Nova Scotia Utility and Review Board

IN THE MATTER OF

The Maritime Link Act, S.N.S 2012 c.9
and the
Maritime Link Cost Recovery Process Regulation, N.S. Reg. 189/2012

NSPML Quarterly Report Q4 2020

December 15, 2020

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1.0 INTRODUCTION

This is the Q3 2020 Quarterly Report for the Maritime Link as directed by the Utility and Review Board (UARB) where the UARB ordered in its Supplemental Decision:

> [115]….detailed reports must be filed by NSPML on a semi-annual basis, on June 15 and December 15 each year. The reports shall commence December 15, 2013. Updated status reports must be filed quarterly.

As per the UARB's order in its Decision regarding the Maritime Link Interim Cost Assessment (M07718), this Report now includes detail regarding the status of the construction of Nalcor's assets.

This Decision also requested that the quarterly reports include an accounting of all transactions related to this project, cash flow analysis, and a reporting of the financial and other benefits realized for ratepayers from the Maritime Link prior to delivery of the Nova Scotia Block and Nalcor market-priced energy. Given that the benefits to ratepayers prior to the Nova Scotia Block and Nalcor market-priced energy are secured by Nova Scotia Power through the Maritime Link, Nova Scotia Power will report on these in its Quarterly Fuel Adjustment Mechanism Report.

2.0 UPDATE OF PROJECT SCHEDULE

The Maritime Link was placed in-service on January 15, 2018.

Detail respecting the status of the Nalcor Project and Muskrat Falls is outlined in Section 2.9.

2.1 Gates and Milestones

The Maritime Link was placed in-service January 15, 2018.

2.2 Safety

NSPML has remained steadfast in its commitment to safety as a fundamental and integral part of every aspect of NSPML's business.

As part of it's COVID-19 response, NSPML initiated a work-from-home approach where possible to secure a core team of staff and contractors working on the Maritime Link asset until such time that it was considered safe to return to normal operations. NSPML remains committed to the thorough management of pandemic-related safety measures to protect against the impact of the COVID-19 virus. While most field staff have transitioned back to site, office staff continue to work from home.

There have been no recordable incidents to date in 2020.

2.3 Commercial Activities

The key major procurement activities are presented in Table 1 with an update of the status for each initiative.

Table 1 Key Major Procurement Activities

Commercial Activity	Background	Initiative Number	Status in December 2020
HVDC Submarine Cable Supply and Installation	The Contract was awarded to Nexans in January 2014. Substantial Completion occurred in September, 2017. Contract Final Completion Certificate signed February 5, 2018.	E11-18	Closed
Converter stations, switchyards and related structures ("converters and structures")	The Contract was awarded to ABB Inc. in June 2014. Final System Test Completed January 15, 2018. Substantial Completion achieved on January 15, 2018.	E12-74	System studies requirements are finalized. Contract is ready to be closed out.
Right of Way Clearing along Transmission Lines	Contracts were awarded to Majors Logging Limited in NL and to R. MacLean Forestry in NS in February 2014.	E13-88	Closed

Commercial Activity	**Background**	**Initiative Number**	**Status in December 2020**
Transmission Structures and Grillages	The Contract was awarded to Kalpataru Power Transmission Ltd. in September 2014 for design and delivery of Structures and Grillages.	E13-85	Closed
Site Preparation Services (Includes construction of access road upgrades)	The Contract was awarded to JonelJim Concrete Construction (1994) Ltd. for NS Site Preparation Services in September 2014. Contracts awarded to Marine Contractors Inc., MCI Limited Partnership for NL Site Preparation Services in September 2014.	E13-92	Closed Closed
Transmission Line Construction	E13-95 contract terminated as of late 2016. Contract replaced with E16-284 and E16-269 previously reported.	E13-95	Contract Closeout is in progress.
Transmission Line Construction – NL AC Line	The contract with PowerTel was re-assigned to NSPML for the completion of the two Grounding Lines and the HVAC Line. Final Completion was achieved January 31, 2019.	E16-284	Contract Closeout is in progress.
Transmission Line Construction - NL and	The contract for the construction of the HVDC Transmission Lines was awarded to a joint venture of	E16-269	Contract Closeout is in progress.

Commercial Activity	**Background**	**Initiative Number**	**Status in December 2020**
NS HVDC Lines	Emera Utility Services and Rokstad Power Corporation (ERJV).		
Transmission Line Conductors	The Contract for the supply of conductors was awarded to Midal Cables in March 2015. The contract for the supply of OPGW was awarded to Composite Power Group Inc. in June 2015. This is also within the scope of the E13-87 initiative.	E13-87	Closed Closed
Horizontal Directional Drill (HDD) Construction Program	Contract awarded to Directional Horizontal Drilling (DHD) in January 2016. E13-157 was divided into two contracts. E13-157 A was awarded to Schlumberger in March 2016 for the supply of HDD fluids. E13-157B was awarded to Baker Hughes in April 2016 for the Supply of directional drilling services, drill bits and other materials. E13-158 for marine intervention services was awarded in April 2016 to DOF Marine.	E13-156 E13-157 E13-158	Closed Closed Closed

Commercial Activity	Background	Initiative Number	Status in December 2020
	The supply of the HDD casing (E15-238) was awarded to East Coast Tubulars Limited in October 2015.	E15-238	Closed
Accommodations Operations	The contract for the accommodations operations services was awarded to East Coast Catering in April 2015.	E13-89	Closed

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2.3.1 Land Access Agreements

The majority of land rights are now in place, and NSPML is in the final stages of securing any outstanding rights; moving to expropriation as required where agreement could not be reached, or landowners could not be found. These easements do not impact the ability of the project to complete contract closeouts or to operate according to plan.

2.3.2 Funding

The IE Certificates allow for Project costs to be paid from the proceeds of the Maritime Link Construction Loan under the payment terms of the Material Project Documents and the Maritime Link Credit Agreement. The final draw against the $1.3 billion was requested in February 2020.

2.3.3 Joint Development Agreements

NSPML continues to work with Nalcor and NS Power to finalize the remaining operational agreements arising from the Formal Agreements with Nalcor. Please refer to Attachment 1 for details on the status of these Agreements, which indicate three Agreements remain to be concluded.

2.4 Engineering Activities

Engineering is captured in three main categories across several Work Breakdown Structures ("WBSs"):

- HVDC Submarine Cable Supply and Installation - Completed.
- HVDC Converters and Substations – Completed.
- Overland Transmission – All project as-builts completed.

2.5 Submarine Cables

Negotiations to secure a contract for the 2020 survey scope have been finalized and the survey is currently underway. Please see Attachment 2 for the Inspection Report from the 2019 survey.

Planning for the marine survey campaign in 2021 is now underway with the intent of retaining a contract to complete the survey in the spring.

Discussions continue regarding a Contingency Services Agreement to support the broader Cable Inspection, Maintenance and Repair framework. The Subsea & Land Cable Maintenance Plan (Plan) was not revised in 2020, as originally anticipated when the Plan was last filed with the UARB in July 2019, as there have been no material changes in the Plan.

2.6 Converters and Substations

The Construction of the Converters and Substations was completed with the conclusion of system testing and the Maritime Link placed in-service on January 15, 2018 and all punch list items are completed.

2.7 Transmission Lines

The overhead transmission system continues to perform well through the third year of operations with no significant reliability or downtime impacts experienced.

Given some delays in delivery of replacement dampers due to COVID-19, the previously identified corrective damper installation work is planned for 2021. There are no safety or reliability issues anticipated from this delay. All other required corrective work on the Transmission lines has been completed.

2.8 Independent Engineer

NSPML continues to be engaged with the Independent Engineer (IE) related to the Operations phase of the Maritime Link, as per the Federal Loan Guarantee requirements.

2.9 Status of Nalcor Project and Muskrat Falls

Muskrat Falls Assets

Commissioning activities for Unit 1 as well as a 72-hour trial run have been completed. Unit 1 was taken off-line in late October to complete post commissioning inspections prior to releasing it for service. Unit 1 was placed online on December 3 for final in-service checks by the Muskrat Falls Commissioning Team prior to being released for service.

A major milestone was achieved on December 4, 2020, when electricity from Unit 1 of the Muskrat Falls Generating Station flowed over Pole 1 of the Labrador Island Link to Newfoundland for the first time.

On October 19, 2020, Unit 2 was turned with water for the first time, marking the beginning of wet commissioning activities on that unit. In early November, the Unit 2

commissioning inspection identified the generator upper cooling air shroud rubber seal failed during an overspeed test; it is being repaired. Resumption of mechanical commissioning is expected prior to the holiday break and online commissioning activities are expected to resume in late January 2021. Nalcor is now planning for completion of Unit 2 commissioning and Ready for Operation in February 2021.

Completion of Unit 3 commissioning and Ready for Operation is forecast for May 2021.

Completion of Unit 4 commissioning and Ready for Operation is forecast for September 2021.

Synchronous Condensers at Soldiers Pond

As mentioned in the NSPML October 2020 Quarterly Report, Nalcor's commissioning work on the synchronous condensers had identified material vibration and binding issues; vibration identified during Unit 3 work and binding during Unit 1 and 2 work. The binding issues have been resolved and dynamic commissioning of Unit 2 recommenced on September 28, 2020. Unit 3 is now reassembled and also undergoing dynamic commissioning. On Unit 1, GE Power is preparing to start foundation modification work which is the more complex of the options to remedy the lateral vibration issue. If the elliptical bearing in Unit 3 is determined not to be a viable solution to resolve the vibration issue, a decision on foundation remediation for Unit 3 will be made.

Labrador Island Link

With respect to the HVDC Control System Software development, Nalcor and its Contractor, GE Grid, were able to safely continue development remotely during the COVID-19 suspension. GE Grid completed the Interim Bipole Software Factory Acceptance Test (FAT) on October 23, 2020, and software arrived at site on October 29, 2020. Development of the Final Bipole Software will continue to progress while the Interim Bipole Software is in use. The Interim Software is an early indicator of performance and reliability of the Final Bipole Software, so any issues that become apparent while the Interim Bipole Software is in use will be resolved in the Final Bipole Software. This ideally will reduce the testing timeline required of the Final Bipole Software and the amount of issues discovered in that version.

As mentioned in the October Quarterly Report, on August 13, 2020, during dynamic commissioning of the LIL, a flashover incident occurred in the Soldier's Pond Pole 2 valve hall. A similar incident occurred on August 22, 2020, in the Muskrat Falls Pole 1 valve hall. Both incidents damaged fiberglass insulating beams and triggered trips of the LIL. The investigation has identified a root cause which has allowed Nalcor to successfully implement temporary remediation measures. The damaged beams at Muskrat Fall and Soldiers Pond have been removed and replaced.

GE Grid's final remediation plan and schedule is pending. As an interim solution, GE has removed, heat cured, and replaced all defective beams in Pole 1. Dynamic commissioning of Pole 1 recommenced on November 28, 2020 and is ongoing. As part of the preparation to resume power transfer, a power transfer test was successfully conducted on Pole 1 on December 2, 2020. As mentioned above, power transferred for the first time over the Labrador Island Link on December 4, 2020.

With respect to the Pole 2 Interim Remediation Plan, beam removal and heat curing is underway. The schedule for dynamic commissioning of Pole 2 to recommence is January 12, 2021, followed by bipole trial operations by February 15, 2021. The Final

Remediation Plan will involve replacing all affected beams, even those that have been heat cured for the Interim Remediation Plan.

NSPML continues to be engaged with Nalcor and is closely monitoring Nalcor's plans to mitigate the effects of COVID-19 and LIL issues to schedule, including consideration of the timing of the Nova Scotia Block and Market-priced Energy.

2.10 Status of Benefits to NS Power Customers

Customer benefits received to date are being reported by NS Power with its Quarterly Fuel Adjustment Mechanism Report.

3.0 UPDATED COST SUMMARY

As per Enerco U-31, section 6, the details below outline the DG3 forecasted costs.

Table 2 provides an updated cost summary for the Maritime Link, which includes actual costs incurred as of September 30, 2020 and forecasted total costs for the remainder of the Project's construction activities.

Costs associated with trenching the submarine cables (and associated with transmission line corrective work noted in section 2.7) are reflected in this report.

NSPML continues to track and report all costs, actual and forecast, consistent with the methodologies used in the cost forecast represented in the Maritime Link Project Application. Capitalized project costs include fully allocated costs for the entire Project Management Team, including contractors, employees, executives dedicated to the project, and NS Power seconded employees at affiliate mark-up rates according to the Affiliate Code of Conduct. All costs provided are in Canadian dollars.

Actual AFUDC has been tracked and recorded monthly up to December 31, 2017 and totals approximately $209 million as of that date, which is below the $230 million amount estimated at the time of filing of NSPML's Application.

Table 2 Updated Cost Summary for the Maritime Link Project

(000's of Canadian Dollars)	Actual Costs						
Description	2011-2019	Q1 2020	Q2 2020	Q3 2020	Total Project to Date	Estimate to Completion	Total Project Estimate at Completion (A)
Emera NL Project Management Costs	**192,250**	**940**	**794**	**531**	**194,515**	**260**	**194,774**
Nalcor Project Support Costs	**16,214**	-	-	-	**16,214**	-	**16,214**
Construction and Engineering Initiatives	**1,345,574**	**(108)**	**1,225**	**2,304**	**1,348,995**	**3,742**	**1,352,737**
Environmental Approval	18,397	-	19	-	18,416	20	18,436
Submarine and related	343,726	(648)	363	8	343,449	277	343,726
Converters, structures, and other ancillary equipment	548,260	50	35	63	548,408	2,410	550,818
AC and DC Transmission	435,191	490	808	2,233	438,722	1,035	439,757
Total	**1,554,038**	**832**	**2,019**	**2,835**	**1,559,724**	**4,002**	**1,563,725**
Contingency					-	-	-
Escalation						**13,629**	**13,629**
Grand Total	**1,554,038**	**832**	**2,019**	**2,835**	**1,559,724**	**17,631**	**1,577,354**

Note: Total forecast for Project completion continues to be within $1.577 M. No amount has been estimated in this forecast for the potential recovery of costs from third parties, which continue to be advanced. Any such recovery will be used to reduce the final cost.

Total Actual Project Costs at end of Q3 2020 Compared to Previous Forecast

The total actual project capital costs incurred during Q3 2020 of $2,835,000 are detailed below:

- Emera NL Project Management Costs of $531,000: Project management costs continue to be incurred as work advances relating to closing out of contracts, procuring and managing punch list and corrective activities, and ensuring appropriate documentation is in place for project closeout and regulatory purposes. NSPML has segregated these capital costs from costs relating to operating and maintenance activities and have expensed such operating and maintenance costs accordingly.

- Submarine and related of $8,000: This reflects an adjustment for final costs associated with the 2019 subsea cable trenching work.

- Converters, structures, and other ancillary equipment of $63,000: This reflects the cost of NL Hydro and NS Power system upgrades and modifications, as well as the procurement of material spares in both provinces.

- AC and DC Transmission of $2,233,000: This reflects corrective transmission activities.

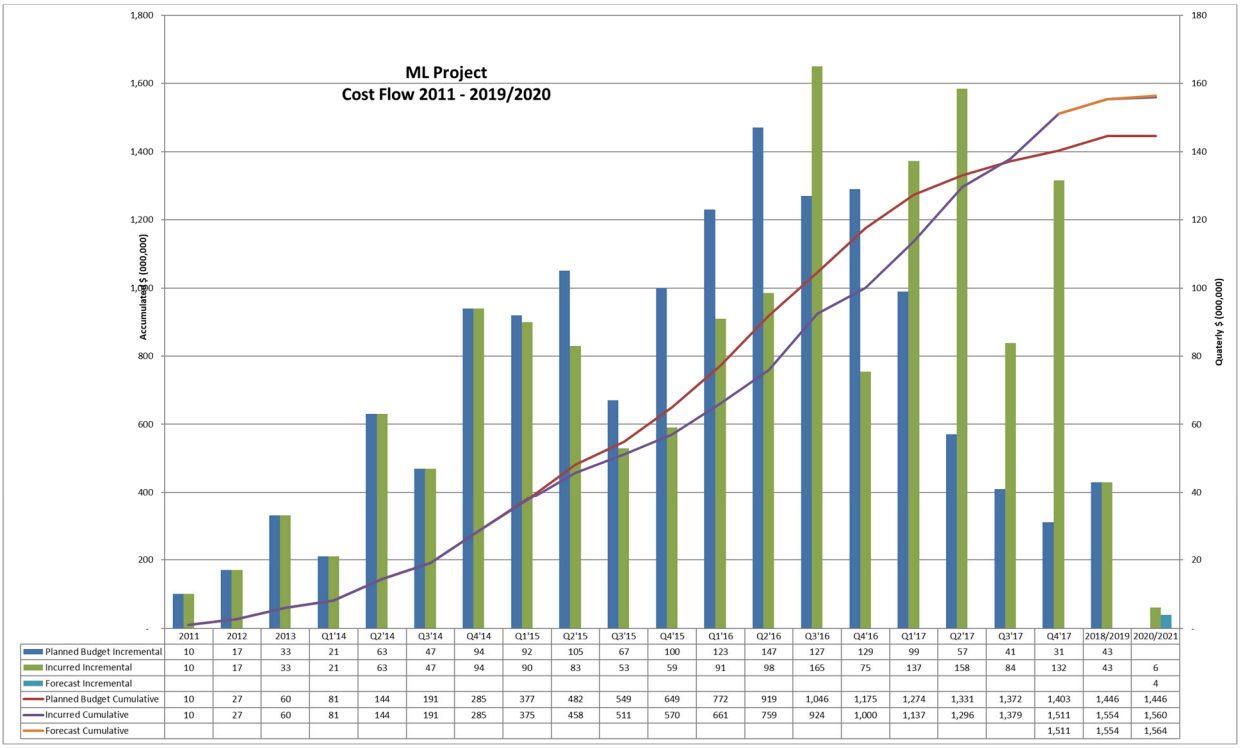
The Project capital cost remains within budget.

4.0 COST FLOW

As per Enerco U-31, section 2.2, please refer to Table 3 below for the cost flow of the Maritime Link. This cost flow report for the base capital spending is forecast at $1.564 billion (prior to the potential recovery of costs from third parties as noted in Section 3.0); no contingency draw has been required since the draw approved by the Company's Board of Directors in Q1 2020.

The remaining budget includes forecasted costs relating to transmission corrective activities, completion of documentation and close out of payments to contractors, as well as regulatory and environmental requirements relating to the construction aspect of the project. Certain of these costs are expected to take place in 2021 and will require further draws on remaining budgeted contingency/escalation balances. The total forecast of base capital spending, escalation, and contingency amounts for the project remains at or below $1.577 billion.

Table 3 Maritime Link Cost Flow



	2011	2012	2013	Q1'14	Q2'14	Q3'14	Q4'14	Q1'15	Q2'15	Q3'15	Q4'15	Q1'16	Q2'16	Q3'16	Q4'16	Q1'17	Q2'17	Q3'17	Q4'17	2018/2019	2020/2021
Planned Budget Incremental	10	17	33	21	63	47	94	92	105	67	100	123	147	127	129	99	57	41	31	43	
Incurred Incremental	10	17	33	21	63	47	94	90	83	53	59	91	98	165	75	137	158	84	132	43	6
Forecast Incremental																					4
Planned Budget Cumulative	10	27	60	81	144	191	285	377	482	549	649	772	919	1,046	1,175	1,274	1,331	1,372	1,403	1,446	1,446
Incurred Cumulative	10	27	60	81	144	191	285	375	458	511	570	661	759	924	1,000	1,137	1,296	1,379	1,511	1,554	1,560
Forecast Cumulative																			1,511	1,554	1,564

5.0 INTERIM ASSESSMENT FINANCIAL UPDATE 2020

With the Maritime Link placed in-service on January 15, 2018, NSPML continues to receive monthly cost recovery revenues from NS Power pursuant to the Board's November 27, 2019 Order. NSPML forecasts its 2020 operating and maintenance, debt and equity financing costs to be within the amounts budgeted for the year.

Operating Agreement Requirements Arising from the Formal Agreements

	Agreement	Parties	Description	Formal Agreement Source	Status
1.	Asset Interconnection Agreement (NL)	Emera, NLH	Interconnection of ML with the Island Interconnected System	ML-JDA, s. 2.1 (c)	Completed
2.	Multi-Party Pooling Agreement	Emera, NLH	NLH (SO) to have operational control of ML NLH AC Upgrades	ML-JDA, s. 2.1 (d)	Completed
3.	Transmission Operating Agreement (NL)	Emera, NLH	NLH (SO) to have operational control of ML NL HVdc Facilities	ML-JDA, s. 2.1 (e)	Completed
4.	Asset Interconnection Agreement (NS)	Emera, NSPI	Interconnection of ML with NS bulk electric transmission system	ML-JDA, s. 2.1 (f)(i)	Completed
5.	Transmission Operating Agreement (NS)	Emera, NSPI	NS SO to have general operational control of the ML	ML-JDA, s. 2.1 (f)(ii)	Completed
6.	ECA – Metering and Measuring Standards – Transmission Losses	NSPML, Nalcor	Metering and measuring standards used in the calculation of Transmission Losses	ECA, Schedule 3, s. 5	Completed
7.	Regulation Service Agreement	NS Power NLH	Nalcor's provision of the Regulation Service with respect to the Nova Scotia Block for the Initial Term	ECA, Schedule 5	Expect completion prior to delivery of the NS Block
8.	Metering and Measuring Standards – NS NTQ transmission losses	NSPML, Nalcor	Metering and measuring standards used in calculation of NS –NTQ Path Peak and Off-Peak Hour transmission losses	NSTUA, Schedule 3, s. 6	Completed
9.	NB Back-up Capacity Agreement	Bayside Power L.P, Nalcor	Emera's provision of backup Capacity to NB to Nalcor until March 31, 2021	NBTUA, s. 2.1(d)	No longer required given sale of Bayside to NB Power.
10.	IOA – ML Transmission Procedures	NSPI, NLH	Rules and practices applicable to administration of transmission service over the ML	IOA, Schedule D	Completed
11.	IOA – Reserve Sharing	NSPI, NLH	Sharing of energy and reserves between the Parties to improve Reliability	IOA, Schedule A	Completed
12.	IOA – Description of Interconnection Facilities	NSPI, NLH	Description of Interconnection Facilities for which each Party is responsible	IOA, Schedule B	Completed
13.	IOA – Functional Operating Relationship	NSPI, NLH	Various matters relating to operating relationship	IOA, Schedule C	Completed

14.	IOA – Operating Procedures	NSPI, NLH	IOC to develop "operating procedures"	IOA s.7.2 and s. 7.4(a)	Completed
15.	IOA – Schedule A1.0	NSPI, NLH	Parties to prepare a plan for NLH participation in Reliability Assessment Program ("RAP")	IOA Schedule A1.0	Completed
16.	ML TSA – ML Scheduling Process	Emera and Nalcor	Scheduling process applicable to the provision of Firm Point-to-Point Transmission Service	MLTSAs, Schedule 2	Completed
17.	Amendments to Formal Agreements	Emera, Nalcor	Amendments to Formal Agreements required by Sanction Agreement	Sanction Agreement	Completed
18.	Energy Access Agreement	Emera, Nalcor	Commitments regarding access to market priced energy	Compliance Filing, Appendix A	Completed
19.	Balancing Service Agreement	Emera, Nalcor	Nalcor commitment to provide balancing services from generation sources in NL for 25 years.	Energy Access Agreement Term Sheet, s. 7(g) and Appendix 1	Completed
20.	Assignment of Transmission Rights under ML(E)TSA	Emera, Nalcor	Assignment of Transmission Rights	ML(E)TSA, s. 3.3 (h)	Completed
21.	Assignment of Energy Access Agreement	Emera, Nalcor, NSPI and Nalcor Energy Marketing (NEM)	Assignment/assumption of Nalcor's rights and obligations to/by NEM	EAA s. 15.1 (a)	Expect completion in 2021.
22.	Assignment of Nalcor Master Agreement (EAA Schedule 2)	Nalcor, NSPI and NEM	Assignment/assumption of Nalcor's rights and obligations to/by NEM	Nalcor Master Agreement s. 10.5 (a)	Expect completion in 2021.
23.	JOA-Joint Operating Committee ("JOC")	Nalcor and NSPML	Establish/Operationalize JOC	JOA s. 3.1, 3.5	Completed
24.	NS Transmission Utilization Agreement	Nalcor and Emera	Status of Emera firm Point to Point Transmission Service	NSTUA s.s.2.2 (a)-(c)	Completed

2019 SUBMARINE CABLE INSPECTION AND SURVEY

PROJECT FINAL REPORT

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Client rev.	DOF rev.	Date	Description	Prepared by	Checked by	Approved by	Client Approval
-	A	04.12.2019	Issued for IDC	CRB	JAI	JAI	-
1	B	04.12.2019	Issued for Review	CRB	JAI	JAI	-
2	C	16.03.2020	Re-Issued for Review	CRB	CAB	JAI	-
3	D	30.04.2020	Re-Issued for Review	CRB	CAB	JAI	
4	00	27.05.2020	Issued for Use	CRB	JAI	JAI	

RECORD OF AMENDMENTS

Revision	Section No	Paragraph No.	Description of Change
C	All		Incorporated client comments
C	5.1		Revised section to summarize changes in 2018-2019 and 2017.
C	5.2		Added commentary on the existence of freespans
C	App B & F		Added commentary to include 2017/2018 findings as well as 2018/2019 changes when describing the cable protection changes in areas where change was present Added Cross Profiles to show the 2017, 2018 and 2019 data sets to illustrate how the cable protection has changed Added supporting photographs of each section where to understand the condition of the cable protection of the described area and allow for understanding of the results shown by the DTM.
C	New		Added new appendix for cable protection review of Nexans 2019 IMR survey data for ML1
C	New		Added new appendix for cable tracker data assessment for ML1
C	New		Added new appendix for Nexans cable tracker data assessment for ML1
D	All		Incorporated client comments
D	New		Added Total Propagated Uncertainty as a new section.
D	New		Moved Freespans to its one section
D	5.1		Added HDD berms
D	5.4		Added the difference charts for Cape Ray KP[redacted] for the scour areas for both Cables.
D	5.1		Added last years significant trench changes for both cables
00	All		Incorporated client comments

HOLD STATUS SHEET

HOLD No.	Section No.	Paragraph No.	Description of HOLD

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ABBREVIATIONS

Abbreviation	Description
ATTU	Accurate Time Tagging Unit
CSRS	Canadian Spatial Reference System
CTD	Conductivity Temperature Density
DCC	Distance Cross Course
DGNSS	Differential Global Navigation Satellite System
DTM	Digital Terrain Model
DPR	Daily Progress Report
DSCA	DOF Subsea Canada
DVL	Doppler Velocity Log
DVR	Digital Video Recorder
ENL	Emera Newfoundland & Labrador
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
GRS80	Geodetic Reference System 1980
HD	High Definition
HDD	Horizontal Directional Drilling
HIPAP	High Precision Acoustic Positioning
HSE	Health, Safety and Environment
HSEQ	Health, Safety, Environment and Quality
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
ITP	Inspection Test Plan
KP	Kilometre Post
LLWLT	Lower Low Water Large Tide
MBE	Multi-beam Echosounder
ML1	Maritime Link 1 Cable
ML2	Maritime Link 2 Cable
MSB	Mean Seabed
NAD83	North American Datum 1983
PPS	Pulse Per Second
QC	Quality Control
RAID	Redundant Array of Independent Disks
ROV	Remotely Operated Vehicle
SD	Standard Definition
SIT	Silicon Intensified Target
STD	Standard
TOC	Top of Cable
USBL	Ultra-Short Baseline
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator
WGS84	World Geodetic System 1984

1.0 INTRODUCTION

The Maritime Link Transmission System has been in operation since January 2018. The system includes two HVdc cables, approximately 167km in length that run across the Cabot Strait between Cape Ray, NL and Point Aconi, NS.

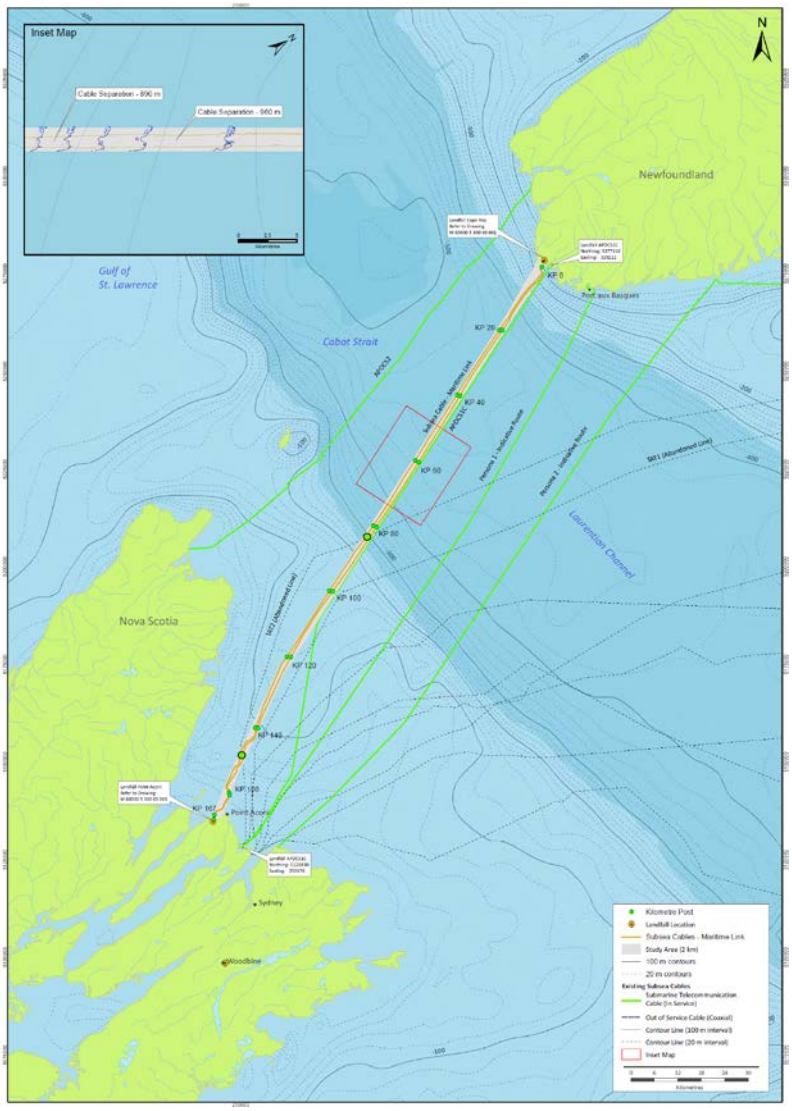


Figure 1: Overview of Survey Site

1.1 SCOPE OF DOCUMENT

The purpose of this document is to detail the operations undertaken during the 2019 Submarine Cable Inspection and Survey.

1.2 SCOPE OF WORK

The Maritime Link Transmission System has been in operation since January 2018. The system includes two HVdc cables, approximately 167km in length, that run across the Cabot Strait between Cape Ray, NL and Point Aconi, NS. Maximum Water Depth of Cable Route: Approx. 470m.

The original Scope of Work which was set to be performed during the 2019 Submarine Cable Inspection and Survey program was as follows:

1. Geo-physical (Multibeam), Depth of Burial and Visual Inspection survey of both submarine cable routes of approx. 167km between each respective provincial landfall.
2. Submarine Cable Route Intervention activities
    - As Required

Once the survey was started, NSPML notified DOF Subsea of a reduced scope of work. The revised scope of work performed during the 2019 campaign was as follows:

1. Geo-physical (Multibeam), Depth of Burial and Visual Inspection survey of Maritime Link 1 [redacted] submarine cable route of approx. 81km between each respective provincial landfall.
2. Geo-physical (Multibeam), Depth of Burial and Visual Inspection survey of Maritime Link 2 [redacted] submarine cable route of approx. 107km between each respective provincial landfall.

2.0 EQUIPMENT AND PERSONNEL

Mobilization commenced onboard the Horizon Star on September 14th in the Port of St. John's, NL. Demobilization was complete October 8, 2019 in the Port of St. John's, NL.

2.1 PERSONNEL

The following table outlines the personnel positions onboard during the project.

