Fugro USA Land, Inc.
CPRA Lidar 2019
Ground Control and Checkpoints
Area of Interest 4
Survey Completed on:
April 17, 2019

Submitted to:
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Submitted by:
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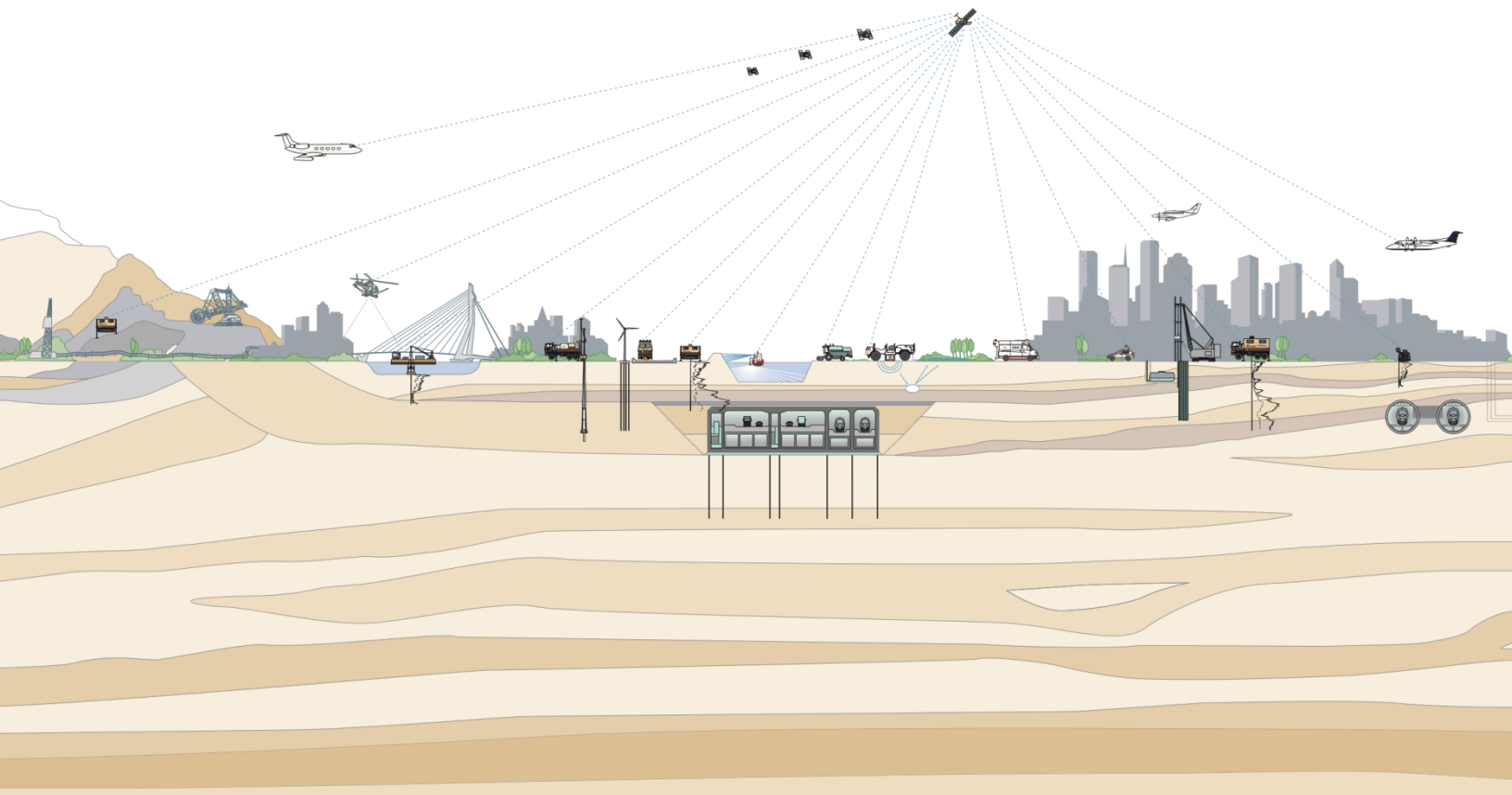
FUGRO Job No. 04.33780163



