Annex 26A: Archaeology & Cultural Heritage Baseline Technical Report: Offshore Transmission Works

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Prepared by

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Beatrice Offshore Wind Farm
Archaeology & Cultural Heritage Baseline Technical Report: Offshore Transmission Works

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Executive Summary

This technical report presents the results of a Maritime Cultural Heritage Assessment, incorporating an archaeological desk-based assessment; archaeological assessment of geophysical data; and an archaeological assessment of geotechnical data for transmission works associated with the Beatrice Offshore Wind Farm Offshore Transmission Cable. The assessment was undertaken by Headland Archaeology (UK) Ltd. on behalf of Beatrice Offshore Wind Limited (BOWL). The purpose of the report is to outline the archaeological potential of the marine environment and identify any sites and areas of archaeological significance within and in proximity to the proposed development area and export cable route.

For the purpose of the assessment the area examined included the proposed transmission cable route corridor; referred to as the 'Inner Study Area'; with a 1km buffer zone referred to as the 'Outer Study Area', appraised in order to identify the archaeological potential of the area. It has been established that there are no Designated Wrecks or any other cultural heritage assets with legal designations within the Inner Study Area. In addition, no wrecks have been identified from the UKHO SeaZone and NMRS datasets within the Inner Study Area. There are eight recorded live wrecks within the Outer Study Area. The NMRS database records more than 1,500 wrecks as having been lost in the Moray Firth/ North Sea area, the majority of which the precise locations are unknown. The relatively large number of recorded maritime losses in the area of the transmission cable route suggests a medium potential for the discovery of unrecorded cultural heritage assets, particularly along the coast in the vicinity of the cable landfall around Portgordon.

The archaeological assessment of geophysical survey data has identified one target of high archaeological potential and 18 targets of medium archaeological potential in the geophysical study area. Pending any further investigation of the identified anomalies the mitigation strategy recommended for this assessment includes the implementation of a 100m exclusion zone for those targets exhibiting high archaeological potential within the study area and the implementation of a 50m exclusion zone for those targets exhibiting medium archaeological potential within the study area.

The geoarchaeological assessment and assessment of geotechnical data has established the presence of fossil marine fauna and of organic bands in the stratigraphic record, indicating that there is some palaeoenvironmental potential within the recorded substrata. However, the absence of organic sediments such as peats also indicates that the potential for the presence of organic archaeological artefacts is regarded as low. The presence of residual flints and lithic artefacts located within the marine sediments remains a possibility. The assessment of the potential for submerged archaeology and palaeolandscapes has established that relative sea-level change in the area combined with glacial isostatic rebound has meant that the Outer Moray Firth has remained either under ice sheets or submerged by the North Sea since the last glacial period. This means that there have been no opportunities for terrestrial deposits of palaeoenvironmental interest to develop. The absence of organic sediments such as peats therefore, indicates that the potential for the presence of organic archaeological artefacts remains low. The presence of residual flints and lithic artefacts located within the marine sediments remains a possibility.

1. INTRODUCTION

Headland Archaeology (UK) Ltd was commissioned by Beatrice Offshore Wind Farm Limited (BOWL) to undertake a maritime cultural heritage impact assessment in advance of a proposed offshore windfarm in the outer Moray Firth in the North Sea. This Baseline Report contains the results of the archaeological baseline assessment for the wind farm offshore transmission works which includes the results of the archaeological desk based assessment, the assessment of geophysical and geotechnical survey data in support of the main cultural heritage impact assessment. The reports are presented in the following format:

2. PROJECT BACKGROUND

The proposed Beatrice Export Cable Routes A and B are 64.770km and 64.650km long respectively. Cable Route A (KP0- KP64.770) and Cable Route B (KP0- KP64.650) follow the same course until 53.850 when they separate to two proposed landfall options at Portgordon, approximately 617 m apart.

3. METHODOLOGY

3.1 Desk- Based Survey

The desk-based assessment is a documentary and cartographic search utilising a number of sources in order to locate all known cultural heritage assets within the study area and within the general location of the proposed transmission cable route, and to identify the archaeological potential of the area, in this case the Moray Firth and North Sea. Sources used for this assessment included:

- Databases of designated cultural heritage assets maintained by Historic Scotland including designated wrecks;
- Maritime records held by the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS);
- UK Hydrographic Office Wrecks and Obstructions Database (SeaZone);
- National Library (for historic charts and maps only);
- Ministry of Defence (military remains only);
- Receiver of Wreck (ROW);
- Relevant SEA reports and Coastal Survey Assessment reports; and
- Other readily available published sources and grey literature e.g. marine geophysical and geotechnical survey reports.

3.2 Assessment of Marine Geophysical Survey Data

All survey data supplied by Gardline Geosurvey was reviewed in its 'raw' digital state with appropriate processing and viewing software. This allowed for the data to be replayed and interrogated in order to effectively assess the position, extent and nature of potential targets. All information with regard to the survey conditions was provided by the relative survey company in order to gauge the quality of the data for the identification of potential cultural heritage assets.

