SURVEY REPORT
FOR CABLE ROUTE DESIGN AND ENGINEERING

For

ACE PHASE 2 SUBMARINE CABLE SYSTEM (ACE)

SEGMENT 4.7 BU4C-Melkbosstrand

SECTION SOUTH AFRICA EEZ- Melkbosstrand

Rev	Date	Description	Prepared by	Checked by	Approved by
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1	21/07/2016	Provisional	Michael LI	-	Chris D Welsh

EXECUTIVE SUMMARY

Cable system: ACE PHASE 2 SUBMARINE CABLE SYSTEM (ACE)
Segment: 4.7
Connection: BU4C-Melkbosstrand or Duynefontein
Cable length: 1527.234 km based on Route Option 2
Client: Alcatel-Lucent Submarine Networks (ASN) /Elettra Tlc S.p.A. (Elettra)
Surveyed by: EGS (Asia) Limited (EGS)
Inshore survey date: 26th April-19th May 2016
Vessel: *MV Tritan Explorer*
Offshore survey date: 4th June – 27th June 2016 in EEZ of South Africa
Vessel: *RV Ridley Thomas (RV RT)*

Cable crossing:
Route Option 2 (KP834.0 -BMH):
1 IS, 8 OOS, 0 P
Report section of Route Option 3 (KP1431.1-1479.6): 1 IS, 3 OOS
Pipeline crossing: 0

Burial: 1m up to 1500m WD; no burial in >1500m WD
RPL: OPT-02_MIDDLE-NORTH_BMH01_CRS03_12-MAY-2016 and
Part of OPT-03_MIDDLE-SOUTH_BMH03_CRS03_12-MAY-2016

The entire ACE Phase 2 system connects South Africa to São Tomé. The configuration routes from São Tomé (São Tomé and Príncipe) to either Duynefontein or Melkbosstrand (South Africa) and landings and/or BUs of the configuration are listed as follows:

- Segment 4.1 São Tomé (São Tomé and Príncipe) – BU4A1
- Segment 4.3 BU4A1 – BU4B
- Segment 4.5 BU4B – BU4C
- **Segment 4.7 BU4C – Melkbosstrand or Duynefontein (South Africa)**

There are two route options surveyed for Segment 4.7 offshore, Route Option 2 towards Duynefontein and part of Route Option 3 towards Melkbosstrand. Route Option 2 is considered as the main route and is located north of Route Option 3. Route Option 3 overlaps with Route Option 2 from the north to the south and diverts to the south at a pinch point at 33°49.304'S, 17°55.012'E (KP1431.3) in 180m WD. The inshore survey was performed based on Route Option 2 as well. Route Option 2 connects to a BMH named BMH01. There is another option in the landing area named Route Option 2A which is slightly different compared to Option 2; it connects to another BMH called BMH01A, to the north of BMH01.

This report text is based on the Route Option 2 and the surveyed section of Route Option 3. It discusses the survey results of ACE S4.7 obtained by *RV Ridley Thomas* and *MV Tritan Explorer* from the South Africa EEZ at 30°32.930'S, 13°35.162'E (KP834.0) to the BMHs in Duynefontein and also from the pinch point of routes Option 2 and Option 3 at 33°49.304'S, 17°55.012'E (KP1431.3) in 180m WD to the end of offshore survey in the south at 33°43.450'S, 18°25.061'E (KP1479.7) in 17m WD. The offshore survey was conducted between 4th June 2016 and 27th June 2016 up to the

EEZ of South Africa and the inshore survey was performed from 26th April to19th May 2016.

This report comprises of a descriptive text and charts showing the seabed features, shallow seabed geology, bathymetry and geomorphology along the route, together with appendices of supporting information.

The breakdowns of the offshore survey operations are summarised and presented below and the inshore operations are summarised in the landfall report in Appendix F.

The following tables summarise the operations performed for each vessel.

Vessel	SSS	SBP	MBES	MAG	GC	GS	MCPT	DIVER	TOPO	SBES
Offshore RV RT	✓	✓	✓	✓	✓	✓	✓	-	-	✓

Vessel	SSS	SBP	MBES	MAG	GC	GS	MCPT	DIVER	TOPO	SBES
Inshore MV Tritan Explorer	✓	✓	✓	✓	-	-	-	✓	✓	✓

Two pre-survey route position lists (RPLs) for offshore are discussed in **Section 3** of this report and are summarised below.

	Survey Route OPT-02_MIDDLE-NORTH_BMH01_CRS03_12-MAY-2016	**Survey Route** (OPT-03_MIDDLE-SOUTH_BMH03_CRS03_12-MAY-2016)	**Change (km)**
Overall Route Lengths	1482.791	1482.227	N/A
Overall Cable Lengths	1527.234	1526.660	N/A

In total, twenty-four (24) days were worked by the *RV RT* survey crew and also twenty-four (24) days were worked by the inshore survey team. No incidents were reported during the surveys. Safety meetings and drills were held regularly on a weekly basis on board *RV RT*.

The following table summarises the hazards and issues encountered during the survey:

Hazards/Issues	Yes	No	Comments
Presence of CORAL reef		✓	None
Presence of seagrass		✓	None
Presence of ROCK on proposed route	✓		**RPL Option 2 (KP834 to BMH)** KP1441.45 to KP1441.89 KP1442.47 to KP1445.50

Hazards/Issues	Yes	No	Comments
			KP1445.56 to KP1446.69 KP1446.76 to KP1446.83 KP1447.34 to KP1447.37 KP1447.44 to KP1447.69 KP1447.74 to KP1449.72 KP1449.72 to KP1449.89 KP1450.43 to KP1450.55 KP1451.58 to KP1451.65 KP1451.94 to KP1452.19 KP1452.35 to KP1452.44 KP1452.50 to KP1452.62 KP1452.65 to KP1452.69 KP1453.14 to KP1453.17 KP1453.91 to KP1454.02 KP1454.11 to KP1454.12 KP1454.15 to KP1454.17 KP1454.74 to KP1455.18 KP1455.29 to KP1455.37 KP1455.49 to KP1455.51 KP1455.67 to KP1455.83 KP1456.06 to KP1456.09 KP1456.45 to KP1456.54 KP1456.58 to KP1456.59 KP1456.64 to KP1456.83 KP1457.22 to KP1457.42 KP1457.70 to KP1457.81 KP1458.21 to KP1458.39 KP1458.44 to KP1458.79 KP1458.83 to KP1459.16 KP1459.24 to KP1461.90 KP1463.01 to KP1463.08 KP1463.75 to KP1470.73 KP1474.65 to KP1474.71 KP1474.82 to KP1474.90 KP1475.22 to KP1475.36 KP1475.80 to KP1475.98 KP1476.85 to KP1476.91 **RPL Option 3 (KP1431.3 to KP1479.6)** KP1441.87 to KP1441.90 KP1442.03 to KP1442.93 KP1443.32 to KP1446.39 KP1446.62 to KP1449.00 KP1449.05 to KP1449.11 KP1449.17 to KP1450.94 KP1450.99 to KP1453.17 KP1453.24 to KP1453.32 KP1453.57 to KP1453.68 KP1453.71 to KP1453.72 KP1453.81 to KP1455.45 KP1455.47 to KP1456.45 KP1456.64 to KP1456.77 KP1456.79 to KP1458.53 KP1458.68 to KP1459.02

Hazards/Issues	Yes	No	Comments
			KP1459.22 to KP1459.72 KP1459.81 to KP1460.10 KP1460.46 to KP1460.53 KP1460.56 to KP1460.60 KP1460.81 to KP1460.87 KP1461.15 to KP1461.22 KP1462.70 to KP1463.20 KP1463.59 to KP1463.71 KP1464.23 to KP1464.83 KP1464.97 to KP1465.15 KP1465.46 to KP1467.15 KP1467.33 to KP1470.55 KP1470.87 to KP1471.09 KP1474.85 to KP1475.77
Presence of ROCK within target burial zone	✓		**RPL Option 2 (KP834 to BMH)** KP1445.50 to KP1445.56 KP1446.69 to KP1446.76 KP1446.83 to KP1447.34 KP1447.37 to KP1447.44 KP1447.69 to KP1447.74 KP1449.72 to KP1449.74 KP1449.89 to KP1450.43 KP1450.55 to KP1451.58 KP1451.65 to KP1451.94 KP1452.19 to KP1452.35 KP1452.44 to KP1452.50 KP1452.62 to KP1452.65 KP1458.39 to KP1458.44 KP1458.79 to KP1458.83 KP1459.16 to KP1459.24 **RPL Option 3 (KP1431.3 to KP1479.6)** KP1441.78 to KP1441.87 KP1441.90 to KP1442.03 KP1449.00 to KP1449.05 KP1449.11 to KP1449.17 KP1450.94 to KP1450.99 KP1453.17 to KP1453.24 KP1453.32 to KP1453.57 KP1453.68 to KP1453.71 KP1453.72 to KP1453.81 KP1455.45 to KP1455.47 KP1467.15 to KP1467.33
Presence of HARDGROUND on proposed route	✓		1369.42 to KP 1369.63
Presence of HARDGROUND within target burial zone	✓		KP1374.76 to KP1393.02 KP1393.21 to KP1393.23 KP1402.86 to KP1418.62 KP1422.00 to KP1441.45 KP1441.90 to KP1442.47 KP1452.69 to KP1453.14 KP1453.17 to KP1453.91

Hazards/Issues	Yes	No	Comments
			KP1454.02 to KP1454.11 KP1454.12 to KP1454.15 KP1454.17 to KP1454.74 KP1455.18 to KP1455.29 KP1455.37 to KP1455.49 KP1455.51 to KP1455.67 KP1455.83 to KP1456.06 KP1456.09 to KP1456.45 KP1456.54 to KP1456.58 KP1456.59 to KP1456.64 KP1456.83 to KP1457.22 KP1457.42 to KP1457.70 KP1457.81 to KP1458.21 KP1461.90 to KP1463.01 KP1463.08 to KP1463.75 KP1470.73 to KP1474.65 KP1474.71 to KP1474.82 KP1474.90 to KP1475.22 KP1475.36 to KP1475.80 KP1475.98 to KP1476.85 KP1476.91 to KP1480.10 Also observed on landing beach from the beach probe tests **RPL Option 3 (KP1431.3 to KP1479.6)** KP1431.08 to KP1441.78 KP1446.39 to KP1446.62 KP1456.45 to KP1456.64 KP1456.77 to KP1456.79 KP1458.53 to KP1458.68 KP1459.02 to KP1459.22 KP1459.72 to KP1459.81 KP1460.10 to KP1460.46 KP1460.53 to KP1460.56 KP1460.60 to KP1460.81 KP1460.87 to KP1461.15 KP1461.22 to KP1462.70 KP1463.20 to KP1463.59 KP1463.71 to KP1464.23 KP1464.83 to KP1464.97 KP1465.15 to KP1466.46 KP1470.55 to KP1470.87 KP1471.09 to KP1474.85 KP1475.77 to KP1479.72
Presence of pockmarks and gas seepage		✓	**RPL Option 2** Occasional depressions observed KP1393.02 to KP1431.08
Presence of very soft sediments with low bearing capacity		✓	None
Presence of sonar contacts within the survey corridor	✓		22 sonar contacts

Hazards/Issues	Yes	No	Comments
Presence of megaripples and sandwaves	✓		Megaripples observed during inshore survey KP1481.44 to KP1481.83
Indication of slumping	✓		Depression possibly due to slumping are observed around KP1431.5 and KP1389.8
Presence of in-service cables crossing	✓		**RPL Option 2** CX IS SAT 3 Seg 1 cable at KP1440.294: 1 time **RPL Option 3 (KP1431.3 to KP1479.6)** CX IS SAFE Seg 1 cable at KP1438.295: 1 time
Presence of in-service pipeline crossing		✓	None
Presence of out of service cables/pipeline crossing	✓		**RPL Option 2** CX 8 times with OOS **RPL Option 3 (KP1431.3 to KP1479.6)** CX 3 times with OOS
Indication of fishing activities (Trawl scars, FADs, etc...)	✓		Fishing activity is low throughout survey period. Trawl scars were observed from KP1413 to KP1431
High level of shipping activity		✓	Low to medium level of shipping activity including cargo ships, tankers and fishing boats observed during survey with limited influence to survey.
The route traverses traffic separations schemes (TSS)	✓		**RPL Option 2** Crosses traffic zone between KP1456.49 and KP1464.39 **RPL Option 3 (KP1431.3 to KP1479.6)** Crosses traffic zone between KP1458.48 and KP1465.94
Presence of anchorage areas along the route		✓	None
Presence of wrecks along the route	✓		A wreck from database is present at ~KP1474.6 with an offset 20m southeast of Route Option 3 but not found during survey
Presence of dumping areas along the route		✓	None
High level of military activity		✓	None
The route traverses military exercise areas	✓		The route enters a Fire Area at KP1401.253 but no influence observed during survey
The route traverses hydrocarbon concessions	✓		6 OCBs
The route traverses mineral/sand extraction/dredging		✓	None
Risk of piracy		✓	None
Presence of adverse currents	✓		Strong wind with accompanying wind current, as well as strong swell, were experienced during the survey

Hazards/Issues	Yes	No	Comments
Occurrence of adverse weather (monsoon, typhoon, hurricane, etc...)	✓		Survey operation stops several times on 10th, 12th, 16th, 19th, 20th and 22nd June 2016 due to bad weather

REPORT LIMITATIONS

EGS has carefully interpreted, quality controlled and cross checked the data presented in the report and charts. Even so, it should be noted that survey results are subjected to physical limitations imposed by the equipment and methods used and are also affected by individual interpretation.

The accuracy of the survey data is based on the technical specifications and technical capabilities of the required/agreed survey systems. Survey equipment and software are kept up to date (where applicable), calibrated and maintained to manufacturer's specifications. The survey data have been correlated, edited and assessed in order to produce graphic and digital models as close to reality as possible. The interpretation is carried out by experienced personnel with appropriate academic qualifications.

All distances referenced in this report are based on the project geodetic projection and are not true distances on the earth surface (spheroid).

Contours and slopes are derived from the specified grid cell size of the processed Multibeam Echo-Sounder and Singlebeam Echo-Sounder bathymetry data. Processing parameters and sounding density are outlined in the technical specifications of the project.

Seabed morphological analysis based on side scan sonar images and Multibeam Echo-Sounder data gives a complementary presentation for localised terrain features. Due to equipment and operational constraints, such as the footprint effect, sounding density limitation and safe altitude of towed systems etc., the resolution degrades with increasing water depths and some small seabed features may not be fully resolved.

Geotechnical information used to derive sedimentology and stratigraphy can only be obtained at specific sample (Gravity Core/Grab Sampling)/in-situ test (Cone Penetration Test) locations. The lateral correlation and interpretation are carefully and appropriately performed by experienced geoscientists. However there remains a risk that some sub bottom layers will remain undetected.

Magnetometer data are very sensitive to environmental conditions. When background noise is high, the data resolution may not be sufficient to identify small anomalies associated with some types of cable.

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DRAWINGS

North-Up Charts	Scale	Chart Numbers	Start KP	End KP	Book
Main Route Option 2 from South Africa EEZ to BMH					
Offshore North-Up Chart	1:100000	ACE-S4.7_NU014_100K	802.28	878.79	2 of 3
Offshore North-Up Chart	1:100000	ACE-S4.7_NU015_100K	866.08	942.26	2 of 3
Offshore North-Up Chart	1:100000	ACE-S4.7_NU016_100K	929.53	1007.34	2 of 3
Offshore North-Up Chart	1:100000	ACE-S4.7_NU017_100K	994.35	1083.91	2 of 3
Offshore North-Up Chart	1:100000	ACE-S4.7_NU018_100K	1069.78	1161.4	2 of 3
Offshore North-Up Chart	1:100000	ACE-S4.7_NU019_100K	1147.34	1240.27	2 of 3
Offshore North-Up Chart	1:100000	ACE-S4.7_NU020_100K	1222.05	1318.98	2 of 3
Offshore North-Up Chart	1:100000	ACE-S4.7_NU021_100K	1296.28	1381.21	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU022_010K	1364.77	1373.11	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU023_010K	1372.24	1380.59	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU024_010K	1379.72	1388.3	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU025_010K	1387.41	1395.91	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU026_010K	1395.02	1403.42	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU027_010K	1402.55	1411.01	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU028_010K	1410.12	1418.62	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU029_010K	1417.74	1426.35	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU030_010K	1425.45	1434.07	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU031_010K	1433.17	1443.48	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU032_010K	1442.57	1451.06	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU033_010K	1450.18	1458.6	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU034_010K	1457.71	1466.24	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU035_010K	1465.36	1473.83	2 of 3
Offshore North-Up Chart	1:10000	ACE-S4.7_NU036_010K	1472.95	1481.36	2 of 3
Inshore North-Up Chart	1:5000	ACE-S4.7_NU037_005K	1478.98	1482.79	2 of 3
Inshore North-Up Chart	1:1000	ACE-S4.7_NU038_001K	1482.34	1482.79	2 of 3
Option 2A inshore part					
Inshore North-Up Chart	1:5000	ACE_S4.7_OPT2A_NU037 _005K	1478.983	1482.775	2 of 3

North-Up Charts	Scale	Chart Numbers	Start KP	End KP	Book
Inshore North-Up Chart	1:1000	ACE_S4.7_OPT2A_NU038_001K	1482.32	1482.78	2 of 3
Route Option 3 from pinch point at KP1431.3 to KP1479.6					
Offshore North-Up Chart	1:10000	ACE_S4.7_OPT3_NU030_010K	1425.449	1433.984	2 of 3
Offshore North-Up Chart	1:10000	ACE_S4.7_OPT3_NU031_010K	1433.113	1441.707	2 of 3
Offshore North-Up Chart	1:10000	ACE_S4.7_OPT3_NU032_010K	1440.807	1449.457	2 of 3
Offshore North-Up Chart	1:10000	ACE_S4.7_OPT3_NU033_010K	1448.546	1457.128	3 of 3
Offshore North-Up Chart	1:10000	ACE_S4.7_OPT3_NU034_010K	1456.243	1464.803	3 of 3
Offshore North-Up Chart	1:10000	ACE_S4.7_OPT3_NU035_010K	1463.925	1472.522	3 of 3
Offshore North-Up Chart	1:10000	ACE_S4.7_OPT3_NU036_010K	1471.586	1480.487	3 of 3

STRIP Charts for RPL: ACE_PHASE_2_SEG_4.7_BU4C-MELKBOSSTRAND_OPT-02_MIDDLE-NORTH_BMH01_CRS03_12-MAY-2016

Strip Charts	Scale	Chart Numbers	Start KP	End KP	Book
Strip Chart	1:10000	ACE_S4.7_PF001.dwg	1362.00	1386.85	3 of 3
Strip Chart	1:10000	ACE_S4.7_PF002.dwg	1386.85	1411.72	3 of 3
Strip Chart	1:10000	ACE_S4.7_PF003.dwg	1411.72	1436.6	3 of 3
Strip Chart	1:10000	ACE_S4.7_PF004.dwg	1436.60	1461.5	3 of 3
Strip Chart	1:10000	ACE_S4.7_PF005.dwg	1461.50	1482.79	3 of 3

STRIP Charts for RPL: ACE_PHASE_2_SEG_4.7_BU4C-MELKBOSSTRAND_OPT-03_MIDDLE-SOUTH_BMH03_CRS03_12-MAY-2016

Strip Charts	Scale	Chart Numbers	Start KP	End KP	Book
Strip Chart	1:10000	ACE_S4.7_OPT3_PF001	1431.00	1455.87	3 of 3
Strip Chart	1:10000	ACE_S4.7_OPT3_PF002	1455.87	1480.79	3 of 3

ABBREVIATIONS

Abbreviation	Meaning
ABxx	As-Built
AC	Alter Course
AF	As-Found (Cable)
AP	Articulated Pipe
AL	Alignment
ALxx	As-Laid
BAS	Burial Assessment Survey
BJ	Joint Box
BJT	Technical Joint Box
BMH	Beach ManHole
BP	Beach Probe
BS	Beach Sample
BU-xxx	Branching Unit
CA	Cable Allowance (Beach/Final Splice)
CB	Concession Block
CC	Cable Corridor
CD	Chart Datum
C.M.	Central Meridian
cm	Centimetre
CPT	Cone Penetration Testing
CR	Client Representative
CRE	Cable Route Estimate
CRS	Cable Route Study
CT	Comment
CX	Cable Crossing
CZ	Contiguous Zone
DA	Double Armour
DB	Database Position
DD MM.mmm	Degrees minutes. decimal minutes
DE	Duct End
DGPS	Differential Global Positioning System
DP	Diver Probe
DPR	Daily Progress Report
DS	Diver Sample
DS	Duct Start
DTM	Digital Terrain Model
DTS	Desk Top Study
EA	Earth Plate
EEZ	Exclusive Economic Zone
EOB	End Of Burial
EZ	Economic Zone
FAD	Fishing Aggregation Device
FS	Final Splice
FZ	Fishing Zone
GC	Gravity Core
GcGPS	Globally Corrected Global Positioning System
GPS	Global Positioning System
GS	Grab Sample
HDD	Horizontal Directionally Drilled

Abbreviation	Meaning
HOP	Hand Over Point
hPa	Hectopascal
HSE	Health and Safety Executive
HWM	High Water Mark
ID	Identification name/number
IFSR	Infield Selected Route
IS	In-Service
IS	Initial Splice
kHz	Kilohertz
km	Kilometre
kPa	Kilopascal
KP	Kilometre Point
LAT	Lowest Astronomical Tide
Lat	Latitude
LC	Land Cable
Long	Longitude
LP	Landing Point
LW	Lightweight
LWM	Low Water Mark
LWP	Lightweight Protected
m	Metre
MAG	Magnetometer
MB	Maritime Boundary
MBES	Multibeam Echo Sounder
MC	Magnetic Contact
MCB	Mineral Concession Block
MCPT	Miniature Cone Penetrometer System
MDA	Medium Double Armour
ML	Mean Level
MPa	Megapascal
MSL	Mean Sea Level
MV	Motor Vessel
NA	Not Applicable
nmh	No measurable height
NU	North Up
OCB	Oil Concession Block
OOS	Out of Service
OV	Overview Chart
PC	Planning Chart
PEP	Project Execution Plan
PLB	Post Lay Burial
PLDN	Plough Down
PLGR	Pre Lay Grapnel Run
PLI	Post-Lay Inspection
PLIB	Post Lay Inspection and Burial
PLN	Planned cable
PLUP	Plough Up
PL-xxx	Post Load
POL	Point On Line
POW	Plan Of Work
PSR-xxx	Post Survey Route
PTEQ	Passive Tilt Equaliser

Abbreviation	Meaning
PWC	Plough With Caution
PX	Pipeline Crossing
REH	Route Engineering Handbook
RPL	Route Position List
R-xxx	Repeater
ROV	Remotely Operated Vehicle
RTCM	Radio Technical Commission for Maritime Services
RTK	Real Time Kinematics
RV	Research Vessel
S xx	Segment xx
SA	Single Armour
SAL	Single Armour Light
SBES	Singlebeam Echosounder
SBP	Sub-Bottom Profiler
SC	Slack Change
SC	Sonar Contact
SCB	Sand Concession Block
SDMP	Seabed Data Management Package
SEI	Seismic Contact
SEQ-xxx	Shape Equaliser
SJ-YYY-xxx	Ship Joint
SLD	Straight Line Diagram
SOB	Start of burial
SOW	Scope of Work
SRxx	Survey Route
SSE	Separate Shore End
SSS	Side Scan Sonar
ST	Seabed Temperature
SVP	Sound Velocity Profile
TEQ-xxx	Tilt Equaliser
TM	Transverse Mercator Projection
TR	Transition
TS	Terminal Station
TSS	Traffic Separation Scheme
TW	Territorial Waters
UCS	Unconfined Compressive Strength
USBL	Ultra Short Baseline
UTM	Universal Transverse Mercator Projection
WD	Water Depth
WGS84	World Geodetic System 1984
XBT	Expendable Bathythermograph

DEFINITIONS

Terminology	Definition
Purchaser/customer	ACE Consortium
Client	Alcatel Lucent Submarine Networks
Contractor	ELETTRA/LIHGTHOUSE (LGH)/EGS
Acoustic penetration	The ability of acoustic waves to travel through the subsurface.
Acoustic reflector	A subsurface that causes the velocity of seismic waves to change.
Beach landing area	The area immediately surrounding the Beach Manhole location extending down to the LWM/Landing Point (shoreline). This is also referred to as the onshore area.
Bedding/layering	A stratified or layered feature associated with sedimentary rocks and/or loose sediments.
Bedform	Any oscillatory topographic deviation from a flat bed produced by fluid movement including wave and current activity, generally in a sandy domain.
Bedrock	The solid rock lying beneath superficial material such as gravels or soils.
Boulder	A separated rock mass larger than a cobble, having a diameter greater than 200 mm. It is rounded in form or shaped by abrasion.
Burial depth	1m from inshore HOP to 1500m water depth and no burial in >1500 WD.
Carbonate	A mineral type containing the carbonate radical (CO_3).
Chart Datum	A level so low that the tide will not frequently fall below it. British Hydrographic Office interprets it as the approximate level of Lowest Astronomical Tide (LAT).
Clay	A complex mineral assemblage with particle size <0.002 mm.
Coarse sediment	Sediment composed mainly of sand and gravel.
Cobble	Detrital sediment with particle size between 60mm and 200mm diameter.
Cohesive sediment	Sediments, typically clay and/or silt that resist separation due to the nature of bonds between fine grained particles.
Concretion	Lumps or nodules found in loose sediment, rounded or irregular in shape, usually harder than the surrounding medium.
Continental shelf	A gently sloping, shallow-water platform extending from the coast to a point where there begins a comparatively sharp descent down the continental slope to the Abyssal floor.
Coral reef	Hard material composed predominantly of corals and calcareous algae.

Terminology	Definition
Corestone	Rounded boulder, occurring individually or in piles at the ground surface, or in exposed sections. It results from an initial phase of subsurface chemical weathering, of a joint-bounded block, followed or accompanied by surface erosion that exposes the corestone.
Debris	Sonar contacts attributed to human activity. Generally angular and distant from areas of rock outcrop and high energy environments.
Deep water areas	Water depths greater than end of burial.
Diagenesis	Process by which chemical and physical properties of soils change.
Escarpment	A high continuous cliff or long, steep slope situated between a lower, more gently inclined surface and a higher surface.
Fine sediment	Sediment composed mainly of silt and clay.
Gas seepage	Escape of fluids (gas) from the seabed.
Gravel	An unconsolidated accumulation consisting of particles larger than sand (diameter 2mm-60mm).
Hardened seafloor (hardpan/hardground)	Loose sediment covering the seafloor partially affected by diagenetic processes that produce a hard surface (with variable geotechnical properties).
Inshore water areas	Nominally those areas shallower than 15m or shallower than the safe working limit of the primary survey vessel.
Induration	Process where soft sediment becomes hard rock.
LAT	This is the lowest level to which sea level can be predicted to fall under normal meteorological conditions and under any combination of astronomical conditions. LAT is not an extreme level, as meteorological conditions can cause a lower level. The level under these conditions is known as a storm surge or negative surge.
Loose sediment	Not cemented sediment, either cohesive or not.
Megaripples	Undulations produced by fluid movement (waves and currents) over sediments, generally with wavelength of 0.5m to 25m.
Offshore water areas	Water depths from 15m or the safe working limit of the primary survey vessel to maximum water depths.
Plateau	A comparatively flat-topped seafloor elevation, usually rising at least 200m above its surroundings.
Pockmark	Shallow seabed depression typically several ten metres across and a few metres deep. Generally formed in soft fine-grained seabed sediments by the escape of fluids into the water column.
Quartz	Crystalline silica, SiO_2, the principal mineral in unconsolidated sand and gravel.
Ridge	A long narrow raised portion of the seafloor, relatively to its surroundings.

Terminology	Definition
Ripples	Undulations (wavelength <0.5m) produced by fluid movement (waves and currents) over sediments.
Rock outcrop	Rock that is exposed.
Sand	A detrital particle larger than a silt grain and smaller than a gravel, having a diameter in the range of 0.063mm to 2mm.
Sand Concession	Sand Extraction License
Sandwaves	Undulations produced by fluid movement (waves and currents) over sediments, generally with wavelength > 25m.
Silt	A detrital particle, finer than very fine sand and coarser than clay, in the range of 0.002mm to 0.062mm.
Shallow water areas	Water depths from 15m to end of burial.
Slumping area	The slipping or sliding down of a mass of sediments relatively soon after its deposition in a sub-aqueous slope.
Subcropping	Where a rock/basement lies within the project and area specific target burial depth.
Veneer	Superficial sediment too thin to be resolved with the seismic profiling system and may show as high reflectivity in side scan sonar data in the cases of soft/loose sediments over rock or hardground. The thickness is typically up to 50cm and could be significantly less than that in favourable surveying situations. Resolution of veneer depends on seismic profiler's dominant signal frequency, seabed nature, and weather conditions during the survey.

