Post Construction Benthic Monitoring Report

Moray East Offshore Wind Farm

November 2024

Moray Offshore Windfarm (East) Limited

Produced by Fugro GB Limited on behalf of Moray Offshore Wind Farm (East) Limited	
Produced by	Paul English
Document Status	Final
Version	1
File Name	MWE-OW-OP-REP-0002
Date	21 November 2024

Review / Approval

Moray East Consents	
Review	**Approval**
Eilidh Bennett Consents Intern	Jimmy Wright Consents and Environmental Compliance Associate

Executive Summary

The Moray East Project Environmental Management Plan (PEMP) for the Moray East Offshore Wind Farm implements the monitoring requirements specified in the respective Marine Licences and Section 36 Consents for the wind farm construction and operation. This document presents the agreed methods for conducting the required benthic ecology assessment which meet the licence monitoring commitments laid out in the PEMP.

As agreed in the PEMP, asset inspection geophysical and Remotely Operated Vehicle (ROV) video data were used to assess benthic ecological impacts of offshore wind farm construction and operation at Moray East. These data were collected at close-range to the installed infrastructure (within a few 10's of meters) where most benthic impacts were predicted to occur in the Moray East Environmental Statement (ES).

Physical impacts of construction, including seabed depressions, seabed scars and soil plug deposits were visible on the seafloor. Seabed recovery from these impacts was in progress with estimated recovery rates indicating that this may be completed within the timeframe predicted within the Moray East ES (up to 5 years). Although not specifically measured on this occasion, benthic infaunal communities were expected to be restored 6 months to 5 years after recovery of the seabed following well-established patterns of species succession. Given this, full restoration of infauna in impacted areas was not anticipated to have been complete at the time of the post-construction asset inspection surveys.

Conspicuous epifauna were broadly comparable to pre-construction conditions although sea pens and some species of fish and crab were not recorded during the post-construction ROV inspection surveys. No accumulation of biomass from fouling communities on the seafloor and no significant discolouration of sediments, potentially indicative of sediment organic enrichment, were recorded at Moray East.

Operational effects included highly localised scouring of fine grained sand sediments at the base of foundation legs, resulting in a shallow depression and a coarser seabed sediment, containing higher proportions of shell material, compared to adjacent non- affected sediments. Other operational effects will relate to habitat change due to the placement of rock protection material along portions of the offshore export cable (OEC) route and at two of the turbine locations and the three offshore substation platforms. Such effects would be ongoing (permanent) throughout the life of the development.

In conclusion, seabed impacts were found to be highly localised, and were recovering as predicted in the Moray East ES. Recommendations for future benthic monitoring using a similar approach at Moray East are provided.

Table of Contents

Abbreviations

EMP	Environmental Management Plan
JNCC	Joint Nature Conservation Committee
JUV	Jack-up Vessels
MBES	Multibeam Bathymetry Echo Sounder
MFRAG	Moray Firth Regional Advisory Group
O&M	Operational and Maintenance
OEC	Offshore OECs
OfTI	Offshore Transmission Infrastructure
OFTO	Offshore Transmission Operator
OSP	Offshore Substation Platforms
OSPAR	Oslo and Paris Commission
OWF	Offshore Wind Farm
PEMP	Project Environmental Management Plan
PMF	Priority Marine Feature
ROV	Remotely Operated Vehicle
SSS	Side Scan Sonar

Tables

Figures

1 Introduction

The Moray East Offshore Wind Farm (OWF) is located in the outer Moray Firth over 22 km from the shore at its closest point. It consists of three offshore wind farms (Telford, Stevenson and MacColl), each of which received Section 36 Consent and Marine Licence awards in March 2014, with subsequent variations granted between 2018 and 2022. The three consented wind farms have since been developed as a single offshore wind farm (Moray East).

Moray East covers an area of 295 km^2 and comprises 100 x 9.5 MW Vestas turbines with a generating capacity of 950 MW. The turbines are installed on three-legged jacket structures, the piles of which measure 2.4 m in diameter at the sediment interface. Moray East is connected by approximately 156 km of inter-array cabling and a 43 km interconnector cable and is supported by the Offshore Transmission Infrastructure (OfTI) consisting of three separate offshore substation platforms (OSP) and three export power cables which transmit power to shore, making landfall at Inverboyndie Bay. On the 22nd February 2024, the ownership of the OfTI was transferred to a new Offshore Transmission Owner (OfTO), Transmission Capital Partners (TCP). Figure 1 shows the location of Moray East and associated OfTI.

Construction of Moray East commenced in 2019 with first power achieved in June 2021. Final construction and full power were accomplished in April 2022 which marked the commencement of the Operational and Maintenance (O&M) phase of the development.

In compliance with requirements of the Marine Licences and Consents for the Telford, Stevenson and MacColl wind farms, indicated above, environmental monitoring must be carried out. This includes the monitoring of benthic ecological conditions at various phases of the development, to document observed seabed habitat and species changes, and to verify impact assessment conclusions made in the Moray East Environmental Statement (ES) (Moray Offshore Wind Farm (East) Limited, 2012). The methods and scope of the environmental monitoring, including any amendments, are to be agreed with the Moray Firth Regional Advisory Group (MFRAG) and reported within a Project Environmental Management Plan (PEMP) (Moray Offshore Wind Farm (East) Limited, 2023a) to ensure that effective and appropriate monitoring is undertaken in collaboration with other developers in the wider Moray Firth area. The following presents the agreed methodologies for the monitoring of benthic ecology at Moray East, as laid out in the current PEMP and the results of the monitoring, in compliance with licence requirements. This document represents the first post-construction benthic monitoring study at Moray East and presents the first observations of the benthic ecology after completion of the construction phase.

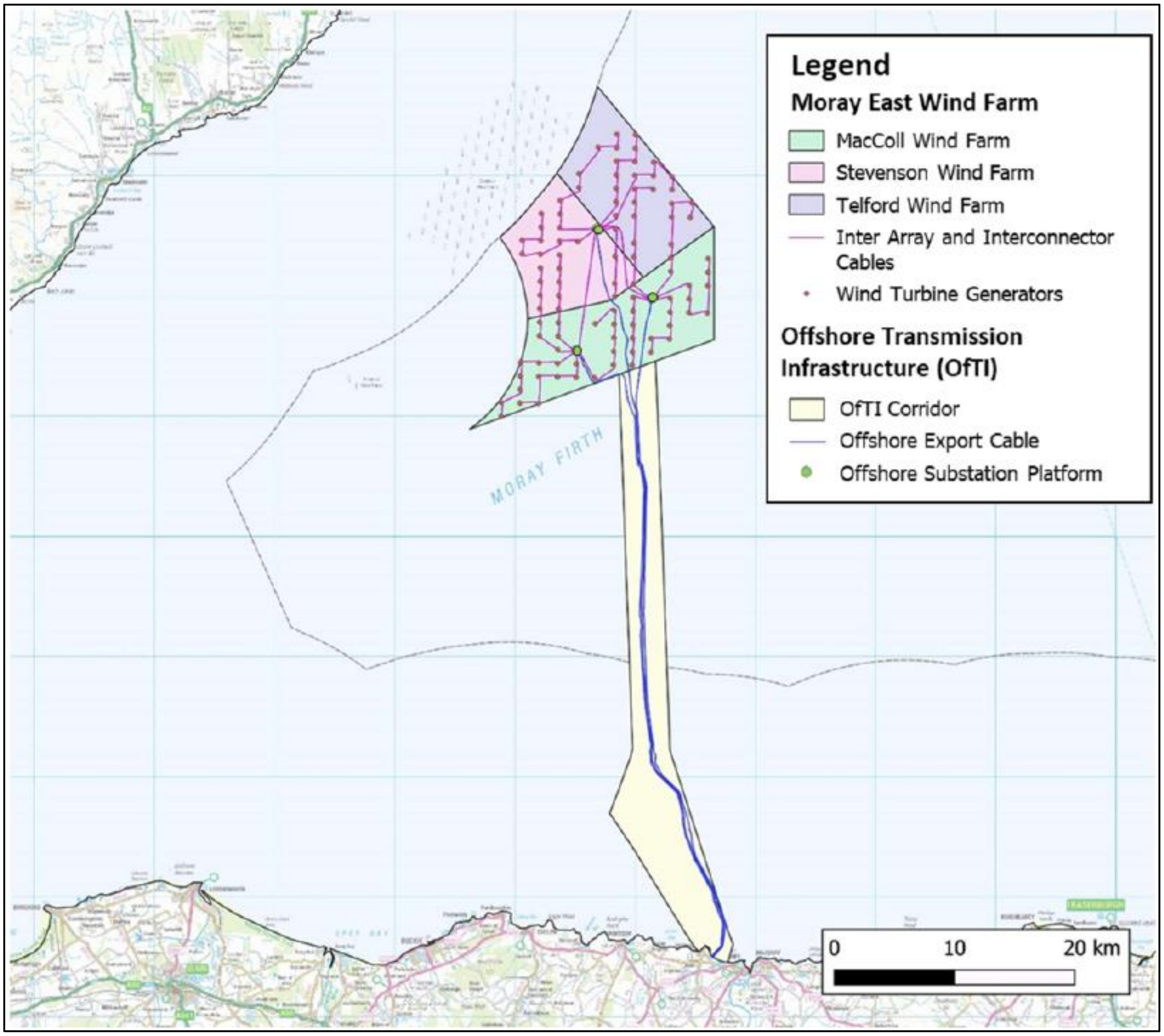


Figure 1. Location of the Moray East OWF

1.1 Project Environmental Management Plan (PEMP)

Marine Licences and Section 36 Electricity Act (1989) Consents were awarded to the various elements of Moray East (Telford, Stevenson & MacColl and OfTI) in 2014 with subsequent variations to the Marine Licence awarded in 2018 and variations to the separate Consents awarded in 2019 and 2020.

Sections 3.2.11 of Marine Licence (Marine (Scotland) Act, 2010 & Marine and Coastal Access Act, 2009) and Condition 26 of the Section 36 Consent (Electricity Act, 1989) require the PEMP to set out the measures that the Licensee will undertake to ensure monitoring of the benthic ecology at Moray East is in alignment with the Application such that it relates to environmental monitoring. The reasons for the monitoring are;

> *'To ensure that all construction and operation activities are carried out in a manner that minimises their impact on the environment, and that mitigation measures contained in the application, or as otherwise agreed, are fully implemented and in accordance with s.29(3)(a) of the 2010 Act and s.71(3)(a) of the 2009 Act'.*

and

> *'To ensure that appropriate and effective monitoring of the impacts of the Development is undertaken'.*

Furthermore,

> '*the monitoring should be done in such a way as to ensure that the data which is collected allows useful and valid comparisons as between different phases of the Development'*, while '*monitoring may also serve the purpose of verifying key predictions in the ES*'.

The current version of the approved Moray East OWF PEMP (version 4) (June 2023) provides the recommendations for the conduct of such monitoring surveys. Section 3 of the PEMP refers to the benthic monitoring methodologies that will be implemented, to meet the monitoring commitments. The environmental monitoring requirements of the OfTI are considered in a separate PEMP and will be addressed by TCP, the OFTO, now the OfTI assets have been transferred.

Baseline benthic ecological data were collected via desk study and site-specific survey during the pre-application phase of the development. These were used to describe pre-construction benthic conditions and to forecast and assess the likely benthic effects of wind farm construction and operation as reported in the Moray East ES. The ES predicted that, with mitigation measures applied, there would be no significant adverse effects of construction and operation of Moray East on benthic ecology. Furthermore, no rare or protected species with respect to the European Union (EU) Habitats Directive 92/43/EEC and / or the Wildlife & Countryside Act 1981, were found within or around the boundaries of the Moray East site and the site did not coincide with any designated site for nature conservation. Muddy sand habitats along much of the deeper water sections of the offshore export cable (OEC) corridor were representative of the 'Burrowed Mud" Priority Marine Feature (PMF), but these were not forecast to be significantly affected by the construction and operation of Moray East.

1.2 Development of the benthic monitoring approach

This section presents the rationale for the method that has been developed and agreed for the monitoring of benthic ecology. Section 3 of the PEMP (Moray East Offshore Wind Farm, 2023a) describes the full methodology and rationale.

The following sources of information were considered in the development of the monitoring requirements in respect of benthic ecology.

1. Requirements of the Section 36 Consents and Marine Licences for Telford, Stevenson and MacColl offshore wind farms.
2. Conclusions of the Moray East ES, which predicted no significant adverse effects on benthic ecology (with mitigation in place) and confirmed the absence of protected areas and protected benthic ecological features within the Moray East boundaries.
3. Conclusions of the review of environmental monitoring programmes of principally Round 1 and 2 OWF projects in the United Kingdom (UK) (MMO, 2014), none of which had recorded any post-construction benthic effects at medium or broader spatial scales.

Considering the ES conclusions and the recommendations of the Marine Management Organisation (MMO) review, the Moray East PEMP recommended the use (or re-purposing) of geophysical data and Remotely Operated Vehicle (ROV) video data that was to be collected as part of seabed scour surveys, local sediment deposition inspections and seabed cable burial assessments (see Section 2.0 of the PEMP). The rationale for using these data for the current benthic monitoring purposes was that the scour and local sediment surveys would be focused on the infrastructure itself, and very close environs, where the greatest potential for seabed impacts would occur due to (i) construction activities, (ii) alterations in localised bottom current flows and/or (iii) biomass growth and species use of the introduced structures. For instance, benthic monitoring over medium and broad spatial scales have, in general, failed to identify any significant benthic impacts attributable to OWFs, as mentioned above (MMO, 2014), but research monitoring at close ranges (within a few 10's of metres of offshore wind infrastructure) has recorded important benthic changes during construction and operational phases (e.g. Erikson et al., 2022; HDR, 2020; Coates et al., 2014). In particular, conspicuous physical seabed impacts, due to the placement of spud legs of construction vessels on the seafloor and trenching of subsea cables, have been found in geophysical datasets and have been shown to persist for months to years, depending on the natural mobility of the seabed. Also, significant modification of benthic habitats has been recorded directly below and close to operational jacket foundation structures, during seabed video surveillance, and was attributed to the accumulation of biomass from species attaching to and colonising the foundations on the seafloor and associated organic enrichment of sediments (Hutchison et al., 2020).

It was considered that such benthic changes at, and close to, the Moray East structures would be readily observable within the geophysical (multi-beam bathymetry and side scan sonar) inspection survey data that are collected to fulfil scour and sediment monitoring requirements at Moray East. Impacts would manifest in the datasets as alterations in seabed topography and changes in sediment textures, bathymetry and/or reflectivity, compared to pre-construction conditions. Furthermore, the close range ROV data collected during scour monitoring surveys, would provide visual verification of the geophysical interpretations, as well as information on any predicted seabed habitat alterations at the base of the foundations, due to scour and/or the accumulation of biomass.

Section 2 of the current PEMP details the methodologies and rationale employed for conducting seabed scour and local sediment deposition monitoring and the cable burial assessments. It explains the importance of seabed scour monitoring around the base of foundations from an engineering perspective, to ensure structural integrity and notes that potential environmental effects will be included in the monitoring when significant scour is detected. The frequency of this type of monitoring is recommended to be once a year for the first three years, after which the frequency of survey will be determined according to the results obtained.

1.3 Baseline benthic conditions

This section presents a summary of the baseline benthic conditions within and around Moray East prior to construction, as presented in the Moray East ES.

Moray East occupies the eastern flank of the Smith Bank; a bathymetric high point in the centre of the Moray Firth. Water depths across the site vary between 35 and 55 m below Chart Datum, with the deepest areas found to the south-east. Seabed sediments generally consist of a thin veneer (generally 1 – 3 m thick) of Holocene clean gravelly sand and sand with low levels of fine particles (silt and clay), overlying a thick layer of glacial till material. The proportion of shell material in sediment grab samples is considered to be high and regularly exceeds 50 %.

Along the OEC corridor, in intermediate water depths, sediments consist of mixed sands and gravels, with small and variable fines content, whilst in deeper water areas seabed sediments become progressively finer, becoming relatively muddy in the deepest parts, at the eastern end of the Southern Trench.

Local tidal currents are largely incapable of mobilising anything larger than fine sand-sized material, but the combination of tidal and non-tidal currents and wave induced currents during storms, result in considerably higher current speeds, capable of mobilising medium-sized sand. During such seabed disturbances, coarser sediments may be transported a short distance in the direction of ambient flow, or down-slope under gravity, before being re-deposited, whilst finer grained material that persist in suspension will eventually be transported in the direction of net tidal residual flow (i.e. to the south west) into the Moray Firth.

Pre-application benthic ecological conditions at and around Moray East and along the OECs to Inverboyndie, derive from the initial site-specific surveys conducted in 2012 and 2014 respectively, data from which were used to inform the Moray East ES (Moray Offshore Wind Farm (East) 2012; 2014). Moray East was investigated using seabed grab sampling and drop-down video surveillance techniques, as well as small (2 m) benthic trawls at pre-determined sampling locations within and around the proposed licence boundaries. Sampling locations were based on previously acquired geophysical data (multibeam echosounder and side scan sonar). The OEC corridor was investigated using a continuous video tow along the seabed between the OSPs and landfall at Inverboyndie. Intertidal habitats at the landfall site were classified and mapped using walk-over biotope mapping techniques. Collectively, these site-specific studies provided detailed information on the extent and distribution of benthic habitats and characterising infaunal and epifaunal species communities, allowing for the ecological value and biodiversity of the site to be determined and the potential impacts of wind farm construction and operation on benthic ecology to be assessed. The evaluation and assessment of benthic ecological impacts were subsequently reported within the Moray East ES in support of licence application.

Pre-application sampling (to inform the Moray East ES) revealed a largely homogeneous seabed habitat consisting of sand and varying levels of gravel, with areas of coarse sediment and shells in some places. Characteristic sediment dwelling (infaunal) species included the polychaetes *Spiophanes bombyx, Ophelia borealis, Poecilochaetus serpens, Chone* sp., *Notomastus* sp., *Lumbrineris gracilis, Aonides paucibranchiata, Glycera lapidum* and *Owenia fusiformis,* the molluscs *Cochlodesma praetenue* and *Crenella decussata,* the urchin *Echinocyamus pusillus,* the amphipod *Atylus vedlomensis* and ribbon worms, *Nemertea*. Conspicuous sessile epifauna included calcareous tube worms *Pomatoceros triqueter* and *Hydroides norvegica*, as well as bryozoans, hydroids and soft coral *Alcyonium digitatum*, all of which were observed attaching to and encrusting larger gravel, pebbles and cobbles. Deeper water areas were characterised by slightly muddier sand and gravel sediments supporting polychaetes *L. gracilis, Magelona alleni* and *Owenia fusiformis,* acorn worms, *Enteropneustra*, ribbon worms and infaunal brittlestars, *Amphiuridae*. All species recorded were considered largely typical for these sediment habitat types.

A total of seven sediment biotopes were classified within the boundaries of Moray East following the pre-application benthic grab sampling surveys (four biotopes were recognised from video survey). Table 1 summarises the biotopes classified at Moray East. The distributions of classified biotopes from grab and video samples at Moray East are presented in Figure 2.

Table 1. Biotopes classified at Moray East

Biotope classification	Description
SS.SSa.CFiSa EpusOborApri	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand.
SS.SCS.CCS. MedLumVen	*Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel.
SS.SSa.OSa. OfusAfil	*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand.
SS.SSa.IMuSa. FfabMag	*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand.
SS.SCS.ICS.Glap	*Glycera lapidum* in impoverished infralittoral mobile gravel and sand.
SS.SCS.ICS.MoeVen	*Moerella* spp. with venerid bivalves in infralittoral gravelly sand.
SS.SMx.Omx.PoVen	Polychaete-rich deep *Venus* community in offshore mixed sediments.

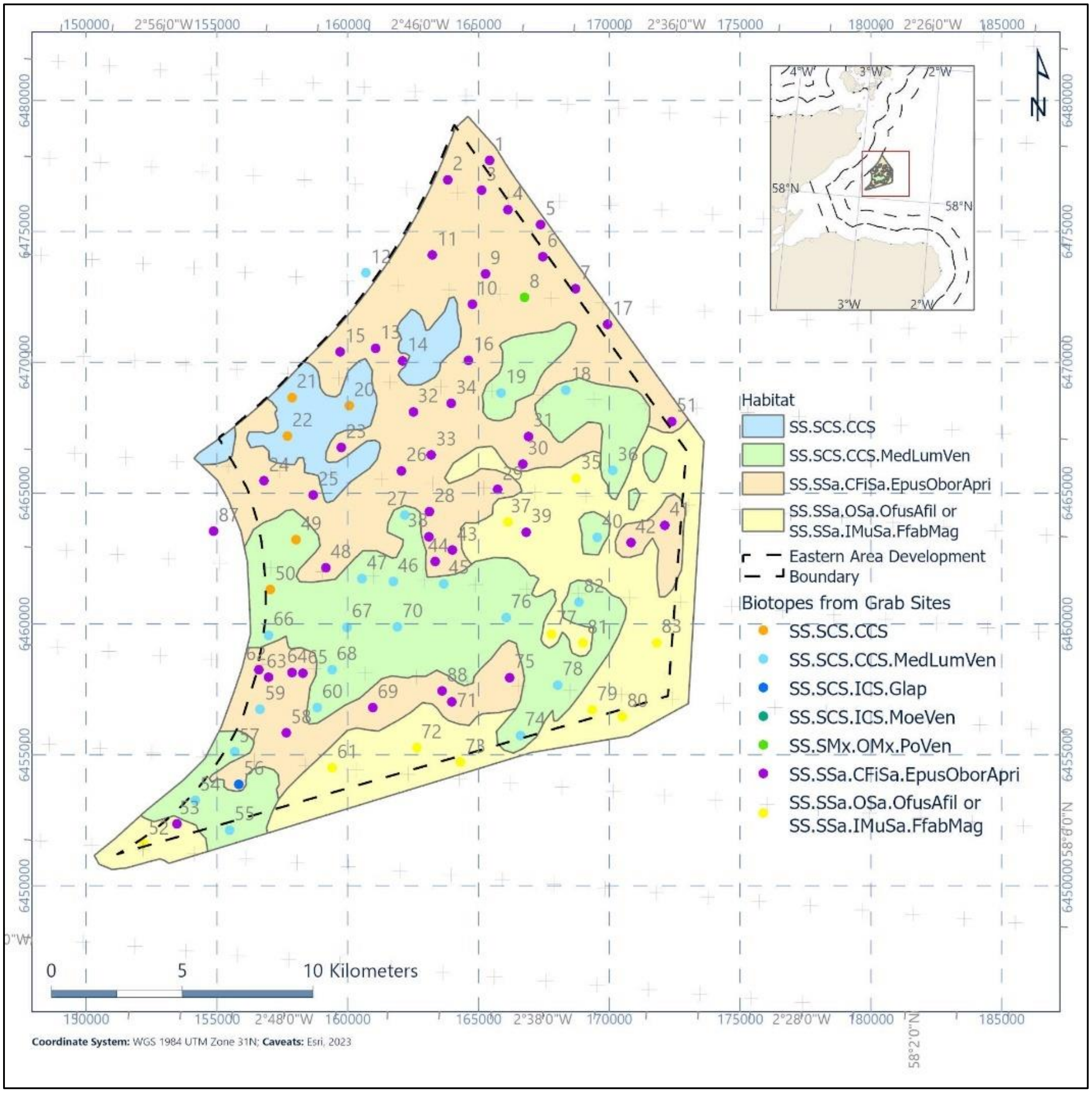


Figure 2. Distribution of pre-application benthic biotopes at the offshore generating station

Larger, more mobile epibenthos recorded during small beam trawl sampling and seabed video surveys at Moray East included pagurid crabs, sea stars, *Asterias rubens, Astropecten irregularis, Crossaster papposus* and *Luidia ciliaris*, fish such as gurnards, Triglidae, thick-backed sole, *Microchirus* *variegatus*, dab *Limanda limanda*, and plaice *Pleuronectes platessa*. Sea pens, *Pennatula phosphorea,* were recorded within muddy sand habitats in deeper waters. Queen scallops, *Aequipecten opercularis,* were recorded ubiquitously in trawl samples across the offshore wind farm area. Patches of mixed coarser sediments along the cable corridor, supported various species of hydroids and bryozoans with squat lobster, *Munida rugosa,* and sea urchin, *Echinus esculentus*, together with small colonies of serpulid worms.

Along the cable corridor, the seabed consisted largely of sand and muddy sand representative of 'Burrowed Mud' PMF habitat. Characteristic species included sea pens, *P. phosphorea* and *Virgularia mirabilis*; sea stars, *A. rubens, Henricia* sp. and *A. irregularis*; hermit crabs, *Paguridae*, king scallop, *Pecten maximus,* and flatfish, *Pleuronectiformes*. Sediments became progressively sandier on approach to the shore, before transitioning into coarse rocky and boulder reef substrata with red and brown algae, sea anemones, *Urticina* sp. and *Metridium senile*, squat lobster, edible crab, *Cancer pagurus*, urchins, and soft coral, *Alcyonium digitatum,* near the coast. Rock outcrops and cobbles were found within inshore areas and supported red and brown foliose algae, coralline algae, bryozoan crusts and soft coral. The biotopes that were classified along the OEC corridor are summarised in Table 2 and presented in Figure 3.

Table 2 Biotopes recorded along the cable route

Biotope classification	Description
SS.SMu.CFiMu.SpnMeg	Sea pens and burrowing megafauna in circalittoral fine mud
CR.MCR.EcCr.FaAlCr.Pom	Faunal and algal crusts on exposed to moderately wave-exposed circalittoral rock
SS.SMx.CMx	Circalittoral mixed sediment
SS.SSA	Sublittoral sands and muddy sands

The intertidal area at the cable landfall site at Inverboyndie Bay was characterised by a sandy sediment in the upper and middle shore, whilst more rocky areas were observed in the mid-lower shore. Sandy areas are largely barren, with the occasional presence of lugworm, *Arenicola marina*. Rocky outcrops comprising of large boulders supported more diverse ecological communities. These included canopies and dense mats of brown, green, and red algae, as well as typical intertidal epifaunal species such as barnacles, limpets, and whelks.

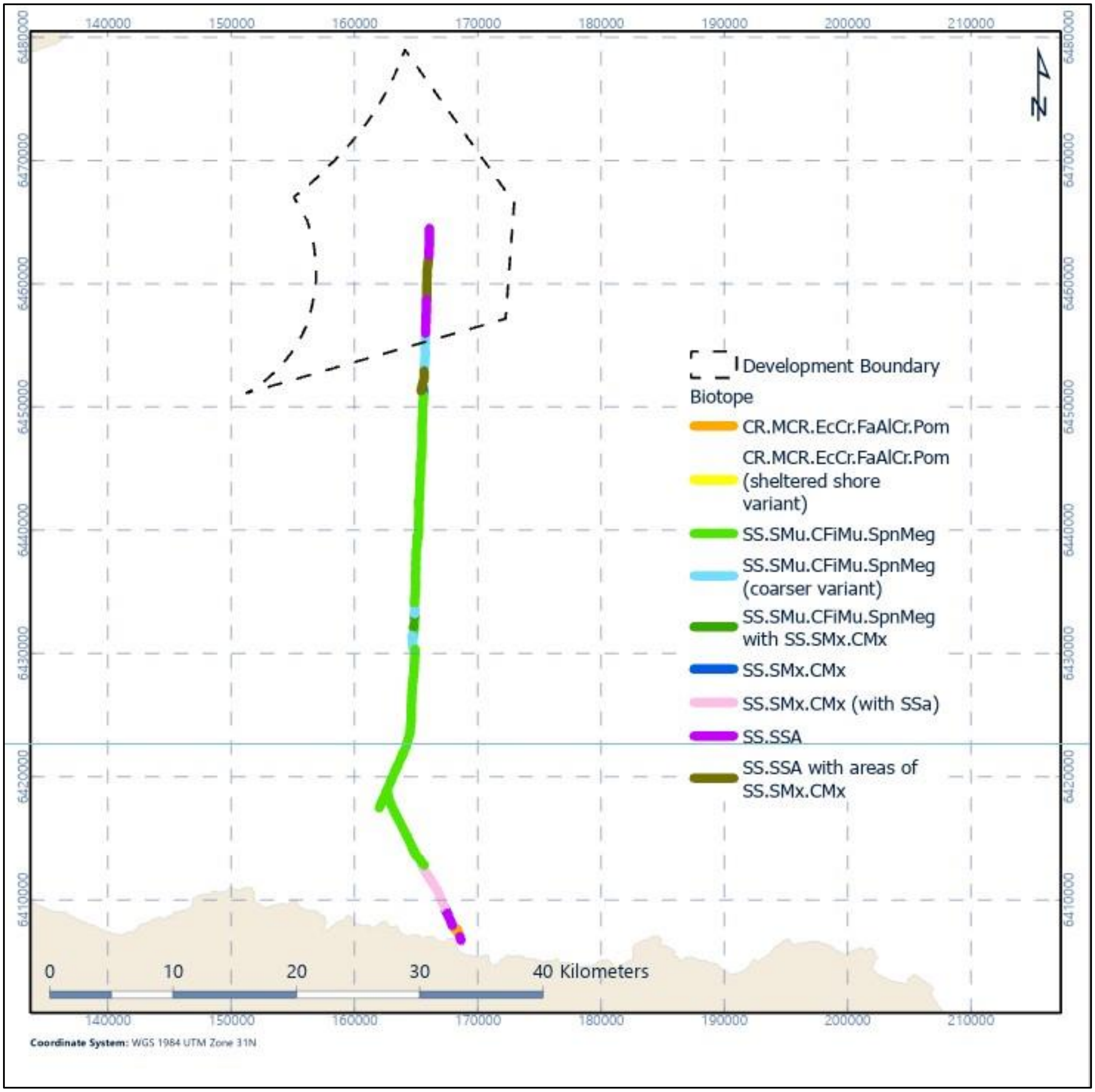


Figure 3. Distribution of benthic biotopes along the Moray East OEC corridor.

1.4 Predicted Impacts

Several potential benthic ecological impacts were identified and assessed within the Moray East ES although none were forecast to be significant, in the presence of mitigation. Impact conclusions made in the ES are summarised in Table 3.

Table 3. Summary predicted impacts of the Moray Offshore windfarm (East) (source Moray Offshore Renewables ES, 2014)

Effect	Effect pathway	Receptor	Pre-mitigation Effect	Mitigation	Post-mitigation Effect
Construction					
Temporary direct seabed disturbance	Placement of the feet (spud-legs) of construction vessels (jack–up barges) on the sea floor and the installation of inter–array cables. Berms of sediment may also be deposited on the seabed as a result of displacement and side casting of material from trenches constructed during cable installation.	Sediment habitats and species	Minor	Adherence to EMP	Minor
Temporary indirect (sediment) disturbance	Settlement of sediment plumes raised due to seabed disturbances during installation.		Minor		Minor
Seabed deposition	Deposition of sediment arisings generated by foundation drilling on the seafloor.		Minor		Minor
Seabed contamination	Release and dispersion of sediment contaminants.		Up to Major		Minor
Operation					
Net reduction in area of original seabed habitat	Loss of original seabed under the footprint of foundations and rock scour	Sediment habitats and species	Minor	n/a	Minor
Habitat change	Introduction of hard (albeit artificial) substrata		Moderate	Adherence to EMP. Monitoring	Minor
Effect on physical processes and related biological changes	Seabed scour due to altered seabed currents around placed infrastructure	Physical processes, habitats and species	Minor	n/a	Minor

Effect	Effect pathway	Receptor	Pre-mitigation Effect	Mitigation	Post-mitigation Effect
Temporary direct seabed disturbance	Ongoing operations and maintenance, major interventions and overhauls of turbines	Sediment habitats and species	Not significant	Adherence to EMP	Not significant
Seabed contamination	Release and dispersion of sediment contaminants.	Water quality, species	Up to Major		Minor
Notes: EMP = Environmental Management Plan					

Predicted direct construction impacts included the creation of seabed depressions and scars caused by the placement of the feet of the legs of jack-up vessels (JUVs) and the trenching of inter-array and OECs. Direct impacts considered in the ES also included the deposition of spoil from drilling of foundation piles. Species within the footprint of these direct impacts may have been dislodged, smothered, damaged and killed resulting in localised effects on species diversity, abundance and biomass.

Indirect impacts predicted in the ES related to the deposition of sediment plumes arising from direct construction impacts and associated sediment scouring and smothering effects on local species and changes to the composition of adjacent seabed sediments. Effects from such indirect impacts were forecast to include temporary reductions in species diversity and abundance and alterations to sediment composition within the influence of sediment plumes.

All construction related effects were forecast to be localised and temporary with recovery of benthic communities occurring quickly once seabed habitats had been restored to pre-construction conditions.

Predicted operational effects included seabed scour around the base of the foundations resulting in localised alterations to sediment composition and benthos, as well as habitat alteration due to the placement of scour and cable protection (rock) material on the seabed. These effects were likely to be permanent throughout the life of Moray East but reversible on decommissioning and removal of the foundation structures and scour material.

Indentations on the seabed up to 0.2 m deep and 2 m wide either side of the OEC routes, due to the passage of the trenching tool along the OEC, were predicted in the Cable Plan (Moray East, 2019). Recovery of the seabed was expected to occur once the trenching tool had passed and over the following months as a result of gradual infilling with mobile sediments.

2 Methodology

Construction and operational benthic impacts of Moray East were assessed using data collected during scheduled post-construction scour surveys, local sediment inspection surveys and cable burial assessments (Moray Offshore Windfarm (East) Limited, 2023b).

The surveys consisted of high resolution geophysical multibeam bathymetry echo sounder (MBES) and side scan sonar (SSS) surveys for the JUV footprints and along inter-array cables, as well as ROV seabed surveillance footage, for inspection of seabed scour and grouted sections of turbine foundations. All geophysical data and ROV seabed video footage were provided by Ocean Winds. A summary of the methods used to undertake these inspection surveys is provided in the Operations and Maintenance Survey Report April 2023 (Moray Offshore Windfarm (East) Limited, 2023b).

The following summarises the data used and the methods of data analysis for the purposes of benthic assessment.

2.1 Geophysical data

For the JUV footprint surveys, MBES data were collected from within 270 m x 270 m square boxes centred on the turbine foundations. This ‘survey box’ around each foundation also covered nearby buried sections of inter-array cable. In addition to this, post-construction MBES data of inter-array cable routes immediately after the trenching of inter-array cables (‘as built’) was provided. The inter-array cables are thus represented by two sets of post-construction data in this study.

Post construction data were compared with similar data collected prior to construction in 2018.

Post-construction SSS were visually inspected to detect any significant variations in sediment texture and reflectivity that might suggest modified benthic habitats potentially attributable to offshore wind farm activities.

The data was supplied as bathymetric xyz files and side scan sonar mosaic geotiff files. The first part of the process was to convert the bathymetry data into ESRI raster datasets, which were loaded into an ArcMap project, along with the side scan sonar data and available cultural data.

At each of the chosen site survey areas (see Section 2.3 below) the bathymetry (MBES) data from 2018 was subtracted from the site survey data from 2023, to create a difference map of seabed elevation over that five-year period.

Significant changes in seabed elevation were noted associated with both jack-up emplacement and cable installation. Therefore, at each of the chosen site survey areas three arbitrary transect lines were drawn: one through a series of representative spud-can footprint depressions, and one across each of the array cable trenches observed extending from each turbine location. Elevation data for all bathymetry datasets were then extracted at 0.5 m intervals along each of the digitised transects. The extracted data were exported to a MS Excel spreadsheet to graph seabed profiles for each of the available datasets along each transect.

Once the seabed transect profiles had been created, they were assessed for any obvious vertical discrepancies between the different years' datasets, that could not be accounted for by natural or anthropogenic processes. These vertical mis-ties were assessed to be the result of the various bathymetric datasets having been reduced to different datums, or possibly different tidal corrections having been applied to them. In order to produce comparison profiles that showed the actual change in seabed shape along each transect, the 2018 pre-survey data was used as a baseline, and the 2021 and 2023 data were manually shifted vertically to match that dataset (Figure 4). To do this, an area of flat seabed was identified in the vicinity of each transect and an average vertical difference calculated, before being applied to the relevant dataset.

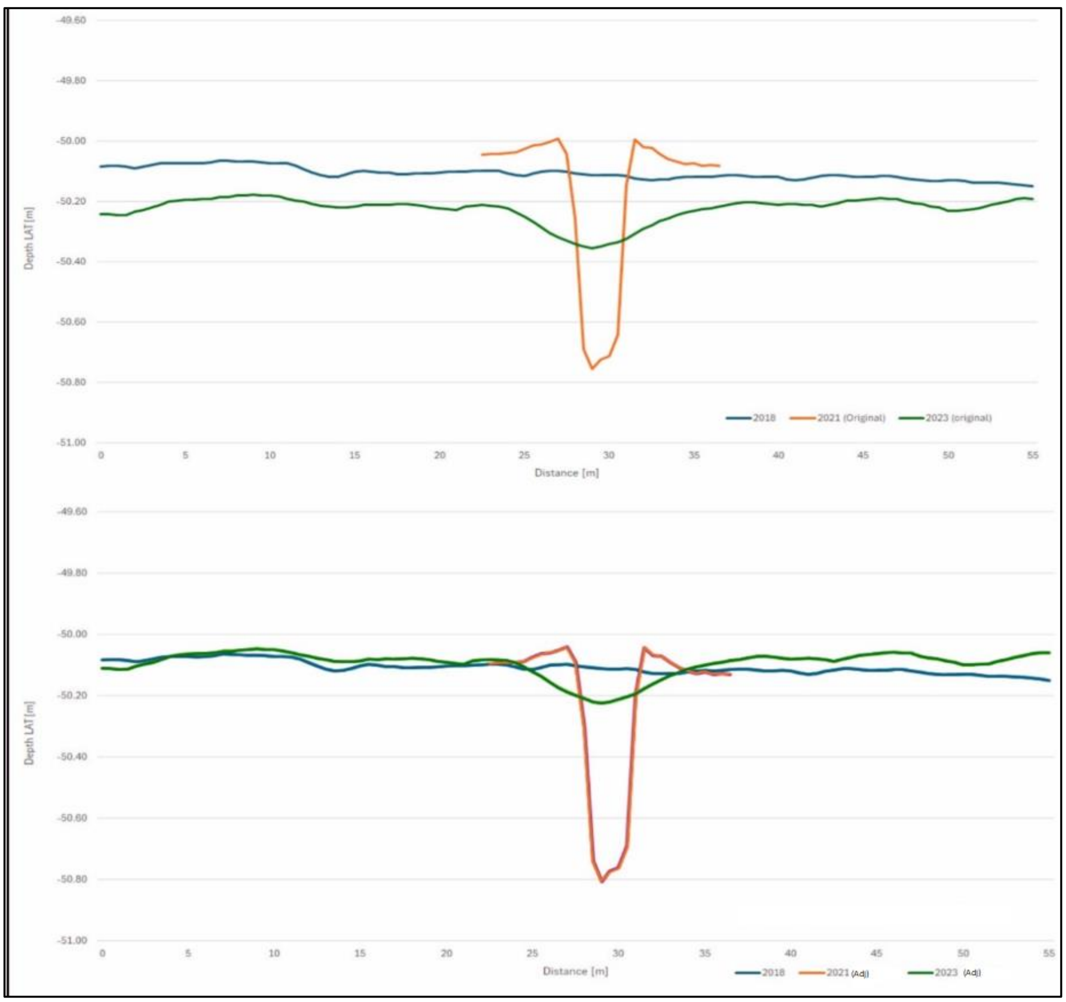


Figure 4. Vertical realignment of bathymetry datasets to better represent 'true' changes in topography.

Geophysical data for the 'as built' OEC corridor was also provided. Data for the OECs were collected within a corridor width of between 30 and 40 m centred on the as-laid cable positions.

2.2 ROV Data

Combined ROV visual and side scan sonar surveys have been undertaken throughout 2022 (Moray Offshore Windfarm (East) Limited, 2023b) for the purposes of assessing the presence of seabed scour at the base of the foundations, assessing local seabed condition and to inspect grouted connections.

The scour surveys and local seabed surveys provided good coverage of the seabed habitat around each of the three leg piles of each of the selected foundations, including areas directly below the jacket (within the jacket footprint) which would otherwise be inaccessible to grab and drop-down video benthic sampling techniques.

For each of the three pile legs at each selected foundation, around 15 – 30 minutes of seabed video footage was available for assessment (around 45 – 90 minutes of footage per turbine foundation). All ROV video footage of the seabed for each selected foundation was reviewed. The seabed sediment type was described together with any evidence of seabed scour and/or grout overspill. Sediment/rock spoil deposits were described where present.

Conspicuous epifauna were recorded and semi-quantified using the Joint Nature Conservation Committee (JNCC) SACFOR abundance scale as per the pre-application benthic survey (Moray Offshore Renewables Ltd, 2014) to allow for species comparison between pre- and post-construction occasions.

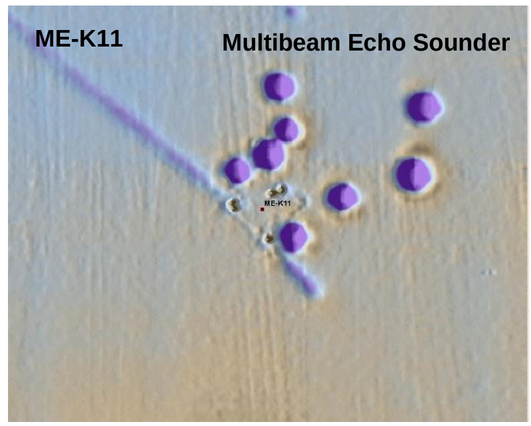
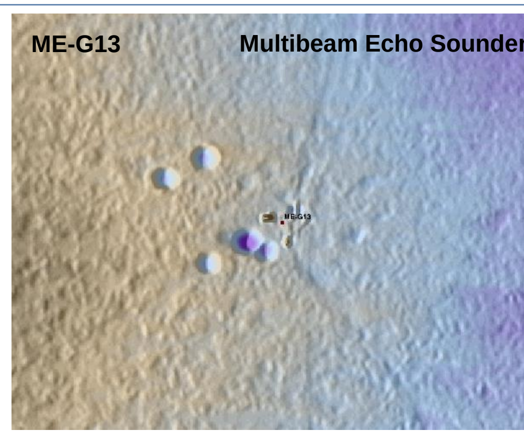
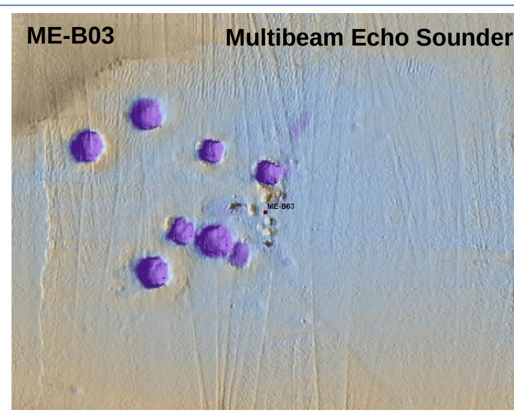
2.3 Data selection

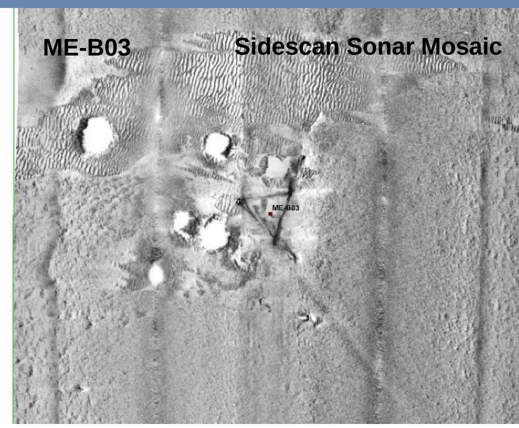
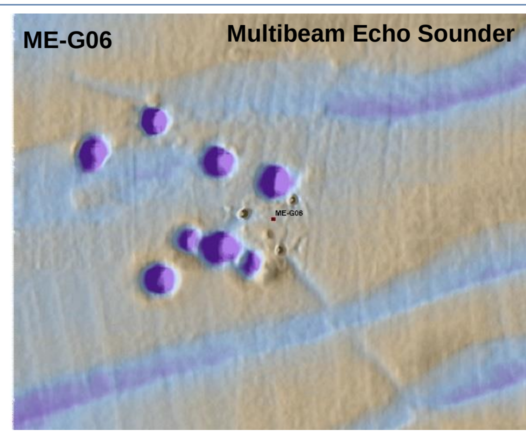
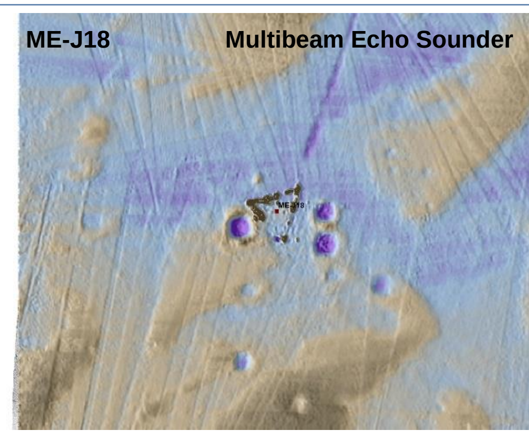
2.3.1 Moray East

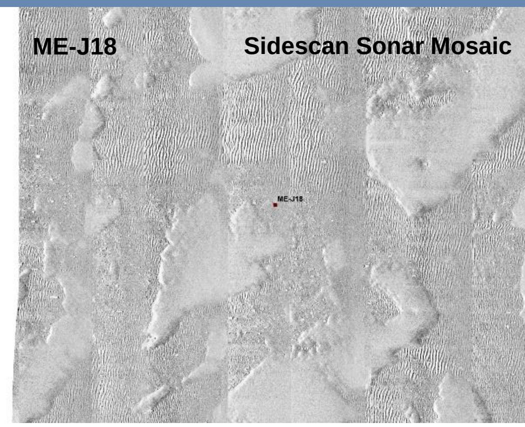
Post-construction geophysical data were provided for 25 of the 100 turbine locations covering the site of the foundations, together with adjacent seabed areas corresponding to buried sections of nearby inter-array cables within a 270 m x 270 m survey box as described above.

