Report of Survey

For:

Project Title:

FabTest Geophysical Survey

Document Control & Revision Status

Client:	University of Exeter (REG)	**Issue Date:**	24/07/14
Document Number:	REP-0191/J64567	**Status:**	Final
Document Title:	Report of Survey		

A1	Issued to client	24/07/2014	OC	ALR	
Rev	**Description**	**Date**	**Originated**	**Approved**	**Client Approved**

Insight Marine Projects Ltd
19A Normandy Way
Bodmin
CORNWALL
PL31 1RB
Tel: +44 (0)1208 77033

www.insight-marine.com

Contents

1.0 Introduction

1.1 Project Overview

Insight Marine Projects Ltd has been contracted by the University of Exeter (Renewable Energy Group) to supply hydrographic survey services on the FaB Test wave energy site, located 5km offshore from Falmouth Bay, UK.

The purpose of the geophysical survey was to acquire data to provide site operators and device developers a baseline dataset which encompasses the entire FaB Test site and will assist with current and future project planning and execution.

This report details the configurations and results of the geophysical survey as conducted in June and July 2014.

Figure 1.1 – General survey location (Source: Streetmap.co.uk)

1.2 Purpose

The purpose of this document is to detail the survey activities completed in support of the project.

1.3 Scope of Work

The primary objectives of the survey were as follows:

1. **Multibeam Bathymetric Survey**

   High resolution bathymetry using multibeam techniques to ensonify entire area within survey extents to be conducted to IHO Order 1A for Hydrographic Surveys with particular emphasis on detection of natural upstands and debris.

2. **Sub-Bottom Profiling**

   Shallow seabed penetration using a sub-bottom profiling techniques to ascertain sediment thickness over bedrock within the survey extents. Required penetration was in the order of -5m sub bottom.

3. **Side Scan Sonar**

   High resolution side scan sonar acquisition across the entire survey extents presented as geo-referenced mosaic seabed imagery.

4. **Sediment Sampling**

   Collection of sediments samples over 12 pre-defined locations supplied by UoE using mechanical grab techniques.

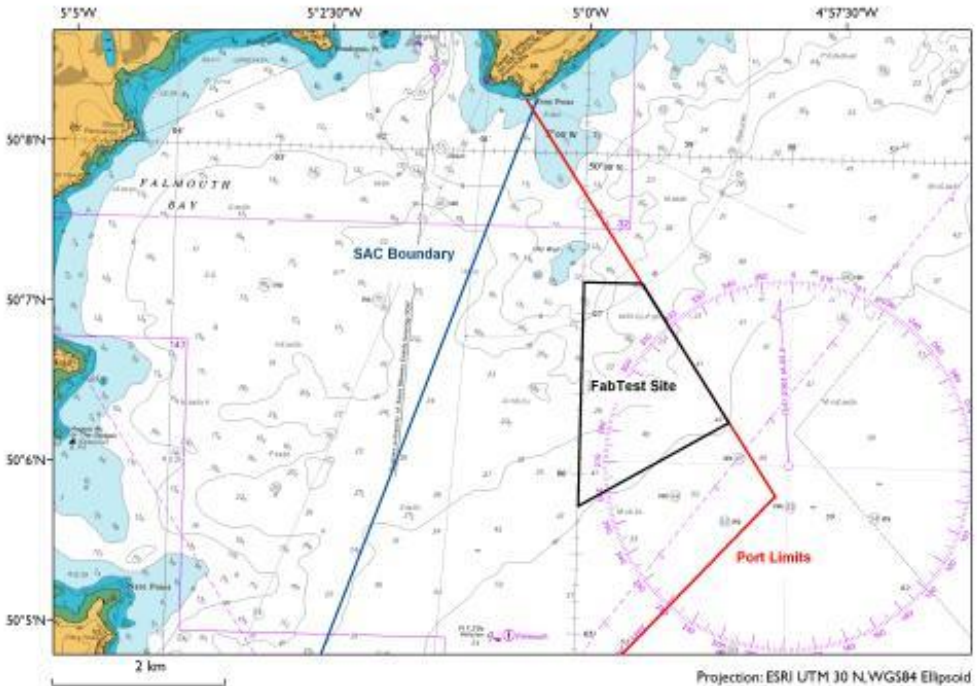


Figure 1.2 –FaB Test survey extents (Source: WaveHub)

1.4 Reference Documents

1.4.1 Client Supplied Documents & Specifications

Document Name	Description
GrabSampleLocations_wgs84.xlsx	Location of sediment grab locations

1.4.2 Insight Marine Projects Documents & Procedures

Document Number	Title
QMS-V1-QAM00	Business Systems Manual (Rev 04)
QMS-V2-SAF00	Health & Safety Manual (Rev 03)
QMS-V2-SAF01	Risk Assessment Manual
QMS-V2-HYD00	Survey Manual
QMS-V2-HYD09	Offset Measurement Procedure
QMS-V2-HYD11	Generic DGPS Installation Procedure
QMS-V2-HYD19	QINSy Documentation
QMS-V1-FOR02	Vessel Offset Diagram
QMS-V1-FOR10	Offline MBES Processing Log
QMS-V1-FOR43	Survey Log
QMS-V1-FOR62	SVP Observation Log
QMS-V1-FOR61	Online MBES Configuration

1.4.3 Other Documentation & Guidance

Document Number	Title
IMCA-S-003	The Use of Multibeam Echosounders in Offshore Surveying
IMCA-S-012	Installation & Maintenance of Differential GPS in Offshore Surveying
IMCA-S-015	Guidelines for GNSS Positioning in the Oil & Gas Industry

1.5 Preamble

This document has been supplied primarily in PDF digital format; hyperlinks are included which link to files on the Insight Marine Projects website or the wider internet. Any text highlighted in blue and underlined can be clicked to link to the relevant file.

1.6 Abbreviations

Abbreviations used in this document:

CAD	Computer Aid Drawing
CD	Chart Datum
CoG	Centre of Gravity
CRP	Common Reference Point
DGPS	Differential Global Positioning System
ETRS89	European Terrestrial Reference System 1989
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
INS	Inertial Navigation System
IMU	Inertial Measurement Unit
MBES	Multibeam Echo Sounder
ODN	Ordnance Datum (Newlyn)
OSBM	Ordnance Survey Bench Mark
OSGB36	Ordnance Survey Great Britain 1936
OSGM02	Ordnance Survey Geoid Model 2002
PDF	Portable Document Format
PPE	Personal Protective Equipment
QC	Quality Control
QMS	Quality Management System
QHSE	Quality, Health, Safety & Environment
RMS	Root Mean Square
RTCM	Radio Technical Commission for Maritime Services
RTK	Real-Time Kinematic
SV	Sound Velocity
SBP	Sub Bottom Profiler
SSS	Side scan Sonar
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
UoE	University of Exeter
VCoR	Vessel Centre of Rotation
WGS84	World Geodetic System 1984

2.0 Technical Highlights

Data acquisition was conducted over two mobilisations, multibeam data acquired during the initial survey was found to be of unacceptable quality during post-processing. The primary reason was due to excessive swell causing movement in the Multibeam (MBES) transducer pole, producing inconsistent misalignment errors which could not be corrected for.

2.1 Equipment & Personnel (Phase 1)

Mobilisation Date:	26th June 2014
Scope of Work:	SSS, SBP, Grabs & MBES
Survey Personnel:	A. Richards (Insight Marine Project Manager)
	O. Cozens (Hydrographic Surveyor)
Vessel Name:	Boy Brendon (Sea Wide Services Ltd)
Dimensions:	LOA: 17.0m
	Beam: 5.0m
	Draft: 1.1m
	Main Propulsion: 1 x Cummins QSM11 405 HP

Figure 2.1 – MV 'Boy Brendan' (Source: Seawide Services Ltd)

2.2 Equipment & Personnel (Phase 2)

Mobilisation Date:	19th July 2014
Scope of Work:	MBES (Resurvey)
Survey Personnel:	A. Richards (Insight Marine Project Manager)
	O. Cozens (Hydrographic Surveyor)
Vessel Name:	MTS Xplorer (MTS Towage)
Dimensions:	LOA: 12.0m
	Beam: 5.2m
	Draft: 1.2m
	Main Propulsion: 2 x Cummins 500 HP

Figure 2.2 –'MTS Xplorer' shown with transducer pole deployed.

2.2.1 Principal Survey Components

Primary Navigation/INS:	Applanix POS/MV 320 (v5) GPS Receiver & IMU
Real-Time Correction Source:	RTK corrections over NTRIP via internal GSM modem
MBES:	R2Sonic 2024 Broadband Multibeam Echo Sounder (Single Head)
Real-Time SV Sensor:	Valeport MiniSVS
SV Profiler:	Valeport Midas SVP
SSS:	Edgetech 4125 Dual Frequency Side Scan Sonar
	STR PCR-75-SS Powered Cable Reel (300m armoured coaxial cable)
	T-Count 14” Wireless Sheave Block + Remote Counter/Input system
	Edgetech acquisition software
SBP:	Innomar SES 2000 Parametric SBP system (Hull Mounted)
Sediment Grabs:	Van Veen FT540 grab (0.025m^3)
Navigation Software:	QPS QINSy Survey (v8.10.2014.03.26.1)
Data Acquisition Hardware:	Impact E-72 Online PC
	Remote Displays
Processing Software:	QPS QINSy/QLOUd
	Chesapeake Technology SonarWiz 5
	AutoCAD Map3D 2015 Map 3D

2.3 Project Coordinate Information

Due to restrictions between the POS-MV hardware and the online QINSy software it was necessary to acquire data on the British National Grid system (OSTN02) in order to make use of real-time RTK height referencing to the OSGM02 vertical datum. Data was subsequently transformed to UTM Zone 30N for presentation. General details and transformation parameters are detailed below.

2.3.1 Geodetic Parameters

Online geodetic parameters were checked prior to operations. Ellipsoid and grid projection parameters used by the QINSy software are detailed below.

Table 2.1 – *Online Geodetic Parameters*

Ellipsoid Parameters	
GPS Datum Name	ETRS89 (EUREF89)
Spheroid Name	GRS 1980
Semi-major axis	6 378 137.000m
Semi-minor axis	6 356 752.314m
Inverse flattening (1/f)	298.2572221010
Flattening (f)	0.0033528107

Ellipsoid Parameters	
Survey Datum	OSGB36 (OSTN02)
Spheroid Name	Airy 1830
Semi-major axis	6 377 563.396m
Semi-minor axis	6 356 256.910m
Inverse flattening (1/f)	299.3249646000
Flattening (f)	0.0033408506

Projection Parameters	
Unit	International metre
Projection	Transverse Mercator
Latitude of Origin	49° 00’ 00.000” N
Central Meridian	02° 00’ 00.000” W
Scale factor on C.M.	0.99960127
False Easting	400000m
False Northing	-100000m

ETRS89 coordinates were transformed to the OSGB36 (OSTN02) grid in real-time by the QINSy survey software for logging and display on the navigation screen. A standard 7-parameter shift was used, as detailed below.

Table 2.2 – *Online Transformation Parameters*

Transformation Parameters	
X-Shift (dX)	-446.448
Y-Shift (dY)	125.1570
Z-Shift (dZ)	-542.0600
X Rotation (Rx)	-0.150200
Y Rotation (Ry)	-0.247000
Z Rotation (Rz)	-0.842100
Scale Correction (ppm)	20.48940000

2.3.2 Vertical Datum Parameters

Vertical control and tidal reduction was maintained using real-time RTK heights from the POS-MV GNSS receiver; this is based on a separation model between the ETRS89 datum and the Ordnance Survey OSGM02 vertical datum. Online conversion was performed by the QINSy software.

A further offset from ODN to reduce the soundings to local Chart Datum was also applied during acquisition.

Table 2.3 –*Vertical Datum Parameters*

Vertical Datum Parameters	
Vertical Datum Name	Geoid Height – OSGM02 (Great Britain)
ODN Offset (to local CD)	-2.910m (Falmouth)

2.3.2 Presentation Geodetic Parameters

Data was transformed to a UTM grid for presentation using the following parameters:

Table 2.4 – *Presentation Geodetic Parameters*

Ellipsoid Parameters	
Ellipsoid	WGS84
Semi-major axis	6 378 137.000000 metres
Semi-minor axis	6 356 752.314245 metres
Inverse flattening (1 / f):	298.2572235630
1st Eccentricity squared (e^2):	0.0066943800

Projection Parameters	
Unit	International Metres
Projection	Universal Transverse Mercator (UTM)
Datum	WGS84
UTM Zone	30 (North Orientated)
Latitude of Origin	000° 00' 00" N
Central Meridian	003° 00' 00" W
Scale factor on C.M.	0.999600
Grid Easting at Origin	500 000.00 metres
Grid Northing at Origin	0.00 metres

2.4 System Offsets

Sensor offsets were established using manually taped measurements from well defined points on the vessel, field log sheets are shown in the Appendices.