The data was subject to an initial scan for any targets of potential cultural heritage interest, after which the data was assessed in detail to:

- familiarise the maritime archaeologist with the survey area;
- correlate anomalies with previously recorded sites;
- identify the absence of anomalies in the vicinity of previously recorded sites.
- identify anomalies indicative of hitherto unrecorded sites;
- check the accuracy of the position, nature and extent of known wrecks; and
- locate and assess unrecorded targets identified by the Gardline Geosurvey survey team.

All targets were 'tagged' and then assessed as to their archaeological potential. The initial potential of identified targets was gauged using a ranking system (see Table 1. below) as a means of prioritising potential assets in order to inform upon subsequent interpretation. It must be stressed that the ranking system is only seen as a guide and is not used as a substitute for professional judgment.

Table 1. Criteria for identifying archaeological potential of targets

Potential of Asset	Character of Anomaly
HIGH	A target that is identified as a known archaeological asset or in the vicinity of such; or a target that is clearly recognisable as a well preserved feature or maritime loss such as a vessel or aircraft (or parts of) and any associated debris
MEDIUM	A target that exhibits characteristics likely to represent the remains of a feature or maritime loss such as a vessel or aircraft or fragments of the same; including any associated debris
LOW	An isolated or fragmentary target that is recognised to be of some interest but may represent a particularly small or fragmentary archaeological, or natural feature

The position and dimensions of identified targets along with any additional anomalies were recorded into a gazetteer (see Appendix E) and sample images of anomalies were acquired, including further maps and images shown in Figures 2-5. The data was cross-referenced with the desk based assessment and the anomalies identified by Gardline Geosurvey. The position of these identified sites and geophysical targets have been mapped in GIS (see Figures 2-4) and all positions are given in Eastings and Northings.

3.3 Assessment of Marine Geotechnical Survey Data

A total of 31 Cone Penetration Test (CPT) and 31 Vibro Core (VC) logs were assessed along the proposed area of the proposed transmission cable route. These records are provided in **Appendix F** and Figure 5. The logs of the boreholes were assessed in order to gauge whether the deposits contained any sediments of palaeoenvironmental potential; in particular peats or sediments with high organic contents such as organic silts. The information for the borehole and grab sample logs has been supplied by Gardline Geosciences Limited.

4. LEGISLATIVE FRAMEWORK AND GUIDANCE

This assessment takes account of the following legislative procedures and guidelines:

- Marine (Scotland) Act 2010;
- The Protection of Military Remains Act 1986;
- Ancient Monuments and Archaeological Areas Act 1979;
- Merchant Shipping Act 1995;
- Valetta Convention;
- ICOMOS; and
- UNESCO;

Full details of these legislative and guidance procedures is given in Appendix C.

The Desk-top baseline study and assessment has been compiled in line with industry best practice and the relevant offshore renewables and marine historic environment guidance. These include:

- Institute for Archaeologists (IfA) guidelines: Standard & Guidance for Archaeological Desk Based Assessment (2008);
- Joint Nautical Archaeology Policy Committee (JNAPC) Code of Practice for Seabed Development;
- COWRIE Historic Environment Guidance for the Offshore Renewable Energy Sector (2007);
- COWRIE Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore renewable Energy (2008);
- COWRIE Guidance for Offshore Geotechnical Investigations and Historic Environment Analysis: guidance for the renewable energy sector (forthcoming);
- The Crown Estate (2010). Offshore Renewables Protocol for Archaeological Discoveries;
- The Crown Estate (2010). Round 3 Offshore Renewables Projects Model Clauses for Archaeological Written Schemes of Investigation; and
- Towards a Strategy for Scotland's Marine Historic Environment (Historic Scotland 2009)

5 BASELINE ENVIRONMENT

The following paragraphs outline the bathymetry and geology of the study area and types of cultural heritage remains that one might expect to encounter in the marine environment.

5.1 Bathymetry, Geology, Geomorphology & Sedimetology

5.1.1 Bathymetry

Following marine survey by Gardline Geosurvey (June 2011), it was found that water depths along the proposed route vary between 0m LAT and 95.8m LAT, with a maximum gradient of 2.5° at KP32.5. Generally the seabed undulates gently within the study area. A general gradient of <0.5° was recorded from 38.8m LAT at KP0 to 51.0m LAT at KP31.8 (ibid.). Within this section of the route a number of linear depressions 0.5 m deep aligned approximately east-west. Between KP31.8 and KP35.43, the seabed gradient increases to a maximum of 2.5° and continues to deepen to KP45.53, the deepest point of the route at 95.8m LAT. The seabed begins to decline at a maximum gradient of 2° until KP47.82, then at a gentler gradient of <1° until KP52. From KP52 until the end of the route at KP64.77 the seabed gradient is generally <0.5°. From KP62 to the landfall the seabed shoals gradually to 0.0m LAT at KP64.45.

