Immingham Green Energy Terminal

TR030008

Volume 6

6.4 Environmental Statement Appendices

Appendix 16.B: Geophysical Survey Report

Planning Act 2008

Regulation 5(2)(a)

Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended)

September 2023

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended)

Immingham Green Energy Terminal

Development Consent Order 2023

6.4 Environmental Statement Appendices

Appendix 16.B: Geophysical Survey Report

Regulation Reference	APFP Regulation 5(2)(a)
Planning Inspectorate Case Reference	TR030008
Application Document Reference	TR030008/APP/6.4
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Version	Date	Status of Version
Revision 1	21 September 2023	DCO Application

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Summary

Associated British Ports (ABP) contracted ABPmer to undertake a marine geophysical seismic survey at the site of the proposed Immingham Green Energy Terminal (IGET) . A full spread geophysical survey was required to provide multibeam bathymetry (MBES), sub-bottom profiler (SBP), sidescan sonar (SSS) and magnetometer (MAG) datasets of the proposed site. The data was required to inform the project design and construction phase as well as for physical processes and marine archaeology assessments in the Environmental Statement to support the Development Consent Order (DCO) application.

Survey operations were conducted onboard the survey vessel, Wessex Explorer, in February/March 2023 with data processing and interpretation taking place in April/May 2023. MBES bathymetry and backscatter data processing and reporting has been conducted by ABPmer. The geophysical processing, interpretation and reporting of the SBP, SSS and MAG data was conducted by CMGeomatics Ltd.

Results from a combination of SSS and MBES data show five seabed sediment classifications: Mixed Sediment, muddy SAND, firm CLAY, soft MUD and rock protection. Firm CLAY has been marked tentatively as an increase in soil strength is only supported by an increase in reflectivity, rather than having been verified by ground truthing.

SSS and MBES datasets have revealed a total of 1064 seafloor contacts. A significant number of debris items have been identified, largely in the southern half of the survey area. A total of 317 magnetic contacts have been identified, 44 of which are able to be correlated with seafloor targets based on proximity, size, and magnetometer altitude.

An initial geological model has been developed based on results of the survey in-conjunction with background information about the site and geotechnical work that has been carried out previously at or near to the survey area. Four main sub surface units have been identified.

The uppermost unit is comprised of surficial alluvium deposits composed of soft SILT/CLAY and SAND with a depth range between 0.0 m – 4.8 m below seabed. A layer of interpreted boulder clay underlies the alluvium which has been interpreted as the Upper Boulder Clay unit. The Upper Boulder Clay ranges between 0.0 m – 10.6 m below seabed and is largely observed to exist in tandem with the underlying Lower Boulder Clay which appears to completely erode away towards the north. The Lower Boulder Clay unit is observed to exist between 0.0 m – 15.0 m below seabed in the survey area. Discontinuous lenses of SAND/GRAVEL are also noted within this unit. The bedrock has been identified as CHALK from geotechnical data. The surface of the CHALK has been observed in the seismic data at depths between 0.0 m – 15.0 m below seabed. The bedrock level below seabed shoals to the north where it is observed at or close to the riverbed.

Two small, isolated regions of acoustic attenuation are observed, likely caused by moderate accumulation of organic matter within the surficial sediments.

There is good confidence in the geophysical interpretation in the deeper waters (proposed berth area) at the northeast of the survey area due to the chalk horizon being clearly observed reaching the seabed and correlating with results of the recent vibrocore campaign. There is less confidence in the geophysical interpretation of the shallower waters due to lack of geotechnical ground-truth information. If further geotechnical information becomes available, interpretation can be revisited to improve confidence in the results.

1. Appendix 16.B: Geophysical Survey Report

1.1. Introduction

1.1.1. Associated British Ports (ABP) contracted ABPmer to undertake a geophysical survey at the site of the proposed location for the Immingham Green Energy Terminal (IGET) development, at Immingham, UK (Plate 1-1).

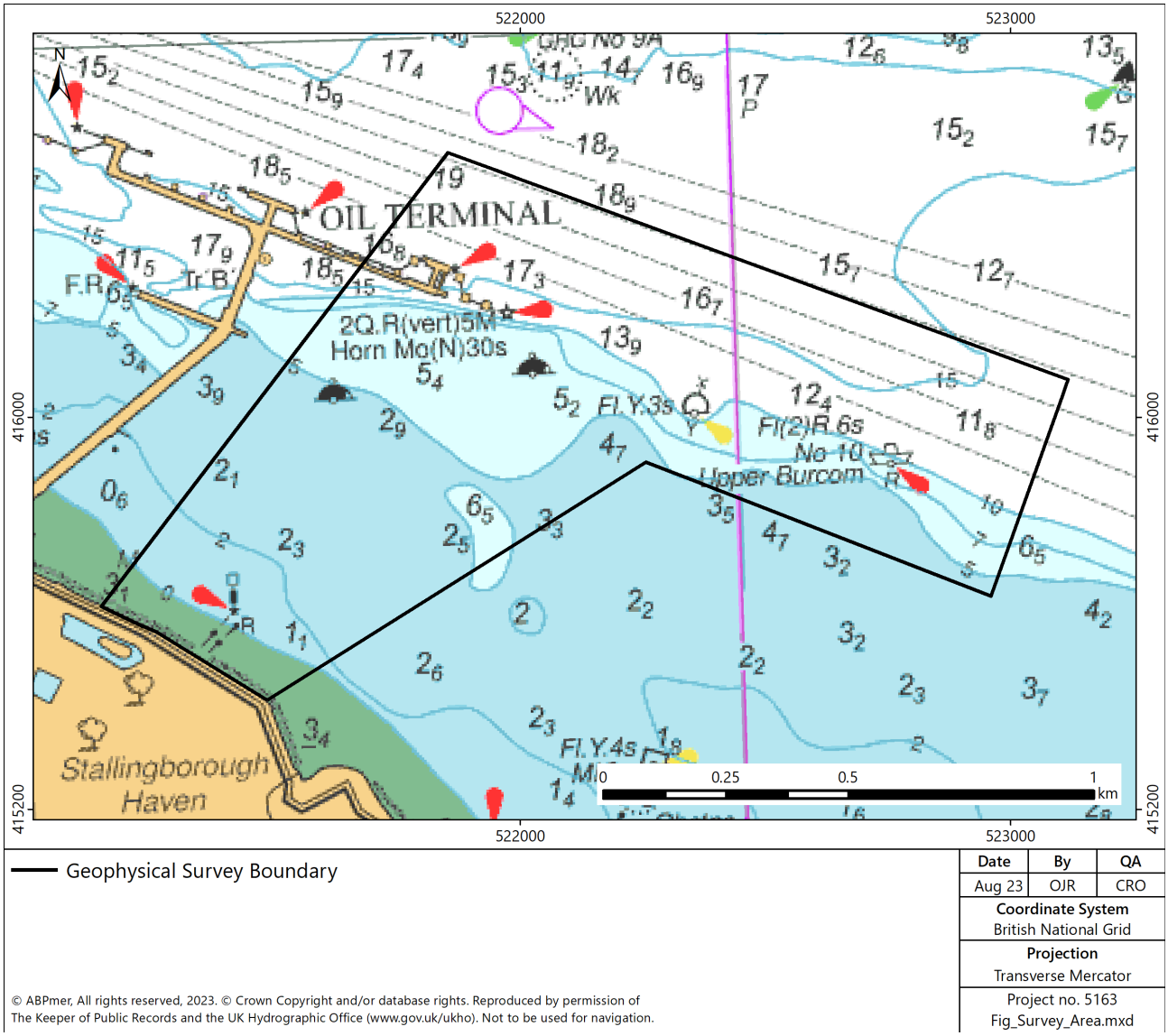

Plate 1-1. Geophysical survey required area

1.1.2. A full geophysical survey was required to provide multibeam bathymetry (MBES), sub-bottom profiler (SBP), sidescan sonar (SSS) and magnetometer (MAG) datasets of the proposed site. The data was required to inform the design and construction phase of a proposed berth for bulk hydrogen handling and reception, as well as to provide context for the respective physical processes and marine archaeology assessments that may be required in the area.

1.1.3. The requirements of the survey included acquisition of full coverage MBES and SSS datasets within an area east of the existing Immingham Oil Terminal (IOT). Survey extents covered a rectangular area around the proposed new berth layout, extending northwards into the main navigation channel and westwards to the IOT. Additionally, survey extents also covered a corridor section between this area and the shore, extending to the 2 m above Chart Datum (CD) contour. LiDAR data acquired by the Environment Agency in 2019 was used to provide topographical data inshore of the acquired bathymetry data.

1.1.4. SBP and MAG data was required within the same survey extents, however extending inshore to the 0 m contour. Required line spacing was 20 m across the full area, and a denser 10 m line spacing directly over the proposed berth footprint and proposed jetty structure. Additional cross lines were required at 100 m spacing.

1.2. Survey Summary

Overview

1.2.1. The geophysical survey commenced on 6 February 2023 with mobilisation of the geophysical survey vessel, *Wessex Explorer* (Plate 1-2). The 15 m mono-hull vessel, with a draft of 1.4 m, is owned and operated by 'Hayes Marine Ltd' and regularly used by ABPmer for geophysical surveys, including previously at this survey location for a bathymetry reconnaissance survey in July 2022.

Plate 1-2. Geophysical survey vessel - *Wessex Explorer*

1.2.2. The survey vessel transited from Southampton on 3–4 February 2023 to Grimsby Fish Docks. The survey team travelled to Grimsby on 6 February 2023 to commence equipment mobilisation.

1.2.3. Alongside equipment mobilisation and static verification procedures were conducted, within Grimsby Fish Docks, between 6–7 February 2023. Upon completion of the alongside mobilisation, the vessel conducted a series of data calibration/verification and data optimisation procedures on 7–8 February 2023 prior to commencing survey operations.

1.2.4. The mobilised SBP system was found to be faulty during equipment verification and was demobilised from the vessel on 9 February 2023. Therefore, the SBP element of the project scope was postponed but the MBES, SSS and MAG data acquisition continued as planned.

1.2.5. MBES, SSS and MAG survey operations took place on 10 – 13 February 2023. Full data QA was conducted onboard in real-time by the onboard geophysical processor and by the shore-based processing team, at CM-Geomatics Ltd, for wider review at the end of each survey day. Following initial completion of all survey lines, a full data review and preliminary processing took place to confirm the required coverage had been achieved and the vessel was demobilised on 14 February 2023.

1.2.6. The vessel was remobilised on 6 March 2023 with two replacement SBP systems; a Geo Marine systems boomer and a geo marine systems freshwater sparker. Full equipment testing and verification of the two systems took place on 7 March 2023. Both systems were confirmed to be operational and producing good data quality. Survey operations commenced on 7 March 2023 and were completed on 12 March 2023. Following a full data review, the survey was confirmed complete, and the vessel was demobilised on 13 March 2023.

Personnel

1.2.7. A summary of the personnel involved in the data acquisition and processing of the survey are detailed in Table 1-1(MBES/SSS/MAG survey) and Table 1-2 (SBP survey).

Table 1-1. Summary of key personnel – MBES/SSS/MAG survey operations

Role	Personnel
Project Manager / Surveyor	Paul Clement (ABPmer)
Hydrographic surveyor	Tom Alker (ABPmer)
Geophysical surveyor / Engineer	Hugh MacKay (Freelance Contractor)
Geophysical Processor (onboard)	Tim Holgate (CM-Geomatics Ltd)
Geophysical Processing Manager	Kayur Patel (CM-Geomatics Ltd)
GIS Analyst	Oliver Ringwood (ABPmer)
Geophysical Vessel Master	Nick Bush (Hayes Marine Ltd)
Geophysical Vessel Mate/Engineer	James Bush (Hayes Marine Ltd)

Table 1-2. Summary of key personnel – SBP survey operations

Role	Personnel
Project Manager	Paul Clement (ABPmer)
Hydrographic surveyor	Tom Alker (ABPmer)
Geophysical surveyor / Engineer	Hugh MacKay (Freelance Contractor)
Geophysical Processing Manager	Kayur Patel (CM-Geomatics Ltd)
GIS Analyst	Oliver Ringwood (ABPmer)
Geophysical Vessel Master	Nick Bush (Hayes Marine Ltd)
Geophysical Vessel Mate/Engineer	James Bush (Hayes Marine Ltd)

1.3. Equipment Mobilisation

Geodetic control

1.3.1. In order to avoid transformation errors during acquisition, all data was acquired relative to UTM30N(ETRS89). The data was then converted to the required OSGB36 coordinate system using the OSTN15 transformation.

1.3.2. In the vertical, data was acquired relative to the ETRS89 ellipsoid and offset to CD using a single geoid separation value of 41.82 m. The value was taken from the VORF (Vertical Offshore Reference Frame) ETRS89-CD geoid model. The geodetics for the project are EPSG: 27700 OSGB36/British National grid.

Geophysical survey

Survey summary

1.3.3. A brief summary of the daily activities conducted as part of the project are provided in Table 1-3 (MBES, SSS, Mag survey) and Table 1-4 (SBP survey). Daily Progress Reports are provided as Annex B, which provide a detailed summary of all survey activities.

Table 1-3. Summary of MBES, SSS and MAG survey operations

Date	Daily Summary
06/02/2023	Survey personnel travel to Grimsby.
07/02/2023	Full project brief and HSE discussion held with all survey and vessel personnel. Commenced mobilisation of Wessex Explorer. MBES pole deployed. SBP, SSS and MAG installed.
08/02/2023	Dynamic MBES position calibration conducted within Grimsby Fish Docks. Independent static position verification conducted alongside. SBP, SSS and MAG systems wet tested. Full MBES patch test successfully conducted at outfall location.
09/02/2023	Dynamic SBP, SSS, MAG position verification conducted at outfall location. Data quality issue identified with SBP system and replacement deemed required.
10/02/2023	Unable to source replacement boomer SBP system in rental market. Mobilise marine sparker SBP system. Marine sparker system not operating correctly. Without suitable replacements available decision to continue with survey without SBP element. Commence running survey lines with MBES, SSS and MAG.
11/02/2023	Continue MBES, SSS and MAG survey.
12/02/2023	Continue MBES, SSS and MAG survey.
13/02/2023	Completed all remaining MBES, SSS, and MAG survey lines. Full data QA prior to demobilisation.
14/02/2023	Data QA confirms requirements coverage achieved. Vessel demobilised. Survey personnel depart Grimsby.

Table 1-4. Summary of SBP survey operations

Date	Daily Summary
06/03/2023	Survey personnel travel to Grimsby.
07/03/2023	HSE discussion held with all survey and vessel personnel. Commenced mobilisation of boomer SBP system on Wessex Explorer. Conduct SBP position verification at outfall location.
08/03/2023	Further SBP position verifications conducted at outfall location. Commence SBP survey operations. SBP, SSS and MAG systems wet tested. Full MBES patch test successfully conducted at outfall location.
09/03/2023	Continue SBP survey operations. Survey operations suspended due to poor weather conditions. Freshwater sparker SBP system mobilised as secondary system.
10/03/2023	Poor weather conditions throughout day. Freshwater sparker system tests conducted within Grimsby Fish Docks.
11/03/2023	Continue SBP survey operations.
12/03/2023	Completed all remaining SBP survey lines. Full data QA prior to demobilisation.
13/03/2023	Data QA confirms required coverage achieved. Vessel demobilised. Survey personnel depart Grimsby.

Equipment

1.3.4. The *Wessex Explorer* was mobilised with a full suite of geophysical equipment. A port-side pole mounted multibeam (MBES) bathymetry system (and position and orientation system), sidescan sonar (SSS), sub-bottom profiler (SBP) and towed magnetometer (MAG) were mobilised to the vessel.

Multibeam system (with integrated inertial positioning)

1.3.5. A Norbit iWBMSh fully integrated multibeam system was mobilised on the port side of the *Wessex Explorer* using a purpose-built over-the-side pole-mount.

1.3.6. An Applanix POSMV Oceanmaster is integrated within the Norbit iWBMSh system, providing online RTK positioning of accuracy <0.02 m; and vessel attitude data to apply to the bathymetry.

1.3.7. The POSMV Oceanmaster is designed to provide accurate attitude, heading, heave, position and velocity data at the location of the multibeam transducer. The system consists of dual GNSS antennas coupled with the integrated Inertial Measurement Unit (IMU). GNSS data is blended with angular rate and acceleration data from the IMU and heading from the GPS Azimuth Measurement System (GAMS) to produce a robust and accurate full six degrees-of-freedom position and orientation solution.

1.3.8. The MBES was interfaced into a central acquisition computer running the navigation acquisition software, BeamworX NavAQ.

Sound velocity

1.3.9. Correcting for changes in sound velocity through the water column is essential for accurate position of soundings. Therefore, an AML Sound Velocity Sensor (SVS) is installed within the housing of the Norbit iWBMSh MBES system, for real-time sound velocity observations to assist in beam forming.

1.3.10. In addition, a Valeport Swift Sound Velocity Profiler (SVP) was used to conduct profiles through the water column at regular intervals during survey operations. The system was deployed over the side of the survey vessel and slowly lowered to the seabed before being hauled back to the vessel. During each deployment, the system observed the sound velocity at 0.2 m intervals throughout the full water column providing a sound velocity profile. The profile was then applied within the acquisition software to correct the positioning of the MBES soundings.

Sub-bottom profiler (SBP)

1.3.11. During the first phase of the geophysical survey operations, an Applied Acoustics CSP-P300 High Voltage Boomer system in conjunction with a towed Applied Acoustics High Voltage plate catamaran assembly (source), and an Applied Acoustics AH360/8 Hydrophone (receive) were mobilised to the vessel. SBP data was acquired using a Chesapeake Sonarwiz acquisition system.

1.3.12. The boomer catamaran was towed from the stern, with an outrigger installed on the starboard side of the vessel to tow the hydrophone. Both instruments were towed at 20 m astern of the vessel throughout operations, with the centre of the hydrophone array approximately level with the boomer plate. The navigation

software, BeamworX NavAQ was set to output a GGA NMEA message to the CSP-P300 of the midpoint towpoint (halfway between source and receive), with the layback (cable-out) already applied using a layback computation within the navigation software. Data was recorded in full waveform SEGY format.

1.3.13. During position verifications of the SBP system data quality issues were identified and were unable to be rectified due to a fault within the boomer itself. The secondary available system, a Geo Marine sparker and streamer was then mobilised, but a power issue meant the system did not trigger correctly in the environment. Without replacement systems available in the rental market, the survey continued without acquiring the SBP element.

1.3.14. Suitable replacement SBP systems were sourced in early March and the vessel was remobilised on 6 March 2023 with two replacement SBP systems: a Geo Marine systems boomer and a geo marine systems freshwater sparker. Full equipment testing and verification of the two systems took place on 7 March 2023. Both systems were confirmed to be operational and producing good data quality. Survey operations commenced on 7 March 2023 and were completed on 12 March 2023. Following a full data review, the survey was confirmed complete, and the vessel was demobilised on 13 March 2023.

Sidescan sonar (SSS)

1.3.15. An Edgetech 4125 side-scan sonar system was mobilised to the vessel for the SSS aspect of the geophysical survey. The system is designed for shallow water environments and operates at two simultaneous frequencies (400/900 kHz), providing an ideal combination of range and resolution. Due to the shallow nature of the survey area, the SSS was mobilised to enable towing from two locations, from the stern (starboard-stern quarter) for the deeper areas of the site, and in a “bow-mount” configuration, alongside the vessel, for the shallow areas. However, it was found that towing from the stern and adjusting layback (cable-out) enabled good data quality across the site and therefore, the bow-mount option was not required.

1.3.16. Data was logged in native JSF format using the Edgetech Discover acquisition software. Both high and low frequency data were logged.

Magnetometer (MAG)

1.3.17. A Geometrics G-882 marine magnetometer system was mobilised to the vessel. The system consists of a caesium vapour high performance sensor, increasing the probability of detecting all sized ferrous targets, an altimeter and a depth sensor. The MAG was towed from the centre of the stern of the vessel, at a layback distance of 30 m. Due to the shallow nature of the survey area, in some areas of the site, floatation was fixed to the MAG cable to prevent the instrument from contacting the seabed whilst keeping a suitable separation from the vessel to avoid the vessel’s magnetic signature.

1.3.18. The magnetometer data was interfaced into the QPS QINSy navigation software. The cable-out was applied within QINSy and a layback system used to compute the magnetometer position. Data was acquired at 10 Hz logging rate.

Equipment offsets

1.3.19. Location of sensors on the vessel relative to one another was measured during a dimensional control survey conducted in late January 2023. While sensors have been removed/replaced since this original dimensional control all measurements are repeatable due to fixed antenna mounts and sonar deployment location.

1.3.20. Offsets and alignments were recalculated to shift the vessel central reference point (CRP) to the Norbit MBES sonar reference point (SRP) and applied in the Norbit GUI and POSView Software to provide accurate real-time positions. Sensor offsets are listed below in Table 1-5.

Table 1-5. Vessel sensor offsets

Sensor/Location	X (+Forward m)	Y (+ Starboard m)	Z (+ Up m)
CRP (Norbit 'Sonar reference point')	0.000	0.000	0.000
Norbit 'Top of bracket flange'	0.000	0.172	0.070
IMU (Integrated)	0.000	0.248	-0.079
Primary antenna mount point	1.153	-0.687	4.723
Secondary antenna mount point	3.655	-0.909	4.643
Primary antenna phase centre	1.153	-0.687	4.780
Secondary antenna phase centre	3.655	-0.909	4.700
GAMS	2.502	-0.222	-0.080
Waterline	0.000	0.000	0.800
Mag tow point	0.600	-6.005	1.873
Boomer tow point	1.966	-5.628	4.830
SSS tow point	2.974	-6.201	1.873
Hydrophone tow point	5.946	-5.925	2.000
Hydrophone-boomer mid point	3.934	-5.861	2.000

Equipment calibration and verification

Navigation system (POSMV INS and QPS Qinsy) verification

1.3.21. On completion of equipment mobilisation, a GAMS (GPS Azimuth Measurement System) calibration was undertaken, whereby a series of tight turns and figure-of-eights were performed, within Grimsby Fish Docks, to enable the inertial navigation system to compute the alignment of the IMU relative to the GNSS antennas. GAMS antenna baseline vector is displayed below in Table 1-6.

Table 1-6. GAMS antenna baseline vector

Offset Node	X (+Forward m)	Y (+ Starboard m)	Z (+ Up m)
GAMS Antenna Baseline Vector	-0.222	2.502	-0.08

1.3.22. A dynamic positioning verification was also conducted to ensure the positioning accuracy of the entire vessel setup as a single system; accounting for the GNSS accuracy, sensor offsets, and MBES sensor accuracy.

Multibeam echosounder calibration and verification

1.3.23. Residual angular misalignment between the MBES and INS system was calibrated for by performing a patch test. A full patch test procedure was conducted on the 8 February 2023. The patch test was conducted at a known outfall location on the Humber Estuary. The outfall near the Burcom Sand sandbank represents an area of seabed with known changing relief suitable for calibration. Prior to commencing the patch test, a sound velocity profile was acquired to ensure that errors in sound velocity did not affect the results.

1.3.24. To identify any roll misalignment in the MBES transducer installation, two lines were run adjacent to each other in reciprocal directions over a relatively flat seabed. To identify any pitch misalignment in the MBES transducer installation, two overlapping lines were run in reciprocal directions over the discrete seabed target. To identify any heading misalignment in the MBES transducer installation, two adjacent lines were run in the same direction passing over the discrete seabed target in the outer beams.

Table 1-7. Patch test calibration values

Patch Test	Roll (+Port up)	Pitch (+Bow Up)	Yaw (+ Clockwise)
Alignment Angle Offsets	-0.25	0.00	0.20

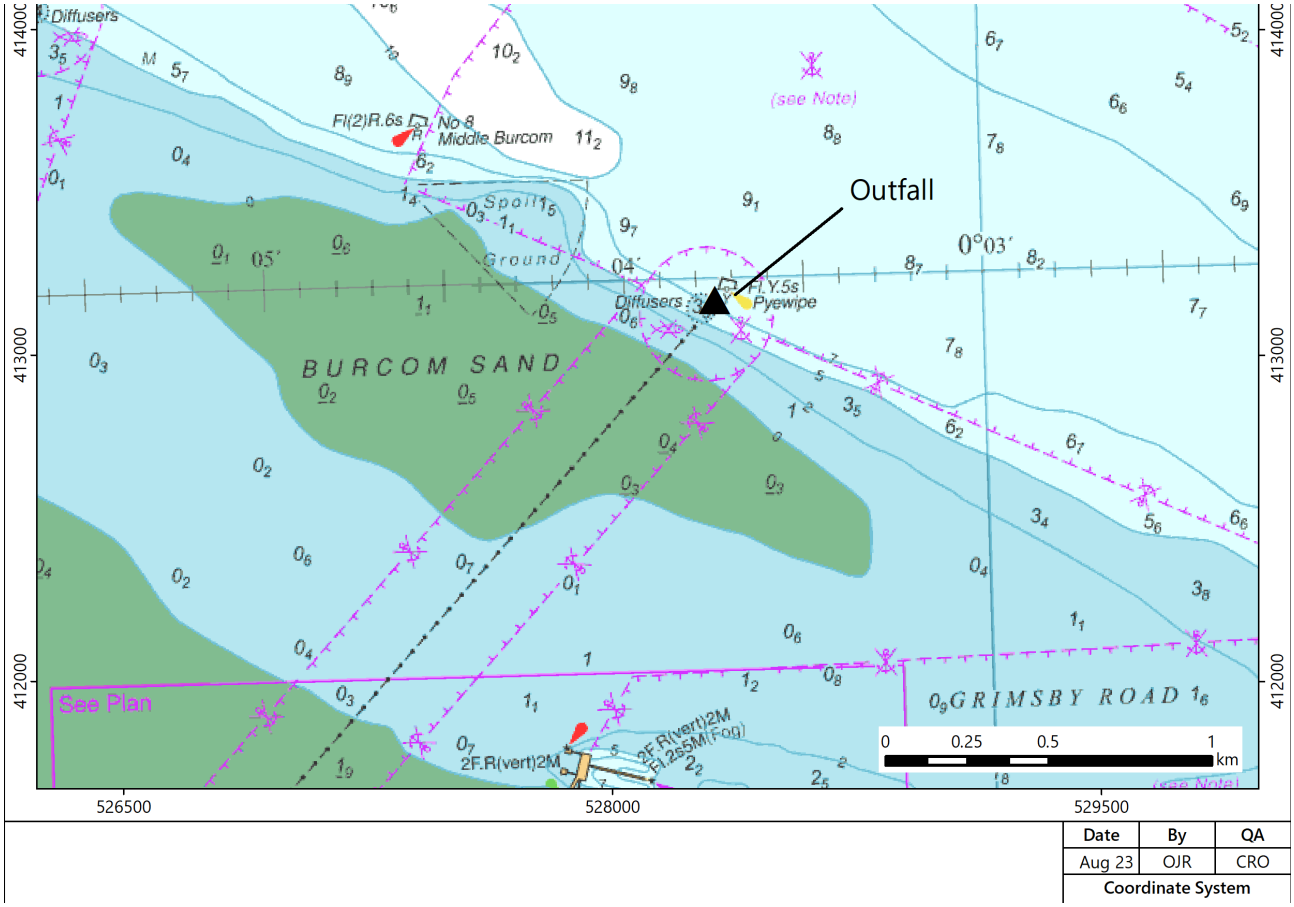

Plate 1-3. Outfall at Burcom Sand, Humber Estuary selected for MBES calibration

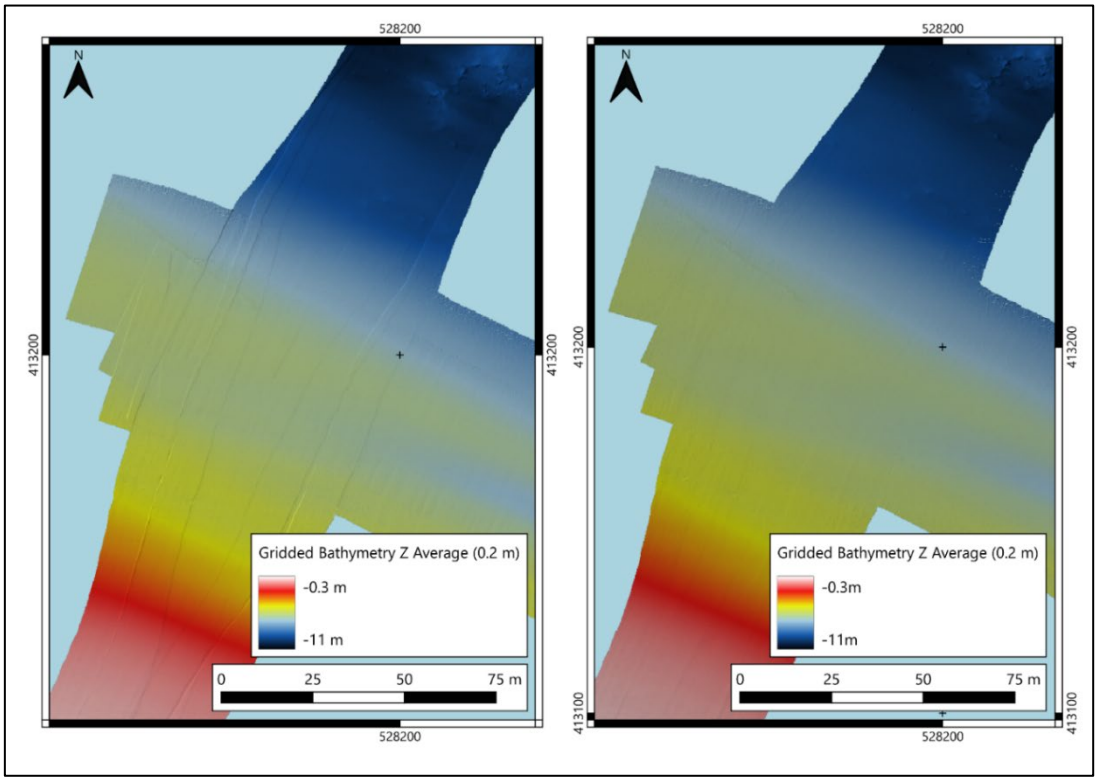

Plate 1-4. Gridded bathymetry (0.2 m) Z average plots before and after application of calibration values