Position	Quantity
Marine Crew	21
Offshore Manager	1
Survey Party Chief	1
Survey Engineer	1
Senior Surveyor	2
Data QC/Processor	2
ROV Supervisor	2
ROV Pilot Technician	4

2.2 EQUIPMENT

The following equipment was utilized for the project;

Description	Quantity
Perry Tritech XLX111 Work class ROV	1
Kongsberg HiPAP500 Acoustic Transceiver System	1
Veripos LD5 GNSS Receiver with ULTRA subscription	1
CNAV 3050 GNSS Receiver with C-NavC²	1
Gyro Compass – Ixsea Octans	1
Attitude Sensor – Seatex MRU5	3
Surface Barometer - Vaisala	1
EIVA NaviPac	1
Remotes (NaviPac)	2
EIVA NaviScan	1
EIVA Timebox (ATTU)	1
Visual DVR	1
Visual Archive	1
Visual Event Professional	1
Multibeam PC (Kongsberg M3)	1
RTS 1 PPS splitter	1
Video Monitors (ROV camera feeds)	3
Reports PC	1
Reports Printer	1
EIVA NaviEdit	1
EIVA NaviModel	1

AutoCAD	1
Offline Data storage RAID	1
Midas CTD	1
RDI Workhorse DVL	1
Depth Sensor (1000m)	1
Valeport MiniSVS	1
Transponder w/ Charger	4
Kongsberg M3 Multibeam	2
MBE Frame	1
HD Camera	1
SD Camera	1
Standard ROV tooling kit	1
XLX Critical Spares Set	1
TSS 350 Cable Tracker	1
SPRINT-Nav 500	1

2.2.1 Software

The following equipment was utilized for the project;

Software	Purpose/Use
EIVA NaviPac	Online navigation software
EIVA NaviScan	Multibeam data acquisition software
EIVA NaviEdit	Data Processing software
EIVA NaviModel	Data Processing Model/DTM software
Visual DVR	Record digital video from the ROV cameras
Visual Event	Records the position of events
Visual Archive	Archiving of all video, events and survey sensor data
Visual Review	Provides the facility to view Visual Works reports without having the Visual Works software
DataLog 400	Acquisition of seawater properties
Hyper-terminal	Testing / Communication Software
Adobe Acrobat Standard	Reading/writing of pdf documents
MS Office	Reporting, log sheets, spreadsheets
AutoCAD	Field drawings/structure drawings
AutoChart	Charting software
Real VNC	To remotely control smart remote PCs
WinZip	Compression of files
wwDPR	DOF standardized DPR reporting program

2.3 HSEQ STATISTICS

The following HSEQ statistics were achieved over the offshore portion of the project;

Leading Indicator	Cumulative
Toolbox Talk	116
Daily Briefing/Meeting	2
Safe Job Analysis	79
Safety Observation	222
Project Briefing	1
Vessel Induction/Familiarization	28
Joint Occupational Health and Safety Committee	1
Muster/Drill	1
Safety/Improvement Suggestion	1
HSE / Management Visit	3
Work Permits	26
Management of Change	1
Procedure/plan review	2
ITPs closed	12
Total	**495**

Lagging Indicator	Cumulative
Fatality	0
Lost Time Injury	0
Restricted Work Case	0
Medical Treatment Injury	0
Recordable Injury	0
First Aid Injury	0
Environmental Report	0
Security Incident	0
Property Damage	0
Incident Report	0
Near Miss Report	0
Asset Damage Reports	0
Non-Conformance Report	0
Total	**0**

3.0 GEODETIC SURVEY PARAMETERS

3.1 INTRODUCTION

The following units and parameters were used for the duration of the project unless it is clearly stated otherwise.

3.1.1 Units

- Linear units are metres.
- Angular units are degrees (°), Grid.
- All times will be recorded in Newfoundland Daylight Time (UTC - 02:30).

3.2 REAL-TIME POSITIONING

3.2.1 Horizontal Datum

All positioning was carried out using the GRS80 spheroid with grid co-ordinates based on the Transverse Mercator projection with a Central Meridian 57º West. Details of the horizontal datum parameters used during the project are presented below:

Local Spheroid Parameters	
Spheroid:	GRS80
Datum:	NAD83 (CSRS)
Semi-major axis:	6 378 137.0 metres
Flattening:	1/298.257222101
Projection Parameters	
Projection:	Universal Transverse Mercator
Central Meridian:	57ºW
UTM Zone	21 (North)
False Easting:	500000 metres
False Northing:	0 metres
Central Meridian Scale Factor:	0.999600
GPS Spheroid Parameters	
Spheroid:	WGS84
Datum:	WGS84
Semi-major axis:	6 378 137.000m
Flattening:	1/298.2572236

3.2.2 Datum Transformation

WGS84 (World Geodetic System 1984) is the geodetic reference system used by GPS.

The working and reporting datum used by the cable installation contractor was NAD83 (CSRS) without any transformation parameters **from** NAD83 (CSRS) **to** WGS84. NAD83 (CSRS) can be considered coincident with WGS84.

Transformation Parameters	
Delta X	-
Delta Y	-
Delta Z	-
Rx	-
Ry	-
Rz	-
Scale	-

3.2.3 Vertical Datum

The data collected in 2017 and provided by ENL to DOF Subsea was tidally corrected to LLWLT during post processing.

Depths reported as stated were reduced to LLWLT based on predicted tidal data from St. Paul (Station #1530) and Port aux Basques (Station #665).

DOF subsea referenced all reported 2019 depths relative to the seabed 2018 depths. This method will minimize any discrepancies between the two data sets and ensure a degree of repeatability and consistency with the previous work scopes.

3.3 SURVEY TOLERANCES

Please refer to the 2019 Mobilization and Calibration Report (D-000OP-0-950-04-217) for information regarding the survey system verification.

3.3.1 System Accuracies

Operation	Accuracy
CNAV 3050 DGNSS	< 0.20 m
Veripos DGNSS	< 0.20 m
USBL HiPAP Positioning	± 0.3° (Angular accuracy) ± 0.2m (Range Detection) (Angle accuracy being a function of S/N ratios).
Vessel Surface Gyrocompass (Octans)	+/- 0.1° secant latitude (heading) 0.01° RMS (pitch/roll)

Operation	Accuracy
Vessel AnschÜtz STD 22	± 0.1 secant latitude (heading)
ROV Gyrocompass (Octans)	+/- 0.1° secant latitude(heading) 0.01° (RMS)(pitch/roll)
Water Sound Velocity (CTD)	Conductivity +0.01s/m Temperature +0.01° Celsius Depth +0.1% full scale
Kongsberg M3	Vertical Beam width 3° Range Resolution: 1cm Frequency: 500 kHz Number of Beams: 256
Depth Sensor (1000m rated)	Pressure 0.01% full scale
ROV Altimeter	Resolution 0.001m
RDI Workhorse DVL - 1200kHz	Minimum Long-term Error Accuracy (cm/s) ±0.2% ±0.01
TSS Cable Tracker	Vertical – 5cm or 5% of slant range whichever is greater Max detection range – Cable detected at vertical range up to 10m and within a total horizontal swath of 20m centered on coil array.
SPRINT-Nav 500	Typical Survey: 0.02% Distance Travelled Distance from Origin (DFO): 0.07% Distance Travelled

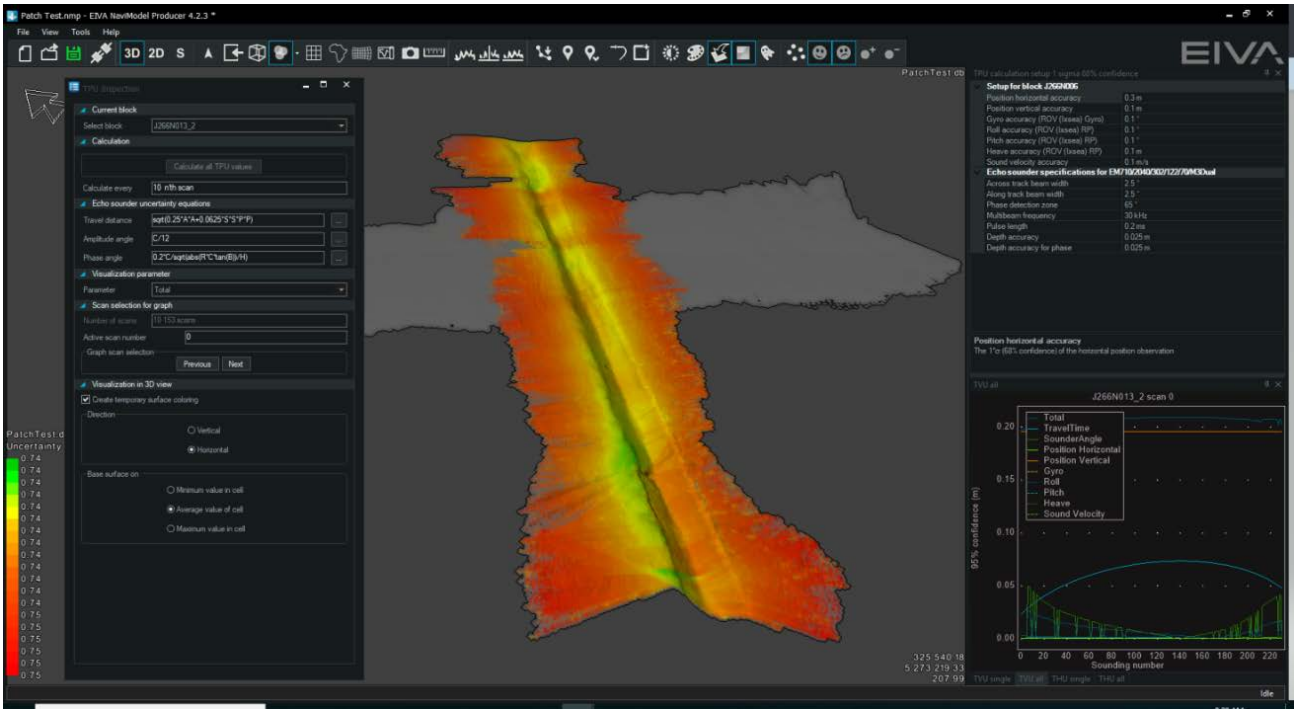
3.3.2 Total Propagated Uncertainty

When evaluating error budgets and survey systems accuracies, one must take the entire survey system spread into account. EIVA has developed a module that incorporates each individual sensor accuracy, along with factors such as like operating conditions, (water depth) and vessel/ROV motion, to produce a Horizonal and Vertical Uncertainty value for each sounding.

For the 2019 campaign, predicted tides were utilized, which only have an accuracy of approximately +/-0.3m. The uncertainty was calculated at a water depth of 208m, where the calibration activities were conducted. The 2019 inspection campaign occurred between 12 – 400m water depth.

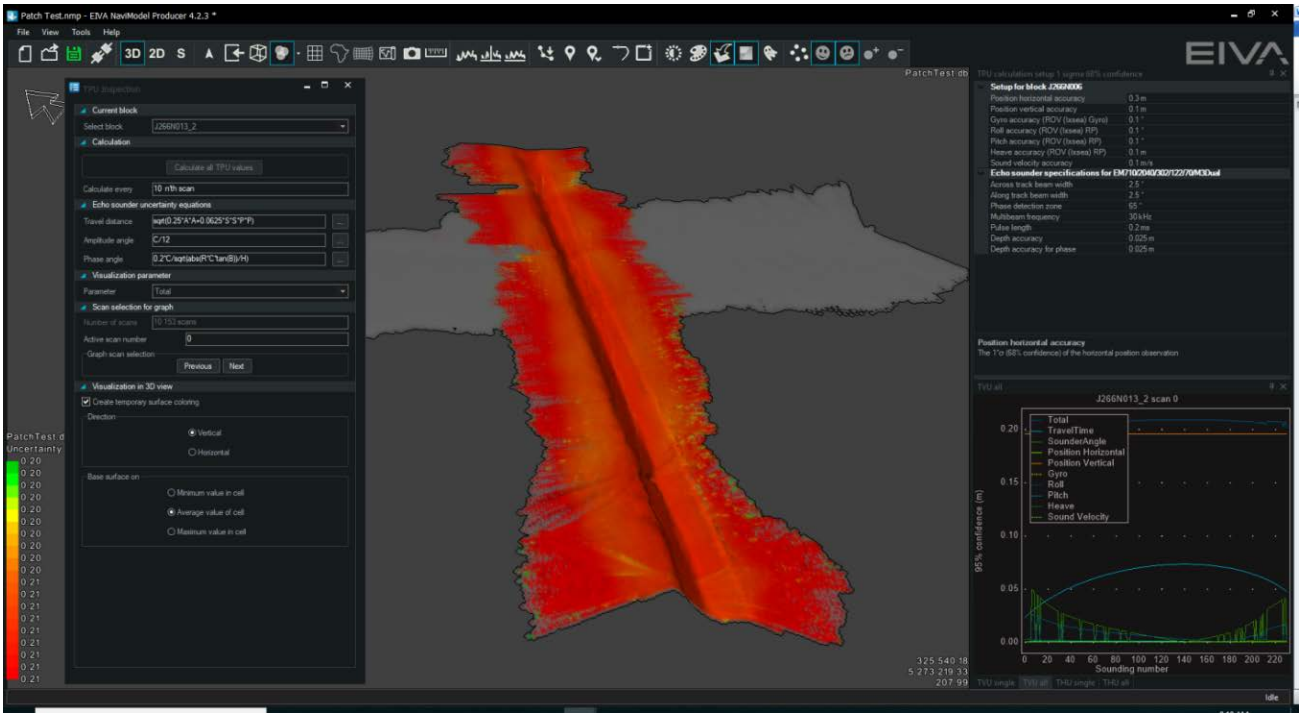
3.3.2.1 **Horizontal Uncertainty**

The horizontal uncertainty was determined to be 0.75m in 208m of water depth.



3.3.2.2 **Vertical Uncertainty**

The vertical uncertainty was determined to be 0.21m in 208m of water depth.



4.0 MOBILISATION AND CALIBRATION RESULTS

The main objective during the mobilization period was to ensure all survey and ROV equipment was onboard and operational, including ROV interfacing completed, fully tested, and the project data was entered into the navigation system prior to the commencement of the project work scope. Full details of the mobilization and calibrations for the project, including positional accuracies of the deliverables can be found in Horizon Star Mobilization Report D-000OP-0-950-04-217.

5.0 SURVEY OPERATIONS

An inspection of the Maritime Link Cables 1 and 2 were performed in September-October 2019. The inspection was performed to monitor the depth of cover, scour, and trench/rock berm condition. A centre multi-camera configuration (HD, SD, and SIT) was utilized.

The recorded video was annotated with the RAW sensor data including date, UTC time, heading, depth, KP and UTM co-ordinates using the video overlay system. The data was monitored by the online surveyor and checked offline by the data processor as part of the data QC process.

Prior to the ROV leaving deck, all survey sensors and video were verified to ensure all data was received offline. A CTD cast was performed when deemed necessary and the values entered in the online software. Typical operations dictated casts to be performed twice a day but depending on changes in depth and sound velocity, additional casts were recorded. CTD cast frequency was also dictated by weather. If the ROV could not continue to the surface safely, the current CTD cast in use would be extended / interpolated.

The mean seabed (MSB) depth was generated from the multibeam data.

Additionally, there was Maritime Link operational constraints where an injected tone source could not be applied to each cable for the depth of burial survey during a certain period spanning the survey duration. Where no tone was available, the natural operating frequency of the Maritime Link cables sensed by the cable tracker equipment provided unusable depth of cover data, hence the requirement to use the Nexans 2017 burial data for areas that had no tone applied. For the Maritime Link 1, the Top of Cable (TOC) contains results from the TSS cable tracker from [redacted] The remaining surveyed area utilizes TOC from 2017 Nexans data. The surveyed sections of Maritime Link 2 uses 2017 Nexans data for TOC. The use of Nexans 2017 data for TOC was required because initially the cable tracker was mounted on the front of the ROV, which resulted in unreliable cable tracker data due to interference between the cable tracker and the ROV. Once the cable tracker was relocated to the aft of the ROV, which allowed for more separation between the cable tracker and ROV, the data was reliable and repeatable.

5.1 SUMMARY OF RESULTS

The following sections highlight areas along each cable route where cable protection levels have changed from 2018 to 2019. The values presented are indicative only. The NaviModel DTMs and 1m Listings detailed in Section 5 should be consulted for true comparative assessments. In areas that protection levels have changed, a further comparison was completed between 2019 and 2017 (as-installed data) to see if cable protection continued to increase or decrease.

Overall, both cables' trenched areas continued to naturally backfill to natural seabed depth with no change in rock berms. The areas where trench widening was observed in 2018 had no further widening in 2019, however the trenches contained a significant amount of Marine Bio Matter.

As with any two datasets, differences will be present due to the error budget associated with each survey system setup. The EIVA NaviModel software has a module with that calculates uncertainties for complete survey sensor spreads.

For the 2019 campaign, the Total Horizontal Uncertainty was calculated to be 0.75m and the Total Vertical Uncertainty was 0.21m in 208m of water depth. These are indicative values as majority of the survey occurred at various depths both deeper and shallower than 208m. Refer to section 3.3.2 for further details.

All data collected fell within the expected survey system accuracies.

5.1.1 Maritime Link 1

5.1.1.1 Maritime Link 1 HDD Berms

5.1.1.1.1 Cape Ray, NL

The largest change occurred from 2017 to 2018, as the top of the berm was rounded off. From 2018 to 2019 there was no change in the shape of cover for the Cape Ray, NL HDD Berm. The below images are from the DTM model and the Video files.

From 2017 to 2018 there was scouring of 0.8m present to the east of the HDD berm for Cape Ray, however from 2018 to 2019 the scoured area appears to of slightly backfilled 0.4m.

5.1.1.1.2 Point Aconi, NS

From 2018 to 2019 there was no change in the Point Aconi HDD Berm, indicating no change in shape or sediment coverage over the cable. The below images are from the DTM model and the Video files.

5.1.1.2 **Maritime Link 1 Trenched Areas**

The below table presents a high-level overview of the changes in the trenched areas observed in 2019 since the 2018 survey, with reference to the original 2017 installation. For more detail on changes from 2017 to 2018 refer to 2018 Project Final Report (D-000OP-0-950-04-019). Refer to Appendix B for a meter by meter level comparison of 2018 to 2019 and 2017 to 2019 for areas where change was observed from 2018 to 2019.

KP Start	KP End	Condition 2018-2019	Condition From 2017-2019
[redacted]	[redacted]	Trenched areas have naturally backfilled. No Trench visible.	Trenched areas have naturally backfilled. Trench partially still visible.
[redacted]	[redacted]	Trench has naturally backfilled, estimated 0.25m additional sediment, Trench still present.	Trench has naturally backfilled, estimated 0.40m additional sediment, Trench still present.

[redacted]	[redacted]	Trench has naturally backfilled, estimated 0.15m additional sediment, Trench still present.	Trench has naturally backfilled, estimated 0.20m additional sediment, Trench still present.
[redacted]	[redacted]	Trenched areas have naturally backfilled. No trench visible.	Trench was partially backfilled from 2017 to 2018. Trench is no longer visible along the entire section.

The 2018 inspection campaign highlighted a large section of trenched area had widened and deepened significantly since installation in 2017. There was no change observed in the trench in these same areas between 2018 and 2019. The wider and deep trench characteristics observed in 2018 are still present. The below table is highlights the area extents of the widened trench.

KP Start	KP End	Condition
[redacted]	[redacted]	Trench edges are scouring resulting in a wider trench – approximately 8.5m in total width. Trench is deepening – gradually and up to a maximum of 1.1m deeper
[redacted]	[redacted]	Trench has naturally backfilled, estimated 1.20m additional sediment
[redacted]	[redacted]	Trench edges are scouring resulting in a wider trench – approximately 7m in total width. Trench is deepening – gradually and up to a maximum of 1.1m deeper

5.1.1.3 **Maritime Link 1 Rock Berm Areas**

No changes in rock berm data was observed between 2018 to 2019.

5.1.1.4 **Maritime Link 1 Cable Tracker Data**

For Maritime Link 1 DOF collected cable tracker data for sections [redacted]. Overall, the average for difference in top of cable from 2017 to 2019 was 0.07m indicating repeatably between data sets. However, there were some significant changes in the TOC from installation in 2017 to 2019. Below is a table of the most significant change. For a more detailed analysis see Appendix D along with the final deliverables.

KP Start	KP End	Condition 2017-2019
[redacted]	[redacted]	Cable tracker showing a deeper TOC of 0.3-1.45m. Area contains significant trench scouring between 2017 and 2018. No change in shape of trench from 2018 to 2019.
[redacted]	[redacted]	Cable tracker showing a shallower TOC of 0.2-0.5m. Area contains significant trench scouring between 2018 and 2019 and exposed cable. No change in shape of trench from 2018 to 2019.
[redacted]	[redacted]	Cable tracker showing a shallower TOC of 0.2-0.7m.

During the 2019 campaign, ENL performed further trenching activities to ensure optimal cable protection. Within this area, a section of cable tracker data was collected by DOF and Nexans. DOF was able to analyze and compare the depth of cables observed by both parties to determine repeatability and have a more definitive depth of cable. The average between the two data sets was 0.06m, with a maximum difference of only 0.13m. These results are within the accepted tolerances of the systems.

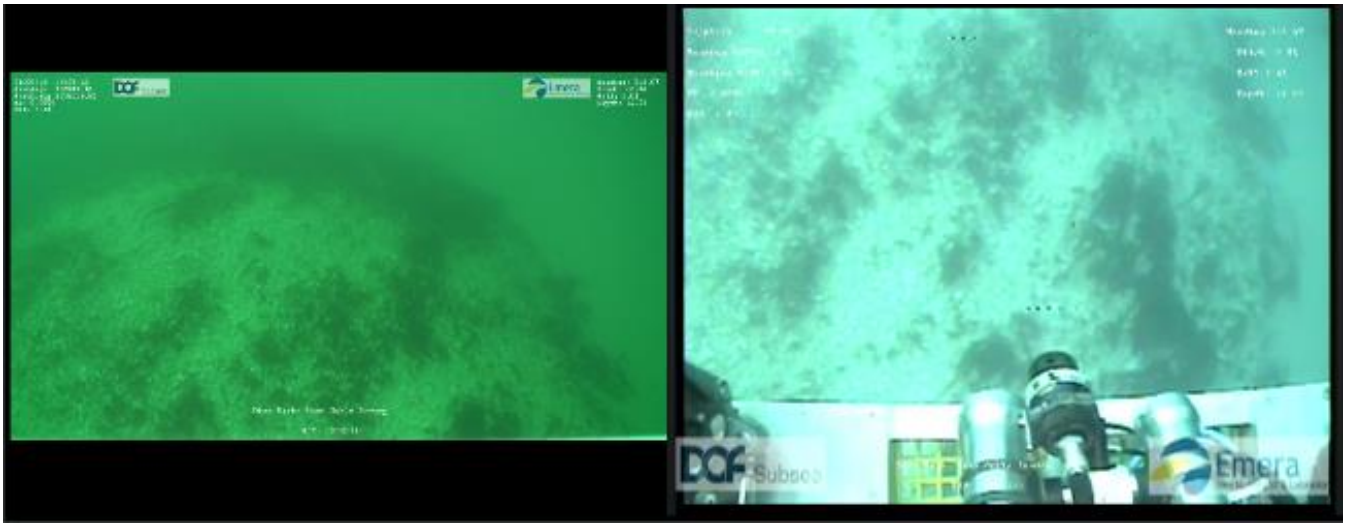
5.1.2 Maritime Link 2

5.1.2.1 Maritime Link 2 HDD Berms

5.1.2.1.1 Cape Ray, NL Berm

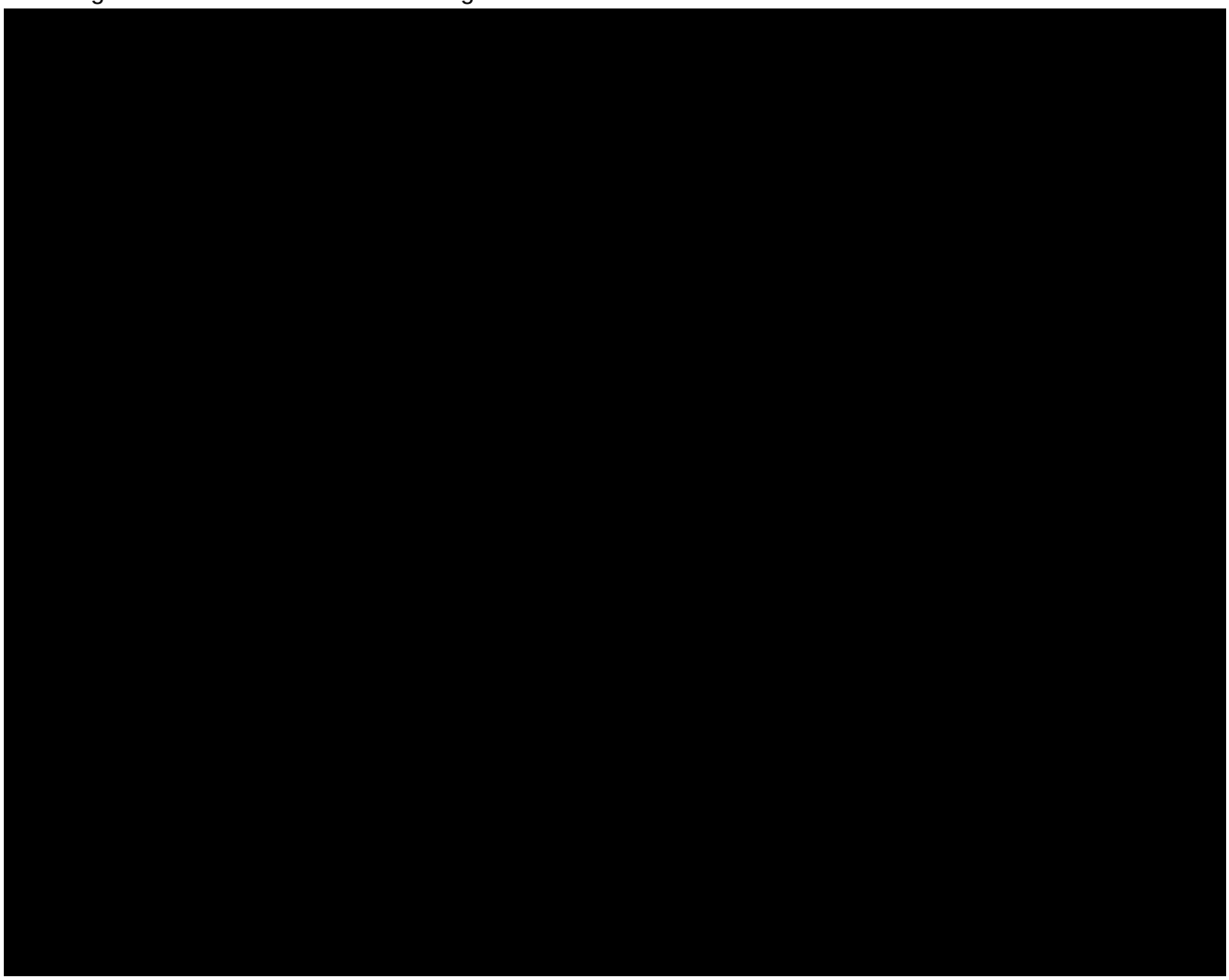
Much of the rock berm is showing minimal change in shape, however from [redacted] there is a substantial navigational discrepancy present both along and cross track. The berm appears to be smoothing out with the peak rounded off and has settled into the seabed. The primary change occurred between 2017-2018, with minimal change in 2019.

Scouring along the berm is no longer present.



5.1.2.1.2 Point Aconi, NS, HDD Berm

From 2018 to 2019 there was no change in the Point Aconi HDD Berm, indicating no change in shape or sediment coverage over the cable. The below images are from the DTM model and the Video files.



5.1.2.2 **Maritime Link 2 Trenched Areas**

The below table presents a high-level overview of the changes in the trenched areas observed in 2019 since the 2018 survey, with reference to the original 2017 installation. For more detail on changes from 2017 to 2018 refer to 2018 Project Final Report (D-000OP-0-950-04-019). Refer to Appendix E for a meter by meter level comparison of 2018 to 2019 and 2017 to 2019 for areas where change was observed from 2018 to 2019.

KP Start	KP End	Condition 2018-2019	Condition From 2017-2019
[redacted]	[redacted]	Trenched areas have naturally backfilled; Trench no longer visible.	Trenched areas have naturally backfilled. Trench was partially still visible in 2018.
[redacted]	[redacted]	Trenched areas have naturally backfilled, estimated 0.2m additional sediment; Trench no longer visible.	Trenched areas have naturally backfilled with 0.4-0.5m of cover over the cable. Trench no longer visible
[redacted]	[redacted]	Intermittent backfilling of trench - estimated 0.3m additional sediment with occasional locations with trench no longer visible	There was no change from 2017 to 2018. Change in cover occurred from 2018 to 2019.
[redacted]	[redacted]	Trenched areas have naturally backfilled, estimated 0.2m additional sediment. Trench no longer visible	Trenched areas have naturally backfilled with 0.6m of cover over the cable. Trench no longer visible
[redacted]	[redacted]	Trenched areas are naturally backfilling, estimated 0.15m additional sediment, trench still visible	Trenched areas have naturally backfilled with 0.2-0.3m of cover over the cable. Trench still visible
[redacted]	[redacted]	Trenched areas have naturally backfilled. Trench no longer visible.	There was no change from 2017 to 2018. Change in cover occurred from 2018 to 2019

The 2018 inspection campaign highlighted a large section of trenched area had widened and deepened significantly since installation in 2017. There was no change observed in the trench in these same areas between 2018 and 2019. The wider and deep trench characteristics observed in 2018 are still present. The below table is highlights the area extents of the widened trench.

KP Start	KP End	Condition
[redacted]	[redacted]	Trench edges are scouring resulting in a wider trench – approximately 6m in total width. Trench is deepening – gradually and up to a maximum of 0.8m deeper
[redacted]	[redacted]	Trench has naturally backfilled, estimated 0.3m additional sediment

5.1.2.3 Maritime Link 2 Rock Berm Areas

One rock berm change was observed from 2018 to 2019. The section in question is from [redacted], where the rock berm appears to have settled into the seafloor. There is no rock visible in the ROV video and the area in question has a loss in cover of approximately 0.2m. There was no change in berm from 2017 to 2018. Refer to images below and in Appendix E.

5.1.2.4 Maritime Link 2 Cable Tracker Areas

As discussed in Section 5, no cable tracker data was collected for Maritime Link 2 cable in the 2019 campaign. Thus, all top of cable depths and location was based on Nexans 2017 data.

5.2 EVENTS

The following event data was collected during the inspections:

1. Rock dump
2. Trench
3. Burial
4. Debris
5. Boulders
6. Marine Bio Matter
    a. Freespan Events within Marine Bio Matter noted

Upon completion of the survey, the event data was reviewed and merged with the smoothed navigation file to allocate each event in a processed position and KP value.

KP values for the inspection were generated based on the design route from the Emera supplied alignment sheets, with [redacted]

In addition, all events are also graphically represented on each chart series. A separate folder including an image of all events was submitted with the Event Listings.

No damage was noted during the inspection survey.

5.2.1 Freespans

Only freespans within Marine Bio Matter were identified for Maritime Link 1. Several additional freespans were observed in the MBE dataset within the marine bio mater areas, but the ROV video did not support this. The ROV video highlighted that the cable was in fact on the seabed or just below. From the ROV video, it is unclear if the Marine Bio Matter provides any support for the cables.

No freespans were identified for Maritime Link 2 as all data was referenced from Nexans 2017 TOC. By using the Nexans 2017 TOC dataset, DOF was not able to adjust the published TOC to match the visual and Multibeam data found in 2019 for Maritime Link 2.

The following is a tabulated list of the areas where the cable is showing freespan within Marine Bio Matter for Maritime Link 1:

KP(m)	Description	Length
[redacted]	Freespan_Start	7.000
[redacted]	Freespan_End	7.000
[redacted]	Freespan_Start	1.00
[redacted]	Freespan_End	1.00
[redacted]	Freespan_Start	1.00
[redacted]	Freespan_End	1.00
[redacted]	Freespan_Start	3.00
[redacted]	Freespan_End	3.00

5.2.2 Engineering Detail Events

Engineering detail events encountered for each cable included the following:

- Trench
- Burial
- Marine Bio Matter

    - o Freespan within Marine Bio Matter
- Rock dump

Sample pictures of each intervention events are presented below:

[redacted]

Marine Bio Matter

Rock Dump

5.2.3 Debris Events

Debris events encountered for each cable can be separated into two categories: hard debris and soft debris. Hard and soft classifications are further categorized into specifics such as litter, netting, plastic, metal, wood, etc. Refer to chart series for a detailed list of all possible event codes for debris.

Sample pictures of debris events are presented below:

A Crab Pot was located at [redacted] on Maritime Link 1 Cable and has been present since August 2017. No change in condition of partially buried crab pot was observed.

5.3 DELIVERABLES

The following deliverables were issued in support of this final report.

5.4 CHARTS

Upon completion of each cable survey and post processing, standard 4 panel charts were generated and comprised the following information:

Panel	Horizontal Scale	Vertical Scale
Plan View	1:5000	N/A
Depth of Burial Relative Longitudinal Profile	1:5000	N/A
Longitudinal Profile	1:5000	1:25
Engineering Detail	1:5000	N/A

5.4.1 Maritime Link 1 Chart Series

Maritime Link 1 chart series includes 34 charts.

Document Title	ENL Document Number	DOF Document Number
2019 - Maritime Link 1 – Chart Series	D-000OP-0-950-04-206	1004417-SV-CL-1035-007-0001

Start KP	End KP	Chart No.
[redacted]	[redacted]	1 of 34
[redacted]	[redacted]	2 of 34
[redacted]	[redacted]	3 of 34
[redacted]	[redacted]	4 of 34
[redacted]	[redacted]	5 of 34
[redacted]	[redacted]	6 of 34
[redacted]	[redacted]	7 of 34
[redacted]	[redacted]	8 of 34
[redacted]	[redacted]	9 of 34
[redacted]	[redacted]	10 of 34
[redacted]	[redacted]	11 of 34
[redacted]	[redacted]	12 of 34
[redacted]	[redacted]	13 of 34
[redacted]	[redacted]	14 of 34
[redacted]	[redacted]	15 of 34
[redacted]	[redacted]	16 of 34
[redacted]	[redacted]	17 of 34
[redacted]	[redacted]	18 of 34
[redacted]	[redacted]	19 of 34
[redacted]	[redacted]	20 of 34

Start KP	End KP	Chart No.
[redacted]	[redacted]	21 of 34
[redacted]	[redacted]	22 of 34
[redacted]	[redacted]	23 of 34
[redacted]	[redacted]	24 of 34
[redacted]	[redacted]	25 of 34
[redacted]	[redacted]	26 of 34
[redacted]	[redacted]	27 of 34
[redacted]	[redacted]	28 of 34
[redacted]	[redacted]	29 of 34
[redacted]	[redacted]	30 of 34
[redacted]	[redacted]	31 of 34
[redacted]	[redacted]	32 of 34
[redacted]	[redacted]	33 of 34
[redacted]	[redacted]	34 of 34

5.4.2 Maritime Link 2 Chart Series

Maritime Link 2 chart series includes 46 charts.