Bathymetric features were also noted such as areas of bedrock, glacial till outcropping and associated boulder fields. Notable ridges and troughs were also identified on the seabed, comprising gravel and sand deposits.

5.1.2 Geology, Geomorphology and sedimentology

The solid geology directly beneath the site is composed of a thick sequence of sandstones and mudstones of Lower Cretaceous age (Regan & Cullen, 2010). This is overlaid with Pleistocene deposits of Quaternary age made up of soft clayey silts to hard gravely clays. The silts are recorded to be <10m, if present at all, with gravels reaching depths of up to 50m in parts likely to represent glacial tills. Above these Quaternary deposits are thin surface sediments of sands and gravels accrued during from the Holocene period. The pre-Holocene sediment deposits in the inner Moray Firth have been recorded up to a maximum depth of 47m from borehole evaluations from the British Geological Survey (BGS). These shallow boreholes from the inner Moray Firth date as far back as mid-last Glaciation and reveal seven units of stratigraphy providing further evidence for the geomorphology of the region.

Shallow soils along the route are variable, with one of three main soil types. The uppermost stratum is a medium dense to very dense sand with variable amounts of silt and gravel. This layer overlays a very soft to stiff clay, which in turn overlies bedrock.

Seabed sediments comprise shelly sand, between KP0 and KP13.980, with numerous minor depressions filled with more gravelly sediment. Areas of megaripples are present between KP14.5 and KP15.7. At KP29.465 numerous ribbons of gravel are present crossing the route. These ribbons of gravel progress to an area of gravelly shelly sand between KP31.385 and KP32.29. From KP 32.29 to KP45.475 the seabed sediments comprise soft clay with various minor partings of sand and silt. There are a number of pockmarks present in this region of soft clay; within this section a number of pockmarks are recorded. Occasional boulders/debris and frequent patches of gravelly sand are also recorded. At KP53.785 seabed sediments change to gravelly sand and remain so until KP62. A number of large boulder fields and areas with numerous boulders and cobbles are present along this section. Between KP62

and the landfalls at KP64.7 seabed sediments comprise a mixture of gravelly sand with frequent boulders and cobbles and sand with frequent boulders and cobbles.

Table 2: Archaeological and Geological Chronology

Age in years BP / BC / AD	British Stages	Archaeological Period
42AD - Present Day		Roman; Early Medieval/Medieval; Medieval to Modern
700BC - 42AD		Iron Age
2,500BC - 700 BC	Holocene	Bronze Age
4,000 BC – 2,500AD		Neolithic
9,000 BC – 4,000BC		Mesolithic
10.000 BP	Younger Dryas (Loch Lomond Stadial)	
11,000 BP	Windermere Interstadial	
13,000 BP	Dimlington Stadial	
70,000 BP–16,000 BP	Devensian	Palaeolithic
110,000BP	Ipswichian	
339,000BP – 130,000BP	Wolstonian	
380,000BP	Hoxnian	
423,000BP	Anglian	
860,000BP – 478,000BP	Cromerian Complex	

5.2 Potential for Submerged Archaeology and Palaeolandscapes

5.2.1 Relative sea-level change

The area of the Moray Firth has been undergoing glacio-isostatic uplift since the end of the last glacial period. Authors, such as Haggart (1982) have estimated that the area of the inner Moray Firth may have undergone as much as 42m of uplift since c. 9600 BP. Thus evidence for relative sea-level change prior to the Loch Lomond Stadial may be seen in raised shorelines between 40m to 26m above the current sea-level (Synge and Smith, 1980). Holocene relative sea-level change has been investigated across sites in northeast Scotland and show a broad trend of falling sea-level from the Late Glacial Maximum of c. 15,000 BP to around 10,000 BP to levels below that of present day sea-level; the early-Holocene minimum (Shennan et al, 2000; Shennan and Horton, 2002). This is followed by a period of sea-level rise, until around 5000 BP when sea-level began to fall, with this trend continuing in the area to the present (Shennan and Horton, 2002). It is thought that the driving cause for this sea level fall within this area is glacio-isostatic uplift (Lambeck, 1992). Sea-level studies from the Moray Firth itself have shown that relative sea-level has fluctuated through the Holocene. Sea-level index points from marine silts and buried peats in the area of the Beauly Firth have shown that in the period between the end of the last glaciation (the Devensian) and the Loch Lomond Stadial (c. 11,000-10,000 BP) relative-sea level was rising (Haggart, 1986, 1987). Prior to this it is believed the area would have been under the ice sheets (Haggart, 1987). The formation of peats at around 9600 BP indicate a fall in relative sea-level, which lasted until around 7800 BP when sea-level began to rise again. At approximately 7300 -7200 BP there is evidence for a high energy event in the sediment

