





Trenching - Performance and Field Experience of the SCAR Tools

Ecosse Subsea Systems

Overview:-

- Ecosse Subsea Systems
- SCAR Seabed System
- Track Record & Project Locations
- Experiences from various projects including testing in the Moray Firth
- Energy projects in the UK and Baltic



Ecosse Subsea Systems



Trenching

SCAR Modular Seabed System is our innovative solution to the subsea product installation challenge: soils testing; trenching services – pre-cut (multi-pass capable), post-lay, simultaneous lay; backfill / backflush.



Route Preparation

SCAR Seabed System can be used for various tasks including route preparation for surface pipe-lay and boulder/obstacle clearance for subsequent installation activities (such as trenching)



Personnel

Ecosse Subsea Systems Personnel Division provides experienced and high calibre personnel to subsea oil, gas and marine markets. We recognise that there is much more to recruitment than simply matching a name to a job description. Currently, ESS personnel are involved in some £400m worth of subsea projects globally.

Engineering Consultancy

Ecosse Subsea Systems provide experienced engineering consultancy, expert witness, project management and onshore / offshore operational support to the energy industry, delivering cost effective, quality and innovative subsea engineering solutions.



Pipe-lay Technologies

Bringing innovative technology to the subsea oil and gas markets, specialities include: offshore cable burial, pipe-lay, pipe spooling technology and wave energy, developed to benefit customers and their strategic requirements.



Ambient Lifting

Technology to allow accurate and safe subsea lifting without the use of heavy lift vessels. Our innovative system can be used to lift, lower or hover any object in a liquid by controlling buoyancy and ballast in pressurised receptacles. The technology enables significant cost savings on installation and decommissioning activities.

Subsea Services that are focused on being:

- Safe
- Simple
- Robust
- Client focused
- Off-the Shelf Components
- Negate the requirement for heavy-lift vessels
- Installable by local people and vessels
- Recoverable, recyclable

ESS has been described as a 'Pseudo'-Contractor – A business that not only undertakes new technology R&D but backs up its developments by performing subsea contracting services – quite unusual!

SCAR Seabed System

One system – 3 processes - takes trenching / backfill off the critical path



Route Preparation

Clears many boulders quickly and effectively



Pre-cut trenching

Trencher makes multiple passes within the existing trench



Backfill

No part of trencher near the cable provides low risk solution for the cable

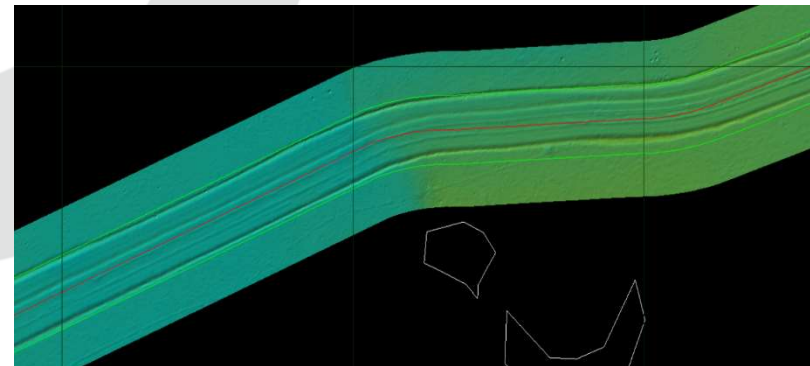
Robust performance through vast range of soils; reliable; fast trench production; versatile – Shore ends, shallow water, deep water

SCAR: Route Preparation Mode

SCAR Seabed System – Route Preparation/Boulder Clearance

Specifications

- Clears swathe widths of 10 or 15m
- Can perform multiple passes to increase cleared width
- 20-50Te bollard pull required, seabed type/boulder frequency dependant
- Depth of seabed penetration controlled by altering keel depth
- Responsive, self-correcting steering arrangement allows for horizontal positioning accuracy of $\pm 0.5\text{m}$. Turns of radii of 50m possible
- Mass of 45Te, 14m (16m) long, 10m (15m) wide, 3m (3m) tall.
- Mobilised from yard on 5 (6) standard trailers; mobilised onto vessel within 24h



SCAR: Pre-cut Trench Mode

SCAR Seabed System – Trenching

Specifications

- 1st pass trench depth of 0.6-1.4m achievable, seabed type dependant
- Further 0.6-1.2m per pass achievable in 2nd or subsequent passes
- Unique in-trench multi-pass ability
- Trench side slope 35°
- Bollard pull of 35-100Te required
- Mass of 20Te, 7m length, variable mould board with and height
- Ballasted up to 38Te for harder soils
- Cutting tip variable for seabed type
- Single moving part, no electronics or hydraulics. Adjustable trench profile.
- Mobilised from yard on 4 standard trailers; mobilised onto vessel within 24h

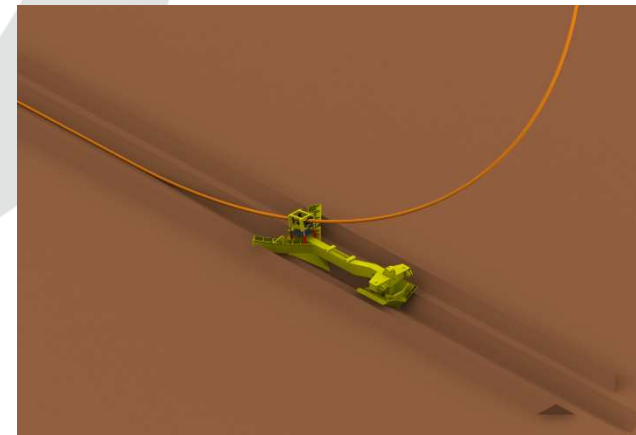
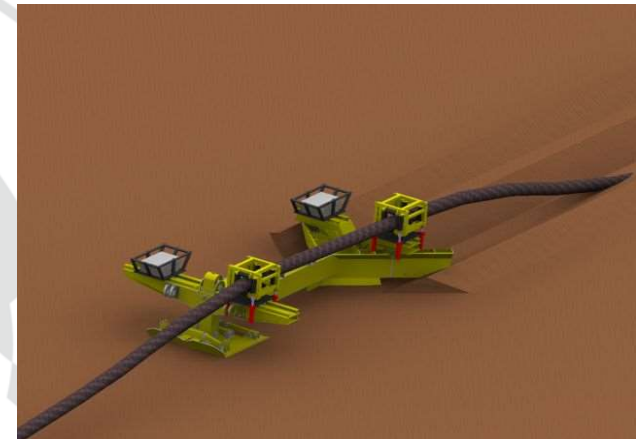


SCAR: Post-Lay/Simultaneous Lay & Burial

SCAR Seabed System – Post-Lay and Simultaneous Lay and Burial

Specifications:

- Same trench depth specifications as Pre-cut trenching mode
- Multi-pass capable
- Suitable for rigid pipelines and flexible products
- Mass of 20-30Te, 10m length, variable mould board with and height
- Can be counter-ballasted to manage heavier products
- Suitable for shallow water and deep water lay
- Bespoke roller cradle design to handle wide range of product weights and diameters