Of these locations, 13 were selected for the current benthic monitoring assessment. Foundation selection was based on the availability of good quality pre- and post-construction data and representativeness of the diversity of the main seabed conditions and sediment biotopes present. Table 4 summarises the different seabed conditions and biotope classifications present at the selected foundation locations. Figure 5 shows the locations of the 13 selected foundations overlaid on to the distribution of sediment biotopes. ROV inspection data were provided for 10 of the selected turbine locations and reviewed as described above.

Table 4. Seabed interpretation from geophysical monitoring data illustrating the different seabed types covered.

Seabed interpretation and biotope classification	Turbine location represented	Example Seabed Image
Flat seabed, no or minimal signs of bedforms or varied sediment texture. SS.SCS.CCS.MedLumVen SS.SSa.OSa.OfusAfil or SS.SSa.IMuSa.FfabMag SS.SSa.CFiSa.EpusOborApri	ME-D09 ME-H05 ME-H06 ME-J08 ME-K11 ME-L13	
Flat seabed, no or minimal signs of bedforms; seabed texture does indicate a significantly harder/coarser substrate when compared to Seabed Type A SS.SSa.CFiSa.EpusOborApri	ME-G13	
Essentially flat seabed, with coarse, rippled patches. SS.SSa.CFiSa.EpusOborApri	ME-B03	

Seabed interpretation and biotope classification	Turbine location represented	Example Seabed Image
		
Seabed dominated by sandwaves. SS.SSa.CFiSa.EpusOborApri	ME-G06	
Low flat hummocks interspaced with coarse, rippled patches/ribbons SS.SCS.CCS SS.SCS.CFSa.EpusOborApri SS.SCS.CCS.MedLumVen	ME-D16 ME-G22 ME-H08 ME-J18	

Seabed interpretation and biotope classification	Turbine location represented	Example Seabed Image
		

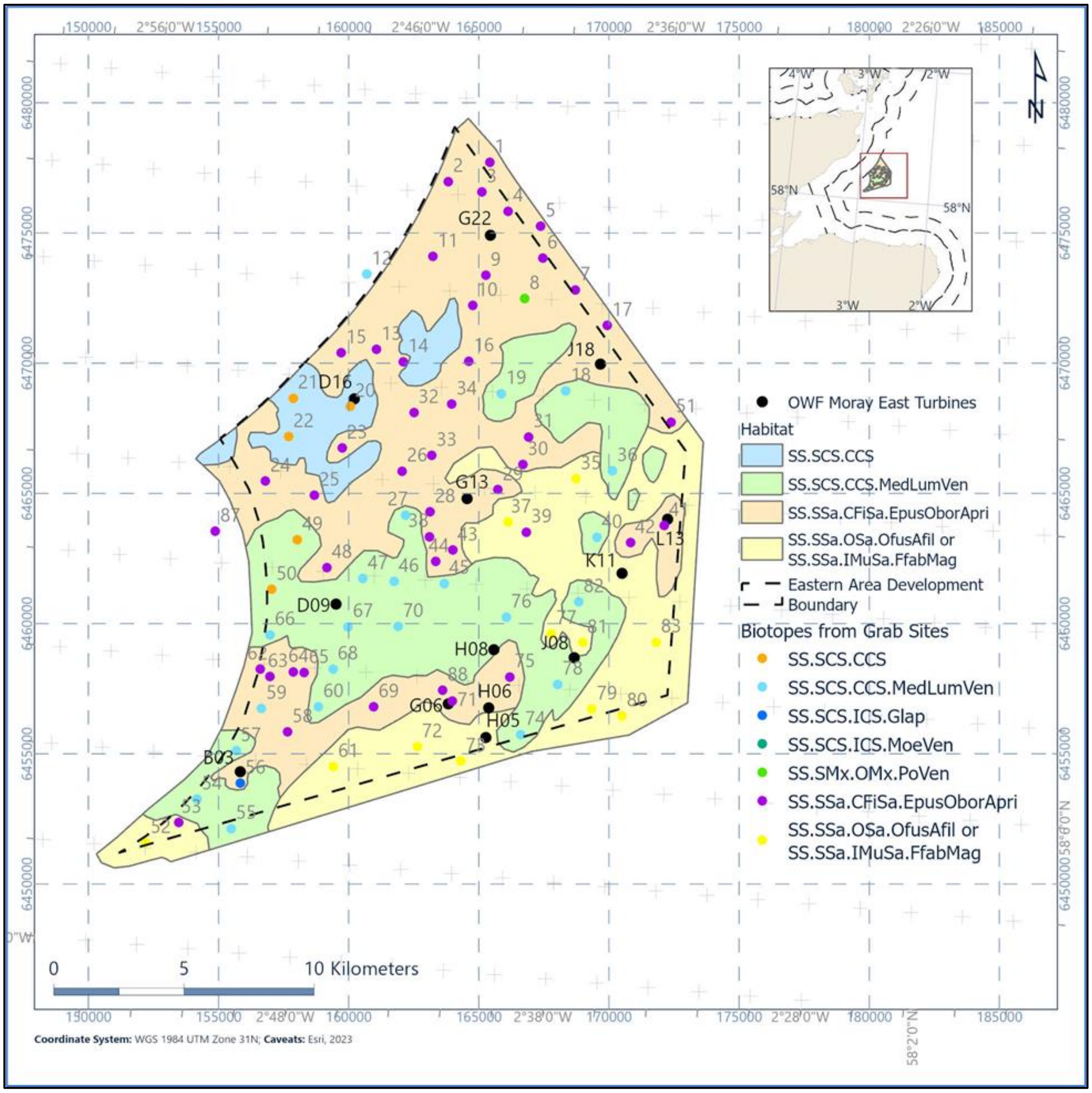


Figure 5. Locations of the selected turbine foundations overlaid on classified biotopes

2.3.2 OEC

At present, only the ‘as built’ geophysical data for the OECs are available. These data represent the condition of the seabed shortly after the installation of the three cables including the placement of rock protection material where necessary.

For this review, four sections (transects) across the OECs were selected as indicated in Figure 6 below. These transects were intended to represent the positions of the different biotopes found along the OEC corridor during the baseline (pre-application) survey. Post-construction ROV data for the OEC routes were not available.

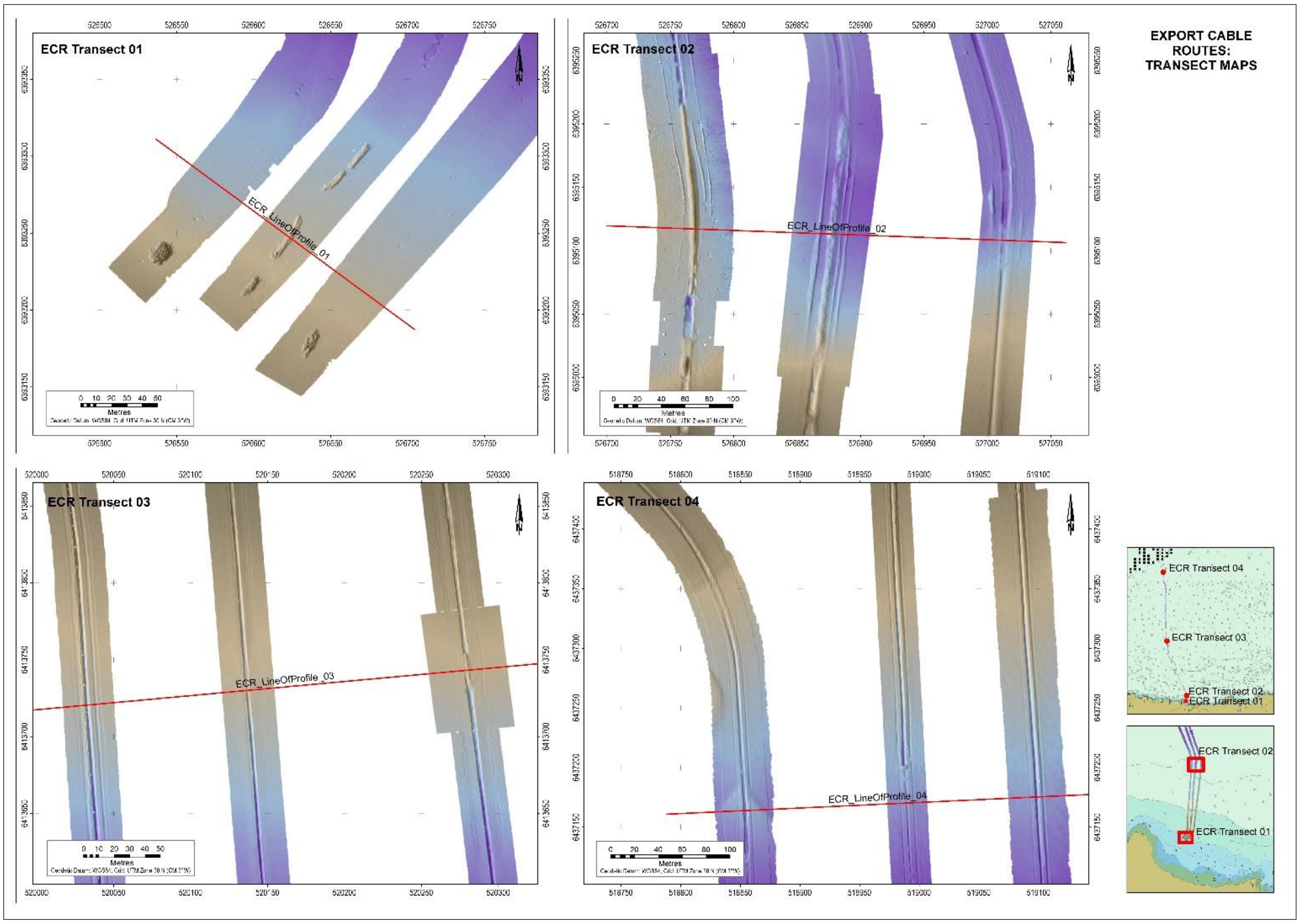


Figure 6. Selected locations along the OEC route reviewed for post-construction seabed effects

2.4 Construction and post-construction survey schedule

2.4.1 Turbine foundations

This section summarises the timings of the different construction installation activities and post-construction inspection surveys relating to the turbine foundations. Installation activities included (i) initial piling, (ii) installation of the jacket structures and (iii) installation of the towers and nacelles. Once installation was completed, MBES and ROV video surveys of the structures and the local seabed were undertaken. Table 5 presents a summary of the construction installation schedule, together with the timings of the post-construction geophysical and ROV surveys for each foundation location, considered in this monitoring assessment.

Heavy lift JUVs were used for the separate piling and installation of the jackets and nacelle & towers. These included the vessels Apollo (piling), Scylla (jacket installation) and Bold Tern or Blue Tern (tower and nacelles installation). On arrival at site, each JUV was positioned over or close to each of the foundation locations at pre-determined locations, depending on the specific installation activity, before lowering their respective spud legs to the seafloor.

Table 5. Summary of construction events at the selected foundation locations

Asset	Installation date			MBES (pre-construction)	Post-construction survey date	
	Piling (Apollo)	Jacket (Scylla)	Tower & Nacelle (Blue/Bold Tern)		MBES	ROV Scour Monitoring
BO3	20/11/2019	19/12/2020	20/08/2021	2018	28/11/2022	20/09/2022
D09	07/12/2019	26/11/2020	12/09/2021	2018	30/09/2023	24/09/2022
D16	11/07/2019	22/08/2020	02/03/2021	2018	08/06/2023	04/05/2022
G06	11/01/2020	09/12/2020	22/07/2024	2018	30/09/2023	-
G13	05/07/2019	10/10/2020	01/05/2021	2018	03/03/2023	11/08/2022
G22*	17/07/2019	18/08/2020	20/03/2021	2018	28/11/2023	05/08/2022
H05	30/11/2019	26/10/2020	15/07/2021	2018	03/02/2023	15/05/2022
H06	25/12/2019	14/11/2020	14/07/2021	2018	30/09/2023	
H08	18/12/2019	17/11/2020	10/07/2021	2018	13/08/2023	21/05/2022
J08	22/08/2019	30/07/2020	11/05/2021	2018	20/05/2022	22/05/2022
J18	20/06/2019	16/07/2020	24/04/2021	2018	19/05/2022	
K11	29/07/2019	27/08/2020	04/07/2021	2018	13/09/2023	03/06/2022
L13	30/12/2019	27/10/2020	20/06/2021	2018	20/05/2022	02/10/2022

Notes
*A further visit using a JUV was undertaken at G22 to undertake a major component repair on 23/02/2023.

The vessel was then jacked-up using its spud legs to the desired height prior to the commencement of the piling or installation activity. Depending on the characteristics of the local geology, the spud legs penetrated the seabed to a depth of between a few meters to several meters below the seabed surface, as determined by prior geotechnical analysis.

The diameter of the spud legs of the construction vessels were 10.8 m (Apollo), 14.5 m (Scylla) and 13.23 m (Bold/Blue Tern). On completion of each installation event, the spud legs were withdrawn from the seabed. Where possible, the jacket and the tower and nacelle installation vessels (Scylla and Blue Tern or Bold Tern) utilised the same footprint at each turbine location to minimise the overall construction footprint on the seabed. The exceptions to this were Turbines D16, G13, G22 and J18 where all three construction vessels were positioned at different locations. Appendix I presents schematics of the positions of the JUV vessels used during construction for each selected foundation location.

With respect to the foundations selected in this monitoring assessment, piling was undertaken between June and December 2019 with jacket installation occurring around one year later between August and December 2020. The towers and nacelles were installed a few months to one year after the jackets between March and September 2021.

Geophysical survey data were collected in 2022 and 2023, three to four years after the foundation piling events and 1 to 2 years after the installation of the towers and nacelles. The ROV scour inspection surveys were undertaken approximately 1½ to 2 years after installation of the jackets.

2.4.2 Inter-array cables

Pre-lay geophysical surveys were undertaken in 2019 to assess seabed conditions prior to installation of the inter-array cables.

Installation of the inter-array cables was undertaken in 2020 and 2021. Installation was achieved via trenching and involved two or three visits per cable section to complete. This included an initial cable lay exercise, where the cable was laid onto the seabed, followed by a second or third visit some weeks later to trench the cable into the substrate and undertake any remedial works if needed.

Geophysical surveys were again undertaken immediately after trenching in 2021 to determine the ‘as built’ seabed condition. Further post-construction geophysical surveys of the inter-array cables were undertaken approximately 12 to 19 months after cable trenching to further assess seabed condition.

Table 6 presents a summary of the inter-array cable installation events for cables connecting the selection foundations as well as the dates of the post-construction geophysical monitoring surveys.

Table 6 Summary of inter-array cable installation events

Asset	IAC route	Dates of Cable Event			Date of post-construction geophysical survey
		Cable Lay	Cable Burial First trenching pass	Cable Burial Remedial trenching pass	
B03	B03-A02	31/03/2021	22/04/2021	28/04/2021	28/11/2022
	B04-B03	31/03/2021	22/04/2021	22/04/2021	
D09	D08-D09	25/03/2021	10/04/2021	25/04/2021	30/09/2023
	D09-D10	25/03/2021	11/04/2021	12/04/2021	
D16	D15-D16	11/10/2020	15/12/2020	27/04/2021	08/06/2023
	D16-D17	11/10/2020	15/12/2020	25/12/2020	
G13	G13-G11	30/10/2020	29/11/2020	02/12/2020	30/09/2023
	G15-G13	02/11/2020	01/12/2020	02/12/2020	
G22	G21-G22	15/10/2020	17/12/2020	NA	03/03/2023
H05	H06-H05	13/03/2021	28/03/2021	19/04/2021	28/11/2023
H06	H06-H05	13/03/2021	28/03/2021	19/04/2021	03/02/2023
	H07-H06	13/03/2021	28/03/2021	19/04/2021	
H08	H08-H07	15/03/2021	28/03/2021	19/04/2021	30/09/2023
	H09-H08	13/03/2021	27/03/2021	20/04/2021	
J08	J08-J07	03/11/2020	28/12/2020	31/12/2020	13/08/2023
	J09-J08	04/11/2020	29/12/2020	NA	
J18	J19-J18	28/10/2020	22/12/2020	NA	20/05/22; 28/11/22
K11	K11-K10	27/02/2021	07/03/2021	19/03/2021	19/05/2022
	OSP3-K11	27/02/2021	11/04/2021	24/04/2021	13/09/2023
L13	L12-L13	02/03/2021	04/03/2021	08/03/2021	20/05/2022

2.4.3 OECs

Three OECs were installed via trenching in 2020 and included boulder clearance operations and pre-lay grapnel runs. In certain areas, selected lengths of the trenched cable were covered with rock material to avoid the cable becoming exposed. Routing and installation of the cables was undertaken in accordance with the agreed Cable Plan and in compliance with the OfTI Marine Licence.

3 Results

3.1 Turbine foundations

Appendix II presents pre- and post-construction MBES data and bathymetry comparison (difference) plots for areas of seabed at each of the selected foundation locations and adjacent seabed areas corresponding to buried sections of nearby inter-array cables. These show and compare the different seabed profiles prior to inter-array cable installation in 2019, immediately after installation in 2021 and 12 to 19 months post-installation in 2023 as well as seabed profiles prior to, and 1 to 2 years after, the installation of the towers and nacelles.

Appendix III presents the spatial extents of interpreted physical seabed impacts from construction JUV spud legs evident in the MBES data.

Appendix IV compares seabed habitat types and conspicuous epifauna recorded during pre- and post-construction seabed video surveys.

3.1.1 Seabed impacts (depressions) from the spud legs of construction vessels

All MBES datasets at each foundation location showed evidence of physical seabed impacts from piling, jacket/tower and nacelle installation and from inter-array cable installation (trenching) (Appendix II & III).

JUV seabed impacts were visible as discrete circular depressions caused by the placement of the spud legs of the construction JUVs on the seafloor during the piling and installation events. Table 7 summarises the spatial extents of construction vessel (spud leg) impacts recorded at the selected foundation locations.

Table 7. Spatial extents of seabed depressions caused by the piling and installation vessels.

Asset	Area of impact [m^2]				
	Apollo	Bold or Blue Tern	Bold/Blue Tern/Scylla	Scylla	Total
BO3	544		887		1431
D09	625		931		1556
D16	315	49		297	661
G06	599		793		1392
G13	428	12		872	1312
G22	463	620		1118	2201
H05	960		1351		2311
H06	287		450		737
H08	321		327		648
J08	287		521		808

Asset	Area of impact [m²]				
	Apollo	Bold or Blue Tern	Bold/Blue Tern/Scylla	Scylla	Total
J18	375	83		314	772
K11	503		752		1255
L13	414		903		1317
TOTAL					16,401

Using the schematics of the positions of the JUVs (Appendix I) it was possible to determine which vessel had caused which seabed impact (depression) and at which time. The data showed that at all of selected foundation locations, impacts from the Apollo (piling) had persisted and had remained clearly visible on the seafloor despite occurring 3 to 4 years ago.

The diameters of the current seabed impacts caused by the spud legs of the Apollo (piling) vessel varied between 10.02 and 29.90 m (average 18.40 m). This is larger than the diameters of the Apollo spud legs (10.8 m) suggesting that the spatial extents of seabed piling impacts have increased (nearly doubled on average) during the intervening 3 to 4 years.

The Scylla and Bold Tern JUVs utilised the same footprint during jacket and tower and nacelle installation (Appendix I) at most turbine locations. Consequently, only one set of seabed impacts representing both construction vessels were visible in the MBES post-construction data (Appendix II). Given that both vessels had used the same footprints, the resulting impacts are taken to be approximately 1 to 2 years old in this assessment and represent Bold Tern impacts as the most recent visitor to the foundation locations.

The largest seabed impacts caused by the JUV piling and installation activities, in terms of spatial extent, were recorded at foundation H05. Here, both the piling and installation vessels resulted in the greatest post-construction impacts (total 2,311 m^2). Comparatively large construction vessel impacts also occurred foundation G22, due partly to the additional repair visit (total 2,201 m^2), and at foundation D09 (total 1,556 m^2). Smaller seabed impacts were recorded at foundations J18 (689 m^2), H08 (648 m^2) and D16 (661 m^2).

The average area of physical benthic impact (seabed depressions), due to JUV construction activities was 1,262 m^2 per foundation. Extrapolating this average value across Moray East equates to a total area of 129,946 m^2 (0.130 km^2) (assuming 100 turbines and 3 OSPs) or approximately 0.044 % of the total area of the Moray East licence.

It was noted that the diameters of the current seabed impacts caused by the spud legs of the Apollo (piling) vessel varied between 10.02 and 29.90 m (average 18.40). This average figure is larger than the diameters of the Apollo spud legs (10.8 m) suggesting that the spatial extents of seabed piling impacts have increased (nearly doubled on average) during the intervening 3 to 4 years. Similarly, the diameters of the seabed impacts caused by the Scylla and Bold/Blue Tern JUVs ranged between 10.48 m and 34.09 m (average 23.72 m). This was again larger than the diameters of the spud legs of these vessels (13.23 and 14.50 m respectively) suggesting that the spatial extents of installation impacts have also increased (nearly doubled) during the intervening 1 to 2 years. This may be related to natural scouring of the edges of the depressions due to water current movements in the area but this is not confirmed at present. Increases in the diameters of construction seabed impacts was not forecast in the Moray East ES.

Despite increases in spatial extents, the depths below seabed of all seabed construction impacts have decreased over time in line with ES predictions. Table 8 summarises the depths below seabed of the seabed depressions caused by the JUV construction activities.

Table 8. Summary of the likely physical seabed impacts from the JUVs during construction at Moray East

Asset	Depths of seabed penetration of spud legs of construction vessels [m]*			Depth of selected seabed depressions during post-construction geophysical survey [m]
	Piling	Jacket installation	Tower and nacelle installation	
BO3	5.2 – 6.0	7.3 – 8.3	6.7 – 8.0	1.5 – 2.7
D09	3.0 – 3.7	2.3 – 5.1	4.0 – 5.8	1.3 – 1.9
D16	1.0 – 1.3	2.5 – 2.7	0.8 – 1.3	0.13 - 0.45
G06	5.1 – 6.7	6.9 – 8.8	7.1 – 8.1	1.2 – 2.2
G13	1.1 – 4.9	3.8 – 5.8	0.8 – 1.3	1.0 – 1.8
G22	1.9 – 4.6	4.8 – 5.4	2.9 – 4.0	0.6 - 1.5
H05	6.8 – 9.1	9.9 – 11.2	6.4 – 9.2	2.4 – 2.7
H06	0.9 – 2.3	1.7 – 3.4	2.8 – 4.3	1.2 - 2.2
H08	1.2 – 2.4	1.5 – 2.0	2.6 – 2.9	0.4 – 0.7
J08	1.5 – 2.3	2.0 – 3.0	2.3 – 3.2	0.7 – 1.2
J18	1.2 – 1.8	1.4 - 2.9	0.5 – 1.0	0.8 – 1.6
K11	4.0 – 5.0	4.4 – 5.9	4.7 – 5.1	1.5 – 1.7
L13	3.2—4.1	5.8 – 6.2	4.1- -5.2	0.76 – 1.93
Notes *Maximum and minimum depths of leg penetration are presented.				

The greatest penetration of the seabed by the legs of construction JUVs occurred at foundation location H05 (up to 11.2 m) (during jacket installation). Since this time, the resultant seabed depressions have been substantially infilled. Taking the maximum depth of leg penetration at this location to be 11.2 m during the jacket installation on 26/10/2020, and an indicative depression depth of between 2.4 and 2.7 m recorded from the most recent geophysical monitoring on 03/02/2023 (27 months later), then this gives an average infill rate of between 0.31 m and 0.33 m per month for this location (or 3.72 m to 3.96 m per year).

Leg penetration was also comparatively deep at foundation location B03 (up to 8.3 m during jacket installation). Taking this maximum depth of leg penetration at this location during the jacket installation on 19/12/2020, and an indicative depression depth of between 1.5 and 2.7 m recorded from the most recent geophysical monitoring on 28/11/2022 (23 months later), then this gives an infill rate of between 0.24 and 0.29 m per month for this location (2.88 m to 3.48 m per year).

Leg penetrations caused by the construction JUVs at foundation location D16, on the other hand, were comparatively shallow measuring up to 2.7 m during the jacket installation and 1.3 m during the installation of the tower and nacelles. Infilling of the resultant seabed depressions appears to be largely complete with depths of the selected seabed impacts measuring between 0.13 and 0.45 m during the recent post-construction geophysical survey. Taking the maximum depth of leg penetration to be 2.7 m during the jacket installation on 22/08/2020, and an indicative depression depth of between 0.13 and 0.45 m from the most recent geophysical monitoring on 08/06/2023 (33 months later) then this gives an infill rate for this location of between 0.07 and 0.08 m per month (0.84 m to 0.96 m per year).

3.1.2 Sediment berms

Sediment berms or partial berms were present around the edge of some of the seabed depressions. These consisted of localised areas of sediment that had been raised above the ambient seabed level due to the penetration of the spud legs into seabed and resultant sediment displacement at the seabed surface. Sediment berms are evident in Appendix II as red-shaded circles or partial circles around some of the seabed depressions on the bathymetric comparison plots, indicating a decrease (shallowing) of the seabed compared to pre-construction conditions. Berms are also evident as peaks (topographic highs) in some of the JUV footprint profile plots (Appendix II).

Table 9 presents maximum heights of sediment berms recorded around seabed depressions at the selected foundation locations.

Table 9. Maximum heights of sediment berms recorded at the selected turbine foundation locations.

Asset	Depression	Maximum height of sediment berms [m]
BO3	Depression 1	0.02
	Depression 2	0.17
D09	Depression 1	0.29
	Depression 2	0.73

Asset	Depression	Maximum height of sediment berms [m]
D16	No describable sediment berms	
G06	Depression 1	0.36
	Depression 2	0.20
G13	No describable sediment berms	
G22	No describable sediment berms	
H05	No describable sediment berms	
H06	Depression 1	0.01
	Depression 2	0.14
H08	Depression 1	0.01
	Depression 2	0.18
J08	Depression 1	0.23
	Depression 2	0.19
J18	Depression 1	0.34
	Depression 2	0.40
K11	Depression 1	0.18
L13	Depression 1	0.26
	Depression 2	0.21

The highest sediment berm was recorded at foundation D09 where one of the seabed depressions exhibited a berm of 0.73 m in height. Otherwise, the sediment berms measured between one and a few tens of centimetres high above the level of the pre-construction seabed.

3.1.3 Seabed scour and sediment alteration

Effects of seabed scour and localised sediment alteration were recorded during the seabed ROV video monitoring (inspection) surveys at the base of the foundation piles that had been installed in sandy seabed areas (e.g. foundations B13, G13, G22, H05, J08, K11 and L13). Appendix IV presents sediment and benthic species descriptions at the selected foundation locations.

Evidence of scour / sediment modification at these locations appeared in the video as shallow pits and/or as accumulations of coarse sediment material, including quantities of dead shells, at the base of the foundation piles. The depth of the scour pits was difficult to determine from the ROV video but appeared to be no more than a few tens of centimetres. Nevertheless, there was a clear difference in substrate composition between scour affects areas and adjacent, non-affected areas. The floor of the scour pits comprised coarse, stony and or shelly substrates and was visibly different from the more homogenous ambient sandy sediment present over adjacent seabed areas (Appendix IV). In most cases, the pits encircled the foundation. The scour pits were highly localised extending no more than 1 – 2 meters from the edge of the foundation legs although measurements on site were not taken.

In contrast, foundations installed in coarser, more mixed sediment areas, such as foundations D09, D16 and H08, did not appear to be associated with any localised scouring or modification due to accumulations of dead shells. Instead, the composition of the sediment immediately below the foundation legs was comparable to the ambient substrates in coarse, mixed seabed areas.

Overlaying the locations of all of the Moray East foundations onto a map of the benthic biotopes (Figure 7), shows that up to 59 foundations have been installed in predominately sandy sediments (denoted by the SS.SSa.CFiSa.EpusOborApri, SS.SSa.OSa.OfusAfil or SS.SSa.IMuSa.FfabMag classifications). Assuming that all 59 foundations would be susceptible to seabed scour and effects and sediment alteration and that such effects are limited to predominately sandy sediments, then the total area of effect in this regard can be calculated as between 805.88 and 1,889.65 m^2 based on the widths of the pits and shell accumulations varying between 1 and 2 m around each of the three foundations piles at each turbine and OSP. This equates to between 0.0027 and 0.0064 % of the area of Moray East that is potentially susceptible, and may be experiencing, post-construction seabed scour effects and local sediment alteration.

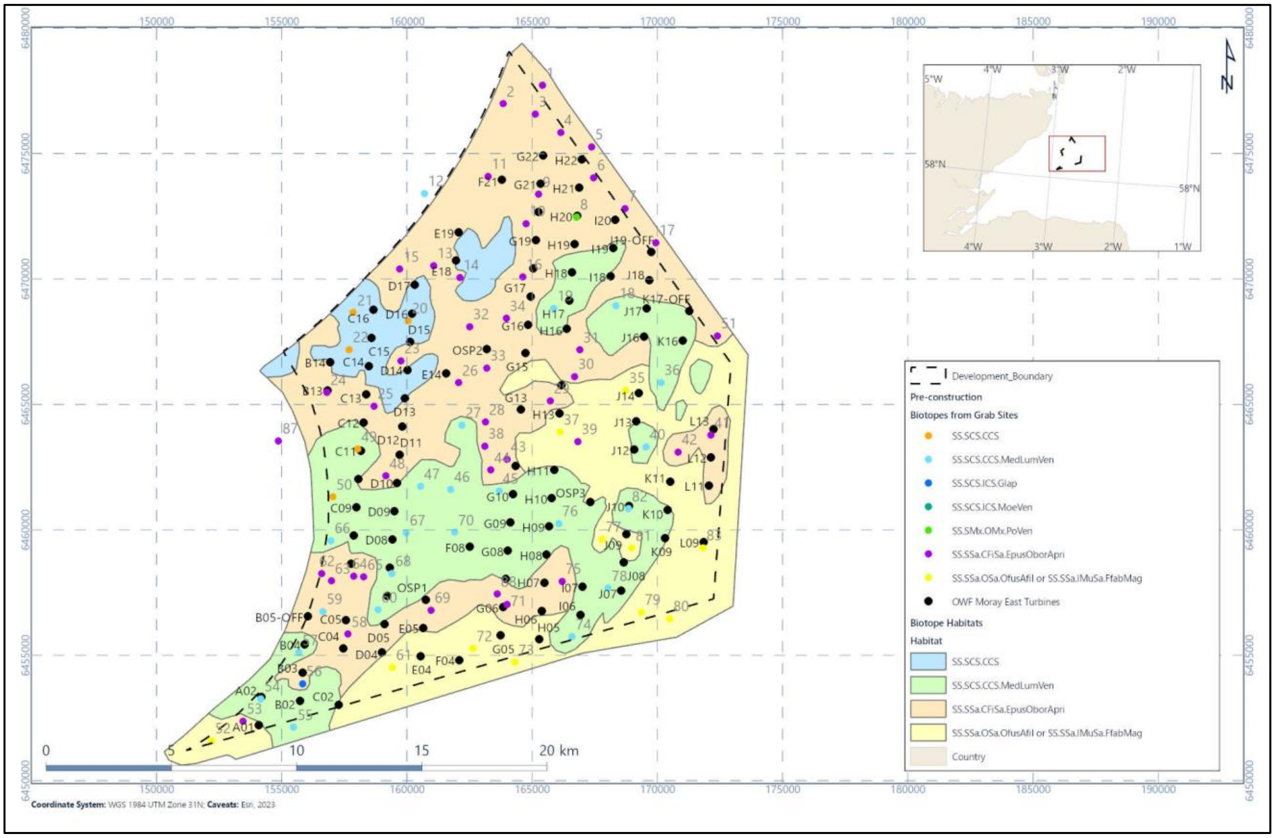


Figure 7. Moray East foundations overlaid onto the pre-application biotopes

The variety of benthic epifauna post-construction was lower than that recorded during the pre-application benthic survey although this may partially be attributed to differences in pre- and post-construction sampling locations and small differences in survey methodology. Characteristic species recorded during the post-construction monitoring included the sea urchin, sea stars *A. rubens* and *L. ciliaris*, hermit crabs, edible crab squat lobster, calcareous (Serpulid) tube worms, hydroids and flatfish, and were comparable to the pre-application survey occasion. The soft coral, *A.digitatum,* was recorded on coarse rock and cobble substrates on occasion. Squid eggs were recorded attached to some of the foundations visited in May (foundations G22 and J08). Fish were frequently observed schooling around the foundations.

The coarse sediment and shell material on the floors of the scour pits appeared to be generally clean with no attaching epifauna present. Mobile epifauna were limited within scour affected areas and included occasional flatfish, hermit crab, urchin and sea stars.

Species not recorded during the post-construction monitoring, but present during the baseline surveys, included the tube dwelling polychaete worms, *Chaetopteros variegatus* and *Lanice conchilega*, sea pens, *P. phosphorea* and *V. mirabilis*, the crab *Liocarcinus* sp., scallops *P.maximus* and *A. opercularis* and some benthic fish including sculpin, Cottidae, and gurnards, Triglidae.

Other than the localised accumulations of dead shell in some instances, no evidence of significant build-up of biomass or discolouration of surface sediments due to organic enrichment was recorded at any of the turbine foundation reviewed here.

3.1.4 Seabed deposits

Seabed (soil plug) deposits were observed on the seafloor close to some of the turbine foundations (Appendix IV). These relate to the removal and disposal of soil plugs that formed inside of the pile during pile driving installation. The deposits were approximately 1 m in height above the seabed and approximately 5 m in diameter (covering roughly 20 m^2 of seabed each) and consisted of rock and cobble, covered by a thin layer of fine sand.

The deposits appeared to be generally afaunal other than the occasional edible crab, sea star and squat lobster. Sessile epifauna, such as calcareous tube worms, hydroids and bryozoans present on surrounding hard substrata, were sparse or absent from the rock piles.

In total, soil plug deposits were observed at four of the turbine foundations (B03, H08, J08, and L13) assessed here.

3.2 Inter-array cables

Bathymetric comparison plots (Appendix II) showed distinct linear seabed scars relating to trenched inter-array cables close to the majority of the selected foundation locations reviewed here. The depths of these seabed scars varied between 5 or 6 cm (foundations H08 and G13 respectively) to 38 cm (foundation J08). Given that the depth of the trenches of the inter-array cables was in general a little over 1 m, at the time of the ‘as built’ geophysical monitoring in 2021, then this suggested that the rate of infilling of the trenches was approximately 1 m per 12 to 19 months.

The ‘as built’ survey data also showed that sediment berms had been created as part of the trenching activity but that these had been largely, or completely eroded over the intervening 12 to 19 months (Appendix II). The heights of the trench berms varied between a few centimetres to around 20 cm at the time of the ‘as built’ survey but were not apparent in the recent monitoring data.

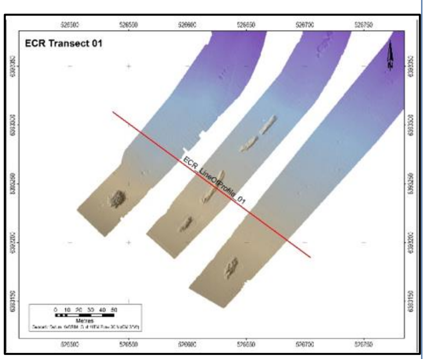
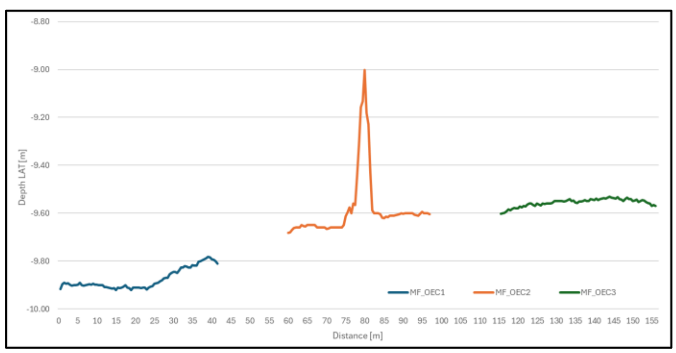
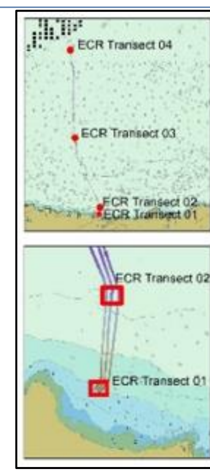
Seabed impacts from trenching the inter-array cables at foundations H05, L13 and B03 were not distinguishable, or appeared as very faint linear scars in the bathymetric data (Appendix II) indicating that they had been already eroded and substantially infilled at these locations. This suggested that complete, or near complete, restitution of the seabed had occurred following inter-array cable installation in 12 to 19 months at these locations (a faint scar remained on the seabed at foundation B03 but this was only 2 cm deep).

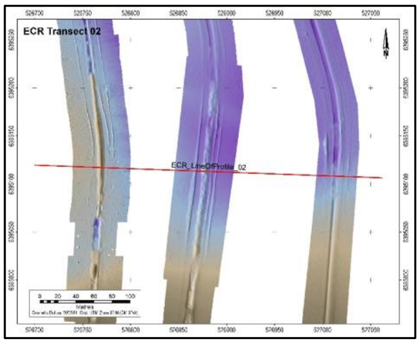
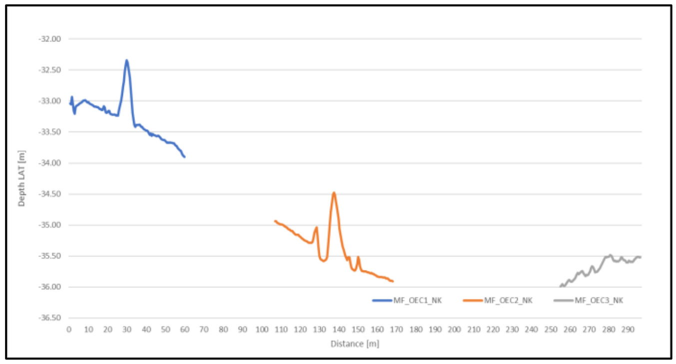
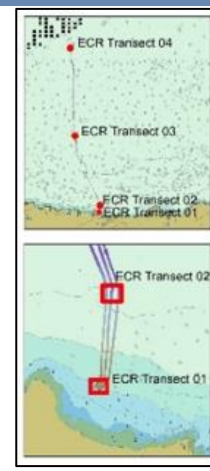
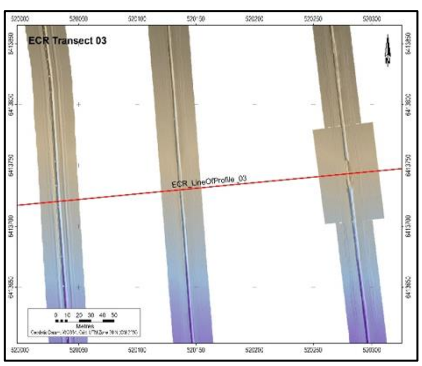
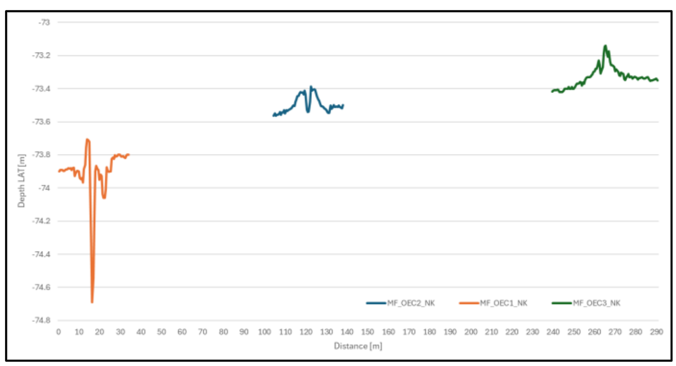
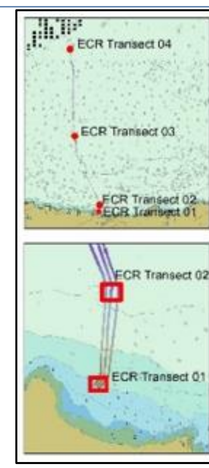
3.3 OECs

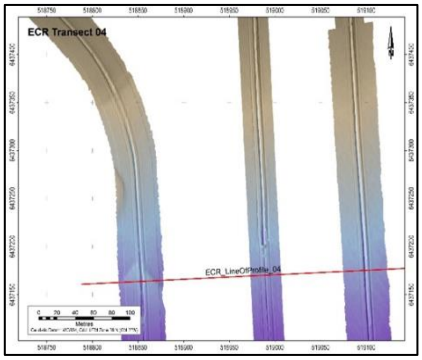
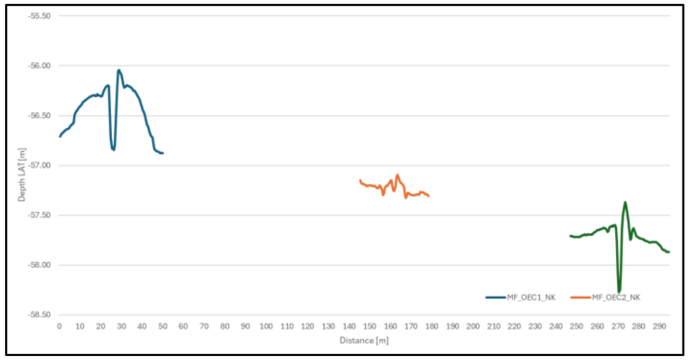
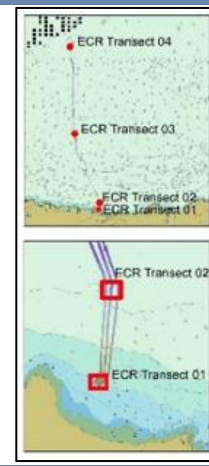
Table 10 shows vertical (height) profiles of the seabed across the OEC corridor at selected locations. Cable protection material is clearly evident on the seabed along selected lengths of the trenched cable at Transects ECR 1 and 2 located inshore. The height of the protection material appears to be approximately 0.6 to 1.0 m above the ambient seabed level. This material will have likely altered the composition of the natural sediment and associated benthic communities within its footprint, effects of which will remain for the duration of the life of the project, as assessed in the Moray East ES.

Linear seabed indentations corresponding to the trenched cable route and the tracks of the trenching tool either side of the trench are evident at Transects ECR 2, 3 and 4. In contrast, no seabed indentations or sediment berms are apparent in the MBES data at Transect ECR 1 located closest to shore suggesting that the seabed physical impacts had recovered at this location at the time of the 'as built' geophysical survey.

Table 10. Seabed Profiles for Selected Transect Locations along the Export Cable Corridor.

Cross section	Vertical (height) profile through cross section	Location along OEC
Transect ECR 1		
Transect ECR 1 takes a cross section of the three OECs as they approach the landfall at Inverboynbie. The seabed over the central OEC is sharply elevated 60 cm above seabed level likely due to the presence of cable protection material. No cable protection is evident on the other two OECs. No sediment berms or linear seabed scars are evident in the MBES suggesting that the seabed has quickly recovered from the physical impacts of OEC installation at this location.		
		
Transect ECR 2		
Transect ECR 2 takes a cross section of the OECs just offshore of the landfall site at Inverboyndie in predominately sand sediment. The seabed over the central and western OECs is sharply elevated up to 1.0 m above seabed level and is likely due to the presence of cable protection material. Seabed berms are evident either side of the OECs in the MBES data suggesting that physical impacts have yet to fully recover at this location.		

<table>
<tr><th>Cross section</th><th>Vertical (height) profile through cross section</th><th>Location along OEC</th></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><th colspan="3">Transect ECR 3</th></tr>
<tr><td colspan="3">Transect ECR 3 takes a cross section of the OECs at an offshore location in deeper water, mid-way between landfall and Moray East in predominantly muddy sand seabed habitat. Linear scars above all three OECs are evident in the MBES suggesting full seabed recovery from cable treching had not occurred at this location. The scar above the western OEC is up to 1.0 m deep. A small amount of cable protection material over the western OEC and up to 25 cm in height above seabed level is shown in the vertical profile.</td></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><th colspan="3">Transect ECR 4</th></tr>
<tr><td colspan="3">Transect ECR 4 takes a cross section of the OECs just to the south of Moray East and south of the southern flank of Smith Bank. As above, linear scars above all three OECs are evident in the MBES suggesting full seabed recovery from cable treching had not occurred at this location. The scars above the eastern and western OECs are up to approximately 1.0 m deep.</td></tr>
</table>

Cross section	Vertical (height) profile through cross section	Location along OEC
		

4 Discussion

In compliance with the monitoring commitments made in the Moray East Offshore Wind Farm PEMP, asset inspection geophysical and ROV monitoring data have been collated and reviewed to assess potential post-construction and operational impacts of Moray East on benthic ecology.