2.4.1 SBP & SSS System Offsets

The following offsets were established within the QINSy software.

***Table 2.5** – QINSy Offsets ('Boy Brendan')*

Point	Fixed Offset Description	DX (m)	DY (m)	DZ (m)
0	IMU (CRP)	0.000	0.000	0.000
1	SES 2000 Tx	0.230	0.000	-3.480
2	Stern Roller	-1.900	-7.300	0.000

The SBP transducer was mounted on a pole on the starboard side of the 'Boy Brendan', the POS-MV Inertial Measurement Unit (IMU) was mounted on the starboard side of the boat as close as possible to the transducer pole.

Figure 2.3 – POS MV IMU shown in secure mounting position on starboard side ('Boy Brendan')

Figure 2.4 – Innomar SES-2000 transducer shown on side mounted pole.

The side scan fish was towed from the centre stern of the vessel, a counter block was mounted amidships from the deck crane and aligned with the stern roller offset point, the amount of cable in/out was controlled by a 240v electric deck winch designed specifically for oceanographic/hydrographic towfish applications.

Figure 2.5 –Edgetech 4125 SSS Deployment arrangement

2.4.2 MBES System Offsets

During mobilisation of the 'MTS Xplorer' for the MBES reacquisition the sensor offsets were again established using manually taped measurements. The following offsets were established within the QINSy software.

***Table 2.6** – QINSy Offsets ('MTS Xplorer')*

Point	Fixed Offset Description	DX (m)	DY (m)	DZ (m)
0	POS M/V 320 E INS	0.000	0.000	0.000
1	R2Sonic MBES Tx	1.979	0.715	-2.900
2	VCoR	-0.700	-0.300	-1.045

The MBES pole was mounted on the starboard side of the 'MTS Xplorer', the MBES transducer offset was measured from the POS MV IMU which was mounted on a dedicated Applanix plate within the wheelhouse. The vessel's centre of rotation (VCoR) was also measured and entered to the POS View software to enable correct heave lever arm calculations.

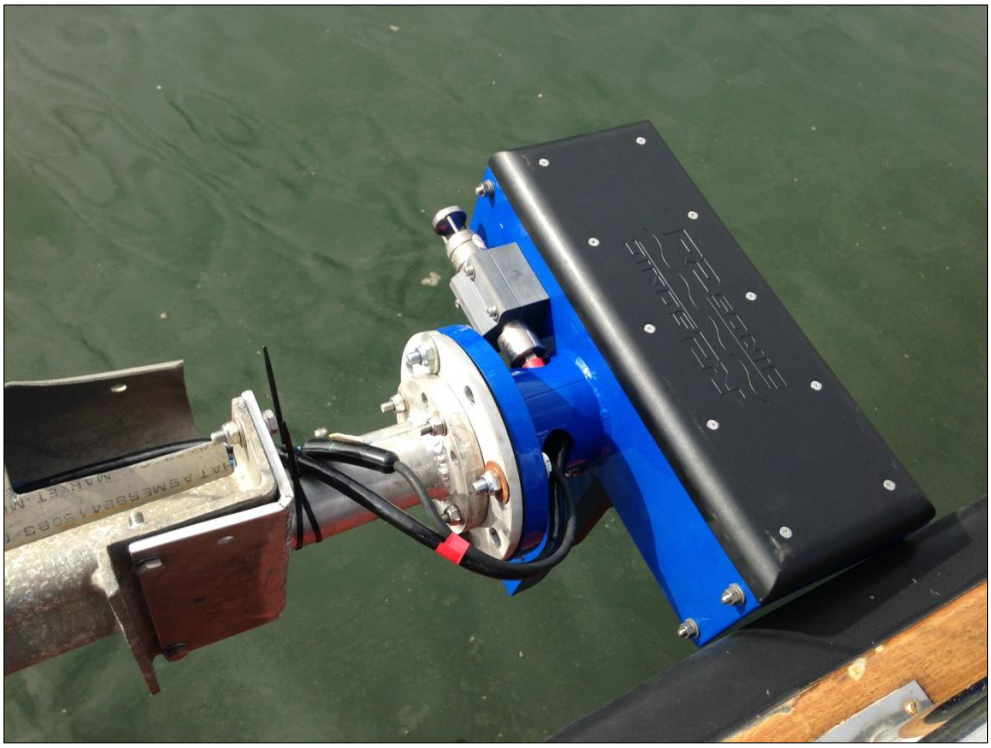


Figure 2.6 - R2 Sonic 2024 MBES mounting arrangement – projector towards the bow

Only the offsets required for the POSView software to determine its orientation with respect to the IMU and primary antenna were entered, all remaining survey offsets were entered to the QINSy software.

Table 2.7 – *POS View Offsets ('MTS Xplorer')*

Point	Fixed Offset Description	DX (m)	DY (m)	DZ (m)
0	IMU Reference	0.000	0.000	0.000
1	Primary GNSS Antenna	6.041	0.937	-2.145
2	VCoR	-0.300	-0.700	1.045

The Applanix POS MV GNSS system received real-time NTRIP RTK position corrections; signal continuity was monitored within the QINSy software with data acquisition halted in the event of any outage.

The delayed TrueHeave values from the POS MV were also logged by QINSy for importing to raw databases in post-processing.

2.5 Verification & Calibrations

In order to determine that all systems were performing correctly the following verifications were undertaken:

2.5.1 MBES Calibration

A series of calibration lines were run near the survey area to allow a calibration of the MBES system offsets. This 'patch test' is used to correct for angular misalignments in pitch, roll and heading between the MBES unit, the motion sensor and the positioning system.

For the MBES calibration the following sailing pattern was followed:

- Roll: two lines over a flat area in opposite directions at the same speed (transducer tracks on top of each other)
- Pitch: two lines over an area with a slope (or an object) in opposite directions at the same speed (transducer tracks on top of each other)
- Heading: two lines over an area with slopes (or an object), the lines overlapping half a swath width, in the same direction and same speed.

The calibration alignment routine was conducted in post-processing and each database was replayed using the newly computed offset angles. The following offsets were entered into the survey software:

Table 2.8 *– Patch Test Results (19/0/14)*

MBES Calibration Results	
Roll Offset	0.580°
Pitch Offset	-2.810°
Heading Offset	1.890°

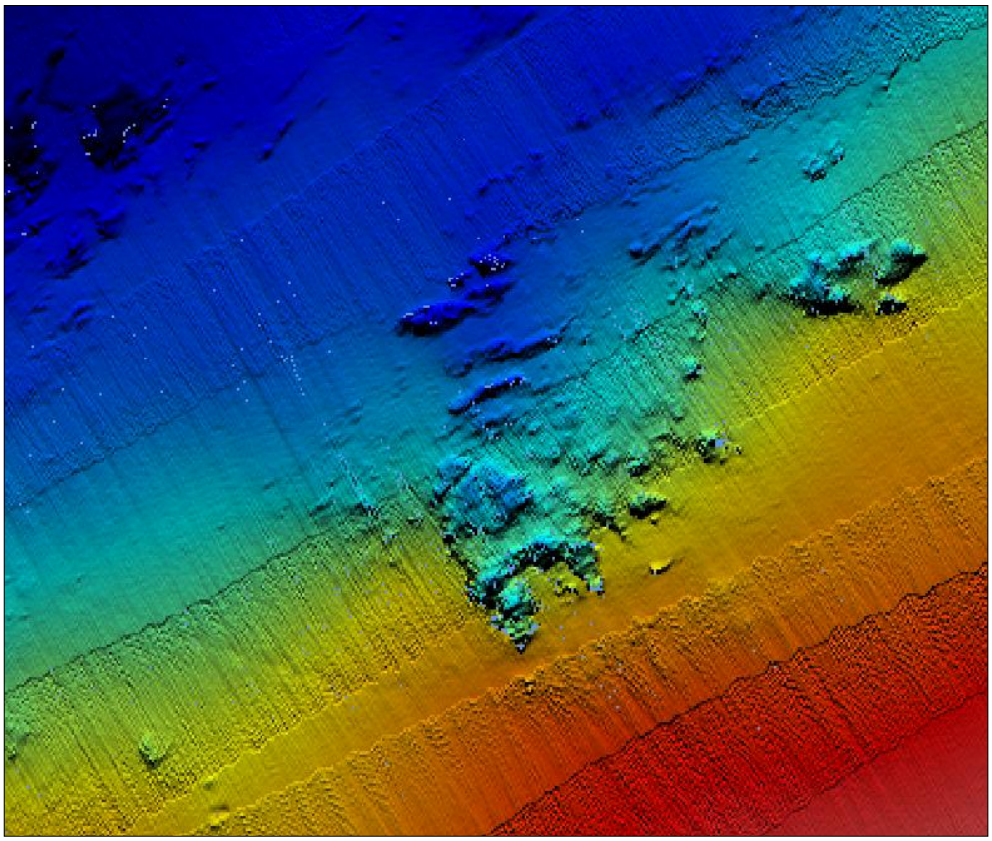


Figure 2.7 – MBES swath data quality prior to patch test calibration and application of SV and TrueHeave

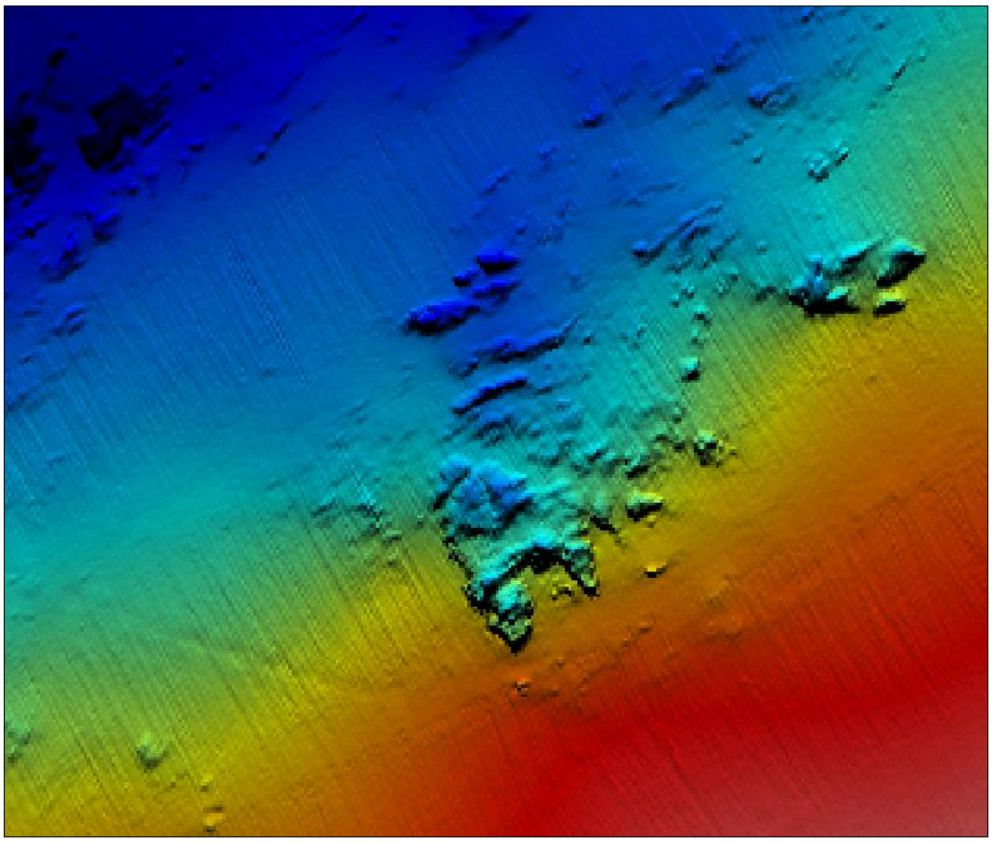


Figure 2.8 – Data quality following calibrations and cleaning

2.5.2 Sound Velocity Calibration

Sound velocity data from the Valeport MiniSVS mounted at the MBES transducer head was transmitted to the R2Sonic topside controller in real-time; this was used to ensure that the launch angle of each individual acoustic beam was corrected for sound velocity variations at the head.

Full depth SV profiles were also taken before and after the survey using a Valeport Midas SVP, these profiles were entered into the QINSy software and were used for ray-tracing during post-processing. Results from each SV cast are shown in the Appendices.

2.5.3 Position Verification

Prior to data acquisition the position and height output from the POS MV unit was checked by occupying an existing local bench mark established specifically for this task. Position solutions were observed for 400 seconds and compared against the accepted BM definition:

Table 2.9 – *Position Verification Results*

Position Verification Results				
Benchmark Name	Normandy Way BM-01			
Grid Reference	SX 079657			
Occupation Time	18th July 2014 (1021 UTC)			
	BM Coords	***POS MV Coords***	***Delta***	***Std Dev***
Eastings	207980.548m	207980.480m	-0.066m	0.015m
Northing	65729.612m	65729.710m	0.053m	0.021m
Height	130.437m	130.440m	0.000m	0.012m

Position verification results are shown graphically in the Appendices. The benchmark check was acquired using NTRIP corrections delivering centimetric accuracy.