1 INTRODUCTION

1.1 Description

The entire ACE Phase 2 system connects South Africa to São Tomé. The configuration routes from São Tomé (São Tomé and Príncipe) to either Duynefontein or Melkbosstrand (South Africa) and landings and/or BUs of the configuration are listed as follows:

- Segment 4.1 São Tomé (São Tomé and Príncipe) – BU4A1
- Segment 4.3 BU4A1 – BU4B
- Segment 4.5 BU4B – BU4C
- **Segment 4.7 BU4C – Melkbosstrand or Duynefontein (South Africa)**

There are two route options surveyed for Segment 4.7 offshore, Route Option 2 towards Duynefontein and part of Route Option 3 towards Melkbosstrand. Route Option 2 is considered as the main route and is located north of Route Option 3. Route Option 3 overlaps with Route Option 2 from the north to the south and diverts to the south at a pinch point at 33°49.304'S, 17°55.012'E (KP1431.3) in 180m WD. The inshore survey was performed based on Route Option 2 as well. Route Option 2 connects to a BMH named BMH01. And there is another option in the landing area named Route Option 2A which is slightly different compared to Route Option 2; it connects to another BMH called BMH01A to the north of BMH01.

This report text is based on the Route Option 2 and the surveyed section of Route Option 3. It discusses the survey results of ACE S4.7 obtained by *RV Ridley Thomas* and *MV Tritan Explorer* from the South Africa EEZ at 30°32.930'S, 13°35.162'E (KP834.0) to the BMHs and also from the pinch point of routes Option 2 and Option 3 at 33°49.304'S, 17°55.012'E (KP1431.3) in 180m WD to the end of offshore survey in the south at 33°43.450'S, 18°25.061'E (KP1479.7) in 17m WD. The offshore survey was conducted between 4th June 2016 and 27th June 2016 up to the EEZ of South Africa and the inshore survey was performed from 26th April to19th May 2016.

This report comprises a descriptive text and charts showing the seabed features, shallow seabed geology, bathymetry and geomorphology along the route, together with appendices of supporting information.

A system overview chartlet is presented as **Figure 1** below.

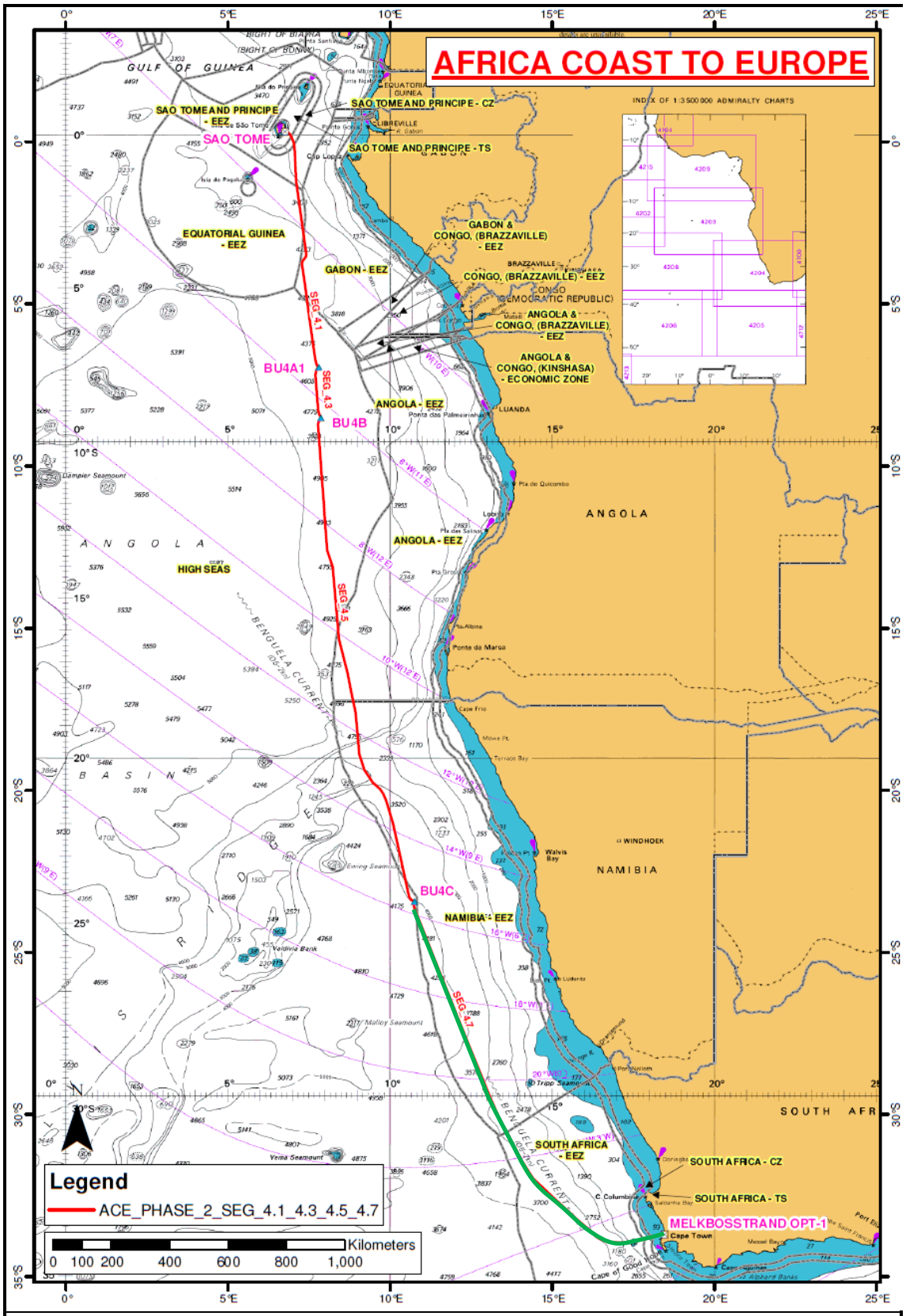

Figure 1: Overview of ACE - S4.7 shown in green

1.2 Purpose

EGS was contracted by Elettra/LGH on behalf of ACE Consortium to supply topographic, hydrographic, and geophysical and geotechnical survey services to provide data to enable ASN to carry out engineering, construction and subsequent maintenance of the ACE Phase 2 cable system. The primary objective of the cable route survey activities was to identify hazards and thereby allow ASN to engineer a secure, technically and economically viable route for the system. This enables exact cable lengths, cable design and installation parameters to be defined to minimise problems over the 25 year life of the system.

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2 SURVEY PROCEDURES

2.1 General

The ACE cable system SEGMENT 4.7 route survey comprised an investigation of bathymetry, seabed features and shallow geology along the proposed route and a subsequent geotechnical sampling programme from BU4C to the landing areas in Melkbosstrand and Duynefontein.

This report details the results from the South Africa EEZ to BMH01 and BMH01A (**Figure 2**) based on Route Option 2 and Option 2A correspondingly and from the pinch point at KP1431.3 to the end of offshore survey based on Route Option 3.

Figure 2: Overview of BMHs in the northern corridor (red line: survey route; green line: survey corridor; cyan line: optional route)

2.2 Project Survey Parameters

2.2.1 Geodetic Parameters

To accord with the project specifications, all charts and reports are presented in Mercator projection, with the parameters below:

Datum Parameters	
Datum	WGS-84
Spheroid	WGS-84
Semi-Major Axis (a)	6378137.000m
Inverse Flattening (1/f)	298.2572235634
Projection Parameters	
Grid Projection	Mercator
Latitude of Origin of Projection	0° N (Equator)
Longitude of Origin of Projection	12° E
False Easting (metres)	1 000 000
False Northing (metres)	4 000 000
Standard Parallel	15° S
Scale Factor	1.00 000 at Standard Parallel

Table 1: Geodetic parameters for survey and charting for ACE

To ensure the geographic transformation parameters were applied accurately, the numerical data were checked against the values shown in **Table 2**.

Name	Input/Output WGS84 Geographical	Input/Output Mercator Grid
BMH ANNOBON	Latitude: 01° 24.5950' S Longitude: 05° 38.5210' E	Northing: 3 849 362.484 m Easting: 316 195.785 m Scale factor: 0.96643311
BMH SAO TOME	Latitude: 00° 18.4258' N Longitude: 06° 44.8875' E	Northing: 4 032 807.451 m Easting: 435 158.277 m Scale factor: 0.96615626
BU4A1	Latitude: 06° 57.5951' S Longitude: 07° 46.9951' E	Northing: 3 254 608.548 m Easting: 546 486.656 m Scale factor: 0.97326684
BU4C	Latitude: 23° 25.8833' S Longitude: 10° 44.3815' E	Northing: 1 423 020.683 m Easting: 864 453.223 m Scale factor: 1.05241649
R4712	Latitude: 33° 56.6118' S Longitude: 16° 54.5040' E	Northing: 137 976.782 m Easting: 1 527 900.819 m Scale factor: 1.16338874
Origin at Standard parallel	Latitude: 15° S Longitude: 12° E	Northing: 2 378 670.400 m Easting: 1 000 000.000 m Scale factor: 1.0000

Note: Positions are taken below:

(1) ACE_PHASE_2_SEG_4.1_SAO_TOME-BU4A1_CRS03_12-MAY-2016

(2) ACE_PHASE_2_SEG_4.3_BU4A1-BU4B_CRS03_12-MAY-2016

(3) ACE_PHASE_2_SEG_4.5_BU4B-BU4C_CRS03_12-MAY-2016

(4) ACE_PHASE_2_SEG_4.7_BU4C-MELKBOSSTRAND_OPT-02_MIDDLE-NORTH_BMH01_CRS03_12-MAY-2016

Table 2: Numerical data for checking transformation computation

2.2.2 Vertical Datum

The vertical datum for this project is Lowest Astronomical Tide (LAT).

2.2.2.1 Inshore Survey

The landfall topographic survey was done with using total station and RTK system, and corrected with the local benchmark as detailed in Appendix F.

2.2.2.2 Offshore Survey

Shallow water bathymetry was reduced to Lowest Astronomical Tide (LAT) using predictions calculated according to the harmonic constants from the tide stations available for the specific segments. The tide station prediction data with Tide Stations information for S4.7 are from the Admiralty Tide Tables Volume 8 (2016) and the details can be found in the **Table 3**.

HARMONIC CONSTANTS															
Station	Lat (S)	Lon (E)	Z0 (m)	M2 (°)	M2 (m)	S2 (°)	S2 (m)	K1 (°)	K1 (m)	O1 (°)	O1 (m)	1/4 diurnal (f4)	1/4 diurnal (F4)	1/6 diurnal (f6)	1/6 diurnal (F6)
3782 (Cape Town)	33°54'	18°26'	0.98	093	0.50	115	0.22	139	0.06	263	0.01	351	0.014	-	-

Table 3: Harmonic constants used for Segment 4.7

No tidal reduction was applied to soundings deeper than 1500m, as tidal height becomes increasingly insignificant relative to the other errors and inaccuracies as water depth increases.

In order to produce contours and bathymetry statistics (i.e. slope angles), the following grid cell sizes were used:

Area	Depth Range (m)	Cell Size (m)
Shallow water	0-50	2
Shallow water	50 - 200	5
Shallow water	200 - 500	10
Shallow water	500 - 1000	20
Shallow water	1000-1500	50
Deep water	1500-2000	50
Deep water	2000-5000	100
Deep water	>5000	150

Table 4: Summary of grid cell sizes for bathymetric data presentation

2.3 Summary of Survey Design

The offshore survey plans were based on the survey RPLs provided by ASN. The survey RPLs are presented as Appendix A1 of this report.

The following criteria were agreed between ASN/Elettra/LGH and EGS representatives before the start of the survey.

Water Depth (LAT)	Survey Corridor Width	Survey Line Spacing	No. of survey lines	SSS Range	Nominal Vessel Speed
15m to 20m	500m	75m	7	100m	4-5knots
20m to 50m	500m	100m	5	150m	4-5knots
50m to 500m	500m	125m	3	150m	4-5knots
500m to 1500m	500m	150m	3	200m	4-5knots
>1500m	3 x WD (max.10km)	NA	1	NA	Full survey speed
Survey at BU Areas					
BU>1000m	6 x WD sq (min.10km)	TBA	TBA	NA	Full survey speed

Table 5: Summary of survey design for ACE Segment 4.7

Sample/ Data Type	Interval
Gravity core *	Nominal 10km
CPT	Nominal 4km

Table 6: Sampling intervals at burial section

***** Note: If there are two unsuccessful gravity core attempts then one grab sample will be acquired. A successful core requires the collection of at least 1m of material.

2.3.1 Change of scope of work

Due to the adverse weather condition and the large Mercator scale factor problem, the SSS range was enlarged from 150m to 200m for several lines with the agreement of all the client representatives on board. These sections are:

Survey line L125 and R125 from KP1431-1447 (RPL Option 3_12-MAY-2016)

Survey line L125 and R125 from KP1431-KP1445 (RPL Option 2_12-MAY-2016)

Survey line L150 and R150 from KP1388-KP1431 (RPL Option 2_12-MAY-2016)

Besides the above change of scope, two development lines were run in enlarge the space for cable engineering in areas with moderate to steep slopes:

Development survey line L350 KP1381-KP1386 and R350 from KP1377.5-KP1382 (RPL Option 2_12-MAY-2016)

2.4 Summary of Operations

The inshore survey was performed from 26th April to 19th May 2016 and the offshore survey operations were undertaken between 4th June 2016 and 27th June 2016 from the South Africa EEZ to the end of offshore survey near the landing areas along routes Option 2 and Option 3.

The full offshore daily progress reports are presented as Appendix A of the vessel specific operations report, presented in Volume O.

2.4.1 Offshore Survey

The following table taken from the survey DPRs gives the breakdown of the S4.7 offshore survey operations up to the South Africa EEZ performed by the *RV RT*. The inshore operation summary can be found in the section 7 of landfall report in Appendix F.

Description	Total Hours	Total Percent
Mobilisation	66.00	11.7%
Trials, Calibration, Safety	20.33	3.6%
Transit	49.55	8.7%
Operational Transit	13.68	2.4%
Operational	174.10	30.7%
Route Development	5.80	1.0%
Standby Weather	60.85	10.7%
Standby Port	98.45	17.4%
Melkbosstrand southern shallow water route	61.32	10.8%
Equipment Downtime	16.30	2.9%
Sum Totals	566.38	100%

Table 7: Summary table of S4.7 survey operations up to the South Africa EEZ

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3 RPL VERSIONS AND DEVIATIONS FROM THE SURVEY ROUTE

The survey RPL, *ACE_PHASE_2_SEG_4.7_BU4C-MELKBOSSTRAND_OPT-02_MIDDLE-NORTH_BMH01_CRS03_12-MAY-2016.xls (Opt2_12-MAY-2016 in short hereafter)*, was provided by ASN to define the offshore survey corridor during survey operation. It is presented as Appendix A1 of this report. This RPL was used for the determination of KPs, offsets and points on line within this report.

Another survey RPL, *ACE_PHASE_2_SEG_4.7_BU4C-MELKBOSSTRAND_OPT-03_MIDDLE-SOUTH_BMH03_CRS03_12-MAY-2016.xls (Opt3_12-MAY-2016 hereafter)*, was provided by ASN to define another survey corridor from the pinch point of Route Option 2 and Option 3 to the southern end of offshore survey at KP1479.7. It is also presented as Appendix A1 of this report. This RPL was used for the determination of KPs, offsets and points on line within this section.

For the inshore survey which is accomplished prior to the offshore survey, two routes were provided by ASN to define the survey corridor. The inshore survey will be described following these two routes.

- To BMH01: *ACE_PHASE_2_SEG_4.7_BU4C-MELKBOSSTRAND_OPT-02_MIDDLE-NORTH_BMH01_CRS03_24-FEB-2016 (Opt2_24-FEB-2016 hereafter)*

- Optional Route to BMH01A: from the first AC of the route *Opt2_24-FEB-2016* to the BMH01A at 33° 41.6668' S, 018° 26.3863' E

Route deviation will be performed to avoid areas of slopes of steep gradient and to minimise the length of route passing through ROCK wherever possible; details of route are presented in the Route Description in the following sections.

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4 SURVEY RESULTS

4.1 Introduction

The following narrative summarises the bathymetry, seafloor morphology, shallow seabed geology and geotechnical sampling results along the route. Examples of the survey records are provided to show distinctive features.

The British Standards BS 5930 (1.3) were referenced to describe sediment samples and seabed classification. **Table 8** and **Figure 3** below show some of the essential parameters used in nomenclature. A summary of the descriptive terms and definitions used is provided as Appendix B1 of this report.

DESIGNATION (FINE GRAIN SEDIMENTS)	UNDRAINED SHEAR STRENGTH (KPA)
VERY SOFT	0-20
SOFT	20-40
FIRM	40-75
STIFF	75-150
VERY STIFF	150-300
HARD	300-400
VERY HARD	Greater than 400
DESIGNATION (COARSE GRAIN SEDIMENTS)	**RELATIVE DENSITY (%)**
Very Loose	0-15
Loose	15-35
Medium dense	35-65
Dense	65-85
Very dense	>85

Table 8: Strengths and relative densities for cohesive and coarse (granular) soils

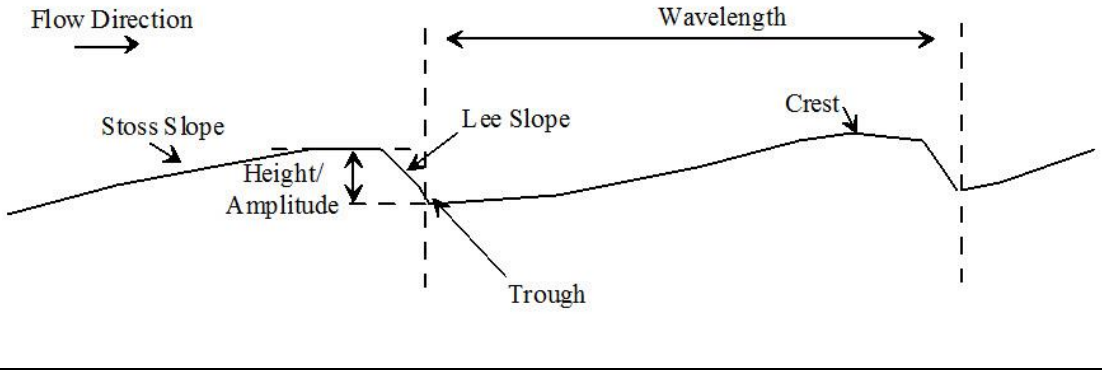

Figure 3: Attributes of Sedimentary Structures (Ripples, Megaripples, Sandwaves)

For the purposes of reporting, the results have been described according to the areas surveyed:

1. Offshore deep water survey by *RV RT:* from the South Africa EEZ to 1500m WD off South Africa continental slope based on RPL *Opt2_12-MAY-2016* (**Section 4.2**)

2. Offshore shallow water survey by *RV RT:* from 1500m WD to the end of offshore survey at 33°42.155'S, 18°24.742'E (KP1480.1) in 15m WD based on *RPL Opt2_12-MAY-2016* (**Section 4.3**).
3. Inshore survey by *MV Tritan Explorer*: from end of inshore survey at 33°42.245'S, 18°24.199'E in 21m WD to the BMHs (**Section 4.4**).
4. Additional Offshore shallow water survey by *RV RT:* from the pinch point at 33°49.304'S, 17°55.012'E (KP1431.3) in 180m WD to the southern end of offshore survey at 33°43.450'S, 18°25.061'E (KP1479.7) in 17m WD following the RPL *Opt3_12-MAY-2016* (**Section 4.5**).

4.2 Offshore deep water survey

From South Africa EEZ to the 1500m WD off South Africa continental slope

This section of the report covers survey results for bathymetry and seafloor morphology along the RPL *Opt2_12-MAY-2016*.

4.2.1 Route Description

South Africa EEZ at 30°32.930'S, 13°35.162'E (KP834.0) in 2905m WD to 31°22.601'S, 14°01.605'E (KP935.0) in 3054m WD

The route exits the Namibia EEZ and enters South Africa EEZ in the beginning of this section at 30°32.930'S, 13°35.162'E (KP834.0) in 2905m WD and proceeds to south-southeast direction over a gentle seabed (**Figure 4**).

A local seabed rise is passed by the route between 30°47.677'S, 13°42.989'E (KP864.0) in 2840m WD and 30°54.564'S, 13°46.651'E (KP878.0) with moderate to steep gradient observed along the sides.

After that, the route runs over a gentle seabed with occasional moderate gradients for approximate 50km until where two scarps are encountered at approximate 31°19.930'S, 14°00.178'E (KP929.6) in 2911m WD and 31°21.304'S, 14°00.913'E (KP932.4) in 3008m WD. Very steep scarps measured up to 28° can be observed along the scarps.

The proposed route crosses several Oil Concession Blocks as follows,

- Exit OCB 3013-OK ENERGY and enter OCB 3113-OK ENERGY at 30°58.855'S, 13°48.935'E (KP886.7) in 2890m WD
- Exits OCB 3113 - OK ENERGY and enter OCB ORANGE DEEP - SHELL at 31°18.644'S, 13°59.491'E (KP927) in 2883m WD.

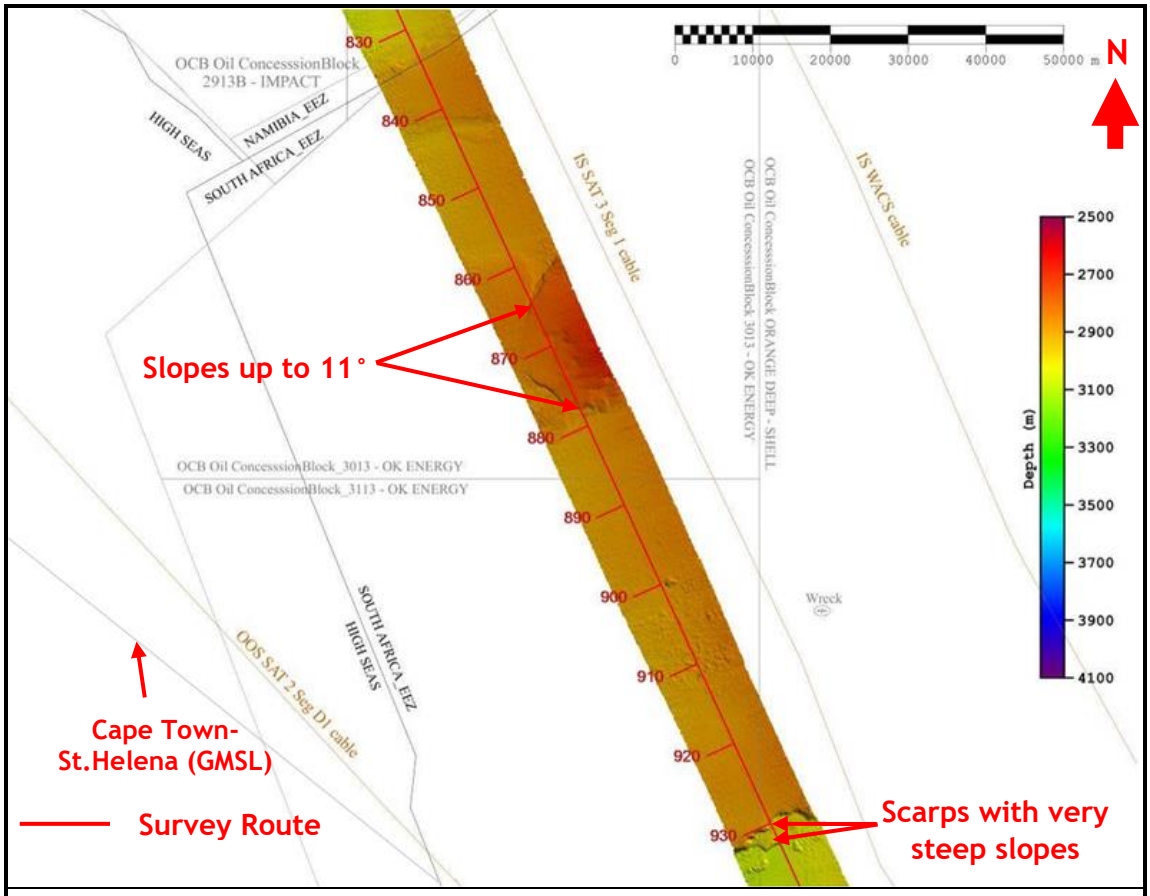

Figure 4: Sun illuminated bathy data example between KP830 and KP930

NB: 10km between KP flags, vertical exaggeration x3

31°22.601'S, 14°01.605'E (KP935.0) in 3054m WD to 33°02.544'S, 15°32.596'E (KP1170.0) in 3346m WD

At the beginning of this section, the proposed route heads south-southeast and then alters gently to the southeast at 31°57.577'S, 14°23.411'E (KP1008.3) in 2968m WD. The seabed is gentle in general with occasional moderate gradients.

The route exits OCB ORANGE DEEP - SHELL and enters OCB 3315 - NEW AGE at 32°59.155'S, 15°28.965'E (KP1161.6) in 3305m WD.

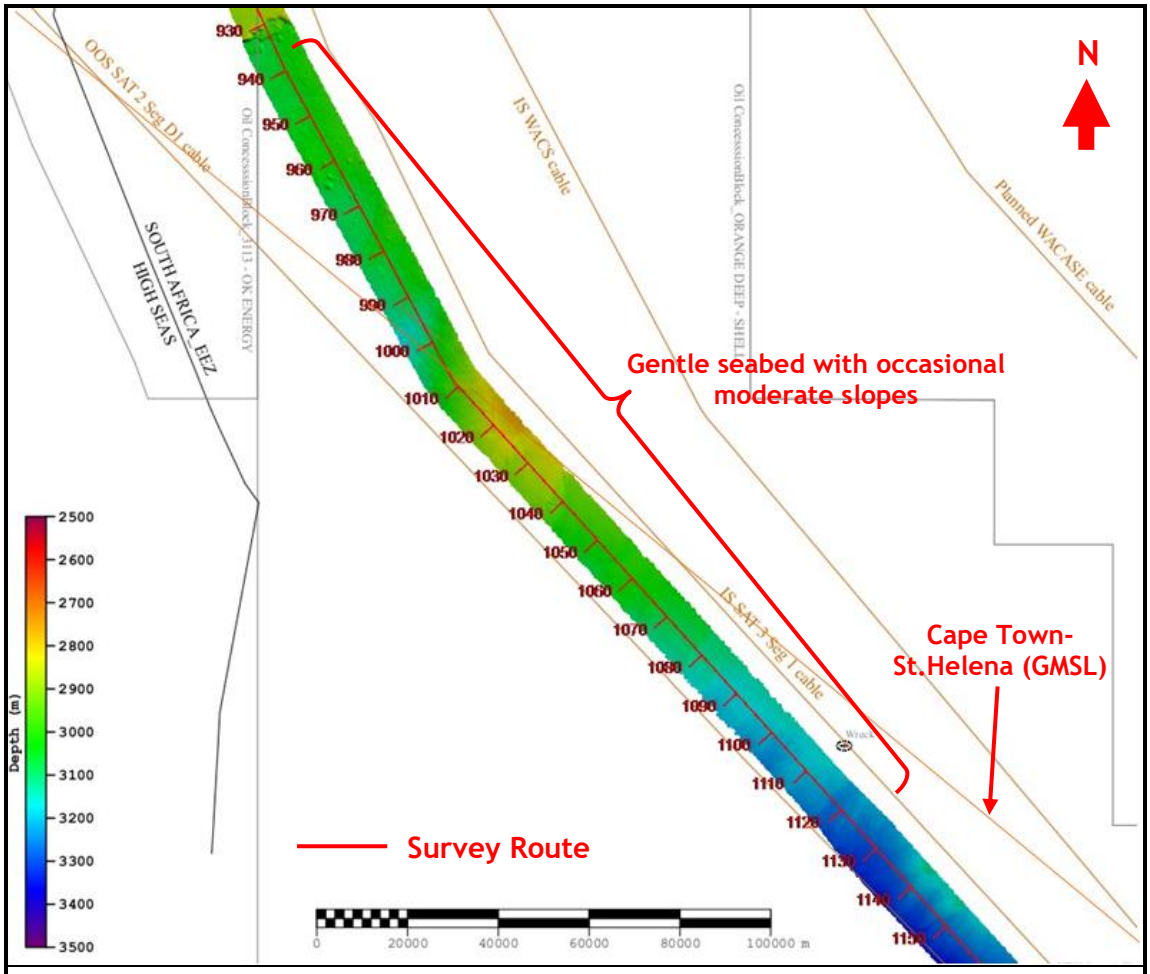

Figure 5: Sun illuminated bathy data example between KP930 and KP1160

NB: 10km between KP flags, vertical exaggeration x3

33°02.544'S, 15°32.596'E (KP1170.0) in 3346m WD to 33°49.140'S, 16°26.485'E (KP1290.0) in 2642m WD

In this section, the seafloor shoals to the southeast along the route (**Figure 6**). The seabed is gentle with localised moderate slope gradients and one scarp with moderate slope is crossed by the route at around 33°17.167'S, 15°48.720'E (KP1206.9) in 3203m WD.