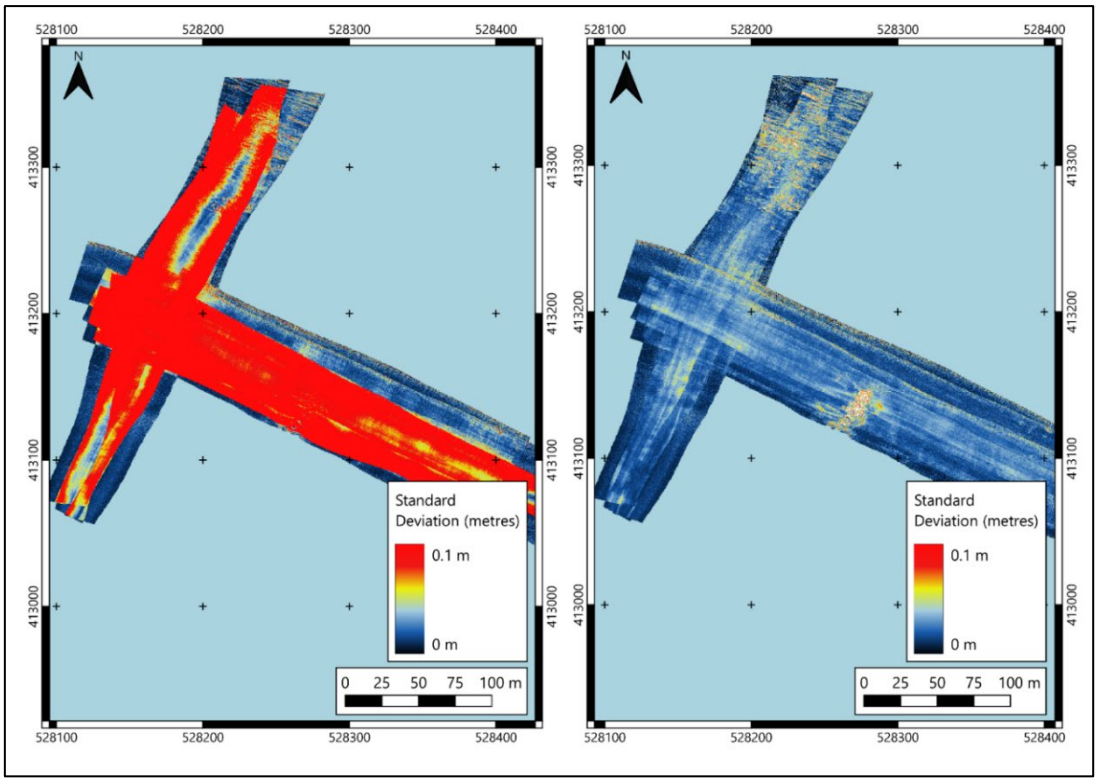

Plate 1-5. Gridded bathymetry (0.2 m) standard deviation plots before and after application of calibration values

SBP/boomer verification

1.3.25. During mobilisation, an alongside tap test of the hydrophone array was conducted to confirm the hydrophone sensitivity. A full wet test (pulse test) was then conducted whilst the vessel was alongside with the boomer pinging and hydrophone deployed, to ensure complete system operation prior to verifications. During verifications at the known outfall location on the Humber Estuary, the tow depth of the streamer was monitored, and floats were added to the streamer to ensure optimal tow depth was achieved to reduce ghosting whilst minimizing wave noise. A SBP position verification was conducted to confirm positional accuracy by running two reciprocal lines over the discrete seabed target.

SSS verification

1.3.26. During mobilisation a rub test was performed whilst alongside to confirm communications with the towfish and correct transducer setup. A wet test was undertaken on a suitable target prior to survey to prove data quality and positional accuracy. Whilst at the known outfall location on the Humber Estuary, a SSS position verification was conducted by running two adjacent lines, in reciprocal directions passing the discrete seabed target, confirming the positional accuracy.

Magnetometer verification

1.3.27. Whilst the vessel was alongside in Grimsby Fish Docks, the magnetometer altimeter and depth sensors' scale and bias values were verified to confirm the accuracy. A MAG position verification was conducted by running two reciprocal lines over, and perpendicular to, a discrete seabed target, confirming the positional accuracy (Plate 1-6).

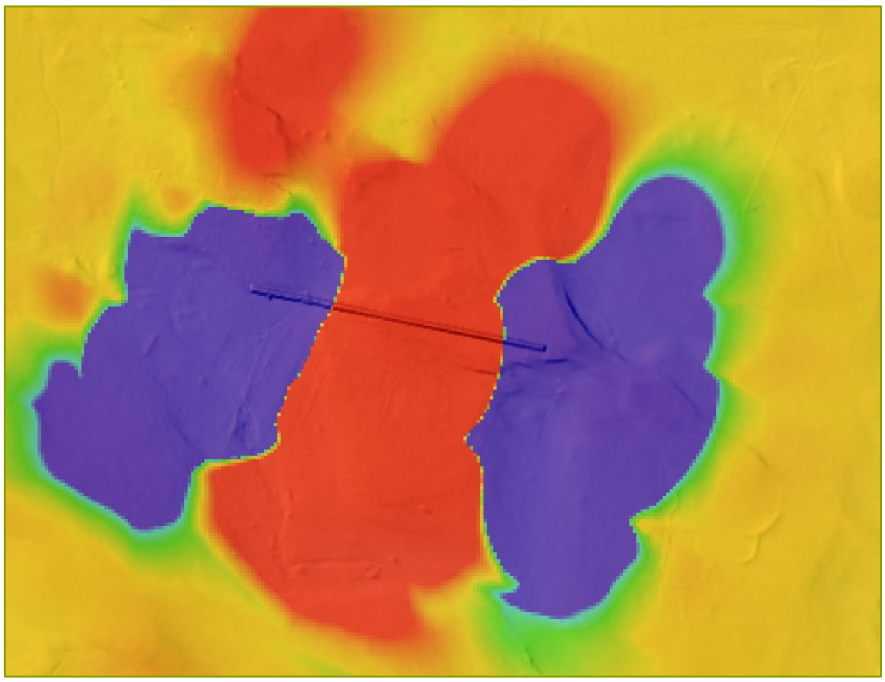

Plate 1-6. Magnetometer verification showing magnetic residual grid with poles aligning with linear target detected in multibeam bathymetry data

1.4. Data Processing and Interpretation

Multibeam bathymetry

Data processing

1.4.1. The multibeam bathymetry data was processed by ABPmer using BeamworX AutoClean 2022.3.1.0.

1.4.2. Bathymetry data was acquired with RTK positioning accurate to < 0.03 m. RTK corrections were received largely uninterrupted throughout survey operations by the integrated Applanix Wavemaster II GNSS system. However, to improve position quality further, data was post-processed in Applanix POSPac and applied to the bathymetry.

1.4.3. The raw XTF bathymetry files were imported into BeamworX AutoClean and a vessel configuration file applied, in order to apply the mobilisation offsets and angular offsets computed from the patch test calibration data. All sound velocity profiles were imported into the project so that raw soundings were corrected for the effects of changes in sound velocity by the profile closest in time, rather than the previous file in time. A coarse filter was applied to automatically remove lone erroneous soundings at extended distances from the seabed. At this site, the hull/keels of several berthed vessels were detected by the MBES but were removed by the coarse filter. The AutoClean inspection feature was then used to manually remove further erroneous soundings. In addition, any structures observed (jetty piles for instance) were removed to ensure that the final bathymetry was a representation of the seabed only.

1.4.4. The final processed bathymetry dataset was gridded at a resolution of 0.25 m and exported as an XYZ, FLT and georeferenced sun-illuminated image (GeoTIFF).

Data quality

1.4.5. MBES data was of good quality throughout survey operations. All survey lines included in the processing had uninterrupted RTK positioning following application of an Applanix smoothed best estimate of trajectory (SBET). Multiple sound velocity profiles were deployed on each survey day. Data was generally ‘clean’ with very few outliers required for manual removal in processing. Full coverage was achieved in the required survey area.

1.4.6. Following initial processing, data was reviewed by a QA processor before production of final deliverables.

Multibeam backscatter

Data processing

1.4.7. The multibeam backscatter data was processed by ABPmer using QPS FMGT (Fledermaus Geocoder Toolbox) 7.10.2.1683 and BeamworX AutoClean 2022.3.1.0.

1.4.8. Backscatter .GSF files written in real-time were imported into FMGT and paired with cleaned .GSF bathymetry files and used to generate a time-series backscatter mosaic with minimal nadir coverage (<25%). A reference surface

was also used to help the mosaic process with inclusion of slope angles. The produced mosaic was reviewed manually and lines re-prioritised within the software to provide better overlap and clarity of seabed targets. Line-specific amplitude adjustment was also conducted on outlier lines that had failed to mosaic properly. Final cleaning/review of erroneous points was conducted in BeamworX before production of deliverables.

1.4.9. The final backscatter dataset was gridded at a resolution of 0.10 m and exported as an XYZ, and georeferenced image (GeoTIFF).

Data quality

1.4.10. Multibeam Backscatter data was generally of good data quality with acquisition settings maintained consistent online to prevent any data “striping”. System power and gain were generally set at values to minimise over-reflective returns.

1.4.11. Data generally showed consistent intensity returns on overlapping lines, and nadir data was minimised (<25%) to generate as seamless a mosaic as possible. Some striping and erroneous intensity returns were present due to acoustic noise but have been minimised through the application of the backscatter processing algorithm where possible. This provided a clearer representation of the seabed.

Sidescan sonar

1.4.12. Side Scan Sonar data were processed by CM-Geomatics Ltd. For a summary of the sidescan sonar processing and interpretation methodology, see Annex A, Section 2.2.

Sub bottom profiler

1.4.13. Sub bottom profiler data were processed by CM-Geomatics Ltd. For a summary of the sub bottom processing and interpretation methodology, see Annex A, Section 2.3.

Magnetometer

1.4.14. Magnetometer data were processed by CM-Geomatics Ltd. For a summary of the magnetometer processing and interpretation methodology, see Annex A, Section 2.4.

1.5. Results

Seabed bathymetry

1.5.1. The bathymetry of the site is characterised by a deeper water, flat seabed located offshore of the IOT in the North-East of the site in the main Humber navigation channel. Here, depths are largely consistent around -15 m CD, with some deeper sections observed adjacent to the IOT -21 m CD. Plate 1-7 provides an overview of the bathymetry data.

1.5.2. This seabed sharply shallows up a steep slope on its South-Westerly edge that quickly rises (in some locations almost vertically), to a plateau at depths of approximately -5 m CD. Depths at the top of this slope slowly shallow further moving inshore (South-West) before rising quickly shoaling again in the extreme shallows adjacent to the shoreline.

1.5.3. Several depressions mark the shallower plateau section of the site approximately 3 m to 4 m in depth relative to adjacent seabed and spaced irregularly. A deeper channel runs perpendicular through the shallow section clearly visible in the MBES bathymetry, backscatter and side-scan datasets.

1.5.4. Depth contours run approximately parallel to the shoreline, adjusted irregularly due to the presence of seabed morphology.

1.5.5. Average depth within the site was -9.98 m. An overall shallowest and deepest observed depth value of 3.41 m CD and -21.29 m CD were observed respectively.

Seabed backscatter

1.5.6. The multibeam backscatter provides an image similar to a side scan sonar mosaic to assist in seabed characterisation (Plate 1-8).

Geophysical results

1.5.7. The processing, interpretation and reporting of the geophysical data (SSS, SBP and MAG) was conducted by CM-Geomatics Ltd. Results summarising the below can be found in Annex A, Section 3.

- Seabed morphology;
- Seabed sediments;
- Seabed contacts;
- Sub-surface conditions:
  - Geological model;
  - Stratigraphic interpretation.

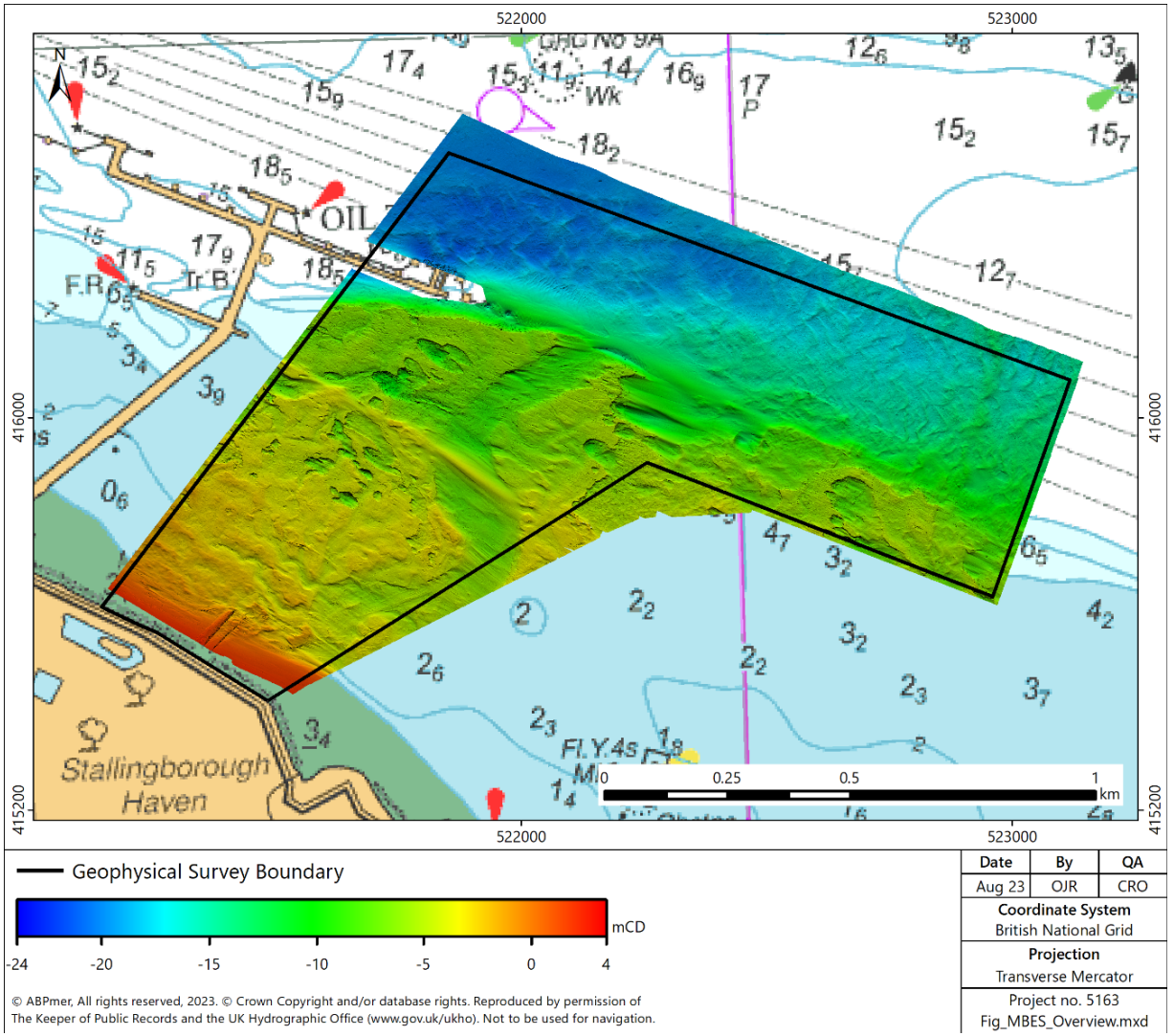

Plate 1-7. Multibeam bathymetry overview

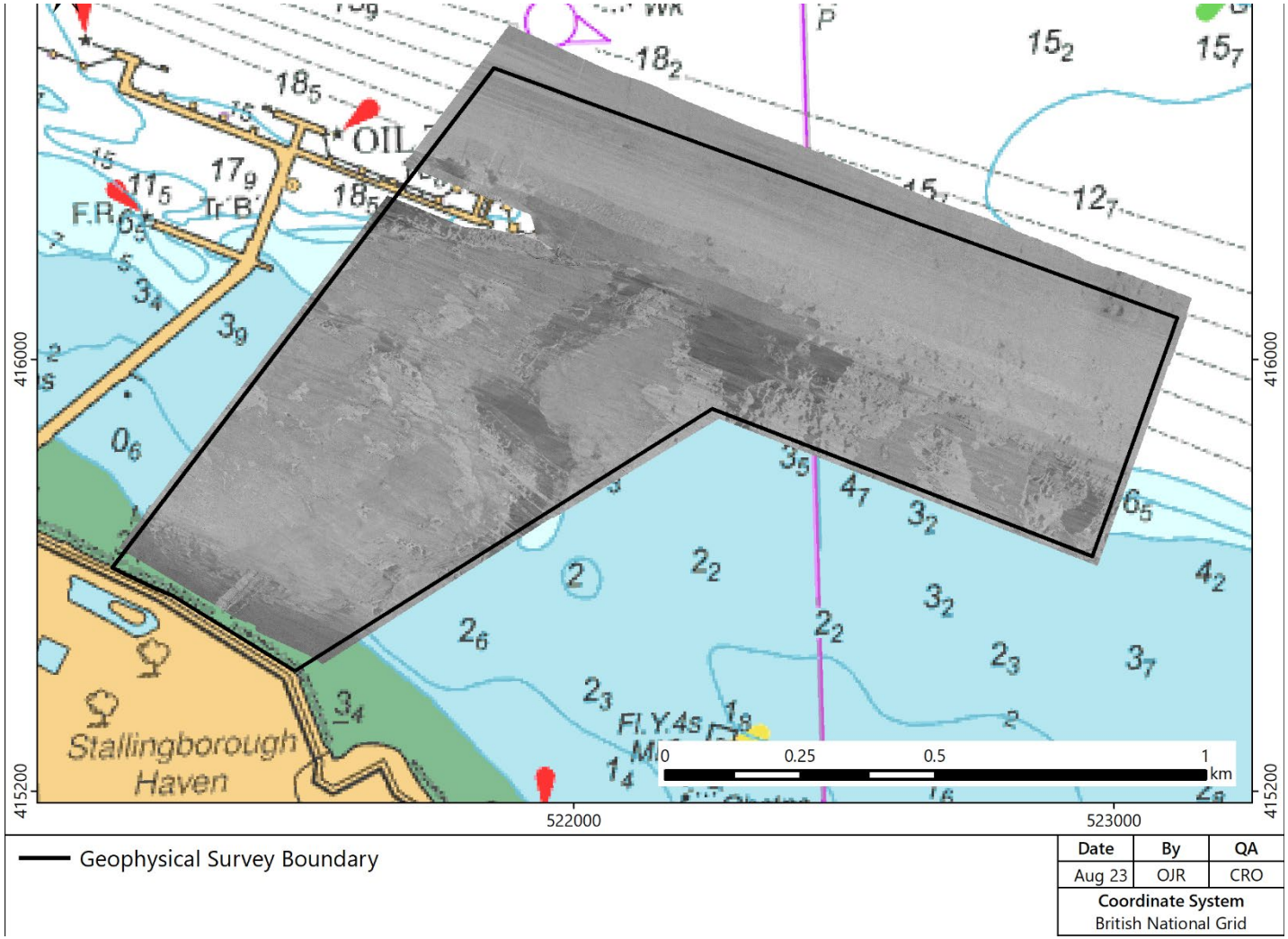

Plate 1-8. Multibeam backscatter overview

1.6. Deliverables

Charts

1.6.1. Geophysical data is presented in a series of five 1-panel charts and one 4-panel chart as described below:

1-panel charts:

- 5163_IGET_Geophysical_MBES_Bathy_A0 (Scale 1:2100 Size: A0)
  - Sun-illuminated bathymetric image
  - Bathymetry contours at 1 m intervals
- 5163_IGET_Geophysical_MBES_Backscatter_A0 (Scale 1:2100 Size: A0)
  - Backscatter mosaic
- 5163_IGET_Geophysical_SSS_A0 (Scale 1:2100 Size: A0)
  - Sidescan Sonar mosaic (Low Frequency)
- 5163_IGET_Geophysical_SBF_Rev0 (Scale 1:1,2100 Size: A0)
  - Interpreted seabed features
  - Seafloor contacts
- 5163_IGET_Geophysical_MAG_Rev0 (Scale 1:1,2100 Size: A0)
  - Magnetic residual field grid
  - Observed magnetic targets

4-panel charts:

- 5163_IGET_Geophysical_SBP_A0 (Scale 1:2100 Size: A0)
  - Panel 1 - Sub Bottom Profiler trackplot
  - Panel 2 – Base of surficial Alluvium – gridded interpretation
  - Panel 3 – Top of lower boulder clay – gridded interpretation
  - Panel 4 – Top of chalk – gridded interpretation

Data deliverables

1.6.2. Table 1-8 summarises and describes the geophysical data deliverables that are provided with this report.

Table 1-8. Geophysical data deliverables

System	Deliverable	Description	Format
1a_MBES Bathymetry	1__XYZ	Gridded bathymetry relative to OSGB36(OSTN15) and CD. • 0.25 m resolution • 0.5 m resolution • 1.0 m resolution	.XYZ

System	Deliverable	Description	Format
	2_ FLT	Gridded bathymetry relative to OSGB36(OSTN15) and CD. • 0.25 m resolution • 0.5 m resolution • 1.0 m resolution	.FLT
	3_TIF	Sun-illuminated bathymetric imagery. • 0.25 m resolution • 0.5 m resolution • 1.0 m resolution	.TIF / .TFW (GeoTIFF)
	4_Contours	Bathymetric contours (CD) at 1 m intervals.	.SHP
	5_Trackplot	Multibeam survey Trackplot	.SHP
1a_MBES Backscatter	1_TIF	Backscatter imagery at 0.1 m resolution	.TIF/.TFW (GeoTIFF)
2_SBP	1_Processed_Data (processed seismic data [CD +5 m])	Processed and tidally reduced seismic data in SGY format. Data undergone basic signal processing plus deconvolution and demultiple processing.	.SEGY (TWTT with fully populated trace and text headers)
	2_Trackplot	Trackplot showing extent of accepted SBP data.	.SHP
	3_Interpretatation (Horizon interpretation including Geohazards)	Horizons in seconds time relative to tidally corrected SGY data, with seismic trace numbers assigned. For use with seismic interpretation software if further work is required.	Text (X, Y, Line, Trace, Time, Amplitude)
	4_Gridded_Surfaces	Gridded and cleaned horizon data representing the surfaces that the files are named for relative to metres below CD.	Text (X, Y, Depth (below CD) and GIS (single band GeoTIFF)
	5_Isopachs	Gridded and cleaned horizon data representing the surfaces that the files are named for relative to metres below seabed.	Text (X, Y, Depth (below Seabed) and GIS (single band GeoTIFF).
3_SSS	1_Processed_Data (Navigation corrected and seabed tracked)	Navigation and altitude corrected sonar data in XTF format.	.XTF

System	Deliverable	Description	Format
	2_Trackplot	Trackplot showing extent of accepted SSS data.	shp
	3_HF_Mosaic	Georeferenced mosaic image of the high frequency SSS data at 0.1 m resolution.	.TIF / .TFW (GeoTIFF)
	4_LF_Mosaic	Georeferenced mosaic image of the low frequency SSS data at 0.1 m resolution.	.TIF / .TFW (GeoTIFF)
	5_Seafloor_Contacts	Contact list containing target specific data for each interpreted SSS/MBES contact and correlations to other datasets.	.CSV / .SHP
	6_Seabed Features (SBF)	Polygon shapefiles marking boundary extents of the seabed conditions. Subdivided into: • 1_Sediments - describes the predominant interpreted sediment composition at the seabed grouped into a single shapefile with attributes to describe sediment types. • 2_Morphology - contains individual polygon shapes to describe various morphological and anthropogenic structures present at the seabed.	.SHP
4_MAG	1_Processed_Data	Processed magnetic data in text format.	.TXT
	2_Trackplot	Trackplot showing extent of accepted MAG data.	.SHP
	3_Residual_Field_FLT	Gridded interpreted residual magnetic field calculated from the recorded total magnetic field.	.FLT
	4_Residual_Field_Image	Gridded interpreted residual magnetic field calculated from the recorded total magnetic field. Georeferenced image format complete with associated ColourBar.	.TIF / .TFW (GeoTIFF)
	5_MAG_Contacts	Contact lists containing target specific data for each interpreted MAG contact and correlations to other datasets.	.SHP

1.7. Abbreviations/Acronyms

ABP	Associated British Ports
AML	AML Oceanographic
AutoClean	Bathymetry processing software
BeamworX	BeamworX bv
CD	Chart Datum
CRP	Central Reference Point
CSP	Sub-bottom Profiler Model
CSV	File FORMAT - Comma-Separated Values
DCO	Development Consent Order
EPSG	European Petroleum Survey Group
ETRS89	European Terrestrial Reference System 1989
FLT	Filetype – GIS Float
FMGT	Fledermaus Geocoder Toolbox
GAMS	GPS Azimuth Measurement System
GeoTIFF	Georeferenced Image
GGA	GPS Positioning Message
GIS	Geographic Information System
GNSS	Global Navigation System
GPS	Global Positioning System
GSF	Generic Sensor Format
GUI	Graphical User Interface
HF	High Frequency
HSE	Health and Safety Executive
IGET	Immingham Green Energy Terminal
IMU	Inertial Measurement Unit
INS	Inertial Navigation System
IOT	Immingham Oil Terminal
iWBMSh	Integrated Wide-Band Multibeam Sonar
JSF	JavaScript File
LF	Low Frequency
LiDAR	Light Detection and Ranging
MAG	Magnetometer
MBES	Multi-Beam Echo Sounder

NavAQ	Navigation and Data Acquisition Software
NMEA	Standard Interfacing Output Message
OSGB36	Ordnance Survey Great Britain 1936
OSTN15	Ordnance Survey Transformation model 2015
POSMV	Applanix Positioning System
POSPac	Applanix Positioning Processing Software
POSView	Applanix Positioning Acquisition Software
QA	Quality Assurance
QINSy	Navigation Acquisition Software
QPS	Quality Positioning Services (Manufacturer of Navigation Software)
RTK	Real-Time Kinematic
SBET	File format - Smoothed Best Estimate of Trajectory
SBP	Sub-Bottom Profiler
SEGY	File format – Sub Bottom Data
SGY	File format – Sub Bottom Data
SHP	File format – GIS Shapefile
Sonarwiz	Sidescan Acquisition Software
SRP	Sonar Reference Point
SSS	Side Scan Sonar
SVP	Sound Velocity Profile
SVS	Sound Velocity Sensor
TFW	File Format - Used to Georeference TIF Files
TIF	File Format – Image
TWTT	Two Way Travel Time
TXT	File Format - Text
UK	United Kingdom
UTM	Universal Transverse Mercator
VORF	Vertical Offshore Reference Frame
Wavemaster	Applanix navigation system model
XTF	File Format – Processed Side Scan Sonar Data
XYZ	File Format –Three-dimensional Coordinates

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Annex A Geophysical Processing and Results Report

Immingham Green Energy Terminal Geophysical Site Survey

Processing and Results Report

26 May 2023

CMG23001-PRR [01]

ABPmer

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Revision Record

Issue Number	Date	Reason for Issue	Issued To	Compiled By	Approved By
Revision 00	14/04/2023	Draft	ABPmer	Kayur Patel	Dave Cullen
Revision 01	26/05/2023	Final	ABPmer	Kayur Patel	Dave Cullen

EXECUTIVE SUMMARY

MBES, SSS, MAG and SBP data have been successfully acquired across the survey area. The key findings are as follows:

Five seabed sediment classifications have been identified from a combination of SSS and MBES data: Mixed Sediment, muddy SAND, firm CLAY?, soft MUD and rock protection. Firm CLAY has been marked tentatively as an increase in soil strength is only supported by an increase in reflectivity. Sediments classifications have not been verified by ground truthing locations.

