 pounds.	a. Heavy lifting (strain/sprain)	a. Assess the weight before lifting. Use proper lifting techniques by keeping body erect and lifting with your legs. Get help if load is too heavy.
	b. Hand Injuries (pinch points/sharp edges)	b. Watch where you place your hands, wear gloves, and use handles on containers whenever possible.
	c. Slips/Trips/Falls	c. Wear appropriate safety shoes. Watch where you walk. Go slow.
	d. Aircraft traffic, Noise	d. Heed warnings, signs, instructions from supervisors, airport personnel, etc. Travel only in designated areas, watch for traffic, and drive slowly. **When possible, hanger space is preferable for installation.** When applicable, hearing protection shall be worn.

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDATIONS TO ELIMINATE OR REDUCE POTENTIAL HAZARDS
4. Mobilizing: Install system on aircraft	a. Heavy lifting (strain/sprain) b. Hand Injuries (pinch points/sharp edges) c. Slips/Trips/Falls d. Aircraft traffic, Noise	a. Assess the weight before lifting. Use proper lifting techniques by keeping body erect and lifting with your legs. Get help if load is too heavy. b. Watch where you place your hands, wear gloves, and use handles on containers whenever possible. c. Wear appropriate safety shoes. Watch where you walk. Go slow. d. Heed warnings, signs, instructions from supervisors, airport personnel, etc. Travel only in designated areas, watch for traffic, and drive slowly. **When possible, hanger space is preferable for installation.** When applicable, hearing protection shall be worn.
5. Test system (Ground test with external power unit & Flight test)	Electrical fire / Aircraft fire	Discuss power hookups with pilot and airport crews. Check outlet with tester to ensure proper voltage. Ensure all circuit breakers and switches are in proper position. Ensure personal on scene are aware of fire extinguisher location on board aircraft and/or hanger ramp area. Ensure good communication.
6. Perform essential job functions	Hazards associated with airborne operations	Adhere to all safety and emergency procedures as set forth by aircraft personal (pilot). Participate in lookout procedures, showing caution to other aircraft, towers, and/or any and all obstructions in work area.
7. Demobilization: Remove equipment from aircraft	Refer to mobilizing hazards: Typical hazards tend to be the same for demobilization procedures.	Refer to procedures for mobilization Take your time and pay attention to detail. Ensure good communication.

JOB SAFETY AND ENVIRONMENTAL ANALYSIS
HELICOPTER SAFETY BRIEFING

Document #	**FAMM-JSEA-007**	CLIENT:	GCMRC
Associated Forms		DATE WORK DONE:	July 2013
PERSON DOING JOB:	Ken Carroll	LOCATION OF ACTIVITY:	Page, AZ
JOB#	503513.00039.00		

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SAFETY EQUIPMENT REQUIRED TO DO THIS JOB:

☐	Hard Hats	☒	Fire Extinguisher	☐	Work Vest	☒	Life Vest (When Required)
☐	Safety Shoes	☐	Safety Glasses w/ Side Shields or Goggles	☐	Life Rings w/ 90' Floating Line	☒	Sun Glasses (If necessary)
☒	Hearing Protection	☐	Lockout/Tag out	☐	Dust Mask	☒	Sun Screen (If necessary)
☐	Gloves	☐	Safety Harness	☐	Back Belts	☒	Head Cover (If necessary)

Comments:

Description of job specific hazards:

Note: All property damage, injury/illness & environmental incidents are to be immediately reported to your supervisor and the HSE department. An incident report is to be completed and submitted along with a copy of the JSEA. The appropriate regulatory agency will be notified if applicable.

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Name(Print): Chris Faught	Company: FAMM	Signature:	Date 7-9-13
Name(Print): Ronald Bertucci	Company: FAMM	Signature:	Date 7-9-13
Name(Print): Marc Yost	Company: FAMM	Signature:	Date 7/9/13
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JOB SAFETY AND ENVIRONMENTAL ANALYSIS
HELICOPTER SAFETY BRIEFING

SEQUENCE OF BASIC JOB STEPS	POTENTIAL ACCIDENTS OR HAZARDS	RECOMMENDATIONS TO ELIMINATE OR REDUCE POTENTIAL HAZARDS
1. Entering the airfield.	a. Moving and running aircraft	a. Get proper permission and/or escort from airport personnel.
2. Approaching the aircraft.	a. Blades flex during start and stop	a. Acquire pilot eye-contact and permission before entering rotor disk area. Never approach helicopter without pilot permission.
	b. Flying debris / Damage to blades	b. Secure loose items (i.e., hats, clothing, work materials). Long items to be carried horizontally.
	c. Helicopter tail rotor	c. Always approach aircraft from the nose only.
	d. Tail rotor is nearly invisible while engine is running	d. Never go past the rear door or booms (when installed), with the engine running.
	e. Damage to hearing	e. Wear ear plugs when approaching running helicopter. Don headset upon entry.
3. Proper way to board and exit the aircraft.	Slips/Trips/Falls	Use three points of contact when boarding and exiting the aircraft.
4. Proper use of doors, windows, and seatbelt.	a. Door opening during flight	a. Close door firmly and push latch into the down position.
	b. Hand Injuries (opening/closing window)	b. Open/close sliding window slowly to prevent pinching and contact with sharp edges.
	c. Falling or being thrown from the aircraft	c. Familiarize yourself with proper seatbelt useage before takeoff. Wear 3 point harness seatbelt properly.
5. Onboard intercom system	Speaking over the intercom (Distracting Pilot / interfering with external communications)	Don't talk while the pilot is comunicating with air traffic tower or other aircraft in the area.
6. During Flight	Antennae, wires, birds, other aircraft (especially in congested airspace), etc…	Call out anything that could potentially cause problems. Speak clearly and define location.
7. Sunny Days	Sunburn/Sun exposure through helicopter bubble	Wear sun screen, head cover and sun glasses (if necessary).
8. Emergency Landing/Hard Landing	a. Flying debris	a. Stay in the aircraft until the blades stop turning.
	b. Uneven ground	b. Never approach the aircraft from high ground or exit the aircraft towards high ground (the blades are closer to the ground).
	c. Flying over water (only if it's necessary)	c. Wear life vest properly. Inflate only when out of the hull!
	d. Fire	d. There is a fire extinguisher between the pilot and copilot seats (only used if someone is trapped in the aircraft).
	e. Trapped in aircraft	e. Familiarize yourself with available emergency egress routes.