Rampion 2 Wind Farm

Category 6: Environmental Statement

Volume 4, Appendix 9.4 Geophysical survey (Part 1 of 7)

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Survey Report for
RWE Renewables UK Ltd

Project:
Rampion 2 OWF Development

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Area A Geophysical Survey

Survey Date:
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Project Number:
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For attention of
Naren Mistry

EXECUTIVE SUMMARY

Gardline Limited was contracted by RWE Renewables UK Ltd to acquire shallow geophysical and UHRS data across areas being considered for development at the Rampion 2 Offshore Windfarm and associated export cable route corridor.

The offshore portion of the survey was undertaken predominantly by M.V. Vigilant, mobilising in Hull on 30-Jun-2020 and demobilising in Hull on 19-Aug-2020 after completion of the shallow geophysical data acquisition. The M.V. Ocean Observer carried out the UHRS portion of the survey including acquiring SBP and magnetometer data infilling the planned gaps in the geophysical survey including all crosslines. It mobilised in Lowestoft on 21-Sept-2020 and demobilised in Great Yarmouth on 13-Oct-2020. The M.V. Titan Discovery and Titan owned Unmanned Aerial Vehicle carried out the nearshore acquisition, mobilising on 01-Jul-2020 and demobilising 12-Aug-2020.

Within the survey area, the water depth ranges from 23.5m LAT to 64.8m LAT. Sandwaves dominant the seabed across much of the survey area, with general heights of 2m. Away from these sandwaves, the seabed undulates due to the underlying geology.

Seabed sediments are expected to comprise predominately gravel and sand, with areas of sandy gravel. Over 1000 boulders have been identified along with 14 debris items and 4 fishing pots. Three areas of dense boulders categorised as boulder fields are also observed. In these areas individual boulders have not been picked. Linear debris is observed sporadically across the site along with fishing gear. A total of 15 wrecks have been identified along with 88 magnetometer contacts and 2 spudcan depressions.

Holocene deposits are interpreted as comprising predominantly gravel and sand are present across much of the survey area, reaching 25m thick in places . They overlie the palaeochannels and occasionally bedrock, which is interpreted to comprise Tertiary Claystones to Cretaceous Chalk strata. These occasionally subcrop and outcrop in the northeast of the survey area.

The Rampion 2 Area A survey area is dominated by a palaeo-basin, with palaeochannels cutting through the bedrock feeding into this basin. Within Rampion 2 Area A there are two main channels interpreted from the data feeding into the palaeo-basin..

Report volumes are as follows:

Report	Report No.
Operations Report	11521.1
Rampion 2 OWF Area A Survey Report	11521.2
Rampion 2 OWF Area B Survey Report	11521.3
Rampion 2 OWF Area C Survey Report	11521.4

This report is the Rampion 2 OWF Area A survey report.

USE OF THIS REPORT

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

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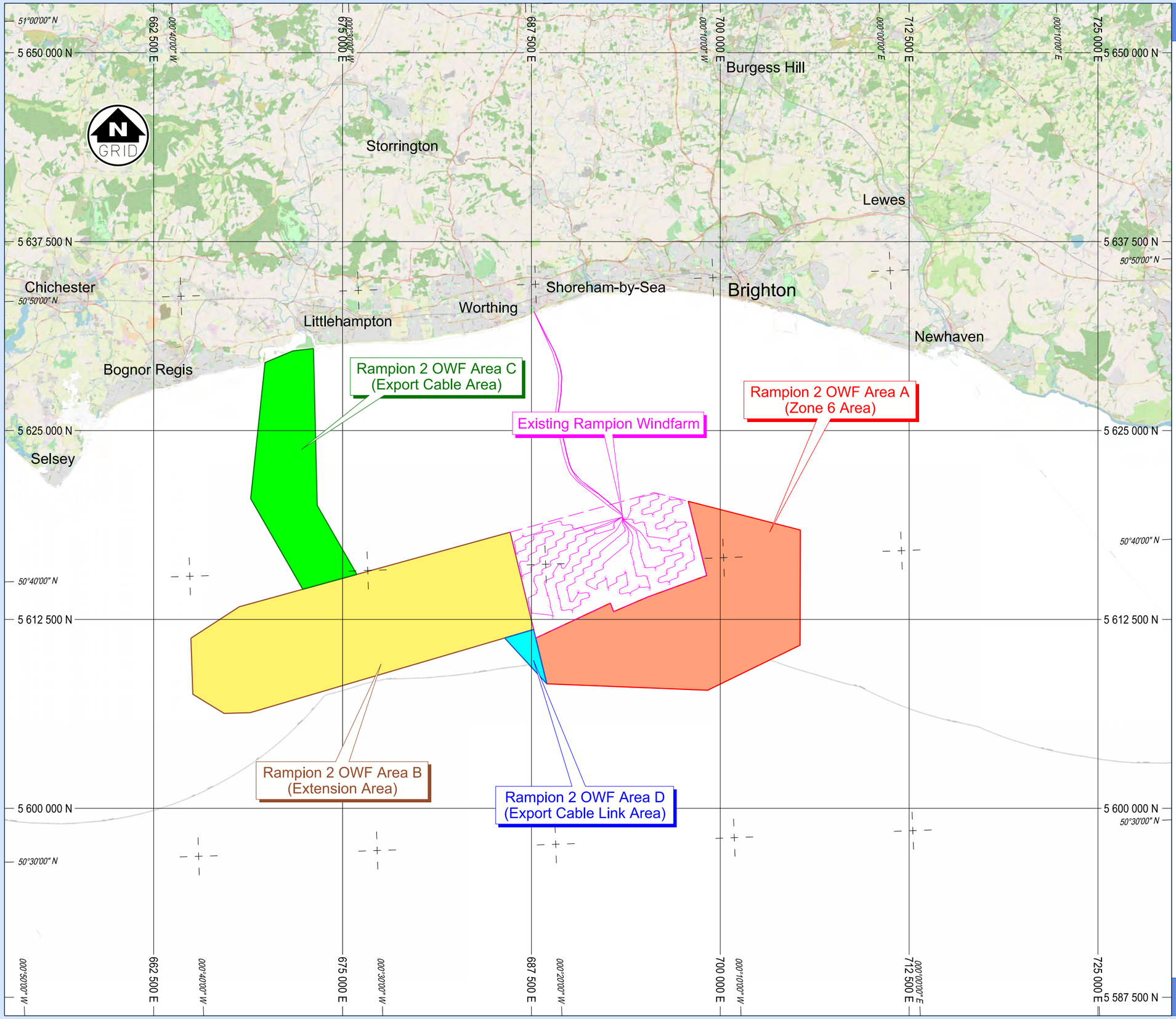

LOCATION MAP
RAMPION 2 OFFSHORE WINDFARM DEVELOPMENT

- PROPOSED RAMPION 2 OWF AREA A (ZONE 6 AREA)
- PROPOSED RAMPION 2 OWF AREA B (EXTENSION AREA)
- PROPOSED RAMPION 2 OWF AREA C (EXPORT CABLE AREA)
- PROPOSED RAMPION 2 OWF AREA D (EXPORT CABLE LINK AREA)
- EXISTING RAMPION WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND FARM CABLE (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION SURVEY AREA (SOURCE: CLIENT PROVIDED)

Scale 1 : 250 000
WGS84/UTM Zone 30N (3°W)

Job No. 11521.2

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Charts are enclosed at a scale of 1:25,000:

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GLOSSARY OF ABBREVIATIONS

AVO	Amplitude Versus Offset
BASE	Bathymetry Associated with Statistical Error
BGS	British Geological Survey
BS	British Standards
BSB	Below Seabed
cm	Centimetre(s)
CMP	Common Mid Point
CoG	Centre of Gravity
CPT(U)	Cone Penetrometer Testing (Unit)
cu. in.	Cubic Inch(es)
d	Delta
dB	Decibel(s)
deg	Degree(s)
(D)GNSS	(Differential) Global Navigation Satellite System
EBS	Environmental Baseline Survey
EC	European Commission
EGNOS	European Geostationary Navigation Overlay Service
EPSG	European Petroleum Survey Group
f	Focal Length
ft	Foot/Feet
h	Hours (times expressed hh:mmh e.g. 12:45h)
H	Height
HDOP	Horizontal Dilution of Precision
ISO	International Organisation for Standardisation
J	Joule(s)
(k)Hz	(Kilo)Hertz
kg	Kilogram(s)
km	Kilometre(s)
kN	Kilonewton(s)
kPa	Kilopascal(s)
kW	Kilowatt(s)
L	Length
LAT	Lowest Astronomical Tide
m	Metre(s)
M	Megapixels
MBES	Multi-Beam Echo Sounder
MDAC	Methane Derived Authigenic Carbonates
MHWI	Mean High Water Interval
ml	Millilitre(s)
mm	Millimetre(s)
MPa	Megapascals
MRU	Motion Reference Unit
ms	Millisecond(s)
m/s	Metres per Second
MSL	Mean Sea Level
MSR	Mean Spring Range
M.V.	Motor Vessel
N,E,S,W	North, East, South, West
nT	NanoTesla
oct	Octave
OGP	International Association of Oil and Gas Producers
OSPAR	Oslo and Paris Commissions
PC	Piston Core
PDOP	Positional Dilution of Precision
ppm	Parts Per Million
QC	Quality Control
QPRO	Quality Procedure
r	Rotation
RMS	Root Mean Square
RPL	Route Positioning List
Rx	Receive
S	Second(s)
SBES	Single Beam Echo Sounder
sd	Standard Deviation
SEGY	Society of Exploration Geophysicists storage format
SNR	Signal to Noise Ratio
SP	Shot Point
SRME	Surface Related Multiple Elimination
SV	Sound Velocity
SWNA	Surface Wave Noise Attenuation
TWT	Two Way Time
Tx	Transmit
UHRS	Ultra High Resolution Seismic
UKCS	United Kingdom Continental Shelf
USBL	Ultra Short Base Line
(U)TM	(Universal) Transverse Mercator
VC	Vibrocore
(V)GPS	(Voyager) Global Positioning System
VORF	Vertical Offshore Reference Frames
WGS84	World Geodetic System 1984

1. PROJECT SUMMARY

1.1 Scope of Work

Gardline Limited carried out a shallow geophysical and UHRS survey for RWE Renewables UK Ltd off the coast of Brighton, Sussex. The objective was to investigate three areas being considered for development using multi-beam echo sounder, side scan sonar, magnetometer, sub-bottom profiler and UHRS equipment.

The three extension areas were designated:

- Area A: “Zone 6 Area” to the south-east of the existing Rampion offshore wind farm. Part of this area was previously surveyed during the original development and there was no requirement for re-surveying at this stage of the development.
- Area B: “Extension Area” to the west of the existing Rampion offshore windfarm.
- Area C: “Export Cable Area” to the north of Area B, with landfall between Littlehampton and Bognor Regis. No UHRS acquisition was required for Area C.

The purpose of the survey was to:

- To provide accurate bathymetry of the site regions and cable routes region
- To identity natural seabed features and any obstructions, man-made objects, debris, or wrecks
- To produce isopach charts to show sediment thickness of the upper, loose, and any mobile material, and of any other significant reflector levels which might impact on the engineering design to 50m below seabed for Areas A and B, and to 10m below seabed for Area C
- To locate any structural complexities or geohazards within the shallow geological succession such as faulting, accumulations of shallow gas, buried channels etc to 50m below seabed for Areas A and B, and to 10m below seabed for Area C
- Locate and identify sites of near surface soft material pertinent to jack-up operations
- To provide detailed geological interpretation to show strata variations and structural feature changes via appropriate maps and sections
- To provide interpretation to assist design of the offshore foundations / structures and cable routing and burial
- To identity items through correlation of magnetic anomalies and sonar contacts that may require further physical survey, for example UXO and wrecks

The offshore work scope was carried out by the Gardline vessel M.V. Vigilant, with additional work undertaken by M.V. Ocean Observer. The M.V. Vigilant acquired full coverage with MBES and SSS of Areas A, B and the offshore part of Area C. In addition, it acquired SBP and magnetometer data on all of the offshore part of Area C with a line spacing of 60m, and 4 out of every 5 main lines in Areas A and B, with a line spacing of 77m.

The M.V. Ocean Observer acquired UHRS, SBP and magnetometer data on Areas A and B at a line spacing of 385m, and on each of the cross lines in Areas A and B at a line spacing of 1336m. Both the main and cross lines are orientated and positioned so as to acquire UHRS data through the proposed locations of the turbines in Areas A and B.

The nearshore work scope was covered by the M.V. Titan Discovery and a Titan owned Unmanned Aerial Vehicle (UAV). Details of operational activities is included in the Operations Report, 11521.1.

All coordinates quoted in the report are with respect to **World Geodetic System 1984 (WGS84), UTM Grid Zone 30N (3° West)**. All water depths are reduced to **Lowest Astronomical Tide (LAT).** Full details of the geodetics used during the project are contained in Appendix A.

The grid of survey lines as acquired for Rampion 2 Area A is illustrated on Charts 1, Chart 2 and Chart 3.

This report is the Rampion 2 Area A Survey Report.

1.2 Equipment Summary

Table 1.1 Survey Equipment – M.V. Vigilant

System	Make/Model
Positioning system	Oceaneering C-Nav DGNSS
	Sonardyne Ranger USBL
Navigation System	Voyager5
Echo Sounder (MBES system)	Simrad EM2040D
Echo Sounder (SBES system)	Simrad EA400
Side Scan Sonar	EdgeTech 4200FS
Magnetometer	Geometrics G882
Sub-Bottom Profiler	GeoAcoustics Pinger

Table 1.2 Survey Equipment – M.V. Ocean Observer

System	Make/Model
Positioning Systems	Fugro Starfix XP2 DGNSS
	Sonardyne Ranger 2 USBL
Navigation System	Voyager5
Echo Sounder (MBES system)	Simrad EM710
Echo Sounder (SBES system)	Kongsberg EA400
Magnetometer	Geometrics G882
Sub-Bottom Profiler	GeoAcoustics Pinger
UHRS	Teledyne 24 Channel Streamer Applied Acoustics Dura Spark

2. ACCURACY AND TERMS FOR SEISMIC INTERPRETATION

2.1 Resolution and Limitations for Site Survey Data

2.1.1 Bathymetry

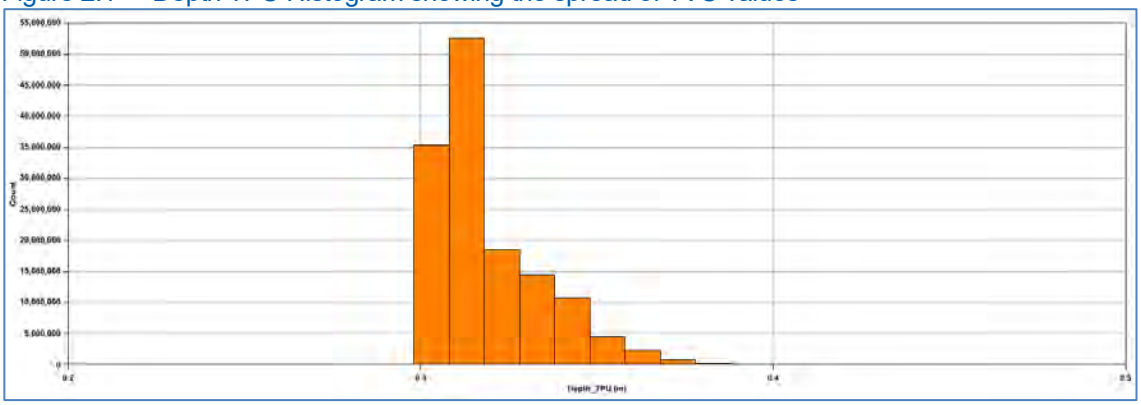
Several factors influence the accuracy of the bathymetric data:

- Variations in sound velocity
- Instrument accuracy (typically 0.2-0.5% of depth depending on beam angle)
- Weather effects/vessel movement
- Morphology of seabed

The uncertainty requirement of the survey is to achieve International Hydrographic Organisation's (IHO) Order 1. In the guidelines produced by the IHO, a formula is outlined to derive an accuracy level depending on the depth of water the survey is being carried out in. This Total Vertical Uncertainty (TVU) value is used to ensure the data collected meets the standard required to meet Order 1a. Using water depths of 21m and 65m as the rough range within which Gardline acquired data, the MBES TVU must be better than +/- 0.570m and +/- 0.926m, respectively.

The data were analysed using the Total Propagated Uncertainty (TPU) engine in CARIS. A depth TPU surface created within CARIS to identify the TVU range. The figure below shows that the TVU values meet the minimum level required to me the IHO Order1.

Figure 2.1 Depth TPU Histogram showing the spread of TVU values



In addition to the standard processing flow of the data, post processing was carried out on the raw GNSS records to produce a more accurate tidal profile to be applied to the data.

Multi-beam echo sounder data have been processed with a 1m bin size. As such, localised gradients of features with a smaller lateral extent will be underestimated.

2.1.2 Seabed Features

Side scan sonar data were collected for the purpose of mapping and imaging features and hazards on the seabed. Collected data from the Vigilant have frequencies of 122kHz and 410kHz and a range of 100m per channel.

From corrections made to the sonar mosaic, and comparing the sonar data with the swathe data, USBL positioning accuracy is expected to be in the order of ±2m, and horizontal resolution is expected to be approximately 0.5m. Vertical protrusions above the seabed over 0.1m should be detectable (and flat-lying objects above 0.1m diameter) measurable to the nearest 0.1m, depending on the range.

2.1.3 Magnetic Survey

Magnetometer data were inspected for potential anomalies with the results being presented on the enclosed Seabed Features Chart.

Records were of average quality with background noise apparent due to the relative close proximity of the magnetometer to the survey vessel due to the shallow water depths on site, as well as induced noise from the underlying geology.

Positioning of ferrous bodies from magnetic anomalies is problematical. Errors are introduced from uncertainties on raw navigation data and on offset errors, as well as from the inherent ambiguity of determining body shape from magnetic anomalies. Where possible magnetic anomalies are cross referenced against other datasets (e.g. bathymetry, side scan sonar, sub-bottom profiler, database records etc), in order to assign a likely centre of the magnetic deviation. Where this is not possible the positioning accuracy will be largely dependent on the acquired line spacing.