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1 COMPANY INFORMATION

Fugro is an internationally-acclaimed consulting firm that specializes in the provision of technical data and information required to design, construct, and maintain large structures and infrastructure in a safe, reliable, and efficient manner. We have been at the forefront of providing geospatial knowledge for over 50 years. Our complete geospatial approach assists our clients through the entire life span of a project: We begin with feasibility and continue through to post-construction and maintenance. Our comprehensive, integrated survey services have been used by a diverse set of industries including oil and gas, rail, electric utility, and government agencies. Access to Fugro's global resources allows us to deliver optimal solutions for projects of every scale.

Fugro is a global company with approximately 10,500 employees in 60 countries, including an active office in Lafayette, Louisiana. Fugro USA Land, Inc. is a wholly-owned subsidiary of Fugro NV, a Dutch corporation whose shares are publicly traded on the Amsterdam Mid-Cap Exchange. Throughout the world the multiple Fugro offices work as One Fugro to provide the most experience and best possible solutions for our clients. Fugro holds a strong market position due to in-house developed technologies, high value services, and a strong international and regional presence. Our highly-qualified specialists work with modern technologies and systems at locations all over the world.

John Chance Land Surveys, Inc. was established in 1957 under the name "John E. Chance & Associates" and joined the Fugro Family of Companies in 1992. Our mission is to serve as a purveyor of geospatial knowledge and to provide customized geospatial solutions designed to accurately measure and characterize the earth for customer projects. We have continuously provided survey services within the Gulf Coast region for 60 years.

Fugro provides registered, licensed Professional Land Surveyors in Louisiana, Alabama and Texas. We provide an ecological and regulatory services group able to conduct wetland delineations, oyster assessments, threatened and endangered species surveys, and other ecological studies. In addition, this group is able to obtain necessary federal, state, and local permits. Fugro also offers hydrographic survey services for underwater projects such as oyster assessments, bathymetric hazard surveys, and coastal restoration projects. Furthermore, we provide high-precision FLI-MAP aerial LiDAR technology for linear projects such as rail, pipeline, and transmission line route surveys. As needed, 3D laser scanning services are also available.

2 PROJECT OVERVIEW

2.1 Project Purpose

Fugro USA Land, Inc. of Lafayette, LA was tasked by Fugro USA Land, Inc. of Fredrick, MD to perform a ground control and checkpoint survey in support of LiDAR data collection of the for the CPRA LiDAR 2019 project. All data and information was conducted under the supervision of a Louisiana RPLS.

A total of 10 ground control points and 17 checkpoints were collected over the course of 3 days.

2.2 Project Location

Area of Interest 4

3 SURVEY METHODOLOGY

3.1 Global Positioning System

Global Positioning System (GPS) was used in Static Differential mode and 20+minute fast static sessions were collected for the required ground control and checkpoints. Post Processing Kinematics (PPK) was used to process the precise positions of the required control and checkpoints by adjusting to the nearest Continuously Operating Reference Stations (CORS) using a single baseline adjustment. OPUS was used as an independent verification to ensure that that the transformation from WGS84 to NAD83(2011) is correct.

3.2 Trimble Business Center

Trimble Business Center (TBC) was used to process the baseline adjustment from the collected points to the CORS.

TBC's provided results are reported at 95% confidence horizontally and vertically.

