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Caithness-Moray (LT21) HVDC Circuit Burial Risk Assessment

For:

Scottish Hydro Electric Transmission Plc

Scottish and Southern Energy
Power Distribution

LR Senergy

Contacts and Document Control

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Executive Summary

Scottish Hydro Electric Transmission Plc is planning to develop a High Voltage Direct Current electricity transmission link between Noss Head in Caithness and Portgordon in Moray.

As part of the Marine Licence application process, Scottish Hydro Electric Transmission Plc has requested that LR Senergy prepare a Burial Risk Assessment report for the route, based on the existing datasets and studies, as well as the current understanding of the project methodology.

This document presents a route burial assessment for the Caithness-Moray circuit, based on the available survey and geotechnical datasets, burial protection index study and the installation contractor's current methodology. It provides an estimate of the achievability of ploughing to the target tool depth of 1.8m along the offshore route, thus the achievability of the required 1.0m depth of cover over the cable to provide adequate protection (excluding any sediment losses).

A detailed evaluation of the geotechnical data, along with the survey alignment charts, has resulted in the determination of eight soil zones along the Caithness-Moray circuit, with four located in each of the route sections – the route sections relate to the survey origin point at the now-discounted offshore hub location and are referenced as Portgordon to Hub Platform and Hub Platform to Noss Head. These soils zones have been further sub-divided into trenching zones, based on a pre-lay ploughed approach. It is noted that there is a significant limitation in the ability to accurately predict soil conditions along the circuit due to the lack of laboratory testing undertaken on the acquired samples, particularly the lack of PSD data to determine fines content within cohesionless soils - fines content can have a significant impact on ploughing operations. This is combined with large data gaps along the Hub Platform to Noss Head route section.

LR Senergy estimates that, theoretically, 75.5% of the Caithness-Moray (LT21) circuit could potentially achieve the burial specification based on trenching and mechanical backfilling (excluding any sediment losses and premature infill), between the two offshore HDD break-out locations at Noss Head and Portgordon. This discounts any areas where the installation contractor – ABB AB - will intentionally not trench the HVDC cable (e.g. cable joint location).

Those route zones where the burial specification is not anticipated to be met, as well as those locations highlighted in this report where trenching will not be attempted, will require rock placement to ensure adequate cable protection from external threats.

Based on LR Senergy's assessment, the required quantity of rock amounts to 154,936Te (instantaneous) and 201,417Te (total). The total quantity is based on a 30% uplift factor for oversizing and losses.

Within the 12 nautical mile limit at Portgordon, this rock requirement equates to 51,738Te (instantaneous) and 67,260Te (total). Out-with the 12 nautical mile limit, the rock quantity is 94,130Te (instantaneous) and 122,369 (total). Finally, within the Noss Head 12 nautical mile limit, the rock requirement is 9,068Te (instantaneous) and 11,788 (total).

Acronyms and Abbreviations

Acronym / Abbreviation	Term
ABB	ABB AB (Installation Contractor)
AIS	Automatic Identification System
BC	Box Core
BERR	Department for Business, Enterprise and Regulatory Reform
BPI	Burial Protection Index
BSB	Below Seabed
cm	Centimetre
CMS	Caithness-Moray-Shetland HVDC Interconnector Project
CPT	Cone Penetration Test
DOC	Depth of Cover
DOL	Depth of Lowering
D_r	Relative Density
DWT	Dead Weight Tonnage
GS	Grab Sample
HDD	Horizontal Directional Drilling
HVDC	High Voltage Direct Current
km	Kilometre
kPa	Kilopascal
KP	Kilometre Point
kV	Kilo-Volt
LAT	Lowest Astronomical Tide
LT09	Caithness-Shetland Offshore HVDC Circuit (SSE Project Code)
LT21	Caithness-Moray Offshore HVDC Circuit (SSE Project Code)
m	Metre
MBR	Minimum Bend Radius
MCA	Maritime and Coastguard Agency
MAIB	Marine Accident Investigation Branch
mm	Millimetre
MMT	Marin Mätteknik AB
MSBL	Mean Seabed Level
MW	Mega-Watt
nm	Nautical Mile
Omega Joint	Offshore HVDC Cable Joint Location
PSD	Partial Size Distribution
RPL	Route Position List
SG	Specific Gravity
SHE Transmission	Scottish Hydro Electric Transmission Plc
SSE	Scottish and Southern Energy Plc
S_u	Undrained Shear Strength
Te	Metric Tonne
VC	Vibrocore
VMS	Vessel Monitoring System

Table of Contents

List of Appendices

List of Tables

List of Figures

1 Introduction

1.1 General Overview

Scottish Hydro Electric Transmission Plc (SHE Transmission), a part of the Scottish and Southern Energy Plc (SSE) group of companies, is planning to develop a High Voltage Direct Current (HVDC) transmission link between Shetland (Weisdale Voe), Caithness (Noss Head) and Moray (Portgordon), collectively known as the Caithness-Moray-Shetland (CMS) project.

In order to achieve the necessary electricity transmission system reinforcement currently required in the north of Scotland, the CMS project has been split into two distinct circuits: The Caithness-Moray (LT21) circuit and the Caithness-Shetland (LT09) circuit.

This report relates solely to the Caithness-Moray (LT21) offshore HVDC cable circuit, between Noss Head and Portgordon respectively.

1.2 Scope

As part of the Marine Licence application process for the Caithness-Moray (LT21) circuit, SHE Transmission has requested that LR Senergy prepare a Burial Risk Assessment report (this document) for the route, based on the existing datasets and studies, as well as the current understanding of the project methodology.

A key output of this study is the requirement to discharge Condition 31 d) of the Marine Licence, as described below:

"A burial risk assessment to ascertain if the burial depths can be achieved. In locations where this is not possible then suitable protection measures shall be provided in line with best industry practices and guidelines and with reference to Crown Estate FLOWW guidelines where they appropriately apply."

In addition, expected burial depths along the route are to be presented along with expected rock placement quantities, where required.

1.3 Marine Licence Application and Project Status

It is understood that two separate Marine Licence applications have been submitted to Marine Scotland for the offshore component of the Caithness-Moray (LT21) circuit. The first application covers the northern section of the offshore route, from Noss Head in Caithness to the proposed cable interface joint (Omega Joint) – See Section 3 for further details on route alignment. The second Marine Licence application covers the southern section of the route, from the Omega Joint to Portgordon in Moray.

The Marine Licence for the northern section was awarded and issued on 19th June 2013 (Licence Number 04368/13/0).

The Marine Licence for the southern section has been applied for and is currently under consideration.

The project secured funding from Ofgem in December 2014. Horizontal Directional Drilling (HDD) activities are expected to commence in January 2016, with the offshore cable installation works starting in January 2017.

2 Offshore HVDC Cable Circuit Properties

The Caithness-Moray (LT21) interconnector features a ±320kV 1,200MW HVDC subsea circuit from Noss Head to Portgordon. Three cables will emerge from separate HDD break-out ducts at each end of the route, at which point they will be bundled together. The cable bundle will consist of the following:

- 2 No. power cables (one positive pole and one negative pole) consisting of copper conductors with cross-linked polyethylene (XLPE) integral insulation, core screening, lead alloy sheath and steel wire armour.

- 1 No. fibre-optic cable for transmission network operational purposes only (i.e. no commercial traffic)

The nominal HVDC cable properties are presented in Table 1.

Caithness-Moray (LT21) HVDC Cable Properties	
Conductor Material	Copper
Conductor Cross-Sectional Area	2,200mm^2
Conductor Diameter	54.6mm
Single Cable Outside Diameter	132mm
Single Cable Minimum Bend Radius (MBR)	3m
Combined Cable Bundle Outside Diameter	270mm
Combined Cable Bundle MBR	3m
Weight of Cable Bundle	100kg/m (air)
	75kg/m (water)

Table 1: Nominal HVDC Cable Properties

Figure 1 and Figure 2 present a provisional visual representation of the overall cable bundle and the properties of the individual HVDC cables.

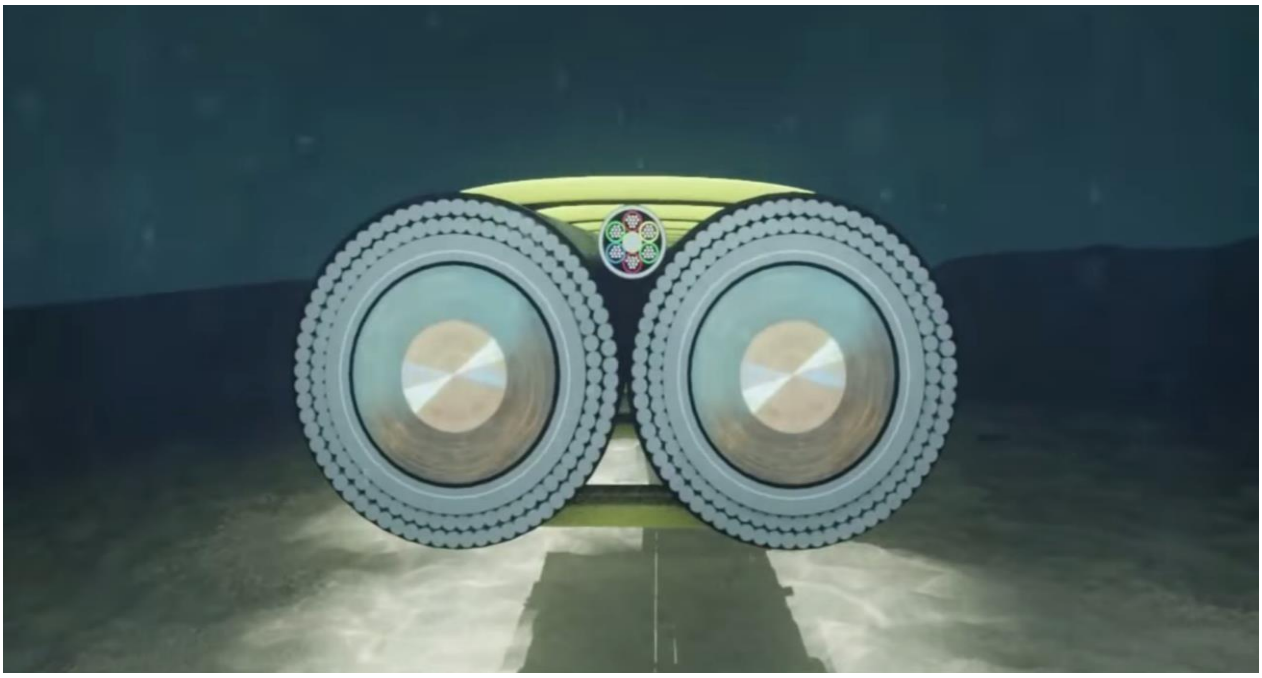

Figure 1: Overview of Caithness-Moray (LT21) Cable Bundle

Conductor	
Type / material	profiled strands / copper
Cross-section	2200 mm^2
Diameter	54.6 mm
Conductor screen	
Material	semi-conductive polymer
Thickness / Diameter	1.5 mm / 58.7 mm
Insulation	
Material	cross-linked DC polymer
Thickness / Diameter	20.0 mm / 98.7 mm
Insulation screen	
Material	semi-conductive polymer
Thickness / Diameter	1.4 mm / 101.5 mm
Longitudinal water barrier	
Material	swelling tape
Thickness / Diameter	0.6 mm / 102.7 mm
Metal sheath	
Type / material	extruded / lead alloy
Thickness / Diameter	2.9 mm / 108.5 mm
Inner sheath	
Type / material	extruded / HDPE
Thickness / Diameter	2.5 mm / 113.5 mm
Tensile armour	
Type / material	wire / galvanized steel
Thickness (wire diameter)	5 mm
Number of wires	69 pcs
Diameter	124.0 mm
Outer serving	
Type	polypropylene yarn, 2 layers
Thickness	4 mm
Complete cable	
Diameter	132 mm
Weight in air	49.4 kg/m
Weight in water	35.7 kg/m
	All values are nominal

Figure 2: Caithness-Moray (LT21) HVDC Cable Properties

3 Caithness-Moray Locations & Route Alignment

The Caithness-Moray (LT21) offshore HVDC circuit extends from Noss Head in Caithness to Portgordon in Moray – See Figure 3 for an overview of the landfall locations.

SHE Transmission has provided landfall Transition Jointing Pit (TJP) locations, as defined by the installation contractor, ABB AB (ABB), at Noss Head and Portgordon, as presented in Table 2 below (Ref. 2).

Co-ordinates: WGS84, UTM Zone 30N, Central Meridian 3° W					
Location	KP	Latitude	Longitude	Easting (m)	Northing (m)
Noss Head (Caithness)	0.000	58° 28' 01.81923" N	003° 03' 18.29274" W	496 786.70	6 480 725.10
Portgordon (Moray)	113.108	57° 39' 48.40000" N	003° 01' 54.20002" W	498 107.36	6 391 241.83

Table 2: Proposed Landfall TJP Locations

It is proposed that the cable transition from the onshore to the offshore section will be via HDD conduits at each end of the route. At Noss Head, the HDD offshore break-out point is expected to be approximately 0.7km from the onshore TJP location. At Portgordon, the offshore break-out location will be approximately 1.6km from the onshore location (Refs. 1 & 2). See Figure 4 and Figure 5 for an overview.

Based on ABB's latest installation methodology (Ref. 1) and information supplied regarding Kilometre Point (KP) and Route Position List (RPL) information (Ref. 2), HDD offshore break-out locations are shown in Table 3.

Co-ordinates: WGS84, UTM Zone 30N, Central Meridian 3° W					
Location	KP	Latitude	Longitude	Easting (m)	Northing (m)
Portgordon Offshore HDD Break-Out	1.578	57° 40' 39.4372" N	003° 01' 53.4752" W	498 120.11	6 392 820.11
Noss Head Offshore HDD Break-Out	112.451	58° 27' 47.63879" N	003° 02' 48.14834" W	497 274.88	6 480 286.16

Table 3: Proposed Offshore HDD Break-Out Locations

Originally, the route development was defined by a survey KP system (Refs. 3, 4 & 5), as laid out by [redacted] (MMT), based on a Survey Origin location at the conceptual Hub Platform location - note that the Hub Platform concept has now been discontinued. The location of the concept Hub Platform and therefore Survey Origin is shown in Table 4. For the purpose of this report, the new KP system developed by ABB is defined, starting at Portgordon (KP 0.000) and continuous along the entire route, ending at Noss Head (Ref. 2). The KP's in Tables 2 and 3, as well as all other KP's stated, are relative to this new system.

Appendix 1 presents ABB's continuous KP system (Ref. 2).

Co-ordinates: WGS84, UTM Zone 30N, Central Meridian 3° W			
Location	Approx. KP	Latitude	Longitude
Survey Origin / Hub Platform	77.696	58° 16.820' N	002° 38.363' W

Table 4: MMT Survey Origin Location (Based on Discontinued Hub Platform Concept Location)

The Caithness Moray offshore HVDC circuit will be installed in two sections, with a cable joint – hereafter referred to as the Omega Joint – to be located on the route between the Survey Origin and Portgordon.

ABB has stated a route point for the Omega Joint in their latest RPL (Ref. 2). This is shown in Table 5 and presented in Figure 6.

Co-ordinates: WGS84, UTM Zone 30N, Central Meridian 3° W					
Location	**KP**	**Latitude**	**Longitude**	**Easting (m)**	**Northing (m)**
Omega Joint	56.695	58° 06' 24.9541" N	002° 35' 44.2068" W	523 831.61	6 440 686.70

Table 5: Offshore HVDC Cable Omega Joint Location

Numerous phases of geophysical survey and associated geotechnical site investigation have been undertaken to date, relevant to the Caithness-Moray (LT21) route alignment. These are discussed in detail in Section 4 of this report but as previously discussed, various ABB and SHE Transmission documentation refer to the KP system developed by MMT during these surveys. To provide an overview of how the MMT developed KP's relate to locations along the cable route based on the new continuous KP system, please refer to Table 6.

Location	Approximate 'Continuous' KP	MMT Survey Phase (Year)
Hub Platform to Portgordon Survey Origin	77.696	2012
Hub Platform to Portgordon Survey Western Route End Point	7.205	2012
Hub Platform to Portgordon Survey Eastern Route End Point	7.480	2012
Portgordon Nearshore Survey Western Route Start Point	7.205	2008
Portgordon Nearshore Survey Western Route End Point	0.000	2008
Portgordon Nearshore Survey Eastern Route Start Point	7.480	2008
Portgordon Nearshore Survey Eastern Route End Point	0.000	2008
Hub Platform to Noss Head Survey Origin	77.696	2010
Hub Platform to Noss Head Survey North Route End Point	111.895	2010
Hub Platform to Noss Head Survey Centre Route End Point	111.895	2010
Hub Platform to Noss Head Survey South Route End Point	111.895	2010
Noss Head Nearshore Survey Start Point	111.895	2012
Noss Head Nearshore Survey End Point	112.571	2012

Table 6: Key Approximate MMT Survey Locations in Continuous Caithness-Moray Route KP System

ABB's latest RPL (Ref. 2) between the Portgordon and Noss Head offshore HDD break-out points will generally follow the MMT 2012 survey 'west' and 2010 survey 'centre' routes, with various deviations as necessary. Figures 4 and 5 show examples of both the MMT survey alignments and the engineered ABB cable route.

For completeness, SHE Transmission has provided RPL's for both the MMT survey Hub Platform to Portgordon 'west' route and Hub Platform to Noss Head 'centre' route, which are attached as Appendix 2 and Appendix 3, respectively, to this document.

4 Survey and Geotechnical Datasets

4.1 Summary of Survey Phases

Numerous survey phases, which have also included geotechnical sampling operations, have been undertaken as part of the CMS project to date. Those which are relevant to the current Caithness-Moray (LT21) route are detailed in Table 7.

Survey Contractor	Contractor Reference	Year	Route	*Relevance to Caithness-Moray Circuit*
MMT	100364	2008	Shetland to Moray	*Nearshore section at Portgordon*
MMT	100711	2010	Hub Platform to Caithness (Noss Head)	*Survey Route from Hub to Noss Head*
MMT	101044	2012	Hub Platform to Moray (Portgordon)	*Survey Route from Hub to Portgordon*

Table 7: Overview of Survey Phases Completed to Date

The various route corridors associated with these survey phases are presented in Figure 7.

The following sections detail the various survey phases in more detail.

4.2 MMT 2008: Shetland to Moray Survey

MMT was commissioned in 2008 by SHE Transmission to undertake a geophysical, geotechnical and environmental cable route survey between Shetland and the Scottish Mainland at Portgordon in Moray (Ref. 3). This survey reflected, at that time, the proposed HVDC interconnector route, which has now been superseded by the CMS project which includes the Caithness-Moray (LT21) circuit.

The survey was performed in 2008 with a key aim to establish the seabed topography, as well as identify and map potential geological features, man-made objects, shallow soils and environmental constraints. The proposed route was surveyed using a combination of multibeam echo sounder, side scan sonar, sub-bottom profiler, magnetometer and environmental sampling equipment. The geotechnical programme comprised the acquisition of both vibrocore and sediment grab samples. However, it should be noted that the coverage / location of this data, relative to the currently defined Caithness-Moray (LT21) circuit, is only relevant to approximately 7.2km, heading offshore from the Portgordon landfall, with only two vibrocores applicable to the new route. Key points relating to this survey are summarised as follows:

- As mentioned in Section 3, within the survey corridor an eastern and a western alignment were defined.
- 2no. vibrocore samples were obtained that are relevant to the current Caithness-Moray (LT21) route:
  - F-E5-001-VC: located at approximately KP 7.100, approaching Portgordon.
  - F-W4-023-VC: located at approximately KP 78.100, near the discontinued Hub Platform location.
- No CPTs were undertaken as part of the survey programme.
- A very limited quantity of laboratory tests were performed on recovered samples.
- No vibrocore samples were retained for future laboratory testing.

MMT reported the survey in three volumes. Volumes 1 and 2 comprised the results of the offshore survey (Western & Eastern Route Options) whilst Volume 3 comprised the results of the nearshore surveys, including the landing options at Portgordon and Shetland (Ref. 3).

4.3 MMT 2010: Hub Platform to Noss Head Survey

MMT was commissioned in 2009 by SHE Transmission to undertake a geophysical, geotechnical and environmental cable route survey between the proposed Hub Platform location and the Caithness Coast. Note that this included landfalls at Noss Head (as per current route alignment) and Sinclair's Bay (now discounted) in Caithness.

The survey was performed in 2010 and the aim was to establish the seabed topography and identify / map potential geological features, man-made objects, shallow soils and environmental constraints. The proposed route was surveyed using a combination of multibeam echo sounder, side scan sonar, sub-bottom profiler, magnetometer and environmental equipment.

Within the survey route corridor, three alignments were defined: north (starboard), centre and south (port).

The geotechnical programme comprised the acquisition of both vibrocore and sediment grab samples:

- 7no. vibrocores were acquired along the proposed Hub Platform to Noss Head route.
- No CPT's were undertaken as part of the survey programme.
- 6no. grab samples were acquired in the nearshore section at Noss Head.
- A limited number of standard tests were performed on recovered samples.
- No samples were retained for future laboratory testing.

MMT's report Volume 1 (Ref. 4) comprises the results of the offshore and nearshore survey between the proposed Hub Platform and Noss Head.

4.4 MMT 2012: Hub Platform to Portgordon Survey

A further survey based on the Hub Platform to Portgordon route section, additional to that undertaken by MMT during 2008, became necessary due to Round 3 offshore wind farm license agreements in the Moray Firth. The previous Hub Platform to Portgordon alignment ran through the proposed Moray Offshore Wind Farm site. The purpose of the MMT 2012 survey was to re-route a section of the cable east around the wind farm site, but west of the in-service SHEFA telecommunications cable, joining the proposed Hub Platform location to Portgordon. This new route corridor is highlighted in Figure 7.

MMT was commissioned in 2011 by SHE transmission to undertake the survey, comprising the acquisition of geophysical, geotechnical and environmental data (Ref. 5).

The new survey between the Hub Platform and Portgordon was performed during 2012, the aim of which was to establish the seabed topography and identify / map potential geological features, man-made objects, shallow soils and environmental constraints that may have the potential to influence the installation and / or operation of the HVDC cable. The proposed route was surveyed using a combination of multibeam echo sounder, side scan sonar, sub-bottom profiler magnetometer, and environmental equipment.

As with the 2008 survey, within the survey route corridor there were two alignments defined: east and west.

The geotechnical programme comprised the acquisition of vibrocores, CPT's and box core sediment samples, summarised as follows:

- 68no. vibrocore samples and 2no. box cores were acquired at seventy locations along the survey route corridor, distributed along the eastern and western alignments in a staggered manor at separations of approximately 1km.
    - 35no. vibrocore samples, 15no. CPT's and 1no. box core were acquired along the western route.
    - 33no. vibrocore samples, 20no. CPTs and 1no. box core were acquired along the eastern route.
- All in-situ tests were logged. Note that very limited testing was performed on the recovered samples.
- It is understood that no samples were retained to facilitate future laboratory testing.

In addition to the aforementioned data acquisition for the Hub Platform to Portgordon route section, during the 2012 campaign a detailed resurvey of the Noss landfall approach was undertaken – as shown in Figure 7.

MMT reported the survey works in numerous volumes (Ref. 5). Volumes 1 and 2 comprise the results of the offshore survey for the Hub Platform to Portgordon, Western & Eastern Route Options respectively. Volume 4 comprises the results of the nearshore re-survey at Noss Head.

5 Analysis of Geophysical and Geotechnical Survey Data

The following sections detail LR Senergy's analysis of the acquired survey datasets, detailing the interpreted route seabed and shallow sub-seabed conditions.

The presentation of this information has been divided into individual sections relevant to the Portgordon to Hub Platform section (KP 0.000 to 77.696) and the Hub Platform to Noss Head section (KP 77.696 to KP 112.571) of the Caithness-Moray (LT21) circuit.

The survey data alignment KP points presented were originally converted from MMT's survey system to a continuous system (commencing at Portgordon) during a previous revision of this report (Rev. 1). Within this revision (Rev. 2), updates have been applied where appropriate, based on consideration given to the overall data accuracy and the correlation between the survey route alignments and ABB's engineered RPL (Ref. 2)).

5.1 Portgordon to Hub Platform Route Section

5.1.1 Geophysical Data Analysis

Bathymetry and side scan sonar data for the offshore route (KP 7.205 to KP 77.696) were acquired during the MMT 2012 geophysical survey (Ref. 5). Bathymetry and side scan sonar data within the Portgordon nearshore zone (KP 0.000 to KP 7.205) were acquired during the MMT 2008 geophysical survey (Ref. 3).

Sections 5.1.1.1 to 5.1.1.2 discuss the bathymetry and seabed features along the Portgordon to Hub Platform route section.

Interpretation of the bathymetry and side scan data is summarised in Table 8 – note that this is presented based on route soil zones, as discussed in the geotechnical: Section 5.1.2. The table presents the minimum and maximum water depths and seabed gradient along the specific route section, as well as the seabed features that have been recorded.

It should be noted the terms used by MMT to describe seabed conditions, such as "rough", are not clearly defined within the survey reports. The use of these terms has not been amended by LR Senergy.

Analysis of the sub-bottom geophysical data for the Portgordon to Hub Platform route section is presented in Table 12.

5.1.1.1 Bathymetry

The water depth along the Portgordon to Hub Platform route section ranges from -6.0m Lowest Astronomical Tide (LAT) at KP 0.000 at Portgordon to 52.6m LAT at the Hub Platform (KP 77.696).

Starting from the Survey Origin / Hub Platform location, the water depth increases from 52.6m LAT at KP 77.696 to 73.7m LAT at KP 41.090, with a general gradient of less than 2°, peaking at 2.6° at KP 61.290 along this particular section. Between approximately KP 71.690 and KP 61.690, the seafloor is gently undulating with water depths ranging between 50.0m LAT and 55.0m LAT. The water depth then increases to 95.5m LAT at around KP 29.690 (there is a localised peak depth of 99.3m LAT associated with a feature at KP 29.690), undulating between 75.0m LAT and 95.0m LAT between KP 29.690 and KP 22.690, with a seabed gradient generally less than 2°. From KP 22.690, the water depth decreases with descending KP, reaching -6.0m LAT at KP 0.000, with 10.0m LAT being recorded at approximately KP 3.170 and 0.0m LAT at approximately KP 0.630. The gradient is generally less than 2° with the maximum gradient of 3.7° along the route recorded at KP 12.290.

5.1.1.2 Seabed Features

Generally the seabed is smooth and featureless between Portgordon and the Hub Platform, with the following notable exceptions:

- The seabed is relatively rough (Ref. 5) and uneven between KP 71.690 and KP 77.696, compared to the rest of the route.
- An area with minor irregularities (Ref. 5), i.e. seabed ripples, is located between KP 59.690 and KP 61.690. These features extend approximately 0.5m above the surrounding seafloor. Similar features are also located at KP 54.690.
- A wreck is located at approximately 180m offset from the route, close to KP 42.690.
- East of KP 41.090, a depression with a diameter of 70m and a depth of 0.7m is located. The centre of the depression is located about 60m offset from the route.
- A mound (Ref. 5), peaking at approximately 14m above surrounding seabed, is located close to KP 29.690.
- Between KP 7.690 and KP 17.690, the seafloor is relatively rough and uneven. A feature, with shallow gradient to its edges runs perpendicular to the route, rising around 0.5m from the surrounding seabed.
- Areas of boulders are located at various sections along the route (Ref. 5). Notable areas of boulders located along the route are as follows:
    - KP 7.390 to KP 9.190.
    - KP 16.190 to KP 18.290.
    - KP 66.490 to KP 67.690.
    - KP 71.190 to KP 74.590.
    - KP 75.390 to KP 76.090.
- Trawl marks are noted at seabed at numerous route locations, most notably between KP 23.890 and KP 37.690, as well as instances between KP 10.690 and KP 17.090.

5.1.1.3 Existing Infrastructure

No existing infrastructure is crossed along the current alignment of the Portgordon to Hub Platform route section of the Caithness-Moray (LT21) offshore HVDC circuit route. However, the SHEFA cable does run parallel to the east edge of route corridor for approximately 9km, between KP 60.690 and KP 69.690.

Soil Zone	KP (From)	KP (To)	Minimum Water Depth (m LAT)	Maximum Water Depth (m LAT)	Seabed Gradient (°)	Seabed Description
PG1	0.000 (Portgordon)	9.190	22.9	-6.0	Less than 2°	The seabed is relatively rough and uneven along this part of the route. Boulders are indicated on the alignment sheets between KP 7.390 and KP 9.190.
PG2	9.190	20.990	85.0	22.9	Generally less than 2° with a max. of 3.7° at KP 12.290	The seabed is relatively rough and uneven along this part of the route. Boulders are indicated on the alignment sheets between KP 16.190 and KP 18.290.
PG3	20.990	41.190	73.7	99.3	Less than 2°	A mound approximately 14m high above surrounding seabed is located close to KP 29.690, with an associated deep of 99.3m LAT. East of KP 41.090, a depression with a diameter of 70m and a depth of 0.7m is located. Surrounding water depth is approximately 73.7m. The seabed is generally smooth and featureless.
PG4	41.190	77.696 (Hub)	51.7	73.7	Generally less than 2° with a max. of 2.6° at KP 61.290	A wreck is located at approx. 180m from the route, close to KP 42.690. From the Hub Platform at KP 77.696 to KP 71.690 the seabed is relatively rough and uneven when compared to the rest of the route. Between KP 61.690 and KP 71.690 the seabed is gently undulating with depths between 50.0m LAT and 55.0m LAT. The seabed is relatively featureless and smooth. An area with minor irregularities (ripples) is located between KP 59.690 and KP 61.690. These features extend approximately 0.5m above the surrounding seafloor. Similar features are also located at KP 54.690. Boulders are indicated on the route alignment sheets between KP 66.490 to KP 67.690, KP 71.190 to KP 74.590 and KP 75.390 to KP 76.090.

Table 8: Bathymetric Data Summary – Portgordon to Hub Platform Route Section

5.1.2 Geotechnical Data Analysis

Geotechnical samples within the Portgordon to Hub Platform offshore zone (KP 7.205 to KP 77.696) were collected during the MMT 2012 survey (Ref. 5). In total, 68no. vibrocores, 35no. CPT's and 2no. box cores were acquired.

The distribution of these vibrocore samples acquired equates to approximately 1km separation along the survey corridor, although data gaps at three locations (approximately KP 12.690 to KP 14.490, KP 55.490 to KP 74.990, and KP 73.690 to KP 74.890) extend to between 1,500m and 1,800m. The CPT's are distributed along the whole 2012 survey route, although there are numerous occurrences of extended gaps between each test of approximately 2,500m.

All of the vibrocore tests acquired during the MMT 2012 survey achieved recoveries of at least 1.5m and all but four achieved recoveries in excess of 2.0m. All of the CPT's achieved a minimum penetration of at least 1.99m.

To date, only one vibrocore sample has been acquired along the nearshore Portgordon section of the route (KP 0.000 to KP 7.205). This was acquired during the MMT 2008 survey phase and the vibrocore is identified as F-E5-001-VC, located at approximately KP 7.100. A recovery of 3.0m was achieved.

In addition, one further vibrocore from the MMT 2008 survey is also relevant to this route section, being located close to the Hub Platform location at KP 77.696. This vibrocore is identified as F-W4-023-VC and achieved 3.0m recovery.

Geotechnical locations are presented in Figures 8 and 9 for the Portgordon to Hub Platform route section.

It is evident from examining the geotechnical datasets that an extremely limited quantity of laboratory testing was undertaken on the acquired vibrocore samples. In particular, there is a lack of classification testing, such as particle size distribution (PSD) tests. Furthermore, it is understood that none of the samples were retained for future testing. The geotechnical analysis therefore relies somewhat disproportionately on the visual descriptions presented on the field logs, particularly for cohesionless soils and the associated fines content. Fines content can have a significant impact on trenching performance and therefore this lack of PSD data is highlighted again (Ref. 6) by LR Senergy as presenting a risk to the project.

LR Senergy has completed an interpretation of the route section shallow soils (within top 2m below seabed), based on the vibrocore log descriptions and CPT's, with due consideration given to the associated geophysical data presented on the survey alignment sheets – note that further information on the geophysical results is presented in Table 12.

Table 11 presents a summary of the route soil conditions between Portgordon (KP 0.000) and the Hub Platform (KP 77.696). The results have enabled this route section to be split into four zones, noting that the actual transition between these zones will in all likelihood be gradual. Approximated ranges of key soil parameters – Relative Density (D_r) for cohesionless soils and Undrained Shear Strength (S_u) for cohesive soils - are also presented, based on the limited laboratory data available.

For reference, a summary of the terms applied to D_r and S_u are presented in Table 9 and Table 10, respectively.

The Portgordon to Hub Platform route section soil zones (i.e. PG1 to PG4) are presented in Figure 10.

Term	D_r: Relative Density (%)
Very Loose	0 – 15
Loose	15 – 35
Medium Dense	35 – 65
Dense	65 – 85
Very Dense	85 - 100

Table 9: Ranges of Relative Density for Cohesionless Soils (Lambe and Whitman, 1969)

Term	S_u: Undrained Shear Strength (kPa)
Very Soft	0 – 20
Soft	20 – 40
Firm	40 – 75
Stiff	75 – 150
Very Stiff	150 – 300
Hard	> 300

Table 10: Ranges of Undrained Shear Strength for Cohesive Soils (BS 5930:1999)

Soil Zone	KP (From)	KP (To)	Route Zone Length (km)	Depth From (m BSB)	Depth To (m BSB)	General Soil Description	Dominant Soil Type	Typical Range	
								D_r	S_u (kPa)
PG1	0.000 (Portgordon)	9.190	9.1	0.00	2.00	Sandy GRAVEL and SAND	GRAVEL	Dense	-
PG2	9.190	20.990	11.8	0.00	2.00	Loose to dense gravelly medium to coarse SAND and sandy GRAVEL. Occasional thick laminations of gravelly clay	SAND	Loose to Dense	-
PG3	20.990	41.190	20.2	0.00	2.00	Very soft to soft silty CLAY and clayey SILT	CLAY	-	2 - 24
PG4	41.190	77.696 (Hub)	36.5	0.00	0.70 - 1.35	Loose to dense gravelly fine to medium SAND and sandy GRAVEL	SAND	Loose to Dense	-
				0.70 - 1.35	2.00	Very soft to firm sandy SILT and sandy silty CLAY	SILT / CLAY	-	4 - 40

Table 11: Geotechnical Data Summary and Soil Zones – Portgordon to Hub Platform Route Section

Soil Zone	KP (From)	KP (To)	Route Zone Length (km)	Geotechnical Data	Seabed Features and Bathymetry	Soil Description *(based on Geotechnical Data)*	Soil Description *(based on Geophysical data)*	Comments
PG1	0.000 (Portgordon)	9.190	9.2	F-E5-001-VC 101044-BC-201	The seabed ascends gently towards landfall. Gradient is less than 2°. Water depth is 22.9m LAT at KP 9.190 and recorded as -6.0m LAT at KP 0.000. The 10m LAT contour is located at approximately KP 2.890. Boulders are indicated on the alignment sheets between KP 7.390 and KP 9.190.	Sandy GRAVEL and SAND.	Seabed sediments generally comprise sandy GRAVEL.	Limited geotechnical data in this zone (1no. VC and 1no. BC).
PG2	9.190	20.990	11.8	101044-VC-057, VC-058, VC-059, VC-060, VC-061, VC-062, VC-063, VC-064, VC-065, VC-066, VC-067, VC-068 101044-BC-200 101044-CPT-128, CPT-129, CPT-130, CPT-131, CPT-132, CPT-133, CPT-134	Water depth decreases from approximately 85.0m LAT at KP 20.690 to 22.9m LAT at KP 9.190. The seabed is smooth without any outstanding features between KP 18.290 and KP 20.990. Between KP 16.190 and KP 18.290, numerous boulders are present. From KP 17.690 heading towards Portgordon, the seafloor is relatively rough and uneven. A gentle feature with low edges, perpendicular to the route, rising around 0.5m from the surrounding seabed, is located here. Seabed gradient is generally less than 2°, with a maximum of 3.7° at KP 12.290. Trawl marks present between KP 15.390 and KP 17.090.	Loose to dense gravelly medium to coarse SAND and sandy GRAVEL. Gravel is medium to coarse. Occasional thick laminations of gravelly clay and thick beds of fine sand.	From KP 11.190 to KP 20.990, gravelly SAND dominates. Sandy GRAVEL with possible soft fine grained sediment dominates from KP 11.190 towards Portgordon, with areas of “DIAMICTON” recorded between KP 10.690 and KP 8.690.	VC-060, VC-061 and VC-067 – Silt and clay dominated profile. S_u = 82kPa and 100kPa recorded in VC-061. S_u = 68kPa to 110kPa recorded in VC-067.

Soil Zone	KP (From)	KP (To)	Route Zone Length (km)	Geotechnical Data	Seabed Features and Bathymetry	Soil Description *(based on Geotechnical Data)*	Soil Description *(based on Geophysical data)*	Comments
PG3	20.990	41.190	20.2	101044-VC-036, VC-037, VC-038, VC-039, VC-040, VC-041, VC-042, VC-043, VC-044, VC-045, VC-046, VC-047, VC-048, VC-049, VC-050, VC-051, VC-052, VC-053, VC-054, VC-055, VC-056 101044-CPT-117, CPT-118, CPT-119, CPT-120, CPT-121, CPT-122, CPT-123, CPT-124, CPT-125, CPT-126, CPT-127	Water depth increases from 73.7m LAT at KP 41.190 to approximately 95.0m LAT at KP 22.690. A localised deep of 99.3m LAT is located close to KP 29.690. From KP 22.690, water depth starts to decrease as the route heads to Portgordon. 60m east of KP 41.090, a depression with a diameter of 70m and a depth of 0.7m is located. A mound, approximately 14m high above surrounding seabed, is located close to KP 29.690. This has been interpreted as clay overlying a hard acoustic unit (potentially bedrock). Trawl marks are present between KP 23.890 and KP 37.690. Seabed gradient is less than 2°.	Very soft to soft silty CLAY and clayey SILT with occasional medium gravel-sized shell fragments.	From KP 21.690 to KP 41.190 the sediment is soft fine grained sediments noted as clay and silt on the alignment sheets. Bedrock interpreted to be encountered at a shallower depth (potentially <2.0m) around KP 29.690.	Locally gravelly CLAY around VC-044 and VC-51 to VC54.

Soil Zone	KP (From)	KP (To)	Route Zone Length (km)	Geotechnical Data	Seabed Features and Bathymetry	Soil Description *(based on Geotechnical Data)*	Soil Description *(based on Geophysical data)*	Comments
PG4	41.190	77.696 (Hub)	36.5	101044-VC-001, VC-002, VC-003, VC-004, VC-005, VC-006, VC-007, VC-008, VC-009, VC-010, VC-011, VC-012, VC-013, VC-014, VC-015, VC-016, VC-017, VC-018, VC-019, VC-020, VC-021, VC-022, VC-023, VC-024, VC-025, VC-026, VC-027, VC-028, VC-029, VC-030, VC-031, VC-032, VC-033, VC-034, VC-035 F-W4-023-VC 101044-CPT-100, CPT-101, CPT-102, CPT-103, CPT-104, CPT-105, CPT-106, CPT-107, CPT-108, CPT-109, CPT-110, CPT-111, CPT-112, CPT-113, CPT-114, CPT-115, CPT-116	From the Hub (KP 77.696) to KP 71.690 the seafloor is relatively rough and uneven compared to the rest of the zone. Water depth gently increases from 52.6m LAT at KP 77.696 to 55.0m LAT at KP 71.690. Depressions with diameters of approximately 10m and mounds around 0.5m above surrounding seabed can be found along the route. Between KP 71.690 and KP 61.690 the seafloor is gently undulating with water depths between 50.0m LAT and 55.0m LAT. The seafloor is relatively featureless and smooth. From KP 61.690 to KP 41.190, the water depth increases with decreasing KP, from 53.7m LAT at KP 61.690 to 73.7m LAT at KP 41.190. An area of ripples is located between KP 59.690 and KP 61.690. These features extend approximately 0.5m above the surrounding seabed. Similar features also located at KP 54.690. Seabed gradient is generally less than 2°, with a maximum of 2.6° at KP 61.290, on a well-defined edge. Boulders are indicated on the alignment sheets between KP 66.490 to KP 67.690, KP 71.190 to KP 74.590 and KP 75.390 to KP 77.390. A wreck is located 180m offset from the route at KP 42.690.	Loose to dense fine to medium gravelly SAND and sandy GRAVEL (gravel is medium to coarse with many shell fragments), overlaying very soft to firm sandy SILT and sandy silty CLAY with occasional gravel and shell fragments.	The surface sediment from the beginning of the survey route at KP 77.696 consist of gravelly SAND / sandy GRAVEL with localised occurrences of fine sediment. SAND dominates from KP 77.696 to ~KP 41.190. This surface unit thickness varies from approximately 0.5m to 2.0m. Ripples and occasional boulders are present. Shallow geology notes that the surface sediments of SAND and GRAVEL overlie silt and clay with localised diamicton.	VC-004 - 1.20m 180kPa Clay – Test potentially influenced by gravel and silt content. VC-031 - Interbedded clay and gravel. VC-035 – Transition zone – VC shows silt profile within top 2.0m.

Table 12: Geophysical and Geotechnical Survey Data Analysis – Portgordon to Hub Platform Route Section

5.2 Hub Platform to Noss Head Route Section

5.2.1 Geophysical Data Analysis

Bathymetry and side scan sonar data was acquired along the Hub Platform to Noss Head route section (KP 77.696 to KP 112.571) of the Caithness-Moray (LT21) circuit during the MMT 2010 survey (Ref. 4). In addition, further nearshore Noss Head survey data was acquired as part of the MMT 2012 survey programme (Ref. 5).

Sections 5.2.1.1 and 5.2.1.2 discuss the bathymetry and seabed features along Hub Platform to Noss Head route section.

The geophysical data presented by MMT is summarised in Table 13. The table presents the minimum and maximum water depths and seabed gradient along the specific route section, as well as the seabed features that have been recorded.

A further detailed breakdown of the survey data analysis is presented in Table 15.

Please refer to Section 5.1.1 regarding terminology used by MMT to describe seabed features.

5.2.1.1 Bathymetry

The water depth along the Hub Platform to Noss Head route section gently increases from approximately 52.0m LAT at KP 77.696 to 54.5m at KP 84.490. The seabed is relatively flat along this section with a gradient generally less than 1°. Between KP 84.490 and KP 86.190, the seabed is slightly rougher, with a gradient generally between 1° and 2°, peaking at 2.5° at KP 85.196. Average water depth is approximately 54.0m LAT.

Water depth then tends to increase, although the seabed undulates slightly, reaching 63.5m LAT at KP 91.690 and 65.0m LAT between KP 95.690 and KP 96.690, where localised gradients of up to 3.1° are also witnessed. A maximum water depth of 67.0m LAT is present close to KP 102.690.

Water depth generally decreases as the Noss Head landfall is approached, with a water depth of 25.8m LAT at KP 111.895, at the end of the 2010 survey centre route alignment. A maximum gradient of 4.7° and localised maximum water depth of 67.0m LAT is witnessed along this final section close to KP 109.000. Water depth estimated as 21.0m at the Noss Head offshore break-out point, based on the 2012 nearshore survey chart.

5.2.1.2 Seabed Features

Generally the seabed is smooth and featureless along the Hub Platform to Noss Head north alignment, especially when compared to the centre and south alignments.

The following features are noted:

- A 4m deep depression below mean seabed level is found between KP 94.690 and KP 96.690, corresponding with the increase in water depth noted in Section 5.2.1.1.
- Sand ripples are present between KP 92.690 and KP 96.690 and KP 99.690 and KP 104.690.
- A depression at KP 102.690 is associated with the maximum water depth witnessed along the route section.
- A 6m high prolonged sand wave runs parallel to the survey centre alignment at KP 104.690. Between KP 106.690 and KP 109.190, a prolonged sandwave runs parallel to the survey route. This section of the route also features ripples and sandwaves. The cable route has been engineered to skirt these features.

- Areas of boulders are located at various sections along the route corridor, noted as follows:
  - KP 78.690 to KP 79.990.
  - KP 81.290 to KP 81.890.
  - KP 107.690 to KP 110.690.

5.2.1.3 Existing Infrastructure

No existing infrastructure is known to cross the Hub Platform to Noss Head route section.

Soil Zone	KP (From)	KP (To)	Minimum Water Depth (m LAT)	Maximum Water Depth (m LAT)	Seabed Gradient (°)	Seabed Description
NH1	77.696 (Hub)	84.490	52.0	55.0	Generally less than 1°	Seabed is generally flat and featureless in this zone. Boulders are indicated on the alignment sheets between KP 78.690 to KP 79.990 and KP 81.290 to KP 81.890.
NH2	84.490	92.490	54.0	63.5	Generally less than 2° but a local peak of 2.5°	The seabed is slightly rougher between KP 84.490 and KP 86.190, with a gradient generally between 1° and 2°. From KP 86.190, the seabed undulates slightly, with shallow gradients (less than 1°).
NH3	92.490	110.180	47.0	67.0	Generally less than 2° but up to a maximum of 3.5°	A 4.0m deep depression is found between KP 94.690 and KP 96.690. Sand ripples between KP 96.690 and KP 96.690, as well as between KP 99.690 and KP 104.690. A depression around KP 102.690 is associated with the maximum water depth along the route. At KP 104.690, a sand wave 6m above surrounding seabed runs parallel to the survey centre alignment. A section with ripples and sandwaves follows between KP 106.690 and KP 109.190 as well as a prolonged sandwave running parallel to the survey alignment along this section. Cable route engineering avoids these features. Boulders are indicated on the alignment sheets from KP 107.690.
NH4	110.180	112.571 (Noss Head)	~21.0	50.5	Less than 3°	Boulders are indicated to approximately KP 110.690. Biological reflectivity noted on the alignment charts – likely associated with the Horse Mussel bed. Water depth decreasing to 25.8m based on the 2010 survey alignments end point. Water depth at HDD break-out location approximately 21.0m LAT based on 2012 nearshore survey chart.

Table 13: Bathymetric Data Summary – Hub Platform to Noss Head Route Section

5.2.2 Geotechnical Data Analysis

A limited number of geotechnical samples were collected during the MMT 2010 survey (Ref. 4). No CPT data has been acquired to date.

Seven vibrocores were acquired along the Hub Platform to Noss Head route section. However, it is noted that no data was acquired between KP 77.696 and KP 94.890.

The seven vibrocores that were acquired between KP 94.890 and KP 110.070 were done so at a variable spacing of between approximately 650m and 4.0km.

Vibrocore 100711-VC-0311A achieved 0.68m recovery whilst all other vibrocores achieved at least 2.0m.

A total of six sediment grab samples (GS) were also acquired in the nearshore section at Noss Head during the 2010 survey.

Geotechnical locations are presented in Figures 11 and 12 for the Hub Platform to Noss Head route section.

As with the MMT 2012 survey between the Hub Platform and Portgordon (see Section 5.2.1), only very limited laboratory testing of the 2010 Hub to Noss Head vibrocore samples has been undertaken and again it is understood that none of the samples have been retained for any further testing.

As vibrocores were not obtained along the majority of the Noss Head route section, the current level of geotechnical data is not suitable to accurately define the soil conditions along its entire length. The lack of laboratory test data presents an increased risk of adverse soil conditions and plough behaviour being experienced during installation.

It should be noted that the MMT survey report describes certain soils as “Diamicton”. In LR Senergy’s experience, use of this term within the survey industry is unique to MMT and whilst arguably geologically correct it is a very much a ‘catch all’ phrase, defined by MMT as a ‘very poorly sorted sediment containing different fractions of sediment from clay to fragments of rock and shells’. From an installation assessment perspective, this term is not especially helpful as it provides no real insight into the nature and / or properties of the seabed.

Based on LR Senergy’s analysis of the datasets, the Hub Platform to Noss Head route section has been split into four soil zones. Vibrocore data has been used were available (i.e. from KP 94.890). For the first section of the route (KP 77.696 to KP 94.890), there is no geotechnical data currently available to correlate the geophysical data against and the interpretation presented in Table 14 has been based on the survey alignment sheets. As such, there is difficulty in accurately estimated where soil layer boundaries may occur.

Geotechnical parameters have been estimated based on the available data but due to the limited quantity, should be independently reviewed by any end user rather than adopted verbatim.

Table 14 summarises the soil conditions along Hub Platform to Noss Head (KP 77.696 to KP 112.571) route section.

Please refer to Table 9 and Table 10 for information on divisions of Relative Density and Undrained Shear Strength.

The Hub Platform to Noss Head route section soil zones (i.e. NH1 to NH4) are presented in Figure 13.

Soil Zone	KP (From)	KP (To)	Route Zone Length (km)	Depth From (m BSB)	Depth To (m BSB)	General Soil Description	Dominant Soil Type	Typical Range	
								D_r	S_u (kPa)
NH1	77.696 (Hub)	84.490	6.8	0.0	2.0	Sandy GRAVEL with localised clayey SAND	GRAVEL	*No Data*	-
NH2	84.490	92.490	8.0	0.0	2.0	Silty CLAY overlying sandy GRAVEL	CLAY	*No Data*	*No Data*
NH3	92.490	110.180	17.7	0.0	2.0	Sandy GRAVEL	GRAVEL	*No Data*	-
NH4	110.180	112.571 (Noss Head)	2.4	0.0	2.0	Sandy GRAVEL and SAND overlying DIAMICTON Locally BEDROCK at surface	GRAVEL and BEDROCK	*No Data*	-

Table 14: Geotechnical Data Summary and Soil Zones – Hub Platform to Noss Head Route Section

Soil Zone	KP (From)	KP (To)	Route Zone Length (km)	Geotechnical Data	Seabed Features and Bathymetry	Soil Description *(based on Geotechnical Data)*	Soil Description *(based on Geophysical data)*	Comments
NH1	77.696 (Hub)	84.490	6.8	*No Data*	Seabed is generally flat and featureless in this zone. Boulders are indicated on the alignment sheets between KP 78.690 to KP 79.990 and KP 81.290 to KP 81.890.	*No Data*	Sandy GRAVEL with localised clayey SAND	Potential variability in soil layer thickness
NH2	84.490	92.490	8.0	*No Data*	The seabed is slightly rougher between KP 84.490 and KP 86.190, with a gradient generally between 1° and 2°. From KP 86.190, the seabed undulates slightly, with shallow gradients (less than 1°).	*No Data*	Silty CLAY overlying sandy GRAVEL	Potential variability in soil layer thickness
NH3	92.490	110.180	17.7	100711-VC-0305, VC-0306, VC-0307, VC-0308, VC-0309, VC-0310, VC-0311A	A 4.0m deep depression is found between KP 94.690 and KP 96.690. Sand ripples between KP 94.690 and KP 96.690, as well as between KP 99.690 and KP 104.690. A depression around KP 102.690 is associated with the maximum water depth along the route. At KP 104.690, a sand wave 6m above surrounding seabed runs parallel to the survey centre alignment. A section with ripples and sandwaves follows between KP 106.690 and KP 109.190 as well as a prolonged sandwave running parallel to the survey centre alignment along this section. Boulders are indicated on the alignment sheets from KP 107.690.	Sandy GRAVEL	Sandy GRAVEL with underlying DIAMICTON	-
NH4	110.180	112.571 (Noss Head)	2.4	GS-NN4, GS_NN5, GS_NN6, GG_NS7, GS_NS8, GS_NS9	Boulders are indicated to approximately KP 110.690. Biological reflectivity noted on the alignment charts - likely associated with the Horse Mussel bed. Water depth decreasing to 21.0m at HDD.	*No Data*	Sandy GRAVEL and SAND overlying DIAMICTON Locally BEDROCK at surface	Soils based on survey data – negligible grab sample recovery

Table 15: Geophysical and Geotechnical Survey Data Analysis - Hub Platform to Noss Head Route Section

6 Standard Trenching Terminology

Within the subsea cable and trenching industry, there is commonly much confusion as to what precisely is meant by the term ‘burial’. For the purposes of this report, the following definitions are applicable:

- Burial – generic term used to describe the activity of cable trenching
- Depth of Lowering (DOL) – the vertical distance between the top of the cable and MSBL
- Depth of Cover (DOC) – the vertical distance between the top of cable and seabed directly above the cable following final trenching pass
- Mean Seabed Level (MSBL) – the elevation of undisturbed seabed, as determined away from any potential changes induced by the burial vehicle itself

The key terms are illustrated in Figure 14 below.

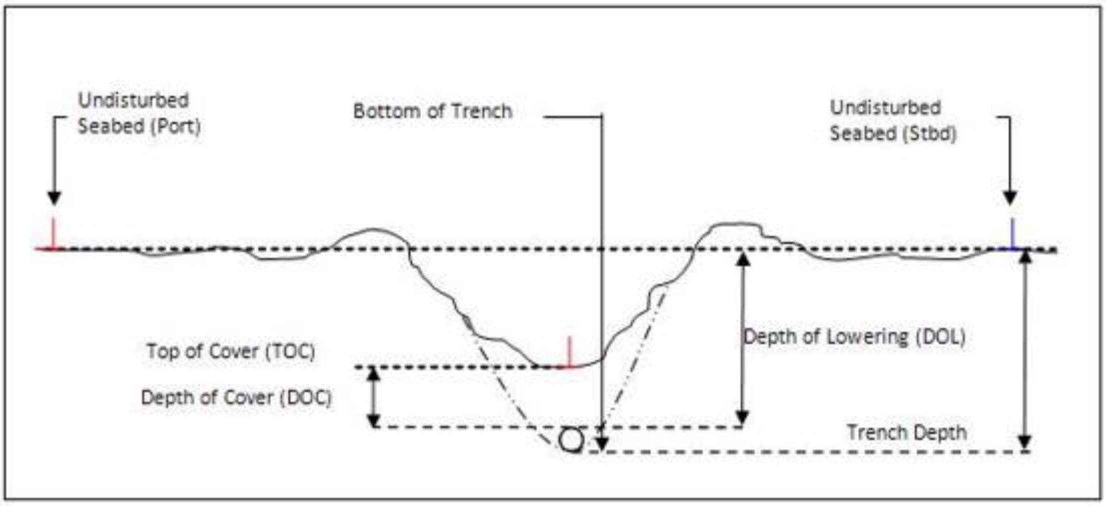

Figure 14: Trenching Terminology

7 BPI Assessment and Fishing Effort Charts

LR Senergy has undertaken a range of studies focusing on cable threat analysis, including analysis of route shipping, anchoring and fishing intensity. This resulted in the production of a Burial Protection Index (BPI) assessment, as well as the preparation of various charts presenting fishing intensity along the Caithness-Moray (LT21) circuit alignment.

The aforementioned aspects are discussed in detail in the following section.

7.1 Overview of Risks to Submarine Cables

In order to define a reasonable depth of lowering for a submarine HVDC cable, the likely risks that may cause damage must first be considered. Risks to submarine HVDC cables can be broadly categorised into two main types of risk: natural and human, as outlined in Table 16 (Ref. 8).

Natural Risks	Human Risks
Submarine Landslides	Trawling and Other Net Fishing
Sediment Mobility	Shell Fishing
Seismic Activity	Anchoring
Iceberg Scour	Dredging
	Dropped Objects
	Foundering

Table 16: Summary of Main Risks to Submarine HVDC Cables

The risks summarised in Table 16 are briefly discussed in the following sections, in relation to their applicability to the Caithness-Moray (LT21) circuit.

7.1.1 Natural Threats

7.1.1.1 Submarine Landslides

Submarine landslides are not considered to pose a risk to the Caithness-Moray (LT21) circuit.

7.1.1.2 Sediment Mobility

LR Senergy has undertaken a detailed assessment of potential sediment mobility and premature trench infill post-ploughing but prior to cable lay. The results of this study are presented in a separate report (Ref. 7), which the reader is hereby directed to. The key conclusion of this study (Ref. 7) is that sediment mobility poses a risk to the cable protection, particularly with regard to achieving adequate depth of lowering and availability of material to provide cover during the actual ploughing and cable lay operations. It is noted that the latest installation schedule (Ref. 17, see Appendix 4) now minimises duration between operations.

