MARINE SURVEY REPORT

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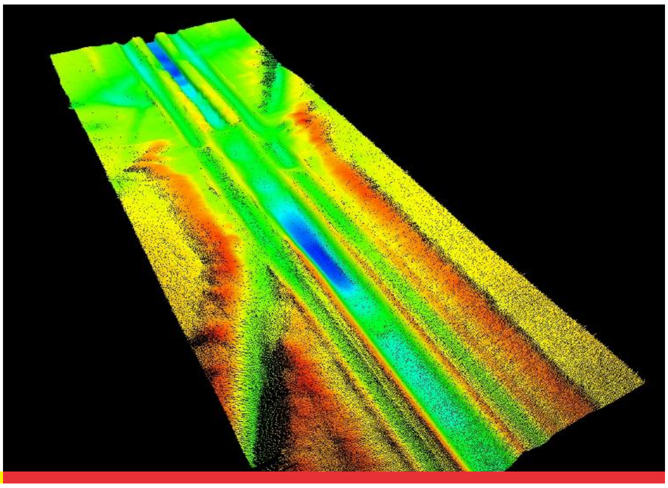

inelfe

BISCAY HVDC WI

ROUTE SURVEY

CAPBRETON CANYON, GULF OF BISCAY
SEPTEMBER 2016 - SEPTEMBER 2017

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MMT

REVISION HISTORY

REVISION	DATE	STATUS	CHECK	APPROVAL	CLIENT APPROVAL
B	2017-11-27	Issue for Use	MB	OS	
A3	2017-10-16	Issue for Client Review	HA	OS	
A2	2017-09-25	Issue for Client Review	MB	OS	
A1	2017-07-11	Issue for Use	MB	OS	
A	2017-03-24	Issue for Use	HA	OS	
02	2017-01-09	Issue for Client Review	HA	OS	
01	2017-01-04	Issue for Internal Review	GC	MB	

REVISION LOG

DATE	SECTION	CHANGE
2017-11-27	N/A	Updated according to Client Comments on revision A3
2017-10-16	1 1.1 2 2.5 3.4.1 5.3 5.4 Appendix Q Appendix R	Updated survey period to include dive survey at Le Grand Crohot. Completion of dive survey at Le Grand Crohot. Section update regarding correlation between geotechnical and geophysical survey results. Results dive operations Le Grand Crohot added. Results dive operations Le Grand Crohot added. Table 30 Updated with dive survey Table 34 updated with dive completion of Le Grand Crohot. Added Geotechnical Report from Insitu Added Geotechnical Summary spreadsheet
2017-09-25	N/A	Updated with Phase 2 results
2017-07-10	N/A	Updated according to Client Comments
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1| INTRODUCTION AND GENERAL REFERENCES

MMT was contracted to perform the reconnaissance route surveys in the Bay of Biscay for INELFE and The Biscay Gulf HVDC Western Interconnector project. The Biscay Gulf HVDC Western Interconnector is a joint project being developed by INELFE on behalf of Réseau de Transport d'Electricité (RTE) and Red Eléctrica de España (REE), and supported by the European Union's Connecting Europe Facility (CEF). It is included in the Project of Common Interest list for the year 2013.

The interconnector will include two high voltage direct current (HVDC) links with converter stations, subsea and underground cables. The subsea cables will run between the coasts of the French Aquitane and the Spanish Basque Country.

The survey was divided into four parts:

- Offshore, divided into seven survey blocks
- Nearshore
- Shallow water
- Onshore

Project details:

Project:	Biscay Gulf HVDC Western Interconnector
MMT Project no:	102354
Survey Types:	Bathymetric, Geophysical, UXO and Geotechnical Survey
Purpose:	Cable Route Design and Engineering
Area:	Bay of Biscay (France, Spain)
Client:	INELFE
Survey Period:	25 September 2016 to 27 September 2017
Survey Vessels:	M/V Franklin, M/V Geo Focus, Plasticbeam, M/V Olympic Delta, M/V JIF Challenger, M/V Esquina, M/V JIF Patrol

1.1| INTRODUCTION TO THE REPORT

This survey report provide details of the survey operations undertaken to collect, analyse and report geophysical and geotechnical data collected along the proposed cable route options. The survey were conducted along a designed route between the proposed landing locations of La Cantine, France and Lemóniz, on the Spanish coast (Figure 4). The initial route design was based on previous knowledge gained from a desk study of published geological studies encompassing the proposed route options. The main objectives were to assess feasibility for installation of the proposed cable with respect to surficial sediment cover, geomorphology and debris hazards. On site analysis of the data highlighted unsuitable conditions along certain sections of the route design whereby the Client instructed further route development work to be undertaken.

The surveys were performed as two separate campaigns. An initial geophysical campaign in 2016 (Phase 1) and in 2017 a campaign that comprised of unexploded ordnance (UXO) survey for the geotechnical sites, a geotechnical survey as well as additional geophysical work nearshore the Spanish landfall (Phase 2).

Phase 1, in 2016, was conducted aboard three (3) survey vessels: M/V Franklin, M/V Geo Focus and Plasticbeam (Appendix A) between 25 September and 7 November 2016. In addition to the involved vessels, dive survey as well as unmanned aerial vehichle (UAV) survey of the three French landfall alternatives were conducted.

Phase 2, in 2017, was conducted aboard four (4) vessels: M/V Olympic Delta, M/V JIF Challenger, M/V Esquina and M/V JIF Patrol (Appendix A) between June 7 and July 19 2017.

Data was acquired using a remotely operated towed vehicle (ROTV) equipped with a multibeam echo sounder (MBES), side scan sonar (SSS), sub-bottom profiler (SBP) and a transverse gradiometer (TVG) on board M/V Franklin. Due to certain seabed conditions being unsuitable for the chirp (SBP), seismic reflection data were also collected using a sparker system along some lines on the French section of the route for the offshore section surveyed by M/V Franklin. M/V Geo Focus was equipped with a pole-mounted Innomar system that collected SSS and SBP and towed a magnetometer from the aft deck. MBES was hull mounted on M/V Geo Focus.

The shallow water survey in Nearshore Spain was surveyed by Plasticbeam using MBES and a Go-Pro camera.

Diver surveys were conducted in the shallow foreshore and UAV surveys onshore at the French landings. The dive survey at the preferred landfall La Cantine was completed 2016, while Lacanau was completed August 2017. The dive survey at Le Grand Crohot was completed in September 2017.

M/V Olympic Delta acquired data using a remotely operated vehicle (ROV) fitted with MBES, SSS, SBP and gradiometer. Geotechnical investigations were performed with vibrocorer (VC), piezo cone penetration test (PCPT) and rockcorer (RC) along the offshore route. Shallow water geotechnical sampling was performed from M/V JIF Challenger using VC and PCPT.

M/V Esquina and M/V JIF Patrol conducted shallow water UXO survey using vessel towed magnetometer.

1.2| TABLE OF CONTENTS

1.2.1| APPENDICES

1.2.2| LIST OF FIGURES

1.2.3| LIST OF TABLES

1.2.4| LIST OF ABBREVIATIONS AND DEFINITIONS

ACHBC	Alternative Canyon Head Bypass Coast (Route Option)
ALARP	As low as reasonably practicable
ARSW	Additional Route Spanish Waters (Route Option)
BSF	Below Sea Floor
CEF	Connecting Europe Facility
CHBC	Canyon Head Bypass Coast (Route Option)
Chirp	A high frequency, frequency modulated sub-bottom profiler system
DCC	Distance Cross Course
DPR	Daily Progress Report
DTM	Digital Terrain Model
DTU10	A geoid model developed at Danmarks Tekniske Universitet
GAMS	GNSS Aided Measurement System
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GRS80	Geodetic Reference System 1980
HDD	Horizontal Directional Drilling
HDCC	HDD Canyon Crossing (Route Option)
HVDC	High voltage direct current
ITRF	International Terrestrial Reference Frame
ITT	Invitation to Tender
kHz	kiloHertz
km	Kilometre
KP	Kilometre Post, used to describe distance along a route (design)
LACO	Lacanau Option (Route Option)
LAT	Lowest Astronomical Tide (vertical datum)
LGCO	Le Grande Crohot Option (Route Option)
MAC	Mobilisation and Calibration
MBES	Multibeam Echo Sounder
MINCS	MMT Improvement and Non Conformity System
MMT	MMT Sweden AB
MOB	Man Over Board
MR	Main Route (Route Option)
M/V	Motor Vessel
NB	Nota Bene
PCPT	Piezo Cone Penetration Test
POS MV	Position and Orientation System for Marine Vessels
PPS	Pulse Per Second
QINSy	Quality Integrated Navigation System
RC	Rock Core
RD	Route Development
REE	Red Eléctrica de España
RMS	Root Mean Square
ROTV	Remotely Operated Towed Vehicle
ROV	Remotely Operated Vehicle
RPA	Red Penguin Associates Ltd
RPL	Route Position List
RTE	Réseau de Transport d’Electricité
RTK	Real Time Kinematics
SBET	Smoothed Best Estimated Trajectory
SBP	Sub-Bottom Profiler
SHP	ESRI Shape File format
SIS	Seafloor Information System
SIT	Surrogate Item Trial
SJA	Safe Job Analysis
SOC	Safety Observation Card
SOPEP	Ship Oil Pollution Emergency Plan
SOW	Scope of Work
SP	Sparker
SROV	Survey ROV
SSS	Side Scan Sonar

SV	Sound Velocity
SVP	Sound Velocity Profile
SVS	Sound Velocity Sensor
TVG	Transverse Gradiometer
TVG	Time Varied Gain
TVU	Total Vertical Propagating Uncertainty
UAV	Unmanned Aerial Vehicle
UKHO	United Kingdom Hydrographic Office
USBL	Ultra Short Base Line
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
UXO	Unexploded Ordnance
VC	Vibro Core
VORF	Vertical Offshore Reference Frame
WGS84	World Geodetic System 1984

1.2.5| GLOSSARY AND KEY WORDS

Acoustic reflector	Geological interface between different rocks or sediments that reflects acoustic energy.
Bedding/Layering	Stratified or layered sequence in sedimentary rocks and loose sediments.
Bedform	Seabed topography, such as ripples, sandwaves etc. usually in sandy sediments produced by wave and current activity.
Bedrock	Rock lying beneath unconsolidated surficial material. Bedrock is not necessarily 'solid' and may be extensively weathered and fractured.
Boulder	Piece of rock, usually rounded and >20 cm diameter.
Chart Datum	The level below which all depths are published on navigational charts. For this project, LAT is used.
Chirp	Hull mounted or towed seismic system referred to as a sub-bottom profiler used for acquiring very shallow geology data.
Coarse sediment	Sediment composed mainly of sand or coarser materials.
Digital Terrain Model (DTM)	A highly detailed representation of seabed topography in digital format.
Facies	Sum total of features that reflect the environmental conditions under which a given sediment or rock was formed or deposited.
Fine sediment	Sediment composed mainly of silt and clay.
Furrow	Longitudinal bed forms that form in fine grained sediments.
GeoPNG	Geographically referenced image in Portable Network Graphics format.
Gravel	Unconsolidated deposit of particle size between 2 mm and 20 mm in diameter.
LAT	The lowest sea level that can be predicted under normal meteorological and astronomical conditions. LAT is not an

	extreme level, as meteorological conditions can cause a lower and higher level referred to as a storm surge.
Magnetometer	Survey equipment towed behind the vessel for the detection of ferrous objects.
Multibeam echo sounder	Survey equipment for acquiring bathymetry data in a swath with a width of up to 10 times the water depth.
Outcrop	Bedrock that has little or no sediment cover.
Quaternary	Period of glaciations, which started approximately 2.6 million years ago.
Re-worked	Sediment that has been eroded and re-deposited.
Ridge	Distinct, long, narrow seabed feature.
Rim	Refers to the edge of a feature/area.
Ripple	Seabed feature with small wavelength produced by waves and currents in loose usually sandy sediment.
Sand	Particle size 0.06 mm to 2 mm diameter.
Side scan sonar	Survey equipment towed behind the vessel, which acoustically images the seabed.
Silt	Particle size 0.002 mm to 0.06 mm diameter.
Slope, very gentle	1-4.9° slope (British Standard).
Slope, gentle	<1° slope (British Standard).
Slope, moderate	5-9.9° slope (British Standard).
Slope, steep	10-14.9° slope (British Standard).
Slope, very steep	>15° slope (British Standard).
Slump	Mass movement of unstable sediment down slope.
SMT Kingdom	Seismic Micro-Technology, Inc. software for the interpretation of sparker and chirp data.
Sound velocity profiling	Measurement of the speed of sound in sea water and applied during processing of MBES data.
Subcropping rock	Bedrock covered by a layer of loose sediment usually <0.5 m thick and may be intermittently exposed at the seabed.
Surficial	Term used to describe a generally thin layer of sediment. Surficial sediments are usually recent and mobile.

1.3| FINAL SCOPE OF PROJECT

1.3.1| SCOPE OF WORK

PHASE 1

Phase 1 was divided in four tasks; Offshore, Nearshore, Inshore (diving and shallow water vessel) and Onshore survey (UAV survey) (Figure 4).

Data collection in Phase 1 was conducted aboard three separate vessels, i.e. M/V Franklin, M/V Geo Focus and Plasticbeam, for full vessel specifications see Appendix A|. The equipment specifications are found in Appendix B|.

The M/V Franklin undertook the offshore survey to the 10 m isobath, the M/V Geo Focus conducted the nearshore survey (in France and Spain) and the Plasticbeam undertook the shallow water work close to land in Spain. The nearshore and offshore surveys overlapped between the 10 m and 20 m isobaths so as to ensure sufficient overlap of data.

The inshore survey in France included probing and measured water depth by using divers along three transects for each of the three landfalls.

The onshore survey for the three landfalls in France were performed with an Aerial Topography Survey. The UAV mapped a corridor 100 m wide that stretches from the diver survey to the end of the route position list (RPL) received from the Clients prior to survey start. No onshore survey was performed in Spain.

The Spanish landfall was surveyed by M/V Geo Focus as close to land as was deemed safe, and at times was required to standby or alter course to avoid fishing gear and vessels. The landfall area is depicted within the green area shown in Figure 6.

The M/V Geo Focus surveyed the area marked green in Figure 5 and Figure 6, going as close to land as safe and practical possible. The shallow water survey in Spain was performed by the Plasticbeam with a pole-mounted MBES system.

ENGINEERING THE CABLE ROUTES

After the reporting for Phase 1 was completed and prior to the start of Phase 2, MMT undertook the process to engineer the four parallel cable routes for each of the route options. This process was done based on instructions from RPA and INELFE; the instructions are summarised below and exemplified for water depths less than 100 m in Figure 1, Figure 2 and Figure 3.

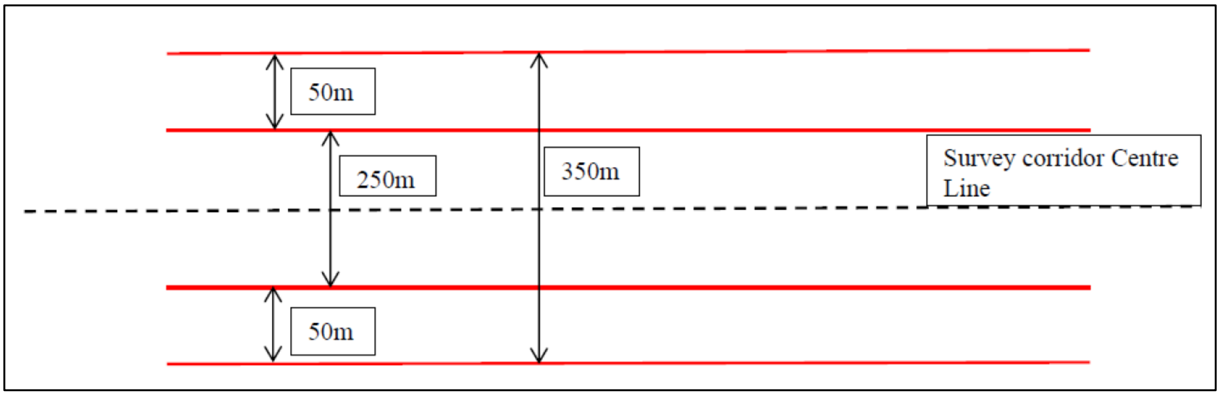

Figure 1 Cable engineering principle with no constraints within the corridor.

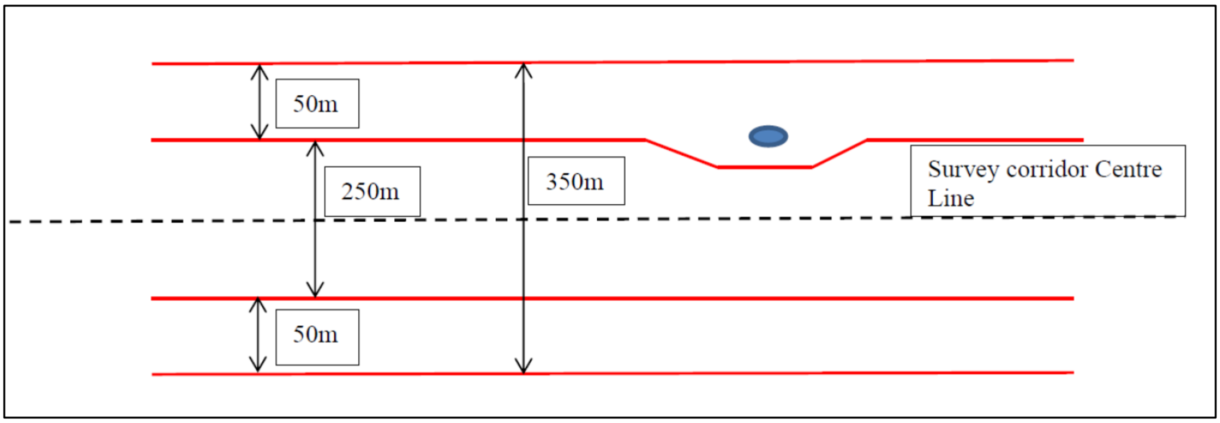

Figure 2 Cable engineering principle with isolated constraints within the corridor.

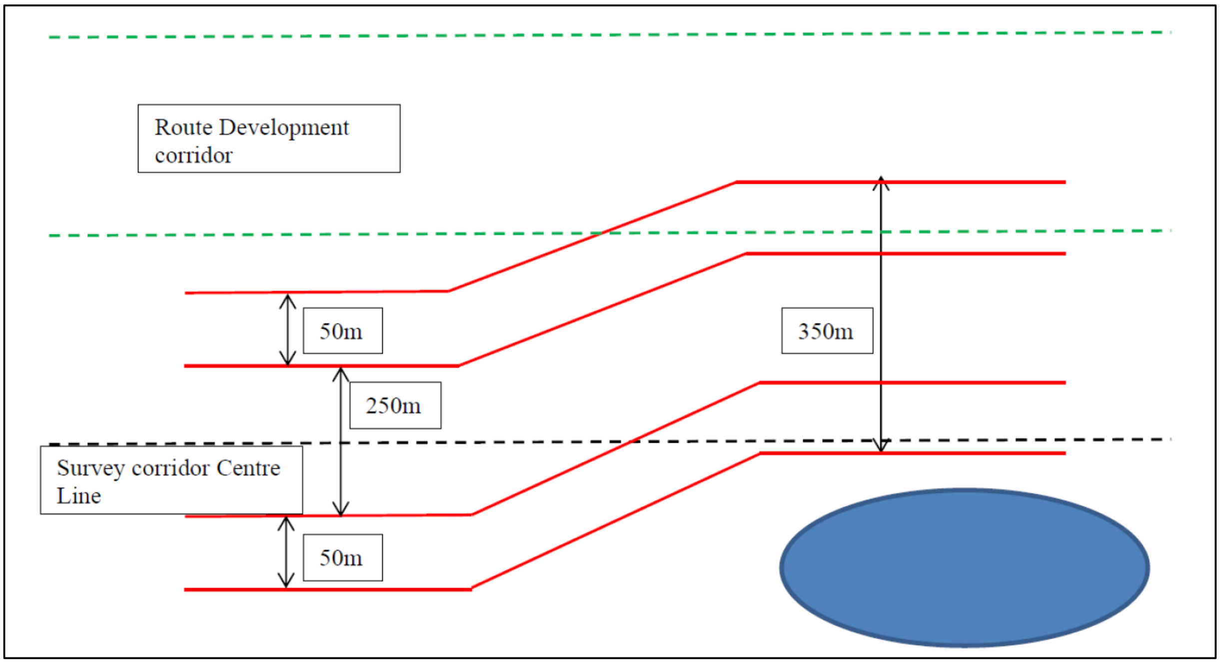

Figure 3 Cable engineering principle with regional constrains within the corridor.

- Two cable pairs with 50 m between cables.
- Each pair to be spaced by 250 m increasing to 325 m where depths > 100 m.
- Where there is sufficient space available 50 m is a typical spacing for pairs of cables and may be considered as a base case.
- It is suggested that 250 m is adopted for spacing between parallel cable systems in water less than 100 m to allow for a repair bight to be laid between the two pairs.
- Along sections of the route where water depth exceeds 100 m it is suggested that 325 m is adopted for spacing between parallel cable systems.
- In the event of a bottle neck within the corridor, it is acceptable to reduce the spacing between cables or in extreme cases, bundle the cable pairs.
- If the cables are bundled, a minimum spacing of 20 m should be maintained between bundles.
- Spacing between the cables and cable pairs may be increased or decreased depending on survey line spacing from Phase 1, at this stage of the process it is of higher importance to have

SBP and magnetic data for the cable routes, where possible, than strickly keeping the above spacing between cables.

- The potential for cable burial should be maximised and the individual cables should be routed in areas of maximum available sediment thickness. Areas with less that 2m of sediment should be avoided when feasible.
- Areas of numerous boulders should be routed around. Individual boulders should be avoided where possible.
- Seabed slopes should be minimised and longitudinal slopes in excess of 15 degrees and transverse slopes in excess of 6 degrees should be avoided where feasible.
- Bedrock should be avoided where possible. Where bedrock cannot be avoided, the vertical relief of the bedrock should be minimised and any areas of isolated sediment used to advantage.
- Crossings should follow ICPC guidance and requirements of crossing agreements. A minimum crossing angle of 70 degrees is suggested in line with ICPC guidance. It is recommended that the regional cable configuration is maintained at the crossing points.
- Cables should be routed at least 25 m from any magnetic anomaly. Further studies are required to identify UXO.
- Cables should be routed at least 50 m from known wrecks.

All results from the geophysical survey, including the route development areas, were used with focus on SSS contacts, magnetic anomalies, boulder fields, outcropping bedrock, outcropping coarse sediment, isopachs indicating shallow burial depths as well as seabed slopes and bathymetry. Individual contacts and magnetic anomalies were avoided by smaller route deviations around the contacts/anomalies, if possible the adjacent cable for that cable pair was mirrored with the same minor route deviation to maintain the distance between the cables.

The routes were named on a basis of its route alternative, e.g. Main Route, and which of the cables it is, e.g Cable 1 etc, where Cable 1 is the most northern/western cable and cable 4 is the most southern/eastern cable. In areas where the cables had to be bundled Cables 1 and 2 create Cable pair 1 and Cables 3 and 4 create Cable pair 2.

A video conference call between all parties were set up in which the proposed cable routes were gone through and reviewed, the proposed cable routes had previously been issued to RPA and INELFE. MMT adjusted the cable routes after Client comments before re-issuing them to RPA and INELFE for approval. In total 24 cable routes were engineered and approved, their respective RPL is found in Appendix N.

SELECTING GEOTECHNICAL SAMPLING SITES

Once the 24 cable routes were approved, the task of selecting the geotechnical sampling sites were started. MMT selected the sampling locations and sent the proposed locations to RPA and INELFE for review and comments. A joint video conference was held were the proposed sampling locations and Client comments were reviewed prior to re-issuing the updated geotechnical sampling site which were approved by RPA and INELFE.

The geotechnical sampling sites were selected with the intention to:

- Spread the sampling locations evenly throughout the route alternatives and cables routes.
- Keep all sample sites on either of the cables routes, preferably were a cable route and a geophysical survey line coincides.
- Sample as many sediment units identified in the geophysical data as possible.
- Isolated less general sediment characteristics identified in the geophysical data was also selected for sampling when deemed of interest.

- Spacing between sample points were adjusted to cover all units/layers and were not only detained by predetermined distances or positions.

All selected smapling sites were also assessed in regards to the items listed below:

- SBP and SSS data were evaluated with respect to surface and sub-surface geological units/layers. Sediment thickness to subcropping BEDROCK and/or coarse material were taken into consideration.
- Water Depths were checked in order to define the sampling site as nearshore or offshore. The definition of nearshore was 15 m LAT.
- Seabed slope was checked and sampling location adjusted if the seabed slope exceeded the equipment specific slope limit. The limit for the VC was 15 degrees, for the PCPT 15 degrees and for the RC 8 degrees.
- All geotechnical locations were checked against SSS contacts and magnetic anomalies and locations adjusted if needed.
- All geotechnical sampling sites were ALARP certified prior to any geotechnical sampling.
- No geotechnical sampling site closer than 50 m of a detected cable/pipeline.

In total 87 VC-sites, 139 PCPT-sites and 21 RC-sites were selected and agreed. A total of 24 sites were combined VC- and PCPT-sites. Of the RC-sites eight (8) were selected as priority sites and agreed to be sampled, the remaining 13 RC-sites were regarding as additional if further RC's were requested by the Client during sampling.

PHASE 2

In 2017 Phase 2 (additional geophysical, UXO and geotechnical investigations) were performed aboard M/V Olympic Delta, M/V JIF Challenger, M/V Esquina and M/V JIF Patrol. For full vessel specifications see Appendix A|. The equipment specifications are found in Appendix B|.

Prior to Phase 2 four cable routes were designed for each of the route options by MMT, reviewved and approved by Red Penguin Associates (RPA) and INELFE. The RPL for these cable routes are found in Appendix N|. All results from Phase 1 and Phase 2 are, however, references to the kilometre post (KP) referenced surveyed centre line for each route option in Phase 1. The geotechnical locations were proposed by MMT, reviewed and accepted by RPA and INELFE.

For the ALARP certification, INELFE contracted Ordtek and prior to Phase 2, a desktop study was conducted by Ordtek, in order to establish the level of risk of UXO presence. If an area was classified as Low-Medium or Medium risk, a UXO survey was carried out prior to the geotechnical campaign. However, if an area was classified Low risk, no UXO survey was required prior to geotechnical operations. Following this, Ordtek provided UXO ALARP Sign-Off Certificates for each geotechnical sampling location Appendix S|).

M/V Olympic Delta conducted an UXO survey, an additional geophysical survey and a geotechnical survey (Figure 8). The offshore UXO scope of work consisted of surveying 50 x 25 m boxes centred on the proposed sample sites that are in areas considered to be of low to moderate and moderate risk (in total 96 boxes) with an ROV mounted 12 pin gradiometer system and camera. The additional geophysical survey was conducted near the Spanish landfall, northwest of Block 6. The survey plan for this operation was modified in the field from a 50 m line spacing to 25 m to achieve sufficient MBES coverage due to the bathymetry.

Based on reconnaissance data, 79 VCs, 130 PCPTs and 8 RCs were originally picked for geotechnical sampling in the offshore section of the route. During the course of the survey some sites designated for the offshore vessel were completed by the nearshore vessel, M/V JIF Challenger. There were also several nearshore designated sites not completed or accepted that the M/V Olympic Delta revisited.

Overviews of the geotechnical sampling locations along the surveyed routes are presented in Figure 9, Figure 10 and Figure 11.

The total number of sample sites, completed by M/V Olympic Delta, for each route and type of geotechnical equipment is presented in Table 1.

The sampling were performed by utilising a VKG-6, a ROSON 10 tonne PCPT and a Rock Coring Drill (mini drill). Target penetration depth for offshore section sampling was 3 m and in areas with sandwaves 4 m. A grab sampler was available on board but not needed for any sample sites performed by M/V Olympic Delta. Geotechnical sample site locations and information is included in Appendix Q| and Appendix P|.

M/V Olympic Delta completed all eight of the high priority rock drilling locations. One additional site was attempted but the mini drill had a major malfunction that prevented completion of the sampling at this location, i.e. 102354-RC-353. Several of the rock cores sites were relocated due to local gradient exceeding safe operational limits or to lack of penetration at original location. Figures showing the original and relocated sites for the rock drilling locations can be found in Appendix T.

Table 1 Distribution of offshore geotechnical sample sites.

Route/Area	No. of VC	No. of PCPT	No. of RC
Main Route (La Cantine to Spanish landfall)	54	89	8
Lacanau Option Route	3	6	0
Le Grand Crohot Option Route	1	3	0
HDD Canyon	2	5	0
Additional Route Spanish Waters	8	12	0
Total	**68**	**116**	**9**

M/V Esquina and M/V JIF Patrol acquired data with a vessel towed G-882 magnetometer used for UXO survey in the shallow water section.

Nearshore geotechnical work was performed by M/V JIF Challenger. Based on the reconnaissance geophysical survey data, 16 samples (on 14 locations) were picked for geotechnical sampling in the shallow water section of the route. The sampling were performed by utilising a VKG-6 and a ROSON 10 tonne PCPT. Target penetration depth for the shallow water sampling was set to 6 m. The total number of sample sites completed by M/V JIF Challenger for each route and type of geotechnical equipment is presented in Table 2.

Table 2 Distribution of Shallow water sample sites.

Route/Area	No. of VC	No. of PCPT
La Cantine	3	1
Lacanau Ocean	0	1
Coastal Bypass	5	6
Total	**8**	**8**

1.4| AREA OF WORK

PHASE 1

An overview of the Phase 1 geophysical survey area (with the RPL for each route option located in Appendix M|) is shown in Figure 4.

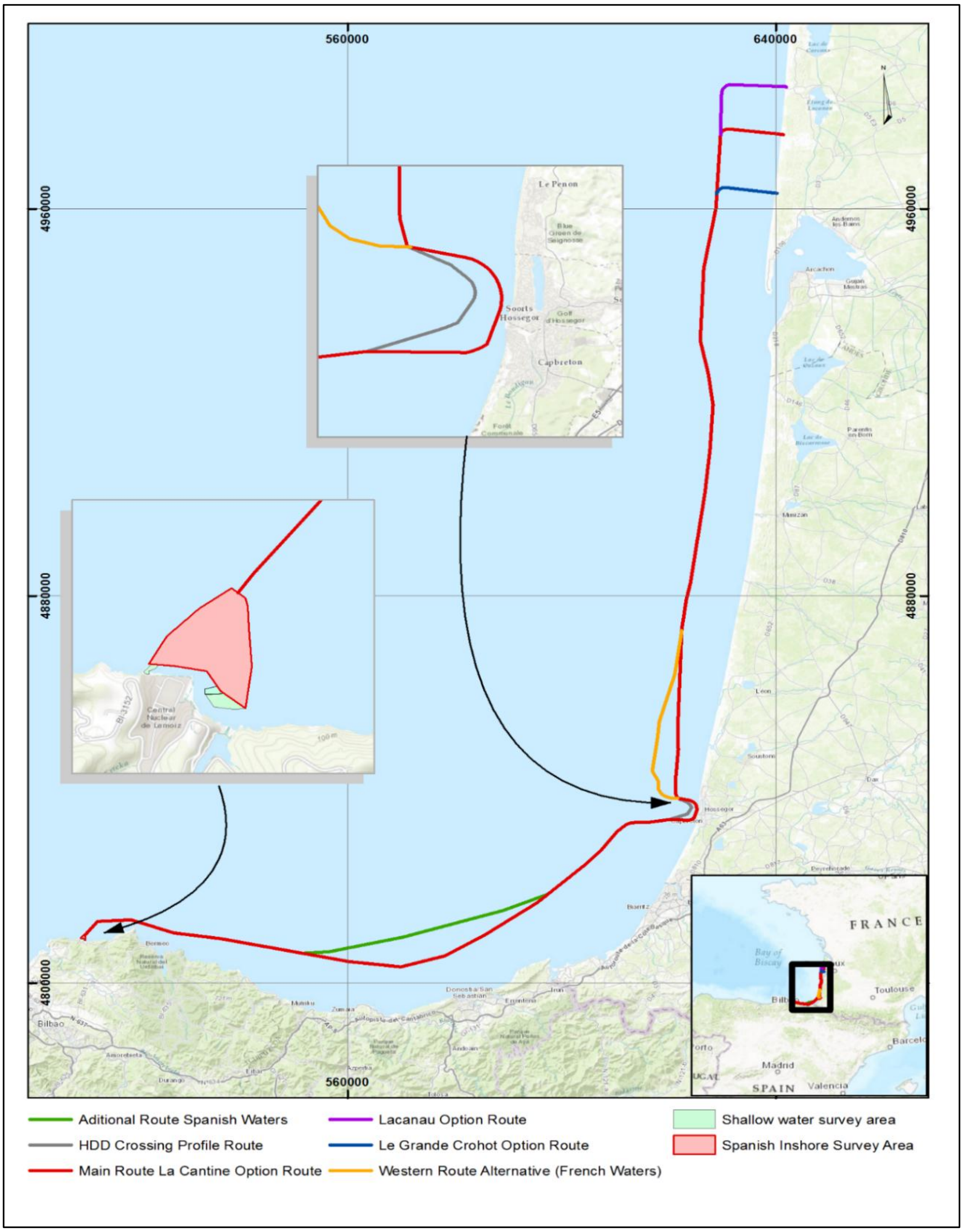

Figure 4 Overview of the entire Phase 1 work area.

Figure 5 shows the survey limits, survey design line plan and the different type of surveys undertaken. The respective vessels that undertook the data collection at the La Cantine nearshore and landing within the proposed route section are also indicated. A similar line plan configuration was used for the alternative landing routes, The Lacanau to the north of La Cantine and Le Grande Crohot to the south (Figure 4).

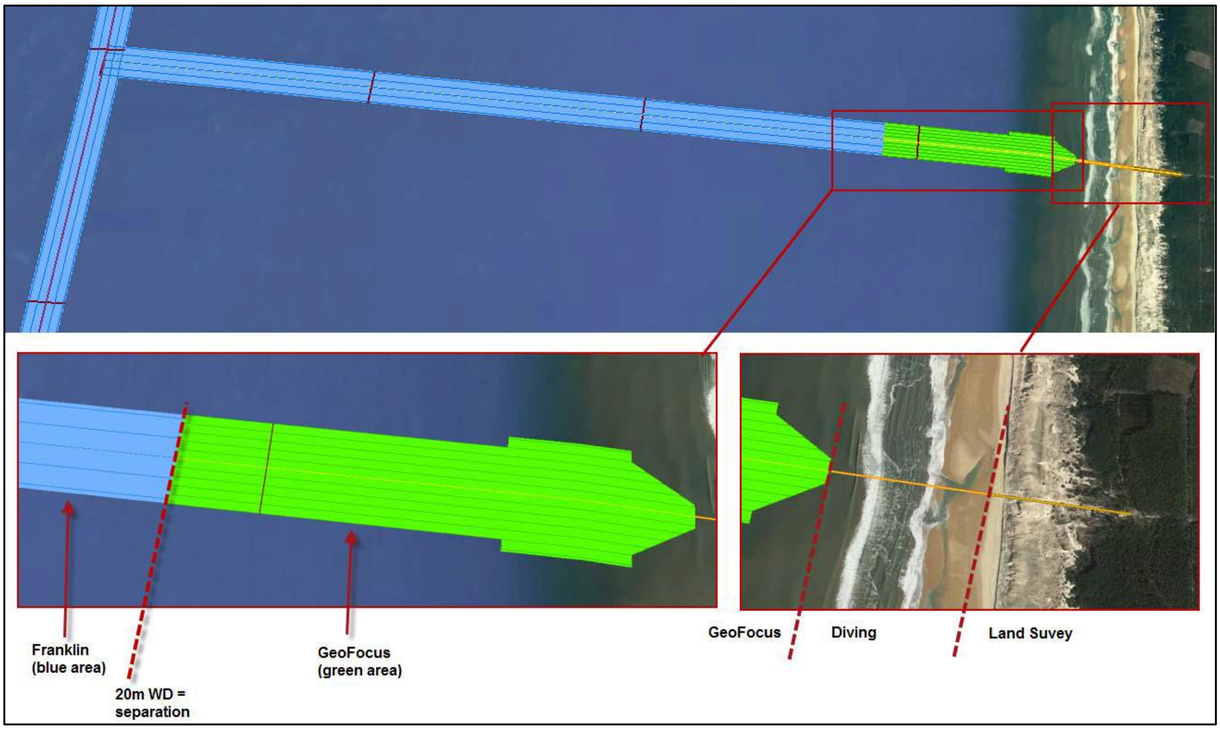

Figure 5 Offshore-Nearshore overlap at La Cantine.

Figure 6 and Figure 7 shows the survey limits, survey design line plan and the different type of surveys undertaken close to the propose landing on the Spanish coast at Lemóniz. The respective vessels that undertook the data collection at the nearshore and landing, within the proposed route section, are also indicated.

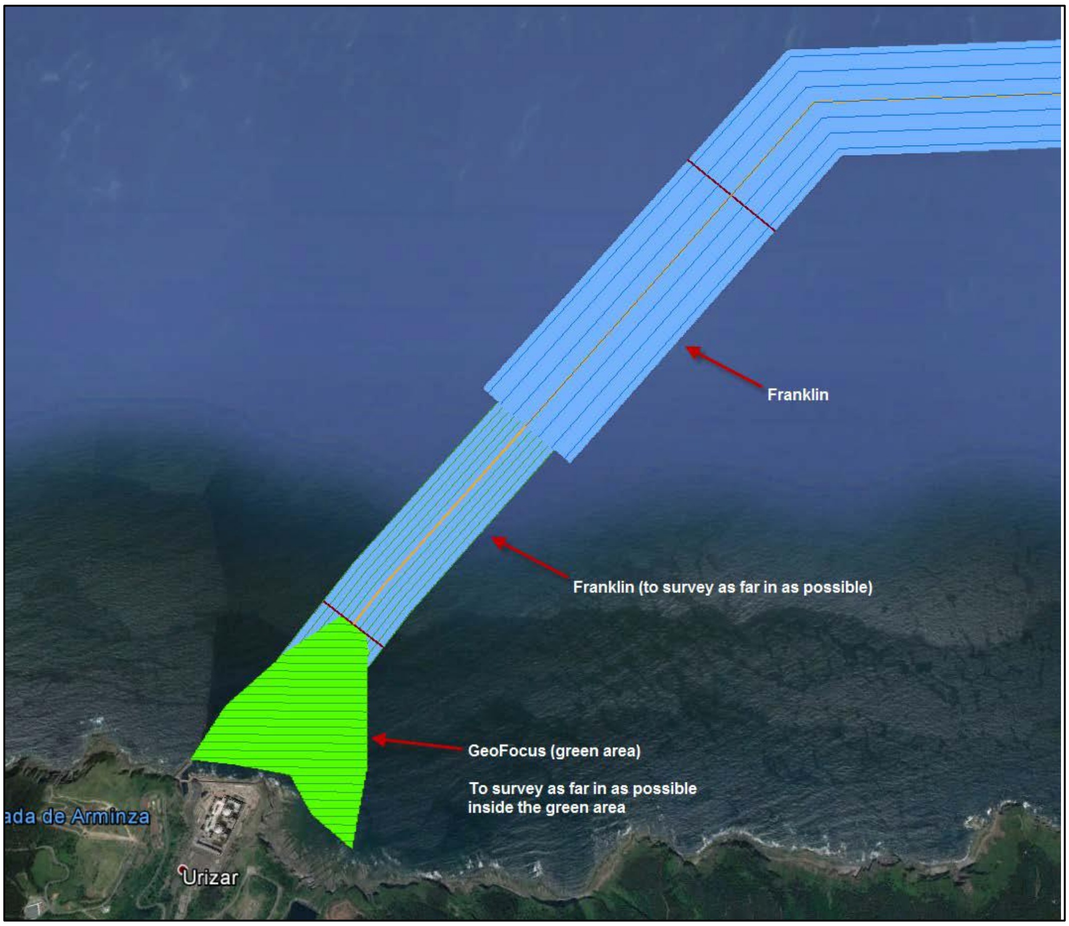

Figure 6 Nearshore section of cable route approaching Spanish coast.

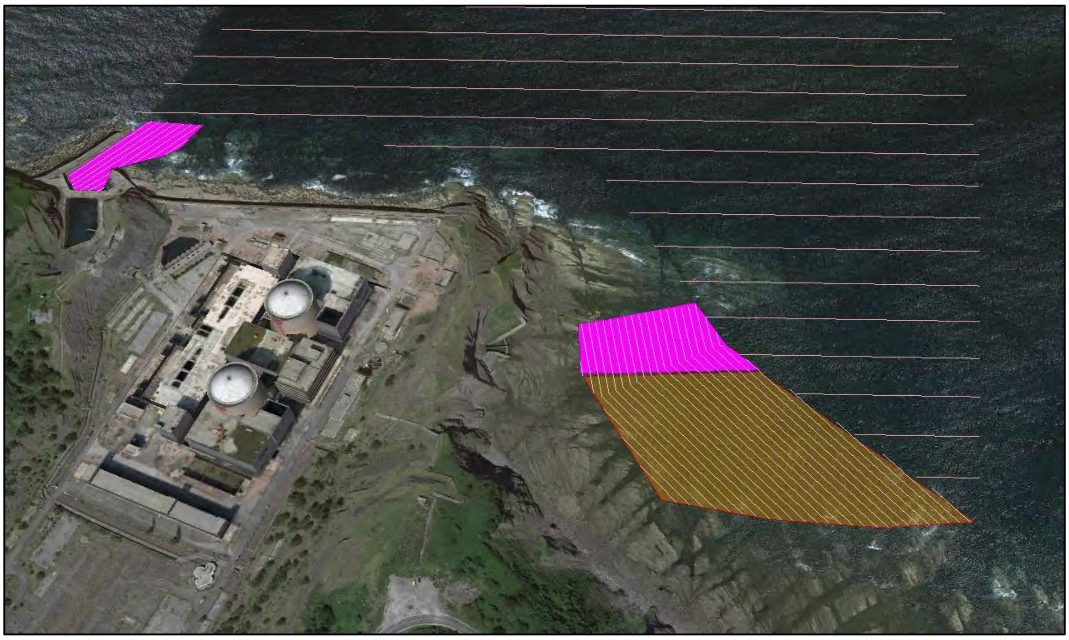

Figure 7 Plasticbeam's shallow water survey of the cable route approaching Spanish coast.

PHASE 2

An overview of the Phase 2 geophysical survey is shown in Figure 8.

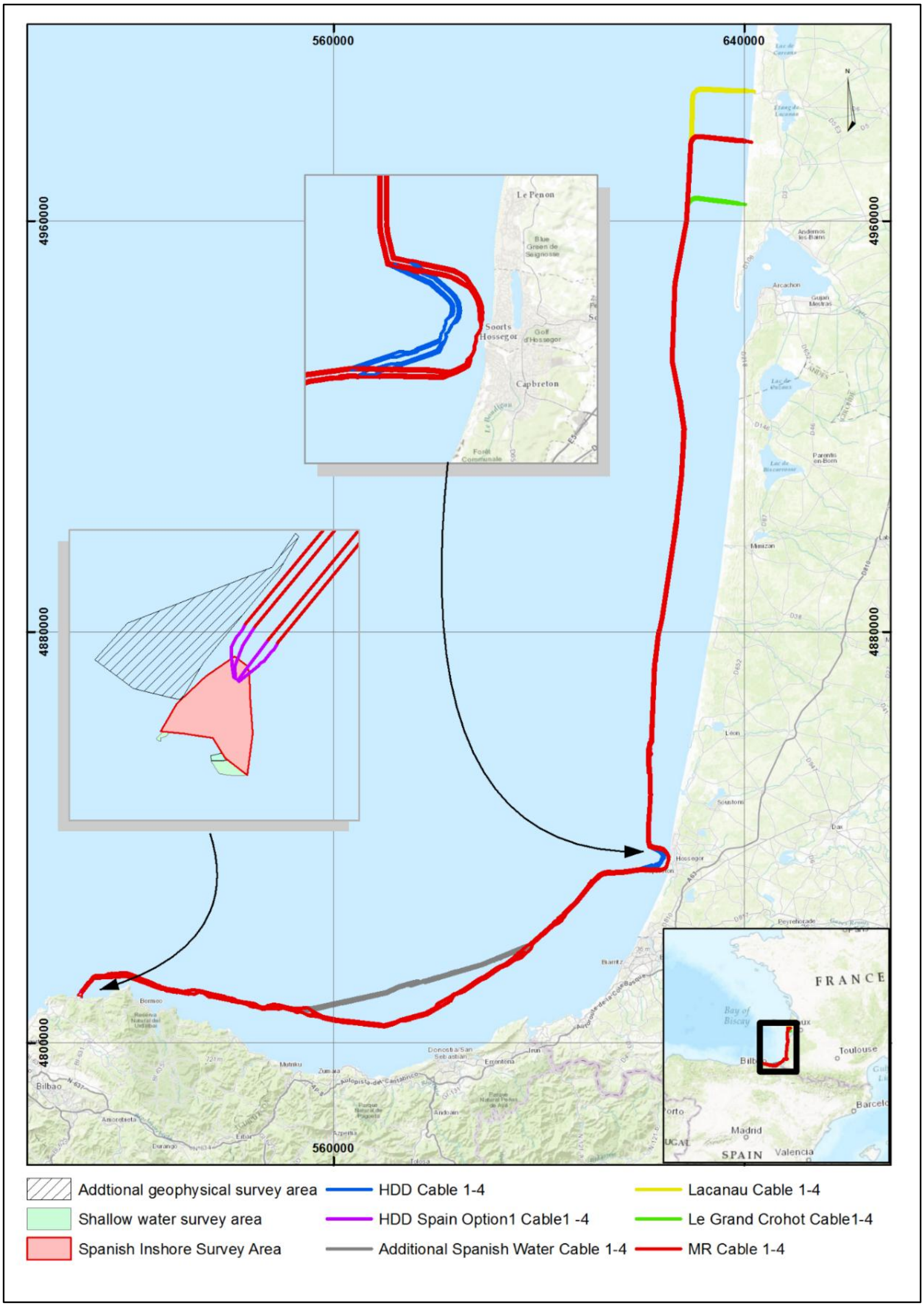

Figure 8 Overview of Phase 2 additional survey area.

Overviews of the proposed geotechnical sampling locations along all the surveyed routes are presented in Figure 9, Figure 10 and Figure 11.

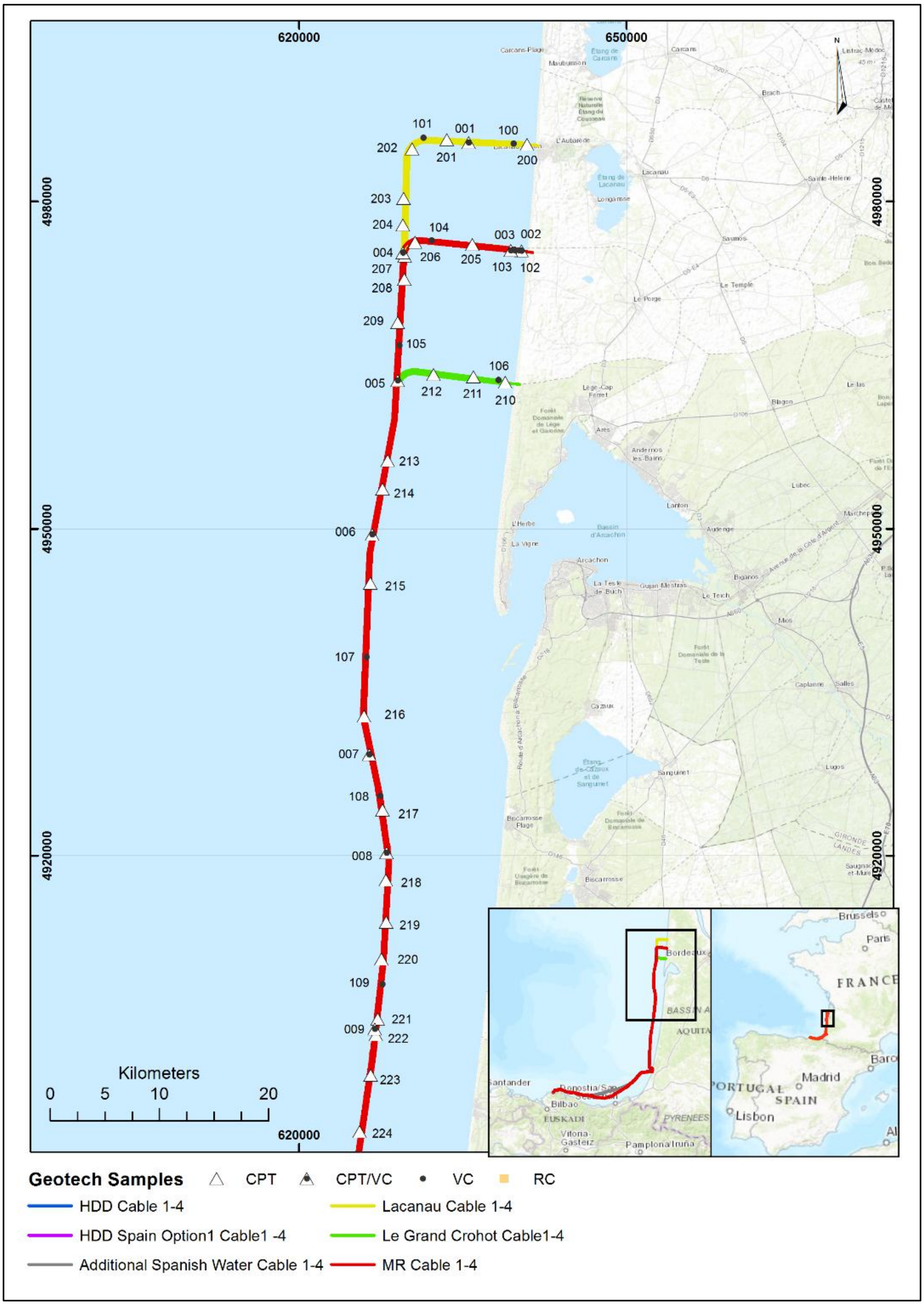

Figure 9 Sampling location overview, northern France.

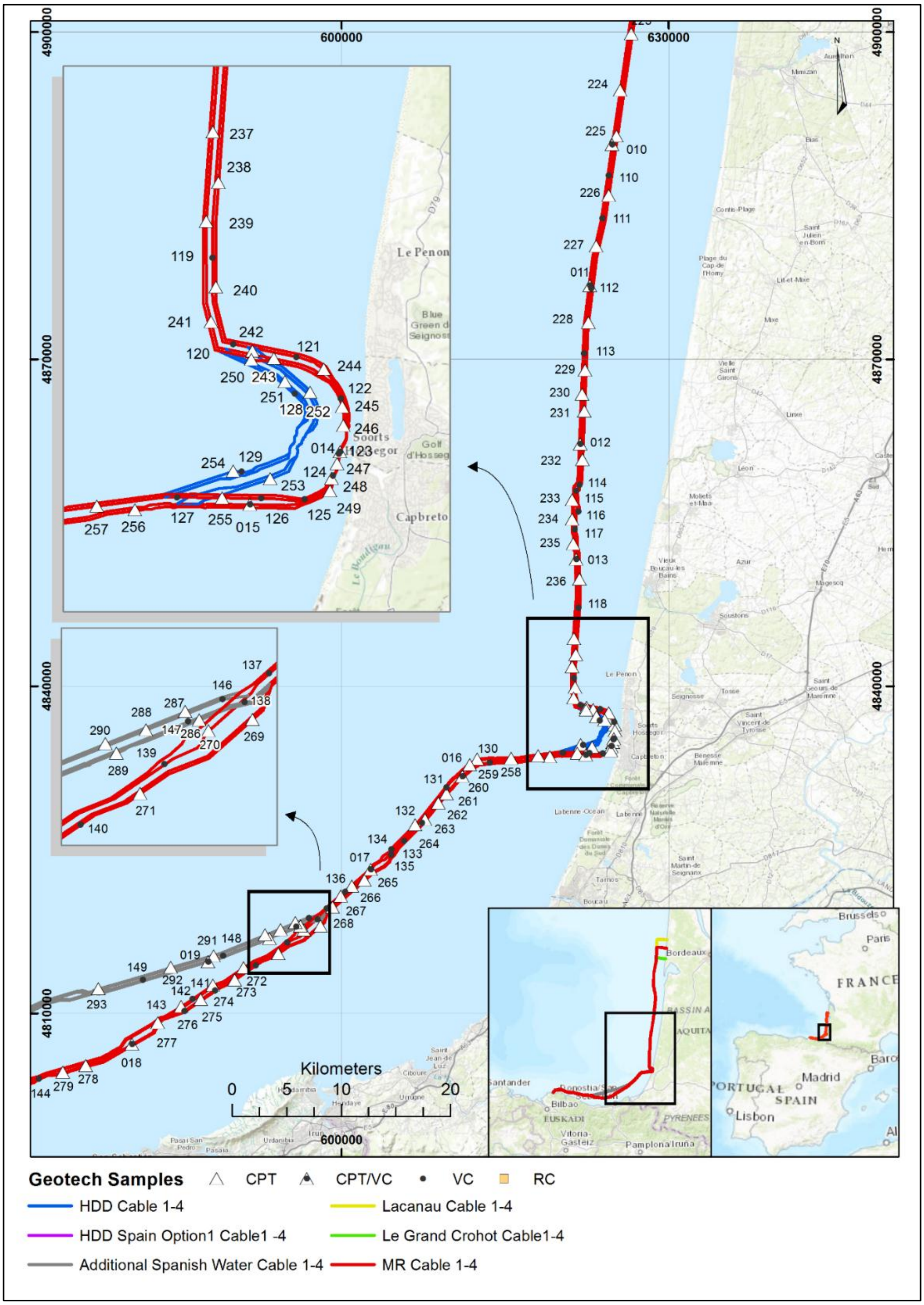

Figure 10 Sampling overview, southern France, Capbreton and northern Spain.

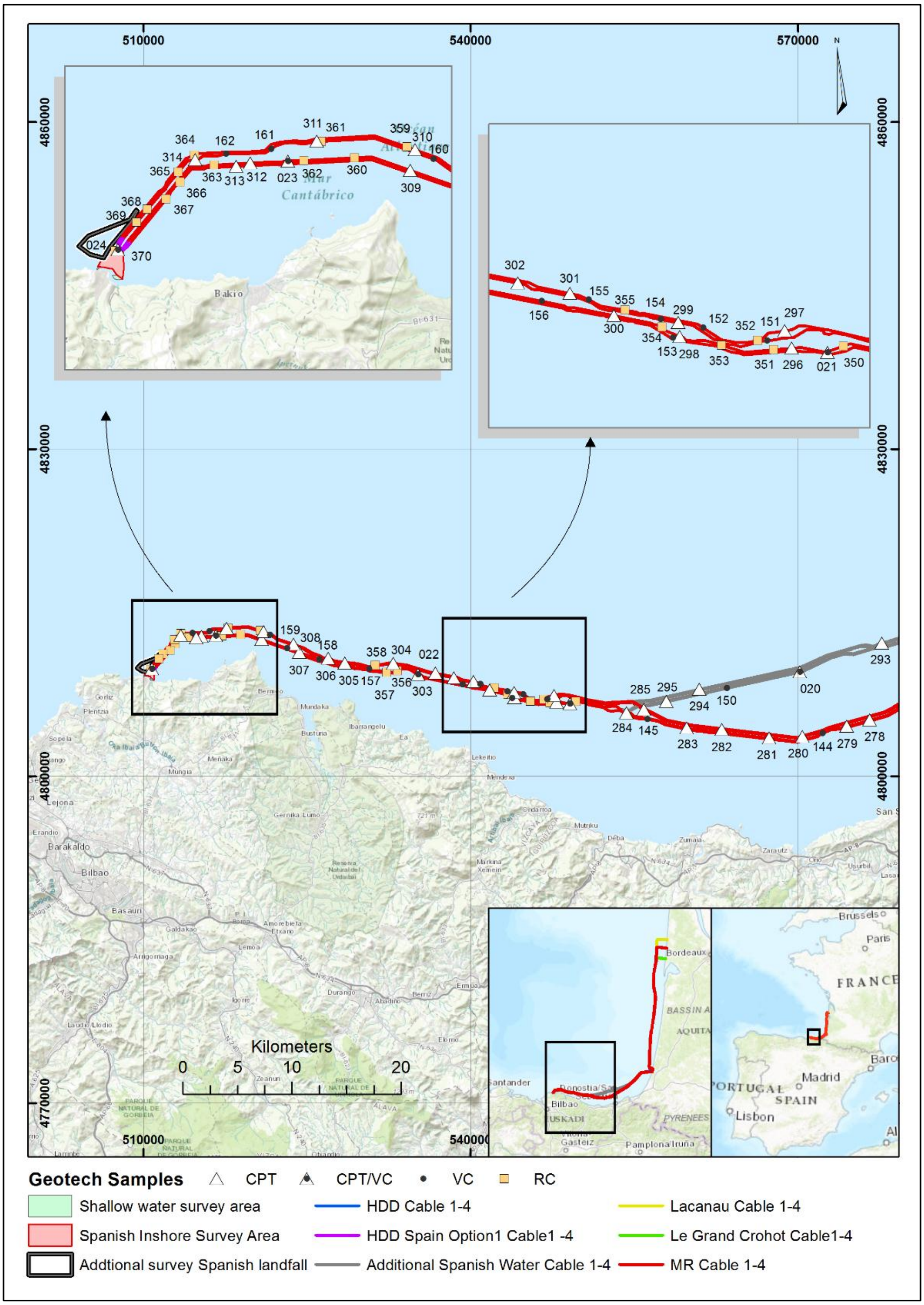

Figure 11 Sampling overview, northern Spain and landfall area.

1.4.1| ROUTE DEVELOPMENT

During Phase 1, onboard assessment of hydrographic and geophysical data sets was performed, several areas of the route corridor were assessed as being challenging for optimal route engineering, e.g. areas of rock outcrop or boulder fields. As such, the corridor was widened as authorised by the Client in order to explore the possibility of finding more amenable seabed or sub-seabed conditions. These tasks were categorised as route development. The areas of route development conducted during the survey works are shown in Figure 12. Route development were also performed in the HDD Canyon Crossing Route and the Canyon Head Bypass Coast Option route.

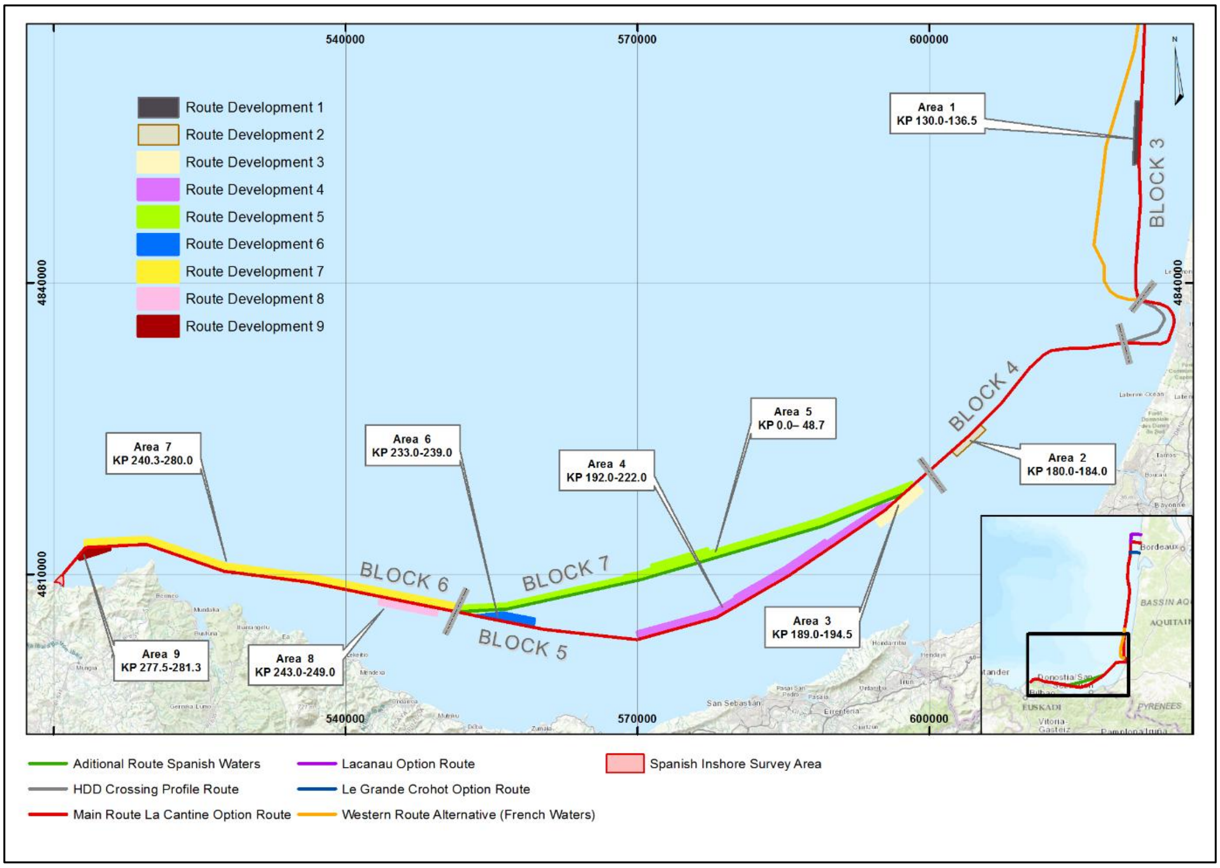

Figure 12 Locations of route development areas as conducted during survey operations.

1.4.2| PERIOD OF WORK

PHASE 1

The main survey vessel, M/V Franklin, began transit to Bayonne for mobilisation on 25 September 2016. After reaching the port of Bayonne on 28 September 2016 the vessel was mobilised and the calibrations data was collected on 2 October 2016. Data collection continued until the survey was completed 7 November 2016. Demobilisation of crew and equipment was performed on the same day.

M/V Geo Focus started the mobilisation on the 26 September 2016 and ended the operations on the 4 November 2016 with demobilisation in Bayonne, France, after completing the survey of the Spanish landfall. Plasticbeam arrived on the 7 October 2016 and demobilised on the 13 October 2016.

The UAV survey was started on the 4 October 2016 and completed two days later on the 6 October.

The dive survey commenced on the 6 October 2016, the dive survey was in the beginning of November put on standby until 2017 due to weather. All three landfalls in France were started in 2016 and the preferred landfall La Cantine was completed during 2016 while Lacanau and Le Grand Crohot was completed in 2017.

PHASE 2

M/V Olympic Delta survey operations for the UXO survey and additional geophysical survey were carried out between the 15 and 27 June 2017. Commencing with survey mobilisation and calibration (MAC) in Bayonne, France and ending with transit to Bayonne for geotechnical survey mobilisation.

M/V Olympic Delta started the geotechnical mobilisation on 28 June 2017 and ended the operations on 17 July 2017 with demobilisation in Bayonne, France, on 19 July 2017.

M/V JIF Challenger started the mobilisation on 14 June 2017 and ended the operations on 27 June with demobilisation in Bayonne, France, 28 June 2017.

M/V Esquina started the mobilisation on the 8 June 2017 and was demobilised on 23 June 2017 due to engine failure. M/V JIF Patrol was mobilised on 24 June 2017 to continue the survey operations and was demobilised on the 27 June 2017 in Archachon, France, after completing the French landfalls locations.

1.4.3| VESSELS

PHASE 1

A total of three vessels were used for the data collection along the proposed routes.

The main part of the route was surveyed by M/V Franklin, a fully equipped vessel for seabed survey in water depths between 10 and 2000 m. The vessel has a long track record performing site, route and inspection surveys.

The nearshore data collection was conducted by M/V Geo Focus and the shallow water work conducted by Plasticbeam.

See Appendix A| for full details on the vessels used.

PHASE 2

A total of four vessels were used for the data collection in Phase 2.

Additional geophysical survey, offshore UXO and offshore geotechnical operations was conducted by M/V Olympic Delta.

Nearshore geotechnical investigations were performed by M/V JIF Challenger.

M/V Esquina and M/V JIF Patrol conducted the nearshore UXO survey.

1.4.4| REPRESENTATIVES

PHASE 1

The RPA offshore Client Representatives acting on behalf of INELFE were Mr. Jean-Pierre Turpin, who embarked the offshore survey vessel M/V Franklin on the 28 September 2016 and Mr. Colin Poat who joined the following day on the 29 September. Both Client Representatives on board M/V Franklin were on board for the entire survey campaign and disembarked M/V Franklin at demobilisation.

The Client representative on board M/V Geo Focus was Mr. Mark Broadbent representing INELFE through RPA.

No Client representative was present on board Plasticbeam.

PHASE 2

The Client representative on board M/V JIF Challenger was Mr. Jean-Pierre Turpin representing INELFE through RPA for M/V JIF Challenger’s entire survey campaign.

The Client Representatives on board M/V Olympic Delta were Mr Mark Broadbent, who embarked on the 14 June 2017 and disembarked on the 11 July 2017. Mr Colin Poat embarked M/V Olympic Delta on the 28 June 2017 and disembarked on the 19 July 2017 and Mr Jean-Pierre Turpin embarked on the 11 July 2017 and disembarked on the 19 July 2017. All three Client Representatives on board M/V Olympic Delta represented INELFE through RPA.

No Client representative was present on board M/V Esquina and M/V JIF Patrol.

1.4.5| REFERENCE DOCUMENTS

The documents used as references to this survey report are presented in Table 3. All referenced documents in Table 3 are attached as appendices to this report, the MAC reports as Appendix C| and the Project Manual, Cad and GIS Specification, the Client’s technical specifications and Requirements as well as the Clarification Register from the Contract between INELFE and MMT as Appendix D|.

Table 3 Reference documents.

DOCUMENT NUMBER	TITLE	AUTHOR
102354-INE-MMT-QAC-PRO-PMQAOFFS	Project Manual and Quality Assurance Plan	MMT
102354-INE-MMT-QAC-PRO-PMQAPLP2	Project Manual and Quality Assurance Plan Phase 2	MMT
102354-INE-MMT-QAC-PRO-CADGIS	CAD & GIS Specification	MMT
102354-INE-MMT-MAC-REP-FRANKLIN	Mobilisation and Calibration Report M/V Franklin	MMT
102354-INE-MMT-MAC-REP-GEOFOCUS	Mobilisation and Calibration Report M/V Geo Focus	MMT
102354-INE-MMT-MAC-REP-PLASTICBEAM	Mobilisation and Calibration Report Plasticbeam	MMT
102354-INE-MMT-MAC-REP-OLYMPICD	Mobilisation and Calibration Report M/V Olympic Delta	MMT
102354-INE-MMT-MAC-REP-JIFCHALLA	Mobilisation and Calibration Report M/V JIF Challenger	MMT
102354-INE-MMT-MAC-REP-SITSHALL	Surrogate Item Trial Report M/V Esquina and M/V JIF Patrol	MMT

DOCUMENT NUMBER	TITLE	AUTHOR
20160411_Geophysical-Geothecnical-UXO_Survey_Part4_TSR_Rev1	Technical Specifications and Requirements (TSR) – Revision 1	INELFE
Clarification Register	Extracted from Contract	MMT/ INELFE

1.4.6| AUTHORISATION AND PERMITS

PERMITS

MMT contracted Business Sweden, France and Spain to assist with the permit applications to ensure they were in place before commencement of the survey data collection. The relevant permits were granted and information given to the relevant authorities as requested.

FRANCE

Marine Survey:

MMT informed Préfecture Maritime Atlantique regarding the planned Phase 1 survey and on the 5 September 2016 received an information letter stating that the information had been acknowledged. In the following year, Préfecture Maritime Atlantique received information on the planned Phase 2 survey and on the 1 June 2017, MMT received confirmation that the information had been acknowledged. Préfecture Maritime Atlantique recommended ways of communication during the survey that MMT applied to. These included updating the French authorities 72 hours in advance of commencement of survey works for each vessel using the following email address:

combrest.infonaut@premar-atlantique.gouv.fr

RTE was responsible for the daily contact with the French military. RTE received AVURNAV from the military.

Diving Survey:

CTS sent Authorisation request letters to the city halls of Le Grand Crohot, Lacanau Océan and Le Proge prior to commencing the survey and received permits prior to commencement.

UAV Survey:

Permits were sent to, and received from:

- Autorisation de la préfecture et Municipalité
- Autorisation de Gendarmerie de Transport
- Autorisation du Control Aérien

SPAIN

For Phase 1 survey work permits for M/V Franklin, M/V Geo Focus and Plasticbeam were received from Ministerio de Asuntos Exteriores y de Cooperacion. The permits were received on the 7 October 2016 with proviso that MMT forwarded details of the commencement of the works, location and equipment to radioavisos.cncs@sasemar.es.

The 2017 permits were received on the 31 May from Ministerio de Asuntos Exteriores y de Cooperacion for Phase 2 work with M/V Olympic Delta.

On receipt of advice Radioavisos sent out navigational warnings on 1462 by Coruña Navtex.

The captains of the vessels provided weekly information of locations and expected work to Coordination Rescue Centres for inclusion in “Notice to mariners” bulletins.

LIAISON

Prior to start of survey it was agreed that the Client Representatives were responsible for the communication with the fishermen. For France a dedicated information circuit to the fishermen was in place, where the regional committee offered to help the project in disseminating to local fishermen before one of the vessels entered a new area.

COMMUNICATION WITH THIRD PARTIES

During all survey operations MMT ensured that all employees and subcontractors as well as Client Representatives used the following statement in case of questions by third parties:

"As part of its public service mission, Réseau de Transport d’Electricité (RTE) and its Spanish counterpart Red Eléctrica de España (REE) are responsible to consider strengthening the electrical interconnection between Spain and France.

In order to have information’s on the seabed in the study area through the Bay of Biscay defined for the project, RTE and REE are launching studies and commissioned a specialized company, MMT, to achieve a "geophysical survey”. These studies include bathymetric surveys and profiling the seabed and close the coastline, without impact on the flora and fauna of the seabed. They are no guarantee of solutions that can be used in this project.

If further questions arose from any third parties MMT was instructed to contact RTE and REE to define the way forward.

2| FINAL RESULTS

The results are presented within following route subdivisions: Main Route; Lacanau; Le Grand Crohot; The Western Route Alternative (French Waters); The HDD Canyon Crossing Route; The Additional Route Spanish Waters, the Spanish Landfall Site and the Additional Spanish Lanfall Site survey (Figure 4).

Under each route subdivision header a general overview of bathymetry and surficial geology is given with reference to any pertinent literature. The KP positions are used to geographically place the narrative and it is recommended the sections are read in conjunction with the relevant alignment charts. All KP's are referenced to the KP reference survey centre line used during Phase 1.

All geophysical interpretations have been correlated to the geotechnical results. It is however important to note the distance between the geotechnical sampling sites and the KP referenced survey centre line. The geotechnical sampling sites were placed on, or close to, the cable routes, and not the KP referenced survey centre line used for reporting purposes. The results of the geotechnical sampling is shown in the Profile in the Alignment charts with a note specifying the distance between the sampling site and the KP referenced survey line for the closest route option. The geotechnical results are also presented in greater detail in Appendix Q.

Man-made debris items, boulders, existing cables and pipelines are listed within tables contained within each route subdivision and also plotted onto the relevant charts. They are not specifically referred to within the text unless of particular significance.

SSS contacts are classed as boulders, debris, objects and others. They have been given a unique ID number in the following format: S_GF_0123. Where S stands for SSS contact, GF stands for vessel (in this case M/V Geo Focus) and the unique number reference at the end. They are listed with their respective position (grid and geographic), relevant route section KP, size (L x W x H) and a distance cross course (DCC) offset to the KP referenced survey line. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|.

Magnetometer contacts are classed with respect to their "dipole" shape: Monopole, Dipole, Asymmetric Dipole or Complex Anomaly. If relevant, comments have been listed with respect to the target being linear or possible geology. They have been given a unique ID number and listed in the same format as SSS contacts except for the T prefix replacing the S prefix for TVG deployed on the M/V Franklin, or M replacing the S for the magnetometer deployed from the M/V Geo Focus. During Phase 2 magnetic anomalies detected during the UXO survey have been given a unique ID according to the same standard as for Phase 1, where G stands for gradiometer and M for magnetometer. These have been plotted onto the relevant charts and lists are contained in Appendix F|.

The term "dune like" bedform is adapted from a study of multi-scale bedforms on the South Aquitaine shelf by Mazières *et al.* (2015). It refers to discrete fine/medium sand assemblages lying in wide areas of coarse grained sediment.

Wrecks found during the survey are presented in the SSS contact list (Appendix E|) as well as separately in Appendix H|. Appendix I| presents three wrecks that according to the background information provided by the Clients should have been found in the survey area but was not detected during the geophysical survey.

NB: All sea water depths in the following bathymetric descriptions are referenced to lowest astronomical tide (LAT). Sound Velocity Profiles (SVP) and Tide Comparisons are presented in Appendix K| and Appendix L| respectively.

NB: All produced charts are presented in Appendix J| together with their name, which route option they correspond to and what type of chart it is.

2.1| ROUTE NOMENCLATURE AND KP PROTOCOL

The proposed routes have a number of possible options for landfall in both France and Spain and at sections along the route that will be assessed with reference to the survey result. The Main Route (MR) and the various options are outlined in the schematic in Figure 4 (the RPL's for the KP referenced survey cente line are found in Appendix M|). The proposed landing at La Cantine, France, is the preferred landfall option and designated as KP 0 for the MR KP protocol (the central option of the three shown in Figure 4). Details, KP and nomenclature for all proposed options are tabulated in Table 4.

Table 4 KP protocol for route sections.

Route Section Name	Abbreviation used in Report	Start KP	End KP	Main Route Split KP	Main Route Join KP
Main Route (La Cantine landing)	MR	0.000	283.730	-	-
La Cantine		0.000	12.433	0.000	12.433
Lacanau	LACO	0.000	21.690	-	12.433
Le Grande Crohot Option Route	LGCO	0.000	12.020	-	24.687
The Western Route Alternative – French Waters	RRNC-AL	0.000	38.130	115.720	150.600
Canyon Head Bypass Coast Option Route	CHBC	150.500	161.900	-	-
Alternative Canyon Head Bypass Coast Option Route	ACHBC	0.000	4.330	-	-
HDD Canyon Crossing Route	HDCC	0.000	8.595	150.460	161.923
Additional Route Spanish Waters	ARSW	0.000	47.680	190.603	240.940
Spanish Landfall Site	No KP reference as shoaling seabed required lines to be run across route direction				
Additional Spanish Landfall	No KP reference				

NB: KP's are referred to the surveyed centre line for each route option.

2.2| MAIN ROUTE

2.2.1| OVERVIEW

The limits of data collected for the Main Route (MR) are KP -0.138 to KP 283.730. KP -0.138 to KP 0.584 were acquired by UAV. KP 0.542 to KP 1.030 were acquired by diver survey. KP 1.030 to KP 283.730 were acquired aboard the M/V Franklin and M/V Geo Focus. The depth ranges from -28 m on land to a maximum of 129 m offshore. The route starts at KP 0 with an seabed surface of SAND covered by intermittent vegetation, with an increasing KP the vegetation give way to SAND and dune like formations creating an more undulating surface closer to the shoreline, in the surf zone the undulations decreases creating a gently sloping beach. The sections KP 1.030 to 12.433 and KP 152.737 to KP 159.554 was surveyed by the M/V Geo Focus with a pole-mounted Innomar SBP and SSS. The bathymetry changes range from gentle dipping or shoaling seabed to one that appears irregularly undulating in response to rock outcrops. The profile in Figure 13 gives an overview of these changes.

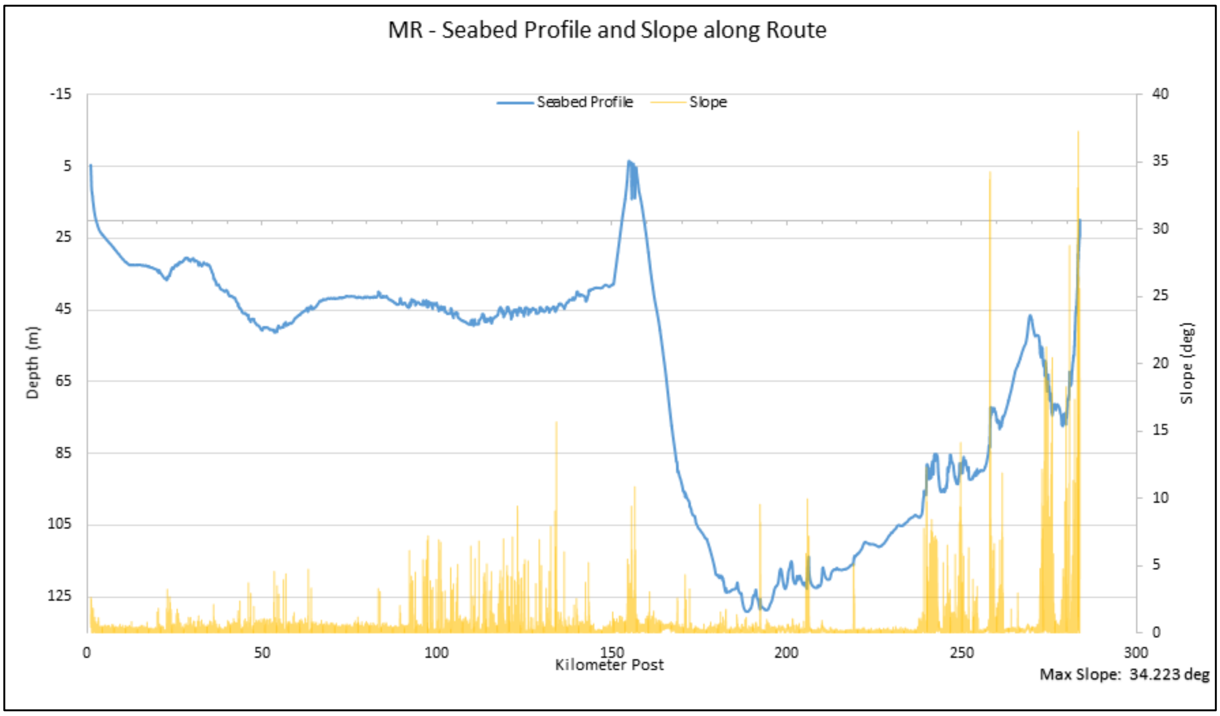

Figure 13 MR - Seabed profile and slope along route.

Across the French section of the route, the surficial geology consists of mobile re-worked surficial fine to medium SAND, organised in to a host of large scale mobile bedforms. Between KP 47.6 to KP 143.9, the mobile surficial sediments become sparser and more isolated from each other, forming dune like bedforms (the morphology of which is described in detail in Mazières *et al.* 2015), overlying coarser SAND and GRAVEL, occurring across the Aquitaine shelf. The extension of these formations can be several hundred metres at times predominantly aligned SW/NE. Smaller scale ripples are seen intermittently along most of the route. Coarse sediments associated with a dense sub-unit of SAND and GRAVEL are at the seabed from KP 132.050 to 134.310. From around KP 143.9 to the end of the French section, the fine to medium SAND becomes the predominant surficial sediment.

Across the Capbreton Canyon, the surficial fine to medium/fine to coarse SAND is characterised by bedforms caused by gravitational slips/slumping in the steep slopes of the canyon.

From here to the end of the MR, within the Spanish sector, the predominant surficial sediments are fine to medium SAND and sandy CLAY, interspersed with BEDROCK outcrops, associated boulder fields and occasional deposits of SILT and fine SAND.

The shallow geology, from the French Landfalls to the Capbreton Canyon, typically comprises of intermittent large scale fine to medium SAND bedforms, up to 2 m thick, up to around KP 143.9. This overlays SAND and GRAVEL, with a dense coarse sub-unit of SAND and GRAVEL outcropping from KP 132.050 to KP 134.310. From KP 133.568, a deeper substrate nominated as CONSOLIDATED SEDIMENT often comes within the top 5 m of seabed. From around KP 143.9 up to the Capbreton Canyon, the fine to medium SAND is mostly continuous at the seabed, intermittently overlaying SAND and GRAVEL, overlaying CONSOLIDATED SEDIMENT <5 m below sea floor (BSF).

Across the Capbreton Canyon, between KP 155.509 to KP 156.750 the route traverses the steep slopes where SBP penetration is poor, making thickness of units difficult to establish, but typically comprises of SAND 1-3 m thick overlying CONSOLIDATED SEDIMENT.

From the Capbreton Canyon to the Spanish Landfalls, the shallow geology typically comprises of unconsolidated fine to medium/fine to coarse SAND or sandy CLAY deposits that range from 0 to >5 m thickness, although tending to be ~2 m in thickness. Underlying these are denser units of SAND and GRAVEL/SILT and SAND, infilling channels and veneers overlaying BEDROCK that is frequently within 5 m of the seabed for this entire section, subcropping and outcropping.

A summary is contained in Table 8 and more comprehensive information in Section 3|.

Side Scan Sonar Contacts, Magnetic Anomalies, and Gradiometer Anomalies

A total of 2 135 SSS contacts (Phase 1) and 242 magnetic anomalies (Phase 1) and 33 gradiometer anomalies (Phase 2) were located within the MR corridor (Appendix E| and Appendix F|).