Geophysical datasets provide continuous coverage of seabed habitat variability and in conjunction with grab and video surveillance, are frequently used in the interpretation of benthic conditions (Ware & Kenny, 2011). In this monitoring assessment, asset and seabed inspection, geophysical data and ROV footage has been successfully used to detect, characterise, and where possible, quantify a series of localised benthic impacts within and around offshore turbine locations and cable routes, as previously predicted in the Moray East ES due to the construction and operation of the Moray East. Whilst medium and far-range benthic effects have not been addressed in this monitoring assessment, previous benthic monitoring at other offshore wind farms has not detected any significant construction and operational impacts at these distance ranges. The monitoring approach adopted here instead focuses on the local area close to individual turbine foundations where construction and operational effects are most likely to occur as predicted in the ES. The use of asset inspection data is considered particularly advantageous for benthic monitoring in this regard as it is collected at the point where construction impacts occur. Furthermore, this approach uses prior learning from previous monitoring and research elsewhere and maximises the value of seabed data already collected.

The most conspicuous benthic impacts visible from the inspection of geophysical datasets, included a series of circular seabed depressions and associated sediment berms near each of the turbine foundations. These had been caused by the placement of the feet of construction JUVs on seafloor and have persisted for 3 to 4 years post-construction piling and for 1 to 2 years post-installation of the jackets, towers and nacelles. Extrapolating current observations, it is estimated that physical seabed impacts caused by construction JUVs currently account for 0.044 % of the Moray East licence area.

As well as the seabed depressions from construction vessel use, shallow linear seabed scars corresponding to the routes of trenched inter-array cables remain on the seabed some 12 to 19 months post trenching.

Despite their persistence on the seafloor, the rate of erosion and infilling of such impacts is consistent with that forecasted in the ES. This predicted that it would take up to 5 years from the cessation of construction for seabed impacts to flatten and disappear, subject to the frequency of large wave events and associated seabed erosion and sediment suspension rates. Using the rates of infilling of seabed depressions estimated in this review, the restitution of benthic habitats at Moray East is expected to be achieved within the 5-year window predicted within the ES. Indeed, sediment berms created either side of the trenched sections of the inter-array cables, as shown in the ‘as built’ geophysical survey data, and some seabed scars of trenched sections of both inter-array and inshore portions of the OEC routes have already disappeared.

Sediment infaunal communities were not sampled or assessed in the current benthic monitoring but their responses to seabed disturbances and characteristics of recovery are well understood (e.g. Hill et al., 2011; Dernie et al., 2003; Cooper et al., 2007, Stephenson et al., 2019; Hutchinson et al., 2020). Since the physical environment strongly influences the structure and functioning of benthic communities, we can surmise infaunal recovery from monitoring restoration of the physical seabed habitats.

Restoration of the seabed habitats will commence on cessation of the disturbance(s) typically via infilling of depressions and scars by transient sediments and erosion of berms and spoil piles by wave action during high energy wave events. In this monitoring approach, habitat recovery is taken as having occurred when the effects of construction, such as seabed scars and depressions and rock spoil piles are no longer visible in acoustic datasets and substrate composition is comparable with reference and/or pre-construction conditions. With reference to the current geophysical inspection monitoring data, restoration of the seabed has not yet been achieved, suggesting that full recovery of infaunal communities within impacted areas is not complete.

As assessed in the Moray East ES, and in line with current understanding, animals within the footprint of seabed construction impacts will have been initially dislodged, damaged or killed whilst significant sediment deposition during construction will scour and smother species resulting in reduced species diversity, abundance and biomass in affected areas. Recovery of benthic species and communities, following seabed construction disturbances, is dependent on a number of factors including the severity of the original impact, the nature of the pre-existing communities, local hydrodynamic regime and the presence of reproducing population nearby and will occur once the sediment composition and stability of benthic habitats have been restored to pre-construction conditions. Species recovery will be via passive import and settlement of larvae from surrounding reproducing populations and active migration of adults, as described in the Moray East ES. With respect to local conditions, full recovery of the main biotopes at Moray East was predicted to take 6 months to 5 years following seabed habitat recovery and therefore may not be expected to be completed at this time.

Characterising epifaunal species recorded during the post-construction (ROV) surveys were comparable to those recorded during the pre-application benthic surveys and included calcareous tube building worms, hydroids, soft coral, hermit crabs, squat lobster, flatfish, echinoderms (urchins and sea stars) and edible crab. Some species were not, however recorded on this occasion including sea pens and certain species of crab and benthic fish. However, the presence of squid eggs attached to some of the turbine foundations was a new observation. Also, large numbers of fish, including juveniles, were frequently seen schooling close to the base of the foundations during the ROV inspections. The fish were not observed to be feeding on the biofouling attached to the foundations but may have been using the structures for protection or orientation.

One unexpected observation from the current monitoring was the apparent increase in the diameters of the seabed depressions caused by the JUVs since construction. These were, on average, nearly twice those of the spud legs of the JUV construction vessels. This was unexpected and was not fully assessed in the Moray East ES, which only considered the diameters of the spud legs with regard to impact magnitude. Consequently, the spatial extents of direct impacts of JUV construction vessels on benthic ecology at Moray East will have been under-estimated. The cause of apparent increases in the extents of impacted areas post-construction is likely to relate to scouring of the edges of the depression pit by natural water current movements. Despite increasing in diameter, the seabed depressions were shown to be infilling, as described above.

Soil plug deposits on the sea floor were encountered during the ROV inspection surveys and represented a significant, albeit localised change in sediment type and seabed topography at Moray East. These deposits have persisted on the seafloor since construction of Moray East (approximately 4 years). The composition of the deposits was different to that of the natural surrounding seabed and included larger stones and cobbles or consolidated sediment overlain with a thin veneer of fine sediment. This differed from the predominantly sand and sandy gravel benthic habitats characterising this area of Smith Bank. The surfaces of the deposits did not appear to be colonised by sessile benthic species such as hydroids, soft corals, calcareous tube worms and bryozoans, as per the natural pebbles and cobbles nearby, and instead were largely devoid of epifauna. The reason for the apparent paucity of species attaching and colonising the spoil deposits is presently unclear but may be related to the relative instability of the substrate veneer overlying the spoil piles and/or effects of sedimentation and scour. Nevertheless, the deposits did appear to provide refuge for small numbers of larger, more mobile species such as edible crab, squat lobster and sea stars as evidenced by the ROV surveys.

The dimensions and footprints of the original soil plug deposits created at the time of construction are not known and so the rates by which they are currently eroding (if at all) are unclear. Currently, it was estimated that the soil plug deposits were approximately 1 m in height above the seabed with a diameter of around 5 m. Continued monitoring of soil plug deposits would be required to determine erosion rates and how long they may persist on the seafloor at Moray East. Such information may be required to inform future assessment and management of local seabed conditions.

Benthic habitat alteration due to seabed scouring effects was recorded at the base of some of the turbine foundations. Effects were restricted to predominantly sandy biotopes, where finer grained particles had been eroded and winnowed from the seabed by modified bottom current flows, and were limited in extent to more than 1 to 2 m from the edge of the foundation legs. No scouring was observed within coarser and more mixed sandy gravel and gravel biotopes.

Whilst the effects of seabed scouring were predicted and assessed in the Moray East ES, this only considered secondary scouring around scour material as a worst case. In the end, scour protection material was not used at Moray East (other than at the OSPs and at two turbine locations) and so the spatial extent of the observed scour was considerably less than that forecasted in the ES. Based on current observations, seabed scour effects are estimated to account for approximately 0.0027 to 0.0064 % of the current area of Moray East.

Seabed scouring effects are likely to be permanent at Moray East lasting for the duration of the life of the project. The spatial extents of the observed scouring however, are unlikely to change over time as this will already have reached an equilibrium point depending on bottom current flows and particle size distribution characteristics.

Other than the soil plug deposits and limited areas of seabed scour, no gross changes in benthic habitat types were observed between pre- and post-construction occasions. The pre-construction sand, sandy gravel and coarser, more mixed substrates habitats, and associated epifauna, were well represented during the post-construction ROV inspection surveys. Significant broadscale habitat alteration was not detected. Visual inspection of SSS data did not reveal any notable variation in seabed textures and reflectivity that might otherwise indicate construction or operational effects.

No evidence of seabed organic enrichment (surface sediment discolouration) was recorded at the selected turbine locations, and no accumulation of biomass from fouling communities was observed. Future benthic ecological reviews at Moray East would benefit from ROV transits within the footprint of the foundations, inboard of the foundation legs, to confirm effects of organic enrichment and biomass accumulation over time.

Placed cable protection material is evident along nearshore sections of the OEC routes. The absence of any linear scars or indentations at nearshore areas of the OEC corridor (Transect ECR 1 in Figure 6 and Table 10) suggests that they have been eroded since the ‘as built’ geophysical survey. In contrast, seabed impacts from cable installation along offshore and deeper water sections of the OEC routes remain visible within the geophysical datasets.

5 Conclusions and Recommendations

Geophysical and ROV asset inspection data have been used to complete licence condition monitoring of benthic impacts of the construction and operation of the Moray East offshore wind farm as described in the Moray East PEMP.

Physical impacts due to construction of the Moray East remain visible on the seabed some 4 years post-construction but are judged to be recovering within the timeframe forecast in the Moray East ES. Seabed topography along some trenched sections of the inter-array cable routes and inshore sections of the OECs has already been restored. Soil plug deposits may require further monitoring to assess seabed recovery rates.

On-going operational (long-term, for the lifetime of infrastructure) impacts include seabed scouring around the base of offshore turbine foundations, but this is limited to predominately sandy sediments and only extends 1 to 2 meters from the edge of the foundation legs. Other operational impacts relate to the presence of cable protection material covering some sections of the OECs resulting in localised habitat change for the duration of the project.

The extents of the different seabed physical impacts were estimated as follows;

- Seabed depressions from JUV positioning = 0.044 % of the total area of the Moray East licence.
- Seabed scour = up to 0.0064 % of the total area of the Moray East licence.

Sea pens and some fish and crab species were not recorded during the current ROV monitoring surveys. Otherwise conspicuous epifauna were comparable to pre-construction conditions. Whilst not specifically measured during this monitoring, infaunal benthic communities are expected to recover to pre-construction conditions on restoration of the baseline seabed topography, sediment composition and stability.

In conclusion, the re-purposing of asset inspection data is a proportional but effective approach for benthic ecological monitoring in the absence of predicted significant effects. Future benthic monitoring and assessment at Moray East may consider the following recommendations:

- Further monitoring of soil plug deposits may be required to confirm erosion rates and to inform later management decisions concerning requirements for seabed restoration, for example at the end of the life of the project.
- The spatial extents of JUV impacts were nearly twice as large as those originally forecast. This is likely due to scouring of the edges of the depression pits due to natural water movements. Continued infilling of seabed depressions is expected to restore seabed topography and benthic conditions over time.
- Seabed data from within the foundation footprints (inboard of the leg piles) should be collected to monitor for biomass accumulation and the effects of sediment organic enrichment.

- The ROV should be fitted with laser points to help with scaling of seabed features.
- Subsequent bathymetric survey data should be processed with the pre-construction bathymetry in mind as a benchmark, to allow accurate comparison with previous datasets. To this end, the processing of subsequent bathymetry data should be carried out using the same vertical datum, and where possible the same method of tidal reduction to minimise vertical offsets between datasets. It would also be desirable for all bathymetric datasets to be acquired and processed to the same horizontal resolution.

6 References

Coates , D.A., Deschutter, Y., Vincx, M. & Vanaverbeke, J. (2014). Enrichment and Shifts in Macrobenthic Assemblages in Offshore Wind farm Area in the Belgian Part of the North Sea. Marine Environmental Research 95:1-12.

Cooper, K., Boyd, S., Eggleton, J., Limpenny, D., Rees, H. & Vanstaen, K. (2007). Recovery of the Seabed following Marine Aggregate Dredging on the Hastings Shingle Bank off the South Coast of England. Estuarine, Coastal and Shelf Science, 75, 547-558.

Connor, D.W., Allen, J.H., Golding, N., Howell, K.L., Lieberknecht, L.M., Northen, K.O. & Reker, J.B. (2004). The Marine Habitat Classification for Britain and Ireland, version 04.05 (internet version). Joint Nature Conservation Committee.

Dernie, K.M>, Kaiser, M.J. & Warwick, R.M. (2003). Recovery rates of benthic communities following physcial disturbance. Journal of Animal Ecology, 73, 1043-1057.

Erickson R, Kelly C, Fonseca M, McMahon A, Tiggelaar J, Graham B (CSA Ocean Sciences Inc., Stuart, FL). (2023). Benthic and Epifaunal Monitoring During Operation at the Block Island Wind Farm, Rhode Island – Technical Report - Year 4. U.S. Department of the Interior, Bureau of Ocean Energy Management.134 p + apps. Report No.: OCS Study BOEM 2022-068. Contract No.: 140M0121D0002

HDR (2020). Benthic and Epifauna Monitoring During Wind Turbine Installation And Operation at the Block Island Offshore Wind Farm, Rhode Island-Project Report. Final report to Bureau of Ocean Energy management, Office of Renewables Energy Programs, OCS Study BOEM 2020-044, Volume I, 263 pp Volume II, 380 pp.

Hill, J.M., Marzialetti, S. & Pearce, B. (2011). Recovery of Seabed Resources Following Marine Aggregate Extraction. Marine ALSF Science Monograph Series No. 2. MEPF 10/P148. (Edited by R.C. Newell & J. Measures). 44pp. ISBN: 978 0 907545 45 3.

Hutchison, Z.L., LaFrance Bartley, M., Degraer, S., English, P., Khan, A., Livermore, J., Rumes, B. & King, J. (2020). Offshore wind energy and benthic habitat changes: Lessons from Block Island Wind Farm. Oceanography 33(4): 58-69.

MMO (2014). Review Of Post-Consent Offshore Wind Farm Monitoring Data Associated With Licence Conditions. A report produced for the Marine Management Organisation, pp 194. MMO Project No: 1031. ISBN: 978-1-909452-24-4.

Moray Offshore Renewables Ltd. (2011). Environmental Statement Technical Appendix 4.2A. Benthic Ecology Characterisation Survey (Wind farm Sites).

Moray Offshore Wind Farm (East) Limited (2012). Moray East Environmental Statement. Report by Moray Offshore Wind Farm (East) Limited.

Moray Offshore Renewables Ltd. (2014). Environmental Statement Modified Transmission Infrastructure for Telford, Stevenson and MacColl Wind Farms. Technical Appendix 4.1A. Subtidal Ecology Characterisation.

Moray Offshore Windfarm (East) Limited (2019). Wind Farm Cable Plan. Moray East Offshore Wind Farm. March 2019.

Moray Offshore Wind Farm (East) Limited (2023a). Wind Farm] Project Environmental Monitoring Programme. Moray East Offshore Wind Farm. Dated June 2023.

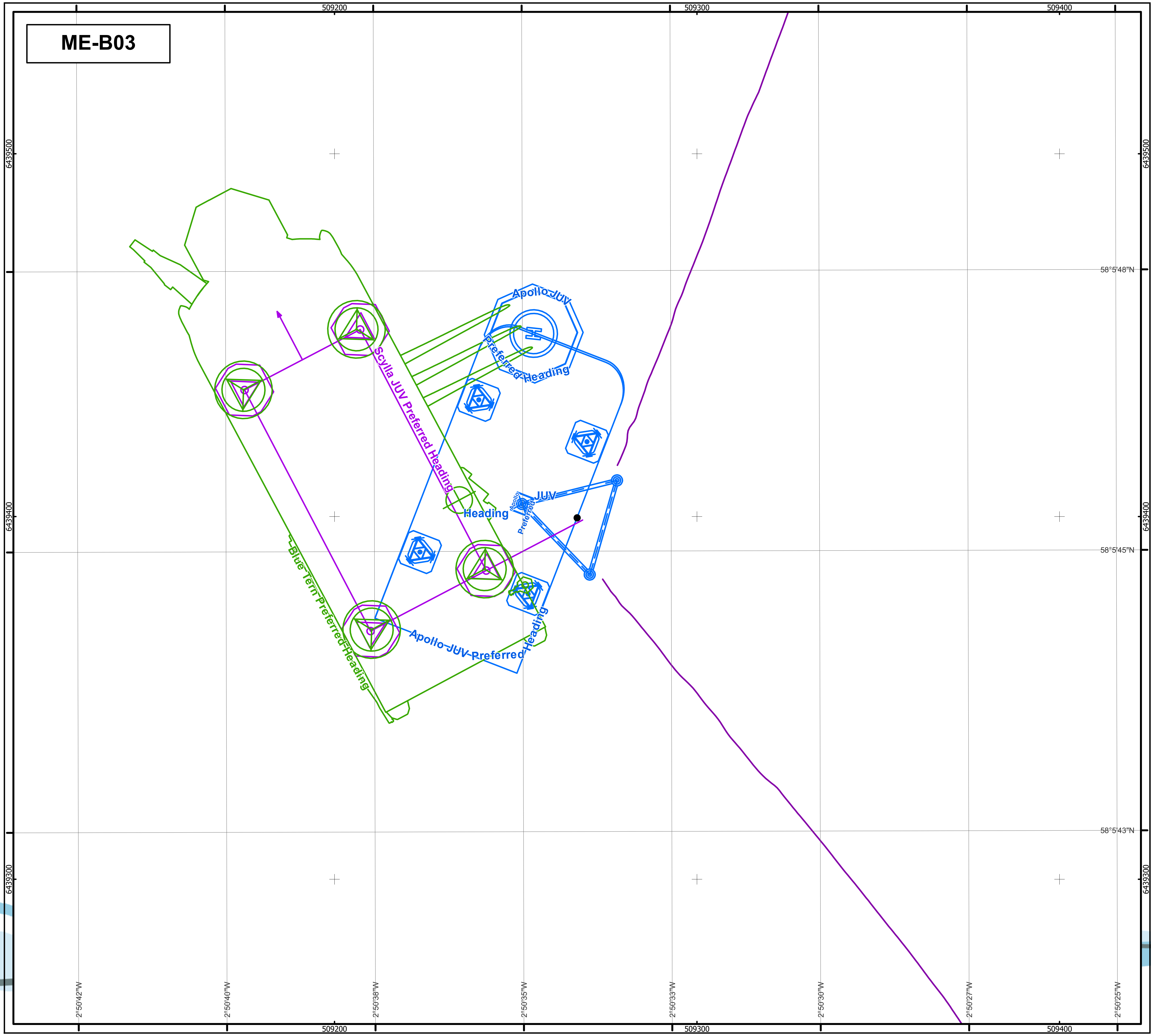
Moray Offshore Windfarm (East) Limited (2023b). Operation and Maintenance Survey Summary Report: April 2022 – December 2022. Reference 84600001=PCA0010-MWE-018. Dated 29 April 2023.

Stephenson F, Bulmer R.H., Meredyth-Young M., Meysick L., Hewitt J.E. and Lundquist C.J. (2019). Effects of Benthic Protection Extent on Recovery Dynamics of a Conceptual Seafloor Community. Front. Mar. Sci. 6:607. doi: 10.3389/fmars.2019.0060

Ware, S. & Kenny, A.J. (2011). Guidelines for the conduct of benthic studies at marine aggregate sites. (2nd Edition). Marine Aggregate Levy Sustainability Fund. 80pp.

APPENDIX I

Schematics of the Positions of the JUV Vessels Used During Construction for Each Selected Foundation Location



MORAY EAST
OFFSHORE WINDFARM

KEY

● WTG location

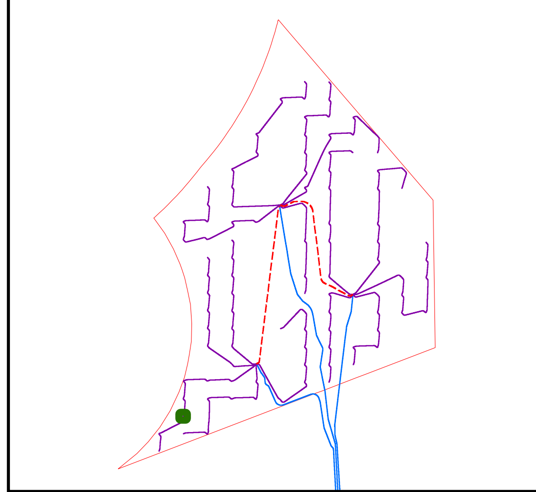
JUV As Built

Vessel

- Apollo
- Blue Tern
- Scylla

Cable As Built

- As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart

0 20 40 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

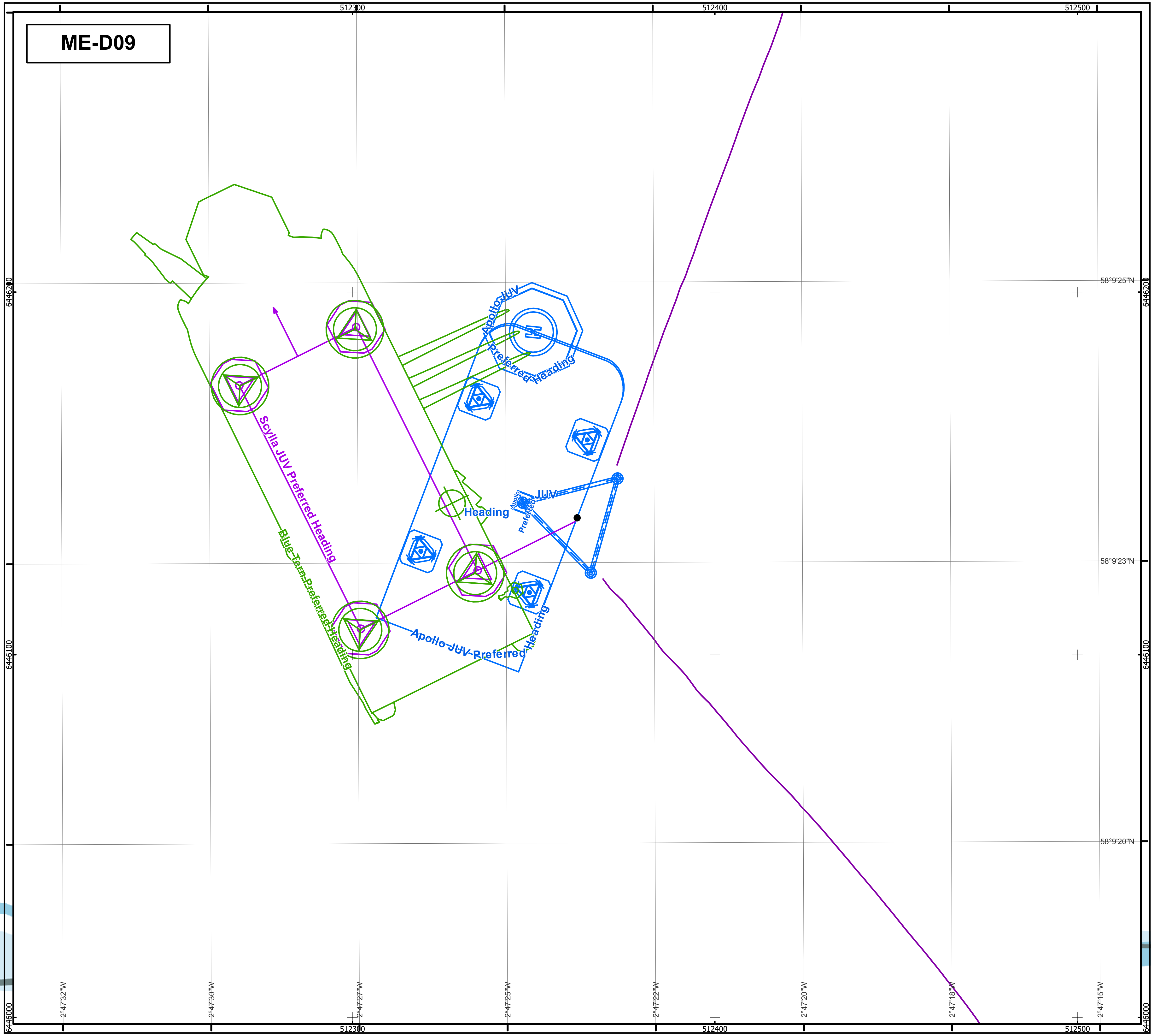
Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024 Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

● WTG location

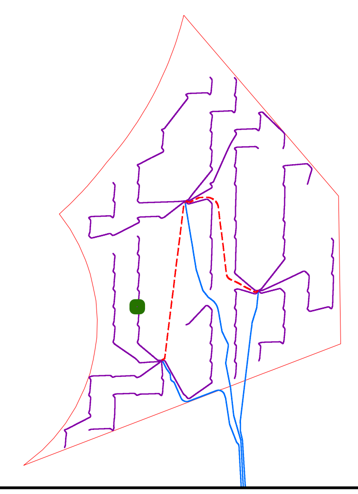
JUV As Built

Vessel

- Apollo
- Blue Tern
- Scylla

Cable As Built

- As-built inter-array cable



Horizontal Scale: 1:1,000 — A3 Chart

0 — 20 — 40 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

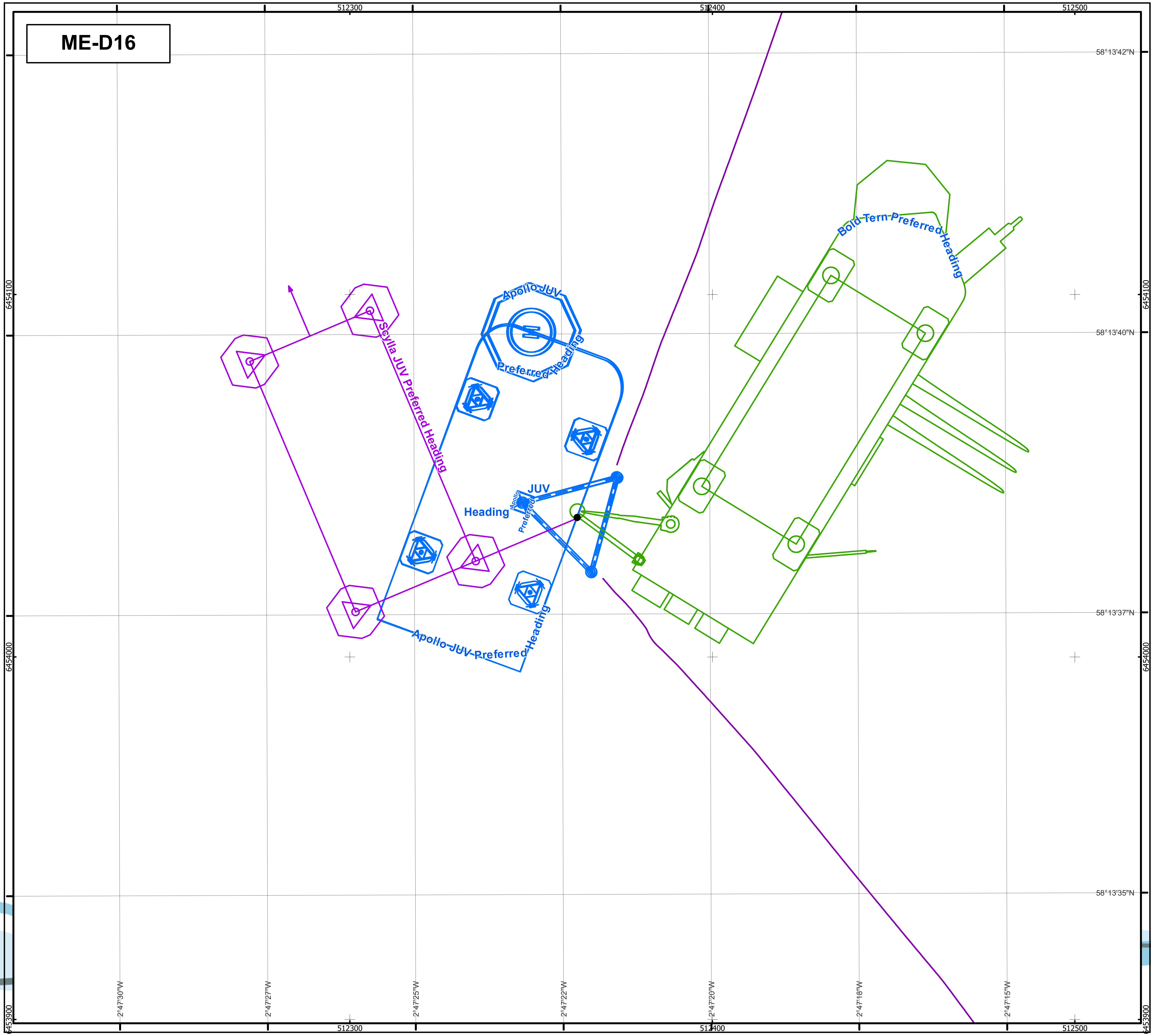
Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024 | Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

● WTG location

JUV As Built

Vessel

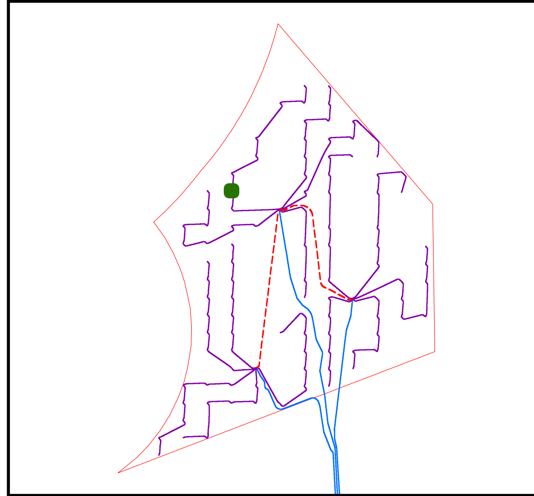
Apollo

Bold Tern

Scylla

Cable As Built

As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart

0 20 40 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

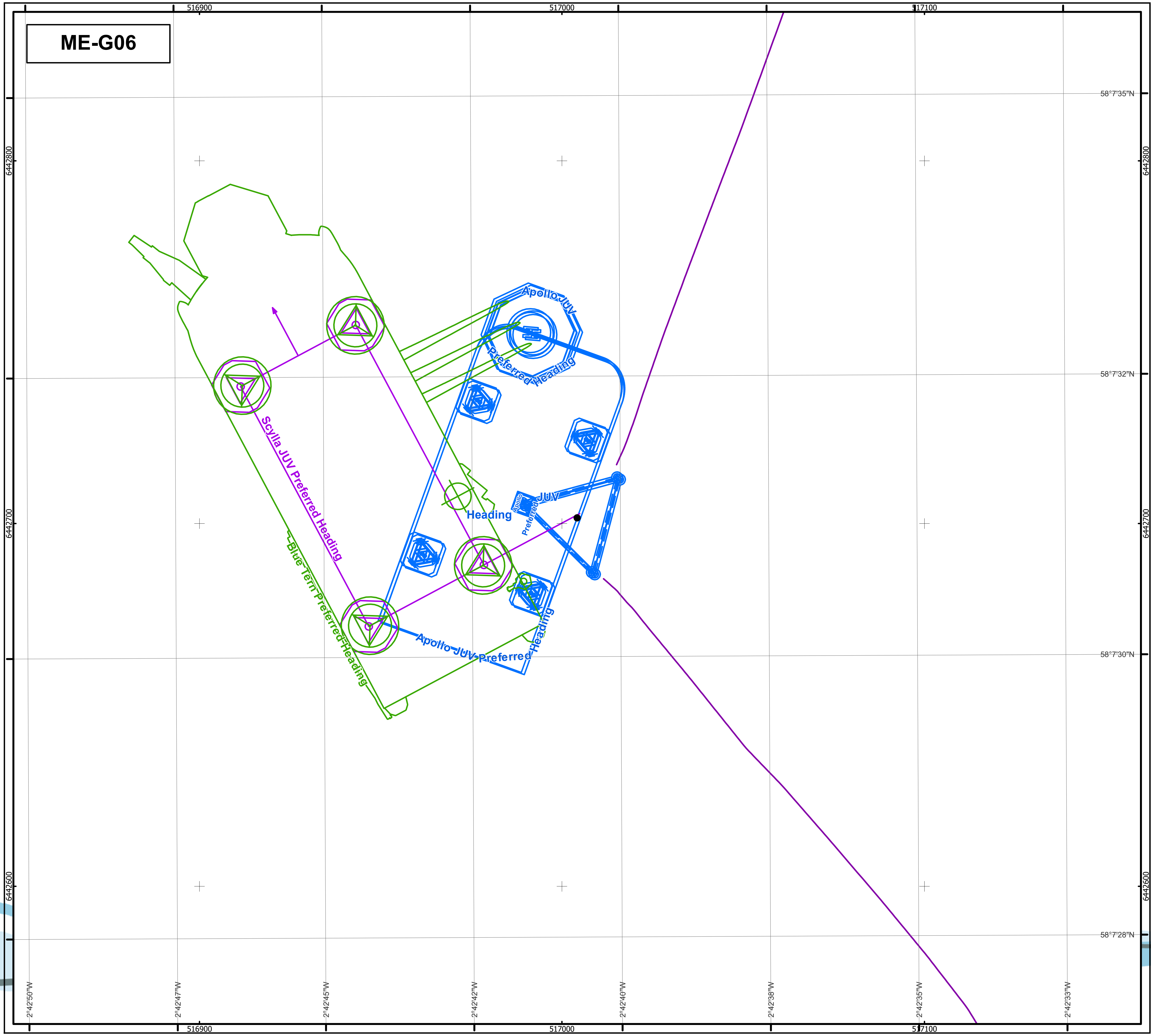
Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024 Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

● WTG location

JUV As Built

Vessel

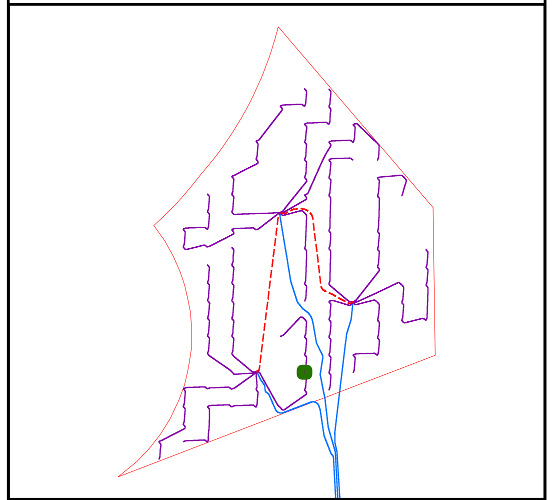
Apollo

Blue Tern

Scylla

Cable As Built

As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart

0 20 40 Meters

Geodetic Parameters: WGS84 UTM Zone 30N

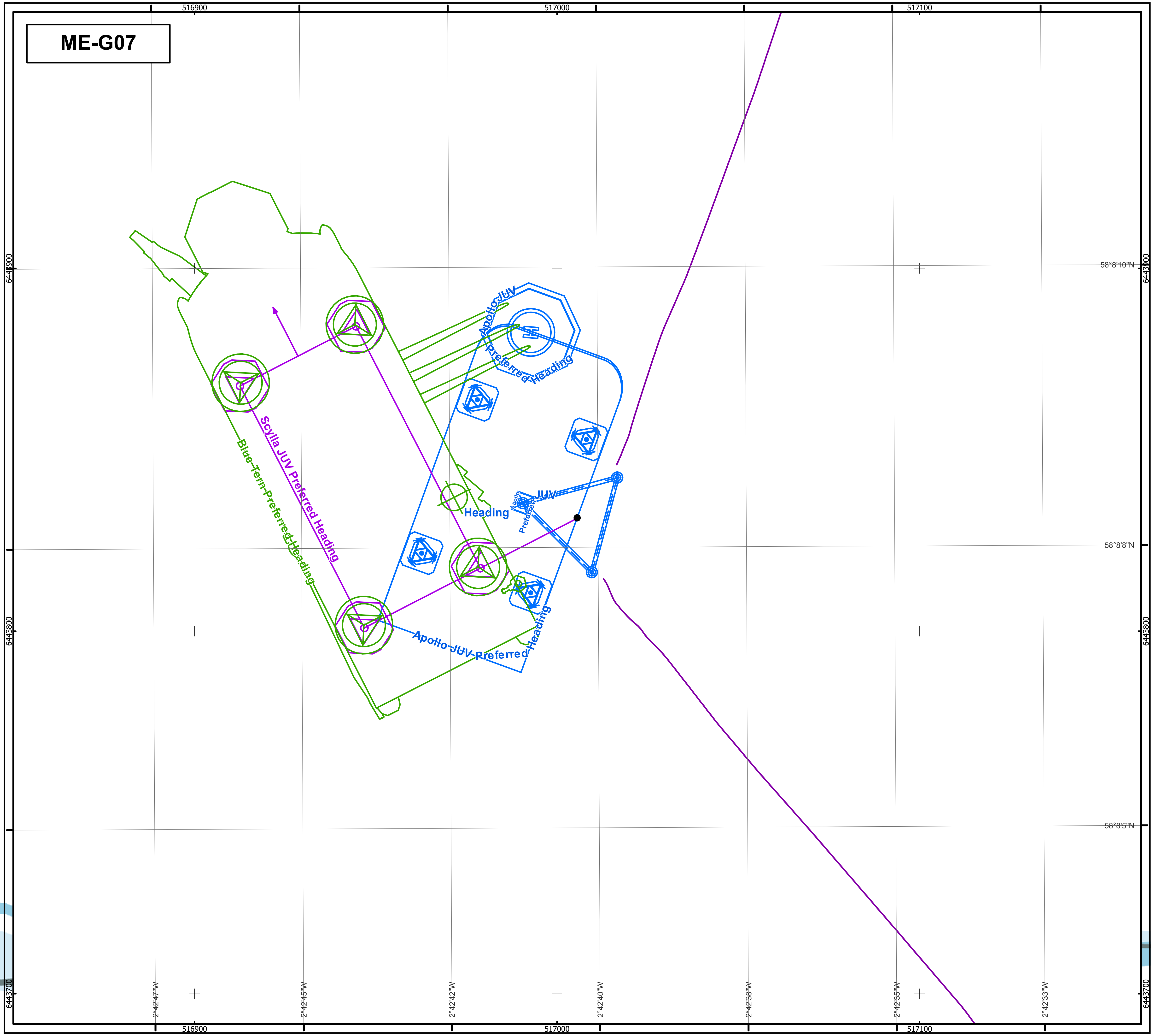
Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024 | Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

- ● WTG location

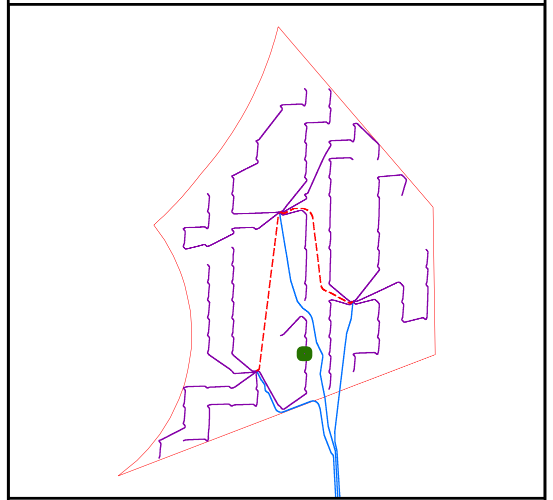
JUV As Built

Vessel

- Apollo
- Blue Tern
- Scylla

Cable As Built

- As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart

0 20 40 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

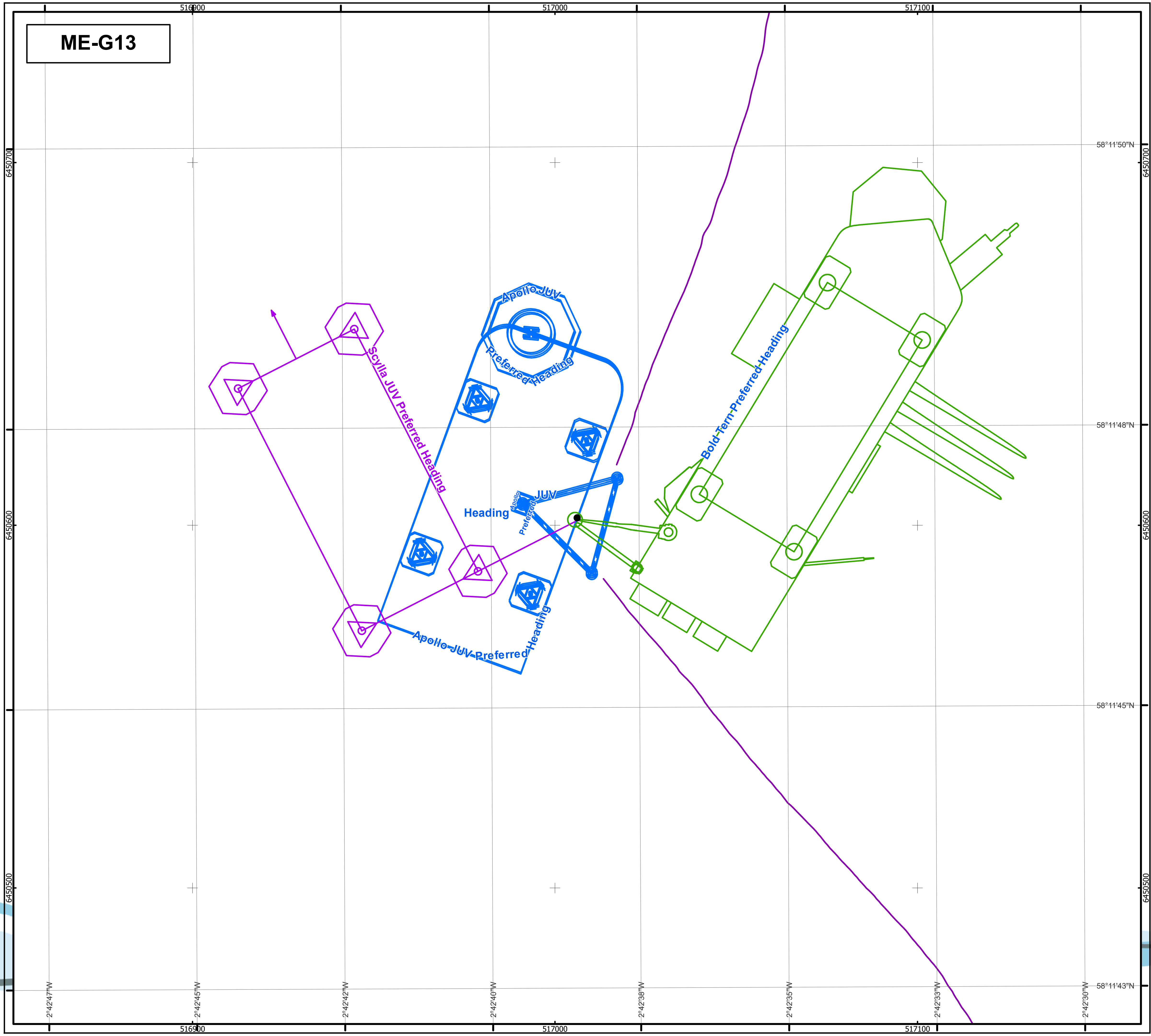
Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024 | Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

- WTG location

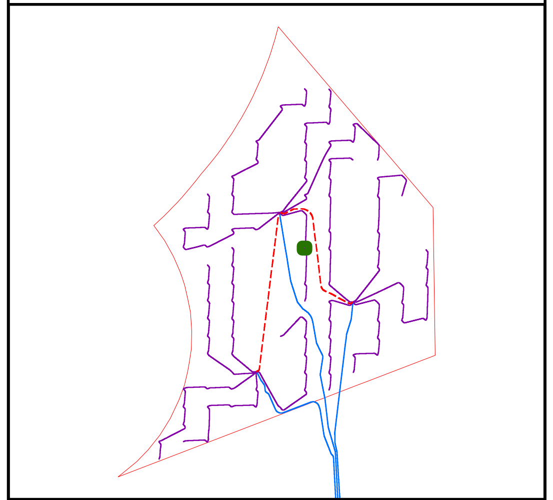
JUV As Built

Vessel

- Apollo
- Bold Tern
- Scylla

Cable As Built

- As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart

0 20 40 Meters N

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: NAL
Reviewed: NAL
Approved: NAL

