KEEPING BRITAIN TRADING

IMMINGHAM EASTERN RO-RO TERMINAL

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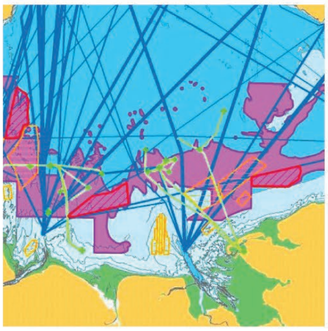
Associated British Ports

Immingham Eastern RoRo Terminal

Marine Geophysical Survey Report

June 2022



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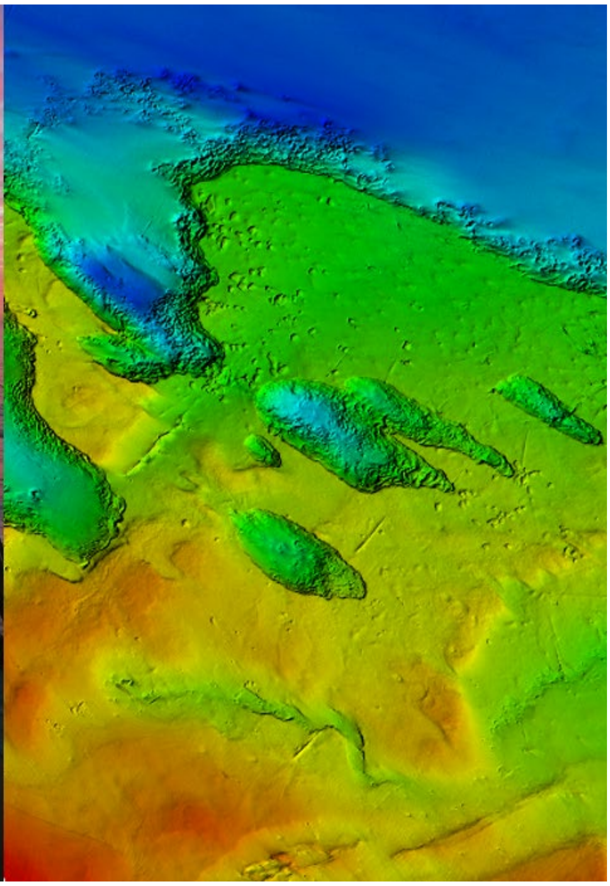

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Summary

Associated British Ports (ABP) contracted ABPmer to undertake a geophysical seismic survey at the site of the proposed Immingham Eastern RoRo development site. 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 design and construction of the Immingham Eastern RoRo Terminal as well as for physical processes and marine archaeology assessments in the Environmental Statement to support the DCO application.

Survey operations were conducted onboard the survey vessel, *Wessex Explorer*, in January 2022 with data processing and interpretation taking place in February 2022.

MBES data processing and reporting has been conducted by ABPmer. The geophysical processing and interpretation of the SBP, SSS and MAG data was conducted experienced geophysicists at *CM-Geomatics Ltd*.

Three seabed sediment classifications have been identified from SSS and MBES data: SILT/MUD, muddy SAND, and firm CLAY. SILT/MUD is the dominant sediment type. Muddy SAND on the northern edge of the site also hosts an area of mobile bedforms. Firm CLAY is present in the south-eastern corner of the site and presents as positive relief exposure at the seabed.

In total 880 seafloor contacts have been identified on SSS and MBES datasets.

In total a primary list of magnetic targets, containing 106 targets have been identified from 142 individual picks that are >5 nT in amplitude. Magnetic results from this survey are only valid for large ferrous targets, not UXO detection purposes.

Four main types of sub surface units have been identified, also with sub-units. 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. The uppermost unit is comprised of alluvium deposits that can be further subdivided into surficial sediments composed of soft SILT/MUD with a depth range between 0-3.0 m below seabed (BSB).

The alluvium is composed of a mix of fluvial sediments comprised of sands, gravels, and clays. The unit presents a complex structure of channelisation and subsequent sediment fill. The base of the alluvium sediments as a whole range between 0.8-9.1 m BSB.

A bright reflector was identified in the upper sub-surface of much of the survey site. This reflector has been interpreted as a layer of 'predominantly alluvium containing organic material' due to severe acoustic attenuation of the seismic data and reference to some historical borehole logs. All subsequent horizon interpretations have been limited by the presence of the organic sediment layer that attenuates the underlying reflectors making them uninterpretable across certain areas of the site.

A layer of boulder clay underlies the alluvium which has been interpreted as the "upper boulder clay" unit. The upper boulder clay ranges between 0-20.0 m BSB. Beneath the boulder clay lies a horizon interpreted from geotechnical data as inter-glacial clays. This horizon ranges between 4.0-25.6 m BSB. A second layer of boulder clay has been interpreted as the "lower boulder clay" unit. This unit is intermittently interpreted between 8.7-37.5 m BSB. The bedrock has been identified as chalk from geotechnical data and has been intermittently observed in the seismic data at depths between 15.4-41.5 m BSB. The bedrock level appears to be dipping downwards towards the north-western edge of the survey area.

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1 Introduction

Associated British Ports (ABP) contracted ABPmer to undertake a geophysical seismic survey at the site of the proposed Immingham Eastern RoRo development. 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 the Immingham Eastern RoRo Terminal as well as to provide context for the respective physical processes and marine archaeology assessments.

The requirements of the geophysical survey included full coverage MBES and SSS data extending up to the Immingham Oil Terminal jetty to the north and east and aligned with the access pontoon of the East Jetty to the west. The required inshore extent was to extend to 30 m inshore of the berth pocket (where safe to do so), or to the 2 m above Chart Datum (CD) contour, where this is further up the shore. LiDAR data acquired by the Environment Agency in 2019 was used to provide topographical data inshore of 2 m above CD contour.

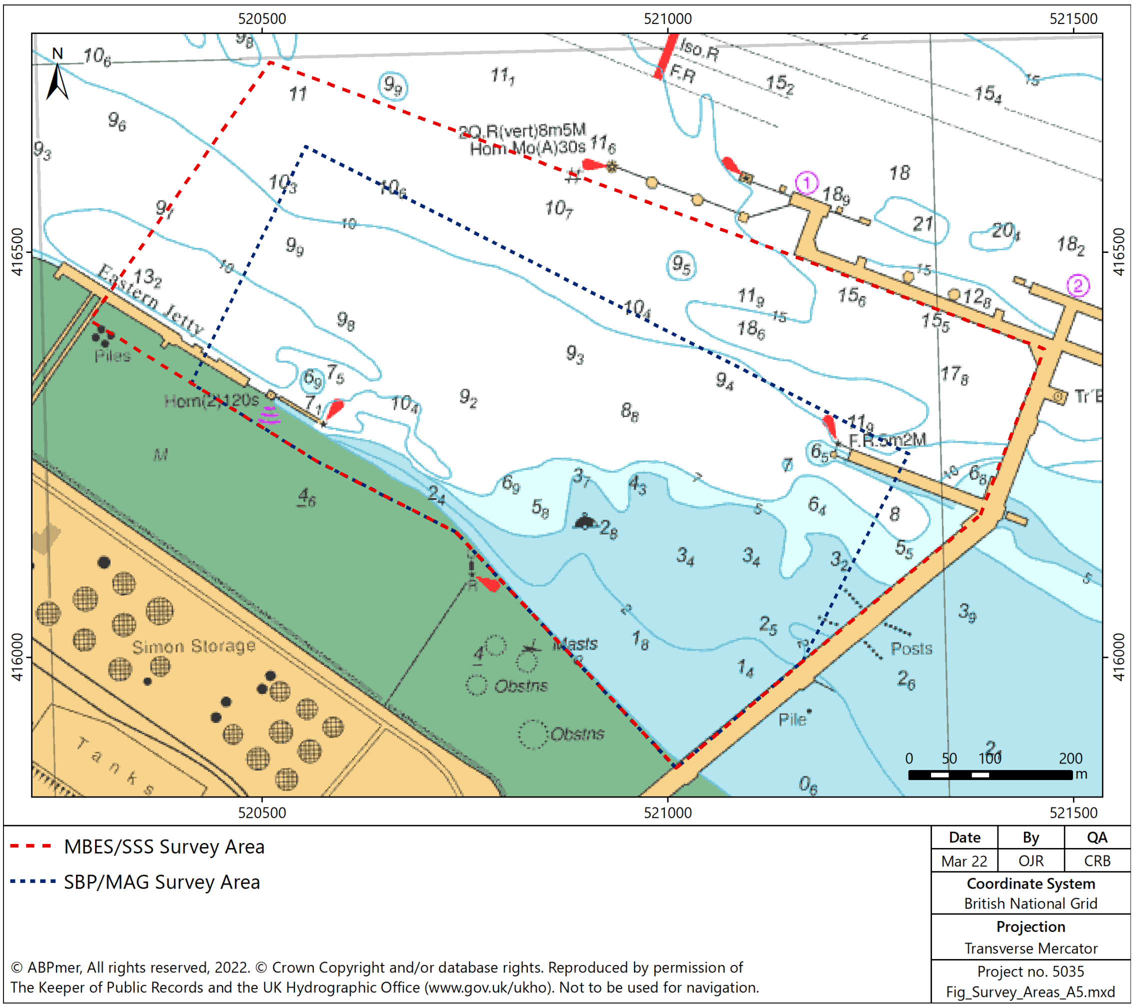


Figure 1. Geophysical survey required coverage

SBP and MAG data was required within an area that extends 100 m north, west and east of the berth pocket, at a 20 m line spacing with cross lines acquired at 100 m spacing. However, in order to achieve a greater understanding of the sub-surface, SBP data was acquired at 10 m line spacing. The required inshore extent of SBP and MAG data was 30 m inshore of the berth pocket (where safe to do so) or the 0 m CD contour, where this is further up the shore.

2 Data Acquisition

The geophysical survey commenced on 24 January 2022 when mobilisation of the geophysical survey vessel, *Wessex Explorer*, commenced. 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.

Figure 2. Geophysical survey vessel - Wessex Explorer

Mobilisation took place in Grimsby, where the vessel operated from on a 12-hour basis during the survey period. Alongside equipment mobilisation and static verification procedures were conducted, within Grimsby Fish Docks, on 24-25 January 2022. Upon completion of the alongside mobilisation, the vessel conducted a series of data calibration/verification and data optimisation procedures on 26 January 2022, prior to commencing survey operations.

Survey operations took place from 27 – 30 January 2022. A full data review and preliminary processing took place on completion of survey to confirm the required coverage had been achieved and the vessel was demobilised on 31 January 2022.

Table 1. Summary of key personnel

Role	Personnel
Project Manager / Surveyor	Paul Clement (ABPmer)
Hydrographic surveyor	Ian Davidson (ABPmer)
Geophysical surveyor / Engineer	Hugh MacKay
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	Deepak Arya (Hayes Marine Ltd)

2.1 Survey control

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.

In the vertical, data was acquired relative to the ETRS89 ellipsoid and offset to Chart Datum (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.

2.2 Geophysical survey

2.2.1 Survey summary

A brief summary of the daily activities conducted as part of the project are provided in Table 2. Daily Progress Reports are provided as Appendix A, which give a detailed summary of all survey activities.

Table 2. Summary of geophysical survey operations

Date	Daily Summary
23/01/2022	▪ Survey personnel travelled to Grimsby.
24/01/2022	▪ Full project brief and HSE discussion held with all survey and vessel personnel. ▪ Commenced mobilisation of Wessex Explorer. ▪ SBP, SSS and MAG successfully wet-tested.
25/01/2022	▪ MBES pole mobilised. ▪ Dynamic position calibration conducted within Grimsby Fish Docks. ▪ Independent static position verification conducted alongside.
26/01/2022	▪ Completed alongside mobilisation and static position verifications. ▪ MBES calibration and towed sensor dynamic position verifications conducted at known outfall location on the Humber Estuary. ▪ Data optimisation procedure of SBP conducted.
27/01/2022	▪ Commenced survey operations. ▪ MBES reconnaissance survey conducted over high water prior to deploying towed sensors. ▪ SBP data acquired at 10 m spacing within the proposed berth pocket.
28/01/2022	▪ Continued MBES/SBP survey at 10 m line spacing.
29/01/2022	▪ SSS/MAG survey conducted at 20 m line spacing. ▪ Weather conditions in afternoon became unworkable and the vessel returned to Grimsby.
30/01/2022	▪ Completed all remaining survey lines (SBP at 10 m spacing, MAG at 20 m spacing and full coverage MBES/SSS). ▪ Full data QA prior to demobilisation.
31/01/2021	▪ Data QA confirms requirements coverage achieved. ▪ Vessel demobilised. ▪ Survey personnel depart Grimsby.

2.2.2 Vessel mobilisation

The survey vessel, *Wessex Explorer,* was already located in Grimsby following a previous ABPmer geophysical project conducted in 2021. The survey team travelled to Grimsby on 23 January 2022 and commenced mobilisation of the *Wessex Explorer* on 24 January 2022. Alongside mobilisation and static verifications were completed on 25 January 2022 with dynamic calibrations/verifications conducted over a known outfall location on the Humber Estuary on 26 January 2022.

2.2.3 Operations

Geophysical survey operations were conducted on a 12-hour basis operating out of Grimsby from 27 – 30 January 2022. On confirmation that all required data was achieved, the vessel was demobilised on 31 January 2022.

2.2.4 Equipment

The *Wessex Explorer* was mobilised with a full suite of geophysical equipment to fulfil all requirements of the Immingham RoRo geophysical survey. A pole mounted multibeam (MBES) bathymetry system, sidescan sonar (SSS), sub-bottom profiler (SBP) and towed magnetometer (MAG) were mobilised to the vessel, as detailed below.

Multibeam system (with integrated inertial positioning)

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.

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.

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.

MBES data was acquired within the navigation acquisition software, QPS QINSy.

Full coverage MBES data was required within the MBES/SSS survey area (illustrated in Figure 1). This was achieved across the majority of the site and bathymetry was acquired inshore of the 2 m above CD contour where safe to do so (east of the Eastern Jetty). However, due to shallow water depths, and lack of space for safe vessel manoeuvrability, data was not acquired inshore of the eastern jetty.

The bathymetry data was acquired using the combined data acquisition and navigation software, QPS QINSy. By use of the fully integrated Norbit iWBMSh multibeam system, the data was acquired in order to meet, and surpass, the minimum requirements defined by the IHO Order 1a specification.

Calibration/verification

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. With the results known, the vessel immediately returned alongside, and a full position verification was conducted. The survey navigation software, QPS QINSy, was set to log positions of multiple nodes around the vessel, whilst simultaneously, an independent Emlid Reach RS2 GNSS system (with RTK corrections) was positioned over the vessel nodes and positions observed. The Emlid data was compared with the QINSy data to ensure that the positioning system was performing as required.

When a multibeam echosounder and inertial positioning system are installed, there will always be some residual angular misalignment between the sensors. To measure this misalignment, a full patch test procedure was conducted on 26 January 2022. The patch test was conducted at a known outfall location on the Humber Estuary. Prior to commencing the patch test, a sound velocity profile was acquired to ensure that errors in sound velocity did not affect the results.

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.

Sound velocity

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.

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 multibeam acquisition software to correct the positioning of the MBES soundings.

Sub-bottom profiler (SBP)

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 Coda DA4G acquisition system.

The boomer catamaran was towed from the port stern quarter, with an outrigger installed on the same side of the vessel to tow the hydrophone. Both instruments were towed at 19 m astern of the vessel throughout operations, with the centre of the hydrophone array approximately level with the boomer plate.

The navigation software, QPS QINSy 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 QPS QINSy. Data was recorded in full waveform SEGY format.

SBP data was acquired along 10 m spaced lines and 100 m cross lines within the SBP/MAG survey area (indicated in Figure 1).

Calibration/verification

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.

Sidescan sonar (SSS)

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.

Data was logged in native JSF format using the Edgetech Discover acquisition software. Both high and low frequency data were logged. Full coverage SSS data was required within the full MBES/SSS survey (indicated in Figure 1). This was achieved in all areas of the site, apart from inshore of the Eastern jetty, where shallow water depths and lack of space for safe vessel manoeuvrability meant the vessel was unable to gain access and hence SSS data not acquired.

Calibration/verification

During mobilisation a rub test was performed whilst alongside to confirm communications with the towfish and correct transducer setup. A wet test and position verification 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 (MAG)

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 hitting the seabed whilst keeping a suitable separation from the vessel to avoid the vessel's magnetic signature.

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 along 20 m spaced lines and 100 m spaced cross lines within the SBP/MAG area identified in Figure 1.

Calibration/verification

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. Whilst at the known outfall location on the Humber Estuary, a MAG position verification was conducted by running two reciprocal lines over, and perpendicular to, the discrete seabed target, confirming the positional accuracy.

3 Data Processing and Interpretation

3.1 Bathymetry

3.1.1 Data processing

The multibeam bathymetry data was processed by ABPmer using BeamworX AutoClean 2021.3.1.2.

Bathymetry data was acquired with RTK positioning accurate to < 0.02 m. RTK corrections were received largely uninterrupted throughout survey operations by the Applanix Oceanmaster initial GNSS system, apart from on one line where accuracy was observed to decrease. This line was rerun and therefore removed from the project data. With all other lines positioned with RTK, post-processing of the navigation data was not required prior to processing of the bathymetry.

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 from the effects of changes in sound velocity by the profile closest in time, rather than the previous. A course filter was applied to automatically remove erroneous soundings at a distance from the seabed, at this site, the hull/keels of berthed vessels were observed by the MBES but quickly removed by the course 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.

The final processed bathymetry dataset was gridded at resolutions of 0.2 m, 0.5 m and 1.0 m. Each grid was then exported as XYZ, FLT and georeferenced sub-illuminated images (GeoTIFF).

3.1.2 Data quality

MBES data was of good quality throughout survey operations. All survey lines included in the processing had uninterrupted RTK positioning. 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, apart from inshore of the Eastern Jetty, where the vessel was unable to survey due to shallow water depths and lack of space for safe vessel manoeuvrability.

SSS data are generally of good quality across the site. Errors in layback positioning were observed due to strong local currents in the area causing discrepancies in heading. This has been mitigated to an extent by moving observed targets on SSS onto the position observed on the MBES data which has better positional accuracy. Water column turbidity was high during acquisition, which has affected the maximum range of the high frequency component of the data, however, full coverage has still been achieved.

3.2 Sidescan sonar

3.2.1 Data processing

Side Scan Sonar data were processed by *CM-Geomatics Ltd* using SeaView 3.7.108.

SSS data were acquired in simultaneous dual-frequency mode. Raw SSS data files in JSF format were loaded into SeaView. The data heading source is usually taken from the towfish heading sensor, but Course Made Good (CMG) 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 utilized 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 frequency and high frequency data at the required resolutions.

3.2.2 Data interpretation

Contacts over 0.5 m 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 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.

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.

3.2.3 Data quality

SSS data were generally of good quality across the site. Errors in layback positioning have been observed due to strong local currents in the area causing discrepancies in heading. This has been mitigated to an extent by moving observed targets on SSS onto the position observed on the MBES data which has better positional accuracy. Water column turbidity was high during acquisition, which has affected the maximum range of the high frequency component of the data, however full coverage has still been achieved.

3.3 Sub bottom profiler

3.3.1 Data processing

SBP data was processed by *CM-Geomatics Ltd using* RadExPro 2021.4. IHS Kingdom 2020 was used to interpret all processed SBP data.

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)
- Zero offset de-multiple*
- Swell filtering (if required)
- Amplitude correction
- Top mute
- Trace-by-trace tidal reduction
- Populate textual header

* De-multiple 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 simultaneously carried out on data with and without this process 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 the 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 were corrected to CD +5 m, for processing purposes, to ensure all times were positive in the data. This 5 m offset was removed from interpretation deliverables so that interpretation is presented relative to the required CD level.

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

3.3.2 Data interpretation

Analysis of SBP data, along with relevant data (previous geological data, MBES and MAG grids etc.) were undertaken to build an integrated interpretative model for the site. Boreholes previously drilled in 1965 were used as a basis for interpretation. MB5, drilled in 1965, intersects the edge of the survey area and lies close to an acquired seismic profile and was used to directly compare the seismic data to observed sediment levels.

Interpretation in IHS Kingdom identified and digitised regional horizons, as well as any localised geohazards. A seismic velocity of 1,650 m/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, interpretation was gridded, and deliverables were exported from IHS Kingdom. Gridding has been undertaken at 5 m resolution and includes 20 m blanking distance to allow interpretation to tie across lines.

3.3.3 Data quality

Data quality for SBP was generally good. Some issues with background noise, source receiver geometry and swell/wave conditions were observed in 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.

The data has been adversely affected by the widespread presence of a bright reflector (interpreted as an organic sediment layer) causing acoustic attenuation and therefore limiting penetration into the subsurface across the western side of the survey area.

3.4 Magnetometer

3.4.1 Data processing

All acquired MAG data was processed and interpreted by *CM-Geomatics* Ltd using Oasis Montaj 2021.2.

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. Where the filtering has been ineffective, manual edits to the background field were implemented. 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 quality controlled to ensure that targets in profile were similar in shape and amplitude to the target present in the total field. Once the residual field passed QC, an unsmoothed analytic signal grid was produced.

3.4.2 Interpretation

Targets were picked manually on profile data to identify all targets ≥ 5 nT that showed wavelengths that might be expected of anthropogenic sources to exclude any geological signals. During rationalisation adjacent targets were checked to see if it was likely that they were derived from the same source and reconciled where necessary. Full parameters were populated for the final Target Listing. Two target lists have been produced, one with primary targets, and one with profile targets that have been reconciled to a primary target. Deliverables were exported directly from Oasis Montaj, with some grid formatting being exported from Global Mapper.

3.4.3 Data quality

Magnetic data quality was variable. Due to the confined nature of the site with ferrous infrastructure and vessel activity, significant noise of the acquired magnetic data were observed. Due to the constraints on vessel turning close to the piers, the magnetometer was towed at a high altitude which further reduced the sensitivity of the dataset. However, the dataset was useable for broad interpretation of large ferrous targets. It should be noted that UXO targets are unlikely to be reliably detected in this dataset.

4 Results

The bathymetry data was processed and reported by ABPmer.

4.1 Bathymetry

4.1.1 Bathymetry overview

An overview of the bathymetry data acquired is shown in Figure 3. Full data coverage was acquired across the site and up to the 2 m above CD contour, apart from inshore of the Eastern Jetty, where shallow water depths and lack of space for vessel manoeuvrability prevented the safe acquisition of data.

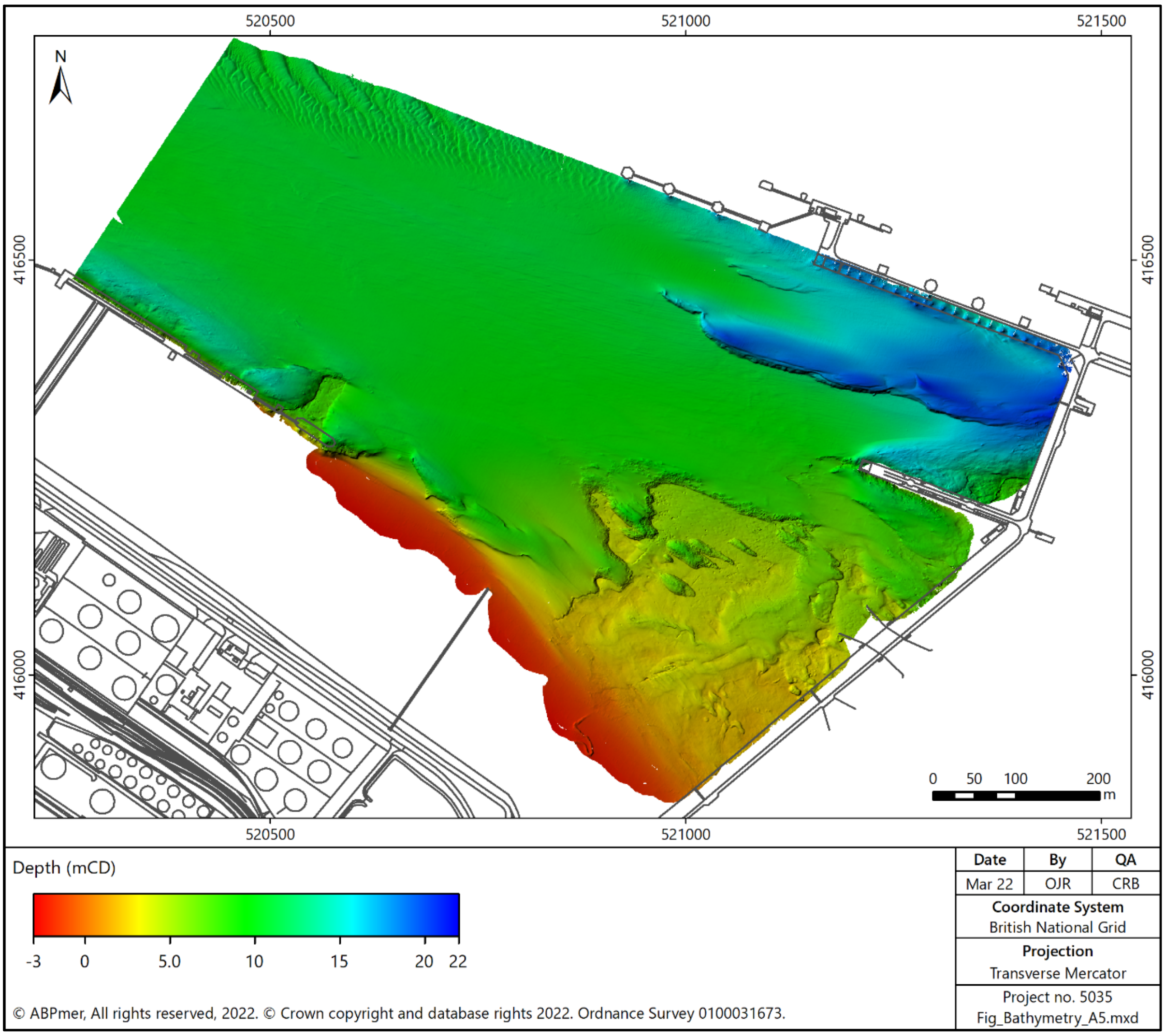


Figure 3. Bathymetry overview across the survey site

The bathymetry across the site shows that water depths range from 3.0 m above CD (intertidal area at southeast of site) to 21.0 m below CD at the northeast of the site. The site is dominated by a flat seabed of depth 9-11 m below CD at the west and centre of the survey area. At the very northwest of the site, megaripples of height 0.9-1.5 m, with an approximate wavelength of 50 m, were observed. Ripples were observed in the same location of height 0.4 m, with a wavelength of 10 m.

Immediately alongside, the eastern jetty, water depths are observed to reach 14.5 m below CD within the berth pockets, with a feature that shoals up to 7.5 m below CD alongside the eastern extent of the Eastern Jetty. Small items of debris are evident within the berth pocket. The intertidal area surveyed southeast of the eastern jetty is observed to be gently sloping inshore from 0 m CD. The shallowest depth achieved across the site was 3.0 m above CD. The south-eastern corner of the site is observed to be undulating with depths ranging from 3.0 m below CD on the uninterrupted surface down to 8.0 m below CD in distinct seabed holes. Within this same area there are small boulders and items of debris evident in the dataset. At the very northeast of the survey area (south of the main Immingham Oil Terminal jetty and north of the 'finger jetty'), the seabed is observed to decrease rapidly from 11.0 m to 20.0 m below CD. Immediately north of the 'finger jetty; water depths are observed to be 16 m below CD within the berth pocket.