7.1.1.3 Seismic Activity

Seismic activity is not considered to pose a risk to the Caithness-Moray (LT21) circuit.

7.1.2 Human Threats

The primary human threats to submarine HVDC cables are associated with fishing and vessel anchoring. These, as well as the others listed in Table 16, are discussed over the following pages.

7.1.2.1 Fishing Gear Interaction

When trawl equipment is towed over or along a cable which is laid on the seabed, the interaction can be considered in three phases, as described below:

- Impact: The initial phase when the trawl board, beam shoe or clump weight hits the cable. This impact occurs over a short time frame and mainly results in localised damage to the shell and protective coating of the cable. This stage has the potential to damage the cables but rarely damages the trawl gear and there is negligible risk to the fishermen on board the vessel.
- Pull over: When a trawl board, beam trawl or clump weight is pulled over the cable. The duration of this phase is longer than that of the initial impact and forces can be significantly greater. Again the risks to fishermen during this phase of the interaction are limited.
- Hooking: Hooking occurs when the trawl equipment becomes “stuck” under the cable. This tends to be a low probability event but it represents the greatest risk to fishermen.

BERR summarised (Ref. 9) a number of studies reviewing cable fault rates relative to the depth of burial of the installed system. This research indicates that most ‘hits’ on cables result from fishing activity. Surface laid cables would be regularly ‘hit’, with fault occurrence directly related to the level of fishing activity. BERR (Ref. 9) further note that cables lowered to 0.6m depth are likely to experience only one or two hits in a 10 to 15 year lifetime (typically in areas of shallow burial or mobile seabed), whilst cables lowered below 1m have a high probability of remaining fault free.

7.1.2.2 Anchoring

Anchoring has the potential to damage a subsea cable if a vessel drops anchor or drags an anchor over the cable. The damage caused depends on the penetration depth of the anchor (which depends on vessel size and type of anchor), the type of seabed and depth to which the cable is buried. It is considered that anchor interaction with a subsea cable will be similar to that of fishing gear interaction, based on impact, pull over and potential snagging phases. Anchoring can take place for a number of reasons, including: adverse weather, machinery failure, and waiting on approach to port. It is worth noting that, as so far as is reasonably possible, cables are normally routed to avoid charted vessel anchorages, such that the risk to the cable is normally from anchors deployed accidentally or in an emergency. The probability therefore of anchor damage to a cable is relatively low as compared to fishing activity.

7.1.2.3 Dropped Objects

A dropped object could arise during transfer operations in port, at an offshore oil and gas installation (over-side lifting) or during lifting works from an offshore barge or construction jack-up.

Dropped objects from commercial vessels are more likely to take place during adverse weather and heavier sea conditions (open sea environments), and as such are considered to be a relatively low probability event along the Caithness-Moray (LT21) circuit. Many factors are likely to influence the potential damage caused to a subsea cable from a dropped object (e.g. type, size and velocity).

7.1.2.4 Military training

The Caithness-Moray (LT21) cable route purposefully avoids a military training area, as they pose a significant risk to a subsea cable due to firing of munitions from coastal ranges and marine based firing / bombing areas used by the Royal Navy and RAF. The primary approach to cable protection in these areas is avoidance.

7.1.2.5 Foundering

This risk is associated with vessel structural failure and / or eventual sinking. This type of incident has the potential to damage a subsea cable if the vessel sinks and ultimately comes to rest on top of a cable and is considered to be extremely low probability and is therefore impracticable to design against in a cost-efficient manner.

7.1.3 Key Threats to the Cable

Based on a review of the threats discussed, the primary risks to the Caithness-Moray (LT21) offshore circuit are from:

- Fishing activity (planned and regular operations)
- Vessel anchoring activities (primarily unplanned deployments)

These aspects are described in greater detail in the following sections.

7.2 Fishing Threat Analysis

Due to the frequency of fishing activity, it presents the greatest risk of damage to a submarine cable. Different fishing technique approaches and associated depths of interaction with the seabed are discussed below.

7.2.1 Fishing Equipment and Methods Used

Anatec (Ref. 10) has conducted a commercial fishing assessment for the Caithness-Moray (LT21) route. This utilised ship Automatic Identification System (AIS) data and sightings statistics to perform a fishing vessel analysis. In addition, the latest available Marine Scotland datasets (Ref. 18) relating to fishing vessel intensity has been reviewed alongside the Anatec results.

The following sections briefly describe the different types of fishing gear that are reportedly used within the vicinity of the Caithness-Moray (LT21) route.

Appendices 5 to 8 present information on typical demersal otter trawling and dredging gear.

7.2.1.1 Demersal Otter Trawls

This is the most commonly used towed fishing equipment in UK fisheries and is the most prevalent type of gear used along the Caithness-Moray (LT21) route. Both finfish and shellfish found on or near the bottom are caught using this method. The gear consists of a net in the shape of a funnel attached to the vessel by wire ropes or ‘warps’. As the net is towed over the seabed the mouth is kept open by a combination of boards, floats and weights. Typically, trawl door construction in the UK is a steel ‘vee’ door (Appendix 5), although the type of trawl door will vary depending on the seabed conditions and seas that the gear is to be used in (Ref. 11).

In comparison to beam trawling, otter trawl speeds are generally much slower but of a greater duration. These extended trawl durations can be attributed to the efficiency of the trawl doors sliding along the seabed which would not be possible if gear was to frequently penetrate the seabed and become stuck.

A single net or multiple nets (twin) may be used (Appendix 5) when otter trawling. In some cases of multi-rig trawling, a clump weight may be used to keep the trawl gear on the seabed.

Appendix 6 provides a summary of typical otter trawl gear parameters (Ref. 11) based on the most common ‘vee’ door construction.

7.2.1.2 Mid-Water Otter Trawls

This method of trawling requires the nets to be trawled higher in the water column. Therefore, this method poses no risk of interaction with a subsea HVDC cable.

7.2.1.3 Dredging

Most scallop dredgers have a chain bag which drags along the bottom collecting the catch. Some also use steel teeth which penetrate the seabed typically 6cm to 10cm (Ref. 12). Like other gear types, greater bottom penetration can occur under unusual conditions, such as when a dredge pushes a rock ahead of it. Appendix 7 (Ref. 12) shows a typical illustration of gear used by dredging vessels.

A dredge 4.5m wide with tickler chains can weigh in excess of 2,200kg when empty and is typically towed at speeds of up to five knots. In some fisheries, deflecting bars and wheels have been added to help the gear pass over seabed obstacles.

Appendix 8 (Ref. 12) provides a summary of some typical dredging gear parameters.

7.2.1.4 Potting

Potting, also described as static fishing, involves placing a pot (or creel) on the seabed to catch, for example, crabs or lobsters. The pots, or creels, are set on the seabed held in place by a steel, concrete or lead weight (clump weight) attached to the bottom of the pot and marked with buoys. Anchors may be used as an alternative to using clump weights to hold the gear in place. The Anatec report (Ref. 10) does not indicate that the vessels operating along the Caithness-Moray (LT21) route use anchors to secure gear.

For the purposes of this study, it is assumed penetration by static gear clump weights, etc. are negligible.

7.2.2 Fishing Activity

7.2.2.1 Relative Density of Fishing Vessels

Anatec (Ref. 10) used Vessel Monitoring System (VMS) datasets to produce plots that show the relative density of fishing vessels (number of vessels per year) within 15km of the Caithness-Moray (LT21) cable corridor.

The “hot spots” for fishing vessels are in the vicinity of the Moray Firth area and at the landfall locations at Noss Head and Portgordon. Figure 15 presents these fishing vessel densities along the Caithness-Moray (LT21) offshore circuit.

In addition, the latest fishing vessel intensity dataset made available by Marine Scotland (Ref. 18) has been plotted. This is noted to closely correlate with the results plotted by Anatec.

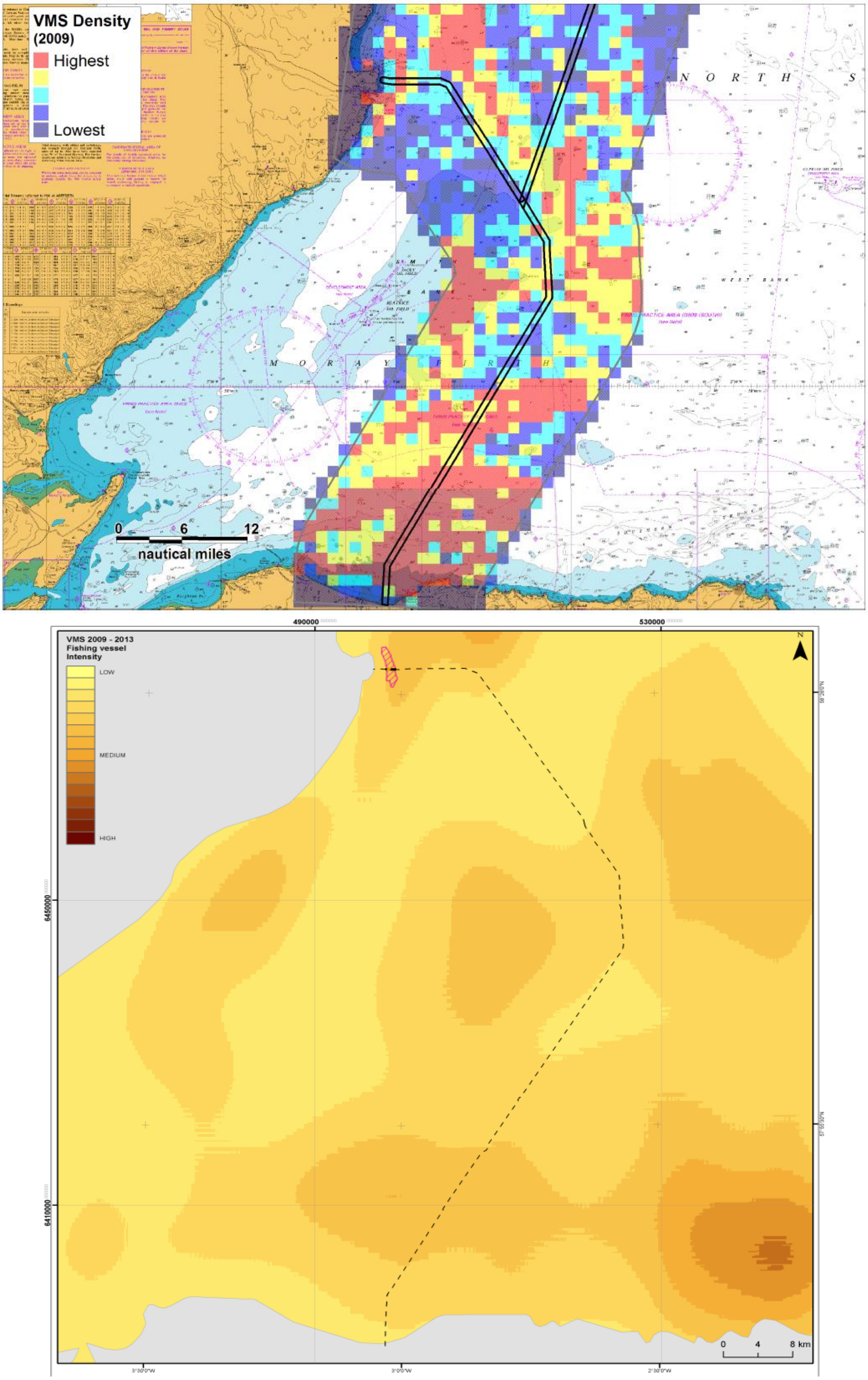

Figure 15: Caithness-Moray Fishing Vessel Intensity (Anatec & Marine Scotland Data)

7.2.2.2 Fishing Vessel and Cable Interactions

Anatec (Ref. 10) assessed the frequency of interactions between fishing vessels and the Caithness-Moray (LT21) route. The analysis is based on VMS data. An interaction is defined as a situation where a fishing vessel crosses a cable route based on consecutive points being either side of the cable. More detailed analysis considers interactions at less than 5 knots, for which it is assumed that vessels are actively fishing.

The total number of fishing vessels crossing the route was determined to be 11,405 per year. Note that the West Alignment and East Alignment within the Hub Platform to Portgordon route survey corridor are were treated individually by Anatec. To assess the frequency of crossings associated with vessels assumed to be fishing, interactions at less than 5 knots have been assessed in more detail. The total number of such interactions was 4,375.

Fishing vessels crossed both the West Alignment and East Alignment for the majority of interactions. If only the first crossing is counted, the total number of crossings of the proposed cable corridor in would have been 2,258. Anatec note that these results may underestimate the actual number of crossings of the cable due to the time gaps of two hours between satellite logging of the positions.

Table 17 presents a summary of actual fishing cable interactions recorded in the Anatec dataset.

Portgordon to Hub Platform Route Section		Hub Platform to Noss Head Route Section
West Alignment	East Alignment	
665	686	81

Table 17: Fishing – Cable Route Interactions

The majority of these interactions are likely to have been by demersal otter trawls, which represent approximately 70% of sightings.

7.2.2.3 Potential Penetration Depth of Fishing Gear

The following section considers nominal gear types as summarised in Appendices 5 to 8.

Demersal otter trawl gear and dredging gear has the greatest potential to penetrate most deeply into the seabed. In the case of otter trawling, opportunity for penetration is primarily due to a potentially high load and trawl door geometry, resulting in a high load over a small bearing area. In the case of dredging, parts of the gear are specifically designed to penetrate the seabed with a typical maximum depth of 0.6m in very soft clay soils.

Both types of gear (otter trawl and dredging) have potential to sink or dig into the seabed, if the soils are particularly loose or soft. The mechanism of penetration may be considered as either static, by penetration under the fishing gears self-weight, or dynamic, whereby the gear penetrates as the gear is being towed.

As noted above, consideration needs to be given to a dynamic case where the trawl gear is being pulled over the seabed, and potentially could be dragged into a sandbank, megaripples or possibly a boulder. In this case the leading edge of the skid / trawl board would see a resistance from the seabed soil as it starts to embed. This is equivalent to an inclined bearing failure on the leading edge of the skid/trawl board.

Table 18 presents a summary of typical penetrations of otter trawling and dredging gear in a range of soil types based on a dynamic case. These figures have been calculated based on available data from other studies in the vicinity of the Caithness-Moray (LT21) route.

Soil Description	Potential Penetration – Otter Trawling (m)	Potential Penetration – Dredging gear (m)
Very loose sands	0.3	0.5
Medium dense sands	0.1	0.3
Very soft clay	0.5	0.6
Soft clay	0.2	0.3

Table 18: Summary of Potential Otter Trawl Gear Penetration

It should be noted that the calculations are likely to be representative of those found along the proposed route and that the potential penetration depths presented in Table 18 should be considered conservative when in relation to published research (Ref. 13) into the effects of trawling gear on the seabed. However, as discussed below, there is still a low probability of occurrence (e.g. trawl gear pushing a boulder along the seabed could lead to greater penetrations).

7.2.2.4 Observed Fishing Gear Penetration

The possible physical impact of trawl gear on the seabed has been the subject of various research studies over the past 40 years. A relatively recent investigation by the Irish Fisheries (Ref. 13) reviewed past research and more current research studies (investigating larger gear types) to determine the likely penetration depth of various types of fishing gear. The study described direct observations from divers and submersible equipment such as underwater cameras and side scan sonar. The findings of this paper indicate that a maximum penetration of 300mm was observed for beam trawls and otter trawl doors penetrating a very soft clay seabed. No penetration exceeding 200mm was observed in sandy seabeds.

Recognising that for reasons of sediment infill following fishing activities, observed seabed scars may not necessarily reflect the true depth of gear penetration, the slightly more conservative values as in Table 18 have been adopted for the purposes of this report.

7.2.2.5 Fishing Threat Analysis Summary

The fishing threat along the Caithness-Moray (LT21) route must be assessed by considering both the type of trawl gear used, the type of soil present and the potential penetration depth of the fishing gear. Table 19 and Table 20 present a summary of the findings of the fishing threat analysis for the Portgordon to Hub Platform and Hub Platform to Noss Head route sections respectively, based on fishing activity as indicated by the current Anatec and Marine Scotland data. It should be noted that fishing activity / density or distribution may change in the future. It should be noted that the maximum penetration depths presented consider penetration of the gear type in the most onerous soils present along each route section.

Soil Zone	KP (From)	KP (To)	Route Section Length (km)	Dominant Soil Type (Top 1m)	Fishing Density (Vessels per Year)	Primary Fishing Type	Secondary Fishing Type	Typical Maximum Gear Penetration (m)	Comment
PG1	0.000	9.190	9.2	GRAVEL	0 - 247	Demersal Trawler	Potter / Creeler	0.1 - 0.3	This section of the route has the highest density of demersal trawling, near landfall at Portgordon. Scallop dredging is known to occur along this section. Survey data indicates that sandy GRAVEL is the dominant soil type.
PG2	9.190	20.990	11.8	SAND	25 - 247	Demersal Trawler	Pelagic Trawler & Scallop Dredger	0.3 – 0.5	This section of the route is predominately demersal trawling along with, to a much lesser degree, potter / creeler and scallop dredging. Soil conditions are loose to dense sandy gravel to SAND.
PG3	20.990	41.190	20.2	CLAY	0 - 247	Demersal Trawler	Pelagic Trawler & Scallop Dredger	0.5 - 0.6	This section of the route is predominately demersal trawling along with, to a much lesser degree, potter / creeler and scallop dredging. The soil conditions are predominantly very soft to soft silty CLAY in the top 2.0m.
PG4	41.190	77.696	36.5	SAND	0 - 24	Potter / Creeler	Demersal Trawler & Scallop Dredger	0.1 – 0.3	This section of the route is predominately demersal trawling along with potter / creeler and scallop dredging. The soil conditions are predominantly loose to dense gravelly SAND to a minimum depth of 0.7m overlaying very soft to firm sandy SILT and silty CLAY.

Note: Fishing Density is the stated value over 1 nm^2 grid within 15 km of the route

Table 19: Summary of Fishing Threat Analysis – Portgordon to Hub Platform Route Section

Soil Zone	KP (From)	KP (To)	Route Section Length (km)	Dominant Soil Type (Top 1m)	Fishing Density (Vessels per Year)	Primary Fishing Type	Secondary Fishing Type	Typical Maximum Gear Penetration (m)	Comment
NH1	77.696	84.490	6.8	GRAVEL	0 – 24	Demersal Trawler	Potter / Creeler & Pelagic Trawler	0.1 - 0.3	This section of the route is predominately demersal trawling along with, to a much lesser degree, potter / creeler and scallop dredging. Soil conditions are sandy GRAVEL and clayey SAND.
NH2	84.490	92.490	8.0	CLAY	0 – 24	Demersal Trawler	Potter / Creeler & Pelagic Trawler	0.5 - 0.6	This section of the route is predominately demersal trawling along with, to a much lesser degree, potter / creeler and scallop dredging. Soil conditions are silty CLAY overlaying sandy GRAVEL. The strength of the clay is unknown.
NH3	92.490	110.180	17.7	GRAVEL	0 – 247	Demersal Trawler	Pelagic Trawler & Scallop Dredger	0.1 - 0.3	This section of the route is predominately demersal trawling along with, to a much lesser degree, potter / creeler and scallop dredging. Soil conditions are sandy GRAVEL.
NH4	110.180	112.571	2.4	GRAVEL and BEDROCK	0 - 24	Potter / Creeler	Scallop Dredging	0.3 – 0.5 *(excluding bedrock)*	Predominately potter / creeler & scallop dredging at landfall. Soil conditions are sandy GRAVEL and SAND overlying DIAMICTON. Locally, BEDROCK at surface.
Note: Fishing Density is the stated value over 1 nm^2 grid within 15 km of the route									

Table 20: Summary of Fishing Threat Analysis – Hub Platform to Noss Head Route Section

7.3 Route Anchoring Threat Analysis

7.3.1 General

Anatec also performed analyses of shipping data in the vicinity of the route corridor (Ref. 10). This comprised a total of eight weeks of data to identify the main ship routing and anchoring characteristics for the area, including any seasonal and tidal variations. It is noted that this period is double the minimum twenty-eight day period specified by the Maritime and Coastguard Agency (MCA) (Ref. 10) for traffic surveys of offshore renewable energy projects in UK waters.

7.3.2 Anchor Locations

The proposed Caithness-Moray (LT21) route does not pass through any designated anchorage areas marked on the Admiralty charts, but during the study period some vessel anchoring is recorded in Spey Bay near Portgordon and Sinclair's Bay near Noss Head.

The vessels that anchored closest to the Caithness-Moray (LT21) route during the study period were the survey vessel Franklin which anchored approximately 0.5km east of the survey corridor in Spey Bay for three days and the cargo vessel Hestia, which anchored 4km north-west of the survey corridor in Sinclair's Bay for six days.

Anatec (Ref. 10) stated that Noss Head partially shields the cable route from these vessels in the event of them dragging anchor, i.e., in some cases they would ground on shore before reaching the cable.

Vessels will be made aware of the position of cable on the seabed via "Notifications to Mariners". As a result vessels will avoid and not drop anchor over a buried cable unless in an emergency.

7.3.3 Shipping Vessel Density and Shipping Routes

Figure 16 presents the shipping densities along the Caithness-Moray (LT21) route. It can be seen that the most highly trafficked areas are in the Hub Platform to Portgordon route section, between approximately KP 8.000 and KP 38.000.

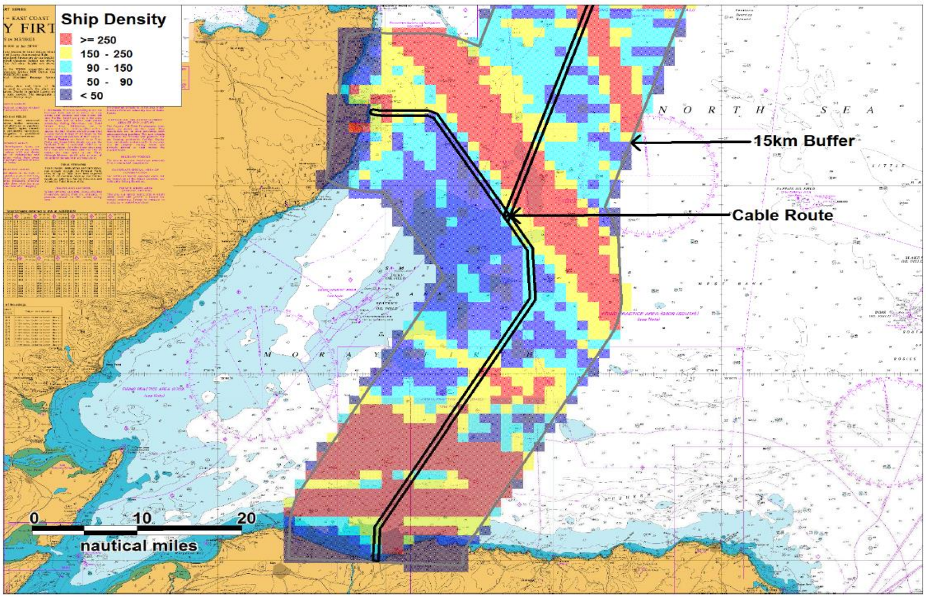

Figure 16: Caithness-Moray (LT21) Shipping Vessel Density (Anatec)

Table 21 presents the percentage of vessel types with their expected tonnage that crosses the entire route (Ref. 10). It should be noted that the statistics presented also include those for the Caithness-Shetland (LT09) circuit of the CMS project. The vessel Dead Weight Tonnage (DWT) of all vessels other than fishing vessels has been assumed based on anchored vessel tonnages within 15km of the Caithness-Moray (LT21) route (Ref. 10). The DWT of all vessels crossing the Caithness-Moray (LT21) route was not presented by Anatec.

Vessel Type	Percentage Crossing Cable Route	Expected Tonnage
Cargo	36	Up to 3,500
Fishing	20	Less than 500
Tanker	14	Up to 100,257
Other	14	Unknown
Passenger	6	Unknown
Tug	3	Less than 1000
Recreation	3	Less than 500
Dredger/Subsea	3	Unknown

Table 21: Percentage of Vessel Type Crossing Route

Anatec (Ref. 10) has used data from the Marine Accident Investigation Branch (MAIB) to assess the frequency of maritime incidents within 15km of the proposed HVDC cable route for a ten year period. It should be noted that the data has been assessed over both CMS circuits, therefore is not specific to the Caithness-Moray (LT21) circuit. 54% of MAIB incidents involved fishing vessels, 20% merchant vessels, 10% recreation and 15% relate to other vessels.

7.3.4 Anchoring Threat Analysis

The following sections discuss the main anchoring threats along the route.

7.3.4.1 Anchor Dragging Frequency

To determine the frequency that a vessel drags anchor over the cable route, Anatec (Ref. 10) used the COLLRISK Anchor Dragging model. The total annual frequency was estimated to be 1.3×10^{-3}, i.e., an average of one dragged anchor over the cable route every 793 years.

The average anchor dragging frequency per KP is 1.8×10^{-6}, corresponding to a dragged anchor event return period of 556,000 years. The KP with the highest anchor dragging frequency is situated in Spey Bay, which has a frequency of 5.5×10^{-4}, or one event per 1,813 years.

7.3.4.2 Emergency Anchor Frequency

Emergency anchor deployment occurs when a vessel needs to stop or slow its rate of drift, especially if it is heading towards a hazard, e.g. grounding risk or an offshore installation or when it suffers a breakdown in the area. All commercial mariners are aware of cable locations and take this into account before deployment, unless failure of the anchor deployment system is the source of the breakdown.

Anatec's COLLRISK Emergency Anchoring model (Ref. 10) uses AIS data to determine the durations (frequency) of vessels passing over the cable route corridor per annum. This is multiplied by the probability of engine failure leading to ship drift, and the probability of dropping anchor in an emergency to estimate the frequency of vessels dropping anchor over the cable route.

The probability of dropping anchor is likely to be higher closer to shore, due to the proximity of grounding hazards, as well as the water depths being more likely to be suitable. If a decision is taken to anchor, a responsible Master would also check charts to identify any subsea structures in the vicinity, as well as checking the nature of the seabed and the depths.

The total duration of vessels transiting over the cable corridor per year multiplied by the probability of engine failure gives an estimated failure rate over the cable corridor of 7.0×10^{-2}, or one event every 14 years on average.

The probability of dropping anchor over the cable route will vary. For the purpose of this assessment, a uniform probability of 10% has been assumed over the entire (30km wide) corridor. This is likely to be conservative, as once the cable is laid ships navigating in the area should have it marked on their charts.

Applying this probability, the overall annual frequency of emergency anchoring is 7.0×10^{-3}, corresponding to a return period of 143 years.

Table 22 presents the frequency of emergency anchoring over the Caithness-Moray (LT21) circuit.

	Portgordon to Hub Platform	Hub Platform to Noss Head
Annual Frequency	4.7×10^{-3}	3.8×10^{-4}
Return Period (Years)	212	2,605

Table 22: Emergency Anchoring Annual Frequency

7.3.4.3 Potential Anchor Penetration

The potential to cause significant damage to cable systems is inherent in anchor design; to penetrate the seabed to generate holding capacity. Vessel anchors may be deployed as a temporary mooring as part of a planned procedure (typically in well-defined anchorages) or as an unplanned event in an emergency, for example due to loss of power, as discussed in the previous sections.

Guidance on anchor size requirements can be found in various regulations including those published by Lloyd's Register, American Bureau of Shipping and the International Association of Classification Societies. An approximation of anchor size based on DWT has been developed and is shown in Figure 17 (Ref. 14).

Typically, anchors fitted to ships are of a stockless type as they can be stowed flat, are easy to deploy and have a reasonable holding capacity to weight ratio. Dimensions of stockless type anchors have been sourced from Vyrhof (Ref. 15) - see Appendix 9.

When an anchor is deployed and dragged across the seabed, the flukes will pivot and penetrate into the soil. It should be noted that in the case of sands, it would be expected that the flukes would be able to open relatively easily. With the exception of very soft clays, the flukes will not typically penetrate to full depth (i.e. the full length of the fluke) due to the resistance of the remaining anchor construction, namely the palm and shank in addition to the penetration resistance of the flukes.

If the seabed soils can support the geometric configuration of the anchor and resist deep penetration, the maximum depth of anchor penetration can be calculated by considering the anchor fluke length and associated opening angle. To optimise the holding efficiency of the anchor, the opening angle will vary depending on the soil type the anchor is to be used in. A fluke opening of 32° is recommended for sands and hard clays whilst 45° to 50° is recommended for soft to very soft clays (Ref. 15). This relationship is shown in Figure 18.

The fifteen vessels that anchored over the survey period have DWT's ranging from 824 tonnes to 100,257 tonnes. Two DWT are unknown, one is greater than 100,000 tonnes and the remaining twelve range between 246 tonnes and 3,418 tonnes.

Table 23 presents typical penetrations of different anchor sizes for a variety of DWT vessel tonnages in a variety of soil types (Ref. 15).

DWT (Tonnes)	Anchor Size (kg)	Soil Type	Potential Penetration [Flukes Only] (m)
Up to 5,000	2,000	Very Loose Sand	1.0
		Medium Dense Sand	0.7
		Very Soft Clay	1.0
		Soft Clay	0.9
Up to 20,000	5,000	Very Loose Sand	1.2
		Medium Dense Sand	0.9
		Very Soft Clay	1.3
		Soft Clay	1.2
Up to 100,000	13,500	Very Loose Sand	1.5
		Medium Dense Sand	1.3
		Very Soft Clay	1.9
		Soft Clay	1.7

Table 23: Typical Anchoring Penetration Analysis Summary

Following analysis of the potential penetration of various types of anchor, it is necessary to identify areas along the route that are heavily trafficked, which type of vessel is most prevalent and areas where the potential for emergency anchor deployment is greatest.

7.3.4.4 Anchoring Threat Analysis Summary

Table 24 and Table 25 summarise the main findings of the anchoring threat analysis, based on the data described in the previous sections, for the Portgordon to Hub Platform and Hub Platform to Noss Head route sections respectively.

There is a low probability of vessels anchoring over the cable route based on the emergency anchor frequency and anchor dragging frequency (Ref. 10). Based on the results presented by Anatec (Ref. 10), the probability for a vessel to anchor over the HVDC cable is considered to be minimal.

KP (From)	KP (To)	Dominant Vessel Type	Known Tonnage (Tonnes)	Recommended Protection from Anchor Size (kg)	Potential Anchor Penetration (m)	Comments
0.000	7.690	Fishing and Cargo	Up to 3,400	2,000	1.5 or greater	Predominately fishing, cargo and tug vessels in this area of the route. Close to shore a high density of vessel traffic occurs. Vessels are known to anchor close to shore, cargo vessels are the main vessel type to anchor. The maximum DWT of known vessels which have anchored in the area is 3,400 tonnes (Ref.10). From KP 7.690, the water depth is less than 20m LAT, decreasing towards landfall at KP 0.000.
7.690	77.696	Fishing	Less than 500	N/A	N/A	Approximately 4km to the east of this section of the route, there is a high density shipping area identified that runs parallel to the route. Cargo, tanker and fishing vessels are the most common type of vessels that cross this section of the route. Vessels are not known to anchor in this area and as the dominant vessel type is fishing vessels with a DWT less than 500 tonnes, there is minimal chance of anchors being dropped along this section of the route and damaging the HVDC cable.

Table 24: Summary of Potential Anchor Penetration – Portgordon to Hub Platform Route Section

KP (From)	KP (To)	Dominant Vessel Type	Known Tonnage (Tonnes)	Recommended Protection from Anchor Size (kg)	Potential Anchor Penetration (m)	Comments
77.696	110.180	Fishing	Less than 500	N/A	N/A	Cargo, tanker and fishing vessels are the most common type of vessels that cross this section of the route. Vessels are not known to anchor in this area and as the dominant vessel type is fishing vessels with a DWT less than 500 tonnes, there is minimal chance of anchors being dropped along this section of the route and damaging the cable.
110.180	112.571	Fishing and cargo	Up to 100,257	13,500	1.5 or greater	Predominately fishing, cargo and tug vessels along this section of the route. Close to shore a high density of vessel traffic occurs. Vessels are known to anchor close to shore, cargo vessels are the main type to anchor. One tanker vessel with a DWT of 100,257 tonnes (Ref.10) anchored in this area.

Table 25: Summary of Potential Anchor Penetration – Hub Platform to Noss Head Route Section

7.4 BPI Depth of Burial Analysis Findings

In order to define an appropriate cable depth of lowering, LR Senergy has considered the type of external threat that the cable product must be protected from, and the likelihood of occurrence.

Table 26 summarises the main risks that have been highlighted in this study from the available datasets. The potential impact they may have on the DOL and the mitigations that are in place have been identified.

Hazard Identified	Impact on Cable Lowering	Mitigation
Fishing gear penetrating the seabed	In order to protect the cable from being damaged or snagged by the fishing gear, the cable should be lowered to a depth at which the fishing gear cannot penetrate. The softer the soils, the greater the penetration requiring a greater DOL.	Varying DOL. Shallower burial where possible in gravels and dense sand, greater in areas of soft clays.
Soft clay resulting in greater penetration of fishing gear	DOL will need to be increased in areas of soft clay to ensure that the cable is adequately protected from the maximum potential penetration of any fishing gear.	Deeper burial required.
Rocky outcrop areas close to shore approaches at Noss Head	Recommended DOL may not be achieved resulting in a reduced DOL and possibility of exposing the cable to unnecessary risks.	Greater protection required. This may include rock protection.
Known anchor zones at Noss Head and Portgordon shore approaches	Achievable DOL limited by tool configuration. To ensure that the cable is adequately protected from the possibility of an anchor being dropped on the cable additional DOC may be required.	Greater protection required. This may be deeper burial (if possible), or rock placement. Cables should be marked on charts to enable mariners to be aware of their location and avoid anchoring over the cable.
Seabed features such as boulders, sandwaves, uneven seafloor & wrecks	Potential for reduced DOL over seabed features.	Specific route planning can avoid these features.
Lack of geotechnical data	It is not possible to make a confident prediction of how these soils will behave during trenching. The lack of laboratory test data presents increased risk of adverse soil conditions / behaviours being experienced by the installation / trenching contractor and increases risk to the project.	Recommend further geotechnical data to be acquired along with appropriate laboratory testing.
Sediment mobility due to metocean conditions - relative to the spoil removed from the trench	Premature infill of the trench following ploughing but prior to cable lay will reduce cable DOL	Minimise the period between ploughing, cable lay and backfilling activities. Avoid undertaking operations or leaving the trench open during potentially harsher winter period with stronger seabed current conditions

Table 26: Summary of Hazards and their Potential Impact on DOL

Based on the analysis undertaken regarding external threats to the cable as well as the soil conditions and potential for variation in geotechnical parameters along the Caithness-Moray (LT21) route, LR Senergy recommended the following DOL and DOC specification:

- Minimum Depth of Lowering (DOL) of 1.5m along the Caithness-Moray (LT21) offshore circuit *(N.B. The actual target DOL will be 1.8m; see Section 8)*
- Target a Depth of Cover (DOC) of 1.0m
- Additional protection (e.g. rock placement) should be considered where the above recommended specification cannot be achieved

7.5 Fishing Effort Charts

LR Senergy has produced a number of fishing effort charts for SHE Transmission based on available Marine Scotland datasets: VMS – Annual Fishing Intensity 2009-2013 and ScotMap – Inshore Fisheries Mapping 2007-2011 (Ref. 18). These include data on a range of target species and associated fishing intensity, summarised as follows:

- Creeling areas with landing value distribution for crab and lobster
- Nephrops trawling intensity
- Nephorops trawling areas with landing values
- ‘Other’ trawling areas with landing values
- Scallop trawling intensity

The above detailed drawings include the Caithness-Moray (LT21) route alignment as well as nominal rock placement locations.

These fishing effort charts, showing the Caithness-Moray (LT21) circuit and the latest rock placement locations based on the assessment presented in this report (see Section 10), are available as Figure 19 to Figure 23 respectively.

8 ABB Trenching Methodology

8.1 Overview

ABB proposes to protect the Caithness-Moray (LT21) offshore HVDC circuit using a pre-cut trench method. This involves the construction of a trench along the majority of the offshore route, into which the cable will subsequently be laid. Additional protection is provided by mechanically backfilling the trench with the spoil heaps created during ploughing operations, thereby covering the cable.

8.2 Equipment

ABB intends to utilise Ecosse Subsea Systems' SCAR 2 plough for the Caithness-Moray (LT21) works. SCAR 2 is a relatively simple asset, capable of multi-pass operations to achieve trench depths in excess of 3m, in addition to operating in other modes (e.g. boulder clearance and backfill). It has a nominal weight of 25 tonnes (Te) in trenching mode, although variable ballast of up to 16Te can be added, should soil or operational conditions require this (see Refs. 19 to 26).

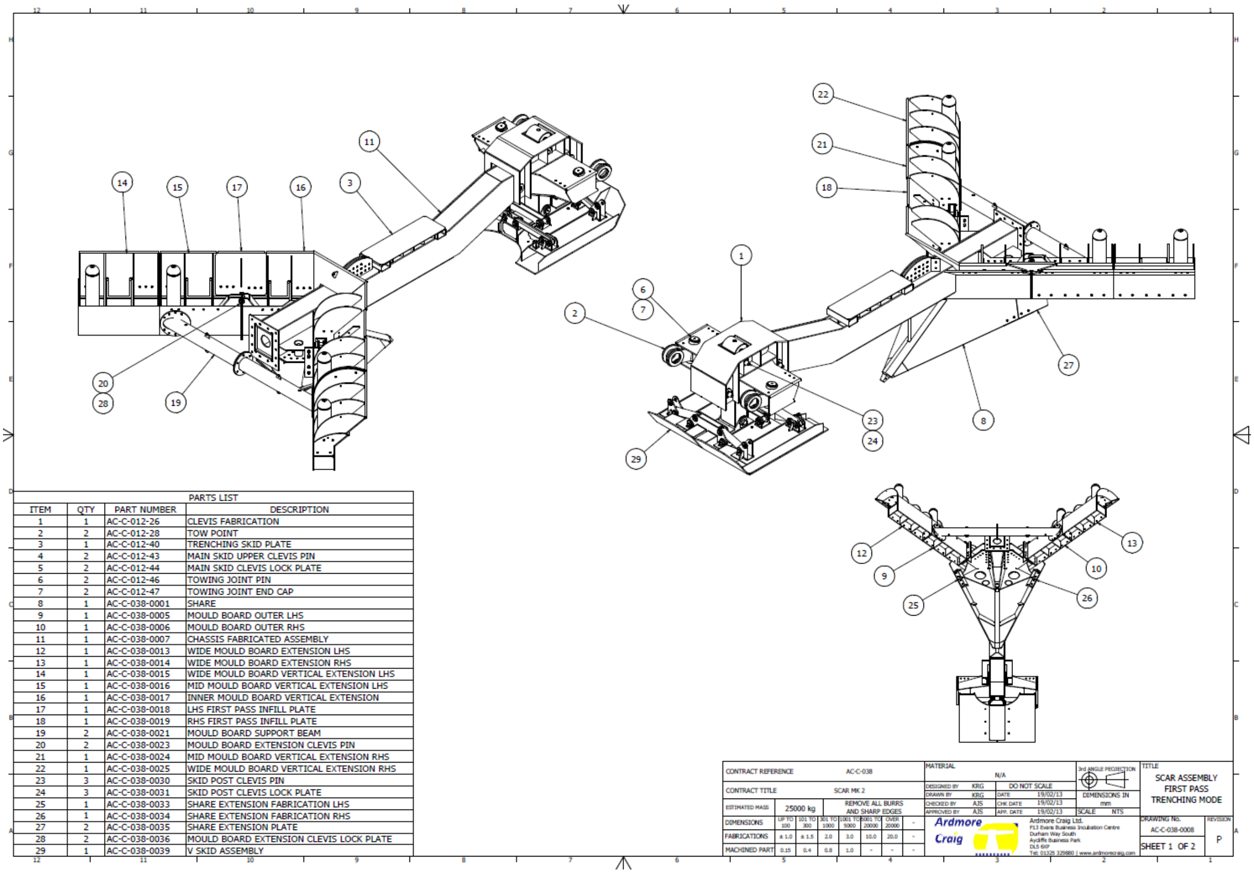

Figure 24: Ecosse SCAR 2 Plough

Figure 24 shows the SCAR 2 plough in trenching mode (Ref. 19). It can also be operated in boulder clearance mode to remove boulders and debris from the route corridor before trenching commences, as well as in backfill mode which pushes the spoil heaps created by trenching back into the trench after the cable has been laid (Refs. 20 to 22).

For operation, the SCAR 2 plough requires a support vessel with a minimum bollard pull of 150Te (Ref. 1).

The technical data provided by Ecosse Subsea systems in relation to the SCAR 2 plough's various configurations for the Caithness-Moray project are detailed in Table 27 (Refs. 23 to 26).

Specification	SCAR 2 Trenching System Configuration			
	Boulder Clearance	Plough – 1st Pass	Plough – 2nd Pass	Backfill
Length (m)	16.0	10.8	10.9	13.5
Width (m)	15.8	8.0	8.3	13.8
Backfill Capture width (m)	-	-	-	13.5
Height (m)	3.8	2.7	3.6	3.8
Mass (Te)	71.8	25.0	25.0	63.0
Max Load (Te)	50	150	150	50
Operational Tow Force (Te)	25 – 75	25 - 100	25 – 100	25 – 75
Progress Rate Range (m/hr)	340 – 1,000	340 – 1,000	340 – 1,000	500
Turning Radius Range (m)	75 - 150	75 – 150	75 – 150	75 – 150
Minimum Turning Radius (m)	50	50	50	50
Maximum Operating Depth (m)	3,000	3,000	3,000	3,000

Table 27: SCAR 2 Configuration Data Supplied by Ecosse Subsea Systems

Extracts from the latest general arrangement drawings, depicting the various SCAR 2 configurations, are presented in Appendix 10.

8.3 Trench Specification

The target depths, as specified by ABB (Ref. 1) to achieve the necessary protection for the Caithness-Moray (LT21) offshore circuit, based on analysis of the available route datasets and consideration of the BPI study, are detailed in Table 28. These are the depths that will be attempted to be achieved by ABB within the procedures detailed in their current installation methodology (Ref. 1). The different depths are defined below:

- Target Tool Depth is the depth below seabed that the plough will attempt to penetrate to and can nominally be considered the same as Target Trench Depth (see Section 6).
- Target Depth of Cover is the level of cover ABB will attempt to achieve – measured from the top of cover after the backfill pass to the top of the laid cable (and prior to any rock placement).

Operation	Target Tool Depth (m BSB)	Target Depth of Cover (m BSB)
1st Pass Ploughing	1.2	-
2nd Pass Ploughing	1.8	1.0

Table 28: ABB Caithness-Moray Circuit Trenching Specification

8.4 Outline of Proposed ABB Trenching Operations

The main aspects of the methodology utilising the SCAR 2 plough are summarised below:

1. Boulder Clearance

- Operating in backfill mode, the plough will create a corridor of 10m width along the Caithness-Moray (LT21) route. Tolerance of ±10m from the route centerline.
- Boulder clearance will comprise of a single pass, with continuous monitoring by ROV.

2. Ploughing

- A two pass approach will be adopted. First pass to a target tool depth of 1.2m and the second pass to a target tool depth of 1.8m.
- No remediation for natural infill proposed (additional depth of cover will be provided by rock placement, if required).

3. Backfill

- One pass with SCAR 2 operated in backfill mode, with continuous monitoring by ROV. Tolerance of ±1m from the trench centerline.
- Following mechanical backfill, ABB proposes to undertake rock placement operations, where required, to achieve the full 1m depth of cover along the Caithness-Moray (LT21) circuit.

The ABB methodology document (Ref. 1) is relatively high level and contains no further aspects on critical details such as operational weather limits, plough speeds or anticipated duration for any of the three activities outline above.

8.5 ABB Rock Placement Strategy

ABB has proposed to use rock armouring in a number of locations both before and after laying of the cable. The locations and/or scenarios where rock placement is anticipated are detailed below:

- From the Noss Head offshore HDD break-out point to 100m prior to the Horse Mussel Bed boundary.
- 250m metres either side of the Omega Joint location (500m total).
- At any locations along the route where the 1.0m depth of cover specification has not been achieved via the plough and backfill methodology.

LR Senergy, as part of this study, has assessed the likelihood of achieving the cable burial specification and has therefore calculated required rock placement locations and volumes along the Caithness-Moray (LT21) route. This is discussed in the following sections.

9 Caithness-Moray (LT21) Circuit Burial Assessment

Based on the analysis presented in the preceding sections, particularly with respect to the route soil conditions, as well as with full consideration of the installation contractor's trenching specification and installation methodology (Ref. 1), LR Senergy has completed an assessment of the achievability of the burial specification for the Caithness-Moray (LT21) circuit. This is summarised in the following section.

9.1 Trenching Zones

Further to the determined route soil zones presented in Table 11 and Table 14, each has subsequently been further sub-divided into discrete trenching zones, based on a detailed analysis of the localised soil conditions, features and likely plough performance within each soil zone.

Trenching zones for the Portgordon to Hub Platform and Hub Platform to Noss Head route sections of the Caithness-Moray (LT21) circuit are presented in Section 9.1.1 and Section 9.1.2, respectively. This includes commentary on the key risks within each zone.

The trenching zones are also presented in Figure 25 for the Portgordon to Hub Platform route section, and Figure 26 for the Hub Platform to Noss Head route section.

9.1.1 Portgordon to Hub Platform - Trenching Zones

Table 29 presents the results of the Portgordon to Hub Platform trenching zone analysis.

Soil Zone	Trenching Zone	KP (From)	KP (To)	Route Zone Length (km)	Identified Soil Risks
PG1	A	1.578 (HDD)	9.190	7.6	Trenching performance will be dependent on shallow water capability within this zone. Numerous boulders.
PG2	A	9.190	10.890	1.7	Diamicton present from seabed surface. Lack of definition of constituent soils – Potential for significant fines content.
	B	10.890	15.690	4.8	Localised seabed ripples.
	C	15.690	18.390	2.7	Silty sands and changeable soil conditions. Interlayers sand, silt and gravel. Localised underlying stiff clay. Seabed ripples present.
	D	18.390	20.990	2.6	Localised increase in seabed gradient.
PG3	A	20.990	22.690	1.7	Transition zone from fine to cohesionless soils - Silty sands, gravels and silt layers indicated. Localised increase in seabed gradient.
	B	22.690	28.690	6.0	-
	C	28.690	29.690	1.0	Potentially bedrock within trench depth. Localised increased seabed gradient associated with feature (mound).
	D	29.690	36.690	7.0	-
	E	36.690	41.190	4.5	Transition zone from sand and gravel to soft clays and silts. Lack of PSD data to determine key primary and secondary constituent soils within this zone.
PG4	A	41.190	42.890	1.7	Transition zone from sand and gravel to soft clays and silts. Lack of PSD data to determine key primary and secondary constituent soils within this zone.
	B	42.890	45.690	2.8	-
	C	45.690	47.690	2.0	Significant silt layers within trench depth and interbedded sandy silty gravel.
	D	47.690	59.690	12.0	Seabed ripples present at KP 23.000.
	E	59.690	61.690	2.0	Interlayered fine sands and gravel with interbedded silt and clay. Seabed ripples present and associated gradient increase.
	F	61.690	71.190	9.5	Occasional boulders.
	G	71.190	77.696 (Hub)	6.5	Silt layers. Fines content within dense fine sands and gravels based on MMT logs. Lack of PSD data to correlate. Potential for localised fine sediments at seabed indicated on alignment charts.

Table 29: Summary of Trenching Zones and Key Risks – Portgordon to Hub Route Section

9.1.2 Hub Platform to Noss Head - Trenching Zones

Table 30 presents the results of the Hub Platform to Noss Head trenching zone analysis.

Soil Zone	Trenching Zone	KP (From)	KP (To)	Route Zone Length (km)	Identified Soil Risks
NH1	A	77.696 (Hub)	78.490	0.8	-
	B	78.490	78.990	0.5	DIAMICTON indicated within majority of trench profile. No geotechnical data to determine constituent soils and associated parameters.
	C	78.990	81.190	4.2	Occasional boulders.
	D	81.190	81.790	0.6	DIAMICTON indicated within majority of trench profile. No geotechnical data to determine constituent soils and associated parameters. Occasional boulders.
	E	81.790	84.490	2.7	Geotechnical data gap.
NH2	A	84.490	86.490	2.0	Undulating seabed. Varying seabed sediments, from silty CLAY to sandy GRAVEL. Lack of geotechnical data to soil properties.
	B	86.490	92.490	6.0	Silty CLAY – No undrained shear strength data. DIAMICTION indicated to be present at a shallower depth.
NH3	A	92.490	94.690	2.2	Geotechnical data gap.
	B	94.690	96.690	2.0	Seabed ripples with associated localised increase in seabed gradient. DIAMICTION indicated to be present at a shallower depth.
	C	96.690	103.855	7.2	-
	D	103.855	106.165	2.3	Increased gradients associated with sandwave feature.
	E	106.165	110.180	4.0	Seabed ripples. Sandwave feature running parallel to route. Localised boulders. DIAMICTION indicated to be present at a shallower depth.
NH4	A	110.180	112.451 (HDD)	2.3	Localised BEDROCK at seabed. Localised DIAMICTON at seabed. Horse Mussel bed.

Table 30: Summary of Trenching Zones and Key Risks – Hub to Noss Head Route Section

9.2 Achievability of ABB Burial Specification

Based on the trenching zones summarised in Table 29 and Table 30, LR Senergy has assessed the potential for the SCAR 2 plough to achieve the burial specification, particularly, the 1.8m Target Trench Depth to maximize the potential for the 1.0m DOC to be achieved, based on the current installation methodology. This is presented in Section 9.2.1 and Section 9.2.2. In addition, Appendices 11 and 12 present the results at 100m intervals along the route sections.

9.2.1 Portgordon to Hub Platform Trenching Analysis

Table 31 presents the results of the Portgordon to Hub Platform trenching assessment results.

Zone	KP (From)	KP (To)	1st Pass			2nd Pass		
			Maximum Tow Force Allowed (Te)	Estimated Speed (m/hr)	Estimated Achievable Trench Depth (m BSB)	Maximum Tow Force Allowed (Te)	Estimated Speed (m/hr)	Estimated Achievable Trench Depth (m BSB)
PG1-A	1.578 (HDD)	9.190		150	1.2		100	1.8▲
PG2-A	9.190	10.890		100	1.2		50	1.4
PG2-B	10.890	15.690		150	1.2		100	1.8
PG2-C	15.690	18.390		100	1.2		50	1.4
PG2-D	18.390	20.990		150	1.2		100	1.8
PG3-A	20.990	22.690		200	1.2		100	1.4
PG3-B	22.690	28.690		400	1.2		250	1.8
PG3-C	28.690	29.690		300	1.2		0▲▲	1.2▲▲
PG3-D	29.690	36.690	90	400	1.2	90	250	1.8
PG3-E	36.690	41.190		200	1.2		100	1.4
PG4-A	41.190	42.890		200	1.2		100	1.4
PG4-B	42.890	45.690		150	1.2		100	1.8
PG4-C	45.690	47.690		100	1.2		50	1.4
PG4-D	47.690	59.690		150	1.2		100	1.8
PG4-E	59.690	61.690		100	1.2		50	1.4
PG4-F	61.690	71.190		150	1.2		100	1.8
PG4-G	71.190	77.696 (Hub)		150	1.2		100	1.4

Table 31: Trenching Assessment – Portgordon to Hub Platform Route Section

Key:

▲ : Trenching start point still to be defined by the installation contractor

▲▲ : Bedrock within trench depth

9.2.2 Hub Platform to Noss Head Trenching Analysis

Table 32 presents the results of the Hub Platform to Noss Head trenching assessment results.

Zone	KP (From)	KP (To)	1st Pass			2nd Pass		
			Maximum Tow Force Allowed (Te)	Estimated Speed (m/hr)	Estimated Achievable Trench Depth (m BSB)	Maximum Tow Force Allowed (Te)	Estimated Speed (m/hr)	Estimated Achievable Trench Depth (m BSB)
NH1-A	77.696 (Hub)	78.490	90	150	1.2	90	100	1.8
NH1-B	78.490	78.990		100	1.2		50	1.4
NH1-C	78.990	81.190		150	1.2		100	1.8
NH1-D	81.190	81.790		100	1.2		50	1.4
NH1-E	81.790	84.490		150	1.2		100	1.8
NH2-A	84.490	86.490		150	1.2		100	1.8
NH2-B	86.490	92.490		250	1.2		150	1.8
NH3-A	92.490	94.690		300	1.2		200	1.8
NH3-B	94.690	96.690		200	1.2		100	1.8
NH3-C	96.690	103.855		150	1.2		100	1.8
NH3-D	103.855	106.165		150	1.2		100	1.8
NH3-E	106.165	110.180		150	1.2		100	1.8
NH4-A	110.180	112.451 (HDD)		0	0.0▲▲▲		0	0.0

Table 32: Trenching Assessment – Hub Platform to Noss Head Route Section

Key:

▲▲▲: No trenching operations 100m prior to the Horse Mussel bed, through the Horse Mussel bed, or from the Horse Mussel bed to the Noss Head offshore HDD break-out point

9.3 Commentary of Trenching Analysis

Based on ABB's installation methodology, as outlined in Section 8, the anticipated trenching performance has been analysed by LR Senergy for each of the zones detailed in Table 29 and Table 30. Note that this is based on limited geotechnical data, particularly with regard to the large data gaps along the Hub Platform to Noss Head route section, as well as the lack of laboratory data relating to density and fines content for cohesionless soils along the entire Caithness-Moray (LT21) circuit – factors which have a significant impact on plough performance.

Table 31 and Table 32 presents the results of this analysis for the 1st and 2nd pass of the SCAR 2 plough, for the Portgordon to Hub Platform and Hub Platform to Noss Head route sections respectively.

It is assumed for the purposes of this assessment that the boulder clearance pass is successful and all route seabed obstructions are removed prior to ploughing operations commencing.

It is noted that the assessment undertaken does not consider potentially changeable metocean conditions and the associated vessel thrust required to maintain the appropriate heading. Due to the difficulty in modelling this changeable aspect along with the dominant soils factors, this has not been included as it would likely lead to significant conservatism in the lengths of route out of specification. However, the installation contractor should assess if the necessary bollard pull can be achieved even during periods of less favourable environmental conditions.

The 2nd pass of the plough is anticipated to be more onerous due to an increase in volume of soil being removed per metre of trench and the general increase in silt content or diamicton at depth, indicated by the available geotechnical data.

9.3.1 Plough Performance – First Pass

It is anticipated that the first pass to a target tool depth of 1.2m may be achievable for the majority of the route, excluding those sections where trenching will not be attempted such as the Omega Joint and Horse Mussel bed, based on ABB's current installation methodology, as can be seen in Table 31 and Table 32. Speeds of typically 150m/hr but up to 400m/hr dependent on soil conditions may be obtainable. Although the first pass may be achievable, it is again highlighted that fluctuation in fines content, particle size and density of the cohesionless soils, and properties of the diamicton, can have a significant impact on ploughing operations.

9.3.2 Plough Performance - Second Pass

Table 31 and Table 32 also present the anticipated target tool depth achievable on the second pass, in accordance with ABB's current installation methodology. It is envisaged that the second pass target tool depth of 1.8m may be achievable for numerous zones along the route, albeit at a generally low nominal speed of 100m/hr.

It is anticipated that certain sections of the route, namely PG2-A, PG2-C, PG3-A, PG3-C, PG3-E, PG4-A, PG4-C, PG4-E, PG4-G, NH1-B and NH1-D could be ploughed to a nominal maximum tool depth of approximately 1.4m. Note that depth of the trench by the time the cable is laid will not necessarily equal the tool depth immediately after ploughing. The trench depth is likely to decrease over time due to premature trench infill caused by sediment from the trench walls and spoil heaps settling onto the bottom of the trench. Erosion of the spoil heaps can also decrease the volume of material available to be backfilled after the cable has been laid, thereby affecting the depth of cover. The extent to which these factors may be a risk are discussed in a separate report (Ref. 7), as mentioned in Section 7.1.1.2. Although, it is noted that recent changes to the construction schedule (Ref. 17, see Appendix 4) reduce the period between trenching and backfilling. For the purpose of this study, only the achievability of the target trench depth at the time of ploughing operations is considered.

