NOAA FORM 76-35A

U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL OCEAN SERVICE

DESCRIPTIVE REPORT

Type of Survey Hydrographic Lidar
Project No. OPR-I169-KRL-10
Registry No. H12271

LOCALITY

State U.S. Virgin Islands
General Locality U.S. Virgin Islands
Sub-Locality Brass Channel

2011

HYDROGRAPHER MARK SINCLAIR
CHIEF OF PARTY SCOTT RAMSAY

LIBRARY & ARCHIVES

DATE

NOAA FORM 77-28 (11-72) U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

REGISTRY No. H12271

HYDROGRAPHIC TITLE SHEET

State U.S. Virgin Islands

General Locality U.S. Virgin Islands

Sub-Locality Brass Channel

Scale 1:10,000 **Date of Survey** January 29 to February 28, 2011

Instructions dated October 2010 **Project No.** OPR-I169-KRL-10

Vessel Fugro LADS Aircraft, call sign VH-EWP

Hydrographer M.J. Sinclair **Chief of Party** S.R. Ramsay

Surveyed by R.J. Bertucci, M.H. Blackbourn, J.G. Guilford, M.S. Hawkins, N.J. Stricklin, B.A. Weidman

Soundings by Laser Airborne Depth Sounder

Graphic record scaled by B.A. Weidman

Graphic record checked by S.R. Ramsay, J.G. Guilford **Automated Plot** N/A

Verification by

Soundings in Meters at MLLW

REMARKS

Requisition / Purchase Req. # NCNJ3000-10-18924

Contractor Fugro LADS, Inc., 2113 Government St., Suite I, Ocean Springs, MS 39564

Sub-Contractor JOA Surveys, LLC, 12001 Audubon Dr., Anchorage, AK 99516

Times All times are recorded in UTC.

Datum and Projection NAD83, UTM (N) Zone 20

Purpose The purpose of this survey is to provide NOAA with modern, accurate hydrographic survey data with which to update the nautical charts of the assigned area.

Acronyms A complete list of all acronyms used throughout this report is provided at Appendix I of the Separates Report. ***The purpose of this survey is to provide contemporary surveys to update National Ocean Service (NOS) nautical charts. All separates are filed with the hydrographic data. Revisions and Rednotes were generated during office processing. The processing branch concurs with all information and recommendations in the DR unless otherwise noted. Page numbering may be interrupted or non-sequential. All pertinent records for this survey, including the Descriptive Report, are archived at the National Geophysical Data Center (NGDC) and can be retrieved via http://www.ngdc.noaa.gov/.***

TABLE OF CONTENTS

DESCRIPTIVE REPORT TO ACCOMPANY

HYDROGRAPHIC SURVEY H12271

SCALE 1:10,000, SURVEYED IN 2011

FUGRO LADS AIRCRAFT, VH-EWP

FUGRO LADS, INC. (FLI)

MARK SINCLAIR, HYDROGRAPHER

PROJECT

Project Number: OPR-I169-KRL-10
Original: DG133C10CQ0060
Date of Instructions: October 2010
Task Order: T001

Registry Number: H12271
Sheet: 1

A. AREA SURVEYED

Survey operations covered three registered sheets over the OPR-I169-KRL-10 project area, U.S. Virgin Islands (see Figure 1 and Figure 2).

A total of 2264 lineal nautical miles were illuminated in the process of flying 197 main scheme survey lines. An additional 590 lineal nautical miles were illuminated flying 71 reflies and 216 lineal nautical miles flying 32 crosslines / investigations. The total seabed area surveyed across the project area, from the Mean High Water (MHW) line to lidar extinction depth, was 58 square nautical miles (see Appendix III for further information).

The Fugro LADS aircraft was based in Fort De France, Martinique throughout January and for the first three days of February, 2011 conducting operations for the SHOM. However, due to adverse weather and water clarity conditions around the island of Martinique, the USVI project area for NOAA was utilized as an alternate area to the French survey. The official mobilization date for OPR-I169-KRL-10 was January 28, 2011, being the day prior to the first survey flight to the USVI.

Survey operations commenced on January 29, 2011 with a reconnaissance / shakedown flight from Martinique to the USVI. The aircraft transited to the main base of operations for the NOAA USVI project, San Juan, Puerto Rico, on February 4. Demobilization of the San Juan base was completed on February 17 and the aircraft departed for Guadeloupe on February 18, in order to commence the next LADS project, also for the SHOM. The final flight to the USVI was conducted from the Guadeloupe base on February 28, 2011.

Survey operations in the USVI during January / February were comprised of 5 flights from Martinique, 7 flights from the main base of operations in San Juan and a final mop-up flight

from Guadeloupe on the last day of February. The flights from Martinique were effective, despite the long transit to the USVI (~3 hours total). Five of the seven flights to the USVI from San Juan were considered fully effective, with technical issues experienced during the other two sorties. The final flight from Guadeloupe was only partially effective, with deteriorated water clarity, high winds and considerable air traffic to negotiate.

The USVI project area was flown on 13 separate occasions during the months of January and February 2011, of which 10.7 sorties were deemed fully effective, due to the increased transit times from Martinique and Guadeloupe and some technical issues.

The specific dates of data acquisition, base of operations, flight time and time on task for the U.S. Virgin Islands project were as follows:

Date	Flight Number	GS Sortie Number	Base of Operations	Flight Time	Time on Task
29-Jan-11	1	8	Martinique	6:27	2:55
30-Jan-11	2	9	Martinique	4:48	3:04
1-Feb-11	3	10	Martinique	6:25	3:00
2-Feb-11	4	11	Martinique	5:19	2:17
3-Feb-11	5	12	Martinique	6:40	3:20
6-Feb-11	6	13	San Juan	6:45	5:49
7-Feb-11	7	14	San Juan	6:03	3:50
8-Feb-11	8	15	San Juan	7:03	5:57
9-Feb-11	9	16	San Juan	7:04	6:02
10-Feb-11	10	18	San Juan	5:30	4:19
12-Feb-11	11	19	San Juan	4:47	2:19
15-Feb-11	12	20	San Juan	6:54	5:47
28-Feb-11	13	22	Guadeloupe	5:20	2:40

Table 1: Specific Dates of Data Acquisition

Environmental factors such as water clarity, tide, wind strength and direction, daylight hours, cloud base height and clouds over high terrain influenced the area and duration of data acquisition on a daily basis. See Section B.2.3 for further details.

This Descriptive Report describes Sheet 1, which covers Brass Channel (see Figure 2).