In total 1064 seafloor contacts have been identified on SSS and MBES datasets. A significant number of debris items have been identified, largely in the southern half of the survey area.

A total of 317 magnetic contacts have been identified that are >5nT in amplitude, 44 of which are able to be correlated with seafloor targets based on proximity, size, and magnetometer altitude. Magnetic results are only valid for large ferrous targets and not UXO.

Four main sub surface units have been identified. The geological model has been based on background information about the site and geotechnical work carried out previously at or near to the survey area. Some conflicts exist between the interpretation made on this data and the legacy boreholes, however recent vibrocores show good correlation in areas where chalk is observed to be shallow.

The uppermost unit is comprised of surficial alluvium deposits composed of soft SILT/CLAY and SAND with a depth range between 0-4.8m BSB.

A layer of interpreted boulder clay underlies the alluvium which has been interpreted as the “Upper Boulder Clay” unit. The Upper Boulder Clay ranges between 0m-10.6m BSB and is largely observed to exist in tandem with the underlying Lower Boulder Clay which appears to completely erode away towards the north.

A second layer of boulder clay has been interpreted as the “Lower Boulder Clay” unit. This unit is observed to exist between 0-15m BSB in the survey area. Discontinuous lenses of SAND/GRAVEL are also noted within this unit.

The bedrock has been identified as CHALK from geotechnical data. The surface of the CHALK has been observed in the seismic data at depths between 0-15m BSB. The bedrock level below seabed shoals to the north where it is observed at or close to the riverbed.

Two isolated regions of acoustic attenuation are observed, likely caused by moderate accumulation of organic matter within the surficial sediments.

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Abbreviations

BSB	Depth Below Seabed
CD	Chart Datum
INS	Inertial Navigation System
LAT	Lowest Astronomical Tide
MAG	Magnetometer
MBES	Multi-Beam Echo Sounder
PPK	Post-Processed Kinematic
QC	Quality Control
SBP	Sub-Bottom Profiler
SSS	Side Scan Sonar
UTM	Universal Transverse Mercator

1. INTRODUCTION

1.1. PROJECT DESCRIPTION

CMGeomatics was commissioned by ABPmer to provide data processing and interpretation services for their geophysical survey on the proposed Immingham Green Energy Terminal development area. The survey comprised of Multi Beam Echo Sounder (MBES) bathymetric data, high-resolution Side Scan Sonar (SSS), Magnetometry (MAG) and Sub-Bottom Profiler (SBP) geophysical data. The SBP element of the survey comprised of both boomer and sparker sources.

Figure 1-1 shows the survey location and site boundary.

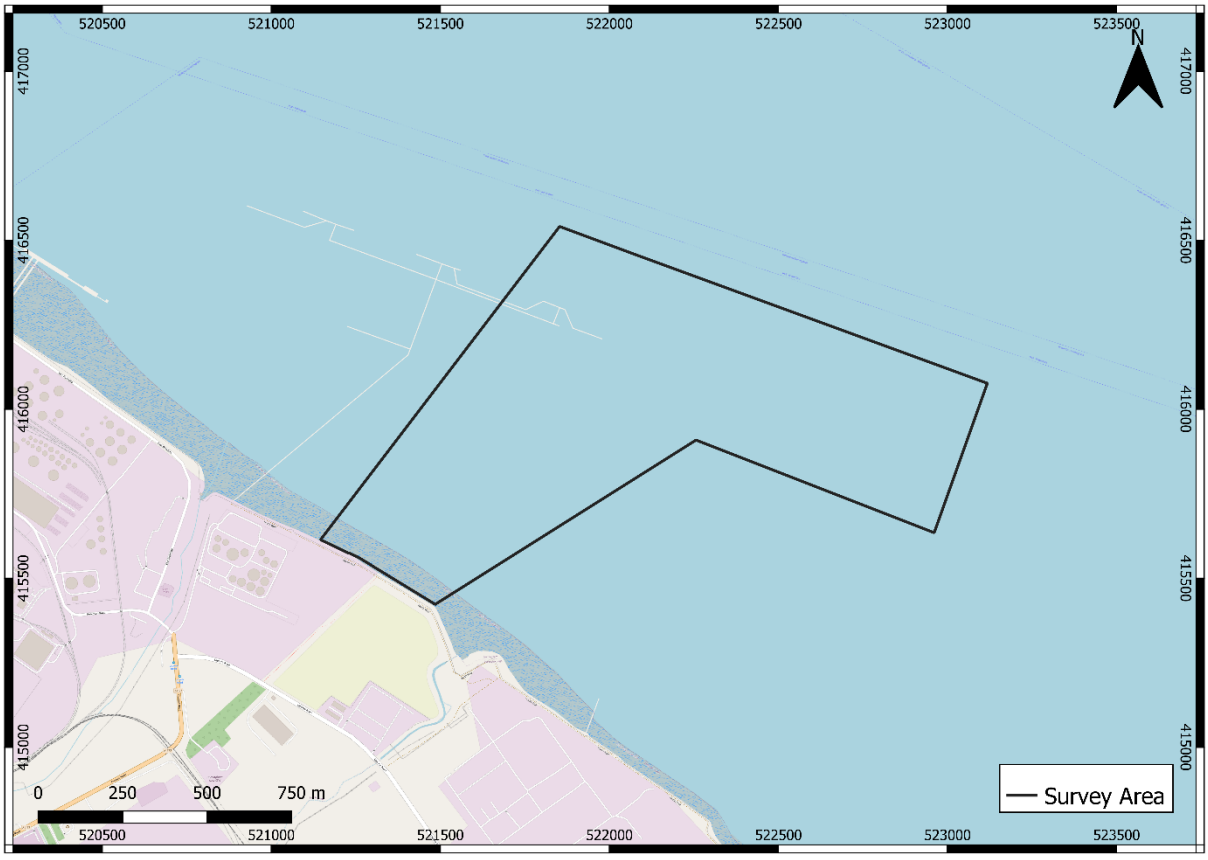


Figure 1-1: Immingham Green Energy Terminal survey area with survey extents.

1.2. SCOPE OF REPORT

This report details the processing applied to each dataset, the results and interpretations made, as well as comparisons between datasets where relevant.

1.3. GEODETICS

1.3.1 Horizontal Datum

Whilst data were logged in ETRS89-UTM30N during acquisition, all data are reported using OSGB36 using the OSTN15 transformation. Details of the OSGB36 projection are detailed in Table 1.1

Table 1.1: Horizontal Geodetic Datum OSGB36.

Geodetic Parameters		Projection Parameters	
Ellipsoid	Airy 1830	Projection	TM
Datum	OSGB 1936	Longitude of Central Meridian	-2°
Semi-Major Axis	6 377 563.396 m	Latitude of Origin	49°
Semi-Minor Axis	6 356 256.909 m	False Easting at Central Meridian	400 000 m
Inverse Flattening (1/f)	299.3249646	False Northing	-100 000 m
Eccentricity Squared (e^2)	0.006670539762	Scale Factor	0.999601272

1.3.2 Vertical Reduction

All bathymetric and SBP data were reduced to Chart Datum (CD).

2. DATA PROCESSING AND INTERPRETATION

2.1. BATHYMETRIC DATA

2.1.1 Data Processing

All bathymetric data and positioning were processed by ABPmer.

2.2. SIDESCAN SONAR

2.2.1 Data Processing

Side Scan Sonar data were processed using Sonarwiz 7.09.02.

SSS data were acquired in simultaneous dual-frequency mode. Raw SSS data files in JSF format were then loaded into Sonarwiz. Heading source is usually taken from the towfish heading sensor, but course made good was also employed to improve positional accuracy on some data where an improvement in positional accuracy was observed. Navigation was projected from latitude and longitude into the project datum. A light 'Boxcar' moving average filter was applied to the navigation to remove outliers and smooth the projected sensor track. Bottom-tracking was then carried out on each file to ensure the correct slant-range and thus the correct measurements of contacts in the interpretation phase. A QC of the data was completed at this stage. Any poor data were removed or cropped as required. As both high and low frequency components are utilised in the interpretation, the corrected navigation applied during the processing of the high frequency data was transferred into the low frequency data, ensuring that each dataset has the same navigation.

Gains and a de-stripe filter were applied to the data to correct backscatter amplitudes to create a mosaic with homogeneous gains between all lines, as well as highlighting areas of low and high reflectivity. Upon completion of all SSS processing, the data was layered to aesthetically optimise the presentation of the mosaics. Mosaics were produced and exported for low and high frequency data at the required resolutions.

2.2.2 Data Interpretation

Contacts measuring over 0.5m in any dimension were interpreted on a line-by-line basis to ensure none were missed. Reconciliation between SSS and MBES data were undertaken to ensure best positions were derived for each target where visible on the MBES data. Correlations with any MAG targets were made during contact picking. MAG targets and the total field residual grid were loaded into QGIS for rationalisation and to aid in the correlation process.

Localised seabed features were picked to aid in the interpretation of the surficial geology and geohazards model. SSS mosaics and interpretation were loaded alongside the processed MBES data within GIS to finalise the seabed features interpretation. The datasets were then used in conjunction to define boundaries for sediment classes, geo-morphology, and existing infrastructure.

2.2.3 Data Quality

SSS data quality is of generally good quality, with some data affected by strong currents. Crosslines suffered from poor towfish heading due to crabbing of the towfish whilst crossing the prevailing current. In the north of the survey site, the high flow rates of the Humber River within the shipping channel, coupled with the increased depths, resulted in the towfish failing to descend to optimal altitudes. As a result, both frequency components of the data have suffered significant attenuation in deeper water. Further attenuation in some places has been due to high water column turbidity during acquisition, which has affected the maximum range of the high frequency component of the data. In the south of the site, the shallow waters have resulted in much higher data quality. Full coverage has been achieved.

2.3. SUB-BOTTOM PROFILER

2.3.1 Data Processing

RadExPro 2022.1 was used for the processing of all acquired SBP data. IHS Kingdom 2020 was then used to interpret all processed SBP data. Both boomer and sparker datasets underwent the same processing steps (aside from sparker not undergoing debubbling due to the introduction of artefacts), however parameters were tuned for each source.

The following processes were applied during processing:

- Apply trace delay to trace data
- Smoothing of position if required
- Burst noise removal
- Butterworth filtering
- FB picking
- Debubbling (Weiner filtering) – Boomer only
- Zero offset de-multiple*
- Swell filtering (if required)

- Amplitude correction
- Top mute
- Trace-by-trace tidal reduction
- Populate textual header

* Demultiple processing had highly variable results and worked well on some lines where source/receiver geometry was stable during acquisition, however some lines did not respond well to this process. As a result, interpretation was carried out on data with and without this process simultaneously to assist in discrimination of deeper reflectors against seabed multiples.

Parameters for processing were tested and optimised during processing. Tidal reductions to CD were undertaken using GPS tide and corrected bathymetry data. However due to shallow nature of the work, some depths were logged above CD which created issues with sgy data as negative times are not supported. To work around this issue the seismic data have been corrected to CD+5m to ensure all times are positive in the data. The 5m offset was removed from interpretation deliverables so that interpretation is presented at CD level.

Processed SGY, vertically corrected to CD+5m, were then exported ready for final QC and subsequent interpretation in IHS Kingdom. Data were then imported into IHS Kingdom using SeismicDirect.

2.3.2 Data Interpretation

Analysis of SBP data, along with relevant data (previous geological data, MBES and SSS mosaic, etc.) were undertaken to build an integrated interpretative model for the site. Preliminary on-site vibrocore logs acquired in 2023 have been utilised to locate the top of chalk in the survey area. Full integration of this data has not been undertaken as the full results were not available at the time of this report, however there is good correlation between the interpretation made for the top of chalk and the preliminary results of these vibrocores. Additionally, boreholes previously drilled in 1965 were used as guidance for interpretation, however some conflicts with these geotechnical locations exist when combined with the chalk interpretation made in this geomodel.

Interpretation in Kingdom involved identifying and digitising regional horizons, as well as any localised geohazards. A seismic velocity of 1650m/s was assumed for subsurface interpretation conversions from time to depth. This value is typical of waterlogged unconsolidated sediments that are thought to make up the shallow soils.

Once completed, the interpretation was gridded, and deliverables were exported from IHS Kingdom. Gridding has been undertaken at 5m resolution and includes 20m blanking distance to allow interpretation to tie across adjacent lines.

2.3.3 Data Quality

Data quality for SBP was generally acceptable, with high variability primarily due to current conditions. Some issues with background noise, source-receiver geometry and swell/wave conditions were observed on the data, which reduced quality on some lines or limited advanced processing techniques. These issues are to be expected when working in a confined area with strong currents. Data acquired during periods of slack water show higher data quality, indicating that data quality was mainly affected by environmental conditions.

Maximum data penetration was approximately <20m, limited by the sea surface multiple in places and also the interpretation of chalk causing attenuation beneath this horizon.

Some deviations in navigation were identified during processing. Acoustic seabed location was occasionally observed to conflict with the expected seabed from bathymetry data, whilst in other locations there was very good correlation between the two expected seabed locations. This variability indicated that the likely source of the issue was due to error in calculating the layback for the seismic system caused by localised and general river currents dragging the towed equipment from their expected location. Attempts have been made to improve the positioning using different heading sources, but occasional position degradation are still observed in the final dataset.

2.4. MAGNETOMETER

2.4.1 Data Processing

Oasis Montaj 2022.2 was used for the processing of all acquired MAG data.

Data were imported into Oasis Montaj for processing and interpretation. Raw total field and altitude data were de-spiked, and the altitude smoothed. Raw layback navigation was also assessed and smoothed. Once processed, each line was subject to quality control, and data not meeting the required specification were masked from further processing.

A series of non-linear filters were applied to the total magnetic field data to deduce the background field. The filter selection was undertaken on an iterative basis to identify a scheme that isolates the majority of targets. The background field was assessed against the total field to ensure that no targets were missed or deformed. Due to the prevalence of geological noise

across the survey area, a manual background field was then formed based on the filter derived background. Anomalies were removed from the background on interpretation of the filtered background.

Once QC on the background field was completed, the result was subtracted from the original total magnetic field to give the residual field. The residual field was gridded and underwent QC to ensure that targets observed in profile are similar in both shape and amplitude to the targets present in the total field profile. Once the residual field passed QC, an unsmoothed analytic signal grid was produced.

2.4.2 Data Interpretation

Targets were picked manually on profile data to identify all targets ≥ 5nT that showed wavelengths that might be expected of anthropogenic sources, to exclude any geological signals. Full parameters were populated for the final Target Listing. Deliverables were exported directly from Oasis Montaj, with some grid formatting being performed in Global Mapper.

2.4.3 Data Quality

Magnetic data quality was generally good. Due to the nature of the site with large ferrous infrastructure, coupled with anomalies interpreted to be geological in nature, creating a reasonable residual field proved difficult. This led to the creation of a manual background field rather than relying on filters. Additionally, the combined survey difficulties presented by the riverine environment and the proximity of infrastructure resulted in the MAG sensor flying at high altitudes, which has reduced the instrument's sensitivity. The presence of large amounts of ferrous infrastructure has possibly obscured some anomalies in close proximity to the pier in the west and the cardinal buoy in the east. However, the dataset was useable for the broad interpretation of large ferrous targets. It should be noted that UXO's are unlikely to be reliably detected in this dataset.

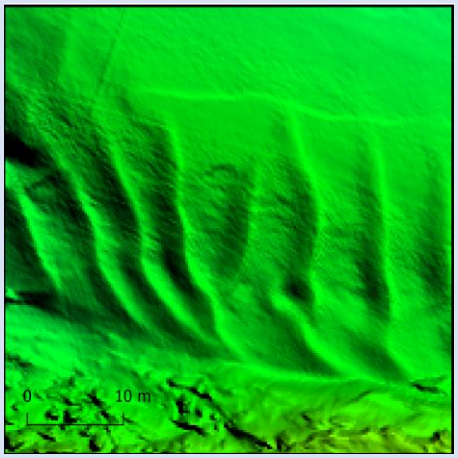
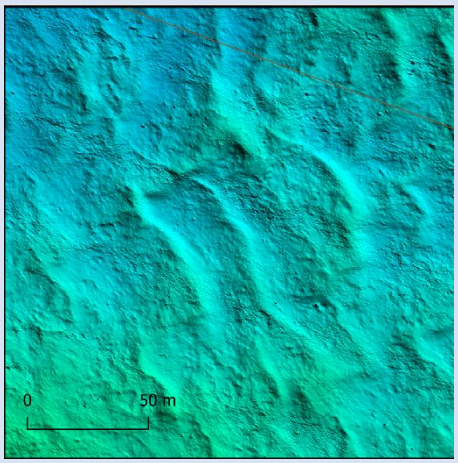
3. RESULTS

3.1. SEABED CONDITIONS

3.1.1 Seabed Morphology

Interpretation of seabed features has been made from a combination of SSS and bathymetry data. Interpreted features are summarised in Table 3.1 with corresponding data examples.

Table 3.1: Summary of interpreted seabed morphology

Data Example	Description
	Mobile Sediments (Active Ripples)
	Possible Relict Bedforms

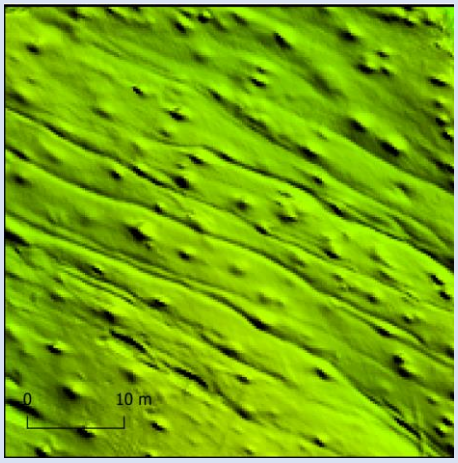
Data Example	Description
	Mound Features

Figure 3-1 shows the spatial distribution of each of the interpreted morphologies across the survey area.

A differentiation has been drawn between the active and interpreted inactive relict bedforms in the morphology classifications. This distinction has been made based on the form and texture of the features in MBES data. The bedforms interpreted as active appear well shaped and sharp, whereas the interpreted relict features appear flattened and more textured. It is possible that some interpreted relict bedforms may be thin bands of active bedforms.

Sediment mounds up to 3m in diameter have been interpreted within surficial sediments classified as mixed sediments (Table 3.2). These features lie within the upper clay horizon observed in SBP data and could be caused by localised areas of increased soil cohesion which has left raised mounds of firmer clays within the surrounding clay soil. It is possible that these mounds are biogenic in origin and contain a higher organic content than the surrounding soils, however no direct evidence to support this is available.

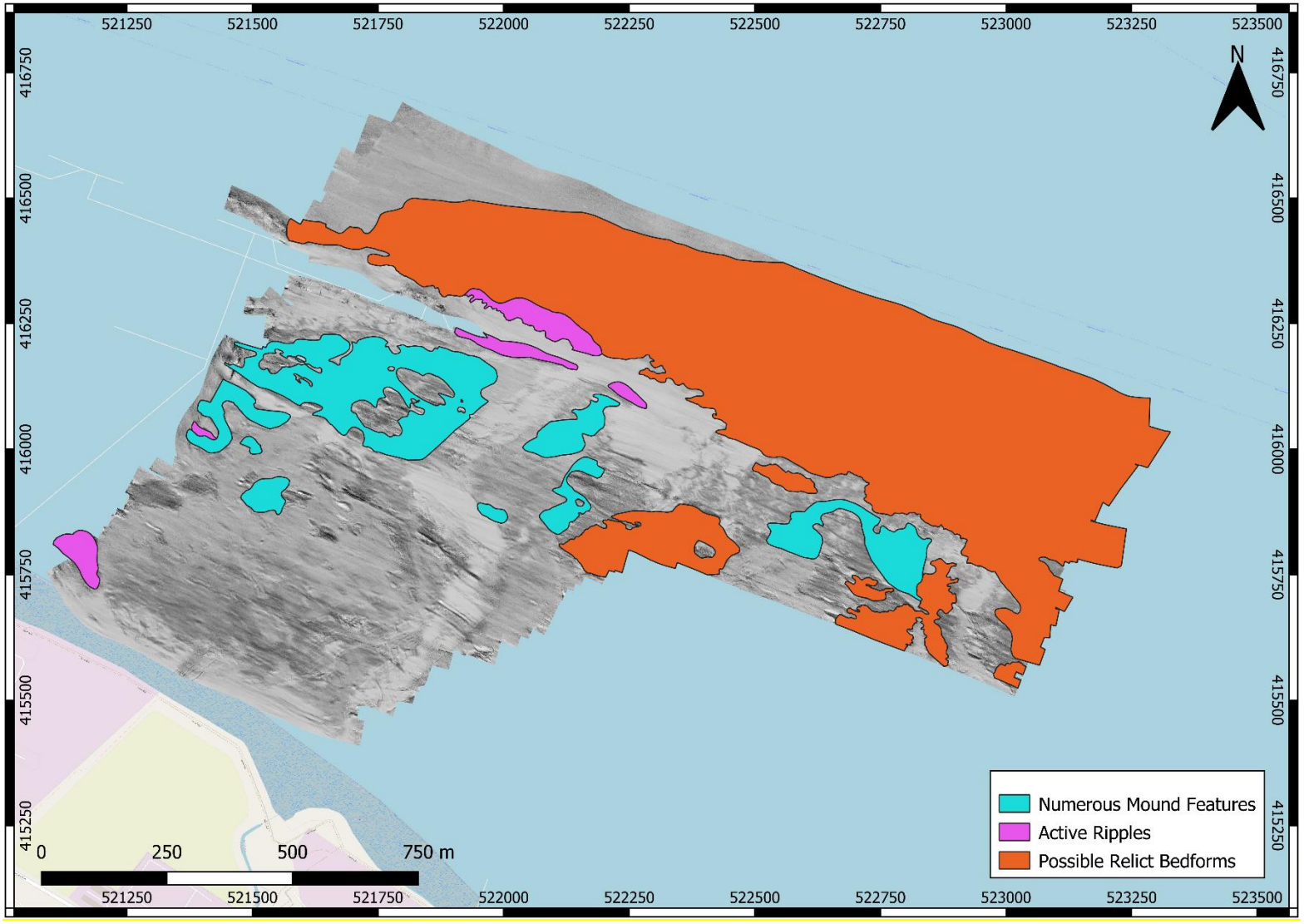


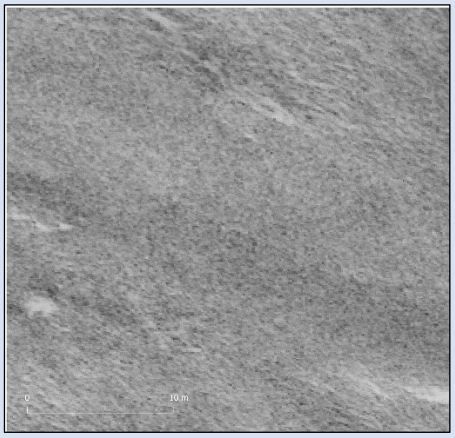
Figure 3-1: Distribution of seabed morphology across the site.

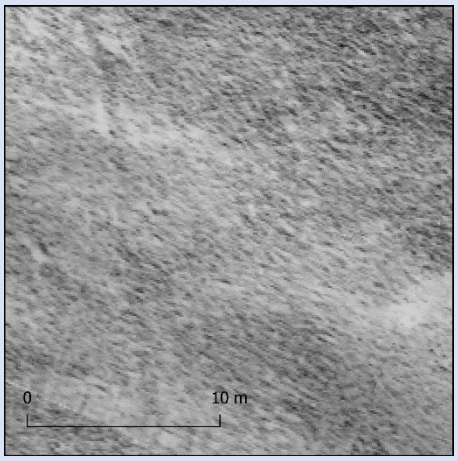
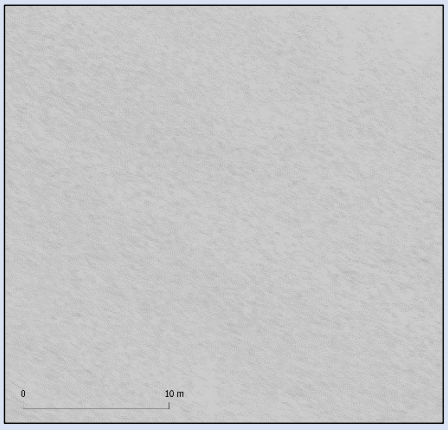
3.1.2 Seabed Sediments

Seabed sediments have been interpreted from the low-frequency SSS data and the MBES backscatter mosaic. The surficial geology of the survey site has been classified into five sediment units, the distribution of which is present in Figure 3-4. Classifications have been assigned based on similar sediment interpretations made on the adjacent IERRT survey area conducted in 2021. Additonal classifications have been added where reflectivity changes in the SSS and MBES backscatter have warranted a new class.

Table 3.2 shows a summary of the sediment classifications interpreted with data examples over each type.

Table 3.2: Summary of interpreted seabed sediment classifications.

Data Example	Description	Morphology Classification
	Medium to high reflectivity	Mixed Sediment
	Medium reflectivity, moderately textured	Muddy SAND

	High reflectivity, moderately textured	Firm CLAY?
	Very high reflectivity, highly textured	Rock Protection
	Low reflectivity, minimal textured	Soft MUD

Mixed sediments are interpreted in areas where there are frequent small scale changes in surficial reflectivity which may indicate thin layers of sediment over another and is likely to comprise of CLAY and SAND in various fractions.

Muddy SAND has been identified in the north of the site, where chalk has been interpreted near the surface (Section 3.2.2.4). It is possible that in places sediments may contain a minor gravel component from erosion of the chalk surface.

Firm CLAY has been tentatively interpreted due to an increase in reflectivity and texture when compared to adjacent clays/mixed sediment, however there in uncertainty in this interpretation because an increase in reflectivity is the only variable supporting an increase in soil strength.

The rock protection has been observed to encase the outfall pipes within the south of the site.

Soft MUD has been interpreted in topographical lows across the survey area. The interpretation of soft MUD has been made due to the very low reflectivity observed on both SSS and MBES backscatter. It is possible that this classification may instead be comprised of very fine SAND, whereas the muddy SAND classification may be composed of a coarser SAND fraction.

Geotechnical data acquired during previous site investigations has been used to aid in the classification of surficial sediments. Further information regarding the geotechnical data can be found in section 3.2.1. The location and surface classification of these boreholes are presented in Figure 3-4, along with the interepreted extents of seabed sediments. The boreholes were acquired prior to the construction of the Immingham Oil Terminal, the process of which may have led to significant sediment displacement. This, coupled with the age of the data means the results may not completely reflect the current seabed state.

For the preliminary vibrocore data provided, there was minimal correlation between the core sediments and low frequency SSS and MBES derived backscatter. This resulted in the cores suggesting homogenous seabed sediments across the site, whilst the large variance in seabed reflectivity suggested the presence of multiple sediment units. For this reason, the preliminary vibrocore data has not been used during the interpretation of seabed sediments at this stage. Integration could be performed when the complete results of the vibrocores acquired become available.