Zone PG3-C is nominally limited to 1.2m target trench depth due to the anticipated presence of bedrock below this depth. The cable will not be trenched throughout zone NH4-A (Ref. 1).

9.4 Summary of Trenching Analysis

Table 33 presents the LR Senergy estimated percentage of the achievability of the 1.8m trench depth specification, based on the current installation methodology. Note that this considers the whole route without taking account of those sections that will intentionally not be trenched, such as at the Omega Joint – These are discussed further in Section 10.

Trenching Operation	Route Section	Route Length (km)	LR Senergy Estimate based on ABB Installation Methodology	
			Route Length – 1.8m Specification NOT Achievable (km)	Route Percentage - 1.8m Specification NOT Achievable
Achievability of Obtaining Target Tool Depth of 1.8m (% of total route length)	Portgordon Offshore HDD Break-out Point to Hub Platform	76.118	23.806	31.3%
	Hub Platform to Noss Head Offshore HDD Break-out Point	34.755	3.371	9.7%
	Caithness-Moray (LT21) Circuit (Noss Head HDD to Portgordon HDD)	110.873	27.177	24.5%

Table 33: Comparison of Estimated Trenching Specification Achievability

The LR Senergy results presented are 'best estimates' based on the currently available geotechnical data and would be subject to review should more route specific data be acquired.

Note that ABB has previously provided preliminary rock quantity data (Ref. 16). Utilising this, as a basis for comparison, Table 34 estimates the percentage of the Caithness-Moray (LT21) route that ABB anticipated would not meet the burial specification through trenching and backfilling alone. Note that there may be some inaccuracy in a direct comparison with the LR Senergy data as the ABB data (Ref. 16) is based on now superseded route parameters (e.g. HDD locations).

Trenching Operation	Route Section	Route Percentage – Burial Specification NOT Achievable
Estimated Achievability of Burial Specification Based on Ploughing and Backfilling Alone *(Based on Previously Supplied ABB Preliminary Rock Requirements)*	Hub Platform to Portgordon Offshore HDD Break-out Point	32.8%
	Hub Platform to Noss Head Offshore HDD Break-out Point	3.1%
	Caithness-Moray (LT21) Circuit (Noss Head HDD to Portgordon HDD)	23.5%

Table 34: ABB Estimated Trenching Specification Achievability

10 Rock Placement Requirement

At any location along the Caithness-Moray (LT21) route where 1.0m depth of cover is not achieved through trenching and backfilling, ABB proposes to construct a rock berm to ensure that adequate protection is afforded to the HVDC cable. This is anticipated to consist of 1” to 5” grade rock.

There are a number of locations along the route where the cable will intentionally not be trenched and instead rock placement will provide the necessary protection. These are detailed as follows:

- From the Noss Head offshore HDD break-out point at KP 112.451 to 100m prior to (west of) the Horse Mussel bed at approximately KP 111.562.
- From 250m prior to the Omega Joint, located at KP 56.695 (Portgordon to Hub Platform route section), until 250m after the Omega Joint.
- It is nominally assumed that rock placement will provide protection from the Portgordon HDD offshore break-out point at approximately KP 1.578 to the 10m LAT water depth contour at approximately KP 3.170.

For trenching zones where the LR Senergy assessment has identified that achieving the 1.8m target trench depth in unlikely, it is assumed that based on the cable properties and lay tolerances, achieving 1.0m DOC will not be possible through mechanical backfill operations alone – discounting potential for any sediment dispersal and trench slumping prior to backfilling. This is due to the condition that even if a maximum trench depth (not DOL) of 1.4m is realised, once factors such as the actual spoil remaining available to provide cover, cable lay accuracy – stated as ±1.0m by ABB (potential for cable to be snaking up the trench wall rather than being located in the centre of the trench), and the cable outside diameter are factored in, it is not considered likely that 1.0m depth of cover will be achieved, therefore additional protection will be required. For these trenching zones, rock placement operations will also be required to ensure adequate protection for the HVDC cable.

Table 35 identifies all locations along the Caithness-Moray (LT21) where rock placement is anticipated to be required, based on LR Senergy’s analysis. In addition, the rock berm height is estimated, based on preliminary design data previously supplied by ABB (Ref. 16).

Route Section	Zone / Location	KP (From)	KP (To)	Zone Length (m)	Berm Height (m)
Portgordon to Hub Platform	HDD to 10m LAT	1.578	3.170	1,592	1.26
	PG2-A	9.190	10.890	1,700	0.83
	PG2-C	15.690	18.390	2,700	0.83
	PG3-A	20.990	22.690	1,700	0.83
	PG3-C	28.690	29.690	1,000	0.83
	PG3-E	36.690	41.190	4,500	0.83
	PG4-A	41.190	42.890	1,700	0.83
	PG4-C	45.690	47.690	2,000	0.83
	Omega Joint	56.445	56.945	500	1.26
	PG4-E	59.690	61.690	2,000	0.83
	PG4-G	71.190	77.696	6,506	0.83
Hub Platform to Noss Head	NH1-B	78.490	78.990	500	0.83
	NH1-D	81.190	81.790	600	0.83
	100m West of Horse Mussel Bed Boundary to Noss Head HDD	111.562	112.451	889	1.26

Table 35: Caithness-Moray (LT21) Route Zones & Locations Requiring Rock Protection

Again based on the preliminary rock berm design data previously supplied by ABB (Ref. 16), berm weight per linear metre is assumed as 5.0Te and 10.2Te for berms of height 0.83m and 1.26m respectively.

LR Senergy has therefore estimated the nominal instantaneous required rock quantities based on the data presented in Table 35 and the aforementioned berm weights. In addition, total rock quantity has been estimated, taking account for oversizing and losses, based on a 30% uplift factor over the instantaneous value. This uplift factor has been applied based on LR Senergy experience of rock placement operations.

The results are presented in Table 36.

Rock Placement	Route Section	Berm Height (m)	Berm Weight per Linear Metre (Te)	Total Rock Berm Length (m)	Rock Quantity (Te)
Instantaneous Quantity	Portgordon Offshore HDD Break-out Point to Hub Platform	0.83	5.0	23,806	119,030
		1.26	10.2	2,092	21,338
	Hub Platform to Noss Head Offshore HDD Break-out Point	0.83	5.0	1,100	5,500
		1.26	10.2	889	9,068
	Caithness-Moray (LT21) Circuit (Noss Head HDD to Portgordon HDD)	0.83	5.0	24,906	124,530
		1.26	10.2	2,981	30,406
Total Quantity (Based on 30% Uplift Factor for Losses, etc.)	Portgordon Offshore HDD Break-out Point to Hub Platform	0.83	5.0	23,806	154,739
		1.26	10.2	2,092	27,739
	Hub Platform to Noss Head Offshore HDD Break-out Point	0.83	5.0	1,100	7,150
		1.26	10.2	889	11,788
	Caithness-Moray (LT21) Circuit (Noss Head HDD to Portgordon HDD)	0.83	5.0	24,906	161,889
		1.26	10.2	2,981	39,528

Table 36: LR Senergy Estimated Rock Quantities

From Table 36, the total instantaneous quantity of rock required from the Caithness-Moray (LT21) circuit is 154,936Te, whilst the total quantity (including allowance for losses, etc.) is 201,417Te, as summarised in Table 37.

Caithness-Moray (LT21) Circuit	LR Senergy Calculated Rock Quantity (Te)
Instantaneous Rock Quantity	154,936
Total Rock Quantity	201,417

Table 37: LR Senergy Calculated Instantaneous and Total Rock Quantity Requirement

Locations highlighted as requiring rock placement are presented in Figure 27 for the Portgordon to Hub Platform route section and in Figure 28 for the Hub Platform to Noss Head route section.

The values in Table 37 can be compared with ABB's previously supplied preliminary rock quantity (Ref. 16), noting that this may now be superseded based on more recent changes in the project route parameters (e.g. HDD locations).

ABB's preliminary rock quantity is presented in Table 38. Note that only an instantaneous quantity was presented.

Caithness-Moray (LT21) Circuit	ABB Preliminary Rock Quantity (Te)
Instantaneous Rock Quantity	152,620
Total Rock Quantity	*Not Provided*

Table 38: ABB Preliminary Rock Quantity (Ref. 16)

Note that the ABB rock quantity in Table 38 was based on significant rock placement operations in soil zone PG3 along the Portgordon to Hub Platform route section, where ABB stated target tool depth would not be achieved. PG3 is a clay dominated soil zone and the LR Senergy assessment contained within this report indicates that not achieving target tool depth is potentially of a lower risk within lengths of PG3 compared to other isolated route sections. This document therefore contains the latest assessment of rock for the Caithness-Moray route.

To provide further clarification of the anticipated rock quantities required for the Caithness-Moray (LT21) circuit, Table 39 presents a breakdown of the rock requirements both within the 12 nautical mile (nm) territorial limit and also out-with the 12nm limit.

LT21 Circuit Section	Rock Quantity – Instantaneous (Te)	Rock Quantity – Total (Te)
Portgordon Offshore HDD Pop-out to Moray 12nm Limit	51,738	67,260
Moray 12nm Limit to Caithness 12nm Limit	94,130	122,369
Noss Head Offshore HDD Pop-out to Caithness 12nm Limit	9,068	11,788

Table 39: Rock Quantities Within and Out-with the 12nm Territorial Limit

11 Conclusions and Recommendations

11.1 Conclusions

This document presents a burial risk assessment for the Caithness-Moray (LT21) circuit, based on the available survey and geotechnical datasets, burial protection index study and ABB's installation methodology. It provides an estimate of the achievability of ploughing to the target tool depth of 1.8m along the Caithness-Moray (LT21) HVDC circuit route, thus the achievability of the required 1.0m depth of cover over the cable to provide adequate protection.

A detailed evaluation of the geotechnical data, along with the survey alignment charts, has resulted in the determination of eight soil zones along the Caithness-Moray (LT21) circuit, with four located in each of the route sections – Portgordon to Hub Platform and Hub Platform to Noss Head. These soils zones have been further sub-divided into trenching zones, based on a pre-lay ploughed approach.

It is noted that there is a significant limitation in the ability to accurately predict soil conditions along the circuit due to the lack of laboratory testing undertaken on the acquired samples, particularly the lack of PSD data to determine fines content within cohesionless soils - fines content can have a significant impact on ploughing operations. This is combined with large data gaps along the Hub Platform to Noss Head route section.

The burial assessment has considered the installation contractor's current installation methodology. LR Senergy estimates that, theoretically, 75.5% of the Caithness-Moray (LT21) circuit could potentially achieve the burial specification based on trenching and mechanical backfilling (excluding any sediment losses), between the two offshore HDD break-out locations at Portgordon and Noss Head. This discounts any areas where ABB will intentionally not trench the HVDC cable (e.g. Omega Joint location).

Those route zones where the burial specification is not anticipated to be met, as well as those locations highlighted in this report where trenching will not be attempted, will require rock placement to ensure adequate cable protection from external threats.

Based on LR Senergy's assessment, the required quantity of rock amounts to 154,936Te (instantaneous) and 201,417Te (total). The total quantity is based on a 30% uplift factor for oversizing and losses.

11.2 Recommendations

ABB's installation methodology document (Ref. 1) currently contains numerous data gaps, particularly in relation to the defined route, joint location and HDD points. However, this revision (Rev. 2) of this burial risk assessment report does include the RPL output from ABB's recently completed detailed route engineering (Ref. 2) and it is expected that ABB's installation methodology document (Ref. 1) will subsequently be updated accordingly during Q4 2015.

Due to the limited geotechnical data along the circuit, it is highly recommended that the installation contractor undertakes their own burial assessment to demonstrate their ability to meet the burial specification based on the installation asset. This should be supplemented with their updated estimation of required rock protection.

As detailed in a separate LR Senergy study investigating the potential for sediment mobility along the Caithness-Moray (LT21) circuit (Ref. 7), and noted within this report (Sections 7.1.1.2 and 9.3.2), it is recommended that the duration between ploughing, cable lay and backfilling is kept to a minimum to ensure maximum spoil is available for backfill, as well as to minimise premature infill of the trench. It is understood that the installation contractor has considered this factor and the latest installation schedule (Ref. 17, see Appendix 4) reduces these periods between operations, compared to those previously anticipated.

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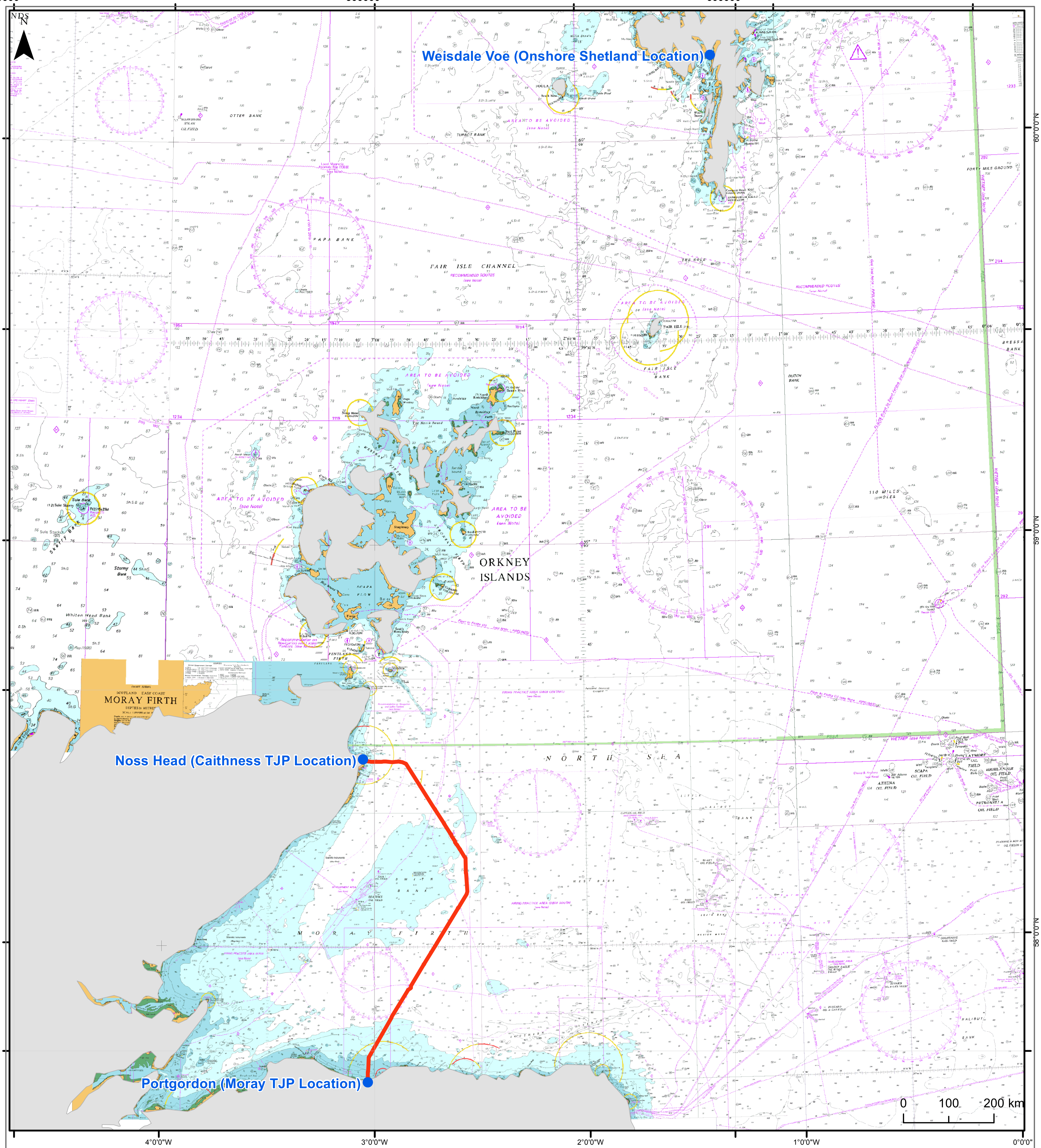
13 Figures



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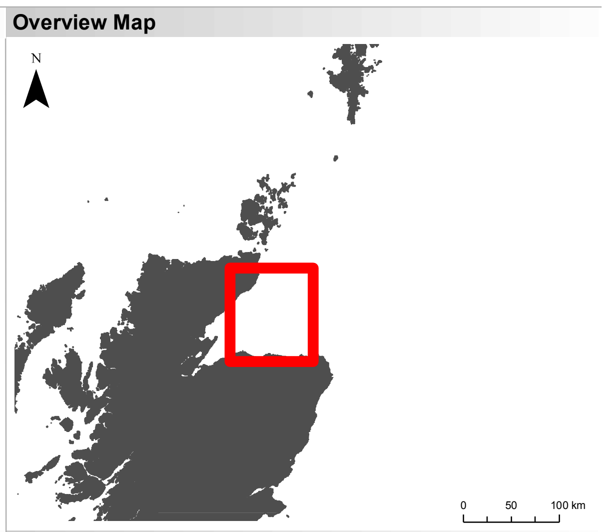
Legend

● Key Locations

HDVC Cable Route Alignment (ABB A05)

Overview Map



Title

Figure 3: General Location Map - CMS Project

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-03-03

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
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Data Sources, Acknowledgements & Notes

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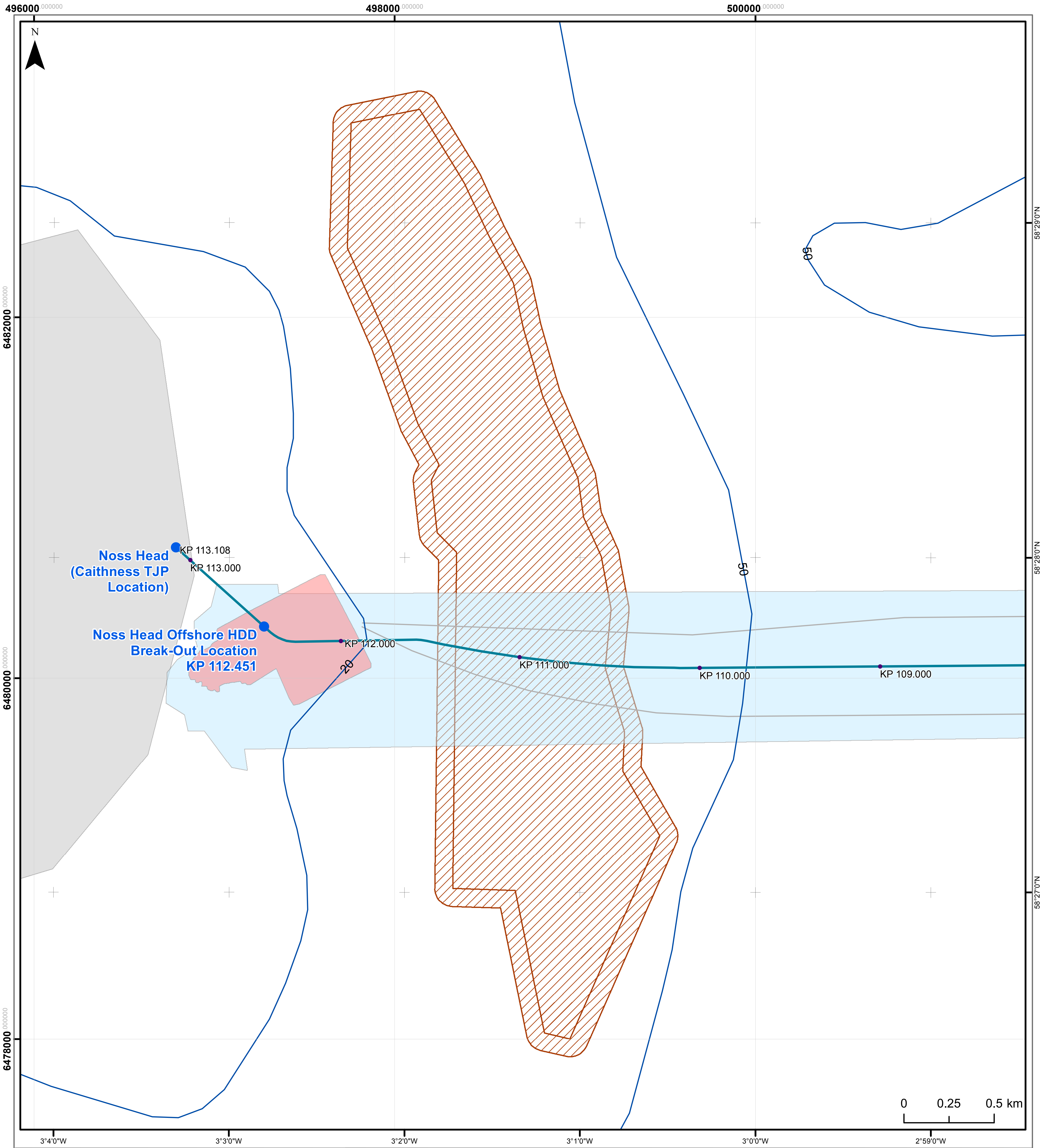

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Title

Figure 4: Noss Head Landfall Detail

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-04-04

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
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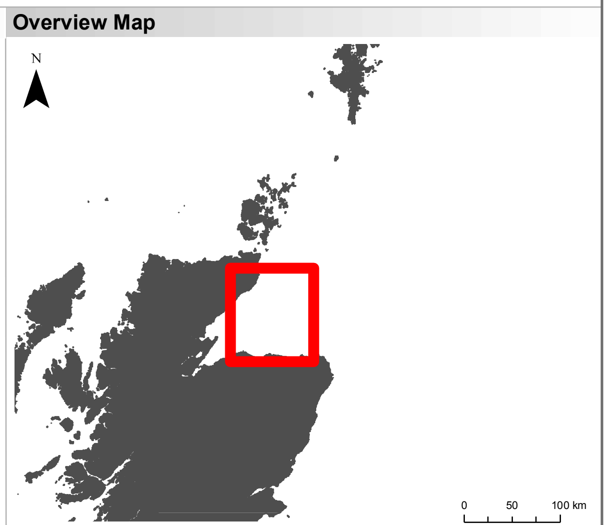
Legend

- Key Locations
- Portgordon to Noss Head Route KP 1km
- HDVC Cable Route Alignment (ABB A05)
- Bathymetry Contours
- Hub to Noss Head Survey 'North' and 'South' Alignments
- MMT 2012 Nearshore Survey Area
- MMT 2010 Hub to Noss Head Survey Corridor
- Horse Mussel Bed (MPA)

Data Sources, Acknowledgements & Notes

Overview Map



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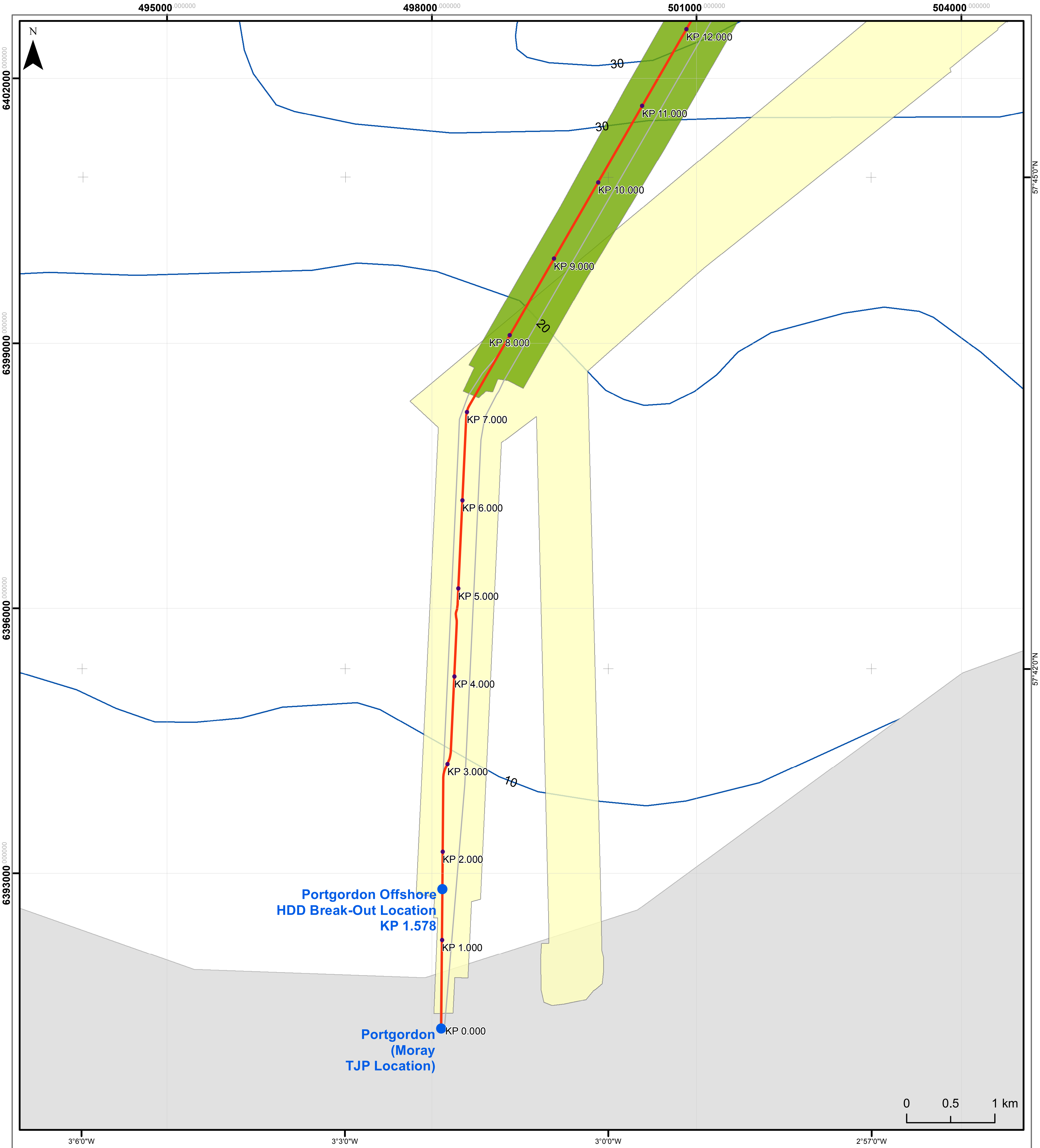

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Title

Figure 5: Portgordon Landfall Detail

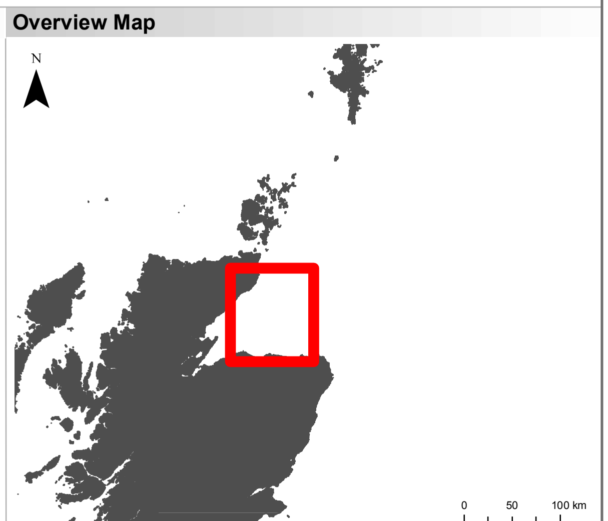
Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-04-04

Legend

- Key Locations
- Portgordon to Noss Head Route KP 1km
- HDVC Cable Route Alignment (ABB A05)
- Portgordon to Hub "West and East" Alignments
- MMT 2012 Hub to Portgordon Survey Corridor
- MMT 2008 Survey - Nearshore Portgordon
- Bathymetry Contours

Overview Map



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Datum: WGS 1984 / **Ellipsoid:** WGS84
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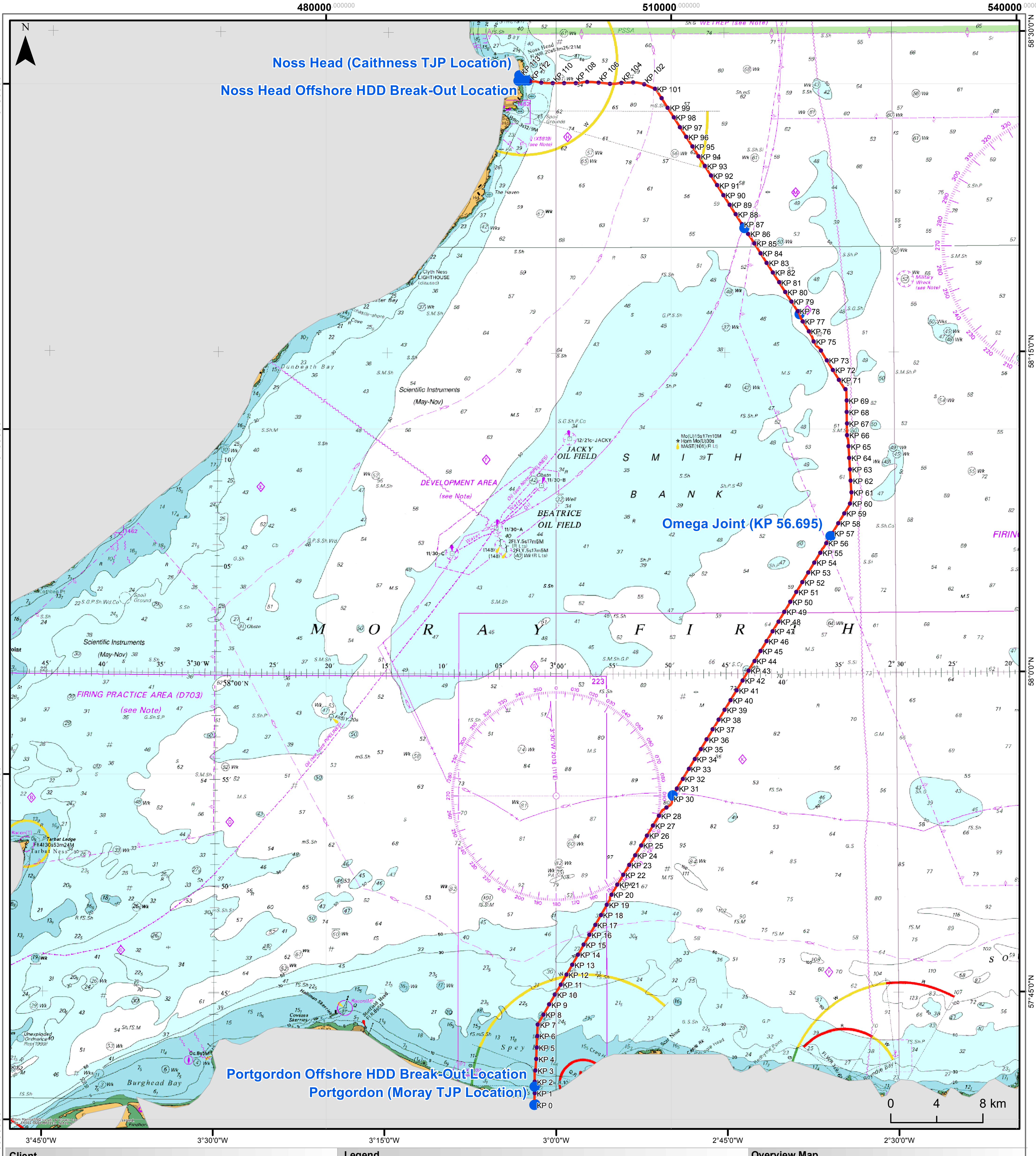

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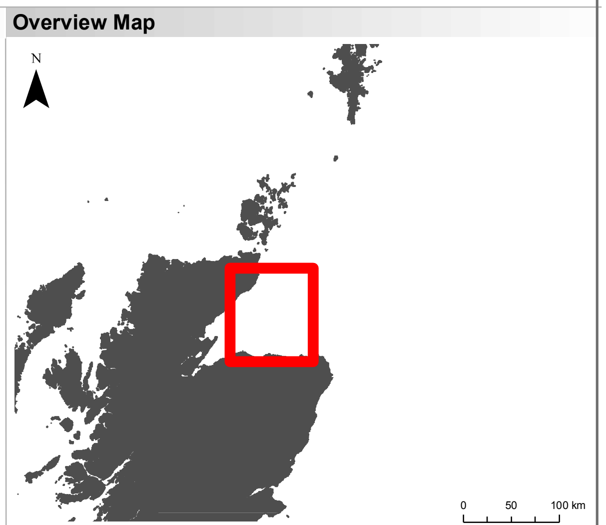
Title

Figure 6: Caithness-Moray (LT21) Route Alignment

Legend

- Key Locations
- Portgordon to Noss Head Route KP 1km
- Portgordon to Noss Head Alignment

Overview Map



Project/Report Information

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Project No	: 2492
Location	: UKCS, Moray Firth, Portgordon to Noss Head
Figure	: 2492-SSE-FIG-06-04

Geodetic Information

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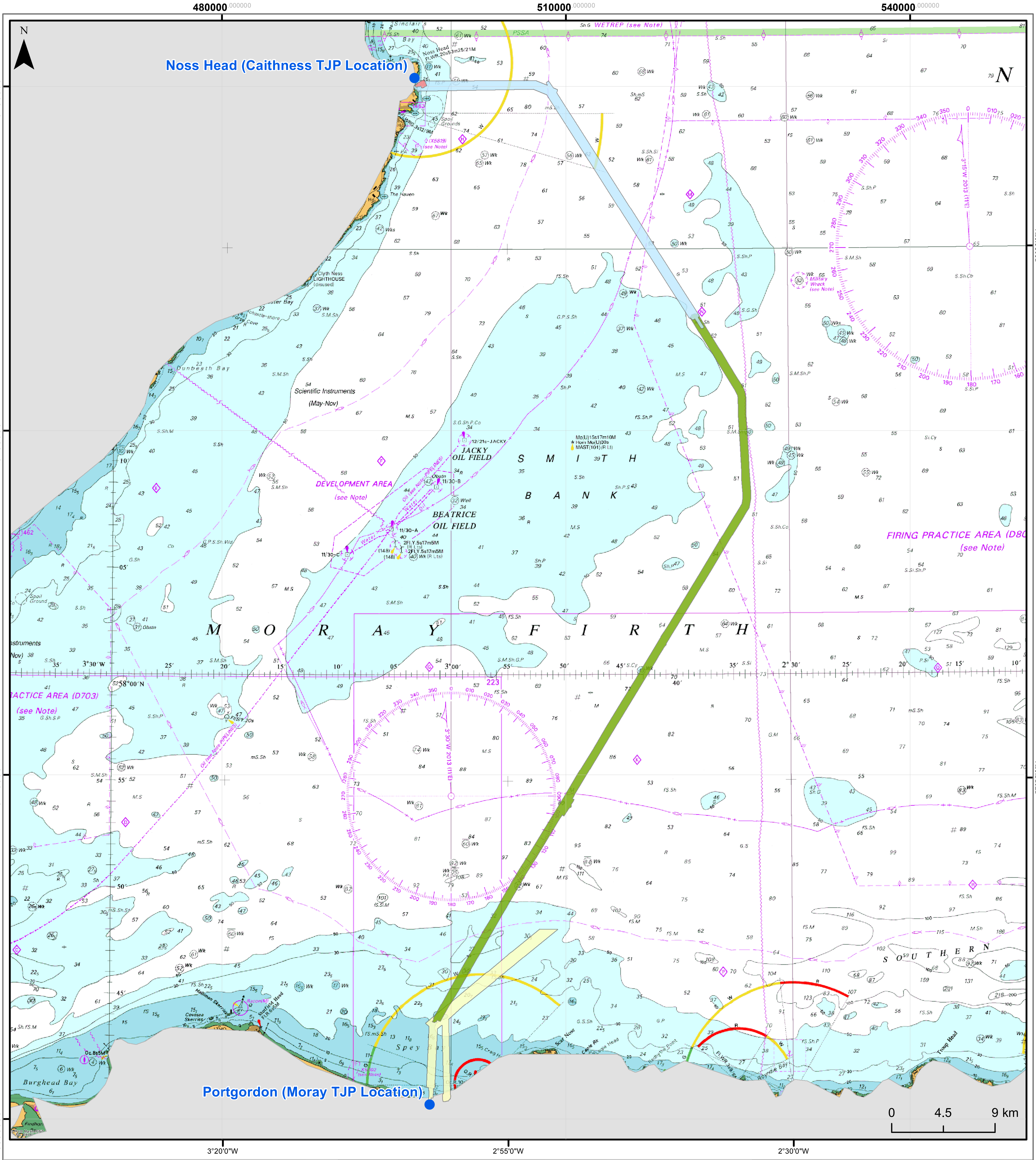

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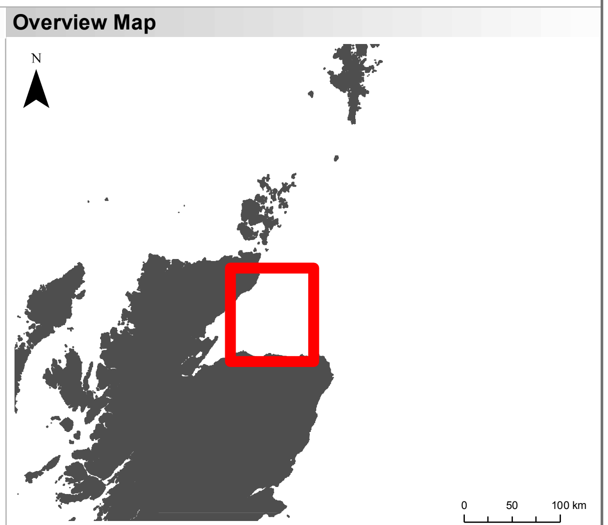
Figure 7: Caithness-Moray (LT21) - Overview of Survey Datasets

Legend

- Key Locations
- MMT 2012 Nearshore Survey Area
- MMT 2010 Hub to Noss Head Survey Corridor
- MMT 2012 Hub to Portgordon Survey Corridor
- MMT 2008 Survey - Nearshore Portgordon

Overview Map



Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-07-03

Geodetic Information

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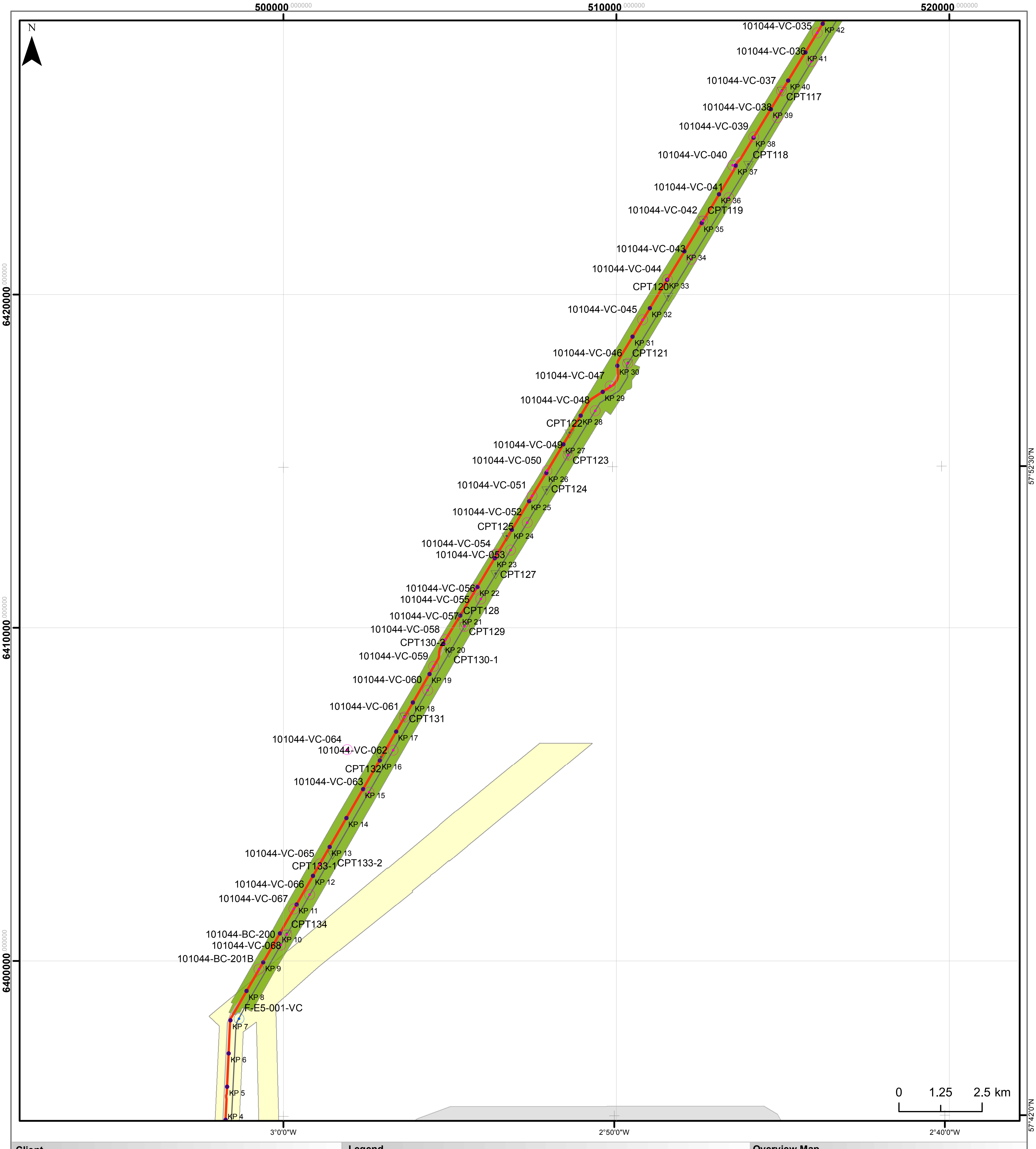

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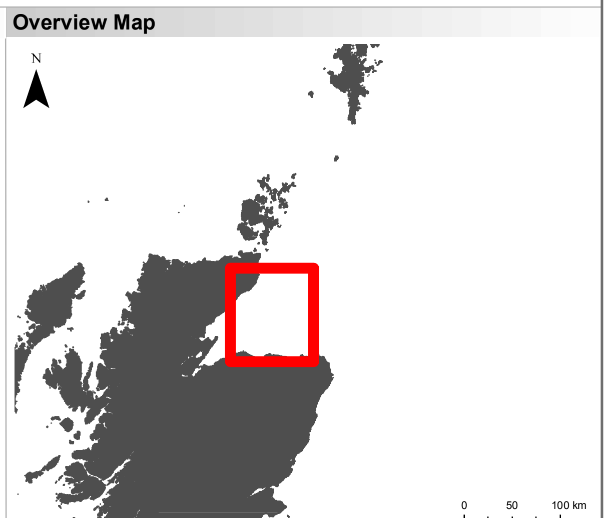
Figure 8: Hub Platform to Portgordon Geotechnical Overview (1 of 2)

Legend

- Key Locations
- Portgordon to Noss Head Route KP 1km
- MMT 2008 Survey Geotechnical Location
- MMT 2012 VC & BC Locations
- MMT 2012 CPT Locations
- HDVC Cable Route Alignment (ABB A05)
- Portgordon to Hub "West and East" Alignments
- MMT 2012 Hub to Portgordon Survey Corridor
- MMT 2008 Survey - Nearshore Portgordon

Overview Map



Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-08-04

Geodetic Information

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Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
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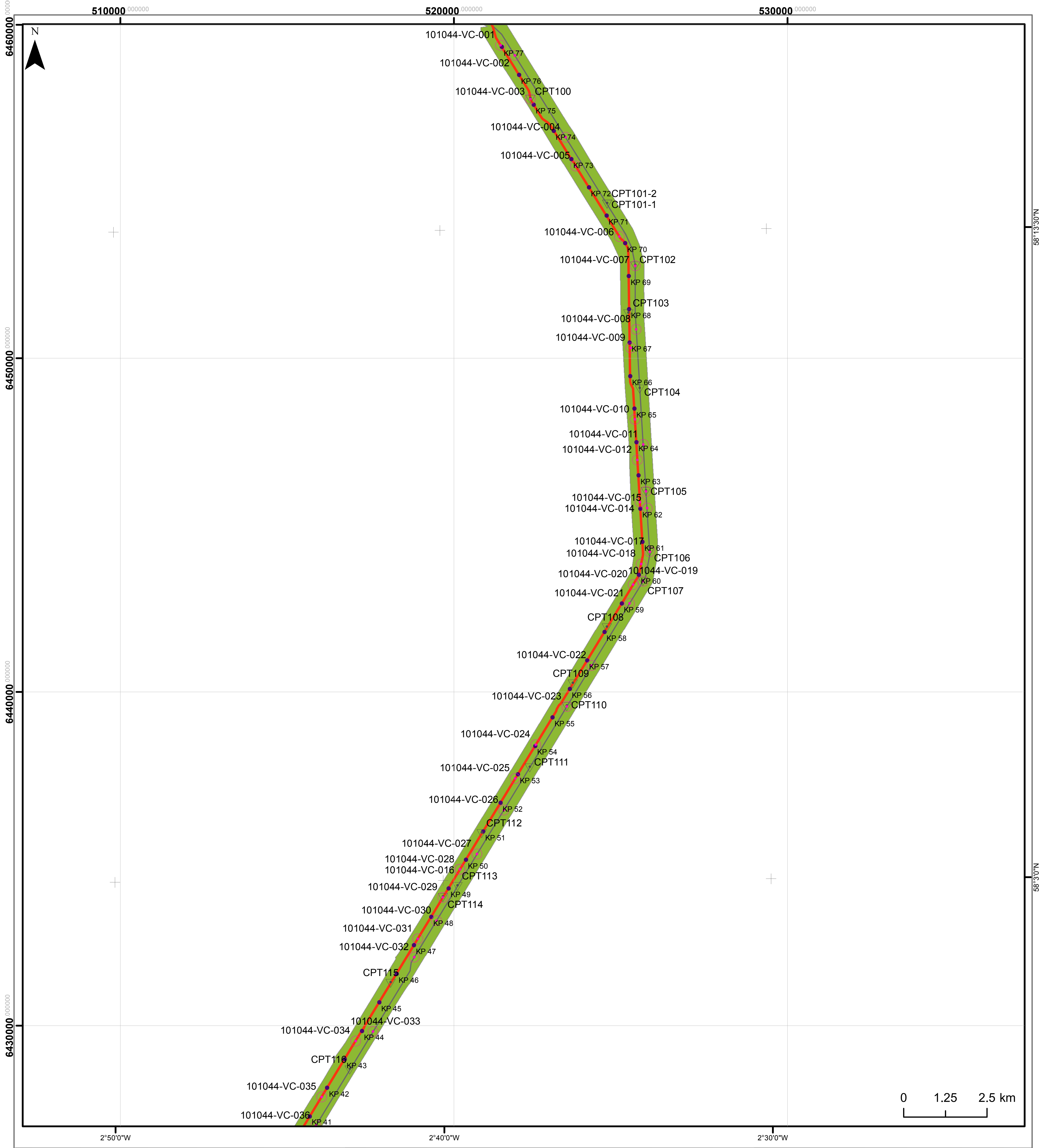

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Title

Figure 9: Hub Platform to Portgordon Geotechnical Overview (2 of 2)

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-09-04

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
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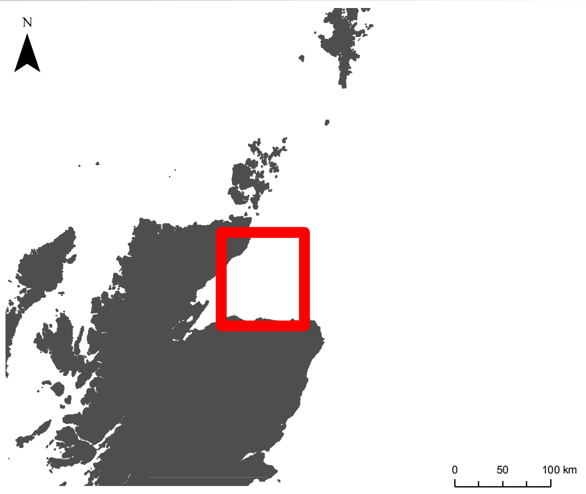
Legend

- Portgordon to Noss Head Route KP 1km
- Key Locations
- MMT 2012 VC Locations
- MMT 2012 CPT Locations
- HVDC Cable Route Alignment (ABB A05)
- Portgordon to Hub Survey 'West' and 'East' Alignments
- MMT 2012 Hub to Portgordon Survey Corridor
- MMT 2008 Survey - Nearshore Portgordon

Data Sources, Acknowledgements & Notes

Overview Map



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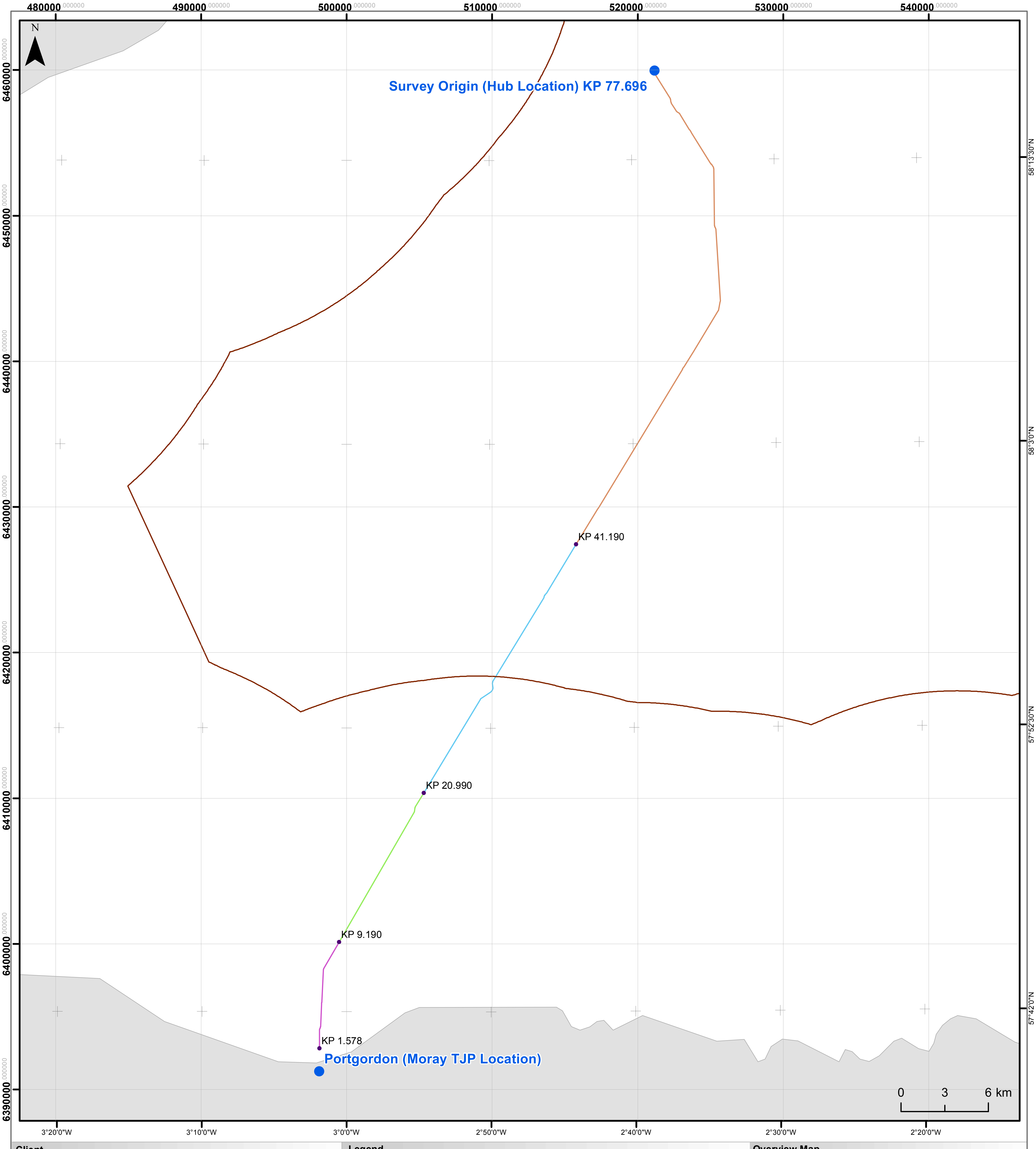

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Power Distribution

Title

Figure 10: Soil Zones - Portgordon to Hub Platform Route Section

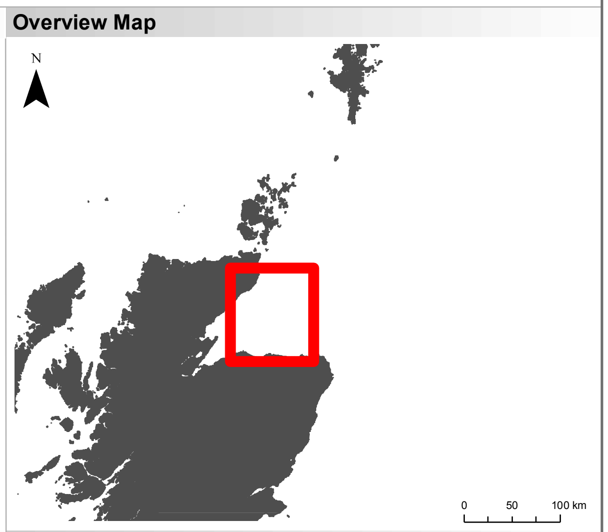
Legend

- Key Locations
- Soil Zone KPs
- 12nm

Portgordon to Hub Platform Soil Zones

- PG1
- PG2
- PG3
- PG4

Overview Map



Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-10-03

Geodetic Information

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Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
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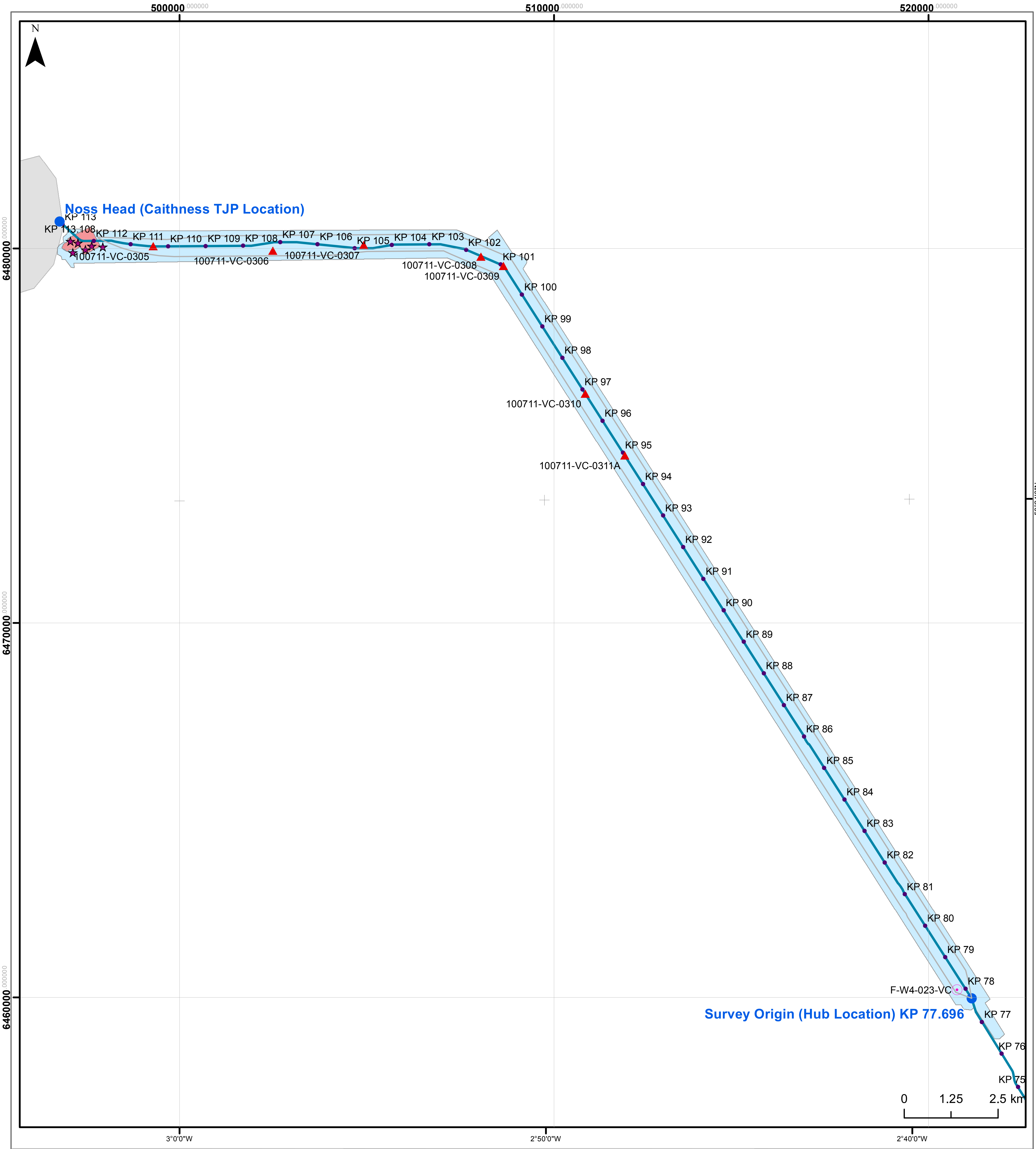