2.1.4 Sub-Seabed Data

Pinger and UHRS data were of good quality and exhibit an average penetration of 15m and 60m respectively. Dependant on the local geological conditions. An assumed seismic velocity of 1650m/s was used for time/depth conversion in the shallow sediments. Maximum vertical resolution may be determined theoretically by one quarter of the wavelength, which would give a maximum vertical resolution of the Pinger and UHRS data is approximately 0.1m and 0.6m respectively, assuming a dominant frequency of approximately 3500Hz and 750Hz. Theoretical minimum detectable layer, estimated at 1/30th the dominant wavelength, is calculated to be approximately 0.016m and 0.073m respectively at seabed.

2.2 Criteria for Horizon Picking

Interpretation of the sub-seabed data has been aided using BGS records and previous reports which are detailed in Section 4.

Horizons were picked where they separated distinct seismo-stratigraphic units. Generally, they were picked on the peak, but where the horizons represented a velocity inversion, they were picked on the trough.

3. GEOPHYSICAL SURVEY RESULTS

3.1 Bathymetry

Rampion 2 Area A bathymetry is illustrated on Chart 4 as a colour shaded relief image with contours at 1m intervals. An overview of the bathymetry is presented as Figure 3.1.

A shaded relief image of the bathymetry is illustrated on Chart 5. An overview of the shaded relief is presented as Figure 3.2.

Seabed Gradient is illustrated on Chart 6. An overview presented as Figure 3.3.

Within the survey area, the shallowest depth is 23.5m LAT on a shoal to the north to 64.8m LAT within a depression to the southwest of the survey area. Seabed gradients across the survey area are generally <1°, dipping towards the south.

Sandwaves are present across the survey area with heights of 2m and wavelengths reaching 25m. The seabed undulates across much of the survey area, influenced by the underlying geology. Large shoals appear to the northeast and west of the survey area, with gradients reaching 7°

2 significant seabed depressions are present in the far north of the survey area and are interpreted as spudcan depressions. They measure between 18-25m across and 1.5m deep, with gradients reaching 24° on their flanks.

The difference between LAT and MSL within the survey area is approximately 3.3m.

BATHYMETRY OVERVIEW FOR RAMPION 2 OWF AREA A

686 250 E
690 000 E
693 750 E
697 500 E
701 250 E
705 000 E
5 621 250 N
5 617 500 N
5 613 750 N
5 610 000 N
5 606 250 N
50°42'00" N
50°39'00" N
50°36'00" N
50°33'00" N
GRID

- PROPOSED RAMPION 2 OWF AREA A (ZONE 6 AREA)
- PROPOSED RAMPION 2 OWF AREA B (EXTENSION AREA)
- PROPOSED RAMPION 2 OWF AREA D (EXPORT CABLE LINK AREA)
- PROPOSED RAMPION 2 WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND FARM CABLE (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION SURVEY AREA (SOURCE: CLIENT PROVIDED)
- 45 BATHYMETRIC CONTOURS SHOWN AT 5 METRE INTERVALS LAT

DEPTH IN METRES BELOW LAT
20 25 30 35 40 45 50 55 60 65

Scale 1 : 75 000
WGS84/UTM Zone 30N (3°W)

Figure 3.1

Job No. 11521.2

SEABED SHADED RELIEF OVERVIEW FOR RAMPION 2 OWF AREA A

686 250 E
690 000 E
693 750 E
697 500 E
701 250 E
705 000 E
000°21'00" W
000°18'00" W
000°15'00" W
000°12'00" W
000°09'00" W
000°06'00" W
5 621 250 N
5 617 500 N
5 613 750 N
5 610 000 N
5 606 250 N
50°42'00" N
50°39'00" N
50°36'00" N
50°33'00" N
GRID

- PROPOSED RAMPION 2 OWF AREA A (ZONE 6 AREA)
- PROPOSED RAMPION 2 OWF AREA B (EXTENSION AREA)
- PROPOSED RAMPION 2 OWF AREA D (EXPORT CABLE LINK AREA)
- PROPOSED RAMPION 2 WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND FARM CABLE (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION SURVEY AREA (SOURCE: CLIENT PROVIDED)

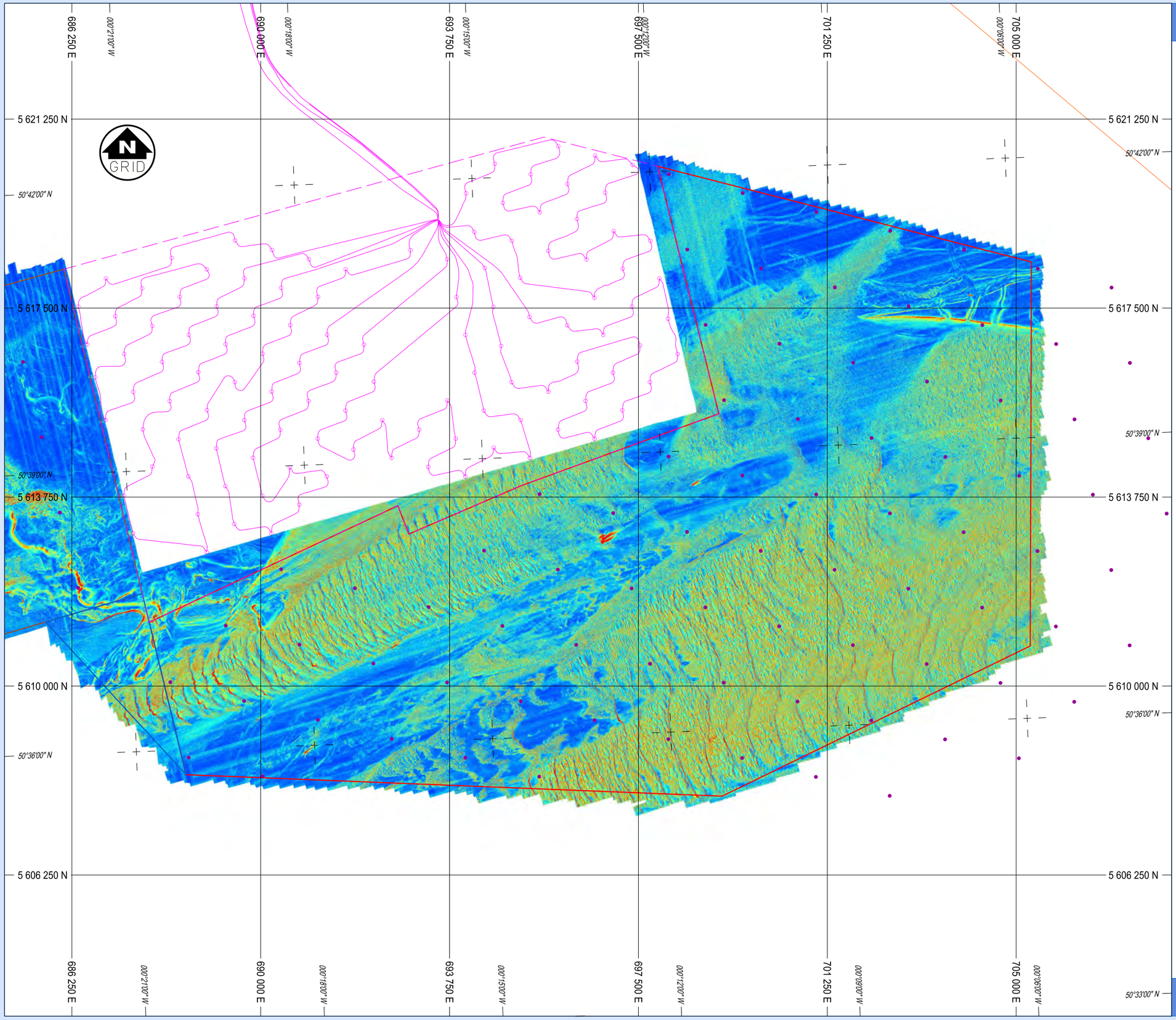
DEPTH IN METRES BELOW LAT
20
25
30
35
40
45
50
55
60
65

Scale 1 : 75 000
WGS84/UTM Zone 30N (3°W)

Figure 3.2

Job No. 11521.2

SEABED GRADIENT OVERVIEW FOR RAMPION 2 OWF AREA A



PROPOSED RAMPION 2 OWF AREA A
(ZONE 6 AREA)

PROPOSED RAMPION 2 OWF AREA B
(EXTENSION AREA)

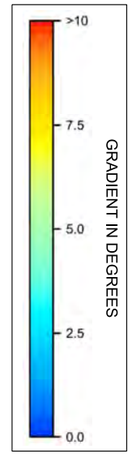
PROPOSED RAMPION 2 OWF AREA D
(EXPORT CABLE LINK AREA)

PROPOSED RAMPION 2
WIND TURBINE GENERATOR LAYOUT
(SOURCE: CLIENT PROVIDED)

EXISTING RAMPION
WIND TURBINE GENERATOR LAYOUT
(SOURCE: CLIENT PROVIDED)

EXISTING RAMPION WIND FARM CABLE
(SOURCE: CLIENT PROVIDED)

EXISTING RAMPION SURVEY AREA
(SOURCE: CLIENT PROVIDED)



Scale 1 : 75 000
WGS84/UTM Zone 30N (3°W)

Figure 3.3

Job No. 11521.2

3.2 Seabed Features

Seabed features are presented on Chart 7, with an overview illustrated as Figure 3.4. A side scan sonar mosaic is presented on Chart 8, with an overview illustrated as Figure 3.5.

Seabed sediments are expected to comprise predominately gravel and sand. with sandy gravel primarily to the north and gravelly sand primarily to the south. Infrequent rock outcrops are located to the north of the survey area.

Sandwaves are prevalent over much of the survey area trending northwest to southeast, with waveheights of up to 2m relative to the surrounding seabed. Localised gradients up to 10° are present on the flanks of the sandwaves. A side scan sonar data example of the sandwaves is illustrated on Figure 3.6.

1381 point contacts exceeding 0.5m in any dimension are interpreted across Area A, 14 of which are interpreted as debris and 4 are interpreted as fishing pots. The remainder are interpreted as boulders. The largest item of debris measuring 1.8m in height, is located to the northeast of the survey area, on a shoal. The largest boulder measures 1.5m in height, and is located in the north of the survey area.

Three areas of dense boulders in the north of the survey area with being associated with rock outcrops, and have been categorised as boulder fields. These are illustrated in Figure 3.7 and Figure 3.8. Boulders found located within interpreted boulder fields have not been individually picked.

Linear debris is observed sporadically across the survey area. 26 items of linear debris are interpreted within the survey area. The longest item of linear debris is 61m in length is located in the north of the survey area, illustrated in Figure 3.9. One linear contact is 97m in length is interpreted as fishing gear, illustrated in Figure 3.10.

No infrastructure is observed across the survey area.

A total of 15 wrecks interpreted across Area A, 14 of these are known wrecks on admiralty charts. All have been observed on side scan sonar, magnetometer and bathymetric records. The longest wreck, illustrated on Figure 3.11, has a length of 124m, width of 23m and a height of 6.4m. Figure 3.12 and Figure 3.13 illustrate 2 other wrecks seen within the survey area. A list of wrecks within Area A is included in Table 3.1.

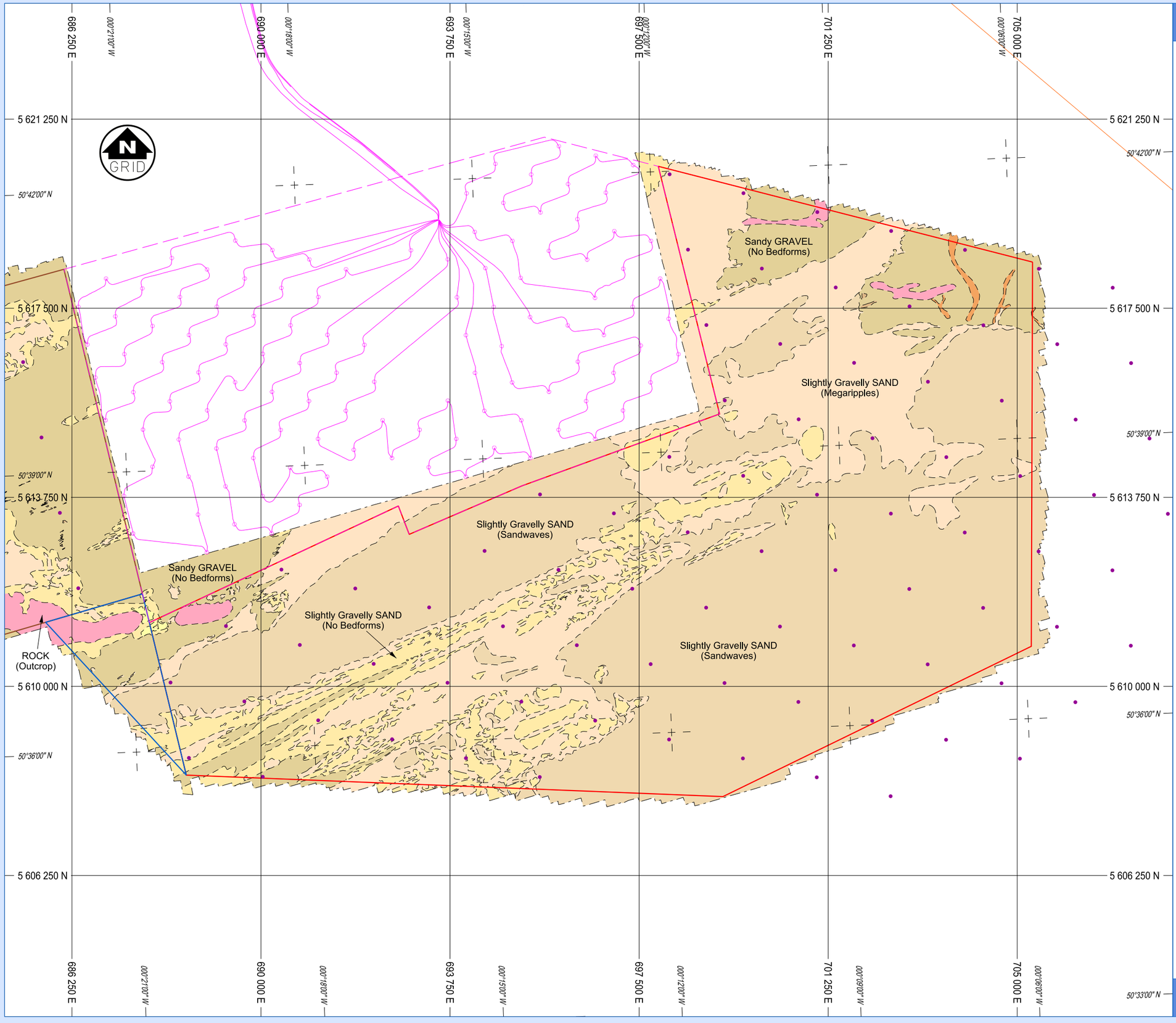
A total of 88 magnetometer contacts have been interpreted across the survey area, and are presented on Chart 9. 36 of which correlate with the observed wrecks . 2 magnetometer contacts are interpreted to be an area of debris, located in the centre of the survey area. The remaining magnetometer targets are interpreted to be buried or - due to the relative distance to underlying geology - associated with geological features. An example of underlying geology is Illustrated on Figure 3.14.

A total of 2 spudcan depressions have been interpreted at the edges of the survey area, and are associated with the existing Rampion Windfarm. One is situated to the northeast, and one to the north, with a maximum depth of 1.5m and gradients up to 24° measured on the flanks. Both are observed on bathymetry and side scan sonar data and are Illustrated on Figure 3.15.

Table 3.1 Table of Wrecks Interpreted in Area A

Name	Easting	Northing	Length (m)	Width (m)	Height (m)
Wreck 1	704 088	5 617 755	85.6	17.3	5.3
Wreck 2	690 384	5 612 653	76.7	13.3	6.9
Wreck 3	689 010	5 612 113	96.4	44.7	4.3
Wreck 4	695 621	5 613 924	76.4	7.6	3.2
Wreck 5	689 720	5 611 773	87.2	36.3	9.5
Wreck 6	698 600	5 614 024	87.3	13.8	4.4
Wreck 7	696 791	5 612 929	123.9	22.5	6.4
Wreck 8A	702 245	5 614 300	17.5	14	2.9
Wreck 8B	702 237	5 614 266	11.2	10.2	1.4
Wreck 9	692 617	5 610 767	60.9	22.6	5.6
Wreck 10	700 789	5 612 623	31.6	6.4	4.0
Wreck 11	689 928	5 609 332	59.2	12.5	10.5
Wreck 12	690 886	5 608 686	57	12.3	3.3
Wreck 13	700 401	5 611 236	22.2	8.1	2.6
Wreck 14	695 796	5 608 677	47.0	7.6	1.9
Wreck 15A	698 908	5 608 953	33.5	11.2	4.7
Wreck 15B	698 906	5 608 919	23.4	11.4	2.2

MBES and side scan sonar montages of Wreck 1, Wreck 6 and Wreck 12 are illustrated on, Figure 3.16, Figure 3.17 and Figure 3.18, respectively.