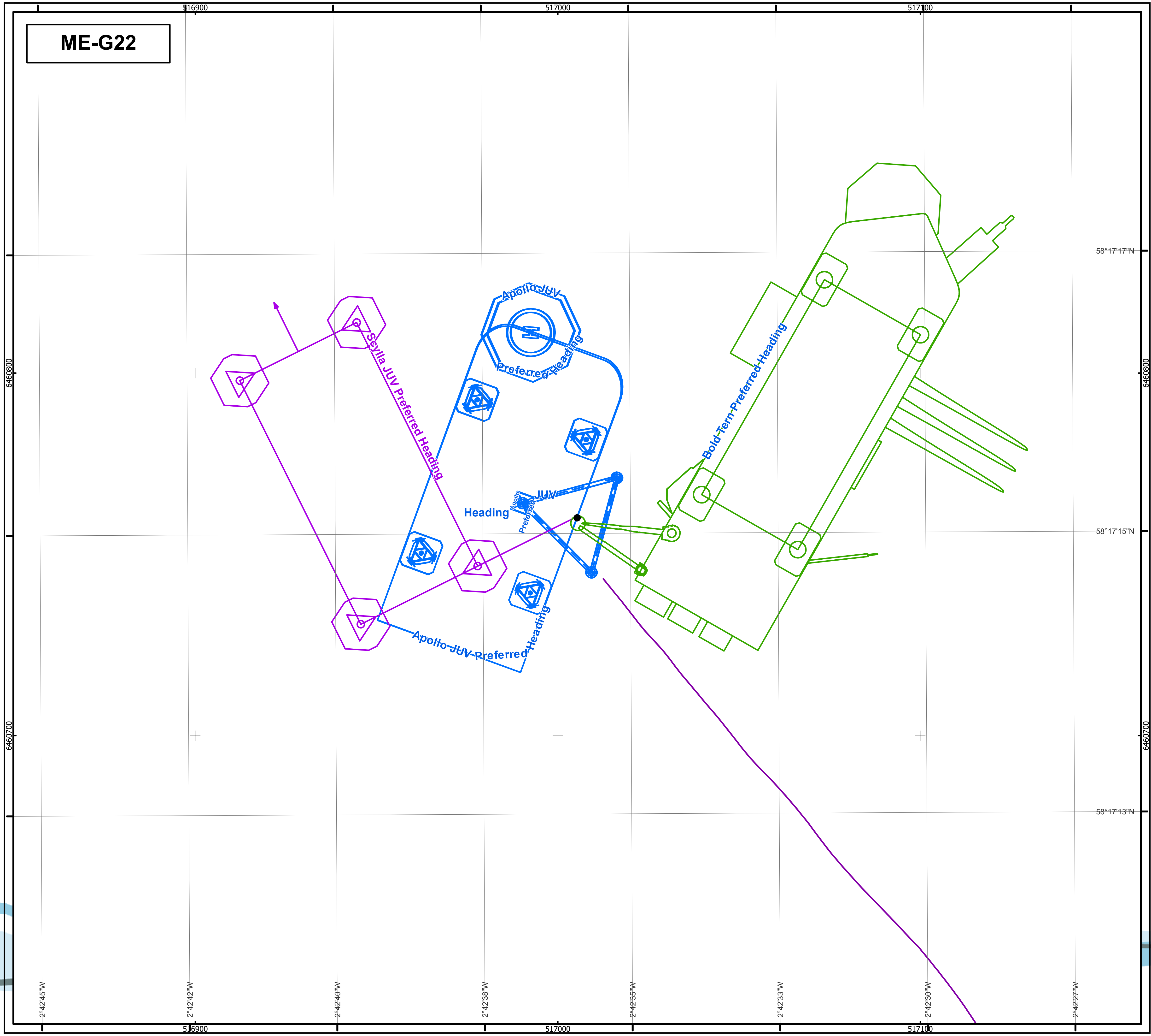
Date: 09/04/2024 Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd

ME-G22



MORAY EAST
OFFSHORE WINDFARM

KEY

● WTG location

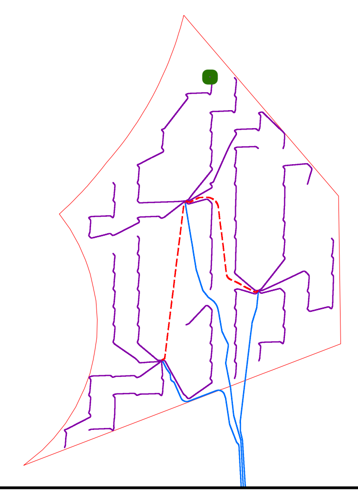
JUV As Built

Vessel

- Apollo
- Bold Tern
- Scylla

Cable As Built

- As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart

0 20 40 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

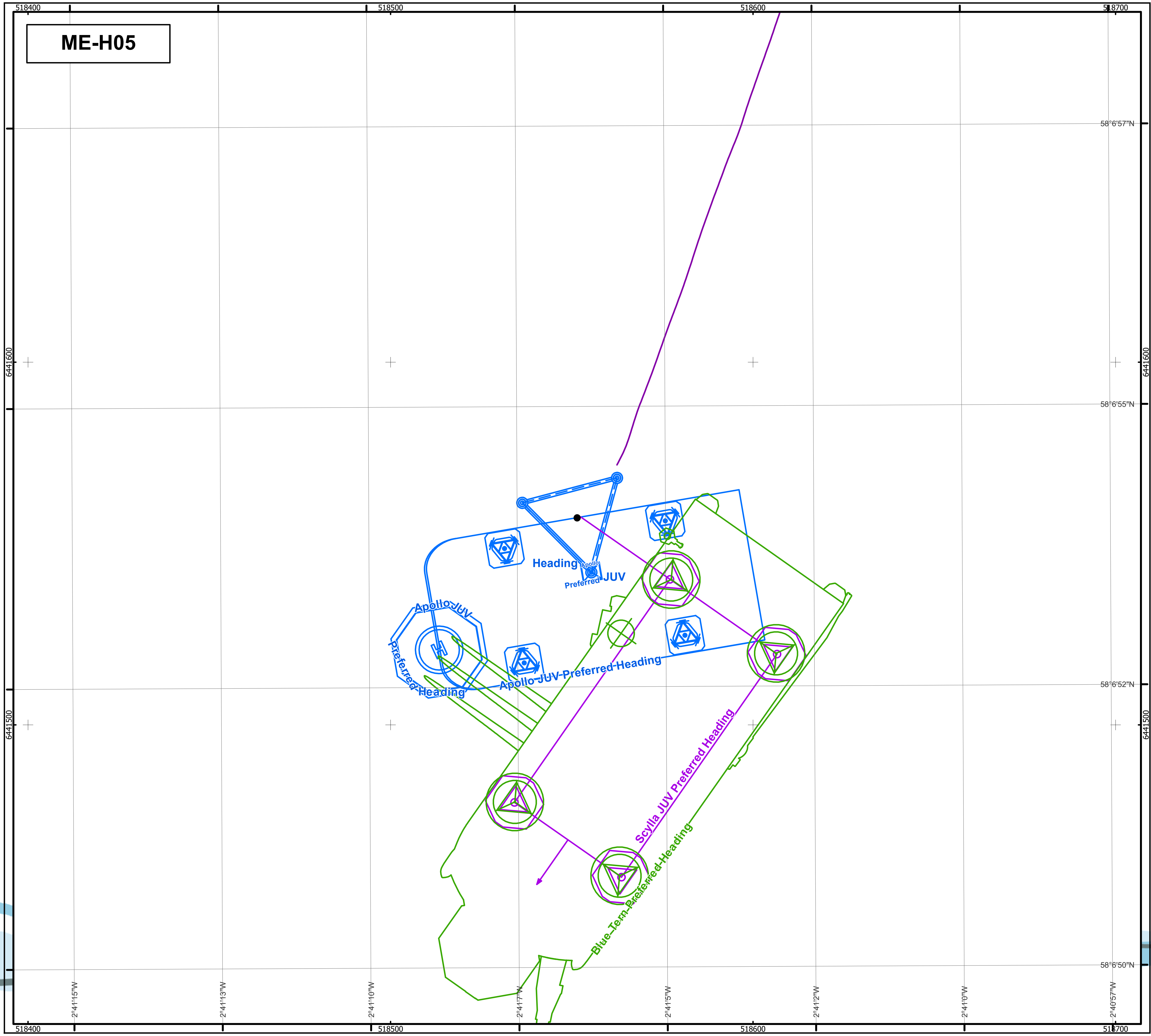
Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024 Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

- WTG location

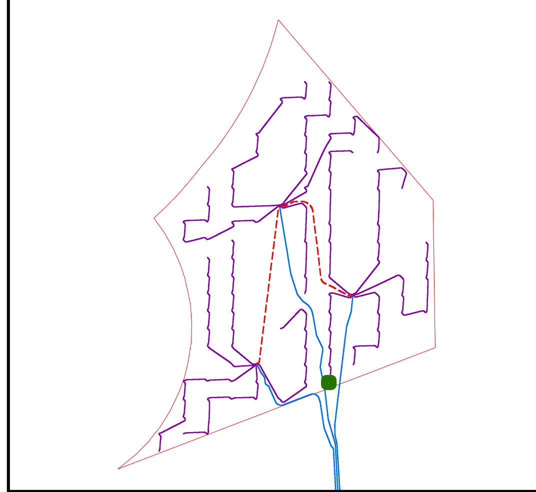
JUV As Built

Vessel

- Apollo
- Blue Tern
- Scylla

Cable As Built

- As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart

0 20 40 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

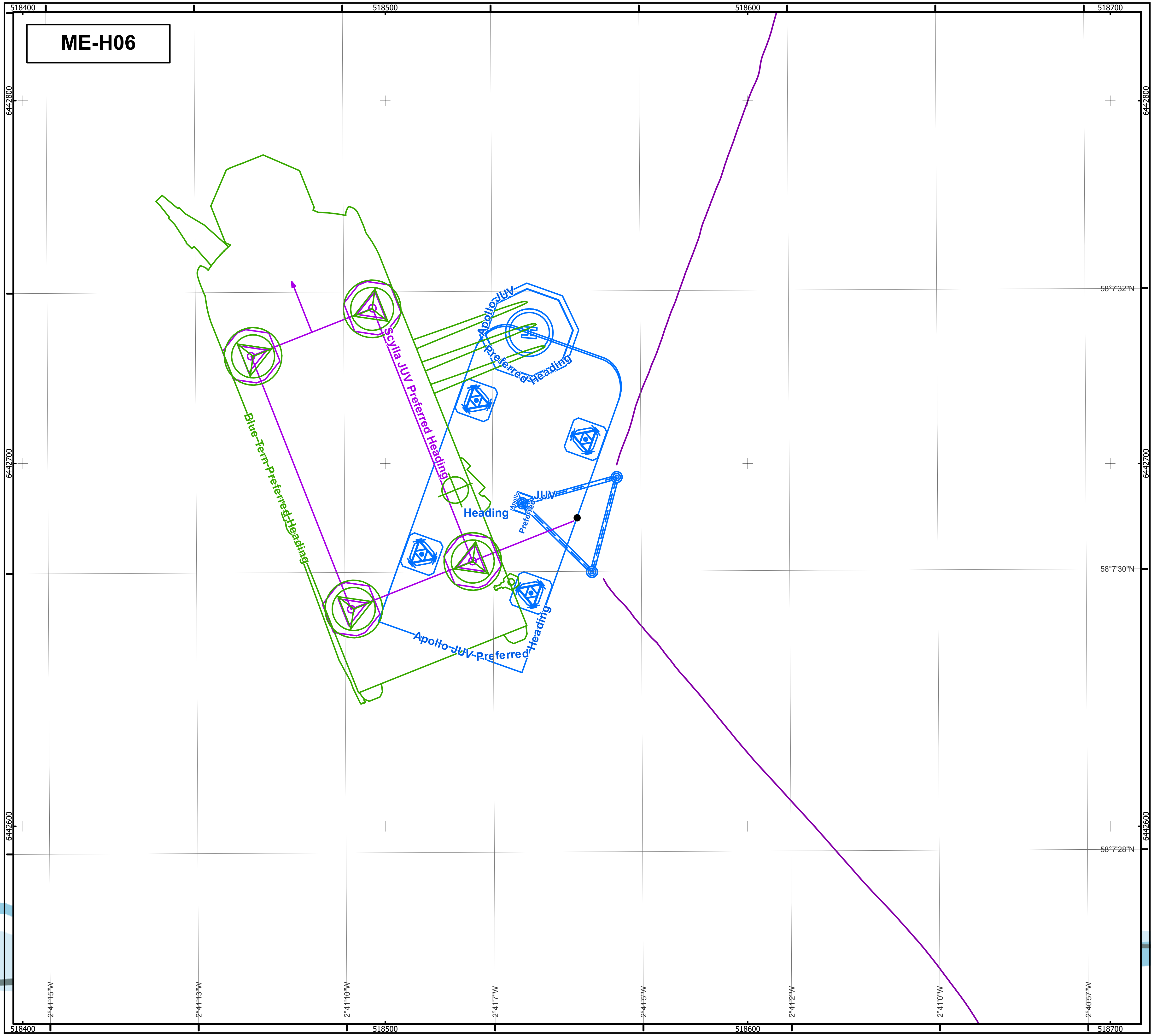
Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024 Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

● WTG location

JUV As Built

Vessel

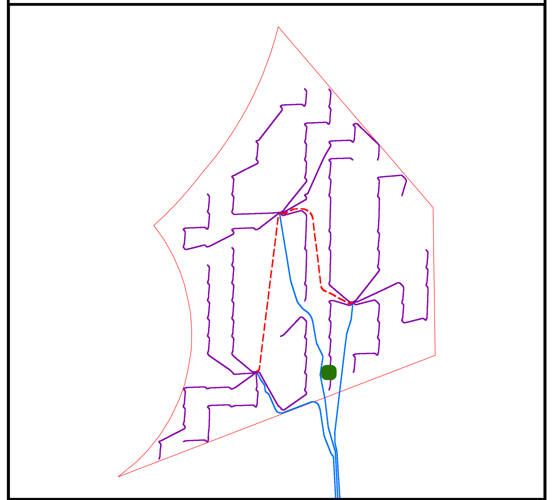
Apollo

Blue Tern

Scylla

Cable As Built

As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart N

0 20 40 Meters

Geodetic Parameters: WGS84 UTM Zone 30N

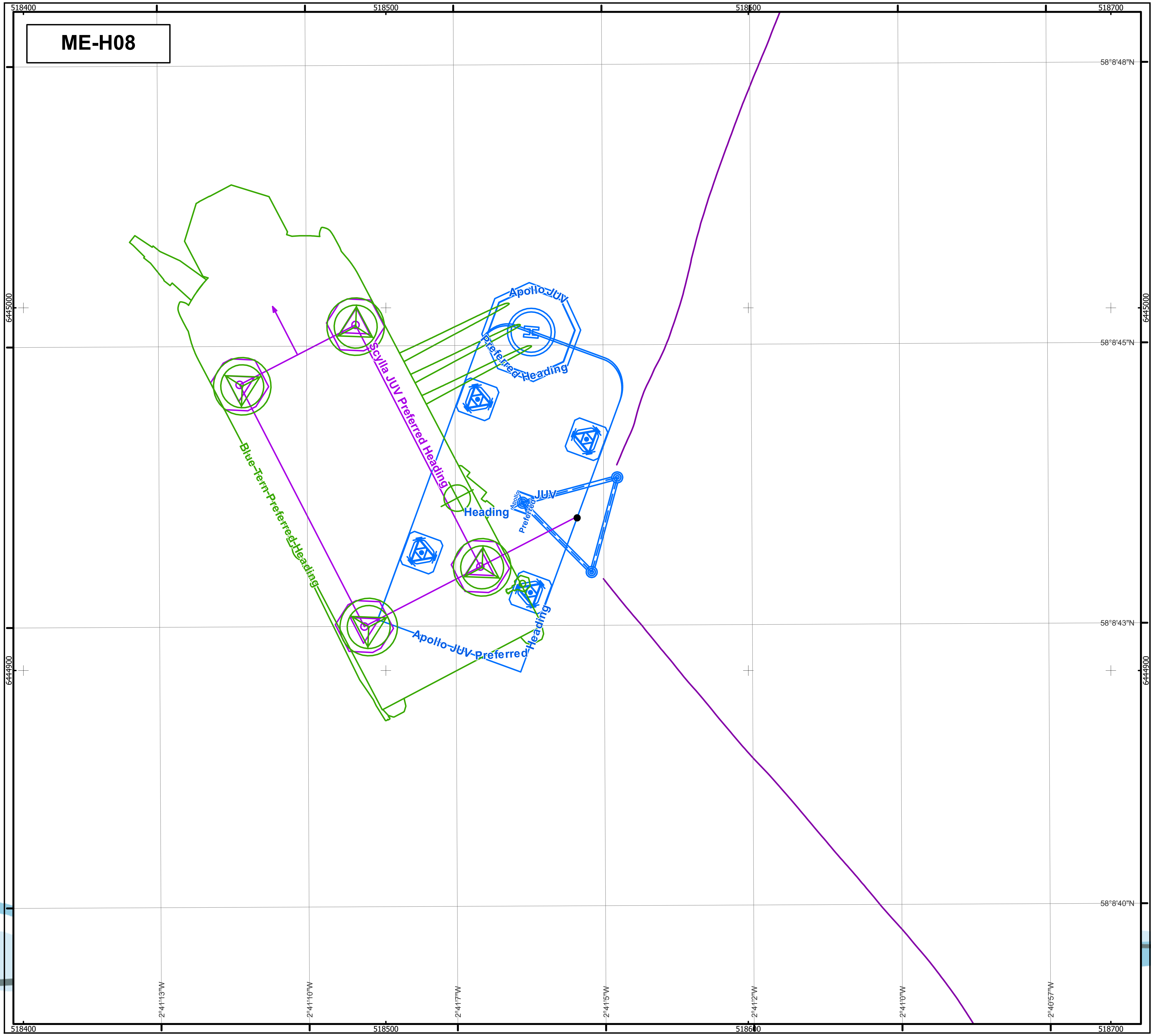
Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024 Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

- WTG location

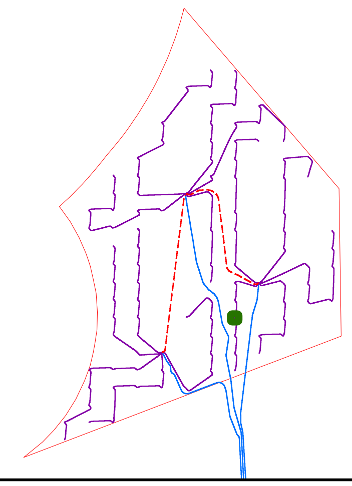
JUV As Built

Vessel

- Apollo
- Blue Tern
- Scylla

Cable As Built

- As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart

0 20 40 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

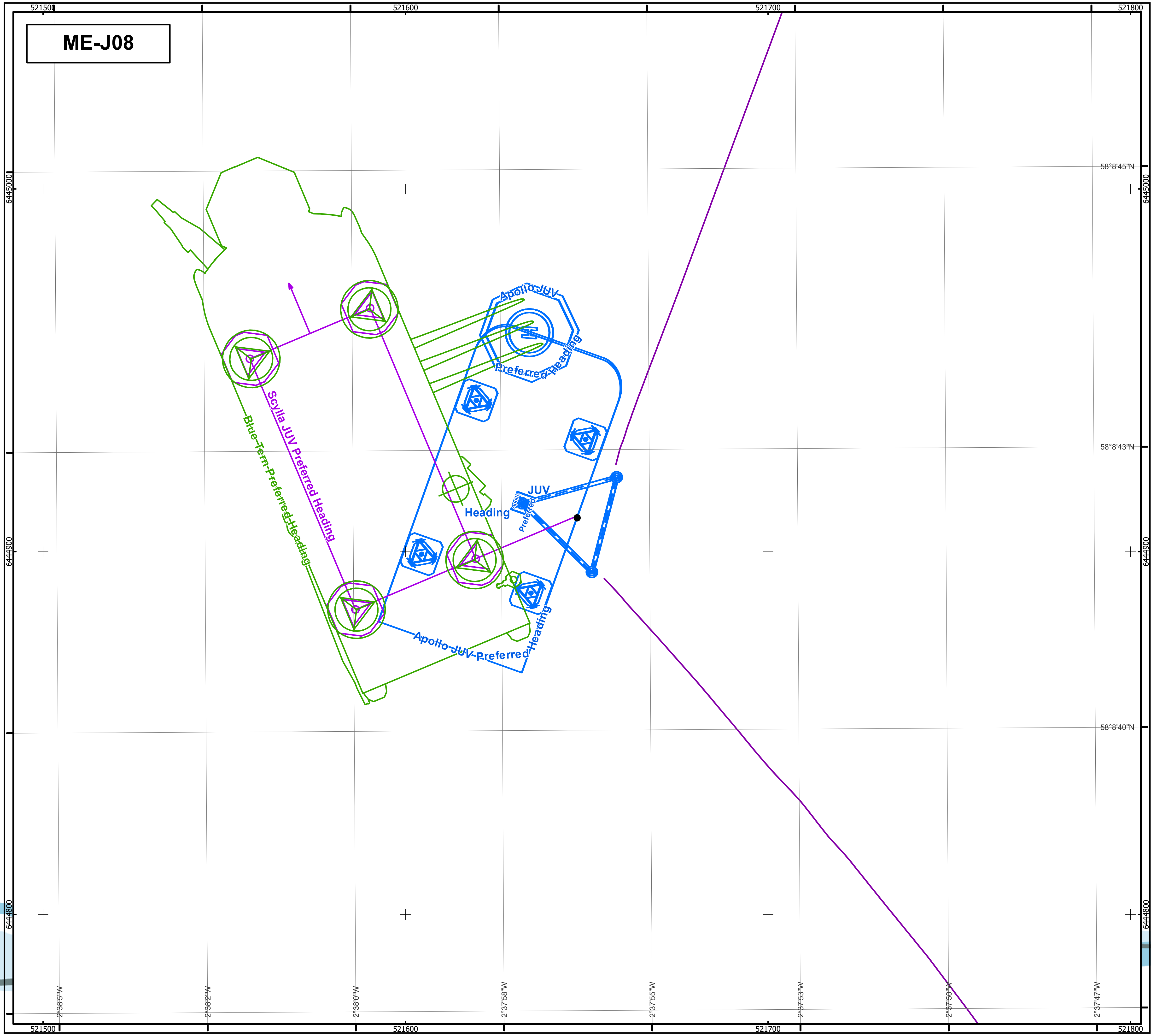
Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024 Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

- ● WTG location

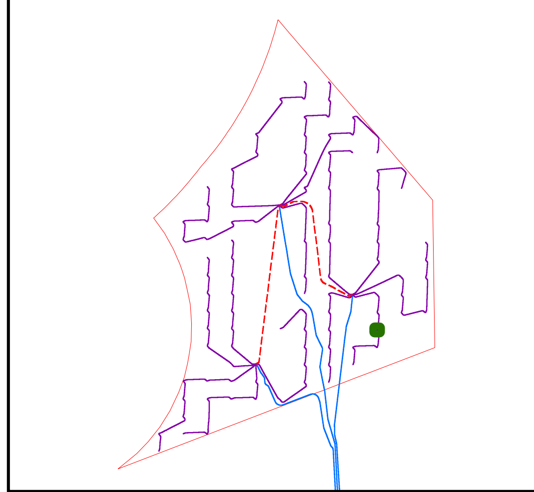
JUV As Built

Vessel

- Apollo
- Blue Tern
- Scylla

Cable As Built

- As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart

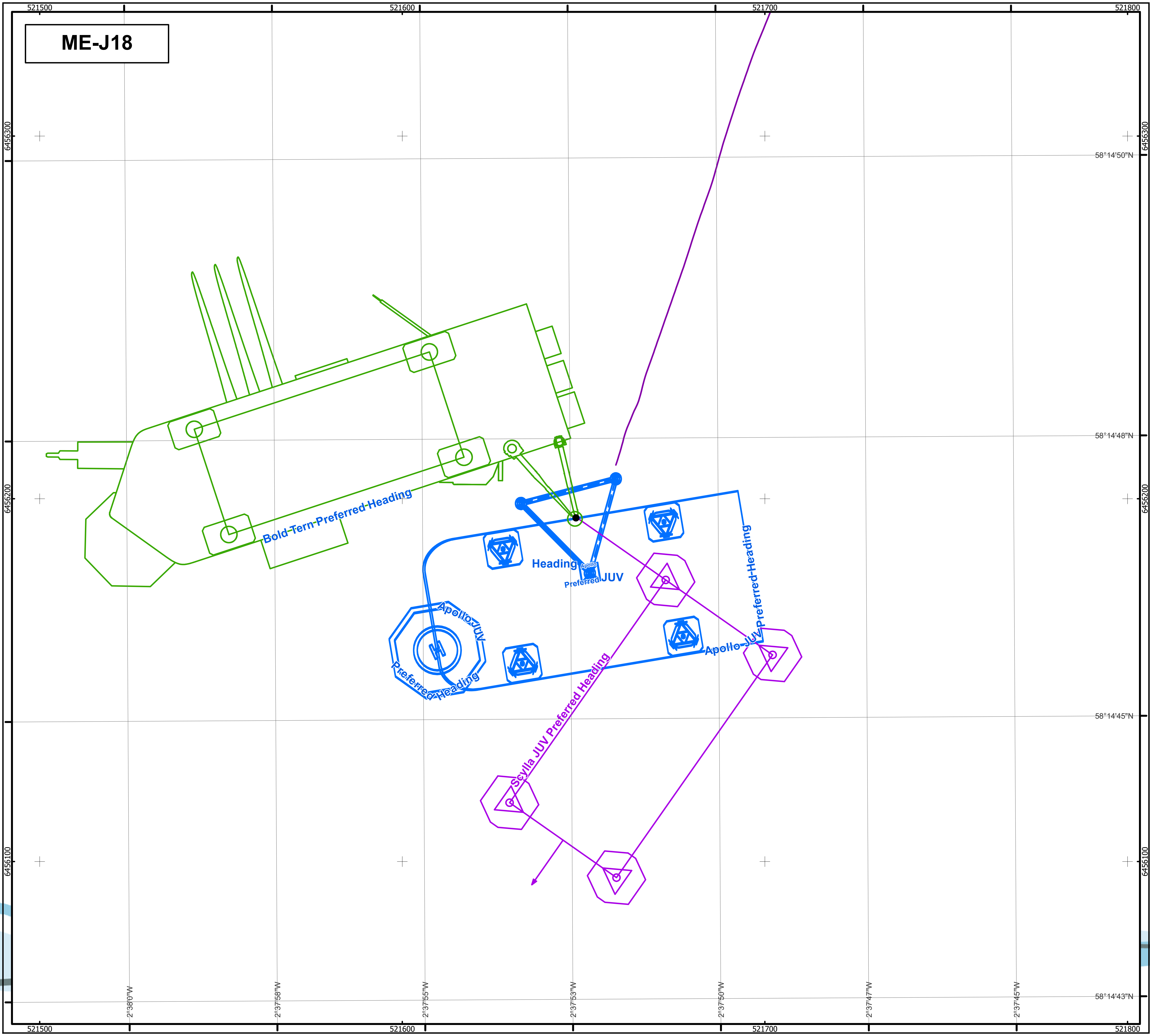
0 20 40 Meters

N

Geodetic Parameters:	WGS84 UTM Zone 30N
Produced: NAL Reviewed: NAL Approved: NAL	
Date: 09/04/2024	Revision: A
REF: 8460001-AAA0000-AAA-AAA-000	

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

● WTG location

JUV As Built

Vessel

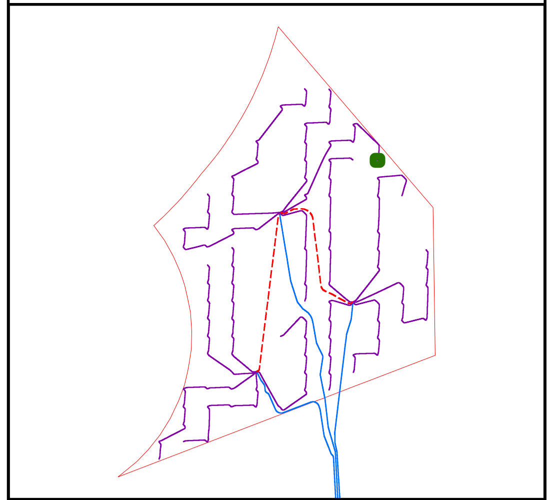
Apollo

Bold Tern

Scylla

Cable As Built

As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart

0 20 40 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

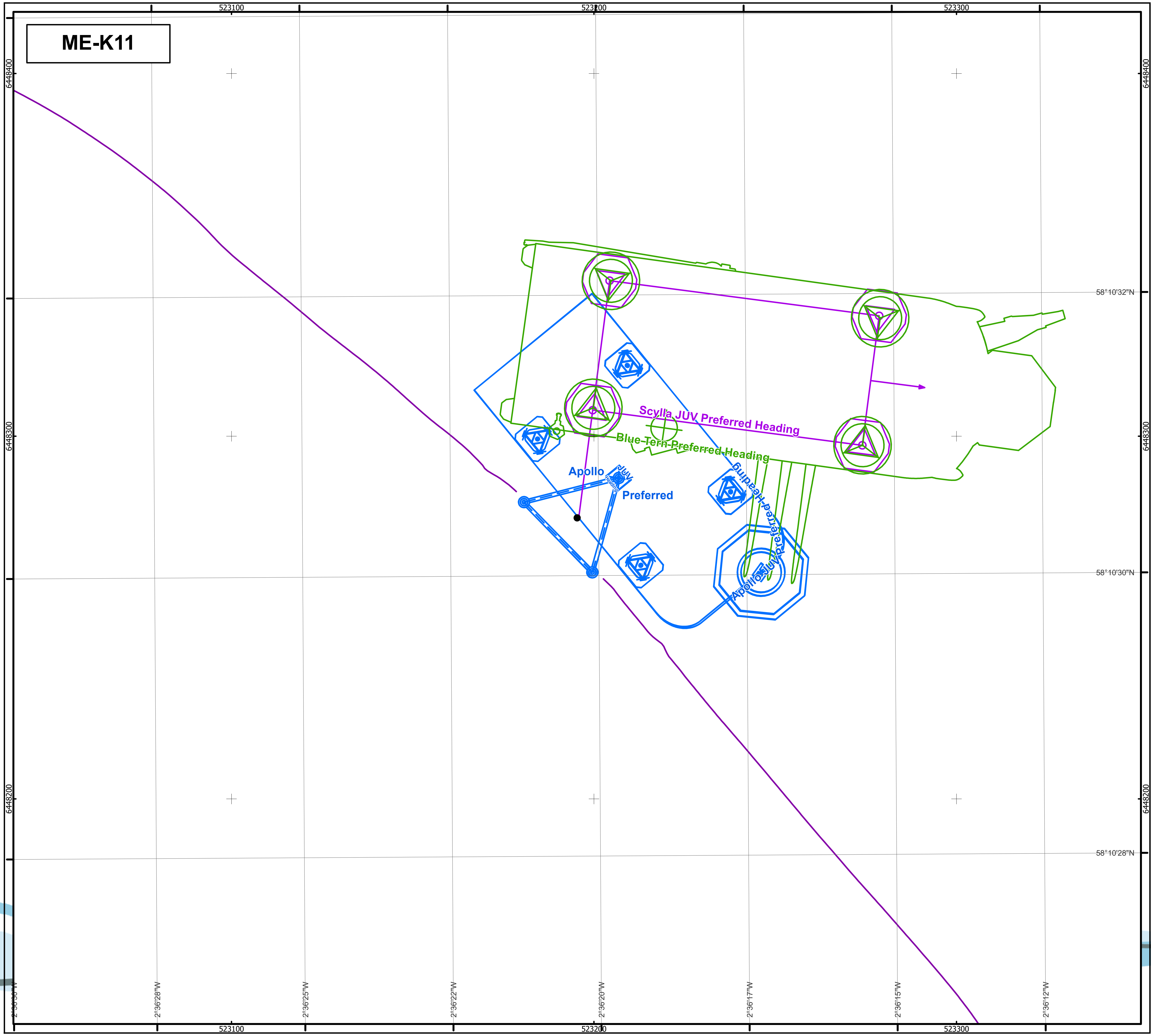
Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024 Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

- ● WTG location

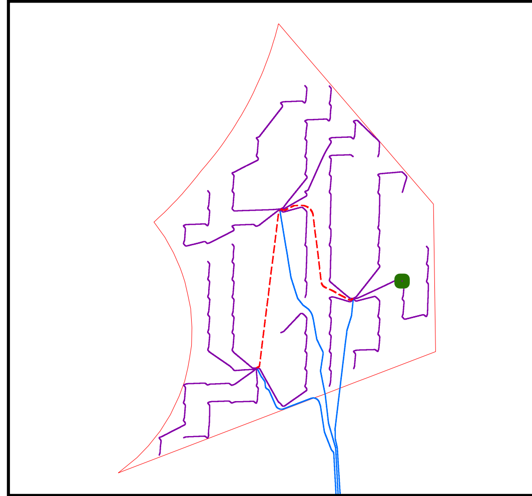
JUV As Built

Vessel

- Apollo
- Blue Tern
- Scylla

Cable As Built

- As-built inter-array cable



Horizontal Scale: 1:1,000 A3 Chart

0 20 40 Meters

N

Geodetic Parameters: WGS84 UTM Zone 30N

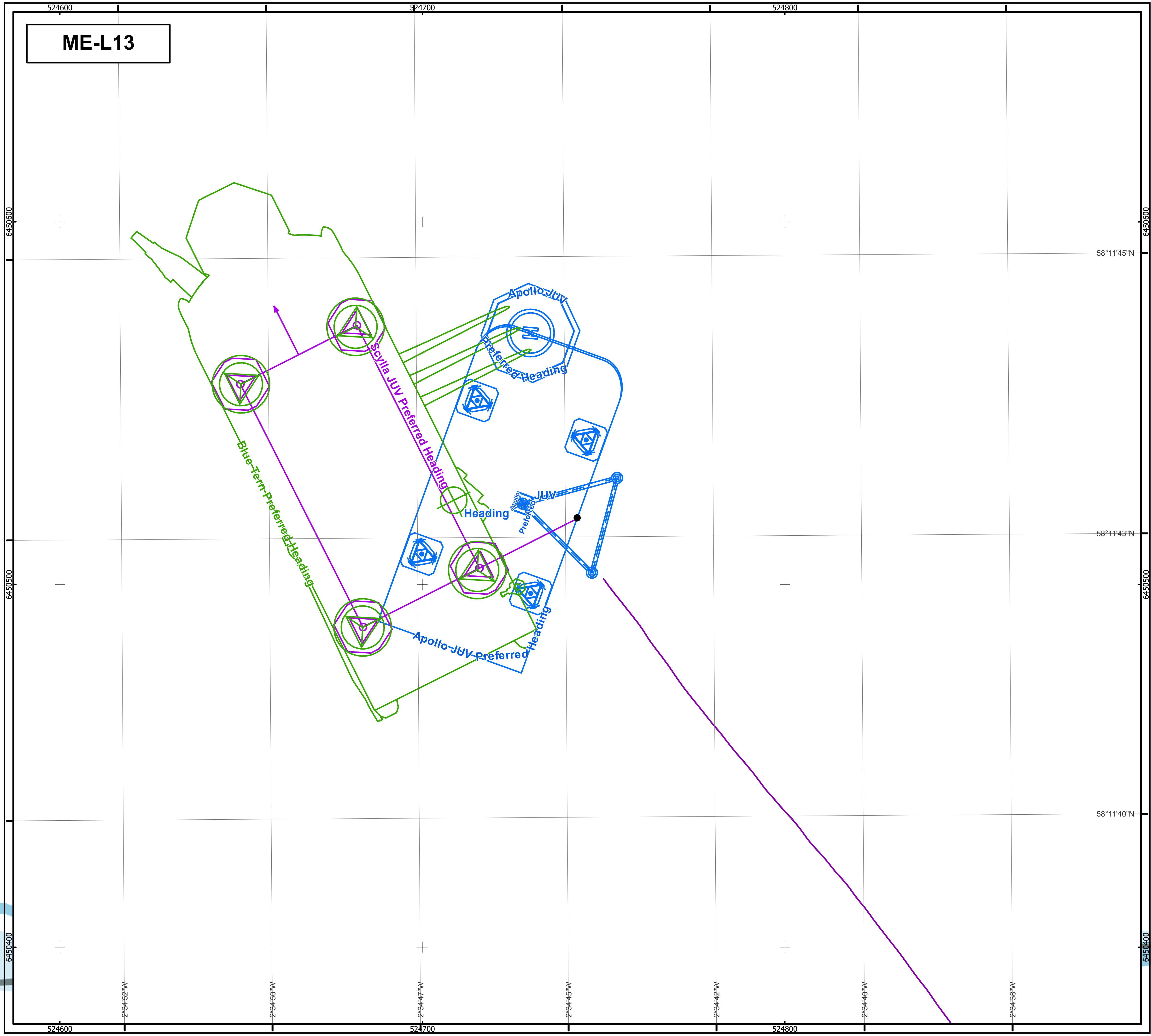
Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024	Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

Moray Offshore Windfarm (East) Ltd



MORAY EAST
OFFSHORE WINDFARM

KEY

- ● WTG location

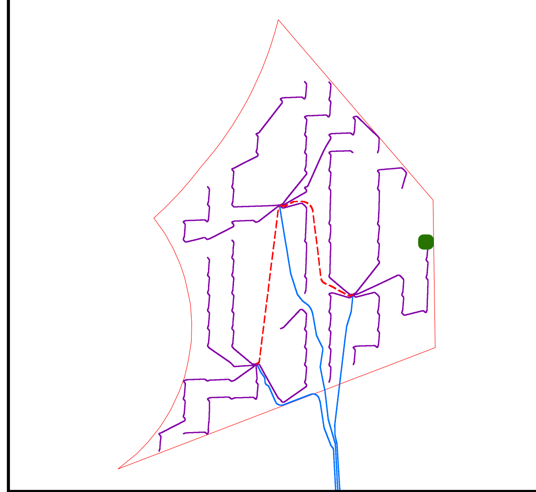
JUV As Built

Vessel

- Apollo
- Blue Tern
- Scylla

Cable As Built

- As-built inter-array cable



Horizontal Scale: 1:1,000 — A3 Chart

0 — 20 — 40 Meters — N

Geodetic Parameters: WGS84 UTM Zone 30N

Produced: NAL
Reviewed: NAL
Approved: NAL

Date: 09/04/2024 | Revision: A

REF: 8460001-AAA0000-AAA-AAA-000

JUV footprint plans for selected locations

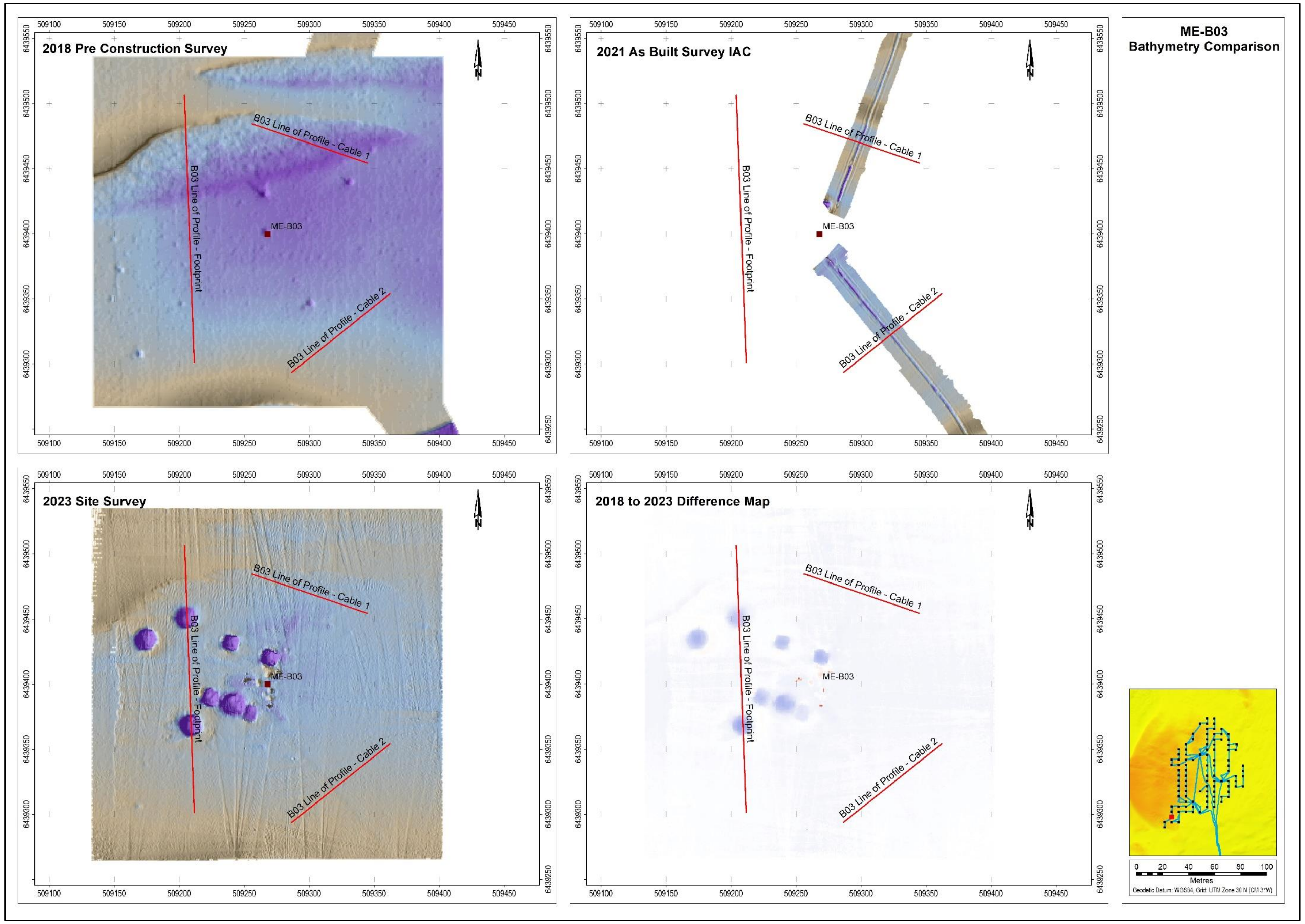
Moray Offshore Windfarm (East) Ltd

APPENDIX II

Pre- and Post-Construction MBES Data and Bathymetry Comparison (Difference) Plots for Areas of Seabed at Each of the Selected Foundation Locations and Adjacent Seabed Areas

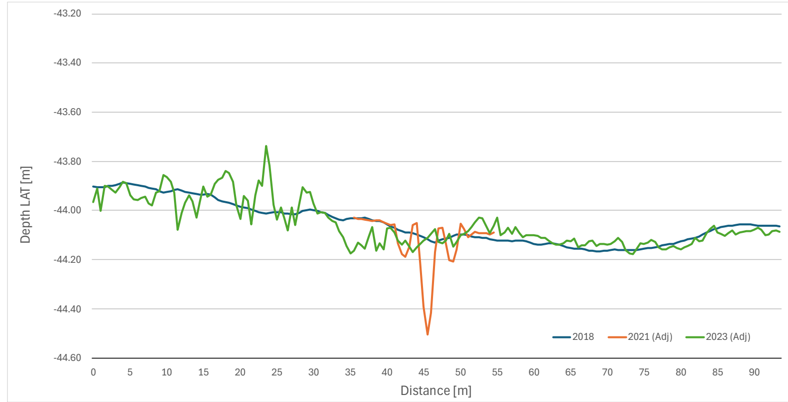
Turbine B03

MBES Comparison Plots

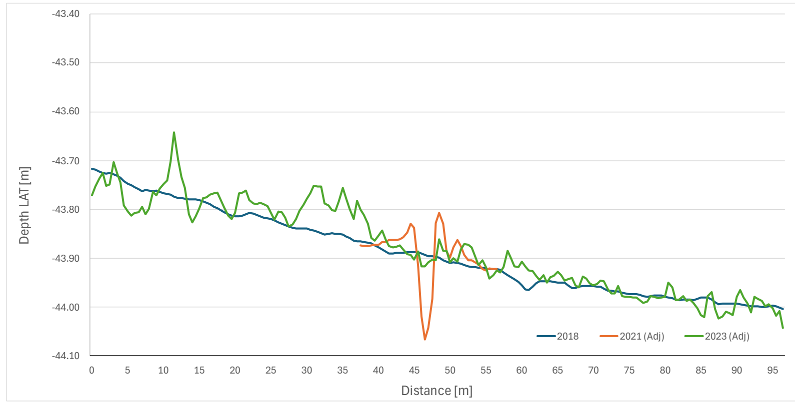


Inter-array cable pre- and post- installation seabed profiles

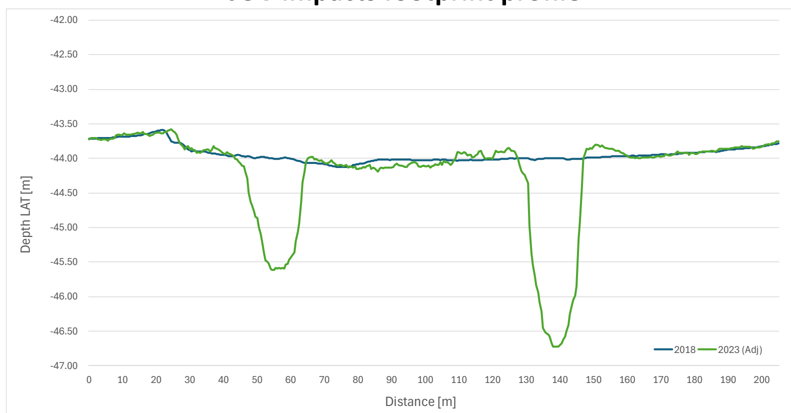
Cable 1



Cable 2

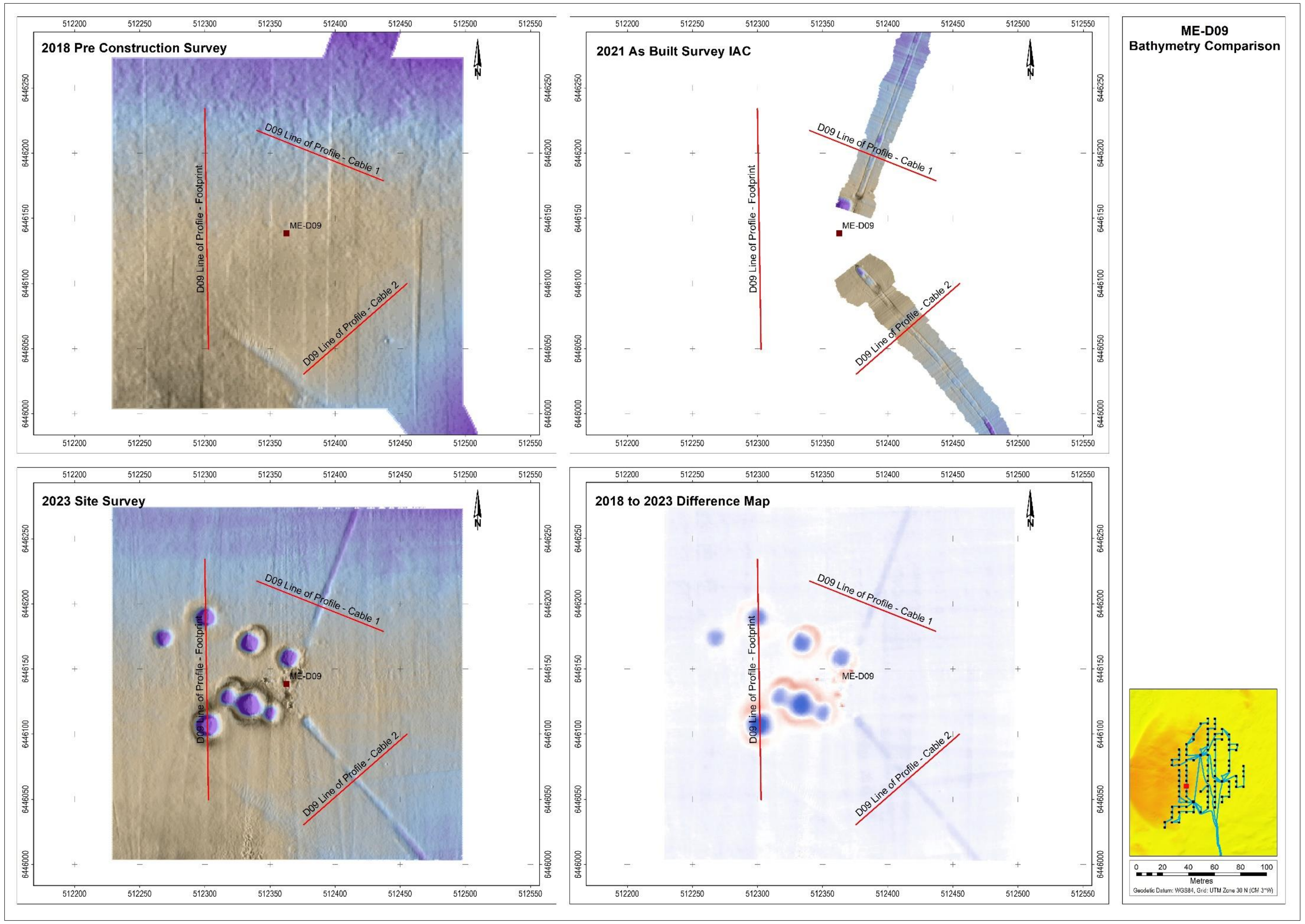


JUV impacts footprint profile



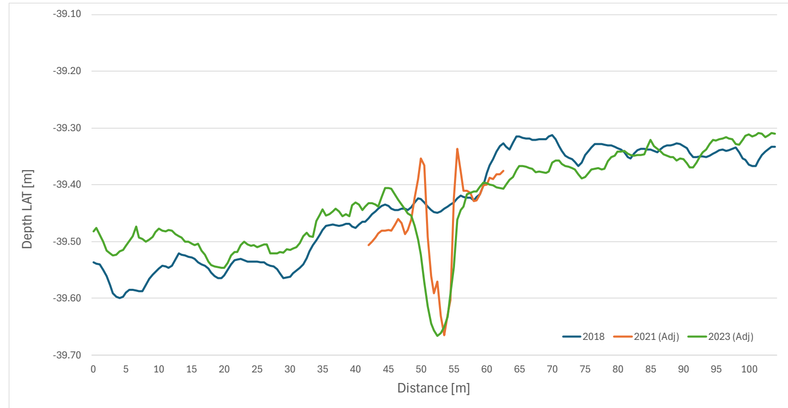
Turbine D09

MBES Comparison Plots



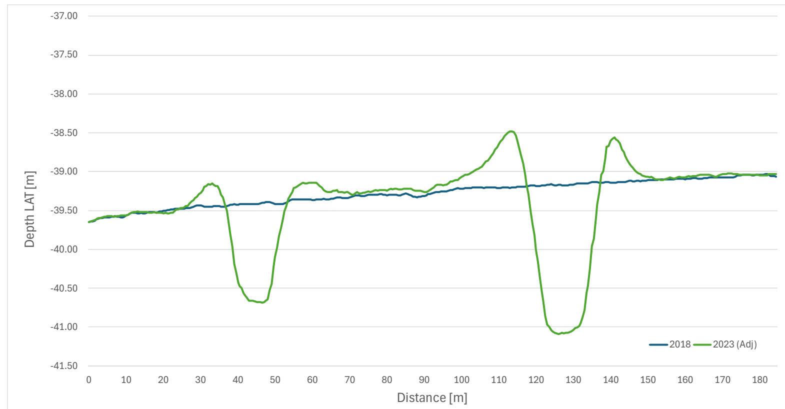
Inter-array cable pre- and post- installation profiles

