Moray West Landfalls

Pipe-Pushing in Scotland
Challenges and Solutions

27th DCA Annual Congress

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LMR Drilling

Leipzig

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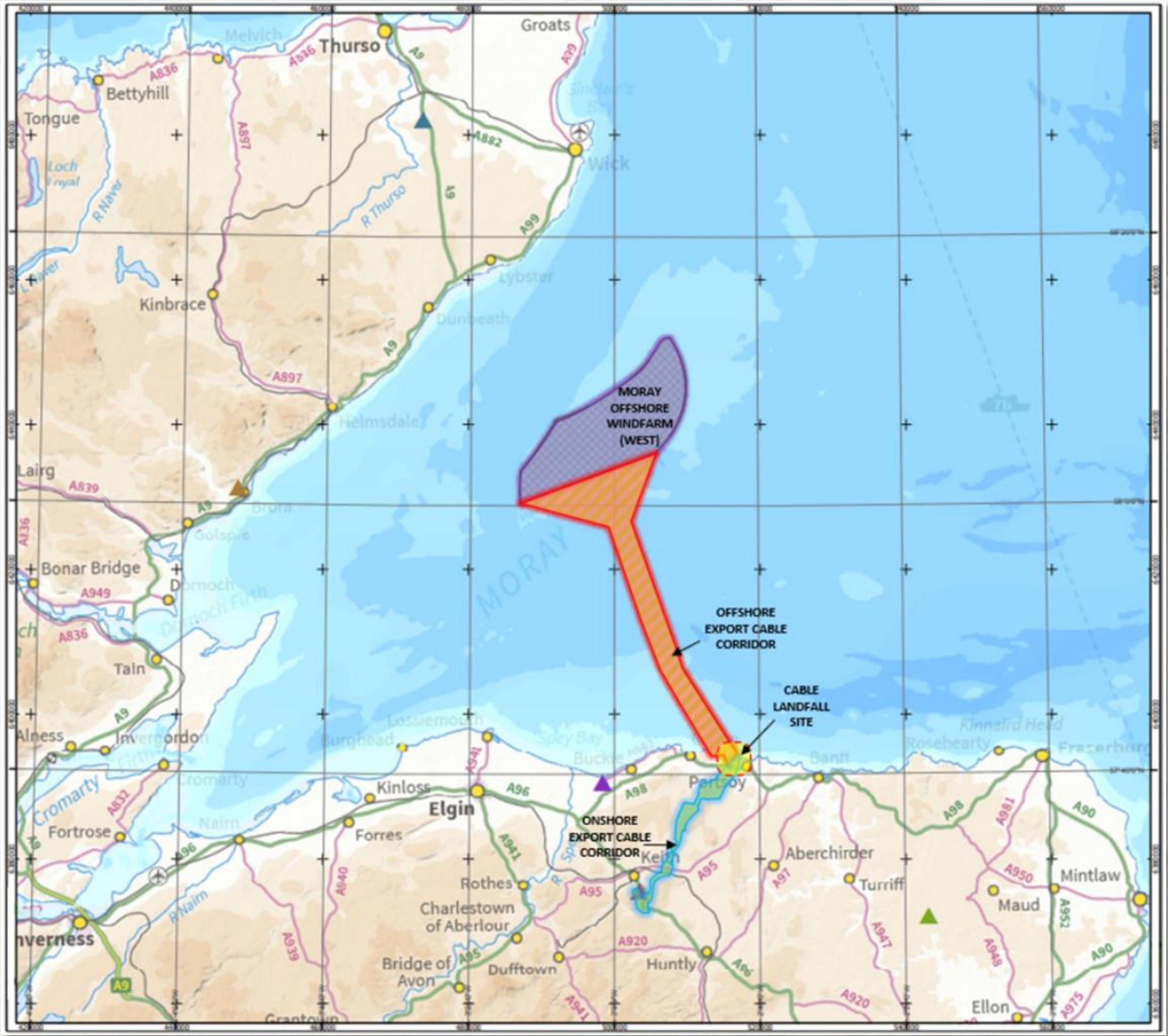
Contents

1 Project Introduction

Project Details

- Client – Ocean Winds (50% EDPR & 50% ENGIE)
- Offshore Cable Contractor – Nexans Norway
- Onshore Cable Contractor – Nexans France
- 2 no. 65km HVDC export cables transmit power to shore
- From landfalls HVDC cables run to Convertor Station and Electrical Substation 20km from landfall site



Landfall Site

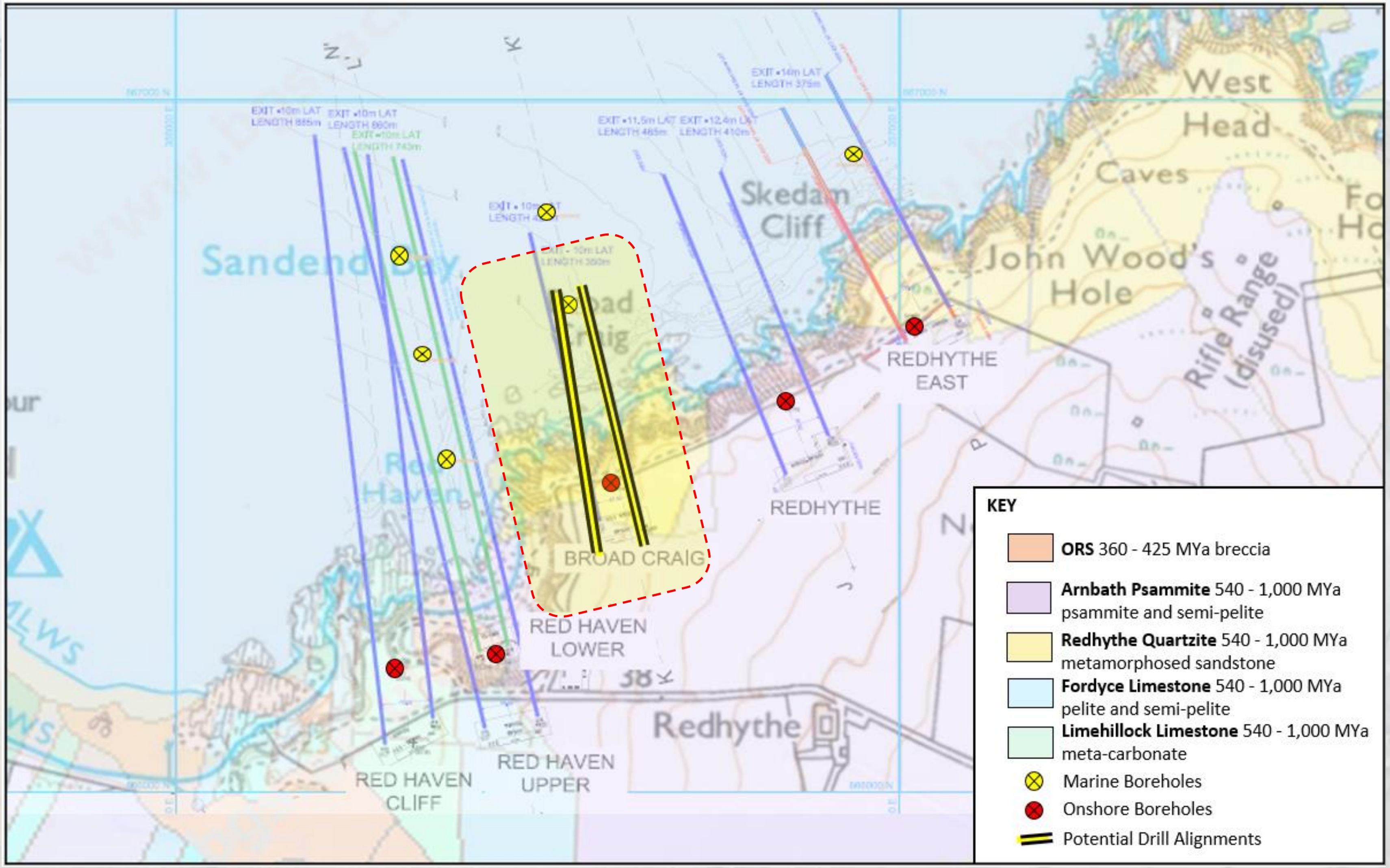
1 Project Introduction

Landfall Details

- 30m high coastal cliffs
- 2 no. drills required
- Minimum duct ID of 450 mm
- Drill length to be minimised
- Depth of cover to be minimised
- Several potential sites to the east of Sandend
- Geology (as always) critical