SEABED SEDIMENTS OVERVIEW FOR RAMPION 2 OWF AREA A

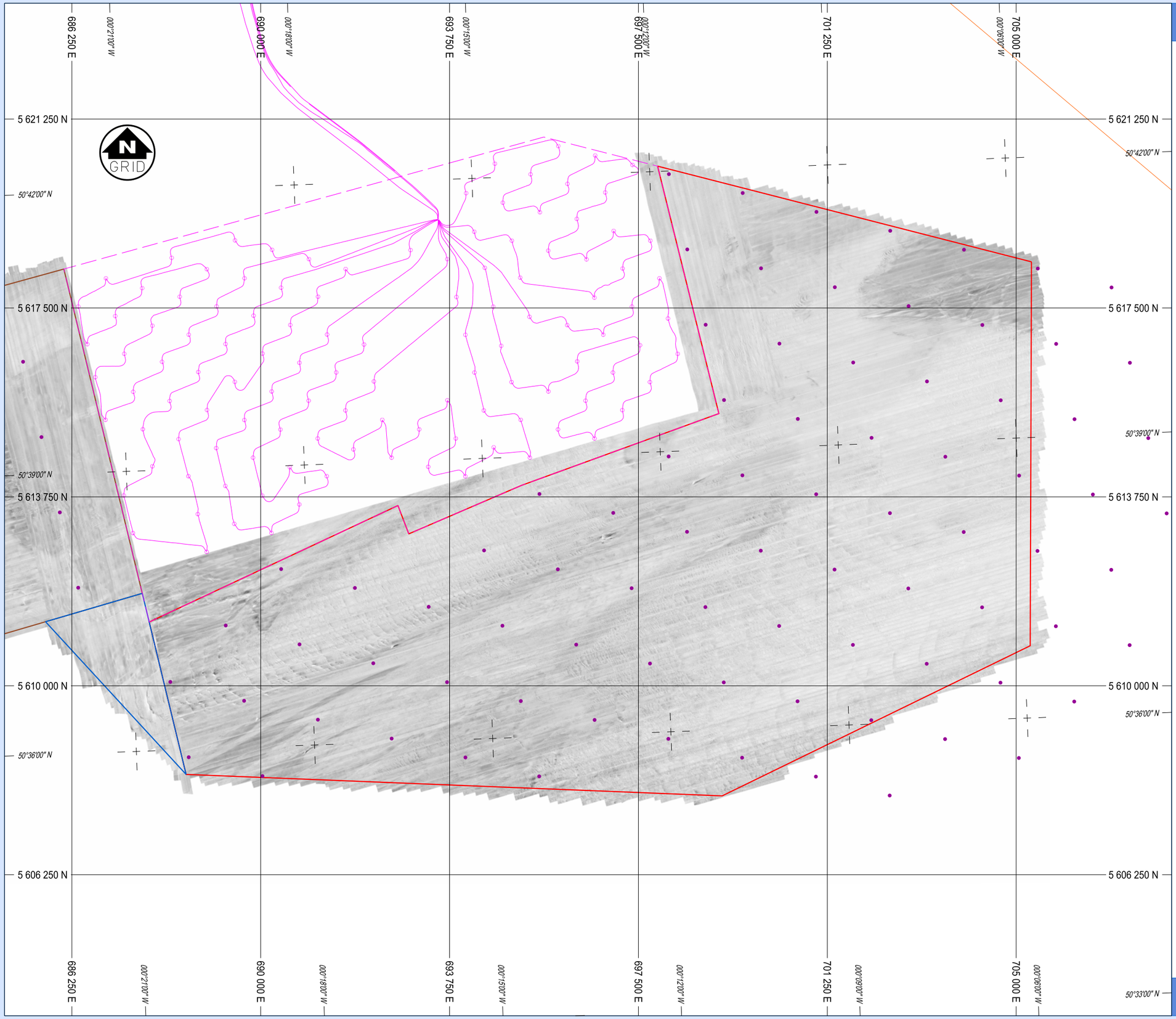
- PROPOSED RAMPION 2 OWF AREA A (ZONE 6 AREA)
- PROPOSED RAMPION 2 OWF AREA B (EXTENSION AREA)
- PROPOSED RAMPION 2 OWF AREA D (EXPORT CABLE LINK AREA)
- PROPOSED RAMPION 2 WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND FARM CABLE (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION SURVEY AREA (SOURCE: CLIENT PROVIDED)
- SAND (MEGARIPPLED)
- SLIGHTLY GRAVELLY SAND (NO BEDFORMS)
- SLIGHTLY GRAVELLY SAND (MEGARIPPLED)
- SLIGHTLY GRAVELLY SAND (SANDWAVES)
- SANDY GRAVEL (NO BEDFORMS)
- SANDY GRAVEL (MEGARIPPLED)
- SANDY GRAVEL (CHANNELLING)
- ROCK (OUTCROP)
- LIMIT OF SIDE SCAN SONAR COVERAGE

Scale 1 : 75 000
WGS84/UTM Zone 30N (3°W)

Figure 3.4

Job No. 11521.2

SIDE SCAN SONAR MOSAIC OVERVIEW FOR RAMPION 2 OWF AREA A

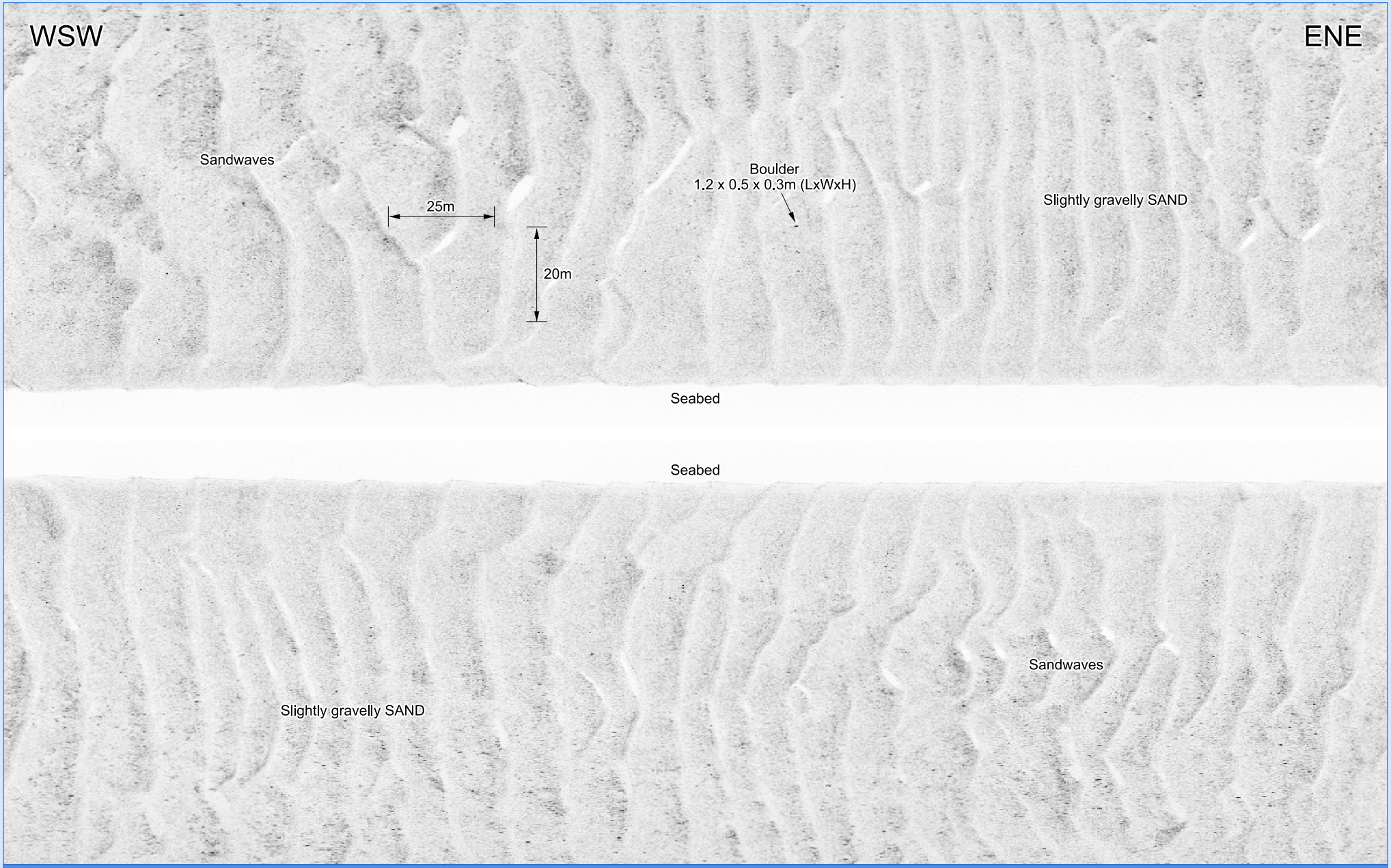


- PROPOSED RAMPION 2 OWF AREA A (ZONE 6 AREA)
- PROPOSED RAMPION 2 OWF AREA B (EXTENSION AREA)
- PROPOSED RAMPION 2 OWF AREA D (EXPORT CABLE LINK AREA)
- PROPOSED RAMPION 2 WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND FARM CABLE (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION SURVEY AREA (SOURCE: CLIENT PROVIDED)

Scale 1 : 75 000
WGS84/UTM Zone 30N (3°W)