3.3 Survey Control Coordinate Systems

Horizontal Datum	Vertical Datum	Geoid Model	Projection	Units
Geographic NAD83(2011)	Ellipsoidal	N/A	N/A	DD.DDDD
NAD83(2011)	NAVD88	Geiod12b	Universal Transverse Mercator (Zone 15 North)	Meters

3.4 Results - Adjusted Lidar Ground Control Points coordinates

3.4.1 NAD83(2011) Geographic Coordinates (DD.dddd)

Point ID	Latitude	Longitude	Ellipsoid Height (Meter)	Description
1000	29.9314135	-91.54946982	-22.610	AOI-4-GCP1
1025	29.92620921	-91.24085775	-25.061	AOI-4-GCP2
1020	29.78418332	-91.17481252	-23.837	AOI-4-GCP3
1005	29.78767357	-91.40896966	-23.648	AOI-4-GCP4
1010	29.63614386	-91.52671473	-24.013	AOI-4-GCP5
1017	29.63108699	-91.19348303	-22.322	AOI-4-GCP6
1013	29.69939106	-91.311684	-24.673	AOI-4-GCP7
1016	29.70102267	-91.22357267	-24.848	AOI-4-GCP8
1021	29.87785847	-91.20843011	-24.436	AOI-4-GCP9
1003	29.88328524	-91.48502158	-18.287	AOI-4-GCP10

3.4.2 NAD83(2011) Universal Transverse Mercator (Zone 15 North) (Meter)

Point ID	Northing	Easting	Elevation (NAVD88)	Description
1000	3312069.837	640003.946	3.758	AOI-4-GCP1
1025	3311909.497	669804.079	1.158	AOI-4-GCP2
1020	3296267.698	676429.985	1.909	AOI-4-GCP3
1005	3296319.172	653786.888	2.174	AOI-4-GCP4
1010	3279375.092	642618.541	1.417	AOI-4-GCP5
1017	3279271.387	674890.129	3.036	AOI-4-GCP6
1013	3286668.707	663334.815	0.861	AOI-4-GCP7
1016	3286977.294	671857.665	0.682	AOI-4-GCP8
1021	3306599.006	673018.284	1.616	AOI-4-GCP9
1003	3306816.318	646295.489	7.886	AOI-4-GCP10

3.5 Results - Adjusted Lidar Checkpoints coordinates

3.5.1 NAD83(2011) Geographic Coordinates (DD.dddd)

Point ID	Latitude	Longitude	Ellipsoid Height (Meter)	Description
1001	29.92265309	-91.54522142	-24.938	AOI-4-NVA-1
1026	29.94671464	-91.25559125	-18.096	AOI-4-NVA-2
1023	29.89557867	-91.20307833	-24.600	AOI-4-NVA-3
1004	29.87967068	-91.4521992	-22.378	AOI-4-NVA-4
1006	29.77531109	-91.40646635	-24.343	AOI-4-NVA-5
1012	29.69178586	-91.3057249	-24.489	AOI-4-NVA-6
1015	29.6970451	-91.22287591	-25.535	AOI-4-NVA-7
1014	29.66218818	-91.24335764	-24.418	AOI-4-NVA-8
1018	29.76105282	-91.1735721	-24.768	AOI-4--NVA-9
1008	29.67709456	-91.45850605	-21.795	AOI-4-NVA-10
1024	29.91740586	-91.22875278	-24.790	AOI-4-VVA-FOR-11
1009	29.67768554	-91.47413844	-23.741	AOI-4-VVA-FOR-12
1002	29.90130979	-91.51913732	-24.486	AOI-4-VVA-NONFOR-13
1022	29.90733589	-91.21702243	-21.656	AOI-4-VVA-NONFOR-14
1019	29.76506444	-91.1745543	-24.628	AOI-4-VVA-NONFOR-15
1011	29.68823359	-91.30726474	-23.316	AOI-4-VVA-NONFOR-16
1007	29.70137963	-91.37936806	-23.265	AOI-4-VVA-NONFOR-17

3.5.2 NAD83(2011) Universal Transverse Mercator (Zone 15 North) (Meter)

Point ID	Northing	Easting	Elevation (NAVD88)	Description
1001	3311104.154	640426.343	1.398	AOI-4-NVA-1
1026	3314160.472	668347.140	8.192	AOI-4-NVA-2
1023	3308571.07	673504.508	1.510	AOI-4-NVA-3
1004	3306457.951	649470.797	3.766	AOI-4-NVA-4
1006	3294952.425	654047.817	1.438	AOI-4-NVA-5
1012	3285834.275	663923.761	1.023	AOI-4-NVA-6
1015	3286537.496	671931.859	-0.016	AOI-4-NVA-7
1014	3282644.034	670008.653	1.016	AOI-4-NVA-8
1018	3293705.974	676590.504	0.911	AOI-4--NVA-9
1008	3283999.300	649161.724	3.708	AOI-4-NVA-10