The accuracy of the GNSS system was continuously monitored during data acquisition using the online Quality Control (QC) facilities within QINSy. Real-time alerts were triggered and logging paused if the position solution was degraded, in which case the survey would be halted until the solution was improved.

2.5.4 Post-Processed Validation

Log files were recorded within the POS-MV system during data acquisition, these files were used to build a POSPac project in post-processing to enable checks to be made on the data validity throughout the survey.

The following plot shows RMS position errors in both horizontal and vertical planes, it can be seen that East/North values are typically around 0.05m whilst vertical errors are around 0.02m during the entire survey.

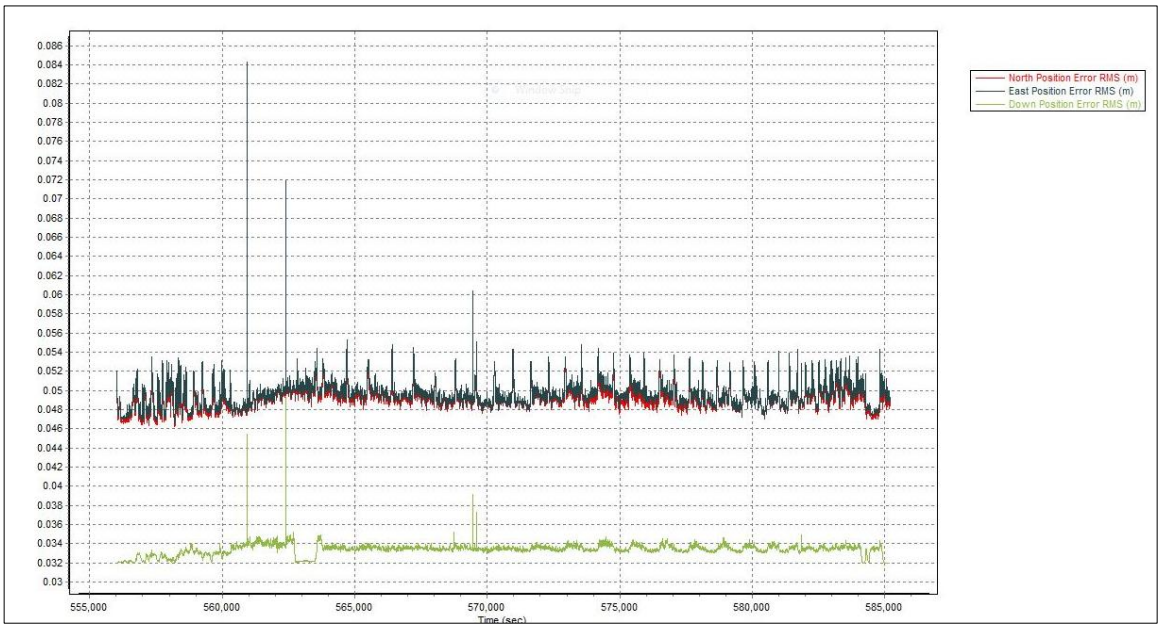


Figure 2.8 – POSPac post processed real-time RMS position error metrics (19/07/14)

2.6 Survey Standards Statement

This hydrographic survey is considered complete to International Hydrographic Organisation 1A standard, with a full bottom search being achieved as per IHO Special Publication S44. The relevant extract from the specification is shown below.

Table 2.10 – *IHO Specifications for Order 1A Surveys (Source: IHO)*

Examples of Typical Areas	Horizontal Accuracy (2σ)	Depth Accuracy (2σ)	Maximum Line Spacing	100% Bottom Search	System Detection Capability
Harbours, harbour approach channels, recommended tracks and some coastal areas with depths up to 100m	5m + 5% of depth	a = 0.5m b = 0.013	Required in selected areas	Cubic features > 2m in depths up to 40m	3 x average depth or 25m, which ever is greater

To calculate the error limits for depth accuracy the corresponding values of *a* and *b* listed in this table should be introduced into the formula:

$$\pm \sqrt{[a^2 + (b*d)^2]}$$

Where:

a	Constant depth error, i.e. the sum of all constant errors
b*d	Depth dependent error, i.e. the sum of all depth dependent errors
b	Factor of depth dependent error
d	Depth

3.0 Results

3.1 MBES Data

The R2Sonic 2024 broadband multibeam echo sounder was operated at a nominal frequency of 400kHz, this gives a high resolution image and is capable of resolving high levels of seabed detail. Following the decision to remobilise due to initial data quality issues the data collected subsequently includes the entire FabTest consented area as specified by the client.

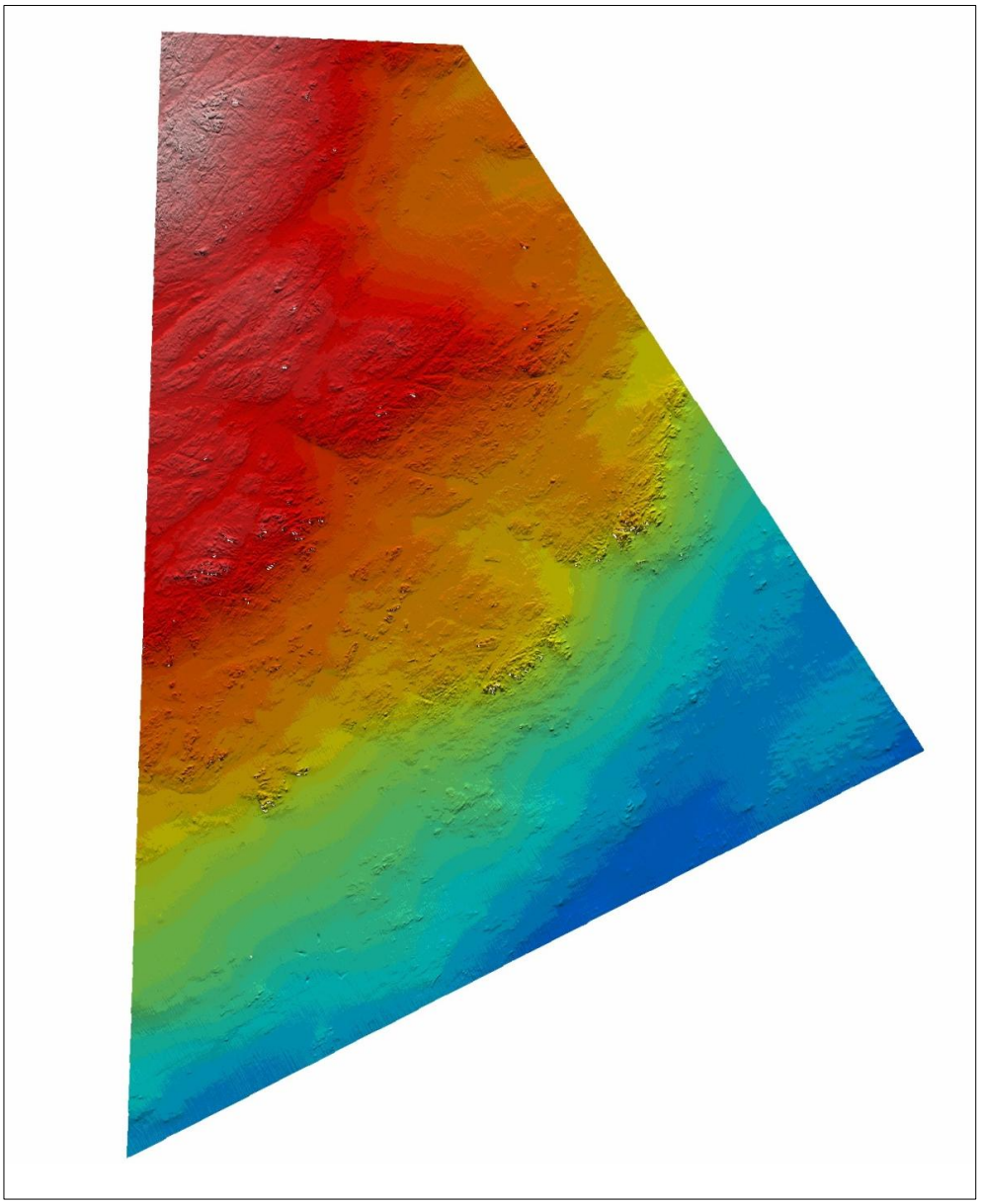


Figure 3.1 – MBES coverage throughout the FabTest site

The MBES data shows in high resolution the change in bottom type throughout the site, from predominantly sand in the south east to rocky outcrops in the northern area. The presence of 5 anchor scars from the previous BOLT-II device installation can also be observed in the south-western corner of the survey area.

3.2 SSS Data

The Edgetech 4125 dual frequency side scan sonar system was used for acquisition of side scan sonar imagery. This system was deployed over the stern of the vessel in a towed configuration using a sheave block with integrated wireless cable counter suspended from the crane arm. The powered winch was operated with a hand operated controller to 'fly' the instrument at a typical height above the seabed of +5m.

Figure 3.2 – Raw SSS coverage throughout the FabTest site

Due to the pole configuration onboard 'Boy Brendan' it was not possible to install a USBL to track the fish position; a manual layback calculation was used instead with updated cable-out values from the wireless T-Count block. The results showed a good layback correlation between adjacent lines.

It was necessary on a number of occasions to move away from the planned survey runlines to avoid floating fishing gear or scientific instrumentation buoys. Occasional gaps in SSS coverage are due to the time it takes to bring the towed fish back onto position.

3.3 SBP Data

An Innomar SES 2000 Light SBP system was deployed to acquire sub bottom profiles of the survey area. The parametric effect is used to produce a low frequency sound pulse from two interfering higher frequencies; the resulting low frequency is able to penetrate sub-bottom sediment layers.

A line spacing of 50m was maintained across the survey area during SBP acquisition.

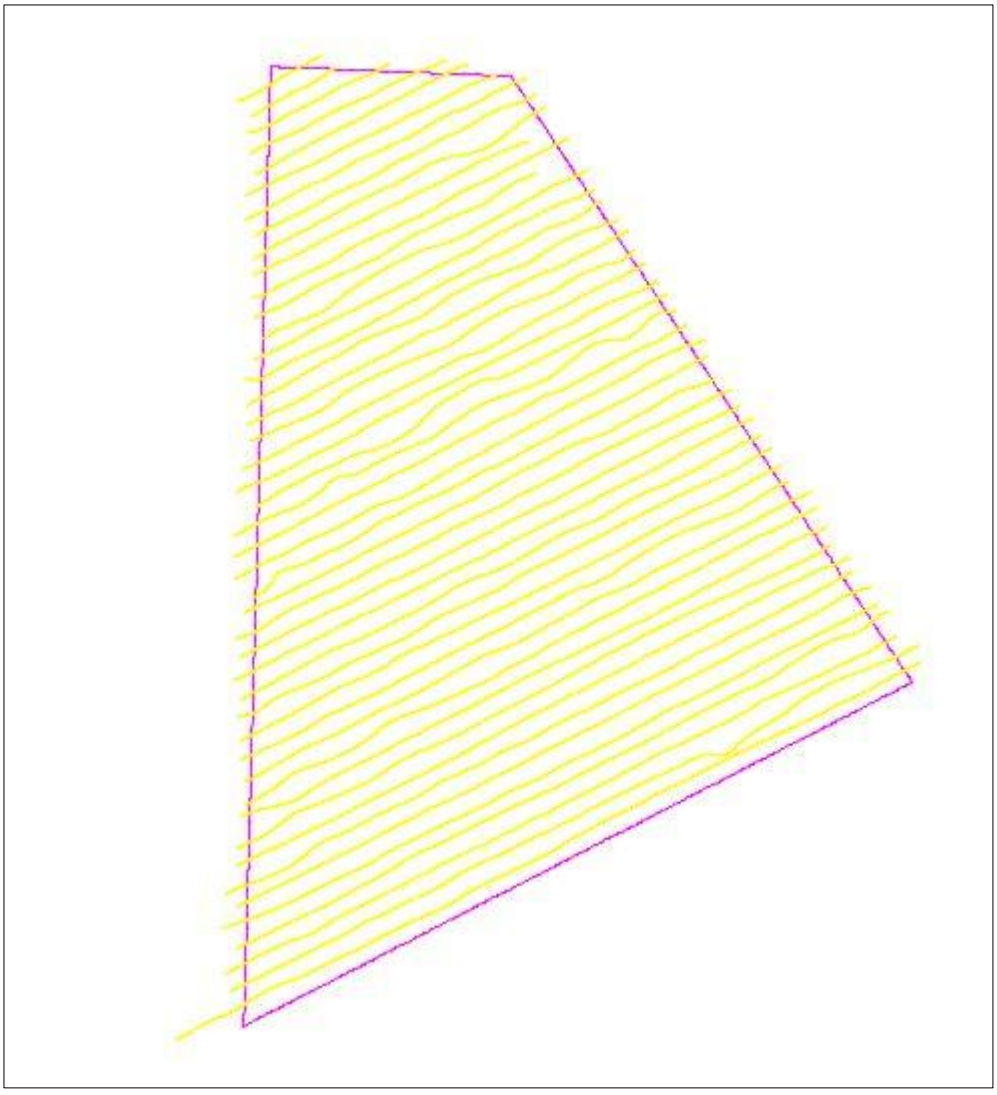


Figure 3.3 – SBP vessel track at nominal 50m line spacing

The results from the SBP show areas of sand build up in the south of the survey area but very little accumulation around the rocky outcrops in the north. XYZ dData has been submitted showing the thickness of the layer between the seabed and the first reflector (Unit1). The digitised Unit1 reflector is shown in the processed echograms as a red line.