The proposed route exits OCB 3315 - NEW AGE and enters OCB 05_06 - ANADARKO at 33°26.000'S, 15°59.101'E (KP1229.8) in 3169m WD.

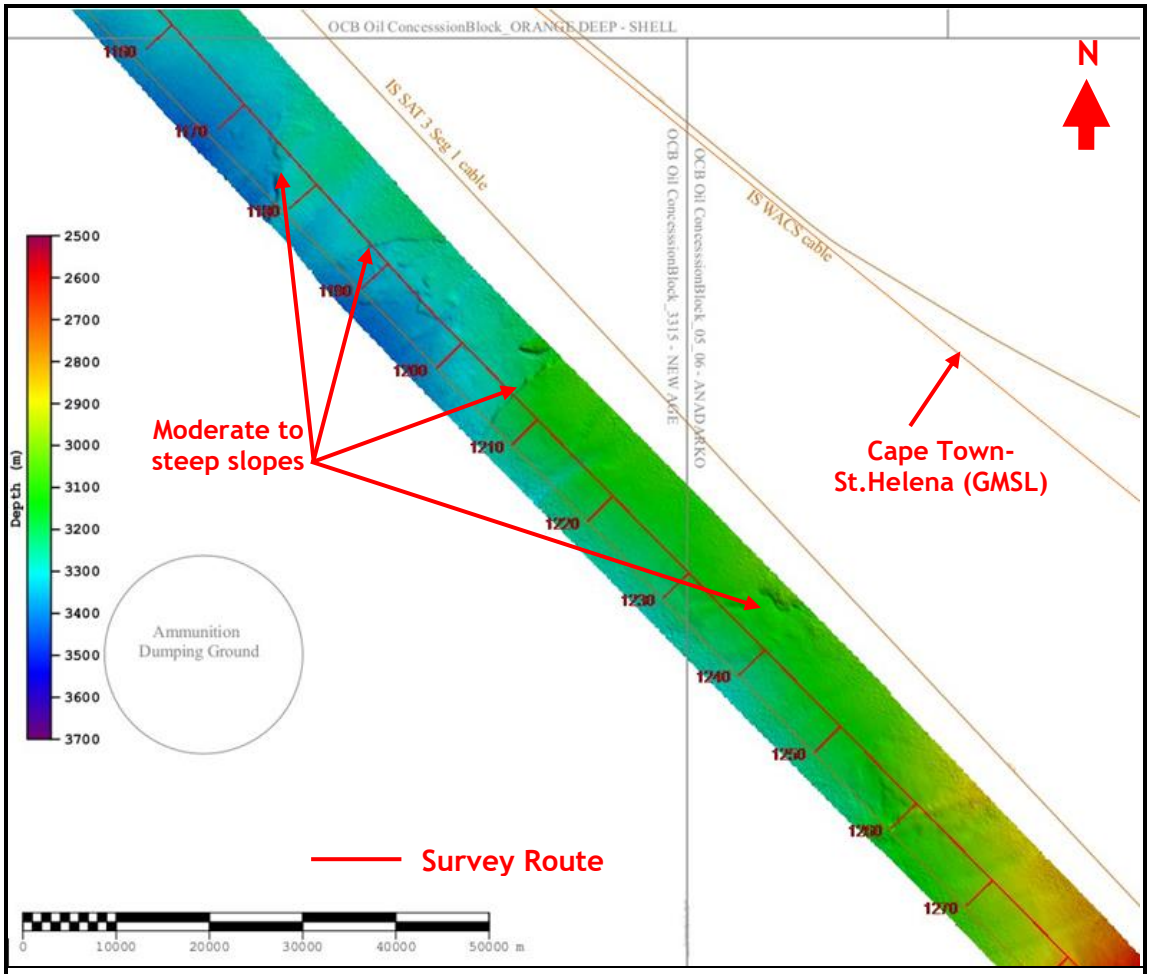

Figure 6: Sun illuminated bathy data example between KP1160 and KP1280

NB: 10km between KP flags, vertical exaggeration x3

33°49.140'S, 16°26.485'E (KP1290.0) in 2642m WD to 33°56.936'S, 17°15.551'E (KP1368.7) in 1500m WD (Offshore shallow water survey boundary)

In this section, the route gradually alters course from the southeast to the east direction. Irregular seabed is present with scattered to numerous moderate to very steep slopes.

The route crosses OOS SAT 2 Seg D1 cable at 33°55.540'S, 16°42.525'E (KP1317.5) in 2794m WD.

At 33°56.936'S, 17°15.551'E (KP1368.7), the route reaches the burial limit of 1500m WD and continues eastwards climbing on the continental slope.

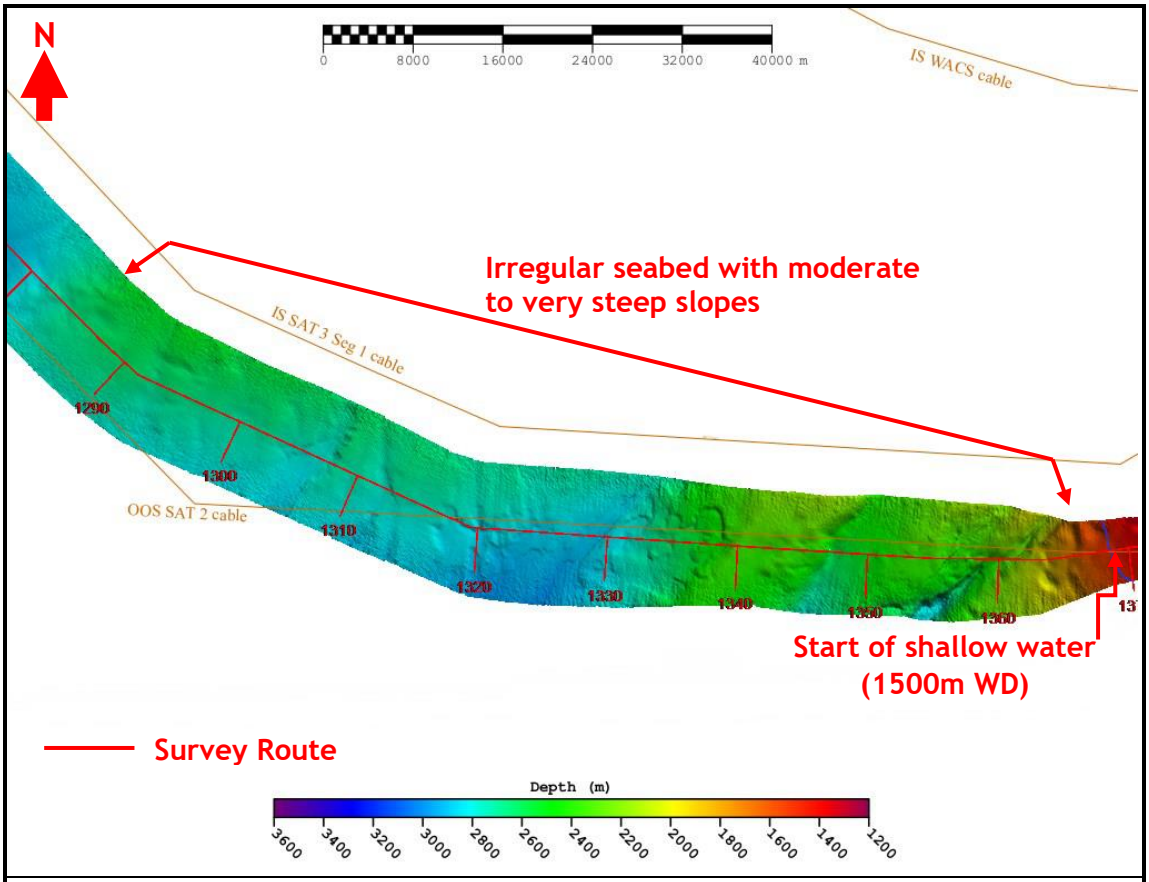

Figure 7: Sun illuminated bathy data example between KP1280 and KP1370

NB: 10km between KP flags, vertical exaggeration x5

4.3 Offshore Shallow Water Survey

From 1500m WD to the end of offshore survey at 33°42.155'S, 18°24.742'E (KP1480.1) in 15m WD

This section of the report covers survey results for bathymetry, seafloor morphology, shallow geology and seabed feature along the route following the RPL *Opt2_12-MAY-2016*.

The following table summarises the results of the operation performed within this survey area.

SSS contact	MAG contacts	GC	GS	MCPT	DP	DS
22	3	24	3	40	-	-

4.3.1 Samples

A nominal spacing of 10km was used as a basis for establishing the seabed sampling program. Locations were selected to ground truth the seabed to assist with the primary interpretation of the geophysical survey. These locations also factored route engineering concerns whenever possible.

A total of twenty-four (24) attempts of gravity coring were acquired at twelve (12) locations. In case of no recovery, grab samples were taken with three (3) attempts at two (2) locations. For more details please refer to Appendix B2.

4.3.2 CPTs

A nominal spacing of 4km was used as a basis for establishing the seabed geotechnical sampling program. Locations were selected to ground truth the seabed to assist with the primary interpretation of the geophysical survey. These locations also factored route engineering concerns whenever possible.

A total of forty (40) attempts of CPT were conducted at twenty-eight (28) locations. For more details please refer to Appendix C.

4.3.3 Sonar Contacts

Sonar contacts are identified as any anomalous target on the seabed and are not confidently attributed to a natural phenomenon. An interpretation was assigned to the target with the detail of that description being a function of how well the target was resolved and the characteristics observed.

Twenty-two (22) sonar contacts were identified as debris. For more details please refer to Appendix D.

4.3.4 Magnetometer Contacts

Magnetic contacts are identified as any metallic objects detected by the magnetometer which is deployed close to the seabed during in-service pipeline/cable crossing survey. An interpretation was assigned to the target with the detail of the magnetic anomaly dimension and the origin whenever possible.

In total, three (3) magnetometer contacts were identified in this section associated with the IS SAT 3 Seg1. For more details please refer to Appendix E.

4.3.5 Route Description

33°56.935'S, 17°15.551'E (KP1368.7) in 1500m WD to 33°54.892'S, 17°27.537'E (KP1387.6) in 520m WD

In this section the route traverse to the east-northeast on a seabed with gentle to locally steep slope gradients. The seabed morphology can be found in **Figure 8**. The seabed shoals eastwards successively. The slope gradients are mainly gentle to moderate. Some local scarp or depressions can be observed on either side of the survey route, with a minimum distance of ~108m at KP1381.5.

From 1500m WD to the east, the seabed geology is characterised with thick sediment stratum (**Figure 9**). The results from gravity cores and CPTs (GC016, GC016a, CP039 and CP038) prove that the surface sediments mainly comprise of very soft to soft sandy SILT over interbedded firm to stiff sandy SILT and medium dense silty SAND. Section of unconformity with possible very stiff/very dense sediment is mapped between 33°56.877'S, 17°16.013'E (KP1369.4) in 1456m WD and 33°56.860'S, 17°16.150'E (KP1369.6) in 1437m WD.

After 33°56.445'S, 17°19.441'E (KP1374.8) in 1105m WD, the seabed sediment becomes denser as confirmed with CP037-CP035. Some medium to high reflectivity patches of firm to stiff clayey SILT, revealed from GC015, was observed on the coarse sediments (**Figure 10**). Then to the east, the seabed is characterised with the high reflectivity of fine sediment as shown in **Figure 11**. Different from the multi-stratum pattern in the west, the sub-seabed here has less/no obvious layering (**Figure 12**). The shallow geology is interpreted as veneer of firm to stiff clayey SILT over dense to very dense silty SAND. After 33°55.486'S, 17°25.163'E (KP1383.8) in 665m WD, the shallow geology becomes intermittent veneers of soft to stiff sandy SILT over medium dense to very dense silty SAND until the end of this section.

Beside the presence of shallow HARDGROUND in the eastern part of this section, in total of eleven (11) sonar contacts attributed to debris are identified. Pre lay grapnel run is recommended. One OOS SAT 2 Seg D1 runs near the route as detailed in the **section 6.1**.

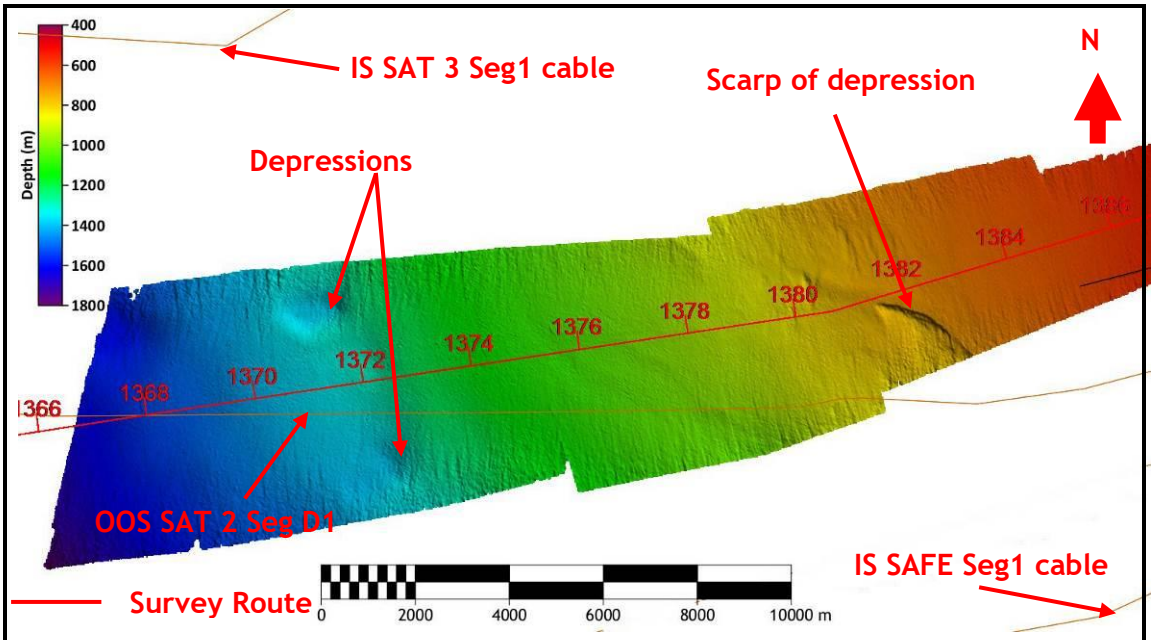

Figure 8: Sun illuminated bathy data example between KP1367 and KP1386

NB: 2km between KP flags, vertical exaggeration x3

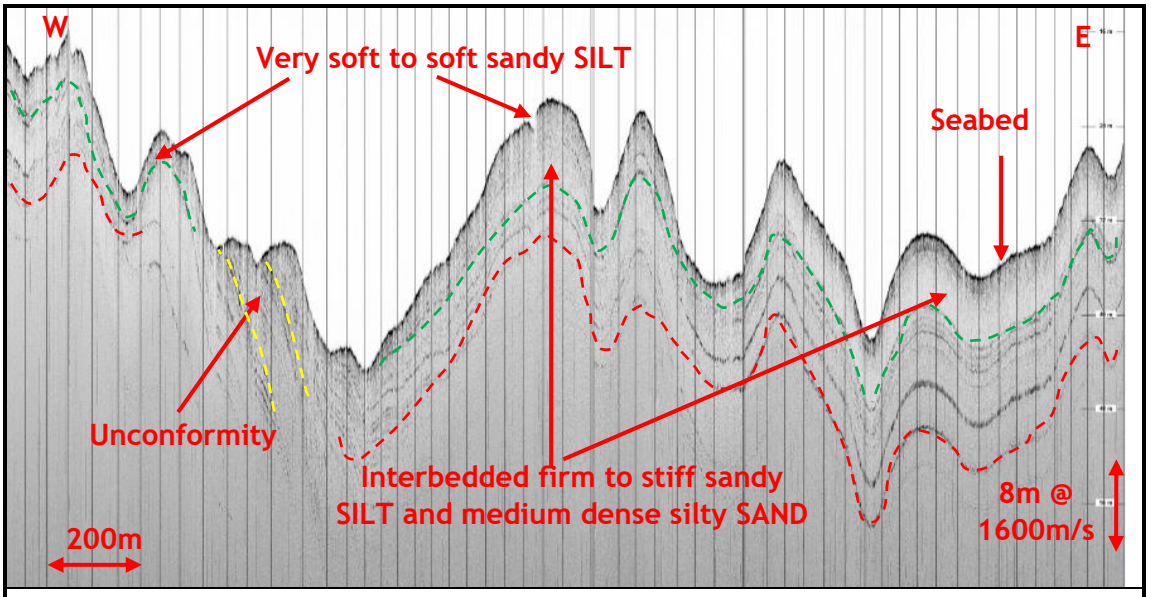

Figure 9: SBP data example from the combined tow-fish along the survey centreline from KP1369.1 to KP1371.6

Note: the apparent rugged seabed is due to height changes of the towed-fish, rather than the real seabed geomorphology.

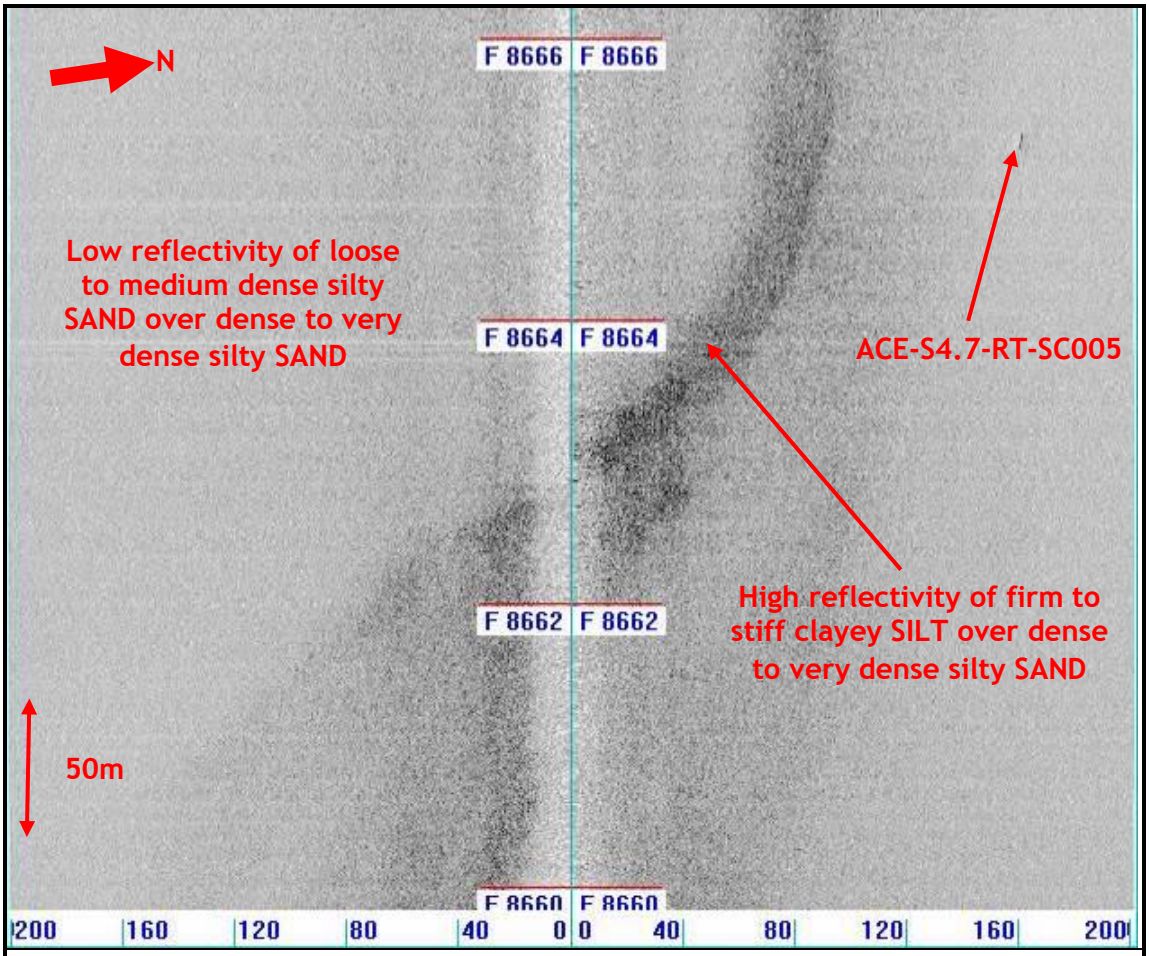

Figure 10: Rectified SSS image showing seabed with high and low reflectivity around KP1375.8

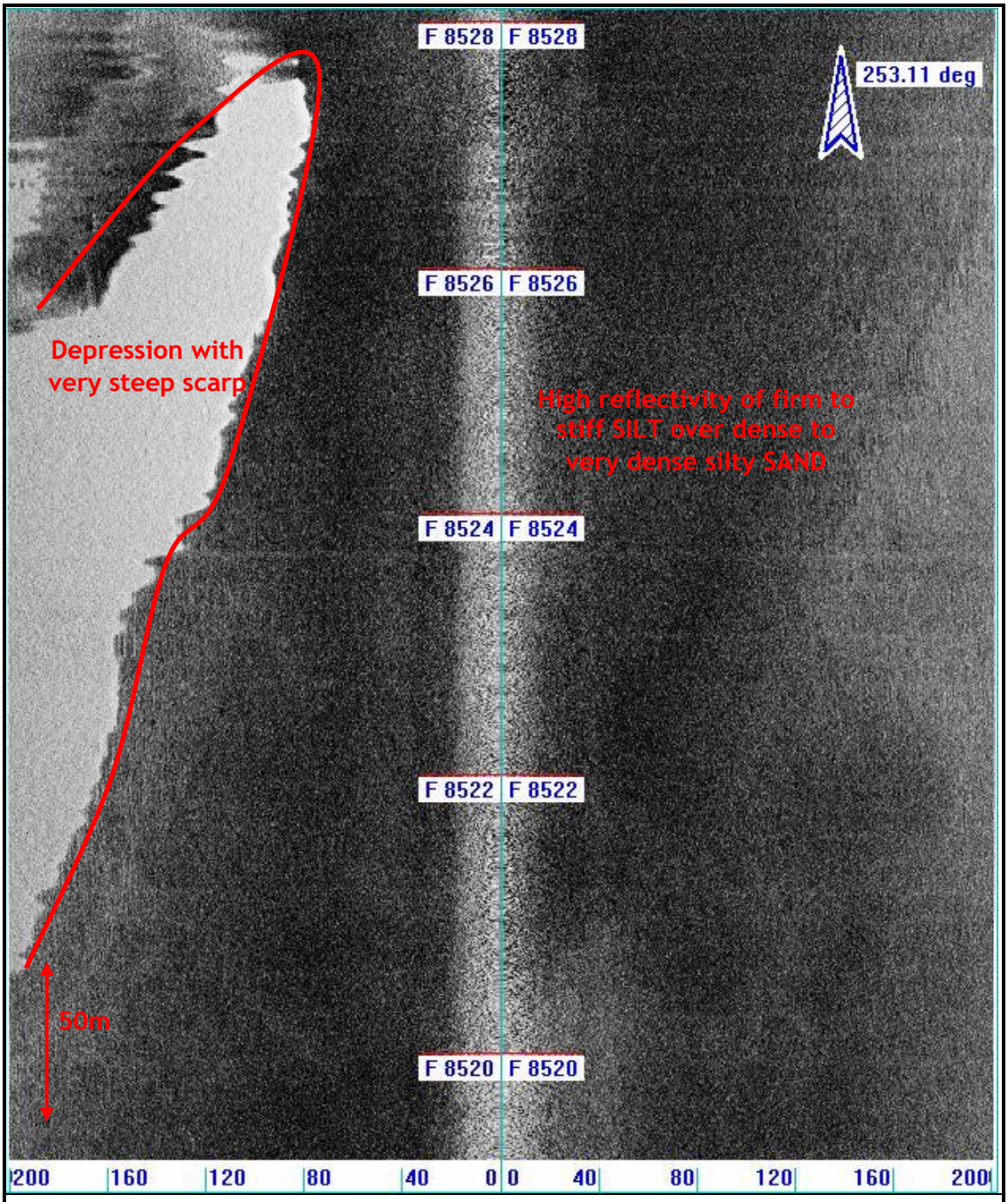

Figure 11: Rectified SSS image showing seabed with high reflectivity around KP1381.6

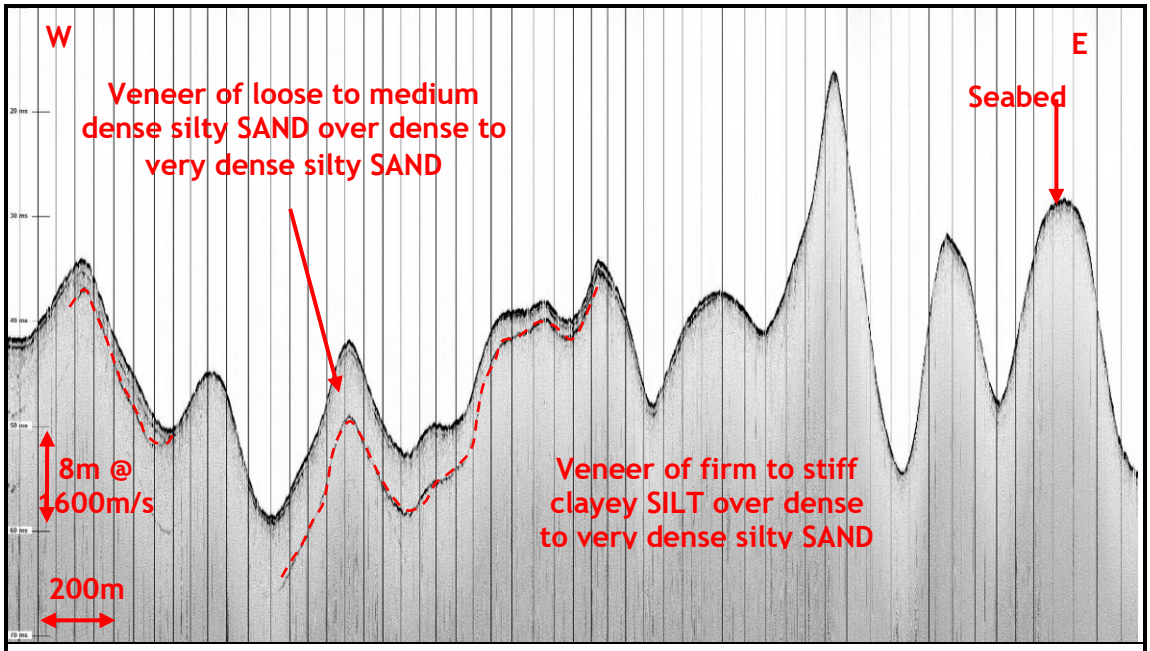

Figure 12: SBP data example from the combined tow-fish along the survey centreline from KP1375.5 to KP1377.7

Note: the apparent rugged seabed is due to height changes of the towed-fish, rather than the real seabed geomorphology.

33°54.892'S, 17°27.537'E (KP1387.6) in 520m WD to 33°50.762'S, 17°49.279'E (KP1422.0) in 228m WD

In this section, the route continues from the continental slope, passes the shelf break area and extends to the east-northeast on the continental shelf of South Africa. The seabed terrain is basically gentle, shoaling eastwards. The bathymetry feature is shown in **Figure 13** and **Figure 14**. One large depression with steep scarp due to souring /slumping should be noticed at KP1389.8 in 432m WD, ~107m south of the route.

From start of this section, the high and low reflectivity character on seabed is still observed as shown in **Figure 15**. According to the CPT and GC results (CP034, CP033, CP032, GC014 and GCO14a), the seabed sediment comprises intermittent veneers of soft to stiff sandy SILT over loose/medium dense to very dense silty SAND with locally thin layers of stiff to very stiff sandy SILT. After about 5.4km to the east, the shallow HARDGROUND layers become less prevalent and the seabed is interpreted as loose to dense silty SAND with locally thin layers of stiff to very stiff sandy SILT, interspersed with scattered patches of soft to firm sandy SILT (**Figure 15**) where target burial depth should be achievable. Occasional depressions (diameter: <10m, depth: <1m) were also observed on the seabed and the SBP data still shows some shallow stratum (**Figure 16**). The CPT results (CP031 and CP030) tell that loose to dense silty SAND is present within the burial depth.