record, which may signal a storm surge event (Haggart, 1988). Evidence for such an event has also been found in the Dornoch Firth to the north (Smith et al, 1992) and elsewhere (e.g. Dounie) indicating a widespread event across the east coast of Scotland, which some authors have suggested may represent a tsunami event (Long et al, 1990; Dawson et al, 1991). This period of relative sea-level rise lasted until c. 5000 BP when sea-level began to fall, which has continued to its present level (Haggart, 1986, 1987). Similar dates for comparable relative sea-level changes in this area have been found in the Dornoch Firth (Smith et al, 1992). The development area itself is known from previous studies (e.g. Flemming, 2004) to have been largely restricted in the past to glacial and marine conditions; therefore never becoming terrestrialised within the last 12,000 years. Relative sea-level change in the area combined with glacial isostatic rebound has meant that the Outer Moray Firth has remained either under ice sheets or submerged by the North Sea since the last glacial period. This means that there have been no opportunities for terrestrial deposits of palaeoenvironmental interest, such as peats to develop.

5.2.2 Sedimentology

A thick sequence of Quaternary sediments of up to 1000m has been deposited in the North Sea Basin, which contain evidence of at least five major glacial episodes over a period of two millennia (Sutherland, 1984). However, little investigation of these offshore sediments in relation to quaternary glacial events has taken place in the Moray Firth (Sutherland, 1984), with studies having largely concentrated in offshore areas such as the Firth of Forth (e.g. Holmes, 1977) and onshore coastal studies (e.g. Synge and Smith, 1980).

Recent borehole results have shown the offshore sediments of the outer Moray Forth consist predominantly of sands and gravels extending to depths in excess of 50m (Senergy Survey and Geo-Engineering Ltd, 2009). The sediments relating to the Holocene deposits are thought to make up the upper 2-3m of the lithostratigraphy of the outer Moray Forth and again largely consist of mobile sands, gravels and sandy clays (courtesy of BGS data). The Quaternary units underlie these sediments, which also consist of medium to dense, stiff clays, coarse sands, with isolated cobbles and boulders. In contrast to the sediments of the outer Moray Firth, those within the inner Moray Forth have been more intensively studied, with intercalated sediments of peats and estuarine silts, containing microfossils having been recorded to depths of up to 7m (Haggart, 1986, 1987). No such organic sediments have been observed in the outer Moray Firth.

5.2.3 Palaeoenvironmental work and future potential

Previous palaeoenvironmental work in this area has been confined to the inner Moray Firth where palaeocological work was undertaken in relation to sea-level change studies (see above). Pollen work from the head of the Beauly Firth (Haggart, 1986, 1987) was able to show vegetation change in response to changes in relative sea-level within this area.

Fluctuations in relative sea-level had an effect on the coastal plant communities and this is reflected in the pollen records of this area with changes from hazel scrub woodland at around 9600 BP to reed swamp communities at approximately 7000 BP corresponds with a period of relative sea-level rise. At approximately 5000 BP relative sea-level then decreases and an alder-carr woodland community is established, while high values of grass pollen indicate some reed swamp remained in the area (Haggart, 1986, 1987). These communities continue to the end of the pollen study as relative sea-level continued to fall (see above). These results are similar to other studies in the region, such as in the Dornoch Firth area (e.g. Smith et al, 1992). The nature of the sediments of the outer Moray Firth, being largely coarse sands and gravels, limits the scope for palaeoenvironmental work, in relation to the development area. The palaeoenvironmental investigations within the inner Moray Forth of pollen and diatom analysis were undertaken on peats and estuarine silts (Haggart, 1986, 1987) where the good preservation of such materials is conducive to research. However, the preservation of such microfossils within sands and gravels is

extremely poor and unlikely indicating the potential for such studies in the proposed Beatrice windfarm development area is very low.

5.3 The Potential for Unrecorded Maritime Cultural Heritage Assets

5.3.1 *Paleolithic (860,000BP to10,000BP)*

The Palaeolithic covers the time from the initial occupation of what is now recognised as mainland Britain believed to have been c. 70,0000BP to10,000BP (Before Present). During this time there have been a number of environmental changes and cycles, glaciations, changes in sea level, and much of the offshore area we are to examine for this report was for long periods exposed as dry land, offering the possibility to examine palaeoenvironmental evidence as well as material culture.

While there have been no reported Palaeolithic finds or deposits of archaeological significance in the vicinity of the study area, the discovery of an array of flint tools and associated faunal remains believed to have been deposited during the Devensian Ice Age which commenced c.70,000BP that were uncovered after offshore dredging works eight miles east of Great Yarmouth in Norfolk (Wessex Archaeology 2007) demonstrates the potential for Paleolithic evidence to survive in offshore submerged contexts.

Elsewhere in the UK Palaeolithic cave sites on the Welsh coast are well documented (Lynch *et al*, 2000), a cluster of which occur at Colwyn Bay including Pontnewydd Cave which contained the remains of at least 3 individuals. Similarly, a late Palaeolithic site along the English coast is known at Blackpool (Manley 1989: 19).