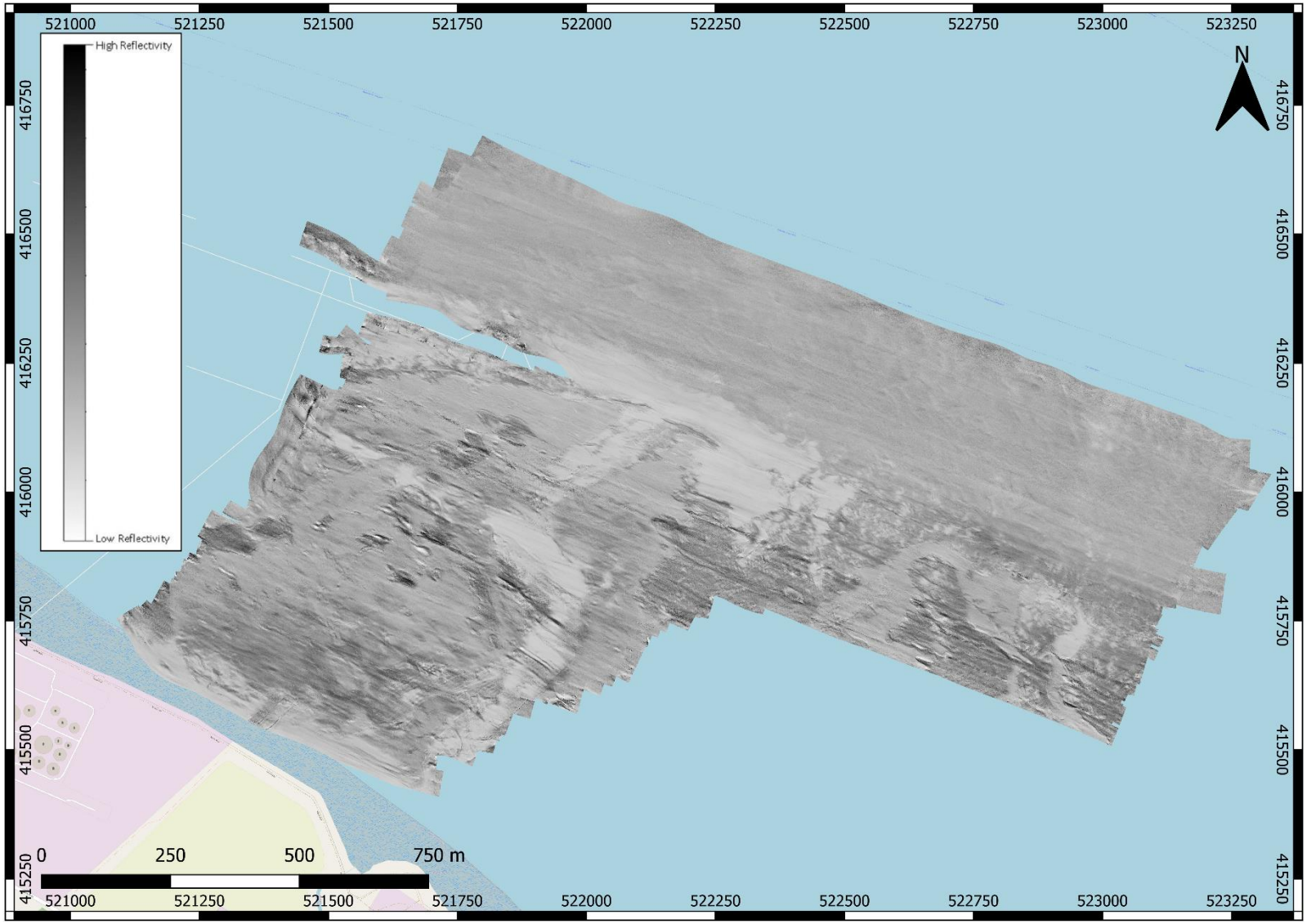


Figure 3-2: Low frequency SSS mosaic of the site.

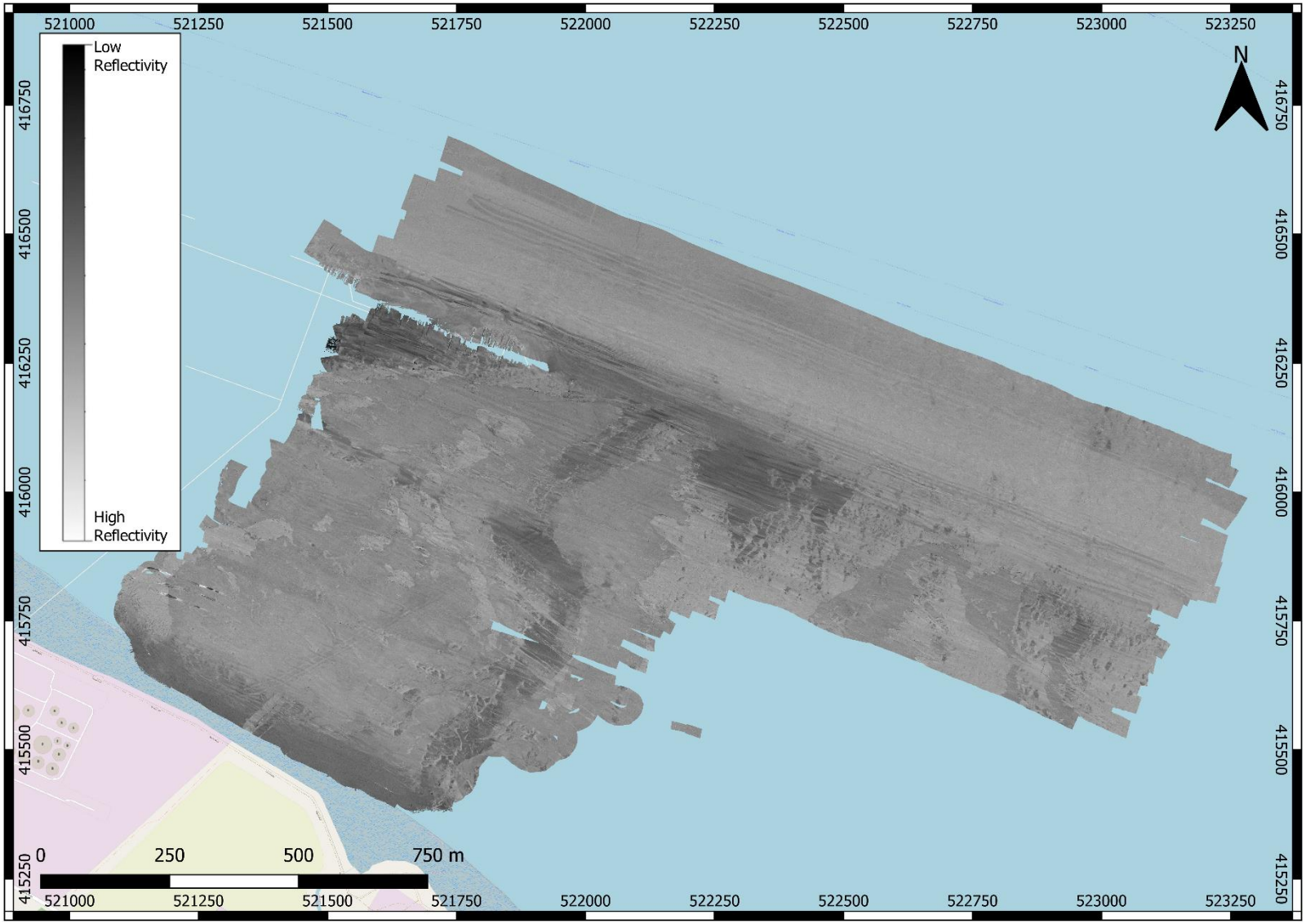


Figure 3-3: MBES backscatter mosaic of the site.

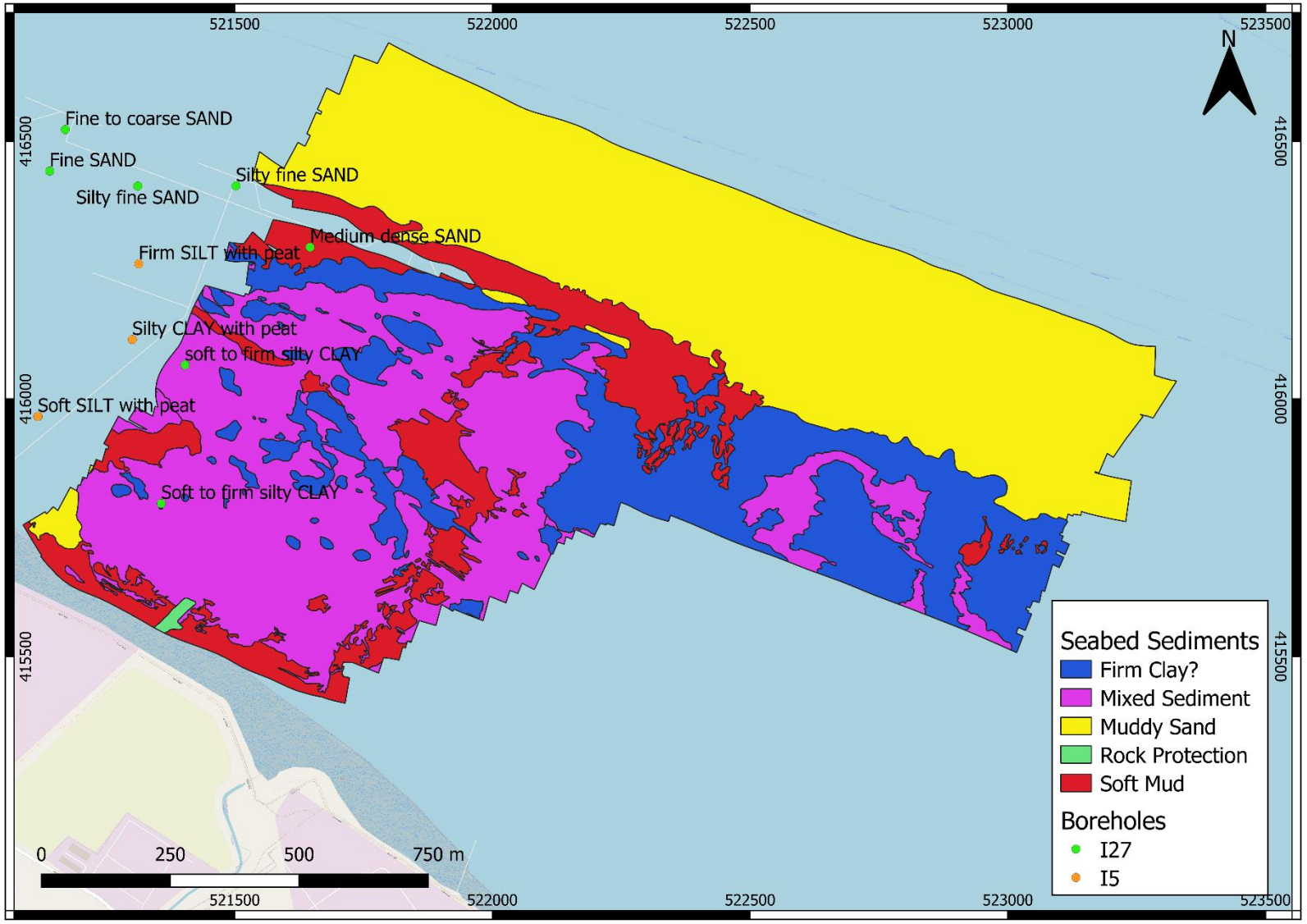


Figure 3-4: Spatial extent of interpreted seabed sediments. Borehole data from previous geotechnical investigations have been overlayed.

3.1.3 Contacts

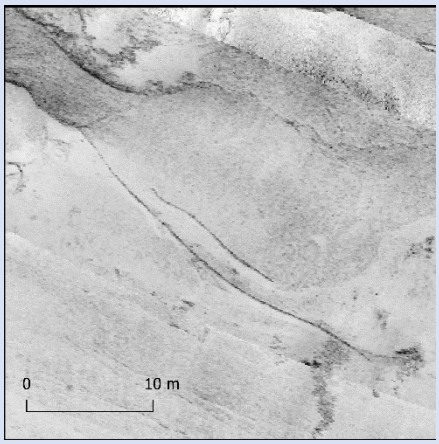
In total 1064 seafloor contacts have been identified on both SSS and MBES datasets. Where possible, SSS contacts have been reconciled to MBES position to optimise positioning quality. A correlation between the seafloor contacts and the magnetic datasets has been undertaken and any correlations noted in the attributes of the delivered contact lists. In total 48 contacts were correlated between seafloor and magnetic datasets.

Table 3.3: Breakdown of interpreted SSS/MBES contacts

Class	Number of Contacts
Boulder	650
Debris (including clusters of debris and Cable/Ropes)	413
Suspected Mooring Assembly	1

Table 3.4 shows some examples of the interpreted seafloor contacts observed in the SSS dataset.

Table 3.4: Examples of interpreted seafloor contact classifications.

Data Example	Contact Description
	Debris Cable / Rope

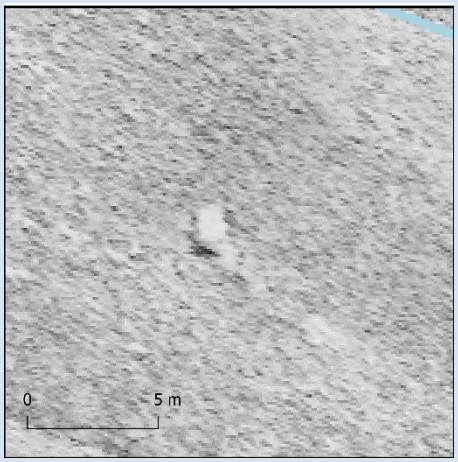
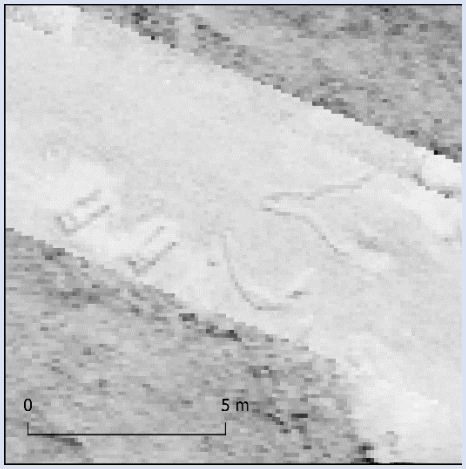
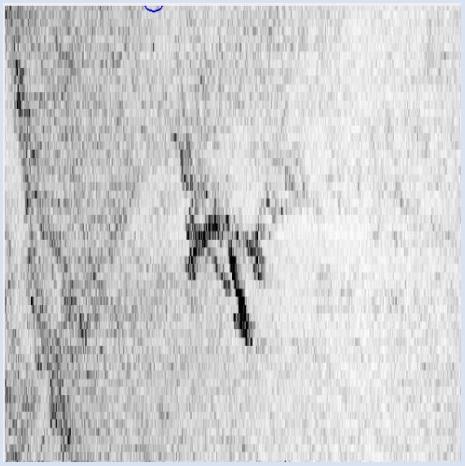
	Boulder
	Debris Rectangular structures (Left) and Cable/Rope (Right)
	Debris Anchor

Figure 3-5 presents the distribution of interpreted seafloor and magnetic contacts. Debris items appear to be concentrated in the southwest and southeast of the survey site. Interpreted boulder targets have been identified across the site and have been classified as such where a target did not appear of obvious anthropogenic nature. It may be the case that some boulder targets are in fact of anthropogenic origin, if investigated further.

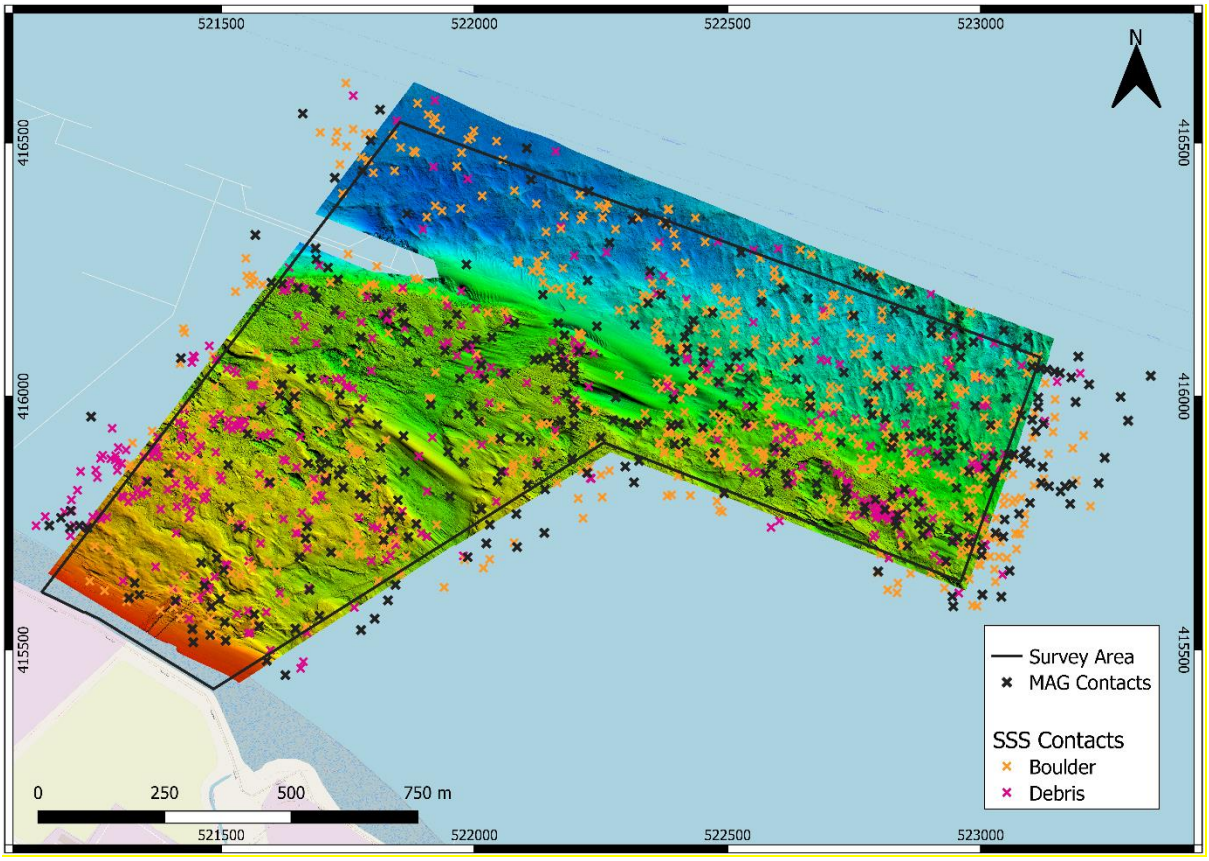


Figure 3-5: Seafloor contacts and magnetic contacts across the survey area.

In total 317 magnetic contacts have been identified that are >5nT in amplitude. The targets identified in this dataset are indicative of large ferromagnetic targets.

The processed magnetic total field is presented in Figure 3-6, note the scale has been clipped to ±5nT and values above these have been clamped to the colour scale on the image presented for display purposes. The data shows that the area is magnetically noisy and that targets have occasionally been detected on multiple lines, hence requiring reconciliation.

The long linear deviation in the north-western corner on the magnetic anomaly grid is likely generated by infrastructure associated with the pontoon and/or moored vessels at the time of survey. The large negative amplitude target in the eastern side of the site is interpreted to be associated with the mooring system for a navigation buoy. In the nearshore area, south-west of the survey area the magnetic anomalies approaching the shoreline are observed to be associated with an outfall pipe observed in the MBES/SSS data.

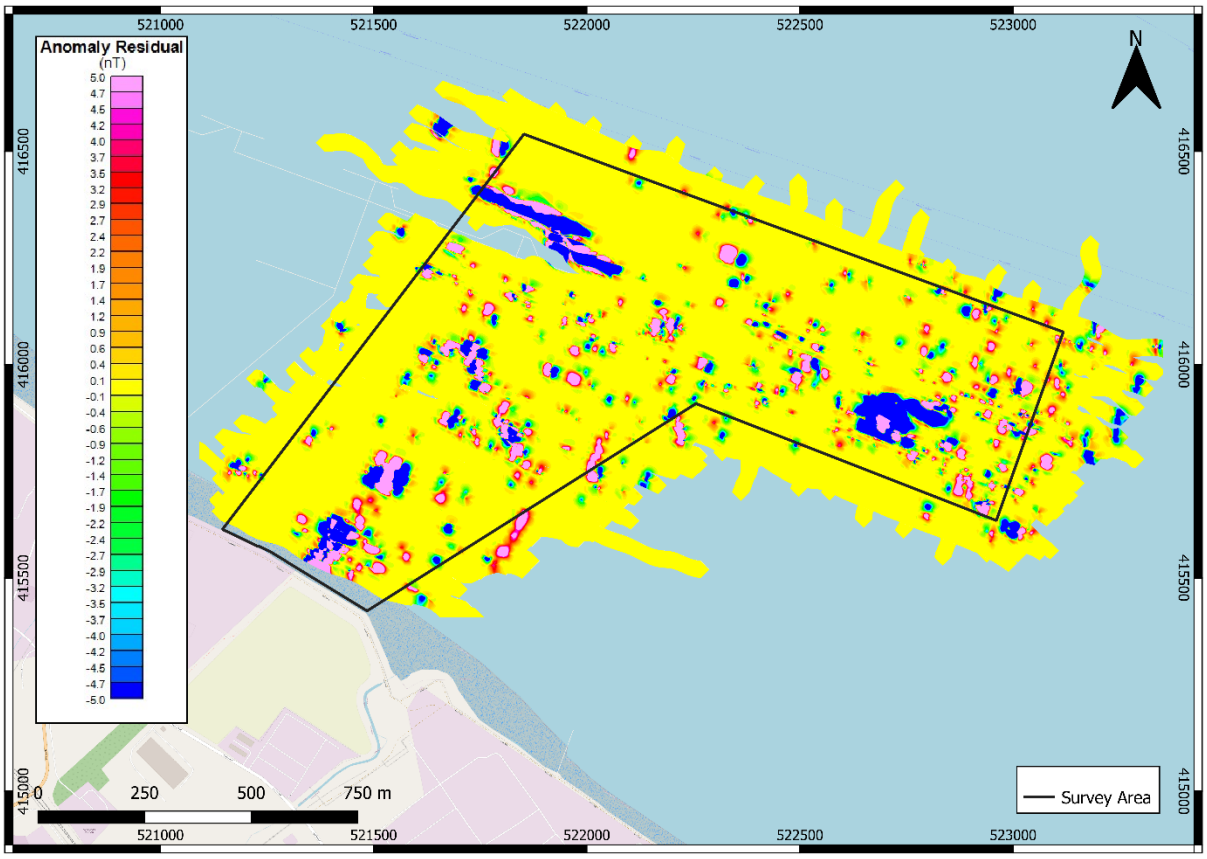


Figure 3-6: Magnetic residual field grid (nT).

A total of 44 magnetic targets have been correlated with seafloor targets. Only approximate correlations were possible due to the flying altitude of the magnetometer during acquisition. Correlations were made on an individual assessment based on a combination of target proximity, size, and magnetometer altitude.

3.2. SUB-SURFACE CONDITIONS

3.2.1 Geological Model

The Humber estuary has had a complex history, with glacial erosion during the last ice age scouring the ground back to bedrock and subsequent glacial deposition, followed by a rise in sea-level. The River Humber now runs along the channel of Lake Humber which formed as a result of the preceding glaciation. It is expected that the area will be comprised of glaciogenic sediments overlying bedrock (Jones, 1988), with recent fluvial alluvium accumulating on the riverbed.

The geological model has been built based on observations made in the boreholes/vibrocores acquired during three geotechnical campaigns. All sources of borehole information are listed in the references section in this document (Section 4). The three geotechnical campaigns are:

- I27 borehole campaign in 1965 (British Transport Docks Board, 1965)
- I5 campaign in 1967 (Ground Exploration Ltd, 1967)
- Immingham Green Energy Terminal vibrocore campaign (Fugro, 2023)

At the time writing of this report, only preliminary site results were available for the acquired vibrocores. The preliminary unit thicknesses were recorded at coarser intervals than usually expected and only generalised soil descriptions were provided.

Any subsequent geotechnical references in this report will refer to the campaign identified rather than repeatedly referencing the source document.

An example summary of the findings from MB2, from the I27 campaign, are presented in Table 3.5. This borehole lies adjacent to the existing pontoon on the eastern edge of the survey area and is also shown in profile in Figure 3-9. MB2 was reported in the site investigation report “I27 – Proposed Oil Jetties at Immingham, Lincolnshire”.

Table 3.5: Summary of results for borehole MB2

Depth below Seabed (ft)	Depth below Seabed (m)	Descriptions
0.0	0.0	Soft to firm silty CLAY
15.0	4.6	Stiff gravelly silty CLAY
31.0	9.4	Very dense fine to medium SAND with gravel
36.0	11.0	Very stiff gravelly silty CLAY

52.0	15.8	Fissured CHALK
106.0	32.3	End of core

Further detail on the spatial distribution of subsurface units can be derived from the borehole campaign undertaken in 1966 (I5), involving four boreholes: BH1, BH2, BH3 and BH4, shown in Figure 3-8. However, these boreholes are located outside of the Immingham Green Energy Terminal survey area to the west but are still able to provide indicative information about the formations expected. A summary of the findings of these boreholes can be found in Figure 3-7, along with an overview of the locations of all known geotechnical data relative to the survey site in Figure 3-8. The boreholes show an upper layer of alluvial sediments, which overlay an expansive unit of boulder clay formed during a period of glaciation. Within this boulder clay there are isolated lenses of sands, with the base of the younger boulder clay being marked by a thin band of gravel. Beneath this gravel there is seen to be a layer of interglacial clays, deposited during a glacial minimum in a low energy lake environment before a further layer of boulder clay is observed beneath this, marking an older period of glaciation. The bedrock in the area is chalk.

From the I27 boreholes in the Immingham Green Energy Terminal survey area, the presence of the interglacial clays is not observed or differentiated from the boulder clays in the recorded soil descriptions. Also, it is pertinent to note that the interpretation made on the data acquired on this survey does conflict with some legacy borehole information and is further discussed in section 3.2.2.

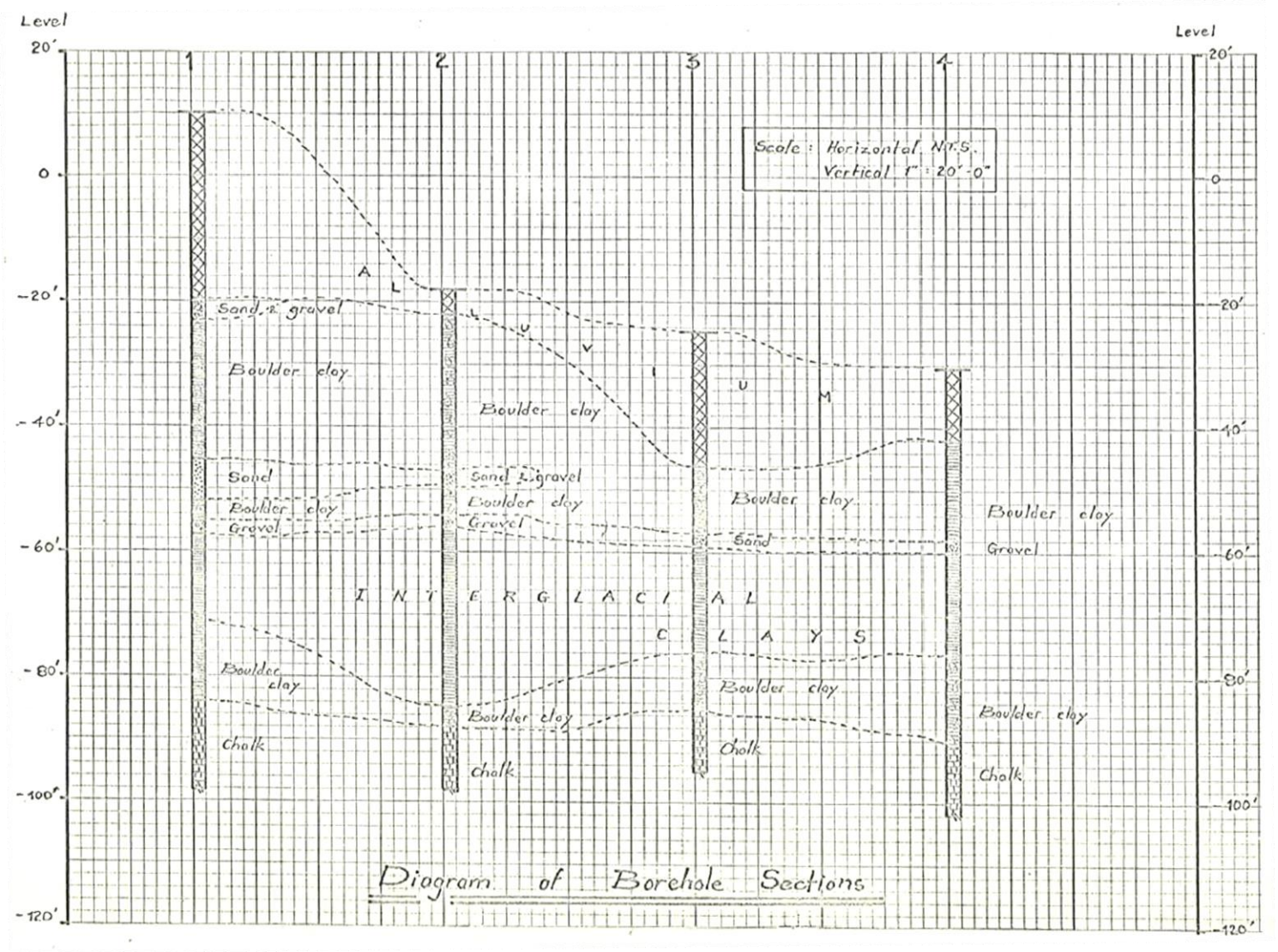


Figure 3-7: Diagram of Borehole Sections, I5 geotechnical campaign.