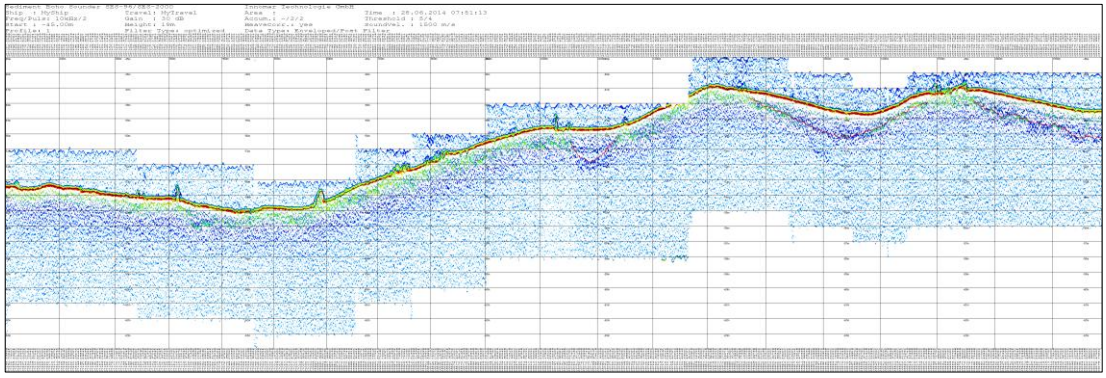


Figure 3.3 – Example echogram showing areas of sand overlaying Unit1 reflector (red line)

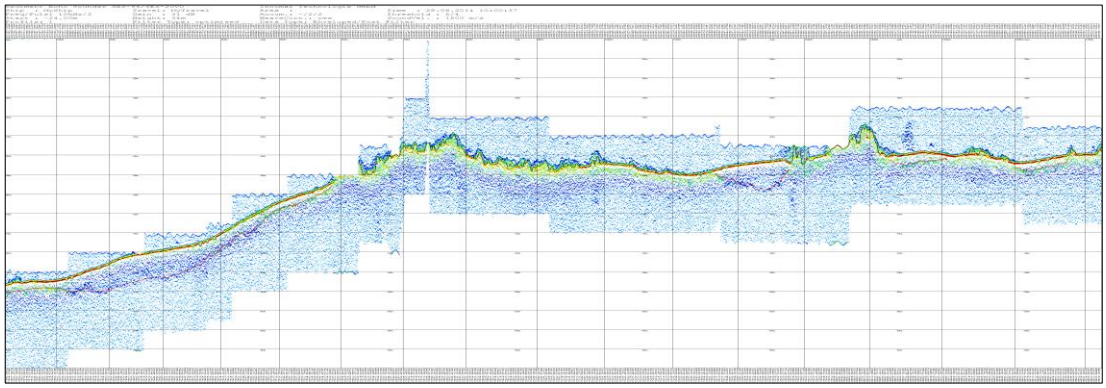


Figure 3.4 – Example echogram showing areas of sand overlaying Unit1 reflector and outcropping rock

SBP data has been submitted a XYZ points of sediment thickness and Unit1 depth, GIF images are also submitted

3.4 Sediment Grabs

The van Veen sediment grab was used at 12 locations within the survey area as requested by the client. The grab was lowered using the hydraulic deck winch on the 'Boy Brendan'; samples were recovered to deck and bagged up with ID tags.

Figure 3.5 –Van Veen sediment grab deployment from 'Boy Brendan'

Samples were subsequently delivered to the client for Particle Size Analysis using their own facilities. The table on the following pages show the recovery location and time of each sediment sample along with a photographic record.

A nil recovery was recorded on one of the locations despite repeated attempts, it is understood this site was close to a rock outcrop.

Sample Ref: **3-T1f** **UTC Time:** n/a **Recovery Easting:** n/a **Recovery Northing:** n/a **Recovery Attempts:** 3 **Comment:** No recovery sample site close to rock outcrop.	*No Image*
Sample Ref: **4-T1H** **UTC Time:** 28/06/14 15:00 **Recovery Easting:** 357994mE **Recovery Northing:** 5553474mN **Recovery Attempts:** 2 **Comment:**	
Sample Ref: **2-T1D** **UTC Time:** 28/06/14 15:07 **Recovery Easting:** 357427mE **Recovery Northing:** 5552802mN **Recovery Attempts:** 1 **Comment:**	

Sample Ref: **7-T2F**

UTC Time: 28/06/14 15:14

Recovery Easting: 358004mE

Recovery Northing: 5552561mN

Recovery Attempts: 1

Comment:

Sample Ref: **8-T2H**

UTC Time: 28/06/14 15:19

Recovery Easting: 358370mE

Recovery Northing: 5552721mN

Recovery Attempts: 1

Comment:

Sample Ref: **12-no ref**

UTC Time: 28/06/14 15:26

Recovery Easting: 358637mE

Recovery Northing: 5552217mN

Recovery Attempts: 1

Comment:

Sample Ref: **11-A15**

UTC Time: 28/06/14 15:35

Recovery Easting: 358125mE

Recovery Northing: 5552079mN

Recovery Attempts: 1

Comment:

Sample Ref: **10-A14**

UTC Time: 28/06/14 15:48

Recovery Easting: 357460mE

Recovery Northing: 5551894mN

Recovery Attempts: 1

Comment:

Sample Ref: **9-A13**

UTC Time: 28/06/14 15:55

Recovery Easting: 357073mE

Recovery Northing: 5550508mN

Recovery Attempts: 1

Comment:

Sample Ref: **5-T2B**

UTC Time: 28/06/14 16:06

Recovery Easting: 357239mE

Recovery Northing: 5552322mN

Recovery Attempts: 1

Comment:

Sample Ref: **1-T1B**

UTC Time: 28/06/14 16:16

Recovery Easting: 357254mE

Recovery Northing: 5552542mN

Recovery Attempts: 2

Comment:

Sample Ref: **6-T2D**

UTC Time: 28/06/14 16:20

Recovery Easting: 357576mE

Recovery Northing: 5552430mN

Recovery Attempts: 1

Comment:

4.0 Reporting

4.1 Survey Deliverables

An overview of deliverables associated with this project is shown below:

- Report of survey (Hardcopy & PDF)
- MBES Data:
  - A1 Overview Soundings Plot at 1:5000 contoured at 0.25m(Hardcopy, DWG & PDF)
  - A1 Soundings Plot (North) at 1:3000 contoured at 0.25m (Hardcopy, DWG & PDF)
  - A1 Soundings Plot (South) at 1:3000 contoured at 0.25m (Hardcopy, DWG & PDF)
  - 0.80m, 1.20m & 3.20m XYZ Export Grids UTM Z30N and reduced to LCD (ASCII XYZ)
  - Sun-Illuminated Geo-referenced Images at 0.80m & 1.20m Grids (GeoTIFF)
- SBP Data:
  - A1 SBP Sediment Thickness Plot (North) at 1:3000 contoured at 0.25m (Hardcopy, DWG & PDF)
  - A1 SBP Sediment Thickness Plot (South) at 1:3000 contoured at 0.25m (Hardcopy, DWG & PDF)
  - XYZ Export Grids - Sedbed-Unit1 Difference (ASCII XZY)
  - Unit1 Digitised SBP Echograms (GIF)
- SSS Data:
  - High & medium resolution geo-referenced SSS mosaic images (GeoTIFF)
  - Individual high resolution geo-referenced SSS records (GeoTIFF)
  - Raw SSS data files (JSF)
- Sediment Samples:
  - Image records (JPG)

Two hardcopies of charts and reports are supplied in addition to digital data on a 32GB memory stick. AutoCAD files are downsaved to 2010 .DWG format and zipped as an eTransmit package.

4.1.1 Drawing Register

Document Title	Format	Description
DWG-0191-J64567 Rev A1 - Sheet 1	DWG/PDF	A1 Soundings Plot Overview (1:5000)
DWG-0191-J64567 Rev A1 - Sheet 2	DWG/PDF	A1 Soundings Plot – North (1:3000)
DWG-0191-J64567 Rev A1 - Sheet 3	DWG/PDF	A1 Soundings Plot – South (1:3000)
DWG-0191-J64567 Rev A1 - Sheet 4	DWG/PDF	A1 SBP Sediment Thickness Plot - North (1:3000)
DWG-0191-J64567 Rev A1 - Sheet 5	DWG/PDF	A1 SBP Sediment Thickness Plot - North (1:3000)

4.1.2 Rendered Data

File Name	Format	Description
0191-J64567_MBES GeoTIFF 80x80 UTM RevA1	GeoTIFF	MBES GeoTIFF 0.80x0.80m
0191-J64567_MBES GeoTIFF 160x160 UTM RevA1	GeoTIFF	MBES GeoTIFF 1.60x1.60m
0191-J64567_MBES GeoTIFF 160x160 UTM RevA1	KML	KML Layer file of 0191-J64567_MBES GeoTIFF 1.60x1.60m UTM RevA1
0191-J64567_MBES 80x80 UTM RevA1.xyz	XYZ	0.80x0.80m MBES point data showing UTM Z30N easting and northing and mean value reduced to LCD
0191-J64567_MBES 160x160 UTM RevA1.xyz	XYZ	1.60x1.60m MBES point data showing UTM Z30N easting and northing and mean value reduced to LCD
0191-J64567_MBES 320x320 UTM RevA1.xyz	XYZ	3.20x3.20m MBES point data showing UTM Z30N easting and northing and mean value reduced to LCD
0191-J64567_SSS GeoTIFF HiRes UTM RevA1	GeoTIFF	0.40x0.40m Georeferenced image of SSS data
0191-J64567_SSS GeoTIFF LoRes UTM RevA1	GeoTIFF	1.20x1.20m Georeferenced image of SSS data
Individual GeoTIFF images from 0191-J64567_SSS GeoTIFF Mosaic	GeoTIFF	0.40x0.40m Georeferenced image of SSS data
Individual time stamped SSS files	JSF	Raw SSS data
0191-J64567_SBP Runlines RevA1	KML	Runlines of SBP related to SBP .GIF images
Individual .GIF profile files showing results from SBP	GIF	SBP profiles showing digitised Unit1 reflector
0191-J64567_SBP DIFF UTM RevA1.xyz	XYZ	Sediment thickness layer between seabed and Unit1 reflector
0191-J64567_SBP UNIT1 UTM RevA1.xyz	XYZ	Unit1 reflector level below seabed
JPEG Images of sediment grabs	JPEG	Images of sediment grabs shortly after recovery (Wet Bagged)

5.0 Equipment & Personnel

5.1 Survey Inventory

Category	Item	Op	Spare
Surface Positioning	Applanix POS MV 320 V5 PCS Unit	1	0
	Applanix POS MV Type 26 IMU	1	0
	Trimble GA530 L1/L2 GNSS antennas	2	2
Survey Instruments	R2Sonic MBES Topside SIM Controller	1	0
	R2 Sonic 2020 MBES Transducer	1	0
	Valeport MiniSVS	1	1
	Valeport Midas SVX2	1	0
	Edgetech 4125 Side Scan Sonar	1	0
	Edgetech Topside Controller (c/w Discover Software)	1	0
	Innomar SES-2000 Compact SBP	1	0
	SES-2000 Transducer	1	0
Online Computer System	QPS QINSy Survey (v8.1.2014) USB dongle	1	1
	1PPS Timing Adaptor (QPS)	1	1
	Remote Helmsman's Display	1	1
	Impact E72 PC (c/w 2 GB RJ45 Network & 4 Port RS232)	1	1
	1Tb hard drive	1	0
Layback system	STR PCR-75-SS Powered Cable Reel	1	1
	T-Count 14" Wireless Sheave Block	1	1
	T-Count Wireless Cable counter system Rx + Tx	2	1
Post Processing Software	QPS QLOUd (Area Cleaning Utility)	1	0
	Applanix POSPac MMS (v6.2)	1	0
	AutoCAD Map 2014	1	0

5.2 Field Personnel

Position	N
Senior Hydrographic Surveyor / Project Manager	Alex Richards
Hydrographic Surveyor	Oli Cozens

6.0 Quality, Health Safety & Environment (QHSE)

All works were carried out in accordance with the project specific safety documents and approved detailed work procedures. A formal hazard identification and risk assessment was undertaken on shore where all aspects of the work scope were discussed. Risk issues resulting from this discussion were addressed by the project team and the necessary Holds, Safety Concerns and Procedure Modifications incorporated into the relevant documents.