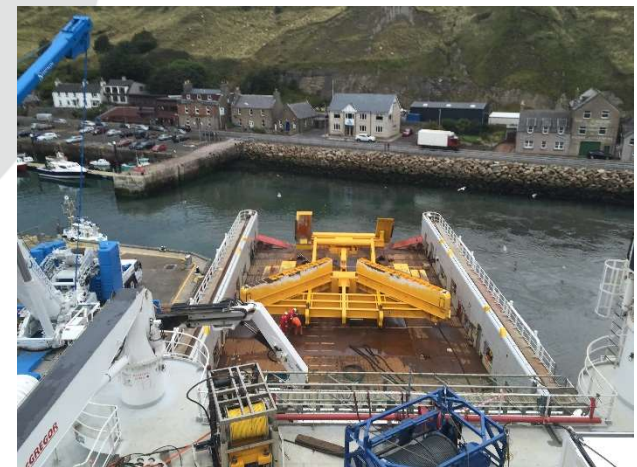


SCAR: Backfill Mode

SCAR Seabed System – Backfill

Specifications

- Catchment widths of 12 or 15m
- Unique split rear skid: no bearing surface of plough is in contact with open or recently filled trench
- 20-70Te bollard pull required spoil volume and type dependant
- Low seabed penetration <100mm
- Responsive, self-correcting steering arrangement allows for horizontal positioning accuracy of $\pm 0.5\text{m}$. Turns of radius 50m possible
- Mass of 45Te, 14m (16m) long, 10m (15m) wide, 3m (3m) tall.
- Mobilised from yard on 5 (6) standard trailers; mobilised onto vessel within 24h
- NO RISK TO PRODUCT



SCAR Seabed System

SCAR® SEABED SYSTEM



SCAR 1

- Pre-cut trenching (multi-pass)
- Route preparation/boulder clearance



SCAR 2 / SCAR 3

- Pre-cut trenching (multi-pass)
- Route preparation/boulder clearance
- Backfill



SCARMax

- Pre-cut trenching (multi-pass)
- Route preparation/boulder clearance
- Backfill



SCARJet

- Post-lay/simultaneous trenching
- Trench remedial works

SCAR MAX



SCAR MAX 2.0m

Parameter	Value
Length	c. 20m (front of skid to rear of mouldboard)
Width	c. 15m (variable, tip to tip mouldboard)
Height	c. 6m (tip of share to top of chassis)
Weight in Air	c. 90Te
Max Continuous Tow Force	1000Te
Max Point Load on Tip	350Te
Max 1 st Pass Trench Depth	2.0m

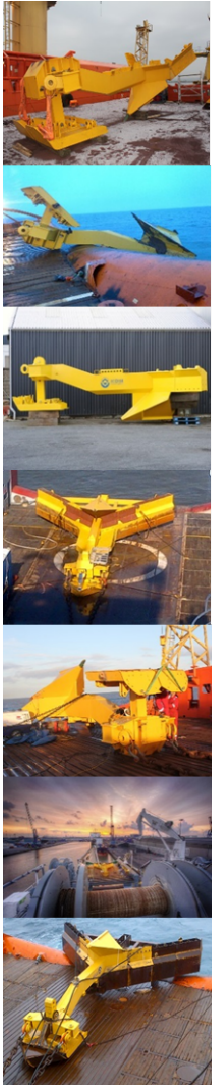


SCAR Seabed System



...because we think **differently**

Why we do it: typical trenching risks



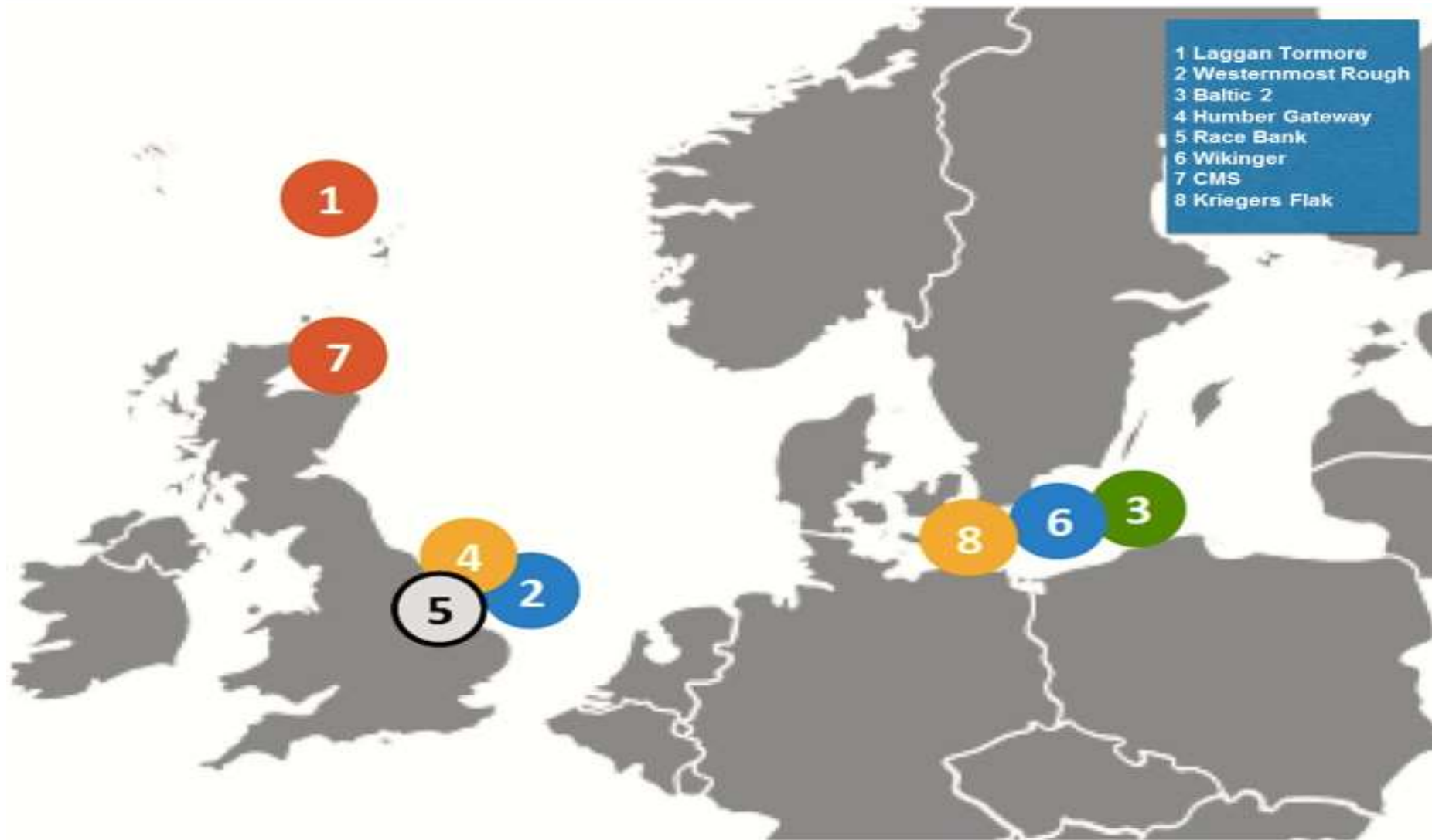
- Risk of cable/pipeline damage
- Risk of not achieving specification (soils)
- Risk of non performance in the field (weather)
- Risk of project schedule delays (performance)
- Equipment and ship availability