The sheet limits are as follows for Sheet 1 (coordinates are NAD83):

H12271 (1)	Latitude (N)	Longitude (W)
NW corner	18° 24' 59.08"	065° 04' 23.14"
SW corner	18° 20' 22.27"	065° 04' 20.24"
SE corner	18° 20' 27.62"	064° 55' 16.09"
NE corner	18° 25' 04.58"	064° 55' 16.25"

Figure 1 – General Locality of OPR-I169-KRL-10

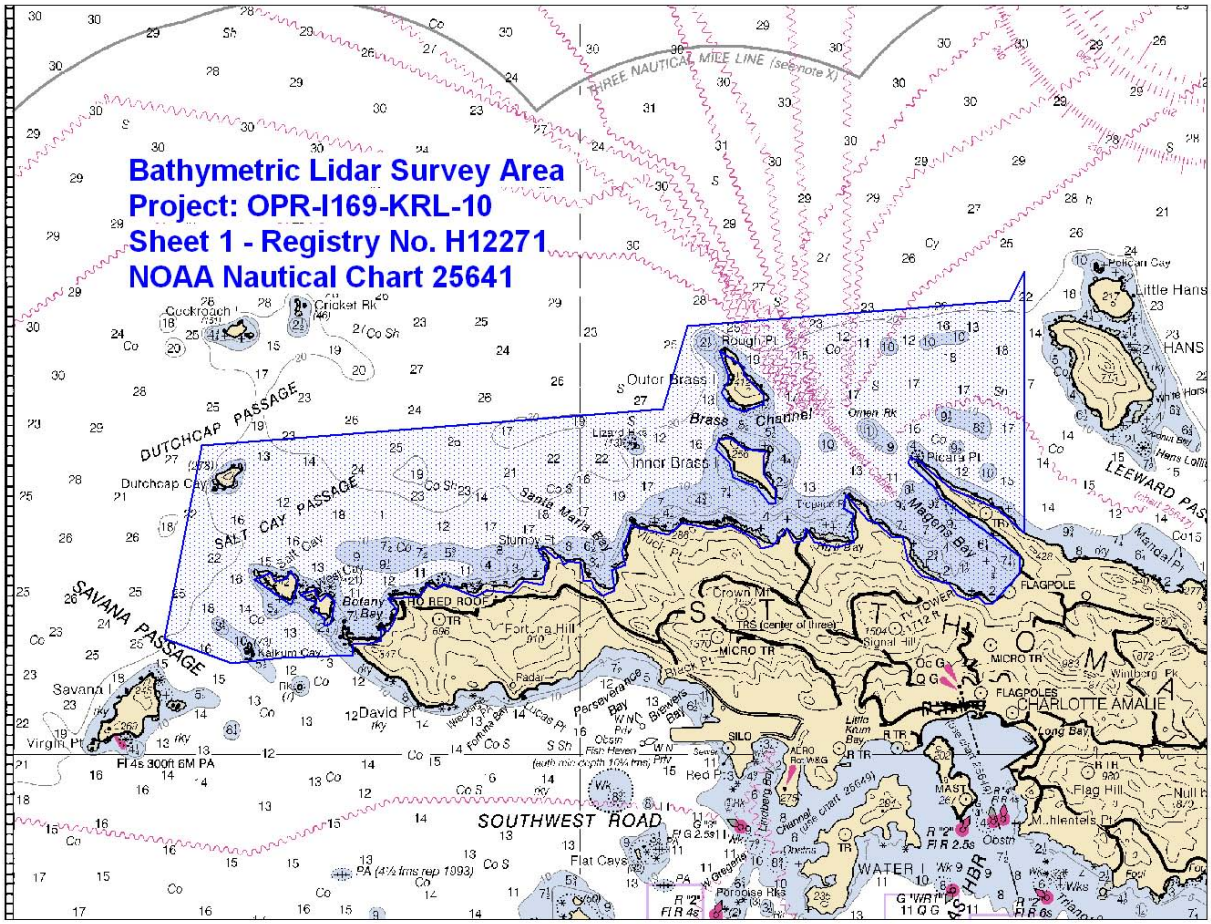

Figure 2 – Sub-Locality of H12271

B. DATA ACQUISITION AND PROCESSING

Refer to the Data Acquisition and Processing Report* for a detailed description of the equipment, processing, and quality control procedures used during LADS surveys. A general description and items specific to this survey are discussed in the following sections.

B.1 EQUIPMENT

Data collection was conducted using the LADS Mk II Airborne System (AS), data processing using the LADS Mk II Ground System (GS), and data visualization, quality control and final products using CARIS HIPS and SIPS 7.1.0 and CARIS BASE Editor 3.2.0.

B.1.1 Airborne System

The LADS Mk II AS platform consists of a Fokker F-27 aircraft, which has a transit speed of 220kts, at altitudes of up to 23,000ft, and an endurance of up to seven hours. Survey operations are conducted from heights between 1,200 and 2,200ft, at ground speeds of between 140 and 210kts. The aircraft is fitted with an Nd: YAG laser, which is eye safe in accordance with ANSI Z136.1-2000, American National Standard for Safe Use of Lasers. The laser operates at 900 Hertz from a stabilized platform to provide a number of different spot spacings across the seabed.

Green laser pulses are scanned beneath the aircraft in a rectilinear pattern. The pulses are reflected from the land, sea surface, within the water column and from the seabed. The height of the aircraft is determined by the infrared laser return, which is supplemented by the inertial height from the Attitude and Heading Reference System (AHRS) and a Global Positioning System (GPS) receiver. Real-time positioning is obtained by an Ashtech GG24 GPS receiver providing autonomous GPS, or is combined with WADGPS (Fugro Omnistar), to provide a differentially corrected position, when coverage is available. Ashtech Z12 GPS receivers are also provided as part of the AS and GS to log data on the aircraft and at a locally established GPS base station.

A digital camera was installed on the LADS Mk II system platform in 2007. This allowed high quality images to be captured in real-time, georeferenced and overlaid with the processed survey data. These images are also combined into a georeferenced image deliverable across the extent of the survey area. The specifications for the Redlake MegaPlus II ES 2020 digital camera are provided in the Data Acquisition and Processing Report.

B.1.2 Ground System

The LADS Mk II GS ‘hydra’ was used to conduct data processing in the field. Hydra, a newly developed distributed processing and shared storage system, replaces the portable Compaq Alpha ES40 Series 3 processor server. The hydra system is a cluster of networked PC’s (nodes). The individual nodes are HP Compaq dc7900 Small Form Factor PC's consisting of Core 2 Duo E8400 processors, 4GB DDR-2 RAM, with 1 TB of storage. The controlling node is connected to SDLT, DLT and DAT drives to allow backups of data, and is networked to plotters and printers for producing documents and plots. The number of nodes networked is dependant on the requirements of the survey. Upon completion of the data

collection phase of the survey, when operations returned to the FLI office in Ocean Springs, MS, the controlling node was Nas2, an HP Proliant DL380 Generation 4 server consisting of a dual core 3.20GHz processor, 4GB DDR-2 RAM, with 2.3TB of storage. Quality control checks and editing of the data were conducted on Nas2 at the FLI office in Ocean Springs, MS.