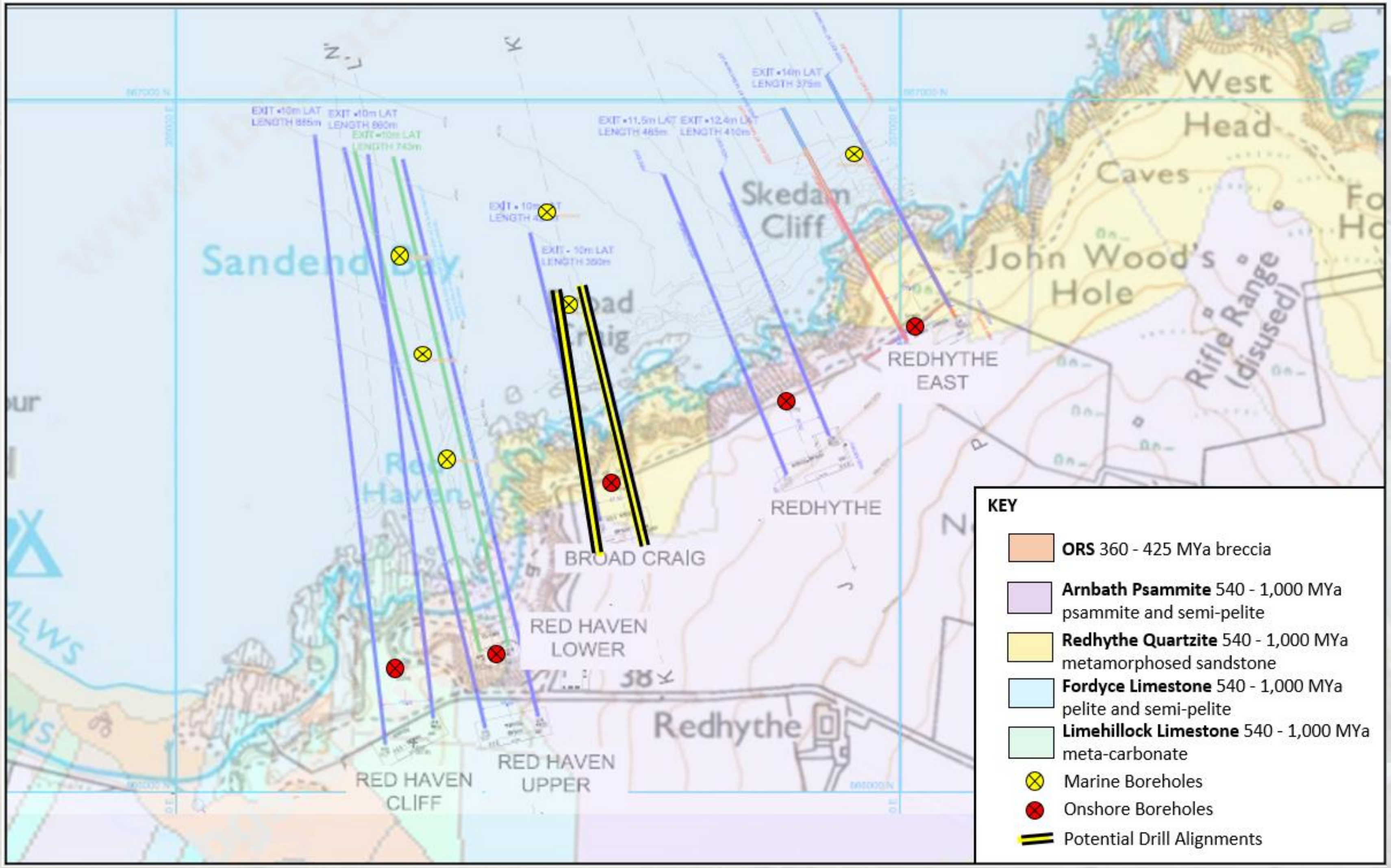
Landfall Details

- 6 possible sites
- Client's Preferred options :
  - Broad Craig
  - Redhythe
- LMR's preference:
  - Broad Craig:
    - Shorter
    - Exit closer to offshore boreholes