Figure 3.5

Job No. 11521.2

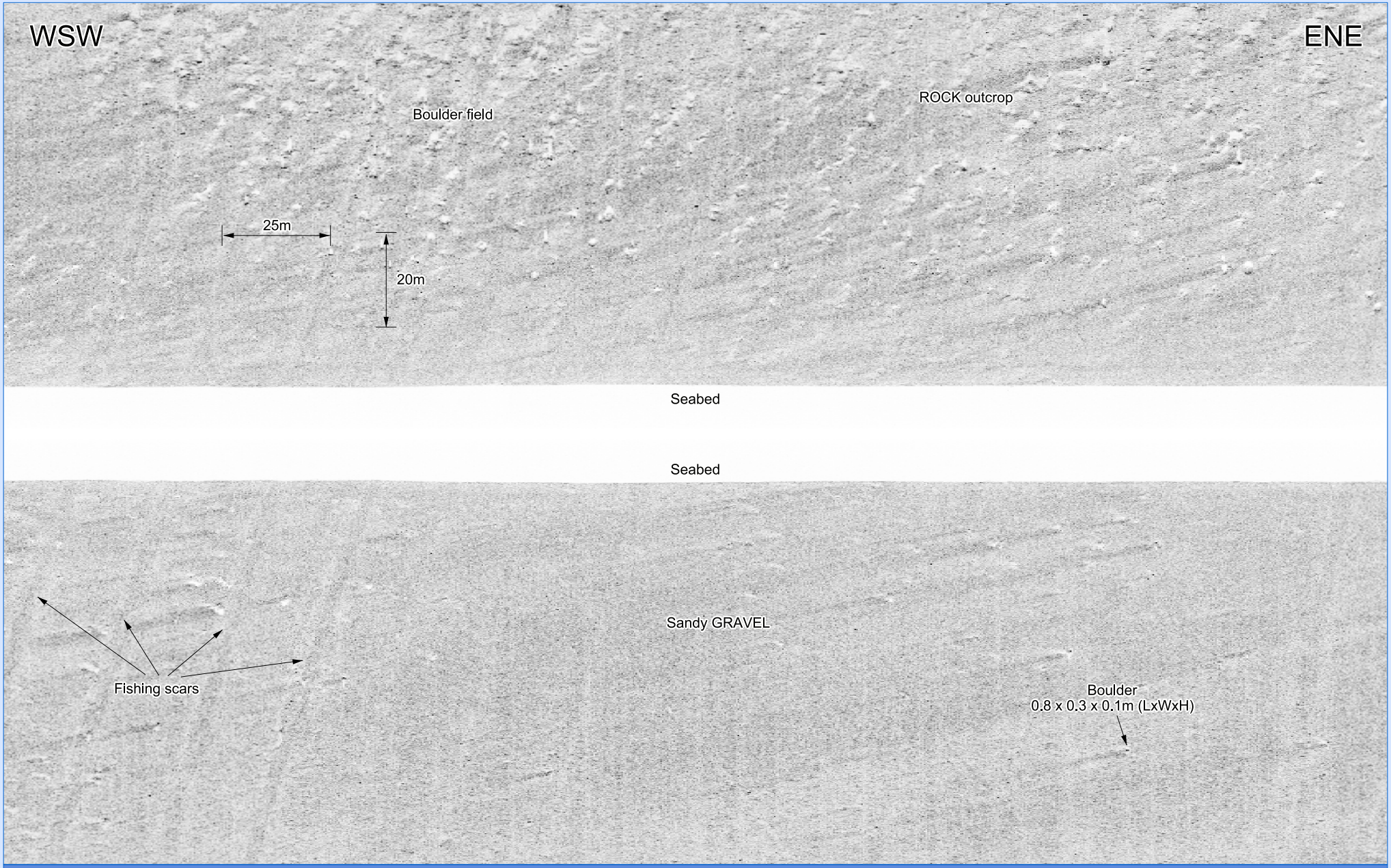


Line A_M-72

SIDE SCAN SONAR
Illustrating sandwaves

Figure 3.6

Job No. 11521.2

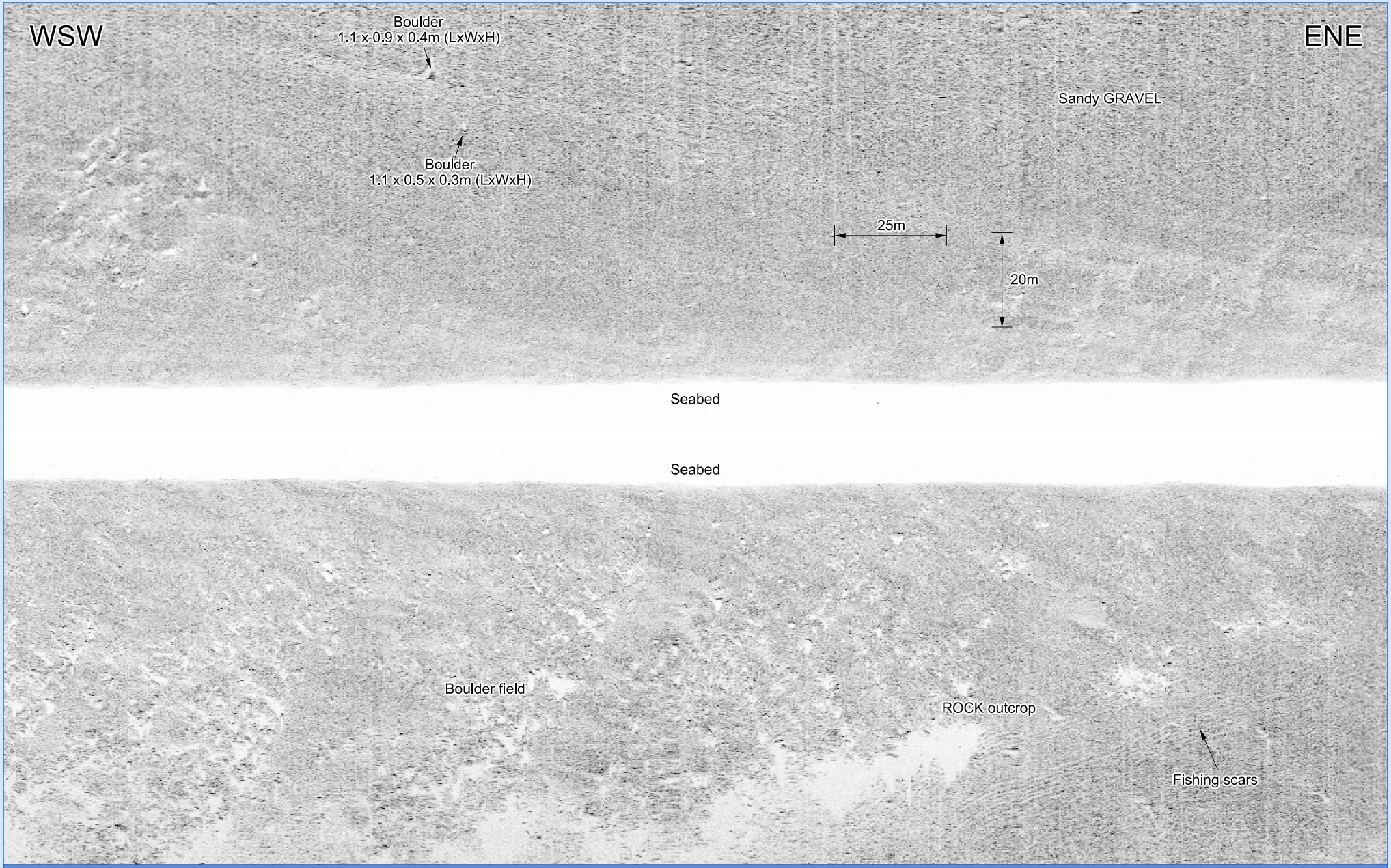


Line A_M-9

SIDE SCAN SONAR
Illustrating boulder field area

Figure 3.7

Job No. 11521.2

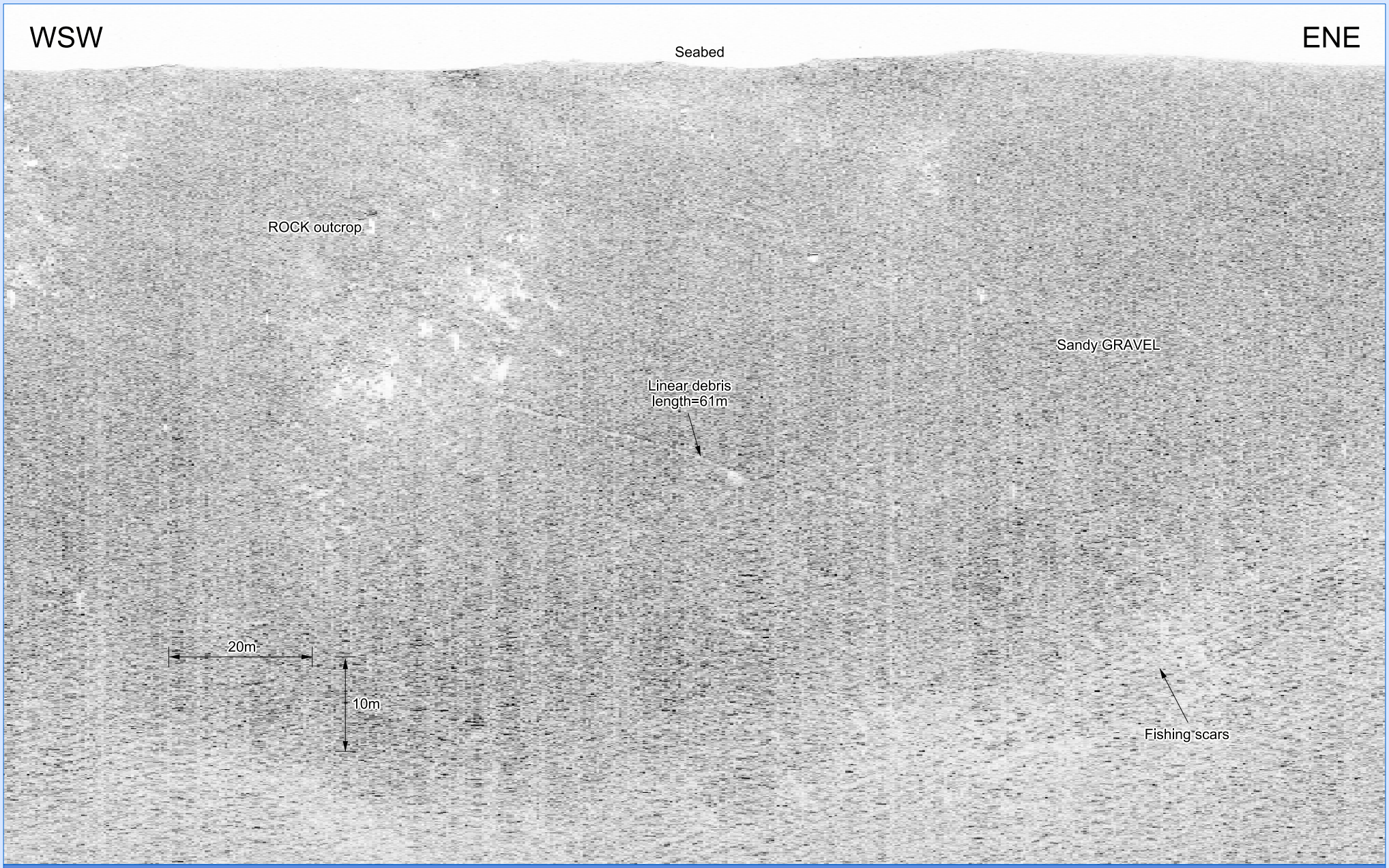


Line A_M-31

SIDE SCAN SONAR
Illustrating boulder field area

Figure 3.8

Job No. 11521.2

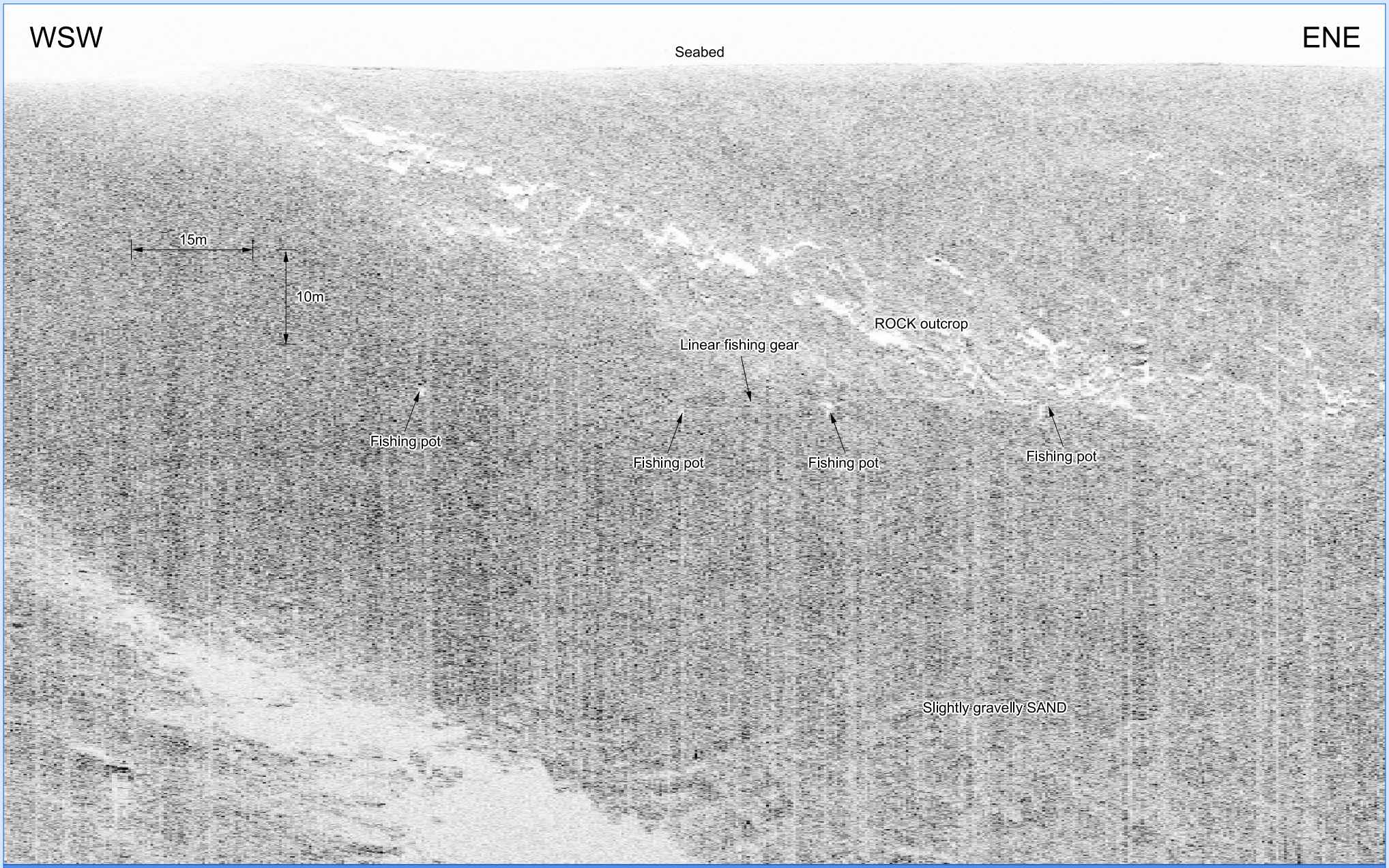


Line A_M-32

SIDE SCAN SONAR
Illustrating linear debris

Figure 3.9

Job No. 11521.2

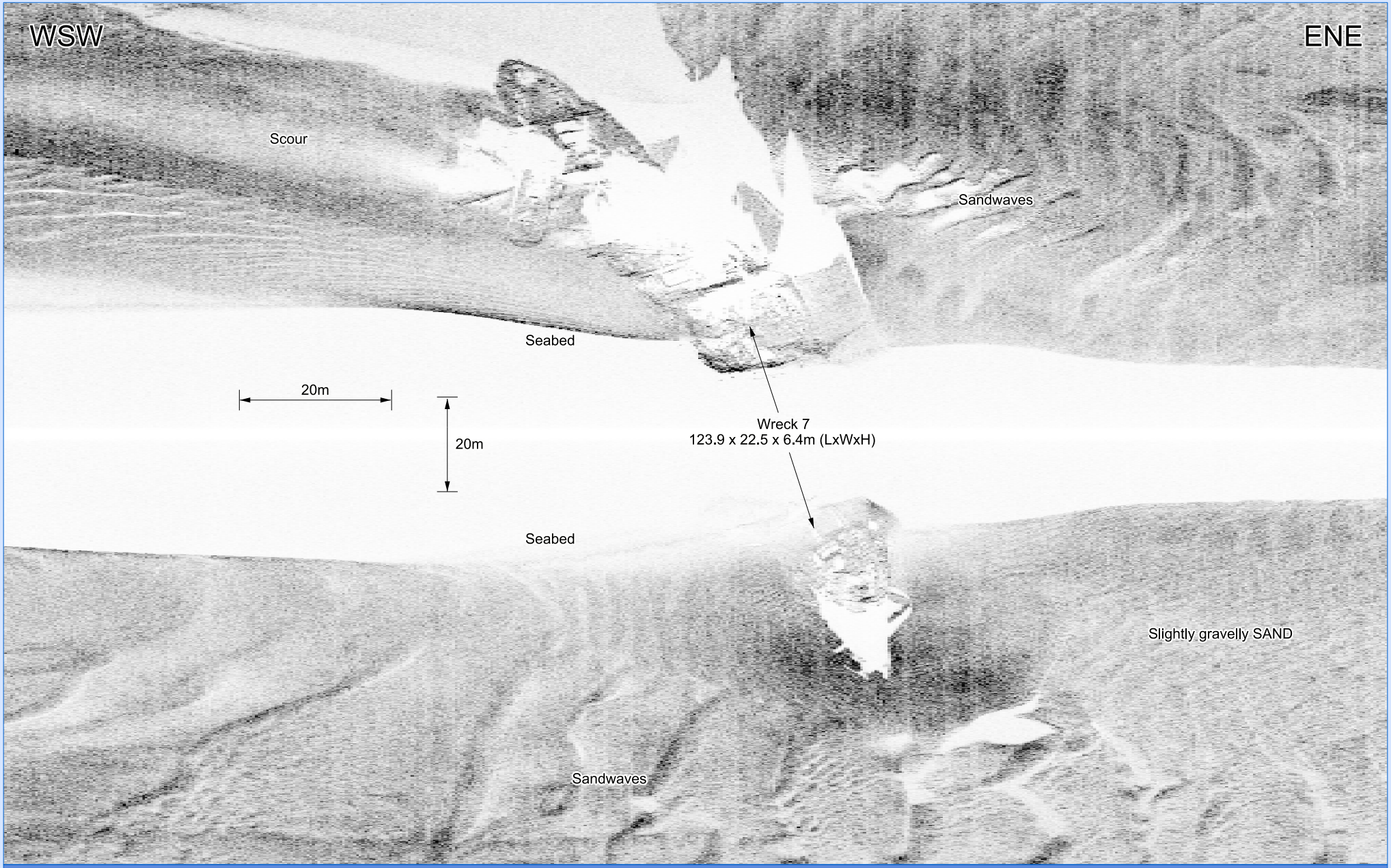


Line A_M-54

SIDE SCAN SONAR
Illustrating fishing gear debris

Figure 3.10

Job No. 11521.2

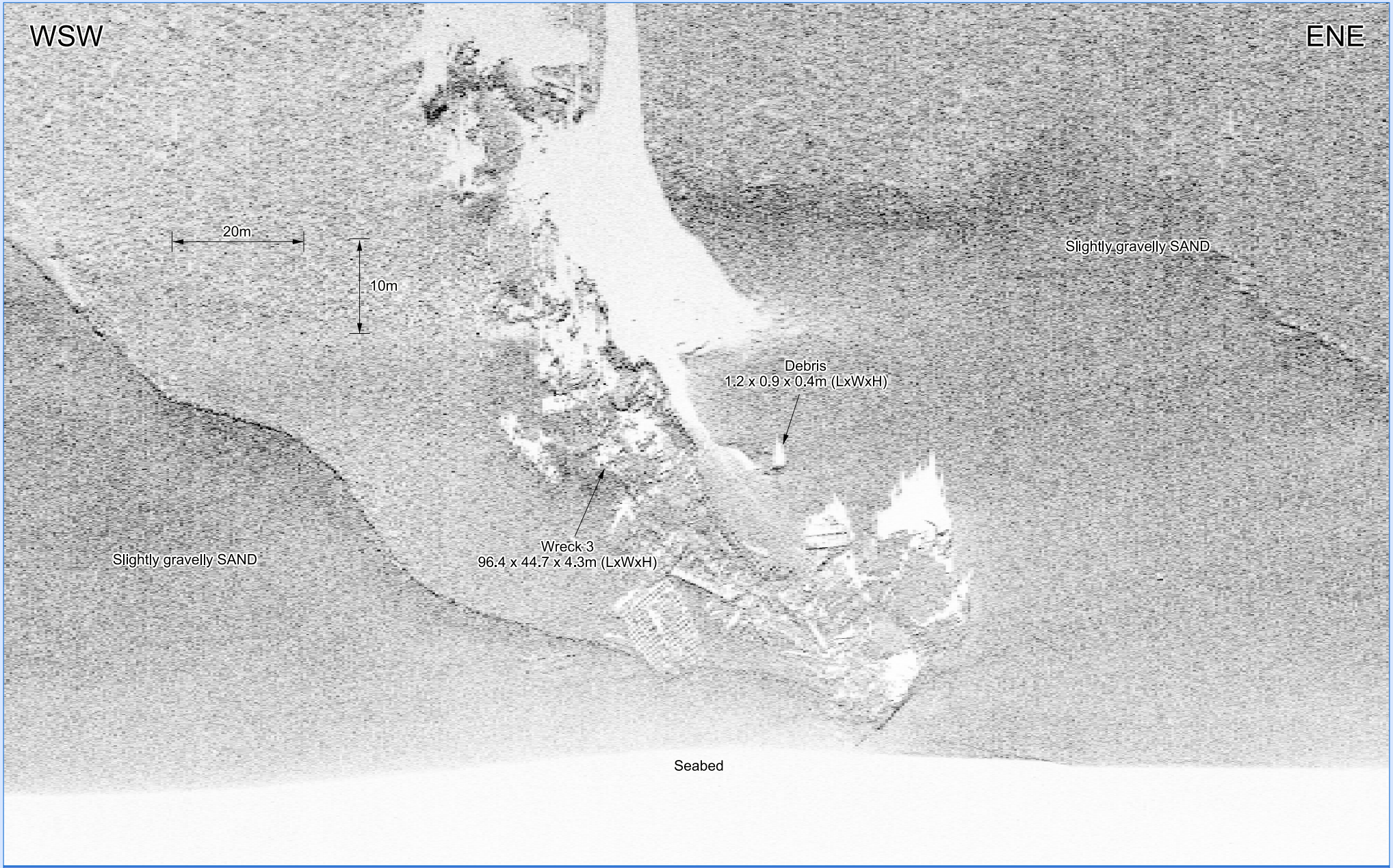


Line A_M-61A

SIDE SCAN SONAR
Illustrating Wreck 7

Figure 3.11

Job No. 11521.2

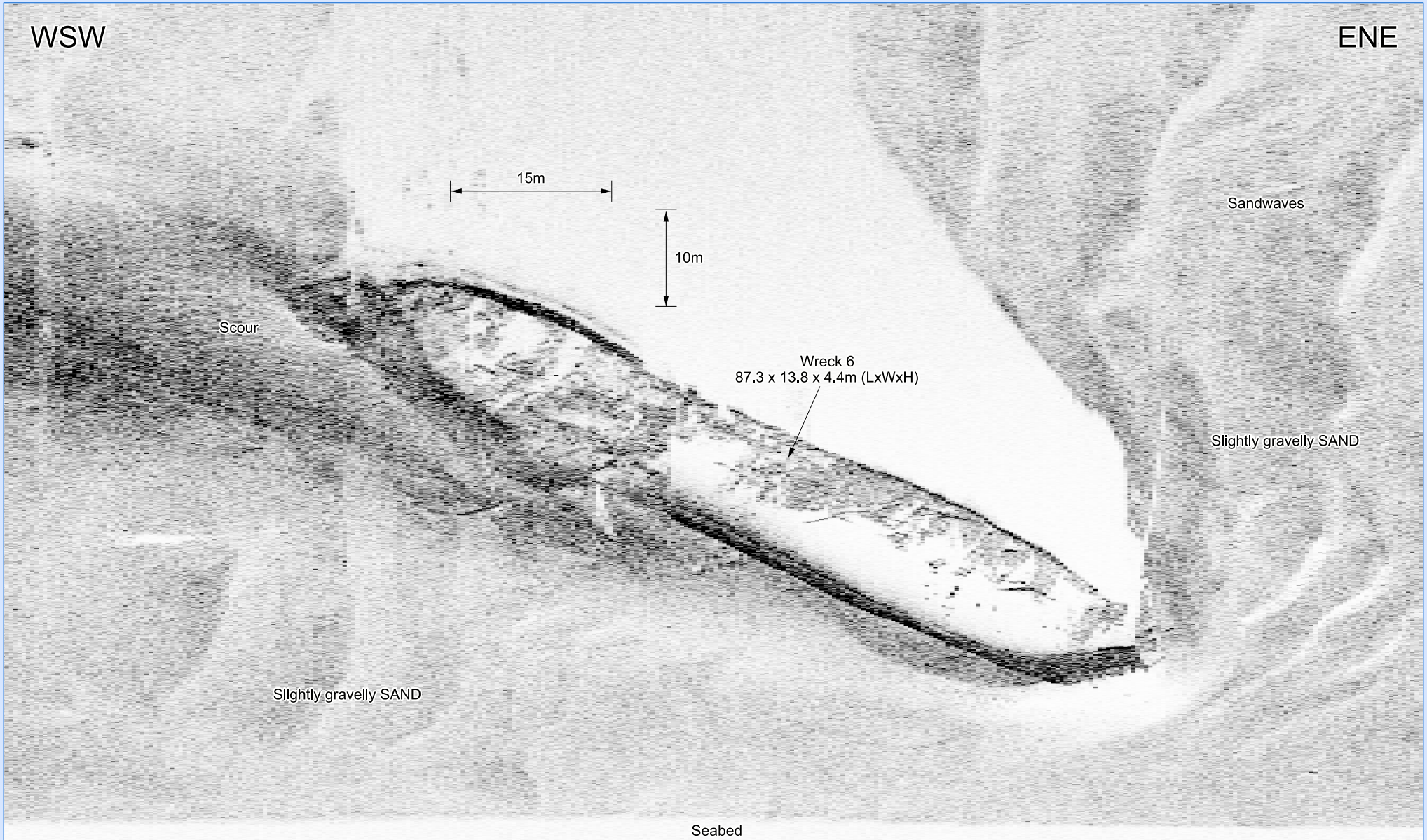


Line A_M-46

SIDE SCAN SONAR
Illustrating Wreck 3

Figure 3.12

Job No. 11521.2

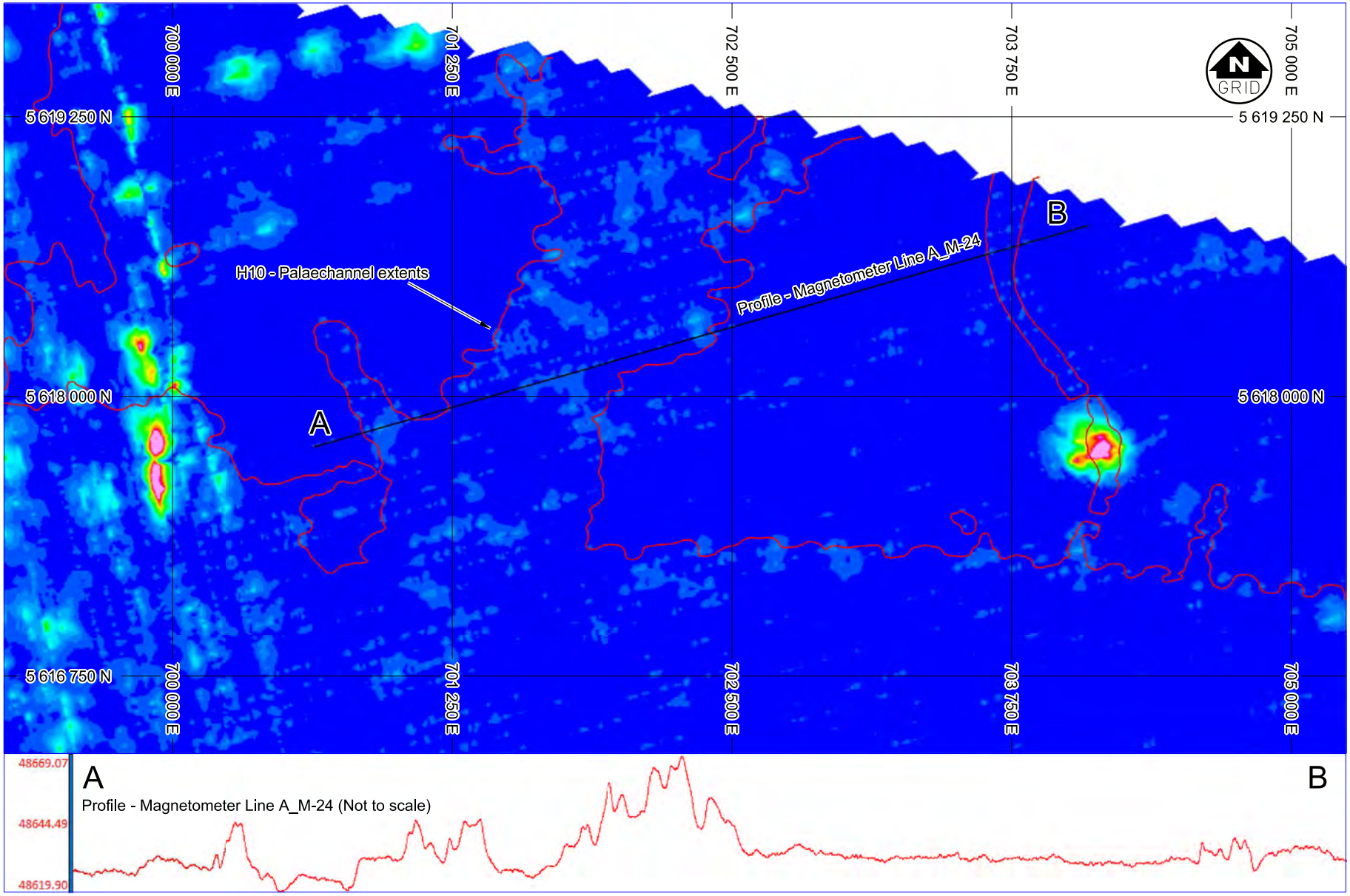


Line A_M-56

SIDE SCAN SONAR
Illustrating Wreck 6

Figure 3.13

Job No. 11521.2

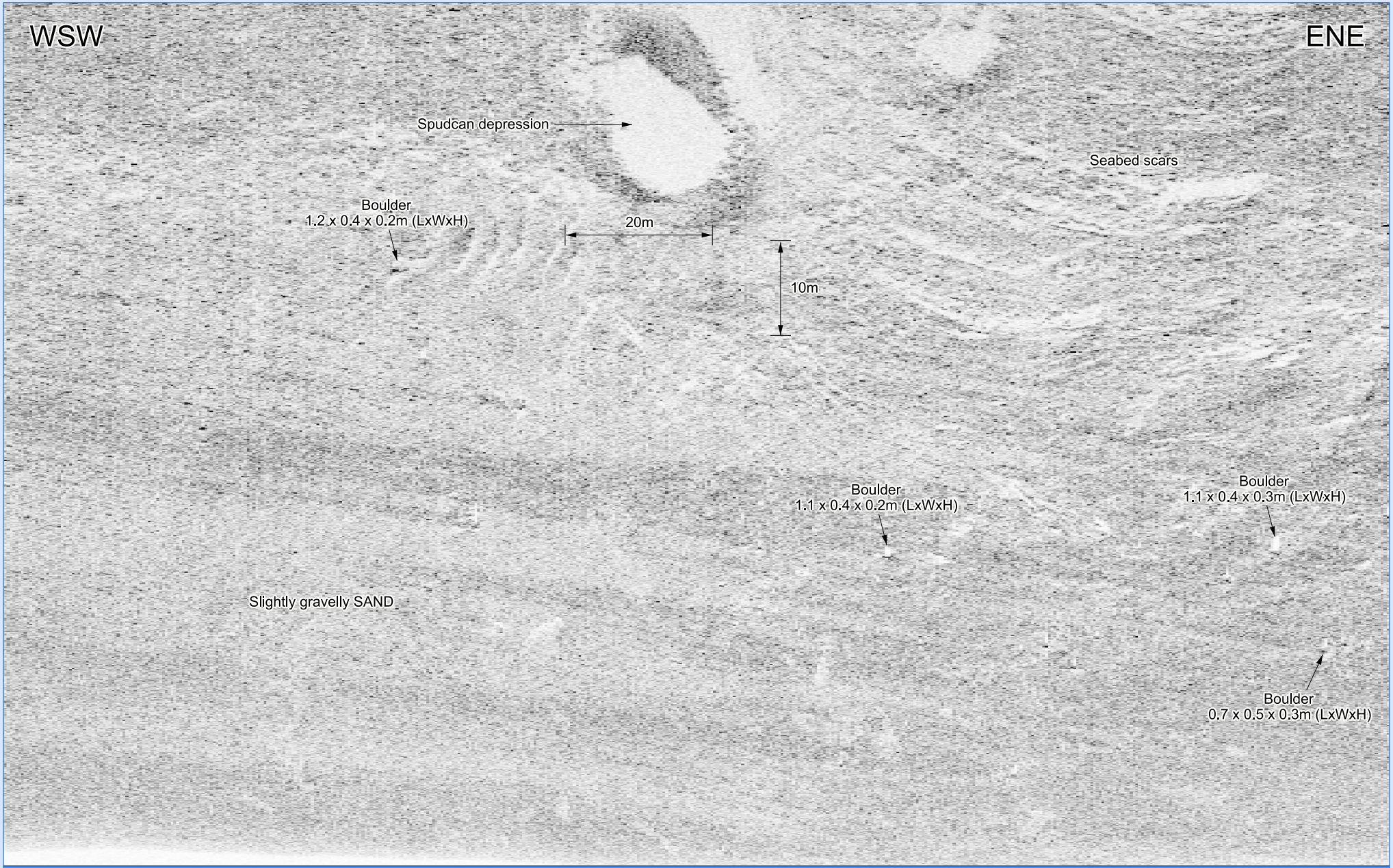


Scale 1 : 25 000
WGS84/UTM Zone 30N (3°W)

Palaeochannels identified on magnetometer data