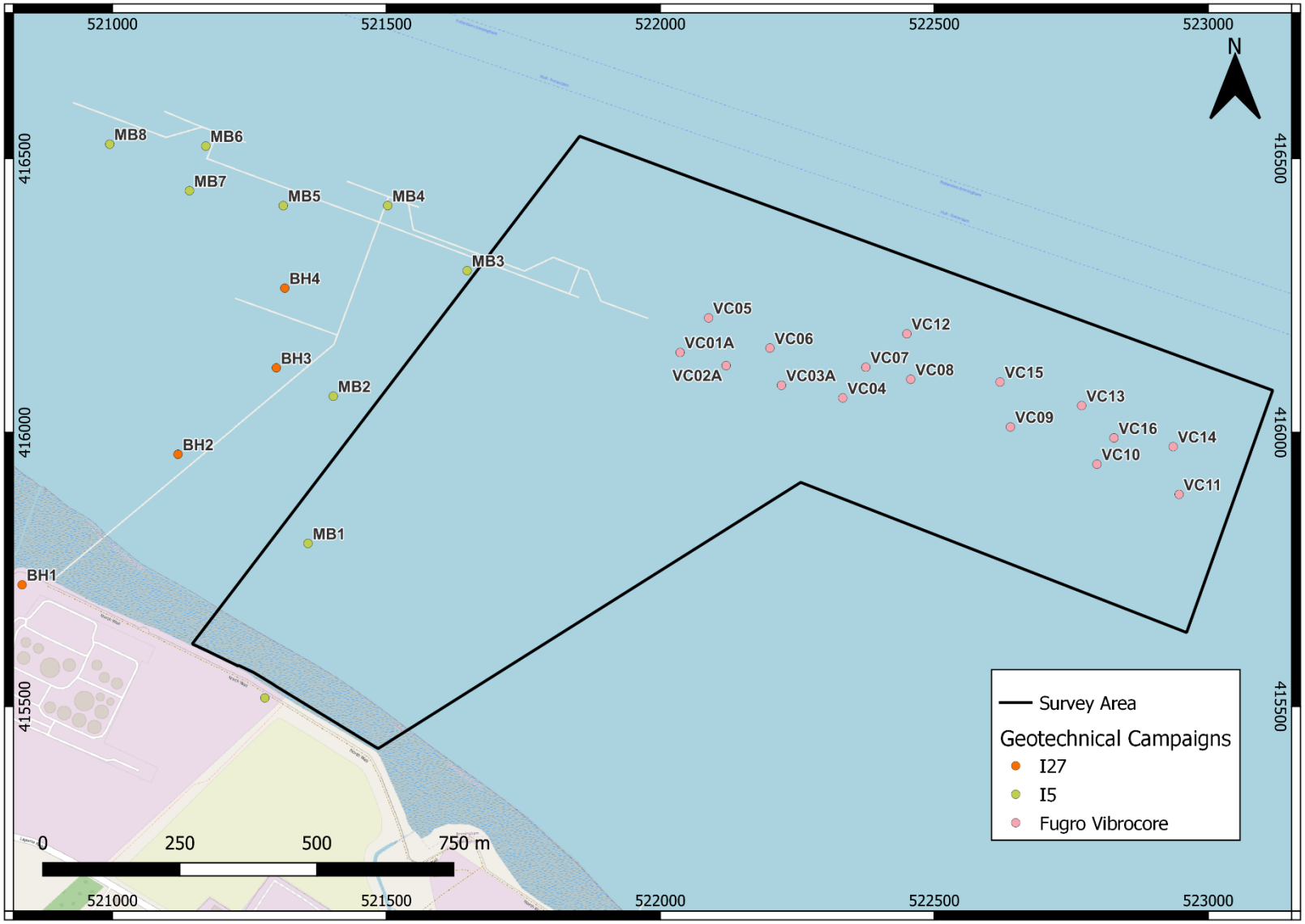


Figure 3-8: Locations of previous geotechnical data collected.

3.2.2 Stratigraphic Interpretation

Table 3.6 presents a summary of the interpretive geomodel used during the interpretation of this dataset. Each stratigraphic unit is discussed in the sections following.

Correlation has been undertaken with the preliminary Immingham Green Energy Terminal vibrocores campaign, and the results of these have generally correlated well for the top of chalk and larger accumulation of surficial alluvial deposits along the central east-west axis of the site where the vibrocores are located.

Additionally, correlation with nearby I27 boreholes has been attempted, however some significant discrepancies are observed between observed seismic reflectors and expected formation tops from the borehole data for MB1 and MB2. The observed discrepancies are exemplified in Figure 3-9, which shows I27 borehole MB2 overlapping with a nearby seismic line. At this location the Upper Boulder Clay and Chalk have been interpreted higher than expected. This is due to a lack of correlating reflectors observed in the SBP data at the expected levels, likely due to masking by a shallow sea surface multiple due to the shallow water depths present in this area coupled with reduced seismic penetration in the nearshore area. Figure 3-19 shows the extent of an area where interpretation has been deemed “low confidence” for this lack of correlation, and where the chalk reflector especially, has become difficult to track towards the south.

It is important to state that in this low confidence area, the top of Chalk and the boundary between Upper and Lower Boulder Clay may well be deeper than the interpretation in this report presents. However, moving north, interpretive confidence is high as the chalk horizon is clearly observed reaching the seabed and correlating with the recent vibrocore campaign. For this reason, interpretation of the top of Chalk was initiated in these areas of good correlation and continued on the most likely reflector further to the south where confidence is reduced due to the mis-tie with the expected depth of chalk indicated in the boreholes.

Other discrepancies between interpretation exists which may be due to a number of factors. Primarily, the boreholes were taken almost 50 years prior to this report and since then the current infrastructure has been built. Changes in the near surface levels are to be expected and may provide a source of error on using these boreholes to correlate to newer seismic data. The boreholes are often some distance from the nearest seismic line and hence may not be representative of exact sediment levels and the surveyed location. Additionally positions for the older boreholes were mapped using triangulation and back sighting from known points, methods that have a much larger positional error when compared to modern

DGPS systems used on this survey. Hence, plotted positions of boreholes may not actually tie with positions logged in this survey.

Figure 3-9 shows the correlation between a seismic line and borehole MB2 that plots approximately 18m west of the nearest point on the seismic data. The figure shows that the interpreted horizons and the expected depths in the borehole data partially correlate between the two datasets at this location. However, some expected changes in soil composition indicated by the borehole are not observed in the seismic data. The vertical line shows the borehole location with the labels indicating changes in the sediments identified on the borehole.

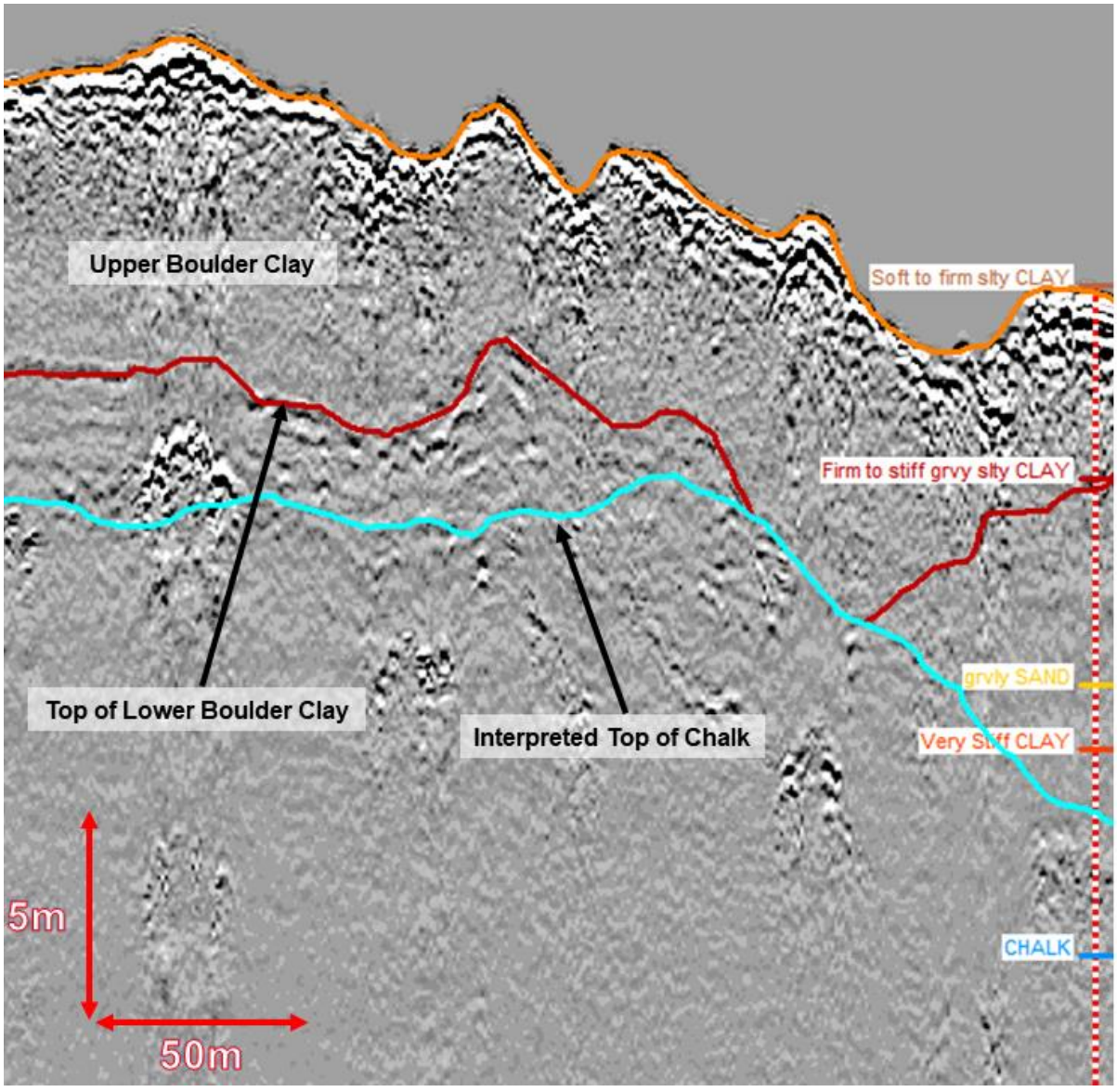


Figure 3-9: Seismic data example (Boomer72) with borehole MB2

Table 3.6: Summary of interpretative geomodel

Unit	Horizon Top	Horizon Base	Depth to Base	Interpreted Composition	Seismic Description	Distribution	Depositional Setting
Alluvium Surficial Sediments	Seabed	H10	0.0-4.8m BSB	SILT/CLAY, however, appears sandier towards the north	Low amplitude seabed reflection where this surficial horizon is present in thicknesses above veneer. Some weak laminations in thicker accumulations of the unit	Largely present as a veneer across the site, however thicker accumulations have been interpreted in depressions/topographical lows	Fluvio-estuarine
Upper Boulder Clay	Seabed/ H10	H50/H60	0.0-10.6m BSB	Soft to stiff CLAY with occasional SAND/GRAVEL beds	A generally chaotic structure with occasional internal reflectors	Typically coincides with the interpretation of the Lower Boulder Clay	Glacial
Lower Boulder Clay	H50	H60	0-15.0m BSB	Very stiff CLAY possibly becoming soft to firm where the unit outcrops at the seabed	Weak to moderate undulating reflector with a generally massive structure demonstrating localised internal reflectors. Upper surface contains occasional gravel beds	The greatest abundance is observed in the south of the survey area. North of the pontoon the boulder clay appears susceptible to erosion where the chalk outcrops at the seabed	Glacial
Bedrock	H60	NA	NA	CHALK	Moderate to weak undulating reflector with some weak parallel reflectors directly beneath	Interpreted across a vast majority of the survey area, except where the bedrock is observed to outcrop at the surface in the north of the survey area. A general south-north shoaling trend is apparent.	Marine

3.2.2.1. Alluvium – Surficial Sediments

It is interpreted that surficial sediments are present across most of the site. Where a thickness has not been interpreted it is likely that a thin veneer of this recent sediment may exist. Figure 3-10 shows the interpreted distribution of the base of this unit (H10) as a depth below seabed grid. Depths range from 0m where it is observed to thin out into the seabed reflector, up to a maximum of 4.8m BSB. Increased thickness is associated with topological lows or features that function as a trap of fine sediments.

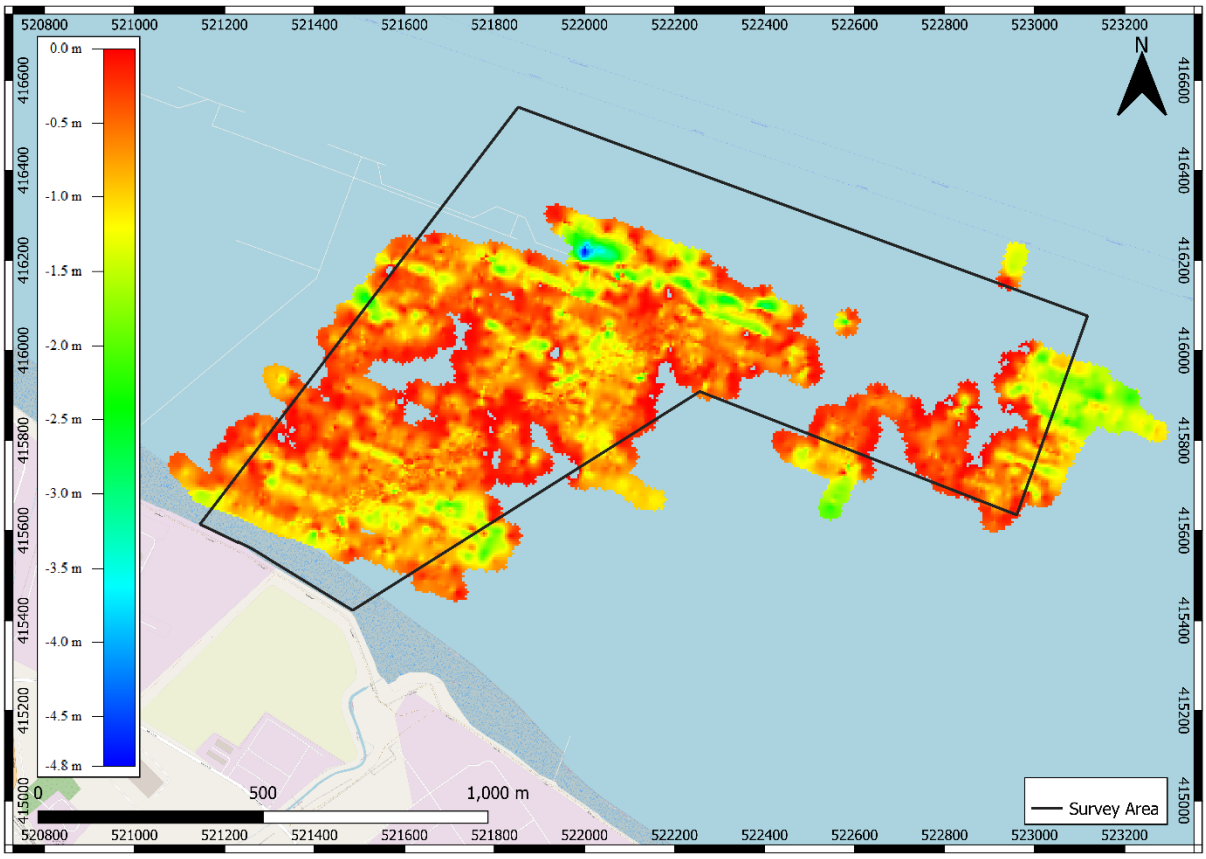
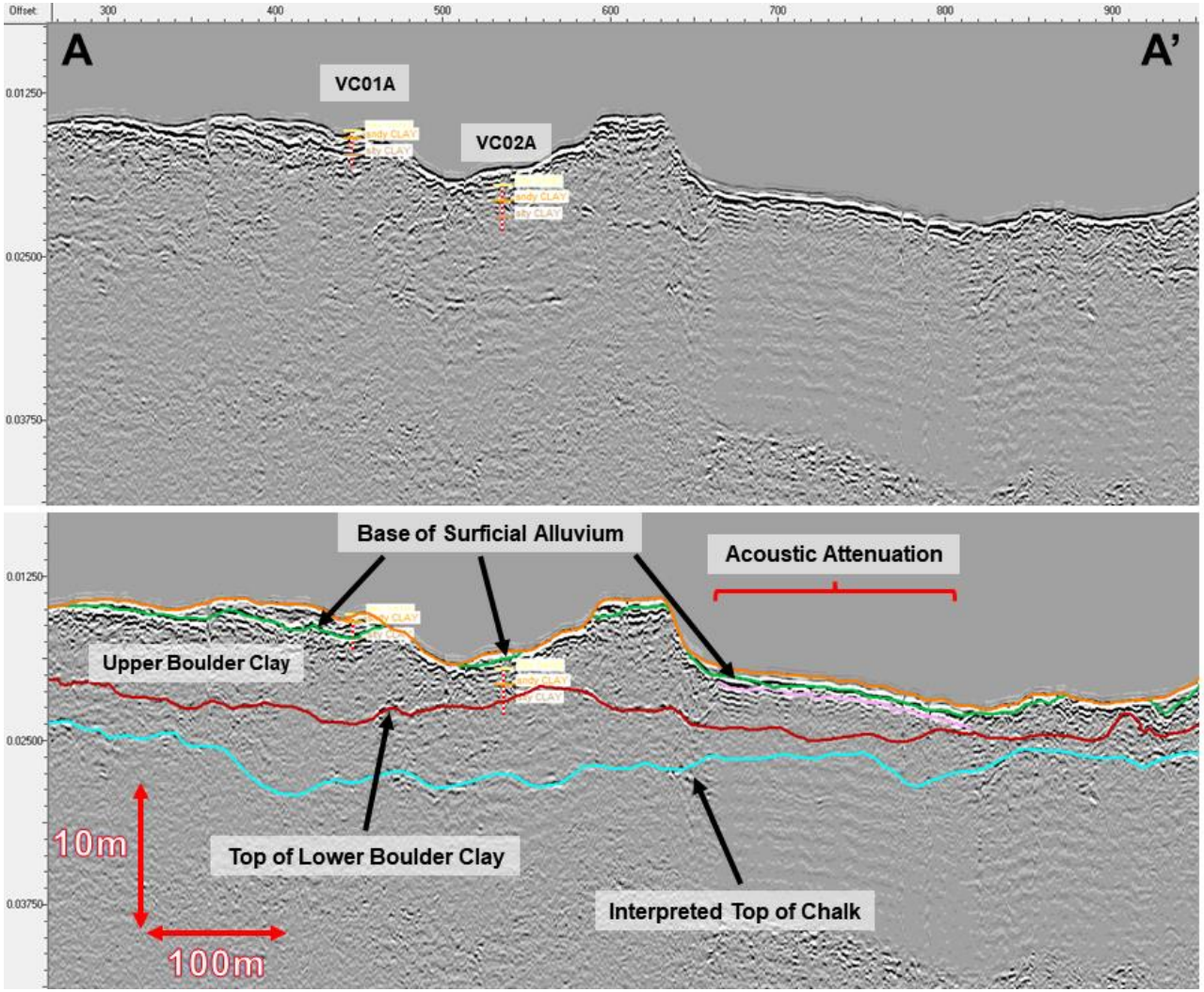


Figure 3-10: Distribution of surficial alluvium (depth below seabed).

Generally, the surficial alluvium is seen to accumulate as thin veneers on the largely flat-lying topography, as seen in Figure 3-11. Also seen in this figure is the close correlation to nearby vibrocores locations; VC01A and VC02A. Figure 3-12 is representative of data where thicker abundances of surficial alluvium have been interpreted, such as the scarp edge observed in the northern section of Boomer line XL12. In Figure 3-12 the original face of the scarp edge is demonstrated in the data, allowing the laminations of the surficial alluvium to contrast against the more chaotic structure of the Upper Boulder Clay. Topographic features such as this are able to behave as sediment traps which enable the enhanced rate of sediment accumulation.

The surficial sediments are interpreted to be composed of SILT/CLAY and SAND. There appears to be a transition of the primary composition of this unit from finer silts and clays in the south to sandier sediments found towards the north, that are noted in the preliminary vibrocores samples. However, no clear horizon is observed to define this change. In some these accumulations, the surficial sediment demonstrates a bright basal reflector with weaker internal parallel laminations, characteristic of colloidal SILT/CLAY composed sediments. Whereas the mobile bedforms observed are likely composed of primarily SAND.



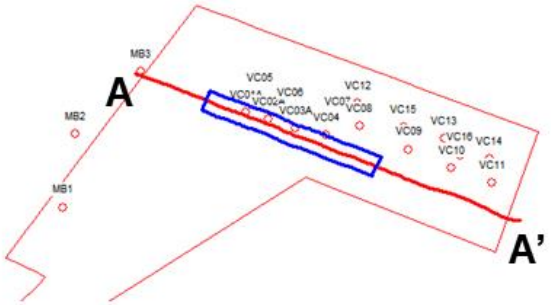
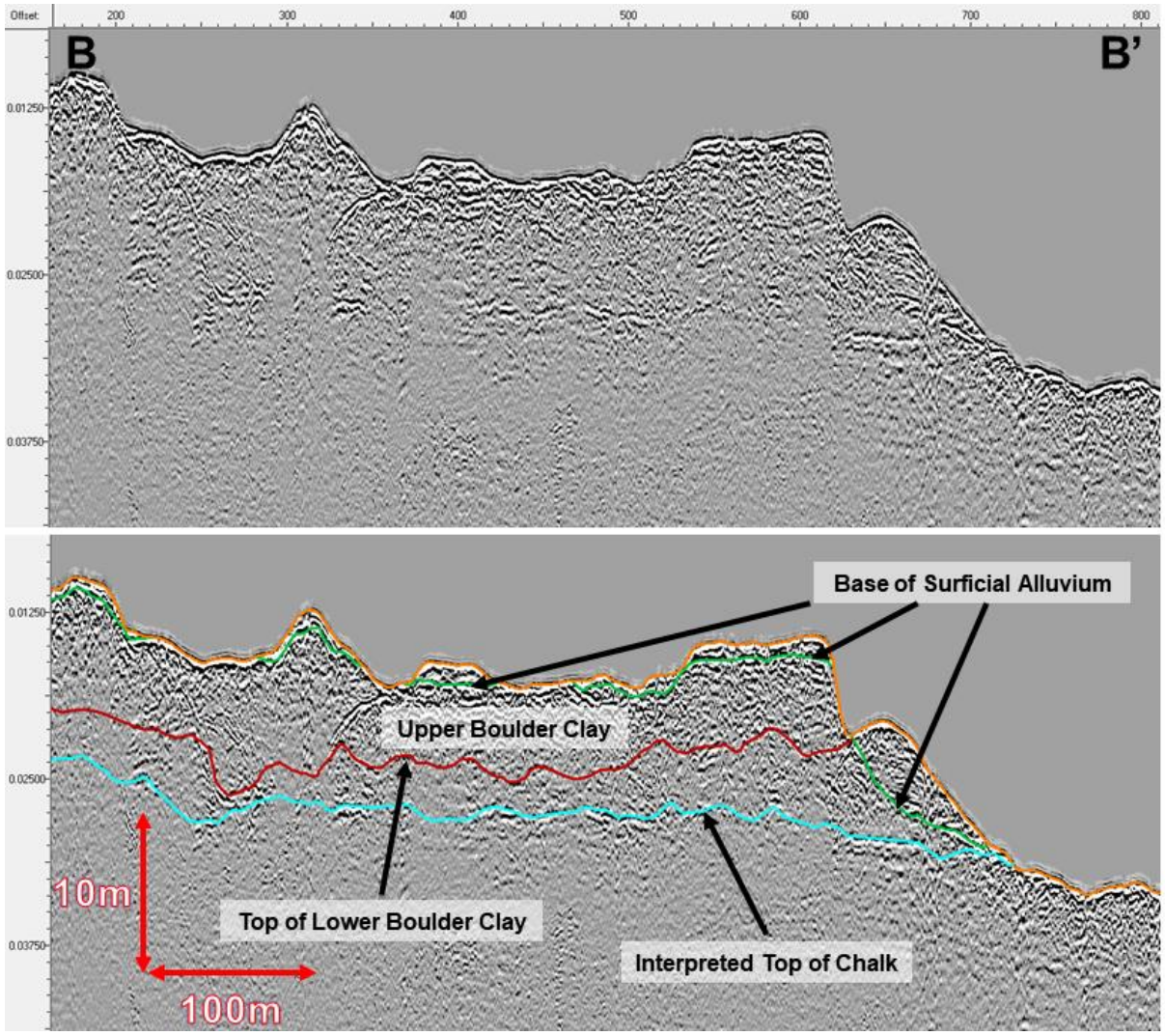


Figure 3-11: Surficial alluvium (H10) data overview (Boomer 7)



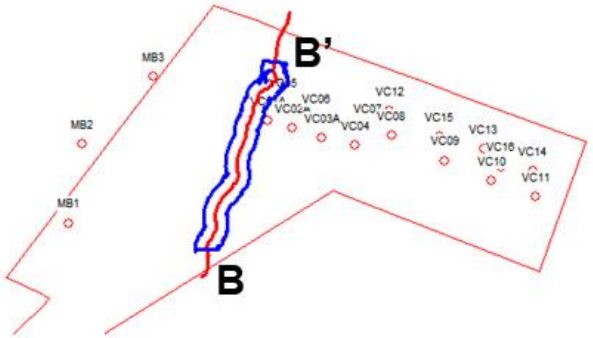


Figure 3-12: Data example of surficial alluvium (H10) accumulating on the side of a scarp edge (Boomer XL12)

3.2.2.2. Upper Boulder Clay

The distribution of the Upper Boulder Clay generally exists in tandem with the interpretation of the top of the Lower Boulder Clay, depicted in Figure 3-12. Both units thin towards the north, where the Chalk approaches the riverbed. The Upper Boulder Clay has been interpreted by differentiation of internal structure to the Lower Boulder Clay. This can be seen in Figure 3-14, where the Upper Boulder Clay is seen to have a chaotic internal structure which heavily contrasts to the more massive structure of the underlying Lower Boulder Clay. The chaotic nature of the Upper Boulder Clay is possibly a product of reworking of glacial material, resulting in a heterogeneous clast size composition. Some internal reflectors within this until show some fluvial features within this unit, possible associated with glacial outwash channels, an example of which can be observed in Figure 3-15 at approximately 600m offset.

The erosional nature of this boundary between the Upper and Lower Boulder Clays presents as an undulating reflector and also results in localised accumulation of gravel beds, possibly representative of glacial outwash channels. The gravel beds do not appear spatially continuous in the SBP data acquired and hence the gravel beds have been incorporated as part of the Lower Boulder Clay unit.