The GS supports survey planning, data processing, quality control and data export. The GS also includes a KGPS base station, which provides independent post-processed position and height data.

B.2 QUALITY CONTROL

B.2.1 Quality Control Checks

The internal relative consistency of the survey data was checked with crossline depth comparisons, depth benchmark comparisons, dynamic position checks, and by observing position confidence quality factors on the GS. System integrity was checked, in an absolute sense, with the local GPS base station site confirmation, the static position check, and navigation position checks.

B.2.1.1 Crosslines

A total of 10 specific crosslines were planned and flown perpendicular to main scheme survey runs. In addition to the planned crosslines, a total of 22 investigation lines were flown across the area, and when the investigation lines had an angle of intersection with main scheme lines of greater than 45°, they were also used for crossline comparisons. Below are the overall depth comparison results for the 813 crossline / main scheme line intersections. A complete summary is presented in the Separates Report.

Total Number of Comparisons	Mean Depth Difference +/- 1 SD (m)	Mean Standard Deviation +/- 1 SD (m)
1,876,456	0.00 +/- 0.06	0.12 +/- 0.05

B.2.1.2 Depth Benchmarks

The depth benchmark areas for this survey were created from a main scheme line flown as a part of the OPR-I169-KRL-10 survey. Line 400.0.2 was flown during Sortie 14 on February 7, 2011. Six separate seabed areas along this line of survey were identified as being large enough (~150m x 200m) and flat enough to be used as depth benchmarks. The subsequent overflight of these benchmark areas during a total of 5 sorties enabled an additional check of the relative depth accuracy of the LADS Mk II system at varying water depths. Center coordinates for the benchmark areas are as follows:

		UTM (N) Zone 20	
Benchmark Name	**Nominal Depth**	**Easting (m)**	**Northing (m)**
BM1	26m	321 466	2 031 254
BM2	3m	315 342	2 030 672
BM3	6m	314 575	2 030 598
BM4	13m	314 174	2 030 559
BM5	17m	306 657	2 029 846
BM6	20m	305 580	2 029 740

The depth benchmark areas created and subsequent benchmark lines flown during sorties were reduced to MLLW using Lameshur Bay, Water Bay, and Leinster Point final tides. The LADS survey data is compared against the gridded benchmark surface in the GS, and statistics are generated which include the number of points compared, the mean depth difference (MDD) and the standard deviation (SD) between the data sets. The benchmark comparison function compares the data against the benchmark surface, and as this data is unedited, it may contain noise normally removed during the validation process. These noisy outliers are flagged as the shoalest and deepest differences.

A summary of the average of the MDD and SD for all depth benchmark area comparisons is presented below. Refer to the Separates Report for detailed results of the depth benchmark comparison results.

GS ID	BM Name	Nominal Depth	Mean MDD +/- 1 SD (m)	Mean SD +/- 1 SD (m)
1	BM1	26m	0.02 +/- 0.05	0.10 +/- 0.01
2	BM2	3m	0.04 +/- 0.06	0.06 +/- 0.01
3	BM3	6m	-0.02 +/- 0.03	0.11 +/- 0.01
4	BM4	13m	-0.02 +/- 0.04	0.07 +/- 0.01
5	BM5	17m	0.02 +/- 0.02	0.06 +/- 0.01
6	BM6	20m	-0.05 +/- 0.06	0.06 +/- 0.01

The depth benchmark comparison results and the crossline comparisons results are well within expected tolerances and show that the LADS Mk II depth accuracy was significantly better than the quoted specifications throughout the survey period.

B.2.1.3 Positioning Checks

Two independent positioning systems were used during the survey. Real-time positions were determined by Wide Area Differential GPS. Post-processed KGPS positions were determined using multi-base station processing, relative to a local GPS base station that was established by FLI personnel and 3 NGS CORS sites. The post-processed KGPS positions were applied

to each sounding during processing and the KGPS height was used in the topographic datum filter.

Position checks were conducted prior to, during, and following data collection as follows:

a. Local GPS Base Station Site Confirmation. A 24-hour certification of the local GPS base station established was conducted on February 12–13, 20011. The results reveal that the local GPS base station is free from site specific problems such as multipath and obstructions. Details are provided in the Horizontal and Vertical Control Report and scatter plots in the Separates Report.

b. Static Position Check. The coordinates of the aircraft GPS antenna were determined relative to single point that was surveyed by FLI personnel on the tarmac of San Juan Airport. Data was logged by each LADS Mk II positioning system while the aircraft was static, enabling the positions to be checked against the known GPS antenna point. The absolute accuracy of the post-processed KGPS solution during the static position check was 0.107m (95% confidence). The results and details of the static position check are enclosed in the Horizontal and Vertical Control Report and Separates Report.

c. Dynamic Position Check. During each sortie, GPS data was logged on the aircraft and at the local GPS base station. This provided a check between the real-time and post-processed GPS positions. The mean difference between the real-time and post-processed positions was 0.865m, with an average standard deviation of 0.153m. Details are provided in the Horizontal and Vertical Control Report.

d. Navigation Position Check. Navigation checks were also conducted over the Isla Culebrita Lighthouse on Culebrita Island, PR. This enabled the known position of the lighthouse to be checked against the downward-looking digital image. This provided a gross error check of real-time positioning and digital camera alignment. The mean error in the Eastings was observed to be -2.13 +/- 2.60m and -1.63 +/- 0.49m in the Northings. Further details are provided in the Separates Report.

e. Position Confidence. The position quality was also monitored on the GS by checking a post-processed position confidence (C3), which is determined from the AS platform error, GPS error, and residual errors between the actual GPS positions and aircraft position, as determined from the line of best fit. No position anomalies were detected.

The position checks were within the expected tolerances and demonstrated that the positioning systems were functioning correctly throughout the survey period.

B.2.2 Uncertainty Values

For this survey area, global horizontal and vertical uncertainties have been assigned based on the defined horizontal and vertical error budget, as stated in the Horizontal and Vertical Control Report. The assigned horizontal uncertainty is 2.52m and the assigned vertical uncertainty is 0.46m.

However, when the calculated grid node SD is greater than the assigned vertical uncertainty, the SD is used as the uncertainty value. This has occurred in areas of high relief, which is

common throughout the survey area. In some cases the SD may exceed IHO Order-1 limits. This could be attributed to the seabed gradient and a 3m grid resolution being used.