4.1.2 Bathymetry combined with LiDAR

For ongoing calculations to be made for future dredge operations, the bathymetry has been combined with the latest available LiDAR data from the Environment Agency. The LiDAR data, acquired in 2019, provides required seabed information further up the intertidal zone and inshore of the Eastern Jetty, where the vessel was unable to access. An overview of the bathymetry data combined with the Environment Agency LiDAR is shown in Figure 4.

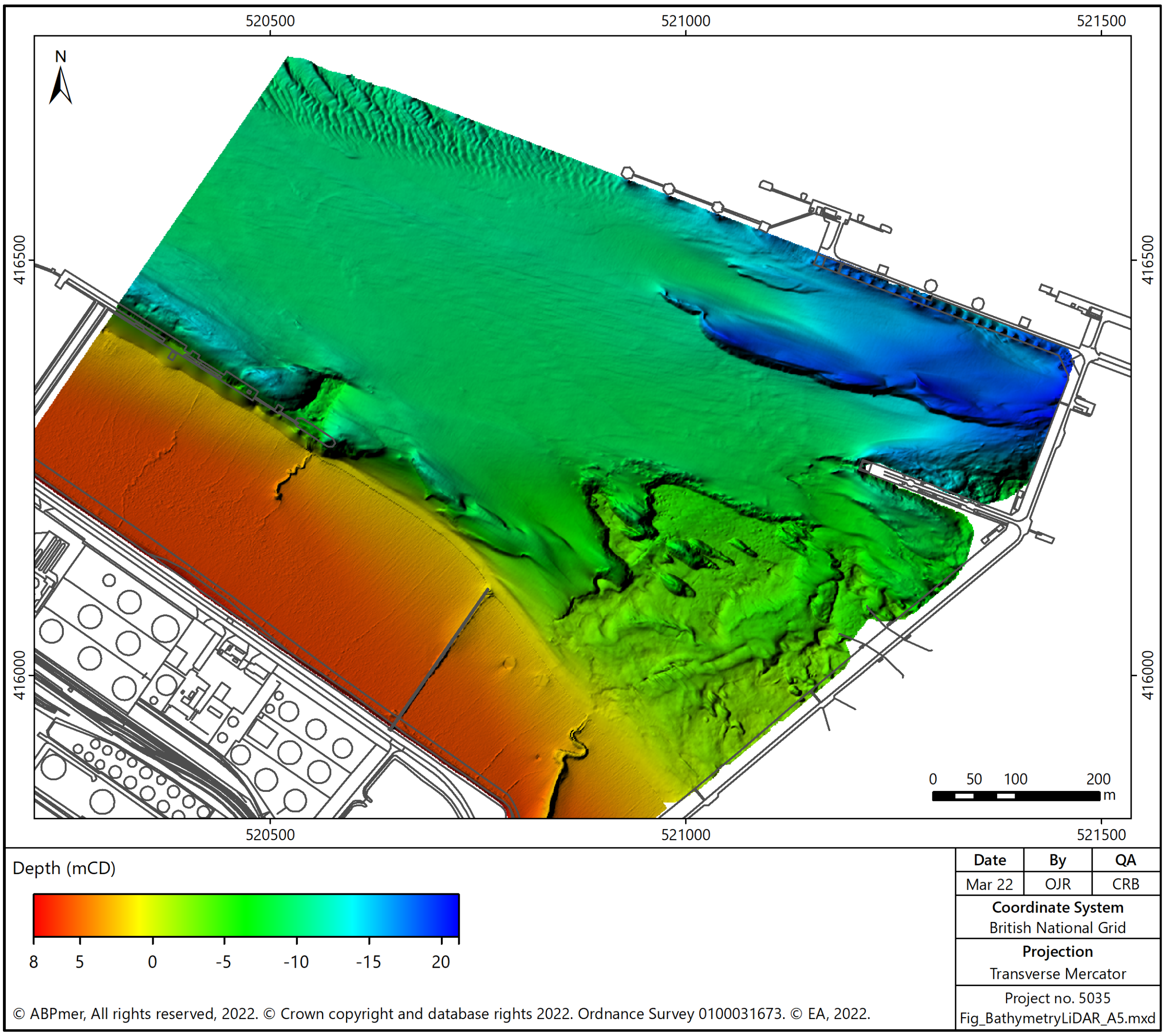


Figure 4. Bathymetry combined with the Environment Agency LiDAR dataset

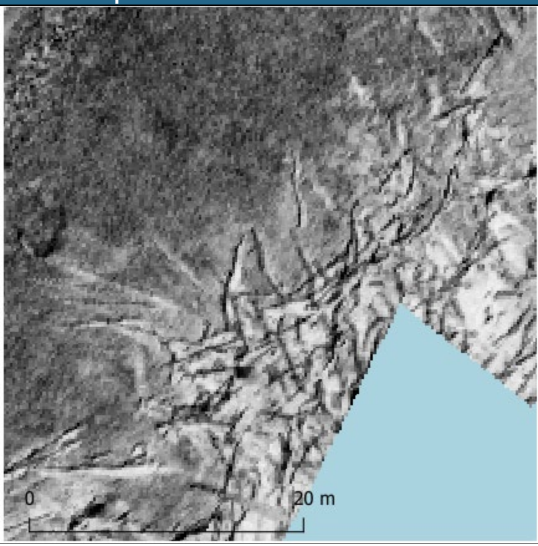
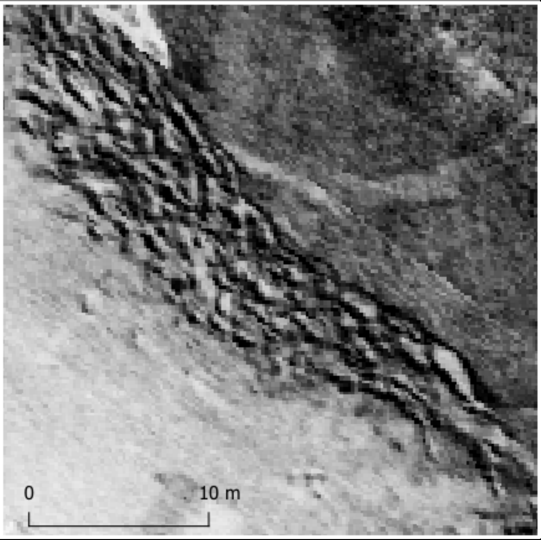
4.2 Seabed conditions

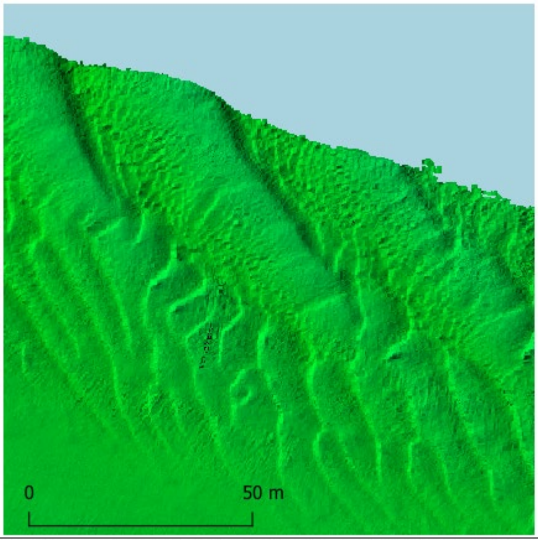
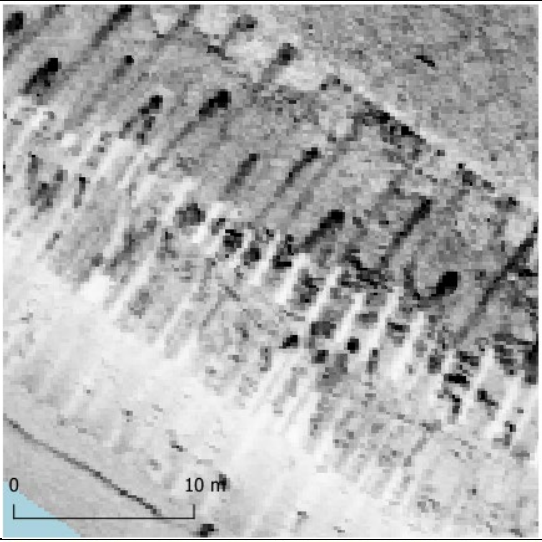
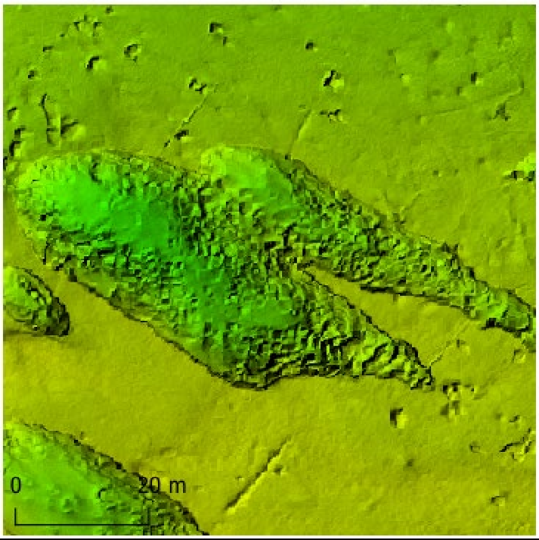
The interpretation and reporting of the seabed conditions has been conducted by *CM-Geomatics Ltd*.

4.2.1 Seabed morphology

Interpretation of seabed features has been made from low frequency SSS data and the bathymetry data. Interpreted features are summarised in Table 3 with corresponding data examples. Figure 5 shows the spatial distribution of each of the interpreted morphologies across the survey area.

Table 3. Summary of interpreted seabed morphology

Data Example	Description
	Debris Field
	Slumped Sediments

Data Example	Description
	Mobile Sediments (mega ripples)
	Infrastructure and Jetty Pilings
	Surface Depressions (previously interpreted as Dredge Pits) (ABPmer interpret these pits to likely be natural depressions or scour in the underlying surface. There is no information to suggest that any dredging has taken place here)

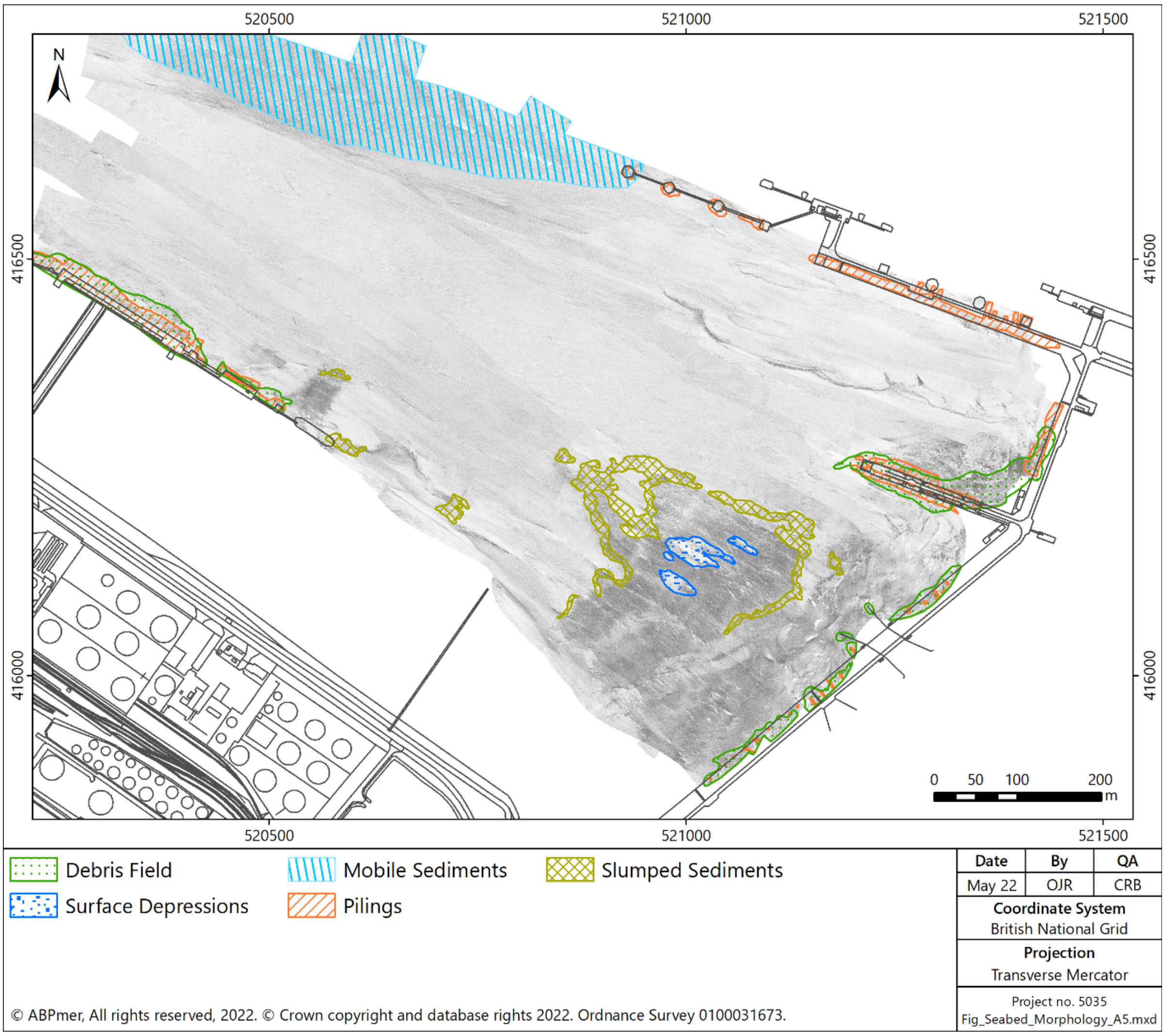
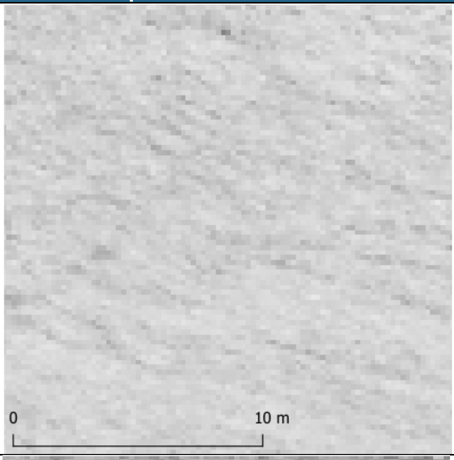
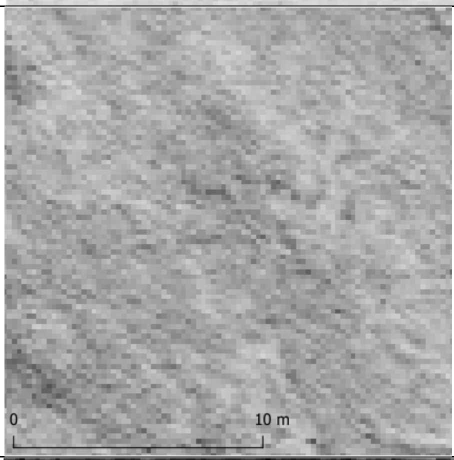
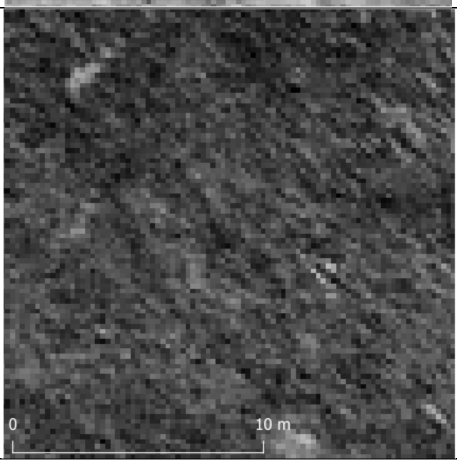


Figure 5. Distribution of seabed morphology across the site

4.2.2 Seabed sediments

Seabed sediments have been interpreted from low-frequency SSS data and the bathymetry grid. Table 4 shows a summary of the sediment classifications interpreted with data examples of each type.

Table 4. Summary of interpreted seabed sediment classifications

Data Example	Description	Morphology Classification
	Medium to low reflectivity sediment MUD/SILT	MUD/SILT
	Medium reflectivity sediment	Muddy SAND
	High reflectivity sediment	Firm CLAY

The surficial geology is primarily covered by a veneer of soft MUD and SILT. The surface morphology of this soft, muddy unit is mostly featureless, with little to no bedload sediment mobility observed. To the north of the site, a band of muddy sand has been interpreted that displays signs of bedload mobility in the form of megaripples.

Exposures of a firm CLAY layer are observed in the southeast of the site, represented by high reflectivity in the SSS data, and generally forming elevated exposures above the surrounding seabed observable on the bathymetry data. The texture of this clay unit appears slightly rougher than the softer mud deposits, with large sediment blocks visible in the bathymetry. Areas of slumping within the interpreted clay have been noted at the margins of the exposure. These areas are likely where the strength of the clay has weakened and slumped down the margins.

Figure 6. Low frequency SSS mosaic of the site

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 0. The location and surface classification of these boreholes are presented in Figure 7, along with the interpreted 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 sediment displacement at the location of the piles. This, coupled with the age of the data means the results may not completely reflect the current seabed state, however, they still remain indicative of the surficial sediments observed.

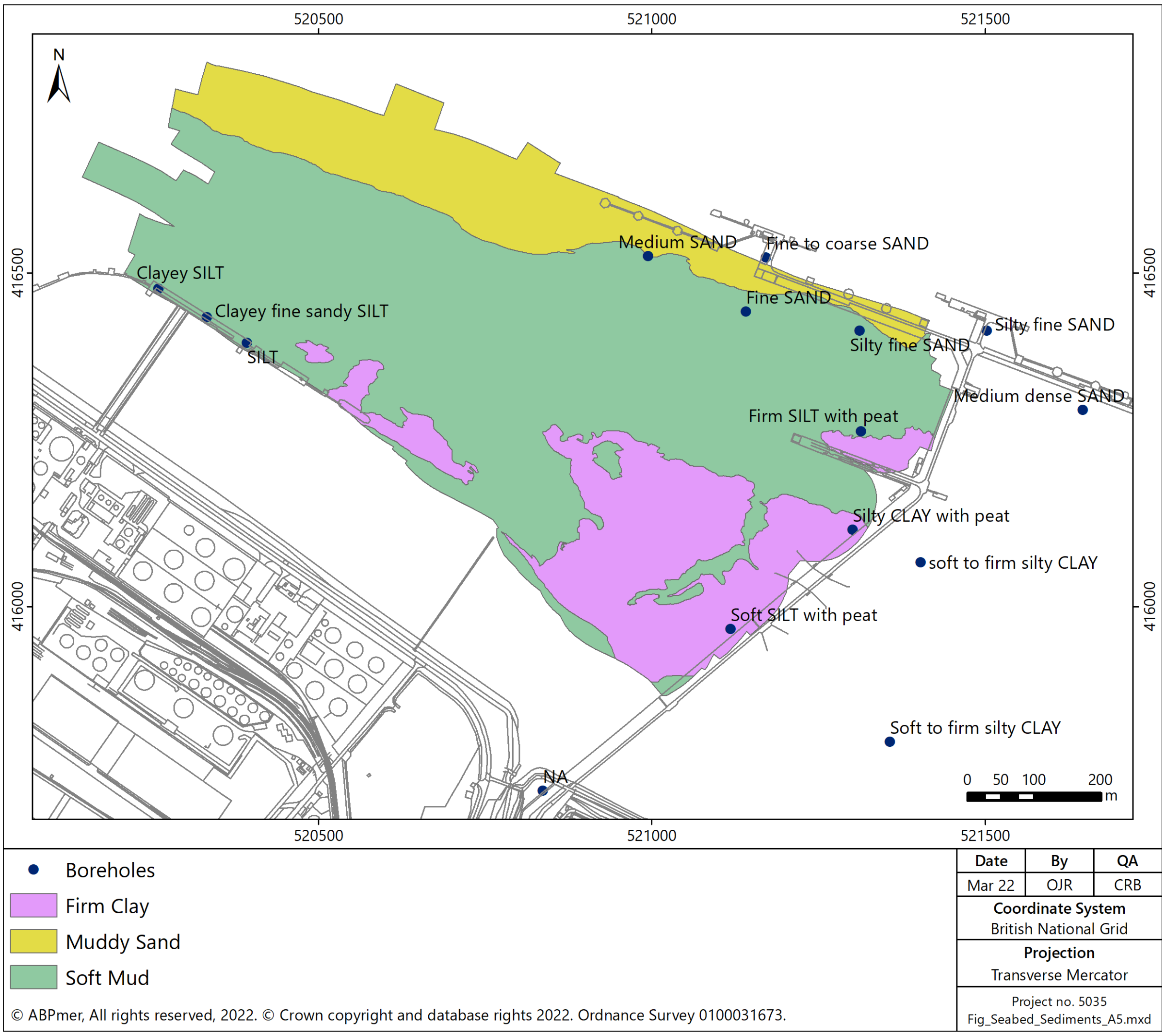


Figure 7. Spatial extent of interpreted sediments with previous borehole locations

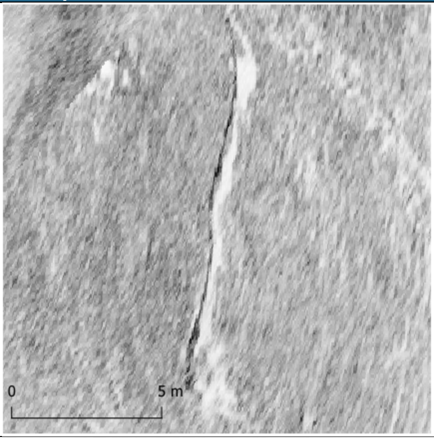
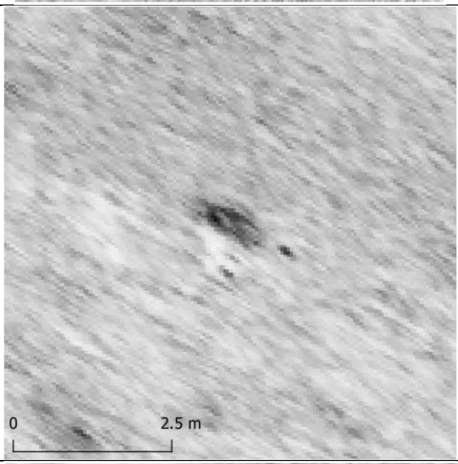
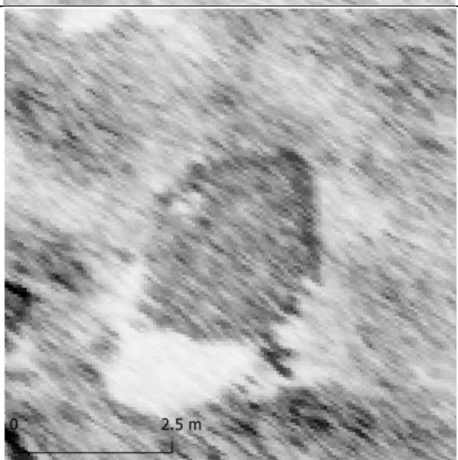
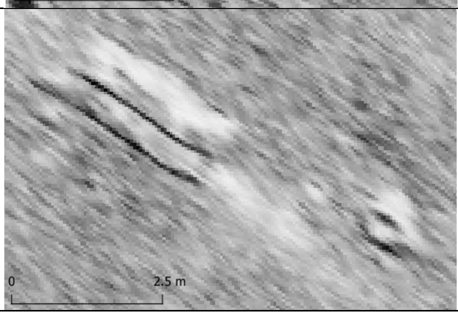
4.2.3 Contacts

In total 880 seafloor contacts have been identified on 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 16 contacts were correlated between seafloor and magnetic datasets.

A number of seafloor contacts have been identified as “Sediment Blocks”. These targets appear as large (generally >1.5 m in any dimension), sub angular objects at the seabed or partially buried within the seabed. These objects appear too large to be boulders that might be expected in this area and do not show strong diffractions in SBP data that boulders of this size would warrant. It is interpreted that these features may be blocks of more cohesive clays that are included within the exposed sediments.

There are also areas of numerous items of debris on the seabed, around and beneath the edges of the pier. Table 5 shows a summary of the interpreted seafloor contacts seen in the SSS dataset.

Table 5. Examples of interpreted seafloor contact classifications

<table>
<tr><th>Data Example</th><th>Contact Description</th></tr>
<tr><td>
</td><td>Cable / Rope</td></tr>
<tr><td>
</td><td>Boulder</td></tr>
<tr><td>
</td><td>Sediment Blocks</td></tr>
<tr><td>
</td><td>Debris
Ladder (left) and Tyre (right)</td></tr>
</table>

In total 142 magnetic contacts have been identified that are > 5 nT in amplitude. The targets identified in this dataset are indicative of large ferromagnetic targets. The targets were reconciled from profile picks and adjacent picks that could possibly be from the same ferrous source were grouped, but the original targets were kept as "reconciled" targets. Hence a primary list of magnetic targets containing 106 targets was generated from the 142 individual picks.

Some complex targets with lower amplitude and long wavelength may be associated with underlying geological changes in soil composition and would require further high-resolution survey to discriminate. Comments on such targets are presented within the magnetic contacts target list.

A higher resolution magnetic survey would be required to further discriminate targets. The processed magnetic total field is presented in Figure 8, note the scale has been clipped to ±10 nT and values above these have been clamped to the colour scale on the image presented for display purposes. The data show that the area is magnetically noisy and that targets have occasionally been detected on multiple lines, hence requiring reconciliation.