The project was undertaken in accordance with Insight Marine's Quality Management System (QMS). The relevant safety procedures are outlined in the SAF Safety Manual (copies available on request).

6.1 Safety Plan

Prior to the commencement of any works a generic Risk Assessment was undertaken and results recorded on the appropriate form. Where risks were identified on sites which were not covered by the generic assessment these were noted and the appropriate advice sought before mitigating actions were undertaken before proceeding.

All field teams were equipped with appropriate first aid kits, life jackets, protective clothing, VHF radios (where appropriate) and mobile phones. PPE was worn at all times where appropriate, e.g. safety harnesses, high visibility jackets and hard hats.

6.2 Health and Safety Policy

Insight Marine Projects Ltd seeks to protect the environment, the health and safety of our employees, clients, subcontractors and others who may be involved with our industry and the communities within which we operate. The relevant policies are outlined in the Business Systems Manual (copies available on request).

6.3 Quality Assurance (QA)

Insight Marine Projects Ltd is accredited by LRQA to the ISO 9001:2008 standard and as such works within a strict document framework. The project will be undertaken in accordance with the Insight Marine Projects management procedures, the appointed manager is **Alex Richards**.

6.4 Mobilisations & Demobilisations

Mobilisation and demobilisation are potentially hazardous periods during the project therefore particular attention was paid to the planning and risk assessment of these activities. The following aspects are known to be critical:

- Sufficient time given to plan the works
- Sufficient time given to execute the works
- The involvement of all subcontractors at the pre-start briefings

A1 Online Resources

Quality Management System Documents

- www.Insight-Marine.com
- Insight Marine Projects Ltd ISO-9001:2008 Quality Manual (QAM-00)
- Insight Marine Projects Ltd ISO 9001:2008 Certificate
- Insight Marine Projects Ltd Capability Statement & Track Record

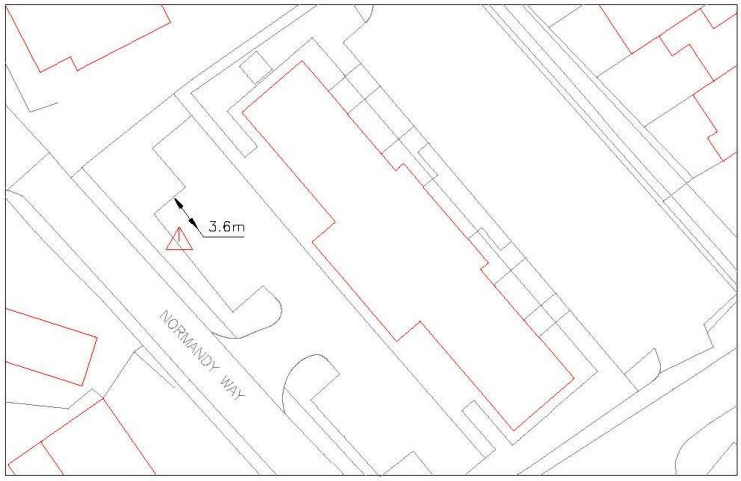
A2 QC Documents

GPS STATION DESCRIPTION

FOR-54 (Rev1.0)

STN: BM-01

WITNESS DIAGRAM



GRID REFERENCE:
(8 FIGURES)

20796572

LOCATION:

19A Normandy Way, Bodmin, PL31 1RB

DESCRIPTION:

PK nail in north-western end of car park, near bay 32 marker.

SURVEYED BY:

Team Surveys Ltd

DATE SURVEYED: MAY 2014

JOB NUMBER: N/A

G.P.S. USABLE? Yes

NETWORK BASED ON O.S. GPS STATIONS:			ALTITUDE BASED ON EXISTING BENCH MARKS:	
1.	3.	5.	1.	type:
2.	4.	6.	2.	type:

ETRS89 CO-ORDINATES:		OSGB36 CO-ORDINATES:	
LATITUDE:	50°27'35".5541 N	EASTING:	207980.548m
LONGITUDE:	004°42'24".2094 W	NORTHING:	65729.612m

ELLIPSOIDAL HEIGHT (m): 183.139m

GPS ORTHOMETRIC HEIGHT (m): 130.437m

VALIDATED:- A RICHARDS

K.M.Square: SX0765

ESTABLISHMENT FIX DEFINITIONS

Database

C:\Users\Administrator\Documents\0191_FaBTest Survey - UoE\QINSy\0191-64567 FabTest Resurvey\Database\BM Che

Establishment Fix

Steered Node computation	:	POS MV 340
Steered Node name	:	BM01 CoG
Point name	:	BM1
Type of establishment fix	:	Point
Identifier for establishment fix	:	1

Fix Coordinates

Easting	:	207980.54800 E
Northing	:	65729.61200 N
Height	:	130.43700 m
Survey Datum	:	OS GB 1936 (Airy 1830)
Survey Projection	:	Transverse Mercator (North Orientated) (Airy 1830)
Vertical Datum	:	Geoid Height - OSGM02 (Great Britain)
Meridian Convergence	:	-2.087146 °

Observation Period

Time span	:	400.00 s

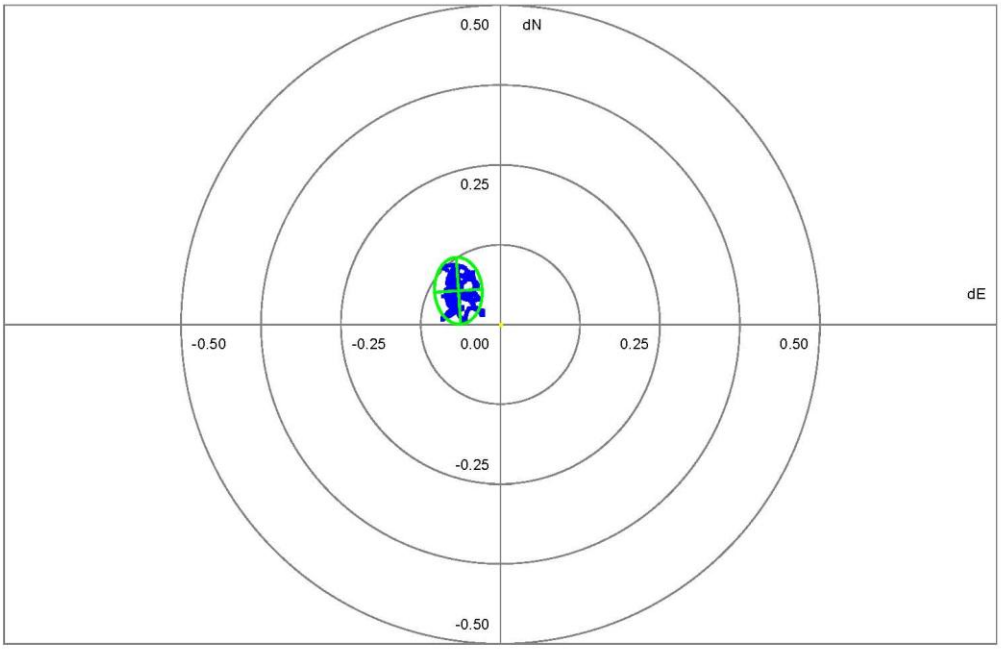
POSITION FIX RESULTS

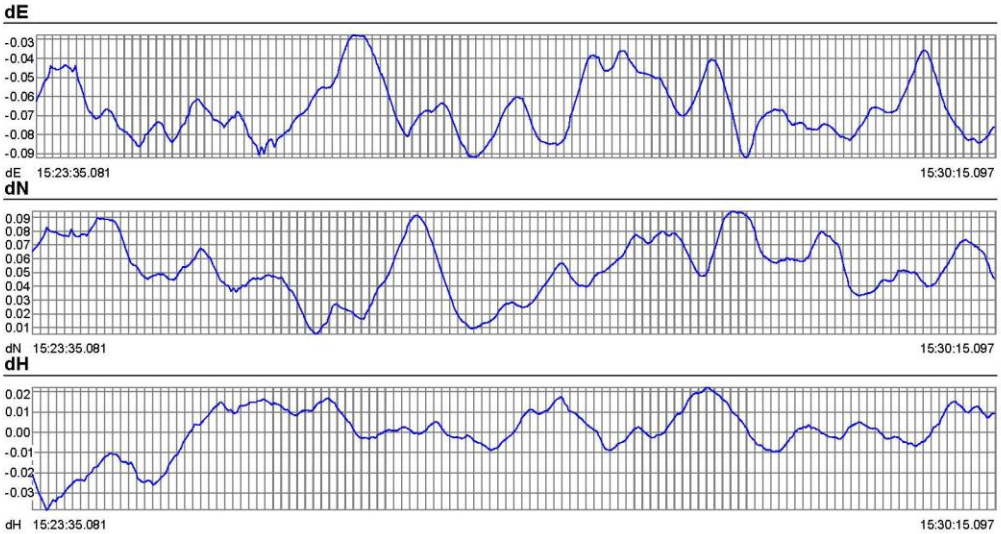
Position Fixes

Number of positions	:	742		
Number of used positions	:	742		
Number of disabled positions	:	0		
UTC time of first position	:	15:23:35.081	:	2014-07-18
UTC time of last position	:	15:30:15.097	:	2014-07-18

Statistics

Value	Minimum	Mean	Maximum	St. Deviation
Easting	207980.46 m	207980.48 m	207980.52 m	0.01533 m
Northing	65729.62 m	65729.67 m	65729.71 m	0.02145 m
Height	130.40 m	130.44 m	130.46 m	0.01218 m
Delta Easting	-0.09213 m	-0.06606 m	-0.02781 m	0.01533 m
Delta Northing	0.00552 m	0.05315 m	0.09455 m	0.02145 m
Delta Height	-0.03839 m	0.00021 m	0.02230 m	0.01218 m
2D Distance Error	0.03255 m	0.08692 m	0.13055 m	0.01814 m
Grid Azimuth Error	275.55 °	308.00 °	331.99 °	13.00 °


0.50
dN
0.25
dE
-0.50
-0.25
0.00
0.25
0.50
-0.25
-0.50


dE
-0.03
-0.04
-0.05
-0.06
-0.07
-0.08
-0.09
dE 15:23:35.081
15:30:15.097
dN
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
dN 15:23:35.081
15:30:15.097
dH
0.02
0.01
0.00
-0.01
-0.02
-0.03
dH 15:23:35.081
15:30:15.097

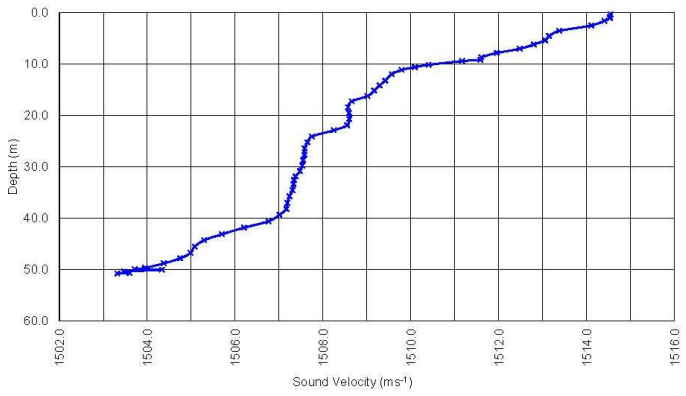
SVP OBSERVATION LOG

Project Title :	FaBtest Survey	Project # :	0191/Resurvey
Hardware :	Valeport MiniSVP	Date :	19/07/2014
SVP Name :	SVP 001	Cast Time :	12:20:00 UTC
Cast Position :	357427mE 5552802mN	Cast Number :	1 of 1

Depth (m)	Velocity (ms^{-1})	Temp (°C)	Salinity (ppm)
0.31	1514.55	17.48	
0.82	1514.54	17.46	
1.07	1514.54	17.42	
1.57	1514.41	17.30	
2.47	1514.11	17.13	
3.54	1513.38	17.00	
4.54	1513.15	16.94	
5.36	1513.06	16.86	
6.18	1512.80	16.75	
7.01	1512.49	16.60	
7.83	1511.96	16.47	
8.68	1511.61	16.42	
9.16	1511.59	16.33	
9.41	1511.17	16.12	
10.14	1510.41	16.01	
10.60	1510.09	15.87	
11.14	1509.79	15.79	
11.96	1509.57	15.72	
13.24	1509.42	15.66	
14.17	1509.29	15.62	
15.14	1509.17	15.55	
16.23	1509.01	15.47	
17.25	1508.66	15.42	
18.41	1508.57	15.41	
19.51	1508.59	15.40	
20.67	1508.60	15.37	
21.92	1508.55	15.29	
22.89	1508.25	15.16	
24.10	1507.75	15.09	