Client

Scottish and Southern Energy
Power Distribution

Title

Figure 11: Hub Platform to Noss Head Geotechnical Overview (1 of 2)

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-11-03

Geodetic Information

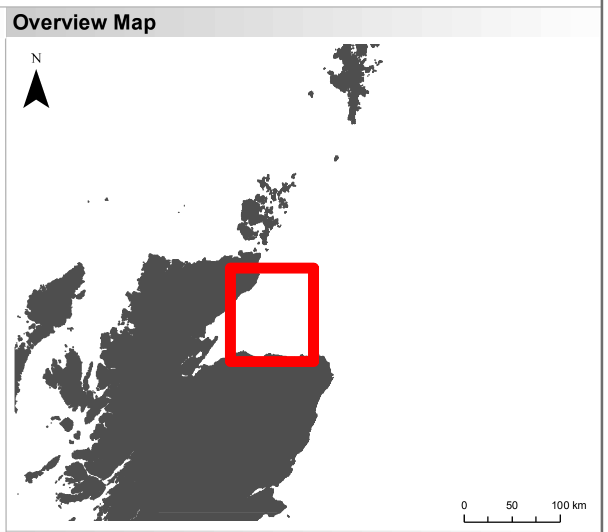
Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Legend

- Key Locations
- Portgordon to Noss Head Route KP 1km
- MMT 2010 VC Locations
- MMT 2010 GS Locations
- MMT 2008 Survey Geotechnical Location
- HDVC Cable Route Alignment (ABB A05)
- Hub to Noss Head 'North' and 'South' Alignments
- MMT 2012 Nearshore Survey Area
- MMT 2010 Hub to Noss Head Survey Corridor

Data Sources, Acknowledgements & Notes

Overview Map



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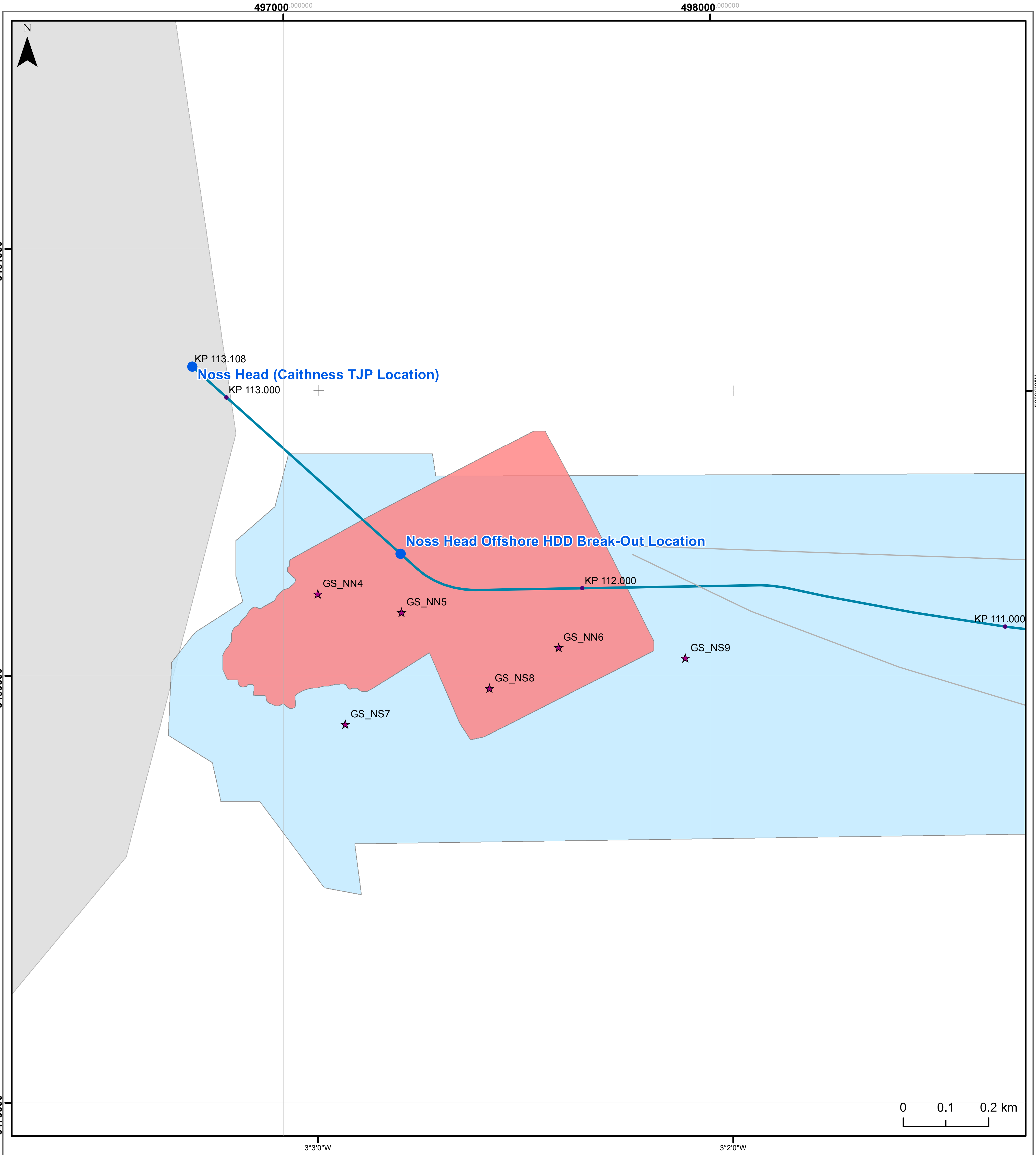


Client

Scottish and Southern Energy Power Distribution

Title

Figure 12: Hub Platform to Noss Head Geotechnical Overview (2 of 2)

Project/Report Information

Project Name	: Caithness - Moray (LT21) Burial Risk Assessment
Project No	: 2492
Location	: UKCS, Moray Firth, Portgordon to Noss Head
Figure	: 2492-SSE-FIG-12-03

Geodetic Information

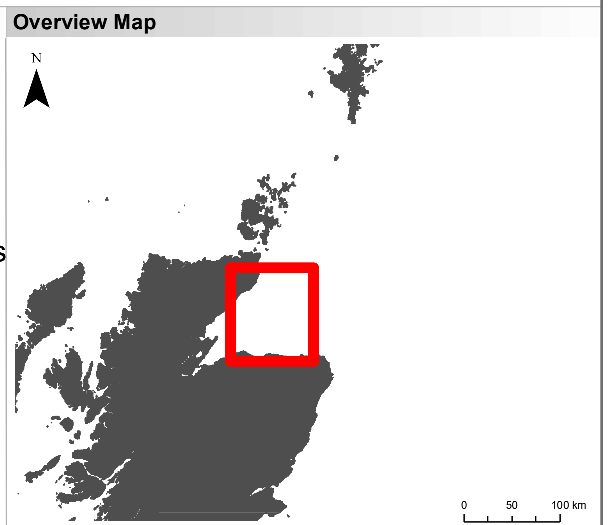
Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Legend

- Portgordon to Noss Head KP 1km
- MMT 2010 GS Locations
- Key Locations
- Hub to Noss Head Survey 'North' and 'South' Alignments
- HDVC Cable Route Alignment (ABB A05)
- MMT 2012 Nearshore Survey Area
- MMT 2010 Hub to Noss Head Survey Corridor

Data Sources, Acknowledgements & Notes

Overview Map



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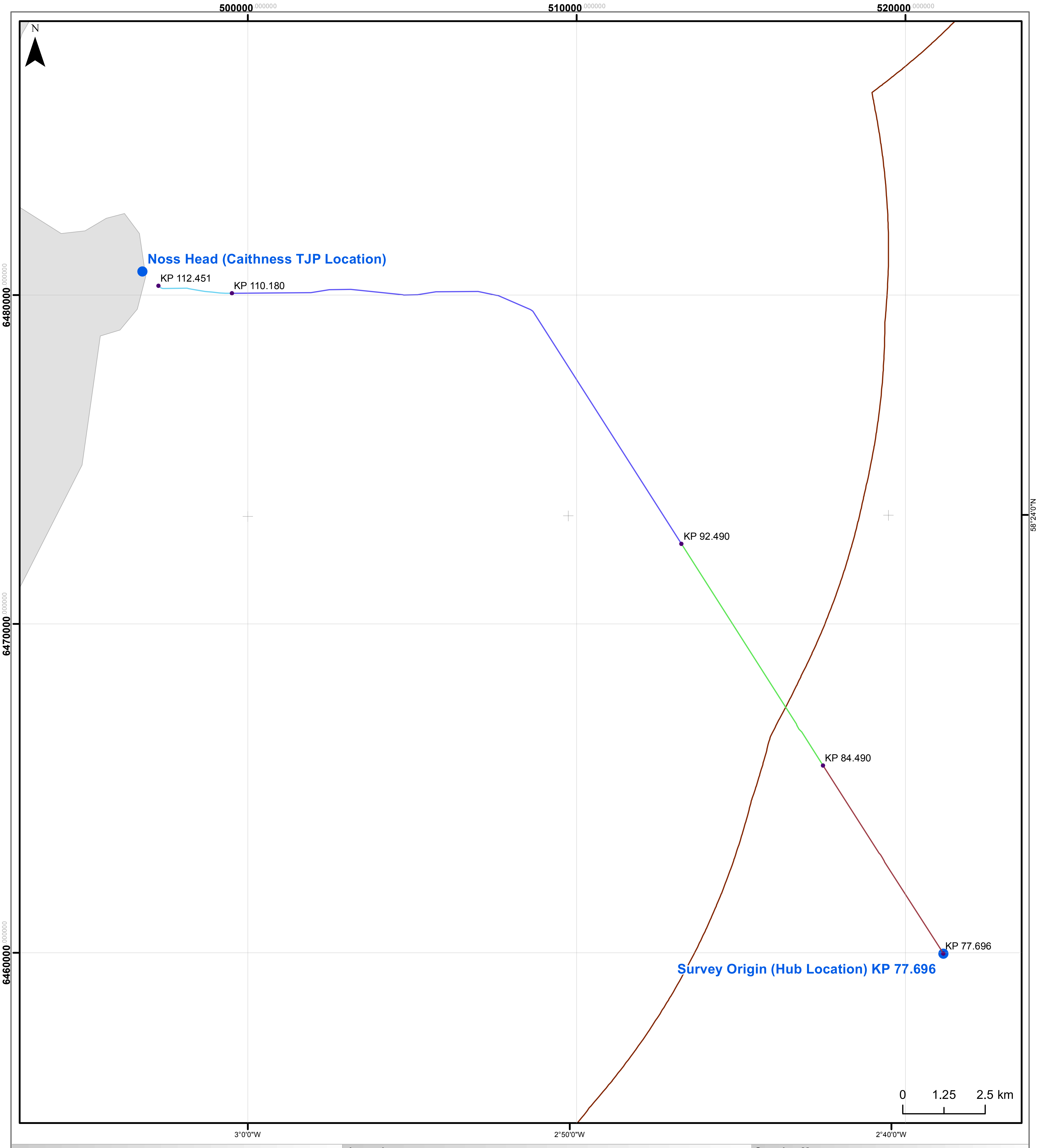

Client

Scottish and Southern Energy
Power Distribution

Title

Figure 13: Soil Zones - Hub Platform to Noss Head Route Section

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-13-03

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Legend

- Soil Zone KPs
- Key Locations
- 12nm

Hub Platform to Noss Head Soil Zones

- NH1
- NH2
- NH3
- NH4

Data Sources, Acknowledgements & Notes

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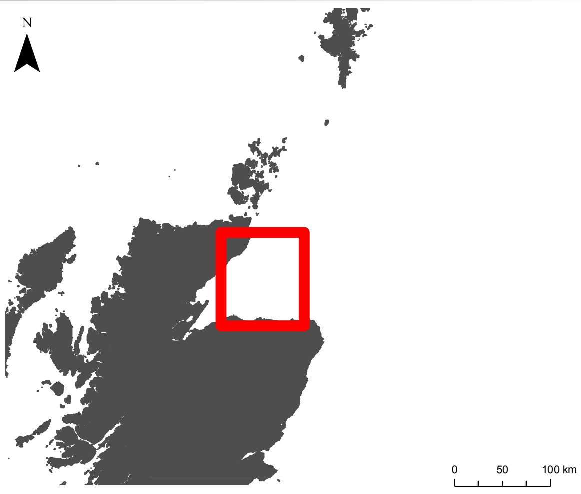
EH (http://www.english-heritage.org.uk/); KISCA

Overview Map



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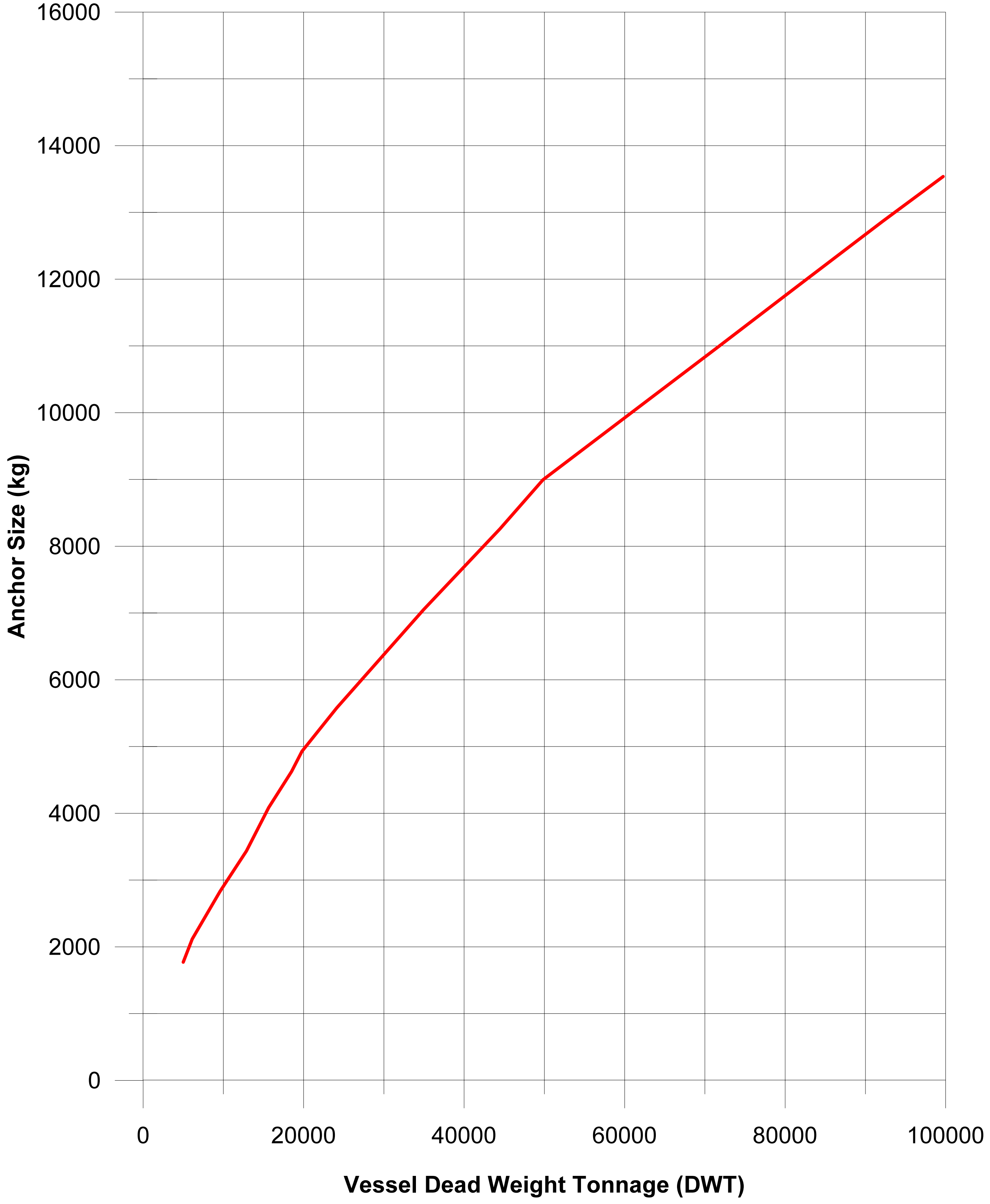
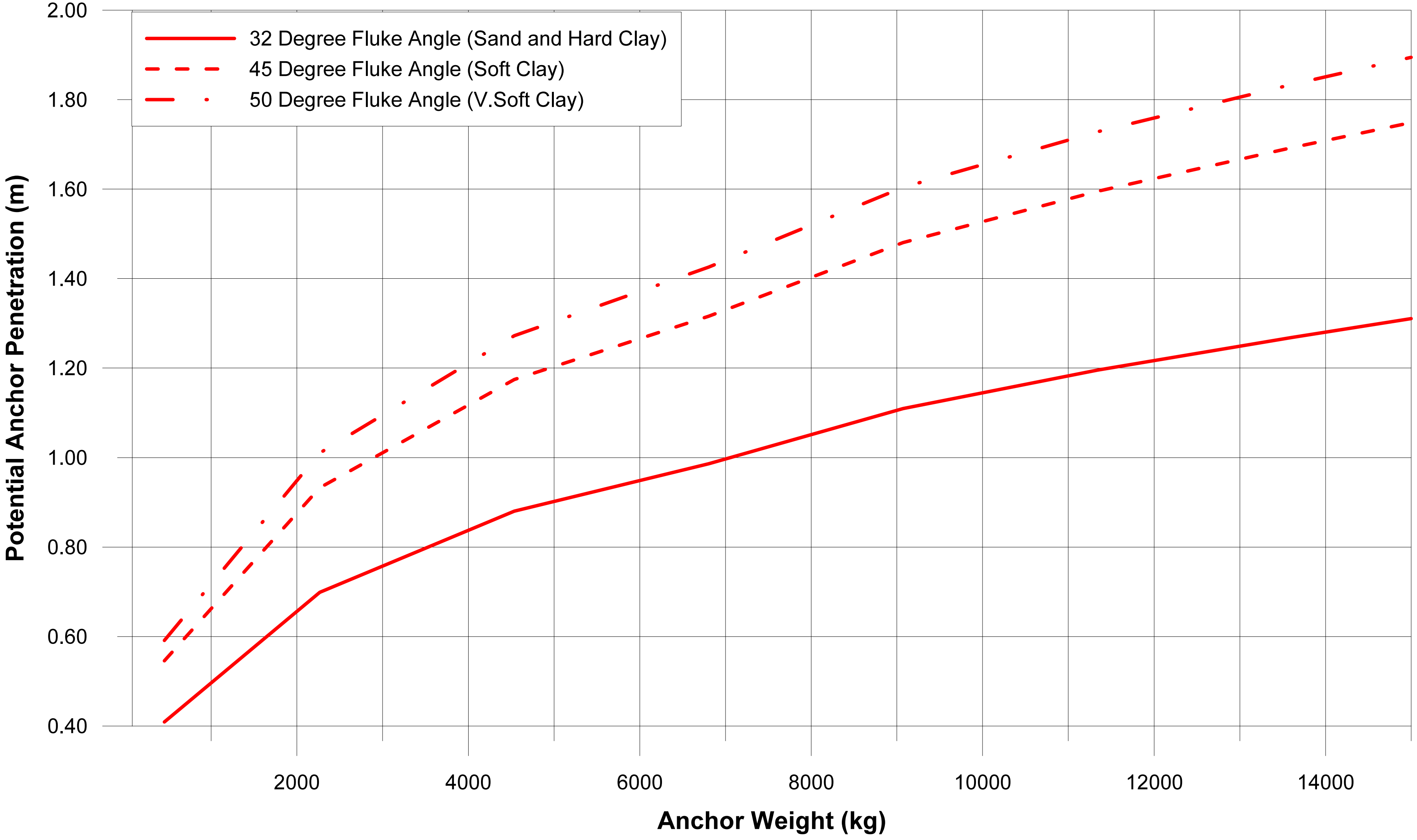
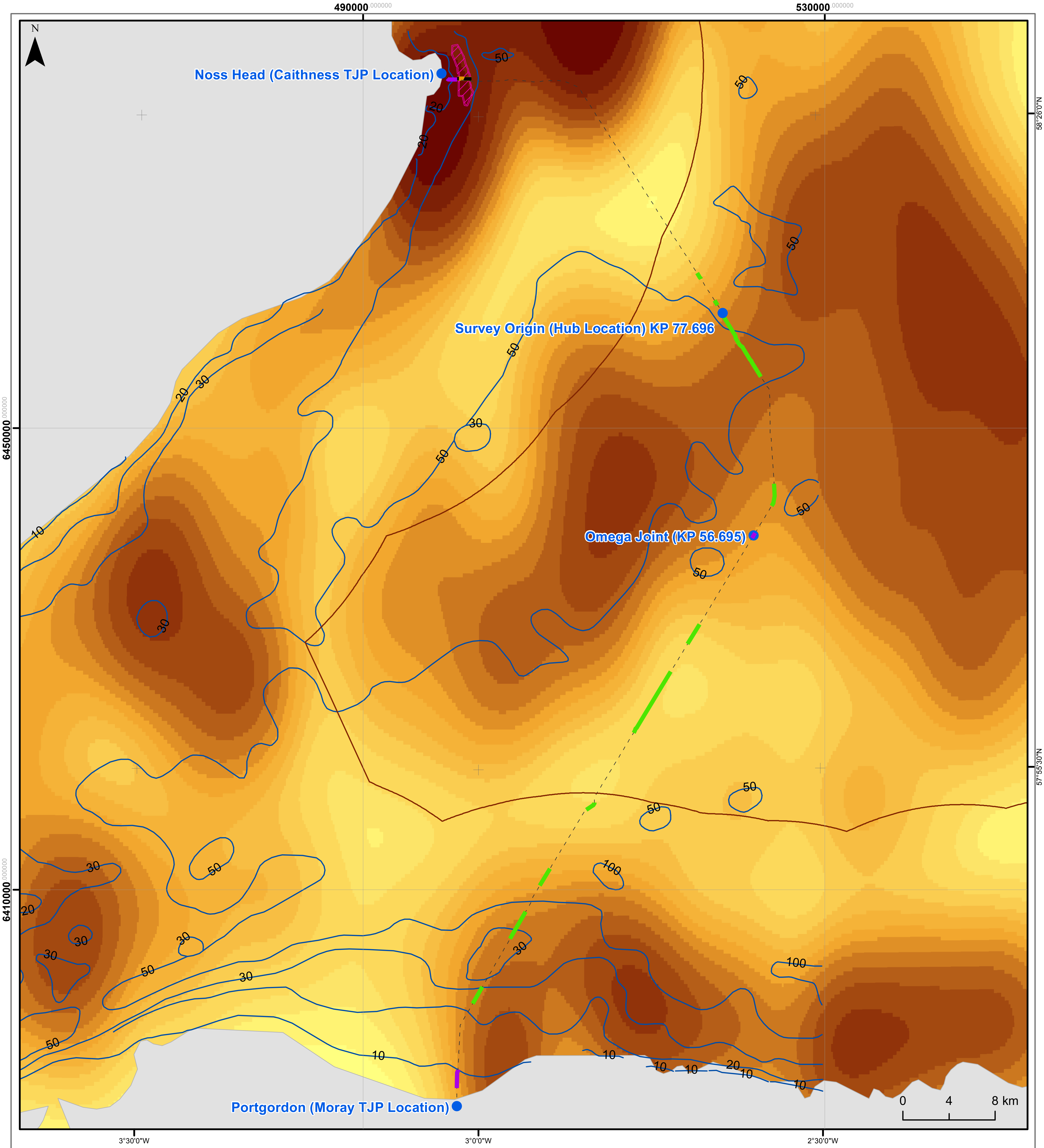


Client:	**Figure 17 - Approximate Anchor Size by Vessel DWT**			
Scottish and Southern Energy Power Distribution	Drawn: [redacted]	**Project:** Caithness-Moray (LT21) Burial Risk Assessment	Date: 27/11/2015	Senergy A member of the Lloyd's Register group
	Checked: [redacted]		Revision: 02	
	Approved: [redacted]	**Report:** 2492-SSE-RPT-02	Figure No: 17	



Client: Scottish and Southern Energy Power Distribution	**Figure 18 - Anchor Penetration (Flukes Only)**	Drawn: [redacted]	Date: 27/11/2015	Senergy A member of the Lloyd's Register group
		Checked:	Revision: 02	
Report No: 2492-SSE-RPT-02	Project: Caithness-Moray (LT21) Burial Risk Assessment	Approved:	Figure No: 18	



Client

Scottish and Southern Energy
Power Distribution

Title

Figure19: Rock Placement Locations with Scallop Trawling Intensity

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-19-04

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Legend

- Key Locations
- HDVC Cable Route Alignment (ABB A05)
- Mussel Bed Uraduct
- 12nm
- Bathymetry contours
- Horse Mussel Bed (MPA)

Scallop Intensity

LOW
MEDIUM
HIGH

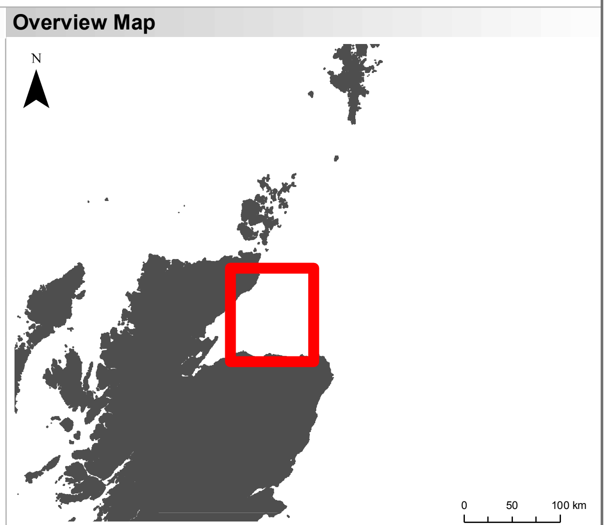
Berm Properties

- Rock Berm Height = 0.83m
- Rock Berm Height = 1.26m

Data Sources, Acknowledgements & Notes

KISCA Data from Marine Scotland: VMS – Annual Fishing Intensity (2009-2013) & ScotMap – Inshore Fisheries Mapping (2007-2011)

Overview Map



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Approved By
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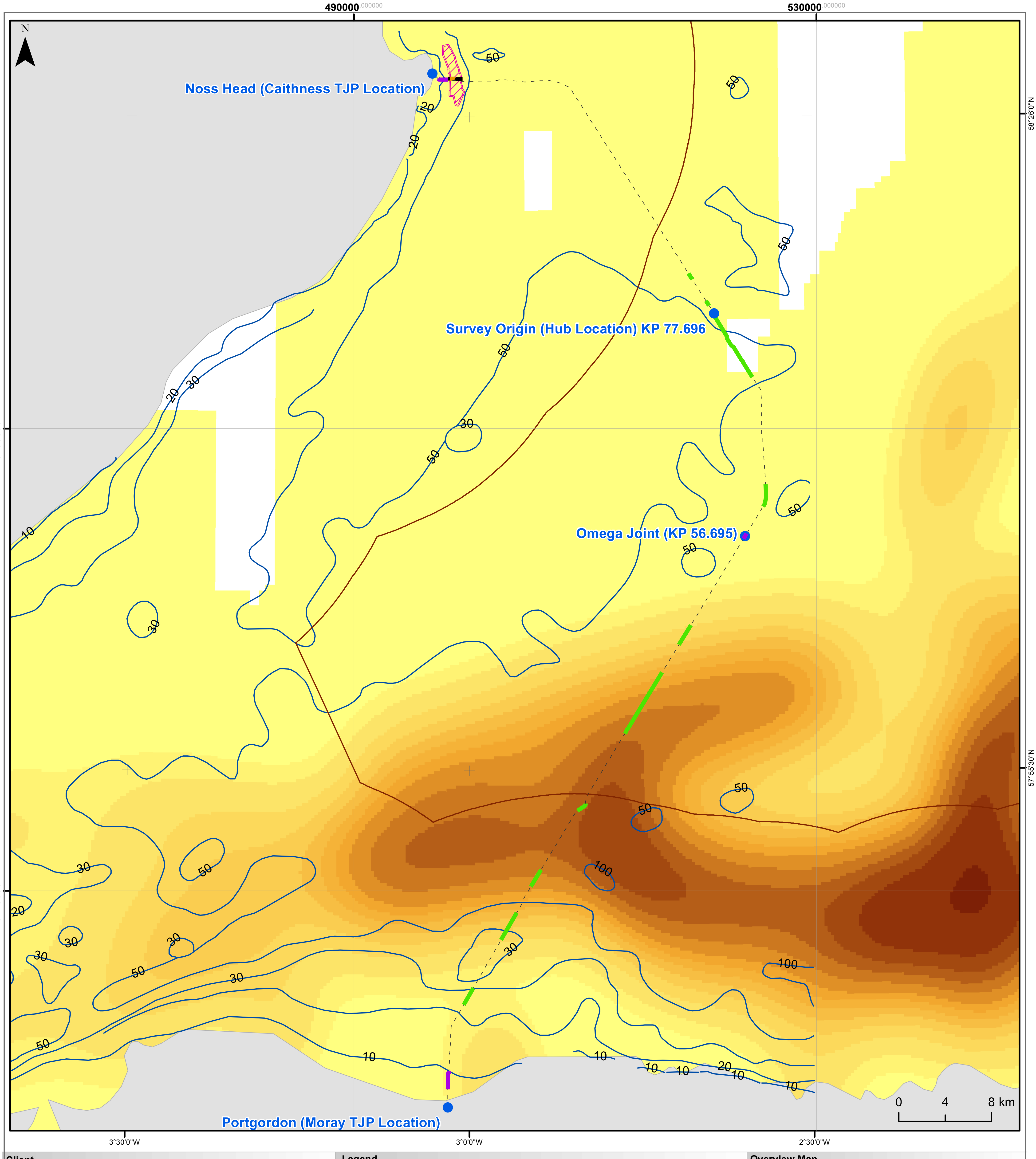
Source MXD: R:\SSE\2492-0915-SSE_Caithness-Port_Gordon\02_data_authored\Fig19_Scallop_Intensity.mxd



Client

Scottish and Southern Energy
Power Distribution

Title

Figure 20: Rock Placement Locations with Nephrops Trawling Intensity

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-20-04

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Legend

- Key Locations
- HDVC Cable Route Alignment (ABB A05)
- Mussel Bed Uraduct
- 12nm
- Bathymetry contours
- Horse Mussel Bed (MPA)

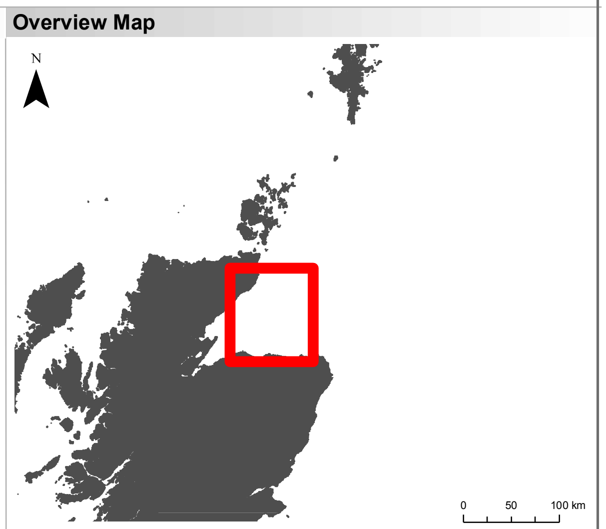
Berm Properties

- Rock Berm Height = 0.83m
- Rock Berm Height = 1.26m

Nephrops Trawling Intensity

LOW
MEDIUM
HIGH

Overview Map



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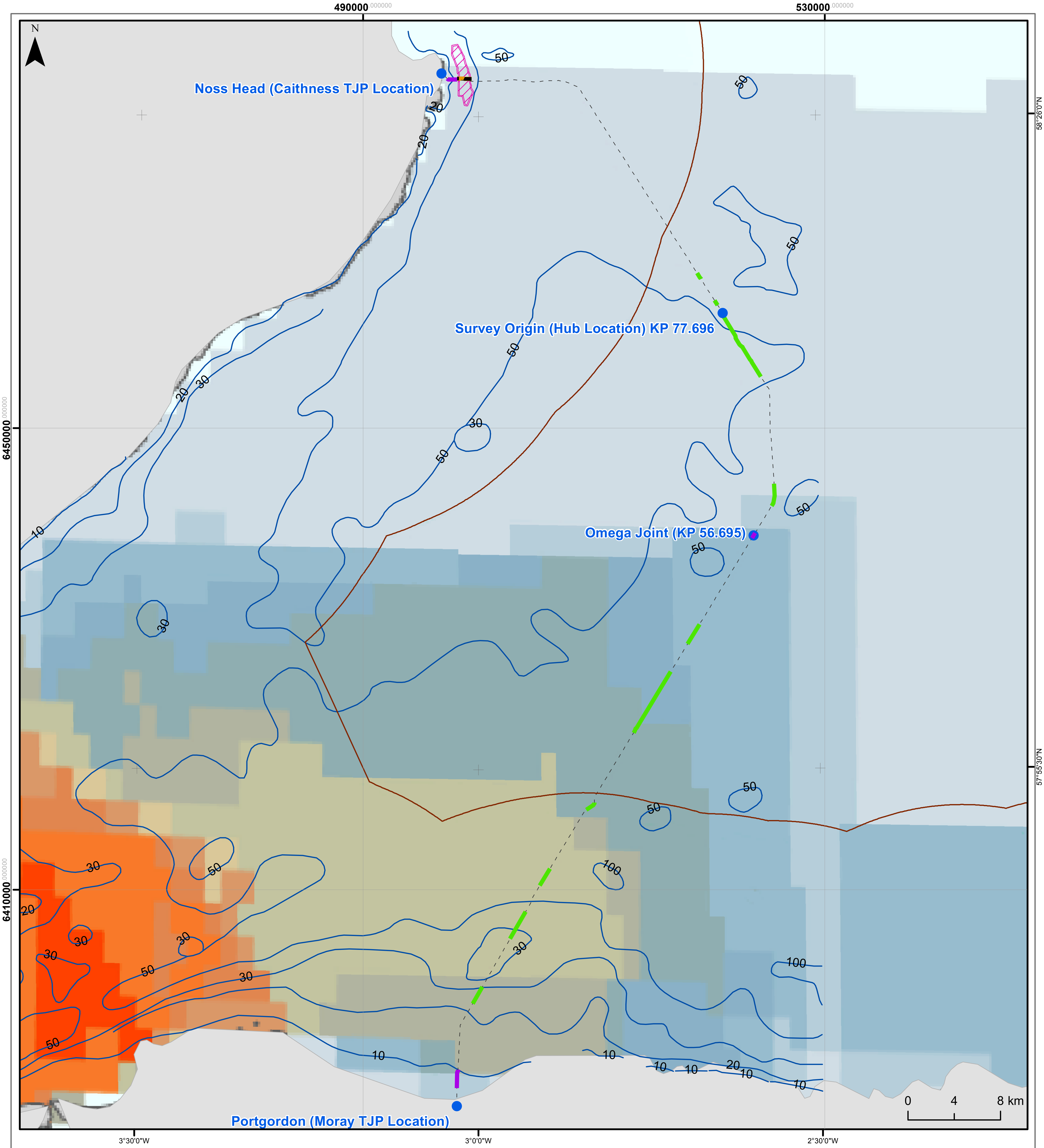
Data Sources, Acknowledgements & Notes

Source MXD: R:\SSE\2492-0915-SSE_Caithness-Port_Gordon\02_data_authored\Fig20_Nephrops_Intensity.mxd



Client

Scottish and Southern Energy
Power Distribution

Title

Figure 21: Rock Placement Locations with Nephrops Trawling Areas (<15m Vessels)

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-21-04

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Legend

- Key Locations
- HDVC Cable Route Alignment (ABB A05)
- Mussel Bed Uraduct
- 12nm
- Bathymetry contours
- Horse Mussel Bed (MPA)

ScotMap - Landings Value distribution for Nephrops trawling £/ cell
LOW
MEDIUM
HIGH

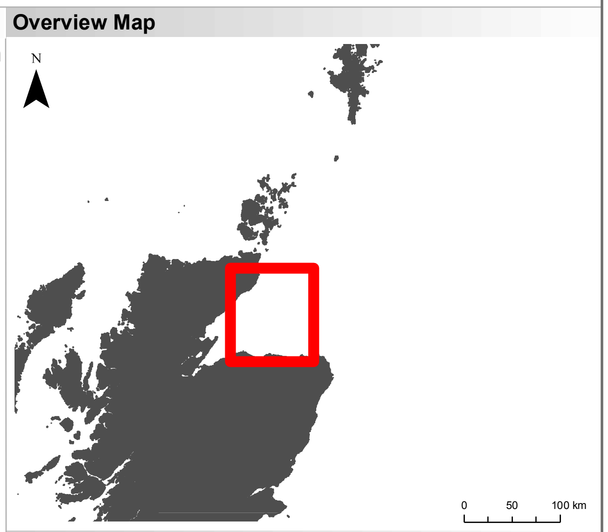
Berm Properties

- Rock Berm Height = 0.83m
- Rock Berm Height = 1.26m

Data Sources, Acknowledgements & Notes

KISCA Data from Marine Scotland: VMS – Annual Fishing Intensity (2009-2013) & ScotMap – Inshore Fisheries Mapping (2007-2011)

Overview Map



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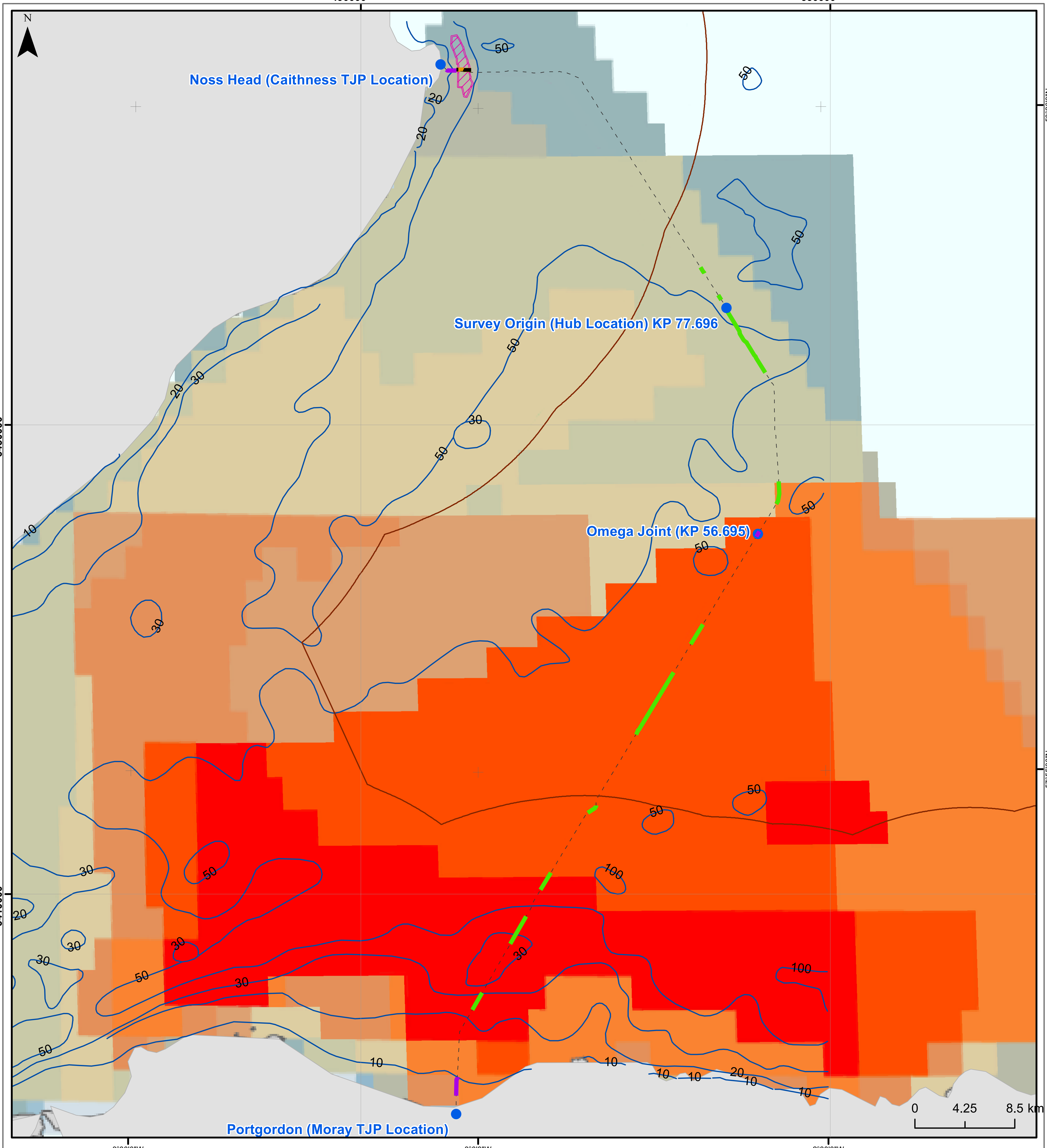


Client

Scottish and Southern Energy
Power Distribution

Title

Figure 22: Rock Placement Locations with 'Other' Trawling (<15m Vessels)

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-22-04

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Legend

- Key Locations
- HDVC Cable Route Alignment (ABB A05)
- Mussel Bed Uraduct
- 12nm
- Bathymetry contours
- Horse Mussel Bed (MPA)

ScotMap - Landings Value distribution for trawling (other) £/ cell

LOW
MEDIUM
HIGH

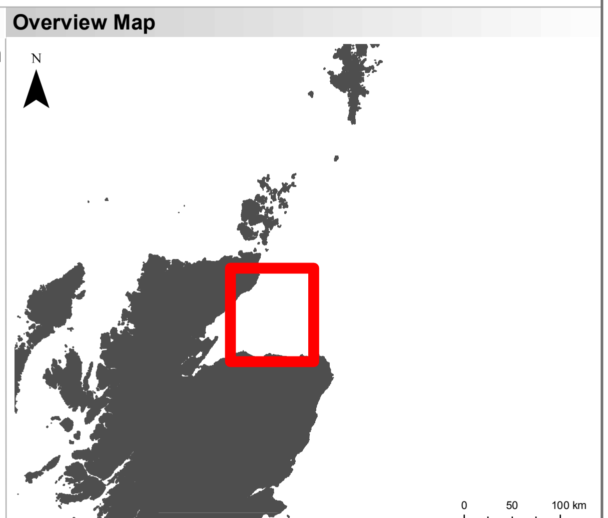
Berm Properties

- Rock Berm Height = 0.83m
- Rock Berm Height = 1.26m

Data Sources, Acknowledgements & Notes

KISCA Data from Marine Scotland: VMS – Annual Fishing Intensity (2009-2013) & ScotMap – Inshore Fisheries Mapping (2007-2011)

Overview Map



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Authored By : [redacted]
Checked By [redacted]
Approved By [redacted]
Date [redacted] 12/2015

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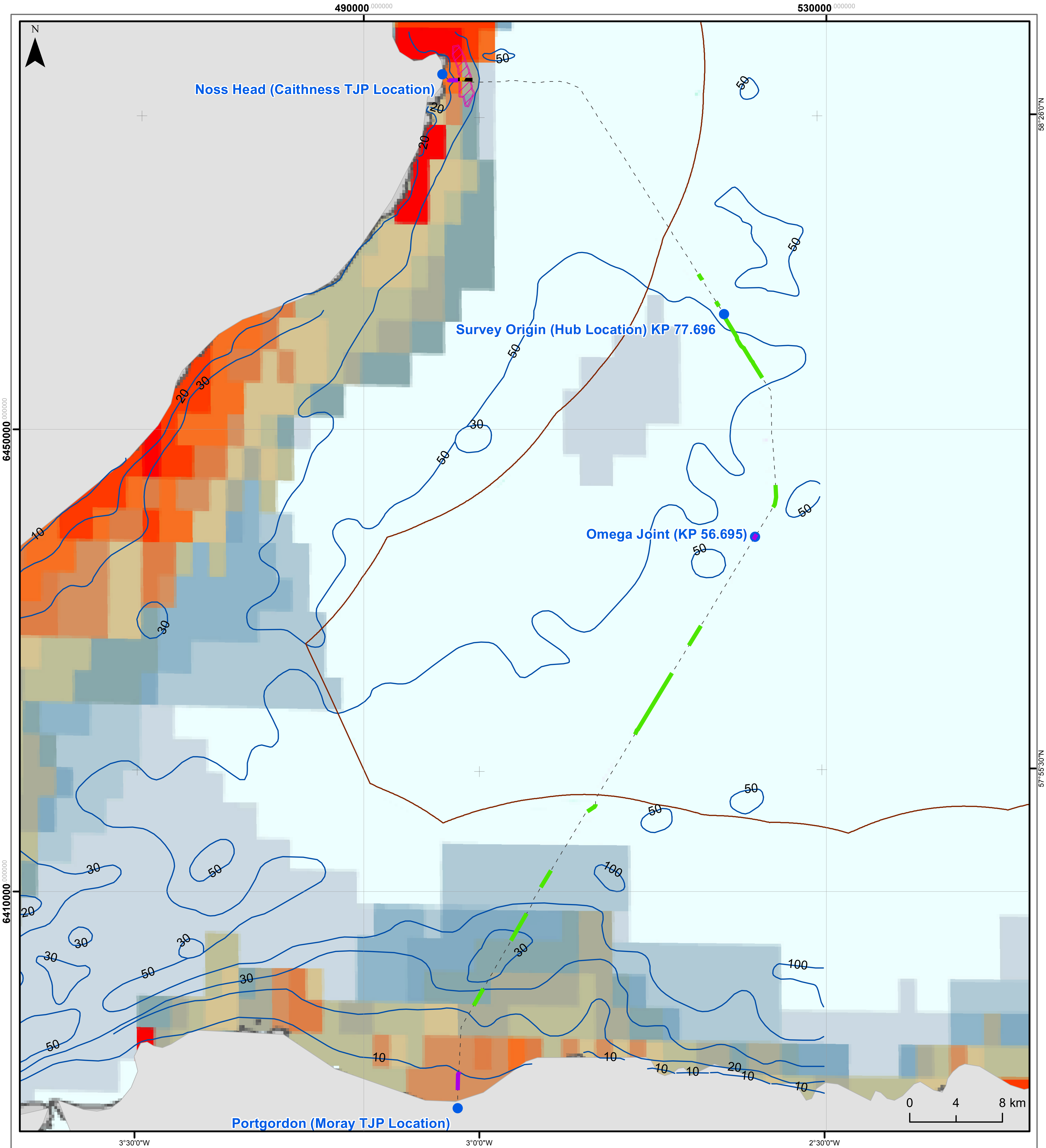
Source MXD: R:\SSE\2492-0915-SSE_Caithness-Port_Gordon\02_data_authored\Fig22_Other_Trawling.mxd



Client

Scottish and Southern Energy
Power Distribution

Title

Figure 23: Rock Placement Locations with Creeling Areas (<15m Vessels)

Legend

- Key Locations
- 12nm
- HDVC Cable Route Alignment (ABB A05)
- Mussel Bed Uraduct
- Bathymetry contours
- Horse Mussel Bed (MPA)

ScotMap - Landings Value distribution for creeling (Crab & Lobster) £/ cell

LOW

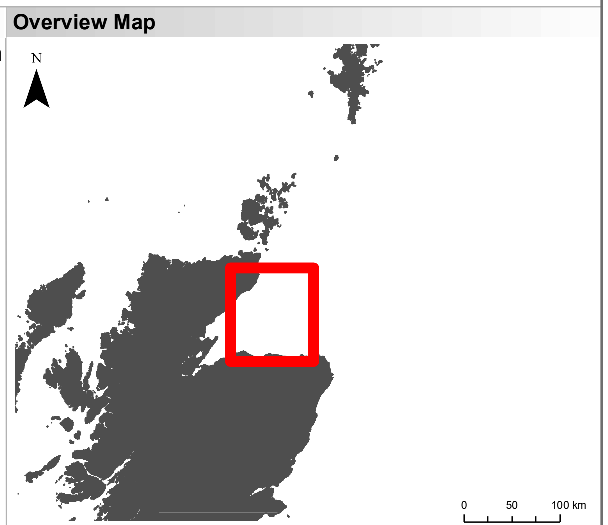
MEDIUM

HIGH

Berm Properties

- Rock Berm Height = 0.83m
- Rock Berm Height = 1.26m

Overview Map



Project/Report Information

Project Name	: Caithness - Moray (LT21) Burial Risk Assessment
Project No	: 2492
Location	: UKCS, Moray Firth, Portgordon to Noss Head
Figure	: 2492-SSE-FIG-23-04

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Data Sources, Acknowledgements & Notes

© Crown Copyright, 2012; DECC (http://og.decc.gov.uk/); EH (http://www.english-heritage.org.uk/); KISCA Data from Marine Scotland: VMS – Annual Fishing Intensity (2009-2013) & ScotMap – Inshore Fisheries Mapping (2007-2011)

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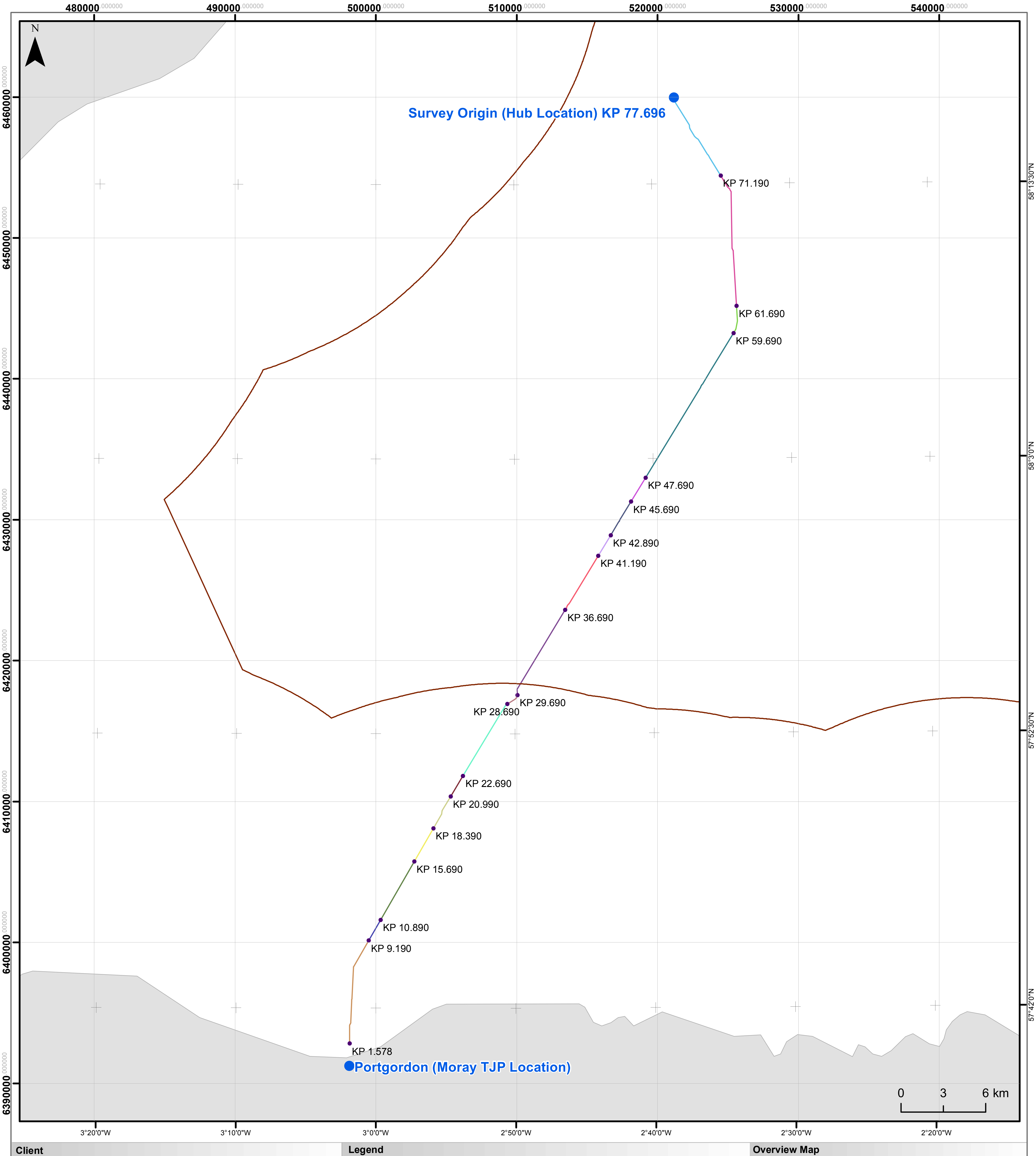


Client

Scottish and Southern Energy
Power Distribution

Title

Figure 25: Trenching Zones - Portgordon to Hub Platform Route Section

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-27-04

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Legend

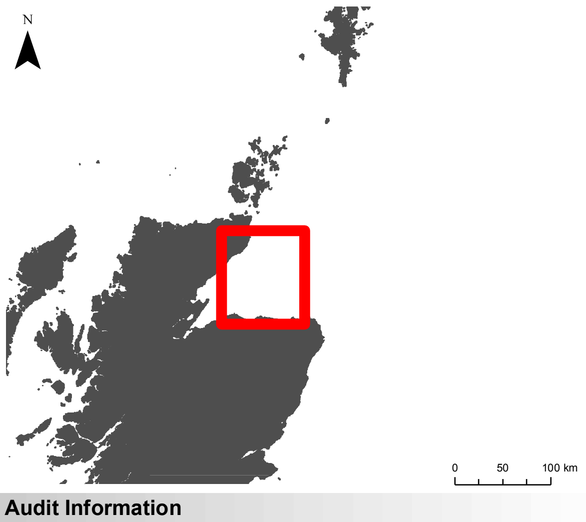
- Key Locations
- Trenching Zone KPs
- 12nm

Portgordon to Hub Platform Trenching Zones

- PG1-A
- PG2-A
- PG2-B
- PG2-C
- PG2-D
- PG3-A
- PG3-B
- PG3-C
- PG3-D
- PG3-E
- PG4-A
- PG4-B
- PG4-C
- PG4-D
- PG4-E
- PG4-F
- PG4-G

Data Sources, Acknowledgements & Notes

Overview Map



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Approved By
Date [redacted] 2015