1024	3310951.758	670987.769	1.398	AOI-4-VVA-FOR-11
1009	3284044.739	647648.017	1.769	AOI-4-VVA-FOR-12
1002	3308770.962	642974.955	1.766	AOI-4-VVA-NONFOR-13
1022	3309853.191	672137.671	4.495	AOI-4-VVA-NONFOR-14
1019	3294149.089	676488.488	1.063	AOI-4-VVA-NONFOR-15
1011	3285438.403	663780.520	2.187	AOI-4-VVA-NONFOR-16
1007	3286795.373	656782.770	2.281	AOI-4-VVA-NONFOR-17

3.6 Ground Control Points Photographs

3.6.1 AOI-4 Ground Control Point 001

AOI-4 GCP 001 Gravel road

AOI-4 GCP 001 Gravel road

3.6.2 AOI-4 Ground Control Point 002

AOI-4 GCP 002 Gravel road

AOI-4 GCP 002 Gravel road

3.6.3 AOI-4 Ground Control Point 003

AOI-4 GCP 003 Asphalt road

AOI-4 GCP 003 Asphalt road

3.6.4 AOI-4 Ground Control Point 004

AOI-4 GCP 004 Gravel road

AOI-4 GCP 004 Gravel road

3.6.5 AOI-4 Ground Control Point 005

AOI-4 GCP 005 Gravel road

AOI-4 GCP 005 Gravel road

3.6.6 AOI-4 Ground Control Point 006

AOI-4 GCP 006 Short Grass/Gravel

AOI-4 GCP 006 Short Grass/Gravel

3.6.7 AOI-4 Ground Control Point 007

AOI-4 GCP 007 Asphalt road

AOI-4 GCP 007 Asphalt road

3.6.8 AOI-4 Ground Control Point 008

AOI-4 GCP 008 Asphalt road

AOI-4 GCP 008 Asphalt road

3.6.9 AOI-4 Ground Control Point 009

AOI-4 GCP 009 Gravel road

AOI-4 GCP 009 Gravel road

3.6.10 AOI-4 Ground Control Point 010

AOI-4 GCP 010 Gravel road

AOI-4 GCP 010 Gravel road

3.7 Checkpoints Photographs

3.7.1 AOI-4 NVA 001

AOI-4 NVA 001 Gravel road

AOI-4 NVA 001 Gravel road

3.7.2 AOI-4 NVA 002

AOI-4 NVA 002 Gravel road

AOI-4 NVA 002 Gravel road

3.7.3 AOI-4 NVA 003

AOI-4 NVA 003 Asphalt road

AOI-4 NVA 003 Asphalt road

3.7.4 AOI-4 NVA 004

AOI-4 NVA 004 Gravel road

AOI-4 NVA 004 Gravel road

3.7.5 AOI-4 NVA 005

AOI-4 NVA 005 Gravel Surface

AOI-4 NVA 005 Gravel Surface

3.7.6 AOI-4 NVA 006

AOI-4 NVA 006 Concrete road

AOI-4 NVA 006 Concrete road

3.7.7 AOI-4 NVA 007

AOI-4 NVA 007 Concrete road

AOI-4 NVA 007 Concrete road

3.7.8 AOI-4 NVA 008

AOI-4 NVA 008 Gravel road

AOI-4 NVA 008 Gravel road

3.7.9 AOI-4 NVA 009

AOI-4 NVA 009 Concrete road

AOI-4 NVA 009 Concrete road

3.7.10 AOI-4 NVA 010

AOI-4 NVA 010 Gravel road

AOI-4 NVA 010 Gravel road

3.7.11 AOI-4 VVA-FOR 011

AOI-4 VVA-FOR 011 Grass with tree line in vicinity

AOI-4 VVA-FOR 011 Grass with tree line in vicinity