Document Title	ENL Document Number	DOF Document Number
2019 - Maritime Link 2 – Chart Series	D-000OP-0-950-04-207	1004417-SV-CL-1035-007-0002

Start KP	End KP	Chart No.
[redacted]	[redacted]	1 of 46
[redacted]	[redacted]	2 of 46
[redacted]	[redacted]	3 of 46
[redacted]	[redacted]	4 of 46
[redacted]	[redacted]	5 of 46
[redacted]	[redacted]	6 of 46
[redacted]	[redacted]	7 of 46
[redacted]	[redacted]	8 of 46
[redacted]	[redacted]	9 of 46
[redacted]	[redacted]	10 of 46
[redacted]	[redacted]	11 of 46
[redacted]	[redacted]	12 of 46
[redacted]	[redacted]	13 of 46
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[redacted]	[redacted]	18 of 46
[redacted]	[redacted]	19 of 46
[redacted]	[redacted]	20 of 46
[redacted]	[redacted]	21 of 46
[redacted]	[redacted]	22 of 46
[redacted]	[redacted]	23 of 46
[redacted]	[redacted]	24 of 46

Start KP	End KP	Chart No.
[redacted]	[redacted]	25 of 46
[redacted]	[redacted]	26 of 46
[redacted]	[redacted]	27 of 46
[redacted]	[redacted]	28 of 46
[redacted]	[redacted]	29 of 46
[redacted]	[redacted]	30 of 46
[redacted]	[redacted]	31 of 46
[redacted]	[redacted]	32 of 46
[redacted]	[redacted]	33 of 46
[redacted]	[redacted]	34 of 46
[redacted]	[redacted]	35 of 46
[redacted]	[redacted]	36 of 46
[redacted]	[redacted]	37 of 46
[redacted]	[redacted]	38 of 46
[redacted]	[redacted]	39 of 46
[redacted]	[redacted]	40 of 46
[redacted]	[redacted]	41 of 46
[redacted]	[redacted]	42 of 46
[redacted]	[redacted]	43 of 46
[redacted]	[redacted]	44 of 46
[redacted]	[redacted]	45 of 46
[redacted]	[redacted]	46 of 46

5.4.3 Difference Charts

Four chart series were completed of the four HDD punch-out locations - two on the Newfoundland side and two on the Nova Scotia side. Where water depth was shallow along the Nova Scotia Coast a chart series over 17kms were generated for the Point Aconi Charts.

Two chart series were completed for the Cape Ray Scour Area from [redacted] to highlight the scour area observed in 2018.

Document Title	ENL Document Number	DOF Document Number
Maritime Link 1 – Cape Ray HDD Exit DTM Difference 2018 vs 2019	D-000OP-0-950-04-226	1004417-SV-CL-908-0001
Maritime Link 1 – Point Aconi HDD Exit and Nearshore Approach DTM Difference 2018 vs 2019	D-000OP-0-950-04-228	1004417-SV-CL-908-0003
Maritime Link 2 – Cape Ray HDD Exit DTM Difference 2018 vs 2019	D-000OP-0-950-04-227	1004417-SV-CL-908-0002
Maritime Link 2 – Point Aconi HDD Exit and Nearshore Approach DTM Difference 2018 vs 2019	D-000OP-0-950-04-229	1004417-SV-CL-908-0004
Maritime Link 1 – Cape Ray Scour Area DTM Difference 2018 vs.2019	D-000OP-0-950-04-245	1004417-SV-CL-908-0005
Maritime Link 1 – Cape Ray Scour Area DTM Difference 2018 vs.2019	D-000OP-0-950-04-246	1004417-SV-CL-908-0006

5.5 VIDEO

ROV video was recorded for the entire scope of the survey for both cables.

Video files are within the below document:

Document Title	ENL Document Number	DOF Document Number
2019 Inspection Survey Video - Maritime Link 1 & 2	D-000OP-0-950-04-214	1004417-SV-CL-1035-014-0001

5.6 1M LISTINGS

Upon completion of each cable survey and post processing, 1m listings were generated.

1m Listings can be found in the below documents:

Document Title	ENL Document Number	DOF Document Number
2019 - Maritime Link 1 – 1m Listing	D-000OP-0-950-04-210	1004417-SV-CL-1035-012-0001
2019 - Maritime Link 2 – 1m Listing	D-000OP-0-950-04-212	1004417-SV-CL-1035-012-0003

The below sample illustrates the format and definitions provided:

KP	DCC (m)	Easting (m)	Northing (m)	TOC (m)	BOC (m)	PA (m)	SA (m)	PS (m)	SS (m)	MSB (m)	MAdj (m)	DOC (m)	DOL(m)
[redacted]	0.60	318720.80	5263949.75	404.24	404.34	404.27	404.28	404.12	404.18	404.15	404.27	-0.03	0.09
[redacted]	0.63	318720.40	5263948.73	404.28	404.38	404.27	404.28	404.23	404.27	404.25	404.27	0.01	0.03
[redacted]	0.65	318720.02	5263947.72	404.35	404.45	404.33	404.34	404.31	404.36	404.34	404.33	0.01	0.01
[redacted]	0.67	318719.65	5263946.73	404.43	404.53	404.44	404.45	404.42	404.50	404.46	404.45	-0.02	-0.03
[redacted]	0.68	318719.29	5263945.74	404.51	404.61	404.54	404.54	404.51	404.61	404.56	404.54	-0.03	-0.04

5.7 EVENT LISTINGS

Upon completion of each cable survey and post processing, event listings were generated for all events recorded.

Events recorded are described in section 5.2.

Event Listings can be found in the below documents:

Document Title	ENL Document Number	DOF Document Number
2019 - Maritime Link 1 – Event Listing	D-000OP-0-950-04-211	1004417-SV-CL-1035-012-0002
2019 - Maritime Link 2 – Event Listing	D-000OP-0-950-04-213	1004417-SV-CL-1035-012-0004

5.8 DIGITAL TERRAIN MODELS

Upon completion of each cable survey and post processing, DTMs were generated for each cable. Each DTM is gridded to 0.20m bin size.

NaviModel DTMs can be found in the below documents:

Document Title	ENL Document Number	DOF Document Number
2019 NaviModel - Maritime Link 1 DTM	D000-OP-0-950-04-208	1004417-SV-CL-1035-008-0001
2019 NaviModel - Maritime Link 2 DTM	D000-OP-0-950-04-209	1004417-SV-CL-1035-008-0002

6.0 CONCLUSION AND RECOMMENDATIONS

The 2019 Submarine Cable Inspection and Marine Survey campaign was completed successfully and safely. All departments (marine, survey, and ROV) worked together as a team to execute the scope of work as safely and efficiently as possible.

Additional survey sensors were incorporated into the campaign in 2019 to improve operational efficiency and deliverable accuracy.

A TSS 350 cable tracker was installed on the front of the ROV, but the results were not optimal due to the restrictive mounting arrangement. Once the issue was discovered, the cable tracker was mounted on the rear of the ROV where the results proved to be more reliable. On future campaigns, the Multibeam frame will be modified to allow the Multibeam and cable tracker to be mounted on the front of the ROV.

A Tone Generator was utilized to induce a tone into each cable to allow the cable tracker to track a known frequency.

A Sonardyne Sprint Nav505 Inertial navigation system was utilized to aid the USBL positioning. This enabled the ROV to follow a more realistic track, provide better positional information in shallow water, and aided in post processing techniques.

The availability and reliability of the induced tone generator on each cable did impact schedule and deliverables. Tone was only available on certain cables at times due to simultaneous ongoing operations. When tone was generated on a cable, ENL shore base support was required numerous times to reset and re-apply the tone.

The cables were also surveyed when the cables were energized. The cable tracker did in fact detect the cable, but the calculated depth of burial was not consistent and considered unusable. Although unusable for depth of burial this did allow the survey to continue during times of reduced visibility.

Based on the improved data quality and collection efficiencies, future inspection campaigns should have the cable tracker and SPRINT INS as part of the standard equipment.

8.4 INSPECTION AND TEST PLAN

Item	Activity	Reference Documents	Acceptance Criteria	Verifying Documents	DSCA	ENL	Date
1	**Preparation**						
1.01	Review Geodetic Information	ENL Drawings. Procedures and other Supporting Documents	Checked and Verified	Geodetic check point Online Survey log book	BB		
1.02	Acquire latest design drawings for ENL	ENL Drawings	NA	Hard Copy or Digital Files	BB		
1.03	Review Runline Files for correct KP/ Design Route	ENL Drawings. Procedures and other Supporting Documents	Checked and Verified	Online Survey Navigation System	BB		
1.04	Download DFO Predicted Tides	Canadian Hydrographic Website	NA	Digital Tide Files	BB		
				Client Signature:			5 OCT 2019

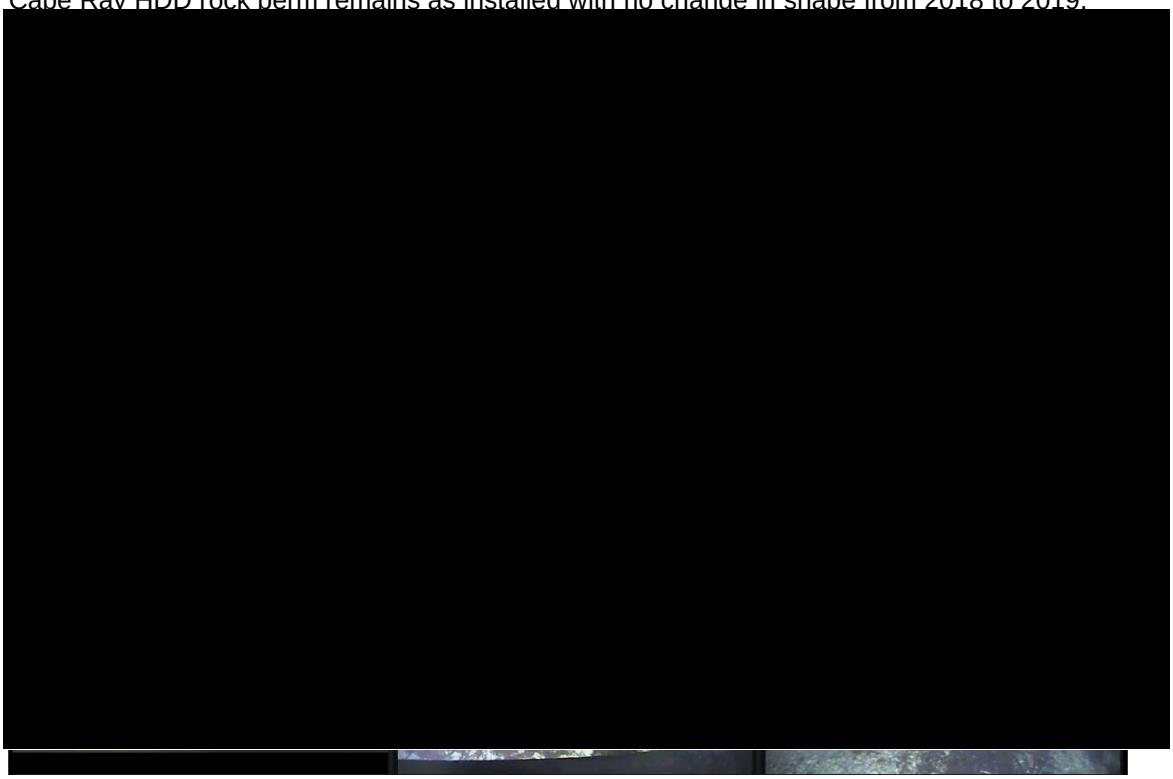
APPENDIX A INSPECTION AND TEST PLAN (SIGNED)

Item	Activity	Reference Documents	Acceptance Criteria	Verifying Documents	DSC	ENL	Date
2	**Offshore Operations**						
2.01	Position Error Check – West Cable HDD – Cape Ray HDD – Point Aconi Crab Pot _West Cable	Survey and Positioning Procedure	Recorded Bathymetry Data, cable tracker data & video	Online survey log QC'd Data Logged Navigation and Video Files	BB	R	
2.02	Position Error Check – East Cable HDD – Cape Ray HDD – Point Aconi	Survey and Positioning Procedure	Recorded Bathymetry Data, cable tracker data & video	Online survey log QC'd Data Logged Navigation and Video Files	BB	R	
2.03	Submarine Cable Inspection / Multibeam Survey – East Cable - Cape Ray, NL - Cable Landfall/HDD Subsea Exit Rock Berm Approx. Start KP 0.610 Approx. End KP 0.646	Survey and Positioning Procedure	Recorded Bathymetry Data, cable tracker data & video	Online survey log QC'd Data Logged Navigation and Video Files	BB	R	
2.04	Submarine Cable Inspection / Multibeam Survey – East Cable - Cable Route Protection between Cape Ray, NL and Point Aconi, NS with combined Trenching and Subsea Rock Installation cable protection. Two locations: SEE MOC 001 Approx. Start KP 0.646 Approx. End KP 16.000 Approx. Start KP 75.290 Approx. End KP 166.924	Survey and Positioning Procedure	Recorded Bathymetry Data, cable tracker data & video	Online survey log QC'd Data Logged Navigation and Video Files	BB	R	
2.05	Submarine Cable Inspection / Multibeam Survey – East Cable - Cable Inspection and Survey at Water Depth greater than 400m with Trenching cable protection Approx. Start KP 16.000 Approx. End KP 75.290 SEE MOC 001	Survey and Positioning Procedure	Recorded Bathymetry Data, cable tracker data & video	Online survey log QC'd Data Logged Navigation and Video Files	BD	R N/A	

Item	Activity	Reference Documents	Acceptance Criteria	Verifying Documents	DSC	ENL	Date
2.06	Submarine Cable Inspection / Multibeam Survey – East Cable - Point Aconi, NS - Cable Landfall/HDD Subsea Exit Rock Berm Approx. Start KP 166.924 Approx. End KP 166.960	Survey and Positioning Procedure	Recorded Bathymetry Data, cable tracker data & video	Online survey log QC'd Data Logged Navigation and Video Files	BB	R N/A	
2.07	Submarine Cable Inspection / Multibeam Survey – West Cable - Cape Ray, NL - Cable Landfall/HDD Subsea Exit Rock Berm Approx. Start KP 0.607 Approx. End KP 0.642	Survey and Positioning Procedure	Recorded Bathymetry Data, cable tracker data & video	Online survey log QC'd Data Logged Navigation and Video Files	BB		
2.08	Submarine Cable Inspection / Multibeam Survey – West Cable - Cable Route Protection between Cape Ray, NL and Point Aconi, NS with combined Trenching and Subsea Rock Installation cable protection. Two locations: Steel Noc 001 Approx. Start KP 0.642 Approx. End KP 15.761 Approx. Start KP 74.709 Approx. End KP 167.297	Survey and Positioning Procedure	Recorded Bathymetry Data, cable tracker data & video	Online survey log QC'd Data Logged Navigation and Video Files	BB		
2.09	Submarine Cable Inspection / Multibeam Survey – West Cable - Cable Inspection and Survey at Water Depth greater than 400m with Trenching cable protection Approx. Start KP 15.761 Approx. End KP 74.709 Steel Noc 001	Survey and Positioning Procedure	Recorded Bathymetry Data, cable tracker data & video	Online survey log QC'd Data Logged Navigation and Video Files	D	R N/A	
2.10	Submarine Cable Inspection / Multibeam Survey – West Cable - Point Aconi, NS - Cable Landfall/HDD Subsea Exit Rock Berm Approx. Start KP 167.297 Approx. End KP 167.348	Survey and Positioning Procedure	Recorded Bathymetry Data, cable tracker data & video	Online survey log QC'd Data Logged Navigation and Video Files	BB		
				Client Signature:			5 Oct 2019

APPENDIX B MARITIME LINK 1 CABLE ASSESSMENT

[redacted]
Cape Ray HDD rock berm remains as installed with no change in shape from 2018 to 2019.



At [redacted], the scouring present along the east of the HDD Berm has filled in 0.4m. In 2018 a scouring of 0.8m was present.

From 2018 to 2019 there has been no change in seabed for this area. The trench has remained fully backfilled and leveled off to natural seabed.

[redacted]

Trenched areas have completely backfilled with approximately 0.3m additional sediment coverage over the cable from 2018 to 2019. The area is now level with the seabed. From 2017 to 2019 there has been a 0.7m-0.9m increase in sediment coverage over the cable, which illustrates a gradual increase of cover over the cable.

[redacted]

No change in the trench, seabed or rock berm from 2018 to 2019. The trench is still visible for this area.

[redacted]

[redacted]

No change in the trench size or shape from 2018 to 2019. There is significant Marine Bio Matter present along most of the trench which has increased significantly over the last year.

[redacted]

No change in the trench, seabed or rock berm from 2018 to 2019. The trench is still visible for this area.

[redacted]

[redacted]

[redacted]

In 2019 ENL conducted further cable protection work. For this section a trench is now present as a result of the cable protection campaign.

[redacted]

This section was not surveyed by DOF in 2019. You can find the metre by metre listing for ENL provided data for [redacted] in Appendix C.

[redacted]

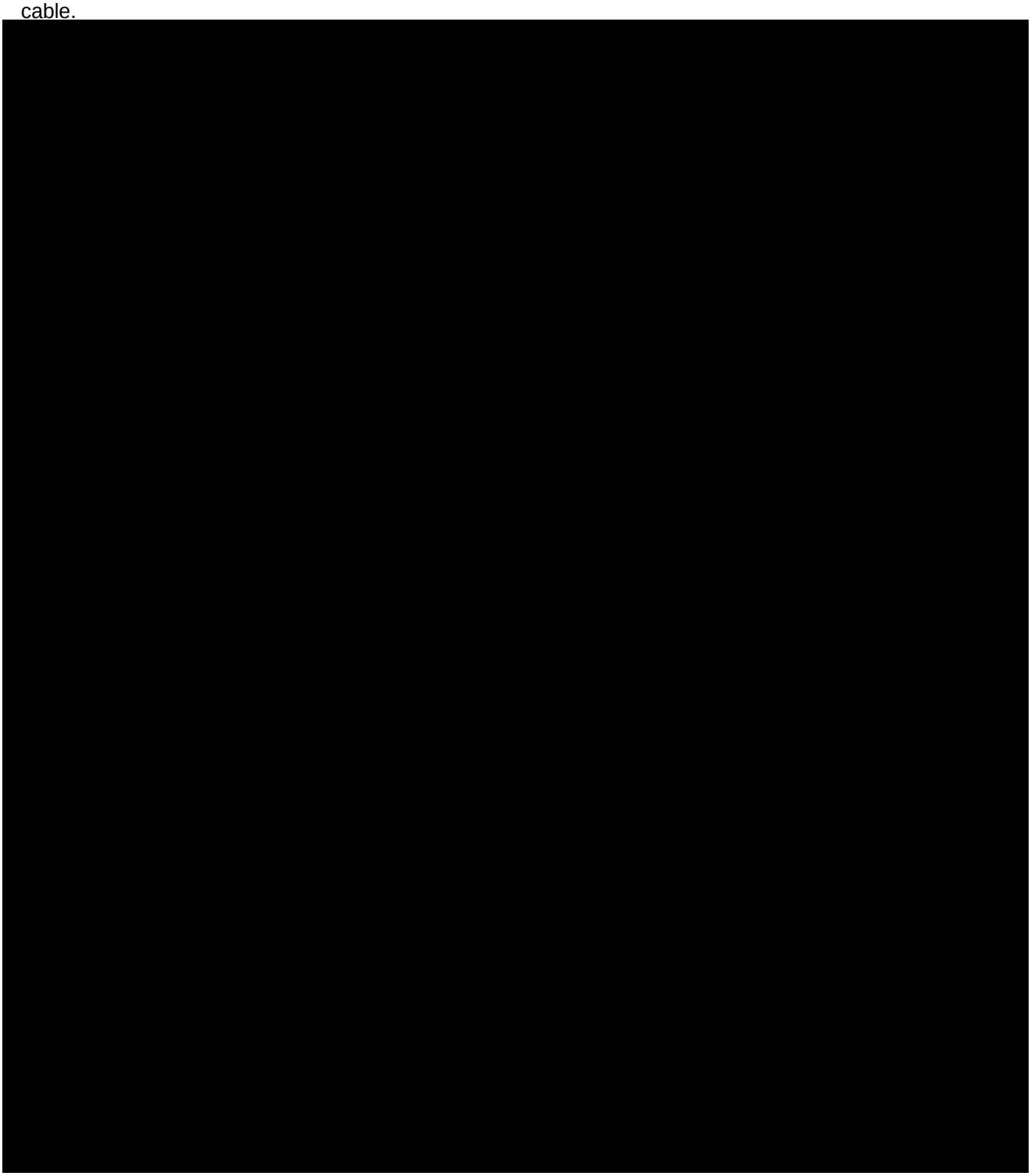
From 2018 to 2019 the trenched areas have naturally backfilled 0.1m; however, the trench remains visible. There was no change in shape or cover from 2017 to 2018. The survey over the rock berms indicated no change in shape or sediment coverage over the cable. Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.

[redacted]

[redacted]
From 2018 to 2019 there was no change in shape or the sediment coverage of the cable for the trenched and rock berm areas. The trench remains visible.

[redacted]

From 2018 to 2019 the trenched areas had an increase of 0.05m-0.1m of sediment coverage over the cable. From 2017 to 2019, this increase was approximately 0.2m. This indicates that the trench is slowly naturally backfilling, and the trench is still visible. No change in rock berm areas for shape or sediment coverage over the cable.



From 2018 to 2019 the trenched areas have naturally backfilled 0.25m; however, the trench remains visible. There was no change in shape or cover from 2017 to 2018.

The survey over the rock berms indicated no change in shape or sediment coverage over the cable. Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.

[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.15m; however, the trench remains visible. There was no change in shape or cover from 2017 to 2018.
Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.

[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.05m; the trench remains visible. There was no change in shape or cover from 2017 to 2018.
Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.

[redacted]

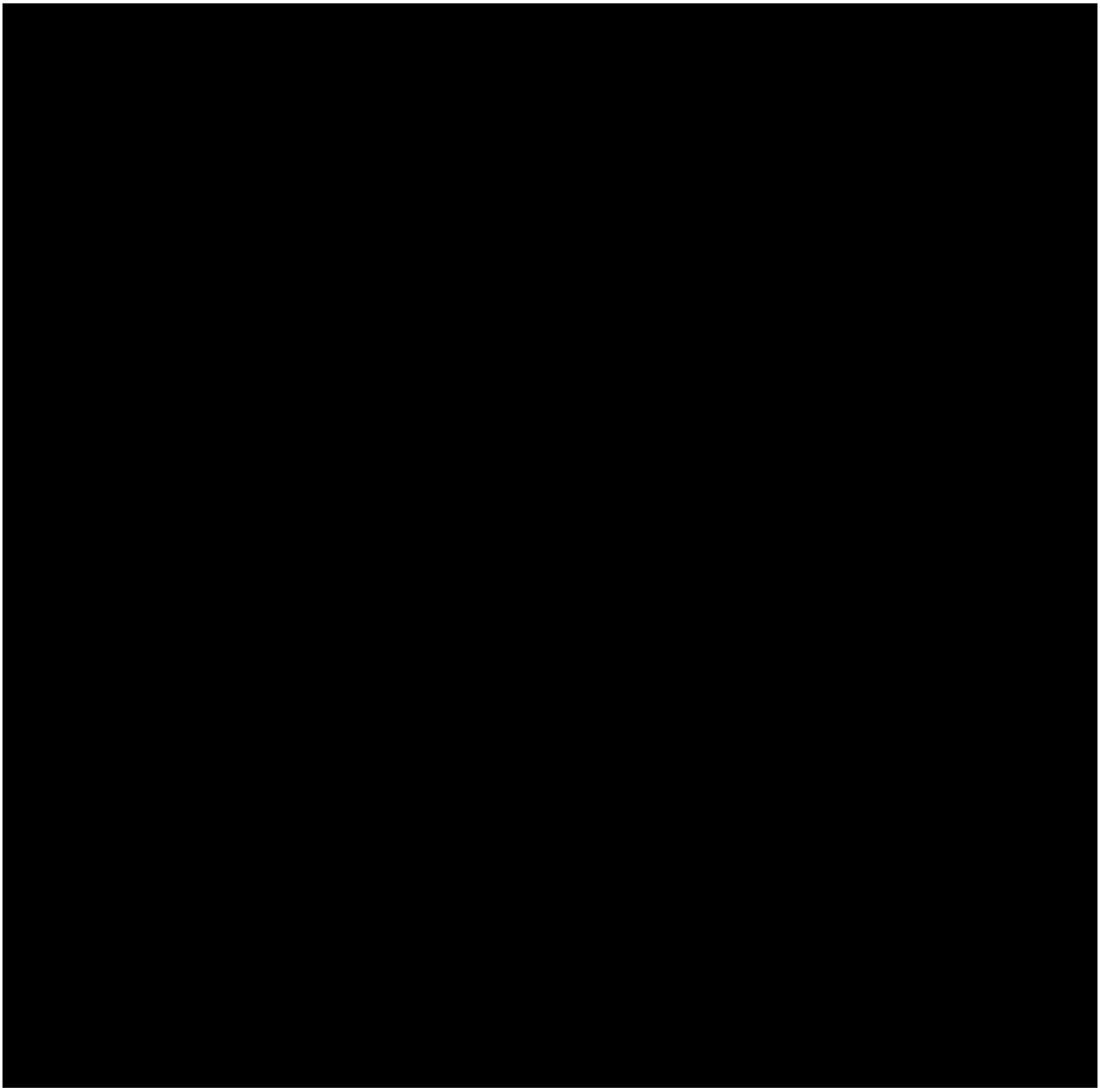
From 2018 to 2019 there was no change in shape or the sediment coverage of the cable for the trenched area. The trench remains visible.
Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.

[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.20m; the trench remains visible. There was no change in shape or cover from 2017 to 2018.
Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.

[redacted]

From 2018 to 2019 there was no change in shape or the sediment coverage of the cable for the trenched and rock berm areas. The trench remains visible.



[redacted]

[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.10m; the trench remains visible. There was no change in shape or cover from 2017 to 2018.
Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.

[redacted]

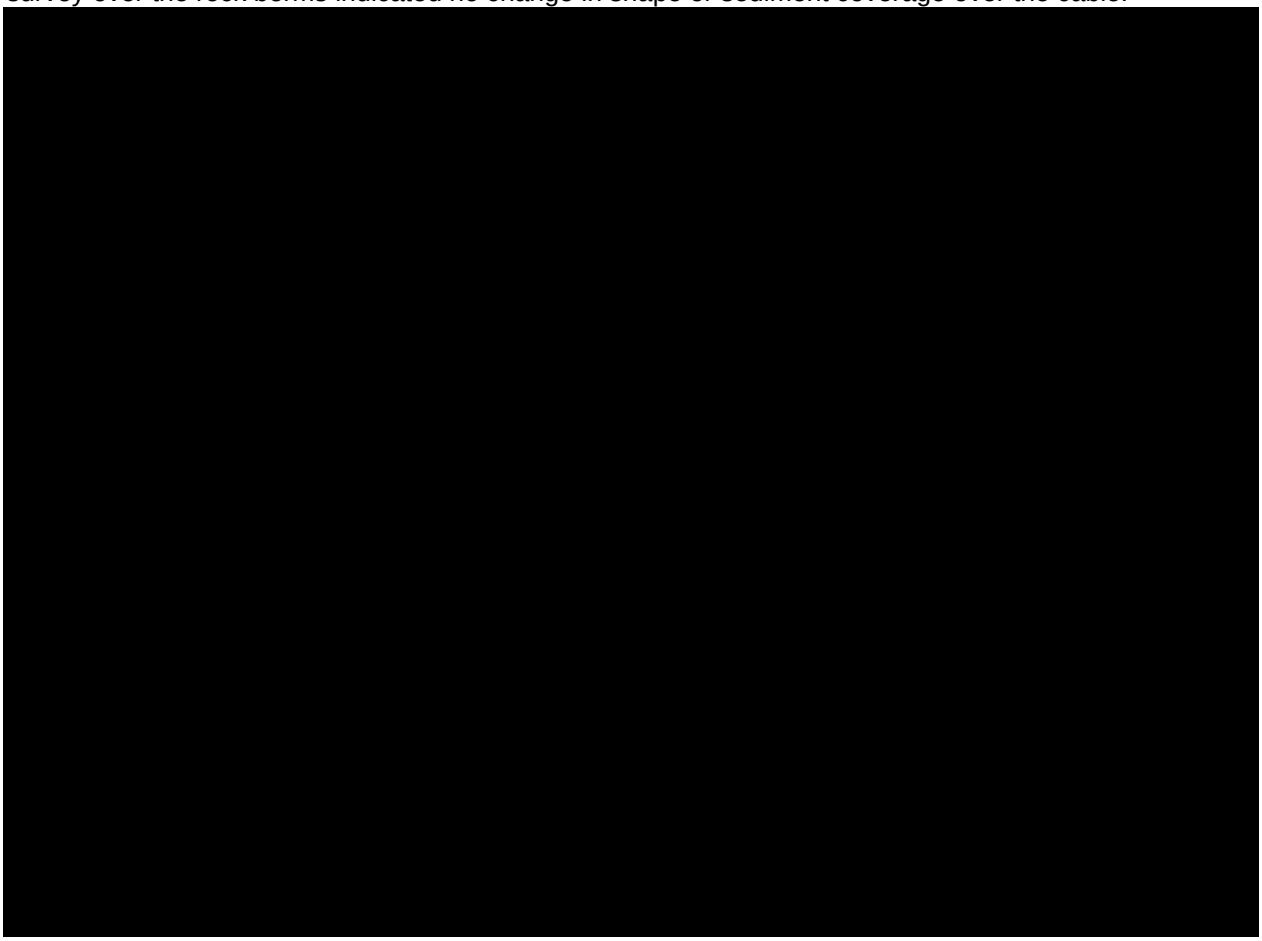
From 2018 to 2019 the trenched areas had an increase of 0.20m of sediment coverage over the cable. From 2017 to 2019 this increase amounts to approximately 0.40m. This indicates that the trench is naturally backfilling; however, the trench is still visible.
Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.

[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.25m; the trench is no longer visible and has naturally backfilled to natural seabed. There was no change in shape or cover from 2017 to 2018.
Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.

[redacted]

From 2018 to 2019 there was no change in trenched areas they remain level with seabed; no trench visible. The survey over the rock berms indicated no change in shape or sediment coverage over the cable.



[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.20m; the trench is no longer visible and has naturally backfilled to natural seabed. There was no change in shape or cover from 2017 to 2018.

[redacted]

From 2018 to 2019 there was no change in shape or the sediment coverage of the cable for the rock berm areas.

[redacted]

From 2018 to 2019 the trenched areas had an increase of 0.25m of sediment coverage over the cable. From 2017 to 2019 this increase amounts to approximately 0.45m. This indicates that the trench has naturally backfilled and the trench is no longer visible. No change in rock berm areas for shape or sediment coverage over the cable.

[redacted]

From 2018 to 2019 there was no change in trenched areas, they remain level with seabed; no trench visible. The survey over the rock berms indicated no change in shape or sediment coverage over the cable.

[redacted]

From 2018 to 2019 the trenched areas had an increase of 0.30m of sediment coverage over the cable. From 2017 to 2019 this increase amounts to approximately 0.55m. This indicates that the trench has naturally backfilled and that the trench is no longer visible.

[redacted]

From 2018 to 2019 there was no change in trenched areas, they remain level with seabed; no trench visible. The survey over the rock berms indicated no change in shape or sediment coverage over the cable.

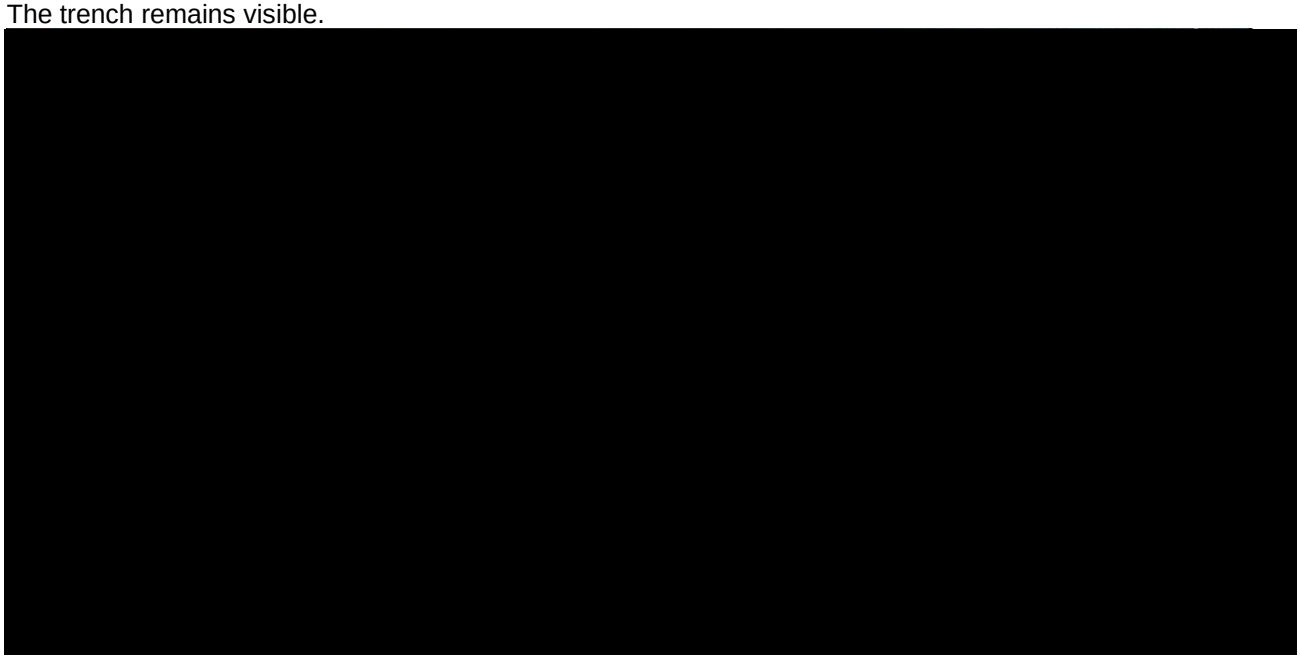
[redacted]

From 2018 to 2019 there was no change in the Point Aconi HDD Berm indicating no change in shape or sediment coverage over the cable.