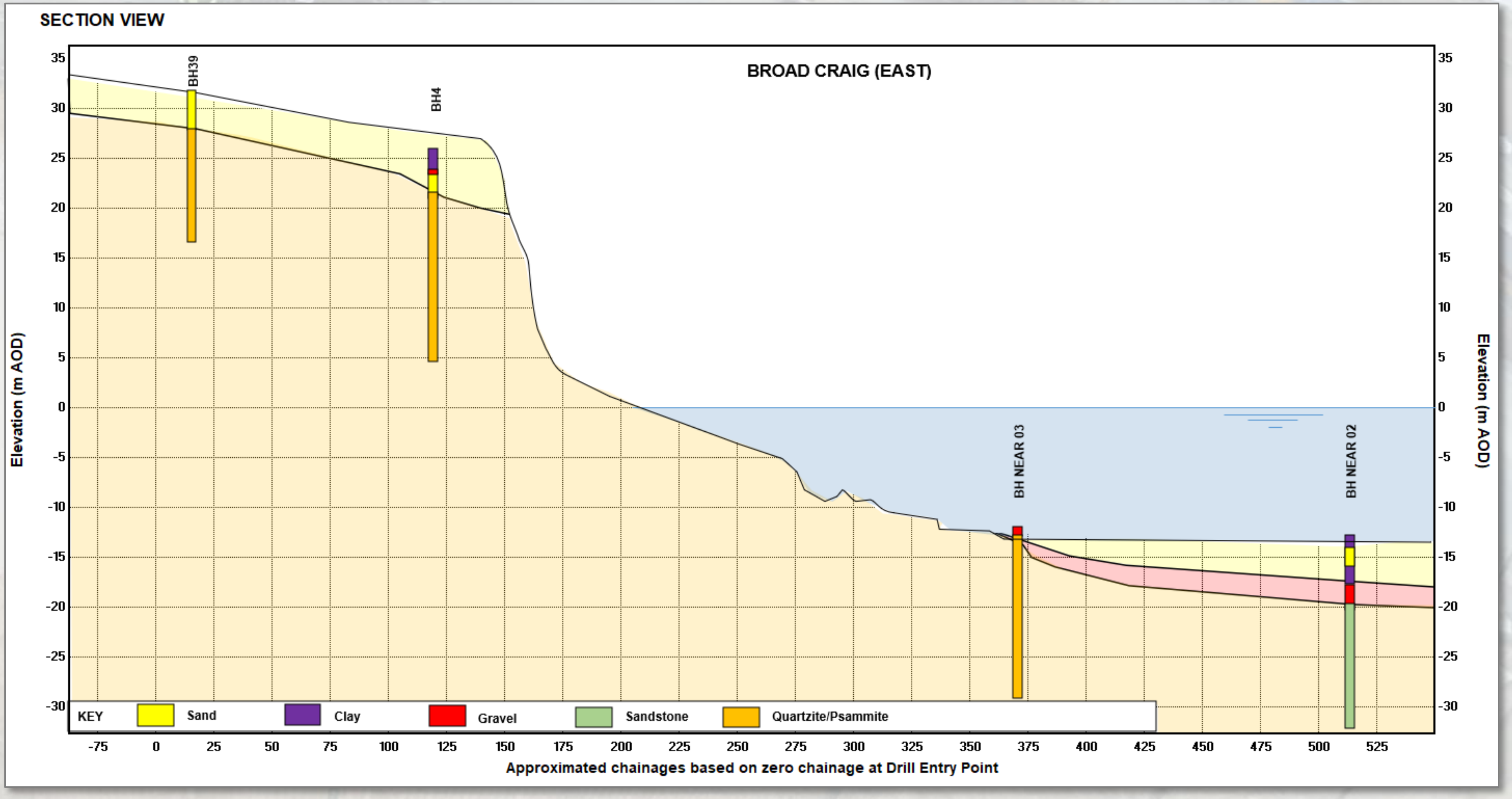
Site Investigation

- BGS Data
- 2 no. onshore boreholes
- 2 no. offshore boreholes
- Onshore and offshore geophysical survey data



Site Investigation – Boreholes & Geophysics

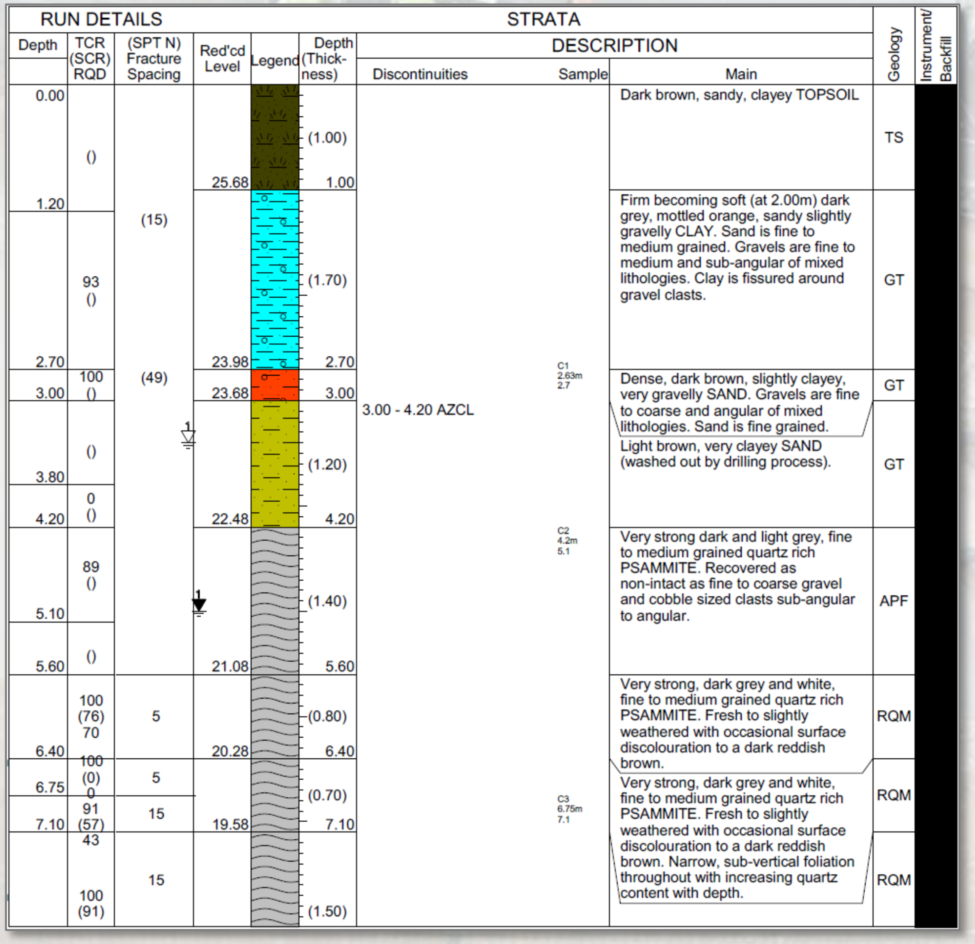
- Boreholes aligned with BGS Date
- 5m of sand and gravel overlying quartzite at entry points
- Quartzite and Psammite for most of drills
- Gravel and sands approaching exit points
- Overburden thicker offshore

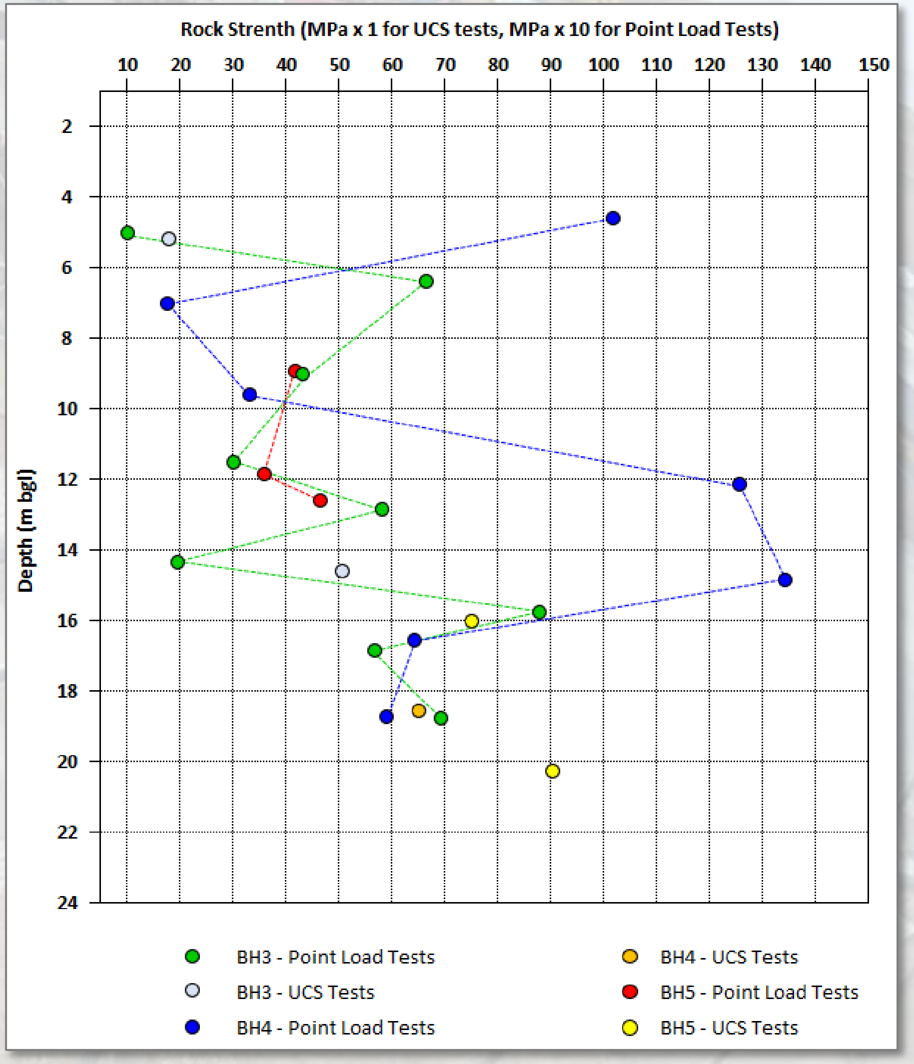


2 Ground Conditions

Site Investigation – Rock Characteristics

- Boreholes described very strong rocks of Redhythe Quartzite Formation
- Lab tests indicated 25-100 MPa
- Highly/extremely abrasive
- Challenging but drillable