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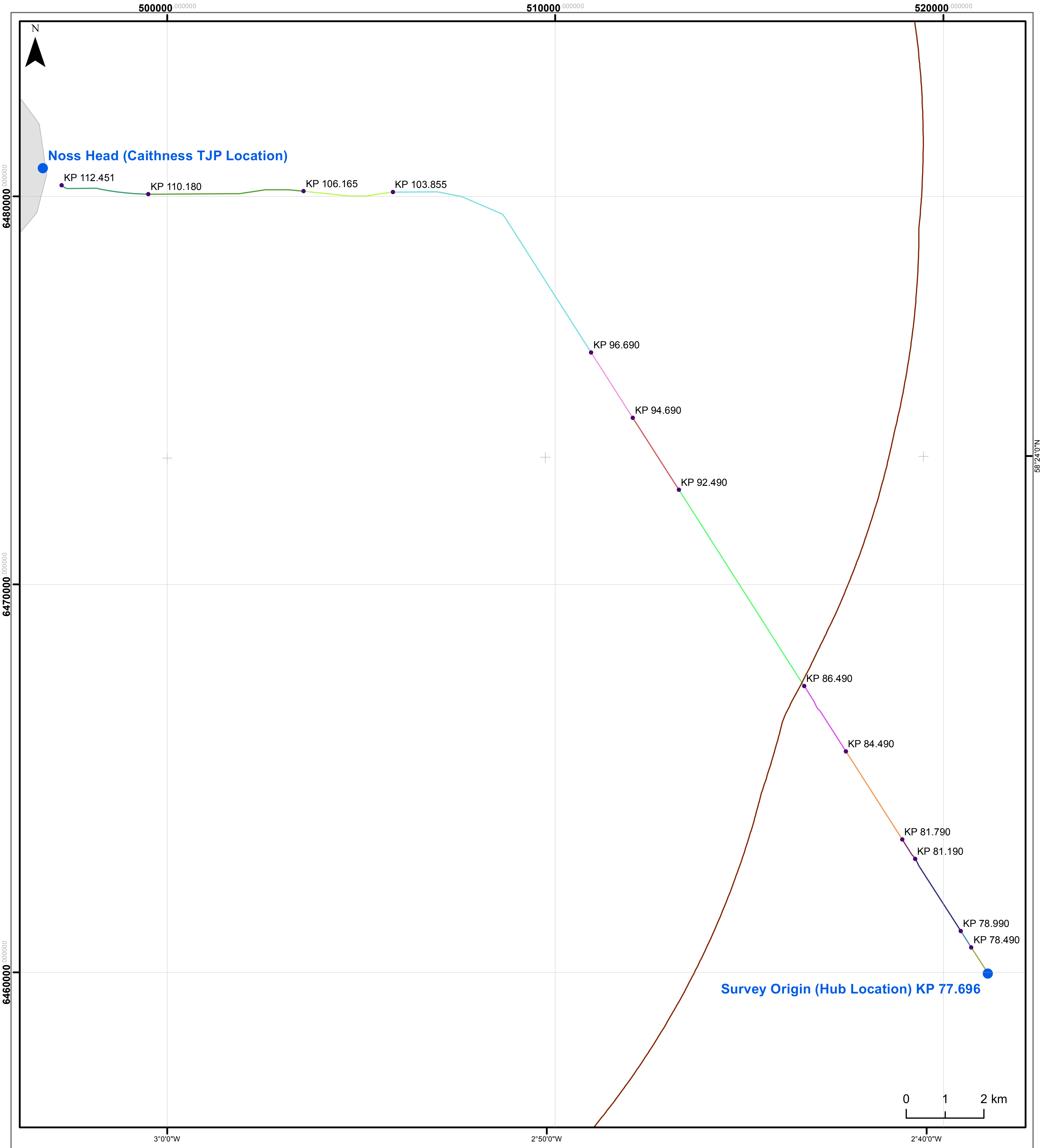


Client

Scottish and Southern Energy
Power Distribution

Title

Figure 26: Trenching Zones - Hub Platform to Noss Head Route Section

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-26-03

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Legend

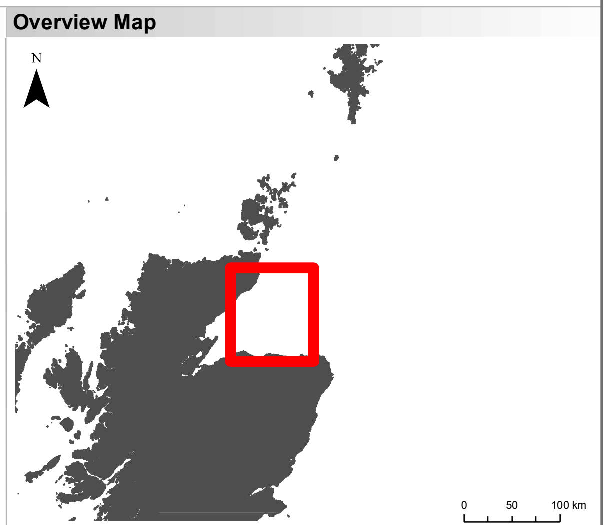
- Key Locations
- Trenching Zone KPs
- 12nm

Hub Platform to Noss Head Trenching Zones

- NH1-A
- NH1-B
- NH1-C
- NH1-D
- NH1-E
- NH2-A
- NH2-B
- NH3-A
- NH3-B
- NH3-C
- NH3-D
- NH3-E
- NH4-A

Data Sources, Acknowledgements & Notes

Overview Map



Audit Information

Authored By [redacted]
Checked By
Approved By
Date 11/2015

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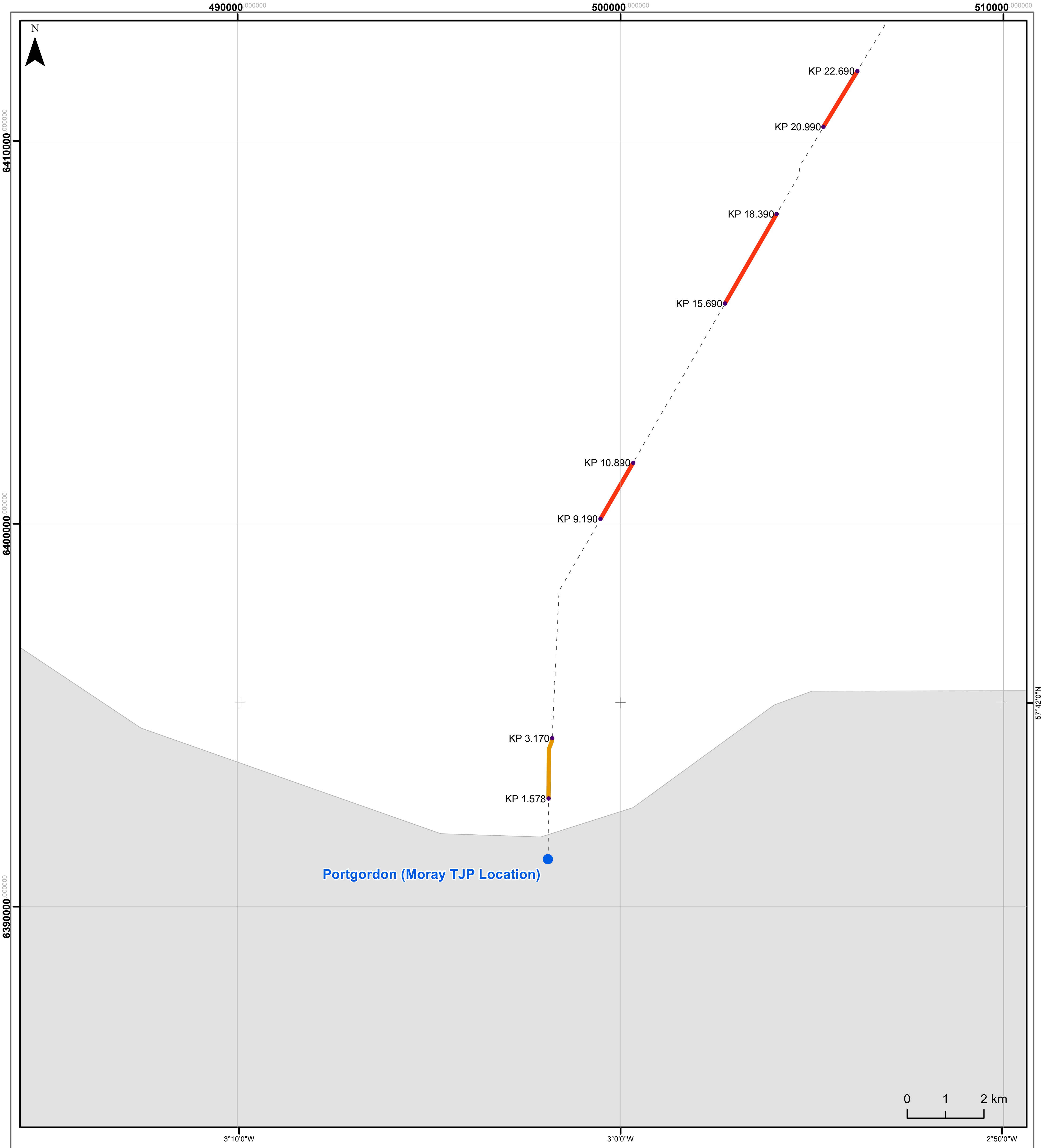


Client

Scottish and Southern Energy
Power Distribution

Title

Figure 27: Rock Placement - Portgordon to Hub Platform

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-27-04

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Legend

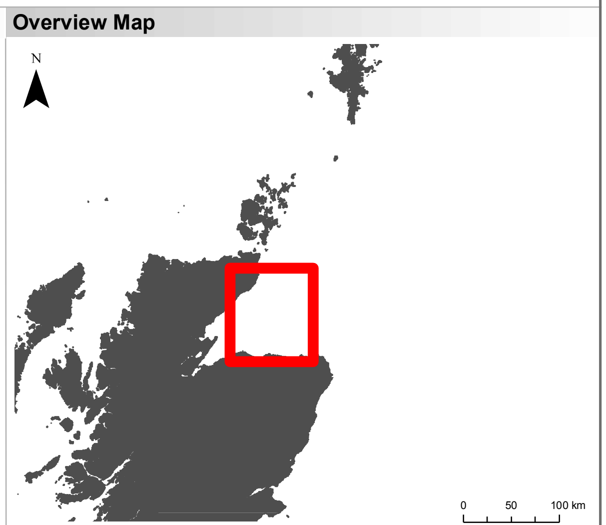
Key Locations
Rock Placement KPs
HDVC Cable Route Alignment (ABB A05)
12nm

Berm Properties

Rock Berm Height = 0.83m
Rock Berm Height = 1.26m

Data Sources, Acknowledgements & Notes

Overview Map



Audit Information

Authored By : [redacted]
Checked By
Approved By
Date 12/2015

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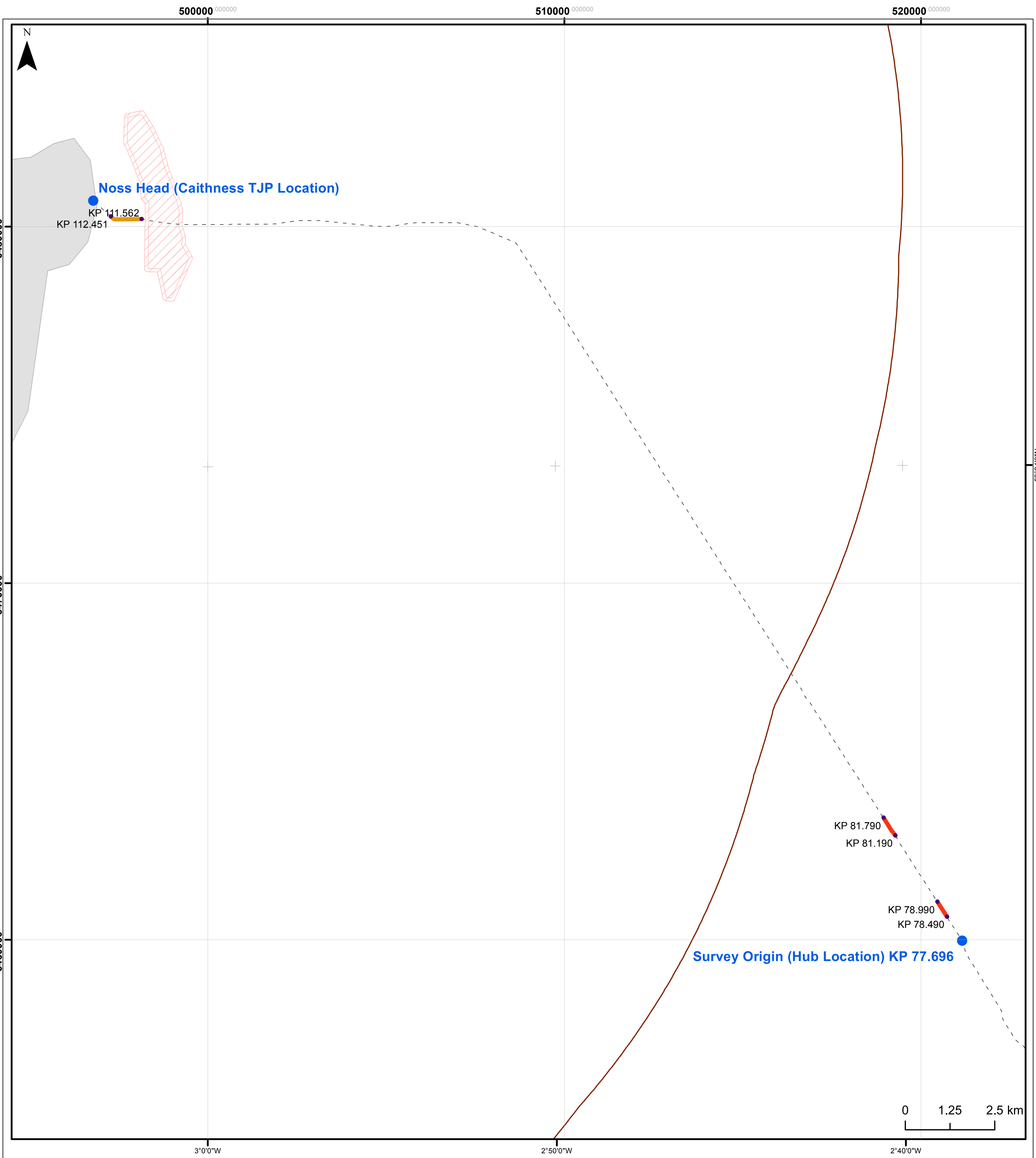


Client

Scottish and Southern Energy
Power Distribution

Title

Figure 28: Rock Placement - Hub Platform to Noss Head

Project/Report Information

Project Name : Caithness - Moray (LT21) Burial Risk Assessment
Project No : 2492
Location : UKCS, Moray Firth, Portgordon to Noss Head
Figure : 2492-SSE-FIG-28-04

Geodetic Information

Coordinate Reference System: WGS 1984 UTM Zone 30N
Projection: Transverse Mercator (Central Meridian: 3°0'0"W)
Datum: WGS 1984 / **Ellipsoid:** WGS84
Suitable for printing @ A3

Legend

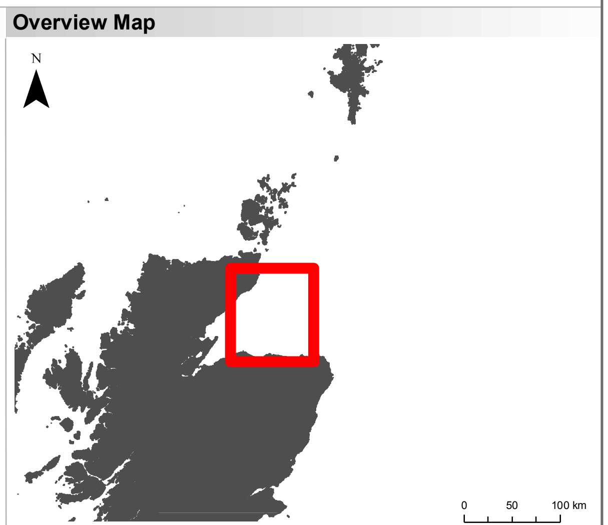
- Key Locations
- Rock Placement KPs
- HDVC Cable Route Alignment (ABB A05)
- 12nm

Berm Properties

- Rock Berm Height = 0.83m
- Rock Berm Height = 1.26m
- Horse Mussel Bed (MPA)

Data Sources, Acknowledgements & Notes

Overview Map



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[redacted]
12/2015

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Source MXD: R:\SSE\2492-0915-SSE_Caithness-Port_Gordon\02_data_authored\Fig28_nh_rockplacement.mxd

Appendix 1

ABB RPL A05

CMS Survey Origin - Noss Route Position List

Revision: A05
Revision Date: 20/10/2015
Route design: Route based on Survey Centre lines MMT 210 Survey Origin to Noss and MMT 2011 - Survey Origin to PortGordon
Route listing preperation: ABB OEC / Maurits Smalt
Route listing check: ABB OEC
Reference system: WGS 84 UTM30N
All KP lengths are calculated on Grid Length
No crossings are encountered along the route

WGS 84 UTM30N												
Point No.	UTM Zone	Latitude	Longitude	Easting	Northing	Headings [degr]	Between GRID (km)	Cummalative GRID (km)	AC No.	Depth (m)	Comment	Type
1	30N	57° 39' 48.40000" N	003° 01' 54.20002" W	498107.36	6391241.83	0.46	1.578	0.000	AC001	-	Portgordon TJP Preliminary (150215)	TJP
2	30N	57° 40' 39.4372" N	003° 01' 53.4752" W	498120.11	6392820.11	0.49	1.265	1.578	AC002	6.0	HDD Pop-up hole (6.0 m contour internsection point)	AC Point
3	30N	57° 41' 20.33480" N	003° 01' 52.86173" W	498130.86	6394084.84	4.37	0.036	2.843	AC003	10.1		AC Point
4	30N	57° 41' 21.49063" N	003° 01' 52.69795" W	498133.59	6394120.58	12.07	0.031	2.879	AC004	10.0		AC Point
5	30N	57° 41' 22.48357" N	003° 01' 52.30221" W	498140.16	6394151.28	19.28	0.031	2.910	AC005	10.3		AC Point
6	30N	57° 41' 23.44216" N	003° 01' 51.67710" W	498150.52	6394180.92	26.48	0.031	2.942	AC006	10.2		AC Point
7	30N	57° 41' 24.35123" N	003° 01' 50.83263" W	498164.52	6394209.03	30.08	0.002	2.973	AC007	10.4		AC Point
8	30N	57° 41' 24.41450" N	003° 01' 50.76428" W	498165.65	6394210.98	24.7	0.047	2.975	AC008	10.4		AC Point
9	30N	57° 41' 25.79201" N	003° 01' 49.58276" W	498185.24	6394253.57	19.32	0.044	3.022	AC009	10.5		AC Point
10	30N	57° 41' 27.14748" N	003° 01' 48.69675" W	498199.93	6394295.48	15.72	0.031	3.067	AC010	10.7		AC Point
11	30N	57° 41' 28.12488" N	003° 01' 48.18402" W	498208.43	6394325.70	7.39	0.041	3.098	AC011	10.6		AC Point
12	30N	57° 41' 29.44767" N	003° 01' 47.86493" W	498213.74	6394366.61	2.65	1.465	3.139	AC012	10.8		AC Point
13	30N	57° 42' 16.77718" N	003° 01' 43.80635" W	498281.57	6395830.21	359.05	0.031	4.605	AC013	16.4		AC Point
14	30N	57° 42' 17.79227" N	003° 01' 43.83849" W	498281.05	6395861.61	353.4	0.018	4.636	AC014	16.7		AC Point
15	30N	57° 42' 18.36820" N	003° 01' 43.96345" W	498278.99	6395879.42	351.29	0.001	4.654	AC015	16.7		AC Point
16	30N	57° 42' 18.39182" N	003° 01' 43.97021" W	498278.88	6395880.15	351.37	0.001	4.655	AC016	16.7		AC Point
17	30N	57° 42' 18.41547" N	003° 01' 43.97696" W	498278.77	6395880.88	347.69	0.018	4.655	AC017	16.7		AC Point
18	30N	57° 42' 18.99040" N	003° 01' 44.21187" W	498274.89	6395898.66	353.35	0.032	4.674	AC018	16.7		AC Point
19	30N	57° 42' 20.01390" N	003° 01' 44.43580" W	498271.19	6395930.31	2.65	0.010	4.705	AC019	16.9		AC Point
20	30N	57° 42' 20.33693" N	003° 01' 44.40809" W	498271.66	6395940.30	10.41	0.018	4.715	AC020	16.8		AC Point
21	30N	57° 42' 20.91580" N	003° 01' 44.20978" W	498274.95	6395958.20	16.07	0.032	4.734	AC021	17.0		AC Point
22	30N	57° 42' 21.90613" N	003° 01' 43.67757" W	498283.77	6395988.82	14	0.001	4.765	AC022	17.2		AC Point
23	30N	57° 42' 21.92934" N	003° 01' 43.66680" W	498283.95	6395989.54	13.94	0.001	4.766	AC023	17.2		AC Point
24	30N	57° 42' 21.95253" N	003° 01' 43.65605" W	498284.13	6395990.26	10.36	0.031	4.767	AC024	17.2		AC Point
25	30N	57° 42' 22.95210" N	003° 01' 43.31545" W	498289.78	6396021.17	4.71	0.018	4.798	AC025	17.3		AC Point
26	30N	57° 42' 23.52914" N	003° 01' 43.22711" W	498291.25	6396039.01	2.65	0.015	4.816	AC026	17.4		AC Point
27	30N	57° 42' 23.99861" N	003° 01' 43.18685" W	498291.92	6396053.53	2.65	2.132	4.831	AC027	17.3		AC Point
28	30N	57° 43' 32.85562" N	003° 01' 37.27637" W	498390.61	6398182.85	5.52	0.025	6.962	AC028	20.0		AC Point
29	30N	57° 43' 33.66120" N	003° 01' 37.13138" W	498393.02	6398207.77	11.99	0.031	6.987	AC029	20.0		AC Point
30	30N	57° 43' 34.65434" N	003° 01' 36.73785" W	498399.54	6398238.48	19.19	0.031	7.019	AC030	20.0		AC Point
31	30N	57° 43' 35.61329" N	003° 01' 36.11471" W	498409.86	6398268.13	26.39	0.031	7.050	AC031	20.0		AC Point
32	30N	57° 43' 36.52287" N	003° 01' 35.27188" W	498423.81	6398296.25	29.99	12.421	7.082	AC032	20.1		AC Point
33	30N	57° 49' 24.30963" N	002° 55' 19.23269" W	504632.65	6409053.83	26.39	0.031	19.502	AC033	55.4		AC Point
34	30N	57° 49' 25.21850" N	002° 55' 18.38494" W	504646.61	6409081.95	19.19	0.031	19.534	AC034	56.7		AC Point
35	30N	57° 49' 26.17689" N	002° 55' 17.75734" W	504656.93	6409111.60	11.02	0.040	19.565	AC035	58.1		AC Point
36	30N	57° 49' 27.44251" N	002° 55' 17.29269" W	504664.55	6409150.75	6.44	0.145	19.605	AC036	60.2		AC Point
37	30N	57° 49' 32.10758" N	002° 55' 16.29519" W	504680.84	6409295.04	11.01	0.040	19.750	AC037	65.8		AC Point
38	30N	57° 49' 33.37065" N	002° 55' 15.83183" W	504688.44	6409334.11	19.17	0.031	19.790	AC038	67.0		AC Point
39	30N	57° 49' 34.32916" N	002° 55' 15.20477" W	504698.75	6409363.76	26.37	0.031	19.821	AC039	67.8		AC Point
40	30N	57° 49' 35.23816" N	002° 55' 14.35749" W	504712.70	6409391.89	31.11	8.655	19.853	AC040	68.4		AC Point
41	30N	57° 53' 34.59505" N	002° 50' 42.25399" W	509185.07	6416801.80	33.49	0.019	28.508	AC041	90.1		AC Point
42	30N	57° 53' 35.10543" N	002° 50' 41.61675" W	509195.53	6416817.61	39.26	0.031	28.527	AC042	90.0		AC Point
43	30N	57° 53' 35.88998" N	002° 50' 40.40691" W	509215.39	6416841.92	46.46	0.031	28.558	AC043	90.0		AC Point
44	30N	57° 53' 36.58761" N	002° 50' 39.02194" W	509238.15	6416863.54	53.66	0.031	28.590	AC044	89.9		AC Point
45	30N	57° 53' 37.18732" N	002° 50' 37.48368" W	509263.44	6416882.15	57.26	0.742	28.621	AC045	89.9		AC Point
46	30N	57° 53' 50.11553" N	002° 49' 59.52410" W	509887.57	6417283.45	53.66	0.031	29.363	AC046	94.0		AC Point
47	30N	57° 53' 50.71508" N	002° 49' 57.98547" W	509912.86	6417302.05	46.46	0.031	29.394	AC047	94.6		AC Point
48	30N	57° 53' 51.41259" N	002° 49' 56.60012" W	509935.62	6417323.68	39.26	0.031	29.426	AC048	95.3		AC Point
49	30N	57° 53' 52.19704" N	002° 49' 55.38985" W	509955.48	6417347.99	33.47	0.019	29.457	AC049	96.0		AC Point
50	30N	57° 53' 52.71046" N	002° 49' 54.74879" W	509966.00	6417363.89	31.29	0.088	29.476	AC050	96.4		AC Point
51	30N	57° 53' 55.13821" N	002° 49' 51.96205" W	510011.70	6417439.09	27.69	0.031	29.564	AC051	98.1		AC Point
52	30N	57° 53' 56.03597" N	002° 49' 51.07185" W	510026.29	6417466.89	20.49	0.031	29.596	AC052	98.4		AC Point
53	30N	57° 53' 56.98604" N	002° 49' 50.39993" W	510037.28	6417496.29	13.29	0.031	29.627	AC053	98.7		AC Point
54	30N	57° 53' 57.97347" N	002° 49' 49.95703" W	510044.49	6417526.85	6.09	0.031	29.658	AC054	98.9		AC Point
55	30N	57° 53' 58.98266" N	002° 49' 49.75003" W	510047.82	6417558.07	358.59	0.034	29.690	AC055	99.0		AC Point
56	30N	57° 54' 00.08090" N	002° 49' 49.79549" W	510046.99	6417592.03	354.7	0.296	29.724	AC056	99.0		AC Point
57	30N	57° 54' 09.60968" N	002° 49' 51.41152" W	510019.64	6417886.64	358.6	0.034	30.020	AC057	96.8		AC Point
58	30N	57° 54' 10.71093" N	002° 49' 51.45677" W	510018.81	6417920.70	6.11	0.031	30.054	AC058	96.6		AC Point
59	30N	57° 54' 11.72008" N	002° 49' 51.24903" W	510022.16	6417951.91	13.31	0.031	30.085	AC059	96.4		AC Point
60	30N	57° 54' 12.70742" N	002° 49' 50.80536" W	510029.38	6417982.47	20.51	0.031	30.117	AC060	96.3		AC Point
61	30N	57° 54' 13.65736" N	002° 49' 50.13274" W	510040.38	6418011.87	27.71	0.031	30.148	AC061	96.3		AC Point
62	30N	57° 54' 14.55494" N	002° 49' 49.24174" W	510054.98	6418039.67	31.31	0.122	30.179	AC061	96.2		AC Point
63	30N	57° 54' 17.9265 N	2° 49' 45.3675 W	510118.50	6418144.09	31.31	6.556	30.302	AC062	95.8	12NM	Boundary
64	30N	57° 57' 18.70813" N	002° 46' 17.26897" W	513525.46	6423744.95	26.02	0.047	36.857	AC063	81.0		AC Point
65	30N	57° 57' 20.06639" N	002° 46' 16.01074" W	513546.00	6423787.03	20.65	0.095	36.904	AC064	80.9		AC Point
66	30N	57° 57' 22.93708" N	002° 46' 13.95453" W	513579.50	6423875.92	26.02	0.047	36.999	AC065	80.7		AC Point
67	30N	57° 57' 24.29532" N	002° 46' 12.69622" W	513600.05	6423917.99	31.39	0.014	37.046	AC066	80.6		AC Point
68	30N	57° 57' 24.67676" N	002° 46' 12.25490" W	513607.26	6423929.81	31.4	0.014	37.060	AC067	80.6		AC Point
69	30N	57° 57' 25.05821" N	002° 46' 11.81357" W	513614.48	6423941.64	36.77	0.047	37.074	AC068	80.6		AC Point
70	30N	57° 57' 26.26790" N	002° 46' 10.10083" W	513642.50	6423979.14	42.14	0.083	37.120	AC069	80.5		AC Point
71	30N	57° 57' 28.25765" N	002° 46' 06.69004" W	513698.36	6424040.87	39.45	0.023	37.204	AC070	80.4		AC Point
72	30N	57° 57' 28.84198" N	002° 46' 05.77902" W	513713.28	6424058.99			37.227	AC071	80.4		AC Point

73	30N	57°	57'	29.36841"	N	002°	46'	05.03383"	W	513725.47	6424075.31	36.76	0.020	37.247	AC072	80.4		AC Point
74	30N	57°	57'	30.00390"	N	002°	46'	04.22028"	W	513738.78	6424095.01	34.04	0.024	37.271	AC073	80.4		AC Point
75	30N	58°	00'	34.94861"	N	002°	42'	30.56103"	W	517226.28	6429828.14	31.31	6.711	43.982	AC074	69.6		AC Point
76	30N	58°	00'	35.82217"	N	002°	42'	29.39338"	W	517245.33	6429855.24	35.11	0.033	44.015	AC075	69.6		AC Point
77	30N	58°	00'	35.88041"	N	002°	42'	29.30401"	W	517246.79	6429857.05	38.92	0.002	44.017	AC076	69.6		AC Point
78	30N	58°	00'	35.93865"	N	002°	42'	29.21466"	W	517248.25	6429858.86	38.9	0.002	44.020	AC077	69.6		AC Point
79	30N	58°	00'	36.81191"	N	002°	42'	28.04729"	W	517267.29	6429885.95	35.11	0.033	44.053	AC078	69.5		AC Point
80	30N	58°	00'	36.87132"	N	002°	42'	27.97852"	W	517268.41	6429887.79	31.32	0.002	44.055	AC079	69.5		AC Point
81	30N	58°	00'	36.90103"	N	002°	42'	27.94413"	W	517268.97	6429888.71	31.27	0.001	44.056	AC080	69.5		AC Point
82	30N	58°	00'	37.17656"	N	002°	42'	27.62527"	W	517274.17	6429897.25	31.31	0.010	44.066	AC081	69.5		AC Point
83	30N	58°	00'	37.45208"	N	002°	42'	27.30641"	W	517279.37	6429905.80	31.31	0.010	44.076	AC082	69.5		AC Point
84	30N	58°	00'	37.48179"	N	002°	42'	27.27202"	W	517279.93	6429906.72	31.32	0.001	44.077	AC083	69.5		AC Point
85	30N	58°	00'	37.54122"	N	002°	42'	27.20325"	W	517281.05	6429908.56	31.32	0.002	44.079	AC084	69.5		AC Point
86	30N	58°	00'	38.48867"	N	002°	42'	26.26352"	W	517296.35	6429937.93	27.52	0.033	44.112	AC085	69.4		AC Point
87	30N	58°	00'	38.55732"	N	002°	42'	26.20606"	W	517297.28	6429940.05	23.71	0.002	44.115	AC086	69.4		AC Point
88	30N	58°	00'	38.62593"	N	002°	42'	26.14859"	W	517298.21	6429942.18	23.72	0.002	44.117	AC087	69.4		AC Point
89	30N	58°	00'	39.57343"	N	002°	42'	25.20885"	W	517313.51	6429971.55	27.51	0.033	44.150	AC088	69.4		AC Point
90	30N	58°	05'	42.86754"	N	002°	36'	33.20870"	W	523036.98	6439380.40	31.31	11.013	55.163	AC089	55.3		AC Point
91	30N	58°	05'	44.16700"	N	002°	36'	31.98555"	W	523056.78	6439420.71	26.16	0.045	55.208	AC090	55.4		AC Point
92	30N	58°	05'	45.17171"	N	002°	36'	31.24424"	W	523068.74	6439451.85	21.01	0.033	55.241	AC091	55.5		AC Point
93	30N	58°	05'	46.17641"	N	002°	36'	30.50292"	W	523080.70	6439482.99	21.01	0.033	55.275	AC092	55.6		AC Point
94	30N	58°	05'	47.47587"	N	002°	36'	29.27971"	W	523100.49	6439523.30	26.16	0.045	55.319	AC093	55.7		AC Point
95	30N	58°	05'	48.36933"	N	002°	36'	28.23977"	W	523117.36	6439551.03	31.31	0.032	55.352	AC094	55.7		AC Point
96	30N	58°	05'	49.26278"	N	002°	36'	27.19982"	W	523134.23	6439578.76	31.31	0.032	55.384	AC095	55.8		AC Point
97	30N	58°	05'	50.42540"	N	002°	36'	25.55725"	W	523160.92	6439614.87	36.47	0.045	55.429	AC096	55.8		AC Point
98	30N	58°	05'	51.22762"	N	002°	36'	24.19537"	W	523183.07	6439639.81	41.62	0.033	55.463	AC097	55.8		AC Point
99	30N	58°	05'	52.02983"	N	002°	36'	22.83346"	W	523205.23	6439664.75	41.62	0.033	55.496	AC098	55.8		AC Point
100	30N	58°	05'	53.19244"	N	002°	36'	21.19082"	W	523231.92	6439700.86	36.46	0.045	55.541	AC098	55.8		AC Point
101	30N	58°	6'	24.9541	N	2°	35'	44.2068	W	523831.61	6440686.70	31.31	1.154	56.695	AC099	56.6	Proposed Joint KP56.695	Omega Joint
102	30N	58°	07'	54.52766"	N	002°	33'	59.78730"	W	525523.17	6443467.47	31.31	3.255	59.950	AC100	53.6		AC Point
103	30N	58°	07'	55.42330"	N	002°	33'	58.88394"	W	525537.77	6443495.26	27.71	0.031	59.981	AC101	53.6		AC Point
104	30N	58°	07'	56.37179"	N	002°	33'	58.19991"	W	525548.77	6443524.67	20.51	0.031	60.012	AC102	53.5		AC Point
105	30N	58°	07'	57.12716"	N	002°	33'	57.83018"	W	525554.67	6443548.07	14.15	0.024	60.037	AC103	53.7		AC Point
106	30N	58°	08'	15.07715"	N	002°	33'	50.77168"	W	525666.55	6444103.94	11.38	0.567	60.604	AC104	53.0		AC Point
107	30N	58°	08'	16.08205"	N	002°	33'	50.49957"	W	525670.80	6444135.04	7.78	0.031	60.635	AC105	53.0		AC Point
108	30N	58°	08'	17.16859"	N	002°	33'	50.47460"	W	525670.99	6444168.65	0.33	0.034	60.669	AC106	52.6		AC Point
109	30N	58°	10'	55.05975"	N	002°	34'	06.83376"	W	525372.18	6449049.91	356.5	4.890	65.559	AC107	52.3		AC Point
110	30N	58°	10'	56.06790"	N	002°	34'	07.05903"	W	525368.31	6449081.06	352.9	0.031	65.590	AC108	52.3		AC Point
111	30N	58°	10'	57.05319"	N	002°	34'	07.52177"	W	525360.55	6449111.49	345.7	0.031	65.622	AC109	52.3		AC Point
112	30N	58°	10'	58.25208"	N	002°	34'	08.44450"	W	525345.24	6449148.47	337.51	0.040	65.662	AC110	52.3		AC Point
113	30N	58°	11'	00.64261"	N	002°	34'	10.72229"	W	525307.56	6449222.16	332.92	0.083	65.745	AC111	52.3		AC Point
114	30N	58°	11'	01.23752"	N	002°	34'	11.23318"	W	525299.10	6449240.51	335.23	0.020	65.765	AC112	52.3		AC Point
115	30N	58°	11'	02.20028"	N	002°	34'	11.84256"	W	525288.95	6449270.22	341.15	0.031	65.796	AC113	52.2		AC Point
116	30N	58°	11'	03.19581"	N	002°	34'	12.21861"	W	525282.62	6449300.97	348.35	0.031	65.828	AC114	52.2		AC Point
117	30N	58°	11'	04.20836"	N	002°	34'	12.35553"	W	525280.18	6449332.27	355.55	0.031	65.859	AC115	52.2		AC Point
118	30N	58°	13'	07.24349"	N	002°	34'	14.32686"	W	525223.74	6453137.10	359.15	3.805	69.664	AC116	54.7		AC Point
119	30N	58°	13'	10.45234"	N	002°	34'	14.42600"	W	525221.49	6453236.33	358.7	0.099	69.763	AC117	54.7		AC Point
120	30N	58°	13'	11.45665"	N	002°	34'	14.57288"	W	525218.90	6453267.37	355.22	0.031	69.795	AC118	54.7		AC Point
121	30N	58°	13'	12.44334"	N	002°	34'	14.95716"	W	525212.43	6453297.85	348.02	0.031	69.826	AC119	54.7		AC Point
122	30N	58°	13'	13.39682"	N	002°	34'	15.57275"	W	525202.20	6453327.27	340.82	0.031	69.857	AC120	54.7		AC Point
123	30N	58°	13'	14.51502"	N	002°	34'	16.64770"	W	525184.44	6453361.74	332.74	0.039	69.896	AC121	54.8		AC Point
124	30N	58°	13'	18.64583"	N	002°	34'	21.44543"	W	525105.34	6453489.00	328.14	0.150	70.046	AC122	54.9		AC Point
125	30N	58°	13'	19.47636"	N	002°	34'	22.55176"	W	525087.13	6453514.57	324.54	0.031	70.077	AC123	54.9		AC Point
126	30N	58°	13'	20.22717"	N	002°	34'	23.84671"	W	525065.85	6453537.66	317.34	0.031	70.108	AC124	54.9		AC Point
127	30N	58°	13'	20.68554"	N	002°	34'	24.82343"	W	525049.82	6453551.73	311.29	0.021	70.130	AC125	55.0		AC Point
128	30N	58°	13'	21.11427"	N	002°	34'	25.81948"	W	525033.49	6453564.89	308.84	0.021	70.151	AC126	55.0		AC Point
129	30N	58°	13'	21.57266"	N	002°	34'	26.79625"	W	525017.46	6453578.96	311.29	0.021	70.172	AC127	55.0		AC Point
130	30N	58°	13'	22.32345"	N	002°	34'	28.09118"	W	524996.18	6453602.05	317.34	0.031	70.203	AC128	55.1		AC Point
131	30N	58°	13'	23.15395"	N	002°	34'	29.19761"	W	524977.97	6453627.62	324.54	0.031	70.235	AC129	55.1		AC Point
132	30N	58°	14'	30.54065"	N	002°	35'	47.52455"	W	523687.45	6455703.81	328.14	2.445	72.679	AC130	53.0		AC Point
133	30N	58°	14'	31.88300"	N	002°	35'	48.77777"	W	523666.76	6455745.20	333.45	0.046	72.726	AC131	53.2		AC Point
134	30N	58°	14'	32.93778"	N	002°	35'	49.54167"	W	523654.11	6455777.75	338.76	0.035	72.761	AC132	53.2		AC Point
135	30N	58°	14'	34.28012"	N	002°	35'	50.79494"	W	523633.42	6455819.14	333.45	0.046	72.807	AC133	52.9		AC Point
136	30N	58°	14'	35.20422"	N	002°	35'	51.86982"	W	523615.72	6455847.61	328.14	0.034	72.840	AC134	53.2		AC Point
137	30N	58°	14'	36.40176"	N	002°	35'	53.57083"	W	523587.76	6455884.48	322.82	0.046	72.887	AC135	53.2		AC Point
138	30N	58°	14'	37.23894"	N	002°	35'	55.00760"	W	523564.18	6455910.23	317.52	0.035	72.922	AC136	53.2		AC Point
139	30N	58°	14'	38.43648"	N	002°	35'	56.70866"	W	523536.22	6455947.11	322.83	0.046	72.968	AC137	53.2		AC Point
140	30N	58°	15'	12.32232"	N	002°	36'	36.13871"	W	522887.16	6456991.31	328.14	1.229	74.197	AC138	52.2		AC Point
141	30N	58°	15'	13.15251"	N	002°	36'	37.24693"	W	522868.94	6457016.88	324.54	0.031	74.229	AC139	52.0		AC Point
142	30N	58°	15'	13.90294"	N	002°	36'	38.54376"	W	522847.67	6457039.97	317.34	0.031	74.260	AC140	52.2		AC Point
143	30N	58°	15'	14.69911"	N	002°	36'	40.36695"	W	522817.80	6457064.42	309.31	0.039	74.299	AC141	52.2		AC Point
144	30N	58°	15'	17.50681"	N	002°	36'	47.91462"	W	522694.26	6457150.54	304.88	0.151	74.449	AC142	51.8		AC Point
145	30N	58°	15'	18.30584"	N	002°	36'	49.74360"	W	522664.30	6457175.08	309.32	0.039	74.488	AC143	51.9		AC Point
146	30N	58°	15'	19.05659"	N	002°	36'	51.03981"	W	522643.03	6457198.18	317.37	0.031	74.519	AC144	52.0		AC Point
147	30N	58°	15'	19.88703"	N	002°	36'	52.14738"	W	522624.83	6457223.76	324.56	0.031	74.551	AC145	52.2		AC Point
148	30N	58°	15'	35.70040"	N	002°	37'	10.53914"	W	522322.25	6457711.11	328.17	0.574	75.124	AC146	52.7		AC Point
149	30N	58°	15'	36.82388"	N	002°	37'	11.62698"	W	522304.32	6457745.76	332.64	0.039	75.163	AC147	52.7		AC Point
150	30N	58°	15'	37.78390"	N	002°	37'	12.25285"	W	522293.95	6457775.39	340.71	0.031	75.195	AC148	52.7		AC Point
151	30N	58°	15'	38.77772"	N	002°	37'	12.64552"	W	522287.38	6457806.09	347.91	0.031	75.226	AC149	52.7		AC Point
152	30N	58°	15'	43.49619"	N	002°	37'	13.92972"	W	522265.62	6457951.90	351.51	0.147	75.374	AC150	52.8		AC Point

153	30N	58°	15'	44.48999"	N	002°	37'	14.32241"	W	522259.05	6457982.60	347.91	0.031	75.405	AC151	52.8		AC Point
154	30N	58°	15'	45.45004"	N	002°	37'	14.94834"	W	522248.68	6458012.23	340.71	0.031	75.436	AC152	52.8		AC Point
155	30N	58°	15'	46.57389"	N	002°	37'	16.03675"	W	522230.75	6458046.89	332.64	0.039	75.475	AC153	52.8		AC Point
156	30N	58°	16'	36.28891"	N	002°	38'	13.90830"	W	521279.24	6459579.23	328.16	1.804	77.279	AC154	53.6		AC Point
157	30N	58°	16'	37.24999"	N	002°	38'	14.86535"	W	521263.49	6459608.87	332.01	0.034	77.313	AC155	53.5		AC Point
158	30N	58°	16'	38.20248"	N	002°	38'	15.53172"	W	521252.48	6459638.27	339.46	0.031	77.344	AC156	53.3		AC Point
159	30N	58°	16'	48.13543"	N	002°	38'	21.16461"	W	521159.06	6459944.97	343.06	0.321	77.665	AC157	52.5		AC Point
160	30N	58°	16'	49.08793"	N	002°	38'	21.83112"	W	521148.04	6459974.37	339.46	0.031	77.696	AC158	52.5		AC Point
161	30N	58°	16'	50.14806"	N	002°	38'	22.90557"	W	521130.37	6460007.07	331.6	0.037	77.733	AC159	52.6		AC Point
162	30N	58°	18'	19.47887"	N	002°	40'	10.45332"	W	519364.81	6462760.82	327.33	3.271	81.004	AC160	55.1		AC Point
163	30N	58°	18'	20.29519"	N	002°	40'	11.31555"	W	519350.65	6462786.00	330.65	0.029	81.033	AC161	55.0		AC Point
164	30N	58°	18'	22.33429"	N	002°	40'	13.18505"	W	519319.91	6462848.91	333.96	0.070	81.103	AC162	55.2		AC Point
165	30N	58°	18'	23.09523"	N	002°	40'	13.98119"	W	519306.83	6462872.38	330.88	0.027	81.130	AC163	54.9		AC Point
166	30N	58°	18'	25.98461"	N	002°	40'	17.40106"	W	519250.72	6462961.47	327.8	0.105	81.236	AC164	54.4		AC Point
167	30N	58°	18'	27.02702"	N	002°	40'	18.86788"	W	519226.69	6462993.59	323.2	0.040	81.276	AC165	54.2		AC Point
168	30N	58°	18'	27.96427"	N	002°	40'	20.42281"	W	519201.24	6463022.46	318.59	0.038	81.314	AC166	54.0		AC Point
169	30N	58°	18'	28.96262"	N	002°	40'	21.83717"	W	519178.07	6463053.22	323.01	0.039	81.353	AC167	54.0		AC Point
170	30N	58°	20'	27.53821"	N	002°	42'	44.37512"	W	516842.18	6466709.85	327.43	4.339	85.692	AC168	53.8		AC Point
171	30N	58°	20'	28.36022"	N	002°	42'	45.50784"	W	516823.65	6466735.19	323.83	0.031	85.723	AC169	54.2		AC Point
172	30N	58°	20'	29.20869"	N	002°	42'	47.04914"	W	516798.47	6466761.32	316.07	0.036	85.759	AC170	54.3		AC Point
173	30N	58°	20'	29.45949"	N	002°	42'	47.56286"	W	516790.09	6466769.05	312.63	0.011	85.771	AC171	54.2		AC Point
174	30N	58°	20'	30.21044"	N	002°	42'	48.90295"	W	516768.19	6466792.18	316.58	0.032	85.803	AC172	54.2		AC Point
175	30N	58°	20'	31.03244"	N	002°	42'	50.03572"	W	516749.66	6466817.52	323.83	0.031	85.834	AC173	54.0		AC Point
176	30N	58°	20'	31.14683"	N	002°	42'	50.17339"	W	516747.41	6466821.05	327.44	0.004	85.838	AC174	54.1		AC Point
177	30N	58°	20'	32.35410"	N	002°	42'	51.62638"	W	516723.62	6466858.29	327.43	0.044	85.882	AC175	54.0		AC Point
178	30N	58°	20'	33.25758"	N	002°	42'	52.56615"	W	516708.22	6466886.16	331.08	0.032	85.914	AC176	54.0		AC Point
179	30N	58°	20'	34.20269"	N	002°	42'	53.27140"	W	516696.63	6466915.35	338.33	0.031	85.946	AC177	53.8		AC Point
180	30N	58°	20'	34.55406"	N	002°	42'	53.48247"	W	516693.15	6466926.20	342.23	0.011	85.957	AC178	53.8		AC Point
181	30N	58°	20'	35.50548"	N	002°	42'	54.15554"	W	516682.08	6466955.58	339.35	0.031	85.988	AC179	53.8		AC Point
182	30N	58°	20'	36.53982"	N	002°	42'	55.20885"	W	516664.82	6466987.49	331.59	0.036	86.025	AC179	53.8		AC Point
183	30N	58°	20'	52.16865	N	2°	43'	14.0230	W	516356.86	6467469.57	327.43	0.572	86.597	AC180	56.1	12NM	Boundary
184	30N	58°	27'	21.15888"	N	002°	51'	03.99602"	W	508688.64	6479475.86	327.43	14.246	100.843	AC181	63.7		AC Point
185	30N	58°	27'	21.97972"	N	002°	51'	05.13546"	W	508670.11	6479501.20	323.83	0.031	100.874	AC182	63.8		AC Point
186	30N	58°	27'	22.71922"	N	002°	51'	06.46228"	W	508648.55	6479524.03	316.63	0.031	100.906	AC183	63.8		AC Point
187	30N	58°	27'	23.36573"	N	002°	51'	07.95546"	W	508624.30	6479543.97	309.43	0.031	100.937	AC184	63.9		AC Point
188	30N	58°	27'	23.90903"	N	002°	51'	09.59152"	W	508597.75	6479560.71	302.23	0.031	100.969	AC185	63.9		AC Point
189	30N	58°	27'	24.25214"	N	002°	51'	10.93472"	W	508575.95	6479571.28	295.86	0.024	100.993	AC186	64.0		AC Point
190	30N	58°	27'	37.61018"	N	002°	52'	10.40622"	W	507611.14	6479982.43	293.08	1.049	102.041	AC187	66.8		AC Point
191	30N	58°	27'	37.95058"	N	002°	52'	12.23109"	W	507581.54	6479992.90	289.48	0.031	102.073	AC188	66.9		AC Point
192	30N	58°	27'	38.10278"	N	002°	52'	13.42112"	W	507562.24	6479997.57	283.6	0.020	102.093	AC189	67.0		AC Point
193	30N	58°	27'	41.78268"	N	002°	52'	48.13430"	W	506999.41	6480110.34	281.33	0.574	102.667	AC190	67.1		AC Point
194	30N	58°	27'	41.92102"	N	002°	52'	50.05333"	W	506968.30	6480114.56	277.73	0.031	102.698	AC191	67.0		AC Point
195	30N	58°	27'	41.94289"	N	002°	52'	51.28943"	W	506948.27	6480115.20	271.83	0.020	102.718	AC192	67.0		AC Point
196	30N	58°	27'	41.69198"	N	002°	54'	04.90342"	W	505755.19	6480105.51	269.53	1.193	103.911	AC193	64.4		AC Point
197	30N	58°	27'	41.59458"	N	002°	54'	07.19037"	W	505718.13	6480102.44	265.27	0.037	103.949	AC194	64.7		AC Point
198	30N	58°	27'	38.74085"	N	002°	54'	41.89876"	W	505155.71	6480013.40	261	0.569	104.518	AC195	66.9		AC Point
199	30N	58°	27'	38.64325"	N	002°	54'	44.18562"	W	505118.65	6480010.33	265.27	0.037	104.555	AC196	67.8		AC Point
200	30N	58°	27'	38.55753"	N	002°	55'	08.00357"	W	504732.62	6480007.20	269.53	0.386	104.941	AC197	67.4		AC Point
201	30N	58°	27'	38.60152"	N	002°	55'	09.72086"	W	504704.79	6480008.53	272.73	0.028	104.969	AC198	67.3		AC Point
202	30N	58°	27'	43.95510"	N	002°	56'	47.21902"	W	503124.42	6480172.52	275.92	1.589	106.558	AC199	65.5		AC Point
203	30N	58°	27'	43.99863"	N	002°	56'	48.95597"	W	503096.27	6480173.85	272.69	0.028	106.586	AC200	65.2		AC Point
204	30N	58°	27'	43.83430"	N	002°	57'	25.10453"	W	502510.41	6480168.35	269.46	0.586	107.172	AC201	63.4		AC Point
205	30N	58°	27'	43.73867"	N	002°	57'	27.35636"	W	502473.92	6480165.37	265.33	0.037	107.209	AC202	63.3		AC Point
206	30N	58°	27'	40.88823"	N	002°	58'	02.07781"	W	501911.23	6480076.89	261.06	0.570	107.778	AC203	60.4		AC Point
207	30N	58°	27'	40.78952"	N	002°	58'	04.36459"	W	501874.16	6480073.82	265.26	0.037	107.815	AC204	60.5		AC Point
208	30N	58°	27'	40.19471"	N	003°	00'	25.72868"	W	499583.00	6480055.00	269.53	2.291	110.107	AC205	47.1		AC Point
209	30N	58°	27'	40.25926"	N	003°	00'	27.76478"	W	499550.00	6480057.00	273.47	0.033	110.140	AC206	46.7		AC Point
210	30N	58°	27'	40.38755"	N	003°	00'	41.64721"	W	499325.00	6480061.00	271.02	0.225	110.365	AC207	44.4		AC Point
211	30N	58°	27'	40.67739"	N	003°	00'	52.93835"	W	499142.00	6480070.00	272.82	0.183	110.548	AC208	42.4		AC Point
212	30N	58°	27'	41.35444"	N	003°	01'	07.80834"	W	498901.00	6480091.00	274.98	0.242	110.790	AC209	41.3		AC Point
213	30N	58°	27'	42.12841"	N	003°	01'	20.39564"	W	498697.00	6480115.00	276.71	0.205	110.995	AC210	40.4		AC Point
214	30N	58°	27'	43.19288"	N	003°	01'	33.78542"	W	498480.00	6480148.00	278.65	0.219	111.215	AC211	37.9		AC Point
215	30N	58°	27'	44.45104"	N	003°	01'	46.80537"	W	498269.00	6480187.00	280.47	0.215	111.429	AC212	33.3		AC Point
216	30N	58°	27'	45.09245"	N	003°	01'	52.53015"	W	498176.23	6480206.88	282.09	0.095	111.524	AC213	31.8		AC Point
217	30N	58°	27'	45.24195"	N	003°	01'	54.44616"	W	498145.18	6480211.52	278.5	0.031	111.556	AC214	30.9		AC Point
218	30N	58°	27'	45.26995"	N	003°	01'	56.01353"	W	498119.78	6480212.40	271.98	0.025	111.581	AC215	30.1		AC Point
219	30N	58°	27'	44.90456"	N	003°	02'	37.39880"	W	497449.04	6480201.47	269.07	0.671	112.252	AC216	22.5		AC Point
220	30N	58°	27'	44.93816"	N	003°	02'	38.88110"	W	497425.02	6480202.53	272.51	0.024	112.276	AC217	22.6		AC Point
221	30N	58°	27'	45.07249"	N	003°	02'	40.40944"	W	497400.25	6480206.70	279.56	0.025	112.301	AC218	22.7		AC Point
222	30N	58°	27'	45.30616"	N	003°	02'	41.89367"	W	497376.20	6480213.94	286.76	0.025	112.326	AC219	22.6		AC Point
223	30N	58°	27'	45.63543"	N	003°	02'	43.31027"	W	497353.25	6480224.14	293.96	0.025	112.351	AC220	22.5		AC Point
224	30N	58°	27'	46.05516"	N	003°	02'	44.63692"	W	497331.76	6480237.14	301.16	0.025	112.376	AC221	22.4		AC Point
225	30N	58°	27'	46.55870"	N	003°	02'	45.85275"	W	497312.06	6480252.73	308.36	0.025	112.401	AC222	22.4		AC Point
226	30N	58°	27'	47.63879"	N	003°	02'	48.14834"	W	497274.88	6480286.16	311.96	0.050	112.451	AC223	22.0	HDD Pop Up hole	AC Point
227	30N	58°	28'	01.81923"	N	003°	03'	18.29274"	W	496786.70	6480725.10	311.96	0.656	113.108	AC224	0	Noss TJP Preliminary rev 3 (09/06/2015)	TJP

Appendix 2

Hub Platform to Portgordon West Alignment RPL

Route Plan List

Company: Scottish Hydro Electric Transmission Limited
MMT ID No.: 101044
WGS 84 UTM 30N
Course presented as Grid course