3.2.2.3. Lower Boulder Clay

Figure 3-13 shows the distribution of interpretation of the top of Lower Boulder Clay (H50) as a depth below seabed grid, which demonstrates a general south to north thinning of the unit. Basal depths of this unit shoal to 0m in the north of the survey area where the unit thins completely as the underlying Chalk is exposed. Maximum basal depths of 15m BSB are observed within the channelised feature, such as that shown in Figure 3-14. There are two regions, aside from the outcropping in the north, where H50 has not been interpreted: a lobe in the west of the survey area and a small section in the central northern area of interpreted extent. These locations are shown as gaps in the interpreted extent shown in Figure 3-13. At both of these locales the Lower Boulder Clay unit is seen to pinch out against the underlying bedrock, shown by the downlapping H50 reflector in Figure 3-15.

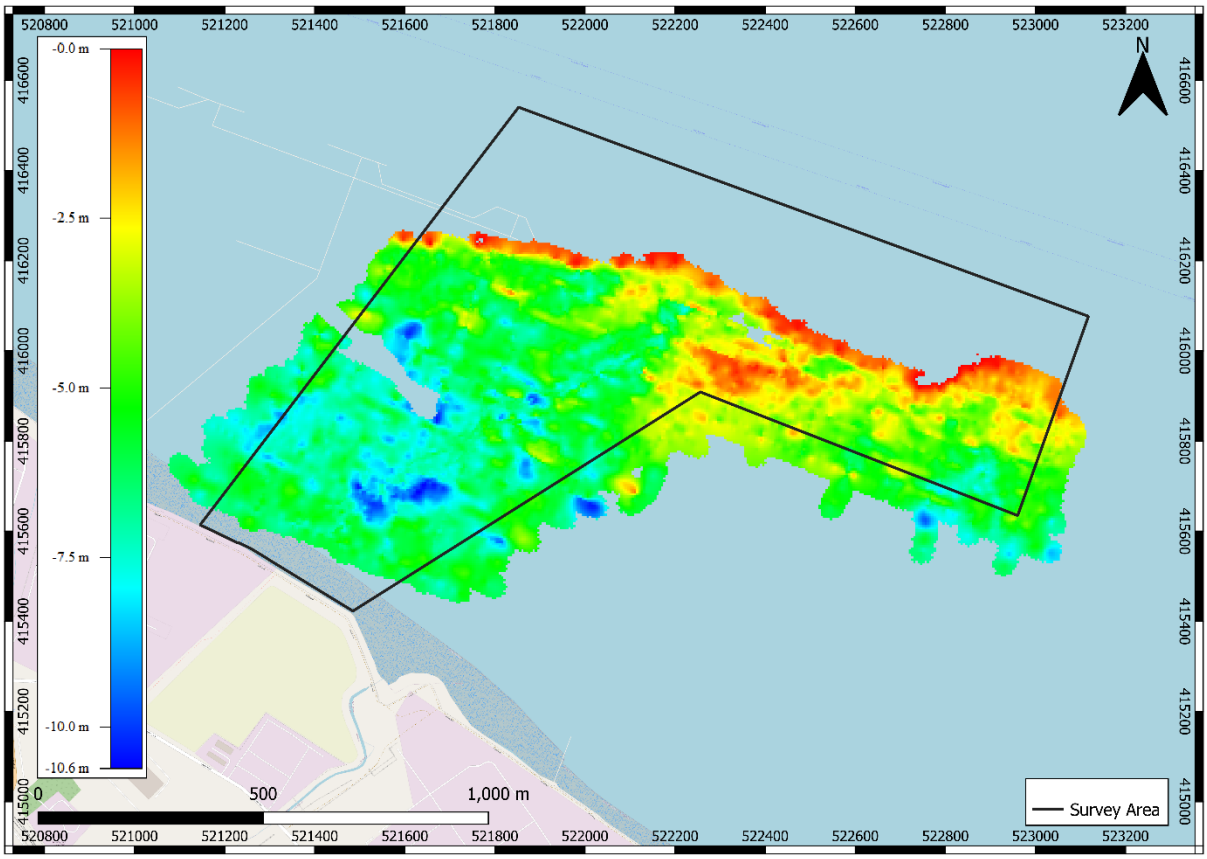
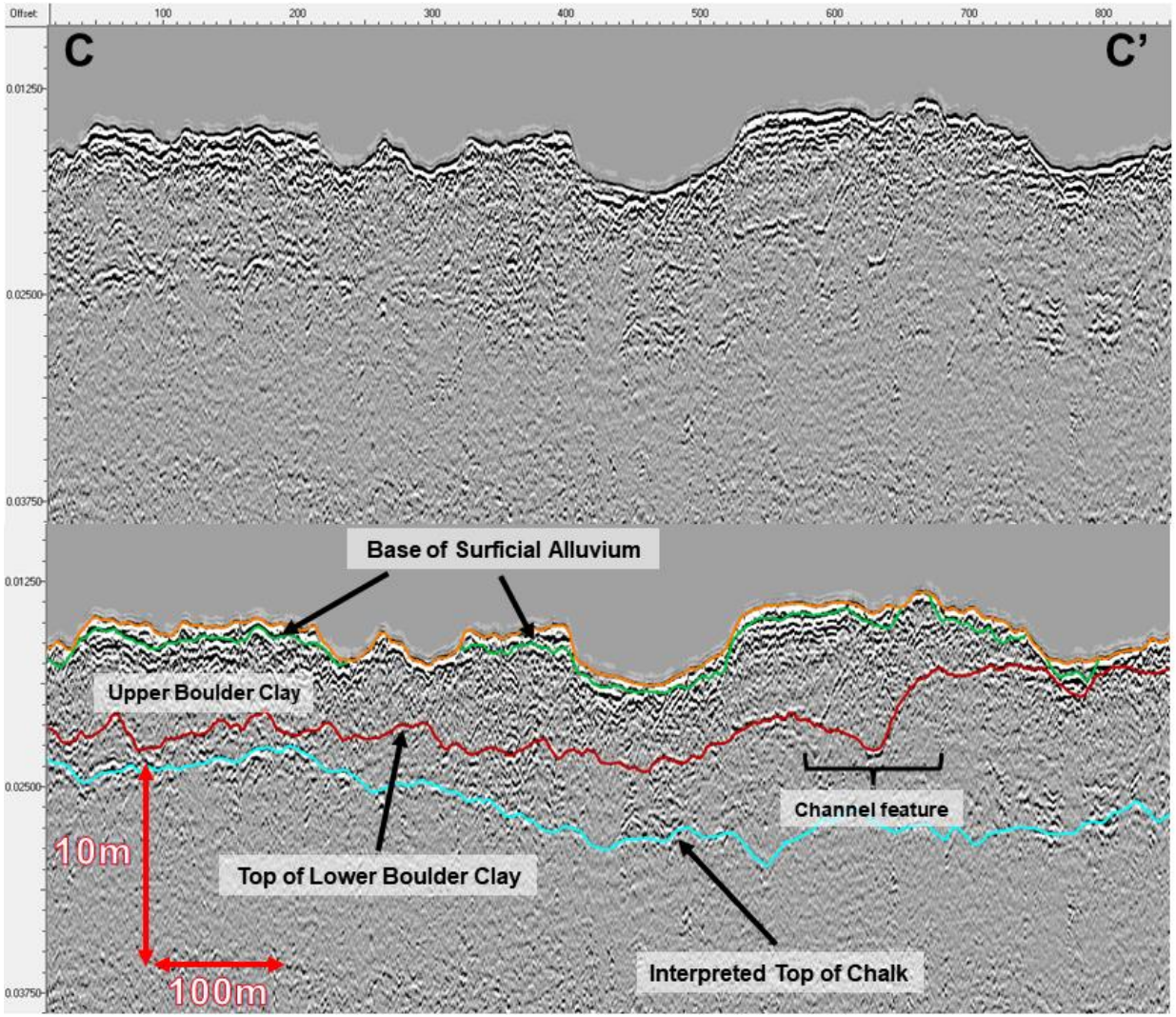


Figure 3-13: Distribution of interpreted top of Lower Boulder Clay (depth below seabed).

Where interpreted, the horizon marking the top of the unit (H50) appears as a weak to moderate amplitude, undulating reflector. The variation in amplitude of the H50 reflector correlates with its DBSB position. Where H50 is deeper, such as in in the south of the survey area the amplitude diminishes in contrast to the northern extent of H50 where the reflector appears brighter where the Lower Boulder Clay becomes more exposed. This is likely due to attenuation associated with increased thickness of overlying boulder clay sediment. This has made the unit difficult to accurately interpret in places and has led to the low confidence classification of the interpretation in the south-western portion of the site.

The seismic data beneath this horizon appears generally acoustically transparent which is characteristic of massive CLAY structures. The unit contains localised lenses of internal reflectors, sometimes shown as a localised increase in H50 reflector amplitude which are likely comprised of gravel beds.



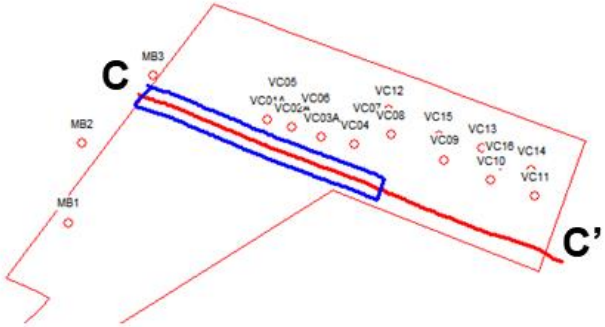


Figure 3-14: Data overview of Lower Boulder Clay (H50) highlighting a localised channel feature (Boomer 74)

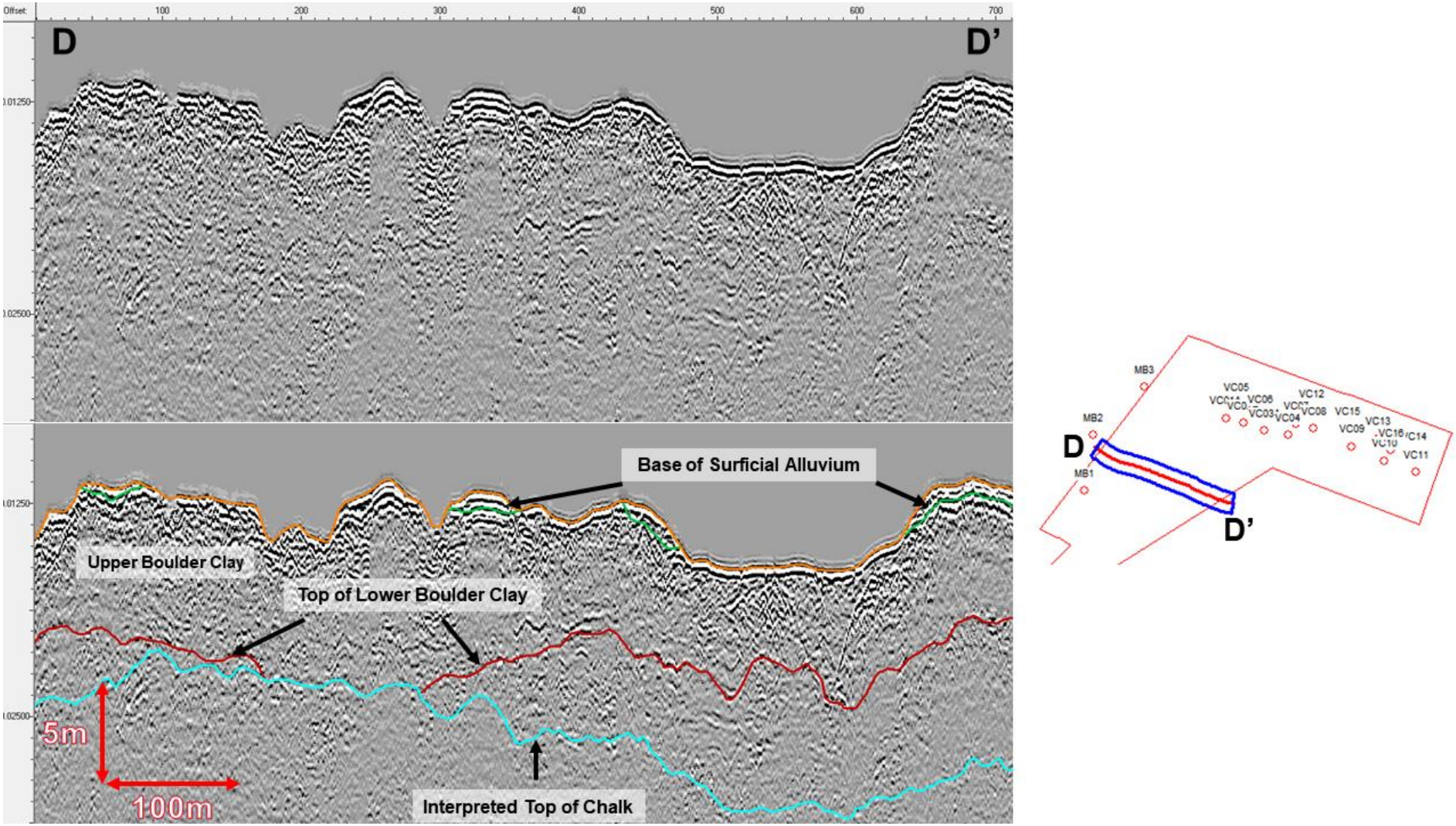


Figure 3-15: Data example of the top of the Lower Boulder Clay (H50) reflector downlapping onto the bedrock (Boomer 19)

3.2.2.4. Bedrock

Bedrock within the area is known to be Chalk from nearby boreholes sampled within the bounds of the survey area. The extent of interpretation for the interpreted top of Chalk (H60) is presented in Figure 3-16 as a depth below seabed grid. Depths range from 0m where it is observed to outcrop at the surface in the north of the survey area, up to a maximum of 15m BSB in the south. In places where the Chalk is interpreted to outcrop at the surface it is likely that it is still overlain by a thin veneer of sediment, which is not observed as the veneer is thinner than the seabed reflection in the data.

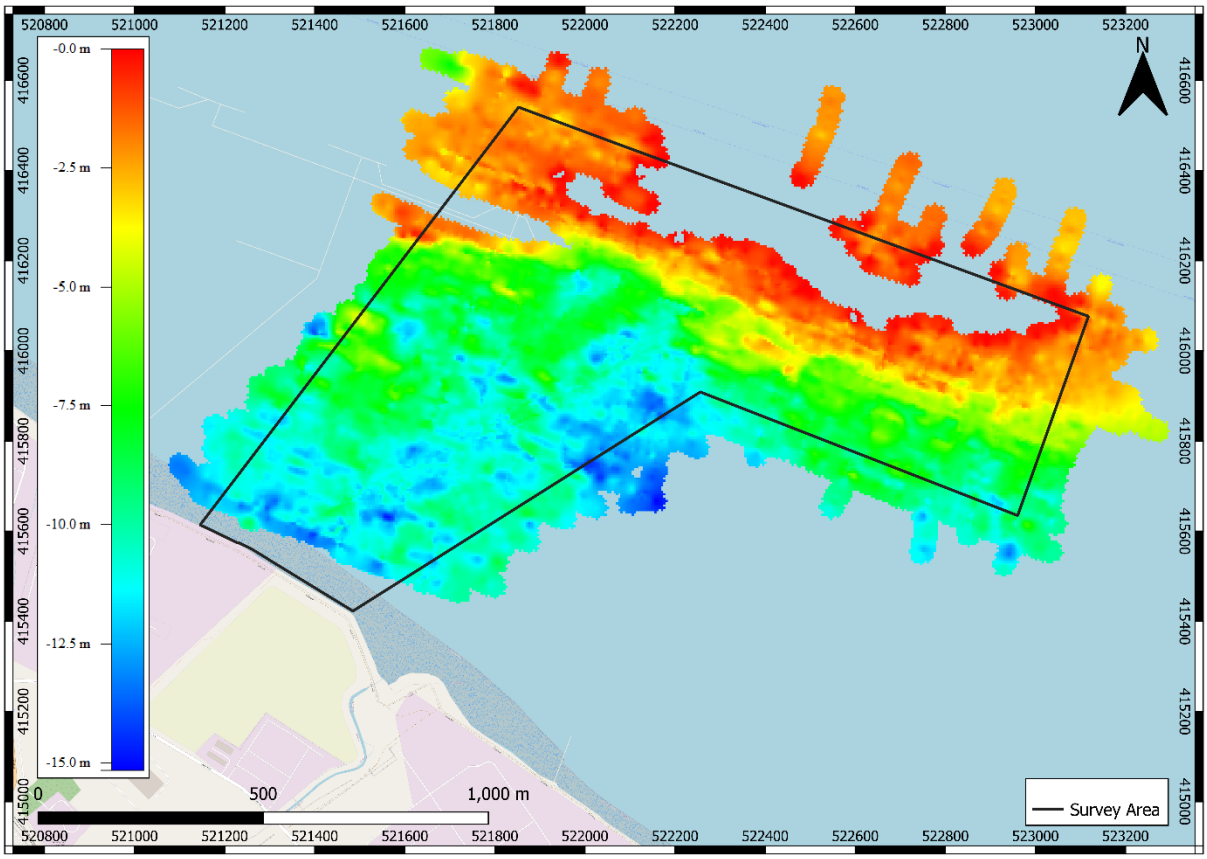
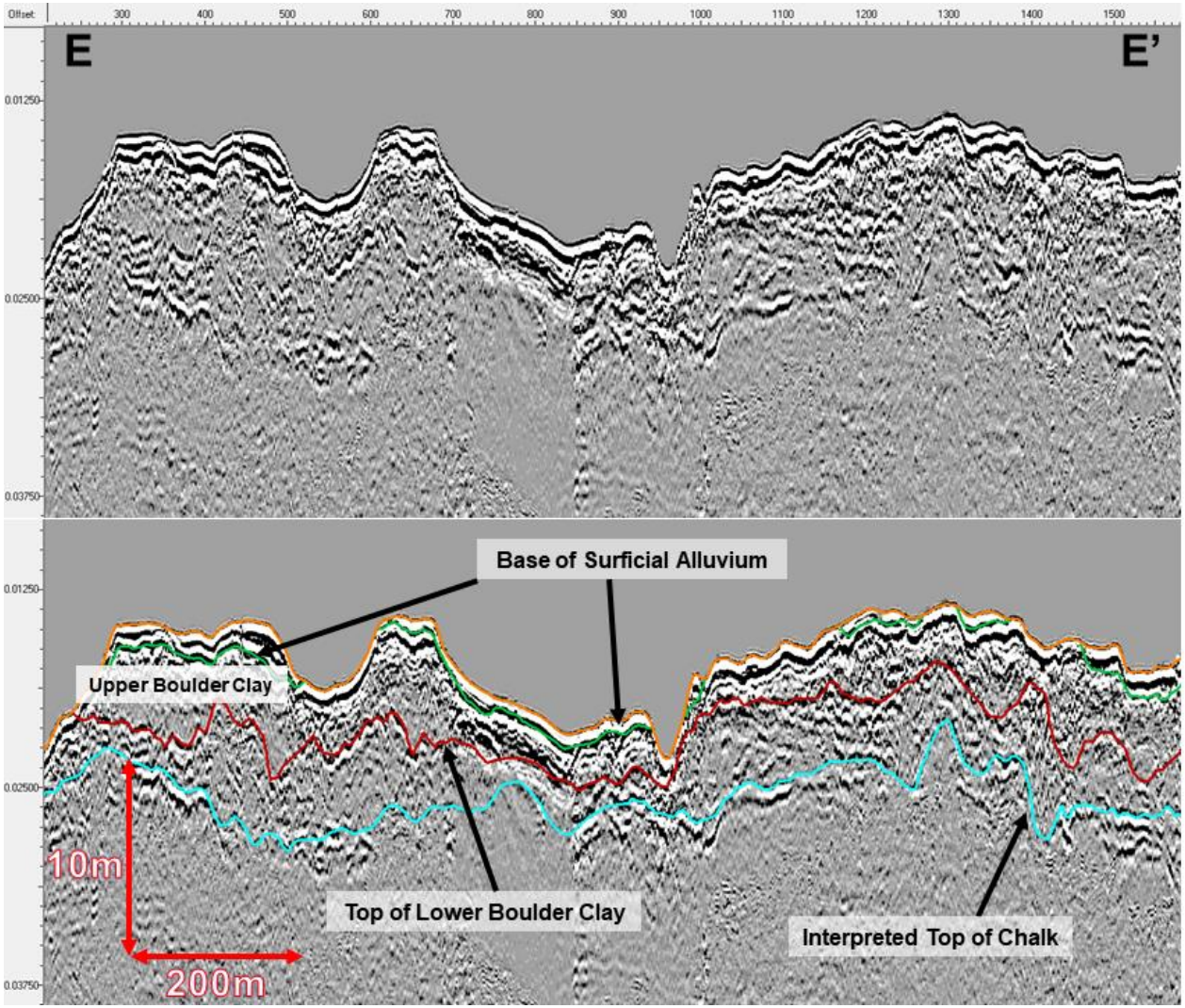


Figure 3-16: Distribution of interpreted top of chalk (depth below seabed).

The reflector marking the top of Chalk (H60) is a weak to moderate, generally undulating surface. This is typical of Chalk lithologies which are more susceptible to erosional and weathering processes that weaken the upper surface of the unit. An overview of the H60 reflector is shown in Figure 3-17. H60 becomes less distinct in the southern section of the survey area, with this region of uncertainty marked in Figure 3-19. This uncertainty correlates with a thicker accumulation of the Upper and Lower Boulder Clay which act to attenuate acoustic energy therefore diminishing the quality of data underlying it, making H60 a less distinct reflector. The strongly laminated internal structure of the Chalk is most distinguished

in the northern section of the survey area where it is seen to outcrop at the surface, which can be seen in Figure 3-18 dipping down towards the east. Similarly to its upper boundary, the internal structure of the Chalk rapidly deteriorates in the southern section of the survey area, marked as low confidence in Figure 3-19. The reduced data quality of the observed Chalk in the south is also further impeded by the increased DBSB of the unit.

In the northern edge of the survey area where the H60 reflector has interpreted depths <2m BSB (Figure 3-16), the Chalk is overlain by an unknown sediment unit. It is possible that this maybe alluvium or may also be a minor component of the boulder clays. However, due to the lack of observed structure in the overlying sediment and no available geotechnical data in this area it has not possible to differentiate the classification of this sediment. This overlying sediment thickness has not been included in the grids for either Alluvium or Boulder Clay due to the associated uncertainty.



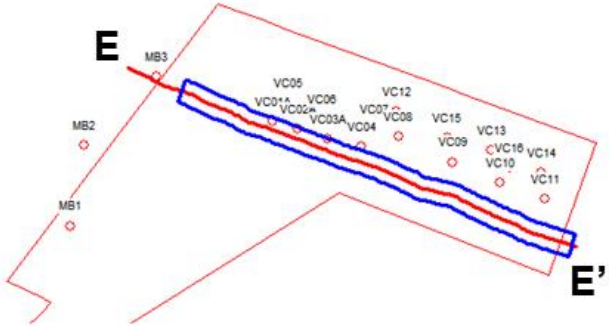


Figure 3-17: A data overview of the interpreted top of Chalk (H60) (Sparker 41A)

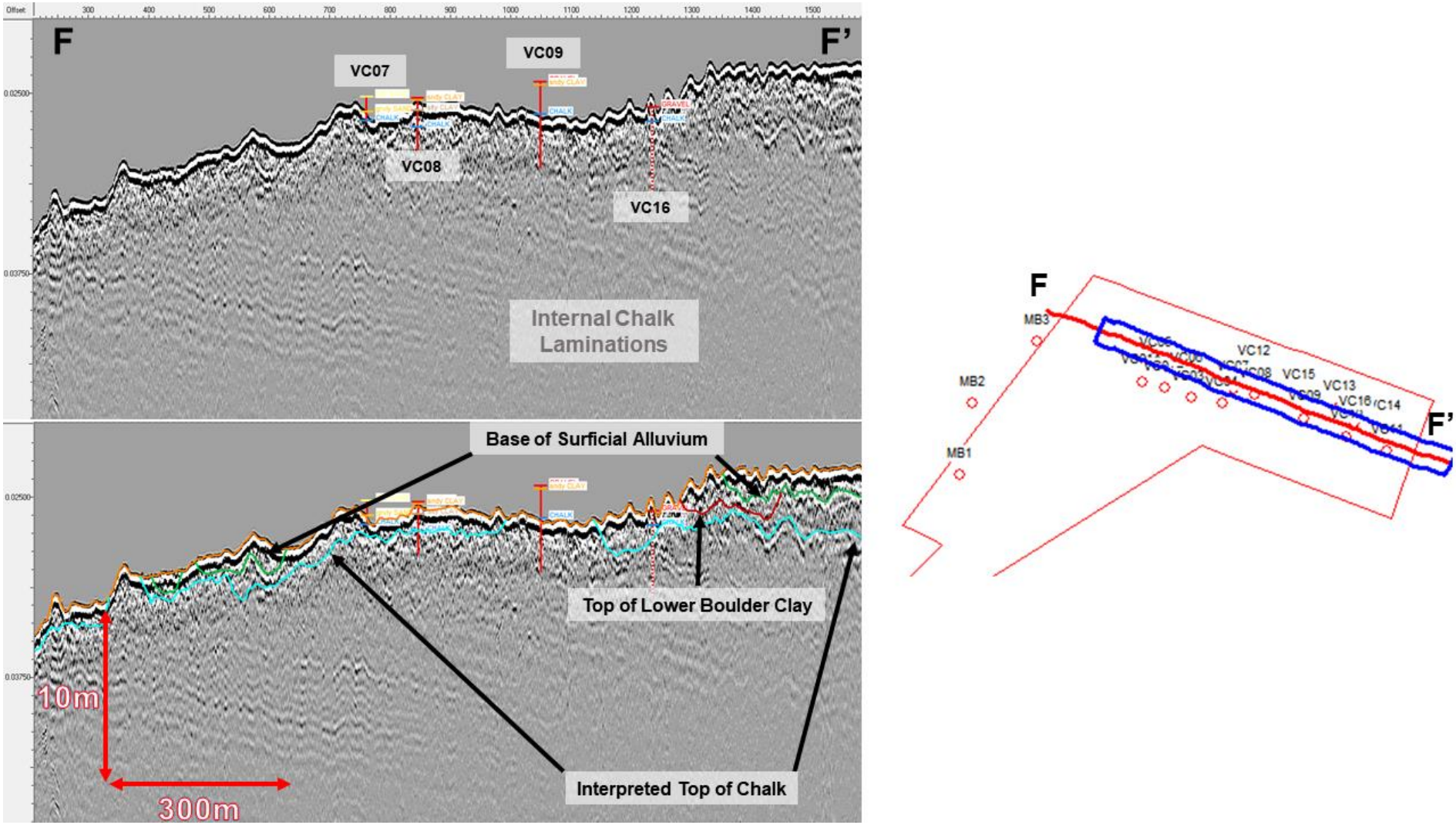


Figure 3-18: Data example of the top of Chalk (H60) outcropping at the seabed (Sparker 55)

3.2.2.5. Acoustic Attenuation

Acoustic attenuation is observed at two isolated locales in the survey area, the spatial distribution of this is depicted in Figure 3-19. In these areas, seismic resolution is significantly diminished in contrast to adjacent data such that the ability to interpret reflectors is negatively impacted. An example of acoustic attenuation is shown both in Figure 3-11 and in more detail in Figure 3-20. The acoustic attenuation is believed to be caused by localised accumulations of organic material within the surficial sediments. These accumulations are believed to only be moderate as attenuation of the seismic is observed rather than blanking, which would be caused by higher organic concentrations.