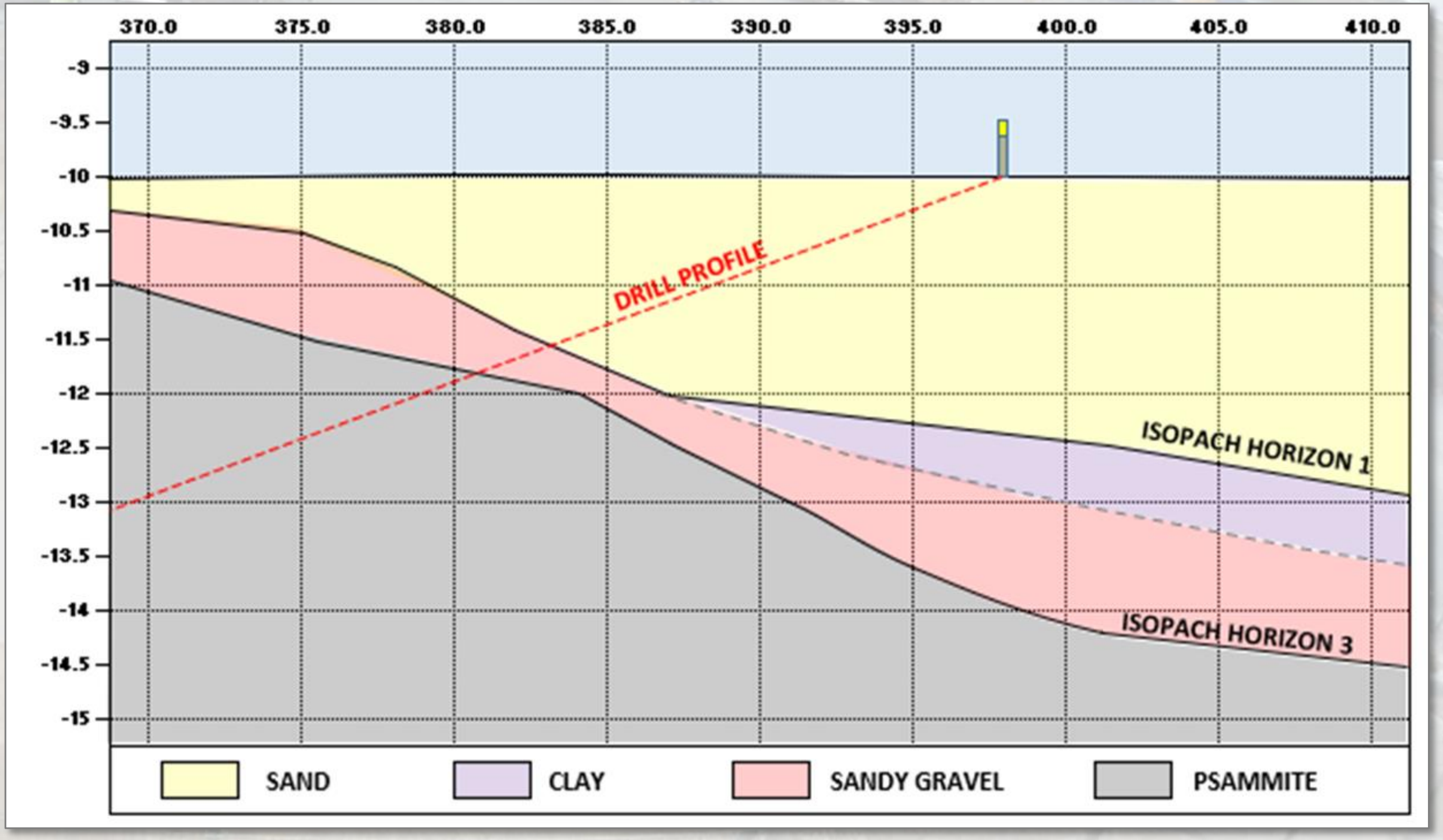




2 Ground Conditions

Site Investigation – Approaching Exit

- Geophysical Data showed 2-3 m of sediment above bedrock at exit points
- Potential 0.5m layer of gravel
- Mostly sand above this gravel layer
- Sediments much thicker offshore