5.3.2 Mesolithic/ Neolithic (9,000BC- 2,500BC)

Mesolithic sites can be difficult to locate and identify but are known from coastal locations on the Northern and Western Isles of Scotland, suggesting the possible use of maritime transport at this time. No evidence for Mesolithic activity has been identified in proximity to the study area. One explanation offered has been fluctuations and rises in sea level and subsequent submergence of coastal sites. A flint scraper recovered from a borehole core sample on the Viking Bank off Shetland in the North Sea represents the only prehistoric find discovered to date (Fleming 2004).

Neolithic sites are known from coastal locations on the north eastern coast including at the Black Isle peninsula close to Moray Firth. Regarding maritime travel, a number of examples of sea-faring vessels have been identified and recovered from coastal locations in eastern Ireland dating from the Neolithic period, including an example which was recovered under two metres of sand during offshore trenching at a landfall site at Gormanstown, County Meath (Brady 2002). The author suggested that this example was modified with outriggers to accommodate long distance sea travel (ibid.). Trade of goods, common ritual ideas and possible migrations are the other main indications of maritime contact during the Neolithic period.

5.3.3 Bronze Age (2,500BC- 700BC)

Archaeological evidence provides us with examples of the continued use of logboats during the Bronze Age and also of the use of small coracle type boats made from leather skins, advances in boat building technology is best witnessed by the discovery of the Dover boat discovered in September 1992 between Dover and Folkestone. The boat is c. 3,500 years old and although damaged may have originally measured 18 metres long and 2.4 metres wide; making it capable of crossing the channel and carrying a substantial cargo. The boat was made up of at least six oak timbers sewn together with wooden strips, with all the joints reinforced with a thin lath of oak, covering moss pushed into the joint. The two central planks are joined by the use of wedges pushed through a central rail

and a series of cleats (Clark 2002). Other similar types of boats recovered from this period include three found at North Ferriby on the Humber near Hull, although no examples of this type of craft have ever been recovered from the Moray Firth or the North Sea area. Evidence for simpler logbaot types have been discovered in the Scottish context however such as that discovered at Carpow in the Tay Estuary (Strachan 2010).

5.3.4 Iron Age and Roman (700BC – 410AD)

The archaeological evidence for maritime travel is evident in the common culture and traditions noted across much of Europe and the British Isles. We know that Wales, Scotland, the Isle of Man and Ireland adopted a Celtic culture at this time and this could not have occurred without maritime travel. The type of craft used for travel at this time is known to have evolved to that known as the Romano-Celtic type, similar to one discovered in the Severn Estuary (Lawer & Nayling 1993). However it is likely that skin covered vessels and dugout canoes continued to be used. A gold ornament representing a boat discovered as part of an Iron Age hoard in Co. Derry in Northern Ireland is generally accepted to represent the type of vessel in use at that time. The detail includes a mast and yard arm, 18 miniature oars and rowers benches, a type of rudder or steering oar, a grappling hook and other tools (Wallace 2002). It gives us a unique insight into the type of vessel used for deep sea and ocean travel but the one detail that cannot be discerned is whether the vessel was intended to represent a boat of hide or of timber (ibid.).

Archaeological and documentary evidence for Roman occupation in Scotland is well documented and discussion with regard to the utilization of the sea around Scotland has also been postulated (Martin in Smout 1991). There is no question that both military and merchant maritime traffic would have been extensively employed during this period, connecting with the many Roman fort networks on the major east coast Firths; notably Cramond on the Forth and Carpow on the Tay, and possibly maritime nodal points such as Aberdeen. Although archaeological evidence for Roman maritime activity is yet to be forthcoming in the Scottish context, it has to be a distinct possibility that evidence of such activity may well survive within the vicinity of the study area.

5.3.5 Early Medieval and Medieval (410AD – 1550AD)

The Early Medieval Period witnessed increasing contact between cultural groups throughout the British Isles, particularly between Ireland and Scotland. The Dalriadic Scots integrated and settled among the native groups of the west coast of Scotland and this interaction is embodied in maritime contact, evidence for which is suggested in pictorial graffiti, such as that discovered at the early Christian site on Inchmarnock opposite the Isle of Bute (Atkinson in Lowe 2008). The depiction of vessels on stones discovered at the site suggests evidence for the potential admixture of maritime boatbuilding traditions during this period. Elsewhere the east of Scotland was dominated by the Pictish tradition and in the absence of archaeological evidence for maritime activity we also rely on sculptural depictions of craft types, such as that noted on the Cossans Stone in Angus. Despite the lack of archaeological evidence for vessel remains, there is still the potential for such discoveries in the future.

Maritime links assumed renewed importance in the Early Medieval period, especially in relation to the spread of Christian culture and the written record from this period makes constant reference to journeys undertaken by those involved with the church between Ireland and Scotland, Wales, Cornwall and Brittany. Well documented voyages include those of Colm Cille, who travelled with a group of monks from Northern Ireland to set up a monastery in Iona and Columbanus who traveled to Gaul (Ó Cróinín 2005). The medieval text Navigatio Sancti Brendani Abbatis (The Voyage of St Brendan the Abbot) tells how a group of 6th century monks built a leather skinned ‘curragh’ type boat and set sail west over the ocean. Evidence of similar Monastic foundations on the east coast of Scotland are well represented, particularly the monastery at Portmahomack opposite the study area (Carver 2008).