RPL list - Western Route									
No (AC)	Latitude DDMM.mmm	Longitude DDMM.mmm	Easting (m)	Northing (m)	Course (º)	Grid Length (m)	Acc Grid Length (m)	True Length (m)	Acc True Length (m)
0	58°16.820' N	002°38.363' W	521149	6459978			0.0		0.0
					163.1	388.1		388.3	
1	58°16.620' N	002°38.249' W	521262	6459607			388.1		388.3
					148.1	1887.5		1888.2	
2	58°15.753' N	002°37.240' W	522258	6458003			2275.6		2276.5
					171.6	250.8		250.9	
3	58°15.619' N	002°37.204' W	522295	6457755			2526.4		2527.4
					148.1	677.4		677.7	
4	58°15.308' N	002°36.841' W	522652	6457180			3203.8		3205.1
					124.8	252.9		253.0	
5	58°15.229' N	002°36.630' W	522860	6457035			3456.7		3458.1
					148.1	4005.1		4006.7	
6	58°13.389' N	002°34.491' W	524974	6453634			7461.8		7464.7
					156.4	394.2		394.4	
7	58°13.194' N	002°34.332' W	525132	6453272			7856.0		7859.1
					168.4	496.9		497.1	
8	58°12.931' N	002°34.233' W	525231	6452786			8352.9		8356.2
					180.1	1400.2		1400.8	
9	58°12.177' N	002°34.244' W	525230	6451385			9753.2		9757.0
					176.5	1285.0		1285.5	
10	58°11.485' N	002°34.172' W	525308	6450103			11038.2		11042.5
					199.9	251.4		251.5	
11	58°11.358' N	002°34.261' W	525222	6449867			11289.5		11294.0
					176.5	544.8		545.1	
12	58°11.065' N	002°34.231' W	525256	6449323			11834.4		11839.0
					152.8	248.6		248.7	
13	58°10.946' N	002°34.117' W	525369	6449102			12083.0		12087.7
					176.5	4162.2		4163.8	
14	58°08.706' N	002°33.885' W	525623	6444947			16245.2		16251.5
					176.5	812.3		812.6	
15	58°08.269' N	002°33.839' W	525673	6444136			17057.4		17064.1
					191.4	643.9		644.2	
16	58°07.929' N	002°33.973' W	525546	6443505			17701.3		17708.3
					211.3	22630.7		22639.7	
17	57°57.541' N	002°46.024' W	513785	6424171			40332.1		40348.0
					241.1	200.7		200.8	
18	57°57.489' N	002°46.202' W	513609	6424074			40532.8		40548.8
					211.4	249.3		249.4	
19	57°57.374' N	002°46.335' W	513479	6423861			40782.1		40798.2
					181.7	202.5		202.6	
20	57°57.265' N	002°46.341' W	513473	6423659			40984.6		41000.8
					211.3	6659.3		6662.0	
21	57°54.205' N	002°49.864' W	510012	6417969			47643.9		47662.7
					174.8	335.9		336.1	
22	57°54.024' N	002°49.834' W	510043	6417635			47979.9		47998.8
					211.3	482.7		482.9	
23	57°53.802' N	002°50.089' W	509792	6417222			48462.5		48481.7
					237.3	685.7		685.9	
24	57°53.603' N	002°50.674' W	509215	6416851			49148.2		49167.6
					211.3	7415.8		7418.7	
25	57°50.193' N	002°54.583' W	505361	6410516			56564.0		56586.4
					210.0	1120.4		1120.9	
26	57°49.670' N	002°55.150' W	504801	6409545			57684.4		57707.2

RPL list - Western Route									
No	Latitude	Longitude	Easting	Northing	Course	Grid	Acc Grid	True	Acc True
(AC)	DDMM.mmm	DDMM.mmm	(m)	(m)	(º)	Length (m)	Length (m)	Length (m)	Length (m)
					186.4	250.1		250.2	
27	57°49.536' N	002°55.178' W	504773	6409297			57934.5		57957.4
					210.0	12031.4		12036.2	
28	57°43.922' N	003°01.251' W	498759	6398877			69965.9		69993.6
					220.7	285.2		285.3	
29	57°43.805' N	003°01.438' W	498573	6398660			70251.1		70278.9
					212.3	300.8		300.9	
30	57°43.668' N	003°01.600' W	498412	6398406			70551.9		70579.8
					200.5	283.3		283.4	
31	57°43.525' N	003°01.700' W	498312	6398141			70835.2		70863.3
					182.3	250.7		250.8	
32	57°43.390' N	003°01.710' W	498302	6397891			71085.8		71114.0
					182.7	3671.2		3672.6	
33	57°41.414' N	003°01.880' W	498132	6394223			74757.0		74786.7
					180.7	2933.2		2934.4	
34	57°39.833' N	003°01.916' W	498095	6391290			77690.2		77721.0

Appendix 3

Hub Platform to Noss Head Centre Alignment RPL

Route Plan List
NOSS_C
SSE
MMT ID No.: 100711
WGS 84 UTM 30N
Course presented as Grid course

RPL list.						
No	Latitude	Longitude	Easting	Northing	Course	Grid
(AC)	DDMM.mmm	DDMM.mmm	(m)	(m)	(º)	Length (m)
0	58°16.820' N	002°38.363' W	521148.9	6459977.8		
					327.3	3320.3
1	58°18.331' N	002°40.182' W	519357	6462773.2		
					333.5	97.8
2	58°18.379' N	002°40.226' W	519313.4	6462860.7		
					327.9	278.3
3	58°18.506' N	002°40.376' W	519165.7	6463096.5		
					319.7	100.7
4	58°18.548' N	002°40.443' W	519100.6	6463173.4		
					327.3	202.9
5	58°18.640' N	002°40.554' W	518991	6463344.2		
					327.4	1726
6	58°19.426' N	002°41.498' W	518062.1	6464798.9		
					332.9	111.4
7	58°19.480' N	002°41.550' W	518011.4	6464898.1		
					322.5	123.3
8	58°19.533' N	002°41.626' W	517936.3	6464995.8		
					327.4	5978
9	58°22.255' N	002°44.903' W	514718.8	6470034.1		
					333.1	86.1
10	58°22.296' N	002°44.943' W	514679.9	6470110.8		
					329.7	79.6
11	58°22.334' N	002°44.984' W	514639.6	6470179.6		
					327.3	198.2
12	58°22.424' N	002°45.093' W	514532.6	6470346.4		
					321.1	101.8
13	58°22.466' N	002°45.158' W	514468.7	6470425.7		
					327.4	10815.9
14	58°27.388' N	002°51.109' W	508647.3	6479541.4		
					293.1	1471.5
15	58°27.700' N	002°52.500' W	507293.3	6480117.6		
					269.5	3693.4
16	58°27.687' N	002°56.298' W	503600	6480087.9		
					269.5	4017
17	58°27.670' N	003°00.429' W	499583.2	6480055.6		
					271.1	33.2
18	58°27.671' N	003°00.463' W	499550	6480056.2		
					271.1	224.9
19	58°27.673' N	003°00.694' W	499325.2	6480060.6		
					273	183.1
20	58°27.678' N	003°00.882' W	499142.4	6480070.2		

					274.9	242.3
21	58°27.689' N	003°01.130' W	498901	6480090.7		
					276.8	205.6
22	58°27.702' N	003°01.340' W	498696.8	6480115.1		
					278.6	219.1
23	58°27.720' N	003°01.563' W	498480.2	6480147.9		
					280.5	214.5
24	58°27.741' N	003°01.780' W	498269.3	6480187.1		
					282.2	186.8
25	58°27.762' N	003°01.967' W	498086.8	6480226.7		
					283.6	135.4
26	58°27.779' N	003°02.103' W	497955.2	6480258.6		
					284.8	141.9
27	58°27.799' N	003°02.244' W	497818	6480295		

Acc Grid Length (m)	True Length (m)	Acc True Length (m)
0		0
	3321.7	
3320.3		3321.7
	97.8	
3418.1		3419.5
	278.4	
3696.4		3697.8
	100.8	
3797.1		3798.6
	203	
4000		4001.6
	1726.7	
5726		5728.3
	111.5	
5837.4		5839.7
	123.3	
5960.7		5963
	5980.4	
11938.7		11943.4
	86.1	
12024.7		12029.5
	79.7	
12104.4		12109.2
	198.3	
12302.6		12307.5
	101.9	
12404.4		12409.4
	10820.3	
23220.4		23229.6
	1472	
24691.8		24701.7
	3694.9	
28385.3		28396.5
	4018.6	
32402.2		32415.1
	33.2	
32435.4		32448.3
	225	
32660.3		32673.3
	183.2	
32843.3		32856.4

	242.4	
33085.6		33098.8
	205.7	
33291.2		33304.5
	219.2	
33510.3		33523.6
	214.6	
33724.8		33738.2
	186.9	
33911.6		33925.1
	135.5	
34047		34060.5
	142	
34188.9		34202.5

Appendix 4

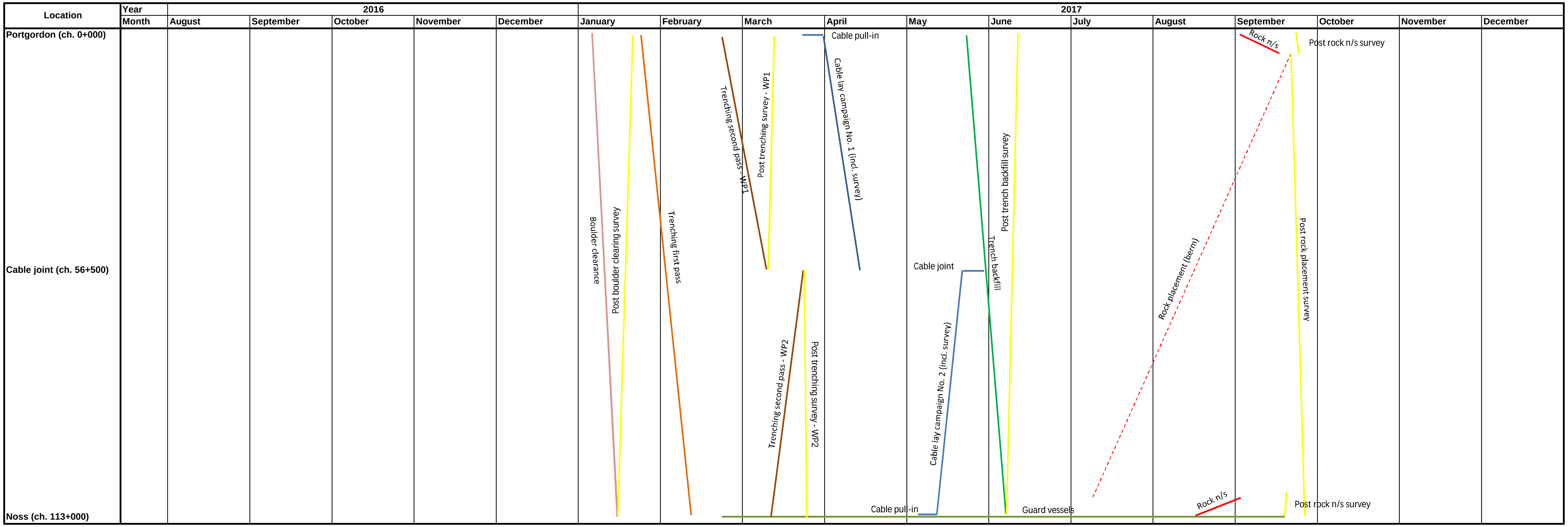
Installation Schedule

Scottish and Southern Energy

LT21_Caithness HVDC Reinforcement

Marine Operations: current programme

Schedule of activities **Date:** **25.09.15** **Doc No.:** **LT000021-PRG-003** **Revision:** **4.0** **Revision note:** **Update to reflect Contractor's Revision 17 installation programme**

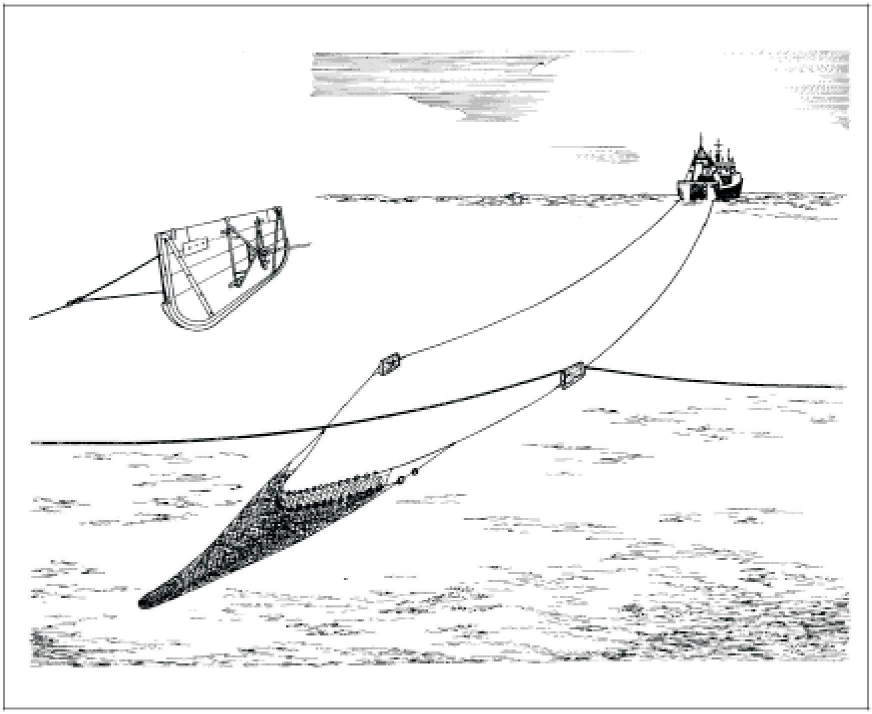


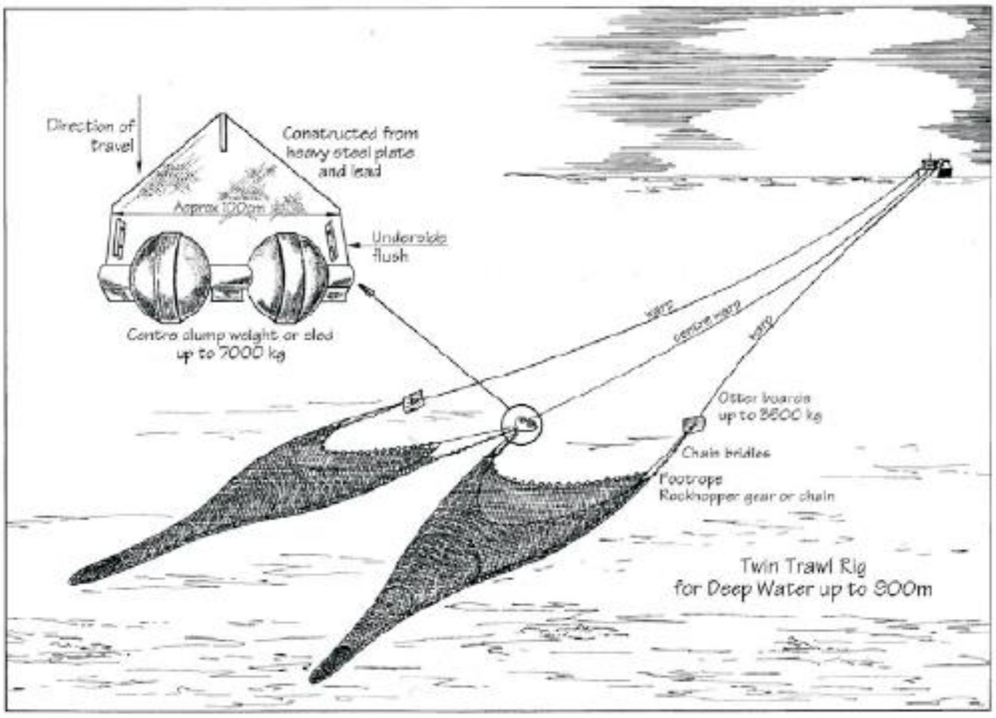
Programme dates

Activity	Start date	Finish date	Duration (days)
Boulder clearance	05/01/2017	15/01/2017	10
Post boulder clearance survey	15/01/2017	20/01/2017	5
Trenching first pass	23/01/2017	11/02/2017	19
Trenching second pass WP1	24/02/2017	08/03/2017	12
Post trenching survey WP 1	08/03/2017	11/03/2017	3
Trenching second pass WP2	11/03/2017	23/03/2017	12
Post trenching survey WP 2	23/03/2017	26/03/2017	3
Cable pull-in (Portgordon)	26/03/2017	31/03/2017	5
Cable lay - campaign 1 (incl. survey)	31/03/2017	14/04/2017	14
Cable pull-in (Noss)	03/05/2017	08/05/2017	5
Cable lay - campaign 2 (incl. survey)	08/05/2017	22/05/2017	14
Cable joint	22/05/2017	30/05/2017	8
Trench backfill	22/05/2017	05/06/2017	14
Post trench backfill survey	05/06/2017	10/06/2017	5
Rock placement (berm)	06/07/2017	22/09/2017	78
Post rock placement survey	22/09/2017	27/09/2017	5
Rock n/s (Noss)	16/08/2017	01/09/2017	16
Rock n/s (Portgordon)	01/09/2017	16/09/2017	15
Post rock n/s survey (Noss)	22/09/2017	23/09/2017	1
Post rock n/s survey (Portgordon)	24/09/2017	25/09/2017	1
Guard vessels (varying quantity)	24/02/2017	27/09/2017	215

Appendix 5

Demersal Otter Trawling Gear Drawings




Direction of travel
Constructed from heavy steel plate and lead
Underside flush
Centre clump weight or sled up to 7000 kg
warp
centre warp
warp
Otter boards
Chain bridles
Footrope
Rockhopper gear or chain
Twin Trawl Rig

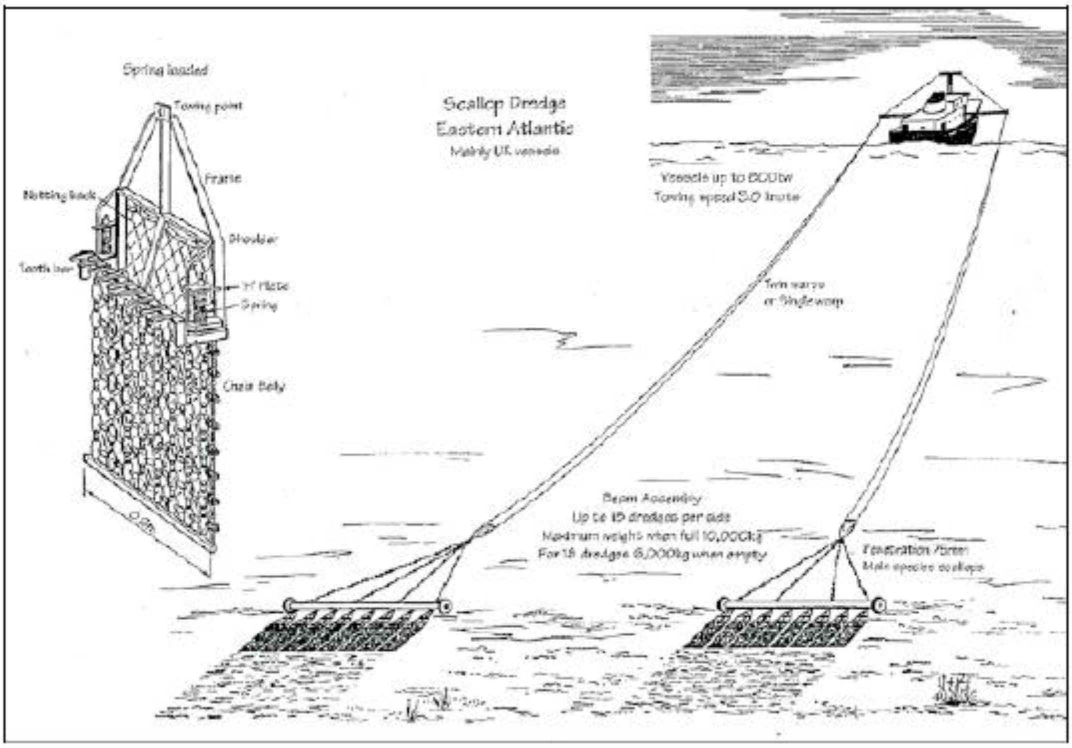
Appendix 6

Demersal Otter Trawling Gear Parameters

Parameter	Units	Smallest config.	Mean config.	Largest config.
Vessel mass	Tonnes	25	220	350
Gear mass				
Total Door mass	kg	152	640	1800
Mass of nets, chains etc	kg	800	2500	3500
Added mass coefficient		22.0	22.0	22.0
(for attack angle)	°	35	35	35
Gear dimensions				
L1	m	0.736	1.06	1.48
L2	m	0.92	1.33	1.85
L3	m	1.83	2.65	3.70
D1	m	0.55	0.81	1.35
D2	m	0.55	0.81	1.35
R	m	0.25-0.5	0.3-0.8	0.3-1.3
Warps and Winches				
Warp diameter	mm	10	16	28
Warp mass	Kg/m	0.34	0.92	2.71
Length v water depth		3.0	3.0	3.0
Warp angle to horiz.		10	10	10
Normal trawl load	tonnes	1.0	3.0	8.0
Max load limiter	tonnes	1.5	5.7	30
Breaking load	tonnes	5.5	14	43
Trawl Parameters				
Velocity	m/s	2.1(+/-)0.5	2.1(+/-)0.5	2.1(+/-)0.5
Duration	hours	3.5-5.0	3.5-5.0	3.5-5.0

Appendix 7

Dredging Gear Drawings


Spring loaded
Towing point
Frame
Shoulder
Tooth bar
'H' Plate
Spring
Chain Belly
Scallop Dredge
Eastern Atlantic
Twin warps
or Single warp
Beam Assembly
Up to 15 dredges per side
Main species scallops

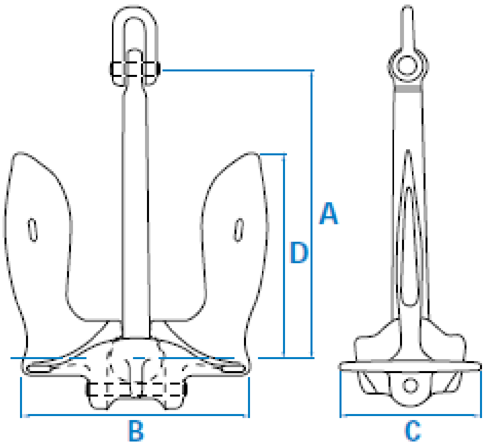
Appendix 8

Dredging Gear Parameters

Description	Units	Standard	Spring Loaded
Total length	m	1.96	2.35
Length of bag	m	0.64	1.06
Width	m	1.22	1.22
Height of mouth opening	m	0.15	0.13
Belly ring internal diameter	mm	83	83
Netting mesh	mm	80	80
Number of teeth		12	12
Width of teeth	mm	25	21
Mean length of teeth	mm	53	86
Mean space between teeth at base	mm	77	80
Mean space between teeth at tip	mm	94	97
Angle of attack of teeth (to horizontal when fished with wheeled bar	O	67.5	77.5
Total weight	kg	91	110

Appendix 9

Anchor Parameters

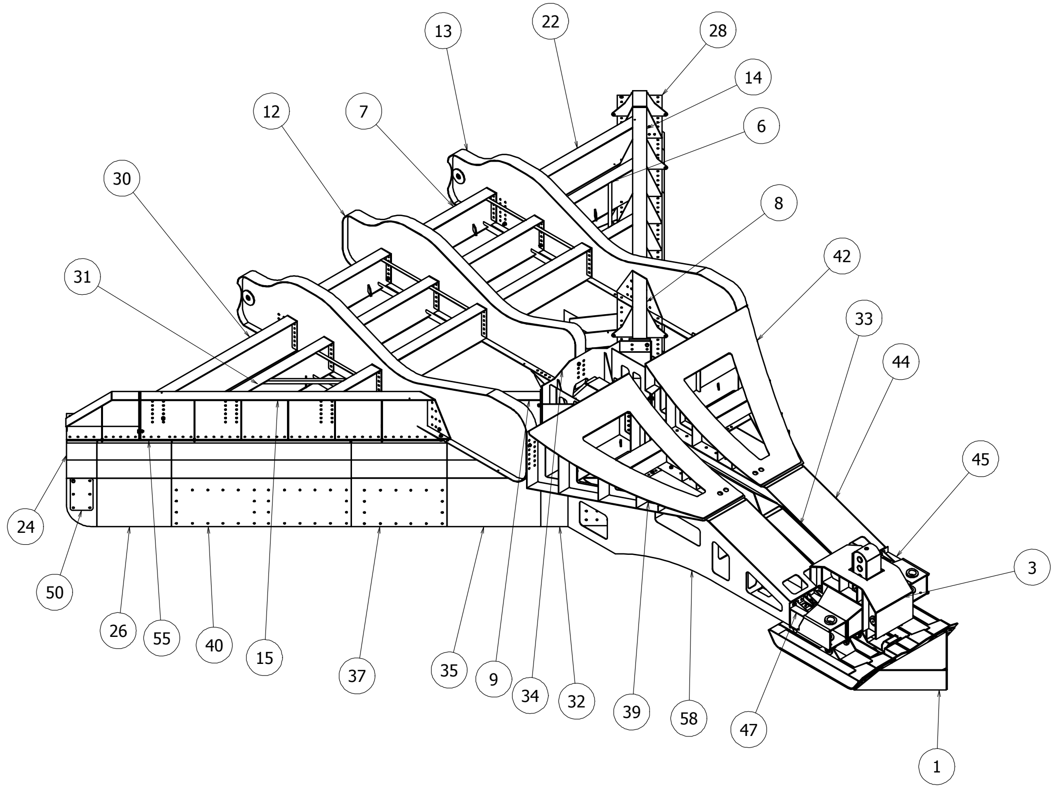


US Navy Stockless					
weight		A	B	C	D
lb.	kg	mm	mm	mm	mm
1000	454	1072	841	521	772
5000	2268	1854	1437	889	1319
10000	4536	2337	1810	1121	1661
15000	6804	2680	2089	1295	1861
20000	9072	2946	2280	1413	2094
25000	11340	3175	2456	1522	2256
30000	13608	3372	2608	1616	2394
35000	15876	3550	2743	1703	2523
40000	18144	3708	2872	1778	2619
60000	27216	4775	3194	2218	3375

Appendix 10

SCAR 2 General Arrangement Drawings and Specifications

PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	AC-C-012-09	FRONT SKID ASSEMBLY
2	3	AC-C-012-15	MAIN SKID CLEVIS LOCK PLATE
3	1	AC-C-012-26	CLEVIS FABRICATION
4	2	AC-C-012-33	CHASSIS AND CLEVIS PIN
5	1	AC-C-012-34	SKID POST AND CLEVIS PIN
6	1	AC-C-121-0001	LEFT CROSS BRACING
7	2	AC-C-121-0002	CENTRAL CROSS BRACING
8	1	AC-C-121-0003	FRONT DIAGONAL BRACING
9	1	AC-C-121-0004	FRONT DIAGONAL BRACING OH
10	2	AC-C-121-0005	CLOSING PLATE
11	2	AC-C-121-0006	CLOSING PLATE
12	1	AC-C-121-0007	MID BRACING BEAM
13	2	AC-C-121-0008	SIDE BRACING BEAM
14	1	AC-C-121-0010	LEFT BACK DIAGONAL BRACING
15	1	AC-C-121-0011	RIGHT BACK DIAGONAL BRACING
16	2	AC-C-121-0015	CLOSING PLATE
17	6	AC-C-121-0016	CLOSING PLATE
18	4	AC-C-121-0019	CLOSING PLATE
19	6	AC-C-121-0020	CLOSING PLATE
20	4	AC-C-121-0021	CLOSING PLATE
21	2	AC-C-121-0022	CLOSING PLATE
22	1	AC-C-121-0023	LEFT BACK CROSS BRACING (EXTENDED)
23	6	AC-C-121-0024	CLOSING PLATE
24	1	AC-C-121-0026	CURVED END MOULD BOARD
25	1	AC-C-121-0027	CURVED END MOULD BOARD OH
26	2	AC-C-121-0028	MOULD BOARD EXTENSION
27	25	AC-C-121-0029	STUD FASTENER
28	2	AC-C-121-0030	BACK DIAGONAL BRACING EXTENSION
29	1	AC-C-121-0031	CONNECTION OF BRACING TO CENTRAL FABRICATION
30	1	AC-C-121-0033	RIGHT BACK CROSS BRACING (EXTENDED)
31	1	AC-C-121-0034	RIGHT CROSS BRACING
32	1	AC-C-121-0040	BOULDER CLEARANCE V-SHAPE MOULD BOARD
33	1	AC-C-121-0042	CHASSIS
34	1	AC-C-121-0045	BOULDER CLEARANCE CHASSIS TO BRACING FABRICATION
35	2	AC-C-121-0047	INNER MOULD BOARD
36	1	AC-C-121-0048	BEARING PLATE
37	2	AC-C-121-0049	SECOND INNER MOULD BOARD
38	1	AC-C-121-0050	BEARING PLATE OH
39	1	AC-C-121-0051	BOULDER CLEARANCE L & R FABRICATION (RIGHT)
40	2	AC-C-121-0052	LONG MOULD BOARD
41	1	AC-C-121-0053	LONG MOULD BOARD MOUNT OH
42	1	AC-C-121-0054	BOULDER CLEARANCE L & R FABRICATION (LEFT)
43	1	AC-C-121-0055	CHASSIS TO CENTRAL BRACING FABRICATION
44	1	AC-C-121-0057	SHALLOW WATER L & R FABRICATION
45	1	AC-C-121-0058	TOW HEAD EXTENSION OH
46	1	AC-C-121-0060	KEEL PLATE
47	1	AC-C-121-0062	TOW HEAD EXTENSION
48	1	AC-C-121-0063	KEEL PLATE OH
49	2	AC-C-121-0066	LARGE CURVED END MOULD BOARD CLOSING PLATE
50	2	AC-C-121-0067	SMALL CURVED END MOULD BOARD CLOSING PLATE
51	4	AC-C-121-0068	CURVED END MOULD BOARD MOUNT
52	2	AC-C-121-0069	MOULD BOARD EXTENSION MOUNT
53	1	AC-C-121-0070	OUTER MOULD BOARD MOUNT
54	1	AC-C-121-0071	INSIDE MOULD BOARD MOUNT
55	2	AC-C-121-0072	MOULD BOARD EXTENSION MOUNT OH
56	1	AC-C-121-0073	OUTER MOULD BOARD MOUNT OH
57	1	AC-C-121-0074	SECOND MOULD BOARD MOUNT
58	1	AC-C-121-0077	SHALLOW WATER L & R FABRICATION OH
59	2	AC-C-121-0078	V-SHAPE MOULD BOARD CLOSING PLATE
60	1	AC-C-121-0079	INNER MOULD BOARD MOUNT
61	1	AC-C-121-0080	LONG MOULD BOARD MOUNT
62	1	AC-C-121-0081	INSIDE MOULD BOARD MOUNT OH
63	1	AC-C-121-0082	INNER MOULD BOARD MOUNT OH
64	1	AC-C-121-0083	FIRST MOULD BOARD MOUNT
65	1	AC-C-121-0084	FIRST MOULD BOARD MOUNT OH
66	1	AC-C-121-0085	SECOND MOULD BOARD MOUNT OH



PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
67	338	M30 x 100	GRADE 8.8 HEX BOLT
68	52	M30 x 110	GRADE 8.8 HEX BOLT
69	6	M30 x 150	GRADE 8.8 HEX BOLT
70	98	M30 x 80	GRADE 8.8 HEX BOLT
71	566	M30 x 90	GRADE 8.8 HEX BOLT
72	12	M36 x 180	GRADE 8.8 HEX BOLT
73	20	M36 x 90	GRADE 8.8 HEX BOLT
74	990	M30 Nut	GRADE 8 HEX NUT
75	32	M36 Nut	GRADE 8 HEX NUT
76	2042	M30 WASHER	GRADE 8.8 PLAIN
77	64	M36 WASHER	GRADE 8.8 PLAIN
78	6	M20 WASHER	GRADE 8.8 PLAIN
79	6	M20 x 70	GRADE 8.8 SHCS

CONTRACT REFERENCE	AC-C-121						
CONTRACT TITLE	2m BACKFILL						
ESTIMATED MASS	71800 kg	REMOVE ALL BURRS AND SHARP EDGES					
DIMENSIONS	UP TO 100	101 TO 300	301 TO 1000	1001 TO 5000	5001 TO 20000	OVER 20000	-
FABRICATIONS	± 1.0	± 1.5	2.0	3.0	10.0	20.0	-
MACHINED PART	0.15	0.4	0.8	1.0	-	-	-

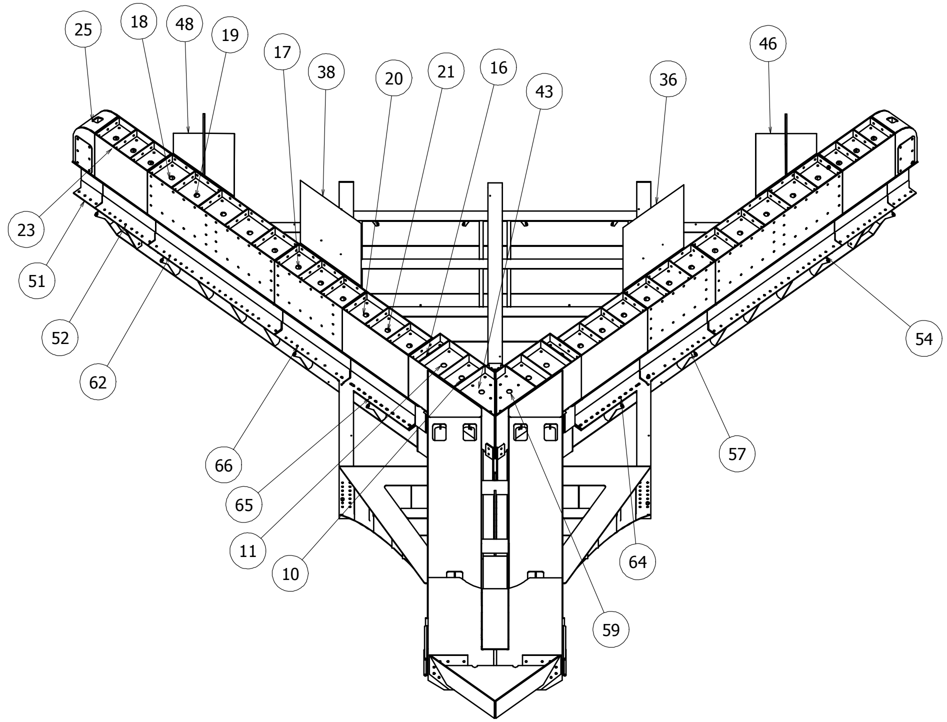
MATERIAL	N/A	3rd ANGLE PROJECTION	
DESIGNED BY	[redacted]	DO NOT SCALE	
DRAWN BY	[redacted]	DATE	22/07/2015
CHECKED BY	[redacted]	CHK DATE	22/07/2015
APPROVED BY	[redacted]	APP. DATE	22/07/2015
DIMENSIONS IN mm		SCALE	1:50

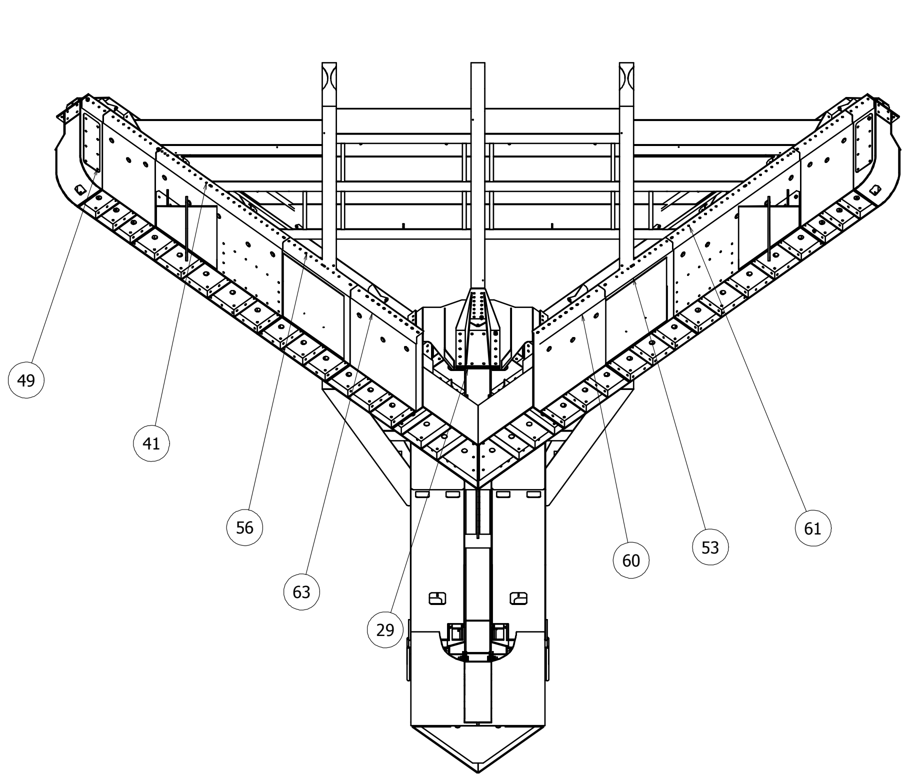
Ardmore Craig

Ardmore Craig Ltd.
F32 Evans Business Incubation Centre
Durham Way South
Aycliffe Business Park
DL5 6XP
Tel: 01325 329880 | www.ardmorecraig.com

TITLE
15.5m
BOULDER CLEARANCE
PLOUGH

DRAWING No.	REVISION
AC-C-12-0039	0
SHEET 1 OF 3	





CONTRACT REFERENCE	AC-C-121						
CONTRACT TITLE	2m BACKFILL						
ESTIMATED MASS	N/A	REMOVE ALL BURRS AND SHARP EDGES					
DIMENSIONS	UP TO 100	101 TO 300	301 TO 1000	1001 TO 5000	5001 TO 20000	OVER 20000	-
FABRICATIONS	± 1.0	± 1.5	2.0	3.0	10.0	20.0	-
MACHINED PART	0.15	0.4	0.8	1.0	-	-	-

MATERIAL	N/A		
DESIGNED BY	[redacted]	DO NOT SCALE	
DRAWN BY	[redacted]	DATE	22/07/2015
CHECKED BY	[redacted]	CHK DATE	22/07/2015
APPROVED BY	[redacted]	APP. DATE	22/07/2015

3rd ANGLE PROJECTION

DIMENSIONS IN mm

SCALE 1:50

TITLE

15.5m BOULDER CLEARANCE FULL ASSEMBLY

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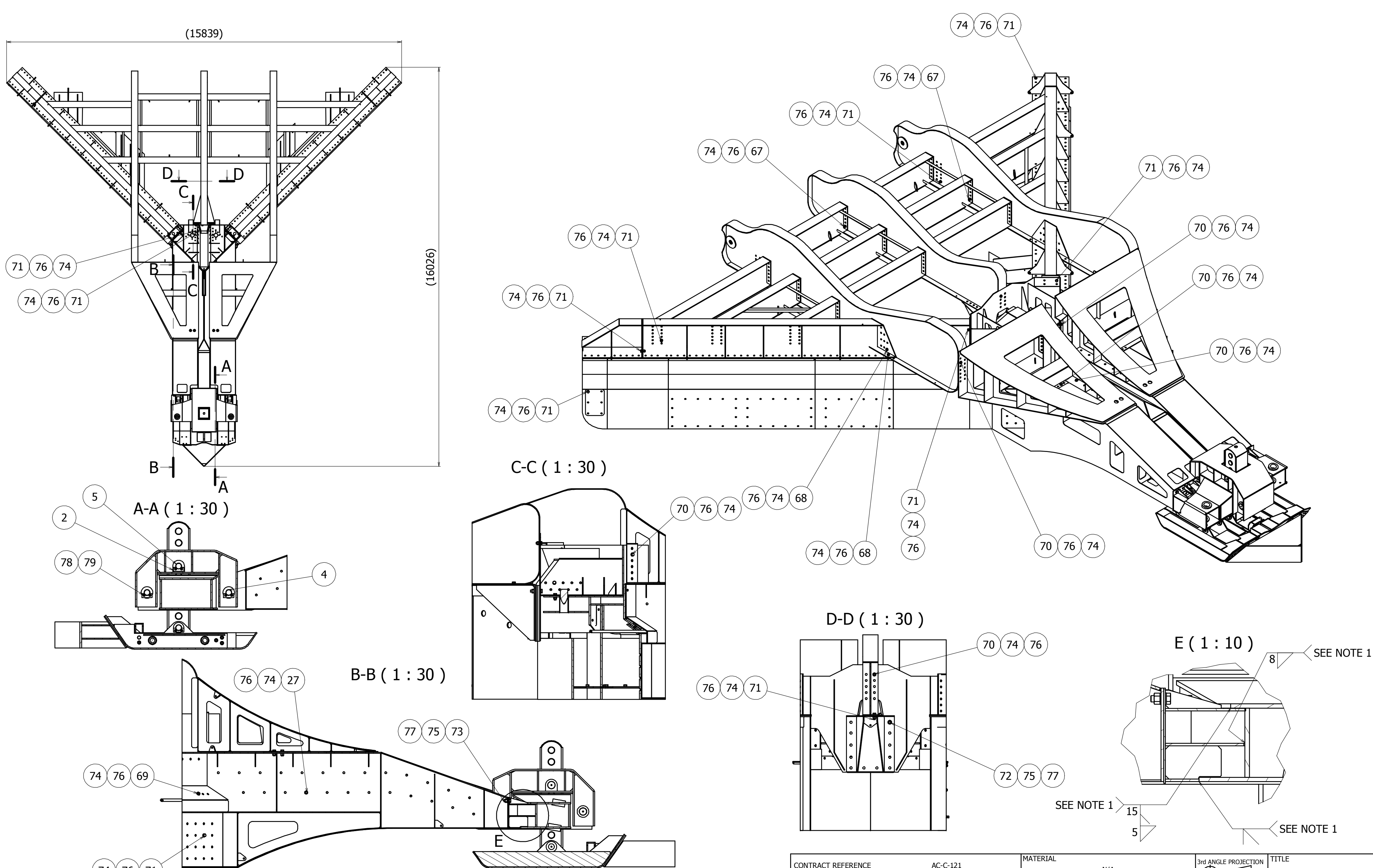
DRAWING No. AC-C-121-0039

REVISION 0

SHEET 2 OF 3



NOTES

1) WELD DETAILS APPLY TO PARTS AC-C-121-0042 AND AC-C-121-0062
2) SEE AC-C-121-0038 FOR WELD DETAILS OF MOULD BOARD MOUNTS

CONTRACT REFERENCE	AC-C-121							
CONTRACT TITLE	2m BACKFILL							
ESTIMATED MASS	N/A	REMOVE ALL BURRS AND SHARP EDGES						
DIMENSIONS	UP TO 100	101 TO 300	301 TO 1000	1001 TO 5000	5001 TO 20000	OVER 20000	-	
FABRICATIONS	± 1.0	± 1.5	2.0	3.0	10.0	20.0	-	
MACHINED PART	0.15	0.4	0.8	1.0	-	-	-	

MATERIAL	N/A		
DESIGNED BY	[redacted]	DO NOT SCALE	
DRAWN BY	[redacted]	DATE	22/07/2015
CHECKED BY	[redacted]	CHK DATE	22/07/2015
APPROVED BY	[redacted]	APP. DATE	22/07/2015

3rd ANGLE PROJECTION

DIMENSIONS IN mm

SCALE 1:70

TITLE
15.5m
BOULDER CLEARANCE
FULL ASSEMBLY

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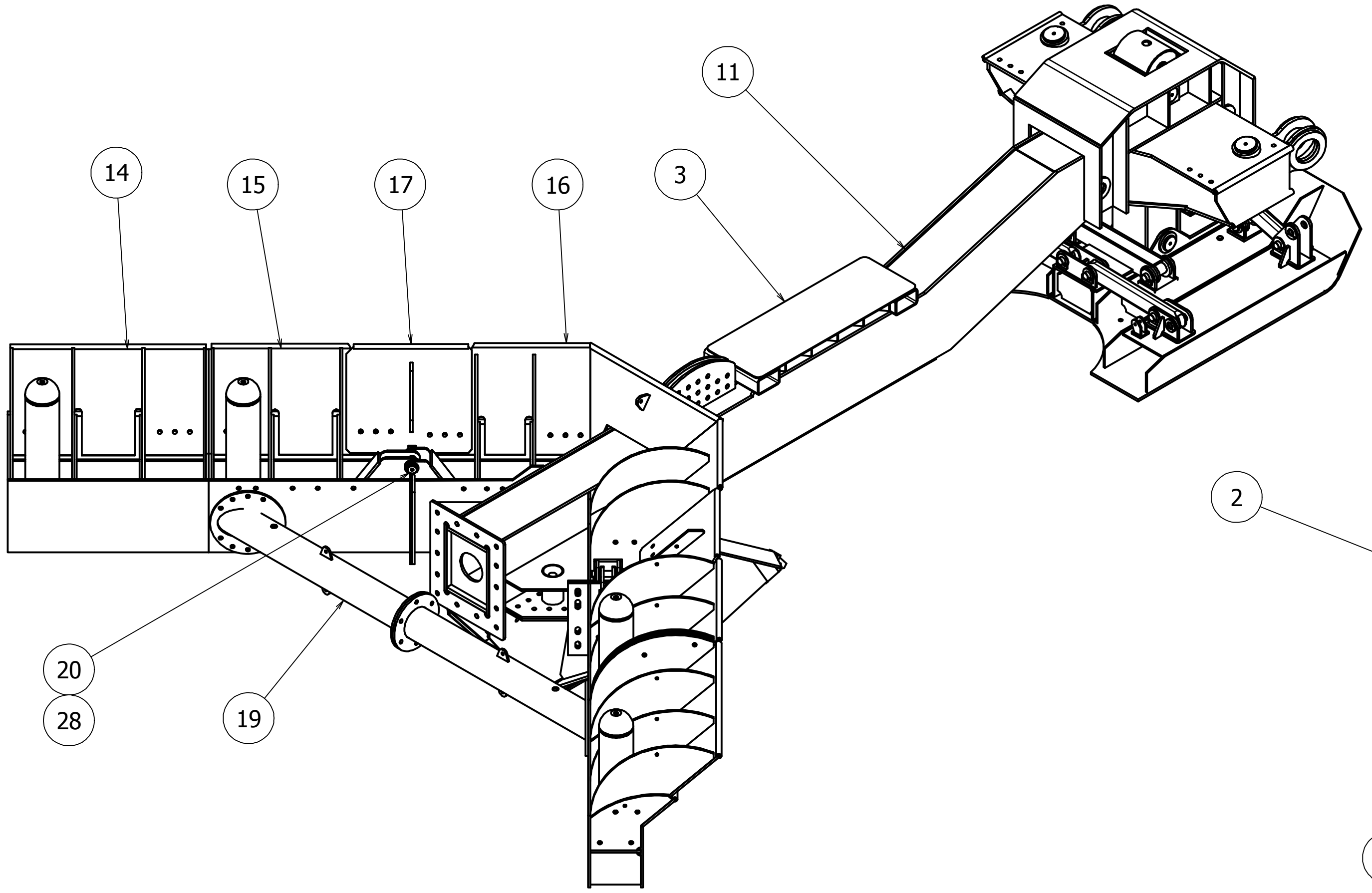
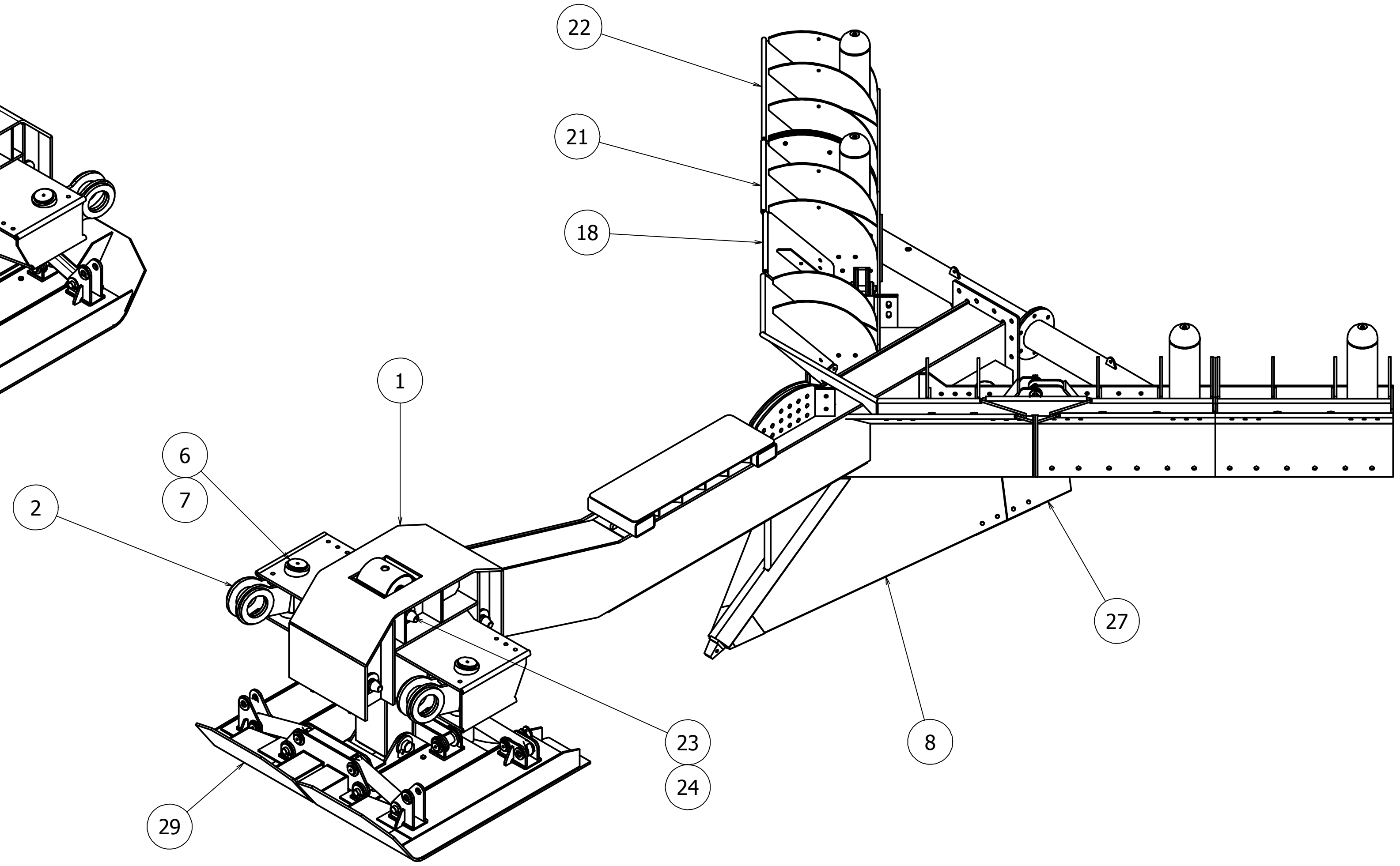
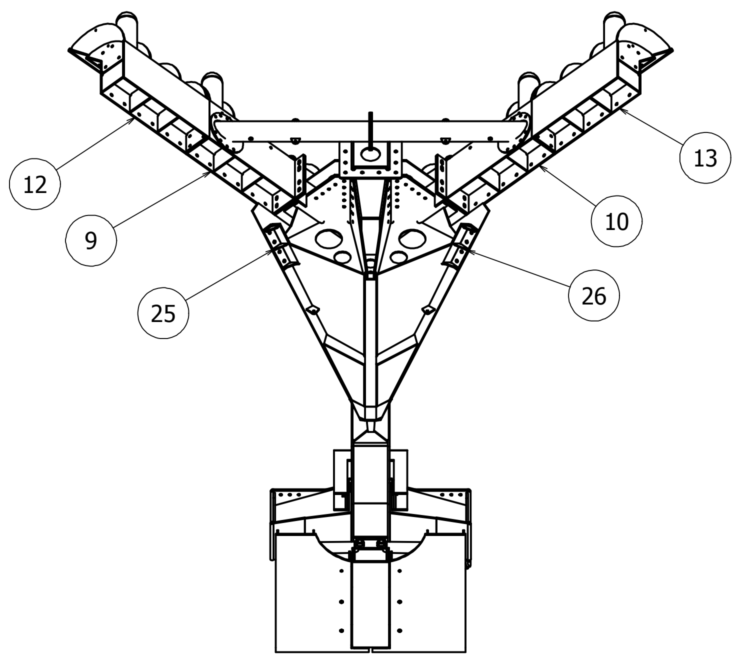
DRAWING No.	REVISION
AC-C-121-0039	0
SHEET 3 OF 3	







PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	AC-C-012-26	CLEVIS FABRICATION
2	2	AC-C-012-28	TOW POINT
3	1	AC-C-012-40	TRENCHING SKID PLATE
4	2	AC-C-012-43	MAIN SKID UPPER CLEVIS PIN
5	2	AC-C-012-44	MAIN SKID CLEVIS LOCK PLATE
6	2	AC-C-012-46	TOWING JOINT PIN
7	2	AC-C-012-47	TOWING JOINT END CAP
8	1	AC-C-038-0001	SHARE
9	1	AC-C-038-0005	MOULD BOARD OUTER LHS
10	1	AC-C-038-0006	MOULD BOARD OUTER RHS
11	1	AC-C-038-0007	CHASSIS FABRICATED ASSEMBLY
12	1	AC-C-038-0013	WIDE MOULD BOARD EXTENSION LHS
13	1	AC-C-038-0014	WIDE MOULD BOARD EXTENSION RHS
14	1	AC-C-038-0015	WIDE MOULD BOARD VERTICAL EXTENSION LHS
15	1	AC-C-038-0016	MID MOULD BOARD VERTICAL EXTENSION LHS
16	1	AC-C-038-0017	INNER MOULD BOARD VERTICAL EXTENSION
17	1	AC-C-038-0018	LHS FIRST PASS INFILL PLATE
18	1	AC-C-038-0019	RHS FIRST PASS INFILL PLATE
19	2	AC-C-038-0021	MOULD BOARD SUPPORT BEAM
20	2	AC-C-038-0023	MOULD BOARD EXTENSION CLEVIS PIN
21	1	AC-C-038-0024	MID MOULD BOARD VERTICAL EXTENSION RHS
22	1	AC-C-038-0025	WIDE MOULD BOARD VERTICAL EXTENSION RHS
23	3	AC-C-038-0030	SKID POST CLEVIS PIN
24	3	AC-C-038-0031	SKID POST CLEVIS LOCK PLATE
25	1	AC-C-038-0033	SHARE EXTENSION FABRICATION LHS
26	1	AC-C-038-0034	SHARE EXTENSION FABRICATION RHS
27	2	AC-C-038-0035	SHARE EXTENSION PLATE
28	2	AC-C-038-0036	MOULD BOARD EXTENSION CLEVIS LOCK PLATE
29	1	AC-C-038-0039	V SKID ASSEMBLY

CONTRACT REFERENCE	AC-C-038						
CONTRACT TITLE	SCAR MK 2						
ESTIMATED MASS	25000 kg	REMOVE ALL BURRS AND SHARP EDGES					
DIMENSIONS	UP TO 100	101 TO 300	301 TO 1000	1001 TO 5000	5001 TO 20000	OVER 20000	-
FABRICATIONS	± 1.0	± 1.5	2.0	3.0	10.0	20.0	-
MACHINED PART	0.15	0.4	0.8	1.0	-	-	-

MATERIAL: N/A

DESIGNED BY	[redacted]	DO NOT SCALE	
DRAWN BY	[redacted]	DATE	19/02/13
CHECKED BY	[redacted]	CHK DATE	19/02/13
APPROVED BY	[redacted]	APP. DATE	19/02/13

3rd ANGLE PEOJECTION

DIMENSIONS IN mm

SCALE NTS

Ardmore Craig

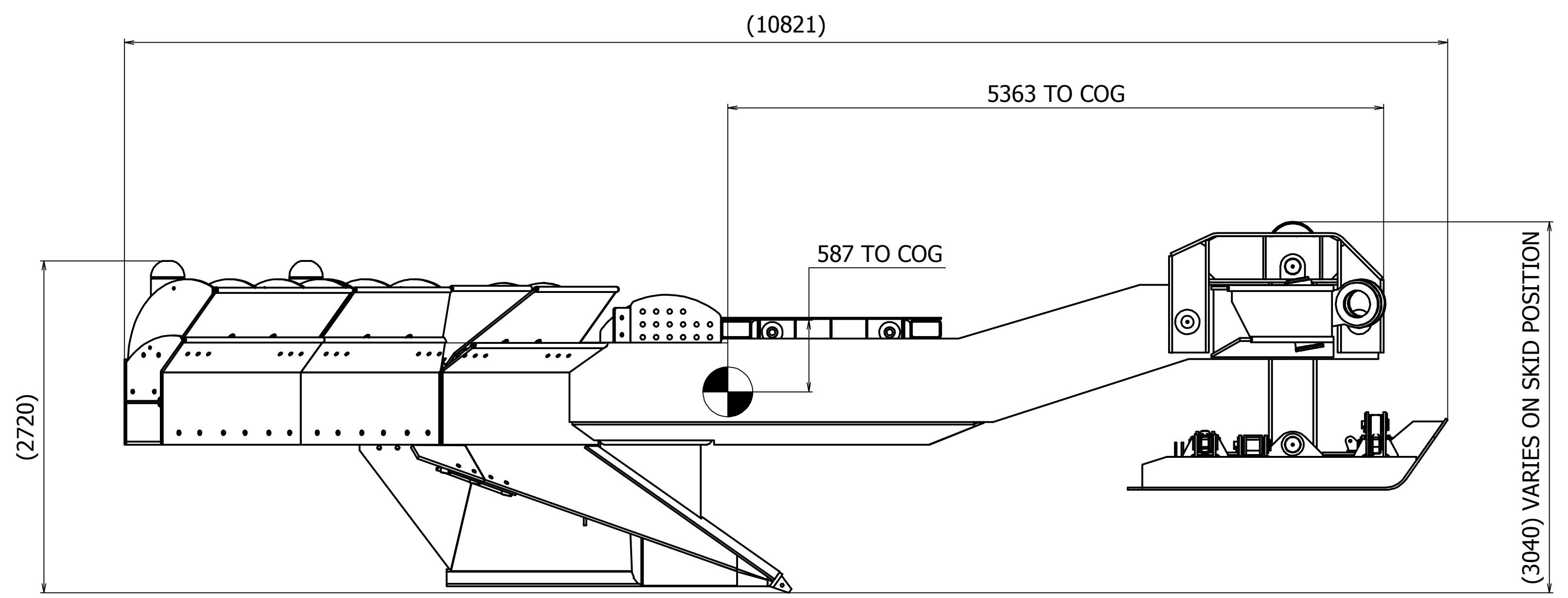
Ardmore Craig Ltd.
F13 Evans Business Incubation Centre
Durham Way South
Aycliffe Business Park
DL5 6XP
Tel: 01325 329880 | www.ardmorecraig.com