B.2.3 Environmental Factors

B.2.3.1 Sea Conditions - Sea State, White Water, Calm Seas, Swell

The sea state generally ranged from 1 to 2 on the Beaufort Scale throughout the survey period. During periods of higher sea state, expansive areas of white water were observed around drying areas and over shallow features, and this data was typically rejected. When such conditions were observed, operations were either suspended, or redirected to alternate sub-areas, to minimize lidar coverage gaps due to white water.

Calm seas were experienced on occasions, but operations were re-directed to alternate sub-areas to minimize the effects of glassy seas. No gaps resulted from glassy sea effects due to the acquisition of 200% main scheme coverage.

Slight swell was experienced during the survey and an allowance has been made in the assessment of vertical accuracy.

B.2.3.2 Water Clarity

The water clarity varied significantly across the survey area and this required careful management to achieve the best possible seabed coverage. Water clarity varied from extremely poor in some localized, low circulation areas to excellent in offshore regions.

B.2.3.3 Topography

The LADS Mk II system can measure topographic heights up to 50m elevation, subject to the depth / topographic logging window selected. For this survey, a 20m topographic height logging window was selected. As a result, the coastline was surveyed and elevations up to 20m were measured.

B.2.3.4 High Ground

For this survey high ground was an issue. Subsequently, the majority of main scheme lines were flown at either 1800 or 2200 feet.

B.2.3.5 Wind

Survey operations were conducted in wind strengths of up to 25kts during the survey. In general, the wind strength during sorties was between 10 and 15kts. In areas of high terrain, wind strengths above 20kts generated turbulence that made data collection difficult. In circumstances when wind speeds were forecast to be greater than 20kts, no flights were planned due to the possibility of dangerous levels of turbulence.

B.2.3.6 Cloud

Low cloud coverage and rain was a factor during the survey. When the cloud base dropped below 1800 feet operations were diverted to offshore sub-areas. Poor weather was monitored using, and decisions on the flying program were based on:

- Local weather conditions at the base of operations - San Juan, Martinique or Guadeloupe
- National Weather Service current conditions including radar, and forecasts for Charlotte Amalie, St. Thomas: http://forecast.weather.gov/MapClick.php?CityName=Charlotte+Amalie&state=VI&site=SJU&textField1=18.344&textField2=-64.9335
- Real-time satellite imagery for the Caribbean http://www.goes.noaa.gov/GSSLOOPS/prvs.html
- Multiple web-cameras positioned across the USVI

  http://www.caribbean-on-line.com/caribbean-web-cams/chocolate-hole-st-john.shtml

  http://www.caribbean-on-line.com/caribbean-web-cams/cruz-bay-st-john-webcam.shtml

  http://www.caribbean-on-line.com/caribbean-web-cams/peter-bay-st-john-webcam.shtml

  http://www.caribbean-on-line.com/caribbean-web-cams/sapphire-beach-st-thomas-webcam.shtml

B.2.4 Data Coverage and Object Detection

B.2.4.1 Nature of the Seabed

The nature of the seabed surrounding Brass Channel is extremely complex. The area contains numerous islands, islets and drying features. The N coast of St Thomas is characterized by several shoaling areas offshore, that often display a relatively steep seabed gradient with depths dropping beyond 25m relatively quickly.

B.2.4.2 Data Coverage

The survey area was illuminated at 4x4m laser spot spacing, resulting in a 192m swath width. Mainlines of sounding were spaced at 85m, which provided the required 200% coverage.

The generally good water clarity observed throughout the survey period resulted in maximum lidar extinction depths of 40m for the project, but typically seabed coverage to 33m depth was achieved for H12271.

B.2.4.3 Object Detection

At the sea surface the footprint of the laser beam is approximately 2.5m in diameter. As the beam passes through the water column, it diverges slightly due to scattering. It should be noted that at 4x4m laser spot spacing, there is a gap of approximately 1.5m between the illuminated area of adjacent soundings at the sea surface. There is a possibility that small objects in shallow water along the coastline may fall between consecutive 4x4m soundings, and not be detected. The additional bathymetry acquired in conducting this project at 200% coverage often illuminated the seabed between adjacent soundings from the first overflight. The 200% coverage often confirmed the presence of small seabed objects detected during the first pass. A description of the Bottom Object Detection (BOD) algorithm used to discriminate small features from the surrounding seabed is presented in the Data Acquisition and Processing Report.

B.3 CORRECTIONS TO SOUNDINGS

Refer to the Data Acquisition and Processing Report for a description of corrections to soundings. There were no deviations from the corrections described therein.

B.4 DATA PROCESSING

B.4.1 Data Management

The database is identified as follows:

Database Name	Sub-Locality	Sheet
10_5usvi	Brass Channel	1

A detailed table of survey line identifiers is presented in the Data Acquisition and Processing Report.

B.4.2 Data Processing Sites

The data acquired during survey flights was processed at the operating sites in Martinique and San Juan following each sortie. The final sortie from Guadeloupe was processed at the main office in Ocean Springs, MS. Final validation, checking, approving, reports and products were conducted at the MS office. The quality control of the data was conducted using CARIS software and was conducted in the Ocean Springs office.

B.4.3 CARIS BASE Surface

One BASE Surface covers the entire survey area. The Shoal layer of the BASE Surface should be used as the official hydrographic record of the survey. A grid resolution of 3m was used for the BASE Surface. Grid resolution does not change relative to depth, as the laser pulse footprint stays relatively constant regardless of depth, and the laser spot spacing is constant irrespective of aircraft altitude. The 3m grid provides the largest amount of detail that can be supported by the lidar density (4x4 laser spot spacing at 200% coverage).

B.4.4 Gap Tagging

During data processing on the GS, the operators have the ability to assign S-57 and user-defined tags to gaps and features in the data. This enables accurate delineation and attribution of unsurveyed polygons for the S-57 feature file (US512271.000).

For this survey, the following user-defined tags were used to delineate the seaward extent of gaps in the lidar seabed coverage, typically at a 50m interval:

GV	Topography / bathymetry data gap due to the presence of vegetation.
GS	Bathymetry / topography data gap due to the Secondary Exclusion Zone.
GW	Bathymetry data gap due to white water.
GT	Bathymetry data gap due to localized turbidity.
GB	Bathymetry data gap due to the presence of a surface vessel during 200% overflight.

Detailed descriptions of these gaps in seabed coverage are presented in Section B.8 of the Data Acquisition and Processing Report.