3.7.12 AOI-4 VVA-FOR 012

AOI-4 VVA-FOR 012 Grass with tree line in vicinity

AOI-4 VVA-FOR 012 Grass with tree line in vicinity

3.7.13 AOI-4 VVA-NONFOR 013

AOI-4 VVA-NONFOR 013 Short Grass

AOI-4 VVA-NONFOR 013 Short Grass

3.7.14 AOI-4 VVA-NONFOR 014

AOI-4 VVA-NONFOR 014 Short Grass

AOI-4 VVA-NONFOR 014 Short Grass

3.7.15 AOI-4 VVA-NONFOR 015

AOI-4 VVA-NONFOR 015 Short grass

AOI-4 VVA-NONFOR 015 Short grass

3.7.16 AOI-4 VVA-NONFOR 016

AOI-4 VVA-NONFOR 016 Short grass

AOI-4 VVA-NONFOR 016 Short grass

3.7.17 AOI-4 VVA-NONFOR 017

AOI-4 VVA-NONFOR 017 Short Grass

AOI-4 VVA-NONFOR 017 Short Grass

3.8 Baseline Processing Report (CORS data) (meter) (95%)

Baseline Processing Report

Processing Summary

Observation	From	To	Solution Type	H. Prec. (Meter)	V. Prec. (Meter)	Geodetic Az.	Ellipsoid Dist. (Meter)	ΔHeight (Meter)
FSHS --- 1000 (B8)	FSHS	1000	Fixed	0.009	0.016	341°55'58"	14704.987	-8.106
FSHS --- 1001 (B7)	FSHS	1001	Fixed	0.009	0.017	342°18'13"	13654.798	-10.433
FSHS --- 1002 (B6)	FSHS	1002	Fixed	0.009	0.018	351°16'47"	10766.543	-9.981
FSHS --- 1003 (B5)	FSHS	1003	Fixed	0.010	0.015	10°53'22"	8802.564	-3.782
FSHS --- 1004 (B4)	FSHS	1004	Fixed	0.010	0.017	30°23'01"	9556.857	-7.873
FSHS --- 1005 (B3)	FSHS	1005	Fixed	0.009	0.017	102°12'25"	9226.678	-9.143
FSHS --- 1006 (B2)	FSHS	1006	Fixed	0.010	0.017	109°43'41"	9838.721	-9.838
FSHS --- 1007 (B1)	FSHS	1007	Fixed	0.010	0.019	134°04'41"	16551.435	-8.760
FSHS --- 1010 (B35)	FSHS	1010	Fixed	0.010	0.024	187°12'17"	18900.273	-9.508
MCHS --- 1021 (B9)	MCHS	1021	Fixed	0.008	0.015	358°40'27"	17811.525	-9.703
MCHS --- 1020 (B10)	MCHS	1020	Fixed	0.008	0.015	20°55'23"	7947.291	-9.104
MCHS --- 1019 (B11)	MCHS	1019	Fixed	0.007	0.011	28°21'52"	6027.617	-9.895
MCHS --- 1018 (B12)	MCHS	1018	Fixed	0.007	0.011	31°20'10"	5689.179	-10.035
MCHS --- 1017 (B13)	MCHS	1017	Fixed	0.007	0.015	173°49'01"	9603.271	-7.589
MCHS --- 1016 (B14)	MCHS	1016	Fixed	0.006	0.012	226°17'48"	2598.185	-10.115
MCHS --- 1015 (B15)	MCHS	1015	Fixed	0.006	0.015	219°00'12"	2877.410	-10.802
MCHS --- 1014 (B16)	MCHS	1014	Fixed	0.008	0.014	211°53'09"	7183.302	-9.685

3.9 Online positioning user service (OPUS) results

Accuracy

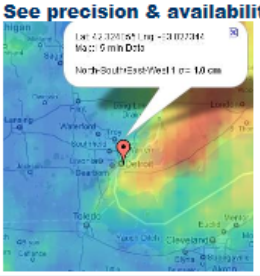
How accurate is it?