Figure 3.14

Job No. 11521.2

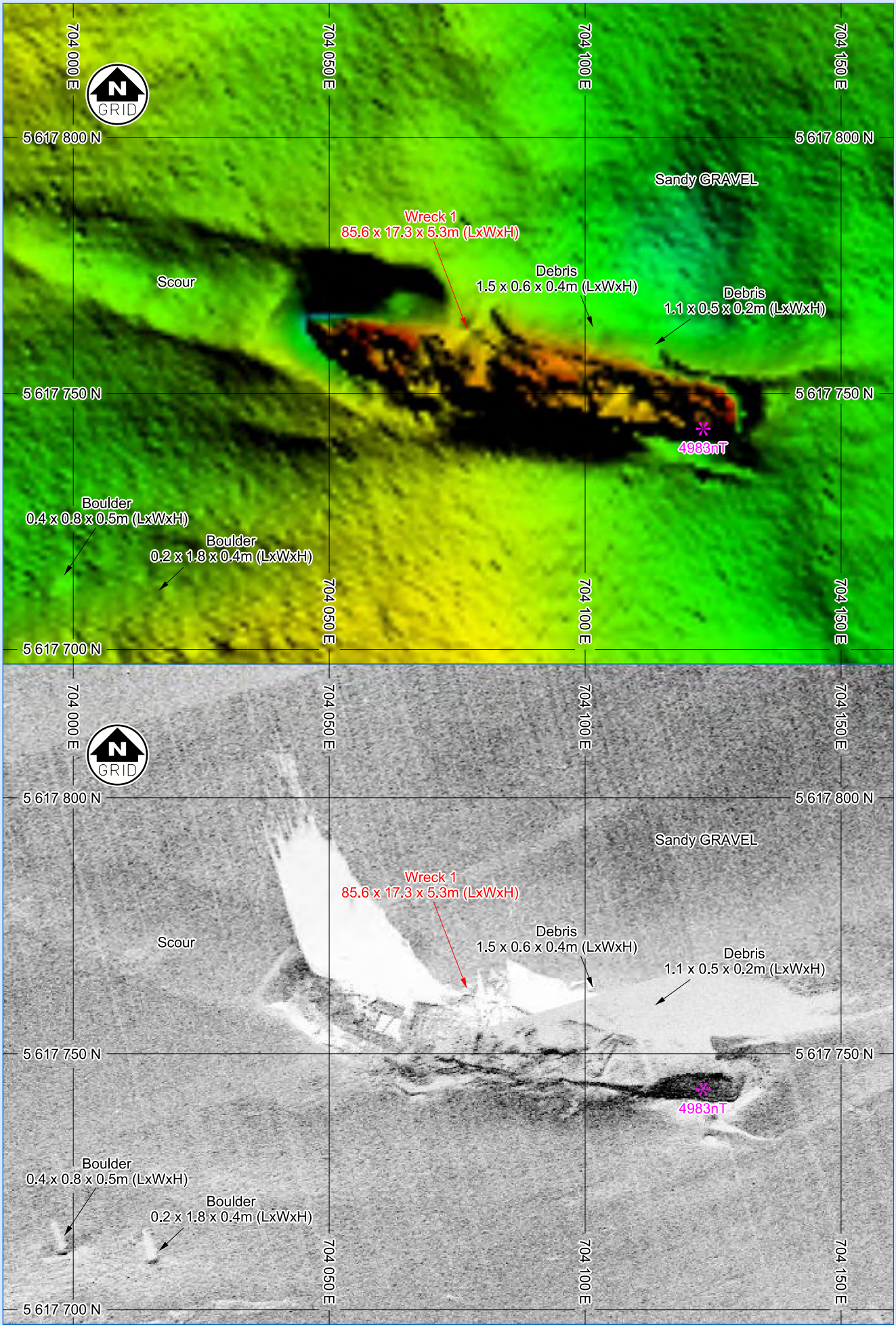


Line A_M-42

SIDE SCAN SONAR
Illustrating spudcan depression

Figure 3.15

Job No. 11521.2

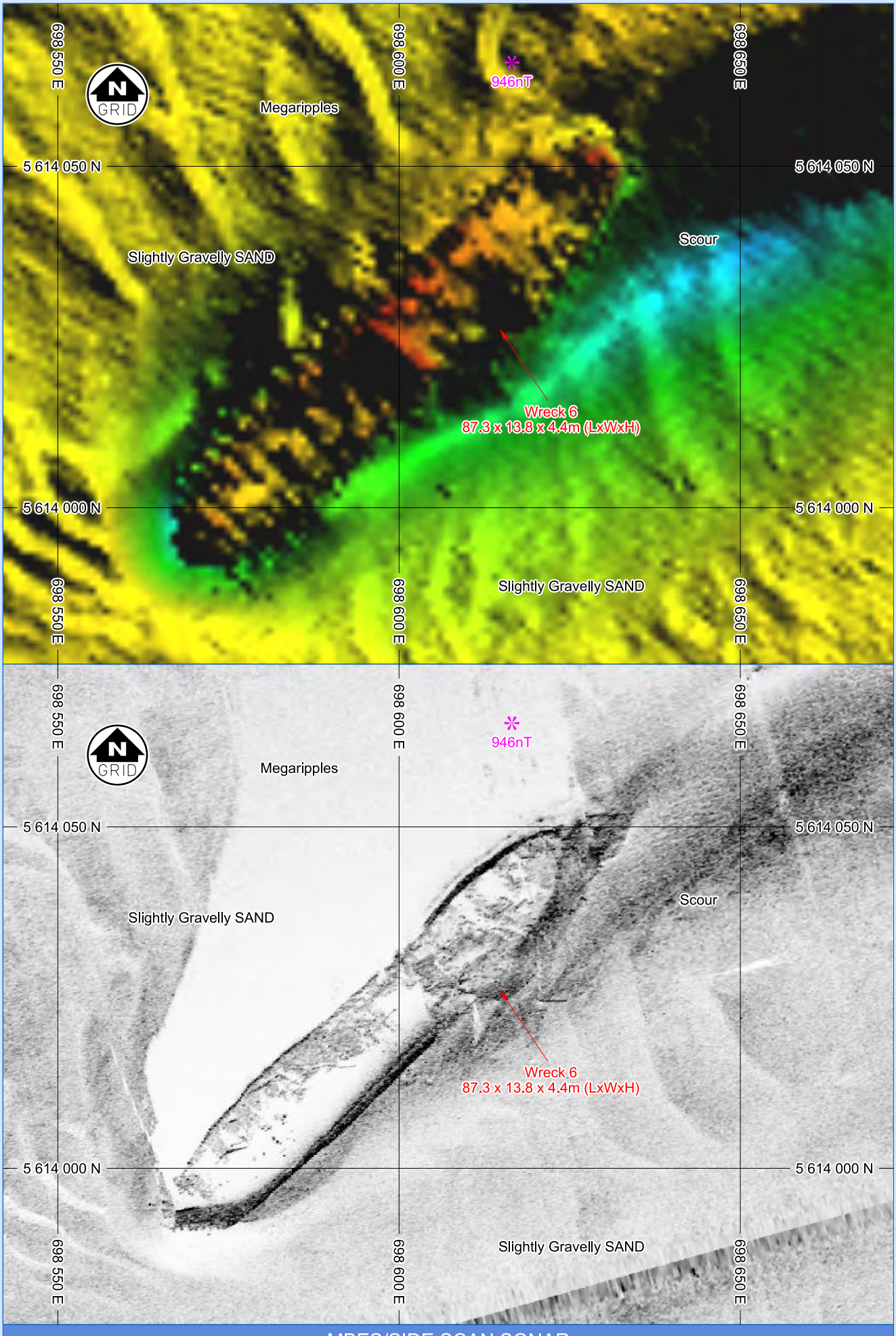


Scale 1 : 1 000
WGS84/UTM Zone 30N (3°W)

MBES/SIDE SCAN SONAR
Illustrating overview of Wreck 1

Figure 3.16

Job No. 11521.2

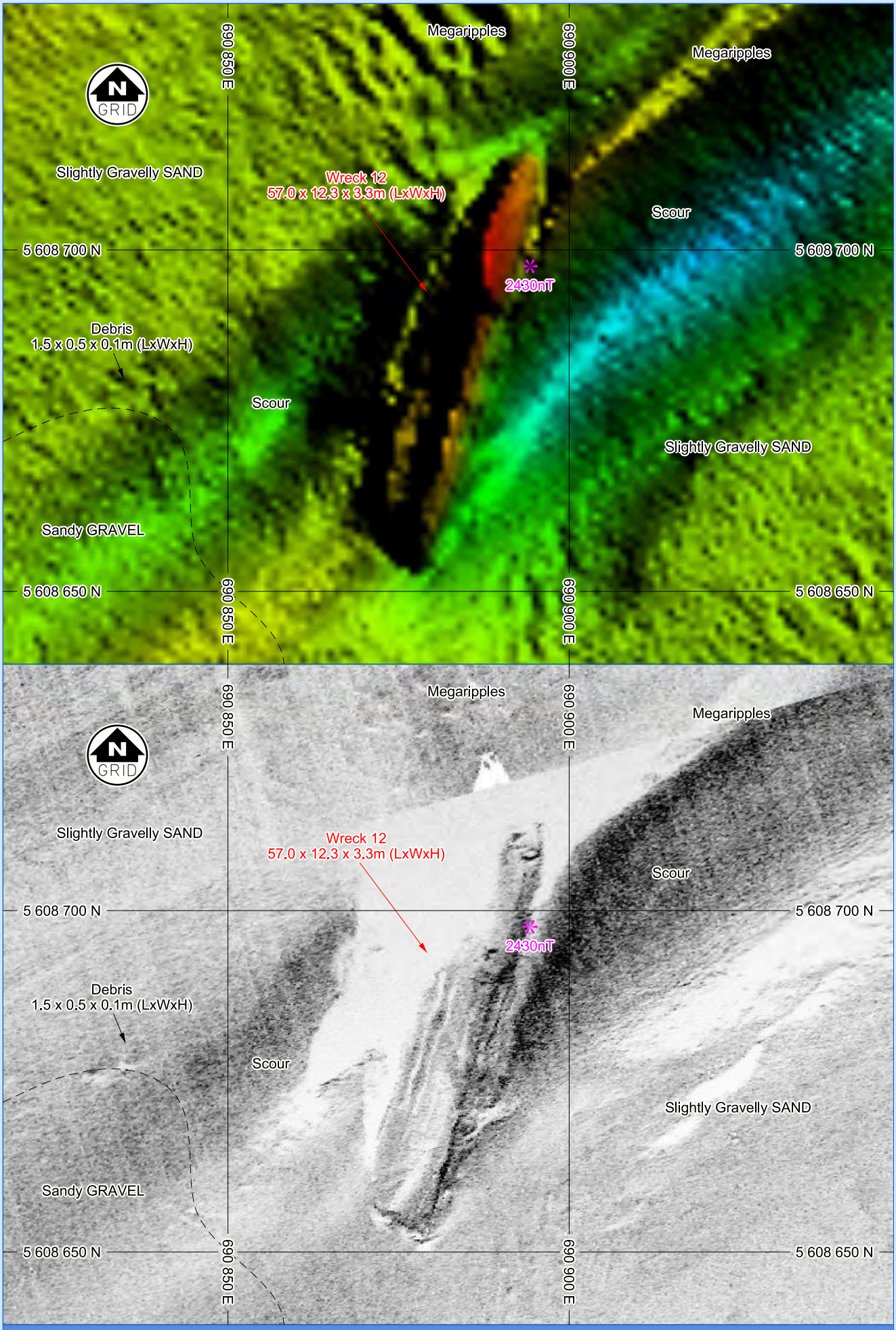


Scale 1 : 750
WGS84/UTM Zone 30N (3°W)

MBES/SIDE SCAN SONAR
Illustrating overview of Wreck 6

Figure 3.17

Job No. 11521.2



Scale 1 : 750
WGS84/UTM Zone 30N (3°W)

MBES/SIDE SCAN SONAR
Illustrating overview of Wreck 12

Figure 3.18

Job No. 11521.2

3.3 Sub-Surface Geology

Pinger and UHRS Sparker data were acquired on Area A. The Pinger and UHRS data were in good agreement with the bathymetry and side scan sonar data and hence aided the interpretation of both the seabed sediments and shallow soils. Penetration of greater than 50m was achieved on the UHRS data as specified in the scope of work. Correlation with previous reports allows for the previously acquired ground truthing results. It should be noted that previously acquired ground truthing results are not covered by the current 2020 survey data.