B.4.5 Georeferenced Imagery

Digital imagery was captured on each sortie. The imagery was used in the validating, checking, and approval stages of survey data cleaning. The images were also combined to produce georeferenced mosaics, H12271_GI.ecw, covering Sheet 1.

B.4.6 Progress Sketches

Progress sketches were provided to NOAA on a monthly basis. The final progress sketch can be found at Appendix III.

B.4.7 Deliverables Data Formats

Data is provided in the following formats:

- Digital S-57 feature file in .000 format
- CARIS BASE Surface file in .csar0 format
- Lidar coverage and Lidar uncertainty images in geotif format
- CARIS features chart comparison file in .hob format and corresponding GS screen captures in .jpg format
- Chart Comparison Spreadsheet in .xls format
- CARIS compatible LADS data in .caf and .cbf formats – soundings and waveforms, which can be imported into CARIS HIPS
- CARIS compatible data in HDCS format – LADS soundings in CARIS HIPS native format
- Tidal data provided in ASCII, .xls and .csv formats
- Digital georeferenced imagery mosaics in .ecw format

Refer to the Data Acquisition and Processing Report for specific details.

C. VERTICAL AND HORIZONTAL CONTROL

Refer to the Horizontal and Vertical Control Report* for a detailed description of the horizontal and vertical control used during this survey. Refer to Appendix IV* for specific times and dates of relevant tide data. A summary of horizontal and vertical control used for the survey follows.

C.1 VERTICAL CONTROL

Vertical control for this survey was based on MLLW at the National Water Level Observation Network (NWLON) stations at San Juan, PR (9755371), Lameshur Bay, VI (9751381), and Charlotte Amalie, VI (9751639), as well as subordinate stations at Ruy Point, VI (9751768), Water Bay, VI (9751583), and Leinster Point, VI (9751309).

The San Juan station (9755371) served as datum control for this project. Data collected at the San Juan station was used to conduct a MLLW datum transfer to the three tertiary gauges installed by JOA. This station was not used for the reduction of soundings. The Lameshur Bay station (9751381) was used for preliminary and final reduction of depth soundings and was used to derive preliminary and final tidal zoning for the project area. The subordinate stations at Ruy Point (9751768), Water Bay (9751583), and Leinster Point (9751309) were established in late 2010 by JOA and were used for preliminary and final reduction of depth soundings. The Charlotte Amalie station (9751639) was used for the preliminary reduction of depth soundings only. All tide stations recorded continuously during data collection periods and were used for the duration of the survey. Station details are as follows:

		NAD83	
Gauge	**Location**	**Latitude (N)**	**Longitude (W)**
9755371	San Juan, PR	18° 27.5’	066° 06.9’
9751381	Lameshur Bay, USVI	18° 19.0'	064° 43.4'
9751639	Charlotte Amalie, USVI	18° 20.1’	064° 55.2’
9751768	Ruy Point, USVI	18° 22.3'	064° 57.8'
9751583	Water Bay, USVI	18° 20.9'	064° 51.8'
9751309	Leinster Point, USVI	18° 22.1'	064° 43.2'

C.2 ZONING

Tide zones covering the extent of the survey area were derived from tide zone coordinates supplied by NOAA CO-OPS. The tide zones were modified to extend approximately 20 miles offshore and to leave no gaps over land to ensure that all lidar coverage would be covered by zones. Also, the zoning cell geometry was simplified, while preserving a similar shape, in order to meet FLI’s requirement that each zoning cell have 10 or fewer vertices. Each of these tide zones use time and range correctors relative to the Lameshur Bay NWLON tide station and three subordinate tide stations installed by JOA. These are as follows:

Tide Zone	GS Identifier	Time Corrector	Range Corrector	Reference Station
VIR80	TA10	-6 minutes	x1.05	9751381
VIR69	TA11	0 minutes	x0.96	9751583
VIR71B	TA12	0 minutes	x1.04	9751583
VIR71A	TA13	0 minutes	x1.04	9751583
VIR75	TA14	0 minutes	x0.96	9751768
VIR74	TA15	0 minutes	x1.00	9751768
VIR1A	TA16	0 minutes	x0.92	9751768
VIR72	TA17	-6 minutes	x1.04	9751583
VIR71	TA18	0 minutes	x1.04	9751583
VIR1B	TA19	-24 minutes	x1.13	9751381
VIR33	TA20	12 minutes	x0.99	9751309
VIR32	TA21	18 minutes	x0.98	9751309
VIR31	TA22	-6 minutes	x1.11	9751381
VIR30	TA23	-6 minutes	x0.99	9751381
VIR35	TA24	0 minutes	x1.00	9751309
VIR34	TA25	6 minutes	x1.00	9751309
VIR35A	TA26	0 minutes	x1.03	9751309
VIR73	TA27	0 minutes	x0.98	9751768
VIR31A	TA28	6 minutes	x1.11	9751381
VIR68	TA29	0 minutes	x1.00	9751583
VIR25	TA30	-12 minutes	x0.99	9751381
VIR27	TA31	-6 minutes	x1.11	9751381
VIR31B	TA32	24 minutes	x1.11	9751381
VIR70	TA33	0 minutes	x1.00	9751583
VIR28	TA34	-12 minutes	x1.11	9751381
VIR29	TA35	-6 minutes	x0.99	9751381
VIR66	TA36	-18 minutes	x1.23	9751381
VIR67	TA37	0 minutes	x1.04	9751583
LAND1	TA38	0 minutes	x1.00	9751381
LAND2	TA39	0 minutes	x1.00	9751381

For final tide application, the time and range correctors were applied to NOAA verified and JOA quality controlled tide data, smoothed by JOA. Soundings were then reduced to MLLW using these final tides. An analysis of depth benchmark and crossline comparisons, and overlaps of the mainlines of sounding concluded that final tide zoning was adequate.

The derived value for the difference between MLLW and MHW at the Ruy Point, USVI tide gauge is 0.32m. From the final zoning, a range factor of 0.98, 1.00, 0.96, and 0.92 was applicable for Sheet 1, resulting in a MHW value of 0.31m.

C.3 HORIZONTAL CONTROL

Data collection and processing were conducted on the AS and GS in World Geodetic System (WGS84) on Universal Transverse Mercator (Northern Hemisphere) projection UTM (N) in Zone 20, Central Meridian 063° W. This data was post-processed and all soundings are positioned relative to the North American Datum 1983 (NAD83). All units are in meters.