APPENDIX C MARITIME LINK 1 CABLE ASSESSMENT (NEXANS DATASET)

[redacted]

From 2018 to 2019 there was no change in shape or the sediment coverage of the cable for the trenched area. The trench remains visible.



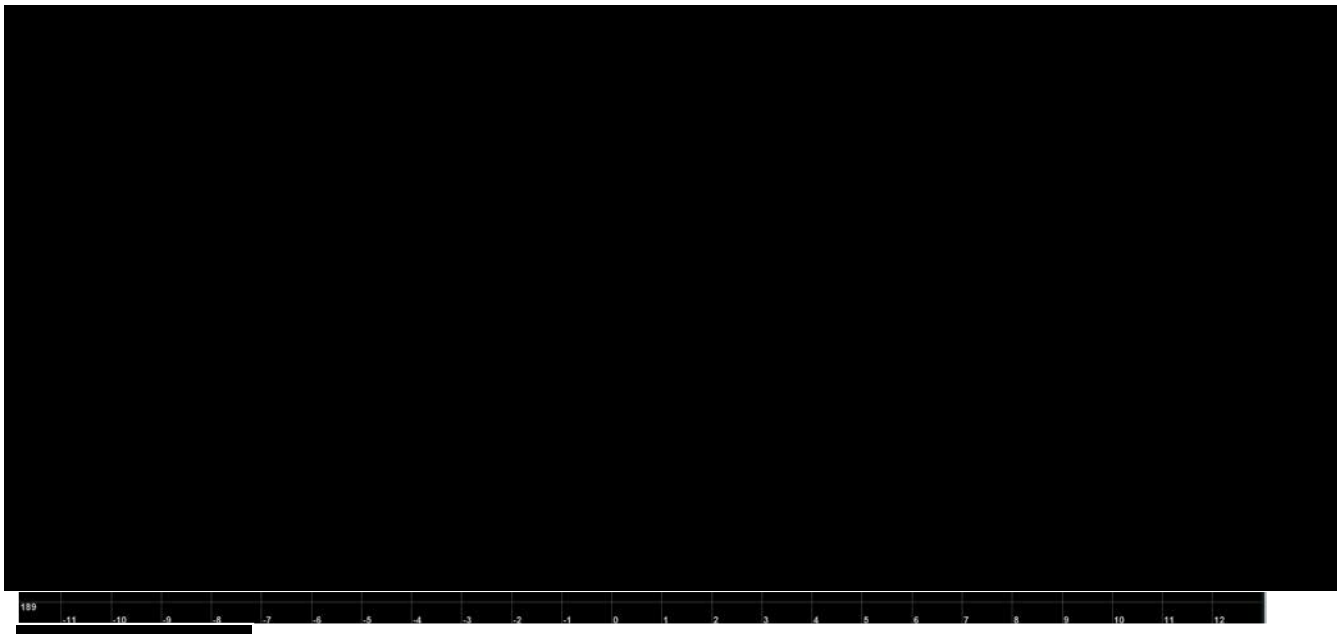
[redacted]

From 2018 to 2019 the trenched areas had an increase of 0.30m of sediment coverage over the cable. From 2017 to 2019 this increase amounts to approximately 0.30-0.50m. This indicates that the trench has naturally backfilled and the trench is partially visible along the route.

[redacted]
From 2018 to 2019 the trenched areas have naturally backfilled 0.35m; the trench is no longer visible and has naturally backfilled to natural seabed. There was no change in shape or cover from 2017 to 2018.

[redacted]
From 2018 to 2019 the trenched areas have naturally backfilled 0.35m; the trench is no longer visible in places while still visible in others. As you can see from the below images the trench is filling in at some locations. There was some change in shape and cover from 2017 to 2018. From observing this pattern over 3 data sets , the trench is slowly backfilling more and more each year.

From 2018 to 2019 the trenched areas had an increase of 0.25m of sediment coverage over the cable. From 2017 to 2019 this increase amounts to approximately 0.50-0.60m. This indicates that the trench has naturally backfilled and that the trench is no longer visible. The survey over the rock berms indicated no change in shape or sediment coverage over the cable.



From 2018 to 2019 the trenched areas have naturally backfilled 0.25m; the trench remains visible. There was no change in shape or cover from 2017 to 2018. The survey over the rock berms indicated no change in shape or sediment coverage over the cable.

No change in the trench, seabed or rock berm from 2018 to 2019. The trench is still visible for this area.

APPENDIX D MARITIME LINK 1 CABLE TRACKER ASSESSMENT

[redacted]

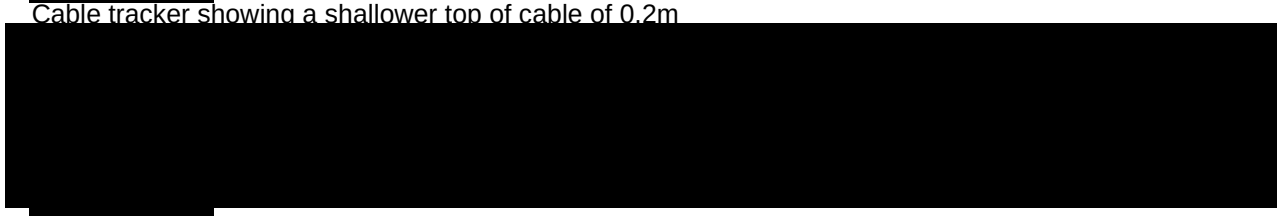
Cable tracker showing a shallower top of cable under the Cape Ray HDD Exit berm.

[redacted]

Cable tracker showing a shallower top of cable of 0.2m

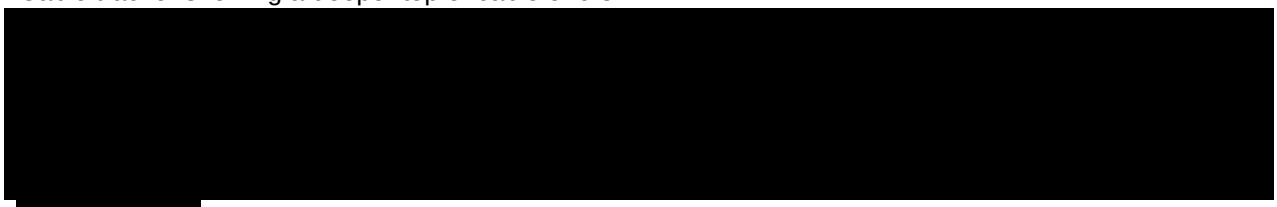
[redacted]

Cable tracker showing a shallower top of cable of 0.2m



[redacted]

Cable tracker showing a deeper top of cable of 0.3m

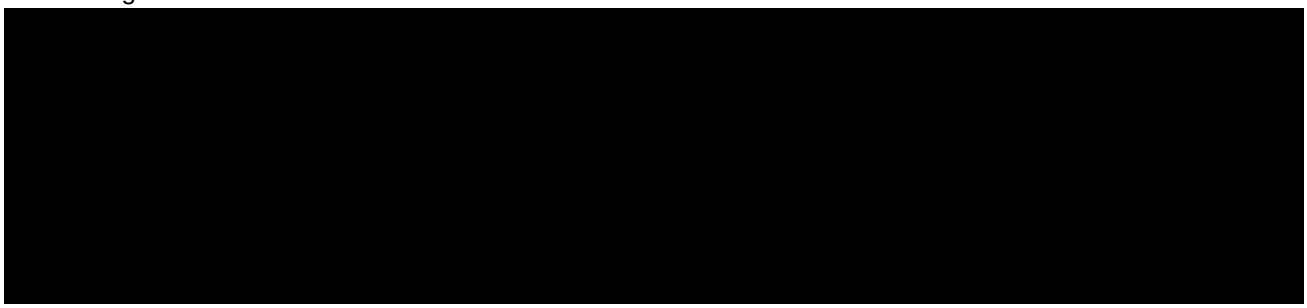


[redacted]

Cable tracker showing a shallower top of cable of 0.2-0.3m

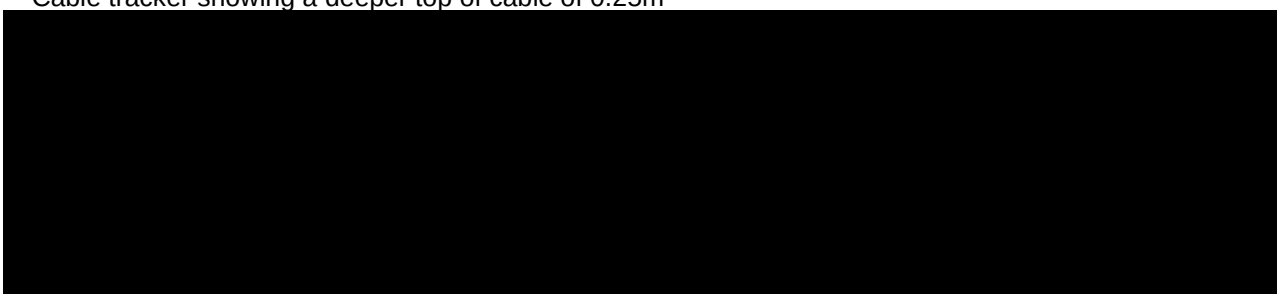
[redacted]
Cable tracker showing a shallower top of cable of 0.3m

[redacted]
Cable tracker showing a deeper top of cable of 0.3m to 1.45m. For this area the trench has widened significantly causing the cable to settle lower on the seabed.



[redacted]
Cable tracker showing a shallower top of cable of 0.2m to 0.5m. For this area the trench has widened with some sections having exposed cable along the bottom of the trench.

[redacted]
Cable tracker showing a deeper top of cable of 0.25m



[redacted]

Cable tracker showing a shallower top of cable of 0.3m

[redacted]

[redacted]

Cable tracker showing a deeper top of cable of 0.20-0.75m. This area we are seeing a difference in seabed of 0.3m which cuts the difference down. The TOC is related to depth of seabed as everything is referenced to the Multibeam.

[redacted]

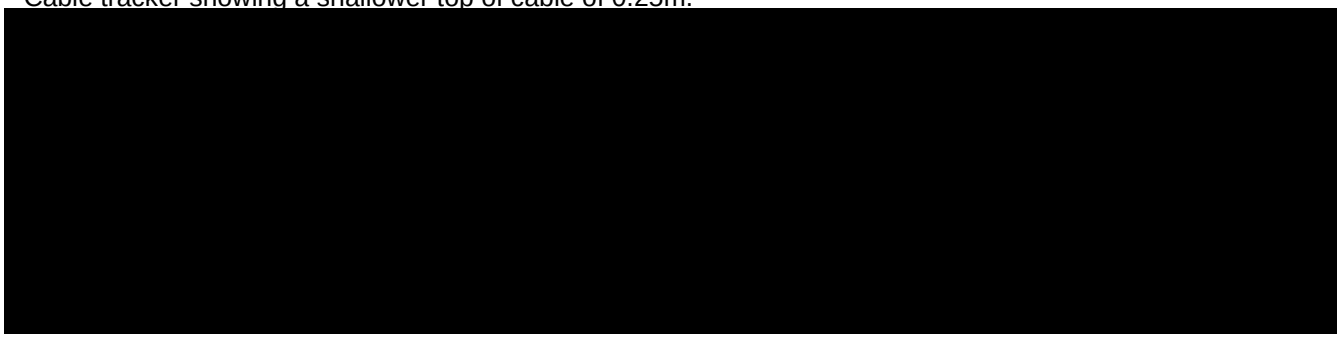
Cable tracker showing a deeper top of cable of 0.20-0.95m. This area we are seeing a difference in seabed of 0.5m which cuts the difference down significantly. The TOC is related to depth of seabed as everything is referenced to the Multibeam.

[redacted]
Cable tracker showing a deeper top of cable of 0.35m. This area we are seeing a difference in seabed of 0.2m which cuts the difference down. The TOC is related to depth of seabed as everything is referenced to the Multibeam.

[redacted]
Cable tracker showing a shallower top of cable of 0.25m.

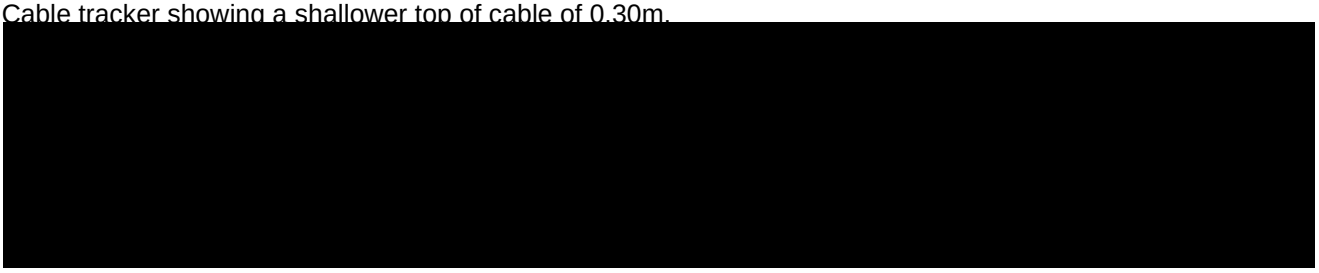
[redacted]
Cable tracker showing a shallower top of cable of 0.35m.

[redacted]
Cable tracker showing a shallower top of cable of 0.25m.



[redacted]
Cable tracker showing a shallower top of cable of 0.25m.

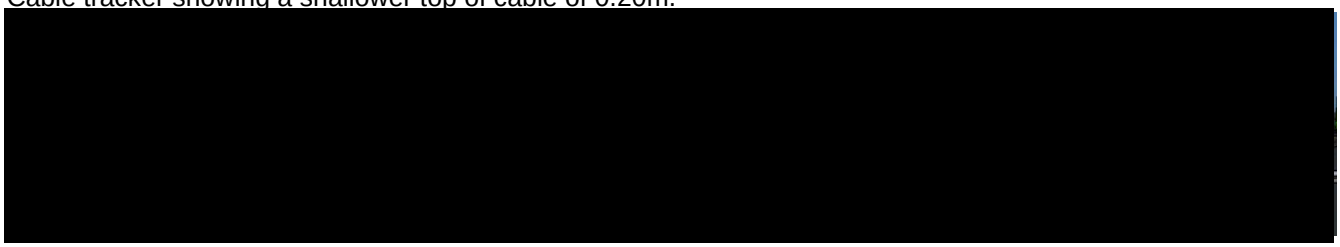
[redacted]
Cable tracker showing a shallower top of cable of 0.30m.



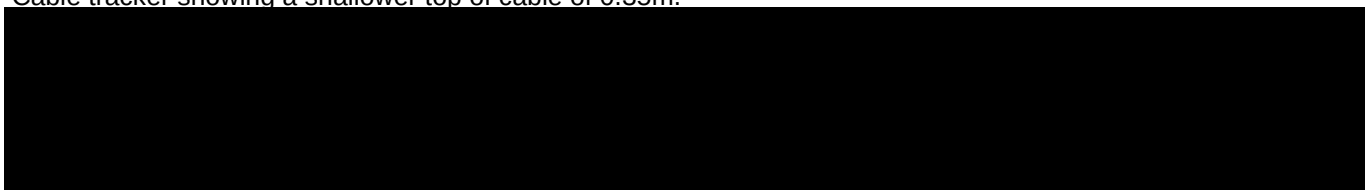
[redacted]
Cable tracker showing a shallower top of cable of 0.20m.

[redacted]
Cable tracker showing a shallower top of cable of 0.30m.

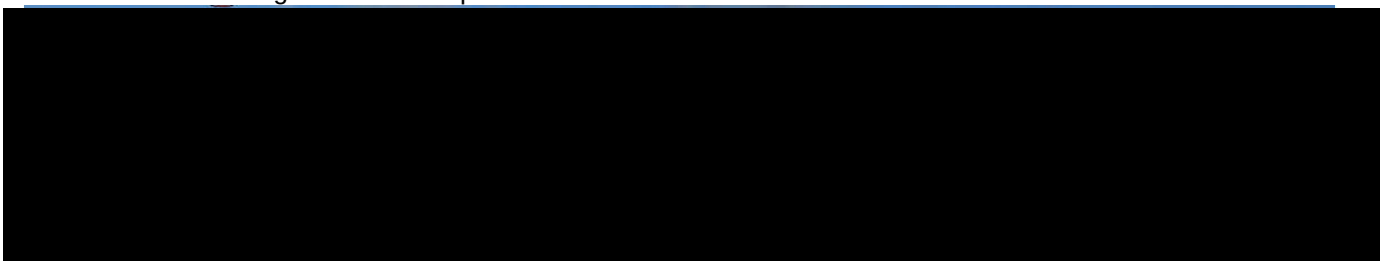
[redacted]
Cable tracker showing a shallower top of cable of 0.20m.



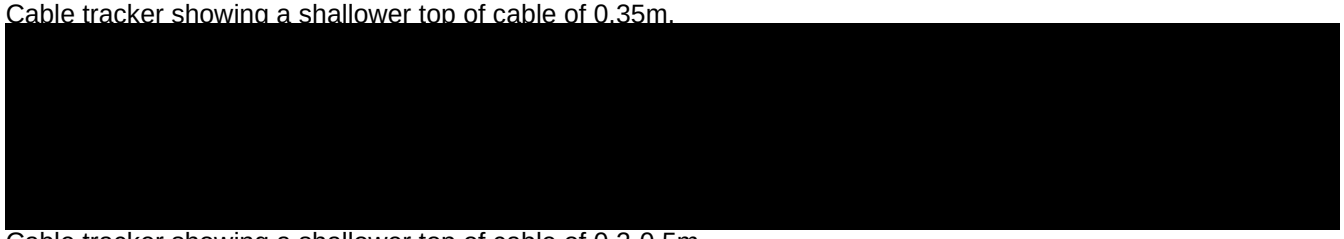
[redacted]
Cable tracker showing a shallower top of cable of 0.35m.



[redacted]
Cable tracker showing a shallower top of cable of 0.5m.



Cable tracker showing a shallower top of cable of 0.35m.



Cable tracker showing a shallower top of cable of 0.2-0.5m.

[redacted]
Cable tracker showing a shallower top of cable of 0.2m. For this area DOFs TOC is more of a straight line whereas Nexans is oscillating.

[redacted]
Cable tracker showing a shallower top of cable of 0.4 m. For this area DOFs TOC is more of a straight line whereas Nexans is oscillating.

[redacted]
Cable tracker showing a shallower top of cable of 0.2-0.7 m. For this area DOFs TOC is more of a straight line whereas Nexans is oscillating.

APPENDIX E MARITIME LINK 1 CABLE TRACKER ASSESSMENT (NEXANS DATASET)

[redacted]

Cable tracker showing a deeper top of cable of 0.15-0.20 m. For this section the cable is oscillating in the 2017 data with the 2019 data being more constant.

[redacted]

[redacted]

Cable tracker showing a shallower top of cable of 0.50 m.

[redacted]

[redacted]

Cable tracker showing a shallower top of cable of 0.35 m.

[redacted]

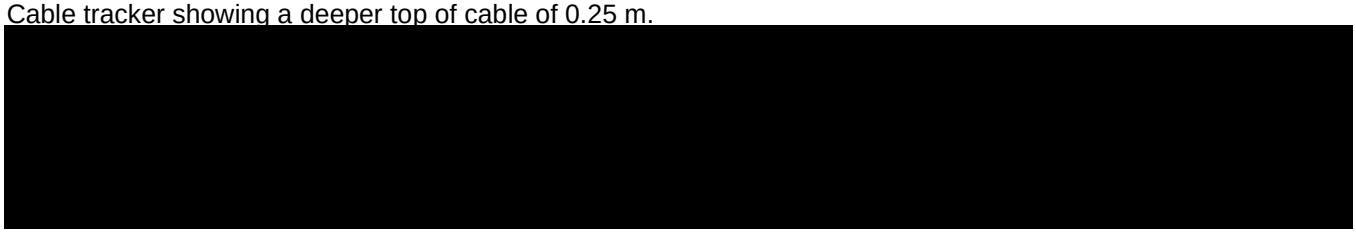
[redacted]

Cable tracker showing a shallower top of cable of 0.45 m.

[redacted]

[redacted]

Cable tracker showing a deeper top of cable of 0.25 m.



APPENDIX F MARITIME LINK 2 CABLE ASSESSMENT

[redacted]
Much of the rock berm is showing minimal change in shape, however from [redacted] there is a substantial navigational discrepancy present both along and cross track. The berm appears to be smoothing out with the peak rounded off and has settled into the seabed. The primary change occurred between 2017-2018, with minimal change in 2019.

Scouring along the berm is no longer present.

[redacted]

From 2018 to 2019 there has been no change in seabed for this area. The trench has remained fully backfilled and leveled off to natural seabed.

[redacted]
Trenched areas have completely backfilled with approximately 0.2m additional sediment coverage over the cable from 2018 to 2019. From 2017 to 2019 there has been a 0.6m increase in sediment coverage over the cable, which illustrates a gradual increase of cover over the cable, with the trench still partially visible in the cross profile.

[redacted]

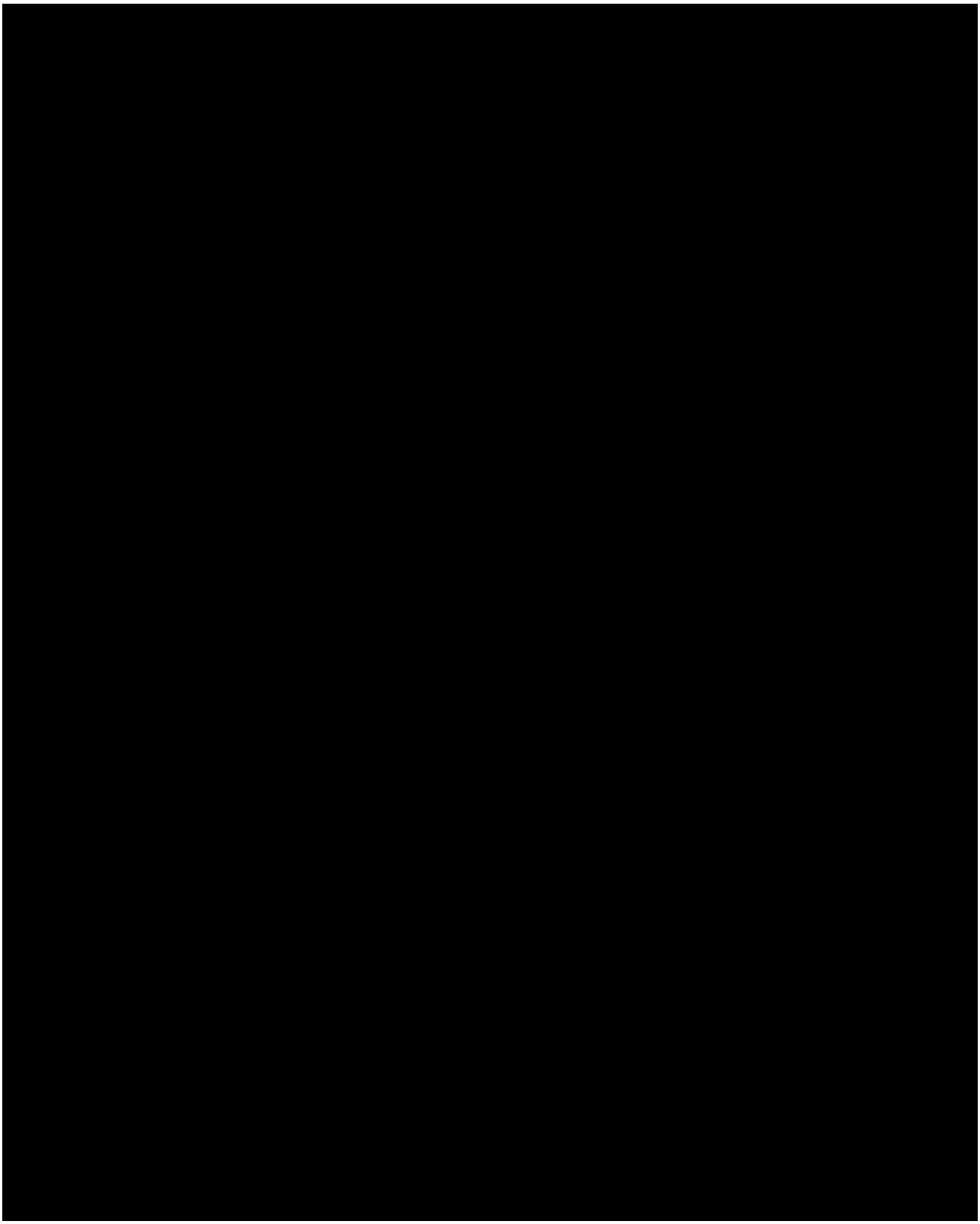
Trenched areas have backfilled with approximately 0.1m additional sediment coverage over the cable from 2018 to 2019. From 2017 to 2019 there has been a 0.4m increase in sediment coverage over the cable, which illustrates a gradual increase of cover over the cable, with the trench still partially visible in the cross profile. Areas along the trench contains some Marine Bio Matter.

[redacted]

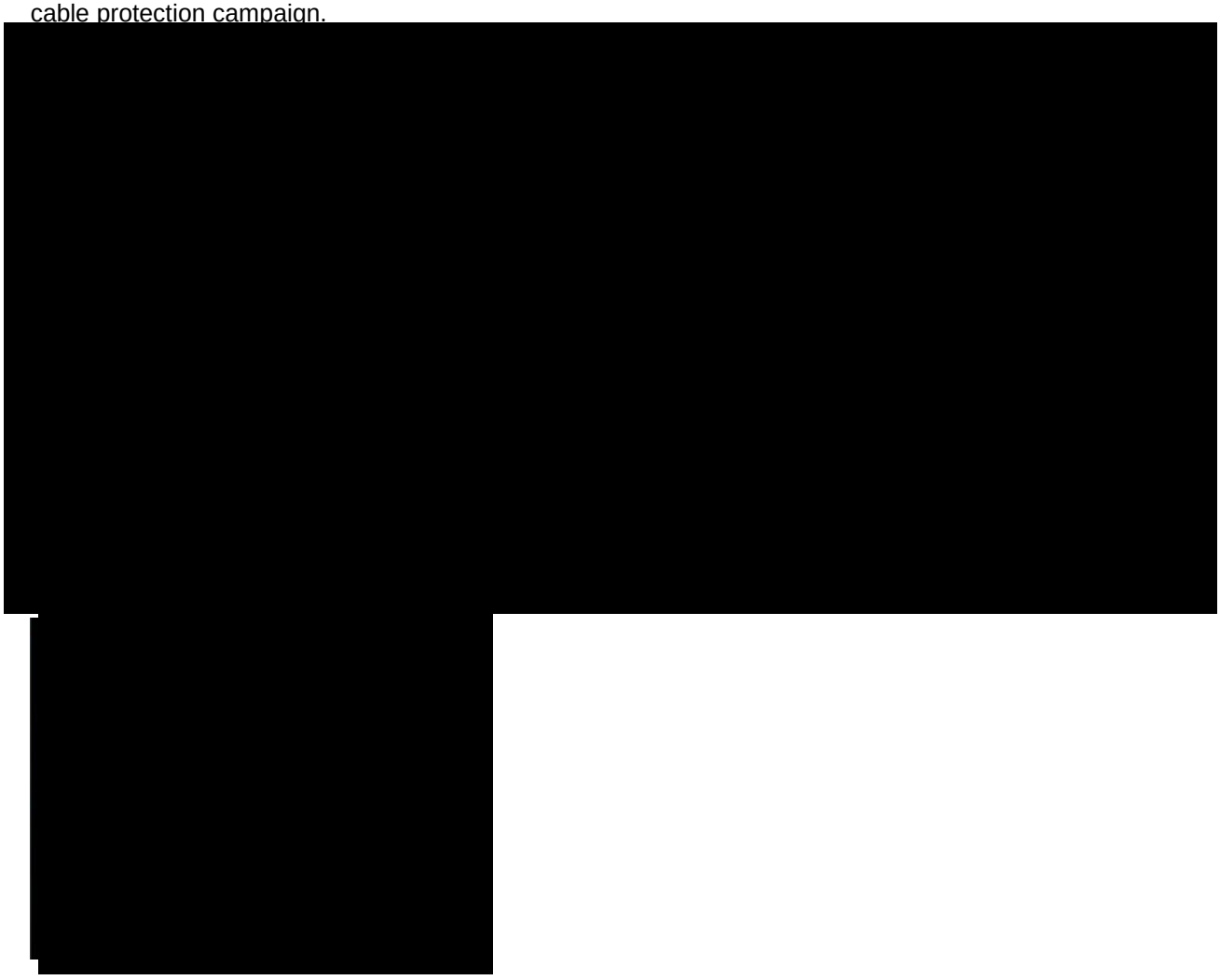
Trenched areas have backfilled with approximately 0.2m additional sediment coverage over the cable from 2018 to 2019. From 2017 to 2019 there has been a 0.5m increase in sediment coverage over the cable, which illustrates a gradual increase of cover over the cable, with the trench still partially visible in the cross profile. Areas along the trench contain some Marine Bio Matter.

[redacted]

No change in the trench size or shape from 2018 to 2019. There is significant Marine Bio Matter present along most of the trench which has increased significantly over the last year.
No change in rock berm areas shape or sediment coverage from 2018 to 2019.



In 2019 ENL conducted further cable protection work. For this section a trench is now present as a result of the cable protection campaign.



Not Surveyed by DOF in 2019.

[redacted]
In the fall of 2019 this section was trenched to ensure cable protection.
[redacted]

[redacted]

From 2018 to 2019 there was no change in shape or the sediment coverage of the cable for the trenched area. The trench remains visible.

[redacted]

[redacted]

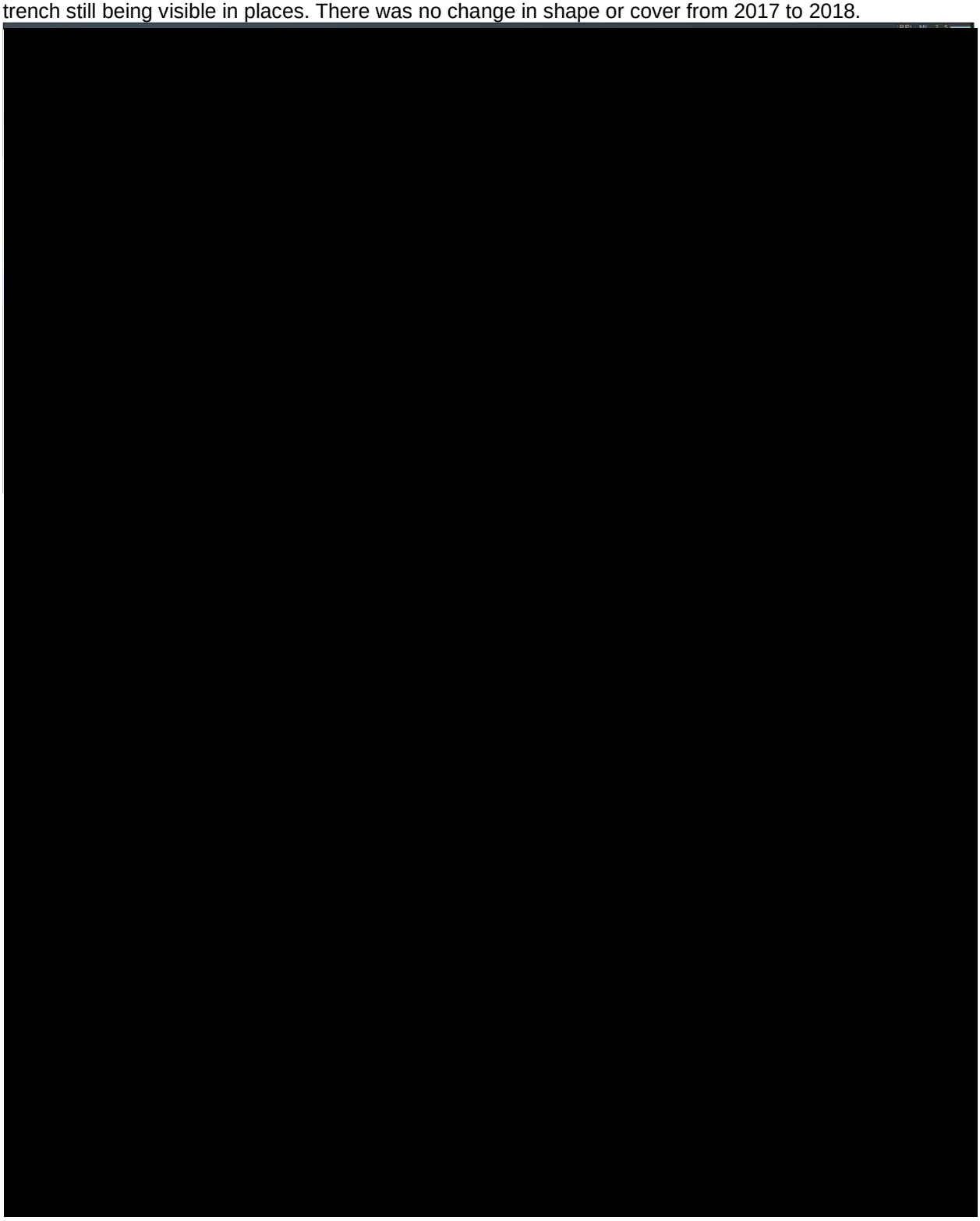
From 2018 to 2019 the trenched areas have naturally backfilled 0.20m; resulting in the trench no longer being visible. There was no change in shape or cover from 2017 to 2018.

