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REVISION HISTORY							
EMPLOYER REVISION	REVISION DATE	PREPARED BY	POSITION/TITLE	CHECKED BY	POSITION/TITLE	APPROVED BY	POSITION/TITLE
01	30/07/2018	Will Manning	Coastal Processes Scientist	Katie Musgrave	Work package leader	Dean Foden	Hinkley Point Programme Lead
02	13/12/2018	Will Manning	Coastal Processes Scientist	Dean Foden	Hinkley Point Programme Lead	Dean Foden	Hinkley Point Programme Lead

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REVISION STATUS/SUMMARY OF CHANGES

Revision	Purpose	Amendment	By	Date
01	Initial submission to NNB GenCo		Cefas	30/07/2018
02	Response to NNB GenCo comments	Appendix B1 presentation updated and minor comments addressed.	Cefas	31/08/2018
03	Response to NNB GenCo comments	Minor formatting updates addressed.	Cefas	13/12/2018

BEEMS Technical Report	TR457
BEEMS Technical Report Title	Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)
Sub-Contract Report Original Title:	Cardiff Grounds Survey: Bathymetric and Grab Sampling Survey (CS0534_Bathy_V1) (June 2018)
Sub-Contractor	Titan Environmental Surveys Limited

Summary of Purpose & Value to BEEMS

Installation of the intake and outfall heads for the Hinkley Point C (HPC) nuclear power station will require dredging to prepare the seabed and subsequent disposal of the dredged material. Consent to carry out this dredge is granted by the Marine Management Organisation in marine licence L/2013/00178/4, as amended (MMO, 2017). Permission to dispose of this material in disposal area LU110 (Cardiff Grounds) is granted in Natural Resources Wales in marine licence 12/45/MLv1 (NRW, 2018). To satisfy the conditions of marine licence 12/45/MLv1 (NRW 2018), monitoring requirements were agreed with NRW and are detailed in BEEMS Technical Report TR429 (Cefas, 2018).

Accordingly, bathymetric and grab sampling surveys were conducted by Titan Environmental Surveys Ltd. and reported in survey report "CS0534_Bathy_V1". Grab samples were analysed for particle size distribution by the Cefas laboratory (Table 1). The sources, dates and volumes of material disposed at LU110 during the 12 months prior to the survey have also been collated by Cefas (Table 2).

Changes to Scope of Works (SoW):

Eleven (11) grab sample sites were originally selected for analysis (TR429). Due to the northwest migration of Cardiff Grounds Bank from its chartered position, "Site 10" was moved 120 m to the NW and an additional "Site 12" was added adjacent to "Site 9". This additional station ensured that the survey adequately covered the Cardiff Grounds Bank. See Figure 1 herein and survey report "CS0534_Bathy_V1" Section 4.7 for full details.

Summary:

This Value-Added Statement (VAS) confirms that Cefas and Titan Environmental Surveys Ltd. have satisfactorily completed the agreed monitoring, stipulated by conditions of marine licence 12/45/MLv1 (NRW, 2018). Please see Table 3 for a summary of the required and completed monitoring requirements.

Table 1: Summary of particle size distributions for LU110. Samples acquired by Titan Environmental Surveys Ltd (see survey report "CS0534_Bathy_V1") and analysed by Cefas.

Sample Number	1	2	3	4	5	6	7	8	9	10	11	12
Sample Type	Bimodal, Very Poorly Sorted	Polymodal, Extremely Poorly Sorted	Trimodal, Very Poorly Sorted	Trimodal, Extremely Poorly Sorted	Trimodal, Very Poorly Sorted	Unimodal, Very Poorly Sorted	Polymodal, Extremely Poorly Sorted	Unimodal, Moderately Sorted	Unimodal, Well Sorted	Unimodal, Well Sorted	Unimodal, Well Sorted	Unimodal, Well Sorted
Textural Group	Slightly Gravelly Mud	Muddy Gravel	Muddy Gravel	Muddy Gravel	Gravelly Muddy Sand	Slightly Gravelly Mud	Gravelly Muddy Sand	Slightly Gravelly Sand	Sand	Sand	Slightly Gravelly Sand	Slightly Gravelly Sand
Sediment Name	Slightly Very Fine Gravelly Medium Silt	Medium Silty Very Coarse Gravel	Medium Silty Very Coarse Gravel	Fine Silty Coarse Gravel	Fine Gravelly Fine Silty Medium Sand	Slightly Very Fine Gravelly Medium Silt	Coarse Gravelly Medium Silty Medium Sand	Slightly Very Fine Gravelly Medium Sand	Well Sorted Medium Sand	Well Sorted Medium Sand	Slightly Fine Gravelly Medium Sand	Slightly Very Fine Gravelly Medium Sand
% Gravel	0.1	32.4	79.9	35.9	14.6	3.7	17.5	0.2	0.0	0.0	0.0	0.0
% Sand	7.1	17.7	9.2	5.2	54.3	9.1	48.8	94.8	100.0	100.0	100.0	100.0
% Mud	92.9	49.9	10.9	58.9	31.2	87.2	33.7	5.0	0.0	0.0	0.0	0.0
% V Coarse Gravel	0.0	25.1	35.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Coarse Gravel	0.0	0.0	20.5	15.2	0.0	0.0	6.4	0.0	0.0	0.0	0.0	0.0
% Medium Gravel	0.0	2.8	9.5	14.2	4.2	0.0	2.1	0.0	0.0	0.0	0.0	0.0
% Fine Gravel	0.0	2.5	11.5	3.7	5.7	1.5	4.1	0.0	0.0	0.0	0.0	0.0
% V Fine Gravel	0.0	2.1	2.9	2.8	4.7	2.2	4.9	0.2	0.0	0.0	0.0	0.0
% V Coarse Sand	0.1	3.1	4.5	1.7	3.8	1.1	5.7	1.3	0.0	0.0	0.0	0.0
% Coarse Sand	0.0	1.8	1.9	0.0	7.1	0.0	10.2	7.8	10.2	0.0	9.1	6.2
% Medium Sand	0.0	6.3	1.6	0.0	30.2	0.0	17.9	63.1	79.3	62.1	81.0	81.6
% Fine Sand	1.9	3.2	0.6	1.7	10.7	3.0	11.3	21.7	10.4	37.8	9.9	12.2
% V Fine Sand	5.1	3.2	0.6	1.8	2.4	5.0	3.8	0.9	0.0	0.0	0.0	0.0
% V Coarse Silt	8.1	3.9	0.9	3.7	2.5	7.3	3.7	0.5	0.0	0.0	0.0	0.0
% Coarse Silt	14.5	7.0	1.6	7.0	4.1	12.3	5.3	0.6	0.0	0.0	0.0	0.0
% Medium Silt	20.5	10.3	2.1	12.3	5.9	17.7	6.5	1.0	0.0	0.0	0.0	0.0
% Fine Silt	19.8	10.2	2.0	12.8	6.3	17.6	6.4	1.1	0.0	0.0	0.0	0.0
% V Fine Silt	12.6	7.5	1.6	9.1	4.8	13.0	4.5	0.7	0.0	0.0	0.0	0.0
% Clay	17.4	11.1	2.8	14.1	7.6	19.4	7.2	1.1	0.0	0.0	0.0	0.0

Table 2: Summary of material sources, dates and volumes disposed of at disposal site LU110 (Cardiff Grounds) during the 12 months prior to the survey. * NOTE: ABP Barry use disposal site LU115 and has not disposed of any material in LU110 during this period.

Material Source	Date of Disposal		Disposal Volume (m ³)
	Start	End	
ABP Barry*	n/a	n/a	0
ABP Cardiff	Jul-17	Jul-17	63,278
	Aug-17	Aug-17	51,353
	Oct-17	Oct-17	80,007
	Dec-17	Dec-17	135,429
	Jan-18	Jan-18	53,734
	Feb-18	Feb-18	43,096
	Mar-18	Mar-18	36,846
	Apr-18	Apr-18	17,196
Cardiff Harbour Authority	17-Jul-18	27-Jul-18	77,500
	14-Jan-18	25-Jan-18	80,511
Total			714,762

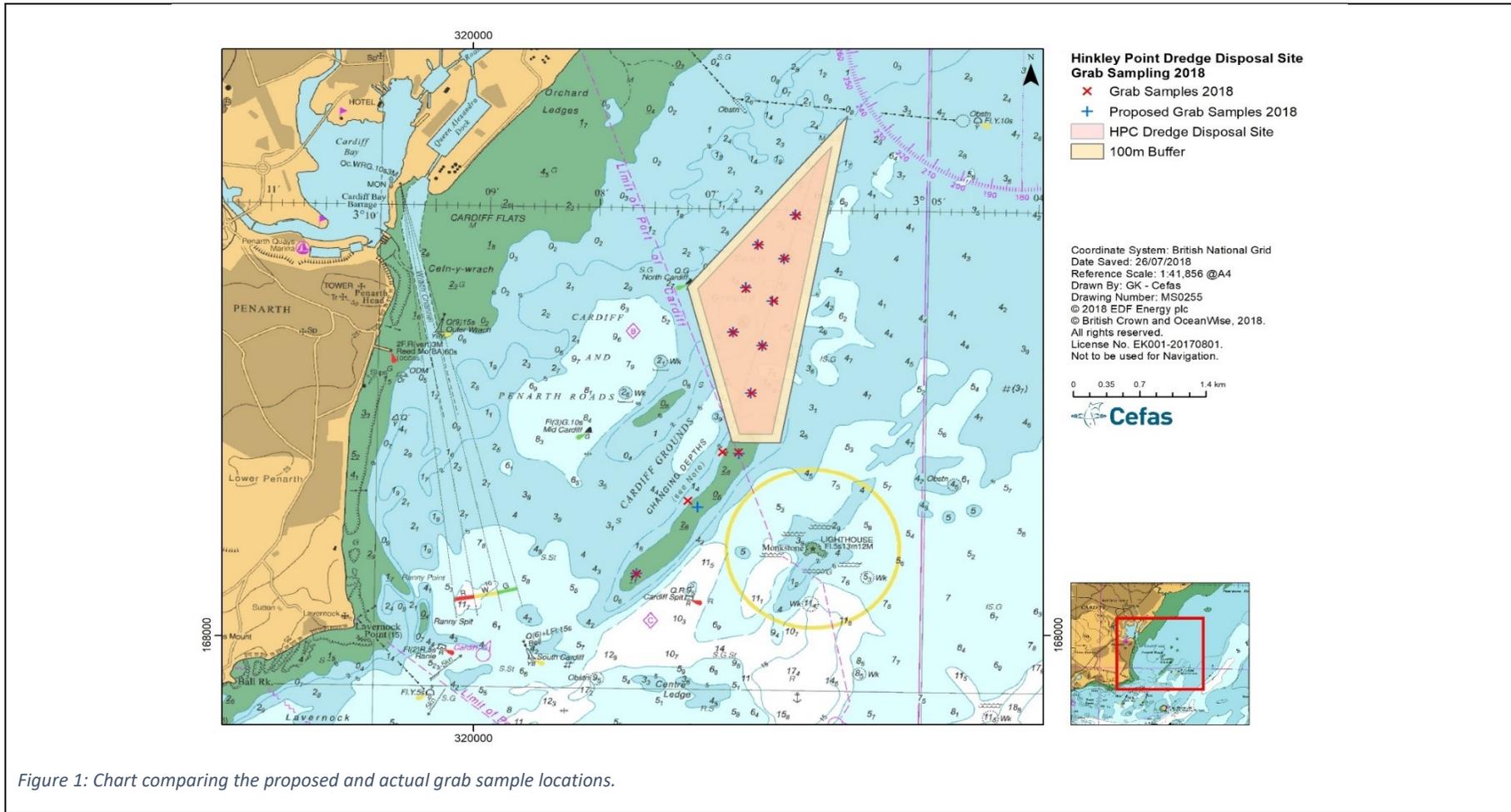


Figure 1: Chart comparing the proposed and actual grab sample locations.

Table 3: Summary of the required and completed monitoring requirements.

Agreed -re-disposal reporting content (from TR429)		Location of content
1	Details of survey operations.	See survey report "CS0534_Bathy_V1" and Appendix A.
2	A bathymetric chart of survey area.	See Appendix B.1. within survey report "CS0534_Bathy_V1". Please note, this chart will provide the baseline data for reference by the dredging contractor during the disposal of all material arising from the works under marine licence L/2013/00178/4, as amended (MMO, 2017), as permitted by marine licence 2/45/MLv1 (NRW, 2018).
3	A volume/area plot of disposal site above a representative contour (e.g. 1m below chart datum).	See Appendix B.3. within survey report "CS0534_Bathy_V1".
4	Figures of three transects (one through the centre of the disposal site along a SW-NE axis and two perpendicular cross-transects in the centres of the northern and southern sectors).	See Appendix B.4. within survey report "CS0534_Bathy_V1".
5	A chart showing the locations of the transects.	See Appendix B.1. within survey report "CS0534_Bathy_V1".
6	A chart showing the locations of the grab sampling sites.	See Appendix B.1. within survey report CS0534_Bathy_V1 and Figure 1 herein.
7	A table showing the coordinates of the grab sampling sites.	See Appendices C.1. and C.2. within survey report "CS0534_Bathy_V1".
8	A table showing the results of the particle size analysis.	See Table 1, reported herein.
9	A table showing the volumes and dates of disposed material from other sources during the 12 months prior to the survey (as provided by ABP Cardiff, ABP Barry and Cardiff Harbour Authority (Cardiff CC)).	See Table 1, reported herein.

References:

Cefas (2018) BEEMS Technical Report TR429. Hinkley Point C – Intake and outfall dredge disposal bathymetric survey plan. Cefas, Lowestoft.

Marine Management Organisation (2017) Marine and Coastal Access Act 2009: Part 4, Marine Licence L/2013/00178/3 (as amended), case reference MLA/2012/00259/2.

Natural Resources Wales (2018) Marine and Coastal Access Act 2009: Part 4 – Marine Licencing, Marine Licence: 12/45/MLv1.

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Cefas Quality Assessor:	Will Manning	
Position in Cefas / BEEMS:	Coastal Processes Scientist	
Date of Evaluation:	23/07/2018	24/08/2018
Internal QA:	Katie Musgrave	
Position in Cefas / BEEMS:	Work Package Leader	
Date of Evaluation:	27/07/2018	31/08/2018
Executive QA	Dean Foden	
Position in Cefas / BEEMS:	Hinkley Point Programme Lead	
Date of Evaluation:	03/08/2018	31/08/2018

Client:
CEFAS

Project:
Cardiff Grounds Survey

Description
Bathymetric and Grab Sampling Survey

Survey Date:
June 2018

Project Number:
CS0534



REPORT AUTHORISATION AND DISTRIBUTION

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Client Name and Address	CEFAS Pakefield Road Lowestoft Suffolk NR33 0HT
For attention of	Dean Foden

USE OF THIS REPORT

This report has been prepared with due care and diligence and with the skill reasonably expected of a reputable contractor experienced in the types of work, carried out under the contract. As such the findings in this report are based on an interpretation of data that is a matter of opinion on which professionals may differ and unless clearly stated is not a recommendation for any course of action.

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TITAN ENVIRONMENTAL SURVEYS LIMITED

Orion House, Parc Crescent, Waterton Ind. Est. Bridgend, CF31 3BQ, Wales, UK
Telephone +44 (0) 1656 673673 Fax +44 (0) 1656 673674
www.titansurveys.com

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1. Introduction

1.1 General

In June 2018, Titan Environmental Surveys Ltd was commissioned by CEFAS to conduct a bathymetric and grab sampling survey across the Hinkley Point Dredge Disposal Site located across Cardiff Spoil Grounds.