After 33°53.174'S, 17°37.211'E (KP1402.9) in 292m WD, the route enters HARDGROUND area again with the shallow geology comprising of loose to dense, locally very dense, silty SAND as confirmed with samples and CPTs (GC012, GC012a, CP029, CP029a, CP028, CP027 and CP027a). One SBP example is show in **Figure 16**. The seabed surface is mainly smooth, keeping similar as eastern part of **Figure 15.** Occasional depressions (diameter: <10m, depth: <1m) and some large depressions can

be found from the bathymetry data (**Figure 14)**. Scattered possible GRAVEL patches are present on the seabed and the majority ones were mainly mapped between KP1416 and KP1421. Scattered trawling scars were observed, especially on the GRAVEL patches. One detailed SSS example is shown in **Figure 17**. It is believed that the trawling activity occurs not only around the GRAVEL patches. Scars on the sandy seabed were mostly backfilled, leaving fewer hints on the SSS data.

From 33°51.251'S, 17°47.167'E (KP1418.6) in 249m WD to the end of this section, the SBP data (**Figure 18**) accompanying with the CPT test (CP026) reveal a more ploughable seabed of loose to dense silty SAND, with scattered GRAVEL patches.

Besides the presence of shallow HARDGROUND in the most part of this section, in total of four (4) sonar contacts attributed to debris are identified. One example is shown in **Figure 19**. The route enters Firing Area at 33°53.316'S, 17°36.185'E (KP1401.3) in 300m WD and enters the Submarine Cable Area (Anchorage and Fishing Prohibited) at 33°52.277'S, 17°42.093'E (KP1410.6) in 258m WD. It also crosses the marine boundary of South Africa EEZ/CZ at 33°50.780'S, 17°49.210'E (KP1421.9) in 228m WD.

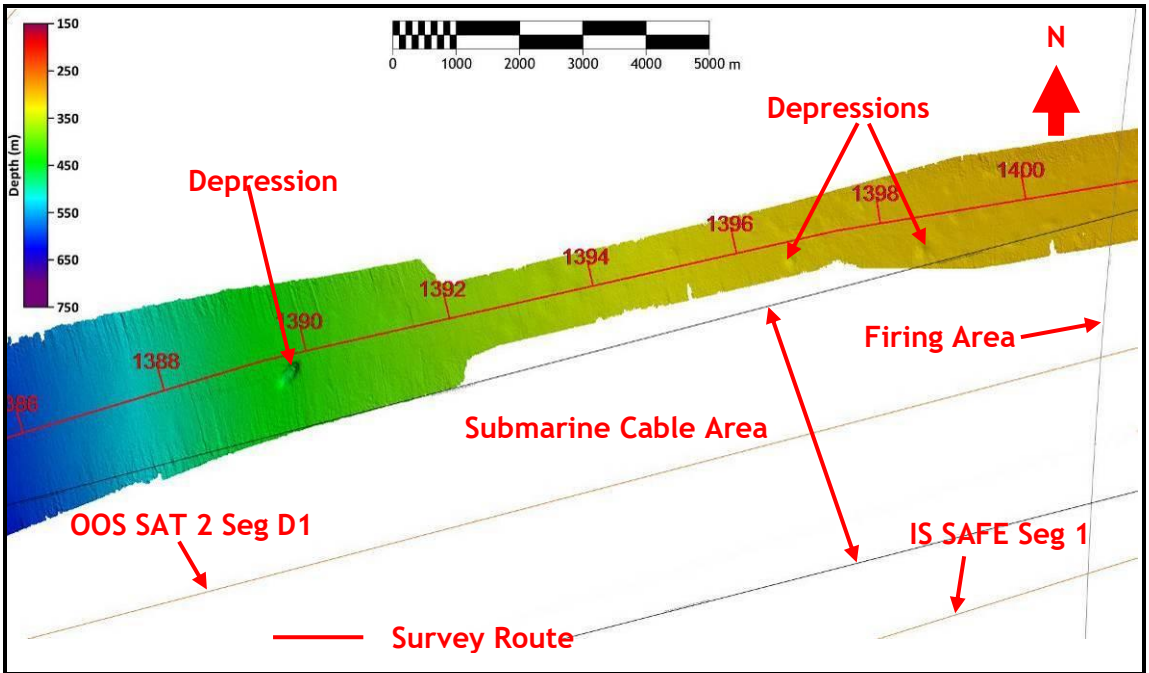

Figure 13: Sun illuminated bathy data example between KP1386 and KP1481

NB: 2km between KP flags, vertical exaggeration x3

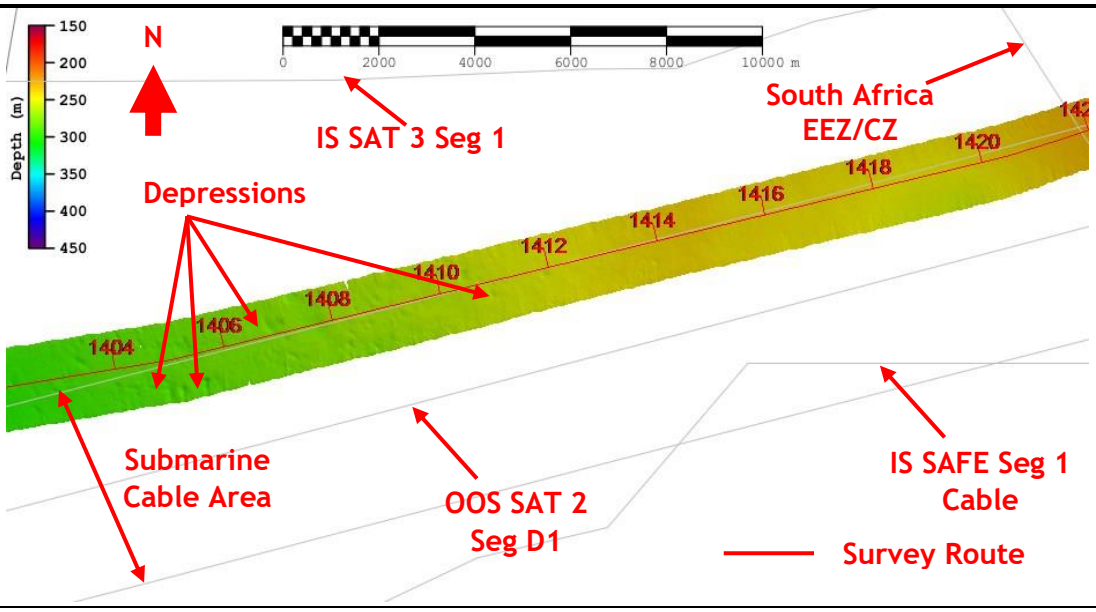

Figure 14: Sun illuminated bathy data example between KP1402 and KP1422

NB: 2km between KP flags, vertical exaggeration x3

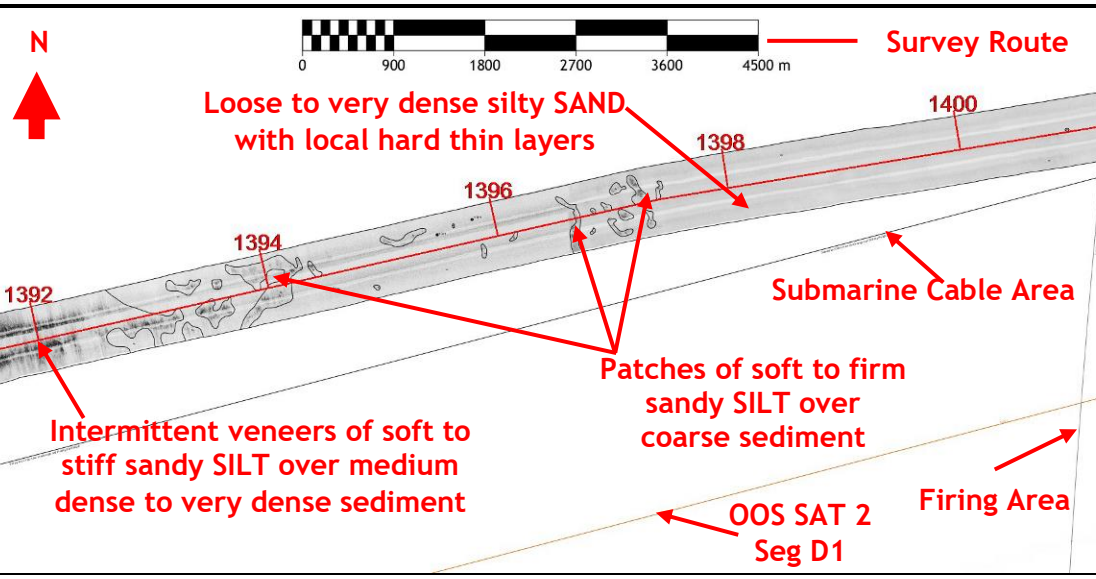

Figure 15: SSS mosaic showing the seabed features from KP1392 to KP1401

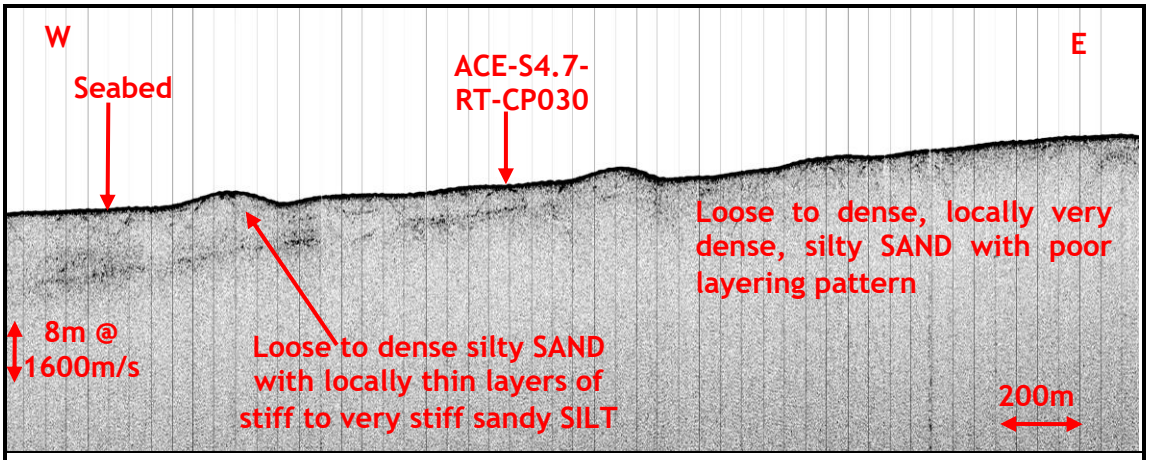

Figure 16: SBP data example along the survey centreline from KP1401.6 to KP1404.0

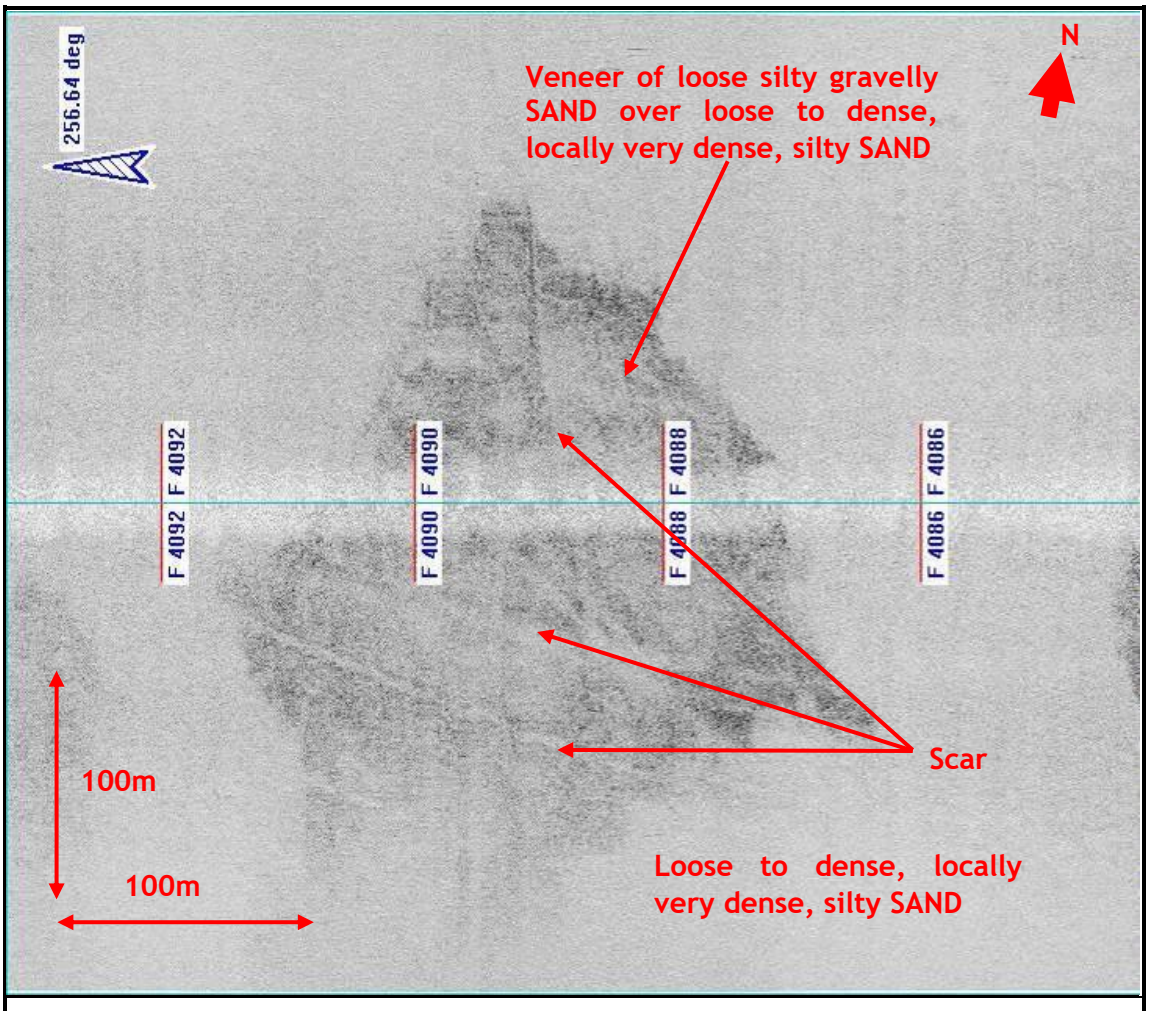

Figure 17: Rectified SSS image showing GRAVEL patch and trawling scars around KP1417.5

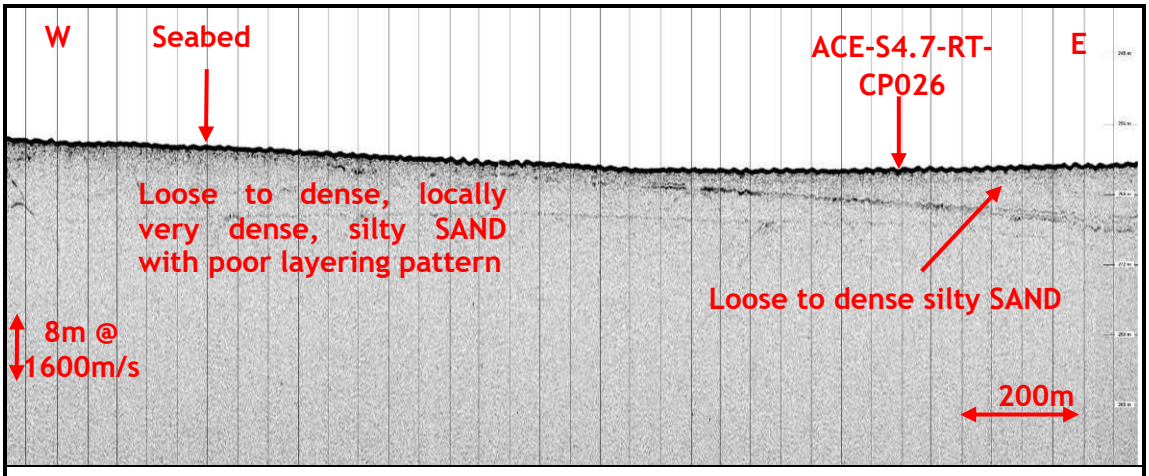

Figure 18: SBP data example along the survey centreline from KP1401.6 to KP1404.0

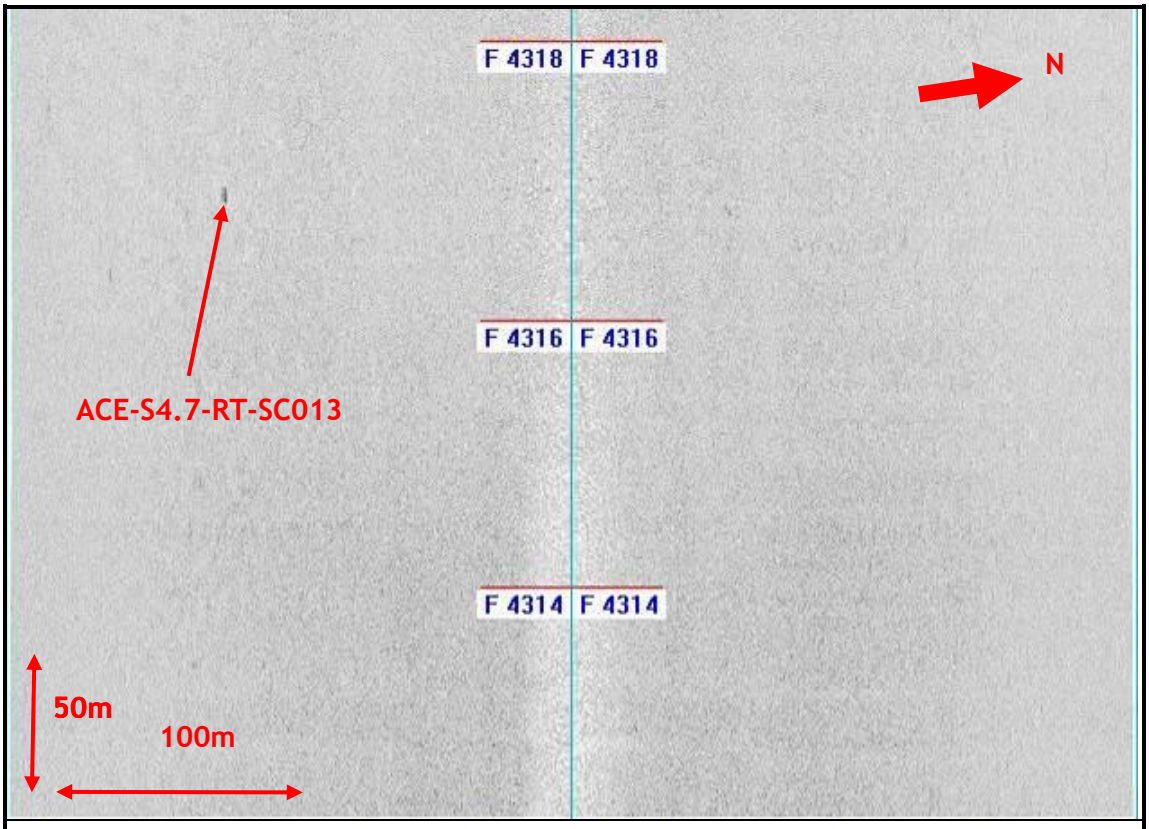

Figure 19: Rectified SSS image showing sonar contact around KP1407.8

33°50.762'S, 17°49.279'E (KP1422.0) in 228m WD to 33°46.626'S, 18°0.399'E (KP1441.4) in 164m WD

In this section the route traverses on a gentle seabed to the east-northeast. It alters course northerly to better pass an IS cable and resumes to east-northeast thereafter. The seabed terrain shoals eastwards and the bathymetry example can be found in **Figure 20**. The route along RPL *Opt3_12-MAY-2016 apparently* diverts to the south-southeast at 33°49.304'S, 17°55.012'E (KP1431.3) in 180m WD.

The route continues on the flat seabed with the shallow geology comprising of <1m of loose to dense silty SAND over very dense to partially cemented silty SAND as confirmed with CPTs (CP025, CP025a, CP024 and CP024a). The seabed is basically flat with occasional depressions (diameter: <10m, depth: <1m). A SSS example is shown in **Figure 21**. The surficial sediment gradually changes to loose to medium dense slightly gravelly silty SAND with locally dense to very dense SAND after 33°49.330'S, 17°54.905'E (KP1431.1) in 180m WD. A SBP example can be found in **Figure 22**. All the CPT tests (CP019, CP019a, CP020, CP020a, CP021 and CP021a) penetrated over 1m; locally layers of dense to very dense SAND are within target burial depth.

Shallow HARDGROUND are predominant in the whole section. Apart from that in total of seven (7) sonar contacts attributed to debris are identified. One example is shown in **Figure 21**. An in-service cable SAT3 S1 (as-found by magnetometer) is crossed by the route along RPL *Opt2_12-MAY-2016* at 33°47.168'S, 18°0.052'E (KP1440.3) in 166m WD. The following marine boundaries are crossed by the route:

- Exits the Submarine Cable Area (Anchorage and Fishing Prohibited) at 33°50.343'S, 17°50.857'E (KP1424.6) in 212m WD
- Exit Oil Concession Block 05 06-ANADARKO and enter Oil Concession Block 3318C-RHINO at 33°47.798'S, 17°59.584'E (KP1438.9) in 168m WD (OCB boundary in the figure below)

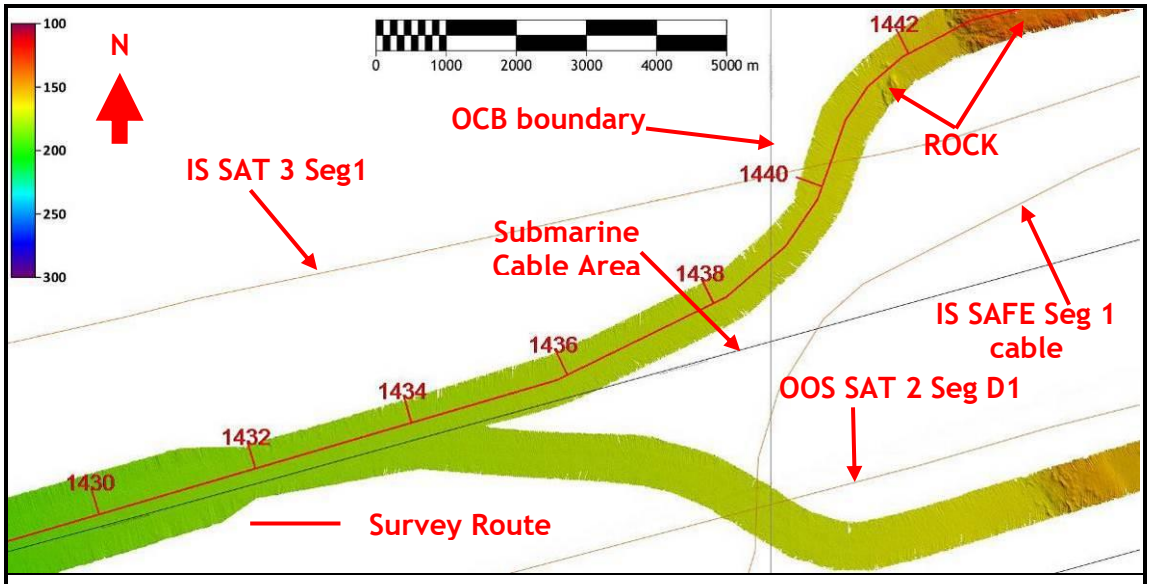

Figure 20: Sun illuminated bathy data example between KP1429 and KP1442

NB: 2km between KP flags, vertical exaggeration x5

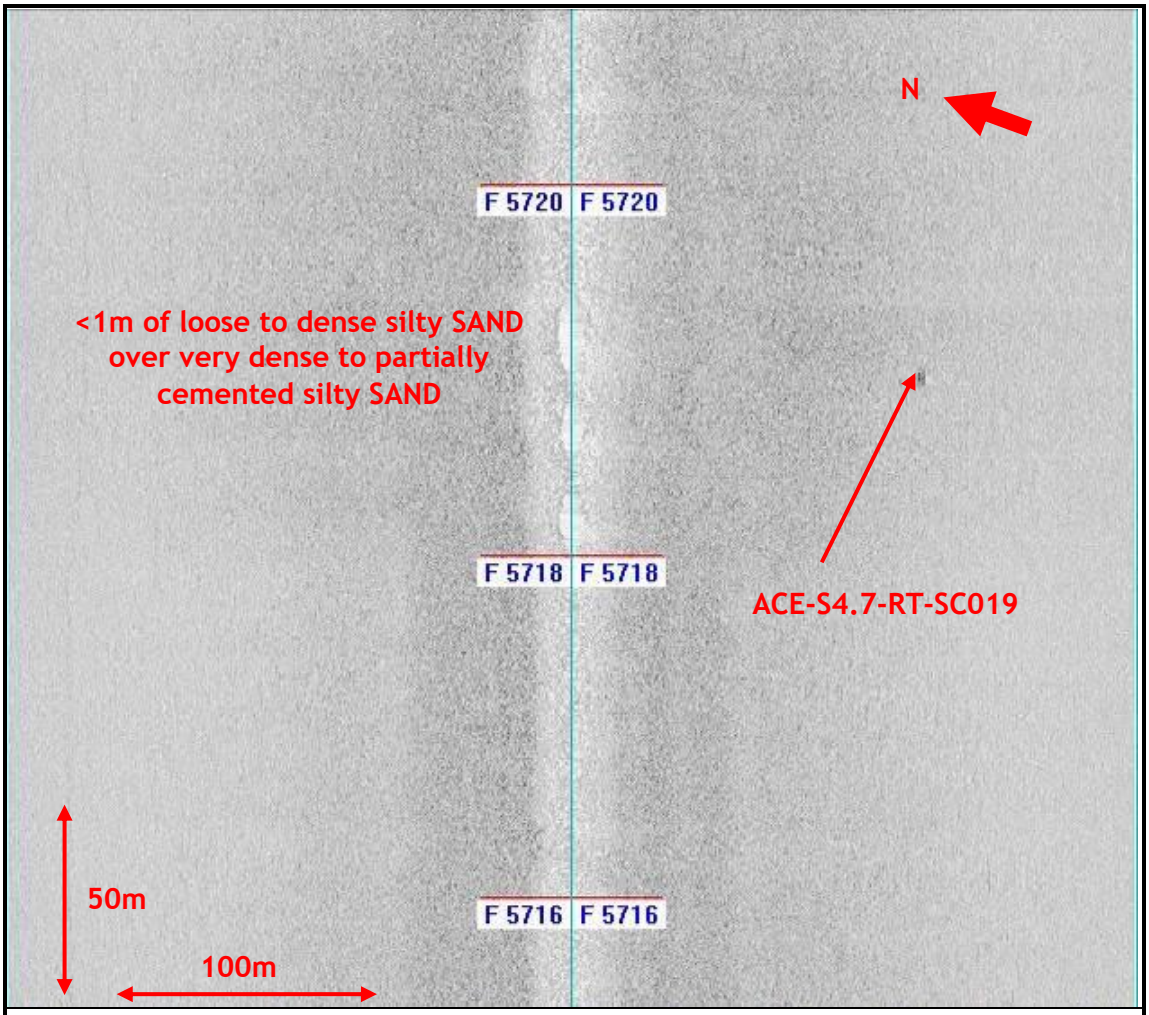

Figure 21: Rectified SSS image around KP1427.2

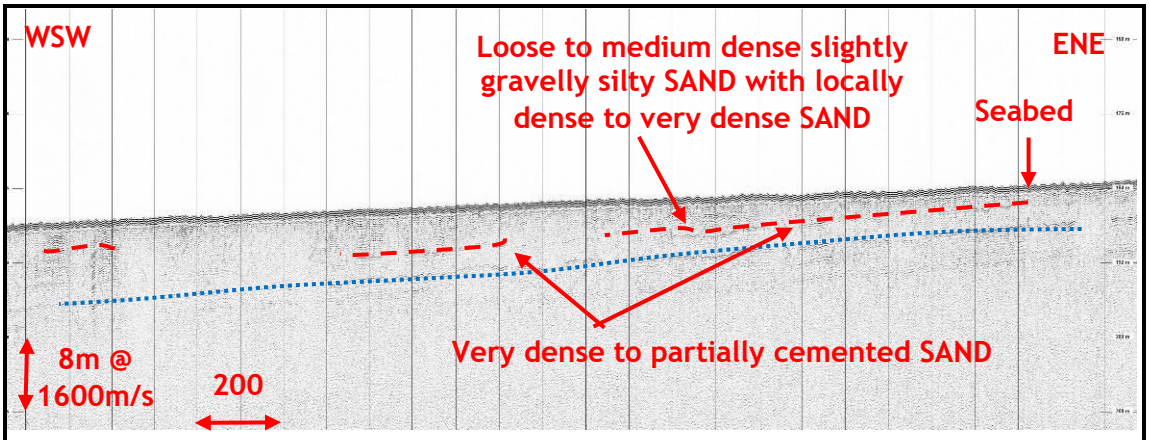

Figure 22: SBP data example along the survey centreline from KP1431.0 to KP1433.3

33°46.626'S, 18°0.399'E (KP1441.4) in 164m WD to 33°42.155'S, 18°24.742'E (KP1480.1) in 17m WD

The route traverses to the east-northeast on an undulated seabed with moderate to very steep slope gradients due to the presence of low to high relief ROCK. The bathymetry data can be found in **Figure 23** and **Figure 24**. The route along RPL *Opt3_12-MAY-2016* runs in parallel with the main route in the south.