[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.30m; resulting in the trench no longer being visible. There was no change in shape or cover from 2017 to 2018.

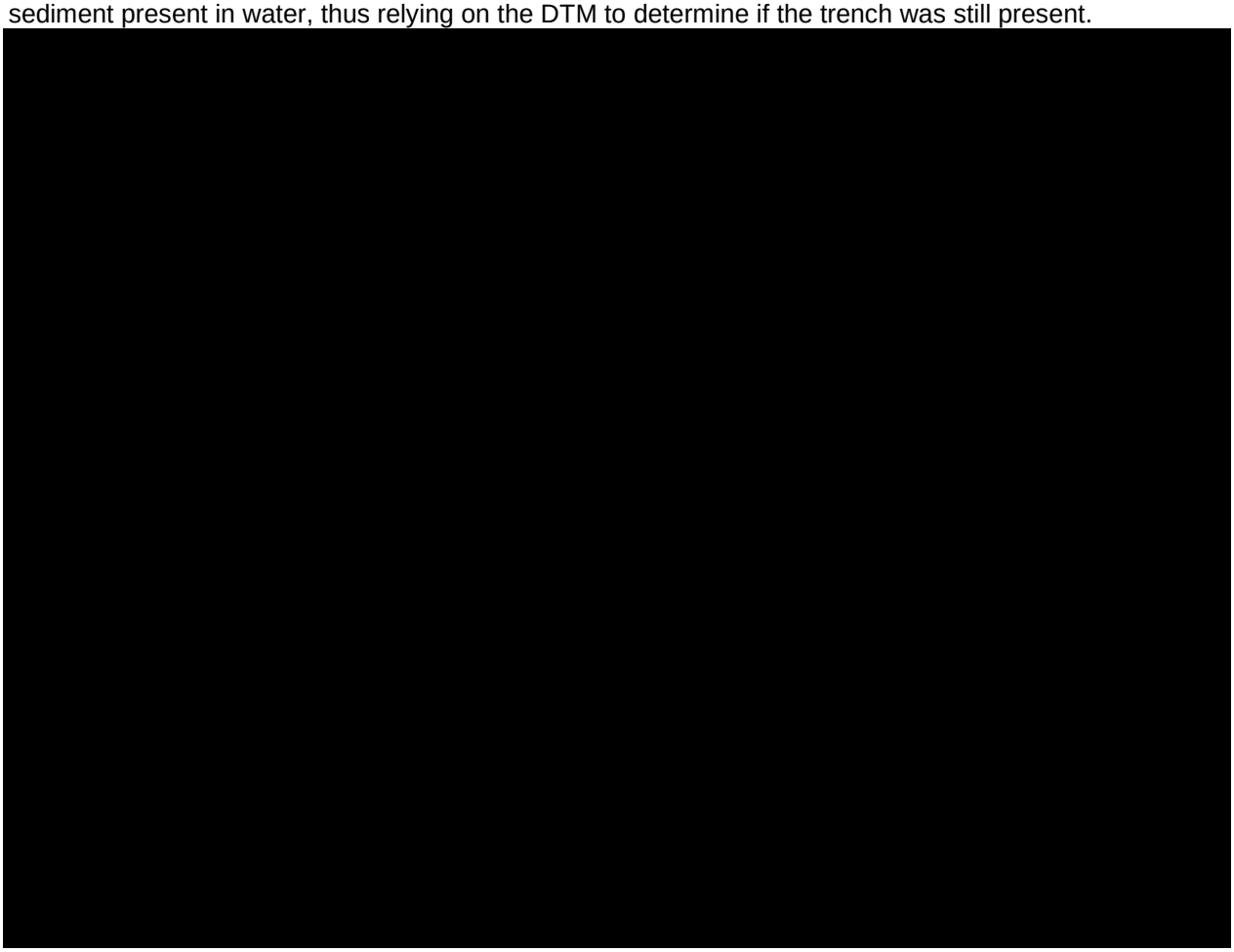
[redacted]

From 2018 to 2019 the trenched areas have intermittently backfilled with approximately 0.20m; resulting in the trench still being visible in places. There was no change in shape or cover from 2017 to 2018.



[redacted]

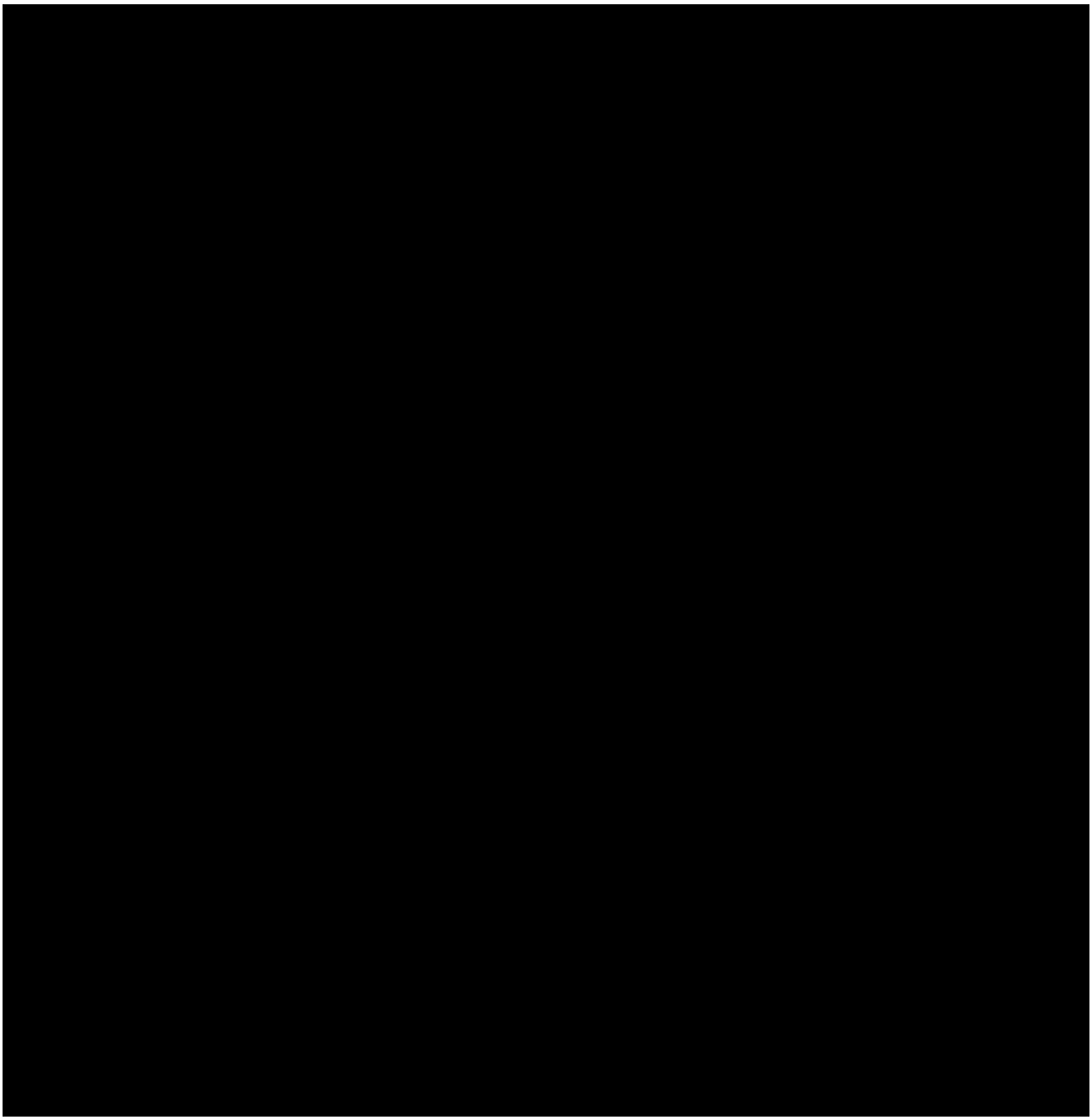
From 2018 to 2019 the trenched areas have naturally backfilled 0.3m; resulting in the trench no longer being visible. There was no change in shape or cover from 2017 to 2018. The survey over the rock berms indicated no change in shape or sediment coverage over the cable. Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.



[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.2m; resulting in the trench no longer being visible. There was no change in shape or cover from 2017 to 2018. The survey over the rock berms indicated no change in shape or sediment coverage over the cable. Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.

From 2018 to 2019 there was no change in shape or the sediment coverage of the cable for the trenched and rock berm areas. The trench remains visible.



[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.20m; however, the trench remains visible. There was no change in shape or cover from 2017 to 2018. Visibility for this area was very limited due to a lot of sediment present in the water, thus relying on the DTM to determine if the trench was still present.

[redacted]

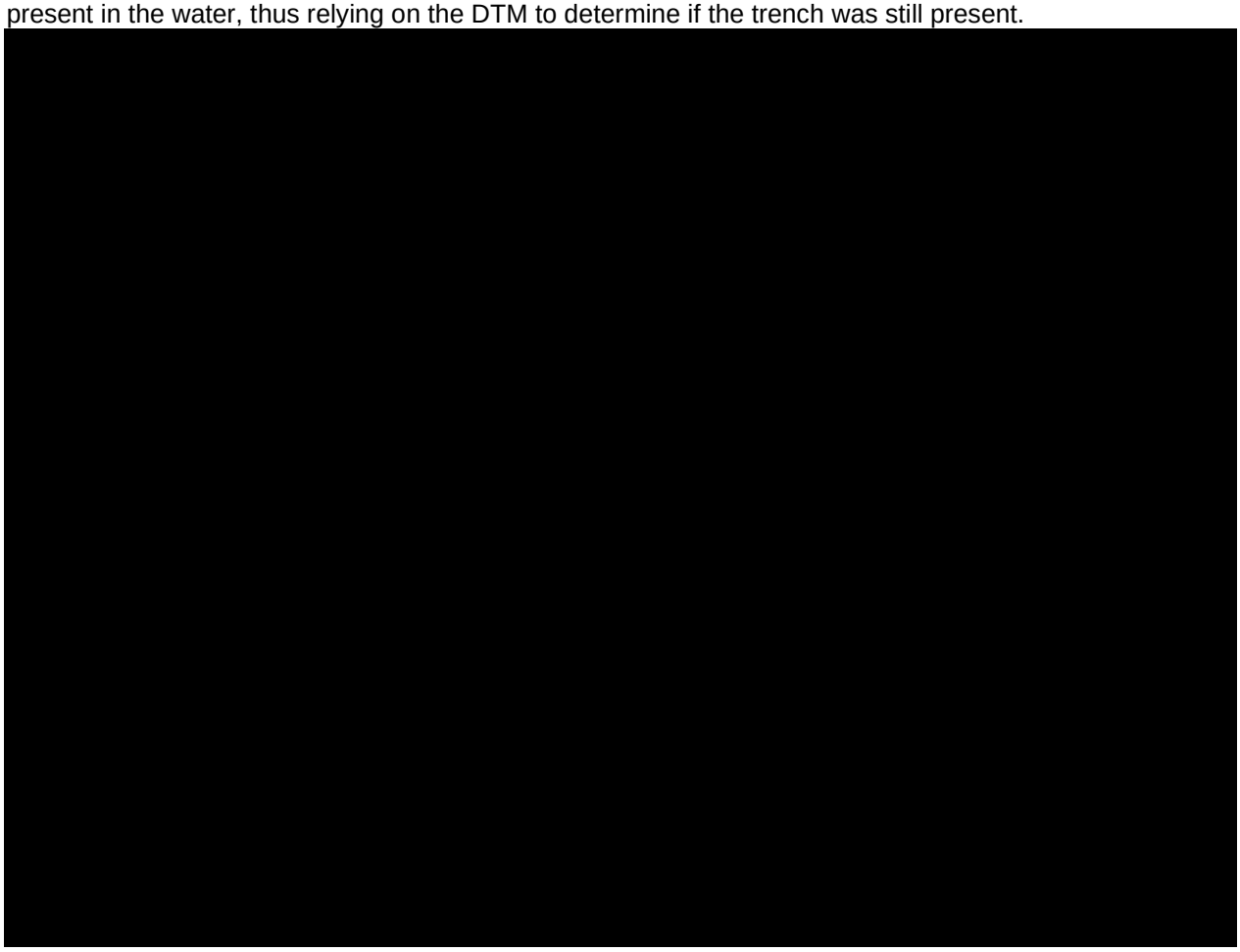
From 2018 to 2019 there was no change in shape or the sediment coverage of the cable for the trenched and rock berm areas. The trench remains visible. Visibility for this area was very limited due to a lot of sediment present in the water, thus relying on the DTM to determine if the trench was still present.

[redacted]

From 2018 to 2019 the trenched areas had an increase of 0.15m-0.2m of sediment coverage over the cable. From 2017 to 2019 this increase amounts to approximately 0.3m. This indicates that the trench is slowly naturally backfilling, and the trench is still visible. No change in rock berm areas for shape or sediment coverage over the cable. Visibility for this area was very limited due to a lot of sediment present in water, thus relying on the DTM to determine if the trench was still present.

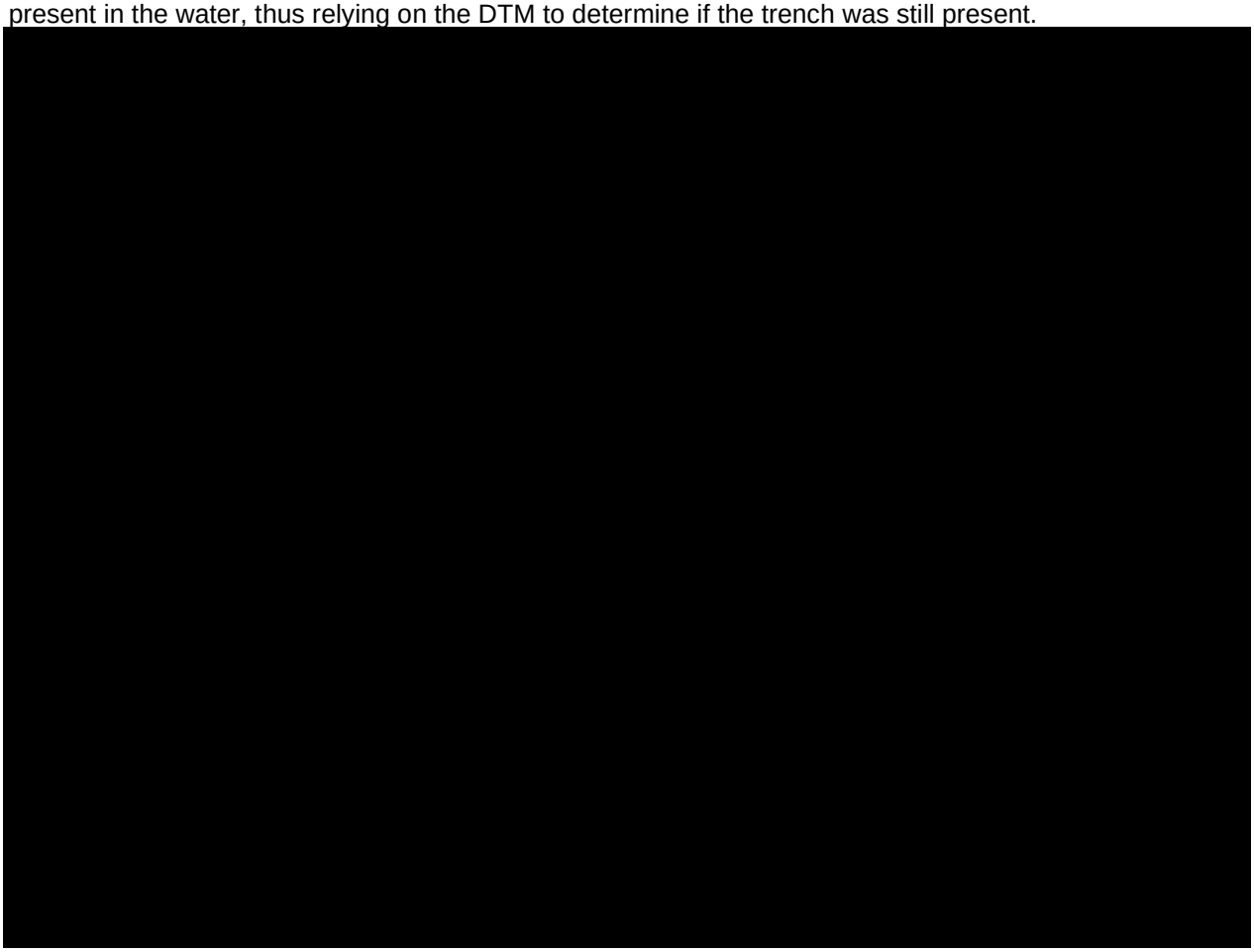
[redacted]

From 2018 to 2019 the trenched areas had an increase of 0.05m-0.1m of sediment coverage over the cable. From 2017 to 2019 this increase amounts to approximately 0.2m. This indicates that the trench is slowly naturally backfilling, and the trench is still visible. Visibility for this area was very limited due to a lot of sediment present in the water, thus relying on the DTM to determine if the trench was still present.



[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.15m; however, the trench remains visible. There was no change in shape or cover from 2017 to 2018. The survey over the rock berms indicated no change in shape or sediment coverage over the cable. Visibility for this area was very limited due to a lot of sediment present in the water, thus relying on the DTM to determine if the trench was still present.

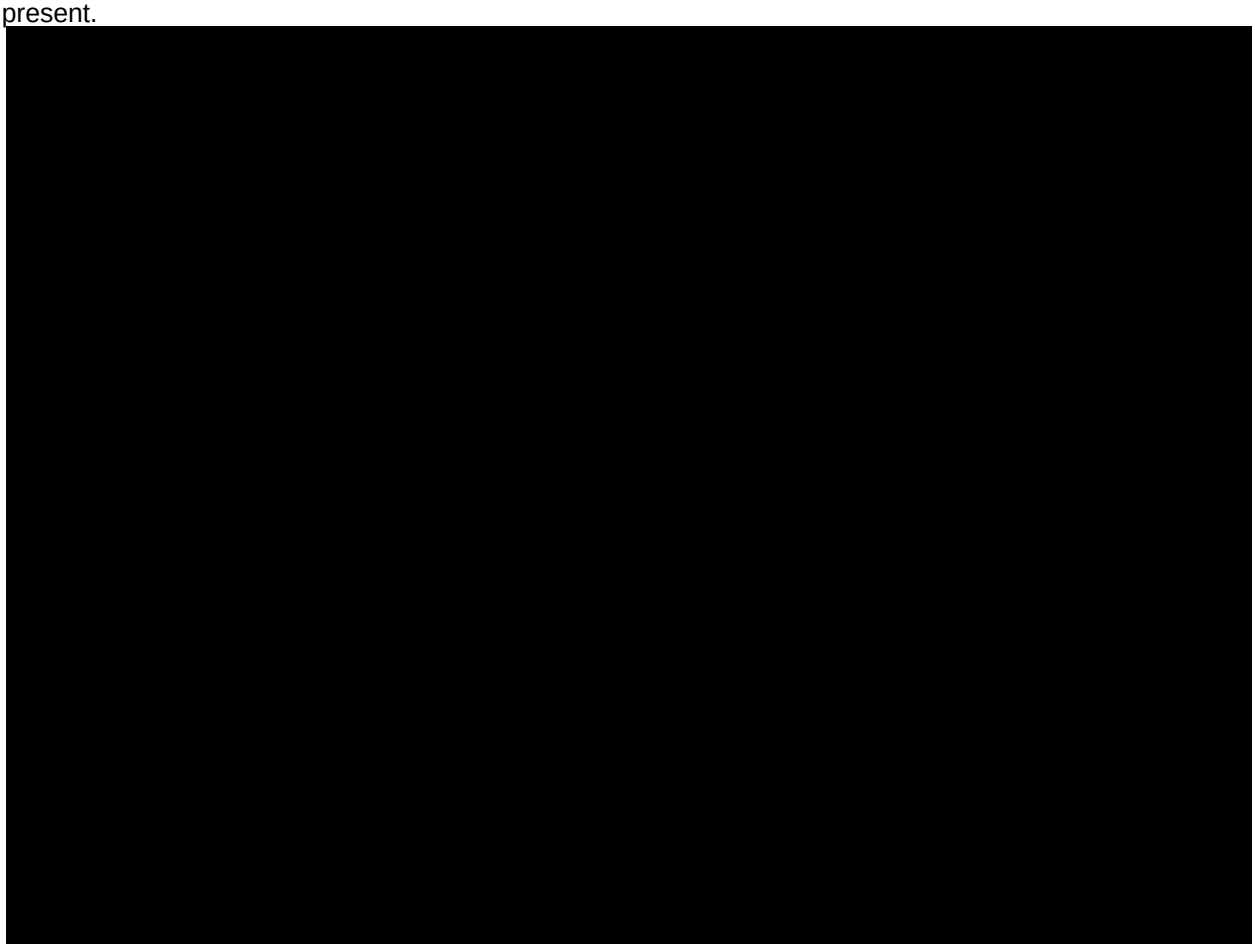


[redacted]

From 2018 to 2019 there was no change in shape or the sediment coverage of the cable for the trenched and rock berm areas. The trench remains visible. Visibility for this area was very limited due to a lot of sediment present in the water, thus relying on the DTM to determine if the trench was still present.

[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.2m; the trench is no longer visible and has naturally backfilled to natural seabed. There was no change in shape or cover from 2017 to 2018.
No change in rock berm areas for shape or sediment coverage over the cable. Visibility for this area was very limited due to a lot of sediment present in the water, thus relying on the DTM to determine if the trench was still present.



[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.25m; the trench is no longer visible and has naturally backfilled to natural seabed. From 2017 to 2019 this increase amounts to approximately 0.4m. Visibility for this area was very limited due to a lot of sediment present in the water, thus relying on the DTM to determine if the trench was still present.

[redacted]

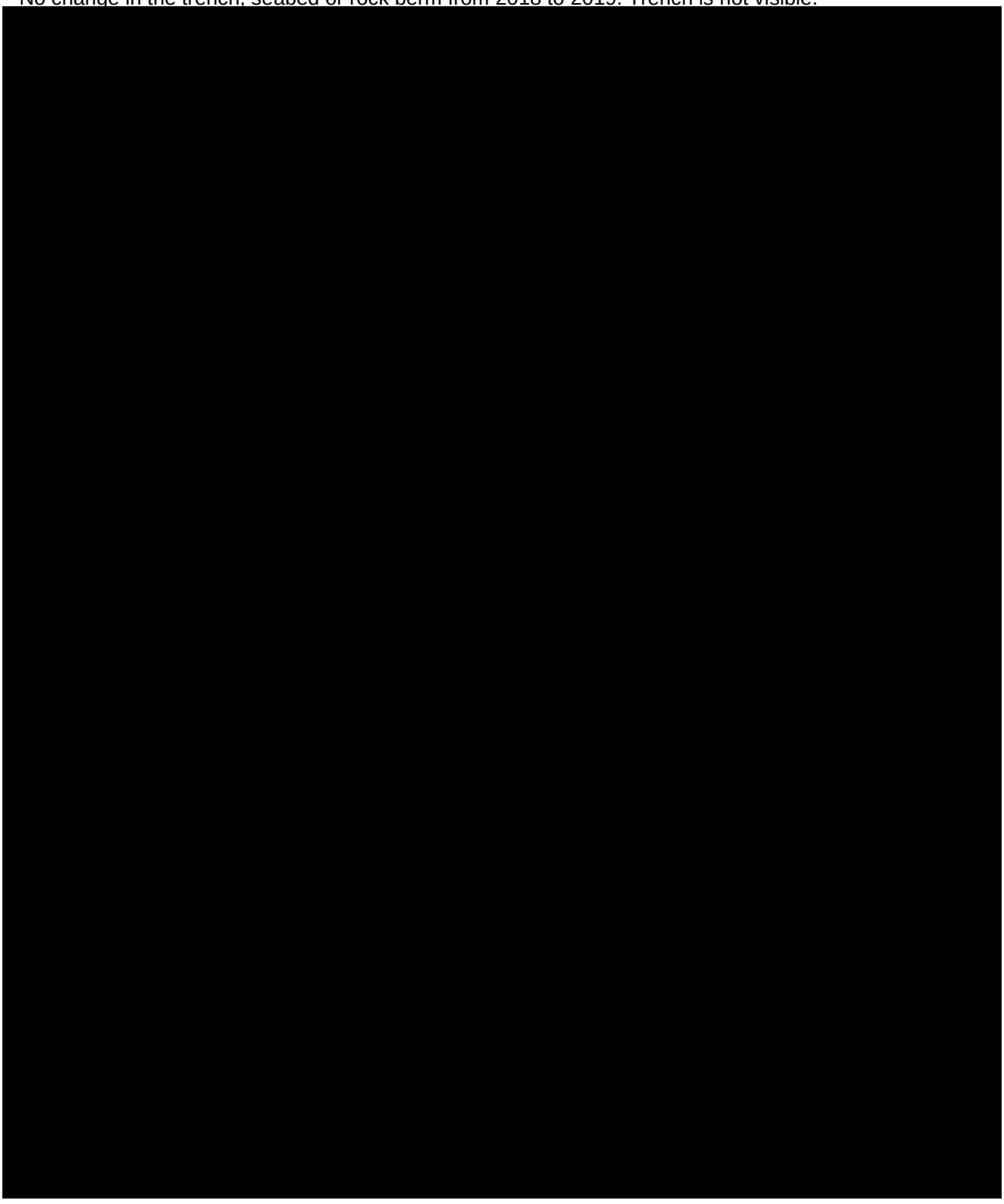
No change in the trench, seabed or rock berm from 2018 to 2019. Trench not visible.

[redacted]

From 2018 to 2019 the trenched areas have naturally backfilled 0.25m; the trench is no longer visible and has naturally backfilled to natural seabed. From 2017 to 2019 this increase amounts to approximately 0.55m.

[redacted]

No change in the trench, seabed or rock berm from 2018 to 2019. Trench is not visible.



From 2018 to 2019 rock berms shape no longer present. Small amounts of rock visible at times. Estimated 0.15 to 0.3m loss of cover. From 2017 to 2018 there was no change in berms shape or cover.
No change in areas between berms. Trench not visible.

[redacted]

[redacted]

No change in the trench, seabed or rock berm from 2018 to 2019. Trench no longer visible.

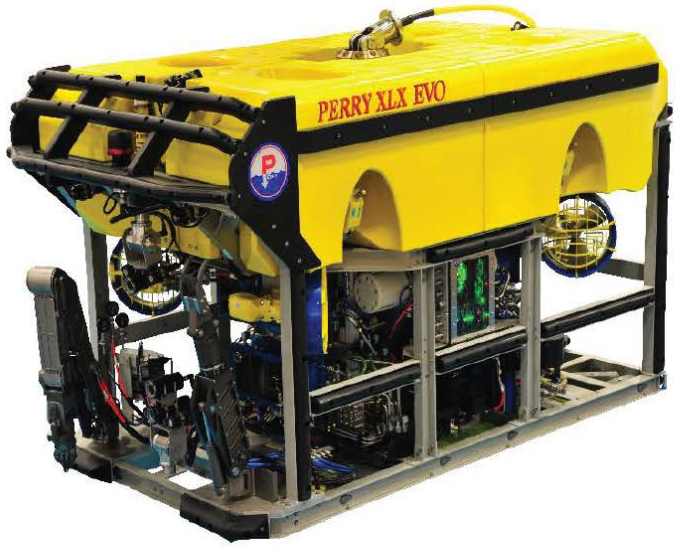
[redacted]

No change in rock berm areas for shape or sediment coverage over cable.

APPENDIX G EQUIPMENT SPECIFICATIONS

everything remotely possible™

FORUM
SUBSEA TECHNOLOGIES



Perry® XLX-Evo

200HP 3000m (4000m)
Work Class ROV

Perry XLX-Evo Work Class ROV

The Forum Energy Technologies Perry XLX Evo ROV represents the latest evolution in the highly successful Perry XL series. The XLX Evo features signifcantly enhanced performance across the full range of demanding intervention and survey tasks without compromise to the outstanding reliability for which the XL series of vehicles is renowned throughout the world.

Building on the success of the XLX vehicle range, the Perry XLX Evo offers extensively reconfgured vehicle control system components. The electrical junction boxes have been re-designed to ease maintenance and the addition of equipment. The user power supply system has also been re-designed to eliminate the need for a one atmospheric control can and to allow ease of confguration.

The Perry XLX Evo also features an enhanced and fully integrated survey system with interfaces compatible with all modern survey equipment, including sub bottom profilers, multibeam sonars, etc. Thruster speed sensing has been introduced to give enhanced thruster response and ease of set up.