Referenced reports include:

- RAM-GAR-SIF-REP-0003_00--Geophysical Investigations Additional Areas Report, Gardline ref: 9370, 2013
- RAM-GAR-SMG-REP-0002_00--Export Cable Routes Report, Gardline ref: 9371, 2013
- RAM-OSI-SMG-SUR-0001_01-at02--Definitive Geophysical Survey Volume 2 Section 1 Report, 2010
- ATKINS_5124296_RampionOWF_KingdomModel

Within Rampion 2 OWF Area A two units have been identified and mapped. The base and distribution of each are presented on Chart 9 and Chart 10. An overview is illustrated in Figure 3.19 and Figure 3.20.

Table 3.2 Summary of Interpreted Horizons within Area A

Horizon	Phase	Description	Expected Geological Conditions
H05	Holocene Sediments	Found over most of Area A, ranging from seabed to 25m depth BSB. Characterised as largely homogeneous and acoustically transparent with faint, discontinuous internal horizons.	Unconsolidated sediments, predominantly sand and gravel. Potentially mobile in places.
H10	Palaeochannels and Palaeo-basin	Found throughout Area A. A channel infill sequence ranging from seabed to 31m depth BSB. Layered sediments, transparent facies are common and with higher amplitudes sometimes blanking obscuring the base.	Fluvial, estuarine and marine deposits. Predominantly sands and gravels overlying normally consolidated sands and clays, with some peat layers and basal gravels.
Bedding Strata	Tertiary and Cretaceous bedrock	Found throughout Area A. Tertiary Claystones to Cretaceous Chalk strata. Simply layered and often gently folded creating dipping beds.	Tertiary bedrock strata consist of softer rocks, comprising mainly sands, gravels and clays, with the older Cretaceous strata comprising typically limestone.

3.3.1 Geological Background

The Rampion 2 windfarm is located offshore Brighton, on the West Sussex coast. The Rampion 2 windfarm survey area lies within the English Channel and contains a variable sequence of Cretaceous and Tertiary bedrock, Palaeochannels and younger Holocene sediments. The general stratigraphy in this section is expected to be bedrock cut through by palaeochannels, all overlain by Pleistocene and Holocene deposits.

During the Pleistocene the English Channel comprised shallow marine environments periodically drying associated with glacial advances and retreats. Extensive fluvial delta systems were able to develop during this period. These rivers cut into the underlying bedrock.

At the end of the Pleistocene, marine conditions returned, infilling the river channels with estuarine then marine sediments. This led to extensive terrace deposits in the region and localised head deposits. During this transgression period sediments were reworked into lag sediments covered the majority of the seabed and subsequent marine deposits.

Throughout the Holocene, marine sediments have begun to build up in some areas of the seabed, covering the Pleistocene sediments and Bedrock outcrops. These deposits are more extensive and thicker further offshore.

BGS information for the area has no quaternary geology information and describes the bedrock as Chalk and interbedded tertiary strata.

A full description is listed in Table 3.2, detailing the horizons mapped and expected geological conditions for the units bounded by them.

3.3.2 Geological Overview

Holocene deposits are interpreted as comprising predominantly gravel and sand, deposited during open marine environments. These deposits are sometimes too thin to map using the sub-bottom data. They overlie the palaeochannels and occasionally the. Bedrock is interpreted to comprise Tertiary Claystones to Cretaceous Chalk strata. The strata are simply layered and often gently folded creating dipping beds. These bedding planes occasionally subcrop and outcrop in the northeast of the survey area.

The Holocene deposits represented by H05 are found over most of the survey area. They are at times too thin to identify on seismic data in the northeast. Where these are absent, bedrock bedding plain are observed to outcrop and tie with bathymetric data. Areas of increased seafloor boulders are also associated with thinning Holocene deposits. This unit is found to thicken towards the south with a maximum depth of 25m below seabed, illustrated in Figure 3.19. Relic bedforms are seen within this unit now overlain by younger sandwaves, illustrated in Figure 3.21.

Area A is dominated by a palaeo-basin, with palaeochannels cutting through the bedrock feeding into this basin. Within Area A there are two main channels, one feeding into the basin in the northwest and the other in the northeast of the survey area heading south. Smaller tributary channels can also been seen feeding into the system, illustrated in Figure 3.20. Background information from previous surveys show that many channels originate from the coast and head south into the Palaeo-basin. Channels are interpreted to comprise interbedded clay, sands and gravels, with peat layers and basal gravels. Figure 3.22 illustrates these channels on the pinger data. They are associated with glacial advances and the associated falls in sea level which allowed for an extensive river delta system to develop. At the end of the Pleistocene, marine conditions returned, infilling the channels with estuarine then marine sediments, as such, channel infill is likely to be variable. Within Area A these Palaeo-systems extend up to 31m below seabed, however occasionally the base of channels are blanked by what is likely to be peat or gravel layers, illustrated in Figure 3.23.

Bedrock is interpreted throughout Area A. It is mostly overlain by Palaeochannel and Holocene sediments. However it is found close to seafloor in the northwest and northeast of the survey area. Tertiary rock to Cretaceous Chalk strata, are simply layered and often gently folded creating bedding plains dipping downwards towards the southwest with an anticline in the northeast of the survey area,

see Figure 3.24 and Figure 3.25. Tertiary bedrock strata are interpreted to consist of sandstone and claystone. Older Cretaceous strata comprise typically of limestone.

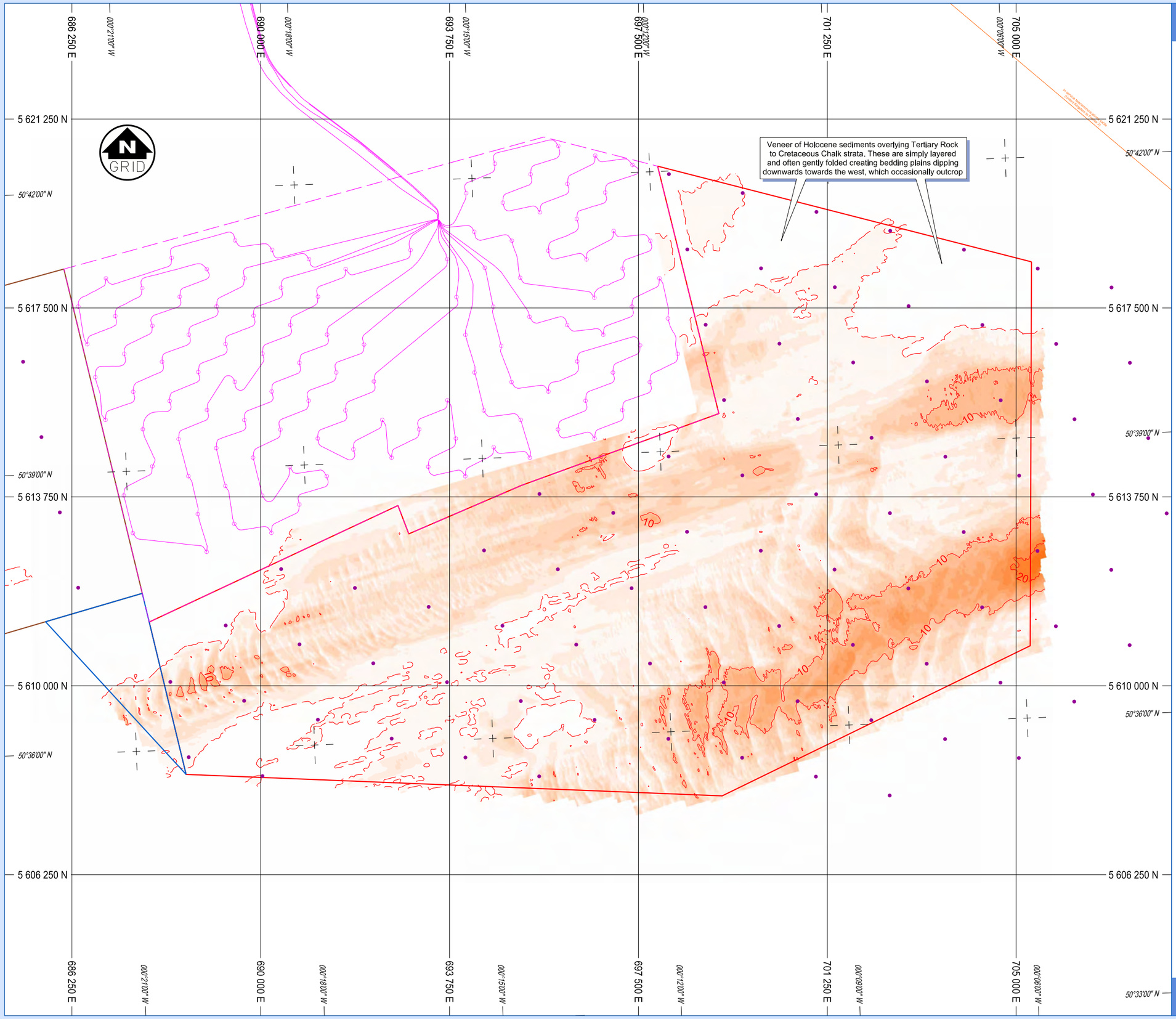
Table 3.3 shows a summary of the bedrock strata interpreted by Atkins and created using:

- RAM-ATK-SIF-DWG-0001_01--Rampion Site Terrain Unit Map Update 2014.pdf

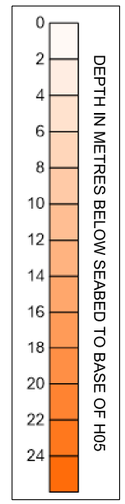
Table 3.3 Summary of Bedrock Strata

Chrono-stratigraphic Name	Stratum Code		Summary Description
Unknown	H		Unknown. Not identified in Atkins report
Bracklesham Group	G		Variable deposit comprising SAND, SILT, and CLAY in beds and channels. Not identified in Area A
UNCONFORMITY			
Thames Group (London Clay Formation)	F		Thinly interlaminated to medium interbedded silty fine to medium SAND and CLAY.
	E		Dense to very dense SAND. Commonly fine sand with beds of silt.
	D		Very dark grey sandy CLAY with extremely closely spaced thin laminae of sand. Also contains cobble beds and/or nodules.
	C	C2	Dense SAND.
		C1	Very dark grey slightly sandy CLAY with beds of sand.
Lambeth Group	B	B2	Mottled and thinly interlaminated grey, brown and red CLAY with beds of sand and organic materials.
		B1	Greyish green glauconitic SAND.
UNCONFORMITY			
Chalk	A		CHALK.

SOILS (H05 - HOLOCENE SAND) OVERVIEW FOR RAMPION 2 OWF AREA A



- PROPOSED RAMPION 2 OWF AREA A (ZONE 6 AREA)
- PROPOSED RAMPION 2 OWF AREA B (EXTENSION AREA)
- PROPOSED RAMPION 2 OWF AREA C (EXPORT CABLE AREA)
- PROPOSED RAMPION 2 OWF AREA D (EXPORT CABLE LINK AREA)
- PROPOSED RAMPION 2 WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND FARM CABLE (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION SURVEY AREA (SOURCE: CLIENT PROVIDED)
- 10 DEPTH IN METRES BELOW SEABED TO BASE OF H05, CONTOURED AT 10 METRE INTERVALS
- LIMIT OF BASE OF H05



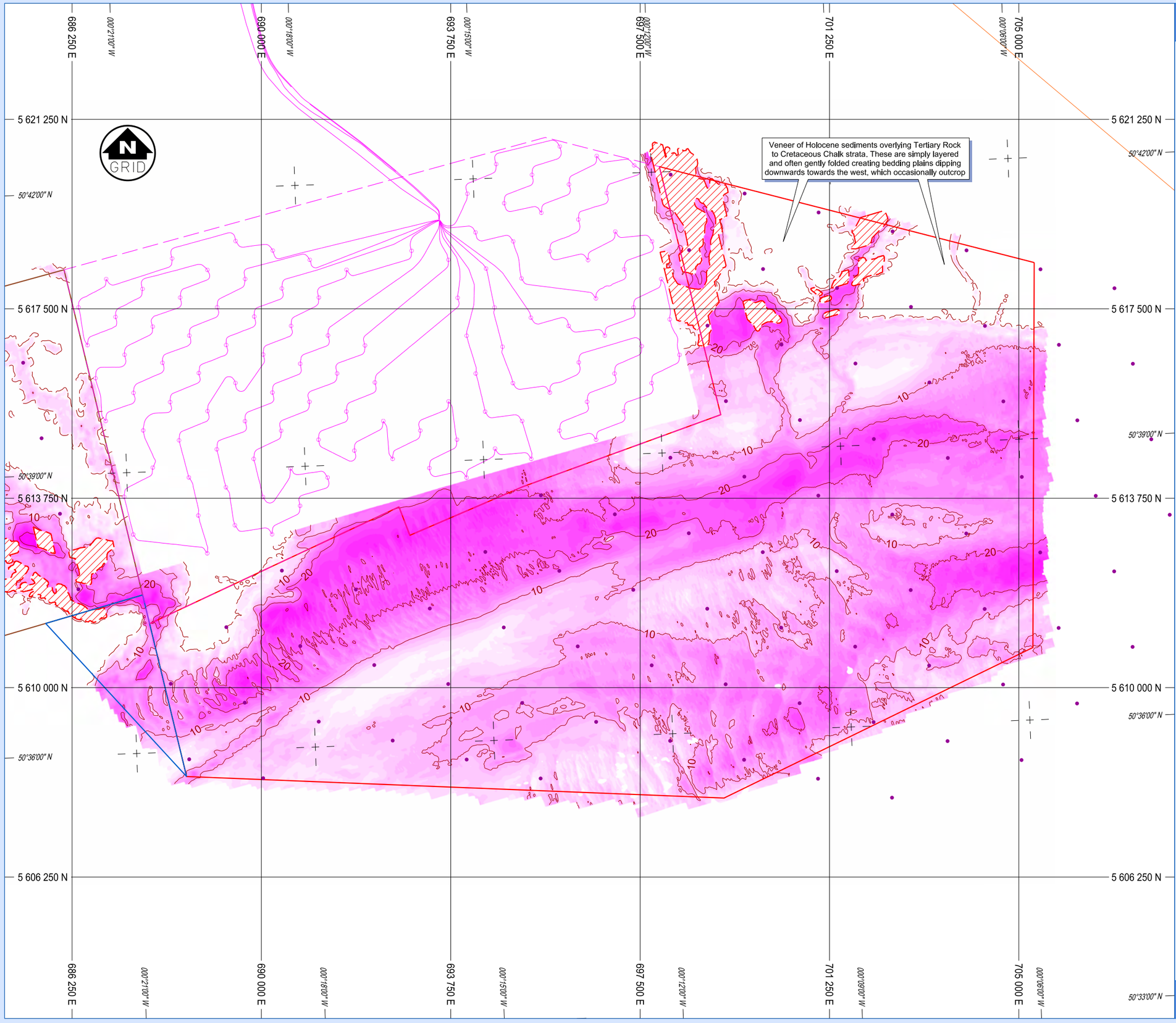
NOTE:

H05 = YOUNGER HOLOCENE DEPOSITS COMPRISING UNCONSOLIDATED SEDIMENTS, LARGELY SAND AND GRAVEL. POTENTIALLY MOBILE IN PLACES

Scale 1 : 75 000
WGS84/UTM Zone 30N (3°W)

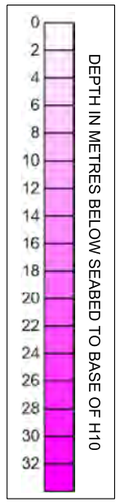
Figure 3.19

Job No. 11521.2



SOILS (H10 - PALAEOCHANNEL) OVERVIEW FOR RAMPION 2 OWF AREA A

- PROPOSED RAMPION 2 OWF AREA A (ZONE 6 AREA)
- PROPOSED RAMPION 2 OWF AREA B (EXTENSION AREA)
- PROPOSED RAMPION 2 OWF AREA C (EXPORT CABLE AREA)
- PROPOSED RAMPION 2 OWF AREA D (EXPORT CABLE LINK AREA)
- PROPOSED RAMPION 2 WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND FARM CABLE (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION SURVEY AREA (SOURCE: CLIENT PROVIDED)
- 10 — DEPTH IN METRES BELOW SEABED TO BASE OF H10 - PALAEOCHANNEL, CONTOURED AT 10 METRE INTERVALS
- LIMIT OF BASE OF H10
- AREA OF BLANKING