Cable 1



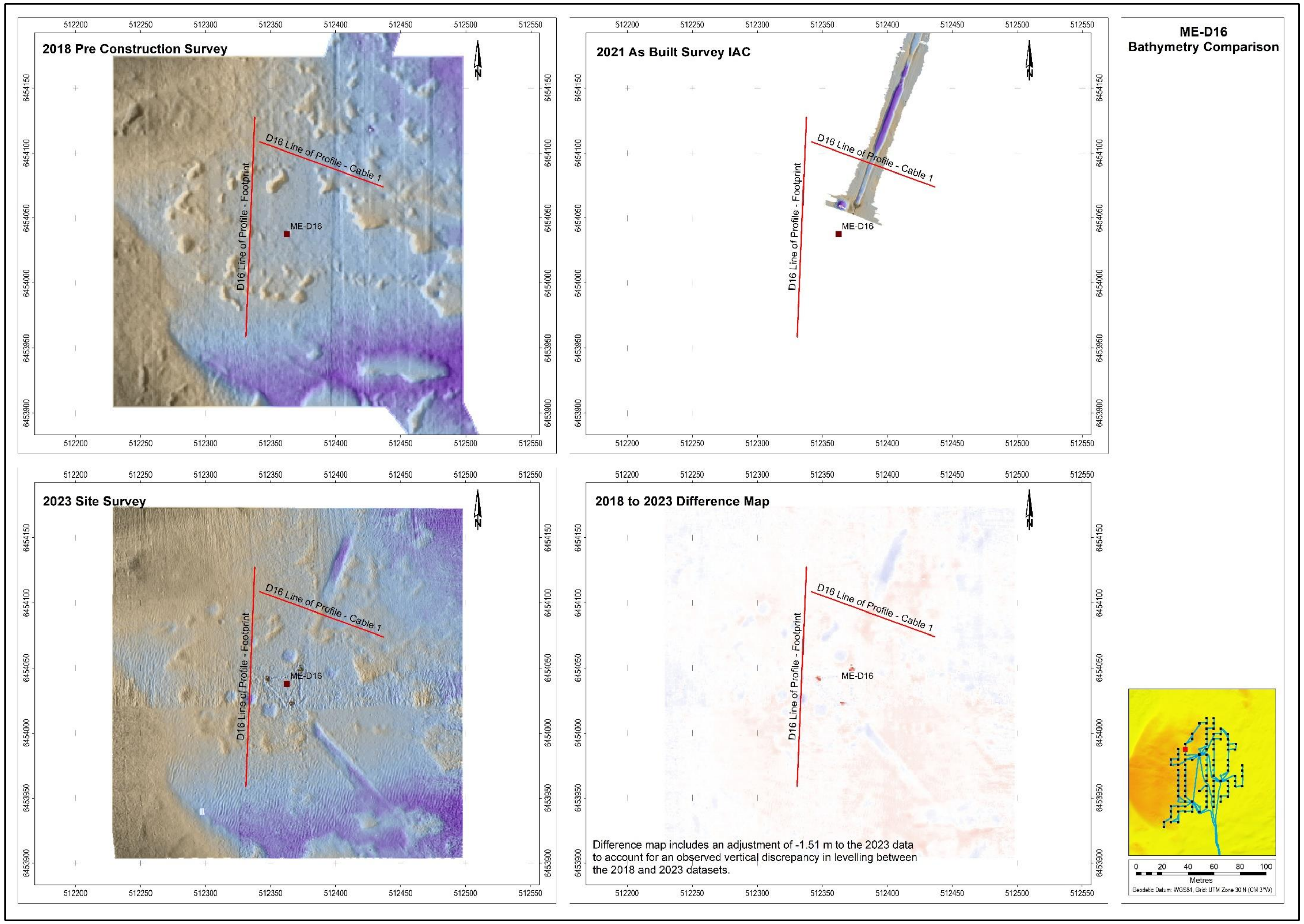
Cable 2

JUV impacts footprint profile



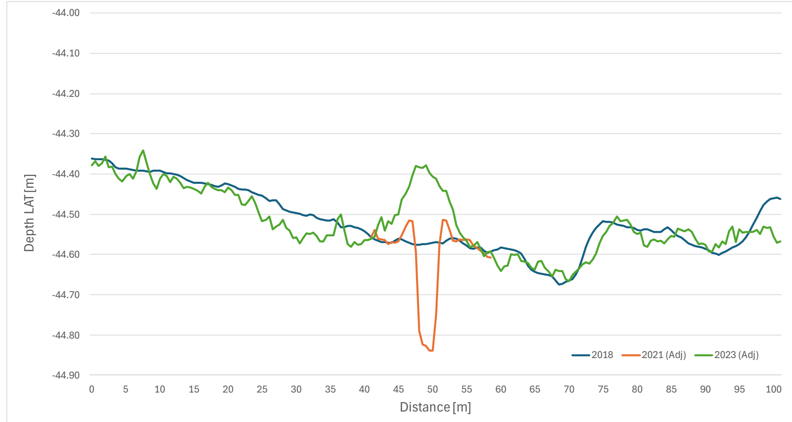
Turbine D16

MBES Comparison Plots



Inter-array cable pre- and post- installation profiles

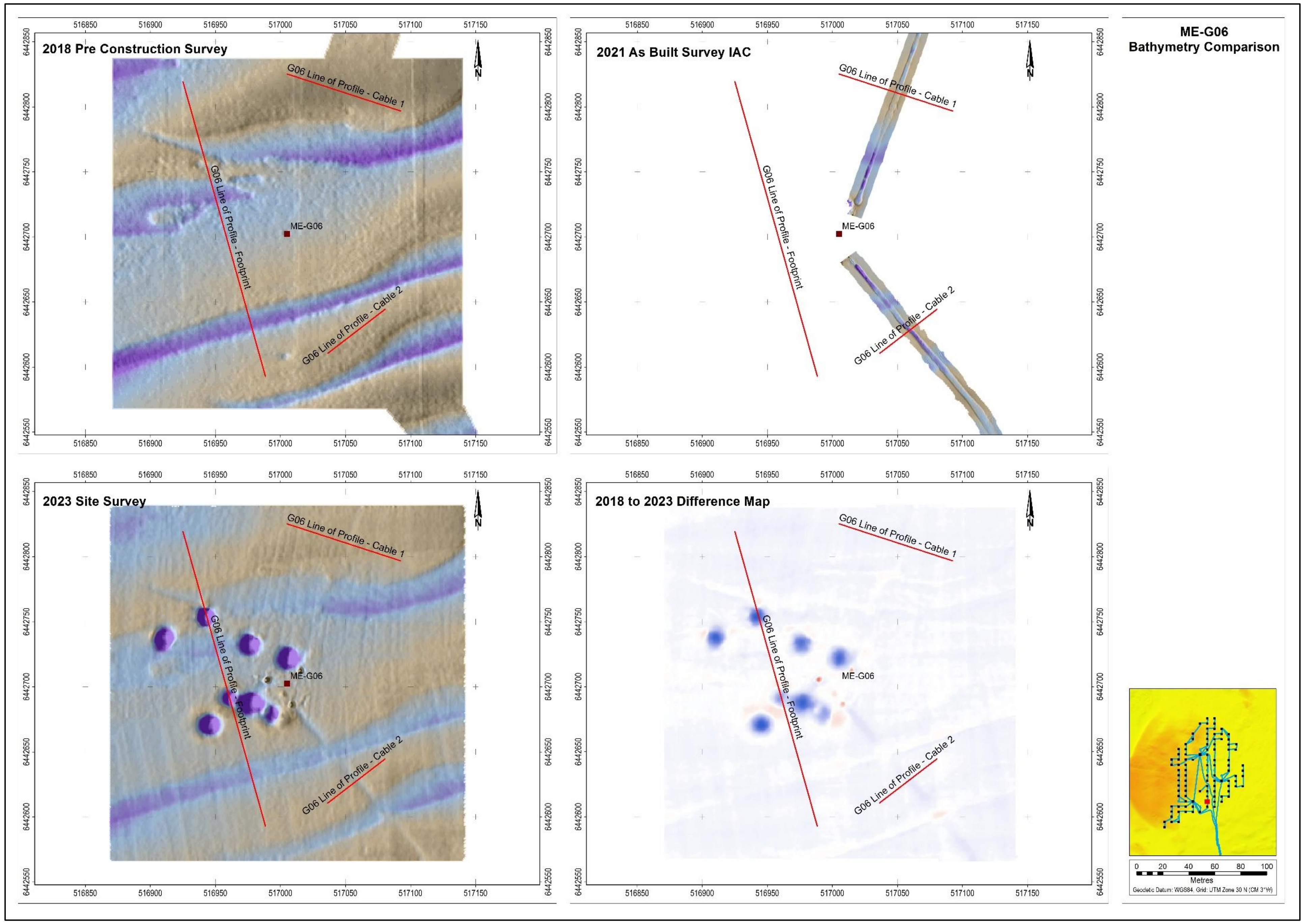
Cable 1



JUV impacts footprint profile

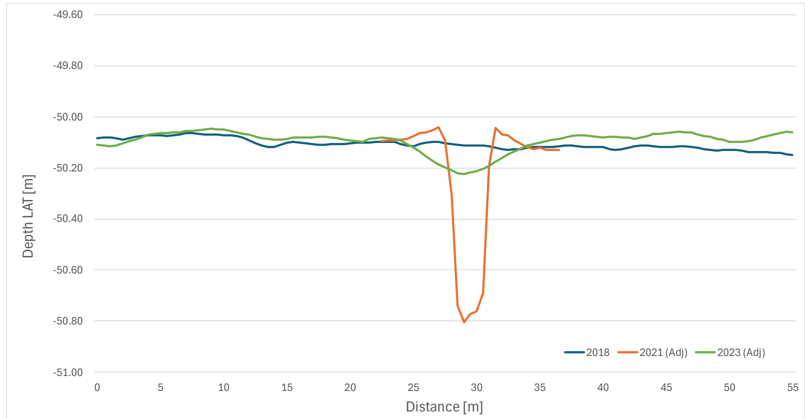
Turbine G06

MBES Comparison Plots



Inter-array cable pre- and post- installation profiles

Cable 1

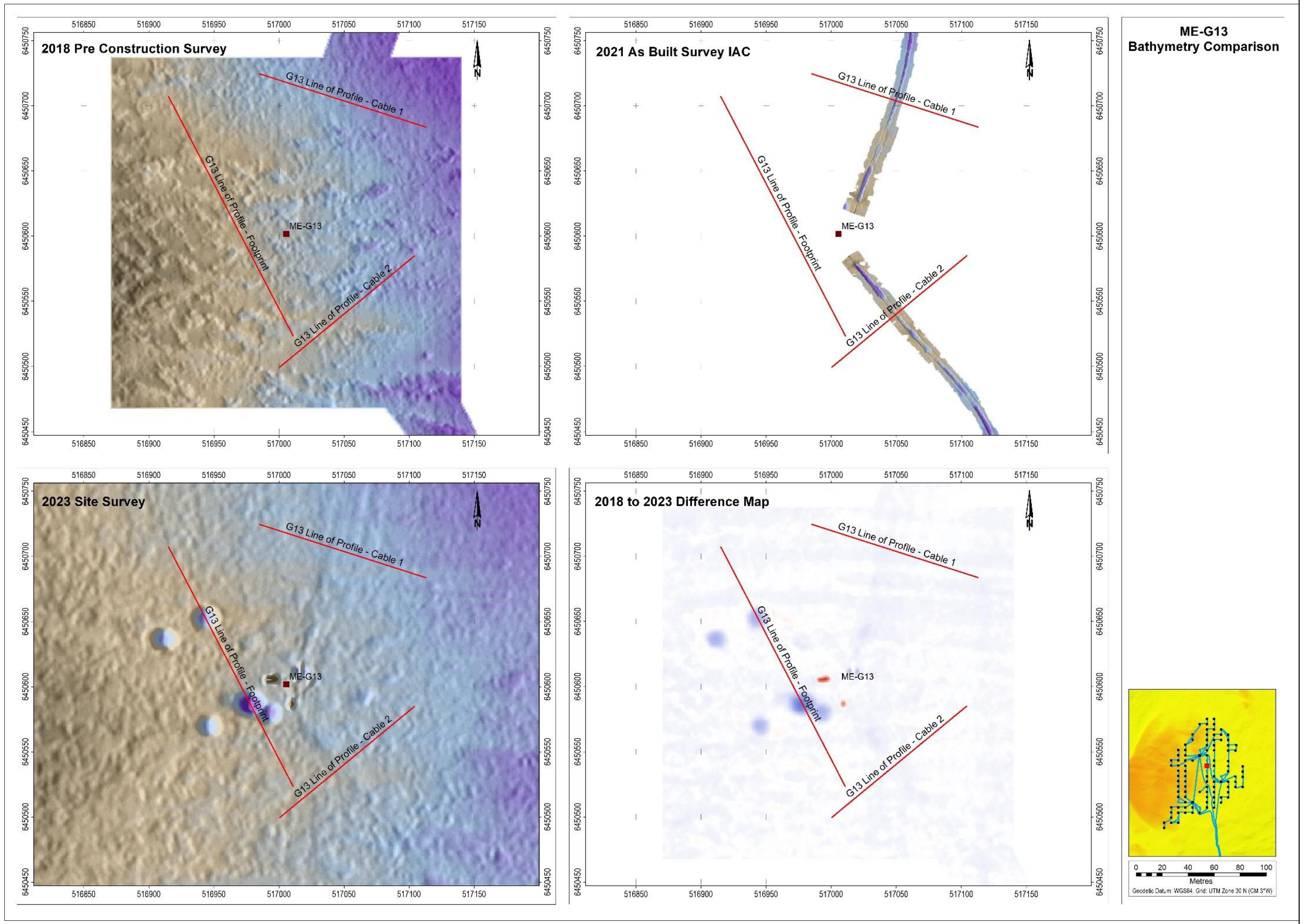


Cable 2

JUV impacts footprint profile

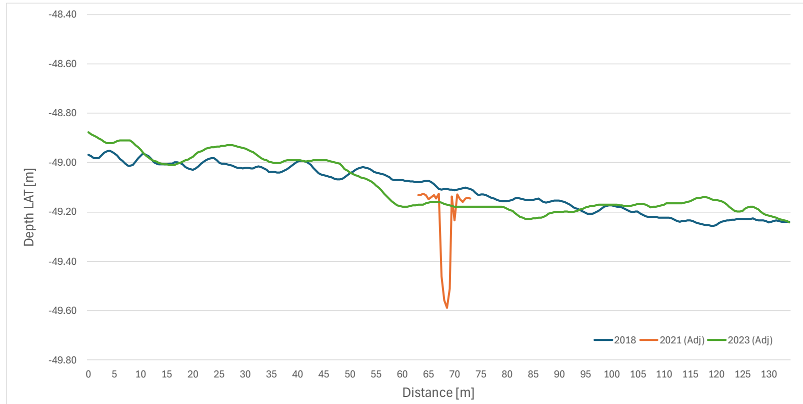
Turbine G13

MBES Comparison Plots

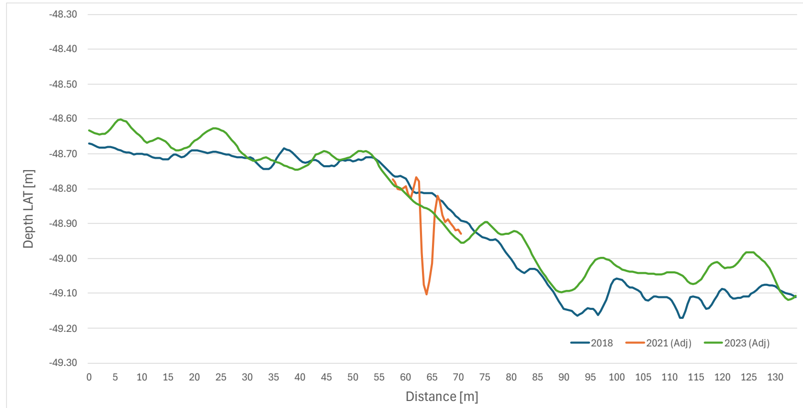


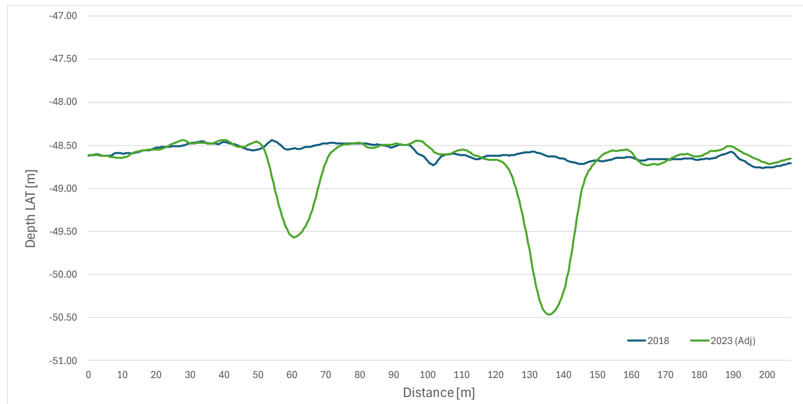
Inter-array cable pre- and post- installation profiles