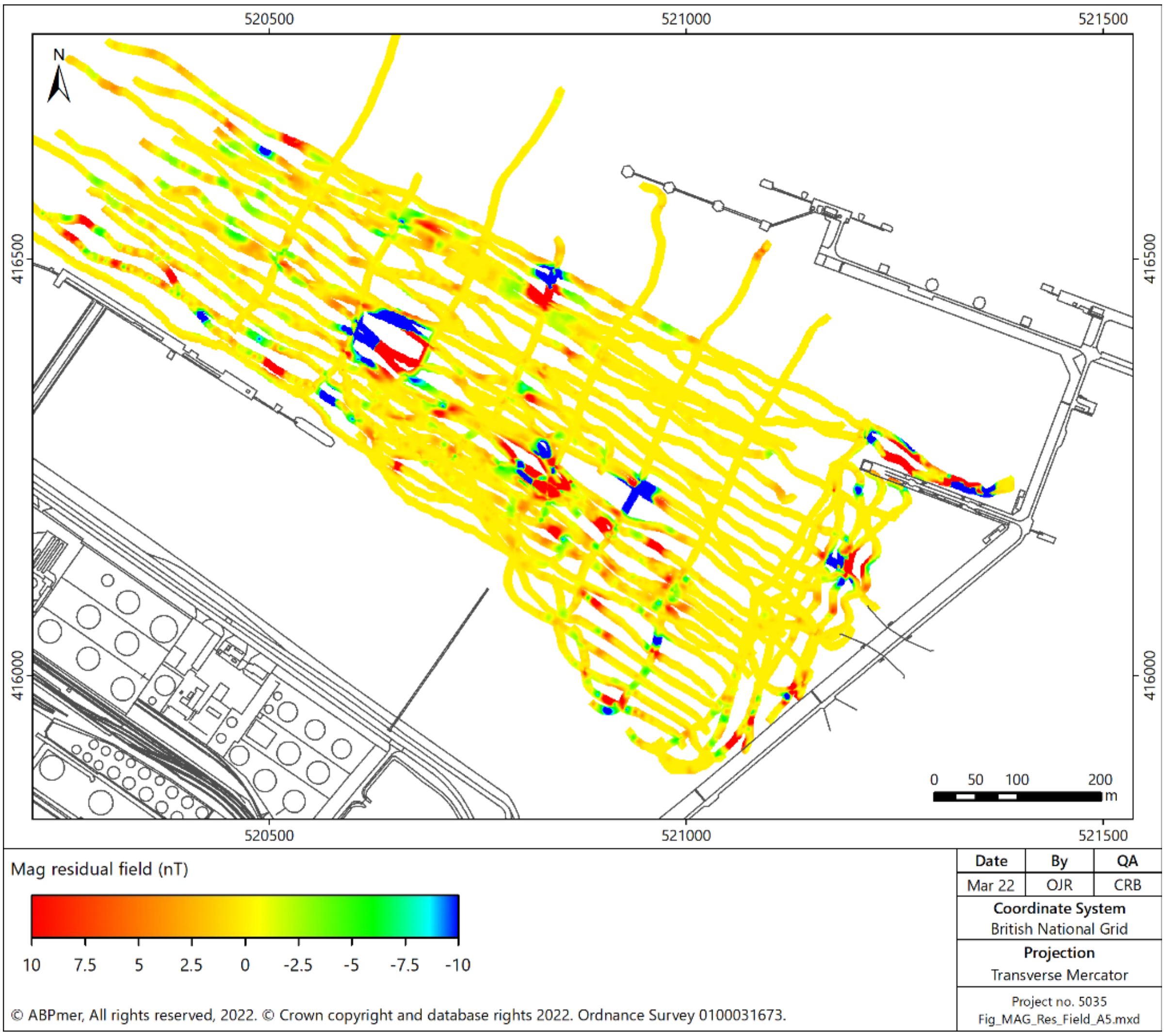


Figure 8. Magnetic residual field grid (nT)

A total of 71 magnetic targets have been correlated with 60 seafloor targets. The difference in target correlation between datasets is due to some targets possessing one or more possible correlations that cannot be differentiated with the current dataset. Only approximate correlations were possible due to the flying altitude of the magnetometer and line spacing during acquisition. Correlations were made on an individual assessment based on target proximity, size, and magnetometer altitude. Correlations that have been made between magnetic targets and seafloor contacts identified as "boulder" or "sediment block" have been retained, however, the confidence in the correlation of these targets is reduced as these targets are not generally expected to exhibit magnetism.

Figure 9 presents the interpreted seafloor and magnetic contacts. Primary and reconciled targets have been separated in the legend key to show all targets and where they have been reconciled. The high density of targets in the southeast are primarily comprised of debris items and interpreted sediment blocks with occasional boulders.

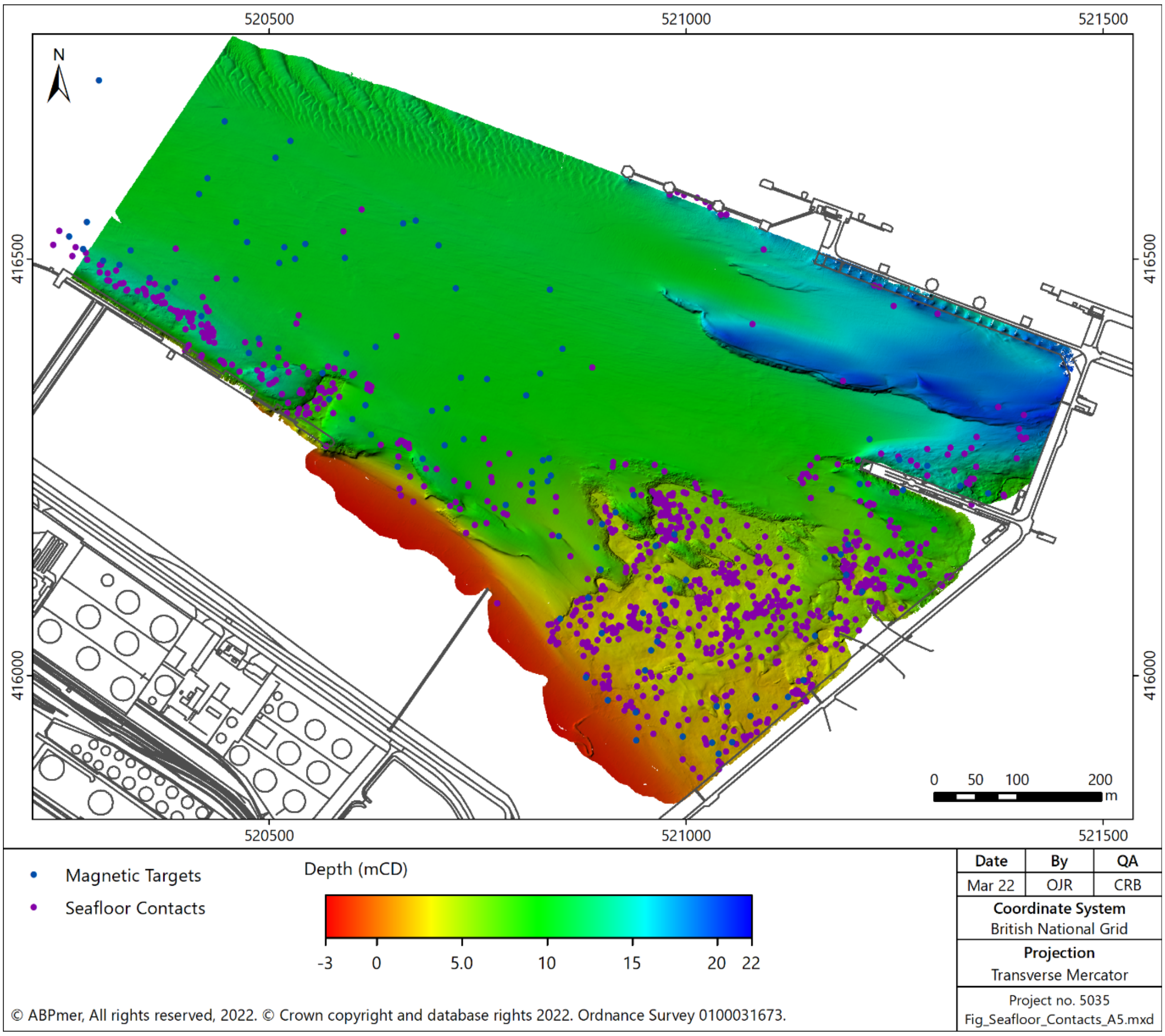


Figure 9. Seafloor contacts and magnetic contacts across the survey area

4.3 Sub-surface conditions

The sub-surface conditions have been interpreted and reported by *CM-Geomatics Ltd*. It should be noted that aspects of the interpretation should be used with caution until a geotechnical campaign across the site provides borehole data to confirm, or provide evidence against, the results.

A bright reflector was identified at the near surface (0 – 2.1 m BSB) which was initially interpreted by *CM-Geomatics Ltd* as a layer of peat. The interpretation of peat, as the horizon responsible for severe acoustic attenuation of the seismic data was made by analysis of the reflector signature and some of the nearby historical borehole logs. The seismic signal of the peat reflection has the characteristic phase reversal that is expected of a transition of a low density medium typical of organic layers.

However, from knowledge of the area and from a geomorphological point of view, it was suggested that the peat layer was unlikely to be as widespread as the initial interpretation suggested. The historical borehole information identified the presence of a thin layer of peat and organic material at the very east of the site so there can be high confidence that organic material with peat-like properties exists in the eastern extent of the site. However, the peat layer was interpreted as being at a relatively constant depth below the seabed across the site (0 – 2.1 m BSB), but the bathymetry across the interpreted peat area varies from 1.5 m below CD in the very southeast to 11 m below CD in the northwest of the site. The initial interpretation therefore suggested that the morphology of the layer of peat was reasonably consistent with the bathymetry, which seemed unlikely. Furthermore, peat was identified at the location across the Eastern jetty berth pocket at a consistent level below the seabed as outside of the berth pocket. As this area has been subject to dredging, the interpretation results seemed unlikely.

To further inform the interpretation, core logs from the vibrocore contamination sampling campaign (October 2021) were made available (see Section 4.3.1). This suggested any presence of peat may not be conclusive or widespread. *CM-Geomatics Ltd* therefore considered the layer previously interpreted as peat, to be an "organic sediment horizon".

Once further geotechnical information is available from a future borehole campaign, the geophysical dataset will be reinterpreted using the additional information.

Section 4.3.1 below provides details of the vibrocores campaign conducted in 2021. Sections 4.3.2 to 4.3.3 are the interpretation results and discussion conducted by *CM-Geomatics Ltd*.

4.3.1 Vibrocore data

In October 2021, a vibrocore sampling campaign was conducted to achieve sediment samples at depth for contamination analysis. Vibrocore sampling was conducted at a total of 10 locations, as shown in Figure 10.

Samples were acquired from the retrieved core at 1 metre intervals, down to the maximum penetration. The samples were then analysed in an MMO approved laboratory for multiple contamination parameters. Upon vibrocore retrieval, the sampling contractor provided a core description. Table 6 provides a summary of the core descriptions, with the vibrocore logs included as Appendix A.

Three of the cores make reference to organic material, one of which is described as 'peaty in appearance'. These three cores are VC04, VC07 and VC10, which are all located at the southeast of the site in the area of shallower undulating seabed. *CM-Geomatics Ltd* reviewed these logs and concluded that the presence of peat may not be as conclusive and widespread as initially interpreted. It was therefore suggested that the initial interpretation of 'peat' should be considered as 'alluvium containing organic sediment'.

Sections 4.3.2 to 4.3.3 are the interpretation results and discussion conducted by *CM-Geomatics Ltd.* In accordance with the above, 'organic sediment' is referred to instead of the initial interpretation of peat.

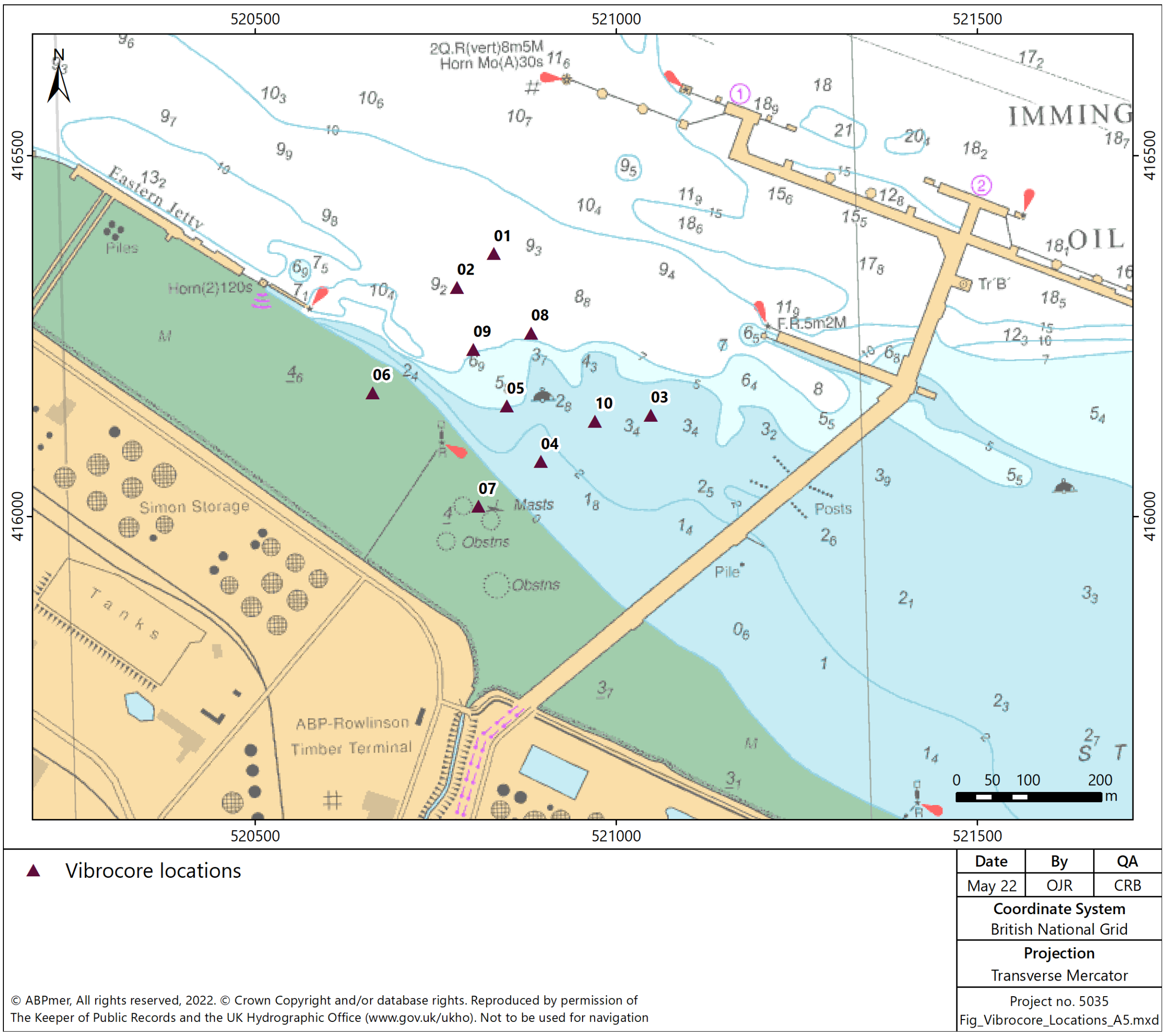


Figure 10. Locations of vibrocore data collected in October 2021

Table 6. Vibrocore core descriptions

Sample ID	Location (OSGB36)	Core Depth	Sample description
2021-807 VC01	520830.6 E 416363.0 N	0.0 m	Soft, black, muddy silt.
		1.0 m	Soft, black, muddy silt, slightly sandy.
		2.0 m	Soft to firm, black, muddy silt, slightly sandy.
		3.0 m	Firm, black, muddy silt, becoming very sandy.
		3.5 m – 4.7 m	Firm/dense, black, silty fine SAND.
2021-807 VC02	520779.9 E 416316.9 N	0.0 m	Soft, black, muddy silt.
		1.0 m	Soft, black, muddy silt.
		2.0 m	Soft to medium firm, brown/black, muddy silt, slightly clayey.

Sample ID	Location (OSGB36)	Core Depth	Sample description
		3.0 m	Firm brown/black, clayey, muddy silt, becoming slightly sandy.
		3.5 m – 3.8 m	Firm/dense, black, silty fine SAND.
2021-807 VC03	521048.1 E 416140.5 N	0.0 m – 0.5 m	Soft, brown/black, muddy silt.
		0.5 m – 1.5 m	Firm/dense, brown, very clayey, fine SAND.
		1.5 m – 3.15 m	Firm to medium firm, silty sandy (fine) CLAY.
2021-807 VC04	520896.2 E 416076.2	0.0 m – 0.5 m	Very soft, grey/black, muddy SILT.
		0.5 m – 1.5 m	Soft to firm, Black, muddy SILT with increasing amounts of black, organic material, peaty in appearance.
		1.5 m – 2.5 m	Dense, brown, silty fine sandy GRAVEL. Gravel is fine to medium.
		2.5 m – 2.7 m	Firm to stiff, grey/brown/white, slightly gravelly CLAY. Gravel is fine, predominantly of chalk.
2021-807 VC05a	520849.0 E 416152.9 N	0.0 m – 2.5 m	Very soft, grey/black, muddy SILT.
			At 2.0 m - becoming slightly sandy (fine), slightly gravelly (fine).
		2.5 m – 4.7 m	Firm brown, slightly sandy (fine) CLAY.
			At 3.2 m – becoming more sandy.
			At 4.0 m – becoming firm to stiff, brown, slightly gravelly CLAY. Gravel is fine, predominantly of broken weathered chalk.
2021-807 VC06	520663.1 E 416171.1 N	0.0 m – 3.5 m	Very soft, grey/brown, muddy SILT.
			At 1.0 m – becoming soft.
			At 2.0 m – becoming soft to firm.
			At 3.0 m – becoming slightly sandy (fine).
		3.5 m – 4.1 m	Dense grey/green, slightly silty, slightly gravelly, fine SAND. Gravel is fine to medium.
2021-807 VC07	520809.3 E 416014.2 N	0.0 m – 2.5 m	Very soft to soft, brown, muddy SILT.
		2.5 m – 4.8 m	Soft to firm, black/brown, clayey SILT, with organic material (possibly grass reeds etc).
2021-807 VC08	520882.49 E 416254.1 N	0.0 – 0.5 m	Very soft to soft, brown, muddy SILT.
		0.5 m – 1.5 m	Soft, black/brown, slightly sandy, muddy SILT.
		1.5 m – 3.65 m	Firm/dense, brown, clayey, fine SAND.
			At 3.0 m – becoming very clayey, fine SAND.
2021-807 VC09	520802.3 E 416231.2 N	0.0 m – 1.5 m	Very soft to soft, brown, becoming dark brown, muddy SILT.
		1.5 m – 2.5 m	Soft, dark brown, slightly sandy (fine), muddy SILT.
		2.5 m – 3.5 m	Soft to firm, brown, very clayey SILT.
		3.5 m – 4.6 m	Firm to stiff, red/brown CLAY.
2021-807 VC10	520970.7 E 416132.0 N	0.0 m – 0.5 m	Sift to firm, grey, muddy SILT with considerable organic material (reed, grass etc).
		0.5 m – 2.4 m	Soft to firm, grey/black, becoming brown, fine sandy SILT.
			At 0.9 m – Piece of plywood whole diameter of core (10-15 mm thick) – possibly 'sterling board'.
			At 2.5 m – Becoming brown.

Sample ID	Location (OSGB36)	Core Depth	Sample description
		2.4 m – 2.65 m	Dense, grey/white, coarse sandy fine to medium GRAVEL.

4.3.2 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 the Humber Lake 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 at the riverbed.

The geological model has been built based from observations made in the boreholes acquired during three geotechnical campaigns. All sources of borehole information are listed in the references section in this document (Section 5). The three campaigns were commissioned in the mid-1960s through to 1980, and documents as below:

- I27 campaign in 1965 (BTDB, 1965a);
- I5 campaign in 1967 (GEL, 1967a and GEL, 1967b); and
- I19 campaign in 1980 (BTDB, 1980).

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

An example summary of the findings from MB7, from the I27 campaign, are presented in Table 7. This borehole lies adjacent to one of the acquired SBP cross lines (BX12). MB7 was reported in the site investigation report "I27 – Proposed Oil Jetties at Immingham, Lincolnshire" (BTDB, 1965b).

Table 7. Summary of results for borehole MB7

Depth Below Seabed (ft)	Depth Below Seabed (m)	Descriptions
0.0	0.0	Medium dense fine brown SAND with pockets of dark grey fine sandy clay and occasional gravel.
2.0	0.6	Medium dense fine to coarse GRAVEL.
8.0	2.4	Medium dense grey silty fine SAND.
17.0	5.2	Medium dense grey coarse SAND, numerous shell fragments and occasional gravel.
20.0	6.1	Stiff brown silty CLAY with occasional layers of silt.
32.3	9.8	Very stiff to hard grey silty CLAY with fine to medium gravel including chalk fragments (Boulder clay).
36.5	11.1	End of core.

Further detail on the spatial distribution of subsurface units can be derived from the borehole campaign undertaken in 1966 (BTBD, 1966). This involved four boreholes, three offshore and one onshore, which are located on the eastern edge of the proposed survey area. A summary of the findings of these boreholes can be found in Figure 11, along with an overview of the locations of all known geotechnical data relative to the survey site in Figure 12.

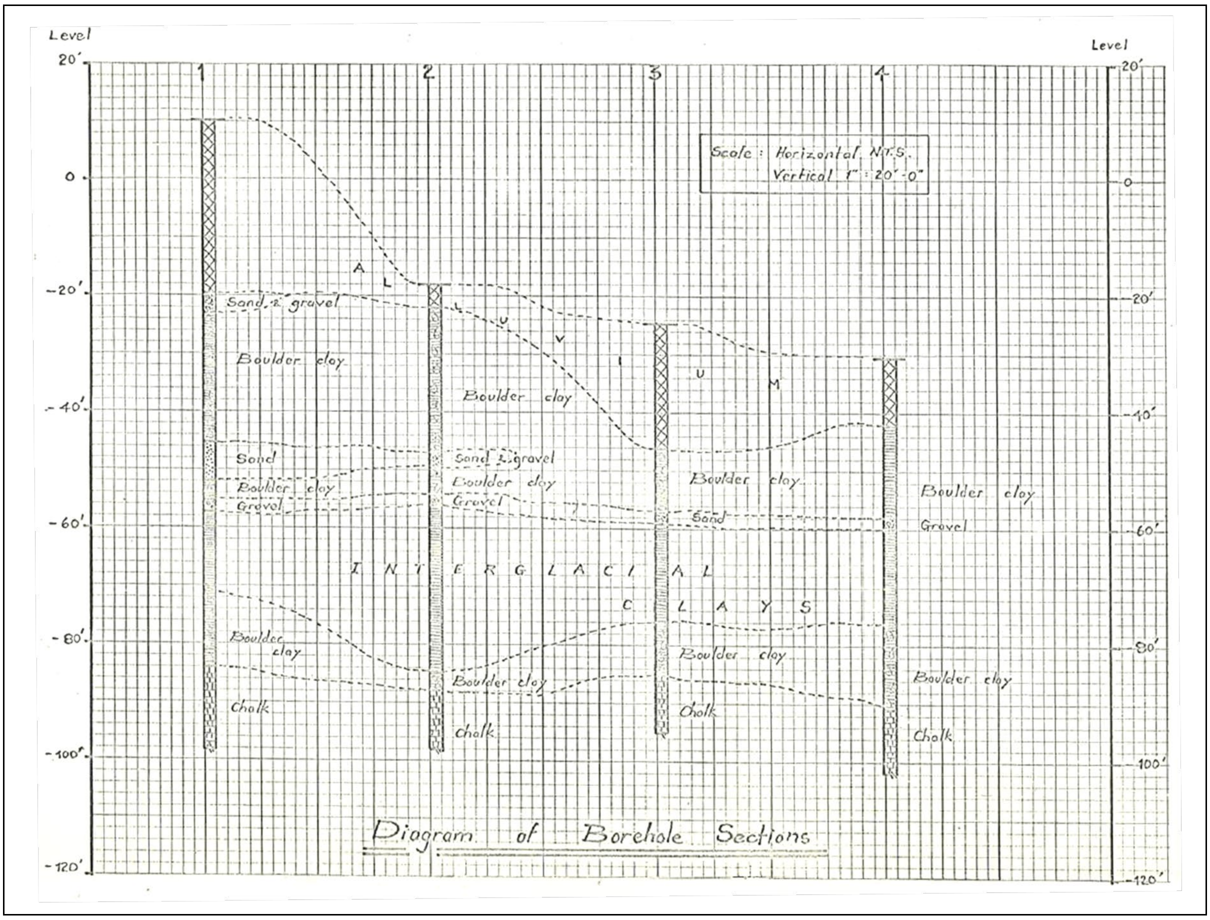


Figure 11. Diagram of borehole sections, I5 geotechnical campaign

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 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.

During acquisition of the boomer dataset, a bright reflector was noted in the near surface. It was tentatively identified as a layer of peat, but later interpreted as 'alluvium with organic sediment'. Some of the nearby boreholes have indicated the presence of organic material and peat. Nearby marshland on the south bank of the Humber, and areas of known peat on the northern bank (Sheppard, 1958), and further upriver in the Humber head levels give credence to the possibility of the presence of peat beds in the area.

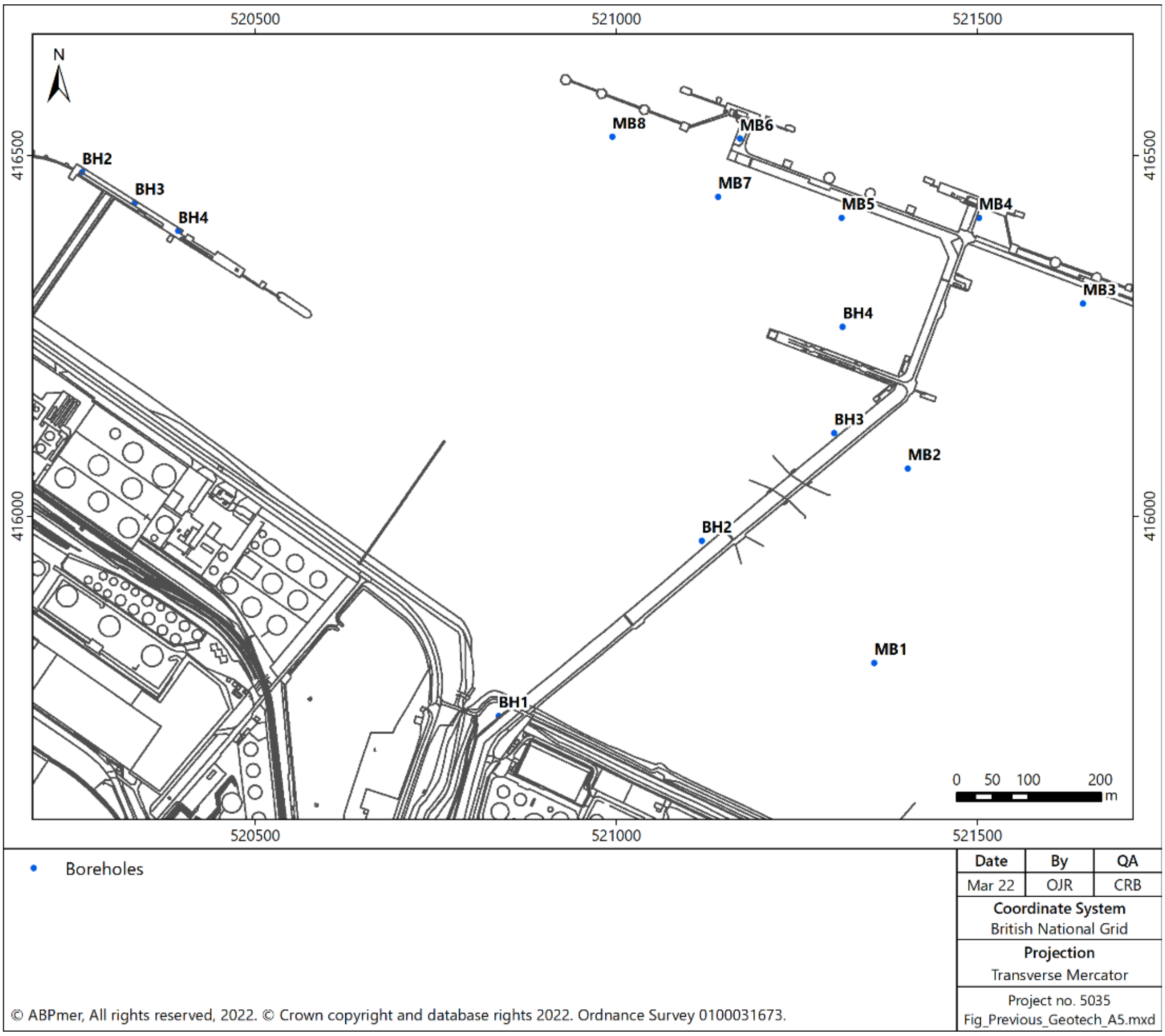


Figure 12. **Locations of previous geotechnical data collected**

4.3.3 Interpretation

Table 8 presents a summary of the interpretive geomodel used during the interpretation of this dataset. Example seismic sections showing interpretation over the seismic data are shown in Figure 15, Figure 16 and Figure 17 demonstrating examples of the data and interpreted horizons. Correlation with nearby boreholes has been undertaken. A selection of boreholes from all three campaigns have been used in this interpretation based on proximity to the seismic data acquired on this survey.