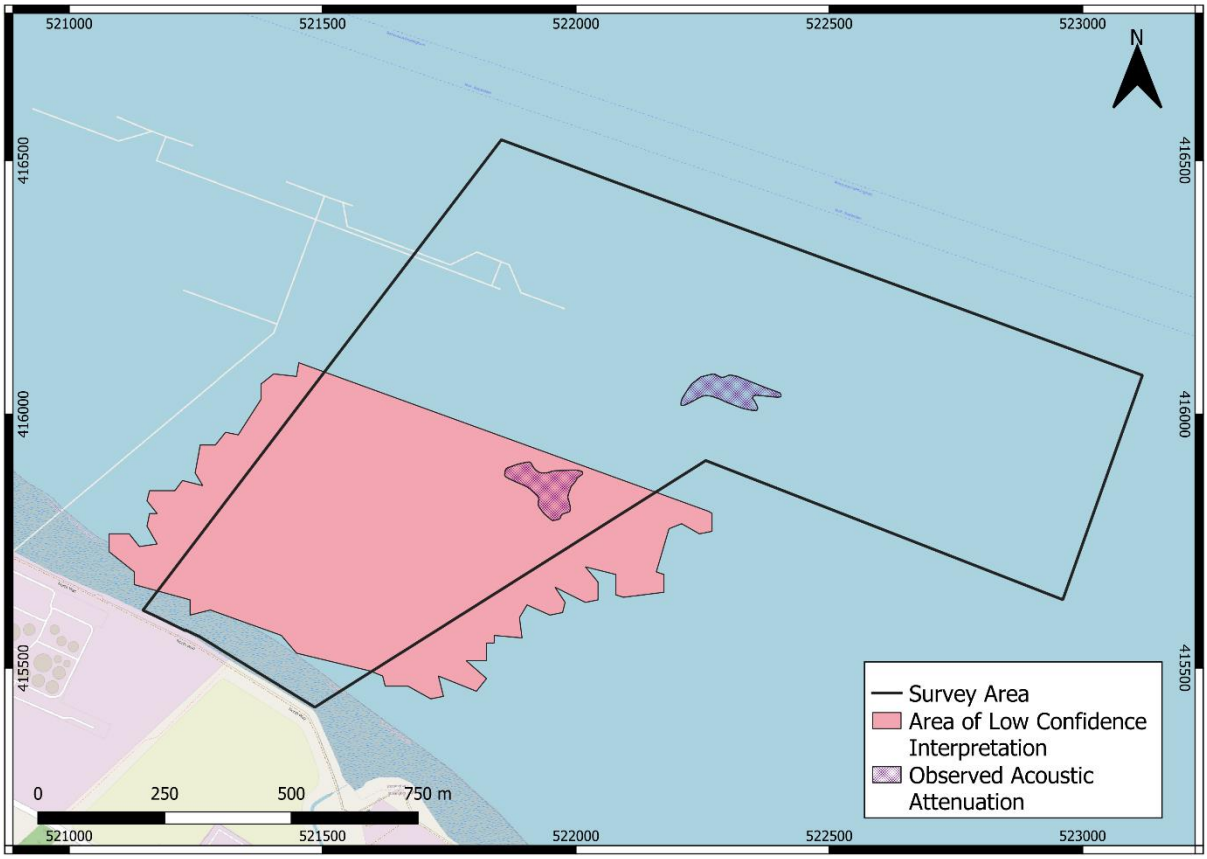


Figure 3-19: Map demonstrating the spatial location of low confidence interpretation and acoustic attenuation.

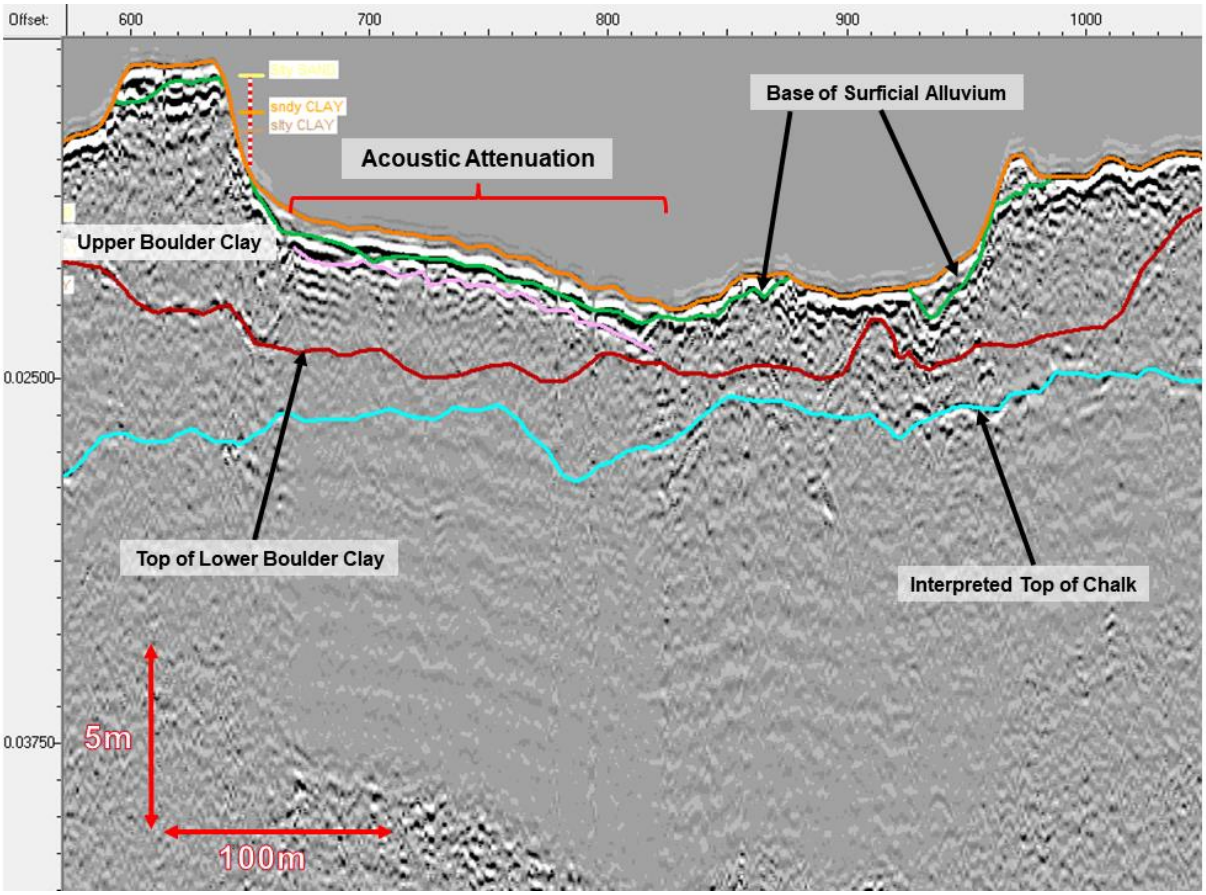


Figure 3-20: Data example of observed acoustic attenuation (Boomer 7)

4. REFERENCES

Ground Exploration Ltd., I5 - Diagram of Borehole Sections (1967)

Ground Exploration Ltd., I5 - Exploration of Ground Conditions at Immingham for British Transport Docks Board (1967)

British Transport Docks Board, I5 - Key Plan of Proposed Borings (1966)

British Transport Docks Board, I19 – Eastern Jetty: Pipe Supports Site Investigation (1980)

British Transport Docks Board, I27 – Boreholes Plan and Logs (1965)

British Transport Docks Board, I27 – Proposed Oil Jetties at Immingham, Lincolnshire. Report on Site Investigation (1965)

Fugro, Preliminary Geotechnical Site Report, 5163_Vibrocore_SampleAnalysis_Rev2.xlsx, (2023)

Jones, N.V. (ed.) A Dynamic Estuary: Man, Nature and the Humber (Hull University Press, 1988)

Sheppard, J.A. The Draining of the Hull Valley (East Yorkshire Local History Soc. Series No. 8, 1958)

Annex B Daily Progress Reports

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *06/02/2023*

Rev0C - 16/01/2023

PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush
Paul Clement	

DAILY LOG

TIME (UTC)	CODE	EVENT
10:00	MOB	Final project preparations in Southampton
15:00	MOB	Survey personnel depart Southampton
22:00	MOB	Survey personnel arrive in Grimsby

WEATHER FORECAST

Tue 7 GMT						
00		2mph	to	3mph	1c	
03		3mph	to	3mph	1c	
06		3mph	to	3mph	1c	
09		5mph	to	7mph	3c	
12		7mph	to	8mph	7c	
15		5mph	to	8mph	8c	
18		5mph	to	6mph	4c	
21		5mph	to	6mph	3c	
Wed 8 GMT						
00		6mph	to	7mph	2c	
03		7mph	to	14mph	1c	
06		8mph	to	18mph	0c	
09		9mph	to	23mph	2c	
12		14mph	to	23mph	6c	
15		14mph	to	28mph	6c	

HSE SUMMARY

No HSE incidents to report. A full project brief and health and safety discussion will be held tomorrow prior to commencing vessel mobilisation.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	12:00	12:00
Operational	OPS	00:00	00:00
Transit	TRA	00:00	00:00
Weather Down Time	WDT	00:00	00:00
Equipment Down Time	EDT	00:00	00:00
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:00	00:00
TOTALS (Day)		**1**	**1**

SURVEY WORK PROGRESS

MBES	0%
SSS	0%
SBP	0%
MAG	0%
TOTAL	**0%**

DAILY SUMMARY

Final preparations took place in Southampton before the survey team travelled to Grimsby. There were initial concerns that the Sparker system will be challenging to mobilise to the Wessex Explorer at the same time as the other sensors, due to its size. The boomer has a larger power supply unit than previously used so we are hopeful that the boomer will achieve the penetration required. However, the sparker system is available in Grimsby as an alternative option.

UPCOMING PLAN

The survey team will arrive at the Wessex Explorer at 0730 GMT. A full health and safety discussion will be held before vessel mobilisation commences. It is anticipated that the vessel will remain alongside throughout the day.+A6:L53

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *07/02/2023*

Rev0C - 16/01/2023

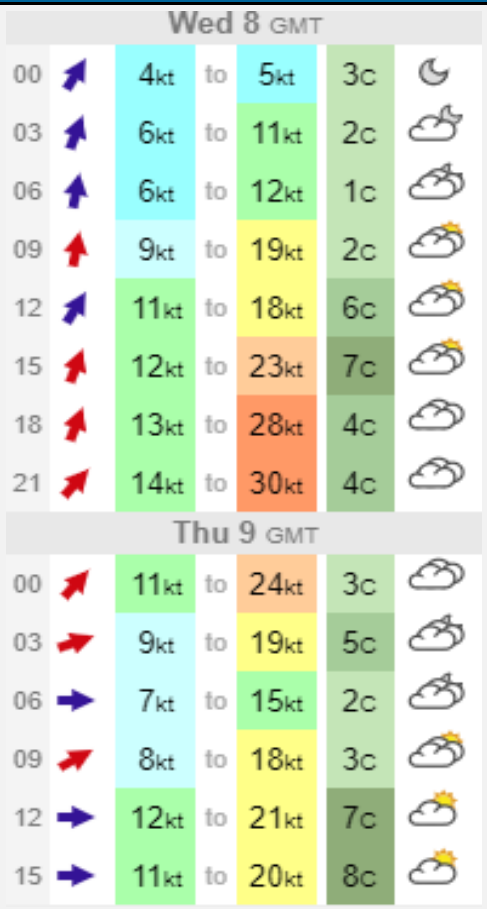
PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush
Paul Clement	

DAILY LOG

TIME (UTC)	CODE	EVENT
07:30	MOB	Survey personnel onboard vessel
07:45	MOB	Project brief and health and safety discussion held prior to commencing mobilisation
08:30	MOB	Load equipment to vessel and commence vessel mobilisation
10:30	MOB	MBES installed on over-the-side pole
14:00	MOB	Boomer, SSS and MAG installed
14:30	MOB	Commence interfacing of all sensors
19:30	MOB	Survey personnel depart vessel

WEATHER FORECAST



HSE SUMMARY

No HSE incidents to report. Project brief and health and safety discussion held prior to commencing vessel mobilisation.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	12:00	24:00
Operational	OPS	00:00	00:00
Transit	TRA	00:00	00:00
Weather Down Time	WDT	00:00	00:00
Equipment Down Time	EDT	00:00	00:00
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:00	00:00
TOTALS (Day)		**1**	**2**

SURVEY WORK PROGRESS

MBES	0%
SSS	0%
SBP	0%
MAG	0%
TOTAL	**0%**

DAILY SUMMARY

Vessel mobilisation of the Wessex Explorer commenced today. The MBES was installed on the over-the-side pole mount and all geophysical sensors were successfully installed. Interfacing of the instruments is now ongoing and expected to be complete tomorrow morning.

UPCOMING PLAN

Interfacing of the instruments will continue tomorrow morning. An alongside position verification will then take place. On completion the vessel will slip ropes to conduct an MBES patch test calibration and dynamic position verifications of the geophysical sensors.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *08/02/2023*

Rev0C - 16/01/2023

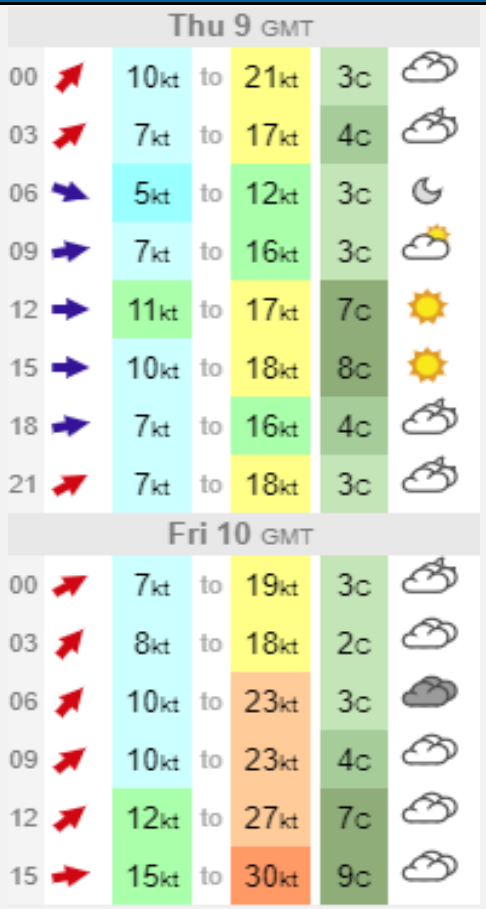
PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush
Paul Clement	

DAILY LOG

TIME (UTC)	CODE	EVENT
07:30	MOB	Survey personnel onboard vessel
07:45	MOB	Continue instrument interfacing
11:30	MOB	Instrument interfacing complete
11:45	MOB	Alongside positioning verification conducted
15:00	MOB	Vessel induction held by skipper
15:30	MOB	TBT held to discuss equipment deployment and recovery procedures
16:15	MOB	Vessel slips ropes to conduct positioning GAMS calibration
16:55	MOB	Vessel alongside
17:00	MOB	Further alongside positioning verification conducted
17:20	MOB	Vessel slips ropes and transits to patch test location
17:35	MOB	MBES pole deployed
17:45	MOB	MBES patch test conducted at outfall location
19:15	MOB	SVP01 deployed
19:30	MOB	MBES pole recovered
19:45	MOB	Vessel alongside Grimsby Fish Docks
19:50	MOB	Survey personnel depart vessel

WEATHER FORECAST



HSE SUMMARY

No HSE incidents to report. Vessel induction held prior to slipping ropes from berth. TBT held to discuss equipment deployment and recovery procedures.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	12:50	36:50
Operational	OPS	00:00	00:00
Transit	TRA	00:00	00:00
Weather Down Time	WDT	00:00	00:00
Equipment Down Time	EDT	00:00	00:00
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:00	00:00
TOTALS (Day)		**1**	**3**

SURVEY WORK PROGRESS

MBES	0%
SSS	0%
SBP	0%
MAG	0%
TOTAL	**0%**

DAILY SUMMARY

Vessel mobilisation continued today. Interfacing was completed before the GAMS position verification and alongside positioning verifications were conducted. The vessel transited to the calibration site where a full MBES patch test calibration was conducted.

UPCOMING PLAN

The vessel will return to the calibration site to conduct dynamic position verifications of the SSS, SBP and MAG data. The vessel will then transit to the survey site where the SBP (Boomer) data quality will be assessed.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *08/02/2023*

Rev0C - 16/01/2023

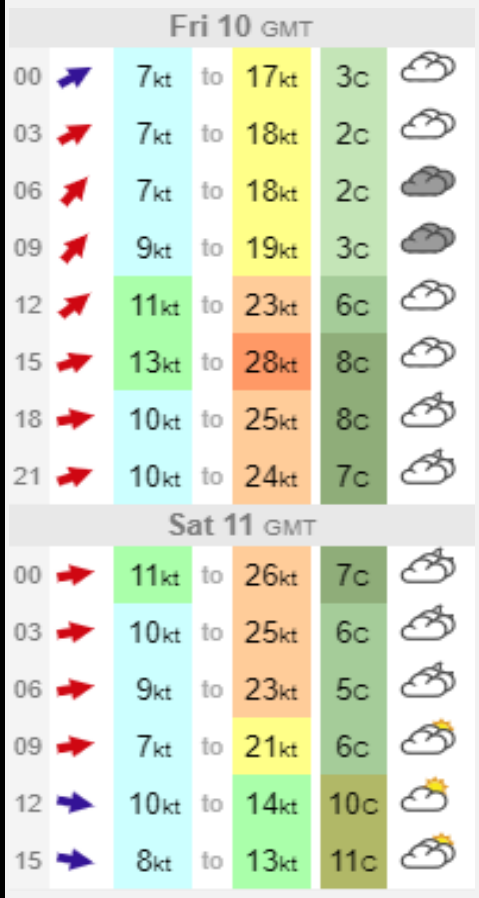
PERSONNEL

Survey Team	Vessel Team
Tom Alker / Paul Clement	Nick Bush
Hugh MacKay	James Bush
Tim Holegate	

DAILY LOG

TIME (UTC)	CODE	EVENT
06:30	MOB	Survey personnel onboard vessel
06:45	MOB	Vessel induction for Tim Holgate
07:00	MOB	Health and safety discussion held for geophysical survey operations and equipment deployment/recovery
07:45	MOB	Vessel departs Grimsby
08:10	MOB	Vessel arrives at calibration site
09:00	MOB	Dynamic position calibrations successfully conducted for MAG, SSS and SBP
12:00	MOB	Boomer data quality issue identified
12:45	MOB	Equipment recovered and vessel transits to survey site for data optimisation
13:45	MOB	Boomer data optimisation commences
16:30	MOB	Data quality remains poor after multiple attempts at changing the configuration
17:20	MOB	Equipment recovered and vessel transits to Grimsby
18:10	MOB	Vessel alongside Grimsby
18:30	MOB	Survey personnel depart vessel

WEATHER FORECAST



HSE SUMMARY

No HSE incidents to report. Vessel induction for new survey team member, Tom Holgate. Full heath and safety discussion held in relation to geophysical survey operations and equipment deployment/recovery procedures.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	12:00	48:50
Operational	OPS	00:00	00:00
Transit	TRA	00:00	00:00
Weather Down Time	WDT	00:00	00:00
Equipment Down Time	EDT	00:00	00:00
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:00	00:00
TOTALS (Day)		**1**	**4**

SURVEY WORK PROGRESS

MBES	0%
SSS	0%
SBP	0%
MAG	0%
TOTAL	**0%**

DAILY SUMMARY

Dynamic position verifications of the MAG, SSS and SBP were successfully conducted this morning. However, a data quality issue was identified with the Boomer SBP system. Data optimisation took place in the afternoon but data quality was not deemed suitable.

UPCOMING PLAN

It is believed that there may be a fault with the boomer system and therefore options are being considered to source a replacement for delivery tomorrow. Alongside boomer pulse tests will be conducted on the current system. Solutions for mobilisation of the sparker system are also being considered.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *10/02/2023*

Rev0C - 16/01/2023

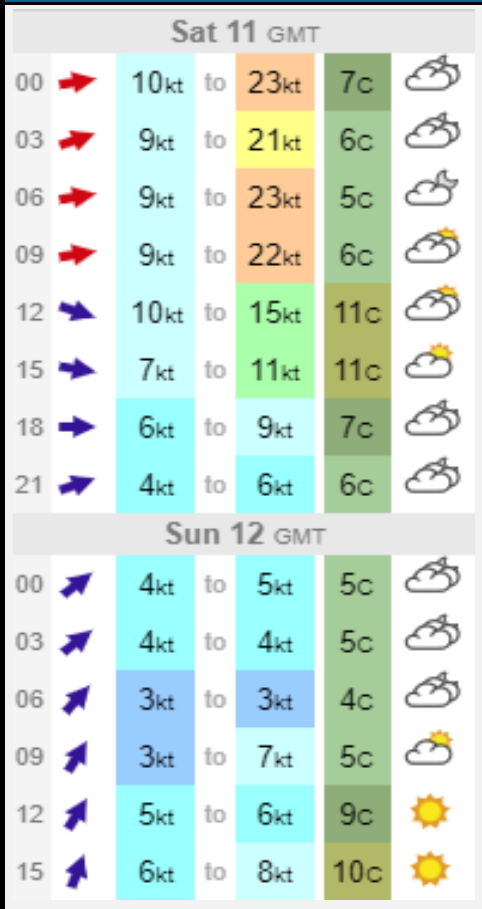
PERSONNEL

Survey Team	Vessel Team
Tom Alker / Paul Clement	Nick Bush
Hugh MacKay	James Bush
Tim Holegate	

DAILY LOG

TIME (UTC)	CODE	EVENT
07:30	MOB	Survey personnel onboard vessel
07:45	MOB	Minor reconfiguration of boomer installation
08:45	MOB	Slip ropes to trial new boomer configuration in harbour
09:45	MOB	No data improvement, return to berth
10:00	MOB	TBT for mobilisation sparker to vessel
12:15	MOB	Sparker mobilisation complete
12:20	MOB	Vessel slips ropes and transits to site
13:15	MOB	SVP deployed
13:20	MOB	MBES and sparker system deployed
13:30	MOB	Problem with sparker - begin tests
15:30	MOB	Unable to solve sparker issue
15:40	MOB	Sparker recovered
15:45	OPS	Commence survey with MBES, SSS and MAG
17:35	MOB	All equipment recovered
17:40	TRA	Begin return transit to Grimsby
18:30	MOB	Alongside Grimsby
18:35	MOB	Prepare sparker for demobilisation
19:00	MOB	Survey personnel depart vessel

WEATHER FORECAST



HSE SUMMARY

No HSE incidents to report. Full TBT held prior to loading sparker system onto vessel. TBT held prior to deployment of sparker and the other geophysical sensors.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	08:50	57:40
Operational	OPS	01:50	01:50
Transit	TRA	00:50	00:50
Weather Down Time	WDT	00:00	00:00
Equipment Down Time	EDT	00:00	00:00
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:00	00:00
TOTALS (Day)		**1**	**5**

SURVEY WORK PROGRESS

MBES	5%
SSS	5%
SBP	0%
MAG	5%
TOTAL	**4%**

DAILY SUMMARY

Some further Boomer tests were conducted within the harbour this morning but no data improvement was made. Therefore the sparker system was mobilised to the vessel. On returning to site, unfortunately the sparker system was unable to trigger reliably and discussions with the manufacturer concluded that the system was likely not suitable for the environment. Therefore survey lines were run acquiring MBES, SSS and MAG data only.

UPCOMING PLAN

An available replacement boomer system has not yet been sourced. We will continue to look for suitable systems but the leading geophysical rental companies do not have anything currently. Therefore MBES, SSS and MAG data will be acquired. SBP data will be acquired when we have a suitable system, either before demobilisation or at a later date.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *11/02/2023*

Rev0C - 16/01/2023

PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush
Tim Holegate	

DAILY LOG

TIME (UTC)	CODE	EVENT
07:30	MOB	Surveyors onboard, sparker demobilisation
09:20	TRA	Slip ropes for site
10:00	OPS	Arrive site, toolbox talk for equipment deployment
10:10	OPS	Deploy pole
10:15	OPS	SVP
10:20	OPS	Deploy Mag
10:30	OPS	Deploy SSS
10:35	OPS	Commence survey ops
13:00	OPS	SVP
17:15	OPS	Recover SSS
17:20	OPS	Recover Mag
17:30	OPS	Recover Pole
17:35	OPS	SVP
17:40	TRA	Depart site for Grimsby
18:10	TRA	Arrive Grimsby, Lock in
18:30	TRA	Alongside, surveyors off vessel

WEATHER FORECAST

Tomorrow Sun 12 Feb GMT

Hour	Wind	Avg.		Gust	Temp.	Rain 3h
00:00	WSW	6 mph	to	7 mph	5 °C	0 mm
03:00	WSW	5 mph	to	5 mph	4 °C	0 mm
06:00	SSW	5 mph	to	5 mph	6 °C	0 mm
09:00	SSW	5 mph	to	8 mph	7 °C	0 mm
12:00	SSW	8 mph	to	10 mph	10 °C	0 mm
15:00	S	7 mph	to	8 mph	11 °C	0 mm
18:00	S	7 mph	to	7 mph	7 °C	0 mm
21:00	S	7 mph	to	12 mph	6 °C	0 mm

▲07:25 ▼17:04

Mon 13 Feb GMT

Hour	Wind	Avg.		Gust	Temp.	Rain 3h
00:00	S	7 mph	to	12 mph	5 °C	0 mm
03:00	S	8 mph	to	16 mph	4 °C	0 mm
06:00	S	8 mph	to	14 mph	3 °C	0 mm
09:00	S	7 mph	to	15 mph	5 °C	0 mm
12:00	S	10 mph	to	15 mph	9 °C	0 mm
15:00	S	10 mph	to	16 mph	10 °C	0 mm
18:00	S	7 mph	to	13 mph	7 °C	0 mm
21:00	S	8 mph	to	17 mph	6 °C	0 mm

HSE SUMMARY

No HSE incidents to report. TBT held prior to deployment of pole, towed sensors and SVP.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	02:00	10:50
Operational	OPS	07:35	01:50
Transit	TRA	01:25	00:50
Weather Down Time	WDT	00:00	00:00
Equipment Down Time	EDT	00:00	00:00
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:00	00:00
TOTALS (Day)		**1**	**5**

SURVEY WORK PROGRESS

MBES	40%
SSS	40%
SBP	0%
MAG	40%
TOTAL	**40%**

DAILY SUMMARY

Sparker system demobilised from the vessel first thing. Survey operations later conducted at site, for areas in vicinity of IOT mid-deep depth range.