At the beginning of this section, the seabed terrain is dominated by low to high relief ROCK with intermittent sediment pockets. The seabed feature examples can be found in **Figure 25** and **Figure 26.** The seabed samplings (GC006, GC006a, GC007 and CG007a) show the sediments are mainly composed of silty SAND with GRAVEL fraction, except GC008 and CG008a which recovered sandy SILT with gravel fraction. The intermittent sediment sections have various thicknesses, from veneer to over burial depth of 1m. A SBP example can be seen in **Figure 27**. The CPT results performed on the sediments reveal the seabed comprises mainly loose to dense silty SAND over very dense to partially cemented SAND. Some gravelly sandy SILT over ROCK is mapped just around KP1447. To the eastern part of this section, after 33°42.219'S, 18°24.417'E (KP1479.6) in 19m WD, the seabed is characterised with thick silty SAND and SAND with considerable strengths. ROCK feature nearly fades out, though outcrop locally; a SBP example there is shown in **Figure 30**.

Besides the HARDGROUND character of the shallow sediments and the presence of ROCK, some depressions with depth <1m were observed during the survey. Two detailed examples can be found in **Figure 28** and **Figure 29**. They are probably related to shallow sediment failure or scouring and cautions are required during cable installations around these areas. The route crosses some marine boundaries and cables in this section and they are abstracted below:

- Exit South Africa CZ and enter South Africa TS at 33°45.926'S, 18°2.620'E (KP1445.2) in 135m WD
- Cross Traffic Zone between the33°44.770'S, 18°9.823'E (KP1456.5) in 117m WD (shown in RPL) and 33°43.791'S, 18°14.778'E (KP1464.4) in 85m WD
- Cross with several OOS cables and details can be found in **Section 6.1**.

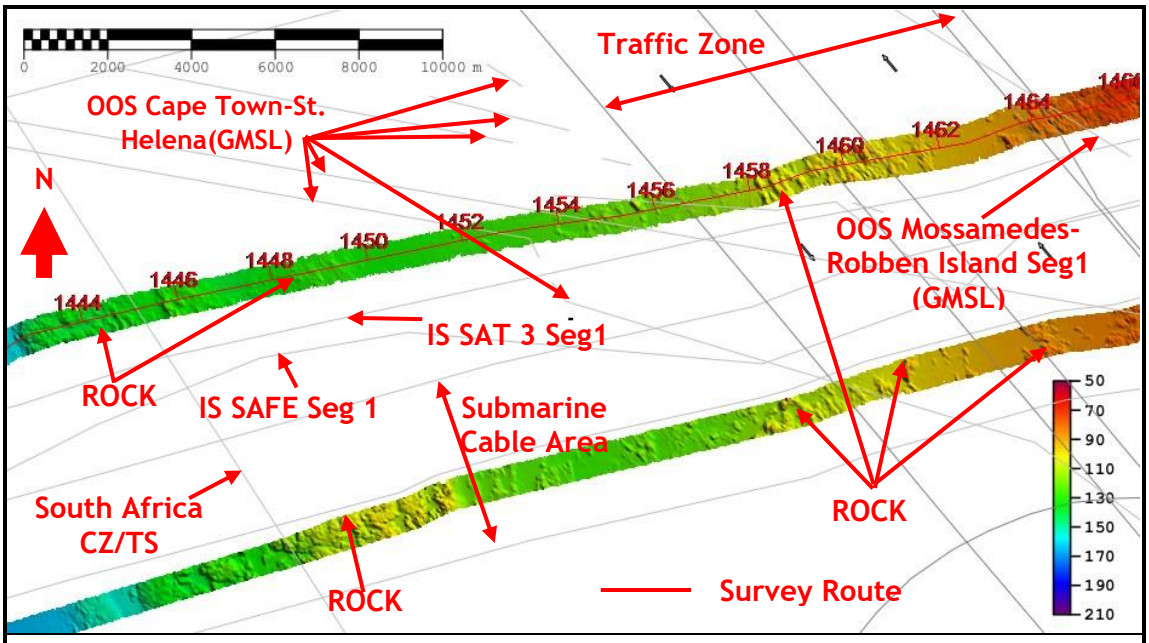

Figure 23: Sun illuminated bathy data example between KP1443 and KP1466

NB: 2km between KP flags, vertical exaggeration x10

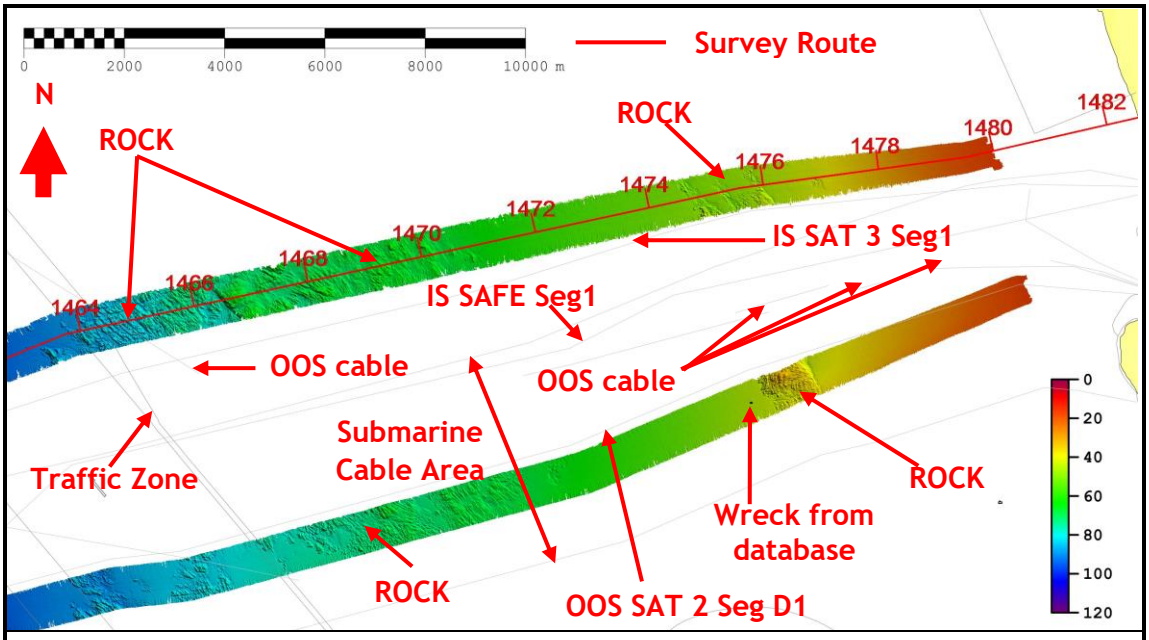

Figure 24: Sun illuminated bathy data example between KP1466 and KP1480

NB: 2km between KP flags, vertical exaggeration x10

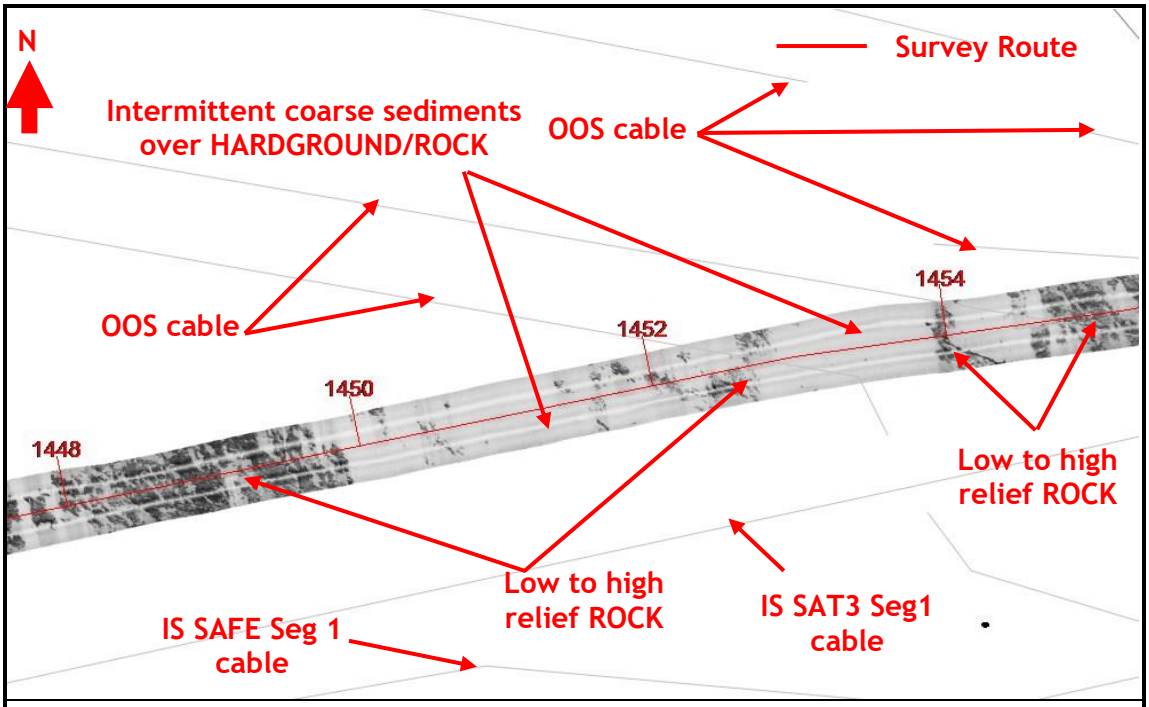

Figure 25: SSS mosaic image showing ROCK and intermittent coarse sediment from KP1448 to KP1455

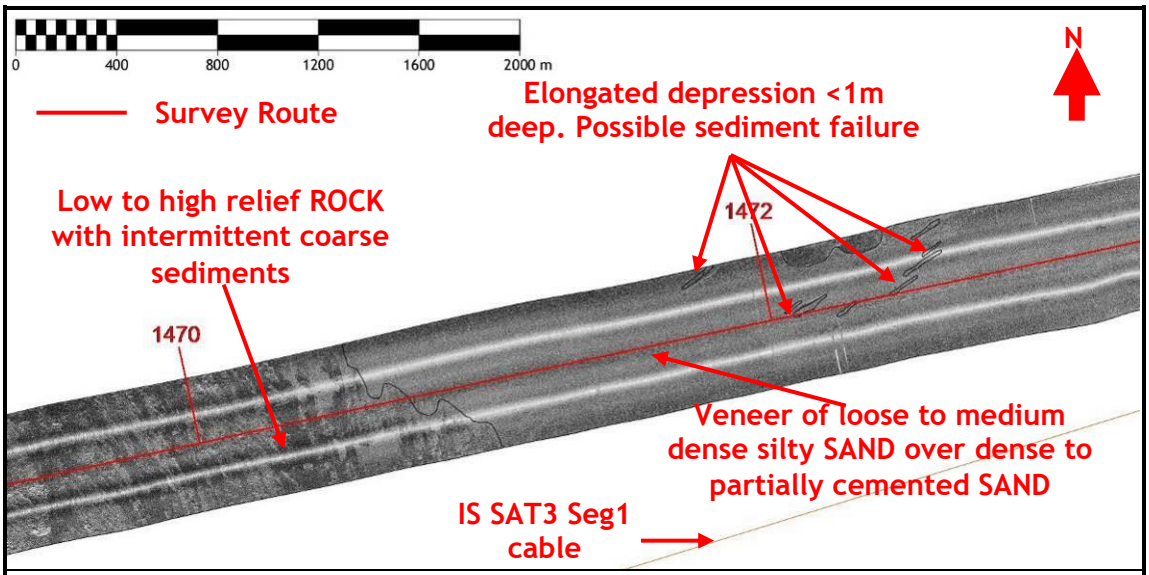

Figure 26: SSS mosaic image showing ROCK and coarse sediment between KP1470 to KP1473

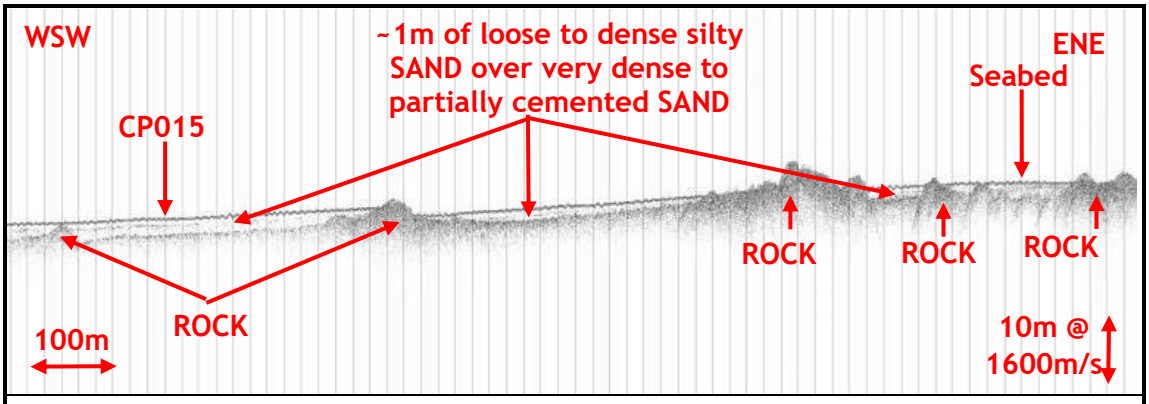

Figure 27: SBP data example along the survey centreline from KP1453.0 to KP1455.8

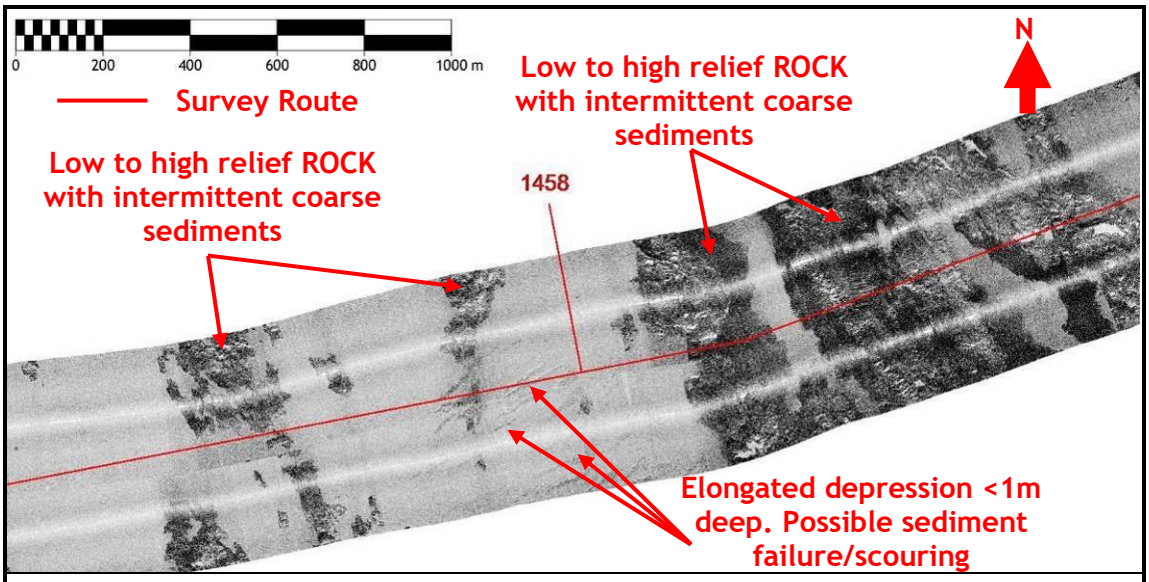

Figure 28: SSS mosaic showing seabed features around KP1457 to KP1459

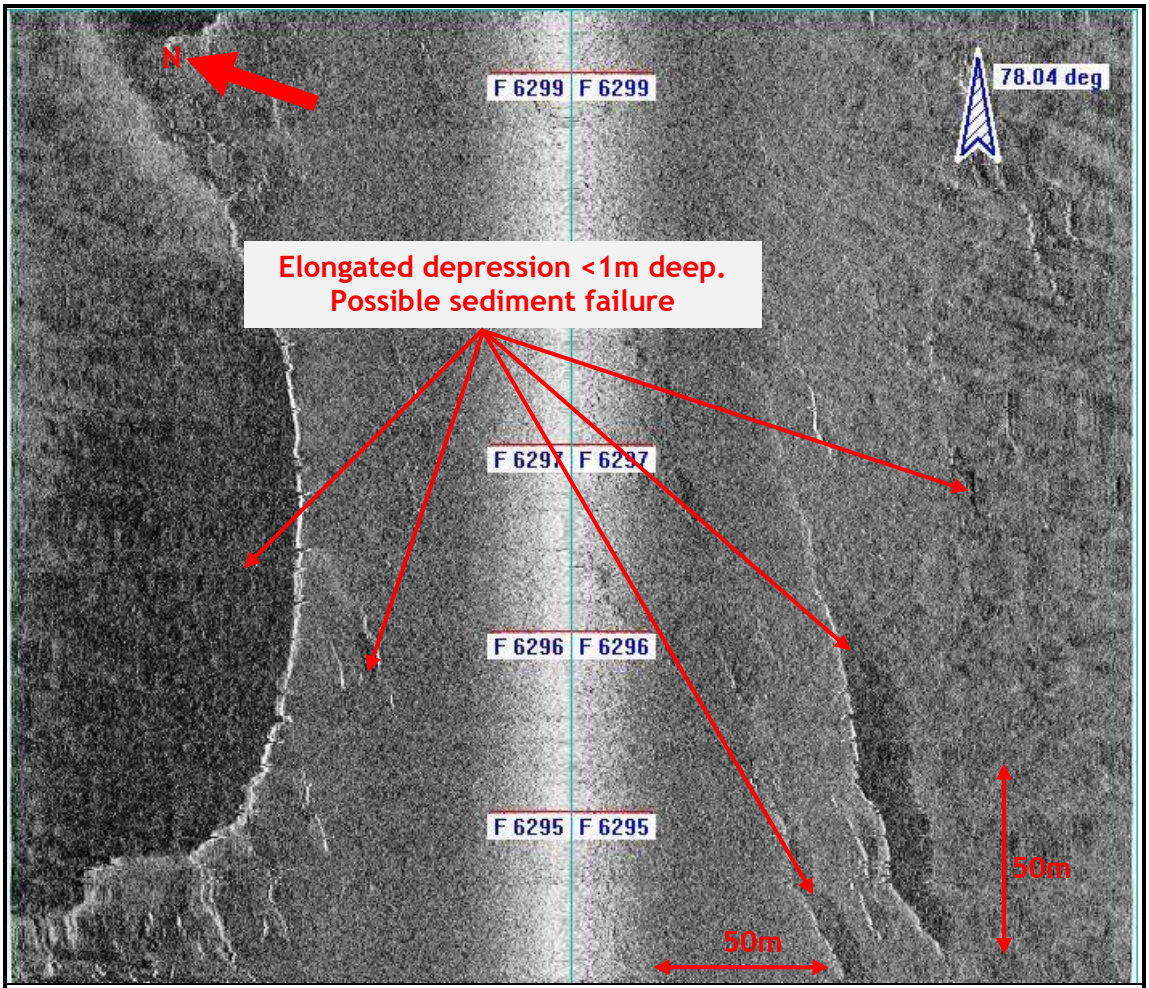

Figure 29: Rectified SSS image around KP1472.2

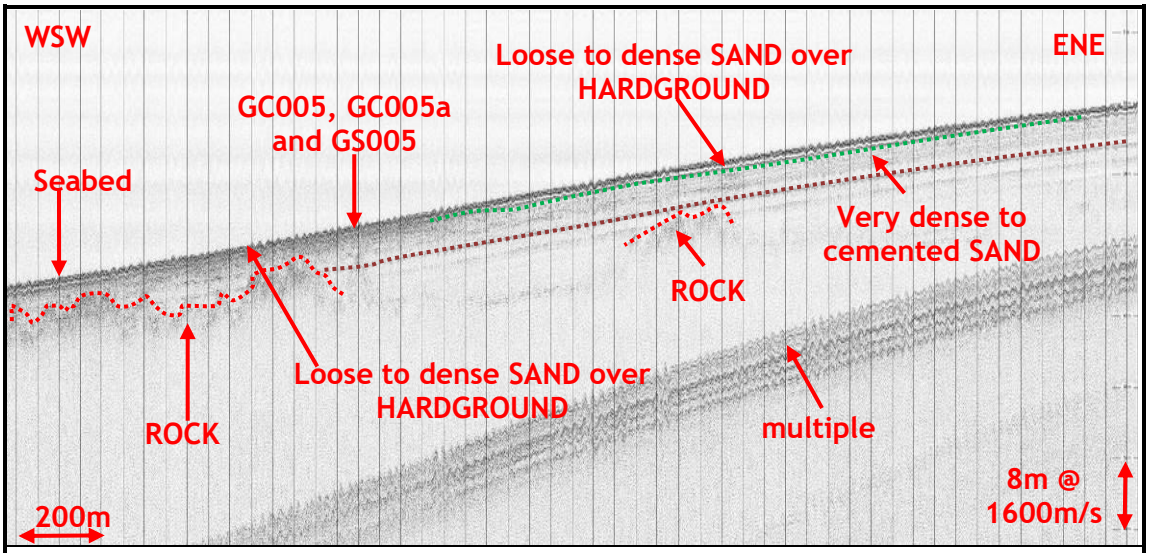

Figure 30: SBP data example along the survey centreline from KP1477.3 to KP1479.6

4.4 Inshore and Landfall survey

From end of inshore survey at 33°42.245'S, 18°24.199'E in 21m WD to the BMH01 and BMH01A

This section of the report covers survey results for bathymetry, seafloor morphology, shallow geology, seabed feature, diver swim survey, magnetometer survey and topographic survey results mainly along the route following the RPL *Opt2_24-FEB-2016* to BMH01 and following the option route to BMH01A.

The landfall and inshore surveys comprises a topographic survey, a land magnetometer survey, a diver swim survey and an inshore marine survey which were conducted between 26th April and 19th May 2016 following the RPL *Opt2_24-FEB-2016* and the option route to BMH01A. The survey corridor is 500m wide for the inshore and 750m along the beach extending over 250m behind the Melkbosstrand BMH. This section of report text is extracted from the landfall survey report showing the survey results. The full landfall survey report is provided in Appendix F.

The table below summarises the operations performed within this section of survey.

SSS contact	MAG contact	BP	DP	DS	GS
0	0	13	6	0	11

4.4.1 Samples

Verbal diver descriptions of the seabed have been noted with diver probes performed. The seabed is characterised by fine sand and no presence of obstructions for a 10m wide corridor on both the routes.

For the grab sampling, locations were selected to ground truth the seabed to assist with the primary interpretation of the geophysical survey. These locations also factored route engineering concerns whenever possible.

Full logs of these samples are provided in Appendix B3.

4.4.2 CPTs

No CPT tests were performed during the inshore survey but two offshore CPTs (CP010 and CP010a) are located within the inshore area.

Six (6) air lance probes were taken during the diver swim survey; thirteen (13) beach probes have been undertaken with an SPT (Standard Penetration Test) to assess the trenchability of the land to the BMH.

Details can be found in Appendix B3.

4.4.3 Sonar Contacts

No sonar contacts were identified in the inshore marine survey.

4.4.4 Magnetometer Contacts

Several tens of marine magnetometer survey lines were run perpendicular to the route in the survey corridor. No reliable magnetic targets were detected.

Land magnetometer survey was also conducted to detect any buried obstructions in the adjacent to the survey route. Some anomalies due to the presence of houses, cars, street lights were observed with no other relevant anomalies detected.

4.4.5 Route Description

4.4.5.1 Inshore Marine Survey

The inshore survey starts at 33°42.245'S, 18°24.199'E in 21m WD until ~3m WD to the east and the survey coverage has been detailed previously in **Figure 2**. The seabed is flat, shoaling very gently to the east-northeast with a mean slope gradient of ~0.3°. The bathymetry data can be found in **Figure 31**. The KP values below are based on RPL *Opt2_24-FEB-2016* and the option route to BMH01A.

The whole surveyed area is characterised by the presence of medium backscatter sediment (**Figure 32**). The grab samples collected show the presence of a non-cohesive very fine SAND. The SBP example is shown in **Figure 33**. It is characterised by the constant presence of a shallow reflector with a thickness between 3.0-3.5 m in deep water and 1.0 m decreasing towards the shore line. The CPT results (CP010 and CP010a) performed in the inshore/offshore overlapping area by the *RV RT* during the offshore survey proved that the shallow geology comprises <1m of loose to dense SAND over very dense to partially cemented SAND. The deeper reflector, with a depth from 4.0m to 1.0m (from the seabed) between about KP1486 and about KP1487 shows the difference of acoustic impedance between a shallow dense sand and a thin layer of about 10cm of cemented sand, which was detected from the 13 beach probes during the land survey at a constant depth of 1.0m. The sediment in deeper should be harder to cemented, due to the regressive event when the paleo beach was exposed to the atmospheric agent.

Near the coast, an area with megaripples (wavelength: 2-5m, height: 0.2m) orientating WSW-ENE, was detected between KP1486.400 and KP1486.787. Then the seabed terrain is characterised by two sand bars (**Figure 34**). The one in about 2m WD shows a height of about 1m and a slope of about 1.2°; the other one in about 5m WD reaches a height of about 0.90m and a slope of about 0.80°. In front of the first sand bar, at about 1.5m WD the principal route crosses an area with irregular morphology due to the presence of particular structures with heights of about 15-20cm. These structures could be the effect of the turbulence of the water current. Another area with similar structure is present in the north side of the corridor.

No sonar contacts were detected throughout the surveyed area and the seabed along both routes appears to be relatively homogeneous, with no evidence of obstacles.