Some 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.

However, some borehole data has tied well with the seismic data. Figure 13 shows the correlation between a seismic line and borehole I5 BH4 that plots approximately 11 m northeast of the nearest point on the seismic data. The figure shows that the interpreted horizons and the expected depths in the borehole data correlate well between the two datasets at this location. The vertical line shows the borehole location with the labels indicating changes in the sediments identified on the borehole.

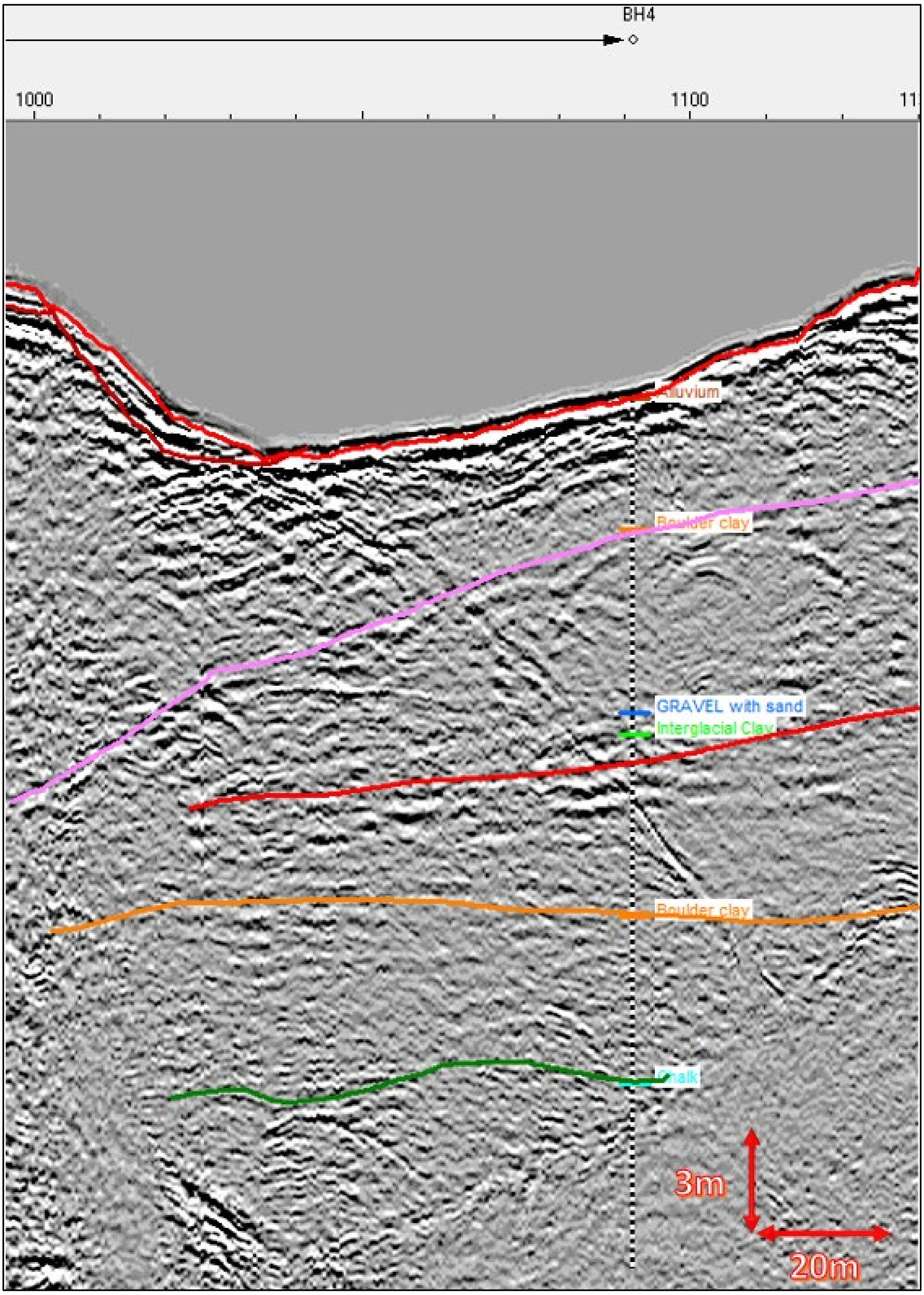
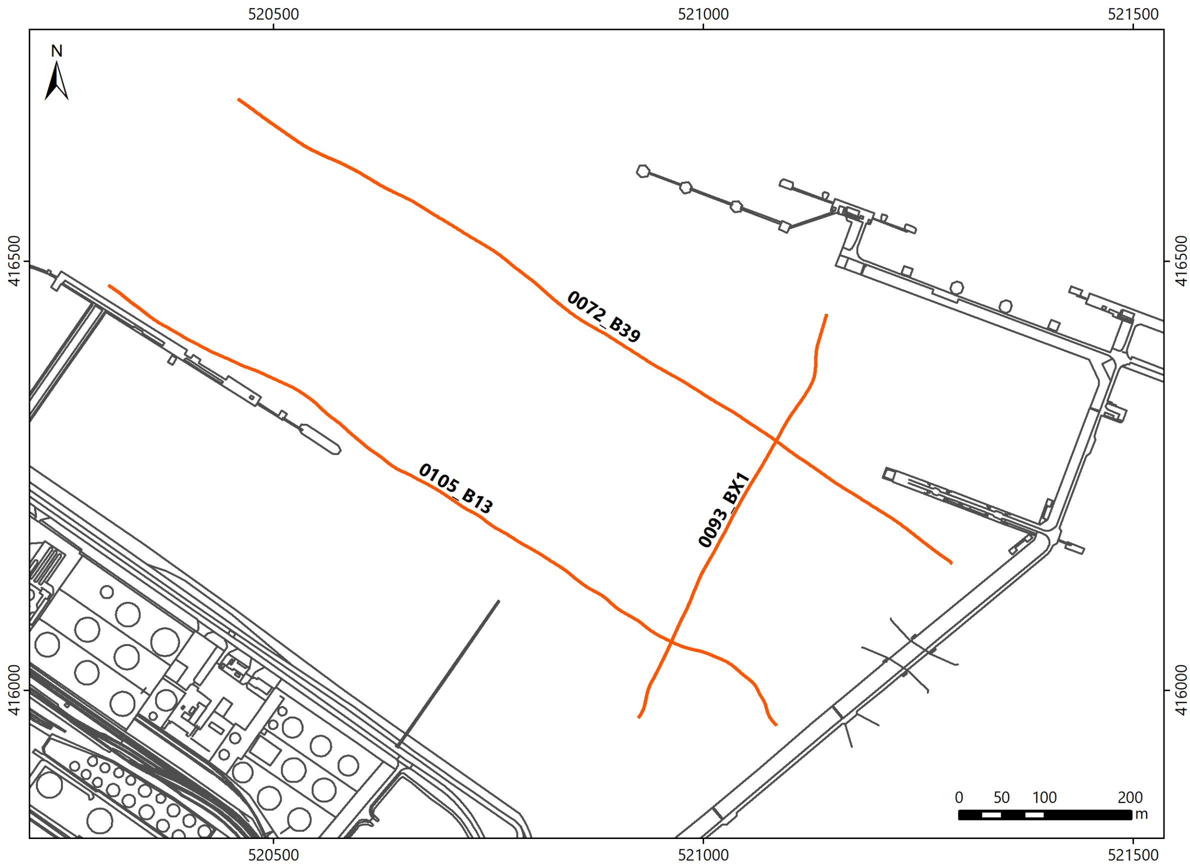


Figure 13. **Seismic data example (0080_B50) with borehole I5-BH4**

Table 8. Summary of interpretative geomodel

Unit	Horizon Top	Horizon Base	Depth to Top	Interpreted Composition	Seismic Description	Distribution	Depositional Setting
Alluvium Surficial Sediments	Seabed	H10	0.0-3.0 m BSB	SILT/CLAY, however, appears sandier towards the northwest	Low amplitude seabed reflection where this surficial horizon is present in thicknesses above veneer. Some weak laminations in thicker part of the unit.	Likely present as a veneer across the site, however thicker accumulations have been interpreted in depressions/topographical lows.	Fluvio-estuarine
Alluvium Organic Sediment	H20	Not defined	0.0-2.1 m BSB	Organic sediment accumulations	High amplitude, phase reversed, generally flat reflector. Highly attenuated acoustic data below this reflector. The base of this reflector is not clearly defined due to the nature of the thick, bright reflection but generally interpreted to be <1 m but might be higher in localized areas.	Widespread across the central part of the survey area. Thins and pinches out against an exposure of interpreted boulder clay. Not widely observed on the southern bank edge or the northern extents of the cross lines.	Fluvio-lacustrine
Alluvium Fluvial Sediments	Seabed H10 H20	H30 H40	0.0-9.1 m BSB	Various layers of SAND, GRAVEL, and CLAY	Numerous internal reflectors of varying amplitudes many of which are discontinuous. One internal horizon (H25) that appeared continuous has been interpreted that marks the top of a laminated thickness of sediments.	Widespread across the central part of the survey area where boulder clay is not near the surface. Possible that this unit is quite thick towards the west beneath the organic sediment.	Fluvial

Unit	Horizon Top	Horizon Base	Depth to Top	Interpreted Composition	Seismic Description	Distribution	Depositional Setting
Top of Upper Boulder Clay	H30	H20	0.0-21.1 m BSB	Stiff CLAY with occasional SAND/GRAVEL beds	Moderate amplitude, undulating reflector with a generally massive structure beneath with occasional internal reflectors.	Mostly present in the east of the survey area where organic sediment does not obscure the subsurface, however, moving west it is likely that this unit has been eroded into during the subsequent fluvial channelization.	Glacial
Top of Interglacial Clay	H40	H50	3.9-25.4 m BSB	SAND/GRAVEL	Moderate amplitude, slightly undulating reflector with a massive structure. Some weak parallel internal bedded is visible in places.	Mostly present in the east of the survey area where organic sediment does not obscure the subsurface, however, moving west it appears that this horizon dips to become significantly deeper but is largely unresolved beneath the organic sediment.	Glacio-lacustrine
Top of Lower Boulder Clay	H50	H60	8.7-37.4 m BSB	Very stiff CLAY	Weak undulating reflector with a massive structure.	Mostly present in the east of the survey area where organic sediment does not obscure the subsurface, however, breaks in the organic sediment have allowed limited interpretation. Horizon appears to dip towards the west.	Glacial
Bedrock	H60	NA	15.3-41.5 m BSB	CHALK	Moderate to weak undulating reflector with some weak parallel reflectors directly beneath.	Mostly present in the east of the survey area where organic sediment does not obscure the subsurface, however, breaks in the organic sediment have allowed limited interpretation. Horizon appears to dip towards the west.	Marine



Date	By	QA
Mar 22	OJR	CRB

Coordinate System
British National Grid

Projection
Transverse Mercator

Project no. 5035
Fig_Seismic_Data_Examples_A5

Figure 14. Boomer data examples – relevant survey line locations

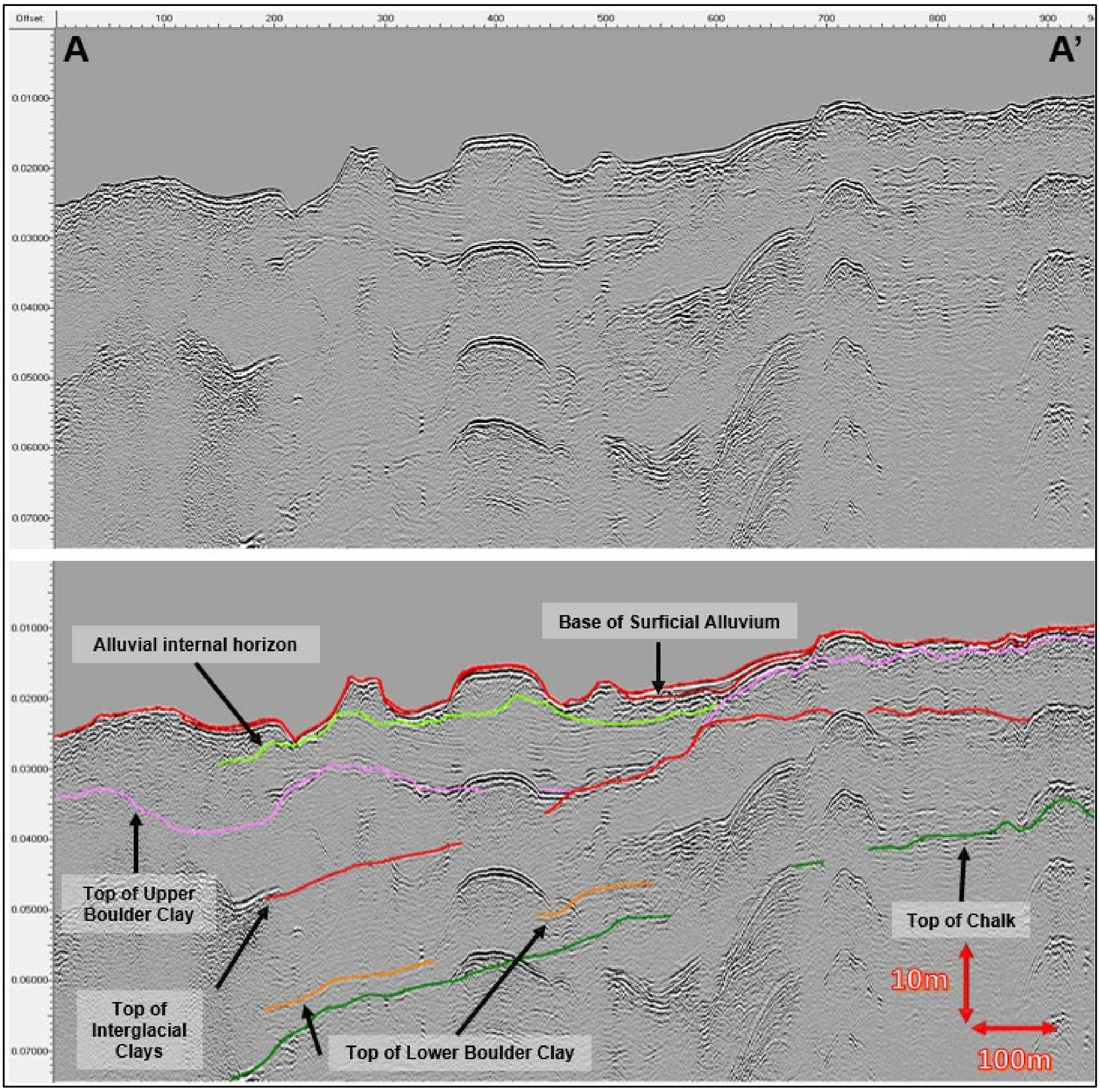


Figure 15. Boomer data example (0105_B13) with interpretation

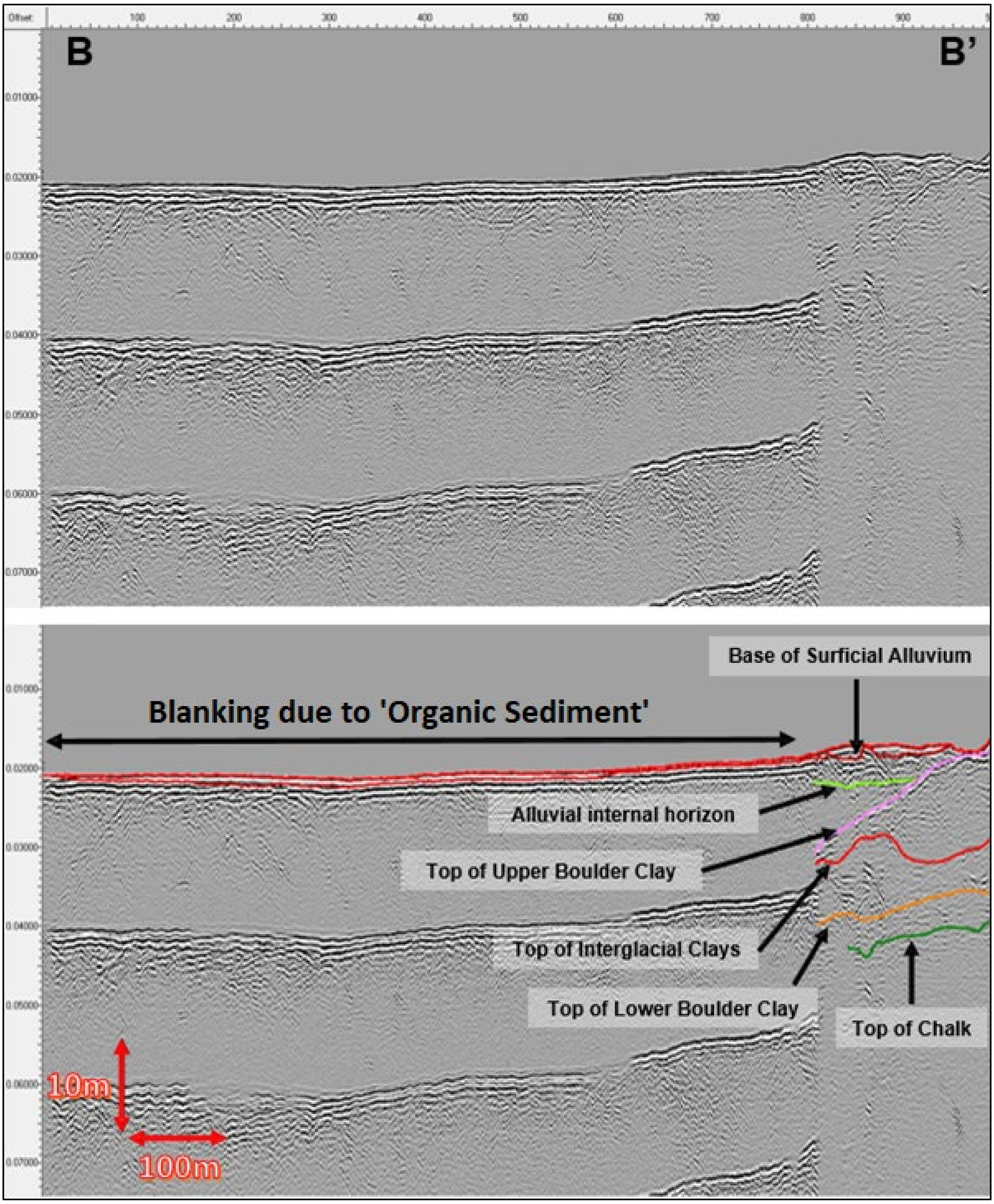


Figure 16. Boomer data example (0072_B39) with interpretation

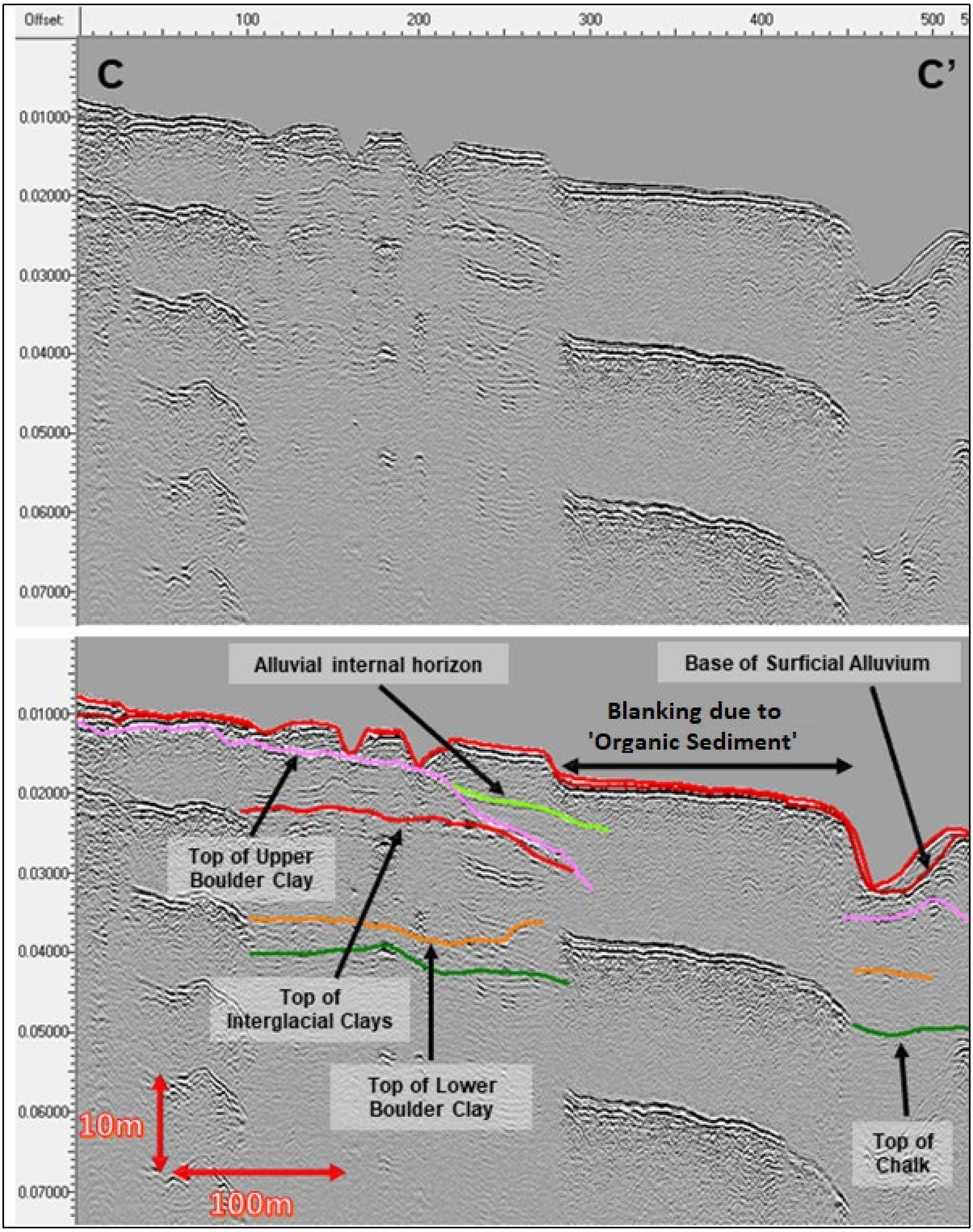


Figure 17. **Boomer data example (0093_BX12) with interpretation**

Alluvium – Surficial sediments

It is interpreted that soft SILT/MUD is present across most of the site. Where a thickness has not been interpreted it is likely that a veneer of this recent sediment may exist. Figure 18 shows the interpreted distribution of this unit as a depth below seabed grid. Increased thickness is associated with topological lows or features that function as a trap of fine sediments.

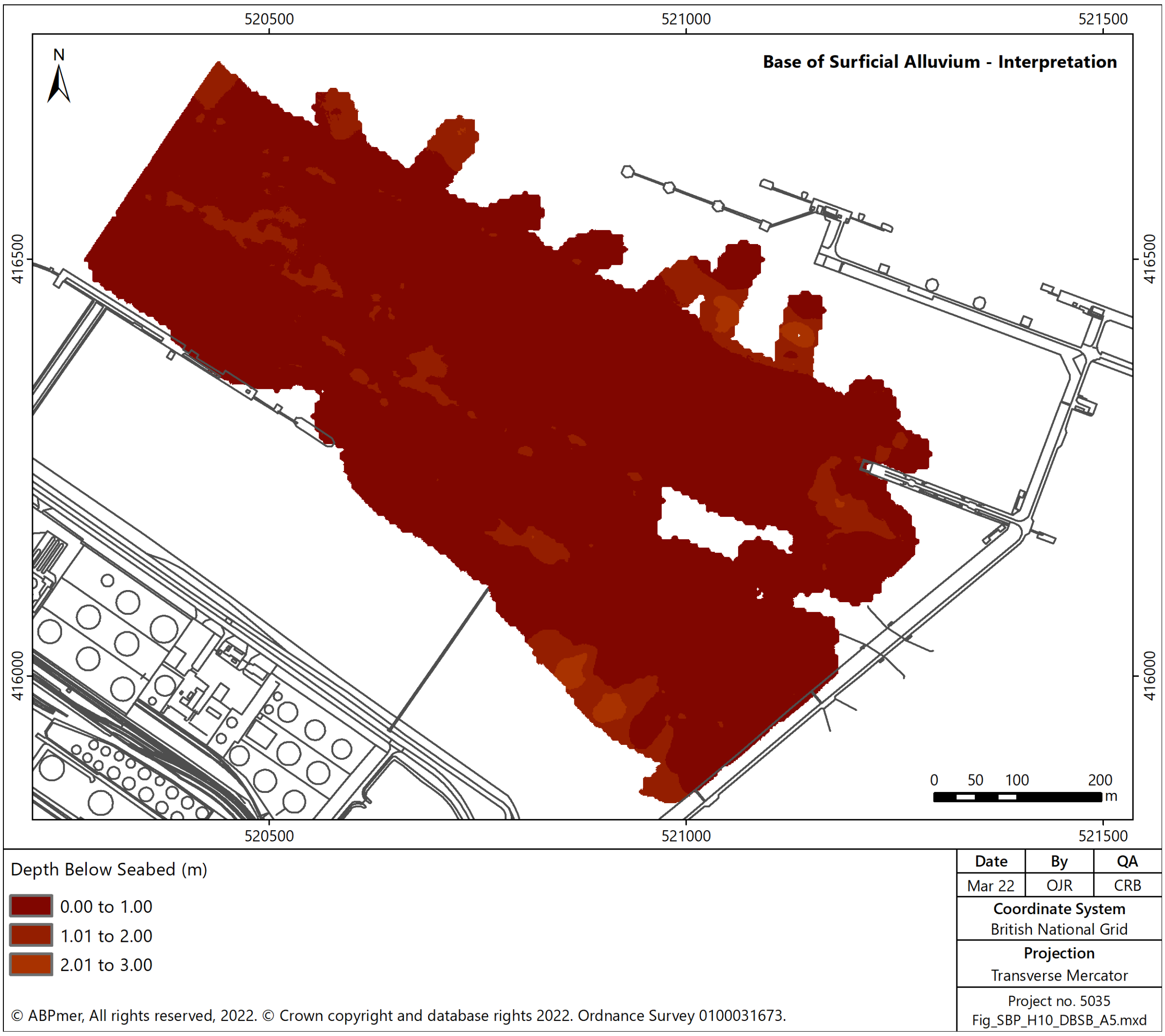


Figure 18. Distribution of surficial alluvium (depth below seabed)

Alluvium – Organic Sediment

The interpretation of 'alluvium containing organic sediment' as the horizon responsible for the severe acoustic attenuation of the seismic data has been made by analysis of the reflector signature and nearby borehole logs. The seismic signal of the organic sediment reflection has the characteristic phase reversal that is expected of a transition of a low density medium typical of organic layers. Nearby borehole logs (I27 MB2/MB3) confirm that organic sediment has been sampled at nearby locations. The organic sediment layer to the west is almost completely continuous with only occasional short breaks in its surface.

Examples of the organic sediment on the seismic data and the effect on the underlying reflectors is shown in Figure 16 and Figure 17. The bright organic reflector is clear in the near surface and the interpreted reflectors are no longer traceable after the onset of the organic layer in each example.

Whilst some of the higher amplitude returns are observable through the organic sediment, they do not appear continuous or in line with the horizons that were being traced. In places it was possible to continue interpretation beneath the organic sediment, possibly in areas where the layer was thinner or broken up.