Pipeline and Cable crossings

The MR crosses two existing gas pipelines: the ENAGAS Pipeline West, 16 inch and the ENAGAS Pipeline East, 6 inch. As both pipelines were buried, they were detected with SBP and magnetometer data on all the run lines. The crossing points with respect to the MR are KP 270.72 for the 16 inch and KP 270.64 for the 6 inch, a pipeline crossing chart has been produced (102354-INE-SUR-DWG-PCSPI001) and details are given in Table 5 and Table 6.

Table 5 Position of top of ENAGAS West 16 inch pipeline, crossing the MR.

ENAGAS Pipeline West, 16 inch						
Line	**Easting**	**Northing**	**Latitude**	**Longitude**	**Depth of Burial (m)**	**Distance to pipeline database (m)**
Centre Line	522379.1	4812104.7	43°27.691'N	-002°43.402'E	0.8	3.0
Port 90 m	522337.1	4812022.5	43°27.647'N	-002°43.433'E	1.0	1.6
Port 180 m	522295.8	4811941.2	43°27.603'N	-002°43.464'E	1.1	1.4
Port 270 m	522257.2	4811859	43°27.558'N	-002°43.493'E	0.9	4.0
Stbd 450 m	522577.7	4812510.4	43°27.910'N	-002°43.253'E	0.6	1.4

Table 6 Position of top of ENAGAS East 6 inch pipeline, crossing the MR.

ENAGAS Pipeline East, 6 inch						
Line	**Easting**	**Northing**	**Latitude**	**Longitude**	**Depth of Burial (m)**	**Distance to pipeline database (m)**
Centre Line	522445.7	4812081.5	43°27.678'N	-002°43.352'E	1.2	3.1
Port 90 m	522406.4	4811998	43°27.633'N	-002°43.382'E	1.2	6.3
Port 180 m	522366.3	4811917.1	43°27.590'N	-002°43.411'E	1.3	6.7
Port 270 m	522322.3	4811835.5	43°27.546'N	-002°43.444'E	1.1	4.0
Stbd 90 m	522483.9	4812160.9	43°27.721'N	-002°43.324'E	1.2	1.8

Geotechnical Survey

During Phase 2, geotechnical investigations were performed with VC (75 samples acquired), PCPT (165 tests acquired) and RC (16 samples acquired) along the MR, including second and third attempts (Appendix P| and Appendix Q|). The sediment types identified in the geotechnical results were used to correlate the geophysical interpretations from Phase 1 wit the actual results from the geotechnical survey. This gives a more detailed and accurate description of the sediments where necessary. This involved cross referencing the sediment sequences observed in the geotechnical data to the geological units observed in the SBP data. Some revisions of seabed classification were made, listed below in Table 7.

Table 7 MR - areas of revised seabed classification after the geotechnical campaign.

KP Start	KP End	Original seabed classification based on geophysical data only	Revised seabed classification with geophysical data correlated to geotechnical results
154.166	155.406	SAND and GRAVEL with large ripples	SAND with large ripples
186.754	196.973	SAND with trawl marks	Sandy CLAY with trawl marks
197.538	200.641	SAND with trawl marks	Sandy CLAY with trawl marks
201.585	203.948	SAND with trawl marks	Sandy CLAY with trawl marks
203.948	222.262	SAND	Sandy CLAY
222.262	234.405	SAND with trawl marks	Sandy CLAY with trawl marks
234.405	237.215	SAND	Sandy CLAY
245.016	249.428	SAND and GRAVEL with ripples (intermittently infilling channels in bedrock)	SAND with ripples (intermittently infilling channels in bedrock)
245.116	245.562	SAND	Sandy CLAY
250.252	250.703	BEDROCK	SAND and GRAVEL (veneer <0.5 m)
253.036	254.658	SAND and GRAVEL with ripples	SAND with ripples
276.540	277.833	SAND	SAND and GRAVEL
277.833	278.852	SAND with ripples	SAND and GRAVEL with ripples
278.852	281.374	SAND with ripples (intermittently infilling channels in bedrock)	SAND and GRAVEL with ripples (intermittently infilling channels in bedrock)

2.2.2| CABLE ROUTE WATER DEPTH, MORPHOLOGY AND SHALLOW GEOLOGY

In Table 8 the water depth, morphology and shallow geology for the MR are summarised.

Table 8 MR - water depth, morphology and shallow geology.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
-0.138	-28.5	0.542	-2.9	Establish beach system, vegetated KP -0.138 to KP 0, KP 0 to KP 0.542, Sand dune system progresses into SAND beach	Surficial SAND
0.542	-2.9	1.060	5.0	Intertidal zone, relatively steep slope	Surficial SAND
1.060	5.0	20.035	34.0	Relatively steep dipping from 5.0 m to 11.5 m at KP 1.250. Dipping with reduced gradient to 23.5 m at KP 4.000 and 32.5 m at KP 12.500 Very gently dipping to 34.0 m at KP 20.035	KP 1.060 – KP 1.240 fine to coarse SAND up to 2 m BSF over gravelly SAND. KP 1.240 – KP 1.725 Intermittent surficial SILT and fine SAND overlying fine to medium SAND to 1 m BSF, overlaying gravelly SAND KP 1.725 –KP 20.035 fine to medium SAND/fine to coarse SAND to depths >5 m BSF, over deeper units of SAND, for majority, with SILT and SAND to within 5 m of seabed between KP 4.908 – 5.045 and KP 5.526 – 5.859.
20.035	34.0	35.567	34.0	Gently undulating seabed between 30 m and 34 m. Few depressions, rough patches and ridges. Occasional scars. Seabed flattening at around KP 31	Intermittent fine to medium SAND 1 to 2 m thick (forming mobile bedforms) over SAND and GRAVEL to depths >5 m BSF.
35.567	34.0	40.223	40.0	Seabed gently dipping with increasing KP then levelling off at 40 m between KP 39.000 and KP 40.220	Fine to medium SAND 1 to 2 m thick, over SAND and GRAVEL >5 m BSF.
40.223	40.0	43.097	43.0	Very gently dipping seabed.	Predominantly fine to medium SAND 1 to 2 m thick, over SAND and GRAVEL >5 m BSF. Occasional thinning of the mobile SAND exposing SAND and GRAVEL at seabed.
43.097	43.0	46.112	46.2	Seabed slope steepens slightly and levels off at 45 m around KP 44.40	Continuous cover of fine to medium SAND 1 to 2 m thick over SAND and GRAVEL to >5 m BSF
46.112	46.5	54.237	51.0	Irregular seabed with shallow ridge features up to 1.5 m high between KP 46.10 and KP 47.65.	SAND and GRAVEL up to 1-3 m BSF over SAND extending >5 m BSF, up to KP 49.648

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
				Continues gently dipping to 50 m then gently undulates between around 50 and 51 m.	KP 49.648 – 54.237, SAND and GRAVEL 2-4 m thick over another unit of SAND and GRAVEL >5 m BSF. Occasional bedforms of fine to medium SAND up to 1 m thick.
54.237	51.0	143.286	41.0	Predominantly at 50 m (except for the ridges of SAND described in adjacent box) until KP 57.0. Gently shoaling levelling off at KP 67.30 at 42 m. Very slightly undulates (1 m) with increasing KP, from KP 85.50 very gently dips to 43 m with slight undulations to KP 100.25, where the slope slightly increases. KP 109.00 seabed levels KP 119.0 seabed shoaling to 45 m at KP 122.00 where it levels off. The seabed continues to vary in response to the sediment overburden and maintaining a depth of around 45 m. The seabed then initially shoals and continues gently undulating (+/-1 m) from an average depth of 45.0 m until KP 136.35 where it begins to shoal very gently to 42.0 m at KP 140.200. The seabed dips very gently to a depth of 43.5 m at KP 142.417, then shoals to a depth of 41.2 m at KP 143.282.	KP 54.237 – KP 132.050 SAND and GRAVEL to depths >5 m BSF for majority of this route. This overlies a very dense unit of SAND that is mostly >5 m BSF but intermittently observed within 2-5 m of seabed. Throughout this section, overlying large scale mobile bedforms of fine to medium SAND, 1 to 2 m thick, crossing the route at the following locations: Between KPs 54.267 - 54.745 Between KPs 56.117 - 56.791 Between KPs 63.229 - 64.059 Between KPs 83.199 - 83.745 Between KPs 89.352 - 89.610 Between KPs 92.105 - 92.224 Between KPs 92.505 - 92.944 Between KPs 93.000 - 93.784 Between KPs 95.969 - 96.205 Between KPs 96.451 - 96.735 Between KPs 96.774 - 97.188 Between KPs 97.432 - 98.033 Between KPs 98.055 - 98.521 Between KPs 98.755 - 102.242- in this deposit there are gullies up to 60 m wide where the underlying SAND AND GRAVEL is exposed. Between KPs 103.945 - 104.289 Between KPs 104.698 - 105.677 Between KPs 105.771 - 105.984 Between KPs 109.628 - 110.299 Between KPs 110.487 - 110.839 Between KPs 111.959 - 113.200 Between KPs 113.337 - 113.520 Between KPs 113.737 - 113.809 Between KPs 114.197 - 114.974 Between KPs 115.055 - 115.546 Between KPs 117.496 - 118.520 - in this deposit there are gullies up to 50 m wide where the underlying SAND AND GRAVEL is exposed. Between KPs 118.775 - 118.990 Between KPs 119.883 - 120.025 Between KPs 120.131 - 121.142- in this deposit there are gullies up to 50 m wide where the underlying SAND AND GRAVEL is exposed. Between KPs 121.537 - 122.826 Between KPs 122.992 - 123.287 Between KPs 123.379 - 124.839

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
					In this section there are gullies up to 50 m wide in the large unit above where the underlying SAND AND GRAVEL exposed. Between KPs 125.075 - 126.048 Between KPs 126.155 - 128.250 Between KPs 129.263 - 129.746 Between KPs 131.171 - 132.050 From KP 132.050 – KP 134.310 a dense sub-unit of SAND and GRAVEL comes to the seabed, with associated outcrops of coarse sediment seen, then from KP 134.310 - 136.337 fine to medium SAND 1 to 2 m thick overlies this dense sub-unit. From KP 133.568 a previously deep unit of CONSOLIDATED SEDIMENT, begins to appear intermittently within 5 m of the seabed, underlying the SAND and GRAVEL. From KP 136.337 to KPs 140.663 the upper 2 units of fine to medium SAND (bedform KPs 139.869 -140.210) and SAND and GRAVEL is >3 m thick, with CONSOLIDATED SEDIMENT underlying this. From KP 139.869 – KP 143.286 CONSOLIDATED SEDIMENT is mostly <2 m from seabed, seen to subcrop at: <1 m KP 141.173 <0.5 m KP 142.419 -142.625 <0.5 m KP 142.816 -142.852 Overlying this is SAND and GRAVEL with a bedform of fine to medium SAND between KPs 140.663 -142.415.
143.286	41.0	150.477	38.0	At KP 143.285 a ridge of SAND decreases the depth to 39.5 m and very gently shoals again, levelling off at 39 m by KP 144.75. From here it continues level until KP 147.00 gently shoaling again to 38.0 m at KP 150.480	Fine to medium SAND, up to 1-3 m thick overlying SAND and GRAVEL, overlaying CONSOLIDATED SEDIMENT the top of which is observed within 1.5 m to 4 m of the seabed throughout. CONSOLIDATED SEDIMENT is subcropping within 1.5 m of seabed at KP 146.756
150.477	38.0	155.509	3.5	The relatively flat and featureless seabed continues to shoal with an increased slope until KP 154.30 where the seabed continues its upward trend, but becomes rough. It reaches the top of the slope at a depth of just	Between 150.477 KP 152.60, fine to coarse SAND increases in thickness from 2 m to >5 m BSF overlying SAND and GRAVEL, overlaying CONSOLIDATED SEDIMENT. The CONSOLIDATED SEDIMENT comes to within 5 m of the seabed between KP 150.477 and KP 152.30.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
				3.5 m at KP 154.70. It continues shallow at around 3 m until KP 155.50, at the edge of the canyon.	At KP 152.60 the fine to coarse SAND unit is 1 m thick, increasing in thickness to 4 m at KP 155.509, overlaying CONSOLIDATED SEDIMENT.
155.509	3.5	155.800	3.5	Steep sided canyon slopes down to 14 m and back up to 3.5 m	Chaotic sub-surface/poor detection of geology across steep slopes of canyon head. Typically SAND overlies CONSOLIDATED SEDIMENT.
155.800	3.5	156.450	6.0	Rough seabed	Fine to coarse SAND 1-3 m thick, overlaying CONSOLIDATED SEDIMENT.
156.450	6.0	156.750	4.0	Steep sided canyon slopes down to 14 m and back up to 4.0 m	SAND overlaying CONSOLIDATED SEDIMENT. SBP data not easily acquired in steep sides, so depth of units not easily established.
156.750	4.0	168.7791	90.0	Relatively flat and featureless seabed slopes down with reasonable gradient to 90 m.	Fine to medium SAND 3-4 m thick KP 157.000 – 157.250, over SAND and GRAVEL to depths >5 m BSF. KP 157.250 - 159.615, fine to medium SAND 1 to 2 m thick, over SAND and GRAVEL to depths >5 m BSF. From KP 159.615 fine to medium SAND >5 m BSF until KP 165.624 where BEDROCK comes to within 5 m of seabed surface, shallowing to within 2 m at KP 167.528, shallowing still to subcropping <0.5 m BSF with a veneer of SAND and GRAVEL between KP 168.424 – 168.849
168.791	90.0	182.547	123.7	The seabed continues to slope down at same gradient until a depth of 119 m where it levels off and continues gently undulating between 119 m and 120 m until KP 181.50 when it slopes down to 124 m at KP 182.75.	From KP 168.791 – KP 177.873, fine to medium SAND 1-3 m thick, overlies highly eroded BEDROCK, with an outcrop at KP 172.187 (with some more small outcrops near the route between KP 172.172 – 172.745). From KP 177.873 – KP182.547, the fine to medium SAND and GRAVEL thins to <1 m, over BEDROCK From KP 180.447 to the end of this section, numerous BEDROCK outcrops are near the route, with outcropping on the route KP 182.487 – 182.507. Between around KP 177-184 an intermittent thin (0.5 – 1.5 m) unit of

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
					CLAY is observed on top of the BEDROCK.
182.547	123.7	188.883	129.0	The seabed very gently shoals to 121 m at KP 185.80. The seabed gently dips slightly undulating until it levels off at 129 m, at KP 188.20. It remains level until KP 189.00 where it starts to gently shoal.	BEDROCK outcrops KP 182.552 – 182.567 KP 182.567 to KP 185.000 clayey SAND, intermittently overlaying SILT and SAND, overlies a highly eroded BEDROCK surface which undulates between 1 m – 5 m BSF, subcropping to <1 m BSF at: KP183.867, KP 184.045, KP 184.472 and KP 184.655. From KP 185.000 – KP 188.883, clayey SAND 1 to 2 m thick, overlays SILT and SAND to >5 m BSF. This overlies BEDROCK, the top of which is generally >5 m BSF except at KP 186.514 where is it subcropping to 1 m BSF.
188.883	129.0	192.272	128.5	Seabed shoals gently to 123 m at KP 191.10 then slopes down gently to 128.5 m at KP 192.25.	KP 188.883 - KP 189.326, sandy CLAY ~1 m thick, overlays SILT and SAND to >5 m BSF. From KP 189.326 – KP 190.079 BEDROCK comes to within 2 m of seabed From KP 190.079 – KP 191.682 sandy CLAY ~2 m thick, overlays SILT and SAND >5 m BSF. From KP 191.682 - KP 192.282 the BEDROCK shallows from 5 m BSF to subcropping/outcropping.
192.272	128.5	192.454	125.5	Rough seabed, relatively steep rock outcrops at depths between 128.5 m and 125.5 m.	BEDROCK outcrop with some sandy CLAY infilling a shallow channel.
192.454	125.5	199.490	123.0	Seabed very gently slopes down to 128.5 m then levels off at KP 193.758 before shoaling again until KP 198.145 reaching depth of 117 m. Then seabed slopes down again reaching depth 123 m at KP 199.490.	KP 192.454 - KP 194.698, sandy CLAY ~2 m thick, over BEDROCK. From KP 194.698 – KP 196.970, sandy CLAY 2 to 3 m thick, over SILT and SAND to depths >5 m BSF. KP 196.970 – KP 197.531, a veneer of fine to medium SAND, overlies sandy CLAY 2 to 3 m thick, over SILT and SAND to depths >5 m BSF. KP 197.531 – 198.475, sandy CLAY 3 m to >5 m thick.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
					KP 198.475 - 199.490, sandy CLAY 1 to 2 m thick, over SILT and SAND to depths >5 m BSF.
199.490	123.0	205.408	122.2	Seabed gently shoals to 115 m at KP 201.25, then slopes down levelling off at 121.2 m at KP 201.20. The seabed remains level for 1000 m then shoals, becoming undulating at KP 202.40 until KP 205.40 at a depth of 122 m	KP 200.630 – 201.584, a veneer of fine to medium SAND, overlies sandy CLAY 1 to 2 m thick, overlies fine to coarse SAND to depths >5 m BSF. KP 201.584 - KP 203.25, sandy CLAY 1-4 m thick, over fine to medium SAND, over SILT and SAND to depths >5 m BSF. From KP 203.250 sandy CLAY overlies BEDROCK, the top of which is <5 m BSF, subcropping <1 m KP 204.734 – 204.408.
205.408	122.2	206.324	118.0	Very rough seabed. Highly undulating between 122.2 m and 113.8 m.	Outcropping BEDROCK, with some veneers of sandy CLAY infilling shallow channels.
206.324	118.00	211.769	120.1	Seabed gently dips levelling off at 122.4 m by KP 208.00, then shoaling to 116.8 m at KP 210.286. The seabed slopes down gently to reach 120.1 m at KP 211.50	Sandy CLAY unit (over BEDROCK) gradually thickens to 4 m BSF at KP 207.478 then reduces to 2 m KP 208.60 - KP 209.10, then gradually thickens to >5 m BSF at KP 210.093. Between KP 210.093 and KP 211.000 sandy CLAY, 2-4 m thick, is over SILT and SAND to depths >5 m BSF. KP 211.000 - 211.769, sandy CLAY, 3 m to >5 m thick, is over BEDROCK.
211.769	120.1	213.689	117.5	Seabed continues at a level of 120.1 m until KP 212.25 and then gently shoals again, levelling off at 117.5 m at KP 213.50, continuing level for 200 m.	Sandy CLAY 3 m to >5 m thick, is over BEDROCK. BEDROCK subcrops to 2 m BSF at KP 212.039
213.689	117.5	218.972	116.0	Seabed remains virtually level at 117.5 m until KP 217.00 where it starts very gently shoaling until reaching bedrock at a depth of 116.0 m at KP 218.95	KP 213.689 – KP 216.315, sandy CLAY 2 to 3 m thick, overlies channel infilled with SILT and SAND generally to depths >5 m BSF. KP 216.315 – 217.112, sandy CLAY 3 m - 5 m thick, overlays BEDROCK. KP 217.112, – KP 218.972, sandy CLAY >5 m thick, over BEDROCK. BEDROCK very quickly comes to the seabed surface from KP 218.855, outcropping at KP 218.972.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
218.972	116.0	219.262	113.5	Rough seabed between KP 218.972 and KP 219.262, ranging from 116.0 m to 113.5 m	Outcropping BEDROCK, with some veneer of sandy CLAY infill.
219.300	113.5	226.100	111.0	Seabed gently shoaling to depth of 109.6 m at KP 222.5. Then very gently sloping down 1 m by KP 223.50 and remaining at this depth until KP 225.00 where it very gently slopes down to 111.0 m at KP 226.10	Sandy CLAY overburden increasing in thickness from 2 m to >5 m BSF by KP 220.353. BEDROCK very quickly comes to within 4 m of seabed at KP 222.936 and remains between 3 to 4 m until dropping down below 5 m at KP 224.00. Sandy CLAY overburden continues >5 m for remainder of this section.
226.100	111.0	229.250	108.0	Seabed very gently shoals to depth of 108 m at KP 229.25	Sandy CLAY remains >5 m thick until BEDROCK comes to within 4 m of seabed between KP 227.65 and KP 227.87, where after SAND thickens again to >5 m From KP 228.829 the BEDROCK becomes <5 m BSF, shallowing up to within 2 m of seabed at KP 229.250.
229.250	108.0	238.500	102.1	Seabed continues gently shoaling to 105 m at KP 231.60. It levels off before gently shoaling again at KP 233.25. It reaches a depth of 102.1 at KP 236.55 and then very gently undulates 1 m to KP 238.50	KP 229.250 – 230.695, sandy CLAY 1 to 2 m thick, over BEDROCK KP 230.695 – 233.960, sandy CLAY 2-5 m thick, over BEDROCK. KP 233.960 – 237.357, sandy CLAY 1 to 2 m thick, over a highly eroded/undulating BEDROCK. KP 237.357 – KP 238.500, sandy CLAY 2-5 m thick, over BEDROCK. Through this section there are occasional channels within the BEDROCK infilled with SILT and SAND.
238.500	102.1	239.776	96.0	The seabed shoals to a depth of 95.5 m at KP 239.20 then continues irregularly undulating +/-1 m until KP 239.776 where the seabed becomes very rough.	Sandy CLAY thins to <1 m at KP 238.778 then thickens to reach >5 m BSF at KP 239.00 and then quickly reduces until KP 239.105 where the BEDROCK outcrops for 100 m. Sandy CLAY thickens to >2 m BSF over the highly eroded BEDROCK that eventually outcrops at KP 239.776. Through this section a veneer of fine to medium SAND/SAND and GRAVEL is on top of the sandy CLAY.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
239.776	96.0	243.240	90.5	Very rough seabed irregularly undulating between 96 m and between 85 m	Outcropping BEDROCK, with numerous veneers of fine to medium SAND infill shallow channels.
243.240	90.5	245.590	94.5	The seabed slopes down to 95.8 m at KP 244.10 then undulates +/-2 m until KP 245.64 to a depth of 94.5 m	KP 243.240 - KP 244.644, channel within the BEDROCK, infilled with fine to medium SAND 1-3 m thick. BEDROCK outcrops between KP 244.644 and 244.691. KP 244.691- KP 245.590, highly eroded/irregular channel within the BEDROCK, infilled with sandy CLAY 1-3 m thick. BEDROCK is subcropping <0.5 m and outcropping KP 245.062 – KP 245.196
245.590	94.5	251.920	91.0	The seabed shoals irregularly to a depth of 85.5 m at KP 246.67. It then irregularly dips again to 93.4 m at KP 248.50. It continues very irregularly shoaling to KP 250.52 and slopes down to an escarpment feature at KP 251.92. The top of this feature is at depth of 89 m and it drops 3 m to 91.2 m	Predominantly BEDROCK outcropping, with frequent thin veneers of fine to medium SAND or SAND and GRAVEL. Shallow channels are present within the BEDROCK, infilled with soft sediments between: KP 246.919 – KP 247.101, fine to medium SAND, <1.5 m deep. KP 247.376 – KP 247.343, fine to medium SAND, <1 m deep. KP 247.473 – KP 248.071, SAND and GRAVEL, <4 m deep. KP 248.080 – KP 248.770, sandy CLAY, <3 m deep. KP 249.079 – KP 249.295, SAND and GRAVEL, <2 m deep. KP 249.364 – 249.434, fine to medium SAND, <1 m deep.
251.920	91.0	257.960	83.2	The seabed continues smoothly level at 91.2 m until KP 253.03 where it becomes rough and gently shoals 2 m by KP 254.73. It then very gently shoals to 83.2 m at KP 257.960	KP 251.920 – KP 254.475, overburden fine to medium SAND intermittently over SAND and GRAVEL, with both units in total 3-5 m thick, over BEDROCK. KP 254.475 – KP 257.960, fine to medium SAND, mostly 2-4 m thick, over BEDROCK, with a subcrop to <1 m at KP 256.325.
257.960	83.2	261.820	75.2	Steep shoaling seabed until KP 258.11 reaching depth of 72.2 m. Very rough undulating seabed +/-2 m until KP 259.30. Then irregularly dipping to 77.4 m at KP 261.330 m and back up to 75.2 m at KP 261.82	Outcropping BEDROCK, with some shallow channels infilled with soft sediments between: KP 259.30 - KP 259.95, SAND and GRAVEL, <2 m deep. KP 261.13 - KP 261.33, fine to medium SAND, <2 m deep. KP 261.675 - KP 261.789, fine to medium SAND, <1 m deep.
261.820	75.2	272.695	58.0	Seabed gently shoaling until KP 269.55 to a depth of	Fine to medium SAND increasing in thickness to 4 m BSF by KP 262.83. It

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
				46.5 m. It then dips to 52.3 m at KP 270.85 and then continues almost level to KP 271.87 where it dips again, reaching 58 m at KP 272.82	remains this thick except between KP 263.00 - 263.50 where BEDROCK comes to within 2 m of seabed. fine to medium SAND thickens to >5 m at KP 267.20 and deepens to beyond detection over >12 m BSF at KP 268.848 At KP 271.50 - KP 271.720, BEDROCK is <5 m BSF and subcrops to 1.5 m BSF at KP 271.090, with an overburden of fine to coarse SAND. KP 271.720 – 272.201, fine to coarse SAND >5 m in thickness, overlies BEDROCK. From KP 272.201 - 272.695, the fine to coarse SAND thins from 5 m, over a highly irregular BEDROCK surface, until BEDROCK outcrops at KP 272.690.
272.695	58.0	276.230	72.2	Very rough seabed trending deeper until KP 276.23 reaching a depth of 72.2 m	Outcropping BEDROCK, with a shallow channel infilled with SILT and fine SAND KP 275.783 – KP 275.827, <2 m deep.
276.230	72.2	278.857	77.4	Seabed undulates +/-2 m until KP 278.000 then gently dips to 77 m at KP 278.500 and remains level until KP 278.850 where it becomes rough terrain and generally shoals.	KP 276.230 – KP 277.340 Channel infill of SAND and GRAVEL, over fine to medium SAND, which thickens to >5 m by KP 276.53. BEDROCK subcrops KP 276.917 – 276.943 to <2 m BSF and KP 277.167 – 277.193 to <3 m BSF. KP 277.340 – KP 278.155, SAND and GRAVEL >5 m BSF, overlays BEDROCK. KP 278.155 – KP 278.857, SAND and GRAVEL, thins from 5 m BSF until BEDROCK outcrops at KP 278.857.
278.857	77.4	281.373	66.0	Very rough generally shoaling seabed until rock peak at KP 280.75 at a depth of 62.1 m. Seabed levels off at 66 m and starts shoaling again from KP 281.18.	Predominantly Outcropping BEDROCK, with numerous shallow channels infilled with SAND and GRAVEL between: KP 279.016 – KP 279.172, <2 m deep. KP 279.577 – 280.475, intermittent channels <2 m deep and outcrops. KP280.788 – 281.373, channel <3 m deep.
281.186	66.0	283.770	20.0	Very rough generally shoaling seabed until KP 283.770 water depth 20 m	Predominately outcropping BEDROCK with shallow channels infilled with SAND and GRAVEL between: KP 282.52 and KP 282.55, <4 m deep. KP 282.74 and KP 283.770, <3 m deep.

2.2.3| HIGH LEVEL CONSTRAINTS TO CABLE ROUTING

An overview of the high constraints to cable routing for the MR is presented in Table 9.

Table 9 Overview of MR portions with high constraints to cable routing.

Overview of Route Portions with High Constraints to Cable Routing		
KP Start	**KP End**	**Comment**
66.7	89.2	Extensive trawl marks area
86.356	86.356	Linear arrangement of MAG anomalies within explosives storage area
115.5	120.1	Extensive trawl marks area
130.1	136.4	COARSE Sediment /Dense sub-unit at or within 2 m of seabed
131.4	134.3	Intermittent areas of Numerous Boulders
140.9	143.4	CONSOLIDATED Sediment within 2 m of seabed.
146.7	146.8	CONSOLIDATED Sediment within 2 m of seabed.
149.5	149.7	CONSOLIDATED Sediment within 2 m of seabed.
154.1	157.4	Canyon Head – area of high sediment mobility/bedforms
155.5	156.8	Canyon Head – areas of steep slopes and high sediment mobility
159.5	163.0	Medium abundance of sonar contacts identified as possible objects
160.5	162.6	Areas of Numerous Boulders
167.5	183.4	BEDROCK within 2 m of seabed. BEDROCK outcropping at KP 172.187 and between 182.487 – 182.507
171.5	173.0	Medium abundance of sonar contacts identified as possible objects
183.3	204.0	Extensive trawl marks area
183.5	185.0	BEDROCK intermittently sub cropping within 2 m of seabed
186.5	186.6	BEDROCK sub cropping within 2 m of seabed
186.5	194.5	Medium abundance of sonar contacts identified as possible objects
189.8	190.1	BEDROCK intermittently sub cropping within 2 m of seabed
192.1	194.4	BEDROCK sub cropping within 2 m of seabed. BEDROCK outcropping at KP 192.272-192.454 and at multiple locations near the route.
204.0	207.5	High abundance of Sonar contacts identified as possible objects
204.4	206.8	BEDROCK sub cropping within 2 m of seabed, outcropping KP 205.408 – 206.324
208.0	224.5	Medium abundance of sonar contacts identified as possible objects
218.9	220.2	BEDROCK sub cropping within 2 m of seabed and outcropping KP 218.972 – 219.262
222.2	234.4	Extensive trawl marks area

Overview of Route Portions with High Constraints to Cable Routing		
229.2	230.7	BEDROCK sub cropping within 2 m of seabed
233.5	246.0	Medium abundance of sonar contacts identified as possible objects
233.9	237.4	BEDROCK intermittently sub cropping within 2 m of seabed
237.6	239.7	Intermittent areas of Numerous Boulders
238.7	239.8	BEDROCK intermittently sub cropping within 2 m of seabed and outcropping KP 239.105 – 239.150
239.8	243.2	Expansive areas of BEDROCK outcropping and occasionally subcropping
243.0	245.5	Abundance of MAG anomalies
243.2	245.8	BEDROCK intermittently sub cropping within 2 m of seabed
245.8	252.1	Expansive areas of BEDROCK outcropping and occasionally subcropping
256.1	256.4	BEDROCK intermittently sub cropping within 2 m of seabed
257.9	262.0	Expansive areas of BEDROCK outcropping and occasionally subcropping
263.0	269.0	Medium abundance of sonar contacts identified as possible objects
265.5	268.5	Areas of Numerous Boulders
271.5	271.7	BEDROCK sub cropping within 2 m of seabed
272.3	276.3	Expansive areas of BEDROCK outcropping and occasionally subcropping
278.2	283.7	Expansive areas of BEDROCK outcropping and occasionally subcropping

2.3| LA CANTINE OPTION ROUTE

2.3.1| OVERVIEW

La Cantine Option Route is 12.433 km in length and is part of the MR. The limits of data collected for the MR are KP -0.138 to KP 283.730, this section covers the results up to KP 12.433, the remaining part of the MR is described in Section 2.2 and Section 3.1. KP -0.138 to KP 0.584 were acquired by UAV. KP 0.542 to KP 1.030 were acquired by diver survey. KP 1.030 to KP 283.730 were acquired aboard the M/V Franklin and M/V Geo Focus. The depth ranges from -28 m on land to a maximum of 11 m offshore. The route starts at KP 0 with a seabed surface of SAND covered by intermittent vegetation, with an increasing KP the vegetation give way to SAND bedforms creating a more undulating surface closer to the shoreline, in the surf zone the undulations decreases creating a gently sloping beach.

The section surveyed by M/V Geo Focus and M/V Franklin begins at KP 1.030 at a water depth of 4.6 m dipping gently to 11 m at KP 1.5, where the slope becomes more gradual dipping to 32.5 m at KP 12.433. The bathymetric profile in Figure 14 gives an overview of these changes.

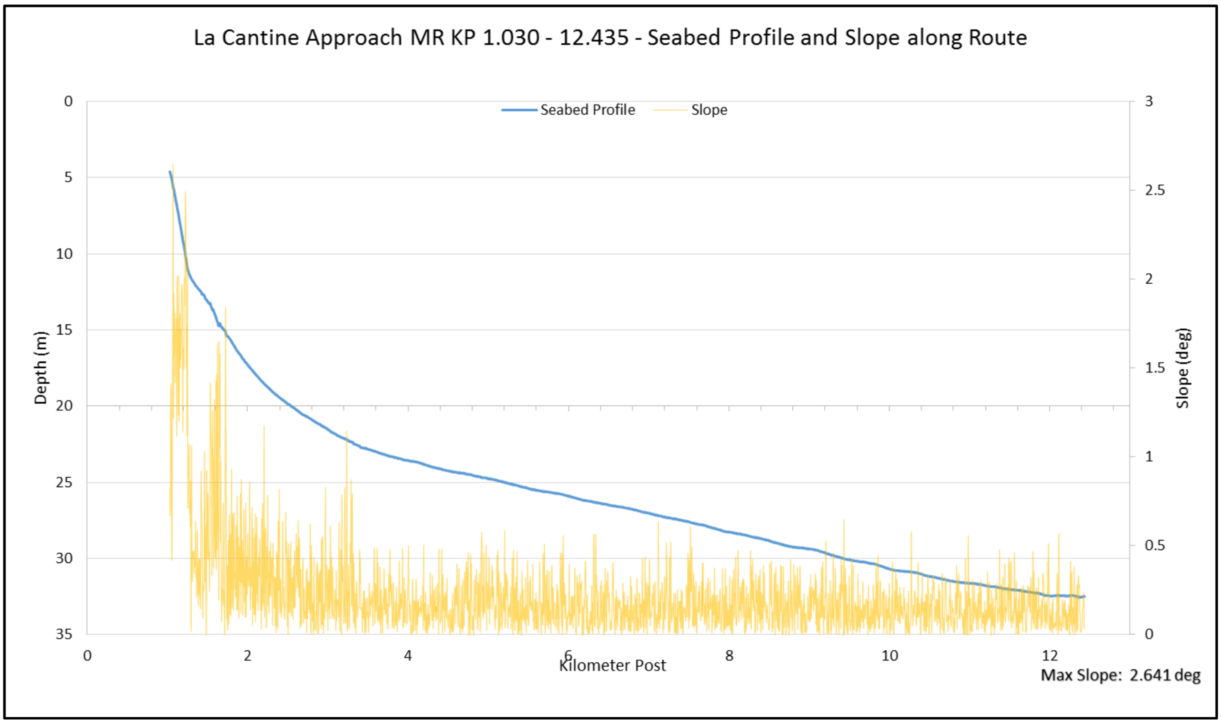

Figure 14 La Cantine Option Route landing seabed profile and slope along route.

The surficial geology comprises of mobile SILT and fine SAND towards the nearshore end of the route, and becoming predominantly fine to medium SAND that often has ripples present.

These overlie a shallow geological sequence comprising of units of SAND to >5 m BSF, occasionally overlaying SILT and SAND, up to around KP 18.50. From here SAND overlays SAND and GRAVEL.

A summary is contained in Table 10 and Table 22 with more comprehensive information in Section 3|.

<u>Side Scan Sonar Contacts, Magnetic Anomalies and Gradiometer Anomalies</u>

A total of 19 SSS contacts (Phase 1), 2 magnetic anomalies (Phase 1) and 4 gradiometer anomalies (Phase 2) were located within the La Cantine corridor (Appendix E| and Appendix F|).

<u>Pipeline and Cable crossings</u>

No existing pipelines or cables cross the proposed route.

<u>Geotechnical Survey</u>

During Phase 2, Geotechnical investigations were performed with VC (5 samples acquired) and PCPT (5 tests acquired) along this route, including second and third attempts (Appendix P| and Appendix Q|). The sediment types identified in the geotechnical results were used to correlate the geophysical interpretations from Phase 1 with the actual results from the geotechnical survey. This gives a more detailed and accurate description of the sediments where necessary. This involved cross referencing the sediment sequences observed in the geotechnical data to the geological units observed in the SBP data. No revisions of seabed classification were made.

2.3.2| CABLE ROUTE WATER DEPTH, MORPHOLOGY AND SHALLOW GEOLOGY

In Table 10 the water depth, morphology and shallow geology for the La Cantine Option Route are summarised.

Table 10 La Cantine Option Route water depth, morphology and shallow geology.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
-0.138	-28.5	0.542	-2.9	Establish beach system, vegetated KP -0.138 to KP 0, KP 0 to KP 0.542, Sand dune system progresses into SAND beach	Surficial SAND
0.542	-2.9	1.060	5.0	Intertidal zone, relatively steep slope	Surficial SAND
1.060	4.6	1.250	11	Relatively steep dipping from 5.0 m to 11 m at KP 1.250	Fine to coarse SAND up to 2 m BSF over gravelly SAND.
1.250	11	4.000	23.5	Dipping with reduced gradient to 23.5 m at KP 4.000	Intermittent surficial SILT and fine SAND overlying fine to medium SAND, overlaying gravelly SAND/SAND. Units of SILT and SAND overlying CONSOLIDATED SEDIMENT at depth.
4.000	23.5	12.433	32.5	Gentle gradient, 32.5 m at KP 12.433	Predominantly fine to coarse SAND at seabed to >5 m BSF, with SILT and SAND to within 5 m of seabed between KP 4.908 – 5.045 and KP 5.526 – 5.859.

2.3.3| HIGH LEVEL CONSTRAINTS TO CABLE ROUTING

There are no high level constraints to cable routing to report.

2.4| LACANAU OPTION ROUTE

2.4.1| OVERVIEW

Lacanau Option Route (LACO) is 21.7 km in length and lies to the north of the MR preferred landing at La Cantine. The limits of data collected for the LACO are KP -0.045 to KP 21.7. KP -0.045 to KP 0.320 were acquired by UAV. KP 0.422 to KP 0.986 were acquired by diver survey. The two survey vessels M/V Franklin (offshore) and M/V Geo Focus (nearshore) acquired data between KP 0.805 to KP 21.7 where it coincides with the MR at KP 12.43 (MR KP protocol). The depth ranges from -27 m on land to a maximum of 33 m offshore. The route starts at KP 0 with a seabed surface of SAND covered by intermittent vegetation. The route lies on a pathway with no vegetation. Closer to the shoreline the surface comprise of SAND, in the surf zone a gently sloping beach.

The surveyed section by M/V Geo Focus of the route begins at KP 0.805 at a water depth of 5 m dipping gently to 14 m at KP 1.2, where the slope becomes more gradual dipping to 22.5 m at KP 2.9 and 32 m at KP 21.7. The bathymetric profile below gives an overview of these changes (Figure 15).

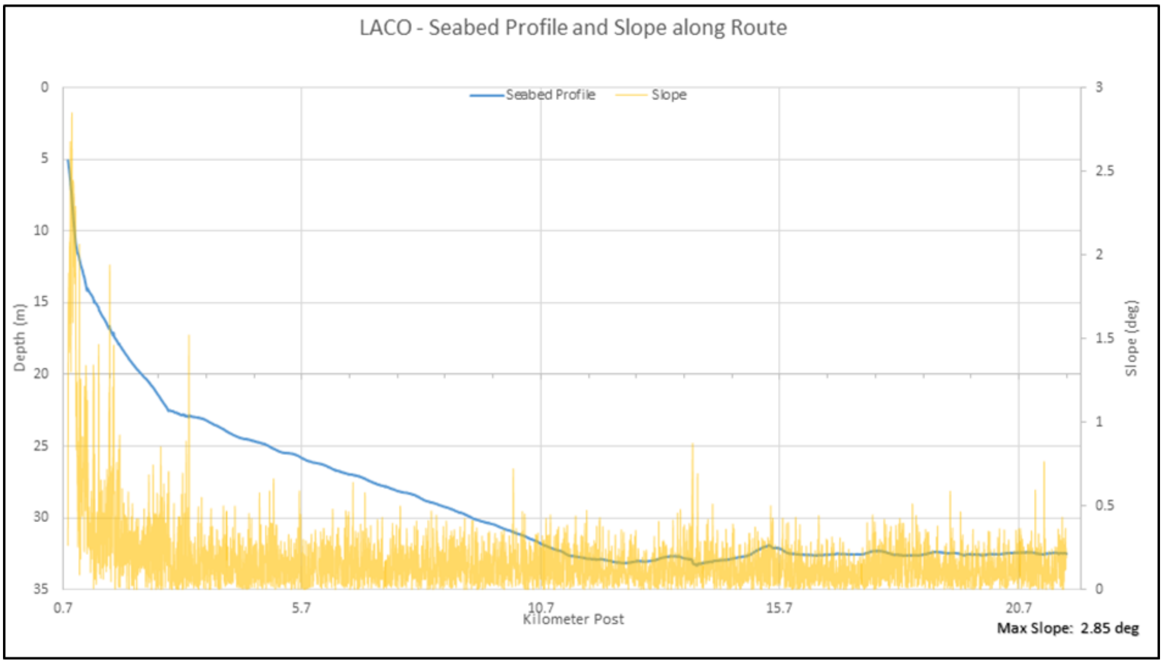

Figure 15 LACO alternative landing seabed profile and slope along route.

The surficial geology comprises of mobile SILT and fine SAND towards the nearshore end of the route, becoming fine to medium SAND that is often rippled.

These overlie a shallow geological sequence consisting of units of SAND to >5 m BSF, occasionally overlaying SILT and SAND.

A summary is contained in Table 11 and more comprehensive information in Section 3|.

<u>Side Scan Sonar Contacts, Magnetic Anomalies and Gradiometer Anomalies</u>

A total of 10 SSS contacts (Phase 1), 9 magnetic anomalies (Phase 1) and 1 gradiometer anomaly (Phase 2) were located within the LACO corridor (Appendix E| and Appendix F|).

<u>Pipeline and Cable crossings</u>

No existing pipelines or cables cross the proposed route.

Geotechnical Survey

During Phase 2, Geotechnical investigations were performed with VC (3 samples acquired) and PCPT (8 tests acquired) along this route, including second and third attempts (Appendix P| and Appendix Q|). The sediment types identified in the geotechnical results were used to correlate the geophysical interpretations from Phase 1 with the actual results from the geotechnical survey. This gives a more detailed and accurate description of the sediments where necessary. This involved cross referencing the sediment sequences observed in the geotechnical data to the geological units observed in the SBP data. No revisions of seabed classification were made.

2.4.2| CABLE ROUTE WATER DEPTH, MORPHOLOGY AND SHALLOW GEOLOGY

In Table 11 the water depth, morphology and shallow geology for the LACO are summarised.

Table 11 LACO water depth, morphology and shallow geology.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
-0.045	-13	0.216	-10	Steep slopes from KP 0 to KP 0.216.	Surface sediment of SAND covered by intermittent vegetation and infrastructure.
0.216	-10	0.855	5	Slopes generally dipping seawards.	Surface sediment of SAND.
0.855	5.0	1.210	12.5	Seabed dipping relatively steeply from 5 m at KP 0.855 to 12.5 m at KP 1.210	Surficial veneer of SILT and fine SAND, overlaying fine to medium SAND 1 to 2 m thick over dense SAND to >5 m BSF.
1.210	12.5	2.910	22.5	Seabed dipping with less gradient to 22.5 m at KP 2.910	Up to KP 1.88 Uppermost unit of fine to medium SAND thins, with dense SAND >5 m BSF. From KP 1.88 a unit of fine to medium SAND >5 m BSF.
2.910	22.5	11.900	33.0	Gently dipping seabed.	Surficial veneer of SILT and fine SAND KP 2.91 to KP 3.27, overlaying fine to medium SAND >5 m BSF. From KP 3.27 fine to medium SAND >5 m continues.
11.900	33.0	21.700	32.50	Seabed levels off, very slight undulations +/-1 m.	fine to medium SAND >5 m.

2.4.3| HIGH LEVEL CONSTRAINTS TO CABLE ROUTING

There are no high level constraints to cable routing to report.

2.5| LE GRANDE CROHOT OPTION ROUTE

2.5.1| OVERVIEW

Le Grande Crohot Option Route (LGCO) lies to the south of the preferred proposed nearshore section. The limits of data collected for LGCO are KP -0.085 to KP 12.430. KP -0.085 to KP 0.577 were acquired by UAV. KP 0.499 to KP 1.102 were acquired by diver survey. The limit of survey with the two survey vessels M/V Franklin (offshore) and M/V Geo Focus (nearshore) were KP 1.051 to KP 12.020, where it coincides with the MR at KP 26.68 (MR KP Protocol).

The route starts in an area surrounded by vegetation and steep slopes, the route itself is however along a pathway of SAND that cuts through the vegetation and dune like morphology down towards the shoreline. The height at the start of the route is -17 m with steep slopes across and on both sides of the route. On the beach itself the slopes become more gentle and mainly dipping towards the shoreline.

The bathymetry and SBP coverage starts at KP 0.995 with SSS from KP 1.069 and all sensors collected data up to KP 12.430 where it coincides with the MR at KP 24.680 (MR KP protocol). The depth ranges from -20.9 m on land to 22.9 m offshore. The route starts at KP 0 with a seabed surface of SAND covered by intermittent vegetation. Closer to the shoreline the surface comprise of SAND, in the surf zone a gently sloping beach.

The seabed slopes from 4.0 m to 10.5 m between KP 0.995 and KP 1.200. Thereafter, the slope becomes more gradual reaching a depth of 22.0 m at KP 3.6 and 33.5 m at KP 12.01 (Figure 16).

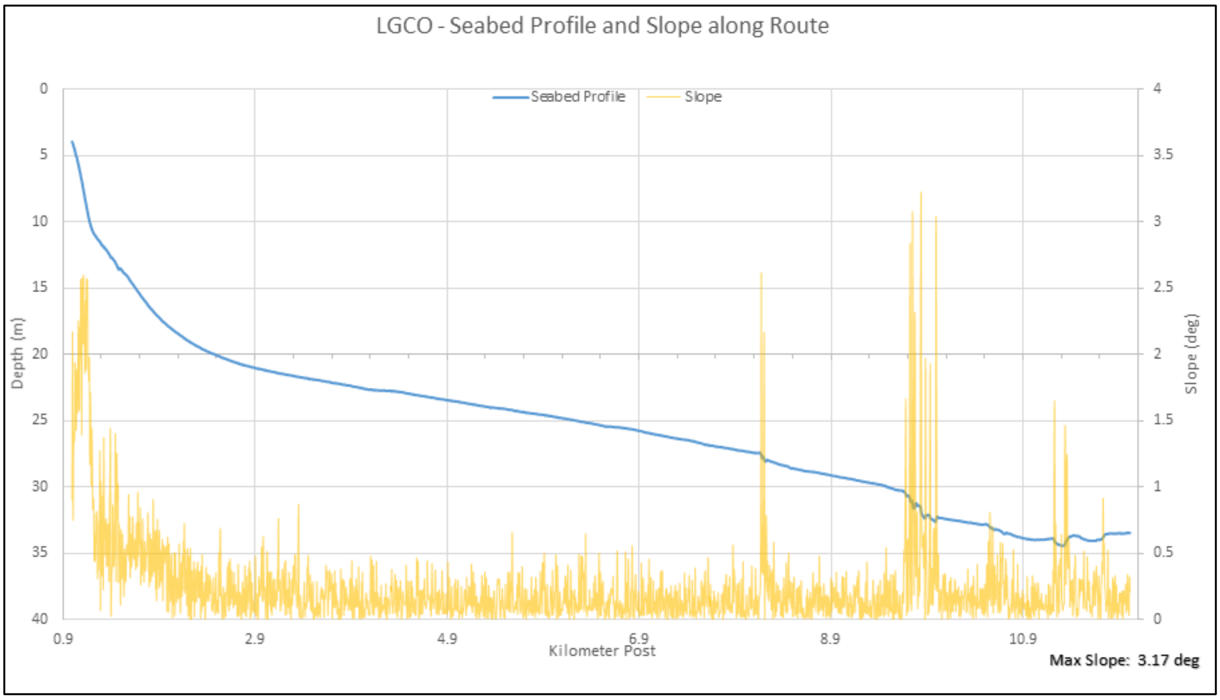

Figure 16 LGCO alternative landing seabed profile and slope along route.

The surficial geology comprises of mobile SILT and fine SAND towards the nearshore end of the route, becoming predominantly fine to coarse SAND that is often rippled. From around KP 7.50 onwards the fine to coarse SAND with ripples is interspersed with patches of SAND and GRAVEL with ripples.

These overlie a shallow geological sequence comprising of SAND >5 m BSF, up to around KP 9.0. From here the uppermost SAND overlies SAND and GRAVEL to depths >5 m BSF.

A summary is contained Table 12 and more comprehensive information in Section 3|.

<u>Side Scan Sonar Contacts, Magnetic Anomalies and Gradiometer Anomalies</u>

A total of 12 SSS contacts (Phase 1), 1 magnetic anomaly (Phase 1) and 1 gradiometer anomaly (Phase 2) were located within the LGCO corridor (Appendix E| and Appendix F|).

Pipeline and Cable crossings

No existing pipelines or cables cross the proposed route.

Geotechnical Survey

During Phase 2, Geotechnical investigations were performed with VC (1 sample acquired) and PCPT (4 tests acquired) along this route, including second and third attempts (Appendix P| and Appendix Q|). The sediment types identified in the geotechnical results were used to correlate the geophysical interpretations from Phase 1 with the actual results from the geotechnical survey. This gives a more detailed and accurate description of the sediments where necessary. This involved cross referencing the sediment sequences observed in the geotechnical data to the geological units observed in the SBP data.No revisions of seabed classification were made.

2.5.2| CABLE ROUTE WATER DEPTH, MORPHOLOGY AND SHALLOW GEOLOGY

In Table 12 the water depth, morphology and shallow geology for LGCO are summarised.

Table 12 LGCO water depth, morphology and shallow geology.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
-0.085	-17	0.577	-11	Steep slopes across and on both sides of the route.	Surface sediment of SAND with vegetation and SAND on both sides of the route.
0.577	-11	0.995	4	More gentle slopes dippings towards the sea.	Surface sediment of SAND.
0.995	4.0	1.158	10.5	Relatively steep dipping seabed to 10.5 m.	Fine to coarse SAND 1 to 4 m thick over dense SAND to >5 m BSF.
1.158	10.5	2.300	19.5	The slope gradient decreases at KP 2.30 at a depth of 19.5 m.	Veneer of SILT and fine SAND KP 1.158-1.601. Fine to coarse SAND ~1 m thick overlying dense SAND >5 m.
2.300	19.5	4.500	23.0	Gently dipping seabed almost levelling at 23 m at KP 4.50	Fine to coarse SAND ~1 m thick overlies dense SAND >5 m.
4.500	23.0	8.961	29.0	Very gently dipping seabed continues.	Fine to coarse SAND >5 m thick.
8.800	29.0	10.490	33.0	Very gently dipping seabed to KP 9.65 at 30.3 m, becoming rough until KP 10.00 irregularly undulating to depth of 32.5 m, then gently dipping to 33.0 m.	Intermittent deposits of fine to coarse SAND <1 m thick, (between KP 8.867 - KP 9.455 and KP 10.000 - KP 10.500), on top of SAND and GRAVEL >5 m BSF.
10.490	33.0	12.020	33.5	Seabed gently undulates +/-1 m, ending at KP 12.02 at depth 33.5 m.	Intermittent deposits of fine to coarse SAND <1 m thick, (between KP 10.830-KP 11.235 KP 11.333-KP 11.557), on top of SAND and GRAVEL >5 m BSF.

2.5.3| HIGH LEVEL CONSTRAINTS TO CABLE ROUTING

There are no high level constraints to cable routing to report.

2.6| WESTERN ROUTE ALTERNATIVE – FRENCH WATERS

2.6.1| OVERVIEW

The Western Route Alternative – French Waters (RRNC-AL) is a 38.13 km section that runs west of the MR (NB not shown in Figure 4). It departs from the MR at KP 115.72 KP (MR KP protocol) and re-joins at KP 150.6 (MR KP protocol). The survey line was conducted to provide a preliminary analysis of seabed conditions farther offshore from the coast.

The seabed profile along the KP referenced survey line dips very gently from its initial depth of 48.2 m at KP 0.000 to 66.2 m at KP 32.850 before gently shoaling to 36.8 m at KP 38.130 (Figure 17).

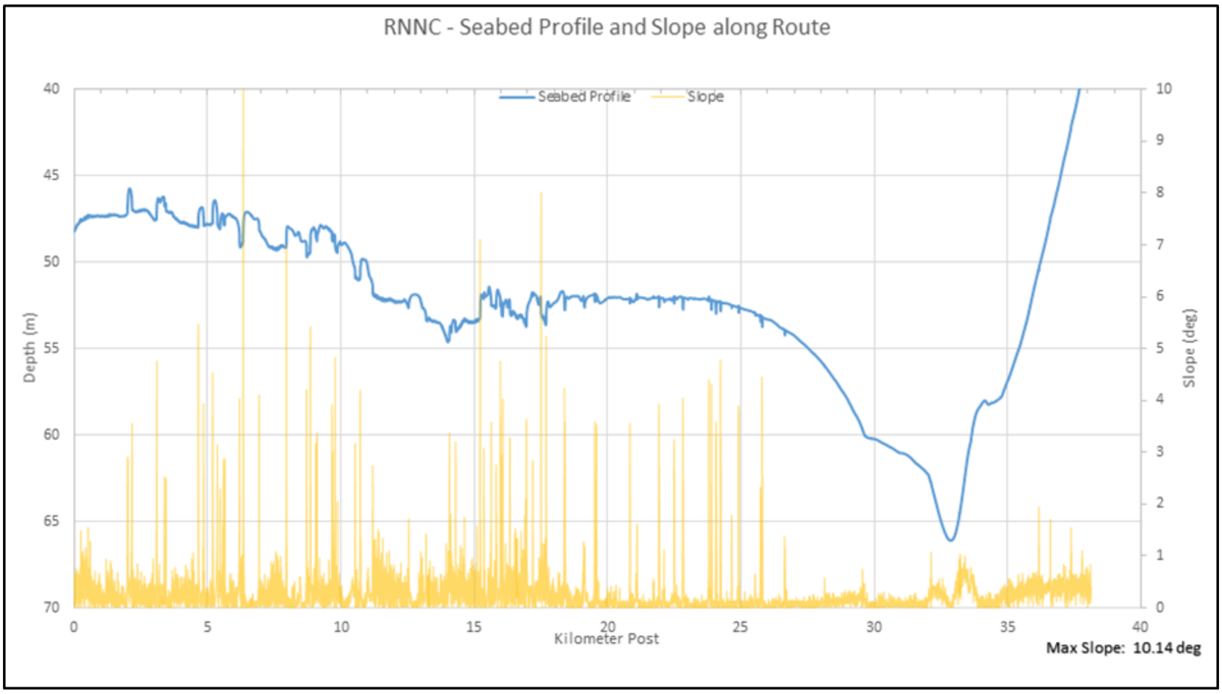

Figure 17 RNNC-AL - Seabed profile and slope along route.

From the start of this route to around KP 17.800, the surficial geology consists of mobile re-worked surficial fine to medium SAND, forming dune like bedforms (the morphology of which is described in detail in Mazières *et al.* 2015), overlying coarser SAND and GRAVEL with ripples. The extension of these formations can be several hundred metres at times predominantly aligned SW/NE. From around KP 17.800 to the end of the route the fine to medium SAND becomes the predominant surficial sediment.

The shallow geology comprises of intermittent fine to medium SAND bedforms, up to 2 m thick, overlaying SAND and GRAVEL to depths >5 m BSF, up to KP 17.800. From here to the end of the route, the fine to medium SAND is mostly continuous at the seabed and thickens often to >5 m BSF. This overlays a SAND and GRAVEL unit, present along the entire length of the route.

CONSOLIDATED SEDIMENT is likely to underlay the SAND and GRAVEL along this route, but penetration of the shallow geology was quite limited in the absence of any sparker data acquired.

A summary is contained in Table 13 and a more comprehensive information in Section 3|.

Side Scan Sonar Contacts, Magnetic Anomalies and Gradiometer Anomalies

A total of seven (7) SSS contacts (Phase 1), one (1) magnetic anomaly (Phase 1) and no gradiometer anomalies (Phase 2) were located within the RRNC-AL corridor (Appendix E| and Appendix F|).

Pipeline and Cable crossings

No existing pipelines or cables cross the proposed route.

Geotechnical Survey

Geotechnical investigations were not performed on this route option. The interpretations of the geophysical data was checked and correlated against the relevant samples along the MR without any changes being needed in the interpretations.

2.6.2| CABLE ROUTE WATER DEPTH, MORPHOLOGY AND SHALLOW GEOLOGY

In Table 13 the water depth, morphology and shallow geology for RRNC-AL are summarised.

Table 13 RRNC-AL water depth, morphology and shallow geology.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
0.000	48.2	3.693	47.2	Relatively flat seabed.	Mobile bedforms consisting of fine to medium SAND, 1.0 to 1.5 m thick, cross the route between: KP 2.000 and 2.176 KP 3.089 and 3.446 These overlay SAND and GRAVEL 1 to 2 m BSF, overlaying SAND to >5 m.
3.693	47.2	8.735	49.7	Very gently dipping seabed.	Mobile bedforms consisting of fine to medium SAND, 1 to 2 m thick, cross the route between: KP 4.647 and 4.859 KP 5.190 and 5.375 KP 5.466 and 5.610 KP 5.648 and 6.200 KP 6.356 and 6.944 KP 7.949 and 8.724 These overlay SAND and GRAVEL to depths >5 m BSF.
8.735	49,7	11.193	52.0	Very gently dipping seabed.	Mobile bedforms consisting of fine to medium SAND, 1 to 2 m thick, cross the route between: KP 8.850 and 9.667 KP 9.694 and 9.789 KP 9.869 and 10.542 KP 10.722 and 11.193 These overlay SAND and GRAVEL to depths >5 m BSF.
11.193	52.0	17.691	53.6	Virtually level seabed with slight undulations (+/-1 m).	Mobile bedforms consisting of fine to medium SAND, 1 to 2 m thick, cross the route between: KP 12.535 and 13.201 KP 14.069 and 14.306 KP 15.223 and 15.641 KP 15.819 and 16.032 KP 16.069 and 16.346 KP 16.957 and 17.518 These overlay SAND and GRAVEL to depths >5 m BSF.
17.691	53.6	29.648	60.0	Virtually level seabed with slight undulations, +/-1 m, to	Fine to medium SAND 1 to 5 m thick, overlying SAND and GRAVEL >5 m BSF.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
				KP 23.500 then very gently dipping to 60.0 m.	
29.648	60.0	32.858	66.2	Very gently dipping seabed to depth 66.2 m at KP.	fine to medium SAND >5 m.
32.858	66.2	38.130	35.8	Gently shoaling seabed.	Fine to medium SAND 1 to >5 m thick, overlying SAND and GRAVEL >5 m BSF.

2.6.3| HIGH LEVEL CONSTRAINTS TO CABLE ROUTING

An overview of the high constraints to cable routing for the RRNC route portions is presented in Table 14.

Table 14 Overview of RRNC Route Portions with high constraints to cable routing.

Overview of Route Portions with High Constraints to Cable Routing		
KP Start	**KP End**	**Comment**
0.0	38.7	Very limited understanding of shallow geology due to poor chirp SBP penetration.
00.	3.5	Extensive trawl marks area
13.7	14.8	Areas of occasional boulders and numerous boulders

2.7| CANYON HEAD BYPASS COAST OPTION

2.7.1| OVERVIEW

The Canyon Head Bypass Coast (CHBC) option route is an 11.4 km section on the MR between KP 150.5 and KP 161.9. This section is designed to skirt nearshore around the head of the canyon. At KP 150.5 the route runs in an easterly direction arcing south by KP 150 and arcing west at KP 157.5. The section KP 152.737 to KP 159.554 was surveyed by the M/V Geo Focus with a pole-mounted Innomar SBP and SSS.

The profile of the route shoals gently from 37.5 m at KP 150.5 to 3.5 m at KP 154.8, thereafter to KP 155.5 it plateaus at approximately 4 m (Figure 18). Between KP 155.5 and KP 156.8 the route traverses the slopes of the canyon head with attendant depths of 14 m and slope gradients of up to 10.5°. From KP 156.88 the seabed descends gradually to a depth of 40.5 m at KP 161.9.

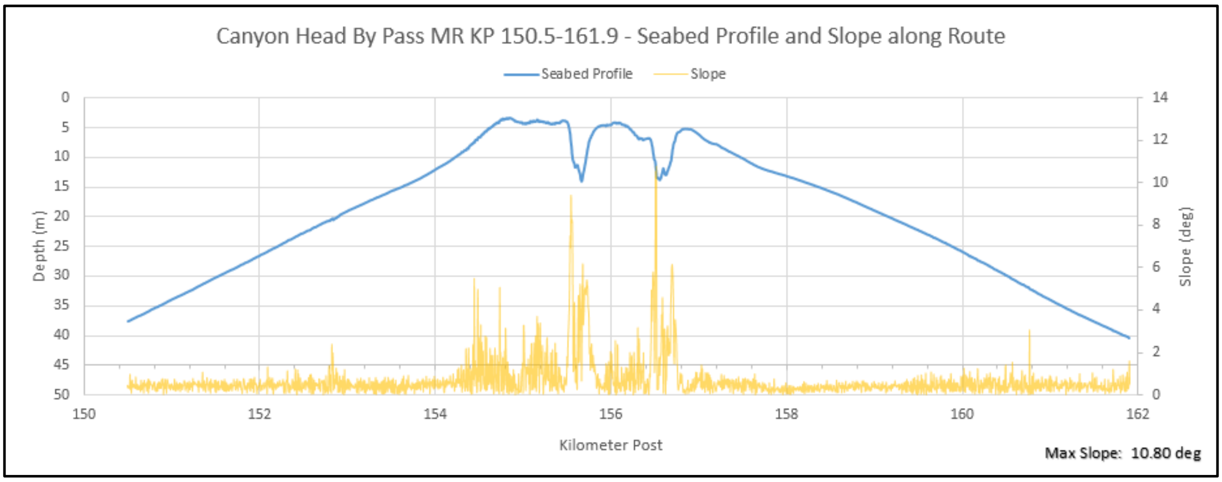

Figure 18 CHBC -seabed profile and slope along route.

The surficial geology is composed of predominantly fine to coarse SAND/fine to medium SAND with small areas of SAND and GRAVEL. Between KP 154.167 and KP157.411, ripples and large ripples become present in the SAND and the western edge of the corridor is characterised by the steep slopes into the Capbreton Canyon resulting in bedforms caused by gravitational slips/slumping.

Between KP 150.460 and KP 155.000 the shallow geology comprises of fine to coarse SAND, overlaying SAND and GRAVEL, overlaying CONSOLIDATED SEDIMENT, each varying in thickness and occasionally becoming undetected. Between KP 155.000 to KP 157.000 the route traverses steep slopes associated with the canyon, where penetration is poor, with SAND expected. From KP 157.00 to KP 159.640 the uppermost unit is fine to medium SAND, overlaying SAND and GRAVEL >5 m BSF. From KP 159.640 through to the end of the route at KP 161.922 fine to medium SAND overlays fine to coarse SAND to >5 m BSF.

A summary is contained in Table 16 and more comprehensive information in Section 3|.

Side Scan Sonar Contacts, Magnetic Anomalies and Gradiometer Anomalies

A total of 85 SSS contacts (Phase 1), 17 magnetic anomalies (Phase 1) and seven (7) gradiometer anomalies (Phase 2) were located within CHBC corridor (Appendix E| and Appendix F|).

Pipeline and Cable crossings

No existing pipelines or cables cross the proposed route.

Geotechnical Survey

During Phase 2, Geotechnical investigations were performed with VC (10 samples acquired) and PCPT (16 tests acquired) along this route, including second and third attempts (Appendix P| and Appendix Q|). he sediment types identified in the geotechnical results were used to correlate the geophysical interpretations from Phase 1 with the actual results from the geotechnical survey. This gives a more detailed and accurate description of the sediments where necessary. This involved cross referencing the sediment sequences observed in the geotechnical data to the geological units observed in the SBP data. Some revisions of seabed classification were made, listed below in Table 15.

Table 15 CHBC - areas of revised seabed classification after the geotechnical campaign.

KP Start	KP End	Original seabed classification based on geophysical data only	Revised seabed classification with geophysical data correlated to geotechnical results
154.166	155.406	SAND and GRAVEL with large ripples	SAND with large ripples

2.7.2| CABLE ROUTE WATER DEPTH, MORPHOLOGY AND SHALLOW GEOLOGY

In Table 16 the water depth, morphology and shallow geology for CHBC are summarised.

Table 16 CHBC route water depth, morphology and shallow geology.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
150.477	38.0	155.509	3.5	The relatively flat and featureless seabed continues to shoal with an increased slope until KP 154.30 where the seabed continues its upward trend, but becomes rough. It reaches the top of the slope at a depth of just 3.5 m at KP 154.70. It continues shallow at around 3 m until KP 155.50, at the head of the canyon.	Between 150.477 KP 152.60, fine to coarse SAND increases in thickness from 2 m to >5 m BSF overlying SAND and GRAVEL, overlaying CONSOLIDATED SEDIMENT. The CONSOLIDATED SEDIMENT comes to within 5 m of the seabed between KP 150.477 and KP 152.30. At KP 152.60 the fine to coarse SAND unit is 1 m in thickness, increasing in thickness to 4 m at KP 155.509, overlaying CONSOLIDATED SEDIMENT.
155.509	3.5	155.800	3.5	Steep sided canyon slopes down to 14 m and back up to 3.5 m	Chaotic sub-surface/poor detection of geology across steep slopes of canyon head. Typically SAND overlies CONSOLIDATED SEDIMENT.
155.800	3.5	156.450	6.0	Textured seabed	Fine to coarse SAND 1 to 3 m thick, overlaying CONSOLIDATED SEDIMENT.
156.450	6.0	156.750	4.0	Traverse of Canyon Head slopes down to 14 m and back up to 4.0 m	SAND overlaying CONSOLIDATED SEDIMENT. SBP data not easily acquired in steep sides, so depth of units not easily established.
156.750	4.0	161.9	40.5	Relatively flat and featureless seabed slopes down with reasonable gradient to 40.5 m.	Fine to medium SAND 3-4 m thick KP 157.000 – 157.250, over SAND and GRAVEL to depths >5 m BSF. KP 157.250 - 159.615, fine to medium SAND 1 to 2 m thick, over SAND and GRAVEL to depths >5 m BSF. From KP 159.615 fine to medium SAND >5 m BSF.

2.7.3| HIGH LEVEL CONSTRAINTS TO CABLE ROUTING

An overview of the high constraints to cable routing for CHBC is presented in Table 17.

Table 17 Overview of CHBC route portions with high constraints to cable routing.

Overview of Route Portions with High Constraints to Cable Routing		
KP Start	**KP End**	**Comment**
154.1	157.4	Canyon Head – area of high sediment mobility/bedforms
155.5	156.8	Canyon Head – areas of steep slopes and high sediment mobility
159.5	163.0	Medium abundance of sonar contacts identified as possible objects
160.5	162.6	Areas of Numerous Boulders

2.8| ALTERNATIVE CANYON HEAD BYPASS COAST OPTION

2.8.1| OVERVIEW

An alternative route option, the Alternative Canyon Head Bypass Coast (ACHBC) route, is proposed running 40 m east of and parallel to the MR between KP 153.9 and KP 158.1 for a distance of 4.2 km with a stand-alone KP protocol. This alternative route lies in the same corridor as the CHBC but with the P40-Line as KP referenced survey line (Figure 19). This section corresponds to alignment chart “102354-INE-MMT-SUR-DWG-ACHBC001”. The section was surveyed by the M/V Geo Focus with a pole-mounted Innomar SBP and SSS.

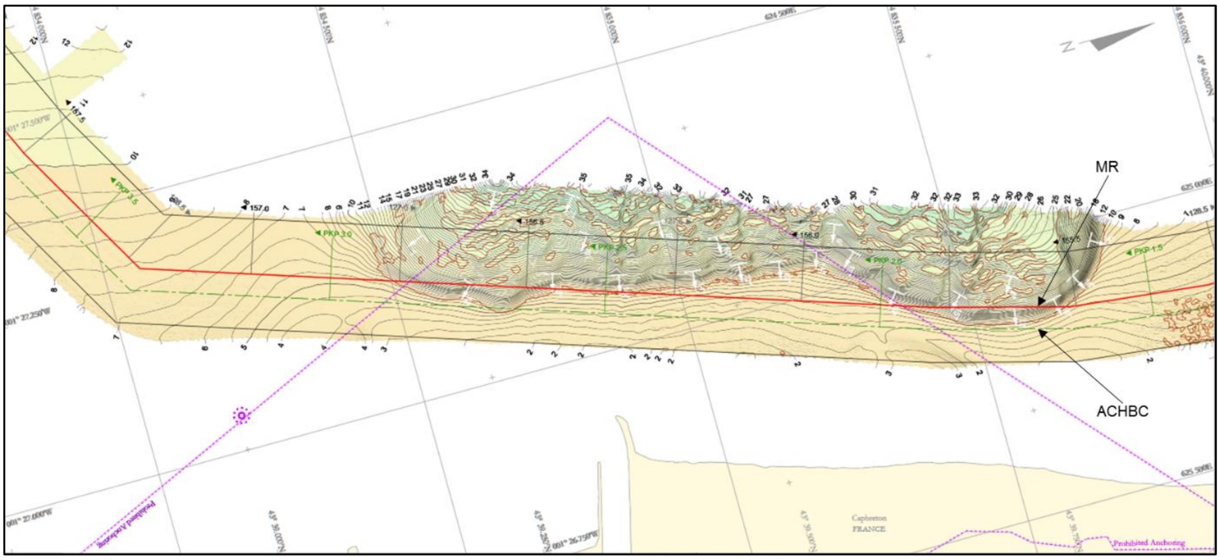

Figure 19 ACHBC (green) and MR (red).
Image show KP 1.400 to 3.600 for ACHBC.

The existing MR traverses the break of a steep canyon head slope with sections of the route likely prone to slumping and steep changes of slope. As the data collected within the nearshore corridor include a wing line 40 m to the east of the MR centre line, an alternative route is presented that passes closer nearshore with seabed gradients that mitigate the risk of sediment slumping and negligible changes in slope (Figure 20).

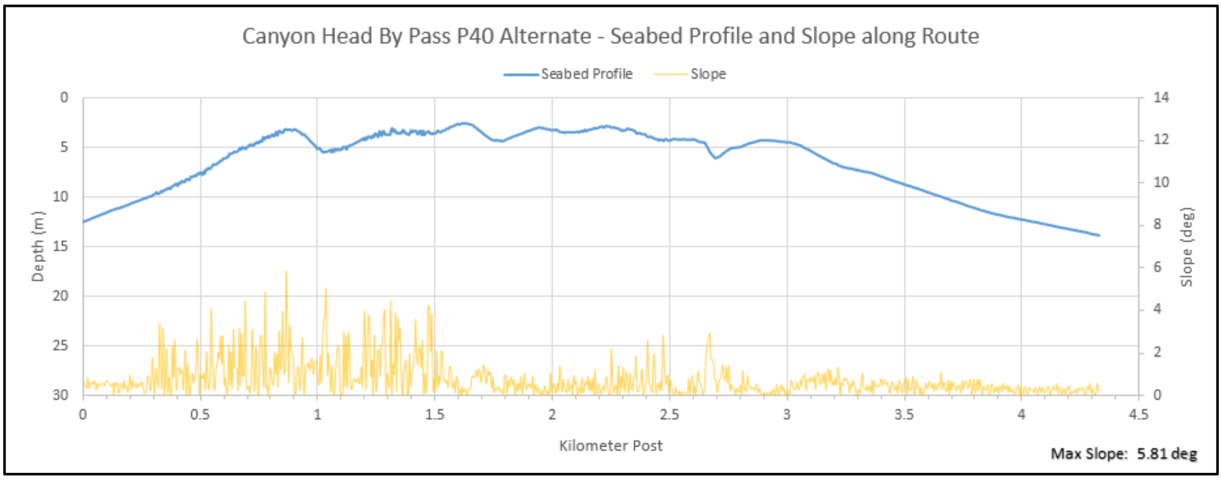

Figure 20 ACHBC -seabed profile and slope along route.

The descriptions are made relative to a KP database configured for this wing line. Between KP 0.000 and KP 0.880 the seabed shoals relatively steeply from 12.5 m to 3.2 m. From KP 0.880 to KP 1.035 the seabed dips to 5.4 m and then shoals with a very irregular surface to 2.5 m at KP 1.630. It then continues between 2.5 m and 4.2 m undulating until KP 2.640. From here it dips to 6.1 m at KP 2.780. Between KP 2.690 it shoals to 4.2 m t at KP 2.910 then gently dips to 14.0 m at KP 4.400.

The surficial geology is composed of predominantly fine to coarse SAND/fine to medium SAND with small areas of SAND and GRAVEL. Between KP 0.267 and KP 3.910 ripples and large ripples become present in the SAND.

The shallow geology comprises of fine to coarse SAND 1-4 m thick, overlaying SAND and GRAVEL to depths >5 m BSF, from KP 0 to ~KP 1.880. From KP 1.880 to KP 4.332 fine to medium SAND 1-4 m thick, overlies SAND and GRAVEL to depths >5 m BSF. The top of CONSOLIDATED SEDIMENT that underlies the SAND and GRAVEL near the canyon is >5 m BSF and has not been detected.

A summary is contained in Table 19 and more comprehensive information in Section 3|.

<u>Side Scan Sonar Contacts, Magnetic Anomalies and Gradiometer Anomalies</u>

A total of 32 SSS contacts (Phase 1), six (6) magnetic anomalies (Phase 1) and no gradiometer anomalies (Phase 2) were located within the ACHBC corridor (Appendix E| and Appendix F|).

<u>Pipeline and Cable crossings</u>

No existing pipelines or cables cross the proposed route.

<u>Geotechnical Survey</u>

During Phase 2, Geotechnical investigations were performed with VC (10 samples acquired) and PCPT (16 tests acquired) along this route (same as Canyon Head Bypass Coast Option), including second and third attempts, (Appendix P| and Appendix Q|). The sediment types identified in the geotechnical results were used to correlate the geophysical interpretations from Phase 1 with the actual results from the geotechnical survey. This gives a more detailed and accurate description of the sediments where necessary. This involved cross referencing the sediment sequences observed in the geotechnical data to the geological units observed in the SBP data. Some revisions of seabed classification were made, listed below in Table 18.

Table 18 ACHBC - areas of revised seabed classification with geophysical data correlated to geotechnical results.

KP Start	KP End	Original seabed classification based on geophysical data only	Revised seabed classification with geophysical data correlated to geotechnical results
0.270	1.543	SAND and GRAVEL with large ripples	SAND with large ripples

2.8.2| CABLE ROUTE WATER DEPTH, MORPHOLOGY AND SHALLOW GEOLOGY

In Table 19 the water depth, morphology and shallow geology for the ACHBC are summarised.

Table 19 ACHBC - water depth, morphology and shallow geology.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
0.000	12.5	0.880	3.2	Relatively steep shoaling seabed.	fine to coarse SAND between 1 and 2 m thick over SAND and GRAVEL >5 m
0.880	3.2	1.035	5.4	Relatively steep dipping seabed.	fine to coarse SAND between 2 and 3 m thick over SAND and GRAVEL >5 m
1.035	5.4	1.630	2.5	Irregularly undulating seabed.	fine to coarse SAND between 2 and 3 m thick over SAND and GRAVEL >5 m
1.630	2.5	2.640	4.2	Irregularly undulating seabed.	fine to medium SAND between 2 and 4 m thick over SAND and GRAVEL >5 m
2.640	4.2	2.690	6.1	Relatively steep dipping seabed.	fine to medium SAND between 1 and 3 m thick over SAND and GRAVEL >5 m
2.690	6.1	2.910	4.2	Relatively steep shoaling seabed.	fine to medium SAND between 1 and 2 m thick over fine to coarse SAND >5 m
2.910	4.2	4.400	14.0	Dipping seabed.	fine to medium SAND between >1 and 2 m thick over SAND and GRAVEL >5 m

2.8.3| HIGH LEVEL CONSTRAINTS TO CABLE ROUTING

An overview of the high constraints to cable routing for the ACHBC is presented in Table 20.

Table 20 Overview of ACHBC route portions with high constraints to cable routing.

Overview of Route Portions with High Constraints to Cable Routing		
KP Start	**KP End**	**Comment**
0.3	4.0	Canyon Head – area of high sediment mobility/bedforms
0.9	2.9	Canyon Head – areas of steep slopes and high sediment mobility
2.2	3.2	Medium abundance of sonar and MAG contacts identified as possible objects

2.9| HDD CANYON CROSSING ROUTE

2.9.1| OVERVIEW

The HDD Canyon Crossing Route (HDCC) is 8.595 km in length and transects the canyon system. It splits from the MR at KP 150.460 and re-joins it at KP 161.922 (MR KP protocol) and runs along the south side of the canyon system.

Due to the steep slopes of the canyon and an abundance of fishing activity, survey with the towed ROTV was not conducted with the exception of the centre line. With the approval of the Client representative, survey operation consisted of hull mounted MBES and surface towed sparker. Due to the hull mounted MBES bathymetry resolution was relaxed to 1 m^2.

The seabed climbs steadily from a depth of 37.7 m at KP 0.000 to 22.5 m at KP 3.432, then dips to 42.5 m by KP 4.100. From the edge of the canyon, it steeply dips to a depth of 109.5 m then steeply shoals back up to 22.5 m at KP 4.815. The seabed gradient decreases along with the depth to reach 16.5 m at KP 5.315 before it dips gently down to a depth of 40.2 m at KP 8.599 (Figure 21). Between KP 5.500 and KP 6.400, a secondary canyon system is apparent within the corridor extent, featuring steep slopes 50-250 m north of the HDCC route. Additional route development survey was conducted south of the corridor in response to the constraints apparent due to this secondary canyon.

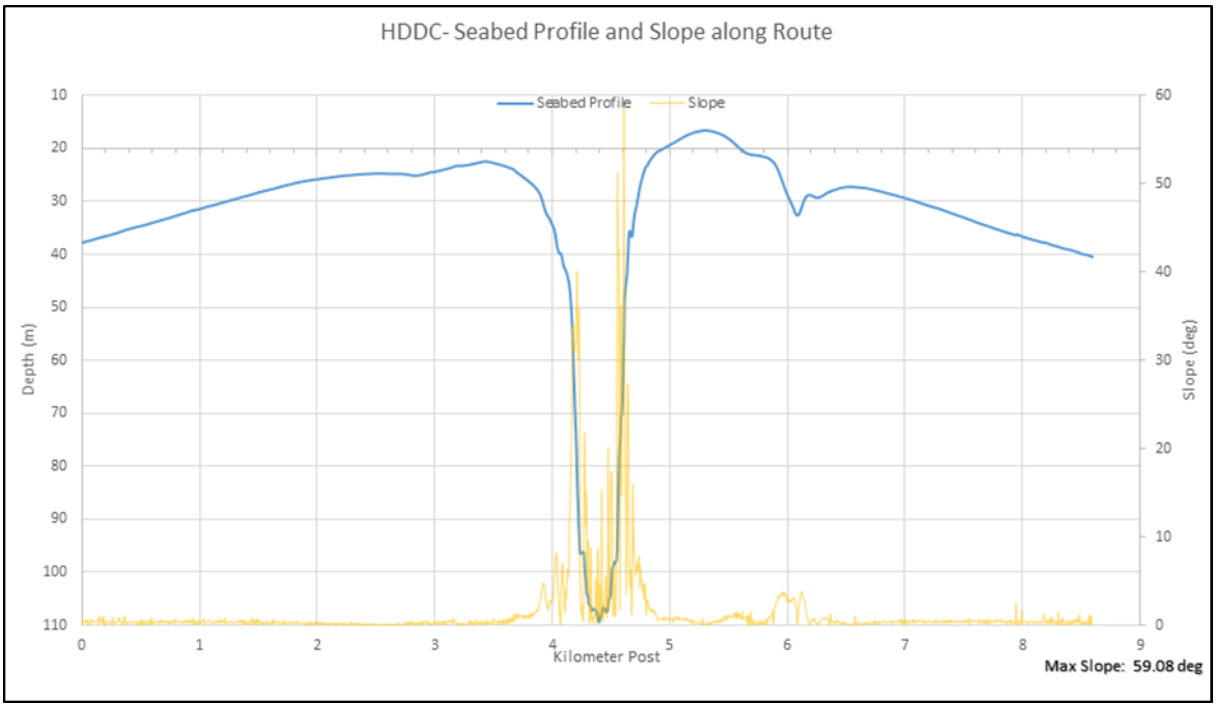

Figure 21 HDCC-Seabed profile and slope along route.

The surficial geology is composed of predominantly fine to coarse SAND/fine to medium SAND with small areas GRAVEL. Between KP 3.124 and KP 6.352 where the route is close to and crossing the steep slopes of the Capbreton Canyon, depressions/bedforms are caused by gravitational slips/slumping.

The shallow geology comprises of fine to coarse SAND/fine to medium SAND, varying from 1 to 9 m in thickness, occasionally overlaying SAND and GRAVEL, overlaying CONSOLIDATED SEDIMENT.

A summary is contained in Table 22 and more comprehensive information in Section 3|.

<u>Side Scan Sonar Contacts, Magnetic Anomalies and Gradiometer Anomalies</u>

A total of 16 SSS contacts (Phase 1), no magnetic anomalies (Phase 1) and five (5) gradiometer anomalies (Phase 2) were located within the HDCC corridor (Appendix E| and Appendix F|).