Documentary sources tell us state that the North Sea was frequently navigated by Danish and Norse Vikings, Orkney becoming a base in their expansion south and west from Norway. The Annals of Ulster report of intermittent raids being carried out by the Norse at monastic sites on the west coast of Scotland at Iona and Northern England at Lindisfarne in 793AD. The Viking longship, clinker built type vessels, was a major factor in the success of their raids and voyages as they were suited to rough seas but also with the ability to navigate shallow estuaries and waterways (Greenhill and Morrison 1998). Evidence for Viking vessels has been found on Orkney, the Isle of Man, at Portrush in County Antrim and on Rathlin Island off the coast of County Antrim. There are a number of accounts of maritime travel by the Vikings from Orkney, including an account from the 13th century when King Haakon Haakonson arrived in Orkney with a fleet of over 100 ships (Ó Cróinín 2005).

During the medieval period it was military campaigns, migration and consequent commercial expansion that accounted for much of the sea travel of the time. During this time the English, Spanish and French had significant naval forces. The importance of ports grew, as did significant populations, prompting an expansion in seaborne trade and commerce. Custom accounts from the 15th century provide evidence of a thriving import and export industry (Rodger 1997).

5.3.6 Post- Medieval - Modern (1550AD - Present)

The post-medieval period saw a steady increase in coastal activity where military activity and the expansion of world-wide trade meant further growth in the volume of shipping. From the 18th century onwards records began to be kept of ship losses and from the middle of the 19th century these records became far more comprehensive. This is reflected in the National Monuments Record for Scotland (NMRS) data collected that shows over 1500 wrecks in the Moray Firth/ North Sea area alone. Many of the recorded losses occurred during major storms, including the Great Storm of 1800 and other famous storms in 1852, 1874, 1875 and 1876. In the 1875 storm at least 15 vessels were lost and in 1876 there appears to have been at least 31 sinkings (Ferguson 1991: 58). So severe were these losses that they encouraged the adoption of steam power for cargo vessels and by the end of WWI most of the larger vessels in the area were steam powered. Fishing has also been a significant industry in the area, with the rise of numerous fishing settlements ringing the Firth during the 18th and 19th centuries with major increases in the populations of Wick, Fraserburgh and Lossiemouth - driven mainly by the growth of herring fishing. It is not surprising therefore, that many of the reported losses in this area are of smaller fishing vessels of various designs. It was not until the 20th century that metal hulls came into use in the herring trade and many of the earlier losses of wooden vessels are likely to be highly degraded and difficult to detect.

5.3.7 Military Remains

Vessel losses: The majority of identified shipwrecks in the seas of the Outer Moray Firth are the result of military activity during WWI and WWII. Initial losses during WWI were caused by the extinguishing of coastal lights which resulted in numerous wrecks concentrated along the shoreline. In the latter half of 1917 a submarine offensive was launched by the German Navy which resulted in the sinking of at least eleven ships in the Outer Moray Firth (Ferguson 1991: 97). Records for shipping casualties are somewhat incomplete between 1939 and 1945 due to censorship but approximately 50 merchant vessels were sunk off the north-east coast as well as numerous military boats, ships, submarines and Allied and German aircraft losses. WWII losses are concentrated around Rattray Head and the eastern approaches to the Moray Firth (Ferguson 1991: 112). The U-73, a German submarine is recorded as having been lost in 1916 to the east of the proposed cable route.

Aircraft losses: There is a moderate concentration of offshore aircraft losses along the north-east coast of Scotland resulting from military operations. There were several airbases in the area including Royal Air Force Lossiemouth to the west of the proposed landfall sites. The RAF base at Lossiemouth was built in 1938 and although mainly a training unit for Bomber crews during the Second World War, some operational raids were launched from there. In the 1980s the wreck of a 4 engine aircraft observed during an inspection of a submarine

oil pipeline off Helmsdale in the Moray Firth has been identified as a Liberator Bomber that had gone down in 1945 with the loss of six lives. A number of aircraft are recorded in the NMRS as having gone down in the Moray Firth, however exact locations are not known. All entries are presented in Appendix B.

6. RECORDED MARITIME CULTURAL HERITAGE

6.1 Limitations of data

One of the greatest limitations when researching known and potential offshore cultural heritage is the difficulty of locating recorded maritime losses. For many losses the location of the sinking of the vessel can be in the form of a general area description, as in 'off Moray Firth' or 'North Sea', which is not practically useful for the purpose of accurate assessment, except to show the potential exists to encounter cultural remains. Recorded losses are far more numerous than confirmed wrecks but are usually very poorly located and as such are useful only to characterise the type of shipwrecks in the area and assess the potential for further discoveries. Other wrecks have been identified through sonar survey but this too presents difficulties as many of these wrecks have been located using GPS, which until relatively recently were only accurate to 100m (Baird 2009: viii) or by DECCA (early navigational position fixing technology) which can give locations accurate to only a kilometre. Another important point about the recorded maritime losses is that they are heavily biased towards 19th and 20th century losses with more comprehensive record keeping of losses.