The distribution of organic sediment is shown in Figure 19, and is widespread with only the eastern areas partially unaffected. Organic sediment has been observed in the uppermost few metres of the seismic data, and occasionally at or near to the seabed. No clear exposures of organic sediment have been identified on SSS data, but it is likely that some exposure exists. The delivered grid for the top of organic sediment has been gridded with a lower blanking distance when compared to the other horizon grids. This has been done to prevent the over interpolation of areas affected by organic sediment and has allowed more accurate mapping of the organic sediment extent shown in Figure 19.

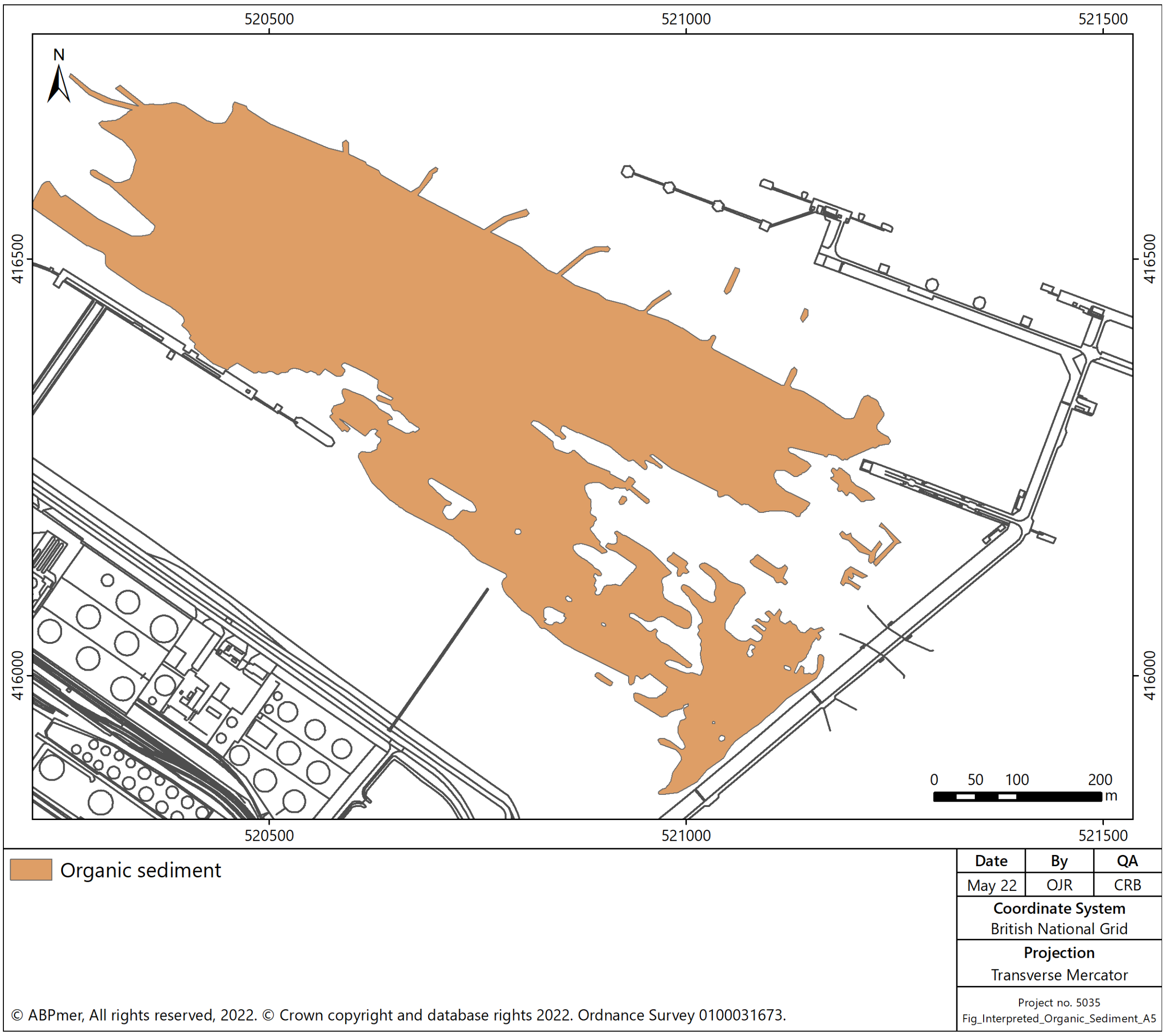


Figure 19. Distribution of interpreted organic sediment

Alluvium – Fluvial sediments

The sediments above the interpreted upper boulder clay are all part of the interpreted alluvium. Comparisons of the I5 and I27 boreholes show that the alluvium is comprised of some coarser sediments including beds of SAND and GRAVEL.

An example of this unit is shown in Figure 16, where a number of internal reflectors can be observed in the seismic data above the upper boulder clay marked in pink. Beneath the organic sediment towards the northwest, there are hints of many internal reflectors in the seismic data, however, none appear continuous enough to interpret as a horizon or lend confidence on an interpretation to state what a horizon might represent. There are instances of truncation and cross cutting reflectors that indicate channelisation likely caused by fluvial erosion and channel migration. These channels have likely then been filled with reworked glacial material in beds of laminated CLAY, and lenses of SAND and GRAVEL.

An internal horizon, H25, has been interpreted to mark an observed change from chaotic clay sediments above to laminated channel fill sediments below. The underlying sediments are likely to be laminated sediments of CLAY with interbeds of silt or sand. This boundary is only partially observed due to acoustic attenuation caused by the organic sediment but offers an example of one such horizon within the complex fluvial sediments. The laminations in the sediment that H25 marks the top of are shown in Figure 15 where multiple parallel internal reflectors can be observed beneath the H25 horizon marked in green. The spatial extent of interpretation of H25 is presented in Figure 20.

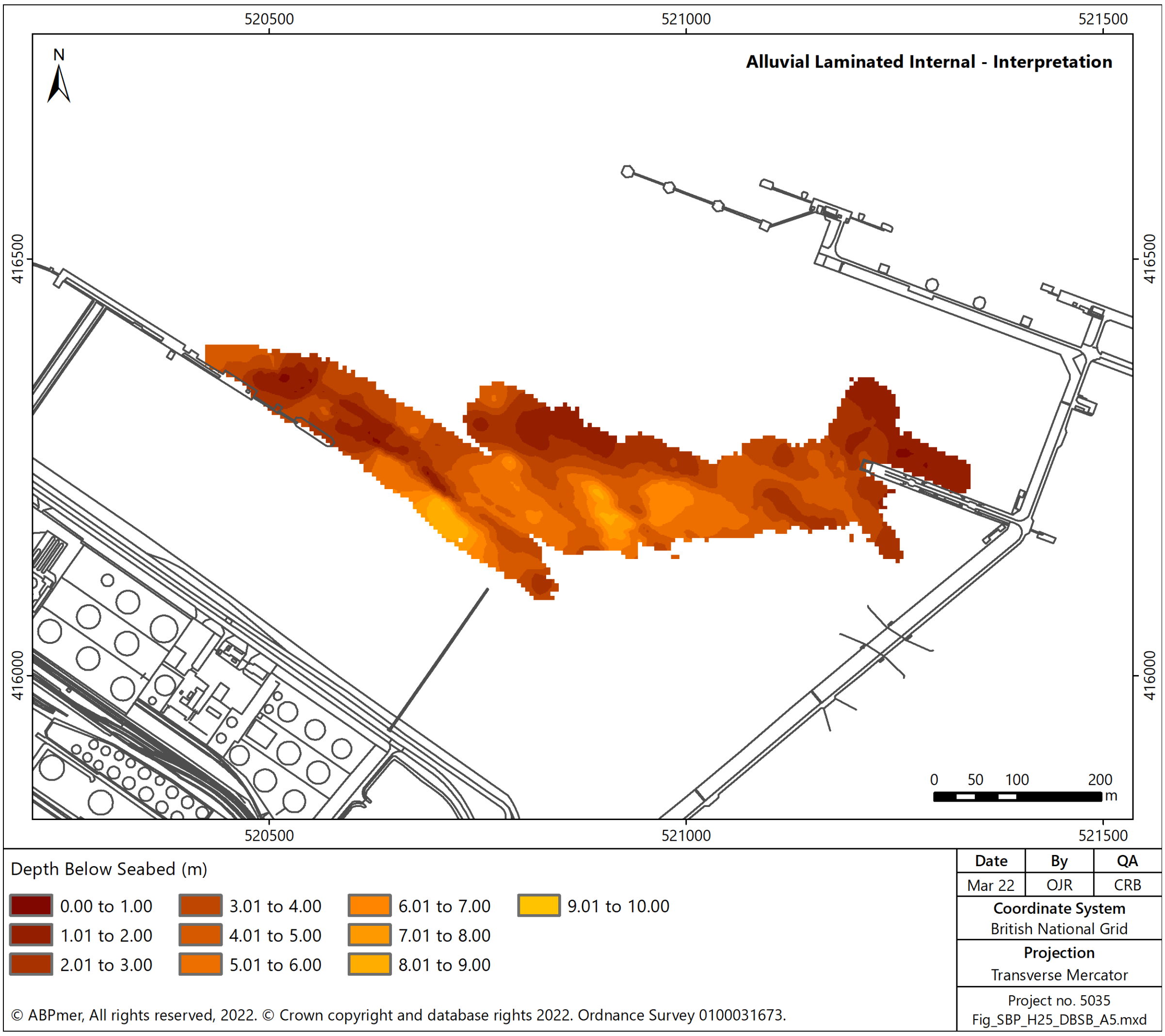


Figure 20. Distribution of interpretation on H25 – alluvium internal (depth below seabed)

Total thickness of the alluvium sediments is determined by the depth to the top of the upper boulder clay. Figure 21 shows the extent of the interpreted base of alluvium sediments/top of upper boulder clay. To the west where the base is not interpreted, alluvium is still expected, however the overlying organic sediment does not allow interpretation of the base. Given the observed channelisation features (Figure 16) it is likely that alluvium thickness to the west remain or exceed the last observed depths.

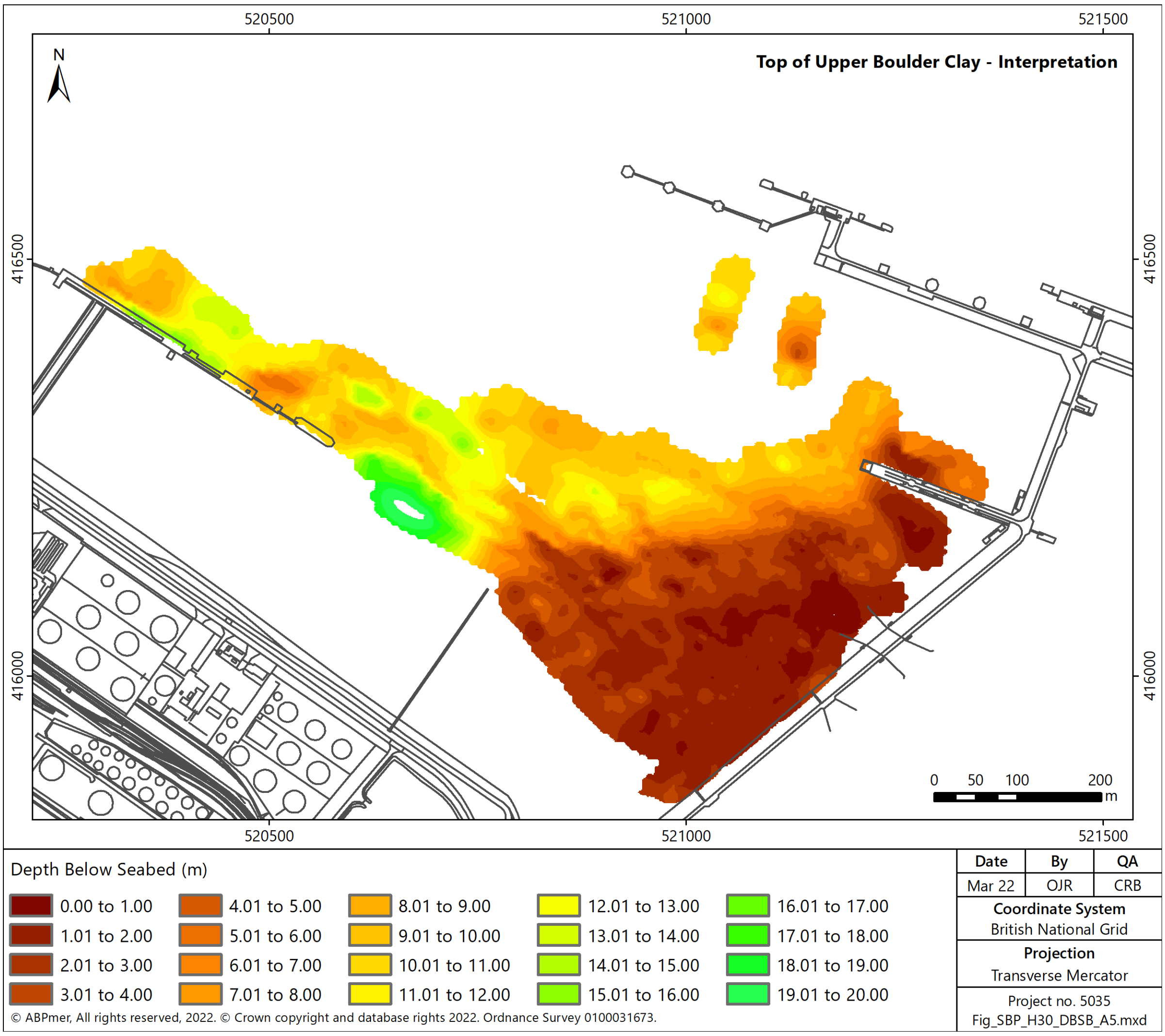


Figure 21. Distribution of alluvium – top of upper boulder clay (depth below seabed)

Upper boulder clay

Examples of the upper boulder clay horizon are presented in Figure 15, Figure 16 and Figure 17 as the pink horizon. This horizon appears to have been eroded by channelisation to the west which has been filled with the overlying alluvium sediments. Figure 21 shows the depth below seabed for the interpreted top surface of the upper boulder clay.

There is a small section where this horizon appears to have been totally eroded away leaving the underlying inter-glacial clays continuing the base of the alluvium. An example of this area is shown in Figure 15, where the pink horizon representing top of upper boulder clay is truncated by the red horizon representing the top of inter-glacial clays. The gap in upper boulder clay spans approximately 100 m. Geotechnical boreholes (I19 BH4) suggest that this boulder clay unit contains beds of SAND and GRAVEL towards its base. These sediment beds are occasionally observed in the seismic data, examples of which can be observed in Figure 15, Figure 16 and Figure 17 as reflectors between the interpreted pink and red horizons.

Inter-glacial clays

Interglacial clays have been interpreted based on the I5 borehole set. A reflector matching the depth of the borehole record was observed and subsequently interpreted as the top of inter-glacial clays. Some occasional internal parallel bedding is observable on data with good penetration, possibly representing the varve cycles expected of a glacial lake setting. It would be expected that this horizon primarily comprises of clays and silts. Examples of interpretation of this horizon are presented in the example figures; Figure 15, Figure 16 and Figure 17 as the red horizon.

The distribution of interpreted inter-glacial clays is presented in Figure 22.

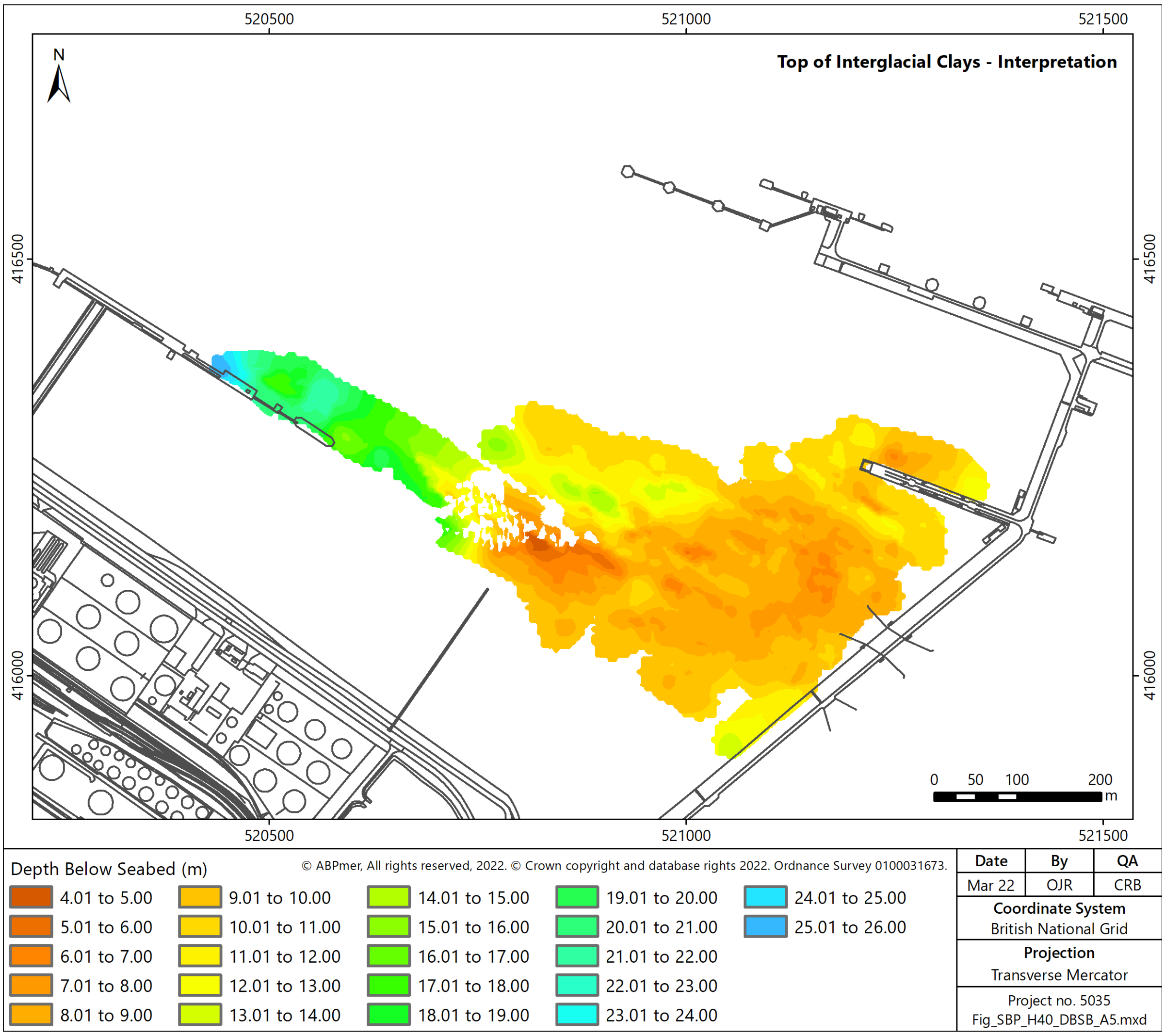


Figure 22. Distribution of interpreted top of inter-glacial clays (depth below seabed)

Lower boulder clay

Examples of the lower boulder clay horizon are presented in Figure 15, Figure 16 and Figure 17 as the orange horizon. Interpretation of this horizon is very intermittent due to the attenuation by organic sediment, the occurrence of seabed multiples that would not supress completely, and the large depths at which the horizon is encountered. Where interpreted, the horizon appears as a gently undulating surface with a general dipping trend towards the northwest. The seismic data beneath this horizon appears acoustically transparent that may indicate massive structure with little to no internal bedding.

Figure 23 shows the distribution of interpretation of the top of lower boulder clay. Whilst it is likely that this horizon exists across the site, interpretation has been limited by depth and acoustic attenuation.

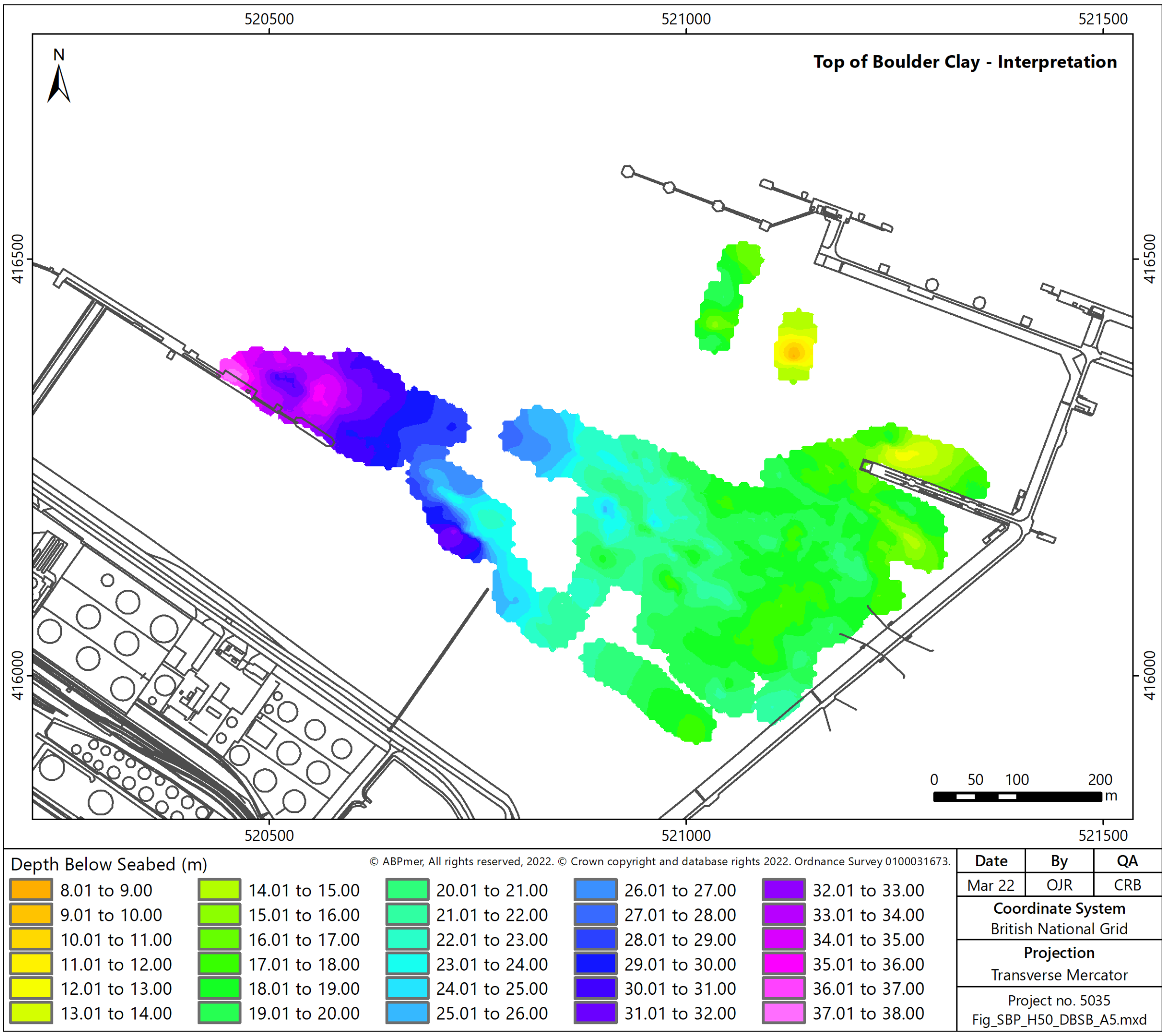


Figure 23. Distribution of interpreted top of lower boulder clay (depth below seabed)

Bedrock

Bedrock within the area is known to be chalk from nearby boreholes sampled in the I5 and I27 campaigns. The boreholes that identify the chalk make consistent reference to the chalk being fissured. Interpretation of the chalk in this dataset has been limited by the same factors that have affected the top of lower boulder clay. However, there appears to be some variability in the chalk reflector which appears stronger in some areas, making it easier to identify in some locations.

The extent of interpretation for the top of chalk is presented in Figure 24.

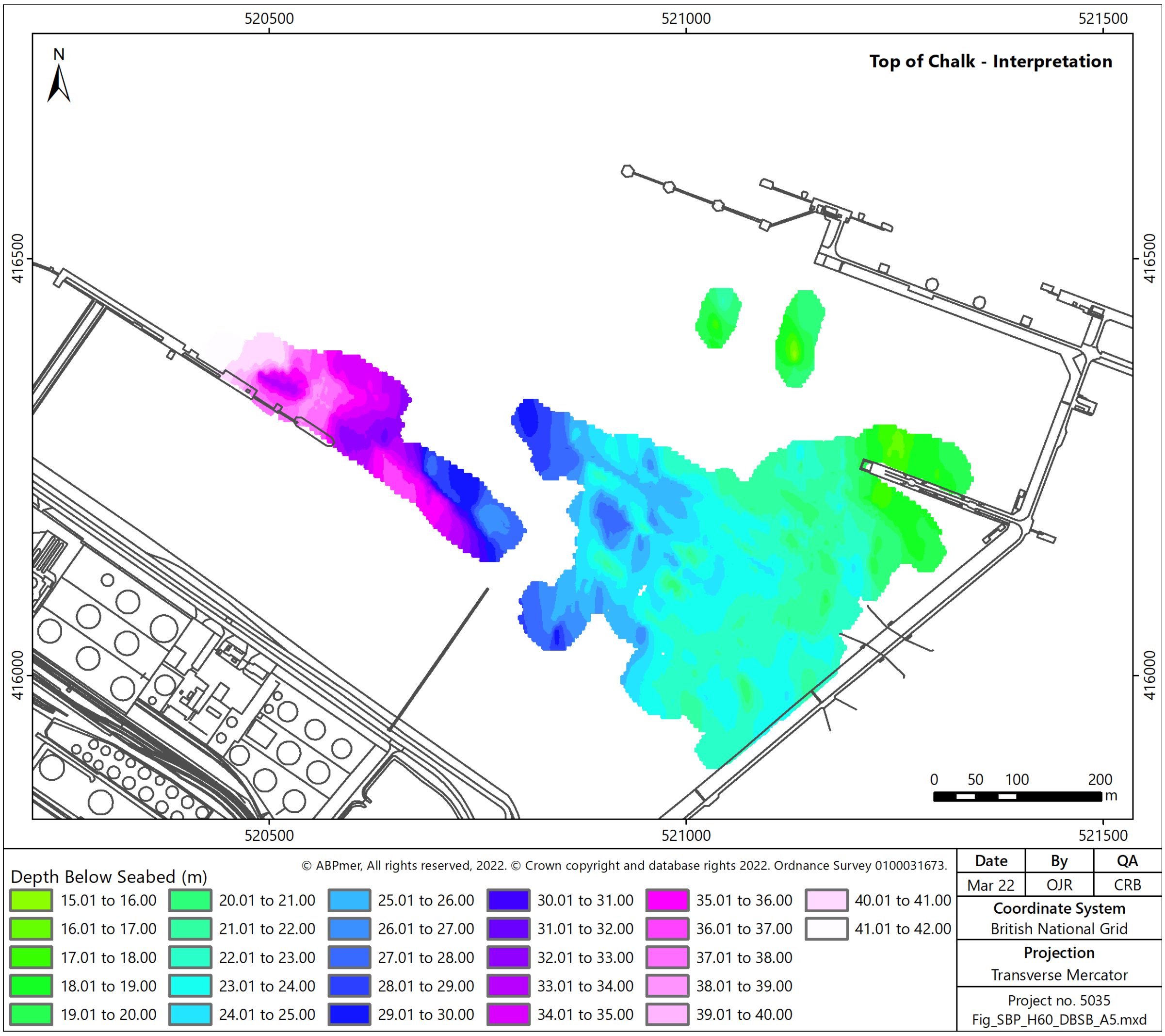


Figure 24. Distribution of interpreted top of chalk (depth below seabed)

4.4 Deliverables

4.4.1 Charts

Geophysical data is presented in a series of four 1-panel charts and two 4-panel charts as described below:

1-panel charts

- 5035_ImmRoRo_Geophysical_MBES_Rev0 (Scale 1:1,300 Size: A0)
  - Sun-illuminated bathymetric image
  - Bathymetry contours at 1 m intervals

- 5035_ImmRoRo_Geophysical_SSS_Rev0 (Scale 1:1,300 Size: A0)
  - Sidescan Sonar mosaic (Low Frequency)

- 5035_ImmRoRo_Geophysical_SBF_Rev0 (Scale 1:1,300 Size: A0)
    - Interpreted seabed features
    - Seafloor contacts overlaid

- 5035_ImmRoRo_Geophysical_MAG_Rev0 (Scale 1:1,300 Size: A0)
    - Magnetic residual field grid
    - Observed magnetic targets overlaid

4-panel charts

- 5035_ImmRoRo_Geophysical_SBP_01_Rev0 (Scale 1:2,500 Size: A0)
    - Panel 1 - Sub Bottom Profiler trackplot
    - Panel 2 – Base of surficial Alluvium – gridded interpretation
    - Panel 3 – Top of organic sediment – gridded interpretation
    - Panel 4 – Alluvial laminated internal – gridded interpretation

- 5035_ImmRoRo_Geophysical_SBP_02_Rev0 (Scale 1:2,500 Size: A0)
    - Panel 1 – Top of upper boulder clay – gridded interpretation
    - Panel 2 – Top of interglacial clays – gridded interpretation
    - Panel 3 – Top of boulder clay – gridded interpretation
    - Panel 4 – Top of chalk – gridded interpretation

4.4.2 Data deliverables

Table 9 summarises and describes the geophysical data deliverables that are provided with this report.