Depth (m)	Velocity (ms^{-1})	Temp (°C)	Salinity (ppm)
25.24	1507.65	15.06	
26.45	1507.59	15.05	
27.70	1507.58	15.03	
28.75	1507.55	15.02	
29.80	1507.53	15.00	
30.86	1507.47	14.97	
31.89	1507.38	14.95	
32.61	1507.34	14.94	
33.41	1507.33	14.92	
34.56	1507.31	14.90	
35.77	1507.24	14.88	
37.04	1507.19	14.85	
38.22	1507.17	14.80	
39.40	1507.01	14.71	
40.62	1506.76	14.57	
41.88	1506.20	14.40	
43.16	1505.70	14.25	
44.33	1505.29	14.16	
45.55	1505.08	14.12	
46.79	1504.98	14.05	
47.86	1504.75	13.96	
48.84	1504.38	13.85	
49.72	1503.95	13.76	
49.95	1503.72	13.65	
50.06	1504.33	13.99	
50.44	1503.47	13.64	
50.71	1503.60	13.80	
50.79	1503.32	13.67	

Sound Velocity Curve :



SIGNED

Name : ALEX RICHARDS Signed : _____ Date : 19/07/2014

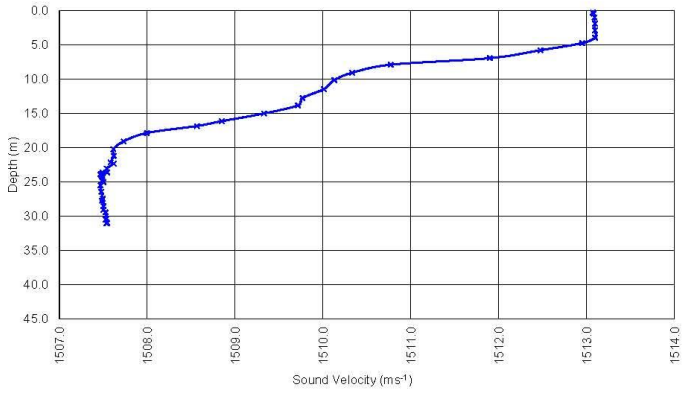
SVP OBSERVATION LOG

Project Title :	FabTest Survey	Project # :	0191/Resurvey
Hardware :	Valeport MiniSVP	Date :	19/07/2014
SVP Name :	SVP 002	Cast Time :	18:15:00 UTC
Cast Position :	357427mE 5552802mN	Cast Number :	2 of 2

Depth (m)	Velocity (ms^{-1})	Temp (°C)	Salinity (ppm)
0.29	1513.08	17.00	
0.42	1513.08	16.99	
0.98	1513.09	16.99	
1.90	1513.10	16.98	
2.87	1513.10	16.95	
3.93	1513.10	16.89	
4.74	1512.95	16.76	
5.78	1512.48	16.57	
6.94	1511.90	16.28	
7.89	1510.77	16.05	
9.06	1510.33	15.96	
10.14	1510.13	15.92	
11.45	1510.01	15.84	
12.76	1509.77	15.78	
13.83	1509.72	15.68	
15.03	1509.33	15.55	
16.15	1508.85	15.40	
16.85	1508.57	15.28	
17.87	1508.00	15.16	
19.10	1507.73	15.11	
20.23	1507.61	15.09	
21.22	1507.62	15.08	
22.17	1507.58	15.07	
22.32	1507.62	15.13	
23.07	1507.54	15.05	
23.61	1507.54	15.09	
23.66	1507.49	15.04	
23.80	1507.49	15.04	
23.86	1507.49	15.04	

Depth (m)	Velocity (ms^{-1})	Temp (°C)	Salinity (ppm)
23.93	1507.47	15.04	
23.95	1507.49	15.04	
24.04	1507.47	15.04	
24.17	1507.49	15.04	
24.86	1507.49	15.03	
25.04	1507.50	15.06	
25.54	1507.47	15.03	
26.45	1507.48	15.04	
26.45	1507.48	15.03	
27.48	1507.49	15.03	
27.77	1507.49	15.03	
28.59	1507.50	15.03	
29.09	1507.50	15.03	
29.47	1507.53	15.03	
30.35	1507.54	15.03	
30.51	1507.53	15.02	
31.01	1507.55	15.02	
31.06	1507.54	15.02	
31.06	1507.54	15.02	
31.07	1507.54	15.02	
31.07	1507.54	15.02	

Sound Velocity Curve :



SIGNED

Name : ALEX RICHARDS Signed : _____ Date : 19/07/2014

Document Title: **FOR61-Online MBES Configuration**
Reference Group: **(FOR) FORMS & TEMPLATES**

Insight Marine Projects Ltd
Quality Management System

ONLINE MBES CONFIGURATION

Date :	19/07/2014	Project # :	0191/Resurvey
Project :	FaBtest Survey	Surveyor :	Alex Richards
Vessel Name :	'MTS Xplorer'	Location :	Falmouth, UK

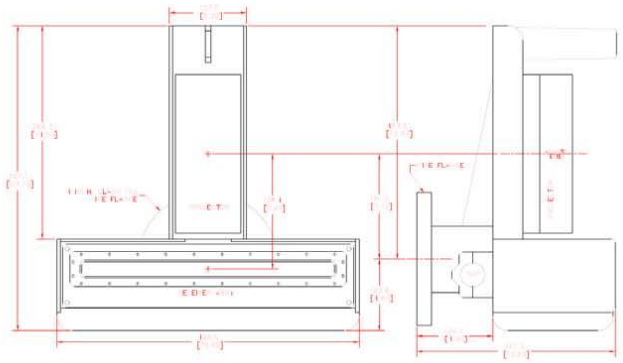
QINSy CONFIGURATION

MBES Driver:	R2Sonic 2000 Series (Network)
Port Number:	4000
Transducer Node:	MBES
Transducer Setup:	Assume Common Acoustic Centre
Sensor Offsets During Acquisition:	
Roll Offset:	0.000°
Pitch Offset:	0.000°
Heading Offset:	0.000°
Max Beams Per Ping:	256.0000
Sound Velocity:	Use from Unit
Stabilization:	Unit is Roll Stabalized Only

HARDWARE CONFIGURATION

MBES Type:	R2Sonic 2024
Acoustic Centre Description:	Rx Array Face - Centre of Projector
MBES Processing Software:	SonicControl 2000 (Build 222013 18:14:32 UTC)
Speed of Sound Sensor:	Valeport MiniSVS
Motion Reference Unit:	Applanix POS MV
1PPS Source:	Applanix POS MV
Sector Size:	120°
Beam Width:	Narrow
Number of Beams:	256
Range, Gain & Display Gain	According to manual settings

TRANSDUCER LAYOUT DIAGRAM



SIGNED

Name : ALEX RICHARDS Signed : _____ Date : 19/07/2014

ONLINE RTK SURVEY CONFIGURATION

Date :	19/07/2014	Project # :	0191/Resurvey
Project :	FaBtest Survey	Surveyor :	Alex Richards
Vessel Name :	'MTS Xplorer'	Location :	Falmouth, UK

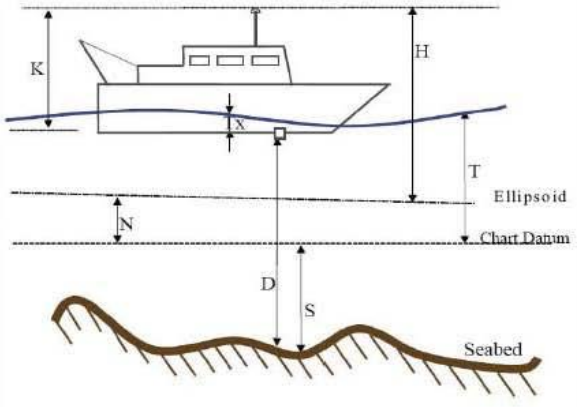
QINSy CONFIGURATION

Predefined Coordinate System:		ETRS89 to OSGB36 (OSTN02) / OSGM02
Datums:		OSGB36 (Survey Datum)
		ETRS89 (EUREF89)
Vertical Datum:		Geoid Height - OSGM02 (Gt Britain)
Height Offset Applied to Local CD:		-2.910m
Datum Shift:		ETRS89 (EUREF89) to OSGB36
Rotation Mode:		Position Vector Rotation (Bursa-Wolf)
	X Shift (dX):	-446.4480
	Y Shift (dY):	125.1570
	Z Shift (dZ):	-542.0600
	X Rotation (Rx):	-0.150200"
	Y Rotation (Ry):	-0.247000"
	Z Rotation (Rz):	-0.842100"
	Scale Correction:	20.48940000ppm
Projection Type:		Transverse Mercator (North Orientated)

HARDWARE CONFIGURATION

RTK Reciever:	Applanix POS MV 320 V5
Correction Source:	NTRIP (Hiretec)
Radio:	Internal Modem
Antenna Reference Point (ARP):	Bottom of Reciever Housing
ARP Offset to Phase Centre:	0.058m

GENERAL LAYOUT DIAGRAM



SIGNED

Name : Alex Richards Signed : _____ Date : 19/07/2014

SENSOR OFFSET DIAGRAM

Date :	19/07/2014	Project # :	0191/Resurvey
Project :	FaBtest Survey	Surveyor :	ALR
Vessel Name :	'MTS Xplorer'	Location :	Falmouth, UK

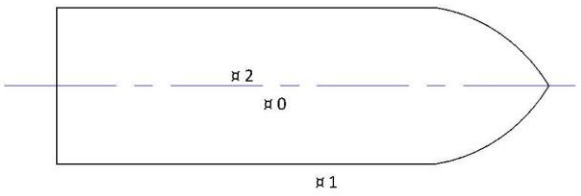
OFFSET MEASUREMENTS

Point	Offset Name	X (m)	Y (m)	Z (m)	Comments
0	IMU Ref	0.000	0.000	0.000	POS MV IMU
1	R2 MBES Tx	1.700	0.897	-2.840	MBES Tx
2	VCOR	-0.700	-0.300	-1.045	Vessel CoG
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

Offset Convention:

X = Positive to Stb of Datum
Y = Positive Ahead of Datum
Z = Positive Upwards of Datum at W/L

GENERAL LAYOUT DIAGRAM



* NOT TO SCALE - INDICATIVE POSITIONS ONLY

SIGNED

Name : ALEX RICHARDS Signed : _____ Date : 19/07/2014

SENSOR OFFSET DIAGRAM

Date :	19/07/2014	Project # :	0191/Resurvey
Project :	FaBtest Survey	Surveyor :	ALR
Vessel Name :	'MTS Xplorer'	Location :	Falmouth, UK

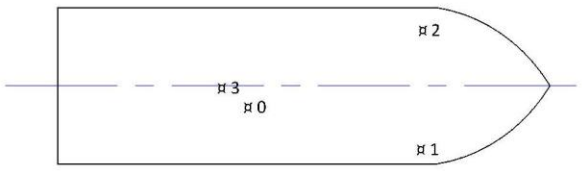
OFFSET MEASUREMENTS (POS MV)

Point	Offset Name	X (m)	Y (m)	Z (m)	Comments
0	IMU Ref	0.00	0.00	0.00	POS MV IMU
1	PRI ANT	6.041	0.937	-2.145	Primary Antenna
2	SEC ANT	6.041	-2.363	-2.145	Secondary Antenna
3	VCOR	-0.300	-0.700	1.045	Vessel CoG
4					
5					
6					
7					
8					
9					
10					
11					
12					

Offset Convention:

X = Positive to Bow of POS IMU
Y = Positive Stb of POS IMU
Z = Positive Downwards of POS IMU

GENERAL LAYOUT DIAGRAM



* NOT TO SCALE - INDICATIVE POSITIONS ONLY

SIGNED

Name : ALEX RICHARDS Signed : _____ Date : 19/07/2014

OFFLINE MBES PROCESSING LOG

Project Title	FabTest Survey	Project # :	0191-64567
Client :	University of Exeter	Acquisition Date :	19/07/2014
Processor :	Oli Cozens	Sheet :	1 of 1

QINSy DB Configurations:

Online DB Name :	0191-64567 FabTest Resurvey	QLOUd Cleaning Profile :	Clip Above -1m
Roll Offset Applied:	0.58		IHO Order 1 Filter
Pitch Offset Applied	-2.81		
Heading Offset Applied:	1.89		