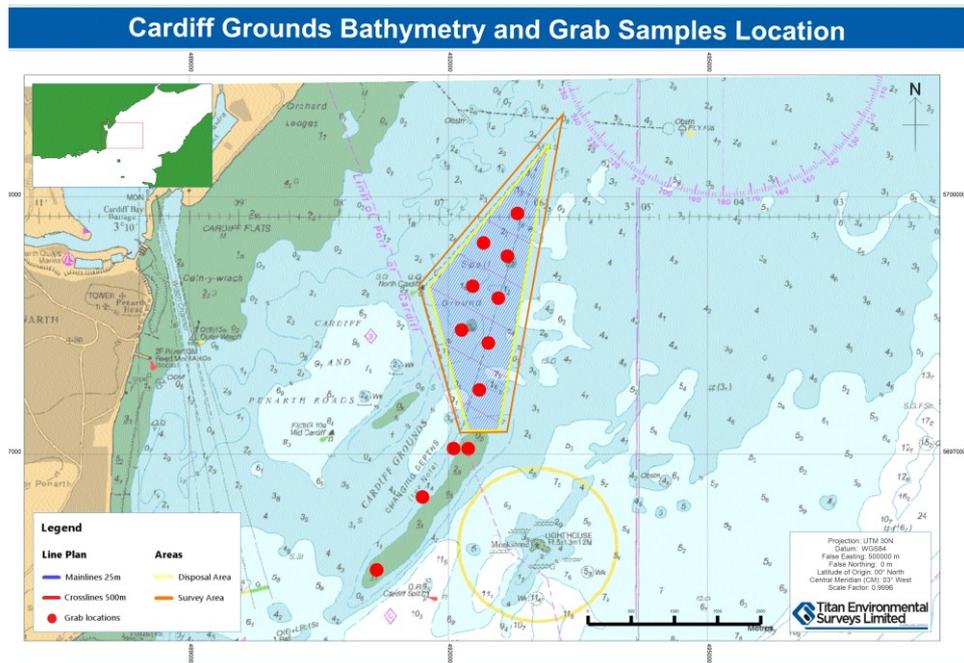


Figure 1.1 Survey Location

1.2 Scope of Work

Under the conditions set out by CEFAS the following tasks were to be performed:

- Multibeam survey utilising the Reson 7125 dual head system, mainlines max spacing 50m, crosslines 500m, 100% coverage, IHO Order 1a
- Grab Sampling using the mini-Hamon Grab across 12 sites, PSA and Radionuclides

All raw data was collected in WGS84 and transformed to OSGB36 in post processing. All co-ordinates provided in this report are referenced to OSGB36 and all depths are quoted to Chart Datum (CD). The survey area, defined by CEFAS is provided in OSGB36.

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Table 1.1 Survey Area Co-ordinates provided in OSGB36

Survey Area Boundary Points	Easting	Northing
1	323254	170303
2	322711	170302
3	322260	172027
4	323953	173998

Titan achieved this by running mainlines at a spacing no greater than 50m and ensuring sufficient overlap of the outer beams. Crosslines were run at 500m intervals. Grab samples were collected at 0.5 kg and 1 kg weights. 0.5 kg samples have been delivered to Cefas. 1 kg samples will be stored with Titan for up to **6 months** awaiting instruction from the client.

1.3 Reporting

This report; CS0534_Bathy_V1 details the operations and results of the survey carried out on the 22nd and 23rd of June; including details of instruments and methods adopted for the survey, calibration/verification of equipment, processing techniques and an assessment of data quality.

Table 1.2 Project Deliverables

Item	Details	Location
1	Details of survey operations	CS0534_Bathy_V1
2	A bathymetric chart of the survey area	Appendix B.1
3	A volume/area plot of disposal site above a representative contour (e.g. 1m below chart datum)	Appendix B.3
4	Figure of three transects (one through the centre of the disposal site along a SW – NE axis and two perpendicular cross-transects in the centre of the northern and southern sector)	Appendix B.4
5	A chart showing locations of the transects	Appendix B.2
6	A chart showing the locations of the grab sampling sites	Appendix B.2
7	A table showing the coordinates of the grab sampling sites	Appendix C.2
8	A table showing the results of the particle size analysis (N.B Requires results from CEFAS)	Appendix C.3
9	A table showing the volumes and dates of disposal material from other sources during the 12 months prior to the survey and dates of disposal material from other sources during the 12 months prior to the survey (as provided by ABP Cardiff #, ABP Barry and Cardiff Harbour Authority (Cardiff CC)) (N.B Requires previous data supplied by CEFAS)	Appendix C.4

2. Survey Operations

2.1 Personnel

Table 2.1 Key Titan Personnel

Key Personnel	
Technical Director	Mark O'Donovan
Project Manager	Gwyn Nelson
Lead Surveyor	Richard Dusgate

2.2 Vessel

The MV Titan Endeavour (Figure 2.1) was used to conduct survey operations on the Cardiff Grounds Bathy survey. The vessel is compliant to the Workboat Code Category 2 (60 nautical miles from a safe haven). Details of the vessel can be found [here](#) and an offset diagram showing the equipment arrangement has been provided in [Appendix A.1](#).



Figure 2.1 The MV Titan Endeavour

2.3 Summary of Operations

A summary of the principal survey activities is given in Table 2.2. A detailed description of the daily activities was presented as Daily Progress Reports during operations, copies of which were submitted to all parties concerned.

Table 2.2 Summary of Survey Activity

Survey Day	Date	Activity
1	22/06/2018	Run MBES mainlines
2	23/06/2018	Complete MBES mainlines, crosslines and 12 grab samples

2.4 Health, Safety and Environment

2.4.1 Health and Safety

All work was carried out in accordance with Titan's Health and Safety Policy. Prior to survey operations, all personnel joining the vessel were given a comprehensive safety briefing by the vessel skipper. This briefing included a detailed description of the survey work to be undertaken, all health and safety procedures aboard the vessel, and a demonstration of all safety equipment on board and its relevant location.

Health and safety toolbox meetings were conducted and recorded to discuss specific issues associated with the vessel or survey.

Any health and safety observations or incidents are recorded on GL30a Observation Cards. These are subsequently reviewed and assessed by Titan's Coastal Survey Manager and Gardline's Health and Safety department. No GL30a cards were submitted during the project duration.

2.4.2 Environment

Titan has recognised the increasing importance of environmental issues. Consequently, great store has been laid upon the protection of the environment with regard to all our operations. In addition to our Health and Safety Organisation, environmental considerations have been incorporated into our daily operations.

During this project:

- Field Staff complied with all relevant local, national and international environmental legislation, which impinged on survey activities. No changes to legislation during the course of this survey.
- All attempts were made to prevent / minimise pollution through: recycling of paper waste and printer cartridges; disposing of waste in a responsible manner; reducing energy use; encouraging the efficient use of transport fleet to both optimise the utilisation of fuel and minimise emissions to the environment.

3. Reference Control

3.1 General

All times quoted in this report are in Coordinated Universal Time (UTC), units of measurements refer to the metric system and all co-ordinates are referred to the OSGB36 horizontal datum. The vertical datum of acquired data is referred to CD.

3.2 Horizontal Control

Primary positioning was achieved using an Applanix POS MV WaveMaster operating in DGPS Mode. In addition positioning of swathe data has been enhanced by post processing data via POSpac MMS to improve positional and attitude data. Datum transformations from the WGS84 data provided by the DGPS receivers were transferred to OSGB36 using the OSTN02 grid transformation; see Table 3.1 and [Appendix A.2](#) for further details. The SPS852 was used as a secondary navigation to provide real-time dynamic comparisons and quality control (QC) of the primary navigation.

Table 3.1 Project Geodetic Parameters

Navigation System Datum	WGS84	Semi-major axis	6378137
		Semi-minor axis	6356752.3141
		Flattening (1/f)	298.25722
Job Datum	OSGB36: OSTN02 Transformation	Semi-major axis	6377563.396
		Semi-minor axis	6356256.9100
		Flattening (1/f)	299.32498
Projection:	Projection type		OSGB36
	Central Latitude		49°00.000'N
	Central Longitude		2°00.000W
	False easting		-100000
	False northing		400000
	Scale factor		0.9996012717

3.3 Vertical Control

All bathymetry data has been reduced to CD using the Vertical Offshore Reference Frame (VORF) model.

4. Equipment Details and Methods

4.1 Bathymetric Survey Spread Summary

Table 4.1 Navigation and Survey Equipment Summary

Navigation and Survey Equipment		
Integrated Navigation Software		Trimble HYDROpro
Primary Navigation		Applan POS MV WaveMaster
Secondary Navigation		Trimble SPS852
Heading		
	Primary	Applanix POS MV WaveMaster
	Secondary	Hemisphere Crescent
Single Beam Echosounder		Odom EchoTrac
Multibeam Echosounder		Reson 7125 Dual-head
	Motion Sensor	Applanix POS MV IMU
	Sound Velocity Sensor	Valeport Miniature Sound Velocity Sensor
	Sound Velocity Probe	Valeport Miniature Sound Velocity Profiler

4.2 Integrated Navigation and Data Acquisition System

- Trimble HYDROpro software package

The Integrated Navigation system operated by Titan Surveys is based around Trimble HYDROpro software that operates on a Windows operating system. This is connected to the vessels internal computer network via standard TCP/IP protocol. Titan Surveys predominately use HYDROpro Navigation for the acquisition and logging of position, heading, bathymetry, positional control information, quality control information and updating of real-time data along with navigational displays. HYDROpro also has a Guidance Object creator tool which allows the user to create survey lines and routes or targets. Once combined with positional, heading and velocity information the software can display the vessels position, distance and track data on helmsman VDU for efficient vessel steering and guidance in relation to a guidance object(s). When combined with high accuracy DGPS or RTK systems; HYDROpro can provide precise 3D positioning in Real Time. All raw and computed data is time tagged to improve real time system latency problems. All raw and computed data is stored within a single Microsoft Access database for efficient file management.

Titan utilised HYDROpro's navigation options to convert positional data to the relevant datum, to input antenna/sensor offsets (relative to the vessels common reference point), event triggering and graphical information display. HYDROpro was used to record event marks at every 20 seconds and a position every 5 meters which was output to the RAW data collected in HYDROpro.

Following collection, the navigation data was edited and processed using HYDROpro to produce a position track chart for the survey area of each instrument to facilitate the interpretation of the survey data.

4.3 Primary Navigation

- Applanix POS MV WaveMaster

An Applanix POS MV WaveMaster was used as the primary navigation system, primary heading system and for the determination of Post Processed Kinematic (PPK) tidal elevations. The POS MV WaveMaster is a tightly coupled system, which uses Applanix unique approach to Inertially Aided Real Time Kinematic technology (IARTK). The GNSS sub-system uses two antenna's and two low noise 72 channel GPS cards to enable logging of both GPS and GLONASS satellite information. The system has centimetre level accuracy of ellipsoidal altitude measurements, enabling highly accurate recording of tidal regimes using GPS technology.

The system was run in DGPS mode during survey operations and was further post-processed.

Table 4.2 Applanix POS MV WaveMaster: Technical Specification

Technical Specifications	
Channel	Two low noise 72 Channel GPS cards
Position	0.5 - 2.0 m (DGPS),
Roll & Pitch	0.03° (DPGS)
True Heading	0.03° with 2 m baseline
Heave	5cm or 5% whichever is greater for ≤20 sec periods

4.3.1 Differential Mode (EGNOS)

The PosMV WaveMaster was configured to receive differential corrections from the satellite transmitted EGNOS for the duration of the survey period. EGNOS consists of a network of ground reference stations and number of geostationary satellites that broadcast signals in the GPS band, providing corrections that increase the reliability, integrity and precision of the GPS signals.

4.3.2 Post Processed Kinematic Mode

PPK mode GPS was used for the tidal reduction of all bathymetric data. Whilst the PosMV was operating in European Geostationary Navigation Overlay System (EGNOS) mode on-board the survey vessel, data was also recorded internally within the receiver; which enabled post processing of the data.

The Position and Orientation System Post Processing Package (POSPac™) Mobile Mapping Suite (MMS) was used as the primary post processing software packages, achieving accuracy between 10cm and 15cm route mean square (RMS). Please see section 6 for information on the methods used to obtain PPK tides.

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Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 23 of 70
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4.4 Secondary Navigation

- Trimble SPS852

The SPS852 was used as the secondary navigation system during survey operations. The system was configured to receive DGPS for the duration of the survey. The system provided real-time comparisons of the primary navigation for QC purposes. Post processing of the data was available for tidal elevation comparisons.

Table 4.3 Trimble SPS852: Technical Specification

Technical Specifications	
Channel	72 Channel L1 C/A code
Horizontal Accuracy	0.25 m +1ppm RMS (DGPS)
Vertical Accuracy	0.5 m +1 ppm RMS (DGPS)
Precise Heading	0.09° (2 m antenna spacing) 0.05° (10 m antenna spacing)
Initialization time	Typically <10 seconds >99%

4.5 Heading

- Applanix POS MV WaveMaster

The Applanix PosMV Wavemaster system was used as the primary heading system. The PosMV system offers true heading accuracy,
A Hemisphere Crescent VS110 Compass System was used as a secondary heading system for quality assurance purposes. The hemisphere crescent comprises of two GPS antennas that use a moving base station RTK technique to provide heading information.

Table 4.4 POS MV WaveMaster: Technical Specification

Technical Specifications	
Channel	Two low noise 72 Channel GPS cards
True Heading	0.03° with 2 m baseline

4.6 Multibeam Echosounder

- Reson 7125 Dual-head MBES

The Reson SeaBat 7125 SV2 Full Rate Dual Head is a high accuracy beam forming multibeam echosounder system used to collect swath bathymetry data. The system offers dynamic, focused beams with ultra-high along track and across track beam resolutions.

For the duration of the survey the multibeam was operated on a 1024 equi-distant beam mode, which allows the system to maintain an extremely high resolution over the entire swath width, maximising both data collection efficiency and resolution. The transmit and receive elements of both transducer heads were rigidly mounted, alongside a motion sensor mini-SVS, and deployed through a centrally fitted moon pool configuration aboard the vessel. At the start of each survey day the two heads were connected, to act in unison from a master PC, and set-up with the system settings specific to the job. Data were recorded in the PDS2000, FeaturePack 4, acquisition software in both .PDS and .s7k format.

Table 4.5 Reson Seabat 7125: Configuration

Configuration	
Frequency	200 kHz
Power	220 dB
Pulse Type	Frequency Modulated
Along-track beamwidth	2° (200 kHz)
Across-track beamwidth	1° (200 kHz)
Depth Resolution	6 mm
Number of Beams	512 (200 kHz)

The PosMV Wavemaster was used for attitude correction for the MBES system. As part of the Wavemaster the Inertial Measurement Unit (IMU) contains 3 gyroscopes and 3 accelerometers, which enables adherence to IHO standards on high specification Multibeam sonar systems out to sonar swath widths greater than $\pm 75^\circ$, under all dynamic conditions. The PosMV system offered true heading accuracy, highly accurate heave measurement using two sided filtering techniques (True Heave).

4.6.1 Sound Velocity Sensor

- Valeport Miniature Sound Velocity Sensor

A Valeport mini-SVS was mounted onto the bathymetry system to record continuous real-time sound velocity. The values from the sensor were applied directly into the bathymetry user interface. Specifications for the unit can be found in Table 4.6.

Table 4.6 Valeport Miniature Sound Velocity Sensor: Technical Specification

Technical Specifications	
Velocity Range	1400 ms ⁻¹ – 1600 ms ⁻¹
Velocity Resolution	0.001 ms ⁻¹
Velocity Accuracy	± 0.06 ms ⁻¹

4.6.2 Sound Velocity Sensor

- Valeport Miniature Sound Velocity Profiler

A Valeport miniature Sound Velocity Probe (mini-SVP) was deployed to record vertical sound velocity profiles through the water column and as quality control against the transducer mounted mini-SVS. The unit was a self-recording/direct reading instrument, which allowed readings to be taken at set depth intervals of 0.5m. The data was downloaded as text files and uploaded into GeoSwath. The unit specifications can be seen in Table 4.7.

Table 4.7 Valeport Miniature Sound Velocity Profiler: Technical Specification

Technical Specifications	
Velocity Range	1400 ms ⁻¹ – 1600 ms ⁻¹
Velocity Resolution	0.001 ms ⁻¹
Velocity Accuracy	±0.06 ms ⁻¹
Pressure Range	50 dbar
Pressure Resolution	0.005% FS
Pressure Velocity Accuracy	±0.1% FS Range

4.7 Mini Hamon Grab Sampling

- Mini Hamon Grab

12 x 0.5lt and 12 x 1kg samples were obtained for PSA and radionuclide analysis respectively, using the Mini Hamon Grab deployed via the central A-frame on-board the Titan Endeavour. 11 sampling locations were originally selected however due to the fact that Cardiff Grounds Bank had migrated north west from its charted position, Site 10 was moved 120m to the NW and an additional Site 12 was added adjacent to Site 9 on-top of Cardiff Grounds Bank. The logs and coordinates of the grab samples can be found in Appendix [C.1](#) and [C.2](#) respectively.

5. Calibration and Verification

5.1 Navigation Quality Control

5.1.1 Static Navigation Verification

A navigation calibration was carried out on 10/06/2018 between primary and secondary navigation systems, whilst the vessel was static alongside in Penarth Marina. The GPS antenna positions were logged for approximately 1 hour. The results of the checks indicate that the DGPS positions had an average difference in position of 0.07 E and 0.12 N, see Figure 5.1. Further information can be found in [Appendix A.3](#).