Table 9. Geophysical data deliverables

System	Deliverable	Description	Format
1_MBES	1_Gridded_XYZ	Gridded bathymetry relative to OSGB36(OSTN15) and CD. ▪ 0.2 m resolution ▪ 0.5 m resolution ▪ 1.0 m resolution	.XYZ
	2_Gridded_FLT	Gridded bathymetry relative to OSGB36(OSTN15) and CD. ▪ 0.2 m resolution ▪ 0.5 m resolution ▪ 1.0 m resolution	.FLT
	3_Gridded_GeoTIFF	Sun-illuminated bathymetric imagery. ▪ 0.2 m resolution ▪ 0.5 m resolution ▪ 1.0 m resolution	.TIF / .TFW (GeoTIFF)
	4_Contours	Bathymetric contours at 1 m intervals.	.SHP
	5_Sound_Velocity_Profiles	Tabulated sound velocity profiles.	.XLSX
2_SBP	1_Processed_Data (processed seismic data [CD +5 m])	Processed and tidally reduced seismic data in SGY format provided as two versions: ▪ 1_Nodemult has had basic signal processing. ▪ 2_Demult has had basic signal processing plus deconvolution and demultiple processing. However, the effectiveness of the demultiple is variable even within single survey lines based on the stability of the source/receiver offsets.	.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).

System	Deliverable	Description	Format
3_SSS	1_Processed_Data (Navigation corrected and seabed tracked)	Navigation and altitude corrected sonar data in XTF format.	.XTF
	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 (with Mag Target correlations included)	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 CSV text format.	.CSV
	2_Trackplot	Trackplot showing extent of accepted MAG data.	.SHP
	3_Residual_Field_grid	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. Note data has been clamped to a range of +10/-10 nT to highlight targets of interest.	.TIF / .TFW (GeoTIFF)

System	Deliverable	Description	Format
	5_MAG_Contacts	Contact lists containing target specific data for each interpreted MAG contact and correlations to other datasets. Three contact lists have been provided: ▪ MAG_Targets-All - contains all individual target picks >5 nT on profile magnetic data ▪ MAG_Targets-Primary - contains a distilled list of main targets to be considered after reconciliation of individual profile picks to remove adjacent picks of the same interpreted ferrous source. ▪ MAG_Targets-Reconciled - contains a list of the targets that were removed from the primary list as they have been interpreted to be associated with a target listed in the primary list.	.CSV / .SHP

5 References

BTDB (1965a). I27 – Boreholes Plan and Logs. British Transport Docks Board.

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

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

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

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

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

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

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

6 Abbreviations/Acronyms

A0	Paper Size (841 × 1189 mm)
ABP	Associated British Ports
AML	Manufacturer of Sound Velocity instruments
AO	Any Other
BeamworX	Bathymetry Processing Software
BSB	Below Seabed
CD	Chart Datum
Ch	Channel (Radio Channel Frequency
CMG	Course Made Good
coda	Coda Octopus Seismic Acquisition System
ColourBar	Colour Scale Bar
CSP	Applied Acoustics Power Supply Unit
CSV	Comma Separated Values
DCO	Development Consent Order
DGPS	Differential Global Positioning System
ED	Equipment Down
ETRS	European Terrestrial Reference Frame
FLT	Three-Dimensional Geometry
GAMS	GPS Azimuth Measurement System
GEL	Ground Exploration Ltd.
GeoTIFF	Metadata Standard (enabling georeferencing information to be embedded within an image file)
GGA	NMEA Positioning Interface String
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HF	High Frequency
HSE	Health and Safety Executive
Hz	Hertz
ID	Identity
IHO	International Hydrographic Organisation
IHS	IHS Markit – Kingdom
IMU	Inertial Measurement Unit
iWBMSh	Norbit Mulitbeam model
JSF	Edgetech Discover Sidescan Data
LF	Low Frequency
LiDAR	Light Detecting and Ranging
M	Mobilise / Demobilise
MAG	Magnetometer
MBES	Multibeam Echosounder
MMO	Marine Management Organisation
NA	Not Applicable
NMEA	National Marine Electronics Association
nT	Nanotesla
O	Operational
Oasis Montaj	Magnetometer Processing Software
OSGB36	Ordnance Survey National Grid
OSTN	Ordnance Survey Transformation Model

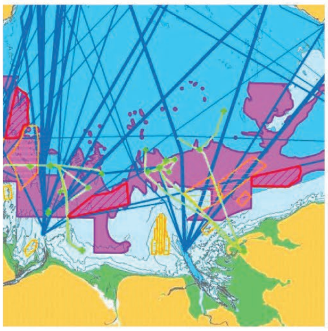
POSMV	Applanix Positioning System
QA	Quality Assured
QA	Quality Assurance
QC	Quality Control
QGIS	Open-Source Geographic Information System
QPS	Quality Positioning Services B.V.
QPS QINSy	Survey Navigation Software
RadExPro	Windows-Based Seismic Processing Software System (DECO Geophysical Software Co)
RoRo	Roll on Roll off
RS2	Emlid Survey System Model ID
RTK	Realtime Kinematic
SBF	Seabed Features
SBP	Sub-Bottom Profiler
SeaView	Sidescan Sonar Processing Software
SEGY	Geophysical Data Storing File Format/Standard (Society of Exploration Geophysicists)
SeismicDirect	IHS Kingdom Processing Tool
SGY	Geophysical Data File
SHP	Shapefile File Format
SSS	Sidescan Sonar
SVP	Sound Velocity Profiler
SVS	Sound Velocity Sensor
T	Transit
TBT	Tributyltin
TFW	Georeferencing Images
TIF	Tag Image File
TWTT	Two Way Travel Time
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
VD	Vessel Down
VORF	Vertical Offshore Reference Frame
W	Weather
XLSX	File format – Microsoft Excel
XTF	File format – Extended Triton Format
XYZ	File format – ASCII Position

Cardinal points/directions are used unless otherwise stated.

SI units are used unless otherwise stated.

Appendices

Innovative Thinking - Sustainable Solutions

ABP mer

A Vibrocore Logs

Drawn by:		**OFFSHORE CORE LOG**	COASTLINE MARINE SERVICES
Date:	20/10/2021		
Checked by:			

PROJECT DETAILS

Contract No:	2021-807	Project Title:	
Vessel:	Obervargh	**Immingham Oil Terminal East**	
Client:	ABP Mer		
Area:	Immingham, Humber		

TEST LOCATION DETAILS

Coordinate Ref System:	British Grid (OSGB36)	Penetration(m):	5.00	Core Number
Easting (m)/Northing (m):	520830.6 416363.0	Recovery(m):	4.70	**VC-01**
Water Depth(m CD):	10.0	KP Distance (m):		
Sampling Date:	17/10/21	Fix Number:	1	
Vibration Time on Seabed:	3 mins	Touchdown (local-time):	7:46 AM	
Comments:	All equipment operating properly. Test stopped constant current no further penetration. No shoe sample. Contamination samples taken every 1m and at base of recovery			

SOIL DESCRIPTION	SOIL LOG	SOIL DEPTH (m)	SAMPLES, FIELD TESTS AND COMMENTS			
			Samples	test depth	Cu/Cr (kPa)	Comments
soft black muddy silt				0.00	/	2x contamination samples
			Core Piece: 0.00-1.00m			
@ 1.0 soft blac muddy silt, slightly sandy				1.00	/	2 x contamination samples
			Core Piece: 1.00-2.00m			
@ 2.0 soft to firm black muddy silt, slighty sandy				2.00	/	2 x contamination samples
			Core Piece: 2.00-3.00m			
@ firm black muddy silt becoming very sandy				3.00	/	2 x contamination samples
		3.50				
firm / dense black silty fine SAND			Core Piece: 3.00-4.00m			
				4.00	/	2 x contamination samples
			Core Piece: 4.00-4.70m			
		4.70		4.70	/	2 x contamination samples

Currently to max depth 5.50 m

Drawn by:		OFFSHORE CORE LOG
Date:	20/10/2021	
Checked by:		

PROJECT DETAILS

Contract No:	2021-807	Project Title:
Vessel:	Obervargh	**Immingham Oil Terminal East**
Client:	ABP Mer	
Area:	Immingham, Humber	

TEST LOCATION DETAILS

				Core Number
Coordinate Ref System:	British Grid (OSGB36)	Penetration(m):	4.80	
Easting (m)/Northing (m):	520779.9 416316.9	Recovery(m):	3.80	**VC-02**
Water Depth(m CD):	9.8	KP Distance (m):		
Sampling Date:	17/10/21	Fix Number:	2	
Vibration Time on Seabed:	3 mins	Touchdown (local-time):	10:03 AM	
Comments:	All equipment operating properly. Test stopped constant current no further penetration. No shoe sample. Contamination samples taken every 1m and at base of recovery			

SOIL DESCRIPTION	SOIL LOG	SOIL DEPTH (m)	SAMPLES, FIELD TESTS AND COMMENTS			
			Samples	test depth	Cu/Cr (kPa)	Comments
soft black muddy silt			Core Piece: 0.00-1.00m	0.00	/	2x contamination samples
@ 1.0 soft black muddy silt			Core Piece: 1.00-2.00m	1.00	/	2 x contamination samples
@ 2.0 soft to medium firm brown black muddy silt, slighty clayey			Core Piece: 2.00-3.00m	2.00	/	2 x contamination samples
@ 3.0 firm brown black clayey muddy silt becoming slightly sandy			Core Piece: 3.00-4.00m	3.00	/	2 x contamination samples
firm / dense black silty fine SAND		3.50				
		3.8		3.80	/	2 x contamination samples

Currently to max depth 5.50 m

CAUTION PRELIMINARY FIELD NOTES

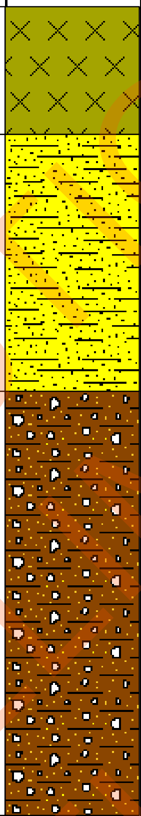
Drawn by:		# OFFSHORE CORE LOG	COASTLINE MARINE SERVICES
Date:	20/10/2021		
Checked by:			

PROJECT DETAILS

Contract No:	2021-807	Project Title:
Vessel:	Obervargh	**Immingham Oil Terminal East**
Client:	ABP Mer	
Area:	Immingham, Humber	

TEST LOCATION DETAILS

Coordinate Ref System:	British Grid (OSGB36)	Penetration(m):	3.75	Core Number
Easting (m)/Northing (m):	521048.05 416140.5	Recovery(m):	3.15	**VC-03**
Water Depth(m CD):	4.7	KP Distance (m):		
Sampling Date:	17/10/21	Fix Number:	3	
Vibration Time on Seabed:	3 mins	Touchdown (local-time):	11:00 AM	
Comments:	All equipment operating properly. Test stopped constant current no further penetration. No shoe sample. Contamination samples taken every 1m and at base of recovery			

SOIL DESCRIPTION	SOIL LOG	SOIL DEPTH (m)	SAMPLES, FIELD TESTS AND COMMENTS: Samples	test depth	Cu/Cr (kPa)	Comments
soft brown black muddy silt				0.00	/	2x contamination samples
		0.50	Core Piece: 0.00-1.00m			
firm/dense brown very clayey fine SAND				1.00	/	2 x contamination samples
		1.50	Core Piece: 1.00-2.00m			
firm to medium firm silty sandy (fine) CLAY				2.00	/	2 x contamination samples
....becoming firm to stiff slightly gravelly CLAY. Gravel is fine, sub angular, subrounded, predominantly of chalk and coal fragments			Core Piece: 2.00-3.15m			
		3.15		3.15	/	2 x contamination samples

Currently to max depth 5.50 m

Drawn by:			
Date:	20/10/2021	**OFFSHORE CORE LOG**	COASTLINE MARINE SERVICES
Checked by:			

PROJECT DETAILS

Contract No:	2021-807	Project Title:
Vessel:	Obervargh	**Immingham Oil Terminal East**
Client:	ABP Mer	
Area:	Immingham, Humber	

TEST LOCATION DETAILS

Coordinate Ref System:	British Grid (OSGB36)	Penetration(m):	3.60	Core Number
Easting (m)/Northing (m):	520896.2 416076.2	Recovery(m):	2.70	**VC-04**
Water Depth(m CD):	3.9	KP Distance (m):		
Sampling Date:	17/10/21	Fix Number:	4	
Vibration Time on Seabed:	3 mins	Touchdown (local-time):	11:53 AM	
Comments:	All equipment operating properly. Test stopped rapidly rising current. No shoe sample. Contamination samples taken every 1m and at base of recovery			

SOIL DESCRIPTION	SOIL LOG	SOIL DEPTH (m)	SAMPLES, FIELD TESTS AND COMMENTS: Samples	test depth	Cu/Cr (kPa)	Comments
very soft grey black muddy SILT			Core Piece: 0.00-1.00m	0.00	/	2x contamination samples
soft to firm black muddy SILT with increasing amounts of brown black organic material, peaty in appearance		0.50		1.00	/	2 x contamination samples
dense brown silty fine sandy GRAVEL. Gravel is fine to medium, sub angular. Patch fine SAND at 1.9m		1.50	Core Piece: 1.00-2.00m	2.00	/	2 x contamination samples
firm to stiff grey brown white slightly gravelly CLAY. Gravel is fine, predominantly of chalk		2.50	Core Piece: 2.00-2.70m			
		2.70		2.70	/	2 x contamination samples

Currently to max depth 5.50 m

Drawn by:		**OFFSHORE CORE LOG**	COASTLINE MARINE SERVICES
Date:	20/10/2021		
Checked by:			

PROJECT DETAILS

Contract No:	2021-807	Project Title:	
Vessel:	Obervargh		**Immingham Oil Terminal East**
Client:	ABP Mer		
Area:	Immingham, Humber		

TEST LOCATION DETAILS

Coordinate Ref System:	British Grid (OSGB36)	Penetration(m):	4.80	Core Number
Easting (m)/Northing (m):	520849 416152.9	Recovery(m):	4.70	**VC-05a**
Water Depth(m CD):	10.1	KP Distance (m):		
Sampling Date:	17/10/21	Fix Number:	6	
Vibration Time on Seabed:	3 mins	Touchdown (local-time):	2:12 PM	
Comments:	All equipment operating properly. 1st test failed due to corer falling over probably due soft mud. Test stopped rapidly rising current. No shoe sample. Contamination samples taken every 1m and at base of recovery			

SOIL DESCRIPTION	SOIL LOG	SOIL DEPTH (m)	Samples	test depth	Cu/Cr (kPa)	Comments
very soft to soft grey black muddy SILT				0.00	/	2x contamination samples
			Core Piece: 0.00-1.00m			
				1.00	/	2 x contamination samples
			Core Piece: 1.00-2.00m			
... becoming slightly sandy (fine) slightly gravelly (fine)				2.00	/	2 x contamination samples
firm brown slight sandy (fine) CLAY		2.50	Core Piece: 2.00-3.00m		/	
				3.00	/	2 x contamination samples
... becoming more sandy			Core Piece: 3.00-4.00m			
				4.00	/	2 x contamination samples
... becoming firm to stiff brown slightly gravelly CLAY. Gravel is fine, predominantly of broken weathered chalk			Core Piece: 4.00-4.70m			
		4.70		4.70	/	2 x contamination samples

Currently to max depth 5.50 m

Drawn by:		**OFFSHORE CORE LOG**	COASTLINE MARINE SERVICES
Date:	20/10/2021		
Checked by:			

PROJECT DETAILS

Contract No:	2021-807	Project Title:	
Vessel:	Obervargh		**Immingham Oil Terminal East**
Client:	ABP Mer		
Area:	Immingham, Humber		

TEST LOCATION DETAILS

Coordinate Ref System:	British Grid (OSGB36)	Penetration(m):	5.20	Core Number
Easting (m)/Northing (m):	0663.05 416171.1	Recovery(m):	4.10	**VC-06**
Water Depth(m CD):	2.1	KP Distance (m):		
Sampling Date:	17/10/21	Fix Number:	7	
Vibration Time on Seabed:	3 mins	Touchdown (local-time):	3:25 PM	
Comments:	All equipment operating properly. Test stopped constant current no further penetration. No shoe sample. Contamination samples taken every 1m and at base of recovery			

SOIL DESCRIPTION	SOIL LOG	SOIL DEPTH (m)	SAMPLES, FIELD TESTS AND COMMENTS: Samples	test depth	Cu/Cr (kPa)	Comments
very soft grey brown muddy SILT			Core Piece: 0.00-1.00m	0.00	/	2x contamination samples
... becoming soft			Core Piece: 1.00-2.00m	1.00	/	2 x contamination samples
... becoming soft to firm			Core Piece: 2.00-3.00m	2.00	/	2 x contamination samples
					/	
... becoming slightly sandy (fine)				3.00	/	2 x contamination samples
dense grey green slightly silty slightly gravelly fine SAND. Gravel is fine to medium, sub angular to sub rounded predominantly of flint, quartz		3.50	Core Piece: 3.00-4.10m			
		4.10		4.10	/	2 x contamination samples

Currently to max depth 5.50 m

Drawn by:		# OFFSHORE CORE LOG	COASTLINE MARINE SERVICES
Date:	20/10/2021		
Checked by:			

PROJECT DETAILS

Contract No:	2021-807	Project Title:
Vessel:	Obervargh	**Immingham Oil Terminal East**
Client:	ABP Mer	
Area:	Immingham, Humber	

TEST LOCATION DETAILS

Coordinate Ref System:	British Grid (OSGB36)	Penetration(m):	5.20	Core Number
Easting (m)/Northing (m):	?0809.25 416014.2	Recovery(m):	4.10	**VC-07**
Water Depth(m CD):	3.3	KP Distance (m):		
Sampling Date:	17/10/21	Fix Number:	8	
Vibration Time on Seabed:	3 mins	Touchdown (local-time):	4:24 PM	
Comments:	All equipment operating properly. Test stopped constant current no further penetration. No shoe sample. Contamination samples taken every 1m and at base of recovery			

SOIL DESCRIPTION	SOIL LOG	SOIL DEPTH (m)	SAMPLES, FIELD TESTS AND COMMENTS			
			Samples	test depth	Cu/Cr (kPa)	Comments
very soft to soft brown muddy SILT			Core Piece: 0.00-1.00m	0.00	/	2x contamination samples
			Core Piece: 1.00-2.00m	1.00	/	2 x contamination samples
			Core Piece: 2.00-3.00m	2.00	/	2 x contamination samples
soft to firm black brown clayey SILT with organic material (possibly grass reeds etc)		2.50			/	
			Core Piece: 3.00-4.00m	3.00	/	2 x contamination samples
... becoming less organic with depth			Core Piece: 4.00-4.80m	4.00	/	2 x contamination samples
		4.80		4.80	/	2 x contamination samples

Currently to max depth 5.50 m

Drawn by:		**OFFSHORE CORE LOG**	COASTLINE MARINE SERVICES
Date:	20/10/2021		
Checked by:			

PROJECT DETAILS

Contract No:	2021-807	Project Title:	
Vessel:	Obervargh		**Immingham Oil Terminal East**
Client:	ABP Mer		
Area:	Immingham, Humber		

TEST LOCATION DETAILS

Coordinate Ref System:	British Grid (OSGB36)	Penetration(m):	4.80	Core Number	
Easting (m)/Northing (m):	0882.49	416254.1	Recovery(m):	3.65	**VC-08**
Water Depth(m CD):	7.8	KP Distance (m):			
Sampling Date:	18/10/21	Fix Number:	9		
Vibration Time on Seabed:	3 mins	Touchdown (local-time):	10:00 AM		
Comments:	All equipment operating properly. Test stopped constant current no further penetration. No shoe sample. Contamination samples taken every 1m and at base of recovery				

SOIL DESCRIPTION	SOIL LOG	SOIL DEPTH (m)	SAMPLES, FIELD TESTS AND COMMENTS: Samples	test depth	Cu/Cr (kPa)	Comments
very soft to soft brown muddy SILT				0.00	/	2x contamination samples
soft black brown slightly sandy muddy SILT		0.50	Core Piece: 0.00-1.00m			
				1.00	/	2 x contamination samples
firm / dense brown clayey fine SAND		1.50	Core Piece: 1.00-2.00m			
				2.00	/	2 x contamination samples
			Core Piece: 2.00-3.00m		/	
.... becoming very clayey fine SAND with depth				3.00	/	2 x contamination samples
			Core Piece: 3.00-3.65m			
		3.65		3.65	/	2 x contamination samples

Currently to max depth 5.50 m

Drawn by:		# OFFSHORE CORE LOG	COASTLINE MARINE SERVICES
Date:	20/10/2021		
Checked by:			

PROJECT DETAILS

Contract No:	2021-807	Project Title:
Vessel:	Obervargh	**Immingham Oil Terminal East**
Client:	ABP Mer	
Area:	Immingham, Humber	

TEST LOCATION DETAILS

Coordinate Ref System:	British Grid (OSGB36)	Penetration(m):	5.40	Core Number
Easting (m)/Northing (m):	0802.31 416231.2	Recovery(m):	4.60	**VC-09**
Water Depth(m CD):	8.9	KP Distance (m):		
Sampling Date:	18/10/21	Fix Number:	10	
Vibration Time on Seabed:	3 mins	Touchdown (local-time):	10:47 AM	
Comments:	All equipment operating properly. Test stopped constant current no further penetration. No shoe sample. Contamination samples taken every 1m and at base of recovery			

SOIL DESCRIPTION	SOIL LOG	SOIL DEPTH (m)	SAMPLES, FIELD TESTS AND COMMENTS: Samples	test depth	Cu/Cr (kPa)	Comments
very soft to soft brown becoming dark brown muddy SILT			Core Piece: 0.00-1.00m	0.00	/	2x contamination samples
				1.00	/	2 x contamination samples
soft dark brown slightly sandy (fine) muddy SILT		1.50	Core Piece: 1.00-2.00m			
				2.00	/	2 x contamination samples
soft to firm brown very clayey SILT		2.50	Core Piece: 2.00-3.00m			
				3.00	/	2 x contamination samples
firm to stiff red brown CLAY		3.50	Core Piece: 3.00-4.00m			
				4.00	/	2 x contamination samples
			Core Piece: 4.00-4.60m			
		4.60		4.60	/	2 x contamination samples

Currently to max depth 5.50 m

Drawn by:		**OFFSHORE CORE LOG**	COASTLINE MARINE SERVICES
Date:	20/10/2021		
Checked by:			

PROJECT DETAILS

Contract No:	2021-807	Project Title:
Vessel:	Obervargh	**Immingham Oil Terminal East**
Client:	ABP Mer	
Area:	Immingham, Humber	

TEST LOCATION DETAILS

Coordinate Ref System:	British Grid (OSGB36)	Penetration(m):	3.90	Core Number
Easting (m)/Northing (m):	0970.74 416132.0	Recovery(m):	2.60	**VC-10**
Water Depth(m CD):	4.4	KP Distance (m):		
Sampling Date:	18/10/21	Fix Number:	11	
Vibration Time on Seabed:	3 mins	Touchdown (local-time):	11:42 AM	
Comments:	All equipment operating properly. Test stopped constant current no further penetration. No shoe sample. Contamination samples taken every 1m and at base of recovery			

SOIL DESCRIPTION	SOIL LOG	SOIL DEPTH (m)	SAMPLES, FIELD TESTS AND COMMENTS: Samples	test depth	Cu/Cr (kPa)	Comments
soft to firm grey muddy SILT with considerable organic material (reed, grss etc)			Core Piece: 0.00-1.00m	0.00	/	2x contamination samples
soft to firm grey black becoming brown fine sandy SILT.		0.50				
Piece of plywood whole diameter of core, 10-15mm thick, possibly "Sterling Board" at ~0.9m				1.00	/	2 x contamination samples
... becoming brown			Core Piece: 1.00-2.00m			
				2.00	/	2 x contamination samples
			Core Piece: 2.00-2.65m			
dense grey white coarse sandy fine to medium GRAVEL, predominantly sub angular to sub rounded of flint, quartz, chalk		2.40				
		2.65		2.65	/	2 x contamination samples

Currently to max depth 5.50 m

B Daily Progress Reports

5035_Sugar_Geophysical

ABP mer

24/01/2022

PERSONNEL

Survey Team	Vessel Team
Paul Clement	Nick Bush
Ian Davidson	Deepak
Hugh MacKay	

WEATHER FORECAST

Tue 25 GMT					
00		4kt	to	5kt	1c
03		3kt	to	3kt	0c
06		4kt	to	4kt	0c
09		4kt	to	6kt	1c
12		5kt	to	7kt	5c
15		4kt	to	7kt	5c
18		6kt	to	10kt	2c
21		7kt	to	17kt	1c
Wed 26 GMT					
00		5kt	to	8kt	1c
03		5kt	to	10kt	1c
06		6kt	to	14kt	2c
09		7kt	to	18kt	2c
12		9kt	to	18kt	6c
15		8kt	to	17kt	7c

DAILY LOG

TIME	CODE	EVENT
08:00	M	Survey personnel onboard Wessex Explorer
08:15	M	Project brief and health and safety discussion
08:45	M	Commence vessel mobilisation
10:00	M	All equipment loaded to vessel
14:30	M	SSS rub test on deck successfully conducted
15:00	M	SSS deployed and successfully wet tested
15:45	M	MAG deployed and successfully wet tested and confirm depth and altitude values
17:15	M	Boomer and hydrophone deployed
17:30	M	Boomer pulse test successfully conducted
18:30	M	Depart vessel

HSE SUMMARY

No HSE incidents to report. Full project brief and HSE discussion held with all survey and vessel personnel.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	M	10:30	10:30
Operational	O	00:00	00:00
Transit	T	00:00	00:00
Weather	W	00:00	00:00
Equipment Down	ED	00:00	00:00
Vessel Down	VD	00:00	00:00
Any Other	AO	00:00	00:00
TOTALS (Day)		**1**	**1**

GEOPHYSICAL WORK PROGRESS

Bathymetry (MBES)	0%
Sidescan Sonar (SSS)	0%
Sub-Bottom Profiler (SBP)	0%
Magnetometer (MAG)	0%
TOTAL	**0%**

DAILY SUMMARY

The survey team arrived in Grimsby yesterday and boarded the Wessex Explorer this morning. Following a full project brief and health and safety discussion, all equipment was loaded to the vessel for mobilisation. All towed sensors (SSS, SBP and MAG) were mobilised and successfully wet tested whilst alongside in Grimsby Fish Docks.