The vehicle is controlled using Perry proven Integrated Controls Engine™ (ICE™). The ICE system is a blend of proprietary hardware and software designs, which together form a general purpose control systems engine that can easily accommodate varying control applications and aid with detailed component level diagnostics.

everything remotely possible™

FORUM SUBSEA TECHNOLOGIES

Perry XLX 200 System Features

- 200 shaft horsepower
- 3000msw (4000msw) Depth Rating
- 5500kg (5850kg) Weight (In-Air)
- 300kg (250kg) Payload
- 3000kg Through Frame Lift
- Bollard Pull (Nominal)
  - 1050kgf Forward
  - 1050kgf Lateral
  - 940kgf Vertical
- ICE Real Time Control System with Gb Telemetry and Graphical Diagnosis

Performance

- Forward 4.4 knots
- Lateral 3.2 knots
- Vertical 3.4 knots
- Turning Rate 40° per second
- Pitch Control ± 15° per second
- Roll Control ± 15° per second

Thrusters

- Axial 4 x Ø380mm
- Vertical 4 x Ø300mm

HPU

- Motor 1800 RPM
- Voltage 3 phase, 4160Vac, 60Hz
- Main Pump 200cc/rev
- System Flow 242lpm @ 240bar
- System Flow 316lpm @ 186bar
- Max. System Flow 348lpm @ 34.5bar
- Aux Pump 200cc/rev
- System Flow 242lpm @ 240bar

Manifolds

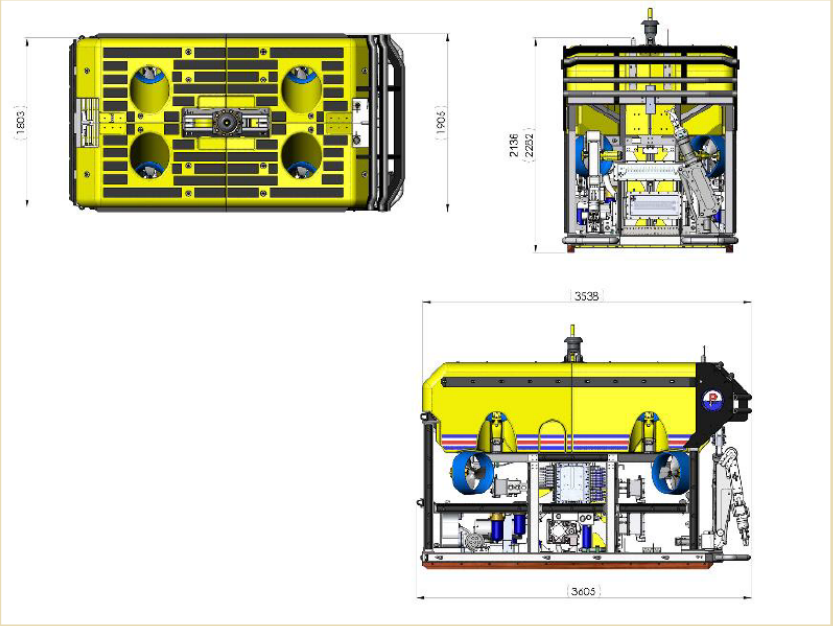
- Main - 16 station proportional/solenoid NG3
- Thruster - 24 station proportional
- Tooling - 12 station proportional (10 x NG3, 2 x NG6)

Auto Functions

- Heading ± 1°
- Depth ± 0.1m
- Altitude ± 0.1m
- Pitch & Roll ± 5° (Range)

Core/Survey JB

- 8 SD/HD Video Channels
- 14 User Configurable Power/Seal Channels; Each RS232 or RS485 and 5/12/24/28 Vdc & 110Vac @10A Max
- 6 lights channels, dimmable, 500W (12 lights)



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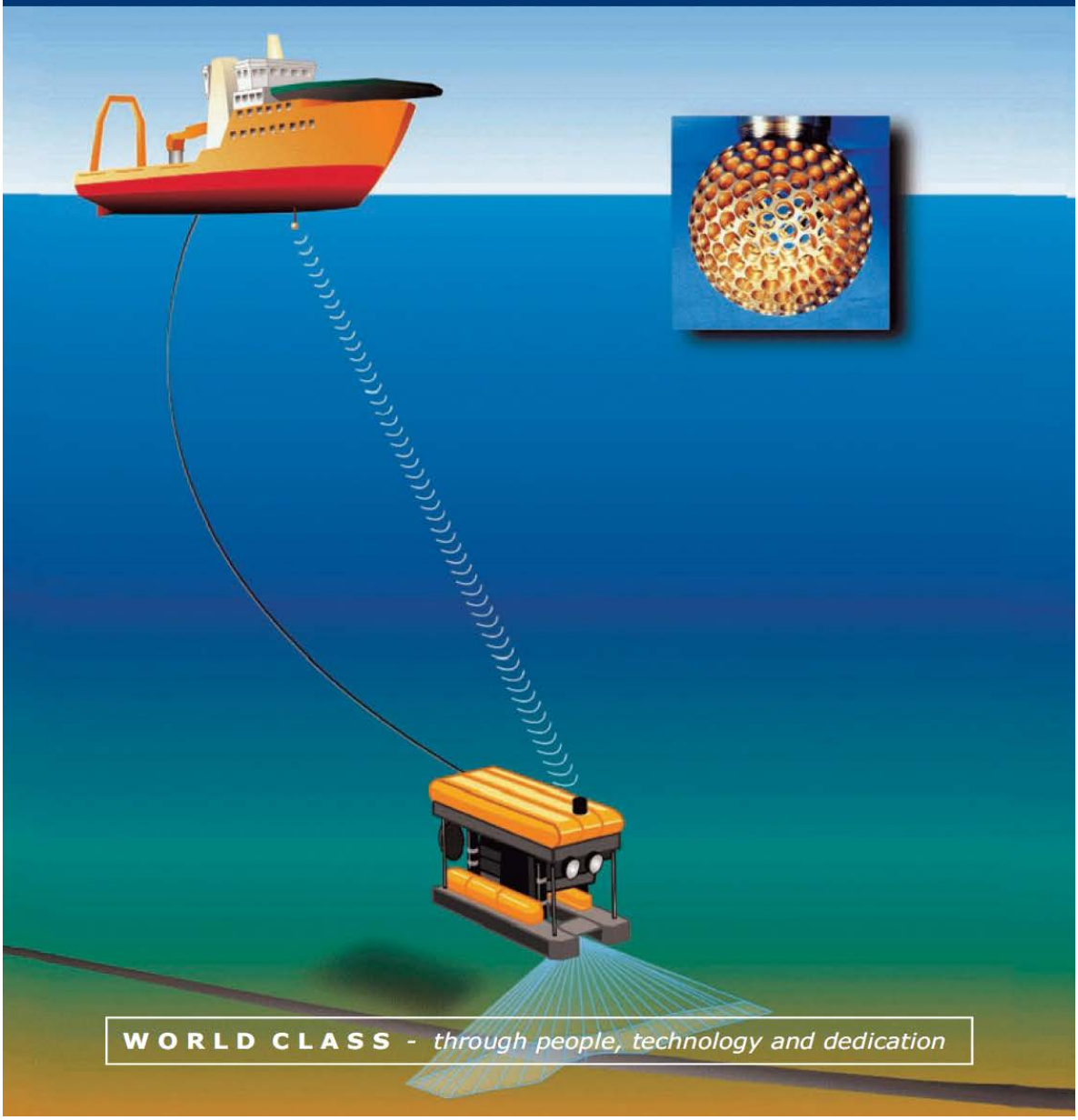
www.f-e-t.com/contact-us

KONGSBERG

HiPAP® 500

High Precision Acoustic Positioning System



WORLD CLASS - *through people, technology and dedication*

Technical specifications

HiPAP 500 basic specifications

Gate valve size required:	500 mm (20 inches)
Transducer diameter:	400 mm
Acoustic operating area:	+/- 100° (Recommended)
Number of active elements:	241
Angle accuracy:[1)]	0 dB S/N: 0.30°
	10 dB S/N: 0.18°
	20 dB S/N: 0.12°
Accuracy dual mode option, dual transducer system:[1)]	20 dB S/N: 0.085°
Range detection accuracy:[1)]	< 20 cm
Typical operating range:[1)]	1 to 4000 m
Narrow pointing receiver beam:	+/- 5°

Note that the technical specifications are subject to change without prior notice.

1) The specifications are based on; Line of sight from transducer to transponder, no influence from ray bending, Signal-to-Noise ratio as specified in water in the 250 Hz receiver band, no error from heading/roll/pitch sensors, and use of correct sound velocity. Operating ranges are typical and conservative, and are assued by using sufficient transponder source level (up to 206 dB dependant on range).

HiPAP 500 standard features

56 transponder channels
Hull unit for transducer deployment
WindowsXP® based operation system

Receive frequency band:	27,0 – 30,5 kHz
Telemetry frequency band:	24,5 – 27,0 kHz
Transmit frequency band:	21,0 – 24,5 kHz

Comprehensive on-line help
Automatic transducer alignment calibration
Compensation for ray-bending
Display of ray-bending
External Depth sensor interface
Position and angle alarm limits
Responder mode
Telegram output to dynamic positioning system
Telegram output to survey system
Transponder Telemetry for full utilization
DGPS Interface

HiPAP 500 optional features

Beacon Mode
Compass Transponder Mode
Depth Sensor Transponder Mode
Inclinometer Transponder Mode
Long Base Line (LBL) functionality
Geographical LBL Calibration
Multi-User LBL functionality (MULBL)
Operator Station Master / Slave function
Blow out preventer (BOP) telemetry function
Offshore Loading Telemetry function
Submerged Turret Loading function
Fast LBL Transponder Positioning mode *
LBL Accurate Metrology mode*
(standard in LBL function)*

855-164508 / Rev.D / October 2003

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E-mail: subsea@kongsberg.com

KONGSBERG

C-Nav
WORLD DGNSS

C-Nav3050




C-Nav3050 FEATURES:

- 66-channel combined GPS/GNSS/L-band receiver.
- Full Constellation tracking, GPS, GLONASS, ***C-NavC***[1] and ***C-NavC***[2], other SBAS (WAAS/EGNOS) signals, and accepts external RTCM input. Corrections over Internet. A choice of data rates make corrections via the internet affordable, and using Iridium delivery, reception at any Latitiude is possible
- Small and lightweight for fast and hassle-free setup.
- Easily configured utilizing C-Nav proprietary PC-based controller software application.
- Easily monitored with intuitive front-panel LEDs or a C-NaviGator IIi Control/Display Unit.

Bluetooth™

GSA Contract Holder
FSS Contract GS-07F-5671P

0191/08

www.cnav.com

C-Nav3050 TECHNICAL SPECS

FEATURES

- "All-in-view" parallel tracking with 66 channels
- SBAS (WAAS/EGNOS/MSAS/GAGAN) Tracking
- Built-in **C-NavC[1]** and **C-NavC[2]** L-band receiver
- **C-NavC[2]** operating mode with automatic failsafe to **C-NavC[1]**
- L1, L2, L5, G1 & G2 full wavelength carrier phase tracking. Low look angle L-Band antenna. Easily installed in series with the existing GNSS antenna, extends satellite delivered coverage area.
- C/A, P1, P2, L2C, L5, G1 and G2 code tracking
- High sensitivity / Low signal level tracking
- Fast signal acquisition / re-acquisition
- Superior interference suppression (both in and out of band)
- Patented multipath rejection
- RTK Extend and C-Nav Over-The-Air activation capabilities
- Configurable as RTK base or rover
- Programmable output rates
- Event Marker input / 1PPS output
- 2GB internal data storage

PHYSICAL/ENVIRONMENTAL

- Size (L x W x H): 6.47" x 4.60" x 2.37" (164 x 117 x 60mm)
- Weight: 1.1 lbs (0.5 kg)
- Front Status Indication: Power/GPS Status, Correction Service Status, Interface Status, and Bluetooth Status
- External Power Input: AC/DC Adapter 110/220VAC, 12VDC Nominal 0.5A (9.0V to 32VDC)
- Connectors
  - I/O Ports: 2 x 9 pin Positronic
  - DC Power: 1 x 9 pin Positronic
  - RF Connector: TNC (with 5VDC bias for antenna/LNA)
- Temperature (ambient)
  - Operating: -40° C to +70° C (-40° F to 158° F)
  - Storage: -40° C to +85° C (-40° F to 185° F)
- Humidity: 95% non-condensing
- Tested in accordance with MIL-STD-810F for: Low pressure, solar radiation, rain, humidity, salt fog, sand dust, and vibration

COMPLIANCE/APPROVALS

- Compliance with the following standards:
  - > IMO performance standard for GPS* > IEC 60529
  - > FCC Part 15 Class B, CE
  - >QC message strings comply with recommendations OGP 373-19 and IMCA S015 (July 2011)
- Type Approvals:
  - > Wheelmark
  - > USCG

PERFORMANCE

GNSS RECEIVER PERFORMANCE

	Horizontal / Vertical (Typical)
Accuracy (RMS):	
RTK (<40km):	1cm + 0.5ppm / 2cm + 1ppm
C-Nav Service:	5cm / 10cm
Code DGNSS (<200km):	45cm + 3ppm / 90cm + 3ppm
Velocity:	0.01ms
RTK Extend (<15 mins):	3cm + 1ppm / 6cm + 2ppm
C-Nav Service (95%):	8cm / 15cm
User-Programmable Output Rates	
Position/Velocity/Time:	1, 5, 10, 25, 50, & 100 Hz
Raw Data:	1, 5, 10, 25, 50, & 100 Hz
Data Latency	
Position/Velocity/Time:	10ms at all rates
Raw Data:	10ms at all rates
Time-to-First-Fix	
Cold/Warm/Hot:	<60s / <50s / <20s (typical values measured per ION-STD 101)
Dynamics	
Acceleration*:	up to 6g
Speed*:	<515m/s (1000 knots)
Altitude*:	<60,000ft (18.3km)

*Restrictions due to export control laws

I/O CONNECTOR ASSIGNMENTS

- Data Interfaces: 2 x RS232 (1 - changeable to RS422, 4800-115200 baud rates)
  1 x USB 2.0 (Host or Device)
  Bluetooth
  Ethernet (10T/100T)

INPUT/OUTPUT DATA MESSAGES

- NMEA-0183: ALM, GBS, GGA, GLL, GRS, GSA, GST, GSV, RMC, RRE, VTG, ZDA, NCT
- Differential Correction: RTCM 2.3 and 3.0, SBAS and C-Nav (proprietary)
- RTK Correction: CMR/CMR+, RTCM, NavCom Ultra RTK
- Receiver Control: NavCom Proprietary Commands (ASCII)

C-NaviGator® CONTROL DISPLAY UNIT OPTION

- Dimensions (W x H x D): 13.97" x 9.78" x 2.24" (35.5 x 24.8 x 5.7cm)

C-NaviGator III Control Display Unit

* In compliance with US and International export control laws

*IMO require all SOLAS class ships to carry a type-approved GPS and further that any new GPS installation shall be compliant with the new performance standard for GPS. This was defined by MSC 112(73) and resulted in the associated test standard IEC 61108-1 Ed. 2.

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C-NavC² Subscription Service

QC CONFIDENCE - WITHOUT THE INCONVENIENCE

C&C Technologies' **C-NavC²** global positioning service offers robust Quality Control through independent solutions and inbuilt duality.

C-NavC² features:

- Full constellation - GPS and GLONASS (Galileo and COMPASS planned)
- Worldwide Precise Point Positioning
- Duality and independence built in
- 2D decimeter level dynamic accuracy
- Mutually compatible generation and application software
- Confidence through real-time user access to the C-Nav worldwide monitor network
- Regular GNSS status updates and notices by email
- 24 hour service on-call backup
- Automatic backup with **C-NavC¹**
- Compliance with the OGP/IMCA "Guidelines for GNSS Positioning in the Oil and Gas industry" QC parameters

REAL-TIME PRECISE POINT POSITIONING (PPP)

The real-time proprietary PPP solution used by **C-NavC²** is the very latest generation in GNSS accuracy enhancements, addressing GNSS uncertainties where they occur - at source.

- Completely independent of **C-NavC¹**
- Proprietary Starfire PPP algorithms
- Orbit correctors for each GPS and GLONASS satellite
- Clock offset correctors for each GNSS satellite
- Dual frequency C-Nav receivers for ionospheric correctors
- Up to 20% reduction in GNSS receiver cold-start pull-in time
- Patented multi-path mitigation software and antenna technology at each **C-NavC²** reference station
- Sinko's Earth tides model incorporated

GROUND SEGMENT

Each **C-NavC²** satellite tracking station includes a minimum of two active receivers with quality controlled feedback loops ensuring performance metrics are maintained.

- Worldwide network of dedicated sites
- Independent A and B dual-frequency engines at each site.
- Real-time comparison of position, accuracy, and precision.
- Simultaneous observations to each GNSS satellite from typically seven stations.
- Secure and robust multi-routed communication links backed up by VSAT and ISDN.

CONTROL SEGMENT

Two independent, geographically separated Processing Centers interconnected by high-speed, high-capacity frame-relay feeds.

Each Processing Center:

- Receives the full complement of **C-NavC²** reference station data (both A and B receivers).
- Two independent production layers - Primary and Secondary.
- Compares the observables from each A and B receiver and independently selects the optimum solution.
- Handles the data cloud completely independently of the other, producing two independent sets of PPP corrections.
- Continuously monitors PPP correctors to ensure there are no errors.
- Resilient and spatially diversified communication routing
- Sends correctors independently to the Land Earth Station network for uplink to the C-Nav **NET-1** and **NET-2** satellites.

SPACE SEGMENT: NET-1 & NET-2

The C-Nav space segment is comprised of six geostationary communication satellites providing global hipower L-Band distribution. Uplinked through six Land Earth Stations (LES), configured as **NET-1** or **NET-2**, a minimum of two satellites are visible to every **C-NavC²** user.

- Each LES is equipped with Primary and Secondary equipment layers.
- Each layer receives **C-NavC²** corrections from both Control Centers with the Primary layer comparing the two correction data sets for integrity then, independently selecting the optimum data set for uplink.
- Secure high-speed cable and VSAT with ISDN backups for data flow between the Control Centers and the Land Earth Stations.
- Communication satellites are constantly monitored to ensure service continuity and quality.
- Backup channel capacity available on adjacent satellites over the same regions.
- Ground station network monitors L-Band signal strength, veracity, and precision of received data in a continuous baseline comparison process.
- Since the inception of NET2 (over five years ago), the uptime of the combined system has been 100%

USER SEGMENT RECEIVER TECHNOLOGY

The international **C-NavC²** subscription service is accessible using the latest Sapphire® powered C-Nav3050 GNSS receiver and C-Nav7000 configurable multi-correction source GNSS receiver.

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090616

LD5 INTEGRATED MOBILE UNIT

veripos ON TARGET

VERIPOS LD5 is a ruggedised integrated sensor with a modern, user friendly interface designed to meet a range of demanding offshore positioning requirements.

The VERIPOS LD5 is a state-of-the-art positioning unit which is available in a number of configurations, from a basic L-band demodulator to a fully integrated mobile positioning unit with demodulator and multi-frequency GNSS receiver. The unit can easily be upgraded to different configurations depending on your requirements. Installation and set up of the LD5 is simple and straightforward. The on-board colour display and intuitive menu structure makes the configuration and operation of the LD5 user friendly. The display also provides the user with valuable real-time position and status information.

The LD5 utilises VERIPOS positioning algorithms and supports all VERIPOS services which can produce position accuracies from metre to decimetre level. The internally installed SD card permits logging of all data, allowing post processing and post mission analysis if required.

The LD5 can also be used as a sensor to output raw GNSS measurements and VERIPOS augmentation data in RTCM format.
This can be used by external processing or quality control software, such as VERIPOS Verify QC. Data can be output through three galvanically isolated serial ports configurable for either EIA232 or EIA422. Data is also available through a USB port or an Ethernet port.

The LD5 is suitable for a wide range of applications including hydrographic/offshore surveying, dredging, offshore construction, seismic exploration and dynamic positioning.

Precise Satellite Positioning Services

www.veripos.com

TECHNICAL SPECIFICATIONS

Physical characteristics

Receiver size: Aluminium housing
90mm(H) x 158mm(W) x 227mm(D)

Rating: IP66

Weight: 2.25kg

Display: MMI colour screen and keypad

Operating temp: -15 to 55 degrees Celsius

Storage temp: -20 to 70 degrees Celsius

Input voltage: 12 to 24V DC

Consumption: Basic configuration - <4W
Intermediate configuration - <7.2W
Enhanced Configuration - <7.5W

Onboard System

ARM 11 533 MHz Processor

512MB RAM

96MB Flash Memory

Windows CE Operating System

Internal SD Card

Data Ports and Interfaces

3 Serial Connectors: 9 way D EIA-232/422 Galvanically isolated

USB Device-Type B socket

Ethernet-RJ45

1PPS-BNC

VERIPOS L-band demodulator

Antenna input: 1525 to 1559 MHz

Connector: TNC

GNSS Options

Septentrio AsteRx2 Family

MF receiver

Hemisphere SBX-4 MF receiver

Dual channel receiver for reception

of MF Beacon services (e.g. IALA)

System Configuration

Basic – Lband demodulator only

Intermediate – Lband and GNSS module

Enhanced – Lband, GNSS and MF module

Regulatory and Environmental

CE

FCC part 15B

Certified to IEC60945-2002

** Specifications subject to change without notice*

Precise Satellite Positioning Services

www.veripos.com

PRODUCT SHEET

HEXAGON
POSITIONING INTELLIGENCE

veripos

VERIPOS ULTRA AND ULTRA² SERVICES

GNSS POSITIONING SERVICES

VERIPOS Ultra and Ultra² services are global, high-accuracy GNSS positioning services designed to meet all offshore positioning and navigation applications. Ultra services provide decimetre accuracy and are complementary to VERIPOS Apex and Apex² services, which, when taken together, provide the user with correction services derived from independent networks and mitigate for single-point failures.

PRECISE POINT POSITIONING

Ultra and Ultra² services operate using Precise Point Positioning (PPP) – an absolute positioning technique which corrects or models all GNSS error sources, i.e. GNSS satellite orbit and clocks, tropospheric, ionospheric and multipath errors. The PPP technique consists of a single set of 'globally applicable' corrections to the satellite orbits and clocks, so position accuracy is maintained regardless of user location.

ORBIT AND CLOCKS

Real-time corrections for the Ultra services are provided by the JPL Orbit and Clock Determination System (OCDS) which uses data from JPL reference stations. Redundant orbit and clock corrections are provided to the VERIPOS Network Control Centres in Aberdeen and Singapore. The orbit and clock corrections for all satellites in the GPS and GLONASS constellations are valid globally, meaning position accuracy is maintained regardless of user location.

CONSTELLATIONS

The Ultra service uses satellites from the GPS constellation while the Ultra² service uses both the GPS and GLONASS constellations. The satellites from the GLONASS constellation provide additional observations. This can help maintain reliable and accurate positioning when masking of satellites occur (e.g. when working close to a platform) or when suffering from ionospheric scintillation. Another benefit of using both satellite constellations is a faster convergence of the positioning solution.

Ultra and Ultra² services are broadcast alongside Apex services via seven geostationary communications satellites to ensure availability and service redundancy.

TECHNICAL SPECIFICATIONS

GNSS Satellite Constellations

Ultra: GPS Ultra²: GPS + GLONASS

Observations Used

Ultra: GPS L1/L2 Ultra²: GPS L1/L2 & GLONASS L1/L2

Positioning Technique

Precise Point Positioning

Reference Station Network

JPL

Availability

Global

Geostationary Satellites

25E, 98W, 143.5E, AORE, AORW, IOR, POR

Horizontal Accuracy*

<10 cm at 2 σ (95%)

Vertical Accuracy*

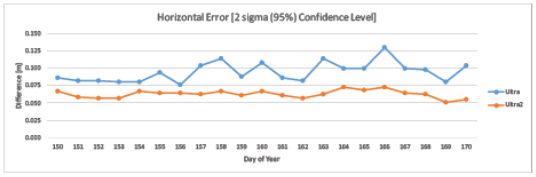
<20 cm at 2 σ (95%)

Coordinate Reference Frame

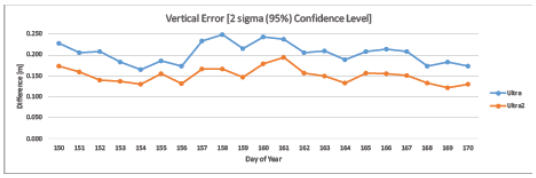
ITRF2014

**Based on static data logged in Aberdeen, Houston and Singapore over a 7 day period. Accuracy will vary with observing conditions.*

**SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE*

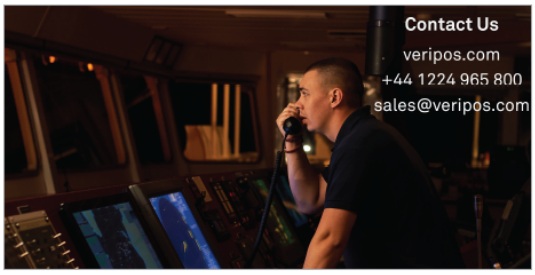


The above graph displays Ultra and Ultra² horizontal positioning error over a 21 day period.



The above graph displays Ultra and Ultra² vertical positioning error over a 21 day period.

ULTRA SERVICES



ABOUT VERIPOS

VERIPOS is a global technology leader, pioneering end-to-end solutions for assured positioning for for the offshore marine oil and gas industry. VERIPOS is part of Hexagon's Positioning Intelligence division. Learn more at veripos.com

REV 2

OCTANS 3000

SUBSEA GYROCOMPASS AND MOTION SENSOR

OCTANS is a subsea survey-grade gyrocompass and complete motion sensor for water depths up to 3,000m. Based on FOG technology it outputs heading, roll, pitch, surge, sway and acceleration. OCTANS 3000 can be easily upgraded to full INS mode (i.e. ROVINS).

FEATURES

- Complete gyrocompass and motion sensor
- Fiber Optic Gyroscope (FOG), unique strap-down technology
- Titanium made
- Small, portable plug and play system
- Optional full featured Inertial Navigation System

BENEFITS

- High-performance real-time outputs of true heading, roll, pitch, heave, surge, sway, acceleration and rate of turn
- No spinning element hence maintenance free
- Lightweight corrosion free housing for water depth up to 3,000 m
- Easy to integrate and interface, saves valuable mobilisation time
- Obtain INS-class system with simple software upgrade

APPLICATIONS • ROV & offshore survey • Multibeam and sonar motion reference • Dredging • Marine construction

OCTANS 3000
TECHNICAL SPECIFICATIONS

PERFORMANCE

Heading	
Accuracy [1][2]	0.1 deg secant latitude
Resolution	0.01 deg
Full accuracy settling time (all conditions)	< 5 min
Heave accuracy	5 cm or 5% (whichever is greater)
Roll / Pitch	
Dynamic accuracy [2]	0.01 deg
Resolution	0.001 deg

OPERATING RANGE / ENVIRONMENT

Operating / Storage Temperature	-20 to +55°C/ -40 to +80 °C
Follow-up speed	Up to 750 deg/s
Acceleration dynamic range	±15 g
Heading / Roll / Pitch	0 to +360 deg / ±180 deg / ±90 deg
MTBF (computed/observed)	40,000 hours / 80,000 hours
No warm-up effects, insensitive to thermal shocks	
Shock and vibration proof	

PHYSICAL CHARACTERISTICS AND INTERFACES

Depth rating (m)	Material	Weight in air/water [kg]	Housing dimensions (Ø x H mm)	Connector	Mounting
3000	Titanium	15 / 6,2	213 x 374	3 x 12 pin 1 x 19 pin 1 x 26 pin SEACON MINI-CON	6 Ø 6,6 holes

INTERFACES

Serial RS232/RS422 port	5 inputs / 5 outputs / 1 configuration
Ethernet port [3]	UDP / TCP Client / TCP server
Pulse port [4]	3 inputs / 2 outputs
Sensors supported	GPS, Speed Log
Intput/Output formats	Industry standards: NMEA0183, ASCII, BINARY
Baud rates	600 bauds to 115.2 kbaud
Data output rate	0.1 Hz to 200 Hz
Power supply	24 VDC
Power consumption	15 W

(1) secant latitude = 1 / cosine latitude
(2) RMS values
(3) All input /output serial ports are available and can be duplicated on Ethernet ports
(4) Input of GPS PPS pulse for accurate time synchronization of OCTANS 3000

Specifications subject to change without notice

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2010-02-PS-OCT3000

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Datasheet
SPRINT-Nav

Description

SPRINT-Nav is the world's highest performing all-in-one hybrid navigator for all subsea vehicles and survey operations.

The SPRINT-Nav is a turnkey solution combining carefully selected inertial sensors, a Syrinx Doppler Velocity Log (DVL) and a high accuracy pressure sensor into a single housing.

The result is not only the highest performing hybrid navigator but also one of the smallest navigation instruments on the market.

All onboard sensors are optimally integrated to provide seamless operation and unprecedented levels of performance compared with standalone instruments from different vendors.

The unit comes pre-calibrated and requires no additional calibration to achieve unprecedented performance with minimal operational complexity.

SPRINT-Nav's inertial dual AHRS & INS algorithm capability is unique in the market and allows for automatic on-board integrity checking between algorithms as well as instantaneous INS start up with North alignment from the on-board AHRS. This capability allows for simultaneous use from one instrument, e.g. AHRS plus DVL for ROV piloting and INS plus DVL for survey operations.

Tight beam-level DVL aiding for the on-board INS with optimal timing and use of proprietary QC metrics provides higher performance and more reliable navigation in demanding bottom-lock environments. Furthermore, the tight integration also enables unconventional mounting arrangements, i.e. tilting the SPRINT-Nav, enabling vehicle integration previously not possible.

Each DVL transducer is fitted with a full depth-rated water block to ensure protection of the internal components. Combined with beam level aiding the SPRINT-Nav will continue to function even if one of the DVL transducers has been damaged.

SPRINT-Nav can be interfaced using a single connection and/or the internal sensors can be interfaced separately depending on requirements.

Internal battery backup provides continuous on-board navigation and data storage supporting post-mission diagnostics and post-processing, even throughout brownout periods.

Export of SPRINT-Nav is simplified as compared to other separate DVL and INS units. For example, shipping from outside the USA does not require a re-export licence.

Applications

- Any subsea vehicle including AUV, AIV, ROV, Towfish & ROTV
- Ideally suited for autonomous and resident vehicles
- Survey and construction

Features

- World's highest performing hybrid navigator
- All-in-one turn-key solution
- Dual concurrent AHRS, INS and DVL output capability for multi-use
- Instantaneous INS initialisation from AHRS with no alignment procedure required
- Dual AHRS & INS algorithms enabling internal health check of orientation
- Highly optimised SWaP
- Proven long life and high MTBF inertial sensors from trusted long-term US supplier
- Remote diagnostics and performance verification
- Fully water blocked DVL endcap protecting internal electronics
- 0.4–175 m bottom track operating range

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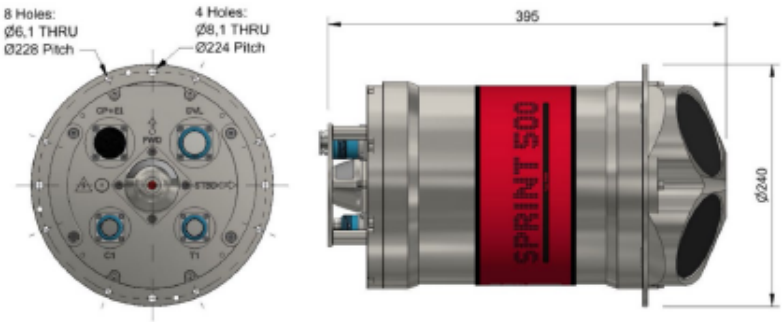
Specifications
SPRINT-Nav



Performance		SPRINT-Nav 300	SPRINT-Nav 500	SPRINT-Nav 700
DVL Aided Accuracy[1]	Typical Survey	0.04% Distance Travelled	0.02% Distance Travelled	0.01% Distance Travelled
	Distance from Origin (DFO)	0.12% Distance Travelled	0.07% Distance Travelled	0.05% Distance Travelled
DVL Aiding Loss/Free Inertial Drift[1]		1.2 m over 1 min 5.0 m over 2 mins	0.6 m over 1 min 2.4 m over 2 mins	0.5 m over 1 min 2.0 m over 2 mins
USBL Aided		3 x precision improvement over USBL	3.5 x precision improvement over USBL	4.5 x precision improvement over USBL
USBL and DVL Aided		3 to 7 x precision improvement over USBL	4 to 10 x precision improvement over USBL	6 to 13 x precision improvement over USBL
Station Keeping		<1 m over 24 hours	<1 m over 24 hours	<1 m over 24 hours
LBL and DVL Aided Accuracy		n/a	3 cm confined area, 20 cm wide area (dynamic)	3 cm confined area, 20 cm wide area (dynamic)
'Synthetic' LBL Aided Accuracy		n/a	<20 cm @ 200 m distance to single transponder	<15 cm @ 200 m distance to single transponder
INS/AHRS Heading Accuracy (Secant Latitude)		0.05° (INS) 0.20° (AHRS)	0.04° (INS) 0.10° (AHRS)	0.02° (INS) 0.08° (AHRS)
AHRS/INS Roll and Pitch Accuracy		0.01°	0.01°	0.01°
Pressure Sensor		0.01% FS removable module	0.01% FS removable module	0.01% FS removable module
Power				
Power Requirements		20–50 V dc, 27 W nominal, 63 W max		
Power Pass Through		3 x for external aiding sensors (up to 3 A per sensor)		
Internal Battery Backup		Li-ion/5 minutes		
Physical / Comms				
Ports		1x Ethernet, 4x RS232/RS485, 4x Triggers		
Construction		Titanium		
Diameter x Height	4,000 m	Ø240 x 395 mm		
	6,000 m	Ø240 x 405 mm		
Weight Air/Water[2]	4,000 m	23.9/13.1 kg		
	6,000 m	28.1/17.2 kg		
Environmental				
Depth Rating		4,000/6,000 metres		
Operating Temperature		-5 to 50°C		
Storage Temperature		-25 to 55°C		

[1] CEP50

[2] Estimated weights

Pipe & Cable Survey

Subsea Detection & Tracking Systems

Industry standard subsea pipe and cable detection

There are thousands of miles of pipes and cables beneath our oceans. Commercial, legal, operational and environmental consideration demand that these remain in good order. This requirement creates a constant need to verify location, condition and burial status – operations that are complicated by the ever-changing seabed topography.

TSS is the world leader in developing and supplying technologies to meet these demands. Having developed the world's first commercial pulse induction pipe and cable survey system (TSS 340) in 1991, followed by the release of the TSS 350 AC tone cable survey system, TSS has gone from strength to strength and become the industry standard.

PRODUCT FEATURES

- Suitable for pipe and cable tracking, burial and survey requirements
- Excellent detection and tracking performance
- High accuracy repeatable range data
- Pulse induction technology allows autonomous operation
- System design facilitates quick and easy mobilisation
- AC tone detection mode for measurement at increased burial depths
- Forward search mode for target location

TELEDYNE TSS
Everywhereyoulook™

A Teledyne Marine Company

350

Subsea Pipe & Cable Tracking System

With modern subsea cable systems becoming increasingly sophisticated and their deployment, recovery and repair a more exacting science, there is a need for accurate subsea cable location. The TSS 350 cable survey system has been developed to meet this requirement in a compact modular system that provides enhanced features whilst remaining easy to use.

The TSS 350 system is designed specifically for the detection and survey of tone-carrying cables. Featuring a comprehensive software display and menu structure, real-time information is presented in a clear graphical format and provided as a digital output for storage and subsequent processing.

This fully integrated system provides accurate survey data, verifying location and burial status of a cable as well as providing operators with fault location, vehicle skew angle and look-ahead information.

The TSS 350 provides today's specialist operating companies with a system that will significantly improve their subsea operations allowing cable detection at greater burial depths for a variety of applications.

PRODUCT FEATURES AND BENEFITS

- Cable location data and depth of burial data
- Cable fault location
- Vehicle skew angle data
- Look-ahead information
- Tone discrimination
- Accurate and reliable survey data with quality control envelope
- Combination of advanced DSP technology and proven tone-detection techniques
- Tone frequency discrimination

Pipe & Cable Survey

Subsea Detection & Tracking Systems

TECHNICAL SPECIFICATIONS

		350	440
System Performance		A C Tone	Pulse induction
	Detection Range	Cable detected at vertical range up to 10m and within a total horizontal swath width of 20m centred on the coil array	3cm armoured cable depth and tracking at 1.2m; 1cm unarmoured cable depth and tracking at 0.6m
	Vertical measurement accuracy (in a low noise environment)	**RMS** 5cm or 5% of slant range – whichever is greater. Stated accuracy applies within the quality envelope of 4m. 3cm armoured cable depth and tracking at 1.2m; 1cm unarmoured cable depth and tracking at 0.6m	**RMS** 5cm or 5% of slant range – whichever is greater
Subsea Electronics Pod (SEP)	Dimensions	140mm (dia) x 450mm (h) (440 – 2 pods, 350 – 1 pod)	
	Weight per pod	10Kg in air; 2Kg in water	
	SDC communication	2-wire 20mA digital current loop or 4-wire 20mA digital current loop RS232 via a multiplexer	
	Voltage input	Standard 110V AC (input range 98-135V AC); Optional 240V AC (input range 198-270V AC)	
	ROV connection	Via 8-way waterproof connector	
	Voltage input	Standard 110V AC (input range 98-135V AV); Optional 240V AC (input range 198-270V AC)	
	ROV connection	Via 8-way waterproof connector	
SDC	Hardware	19" military grade touch screen panel PC Rear mounted comms endorse for all external interfaces	
	Display resolution	1280 x 1080	
	Dimensions	599 x 480 x 345mm (including transit case)	
	Power consumption	250W max	
	Shock resistance	Operating: better than 5g for <10ms Non-operating: better than 40g for <10ms	
Altimeter	Dimensions	140mm (dia) x 290mm (h)	
	Frequency	200kHz	
	Range	30cm to 30m	
	Connection cable	4m length (7m length optional)	
	Connection to	Subsea electronics pod	
Depth Rating	All subsea components are depth rated to 3000m (optional 6000m)		
Field Support Kit	Supplied as part of the recommended system		
Warranty	12 months international warranty including parts and labour.		