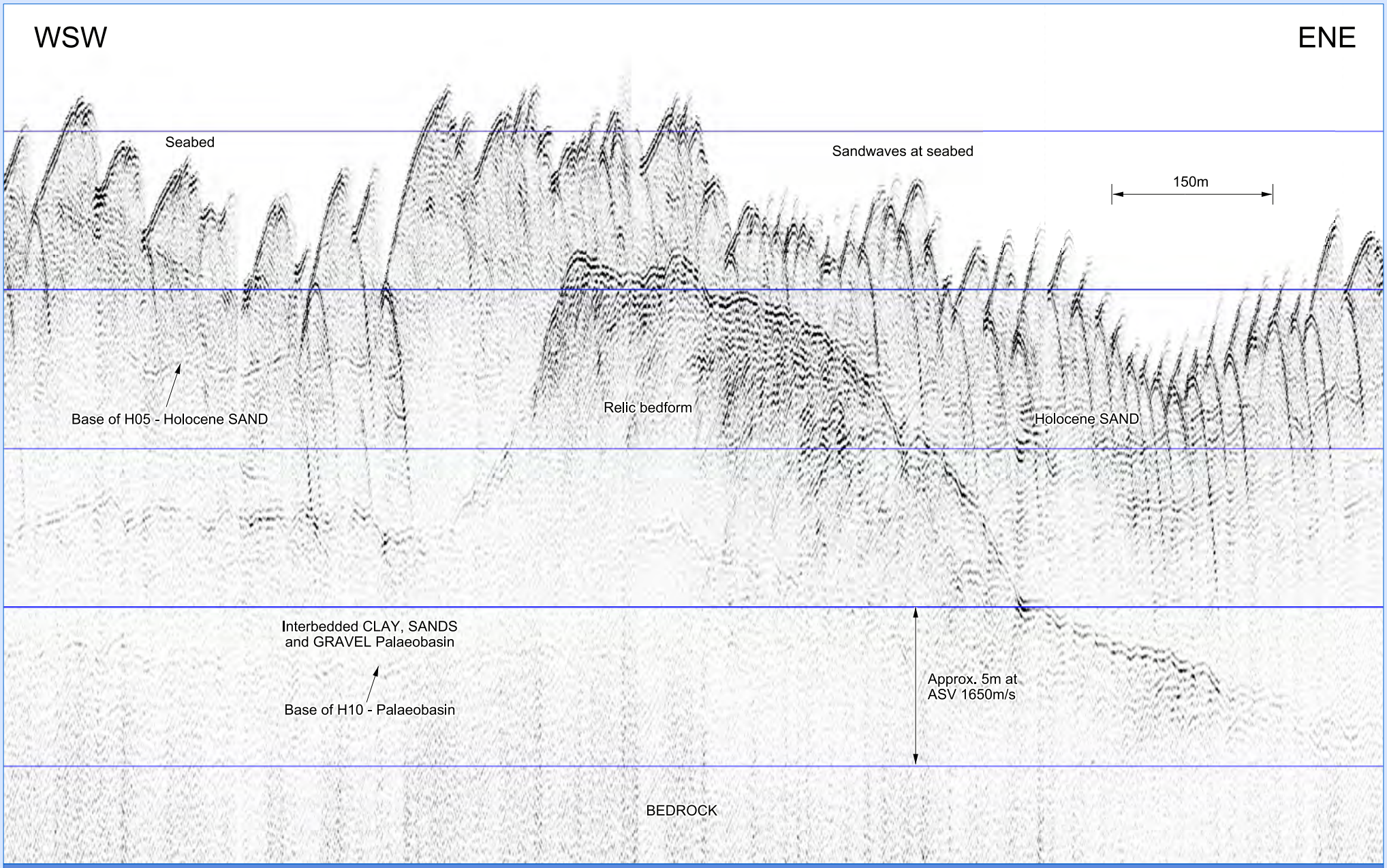
NOTE:

H10 = PALAEOCHANNELS ARE SEEN CUTTING THROUGH THE BEDROCK. THESE CHANNELS ARE INTERPRETED TO COMPRISE INTERBEDDED CLAY, SANDS AND GRAVELS, WITH PEAT LAYERS AND BASAL GRAVELS AND ARE ASSOCIATED WITH GLACIAL ADVANCES AND THE ASSOCIATED FALLS IN SEA LEVEL

Scale 1 : 75 000
WGS84/UTM Zone 30N (3°W)

Figure 3.20

Job No. 11521.2

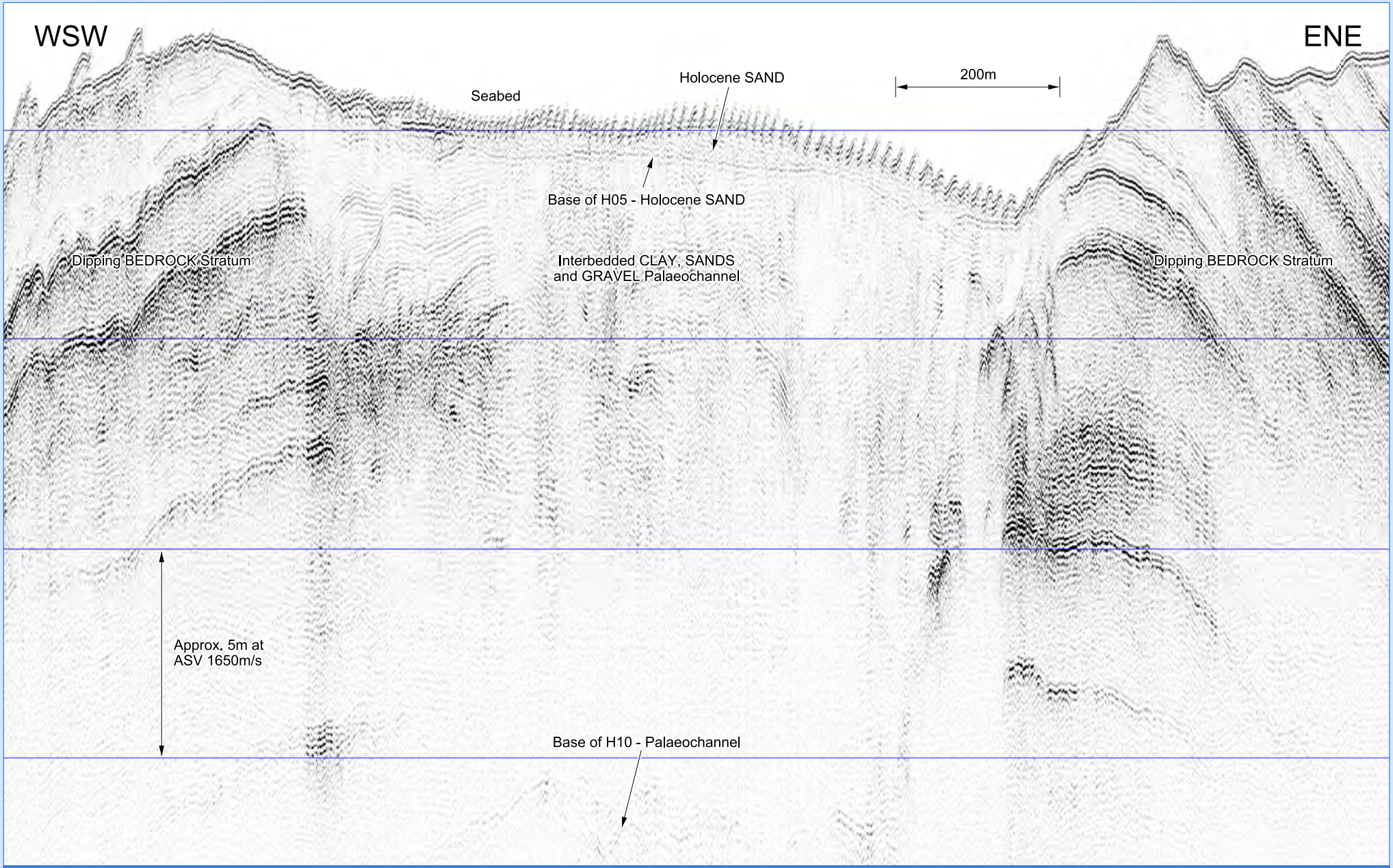


Line A_M-70

PINGER
Illustrating relic bedforms seen within this unit now overlain by younger sandwaves

Figure 3.21

Job No. 11521.2

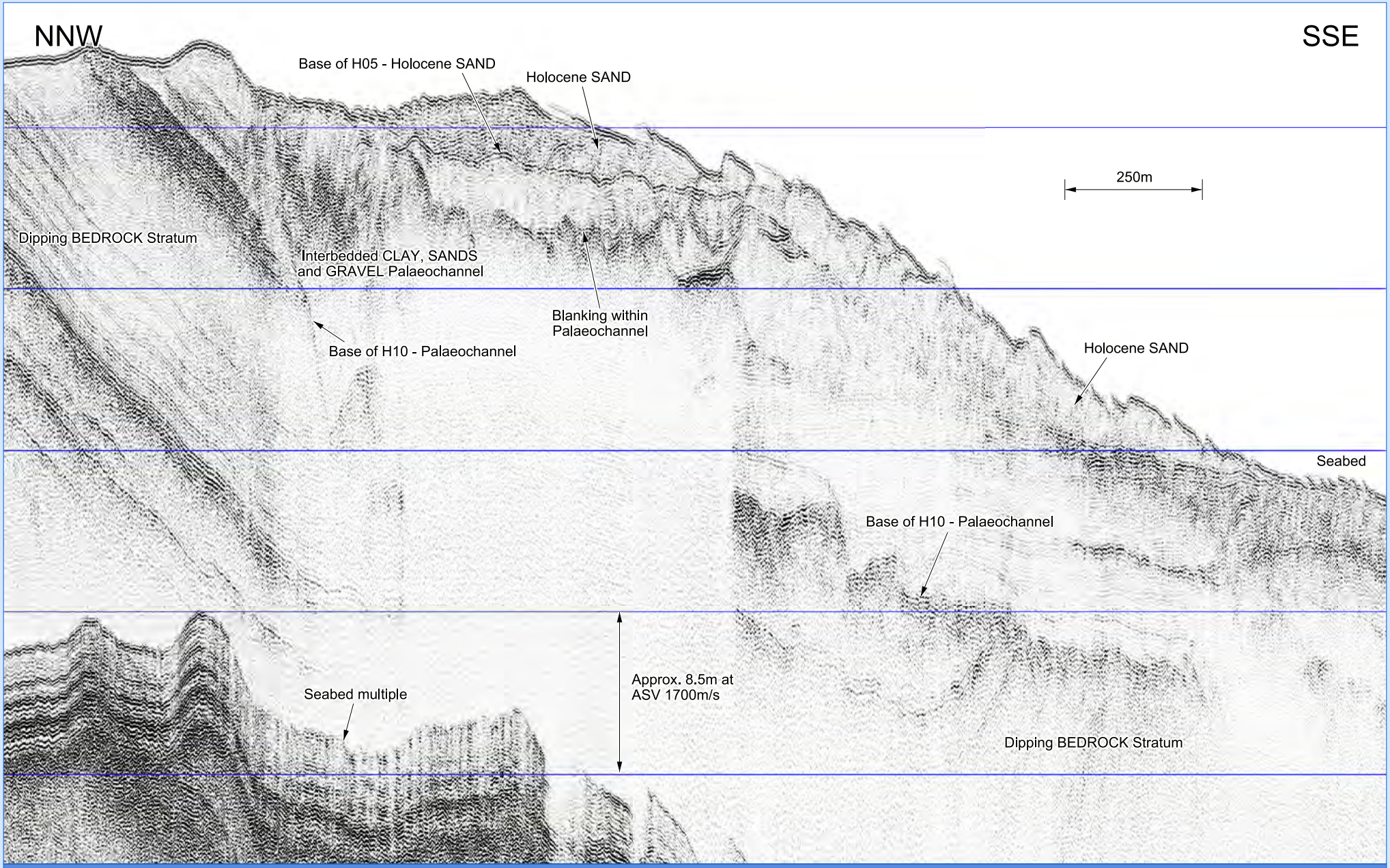


Line A_M-25

PINGER
Illustrating palaeochannels within bedrock stratum

Figure 3.22

Job No. 11521.2

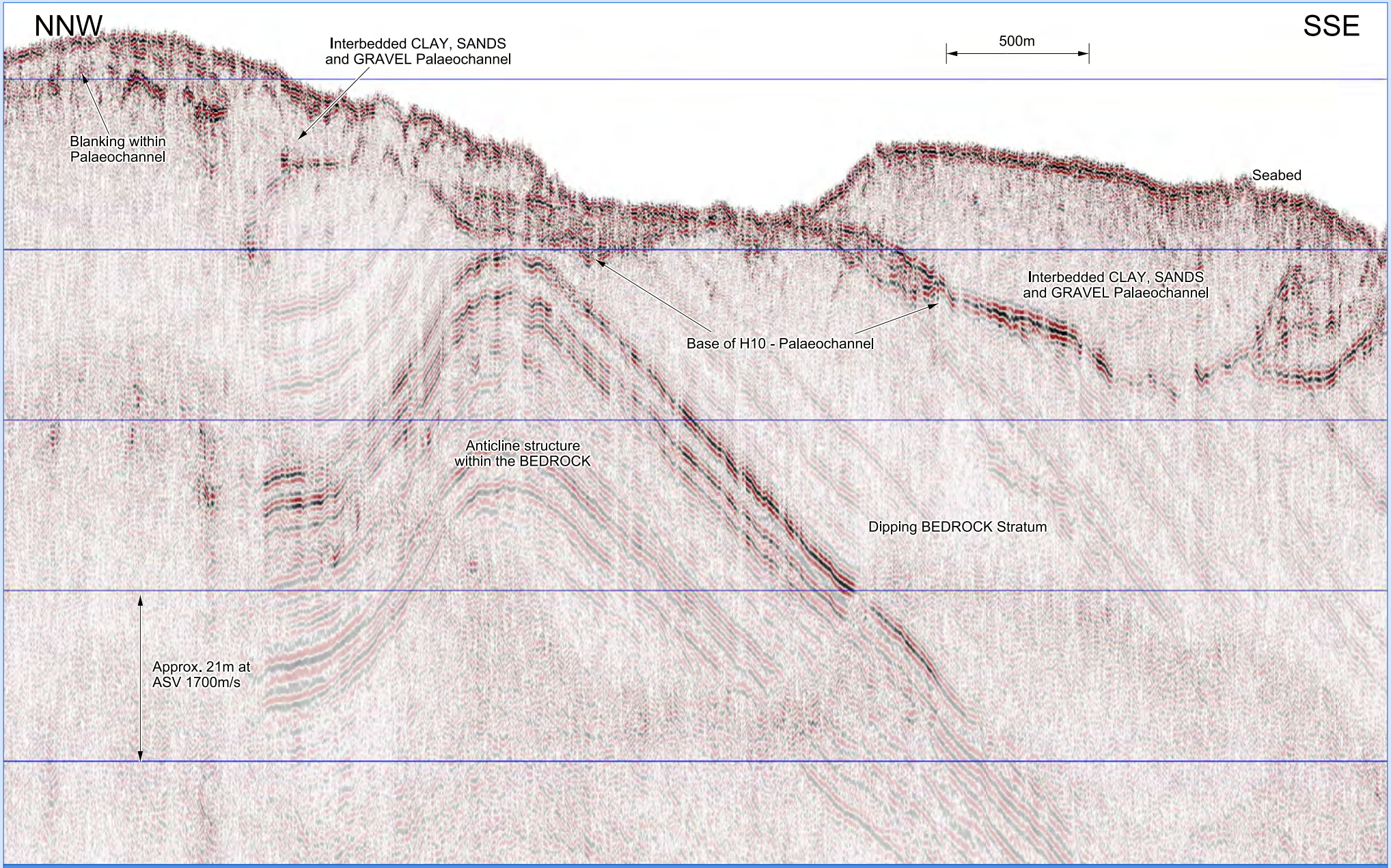


Line A_M-135

PINGER
Illustrating blanking within palaeochannels

Figure 3.23

Job No. 11521.2

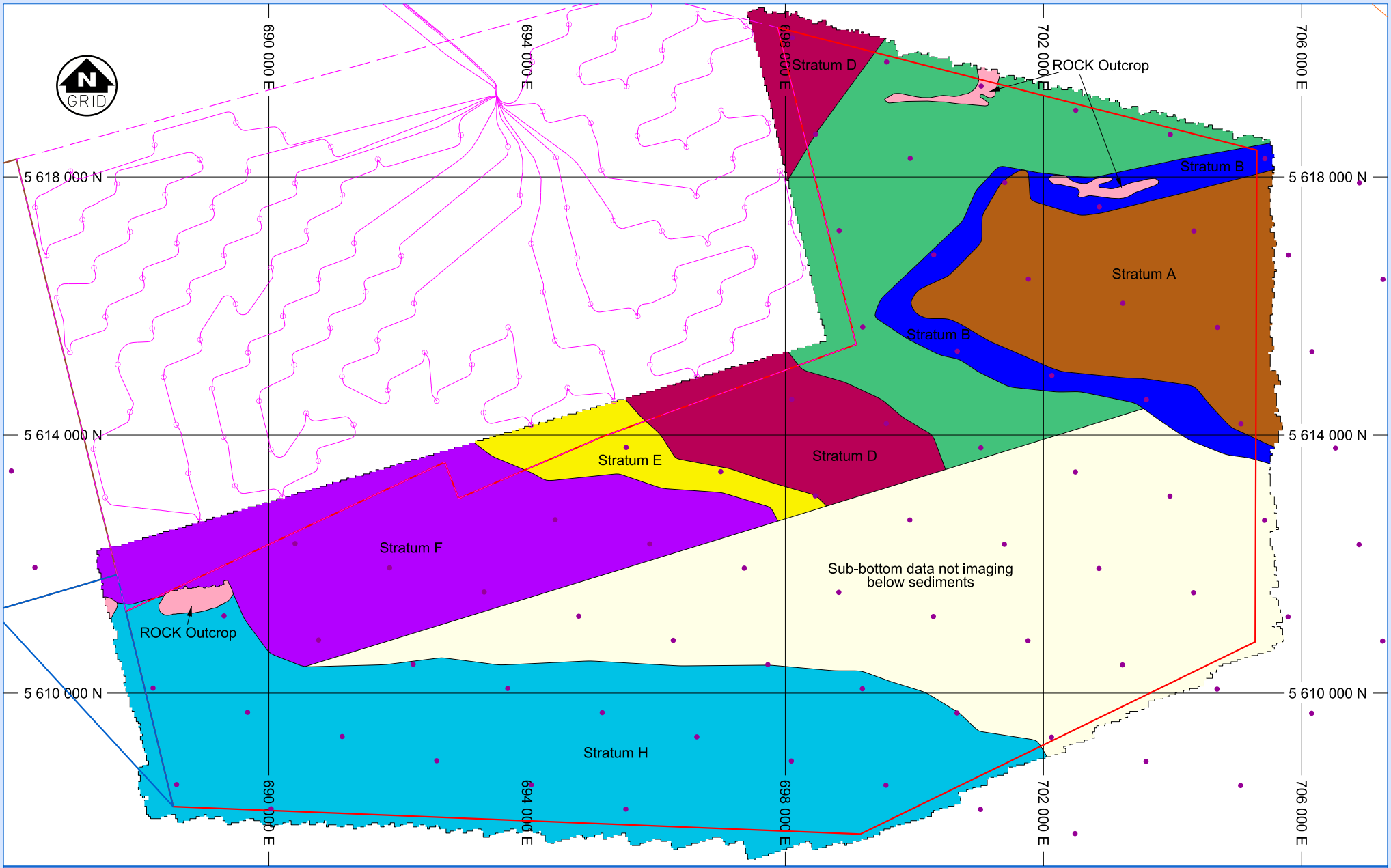


Line A_UHRS_45

ULTRA HIGH RESOLUTION SEISMIC
Illustrating dipping stratum and anticline structure

Figure 3.24

Job No. 11521.2



Scale 1 : 80 000
WGS84/UTM Zone 30N (3°W)

Bedrock Strata Overview

Figure 3.29

Job No. 11521.2

4. BACKGROUND INFORMATION

Geophysical data have been interpreted with reference to BGS charting for the area as follows:

Wight BGS Chart, Sheet 50°N - 02°W,
British Geological Survey, 1:250,000 Series,
Published by Ordnance Survey.