UPCOMING PLAN

Weather and tides remain favourable. Survey of shallow water area on tomorrow's high-tide. Infill of any required areas/re-runs.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *12/02/2023*

Rev0C - 16/01/2023

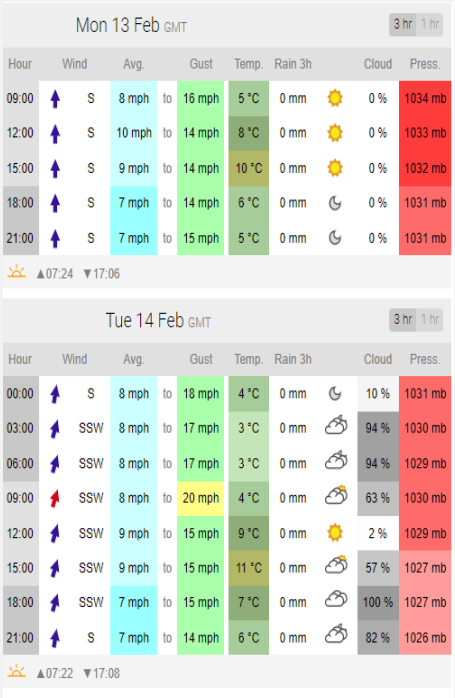
PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush
Tim Holegate	

DAILY LOG

TIME (UTC)	CODE	EVENT
06:00	TRA	Surveyors onboard
06:10	TRA	Lock out
06:20	TRA	Lock out complete, transit to site
06:50	OPS	Arrive site, toolbox talk for shallow water work
06:55	OPS	Deploy Pole
07:05	OPS	SVP
07:25	OPS	Deploy SSS
07:30	OPS	Deploy Mag
07:35	OPS	Commence survey ops - shallow water
09:35	AOB	Acquisition PC crash, restart
09:45	OPS	Resume survey ops
13:10	OPS	Recover SSS and Mag, reconfigure for deep
13:15	OPS	SVP in shallow water
13:20	OPS	SVP in deep water
13:30	OPS	Re-deploy SSS and Mag, commence survey ops
14:20	AOB	Acquisition PC crash, restart
14:30	OPS	Resume survey ops
17:35	OPS	Recover SSS and Mag
17:45	OPS	Recover Pole
17:50	OPS	SVP
17:55	TRA	Transit to Grimsby
19:00	TRA	Alongside

WEATHER FORECAST



Mon 13 Feb GMT (3 hr / 1 hr)

Hour	Wind	Avg.	Gust	Temp.	Rain 3h	Cloud	Press.
09:00	S	8 mph	16 mph	5 °C	0 mm	0 %	1034 mb
12:00	S	10 mph	14 mph	8 °C	0 mm	0 %	1033 mb
15:00	S	9 mph	14 mph	10 °C	0 mm	0 %	1032 mb
18:00	S	7 mph	14 mph	6 °C	0 mm	0 %	1031 mb
21:00	S	7 mph	15 mph	5 °C	0 mm	0 %	1031 mb

▲07:24 ▼17:06

Tue 14 Feb GMT (3 hr / 1 hr)

Hour	Wind	Avg.	Gust	Temp.	Rain 3h	Cloud	Press.
00:00	S	8 mph	18 mph	4 °C	0 mm	10 %	1031 mb
03:00	SSW	8 mph	17 mph	3 °C	0 mm	94 %	1030 mb
06:00	SSW	8 mph	17 mph	3 °C	0 mm	94 %	1029 mb
09:00	SSW	8 mph	20 mph	4 °C	0 mm	63 %	1030 mb
12:00	SSW	9 mph	15 mph	9 °C	0 mm	2 %	1029 mb
15:00	SSW	9 mph	15 mph	11 °C	0 mm	57 %	1027 mb
18:00	SSW	7 mph	15 mph	7 °C	0 mm	100 %	1027 mb
21:00	S	7 mph	14 mph	6 °C	0 mm	82 %	1026 mb

▲07:22 ▼17:08

HSE SUMMARY

No HSE incidents to report. TBT held prior to deployment of shallow water work and deployment of pole, towed sensors and SVP.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	00:00	59:40
Operational	OPS	10:40	20:05
Transit	TRA	02:00	04:15
Weather Down Time	WDT	00:00	00:00
Equipment Down Time	EDT	00:00	00:00
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:20	00:20
TOTALS (Day)		**1**	**7**

SURVEY WORK PROGRESS

MBES	95%
SSS	95%
SBP	0%
MAG	80%
TOTAL	**85%**

DAILY SUMMARY

Survey operations conducted across the shallow section of the site in the AM and deep water section in the PM. Coverage complete over most of the survey area for MBES and SSS. Remaining areas include crosslines, and infill/re-run lines. Several acquisition PC crashes today lost some acquisition time, cause unknown but continuing to investigate

UPCOMING PLAN

Conduct crosslines, infill and re-runs tomorrow (2023/02/13) and expected completion of survey ops.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *13/02/2023*

Rev0C - 16/01/2023

PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush
Tim Holegate	

WEATHER FORECAST

n/a

DAILY LOG

TIME (UTC)	CODE	EVENT
07:30	TRA	Surveyors onboard, waiting for lock
07:45	TRA	Slip
07:50	TRA	Lock out
08:00	TRA	Lock out complete, transit to site
08:45	OPS	Arrive site, Toolbox talk for days operations
08:50	OPS	Deploy pole and SVP
08:55	OPS	Deploy towed gear
09:10	OPS	Commence survey ops
10:20	OPS	Recover towed gear for MBES infill
10:25	OPS	MBES infill
11:05	OPS	SVP shallow
11:10	OPS	SVP deep
11:15	OPS	Deploy boomer
11:20	EDT	Boomer troubleshooting
12:10	OPS	Recover boomer
12:25	OPS	Deploy mag and SSS, resume infill
12:40	OPS	Commence survey ops
17:05	OPS	Recover towed gear
17:10	OPS	Recover pole and SVP
17:15	AOB	Man overboard drill
17:20	TRA	Transit to Grimsby
18:00	TRA	Arrive Grimsby, lock in
18:30	TRA	Alongside, surveyors off vessel

HSE SUMMARY

No HSE incidents to report. TBT held prior to deployment of pole, towed sensors and SVP. Man overboard drill conducted following equipment recovery at end of day. Fender recovered following vessel procedure without incident.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	00:00	59:40
Operational	OPS	08:10	28:15
Transit	TRA	01:55	06:10
Weather Down Time	WDT	00:00	00:00
Equipment Down Time	EDT	00:50	00:50
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:05	00:25
TOTALS (Day)		**1**	**8**

SURVEY WORK PROGRESS

MBES	100%
SSS	100%
SBP	0%
MAG	100%
TOTAL	**75%**

DAILY SUMMARY

Survey operations and infill completed for MBES, SSS and Mag data.

UPCOMING PLAN

Demobilisation tomorrow following lack of available, and suitable rental SBP system. Remobilise when available to complete SBP work scope.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *14/02/2023*

Rev0C - 16/01/2023

PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush
Tim Holegate	

WEATHER FORECAST

n/a

DAILY LOG

TIME (UTC)	CODE	EVENT
07:00	OPS	Surveyors onboard, toolbox talk for demob
07:10	MOB	Begin demobilisation
11:00	MOB	Demobilisation complete, surveyors and crew departing site. Vessel stood-down.

HSE SUMMARY

No HSE incidents to report

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	03:55	63:35
Operational	OPS	00:05	28:20
Transit	TRA	00:00	06:10
Weather Down Time	WDT	00:00	00:00
Equipment Down Time	EDT	00:00	00:50
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:00	00:25
TOTALS (Day)		**1**	**9**

SURVEY WORK PROGRESS

MBES	100%
SSS	100%
SBP	0%
MAG	100%
TOTAL	**75%**

DAILY SUMMARY

All equipment demobilised and transported back to rental provider.

UPCOMING PLAN

Vessel stood-down in Grimsby. Surveyors and crew off-site. Sourcing appropriate rental SBP system to resume works.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *07/03/2023*

Rev0C - 16/01/2023

PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush

DAILY LOG

TIME (UTC)	CODE	EVENT
07:45	MOB	Surveyor onboard, TBT for mobilisation
09:00	MOB	Commence mobilisation
16:43	TRA	Slip (freeflow)
17:10	MOB	Arrive at calibration location, TBT
17:15	MOB	Deploy streamer and pole
17:35	MOB	Equipment deployed, commence cals
18:45	MOB	Recover equipment
19:00	TRA	Transit to Grimsby
19:30	MOB	Alongside, surveyors off vessel

WEATHER FORECAST

Tomorrow Wed 8 Mar GMT — 3 hr 1 hr

Hour	Wind	Avg.		Gust	Temp.	Rain 3h	Cloud	Press.
00:00	SSW	6 mph	to	8 mph	-1 °C	0 mm	100 %	998 mb
03:00	S	5 mph	to	6 mph	-1 °C	0 mm	100 %	996 mb
06:00	E	5 mph	to	7 mph	0 °C	0.1 mm	100 %	994 mb
09:00	E	10 mph	to	14 mph	3 °C	0.1 mm	100 %	994 mb
12:00	E	14 mph	to	16 mph	4 °C	0.1 mm	100 %	994 mb
15:00	E	14 mph	to	16 mph	4 °C	0.1 mm	100 %	993 mb
18:00	ENE	12 mph	to	18 mph	2 °C	0 mm	100 %	994 mb
21:00	ENE	9 mph	to	16 mph	2 °C	0 mm	100 %	996 mb

▲06:32 ▼17:50

Thu 9 Mar GMT — 3 hr 1 hr

Hour	Wind	Avg.		Gust	Temp.	Rain 3h	Cloud	Press.
00:00	ENE	8 mph	to	13 mph	2 °C	0 mm	93 %	996 mb
03:00	ENE	6 mph	to	8 mph	1 °C	0 mm	98 %	997 mb
06:00	ENE	6 mph	to	7 mph	1 °C	0 mm	94 %	999 mb
09:00	E	9 mph	to	10 mph	4 °C	0.1 mm	100 %	1000 mb
12:00	ESE	13 mph	to	15 mph	5 °C	0.8 mm	100 %	1000 mb
15:00	E	15 mph	to	22 mph	3 °C	2.4 mm	100 %	998 mb
18:00	E	18 mph	to	29 mph	2 °C	3.5 cm	100 %	996 mb
21:00	E	21 mph	to	31 mph	2 °C	2.9 cm	100 %	994 mb

▲06:30 ▼17:52 = Snow

HSE SUMMARY

No HSE incidents to report. Toolbox talk for equipment mobilisation and deployment for calibrations.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	10:48	74:23
Operational	OPS	00:00	28:20
Transit	TRA	00:57	07:07
Weather Down Time	WDT	00:00	00:00
Equipment Down Time	EDT	00:00	00:50
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:00	00:25
TOTALS (Day)		**1**	**10**

SURVEY WORK PROGRESS

MBES	100%
SSS	100%
SBP	0%
MAG	100%
TOTAL	**75%**

DAILY SUMMARY

Boomer and nav system mobilised onto vessel. Initial verifications conducted at Outfall outside of Grimsby.

UPCOMING PLAN

Pending review of verification data commence survey ops on site.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *08/03/2023*

Rev0C - 16/01/2023

PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush

DAILY LOG

TIME (UTC)	CODE	EVENT
07:00	MOB	Surveyor onboard, review boomer setup
07:41	TRA	Slip (free flow), for verifications at outfall
07:56	MOB	Arrive at outfall, TBT for deployment
08:00	MOB	Deploy equipment
08:09	MOB	Commence verifications
08:46	MOB	Equipment recovery
08:58	TRA	Transit to site
09:20	OPS	Arrive site, deploy equipment
09:34	OPS	Equipment deployed
12:25	OPS	Streamer adjustments
17:34	OPS	Weather declining, lift gear
17:47	TRA	Gear recovered, depart site for Grimsby
18:25	TRA	Arrive Grimsby, wait for lock in
19:15	TRA	Alongside

WEATHER FORECAST

Tomorrow Thu 9 Mar GMT (3 hr | 1 hr)

Hour	Wind	Avg.		Gust	Temp.	Rain 3h	Cloud	Press.
00:00	E	9 mph	to	16 mph	1 °C	0 mm	100 %	995 mb
03:00	E	8 mph	to	14 mph	1 °C	0 mm	100 %	995 mb
06:00	E	8 mph	to	16 mph	2 °C	0.1 mm	100 %	996 mb
09:00	ESE	15 mph	to	21 mph	3 °C	3.9 mm	100 %	995 mb
12:00	ESE	16 mph	to	26 mph	2 °C	3.1 mm FOG	100 %	994 mb
15:00	E	20 mph	to	30 mph	2 °C	9.7 mm FOG	100 %	990 mb
18:00	E	23 mph	to	35 mph	3 °C	5.7 mm FOG	100 %	987 mb
21:00	E	18 mph	to	24 mph	5 °C	2 mm	100 %	983 mb

▲06:30 ▼17:52

Fri 10 Mar GMT (3 hr | 1 hr)

Hour	Wind	Avg.		Gust	Temp.	Rain 3h	Cloud	Press.
00:00	E	8 mph	to	12 mph	6 °C	3.3 mm	100 %	981 mb
03:00	NE	21 mph	to	26 mph	5 °C	2.3 mm FOG	100 %	981 mb
06:00	NNE	33 mph	to	44 mph	2 °C	4 cm	100 %	985 mb
09:00	N	29 mph	to	40 mph	2 °C	2.6 cm	100 %	993 mb
12:00	N	21 mph	to	32 mph	2 °C	0.7 cm	91 %	998 mb
15:00	NNW	20 mph	to	28 mph	3 °C	0.1 mm	12 %	1001 mb
18:00	WNW	14 mph	to	23 mph	0 °C	0 mm	32 %	1005 mb
21:00	WNW	12 mph	to	22 mph	-1 °C	0 mm	19 %	1007 mb

▲06:27 ▼17:54 = Snow

HSE SUMMARY

No HSE Incidents to report. TBT conducted for equipment deployment/recovery with specific reference to declining weather conditions, cold, and snow on deck.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	01:43	76:06
Operational	OPS	08:27	36:47
Transit	TRA	02:05	09:12
Weather Down Time	WDT	00:00	00:00
Equipment Down Time	EDT	00:00	00:50
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:00	00:25
TOTALS (Day)		**1**	**10**

SURVEY WORK PROGRESS

MBES	100%
SSS	100%
SBP	49%
MAG	100%
TOTAL	**75%**

DAILY SUMMARY

Additional verifications conducted at Outfall location before transit to site. Survey operations were conducted within the survey extents Inshore of the IOT. Areas of SBP penetration blanking observed and variable results due to weather conditions. Data to be processed and reviewed to determine quality, however pending quality assessment SBP workscope is 49% complete.

UPCOMING PLAN

Continue survey operations tomorrow (Thursday 9th March) within suitable weather conditions with possible early equipment recovery due to weather. Possible weather standby on Friday.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *09/03/2023*

Rev0C - 16/01/2023

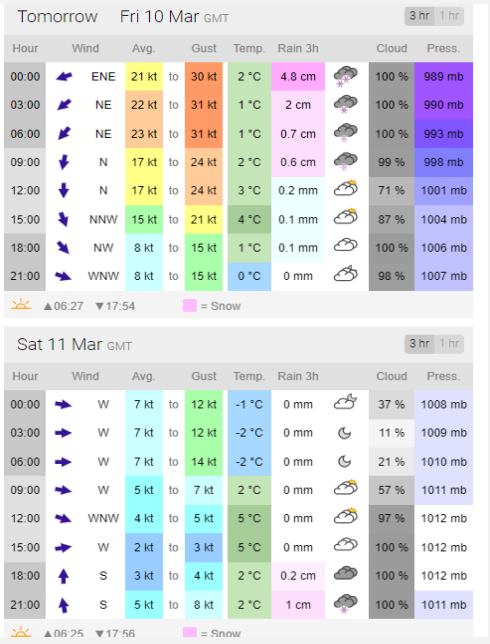
PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush

DAILY LOG

TIME (UTC)	CODE	EVENT
06:50	AOB	Surveyor onboard, wait for flood gates
07:20	TRA	Slip
08:00	AOB	Arrive at site, TBT for deployment/recovery
08:05	OPS	Deploy equipment
08:12	OPS	Equipment deployed, commence survey ops
10:31	OPS	Weather declining
12:37	OPS	Conditions unsuitable for data, recover gear
12:47	WDT	Gear recovered, standby on site ,review weather
13:34	WDT	Weather declining further, depart for Grimsby
14:15	WDT	Arrive Grimsby, lock in
14:29	WDT	Lock in complete
14:40	MOB	Alongside, sparker mob
17:32	MOB	Sparker mobilised, pending saltwater reservoir
17:32	WDT	Surveyors off vessel, weather downtime
19:00	AOB	Surveyors off shift

WEATHER FORECAST



HSE SUMMARY

No HSE incidents to report, TBT for equipment deployment/recovery.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	02:52	78:58
Operational	OPS	04:42	41:29
Transit	TRA	00:40	09:52
Weather Down Time	WDT	03:21	03:21
Equipment Down Time	EDT	00:00	00:50
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:35	01:00
TOTALS (Day)		**1**	**12**

SURVEY WORK PROGRESS

MBES	100%
SSS	100%
SBP	65% (pending QA)
MAG	100%
TOTAL	**80% (pending QA)**

DAILY SUMMARY

Survey operations suspended due to poor weather. Spare-sparker system mobilised while alongside to test seabed penetration through consolidated mud sections.

UPCOMING PLAN

Survey operations to resume tomorrow (10th March 2023) pending suitable weather. Use of sparker system to complete remaining lines, conduct infill, and test over consolidated mud areas within the site.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *10/03/2023*

Rev0C - 16/01/2023

PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush

DAILY LOG

TIME (UTC)	CODE	EVENT
07:10	AOB	Surveyor onboard, assess weather
07:15	WDT	Weather unsuitable, standby
14:00	MOB	Fresh water
16:00	MOB	Sparker tests
19:00	WDT	Surveyors off vessel

WEATHER FORECAST

Tomorrow Sat 11 Mar GMT (3 hr | 1 hr)

Hour	Wind	Avg.		Gust	Temp.	Rain 3h		Cloud	Press.
00:00	W	6 kt	to	9 kt	-2 °C	0 mm		86 %	1009 mb
03:00	WSW	6 kt	to	9 kt	-2 °C	0 mm		87 %	1008 mb
06:00	WSW	6 kt	to	8 kt	-2 °C	0 mm		98 %	1009 mb
09:00	WSW	7 kt	to	9 kt	1 °C	0 mm		91 %	1010 mb
12:00	WSW	8 kt	to	10 kt	4 °C	0 mm		88 %	1010 mb
15:00	SW	6 kt	to	8 kt	5 °C	0 mm		100 %	1009 mb
18:00	SSE	4 kt	to	5 kt	3 °C	0.3 mm		100 %	1008 mb
21:00	SSE	8 kt	to	16 kt	2 °C	2.5 cm		100 %	1007 mb

▲06:25 ▼17:56 = Snow

Sun 12 Mar GMT (3 hr | 1 hr)

Hour	Wind	Avg.		Gust	Temp.	Rain 3h		Cloud	Press.
00:00	SE	10 kt	to	19 kt	1 °C	2.1 mm	FOG	100 %	1005 mb
03:00	SSE	7 kt	to	13 kt	2 °C	0.6 mm	FOG	100 %	1003 mb
06:00	W	10 kt	to	24 kt	4 °C	0.1 mm	FOG	100 %	1003 mb
09:00	W	12 kt	to	26 kt	6 °C	0 mm		100 %	1006 mb
12:00	WSW	12 kt	to	19 kt	7 °C	0 mm		100 %	1007 mb
15:00	SW	10 kt	to	18 kt	9 °C	0 mm		100 %	1005 mb
18:00	S	10 kt	to	23 kt	8 °C	0.2 mm		100 %	1003 mb
21:00	S	16 kt	to	31 kt	8 °C	5.7 mm		100 %	998 mb

▲06:22 ▼17:58

HSE SUMMARY

No HSE incidents to report, TBT for equipment deployment/recovery.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	05:00	83:58
Operational	OPS	00:00	41:29
Transit	TRA	00:00	09:52
Weather Down Time	WDT	06:45	10:06
Equipment Down Time	EDT	00:00	00:50
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:05	01:05
TOTALS (Day)		**1**	**13**

SURVEY WORK PROGRESS

MBES	100%
SSS	100%
SBP	65% (pending QA)
MAG	100%
TOTAL	**80% (pending QA)**

DAILY SUMMARY

Vessel alongside on weather. While waiting sparker system mobilised and tested

UPCOMING PLAN

Survey operations tomorrow (11th March 2023)

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *11/03/2023*

Rev0C - 16/01/2023

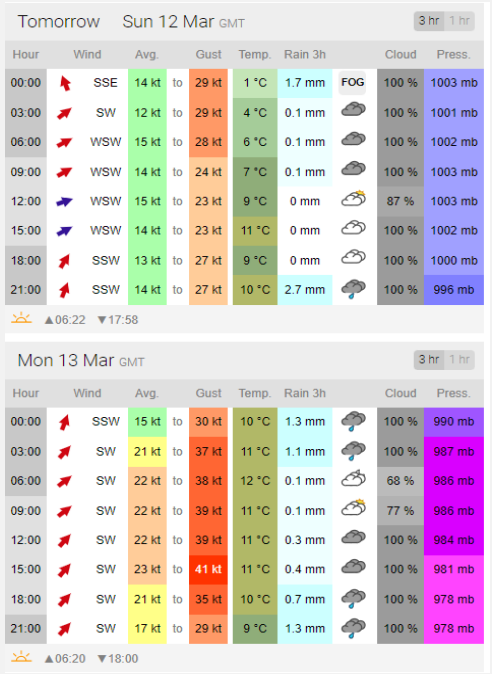
PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush

DAILY LOG

TIME (UTC)	CODE	EVENT
06:00	OPS	Surveyor onboard, slip
06:05	VDT	Waiting on traffic
06:15	OPS	Depart Grimsby for site
06:45	OPS	Arrive on site, TBT for deployment/recovery
06:50	OPS	Deploy survey gear
07:10	OPS	Commence survey ops
09:00	VDT	Waiting on traffic
09:07	OPS	Resume survey ops
10:11	VDT	Waiting on traffic
10:24	OPS	Resume survey ops
10:52	OPS	Swap to one-way operations due to tide
12:10	VDT	Waiting on traffic
12:27	OPS	Resume survey ops
14:57	EDT	Sparker bang-box HV 1 error, investigating
15:25	EDT	Recover gear
15:45	TRA	Transit to Grimsby
16:20	TRA	Lock In
16:35	EDT	Alongside
16:40	EDT	Swap out bang-box
18:30	EDT	Mobilised, surveyors off vessel

WEATHER FORECAST



Tomorrow Sun 12 Mar GMT (3 hr / 1 hr)

Hour	Wind	Avg.		Gust	Temp.	Rain 3h		Cloud	Press.
00:00	SSE	14 kt	to	29 kt	1 °C	1.7 mm	FOG	100 %	1003 mb
03:00	SW	12 kt	to	29 kt	4 °C	0.1 mm		100 %	1001 mb
06:00	WSW	15 kt	to	28 kt	6 °C	0.1 mm		100 %	1002 mb
09:00	WSW	14 kt	to	24 kt	7 °C	0.1 mm		100 %	1003 mb
12:00	WSW	15 kt	to	23 kt	9 °C	0 mm		87 %	1003 mb
15:00	WSW	14 kt	to	23 kt	11 °C	0 mm		100 %	1002 mb
18:00	SSW	13 kt	to	27 kt	9 °C	0 mm		100 %	1000 mb
21:00	SSW	14 kt	to	27 kt	10 °C	2.7 mm		100 %	996 mb

▲06:22 ▼17:58

Mon 13 Mar GMT (3 hr / 1 hr)

Hour	Wind	Avg.		Gust	Temp.	Rain 3h		Cloud	Press.
00:00	SSW	15 kt	to	30 kt	10 °C	1.3 mm		100 %	990 mb
03:00	SW	21 kt	to	37 kt	11 °C	1.1 mm		100 %	987 mb
06:00	SW	22 kt	to	38 kt	12 °C	0.1 mm		68 %	986 mb
09:00	SW	22 kt	to	39 kt	11 °C	0.1 mm		77 %	986 mb
12:00	SW	22 kt	to	39 kt	11 °C	0.3 mm		100 %	984 mb
15:00	SW	23 kt	to	41 kt	11 °C	0.4 mm		100 %	981 mb
18:00	SW	21 kt	to	35 kt	10 °C	0.7 mm		100 %	978 mb
21:00	SW	17 kt	to	29 kt	9 °C	1.3 mm		100 %	978 mb

▲06:20 ▼18:00

HSE SUMMARY

No HSE incidents to report, TBT for equipment deployment/recovery.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	00:00	83:58
Operational	OPS	08:10	49:39
Transit	TRA	00:50	10:42
Weather Down Time	WDT	00:00	10:06
Equipment Down Time	EDT	02:43	03:33
Vessel Down Time	VDT	00:47	00:47
Any Other	AOB	00:00	01:05
TOTALS (Day)		**1**	**14**

SURVEY WORK PROGRESS

MBES	100%
SSS	100%
SBP	85%
MAG	100%
TOTAL	**92%**

DAILY SUMMARY

Successful survey operations with the sparker system conducting the majority of remaining lines. Unexpected power supply failure to sparker ended operations early however a spare system was mobilised upon return to Grimsby

UPCOMING PLAN

Finish survey operations tomorrow (12thMarch 2023) completing the remaining 10 lines any addiitional required infill and water sampling. Pending final QA, demobilisation on the 13th March 2023.

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *12/03/2023*

Rev0C - 16/01/2023

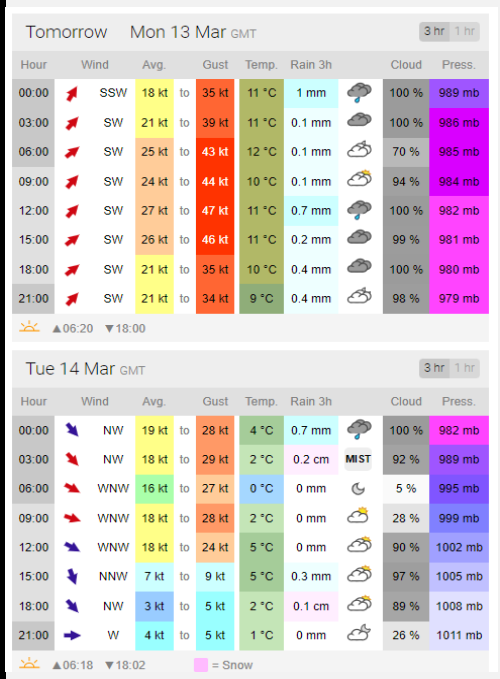
PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush

DAILY LOG

TIME (UTC)	CODE	EVENT
06:30	MOB	Surveyor onboard, slip
06:45	TRA	Transit to Site
07:45	OPS	Arrive site, toolbox talk for water sampling
08:00	OPS	Water sampling
08:15	OPS	Deploy towed gear
08:30	OPS	Commence survey ops
12:25	OPS	Recover towed gear
12:40	OPS	Continue water sampling
17:40	TRA	Depart site for Grimsby
18:20	TRA	Arrive Grimsby
18:30	TRA	Alongside
18:40	TRA	Surveyors off vessel

WEATHER FORECAST



Tomorrow Mon 13 Mar GMT (3 hr / 1 hr)

Hour	Wind	Avg.		Gust	Temp.	Rain 3h	Cloud	Press.
00:00	SSW	18 kt	to	35 kt	11 °C	1 mm	100 %	989 mb
03:00	SW	21 kt	to	39 kt	11 °C	0.1 mm	100 %	986 mb
06:00	SW	25 kt	to	43 kt	12 °C	0.1 mm	70 %	985 mb
09:00	SW	24 kt	to	44 kt	10 °C	0.1 mm	94 %	984 mb
12:00	SW	27 kt	to	47 kt	11 °C	0.7 mm	100 %	982 mb
15:00	SW	26 kt	to	46 kt	11 °C	0.2 mm	99 %	981 mb
18:00	SW	21 kt	to	35 kt	10 °C	0.4 mm	100 %	980 mb
21:00	SW	21 kt	to	34 kt	9 °C	0.4 mm	98 %	979 mb

▲06:20 ▼18:00

Tue 14 Mar GMT (3 hr / 1 hr)

Hour	Wind	Avg.		Gust	Temp.	Rain 3h	Cloud	Press.
00:00	NW	19 kt	to	28 kt	4 °C	0.7 mm	100 %	982 mb
03:00	NW	18 kt	to	29 kt	2 °C	0.2 cm	92 %	989 mb
06:00	WNW	16 kt	to	27 kt	0 °C	0 mm	5 %	995 mb
09:00	WNW	18 kt	to	28 kt	2 °C	0 mm	28 %	999 mb
12:00	WNW	18 kt	to	24 kt	5 °C	0 mm	90 %	1002 mb
15:00	NNW	7 kt	to	9 kt	5 °C	0.3 mm	97 %	1005 mb
18:00	NW	3 kt	to	5 kt	2 °C	0.1 cm	89 %	1008 mb
21:00	W	4 kt	to	5 kt	1 °C	0 mm	26 %	1011 mb

▲06:18 ▼18:02 = Snow

HSE SUMMARY

No HSE incidents to report, TBT for equipment deployment/recovery and water sampling.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	00:15	84:13
Operational	OPS	09:55	59:34
Transit	TRA	02:00	12:42
Weather Down Time	WDT	00:00	10:06
Equipment Down Time	EDT	00:00	03:33
Vessel Down Time	VDT	00:00	00:47
Any Other	AOB	00:00	01:05
TOTALS (Day)		**1**	**15**

SURVEY WORK PROGRESS

MBES	100%
SSS	100%
SBP	100% (pending QA)
MAG	100%
TOTAL	**100% (pending QA)**

DAILY SUMMARY

Remaining SBP lines completed, closing out work scope following final QA. Water sampling at regular intervals on site.

UPCOMING PLAN

Pending final QA/review commence demobilisation tomorrow (13th March 2023).

Daily Progress Report

Project: *5163 Geophysical*
Vessel: *Wessex Explorer*
Date: *13/03/2023*

Rev0C - 16/01/2023

PERSONNEL

Survey Team	Vessel Team
Tom Alker	Nick Bush
Hugh MacKay	James Bush

WEATHER FORECAST

n/a

DAILY LOG

TIME (UTC)	CODE	EVENT
07:30	MOB	Surveyor onboard, TBT for vessel demob
07:45	MOB	Commence vessel demobilisation
11:45	MOB	Demobilisation complete, surveyors off
		vessel

HSE SUMMARY

No HSE incidents to report, TBT for equipment demobilisation

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	MOB	04:15	14:21
Operational	OPS	00:00	03:33
Transit	TRA	00:00	00:47
Weather Down Time	WDT	00:00	01:05
Equipment Down Time	EDT	00:00	360:00
Vessel Down Time	VDT	00:00	00:00
Any Other	AOB	00:00	00:00
TOTALS (Day)		**1**	**15**

SURVEY WORK PROGRESS

MBES	100%
SSS	100%
SBP	100%
MAG	100%
TOTAL	**100%**

DAILY SUMMARY

Vessel demobilised of equipment. Surveyors and crew off-site

UPCOMING PLAN

n/a