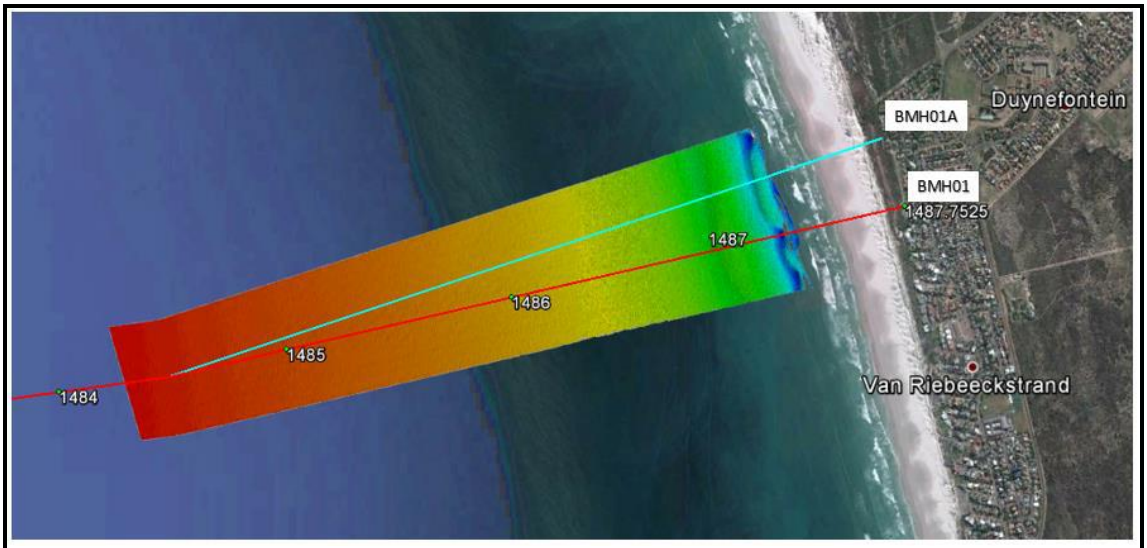

Figure 31: DTM overview (red line: survey route; cyan line: optional route)

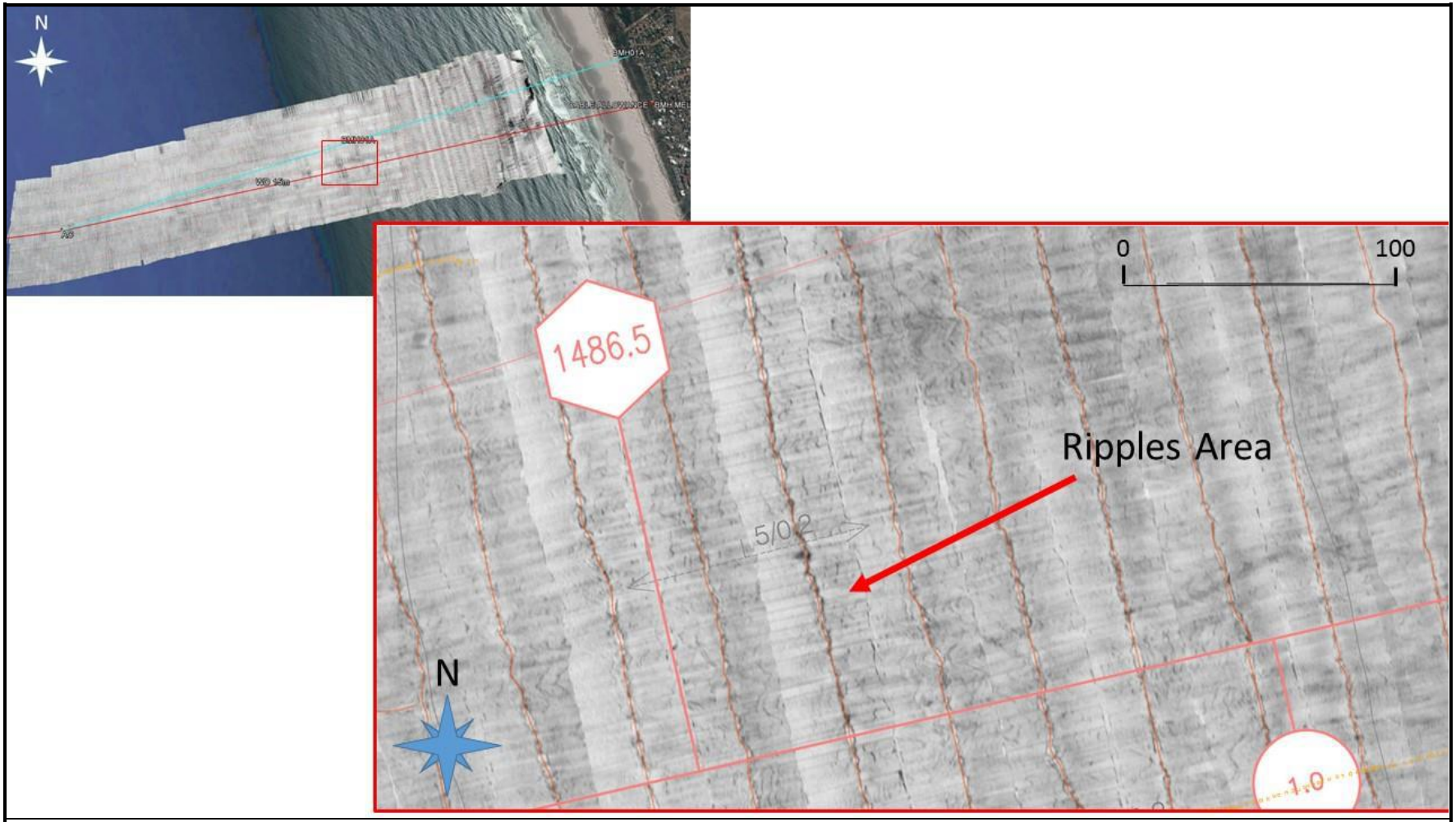

Figure 32: SSS mosaic detail - ripple area (wavelength 5.0m, high about 0.2m)

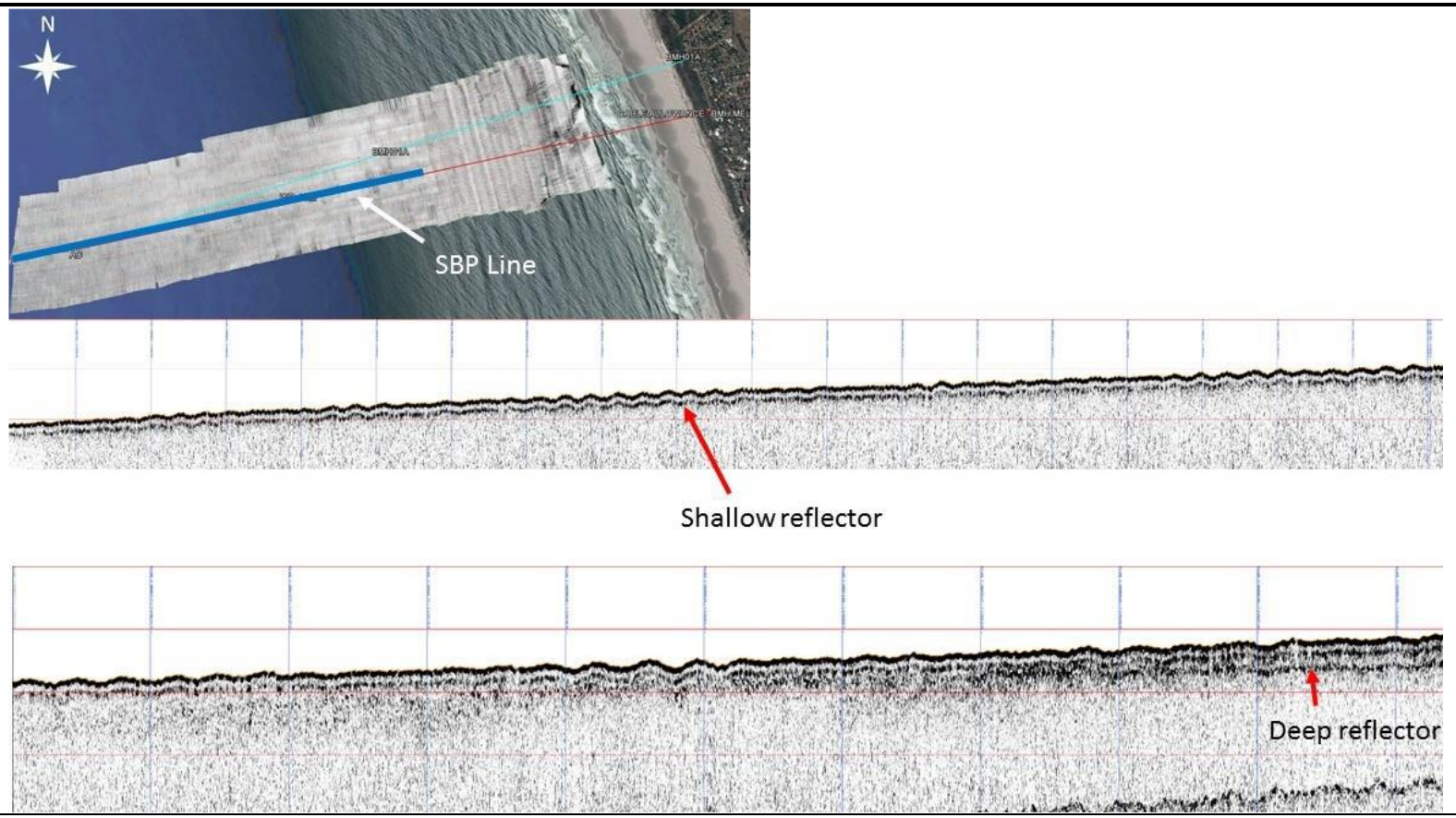

Figure 33: SBP example along survey central line

(red line: route for BMH1; Cyan line: route for BMH1A, blue line SBP Section)

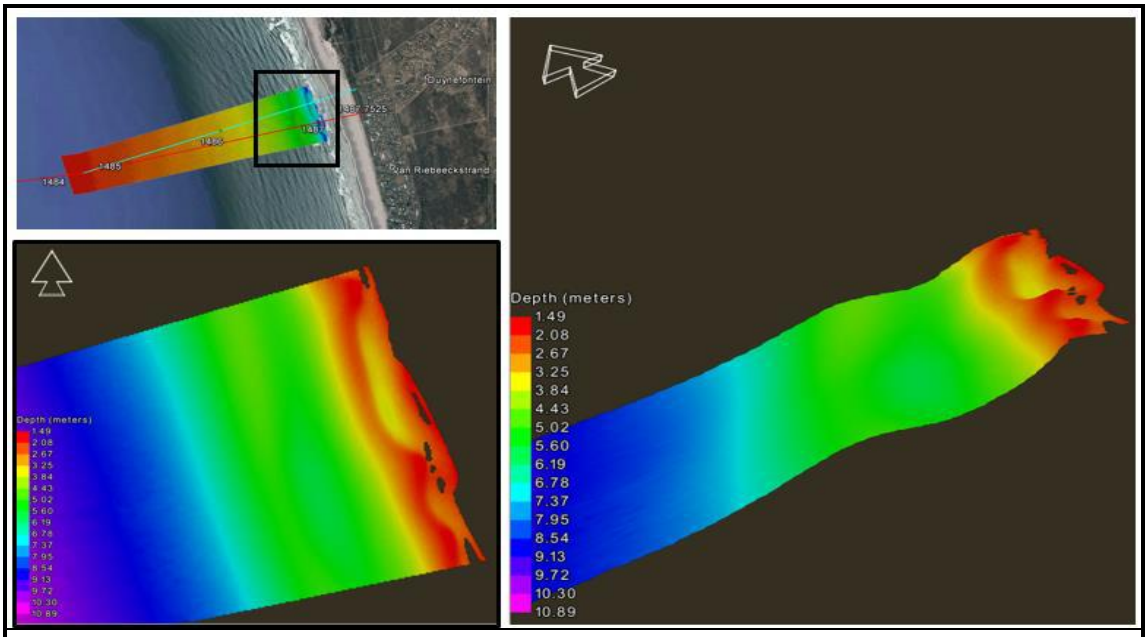

Figure 34: Detail of sand bars toward the coast.

4.4.5.2 Diver Swim Survey

The diver survey has been carried out on the 17th - 18th May and 25th May to determine the nature of the seabed and to identify any obstruction along the proposed cable route, in the shore area which cannot be reached by the vessel (about 1m WD) for about 180m seawards. See **Figure 35**.

A video survey has been performed but it was impossible to use because of the poor visibility in the water, in particular due to the presence of currents from north that created turbulence and contributed to particles suspension and sand movements.

Verbal diver descriptions of the seabed have been noted. The seabed is characterised by fine sand and no presence of obstructions for a 10m wide corridor on both the routes. In total of six (6) air lance probes were taken with the first two (ACE-S4.7-DS-DP001 and ACE-S4.7-DS-DP002) penetrate about 1m and the rest four with penetrations of over 2m.

For details of the probe results please refer to Appendix B3.

Figure 35: Diver operations

4.4.5.3 Beach Manhole and Landing Site at Melkbosstrand

The whole beach is characterised by the presence of very fine sand. The penetration was about 2.0m for all the beach probes. For the probes in proximity of the shore line a thin (0.1m) layer of cemented sand was approved.

The land magnetic survey has also been carried out with no obvious obstruction detected along the route.

Land topographic survey was conducted at Melkbosstrand with a corridor of 750m wide from limit of topographic survey near the low water mark to the Beach Manhole (BMH01 and BMH01A) and their surrounding areas.

The BMH01 was surveyed at:

Latitude:	33° 41.8260' S
Longitude:	018° 26.4500' E
Level:	6.15m (above LAT)

The BMH01A was surveyed at:

Latitude:	33° 41.6668' S
Longitude:	018° 26.3863' E
Level:	5.50m (above LAT)

Figure 36 below shows the environment of the two BMHs. Easily accessible from the road, located in a residential neighborhood, the proposed BMH01 location is about 95m from the beach crossing dunes and a swampy area approximately 200m from the high water mark (HWM). See **Figure 37**. There is no shelter from the weather – this site would prove extremely challenging from an installation point of view.

The BMH01A is located 300m north from the BMH01, 1.9km south of the Koeberg Nuclear Power Station. Rain drainage ditch and pipe were observed near the BMH01A during the survey time. Site conditions can be found in **Figure 38** and **Figure 39**.

Figure 36: Site view for Melkbosstrand BMHs and landing point

(Google Earth Imagery Is From February 2016)

Figure 37: BMH01 area

Figure 38: Pathway overview of BMH01A

Figure 39: Drainage ditch in proximity of BMH01A

4.5 Additional Offshore Shallow Water Survey (RPL *Opt3_12-MAY-2016*)

From the pinch point at 33°49.304'S, 17°55.012'E (KP1431.3) in 180m WD to southern end of offshore survey at 33°43.450'S, 18°25.061'E (KP1479.7) in 17m WD

This section of the report covers survey results for bathymetry, seafloor morphology, shallow geology and seabed feature along the route following the RPL *Opt3_12-MAY-2016*.

The following table summarises the results of the operation performed within this survey area.

SSS contact	MAG contacts	GC	GS	MCPT	DP	DS
0	0	8	4	19	-	-

4.5.1 Samples

A nominal spacing of 10km was used as a basis for establishing the seabed sampling program. Locations were selected to ground truth the seabed to assist with the primary interpretation of the geophysical survey. These locations also factored route engineering concerns whenever possible.

In total eight (8) attempts of gravity coring were acquired at four (4) locations. Four (4) grab samples were conducted in lieu of four unsuccessful recoveries of gravity core. For more details please refer to Appendix B2.

4.5.2 CPTs

A nominal spacing of 4km was used as a basis for establishing the seabed geotechnical sampling program. Locations were selected to ground truth the seabed to assist with the primary interpretation of the geophysical survey. These locations also factored route engineering concerns whenever possible.

A total of nineteen (19) attempt of CPT was acquired at eleven (11) locations. For more details please refer to Appendix C.

4.5.3 Sonar Contacts

Sonar contacts are identified as any anomalous target on the seabed and are not confidently attributed to a natural phenomenon. An interpretation was assigned to the target with the detail of that description being a function of how well the target was resolved and the characteristics observed.

No sonar contacts were identified in this section.

4.5.4 Magnetometer Contacts

Magnetic contacts are identified as any metallic objects detected by the magnetometer which is deployed close to the seabed during in-service pipeline/cable crossing survey. An interpretation was assigned to the target with the detail of the magnetic anomaly dimension and the origin whenever possible.

No magnetometer survey was conducted since the in-service cable SAFE and the OOS cable were observed on SSS.

4.5.5 Route Description

Pinch point at 33°49.304'S, 17°55.012'E (KP1431.3) in 180m WD to southern end of offshore survey at 33°43.450'S, 18°25.061'E (KP1479.7) in 17m WD

The route of Option 3 apparently diverts from the main route (Option 2) at 33°49.304'S, 17°55.012'E (KP1431.3) in 180m WD to the southeast. Then it alters course to the east-northeast and generally maintains the course until the end of this section. The seabed terrain is gentle for the first ~11km and then becomes rugged due to the presence of low to high relief ROCK outcrops with moderate to very steep slopes. Near the end this section, two areas of flat seabed with sediment are encountered. The bathymetry data can be referred to **Figure 40** to **Figure 42** below.

The route traverses on a gentle seabed with the shallow geology consisting of loose to medium dense slightly gravelly silty SAND (GC009 and GC009a), with locally dense to very dense SAND. After 33°49.121'S, 17°58.160'E (KP1436.1) in 172m WD, the underlying hard layer become more common covered with ~1m of loose to dense slightly gravelly silty SAND. A SBP example is shown in **Figure 43**. In this area, one OOS cable and one in-service cable (IS SAFE Seg 1) were found with SSS as illustrated in **Figure 44**, with the in-service cable crossing with route at 33°49.452'S, 17°59.470'E (KP1438.3) in 170m WD.

After ~6km at 33°49.406'S, 18°1.604'E (KP1441.8) in 164m WD, the route enters an area with veneer to <1m of loose to medium dense gravelly silty SAND over ROCK. Then the ROCKs expose and occupy most of the seabed to the east, interspersed with pockets of coarse sediments. See **Figure 45** and **Figure 46.** The sediment mainly consists of veneer to <1m of loose to dense silty gravelly SAND over very dense to partially cemented SAND, according to CPT results (CP001 to CP005) and the ground-truthing (GC001-GC003, GC001a-GC003a and GS001-GS003). A SBP example is shown in **Figure 47**. The prominent sections with variable thickness of coarse sediments over ROCK/very dense to partially cemented SAND are summarised below and detailed in the hazard table in the Executive Summary:

- From 33°49.224'S, 18°2.318'E (KP1442.9) in 155m WD to 33°49.163'S, 18°2.559'E (KP1443.3) in 152m WD with loose to dense silty gravelly SAND;
- From 33°46.494'S, 18°13.689'E (KP1461.2) in 95m WD to 33°46.288'S, 18°14.618'E (KP1462.7) in 89m WD with <1m of loose to dense silty gravelly SAND over HARDGROUND;
- From 33°46.041'S, 18°16.170'E (KP1465.1) in 81m WD to 33°45.858'S, 18°16.988'E (KP1466.5) in 76m WD with <1m of loose to dense silty gravelly SAND over HARDGROUND.

After 33°45.285'S, 18°19.547'E (KP1470.5) in 68m WD, the route exits the ROCK areas and enters a region with loose to medium dense silty gravelly SAND with locally dense to very dense SAND. Two sections of ROCK are encountered between 33°45.239'S, 18°19.749'E (KP1470.9) in 66m WD and 33°45.209'S, 18°19.884'E (KP1471.1) in 66m WD, and between 33°44.441'S, 18°22.141'E (KP1474.9) in 44m WD and 33°44.252'S, 18°22.692'E (KP1475.8) in 42m WD. A SBP example is shown in **Figure 48**. Before the route reach end of offshore survey, a seabed with <1m of loose to dense SAND over very dense to partially cemented SAND/HARDGROUND (confirmed with CP008, CP009

and CP009a) is mapped. And this sediment characterised the seabed until the end of this section at 33°43.456'S, 18°25.006'E (KP1479.6) in 17m WD.

The route crosses with several marine boundaries in this section, including entering an Submarine Cable Area (Anchorage and Fishing Prohibited), crosses Oil Concession Blocks' boundary, exiting South Africa CZ/entering TS, and crossing one Traffic Zone. Details can be found in **Section 6.2**.

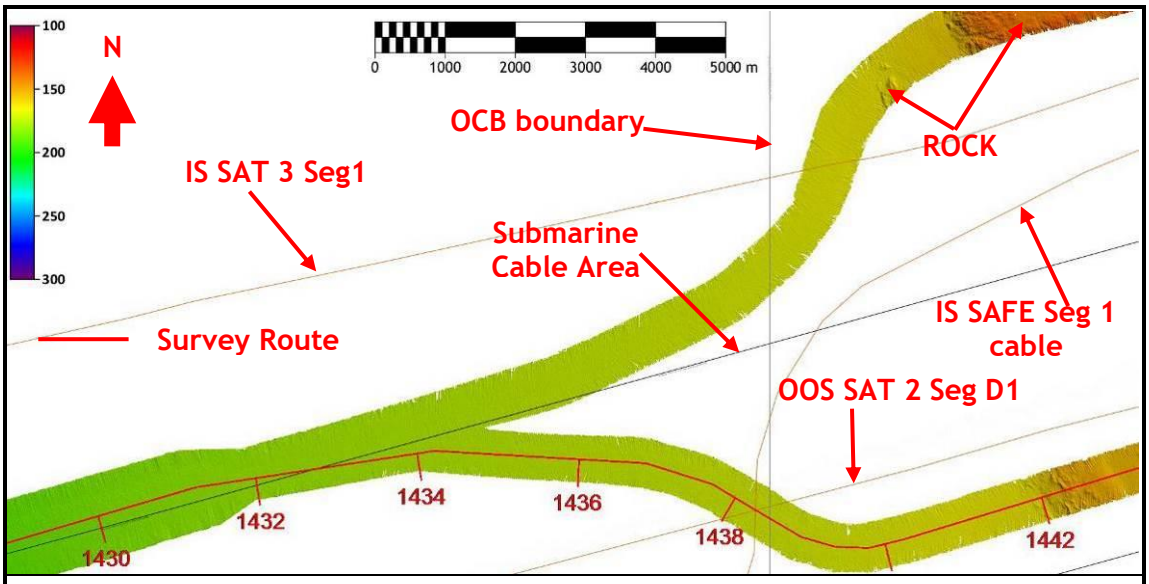

Figure 40: Sun illuminated bathy data example between KP1429 and KP1442

NB: 2km between KP flags, vertical exaggeration x5

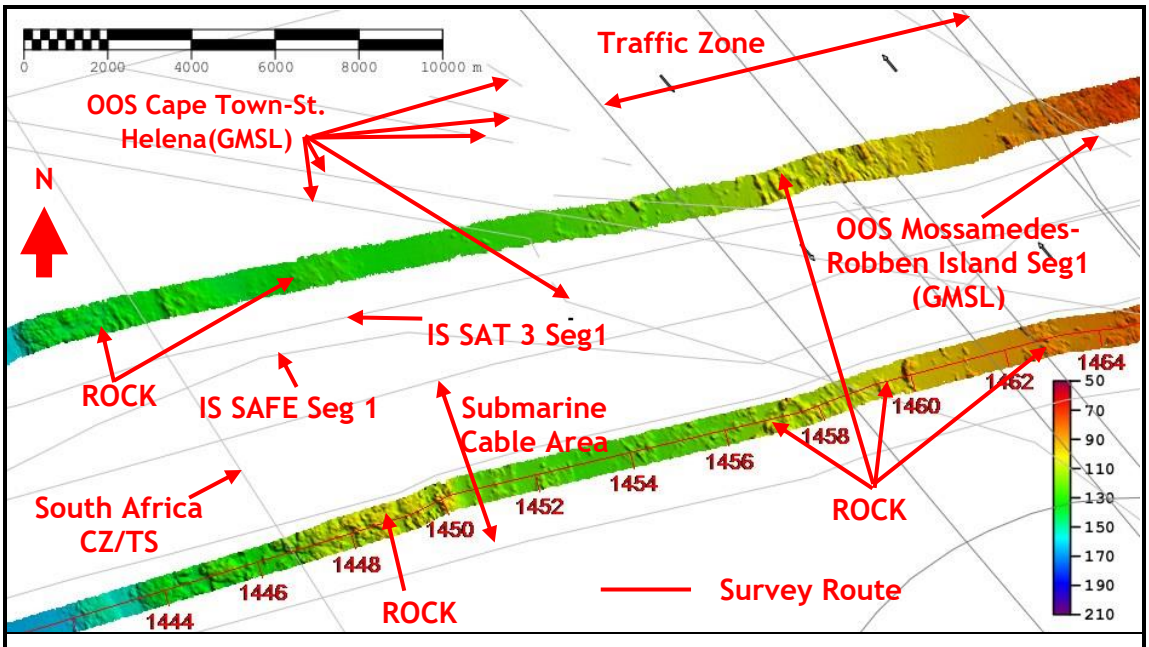

Figure 41: Sun illuminated bathy data example between KP1443 and KP1466

NB: 2km between KP flags, vertical exaggeration x10

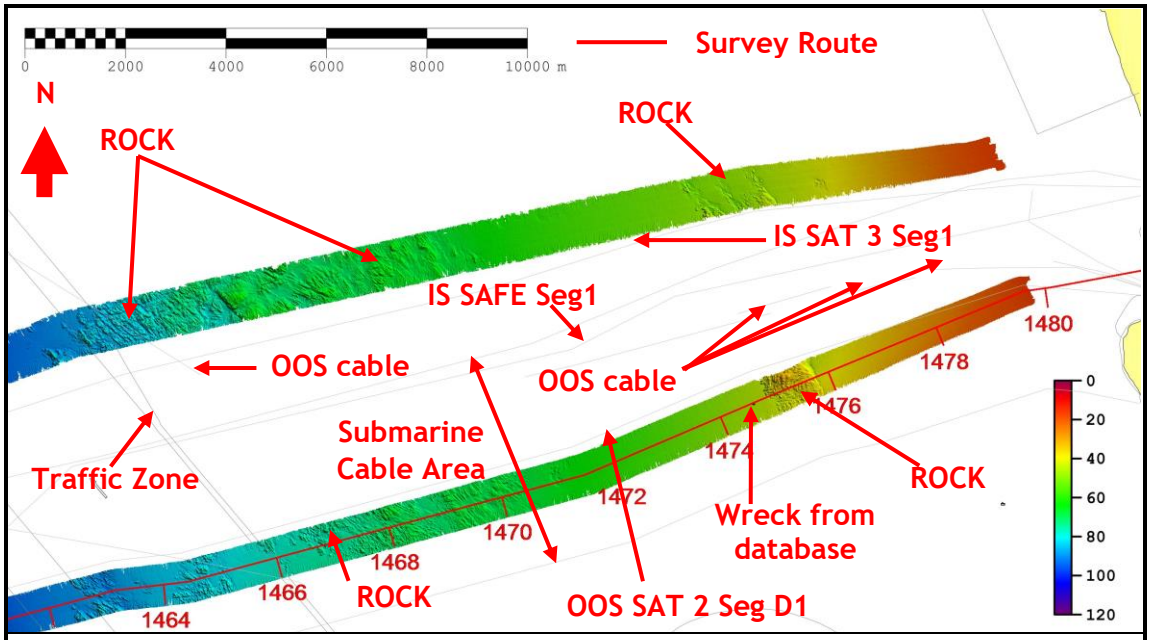

Figure 42: Sun illuminated bathy data example between KP1466 and KP1480

NB: 2km between KP flags, vertical exaggeration x10

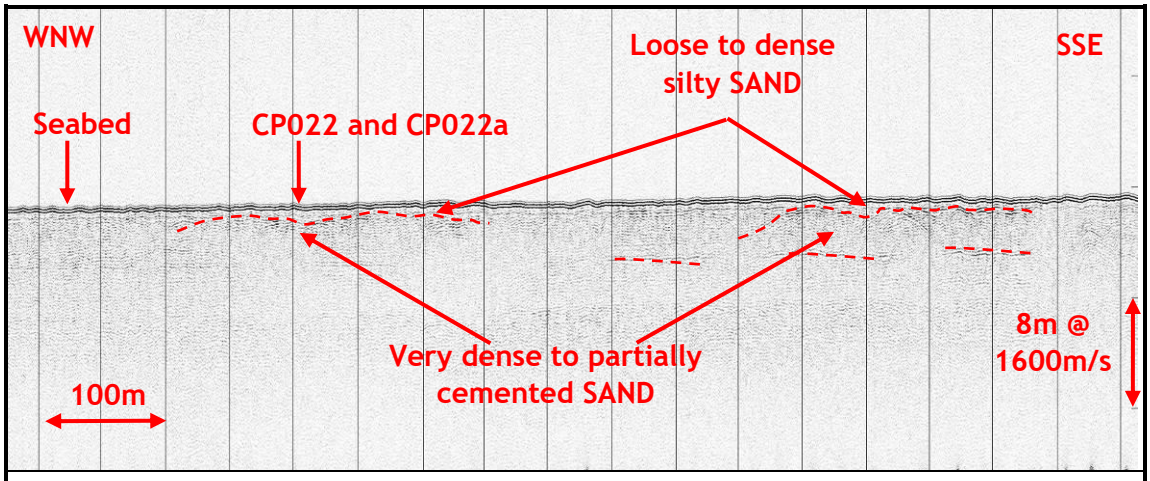

Figure 43: SBP data example along the survey centreline from KP1436.8 to KP1437.4