MBES PROCESSING LOG

Seq Num	DB Line Name	Cal / Online	DB Offsets Applied	Data Replayed	Validator	SVP Applied	Data Cleaned in Qloud	Nav Surface	Gridded	Comments
01	Resurvey 190714-112122 Cal 1 270614 - 0001.db	C	✓	✓	✓	✓	✓	✓	✓	
02	Resurvey 190714-111534 Cal 1 270614 - 0001.db	C	✓	✓	✓	✓	✓	✓	✓	
03	Resurvey 190714-113412 Cal2 190714 - 0001.db	C	✓	✓	✓	✓	✓	✓	✓	
04	Resurvey 190714-112813 Cal2 190714 - 0001.db	C	✓	✓	✓	✓	✓	✓	✓	
05	Resurvey 190714-182546 0009 P-1 - 0001.db	O	-	-	-	-	-	-	-	DNP
06	Resurvey 190714-120535 0010 P-1 - 0001.db	O	✓	✓	✓	✓	✓	✓	✓	
07	Resurvey 190714-120535 0011 P-1 - 0001.db	O	✓	✓	✓	✓	✓	✓	✓	
08	Resurvey 190714-120535 0011 P-1 - 0002.db	O	✓	✓	✓	✓	✓	✓	✓	
09	Resurvey 190714-120535 0011 P-1 - 0003.db	O	✓	✓	✓	✓	✓	✓	✓	
10	Resurvey 190714-120535 0011 P-1 - 0004.db	O	✓	✓	✓	✓	✓	✓	✓	
11	Resurvey 190714-120535 0011 P-1 - 0005.db	O	✓	✓	✓	✓	✓	✓	✓	
12	Resurvey 190714-120535 0011 P-1 - 0006.db	O	✓	✓	✓	✓	✓	✓	✓	
13	Resurvey 190714-120535 0011 P-1 - 0007.db	O	✓	✓	✓	✓	✓	✓	✓	
14	Resurvey 190714-120535 0011 P-1 - 0008.db	O	✓	✓	✓	✓	✓	✓	✓	
15	Resurvey 190714-120535 0011 P-1 - 0009.db	O	✓	✓	✓	✓	✓	✓	✓	
16	Resurvey 190714-120535 0011 P-1 - 00010.db	O	✓	✓	✓	✓	✓	✓	✓	
17	Resurvey 190714-120535 0011 P-1 - 0011.db	O	✓	✓	✓	✓	✓	✓	✓	
18	Resurvey 190714-120535 0011 P-1 - 0012.db	O	✓	✓	✓	✓	✓	✓	✓	
19	Resurvey 190714-120535 0011 P-1 - 0013.db	O	✓	✓	✓	✓	✓	✓	✓	
20	Resurvey 190714-120535 0011 P-1 - 0014.db	O	✓	✓	✓	✓	✓	✓	✓	
21	Resurvey 190714-120535 0012 P-1 - 0001.db	O	✓	✓	✓	✓	✓	✓	✓	

SIGNED

Name : Oli Cozens Signed : _____ Date : 22/07/2014

A3 Principal Datasheets

High Resolution Multibeam Systems for:

Hydrography

Offshore

Dredging

Defense

Research

SONIC 2024

Multibeam Echo Sounder

Features:

- 60kHz Wideband Signal Processing
- Focused 0.5° Beam Width
- Selectable Frequencies 200-400kHz
- Selectable Swath Sector 10° to 160°
- System Range to 500m
- Embedded Processor/Controller
- Equiangular or Equidistant Beams
- Roll Stabilization
- Rotate Swath Sector

Applications:

- Hydrographic Survey
- Offshore Site Survey
- Pre & Post Dredge Survey
- Defense & Security
- Marine Research

System Description:

The Sonic 2024 is the world's first proven wideband high resolution shallow water multibeam echo sounder. With proven results and unmatched performance, the Sonic 2024 produces reliable and remarkably clean data with maximum user flexibility through all range settings to 500m.

The unprecedented 60 kHz signal bandwidth offers twice the resolution of any other commercial sonar in both data accuracy and image. With over 20 selectable operating frequencies to chose from 200 to 400 kHz, the user has unparalleled flexibility in trading off resolution and range and controlling interference from other active acoustic systems.

In addition to selectable operating frequencies, the Sonic 2024 provides variable swath coverage selections from 10° to 160° as well as ability to rotate the swath sector. Both the frequency and swath coverage may be selected 'on-the-fly', in real-time during survey operations.

The Sonar consists of the three major components: a compact and lightweight projector, a receiver and a small dry-side Sonar Interface Module (SIM). Third party auxiliary sensors are connected to the SIM. Sonar data is tagged with GPS time.

The sonar operation is controlled from a graphical user interface on a PC or laptop which is typically equipped with navigation, data collection and storage applications software.

The operator sets the sonar parameters in the sonar control window, while depth, imagery and other sensor data are captured and displayed by the applications software.

Commands are transmitted through an Ethernet interface to the Sonar Interface Module. The Sonar Interface Module supplies power to the sonar heads, synchronizes multiple heads, time tags sensor data, and relays data to the applications workstation and commands to the sonar head. The receiver head decodes the sonar commands, triggers the transmit pulse, receives, amplifies, beamforms, bottom detects, packages and transmits the data through the Sonar Interface Module via Ethernet to the control PC.

The compact size, low weight, low power consumption of 50W and elimination of separate topside processors make Sonic 2024 *very well suited* for small survey vessel or ROV/AUV operations.

R2Sonic LLC
1503-A Cook Pl.
Santa Barbara
California,
USA 93117

T: 805 967 9192
F: 805 967 8611

www.r2sonic.com

Spec Sheet version 3.2 February 2010. Subject to change without notice

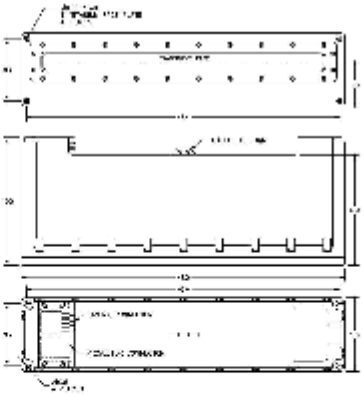
Sonic 2024 Multi Beam Echo Sounder

Systems Specification:	
Frequency	200kHz-400kHz
Beamwidth, across track	0.5°
Beamwidth, along track	1.0°
Number of beams	256
Swath sector	Up to 160°
Max Range	500m
Pulse Length	10µs-500µs
Pulse Type	Shaped CW
Ping Rate	Up to 60 Hz
Depth rating	100m
Operating Temperature	0°C to 50°C
Storage Temperature	-30°C to 55°C
Electrical Interface	
Mains	90-260 VAC, 45-65Hz
Power consumption	<50W
Uplink/Downlink:	10/100/1000Base-T Ethernet
Data interface	10/100/1000Base-T Ethernet
Sync In, Sync out	TTL
GPS	1PPS, RS-232
Auxiliary Sensors	RS-232
Deck cable length	15m
Mechanical:	
Receiver Dim (LWD)	480 x 109 x 190 mm
Receiver Mass	12 kg
Projector Dim (LWD)	273 x 108 x 86 mm
Projector Mass	6 kg
Sonar Interface Module Dim (LWH)	280 x 170 x 60 mm
Sonar Interface Module Mass	2.4 kg

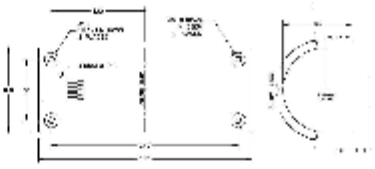
Sonar Options:

Snippets Imagery Output
Switchable Forward Looking Sonar Output
Mounting Frame & Hardware
Over-the-side Pole Mount
Sound Velocity Probe & Profiler
Extended Sonar Deck Cable, 25m or 50m
3000m Depth Immersion Depth

Sonar Interface Module



Sonic 2024 Receiver



Sonic 2022 Projector

High Resolution Multibeam Systems for:

Hydrography

Offshore

Dredging

Defense

Research

R2Sonic LLC
1503-A Cook Pl.
Santa Barbara
California,
USA 93117

T: 805 967 9192
F: 805 967 8611

www.r2sonic.com

Robust Position and Orientation Solutions for Marine Mapping

Applanix Position and Orientation Systems for Marine Vessels (POS MV) are engineered to support water science data collection operations, particularly those where accurate, uninterrupted, and robust solutions are needed for direct georeferencing and mapping. Professionals involved in surf zone and costal area mapping, harbor lane surveys, environmental assessments, channel inspection and dredging assessment, offshore resource exploration, erosion mapping, maritime and coastal waterway infrastructure inventory mapping depend on POS MV solutions.

Employing state-of-the-art high precision gyros which are tightly coupled to supporting GPS, the POS MV provides continuous and accurate position and orientation data logging for vessel and sensor guidance. Reliable POS MV output is produced in severe sea conditions, during periods of blocked or intermittent GPS, in areas where GPS reception is compromised by multipath effects, or at times when position drift must be reduced and faster signal reacquisition is essential.

POS MV delivers a full six degree-of-freedom position and orientation solution measuring location, velocity, attitude, and heave plus acceleration and angular rate vectors. Applanix marine solutions are able to affix position and orientation data accurately under the most demanding conditions, regardless of vessel dynamics, 200 times each second, making direct georeferencing and motion compensation for maritime remote sensing operations a productive and practical option.

PERFORMANCE SUMMARY - POS MV Accuracy

POS MV 320	DGPS	RTK	GPS Outage
Position	0.5 - 2 m[1]	0.02 - 0.10 m[1]	<2.5 m for 30 s outages, <6 m for 60 s outages
Roll & Pitch	0.020°	0.010°	0.020°
True Heading	0.020° with 2 m baseline 0.010° with 4 m baseline	-	Drift less than 1° per hour (negligible for outages <60 s)
Heave	5 cm or 5%[2]	5 cm or 5%[2]	5 cm or 5%[2]

POS MV WaveMaster	DGPS	RTK	GPS Outage
Position	0.5 - 2 m[1]	0.02 - 0.10 m[1]	<3 m for 30 s outages, <10 m for 60 s outages
Roll & Pitch	0.030°	0.020°	0.040°
True Heading	0.030° with 2 m baseline	-	Drift less than 2° per hour
Heave	5 cm or 5%[2]	5 cm or 5%[2]	5 cm or 5%[2]

POS MV Elite	DGPS	RTK	GPS Outage
Position	0.5 - 2 m[1]	0.02 - 0.10 m[1]	<1.5 m for 60 s outages DGPS, <0.5 m for 60 s outage RTK
Roll & Pitch	0.005°	0.005°	0.005°
True Heading	0.025°	0.025°	Drift less than 0.1° per hour (negligible for outages <60 s)
Heave	3.5 cm or 3.5%[2]	3.5 cm or 3.5%[2]	3.5 cm or 3.5%[2]

[1] One Sigma, depending on quality of differential corrections
[2] Whichever is greater, for periods of 20 seconds or less

AVAILABLE OPTIONS

	PCS-29	PCS-45	IMU-2	IMU-17	IMU-33
POS MV 320	X	X	X		
POS MV Wavemaster	X	X		X	
POS MV Elite	X				X

SYSTEM SPECIFICATIONS

COMPONENT	DIMENSIONS	WEIGHT	TEMPERATURE	HUMIDITY	POWER
PCS-29	L = 432mm, W = 89mm, H = 356mm	5 Kg	0 °C to +55 °C	10 - 80% RH	110/230 Vac, 50/60 Hz, auto-switching 80 W
PCS-45	L = 281mm, W = 165mm, H = 90mm	3 Kg	-20 °C to +60 °C	5 - 90% RH	24 Vdc, 50 W (peak)

HOUSING AND ADAPTOR PLATES

COMPONENT	DIMENSIONS	IP RATING
Waterproof Housing	L = 209 mm, H = 181 mm	IP68
Adaptor Plate	L = 135 mm, W = 142 mm, H = 19 mm	IP68

INERTIAL MEASUREMENT UNIT (IMU)

TYPE	DIMENSIONS	WEIGHT	TEMPERATURE	ORIGIN
IMU-2	L = 204 mm, H = 204 mm, W = 168 mm	4.5 Kg	-40 °C to +70 °C	US
IMU-17	L = 204 mm, W = 204 mm, H = 108 mm	3.6 Kg	-40 °C to +60 °C	US
IMU-33	L = 229 mm, W = 315 mm, H = 196 mm	3.5 Kg	-40 °C to +60 °C	US

GLOBAL NAVIGATION SATELLITE SYSTEM (GNSS)

COMPONENT	DIMENSIONS	WEIGHT	TEMPERATURE	HUMIDITY
GNSS Antenna	L = 187 mm Ø, W = 53 mm	0.64 Kg	-40 °C to +70 °C	0-100% RH

1. ETHERNET INPUT OUTPUT

Ethernet	(100 base-T)
Parameters	Time tag, status, position, attitude, heave, velocity, track and speed, dynamics, performance metrics, raw IMU data, raw GPS data
Display Port	Low rate (1 Hz) UDP protocol output
Control Port	TCP/IP input for system commands
Primary Port	Real-time (up to 200 Hz) UDP protocol output
Secondary Port	Buffered TCP/IP protocol output for data logging to external device

2. SERIAL RS232 INPUT OUTPUT

5 COM Ports	User assignable to: NMEA output (0-5), Binary output (0-5), Auxiliary GPS input (0-2), Base GPS correction input (0-2)

3. NMEA ASCII OUTPUT

Parameters	NMEA Standard ASCII messages: Position ($INGGA), Heading ($INHDT), Track and Speed ($INVTG), Statistics ($INGST), Attitude ($PASHR, $PRDID), Time and Date ($INZDA, $UTC).
Rate	Up to 50 Hz (user selectable)
Configuration	Output selections and rate individually configurable on each assigned com port.