Under normal conditions, most positions can be resolved to within a few centimeters. Estimating the accuracy for a specific solution is difficult, however, as formal error propagation is notoriously optimistic for GPS reductions. Systematic errors, such as misidentification of antenna or height, are not detected. Local multipath or adverse atmospheric conditions may also negatively impact your solution.

Static: Static processing provides "peak-to-peak" errors for each coordinate (X, Y, Z, Φ, λ, h, and H). These describe the error range, the disagreement between the 3 baseline solutions, as shown above.

One advantage of peak-to-peak errors is that they include any error from the CORS reference coordinates.

See precision & availability



Rapid static: Absent any warning messages, the best estimates of coordinate accuracy are the standard deviations reported by single baseline analysis. Our experiments indicate that the actual error is less than these estimated accuracies more than 95 percent of the time.

Source: https://www.ngs.noaa.gov/OPUS/about.jsp

3.9.1 Opus results for point number 1003 compared to results provided from single point baseline processing

Grid azimuth:	199°16'59"
Grid distance:	0.013 m
Δ Elevation:	-0.022 m
Geodetic azimuth:	200°02'17"
Forward:	200°02'17"
Backward:	20°02'17"
Ellipsoid distance:	0.013 m
Ground distance	
Geodetic:	0.013 m
Δ Height:	-0.022 m

1003	3306816.318	646295.489	7.88606	AOI-4-GCP10

FILE: 27721053.19o OP1555942696246

NGS OPUS-RS SOLUTION REPORT
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All computed coordinate accuracies are listed as 1-sigma RMS values.
For additional information: https://www.ngs.noaa.gov/OPUS/about.jsp#accuracy

USER: lcastille@fugro.com DATE: April 22, 2019
RINEX FILE: 2772105t.19o TIME: 14:20:40 UTC

SOFTWARE: rsgps 1.38 RS53.prl 1.99.3 START: 2019/04/15 19:16:15
EPHEMERIS: igr20491.eph [rapid] STOP: 2019/04/15 19:36:27
NAV FILE: brdc1050.19n OBS USED: 2232 / 2520 : 89%
ANT NAME: TRMR8_GNSS3 NONE QUALITY IND. 22.61/ 6.34
ARP HEIGHT: 2.000 NORMALIZED RMS: 0.308

REF FRAME: NAD_83(2011)(EPOCH:2010.0000) IGS08 (EPOCH:2019.28715)

X:	-143435.112(m)	0.005(m)	-143435.941(m)	0.005(m)
Y:	-5532839.439(m)	0.029(m)	-5532837.949(m)	0.029(m)
Z:	3159153.384(m)	0.018(m)	3159153.194(m)	0.018(m)
LAT:	29 52 59.82647	0.007(m)	29 52 59.84486	0.007(m)
E LON:	268 30 53.92213	0.006(m)	268 30 53.88984	0.006(m)
W LON:	91 29 6.07787	0.006(m)	91 29 6.11016	0.006(m)
EL HGT:	-18.308(m)	0.033(m)	-19.675(m)	0.033(m)
ORTHO HGT:	7.865(m)	0.035(m)	[NAVD88 (Computed using GEOID12B)]	

	UTM COORDINATES (UTM (Zone 15))	STATE PLANE COORDINATES (SPC (1702 LA S))
Northing (Y) [meters]	3306816.305	153339.048
Easting (X) [meters]	646295.485	985348.126
Convergence [degrees]	0.75495000	-0.07584722
Point Scale	0.99986406	0.99992784
Combined Factor	0.99986693	0.99993072

US NATIONAL GRID DESIGNATOR: 15RXP4629506816(NAD 83)

4 QUALITY ASSURANCE

Fugro has a totally integrated Quality Assurance System that is documented, implemented, and under the control of a Quality Manager. Certification and compliance of this system to the ISO standards listed below verifies our commitment to meet customer needs by providing the proper policies, procedures, and resources. The Quality Assurance System is used to provide job control and promote optimal client communication during all stages of a project – from the initial proposal to final invoicing. Implementation of our Quality Assurance System assures compliance with all applicable regulatory and ecological requirements. For data management, the Fugro Quality System provides checks to validate and confirm that all survey data and processed data are interpreted and stored as required. The effectiveness of these business and operational processes are monitored, measured and analyzed as part of our compulsory quarterly Management Review of the Quality Assurance System which includes surveillance audits and certification renewal audits.