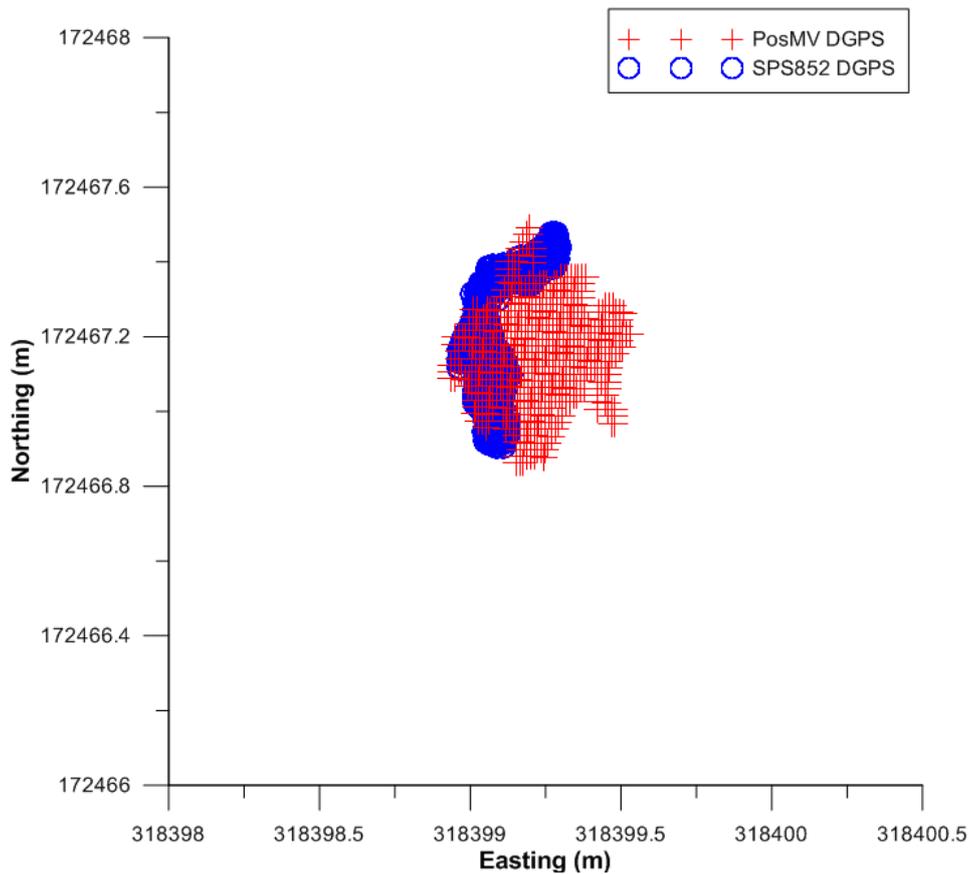


Figure 5.1 Navigation Static Verification Scatter Plot

5.1.2 Absolute Accuracy, Dynamic Verification

During survey operations, comparisons were made between the primary and secondary navigation systems. Analysis suggested that an average difference in Easting of 0.053m and an average difference in Northing 0.072m was recorded confirming the accuracy of the primary navigation system.

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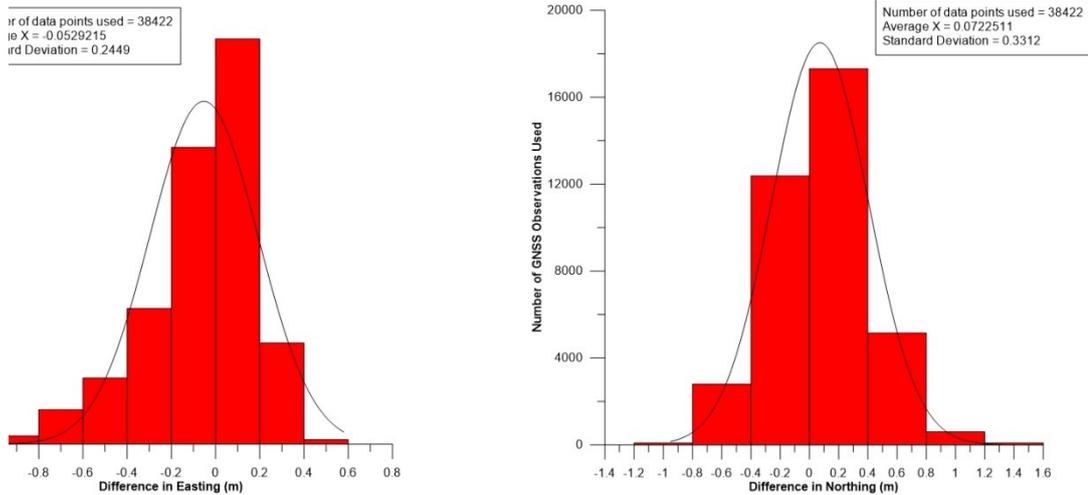


Figure 5.2 Difference in Easting and Northing between the Primary and Secondary Navigation Systems during Survey Operations

Throughout the survey GPS quality figures were logged for each fix. These figures were processed and presented in tabulated form to enable positional verification. Sigma figures are generated for the axes of Sigma North, Sigma East and Sigma Up. Each individual sigma display was a probability estimate of how close actual position was to the GPS displayed position. Given the sigma values for a position fix, it was possible to construct an error ellipse; this was a graphical representation of the position fix, which displayed the indicated GPS position at the centre of the ellipse with the relevant sigma error ellipse centred on this position (Figure 5.3). The 1-sigma error ellipse represented the probability that a position fix was within 68% of the indicated position and the two-sigma error ellipse represented the chance of a position fix being within 86.4% of the indicated position.

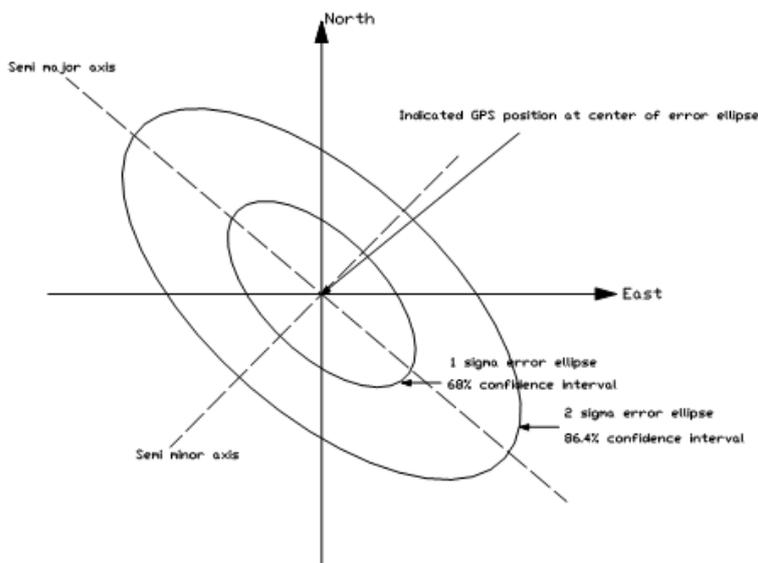


Figure 5.3 Schematic Diagram of a Two-Sigma Error Ellipse

Figure 5.4 below displays histograms of the Sigma East and Sigma North values recorded for the Primary Navigation for the duration of the survey with the average Sigma East and Sigma North at 0.397 and 0.471 respectively.

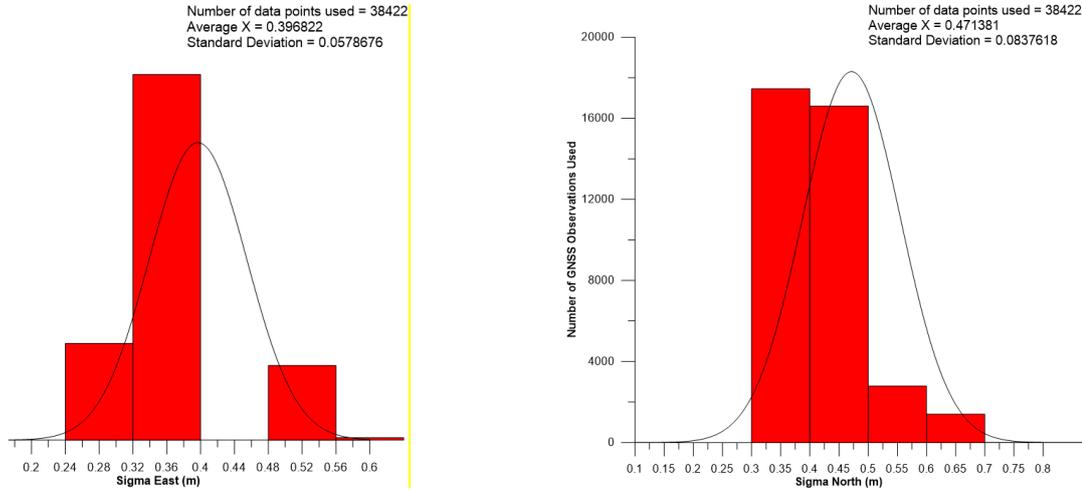


Figure 5.4 Sigma East and North Recorded from the Primary Navigation System for the Duration of the Survey

5.1.3 Heading Verification

A heading calibration was conducted alongside the navigation calibration. This enabled a direct comparison of the primary and secondary heading systems/known heading of the pontoon, see Figure 5.5. Further information can be found [Appendix A.4](#).

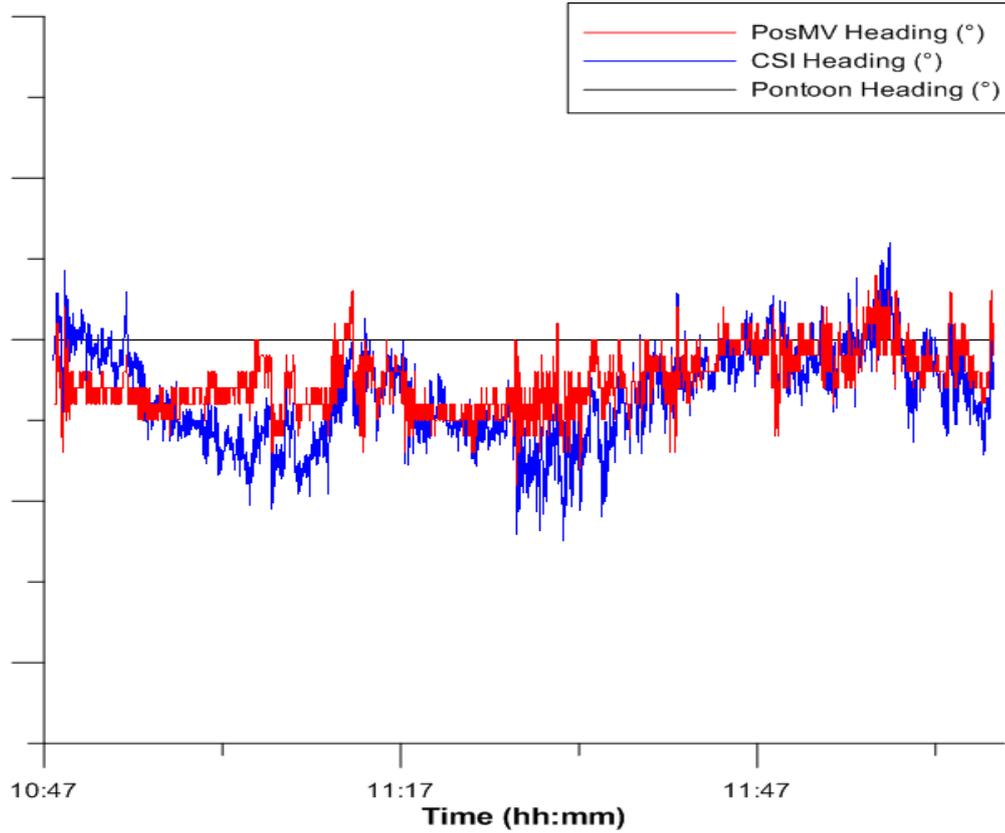


Figure 5.5 Heading Verification Plot

5.2 Swathe Calibration – Patch Test

A patch test was completed on 13/06/2018 to establish the correct motion sensor offset angles for the MBES system. The patch test consisted of the motion sensor offset values in the acquisition software being set to 0.00, and running the standard set of patch test lines. For more information see [Appendix A.5](#). Latency was negated using a 1 PPS string from the primary navigation to ensure timings with the MBES system was constantly synchronised to GPS time; thus making the latency 0.00s. See results in Table 5.1 and Figure 5.6 below.

Table 5.1 Swathe Calibration Results

	Port	Starboard
Latency	0.00s	0.00s
Roll	14.79	-14.51
Yaw	1.07	0.95
Pitch	0.63	0.68

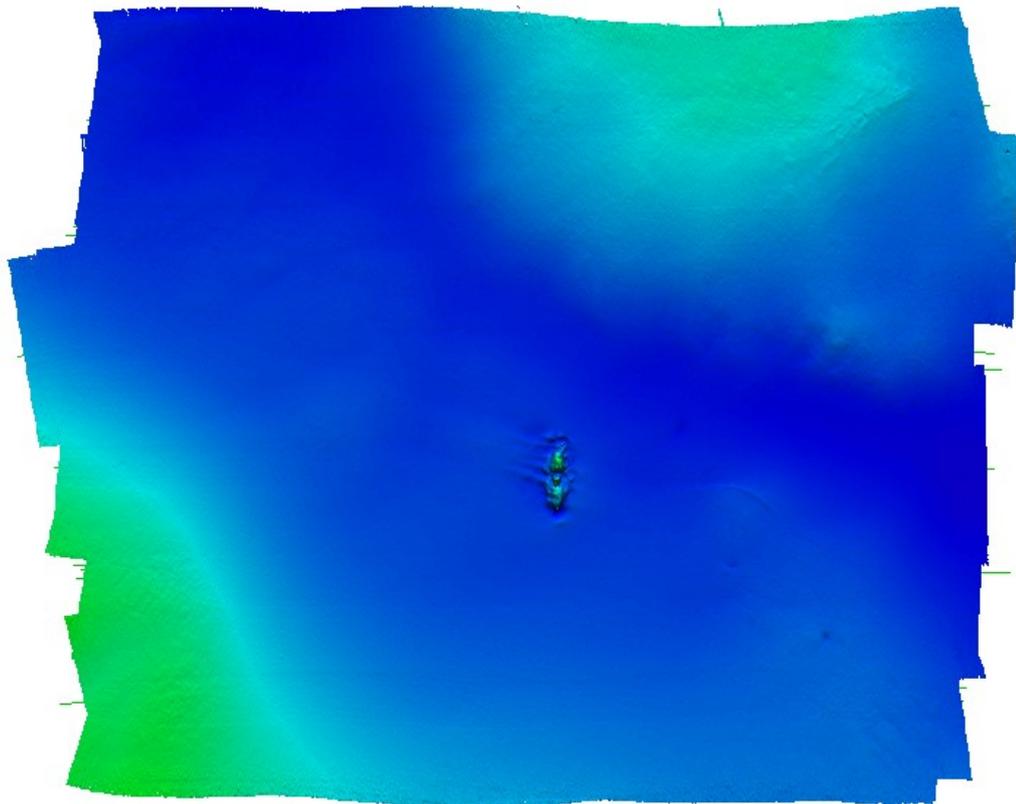


Figure 5.6 Calibration Results applied for the Patch Test Area

6. Data Processing

6.1 Post Processed Kinematic Tide

Titan processed observed tidal heights from the POSMV using Applanix POSPac MMS to derive a PPK tide, which was later used to reduce bathymetry data to the specified vertical datum. The software package, which includes IN-Fusion technology, provided multiple processing modes to handle different combinations of rover and reference GNSS data that occurs during a survey.

VRSNow Rinex Continuously Operating Reference Stations (CORS) were downloaded to triangulate the position of the vessel. CORS stations were downloaded for Cardiff (GBCD).

The SingleBase processing mode was utilised for this project to provide accurate positional and height corrections to the RAW data. The data is run through the GNSS Inertial Processor which uses the position of the GNSS receivers and a velocity solution from the IMU unit to achieve a final post processed trajectory solution.

The data is QC'd within POSPac MMS before being exported as a Smoothed Best Estimate Trajectory (SBET), i.e. the PPK Tide. Tidal elevations were QC'd through comparisons against predicted tides for:

- Cardiff
- Barry
- Clevedon
- Newport

6.2 Multi Beam Bathymetry Processing

- Caris Hips and Sips v9.1

Caris Hips and Sips v9.1 processing package was used to process the swathe bathymetry data collected.

Data files are converted into Caris format (HDCS) before the software can carry out any processing or cleaning. Once in this format a project can be opened for the analysis of data.