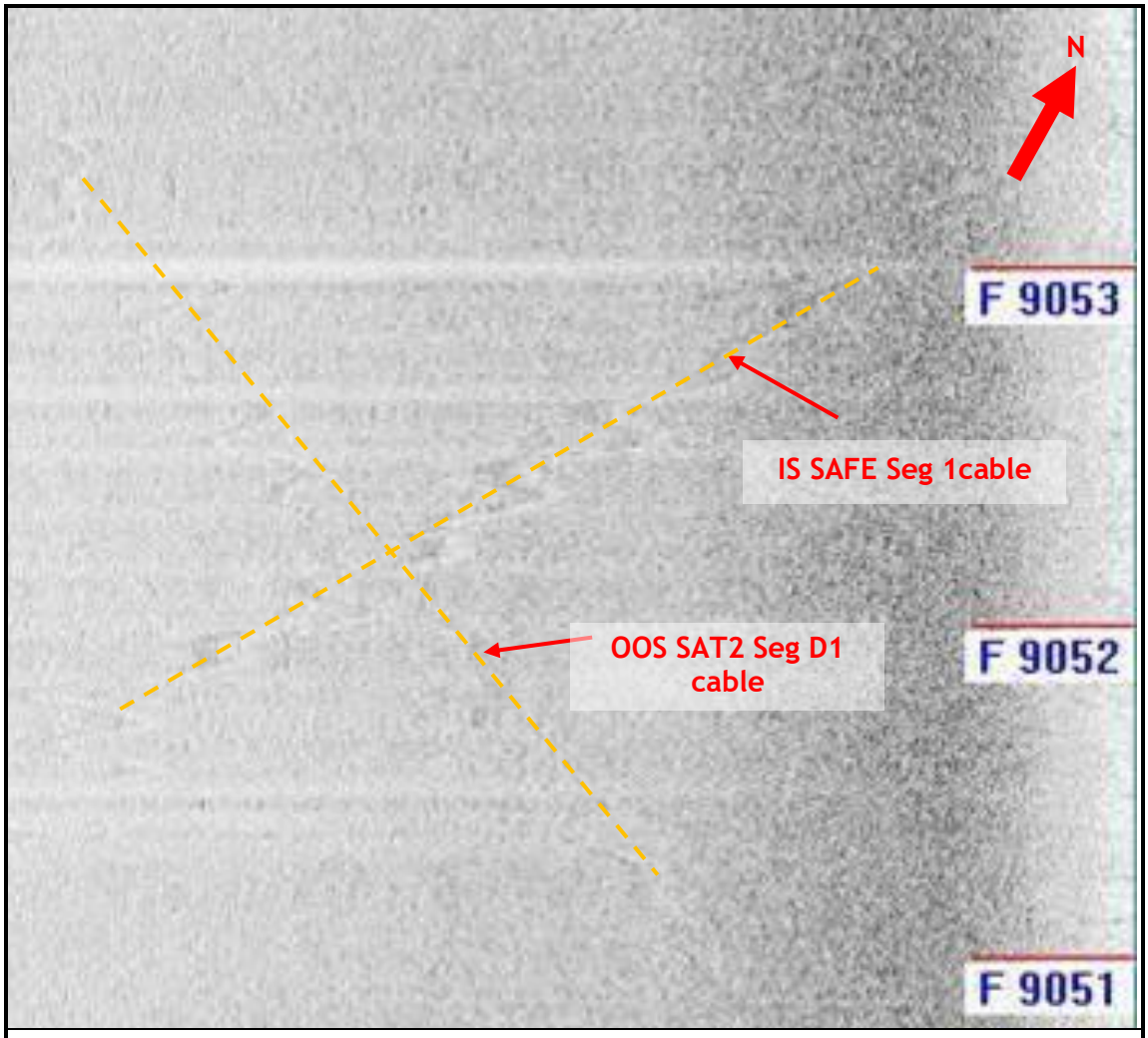

Figure 44: Rectified SSS image showing as-found cables/cable trenches

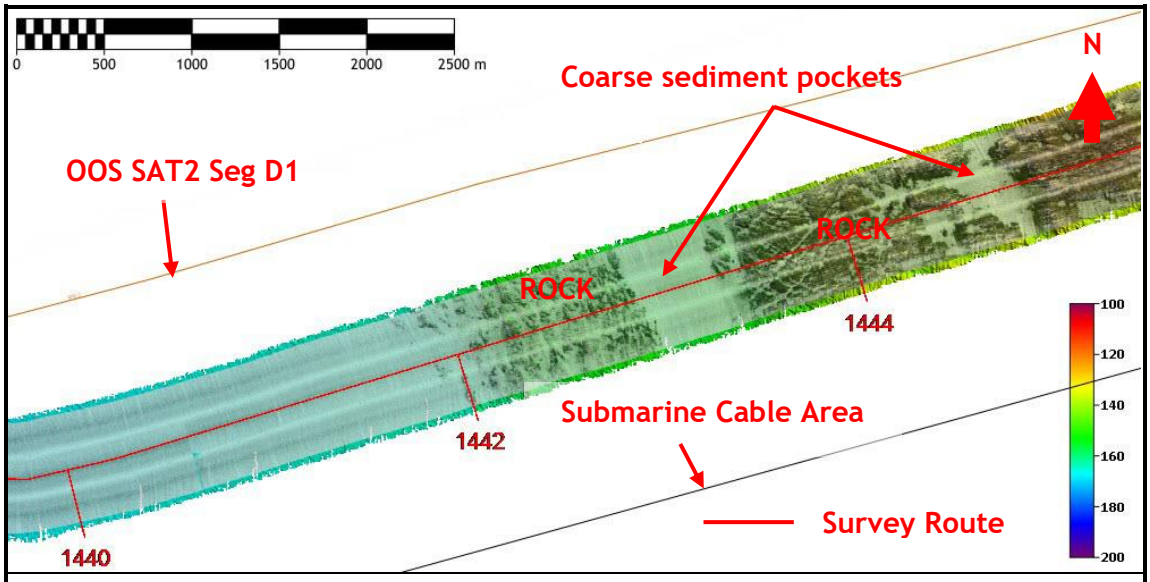

Figure 45: SSS mosaic over sun illuminated bathymetry data between KP1440 and KP1445

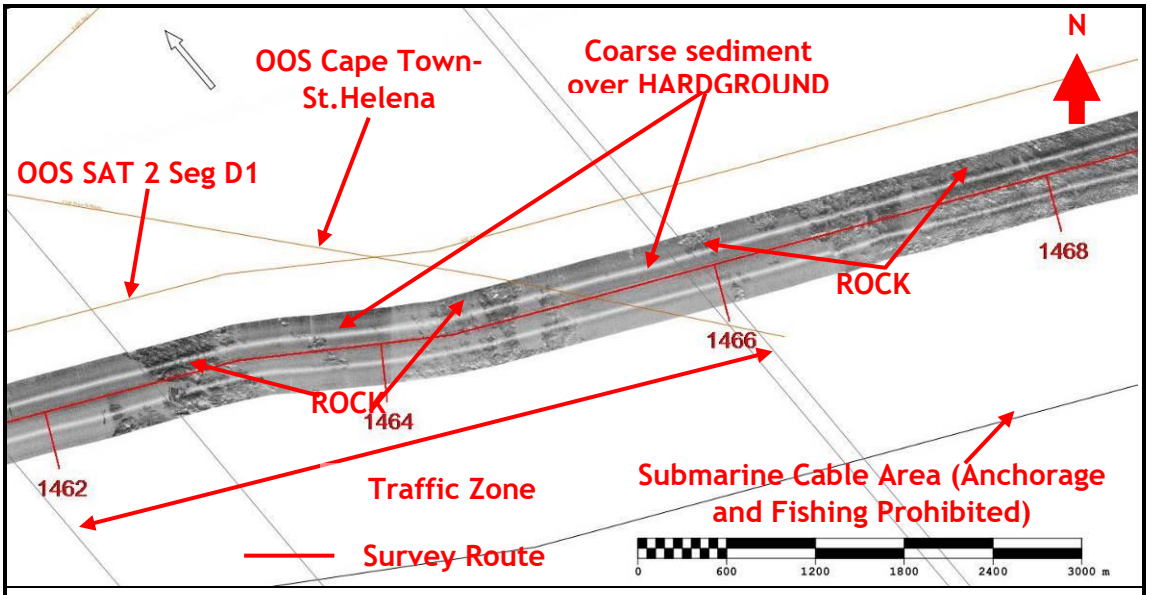

Figure 46: SSS mosaic between KP1462 and KP1468

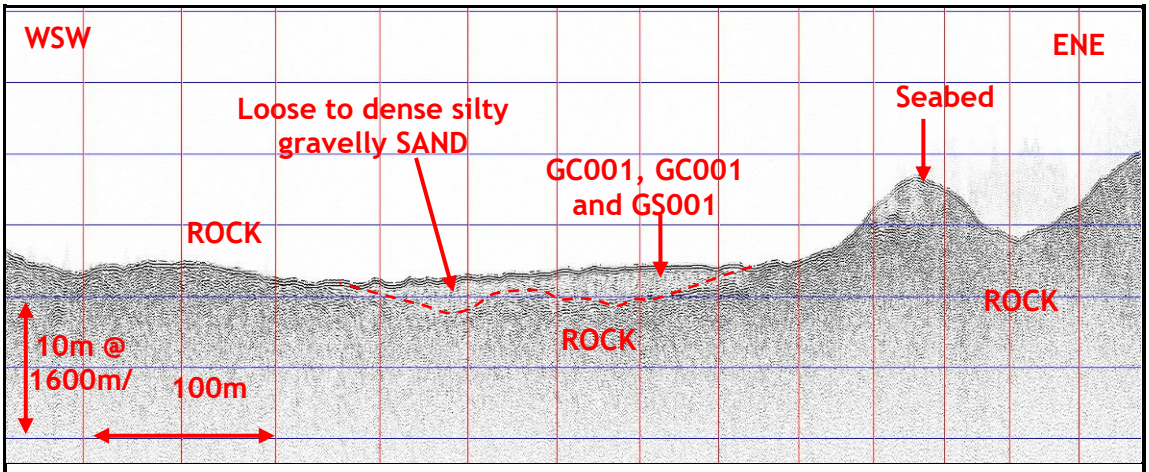

Figure 47: SBP data example along the survey centreline from KP1446.2 to KP1446.8

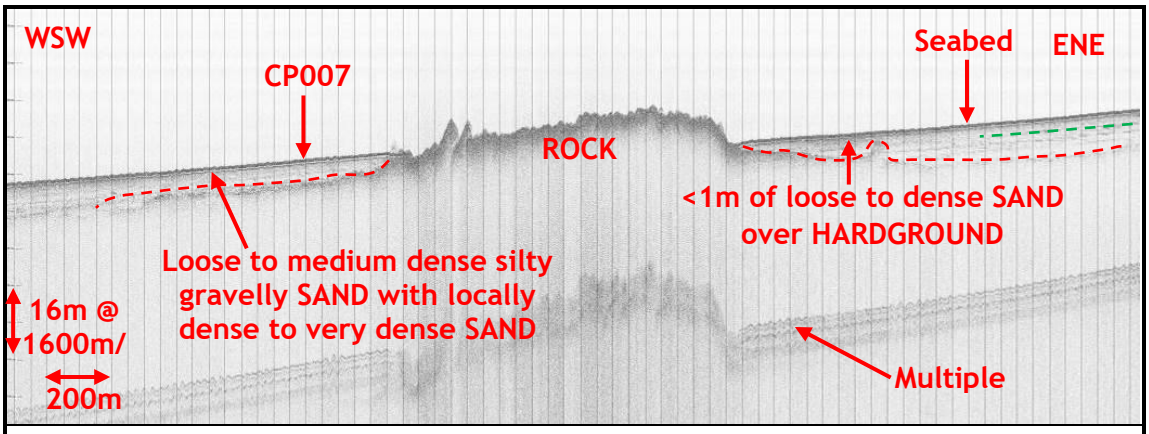

Figure 48: SBP data example along the survey centreline from KP1473.9 to KP1476.9

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5 BURIAL ASSESSMENT SURVEY (BAS)

This section of the report details the methods of data interpretation, data presentation and conclusions for Burial Assessment Survey (BAS), by geographic location and KP location. It will be attached in later revision of the report.

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6 HAZARDS AND OBSTRUCTIONS

6.1 Cable and Pipeline Crossings

The Route Option 2 crosses with an in-service cable IS SAT Seg 1 for one time and with several out-of-service cables for eight times. The Route Option 3 (KP1431.3 to KP1479.6) crosses with in-service cable SAFE Seg 1 for one time and with three out-of-service cables for three times.

In shallow water survey corridor, the in-service cables crossed are confirmed with magnetometer and SSS. One out-of-service cable was found on the SSS records. Other out-of-service are crossed based on the RPL/database but were not identified during survey.

There are no pipeline crossings along the proposed route.

Table 9 summarises the cable crossing information for ACE S4.7.

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CABLE CROSSED	STATUS	KP	Chart number	Latitude Longitude	WD (m)	CABLE ARMOUR	CROSSED CABLE ARMOUR	CROSSING ANGLE (°)	DISTANCE TO SYSTEM REPEATER (KM)	DISTANCE TO EXISTING REPEATER (KM)
Crossed by Route Option 2 from South Africa EEZ to BMH										
Cape Town-St.Helena (GMSL)	OOS	1006.234	NU016, NU017	31° 56.612' S 14° 22.801' E	3005	LW -17	NA	22°	NA	NA
SAT 2 Seg D1	OOS	1317.489	NU020, NU021	33° 55.540' S 16° 42.525' E	2794	LWP-17	NA	21°	NA	NA
SAT 2 Seg D1	OOS	1367.984	NU021, NU022	33° 56.993' S 17° 15.091' E	1532	SAL-17	NA	8°	NA	NA
SAT 3 Seg 1 (As-found by MAG)	IS	1440.294	NU031	33° 47.168' S 18° 0.052' E	166	SAL-17	NA	61°	NA	NA
CHART (only shown in RPL)	OOS	1442.220	NU031	33° 46.383' S 18° 0.804' E	160	SAL-17	NA	NA	NA	NA
Cape Town-St.Helena (GMSL)	OOS	1452.815	NU033	33° 45.084' S 18° 7.471' E	128	SAL-17	NA	22°	NA	NA
Cape Town-St.Helena (GMSL)	OOS	1454.723	NU033	33° 44.938' S 18° 8.694' E	122	SAL-17	NA	18°	NA	NA
Cape Town-St.Helena (GMSL)	OOS	1456.619	NU033	33° 44.757' S 18° 9.902' E	117	SAL-17	NA	15°	NA	NA
Mossamedes-Robben island (GMSL)	OOS	1464.668	NU034	33° 43.758' S 18° 14.957' E	81	SAL-17	NA	44°	NA	NA
Crossed by Route Option 3 from pinch point at KP1431.3 to KP1479.6										
SAFE Seg 1 (As-found by SSS)	IS	1438.295	NU031, OPT3_NU031	33° 49.452' S 17° 59.470' E	170	SAL-17	NA	60°	NA	NA
SAT 2 Seg D1(As-found by SSS)	OOS	1438.301	NU031, OPT3_NU031	33° 49.454' S 17° 59.473' E	170	SAL-17	NA	37°	NA	NA

CABLE CROSSED	STATUS	KP	Chart number	Latitude Longitude	WD (m)	CABLE ARMOUR	CROSSED CABLE ARMOUR	CROSSING ANGLE (°)	DISTANCE TO SYSTEM REPEATER (KM)	DISTANCE TO EXISTING REPEATER (KM)
Cape Town-St.Helena (GMSL)	OOS	1458.931	OPT3_NU034	33° 46.825' S 18° 12.262' E	106	SAL-17	NA	37°	NA	NA
Cape Town-St.Helena (GMSL)	OOS	1465.267	OPT3_NU035	33° 46.025' S 18° 16.244' E	80	SAL-17	NA	26°	NA	NA

Table 9: Cable crossing list

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6.2 Maritime Boundaries and Special Areas

Table 10 lists the national marine boundaries and special maritime boundaries crossed by both routes.

Name	Chart No.	KP	Latitude	Longitude
Crossed by Route Option 2 from South Africa EEZ to BMH				
Exit High Seas/Enter Namibia Exclusive Economic Zone	NU001, NU002	40.795	23° 49.908' S	10° 49.190' E
Exit Namibia EEZ/ Enter South Africa EEZ	NU014	834.020	30° 32.930' S	13° 35.162' E
Enter Firing Area	NU026	1401.253	33° 53.316' S	17° 36.185' E
Enter Submarine Cable Area (Anchorage and Fishing Prohibited)	NU027, NU028	1410.569	33° 52.277' S	17° 42.093' E
Exit South Africa EEZ /Enter South Africa CZ	NU029	1421.892	33° 50.780' S	17° 49.210' E
Exit Submarine Cable Area (Anchorage and Fishing Prohibited)	NU029	1424.558	33° 50.343' S	17° 50.857' E
Exit South Africa CZ/Enter South Africa TS	NU032	1445.165	33° 45.926' S	18° 2.620' E
Enter Traffic Zone (shown in RPL)	NU033	1456.494	33° 44.770' S	18° 9.823' E
Exit Traffic Zone	NU034	1464.385	33° 43.791' S	18° 14.778' E
Crossed by Route Option 3 from pinch point at KP1431.3 to KP1479.6				
Enter Submarine Cable Area (Anchorage and Fishing Prohibited)	NU030, OPT3_NU030	1432.732	33° 49.181' S	17° 55.961' E
Exit South Africa CZ/Enter South Africa TS	OPT3_NU032	1446.763	33° 48.620' S	18° 4.696' E
Enter Traffic Zone (shown in RPL)	OPT3_NU034	1458.484	33° 46.910' S	18° 11.991' E
Exit Traffic Zone	OPT3_NU035	1465.941	33° 45.930' S	18° 16.666' E

Table 10: Maritime boundaries and special areas

6.3 Fishing Activities

Fishing activity was low during the offshore survey operations. The sea conditions were adverse from time to time during the survey which may have been a contributing factor to reducing fishing activities in the survey area. There was no major impact on the survey operations. Shipping cargo, tankers and fishing boats were observed during the shallow water survey (**Figure 49**). No vessels were observed working nearby the inshore survey area.

Marine Activity Logs compiled from offshore bridge observations are presented as Appendix H in this report.

Figure 49: Fishing boat observed at around KP1389

6.4 Shipping

Shipping activity was low during survey. During the survey period no vessel or tourist ships were observed anchoring nearby the route. Marine Activity Logs compiled from bridge observations are presented as Appendix H in this report.

Figure 50: Tanker observed around KP1451

6.5 Anchorages

There is no anchorage area crossed by the route.

6.6 Piracy

There was no piracy incident reported during survey operations.

A piracy centre at Kuala Lumpur, Malaysia, operates a 24-hour piracy reporting and advice scheme at the following address:

ICC International Maritime Bureau
16.03A Wisma Nusantara, Jalan Punchak
50250 Kuala Lumpur, Malaysia
Tel. +60 3 2031 0014 (24 hour anti piracy help line)
Fax +60 3 2078 5769
TELEX MA 34199 Iimbpci
E-mail ccskl@imbkl.po.my or piracy@imbpiracy.org
Web site: http://icc-ccs.org/piracy-reporting-centre/live-piracy-map
The IMB is seen as a statistical body and source of information that is broadcast to shipping via Navtex.

6.7 Dumping Grounds

No evidence of systematic dumping activity was observed within the survey corridor.

6.8 Wrecks

No wrecks are located within the area of survey. One (1) charted wreck is present at 33°44.500'S, 18°22.000'E (KP1474.6) in 45m WD, ~20m southeast of the survey route of Option 3 but not identified from data record. And no other suspected wrecks in the survey corridor.

6.9 Dredging

No dredging activity was observed during the survey.

6.10 Hydrocarbon Exploitation

The main Route Option 2 crosses six (6) oil concession blocks. No active hydrocarbon exploitation was neither observed nor showed on the database within the survey corridor. **Table 11** lists the hydrocarbon concession blocks boundaries crossed by the proposed routes.

Name	Chart No.	KP	Longitude	Latitude
Crossed by Route Option 2 from South Africa EEZ to BMH				
Exit OCB 3013-OK ENERGY/Enter OCB 3113-OK ENERGY	NU015	886.723	13° 48.935' E	30° 58.855' S
Exit OCB 3113-OK ENERGY/Enter OCB ORANGE DEEP-SHELL	NU015	926.956	13° 59.491' E	31° 18.644' S
Exit OCB ORANGE DEEP-SHELL/Enter OCB 3315-	NU019	1161.561	15° 28.965' E	32° 59.155' S

Name	Chart No.	KP	Longitude	Latitude
NEW AGE				
Exit OCB 3315-NEW AGE/Enter OCB 05 06-ANADARKO	NU019; NU020	1229.804	15° 59.101' E	33° 26.000' S
Exit OCB 05 06-ANADARKO/Enter OCB 3318C-RHINO	NU031; OPT3_NU031	1438.901	17° 59.584' E	33° 47.798' S
Crossed by Route Option 3 from pinch point at KP1431.3 to KP1479.6				
Exit OCB 05 06-ANADARKO/Enter OCB 3318C-RHINO	OPT3_NU031	1438.499	17° 59.583' E	33° 49.509' S

Table 11: Hydrocarbon concession blocks

6.11 Military Activity

No military activity was observed during the survey. The route enters a Firing Area at 33°53.316'S, 17°36.185'E (KP1401.3) in 300m WD.

6.12 Navigation Restrictions

One (1) Traffic Zone is crossed by the routes of the two options. A Submarine Cable Area (Anchorage and Fishing Prohibited) zone was partially crossed by the routes. Crossing details can be found in **Section 6.2.**

No other navigation restriction was received during the survey operations.

6.13 Other Hazards

No other hazard was encountered during the survey operations.

6.14 Other Activities

No other activities were encountered during the survey operations.

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7 ENVIRONMENTAL OBSERVATIONS

Regular environmental and meteorological observations were recorded in the ship's log during the survey. These observations include temperature, sea state, ocean swell, and wind (direction and strength).

7.1 Sea Floor Temperatures

Profiles of the water temperature and the associated speed of sound were collected at regular intervals during the survey. This information is required primarily for the MBES systems, although information on seabed temperatures is also an important consideration when engineering cable systems. Profiles were generally collected at the start and end of each survey block (approximately one per day). Profiles were collected using AML-PLUS X and XBT T5 probes.

The AML-PLUS X profiler system is flexible to install several sensors, including the sound velocity sensor, temperature sensor, depth sensor, etc. These swappable sensor were normally loaded on the AML-PLUS X during the survey to measures the sound velocity, water temperature, and water pressure (depth) continuously, logging the measurements in an internal memory. Measurements are recorded throughout the water column as the equipment is lowered to close to the seabed and also as the system is being recovered back to the surface.

The XBT profiler system measures the water temperature and depth. Measurements are recorded with software "WinMK21" throughout the water column as the XBT is deployed. The speed of sound in water is calculated automatically using the Chen & Millero formula in the "WinMK21" software. Then the surface sound velocity will compared with mini sound velocity which is installed on the ship's hull. Besides that, the XBP profiler was deployed simultaneously with the AML-PLUS X profiler for several times to compare their performance and the results were in good consistence. All the velocity profiles were compared during the survey to monitor the data quality.

These observations are presented in Appendix I of this report.

Besides the conventional SVP tests, a temperature sensor was also attached on the CPT rig to measure the bottom temperature when the CPT is locating on seabed. The tests are named after the primary CPT, e.g. temperature measurement performed during ACE-S4.7-RT-CP005 and ACE-S4.7-RT-CP005a is identified as ACE-S4.7-RT-CPT-SV005.

All the acquired temperatures the maximum depths reached at each SVP location are tabulated in **Table 12** and the extra bottom temperature measurement during CPT are listed in **Table 13**. All the KP values and offset are based on the main route RPL *Opt2_12-MAY-2016* for simple presenting.

Probe Number	Chart number	Latitude Longitude	Max. Depth (m)	KP RPL offset	Bottom Temp (°C)
ACE-S4.7-RT-SV001	OPT3_NU032, OPT3_NU033	33° 47.996' S 18° 6.311' E	105	1449.977 5704m S	NA
ACE-S4.7-RT-SV002	OPT3_NU036	33° 45.010' S 18° 20.994' E	57	1473.301 4914m S	9.8
ACE-S4.7-RT-SV003	NU036, NU037, OPT2A_NU037, OPT3_NU036	33° 42.326' S 18° 24.700' E	16	1479.947 340m S	11.9

Probe Number	Chart number	Latitude Longitude	Max. Depth (m)	KP RPL offset	Bottom Temp (°C)
ACE-S4.7-RT-SV004	NU032	33° 46.034' S 18° 2.140' E	134	1444.397 23m S	9.0
ACE-S4.7-RT-SV005	NU036, OPT3_NU036	33° 42.617' S 18° 20.829' E	53	1473.980 168m N	9.9
ACE-S4.7-RT-SV008	NU032	33° 46.154' S 18° 2.063' E	136	1444.230 241m S	9.1
ACE-S4.7-RT-SV009	NU034	33° 44.150' S 18° 11.652' E	102	1459.490 501m N	9.6
ACE-S4.7-RT-SV010	NU036, NU037, OPT2A_NU037, OPT3_NU036	33° 42.332' S 18° 24.523' E	19	1479.679 282m S	12.8
ACE-S4.7-RT-SV011	OPT3_NU034	33° 46.604' S 18° 12.499' E	101	1460.002 4948m S	9.6
ACE-S4.7-RT-SV012	NU036, OPT3_NU036	33° 43.542' S 18° 24.520' E	20	1479.393 2833m S	12
ACE-S4.7-RT-SV013	NU030, OPT3_NU030	33° 49.061' S 17° 54.418' E	191	1430.497 801m N	8.8
ACE-S4.7-RT-SV014	NU032	33° 45.550' S 18° 3.159' E	127	1446.119 575m N	9.1
ACE-S4.7-RT-SV015	NU025	33° 54.455' S 17° 29.229' E	454	1390.322 102m N	7.1
ACE-S4.7-RT-SV016	NU025	33° 54.940' S 17° 29.065' E	402	1389.879 853m S	7.2
ACE-S4.7-RT-SV017	NU030, OPT3_NU030	33° 49.169' S 17° 55.599' E	171	1432.190 18m S	9
ACE-S4.7-RT-SV018	NU021, NU023	33° 56.222' S 17° 21.152' E	1000	1377.431 16m N	3.5
ACE-S4.7-RT-SV019	NU021, NU022	33° 56.513' S 17° 13.869' E	1650	1366.256 1349m N	3
ACE-S4.7-RT-SV020	NU025	33° 54.653' S 17° 28.338' E	462	1388.907 80m N	6.9
ACE-S4.7-RT-SV021	NU021, NU022	33° 56.960' S 17° 17.512' E	1326	1371.681 579m S	3.2
ACE-S4.7-RT-SV022	NU021, NU022	33° 56.871' S 17° 16.095' E	1441	1369.547 9m S	3.0
ACE-S4.7-RT-SV023	NU021	33° 55.967' S 16° 43.847' E	1815	1319.713 125m N	3.0
ACE-S4.7-RT-SV024	NU019	33° 0.091' S 15° 29.968' E	1815	1163.891 1m NE	3
ACE-S4.7-RT-SV025	NU017	32° 7.068' S 14° 33.472' E	1815	1031.893 8m NE	3.6
ACE-S4.7-RT-SV026	NU014, NU015	30° 53.016' S 13° 45.831' E	1815	874.856 6m NE	3.0

Table 12: Summary of bottom temperatures at SVP locations

Note: Generally, the deepest reading is close to the seabed, but this is not always the case. The tabulated temperature values were recorded at the stated depth-not necessarily the actual WD at that location. For XBT, the deepest water depth with measurement would be 1815m.