4. HIGH RATE ATTITUDE OUTPUT

Parameters	User selectable binary messages: attitude, heading, speed
Rate	Up to 100 Hz (user selectable)
Configuration	Output selections and rate individually configurable on each assigned com port.

5. AUXILIARY GPS INPUTS

Parameter	NMEA Standard ASCII messages: $GPGGA, $GPGST, $GPGSA, $GPGSV. Uses Aux input with best quality.
Rate	1 Hz

6. BASE GPS CORRECTION INPUTS

Parameter	RTCM 1, 9, 18, 19, CMR and CMR+ input formats accepted. Combined with raw GPS observables in tightly-coupled navigation solution.
Rate	1 Hz

6. DIGITAL I/O

1PPS	1 pulse-per-second Time Sync output, normally high, active low pulse
Event Input (2)	Time mark of external events. TTL pulses > 1 msec width, rising or falling edge, max rate 200 Hz.

7. USER SUPPLIED EQUIPMENT

- PC for POS Controller (Required for configuration): Pentium 90 processor (minimum), 16 MB RAM, 1 MB free disk space, Ethernet adapter (RJ45 100 base T), Windows 98/2000/NT/XP
- PC for POSPac Post-processing Software: Pentium III 800Mhz or equivalent (minimum), 256 MB RAM, 400 MB free disk space, USB Port (For Security Key), Windows 2000/XP

Headquarters: 85 Leek Crescent Richmond Hill, ON Canada L4B 3B3 T 905.709.4600 F 905.709.6027
United Kingdom: Forester's House, Old Racecourse Oswestry UK SY10 7PW T 44 1691 659359 F 44 1691 659299
Texas: 17461 Village Green Drive, Houston TX USA 77040 T 713.896.9900 F 713.896.9919
www.applanix.com

applanix
A TRIMBLE COMPANY

EdgeTech
An Affiliate of ORE Offshore

4125
SIDE SCAN SONAR SYSTEM

FEATURES

- Ultra high resolution images
- Lightweight for one person deployment
- Standard heading, pitch, roll & pressure sensors
- Choice of dual simultaneous frequencies
- Runs on AC or DC
- Pole mount option for shallow water use

APPLICATIONS

- Hydrographic Surveys
- Geological Surveys
- Search & Recovery
- Channel/Clearance Surveys
- Bridge/Pier/Harbor Wall Inspection
- Hull Inspections

EdgeTech's 4125 Side Scan Sonar System was designed with both the Search & Recovery (SAR) and shallow water survey communities in mind. The 4125 utilizes EdgeTech's Full Spectrum® CHIRP technology, which provides higher resolution imagery at ranges up to 50% greater than non-CHIRP systems operating at the same frequency. This translates into more accurate results and faster surveys, thus cutting down on costs.

Two dual simultaneous frequency sets are available for the 4125 depending on the application. The 400/900 kHz set is the perfect tool for shallow water survey applications, providing an ideal combination of range and resolution. The 600/1600 kHz set is ideally suited for customers that require ultra high resolution imagery in order to detect very small targets (SAR).

There are two towfish options for the system; one with telemetry and one without. The towfish with added telemetry provides the ability to operate over longer tow cable lengths for operation in deeper waters. Both frequency sets are available for either towfish.

The 4125 system can be powered by both AC and DC for added versatility and is delivered in portable rugged cases for ease of transport from site-to-site. As is standard with all of EdgeTech's towed side scan systems, the 4125 comes with a safety recovery system which will prevent the loss of a towfish if it becomes snagged on an obstacle during a survey.

A standard 4125 System comes with a choice of towfish and a portable water resistant topside processor with a splash-proof, drop & shock resistant laptop computer including EdgeTech's easy-to-use Discover acquisition software. A 50m Kevlar tow cable is included as standard with customer-specified lengths also available. Multiple options are available such as a v-fin depressor, keel weight, pole mount and hull scan bracket for added versatility.

For more information please visit EdgeTech.com

info@EdgeTech.com | USA 1.508.291.0057

EdgeTech
An Affiliate of ORE Offshore

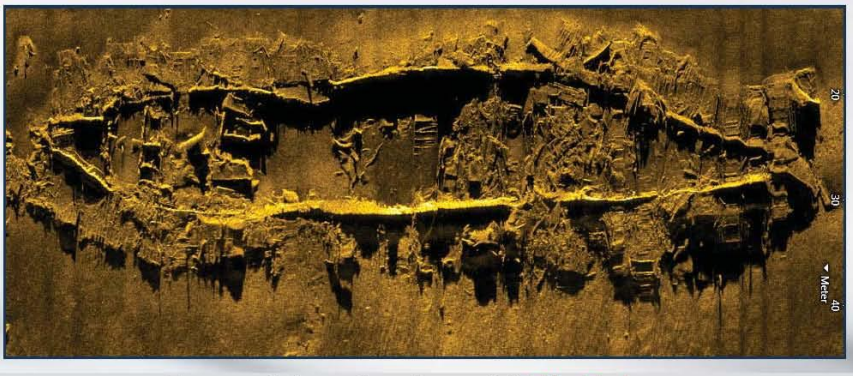
4125
SIDE SCAN SONAR SYSTEM

KEY SPECIFICATIONS

SONAR		
Frequencies (Dual Simultaneous)	Choice of either a 400/900 kHz or 600/1600 kHz towfish	
Pulse Type	EdgeTech's Full Spectrum® CHIRP (user-selectable CW pulses also included)	
Operating Range	150m @ 400 kHz, 75m @ 900 kHz; 120m @ 600 kHz, 35m @ 1600 kHz	
Horizontal Beam Width	0.46° @ 400 kHz, 0.28° @ 900 kHz; 0.33° @ 600 kHz, 0.20° @ 1600 kHz	
Vertical Beam Width	50°	
Resolution Across Track	400 kHz: 2.3 cm, 900 kHz: 1.5 cm, 600 kHz: 1.5 cm, 1600 kHz: 0.6 cm	
TOWFISH	**4125 Towfish**	**4125 Towfish with added telemetry***
Diameter	9.5 cm (3.75 inches)	9.5 cm (3.75 inches)
Length	97 cm (38 inches)	112 cm (44 inches)
Weight in Air	15 kg (34 pounds)	20 kg (44 pounds)
Tow Cable Type	Multi-conductor up to 150m max length (will provide a typical operational depth down to 50m)	Coaxial up to 600m max length (will provide a typical operational depth down to 200m)
Max Depth Rating of Towfish	200m	
Material	Stainless Steel	
Standard Sensors	Heading, Pitch, Roll, Pressure (Depth)	

** The 4125 Towfish with added telemetry is slightly larger to incorporate the electronics necessary to run over longer coaxial tow cables*

SPLASH-PROOF TOPSIDE PROCESSOR	
Power Input	12-24 VDC or 115/230 VAC, 50/60 Hz
Connections	AC, DC, Ethernet (to laptop), Towfish
Hardware	Ruggedized splash-proof, drop & shock resistant laptop
Operating System	Windows® XP
Acquisition Software	EdgeTech DISCOVER
SYSTEM OPTIONS	Keel weight, v-fin depressor wing, pole mount, quick change hull scan bracket



For more information please visit EdgeTech.com

info@EdgeTech.com | USA 1.508.291.0057

Performance
- water depth range: 0.5 – 400 m
- penetration: up to 40 m, depending on sediments
- layer resolution: up to 5 cm
- motion compensation: heave
- beam width @ 3 dB: ±2° / footprint < 7 % of water depth for all frequencies

Transmitter
- primary frequencies: approx. 100 kHz (band 85 – 115 kHz)
- secondary low frequencies: 4, 5, 6, 8, 10, 12, 15 kHz (band 2 – 22 kHz)
- primary source level: > 238 dB//µPa re 1 m
- pulse width: 0.07 – 1 ms
- pulse rate: up to 50/s
- multi-ping mode
- pulse type: CW, Ricker

Acquisition
- primary frequency (echo sounder, bottom track)
- secondary low frequency (sub-bottom data, multi-frequency mode)
- sample rate 96 kHz @ 24 bit

System Components
- transceiver unit 19 inch / 7 U (WHD: 0.52 m x 0.35 m x 0.40 m; 31 kg)
- transducer incl. 20 m cable (WHD: 0.34 m x 0.08 m x 0.26 m; 22 kg)
- system control: internal PC

SES-2000 light
Parametric Sub-bottom Profiler

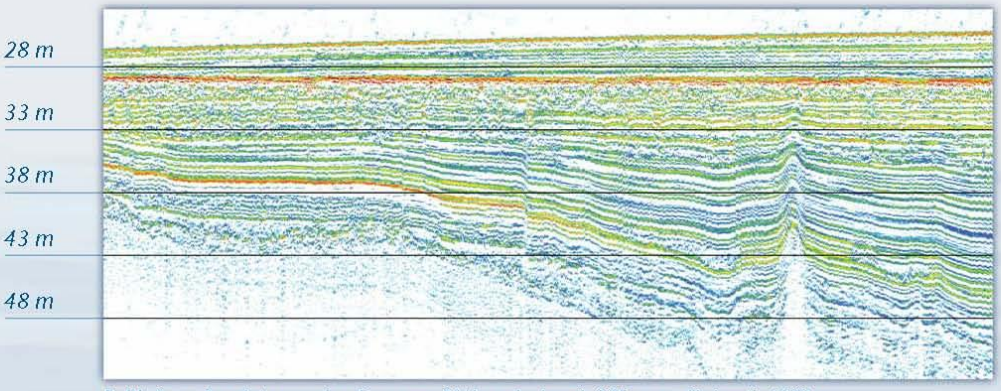
Software
- SESWIN data acquisition software
- SES Convert SEG-Y/XTF data export
- SES NetView remote display
- ISE post-processing software

Power Supply Requirements
- 100 – 240 V AC / 50 – 60 Hz
- power consumption: < 250 W

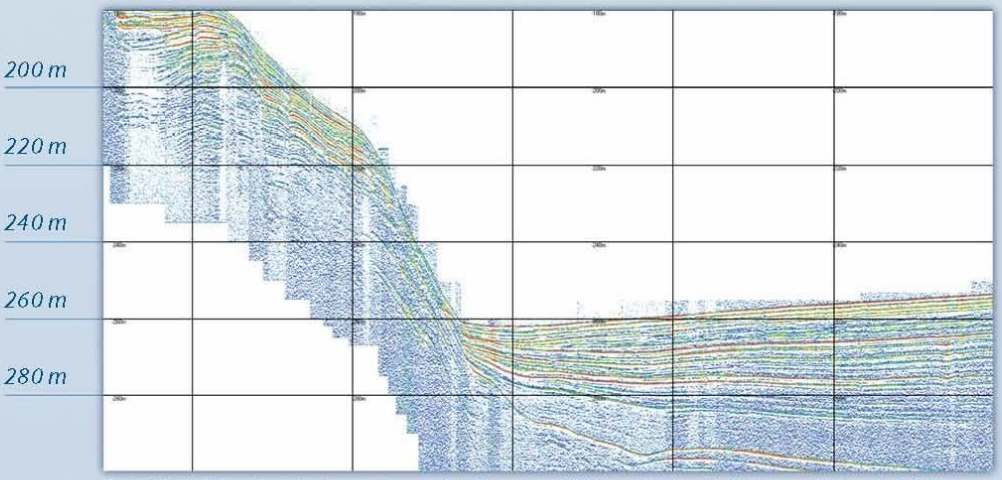
Innomar

www.innomar.com

Survey examples of SES-2000 light



Baltic Sea echo plot example – Frequency 8 kHz, pulse length 375 µs, profile length 4000 m



Lake Ohrid (Macedonia) echo plot example – Frequency 10 kHz, pulse length 500 µs, profile length 5500 m

Innomar Technologie GmbH

Schutower Ringstraße 4
D-18069 Rostock
Phone (Fax) +49 381 44079-0 (-299)
E-Mail info@innomar.com

www.innomar.com

Insight Marine Projects Ltd
19A Normandy Way
Bodmin
CORNWALL
PL31 1RB
United Kingdom
Tel: +44 (0)1208 77033
Fax: +44 (0)1208 74977

www.insight-marine.com