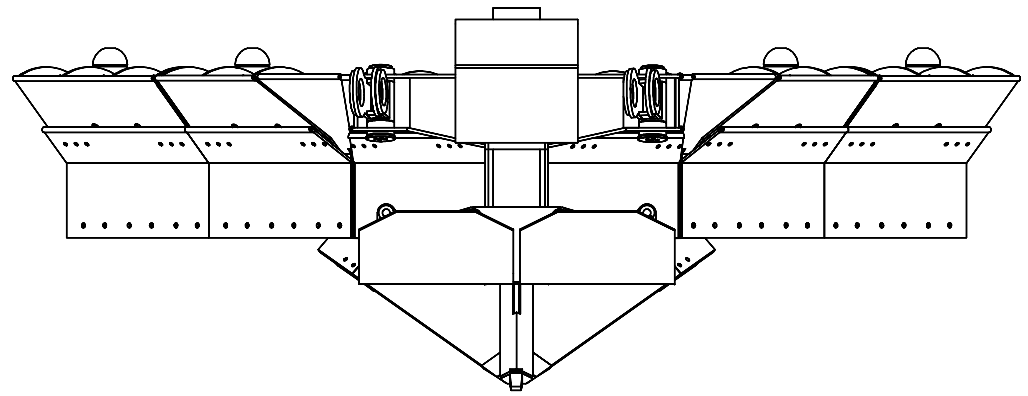
TITLE: SCAR ASSEMBLY FIRST PASS TRENCHING MODE

DRAWING No. AC-C-038-0008

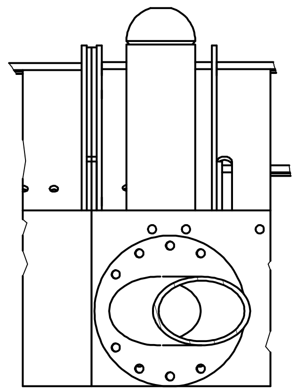
REVISION P

SHEET 1 OF 2





SECTION D-D (1 : 15)



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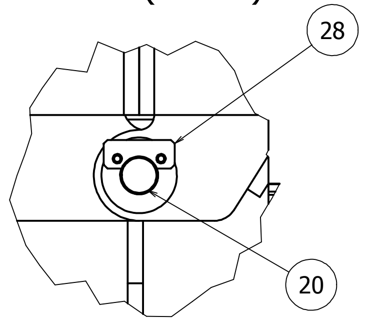
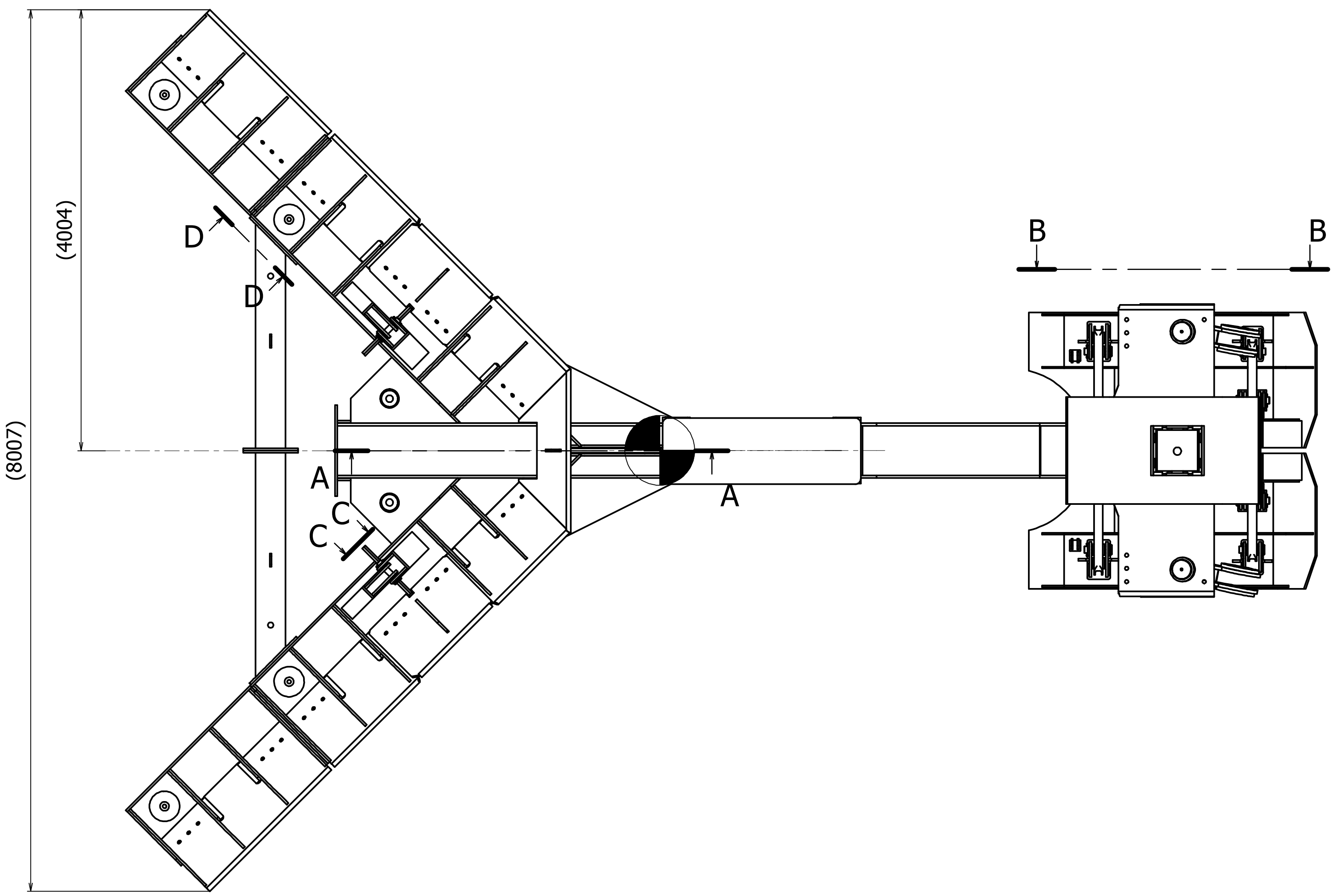
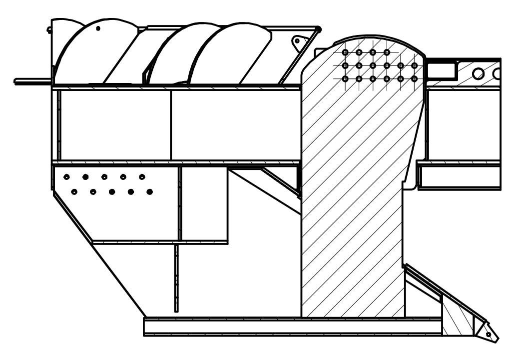
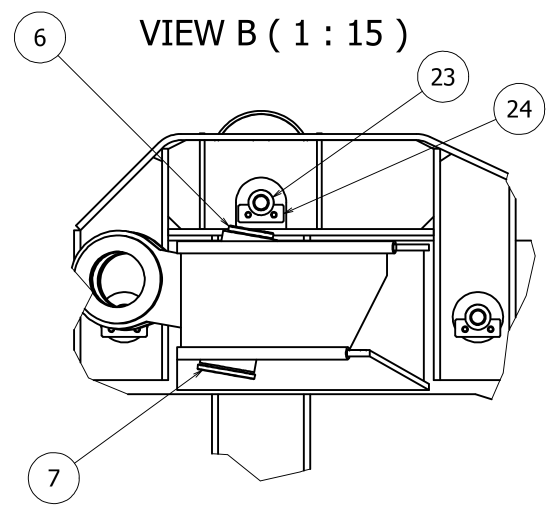




SECTION A-A (1 : 30)



VIEW B (1 : 15)



CONTRACT REFERENCE		AC-C-038					
CONTRACT TITLE		SCAR MK 2					
ESTIMATED MASS	25000 kg	REMOVE ALL BURRS AND SHARP EDGES					
DIMENSIONS	UP TO 100	101 TO 300	301 TO 1000	1001 TO 5000	5001 TO 20000	OVER 20000	-
FABRICATIONS	± 1.0	± 1.5	2.0	3.0	10.0	20.0	-
MACHINED PART	0.15	0.4	0.8	1.0	-	-	-

MATERIAL N/A			
DESIGNED BY	[redacted]	DO NOT SCALE	
DRAWN BY	[redacted]	DATE	19/02/13
CHECKED BY	[redacted]	CHK DATE	19/02/13
APPROVED BY	[redacted]	APP. DATE	19/02/13

3rd ANGLE PEOJECTION

DIMENSIONS IN mm

SCALE 1 : 20

TITLE
SCAR ASSEMBLY
FIRST PASS
TRENCHING MODE

Ardmore Craig

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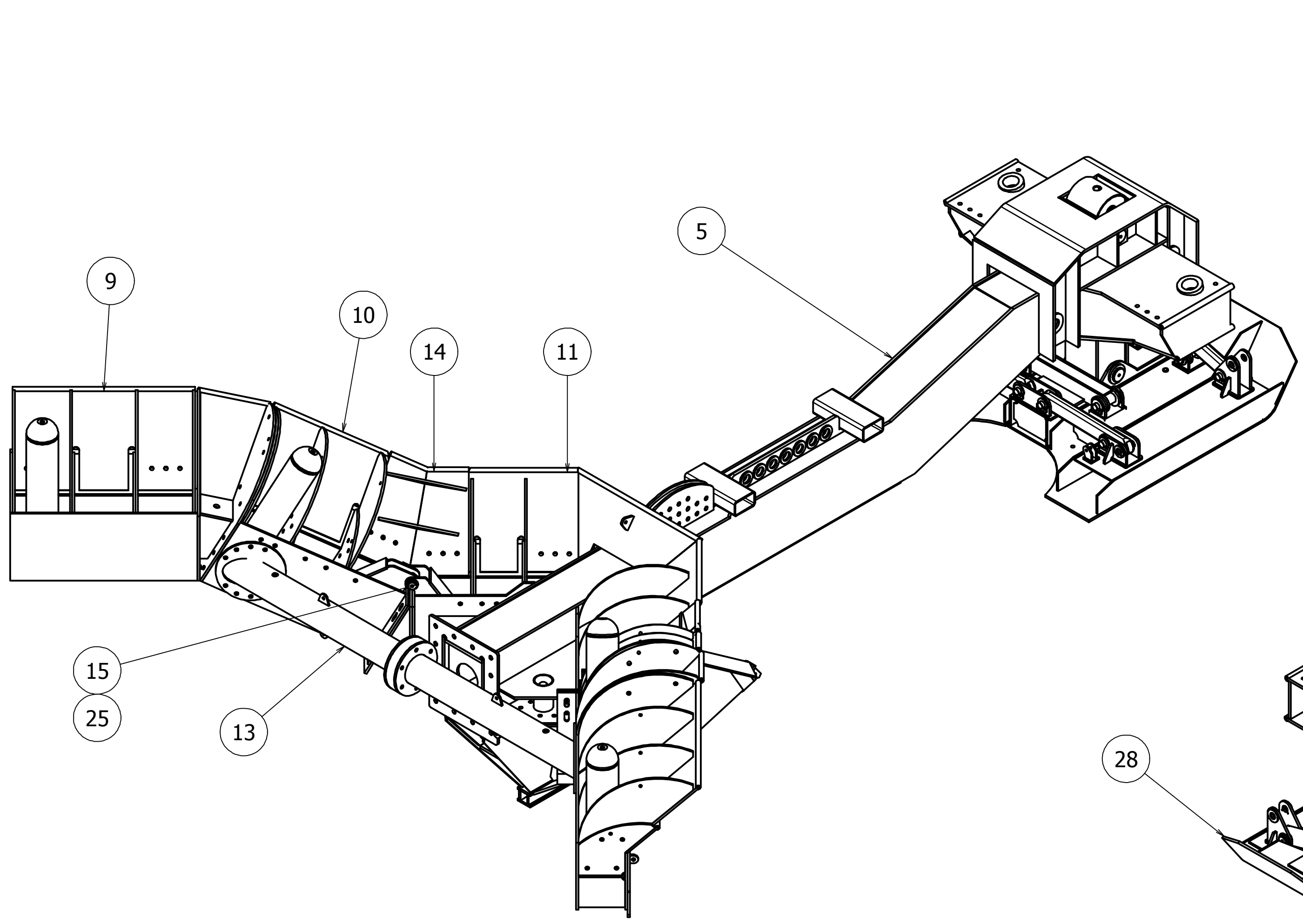
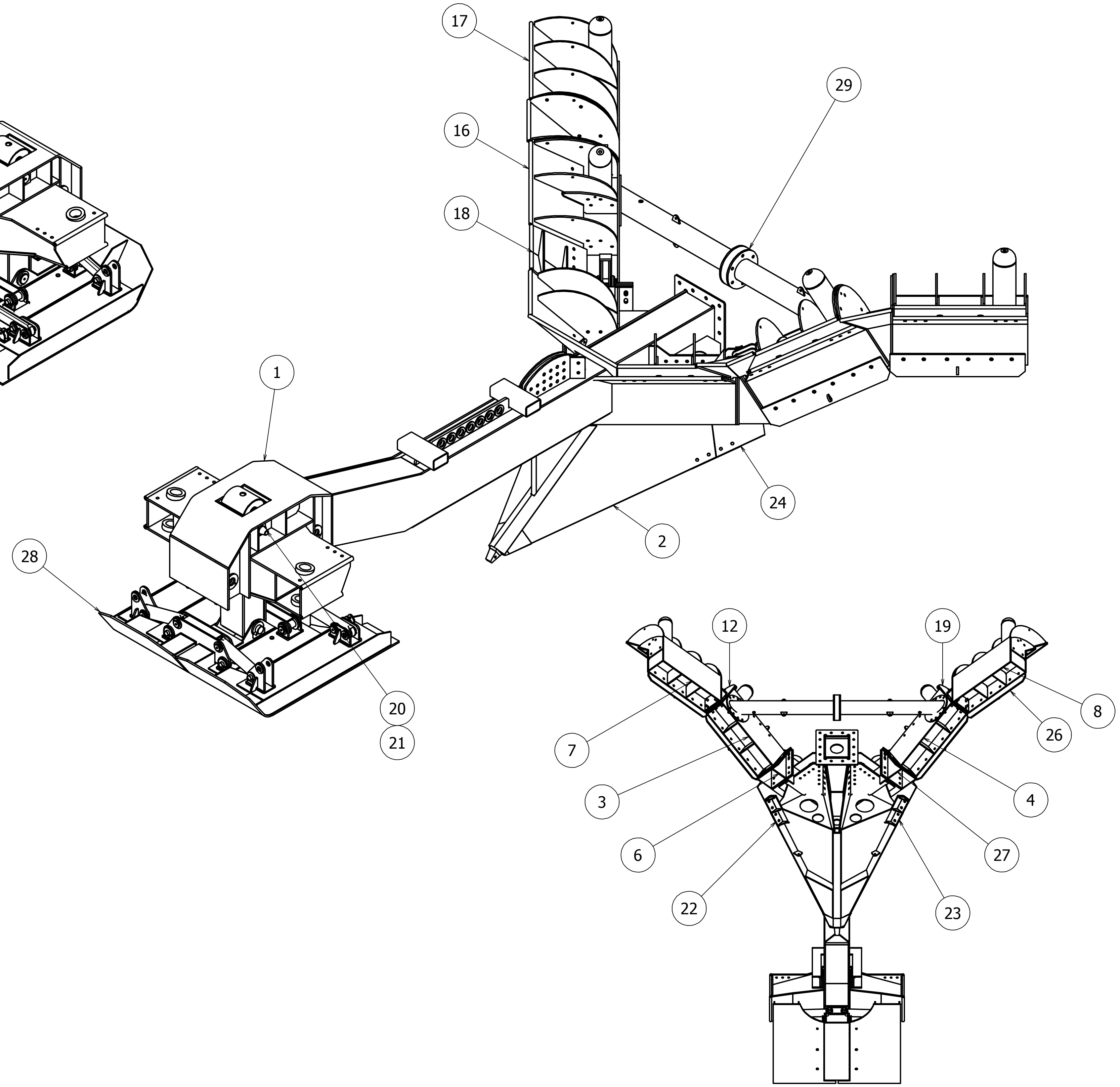
DRAWING No. AC-C-038-0008

REVISION P

SHEET 2 OF 2





PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	AC-C-012-26	CLEVIS FABRICATION
2	1	AC-C-038-0001	SHARE
3	1	AC-C-038-0005	MOULD BOARD OUTER LHS
4	1	AC-C-038-0006	MOULD BOARD OUTER RHS
5	1	AC-C-038-0007	CHASSIS FABRICATED ASSEMBLY
6	1	AC-C-038-0011	MULTI PASS WEDGE
7	1	AC-C-038-0013	WIDE MOULD BOARD EXTENSION LHS
8	1	AC-C-038-0014	WIDE MOULD BOARD EXTENSION RHS
9	1	AC-C-038-0015	WIDE MOULD BOARD VERTICAL EXTENSION LHS
10	1	AC-C-038-0016	MID MOULD BOARD VERTICAL EXTENSION LHS
11	1	AC-C-038-0017	INNER MOULD BOARD VERTICAL EXTENSION
12	1	AC-C-038-0020	OUTER MOULD BOARD WEDGE LHS
13	2	AC-C-038-0021	MOULD BOARD SUPPORT BEAM
14	1	AC-C-038-0022	MULTI PASS INFILL PLATE LHS
15	2	AC-C-038-0023	MOULD BOARD EXTENSION CLEVIS PIN
16	1	AC-C-038-0024	MID MOULD BOARD VERTICAL EXTENSION RHS
17	1	AC-C-038-0025	WIDE MOULD BOARD VERTICAL EXTENSION RHS
18	1	AC-C-038-0026	MULTI PASS INFILL PLATE RHS
19	1	AC-C-038-0027	OUTER MOULD BOARD WEDGE RHS
20	1	AC-C-038-0030	SKID POST CLEVIS PIN
21	1	AC-C-038-0031	SKID POST CLEVIS LOCK PLATE
22	1	AC-C-038-0033	SHARE EXTENSION FABRICATION LHS
23	1	AC-C-038-0034	SHARE EXTENSION FABRICATION RHS
24	2	AC-C-038-0035	SHARE EXTENSION PLATE
25	2	AC-C-038-0036	MOULD BOARD EXTENSION CLEVIS LOCK PLATE
26	4	AC-C-038-0037	MOULD BOARD EXTENSION PLATE
27	1	AC-C-038-0038	MULTI PASS WEDGE O/H
28	1	AC-C-038-0039	V SKID ASSEMBLY
29	1	AC-C-038-0029	MOULD BOARD SUPPORT BEAM SHIM

CONTRACT REFERENCE	AC-C-038							
CONTRACT TITLE	SCAR MK 2							
ESTIMATED MASS	26000 kg		REMOVE ALL BURRS AND SHARP EDGES					
DIMENSIONS	UP TO 100	101 TO 300	301 TO 1000	1001 TO 5000	5001 TO 20000	OVER 20000	-
FABRICATIONS	± 1.0	± 1.5	2.0	3.0	10.0	20.0	-
MACHINED PART	0.15	0.4	0.8	1.0	-	-	-

MATERIAL N/A

DESIGNED BY	[redacted]	DO NOT SCALE	
DRAWN BY	[redacted]	DATE	19/02/13
CHECKED BY	[redacted]	CHK DATE	19/02/13
APPROVED BY	[redacted]	APP. DATE	19/02/13

3rd ANGLE PEOJECTION

DIMENSIONS IN mm

SCALE NTS

TITLE

SCAR ASSEMBLY
MULTI PASS
TRENCHING MODE

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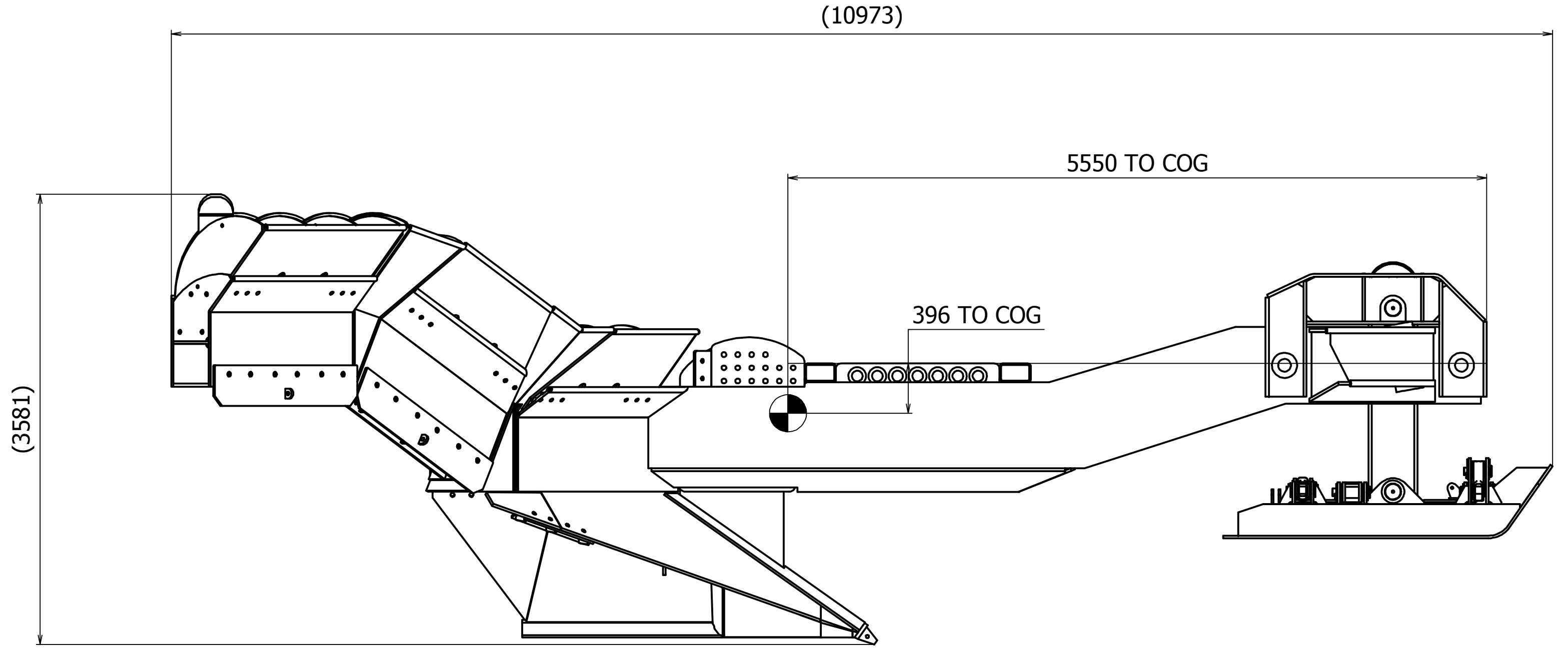
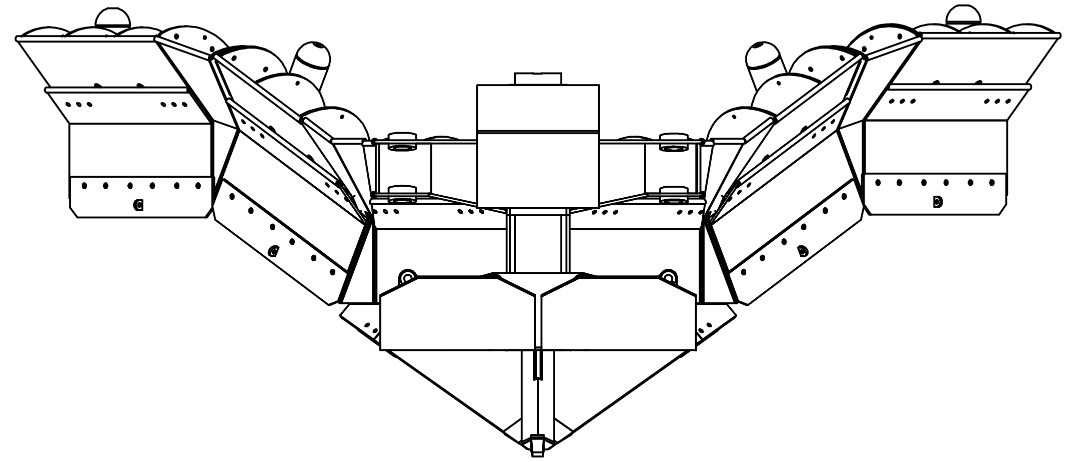
DRAWING No. AC-C-038-0012

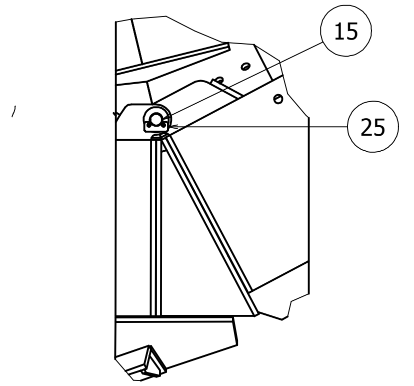
REVISION P

SHEET 1 OF 2

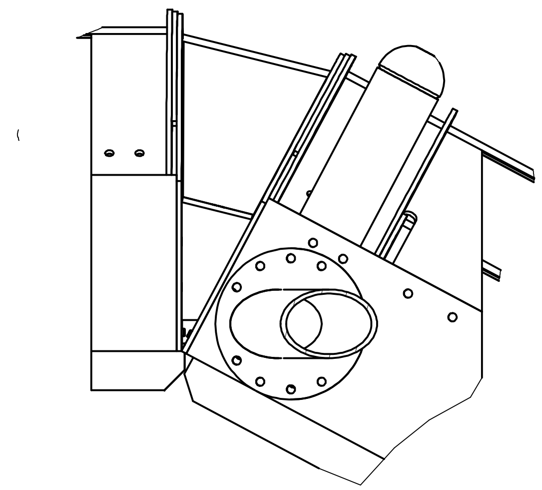


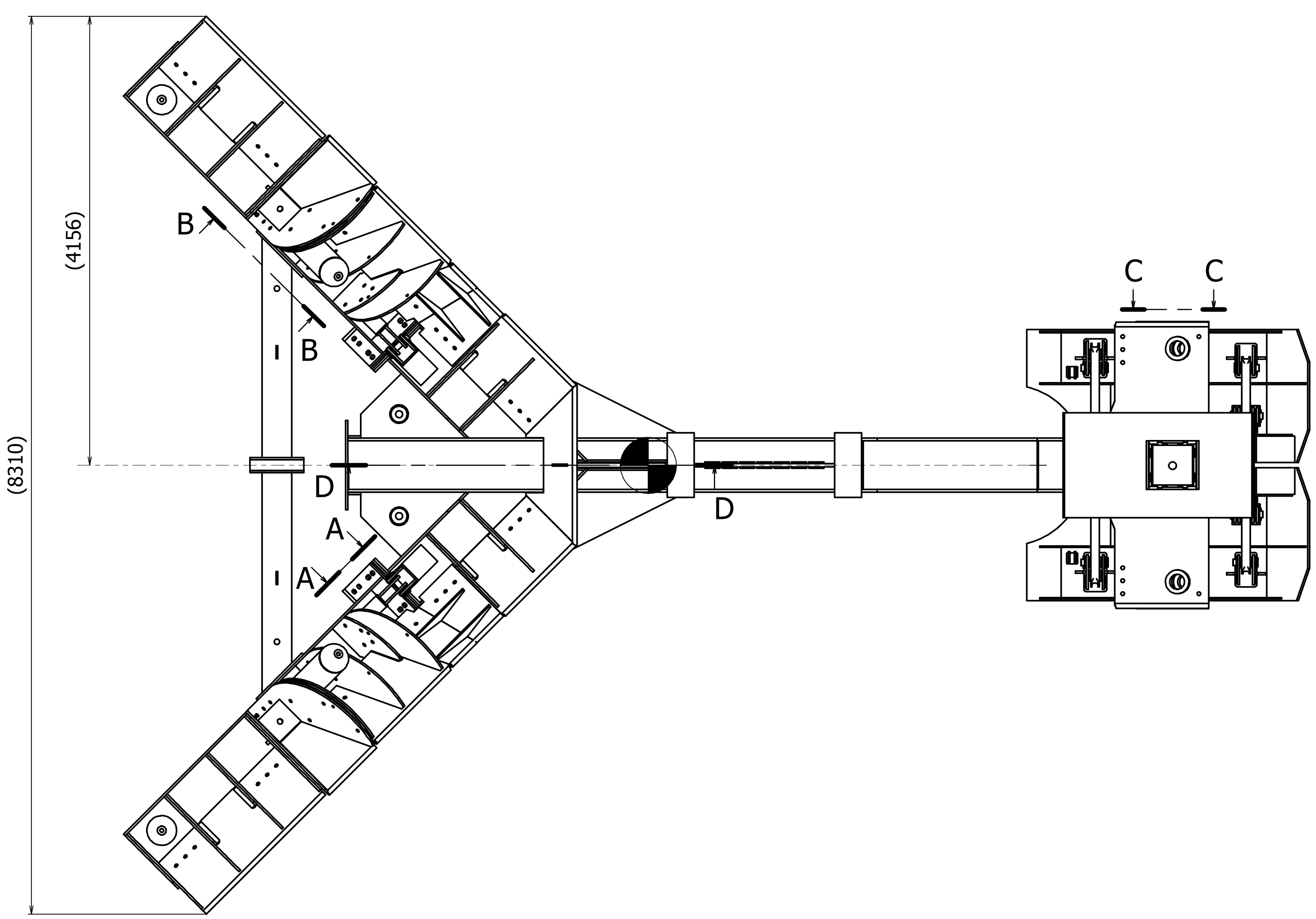


VIEW A (1 : 15)

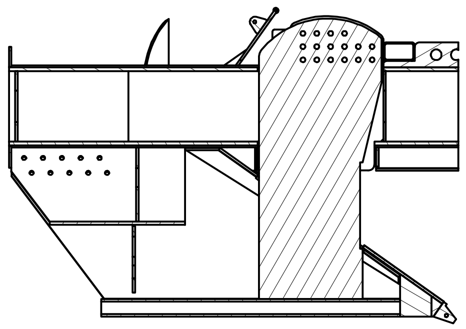


SECTION B (1 : 15)

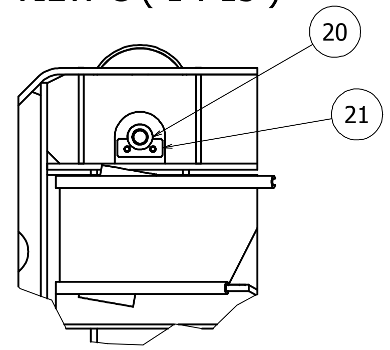




SECTION D-D (1 : 30)

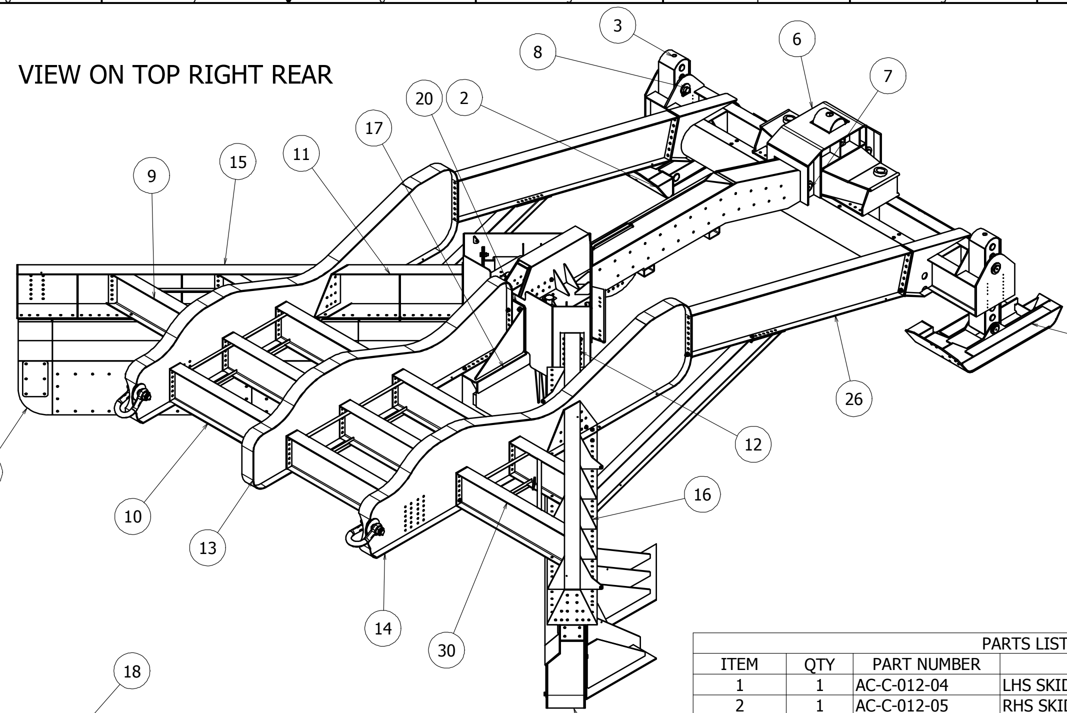


VIEW C (1 : 15)

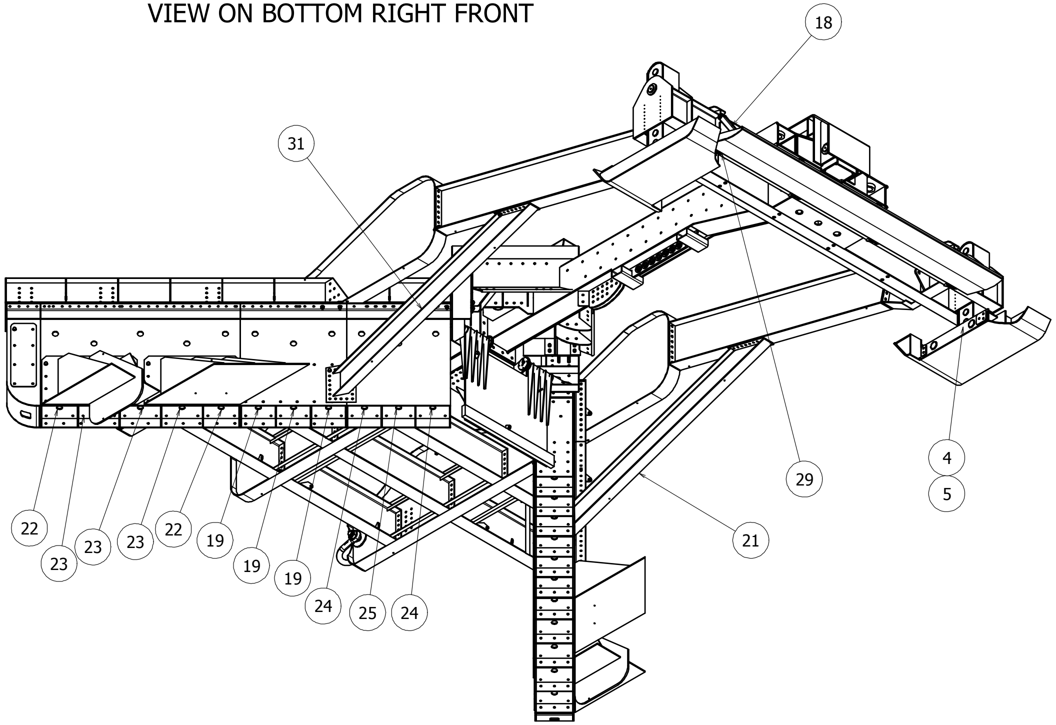


CONTRACT REFERENCE	AC-C-038							MATERIAL N/A		3rd ANGLE PEOJECTION	TITLE SCAR ASSEMBLY MULTI PASS TRENCHING MODE
CONTRACT TITLE	SCAR MK 2							DESIGNED BY [redacted]	DO NOT SCALE		
								DRAWN BY [redacted]	DATE 19/02/13	DIMENSIONS IN mm	
ESTIMATED MASS	26000 kg	REMOVE ALL BURRS AND SHARP EDGES						CHECKED BY [redacted]	CHK DATE 19/02/13		
								APPROVED BY [redacted]	APP. DATE 19/02/13	SCALE 1 : 30	
DIMENSIONS	UP TO 100	101 TO 300	301 TO 1000	1001 TO 5000	5001 TO 20000	OVER 20000	-	Ardmore Craig	Ardmore Craig Ltd. F13 Evans Business Incubation Centre Durham Way South Aycliffe Business Park DL5 6XP Tel: 01325 329880 | www.ardmorecraig.com		DRAWING No. AC-C-038-0012 — REVISION P
FABRICATIONS	± 1.0	± 1.5	2.0	3.0	10.0	20.0	-				SHEET 2 OF 2
MACHINED PART	0.15	0.4	0.8	1.0	-	-	-				

VIEW ON TOP RIGHT REAR



VIEW ON BOTTOM RIGHT FRONT



PARTS LIST			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	1	AC-C-012-04	LHS SKID FABRICATION
2	1	AC-C-012-05	RHS SKID FABRICATION
3	2	AC-C-012-10	SKID POST
4	2	AC-C-012-14	MAIN SKID CLEVIS PIN
5	7	AC-C-012-15	MAIN SKID CLEVIS LOCK PLATE
6	1	AC-C-012-26	CLEVIS FABRICATION
7	2	AC-C-012-33	CHASSIS AND CLEVIS PIN
8	3	AC-C-012-34	SKID POST AND CLEVIS PIN
9	1	AC-C-121-0001	LEFT CROSS BRACING
10	2	AC-C-121-0002	CENTRAL CROSS BRACING
11	1	AC-C-121-0003	FRONT DIAGONAL BRACING
12	1	AC-C-121-0004	FRONT DIAGONAL BRACING OH
13	1	AC-C-121-0007	MID BRACING BEAM
14	2	AC-C-121-0008	SIDE BRACING BEAM
15	1	AC-C-121-0010	LEFT BACK DIAGONAL BRACING
16	1	AC-C-121-0011	RIGHT BACK DIAGONAL BRACING
17	1	AC-C-121-0013	FLAPPER BOARD ATTACVHMENT
18	4	AC-C-121-0014	SPOILER ADJUSTMENT BEAM
19	6	AC-C-121-0016	571mm CLOSING PLATE
20	1	AC-C-121-0017	CHASSIS TO MID BRACING CONNECTOR PLATE
21	1	AC-C-121-0018	BACKFILL BEAM BRACING
22	4	AC-C-121-0019	600mm CLOSING PLATE
23	6	AC-C-121-0020	681mm CLOSING PLATE
24	4	AC-C-121-0021	560mm CLOSING PLATE
25	2	AC-C-121-0022	550mm C LOSING PLATE
26	2	AC-C-121-0025	BF SKIDS TO SIDE BRACING BEAM
27	1	AC-C-121-0026	CURVED END MOULD BOARD
28	1	AC-C-121-0027	CURVED END MOULD BOARD OH
29	4	AC-C-121-0032	SPOILER PIN B
30	1	AC-C-121-0034	RIGHT CROSS BRACING
31	1	AC-C-121-0035	BACKFILL BEAM BRACING OH

CONTRACT REFERENCE	AC-C-121						
CONTRACT TITLE	2m BACKFILL						
ESTIMATED MASS	63096 kg	REMOVE ALL BURRS AND SHARP EDGES					
DIMENSIONS	UP TO 100	101 TO 300	301 TO 1000	1001 TO 5000	5001 TO 20000	OVER 20000	-
FABRICATIONS	± 1.0	± 1.5	2.0	3.0	10.0	20.0	-
MACHINED PART	0.15	0.4	0.8	1.0	-	-	-

MATERIAL: BSEN 10025-2:2004 S355 J2 G3

3rd ANGLE PROJECTION

DESIGNED BY	[redacted]	DO NOT SCALE	
DRAWN BY	[redacted]	DATE	23/07/2015
CHECKED BY	[redacted]	CHK DATE	23/07/2015
APPROVED BY	[redacted]	APP. DATE	23/07/2015

DIMENSIONS IN mm

SCALE 1:45

TITLE: BACKFILL SHORT ASSEMBLY

Ardmore Craig

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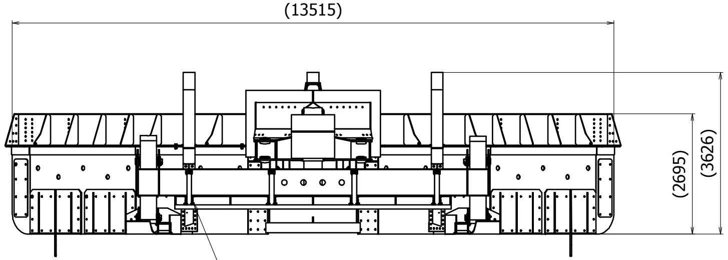
F32 Evans Business Incubation Centre
Durham Way South
Aycliffe Business Park
DL5 6XP
Tel: 01325 329880 | www.ardmorecraig.com

DRAWING No. AC-C-121-0012

REVISION 0

SHEET 1 OF 3

VIEW ON FRONT



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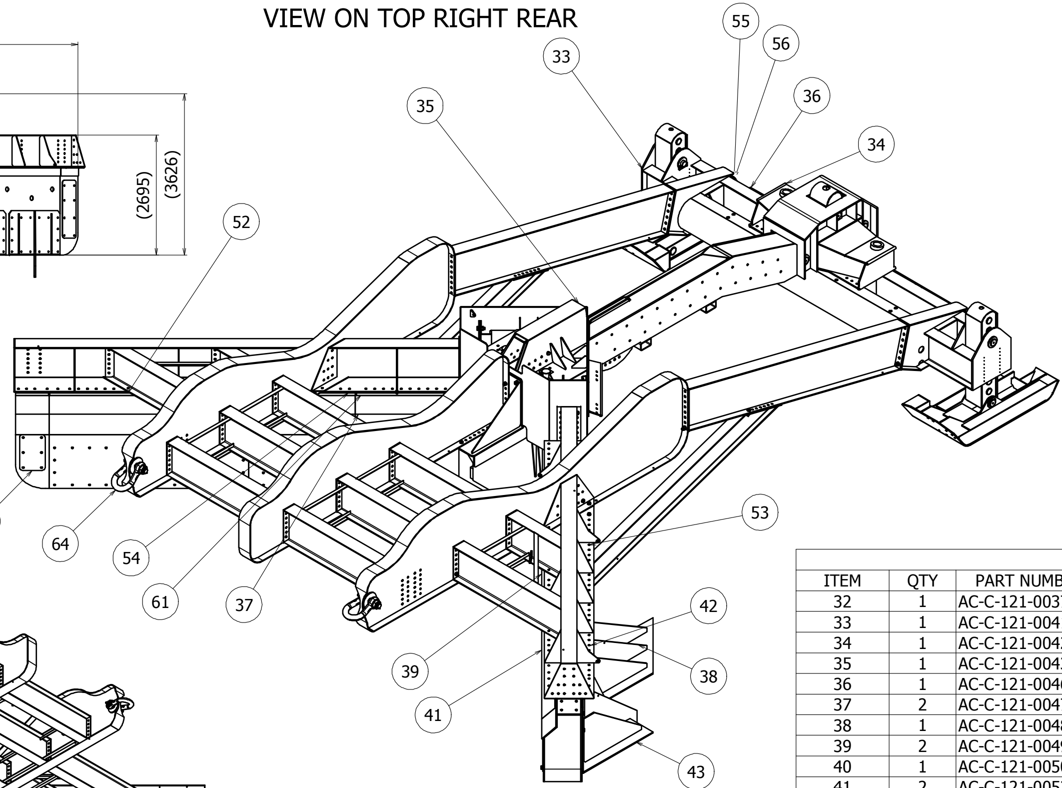

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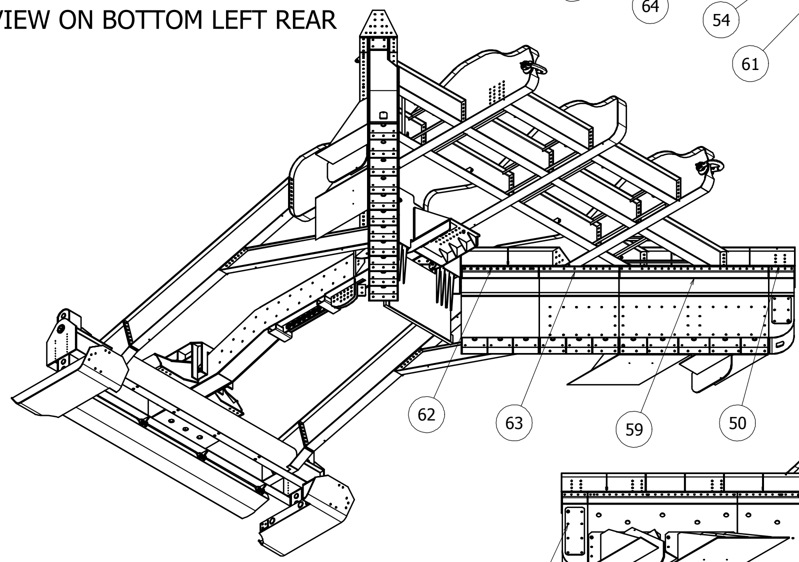
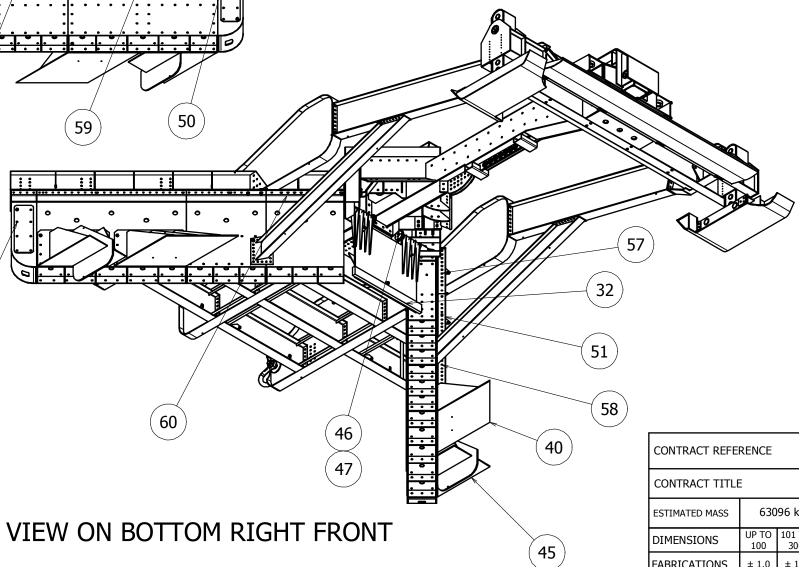


VIEW ON BOTTOM RIGHT FRONT



PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
32	1	AC-C-121-0037	BACKFILL FLAPPER BOARD
33	1	AC-C-121-0041	SKID BRACING BACKFILL MODE
34	1	AC-C-121-0042	CHASSIS
35	1	AC-C-121-0043	BACKFILL CHASSIS TO BRACING FABRICATION
36	1	AC-C-121-0046	BACKFILL SKID SPOILER
37	2	AC-C-121-0047	INNER MOULD BOARD
38	1	AC-C-121-0048	BEARING PLATE
39	2	AC-C-121-0049	SECOND INNER MOULD BOARD
40	1	AC-C-121-0050	BEARING PLATE OH
41	2	AC-C-121-0052	LONG MOULD BOARD
42	1	AC-C-121-0053	LONG MOULD BOARD MOUNT OH
43	1	AC-C-121-0060	KEEL PLATE
44	4	AC-C-121-0061	SPOILER PIN C
45	1	AC-C-121-0063	KEEL PLATE OH
46	2	AC-C-121-0064	FLAPPER BOARD PIN END CAP
47	2	AC-C-121-0065	FLAPPER BOARD PIN
48	2	AC-C-121-0066	LARGE CURVED END MOULD BOARD CLOSING PLATE
49	2	AC-C-121-0067	SMALL CURVED END MOULD BOARD CLOSING PLATE
50	4	AC-C-121-0068	CURVED END MOULD BOARD MOUNT
51	1	AC-C-121-0070	OUTER MOULD BOARD MOUNT
52	1	AC-C-121-0071	INNER MOULD BOARD MOUNT
53	1	AC-C-121-0073	OUTER MOULD BOARD MOUNT OH
54	1	AC-C-121-0074	SECOND MOULD BOARD MOUNT
55	4	AC-C-121-0075	SPOILER PIN A
56	12	AC-C-121-0076	50mm PIN LOCKPLATE
57	1	AC-C-121-0079	INNER MOULD BOARD MOUNT
58	1	AC-C-121-0080	LONG MOULD BOARD MOUNT
59	1	AC-C-121-0081	INSIDE MOULD BOARD MOUNT OH
60	1	AC-C-121-0082	INNER MOULD BOARD MOUNT OH
61	1	AC-C-121-0083	FIRST MOULD BOARD MOUNT
62	1	AC-C-121-0084	FIRST MOULD BOARD MOUNT OH
63	1	AC-C-121-0085	SECOND MOULD BOARD MOUNT
64	2	HDGPHM0120	GREEN PIN SHACKLE

CONTRACT REFERENCE	AC-C-121						
CONTRACT TITLE	2m BACKFILL						
ESTIMATED MASS	63096 kg	REMOVE ALL BURRS AND SHARP EDGES					
DIMENSIONS	UP TO 100	101 TO 300	301 TO 1000	1001 TO 5000	5001 TO 20000	OVER 20000	-
FABRICATIONS	± 1.0	± 1.5	2.0	3.0	10.0	20.0	-
MACHINED PART	0.15	0.4	0.8	1.0	-	-	-

MATERIAL: BSEN 10025-2:2004 S355 J2 G3

DESIGNED BY	[redacted]	DO NOT SCALE	
DRAWN BY	[redacted]	DATE	23/07/2015
CHECKED BY	[redacted]	CHK DATE	23/07/2015
APPROVED BY	[redacted]	APP. DATE	23/07/2015

3rd ANGLE PROJECTION

DIMENSIONS IN mm

SCALE 1:60

TITLE: BACKFILL SHORT ASSEMBLY

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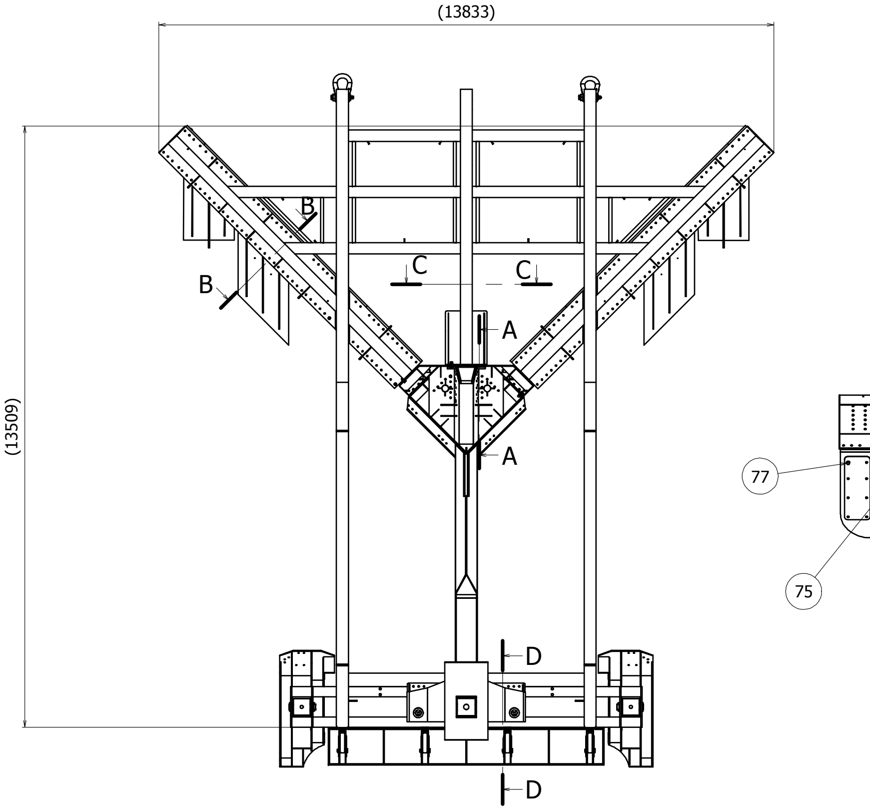
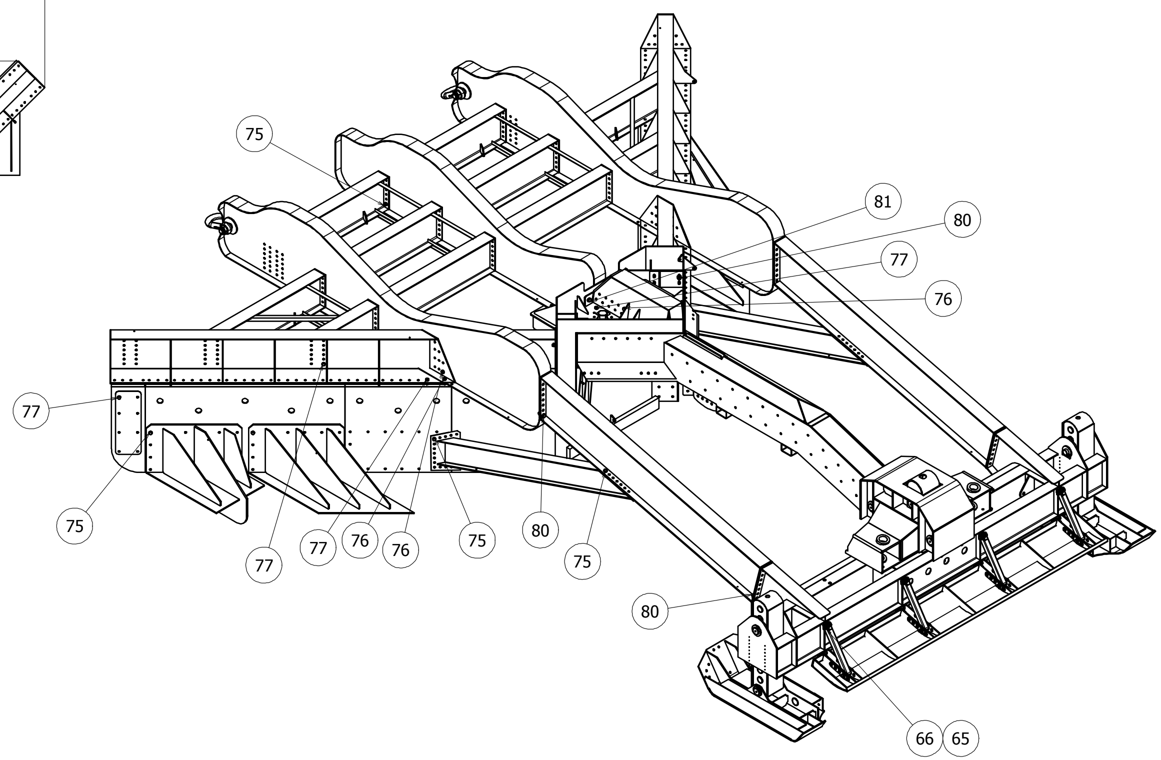
DRAWING No. AC-C-121-0012