<u>Pipeline and Cable crossings</u>

No existing pipelines or cables cross the proposed route.

<u>Geotechnical Survey</u>

During Phase 2, Geotechnical investigations were performed with VC (3 samples acquired) and PCPT (6 tests acquired) along this route, including second and third attempts (Appendix P| and Appendix Q|). The sediment types identified in the geotechnical results were used to correlate the geophysical interpretations from Phase 1 with the actual results from the geotechnical survey. This gives a more detailed and accurate description of the sediments where necessary. This involved cross referencing the sediment sequences observed in the geotechnical data to the geological units observed in the SBP data. Some revisions of seabed classification were made, listed below in Table 21.

Table 21 HDCC - areas of revised seabed classification with geophysical data correlated to geotechnical results.

KP Start	KP End	Original seabed classification based on geophysical data only	Revised seabed classification with geophysical data correlated to geotechnical results
3.124	3.482	SAND and GRAVEL with depressions	SAND with depressions
4.011	4.654	SAND and GRAVEL with depressions	SAND with depressions
6.306	6.733	SAND and GRAVEL	SAND

2.9.2| CABLE ROUTE WATER DEPTH, MORPHOLOGY AND SHALLOW GEOLOGY

In Table 22 the water depth, morphology and shallow geology for the HDCC are summarised.

Table 22 HDCC route water depth, morphology and shallow geology.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
0.000	37.7	3.432	25.0	Seabed gently shoals.	From KP 0 to KP 2.717, fine to coarse SAND 3-4 m thick, overlaying SAND and GRAVEL, overlaying Consolidated sediments. KP 2.717 to KP 3.432, fine to coarse SAND, 3 m to >5 m thick, overlaying Consolidated sediments.
3.432	25.0	3.710	25.0	Seabed gently shoals to 22.5 m at KP 3.695 then dips to 25 m at KP 3.710.	Fine to coarse SAND 4 m to >5 m thick, overlaying Consolidated sediments.
3.710	25.0	4.100	42.5	Seabed dips with increasing gradient.	Fine to coarse SAND 4 m thinning to 2 m thick, overlaying Consolidated sediments.
4.100	42.5	4.396	109.5	Very steep dipping seabed.	Fine to coarse SAND along canyon floor <1 m thick, overlaying CONSOLIDATED SEDIMENT.
4.396	109.5	4.815	22.5	Very steep shoaling seabed.	Fine to coarse SAND along canyon floor 1 to 2 m thick, overlaying CONSOLIDATED SEDIMENT. Fine to medium SAND >5 m thick towards upper part of canyon wall.
4.815	22.5	5.315	16.5	Gently shoaling seabed.	Fine to medium SAND 4 m to >5 m thick, over CONSOLIDATED SEDIMENT with irregular undulating surface.
5.315	16.5	8.599	40.2	Seabed gently dipping down. Channel profile between KP 5.884 and KP 6.505 to max depth 4 m.	Fine to medium SAND, generally over 5 m thick, over CONSOLIDATED SEDIMENT with irregular undulating surface. There are a few areas where the CONSOLIDATED SEDIMENT is within 5 m of the seabed:

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
					KP 5.315–5.324, <5 m BSF (min 4 m). KP 6.021–6.085, <5 m BSF (min 3 m). KP 6.362–6.606, <5 m BSF (outcropping with channel deposit of SAND).

Side Scan Sonar Contacts and Magnetic Anomalies

A total of 16 SSS contacts, no magnetic anomalies and no gradiometer anomalies were located within the HDD Canyon corridor (Appendix E| and Appendix F|).

Pipeline and Cable crossings

No existing pipelines or cables cross the proposed route

2.9.3| HIGH LEVEL CONSTRAINTS TO CABLE ROUTING

An overview of the high constraints to cable routing for the HDCC route portions is presented in Table 23.

Table 23 Overview of HDCC route portions with high constraints to cable routing.

Overview of Route Portions with High Constraints to Cable Routing		
KP Start	**KP End**	**Comment**
3.1	3.5	Area of high sediment mobility and depressions/bedforms
3.5	5.2	Canyon – areas of steep slopes and high sediment mobility
4.0	4.7	Area of high sediment mobility and depressions/bedforms
5.5	6.4	Slopes descending into canyon (north of the route corridor)
6.3	6.7	CONSOLIDATED SEDIMENT at or near the surface

2.10| ADDITIONAL ROUTE SPANISH WATERS

2.10.1| OVERVIEW

The Additional Route Spanish Waters route (ARSW) is a 47.690 km long section that splits from the MR at KP 190.603 and re-joins it at KP 241.940 (MR KP protocol). The survey was conducted using KP Protocol specifically for the alternative route commencing with KP 0.000 and completed with KP 47.690.

The route commences at a depth of 124.6 m and proceeds to dip with undulating profile (+/-2 m) to a depth of 134.3 m at KP 7.240. It shoals very gently at first then with increasing gradient to a depth of 125 m, then dips to 125 m at KP 9.8, before dipping once more to 133.2 m at KP 11.641. The seabed very gently shoals again to a depth of 127.6 m at KP 13.326 and runs level for about 280 m then dips gently to 133.6 m at KP 14.975.

From KP 14.975 the seabed gently shoals to 127.5 m at KP 16.069 then dips to 131.5 m at KP 17.000 and runs virtually level until KP 17.889 where it gently shoals again to 126.0 m at KP 29.328. It dips with undulating profile from here to a depth of 134.2 m at KP 22.281 and continues dipping and shoaling gently between 134.2 m and 132.4 m until KP 24.162. From here the seabed dips with an irregular undulating profile to 135.2 m at KP 27.542.

From KP 27.542 the seabed gently shoals with very slight undulations to a depth of 104.2 m at KP 45.826 where it steeply shoals to a peak of bedrock at a depth of 97.6 m at KP 46.040. It then steeply dips to 102 m at KP 46.335 and then shoals 90 m at limit of survey, KP 47.690 (Figure 22 and Table 25).

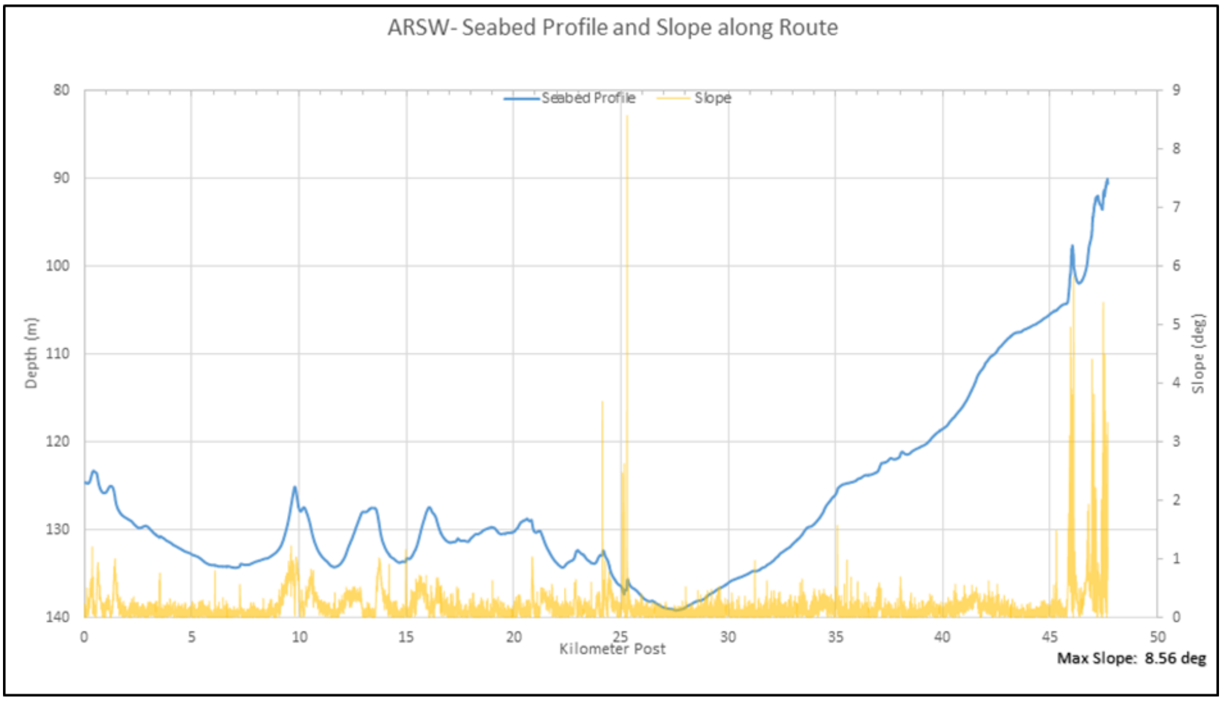

Figure 22 ARSW seabed profile and slope along route.

The surficial geology comprises for the most part of sandy CLAY with Trawl Scars, occasional small BEDROCK outcrops and isolated areas of fine to medium SAND. From KP 44.468 the surficial geology changes to fine to medium SAND with BEDROCK outcrops and areas of SAND and GRAVEL with occasional/numerous boulders.

The shallow geology consists predominantly of sandy CLAY, occasionally overlaying SILT and SAND, overlaying BEDROCK. The BEDROCK is commonly within 5 m of the seabed for most of this route, frequently subcropping to <2 m of seabed and occasionally outcropping.

A summary is contained in Table 25 and more comprehensive information in Section 3|.

<u>Side Scan Sonar Contacts, Magnetic Anomalies and Gradiometer Anomalies</u>

A total of 845 SSS contacts (Phase 1), 38 magnetic anomalies (Phase 1) and five (5) gradiometer anomalies (Phase 2) were located within the ARSW corridor and a total of (Appendix E| and Appendix F|).

Pipeline and Cable crossings

No existing pipelines or cables cross the proposed route.

Geotechnical Survey

During Phase 2, Geotechnical investigations were performed with VC (7 samples acquired) and PCPT (13 tests acquired) along this route, including second and third attempts (Appendix P| and Appendix Q|). The sediment types identified in the geotechnical results were used to correlate the geophysical interpretations from Phase 1 with the actual results from the geotechnical survey. This gives a more detailed and accurate description of the sediments where necessary. This involved cross referencing the sediment sequences observed in the geotechnical data to the geological units observed in the SBP data. Some revisions of seabed classification were made, listed below in Table 24.

Table 24 ARSW - areas of revised seabed classification with geophysical data correlated to geotechnical results.

KP Start	KP End	Original seabed classification based on geophysical data only	Revised seabed classification with geophysical data correlated to geotechnical results
0.000	9.891	SAND with trawl marks	Sandy CLAY with trawl marks
10.698	16.121	SAND with trawl marks	Sandy CLAY with trawl marks
17.022	35.175	SAND with trawl marks	Sandy CLAY with trawl marks
35.859	43.501	SAND with trawl marks	Sandy CLAY with trawl marks
43.501	44.467	SAND	Sandy CLAY

2.10.2| CABLE ROUTE WATER DEPTH, MORPHOLOGY AND SHALLOW GEOLOGY

In Table 25 the water depth, morphology and shallow geology for the ARSW are summarised.

Table 25 ARSW route option's water depth, morphology and shallow geology.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
0.000	124.6	1.640	128.0	Seabed undulating +/-2 m with dipping trend to KP 1.64 reaching depth 128 m.	Sandy CLAY 1 to 3 m thick overlying SILT and SAND >5 m thick.
1.640	128.0	3.480	130.8	Seabed gently dipping with slight undulations +/-0.5 m to depth 130.8 at KP 3.48.	Sandy CLAY 1 to 2 m BSF over SILT and SAND >5 m BSF, until KP 2.26 From KP 2.26 sandy CLAY ~1 m thick overlies BEDROCK to depths >5 m BSF.
3.480	130.8	3.525	130.8	Level seabed.	Outcropping BEDROCK.
3.525	130.8	7.240	134.3	Gently dipping seabed until KP 6.23, levelling off at 134.1 m until KP 7.23	Sandy CLAY 2 to 3 m thick over BEDROCK.

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
					Sandy CLAY thinning to 1 m BSF for 200 m either side of KP 5.50. BEDROCK subcropping <1 m of seabed from KP 7.190
7.240	134.3	11.640	133.2	Seabed level until KP 7.70 then very gently shoals to 125 m at KP 9.80 before gently dipping (with undulation of 2 m) to depth 133.2 m at KP 11.64	BEDROCK subcropping <1 m of seabed up to KP 7.300 KP 7.240-9.892, sandy CLAY 1 to 5 m thick, overlays SILT and SAND, overlays BEDROCK KP 9.892 – 10.700 fine to medium SAND 1-3 m thick, overlays SILT and SAND KP 10.700 - 11.640, sandy CLAY 1 to 2 m thick overlays BEDROCK.
11.640	133.2	14.650	133.8	Seabed shoaling to 127.5 m at KP 13.58 the dipping to 133.8 m at KP 14.65 where seabed levels off.	KP 11.640 -12.924 sandy CLAY 1 - 3 m thick overlays BEDROCK. KP 12.924 -13.751 sandy CLAY is >5 m thick. KP 13.751 - 14.650 sandy CLAY ~1 m thick, overlays BEDROCK.
14.650	133.8	16.070	127.5	Level seabed continues for 500 m then shoals to 1267.5 m at KP 16.07.	Sandy CLAY 1 to 2 m over BEDROCK until KP 15.10 where a veneer of sandy CLAY overlies fine to medium SAND >5 m BSF.
16.070	126.5	20.840	129.0	Seabed dips to 131.5 m at KP 17.00 and continues level, slightly undulating +/-2 m until KP 20.84 at 129.0 m.	Fine to medium SAND >5 m BSF up to KP 16.349. KP 16.349 – 16.903 a veneer of fine to medium SAND overlies a unit of sandy CLAY ~1 m thick, overlying fine to medium SAND. KP 16.903 – 20.160 sandy CLAY 0.5 - 2 m thick, overlaying BEDROCK. KP 20.160 - 20.840, the sandy CLAY 0.5 -2 m thick, overlies a unit of SILT and SAND.
20.840	129.0	24.130	133.0	Seabed dips to 134.3 m at KP 22.27 then shoals up to 132.3 m at KP 22.92 then undulates +/-1 m to KP 24.13.	Sandy CLAY 0.5 – 2 m thick, over BEDROCK for the majority of this section. Apparent palaeovalley/erosional channel into the BECKROCK infilled with SILT and SAND, between KP 21.05 and KP 21.30.
24.130	133.0	27.650	139.2	Seabed dips to 137 m at KP 25.080 then undulates	Sandy CLAY 0.5 – 3 m thick, overlaying BEDROCK for majority of

KP Start	W.D. (m)	KP End	W.D. (m)	Bathymetry and Morphological Features Depths relative to LAT	Shallow Geology Features
				irregularly for 300 m then continues to dip to 139.2 m at KP 27.542.	this section, with Outcropping and subcropping BEDROCK, on or near the route, between KP 24.130 – 25.310. KP 25.310 - 27.650 sandy CLAY then thickens to 2 to 3 m BSF, overlaying BEDROCK.
27.542	139.2	41.370	114.0	Seabed gently shoals to 114 m at KP 41.37	Sandy CLAY continues at 2 to 3 m thick, over BEDROCK At KP 37.10 - 38.20. sandy CLAY thins to <1 to 2 m at KP 38.20 - 41.370 sandy CLAY 2 to 3 m thick, occasionally overlaying SILT and SAND channel infill, over BEDROCK.
41.370	114.0	46.31	108.0	Seabed continues to shoal until KP 45.82 at 104 m. Then the seabed shoals steeply to 97.5 m at KP 46.040, then dips steeply to 102 m at KP 46.335	Sandy CLAY >1 m to 2 m thick overlies very irregular BEDROCK up to KP 43.878 KP 43.878 - 45.885 a veneer or fine to medium SAND/SANDY and GRAVEL, on top of sandy CLAY 2 to 4 m thick, over very irregular BEDROCK BEDROCK rises steeply and outcrops between KP 45.885 KP 46.123. From KP 46.123 a veneer of fine to medium SAND, overlies a channel in the BEDROCK, infilled with sandy CLAY >3 m BSF
46.31	108.0	47.690	90.0	Seabed shoals to depth of 90.0 m by KP 47.690, the limit of survey. The seabed surface becomes rough from KP 46.930	A veneer of fine to medium SAND, overlies a channel in the BEDROCK, infilled with sandy CLAY >3 m BSF From KP 46.926 - 47.690, BEDROCK outcrops with shallow channels 1 to 2 m deep filled with fine to medium SAND.

2.10.3| HIGH LEVEL CONSTRAINTS TO CABLE ROUTING

An overview of the high constraints to cable routing for the ARSW route portions is presented in Table 26.

Table 26 Overview of ARSW route portions with high constraints to cable routing.

Overview of Route Portions with High Constraints to Cable Routing		
KP Start	**KP End**	**Comment**
0.0	43.5	Extensive trawl marks area
2.2	7.9	BEDROCK intermittently sub cropping within 2 m of seabed and outcropping at KP 3.480 – 3.525 and at multiple places near the route.
10.6	12.0	BEDROCK sub cropping within 2 m of seabed
13.7	15.2	BEDROCK sub cropping within 2 m of seabed
16.8	26.7	BEDROCK predominantly sub cropping within 2 m of seabed, with multiple outcrops near the route and outcrops on the route between KP 24.130 – 25.310
23.5	27.0	Abundance of SSS contacts classified as objects and debris
35.1	38.7	BEDROCK intermittently sub cropping within 2 m of seabed
41.3	43.9	BEDROCK predominantly sub cropping within 2 m of seabed
44.5	47.685	Abundance of SSS contacts classified as objects and debris
44.6	46.5	Areas of occasional and numerous boulders.
45.8	46.2	Outcropping BEDROCK
46.9	47.685	BEDROCK outcropping and occasionally subcropping

2.11| SPANISH LANDFALL SITE SURVEY

2.11.1| OVERVIEW

The Spanish Landfall Site Survey was conducted by the M/V Geo Focus and Plasticbeam the end of the MR. Due to dangerous shoaling BEDROCK close nearshore the survey runlines were made offset from and across the route. Also, the two HDD route options were provided after the survey was completed, therefore, there is no KP data base with which to use as reference in the following descriptions.

2.11.2| CABLE ROUTE WATER DEPTH, MORPHOLOGY AND SHALLOW GEOLOGY

Water depths across the site vary between 1.6 m and 23.2 m. The surficial geology is mostly outcropping bedrock with veneer of SAND and GRAVEL. These deposits are depicted on the MBES data image (Figure 131). Two SBP lines were run to provide options and assess the areas where surficial sediments predominate.

The sub-surface geology comprises BEDROCK with a deposit of SAND and GRAVEL up to 2.5 m BSF situated within the mid-section of the nearshore route. The SAND and GRAVEL deposit is more extensive on the northern of the two options.

Side Scan Sonar Contacts, Magnetic Anomalies and Gradiometer Anomalies

A total of 11 SSS contacts (Phase 1), one (1) magnetic anomaly (Phase 1) and no gradiometer anomalies (Phase 2) were located within the Spanish landfall corridor (Appendix E| and Appendix F|).

Pipeline and Cable crossings

No existing pipelines or cables cross the proposed route.

Geotechnical Survey

During Phase 2, geotechnical investigations were performed with VC (1 sample acquired) and RC (2 samples acquired) along this route (Appendix P| and Appendix Q|).The sediment types identified in the geotechnical results were used to correlate the geophysical interpretations from Phase 1 with the actual results from the geotechnical survey. This gives a more detailed and accurate description of the sediments where necessary. This involved cross referencing the sediment sequences observed in the geotechnical data to the geological units observed in the SBP data.

2.11.3| HIGH LEVEL CONSTRAINTS TO CABLE ROUTING

Extensive BEDROCK predominantly outcropping, with some subcropping, throughout.

2.12| ADDITIONAL SPANISH LANDFALL SITE SURVEY

2.12.1| OVERVIEW

The Additional Survey Spanish Landfall was conducted by the M/V Olympic Delta and overlaps the MR and the Spanish Landfall Site Survey. There is no KP data base with which to use as reference in the following descriptions

2.12.2| CABLE ROUTE WATER DEPTH, MORPHOLOGY AND SHALLOW GEOLOGY

The water depths across the site vary between 11.9 m and 53.8 m. The surficial geology is mostly outcropping bedrock with veneer of SAND and GRAVEL. These deposits are depicted on the MBES data image (Figure 131).

The sub-surface geology comprises BEDROCK with veneer of SAND and GRAVEL.

Side Scan Sonar Contacts, Magnetic Anomalies and Gradiometer Anomalies

A total of 39 SSS contacts (Phase 2) were located within the Additional Survey Spanish Landfall corridor (Appendix E|). No magnetic or gradiometer surveys were carried out in the Additional Spanish Landfall Area.

Pipeline and Cable crossings

No existing pipelines or cables cross the proposed route.

Geotechnical Survey

Geotechnical investigations were not performed in this area.

2.12.3| HIGH LEVEL CONSTRAINS TO CABLE ROUTING

Extensive BEDROCK predominantly outcropping, with some subcropping, throughout.

3| DETAILED RESULTS

3.1| MAIN ROUTE

The northern section of the MR, from KP 0 at La Cantine to approximately KP 160, is situated on the South Aquitaine platform. Sedimentation on the platform is controlled by glacial cycles accelerating fluvial sedimentation from the Pyrenees and Central Massif. Much of the sedimentary environments encountered within the proposed burial depth along this section of the route are fluvial, deltaic sediment deposits. Closer to the coast these sediments have been subsequently re-worked into barrier islands and beaches during sea level regression (see references listed in Section 6|).

The survey limits for the MR are from KP -0.138 to KP 283.730, including UAV survey, dive survey, nearshore survey by M/V Geo Focus and offshore survey by M/V Franklin for Phase 1. M/V Esquina and JIF Patrol for the nearshore survey of Phase 2 as well as M/V Olympic Delta for the offshore survey of Phase 2.

The preferred MR extends around 280 km from the La Cantine landfall, on the French coast, to offshore to Lemóniz in Spain. It crosses a deep canyon close to Capbreton and it has been subdivided in MR North and MR South either side of the canyon. See Figure 4 for overview.

3.1.1| POSITIONING

The calibrations and positioning test were carried out prior to any data collection phases. The results of these are presented in the MAC reports located in Appendix C|. Underwater positioning can be affected by pycnoclines and thermoclines that exist within water columns containing two or more bodies of water with differing densities and temperatures. The SSS images were indeed affected by these phenomena although the underwater positioning system for the ROTV functioned according to specification.

3.1.2| BATHYMETRY

The limits of data collected for the MR are KP -0.138 to KP 283.730.

KP-0.138 to KP 1.060: KP -0.138 to KP 0.584 were acquired by UAV. KP 0.542 to KP 1.030 were acquired by diver survey. From KP 1.030 to the end of the route bathymetric data were acquired aboard the M/V Geo Focus and M/V Franklin. The first part of the MR is on land and characterised by undulating topography and sand dunes with intermittent vegetation. Maximum height is -28.5 m.

KP 1.060 to KP 20.035: Along the initial east to west nearshore section of the MR, the water depth increases from 5.0 m at KP 1.060 to 11.5 m at KP 1.250 (Figure 23). The water then deepens further; to 23.5 m at KP 4 and again to 32.5 m by KP 12.500, at this location the route turns south. From the turn the seabed dips very gently to a depth of 34.0 m at KP 20.035. The depths gradually increase from the beginning of the route until KP 20, exhibiting a relatively flat seabed– except for a few slopes and depressions at KP 13.00 (Figure 24). From KP 20.00 to KP 20.80, there are two depressions at 40 m water depth - the most northern one is about 300 m long and the second one is about 215 m long (Figure 25). Both of them are approximately 80 m wide and dips 1 m.

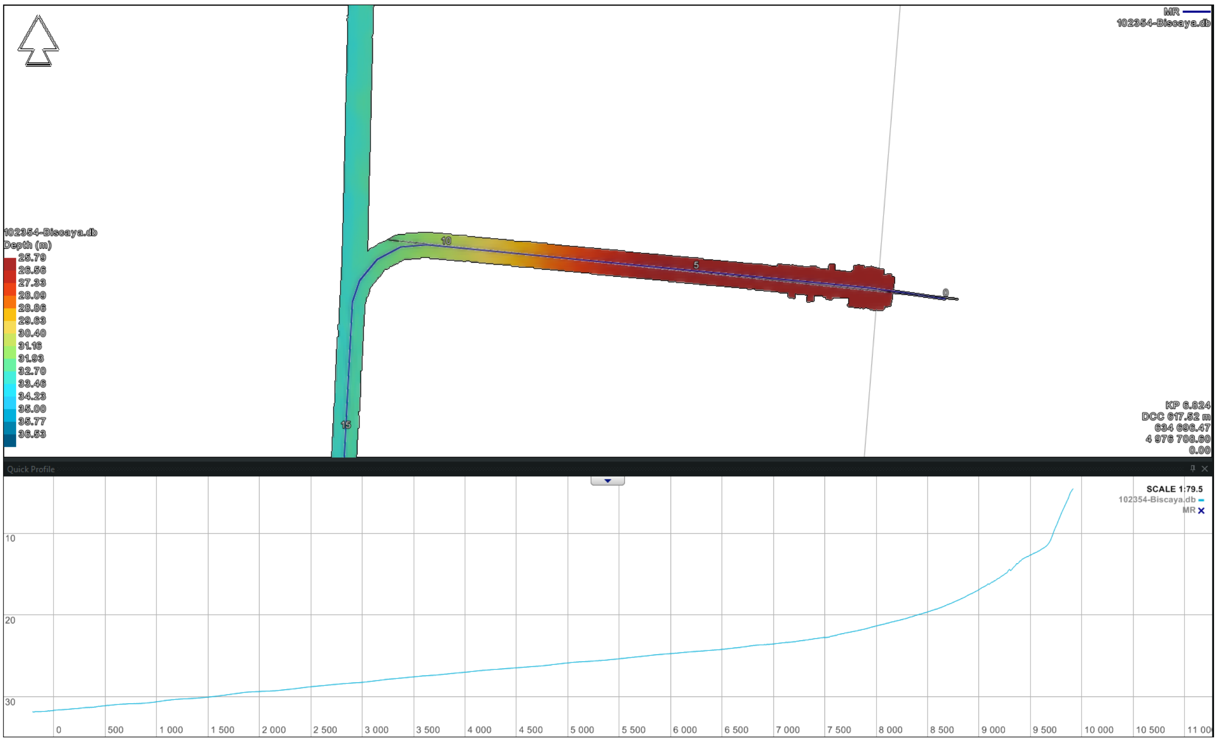

Figure 23 Overview of La Cantine landfall with significant depth increase, KP 1.07 to KP 10.80.

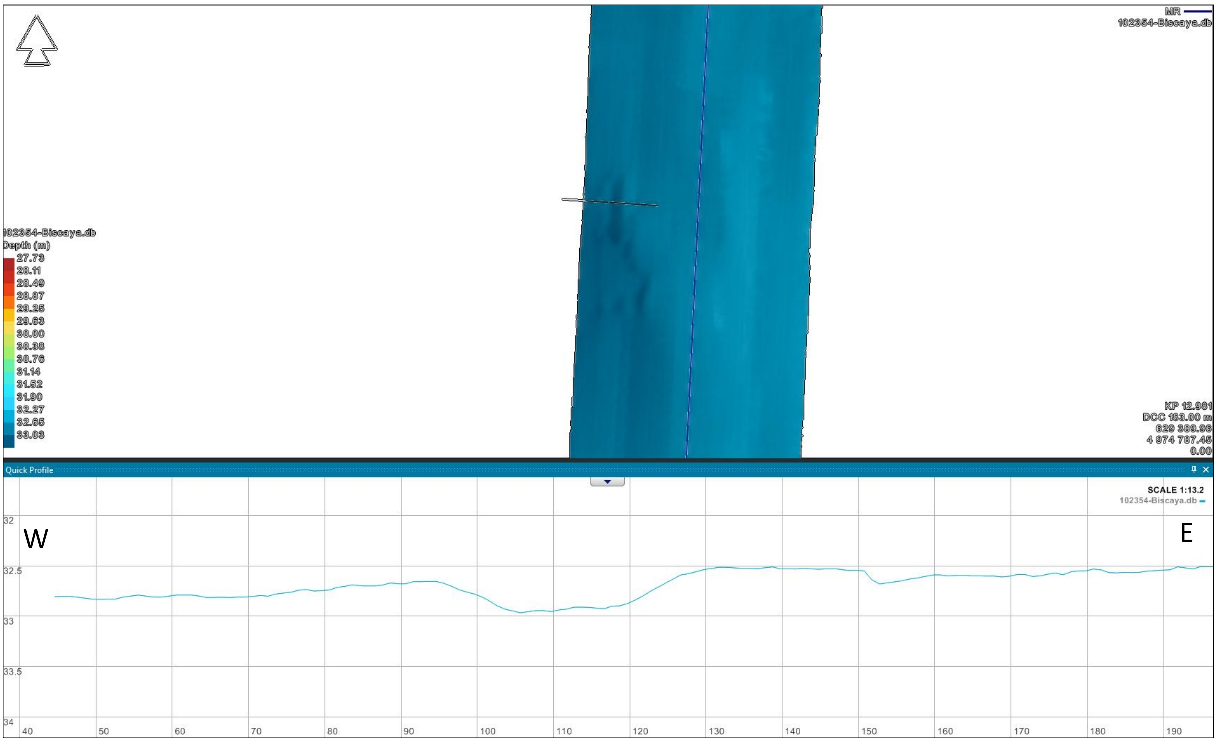

Figure 24 MR shaded bathymetric depression at KP 13.00.

<u>KP 20.035 to KP 22.724:</u> The route heads in a southward direction over undulating seabed (+/-1 m) for the initial 800 m (Figure 25 and Figure 26) and the seabed continues in a very gently dip, reaching a depth of 36.5 m before starting to shoal with increasing KP. A depression is situated at KP 22.85 (Figure 26). It crosses the route diagonally, it is 800 m long, 100 m wide and 60 cm to 80 cm deep.

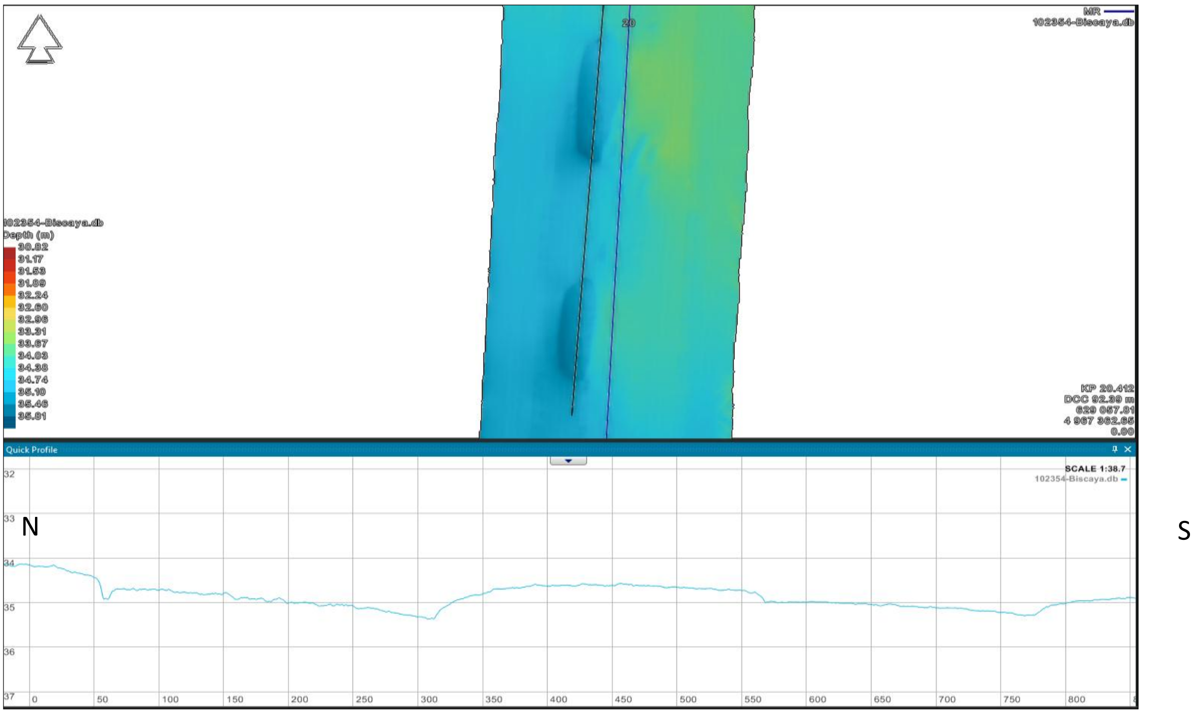

Figure 25 MR shaded bathymetric depression from KP 20.00 to KP 20.80.

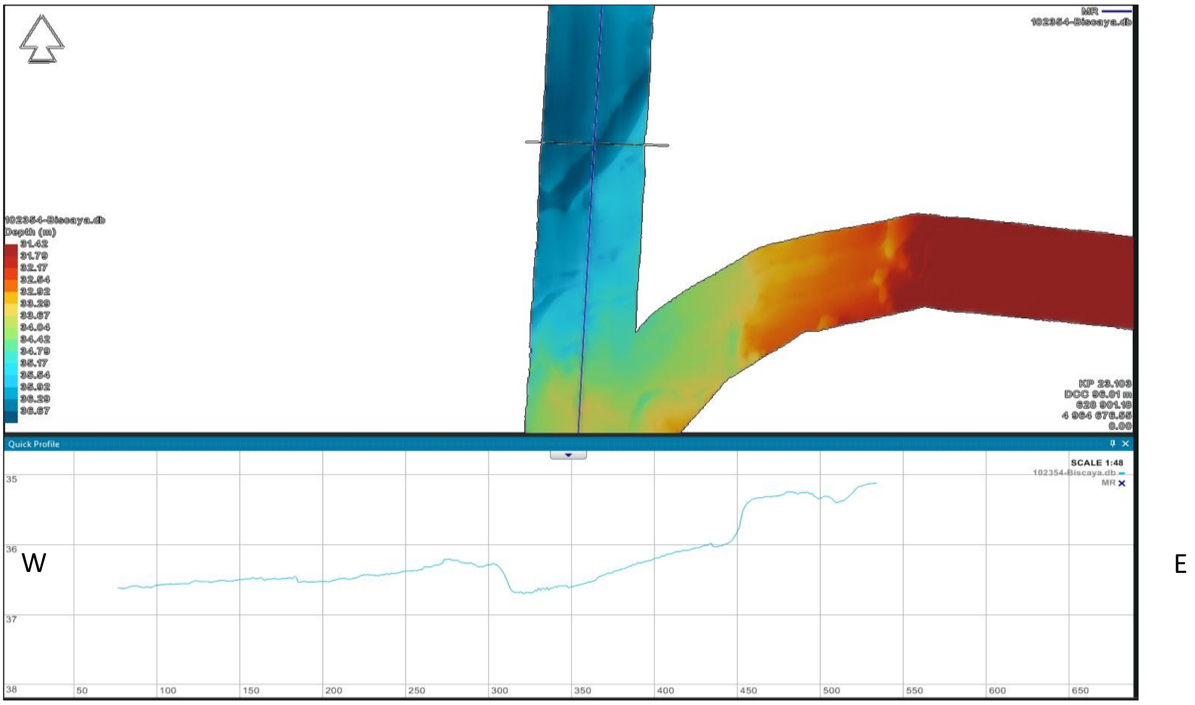

Figure 26 MR shaded bathymetric relief at KP 22.85.
Profile showing shallow depression crossing route corridor.

KP 22.724 to KP 30.345: The route maintains its southward direction and the seabed continues to shoal very gently until reaching a depth of 30.6 m at KP 30.345. It is reasonably undulating in nature between KP 22.724 and KP 26.831 (Figure 27) then becomes relatively smooth again.

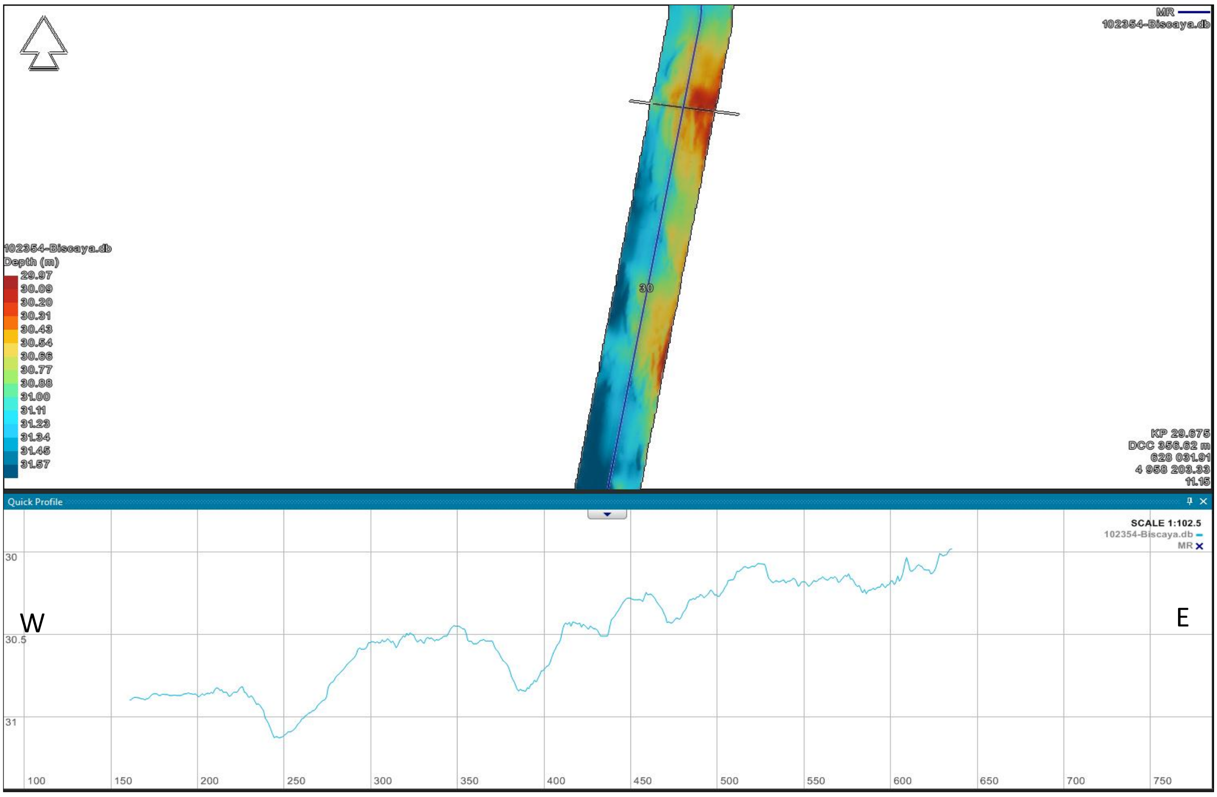

Figure 27 MR uneven seabed feature at KP 29.67.
The relatively rough nature of the route coincides with an exposed patch of SAND and GRAVEL.

KP 30.345 to KP 43.485: The seabed generally dips very gently with irregular undulations of +/-1 m amplitude to a depth of 43.0 m.

KP 43.485 to KP 47.648: The seabed continues to generally dip gently and is occasionally furrowed between the surficial SAND deposits. These persist to a depth of 48.0 m

KP 47.648 to KP 86.205: Seabed continues to very gently dip until levelling off at KP 55.505 at a depth of 51 m, then continues level until KP 54.264. Also within this section from KP 50.00 to KP 54.281, the seabed depth varies between 49.5 m and 51.4 m in response to the occurrence of mobile “dune like” SAND bedform deposits. It then starts to very gently shoal with the same irregular profile at first and becoming slightly undulating with a decreasing occurrence of SAND deposits to a depth of 44.8 m at KP 64.060 (Figure 28). From this point it begins to shoal again very gently until KP 67.360, then it levels off at 42.2 m and very gently undulates +/-1 m either side of 42 m until KP 86.205 where it starts to gently dip.

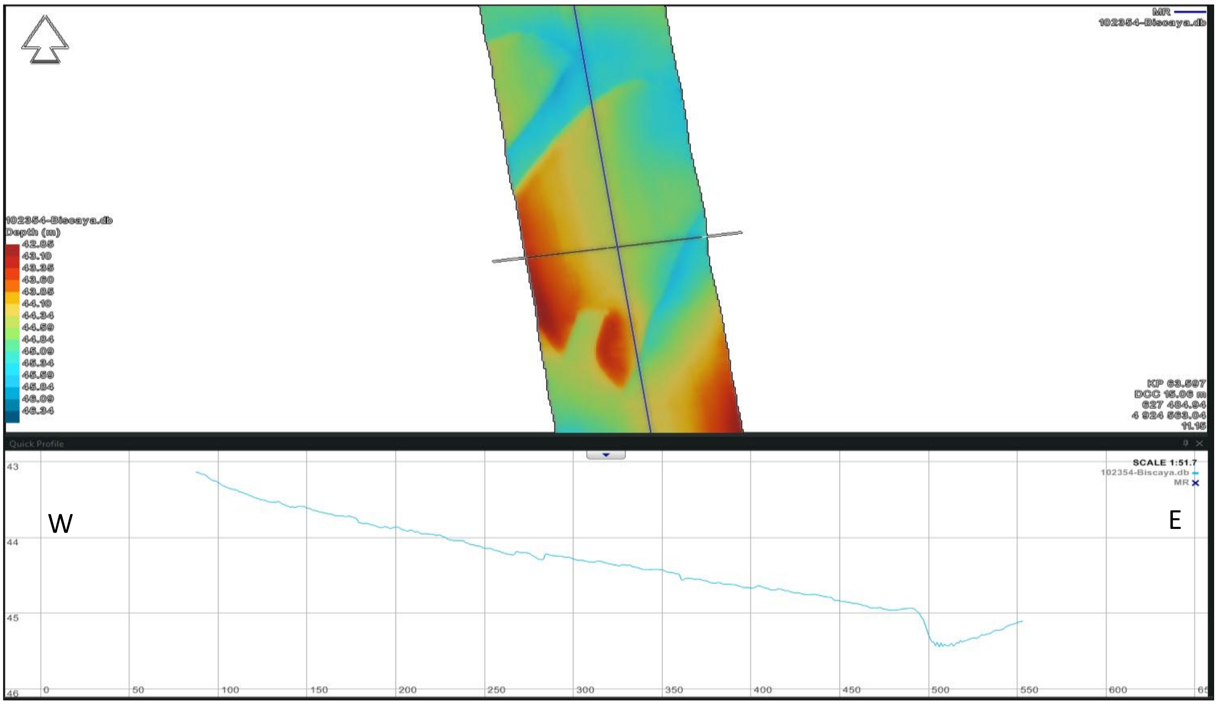

Figure 28 MR shaded bathymetric view of the dune like SAND bedforms KP 63.60.

<u>KP 86.205 to KP 132.050:</u> The bathymetry continues to be affected by the large, randomly spaced deposits of fine to medium SAND that has formed into “dune like” bedforms, 1 to 2 m thick (Table 8). The average water depth continues at around 43.0 m at KP 95.000 then gently dips to 46.0 m by KP 102.900 and continues at this level until KP 105.894. The irregular seabed profile is again in response to SAND bedforms of 1 to 2 m amplitude (Figure 29).

From KP 105.894 the seabed gently dips to 49.0 m and continues level from KP 109.000. Irregular seabed profile is in response to the surficial bedforms. From KP 115.557 the seabed very gently shoals with a very irregular undulating (+/-2 m) profile in response to the dune like SAND bedforms. The average seabed depth at KP 122.000 is 46.0 m and the irregularly undulating seabed continues in response to SAND bedforms until KP 132.060 where these large scale bedforms dissipate.

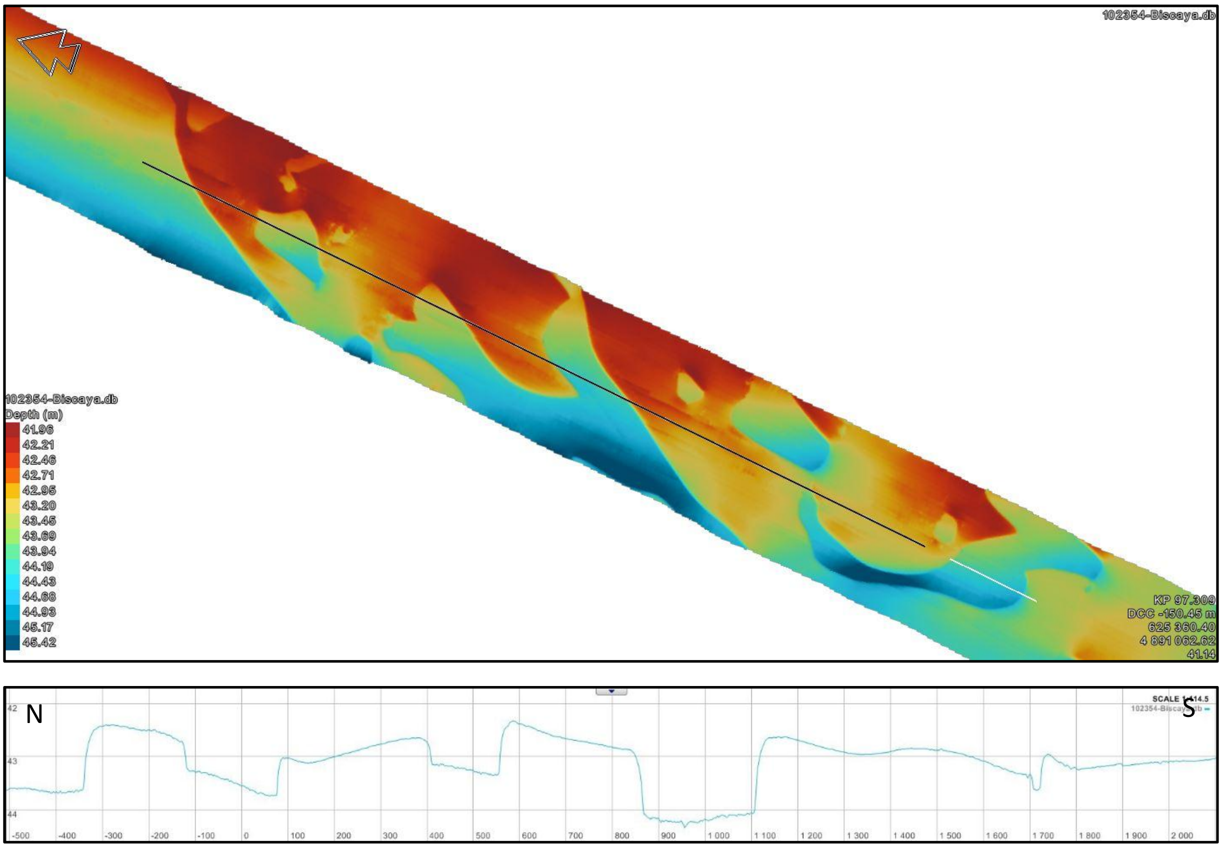

Figure 29 MR overview of area with "dune like" sand bedforms around KP 90.00.

<u>KP 132.050 to KP 150.480:</u> The seabed very gently shoals and undulates, +/-1 m, from an average depth of 45 m. It gently shoals further from KP 136.346 to 39.8 m at KP 139.975. The seabed then gently dips to a depth of 42.5 m at KP 142.406 and then again shoals very gently undulating to a depth of 38.8 m at KP 150.480.

<u>KP 150.480 to KP 156.420</u>: The seabed shoals relatively quickly then levels off at KP 154.765 at a depth of 3.5 m. The route traverses the head of the Capbreton Canyon between KP 155.5 and 156.7 (Figure 30), it dips down steeply to a depth of 14 m then back up to 5 m at KP 155.834, shoals a bit more than a metre and then dips to 6.0 m along the edge of the canyon at KP 156.27. Again, the seabed dips steeply to 13.8 m and then shoals steeply to 5.3 m at KP 156.845 (Figure 31).

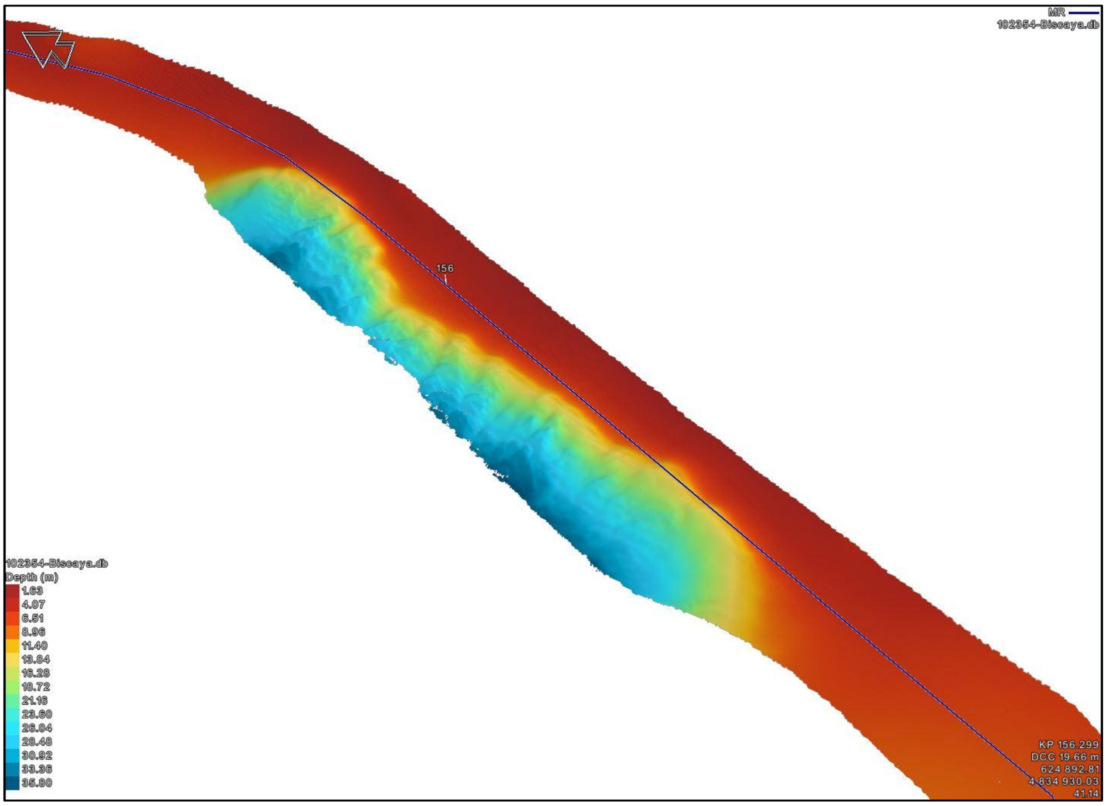

Figure 30 Overview of the Canyon Head Bypass section of the MR between KP 155 and KP 157.

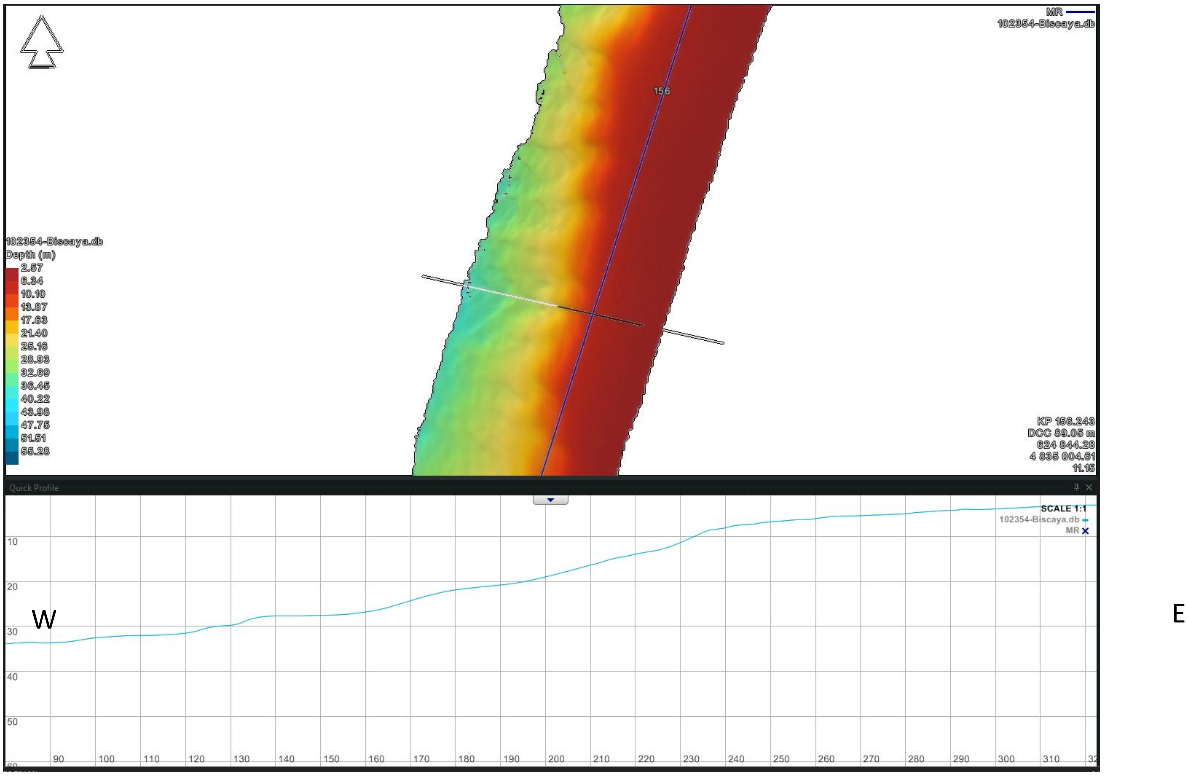

Figure 31 MR shaded bathymetric view of edge of canyon around KP 156.00.

<u>KP 156.420 to KP 170.186:</u> The seabed dips down relatively steep from a depth of 5 m to reach a depth of 94.5 m at KP 170.186.

<u>KP 170.186 to KP 179.832:</u> The seabed is relatively smooth and gently dips until KP 170.660 where it irregularly undulates until KP 171.374 and becomes relatively smooth. It continues to gently dip with slight undulations, +/-1 m, until a depth of 119 m at KP 179.832, where the seabed levels.

<u>KP 179.832 to KP 191.110:</u> The relatively level seabed starts to very slightly undulate from KP 180.305 +/-1 m from a depth of 120 m. The undulations randomly increase and the seabed dips down to a depth of 123.8 m at KP 182.757. The seabed starts to very gently shoal to a depth of 120.9 m at KP 185.824 then dips with a slightly undulating profile to a depth of 129 m at KP188.360. The seabed remains level at this depth until KP 188.995 when it begins to shoal gently to a depth of 123 m at KP 191.110.

<u>KP 191.110 to KP 203.638</u>: The seabed dips gently to a ridge of outcropping BEDROCK lying between KP 192.275 and KP 192.490 at a depth of 125.5 m to 128.5 m. The seabed continues virtually level until KP 194.500 where it starts to gently shoal to a depth of 117.1 m at KP 198.180. It dips further to 128.2 m at KP 199.495 then shoals to 115 m at KP 201.263 with slight undulations. The seabed dips to 121.3 m at KP 202.207 the shoals with a 2 m undulation to 119 m at KP 203.638.

<u>KP 203.368 to KP 218.970:</u> The seabed dips gently to a depth of 122.2 m at KP 205.405 with slight undulations, +/-1 m. The seabed irregularly shoals over outcropping BEDROCK to a depth of 113.8 m at KP 206.228. It then dips steeply down the side of outcropping BEDROCK then more gently to a depth of 122.5 m at KP 208.252 where it levels off before gently shoaling to a depth of 116.8 at KP 210.283. The seabed very gently dips to 120.1 m at KP 211.569 and continues level for 525 m then gently shoals to 116.8 m at KP 214.258. It remains at this depth, with very slight undulations until KP 218.970, where BEDROCK outcrops.

<u>KP 218.970 to KP 236.590:</u> The seabed shoals, initially irregularly over BEDROCK then gently to a depth of 109.6 m at KP 220.320. It then dips very gently to a depth of 111.0 m at KP 226.026, continues level for 300 m then starts to very gently shoal with very gentle undulations, +/-1 m, to a depth of 102.1 m at KP 236.590.

<u>KP 236.590 to KP: 239.812</u>: The seabed very gently slopes down 1 m then shoals very gently back to 102 m at KP 238.500. It then shoals more quickly to a depth of 95.5 m at KP 239.159 before continuing with irregular undulations, +/-1 m, either side of this depth until KP 239.812, to 96 m.

<u>KP 239.812 to KP 248.773</u>: The seabed exhibits a very irregular surface as it generally shoals to a depth of 85 m at KP 242.042 and continues randomly over rough terrain to within 1 m of this depth until KP 243.035 where is dips down relatively steeply to a depth of 95.7 m at KP 244.072. The profile in Figure 26 illustrates the rough seabed. It then very gently undulates to KP 244.655 between 95 m and 96 m then more irregularly as it shoals to a depth of 86.5 m at KP 246.669. The seabed exhibits a rough profile as it irregularly dips down to a depth of 95.4 m at KP 248.579 and continues irregularly undulating, +/-0.5 m, to KP 248.773 (Figure 33).

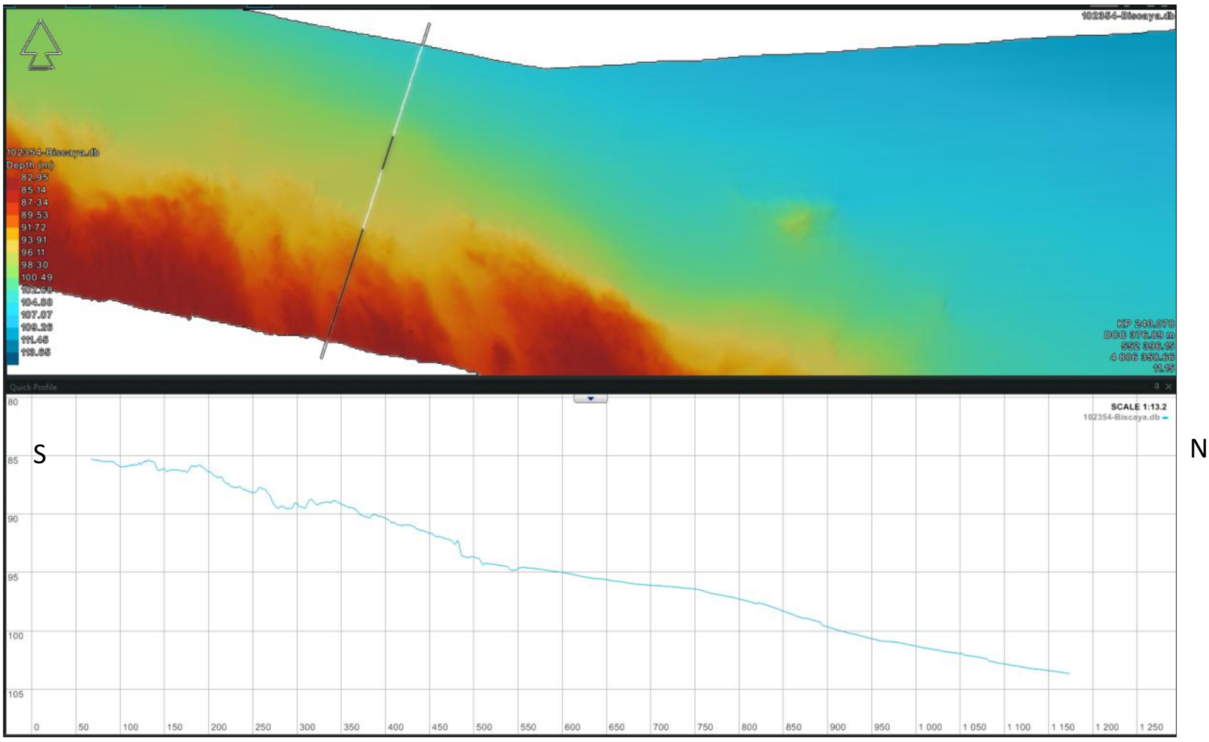

Figure 32 Shaded bathymetric relief of bedrock and rough seabed profile at KP 240.00.

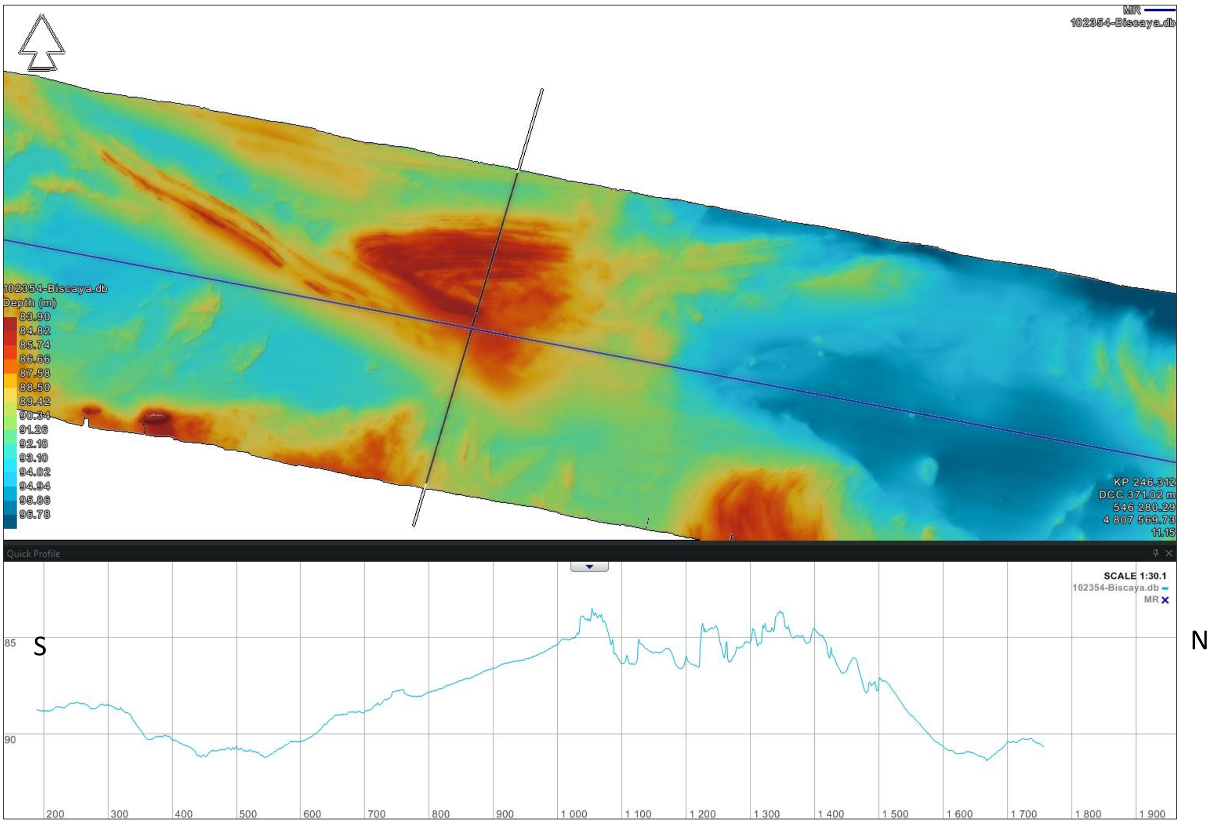

Figure 33 Shaded bathymetric relief of outcropping bedrock.
The section line across the route is at KP 246.31.

KP 248.773 to KP 257.970: The seabed continues to shoal over very irregular seabed to a depth of 86 m at KP 250.515. It then slopes down with undulations, +/-2 m, to a depth of 92.2 m at KP 252.094 and continues almost level for 1000 m. From here it starts to very gently shoal with slight undulations (+/- 1.5 m) to a depth of 89.5 m at KP 254.360. It then continues level with slight undulations to KP 256.880 where it shoals to a depth of 82.7 m at KP 257.763, it then dips very gently to KP 257.970.

KP 257.970 to KP 272.693: The seabed shoals very steeply to a depth of 72.1 m at KP 258.102, then continues very irregularly between 72 m and 75 m to KP 259.315 where it begins to dip with an uneven surface to a depth of 78.2 m at KP 260.773. It then shoals with a very irregular surface to a depth of 75 m at KP 261.815, then continues to shoal with smooth surface to a depth of 46.5 m at KP 265.500. It then dips down gently to 50 m at KP 272.693.

KP 272.693 to KP: 283.278: The very irregular seabed generally shoals reaching a depth of 72 m at KP 276.201. It continues level undulating gently until KP 278.000 when it dips from a depth of 73 m to 77 m at KP 278.500. It runs level at this depth, then shoals very irregularly to a depth of 24.5 m at KP 283.278, the limit of the survey (Figure 34).

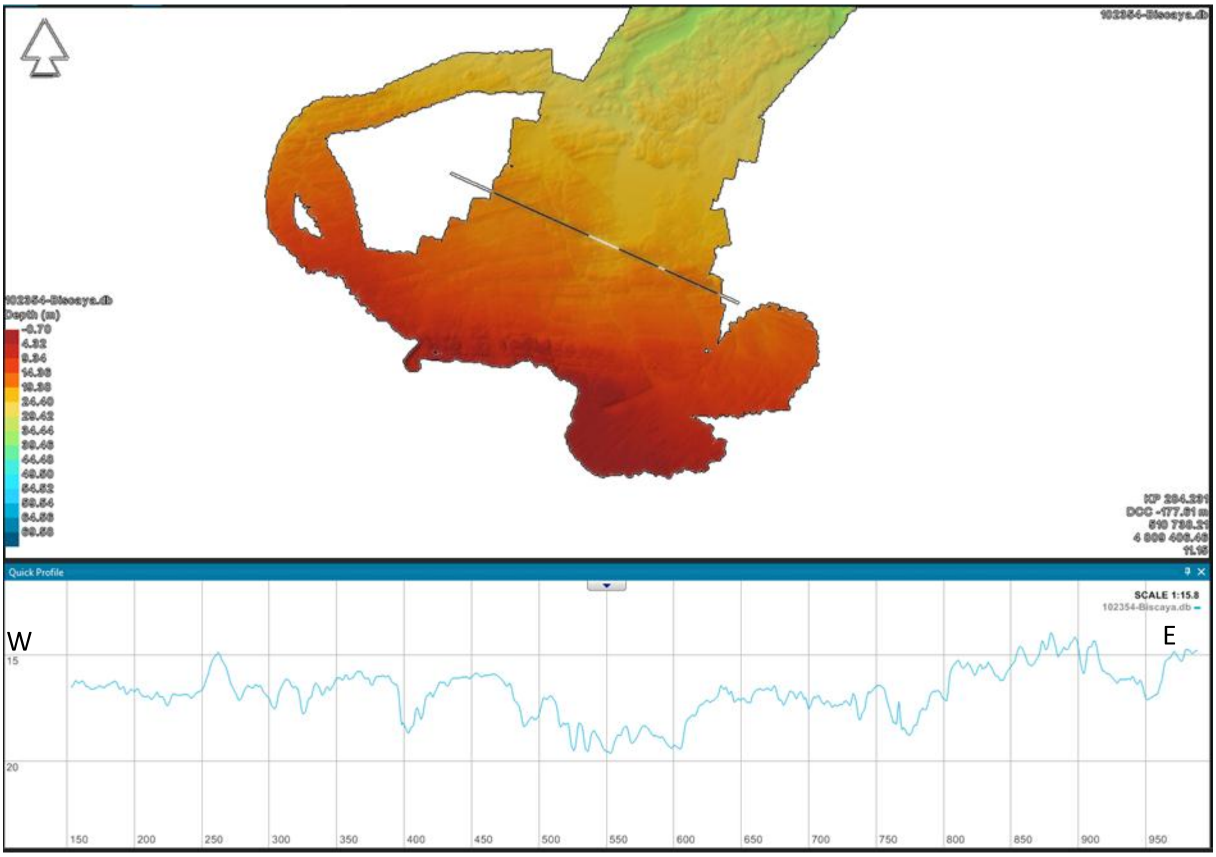

Figure 34 Bathymetric overview illustrating the rough seabed along the approach to the Spanish landfall, KP 282.

3.1.3| SURFICIAL GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

The limits of data collected for the MR are KP -0.138 to KP 283.730.

KP-0.138 to KP 1.060: KP -0.138 to KP 0.584 were acquired by UAV. KP 0.542 to KP 1.030 were acquired by diver survey. The surface geology is characterised by SAND with intermittent vegetation, with an increasing KP the vegetation disappears and SAND covers the entire surveyed area.

KP 1.060 to KP 20.035: The surficial geology along this section is made up of the following surficial sediments; SILT and fine SAND, fine to medium SAND with ripples and fine to medium SAND (Figure 35).The surface geology of the nearshore La Cantine landfall from around KP 1.06 to KP 1.24 mainly comprises fine to coarse SAND. From KP 1.24 to KP 1.89 it becomes fine to coarse SAND with Ripples overlain by mobile SILT and fine SAND. The very coarse SAND fraction comprises of shell components. The ripples have a wavelength 0.3 to1.0 m, orientated in a NNE-SSW direction and are likely caused by the water movements from tide, current and wave action.

From KP 3.29, where the offshore section of the MR begins, the seabed sediments are interpreted to be featureless fine to medium SAND until KP 8.10. From here until around KP 15.500 ripples are observed in the fine to medium SAND with wavelength 0.3 to 1.0 m and an orientation of NNE-SSW direction (Figure 36). Within this section there are a few isolated depressions in the SAND. Inside these depressions is a surficial cover of coarser sediments that is comprised of SAND and GRAVEL with ripples. The ripples have a longer wavelength than those outside the depressions, 0.5 to 1.5 m, which are also orientated in a NNE-SSW direction.

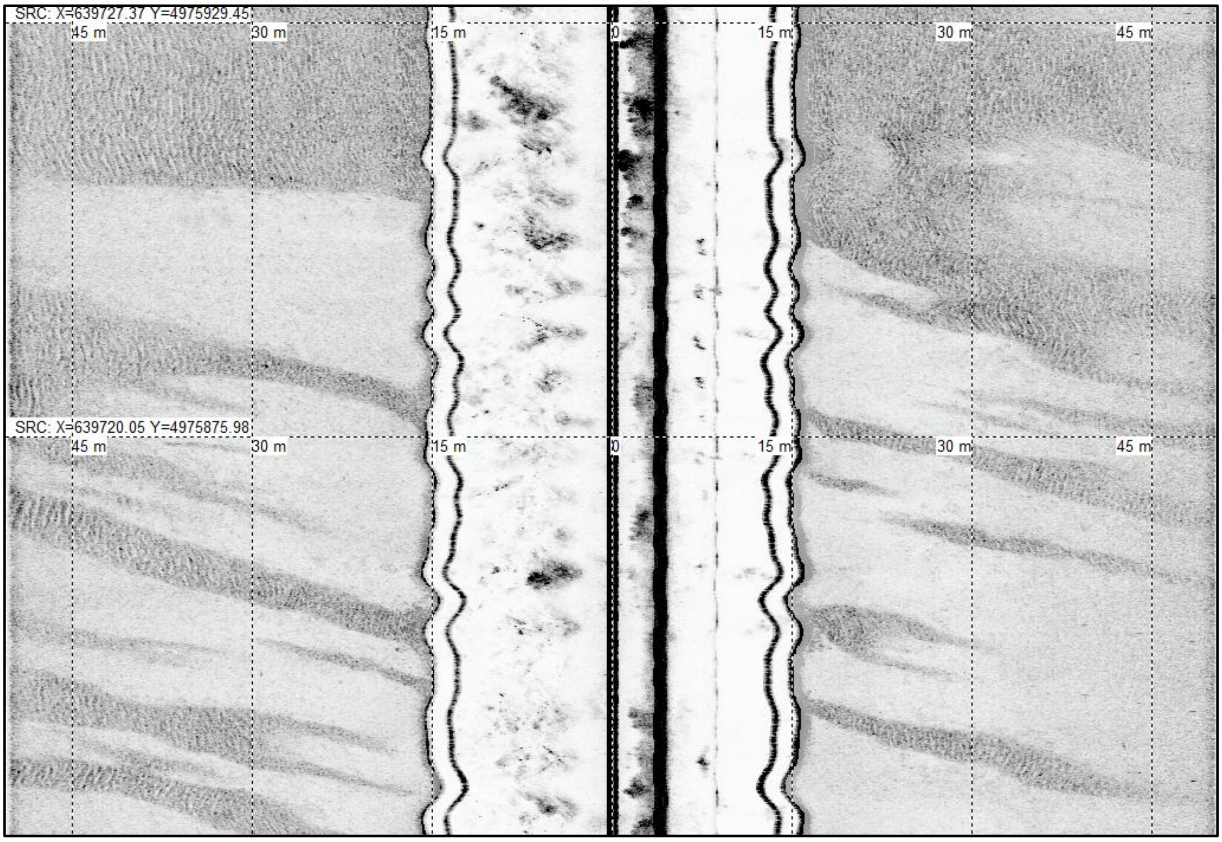

Figure 35 SSS data image from La Cantine at KP 1.70. Illustrating surficial sediments of fine to coarse SAND with ripples overlain by SILT and fine SAND.

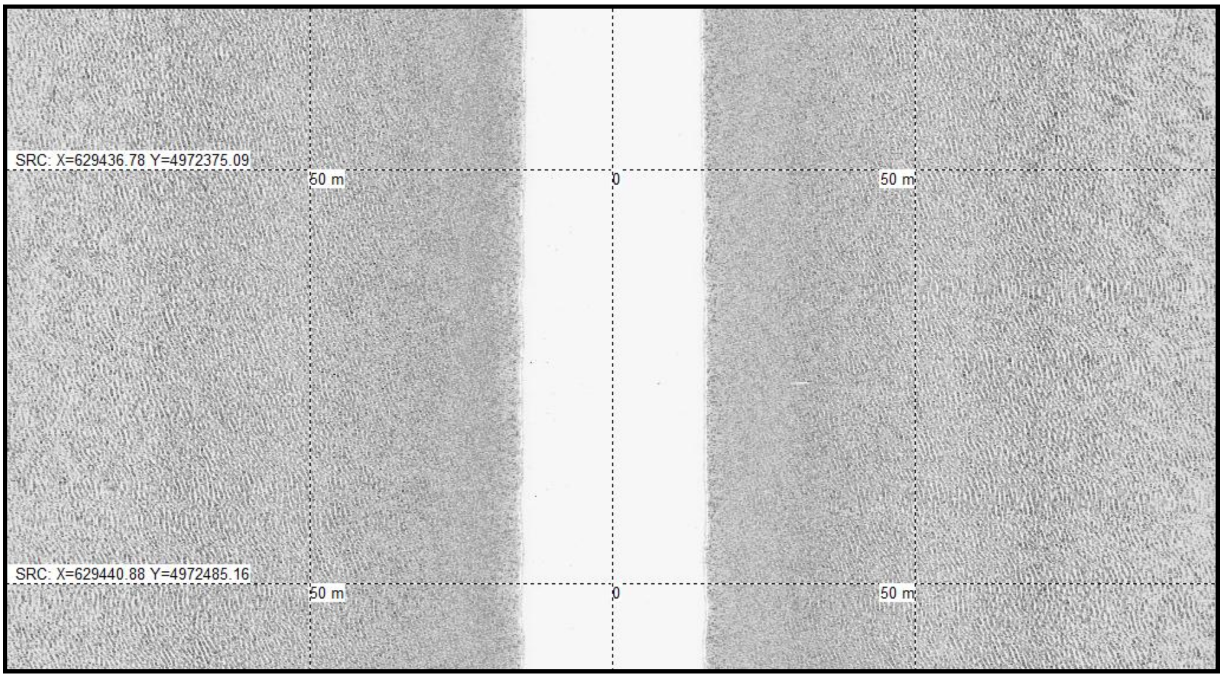

Figure 36 SSS data image of fine to medium SAND with ripples at KP 15.50.

KP 20.035 to KP 22.724: The surficial geology comprises rippled fine to medium SAND with occasional patches of SAND and GRAVEL.

KP 22.724 to KP 30.345: The surficial geology is made up initially by SAND and GRAVEL with ripples up to KP 26.831, with occasional patches of rippled fine to medium SAND (Figure 37). These coincide with the relatively rough seabed texture. The fine to medium SAND forms distinct large scale mobile bedforms and ribbons. The surficial geology becomes predominantly rippled fine to medium SAND with very occasional exposed deposits of SAND and GRAVEL. The SAND and GRAVEL is characterised with ripples that have a wavelength of 0.5-1.3 m and orientated ESE-WNW. Of note are the distinct boundaries between sediment types, the basal SAND and GRAVEL rippled where exposed overlain by fine to medium SAND 1 to 2 m thick.

Figure 37 SSS data image at KP 25.70 illustrating SAND and GRAVEL with ripples.

KP 30.345 to KP 43.485: The surficial geology sees a continuation of rippled fine to medium SAND with very occasional SAND and GRAVEL patches, as above in Figure 37.

KP 43.485 to KP 47.648: The surficial geology comprises extensive furrowed fine to medium SAND bedforms. These large scale bedforms are intersected with patches of rippled SAND or GRAVEL (Figure 38).

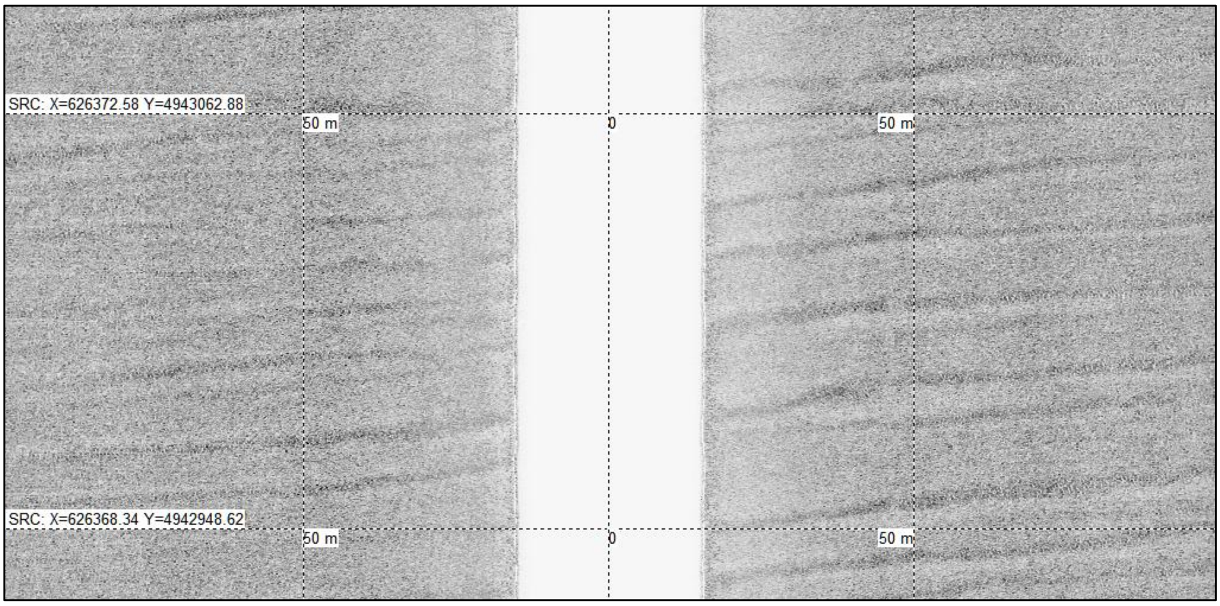

Figure 38 SSS data image of elongated furrowed fine to medium SAND deposits at KP45.00.

KP 47.648 to KP 64.055: The surficial geology comprises of sediments that are predominantly rippled SAND and GRAVEL with isolated patches of fine to medium SAND. These mobile surficial sediments form dune like bedforms (the morphology of which is described in detail in Mazières *et al.* 2015). The extension of these formations can be several hundred metres at times.

KP 64.055 to KP 83.191: The surficial geology comprises rippled SAND and GRAVEL, whilst from KP 66.669 where numerous trawl scars extend across the route (Figure 39) until KP 79.690.

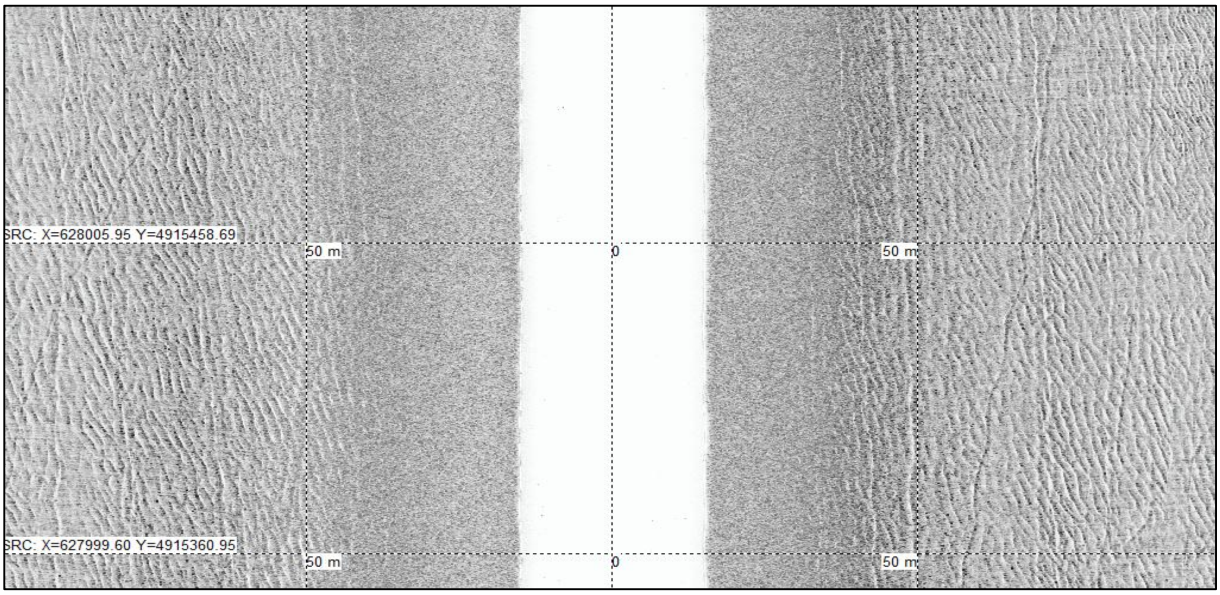

Figure 39 SSS data image of SAND and GRAVEL with ripples, and SAND with numerous trawl scars from KP 72.810.