UPCOMING PLAN

The MBES will be installed tomorrow morning and all instruments will be interfaced ahead of calibrations and verifications. It is expected that alongside mobilisation will be complete tomorrow. If time allows calibrations will commence and complete on Wednesday ahead of commencing survey operations.

5035_Sugar_Geophysical

25/01/2022

PERSONNEL

Survey Team	Vessel Team
Paul Clement	Nick Bush
Ian Davidson	Deepak
Hugh MacKay	

DAILY LOG

TIME	CODE	EVENT
08:00	M	Survey personnel onboard Wessex Explorer
08:05	M	Continue vessel mobilisation
09:30	M	MBES pole deployed on port side
11:00	M	MBES successfully tested alongside
14:00	M	Hydrophone boom arm installed on port side
16:30	M	Vessel slips ropes from pontoon
17:05	M	Dynamic positioning calibration conducted within Grimsby Fish Docks
17:15	M	MBES testing conducting within Fish Docks
17:45	M	Vessel returns alongside pontoon
18:30	M	Commence alongside position verification
19:45	M	Alongside position verification complete
20:00	M	Depart vessel

WEATHER FORECAST

Wed 26 GMT				
00	5kt	to	10kt	0c
03	6kt	to	12kt	1c
06	6kt	to	16kt	1c
09	7kt	to	20kt	2c
12	10kt	to	21kt	7c
15	9kt	to	19kt	7c
18	11kt	to	25kt	4c
21	13kt	to	29kt	4c
Thu 27 GMT				
00	13kt	to	31kt	5c
03	13kt	to	30kt	7c
06	13kt	to	27kt	8c
09	12kt	to	25kt	8c
12	14kt	to	30kt	10c
15	13kt	to	22kt	9c

HSE SUMMARY

No HSE incidents to report. Full project brief and HSE discussion held with all survey and vessel personnel.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	M	12:00	22:30
Operational	O	00:00	00:00
Transit	T	00:00	00:00
Weather	W	00:00	00:00
Equipment Down	ED	00:00	00:00
Vessel Down	VD	00:00	00:00
Any Other	AO	00:00	00:00
TOTALS (Day)		**1**	**2**

GEOPHYSICAL WORK PROGRESS

Bathymetry (MBES)	0%
Sidescan Sonar (SSS)	0%
Sub-Bottom Profiler (SBP)	0%
Magnetometer (MAG)	0%
TOTAL	**0%**

DAILY SUMMARY

Vessel mobilisation continued today. The MBES was installed on the port side of the vessel and data quality tested within the Grimsby Fish Docks. A dynamic position calibration was conducted followed by an alongside independent position verification.

UPCOMING PLAN

A further dynamic position verification will be conducted tomorrow morning prior to departing Grimsby Fish Docks. MBES calibrations and towed sensor position verifications will be conducted. It is therefore currently planned that survey operations will commence on Thursday (27/2/22) morning.

5035_Sugar_Geophysical — ABP mer — 26/01/2022

PERSONNEL

Survey Team	Vessel Team
Paul Clement	Nick Bush
Ian Davidson	Deepak
Hugh MacKay	

DAILY LOG

TIME	CODE	EVENT
08:00	M	Survey personnel onboard Wessex Explorer
09:40	M	Vessel slips ropes for dynamic positioning verification check
10:15	M	Vessel alongside to conduct static position verification check
10:45	M	Vessel departs Grimsby Fish Dock
11:15	M	Arrive at calibration site
11:25	M	MBES pole deployed
11:40	M	SVP001 deployed
12:20	M	Commence MBES calibration
13:15	M	Complete MBES calibration
13:30	M	SSS deployed for SSS position verification
14:15	M	SSS position verification complete
14:45	M	SBP deployed for SBP position verification and data optimisation
16:45	M	SBP verification and optimisation complete
17:05	M	MAG deployed for MAG position verification
17:40	M	MAG position verification complete
17:45	M	MBES pole recovered - begin transit to Grimsby
18:25	M	Alongside Grimsby Fish Docks
18:30	M	Depart vessel

WEATHER FORECAST

00	14kt	to	31kt	6c
03	15kt	to	32kt	8c
06	14kt	to	27kt	9c
09	12kt	to	25kt	7c
12	15kt	to	27kt	9c
15	15kt	to	27kt	9c
18	10kt	to	23kt	7c
21	7kt	to	18kt	5c
Fri 28 GMT				
00	5kt	to	7kt	3c
03	4kt	to	5kt	3c
06	5kt	to	6kt	3c
09	6kt	to	14kt	4c
12	10kt	to	21kt	7c
15	10kt	to	24kt	8c

HSE SUMMARY

No HSE incidents to report. Vessel induction and TBT for equipment deployment/recovery procedure held prior to departing Grimsby Fish Docks.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	M	10:30	33:00
Operational	O	00:00	00:00
Transit	T	00:00	00:00
Weather	W	00:00	00:00
Equipment Down	ED	00:00	00:00
Vessel Down	VD	00:00	00:00
Any Other	AO	00:00	00:00
TOTALS (Day)		**1**	**3**

GEOPHYSICAL WORK PROGRESS

Bathymetry (MBES)	0%
Sidescan Sonar (SSS)	0%
Sub-Bottom Profiler (SBP)	0%
Magnetometer (MAG)	0%
TOTAL	**0%**

DAILY SUMMARY

Further dynamic and static position verifications were successfully completed this morning prior to departing Grimsby Fish Docks. The vessel transited to an outfall location where an MBES calibration and towed sensor position verifications were successfully conducted. Time was spent on optimising the data quality of the SBP.

UPCOMING PLAN

Survey operations will commence at the Immingham survey are tomorrow. Only MBES data will be acquired initially to provide water depth information, and to enable a full familiarisation of the difficult survey site prior to deploying the towed sensors.

5035_Sugar_Geophysical

ABP mer

27/01/2022

PERSONNEL

Survey Team	Vessel Team
Paul Clement	Nick Bush
Ian Davidson	Deepak
Hugh MacKay	

DAILY LOG

TIME	CODE	EVENT
07:00	O	Survey personnel onboard Wessex Explorer
07:15	O	Depart Grimsby Fish Docks
07:45	O	Comms with Ch69 (APC) and Ch68 (Immingham Dock) to make aware of our arrival at site
08:00	O	Await movement of Solway Fisher vessel
08:45	O	MBES pole and SVP001 deployed
09:45	O	Commence MBES only operations
10:40	O	SVP002 deployed
10:45	O	Boomer deployed to run SBP and MBES
12:00	O	Boomer recovered
12:10	O	MBES data acquired inshore at high water
13:45	O	Boomer deployed to continue SBP operations
15:00	O	SVP003 deployed
17:40	O	All equipment recovered
18:45	O	Alongside Grimsby Fish Docks
19:00	O	Depart vessel

WEATHER FORECAST

00	5kt	to	7kt	4c
03	4kt	to	5kt	4c
06	5kt	to	9kt	3c
09	7kt	to	15kt	4c
12	10kt	to	19kt	7c
15	11kt	to	25kt	8c
18	13kt	to	29kt	8c
21	12kt	to	28kt	9c
Sat 29 GMT				
00	14kt	to	31kt	9c
03	16kt	to	30kt	11c
06	15kt	to	30kt	10c
09	17kt	to	36kt	11c
12	23kt	to	45kt	12c
15	19kt	to	37kt	8c

HSE SUMMARY

No HSE incidents to report. TBT held to discuss required radio communications and equipment deployment/recovery.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	M	10:30	33:00
Operational	O	12:00	12:00
Transit	T	00:00	00:00
Weather	W	00:00	00:00
Equipment Down	ED	00:00	00:00
Vessel Down	VD	00:00	00:00
Any Other	AO	00:00	00:00
TOTALS (Day)		**1**	**4**

GEOPHYSICAL WORK PROGRESS

Bathymetry (MBES)	30%
Sidescan Sonar (SSS)	0%
Sub-Bottom Profiler (SBP)	40%
Magnetometer (MAG)	0%
TOTAL	**20%**

DAILY SUMMARY

Survey operations commenced this morning. Only MBES was acquired initially to enable a full reconnaissance of the 'difficult' survey site. Over high water MBES data was acquired up to the required -2m CD contour. Boomer and MBES data were then acquired at 10m line spacing within the proposed berth pocket. Due to the relative size of the site and the complexities of running so close to existing structures it has been decided that we will not run all sensors concurrently.

UPCOMING PLAN

The vessel will return to site tomorrow and continue MBES/SBP operations. It is expected that SBP operations will be close to completion by end of tomorrow so that SSS/Mag operations can commence on Saturday.

5035_Sugar_Geophysical

ABP mer

28/01/2022

PERSONNEL

Survey Team	Vessel Team
Paul Clement	Nick Bush
Ian Davidson	Deepak
Hugh MacKay / Tim Holgate	

DAILY LOG

TIME	CODE	EVENT
06:45	O	Survey personnel onboard Wessex Explorer
07:00		Vessel induction for Tim Holgate
07:15	O	Depart Grimsby Fish Docks
08:00	O	Comms with Ch69 (APC) and Ch68 (Immingham Dock) to make aware of our arrival at site
08:10	O	Arrive at survey site
08:20	O	MBES pole and SVP004 deployed
08:45	O	Continue MBES/SBP operations
12:05	O	SVP005 deployed
15:10	O	SVP006 deployed
17:35	O	Equipment recovered
17:40	O	Begin return transit to Grimsby
18:30	O	Alongside Grimsby Fish Docks
18:45	O	Depart vessel

WEATHER FORECAST

00	13kt	to	30kt	9c
03	17kt	to	33kt	10c
06	17kt	to	35kt	10c
09	22kt	to	44kt	11c
12	25kt	to	45kt	11c
15	19kt	to	38kt	9c
18	16kt	to	31kt	7c
21	12kt	to	24kt	5c
Sun 30 GMT				
00	10kt	to	22kt	4c
03	6kt	to	17kt	2c
06	4kt	to	5kt	1c
09	3kt	to	3kt	2c
12	8kt	to	10kt	5c
15	9kt	to	16kt	6c

HSE SUMMARY

No HSE incidents to report. Vessel induction for Tim Holgate and TBT for equipment deployment/recovery.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	M	10:30	33:00
Operational	O	12:00	24:00
Transit	T	00:00	00:00
Weather	W	00:00	00:00
Equipment Down	ED	00:00	00:00
Vessel Down	VD	00:00	00:00
Any Other	AO	00:00	00:00
TOTALS (Day)		**1**	**5**

GEOPHYSICAL WORK PROGRESS

Bathymetry (MBES)	60%
Sidescan Sonar (SSS)	0%
Sub-Bottom Profiler (SBP)	90%
Magnetometer (MAG)	0%
TOTAL	**40%**

DAILY SUMMARY

The vessel returned to site today and MBES/SBP operations continued. After preliminary processing of yesterdays SBP files, results show that average penetration below the seabed is 10-15m, with some isolated features visible down to 20+m. This lower than expected penetration is due to the seabed composition of the area. However, tests have been run with different boomer settings to see if the penetration can be improved.

UPCOMING PLAN

Further QA of the SBP data will take place and additional survey lines / infills will be run if deemed necessary. MAG and SSS data lines will be run tomorrow.

5035_Sugar_Geophysical — ABP mer — 29/01/2022

PERSONNEL

Survey Team	Vessel Team
Paul Clement	Nick Bush
Ian Davidson	Deepak
Hugh MacKay / Tim Holgate	

DAILY LOG

TIME	CODE	EVENT
06:45	O	Survey personnel onboard Wessex Explorer
07:15	O	Depart Grimsby Fish Docks
08:00	O	Comms with Ch69 (APC) and Ch68 (Immingham Dock) to make aware of our arrival at site
08:10	O	Arrive at survey site
08:15	O	TBT for equipment deployment and to discuss additional risks due to expected deteriorating weather conditions.
08:15	O	MBES pole and SVP007 deployed
08:20	O	SSS and MAG deployed from stern
09:20	O	Commence SSS/MAG survey at 20m spacing
11:00	O	Wind increasing and gusting 40knts
13:00	O	Further increase in wind speed
14:15	W	Decision made to end survey due to conditions
14:30	W	All equipment recovered
14:35	W	Begin return transit to Grimsby
15:35	W	Alongside Fish Docks
16:00	W	Depart vessel
18:45	W	Continue geophysical data QA.

WEATHER FORECAST

Sun 30 GMT				
00	9kt	to	21kt	4c
03	6kt	to	16kt	2c
06	4kt	to	4kt	1c
09	3kt	to	3kt	2c
12	8kt	to	12kt	6c
15	11kt	to	18kt	6c
18	14kt	to	30kt	5c
21	18kt	to	36kt	7c
Mon 31 GMT				
00	26kt	to	48kt	6c
03	24kt	to	46kt	6c
06	22kt	to	44kt	4c
09	19kt	to	39kt	4c
12	16kt	to	31kt	6c

HSE SUMMARY

TBT held prior to survey operations to discuss SSS/MAG deployments and additional risks due to expected increasing weather conditions.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	M	10:30	33:00
Operational	O	07:30	31:30
Transit	T	00:00	00:00
Weather	W	04:30	04:30
Equipment Down	ED	00:00	00:00
Vessel Down	VD	00:00	00:00
Any Other	AO	00:00	00:00
TOTALS (Day)		**1**	**6**

GEOPHYSICAL WORK PROGRESS

Bathymetry (MBES)	60%
Sidescan Sonar (SSS)	70%
Sub-Bottom Profiler (SBP)	90%
Magnetometer (MAG)	70%
TOTAL	**65%**

DAILY SUMMARY

The weather forecast for today was poor with very high winds expected. However, due to the sheltered survey area the vessel transited to site to continue survey operations. SSS and MAG data was acquired at 20m spacing. As forecast, wind speeds increased and gusts were observed to exceed 40knts. Therefore the decision was made to recover the equipment and return to Grimsby. Further data QA took place when back at accommodation.

UPCOMING PLAN

With conditions forecast to be better tomorrow, the vessel will return to site to continue survey operations. Further boomer lines will be run at 200J power setting to see if greater penetration can be achieved. MAG and SBP lines will be acquired inshore over the High Water. Subject to further data QA, it is currently expected that the survey will be completed by the end of Monday (31st Jan 22).

5035_Sugar_Geophysical — ABP mer — 30/01/2022

PERSONNEL

Survey Team	Vessel Team
Paul Clement	Nick Bush
Ian Davidson	Deepak
Hugh MacKay / Tim Holgate	

DAILY LOG

TIME	CODE	EVENT
06:45	O	Survey personnel onboard Wessex Explorer
07:15	O	Depart Grimsby Fish Docks
08:20	O	Comms with Ch69 (APC) and Ch68 (Immingham Dock) to make aware of our arrival at site
08:25	O	Arrive at survey site
08:30	O	MBES pole and SVP008 deployed
08:50	O	SSS deployed
09:10	O	Commence SSS/MBES lines
11:00	O	MAG deployed
11:05	O	Commence SSS/MAG crosslines
12:00	O	SSS/MAG recovered. Deploy SBP
12:05	O	Continue SBP lines at 200J
13:30	O	SBP recovered. Deploy SSS/MAG
15:25	O	Complete all required SSS/MAG lines
15:30	O	Recover SSS/MAG. Deploy SBP
16:40	O	Complete all required SBP lines
16:55	O	SBP and MBES pole recovered
17:00	O	Begin transit back to Grimsby
18:05	O	Alongside Grimsby Fish Docks
18:15	O	Depart vessel.

WEATHER FORECAST

Mon 31 GMT				
00	23kt	to	44kt	6C
03	25kt	to	46kt	5C
06	22kt	to	41kt	4C
09	18kt	to	34kt	3C
12	16kt	to	33kt	5C
15	12kt	to	25kt	5C
18	7kt	to	19kt	3C
21	10kt	to	24kt	3C
Tue 1 GMT				
00	9kt	to	23kt	5C
03	12kt	to	28kt	7C
06	16kt	to	32kt	9C
09	18kt	to	33kt	10C
12	21kt	to	35kt	11C
15	19kt	to	35kt	11C

HSE SUMMARY

No HSE incidents to report.

CUMULATIVE TIME

ITEM	CODE	TODAY	TOTAL
Mob/Demob	M	10:30	33:00
Operational	O	12:00	43:30
Transit	T	00:00	00:00
Weather	W	04:30	04:30
Equipment Down	ED	00:00	00:00
Vessel Down	VD	00:00	00:00
Any Other	AO	00:00	00:00
TOTALS (Day)		**1**	**7**

GEOPHYSICAL WORK PROGRESS

Bathymetry (MBES)	100%
Sidescan Sonar (SSS)	95%
Sub-Bottom Profiler (SBP)	95%
Magnetometer (MAG)	95%
TOTAL	**98%**

DAILY SUMMARY

Weather conditions were excellent today and the vessel remained onsite throughout. Subject to data QA, all required lines have been acquired (SBP at 10m spacing, MAG at 20m spacing, full coverage MBES/SSS). A full data review will now take place to ensure all data is of good quality. Unfortunately running the SBP at a higher power setting has not improved the penetration due to the suspected peat layer.

UPCOMING PLAN

Weather conditions are expected to be poor tomorrow. However, if data QA flags up a requirement for some reruns, the vessel will transit to site if conditions allow. A discussion will be had with the ABP project manager in the morning. If in agreement the vessel will be demobilised.

C Equipment Specifications

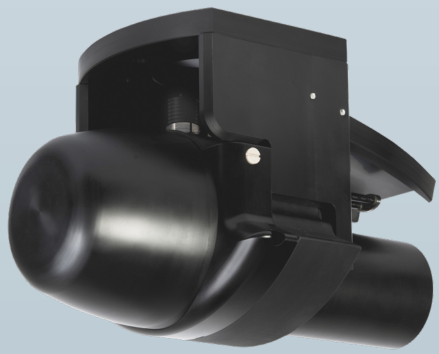
NORBIT
- explore more -

NORBIT - iWBMSh
HIGH-END TURNKEY MULTIBEAM SONAR SYSTEM

For High Resolution Bathymetric Survey In All Conditions

Go-anywhere, go-anytime ultra-high resolution curved-array bathymetric mapping solution featuring industry leading GNSS/INS positioning system from NORBIT.

This most compact, highest resolution, tightly integrated, broadband multibeam sonar solution offering a curved array and GNSS/INS that is suited for the most demanding environments (Applanix OceanMaster). The iWBMSh is ready for rapid mobilisation and delivers highest XYZ performance for the price.



The iWBMSh is fully integrated with the highest performing sensors to work in the most challenging environments (under bridges or in rough sea conditions). Small form factor, low power draw and tight integration allow installation on any survey platform (permanent hull mount or pole mount). Hands-free system tuning ensures quality data on the first survey. The WBMS sonars are based on a state of the art analogue, and digital platform featuring powerful signal processing capabilities, offering roll stabilised bathymetry and several imagery and backscatter output. With broad R&D expertise, NORBIT has developed, from the ground-up, exciting new technology that allows existing and new applications to benefit from the advantages offered by a compact wideband curved-array multibeam sonar. Supported by DCT (Data collection Tool) for data acquisition.

Features

- ✓ Multibeam Sonar with Integrated Inertial Navigation System & Integrated NTRIP Client.
- ✓ 80kHz Bandwidth
- ✓ Roll-stabilisation
- ✓ Backscatter outputs (Intensity, Sidescan, Sidescan Snippets, Snippets, Water Column)
- ✓ Multidetect
- ✓ Simple Ethernet Interface
- ✓ Integrated Sound Velocity Probe
- ✓ Hydrodynamic Fairing
- ✓ Mounting Bracket Included
- ✓ FM & CW Processing
- ✓ Exceeds IHO *Special Order,* CHS *Exclusive Order* & USACE *New Work*

Applications

- ✓ Coastal Zone and Offshore Bathymetry
- ✓ Pipeline Surveys
- ✓ Pond, River and Estuary Surveys
- ✓ Harbor and Lake Surveys
- ✓ USV & UUV Ready

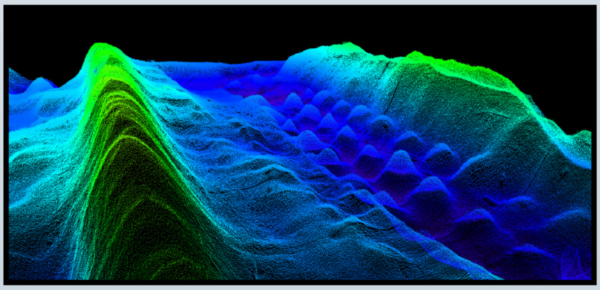
Options

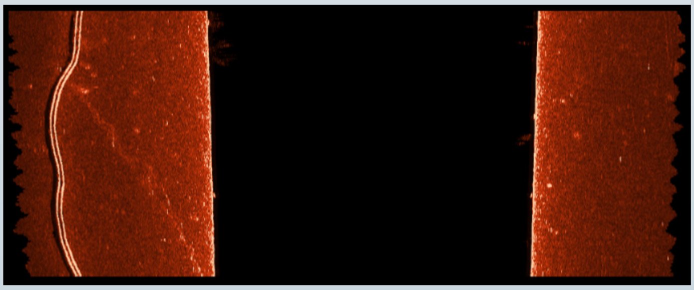
- ✓ Senior Hydrographer for Support and Training
- ✓ Sound Velocity Profiler
- ✓ Laptop
- ✓ Data Collection Tool (DCT)
- ✓ Turnkey Survey Solutions
- ✓ Permanent Hull Mount Option
- ✓ Pole Mount and Travel Option
- ✓ Narrow Beam Option
- ✓ Backscattering Strenght Output
- ✓ Acquisition, Navigation and Post Processing Software
- ✓ Can be Delivered with Software Packages e.g. DCT, HYPACK, Qinsy, EIVA, CARIS and Others

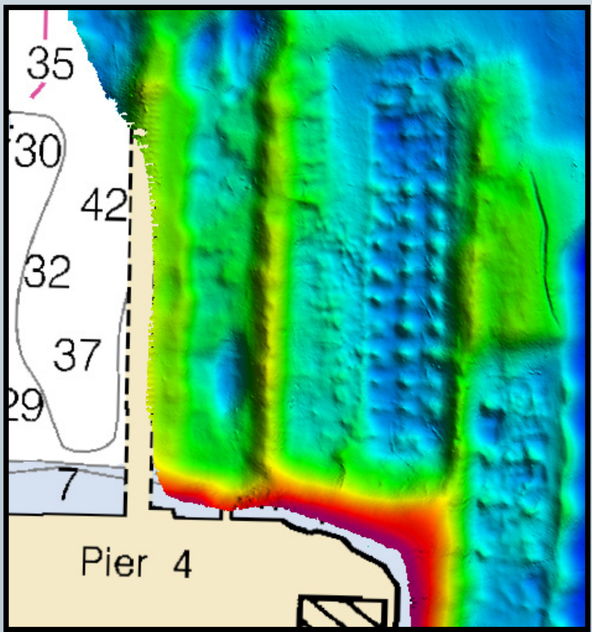
[redacted]

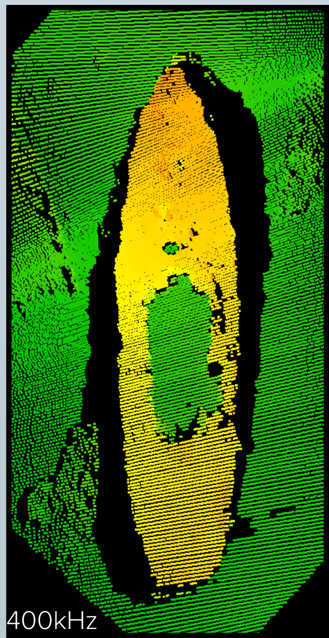
NORBIT High-End Turnkey Multibeam Sonar System

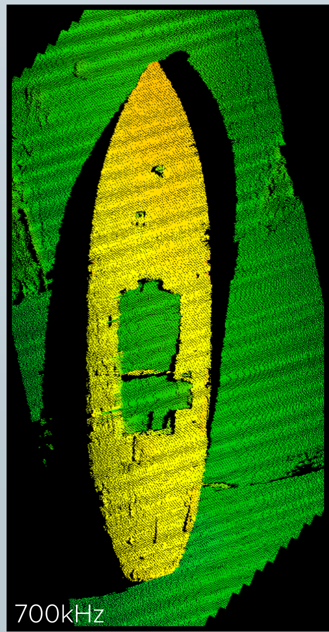
For High Resolution Bathymetric Survey In All Conditions





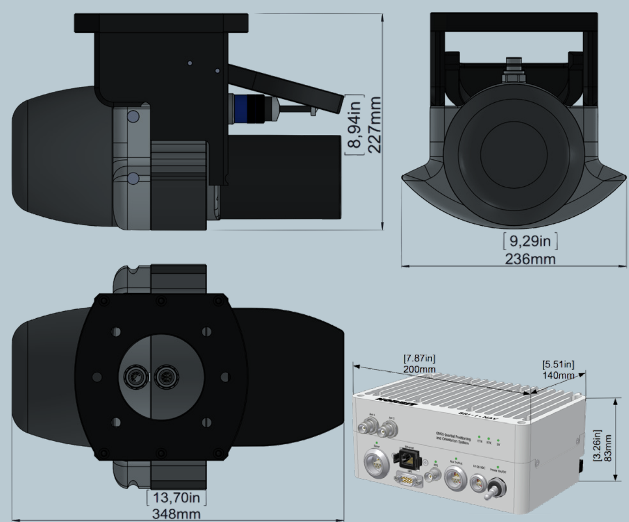






TECHNICAL SPECIFICATION

SWATH COVERAGE	5-210° FLEXIBLE SECTOR (SHALLOW WATER IHO SPECIAL ORDER >155°)
RANGE RESOLUTION	<10mm ACOUSTIC W. 80kHz BANDWIDTH
NUMBER OF BEAMS	256-512 EA & ED
OPERATING FREQUENCY	NOMINAL FREQUENCY 400kHz (FREQUENCY AGILITY 200-700kHz)
DEPTH RANGE	0.2-275m (160m TYPICAL)
PING RATE	UP TO 60Hz, ADAPTIVE
RESOLUTION (ACROSS X ALONG)	STANDARD: 0.9° X 1.9° @400kHz AND 0.5° X 1.0° @700kHz. NARROW OPTION: 0.9° X 0.9° @400kHz AND 0.5° X 0.5° @700kHz
POSITION	HOR: ±(8mm +1ppm X DISTANCE FROM RTK STATION) VER: ±(15mm +1ppm X DISTANCE FROM RTK STATION) *(ASSUMES 1m GNSS SEPARATION)*
HEADING ACCURACY	0.02° (RTK) WITH 2m ANTENNA SEPARATION
PITCH/ROLL ACCURACY	0.01° INDEPENDENT OF ANTENNA SEPARATION
HEAVE ACCURACY	2 cm OR 2% (TRUEHEAVE™), 5 cm OR 5% (REAL TIME)
WEIGHT	8.5kg (AIR) 3.5kg (WATER)
INTERFACE	ETHERNET
CABLE LENGTH	STD: 8m, OPTIONS: 2m, 25m AND 50m
POWER CONSUMPTION	60W (10-28VDC, 110-240VAC)
OPERATING TEMP.	-4°C to +40°C (TOPSIDE -20°C to +55°C)
STORAGE TEMP.	-20°C TO +60°C
ENVIRONMENTAL	TOPSIDE: IP67: DUST TIGHT, PROTECTED AGAINST THE EFFECT OF IMMERSION UP TO 1m/WET-END (SONAR): 100m



Part #12007-AACDB4

NORBIT SUBSEA | STIKLESTADVEIEN 1 | N-7041 TRONDHEIM | NORWAY | PHONE +47 73 98 25 50 | subsea@norbit.com

SWiFT SVP

Sound Velocity /Temperature/ Pressure
Salinity /Conductivity / Density

Designed from the outset with the intention of a seamless workflow, the SWiFT profiler provides survey-grade sensor technology coupled with the convenience of Bluetooth connectivity and rechargeable batteries. An integral GPS module, to geo-locate each profile, completes the package. Data can be easily and quickly downloaded and reviewed wirelessly, via Bluetooth, using the SWiFT App on iOS devices and instantly shared, in industry standard SVP formats through email and cloud services. Using the provided USB adapter or cable, Valeport's DataLog x2 software package provides further tools.