C.3.1 LADS Local GPS Base Station – San Juan

Real-time positions were determined using an Ashtech GG24 GPS receiver on the aircraft, operating in Wide Area Differential GPS mode. Post-processed KGPS solutions for flights conducted from Martinique and Guadeloupe utilized the GPS base station data from 3 NGS CORS sites in the USVI and Puerto Rico. Prior to flights commencing out of the main base of operations at San Juan, a local GPS base station was established by FLI personnel. The data from this independent LADS GPS site provided base station redundancy and reduced risk in using a NGS CORS multi-base station KGPS solution only.

The derived NAD83 coordinates for the LADS local GPS base station are:

NAD83		**UTM (N) Zone 20**		
Latitude (N)	**Longitude (W)**	**Easting (m)**	**Northing (m)**	**Ellipsoidal Height (m)**
18° 27' 20.2748"	066° 04' 56.2682"	174 421.834	2 043 370.320	13.252

Post-processed KGPS positions were determined offline using data logged at the local GPS base station (when based in San Juan), 3 NGS CORS sites and on the aircraft. This data was processed with Waypoint GrafNav software to calculate a multi-base station KGPS position solution for the survey flights. The post-processed KGPS positions were imported into the GS and applied to all soundings. This provided increased sounding position accuracy from the real-time WADGPS.

D. RESULTS AND RECOMMENDATIONS

The results for the H12271 survey are submitted separately to this Descriptive Report as the S-57 feature file, BASE Surface, CARIS .hob files, georeferenced imagery, Chart Comparison Spreadsheet, etc. on the USB flash drive. Refer to Appendix II of the Data Acquisition and Processing Report for a list of all the deliverable files from H12271.
Below is a table listing the S-57 feature objects found in the S-57 feature file (US512271.000):

S-57 Object Class	S-57 Object Acronym	Geometry	Description	Spatial Attribute	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Comments
Building	BUISGL	P	A permanent structure on land.						Used for defining conspicuous building detected by lidar.
Coastline	COALNE	L	The high waterline. Where depth equals 0 relative to MHW.	Quality of position (QUAPOS)	Category of Coastline (CATCOA)				The spatial attribute QUAPOS is used when coastline is interpolated from the (GV) tags or the georeferenced imagery. CATCOA is used to identify mangroves.
Depth Contour	DEPCNT	L	The approximate location of the line of equal depth. Also referred to as a depth curve.		Value of depth contour (VALDCO)				Fugro is only responsible for defining the 0m curve.
Land Area	LNDARE	P	The solid portion of the Earth's surface, as opposed to sea, water.						Used for defining islet point features.
Land Elevation	LNDELV	P	The vertical distance of a point or level measured from a specified vertical datum.		Elevation (ELEVAT)				Used for defining islet heights related to MLLW.
Offshore Platform	OFSPLF	P	A permanent offshore structure, either fixed or floating.		Category of Platform (CATOFP)				Used for defining unidentified platforms, not connected to land.
Pipeline, submerged	PIPSOL	L	A string of interconnected pipes used for the transport of matter.						Used for defining pipelines visible in the digital imagery or lidar data.

S-57 Object Class	S-57 Object Acronym	Geometry	Description	Spatial Attribute	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Comments
Shoreline Construction	SLCONS	L	A fixed artificial structure attached to the land.	Quality of position (QUAPOS)	Category of shoreline construction (CATSLC)				Used for defining jetties, groynes, artificial coastline such as seawalls and breakwaters.
Unsurveyed Area	UNSARE	A	An area for which no bathymetric survey information is available.		INFORM				Used for defining gaps in data coverage as a result of secondary exclusion zone, turbidity, boats.
Underwater / Awash Rock	UWTROC	P	A concreted mass of stony material or coral which dries, is awash or is below the water surface.		Water level effect (WATLEV)	Quality of sounding measurement (QUASOU)	Technique of sounding measurement (TECSOU)	Value of sounding (VALSOU)	For H12271 drying rocks are between -0.62m and -0.32m above MLLW, awash rocks are between -0.31m and 0.31m relative to MLLW, and all submerged rocks are 0.32m and deeper relative to MLLW.
Water Turbulence	WATTUR	A	Area of white water or breaking waves.		Category of water turbulence (CATWAT)				Used for defining gaps in coverage as a result of white water.
Meta Objects									
Coverage	M_COVR	A	A geographical area that describes the coverage and the extent of spatial objects.		Category of coverage (CATCOV)				M_COVR: CATCOV = 1 polygons define the extents of good LIDAR data coverage.
Quality of Data	M_QUAL	A	An area within which a uniform assessment of the quality of the data exists.		Category of zone of confidence in data (CATZOC)				

Table 2: S-57 Attribution for the S-57 feature file (US512271.000)

Recommendations for charting action for registry number H12271 are provided in Sections D.1.1 to D.1.6 below.

A summary of charting actions is provided in Section D.2.2.

D.1 CHART COMPARISON

H12271 LADS survey deliverables were compared to:

- ENC US4PR11M Edition 6, compiled from Raster Charts 25641. ENC issue date August 27, 2010 at scale 1:100,000.
- Raster Chart 25641 28th Edition with a print date of March 1, 2011 at scale 1:100,000. Corrected through LNTM on July 12, 2011 and NGA on July 23, 2011.

These charts were downloaded from the NOAA Office of Coast Surveys – Nautical Charts and Publications website on May 24, 2011.
(http://www.nauticalcharts.noaa.gov/staff/chartspubs.html)

D.1.1 Dangers to Navigation

No features considered a Danger to Navigation (DTON) were identified within the extents of H12271.

D.1.2 AWOIS

No AWOIS were assigned to this Task Order.

D.1.3 Aids to Navigation

No aids to navigation were identified in the lidar data or digital imagery within the extents of H12271.

D.1.4 Charted Depths and Features

Registry number H12271 covers parts of NOAA ENC US4PR11M and Raster Chart 25641. From the Source Diagram, the H12271 survey area was covered by NOS surveys between 1970 and 1989. Single beam echo sounding was most likely used to achieve partial bottom coverage. The existing chart in this area has been relatively well surveyed, however the area surveyed within H12271 is represented by the BASE Surface and S-57 feature file in considerably more detail than is currently shown on the ENC. The following general recommendations are relevant when comparing the area surveyed to the ENC:

a. Coastline. The charted coastline within H12271 is generalized when compared with the surveyed coastline. The surveyed coastline differs from the charted position by an average of 25m and a maximum of 100m. In areas of white water the mean high water line was interpolated utilizing the georeferenced digital imagery. It is recommended that the coastline on the chart be amended to match the LADS surveyed and interpolated MHW line.

b. Islets. A large number of islets have been surveyed within the sheet limits. It is recommended that the chart be amended to match the LADS survey deliverables. Where there is a significant difference, these islets are detailed in the Chart Comparison Spreadsheet in Section D.1.6.

c. Rocks. Many drying rocks, submerged rocks and shoals have been surveyed within the sheet limits, which are not presently shown on the chart. It is recommended that the chart be amended to match the LADS survey deliverables. Where significant, these items are detailed in the Chart Comparison Spreadsheet in Section D.1.6.