KP 83.191 to KP 143.932: The surficial geology comprises of sediments that are predominantly rippled SAND and GRAVEL with isolated patches of fine to medium SAND. These mobile surficial sediments form dune like bedforms (the morphology of which is described in detail in Mazières *et al.* 2015). The extension of these formations can be several hundred metres at times, see Table 8 for positional details. The fine to medium SAND formations become furrowed between the following intervalls:

- KP 89.352- KP 89.590
- KP 117.335-KP 118.522
- KP 120.143-KP 121.152
- KP 121.732-KP 122.005
- KP 12.252-KP 122.734
- KP 123.158-KP 124.462
- KP 129.269-KP 129.936
- KP 131.182- KP 131.500
- KP 133.735-KP 134.310
- KP 141.101-KP 143.284
- KP 143.279 - KP 143.932

Occasional outcropping Coarse Sediments associated with a dense sub-unit of SAND and GRAVEL. Are present between KP 133.735 and KP 134.310 (Figure 40).

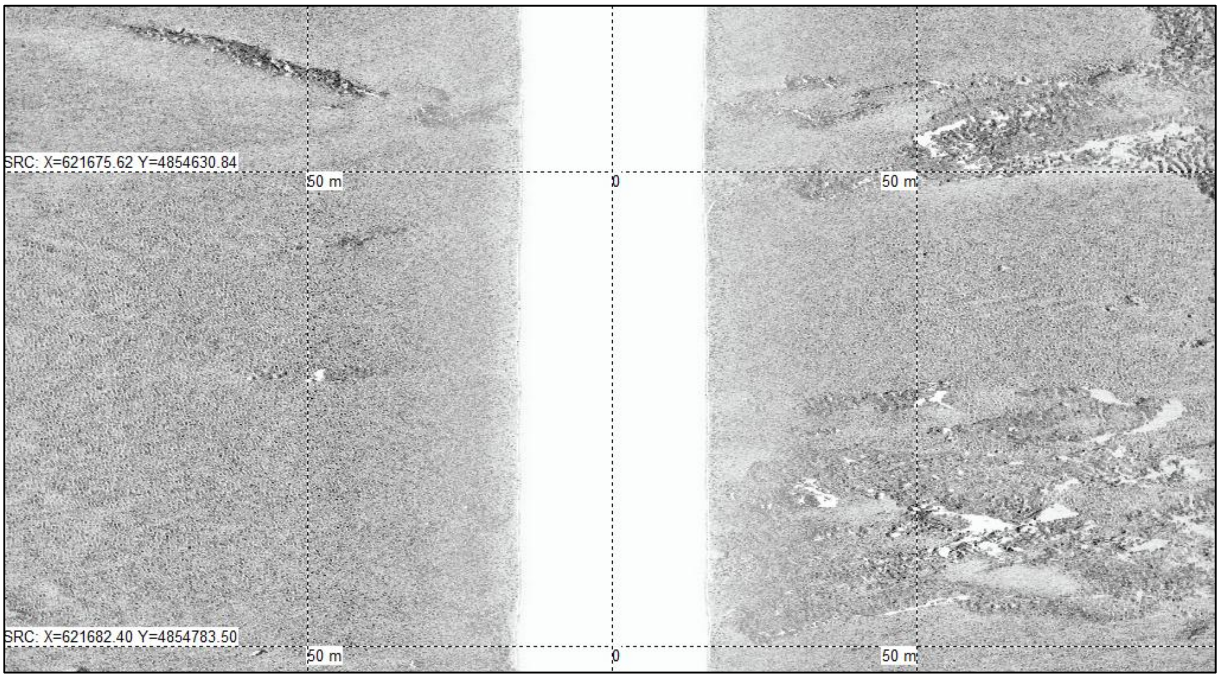

Figure 40 SSS data around KP 134.00. SAND and GRAVEL with outcropping Coarse Sediment with numerous boulders.

KP 143.932 - KP 156.420: The surficial geology is composed of generally featureless fine to medium SAND, except for some small isolated areas of the outcropping CONSOLIDATED SEDIMENT. These outcrops are observed at KP 146.20, 250 m east of the planned route and KP148.12, 100 m and 160 m to the west of the planned route. From around 150.480 the SAND transitions to Fine to Coarse, which becomes fine to coarse SAND with large ripples at KP 154.165 until KP 155.404, where fine to coarse SAND with ripples is observed (Figure 41).

Canyon Head Bypass Coast Option: CHBC of the route comprise of Fine to Coarse SAND, with a variety of ripple sizes ranging from ripples to large ripples and with varying orientation and compaction. Between KP 154.17 and KP 155.41 the sediments mostly comprise fine to coarse SAND with large ripples, wavelength 5.0 to 7.0 m, with small patches of fine to coarse SAND with ripples, wavelength 1.0 to 2.0 m.

From KP 155.41 to KP 156.420 the sediment becomes fine to coarse SAND with ripples, wavelength 0.5 to 3.0 m (Figure 41). Within this area, between KP 155.41 and KP 156.420, the western edge of the corridor is characterised by the steep slopes into the Capbreton Canyon resulting in bedforms caused by gravitational slips/slumping (Figure 42) the slope/slump deposits are more apparent on the MBES bathymetry (Figure 31).

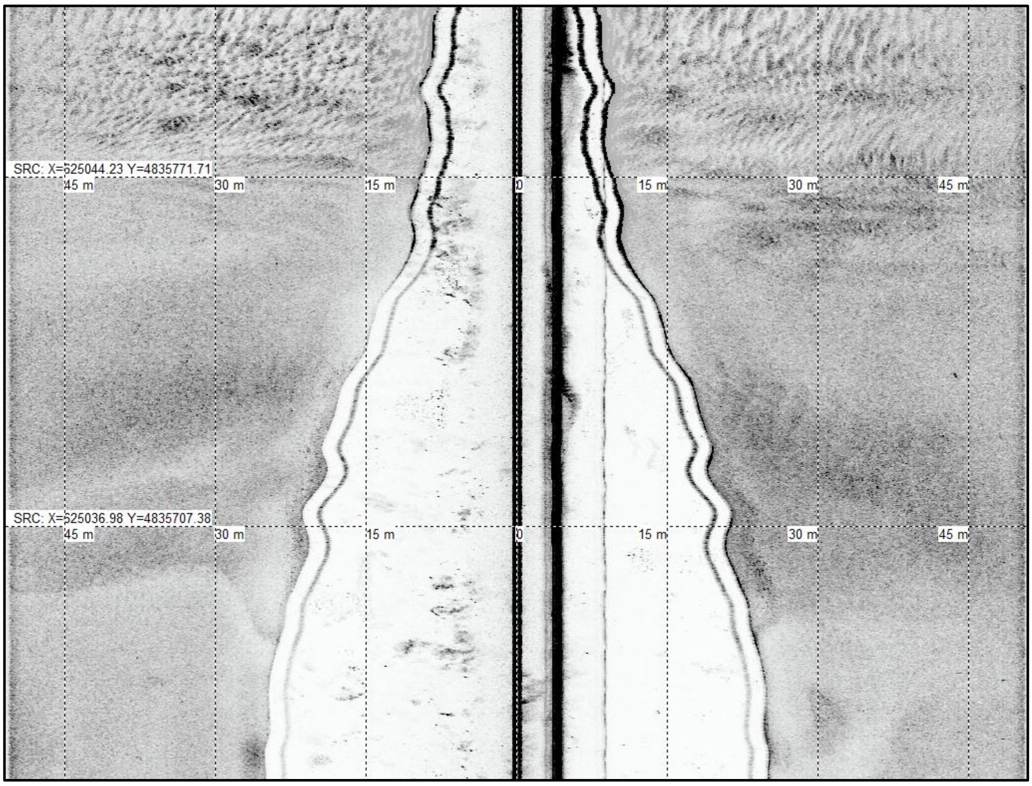

Figure 41 SSS data image of rippled sediments along the edge of the canyon at KP 155.50.

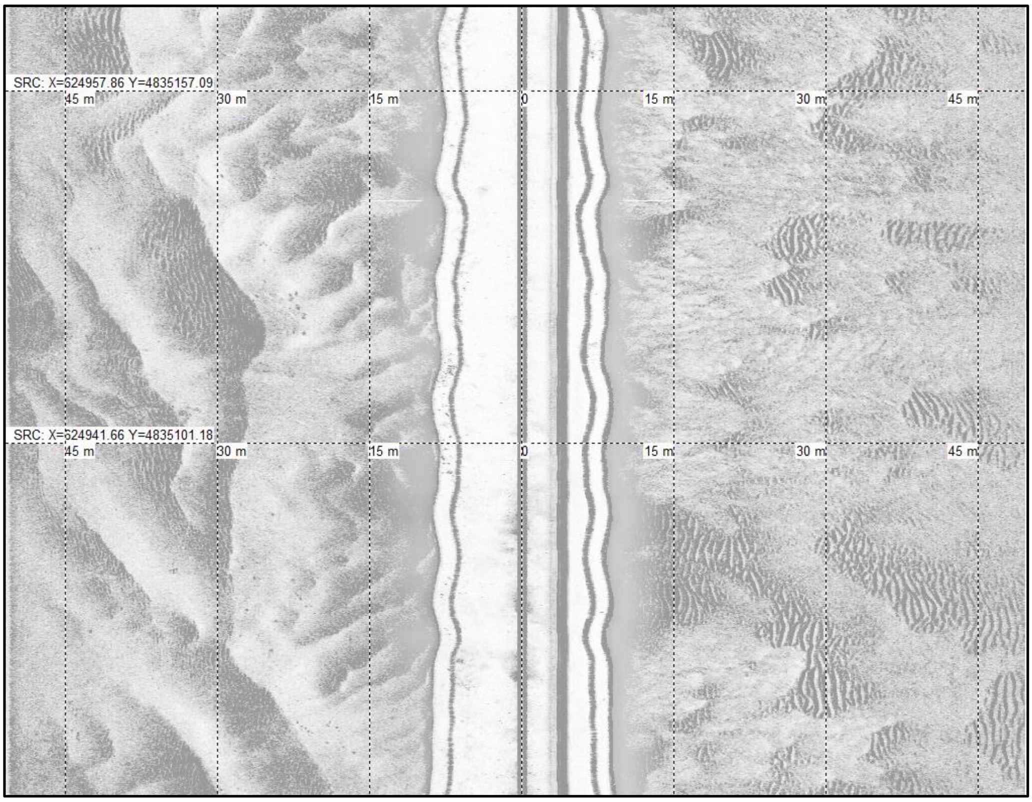

Figure 42 SSS data image of rippled sediments (on the right) and slumped deposits (on the left) along the edge of the canyon at KP 156.20.

KP 156.420 to KP 170.186: The surficial geology comprises fine to medium SAND and fine to medium SAND with ripples. Clusters of Boulders appear between KP 162.280 and KP 162.595. SAND and GRAVEL is observed KP 168.424 until KP 168.851, with a few small outcrops of BEDROCK >100 m from the route. SAND continues until KP 170.186. Occasional boulders within route corridor (Appendix E|).

KP 170.186 to KP 179.832: The surficial geology is composed of fine to medium SAND that continues with patches of furrowed SAND and GRAVEL crossing the proposed route between KP 170.315 and KP 171.232. Also, numerous trawl scars cross the entire corridor between KP 170.190 and KP 171.040. SAND continues with occasional boulders randomly distributed along this section (Appendix E|).

KP 179.832 to KP 186.755: The surficial geology is made up of fine to medium SAND with occasional outcrops of BEDROCK across the route corridor. Extensive trawl scars exist along the route from KP 183.310. Occasional boulder within corridor (Appendix E|).

KP 186.755 to KP 203.948: The surficial geology is composed of sandy CLAY sediments that have been extensively scarred by trawling across the entire route corridor. The BEDROCK outcrops are partially apparent across the entire corridor between approximately KP 189.190 and KP 194.330 (Figure 43). A number of boulders are distributed across the proposed route corridor (Appendix E|).

Two isolated veneers of fine to medium SAND, are present KP 196.970 to KP 197.539 and KP 200.639 to KP 201.588.

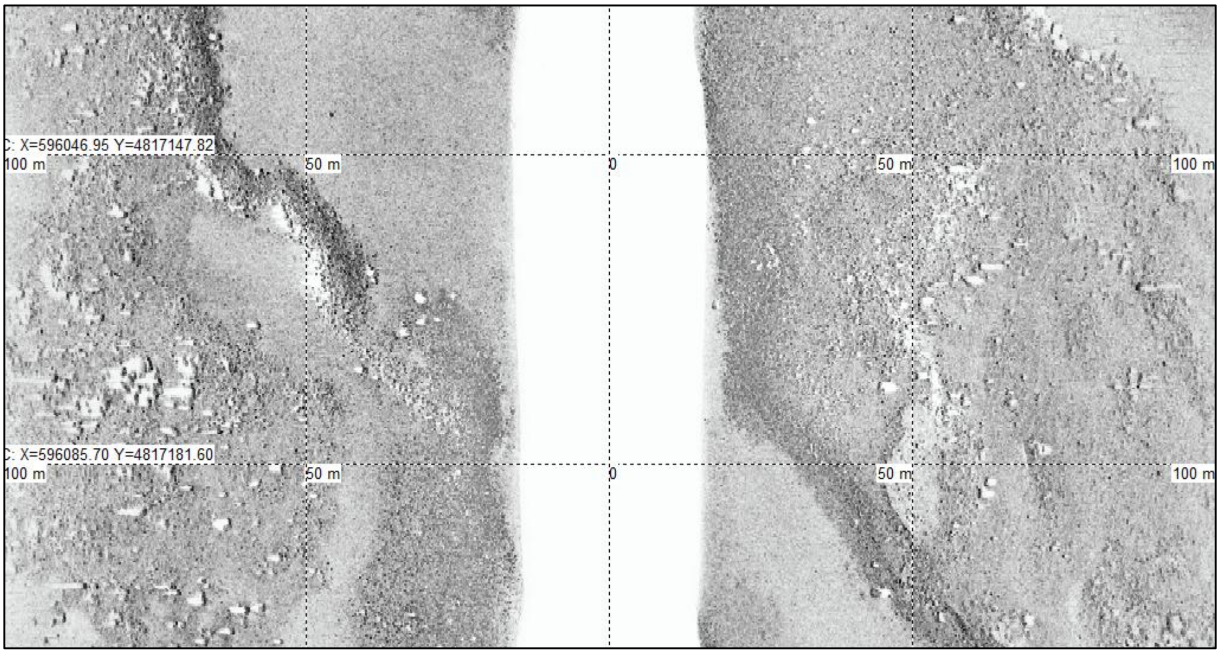

Figure 43 SSS data image showing outcropping BEDROCK and boulder clusters at KP 191.40.

KP 203.948 to KP 222.262: The surficial geology is made up of sandy CLAY with patches of outcropping BEDROCK crossing the proposed route between KP 205.419 and KP 205.476, between KP 205.677 and KP 206.669, and between KP 218.970 and KP 219.230. A number of boulders are randomly spread across proposed route (Appendix E|).

KP 222.262 to KP 234.395: The surficial geology is made up of sandy CLAY with numerous trawl scars, (Figure 44), and occasional patches of SAND and GRAVEL.

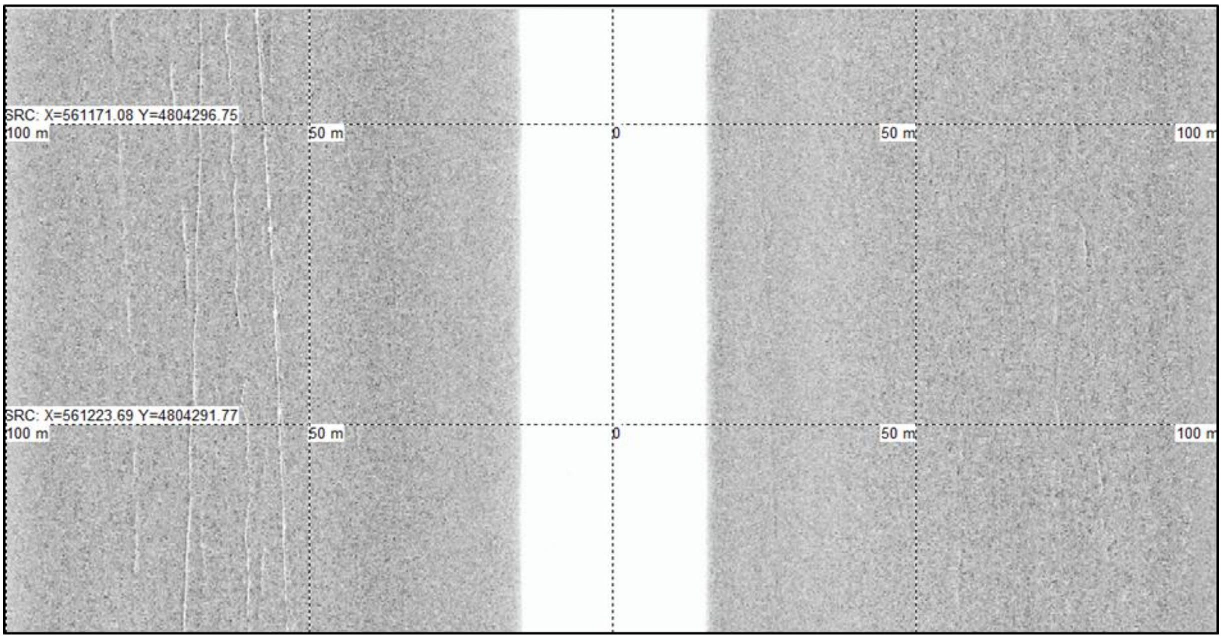

Figure 44 SSS image of SAND with numerous trawl scars at KP 230.0.

<u>KP 234.395 to KP 237.214:</u> The surficial geology is made up of sandy CLAY and occasional outcrops of BEDROCK.

<u>KP 237.214 to KP 239.812:</u> The surficial geology comprises of fine to medium SAND interspersed with SAND and GRAVEL with numerous boulders crossing the KP reference survey centre line between: KP 237.601 and KP 237.860; KP 230.28 and KP 238.556; KP 238.653 and KP 238.789; KP 236.609 and KP 239.669 (Figure 45). BEDROCK outcrops at KP 239.117 for 40 m. A significant number of boulders are located across the proposed route (Appendix E|).

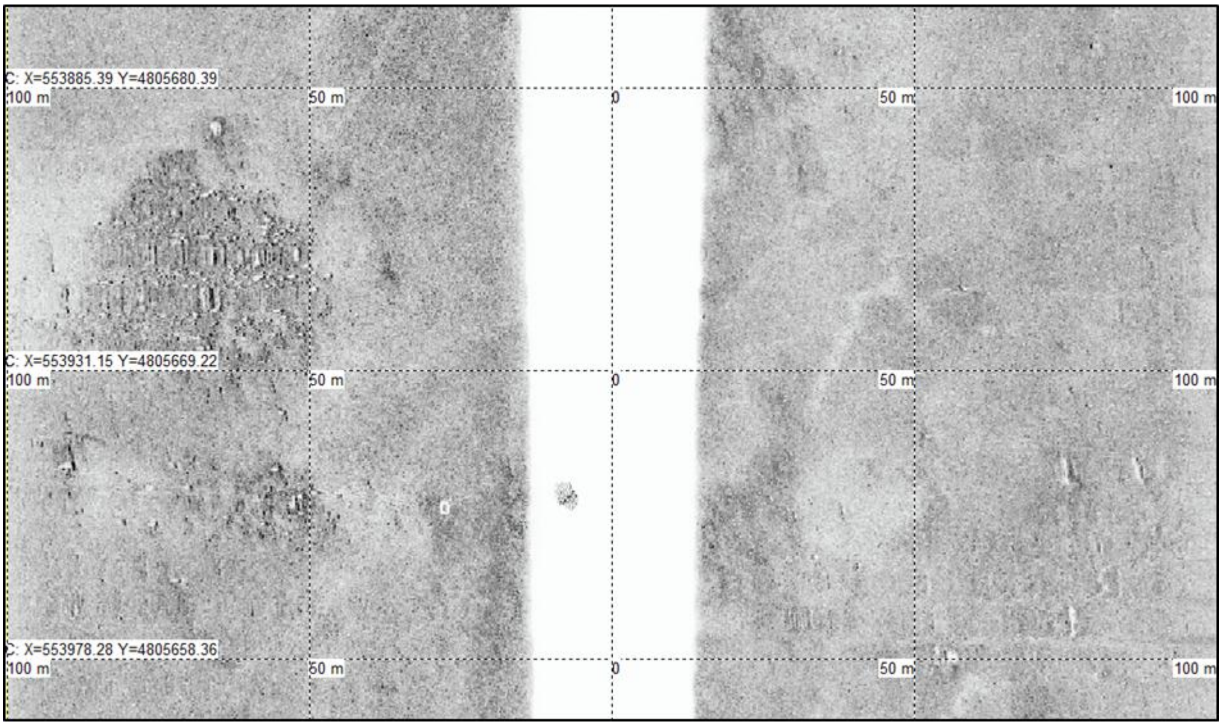

Figure 45 SSS Data image of SAND and GRAVEL with numerous boulders at KP 237.40.

KP 239.812 to KP 246.714: The surficial geology has an area of outcropping BEDROCK until KP 243.138. Fine to medium SAND with ripples continues until KP 243.272, then fine to medium SAND with significant number of boulders (Figure 46 and Appendix E|). A BEDROCK outcrop appears within the SAND at KP 244.669 for 37 m and KP 245.053 for 40 m. From here intermittent thin veneers of sandy CLAY, fine to medium SAND and fine to medium SAND with ripples chaotically distributed over the BEDROCK, until the BEDROCK outcrops again at KP 245.806 to KP 246.714.

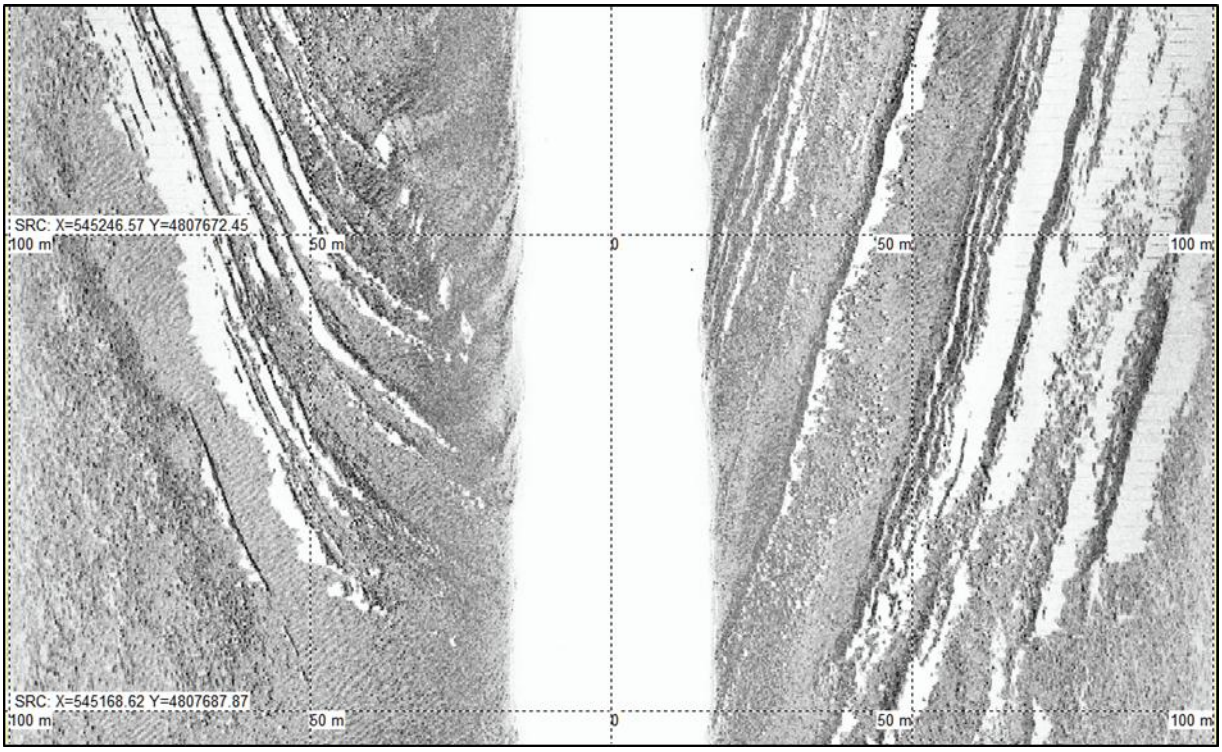

Figure 46 SSS data of outcropping BEDROCK at KP 246.40.
The bedding planes are visible with SAND and GRAVEL with ripples deposits within the depressions.

KP 246.714.to KP 252.176: The surficial geology is made up of patchy veneers of fine to medium SAND, rippled fine to medium SAND, and ripples of SAND and GRAVEL, which are chaotically distributed over outcropping BEDROCK. A number of boulders are distributed across the KP referenced survey line (Appendix E|).

KP 252.176 to KP 257.970: The surficial geology is made up of fine to medium SAND and fine to medium SAND with ripples, with small random outcrops of BEDROCK >60 m from the proposed route.

KP 257.970 to KP 261.822: The surficial geology comprises outcropping BEDROCK with chaotic patches of veneers of fine to medium SAND with ripples and SAND and GRAVEL with ripples.

KP 261.822 to KP 272.692: The surficial geology becomes fine to medium SAND becoming fine to coarse SAND. Where the two buried ENAGAS pipelines are located at KP 270.643 and KP 270.714 the seabed comprises featureless fine to coarse SAND (Figure 47). Between KP 265.200 and KP 266.300 SAND and GRAVEL with numerous boulder extend across the proposed route (Figure 48) and the SAND and GRAVEL is extensively furrowed between KP 272.171 and KP 272.345.

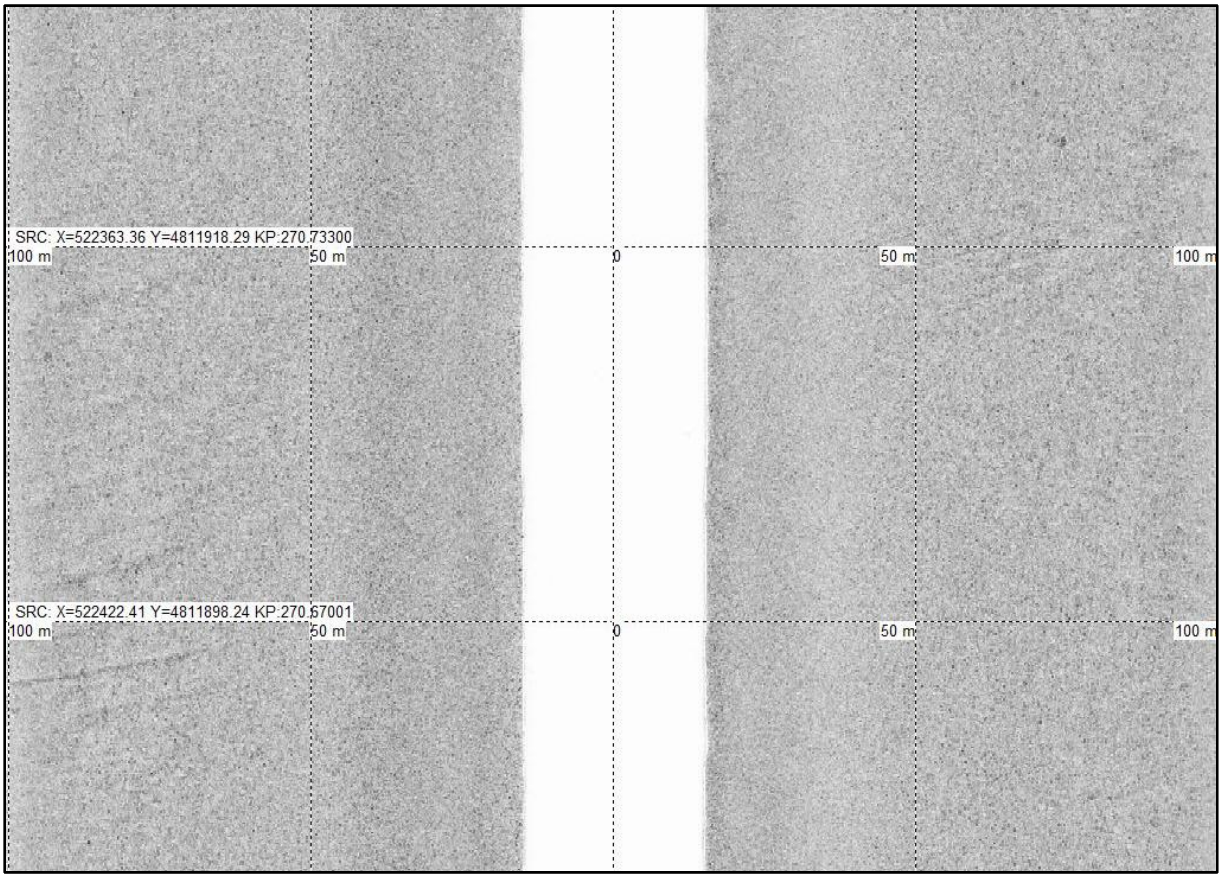

Figure 47 SSS data image of fine to coarse SAND at the ENAGAS Pipeline crossings. KP270.647 and KP 270.714 for the MR.

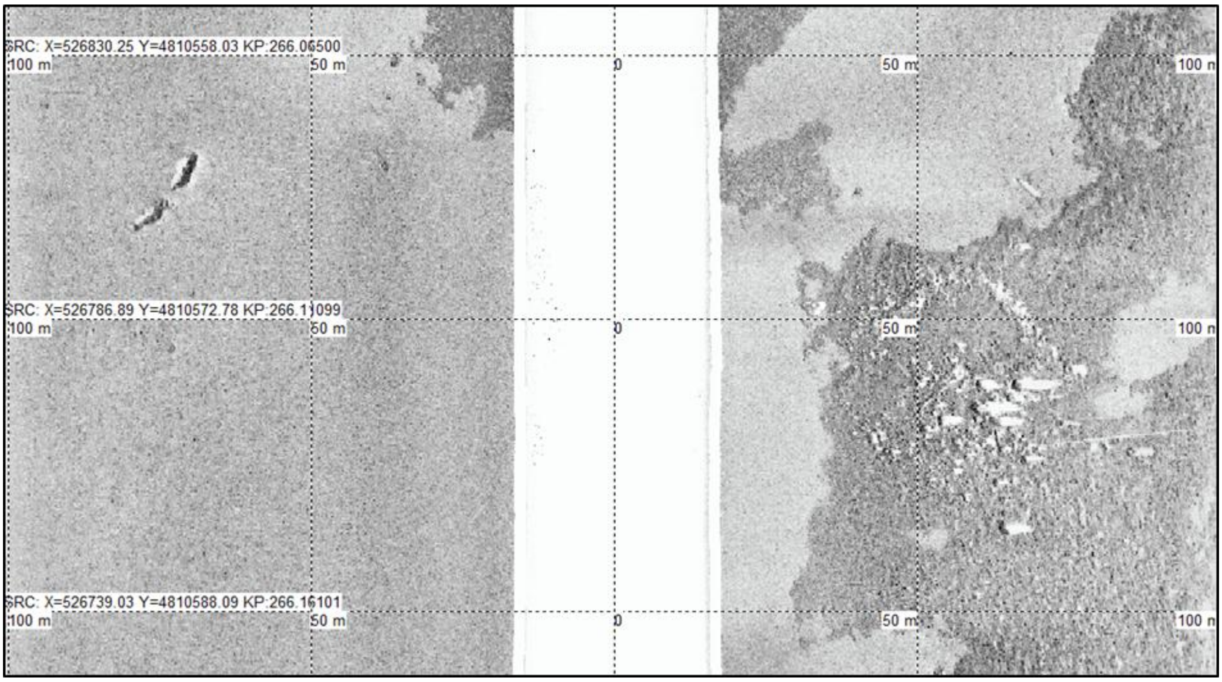

Figure 48 SSS data image of fine to medium SAND and SAND and GRAVEL with numerous Boulders at KP 265.05.

KP 272.693 to KP 276.295: The surficial geology shows predominantly outcropping BEDROCK.

KP 276.295 to KP 278.853: The surficial geology shows mostly SAND and GRAVEL, and rippled SAND and GRAVEL. A number of boulders are randomly distributed across the route

KP 278.853 to KP 283.278: BEDROCK with a patchy veneer of SAND and GRAVEL with ripples.

3.1.4| SHALLOW GEOLOGY

The following geophysical interpretations of the shallow geology are based on changes in acoustic character and are supported with geotechnical results.

KP 1.060 to KP 20.035: The shallow geology is interpreted to comprise of a wedge of Medium to Coarse SAND, initially 1 to 2 m thick thinning to 0.5 m by KP 2 (Figure 49). The underlying gravelly SAND unit is situated on another deposit of SAND extending down to more than 5 m. The fine to medium is present along the top of this section from KP 2.040 to KP 20.035 (Figure 49 and Figure 50).

Fine to coarse SAND within the upper 5 m is interpreted through to KP 11.8. Between KP 11.8 and KP 15.8 a complex relic channel like structure is present at or near the surface (Figure 51). The channel infill is interpreted as probable sandy CLAY/silty SAND/gravelly SAND, overlain by fine to coarse SAND at the seabed interface. The channel infill structure is at or near the surface for 600 m at KP 12.8.

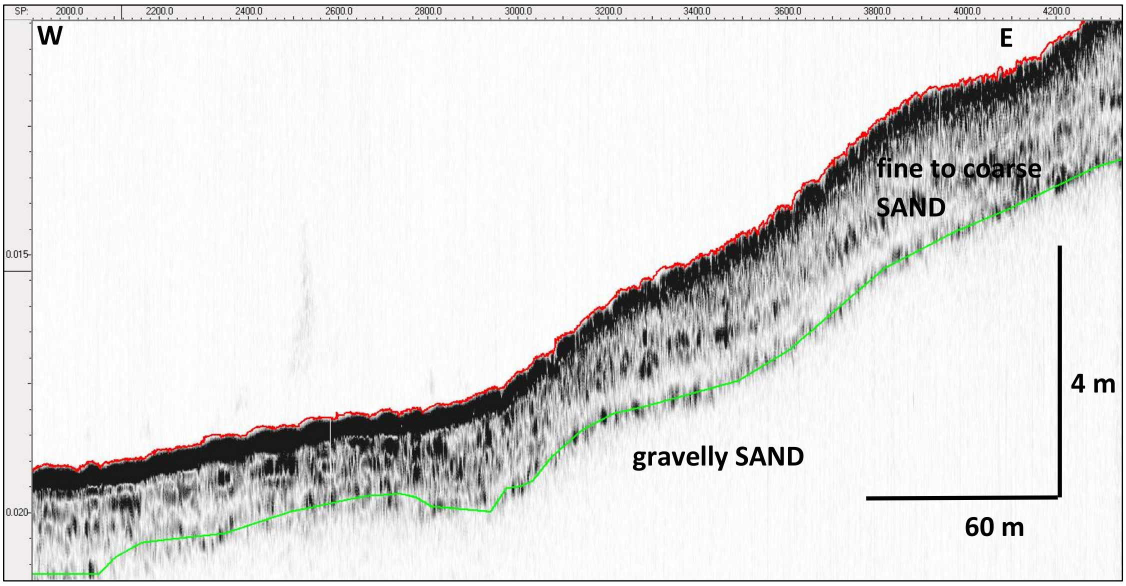

Figure 49 SBP data image with picked horizon below 1 to 2 m of fine to coarse SAND at KP 1.25. Seabed flattening applied to data.

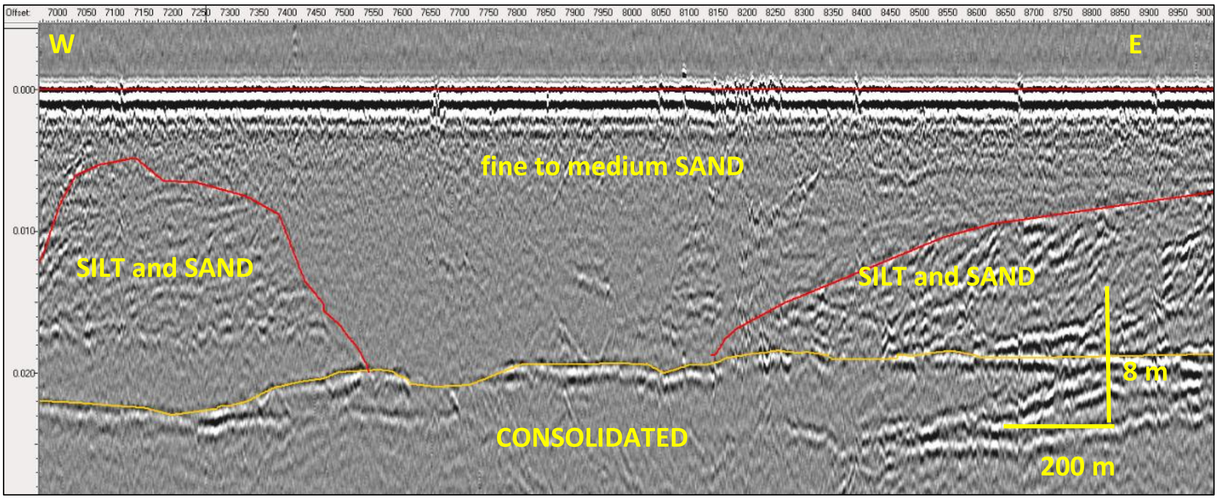

Figure 50 Sparker data image showing thick SAND units over consolidated sediment at +15 m BSF, at KP 4.000. Seabed flattening applied to data.

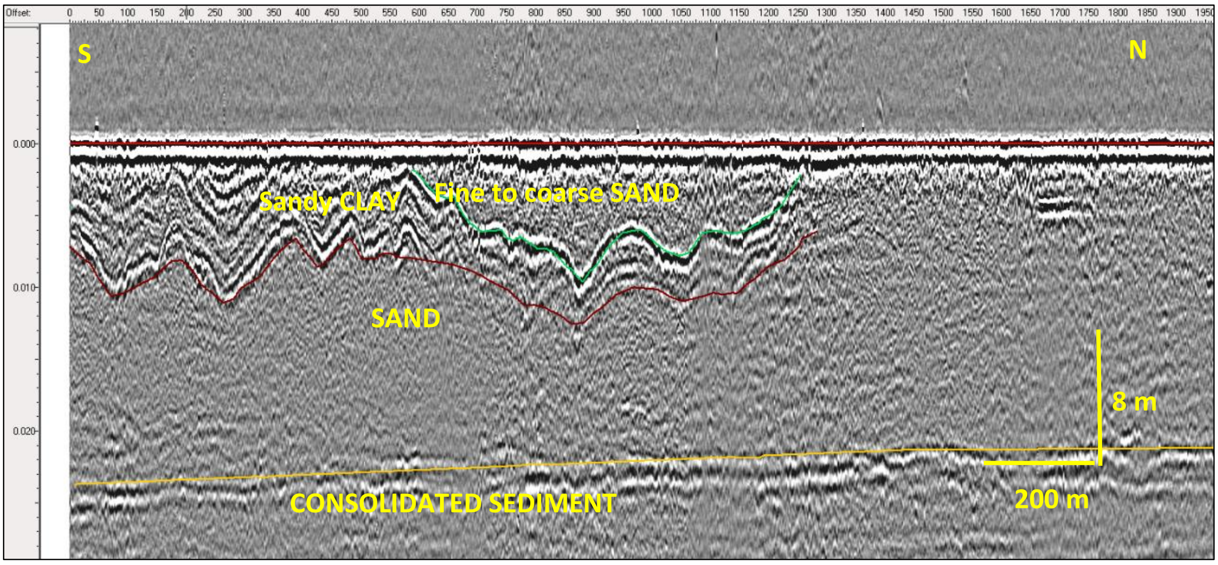

Figure 51 Sparker data image showing SAND units thicker than 5 m BSF alongside SILT and SAND deposits, at KP 11.8.
Seabed flattening applied to data.

KP 20.035 to KP 22.724: The shallow geology consists of a top unit of fine to medium SAND. Up to 1.5 m BSF overlying SAND and GRAVEL to a depth of 5 m, (Figure 52).

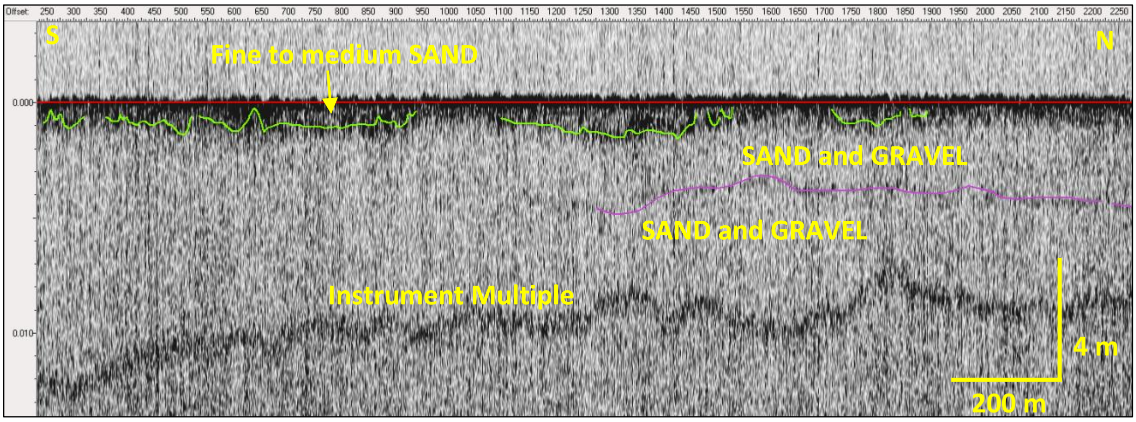

Figure 52 Chirp data image of sediments from KP 22.035 and KP 22.724. Seabed flattening applied to data.

KP 22.724 to KP 30.345: The sub-surface geology is predominantly fine to medium SAND up to 2 m thick, over SAND and GRAVEL. The SAND and GRAVEL unit is at the seabed surface at a number of locations where the mobile SAND is not present.

KP 30.345 to KP 43.485: The shallow geology is predominantly fine to coarse SAND up to 2 m thick, over SAND and GRAVEL to depths exceeding 5 m. The SAND and GRAVEL unit is at the seabed surface at a number of locations where the mobile SAND is not present. (Figure 53).

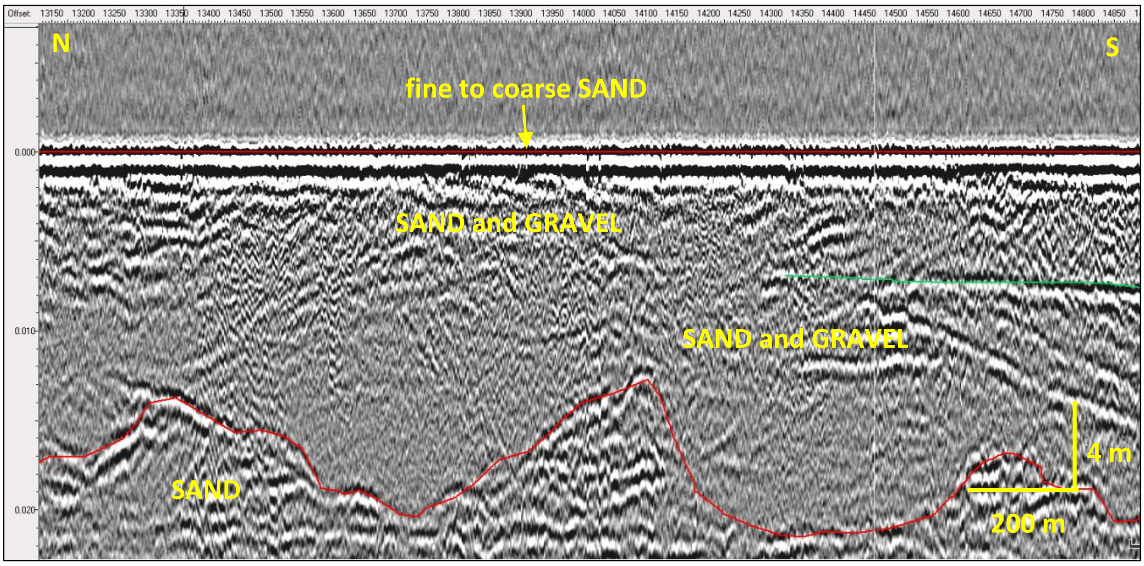

Figure 53 Sparker data image of SAND and GRAVEL over thick unit of SAND at KP 32.25. Seabed flattening applied to data.

KP 43.485 to KP 47.648: The shallow geology is predominantly fine to coarse SAND up to 2 m thick, over SAND and GRAVEL to depths exceeding 5 m. The SAND and GRAVEL unit is at the seabed surface at a number of locations where the mobile SAND is not present. (Figure 54).

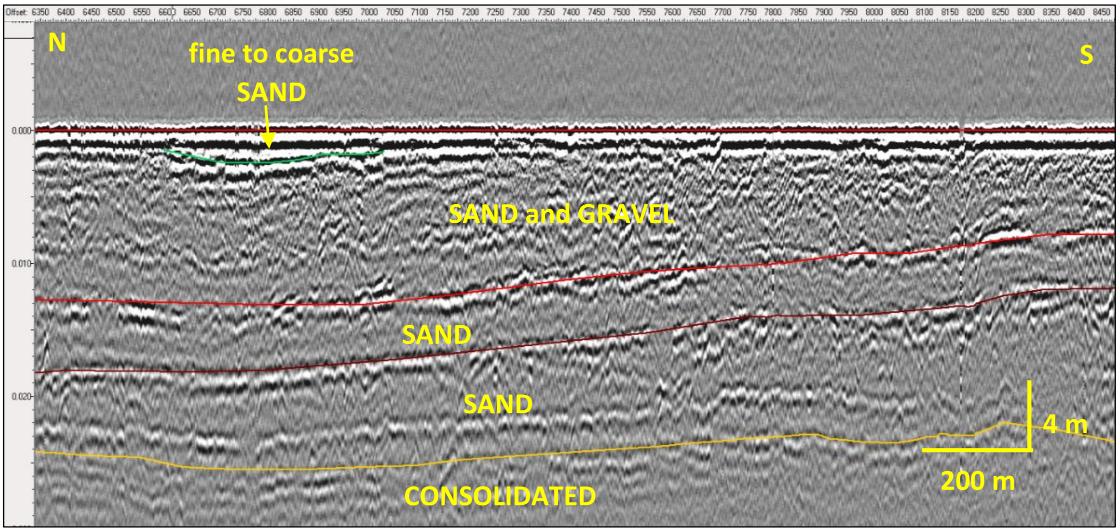

Figure 54 Sparker data image fine to medium SAND, and SAND and GRAVEL over thick units of SAND, at KP 45.75.
Seabed flattening applied to data.

KP 47.648 to KP 86.205: The mobile surficial fine to coarse SAND/fine to medium SAND becomes sparser and more isolated, forming dune like bedforms (the morphology of which is described in detail in Mazières *et al.* 2015) overlying SAND and GRAVEL (Figure 55). The shallow geology is predominantly SAND and GRAVEL units over irregularly eroded SAND, to greater than 5 m BSF. By KP 68.000 the deeper SAND unit has become deeper than 5 m BSF (Figure 56) then appears again with 5 m of seabed at KP 79.450 and continues as such until KP 84.450 when it dips down beyond 5 m and then reappears within 5 m at KP 85.504 (Figure 57).

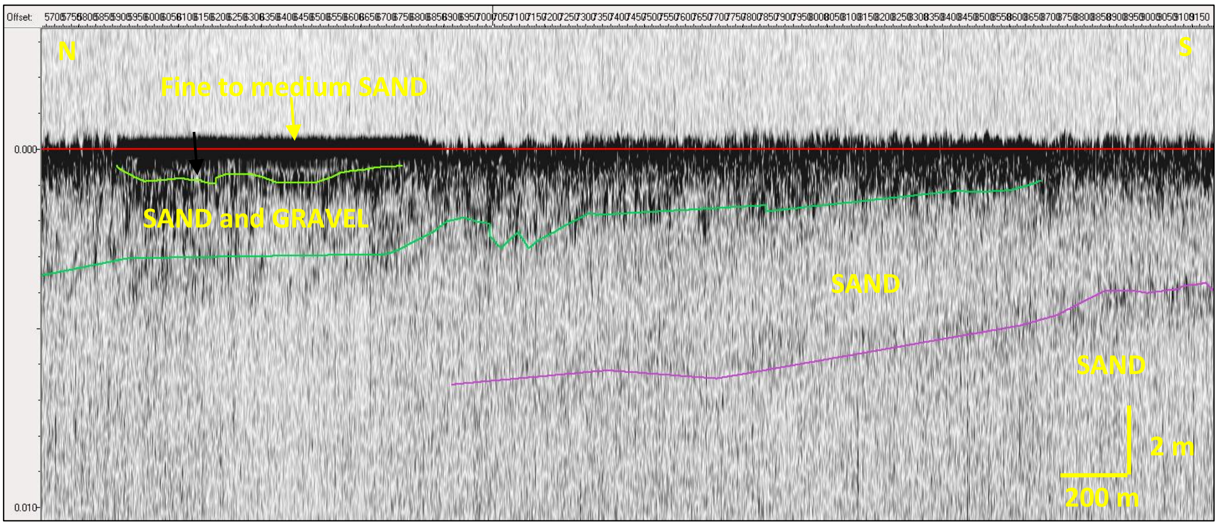

Figure 55 Chirp data image of fine to medium SAND over SAND and GRAVEL, at KP 49.00.
Seabed flattening applied to data.

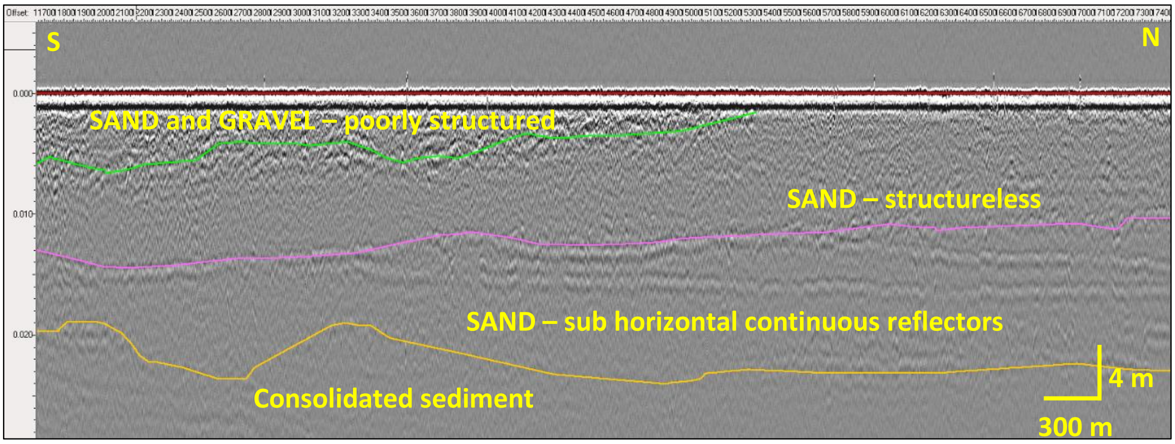

Figure 56 Sparker data image of SAND and GRAVEL over SAND, KP 67.5.
Seabed flattening applied to data.

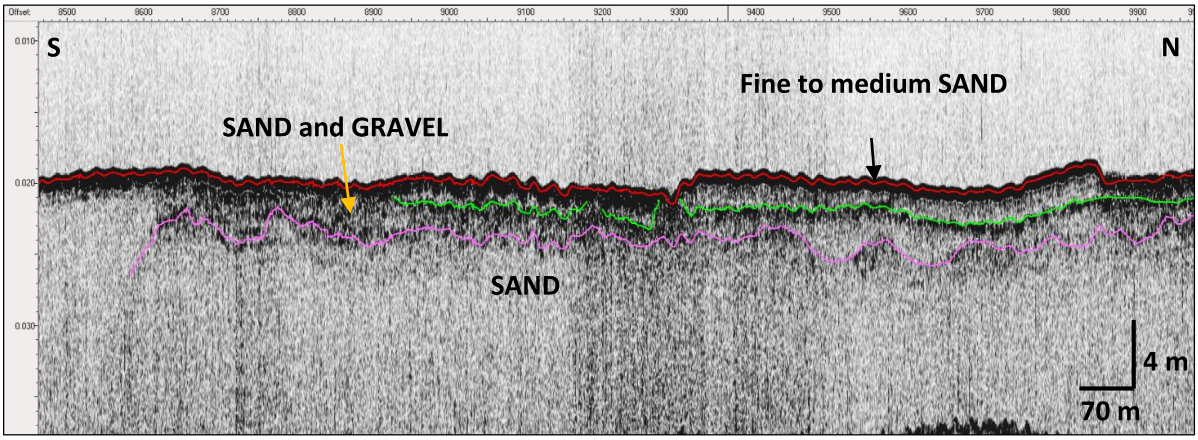

Figure 57 Chirp data image of shallow geology at KP 83.7.

<u>KP 86.205 to KP 132.050:</u> The shallow geology remains consistently with mobile surficial fine to medium SAND becomes sparser and more isolated, forming dune like bedforms (the morphology of which is described in detail in Mazières *et al.* 2015) overlying SAND and GRAVEL

The underlying SAND unit irregularly dips below 5 m. A poorly defined dense SAND and GRAVEL unit comes to within 5 m of the seabed at KP 127.000 and then gradually closes the seabed surface, eventually outcropping at KP 132.050 (Figure 59). The outcropping unit is interpreted to be the base of unconsolidated sediment used for “Type A” isopach. Where the outcropping occurs the surficial geology (Figure 40) features a coarse unit that is interpreted to be a weathered surface subaerially exposed during a sea level low stand. The upper sediments in this unit that were exposed to weathering are likely to be a dense unit. Route development was conducted between KP 129.9 to 136.6 to the west of the corridor to avoid the exposures and shallow burial of the dense unit. There is considerable uncertainty as to the degree of consolidation within the unit of the “Type B” isopach due to an absence of supporting geotechnical information.

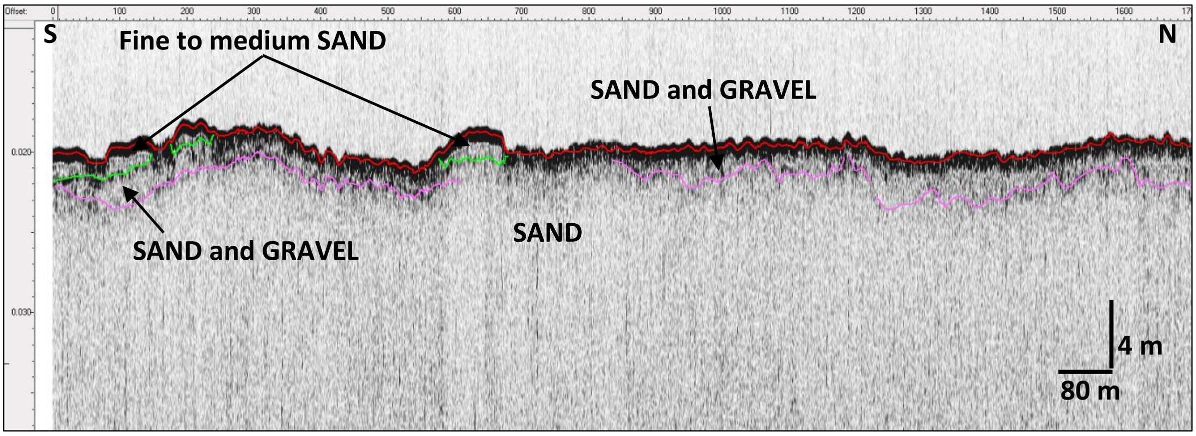

Figure 58 Chirp data image of SAND deposits over SAND and GRAVEL with lower unit of SAND to 5 m BSF, at KP 92.0.

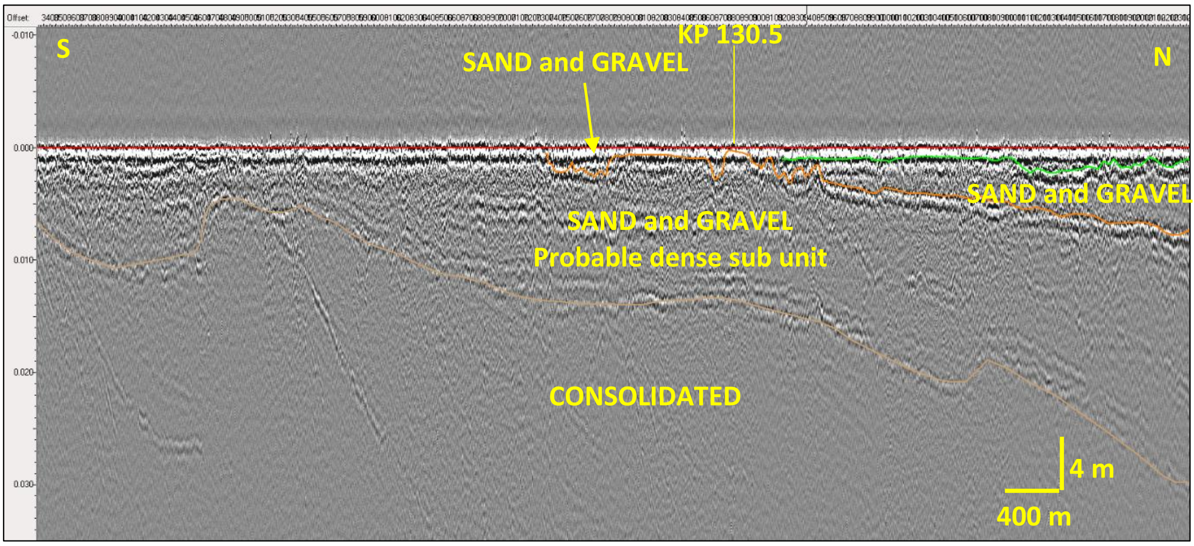

Figure 59 Sparker data image of geological sequence showing the SAND and GRAVEL unit sloping up towards the seabed with increasing KP, from KP 129.0.
Seabed flattening applied to data.

KP 132.050 to KP 136.337: The dense SAND and GRAVEL with Coarse Sediment outcrops and subcrops, extending more than 5 m BSF, up to KP 134.310. From here until KP 136.337 this dense SAND and GRAVEL unit is covered with extensive deposits of fine to medium SAND, 1 to 2 m thick. From KP 133.568, below the dense SAND and GRAVEL unit, a previously deeper unit of underlying CONSOLIDATED SEDIMENT begins to appear intermittently within 5 m of the seabed

KP 136.337 to KP 150.480: SAND and GRAVEL continues extending more than 5 m BSF until KP 139.386 when CONSOLIDATED SEDIMENT comes to within 5 m BSF, is <2 m BSF KP 139.869 to KP 143.286 , with a subcrop KP 142.419 to KP 142.852 (Figure 60). From KP 143.286, the top 5 m continues with fine to medium SAND, over SAND and GRAVEL, over CONSOLIDATED SEDIMENT, the top of which is observed within 1.5 m to 4 m of the seabed throughout.

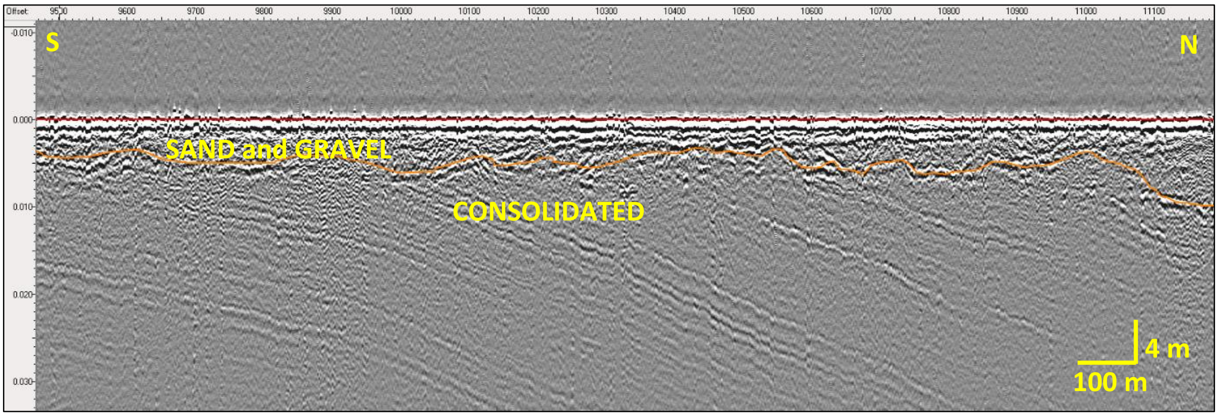

Figure 60 Sparker data image of SAND and GRAVEL over CONSOLIDATED SEDIMENT, KP 142. Seabed flattening applied to data.

KP 150.480 to KP 155.450: The route bifurcates with the Canyon Head Bypass Option turning inshore whilst the HDD Crossing option continues across the canyon (further discussed in Section 2.9| and 3.8|)

Between KP 150.480 and KP 152.310 the shallow geology comprises of fine to coarse SAND, ranging from 2 m thick to >5 m thick, overlaying SAND and GRAVEL, overlaying CONSOLIDATED SEDIMENT (Figure 61). Then from KP 152.660 to KP 154.500 fine to coarse SAND, ranging from 1 to 2 m thick, overlays SAND and GRAVEL. From KP 154.500 to KP 155.450 fine to coarse SAND, increasing in thickness to 2 to 4 m thick, overlays CONSOLIDATED SEDIMENT.

The shallow water section, skirting the head of the canyon between KP 152.75 to KP 159.500, has been surveyed by the M/V Geo Focus with the Innomar system.

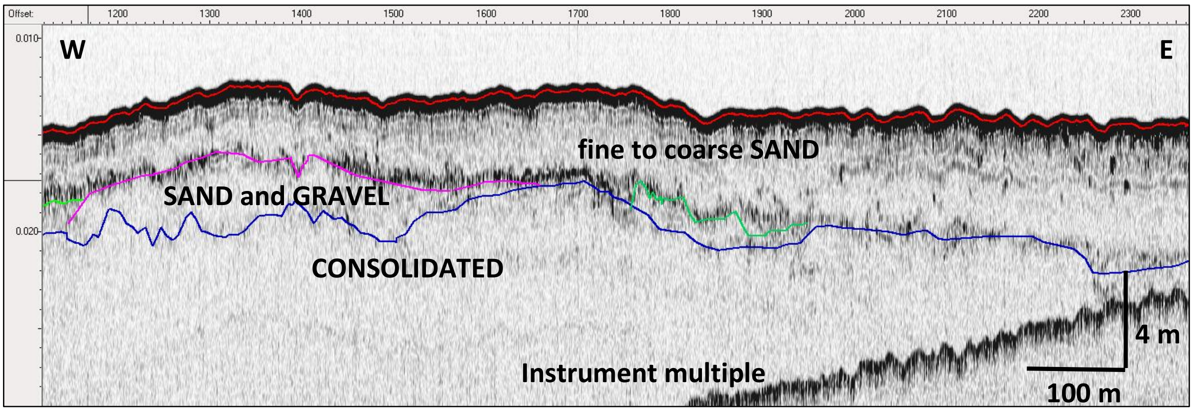

Figure 61 Chirp data image from KP 151.7 to approximately KP 153.0.

KP 155.450 to 156.793: The MR traverses steep slopes associated with the head of the canyon through this section, penetration is poor either due to the slope, the nature of the sediments or that the sediment units are structureless due to slumping processes (see alignment chart 102354-INE-MMT-SUR-DWG-AMR00035 for overview). Across this area, fine to medium SAND <1m to 3m thick, overlays CONSOLIDATED SEDIMENT (Figure 62 and Figure 103).

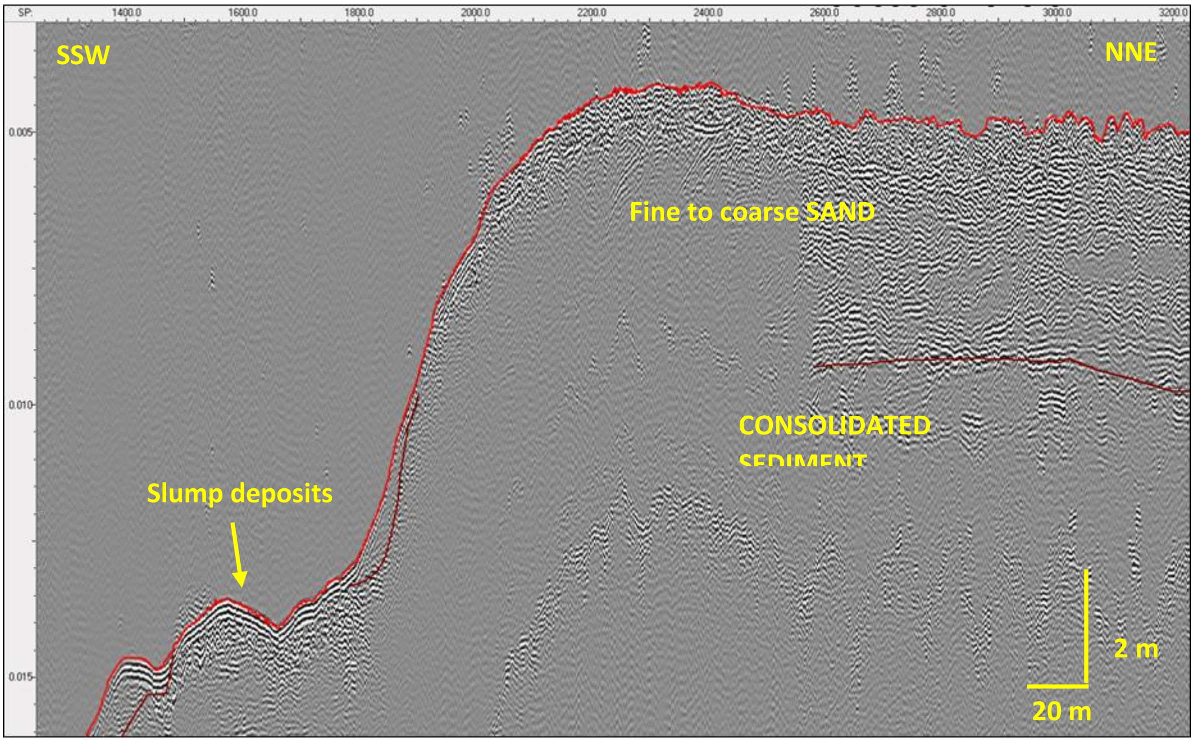

Figure 62 Innomar data image of the eastern side of the canyon system KP 155.55.
Showing evidence of slump deposits toward the base.

<u>KP 156.793</u> <u>to KP 167.528:</u> The shallow geology is fine to medium SAND, 1 to 5 m thick, over SAND and GRAVEL >5 m thick. From KP 159.636 the fine to medium SAND becomes >5 m BSF. A Sparker crossline at KP 160.35 detects a unit of consolidated sediment at 8 m BSF (Figure 104). From KP 163.5 BEDROCK is initially detected at depths of 16 m and comes to within 5 m BSF at KP 165.624 and within 2 m at KP 167.528.

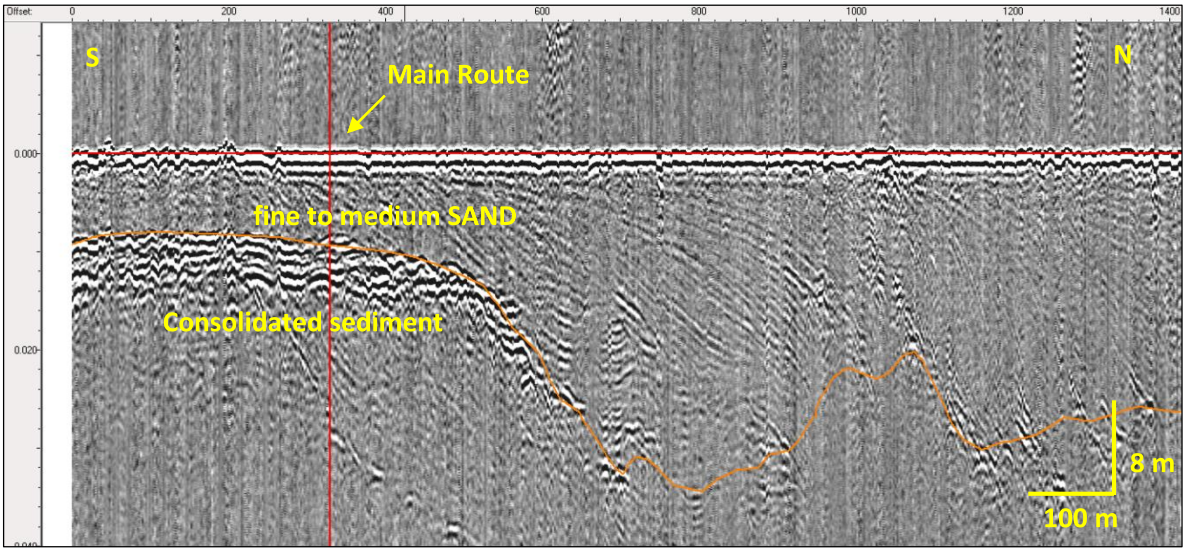

Figure 63 Sparker data image of crossline at KP 160.35 with red line indicating intersection of MR, CONSOLIDATED SEDIMENT at 8 m BSF.
Seabed flattening applied to data.

KP 167.528 to KP 182.973: The shallow geology comprises of fine to medium SAND up to 3 m BSF overlying BEDROCK, shallows to subcropping <0.5 m BSF with a veneer of SAND and GRAVEL between KP 168.424 and 168.849 (Figure 64) and dips to 2 m BSF at KP 170.186.

The BEDROCK shallows to less than 0.5 m BSF at KP 171.550, with an outcrop at KP 172.187. From here the thickness of the fine to medium SAND unit varies between 1 and 2 m over very irregularly eroded BEDROCK until becoming less than 0.5 m at KP 177.873 (Figure 65). The BEDROCK continues around this depths and outcrops on the route between KP 182.487 and 182.507, as well as between KP 182.552 and 182.567. Note that around KP 177 to 184 an intermittent thin (0.5 to 1.5 m) unit of CLAY is sometimes observed on top of the BEDROCK.

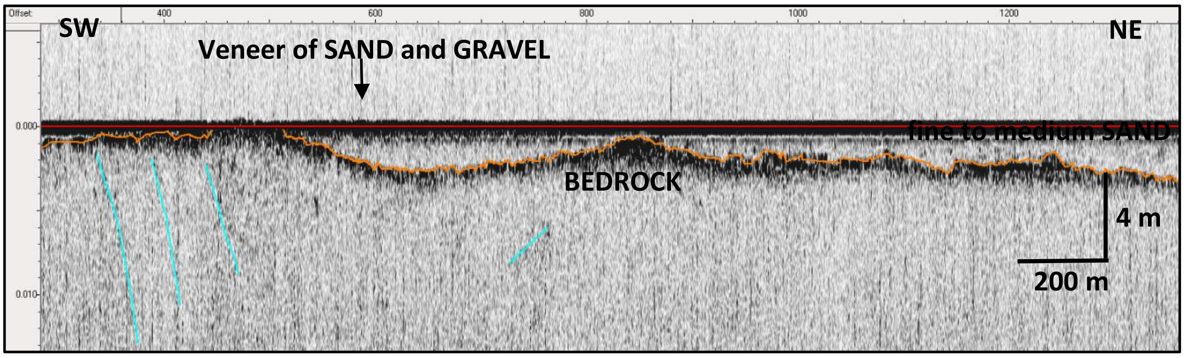

Figure 64 Chirp data image of BEDROCK at or near the seabed surface proximal to KP 168.4. Seabed flattening applied to data.

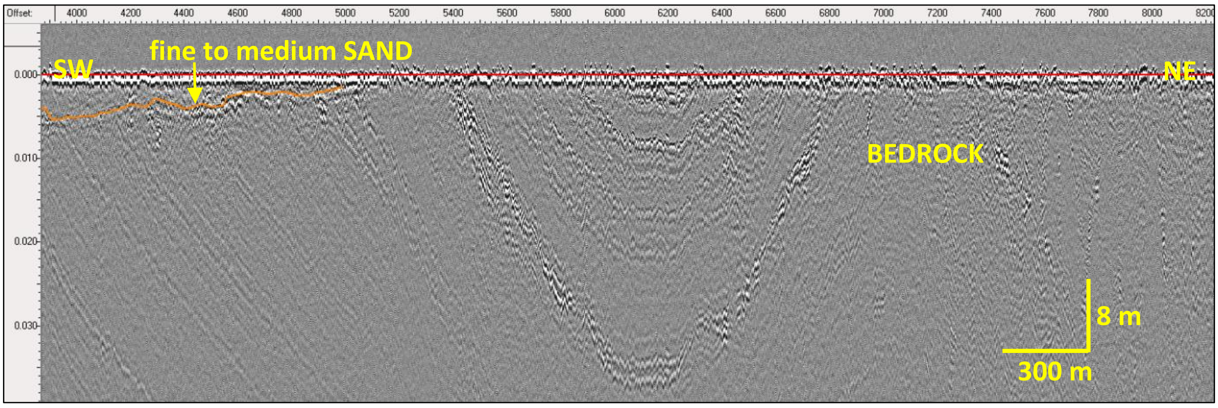

Figure 65 Sparker data image of BEDROCK coming close to seabed with thin veneer <0.5 m of SAND, KP 175.5.
Seabed flattening applied to data.

KP 182.973 to KP 192.131: For the most part the top 5 m comprises clayey SAND transitioning into sandy CLAY at around KP 188.500, overlaying subunits of SILT and SAND within 2 m of the seabed (Figure 66 and Figure 67). These sub units are likely to comprise different physical properties than the surrounding sediment units. The highly eroded BEDROCK surface generally undulates >2 m BSF. Subcropping BEDROCK to <1 m BSF occurs at KP183.867, KP 184.045, KP 184.472 and KP 184.655. The BEDROCK attains a depth in excess of 5 m by KP 185.369 (Figure 66), except for KP 186.514 where it subcrops <1 m, and <2 m from KP 189.326 to KP 190.079 (Figure 67).

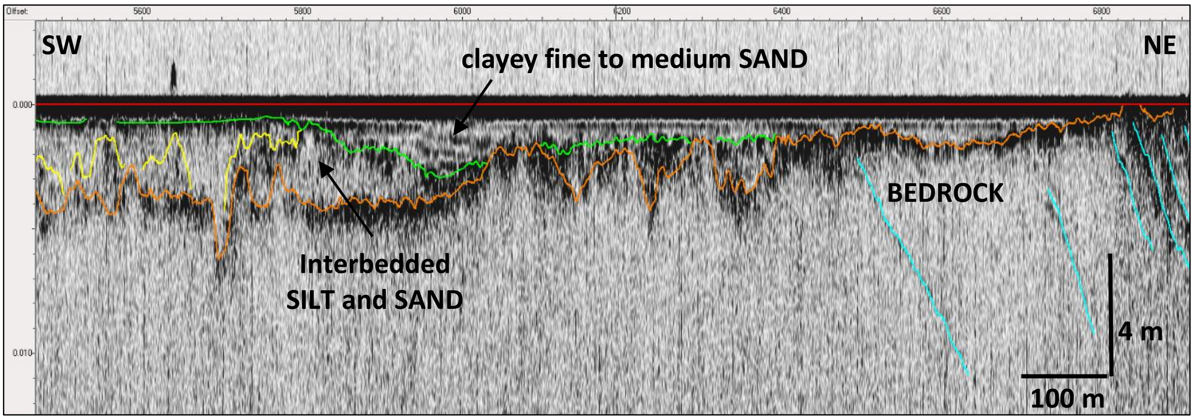

Figure 66 Chirp data image from KP 183.3 showing outcropping and subcropping BEDROCK. Seabed flattening applied to data.

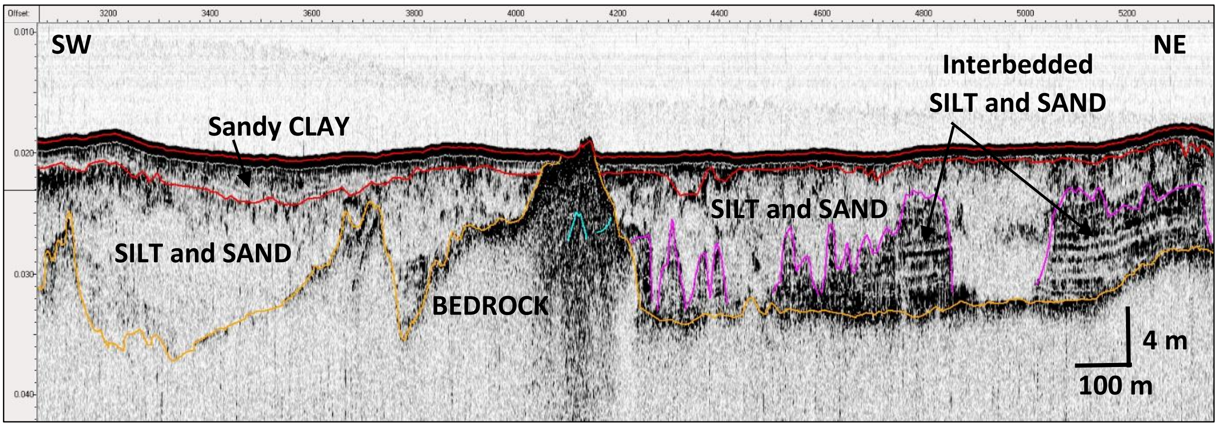

Figure 67 Chirp data image of shallow geology between KP 189.75 to KP 191.0.

KP 192.131- KP 195.210: The shallow geology comprises of sandy CLAY 2-5 m thick, over BEDROCK, with an outcrop KP 192.282-192.545.

KP 195.210 to KP 203.250: The shallow geology comprises of sandy CLAY, over SILT and SAND over BEDROCK, the top of which is >5 m BSF. The uppermost unit of sandy CLAY is 2 to 3 m thick, increasing to 5 m at KP 198.000, then thinning to 1 to 2 m at KP 198.500, then thickening to 4 m BSF at KP 200.000, then thinning to less than 1 m at KP 201.373. From KP 200.922 the sandy CLAY is underlain by SAND over SILT and SAND extending to depths greater than 5 m.

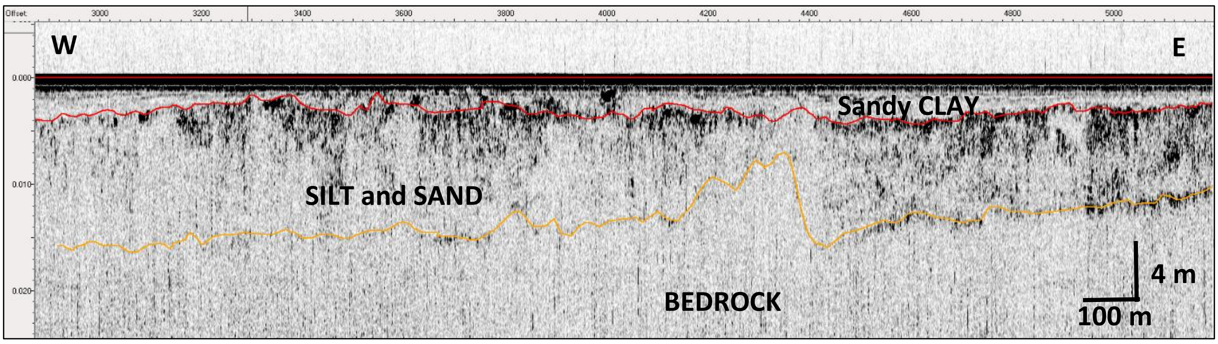

Figure 68 Chirp data image of shallow geology between KP 196.5 and KP 197.7 Seabed flattening applied to data.