Fugro has qualified for and applied the following standards to our business and operational activities:

Quality Management System:
ISO 9001:2008
Certificate NO. UQA 4000406/AB
Approved by: Lloyd's Register Quality Assurance
Provision of Advanced Surveying, Mapping, Regulatory and Ecological Services for Land Applications and Airborne LIDAR data Collection and Interpretation

Environmental Management System:
ISO 14001:2004
Certificate NO. UQA 4000406/CB
Approved by: Lloyd's Register Quality Assurance
Provision of Advanced Surveying, Mapping, Regulatory and Ecological Services for Land Applications and Airborne LIDAR data Collection and Interpretation

Occupational Health & Safety Management System:
OHSAS 18001:2007
Certificate NO. UQA 4000406/BB
Approved by: Lloyd's Register Quality Assurance
Provision of Advanced Surveying, Mapping, Regulatory and Ecological Services for Land Applications and Airborne LIDAR data Collection and Interpretation

If desired, Fugro can develop and implement a specific project Quality Assurance/Quality Control (QA/QC) plan for this project. Fugro ensures that all surveys and associated documentation will be accurate and will comply with accepted Industry Standards.

5 SAFETY

Fugro has developed and implemented an Occupational Health & Safety (OH&S) and Environmental Management System (EMS) to satisfy the needs of our customers, employees, shareholders, and community. We continually strive to improve our employee and company performance in the areas of health, safety, and protection of the environment. Fugro assures that ALL required safety equipment and gear including personal protective equipment (PPE) were utilized on this project.

Fugro also strives to prevent wasteful and inefficient operations, avoid damage to property and equipment, show respect for the environment, and, foremost, to protect the safety and well-being of all employees. Fugro employees received all safety training as specified in the contract.

The schedule of safety meetings and drills executed for this project included but were not limited to:

- Pre-job safety meetings;
- Pre-job vessel health, safety, and environmental orientation including man overboard, fire, and abandon ship drills;
- Daily tailgate safety meetings prior to each day's operations;
- When a new procedure or piece of equipment is introduced, including a written Job Safety Analysis; and
- Document a Near Miss accident or Injury.

Fugro ensures compliance with all applicable rules, regulations, orders, standards and interpretations promulgated under the Occupational Safety and Health Act (1997) and all other applicable laws, ordinances, rules, regulations and orders of anybody having jurisdiction over safety and health of persons or property or the protection of same to protect them from injury, illness, damage or loss. The Fugro Survey Project Manager or his designee conducted and documented a daily safety meeting at the beginning of each work day. A copy of the daily safety meeting minutes will be furnished upon request.

Fugro ensures that Personal Protective Equipment (PPE) will be utilized and maintained in accordance with the written PPE program. Training in the proper use, maintenance and inspection of PPE is provided to all Fugro employees prior to beginning work. Fugro will supply all required PPE required at the work site. Unless otherwise specified, the minimum PPE includes:

- Hard hats
- Safety glasses with side shields or side impact protection as necessary
- Safety toe shoes/boots (steel/composite toe or approved toe caps)
- Protective clothing with high visibility vest
- Task appropriate gloves

6 CONTACT INFORMATION

By use of these specific contact points, Fugro ensures quality control and prompt action with respect to all project-related issues.

Morgan Reed: For all corporate, legal, and contractual issues

David Cormier, PLS: For all operational QA/QC issues from mobilization through final product delivery and for final project responsibility

CONTACT INFORMATION			
	Fugro USA Land, Inc. 226 Dulles Drive Lafayette, LA 70506		
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This geodetic survey was conducted under my direct supervision.

David L. Cormier
Professional Land Surveyor
Louisiana Registration No. 4715
License VF.0000794