The following versions are available:

Sea Bed Sediments
Quaternary Geology
Solid Geology

Useful information was also obtained from the following sources:

Osiris Hydrographic & Geophysical Projects Ltd. 2010. E.ON Climate & Renewables, Rampion Offshore Wind Farm, Definitive Geophysical Survey.

Osiris Hydrographic & Geophysical Projects Ltd. 2011. E.ON Climate & Renewables, Rampion Offshore Wind Farm, Extension and BH13 UXO Survey.

Fugro GeoConsulting Ltd. 2013. E.ON Climate & Renewables, Rampion Offshore Wind Farm, Geotechnical Investigation Quadrant 99.

Gardline Ltd. 2013. E.ON Climate & Renewables, Rampion Offshore Wind Farm, Additional Areas Geophysical Survey.

APPENDICES

APPENDIX A. GEODETIC REFERENCE SYSTEM

Geodetic Datum	
Geodetic Datum	World Geodetic System 1984
EPSG Code	6326

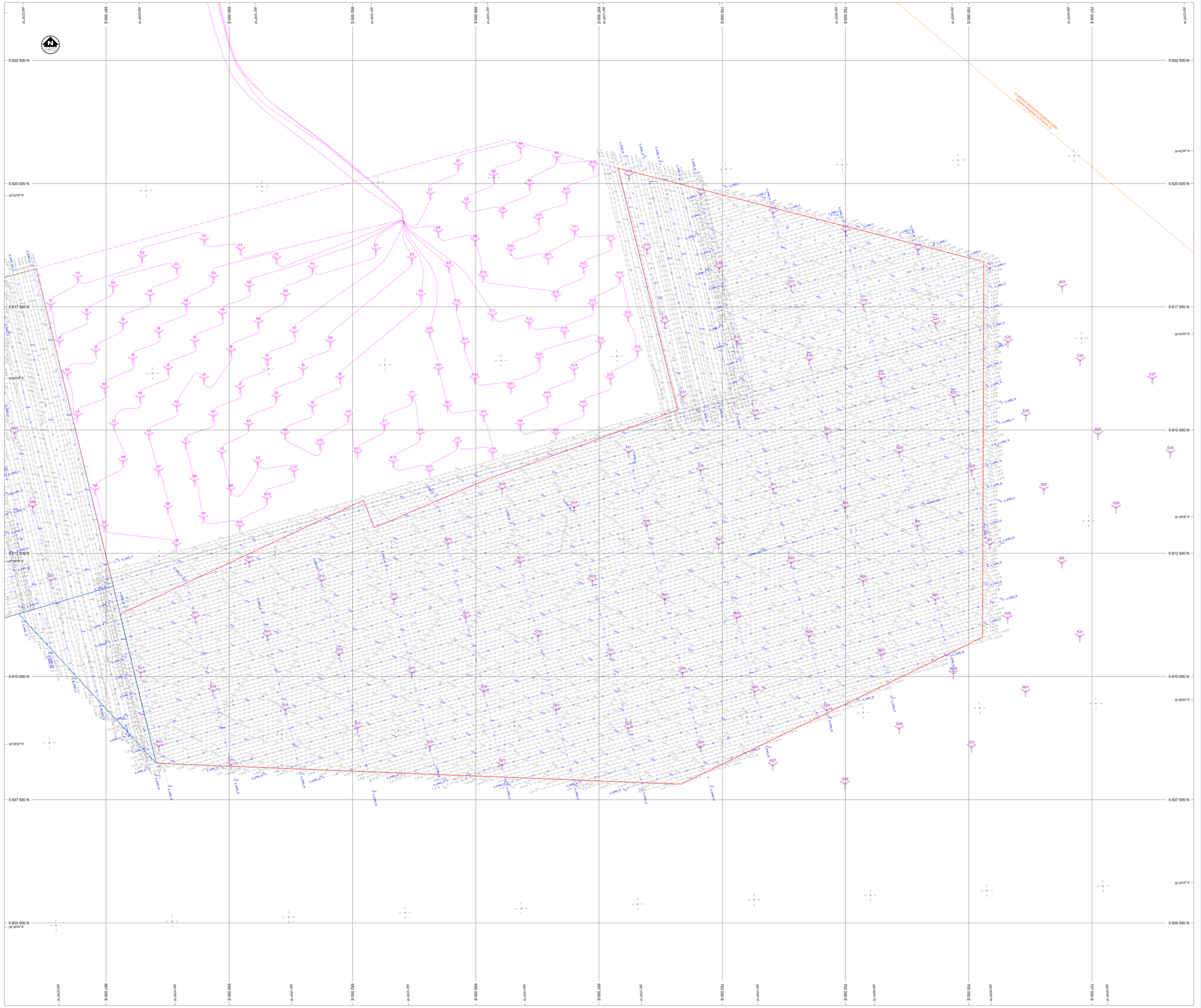
Ellipsoid	
Ellipsoid	WGS 84
EPSG Code	7030
Semi-major Axis (a)	6 378 137.000m
Semi-minor Axis (b)	6 356 752.314m
Inverse Flattening (1/f)	298.257 223 560
Eccentricity sq. (e^2)	0.006 694 379 990

Projection	
Projection	UTM Zone 30N
Projection Type	Transverse Mercator
EPSG Code	16030
Origin Latitude	00° 00' 00.000" North
Origin Longitude	003° 00' 00.000" West
Origin False Easting	500 000.000
Origin False Northing	0.000
Scale Factor	0.9996
Grid Unit	Metres
EPSG Code	9001

Source of Information: EPSG geodesy parameters dataset version 9.9.

ENCLOSURES

CHARTS 11521.2.01 –11521.2.14

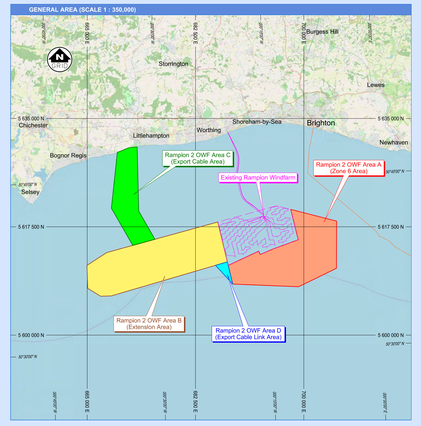


LEGEND

- PROPOSED RAMPION 2 OWF AREA A (ZONE 6 AREA)
- PROPOSED RAMPION 2 OWF AREA B (EXTENSION AREA)
- PROPOSED RAMPION 2 OWF AREA D (EXPORT CABLE LINK AREA)
- PROPOSED RAMPION 2 WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND FARM CABLE (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION SURVEY AREA (SOURCE: CLIENT PROVIDED)
- CABLE (SOURCE: CLIENT PROVIDED)
- REFERENCE POINT TRACK - SHALLOW GEOPHYSICAL LINES (M.V. VIGILANT)
- REFERENCE POINT TRACK - ULTRA HIGH RESOLUTION SEISMIC (UHRS) LINES (M.V. OCEAN OBSERVER)

NOTES

GENERAL AREA (SCALE 1 : 350,000)



GEODETIC REFERENCE SYSTEM

GEODETIC DATUM:	WGS84
ELLIPSOID:	WGS84
PROJECTION:	UTM ZONE 30 N (CENTRAL MERIDIAN 3° W)

SURVEY INFORMATION

	M.V. VIGILANT	M.V. OCEAN OBSERVER
SURVEY VESSEL:	30-JUN-2020 TO 01-AUG-2020	16-SEP-2020 TO 13-OCT-2020
SURVEY DATE:	OCEANERING C-NAV DGNSS	FUGRO STARFIX DGNSS
POSITIONING SYSTEM:	SONARDYNE RANGER USBL	SONARDYNE RANGER USBL
NAVIGATION SYSTEM:	VOYAGER 5	VOYAGER 5
ECHO SOUNDER (MULTI-BEAM SYSTEM):	SIMRAD EM2040D	SIMRAD EM2040
ECHO SOUNDER (SINGLE-BEAM SYSTEM):	SIMRAD EA400	SIMRAD EA400
SIDE SCAN SONAR:	EDGETECH 4200FS	EDGETECH 4200FS
MAGNETOMETER:	GEOMETRICS G882	GEOMETRICS G882
SUB-BOTTOM PROFILER:	GEOACOUSTICS PINGER	GEOACOUSTICS PINGER
ULTRA HIGH RESOLUTION SEISMIC (UHRS):		1 x 10 cu.in. T.I. SLEEVE GUN 75m TELEDYNE STREAMER

SCALE (A0 ORIGINAL)

1 : 25 000 (Horizontal)

250 0 1250 2500

METRES

TITLE

SURVEY CONTRACTOR

GARDLINE LIMITED
ENDEAVOUR HOUSE, ADMIRALTY ROAD, GREAT YARMOUTH, NORFOLK NR30 3NG, ENGLAND
TELEPHONE +44 (0) 1493 845600 FAX +44 (0) 1493 852106 WEBSITE WWW.GARDLINE.COM

CLIENT

PROJECT TITLE

RAMPION 2 OFFSHORE WINDFARM DEVELOPMENT GEOPHYSICAL SITE SURVEY FOR AREA A

DRAWING TITLE

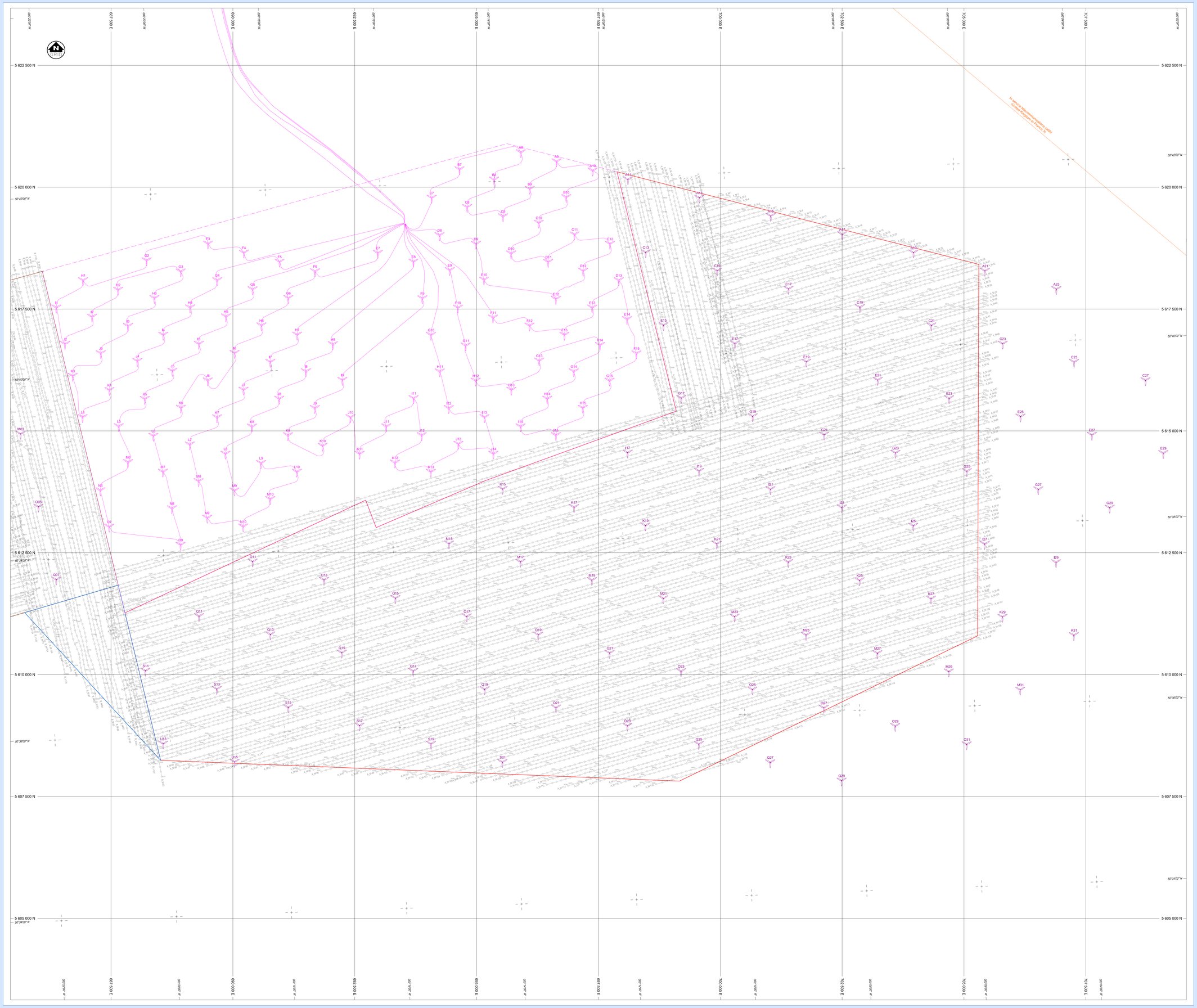
REFERENCE POINT TRACK

CHART 1

REVISION

REV.	DATE	TITLE	DESCRIPTION	AUTHOR	DRAWN	CHECKED	APPROVED
0	16-DEC-2020	DRAFT	FIRST ISSUE FOR CLIENT REVIEW, PDF ONLY	MC	JS	MK	DIG

CLIENT REFERENCE		REPORT REFERENCE	11521.2
DRAWING NUMBER	11521.2.01		

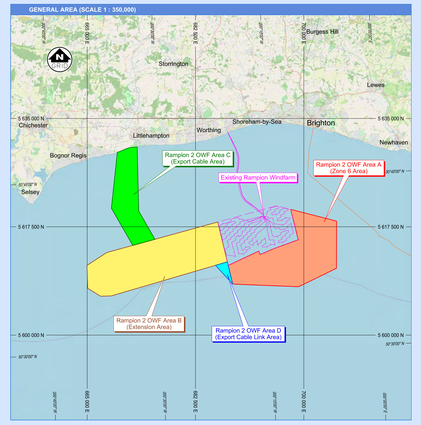


LEGEND

- PROPOSED RAMPION 2 OWF AREA A (ZONE 6 AREA)
- PROPOSED RAMPION 2 OWF AREA B (EXTENSION AREA)
- PROPOSED RAMPION 2 OWF AREA D (EXPORT CABLE LINK AREA)
- PROPOSED RAMPION 2 WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND TURBINE GENERATOR LAYOUT (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION WIND FARM CABLE (SOURCE: CLIENT PROVIDED)
- EXISTING RAMPION SURVEY AREA (SOURCE: CLIENT PROVIDED)
- CABLE (SOURCE: CLIENT PROVIDED)
- SIDE SCAN SONAR TRACK - SHALLOW GEOPHYSICAL LINES (M.V. VIGILANT)

NOTES

GENERAL AREA (SCALE 1 : 350,000)



GEODETIC REFERENCE SYSTEM

GEODETIC DATUM:	WGS84
ELLIPSOID:	WGS84
PROJECTION:	UTM ZONE 30 N (CENTRAL MERIDIAN 3° W)

SURVEY INFORMATION

SURVEY VESSEL:	M.V. VIGILANT	M.V. OCEAN OBSERVER
SURVEY DATE:	30-JUN-2020 TO 01-AUG-2020	16-SEP-2020 TO 13-OCT-2020
POSITIONING SYSTEM:	OCEANERRING C-NAV DGNSS SONARDYNE RANGER USBL	FUGRO STARFIX DGNSS SONARDYNE RANGER USBL
NAVIGATION SYSTEM:	VOYAGER 5	VOYAGER 5
ECHO SOUNDER (MULTI-BEAM SYSTEM):	SIMRAD EM2040D	SIMRAD EM2040
ECHO SOUNDER (SINGLE-BEAM SYSTEM):	SIMRAD EA400	SIMRAD EA400
SIDE SCAN SONAR:	EDGETECH 4200FS	EDGETECH 4200FS
MAGNETOMETER:	GEOMETRICS G882	GEOMETRICS G882
SUB-BOTTOM PROFILER:	GEOACOUSTICS PINGER	GEOACOUSTICS PINGER
ULTRA HIGH RESOLUTION SEISMIC (UHRS):		1 x 10 cu.in. T.I. SLEEVE GUN 75m TELEDYNE STREAMER

SCALE (A0 ORIGINAL)

1 : 25 000 (Horizontal)

250 0 1250 2500

METRES

TITLE

SURVEY CONTRACTOR

GARDLINE LIMITED
ENDEAVOUR HOUSE, ADMIRALTY ROAD, GREAT YARMOUTH, NORFOLK NR30 3NG. ENGLAND
TELEPHONE +44 (0) 1493 845600 FAX +44 (0) 1493 852106 WEBSITE WWW.GARDLINE.COM

CLIENT

PROJECT TITLE

RAMPION 2 OFFSHORE WINDFARM DEVELOPMENT GEOPHYSICAL SITE SURVEY FOR AREA A

DRAWING TITLE

SIDE SCAN SONAR TRACK

CHART 2

REVISION

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