COMPANY WITH MANAGEMENT SYSTEMS CERTIFIED BY DNV
– ISO 9001 –
– ISO 14001 –

TELEDYNE TSS
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VAISALA www.vaisala.com

PTB210 Digital Barometer

The Vaisala BAROCAP® Digital Barometer PTB210 is a reliable outdoor barometer that withstands harsh conditions.

The PTB210 paired with the SPH10 Static Pressure Head.

For Harsh Environments

The Vaisala BAROCAP® Digital Barometer PTB210 is ideal for outdoor installations and harsh environments. The barometers are designed to operate in a wide temperature range, and the electronics housing provides IP65 (NEMA 4) standardized protection against sprayed water.

Features/Benefits

- 500 ... 1100 hPa or 50 ... 1100 hPa pressure ranges with serial output
- Different scalings between 500 ... 1100 hPa with analog output
- Electronics housing IP65 protected against sprayed water
- Accurate and stable measurement
- NIST traceable (certificate included)

The PTB210 barometers are ideal for use in applications such as weather stations, data buoys and ships, airports, and agrology. They are also an excellent solution for monitoring barometric pressure in industrial equipment such as laser interferometers and engine test benches.

Several Pressure Ranges

The PTB210 barometers are designed for various pressure ranges. They are available in two basic configurations: serial output for 500 ... 1100 hPa and 50 ... 1100 hPa and analog output with different scalings between 500 ... 1100 hPa.

Accurate and Stable Measurement

All the PTB210 barometers are digitally adjusted and calibrated by using electronic working standards. A higher accuracy barometer, that is fine-tuned and calibrated against a High Precision Pressure Calibrator, is available for the 500 ... 1100 hPa pressure range.

In addition, the PTB210 integrates directly with Vaisala Static Pressure Head Series SPH10/20. This pairing offers accurate measurement in all wind conditions.

Vaisala BAROCAP® Technology

The PTB210 barometers use the Vaisala BAROCAP® Sensor, a silicon capacitive absolute pressure sensor developed by Vaisala for barometric pressure applications. The Vaisala BAROCAP® Sensor provides excellent hysteresis and repeatability characteristics and outstanding temperature and long-term stability. All PTB210 barometers are delivered with a factory calibration certificate which is NIST traceable.

Technical Data

Operating Range (1hPa=1mbar)

Pressure range (order specified)	
serial output	500 ... 1100 hPa
	50 ... 1100 hPa
analog output	500 ... 1100 hPa
	600 ... 1060 hPa
	800 ... 1060 hPa
	900 ... 1100 hPa
Operating temperature range	-40 ... +60 °C (-40 ... +140 °F)
Humidity range	non-condensing

Accuracy

SERIAL OUTPUT (units in hPa)

Pressure range	500 ... 1100		50 ... 1100
	Class A	Class B	
Non linearity*	± 0.10	± 0.15	± 0.20
Hysteresis*	± 0.05	± 0.05	± 0.10
Repeatability*	± 0.05	± 0.05	± 0.10
Calibration uncertainty**	± 0.07	± 0.15	± 0.20
Accuracy at +20 °C (+68 °F)***	± 0.15	± 0.20	± 0.35
Temperature dependence****	± 0.20	± 0.20	± 0.40
Total accuracy***	± 0.25	± 0.30	± 0.50
-40 ... +60 °C (-40 ... +140 °F)			
Long term stability (hPa/year)	± 0.10	± 0.10	± 0.20

ANALOG OUTPUT

Non linearity*	± 0.20 hPa
Hysteresis*	± 0.05 hPa
Repeatability*	± 0.05 hPa
Calibration uncertainty**	± 0.15 hPa
Accuracy at +20 °C (+68 °F)***	± 0.30 hPa
Temperature dependence****	± 0.50 hPa
Total accuracy*** -40 ... +60 °C (-40 ... +140 °F)	± 0.60 hPa
Long term stability	± 0.10 hPa/year

* Defined as the ±2 standard deviation limits of end point non-linearity, hysteresis error or repeatability error.
** Defined as ±2 standard deviation limits of inaccuracy of the working standard including traceability to NIST.
*** Defined as the root sum of the squares (RSS) of end point non-linearity, hysteresis error, repeatability error and calibration uncertainty at room temperature.
**** Defined as ±2 standard deviation limits of temperature dependence over the operating temperature range.

General

(· Factory setting)

SERIAL OUTPUT

Current consumption	
normal mode	< 15 mA·
power down mode	< 0.8 mA
shutdown mode	0.2 mA
Shutdown	ON/OFF
Settling time at power up	2 s
Serial I/O (factory setting·)	RS232C
	RS232C /TTL (optional)
	RS485, non isolated (optional)
parity	none, even·, odd
data bits	7·, 8
stop bits	1·, 2
Baud rate	1200, 2400, 4800, 9600·, 19200
Response time	1 s·
Resolution	0.01 hPa (1 measurement/s)
	0.03 hPa (10 measurements/s)

ANALOG OUTPUT

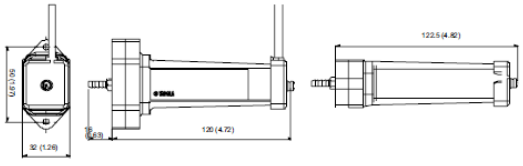
Outputs	0 ... 5 VDC, 0 ... 2.5 VDC (order specified)
Current consumption	
normal mode	< 8 mA
shutdown mode	0.2 mA
Shutdown	ON/OFF
Response time	500 ms
Resolution	300 µV
Measurement rate	3 measurements/s

ALL MODELS

Supply voltage (reverse polarity protected)	
with RS232/TTL output	5 ... 28 VDC
with RS485 or analog output	8 ... 18 VDC
Max. pressure	5 000 hPa abs.
Pressure connector	M5 (10-32) internal thread
Pressure fitting	barbed fitting for 1/8" I.D. tubing
Housing	
electronics	IP65 (NEMA 4)
sensor	IP53
Housing material	PC plastic
Supply/output cable length	1, 2, 3, 5 or 10 m
Instrument	110 g
Cable	28 g/m
Electromagnetic compatibility	Complies with EMC standard EN61326-1, Generic Environment

Dimensions

Dimensions in mm (inches)



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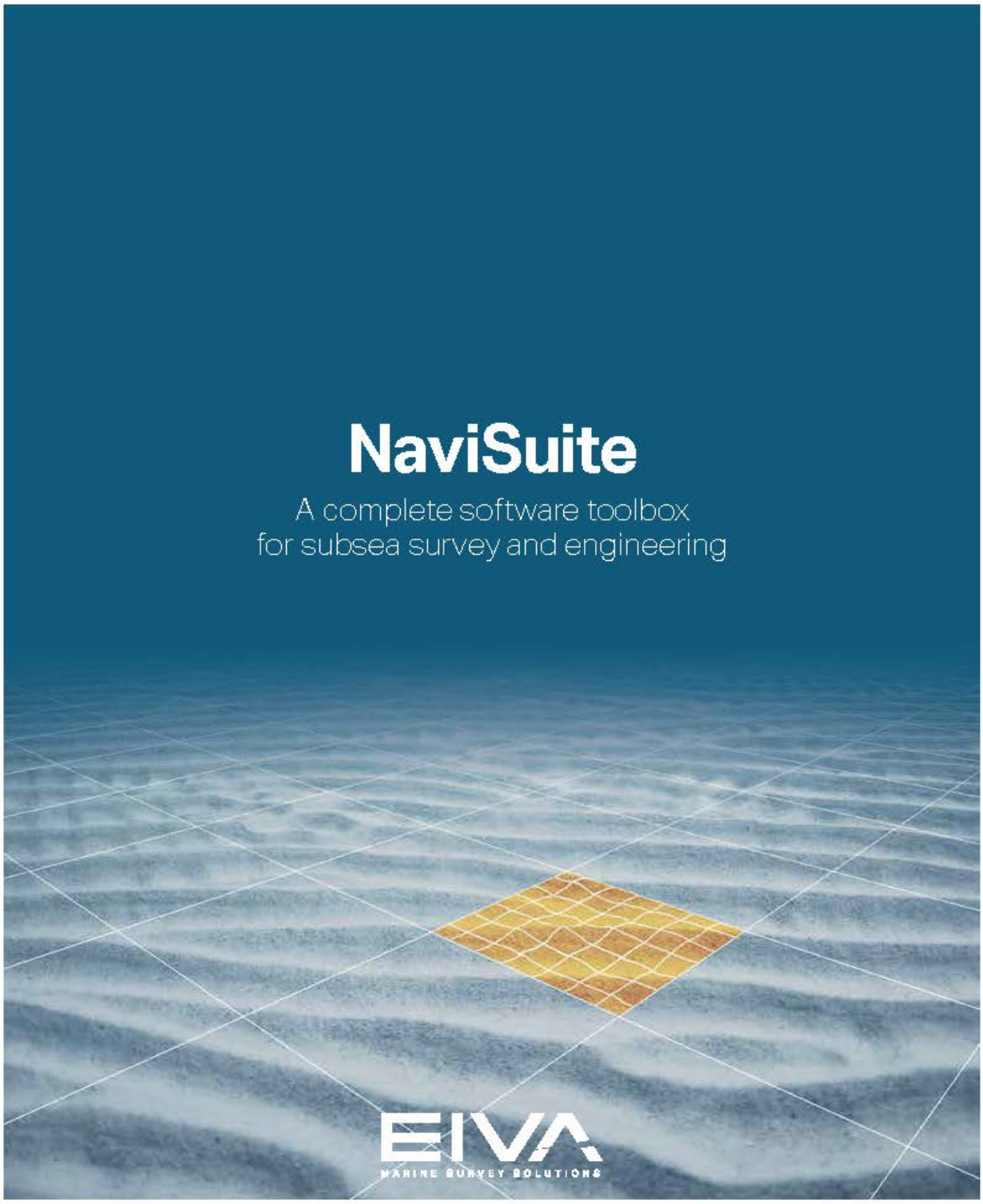
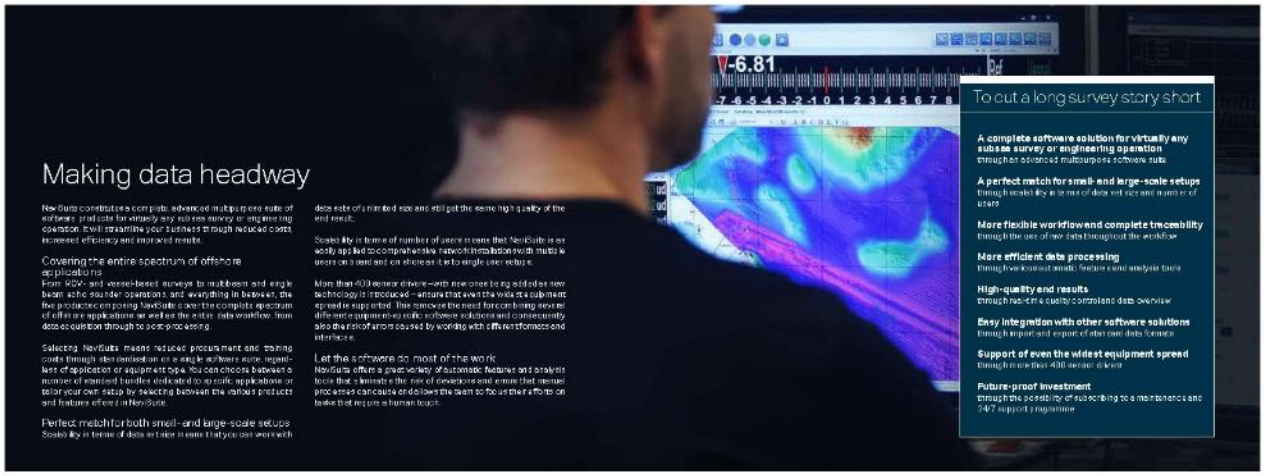
Please contact us at
www.vaisala.com/requestinfo

www.vaisala.com

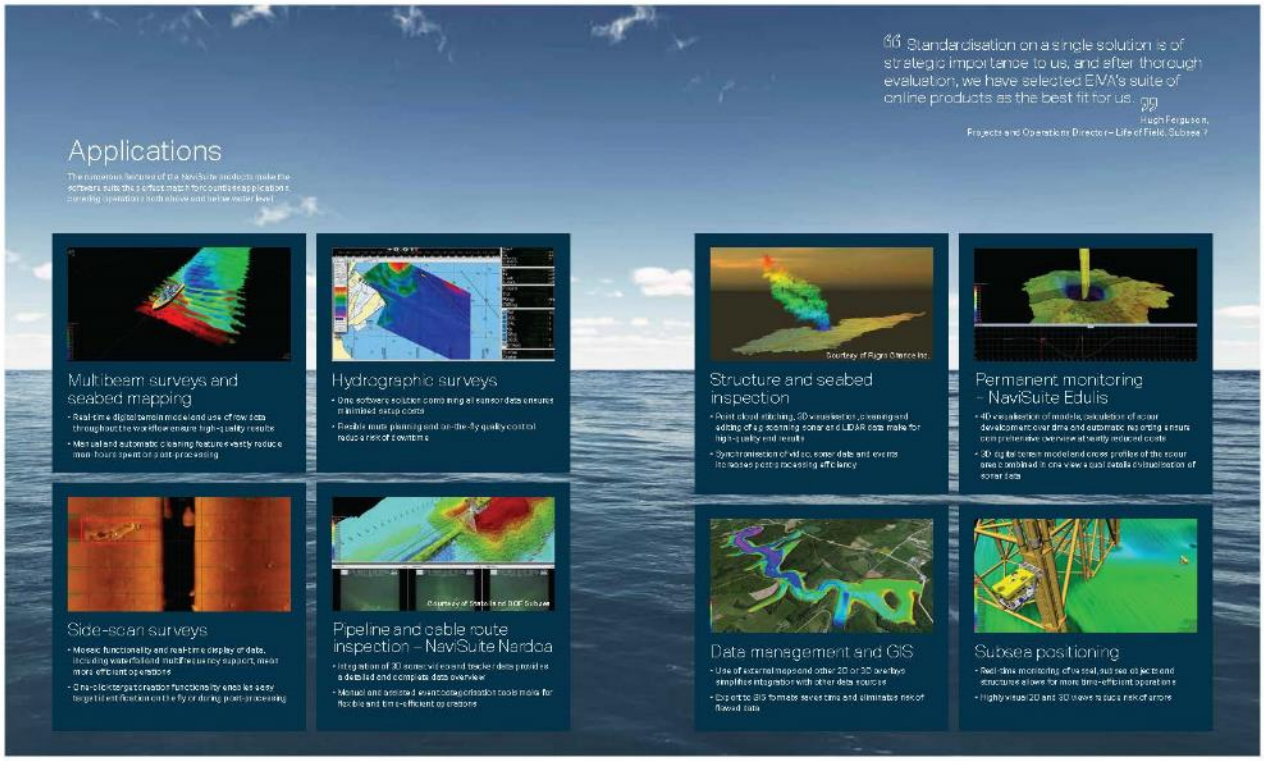
Scan the code for more information

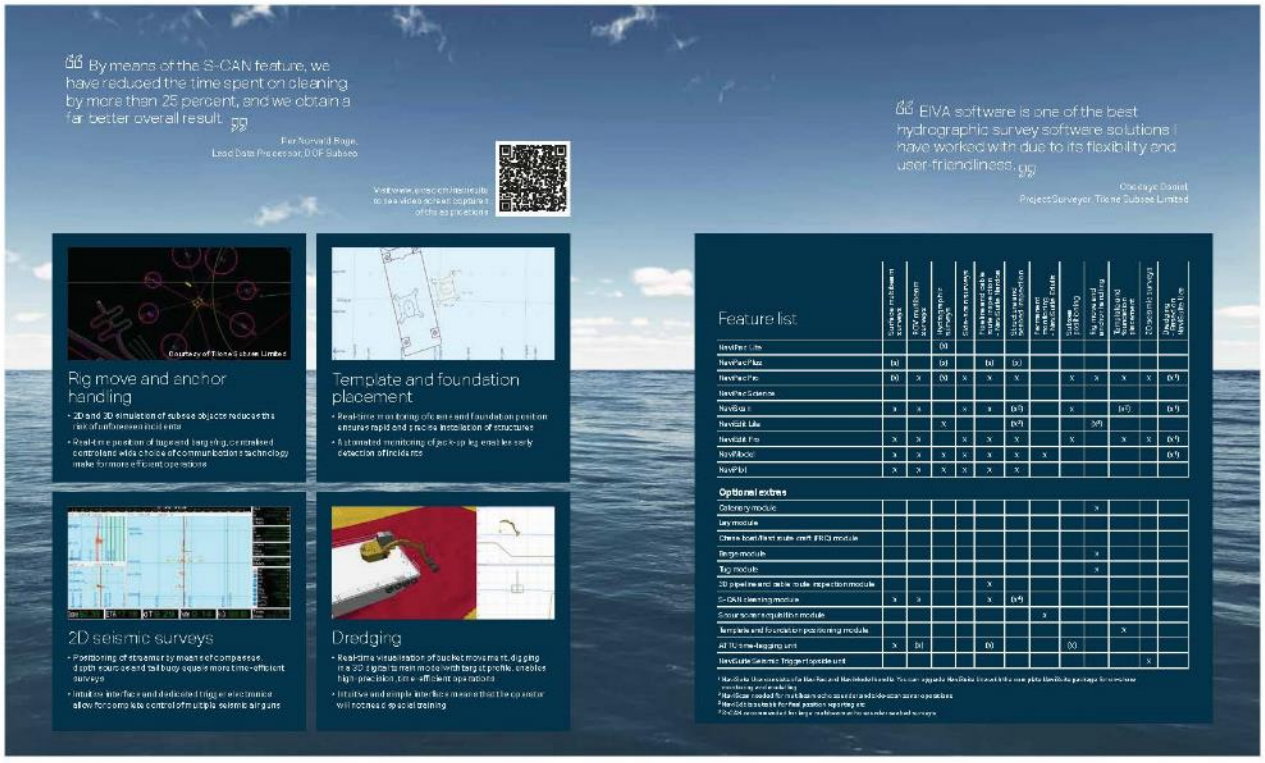
CE

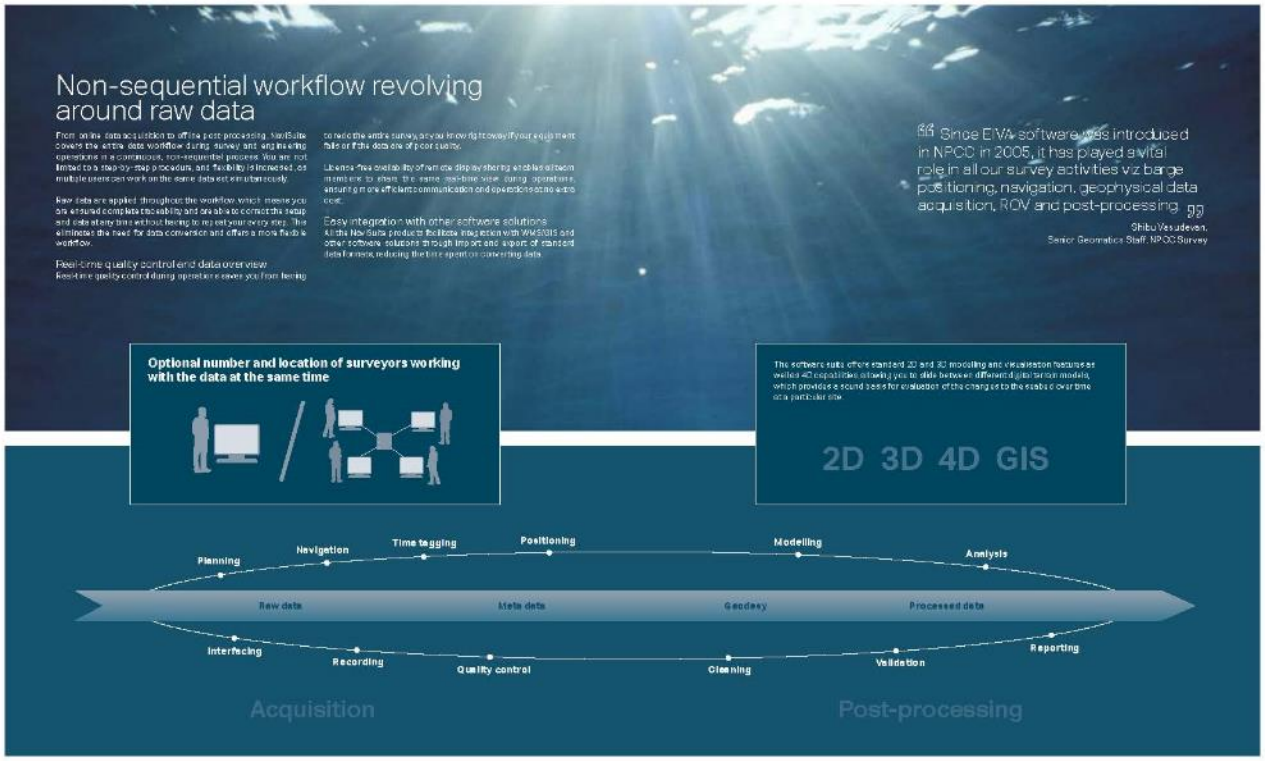

NaviSuite
A complete software toolbox
for subsea survey and engineering
EIVA
MARINE SURVEY SOLUTIONS

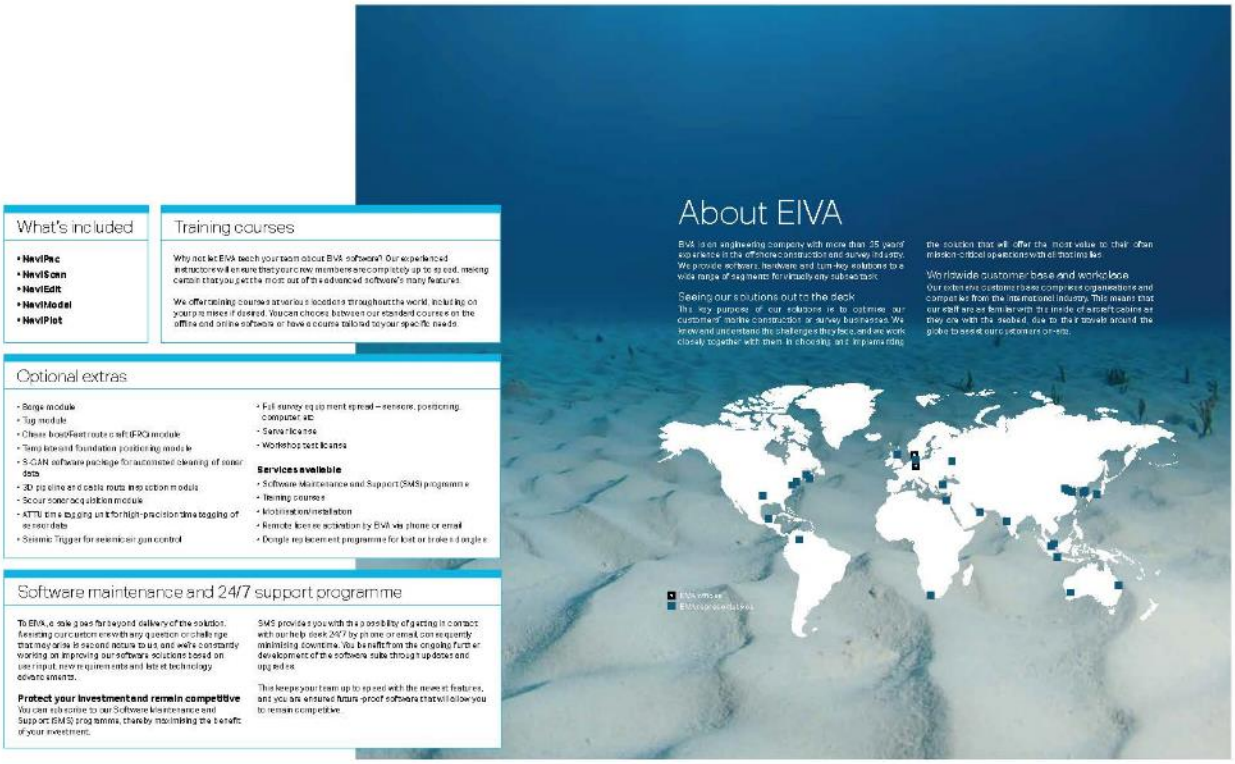

Making data headway
New Suns constitutes a complete, advanced multipurpose suite of software products for virtually any subsea survey or engineering operation. It will streamline your business through reduced costs, increased efficiency and improved results.
Covering the entire spectrum of offshore applications
From ROV- and vessel-based surveys to multibeam and single beam echo sounder operations, and everything in between, the five products comprising NaviSuite cover the complete spectrum of offshore applications as well as the entire data workflow, from data acquisition through to post-processing.
Selecting NaviSuite means reduced procurement and training costs through total satisfaction of a single software suite, regardless of application or equipment type. You can choose between a number of standard bundles dedicated to specific applications or tailor your own setup by selecting between the various products and features offered in NaviSuite.
Perfect match for both small- and large-scale setups
Scalability in terms of data or size means that you can work with data sets of a limited size and still get the same high quality of the end result.
Scalability in terms of number of users means that NaviSuite is as easily applied to comprehensive network installations with multiple users on board and on shore as it is to single user setups.
More than 400 sensor drivers – with new ones being added as new technology is introduced – ensure that even the widest equipment spreads are supported. This removes the need for combining several different equipment-specific software solutions and consequently also the risk of errors caused by working with different formats and interfaces.
Let the software do most of the work
NaviSuite offers a great variety of automatic features and analysis tools that eliminate the risk of deviations and ensure that manual processes can cease and allows the team to focus their efforts on tasks that require a human touch.
To cut a long survey story short
A complete software solution for virtually any subsea survey or engineering operation
through an advanced multipurpose software suite
A perfect match for small- and large-scale setups
through scalability in terms of data set size and number of users
More flexible workflow and complete traceability
through the use of raw data throughout the workflow
More efficient data processing
through various automatic feature and analysis tools
High-quality end results
through real-time quality control and data overview
Easy integration with other software solutions
through import and export of standard data formats
Support of even the widest equipment spread
through more than 400 sensor drivers
Future-proof investment
through the possibility of subscribing to a maintenance and 24/7 support programme


NaviSuite products
NaviPac
Navigation and positioning
NaviScan
Sonar data acquisition
NaviEdit
Survey data editing
NaviModel
4D modelling and visualisation
NaviPlot
Chart production


"Standardisation on a single solution is of strategic importance to us, and after thorough evaluation, we have selected EIVA's suite of online products as the best fit for us."
Hugh Ferguson,
Projects and Operations Director – Life of Field, Subsea 7
Applications
Multibeam surveys and seabed mapping
Hydrographic surveys
Structure and seabed inspection
Permanent monitoring – NaviSuite Edulis
Side-scan surveys
Pipeline and cable route inspection – NaviSuite Nardoa
Data management and GIS
Subsea positioning


By means of the S-CAN feature, we have reduced the time spent on cleaning by more than 25 percent, and we obtain a far better overall result.
Per Norvald Boge,
Lead Data Processor, DOF Subsea
Visit www.eiva.com/datasuite to see video screen captures of this application
EIVA software is one of the best hydrographic survey software solutions I have worked with due to its flexibility and user-friendliness.
Obadaye Daniel,
Project Surveyor, Tikne Subsea Limited
Courtesy of Tikne Subsea Limited
Rig move and anchor handling
• 2D and 3D simulation of subsea objects reduces the risk of subsea incidents
• Real-time position of lay and bury rig, combined controls and wide choice of communication technology make for more efficient operations
Template and foundation placement
• Real-time monitoring of template and foundation position ensures rapid and precise installation of structures
• Automated monitoring of pick-up leg ensures early detection of incidents
2D seismic surveys
• Positioning of streamers by means of compasses, depth sounders and tail buoy aquisis more time-efficient surveys
• Intuitive interface and dedicated trigger electronics allow for complex control of multiple seismic airguns
Dredging
• Real-time visualisation of bucket movement, digging in a 3D signals main motor with target profile, enables high precision, time-efficient operations
• Intuitive and simple interface means that the operator will not need a special training
Feature list
Optional extras


Non-sequential workflow revolving around raw data
From online data acquisition to off-line post-processing, NaviSuite covers the entire data workflow during survey and engineering operations in a continuous, non-sequential process. You are not limited to a step-by-step procedure, and flexibility is increased, as multiple users can work on the same dataset simultaneously.
Raw data are applied throughout the workflow which means you are ensured complete traceability and are able to correct the setup and data at any time without having to repeat your every step. This eliminates the need for data conversion and offers a more flexible workflow.
Real-time quality control and data overview
Real-time quality control during operations saves you from having to redo the entire survey, as you know right away if your equipment fails or if the data are of poor quality.
Licens-free overlability of remote display sharing enables all team members to share the same real-time view during operations, ensuring more efficient communication and operations at no extra cost.
Easy integration with other software solutions
All the NaviSuite products facilitate integration with WWS315 and other software solutions through import and export of standard data formats, reducing the time spent on converting data.
Since EIVA software was introduced in NPCC in 2005, it has played a vital role in all our survey activities viz barge positioning, navigation, geophysical data acquisition, ROV and post-processing.
Shibu Vasudevan,
Senior Geomatics Staff, NPCC Survey
Optional number and location of surveyors working with the data at the same time
The software suite offers standard 2D and 3D modelling and visualisation features as well as 4D capabilities allowing you to slide between different data sets or models, which provides a sound basis for evaluation of the changes to the seabed over time on a particular site.
2D 3D 4D GIS
Planning
Navigation
Time tagging
Positioning
Modelling
Analysis
Raw data
Meta data
Geodesy
Processed data
Interfacing
Recording
Quality control
Cleaning
Validation
Reporting
Acquisition
Post-processing



What's included

- **NaviPac**
- **NaviScan**
- **NaviEdit**
- **NaviModel**
- **NaviPlot**

Training courses

Why not let EIVA teach your team about EIVA software? Our experienced instructors will ensure that your new members are completely up to speed, making certain that you get the most out of the advanced software's many features.

We offer training courses at various locations throughout the world, including on your premises if desired. You can choose between our standard courses on the offline and online software or have a course tailored to your specific needs.

Optional extras

- Barge module
- Tug module
- Chase boat/Fast route outfit (FRO) module
- Temp lite and Foundation positioning module
- S-CAN software package for automated cleaning of sonar data
- 3D pipeline and cable route inspection module
- Scour sonar acquisition module
- ATTU time tagging unit for high-precision time tagging of external data
- Seismic Trigger for seismic air gun control
- Full survey equipment spread – sensors, positioning, computer etc.
- Server license
- Workshop test license

Services available

- Software Maintenance and Support (SMS) programme
- Training courses
- Mobilisation/installation
- Remote license activation by EIVA via phone or email
- Dongle replacement programme for lost or broken dongles

Software maintenance and 24/7 support programme

To EIVA, customer care goes far beyond delivery of the solution. Assisting our customers with any question or challenge that may arise is second nature to us, and we're constantly working on improving our software solutions based on user input, new requirements and latest technology advancements.

Protect your investment and remain competitive
You can subscribe to our Software Maintenance and Support (SMS) programme, thereby maximising the benefit of your investment.

SMS provides you with the possibility of getting in contact with our help desk 24/7 by phone or email, consequently minimising downtime. You benefit from the ongoing further development of the software suite through updates and upgrades.

This keeps your team up to speed with the newest features, and you are ensured future-proof software that will allow you to remain competitive.

About EIVA

EIVA is an engineering company with more than 25 years' experience in the offshore construction and survey industry. We provide software, hardware and turn-key solutions to a wide range of segments for virtually any subsea task.

Seeing our solutions out to the deck

The key purpose of our solutions is to optimise our customers' maritime construction or survey businesses. We know and understand the challenges they face, and we work closely together with them in choosing and implementing the solution that will offer the most value to their often mission-critical operations with all floating lies.

Worldwide customer base and workplace

Our solutions customer base comprises organisations and companies from the international industry. This means that our staff are as familiar with the inside of aircraft cabins as they are with the seabed, due to their travels around the globe to assist our customers on-site.

EIVA
MARINE SURVEY SOLUTIONS

ATTU

Accurate Time Tagging Unit

- **Increased quality of survey results for multi-sensor, high precision surveys**
- **Reduced cost of cable installation onboard survey vessel**
- **Available in rack-mount and subsea version**

Precise time tagging for improved survey results
Knowing the time of your sensor data as well as position and orientation of your sensors is essential for obtaining the highest precision and best possible data quality in marine surveys.