Before the swathe data is examined, the sensor data (attitude and navigation) is inspected. During this process the sensor data can be queried or rejected using either a break or an interpolation between points. Both attitude and navigation data can be smoothed and/or interpolated. In the case of the attitude data interpolation is not required, but navigation data require some method of interpolation to provide positional data for pings that fall between navigation epochs. At this point in the process the SBET files are imported to ensure the correct data is used.

Following SBET application, Sound Velocity Correction is applied.

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Once this has been undertaken tidal data are applied. The tides are generated using GNSS height observations combined with the UKHO VORF model.

The next stage is to merge selected lines. The merge process is actually combining the sensor data, tides and offsets contained in the Vessel Configuration File to produce geo-referenced data.

The raw weighted grid is then created and is then kept and used as a control surface for all data cleaning. Before further cleaning is carried out the raw grid is inspected to identify possible targets and/or noise within the data.

Lines then have a global (applied on a line by line basis after assessment) set of filtering parameters applied. The purpose of this is to carry out functions such as rejecting beams, depth filters, quality filters and applying a de-spike filter on a line-by-line basis.

After filtering, the processed Base Surface can be recomputed and compared with the original raw grid to ensure possible targets have not been flagged out. Further examination will then be carried out using the swathe editor and subset editors.

The swathe editor and subset editor processes are used in an iterative approach before a final Base Surface is created. Caris does not actually remove any data points, it will either flag the point as being accepted or rejected. If the point is rejected the reason for the rejection will also be available (e.g. manually removed, line filtered, statistically cleaned). In most of the Caris component programs it is also possible to query data from which a full history of the sounding can be found. It is possible to display flagged data, so that soundings over targets can be viewed to ensure all relevant soundings are kept. The queries can be saved to text files and so information such as position, time, sounding and tide can be exported giving the ability to compare the co-tidal model used with single point models for the sounding location.

A final base surface is created in the OSGB36 coordinate system and then exported into an ASCII xyz format. The full workflow is outlined in Figure 6.1 for all processing in Caris.

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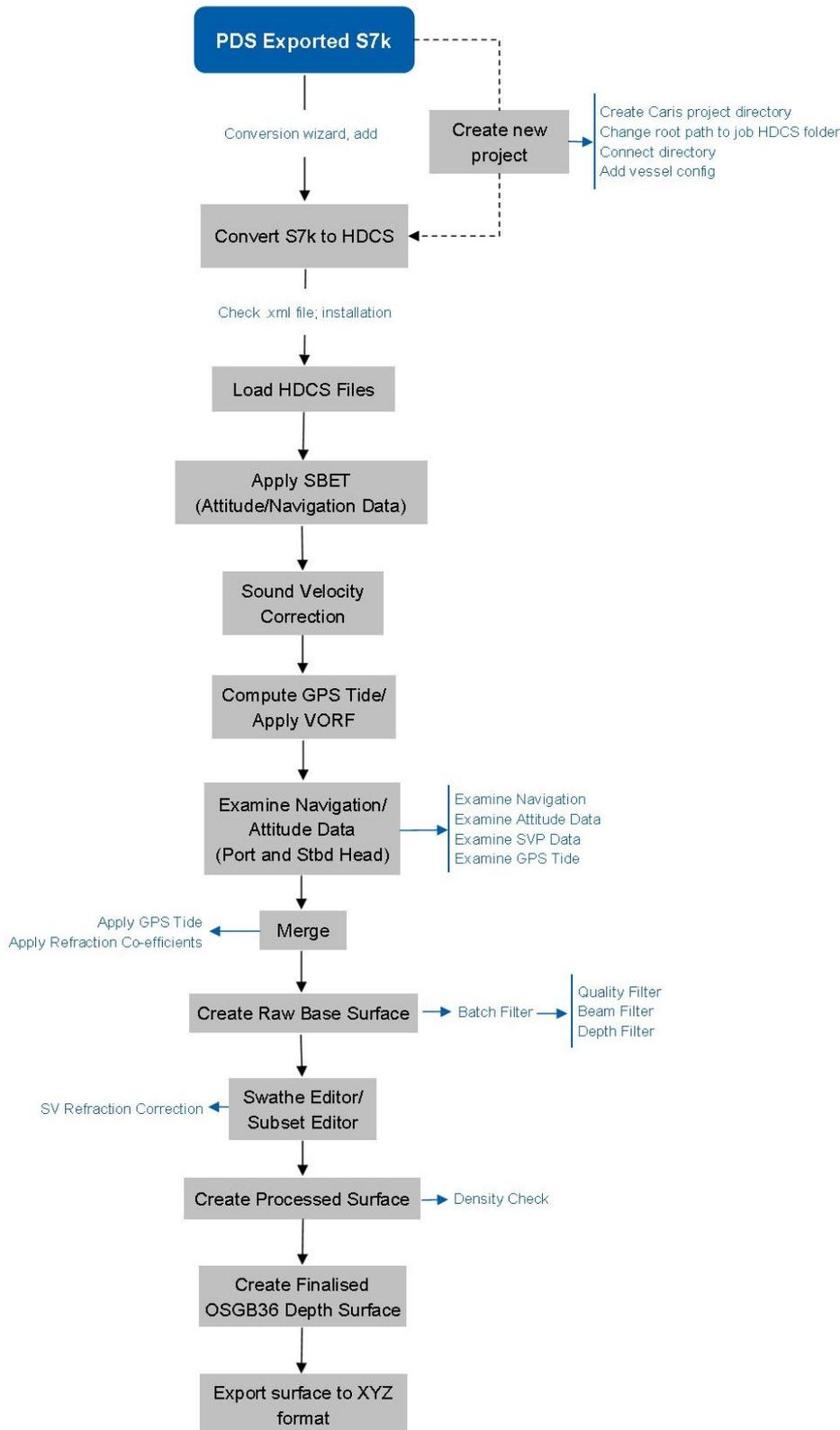


Figure 6.1 Caris MBES Processing Workflow

APPENDIX A

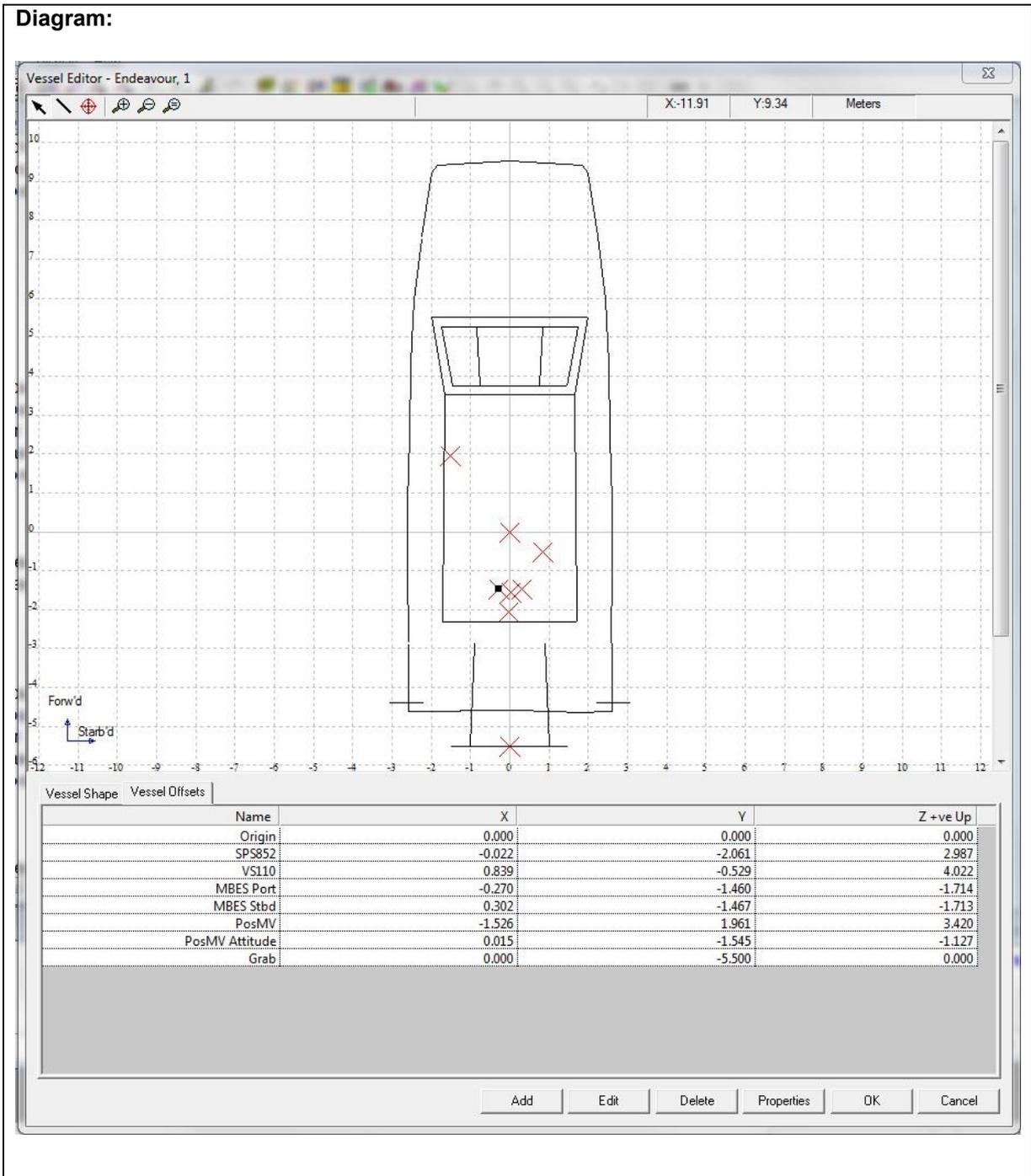
TITAN QUALITY ASSURANCE

A.1	MV Titan Endeavour Vessel Offset Diagram
A.2	Navigation and Geodesy Summary
A.3	Navigation Verification
A.4	Gyro Verification
A.5	MBES Patch Test Summary

A.1 MV TITAN ENDEAVOUR VESSEL OFFSET DIAGRAM

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	<h2 style="margin: 0;">TQA042 Vessel Offset Diagram</h2>						
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">Client: CEFAS</td> <td style="width: 50%;">Project Name: Cardiff Ground Survey</td> </tr> <tr> <td>Project Code: CS0534</td> <td>Personnel: RD GM BH</td> </tr> <tr> <td colspan="2">Vessel: MV Titan Endeavour</td> </tr> </table>	Client: CEFAS	Project Name: Cardiff Ground Survey	Project Code: CS0534	Personnel: RD GM BH	Vessel: MV Titan Endeavour		
Client: CEFAS	Project Name: Cardiff Ground Survey						
Project Code: CS0534	Personnel: RD GM BH						
Vessel: MV Titan Endeavour							



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A.2 NAVIGATION AND GEODESY SUMMARY

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Titan Environmental Surveys Limited		TQA004 Navigation & Geodesy	
Client: Cefas		Project Name: Cardiff Grounds Survey	
Project Code: CS0534			
Issued By:	RD		
Checked By:	MJ		
Approved By:			
Navigation System Datum:	WGS84 : ETRF89	Semi Major Axis	6378137
		Semi minor Axis	6356752.3141
		Flattening (1/f)	298.25722
Job Datum: OSGB36 : OSTN02 Transformation		Semi Major Axis	6377563.396
		Semi minor Axis	6356256.9100
		Flattening (1/f)	299.32498
Projection: OSGB36		Central Latitude	49°00.000'N
		Central Longitude	2°00.000'W
		False Northing	-100000
		False Easting	400000
		Scale Factor	0.9996012717
Datum Transformation from Navigation System Datum to Job Datum		Rotation X (secs)	OSTN02
		Rotation Y (secs)	N/A
		Rotation Z (secs)	N/A
		Scale Factor (ppm)	N/A
		Translation X (m)	N/A
		Translation Y (m)	N/A
		Translation Z (m)	N/A
Co-ordinate System Group		OSGB36	
Zone		OSGB36	
Datum Transformation		OSTN15	
Geoid Model		OSGM15	
TEST POINT CALCULATION from Navigation System Datum to Job Datum			
Latitude	51°22.537'N	Easting	3222225.113
Longitude	003°07.129'W	Northing	164658.076
Height	60m	Height	60m
PRIMARY NAVIGATION SYSTEM		SECONDARY NAVIGATION SYSTEM	
GPS Receiver	POSMV Wavemaster	GPS Receiver	Trimble SP5852
Differential Receiver	EGNOS	Differential Receiver	EGNOS
Differential Base Station Operator	EGNOS	Differential Base Station Operator	EGNOS
Differential Base Station	Site name: EGNOS	Differential Base Station	N/A : EGNOS
	Latitude: N/A		Latitude: N/A
	Longitude: N/A		Longitude: N/A
	Frequency: N/A		Frequency: N/A
	Nominal range: N/A		Nominal range: N/A

A.3 NAVIGATION VERIFICATION

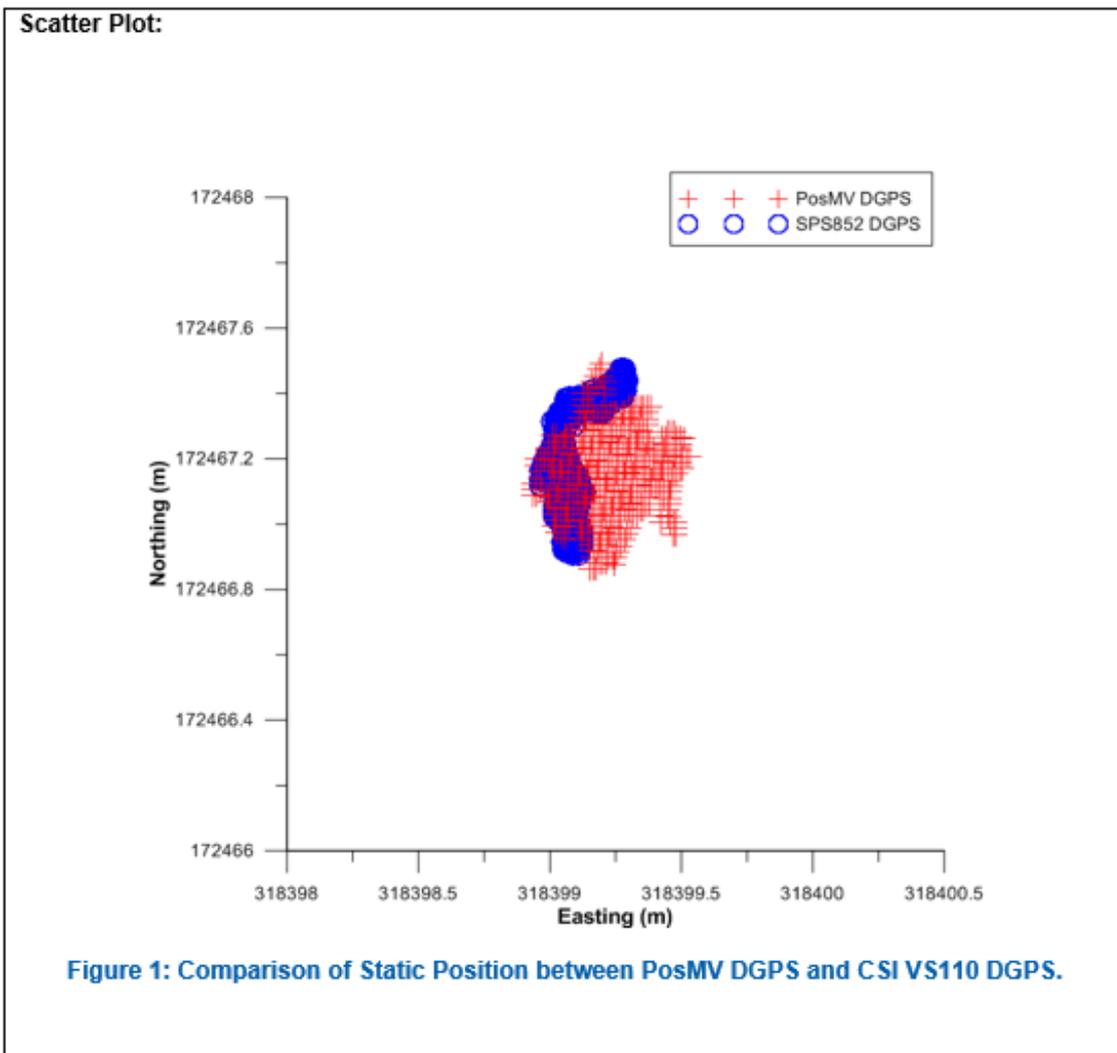
Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 41 of 70
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 Titan Environmental Surveys Limited <small>A GAROLINE COMPANY</small>	TQA017a Navigation Verification Form	
	Client: CEFAS Project Code: CS0534	Project Name: Cardiff Grounds Survey Personnel: RD GM BH