D.1.5 Detailed Chart Comparison

In addition to the general recommendations above, some 23 specific differences between the chart and the LADS survey have been identified and are described in Section D.1.6. An expanded version of the spreadsheet is included digitally on the USB flash drive (H12271_ChartComp.xls). A CARIS .hob file containing just the chart comparison items has also been compiled and is provided as part of survey deliverables (H12271_ChartComp.hob). The attribution methodology for this file is presented below:

S-57 Object Class	S-57 Object Acronym	Geometry	Description	Attribute 1	Attribute 2	Attribute 3	Attribute 4
Built-up Area	BUAARE	P	Used as a placeholder to store information relating to the chart comparison	OBJNAM (used for storing a unique chart comparison ID)	INFORM (used for storing the charting recommendation)	NINFOM (used for storing a reference to a Feature for Investigation)	PICREP (used for storing a link to GS screen captures)

The chart comparison was conducted by reviewing the electronic and raster charts, the LADS survey deliverables and the georeferenced digital imagery. For each item identified, screen dumps of the Local Area Display, Raw Waveform Display and Digital Image Window were extracted from the LADS Mk II GS.

These have been reviewed in order to make the following assessments:

a. Type of Feature

b. Least Depth Found

c. Charting Recommendation

d. Remarks

When the least depth has been adequately surveyed by lidar, the LDF Column is populated with a ‘Y’ for yes. The charting recommendation for a feature that has an adequately surveyed least depth will be either ‘Insert’ for a new feature, ‘Replace’ for an amendment to an existing charted feature or ‘Remove’ for a disproved charted feature.

Each chart comparison was categorized as follows:

1. New shoal found
2. Charted shoal disproved / not found

The fields in the Chart Comparison Spreadsheet have been developed from experience learned and feedback received from previous lidar surveys in Alaska, witnessing survey operations aboard NOAA ship Rainier, from meetings at PHB and UNH and the 2007 NOAA Field Procedures Workshop. They have been designed for ease of use and to minimize double handling of data and transcription. Continued feedback is welcomed in order to develop these formats to achieve further efficiencies in data handling.

D.1.6 Chart Comparison Spreadsheet

			CHARTED			SURVEYED							
Sequence No	**Shoal No**	**Category**	**Charted Depth (meters)**	**NAD83 Latitude N (DMS)**	**NAD83 Longitude W (DMS)**	**Surveyed Depth (meters)**	**NAD83 Latitude N (DMS)**	**NAD83 Longitude W (DMS)**	**Type of Feature**	**White Water Area**	**Least Depth Found**	**Charting Recommendation**	A
1	A1	2	Islet	18° 23' 53.13"	64° 58' 16.26"				Coast	Y	N	Remove	Ch of ran
2	A2	2	Islet	18° 23' 42.23"	64° 58' 5.09"				Slope	N	Y	Remove	Ch obs
3	A3	2	Islet	18° 23' 28.32"	64° 58' 16.3"				Slope	N	Y	Remove	Ch obs
4	A4	1				-12.29	18° 23' 34.42"	64° 58' 1.76"	Islet	Y	Y	Insert	
5	A5	1				-2.51	18° 23' 3.16"	64° 57' 56.86"	Islet	Y	Y	Insert	
6	A6	1				6.03	18° 23' 4.99"	64° 57' 51.89"	Rk	N	Y	Insert	
7	A7	2	22.0	18° 22' 17.54"	65° 1' 26.19"	19.90	18° 22' 17.96"	65° 1' 30.47"	Shoal	N	Y	Replace	No this adj
8	A8	1				-2.74	18° 22' 22.26"	64° 59' 30.35"	Islet	N	Y	Insert	
9	A9	1				9.78	18° 22' 23.39"	64° 59' 32.84"	Rk	N	Y	Insert	
10	A10	1				-1.55	18° 22' 20.89"	64° 58' 57.68"	Islet	N	Y	Insert	
11	A11	1				-6.56	18° 22' 21.84"	64° 58' 27.09"	Islet	N	Y	Insert	
12	A12	2	Islet	18° 22' 34.26"	64° 57' 52.3"				Slope	N	Y	Remove	Ch obs
13	A13	1				-0.72	18° 22' 18.53"	64° 57' 48.84"	Islet	Y	Y	Insert	
14	A14	1				-0.88	18° 21' 48.52"	65° 3' 26.51"	Islet	Y	Y	Insert	
15	A15	2	Islet	18° 21' 49.8"	65° 3' 12.2"				Slope	N	Y	Remove	Ch obs
16	A16	2	20.1	18° 21' 50.91"	65° 1' 12.82"	14.22	18° 21' 50.35"	65° 1' 12.16"	Shoal	N	Y	Replace	
17	A17	1				-11.71	18° 21' 47.38"	65° 0' 29.62"	Islet	N	Y	Insert	
18	A18	1				-0.17	18° 21' 53.96"	64° 59' 40.27"	Rk Awash	N	Y	Insert	
19	A19	1				-5.09	18° 21' 40.96"	65° 1' 4.8"	Islet	Y	Y	Insert	
20	A20	2	Islet	18° 21' 42.24"	65° 2' 48.39"				Slope	N	Y	Remove	Ch obs
21	A21	1				-1.13	18° 21' 19.91"	65° 2' 34.44"	Islet	Y	Y	Insert	
22	A22	1				-0.90	18° 20' 57.57"	65° 3' 27.88"	Islet	N	Y	Insert	
23	A23	1				0.22	18° 21' 6.43"	65° 3' 29.86"	Rk Awash	N	Y	Insert	

Table 3: Chart Comparison Spreadsheet

D.2 ADDITIONAL RESULTS

D.2.1 Supplemental Information for Boatwork

For the H12271 survey, the supplemental information for further boatwork was compiled by:

1. Defining the seaward limit of good lidar seabed coverage as a M_COVR, CATCOV=1 polygon.

D.2.1.1 Seaward Limit of Lidar Coverage

The survey area for H12271 consists of a large number of islands, islets, drying features and shoals. As a result of the small tidal range, there are several inshore areas less than 0.5m deep, where gaps exist as a result of the secondary exclusion zone. In addition to this, there are several areas that exhibited poor coverage due to the presence of breakers or localized turbidity. This is reflected by gaps in the BASE Surface rendered as part of the survey deliverables.