3 Engineering

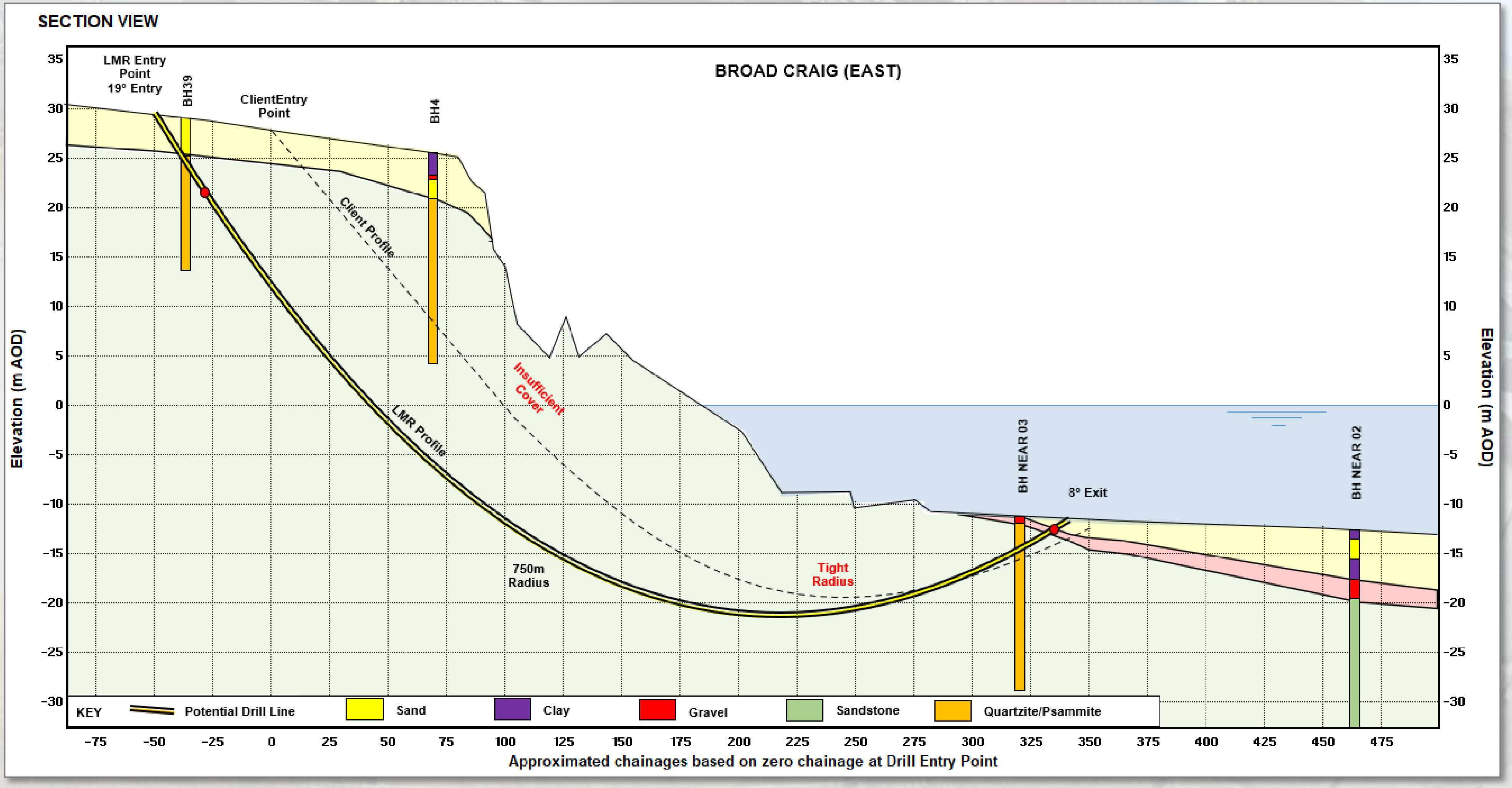
Drill Profiles

Move Exit Point Inshore slightly – less overburden and closer to borehole

Increase Drill Radius to 750m (1,000 x hole dia.)

Straight tangent to allow casing installation

To incorporate these criteria required moving entry points inland

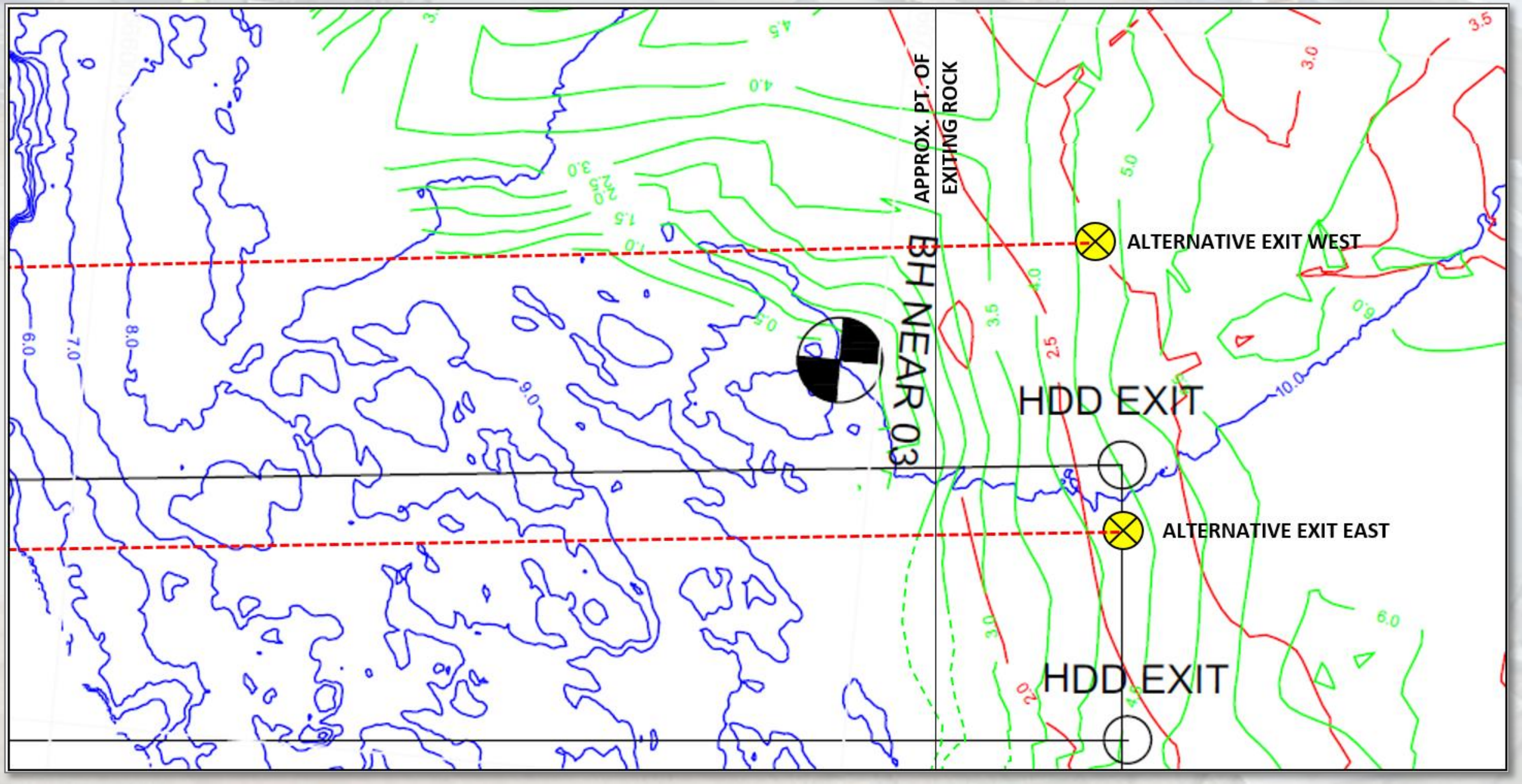


Drill Alignments

Move exit points to west to:

- Move closer to boreholes
- Reduce depth of overburden

To incorporate these criteria required reducing exit point water depth from 10m LAT to 9.5m LAT at western exit point



Steering System

- The Vector gyro system was used with Inrock providing the tooling and survey services. Features of system included:
  - Gyro data avoiding corruption from magnetic interference. Essential with large drilling assemblies and tight tolerances
  - 150m entry coil for integrated Paratrack system allowed verification of elevation and inclination bias
  - PWD system provided real-time annular pressure data
  - Ability to house the steering tool in any size of drill collar with any form of connection
  - No ‘HDD-world’ limit on operating pressure of gyro – flexibility with mud motor specification

Duct Design

- Design Assessment determined need for SDR11 duct specification
- 560mm SDR 11 PE100 duct specification chosen to provide minimum 450mm ID
- Duct to be welded inland from drill site and to be pushed into the hole using a pipe pusher
- Duct to be internally debeaded
- Integrity verification to include :
  - Weld Records
  - Video of debeaded joints
  - Air-test pre-installation
  - Gauging-pig run post-installation

Duct Termination Design

- Pushing duct means offshore end of duct passes through hole.
- Ducts tend to require a fitting on the seaward end to :
  - Allow the end to be sealed securely while awaiting cable installation, often a year or more later.
  - For the fitting of a bellmouth prior to cable installation.
  - Allow a cable seal to be fitted post-cable installation to enable annular grouting
- Conventional solutions include:
  - Fitting a mechanical coupler to the end of the pipe on the seabed.
  - Push through excess pipe, lift duct-end to a vessel and fit/weld a fitting to the end of the duct before lowering back to the seabed and potentially pulling the duct back up the hole into the preferred position.
- Solution needs to provide an internally flush surface for the cable.
- An alternative solution accepted by the Client on this Project and worked well.

Duct Termination Design

- This involved a tapered end-section of the duct which allowed a welded flange to be fitted to the duct and to be pushed through the hole.