Occupied Station: MV Titan Endeavour Network Info: Datum: OS National Grid (OSTN02)	Station Code: <u>TEn</u> Date Occupied: 10/06/2018 Ellipsoid: Airy 1830
--	--

Primary Equipment Used:	
Receiver: Applanix POS MV WaveMaster Frequency: N/A	Differential Mode: DGPS Differential Station: EGNOS

Secondary Equipment Used:	
Receiver: Trimble SPS852 Frequency: N/A	Differential Mode: DGPS Differential Station: EGNOS



Histograms:

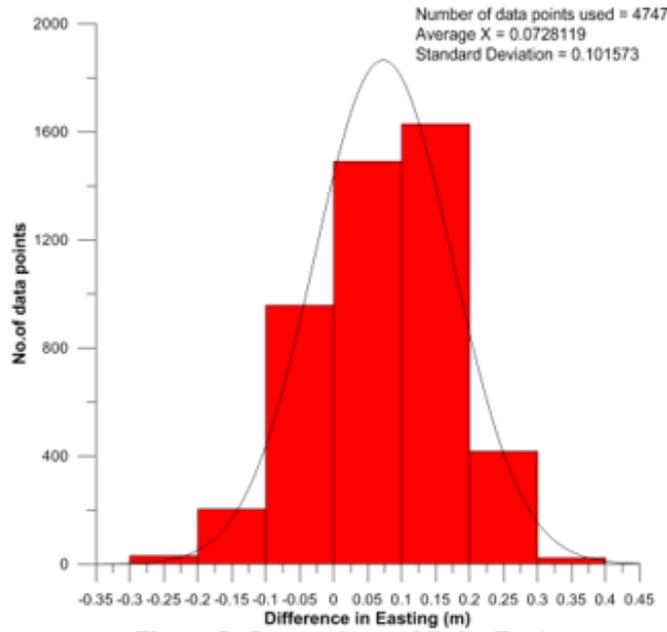


Figure 2: Comparison of Delta East

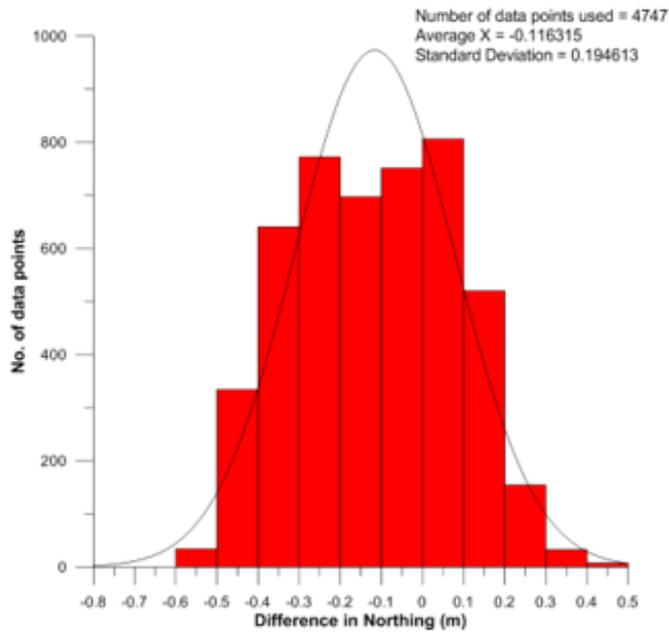


Figure 3: Comparison of Delta North

A.4 GYRO VERIFICATION

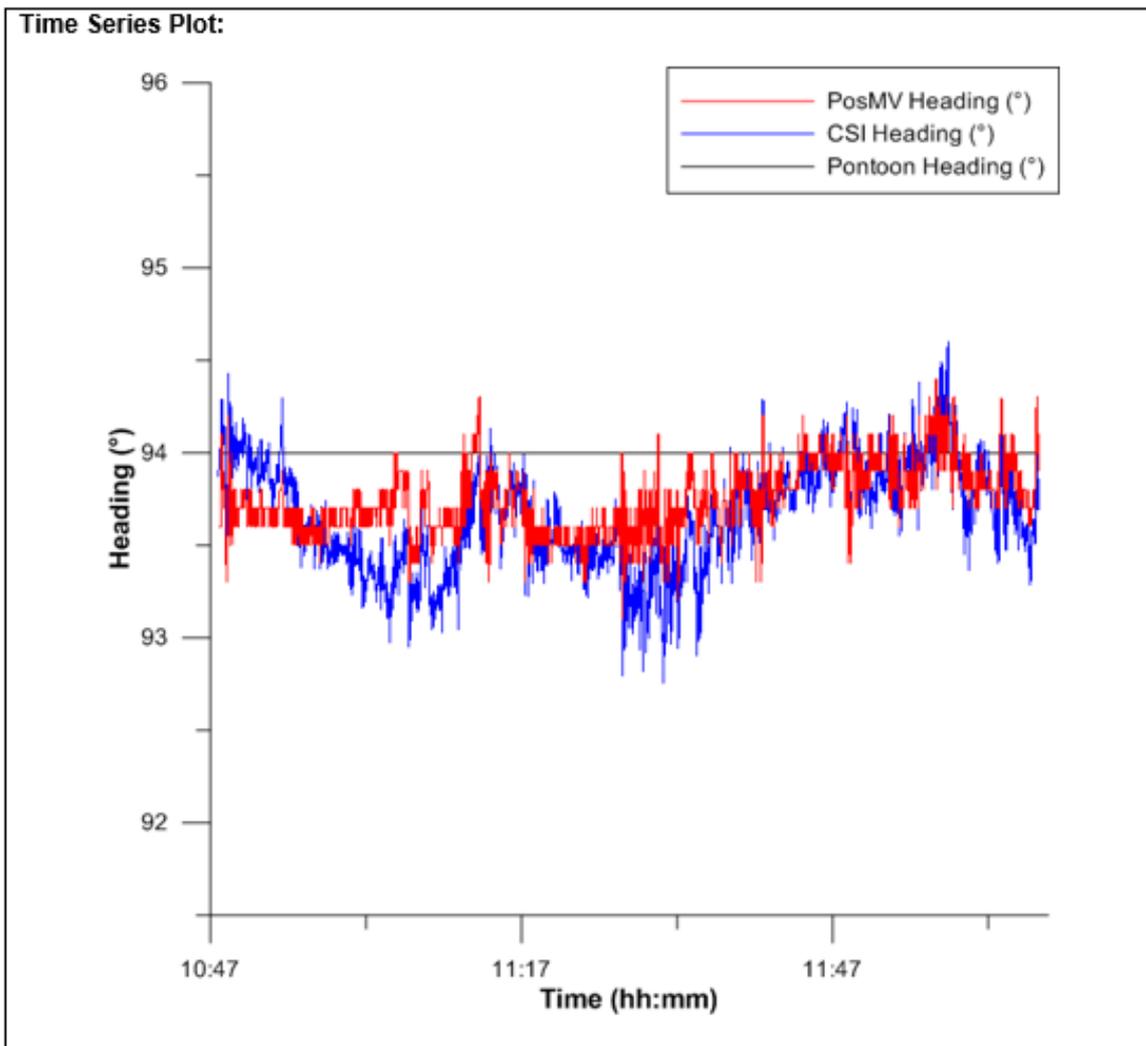
Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 44 of 70
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		<h2 style="text-align: center;">TQA038 Gyro Verification Form</h2>	
Client:	CEFAS	Project Name:	Cardiff Grounds Survey
Project Code:	CS0534	Personnel:	RD GM BH

Occupied Station:	MV Titan Endeavour	Station Code:	TE0
Network Info:		Date Occupied:	10/06/2018
Datum:	OS National Grid (OSTN02)	Ellipsoid:	Airy 1830

Primary Equipment Used:	
Heading:	Applanix POS MV WaveMaster

Secondary Equipment Used:	
Heading:	Hemisphere Crescent VS110



A.5 MBES PATCH TEST SUMMARY

Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 46 of 70
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		TQA035c Reson Swathe Calibration Summary	
Client:	Cefas	Vessel	Titan Endeavour
Project Code	CS0534	Collected By:	RD GM BH
Project Name	Cardiff Grounds Bathy	Processed By:	RD
Date Collected:	13/06/2018	Date Processed:	14/06/2018

Overview:

A patch test was completed on the 13/06/2018 to establish the correct motion sensor offset angles for the Reson 7125 on board the Titan Endeavour.

The calibration site chosen was a wreck situated on a flat area of seabed located 51°27'19.711"N, 3°53'26.230"W in circa 30m of water. This wreck was chosen after conducting a recce survey of the site to check for major sub-surface obstructions that would impede the use of underwater equipment. The seabed was relatively flat in the surrounding area making the site suitable for roll calibrations, and contained a suitable feature for pitch and yaw calibrations. The calibration lines were planned using the online Trimble HYDROpro system, acquired using the Teledyne PDS acquisition software, and processed using Teledyne PDS.

Summary and Historic Results:

Date	17/04/2016	27/07/2016	07/09/2016	20/04/2017	13/06/2018
Job No.	CS0485	CS0495	CS0498	CS0513	CS0534
Latency	0.00s	0.00s	0.00s	0.00s	0.00s
MRU Latency	0.00s	0.00s	0.00s	0.00s	0.00s
Roll Port	14.82	14.80	14.77	14.79	14.79
Roll Stbd	-14.41	-14.51	-14.51	-14.51	-14.51
Roll Attitude	-0.23	-0.23	-0.23	-0.23	-0.23
Pitch Port	0.67	0.62	0.66	0.61	0.63
Pitch Stbd	0.61	0.66	0.68	0.65	0.68
Pitch Attitude	0.122	0.122	0.122	0.122	0.122
Yaw Port	0.83	0.85	0.87	1.11	1.07
Yaw Stbd	0.71	0.78	0.78	1.09	0.95
Yaw Attitude	0.721	0.721	0.721	0.721	0.721

Approximate Position of Patch Test Site

Datum	Ellipsoid	Projection
ETRS89	GRS80	UTM 30N
51°27'19.711"N, 3°53'26.230"W		

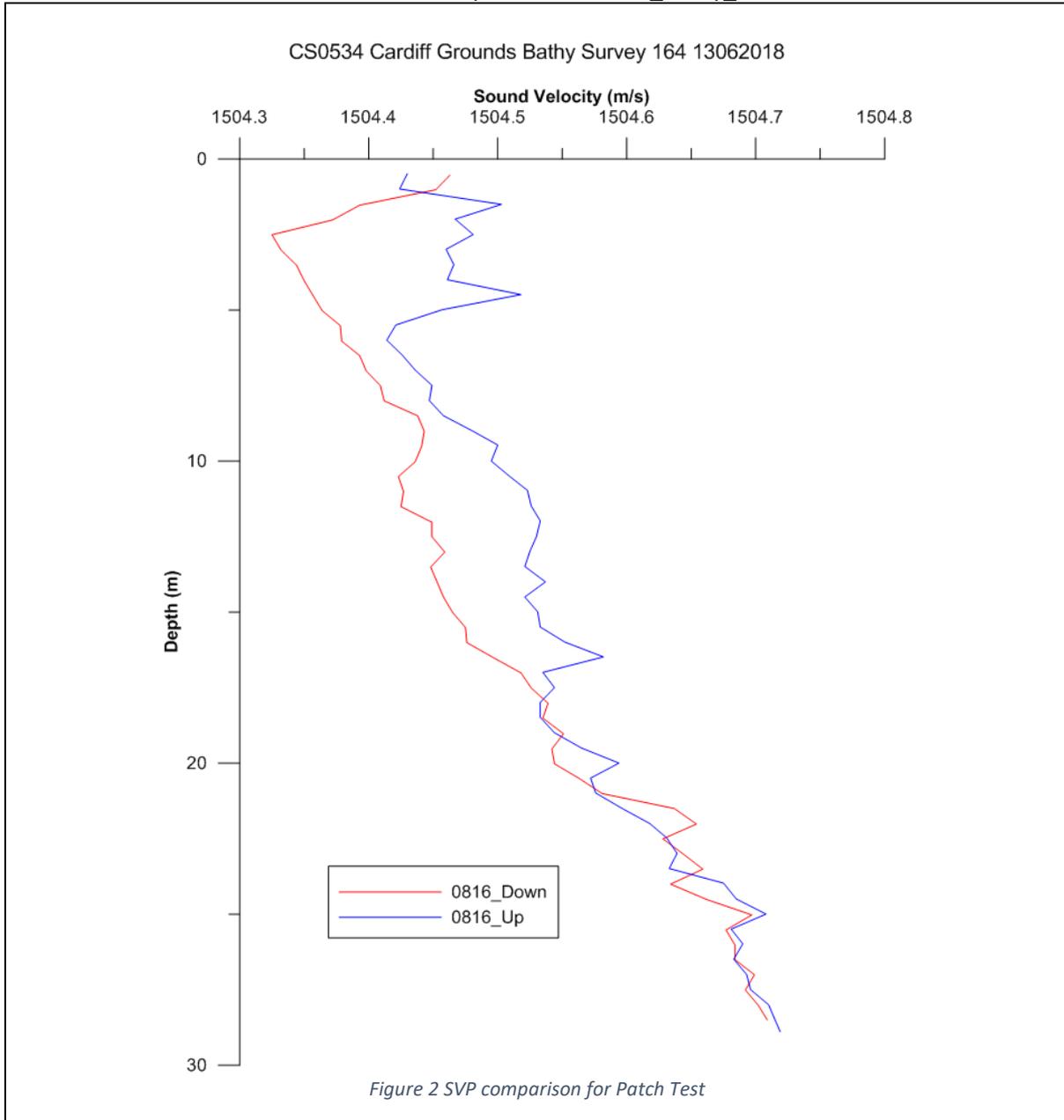
The calibration lines were created as advised by Reson for the system; 5 main lines run parallel to each other at a spacing of 105m across the selected patch test site in a E to W direction.

Calibration Procedure

Sound Velocity Summary	
Downcast Mean Velocity	1504.504m/s
Up-cast Mean Velocity	1504.558m/s
Mean Velocity	1504.531m/s
Mean SVS	1504.600m/s
Surface Temperature	15.05°C
Mean Temperature	15.29°C

A visual comparison was made between the data from the SVP and the value of the SVS positioned on the transducer head and both sets of data were found to agree to within 0.1m/s.

At the time of the patch test the sea state was slight (surface waves 0.3m with an underlying 0.5m underlying SW swell).



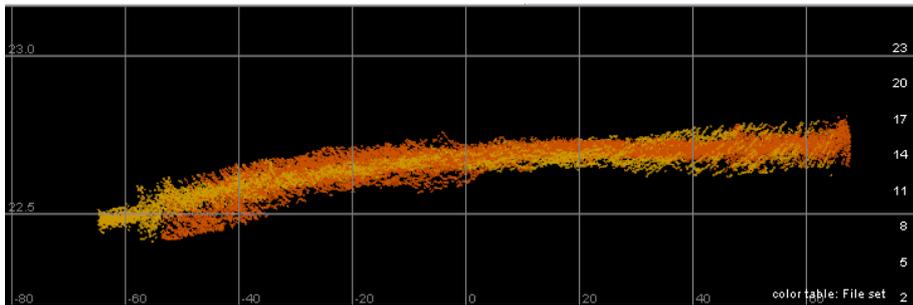
Latency

A latency correction value of 0.00s remained as no correction is required. This is due to the Reson 7125 dual head system on the Titan Discovery receiving 1PPS directly from the PosMV GPS navigation system and therefore mitigating the need for a latency calibration.

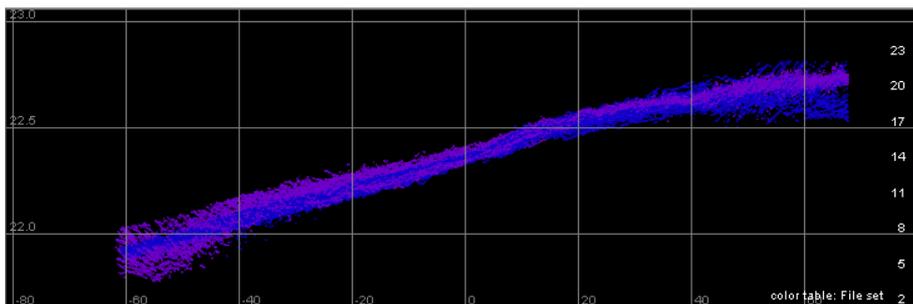
Roll

To determine the Roll correction, five lines were run in opposite directions to determine the effects on the port and starboard heads. Screen shot's below show horizontal profiles from both the port and starboard heads.