SCAR Seabed System: Track Record

Client	Project	Brief Description	Year
Prysmian Group	Wikinger OWF (See Data Examples)	Pre-cut Trenching in single and multi-pass modes for 70 inter-array cable routes	2016
Prysmian Group	Wikinger OWF (See Data Examples)	Route Preparation/Boulder Clearance operations on 45 inter array routes	2016
ABB Backfill Demonstration Project	Caithness Moray HVDC Link	Pre-Cut Trenching, Cable lay and Backfilling 2 x 500m Trial Locations	2016
Dong Energy	Race Bank OWF (See Data Examples)	Route Preparation/Boulder Clearance 2 x export cable routes	2015
DONG Energy	Race Bank OWF	Boulder Grabbing utilising orange-peel grab	2015/16
Dong Energy	Westermest Rough	Multi-pass Route Preparation/Boulder Clearance operations on 37 inter-array routes	2014
E.ON C&R	Humber Gateway OWF	Route Preparation/Boulder Clearance 2 x 7km export cables and 2 inter array cable routes.	2013
Siem Offshore Contractors/ EnBW	Baltic 2 OWF	Pre-cut Trenching along 86 inter-array routes	2013
Siem Offshore Contractors/EnBW	Baltic 2 OWF	Route Preparation/Boulder Clearance of 86 inter-array routes	2013
E.ON C&R	Humber Gateway OWF	Demonstration project of SCAR Subsea Trenching System in Humber Gateway wind farm site. Route Preparation/Boulder Clearance, single pass and multi pass Trenching successfully demonstrated	2012
TOTAL	Laggan Tormore Oil Field Development	Route Preparation/ Boulder Clearing trials and subsequent 67km work scope along export pipeline route	2012

Project Locations



Laggan Tormore Project: A Case Study



- Completed 67km long, 10m wide swathe in 6 days
- Operated in water depths >600m
- Overboarded and placed on the seabed in 3m Sig. Waves
- No plough downtime
- Operated through a variety of seabeds including:-
 - Mega-Ripples
 - Soft Sands
 - Hard to Soft Clays
 - Gravels

Baltic 2 OWF Project: A Case Study



- A \$7.5 million boulder clearing and pre-lay trenching project which has been one of the most successful ever conducted for the wind energy sector.
- 86 boulder clearing passes followed by 172 first and multi-passes over a 90km route during a 13-week boulder clearing and trenching campaign on the EnBW Baltic 2 offshore wind farm project.
- Mobilisation on the 86 cable route work scope started in Gdansk/Poland, with ESS transporting its SCAR® ploughing technology by road from Aberdeen.
- Several thousand boulders ranging up to 4m in size were cleared from the individual cable routes and ESS performed 260 individual route passes in varying and sometimes challenging soil conditions.
- Reliability of the plough equipment was excellent as expected with more than 95% uptime.

Westernmost Rough Project: A Case Study



- A \$10 million boulder clearing project on Westernmost Rough Wind Farm
- 33 routes cleared in high currents on spring as well as neap tides
- 20m corridor required
- Generally 5 passes per string, Centre line, 2 x Wing lines (accuracy essential) and lay downs at either end (accuracy essential)
- Campaign was 72 days to include - Ploughing, Surveying, Transiting, Port calls
- Mobilisation in 47 hours in Aberdeen
- Demobilisation in 24 hours
- Within the 20m wide corridors between the 35 towers there were 48,000 on seabed target boulders 0.35m and above.
- The project was on schedule and on budget.

Westernmost Rough: SCAR Statistics

SCAR System: SCAR1 RP (10m swathe)

Type of route: Inter-array

Infrastructure in place: Turbine foundations

No of routes: 35

Corridor width: 18m

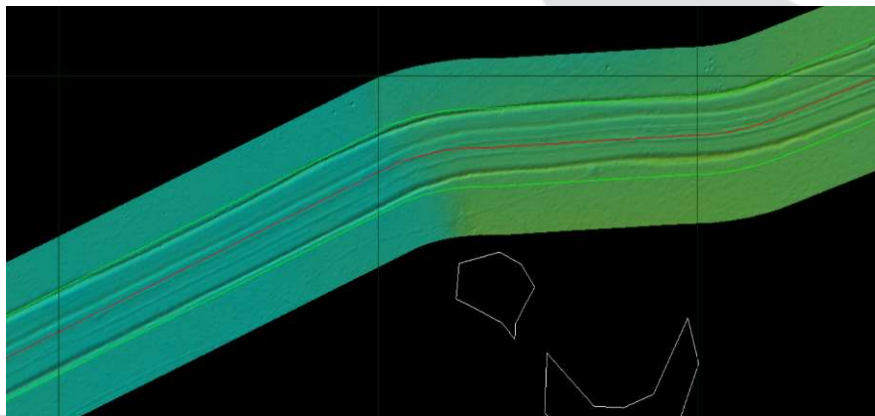
No of passes/route: up to 8

Total number of passes: 300

Total distance cleared: +150km

Manhours: 1715

LTI's: 0



Race Bank OWF Phase 1: SCAR Statistics

SCAR System: SCAR1 RP (10m swathe), SCAR2 RP (15m swathe)