In particular, the areas of poor lidar seabed coverage include:

- In Magens Bay, at position 18° 22’ 07” N, 64° 55’ 41” W, due to localized turbidity.
- Along the east coast of Outer Brass Island, at position 18° 23’ 44” N, 64° 58’ 10” W, due to white water.

In general the sheet H12271 displays good coverage to 33m. The seaward limit of good lidar data coverage has been described by the S-57 feature object M_COVR in the S-57 feature file (US512271.000).

D.2.1.2 Lidar Features Requiring Further Investigation

No features have been identified within the extents of H12271 that require further investigation.

D.2.1.3 Recommended Junctioning with Unsurveyed Lidar Areas

The ‘unsurveyed’ gaps in lidar seabed coverage are defined as polygons in the S-57 feature file. They were constructed utilizing the export of the operator assigned gap tags covered in Section B.4.4. In the case of ‘unsurveyed’ areas for the secondary exclusion zone and white water, multibeam junctioning is not recommended for the obvious risks to surface vessels. Extreme care should be taken when junctioning with all other unsurveyed lidar areas, especially those caused by localized turbidity.

D.2.1.4 Comparison with prior Surveys

Comparison with prior surveys was not required under this Task Order. See Section D.1 for comparison to the nautical charts.

D.2.2 Summary of Charting Actions - H12271

Total number of new significant islets recommended for insertion on chart: 11
Total number of new significant drying rocks recommended for insertion on chart: 0
Total number of new significant rocks awash recommended for insertion on chart: 2
Total number of new significant rocks or shoals recommended for insertion on chart: 2
Total number of new significant obstructions recommended for insertion on chart: 0
Total number of charted features disproved by lidar (Remove): 6
Total number of charted features recommended for amendment by lidar (Replace): 2

E. APPROVAL SHEET

LETTER OF APPROVAL – OPR-I169-KRL-10

This report and the accompanying LADS survey deliverables are respectfully submitted.

Field operations contributing to the accomplishment of this survey were conducted under my direct supervision with frequent personal checks of progress and adequacy. This report and the accompanying LADS survey deliverables have been closely reviewed and are considered complete and adequate as per the Statement of Work.

Report	Submission Date
Descriptive Report – H12271	August 3, 2011

Mark Sinclair
Hydrographer
Fugro LADS, Incorporated

Date August 3, 2011

Appendix I
Tides and Water Levels

APPENDIX IV – TIDES AND WATER LEVELS

Abstract of Times of Hydrography

Start and End times refer to tidal applications requirement.

Time on Task indicates actual time of task in the survey area. All times and dates are in UTC. The dates listed below are the dates for the start times of tidal application requirements.

10_5USVI

Date	JD	Sortie	Start Time	End Time	Tide Duration	Time on Task
29-Jan-11	029	8	11:00	19:00	8:00	2:55
30-Jan-11	030	9	14:00	20:00	6:00	3:04
1-Feb-11	032	10	12:00	18:00	6:00	3:00
2-Feb-11	033	11	14:00	20:00	6:00	2:17
3-Feb-11	034	12	12:00	18:00	6:00	3:20
6-Feb-11	037	13	15:00	23:54	8:54	5:49
7-Feb-11	038	14	16:00	23:54	7:54	3:50
8-Feb-11	039	15	15:00	23:54	8:54	5:57
9-Feb-11	040	16	15:00	23:54	8:54	6:02
10-Feb-11	041	18	17:00	23:54	6:54	4:19
12-Feb-11	043	19	10:00	16:00	6:00	2:19
15-Feb-11	046	20	10:00	19:24	9:24	5:47
28-Feb-11	059	22	10:00	18:00	8:00	2:40

T I D A L D A T U M S

Station: 9755371

Name: SAN JUAN, LA PUNTILLA, SAN JUAN BAY, PR

Units: Meters

Datum	Value	Description
MHHW	1.512	Mean Higher-High Water
MHW	1.432	Mean High Water
DTL	1.272	Mean Diurnal Tide Level
MTL	1.264	Mean Tide Level
MSL	1.266	Mean Sea Level
MLW	1.095	Mean Low Water
MLLW	1.032	Mean Lower-Low Water

Station: 9751381

Name: LAMESHUR BAY, ST. JOHN, VI

Units: Meters

Datum	Value	Description
MHHW	9.054	Mean Higher-High Water
MHW	9.041	Mean High Water
DTL	8.930	Mean Diurnal Tide Level
MTL	8.931	Mean Tide Level
MSL	8.923	Mean Sea Level
MLW	8.821	Mean Low Water
MLLW	8.805	Mean Lower-Low Water

Station: 9751639

Name: CHARLOTTE AMALIE, ST. THOMAS, VI

Units: Meters

Datum	Value	Description
MHHW	1.841	Mean Higher-High Water
MHW	1.828	Mean High Water
DTL	1.721	Mean Diurnal Tide Level
MTL	1.722	Mean Tide Level
MSL	1.715	Mean Sea Level
MLW	1.615	Mean Low Water
MLLW	1.601	Mean Lower-Low Water

Station: 9751768

Name: RUY POINT, ST. THOMAS, VI

Units: Meters

Datum	Value	Description
MHW	5.516	Mean High Water
MLLW	5.196	Mean Lower-Low Water

Station: 9751583

Name: WATER BAY, ST. THOMAS, VI

Units: Meters

Datum	Value	Description
MHW	5.732	Mean High Water
MLLW	5.438	Mean Lower-Low Water

Station: 9751307

Name: LEINSTER POINT, ST. JOHN, VI

Units: Meters

Datum	Value	Description
MHW	8.847	Mean High Water
MLLW	8.573	Mean Lower-Low Water

Appendix II
Supplemental Survey Records and Correspondence

-none

Appendix III
Feature Report

i. AWOIS
-none

ii. DtoNs
-none

iii. Maritime Boundary
-none

iv. Wrecks
-none

APPROVAL PAGE

H12271

Data meet or exceed current specifications as certified by the OCS survey acceptance review process. Descriptive Report and survey data except where noted are adequate to supersede prior surveys and nautical charts in the common area.

The following products will be sent to NGDC for archive

- H12271_DR.pdf
- Collection of depth varied resolution BAGS
- Processed survey data and records
- H12271_GeoImage.pdf

The survey evaluation and verification has been conducted according current OCS Specifications, and the survey has been approved for dissemination and usage of updating NOAA's suite of nautical charts.

Approved: 

Digitally signed by Abigail Higgins
DN: cn=Abigail Higgins, o=NOAA, ou=Office of Coast Survey, email=abigail.higgins@noaa.gov, c=US
Date: 2012.06.28 16:44:15 -04'00'

LT Abigail Higgins
Chief, Atlantic Hydrographic Branch