Port Roll: **14.79**



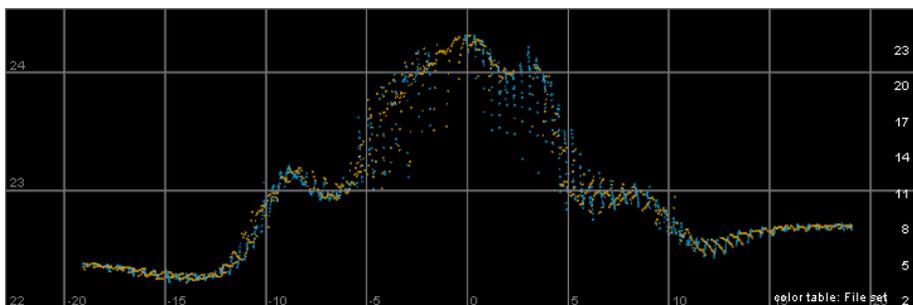
Starboard Roll: **-14.51**



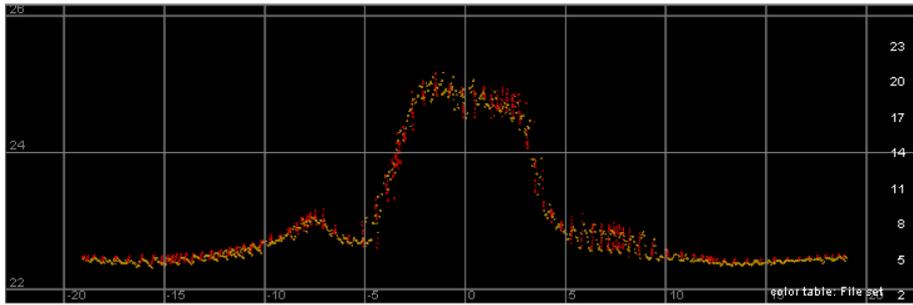
Pitch

To determine the pitch correction, a centre line was run multiple times in opposite directions. Screen shot's below show the longitudinal profiles from both lines on the port and starboard heads.

Port Pitch: **0.63**



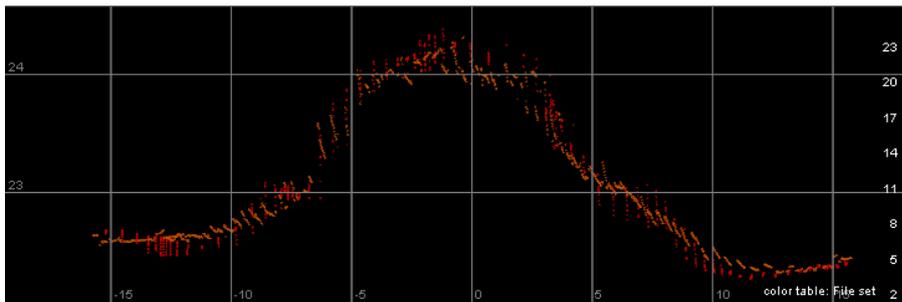
Starboard Pitch: **0.68**



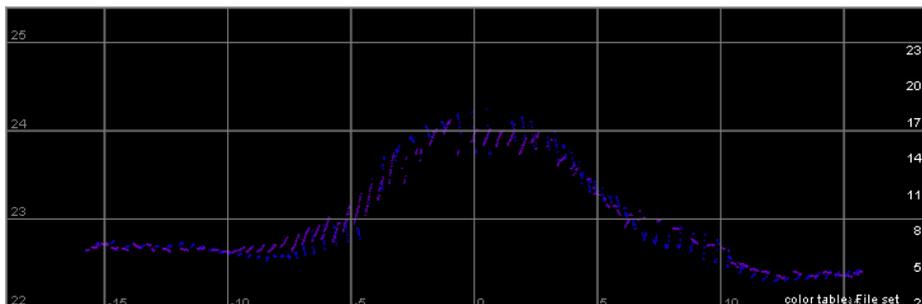
Yaw

To determine the Yaw correction, a total of nine survey lines run over a well-defined feature and were utilised to determine the effects on the transducer heads. All three lines were run in both directions multiple times to allow for several comparisons. The images below show longitudinal profiles from both the port and starboard heads.

Port Yaw: **1.07**

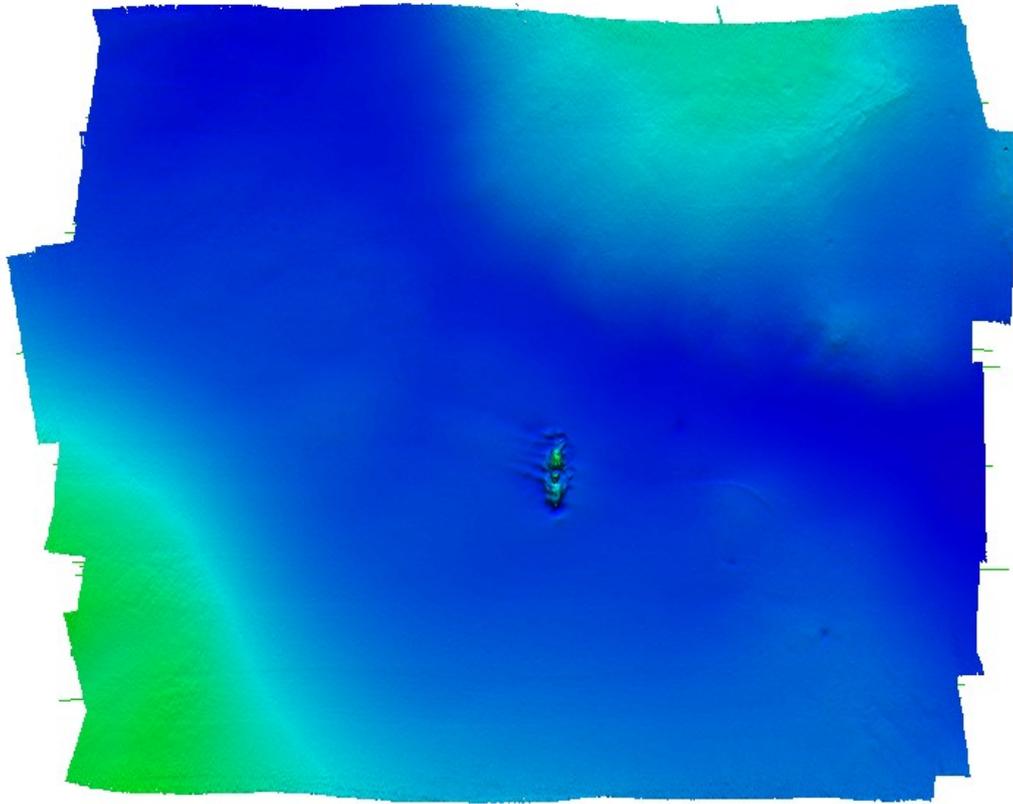


Starboard Yaw: **0.95**



Check

The patch test values were re-computed and applied to the Titan Endeavour MBES configuration and processed using Caris HIPS and SIPS 9.1 to check quality, see image below.



Methodology

Lines were set using the following runtime parameters:

	Coverage Angle	Pulse Type	Pulse Length	Beam Mode	Frequency
Port Head	114° (076°/038°)	FM	1000	EQBS	200
Stbd Head	114° (038°/076°)	FM	1000	EQBS	200

The calibration area was chosen to evaluate the different calibration factors using various criteria as follows:

- Precise surface positioning
- Uniform water mass, avoiding areas with marked thermoclines
- Calibration performed in good survey weather
- Flat area for evaluation of roll error
- Significant seabed feature for evaluation of the pitch and heading error

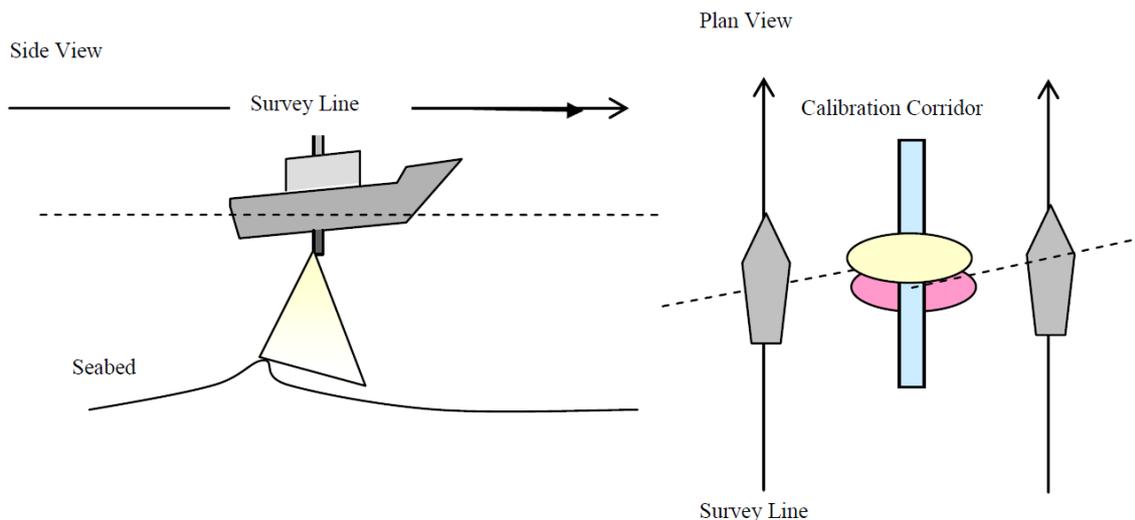
In the determination of angular errors, the greater the water depth, the more apparent the system errors become in the bathymetric data, and the easier they are to evaluate.

A significant linear feature, such as a wreck or ridge is desirable to evaluate any positioning delay. To reduce the effect of any angular errors it is preferable to find such a feature in shallower water.

Below describes the methods used for determining each set of results.

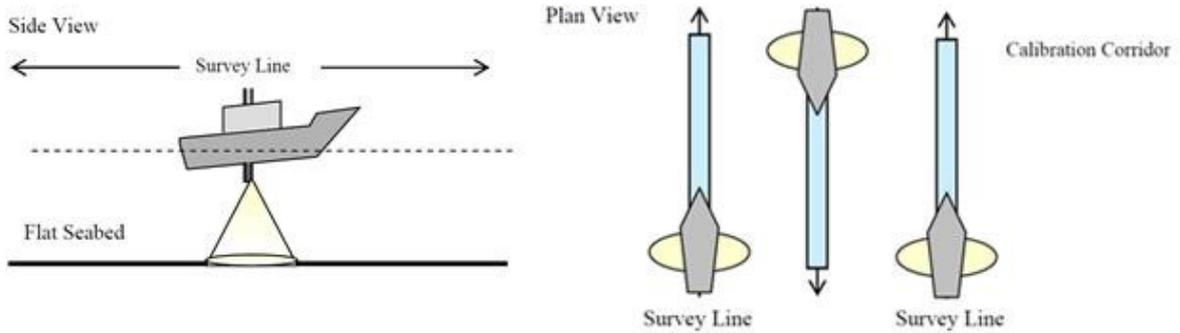
Pitch Calibration

Pitch calibrations required the survey vessel to steam at constant speed along a chosen transect (in opposite directions) over a well-defined feature to determine the effect on the transducer heads. In addition, outer transect lines may be run to ensure an entire feature is covered. These lines are run in the opposite direction to the centre line.



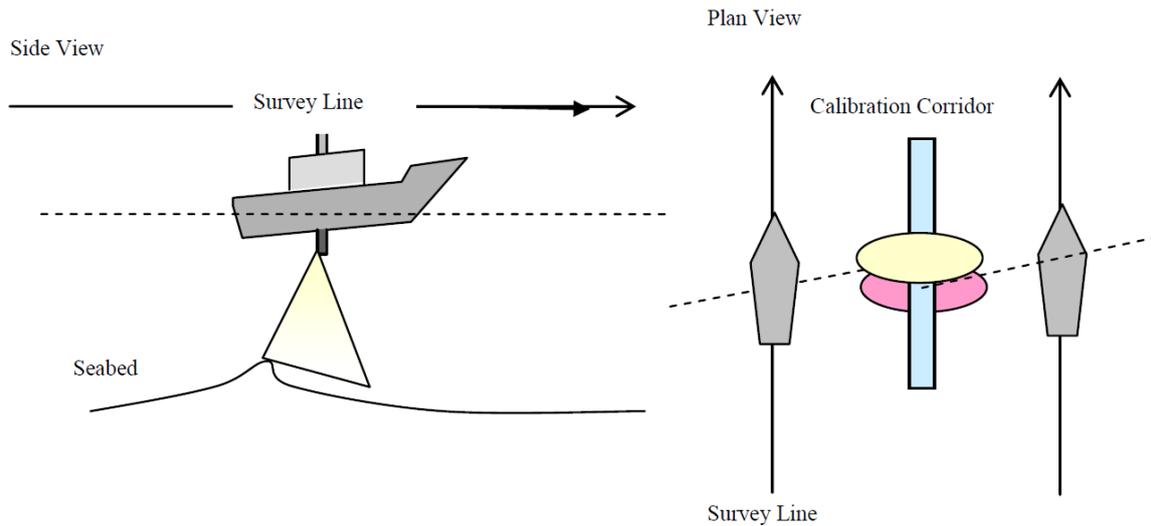
Roll Calibration

Roll calibrations required the survey vessel to steam at constant speed along a chosen transect (in opposite directions) over a section of flat featureless seabed to determine the effect on the transducer heads.



Horizontal Alignment Error (Yaw)

Yaw calibrations required the survey vessel to steam at constant speed along three parallel and adjacent lines over a well-defined feature to determine the effects on the transducer heads.



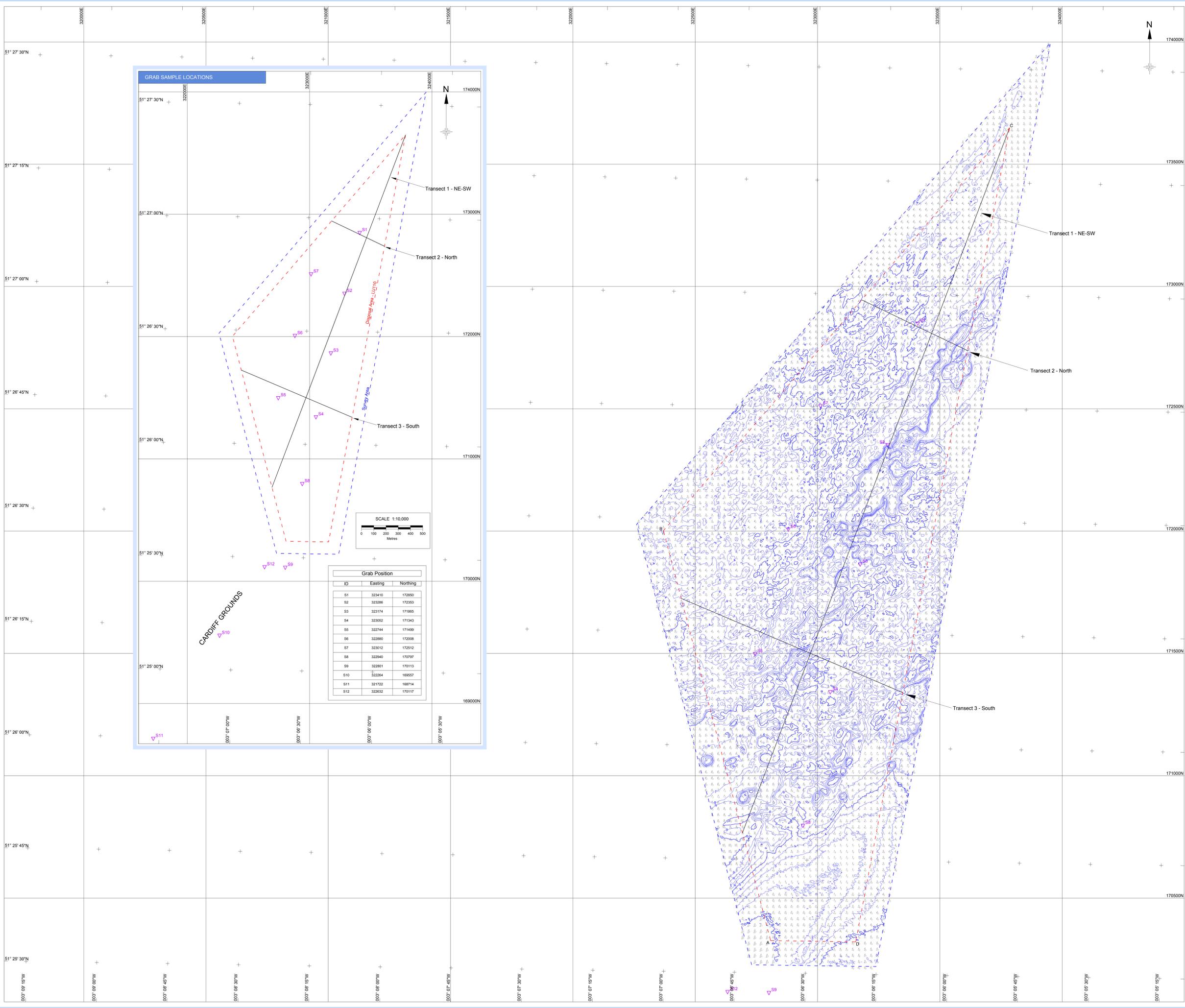
APPENDIX B

CHARTS

B.1	Bathymetry
B.2	Seabed Relief
B.3	Isochores above 12m Isobath
B.4	Bathymetry Transects