Type of route: Export

Infrastructure in place: None

No of routes: 2 export line, 8 locations

Corridor width: 22m

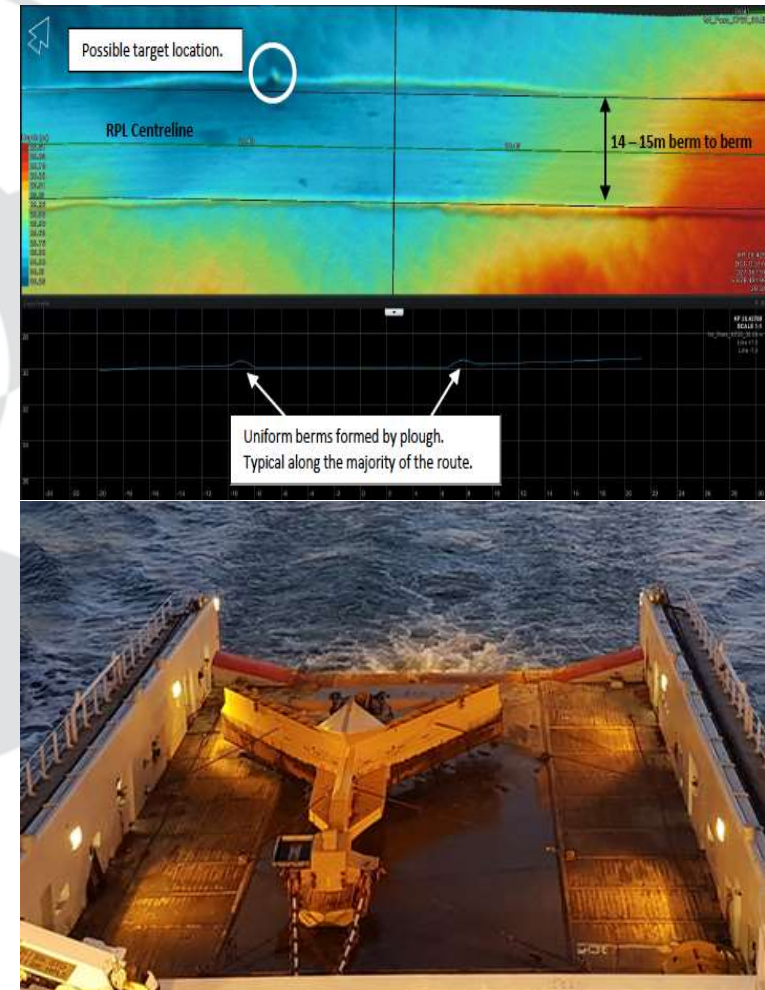
No of passes/route: up to 3

Total number of passes: 20

Total distance cleared: 115km

Manhours: 920

LTI's: 0



Race Bank OWF Phase 2: SCAR Statistics

SCAR System: SCAR2 RP (15m swathe)

Type of route: Export

Infrastructure in place: None

No of routes: 2 export line, 4 locations

Corridor width: 30m+

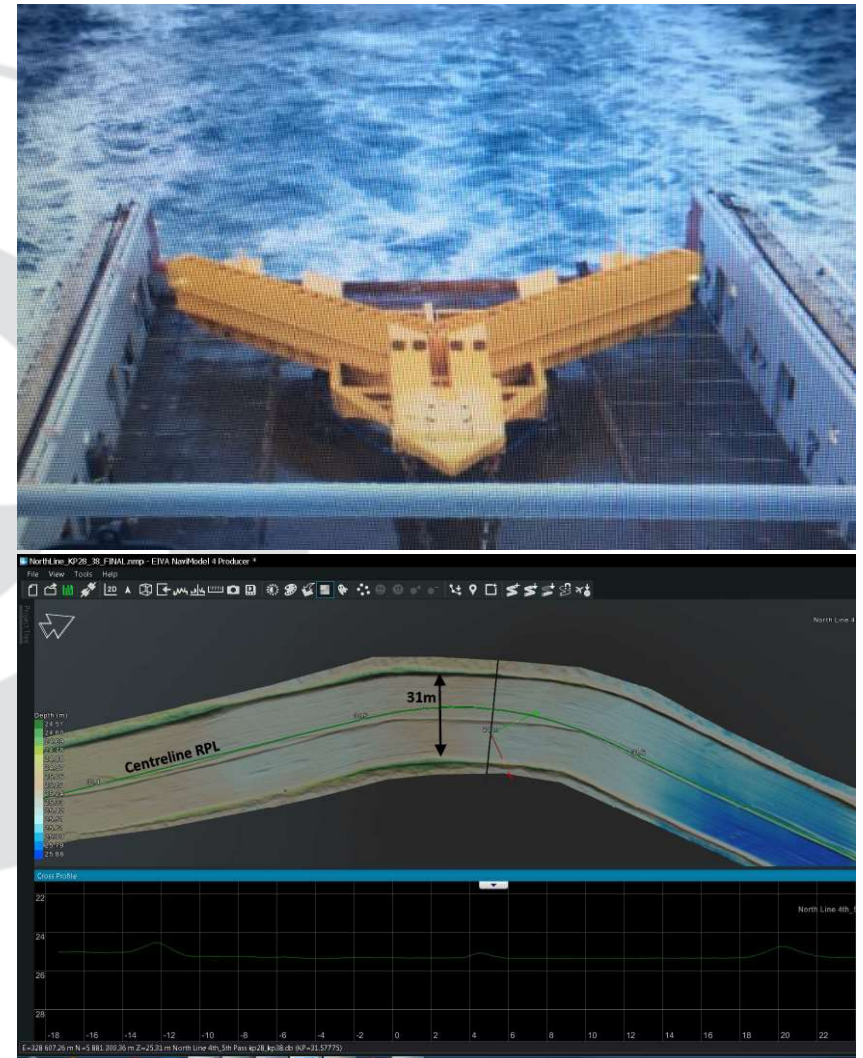
No of passes/route: 5

Total number of passes: 20+

Total distance cleared: 130km

Manhours: 1486

LTI's: 0



Typical Seabed Profile and Section at KP31.546

Wikinger Project: A Case Study



- Ecosse Subsea Systems cleared 45 routes of boulders covering 33.8km
- Pre-cut trenching in first pass mode of 70 routes covering 62.9km
- Pre-cut trenching in second pass mode of 25 routes covering - 18.9k
- Second pass clearance at 10 Tower locations to displace spoil heaps as extra work for the Client covering -1.4km
- In total 117km of Wikinger seabed was covered by the SCAR Seabed System
- ESS undertook 39 pile fixes
- Target Trench Depth was achieved in 85% of all 1st pass trenches (60% was estimated - due to soil conditions)