- Simp
  conn
- Mini
- 900m
  duct
- 1,50
  ID

Methodology

- Each drill required the following operations:
  - Pre-drill and enlarge first 30m of hole and install steel casing/conductor pipe
  - Drill 16” diameter pilot hole from end of conductor pipe to within 50m of exit point
  - Push Hole-Opening to 32” diameter
  - Breakthrough onto seabed
  - Survey to verify suitability of exit position and acceptability of separation from adjacent drilled holes
  - Install cable duct into drilled hole

Dogger Bank A & B Offshore Wind Farm

3 Engineering

Drill and Pipe Sites

4 Drilling Works

Programme

Throughout Scottish Winter

Casing, Pilot and start Hole-Opening on HDD 1 in 2022

Complete both drills by April 2023

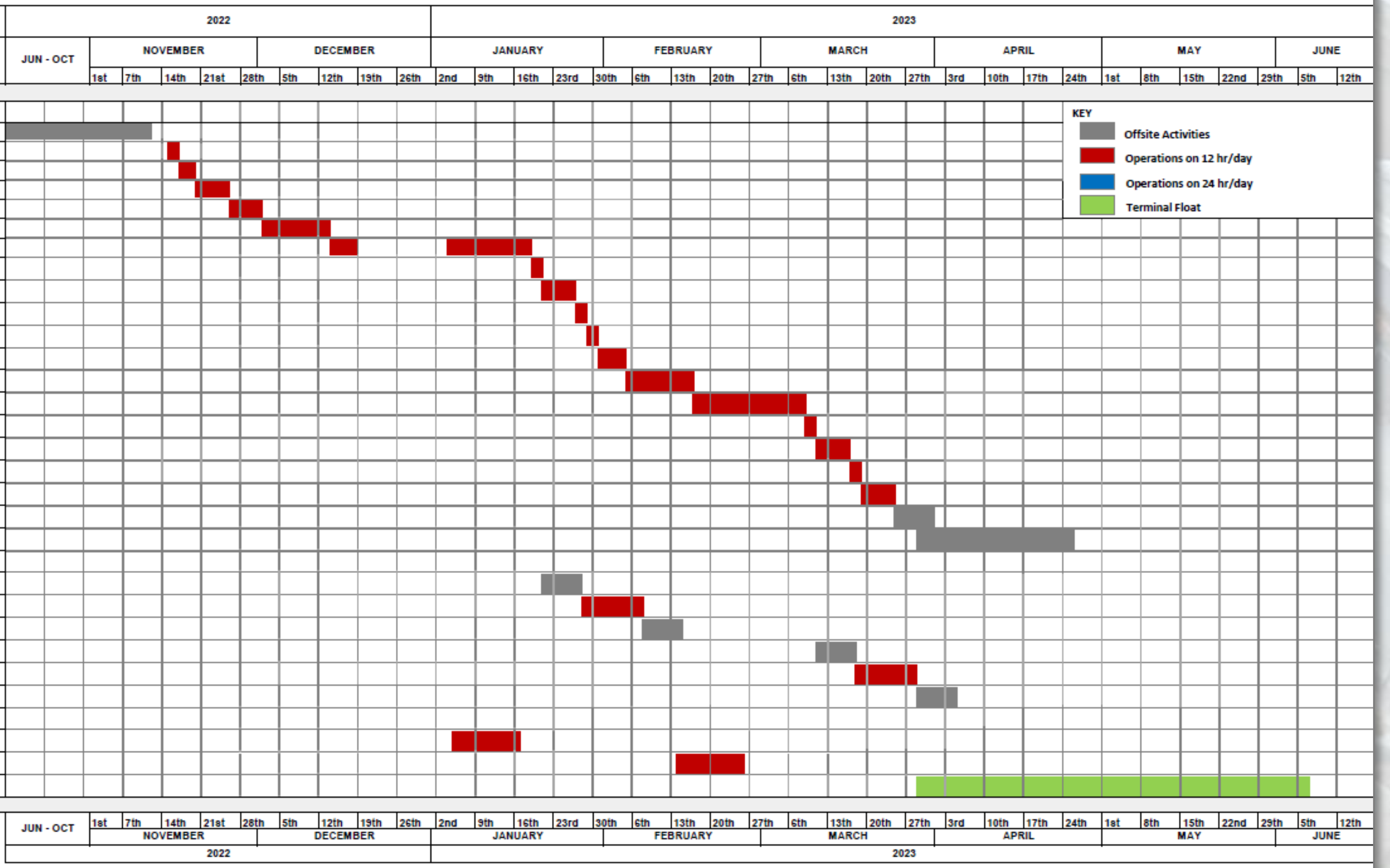
Planned on 12/7 working

LMR Drilling UK Ltd.

Project MOWW
Client Nexans
Crossing Broad Craig

PROGRAMME
PG-1601-NXN03-C1
560 mm SDR11 Ducts
Broad Craig

Ref.	Task Name		Shifts	Start	End
	DRILLING OPERATIONS				
1	Preliminaries		180	16/05/22	11/11/22
2	Welfare Set-Up		2	15/11/22	16/11/22
3	Mobilisation of Drill Spread		3	17/11/22	19/11/22
4	Rig-Up Drill Spread		6	20/11/22	25/11/22
5	Drill and Install Casing	HDD No.1	5	26/11/22	30/11/22
6	Pilot Drilling to 350 m	HDD No.1	12	01/12/22	12/12/22
7	30" Hole-Opening	HDD No.1	20	13/12/22	18/01/23
8	Cleaning Run	HDD No.1	2	19/01/23	20/01/23
9	Breakthrough to Seabed	HDD No.1	6	21/01/23	26/01/23
10	Pipe Installation	HDD No.1	2	27/01/23	28/01/23
11	Rig Move		2	29/01/23	30/01/23
12	Drill and Install Casing	HDD No.2	5	31/01/23	04/02/23
13	Pilot Drilling to 350 m	HDD No.2	12	05/02/23	16/02/23
14	30" Hole-Opening	HDD No.2	20	17/02/23	08/03/23
15	Cleaning Run	HDD No.2	2	09/03/23	10/03/23
16	Breakthrough to Seabed	HDD No.2	6	11/03/23	16/03/23
17	Pipe Installation	HDD No.2	2	17/03/23	18/03/23
18	De-Rig & Load-Out		6	19/03/23	24/03/23
19	Demobilisation		7	25/03/23	31/03/23
20	As built and Close-out Report		28	29/03/23	25/04/23
	MARINE OPERATIONS				
21	Mobilise Marine Spread - HDD 1		7	21/01/23	27/01/23
22	Post-Installation Works - HDD 1		11	28/01/23	07/02/23
23	Demobilise Marine Spread - HDD 1		7	08/02/23	14/02/23
24	Mobilise Marine Spread - HDD 2		7	11/03/23	17/03/23
25	Post-Installation Works - HDD 2		11	18/03/23	28/03/23
26	Demobilise Marine Spread - HDD 2		7	29/03/23	04/04/23
	OTHER ACTIVITIES				
27	Duct Delivery & Welding - HDD 1		12	29/11/22	10/12/22
28	Duct Delivery & Welding - HDD 2		12	24/01/23	04/02/23
29	Terminal Float		70	29/03/23	06/06/23