Number	Chart number	Latitude Longitude	Max. Depth (m)	KP RPL offset	Bottom Temp (°C)
ACE-S4.7-RT-CPT-SV001	OPT3_NU033	33° 47.476' S 18° 8.963' E	125	1454.494 5461m S	9.2
ACE-S4.7-RT-CPT-SV002	OPT3_NU034	33° 46.685' S 18° 13.110' E	99	1460.906 5306m S	9.4
ACE-S4.7-RT-CPT-SV003	OPT3_NU034	33° 46.391' S 18° 14.164' E	91	1462.604 5007m S	9.5
ACE-S4.7-RT-CPT-SV004	OPT3_NU034, OPT3_NU035	33° 46.159' S 18° 15.451' E	84	1464.472 5223m S	9.6
ACE-S4.7-RT-CPT-SV005	OPT3_NU035	33° 46.017' S 18° 16.318' E	80	1465.835 5255m S	9.6
ACE-S4.7-RT-CPT-SV006	OPT3_NU035	33° 45.333' S 18° 19.594' E	68	1471.061 5065m S	9.7
ACE-S4.7-RT-CPT-SV007	OPT3_NU036	33° 44.496' S 18° 21.977' E	45	1474.985 4205m S	10
ACE-S4.7-RT-CPT-SV008	NU036, OPT3_NU036	33° 43.998' S 18° 23.425' E	34	1477.604 3538m S	10.4
ACE-S4.7-RT-CPT-SV009	NU036, OPT3_NU036	33° 43.457' S 18° 25.006' E	17	1479.939 2828m S	12.1
ACE-S4.7-RT-CPT-SV010	NU036, NU037, OPT2A_NU037	33° 42.165' S 18° 24.690' E	17	1479.999 1m S	10.8
ACE-S4.7-RT-CPT-SV011	NU036, OPT3_NU036	33° 42.461' S 18° 22.314' E	45	1476.286 2m S	10
ACE-S4.7-RT-CPT-SV012	NU035	33° 42.908' S 18° 19.658' E	59	1472.099 3m S	9.8
ACE-S4.7-RT-CPT-SV013	NU034	33° 44.042' S 18° 13.841' E	92	1462.860 2m N	9.4
ACE-S4.7-RT-CPT-SV014	NU033, NU034	33° 44.675' S 18° 10.721' E	111	1457.889 107m S	9.3
ACE-S4.7-RT-CPT-SV015	NU033	33° 45.035' S 18° 7.840' E	126	1453.391 2m N	9.3
ACE-S4.7-RT-CPT-SV016	NU032, NU033	33° 45.283' S 18° 6.323' E	132	1451.005 3m S	9.2
ACE-S4.7-RT-CPT-SV017	NU032	33° 45.694' S 18° 3.909' E	139	1447.201 2m N	9.3
ACE-S4.7-RT-CPT-SV018	NU031	33° 46.382' S 18° 0.798' E	160	1442.212 7m NW	9
ACE-S4.7-RT-CPT-SV019	NU031, OPT3_NU031	33° 47.761' S 17° 59.632' E	168	1439.003 4m NW	8.9
ACE-S4.7-RT-CPT-SV020	NU031, OPT3_NU031	33° 48.734' S 17° 57.345' E	174	1435.001 2m S	8.9
ACE-S4.7-RT-CPT-SV021	NU030, OPT3_NU030	33° 49.308' S 17° 54.995' E	180	1431.224 1m N	8.7
ACE-S4.7-RT-CPT-SV022	NU031, OPT3_NU031	33° 49.173' S 17° 58.710' E	171	1436.553 1755m SE	8.9
ACE-S4.7-RT-CPT-SV023	NU031, OPT3_NU031, OPT3_NU032	33° 49.415' S 18° 1.553' E	164	1439.131 4936m SE	9
ACE-S4.7-RT-CPT-SV024	NU030, OPT3_NU030	33° 49.619' S 17° 53.711' E	187	1429.160 6m N	8.8
ACE-S4.7-RT-CPT-SV025	NU029, NU030, OPT3_NU030	33° 50.146' S 17° 51.573' E	206	1425.720 12m N	8.7
ACE-S4.7-RT-CPT-SV026	NU029	33° 51.207' S 17° 47.388' E	249	1418.971 3m S	8.2
ACE-S4.7-RT-CPT-SV027	NU028	33° 51.771' S 17° 44.598' E	240	1414.543 2m S	8.2
ACE-S4.7-RT-CPT-SV028	NU027	33° 52.402' S 17° 41.474' E	263	1409.587 1m S	8.2

Number	Chart number	Latitude Longitude	Max. Depth (m)	KP RPL offset	Bottom Temp (°C)
ACE-S4.7-RT-CPT-SV029	NU027	33° 52.881' S 17° 39.125' E	279	1405.858 8m S	8.2
ACE-S4.7-RT-CPT-SV030	NU026, NU027	33° 53.188' S 17° 37.088' E	294	1402.666 6m N	8
ACE-S4.7-RT-CPT-SV031	NU026	33° 53.394' S 17° 35.633' E	304	1400.389 4m S	7.8
ACE-S4.7-RT-CPT-SV032	NU025, NU026	33° 53.898' S 17° 32.431' E	325	1395.364 2m N	7.9
ACE-S4.7-RT-CPT-SV033	NU025	33° 54.219' S 17° 30.802' E	357	1392.784 26m S	7.5
ACE-S4.7-RT-CPT-SV034	NU025	33° 54.517' S 17° 28.888' E	431	1389.785 107m N	6.9
ACE-S4.7-RT-CPT-SV035	NU024	33° 55.204' S 17° 26.294' E	605	1385.597 2m S	4.8
ACE-S4.7-RT-CPT-SV036	NU024	33° 55.634' S 17° 24.578' E	701	1382.834 3m S	4
ACE-S4.7-RT-CPT-SV037	NU021, NU023	33° 56.140' S 17° 21.901' E	913	1378.595 10m S	3.4
ACE-S4.7-RT-CPT-SV038	NU021, NU023	33° 56.448' S 17° 19.427' E	1106	1374.740 3m S	3.1
ACE-S4.7-RT-CPT-SV039	NU021, NU022	33° 56.747' S 17° 17.058' E	1360	1371.048 3m S	3.1

Table 13: Summary of bottom temperatures at CPT locations

Note: The depths are correlated to the CPT locations.

7.2 Currents

The surface and mid-water currents can affect cable-laying operations. Bottom currents can cause abrasion to a cable laid over obstacles such as when having a free-span. Sediment movement by bottom currents can uncover a buried cable and even result in cable suspensions, exposing the cable to subsequent damage by fishing activities or chafe. This is particularly the case in areas of sandwaves.

In areas with strong currents, the cable may end up being laid well away from the track of the cable-laying vessel because of current action. The subsurface current can also affect the performance of the plough/ROV during burial, launch and recovering. Caution should be taken during the operations.

General information on surface and seabed currents was discussed in the desktop study report according to the areas that ACE cable system runs through. For S4.7 survey, the current effect is mainly related to the northward Benguela Current. The Benguela Current skirts the western African coast equator ward until around 24°S-30°S. The Benguela Current has a well-defined mean flow that is mostly confined near the continent and a more variable transient flow on its western side. The surface speed of the current would range from >11cm/s to 23cm/s. The prevailing winds are responsible for strong Ekman transport and the resulting coastal upwelling of cool, nutrient-rich water that stimulates primary productivity.

During the offshore survey operations, regular surface current observations were made by the helmsmen and/or a numerical approach was adopted to estimate the magnitude and direction of the surface and subsurface currents generally every 4 hours. This is to assist in determining the lay accuracy and foreseeing areas which will

be challenging due to currents. The calculations of magnitude and direction of the surface and subsurface currents are based on the vessel crab angle and towed equipment crab angle respectively. It should be noted that the numerical approach is applied to a simplified model with assumptions. The information on currents derived from this approach is affected by tidal, weather and seasonal conditions prevailing during the survey and should only be used as a guide to magnitudes but not as an engineering parameter. Accurate current information along the survey route should be acquired by proper current measuring equipment, for example, Acoustic Doppler Current Profilers, if information on currents is critical.

The current observation log is presented as Appendix J of this report. It shows that during the offshore route survey for SEGMENT 4.7 up to the South Africa EEZ, both the observed and the estimated surface current were mostly to the north quadrants, mainly between northeast and northwest. The calculated surface current speed is less than 0.9knot (over 90%) with an average of 0.52knot, prevailing to the north-northwest. And the calculated subsurface current has a speed less than 0.6knot (>70%) with no prevailing direction.

An electromagnetic current meter (ECM) was mounted on the CPT rig to measure the bottom current when the CPT rig is on or near seabed (from seabed to 1m above seabed). The current measurement is named after the CPT I.D., e.g. the current measurement acquired during ACE-S4.7-RT-CP005 and ACE-S4.7-RT-CP005a is identified as ACE-S4.7-RT-ECM005. The details of the bottom current measurement are shown in **Table 14** and sketched in **Figure 51** and **Figure 52**. According to the results, the mean bottom current was 0.2knot. At the western part of the continental slope, the bottom current was generally steady to the south/south-southeast/south-southwest with a mean of 0.12knots. As the seabed shoaling to the east, the current was observed more northwards and turbulent up to ~KP1415, particularly between KP1390 and KP1400 around the shelf break area. This could affect the MBES data and cautions should also be taken during plough operations. East of KP1415 along Route Option 2, the bottom current generally set to the northern quadrates, with maximum speed of 0.47knot at ECM025. However, the results along Route Option 3 show more southward bottom current. The presence of low to high relief ROCKs could probably make the bottom current more chaotic and even locally reversed to the ambient. It should also be noted that all the measurement only reflects the conditions at that period which may be influenced by tide, geomorphology, weather, etc.

Number	Chart number	Latitude Longitude	Max. Depth (m)	KP RPL offset	Ave. bottom current speed (knot)	Prominent direction
ACE-S4.7-RT-ECM001	OPT3_NU033	33° 47.476' S 18° 8.963' E	125	1454.494 5461m S	0.23	SSW
ACE-S4.7-RT-ECM002	OPT3_NU034	33° 46.685' S 18° 13.110' E	99	1460.906 5306m S	0.10	SSE to S
ACE-S4.7-RT-ECM003	OPT3_NU034	33° 46.391' S 18° 14.164' E	91	1462.604 5007m S	0.10	SSW
ACE-S4.7-RT-ECM004	OPT3_NU034, OPT3_NU035	33° 46.159' S 18° 15.451' E	84	1464.472 5223m S	0.27	NA/variable
ACE-S4.7-RT-ECM005	OPT3_NU035	33° 46.017' S 18° 16.318' E	80	1465.835 5255m S	0.31	SW
ACE-S4.7-RT-ECM006	OPT3_NU035	33° 45.333' S 18° 19.594' E	68	1471.061 5065m S	0.14	NE but slightly variable

Number	Chart number	Latitude Longitude	Max. Depth (m)	KP RPL offset	Ave. bottom current speed (knot)	Prominent direction
ACE-S4.7-RT-ECM007	OPT3_NU036	33° 44.496' S 18° 21.977' E	45	1474.985 4205m S	0.16	W
ACE-S4.7-RT-ECM008	NU036, OPT3_NU036	33° 43.998' S 18° 23.425' E	34	1477.604 3538m S	0.16	WSW to W
ACE-S4.7-RT-ECM009	NU036, OPT3_NU036	33° 43.457' S 18° 25.006' E	17	1479.939 2828m S	0.25	NA/variable
ACE-S4.7-RT-ECM010	NU036, NU037, OPT2A_NU037	33° 42.165' S 18° 24.690' E	17	1479.999 1m S	0.35	ENE but slightly variable
ACE-S4.7-RT-ECM011	NU036, OPT3_NU036	33° 42.461' S 18° 22.314' E	45	1476.286 2m S	0.23	NA/variable
ACE-S4.7-RT-ECM012	NU035	33° 42.908' S 18° 19.658' E	59	1472.099 3m S	0.16	NE to NNE
ACE-S4.7-RT-ECM013	NU034	33° 44.042' S 18° 13.841' E	92	1462.860 2m N	0.19	NE
ACE-S4.7-RT-ECM014	NU033, NU034	33° 44.675' S 18° 10.721' E	111	1457.889 107m S	0.14	NNE to N
ACE-S4.7-RT-ECM015	NU033	33° 45.035' S 18° 7.840' E	126	1453.391 2m N	0.23	WNW to NNW
ACE-S4.7-RT-ECM016	NU032, NU033	33° 45.283' S 18° 6.323' E	132	1451.005 3m S	0.14	WSW but slightly variable
ACE-S4.7-RT-ECM017	NU032	33° 45.694' S 18° 3.909' E	139	1447.201 2m N	0.21	W to NW
ACE-S4.7-RT-ECM018	NU031	33° 46.382' S 18° 0.798' E	160	1442.212 7m NW	0.06	E to SSE
ACE-S4.7-RT-ECM019	NU031, OPT3_NU031	33° 47.761' S 17° 59.632' E	168	1439.003 4m NW	0.08	SW to SSW
ACE-S4.7-RT-ECM020	NU031, OPT3_NU031	33° 48.734' S 17° 57.345' E	174	1435.001 2m S	0.37	NNW to NW
ACE-S4.7-RT-ECM021	NU030, OPT3_NU030	33° 49.308' S 17° 54.995' E	180	1431.224 1m N	0.29	SW but slightly variable
ACE-S4.7-RT-ECM022	NU031, OPT3_NU031	33° 49.173' S 17° 58.710' E	171	1436.553 1755m SE	0.45	SSW to SSE
ACE-S4.7-RT-ECM023	NU031, OPT3_NU031, OPT3_NU032	33° 49.415' S 18° 1.553' E	164	1439.131 4936m SE	0.21	WSW but variable
ACE-S4.7-RT-ECM024	NU030, OPT3_NU030	33° 49.619' S 17° 53.711' E	187	1429.160 6m N	0.47	NW to N
ACE-S4.7-RT-ECM025	NU029, NU030, OPT3_NU030	33° 50.146' S 17° 51.573' E	206	1425.720 12m N	0.25	N
ACE-S4.7-RT-ECM026	NU029	33° 51.207' S 17° 47.388' E	249	1418.971 3m S	0.19	NE
ACE-S4.7-RT-ECM027	NU028	33° 51.771' S 17° 44.598' E	240	1414.543 2m S	0.17	S to SSW
ACE-S4.7-RT-ECM028	NU027	33° 52.402' S 17° 41.474' E	263	1409.587 1m S	0.43	W to SW
ACE-S4.7-RT-ECM029	NU027	33° 52.881' S 17° 39.125' E	279	1405.858 8m S	0.25	NW
ACE-S4.7-RT-ECM030	NU026, NU027	33° 53.188' S 17° 37.088' E	294	1402.666 6m N	0.12	NNE

Number	Chart number	Latitude Longitude	Max. Depth (m)	KP RPL offset	Ave. bottom current speed (knot)	Prominent direction
ACE-S4.7-RT-ECM031	NU026	33° 53.394' S 17° 35.633' E	304	1400.389 4m S	0.17	W
ACE-S4.7-RT-ECM032	NU025, NU026	33° 53.898' S 17° 32.431' E	325	1395.364 2m N	0.21	ENE
ACE-S4.7-RT-ECM033	NU025	33° 54.219' S 17° 30.802' E	357	1392.784 26m S	0.12	WSW to SW
ACE-S4.7-RT-ECM034	NU025	33° 54.517' S 17° 28.888' E	431	1389.785 107m N	0.14	NE
ACE-S4.7-RT-ECM035	NU024	33° 55.204' S 17° 26.294' E	605	1385.597 2m S	0.16	N
ACE-S4.7-RT-ECM036	NU024	33° 55.634' S 17° 24.578' E	701	1382.834 3m S	0.10	SSW to SW
ACE-S4.7-RT-ECM037	NU021, NU023	33° 56.140' S 17° 21.901' E	913	1378.595 10m S	0.29	NA/variable
ACE-S4.7-RT-ECM038	NU021, NU023	33° 56.448' S 17° 19.427' E	1106	1374.740 3m S	0.10	S to SSE
ACE-S4.7-RT-ECM039	NU021, NU022	33° 56.747' S 17° 17.058' E	1360	1371.048 3m S	0.17	SE

Table 14: Summary of average bottom current speed and prominent direction at CPT locations

Note: The depths are correlated to the CPT locations.

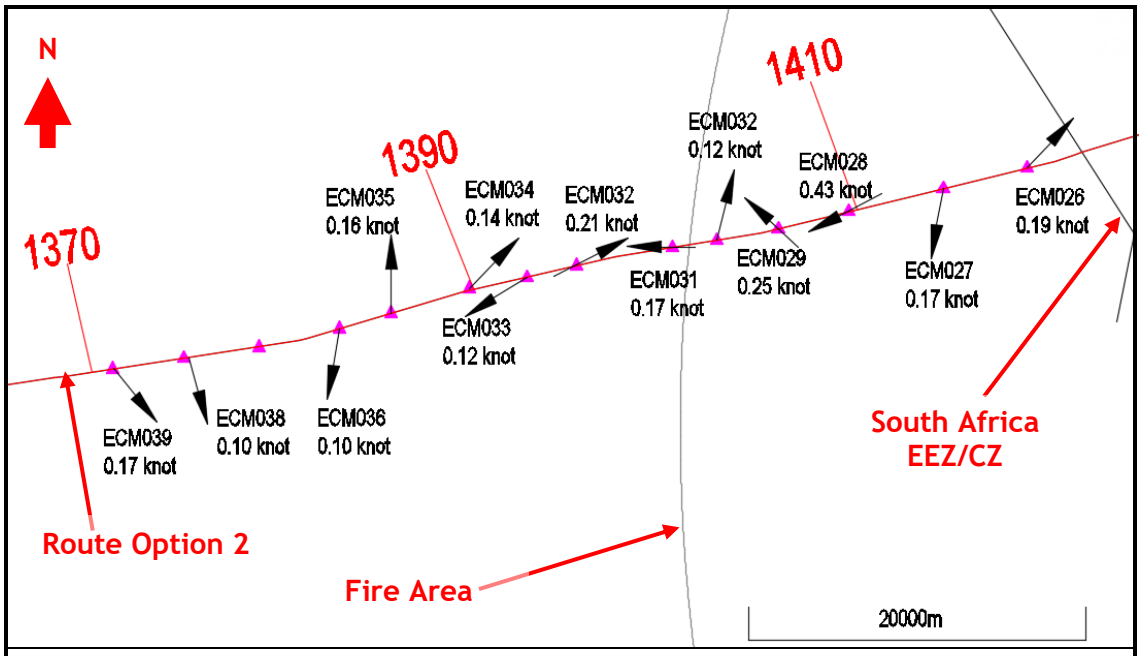

Figure 51: Prominent bottom current direction between KP1370 and KP1420
Note: the magenta solid triangles are the current measurement positions; the arrows roughly indicate the prominent direction of the bottom current at the corresponding measurement positions; results with no prominent directions are not displayed.

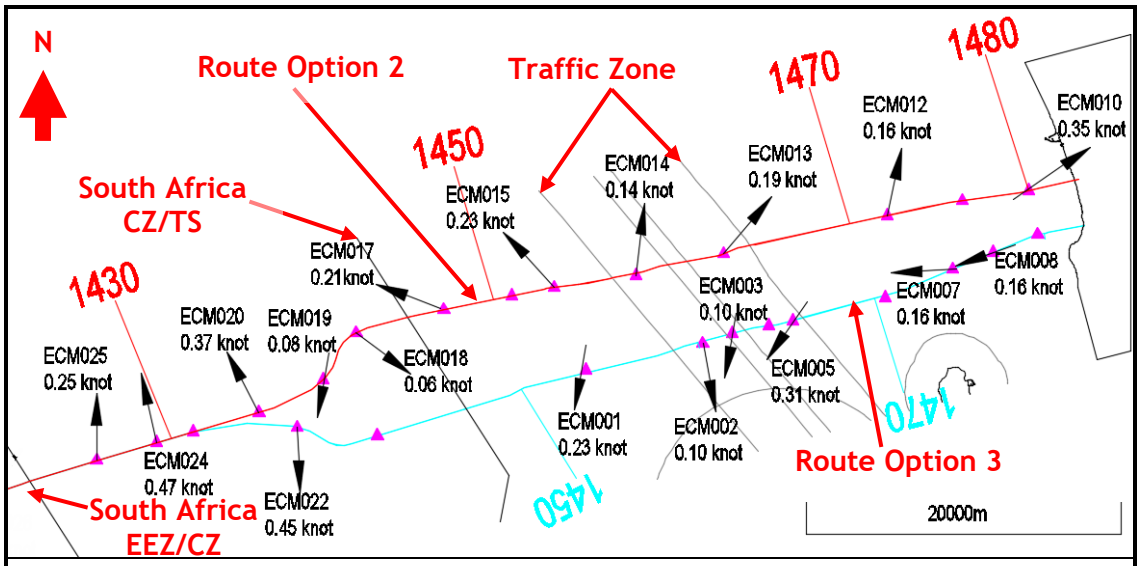

Figure 52: Prominent bottom current direction between KP1420 and KP1480
Note: the magenta solid triangles are the current measurement positions; the arrows roughly indicate the prominent direction of the bottom current at the corresponding measurement positions; results with no prominent directions are not displayed.

7.3 Sea State and Wind Direction

The ACE S4.7 offshore survey was conducted by *RV RT* between the 4th June and 27th June 2016 between the South Africa EEZ to the landing area in Melkbosstrand. The sea state and wind direction were recorded daily in the daily progress reports. The figures below summarise those observations.

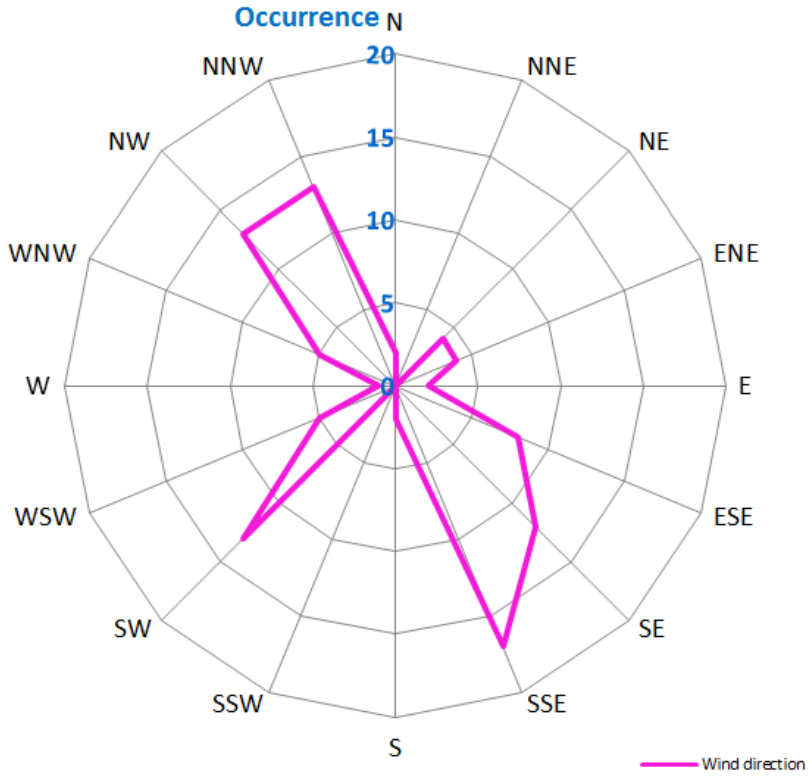

Figure 53: Rose diagram presenting wind direction

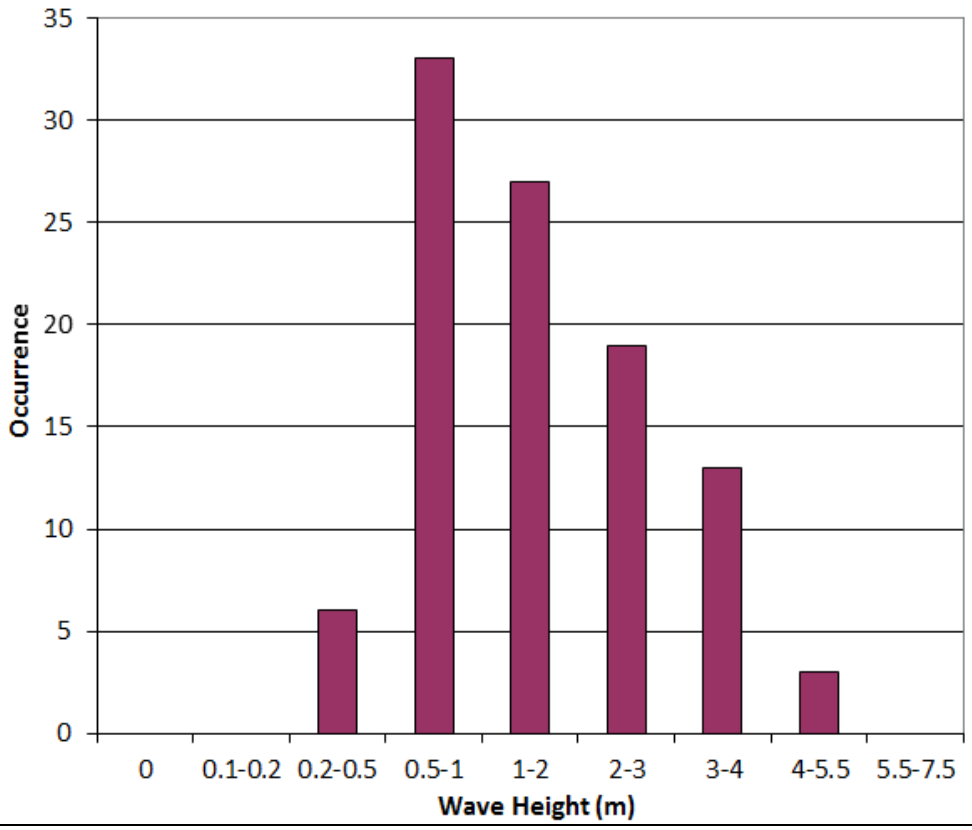

Figure 54: Graph showing occurrence of observed wave heights

Impact during the survey:	There were 60.9 hours of weather standby during the survey operations offshore as detailed in the hazards table and operations report.
Possible impact for cable installation and maintenance:	The highest problems will be probably connected with the presence of swell (May to October, up to 7m, from S) which should better be avoided.

7.4 Meteorological Observations

The wind speed was recorded daily in the daily progress reports. The figures below summarise those observations.

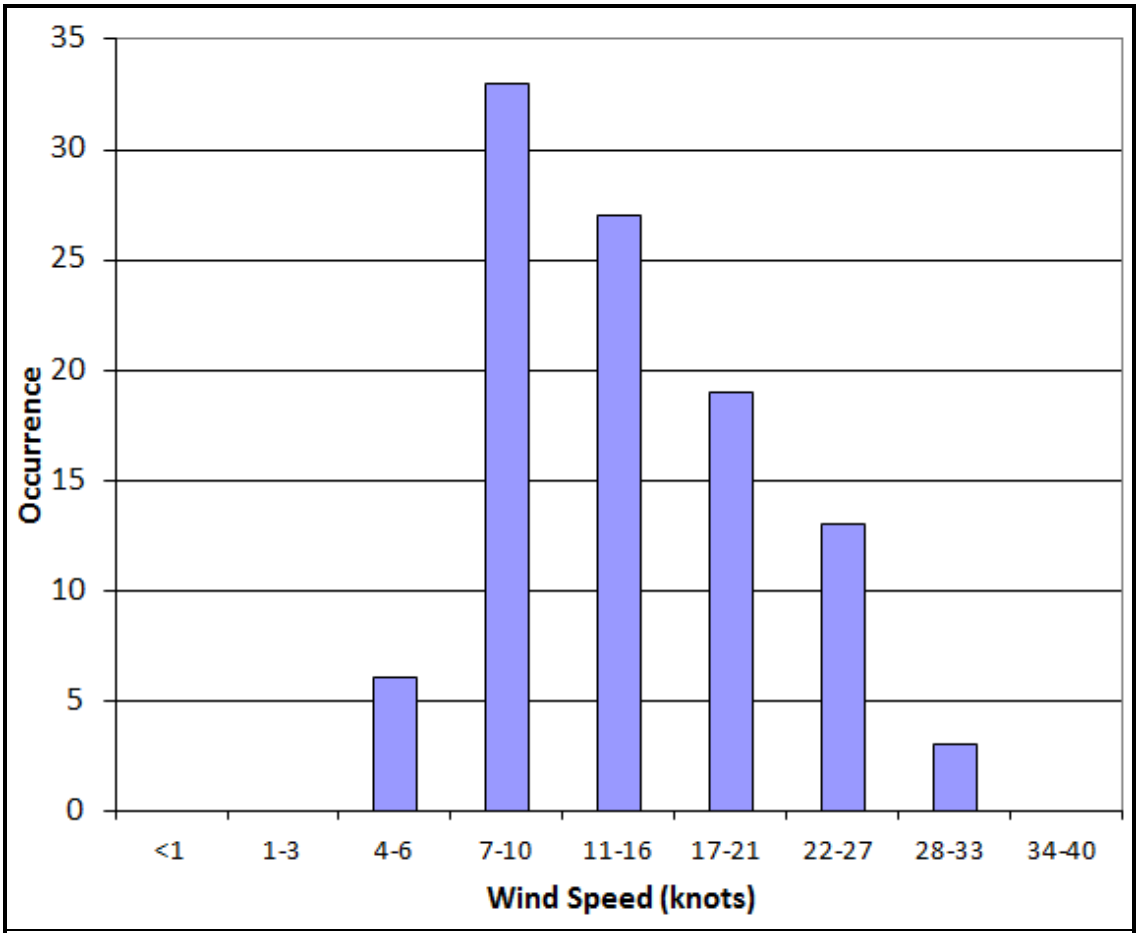

Figure 55: Graph showing occurrence of observed wind speeds

The wind direction was mainly from the NNW/NW and SSE with wind speed up to 33 knots. Wind speeds between 7knots and 27knots were quite common. Weather standby was required due to poor sea state occasionally. Wave heights were mostly between 0.5m and 4m during the survey.

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8 ENVIRONMENT CONSIDERATIONS

The west coast of South Africa is an important nursery area for pelagic fish in winter, whereas the adult fish spawn mainly in summer on the south coast.

Groups of seals were observed during the survey, revealing abundant fishing product in this area.

All measures were used so as not to damage the marine environment.

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9 SAFETY

In total, twenty-four (24) days were worked by the *RV RT* survey operations and twenty-four (24) days for the inshore survey. There were no reportable incidents during the surveys. Safety meetings and drills were held regularly. This was to ensure that all ship and survey crew were familiar with the safety measures in case of emergencies. A vessel hazard identification card system was operated for reporting any hazards observed.

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10 ENGINEERING CONSIDERATIONS

This report provides the findings of geophysical and hydrographic survey undertaken for ACE S4.7 up to the South Africa EEZ. The findings in this report are supplementary to the Cable Route Desktop Study and should be read in conjunction with that report.

The route in this report starts at South Africa EEZ, traverses south-southeast in the abyssal basin, then alters course to the east, climbing the continental slope and extents east-northeast on the continental shelf up to the landing area in Melkbosstrand and Duynefontein. The continental slope is with gentle to steep slopes. The continental shelf is flat and has large areas of coarse sediments over HARDGROUND. In the Territorial Water of South Africa, low to high relief ROCK are commonly observed. Near the landing areas, there are several options for the cable to land, option 2, option 2a, and option 3, which basically traverse on seabed with coarse sediments over possible HARDGROUND.

The table summarising the hazards and issues encountered during the survey is shown in the executive summary.

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