Wikinger OWF: SCAR Statistics

SCAR System: SCAR1 RP (15m swathe), SCAR1 Pre-Cut & SCAR1 Multi-Pass

Type of route: Inter-array

Infrastructure in place: Piles & turbine towers

No of routes: 45 route cleared, 70 pre-cut trenched & 25 multi-pass

Corridor width: 10m

No of passes/route: 1

Total number of passes: 20+

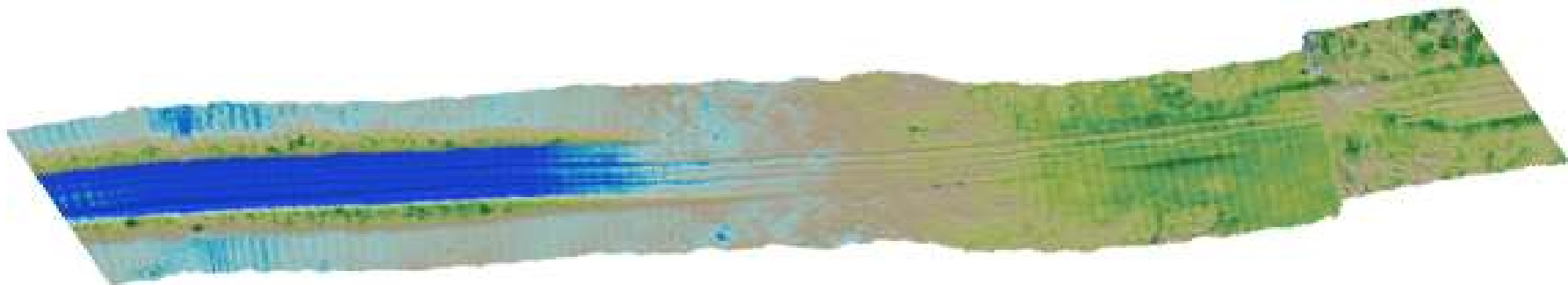
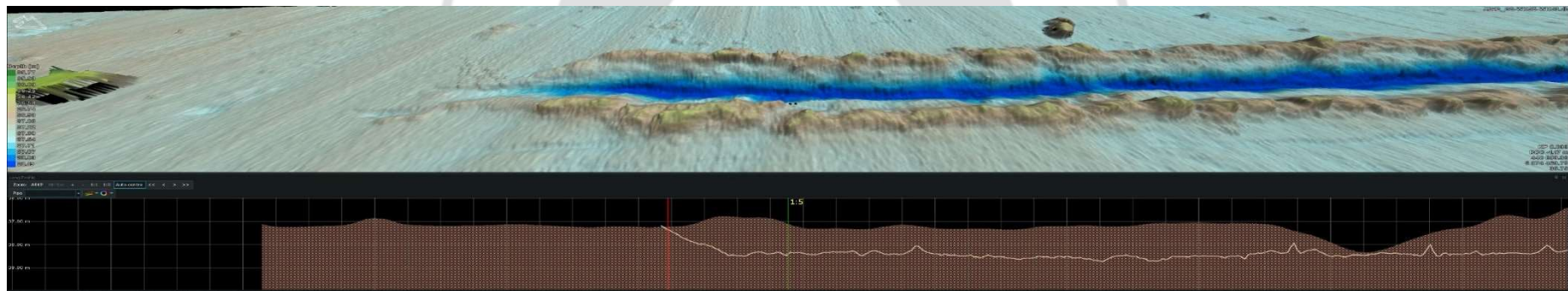
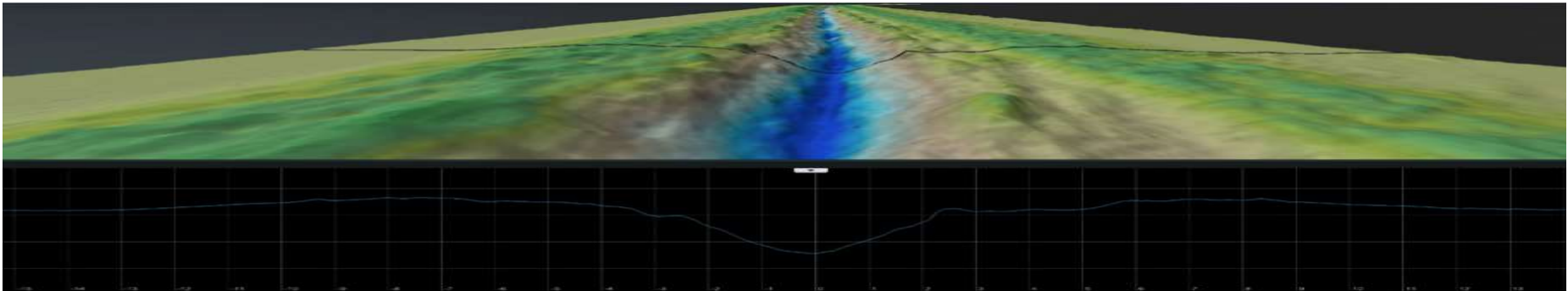
Total distance cleared: 34km

Total distance trenched: 63km 1st Pass & 20km multi-pass

Manhours: 60,000

LTI's: 0

Wikinger OWF: SCAR Statistics





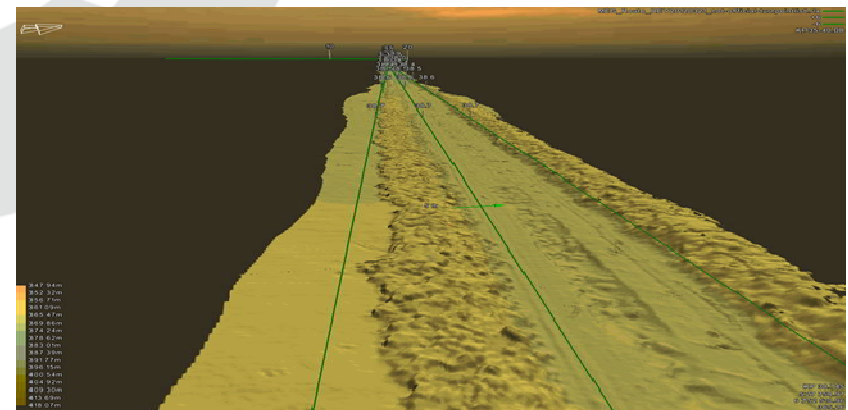
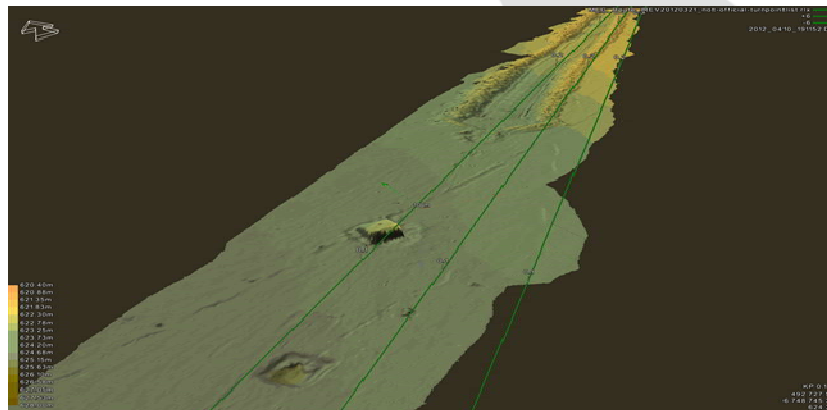
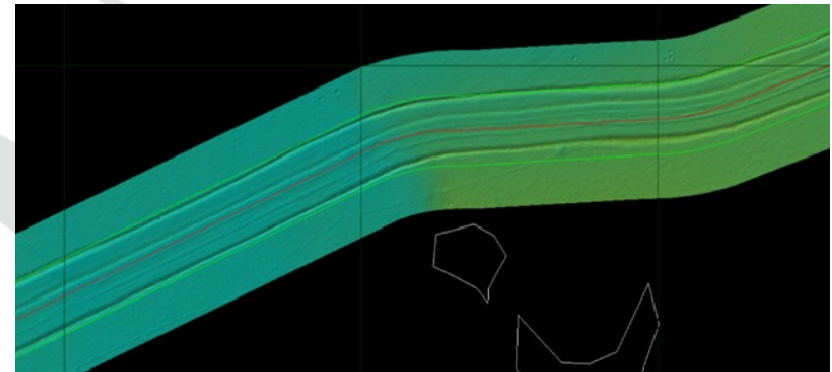
SCAR Seabed System: Boulder Clearance