REVISION HISTORY

Rev.	Details
C1	Updated to reflect sequence of marine works

Date	Engineer	Approved	Rev	Status
06.07.22	JMS	JMS	C1	Contract

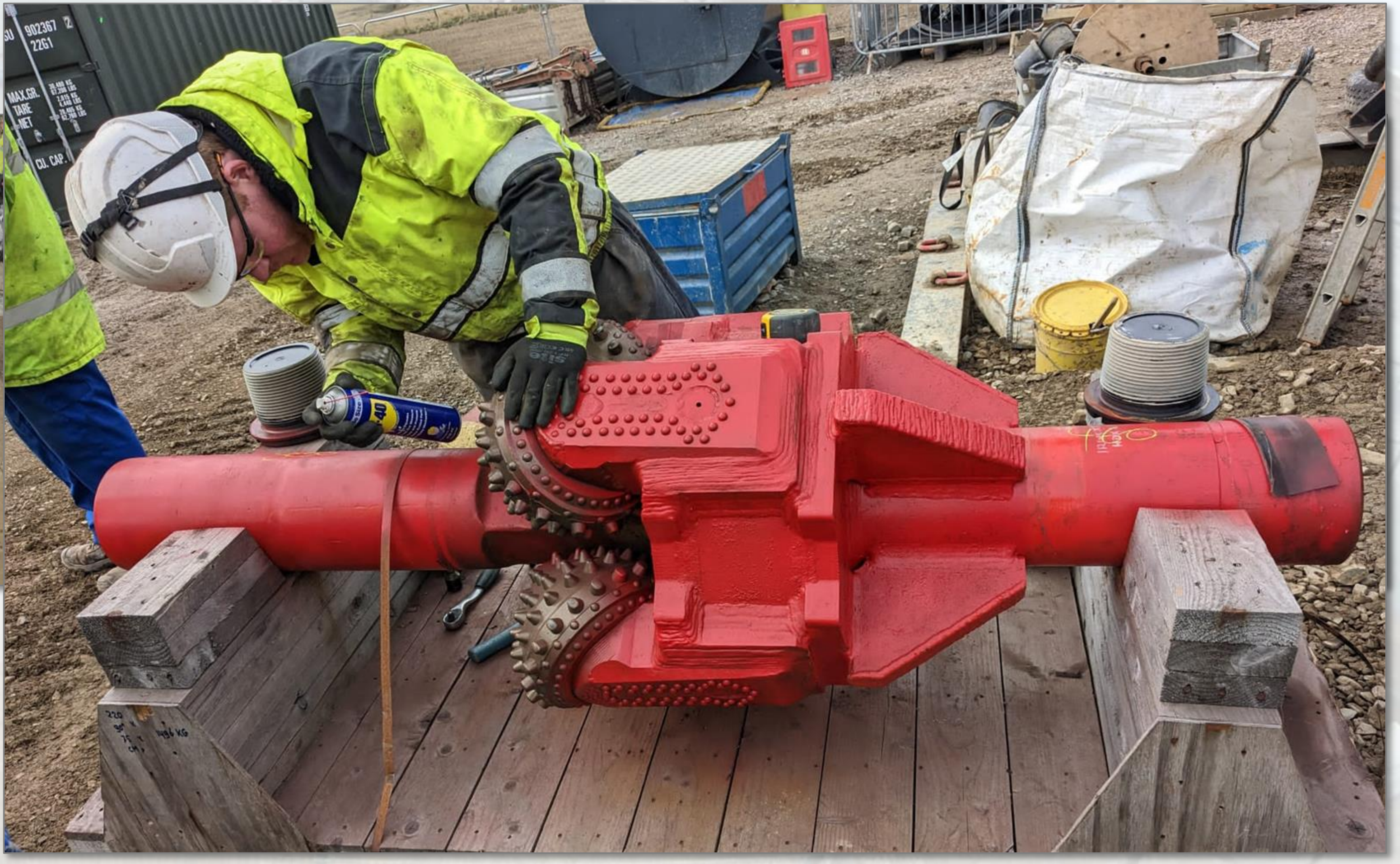
Pilot Drilling

- Fairly Conventional with 16.25” HDX drill bit on 9⅝” mud-motor
- Proceeded well but ROP slower than expected
- Completed largely in line with programme as no problems with wireline etc.
- Steering control well
- Drill fluid returns maintained throughout
- Bit-Wear not excessive

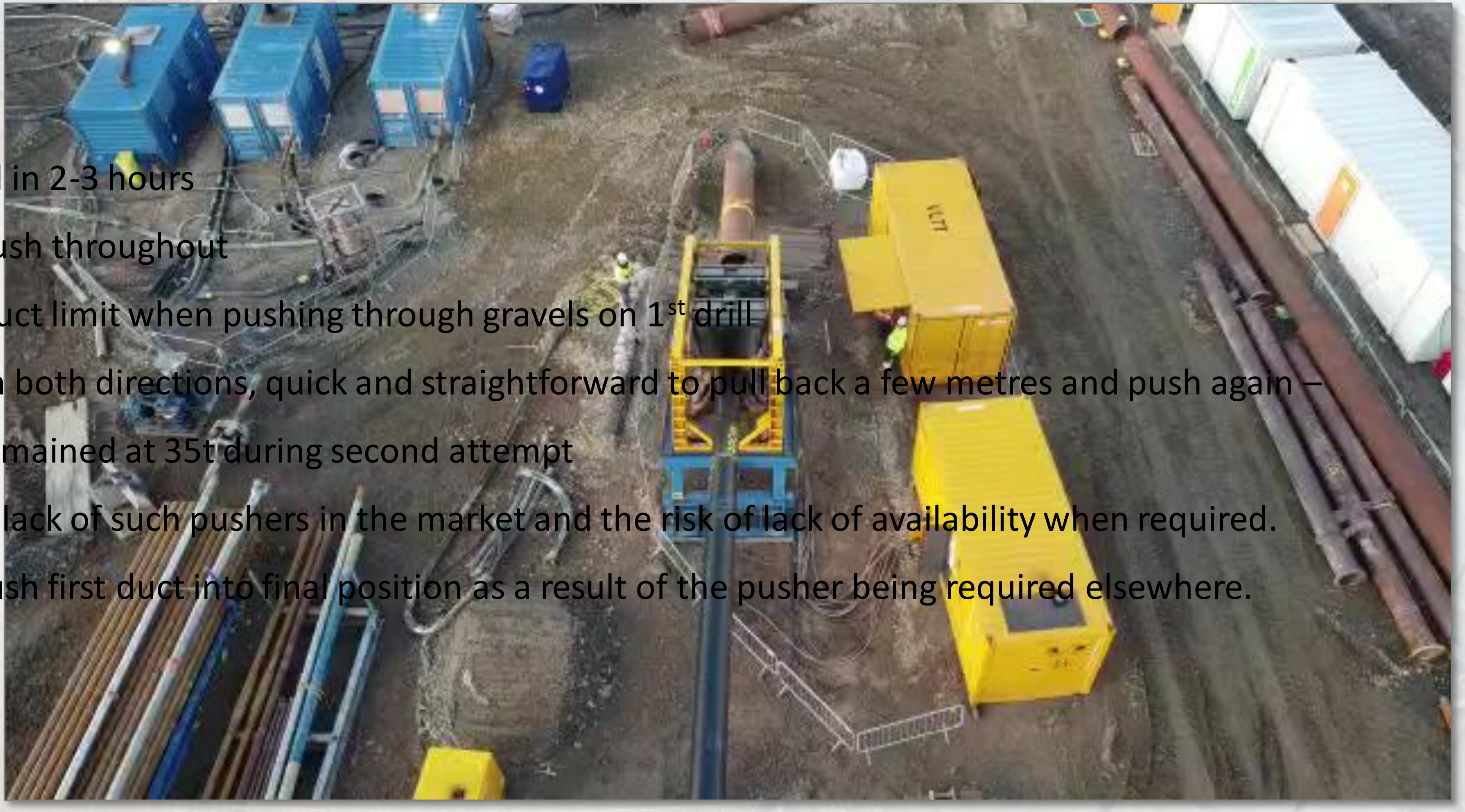
Hole-Opening

- Straight to 32” diameter
- ROP slower than expected due to very high rock strength
- Wear on tools excessive
- Despite challenges, hole-opening completed successfully
- Drill fluid returns maintained throughout hole-opening operations