Cable 1



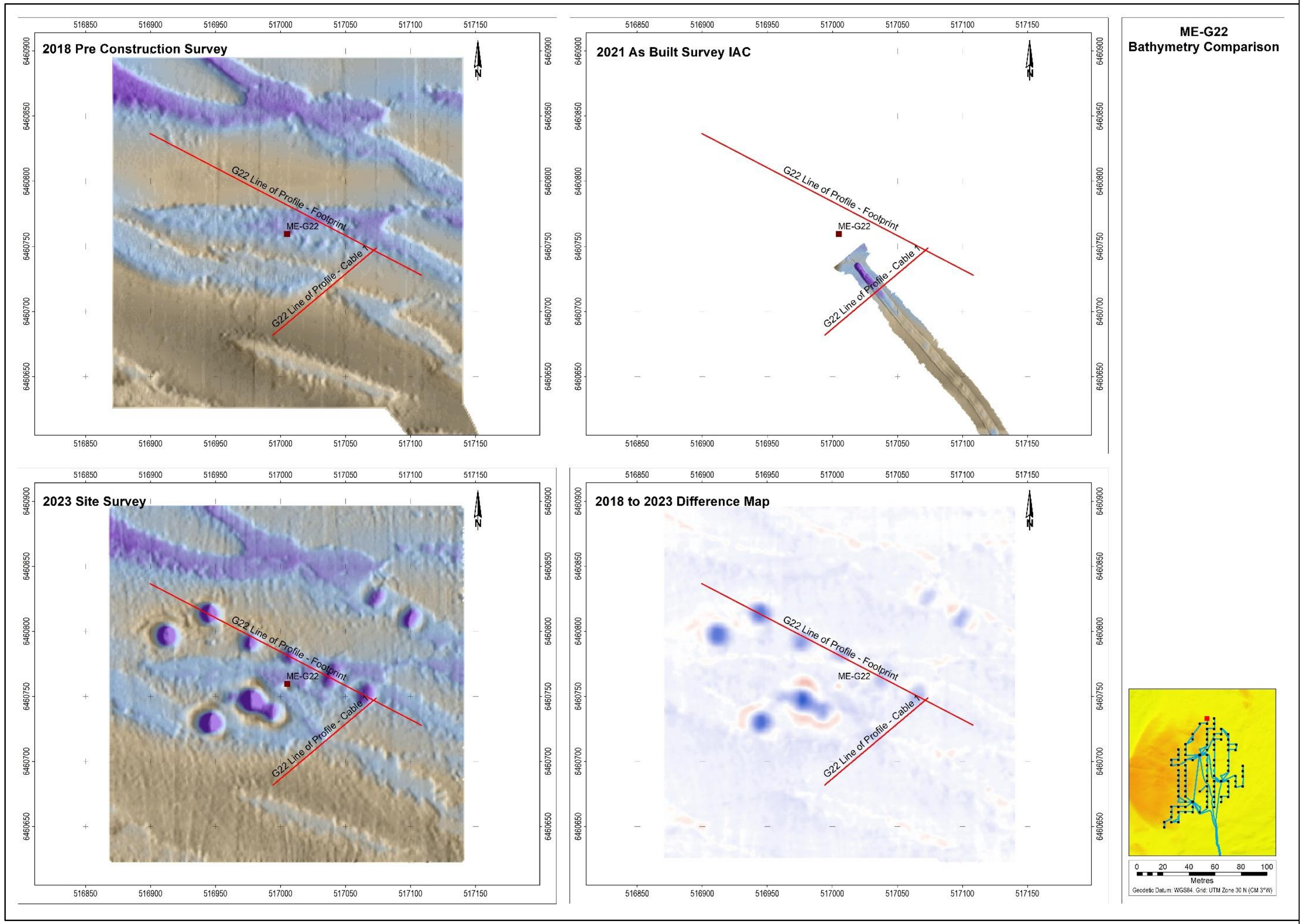
Cable 2



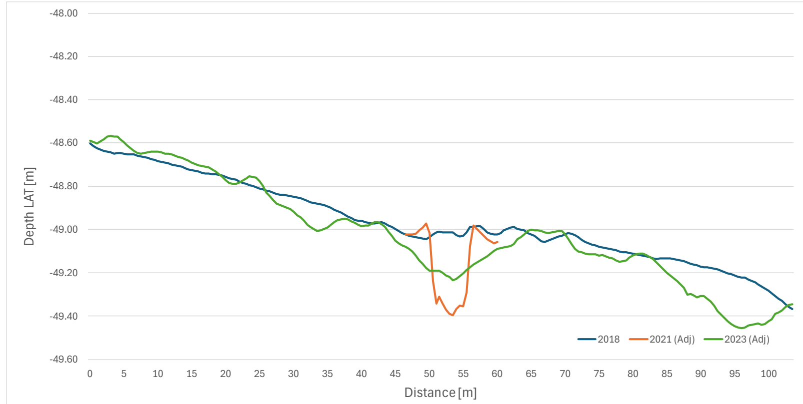


Turbine G22

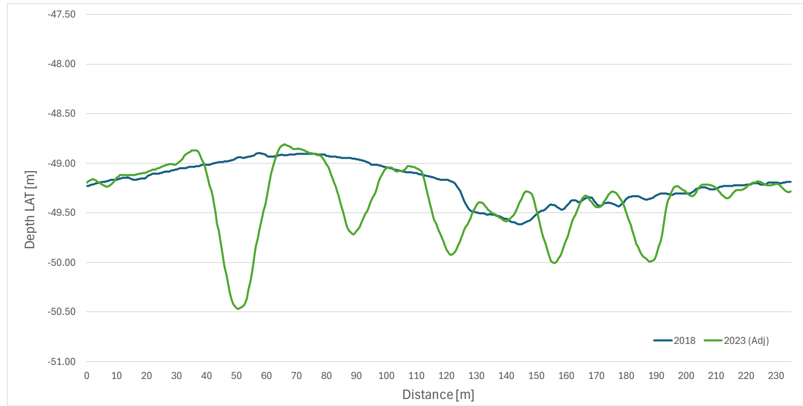
MBES Comparison Plots



Inter-array cable pre- and post- installation profiles

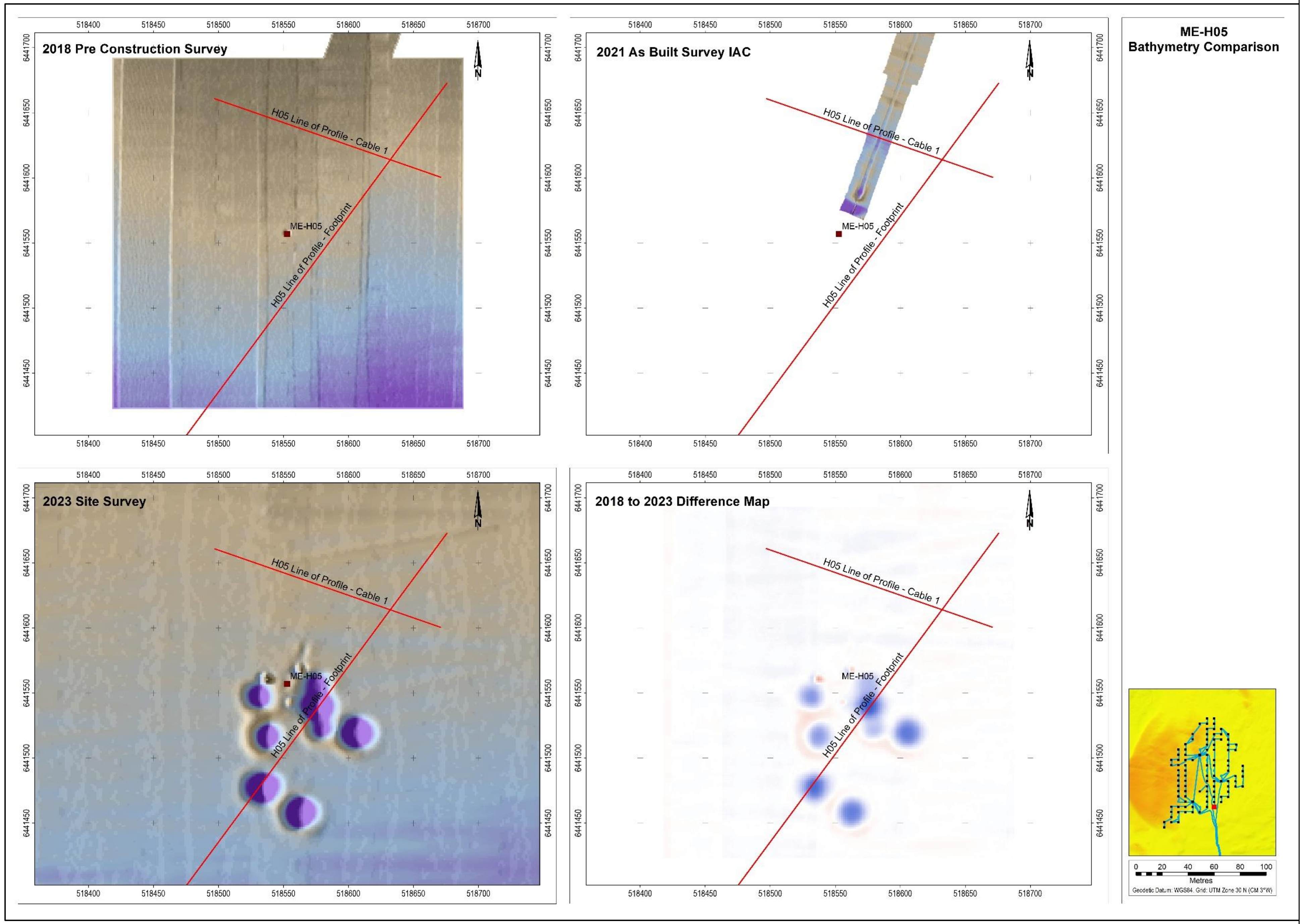


JUV impacts footprint profile



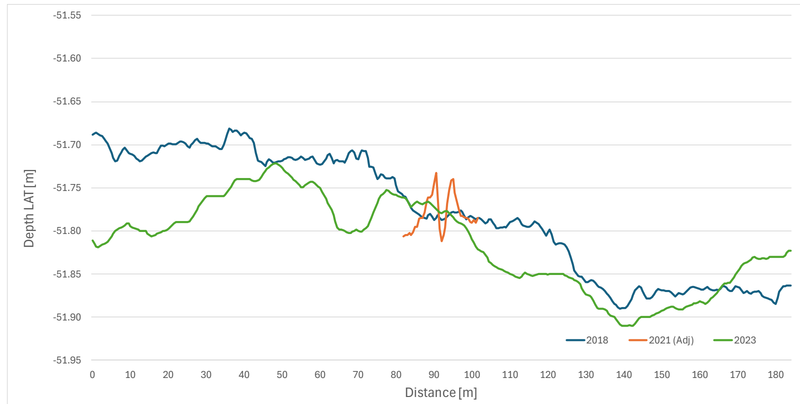
Turbine H05

MBES Comparison Plots

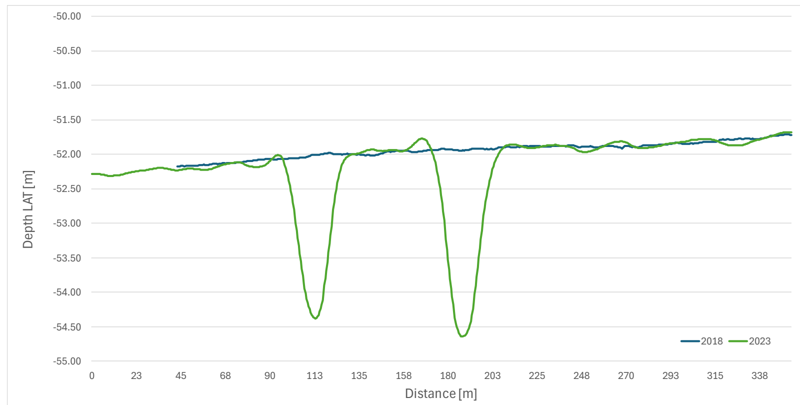


Inter-array cable pre- and post- installation profiles

Cable 1

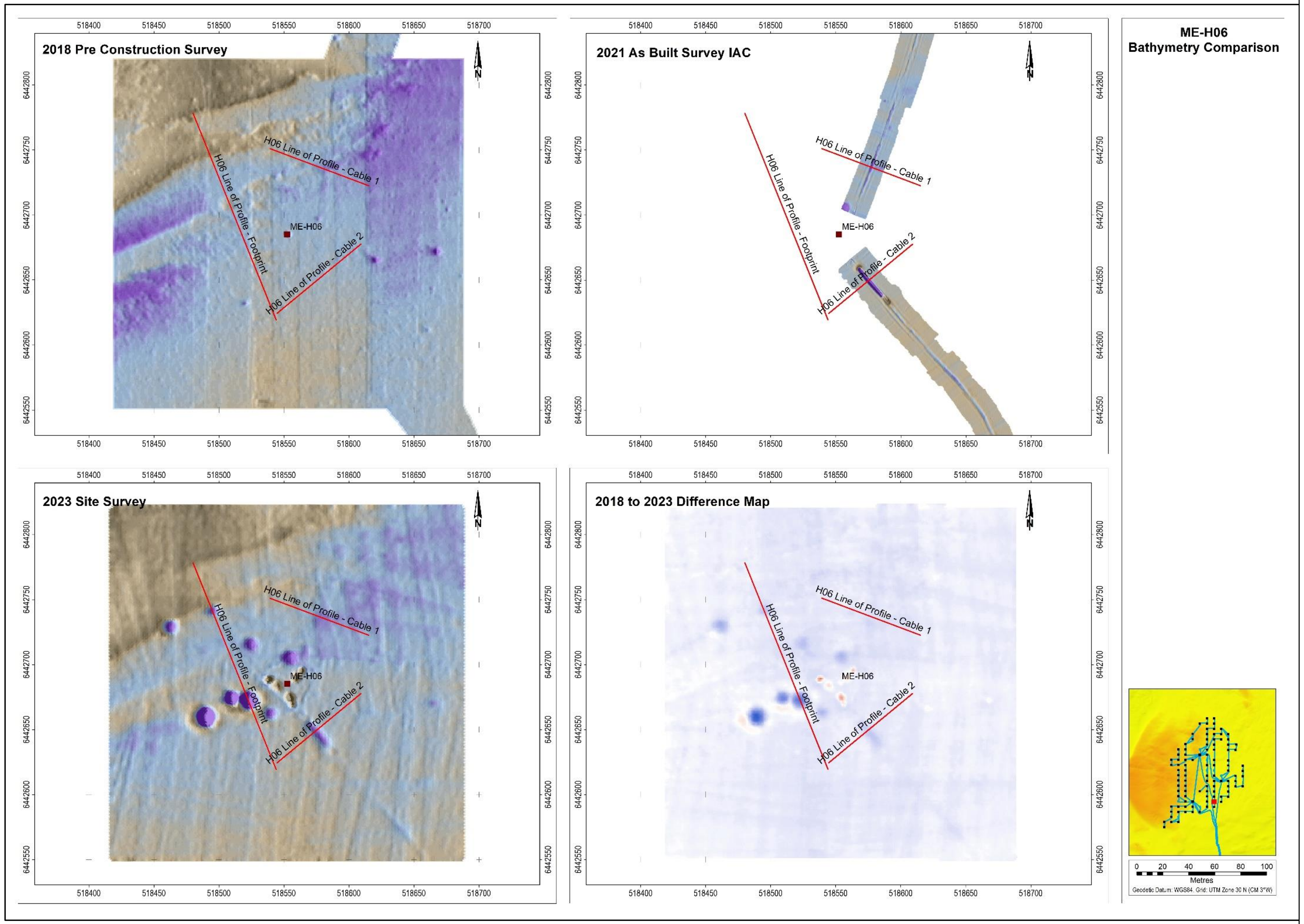


JUV impacts footprint profile



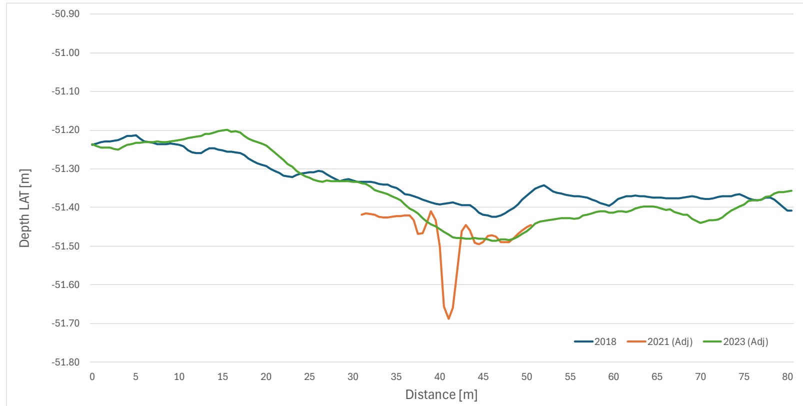
Turbine H06

MBES Comparison Plots

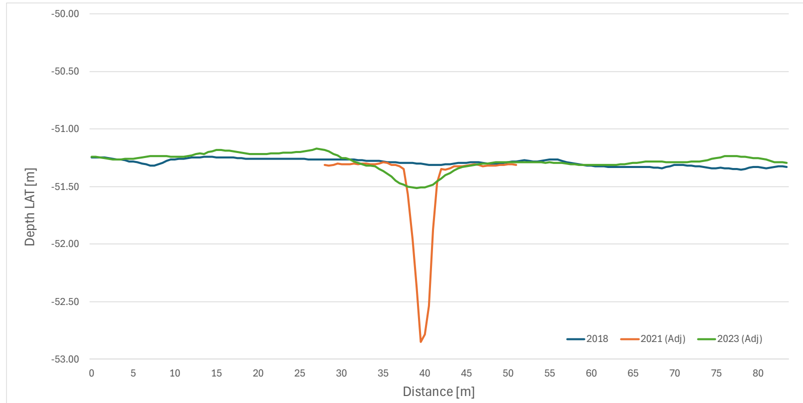


Inter-array cable pre- and post- installation profiles

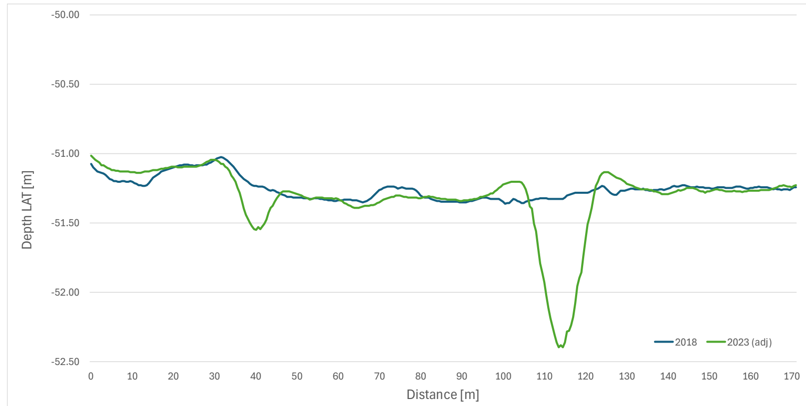
Cable 1



Cable 2

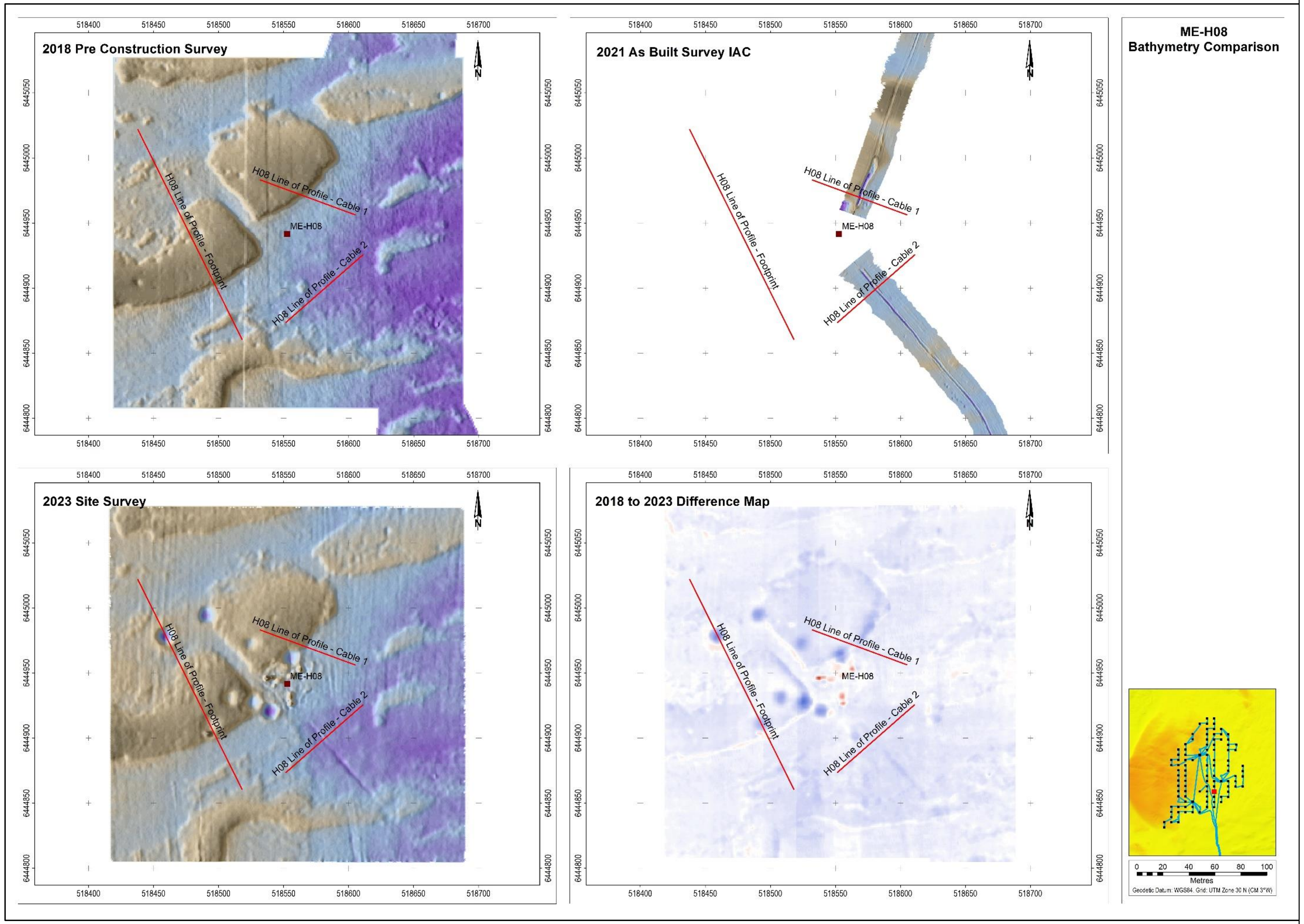


JUV impacts footprint profile



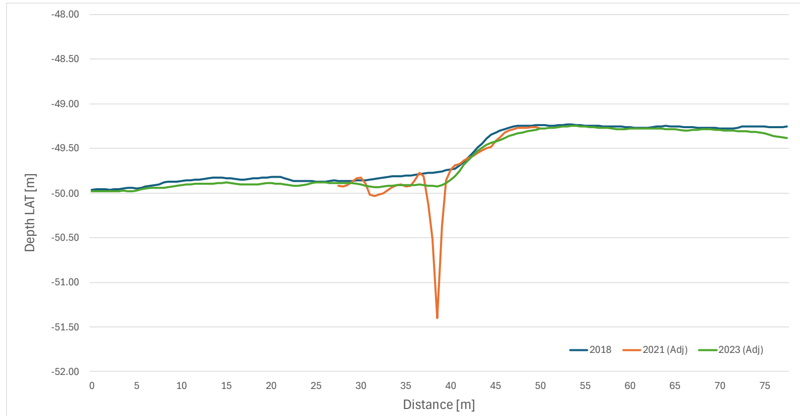
Turbine H08

MBES Comparison Plots

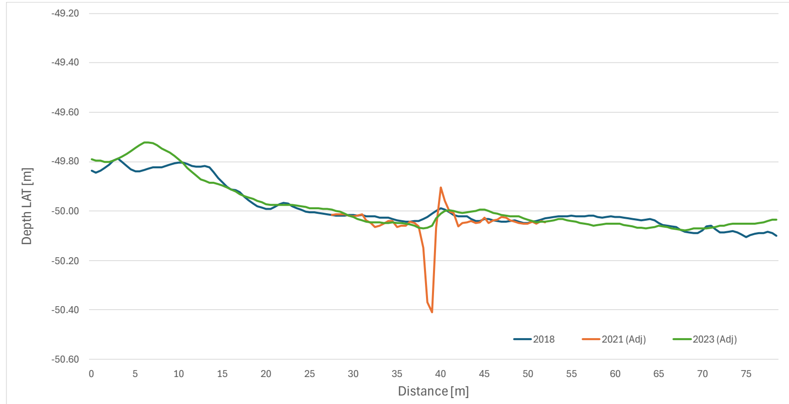


Inter-array cable pre- and post- installation profiles

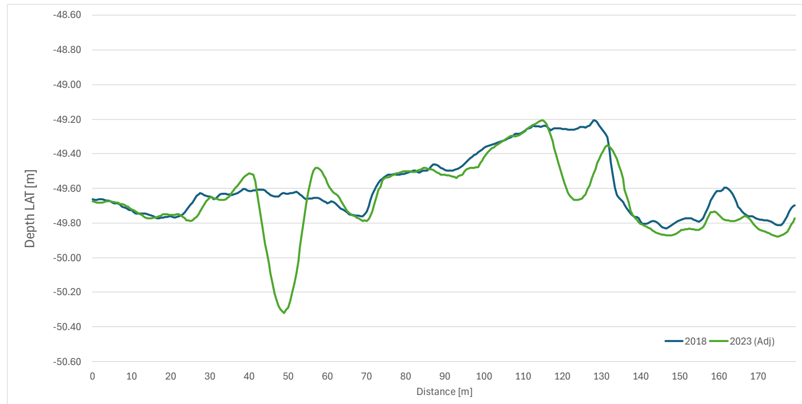
Cable 1



Cable 2

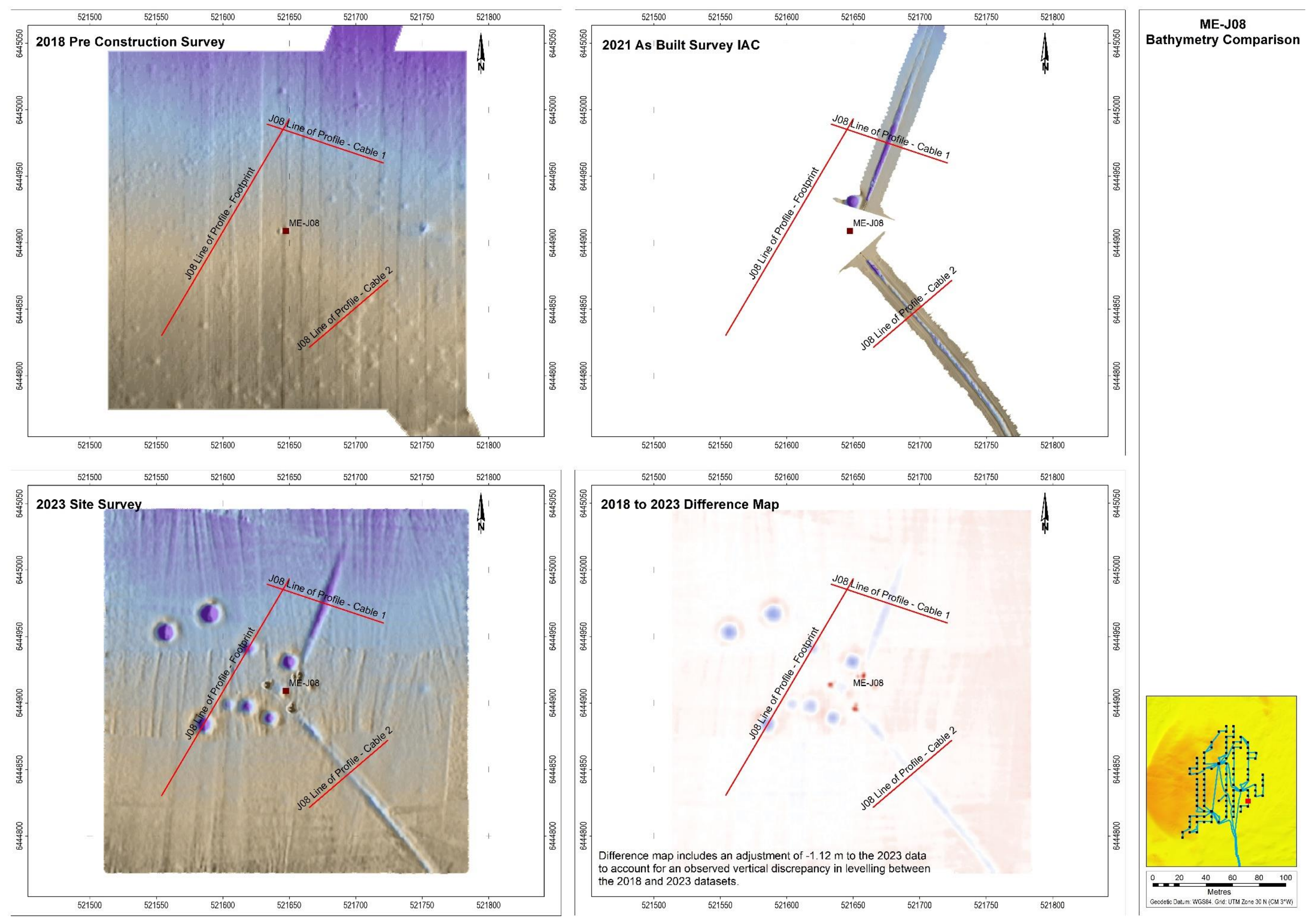


JUV impacts footprint profile



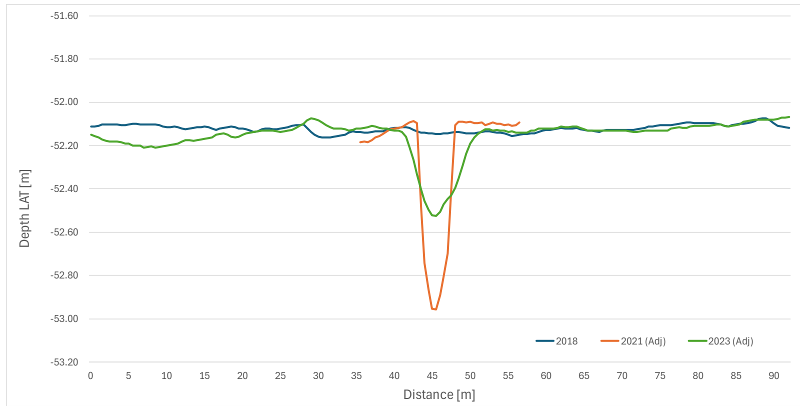
Turbine J08

MBES Comparison Plots

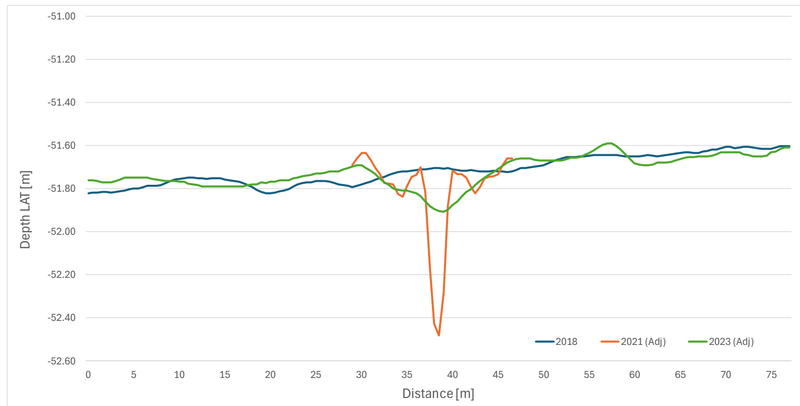


Inter-array cable pre- and post- installation profiles

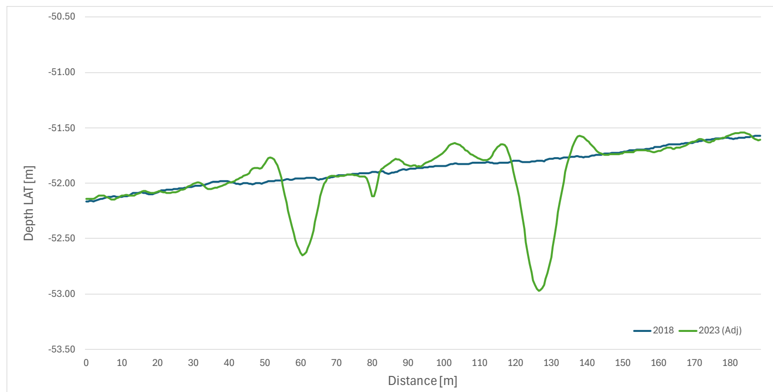
Cable 1



Cable 2

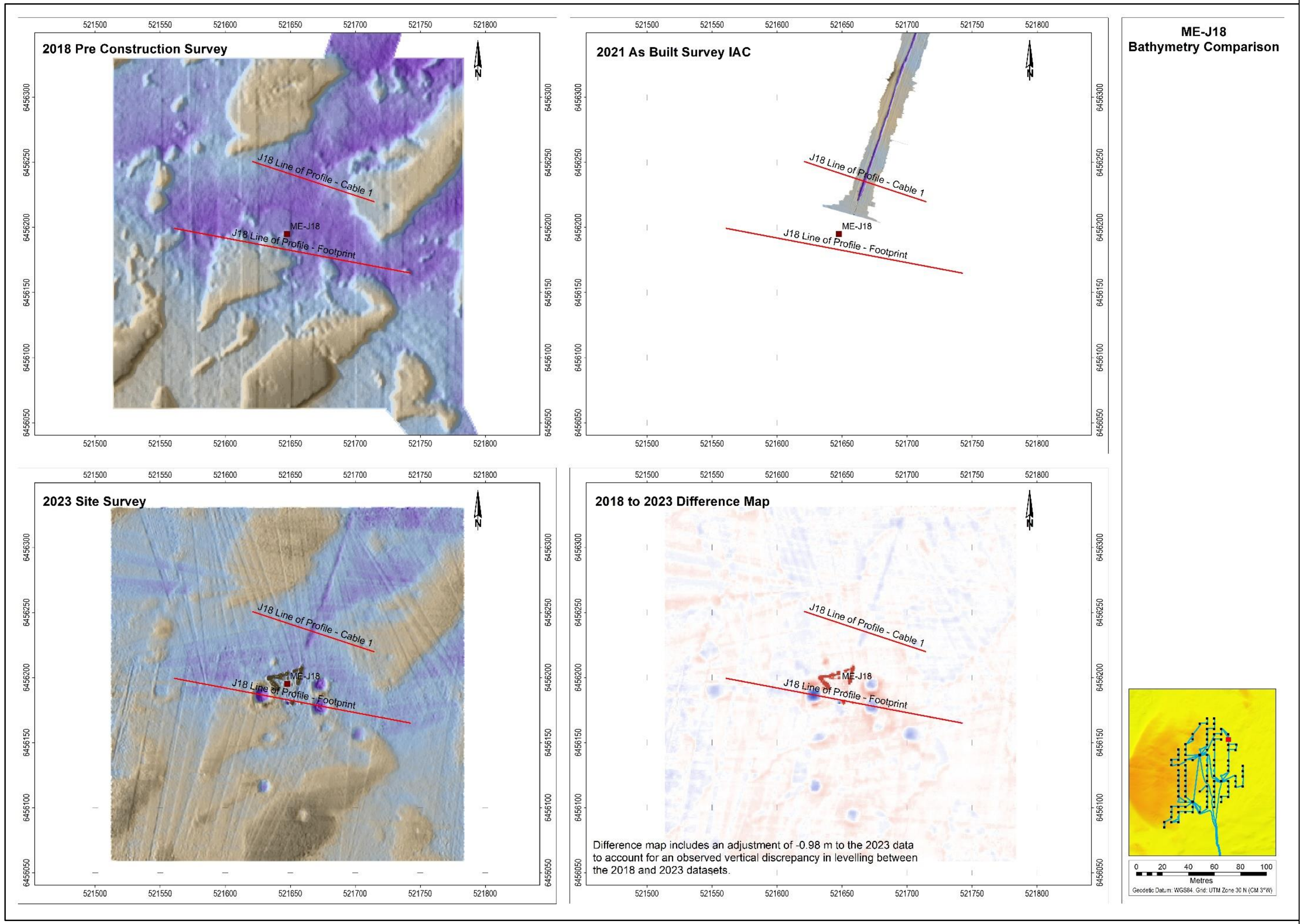


JUV impacts footprint profile



Turbine J18

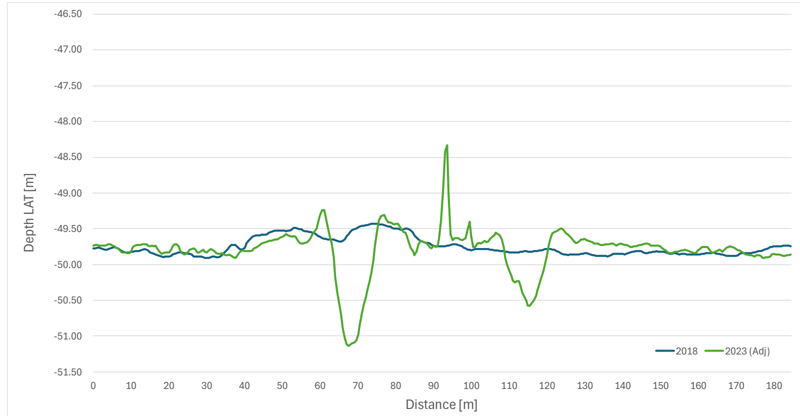
MBES Comparison Plots



Inter-array cable pre- and post- installation profiles

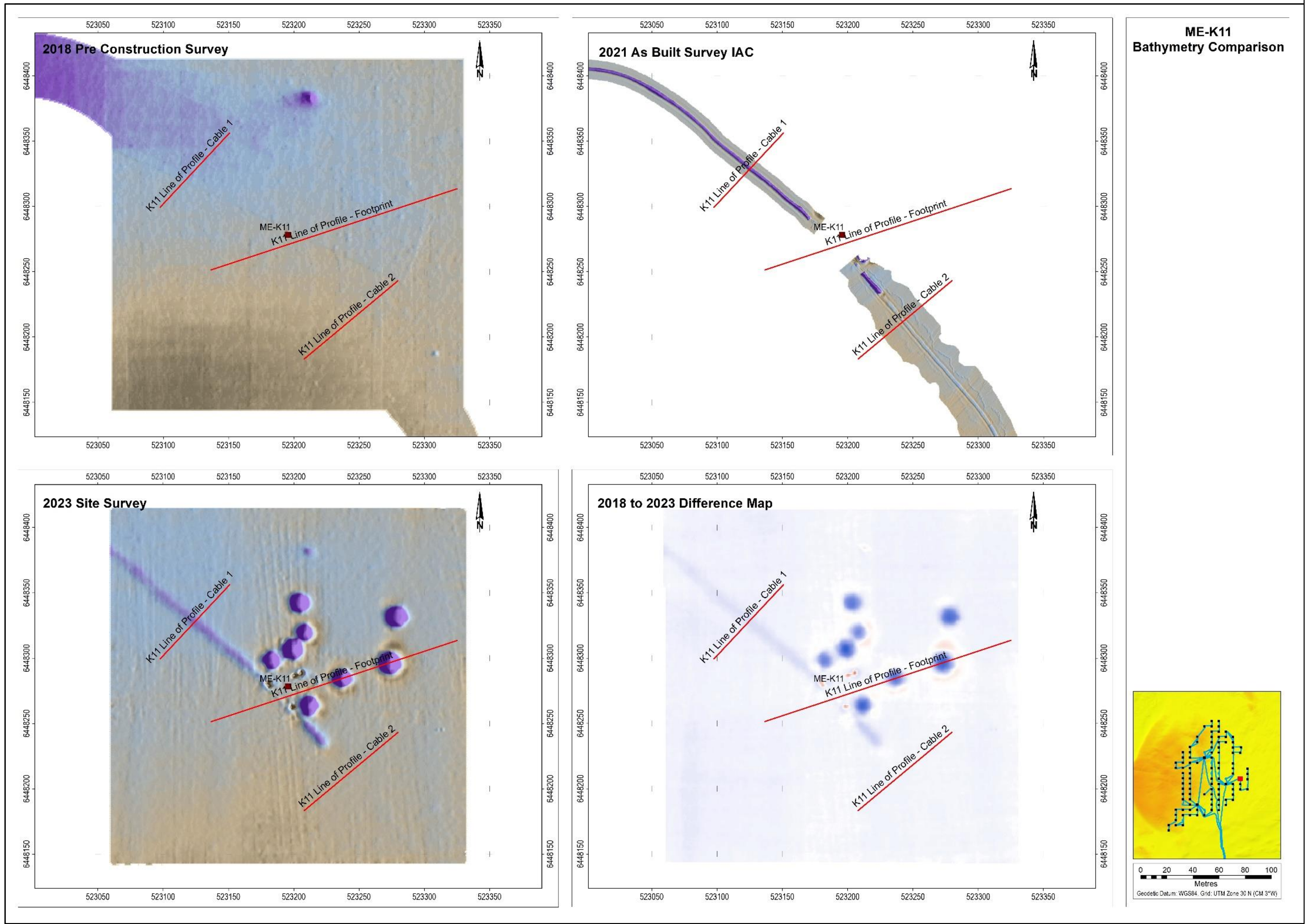
Cable 1

JUV impacts footprint profile



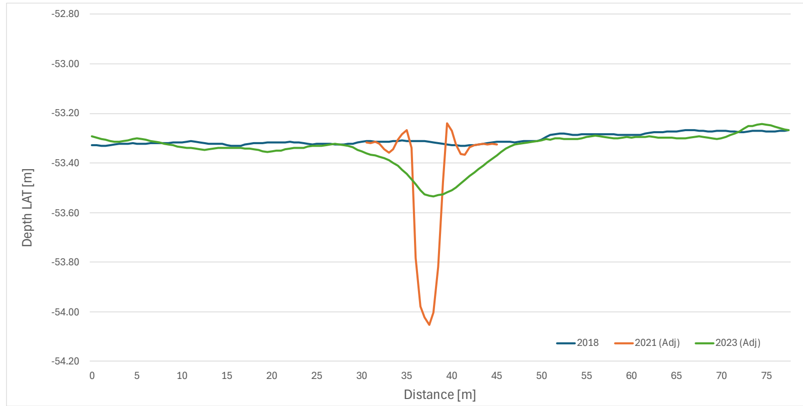
Turbine K11

MBES Comparison Plots



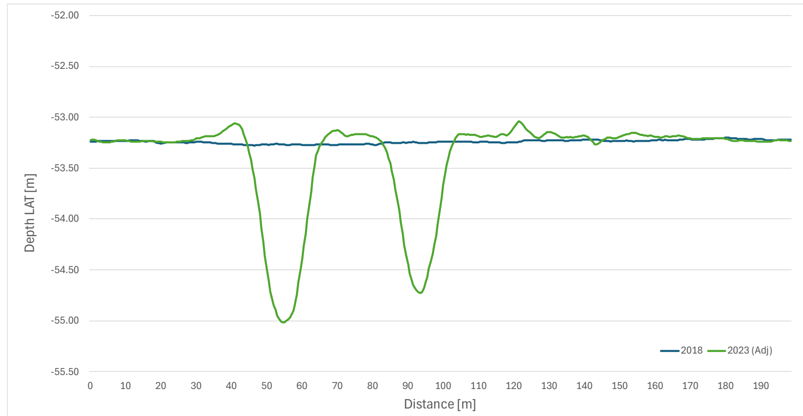
Inter-array cable pre- and post- installation profiles

Cable 1



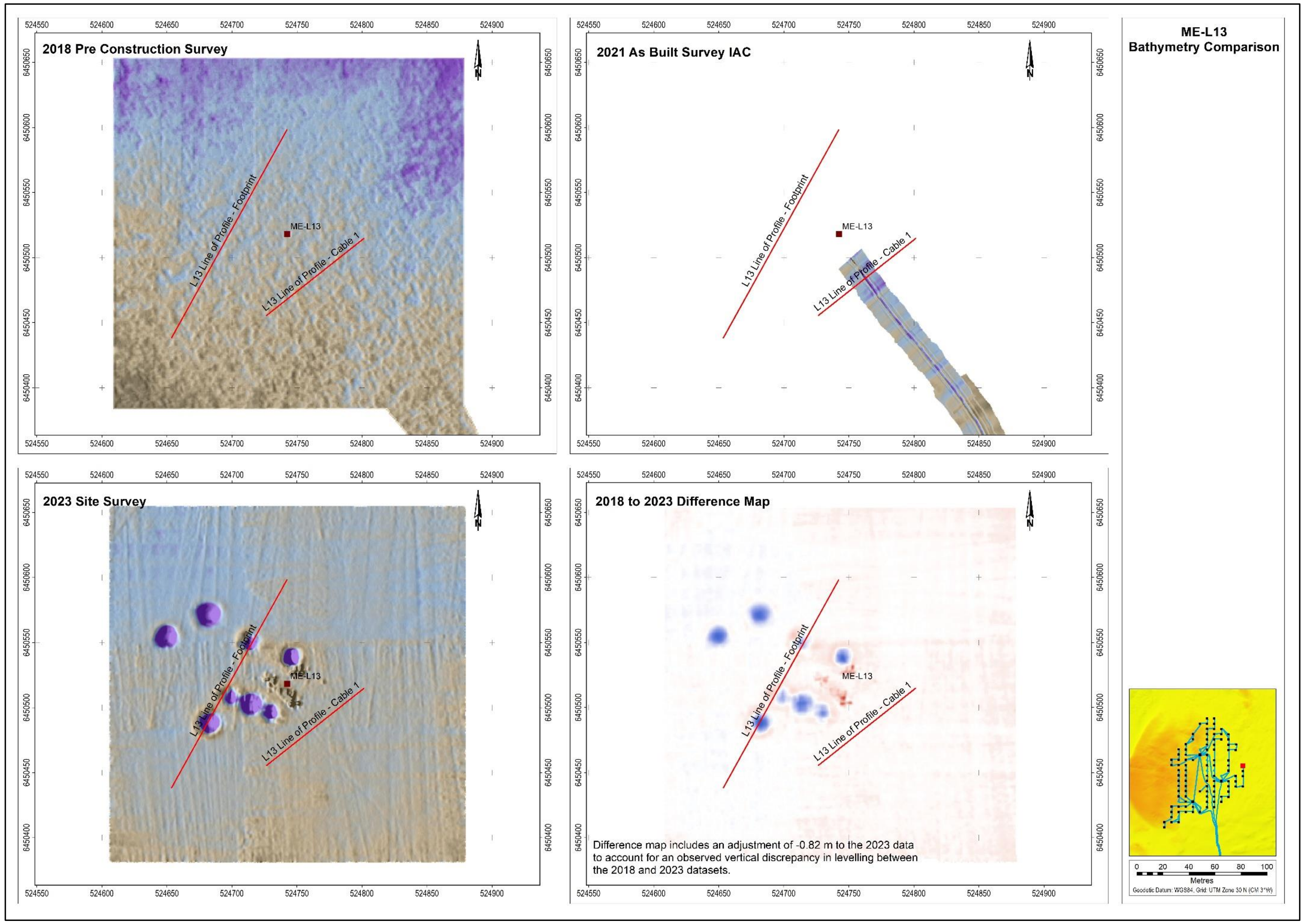
Cable 2

JUV impacts footprint profile



Turbine L13

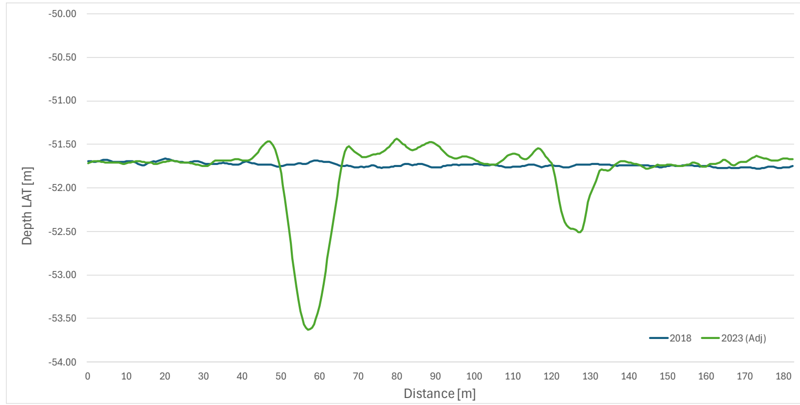
MBES Comparison Plots



Inter-array cable pre- and post- installation profiles

Cable 1

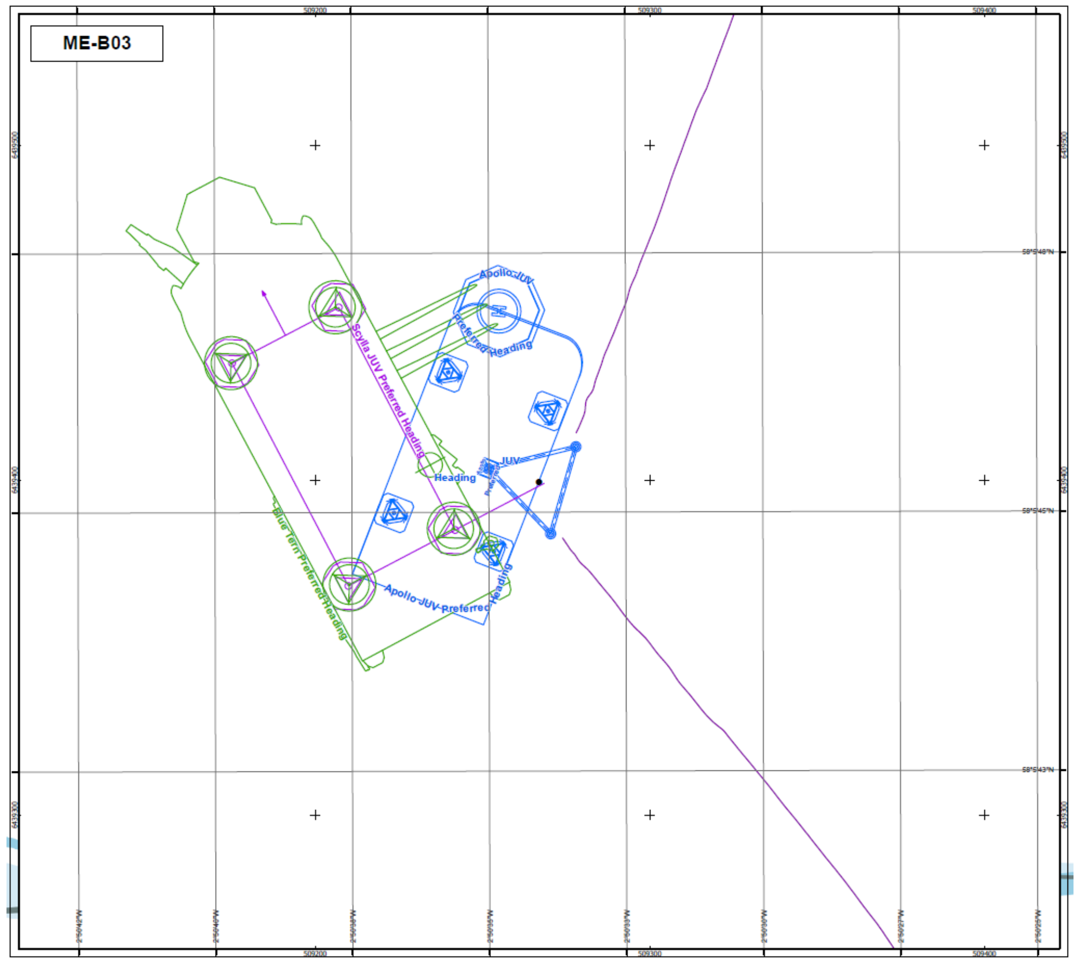
JUV impacts footprint profile

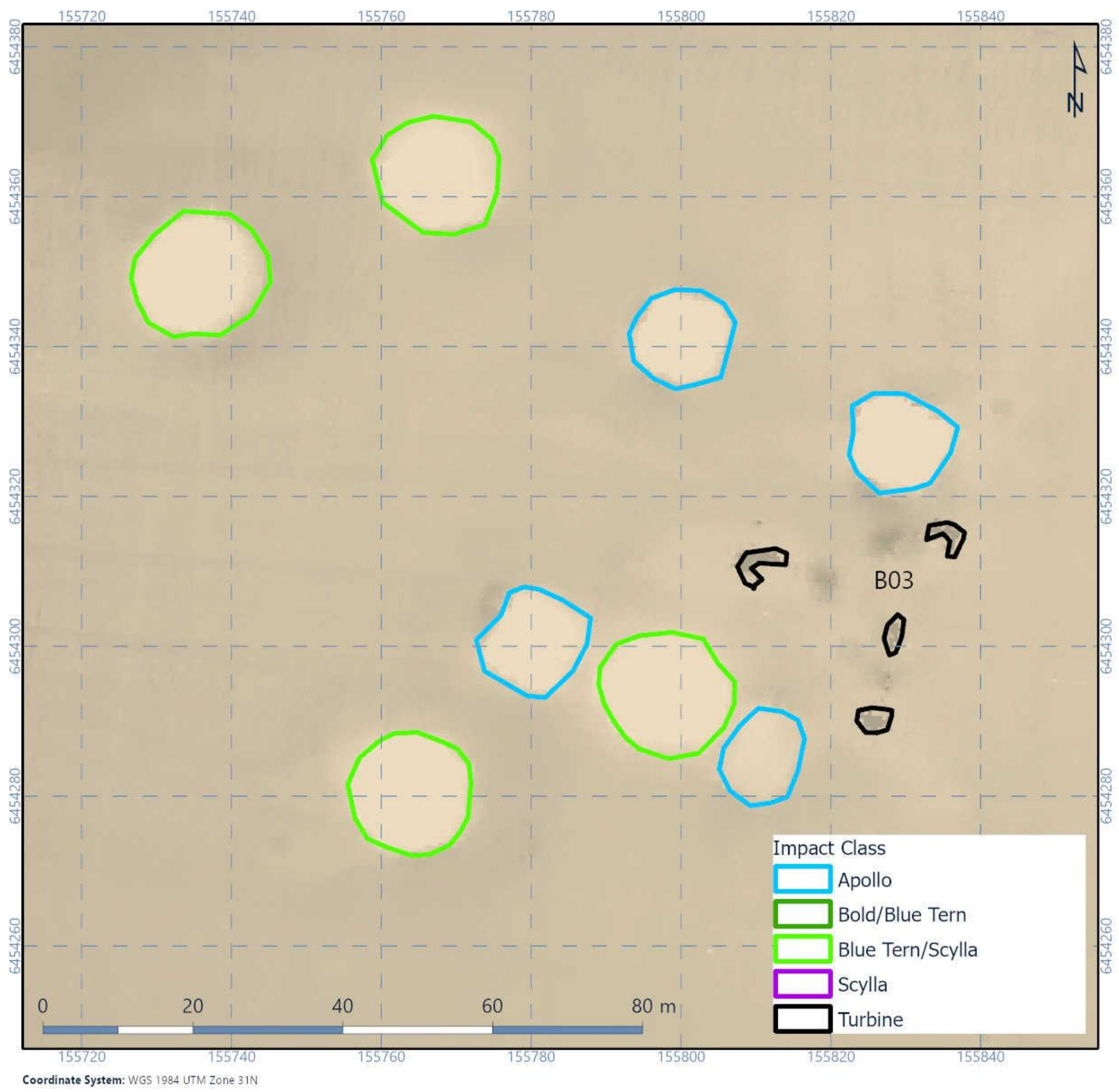


APPENDIX III

Spatial Extents of Interpreted Physical Seabed Impacts from Construction JUV Spud Legs

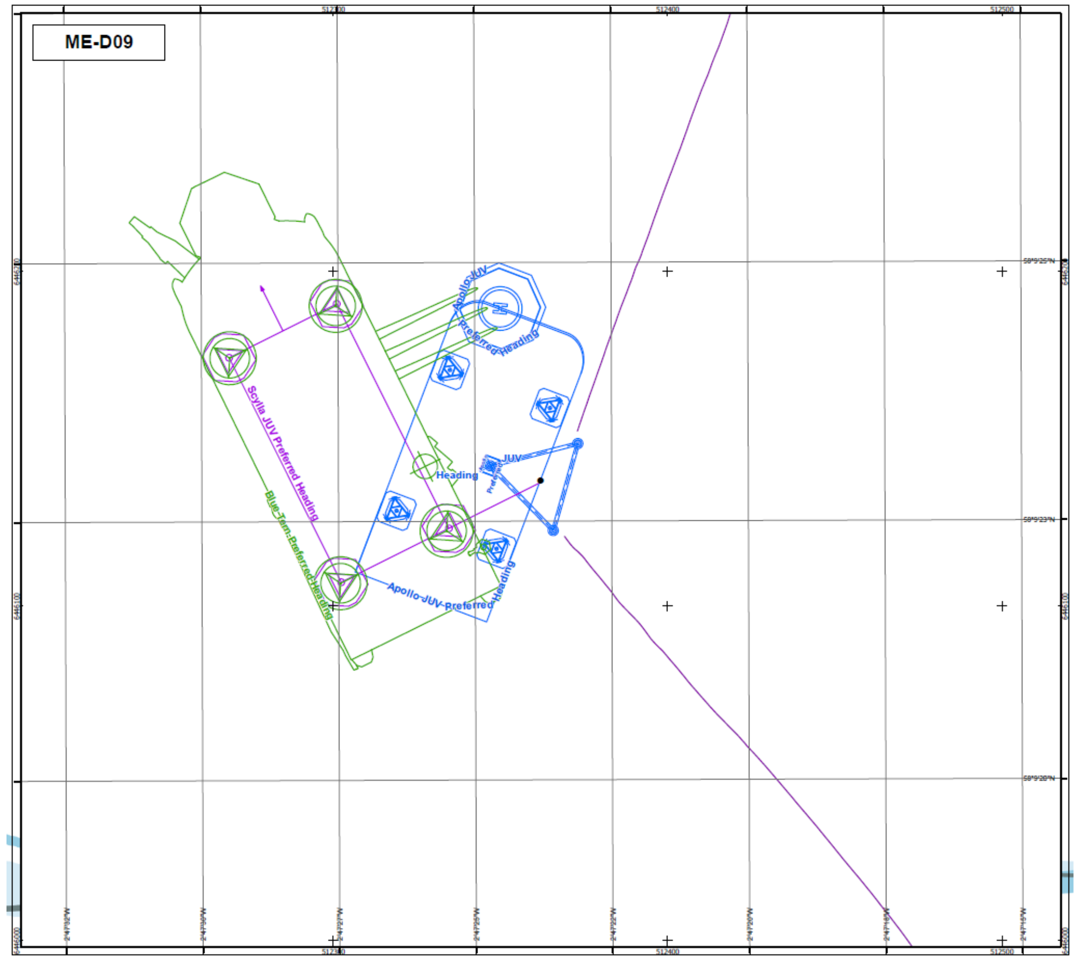
Asset	Area of seabed impact [m²]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
BO3	544		887		1431	

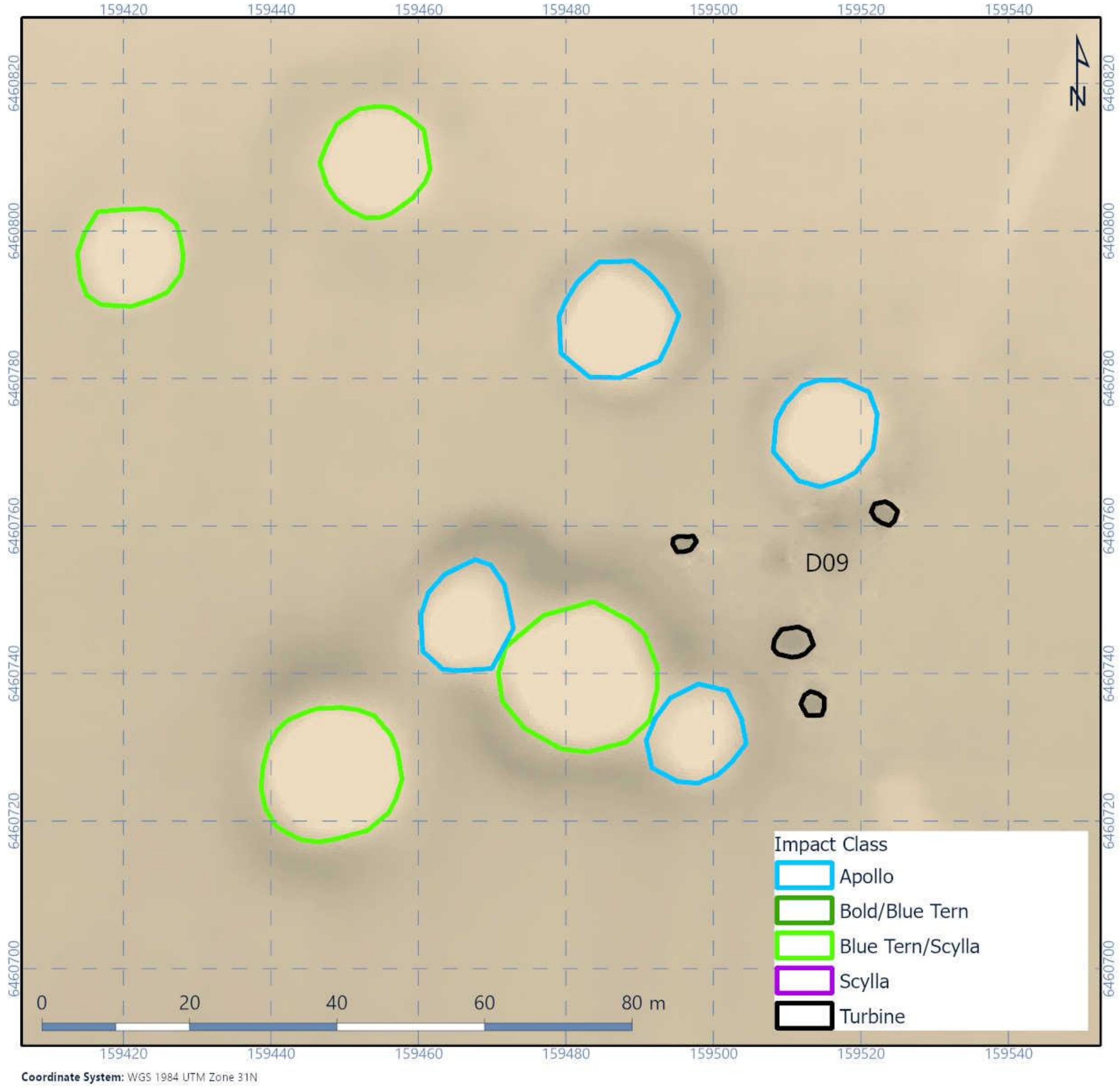




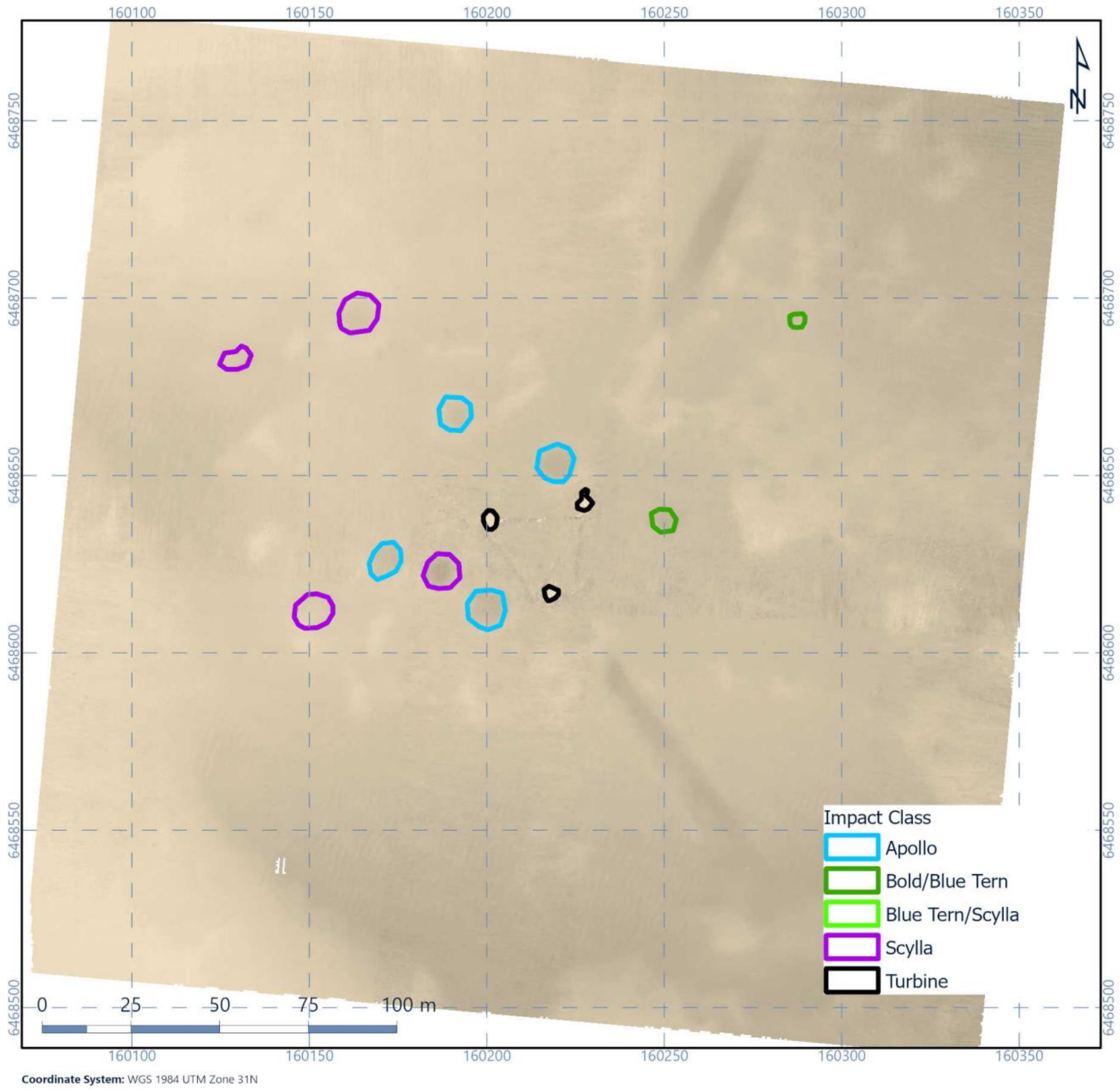
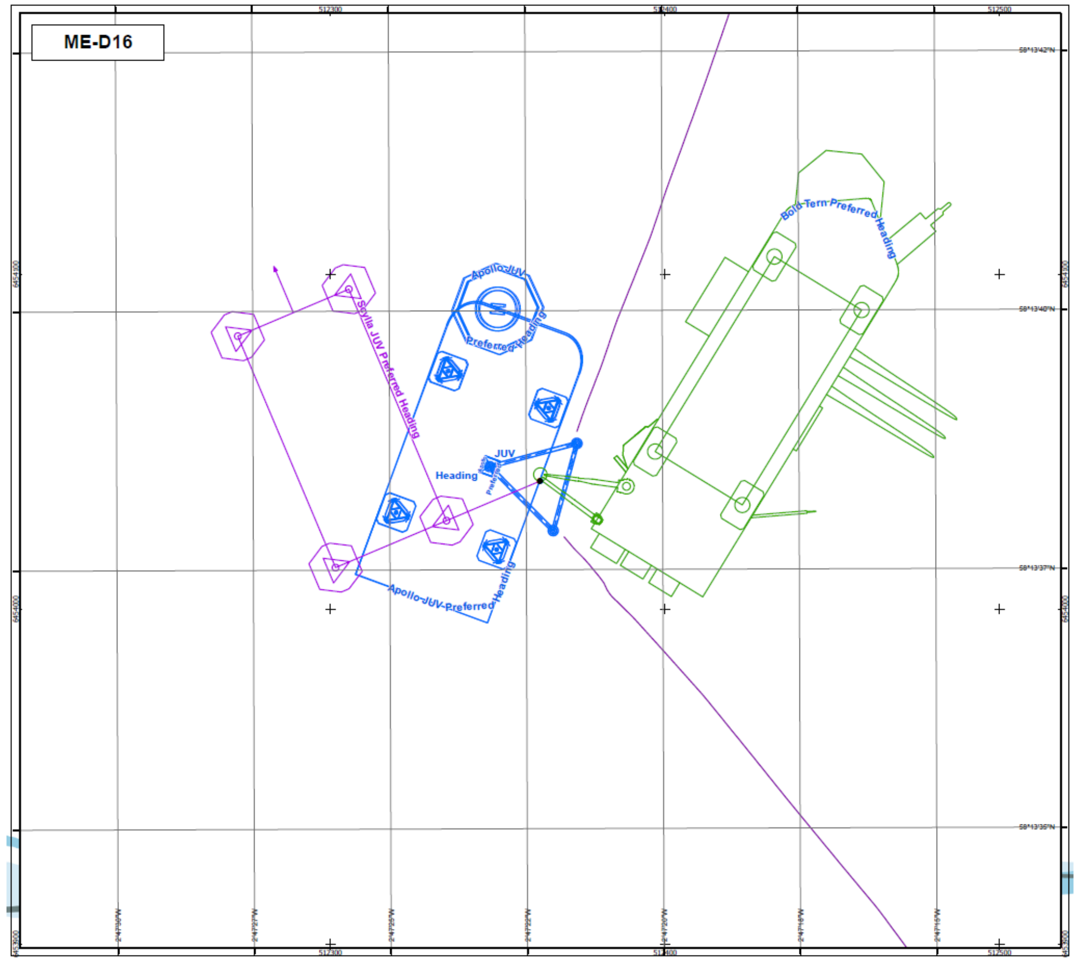
Seabed impacts from the use of all four of the spud legs of the Apollo and the combined impacts from the use of the Scylla and Blue Tern remain visible on the seabed.