KP 203.250 to KP 218.972: The shallow geology comprise sandy CLAY over SAND with a thickness of 5 m to less than 1 m by KP 204.896 as BEDROCK slopes up towards the seabed. The BEDROCK then dips down to 3 m BSF at KP 205.204 before sloping back up to outcrop at KP 205.419. BEDROCK remains outcropping or with just a 1 to 2 m veneer of sandy CLAY until KP 206.669. From here sandy CLAY thickens gradually to 3 to 4 m over BEDROCK, by KP 207.500, and greater than 5 m by KP 210.000. BEDROCK comes to within 2 m of the seabed between KP 208.600 - 209.100. The sandy CLAY over SILT and SAND continues in excess of 5 m BSF, until KP 210.940 where BEDROCK comes to within 3 m of the seabed, before thickening to > 5 m BSF at KP 211.418, whilst between KP 212.130 to KP 213.119 sandy CLAY is found over BEDROCK within 3 m of seabed. From here the sandy CLAY over SILT and SAND increases to greater than 5 m (Figure 69), except between KP 216.293-KP 217.069 where BEDROCK is within 3 m of seabed. The sediments pinch out quickly as the BEDROCK steeply comes to the seabed surface and outcrops at KP 218.972.

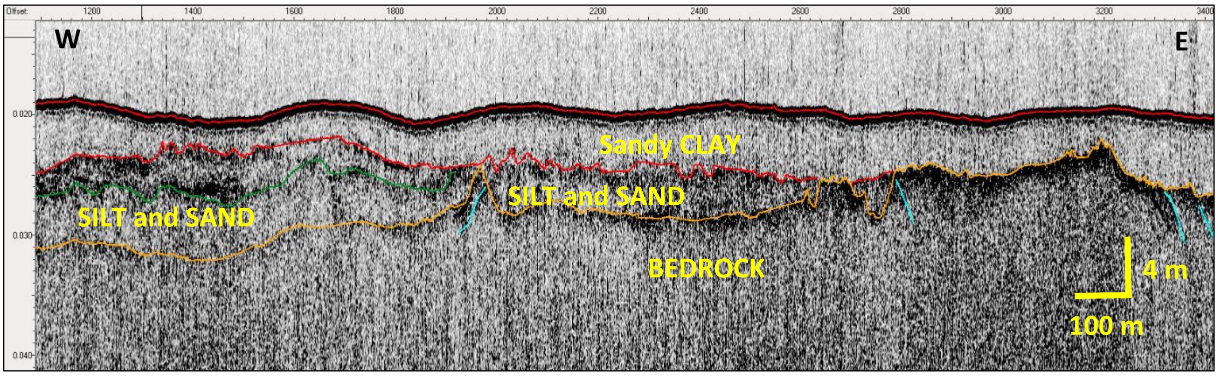

Figure 69 Chirp data image of shallow geology between KP 212.2 and KP 213.5.

KP 218.972 to KP 239.776: The shallow geology comprises of outcropping BEDROCK KP 218.972 to KP 219.355, which from here dips down and is overlain by 2 to 3 m of sandy CLAY, it then dips further reaching >5 m BSF at KP 220.353. From here the sandy CLAY is mostly >5 m thick, overlying SILT and SAND and continues with a thickness greater than 5 m BSF until KP 228.829, except for between KP 222.936 and KP 224.000 where the BEDROCK comes to within 3 m of the seabed surface, and between KP 227.650 and KP 227.870 where it is within 4 m of the seabed.

From KP 229.250 to KP 230.695 the SAND overburden is <2 m, which then increases between KP 230.695 and 233.960, to between 2 and 5 m of thickness, over BEDROCK (Figure 70). From KP 233.960 to 237.357, the sandy CLAY is 1 to 2 m thick, over a highly eroded/undulating BEDROCK, the unit thickens from KP 237.357 to KP 238.500, to 2 to 5 m, still over BEDROCK. From here the overburden then starts to thin as the BEDROCK comes close to the seabed surface, and outcrops at KP 239.105 for 100 m. The sandy CLAY unit, 1 to 2 m thick, then continues to overlie the BEDROCK unit the BEDROCK outcrops at KP 239.776.

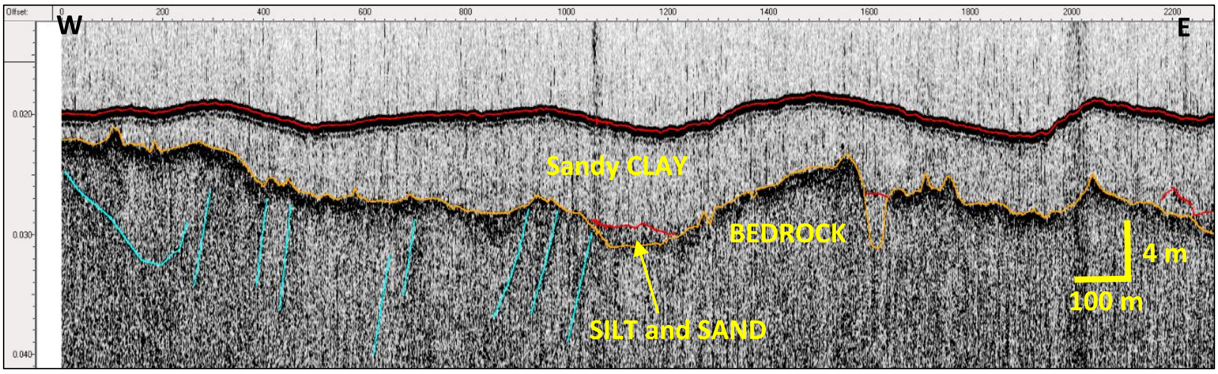

Figure 70 Chirp data image of shallow geology between KP 228.7 and KP 230.00.

KP 239.776 to KP 251.920: The shallow geology comprises outcropping BEDROCK with numerous veneers of fine to medium SAND infilling shallow channels between KP 239.776 and KP 243.240. From KP 243.240 to KP 244.644, a channel within the BEDROCK is infilled with fine to medium SAND approximately 1 to 3 m thick. BEDROCK outcrops again between KP 244.644 and KP 244.691. This is followed by another highly eroded/irregular channel within the BEDROCK between KP 244.691 and KP 245.590, infilled with sandy CLAY 1 to 3 m thick. Within this channel, BEDROCK is subcropping <0.5 m and outcropping between KP 245.062 and KP 245.196. From KP 245.590 BEDROCK is outcropping, with frequent thin veneers of fine to medium SAND or SAND and GRAVEL, and numerous eroded channels infilled with fine to medium SAND, SAND and GRAVEL, and sandy CLAY, the most notable from KP 247.473 to KP 248.770 with 0.5 m to 4 m of infilled sediments.

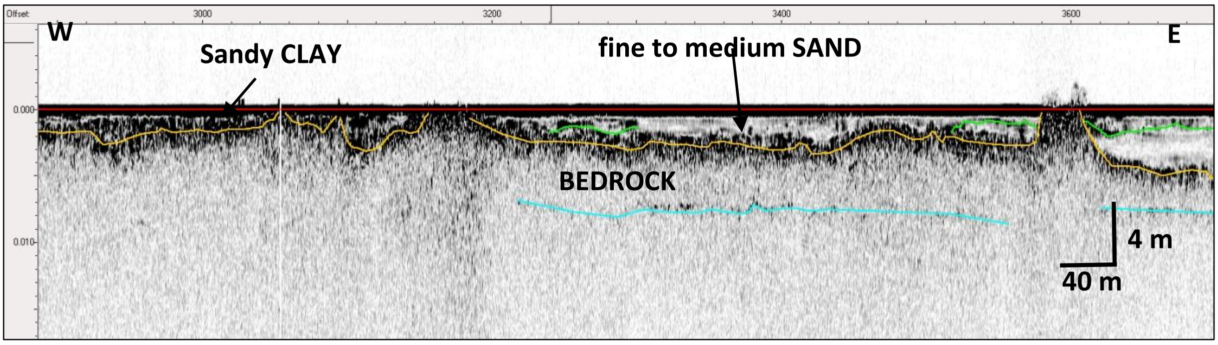

*Figure 71 Chirp data image of shallow geology between KP 244.5 to KP 245.7.
Seabed flattening applied to data.*

KP 251.920 to KP 257.960: The shallow geology comprises of an overburden fine to medium SAND intermittently over SAND and GRAVEL, with both units in total 3 to 5 m thick, over BEDROCK, until KP 254.475. From here fine to medium SAND, 2 to 4 m thick, overlies BEDROCK, with a subcrop to <1 m at KP 256.325 (Figure 72). The BEDROCK comes to the seabed almost vertically from 2.5 m below at KP 257.970.

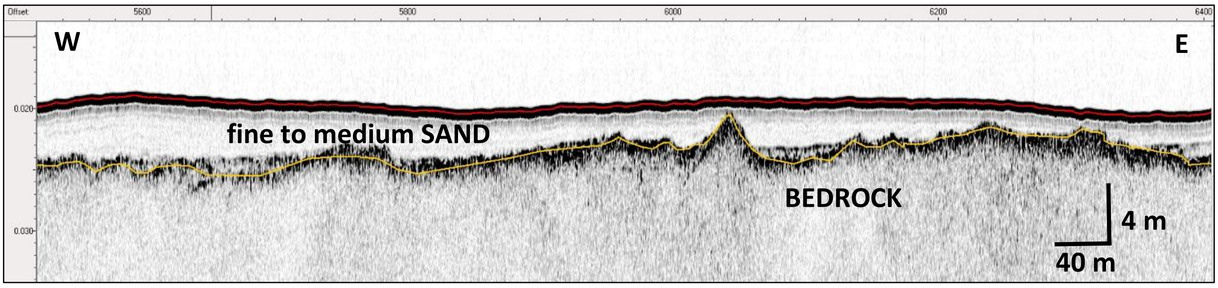

Figure 72 Chirp data image of shallow geology between KP 256.0 and KP 257.3.

KP 257.970 to KP 261.820: The shallow geology is made up from outcropping BEDROCK with occasional infilled shallow channels/patches of SAND and GRAVEL or fine to medium SAND with 2 m thickness.

KP 261.820 to KP 272.690: The shallow geology comprise of fine to coarse SAND over BEDROCK. The SAND overburden increases in thickness with KP to more than 5 m BSF by KP 267.200 and deepens to beyond detection over >12 m BSF at KP 268.848. Between KP 271.50 and KP 271.720, BEDROCK is <5 m BSF and subcrops to 1.5 m BSF at KP 271.090, with an overburden of fine to coarse SAND. (Figure 73). The SAND thickens to beyond 5 m and continues at this until KP 272.201 where the BEDROCK approaches the seabed surface and eventually outcrops at KP 272.690.

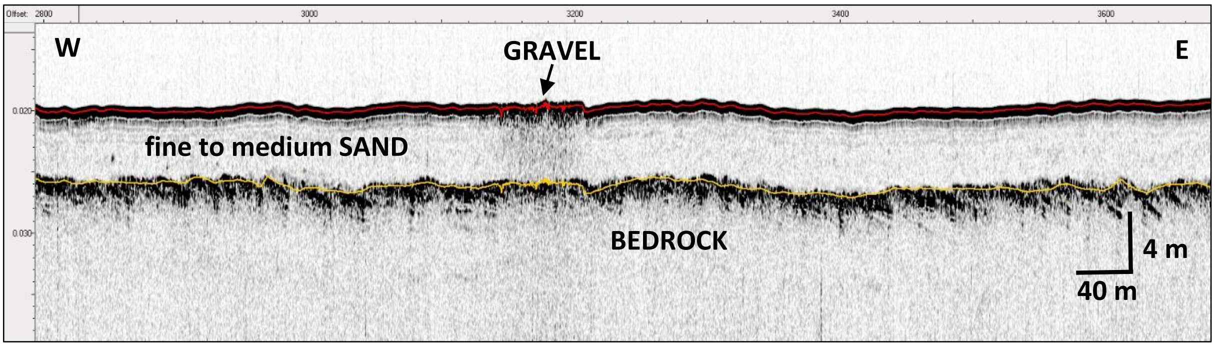

Figure 73 Chirp data image of shallow geology between KP 266.00 and KP 267.3.

Two existing gas pipelines cross the proposed route: the ENAGAS Pipeline West, 16 inch, and the ENAGAS Pipeline East, 6 inch. Both were detected with SBP and magnetometer data on all the run lines (Figure 74 and 102354-INE-MMT-SUR-DWG-PCSPI001). The crossing points with respect to the centre line of the KP referenced survey centre line are KP 270.72 for the 16 inch and KP 270.64 for the 6 inch, further crossing details are given in Table 5 and Table 6.

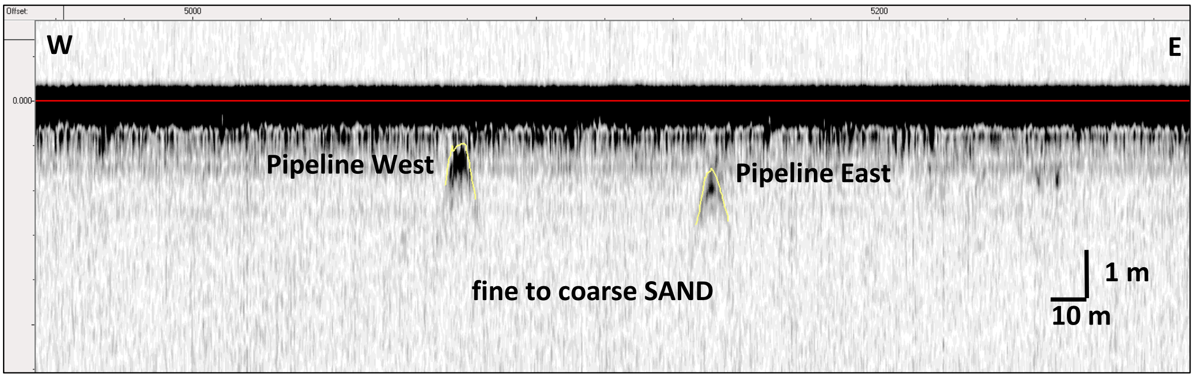

Figure 74 Chirp data image of two buried pipelines within top 2 m of shallow geology. Seabed flattening applied to data.

<u>KP 272.690 to KP 276.230:</u> The shallow geology comprise outcropping BEDROCK

<u>KP 276.230 to KP 278.857</u>: The shallow geology comprises of SAND and GRAVEL, over fine to medium SAND, which increases in thickness to 5 m BSF by KP 276.530, over BEDROCK (Figure 75). BEDROCK subcrops between KP 276.917 and 276.943 to <2 m BSF and between KP 277.167 and 277.193 to <3 m BSF. Followed by SAND and GRAVEL >5 m BSF over BEDROCK. The BEDROCK starts to shallow to less the 5 m BSF from KP 278.155.

<u>KP 278.857 to KP 283.770:</u> The shallow surface geology comprises of predominantly outcropping BEDROCK with irregular veneers and shallow channel infill with SAND and GRAVEL down to 2 to 4 m BSF (Figure 76).

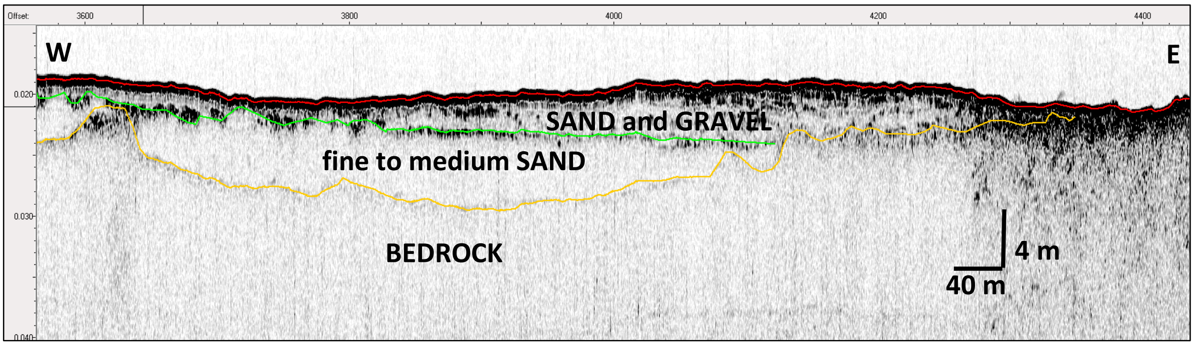

*Figure 75 Chirp data image showing outcropping BEDROCK at KP 276.201.
The BEDROCK is dipping below an overburden of SAND and GRAVEL.*

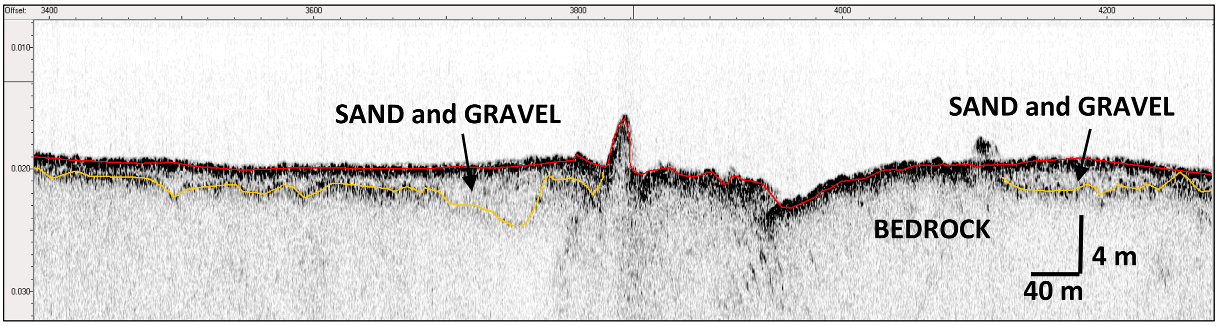

*Figure 76 Chirp data image of BEDROCK with a thin veneer of SAND.
The image is from the approach to the Spanish landfall from KP 280.75.*

3.1.5| SIDE SCAN SONAR CONTACTS

There are a total of 2133 SSS contacts located within the MR corridor. The SSS contacts have been reported as boulders, debris, objects and others. They are listed with their respective position (grid and geographic), relevant KP referenced survey centre line, size (L x W x H) and a DCC offset to the KP reference. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|. A summary of the boulder field occurrence, including surveyed centreline intersection, is presented in Table 27.

Table 27 Overview of boulder field occurrence along the MR corridor by KP.

KP Start	DCC (m)	KP End	DCC (m)	Boulder field	Boulder density	Average Size (m) L x W x H	Surveyed centreline Intersection KP Start	Surveyed centreline Intersection KP END
115.910	28	115.945	28	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	4.8x1.1x2.0	-	-
129.070	185	129.146	185	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.6 x 1.1 x 2.1	-	-
131.475	211	131.426	228	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.0 x 0.4 x 1.1	-	-
131.897	215	132.128	22	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.8 x 1.1 x 1.5	-	-
132.080	321	132.154	383	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.7 x 1.0 x 1.5	-	-

KP Start	DCC (m)	KP End	DCC (m)	Boulder field	Boulder density	Average Size (m) L x W x H	Surveyed centreline Intersection KP Start	Surveyed centreline Intersection KP END
132.239	66	132.704	76	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.7 x 1.3 x 1.3	132.307	132.525
132.334	592	132.355	592	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.0 x 0.8 x 1.7	132.308	132.513
132.405	551	132.445	551	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.0 x 0.4 x 0.6	-	-
132.424	620	132.462	620	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	2.2 x 1.7 x 1.2	-	-
133.350	236	134.357	155	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.9 x 1.7 x 1.4	133.719	134.306
135.724	119	135.757	73	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	2.0 x 1.4 x 1.3	-	-
135.815	79	135.835	77	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 1.1 x 1.0	-	-
135.825	161	135.842	155	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.3 x 1.0 x 0.7	-	-
160.590	8	160.596	8	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	0.6 x 0.7 x 0.3	160.687	160.691
160.768	65	160.821	11	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	0.9 x 0.7 x 0.5	160.791	160.819
161.087	21	161.239	47	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	0.6 x 0.5 x 0.5	161.153	161.187
161.291	140	161.348	142	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	0.7 x 0.5 0.6	-	-
162.269	87	162.412	101	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	1.0 x 0.7 x 0.8	-	-
162.476	55	162.530	35	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	0.7 x 0.4 x 0.7	-	-
162.525		162.593		Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	0.5 x 0.6 x 0.2	162.525	162.593
171.784	284	172.007	328	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	1.2 x 1.1 x 0.8	-	-
171.990	91	172.148	113	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	2.2 x 1.5 x 1.0	-	-
181.020	264	181.249	340	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.5 x 0.8 x 1.9	-	-
182.139	300	182.280	298	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.2 x 0.8 x 0.9	-	-
182.728	84	182.618	65	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	1.4 x 0.9 x 1.1	-	-
204.748	94	204.816	96	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 0.8 x 1.1	-	-
237.602	0	237.910	123	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.8 x 0.8 x 0.5	237.602	237.856

KP Start	DCC (m)	KP End	DCC (m)	Boulder field	Boulder density	Average Size (m) L x W x H	Surveyed centreline Intersection KP Start	Surveyed centreline Intersection KP END
237.880	32	238.813	365	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 0.6 x 1.1	238.020	238.568
238.619	47	238.836	124	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.2 x 0.6 x 1.1	238.648	238.788
238.738	216	238.792	198	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.0 x 0.5x 1.4	-	-
239.613	0	239.680	25	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 0.6 x 0.8	239.613	239.669
239.639	241	239.754	292	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.9 x 0.5 x 0.5	-	-
264.856	56	264.911	22	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 0.8 x 0.9	-	-
265.813	89	265.910	76	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.2 x 1.0 x 1.0	-	-
265.943	0	266.028	0	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 1.0 x 0.9	265.943	266.028
265.810	315	266.935	646	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.3 x 1.1 x 0.9	-	-
265.880	72	266.165	9	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 0.8 x 0.6	-	-
265.910	25	265.976	63	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.3 x 0.8 x 0.6	-	-
265.880	241	265.941	228	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.0 x 1.0 x 0.5	-	-
265.960	221	266.211	286	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.9 x 0.8 1.1	-	-
266.147	170	266.430	51	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.2 x 0.9 x 0.9	-	-
266.200	29	266.257	38	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 0.6 x 0.8	-	-
266.193	38	266.271	47	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.2 x 1.4 x 1.4	-	-
265.912	280	266.070	326	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.8 x 1.4 x 1.1	-	-
265.933	132	266.065	139	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.9 x 0.9 x 0.9	-	-
265.925	605	265.940	586	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.8 x 1.2 x 0.9	-	-
266.192	33	266.269	42	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.2 x 1.4 x 1.4	-	-
266.235	242	266.331	261	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 1.0 x 1.0	-	-
266.368	380	266.470	275	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.0 x 0.8 x 0.7	-	-

KP Start	DCC (m)	KP End	DCC (m)	Boulder field	Boulder density	Average Size (m) L x W x H	Surveyed centreline Intersection KP Start	Surveyed centreline Intersection KP END
266.530	200	265.470	200	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	0.8 x 0.8 x 0.7	-	-
266.440	275	266.540	285	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.9 x 0.7 x 0.9	-	-
266.670	143	266.745	138	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.8 x 0.8 x 0.8	-	-
266.860	23	266.802	48	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.8 x 0.8 x 0.7	-	-
267.003	355	267.030	363	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.8 x 0.6 x 0.6	-	-
266.930	673	267.044	661	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 0.9 x 0.9	-	-
267.140	373	267.203	367	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 1.0 1.0	-	-
267.370	419	267.470	412	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.3 x 0.8 x0.8	-	-
267.402	182	267.493	189	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.4 x 1.1 x 0.8	-	-
268.038	171	268.096	154	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.2 x 0.8 x 0.8	-	-
268.363	90	268.417	72	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.4 x 0.9 x 1.2	-	-
268.247	479	268.324	468	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 1.0 x 0.8	-	-

3.1.6| MAGNETIC AND GRADIOMETER ANOMALIES

There are a total of 242 magnetic anomalies (Phase 1) and 33 gradiometer anomalies (Phase 2) located within the MR corridor. They are classed with respect to their “dipole” shape: Monopole, Dipole, Asymmetric Dipole or Complex Anomaly. If relevant, comments have been listed with respect to the target being linear, possible geology or potential UXO. These anomalies have been plotted onto the relevant charts and lists are contained in Appendix F|.

Of particular note, there is a substantial linear feature reported as magnetic contacts T_FR_0008, T_FR_0013, T_FR_0010 and T_FR_0006 at KP 86.356, 90 m to starboard of the MR this lies within an explosives storage designated area (Figure 77).

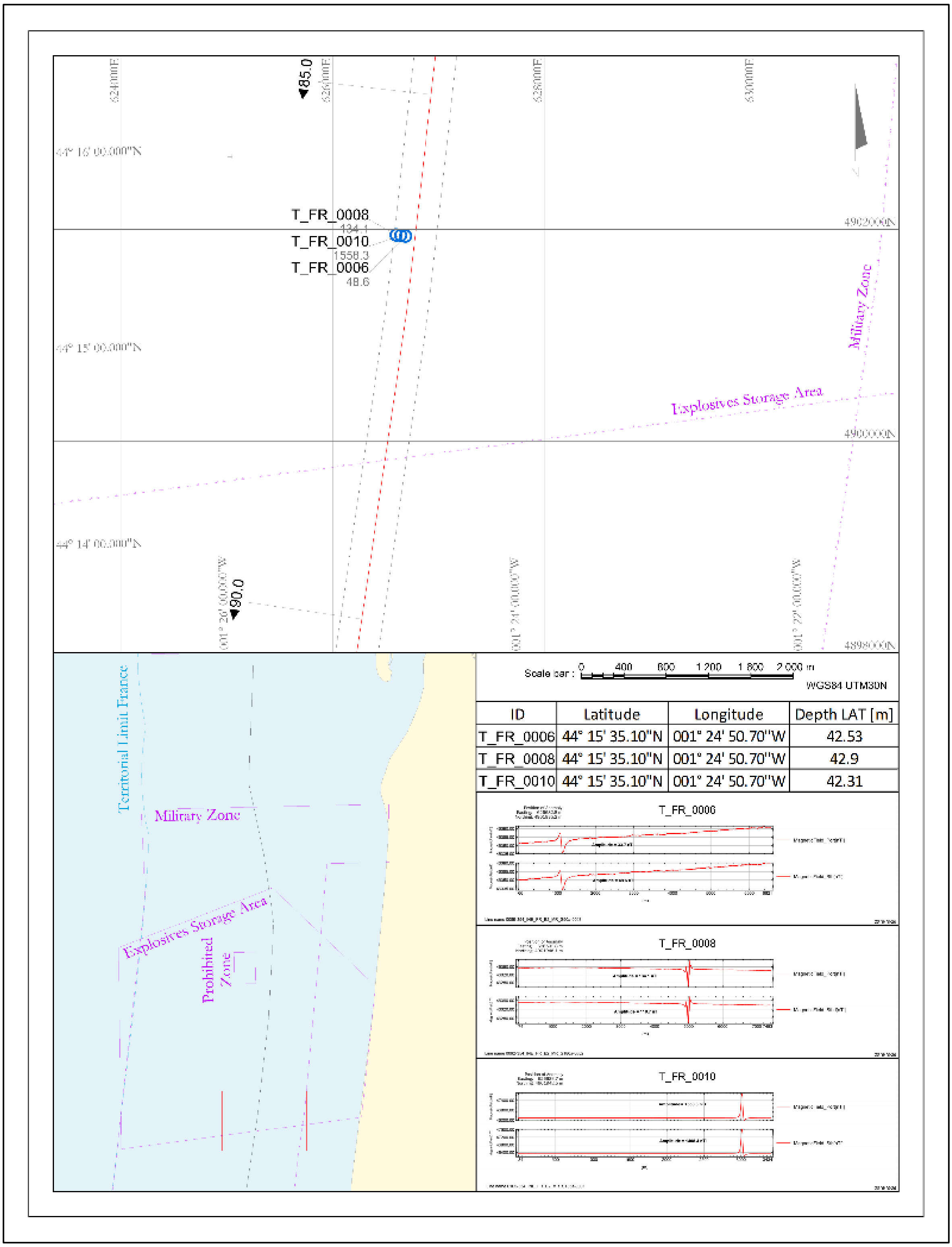

Figure 77 Magnetic contacts T_FR_0008, T_FR_0013, T_FR_0010 and T_FR_0006 at KP 86.356.

3.1.7| CABLES AND PIPELINES

Two existing, buried pipelines cross the MR: The ENAGAS Pipeline West, 16 inch and the ENAGAS Pipeline East, 6 inch. Both were located with SBP on each of the five survey run lines that crossed their respective locations. Details of the crossing points are given in chart 102354-INE-MMT-SUR-DWG-PCSPI001, Table 5 and Table 6 respectively. Their positions corresponded well with the existing RPL databases.

3.1.8| ADDITIONAL INFORMATION

The migratory mobile bedforms interpreted as dune like SAND deposits are present across extensive sections of the proposed route. As mobile features they would present a risk of exposure to cables buried within them. They are present between KP 47.648 and KP 143.932. (For specific location of these features see Table 8 and Alignment Charts 102354-INE-MMT-SUR-DWG-AMR00012 to 102354-INE-MMT-SUR-DWG-AMR00032).

There also are extensive areas of trawl scars present along a significant section of the proposed route between KP 66.655 and KP 89.198. This type of activity would present a risk to exposed or shallow buried cables (Charts 102354-INE-MMT-SUR-DWG-AMR00015 to 102354-INE-MMT-SUR-DWG-AMR00020).

The steep sided canyon head that the KP referenced survey centre line traverses between KP 153.9 and KP 158.1 may present some hazards to the installation of the proposed cables. After installation possible slumping of sediments down the steep canyon sides may adversely affect the cable. An alternative route option is presented in Section 2.8| and 3.7|.

3.2| LA CANTINE OPTION ROUTE

La Cantine Option Route is 12.433 km in length and is part of the MR. The limits of data collected for the MR are KP -0.138 to KP 283.730, this section covers the results up to KP 12.433, the remaining part of the MR is described in Section 2.2 and Section 3.1. KP -0.138 to KP 0.584 were acquired by UAV. KP 0.542 to KP 1.030 were acquired by diver survey. KP 1.030 to KP 283.730 were acquired aboard the M/V Franklin and M/V Geo Focus.

The depth on land ranges from - 28 m to a maximum of 11 m offshore. The route starts at KP 0 with an surface of SAND covered by intermittent vegetation, the vegetation give way with an increasing KP to SAND and dune like formations creating an more undulating surface closer to the shoreline, in the surf zone the undulations decreases creating a gently sloping beach.

3.2.1| POSITIONING

The calibrations and positioning test were carried out prior to any data collection phase. The results of these are presented in the MAC reports located in Appendix C|. Underwater positioning can be affected by pycnoclines and thermoclines that exist within water columns containing two or more bodies of water with differing densities and temperatures. The SSS images were indeed affected by these phenomena although the underwater positioning system for the ROTV functioned according to specification.

3.2.2| BATHYMETRY

KP -0.138 to KP 0.584 were acquired by UAV. KP 0.542 to KP 1.030 were acquired by diver survey. From KP 1.030 to the end of the route bathymetric data were acquired aboard the M/V Geo Focus and M/V Franklin. The first part of the MR is on land and characterised by undulating topography and sand dunes with intermittent vegetation. Maximum height is -28.5 m.

Along the initial E-W nearshore La Cantine section of the MR, the water depth increases from 5.0 m at KP 1.060 to 11.5 m at KP 1.250 (Figure 14). The water then deepens further; to 23.5 m at KP 4 and again to 32.5 m by KP 12.500, at this location the route turns south.

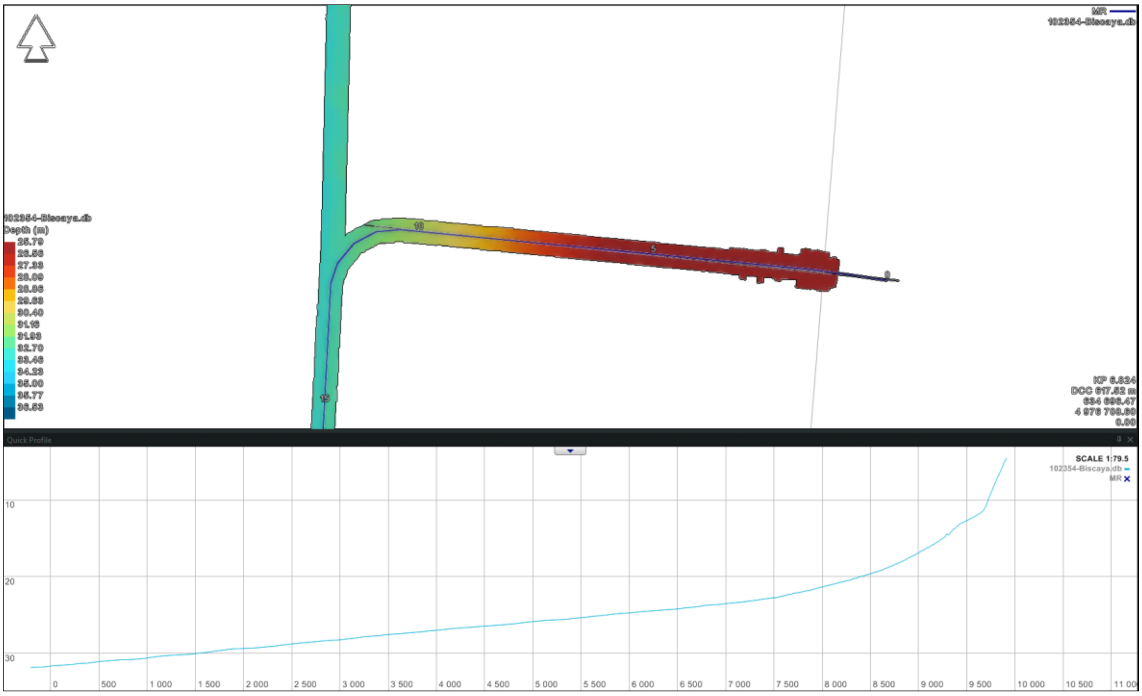

Figure 78 Overview of La Cantine landfall with significant depth increase, KP 1.07 to KP 10.80.

3.2.3| SURFICIAL GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

The surficial geology along this section is made up of the following surficial sediments; SILT and fine SAND and fine to coarse SAND (Figure 79).

The surficial geology of the nearshore La Cantine landfall from around KP 1.06 to KP 1.24 mainly comprises of fine to coarse SAND. From KP 1.24 to KP 3.29 it becomes SAND with ripples overlain by mobile SILT and fine SAND. The SAND with ripples is likely to range from fine to medium SAND, with a slightly gravelly fraction comprising of shell fragments. The ripples have a wavelength 0.3-1.0 m, orientated in a NNE-SSW direction and are likely caused by the water movements from tide, current and wave action.

From KP 3.29 (where the offshore section of the MR begins), the seabed sediments are interpreted to be featureless fine to medium SAND until KP 8.10. From here until around KP 12.43 ripples are observed in the SAND with wavelength of 0.3 to 1.0 m and these are orientated in a NNE-SSW direction (Figure 80).

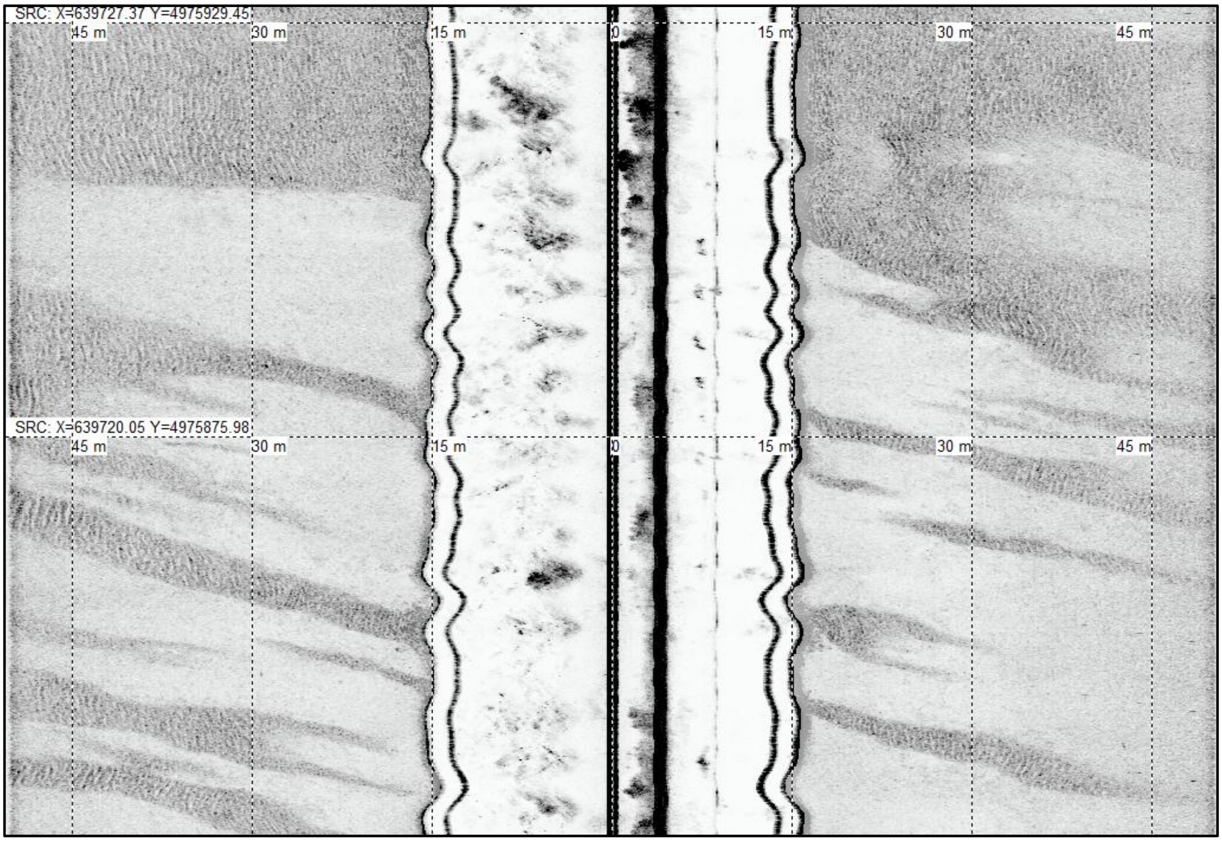

Figure 79 SSS data image from La Cantine at KP 1.70.
Illustrating surficial sediments of SAND with ripples overlain by SILT and fine SAND.

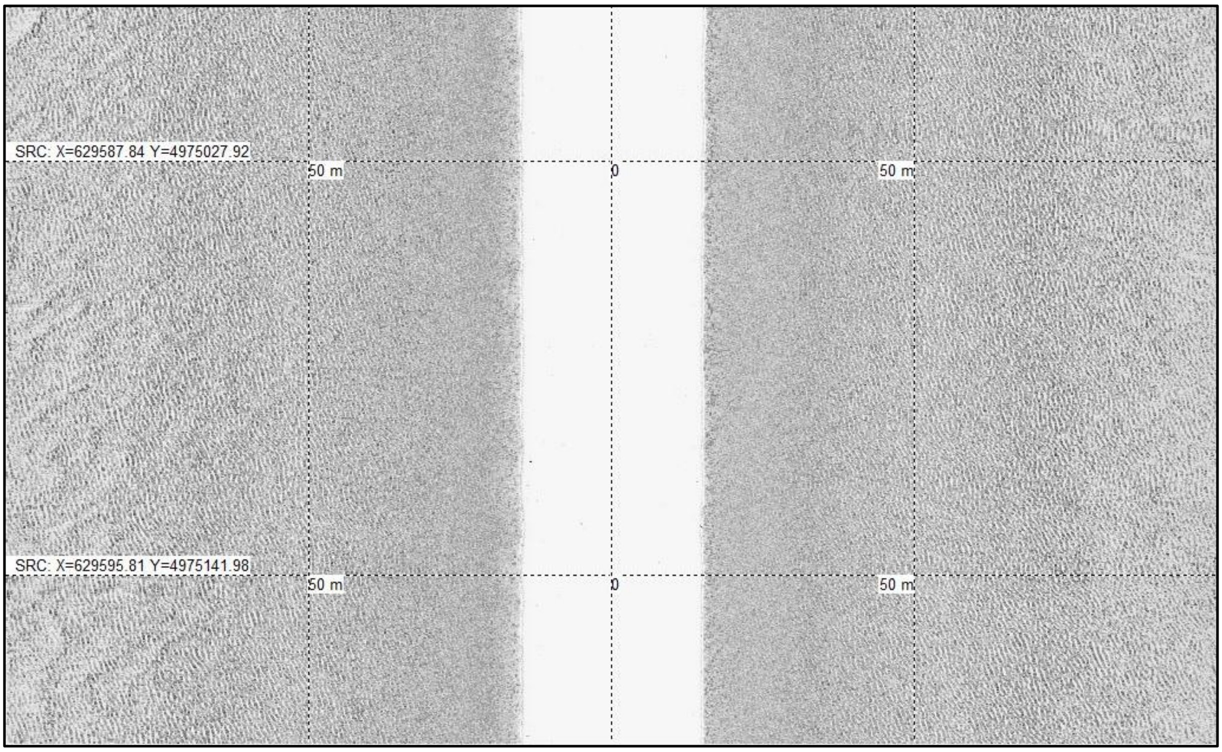

Figure 80 SSS data image of SAND with ripples at KP 12.00.

3.2.4| SHALLOW GEOLOGY

The following geophysical interpretations of the shallow geology are based on changes in acoustic character and are supported with geotechnical results.

The shallow geology is interpreted to comprise of fine to coarse SAND, initially 1 to 2 m thick thinning to 0.5 m by KP 2.04 (Figure 81). The underlying dense gravelly SAND overlies another deposit of SAND >5 m BSF.

Between KP 2.04 to KP 12.43 an uppermost unit of fine to medium SAND/fine to coarse SAND is present to depths >5 m, overlaying an undulating unit of SILT and SAND visible up to KP 7.14 (Figure 82 and Figure 83). From KP 11.82 to KP 12.43 the SAND is underlain by a poorly structured unit of sandy CLAY.

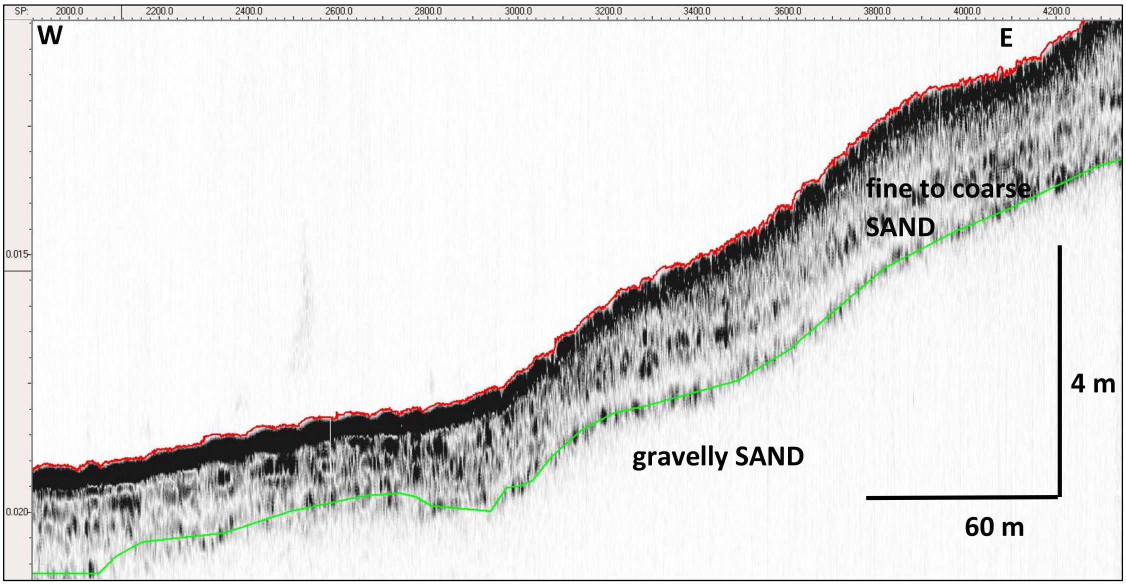

Figure 81 Innomar SBP data image with picked horizon below 1 to 2 m of SAND at KP 1.25. Seabed flattening applied to data.

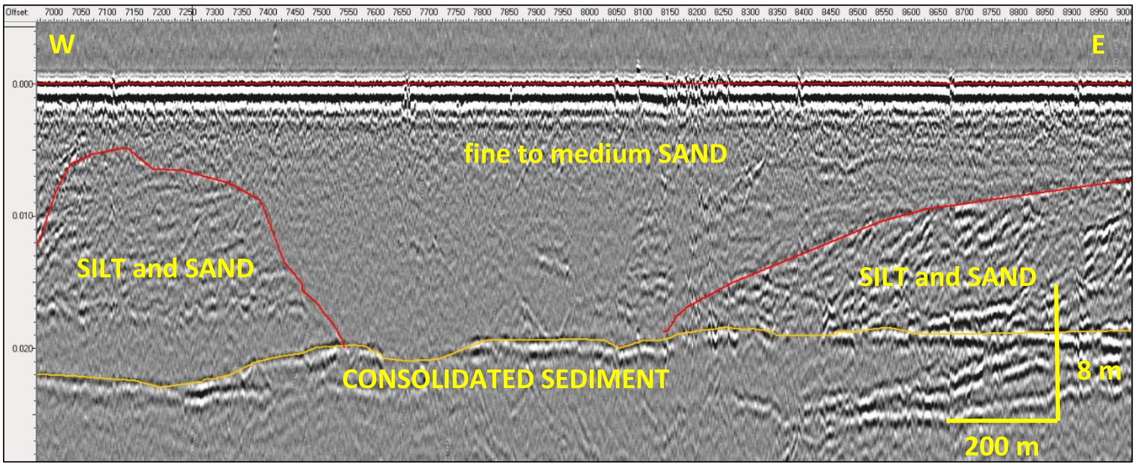

Figure 82 Sparker data image showing thick SAND units over CONSOLIDATED SEDIMENT >15 m BSF, at KP 4.00. Seabed flattening applied to data.

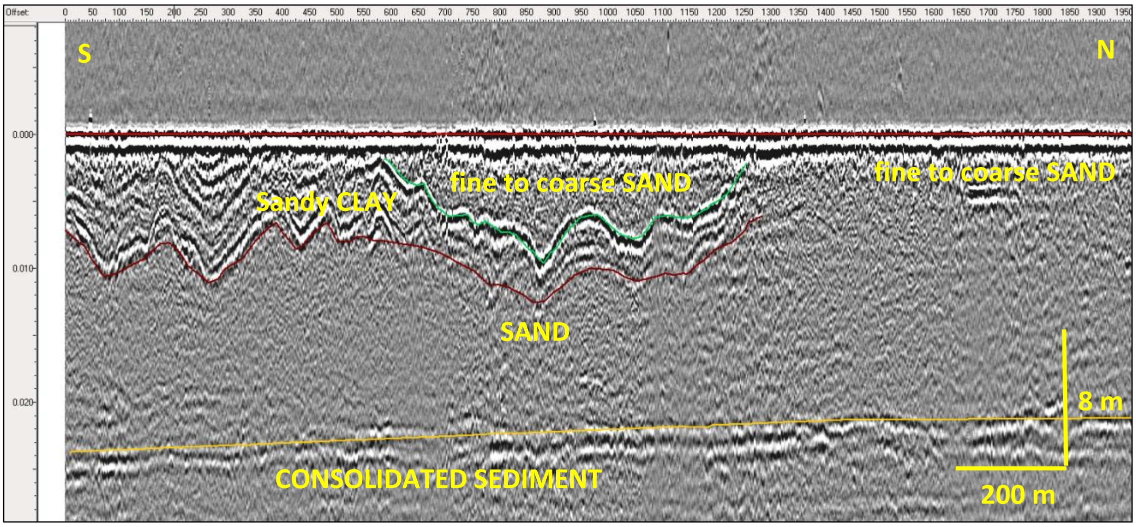

Figure 83 Sparker data image showing SAND units thicker than 5 m BSF overlaying sandy CLAY and SAND, at KP 11.8. Seabed flattening applied to data.

3.2.5| SIDE SCAN SONAR CONTACTS

There are a total of 19 SSS contacts located within the La Cantine Option Route corridor. The contacts have been reported as boulders, debris, objects and others. They are listed with their respective position (grid and geographic), relevant route section KP, size (L x W x H) and a DCC offset to the proposed route. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|

3.2.6| MAGNETIC AND GRADIOMETER ANOMALIES

There are a total of two (2) magnetic anomalies (Phase 1) and four (4) gradiometer anomalies (Phase 2) located within the La Cantine Option Route corridor. They are classed with respect to their "dipole" shape: Monopole, Dipole, Asymmetric Dipole or Complex Anomaly. If relevant, comments have been listed with respect to the target being linear, possible geology or potential UXO. These anomalies have been plotted onto the relevant charts and lists are contained in Appendix F|.

3.2.7| CABLES AND PIPELINES

No existing pipelines or cables cross the proposed route.

3.2.8| ADDITIONAL INFORMATION

There were no specific hazards, such as large scale mobile bedforms or trawl scars, observed within the surveyed corridor.

3.3| LACANAU OPTION ROUTE

LACO is 21.7 km in length and lies to the north of the MR preferred landing at La Cantine. The limits of data collected for the LACO are KP -0.045 to KP 21.7. KP -0.045 to KP 0.320 were acquired by UAV. KP 0.422 to KP 0.986 were acquired by diver survey. The two survey vessels M/V Franklin (offshore) and M/V Geo Focus (nearshore) acquired data between KP 0.805 to KP 21.7 where it coincides with the MR at KP 12.43 (MR KP protocol).

The depth ranges from - 27 m on land to a maximum of 33 m offshore. The route starts at KP 0 with a surface of SAND covered by intermittent vegetation. The route lies on a pathway with no vegetation. Closer to the shoreline the surface comprise of SAND, in the surf zone a gently sloping beach.

3.3.1| POSITIONING

The calibrations and positioning test were carried out prior to any data collection phase. The results of these are presented in the MAC reports located in Appendix C|. Underwater positioning can be affected by pycnoclines and thermoclines that exist within water columns containing two or more bodies of water with differing densities and temperatures. The SSS images were indeed affected by these phenomena although the underwater positioning system for the ROTV functioned according to specification.

3.3.2| BATHYMETRY

The LACO landfall is the most northern of the three options along the French coast. The limits of data collected for the LACO are KP -0.045 to KP 21.7. KP -0.045 to KP 0.320 were acquired by UAV. KP 0.422 to KP 0.986 were acquired by diver survey.

The depth ranges from -27 m on land to a maximum of 33 m offshore. The route starts at KP 0 with a seabed surface of SAND covered by intermittent vegetation. The route lies on a pathway with no vegetation. Closer to the shoreline the surface comprise of SAND, in the surf zone a gently sloping beach. The depths increase quite significantly from the start of the route until KP 14.00. The bathymetry is fairly even from KP 14 to KP 22 at roughly 35 m with a few areas of irregular seabed at about KP 14.00 and KP 15.7 (Figure 15).

3.3.3| SURFICIAL GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

The surficial geology comprises alternating patches of mobile SILT and fine SAND and in areas ripples are observed. rippled (Figure 84). From KP 3.3 to KP 10.5 featureless fine to medium SAND is present, which becomes fine to medium SAND with ripples from KP 10.5 to the end of the route (Figure 85).

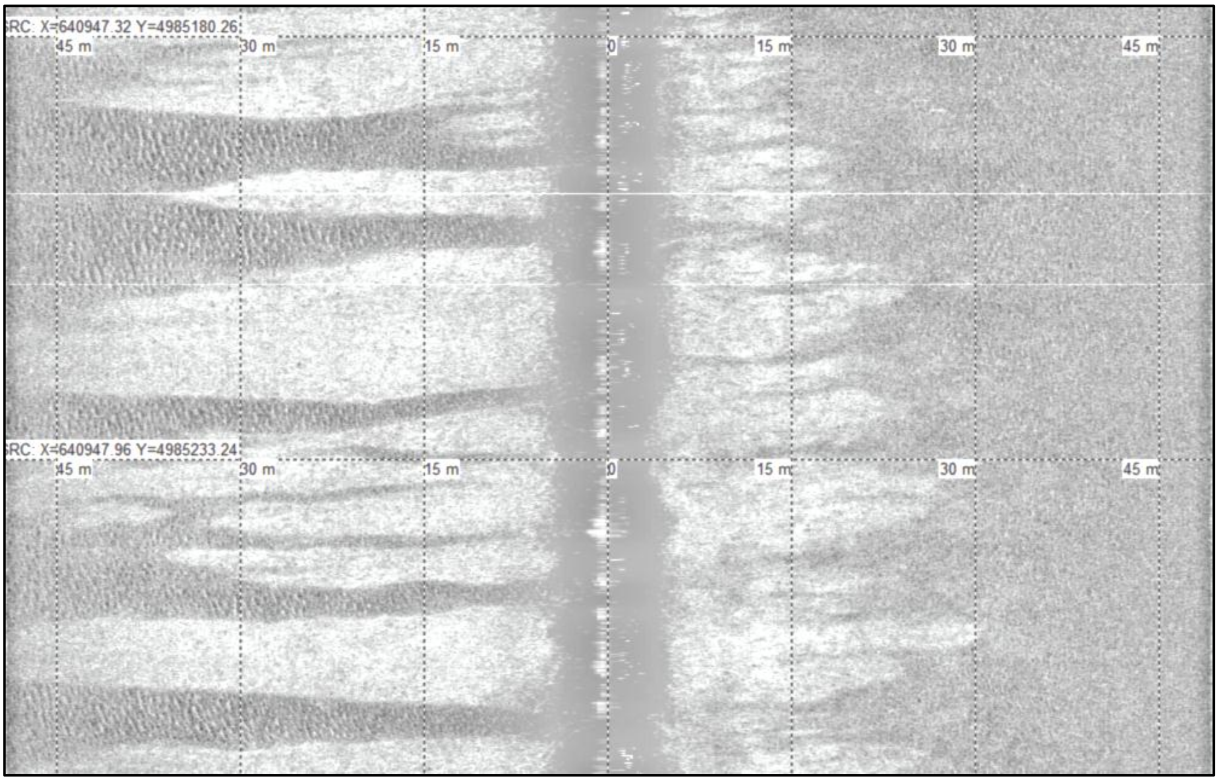

Figure 84 SSS data image from LACO landfall, KP 1.00.

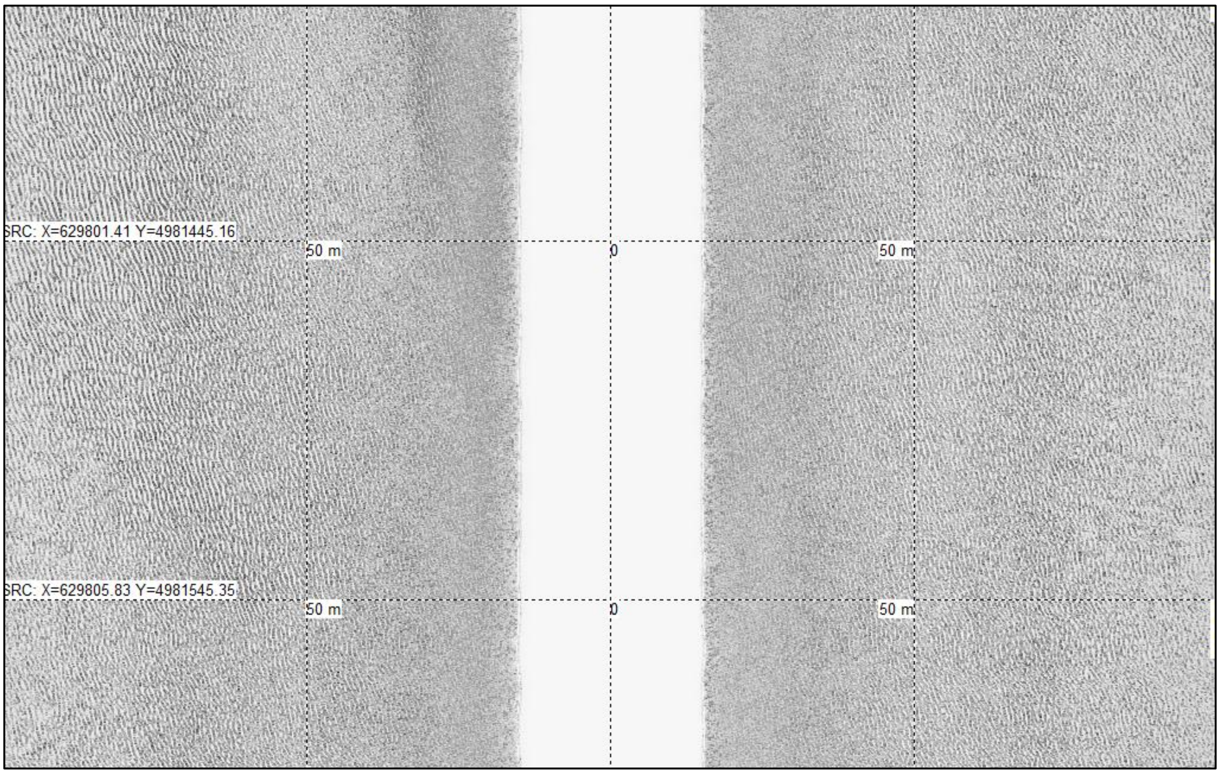

Figure 85 SSS data image of SAND with ripples at KP 16.00 along LACO route option.

3.3.4| SHALLOW GEOLOGY

The following geophysical interpretations of the shallow geology are based on changes in acoustic character and are supported with geotechnical results.

The shallow geology comprises an intermittent veneer of SILT and fine SAND, over a fine to medium SAND ~1.5 m BSF at KP 0.85 decreasing to less than 1.0 m at KP 1.88, overlaying a unit of dense SAND >5 m BSF (Figure 86).

From KP 1.88 onwards, fine to medium SAND >5 m BSF extends along almost the entire route with a SILT and fine SAND veneer between KP 2.91 to KP 3.27. Up to KP 9.44 this overlays an intermittent unit of SILT and SAND generally >5 m BSF, except at KP 4.74 to KP 5.03 where the SILT and SAND is within 4 m of seabed (Figure 87).

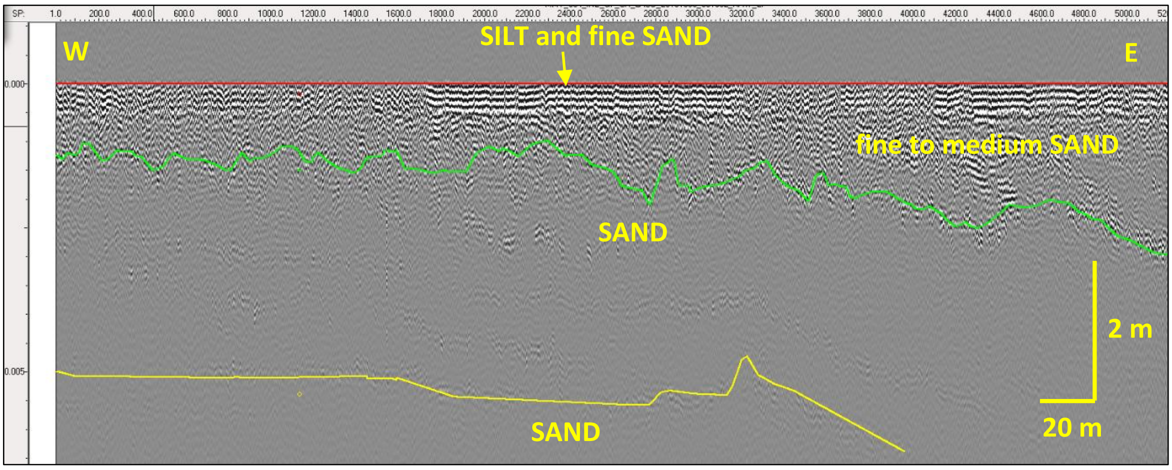

Figure 86 Innomar data image of shallow geology at KP 1.25 along LACO option. (Seabed flattening of data applied).

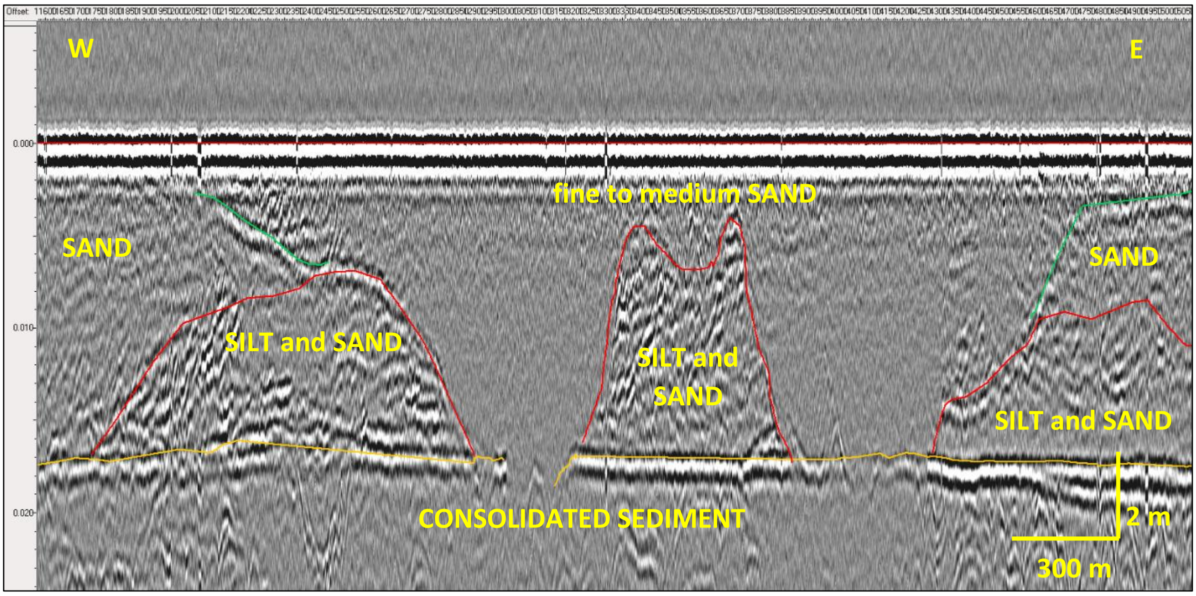

Figure 87 Sparker data image of shallow geology at KP 5.00 showing SAND unit >5 m BSF along LACO option. Seabed flattening of data applied.

3.3.5| SIDE SCAN SONAR CONTACTS

There are a total of 10 SSS contacts located within the LACO option corridor. The contacts have been reported as boulders, debris, objects and others. They are listed with their respective position (grid and geographic), relevant KP reference survey centre line, size (L x W x H) and a DCC offset to the KP reference. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|

3.3.6| MAGNETIC AND GRADIOMETER ANOMALIES

There are a total of nine (9) magnetic anomalies (Phase 1) and one (1) gradiometer anomaly (Phase 2) located within the LACO corridor. They are classed with respect to their “dipole” shape: Monopole, Dipole, Asymmetric Dipole or Complex Anomaly. If relevant, comments have been listed with respect to the target being linear, possible geology or potential UXO. These anomalies have been plotted onto the relevant charts and lists are contained in Appendix F|.

3.3.7| CABLES AND PIPELINES

No existing pipelines or cables cross the proposed route.

3.3.8| ADDITIONAL INFORMATION

There were no specific hazards, such as large scale mobile bedforms or trawl scars, observed within the surveyed corridor.

3.4| LE GRANDE CROHOT OPTION ROUTE

3.4.1| POSITIONING

The calibrations and positioning test were carried out prior to any data collection phase. The results of these are presented in the MAC reports located in Appendix C|. Underwater positioning can be affected by pycnoclines and thermoclines that exist within water columns containing two or more bodies of water with differing densities and temperatures. The SSS images were indeed affected by these phenomena although the underwater positioning system for the ROTV functioned according to specification.

LGCO lies to the south of the preferred proposed nearshore section. The limits of data collected for LGCO are KP -0.085 to KP 12.430. KP -0.085 to KP 0.577 were acquired by UAV. KP 0.499 to KP 1.102 were acquired by diver survey. The limit of survey with the two survey vessels M/V Franklin (offshore) and M/V Geo Focus (nearshore) were KP 1.051 to KP 12.020 where it coincides with the MR at KP 24.687 (Table 4).

The depth ranges from -20.9 m on land to 22.9 m offshore. The route starts at KP 0 with a seabed surface of SAND covered by intermittent vegetation. Closer to the shoreline the surface comprise of SAND, in the surf zone a gently sloping beach

3.4.2| BATHYMETRY

LGCO route is the southern alternative landfall route in the French sector. The route starts in an area surrounded by vegetation and steep slopes, the route itself is however along a pathway of SAND that cuts through the vegetation and dune like morphology down towards the beach. The height at the start of the route is -17 m with steep slopes across and on both sides of the route. On the beach itself the slopes become more gentle and mainly dipping towards the shoreline.

The seabed is predominantly featureless and the seabed slopes from 4 m to 10.5 m between KP 0.995 and KP 1.200. Thereafter, the slope becomes more gradual reaching a depth of 22 m at KP 3.6 and 33.5 m at KP 12.01 (Figure 16). There are a few noteworthy reliefs from KP 8.00 to KP 12.00 (Figure 88) where the end of the route merges with the MR route.

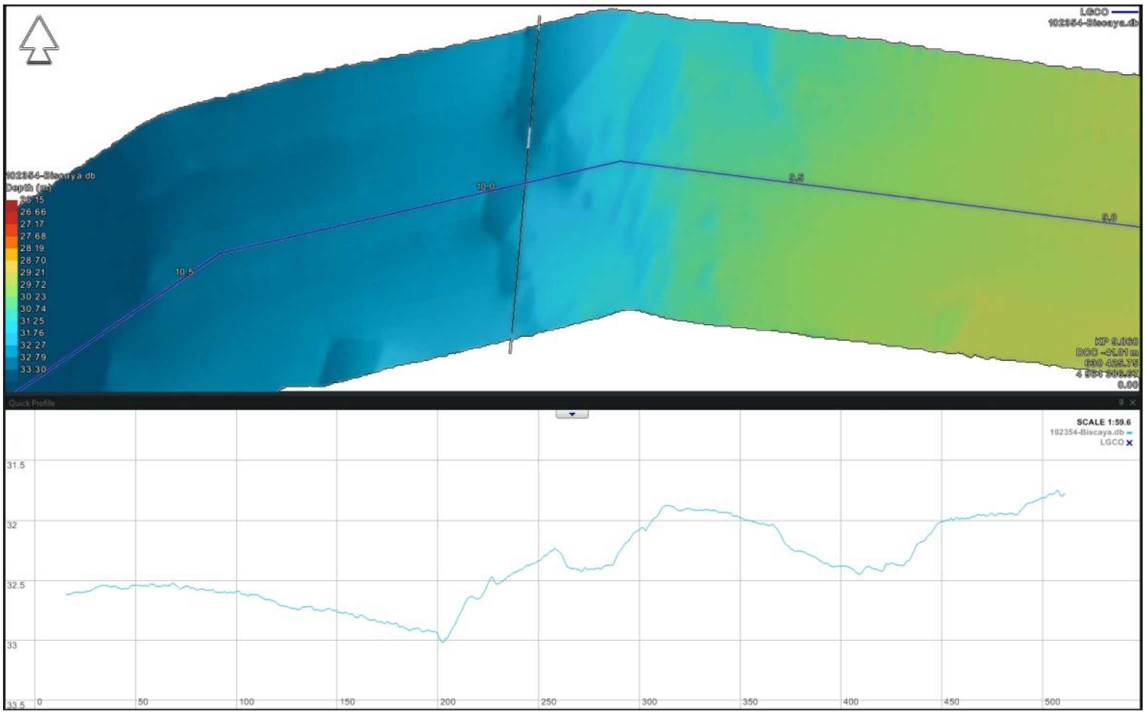

Figure 88 Shaded bathymetric relief at KP 9.86 of LGCO route.

3.4.3| SURFICIAL GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

The surficial geology comprises rippled fine to coarse SAND between KP 1.069 and KP 1.150, with mobile SILT and fine SAND KP 1.150 to KP 1.603, continuing with rippled fine to coarse SAND until KP 3.820 (Figure 89).

Featureless fine to coarse SAND extends from KP 3.820 until KP 7.500.

Between KP 7.50 and KP 11.230, the seabed comprises of mobile fine to coarse SAND with ripples, 0.3-1.5 m, orientated N-S, interspersed with furrowed exposures of SAND and GRAVEL with ripples, wavelength of 0.5-1.5 m, orientated in a NNE-SSW direction.

From KP 11.230 to the end of this route at KP 12.020 there is a transition to rippled SAND and GRAVEL with isolated dune like moble SAND bedforms (Figure 90).

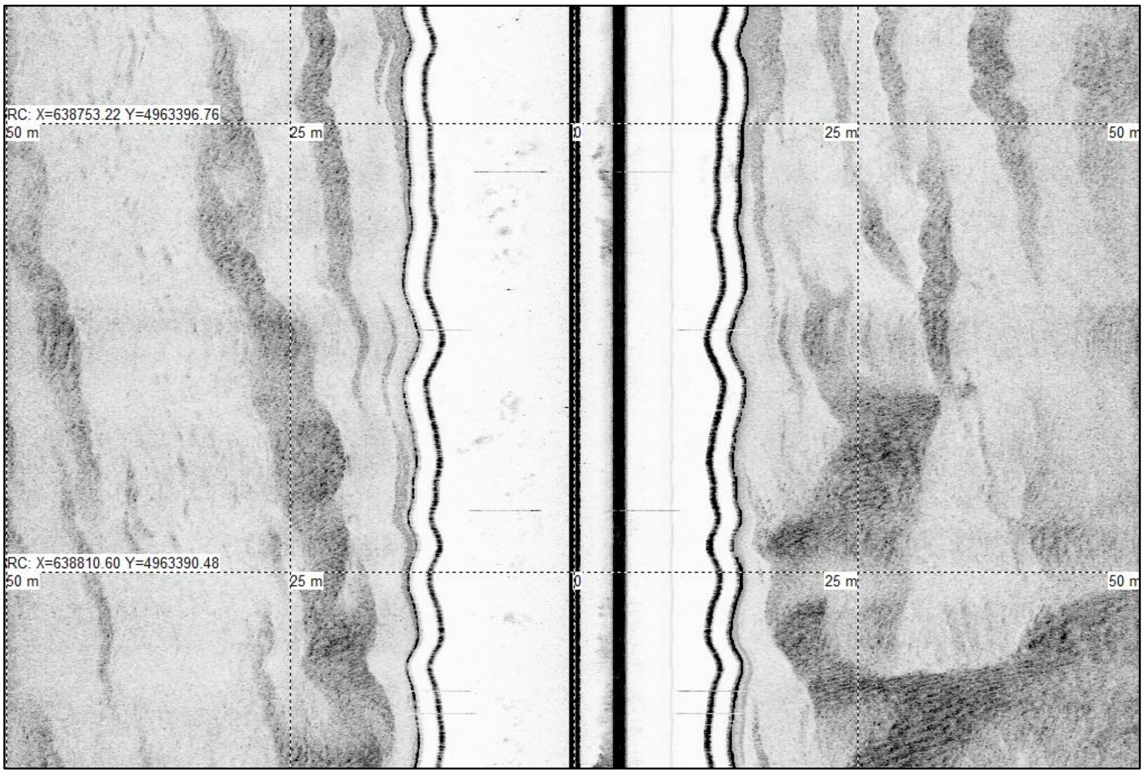

Figure 89 SSS data image from LGCO at KP 1.40 showing SAND with ripples interspersed with mobile SILT and fine SAND deposits.

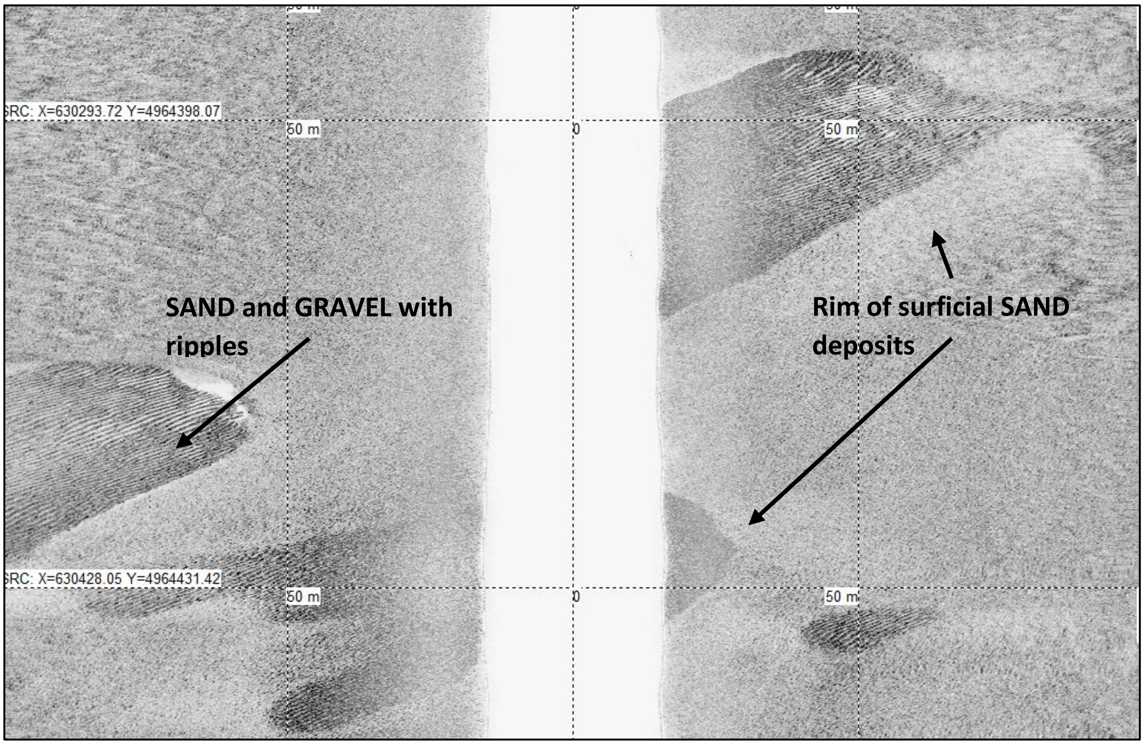

Figure 90 SSS Data from LGCO at KP 9.80.SAND over substrate of SAND and GRAVEL with ripples.

3.4.4| SHALLOW GEOLOGY

The following geophysical interpretations of the shallow geology are based on changes in acoustic character and are supported with geotechnical results.

Between KP 0.995 to KP 3.388, the shallow geology comprises of an intermittent veneer of mobile SILT and fine SAND, overlaying a unit of fine to coarse SAND up to 1 m BSF, overlying a unit of dense SAND that extends to greater than 5 m BSF (Figure 91). From here until KP 8.967 the uppermost unit of fine to coarse SAND extends to depths greater than 5 m BSF

From KP 8.967 the intermittent mobile unit of fine to coarse SAND, up 1.5 m thick, becomes underlain by SAND and GRAVEL. (Figure 92 and Figure 93). The mobile SAND is observed between KP 8.867-KP 9.455, KP 10.005-KP 10.490, KP 10.830-KP 11.235, and KP 11.333-KP 1.557.

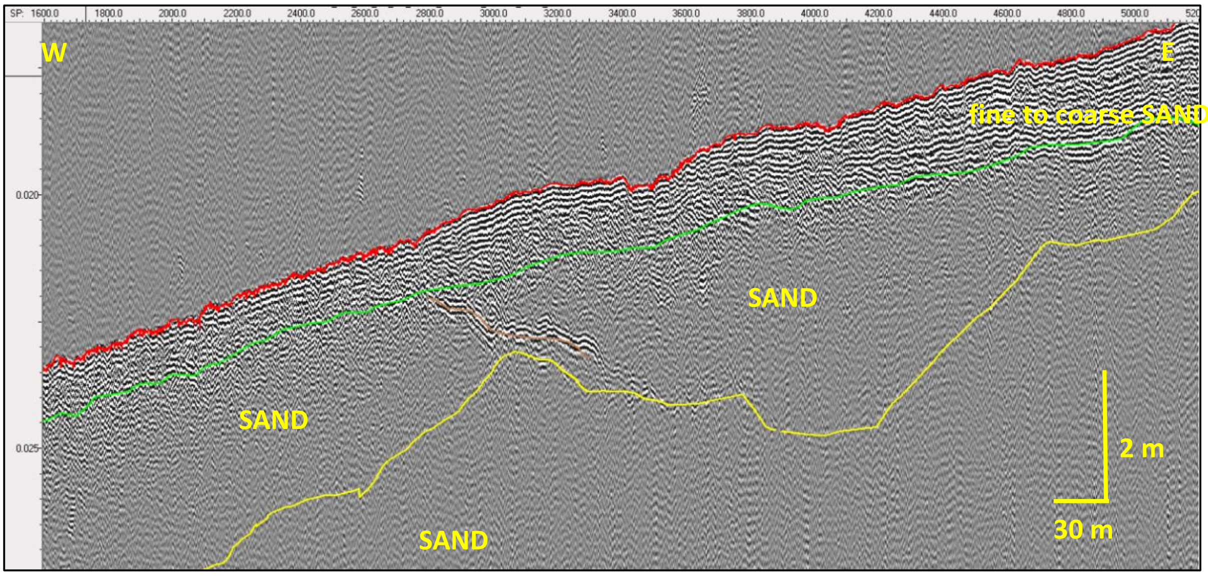

Figure 91 Sparker data image of the shallow geology along the LGCO route option from KP 1.40.

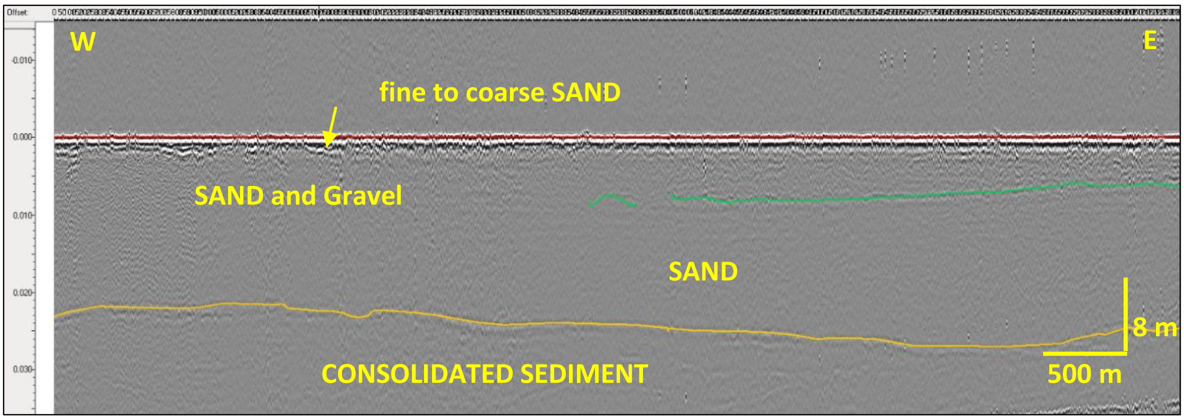

Figure 92 Sparker data image of shallow geology between KP 5 and KP 12 of the LGCO. Seabed flattening applied to data.

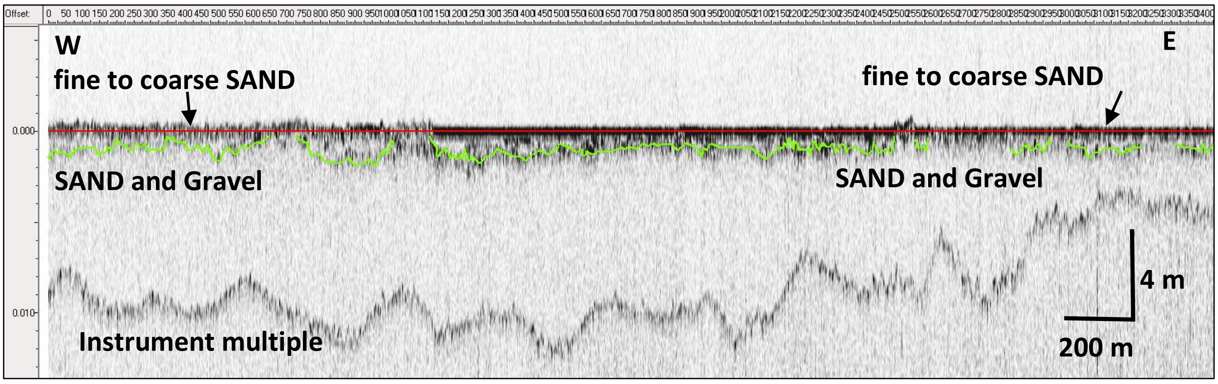

Figure 93 Chirp data image of fine to coarse SAND overburden towards end of LGCO. Seabed flattening applied to data.

3.4.5| SIDE SCAN SONAR CONTACTS

There are a total of 12 SSS contacts located within the LGCO corridor. The contacts have been reported as boulders, debris, objects and others. They are listed with their respective position (grid and geographic), relevant KP reference survey centre line, size (L x W x H) and a DCC offset to the KP reference. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|.

3.4.6| MAGNETIC AND GRADIOMETER ANOMALIES

There was just one (1) magnetic anomalies (Phase 1) and one (1) gradiometer anomaly (Phase 2) located within the LGCO corridor. If relevant, comments have been listed with respect to the target being linear, possible geology or potential UXO. It has been plotted on the relevant chart and listed in Appendix F|.

3.4.7| CABLES AND PIPELINES

No existing pipelines or cables cross the proposed route.