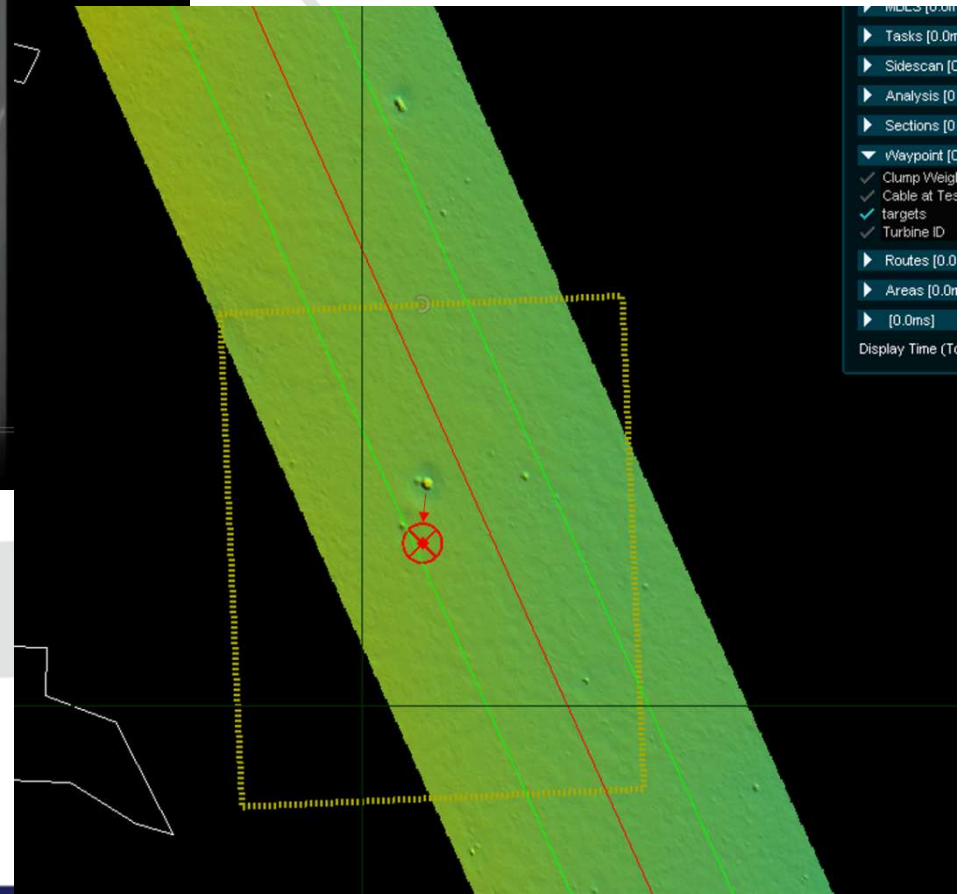
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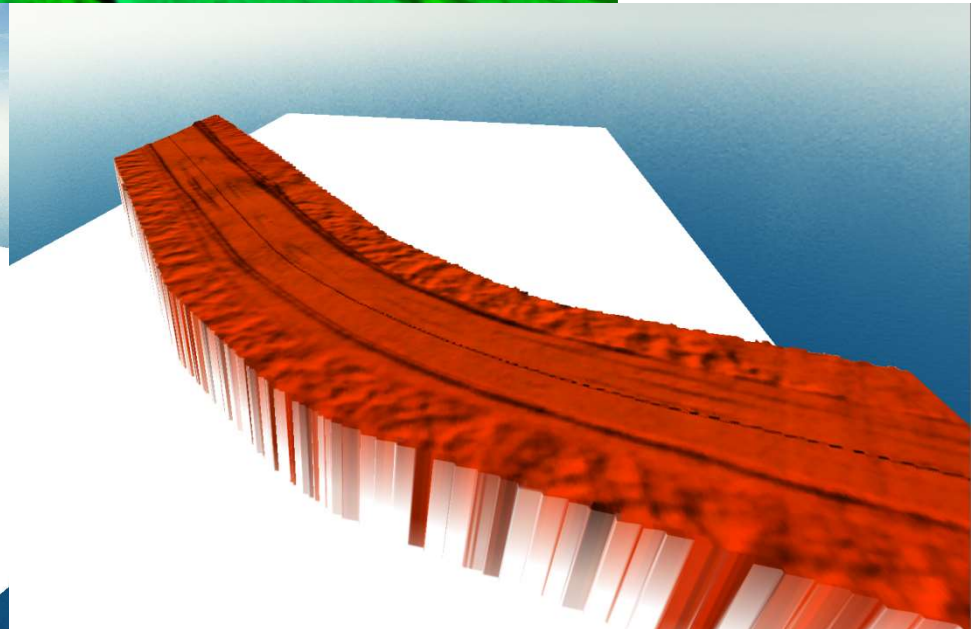
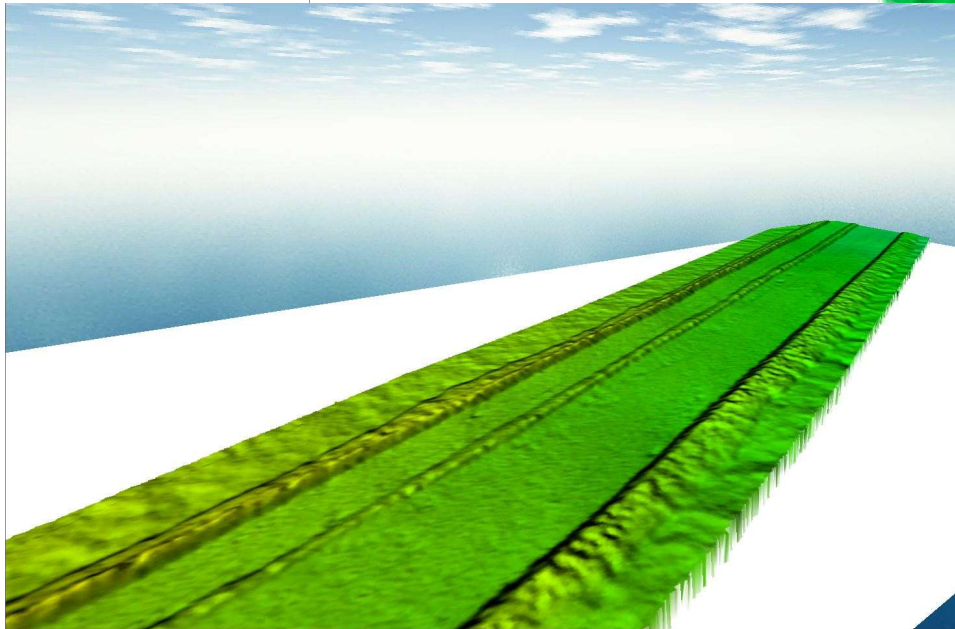
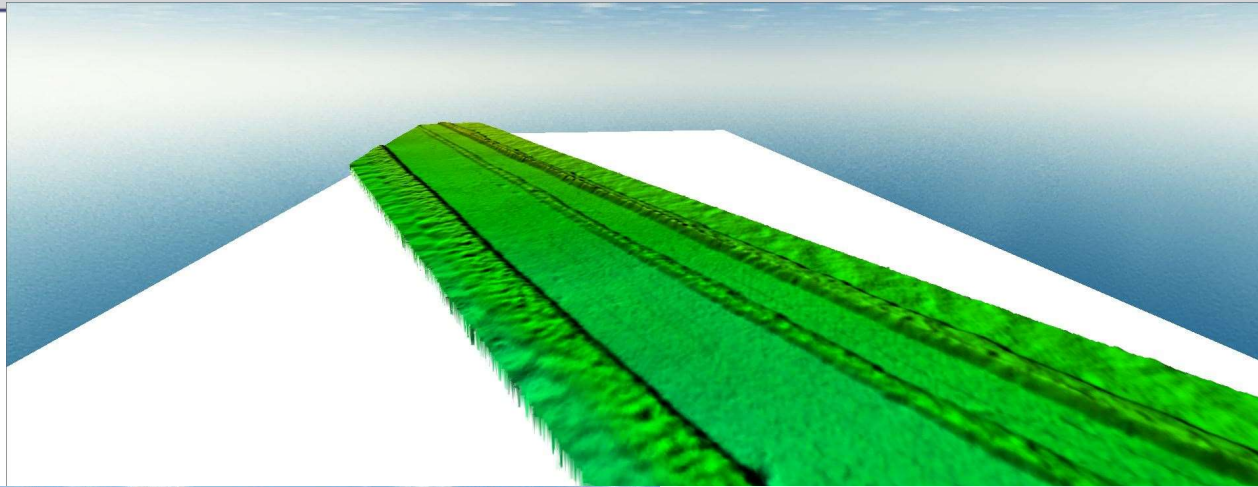