REVISION 0

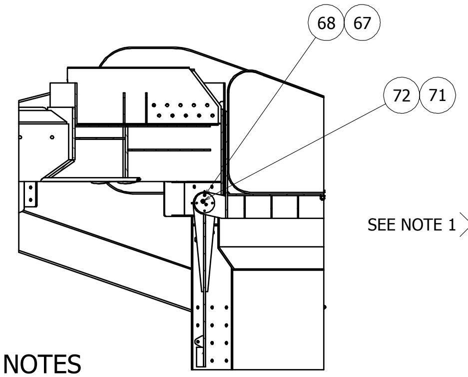
SHEET 2 OF 3



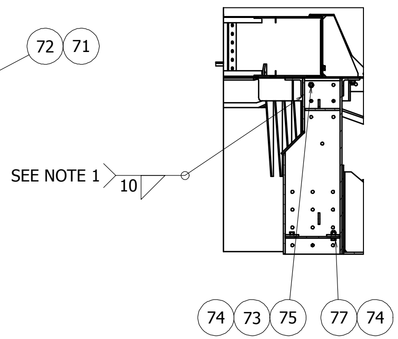
VIEW ON FRONT TOP RIGHT



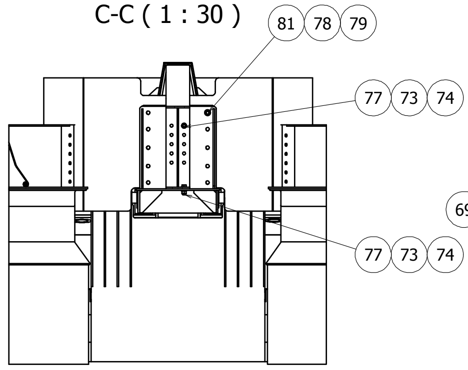
A-A (1 : 30)



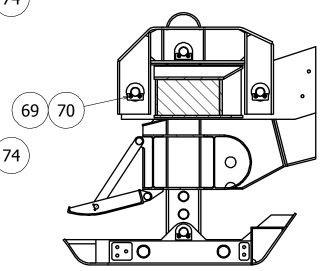
B-B (1 : 30)



C-C (1 : 30)



D-D (1 : 30)



PARTS LIST

ITEM	QTY	PART NUMBER	DESCRIPTION
65	24	M10 WASHER	GRADE 8 PLAIN WASHER
66	24	M10 x 25	GRADE 8.8 SHCS
67	8	M12 WASHER	GRADE 8 PLAIN WASHER
68	8	M12 x 40	GRADE 8.8 SHCS
69	14	M20 WASHER	GRADE 8 PLAIN WASHER
70	14	M20 x 70	GRADE 8.8 SHCS
71	4	M24 WASHER	GRADE 8 PLAIN WASHER
72	4	M24 x 50	GRADE 8.8 SHCS
73	664	M30 NUT	GRADE 8 HEX NUT
74	1336	M30 WASHER	GRADE 8 PLAIN WASHER
75	6	M30 x 100	GRADE 8.8 HEX BOLT
76	76	M30 x 110	GRADE 8.8 HEX BOLT
77	270	M30 x 90	GRADE 8.8 HEX BOLT
78	88	M36 NUT	GRADE 8 HEX NUT
79	176	M36 WASHER	GRADE 8 PLAIN WASHER
80	76	M36 x 110	GRADE 8.8 HEX BOLT
81	12	M36 x 130	GRADE 8.8 HEX BOLT

NOTES

1) ONLY WELD ANGLED PLATE TO AC-C-121-0026, AC-C-121-0027, AC-C-121-0047, AC-C-121-0049 AND AC-C-121-0052

CONTRACT REFERENCE	AC-C-121						
CONTRACT TITLE	2m BACKFILL						
ESTIMATED MASS	63096 kg	REMOVE ALL BURRS AND SHARP EDGES					
DIMENSIONS	UP TO 100	101 TO 300	301 TO 1000	1001 TO 5000	5001 TO 20000	OVER 20000	-
FABRICATIONS	± 1.0	± 1.5	2.0	3.0	10.0	20.0	-
MACHINED PART	0.15	0.4	0.8	1.0	-	-	-

MATERIAL: BSEN 10025-2:2004 S355 J2 G3

DESIGNED BY	[redacted]	DO NOT SCALE	
DRAWN BY	[redacted]	DATE	23/07/2015
CHECKED BY	[redacted]	CHK DATE	23/07/2015
APPROVED BY	[redacted]	APP. DATE	23/07/2015

3rd ANGLE PROJECTION

DIMENSIONS IN mm

SCALE 1:60

TITLE: BACKFILL SHORT ASSEMBLY

Ardmore Craig Ltd.
F32 Evans Business Incubation Centre
Durham Way South
Aycliffe Business Park
DL5 6XP
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DRAWING No. AC-C-121-0012

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SHEET 3 OF 3

ESS Equipment Datasheet – SCAR 15m Route Preparation System

Equipment General Arrangement (GA):
Figure 1 below details the GA of specified equipment:

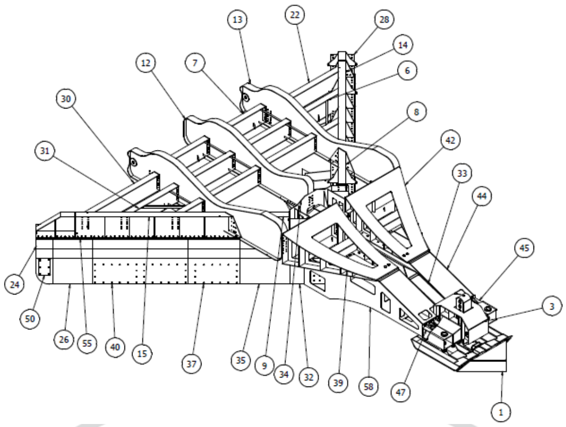

Figure 1: GA; Extracted from *AC-C-121-0039, 15m Route Preparation GA*

Equipment Specifications:

Item	Specification	Additional Notes
Length	16.0m	
Width	15.8m	*Single pass corridor width*
Multiple Pass Width	6.0m	*Additional per pass*
Height	3.8m	
Mass	71.8 kg	
Max Load	50Te	*At mouldboard outer edge*
Operational Tow Force	25-75Te	*Boulder density/seabed dependent*
Progress Rate Range	340-1000+ m/hr	*Boulder density/seabed dependent*
Turning Radius Range	75-150m	*Recommended*
Min Turning Radius	50m	
Operating Depth	3000m +	

Equipment General Arrangement (GA):

Figure 1 below details the GA of specified equipment:

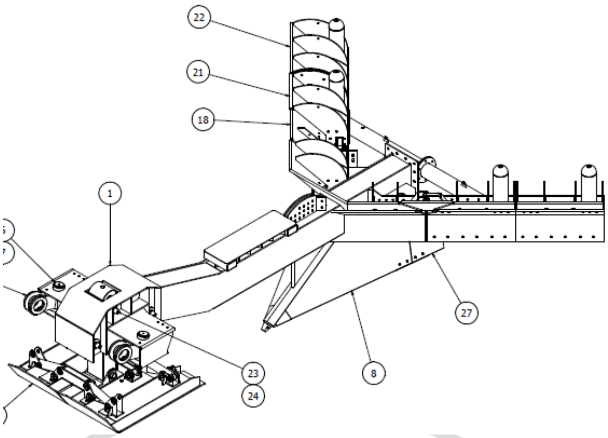

Figure 1: GA; Extracted from *AC-C-038-0008, 1st Pass GA*

Equipment Specifications:

Item	Specification	Additional Notes
Length	10.8m	
Width	8.0m	
Height	2.7m	
Mass	25000kg	
Max Load	150Te	*At Share tip*
Operational Tow Force	25-100Te	
Progress Rate Range	340-1000m/hr +	
Turning Radius Range	75-150m	*Recommended*
Min Turning Radius	50m	
Operating Depth	3000m +	

ESS Equipment Datasheet – SCAR 2 Trenching System: 2nd Pass Mode

Equipment General Arrangement (GA):

Figure 1 below details the GA of specified equipment:

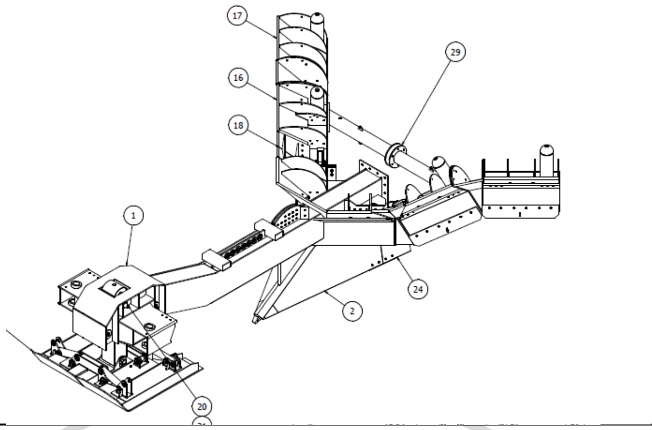

Figure 1: GA; Extracted from *AC-C-038-0012, 2nd Pass GA*

Equipment Specifications:

Item	Specification	Additional Notes
Length	10.9m	
Width	8.3m	
Height	3.6m	
Mass	25000kg	
Max Load	150Te	*At Share tip*
Operational Tow Force	25-100Te	
Progress Rate Range	340-1000m/hr +	
Turning Radius Range	75-150m	*Recommended*
Min Turning Radius	50m	
Operating Depth	3000m +	

Equipment General Arrangement (GA):
Figure 1 below details the GA of specified equipment:

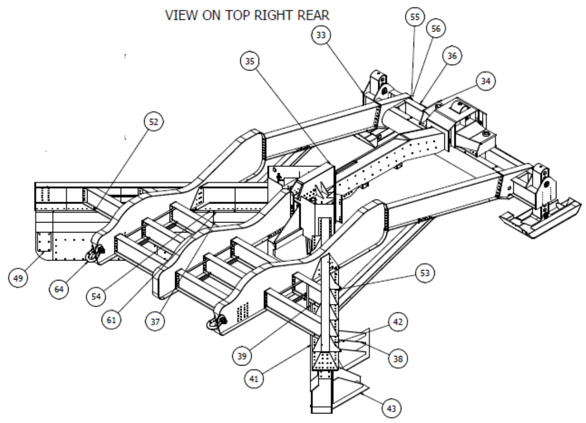

Figure 1: GA; Extracted from *AC-C-121-0012, 13.5m Backfill GA*

Equipment Specifications:

Item	Specification	Additional Notes
Length	13.5m	*Can be extended to 16.0m*
Width	13.8m	*Can be extended to 15.8m*
Backfill Capture Width	13.5m	*Can be extended to 15.5m*
Height	3.8m	
Mass	63.0 kg	
Max Load	50Te	*At mouldboard outer edge*
Operational Tow Force	25-75Te	
Progress Rate Range	500m/hr	
Turning Radius Range	75-150m	*Recommended*
Min Turning Radius	50m	
Operating Depth	3000m +	

Appendix 11

Burial Assessment per 100m Intervals –

Portgordon to Hub Platform Route Section

Caithness-Moray (LT21) Circuit - Portgordon to Hub Platform Route Section			
KP	**1st Pass - Estimated Achievable Trench Depth**	**2nd Pass - Estimated Achievable Trench Depth**	**Estimated Depth of Cover**
1.578 (HDD)	1.2	1.8	1.0
1.600	1.2	1.8	1.0
1.700	1.2	1.8	1.0
1.800	1.2	1.8	1.0
1.900	1.2	1.8	1.0
2.000	1.2	1.8	1.0
2.100	1.2	1.8	1.0
2.200	1.2	1.8	1.0
2.300	1.2	1.8	1.0
2.400	1.2	1.8	1.0
2.500	1.2	1.8	1.0
2.600	1.2	1.8	1.0
2.700	1.2	1.8	1.0
2.800	1.2	1.8	1.0
2.900	1.2	1.8	1.0
3.000	1.2	1.8	1.0
3.100	1.2	1.8	1.0
3.200	1.2	1.8	1.0
3.300	1.2	1.8	1.0
3.400	1.2	1.8	1.0
3.500	1.2	1.8	1.0
3.600	1.2	1.8	1.0
3.700	1.2	1.8	1.0
3.800	1.2	1.8	1.0
3.900	1.2	1.8	1.0
4.000	1.2	1.8	1.0
4.100	1.2	1.8	1.0
4.200	1.2	1.8	1.0
4.300	1.2	1.8	1.0
4.400	1.2	1.8	1.0
4.500	1.2	1.8	1.0
4.600	1.2	1.8	1.0
4.700	1.2	1.8	1.0
4.800	1.2	1.8	1.0
4.900	1.2	1.8	1.0
5.000	1.2	1.8	1.0
5.100	1.2	1.8	1.0
5.200	1.2	1.8	1.0
5.300	1.2	1.8	1.0
5.400	1.2	1.8	1.0
5.500	1.2	1.8	1.0
5.600	1.2	1.8	1.0
5.700	1.2	1.8	1.0
5.800	1.2	1.8	1.0
5.900	1.2	1.8	1.0
6.000	1.2	1.8	1.0
6.100	1.2	1.8	1.0
6.200	1.2	1.8	1.0
6.300	1.2	1.8	1.0
6.400	1.2	1.8	1.0
6.500	1.2	1.8	1.0
6.600	1.2	1.8	1.0
6.700	1.2	1.8	1.0
6.800	1.2	1.8	1.0
6.900	1.2	1.8	1.0
7.000	1.2	1.8	1.0
7.100	1.2	1.8	1.0
7.200	1.2	1.8	1.0
7.300	1.2	1.8	1.0
7.400	1.2	1.8	1.0
7.500	1.2	1.8	1.0
7.600	1.2	1.8	1.0
7.700	1.2	1.8	1.0
7.800	1.2	1.8	1.0
7.900	1.2	1.8	1.0
8.000	1.2	1.8	1.0
8.100	1.2	1.8	1.0
8.200	1.2	1.8	1.0
8.300	1.2	1.8	1.0
8.400	1.2	1.8	1.0
8.500	1.2	1.8	1.0
8.600	1.2	1.8	1.0
8.700	1.2	1.8	1.0
8.800	1.2	1.8	1.0
8.900	1.2	1.8	1.0
9.000	1.2	1.8	1.0
9.100	1.2	1.8	1.0
9.200	1.2	1.4	< 1.0
9.300	1.2	1.4	< 1.0
9.400	1.2	1.4	< 1.0

9.500	1.2	1.4	< 1.0
9.600	1.2	1.4	< 1.0
9.700	1.2	1.4	< 1.0
9.800	1.2	1.4	< 1.0
9.900	1.2	1.4	< 1.0
10.000	1.2	1.4	< 1.0
10.100	1.2	1.4	< 1.0
10.200	1.2	1.4	< 1.0
10.300	1.2	1.4	< 1.0
10.400	1.2	1.4	< 1.0
10.500	1.2	1.4	< 1.0
10.600	1.2	1.4	< 1.0
10.700	1.2	1.4	< 1.0
10.800	1.2	1.4	< 1.0
10.900	1.2	1.8	1.0
11.000	1.2	1.8	1.0
11.100	1.2	1.8	1.0
11.200	1.2	1.8	1.0
11.300	1.2	1.8	1.0
11.400	1.2	1.8	1.0
11.500	1.2	1.8	1.0
11.600	1.2	1.8	1.0
11.700	1.2	1.8	1.0
11.800	1.2	1.8	1.0
11.900	1.2	1.8	1.0
12.000	1.2	1.8	1.0
12.100	1.2	1.8	1.0
12.200	1.2	1.8	1.0
12.300	1.2	1.8	1.0
12.400	1.2	1.8	1.0
12.500	1.2	1.8	1.0
12.600	1.2	1.8	1.0
12.700	1.2	1.8	1.0
12.800	1.2	1.8	1.0
12.900	1.2	1.8	1.0
13.000	1.2	1.8	1.0
13.100	1.2	1.8	1.0
13.200	1.2	1.8	1.0
13.300	1.2	1.8	1.0
13.400	1.2	1.8	1.0
13.500	1.2	1.8	1.0
13.600	1.2	1.8	1.0
13.700	1.2	1.8	1.0
13.800	1.2	1.8	1.0
13.900	1.2	1.8	1.0
14.000	1.2	1.8	1.0
14.100	1.2	1.8	1.0
14.200	1.2	1.8	1.0
14.300	1.2	1.8	1.0
14.400	1.2	1.8	1.0
14.500	1.2	1.8	1.0
14.600	1.2	1.8	1.0
14.700	1.2	1.8	1.0
14.800	1.2	1.8	1.0
14.900	1.2	1.8	1.0
15.000	1.2	1.8	1.0
15.100	1.2	1.8	1.0
15.200	1.2	1.8	1.0
15.300	1.2	1.8	1.0
15.400	1.2	1.8	1.0
15.500	1.2	1.8	1.0
15.600	1.2	1.8	1.0
15.700	1.2	1.4	< 1.0
15.800	1.2	1.4	< 1.0
15.900	1.2	1.4	< 1.0
16.000	1.2	1.4	< 1.0
16.100	1.2	1.4	< 1.0
16.200	1.2	1.4	< 1.0
16.300	1.2	1.4	< 1.0
16.400	1.2	1.4	< 1.0
16.500	1.2	1.4	< 1.0
16.600	1.2	1.4	< 1.0
16.700	1.2	1.4	< 1.0
16.800	1.2	1.4	< 1.0
16.900	1.2	1.4	< 1.0
17.000	1.2	1.4	< 1.0
17.100	1.2	1.4	< 1.0
17.200	1.2	1.4	< 1.0
17.300	1.2	1.4	< 1.0
17.400	1.2	1.4	< 1.0
17.500	1.2	1.4	< 1.0
17.600	1.2	1.4	< 1.0

17.700	1.2	1.4	< 1.0
17.800	1.2	1.4	< 1.0
17.900	1.2	1.4	< 1.0
18.000	1.2	1.4	< 1.0
18.100	1.2	1.4	< 1.0
18.200	1.2	1.4	< 1.0
18.300	1.2	1.4	< 1.0
18.400	1.2	1.8	1.0
18.500	1.2	1.8	1.0
18.600	1.2	1.8	1.0
18.700	1.2	1.8	1.0
18.800	1.2	1.8	1.0
18.900	1.2	1.8	1.0
19.000	1.2	1.8	1.0
19.100	1.2	1.8	1.0
19.200	1.2	1.8	1.0
19.300	1.2	1.8	1.0
19.400	1.2	1.8	1.0
19.500	1.2	1.8	1.0
19.600	1.2	1.8	1.0
19.700	1.2	1.8	1.0
19.800	1.2	1.8	1.0
19.900	1.2	1.8	1.0
20.000	1.2	1.8	1.0
20.100	1.2	1.8	1.0
20.200	1.2	1.8	1.0
20.300	1.2	1.8	1.0
20.400	1.2	1.8	1.0
20.500	1.2	1.8	1.0
20.600	1.2	1.8	1.0
20.700	1.2	1.8	1.0
20.800	1.2	1.8	1.0
20.900	1.2	1.8	1.0
21.000	1.2	1.4	< 1.0
21.100	1.2	1.4	< 1.0
21.200	1.2	1.4	< 1.0
21.300	1.2	1.4	< 1.0
21.400	1.2	1.4	< 1.0
21.500	1.2	1.4	< 1.0
21.600	1.2	1.4	< 1.0
21.700	1.2	1.4	< 1.0
21.800	1.2	1.4	< 1.0
21.900	1.2	1.4	< 1.0
22.000	1.2	1.4	< 1.0
22.100	1.2	1.4	< 1.0
22.200	1.2	1.4	< 1.0
22.300	1.2	1.4	< 1.0
22.400	1.2	1.4	< 1.0
22.500	1.2	1.4	< 1.0
22.600	1.2	1.4	< 1.0
22.700	1.2	1.8	1.0
22.800	1.2	1.8	1.0
22.900	1.2	1.8	1.0
23.000	1.2	1.8	1.0
23.100	1.2	1.8	1.0
23.200	1.2	1.8	1.0
23.300	1.2	1.8	1.0
23.400	1.2	1.8	1.0
23.500	1.2	1.8	1.0
23.600	1.2	1.8	1.0
23.700	1.2	1.8	1.0
23.800	1.2	1.8	1.0
23.900	1.2	1.8	1.0
24.000	1.2	1.8	1.0
24.100	1.2	1.8	1.0
24.200	1.2	1.8	1.0
24.300	1.2	1.8	1.0
24.400	1.2	1.8	1.0
24.500	1.2	1.8	1.0
24.600	1.2	1.8	1.0
24.700	1.2	1.8	1.0
24.800	1.2	1.8	1.0
24.900	1.2	1.8	1.0
25.000	1.2	1.8	1.0
25.100	1.2	1.8	1.0
25.200	1.2	1.8	1.0
25.300	1.2	1.8	1.0
25.400	1.2	1.8	1.0
25.500	1.2	1.8	1.0
25.600	1.2	1.8	1.0
25.700	1.2	1.8	1.0
25.800	1.2	1.8	1.0

25.900	1.2	1.8	1.0
26.000	1.2	1.8	1.0
26.100	1.2	1.8	1.0
26.200	1.2	1.8	1.0
26.300	1.2	1.8	1.0
26.400	1.2	1.8	1.0
26.500	1.2	1.8	1.0
26.600	1.2	1.8	1.0
26.700	1.2	1.8	1.0
26.800	1.2	1.8	1.0
26.900	1.2	1.8	1.0
27.000	1.2	1.8	1.0
27.100	1.2	1.8	1.0
27.200	1.2	1.8	1.0
27.300	1.2	1.8	1.0
27.400	1.2	1.8	1.0
27.500	1.2	1.8	1.0
27.600	1.2	1.8	1.0
27.700	1.2	1.8	1.0
27.800	1.2	1.8	1.0
27.900	1.2	1.8	1.0
28.000	1.2	1.8	1.0
28.100	1.2	1.8	1.0
28.200	1.2	1.8	1.0
28.300	1.2	1.8	1.0
28.400	1.2	1.8	1.0
28.500	1.2	1.8	1.0
28.600	1.2	1.8	1.0
28.700	1.2	1.2	< 1.0
28.800	1.2	1.2	< 1.0
28.900	1.2	1.2	< 1.0
29.000	1.2	1.2	< 1.0
29.100	1.2	1.2	< 1.0
29.200	1.2	1.2	< 1.0
29.300	1.2	1.2	< 1.0
29.400	1.2	1.2	< 1.0
29.500	1.2	1.2	< 1.0
29.600	1.2	1.2	< 1.0
29.700	1.2	1.8	1.0
29.800	1.2	1.8	1.0
29.900	1.2	1.8	1.0
30.000	1.2	1.8	1.0
30.100	1.2	1.8	1.0
30.200	1.2	1.8	1.0
30.300	1.2	1.8	1.0
30.400	1.2	1.8	1.0
30.500	1.2	1.8	1.0
30.600	1.2	1.8	1.0
30.700	1.2	1.8	1.0
30.800	1.2	1.8	1.0
30.900	1.2	1.8	1.0
31.000	1.2	1.8	1.0
31.100	1.2	1.8	1.0
31.200	1.2	1.8	1.0
31.300	1.2	1.8	1.0
31.400	1.2	1.8	1.0
31.500	1.2	1.8	1.0
31.600	1.2	1.8	1.0
31.700	1.2	1.8	1.0
31.800	1.2	1.8	1.0
31.900	1.2	1.8	1.0
32.000	1.2	1.8	1.0
32.100	1.2	1.8	1.0
32.200	1.2	1.8	1.0
32.300	1.2	1.8	1.0
32.400	1.2	1.8	1.0
32.500	1.2	1.8	1.0
32.600	1.2	1.8	1.0
32.700	1.2	1.8	1.0
32.800	1.2	1.8	1.0
32.900	1.2	1.8	1.0
33.000	1.2	1.8	1.0
33.100	1.2	1.8	1.0
33.200	1.2	1.8	1.0
33.300	1.2	1.8	1.0
33.400	1.2	1.8	1.0
33.500	1.2	1.8	1.0
33.600	1.2	1.8	1.0
33.700	1.2	1.8	1.0
33.800	1.2	1.8	1.0
33.900	1.2	1.8	1.0
34.000	1.2	1.8	1.0

34.100	1.2	1.8	1.0
34.200	1.2	1.8	1.0
34.300	1.2	1.8	1.0
34.400	1.2	1.8	1.0
34.500	1.2	1.8	1.0
34.600	1.2	1.8	1.0
34.700	1.2	1.8	1.0
34.800	1.2	1.8	1.0
34.900	1.2	1.8	1.0
35.000	1.2	1.8	1.0
35.100	1.2	1.8	1.0
35.200	1.2	1.8	1.0
35.300	1.2	1.8	1.0
35.400	1.2	1.8	1.0
35.500	1.2	1.8	1.0
35.600	1.2	1.8	1.0
35.700	1.2	1.8	1.0
35.800	1.2	1.8	1.0
35.900	1.2	1.8	1.0
36.000	1.2	1.8	1.0
36.100	1.2	1.8	1.0
36.200	1.2	1.8	1.0
36.300	1.2	1.8	1.0
36.400	1.2	1.8	1.0
36.500	1.2	1.8	1.0
36.600	1.2	1.8	1.0
36.700	1.2	1.4	< 1.0
36.800	1.2	1.4	< 1.0
36.900	1.2	1.4	< 1.0
37.000	1.2	1.4	< 1.0
37.100	1.2	1.4	< 1.0
37.200	1.2	1.4	< 1.0
37.300	1.2	1.4	< 1.0
37.400	1.2	1.4	< 1.0
37.500	1.2	1.4	< 1.0
37.600	1.2	1.4	< 1.0
37.700	1.2	1.4	< 1.0
37.800	1.2	1.4	< 1.0
37.900	1.2	1.4	< 1.0
38.000	1.2	1.4	< 1.0
38.100	1.2	1.4	< 1.0
38.200	1.2	1.4	< 1.0
38.300	1.2	1.4	< 1.0
38.400	1.2	1.4	< 1.0
38.500	1.2	1.4	< 1.0
38.600	1.2	1.4	< 1.0
38.700	1.2	1.4	< 1.0
38.800	1.2	1.4	< 1.0
38.900	1.2	1.4	< 1.0
39.000	1.2	1.4	< 1.0
39.100	1.2	1.4	< 1.0
39.200	1.2	1.4	< 1.0
39.300	1.2	1.4	< 1.0
39.400	1.2	1.4	< 1.0
39.500	1.2	1.4	< 1.0
39.600	1.2	1.4	< 1.0
39.700	1.2	1.4	< 1.0
39.800	1.2	1.4	< 1.0
39.900	1.2	1.4	< 1.0
40.000	1.2	1.4	< 1.0
40.100	1.2	1.4	< 1.0
40.200	1.2	1.4	< 1.0
40.300	1.2	1.4	< 1.0
40.400	1.2	1.4	< 1.0
40.500	1.2	1.4	< 1.0
40.600	1.2	1.4	< 1.0
40.700	1.2	1.4	< 1.0
40.800	1.2	1.4	< 1.0
40.900	1.2	1.4	< 1.0
41.000	1.2	1.4	< 1.0
41.100	1.2	1.4	< 1.0
41.200	1.2	1.4	< 1.0
41.300	1.2	1.4	< 1.0
41.400	1.2	1.4	< 1.0
41.500	1.2	1.4	< 1.0
41.600	1.2	1.4	< 1.0
41.700	1.2	1.4	< 1.0
41.800	1.2	1.4	< 1.0
41.900	1.2	1.4	< 1.0
42.000	1.2	1.4	< 1.0
42.100	1.2	1.4	< 1.0
42.200	1.2	1.4	< 1.0

42.300	1.2	1.4	< 1.0
42.400	1.2	1.4	< 1.0
42.500	1.2	1.4	< 1.0
42.600	1.2	1.4	< 1.0
42.700	1.2	1.4	< 1.0
42.800	1.2	1.4	< 1.0
42.900	1.2	1.8	1.0
43.000	1.2	1.8	1.0
43.100	1.2	1.8	1.0
43.200	1.2	1.8	1.0
43.300	1.2	1.8	1.0
43.400	1.2	1.8	1.0
43.500	1.2	1.8	1.0
43.600	1.2	1.8	1.0
43.700	1.2	1.8	1.0
43.800	1.2	1.8	1.0
43.900	1.2	1.8	1.0
44.000	1.2	1.8	1.0
44.100	1.2	1.8	1.0
44.200	1.2	1.8	1.0
44.300	1.2	1.8	1.0
44.400	1.2	1.8	1.0
44.500	1.2	1.8	1.0
44.600	1.2	1.8	1.0
44.700	1.2	1.8	1.0
44.800	1.2	1.8	1.0
44.900	1.2	1.8	1.0
45.000	1.2	1.8	1.0
45.100	1.2	1.8	1.0
45.200	1.2	1.8	1.0
45.300	1.2	1.8	1.0
45.400	1.2	1.8	1.0
45.500	1.2	1.8	1.0
45.600	1.2	1.8	1.0
45.700	1.2	1.4	< 1.0
45.800	1.2	1.4	< 1.0
45.900	1.2	1.4	< 1.0
46.000	1.2	1.4	< 1.0
46.100	1.2	1.4	< 1.0
46.200	1.2	1.4	< 1.0
46.300	1.2	1.4	< 1.0
46.400	1.2	1.4	< 1.0
46.500	1.2	1.4	< 1.0
46.600	1.2	1.4	< 1.0
46.700	1.2	1.4	< 1.0
46.800	1.2	1.4	< 1.0
46.900	1.2	1.4	< 1.0
47.000	1.2	1.4	< 1.0
47.100	1.2	1.4	< 1.0
47.200	1.2	1.4	< 1.0
47.300	1.2	1.4	< 1.0
47.400	1.2	1.4	< 1.0
47.500	1.2	1.4	< 1.0
47.600	1.2	1.4	< 1.0
47.700	1.2	1.8	1.0
47.800	1.2	1.8	1.0
47.900	1.2	1.8	1.0
48.000	1.2	1.8	1.0
48.100	1.2	1.8	1.0
48.200	1.2	1.8	1.0
48.300	1.2	1.8	1.0
48.400	1.2	1.8	1.0
48.500	1.2	1.8	1.0
48.600	1.2	1.8	1.0
48.700	1.2	1.8	1.0
48.800	1.2	1.8	1.0
48.900	1.2	1.8	1.0
49.000	1.2	1.8	1.0
49.100	1.2	1.8	1.0
49.200	1.2	1.8	1.0
49.300	1.2	1.8	1.0
49.400	1.2	1.8	1.0
49.500	1.2	1.8	1.0
49.600	1.2	1.8	1.0
49.700	1.2	1.8	1.0
49.800	1.2	1.8	1.0
49.900	1.2	1.8	1.0
50.000	1.2	1.8	1.0
50.100	1.2	1.8	1.0
50.200	1.2	1.8	1.0
50.300	1.2	1.8	1.0
50.400	1.2	1.8	1.0

50.500	1.2	1.8	1.0
50.600	1.2	1.8	1.0
50.700	1.2	1.8	1.0
50.800	1.2	1.8	1.0
50.900	1.2	1.8	1.0
51.000	1.2	1.8	1.0
51.100	1.2	1.8	1.0
51.200	1.2	1.8	1.0
51.300	1.2	1.8	1.0
51.400	1.2	1.8	1.0
51.500	1.2	1.8	1.0
51.600	1.2	1.8	1.0
51.700	1.2	1.8	1.0
51.800	1.2	1.8	1.0
51.900	1.2	1.8	1.0
52.000	1.2	1.8	1.0
52.100	1.2	1.8	1.0
52.200	1.2	1.8	1.0
52.300	1.2	1.8	1.0
52.400	1.2	1.8	1.0
52.500	1.2	1.8	1.0
52.600	1.2	1.8	1.0
52.700	1.2	1.8	1.0
52.800	1.2	1.8	1.0
52.900	1.2	1.8	1.0
53.000	1.2	1.8	1.0
53.100	1.2	1.8	1.0
53.200	1.2	1.8	1.0
53.300	1.2	1.8	1.0
53.400	1.2	1.8	1.0
53.500	1.2	1.8	1.0
53.600	1.2	1.8	1.0
53.700	1.2	1.8	1.0
53.800	1.2	1.8	1.0
53.900	1.2	1.8	1.0
54.000	1.2	1.8	1.0
54.100	1.2	1.8	1.0
54.200	1.2	1.8	1.0
54.300	1.2	1.8	1.0
54.400	1.2	1.8	1.0
54.500	1.2	1.8	1.0
54.600	1.2	1.8	1.0
54.700	1.2	1.8	1.0
54.800	1.2	1.8	1.0
54.900	1.2	1.8	1.0
55.000	1.2	1.8	1.0
55.100	1.2	1.8	1.0
55.200	1.2	1.8	1.0
55.300	1.2	1.8	1.0
55.400	1.2	1.8	1.0
55.500	1.2	1.8	1.0
55.600	1.2	1.8	1.0
55.700	1.2	1.8	1.0
55.800	1.2	1.8	1.0
55.900	1.2	1.8	1.0
56.000	1.2	1.8	1.0
56.100	1.2	1.8	1.0
56.200	1.2	1.8	1.0
56.300	1.2	1.8	1.0
56.400	1.2	1.8	1.0
56.500	1.2	1.8	1.0
56.600	1.2	1.8	1.0
56.700	1.2	1.8	1.0
56.800	1.2	1.8	1.0
56.900	1.2	1.8	1.0
57.000	1.2	1.8	1.0
57.100	1.2	1.8	1.0
57.200	1.2	1.8	1.0
57.300	1.2	1.8	1.0
57.400	1.2	1.8	1.0
57.500	1.2	1.8	1.0
57.600	1.2	1.8	1.0
57.700	1.2	1.8	1.0
57.800	1.2	1.8	1.0
57.900	1.2	1.8	1.0
58.000	1.2	1.8	1.0
58.100	1.2	1.8	1.0
58.200	1.2	1.8	1.0
58.300	1.2	1.8	1.0
58.400	1.2	1.8	1.0
58.500	1.2	1.8	1.0
58.600	1.2	1.8	1.0

58.700	1.2	1.8	1.0
58.800	1.2	1.8	1.0
58.900	1.2	1.8	1.0
59.000	1.2	1.8	1.0
59.100	1.2	1.8	1.0
59.200	1.2	1.8	1.0
59.300	1.2	1.8	1.0
59.400	1.2	1.8	1.0
59.500	1.2	1.8	1.0
59.600	1.2	1.8	1.0
59.700	1.2	1.4	< 1.0
59.800	1.2	1.4	< 1.0
59.900	1.2	1.4	< 1.0
60.000	1.2	1.4	< 1.0
60.100	1.2	1.4	< 1.0
60.200	1.2	1.4	< 1.0
60.300	1.2	1.4	< 1.0
60.400	1.2	1.4	< 1.0
60.500	1.2	1.4	< 1.0
60.600	1.2	1.4	< 1.0
60.700	1.2	1.4	< 1.0
60.800	1.2	1.4	< 1.0
60.900	1.2	1.4	< 1.0
61.000	1.2	1.4	< 1.0
61.100	1.2	1.4	< 1.0
61.200	1.2	1.4	< 1.0
61.300	1.2	1.4	< 1.0
61.400	1.2	1.4	< 1.0
61.500	1.2	1.4	< 1.0
61.600	1.2	1.4	< 1.0
61.700	1.2	1.8	1.0
61.800	1.2	1.8	1.0
61.900	1.2	1.8	1.0
62.000	1.2	1.8	1.0
62.100	1.2	1.8	1.0
62.200	1.2	1.8	1.0
62.300	1.2	1.8	1.0
62.400	1.2	1.8	1.0
62.500	1.2	1.8	1.0
62.600	1.2	1.8	1.0
62.700	1.2	1.8	1.0
62.800	1.2	1.8	1.0
62.900	1.2	1.8	1.0
63.000	1.2	1.8	1.0
63.100	1.2	1.8	1.0
63.200	1.2	1.8	1.0
63.300	1.2	1.8	1.0
63.400	1.2	1.8	1.0
63.500	1.2	1.8	1.0
63.600	1.2	1.8	1.0
63.700	1.2	1.8	1.0
63.800	1.2	1.8	1.0
63.900	1.2	1.8	1.0
64.000	1.2	1.8	1.0
64.100	1.2	1.8	1.0
64.200	1.2	1.8	1.0
64.300	1.2	1.8	1.0
64.400	1.2	1.8	1.0
64.500	1.2	1.8	1.0
64.600	1.2	1.8	1.0
64.700	1.2	1.8	1.0
64.800	1.2	1.8	1.0
64.900	1.2	1.8	1.0
65.000	1.2	1.8	1.0
65.100	1.2	1.8	1.0
65.200	1.2	1.8	1.0
65.300	1.2	1.8	1.0
65.400	1.2	1.8	1.0
65.500	1.2	1.8	1.0
65.600	1.2	1.8	1.0
65.700	1.2	1.8	1.0
65.800	1.2	1.8	1.0
65.900	1.2	1.8	1.0
66.000	1.2	1.8	1.0
66.100	1.2	1.8	1.0
66.200	1.2	1.8	1.0
66.300	1.2	1.8	1.0
66.400	1.2	1.8	1.0
66.500	1.2	1.8	1.0
66.600	1.2	1.8	1.0
66.700	1.2	1.8	1.0
66.800	1.2	1.8	1.0

66.900	1.2	1.8	1.0
67.000	1.2	1.8	1.0
67.100	1.2	1.8	1.0
67.200	1.2	1.8	1.0
67.300	1.2	1.8	1.0
67.400	1.2	1.8	1.0
67.500	1.2	1.8	1.0
67.600	1.2	1.8	1.0
67.700	1.2	1.8	1.0
67.800	1.2	1.8	1.0
67.900	1.2	1.8	1.0
68.000	1.2	1.8	1.0
68.100	1.2	1.8	1.0
68.200	1.2	1.8	1.0
68.300	1.2	1.8	1.0
68.400	1.2	1.8	1.0
68.500	1.2	1.8	1.0
68.600	1.2	1.8	1.0
68.700	1.2	1.8	1.0
68.800	1.2	1.8	1.0
68.900	1.2	1.8	1.0
69.000	1.2	1.8	1.0
69.100	1.2	1.8	1.0
69.200	1.2	1.8	1.0
69.300	1.2	1.8	1.0
69.400	1.2	1.8	1.0
69.500	1.2	1.8	1.0
69.600	1.2	1.8	1.0
69.700	1.2	1.8	1.0
69.800	1.2	1.8	1.0
69.900	1.2	1.8	1.0
70.000	1.2	1.8	1.0
70.100	1.2	1.8	1.0
70.200	1.2	1.8	1.0
70.300	1.2	1.8	1.0
70.400	1.2	1.8	1.0
70.500	1.2	1.8	1.0
70.600	1.2	1.8	1.0
70.700	1.2	1.8	1.0
70.800	1.2	1.8	1.0
70.900	1.2	1.8	1.0
71.000	1.2	1.8	1.0
71.100	1.2	1.8	1.0
71.200	1.2	1.4	< 1.0
71.300	1.2	1.4	< 1.0
71.400	1.2	1.4	< 1.0
71.500	1.2	1.4	< 1.0
71.600	1.2	1.4	< 1.0
71.700	1.2	1.4	< 1.0
71.800	1.2	1.4	< 1.0
71.900	1.2	1.4	< 1.0
72.000	1.2	1.4	< 1.0
72.100	1.2	1.4	< 1.0
72.200	1.2	1.4	< 1.0
72.300	1.2	1.4	< 1.0
72.400	1.2	1.4	< 1.0
72.500	1.2	1.4	< 1.0
72.600	1.2	1.4	< 1.0
72.700	1.2	1.4	< 1.0
72.800	1.2	1.4	< 1.0
72.900	1.2	1.4	< 1.0
73.000	1.2	1.4	< 1.0
73.100	1.2	1.4	< 1.0
73.200	1.2	1.4	< 1.0
73.300	1.2	1.4	< 1.0
73.400	1.2	1.4	< 1.0
73.500	1.2	1.4	< 1.0
73.600	1.2	1.4	< 1.0
73.700	1.2	1.4	< 1.0
73.800	1.2	1.4	< 1.0
73.900	1.2	1.4	< 1.0
74.000	1.2	1.4	< 1.0
74.100	1.2	1.4	< 1.0
74.200	1.2	1.4	< 1.0
74.300	1.2	1.4	< 1.0
74.400	1.2	1.4	< 1.0
74.500	1.2	1.4	< 1.0
74.600	1.2	1.4	< 1.0
74.700	1.2	1.4	< 1.0
74.800	1.2	1.4	< 1.0
74.900	1.2	1.4	< 1.0
75.000	1.2	1.4	< 1.0

75.100	1.2	1.4	< 1.0
75.200	1.2	1.4	< 1.0
75.300	1.2	1.4	< 1.0
75.400	1.2	1.4	< 1.0
75.500	1.2	1.4	< 1.0
75.600	1.2	1.4	< 1.0
75.700	1.2	1.4	< 1.0
75.800	1.2	1.4	< 1.0
75.900	1.2	1.4	< 1.0
76.000	1.2	1.4	< 1.0
76.100	1.2	1.4	< 1.0
76.200	1.2	1.4	< 1.0
76.300	1.2	1.4	< 1.0
76.400	1.2	1.4	< 1.0
76.500	1.2	1.4	< 1.0
76.600	1.2	1.4	< 1.0
76.700	1.2	1.4	< 1.0
76.800	1.2	1.4	< 1.0
76.900	1.2	1.4	< 1.0
77.000	1.2	1.4	< 1.0
77.100	1.2	1.4	< 1.0
77.200	1.2	1.4	< 1.0
77.300	1.2	1.4	< 1.0
77.400	1.2	1.4	< 1.0
77.500	1.2	1.4	< 1.0
77.600	1.2	1.4	< 1.0
77.696	1.2	1.4	< 1.0

Appendix 12

Burial Assessment per 100m Intervals –

Hub Platform to Noss Head Route Section

Caithness-Moray (LT21) Circuit - Hub Platform to Noss Head Route Section			
KP	**1st Pass - Estimated Achievable Trench Depth**	**2nd Pass - Estimated Achievable Trench Depth**	**Estimated Depth of Cover**
77.696	1.2	1.8	1.0
77.700	1.2	1.8	1.0
77.800	1.2	1.8	1.0
77.900	1.2	1.8	1.0
78.000	1.2	1.8	1.0
78.100	1.2	1.8	1.0
78.200	1.2	1.8	1.0
78.300	1.2	1.8	1.0
78.400	1.2	1.8	1.0
78.500	1.2	1.4	< 1.0
78.600	1.2	1.4	< 1.0
78.700	1.2	1.4	< 1.0
78.800	1.2	1.4	< 1.0
78.900	1.2	1.4	< 1.0
79.000	1.2	1.8	1.0
79.100	1.2	1.8	1.0
79.200	1.2	1.8	1.0
79.300	1.2	1.8	1.0
79.400	1.2	1.8	1.0
79.500	1.2	1.8	1.0
79.600	1.2	1.8	1.0
79.700	1.2	1.8	1.0
79.800	1.2	1.8	1.0
79.900	1.2	1.8	1.0
80.000	1.2	1.8	1.0
80.100	1.2	1.8	1.0
80.200	1.2	1.8	1.0
80.300	1.2	1.8	1.0
80.400	1.2	1.8	1.0
80.500	1.2	1.8	1.0
80.600	1.2	1.8	1.0
80.700	1.2	1.8	1.0
80.800	1.2	1.8	1.0
80.900	1.2	1.8	1.0
81.000	1.2	1.8	1.0
81.100	1.2	1.8	1.0
81.200	1.2	1.4	< 1.0
81.300	1.2	1.4	< 1.0
81.400	1.2	1.4	< 1.0
81.500	1.2	1.4	< 1.0
81.600	1.2	1.4	< 1.0
81.700	1.2	1.4	< 1.0
81.800	1.2	1.8	1.0
81.900	1.2	1.8	1.0
82.000	1.2	1.8	1.0
82.100	1.2	1.8	1.0
82.200	1.2	1.8	1.0
82.300	1.2	1.8	1.0
82.400	1.2	1.8	1.0
82.500	1.2	1.8	1.0
82.600	1.2	1.8	1.0
82.700	1.2	1.8	1.0
82.800	1.2	1.8	1.0
82.900	1.2	1.8	1.0
83.000	1.2	1.8	1.0
83.100	1.2	1.8	1.0
83.200	1.2	1.8	1.0
83.300	1.2	1.8	1.0
83.400	1.2	1.8	1.0
83.500	1.2	1.8	1.0
83.600	1.2	1.8	1.0
83.700	1.2	1.8	1.0
83.800	1.2	1.8	1.0
83.900	1.2	1.8	1.0
84.000	1.2	1.8	1.0
84.100	1.2	1.8	1.0
84.200	1.2	1.8	1.0
84.300	1.2	1.8	1.0
84.400	1.2	1.8	1.0
84.500	1.2	1.8	1.0
84.600	1.2	1.8	1.0
84.700	1.2	1.8	1.0
84.800	1.2	1.8	1.0
84.900	1.2	1.8	1.0
85.000	1.2	1.8	1.0
85.100	1.2	1.8	1.0
85.200	1.2	1.8	1.0
85.300	1.2	1.8	1.0
85.400	1.2	1.8	1.0
85.500	1.2	1.8	1.0

85.600	1.2	1.8	1.0
85.700	1.2	1.8	1.0
85.800	1.2	1.8	1.0
85.900	1.2	1.8	1.0
86.000	1.2	1.8	1.0
86.100	1.2	1.8	1.0
86.200	1.2	1.8	1.0
86.300	1.2	1.8	1.0
86.400	1.2	1.8	1.0
86.500	1.2	1.8	1.0
86.600	1.2	1.8	1.0
86.700	1.2	1.8	1.0
86.800	1.2	1.8	1.0
86.900	1.2	1.8	1.0
87.000	1.2	1.8	1.0
87.100	1.2	1.8	1.0
87.200	1.2	1.8	1.0
87.300	1.2	1.8	1.0
87.400	1.2	1.8	1.0
87.500	1.2	1.8	1.0
87.600	1.2	1.8	1.0
87.700	1.2	1.8	1.0
87.800	1.2	1.8	1.0
87.900	1.2	1.8	1.0
88.000	1.2	1.8	1.0
88.100	1.2	1.8	1.0
88.200	1.2	1.8	1.0
88.300	1.2	1.8	1.0
88.400	1.2	1.8	1.0
88.500	1.2	1.8	1.0
88.600	1.2	1.8	1.0
88.700	1.2	1.8	1.0
88.800	1.2	1.8	1.0
88.900	1.2	1.8	1.0
89.000	1.2	1.8	1.0
89.100	1.2	1.8	1.0
89.200	1.2	1.8	1.0
89.300	1.2	1.8	1.0
89.400	1.2	1.8	1.0
89.500	1.2	1.8	1.0
89.600	1.2	1.8	1.0
89.700	1.2	1.8	1.0
89.800	1.2	1.8	1.0
89.900	1.2	1.8	1.0
90.000	1.2	1.8	1.0
90.100	1.2	1.8	1.0
90.200	1.2	1.8	1.0
90.300	1.2	1.8	1.0
90.400	1.2	1.8	1.0
90.500	1.2	1.8	1.0
90.600	1.2	1.8	1.0
90.700	1.2	1.8	1.0
90.800	1.2	1.8	1.0
90.900	1.2	1.8	1.0
91.000	1.2	1.8	1.0
91.100	1.2	1.8	1.0
91.200	1.2	1.8	1.0
91.300	1.2	1.8	1.0
91.400	1.2	1.8	1.0
91.500	1.2	1.8	1.0
91.600	1.2	1.8	1.0
91.700	1.2	1.8	1.0
91.800	1.2	1.8	1.0
91.900	1.2	1.8	1.0
92.000	1.2	1.8	1.0
92.100	1.2	1.8	1.0
92.200	1.2	1.8	1.0
92.300	1.2	1.8	1.0
92.400	1.2	1.8	1.0
92.500	1.2	1.8	1.0
92.600	1.2	1.8	1.0
92.700	1.2	1.8	1.0
92.800	1.2	1.8	1.0
92.900	1.2	1.8	1.0
93.000	1.2	1.8	1.0
93.100	1.2	1.8	1.0
93.200	1.2	1.8	1.0
93.300	1.2	1.8	1.0
93.400	1.2	1.8	1.0
93.500	1.2	1.8	1.0
93.600	1.2	1.8	1.0
93.700	1.2	1.8	1.0

93.800	1.2	1.8	1.0
93.900	1.2	1.8	1.0
94.000	1.2	1.8	1.0
94.100	1.2	1.8	1.0
94.200	1.2	1.8	1.0
94.300	1.2	1.8	1.0
94.400	1.2	1.8	1.0
94.500	1.2	1.8	1.0
94.600	1.2	1.8	1.0
94.700	1.2	1.8	1.0
94.800	1.2	1.8	1.0
94.900	1.2	1.8	1.0
95.000	1.2	1.8	1.0
95.100	1.2	1.8	1.0
95.200	1.2	1.8	1.0
95.300	1.2	1.8	1.0
95.400	1.2	1.8	1.0
95.500	1.2	1.8	1.0
95.600	1.2	1.8	1.0
95.700	1.2	1.8	1.0
95.800	1.2	1.8	1.0
95.900	1.2	1.8	1.0
96.000	1.2	1.8	1.0
96.100	1.2	1.8	1.0
96.200	1.2	1.8	1.0
96.300	1.2	1.8	1.0
96.400	1.2	1.8	1.0
96.500	1.2	1.8	1.0
96.600	1.2	1.8	1.0
96.700	1.2	1.8	1.0
96.800	1.2	1.8	1.0
96.900	1.2	1.8	1.0
97.000	1.2	1.8	1.0
97.100	1.2	1.8	1.0
97.200	1.2	1.8	1.0
97.300	1.2	1.8	1.0
97.400	1.2	1.8	1.0
97.500	1.2	1.8	1.0
97.600	1.2	1.8	1.0
97.700	1.2	1.8	1.0
97.800	1.2	1.8	1.0
97.900	1.2	1.8	1.0
98.000	1.2	1.8	1.0
98.100	1.2	1.8	1.0
98.200	1.2	1.8	1.0
98.300	1.2	1.8	1.0
98.400	1.2	1.8	1.0
98.500	1.2	1.8	1.0
98.600	1.2	1.8	1.0
98.700	1.2	1.8	1.0
98.800	1.2	1.8	1.0
98.900	1.2	1.8	1.0
99.000	1.2	1.8	1.0
99.100	1.2	1.8	1.0
99.200	1.2	1.8	1.0
99.300	1.2	1.8	1.0
99.400	1.2	1.8	1.0
99.500	1.2	1.8	1.0
99.600	1.2	1.8	1.0
99.700	1.2	1.8	1.0
99.800	1.2	1.8	1.0
99.900	1.2	1.8	1.0
100.000	1.2	1.8	1.0
100.100	1.2	1.8	1.0
100.200	1.2	1.8	1.0
100.300	1.2	1.8	1.0
100.400	1.2	1.8	1.0
100.500	1.2	1.8	1.0
100.600	1.2	1.8	1.0
100.700	1.2	1.8	1.0
100.800	1.2	1.8	1.0
100.900	1.2	1.8	1.0
101.000	1.2	1.8	1.0
101.100	1.2	1.8	1.0
101.200	1.2	1.8	1.0
101.300	1.2	1.8	1.0
101.400	1.2	1.8	1.0
101.500	1.2	1.8	1.0
101.600	1.2	1.8	1.0
101.700	1.2	1.8	1.0
101.800	1.2	1.8	1.0
101.900	1.2	1.8	1.0

102.000	1.2	1.8	1.0
102.100	1.2	1.8	1.0
102.200	1.2	1.8	1.0
102.300	1.2	1.8	1.0
102.400	1.2	1.8	1.0
102.500	1.2	1.8	1.0
102.600	1.2	1.8	1.0
102.700	1.2	1.8	1.0
102.800	1.2	1.8	1.0
102.900	1.2	1.8	1.0
103.000	1.2	1.8	1.0
103.100	1.2	1.8	1.0
103.200	1.2	1.8	1.0
103.300	1.2	1.8	1.0
103.400	1.2	1.8	1.0
103.500	1.2	1.8	1.0
103.600	1.2	1.8	1.0
103.700	1.2	1.8	1.0
103.800	1.2	1.8	1.0
103.900	1.2	1.8	1.0
104.000	1.2	1.8	1.0
104.100	1.2	1.8	1.0
104.200	1.2	1.8	1.0
104.300	1.2	1.8	1.0
104.400	1.2	1.8	1.0
104.500	1.2	1.8	1.0
104.600	1.2	1.8	1.0
104.700	1.2	1.8	1.0
104.800	1.2	1.8	1.0
104.900	1.2	1.8	1.0
105.000	1.2	1.8	1.0
105.100	1.2	1.8	1.0
105.200	1.2	1.8	1.0
105.300	1.2	1.8	1.0
105.400	1.2	1.8	1.0
105.500	1.2	1.8	1.0
105.600	1.2	1.8	1.0
105.700	1.2	1.8	1.0
105.800	1.2	1.8	1.0
105.900	1.2	1.8	1.0
106.000	1.2	1.8	1.0
106.100	1.2	1.8	1.0
106.200	1.2	1.8	1.0
106.300	1.2	1.8	1.0
106.400	1.2	1.8	1.0
106.500	1.2	1.8	1.0
106.600	1.2	1.8	1.0
106.700	1.2	1.8	1.0
106.800	1.2	1.8	1.0
106.900	1.2	1.8	1.0
107.000	1.2	1.8	1.0
107.100	1.2	1.8	1.0
107.200	1.2	1.8	1.0
107.300	1.2	1.8	1.0
107.400	1.2	1.8	1.0
107.500	1.2	1.8	1.0
107.600	1.2	1.8	1.0
107.700	1.2	1.8	1.0
107.800	1.2	1.8	1.0
107.900	1.2	1.8	1.0
108.000	1.2	1.8	1.0
108.100	1.2	1.8	1.0
108.200	1.2	1.8	1.0
108.300	1.2	1.8	1.0
108.400	1.2	1.8	1.0
108.500	1.2	1.8	1.0
108.600	1.2	1.8	1.0
108.700	1.2	1.8	1.0
108.800	1.2	1.8	1.0
108.900	1.2	1.8	1.0
109.000	1.2	1.8	1.0
109.100	1.2	1.8	1.0
109.200	1.2	1.8	1.0
109.300	1.2	1.8	1.0
109.400	1.2	1.8	1.0
109.500	1.2	1.8	1.0
109.600	1.2	1.8	1.0
109.700	1.2	1.8	1.0
109.800	1.2	1.8	1.0
109.900	1.2	1.8	1.0
110.000	1.2	1.8	1.0
110.100	1.2	1.8	1.0

110.200	0.0	0.0	0.0
110.300	0.0	0.0	0.0
110.400	0.0	0.0	0.0
110.500	0.0	0.0	0.0
110.600	0.0	0.0	0.0
110.700	0.0	0.0	0.0
110.800	0.0	0.0	0.0
110.900	0.0	0.0	0.0
111.000	0.0	0.0	0.0
111.100	0.0	0.0	0.0
111.200	0.0	0.0	0.0
111.300	0.0	0.0	0.0
111.400	0.0	0.0	0.0
111.500	0.0	0.0	0.0
111.600	0.0	0.0	0.0
111.700	0.0	0.0	0.0
111.800	0.0	0.0	0.0
111.900	0.0	0.0	0.0
112.000	0.0	0.0	0.0
112.100	0.0	0.0	0.0
112.200	0.0	0.0	0.0
112.300	0.0	0.0	0.0
112.400	0.0	0.0	0.0
112.451 (HDD)	0.0	0.0	0.0