3.4.8| ADDITIONAL INFORMATION

There were no specific hazards, such as large scale mobile bedforms or trawl scars, observed within the surveyed corridor.

3.5 | WESTERN ROUTE ALTERNATIVE - FRENCH WATERS

RRNC-AL is a 38.130 km section that runs north of the MR (NB not shown in Figure 1). It departs from the MR at KP 115.720 KP (Table 4) and re-joins at KP 150.600 (Table 4). The survey of the route consists of a single line without any sparker data.

To be noted is that the RRNC-AL was surveyed during Phase 1 and that no UXO- or geotechnical surveys were performed during Phase 2.

3.5.1 | POSITIONING

The calibrations and positioning test were carried out prior to any data collection phase. The results of these are presented in the MAC reports located in Appendix C|. Underwater positioning can be affected by pycnoclines and thermoclines that exist within water columns containing two or more bodies of water with differing densities and temperatures. The SSS images were indeed affected by these phenomena although the underwater positioning system for the ROTV functioned according to specification.

3.5.2 | BATHYMETRY

The seabed very gently shoals from KP 0.00 at a depth of 48.2 m to 47.0 m by KP 0.500, it continues virtually level to KP 1.995 then very gently dips to 49.7 m at KP 8.723. From here it shoals very gently to 49 m at KP 9.663, then dips gently to 54.6 m at KP 14.000. The bathymetric profile below (Figure 94) shows the seabed undulating, +/-2 m, until becoming more level from KP 18.410, at a depth of 52.0 m. Then the seabed dips gently from KP 23.500 to 60.1 m KP 29.692, then contuse dipping very gently to 66.2 m at KP 32.865. From his point the seabed shoals to a depth of 36.8 m at KP 38.127 (Figure 17).

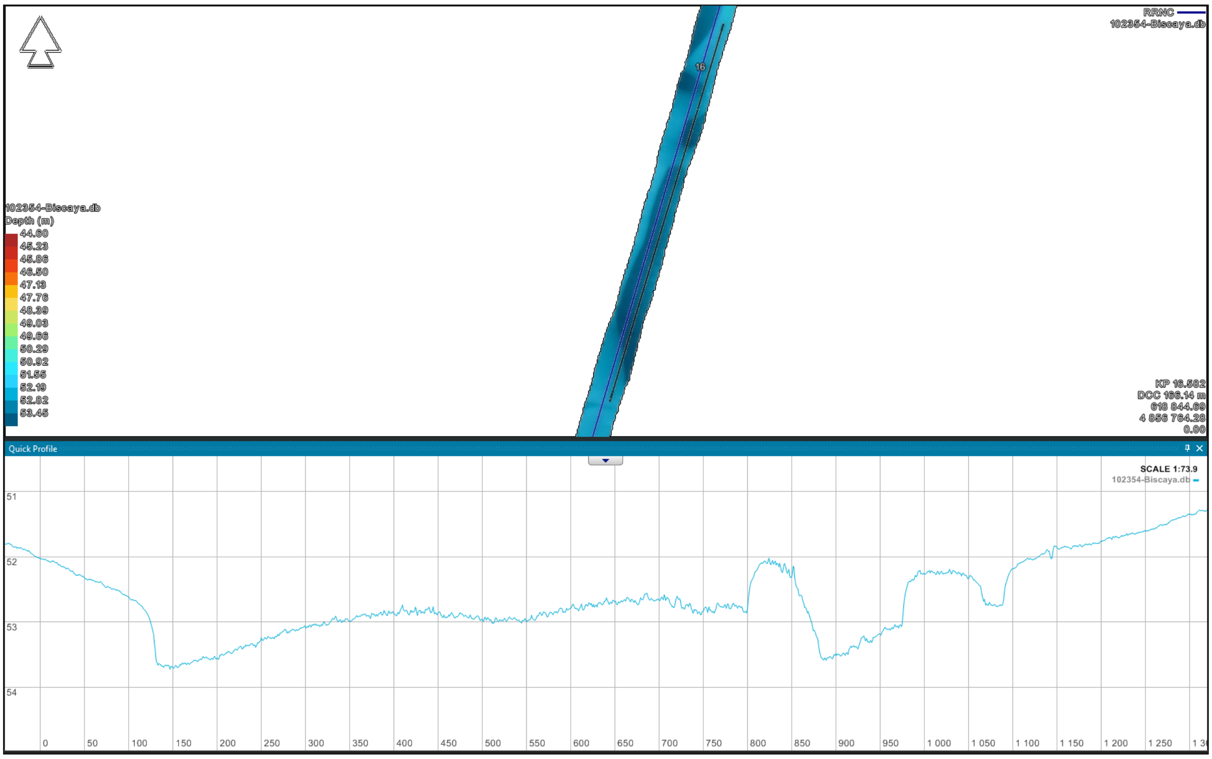

Figure 94 Bathymetry along a section of RNNC-AL between KP 17.00 and KP 18.00.

3.5.3| SURFICIAL GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

The surficial geology from KP 0.000 comprises SAND and GRAVEL with ripples (orientated NE-SW) that has been extensively trawled up to KP 3.450. From KP 1.990 to around KP 17.800, mobile re-worked surficial fine to medium SAND, forming dune like bedforms (the morphology of which is described in detail in Mazières *et al.* 2015), overlies coarser SAND and GRAVEL with ripples. (Figure 95). From around KP 17.800 to the end of this route the fine to medium SAND becomes the predominant surficial sediment.

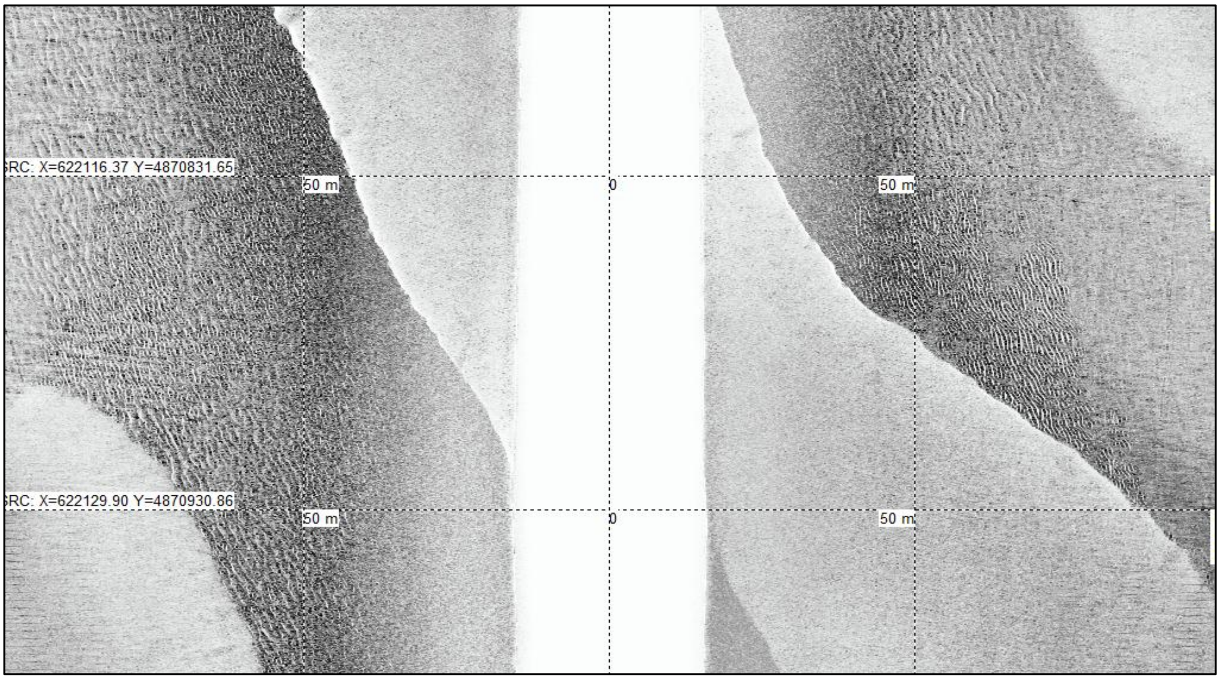

Figure 95 SSS data image of SAND and GRAVEL with ripples overlain by mobile SAND bedforms. From KP 2.10 along the route.

3.5.4| SHALLOW GEOLOGY

The following geophysical interpretations of the shallow geology are based on changes in acoustic character and are supported with geotechnical results.

From the Start of this route to KP 17.8 intermittent fine to medium SAND bedforms, up to 2 m thick, overlaying SAND and GRAVEL to depths >5 m BSF, up to KP 17.800. From here to the end of the route, the fine to medium SAND is mostly continuous at the seabed and thickens often to >5 m BSF. This overlays a SAND and GRAVEL unit, present along the entire length of the route. (Figure 96 and Figure 97).

CONSOLIDATED SEDIMENT is likely to underlay the SAND and GRAVEL along this route, but penetration of the shallow geology was quite limited in the absence of any sparker data acquired.

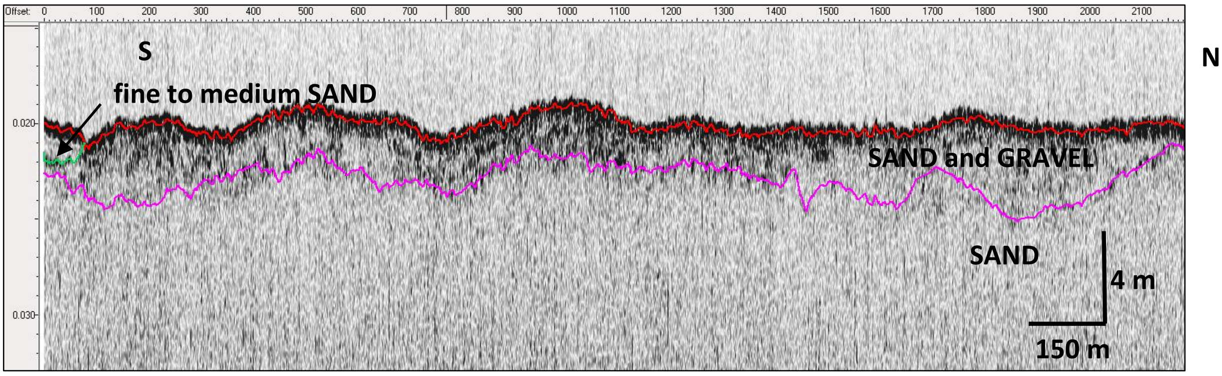

Figure 96 Chirp data image of shallow geology at KP 1.000 along the RRNC-AL route.

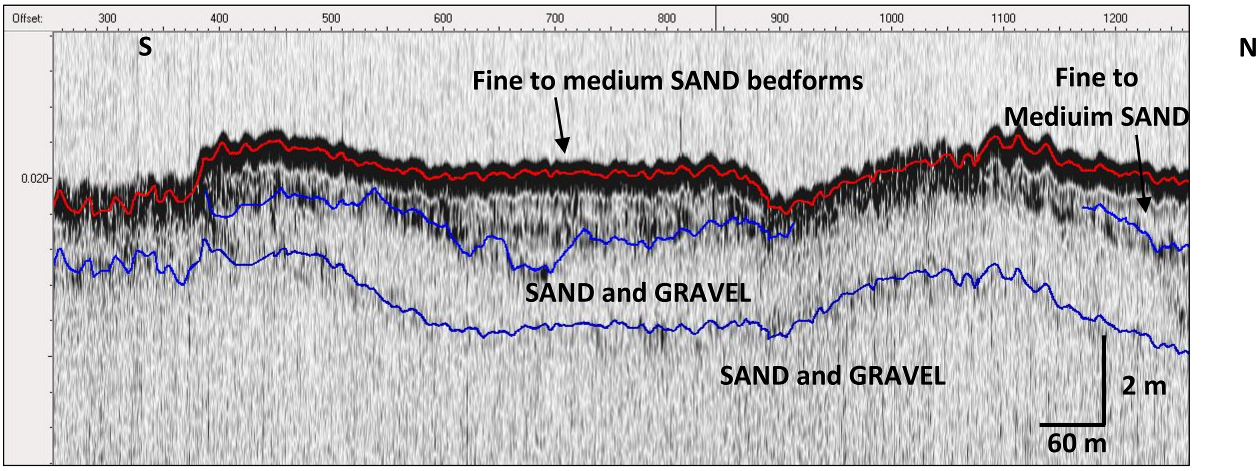

Figure 97 Chirp data image between KP 10.722 and KP 11.193 along the RNNC-AL route. Showing the shallow geology including mobile "dune like" SAND bedforms.

3.5.5| SIDE SCAN SONAR CONTACTS

There are a total of seven (7) SSS contacts located within the RRNC-AL corridor option. The contacts have been reported as boulders, debris, objects and others. They are listed with their respective position (grid and geographic), relevant KP reference survey centre line, size (L x W x H) and a DCC offset to the KP reference. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|. A summary of the boulder field occurrence is presented in Table 28.

Table 28 Overview of boulder field occurrence along RRNC-AL by KP.

KP Start	DCC (m)	KP End	DCC (m)	Boulder field	Boulder density	Average Size (m) L x W x H	Surveyed centreline Intersection KP Start	Surveyed centreline Intersection KP END
0.170	69	0.211	60	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	4.8x1.1x2.0	-	-
13.860	0	14.399	0	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.5 x 0.7 x 0.8	-	-
14.460	0	14.595	0	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.2 x 0.9 x 1.2	-	-
14.830	0	14.904	13	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.0 x 0.7 x 0.7	-	14.865

3.5.6| MAGNETIC AND GRADIOMETER ANOMALIES

There was just one (1) magnetic anomaly (Phase 1) located within the RRNC-AL corridor. It was classed with respect to its shape as a monopole. No other assessment or comment of the target is made at this stage. It has been plotted on the relevant chart and listed in Appendix F|.

3.5.7| CABLES AND PIPELINES

No existing pipelines or cables cross the proposed route.

3.5.8| ADDITIONAL INFORMATION

The mobile “dune like” SAND bedforms exist across extensive sections of the proposed route. As mobile features they would present a risk of exposure to cables buried within them. They are present between KP 2.000 and KP 17.518. For specific location of these features see Table 13 and Alignment 102354-INE-MMT-SUR-DWG-ARRNC001 to 102354-INE-MMT-SUR-DWG-ARRNC004.

Also there are extensive areas of trawl scars present along a significant section of the proposed route between KP 0.000 and KP 3.450. This type of activity would present a risk to either exposed or shallow buried cables.

3.6| CANYON HEAD BYPASS COAST OPTION

CHBC option route is an 11.4 km section on to the MR between KP 150.5 and KP 161.9 (Table 4). This section is designed to skirt nearshore around the head of the canyon. At KP 150.5 the route runs in an easterly direction arcing south by KP150 and arcing west at KP 157.5. The section KP 152.737 to KP 159.554 was surveyed by the M/V Geo Focus with a pole-mounted Innomar SBP and SSS.

3.6.1| POSITIONING

The calibrations and positioning test were carried out prior to any data collection phases. The results of these are presented in the MAC reports located in Appendix C|. Underwater positioning can be affected by pycnoclines and thermoclines that exist within water columns containing two or more bodies of water with differing densities and temperatures. The SSS images were indeed affected by these phenomena although the underwater positioning system for the ROTV functioned according to specification.

3.6.2| BATHYMETRY

The seabed shoals relatively quickly from 37.5 m at KP 150.500 and then levels off at KP 154.765 at a depth of 3.5 m (Figure 18). The route traverses the head of the Capbreton Canyon, it dips down steeply to a depth of 14 m then back up to 5 m at KP 155.834 shoals another meter or so then dips to 6.0 m along the edge of the canyon at KP 156.27. Again the seabed dips steeply to 13.8 m and then shoals steeply to 5.3 m at KP 156.845 (Figure 98). The seabed dips down relatively steeply from a depth of 5 m to reach a depth of 40.5 at KP 161.900.

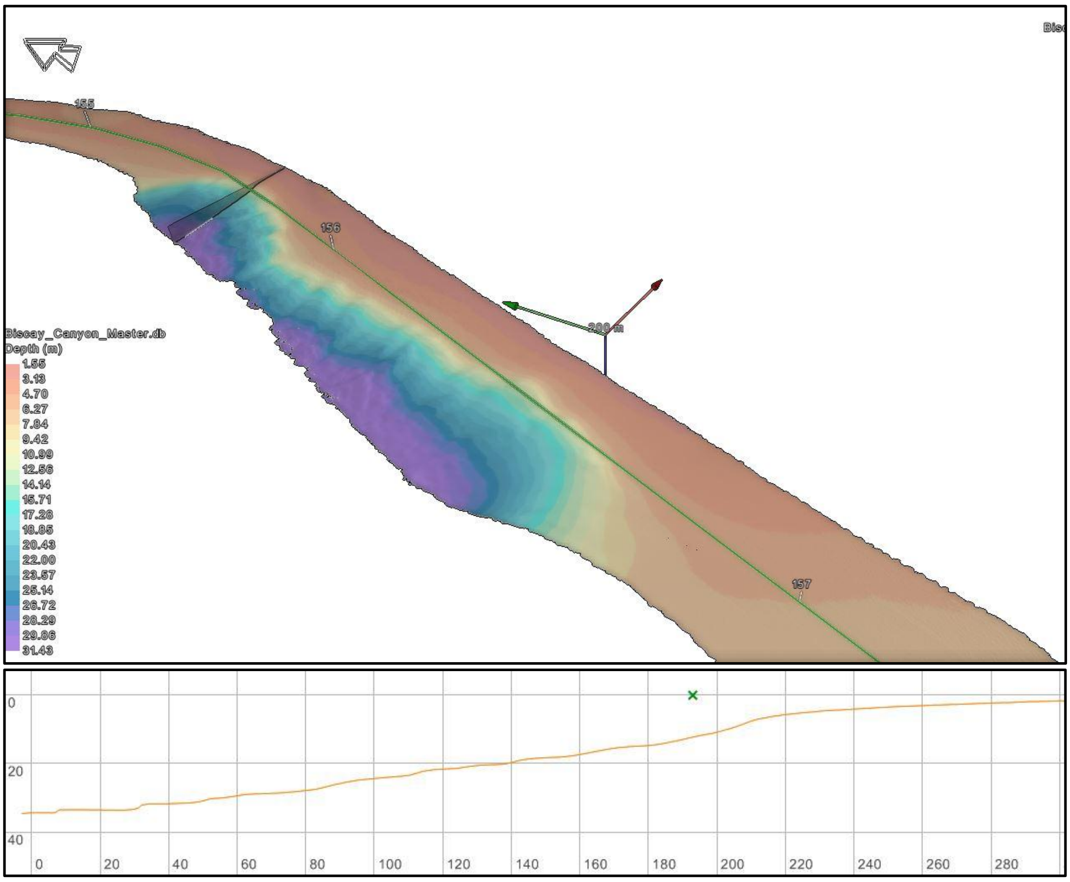

Figure 98 Bathymetric overview of the Canyon Head section of the CHBC option route. The profile runs across route at KP 155.7. The CHBC is run along the MRs P40 survey line.

3.6.3| SURFICIAL GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

The surficial geology is composed of predominantly fine to coarse SAND/fine to medium SAND with infrequent small areas of SAND and GRAVEL.

From KP 150.460 to KP 154.167, featureless fine to coarse SAND is observed. From KP 154.167 until KP 155.405 fine to coarse SAND with large ripples, wavelength of 5.0 to 7.0 m are present (Figure 99).

From KP 155.405 to KP 157.411 fine to medium SAND with some areas of ripples, wavelength 0.5-3.0 m, is observed (Figure 99). Within this area, between KP 155.450 and KP 156.793, the western edge of the corridor is characterised by the steep slopes into the Capbreton Canyon resulting in bedforms caused by gravitational slips/slumping (Figure 100). The slope/slump deposits are more apparent on the MBES bathymetry (Figure 101).

From KP 157.411 through to KP 161.923 the surficial geology comprises of predominantly featureless fine to medium SAND, with some area of occasional boulders.

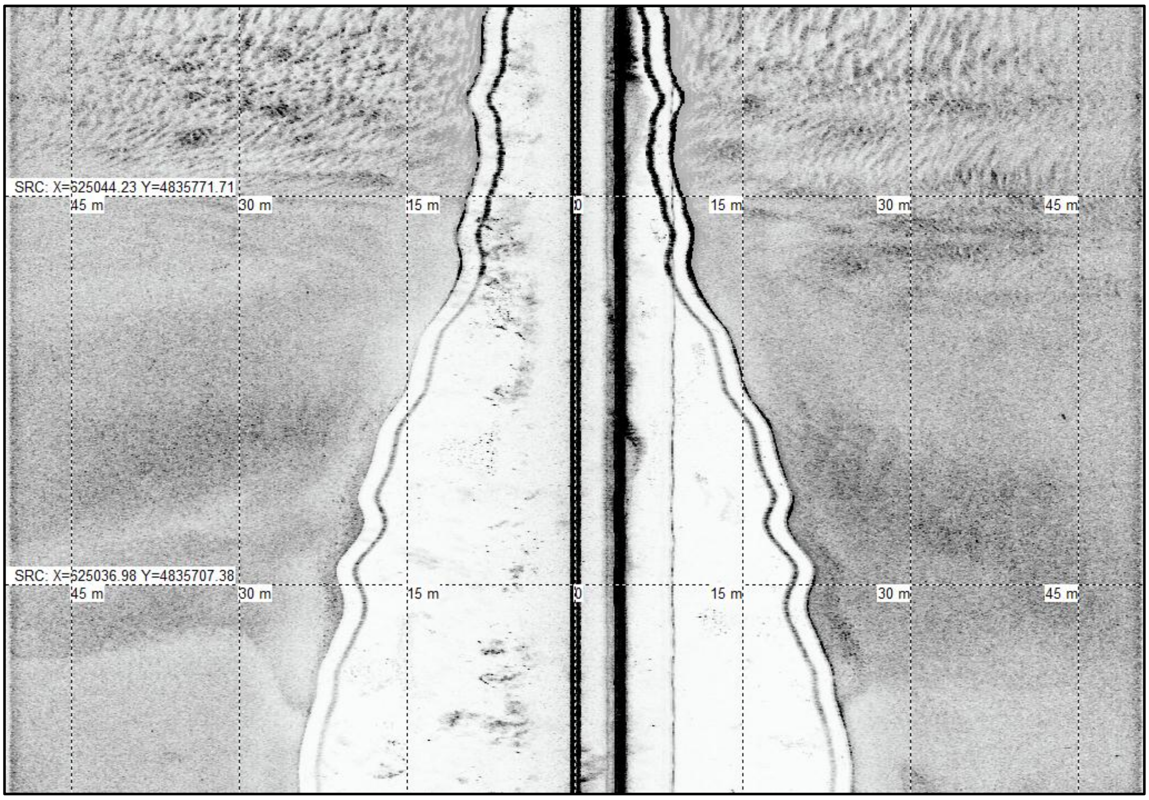

Figure 99 SSS data image of rippled sediments along the edge of the canyon at KP 155.50.

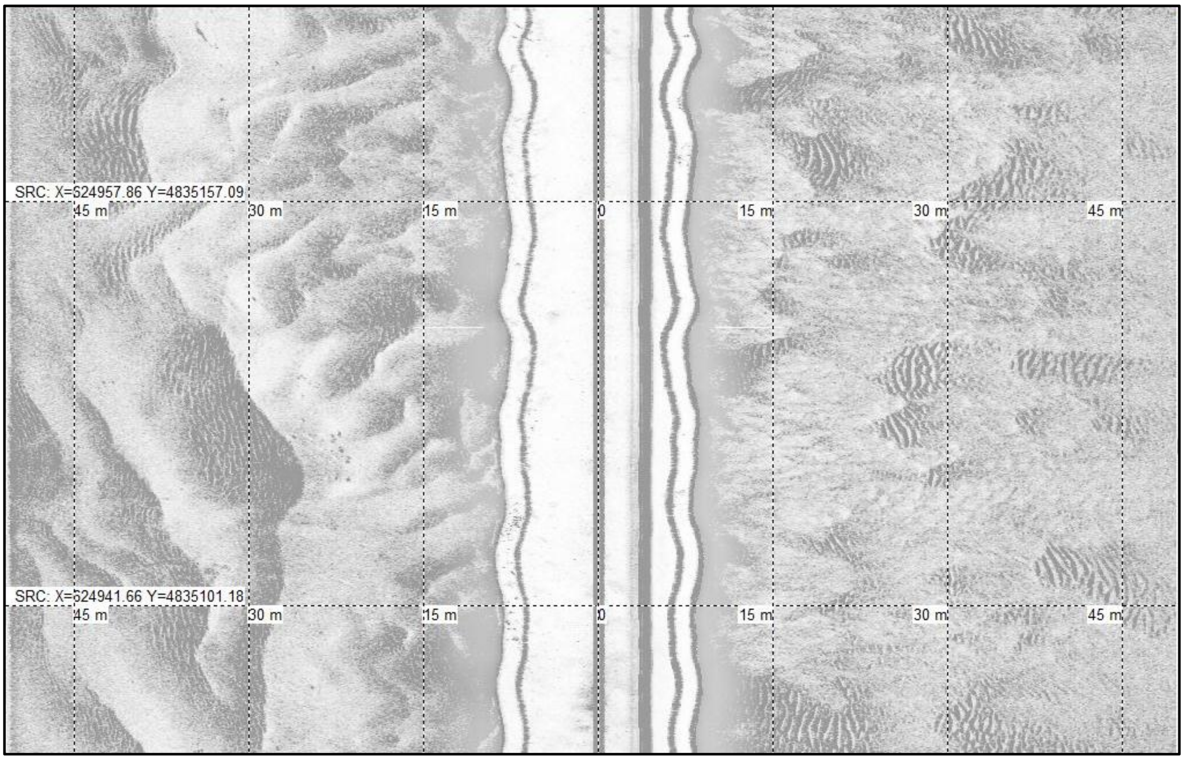

Figure 100 SSS data image of rippled sediments (on the right) and slumped deposits (on the left) along the edge of the canyon at KP 156.20.

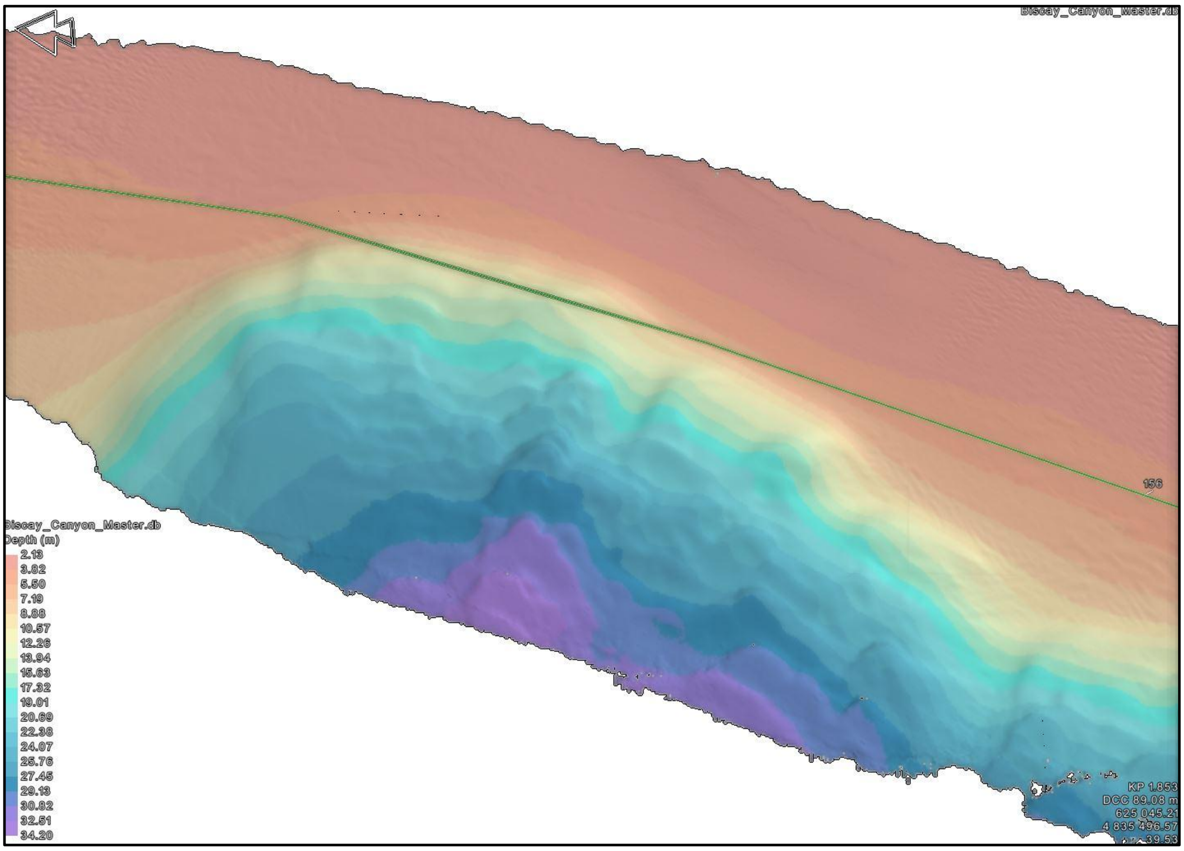

Figure 101 MBES data image at KP 155.7 showing the sediment slumping/creep.

3.6.4| SHALLOW GEOLOGY

The following geophysical interpretations of the shallow geology are based on changes in acoustic character and are supported with geotechnical results.

Between KP 150.50 and KP 152.310 the shallow geology comprises of fine to coarse SAND, ranging from 2 m thick to >5 m thick, overlaying SAND and GRAVEL, overlaying CONSOLIDATED SEDIMENT (Table 16 and Figure 102).

Then from KP 152.660 to KP 154.500 fine to coarse SAND, ranging from 1 to 2 m thick, overlays SAND and GRAVEL.

From KP 154.500 to KP 155.450 fine to coarse SAND, increasing in thickness to 2-4 m thick, overlays CONSOLIDATED SEDIMENT.

The shallow water section, skirting the head of the canyon between KP 152.75 to 159.5, has been surveyed by the M/V Geo Focus with the Innomar system.

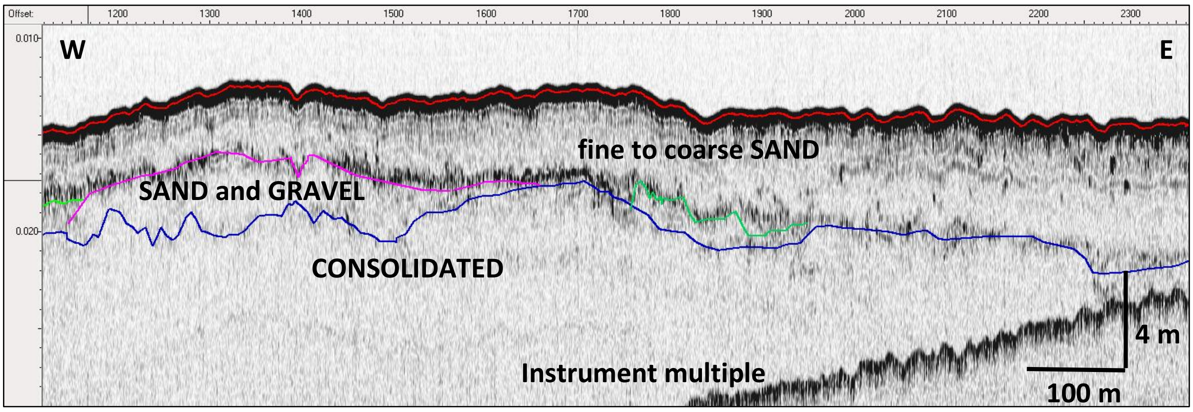

Figure 102 Chirp data image from KP 151.7 to approximately KP 153.0.

Between KP 155.450 and KP 156.793 the route traverses steep slopes associated with the head of the canyon through this section, penetration is poor (Figure 103) either due to the slope, the nature of the sediments or that the sediment units are structureless due to slumping processes (see alignment chart 102354-INE-MMT-SUR-DWG-AMR00035 for overview). Across this area, fine to medium SAND <1 m to 3 m thick, overlays CONSOLIDATED SEDIMENT.

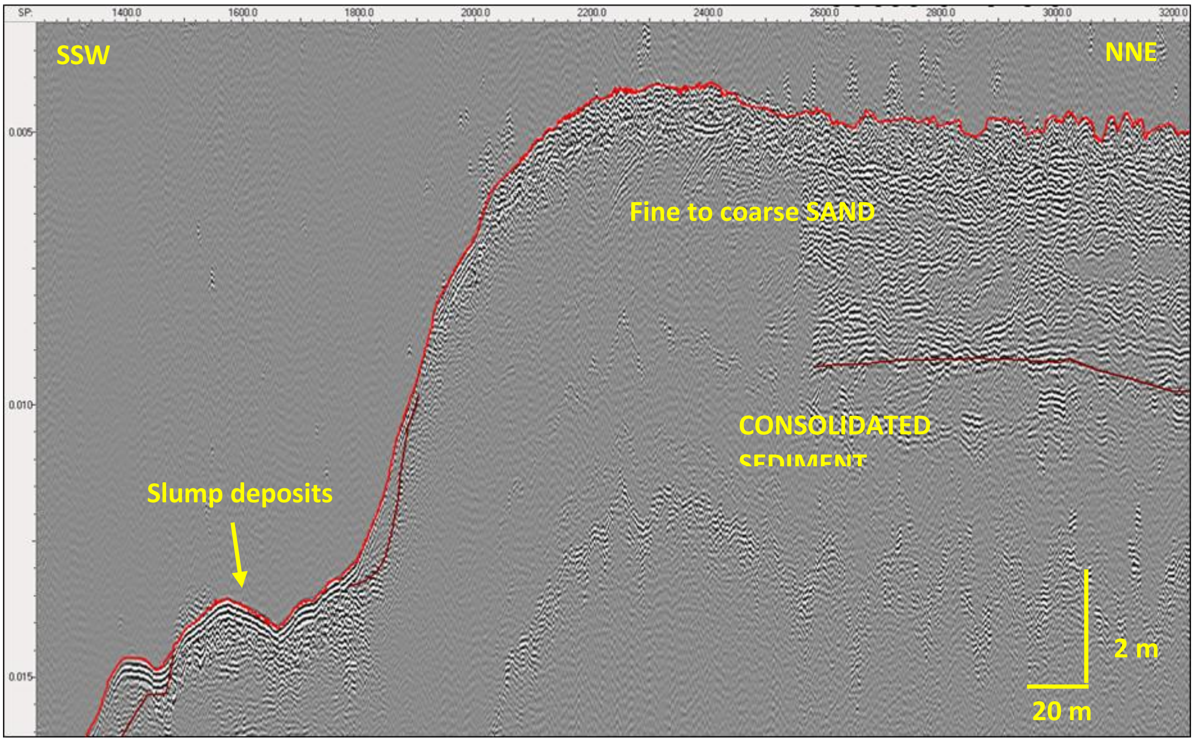

Figure 103 Innomar data image of the eastern side of the canyon system KP 155.55. Showing evidence of slump deposits towards the base.

From KP 156.793 to KP 159.636 the shallow geology is fine to medium SAND, 1 to 5 m thick, over SAND and GRAVEL >5 m thick. From KP 159.636 to KP 161.923 the fine to medium SAND becomes >5 m BSF. A sparker crossline at KP 160.35 detects a unit of CONSOLIDATED SEDIMENT at 8 m BSF (Figure 104).

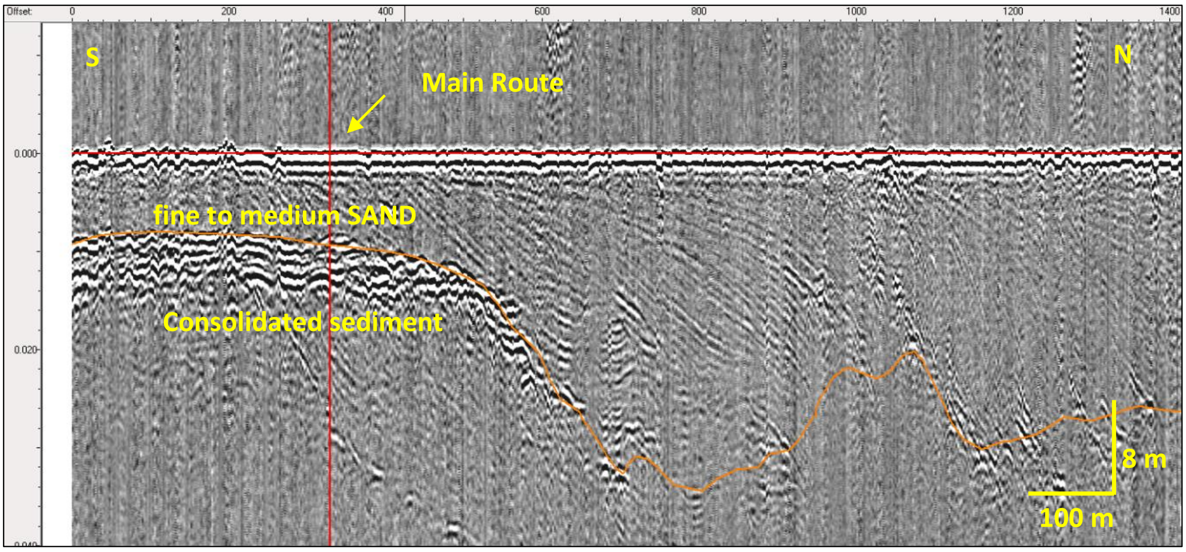

Figure 104 Sparker data image of crossline at KP 160.35 ahowing CONSOLIDATED SEDIMENT. Red line indicating intersection of MR, Seabed flattening applied to data.

3.6.5| SIDE SCAN SONAR CONTACTS

There are a total of 85 SSS contacts located within the CHBC corridor. The SSS contacts have been reported as boulders, debris, objects and others. They are listed with their respective position (grid and geographic), relevant KP reference survey centre line, size (L x W x H) and a DCC offset to the KP reference. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|. A summary of the boulder field occurrence is presented in Table 29.

Table 29 Overview of boulder field occurrence along CHBC corridor.

KP Start	DCC (m)	KP End	DCC (m)	Boulder field	Boulder density	Average Size (m) L x W x H	Surveyed centreline Intersection KP Start	Surveyed centreline Intersection KP END
160.594	0	160.683	0	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.6 x 0.7 x 0.3	160.594	160.683
160.792	0	160.819	0	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.9 x 0.7 x 0.5	160.792	160.819
161.087	21	161.239	47	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	0.6 x 0.5 x 0.5	161.153	161.187
161.291	140	161.348	142	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	0.7 x 0.5 0.6	-	-

3.6.6| MAGNETIC AND GRADIOMETER ANOMALIES

There are a total of 17 magnetic anomalies (Phase 1) and seven (7) gradiometer anomalies (Phase 2) located within the CHBC corridor. They are classed with respect to their “dipole” shape: Monopole, Dipole, Asymmetric Dipole or Complex Anomaly. If relevant, comments have been listed with respect to the target being linear, possible geology or potential UXO. These anomalies have been plotted onto the relevant charts and lists are contained in Appendix F|.

3.6.7| CABLES AND PIPELINES

No existing pipelines or cables cross the proposed route.

3.6.8| ADDITIONAL INFORMATION

The steep sided canyon head that the proposed route traverses between KP 153.9 and KP 158.1 is likely to present hazards to the installation of the proposed cable. After installation, possible slumping of sediments down the steep canyon sides may adversely affect the cable. These processes are discussed in Mazières *et al*., 2014. An alternative route option is presented in Section 2.8| and Section 3.7| to help mitigate these risks.

3.7| ALTERNATIVE CANYON HEAD BYPASS COAST OPTION

ACHBC route option is 4.2 km in length 40 m east of, and parallel, to the MR. The route has its own unique KP protocol from an initial KP 0.000 at the NE end. In relation to the MR KP protocol (Table 4) it initiates 40 m east of the MR at KP 153.9 and terminates at KP 4.2 40 m east of the MR at KP 158.1 on the south side of the canyon head.

3.7.1| POSITIONING

The calibrations and positioning test were carried out prior to any data collection phase. The results of these are presented in the MAC reports located in Appendix C|. Underwater positioning can be affected by pycnoclines and thermoclines that exist within water columns containing two or more bodies of water with differing densities and temperatures.

3.7.2| BATHYMETRY

<u>KP 0.000 to KP4.330:</u> The water depth shoals gradually from KP 0 to KP 0.88 from 12.5 to 3.2 m, between KP 0.88 and KP 2.91 it varies between 2.5 m and 6.1, thereafter it deepens gradually to 14 m at KP 4.4 (Figure 20 and Figure 105)

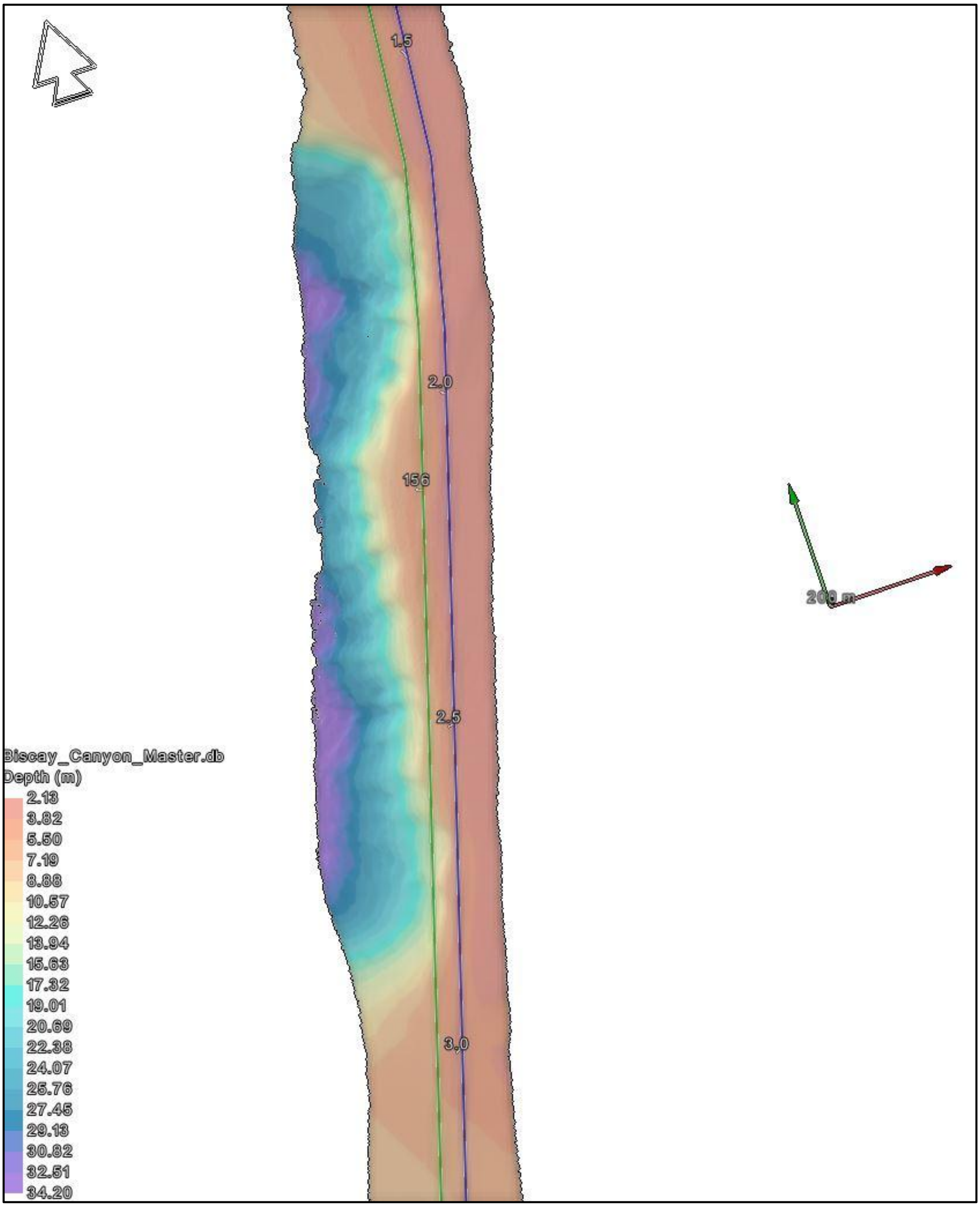

Figure 105 Overview of the ACHBC option between KP 1.5 and KP 3. ACHBC is the blue line with MR as the green line.

3.7.3| SURFICIAL GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

The surficial geology comprises of featureless fine to coarse SAND at KP 0 which becomes fine to coarse SAND with large ripples (wavelength 5.0 to 7.0 m) from KP 0.267 until KP 1.531, with occasional isolated patches of fine to coarse SAND with ripples (wavelength 1.0 to 2.0 m) present.

Between KP 1.531 and KP 3.910 the surficial geology consists predominantly of fine to medium SAND with ripples, wavelength 0.5 to 3.0 m (Figure 106). Just to the west of this route, between KP 1.5 and KP 3.0, the onset of the slopes into the Capbreton Canyon, resulting in bedforms caused by gravitational slips/slumping, are observed (Figure 107).

From KP 3.910 to the end of the route at KP 4.330, predominantly featureless fine to medium SAND is present, with some area of occasional boulders.

Figure 106 SSS data image of rippled sediments along the edge of the canyon at KP 1.6.

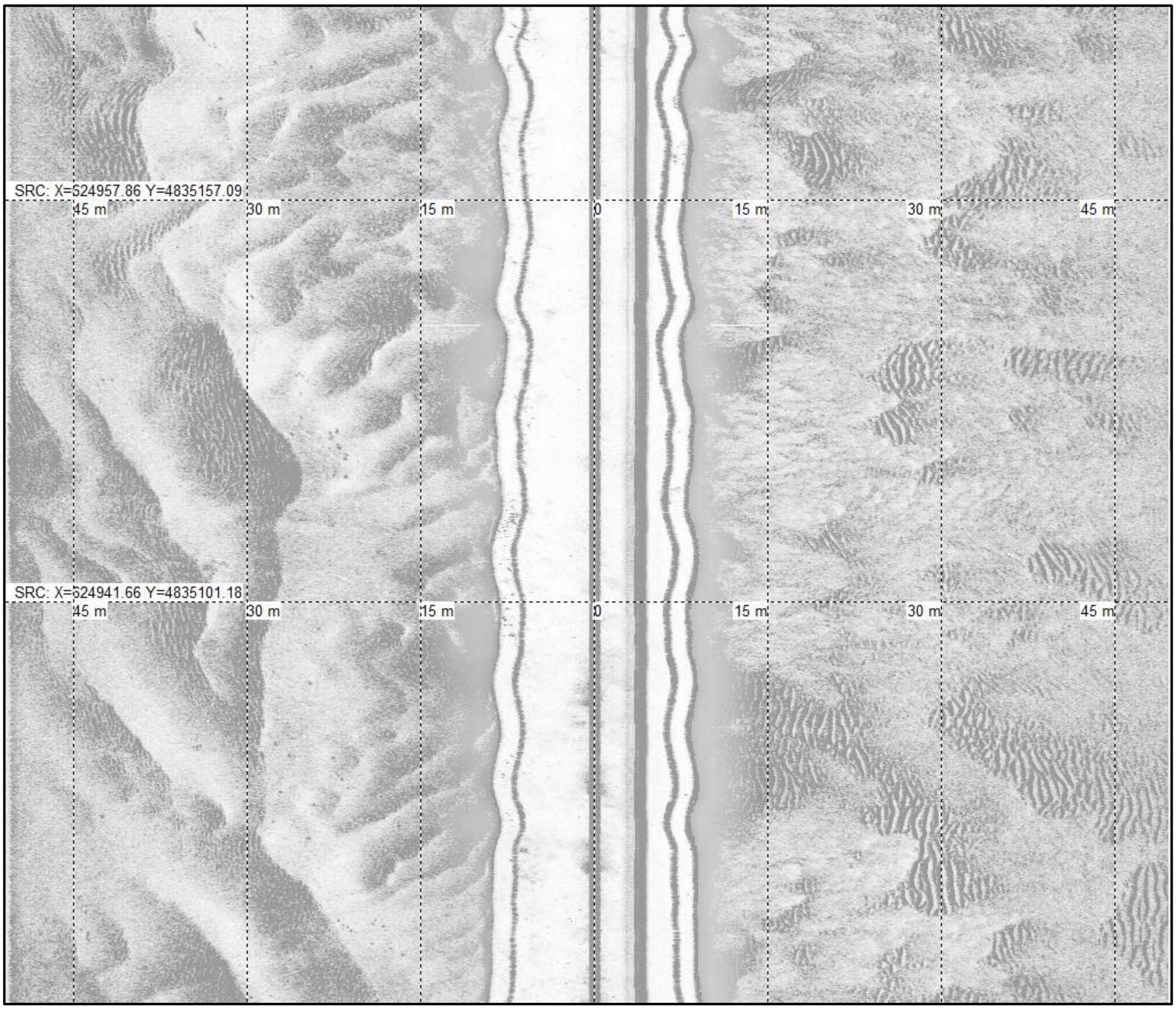

Figure 107 SSS data image of rippled sediments (on the right) and slumped deposits (on the left) along the edge of the canyon at KP 2.3.

3.7.4| SHALLOW GEOLOGY

The following geophysical interpretations of the shallow geology are based on changes in acoustic character and are supported with geotechnical results.

The shallow geology comprises of fine to coarse SAND 1-4 m thick, overlaying SAND and GRAVEL to depths >5 m BSF, from KP 0 to KP 1.880. From KP 1.880 to KP 4.332 fine to medium SAND 1-4 m thick, overlies SAND and GRAVEL to depths >5 m BSF.

The shallow geology comprises of fine to coarse SAND, overlaying SAND and GRAVEL to depths >5 m BSF, from KP 0 to ~KP 1.880. (Table 19 and Figure 108). At KP 0 the basal CONSOLIDATED SEDIMENT is not detected by the Innomar system, penetration is typically limited to <5 m. The fine to coarse SAND is typically 1 to 2 m thick up to ~KP 0.700. From KP 0.700 to KP 1.880 the fine to coarse SAND thickens to 2-4 m thick.

From KP 1.880 to KP 4.332 fine to medium SAND, overlies SAND and GRAVEL to depths >5 m BSF. The fine to coarse SAND thins from 3 m at KP 2.000 to <1 m at KP 4.286 (Figure 109). The lower unit of SAND and GRAVEL attenuates the Innomar signal, likely due to the coarse grained nature of the sediment. The top of CONSOLIDATED SEDIMENT that underlies the SAND and GRAVEL near the canyon is >5 m BSF and has not been detected.

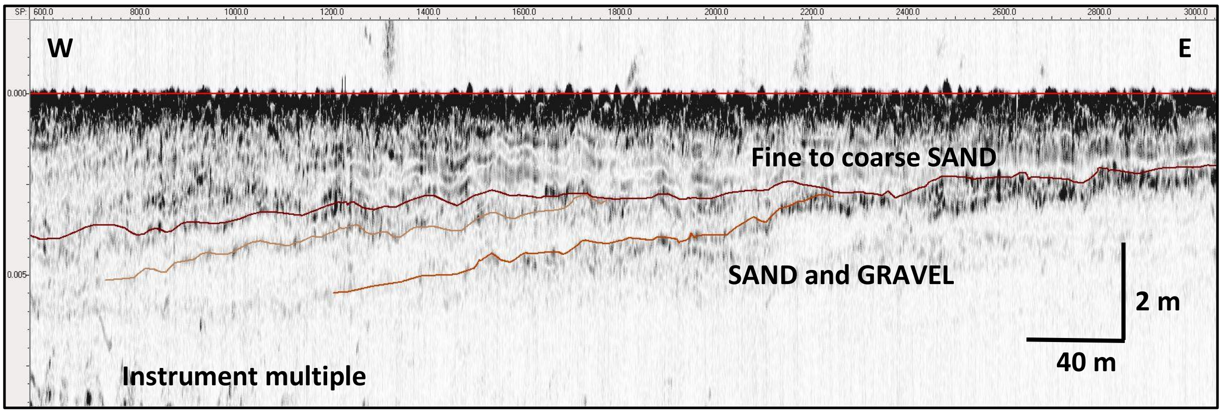

Figure 108 Innomar data image of the two units in relation to each other from KP 0.4 to approximately KP 1.

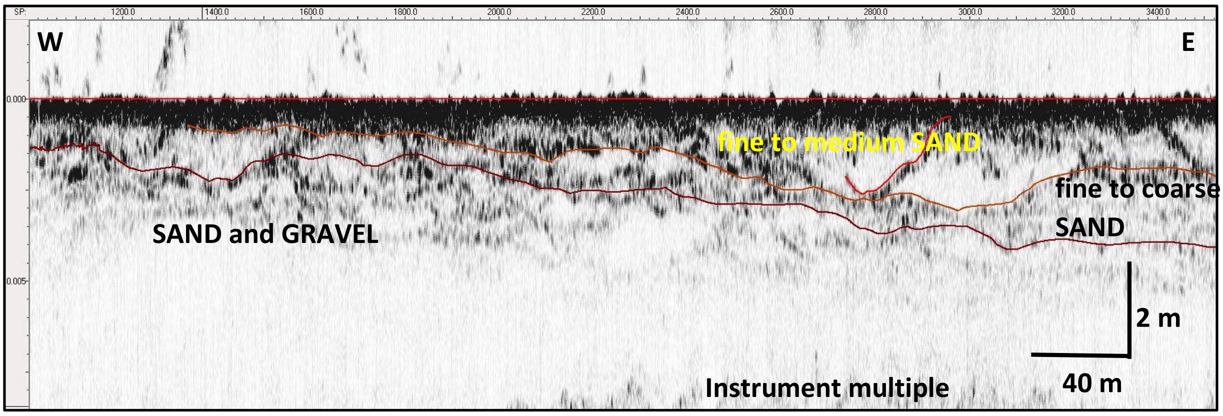

Figure 109 Innomar data image of the two units in relation to each other from KP 2.2 to KP 2.6.

3.7.5| SIDE SCAN SONAR CONTACTS

There are a total of 32 SSS contacts located within the MR corridor. The SSS contacts have been reported as boulders, debris, objects and others. They are listed with their respective position (grid and geographic), relevant KP reference survey centre line, size (L x W x H) and a DCC offset to the KP reference. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|.

3.7.6| MAGNETIC AND GRADIOMETER ANOMALIES

There are a total of six (6) magnetic anomalies (Phase 1) and no gradiometer anomalies (Phase 2) located within the ACHBC option corridor. They are classed with respect to their “dipole” shape: Monopole, Dipole, Asymmetric Dipole or Complex Anomaly. If relevant, comments have been listed with respect to the target being linear or possible geology. These anomalies have been plotted onto the relevant charts and lists are contained in Appendix F|.

3.7.7| CABLES AND PIPELINES

No existing pipelines or cables cross the proposed route.

3.7.8| ADDITIONAL INFORMATION

The ACHBC option route is situated in a high energy environment with significant sediment transport as discussed in Mazières *et al.* 2014. The paper presents a time series of MBES datasets showing that the head of the canyon experiences rapid erosional and reworking processes.

3.8| HDD CANYON CROSSING OPTION ROUTE

HDCC is 8.595 km in length and transects the canyon system. The route has its own unique KP protocol from an initial KP 0.000 at the NE end. In relation to the MR KP protocol it splits from the MR at KP 140.460 and re-joins it at KP 161.923, on the south side of the canyon system (Table 4).

3.8.1| POSITIONING

The calibrations and positioning test were carried out prior to any data collection phases. The results of these are presented in the MAC reports located in Appendix C|. Underwater positioning can be affected by pycnoclines and thermoclines that exist within water columns containing two or more bodies of water with differing densities and temperatures. The SSS images were indeed affected by these phenomena although the underwater positioning system for the ROTV functioned according to specification.

3.8.2| BATHYMETRY

<u>KP 0.000 to KP 8.595:</u> Between KP 0.000 and KP 3.432 the water depth shoals from 37.7 m to 22.5 m and dips down to 25.0 m by KP 3.710. It continues dipping gently to a depth of 42.5 m by KP 4.100, the NE edge of the canyon. From here the seabed steeply dips to the canyon floor at a maximum depth of 109.5 m at KP 4.396. It shoals 2.0 m to 107.5 m between KP 4.420 and KP 4.480, then shoals very steeply to a depth of 22.5 m at KP 4.815 (Figure 110). From the SW edge of the canyon at KP 4.815 the seabed shoals with a reduced gradient to a depth of 16.5 m at KP 5.315 then begins to gently dip, reaching a depth of 40.2 m at KP 8.599. North of the route between KP 5.5 through KP 6.4 there is a second canyon system encroaching on the survey corridor (Figure 111). There are attendant steep slopes and water depths descending to 129 m, route development to the south of the corridor was conducted to mitigate the canyon system and rerouting utilising the south of the corridor throughout the section is possible with water depths of 25 m.

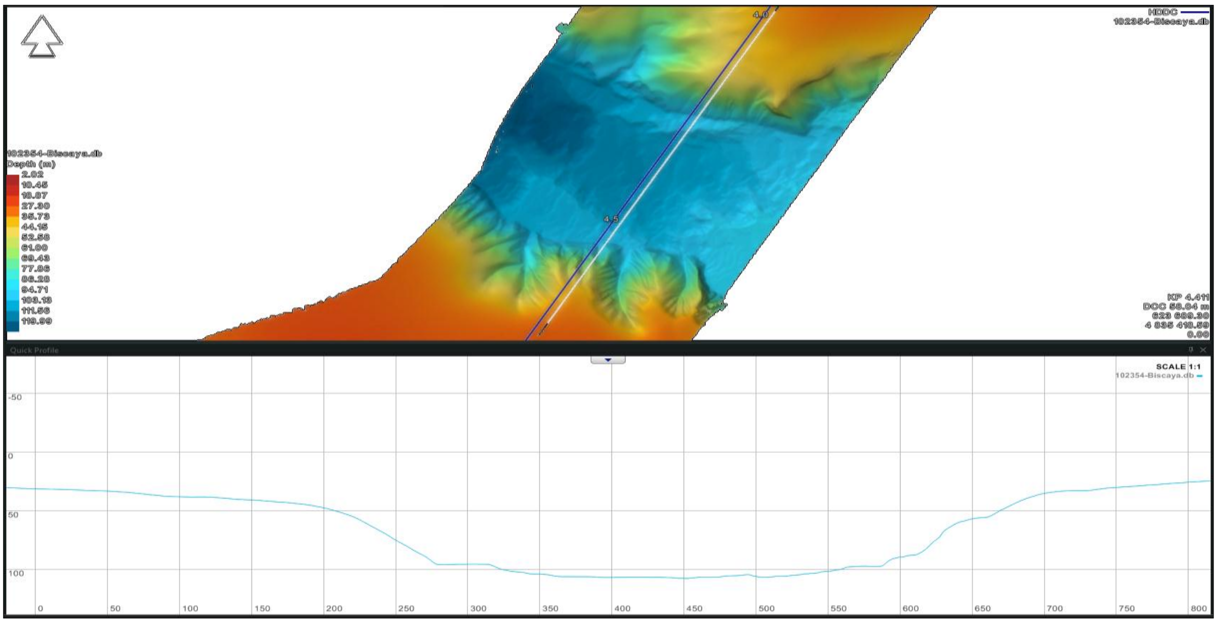

Figure 110 HDCC overview of canyon bathymetry between KP 4.000 and KP 4.800.

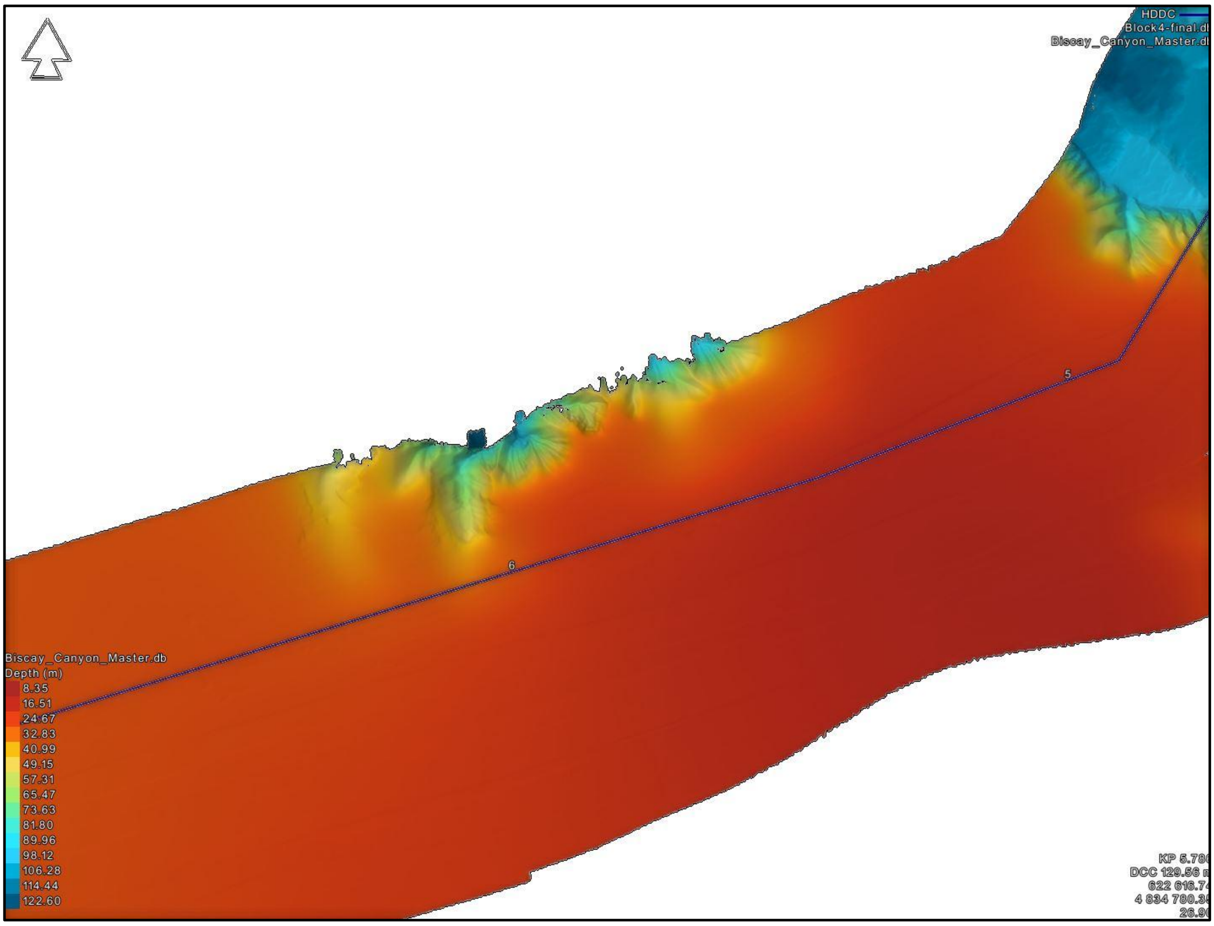

Figure 111 HHDC overview of the bathymetry of the canyon system proximal to KP 6.

3.8.3| SURFICIAL GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

Due to the steep slopes of the canyon walls and an abundance of fishing activity, the survey of the HDCC Option was limited to the centre line for ROTV, the rest of the lines were conducted with hull mounted instruments. It was therefore necessary to supplement the SSS data with the hull mounted MBES data. MBES backscatter data were used to supplement the SSS data from the starboard wing line to complete the coverage of the corridor to characterise the surficial geology.

From KP 0.000 to KP 3.124, predominantly featureless fine to coarse SAND is observed, with one small area 50 m x 100 m of GRAVEL at KP 3.00, 100 m W of the route, associated with underlying unit of CONSOLIDATED SEDIMENT (Figure 112).

Between KP 3.124 and KP 3.480 (Figure 113) is an area of fine to coarse SAND with bedforms/slumps, followed by featureless fine to coarse SAND to KP 4.013 (Figure 113).

The canyon walls and floor between KP 4.013 and KP 4.656 (Figure 114/Figure 115) are interpreted to comprise fine to coarse SAND with sediment slumping/slides evident on the canyon floor (Figure 115).

From KP 4.656 to the end of the route at KP 8.595, the predominant surficial sediment is fine to medium SAND. Within this section, between KP 5.450 and KP 6.400 there is another canyon system north of the route (Figure 116). Also within this section from KP 6.220 to KP 6.592 outcrops of GRAVEL correlate with an underlying unit of CONSOLIDATED SEDIMENT being at or near the seabed surface. A number of boulders are present across the route from KP 7.500 (Appendix E|).

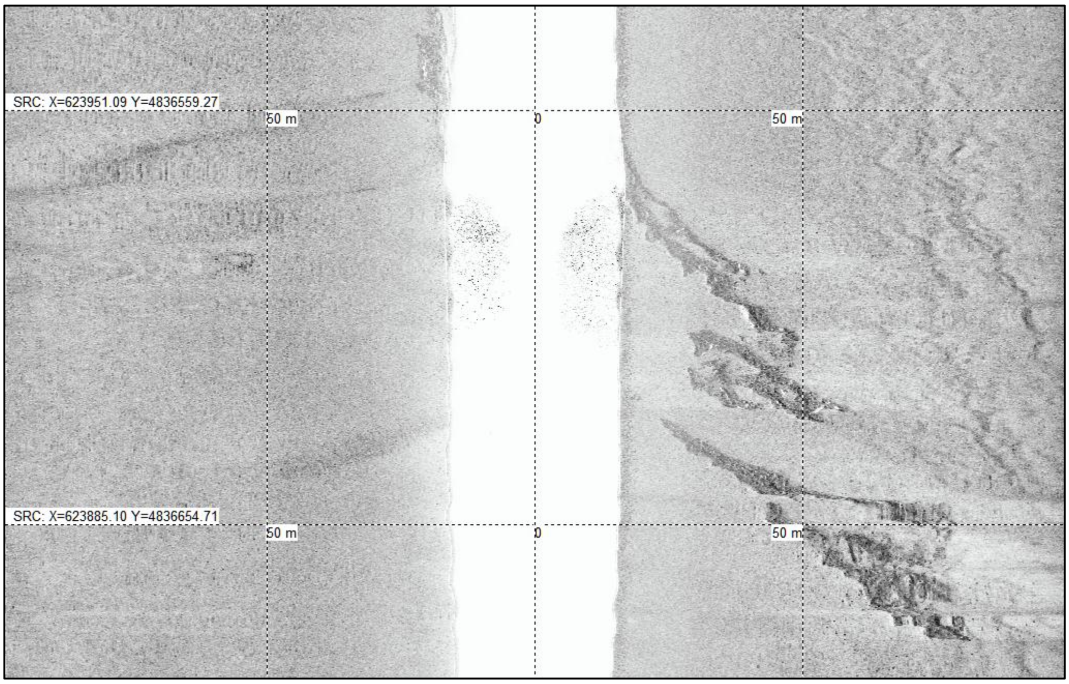

Figure 112 SSS data image of SAND with GRAVEL deposits situated 100 m W of the route at KP 3.

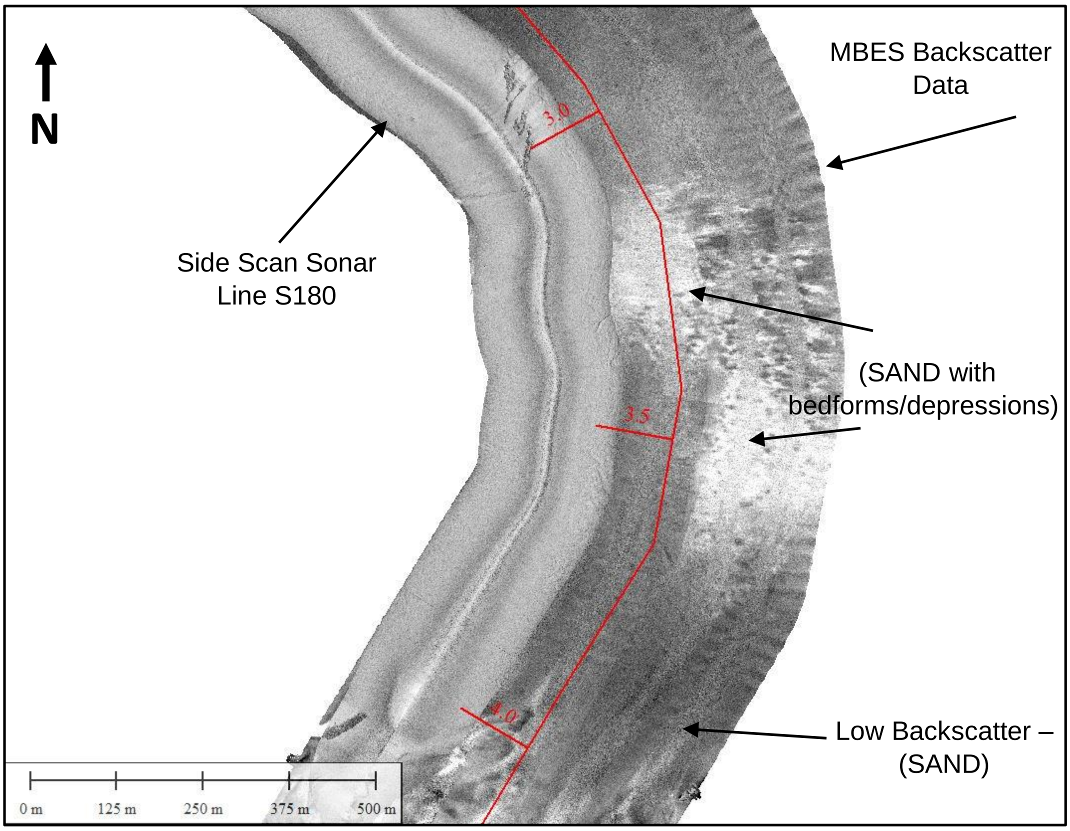

Figure 113 Composite image of SSS data overlaying MBES Backscatter from KP 2.75 to KP 4.25.

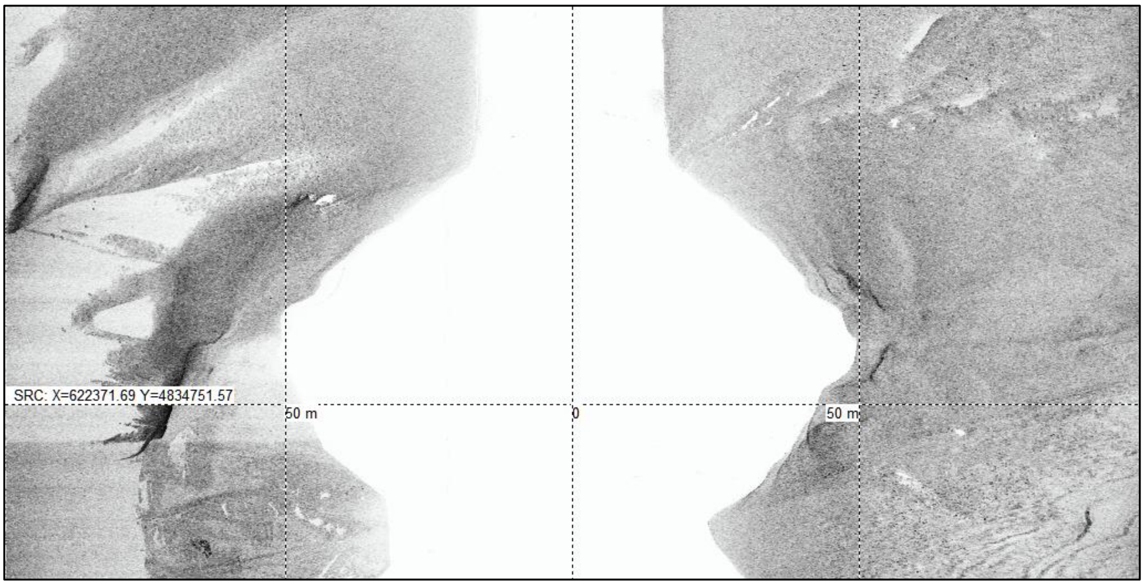

Figure 114 SSS data image of the canyon. Mix of SAND and GRAVEL with slump deposits.

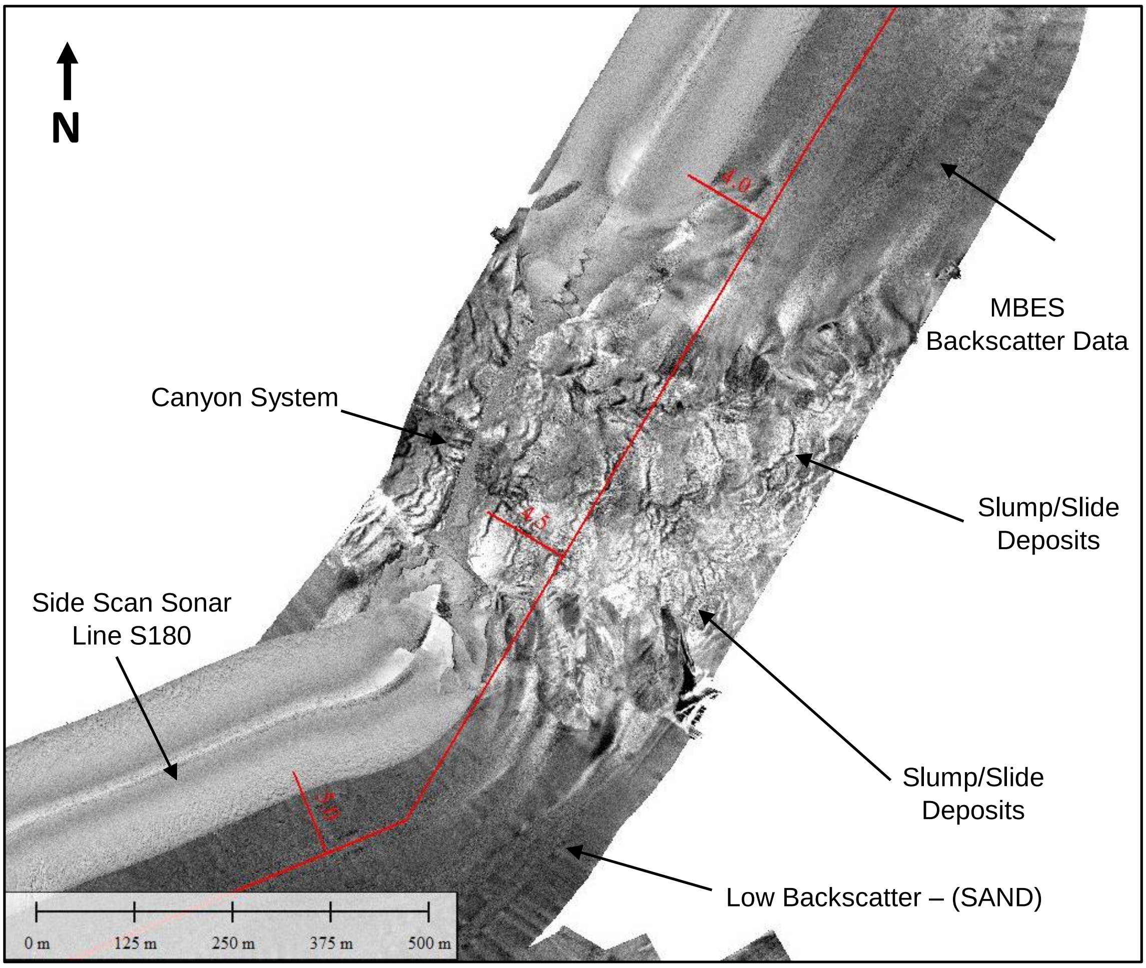

Figure 115 Composite image of SSS data overlaying MBES Backscatter from KP 3.75 to KP 5.25.

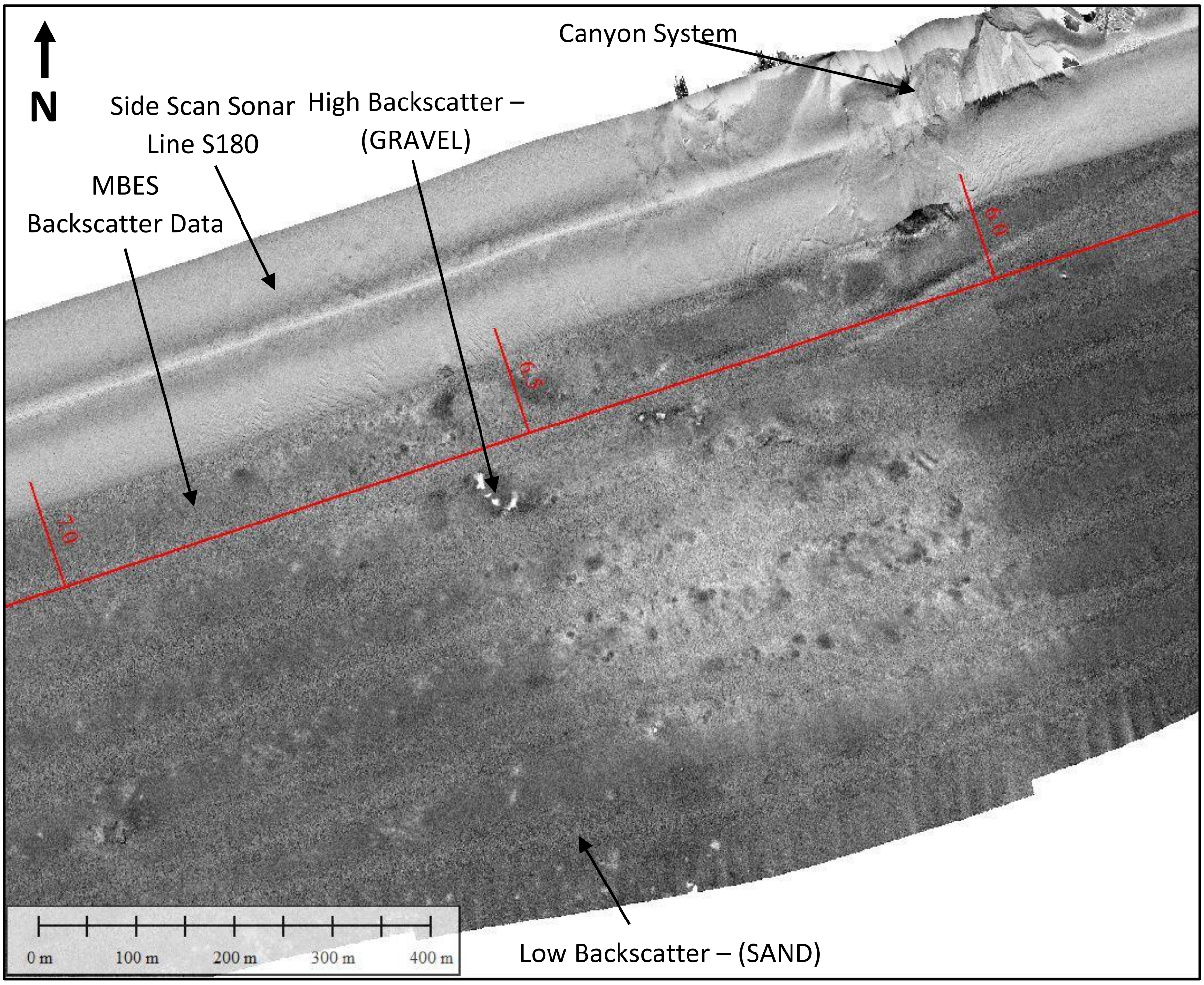

Figure 116 Composite image of SSS data overlaying MBES Backscatter between KP 6 and KP 7.

3.8.4| SHALLOW GEOLOGY

The following geophysical interpretations of the shallow geology are based on changes in acoustic character and are supported with geotechnical results.

The shallow geology is made up from fine to coarse SAND, 3-5 m thick, overlying CONSOLIDATED SEDIMENT between KP 0.00-0.480. From KP 0.480-2.720 the fine to coarse SAND (2-4 m thick), overlies a channel infill unit of SAND and GRAVEL to depths >5 m BSF, overlaying CONSOLIDATED SEDIMENT (Figure 117). From KP 2.720 the underlying CONSOLIDATED SEDIMENT slopes up steeply to within 3-4 m of seabed surface and continues at this level until KP 3.230.

From KP 3.230 to KP 3.968, the fine to coarse SAND is >5 m thick, with a deep channel observed within the CONSOLIDATED SEDIMENT, indicative of a crosscutting palaeochannel system (Figure 118). From KP 3.968, the fine to coarse SAND unit thins from 5 m BSF to pinching out down the sides of the steep canyon. This, however, could be due to the steep sided canyon walls not returning the SBP signal back to the receiver and, therefore, not able to define the sediment boundaries. Across the Canyon floor a thin layer of fine to coarse SAND, 1 to 2 m thick overlies the CONSOLIDATED SEDIMENT.

From KP 4.650 to KP 6.085 the SAND unit varies in thickness between 1 m to >5 m overlying an irregularly eroded CONSOLIDATED SEDIMENT unit. From KP 6.085 to KP 6.362, another channel is present within the CONSOLIDATED SEDIMENT, increasing the thickness of the fine to medium SAND to >5 m.

Between KP 6.069 and KP 6.380 the CONSOLIDATED SEDIMENT unit outcrops for 70 m, followed by a shallow channel of fine to medium SAND, then outcropping again for another 50 m before dipping again almost vertically to beyond 5 m.

From KP 6.380 to the end of the route at KP 8.595, fine to medium SAND >5 m thick continues (Figure 119).