B.1 BATHYMETRY

Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 56 of 70
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LEGEND

- Disposal Area - LU110
- Survey area (LU110 + 100m buffer)
- Grab sample
- Soundings in metres and decimetres reduced to Chart Datum (all depths are above CD)
- Isobaths at 1m intervals (CD)

NOTES

- Positioning by DGPS.
- Data acquired using Reson Seabat Multibeam Echosounder System.
- Survey date: 22nd June to 23rd June 2018.
- All Depths are reduced to Chart Datum (CD) using PPK tides and the Vertical Offset Reference Frame (VORF) model.
- Contours generated using Fledermaus.
- Survey area supplied by CEFAS. (t429_hpc-intake-and-outfall-dredge-disposal-bathymetric-survey-plan-prel-v600.doc)

LU110 - Disposal Area

Point	Easting	Northing
A	322808	170326
B	322370	172602
C	323785	173646
D	323156	170321

7. Transect co-ordinates below:

Transect	Point	Start Easting	Start Northing	End Easting	End Northing
Transect 1 - NE-SW	A	322808	170326	323785	173646
Transect 2 - North	B	322370	172602	323614	172738
Transect 3 - South	D	323156	170321	323349	171340

GENERAL AREA

CHART PANELS

GEODETIC REFERENCE SYSTEM

GEODETIC DATUM	: OSGB36	PROJECTION	: O.S. National Grid
ELLIPSOID	: AIRY	FALSE EASTING	: 400,000m
SEMI MAJOR AXIS	: 6377663.398	FALSE NORTHING	: 100,000m
INVERSE FLATTENING	: 296.325	LATITUDE OF ORIGIN	: 49° 07' 00.00" North
TRANSFORMATION	: WGS84-OSGB36 using OSTN02 Model	CENTRAL MERIDIAN (CM)	: 02° 00' 00.00" West
		SCALE FACTOR AT CM	: 0.99960127

SURVEY INFORMATION

SURVEY VESSEL	: MV TITAN ENDEAVOUR
SURVEY DATE	: 22 JUN 2018 TO 23 JUN 2018
POSITIONING SYSTEM	: POSNAV WAVEMASTER TRIMBLE SP582
ECHO SOUNDER (MULTI-BEAM SYSTEM)	: RESON SEABAT 7125

SCALE (AS ORIGINAL)

MAIN CHART SCALE 1:5000

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Cefas

HINKLEY POINT C (CARDIFF GROUNDS)
PRE-DISPOSAL BATHYMETRIC SURVEY

BATHYMETRY

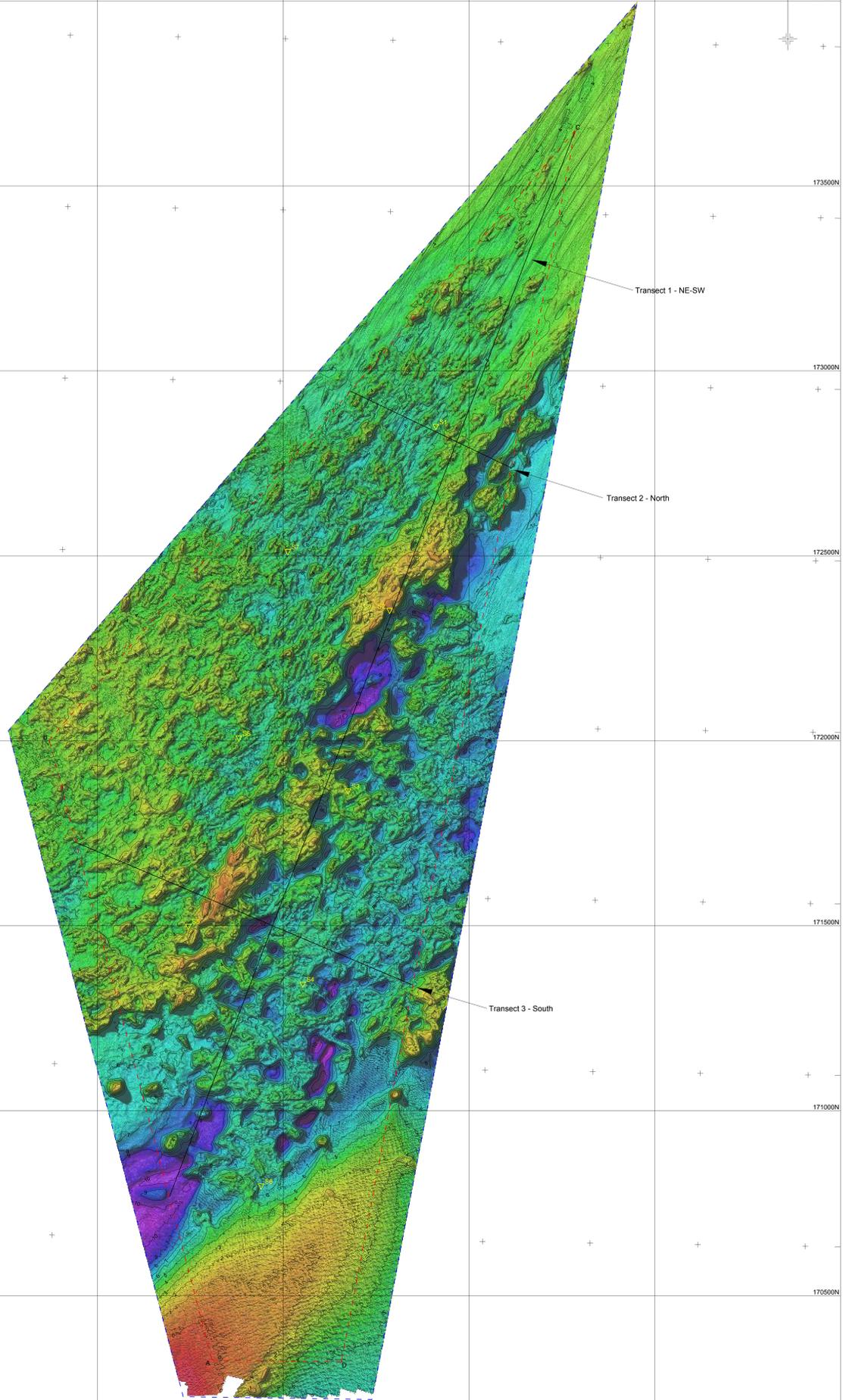
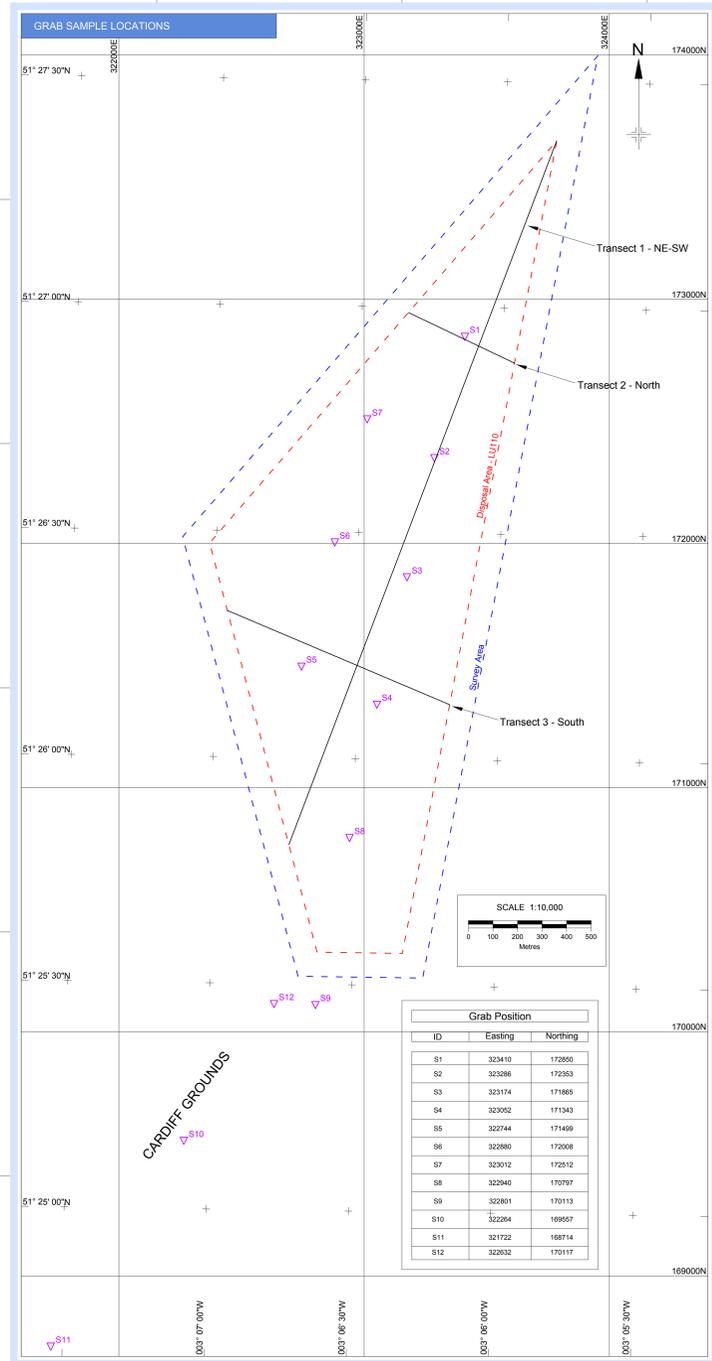
JULY 2018

REV	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APPD
0	6-Jul-2018	FINAL	TES	CA	VG	VG
1	29-Aug-2018	Changed colour of isobaths	TES	CA	VG	VG

PROJECT REF: C50534
DRAWING REF: C50534A011
APPENDIX NO. B.1
CHART NO. 1 of 1

B.2 SEABED RELIEF

Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 58 of 70
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LEGEND

- Disposal Area - LU110
- Survey area (LU110 + 100m buffer)
- Grab sample
- Isobaths at 1m intervals (CD)

Colour Palette (metres CD)

0
1.5
3
4.5
6.0
7.5
9.0
10.5

NOTES

- Positioning by DGPS.
- Data acquired using Reson Seabat Multibeam Echosounder System.
- Survey date: 22nd June to 23rd June 2018
- Contours and image generated using Fledermaus
- Survey area supplied by CEFAS.

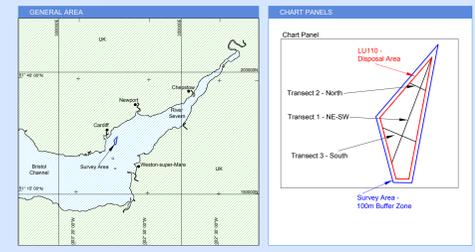
(t429_hpc-intake-and-outfall-dredge-disposal-bathymetric-survey-plan-pre-v000.doc)

LU110 - Disposal Area

Point	Easting	Northing
A	322898	170326
B	322370	172002
C	323785	173649
D	323196	170321

6. Transect co-ordinates below:

Transect	Point	Start Easting	Start Northing	End Easting	End Northing
Transect 1 - NE-SW	A	322898	170326	323785	173649
	B	322370	172002	323181	172946
Transect 2 - North	C	323785	173649	323442	171725
	D	323196	170321	32349	171340

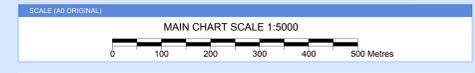


GEODEIC REFERENCE SYSTEM

GEODEIC DATUM	: OSGB36	PROJECTION	: O.S. National Grid
ELLIPSOID	: AIRY	FALSE EASTING	: 400,000m
SEMI MAJOR AXIS	: 6377563.396	FALSE NORTHING	: 100,000m
INVERSE FLATTENING	: 299.325	LATITUDE OF ORIGIN	: 49° 00' 00.00" North
TRANSFORMATION	: WGS84-OSGB36 using OSTN02 Model	CENTRAL MERIDIAN (GM)	: 02° 00' 00.00" West
		SCALE FACTOR AT CM	: 0.99960127

SURVEY INFORMATION

SURVEY VESSEL	: MV TITAN ENDEAVOUR
SURVEY DATE	: 22-JUN-2018 TO 23-JUN-2018
POSITIONING SYSTEM	: POSMV WAVEMASTER
ECHO SOUNDER (MULTI-BEAM SYSTEM)	: TRIMBLE SP8252 RESON SEABAT 7125