Asset	Area of seabed impact [m²]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
D09	625		931		1556	

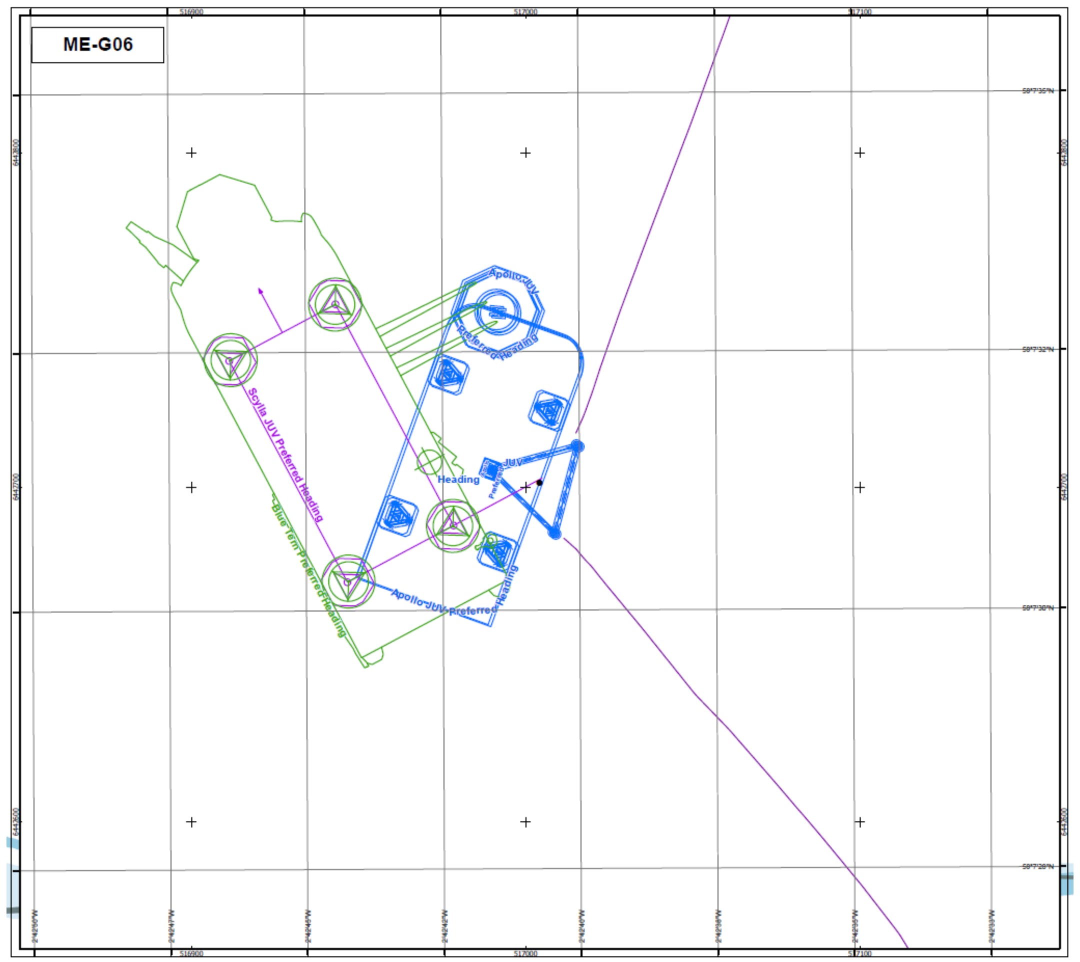


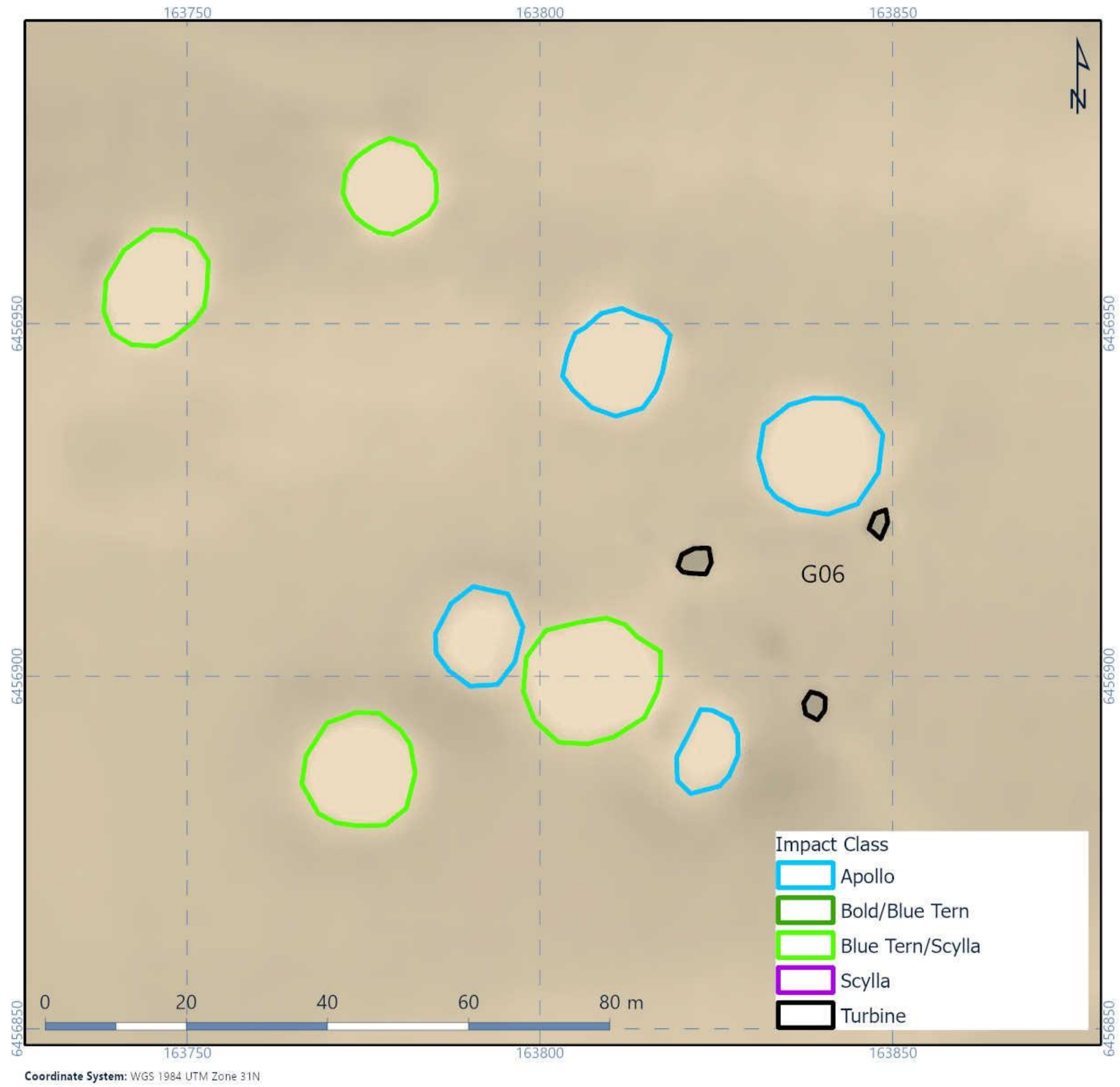


Seabed impacts from the use of all four of the spud legs of the Apollo and the combined impacts from the use of the Scylla and Blue Tern remain visible on the seabed.

Asset	Area of seabed impact [m^2]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
D16	315	49		297	661	
						
Seabed depressions caused by the use of all four of the spud legs of both the Apollo and Scylla JUVs remain conspicuous on the seabed some 3 years 10 months (Apollo) and 2 years 9 months (Scylla) post-installation. Seabed impacts from only two spud legs of the Bold Tern remains evident 2 years 3 months port installation. The remaining impacts of the Blue Tern spud legs appear to have been infilled.						

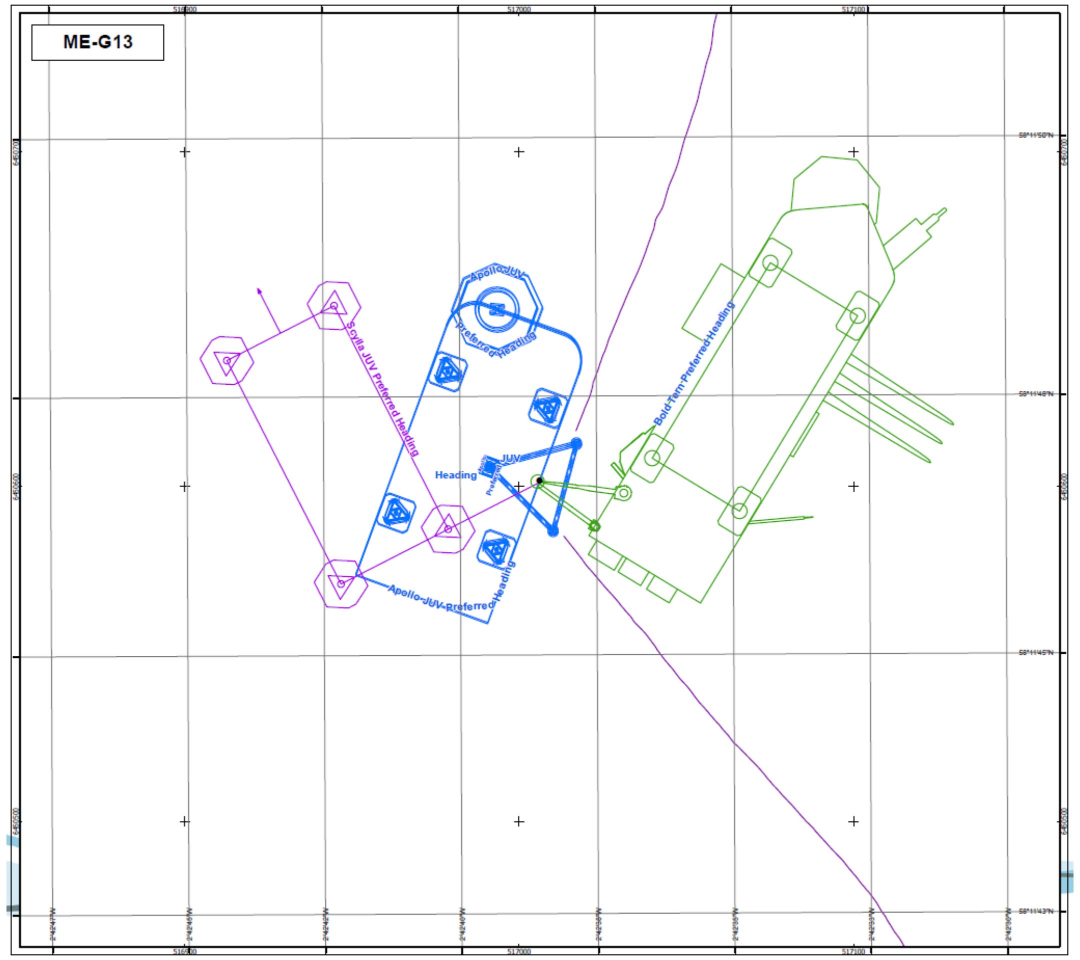
Asset	Area of seabed impact [m²]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
G06	599		793		1392	



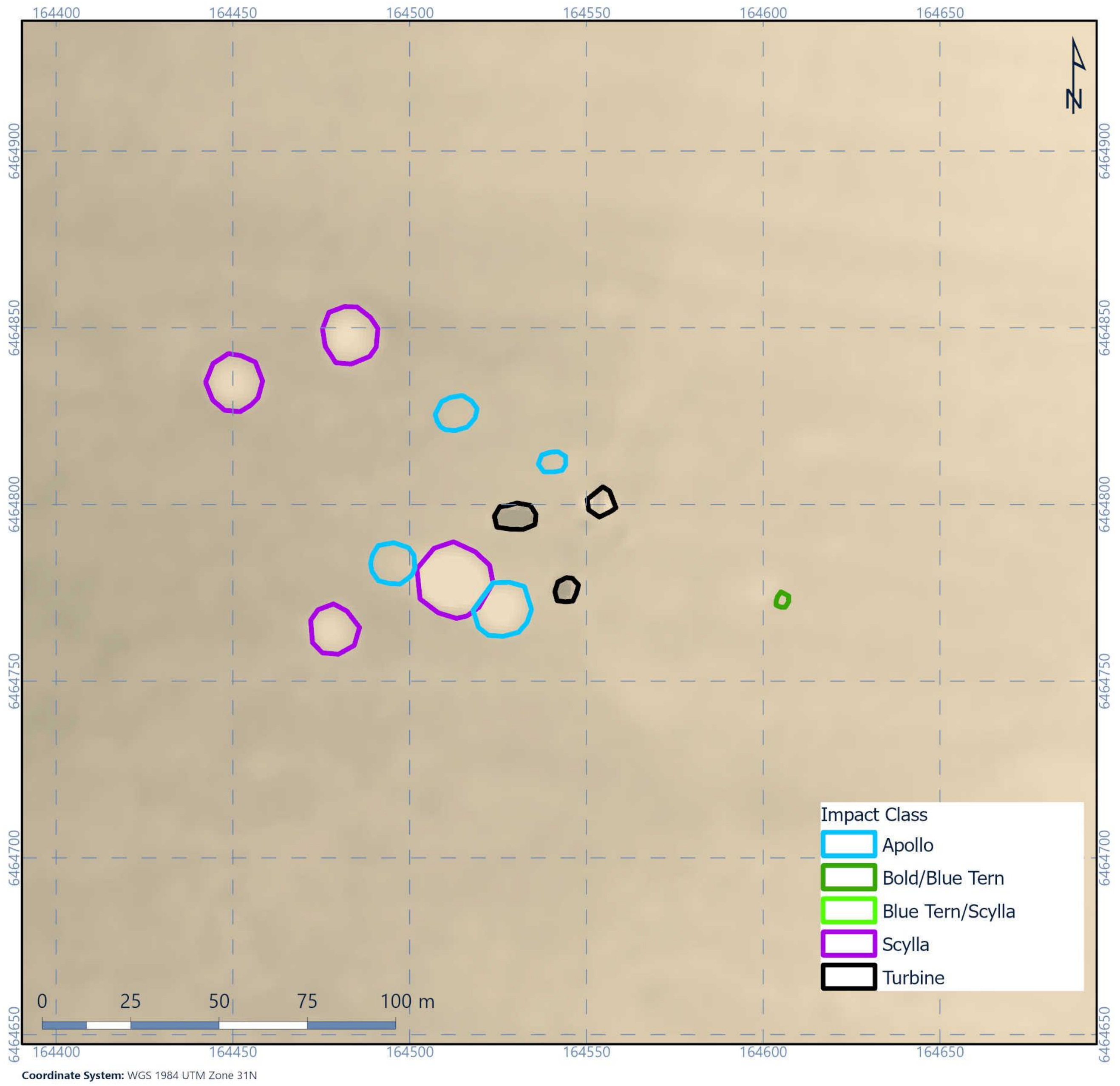


Seabed impacts from the use of all four of the spud legs of the Apollo and the combined impacts from the use of the Scylla and Blue Tern remain visible on the seabed.

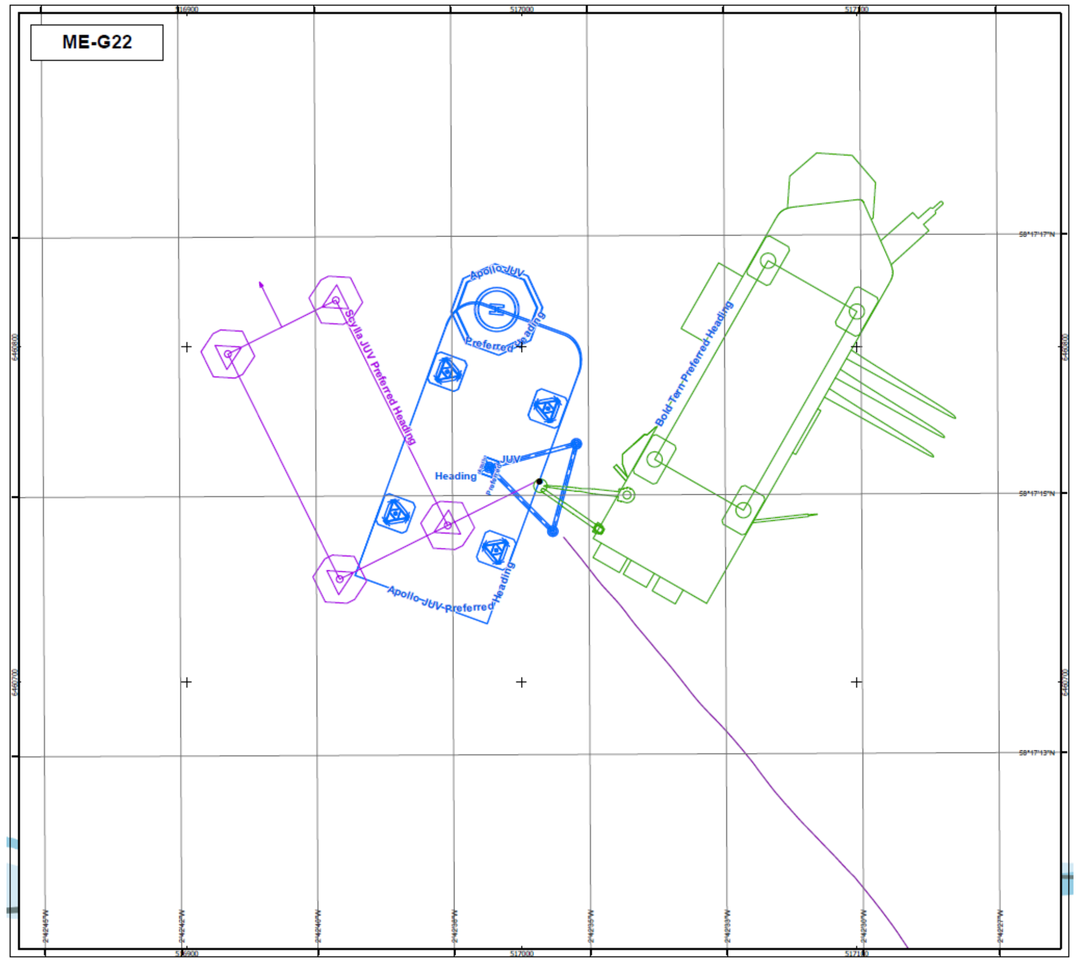
Asset	Area of seabed impact [m²]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
G13	428	12		872	1312	

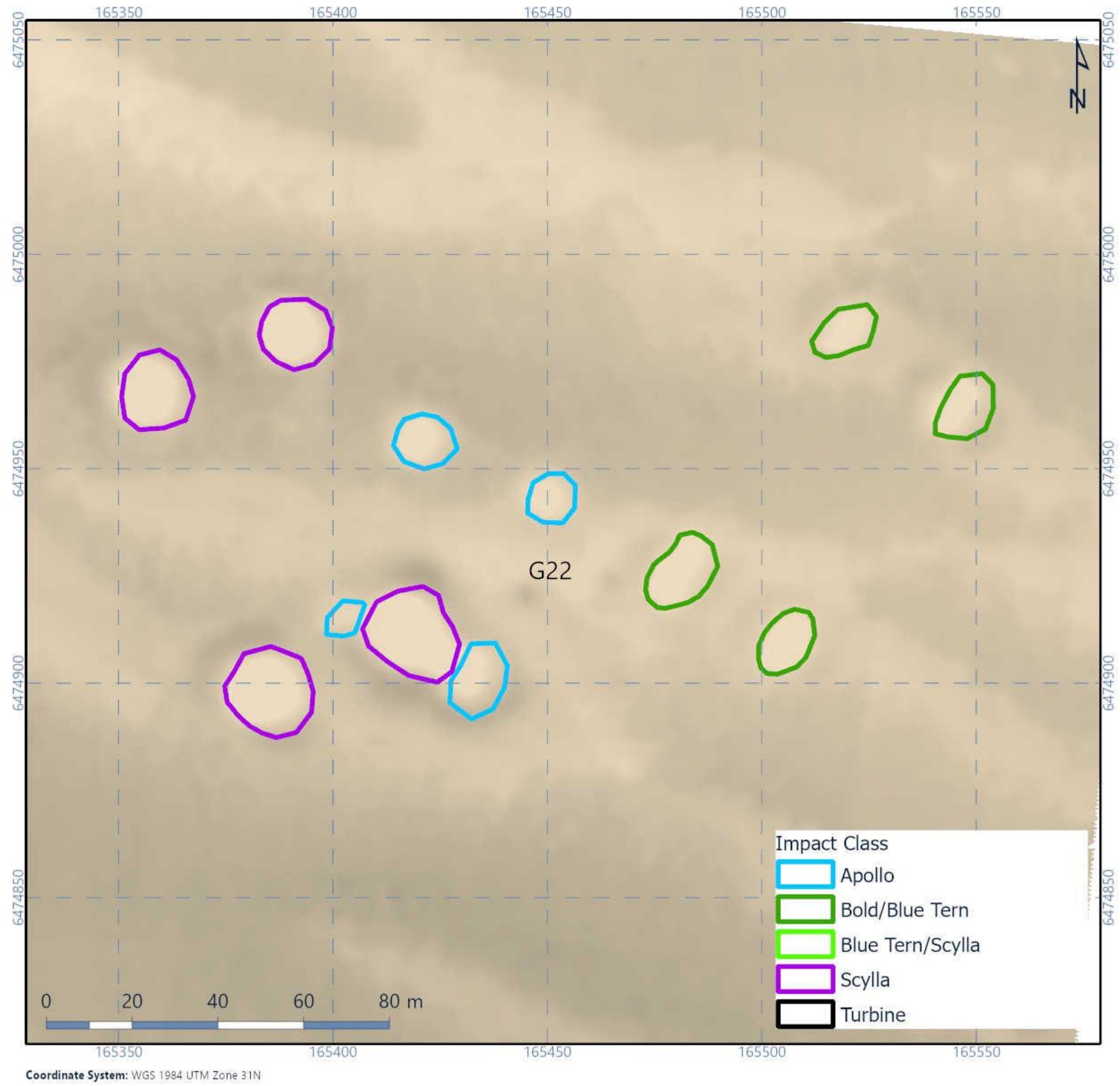


Seabed depressions caused by the use of all four of the spud legs of both the Apollo and Scylla JUVs remain conspicuous on the seabed some 3 years 7 months (Apollo) and 2 years 4 months (Scylla) post-installation. Seabed impacts from only one spud leg of the Blue Tern remains evident 1 year 10 months port installation. The remaining impacts of the Blue Tern appear to have been infilled and are no longer visible in the data.



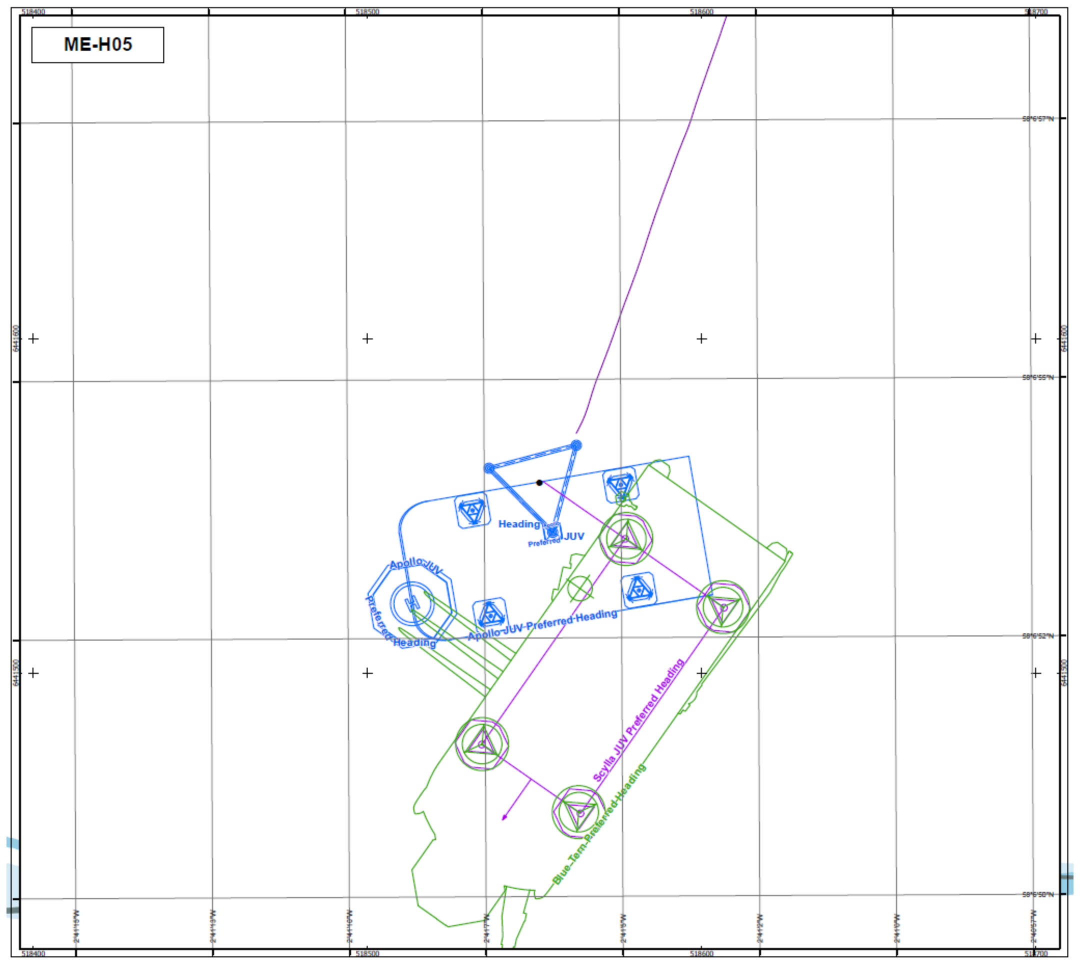
Asset	Area of seabed impact [m²]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
G22	463	620		1118	2201	

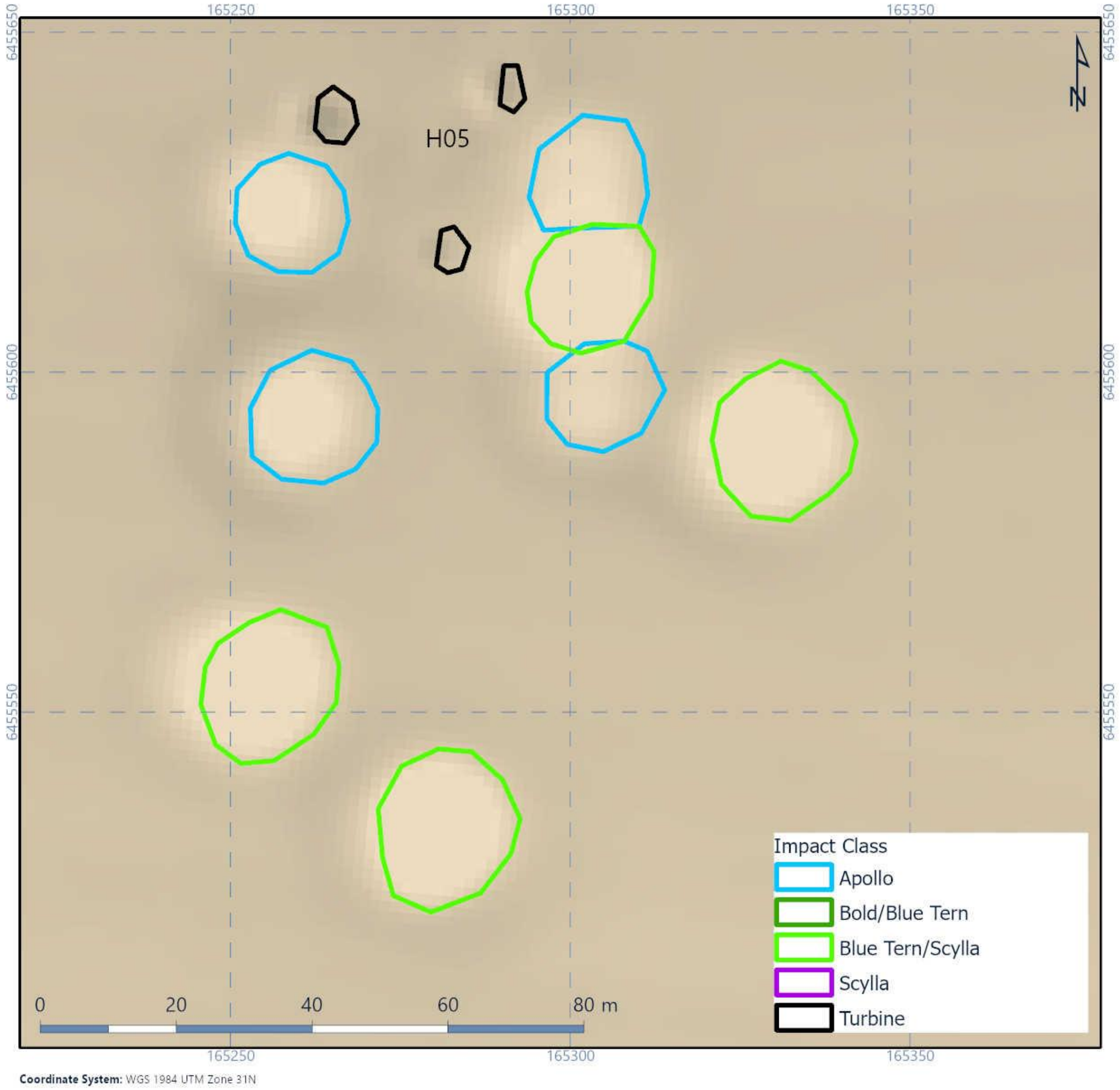




Seabed depressions caused by the use of all four of the spud legs of both the Apollo and Scylla JUVs remain conspicuous on the seabed some 4 years 4 months (Apollo) and 2 years 4 months (Scylla) post-installation. Seabed impacts from only one spud leg of the Blue Tern remains evident 1 year 10 months port installation. The remaining impacts of the Blue Tern appear to have been infilled.

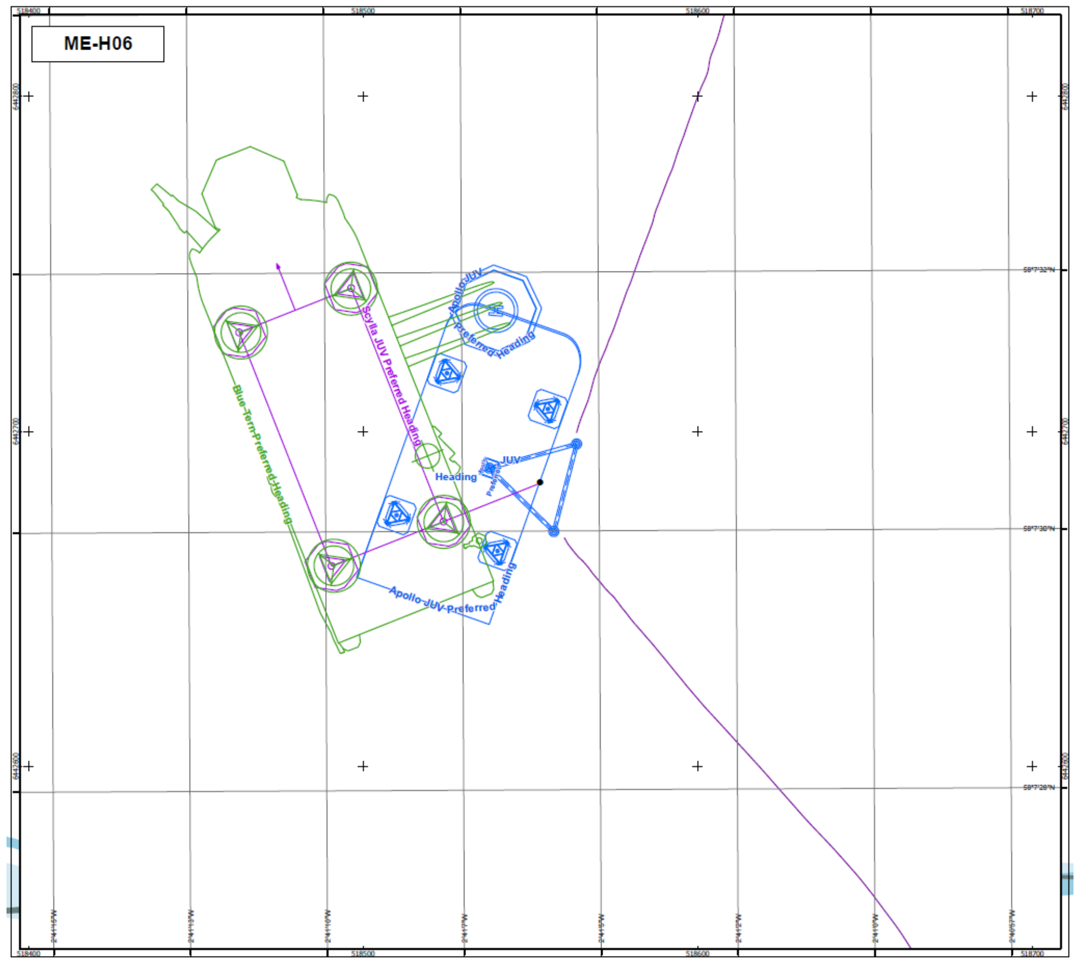
Asset	Area of seabed impact [m²]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
H05	960		1351		2311	

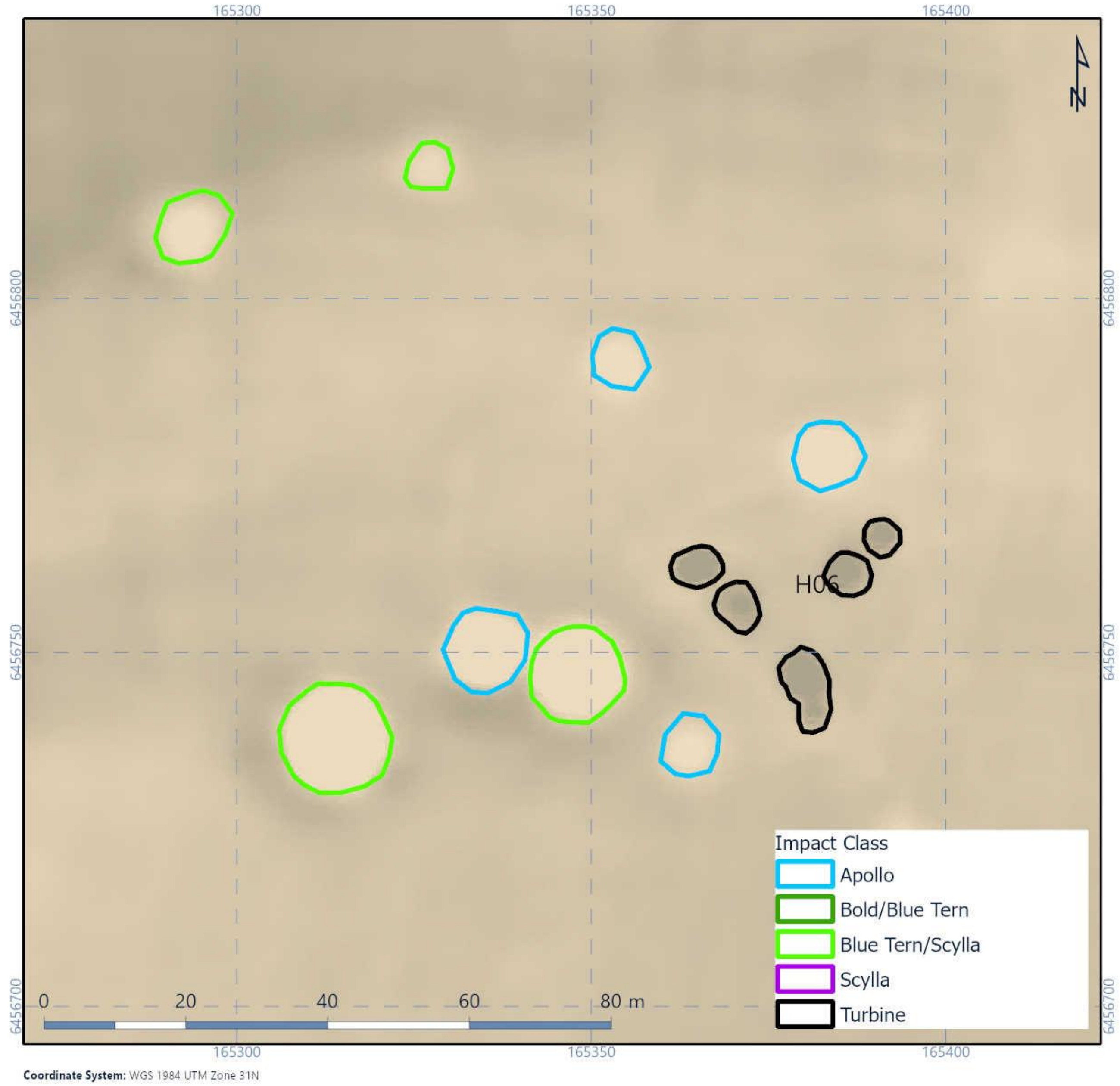




Seabed impacts from the use of all four of the spud legs of the Apollo and the combined impacts from the use of the Scylla and Blue Tern remain visible on the seabed.

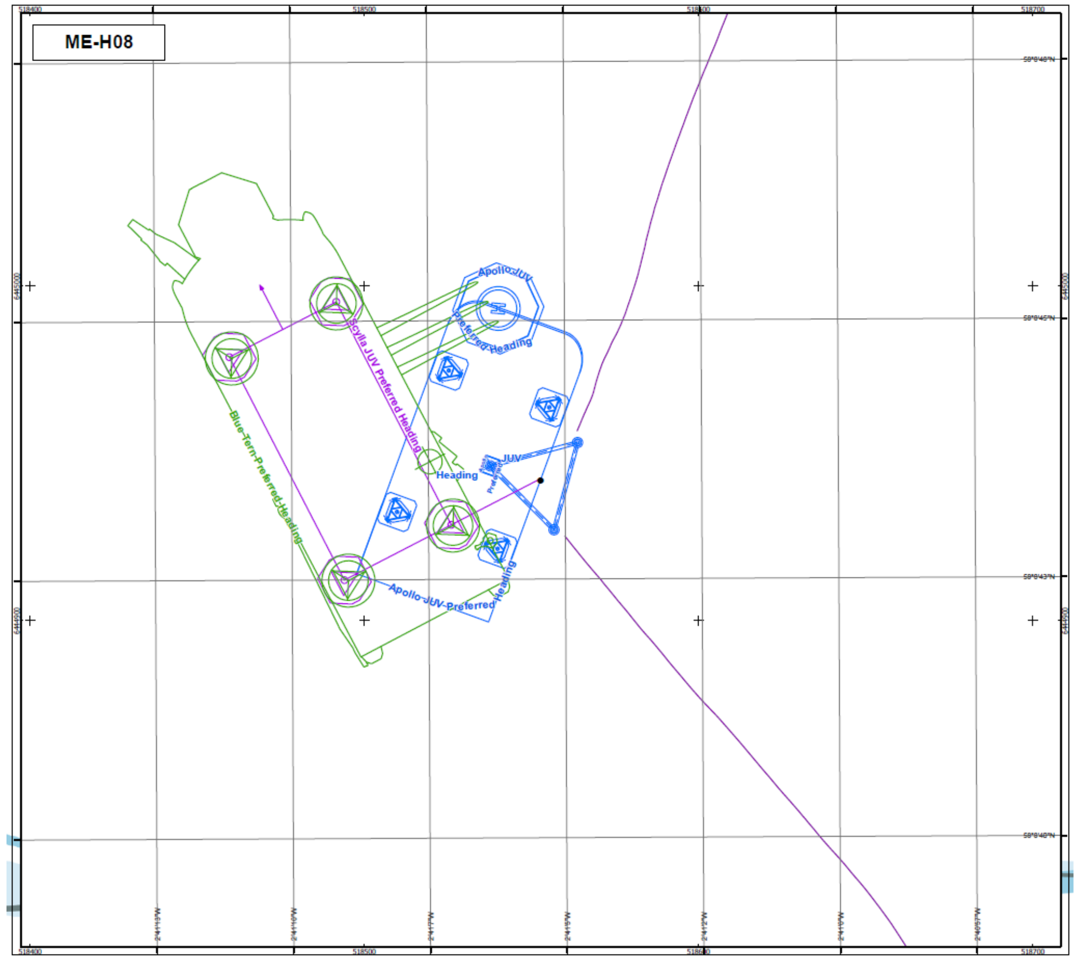
Asset	Area of seabed impact [m^2]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
H06	287		450		737	

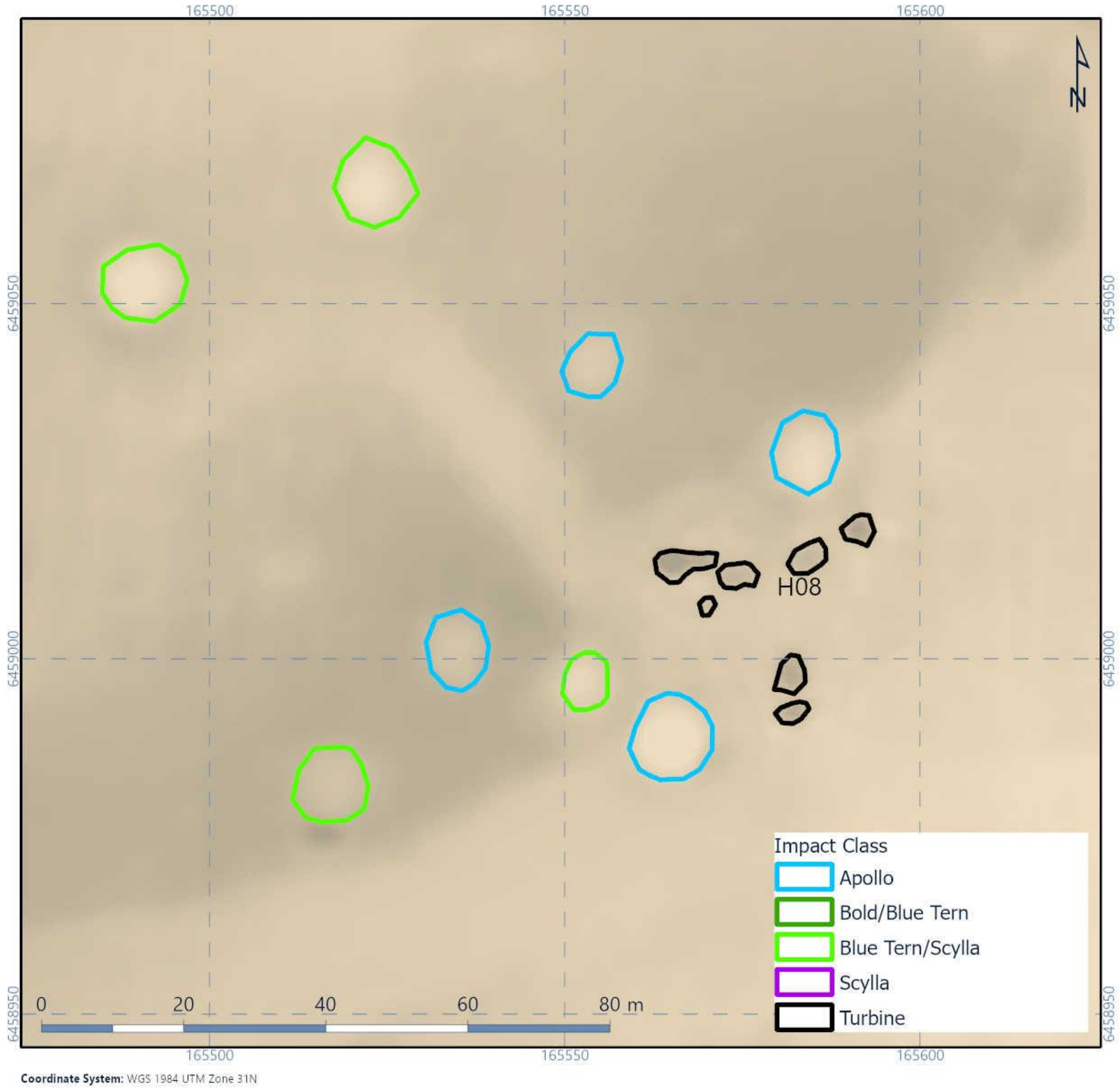




Seabed impacts from the use of all four of the spud legs of the Apollo and the combined impacts from the use of the Scylla and Blue Tern remain visible on the seabed.