Hole-Opening



Duct Installation



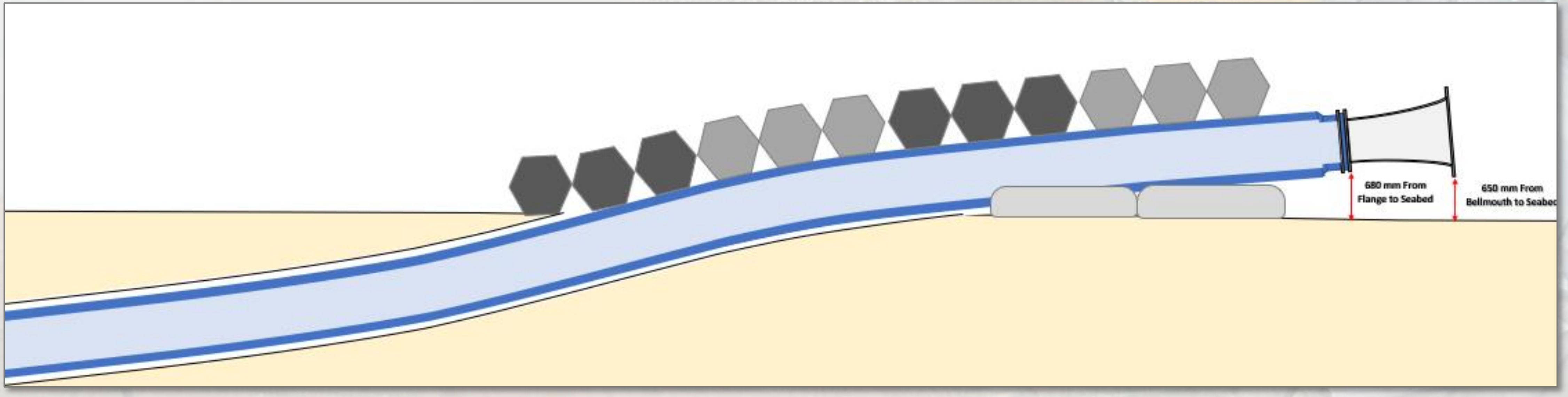
- Pipe Pusher :
  - Worked very well
  - Each duct installed in 2-3 hours
  - Generally, 5-25t push throughout
  - Increased to 70t duct limit when pushing through gravels on 1st drill
  - As pusher works in both directions, quick and straightforward to pull back a few metres and push again – installation load remained at 35t during second attempt
- Biggest challenge is the lack of such pushers in the market and the risk of lack of availability when required.
- Had to use drill rig to push first duct into final position as a result of the pusher being required elsewhere.

Marine Works

- Minimised by having flanged end connection
- Weather risk reduced by minimising the required extension of the duct beyond the exit point
- Marine works consisted of:
  - Removal of push-head
  - Recovery of gauging pig
  - Fitting bellmouth
  - Securing messenger wire and sealing bellmouth
  - Installing seabed stabilisation
  - Fitting marker buoy
- Spread consisted of Dive/Workboat, Crew-Transfer Vessel operating out of Buckie, 10 km to west

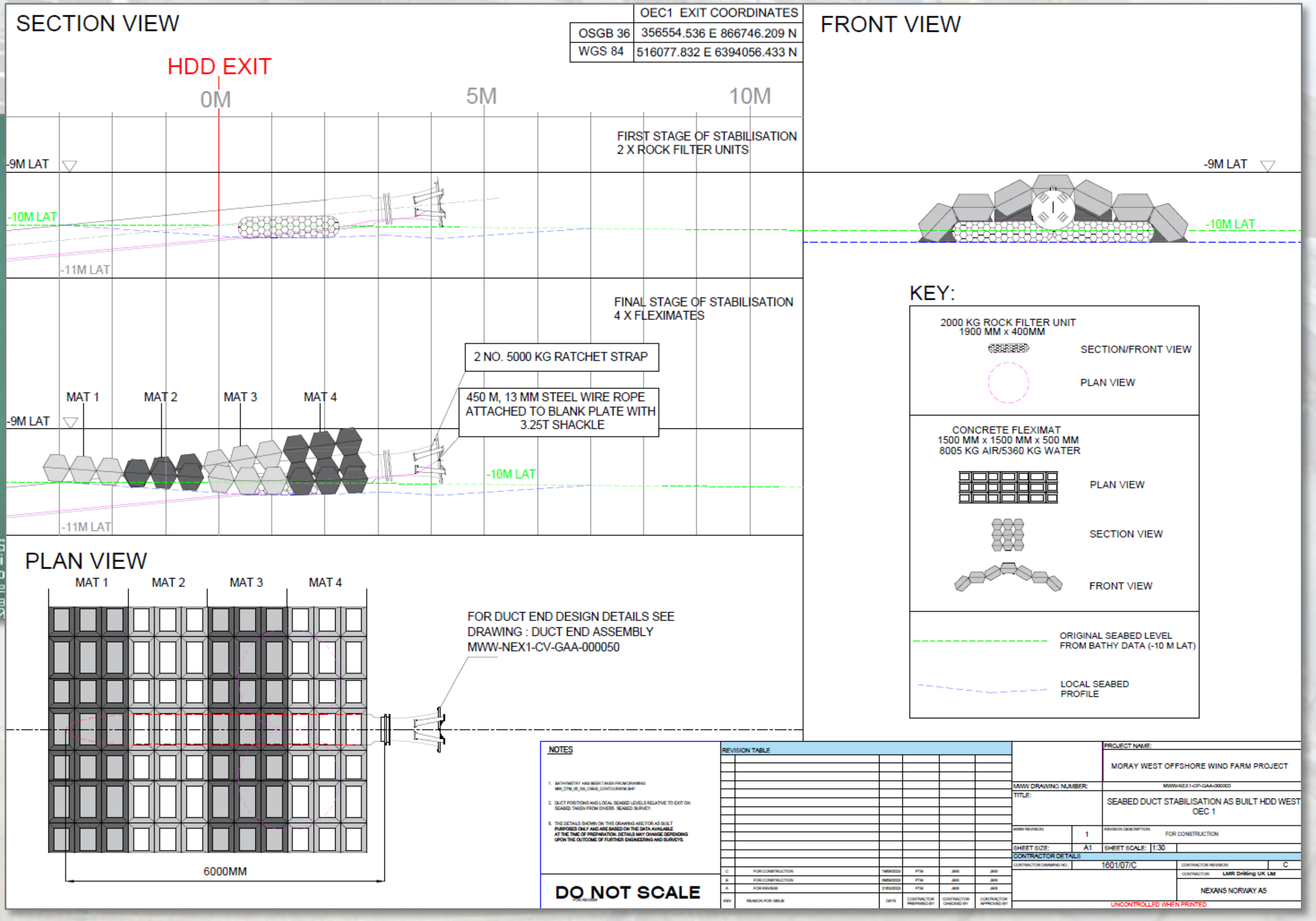
Marine Works - Design

- Initially, Offshore Contractor required 18m long length of duct on seabed
- This exceeded the length of duct that could be safely left on seabed without stabilisation, presenting an adverse weather delay risk to the duct installation process.
- Agreed to reduce the exposed length to 6 metres which could be left on seabed for several days without stabilisation



5 Duct Installation

Marine Works - Construction



Challenges and Solutions

- Winter Landfalls – Pipe Installation :
  - Duct pushing
- Duct Pushing :
  - Suitability of Fittings on end of duct – potential for slim-flange or similar fittings
  - Availability of pipe-pushers – more required
  - Stringing sites – need to be considered during project development