The SeaZone wrecks and obstructions dataset mainly includes only those wrecks and obstructions with known locations although there are also a small number of reported losses with no subsequent positional information. Some possible wreck or obstruction locations have not been found during more modern surveys and their status has been amended by the UKHO to 'dead'. These are wrecks or obstructions which have not been detected by repeated surveys and which are therefore considered not to exist. This may be due to a mistaken identification, inaccurate co-ordinates, degradation/destruction of the asset or through covering of the asset through sediment deposition.

6.2 Cultural heritage assets within the Inner Study Area

There are no recorded cultural heritage assets within the Inner Study Area. However, an archaeological assessment of geophysical survey data undertaken for the Inner Study Area has identified one target of high archaeological potential and 18 targets of medium archaeological potential (see Section 6.4).

6.3 Cultural heritage assets within the Outer Study Area

The details for specific offshore cultural heritage assets are derived from two main sources, the National Monuments Record of Scotland held by the Royal Commission on Ancient and Historic Monuments of Scotland (RCAHMS) and SeaZone Hydrospatial Data (itself largely derived from UK Hydrographic Office data). These databases are both derived in turn from a variety of sources including various published lists of marine losses and marine surveys (Baird 2009; Larne and Larne 1998; Nash 2009 etc). There is consequently a large overlap between the datasets.

The discussion and table below covers all UKHO entries within the study area including dead entries. This is due to the fact that while in some cases there may be vessels which have failed to show up on recent geophysical surveys the locations may still contain remains of cultural heritage interest. In other cases, however, it is clear from the details of the entry that there is no reason to believe that there are now or ever have been archaeological

remains. These entries have also been included in the text and illustrations and are discussed on a case by case basis below.

All known cultural heritage assets within the study area, including undesignated assets, have been assigned Headland Archaeology (HA) numbers and a full gazetteer with concordance is provided in Appendix A.

There are no Designated Wrecks or other cultural heritage assets with legal designations within the Outer Study Area.

There are **eight** entries within the SeaZone wrecks and obstructions dataset which fall within the Outer Study Area 1km 'buffer' (**HA1001- HA1008**). These are listed in Table 3 and shown in Figure 1. A description of each entry where available is given in the gazetteer in Appendix A. HA1001, HA1003, HA1005, HA1006 and HA1008 are considered to be 'live' and are confirmed shipwrecks in the location indicated. HA1002, 1004 and HA1007 are considered to be 'dead' wrecks, which have not been found by repeated surveys.
There are five reported losses with confirmed locations within the offshore outer study area recorded in the National Monuments Record of Scotland. These losses correspond with the UKHO SeaZone entries (**HA1003-HA1007**) and are therefore assigned the same HA numbers in this report.

Table 3: Offshore cultural heritage assets with known locations including UKHO 'dead' entries (those in bold are live).

HA No.	UKHO No.	Name	Designations	NGR	Status
1001	**00897**	**Sunbeam (Possibly)**	**None**	**496719.788 6439047.215**	**Live**
1002	00895	Day Jet	None	498924.265 6428676.953	Dead
1003	**02119**	**Unknown Craft**	**None**	**497031.018 6422183.054**	**Live**
1004	02116	Unknown Craft	None	498756.869 6418503.008	Dead
1005	**02096**	**John Dunkin**	**None**	**497192.683 6417336.969**	**Live**
1006	**02117**	**Unknown Aircraft**	**None**	**497335.503 6410124.405**	**Live**
1007	02103	Pharon	None	496730.233 6395306.391	Dead
1008	02068	Bpt No 31	None	496876 6391921	Live

There are four 'live' entries and three 'dead' entries in the SeaZone Hydrospatial Wrecks and Obstructions layers. Of these one has a possible identification and two have been positively identified.

Sunbeam (possibly) (HA1001)
Sunbeam was a British Merchant sailing vessel (Schooner). On the 4th July 1915 when 17 miles S by E from Wick, Scotland she was captured by German submarine U-25 and sunk by gunfire. She was found by multi-beam in a general depth of 42 m, her length recorded at 25 m with a width of 10 m and a height 2.5 m proud of the seabed. The wreck appears to be highly degraded. No magnetic anomaly is associated.

Unknown (HA1002)
This is the site of an Aircraft that was ditched in the Moray Firth. Survey has failed to locate the remains and the UKHO data record this as a 'dead' wreck with unreliable positional data.

Unknown (HA1003)
A small wreck, about 20 metres (65 feet) long, was examined on the 21 November 1987. The least echosounder depth was 74 in a general depth of 77 metres. The side scan sonar indicated a height of 2.6 metres. Found by echo-sounder.