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Cefas

HINKLEY POINT C (CARDIFF GROUNDS) PRE-DISPOSAL BATHYMETRIC SURVEY

SEABED RELIEF

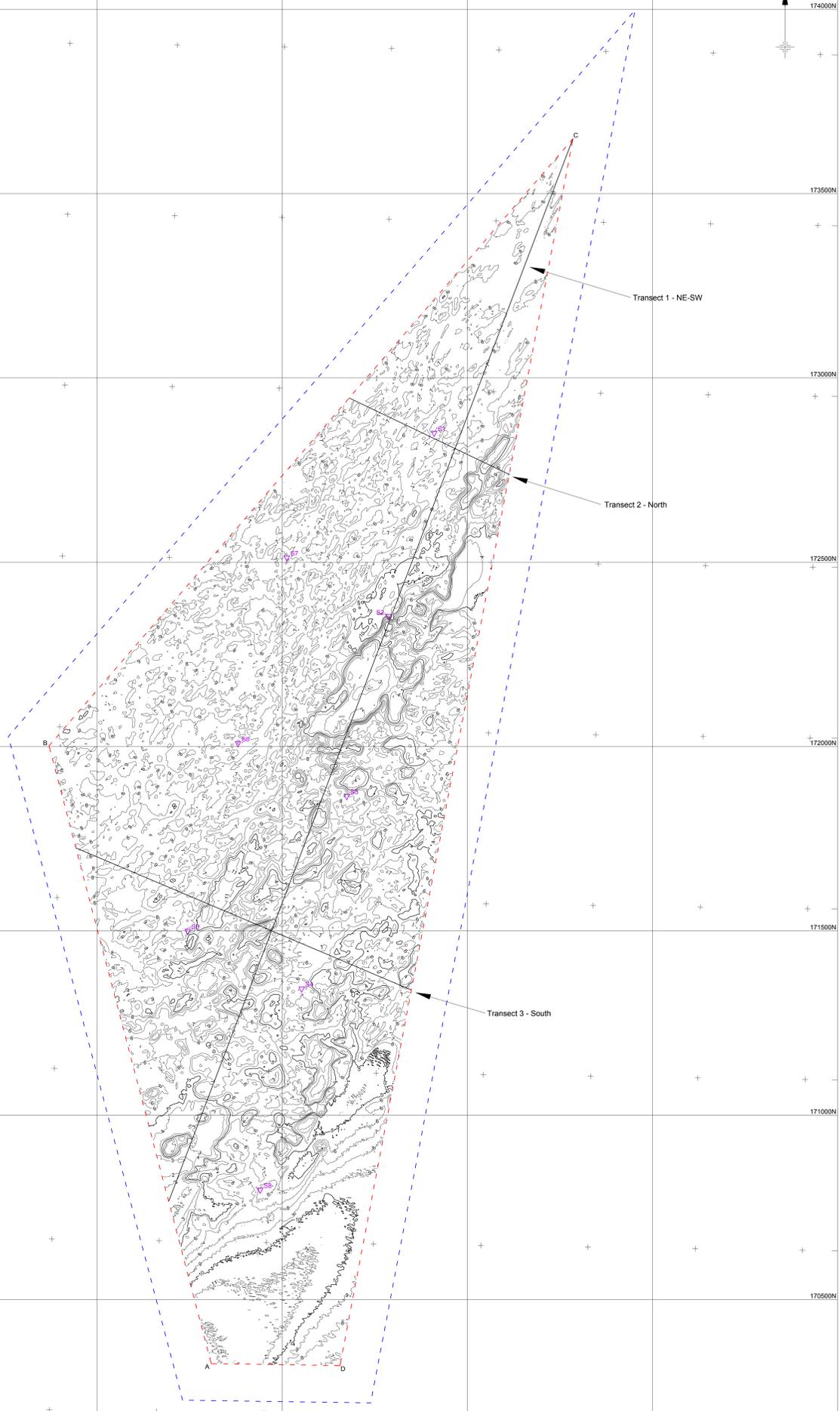
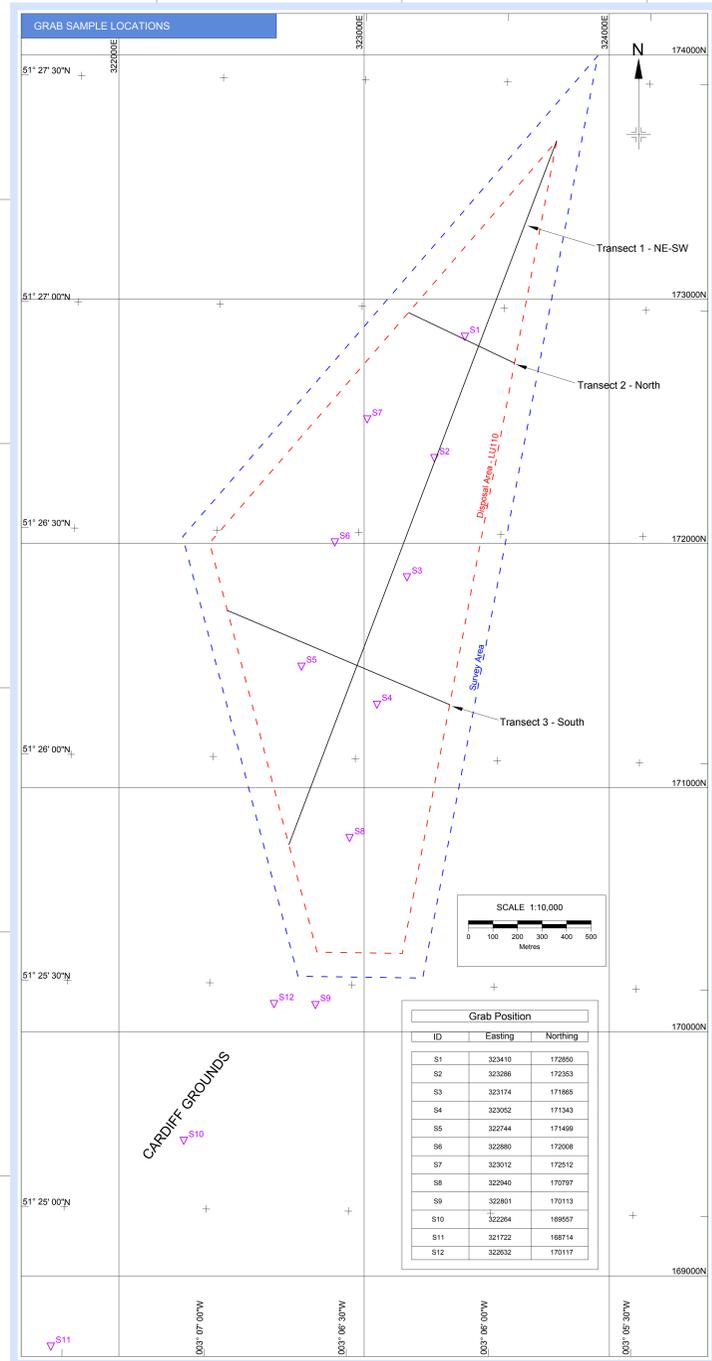
JULY 2018

REV	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APPD
0	6-JUL-2018	FINAL	TES	CA	YGD	VG

PROJECT REF: CS0554 DRAWING REF: CS0554A020 APPENDIX NO. B.2 CHART NO. 1 of 1

B.3 ISOCHORES ABOVE 12M ISOBATH

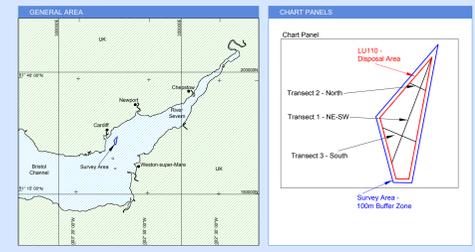
Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 60 of 70
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LEGEND

- Disposal Area - LU110
- Survey area (LU110 + 100m buffer)
- Grab sample
- Isochores at 1m intervals (from seabed to 12m CD isobath)

- NOTES**
- Positioning by DGPS.
 - Data acquired using Reson Seabat Multibeam Echosounder System.
 - Survey date: 22nd June to 23rd June 2018
 - Contours and image generated using Fledermaus
 - Survey area supplied by CEFAS.
- (t429_hpc-intake-and-outfall-dredge-disposal-bathymetric-survey-plan-pre-v000.doc)
- LU110 - Disposal Area**
- | Point | Easting | Northing |
|-------|---------|----------|
| A | 322808 | 170326 |
| B | 322370 | 172002 |
| C | 323785 | 173649 |
| D | 323196 | 170321 |
6. Transect co-ordinates below:
- | Transect | Start Easting | Start Northing | End Easting | End Northing |
|--------------------|---------------|----------------|-------------|--------------|
| Transect 1 - NE-SW | 322693 | 172766 | 323785 | 173649 |
| Transect 2 - North | 323181 | 172946 | 323614 | 172738 |
| Transect 3 - South | 322442 | 171725 | 323349 | 171340 |
7. This chart presents isochores (true vertical thickness contours) between the seabed and the level of the 12m CD isobath. The volume above this level is 15,453,667m³. The deepest depth encountered during the survey was 11.1m CD.

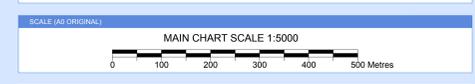


GEODEIC REFERENCE SYSTEM

GEODEIC DATUM	: OSGB36	PROJECTION	: O.S. National Grid
ELLIPSOID	: AIRY	FALSE EASTING	: 400,000m
SEMI MAJOR AXIS	: 6377563.396	FALSE NORTHING	: 100,000m
INVERSE FLATTENING	: 299.32	LATITUDE OF ORIGIN	: 49° 00' 00.00" North
TRANSFORMATION	: WGS84-OSGB36 using OSTN02 Model	CENTRAL MERIDIAN (GM)	: 02° 00' 00.00" West
		SCALE FACTOR AT CM	: 0.99960127

SURVEY INFORMATION

SURVEY VESSEL	: MV TITAN ENDEAVOUR
SURVEY DATE	: 22-JUN-2018 TO 23-JUN-2018
POSITIONING SYSTEM	: POSMV WAVEMASTER
ECHO SOUNDER (MULTI-BEAM SYSTEM)	: TRIMBLE SP852 RESON SEABAT 7125



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HINKLEY POINT C (CARDIFF GROUNDS) PRE-DISPOSAL BATHYMETRIC SURVEY
ISOCHORES ABOVE 12M ISOBATH
JULY 2018

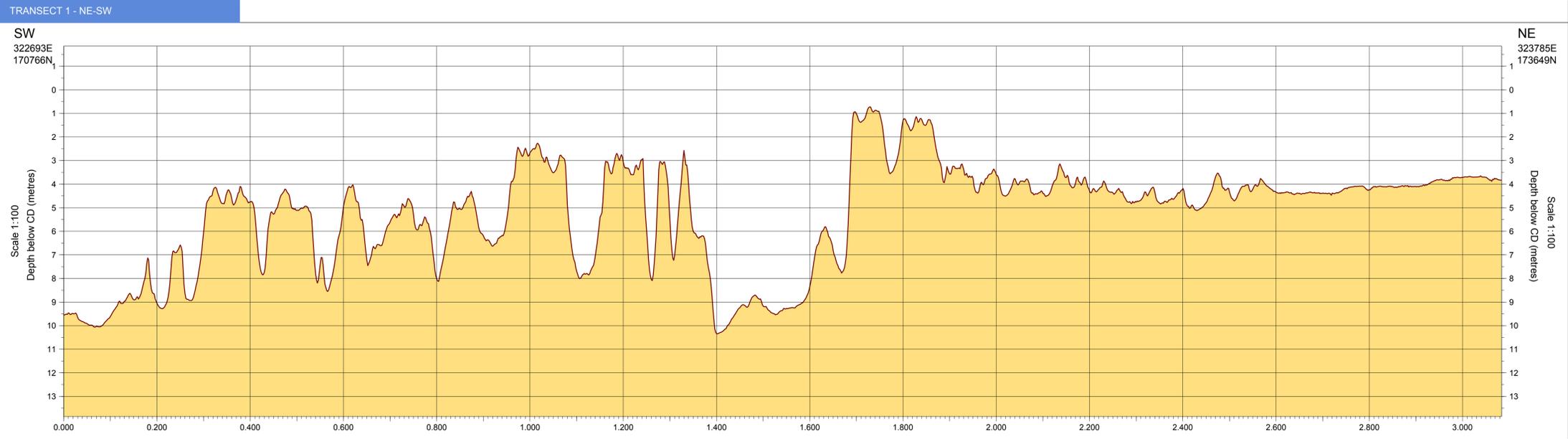
REVISION

REV	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	6-JUL-2018	FINAL	TES	CA	YGO	VG

PROJECT REF: CS0554 DRAWING REF: CS0554A030 APPENDIX NO. 3 CHART NO. 1 of 1

B.4 BATHYMETRY TRANSECTS

Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 62 of 70
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LEGEND

General

Seabed profile (CD)

NOTES

1. All Depths are reduced to Chart Datum (CD) using PPK tides and the Vertical Offset Reference Frame (VORF) model.
2. The longitudinal profile has been produced from the bathymetry DTM.

GENERAL AREA

CHART KEY

Chart Panel

LU110 - Disposal Area

Transect 2 - North

Transect 1 - NE-SW

Transect 3 - South

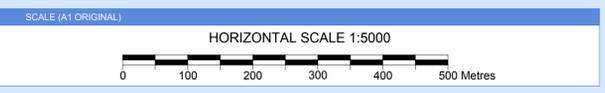
Survey Area - 100m Buffer Zone

GEODETTIC REFERENCE SYSTEM

GEODETTIC DATUM : OSGB(36)	PROJECTION : O.S. National Grid
ELLIPSOID : AIRY	FALSE EASTING : 400,000m
SEMI MAJOR AXIS : 6377563.396	FALSE NORTHING : -100,000m
INVERSE FLATTENING : 299.325	LATITUDE OF ORIGIN : 49° 00' 00.00" North
TRANSFORMATION : WGS84-OSGB36 using OSTN02 Model	CENTRAL MERIDIAN (CM) : 02° 00' 00.00" West
	SCALE FACTOR AT CM : 0.99960127

SURVEY INFORMATION

SURVEY VESSEL : MV TITAN ENDEAVOUR
SURVEY DATE : 22-JUN-2018 TO 23-JUN-2018
POSITIONING SYSTEM : POSMV WAVEMASTER
ECHO SOUNDER (MULTI-BEAM SYSTEM) : TRIMBLE SPS852
RESON SEABAT 7125



TITLE

Titan Environmental Surveys Limited

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Cefas

**HINKLEY POINT C (CARDIFF GROUNDS)
PRE-DISPOSAL BATHYMETRIC SURVEY**

BATHYMETRY TRANSECTS

JULY 2018

REVISION

REV	DATE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APP'D
0	11-JUL-2018	FINAL	TES	CA	VG	VG

REPORT REF. CS0534 DRAWING REF. CS0534B010 APPENDIX NO. B.4 CHART NO. 1 of 1

APPENDIX C

SEDIMENT SAMPLING

- C.1 Grab Sampling Logs
- C.2 Grab Sample Locations
- C.3 Particle Size Analysis Results
- C.4 Volumes of Disposal Material

Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 64 of 70
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C.1 GRAB SAMPLING LOGS

Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 65 of 70
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			TQA003 Grab Sample Log		
Client: CEFAS		Project: Cardiff Grounds Bathy		Job No: CS0534	Notes / Diagrams:
Vessel: MV Titan Endeavour		Date: 23/06/2018	Personnel: RD JC GM BH		
DataBase: 174_23062018_Ten			Sheet: 1 of 1		
Nav System: OSTN02		Sea State: Calm	Grab Type: Mini Hamon Grab		
Spheroid Projection:		Time HW/LW (UTC): 08:56 (LW) / 15:18 (HW)	Other Tests:		

Site No.	Fix No	Time (UTC)	Easting/ Latitude	Northing/ Longitude	Depth (m)	Photo ID	Grab Sample Description	Other Tests			Comments
S3	2	10:45	323174	171865	07.99	20180623_104500_S3_A1_TEn	mG + sh				Attempt 1 - PSA Sample
S3	3	10:59	323164	171853	06.90	No photo	-				Attempt 2 - No Sample
S3	4	11:05	323161	171861	07.25	20180623_110500_S3_A3_TEn	mG + shells				Attempt 3 - Radio Nuc. Sample
S6	5	11:16	322880	172008	09.16	20180623_111800_S6_A1_TEn	gM				Attempt 1 - Both Sample
S7	6	11:34	323012	172512	08.65	20180623_113400_S7_A1_TEn	gM				Attempt 1 - Both Sample
S1	7	11:46	323410	172850	10.04	20180623_114600_S1_A1_TEn	M				Attempt 1 - Both Sample
S2	8	12:00	323291	172349	06.07	20180623_120000_S2_A1_TEn	sG				Attempt 1 - No Sample
S2	9	12:06	323286	172353	06.16	20180623_120600_S2_A2_TEn	gM + shells				Attempt 2 - Both Sample
S5	10	12:21	322744	171499	10.25	20180623_122100_S5_A1_TEn	gmS				Attempt 1 - Both Sample
S4	11	12:29	323069	171338	11.23	No photo	-				Attempt 1 - No Sample
S4	12	12:34	323052	171343	11.57	20180623_123400_S4_A2_TEn	gM + shells				Attempt 2 - Both Sample
S8	13	12:45	322940	170797	12.64	20180623_124500_S8_A1_TEn	S				Attempt 1 - Both Sample
S9	14	12:59	322801	170113	09.10	20180623_125900_S9_A1_TEn	S				Attempt 1 - Both Sample
S10	15	13:12	322264	169557	05.12	20180623_131200_S10_A1_TEn	S				Attempt 1 - Both Sample
S11	16	13:27	321722	168714	07.01	20180623_132700_S11_A1_TEn	S				Attempt 1 - Both Sample
S12	17	13:38	322632	170117	06.40	20180623_133800_S12_A1_TEn	S				Attempt 1 - Both Sample

C.2 GRAB SAMPLE LOCATIONS

OSGB36		
Site Number	Easting (m)	Northing (m)
1	323410	172850
2	323286	172353
3	323174	171865
4	323052	171343
5	322744	171499
6	322880	172008
7	323012	172512
8	322940	170797
9	322801	170113
10	322264	169557
11	321722	168714
12	322632	170117

C.3 PARTICLE SIZE ANALYSIS RESULTS

Please refer to Table 1: Summary of particle size distributions for LU110. Samples acquired by Titan Environmental Surveys Ltd (see survey report "CS0534_Bathy_V1") and analysed by Cefas. Table 1.

Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 68 of 70
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C.4 VOLUMES OF DISPOSAL MATERIAL

Please refer to Table 1: Summary of particle size distributions for LU110. Samples acquired by Titan Environmental Surveys Ltd (see survey report "CS0534_Bathy_V1") and analysed by Cefas. Table 2.

Cefas BEEMS TR457 Cardiff Grounds (LU110) bathymetric survey and grab sample analyses (Marine Licence 12/45/MLv1)	NOT PROTECTIVELY MARKED	Page 69 of 70
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APPENDIX D

DELIVERED DATA

Grabs	:	0.5 kg Sediment Samples (delivered)		
	:	1 kg Sediment Samples (stored at Titan for 6 months after recovery awaiting instruction from client)		
Swathe	:	Raw s7k files (delivered)		
	:	CS0534_Cardiff_Grounds_2m_OSGB36_V2.txt		
Report	:	CS0530_Bathy_V1.pdf		
Charts / Dwg	:	Ref. CS0534A010_Bathymetry	(.pdf)	Scale 1:5,000
	:	Ref. CS0534A020_SBR	(.pdf)	Scale 1:5,000
	:	Ref. CS0534A030_Volume	(.pdf)	Scale 1:5,000
	:	Ref: CS0534B010_Transects	(.pdf)	Scale 1:5,000