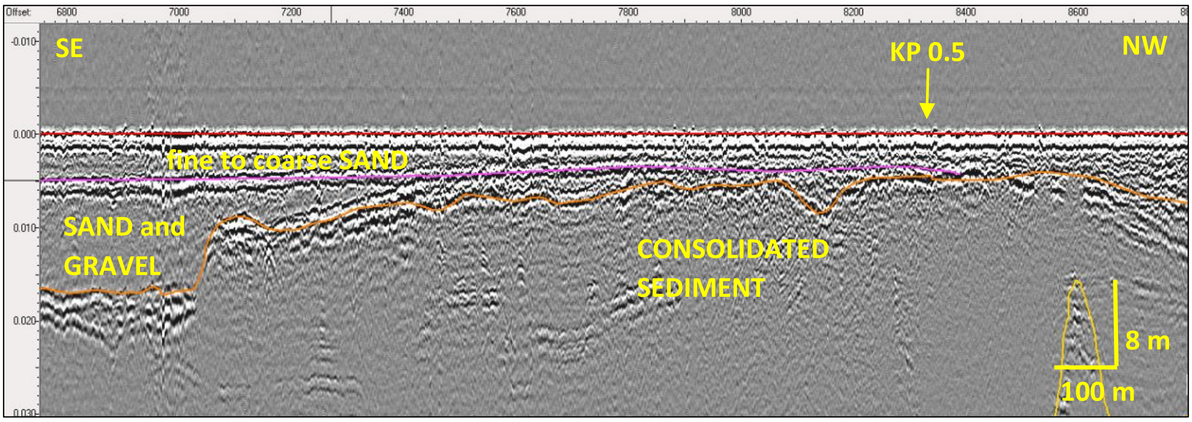

Figure 117 Sparker data image between KP 0.000 and KP 2.000 of the HHDC route. Seabed flattening applied to the data.

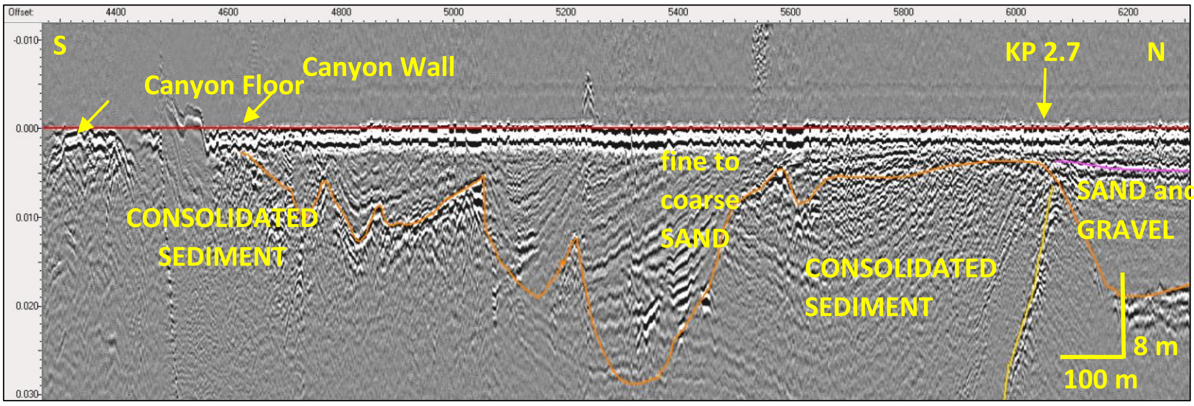

Figure 118 Sparker data image of canyon system between KP 2.000 and KP 4.250. Seabed flattening applied to data.

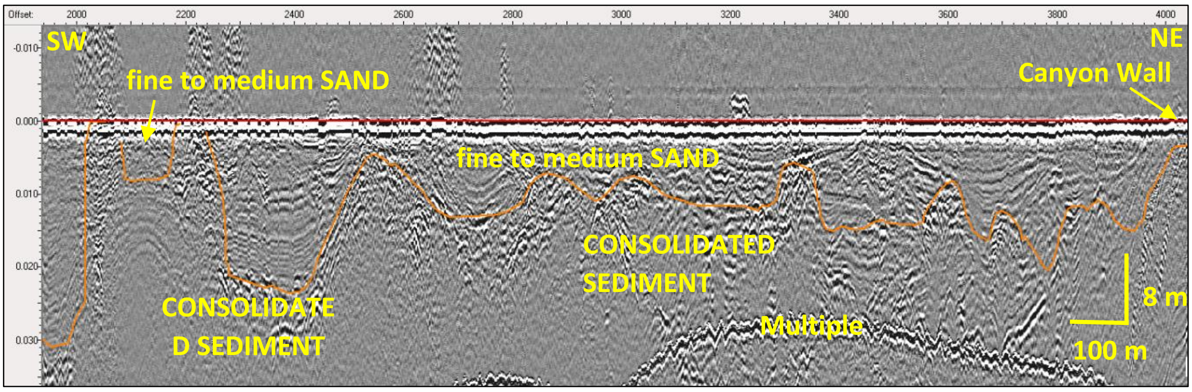

Figure 119 Sparker data image of seabed to SW of canyon system between KP 4.600 and KP 6.600. Seabed flattening applied to data.

3.8.5| SIDE SCAN SONAR CONTACTS

There are a total of 16 SSS contacts located within the HDCC corridor. The contacts have been reported as boulders, debris, objects and others. They are listed with their respective position (grid and geographic), relevant KP reference survey centre line, size (L x W x H) and a DCC offset to the KP reference. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|.

3.8.6| MAGNETIC AND GRADIOMETER ANOMALIES

No magnetic anomalies (Phase 1) and five (5) gradiometer anomalies (Phase 2) were located with the HDCC corridor. They are classed with respect to their "dipole" shape: Monopole, Dipole, Asymmetric Dipole or Complex Anomaly. If relevant, comments have been listed with respect to the target being possible geology or potential UXO. These anomalies have been plotted onto the relevant charts and lists are contained in Appendix F|.

3.8.7| CABLES AND PIPELINES

No existing pipelines or cables cross the proposed route.

3.9| ADDITIONAL ROUTE SPANISH WATERS

ARSW is a 47.680 km long section that splits from the MR at KP 190.603 and re-joins it at KP 241.940 (Table 4). The survey was conducted using KP Protocol specifically for the alternative route commencing with KP 0.000 and completed with KP 47.680.

3.9.1| POSITIONING

The calibrations and positioning test were carried out prior to any data collection phase. The results of these are presented in the MAC reports located in Appendix C|. Underwater positioning can be affected by pycnoclines and thermoclines that exist within water columns containing two or more bodies of water with differing densities and temperatures. The SSS images were indeed affected by these phenomena although the underwater positioning system for the ROTV functioned according to specification.

3.9.2| BATHYMETRY

KP 0.00 to KP 7.240: The water depth at the start of the route is 124.5 m and dips with an undulating profile (+/-2 m) to 134.2 m at KP 7.240.

KP 7.240 to KP 14.965: The seabed gently shoaling at start then slightly steeper where it reaches a depth of 125 m at KP 9.799 before dipping and undulating +/-2 m to a depth of 134.2 m at KP 11.722. From here the seabed runs level for 200 m, then shoals gently to 127.5 m at KP 13.310, runs level for 270 m then dips gently to a depth of 133.6 m at KP 14.965 (Figure 120).

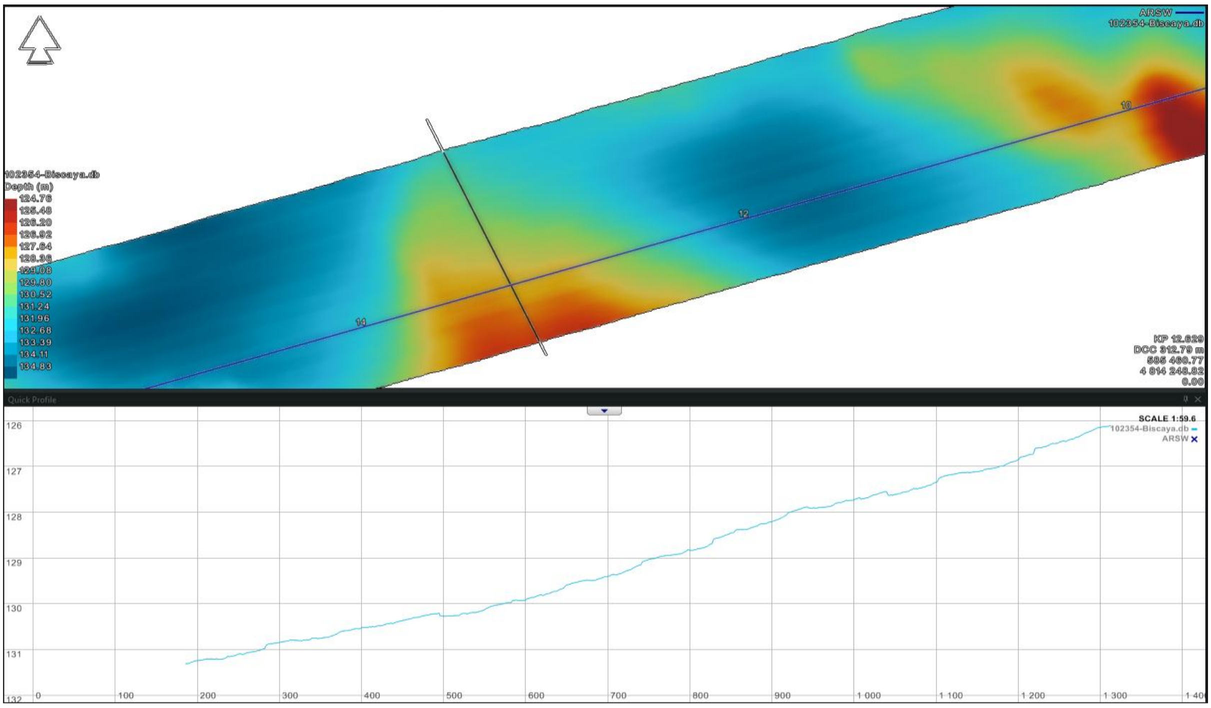

Figure 120 ARSW route showing bathymetric image example of gradual undulations along route at KP 12.62.

KP 14.965 to KP 24.134: The seabed shoals gently to 127.5 m at KP 16.065, then dips gently to a depth of 131.4 m at KP 17.121 and then continues level with very slight undulations, +/-1 m, to KP 20.827 at a depth of 128.8 m. It then dips down gently with slight undulation to a depth of 134.3 m at KP 22.287. It then shoals very gently to 132.4 m at KP 22.412 and then undulates irregularly, +/-1 m, before gently dipping from KP 24.173 (Figure 121).

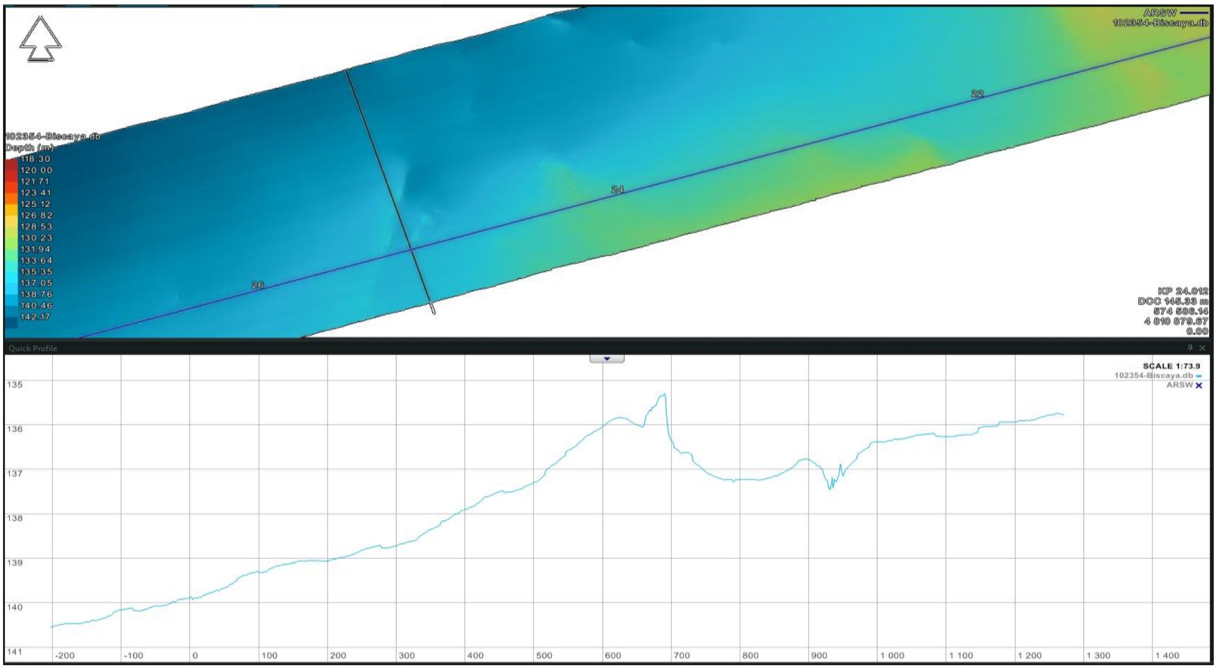

Figure 121 ARSW seabed profile highlighting irregular nature of undulating seabed, KP 24.010.

KP 24.134 to KP 47.674: The seabed dips gently to a depth of 138 m at KP 25.078 then irregularly undulates +/-1.5 m for 400 m before it slopes downwards very gently to 139.2 m at KP 27.560 and then shoals gently with very slight undulations +/-0.5 m until KP 45.821 to a depth of 104.2 m. It then shoals steeply to 97.6 m at KP 46.036 and quickly dips to 102 m at KP 46.326. The seabed shoals again to 90.5 m at KP 47.674. Between KP 46.923 and KP 47.674 the seabed irregularly undulates.

3.9.3| SURFICIAL GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

The trawl scars and rock outcrops are present along the majority of the route and both features appear similar on the SSS records, therefore, one SSS data example of each of these features is shown to illustrate these features.

From KP 0.00 to KP 9.891, the surficial geology comprises of sandy CLAY that is extensively trawled, some isolated boulders (Appendix E|) and outcropping BEDROCK within the route corridor. The BEDROCK is apparent at KP 3.480 for 45 m and at numerous locations inside the route corridor.

Between KP 9.892 and KP 10.700 an area of fine to medium SAND with trawl scars is observed.

From KP 10.700 to KP 16.120 the surficial geology comprises sandy CLAY that is extensively trawled and some isolated boulders (Appendix E|) and outcropping BEDROCK is present in the corridor between KP 14.5 and KP 15.0.

Between KP 16.120 and KP 17.022 an area of fine to medium SAND with trawl scars is observed (Figure 122).

From KP 17.022 to KP 35.175 the surficial geology comprises sandy CLAY that is extensively trawled and occasional outcrops of BEDROCK at following locations on the route: KP 20.80 to KP 21.25, KP 22.81 to KP 23.13, KP 23.89 to KP 24.13, KP 25.08 to KP 25.16 and KP 25.28 to KP 25.31.

Between KP 35.175 and KP 35.859 an area of fine to medium SAND with trawl scars is observed.

From KP 35.859 to KP 44.467 the surficial geology comprises sandy CLAY that is extensively trawled

From KP 44.467 to the end of the route, the trawl scars start to subside and small patches of randomly distributed BEDROCK outcrops appear across the route corridor (Appendix E|) and SAND and GRAVEL with occasional to numerous boulders lie across the KP referenced survey centre line between KP 44.682 and KP 44.735. Outcropping BEDROCK is observed across the route between KP 45.886 and KP 46.122 and again from KP 46.932 the end of the route, intermittent with fine to medium SAND veneers/shallow channel infill (Figure 123).

Figure 122 SSS data image showing fine to medium SAND with trawl scars at KP 16.50.

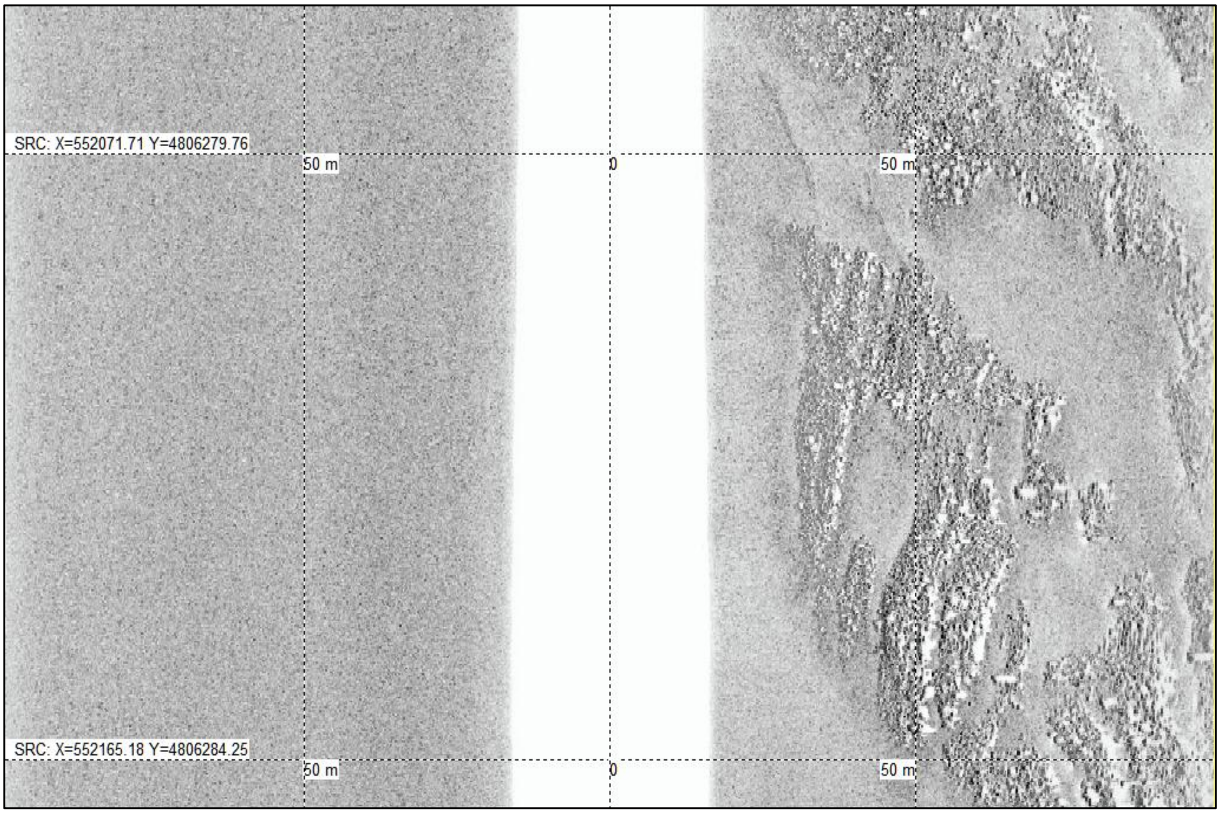

Figure 123 SSS data record at KP 47.100. Fine to medium SAND with outcropping BEDROCK and Boulders.

3.9.4| SHALLOW GEOLOGY

The following geophysical interpretations of the shallow geology are based on changes in acoustic character and are supported with geotechnical results.

From KP 0.00 to KP 7.240, the shallow geology comprises sandy CLAY 1 - 3 m thick overlying SILT and SAND to a depth greater than 5 m BSF until KP 1.435 where the underlying BEDROCK slopes up to within 1 m of the seabed at KP 2.593 and remains at this level until it outcrops on the route at KP 3.480 for 45 m (Figure 124). The BEDROCK slopes down again from KP 3.523 to a depth of between 1 and 2 m below seabed and then slopes up to almost outcrop at KP 7.40.

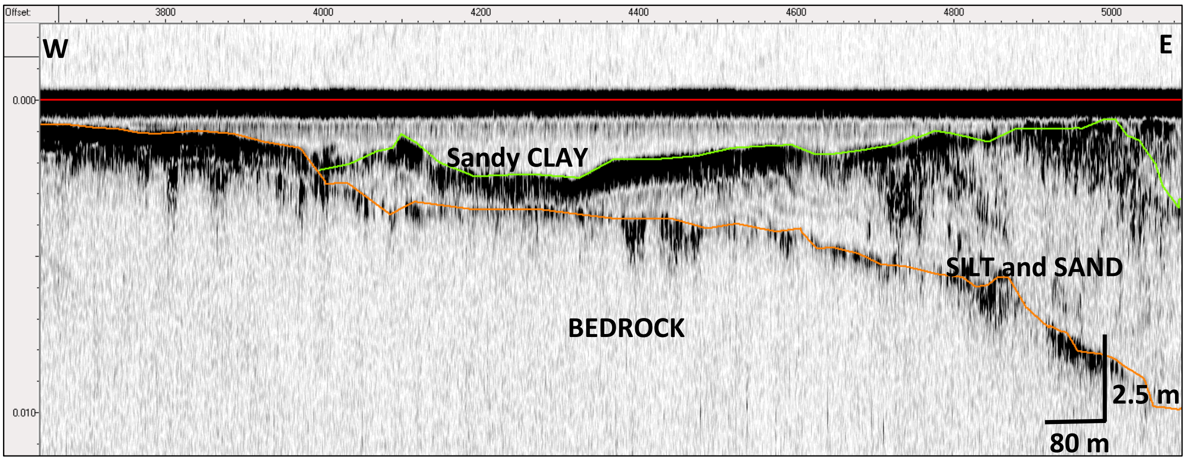

Figure 124 Chirp data image of shallow geology along ARSW route between KP 1.25 and KP 2.600.

From KP 7.240 to KP 14.965, the shallow geology is made up of sandy CLAY overlying BEDROCK that quickly dips down from KP 7.240 to a depth of 2 m BSF then gradually to 4 m by KP 8.500. The sandy CLAY unit is underlain by SILT and SAND that thickens from KP 7.495 (Figure 125). These sediments extend beyond 5 m BSF at KP 9.247. Between KP 8.00 and KP 9.00, the SILT and SAND is interbedded (Figure 125). BEDROCK reappears to within 5 m of seabed at KP 10.395 and to within 1.5 m at KP 10.665. The overburden of sandy CLAY then thickens gradually to 5 m at KP 12.833. At KP 13.760 the sandy CLAY thins out to 1 m thick and overlies the BEDROCK. The sandy CLAY continues with a thickness of 1 m to KP 14.965.

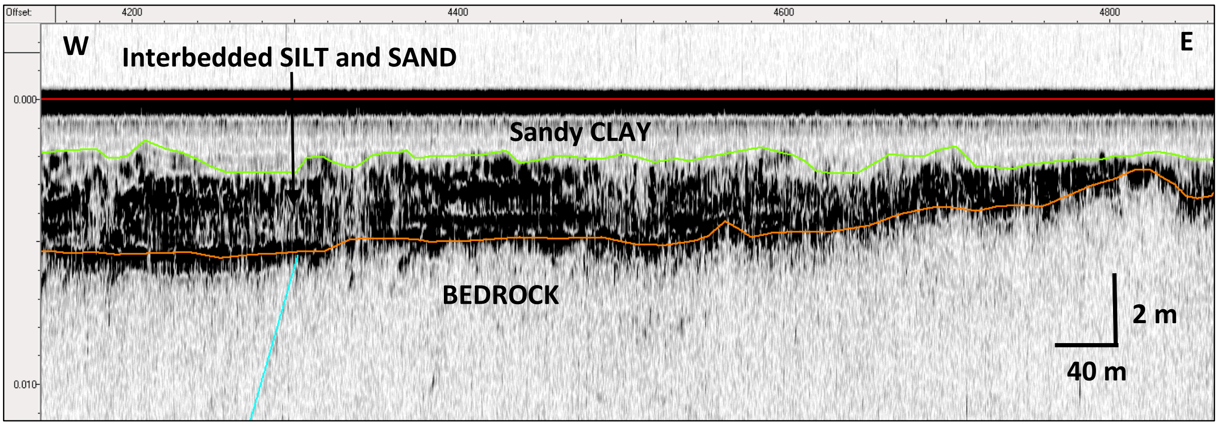

Figure 125 Chirp data image of the shallow geology between KP 7.6 and KP 8.5.

From KP 14.965 to KP 24.134, the shallow geology comprises 1 m of sandy CLAY over BEDROCK at KP 14.965. The BEDROCK quickly dips to a depth greater than 5 m from the seabed at KP 15.679. Fine to medium SAND underlies the 1 to 2 m deposit of sandy CLAY between KP 15.207 and KP 16.950.

The BEDROCK comes to within 5 m of the seabed at KP 16.405 and then slopes up to within 1 m BSF at KP 16.920 and continues to be within 1.5 m of the seabed until KP 20.162 (Figure 126). Here it dips down 3.5 m below seabed at KP 20.743, located at the base of a sub-seabed palaeovalley system. The BEDROCK subsequently undulates to KP 21.299 and is backfilled with SILT and SAND. The sandy CLAY, 1 to 1.5 m thick, continues to overlie the BEDROCK until KP 24.134,

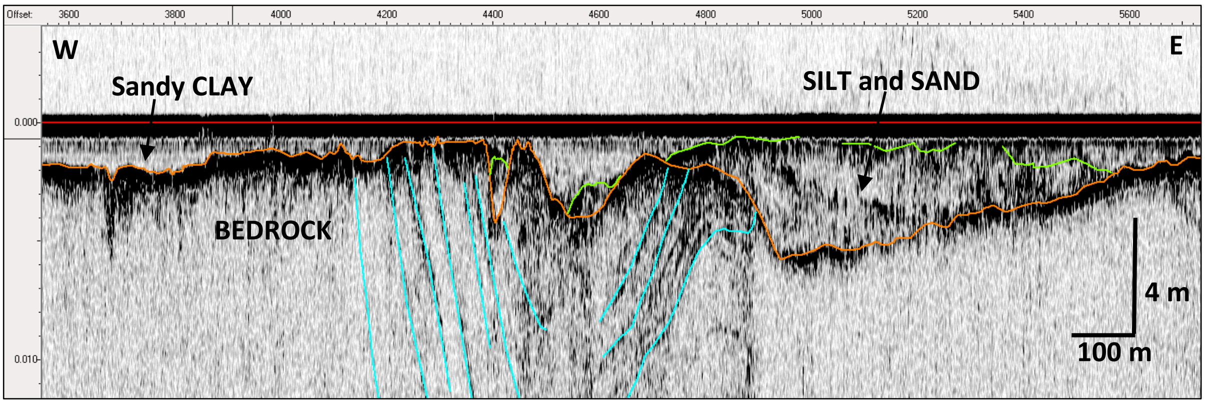

Figure 126 Chirp data image of shallow geology along ARSW route highlighting bedrock near seabed surface, KP 20.900 to KP 21.100.

From KP 24.134 to KP 47.674, the shallow geology comprises 1 to 2 m of sandy CLAY overlying BEDROCK except at the outcropping locations detailed above. From KP 25.250 the sandy CLAY begins to thicken and continues between 2 and 3 m until KP 36.955 where the sandy CLAY overburden thins to less than 1 m for a distance of 1.2 km before thickening again to 2 m. From KP 38.920 the BEDROCK dips down going beyond 5 m from the seabed surface at KP 39.376. From this point SILT and SAND, 2 to 3 m thick, underlies 2 to 3 m of sandy CLAY. The underlying SILT and SAND unit thins and pinches out at KP 40.295, the sandy CLAY remains between 2 and 3 m of thickness (Figure 127).

At KP 41.372 the BEDROCK surface slopes to with 1 to 2 m of the seabed and becomes very irregularly eroded.

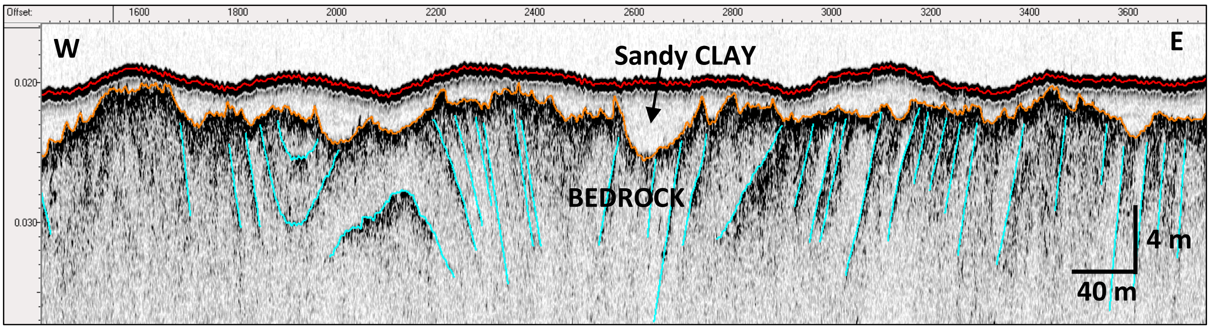

Figure 127 Chirp data image of irregularly eroded bedrock overlain by sandy CLAY, KP 42.750.

From KP 44.000 the sandy CLAY thickens gradually to 4.5 m at KP 45.820 at which point the BEDROCK slopes up very steeply and outcrops. There is a sandy CLAY overburden up to 3 m thick between KP 46.120 and KP 46.932 with a fine to medium SAND veneer (Figure 128).

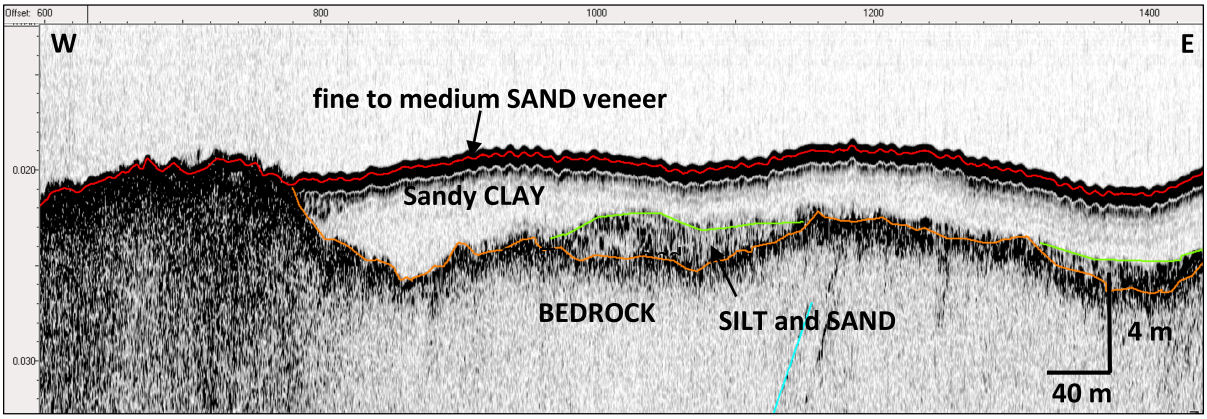

Figure 128 Chirp data image at KP 46.300 to KP 47.200. Showing the underlying BEDROCK coming to seabed surface and outcropping.

3.9.5| SIDE SCAN SONAR CONTACTS

There are a total of 845 SSS contacts located within the ARSW corridor. The contacts have been reported as boulders, debris, objects and others. They are listed with their respective position (grid and geographic), relevant KP reference survey centre line, size (L x W x H) and a DCC offset to the KP reference. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|. A summary of the boulder field occurrence is presented in Table 30.

Table 30 Overview of boulder field occurrence along the ARSW by KP.

KP Start	DCC (m)	KP End	DCC (m)	Boulder field	Boulder density	Average Size (m) L x W x H	Surveyed centreline Intersection KP Start	Surveyed centreline Intersection KP End
44.513	129	44.943	74	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	1.0 x 0.7 x 0.9	44.678	44.739
44.721	398	45.602	24	Occasional Boulders	10-20 per 100 m^2. Boulders are >0.5 m	1.7 x 1.3 x 1.4	45.058	45.354
44.970	93	45.336	0	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.7 x 1.3 x 1.4	45.176	45.338
45.422	503	45.701	256	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.2 x 0.6 x 1.1	-	-
45.732	34	45.789	61	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.1 x 0.8 x 0.8	-	-
46.323	0	46.457	0	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	0.9 x 0.5 x 0.5	46.323	46.457
46.510	293	46.574	311	Numerous Boulders	>20 per 100 m^2. Boulders are >0.5 m	1.6 x 1.3 x 0.9	-	-

3.9.6| MAGNETIC AND GRADIOMETER ANOMALIES

There are a total of 38 magnetic anomalies (Phase 1) and five (5) gradiometer anomalies (Phase 2) located within the ARSW corridor. They are classed with respect to their “dipole” shape: Monopole, Dipole, Asymmetric Dipole or Complex Anomaly. If relevant, comments have been listed with respect to the target being linear, possible geology or potential UXO. These anomalies have been plotted onto the relevant charts and lists are contained in Appendix F|.

3.9.7| ADDITIONAL INFORMATION

The relatively thin cover of surficial sediments over what has been interpreted as BEDROCK may not allow sufficient depth of burial for the proposed cable. In addition there is extensive trawling activity along a majority of the proposed route from KP 0.000 to KP 45.000.

3.10| SPANISH LANDFALL SITE SURVEY

The Spanish Landfall Site Survey was conducted by the MV Geo Focus and Plasticbeam and overlapped the end of the MR. Water depths across the site vary between -1.6 m and 23.2 m. The surficial geology is predominantly BEDROCK with a patchy veneer of SAND and GRAVEL varying in thickness up to 2.5 m BSF. Two SBP lines were run to provide options and assess the areas where surficial sediments predominate.

The Spanish Landfall Site was surveyed with runlines across the route direction because of the dangers presented by the rocky shoaling seabed. Since the proposed route ends at the start of this area there are no KP references presented in this result section.

3.10.1| POSITIONING

The calibrations and positioning test were carried out prior to any data collection phase. The results of these are presented in the MAC reports located in Appendix C|. Underwater positioning can be affected by pycnoclines and thermoclines that exist within water columns containing two or more bodies of water with differing densities and temperatures.

3.10.2| BATHYMETRY

The seabed along the approach to the Spanish landfall shoals from 30 m to the landfall.

Water depths across the site vary between -1.6 m in the southwest and 23.2 m in the northwest (Figure 129).

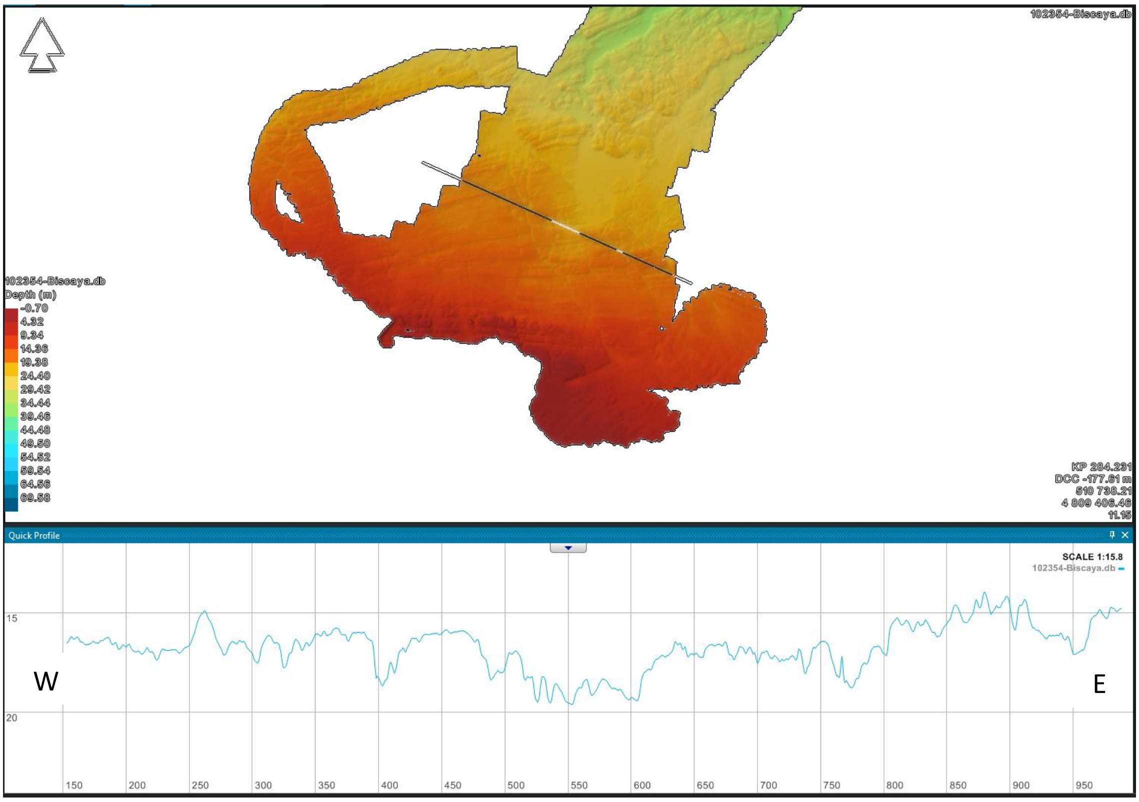

Figure 129 Bathymetry of Spanish Landfall Site.

3.10.3| SURFICIAL GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

The Spanish landfall is predominantly BEDROCK with small areas of SAND and GRAVEL with ripples, wavelength, 0.5-1.5 m, height 0.2 m, orientated WSW to ENE, overlying the BEDROCK (Figure 130). There are two bigger deposits of SAND and GRAVEL up to 1.5 m thick. The extent of these deposits are depicted on the MBES data image (Figure 131).

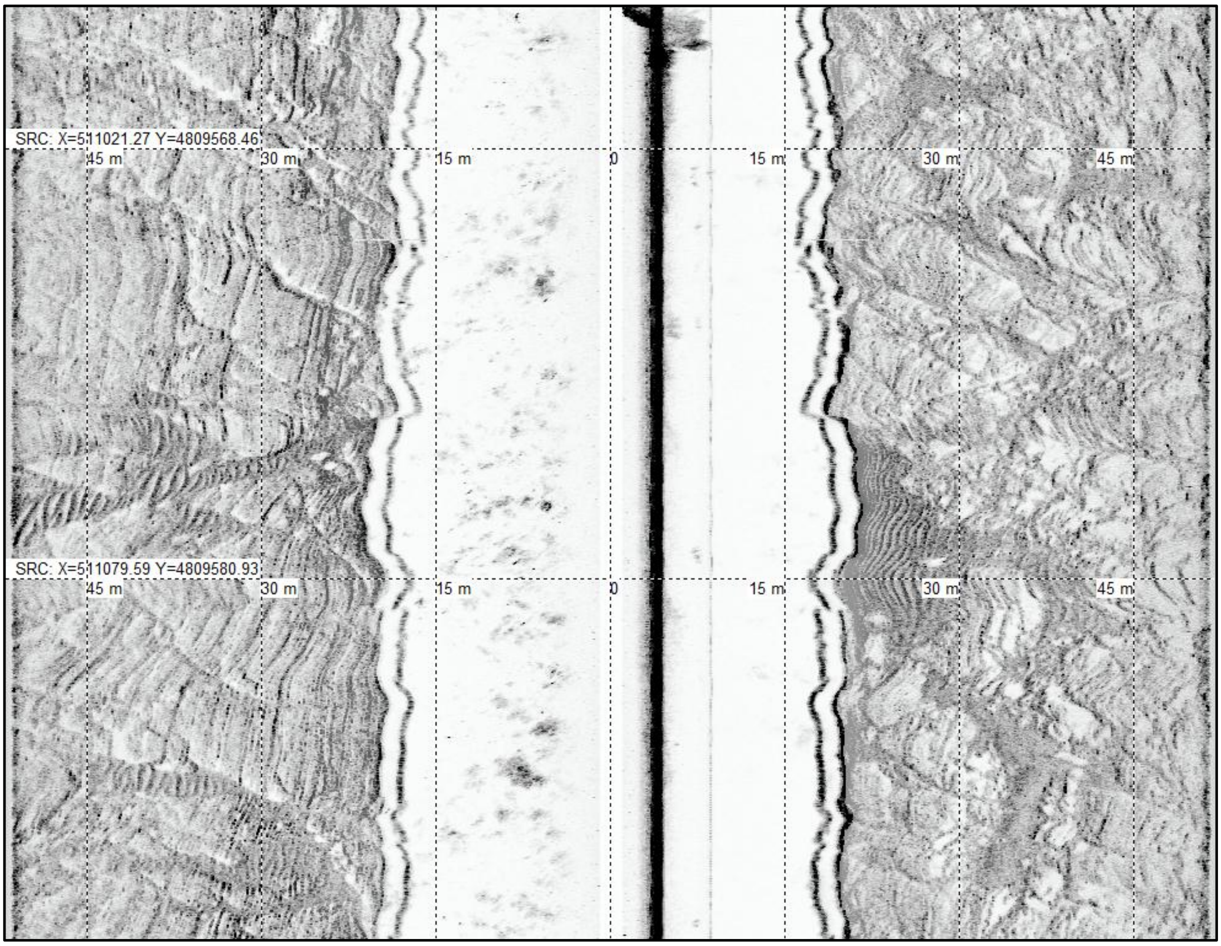

Figure 130 SSS data image of the outcropping BEDROCK within the Spanish Landfall Site with patches of thin SAND and GRAVEL with ripples.

3.10.4| SHALLOW GEOLOGY

The following geophysical interpretations of the shallow geology are based on changes in acoustic character and are supported with geotechnical results.

The shallow geology comprises bedrock with small deposits of SAND and GRAVEL up to 1.5 m BSF, infilling shallow channels, situated within the mid-section of the nearshore route (Figure 131).

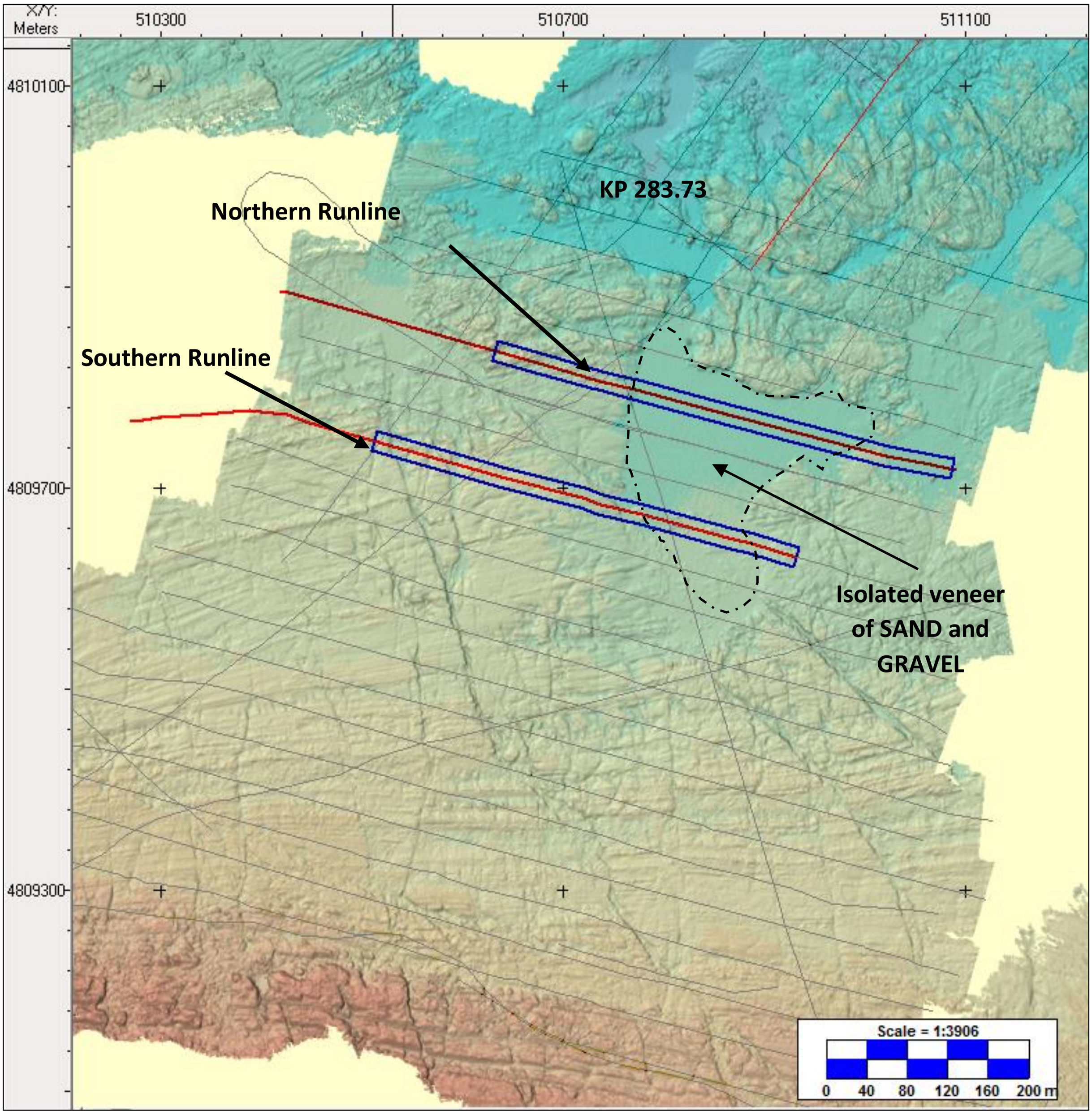

Figure 131 Shaded relief of Spanish Landfall Site.
Highlighted are the two Innomar runlines lines and the isolated patches of SAND and GRAVEL.

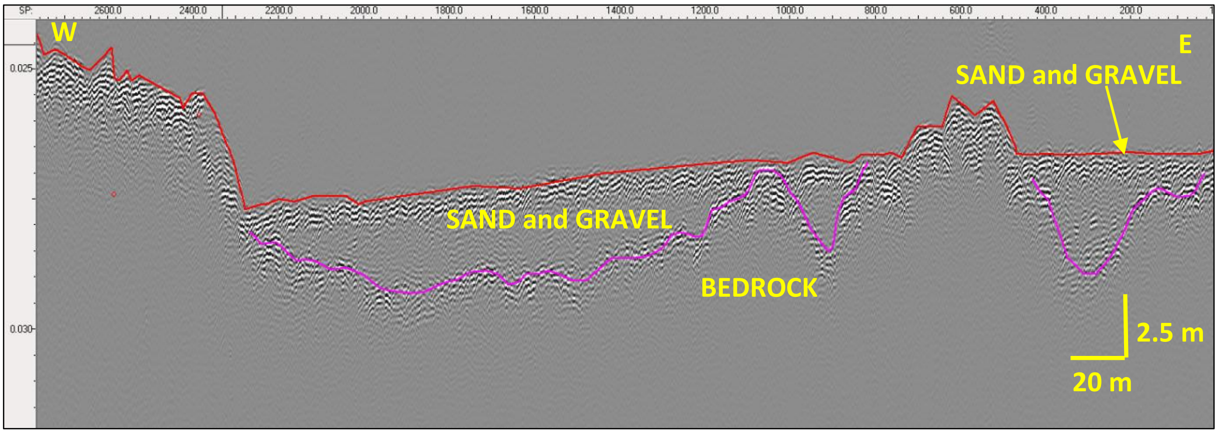

Figure 132 Innomar data record along northern runline.

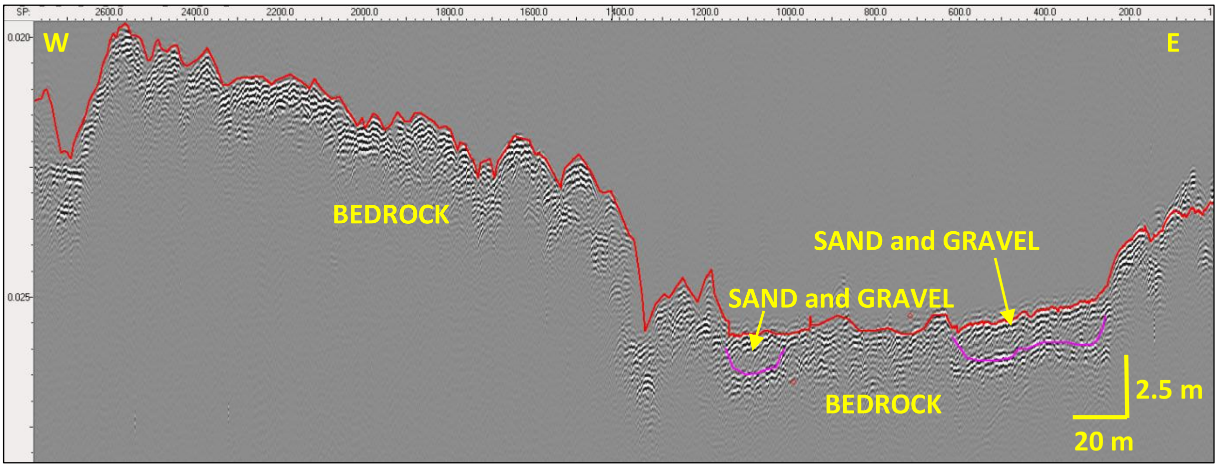

Figure 133 Innomar data record along southern runline.

3.10.5| SIDE SCAN SONAR CONTACTS

There are a total of 11 SSS contacts located within the Spanish landfall corridor. The contacts have been reported as boulders, debris, objects and others. They are listed with their respective position (grid and geographic) and size (L x W x H). KP and DCC is not present since the area does not have a KP referenced survey line. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|.

3.10.6| MAGNETIC AND GRADIOMETER ANOMALIES

There was one (1) magnetic anomaly (Phase 1) and no gradiometer anomalies (Phase 2) located within the Spanish Landfall Site Survey Area. It was classed with respect to its shape as a monopole. No other assessment or comment of the target is made at this stage. It has been plotted on the relevant chart and listed in Appendix F|.

3.10.7| ADDITIONAL INFORMATION

The paucity of sediment cover over the bedrock within the Spanish landfall approach restricts the option to bury the proposed cable in sediments e.g. SAND or GRAVEL, and increase the likelihood of exposure post installation. This is also seen when comparing boundary between the 2016 data for the Spanish

Landfall Site against the 2017 data for the Additional Spanish landfall site, some areas that were covered by sediment in 2016 show exposed BEDROCK in 2017 and vice versa.

3.11| ADDITIONAL SPANISH LANDFALL SITE SURVEY

The Additional Survey Spanish Landfall was conducted by the M/V Olympic Delta and overlaps the MR and the Spanish Landfall Site Survey. The water depths across the site vary between 11.9 m and 53.8 m. The surficial geology is mostly outcropping bedrock with veneer of SAND and GRAVEL.

3.11.1| POSITIONING

The calibrations and positioning test were carried out prior to any data collection phase. The results of these are presented in the MAC reports located in Appendix C|. Underwater positioning can be affected by pycnoclines and thermoclines that exist within water columns containing two or more bodies of water with differing densities and temperatures.

3.11.2| BATHYMETRY

The seabed along the approach to the Spanish landfall shoals from 50 m to 12 m.

Water depths across the site vary between 11.9 m in the southwest and 53.8 m in the northwest (Figure 134).

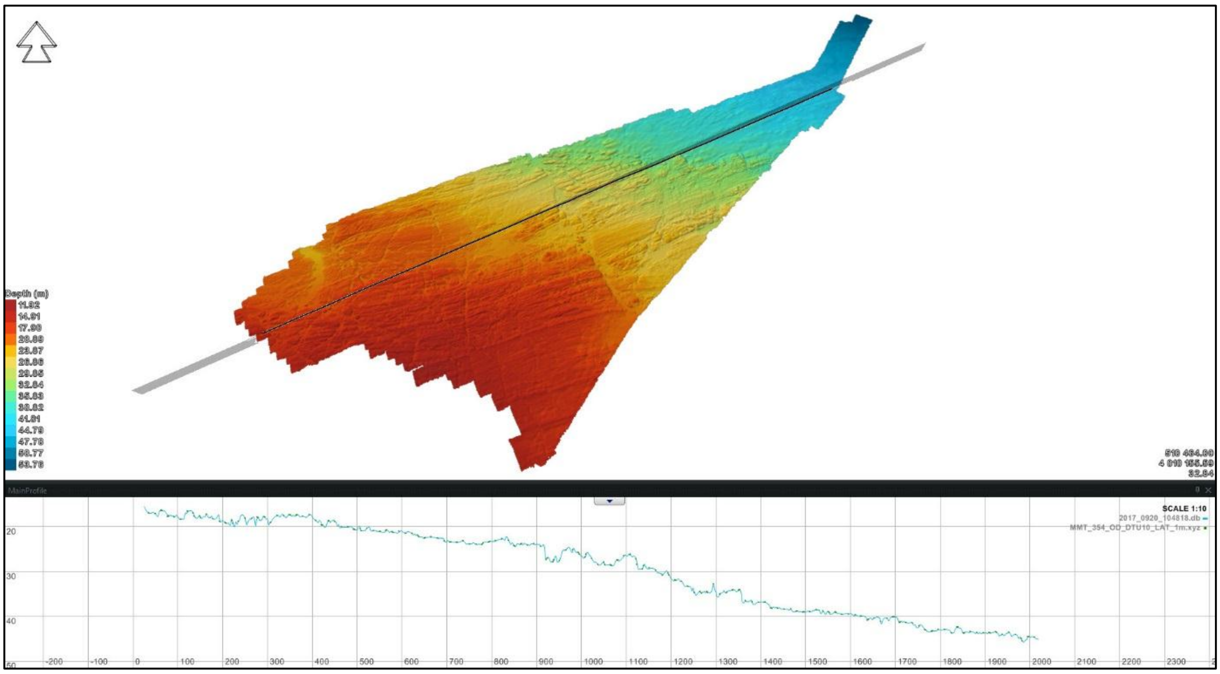

Figure 134 Bathymetry of Additional Spanish landfall site.

3.11.3| SURFICIAL GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

The Additional Spanish landfall survey is predominantly BEDROCK with small areas of SAND and GRAVEL with ripples, wavelength, 0.5-2 m, height 0.2 m, orientated WSW to ENE, overlying the BEDROCK (Figure 135).

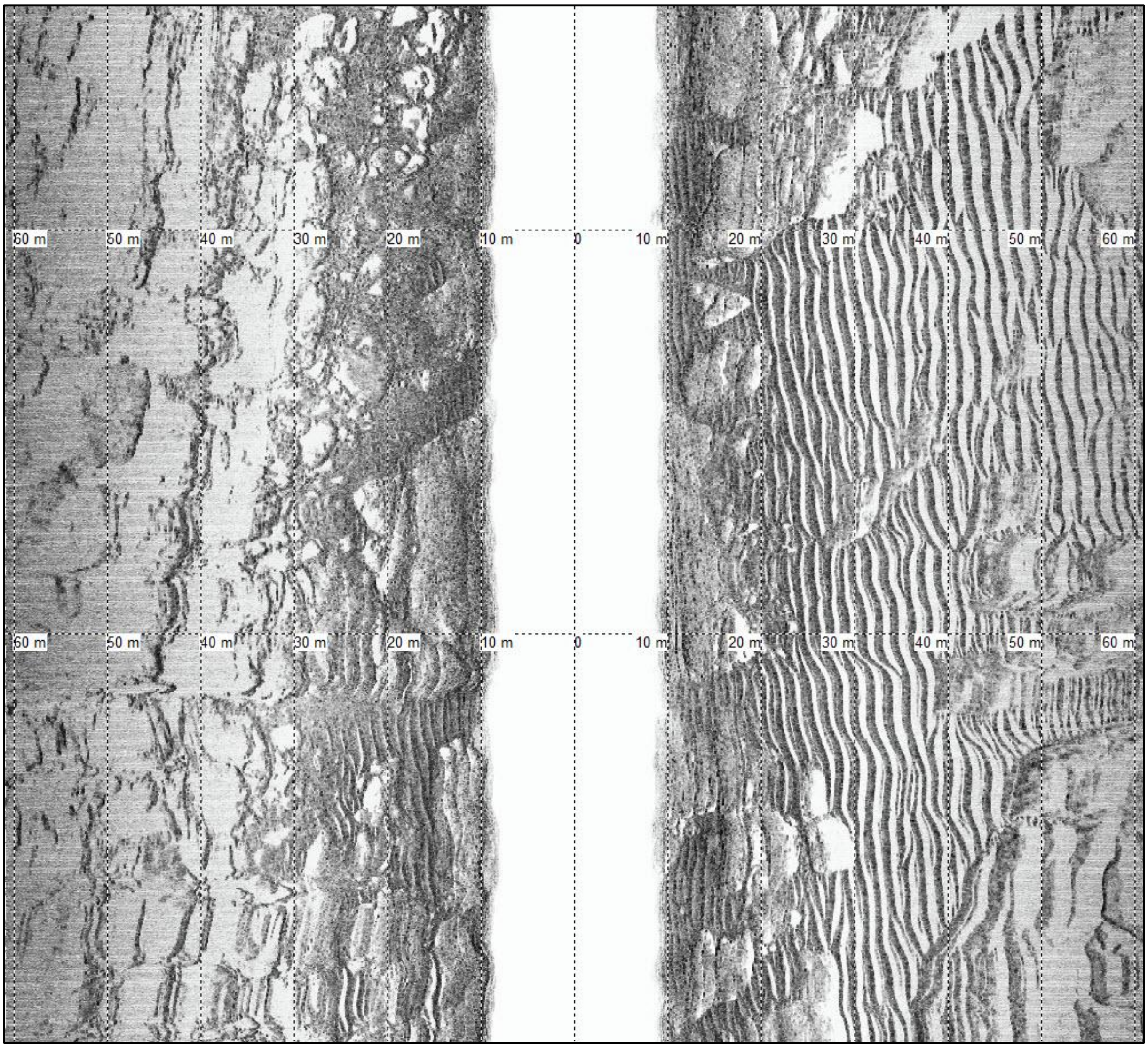

Figure 135 SSS data image of the outcropping BEDROCK within the Additional Spanish landfall site with patches of thin SAND and GRAVEL with ripples.

3.11.4| SHALLOW GEOLOGY

The sediment types discussed are based on interpretations of changes in acoustic character, mainly reflectivity and texture from the SSS data, and are supported by geotechnical results. They are additionally supported by the sediment classifications in the referenced articles contained in Section 6|.

The shallow geology comprises bedrock with small deposits of SAND and GRAVEL, infilling shallow channels.

3.11.5| SIDE SCAN SONAR CONTACTS

There are a total of 39 SSS contacts located in the Additional Survey Spanish Landfall survey area. All contacts have been reported as boulders. They are listed with their respective position (grid and geographic) and size (L x W x H). KP and DCC is not present since the area does not have a KP referenced survey line. These contacts have been plotted onto the relevant charts and lists are contained in Appendix E|.

3.11.6| MAGNETIC AND GRADIOMETER ANOMALIES

No magnetometer or gradiometer survey was done in the Additional Spanish Landfall Area.

3.11.7| ADDITIONAL INFORMATION

The paucity of sediment cover over the bedrock within the Spanish landfall approach restricts the option to bury the proposed cable in sediments e.g. SAND or GRAVEL, and increase the likelihood of exposure post installation

3.12| ISOPACH CREATION

Four types of contoured isopachs were created across the entire survey area depending on the geophysical instrument available and the physical environment surveyed. These four types are described in the sections below. To get one final isopach for the entire survey area they have been combined into one isopach. The interpreted and interpolated hard surface. “Type A” and “Type B” were created from the available sparker data to determine the depth of the unconsolidated sediment. “Type C” was created from the chirp data set where the depth to bedrock could be assessed using the data or where chirp data was the only available data set available due to operational constraints. Type D was created from the Innomar data set taken from the nearshore zones.

In order to create the isopachs, horizons of interest are picked using the IHS Kingdom software. The difference (in milliseconds (ms)) between the seabed and the horizon is computed and a time to depth conversion applied resulting in a thickness of a depth for each horizon in metres. A constant velocity of 1600 ms^{-1} was assumed throughout the survey area for SAND (Hamilton and Bachmann, 1982). Assuming a maximum deviation of 50 ms^{-1} from the assumed velocity this would introduce a 0.12 m error per 5 ms two way travel time.

Within IHS Kingdom the depth data from the lines were gridded using an inverse distance to power algorithm with a “search distance” and grid cell size appropriate to the spatial density of the dataset i.e. a greater density of adjacent lines requires less interpolation and the production of a higher resolution grid for contouring.

3.12.1| TYPE A ISOPACH

The “Type A” isopach was created from the available sparker data on the MR between KP 2.6 and KP 132.25, along the approach LACO, between KP 2.9 and KP 21.7 and on the alternative approach LGCO between KP 3.4 and KP 12.02. While the sparker data acquired throughout is spatially discontinuous it enables a determination of the depth of unconsolidated sediment (Loose SAND etc.) that was otherwise impossible with the chirp data. This required interpolation between lines is up to 300 m apart, in areas where sparker lines are sparse, but due to the depth of sediment, approximately 15-20 m, and the lateral continuity of the reflectors it is considered to be acceptable. In the absence of geotechnical data, the unconsolidated sediment depth, i.e. sediment deposited during the Late Quaternary less than 120,000 years BP, assessment on the South Aquitaine platform is made with reference to Bellec (2003) and Ifremer (2012).

Where this unit is at or near the surface from KP 130.5, along the centre line, there are areas which exhibit the texture of “hard ground” detected on the SSS data (Figure 40 and Figure 136).

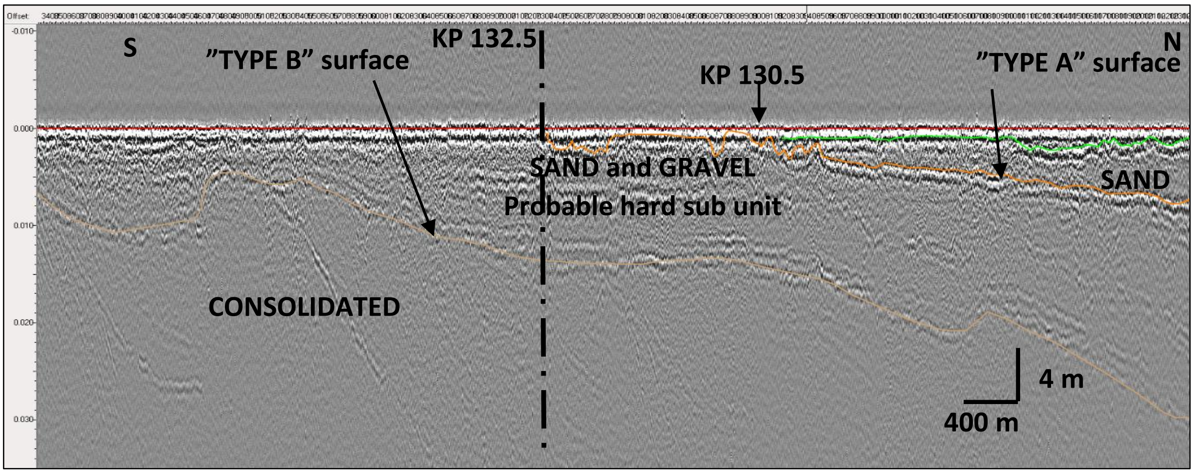

Figure 136 Sparker data image showing the boundaries used to delineate the type A and type B isopachs at KP 132.5. Seabed flattening of data applied.

3.12.2| TYPE B ISOPACH

The “Type B” isopach was also created from horizons picked using the sparker data. The data sets include: KP 132.25 to KP 150.2 50 and KP 161 to KP 166 on the MR and throughout the HDCC. The horizon delineating the top of the CONSOLIDATED SEDIMENT unit (dense SAND etc.) was used to create the isopach. There is considerable uncertainty however between KP 132.25 and KP 141 as to the degree of consolidation of the sediment within the overlying unit (Figure 136). While the unit is likely to be “hard” at the interface from weathering during sea level regression, the extent of compaction of the sedimentary unit is unclear. From KP 141 to KP 150.2 and for the HDCC, the base of the units interpreted as SAND and/or, SAND and GRAVEL is used for the isopach.

3.12.3| TYPE C ISOPACH

The “Type C” isopach was created from the chirp dataset collected between KP 150.25 and KP 152.30 on the MR north of Capbreton, from KP 166 to KP 283.73 south of Capbreton and on the ARSW route. North of Capbreton the horizon for the top of the unit labelled as “CONSOLIDATED SEDIMENT” or “BEDROCK” is used for to generate the isopach (Figure 64). South of Capbreton, where the chirp data is used for the isopach, the delineation of the eroded sedimentary bedrock surface is a less ambiguous surface in which to define the base of the unconsolidated sediment.

3.12.4| TYPE D ISOPACH

The “Type D” isopach was created from the Innomar dataset and was used to define the sediment overburden along the three French nearshore landfall options, the Capbreton Canyon Head bypass (MR KP 152.5 to KP 159.5) and the Spanish Landfall Site Survey Area (Figure 131). Where the base of the unconsolidated unit could not be detected (as was the case for the three French nearshore landfalls and the Capbreton Canyon Head bypass) the lower most horizon was picked, which would provide a minimum depth. However, due to the high attenuation character of the sediment it is likely that the unconsolidated sediment unit is thicker than indicated.

4| SURVEY PARAMETERS AND METHODOLOGY

4.1| GEODETIC DATUM AND GRID COORDINATE SYSTEM

The geodetic and projection parameters used in the project are presented in Table 31 and Table 32.

Table 31 Geodetic parameters.

GEODETIC DATUM PARAMETERS	
Datum	ITRF2008
ESPG Datum code	5332
Spheroid	GRS 80
Semi Major Axis	6378137.000 m
Semi Minor Axis	6356752.314 m
Inverse Flattening (1/f)	298.25722101
Eccentricity Squared (e2)	0.0066943800

Table 32 Projection parameters.

PROJECTION PARAMETERS	
Zone	UTM30
Central Meridian	3º E
Latitude Origin	0º
False Northing	0
False Easting	500 000
Central Scale Factor	0.9996
Units	m

4.2| VERTICAL DATUM

The vertical parameters used during the project are presented in Table 33.

Table 33 Vertical parameters.

VERTICAL PARAMETERS	
Vertical Datum	LAT
Height Model	DTU 10
Time Datum	Coordinated universal time (UTC)

Global Navigation Satellite System (GNSS) tide was used to correct the bathymetry data to the defined vertical datum, LAT (Figure 137). The GNSS tide was obtained by post processing GNSS data collected by an Applanix POSMV 320 system. The GNSS data was post processed in the software POSPac MMS. Both the POS MV and POSPac MMS are developed by Applanix. The output from POSPac is ellipsoidal heights with accuracies of 5 cm RMS and are corrected for motion and referenced to the MBES reference point. By incorporating the DTU10 model into the process, the heights were referenced to LAT. The DTU10 model is developed by the Danish National Space Centre and has accuracy within a decimetre. Comparisons with the closest water level station will be done to ensure that the data is levelled correctly. In addition the data collected in France and Spain was continuously controlled against a tide gauge, set up in the vicinity, to ensure that no busts were present in the data. Adjacent lines were also used as a QC.

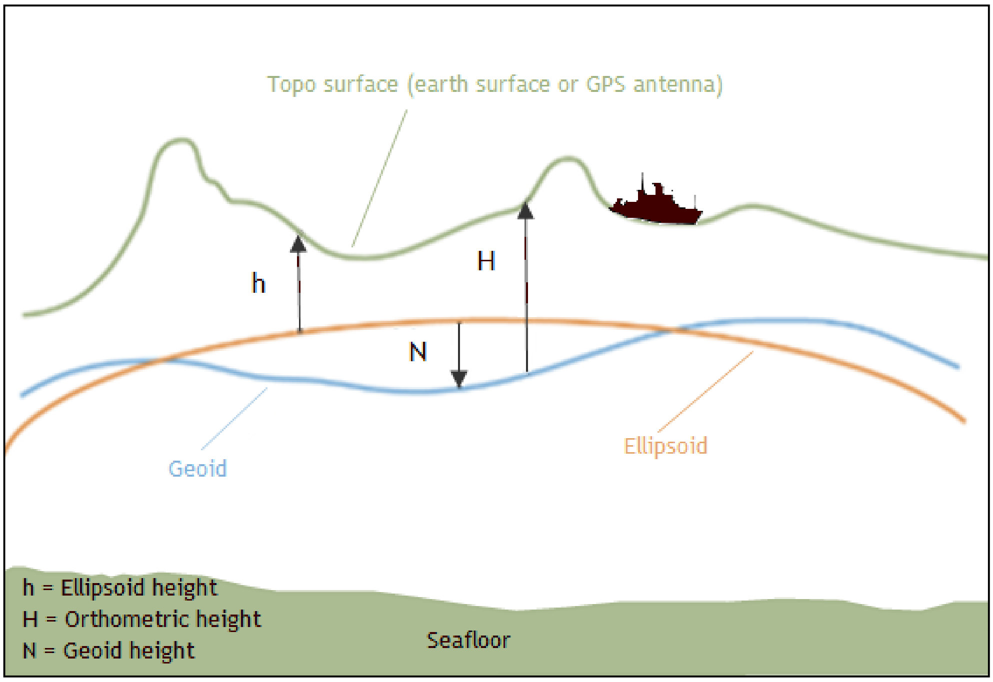

Figure 137 Overview of the tide methodology.

This tidal reduction methodology encompasses all vertical movement of the vessel, including tidal effect and vessel movement due to waves and currents. The short variations in height are identified as heave and the long variations as tide.

This methodology is very robust since it is not limited by the filter settings defined online and provides very good results in complicated mixed wave and swell patterns. The vessel navigation is exported into a post processed format, Smoothed Best Estimated Trajectory (SBET) that is then applied to the MBES data.

The methodology has proven to be very accurate as it accounts for any changes in height caused by changes in atmospheric pressure, storm surge, squat, loading or any other effect not accounted for in a tidal prediction.

4.3| TIME DATUM

UTC was used on all survey systems on board the vessel. The synchronisation of the vessels on board system was governed by the pulse per second (PPS) issued by the primary positioning system. All displays, overlays and logbooks were annotated in UTC. The DPR refers to UTC.

4.4| MULTIBEAM ECHO SOUNDER BATHYMETRY

An R2Sonic high resolution MBES system, mounted on the ROTV, was used by M/V Franklin to produce digital terrain models (DTM) with 1 x 1 m grid size with a density of 10 pings per cell.

M/V Geo Focus used an EM2040D high resolution MBES system to produce DTMs with 1 x 1 m grid size with a density of 10 pings per cell.

M/V Olympic collected bathymetrical data with a dual head R2Sonic 2024 high resolution MBES system mounted on the ROV to produce DTM with 1 x 1 m grid size with a density of 10 pings per cell.

The general MBES processing workflow is presented in Figure 138.

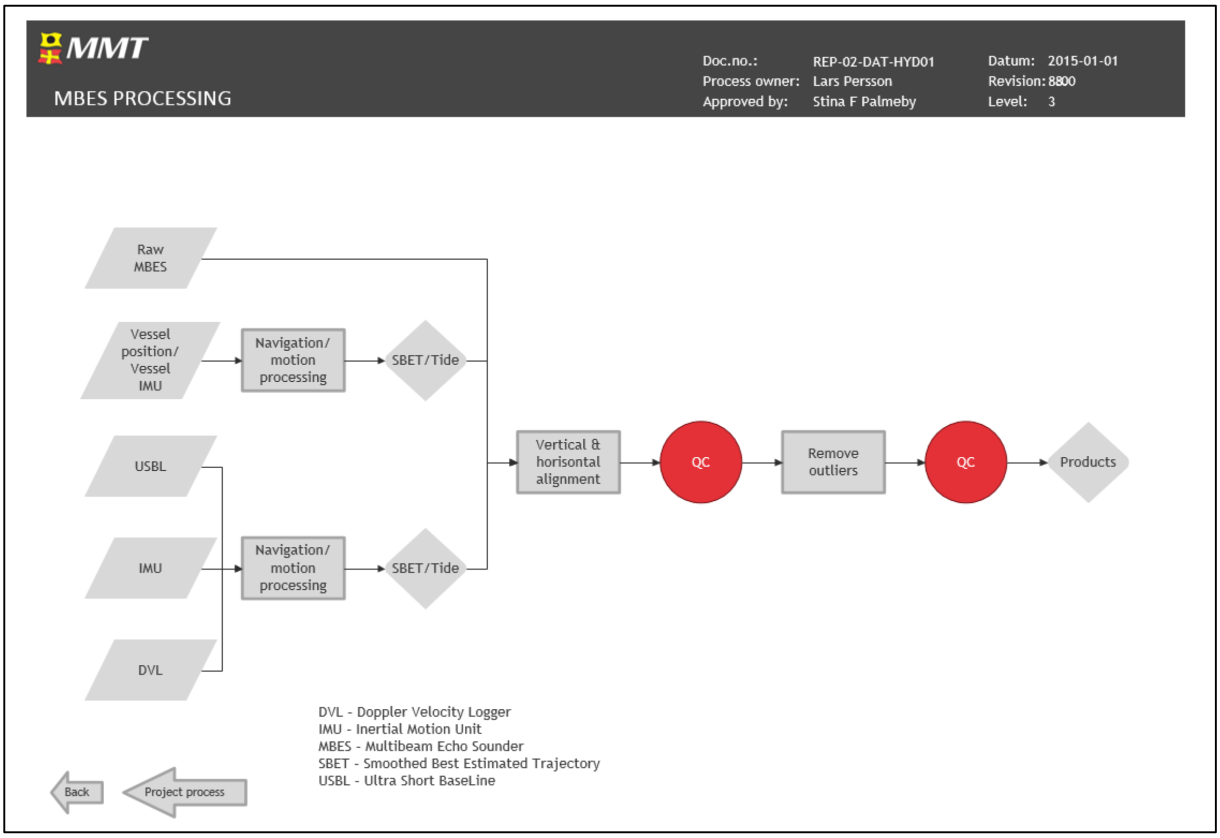

Figure 138 Workflow of MBES Processing.

4.5| SIDE SCAN SONAR

In accordance with the original SOW for Phase 1 offshore work a 300/600 kHz Edgetech SSS system, mounted on a ROTV was deployed from M/V Franklin in order to determine sediment features, such as objects, linear features, obstructions, pipelines and cables and sediment characteristics. Adjacent lines were run in opposite directions. The range of the SSS was set to 100 m allowing to ensure at least 110 % overlap between adjacent swaths. However, there was a failure of the 600 kHz transducer and a 900 kHz transducer was used for part of the survey until the 600 kHz unit could be replaced.

M/V Geo focus was equipped with a 250/600 kHz Innomar SSS system for the nearshore geophysical survey in Phase 1. The range of the SSS was set to 50 m to ensure at least 110 % overlap between adjacent swaths.

During Phase 2 offshore operations a 300/600 kHz Edgetech SSS system, mounted on the ROV was used to determine sediment features, such as objects, linear features, obstructions, pipeline and cables and sediment characteristics. Adjacent lines were run in opposite directions where possible. The range of the SSS was set to 70 m allowing to ensure at least 110 % overlap between adjacent swaths

Further details are contained in Appendix G|.

4.5.1 | GENERAL PROCESSING

- The jsf files are continuously loaded into SonarWiz with the appropriate file type specific settings (TVG retrieved from Discover). The appropriate settings are determined during the MAC tests.
- The data quality is checked. If the data quality is not accepted, the Offshore Manager is alerted.
- The navigation is checked and, where necessary, smoothed and spikes are removed.
- The bottom track is automatically tracked and then, if needed, adjusted manually.
- The coverage is checked for navigation gaps, overlap and data loss. If any are apparent, the Offshore Manager is alerted. The QC of this step is usually performed by another geologist than the one performing the original task, if the project involves several geologists.
- Offset from the survey line is checked.
- The settings are fine-tuned to optimise for mosaic creation and contact identification. The appropriate overlapping mode is set.
- The ecoframes are loaded and data is cropped to the ecoframes and exported as geoPNG.
- If it is a Client requirement, each SSS file is exported as geoPNG.
- Tracklines are exported as.shp (single polyline per file).

Overview of general SSS processing is outlined in Figure 139 and Figure 140.

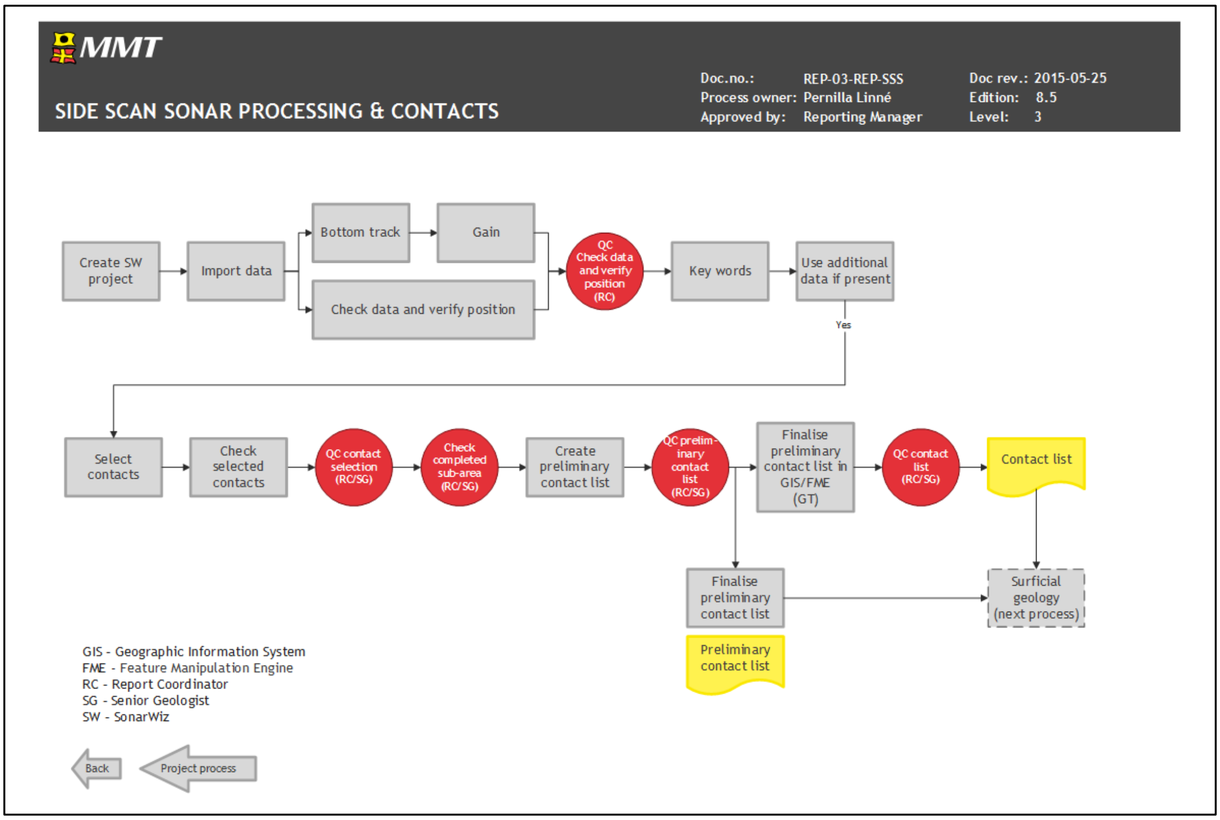

Figure 139 Workflow of SSS processing 1.

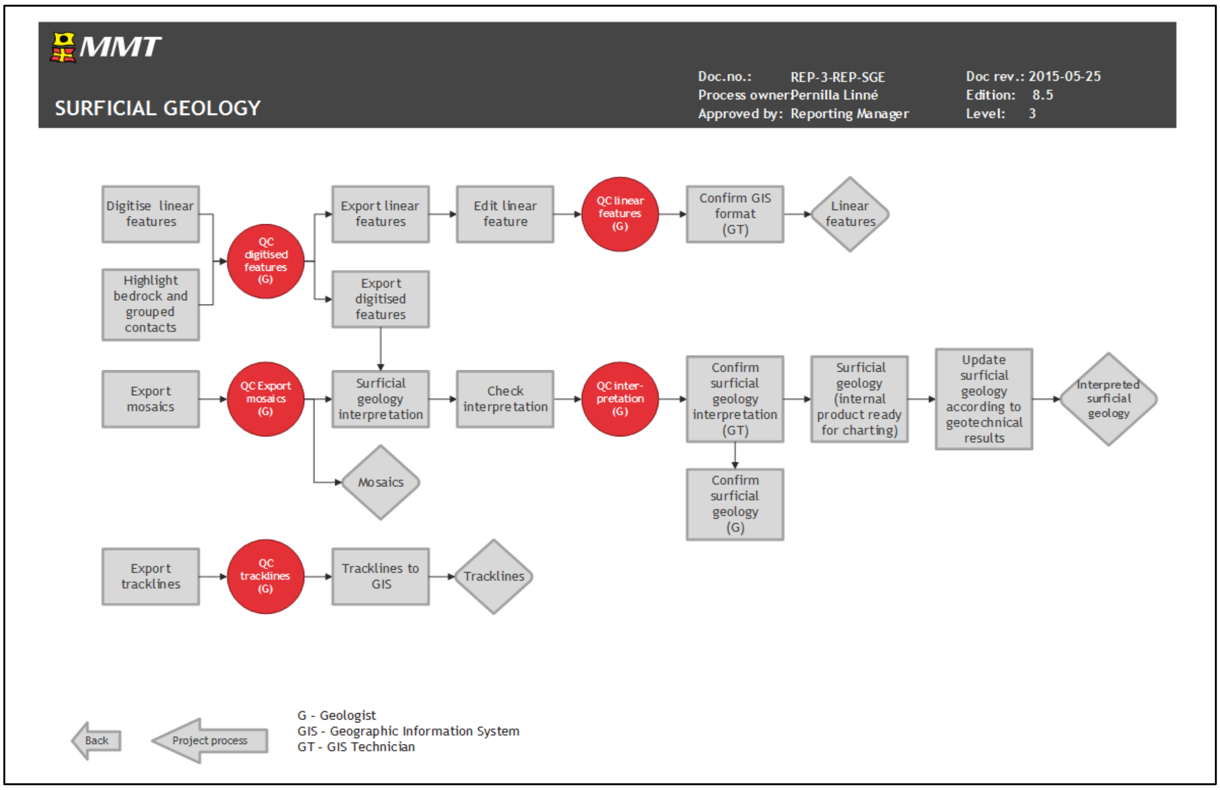

Figure 140 Workflow of SSS processing 2.