In addition to the directly measured sound speed, temperature and pressure observations, Conductivity, Salinity and Density are calculated using Valeport's proprietary algorithm developed from extensive laboratory and field work.

With an operational battery life of up to 5 days and the convenience of charging via USB, SWiFT is intended for coastal, harbour and inland hydrographic survey use and offers the highest quality sound velocity profiles in a compact, robust and portable package.

Optionally, the supplied deployment weight is available to bolt onto the sensor protection cage to help get the SWiFT to depth in fast flowing currents.

Sensor Specifications

The SWiFT SVP is fitted with Valeport's digital time of flight sound velocity sensor, temperature compensated piezo-resistive pressure transducer and a PRT temperature sensor

Sound Velocity	
Range:	1375 – 1900 m/s
Resolution:	0.001 m/s
Accuracy:	±0.02 m/s

Pressure	
Range:	10 Bar or 20Bar
Resolution:	0.001% FS
Accuracy:	±0.05% FS

Temperature	
Range:	-5°C to +35°C
Resolution:	0.001°C
Accuracy:	±0.01°C

Calculated Accuracies

Conductivity:	±0.05 mS/cm
Salinity:	±0.05 PSU
Density:	±0.05 kg/m^3

Physical

Materials:	Titanium Stainless Steel deployment weight
Depth Rating:	200m
Dimensions:	Ø78mm x Length 277mm
	321mm with deployment weight
Weight:	2.0kg (in air) / 0.9kg (in water)
	3.0kg (in air) /1.8kg (in water) with deployment weight

Communications (set up and data offload)

USB Serial
Bluetooth v4 - low energy

Memory

2 GB Internal Flash Card Storage

Electrical

Battery:	Internal Rechargeable Battery Pack
Battery Life:	Up to 5 days of operations
Charging:	USB typically, 1 hour fast charging will give 12 hours operation

Software

iOS App for Bluetooth 4 compatible iPad and iPhone – instrument set up, data offload, display and translation to common SVP formats, Android to follow.
DataLog x2 Windows based PC software, with both USB cable and Bluetooth 4 connectivity, for instrument setup, data extraction, display and translation to common SVP formats.

Ordering

0660047 XX	SWIFT SVP Profiler - Titanium housing rated to 200m
Note:	XX pressure transducer range - select from 10 or 20 Bar
	Supplied with: • Deployment weight • 20m deployment line • PC Bluetooth adapter • USB interface and charging cable • 1.5 A charger • DataLog x2 software, operating manual • System transit case

Valeport Limited, St. Peter's Quay Totnes, Devon, TQ9 5EW UK
t. +44 (0)1803 869292 f. +44 (0)1803 869293 e. sales@valeport.co.uk [redacted]

Applied Acoustic Engineering Ltd
Marine House, Marine Park, Gapton Hall Road, Great Yarmouth, NR31 0NB, United Kingdom

AA251, AA301 Boomer Seismic Sound Source

Key Features

- **Stable pulse shape clarity with minimum reverberation**
- **Rugged mechanical design with weight kept to a minimum**
- **Supplied as individual product, or with a catamaran**
- **Supplied with RMK connectors and locking collars as standard.**
- **AA251 forms part of the Inshore Boomer System, ideal for coastal surveys**
- **AA301 ideal for nearshore and shallow water surveys (up to 120m) depending on geology**

The AA251 and AA301 boomer plates are seismic sound sources that produce a sharp repeatable pulse from a floating position on the sea surface.

The AA251, deployed on either a robust CAT100 or CAT200 catamaran, is ideal for inshore surveys from small craft.

The AA301 is designed for higher power applications and can also be used as a variable frequency boomer when combined with the CSP-D range of energy sources.

Technical Specification

PHYSICAL

	Size	Weight air/water	Fixing centres	Connector
AA251 Boomer plate	380 x 380mm	18kg/10kg	315mm^2	RMK 1/0
AA301 Boomer plate	620 x 520mm	25kg/14kg	485mm x 440mm	RMK 1/0

ELECTRICAL INPUT

Recommended energy	AA251	50 – 200J/shot
	AA301	100 – 300J/shot
Maximum energy	AA251	300J/shot
	AA301	350J/shot

AA251, AA301 Technical Specification continued...

Average energy	AA251	600J/second
	AA301	1000J/second
Operating voltage	3600 to 4000Vdc	

SOUND OUTPUT

Source level	AA251	Typically 212dB re 1µPa at 1 metre with 200J
	AA301	Typically 215dB re 1µPa at 1 metre with 300J
Pulse length	AA251	120/150/180µs at 50/100/200J
	AA301	200µs depending on energy setting of CSP
Reverberation	AA251	<10% of initial pulse
	AA301	<10% of initial pulse

COMPATIBLE ENERGY SOURCES

AA251	CSP-L, CSP-P, CSP-D, CSP-N, CSP-S1250, CSP-S4000, CSP-S6000
AA301	CSP-P, CSP-D, CSP-N, CSP-S1250, CSP-S4000, CSP-S6000

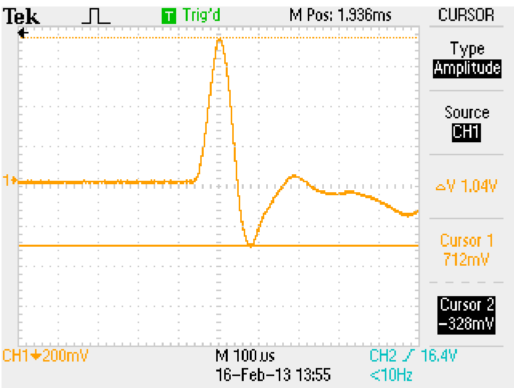
COMPATIBLE CATAMARAN

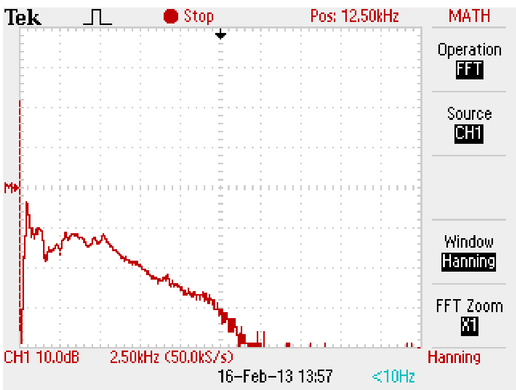
AA251	CAT 100:	940 (L) x 740 (W) x 500 (H) mm
	CAT 200:	1280 (L) x 915 (W) x 525 (H) mm
AA301	CAT 200:	1280 (L) x 915 (W) x 525 (H) mm
	CAT 300:	1700 (L) x 660 (W) 490 (H) mm

COMPATIBLE HV CABLE

AA251 and AA301	HVC 2000
	Standard length 50m
	RMK 1/0 connectors complete with locking collars

AA301 TYPICAL PULSE SIGNATURE AT 300J





APPLIED ACOUSTICS
Underwater Technology

Due to continual product improvement, specification information may be subject to change without notice.
AA251, AA301 Boomers/Jan 2015

Registration No. U6447
BS: EN: ISO9001

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APPLIED ACOUSTICS
Underwater Technology

Applied Acoustic Engineering Ltd
Marine House, Marine Park, Gapton Hall Road, Great Yarmouth, NR31 0NB, United Kingdom

CSP-P Seismic Energy Source

The CSP-P is a small, light 350 Joule power source intended primarily as a boomer power supply but it can be used with small sparkers.

Recently upgraded, the CSP-P now incorporates dual-voltage technology that allows the operator to tune the sound source to a particular application for improved data quality.

Key Features

- **Incorporates dual-voltage technology for exceptional versatility**
- **Variable Input Power Circuitry for 'soft start'**
- **Proprietary pulse shaping circuitry for high resolution data**
- **Additional safety/protection features**
- **All settings externally selectable**
- **LED fault indicators**
- **High current and voltage solid state (semi-conductor) discharge method**
- **Meets EC emissions regulations enabling interference-free field use**
- **Supplied in robust transit case, with HV junction box (HVJ2000), mains lead and HV connector plug**

Technical Specification

PHYSICAL

Size	Transit Case (4U) with cover in place and handles flat: 29cm(H) x 56cm(W) x 56cm(D)
Weight	CSP-P, case and cover: 35kg

ELECTRICAL SPECIFICATION

Mains Input	110 or 240Vac (fixed) 45-65Hz@2.0kVA single phase. 3 pin connector Variable Input Power Circuitry (AVIP) 'soft start' circuitry
Voltage Output	2500 to 3950 Vdc, 4 pin interlocked connector Solid state semi-conductor discharge method
Output Energy	Easy switch selectable in increments 50,100,150,200,300 and 350 Joules
Charging Rate	1500J/second for continuous operation at 0-45°C ambient

CSP-P Technical Specification continued…

Capacitance	48µF at 10^8 shot life
Trigger	+ve key opto isolated or isolated closure set by front panel switch BNC connector on front panel and remote box (optional)
Repetition rate	6pps max Limited by charge rate, energy level and sound source rating
Earth	M8 stainless steel stud on front panel

SAFETY FEATURES

Main electronic control circuits and secondary layer of safety circuitry
Specially designed HV connector with interlock
High speed dump resistors for high voltage components
Capacitor bleed resistors
Open circuit shutdown
Timer shutdown
Output current monitor and shutdown
Over temperature shut-down
Cover and connector interlocks
HV fault indicator for internal temperature, low input voltage or capacitor fault
Remote control available for triggering and operation

The unit's internal design has a modular construction for ease of servicing and capacitor replacement. However, for safety reasons, only Applied Acoustics trained engineers should attempt a repair.

COMPATIBLE SOUND SOURCES

AA201, AA251 and AA301 Boomer plates
Squid 501 Sparker

EQA European Quality Assurance
UKAS Management Systems 047
Registration No. U6447
BS: EN: ISO9001

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Applied Acoustic Engineering Ltd
Marine House, Marine Park, Gapton Hall Road, Great Yarmouth, NR31 0NB, United Kingdom

Streamer Hydrophones

High quality streamer hydrophones available as 1, 8, 12 or 20 element MF designs and 24 element LF design. Each is supplied with a pre-amplifier and connectors for standard seismic acquisition systems.

Key Features

- **Filled with silicon oil for neutral buoyancy**
- **Supplied with robust 50m tow leader**
- **Complete with pre-amplifier**
- **Standard models and customised units with grouped elements available**
- **Medium frequency and low frequency versions**

Technical Specification

Streamer hydrophone, fluid filled with multi-elements

Model number	AH1	AH360/8
Tow leader	50m	50m
Array Tube type	Polyurethane	Polyurethane
Array tube length	4.5m	4.5m
Number of elements	1	8
Element spacing	n/a	360mm
Array sensitivity	-187dB ref 1V per µPa	-169dB ref 1V per µPa
Fluid type	Polydimethylsiloxane, PMX561	Polydimethylsiloxane, PMX561
Power	Battery, 9V alkaline, PP3/MN1604	Battery, 9V alkaline, PP3/MN1604
Frequency response	140Hz to 10kHz (-3dB)	140Hz to 10kHz (-3dB)
Signal output	Up to 8V peak to peak	Up to 8V peak to peak
Preamp	Single ended, fixed gain	Single ended, fixed gain
Connector type	BNC, 50/75 ohm cable can be used	BNC, 50/75 ohm cable can be used
Elements		
Dimensions	55 x 16 x 10 mm	55 x 16 x 10 mm
Sensitivity	-187dB ref 1V per µPa	-187dB ref 1V per µPa
Depth recoverable	30m max	30m max
Operating depth	Typical 10m	Typical 10m
Type	Non acceleration cancelling	Non acceleration cancelling
Resonance	@ 9 kHz	@ 9 kHz

Streamer Hydrophones Continued…

Model number	AH250/12	AH150/20
Tow leader	50m	50m
Array Tube type	Polyurethane	Polyurethane
Array tube length	4.5m	4.5m
Number of elements	12	20
Element spacing	250mm	150mm
Array sensitivity	-165dB ref 1V per µPa	-161dB ref 1V per µPa
Fluid type	Polydimethylsiloxane, PMX561	Polydimethylsiloxane, PMX561
Power	Battery, 9V alkaline, PP3/MN1604	Battery, 9V alkaline, PP3/MN1604
Frequency response	140Hz to 10kHz (-3dB)	140Hz to 10kHz (-3dB)
Signal output	Up to 8V peak to peak	Up to 8V peak to peak
Preamp	Single ended, fixed gain	Single ended, fixed gain
Connector type	BNC, 50/75 ohm cable can be used	BNC, 50/75 ohm cable can be used
Elements		
Dimensions	55 x 16 x 10 mm	55 x 16 x 10 mm
Sensitivity	-187dB ref 1V per µPa	-187dB ref 1V per µPa
Depth recoverable	30m max	30m max
Operating depth	Typical 10m	Typical 10m
Type	Non acceleration cancelling	Non acceleration cancelling
Resonance	@ 9 kHz	@ 9 kHz

Model number	AH365/20	AH610/24LF (Low Frequency)
Tow leader	50m	50m
Array Tube type	Polyurethane	Polyurethane
Array tube length	10m	14
Number of elements	20	24
Element spacing	365mm	610mm
Array sensitivity	-161dB ref 1V per µPa	-162dB ref 1V per µPa
Fluid type	Polydimethylsiloxane, PMX561	Polydimethylsiloxane, PMX561
Power	Battery, 9V alkaline, PP3/MN1604	24Vdc
Frequency response	140Hz to 10kHz (-3dB)	115Hz to 7.2kHz (-3dB)
Signal output	Up to 8V peak to peak	Up to 8V peak to peak
Preamp	Single ended, fixed gain	Differential output, link adjustable gain
Connector type	BNC, 50/75 ohm cable can be used	BNC, 50/75 ohm cable can be used
Elements		
Dimensions	55 x 16 x 10 mm	53 x 20mm
Sensitivity	-187dB ref 1V per µPa	-192dB ref 1V per µPa
Depth recoverable	30m max	30m max
Operating depth	Typical 10m	Typical 10m
Type	Non acceleration cancelling	Acceleration cancelling
Resonance	@ 9 kHz	@ 9 kHz

Other element configurations are available to order

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4125
SIDE SCAN SONAR SYSTEM

FEATURES

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

APPLICATIONS

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

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

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

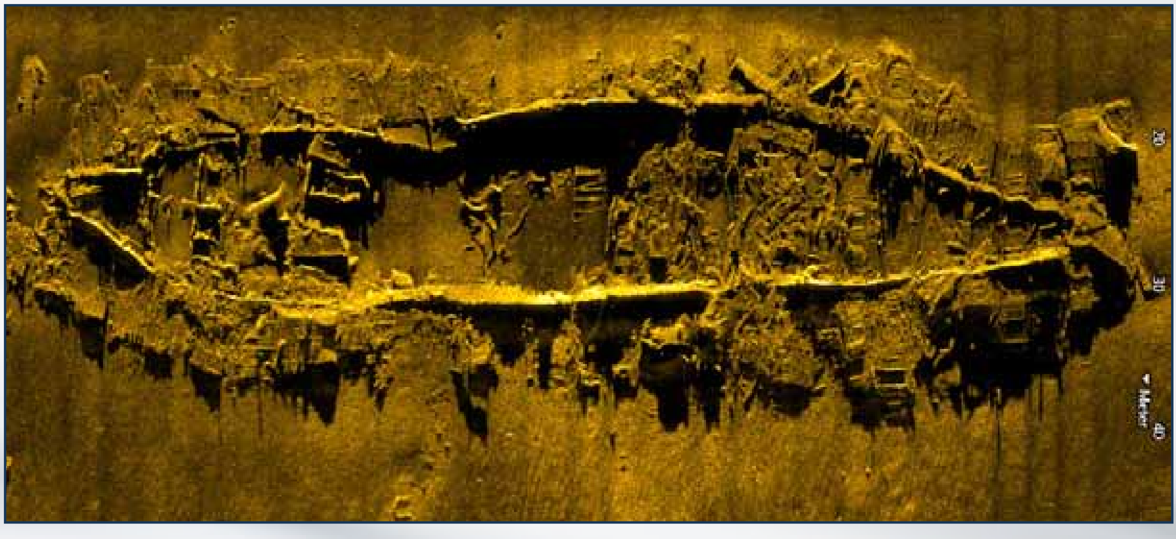
The 4125 system can be powered by both AC and DC for added versatility and is delivered in portable rugged cases for ease of transport from site-to-site. As is standard with all of EdgeTech's towed side scan systems, the 4125 comes with a safety recovery system which will prevent the loss of a towfish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

A standard 4125 System comes with a rugged stainless steel towfish and a portable water resistant topside processor including a laptop computer (Optional: Splash Proof/Ruggedized Laptop). A 50 meter Kevlar tow cable is included as standard with customer-specified lengths also available. Multiple options are available such as a v-fin depressor, keel weight, pole mount and hull scan bracket for added versatility.

4125
SIDE SCAN SONAR SYSTEM

KEY SPECIFICATIONS

SONAR	
Frequencies (Dual Simultaneous)	Choice of either a 400/900 kHz or 600/1600 kHz towfish
Pulse Type	EdgeTech's Full Spectrum® CHIRP
Operating Range	150m @ 400 kHz, 75m @ 900 kHz; 120m @ 600 kHz, 35m @ 1600 kHz
Horizontal Beam Width	0.46° @ 400 kHz, 0.28° @ 900 kHz; 0.33° @ 600 kHz, 0.20° @ 1600 kHz
Vertical Beam Width	50°
Resolution Across Track	400 kHz: 2.3 cm, 900 kHz: 1.0 cm, 600 kHz: 1.5 cm, 1600 kHz: 0.6 cm
TOWFISH	
Diameter	9.5 cm (3.75 inches)
Length	112 cm (44 inches)
Weight in Air	20 kg (44 pounds)
Tow Cable Type	Coaxial up to 600m max length (will provide a typical operational depth down to 200m)
Max Depth Rating of Towfish	200m
Material	Stainless Steel
Standard Sensors	Heading, Pitch, Roll, Pressure (Depth)
TOPSIDE PROCESSOR	
Power Input	12-24 VDC or 115/230 VAC, 50/60 Hz
Connections	AC, DC, Ethernet (to laptop), Towfish
Hardware	Laptop Computer (Optional: Splash Proof/Ruggedized Laptop)
Operating System	Windows® 7
Acquisition Software	EdgeTech DISCOVER
SYSTEM OPTIONS	Keel weight, v-fin depressor wing, pole mount, quick change hull scan bracket



For more information please visit [redacted]

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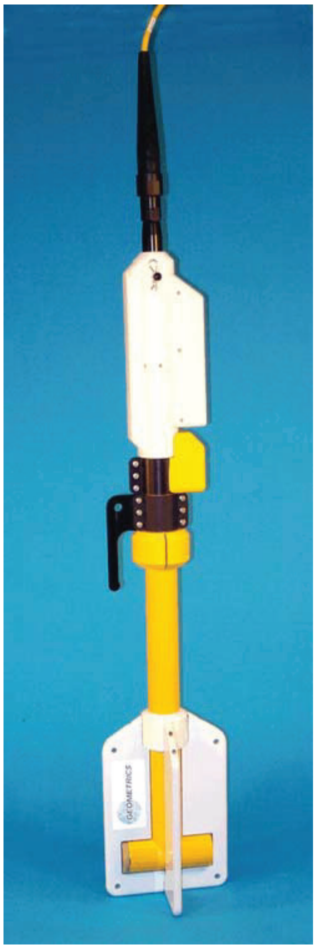
GEOMETRICS

G-882 MARINE MAGNETOMETER

- ***CESIUM VAPOR HIGH PERFORMANCE – Highest detection range and probability of detecting all sized ferrous targets***
- ***NEW STREAMLINED DESIGN FOR TOW SAFETY – Low probability of fouling in lines or rocks***
- ***NEW QUICK CONVERSION FROM NOSE TOW TO CG TOW – Simply remove a stainless steel locking pin, move tow point and reinsert. New easy carry handle built in!***
- ***NEW INTERNAL CM-221 COUNTER MODULE – Provides Flash Ram for storage of default parameters set by user***
- ***NEW ECHOSOUNDER / ALTIMETER OPTION***
- ***NEW DEPTH RATING – 4,000 psi !***
- ***HIGHEST SENSITIVITY IN THE INDUSTRY – 0.004 nT/Hz RMS with the internal CM-221 Mini-Counter***
- ***EASY PORTABILITY & HANDLING – no winch required- single man operation, 44 lbs with 200 ft cable (without weights or depressor wing)***
- ***COMBINE TWO SYSTEMS FOR INCREASED COVERAGE – Internal CM-221 Mini-Counter provides multi-sensor data concatenation allowing side by side coverage which maximizes detection of small targets and reduces noise***



G-882 with Weight Collar Depth Option

Very high resolution Cesium Vapor performance is now available has been incorporated into a low cost, small size system for professional surveys in shallow or deep water. High sensitivity and sample rates of total field measurements are maintained for all applications. The well proven Cesium sensor is combined with a unique new CM-221 Larmor counter and ruggedly packaged for small or large boat operation. Use your computer and standard printer with our MagLog Lite™ software to log, display and print GPS position and magnetic field data. Model G–882 is the lowest priced - highest performance fully operational marine mag system ever offered.

The G-882 is flexible for operation in small boat, shallow water surveys as well as deep tow applications (4,000 psi rating, telemetry over steel coax available to 10Km). Being small and lightweight (44 lbs net, no weights) it is easily deployed and operated by one man. But add several no-foul weight collars and the system can quickly weigh in at more than 100 lbs. Power may be supplied from a 24 to 30 VDC battery supply or the included 110/220 VAC power supply. The tow cable uses high strength Kevlar and it's length is standard at 200 ft (61 m) with optional cable up to 500m (no telemetry). The shipboard end of the tow cable is attached to a junction box or on-board cable for quick and simple hookup to power and output of data into any IBM PC computer. A rugged fiber-wound fiberglass housing provides selectable orientation of the sensor and therefore maintains operations throughout the world with only small limitations as to direction of survey in equatorial regions.

The G-882 Cesium magnetometer provides the same operating sensitivity and sample rates as the larger deep tow model G-880. MagLogLite™ Logging Software is offered with each magnetometer and allows recording and display of data and position with Automatic Anomaly Detection! Additional options include: MagMap2000 plotting and contouring software and post acquisition processing software MagPick™ (free from our website.)

The G-882 system is particularly well suited for the detection and mapping of all sizes of ferrous objects. This includes anchors, chains, cables, pipelines, ballast stone and other scattered shipwreck debris, munitions of all sizes, aircraft, engines and any other object with magnetic expression. Objects as small as a 5 inch screwdriver are readily detected provided that the sensor is close to the seafloor and within practical detection range.(Refer to table at right).

The design of this special marine unit is directed toward the largest number of user needs. It is not intended to meet all marine requirements such as deep tow through long cables or monitoring fish altitude. Rugged design with highest performance at lowest cost are the goals.

Typical Detection Range For Common Objects

Ship 1000 tons	0.5 to 1 nT at 800 ft (244 m)
Anchor 20 tons	0.8 to 1.25 nT at 400 ft (120 m)
Automobile	1 to 2 nT at 100 ft (30 m)
Light Aircraft	0.5 to 2 nT at 40 ft (12 m)
Pipeline (12 inch)	1 to 2 nT at 200 ft (60 m)
Pipeline (6 inch)	1 to 2 nT at 100 ft (30 m)
100 KG of iron	1 to 2 nT at 50 ft (15 m)
100 lbs of iron	0.5 to 1 nT at 30 ft (9 m)
10 lbs of iron	0.5 to 1 nT at 20 ft (6 m)
1 lb of iron	0.5 to 1 nT at 10 ft (3 m)
Screwdriver 5 inch	0.5 to 2 nT at 12 ft (4 m)
1000 lb bomb	1 to 5 nT at 100 ft (30 m)
500 lb bomb	0.5 to 5 nT at 50 ft (16 m)
Grenade	0.5 to 2 nT at 10 ft (3 m)
20 mm shell	0.5 to 2 nT at 5 ft (1.8 m)

MODEL G-882 CESIUM MARINE MAGNETOMETER SYSTEM SPECIFICATIONS

OPERATING PRINCIPLE:	Self-oscillating split-beam Cesium Vapor (non-radioactive)
OPERATING RANGE:	20,000 to 100,000 nT
OPERATING ZONES:	The earth's field vector should be at an angle greater than 6° from the sensor's equator and greater than 6° away from the sensor's long axis. Automatic hemisphere switching.
CM-221 COUNTER SENSITIVITY:	<0.004 nT/ √Hz rms. Typically 0.02 nT P-P at a 0.1 second sample rate or 0.002 nT at 1 second sample rate. Up to 10 samples per second
HEADING ERROR:	±1 nT (over entire 360° spin and tumble)
ABSOLUTE ACCURACY:	<3 nT throughout range
OUTPUT:	RS-232 at 9600 Baud
MECHANICAL:	
Sensor Fish:	Body 2.75 in. (7 cm) dia., 4.5 ft (1.37 m) long with fin assembly (11 in. cross width), 40 lbs. (18 kg) Includes Sensor and Electronics and 1 main weight. Additional collar weights are 14lbs (6.4kg) each, total of 5 capable
Tow Cable:	Kevlar Reinforced multiconductor tow cable. Breaking strength 3,600 lbs, 0.48 in OD, 200 ft maximum. Weighs 17 lbs (7.7 kg) with terminations.
OPERATING TEMPERATURE:	-30°F to +122°F (-35°C to +50°C)
STORAGE TEMPERATURE:	-48°F to +158°F (-45°C to +70°C)
ALTITUDE:	Up to 30,000 ft (9,000 m)
WATER TIGHT:	O-Ring sealed for up to 9000 ft (2750 m) depth operation
POWER:	24 to 32 VDC, 0.75 amp at turn-on and 0.5 amp thereafter
ACCESSORIES:	
Standard:	CM-201 View Utility Software operation manual and ship case
Optional:	Telemetry to 10Km coax, gradiometer (longitudinal or transverse)
MagLog Lite™ Software:	Logs, displays and prints Mag and GPS data at 10 Hz sample rate. Automatic anomaly detection and single sheet Windows printer support

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE ***4/03***

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