Route Preparation Results



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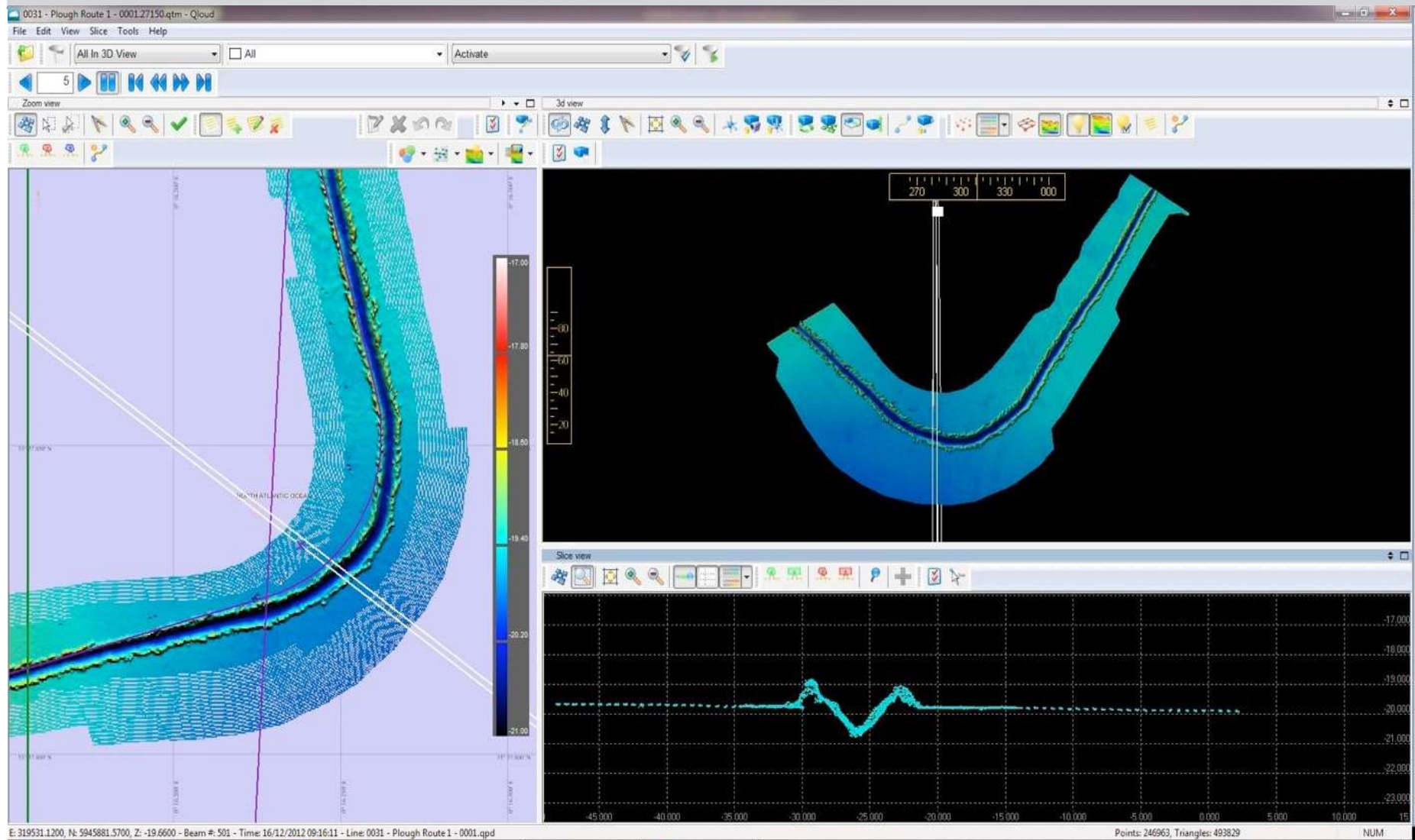
Route Preparation Results