4.5.2| SURFICIAL GEOLOGY AND SEABED FEATURES

- The surficial seabed geology is classified into a number of units. The number of seabed classes is agreed on with the Client, depending on the type of geology in the survey area.
- In areas with multiple units, the polygon for one unit, with the exception of bedrock, should not be less than 100 m in diameter for chart scale 1:10 000, 50 m for chart scale 1:5 000 and 20 m for chart scale 1:2 000 and less. These settings are used if there are no detailed requirements from the Client that state otherwise.
- All bedrock outcrops are mapped by enclosing them within a boundary.
- If applicable, the geo-boundaries are digitised as features on screen in SonarWiz. The boundaries are saved as.dxf.
- Mosaics are created. The mosaic geoPNGs and, if any,.dxfs are inserted into AutoCAD.
- The geo-boundaries are digitised on screen from the mosaic geoPNGs in AutoCAD.
- Seabed features, such as ripple formations and dunes, are identified. The approximate size and transport direction are recorded.
- The geo-boundaries are correlated to the bathymetry data and to the magnetic grid where magnetometer data is processed.
- The QC of the interpretation is performed by the Offline Coordinator or Senior Geologist.

4.5.3| CONTACT CLASSIFICATION

- The.jsf files are viewed within the digitising mode and the contacts are selected according to specifications. The image is measured, classified and zoomed appropriately. Special attention is made to wrecks, cables or archaeologically interesting objects. Wrecks and cables are immediately correlated to existing databases, e.g. MMT or UKHO, if available. Cables and linear features are also digitised on screen.
- The contacts are correlated to bathymetry on screen.
- The QC of the contacts and the correlation to bathymetry is performed by another geologist than the one performing the original processing, if the project involves several geologists.
- A contact list of all accepted contacts is created.
- The QC of the contact list is performed by the Report Coordinator or Senior Geologist.

4.6| SUB-BOTTOM PROFILER

An EdgeTech DW 106 chirp SBP system and a GeoSpark 200 sparker were used simultaneously to ensure penetration to a depth of 2 m on board M/V Franklin. The sparker was only used in the French waters and was not mobilised from the start but added at Client request. Depending on the sediment characteristics one of the two SBP systems are favourable. The data from both systems were used for interpretation. On board M/V Geo Focus a combined Innomar system was used for the SSS and SBP.

During geophysical work from M/V Olympic an EdgeTech DW-216 (2-16 kHz) chirp was used for sub-bottom data acquisition. The SBP was mounted forward and on the upper frame of the ROV.

The workflow of the SBP processing is outlined in Figure 141.

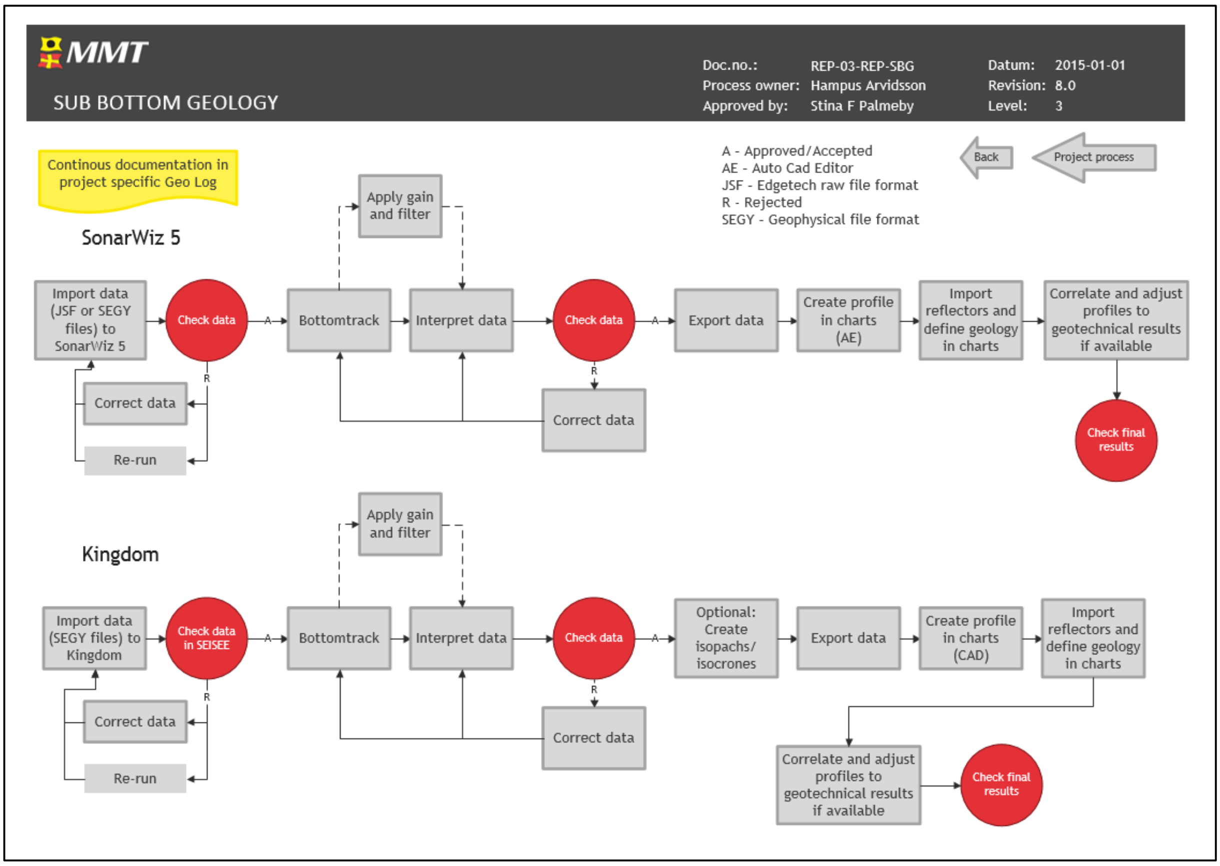

Figure 141 Workflow for SBP processing.

4.6.1 | GENERAL SUB-BOTTOM PROFILER PROCESSING IN SMT KINGDOM

- The .segy files are continuously loaded into IHS Kingdom with the appropriate specified file type settings. The appropriate settings are determined during the MAC tests.'
- The data quality is checked. If the data quality is not accepted, the Offshore Manager is alerted.
- The navigation is checked and, where necessary, smoothed and spikes are removed.
- The bottom track is semi-automatically tracked and, if required, adjusted manually.
- The coverage is checked for navigation gaps, overlap and data loss. If any, the Offshore Manager is alerted. The QC of this step is usually performed by a geologist who was not responsible for original interpretation, if the project involves several geologists.

4.6.2 | GRID AND CONTOURS-ISOPACHS

Isopach horizons and grids for the top of hard surface in the SBP data has been created using IHS Kingdom.

4.7 | TVG AND MAGNETOMETER

Two magnetometers in TVG set up, separated 1.5 m were used on M/V Franklin.

M/V Geo Focus, M/V Esquina and M/V JIF Patrol were equipped with vessel towed single magnetometers.

M/V Olympic Delta performed UXO survey with a 12 pin Model T gradiometer system mounted via a hydraulic frame onto a work class ROV. The gradiometer sensors were spaced 0.78 m apart along the frame. The frame was also equipped with three separate altimeters.

Magnetic data were exported from the magnetometer and gradiometer systems as position and field values and input into Geosoft Oasis Montaj. The UXO-detect extensions of Oasis Montaj were used to QC and apply a series of filters to remove background and calculate the residual field of the data and separate high and low frequency magnetic anomalies. Contacts were selected directly from gridded plots of the residual data with additional measurements taken from the profiles.

5| SURVEY PERFORMANCE

Breakdown of operational hours for the different vessels are presented in Appendix O|.

5.1| MOBILISATION AND CALIBRATIONS TESTS

A MAC was performed for each involved vessel, all four mobilisations and calibrations were successful and the performance of the equipment was accepted. Before UXO surveys a Surrogate Item Trial (SIT) was also performed. Detailed methodology and calibration test procedures are presented in the MAC reports, presented in Appendix C|.

5.2| PROPOSED SCOPE OF WORK

The proposed line plan is based on the requirement specified in the invitation to tender (ITT) provided by the Client and presented in Table 34.

Table 34 Proposed line plan.

OFFSHORE LINE PLAN REQUIREMENTS	
Corridor width	400 m (<50 m W.D.) 625 m (>50 m W.D.)
No. of survey lines	11 (<20 m W.D.) 5 (<50 m W.D.) 7 (>50 m W.D.)
Line spacing	40 m (<20 m W.D.) 90 m (>20 m W.D.)
Crosslines	Every 3 km. Exact position was decided offshore
NEARSHORE LINE PLAN REQUIREMENTS	
Corridor width	French Landfalls: 400 m. At 10 m water depth a 500 m box should be mapped. From 10 m and shallower decreasing corridor width to 100 m Canyon Head By Pass: Minimum 150 m Nearshore Spain: Varying
No. of survey lines	11-13 at the French Landfalls 5 at Canyon Head By Pass
Line spacing	40 m
Crosslines	At least 3 crosslines per landfall.
DIVE SURVEY LINE PLAN REQUIREMENTS	
Corridor width	100 m
No. of survey lines	3
Line spacing	30 m
Crosslines	none
SPANISH INSHORE SURVEY LINE PLAN REQUIREMENTS	
Corridor width	Varying
No. of survey lines	MBES Coverage
Line spacing	MBES Coverage
Crosslines	None
Camera	At 6 locations

5.3| ACTUAL PLAN OF WORK

The actual plan of work is presented in Table 35.

Table 35 Actual plan of work.

Task	Date	Description
M/V Franklin Mobilisation & Calibration	2016-09-25 to 2016-10-02	Mobilisation and Calibration
M/V Geo Focus Nearshore France	2016-09-29 to 2016-10-04	Geophysical survey
M/V Franklin Block 4	2016-10-02 to 2016-10-22	Geophysical survey
M/V Franklin Block 3	2016-10-03 to 2016-10-19	Geophysical survey
Drone Survey	2016-10-04 to 2016-10-06	Drone Survey
M/V Geo Focus Nearshore Spain	2016-10-05 to 2016-10-06	Geophysical survey
M/V Franklin Block 1	2016-10-06 to 2016-10-16	Geophysical survey
Dive Survey	2016-10-06 to 2016-11-03	Dive Survey
Plasticbeam Shallow Survey Spain	2016-10-07 to 2016-10-13	Geophysical survey
M/V Franklin Block 2	2016-10-08 to 2016-10-16	Geophysical survey
M/V Franklin Block 5 with route development	2016-10-22 to 2016-11-03	Geophysical survey
M/V Franklin Block 7 with route development	2016-10-24 to 2016-11-02	Geophysical survey
M/V Franklin Block 6 with route development	2016-11-02 to 2016-11-06	Geophysical survey
M/V Esquina Challenger Mobilisation & Calibration	2017-06-05 to 2017-06-09	Mobilisation and Calibration
M/V Esquina SIT and UXO survey	2017-06-10 to 2017-06-22	UXO survey
M/V JIF Patrol Mobilisation	2017-06-22	Mobilisation
M/V JIF Patrol UXO survey	2017-06-23 to 2017-06-27	UXO survey
M/V JIF Patrol Demobilisation for the project	2017-06-28	Alongside Arcachon, France
M/V JIF Challenger Mobilisation & Calibration	2017-06-14 to 2017-06-16	Mobilisation and Calibration
M/V JIF Challenger Geotechnical sampling	2017-06-17 to 2017-06-27	Geotechnical Sampling
M/V JIF Challenger Demobilisation for the project	2017-06-28	Alongside Bayonne, France
M/V Olympic Delta Mobilisation and Calibration	2017-06-15 to 2017-06-19	UXO and Geophysical Equipment
M/V Olympic Delta UXO survey	2017-06-15 to 2017-06-25	Geotechnical site UXO survey
M/V Olympic Delta Additional Geophysical Survey	2017-06-25 to 2017-06-27	Additional geophysical survey
M/V Olympic Delta Geotechnical Mobilisation & Project Kick-off	2017-06-28 to 2017-06-30	Alongside Bayonne, France
M/V Olympic Delta PCPT & VC mobilisation	2017-06-28 to 2017-06-30	Alongside Bayonne, France

Task	Date	Description
M/V Olympic Delta PCPT & VC Operations	2017-06-30 to 2017-07-09	Geotechnical survey
M/V Olympic Delta Demob of PCPT/MOB of Rock Drill	2017-07-10 to 2017-07-11	Alongside Bayonne, France
M/V Olympic Delta Rock Drilling Operations	2017-07-13 to 2017-07-17	Geotechnical survey
M/V Olympic Delta Demobilisation for the project	2017-07-18 to 2017-07-19	Alongside Bayonne, France
Dive Survey	2017-08-02	Lacanau, France
Dive Survey	2017-09-27	Le Grand Crohot, France

The specific locations for the route development areas are schematically represented in Figure 12.

5.4| DAILY NARRATIVE

The daily narrative for the offshore and nearshore operations are presented in Table 36 to Table 43. For the full DPR's please refer to Appendix G|.

Table 36 Daily narrative M/V Franklin operations.

Date	Comment
2016-09-25	Survey vessel M/V Franklin in transit to Bayonne for start of project.
2016-09-26	Continue transit to Bayonne for start of project.
2016-09-27	Continue transit to Bayonne for start of project.
2016-09-28	Complete transit to Bayonne. Crew change and equipment mobilisation. One of the Client Representatives embarked the vessel.
2016-09-29	Mobilisation continued through the day in Bayonne. The ROTV MBES system arrived. Second Client representative embarked the vessel.
2016-09-29	A project start up meeting was held with MMT project management and the Client on board the vessel. 2 SJA meetings were held, one for each shift. The Client attended one meeting. A MOB drill was held mid-day and a muster/fire/abandon ship drill was held in the afternoon. Vessel familiarisation performed for new personnel. Static calibrations were performed in the evening. The line km and block division table in the DPR was updated by MMT prior to start of survey.
2016-09-30	M/V Franklin left port early in the morning and sailed to the calibration area. Dynamic verification and spin test was completed successfully. After ROTV launched it was noticed that one 600 kHz SSS transceiver was not pinging and fault finding initiated. The fault was narrowed down to the transceiver itself and new system already in transit to the MMT office towards was redirected to Bayonne instead. Until arrival of this system, it was agreed with the Client that the 900 kHz system was deployed instead. It was agreed on board between the Client and MMT to increase the number of lines to ensure complete coverage within the LS while the 900 kHz transducer was used, until the replacement 600 kHz was fitted. Continued with MBES, but interfacing issues in NaviScan, therefore, data was rejected. The re-configuration to 900 kHz and the MBES issue were resolved, simultaneously. Moderate swell of 1.6-1.8 m observed through the day.
2016-10-01	After the SSS was converted to 900 kHz the ROTV was re-launched. During the initiation of MBES patch test connection was lost to one of the MBES heads and system recovered. On inspection the receiver head cable which was completely water filled. A new cable was successfully installed and tested on the ROTV. After the cable termination had cured it was mounted on the ROTV and the system was launched and tested thoroughly. Moderate swell of 1.3-1.4 m observed during the day.
2016-10-02	MBES patch test and SSS/SBP/MAG verifications continued through the day. By evening the results were to specification and Client agreed to allow commencement of data collection. A faulty cable for the mag altimeter was changed before start. Survey was started in the southern part of coastal bypass. The offshore operations table has been updated with the blocks and line km plan. Due to using 900 kHz SSS there is a reduced range and, therefore, more lines had to run as consequence. It follows that the accumulated surveyed km will be more than the contractual number. Moderate swell of 1.5 m observed through the day.
2016-10-03	Survey continued through the night and early morning. Some SSS dropouts were investigated. Lots of fishing gear was spotted in the survey area and a fishing gear recon run was made. A MBES recon was also made of the HDD route assess potential dangers before ROTV operations were conducted along this section. With improved cable routing to the ROTV pod the survey continued along the near shore areas of B4 and after that B3. Some adjustments were made on

Date	Comment
	the magnetometers before starting on the long lines in B3 heading north. A safety walk was performed on the deck areas in the afternoon with a few minor issues. 2 safety observation cards reported - 1 positive regarding vessel welfare and food and one negative regarding lack of proper PPE on deck. Moderate swell of 1-1.5 m observed through the day.
2016-10-04	Survey on the long lines through B3 started just after midnight, with completion of 1.5 lines were completed. Notice that the replacement 600 kHz SSS transducer had arrived and rendezvous arranged with a pilot boat for 12:30 outside Bayonne. The ROTV was recovered and transit to meet pilot boat. The equipment was collected and mounted on the ROTV and a calibration was performed with some difficulty due to the increased swell and wind. Consequently noisy data made targets harder to pick and data collection suspended. The survey resumed in the evening on the C line in B3. Note: The SW and SOCs from yesterday were missing in the DPR but were amended. By the afternoon the swell had increased to 1.8-2.5 m and continued into the evening.
2016-10-05	As an SVP was performed at midnight and a problem with ROTV pressure sensor was rectified. The survey continued along the MR and after that the P90 and S90 lines. The data recorded so far in B3 was reviewed with the Client Representatives and only issue of concern in areas of hard seabed, ringing on SBP. However, it was decided to continue with all lines in B3, and sparker could be used instead to overcome problem. The French military informed the vessel that B2 and part of B1 will be closed off for live firing exercises during Thursday and Friday. Moderate swell of 1.5-1.8 m observed during the day.
2016-10-06	Survey continued in B3, Lines S90 and P180 completed. The RRNC line of the western option was surveyed which was a total of 38.127km under route development (RD). Transit around B2 and start in B1 due to military exercise. The RRNC line of B1 was started. The southern part of B1 is located within the military exclusion zone and was surveyed in conjunction with B2. Please note that the 109 % completion in B3 is due to the increased amount of running lines for 900 kHz SSS. A moderate swell of 1.3-1.6 m was observed through the day.
2016-10-07	Survey continued up through B1 to complete the Lacanau landfall and transit on to La Cantine. 1 SOC received regarding a good and thorough cleanout of one of the areas on the ship. Low swell of 0.5-1.2 m was observed during the day.
2016-10-08	Lacanau was completed and survey continued down through B1 and started in B2. There was a shift in blocks is due to the scheduled military exercise in B2 on following Thursday. 1 SOC received regarding gym equipment in poor condition. Low swell of 0.5 m was observed during the day.
2016-10-09	Survey continued in B2. Permission was received from French authorities for use of sparker system which was deployed from line P90. SOC regarding bad smell from the AC drain - Engine dept. to investigate. Low swell of 0.5 m observed through the day.
2016-10-10	Geophysical survey in B2 continued. Cross lines were completed on transit north and also an infill line at S135 due to the thermoclines. 8 cross lines completed before midnight. 1 SOC regarding mouldy bread. A safety walk was performed in the accommodation with only minor issues noted. Low swell of 0.5 m was observed through the day.
2016-10-11	Cross lines and infills due to thermocline continued. Since the S90 and S180 lines were completed before data collection with sparker, the S135 line was also logged with sparker. On completion of these infills on the P side were undertaken To make the operation as efficient as possible, infills were undertaken between the cross lines. MBES and SSS infills were done going south so as to end up as close to Bayonne as possible, for crew change. ROTV multi-function pod indicated water intrusion just before completion of survey before transiting to Bayonne. The system was checked and small drops of water was found in the

Date	Comment
	multi-function pod. O-rings were changed and system tested successfully. Arrival in Bayonne in the evening awaiting crew change.
2016-10-12	Crew change in Bayonne. By 07:00 all crew had changed. Provision and bunker received. A SJA meeting was held for new on-signers and vessel familiarisation for 3 persons. 3 persons from the fishermen's association visited M/V Franklin. Vessel departed 12:00 and transited to B2. Infill lines in sections of thermocline masking were done during transit. The sparker was re-deployed and commenced with line on P180 in B1.
2016-10-13	Survey on the landfalls continued through the day. Lacanau was finished with infills and cross lines and survey in La Cantine was started. Infill with SSS (due to thermocline masking) those for MBES gaps were conducted simultaneously. Confirmation that RD is to be undertaken in B3 was received. KP130 - 136.5 will be surveyed with 5 more lines to find a way around the hard bottom. 2 SOCs received - One negative regarding short alarm during muster drill and one positive regarding good homemade bread. Low swell of 0.5 m was observed through the day.
2016-10-14	Survey of the landfalls was completed followed by infills in B1. The latter was for both SSS (thermocline masking) and MBES (gaps) the sparker was recovered for tip maintenance around noon. Low to moderate swell of 0.5-2.0 m was observed through the day.
2016-10-15	Survey of the landfalls was completed and we continued with infills in B1. B1 is a complicated mix of SSS and bathy infills but most Bathy infills also had thermocline infills at the same spot. The sparker was recovered for tip maintenance around noon. Low to moderate swell of 0.5-2.0 m was observed through the day.
2016-10-16	The remaining infills and cross lines were completed in B1. Since 3 lines of sparker data had been collected in B2, the sparker was recovered and continued with required infills with the other sensors. On completion of B2 infills the sparker was re-launched prior to B3 infills so as to acquire sparker data within B3, as none collect previously. During a transit the ROTV was recovered in order to change the TVG cable due to noise appearing on data. Moderate swell of 2-2.5 m was observed through the day.
2016-10-17	Infills continued in B3 until morning then data collection along RD commenced. Any infills (although not X-Lines) in the RD section were completed before continuing with data collection in B3. A safety walk was performed in the engine room with no findings. Moderate swell of 1.5 m was observed through the day.
2016-10-18	Survey continued in B3 with infills and cross lines. Survey halted as it became dark due to presence of fishing gear. This left 2 infills and 1 cross line to be completed. The survey continue until daylight in the safer area of B4. Some RD areas were also surveyed. The line km from the day rate RD was added to DPR. Low swell of 0.5-1 m was observed through the day.
2016-10-19	Due to risk posed by fishing equipment to the ROTV the system was recovered after completing one line on B3 infills. The hull mounted EM2040 and sparker were used for the remaining lines within the HDD alignment area. 4 lines completed before nightfall and the ROTV deployed again in B4 through the night. 19.5km of re runs due to thermocline in the RD section. Low swell of 0.5-1.0 m was observed throughout day.
2016-10-20	Survey within B4 continued during night and ops planned to allow arrival in HDD area by daybreak. The ROTV was recovered and survey within HDD alignment completed with hull mounted sensors. Due to steep subsea canyon slope RD lines to the south of this feature were surveyed. Some infills due to fishing boats and gear were completed. Further infills of canyon bypass section were completed before recommencement of survey within B4. As with B3 more line km completed in B4 than outlined in original survey plan due to use of 900 kHz system.48 hour notice sent to Spanish military.

Date	Comment
	weather
2016-10-21	Continue survey in B4 with cross lines after main lines completed. RD undertaken between KP 180-184 consisting of 5 additional lines and 1 cross line. Some infills were completed after these. Apparent fault with MBES rectified after switching off for 20 minutes. Engine room leak also fixed during this period. A medical drill with Samaritan group was held. Some adjustments to DPR 24, 25 and 26 timings were made. Long swell of 0.5 m-1 m was observed throughout day.
2016-10-22	The last remaining cross line and infills were completed in B4. Vessel transited to B5 and commenced survey within block. A SOPEP drill was held on board. The medical drill the other day was not added to the total number so 2 were added today. A moderate swell of 2-2.5 m was observed through the day.
2016-10-23	Survey continued through the day in B5 with good progress made. Data collection continued despite sudden strong offshore winds in morning. A work place inspection was performed. Low swell of 1 m was observed through the day.
2016-10-24	Main lines completed in B5. To give processors more time on B5 data, B7 main lines were started. Lots of Spanish fishing vessels refusing to deviate from their course just before midnight causing changes to planned survey program. One SOC regarding poor condition of desk chairs in cabins. Moderate swell of 2.5-3 m was observed through the day.
2016-10-25	Problems with pair trawlers continue, lines run in opposite direction for a while, but increase in fishing activity necessitated recovery of ROTV and the vessel was on standby until trawlers left area. Low swell of 1.5-2 m was observed through the day.
2016-10-26	Survey stopped in B7 due to scheduled crew change. Crew change conducted in Bilbao with SJA and project briefing was held for new personnel, followed by safety induction tour of vessel. Survey resumed in B7 by the evening. Low swell of 1 m was observed through the day.
2016-10-27	Main line survey in B7 completed except for minor infills and a 4.1km gap on the outer main line (P270) due to fishing gear. Apparently fishing vessel AMETS was informed about survey, but still deployed nets in the area. They claimed to have been fishing in this area all week without notice of survey activity. RD survey started in B5. Muster drill held. Low swell of 1 m was observed through the day.
2016-10-28	Continued with RD in B5 with some minor infills completed during extended line turn. RD suggestion for B7 received. 3 x full lines ~48 km and 2 x ~30 km lines, ~36 h Low swell of <1 m was observed through the day.
2016-10-29	The RD program in B5 was completed with minor infills undertaken during extended line turns. On completion of B5 the RD program in B7 was started. SOC issued regarding food taken from the chefs’ fridge during night shift that was intended for breakfast. SOC issued regarding strong smell from paint coming through the ventilation. Low swell of <1 m was observed through the day.
2016-10-30	Continued survey of lines of RD within Block 7. Water ingress in a cable on the TVG resulted in two burnt fuses on the ROTV. The cable and fuses were replaced and survey resumed. 5 additional RD lines added in B5 between KP 189-194.5. Muster drill held, marine crew only. Low swell of <1 m was observed through the day.
2016-10-31	First revision of RD in B7 and B5 completed and cross lines across both blocks. 4 additional S-lines were added as route development in B7 between KP 21-27. Fishing vessels caused delays during cross line survey. Workplace Inspection conducted. MOB drill conducted. Low swell of <1 m was observed through the day.

Date	Comment
2016-11-01	Survey continued with cross lines in B5 and B7 and the RD program for B7 completed. The timing issues on DPR due to fishing activity and re scheduling of areas of survey were resolved. Low swell of <1 m was observed through the day.
2016-11-02	Survey continued with cross lines in B5 and B7, and geophysical survey of main lines in B6 started. This included a hull mounted MBES reconnaissance survey conducted at B6 Landfall during daylight. Unresponsive fishing vessel, Gorostiaga Hnos, shoots nets across M/V Franklin path, forcing us to change survey area. Time spent for additional survey during extended cross lines due to RD listed as one post in order to ease the overview. Low swell of <1 m was observed through the day.
2016-11-03	Survey of cross lines in B5 and B7 completed which completed the geophysical work in these two blocks. Surveys operations continued in B6 Landfall area completed at KP 280-284. Unresponsive fishing vessel caused M/V Franklin to deviate from survey line just before midnight, resulting in ~3 km data gap. SOC issued regarding empty cardboard boxes from the dry storage stored in the computer room. Low swell of 1 m was observed through the day.
2016-11-04	The survey of B6 main lines was completed, with infills due to topography and fishery remaining. Eiva software crash during the night caused ~1 h delay due to line turn. RD in Block 6 added to SOW: 6 x S-lines between KP 241-280 5 x P-lines between KP 243-2497 X-Lines in corner at KP 280 Medium swell of 1 m was observed through the day.
2016-11-05	Survey of RD in B6 continued, but deteriorating weather dictates that survey run lines can only be conducted in westerly direction by late afternoon and evening. Further adjustments to survey plan necessary and vessel moved from S-lines to the shorter P-lines in order to reduce weather impact. Client advised that possible additional RD, pending confirmation. 5 x P-lines between KP 249-264 and 4 X-Lines in corner at KP 280. Medium swell of 1 to 2 m was observed through the day.
2016-11-06	RD in B6 put on hold due to increasing weather conditions. Heavy swell and increasing waves limited efficiency to survey in westerly direction. Therefore, started cross line survey with all cross lines extended to cover RD areas. Survey halted at 17.02 due to weather. During recovery of the ROTV the main engine cooling water pump failed. M/V Franklin headed to Bilbao and was alongside at 21:20 to facilitate pump repair. A MINCS report will be issued regarding the cooling water pump. Medium swell of 2 to 3 m was observed through the day.
2016-11-07	The cooling water pump and two technicians arrived on board M/V Franklin during the afternoon. The pump was replaced and M/V Franklin was operational by 19:00. MINCS #1541 was issued regarding the cooling water pump. During the afternoon a conference call was held onshore to discuss the remaining scope of work and a decision was taken to accept acquired data “as is” and terminate the project due to extended unworkable forecasted weather conditions. Demobilisation started 16:00 on Monday 7 November. Data processing and preparation for data transfer to office was continued on board during Tuesday and Wednesday.

Table 37 Daily narrative M/V Geo Focus operations.

Date	**Comments**
2016-09-26	07.00 to 24.00 Alongside Bayonne mobilisation and in port calibrations.
2016-09-27	Continue alongside mobilisation and calibrations.
2016-09-28	Depart Bayonne and perform required calibrations. Transit to Bayonne at 18.10 to collect spare PC. Transit to nearshore section Capbreton and perform MBES reconnaissance before SSS patch test.
2016-09-29	Geophysical survey of CHBC after resolving SSS issue. Fishing boat restricts operations. Magnetometer failure and necessary to return to Bayonne for repair of tow cable. Return to site by 11.54 and commence negotiations with fishermen to remove gear. Requires overnight standby while fishing gear cleared.
2016-09-30	Fishing gear cleared by 05.46 and commence geophysical survey ops. Main lines and infill lines until 23.17 then transit to landfall at La Cantine.
2016-10-01	Arrive at landfall La Cantine at 08.22 and perform SVP dip and MBES reconnaissance. Geophysical survey of main lines and cross lines. No magnetometer on CANO centre line.
2016-10-02	Infill of CANO section and slow transit to La Grande Crohot Landfall. Arrive 0.400 and await daylight. Await fishing gear to be removed and perform SVP followed by MBES reconnaissance survey. Geophysical survey PORO.
2016-10-03	Infill geophysical survey Le Grande Crohot nearshore and slow transit to Lacanau and standby awaiting daylight. SVP and MBES reconnaissance survey followed by geophysical survey of Lacanau. Infills required due to drifting RTK height, required trouble shooting and transferring to secondary RTK network.
2016-10-04	Geophysical survey infills and cross lines of Lacanau nearshore area. 12.30 to 17.03 transit to Bayonne for provisions and data drop. Transit to Spain nearshore area.
2016-10-05	Continue with transit arrive Spain nearshore 05.00 and standby awaiting daylight. 06.10 MBES reconnaissance survey and commence geophysical survey at 07.44 until 16.11 MBES survey Spain nearshore-offshore overlap completed by 17.40 and transit to Bayonne.
2016-10-06	Continue transit to Bayonne and arrive at 05.00. Demobilisation complete by 15.00.

Table 38 Daily narrative Plasticbeam operations.

Date	**Comments**
2016-10-06	08.00 to 18.00 Standby in Bilbao then 18.00 until 24.00 standby overnight.
2016-10-07	00.00 TO 06.00 Standby overnight, 06.00 to 18.00 offshore mobilisation and 18.00 standby overnight.
2016-10-08	00.00 to 06.00 Standby overnight. 06.00 to 18.00 Offshore mobilisation. 18.00 to 24.00 Standby overnight.
2016-10-09	00.00 to 06.00 Standby overnight. 06.00 to 18.00 Standby Bilbao. 18.00 to 24.00 Standby overnight.
2016-10-10	00.00 to 06.00 Standby overnight. 06.00 to 18.00 Deployed and mobilisation in Getxo marina. 18.00 to 24.00 Standby overnight.
2016-10-11	00.00 to 06.00 Standby overnight.

Date	Comments
	06.00 to 12.00 Mobilisation in Getxo marina. 12.00 to 14.00 Gyro GAMS calibration outside Bilbao port. 14.00 to 16.00 Mobilisation in Getxo marina. 16.00 to 18.00 MBES patch test outside Bilbao port. 18.00 to 24.00 Standby overnight.
2016-10-12	00.00 to 07.30 Standby overnight. 07.30 to 08.41 Mobilisation. 08.41 to 09.32 Camera survey 09.32 to 13.12 MBES survey. Issues with Plasticbeam engines required looking at and new Go-Pro camera needed. 13.12 to 14.20 Transit back. 14.20 to 24.00 Standby overnight.
2016-10-13	00.00 to 07.30 Standby overnight. 08.30 to 13.45 maintenance on Plasticbeam engine and purchase of new Go-Pro camera, then transit to site. 14.10 to 15.00 complete drop-cam locations followed by MBES infills between 15.00 and 15.25. 15.25 to 17.00 transit to Bilbao then demob until 20.00.

Table 39 Daily narrative of Dive operations.

Date	Comments
2016-10-06	14:00 to 16:00 Kick-off meeting with CTS and CREOCEAN and mobilisation 16:00 to 24:00 Standby
2016-10-07	00:00 to 04:30 Standby 04:30 to 05:42 Team arrived on board and mobilised equipment 05:42 to 07:50 Transit to La Cantine landfall 07:50 to 12:00 Dive survey of the three transects 12:00 to 14:20 Transit to Le Cap Ferret 14:20 to 24:00 Data processing and Standby over the night
2016-10-08	00:00 to 05:20 Standby 05:20 to 06:00 Mobilisation of the equipment onboard vessel 06:00 to 07:28 Transit to Le Grand Crohot landfall 07:28 to 11:50 Dive survey of the 3 transects 11:50 to 13:50 Transit back to Cap Ferret 13:50 to 24:00 Standby
2016-10-09	00:00 to 24:00 Standby
2016-10-17	00:00 to 08:00 Standby during night 08:00 to 14:00 Survey La Cantine landfall 14:00 to 20:00 Survey Le Grand Crohot 20:00 to 24:00 Standby during night
2016-10-18	00:00 to 08:00 Standby during night 08:00 to 14:00 Survey at Lacanau Landfall 14:00 to 24:00 Demobilisation
2016-11-03	00:00 to 09:00 Standby during night 09:00 to 09:30 Arrival on site of La Cantine 09:30 to 11:30 Positioning of 3 points on shore for each transect (3 times): T7-23, T7-24, T7-25, T8-23, T8-24, T8-25, T9-23, T9-24, T9-25. Materialization with poles 11:30 to 12:00 Installation of diving rope on transect T9 using alignment of points T9-23, T9-24 and T9-25 12:00 to 12:30 Beginning of survey on transect T9, starting from T9-17 to T9-7 12:30 to 13:00 Installation of diving rope on transect T8 using alignment of points T8-23, T8-24 and T8-25

Date	Comments
	13:00 to 13:25 Survey of transect T8 from T8-17 to T8-7 13:25 to 13:50 Installation of diving rope on transect T7 using alignment of points T7-23, T7-24 and T7-25 13:50 to 14:20 Survey of transect T7 from T7-17 to T7-7 14:20 to 24:00 Standby during night
2017-08-02	Dive survey of Lacanau. Area completed.
2017-09-27	Dive survey of Le Grand Crohot completed.

Table 40 Daily narrative of UAV operations.

Date	Comments
2016-10-04	07:00 to 09:00 Kick-off meeting and mobilisation 09:00 to 16:30 UAV survey at La Cantine landfall France 16:30 to 24:00 Standby 12 h
2016-10-05	00:00 to 08:00 Standby 12H 08:00 to 09:00 Travel to Le Grand Crohot and mobilisation of the equipment 09:00 to 13:00 UAV survey at Le Grand Crohot landfall 13:00 to 15:00 Demobilisation and travel back to the crew house 15:00 to 24:00 Standby 12H
2016-10-06	00:00 to 10:00 Standby 12H 10:00 to 10:35 Mobilisation of the equipment 10:35 to 13:00 UAV survey at Lacanau Ocean landfall 13:00 to 14:00 Demobilisation and travel back to the crew house

Table 41 Daily narrative M/V Olympic Delta operations.

Date	Comments
2017-06-10	Mobilisation on Buoy Island, Stavanger continues. Leave Buoy Island for bunkers in Tannanger, Stavanger Complete bunkers in Tannanger, Stavanger Start transit to Bayonne, France.
2017-06-11	Continue transit to Bayonne, France Muster drill 16:00hrs.
2017-06-12	Continue transit to Bayonne, France.
2017-06-13	Continue transit to Bayonne, France.
2017-06-14	Continue transit to Bayonne, France.
2017-06-15	The M/V Olympic Delta continued transit to Bayonne, France. The transit was paused to carry out a HIPAP calibration in 220 m Water Depth off Bayonne, France. Transit was then continued to Bayonne, France where the vessel was berthed for marine crew change and project mobilisation. Project crew joined the M/V Olympic Delta. Project kick-off meeting was carried out on board M/V Olympic Delta which also included M/V JIF Challenger personnel. Project briefing/SJA and HSE presentation were given to M/V Olympic Delta personnel. Ground fault on ROV Survey MUX, awaiting replacement. NOTE: Cumulative man hours and breakdown of hours reported in this DPR also include times from the whole transit from Norway.
2017-06-16	The M/V Olympic Delta continued mobilisation alongside Bayonne, France. Project briefing/SJA and HSE presentation were given to the remainder of the M/V Olympic Delta personnel. Ground fault on ROV Survey MUX due to water ingress, awaiting replacement.
2017-06-17	The M/V Olympic Delta continued mobilisation alongside Bayonne, France. We were awaiting delivery of a replacement ROV Survey MUX due to water ingress and ground fault. The replacement ROV Survey MUX arrived on board at

Date	Comments
	15:00hrs The vessel departed Bayonne at 15:30hrs heading for a calibration site offshore Bayonne. A DGPS mobile position validation was carried out at the calibration site, subsequent calibrations were put on hold due to fiber link problems with the replacement ROV Survey MUX.
2017-06-18	We continued investigating the fiber link problems with the replacement ROV Survey MUX. We found that the problem with MUX communications was a failed fiber in the fiber assembly and a poor fiber connection in the fiber adaptor pod. Once the MUX was repaired we continued verifying parameters in our mux connected equipment. We then carried out a gradiometer calibration and sent the data ashore for processing. Problems were then experienced with our digi port server serial bridge connections, physical cables were run to overcome this problem for required sensors. We then carried out a DVL calibration and gradiometer sweep prior to installation of the gradiometer SIT target. The gradiometer was then removed from the front of the ROV so that we could begin MBES (multibeam echo sounder) patch tests.
2017-06-19	We completed the multibeam echo sounder (MBES) patch test. We completed the SSS patch test. We had two ROV recoveries due to leak alarms. We completed the SBP patch test. We completed The UXO SIT trails. We had a short transit to rendezvous with the Bayonne port pilot to disembark one person for compassionate reasons. We began the transit to the north of the survey area where we will begin UXO survey from the north of the survey area working our way south.
2017-06-20	We continued the transit to the north of survey area in order to begin UXO surveys. We completed 10 geotechnical site UXO surveys.
2017-06-21	We continued geotechnical site UXO surveys working our way from the north of the survey area towards the South, completing 17 UXO surveys.
2017-06-22	We continued geotechnical site UXO surveys working our way from the north of the survey area towards the south, completing 19 UXO surveys.
2017-06-23	We continued geotechnical site UXO surveys working our way from the north of the survey area towards the south east, completing 19 UXO surveys.
2017-06-24	We continued UXO Surveys from the south east of the survey area working our way west into Spanish waters, completing 25 UXO surveys.
2017-06-25	We continued geotechnical site UXO surveys, working our way west within Spanish waters. We completed 6 UXO surveys, this completed the UXO survey scope. We then transited to the Spanish landfall area where we set up our geophysical sensors and began survey of the additional geophysical survey block. After an initial line we noted that due to the irregular rocky seabed we were experiencing MBES data shadows. We have decreased our line spacing to compensate for this.
2017-06-26	We completed geophysical survey at the Spanish landfall approach. We began transit on MMT standby to a deep water location in the Spanish sector to carry out MMT deep water ROV trials.
2017-06-27	We completed MMT deep water ROV trials and then transited to Bayonne for mobilisation of geotechnical equipment. M/V Olympic Delta berthed at 14:55hrs.
2017-06-28	We continued mobilisation of geotechnical equipment alongside Bayonne, France.
2017-06-29	We continued mobilisation of geotechnical equipment alongside Bayonne, France. NDT of welds and CPT and VC wet tests outstanding.
2017-06-30	We continued mobilisation of geotechnical equipment alongside Bayonne, France. CPT and VC wet tests completed, NDT of seafastening welds. Vessel departed Bayonne at 15:10 and began transit to the north of the survey area.

Date	Comments
	Transit speed had to be slowed to approximately half standard speed due to high sea state. Vessel course could not be direct due to the wave direction.
2017-07-01	We transited to the military exercise area to begin geotechnical sampling with the intension of completing sampling in this area prior to military exercises which start on 04/07/2017. Transit speed had to be slowed to approximately half standard speed due to high sea state. Vessel course could not be direct due to the wave direction. On arrival sea conditions were poor and we began waiting on weather.
2017-07-02	We continued waiting on weather, when sea conditions allowed we intended to begin geotechnical sampling with an initial vibrocore in the military exercise area, to the north of the survey area. When setting up for sampling we realised that vibrocore sampling was more weather dependent than CPT sampling and we then moved location to begin CPT sampling. We completed 9 CPT locations prior to a period of CPT maintenance where we completed 4 vibrocore sites.
2017-07-03	We completed all vibrocore and CPT sampling within the military exercise zone and then transited to the north of the zone to work northwards towards the landfall routes. 5 vibrocores and 13 CPTs were completed today.
2017-07-04	We completed geotechnical sampling on the landfall routes to the north of the survey area, including three incomplete sampling sites from the M/V Jiff Challenger work scope. We then began transit towards the south of the military exercise area.
2017-07-05	We completed transit from the north of the survey area, through the military exercise zone to an area north of the HDD routes. We began geotechnical sampling southwards, completing the HDD routes area then began working westwards. 10 vibrocores and 21 CPTs were completed today.
2017-07-06	We continued geotechnical sampling to the west towards the Spanish landfall. We entered Spanish waters at 10:40hrs. We had a period of CPT maintenance and we had a period of VC breakdown.
2017-07-07	We continued geotechnical sampling to the west in the direction of the Spanish landfall then we looped back east along the ARSW. 9 vibrocores and 22 CPTs were completed today.
2017-07-08	We completed the ARSW loop then we continued geotechnical sampling towards the west in the direction of the Spanish landfall. We had a period of VC breakdown as during pre-launch checks a crack was noted in the VC motor assembly barrel mounting clamp. This clamp was replaced with a spare. 12 vibrocores and 14 CPTs were completed today.
2017-07-09	We continued working westwards towards the Spanish shore approach. We experienced some breakdown of the CPT while replacing rods and a cone which were lost during an extended sample. We completed CPT and VC geotechnical operations at 15:24hrs and began transit to the port of Bayonne, France at economical speed. 7 vibrocores and 10 CPTs were completed today.
2017-07-10	We continued transit to Bayonne at economical speed. We entered the port on the high tide of 06:00hrs and were alongside at 06:40hrs. We completed de-mobilisation of the CPT equipment to the quayside for loading/transport tomorrow.
2017-07-11	We completed loading of CPT equipment from quayside to a flat bed lorry at 13:30hrs for transport to the UK. Rock drilling equipment and personnel arrived at the vessel at 14:45hrs and equipment was loaded on board by 16:30hrs. Welders arrived to sea fasten drilling equipment at 15:30hrs and sea fastening was completed at 20:30hrs.
2017-07-12	We continued mobilisation of the rock drilling equipment. NDT on the rock drill equipment sea fastening welds was carried out. We carried out a wet test of the rock drill between 15:05hrs and 15:41hrs. The port pilot was requested at 15:45hrs and the vessel departed for drill sites in Spanish waters at 17:03hrs.

Date	Comments
	Transit was at economical speed to arrive at shallow water off the Spanish shore approach at dawn.
2017-07-13	We continued vessel transit to the Spanish shore approach and set up on location at dawn once it was possible to identify any possible fixed fishing equipment in the area. Rock core drilling operations commenced with a toolbox talk for both shifts prior to launching the rock drill. We carried out cores at the following locations RC-370, RC-370A, RC-369, RC-369A and commenced operations for RC-364.
2017-07-14	We continued rock core drilling operations from the Spanish landfall towards the east, targeting the top eight priority locations. We carried out cores at the following locations RC-364, RC-362, RC-362A, RC-360, RC-356, and commenced operations at location RC-356A.
2017-07-15	We continued rock core drilling operations from the Spanish landfall towards the east, targeting the top eight priority locations. We carried out cores at the following locations RC-356A, RC-355, RC-355A and RC-355B. On recovery of the mini drill at site RC-355B water ingress to the mini drill umbilical termination caused a short circuit which halted further operations. The mini drill hydraulic motor bearing was also damaged during this failure. We began transit to Bayonne to receive spare parts. Re-termination of the mini drill umbilical and replacement of the hydraulic motor bearing continues.
2017-07-16	We completed re-termination of the mini drill umbilical and replacement of the hydraulic motor upper bearing. We carried out a successful mini drill wet test and returned to site RC-350 for core drilling operations. We carried out cores at the following locations RC-350 and RC-350A then experienced further mini drill hydraulic motor issues. Investigation and repair of the mini drill hydraulic motor issues commenced.
2017-07-17	We continued transit to Bayonne, France, to collect spare parts for the mini drill. Spare parts were received and the mini drill was repaired. We carried out a successful mini drill wet test then transited back to site. Rock core drilling commenced at RC-353. After a short period of coring a short circuit in the mini drill hydraulic motor occurred. Rock core drilling operations could no longer continue and we began transit to Bayonne, France, to begin demobilisation of equipment.
2017-07-18	We continued transit to the port of Bayonne, France. We were alongside at 10:35hrs and continued demobilisation of equipment and personnel from the project. Igeotest mini drill and personnel left the vessel at 13:30hrs.
2017-07-19	We continued demobilisation of equipment and personnel alongside the port of Bayonne, France. At 08:00hrs the unloading of the vibro core equipment was completed and this equipment left the vessel. At 15:30hrs the unloading of the vibrocore samples and rock cores was completed and this shipment left the vessel. At 16:00hrs the last of the MMT personnel left the vessel Rock core samples were taken at 8 locations in Block 6, MR Spain, and at one location in the Spanish landfall Block.

Table 42 Daily narrative M/V JIF Challenger operations.

Date	Comments
2017-06-14	M/V JIF Challenger alongside in Bayonne. MMT personal arrived at 07:00 UTC. Equipment delivered at 08:00 and mobilisation of CPT and VC started.
2017-06-15	M/V JIF Challenger alongside in Bayonne. Mobilisation continued all day. CPT mobilisation completed and CPT wet test at 14:00 UTC. Standby overnight.
2017-06-16	Standby overnight in Bayonne. Continued the mobilisation. Startup and HSE meeting hold at 08:00 UTC. GPS antenna and QINSY set up. VC mobilisation completed at 14:00 and VC successfully wet tested. Man over board drill completed with success from 14:45 to 15:15. Standby overnight.
2017-06-17	Standby overnight in Bayonne. Departed at 03:00 UTC. A 1.5 m short period swell forced us to reduce the speed during the transit. Arrived within the low UXO risk area (extended SOW) at 06:00. DP trials completed at 06:20. TBT, radio and GPS antenna offsets check performed prior launching the CPT. CPT-236 performed successfully however the location of the launch point was not corresponding to the set up (6 m error on the position). As a result CPT-236 was redone. CPT-013 completed. Once the CPT recovered it was noticed the crane wire was damaged and needs a certified reterm (MINCS-1608). Transit to Bayonne started 11:45. M/V JIF Challenger alongside at 16:45. Started remobilising the VC to be used with aft crane as the reterm can't be done before next week. Standby overnight in Bayonne positive SOC: Very good TBT and R.A. regarding the CPT operations - The work will be safely executed.
2017-06-18	Standby overnight in Bayonne. VC mobilisation onto aft crane completed and wet tested at 08:00 UTC. Departed Bayonne at 08:30. Transit to the low UXO risk area (M/V Olympic Delta SOW) covered by the live fire military exercise from Monday morning. Arrived at location at 13:20. TBT carried out prior launching the VC.VC-111, VC-110 and VC-010 completed. Transit to VC-112 at 20:13. Standby overnight at location. Positive SOC: (1) Very good team work for remobilising the VC onto the aft crane. Breakdown equipment time kept to a minimum.(2) Food is good and well prepared, accommodation small but clean, good atmosphere onboard.
2017-06-19	Standby overnight on DP at VC-112 location. Samples started at 06:00 UTC. VC-112, VC-011, VC-113, VC-012, VC_114 and VC-115 completed (M/V Olympic Delta SOW). Two attempts were necessary on all the locations (except VC-112) and recovery have been poor due to the nature of the soil. Grab sample has been required on VC-011 as no sample was recovered from the two attempts with the VC. Standby overnight on site. Negative SOC: Vessel on DP all night too noisy to sleep and obtain a good rest after a long shift. Corrective action: The vessel won't use the DP system during the night.
2017-06-20	Standby overnight on site VC-116. VC-116, VC-117 and VC-013 completed. Two attempts required on each site. Poor recovery due to the seabed nature. Extended VC SOW now completed. Transit to Bayonne at 10:00 as we cannot do CPT for the moment and are waiting for ALARP certs to be issued for the shallow SOW. Vessel alongside at 13:00. Main crane wire unspooled to be send to Bordeaux for a reterm. Wire picked up at 16:20. Should have the wire back on Thursday morning and should be operational on Thursday afternoon. Standby overnight in Bayonne.
2017-06-21	Standby overnight in Bayonne. Karl Beckman and Felipe Sánchez signed off at 06:00 UTC. Welders arrived onboard at 08:00 to add protection onto the CPT corners to avoid any wire to get caught under the frame (MINCS-1608). Departed Bayonne at 10:15. Arrived on site VC-014 at 12:21. VC-014 completed (2 attempts required). Transit to VC-123. One attempt on VC-123. When launching the VC for the second attempt the VC motor stopped vibrating. VC recovered on deck for faultfinding. Fault not identified at 18:00. Decision made to swap for CPT in the morning while fault finding the VC. Standby overnight at sea off Capbreton.

Date	Comments
2017-06-22	Standby off Capbreton during the night. Mobilisation of the CPT onto the bow crane at 05:00 UTC. At location CPT-246 at 06:15. CPT deployed at 06:44. On the first push at 4.5 m the rod bent suddenly. As the result, we lost 5 m of rod in the seabed, the cone and a friction roller (625085.52 E, 4835905.21 N). Rod and new cone fitted. CPT operational at 09:37 but the weather wasn't workable anymore. Decision made to go back to Bayonne to fit the reterminated wire onto the crane. Alongside at 12:45. While starting to refit the reterminated wire, the crane operator used the wrong remote controller. As a result the aft crane damaged the VC strands head and the umbilical (MINCS- 1611). VC strand head repaired by welders and umbilical reterminated. Spare set of strands used and VC motor back on the strands at 20:00 UTC. Waiting for the mold to set during the night. Faultfinding on VC electrical problem continued. Standby overnight in Bayonne.
2017-06-23	Standby overnight in Bayonne. Departed at 03:05 UTC. Arrived at location CPT-246 at 05:10. On the first attempt the cone and 1 m rode were lost in the seabed due to weather conditions. Decision made to abort the shallow operations and transit to M/V Olympic Delta SOW (low UXO risk area). Weather standby from 06:04 to 11:57. CPT-235, CPT-234, CPT-233 and CPT-232 completed. Another cone was lost while doing CPT-234. Decision was made to set an alarm at 35MPa. The thrust is then manually started again and stopped when the tip resistance and friction values show the operators the CPT encounters really dense seabed and reaches the limit of the system. This is to avoid to lose more cones and bits of rod in the seabed. If the expected penetration is not reached then a second attempt is carried out. If the trend is confirmed on the second attempt decision made with the Client rep onboard to validate the push or to go for another one. Standby over night at location CPT-012.
2017-06-24	Standby overnight at sea. At location CPT-012 at 06:00 UTC. CPTs performed all day. M/V Olympic Delta (low UXO risk area) SOW completed at 16:28. CPT-012, CPT-231, CPT-230, CPT-229, CPT-228, CPT-011, CPT-227, CPT-226, CPT-010, CPT-225 and CPT-224 completed. CPT-225 has provisional acceptance only as penetration was 3.08 m (4 m push expected). Transit to Bayonne as we cannot work off Capbreton during the weekend and are still waiting for Shallow UXO survey to be performed in Lacanau, La Cantine and Le Grand Crohot. Alongside at 11:10. Standby overnight in Bayonne.
2017-06-25	Standby overnight in Bayonne. MMT standby all day - waiting for M/V JIF Patrol to complete their SOW in Lacanau, La Cantine and Le Grand Crohot. Karl Beckman onboard at 12:00. VC motor swapped for the spare one - VC operational. Vessel maintenance - motor oil loading. Standby overnight in Bayonne.
2017-06-26	Standby overnight in Bayonne. Transit to Capbreton. Capbreton shallow CPT operations completed in the morning (CPT-246, CPT-014, CPT-247, CPT-248, CPT-249, CPT-245) and VC operations (VC-122, VC-123, VC-124, VC-125) completed in the evening. Transit to Lacanau during the night.
2017-06-27	Night transit to Lacanau site. CPT-200 has provisional acceptance only (4.64 m - cone lost in seabed).Transit to La Cantine sites. CPT-002, VC-002, VC-102 completed. VC-103 requires a second attempt. Transit to Le Grand Crohot site. At location CPT-210, when deploying the CPT the fore crane hydraulics failed (MINCS-1614). After a few trials conclusion was that the fore crane was not usable anymore and decision was made to abort the operations as the few remaining tasks can be done by M/V Olympic Delta. Transit back to Bayonne. Alongside at 22:35. Standby overnight in Bayonne.
2017-06-28	Standby overnight in Bayonne. Loading of MMT equipment left on the quay on the vessel completed at 06:37. Departed Castel Quay at 06:50 and alongside Tarnos Quay at 07:18. Offloading of all MMT equipment on the quay for transfer to M/V Olympic Delta. Vessel off hire at 11:00. Note M/V Olympic Delta will complete the few tasks remaining of M/V JIF Challenger SOW. This is the last DPR for M/V JIF Challenger. MMT would like to thanks all personnel involved.

Table 43 Daily narrative M/V Esquina / M/V JIF Patrol operations.

Date	Comments
2017-06-07	M/V Esquina arrived in Royan at 21:30 UTC.
2017-06-08	Standby overnight in Royan. Survey crew arrived on vessel at 06:00 UTC. Equipment loaded on the vessel and mobilisation started. Vessel crew arrived onboard at 07:00 to respect their rest hours. Starboard engine maintenance and repair required from 07:00 to 07:30. The engine was tested at sea from 07:30 to 08:15 and bunkering was done after this from 08:15 to 09:15. GPS positioning system check was carried out onshore over a known control point from IGN from 09:15 to 11:15. Mobilisation and calibration of the equipment continued from 11:15 to 21:00 with offsets measurement, MAG altimeter, MAG depth sensor and USBL calibrations. Issues encountered while calibrating the USBL system - not completed at the moment. Standby overnight in Royan for the rest of the day.
2017-06-09	Standby over night in Royan. Crew arrived onboard at 06:00 UTC. USBL calibration from 06:00 to 10:00. Issues encountered during the USBL calibration not resolved. Calibration not completed. Decision made to position the MAG with a manual layback offset and test this solution during the SIT trials. Toolbox Talk carried out during M/V Esquina transit from Royan port to SIT trial area just outside port of Royan. Arrived at location at 10:25 (12 m water depth). MAG deployed and recovered as extra weight required. Port engine issue at 12:00. M/V Esquina back to port of Royan at 13:30 to fix the problem. At 15:00, while still trying to fix the engine, decision was made to start survey again on Monday morning from Capbreton. Standby over night in Royan.
2017-06-10	Standby MMT. Start transit from Royan to Capbreton. Standby overnight in Arcachon.
2017-06-11	Standby MMT. Transit from Arcachon to Capbreton. Arrived in Capbreton at 14:00 UTC. Standby over night in Capbreton.
2017-06-12	Standby over night in Capbreton. Aquatopo surveyor arrived onboard at 09:00 UTC. mobilisation started. External compass to use with the USBL system arrived at 10:00 UTC but could not be connected as a cable was missing. Despite research, it was not possible to buy this type of cable in Capbreton/Bayonne. The missing cable was shipped by Aquatopo at 14:00 UTC and should arrive on Tuesday before 10:00 UTC. Additional tests were carried out in port to try to faultfinding the USBL system. Bunkering taken between 12:45 and 13:00 (only a small amount of gazoil was taken on full taxes as professional bunkering is closed on Monday). Decision made to carry out the SIT tests with the manual layback option as the USBL system is showing no consistency. M/V Esquina sailed to survey area outside Capbreton port at 13:00. Sea conditions not workable (1.5 m waves coming from NW). It is not possible to find sheltered areas on the French Atlantic coast with westerly swell/waves. Decision made to go back to port at 13:40. Once alongside, more time was spent faulting the USBL system. Standby overnight in Capbreton for the rest of the day.
2017-06-13	Bunkering from 08:30 UTC to 09:45 UTC. Transit to SIT test area (15 m water depth) outside Capbreton. Arrived at location at 10:00. Toolbox talk (TBT) carried out before launching the MAG. MAG launched at 10:25 to perform the clearance survey (200x25 m box) prior SIT trials. MAG recovered at 11:25. Issues encountered to export altitude data from HYPACK - data not usable. New clearance survey performed from 13:00 to 14:00. After processing the new set of lines it was decided that few extra lines were necessary to find an area free of magnetic anomaly. Extra lines acquired and processing done by 16:00. Location for target deployment defined and TBT carried prior to deploy the target. Surrogate item deployed at 16:30 and recovered at 17:00 as it was dragged away from the chosen location while deployed. Item deployed again at 17:15. Towfish launched and recovered at 17:30 as weather was not workable (1.3 m swell and 15-20kts of westerly wind). Decision made to go back to port. Surrogate item recovered at 17:40. Alongside at 17:55. Standby 12h in Capbreton.

Date	Comments
2017-06-14	Standby 12h in Capbreton. Crew onboard at 04:30 UTC. Mobilisation of the equipment until 05:05. Transit to SIT test area. Arrived on site at 05:05. Problem with the auxiliary generator and the vessel power inverter. Decision made to go back to port to solve the issue. Alongside at 06:05. Rented generator arrived onboard at 08:30. Transit to SIT test area. Target and towfish deployed at 08:55. SIT test performed at 16:00. Back to alongside at 16:15. Erwann LEGUEN from CTS visited M/V Esquina to discuss the results and general progress. Standby overnight in Capbreton.
2017-06-15	Standby overnight in Capbreton. Crew arrived onboard at 06:15 UTC. Transit to SIT area. At location at 06:45. Reckon survey for fishing equipment carried out prior deployment. Fish deployed at 06:55. The MAG got snagged on a fishing net at 07:00 and was recovered (MINCS 1607). After inspection of the equipment it was discovered the tow cable was damaged and decision was made to go back to port as survey company Aquatopo had to go through a HIRA procedure. M/V Esquina alongside at 07:30. Once the HIRA procedure completed and cable repaired Esquina transitted back to SIT area. Location and picture of the buoy plus flag indicating the net were taken. At location the sea state appeared to have built up and decision was made to go back to port. Alongside at 09:20. M/V Esquina made the most of the WOW time to take bunkering. The vessel transited back to SIT area at 10:40. The fish was deployed at 11:05 but no communication could be established with the fish. Faultfinding resulted in discovering the tow cable was broken. As no spare cable was onboard decision was made to go back to port. M/V Esquina was alongside at 11:50. Equipment breakdown from 11:50 to 16:00. Standby MMT the rest of the day. Survey will be resumed on Monday.
2017-06-16	Standby MMT. Plan is to start again survey in Capbreton on Monday morning.
2017-06-17	Standby MMT.
2017-06-18	Standby MMT. MMT surveyor arrived in Capbreton with spare tow cables.
2017-06-19	Crew arrived onboard at 05:00 UTC. Mobilisation of the new equipment (tow cable and QINSy) completed at 12:00. UXO survey off Capbreton from 12:00 to 16:53.VC-124 and VC-125 completed. Alongside at 17:05. Standby over night in Capbreton.
2017-06-20	Standby overnight in Capbreton. Team arrived onboard at 04:00 UTC. Transit to site. TBT carried out prior launching the MAG.UXO survey started at 04:35. CPT-249, CPT-248, VC-CPT-014, CPT-245 and CPT-246 completed at 16:28. Alongside in Capbreton at 16:40. Standby overnight in Capbreton.
2017-06-21	Standby 12h in Capbreton. Crew onboard at 04:00 UTC. Transit to site. Start UXO survey at 04:30. CPT-247, VC-122 and VC-123 and all infills completed at 08:50. Alongside fuel berth at 09:40. Start transit to Arcachon. Vessel arrived in Arcachon at 15:15. Standby 12h in Arcachon.
2017-06-22	Crew arrived onboard at 04:15. Transit to survey site. While transiting M/V Esquina experienced problem with one of her engine. Return to Arcachon for engine maintenance and repair. Standby overnight in Arcachon. Decision made to demob M/V Esquina as the engine could not be repaired today. The M/V JIF Patrol will be the replacement vessel.
2017-06-23	Standby overnight in Arcachon. Demobilisation of M/V Esquina due to engine problem. M/V JIF Patrol started transit to Arcacahon at 03:00 UTC and was alongside at 10:30. Mobilisation of M/V JIF Patrol then transit to Lacanau. UXO survey in Lacanau until 17:00. Transit back to Arcachon to arrive before the night. Standby overnight in Arcachon.
2017-06-24	Standby overnight in Arcachon. Crew onboard at 07:00 UTC. Transit to survey site and MAG data acquisition off La Cantine (VC-103) and Le Grand Crohot (CPT-210). Standby overnight in Arcachon.

Date	Comments
2017-06-25	Standby overnight in Arcachon. Transit to site. Shallow UXO survey off Lacanau then transit to La Cantine. Shallow UXO survey off La Cantine. Transit to Arcachon with infills en route. Standby overnight in Arcachon.
2017-06-26	Standby overnight in Arcachon. Transit to survey site. Shallow UXO survey off La Cantine (VC- CPT-002) and VC 103 and VC- 102 infills completed. Transit to Lacanau. CPT- 200 infills completed. Transit to Le Grand Crohot. CPT- 210 infills completed. Transit back to Arcahachon. Data sent to Ordtek for data to be checked and the ALARP certifications to be issued. Standby overnight in Arcachon.
2017-06-27	All shallow UXO data validated and ALARP certificates issues. M/V JIF Patrol SOW completed. Vessel demobilised. Thanks to all personnel involved.

5.5| VESSELS

A total of seven (7) survey vessels were used to undertake the survey: M/V Franklin, M/V Geo Focus, Plasticbeam, M/V Olympic Delta, M/V JIF Challenger, M/V Esquina and M/V JIF Patrol. For detailed vessel specification, see Appendix A.

5.6| PERSONNEL

The personnel involved in the survey operations are presented in Table 44 to Table 48.

Table 44 Survey personnel M/V Franklin.

Name	Position	Date	Nationality
Alexey Kononkov	Geologist	2016-10-12 to 2016-11-09	Russian
Andreas Svensson	Surveyor	2016-09-28 to 2016-10-12	Swedish
Cajsa Hermansson	Offshore Coordinator	2016-09-28 to 2016-10-26	Swedish
Carl Wästfelt	Chart Editor	2016-09-28 to 2016-10-12	Swedish
Cathal Clarke	Geologist	2016-10-26 to 2016-11-09	Irish
Danielle Martin	Senior Data Processor	2016-09-28 to 2016-10-12 2016-10-26 to 2016-11-09	British
Danny Passco	Senior Surveyor	2016-10-12 to 2016-11-09	British
Emil Fager	Surveyor	2016-10-26 to 2016-11-09	Swedish
Erik Bäckman	Geologist	2016-10-26 to 2016-11-09	Swedish
Erik Ungman	Offshore Manager	2016-09-28 to 2016-10-26	Swedish
Fredrik Johansson	Field Engineer	2016-09-28 to 2016-10-12	Swedish
Gabrielle Byrd	Geologist	2016-09-28 to 2016-10-26	American
Gareth Boardman	Surveyor	2016-10-12 to 2016-10-26	British
Graham Robertson	Data Processor	2016-10-26 to 2016-11-09	British
Gunnar Johansson	Senior Surveyor	2016-09-28 to 2016-10-26	Swedish
Iain Hodgkinson	Senior Data Processor	2016-09-28 to 2016-10- 26	British
Joakim Winberg	Surveyor	2016-10-26 to 2016-11-09	Swedish
Julian Will	Chart Editor	2016-10-12 to 2016-11-09	German
Katie Stoddart	Data Processor	2016-10-26 to 2016-11-09	British
Katherine Ciembronowicz	Offline Coordinator	2016-10-26 to 2016-11-09	American
Kyle Ford	Data Processor	2016-10-12 to 2016-11-09	British
Martin Åkesson	Offshore Manager	2016-09-25 to 2016-09-28 2016-10-26 to 2016-11-09	Swedish
Patrik Torim	Field Engineer	2016-10-12 to 2016-11-09	Swedish
Per Franzén	Field Engineer	2016-09-28 to 2016-10-12	Swedish
Peter Slagbrand	Geologist	2016-09-28 to 2016-10-12	Swedish
Petra Slavec	Data Processor	2016-09-28 to 2016-10-12	Slovenian
Pontus Eneberg	Geologist	2016-09-28 to 2016-10-12	Swedish
Robert Aridun	Surveyor	2016-09-28 to 2016-10-26	Swedish

Name	Position	Date	Nationality
Robert Mastad	Senior Surveyor	2016-10-26 to 2016-11-09	Swedish
Tobias Brattström	Geologist	2016-10-12 to 2016-10-26	Swedish
Wayne Agar	Surveyor	2016-09-28 to 2016-10-12	British
In addition to the above mentioned project personnel a marine crew of 12 persons were on board M/V Franklin during the survey operations.			

Table 45 Survey personnel M/V Geo Focus.

Name	Position	Date	Nationality
Petter Tillmar	Surveyor in charge	2016-09-26 to 2016-10-06	Swedish
Niels Wienke	Senior Surveyor	2016-09-26 to 2016-10-06	Dutch
Pierre Lowe	Surveyor	2016-09-26 to 2016-10-06	British
Paulus van Rijnsoever	Surveyor	2016-09-26 to 2016-10-06	Dutch
Sergey Provanov	Offline Coordinator	2016-09-26 to 2016-10-06	Russian
Katie Stoddart	Data Processor	2016-09-26 to 2016-10-06	British
Matthew Ireson	Data Processor	2016-09-26 to 2016-10-06	British
Alexey Kononkov	Marine Geologist	2016-09-26 to 2016-10-06	Russian
Rebecca Millsap	Marine Geologist	2016-09-26 to 2016-10-06	American

Table 46 Survey personnel Plasticbeam.

Name	Position	Date	Nationality
Petter Tillmar	Surveyor in Charge	2016-10-07 to 2016-10-12	Swedish
Pierre Lowe	Surveyor	2016-10-07 to 2016-10-15	British
Katie Stoddart	Data Processor	2016-10-07 to 2016-10-14	British

Table 47 Survey personnel for Diving operations.

Name	Position	Date	Nationality
Manusset Cedric	Security	2016-10-04 to 2016-10-07	French
Johann Manson	Manager	2016-10-04 to 2016-10-07	French
Sifferlen Mederic	Pilot	2016-10-04 to 2016-10-07	French
Frank Reynouth	Client Rep	2016-10-03 to 2016-10-07	Dutch
Valentine Lanfumey	Site Manager	2016-10-02 to 2016-10-16	French

Table 48 Survey personnel for UAV operations.

Name	Position	Date	Nationality
David Ducourneau	Manager	2016-10-06 to 2016-10-07	French
Giovanni Mercourt	Site Manager	2016-10-06 to 2016-11-30	French
Simon Kevin	Diver	2016-10-06 to 2016-11-30	UK
Dourisboure Mikel	Diver	2016-10-06 to 2016-11-30	UK

Name	Position	Date	Nationality
Bordessoules Cyrille	Diver	2016-10-06 to 2016-11-30	French
Crochet Samuel	Diver	2016-10-06 to 2016-11-30	French
Davignon Jerome	Technician	2016-10-06 to 2016-11-30	French
Bergeron Jean-Damien	Manager	2016-10-06 to 2016-10-07	French
Lanfumey Valentine	Site Manager	2016-10-06 to 2016-11-30	French

Table 49 Survey personnel M/V Olympic Delta.

Name	Position	Date	Nationality
Morgan Kråböl	Assistant ROV Supervisor	2017-06-15 to 2017-06-28	Norwegian
Sergey Chabanenko	Data Processor	2017-06-15 to 2017-06-28	Russian
Nicholas Molloy	Field Engineer	2017-06-10 to 2017-06-30	British
Andrew Evans	Geotechnical Engineer	2017-06-28 to 2017-07-11	British
Ben Bilsbrough	Geotechnical Engineer	2017-06-28 to 2017-07-11	British
James McDonald	Geotechnical Engineer	2017-06-28 to 2017-07-11	British
Mathew Taylor	Geotechnical Engineer	2017-06-28 to 2017-07-11	British
Sean Rodgres	Geotechnical Engineer	2017-06-28 to 2017-07-11	British
Cathal Clarke	Marine Geologist	2017-06-15 to 2017-06-18	Irish
Farnaz Alebouyeh	Marine Geologist	2017-06-15 to 2017-07-11	Iranian
Tobias Brattström	Marine Geologist	2017-06-28 to 2017-07-19	Swedish
Katherine Ciembronowicz	Offline Coordinator	2017-06-15 to 2017-07-19	USA
David Auckland	Offshore Manager	2017-06-10 to 2017-07-19	British
Claes Bergman	Rigger	2017-06-28 to 2017-07-19	Swedish
Joseph Kennedy	Rigger	2017-06-28 to 2017-07-19	British
Oscar Rådbo	Rigger	2017-06-28 to 2017-07-19	Swedish
Wiliam Graystone	Rigger	2017-06-28 to 2017-07-19	Swedish
Anthony Paul Landry	ROV Pilot	2017-06-10 to 2017-07-19	USA
Chad Aron Smith	ROV Pilot	2017-06-10 to 2017-06-14	USA
Christopher M. Vance	ROV Pilot	2017-06-10 to 2017-06-28	USA
Jörgen Ladefoged	ROV Pilot	2017-06-15 to 2017-06-28	Danish
Marius Gjose	ROV Pilot	2017-06-15 to 2017-06-28	Norwegian
O.K Førre	ROV Supervisor	2017-06-15 to 2017-06-28	Norwegian

Name	Position	Date	Nationality
Anton Edgren Westerberg	Senior Surveyor	2017-06-10 to 2017-06-14	Swedish
John Houlder	Senior Surveyor	2017-06-15 to 2017-07-19	British
Daniel Tindall	Surveyor	2017-06-28 to 2017-07-19	British
Karl Beckman	Surveyor	2017-06-28 to 2017-07-19	Swedish
Peter Wilks	Surveyor	2017-06-10 to 2017-06-28	British
Phillip Silvester	Surveyor	2017-06-10 to 2017-06-28	British
Robert Aridun	Surveyor	2017-06-10 to 2017-06-28	Swedish
Amadeu Deu	Technician	2017-07-11 to 2017-07-19	Spanish
Fernando Luis Ramirez	Technician	2017-07-11 to 2017-07-19	Spanish
Francisco Romero	Technician	2017-07-11 to 2017-07-19	Spanish
Ivan Lopez	Technician	2017-07-11 to 2017-07-19	Spanish
Joel Costa Vidal	Technician	2017-07-11 to 2017-07-19	Spanish
Nils Gunnar Kröling	Technician	2017-06-15 to 2017-06-15	Norwegian
Cécile Helleringer	Trainee	2017-06-15 to 2017-07-19	French
In addition to the above mentioned project personnel a marine crew of 15 persons were on board M/V Olympic Delta during the survey operations.			

Table 50 Survey personnel M/V JIF Challenger.

Name	Position	Date	Nationality
Felipe Sánchez	Geologist	2017-06-14 to 2017-06-20	Chilean
James McDonald	Geotechnical Engineer	2017-06-14 to 2017-06-28	British
Karl Beckman	Geotechnical Engineer	2017-06-14 to 2017-06-28	Swedish
Mathew Taylor	Geotechnical Engineer	2017-06-14 to 2017-06-28	British
Sean Rodgres	Geotechnical Engineer	2017-06-14 to 2017-06-28	British
Valentine Lanfumey	Surveyor in Charge	2017-06-14 to 2017-06-28	French

Table 51 Survey personnel M/V Esquina.

Name	Position	Date	Nationality
Yann Flurh	CTS Offshore Manager	2017-06-12 to 2017-06-27	French
Suzana El-Massri	Geologist	2017-06-23 to 2017-06-27	Polish
Thomas Potter	Geologist	2017-06-12 to 2017-06-23	English
Daley Harris	Senior surveyor	2017-06-19 to 2017-06-19	Barbadian
Valentine Lanfumey	Site Manager MMT	2017-06-12 to 2017-06-14	French
Thomas Sardon	Surveyor	2017-06-12 to 2017-06-18	French
Pawel Sliwinski	Surveyor Grade II	2017-06-20 to 2017-06-27	British

5.7| EQUIPMENT

A summary of the equipment used during the project are presented in the tables Table 52 to Table 60.

Table 52 List of equipment M/V Franklin.

Equipment	Name
Navigational System	QINSy
Positioning System	Primary: Applanix POSMV 320 with C-NAV correctionsSecondary: C-NAV DGPS
Underwater Positioning	Sonardyne Ranger II
Heading System	Applanix POSMV 320
Motion System	IxSea ROVINS
Multibeam Echo Sounder	R2Sonic
Side Scan Sonar	Edgetech 4200 900/300 and 600/300 kHz
Sub-Bottom Profiler	EdgeTech DW 106, 1-6 kHz and GeoSpark 200 TIP
Magnetometer	2 Geomatrics G-882 in TVG setup

There were some issues with the equipment used during the survey operations. The SSS 600 kHz transceiver malfunctioned during the Acceptance Test Report (ATR). It was agreed with the Client representative to replace it with 900 kHz while waiting on spare 600 kHz transceiver. The cable to the altimeter on the magnetometer was replaced prior to start of survey due to not functioning properly. In French waters the sparker was deployed in addition to the chirp after the start of survey due to limited penetration of the chirp.

There was also some problems with the MBES system, the receiver head cable was water filled and the cable was replaced. Launched and tested thoroughly prior to commencing survey operations again. One of the MBES heads stopped working. After a cool down period of 20 minutes it was operational again.

For full specifications and details see Appendix B|.

Table 53 List of equipment M/V Geo Focus.

Equipment	Name
Navigational System	QINSy

Equipment	Name
Positioning System	Primary: Trimble SPS 852 RTK Secondary: C-NAV 3050, PPP/RTG/RTK/DGPS
Underwater Positioning	N/A
Heading System	IXSEA Hydrins III
Motion System	IXSEA Hydrins III
Multibeam Echo Sounder	Kongsberg EM 2040 (hull mounted)
Side Scan Sonar	Innomar SES-2000 Light Plus (pole-mounted), 250/600 kHz
Sub-Bottom Profiler	Innomar SES-2000 Light Plus (pole-mounted) 8 kHz
Magnetometer	1x Geomatrics G-882 (soft tow)

The combined Innomar SSS and SBP system had interferences from the SBP in the SSS data, partly sorted with adjusting the SSS frequency.

The soft tow cable for the magnetometer was reterminated after the magnetometer was caught in fishing gear, which damaged the cable.

During the survey at the Lacanau landfall there were some problems with V-sat coverage.

For full specifications and details see Appendix B|.

Table 54 List of equipment Plasticbeam.

Equipment	Name
Navigation and Positioning System	NORBIT
Sound Velocity	Sound Velocity Probe : Valeport mini SVP
Geophysical Pole-mounted Equipment	NORBIT 400 kHz MBES Go-Pro camera

The drop camera was flooded and had to be replaced by a new one, all other equipment was functioning well.

For full specifications and details see Appendix B|.

Table 55 List of equipment Dive survey.

Equipment	Name
Navigation and Positioning System	Applied Acoustics Easytrack USBL
Ground truthing	Bar Probe

Table 56 List of equipment UAV survey.

Equipment	Name
UAV	Microcopter unmanned aerial vehicle
Camera	Sony Nex 7 24 Mega Pixels with 16 mm lens

Table 57 List of equipment M/V Olympic Delta

Equipment	Name
Navigational System	QPS QINSy
Positioning System	Primary: Applanix POSMV 320 with C-NAV 3050 and C2 corrections Secondary: Kongsberg DPS 232 with Fugro Seastar G2 corrections
Underwater Positioning	The HIPAP 500, together with the IxBlue ROVINS
Heading System	Applanix POSMV 320
Motion System	IxBlue ROVINS
Multibeam Echo Sounder	R2Sonic 2024
Side Scan Sonar	EdgeTech 2200 (300/600kHz)
Sub-Bottom Profiler	EdgeTech DW-216 (2-16 kHz) chirp
Vibrocorer	VKG-6 (3/6 m)
PCPT	ROSON 10 tonne
Probe needle	KD2 Probe needle
Rock Corer	MiniDrill MDS-600

The VC and PCPT worked overall fine, one cone on the PCPT had to be replaced. The VC had some issues with penetration due to dense sand but. The RC had engine issues and the RC had to be demobilised because of this, however the main SOW was completed.

For full specifications and details see Appendix B|.

Table 58 Summary of equipment, mounted on the Schilling HD work class ROV.

INSTRUMENT	NAME
Navigational System	QINSy
Positioning System	Primary: Applanix POSMV 320 with C-NAV corrections Secondary: C-NAV DGPS
Underwater Positioning	Kongsberg HIPAP 500
Sound Velocity Sensor	Valeport miniSVS
CTD probe	Valeport miniCT
Primary Obstacle Avoidance Sonar	Tritech Gemini 720
Altimeter on ROV	Tritech PA500 (500 kHz)
DVL	TOGSNAV bundled RDI Workhorse (1200 kHz)
Zoom Camera	Pegasus Colour Zoom
Low Light Camera	Insite Pacific Silicon Intensifier
Underwater lasers	Sealaser 100 green line laser with parallel alignment bracket
Heading System	Applanix POSMV 320
Motion System	IxSea ROVINS
LED flood lights	4 x ROS Q-LED II (3500 Lux)
LED spot light	6 x ROS MV II LED (890 Lumen)
Gradiometer	Model T 12 pin gradiometer mounted on ROV frame

The GMA-1000 gradiomieter sensors worked fine during it's entire scope.

For full specifications and details see Appendix B|.

Table 59 List of equipment M/V JIF Challenger.

Equipment	Name
Gyro	Computed heading from GNSS antennas
Positioning System	Primary: C-Nav 3050 with C2 corrections Secondary: Crescent hemisphere R110 with IALA and SBAS
Vibrocorer	VKG-6 (3/6 m)
PCPT	ROSON 10 tonne
Probe needle	KD2 Probe needle
Rock Corer	MiniDrill MDS-600

The PCPT had no issues during the project, some cones needed to be replaced but replacement cones were onboard the vessel. The VC had some engine issues and limited penetration in areas with dense sand.

For full specifications and details, see Appendix B|.

Table 60 List of equipment M/V Esquina and M/V JIF Patrol.

Equipment	Name
Positioning System	Leica RTK and QINSy
Magnetometer	Geometrics G882- fixed layback

The magnetomer worked well during the project, however the USBL system was malfunctioning and a manual offset was used.

For full specifications and details see Appendix B|.

6| REFERENCES

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APPENDICES

APPENDIX A | VESSEL SPECIFICATIONS

APPENDIX B | EQUIPMENT SPECIFICATIONS

APPENDIX C | MOBILISATION AND CALIBRATION REPORTS

APPENDIX D | REFERENCED DOCUMENTS

APPENDIX E | SIDE SCAN SONAR LISTINGS

APPENDIX F | MAGNETIC ANOMALY LISTINGS

APPENDIX G | DAILY PROGRESS REPORTS

APPENDIX H | OVERVIEW DETECTED WRECKS

APPENDIX I | WRECKS NOT DETECTED

APPENDIX J | LIST OF PRODUCED CHARTS

APPENDIX K | SOUND VELOCITY PROFILES

APPENDIX L | TIDE COMPARISON

APPENDIX M | RPL SURVEYED CENTRELINES

APPENDIX N | RPL CABLE ROUTES

APPENDIX O | SURVEY PERFORMANCE

APPENDIX P | GEOTECHNICAL FIELDLOGS

APPENDIX Q | GEOTECHNICAL REPORT (INSITU)

APPENDIX R| GEOTECHNICAL SUMMARY SPREADSHEET

APPENDIX S| ALARP CERTIFICATES

APPENDIX T| ROCK CORE LOCATIONS