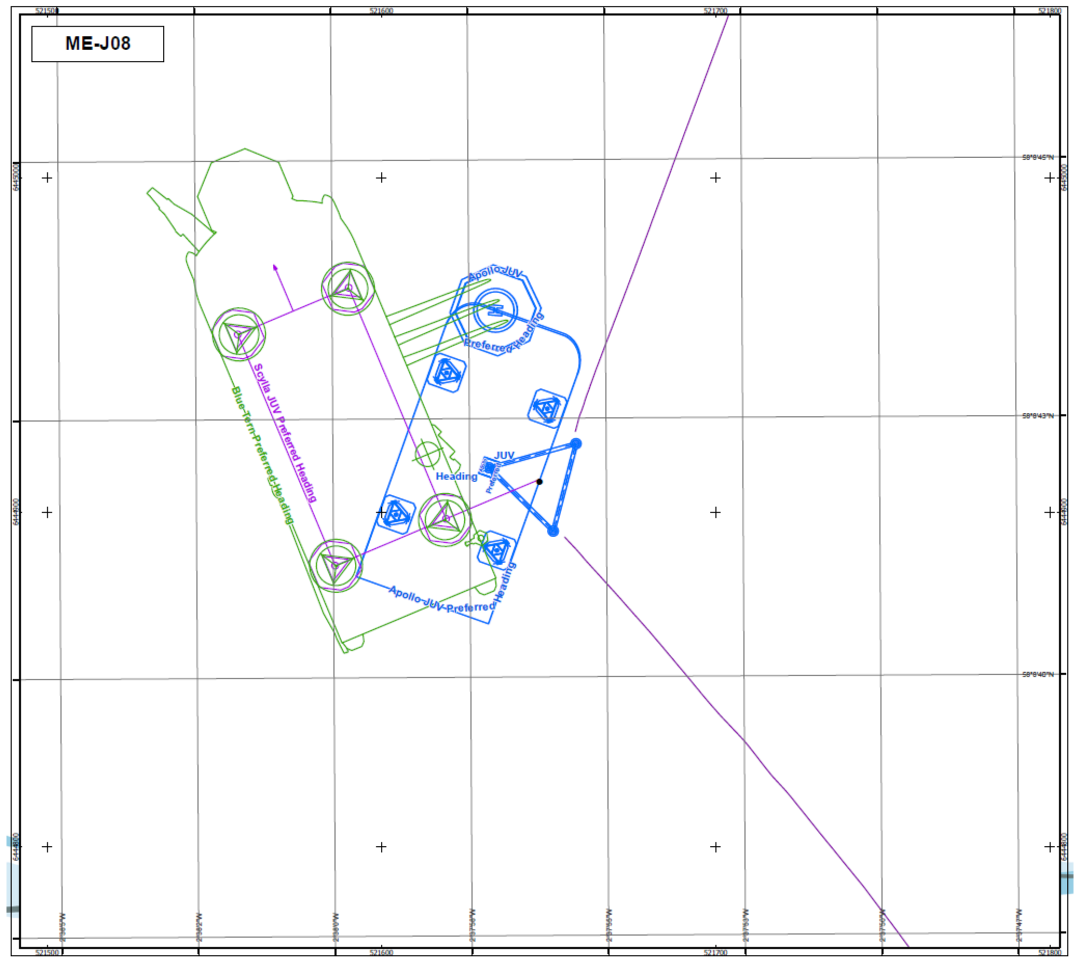
Asset	Area of seabed impact [m²]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
H08	321		327		648	

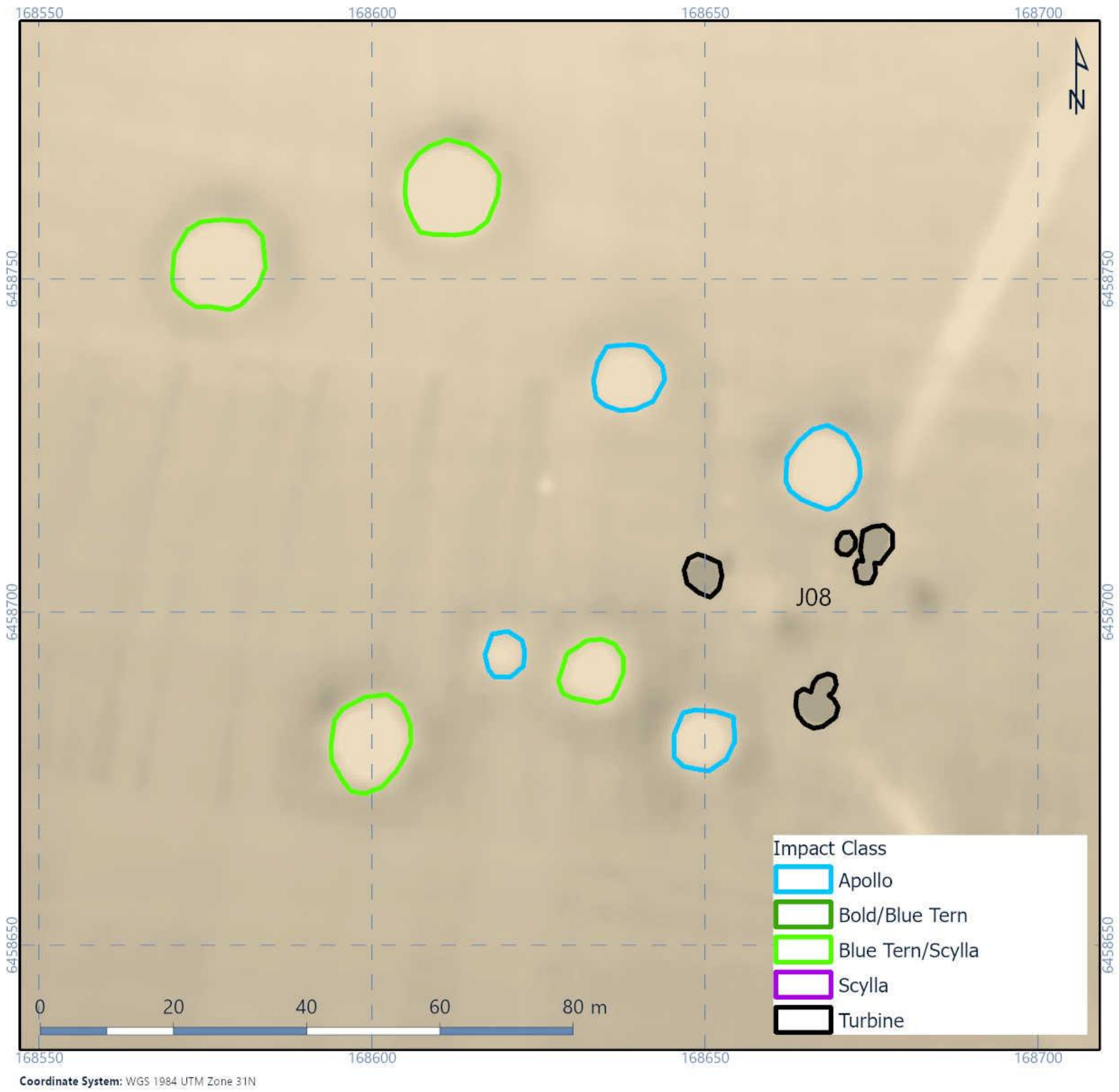




Seabed impacts from the use of all four of the spud legs of the Apollo and the combined impacts from the use of the Scylla and Blue Tern remain visible on the seabed.

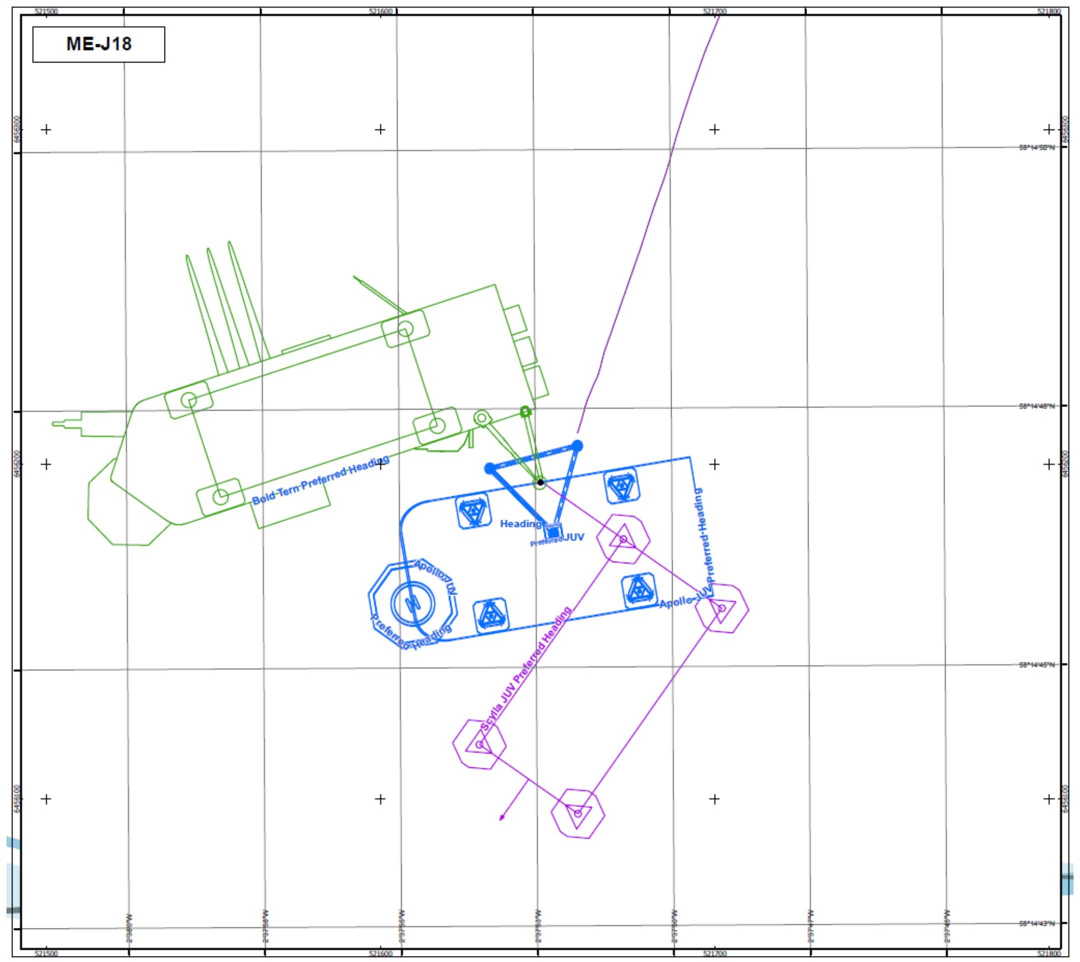
Asset	Area of seabed impact [m²]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
J08	287		521		808	

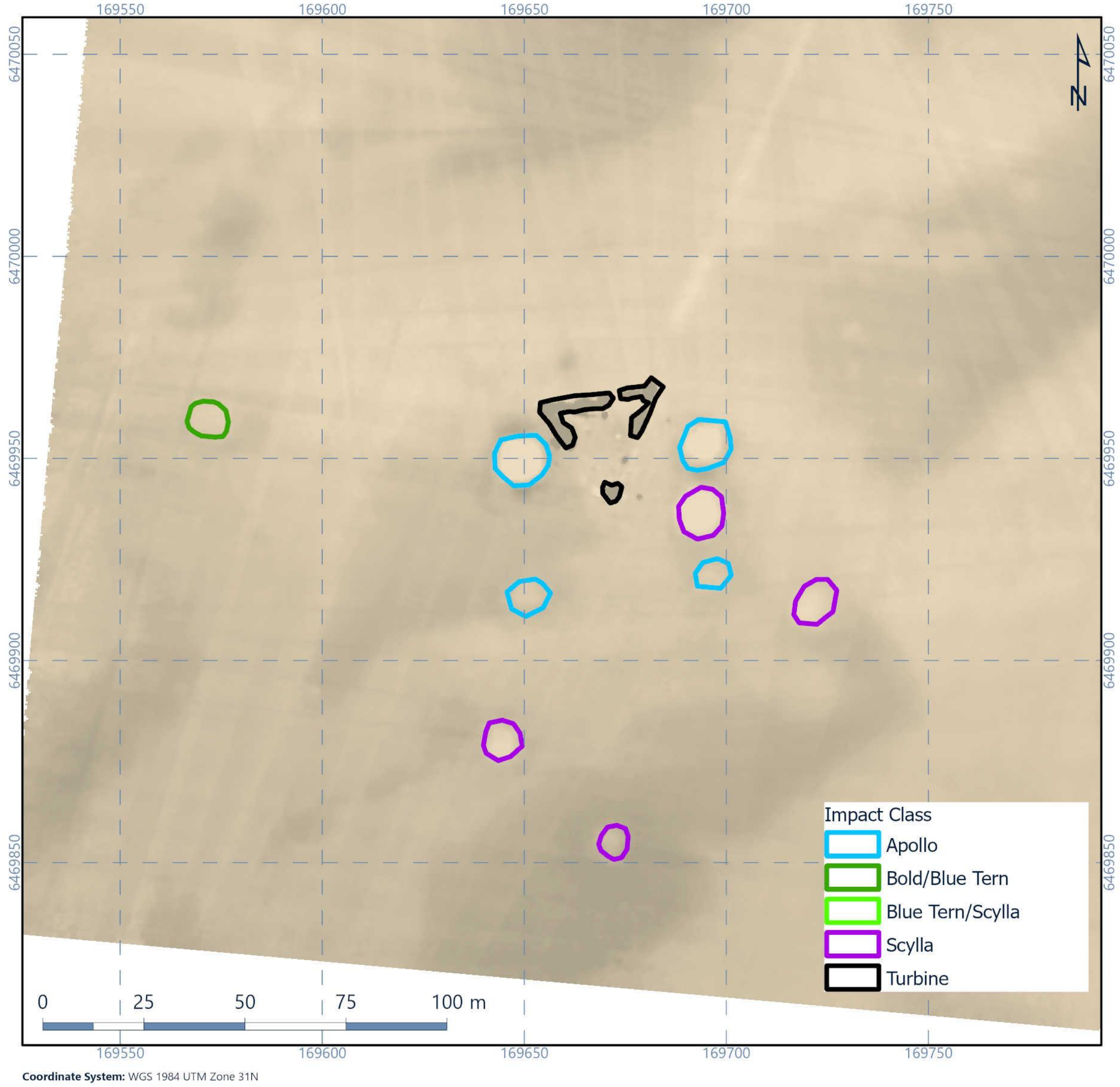




Seabed impacts from the use of all four of the spud legs of the Apollo and the combined impacts from the use of the Scylla and Blue Tern remain visible on the seabed.

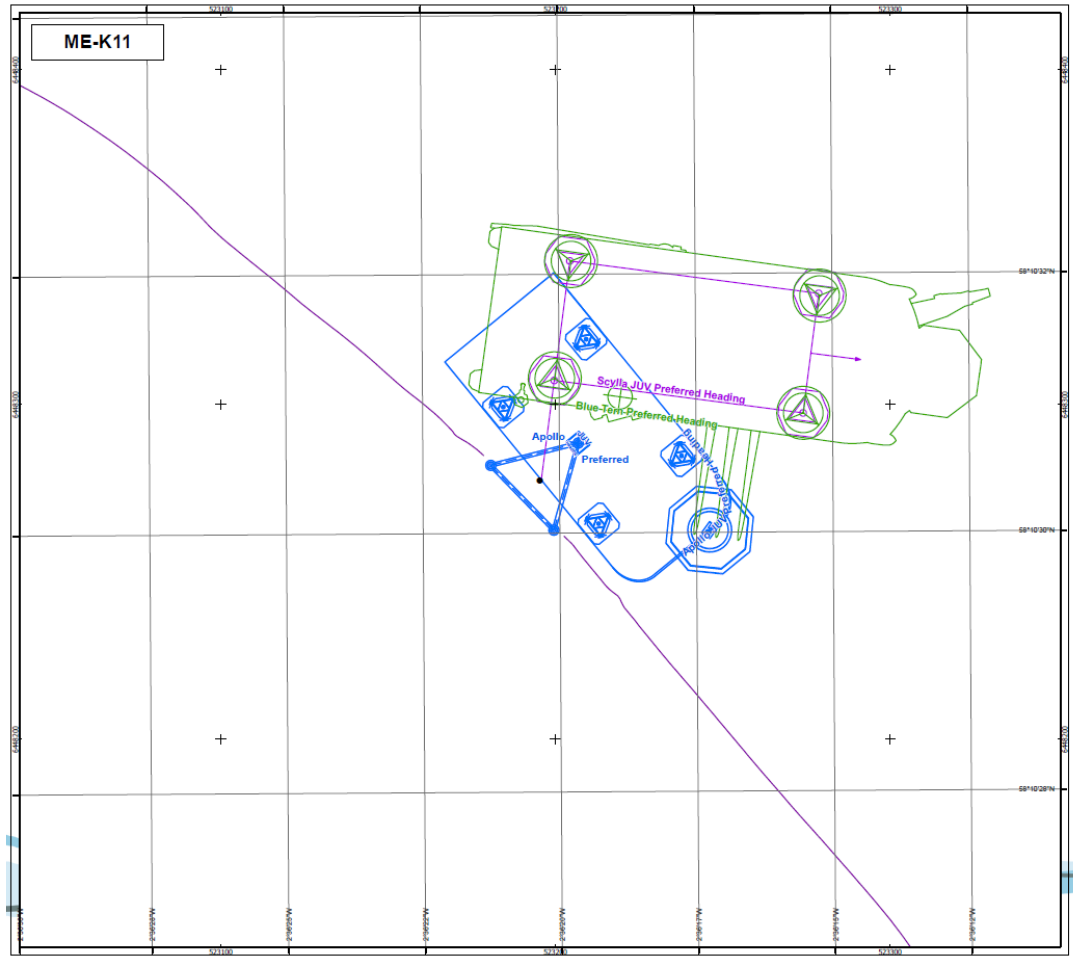
Asset	Area of seabed impact [m²]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
J18	375	83		314	689	

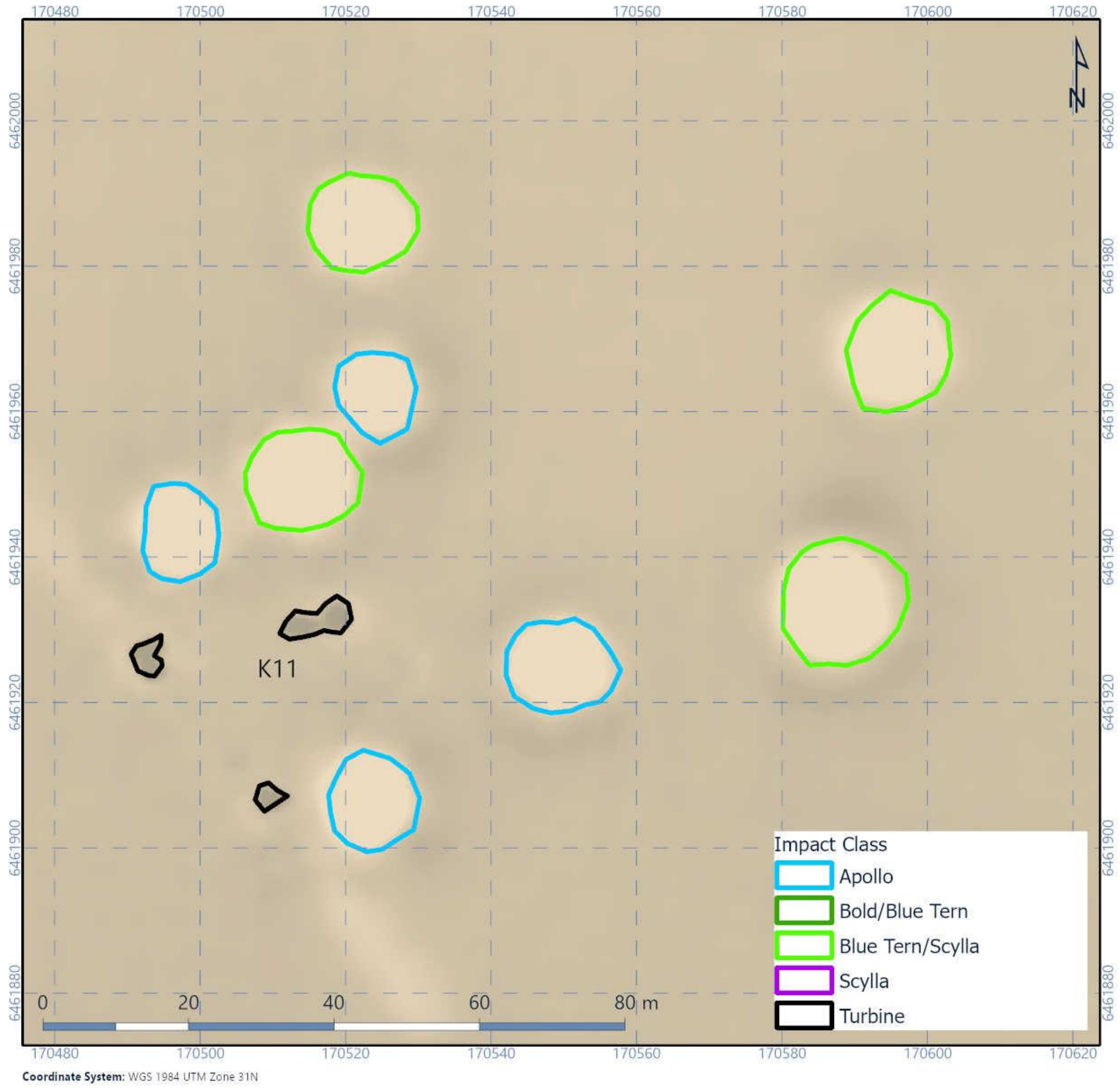




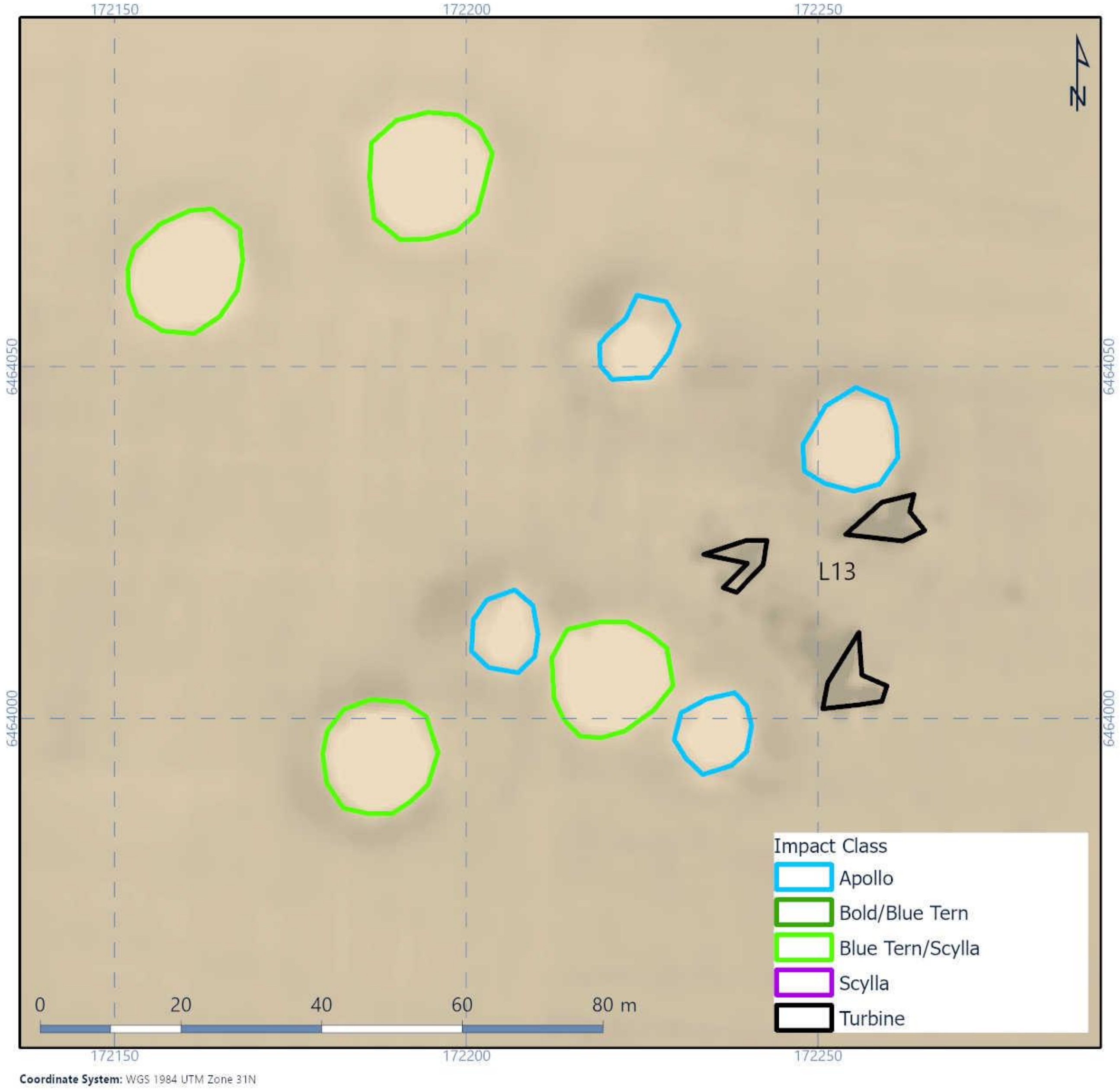
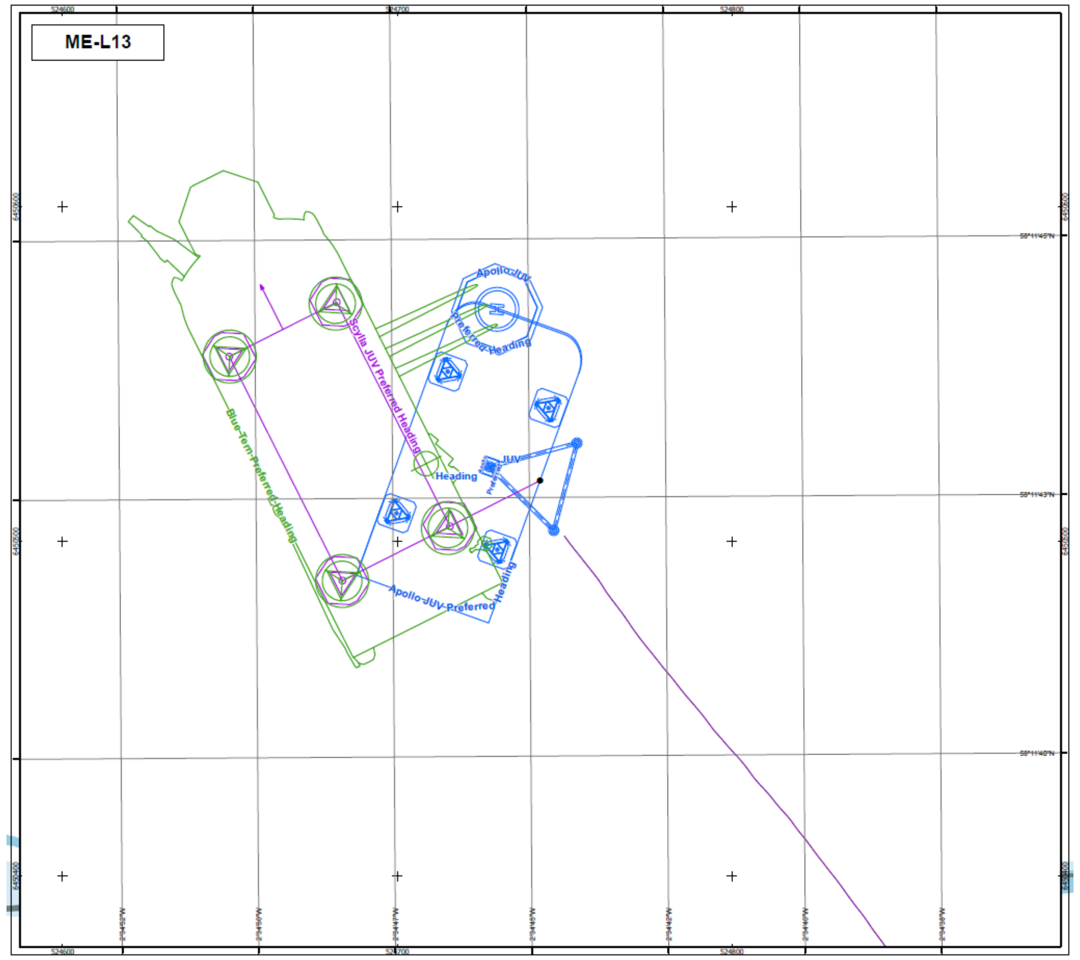
Seabed impacts from the use of all four spud legs of the Apollo and Scylla remain conspicuous on the seabed some 2 years 10 month (Apollo) and 1 year 9 months (Scylla) post-installation. Impacts from the use of only one of the spud legs the Bold Tern remains visible in MBES data after one-year post-installation of the tower and nacelle. The remaining impacts of the Bold Tern spud legs appear to have been infilled during this time.

Asset	Area of seabed impact [m²]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
K11	503		752		1255	





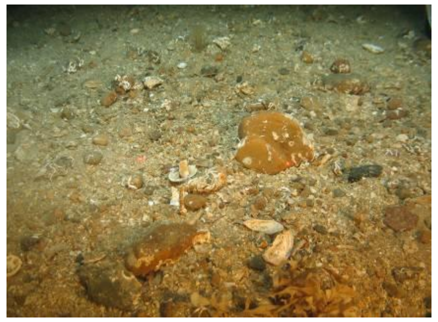
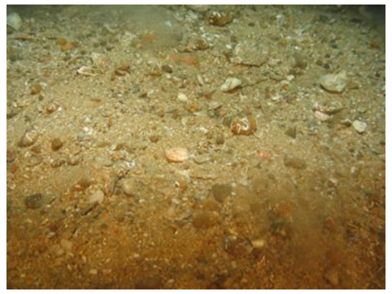
Seabed impacts from the use of all four of the spud legs of the Apollo and the combined impacts from the use of the Scylla and Blue Tern remain visible on the seabed.

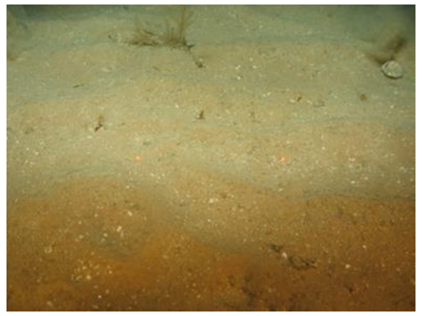
Asset	Area of seabed impact [m²]					JUV footprints on seabed
	Apollo	Blue or Bold Tern	Blue/Bold Tern/Scylla	Scylla	Total	
L13	414		903		1317	
						
Seabed impacts from the use of all four of the spud legs of the Apollo and the combined impacts from the use of the Scylla and Blue Tern remain visible on the seabed.						
TOTAL					16,401	

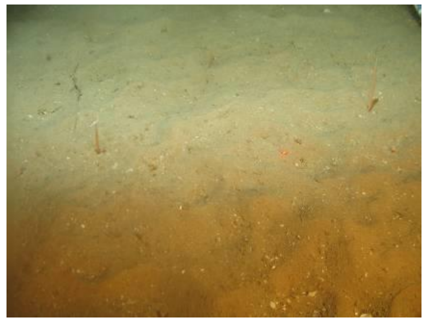
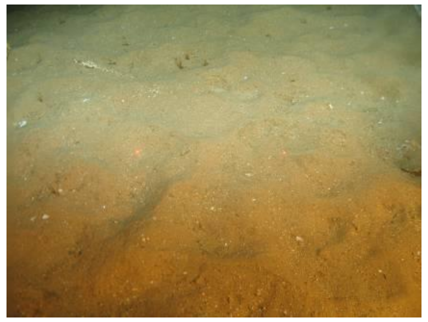
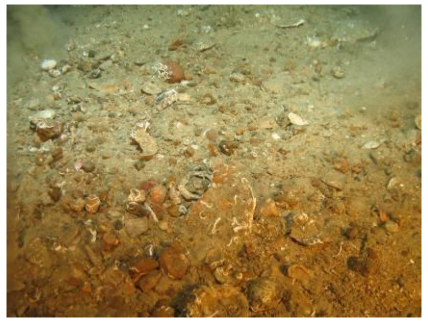
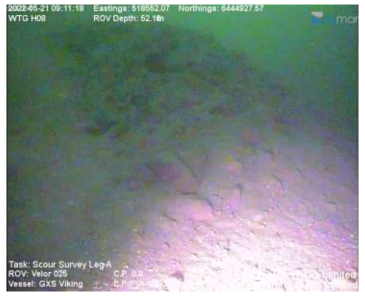
APPENDIX IV

Sediment and Benthic Species Descriptions at the Selected Foundation Locations

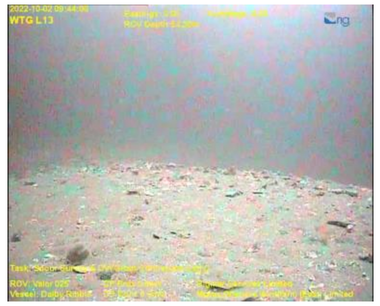
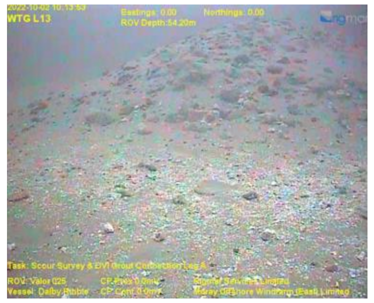
Appendix IV – Results of the Benthic Assessment of the ROV Seabed Inspection Data (SACFOR scale: S = Superabundant, A = Abundant, C = Common, F = Frequent, O = Occasional, R = Rare)

Asset	Installation Dates		Pre-construction			Post-construction			
	Jacket	Tower & Nacelle	Representative seabed photograph	Seabed description	Species present from seabed video	Seabed description	Representative seabed photographs	Date of ROV Scour Survey	Species present from seabed ROV video
BO3	19/12/2020	20/08/2021	Site 56  	Very poorly sorted sandy gravel and gravelly sand. Rippled gravelly sand with pebbles, cobbles and shells. Along the transect were patches where the proportion of pebbles and shell increased. A couple of angular boulders were present.	*Munida rugosa* (O) *Pomatoceros* sp. (Locally C) Bryozoan crust (Locally F) *Asterias rubens* *Echinus esculentus* (O) *Lanice conchilega* (F *Liocarcinus* sp. (O) Caridea (P) Hydroid turf (O) *Flustra foliacea* (R) *Liocarcinus depurator* (O) Corallinaceae (Locally O) *Sabella* sp. (O) *Halecium* sp. (R)	Flat, slightly ripped sandy seabed with shell, stones and occasional cobbles. Sediment is notably coarser with a higher proportion of dead shell within 1-2 m radius around each jacket leg pile. Soil plug deposits 5 m diameter and 1 m height adjacent to two of the jacket legs. Starfish, squat lobster and edible crab on piles Sediment berm surrounding a seabed depression located to the east of the foundation. Depression was estimated to be 8 m in diameter.	  	20 April 2022 (1 year 4 months from jacket installation)	*Echinus esculentus* (F) *Asterias rubens* (C) *Cancer pagurus* (P) *Munida rugosa* (O)
D09	26/11/2020	12/09/2021	Site 47 	Very poorly sorted gravelly sand Rippled gravelly shelly sand with pebbles and cobbles, and boulders. Varying proportion of gravel, pebbles, cobbles and boulders along transect.	*Aequipecten opercularis* (O) Hydroid turf (R) *Pomatoceros* sp. (F-A) Bryozoan crust (O-F) *Lanice conchilega* (F) *Melanogrammus aeglefinus* (P) *Munida rugosa* (O) *Asterias rubens* (O) Cirripedia (R) Rajidae (P) Ammodytidae (P) Hydroid/bryozoan meadow (R) *Calliostoma zizyphinum* (O) *Chaetopterus variepedatus* (O)	Rippled sandy gravel and with Mixed coarse sediment including pebbles, cobbles and shell. Grout overspill on the seabed		29 April 2022 (1 year 5 months from jacket installation)	*Echinus esculentus* (C)) Pleuronectiformes (F) *Pomatoceros* sp (A) *Asterias rubens* (O)

Asset	Installation Dates		Pre-construction			Post-construction			
	Jacket	Tower & Nacelle	Representative seabed photograph	Seabed description	Species present from seabed video	Seabed description	Representative seabed photographs	Date of ROV Scour Survey	Species present from seabed ROV video
D16	22/08/2020	02/03/2021	Site 20 	Shelly sand with pebbles and cobbles (no PSD sample) Sandy pebbles, gravel, cobbles and rarely occurring boulders. Cobbles and boulders are on or embedded within the sandy gravel. One possible bedrock outcrop.	*Echinus esculentus* (F-C) *Asterias rubens* (O) Hydroid turf (O) *Pecten maximus* (O) *Pomatoceros* sp. (C Bryozoan crust (O-F) *Macropodia* sp. (O) *Metridium senile* (R) Porifera crusts (R)	Slightly rippled gravelly sand with patches of pebbles, cobble and dead shell. Grout overspill on seabed.		4 May 2022 (1 year 8 months from jacket installation)	*Echinus esculentus* (C) Hydroid turf *Pomatoceros* sp. (F) *Alcyonium digitatum* (O) Pleuronectiformes (C) *Pomatoceros* sp. (F)
G13	10/10/2020	01/05/2021	Site 29 	Poorly sorted gravelly sand Shelly gravelly sand with occasional pebbles and cobbles.	*Nemertesia antennina* (R) Hydroid turf (R) Bryozoan crusts (O) *Munida rugosa* (F) Cottidae (P) *Pomatoceros* sp. (O) *Aequipecten opercularis* (O) *Liocarcinus* sp. (O) *Lanice conchilega* (F) *Hydrallmania falcata* (R) Paguridae (O)	Dense shells with pebbles on seabed surface around the base of the leg piles. Predominately flat sandy seabed beyond 1-2 m of the leg piles. Grout overspill on seabed.		7 August 2022 (1 year 9 months from jacket installation)	*Asterias rubens* (C) Juvenile Gadidae (A) Hydroid turf (C) *Cancer pagurus* Pleuronectiformes (O) Paguridae (O)
G22	18/08/2020	20/03/2021	Site 3 	Moderately sorted slightly gravelly sand Rippled sand with burrows and *Echinocardium cordatum* tests.	Hydroid turf (R) *Liocarcinus* sp. (O) *Melanogrammus aeglefinus* (P) *Microchirus variegatus* (P) *Echinus esculentus* (O) *Hydrallmania falcata* (R) *Lanice conchilega* (O)	Slightly rippled gravelly sand with occasional pebble and shell. Notably coarser sediment comprising dead shells immediately around the base of the leg piles.		10 May 2022 (1 year 8 months from jacket installation)	*Asterias rubens* (C) Juvenile Gadidae (A) Pleuronectiformes (C) Paguridae (O) *Echinus esculentus* (C) Hydroid turf (F) *Nemertesia sp.*(C) Squid egg (on structure)

Asset	Installation Dates		Pre-construction			Post-construction			
	Jacket	Tower & Nacelle	Representative seabed photograph	Seabed description	Species present from seabed video	Seabed description	Representative seabed photographs	Date of ROV Scour Survey	Species present from seabed ROV video
H05	26/10/2020	15/07/2021	Site 73 	Moderately sorted slightly gravelly sand Rippled shelly sand	*Lanice conchilega* (F) Hydroid turf (R) *Alcyonidium diaphanum* (R) *Liocarcinus* sp. (O) *Virgularia mirabilis* (C-A) *Melanogrammus aeglefinus* (P) *Asterias rubens* (O) *Alcyonium digitatum* (R) *Pennatula phosphorea* (O) Caridea (P) *Hydrallmania falcata* (R) Bivalve siphons (P) *Pomatoceros* sp. (O)	Slightly gravelly sand with quantities of dead shell and pebbles accumulated on seabed surface within 1 – 2 m of the pile legs. Grout overspill on seabed		15 May 2022 (1 year 6 months from jacket installation)	*Echinus esculentus* (F) *Cancer pagurus* (O) *Asterias rubens* (F) *Paguridae* (O) Hydroid turf (O)
H06	14/11/2020	14/07/2021	Site 71 	Moderately well sorted slightly gravelly sand Rippled shelly sand	*Chaetopterus variepedatus* (O) *Lanice conchilega* (C-F) Hydroid turf (R) *Flustra foliacea* (R) *Asterias rubens* (O) *Pagurus bernhardus* (O) Hydractinia echinata (O) *Callionymus* sp. (P) *Liocarcinus* sp. (O) *Pomatoceros* sp. (O)				
H08	17/11/2020	10/07/2021	Site 76 	Very poorly sorted sandy gravel Gravelly shelly sand with pebbles and low-lying cobbles.	*Pomatoceros* sp. (O-C) Bryozoan crust (O-F) Hydroid turf (O-R) *Flustra foliacea* (R) Triglidae (P) *Echinus esculentus* (O-F) *Chaetopterus variepedatus* (O) *Lanice conchilega* (O)	Rippled slightly gravelly sand with occasional cobbles, Mixed sandy gravel adjacent to the leg pile. Grout overspill Soil plug deposits inside jacket	 	21 May 2022 (1 year 6 months from jacket installation)	*Echinus esculentus (C)* *Cancer pagurus* Pleuronectiformes (C) *Munida rugosa* (O) Paguridae (O)

Asset	Installation Dates		Pre-construction			Post-construction			
	Jacket	Tower & Nacelle	Representative seabed photograph	Seabed description	Species present from seabed video	Seabed description	Representative seabed photographs	Date of ROV Scour Survey	Species present from seabed ROV video
J08	30/07/2020	11/05/2021	Site 78 	Very poorly sorted gravelly sand Rippled shelly sand with varying proportion of shell and gravel along transect. Dead *Ensis* sp. shells, and burrows, and rarely occurring low lying small cobbles.	Paguridae (O) *Liocarcinus* sp. (O) *Microchirus variegatus* (P) *Pomatoceros* sp. (O) Hydroid turf (R) *Lanice conchilega* (C-F) Actinaria (R) *Hydrallmania falcata* (R) Ophiurida (O) Caridea (O) Bryozoan crust (O) *Chaetopterus variepedatus* (O) *Liocarcinus depurator* (O) *Melanogrammus aeglefinus* (P)	Shell and stones on seabed surface close to pile leg. Possible soil plug deposits evident on sonar at 10 m distance to east		22 May 2023 (1 year 9 months from jacket installation)	**<u>May 2023 visit</u>** *Luidia ciliaris* (F) *Echinus esculentus* (F) *Asterias rubens* (O) *Cancer pagurus* (O) Paguridae (P) Pleuronectiformes (O) Squid eggs (on structure) Juvenile Gadidae
J18	16/07/2020	24/04/2021	Site 17 	Poorly sorted gravelly sand Rippled sand with burrows and *Echinocardium cordatum* tests. Varying proportion of whole shells and gravel along transect. Patches of gravelly sand present, and rarely occurring cobbles and low-lying boulders	Bivalve siphons (O) *Lanice conchilega* (F) *Asterias rubens* (O) Hydroid turf (R-O) *Pecten maximus* (O) Ophiurida (O) Triglidae (P) Paguridae (O) *Pomatoceros* sp. (O) Bryozoan crust (O)				
K11	27/08/2020	04/07/2021	Site 83 	Moderately sorted slightly gravelly sand Rippled shelly sand with burrows and *Echinocardium cordatum* tests. Varying proportion of shell along transect. Whole shells found in patches	*Pomatoceros* sp. (O) *Lanice conchilega* (F) Pleuronectiformes (P) Bryozoan crust (R) Hydroid turf (O-R) *Melanogrammus aeglefinus* (P) Paguridae (O) *Eutrigla gurnardus* (P) *Hydrallmania falcata* (R) *Nemertesia ramosa* (R) *Pagurus bernhardus* (O) Triglidae (P) *Liocarcinus depurator* (O) *Alcyonium digitatum* (R) *Macropodia* sp. (O) *Microchirus variegatus* (P) *Agonus cataphractus* (P)	Slight lowering of seabed and accumulation of shell material at base of pile leg within an otherwise slightly gravelly sand seabed. Some grout overspill on seabed (breaking up).		3 June 2022 (1 year 9 months from jacket installation)	*Alcyonium digitatum* (O) Paguridae (O) Pleuronectiformes (F) *Asterias rubens* (O)

Asset	Installation Dates		Pre-construction			Post-construction			
	Jacket	Tower & Nacelle	Representative seabed photograph	Seabed description	Species present from seabed video	Seabed description	Representative seabed photographs	Date of ROV Scour Survey	Species present from seabed ROV video
L13	27/10/2020	20/06/2021	Site 41 	Poorly sorted slightly gravelly sand Rippled shelly sand with burrows and *Echinocardium cordatum* tests	*Hydrallmania falcata* (R) Hydroid turf (R) *Lanice conchilega* (F) Ammodytidae (P) Ophiurida (O) Bivalve siphons (O) *Aequipecten opercularis* (O)	Slightly gravelly sand. Slight lowering of the seabed with accumulations of dead shell within depression within 1-3 m of the leg piles. Grout overspill on seabed Coarser, sandy gravel seabed around the edge of a seabed depression caused by the spud leg of a construction vessel Soil plug deposit 5 m diameter	   	2 October2022 (1 year 11 months from jacket installation)	Alcyonium digitatum (O) Pleuronectiformes (C) Juvenile Gadidae (A) *Asterias rubens* (O) Paguridae (F)