Time accuracy better than 50µs
Leading operators and users within the offshore industry is asking for extremely precise time stamping of sensor data to meet the demands for increased survey.accuracy. The EIVA ATTU performs time stamping of sensor data to a precision better than 50µs – far better than what can be obtained through use of the internal clock of an ordinary PC.

Multiplexing sensor feeds onto IP reduces cable installations
The ATTU contains a multiplexer which converts the serial sensor feeds into a single UDP/IP feed wrapped in the same time format. The benefit of this approach is that the ATTU simplifies onboard installations thus eliminating the need for complex cable installations.

- **Rack-mounted unit (2U) or subsea housing**
- **RS232/RS422/RS485 interfaces to sensors**
- **8, 16 or 24 port versions available**
- **Independent of sensor data format**
- **Network time server (NTP) for other units in the network**
- **Simple to use web interface for configuration**
- **Time synchronization via GPS or global time server**
- **Visible PPS indicator**
- **Recording to USB disk**

About the ATTU

Marine Survey Solutions

With the latest generation ATTU we have made it even simpler to add time tagging to any solution using NaviPac/NaviScan software for navigation and data acquisition.

The rack-mounted unit is plug-and-play installation into existing solutions – simply connect the sensors and configure the unit, and time tagging of sensor data is made with a much higher precision than before.

Should you want to use the ATTU within your own software applications, we also license out the ATTU protocols and formats on a case-by-case basis.

SUBSEA ATTU

The ATTU is available in two different versions for subsea usage.

ATTU subsea housing
For installations like ROVs with lots of mounted sensors, we offer a version of the ATTU, where we have put the electronics and firmware inside a subsea housing with a number of serial connections and a build-in multiplexer converting data from serial to IP. The unit can be delivered in different depths certifications: 500m or 3000m. We offer communication modules of either 1 GB/s fiber-optical or 20-100MB/s via cable depending on cable length.

OEM for your integration
We also offer an OEM version where it is simply the same subsea electronics and firmware but without the housing and connectors, so that it can be integrated directly into your own subsea unit.

EIVA
MARINE SURVEY SOLUTIONS

T +45 8628 2011 • eiva@eiva.dk • EIVA.dk

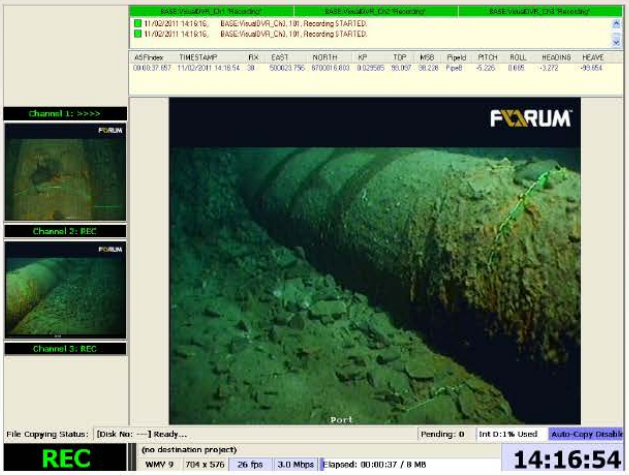
VisualDVR

VisualDVR is a 4U rack-mountable digital video recorder specifically designed for the offshore survey, inspection and ROV market. Available in a basic model with one to four standard definition video channels which records in Windows Media Video format using a software video encoder. This system includes the ability to add a text and graphics overlay to the video when recording it, and the ability to record both a dive log and a full inspection eventing log.

VisualDVR is fully configurable: Units can are networked together and synchronised, with control from any of the units or an external controller. Built in logging can record all relevant information from ROV or diver hand-held sensors. All data can be displayed as an overlay in a practical and legible format.
In addition **VisualDVR** has the ability to auto-copy the video, events and sensor data directly to multiple external drives for client deliverables.

Available Options and Upgrades:

- Add extra SD video channels to record two or four video channels
- Add video overlay cards for distributable overlay with video (available per video channel)
- Add a software MPEG encoder to record either WMV or MPEG using the same unit
- Add a software H.264 encoder to record either WMV or H.264 using the same unit
- Add software MPEG & H.264 encoders to record all formats using the same unit
- Upgrade from software MPEG encoder to a high quality hardware MPEG encoder (available per video channel)
- Upgrade to High Definition video encoding with WMV or MPEG software encoding formats (available as a one channel unit only)
- Upgrade from software HD MPEG encoder to a high quality hardware HD MPEG encoder (available as one video channel only)



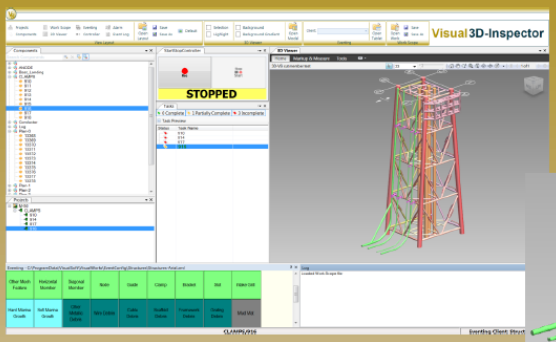
FORUM™

SUBSEA TECHNOLOGIES

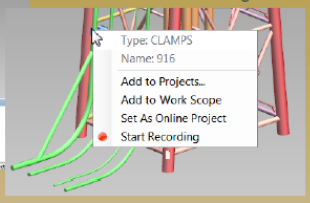
VisualDVR VisualSoft Suite

Concorde House, Endeavour Drive, Westhill, Aberdeen, AB32 6UF
+44 (0) 1224 766000 [t] +44 (0) 1224 279737 [f]
www.f-e-t.com/visualsoft

VisualDVR



VisualDVR may also be controlled using our inspection management software **Visual3D-Inspector**, which can control logging projects, event and inspection logging and has full control of video recording.



	VisualDVR	VisualDVR-HD	VisualDVR Black Box
Recording channels			
One channel	Yes	Yes	
Two channel	Optional	Multi-unit sync	Yes
Four channel	Optional	Multi-unit sync	
Storage & Copying			
Auto Copy	Yes	Yes	No
Black Box recording	Yes	Yes	Yes
Video Formats			
HD 1080p		Yes	
WMV format	Yes	Yes	Yes
MPEG-2 format	Optional	Optional	Optional
H.264/MPEG-4 format	Optional	Optional	Optional
Overlay			
Built in overlay	Yes	Yes	Yes
Distributed overlay	Optional		Optional
Logging & Control			
Visual3D-Inspector	Yes	Yes	N/A
Operational dive log	Yes	Yes	Yes
Configurable event logger	Yes	Yes	Yes
Hardware			
4U rack mountable	Yes	Yes	Yes
Core i7 CPU	Yes	Yes	Yes

The **VisualSoft** product range is the worldwide leader for digital video capture of subsea inspection survey data providing users with a complete suite of video capture, data management, data editing, survey data processing and final reporting tools that has become the industry standard over the last 10 years. **VisualSoft** is a brand of Forum Energy Technologies ("FET") a global provider of manufactured technologies and applied products to the energy industry, headquartered in Houston, Texas.

FORUM™

SUBSEA TECHNOLOGIES

VisualDVR VisualSoft Suite

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www.f-e-t.com/visualsoft

M3 Series
MultiMode Multibeam Sonar

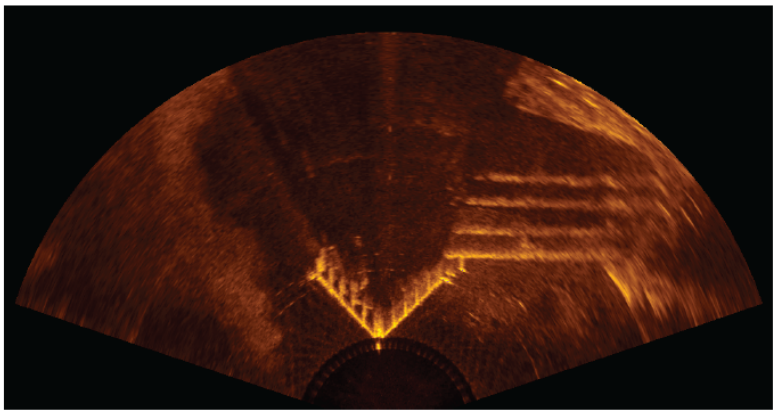
KONGSBERG

M3 Sonar - 4000m Depth

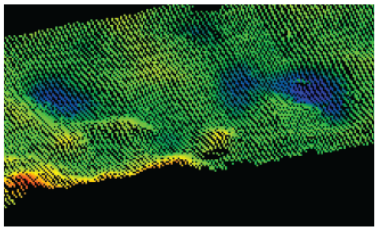
Description

The Kongsberg Mesotech Ltd. M3 Sonar is a 2D multibeam system with imaging and profiling capabilities. the M3 Sonar provides high-resolution and easy to interpret images by combining the rapid refresh rate of a conventional multibeam sonar with image quality comparable to a single-beam sonar.

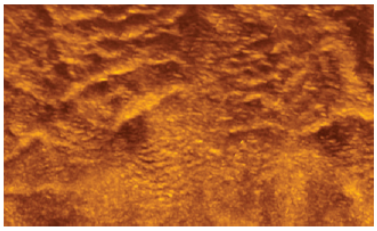
Detection of small objects out to 150 meters combined with a 120° to 140° field of view allows the operator to see the complete underwater picture in real-time.



Cooling intakes for a power station using eIQ mode



Profile of a dredged channel



Bedform mosaic using GeoTiff Export

M3 Sonar Applications

- Marine Engineering
  - construction support
  - dredge and pipeline monitoring
- Site Inspection
  - bridge and dam inspections
  - diver support
  - gas leak detection
- Environmental Monitoring
  - fish and marine behaviour studies
  - geological studies (e.g. bedforms)
- Site Clearance
  - oil rig decommissioning
  - UVI aid to navigation and obstacle avoidance
- Defense and Security
  - berth clearance
  - underwater recovery

Features

- Multiple modes for multiple applications
- GeoTIFF output
- Multiple true zoom windows
- CHIRP and Doppler modes of operations

Benefits

- High update rate
- Significant time savings during operations
- Uniform large coverage area
- MultiMode capability
- Low power consumption
- User friendly

Installation Options

- Suitable for a wide range of vehicles from large work-class ROVs to small observation-class ROVs
- Polemount on surface vessel
- Tripod mounted

M3 Software

The M3 software was developed specifically for the M3 system to manage communications with the sonar head and operate all beam-forming and imaging processing.

Four Pre-Defined Modes:

1. Imaging: long range navigation with high speed update
2. Enhanced Image Quality (eIQ): greatest image quality (0.95° angular resolution) from a short range with a slower update
3. ROV Navigation: selects eIQ or imaging based on range
4. Profiling: narrow 3° beam used to generate a 3D point cloud

Technical specifications

P/N 922-20020000

Sonar Specifications

- Range: 0.2 to 150 m
- Range Resolution: 1 cm
- Frequency: 500 kHz
- Pulse Types: CW, CHIRP
- Modes: Variable Vertical Beamwidth, eIQ

Variable Vertical Beamwidth Mode

- Horizontal Field of View: 120°
- Vertical Beamwidth: 3°, 7°, 15°, 30°
- Angular Resolution: 1.6°
- Update rate: up to 40 Hz

eIQ Imaging Mode

- Horizontal Field of View: 140°
- Vertical Beamwidth: 30°
- Angular Resolution: 0.95°
- Update rate: up to 10 Hz

Profiling Mode

- Horizontal Field of View: 120°
- Vertical Beamwidth: 3°
- Number of Beams: 256
- Update rate: up to 40 Hz

Interface Specifications

- Communication: Ethernet
- Data Rates: 10/100/1000 Mbps
- Input Voltage: 11 to 36 VDC
- Input Power: 22 W (Typical)
- O/S: Windows 7 Professional SP1 or Windows XP Professional SP3

Environmental

Temperature

- Operation: -2°C to +38°C
- Storage: -40°C to +55°C

Shock and Vibration

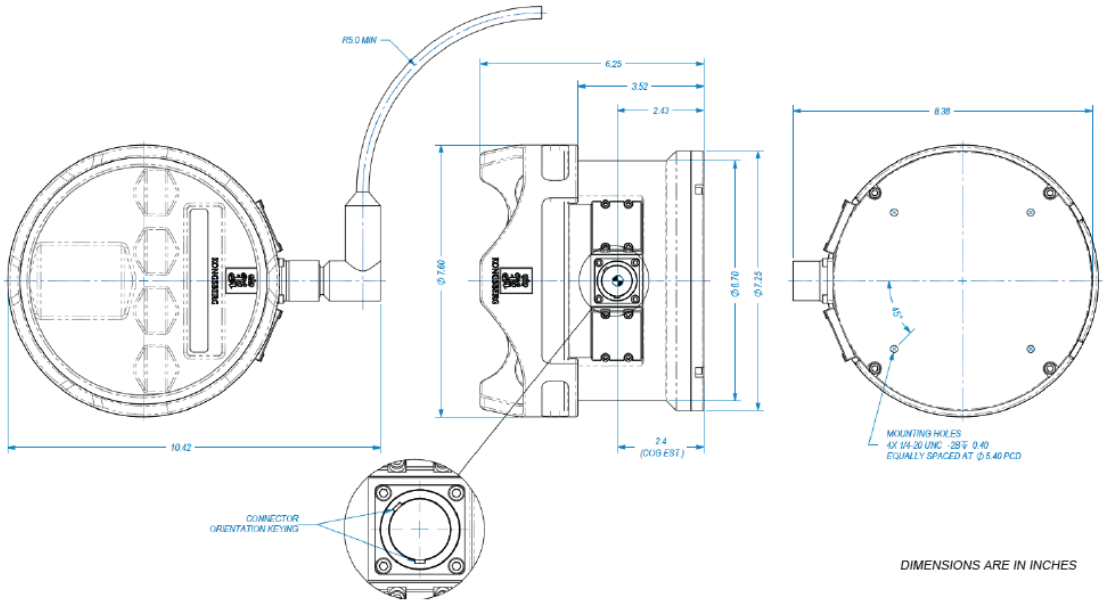
- Shock Qualified: +/-50gs, 3 Axes, 6 shocks per axis
- Vibration Qualified: 4g, 30Hz, 3 axes, 2 hours per axis. No resonance below 800Hz.

Mechanical Specifications

- Dimensions: (see below)
- Weight in air: 8.4 kg
- Weight in water: 5.2 kg
- Depth Rating: 4000 m
- Connector Type: SEA CON®
- Connector Model: MINK-10-FCRL

Materials

- Titanium
- Stainless Steel 316
- Elastomeric Polyurethane



Due to the continuous development of its products, Kongsberg Mesotech Ltd. reserves the right to alter the specifications shown above without notice. Please contact the manufacturer for information on any updated specifications.

922-20027901-1.2

Kongsberg Mesotech Ltd.

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Telefax: +1 604 941 5423
www.kongsberg-mesotech.com
km.sales.vancouver@kongsberg.com

RTS PPS Distribution

GPS time syncronization

The RTS PPS distribution panel is the key solution for distributing GPS timing signals to survey spreads. It can be used to distribute one or two separate timing telegrams together with PPS pulse. The system consist of two RS232 splitters combined with three PPS pulse splitters. Selectable PPS pulse width, 500us, 1ms or directly from the GPS. Selectable PPS trigging, positive or negative edge. Typically used for time synchronisation of logging systems and multiple sensor synchronization.

Main features

- Two eight-channel RS232 splitters
- PPS pulse width extender
- Supports baud rates up to 115kbps
- Full RS232 levels (+/-8V)
- PPS TTL Level
- Low Latency
- Data, PPS and power indicators
- ESD-protected inputs
- Selectable PPS trig

TECHNICAL SPECIFICATIONS

Connections		
	Input	1 x PPS / BNC
		2 x RS232 / RJ45
	Output	2 x 8 RS232 + PPS / RJ45
		8 x PPS / BNC
Power		110 - 240V 50-60 Hz AC Supply
Environmental		
	Operating temperature	-2°C to +55°C
	Weight	4,7 kg
	Housing	Aluminium & Steel
Dimensions		482,6mm x 89mm x 255mm (19", 2U)

RTS is a supplier of engineering solutions, equipment rental, product sales and personnel. We are based in Karmøy in south-west Norway, close to the main oil bases. With our wide range of equipment and personnel, we offer complete solutions to the subsea industry. Key words are positioning, environmental, hydrographic, logging, PC and video products. The information in this datasheet is subject to change without notice and does not represent a commitment on the part of RTS. 01/2016

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MIDAS SVX2 Combined SVP/CTD

The MIDAS SVX2 is the latest version of Valeport's unique instrument. Recognising the conflict faced by users requiring the superior Sound Velocity data from an SVP, but still needing the Salinity and Density data from a CTD, the MIDAS SVX2 combines both technologies to give the best of both worlds. Now fitted with a 0.01% pressure sensor as standard, the SVX2 also uses synchronised sampling to ensure perfect profiles, and since the digital time of flight SV sensor is the most accurate in the world, it's also possible to compare the true sound velocity data with that generated by commonly used equations.

Sensors

The MIDAS SVX2 is fitted with Valeport's digital time of flight sound velocity sensor, high stability conductivity sensor, a high accuracy temperature compensated piezo-resistive pressure transducer, and a fast response PRT temperature sensor.

Sound Velocity

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

Conductivity

Range:	0 to 80 mS/cm
Resolution:	0.003mS/cm
Accuracy:	±0.01mS/cm

Temperature

Range:	-5°C to +35°C
Resolution:	0.005°C
Accuracy:	±0.01°C

Pressure

Range:	10, 50, 100, 300 or 600bar
Resolution:	0.001% range
Accuracy:	±0.01% range

Data Acquisition

The MIDAS SVX2 uses the concept of distributed processing, where each sensor has its own microprocessor controlling sampling and calibration of readings. Each of these is then controlled by a central processor, which issues global commands and handles all the data. This means that all data is sampled at precisely the same instant, giving superior quality profile data.

Sampling Modes

Continuous:	Regular output from all sensors at 1, 2, 4 or 8Hz.
Burst:	Regular sampling pattern, where instrument takes a number of readings, then sleeps for a defined time.
Trip/Profile:	Data is output as a chosen parameter changes by a set value, usually Pressure for profiling.
Conditional:	Instrument sleeps until a selected parameter reaches a set value.
Delay:	Instrument sleeps until predefined start time

Electrical

Internal:	8 x C cells, 1.5v alkaline or 3.6v lithium
External:	9 - 30vDC
Power:	0.7W (sampling), <1mW (sleeping)
Battery Life:	<100 hours operation (alkaline) <250 hours operation (lithium)
Connector:	Subconn Titanium MCBH10F

Software

System is supplied with DataLog Express Windows based PC software, for instrument setup, data extraction and display. DataLog Express is licence free.

Communications

The instrument will operate autonomously, with setup and data extraction performed by direct communications with PC before and after deployment. It also operates in real time, with a choice of communication protocols for a variety of cable lengths, all fitted as standard and selected by pin choice on the output connector:

Standard

RS232	Up to 200m cable, direct to serial port via USB adaptor
RS485	Up to 1000m cable, addressable half duplex communication

Options

FSK	2 wire power & communications up to 6000m cable (cable dependant)
Baud Rate:	2400 - 115200 (FSK fixed at 19200, USB 460800)
Protocol:	8 data bits, 1 stop bit, No parity, No flow control

Memory

The MIDAS SVX2 is fitted with 16Mb solid state non-volatile FLASH memory. Total capacity depends on sampling mode; continuous & burst modes have a single time stamp at the start of the file, trip mode (profiling) stores a time stamp with each reading. A single line of SVP data uses 10 bytes, and a time stamp uses 7 bytes.

Continuous:	>1,600,000 data points
Profile:	>980,000 data points (>80 profiles to 6000m).

Physical

Materials:	Titanium housing, polycarbonate & composite sensor components, stainless steel (316) cage
Depth Rating:	6000m (may be limited by pressure sensor)
Instrument Size:	88mmØ x 665mm long
Cage Size:	750 x 140 x 120mm
Weight (in cage):	11.5kg (in air), 8.5kg (in water)
Shipping:	100 x 18 x 49cm, 24kg

Ordering

0650010-XX	MIDAS SVX2 Profiler, supplied with deployment cage, Subcon switch plug, 3m communications lead, USB adaptor, DataLog Express software, manual , tool kit and transit case.
Note:	XX denotes transducer range. Select from 10, 50, 100, 300 or 600bar
0400002	16 Mbyte memory upgrade (max 64 Mbyte)
0400EA5	FSK modem adaptor
TB0400FSK	Probe board set required for FSK operation

Datasheet Reference: MIDAS SVX2 version 2B, June 2013

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miniSVS

Our unique digital time of flight technology gives unmatched performance figures, with signal noise an order of magnitude better than any other sensor. The miniSVS is available in a selection of configurations and with optional pressure or temperature sensors. There are a variety of sizes to suit many applications.

miniSVS - still the most accurate sound velocity sensor in the world. Nothing else comes close.

Sound Velocity Measurement

Each sound velocity measurement is made using a single pulse of sound travelling over a known distance, so is independent of the inherent calculation errors present in all CTDs. Our unique digital signal processing technique virtually eliminates signal noise, and gives almost instantaneous response; the digital measurement is also entirely linear, giving predictable performance under all conditions.

Range:	1375 - 1900m/s	
Resolution:	0.001m/s	
Accuracy:	Dependent on sensor size	
100mm	Random noise (point to point)	±0.002m/s
	Max systematic calibration error	±0.013m/s
	Max systematic clock error	±0.002m/s
	Total max theoretical error	**±0.017m/s**
50mm	Total max theoretical error	±0.019m/s
25mm	Total max theoretical error	±0.020m/s
Acoustic Frequency:	2.5MHz	
Sample Rate:	Selectable, dependent on configuration	

Rate	SV	SV+P	SV+T
Single Sample	●	●	●
1Hz	●	●	●
2Hz	●	●	●
4Hz	●	●	●
8Hz	●	●	●
16Hz	●	●	●
32Hz	●	●	
60Hz	●		

Optional Sensors

The miniSVS may be optionally supplied with either a pressure or temperature sensor (but not both). Data is sampled at the rates shown above

Sensor	**Pressure**	**Temperature**
Type	Strain Gauge	PRT
Range	5, 10, 50, 100 or 600 Bar	-5°C to +35°C
Resolution	0.001% range	0.001°C
Accuracy	±0.05% range	±0.01°C

Data Output

Unit has RS232 & RS485 output, selected by command code. RS232 data may be taken directly into a PC over cables up to 200m long, whereas RS485 is suitable for longer cables (up to 1000m) and allows for multiple addressed units on a single cable.

Baud Rate: 2400 - 115200 (NB. Low baud rates may limit data rate)

Protocol: 8 data bits, 1 stop bit, No parity, No flow control

Electrical

Voltage: 8 - 30vDC

Power: 0.25W (SV only)
0.35W (SV + Pressure)

Connector: Subconn Titanium MCBH6F (alternatives on request)

Data Format

Examples of data formats are:
<space>{sound_velocity}<cr><lf>
<space>{pressure}<space>{sound_velocity}<cr><lf>
<space>{temperature}<space>{sound_velocity}<cr><lf>

SV: Choose from mm/s (1510123), m/s to 3 decimal places (1510.123), or m/s to 2 decimal places (1510.12)

Pressure: If fitted, pressure is always output in dBar with 5 digits, with a decimal point, including leading zeroes if necessary. Position of the point is dependent on sensor range, e.g.

50dBar	47.123
100dBar	047.12
1000dBar	0047.1

Temperature: If fitted, temperature is output as a 5 digit number with 3 decimal places and leading zeroes, signed if negative, e.g.

21.456
02.298
-03.174

Physical

Please refer to drawing on reverse for detailed dimensions.

Depth Rating:	6000m (Titanium), 500m (acetal)
Weight:	1kg (housed type)
Housing & Bulkhead:	Titanium or acetal, as selected
Transducer Window:	Polycarbonate
Sensor Legs:	Carbon Composite
Reflector Plate:	Titanium

Ordering

All systems supplied with operating manual and carry case. OEM units come with a test lead, housed units with a 0.5m pigtail.

Configuration	100mm	50mm	25mm
Titanium Housed	0652004	0652005	0652006
Acetal Housed	0652045	0652046	0652047
Bulkhead OEM	0652001	0652002	0652003
Remote OEM	0652007	0652008	0652009

0652010	Spare 50cm Pigtail
0652013	Pressure sensor option (specify range)
0652028	Temperature sensor option

Datasheet Reference Number: miniSVS v1E

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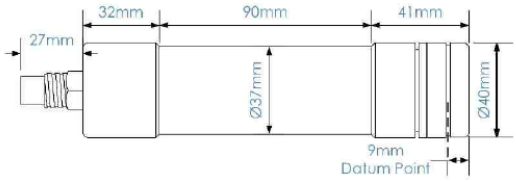
miniIPS - Intelligent Pressure Sensor

The miniIPS is a precision underwater pressure sensor; 0.01% accuracy, a titanium housing and a choice of pressure ranges make it a cost effective solution for offshore engineers, vehicle pilots, and other operators who require highly accurate depth information in real time. The miniIPS is also supplied as an OEM for sensor integration to other manufacturers.

The miniIPS is compatible with Valeport's MIDAS BathyPack and BathyLog software, allowing the depth data to be continually updated for Density variations in the water column.



Pressure Sensor

The pressure sensor fitted to the miniIPS is a temperature compensated piezo-resistive sensor, which delivers the performance previously only available from a resonant quartz sensor at a more cost-effective price.

It also brings the added advantages of long-term stability, allowing longer intervals between calibration, and a smaller and more robust construction; complex and vulnerable arrangements of diaphragms and oil filled capillaries & reservoirs are therefore no longer necessary.

The miniIPS can be re-calibrated by customers using a Class A deadweight tester.

Type:	Temperature compensated piezo-resistive
Range:	10, 30, 50, 100, 300 or 600 Bar
Accuracy:	±0.01% FS
Resolution:	0.001% FS

Data Acquisition

Sampling:	Continuous, burst average or data on demand.
Data Rate:	1, 2, 4 or 8Hz continuous, down to 1 sample per day bursting
Units:	Secondary calibration function allows conversion of dBar pressure units into metres or feet, or other required units
Tare:	Tare Function allows correction for atmospheric offset

Physical

Housing:	Titanium (6000m rated)
Size:	40mmØ x 185mm (including connector)
Weight:	<1kg (air)
Connector:	SubConn MCBH6F (titanium) (other connector available on request)
Shipping:	36 x 29 x 16cm, 2kg

Communications

Output:	RS232 & RS485 fitted as standard
Protocol:	4800 to 115200 baud, (8,1,N)
Format:	ASCII text Data format compatible with Valeport's BathyLog software, allowing real time depth correction using Density Profiles

Power Requirements

Input:	9 – 30V DC (isolated)
Power:	less than 0.4W (40mA @ 12V DC)

Ordering

0760001-XX	miniIPS Fitted with: • 0.01% piezo-resistive sensor Supplied with: - interface lead - Operating manual and transit case
Note:	XX denotes pressure transducer range. Select from 10, 30, 50, 100, 300 or 600bar
0760005-XX	miniIPS – OEM remote sensor Fitted with: • 0.01% piezo-resistive sensor - OEM remote sensor with PCB • Operating manual and transit case
Note:	XX denotes pressure transducer range. Select from 10, 30, 50, 100, 300 or 600bar
0760002	Calibration adapter to allow users to perform their own calibration against a deadweight tester

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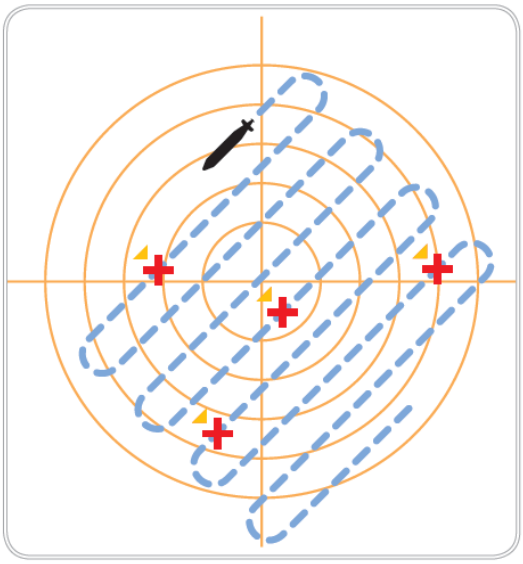
A Teledyne RD Instruments Navigation Datasheet

Teledyne RD Instruments

Workhorse Navigator

Doppler Velocity Log (DVL)

Precision Navigation for the Marine Environment



The WORKHORSE NAVIGATOR is the industry's first choice for precision navigation applications. Teledyne RDI's highly acclaimed Doppler Velocity Log (DVL) provides precise velocity and altitude updates for a wide variety of underwater tasks.

The highly flexible design allows the unit to be used in a stand-alone configuration or integrated with other navigation systems.

The compact and powerful Workhorse Navigator provides:

- Broadband processing technology, providing users with both short and long-term high-precision velocity data
- Reliable, accurate high-rate navigation and positioning data
- Proven bottom detection algorithms, and single ping bottom location, for robust and reliable bottom tracking over indeterminate terrain
- Superior low-altitude bottom tracking capability
- Real-time current profiling data

PRODUCT FEATURES

Navigator Full Suite of Capabilities:

- Bottom track velocity
- Water track velocity
- Altitude: 4 individual measurements
- Error velocity (data quality indicator)
- Temperature
- Heading/Tilt
- Acoustic echo intensity
- Pressure and depth (optional)
- Current profiling (optional)

Navigator Applications:

- Subsea vehicle and surface vessel navigation
- Hydrographic, geophysical, and oceanographic survey positioning data
- LBL and USBL position aiding
- Spool piece metrology
- Inertial navigation correction and integration
- Cable burial operations
- Deep water positioning
- Station keeping and autopilot control
- Pipeline touchdown monitoring
- Dredge spoils, plume, and sediment tracking

A Member of Teledyne Marine

TELEDYNE RD INSTRUMENTS Everywhereyoulook™

A Teledyne RD Instruments Navigation Datasheet

Workhorse Navigator

Doppler Velocity Log (DVL)

TECHNICAL SPECIFICATIONS

			WHN 300	WHN 600	WHN 1200
Bottom Velocity	Single-ping precision				
	Std dev at 1m/s[1]		±0.4cm/s	±0.3cm/s	±0.3cm/s
	Std dev at 3m/s[1]		±0.7cm/s	±0.5cm/s	±0.5cm/s
	Std dev at 5m/s[1]		±0.9cm/s	±0.7cm/s	±0.7cm/s
	Long-term accuracy		±0.4%±0.2cm/s	±0.2%±0.1cm/s	±0.2%±0.1cm/s
	Minimum altitude[2]		1.0m	0.7m	0.5m (0.25 optional)
	Maximum altitude[2]		200m	90m	25m
Parameters	Velocity range[3]		±10m/s	±10m/s	±10m/s
	Velocity resolution		0.1cm/s	0.1cm/s	0.1cm/s
	Ping rate		7Hz max	7Hz max	7Hz max
Water Reference Velocity	Accuracy		±0.4% ±0.2cm/s	±0.3% ±0.2cm/s	±0.2% ±0.1cm/s
	Layer size		selectable	selectable	selectable
	Minimum range		1.9m	1.2m	0.8m
	Maximum range		110m	50m	15m
Environmental	Operating temperature		-5 to 45°C	-5 to 45°C	-5 to 45°C
	Storage temperature		-30 to 60°C	-30 to 60°C	-30 to 60°C
	Depth rating		3000m or 6000m	3000m or 6000m	3000m or 6000m
	Weight in air:	3000m	15.8kg	15.8kg	12.4kg
		6000m	20.1kg	20.1kg	18.0kg
	Weight in water:	3000m	8.8kg	8.8kg	6.1kg
		6000m	13.6kg	13.6kg	12.1kg
Power	DC input		20–50VDC, external supply (48VDC typical)		
	Current		0.4A minimum power supply capability		
	Transmit[4] Peak power @ 24VDC		66w	21w	8w
	Average power (24/32VDC)		9/15w	4/6w	3/3w
Standard Sensors	Compass		±2° @ 60° dip, 0.5g		
	Tilt		±0.5° up to ±15°		
	Temperature		-5° to 45°C		
Hardware	Configuration		4-beam Janus array convex transducer, 30° beam angle		
	Communications		NMEA0183, ASCII, or binary outputs at 1200–115,200 baud user-selectable; serial port is switch-selectable for RS232 or RS422		
	Trigger inputs		1) ASCII; 2) RDS3; 3) low latency		
Options	• Current profiling firmware upgrade • Integrated pressure sensor (±0.25% full scale) • 25m serial/DC/computer cable • 5m serial/DC/computer cable • Internal memory cards (2GB max) • Enhanced low altitude bottom tracking for model 1200				
Dimensions	WHN 300/600: Height 244.5mm, diameter 225.2mm; WHN 1200: Height 242.9mm, diameter 201.9mm *(line drawings available upon request)*				

1 Standard deviation refers to single-ping horizontal velocity, specified at half the maximum altitude.
2 @5°C and 35 ppt, 42VDC.
3 Maximum bottom-tracking range may be reduced due to flow noise at high speed and/or cavitation.
4 @ 15% duty cycle at peak power (standby 1mW).

TELEDYNE RD INSTRUMENTS
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