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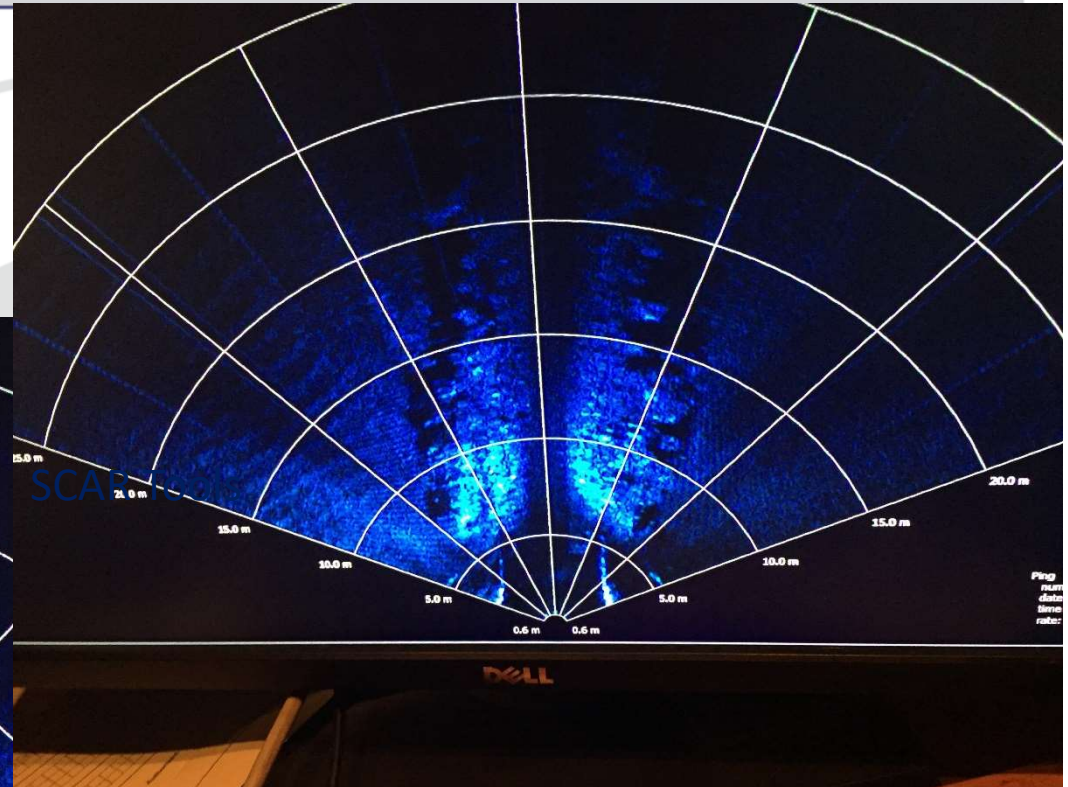
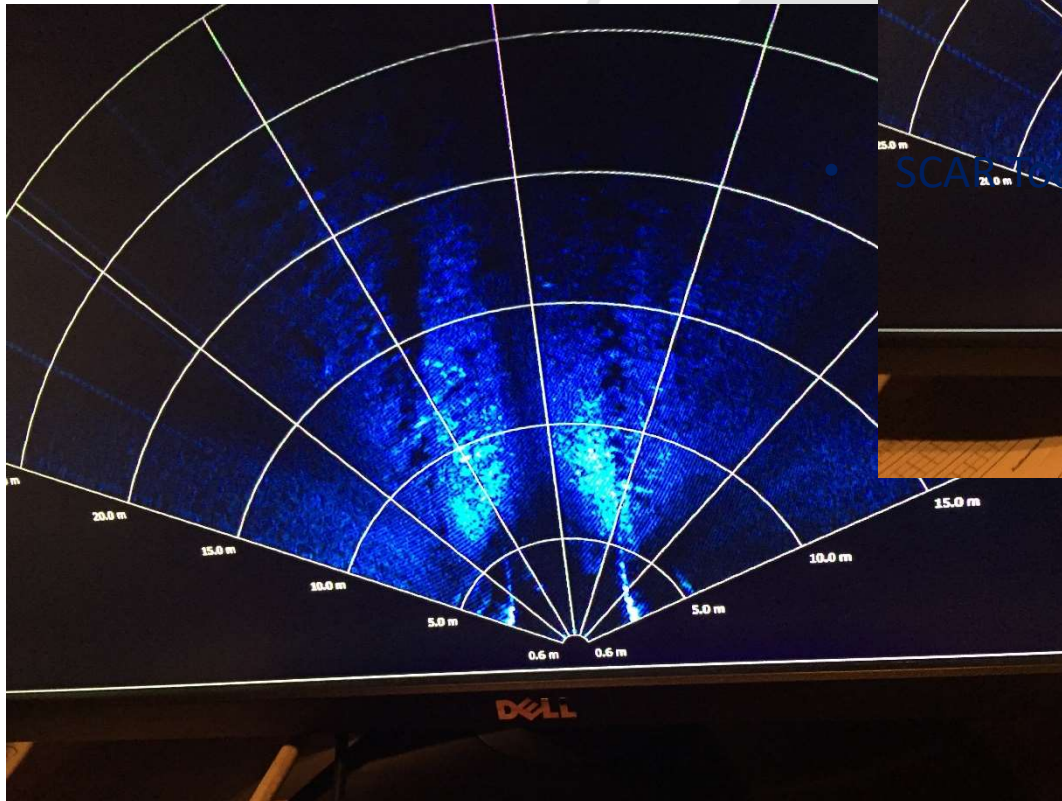


Pre-Cut Trenching Results 50m radius curve

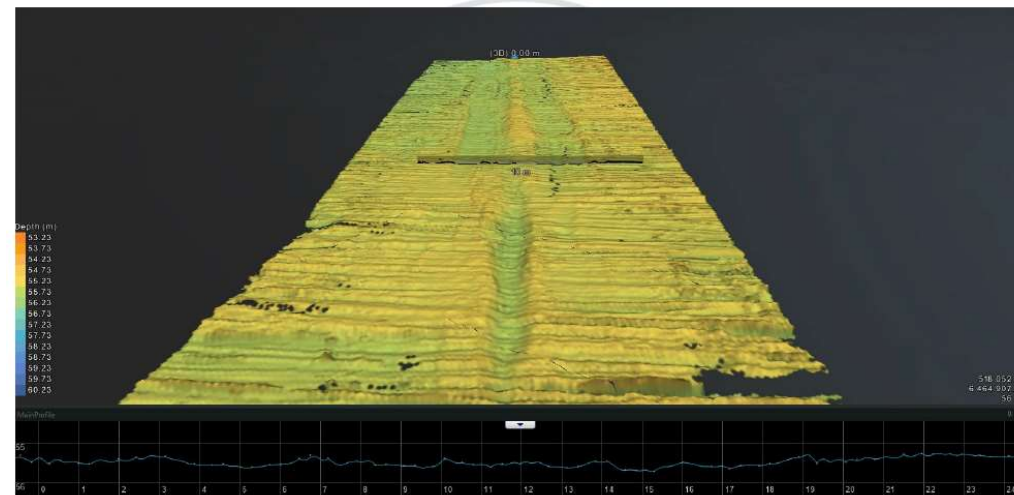
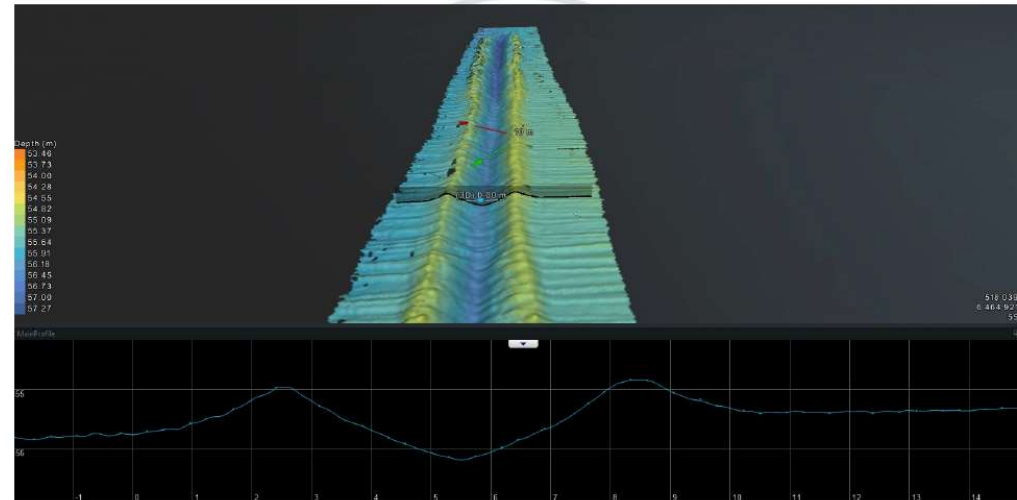


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Backfilling view from ROV



Pre & Post Backfill Results



Intellectual Property (IP)

- All equipment shown in these presentations is covered by patents or patents pending.
- Ecosse Subsea Systems will vigorously defend it's IP and pursue any individual or corporation that builds or operates or contracts to operate infringing IP in territories covered by our patents.



Thank you for listening!
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