Unknown (HA1003)
Possible wreckage is reported by a local fishing skipper in August 1986. Survey has failed to locate the remains and the UKHO data record this as a 'dead' wreck with unreliable positional data.

John Dunkin (HA1005)
John Dunkin FV was a British Strath Class Trawler of 215 tons built in 1918 by Fleming & Ferguson, Paisley. From 1918 to 1921 she was owned by the Admiralty but from May 1919 she was loaned to the United States Navy for post war mine clearing (based at Kirkwall). She was sold for mercantile use 1921. In 1941 she was sunk by German bombing 13 miles N by E of Buckie. One crewman was lost.

Unknown Aircraft (HA1006)
On 6 August 1986 the wreck of an aircraft was reported by a local fishing skipper at 57 50 00N, 003 02 36W. UKHO data record this as a 'live' wreck but its co-ordinates are unreliable.

Pharon (HA1007)
A fishing vessel is recorded as being lost at this location on 10/05/1981. approximate location. Survey has failed to locate the remains and the UKHO data record this as a 'dead' wreck with unreliable positional data.

Bpt No 31 (HA1008)
This British battle target practice has been located within the intertidal zone. The wreckage lies in an area of 7 m x 2 m and orientated N- S. Metal ribs are exposed 0.3 m above the sand during low water. Other wreckage less than 1 m in size lies 25 m to the east.

6.4 RESULTS OF THE ARCHAEOLOGICAL ASSESSMENT OF GEOPHYSICAL DATA

Introduction

This report presents the results of an archaeological assessment of marine geophysical survey data acquired for transmission works associated with the Beatrice Offshore Wind Farm. The report has been produced to provide baseline information to inform the Beatrice Offshore Wind Farm Offshore Transmission Works. The proposed wind farm and transmission works are located in the Moray Firth off the north eastern coast of Scotland. The transmission works consists of two proposed cable routes (Cable Route A & Cable Route B) extending southwards from the proposed Beatrice Offshore Wind Farm to two landfall options at Portgordon.

Aims

The principal aim of this marine geophysical archaeological assessment is to identify any cultural heritage assets recorded from the surveyed cable route area and to inform the baseline study and Environmental Impact Assessment for the proposed development. This assessment is intended to be read in conjunction with Guardline's Geosurvey Report (Beatrice Offshore Wind Limited, Beatrice Windfarm Development Export Cable Route Surveys, Moray Firth, Gardline Geosurvey, Project Ref. 1787-0111-SER, June 2011.).

The specific objectives are:

- to confirm the presence of previously identified marine sites and to comment on their apparent character;
- to identify, locate and characterise hitherto unrecorded marine sites;
- to review available data in respect of seabed and sub-seabed deposits likely to be of archaeological interest; and
- to present mitigation measures in conjunction with the results of the desk-based study and impact assessment.

RESULTS

Gardline Geosurvey Targets Identified within the Wind Farm Transmission Works Development Area
Gardline Geosurvey identified 870 sidescan anomalies associated with Cable Route Option A and 870 sidescan anomalies associated with Cable Route Option B within the Inner Study Area. Both options follow the same course for the most of the route the majority of these targets are duplicate. Gardline Geosurvey identified 133 magnetic anomalies associated with Cable Route Option A and 133 magnetic anomalies associated with Cable Route Option B within the Inner Study Area. Similarly the majority of these targets are duplicate. The magnetic and sonar results were compared to see if there was any correlation between the two. These anomalies are for the majority identified as geological features including large and small boulders, however some linear features have also been identified. Gardline Geosurvey identified a large number of targets labelled as small boulders; further assessment of these targets by Headland Archaeology has established the nature of these anomalies and confirms their likely natural origin. This is based on their characteristics and position within areas of the seabed dominated by geological 'features'. These targets are regarded to be of low archaeological potential within this assessment.

Sidescan Targets Located within the Wind Farm Transmission Works Development Area
A total of 168 anomalies were identified by Headland Archaeology within the development area. After analysis by Headland Archaeology the majority of these these targets have been tagged as low potential and are deemed to be of likely natural origin. Each identified target was given an archaeological potential rating, the results of which identified one target of high potential (HA68); 18 targets of medium potential and 149 targets of low potential. High and medium targets are identified in Table 4 below.

Table 4. Headland High and Medium targets recorded in the Development Area

HA.NO	Site_Description	Sidescan_Potential	UTM30NmE	UTM30NmN

HA.NO	Site_Description	Sidescan_Potential	UTM30NmE	UTM30NmN
17	Linear debris	Medium	497470.56	6392102.62
20	Linear debris	Medium	497753.5	6391816.63
28	Linear debris	Medium	497963.84	6392176.34
33	Linear debris	Medium	497567.7	6392092.86
52	Debris	Medium	498347.52	6392925.68
61	Linear debris	Medium	498398.56	6393553.55
63	Debris	Medium	498309.52	6394711.45
68	Wreck	High	498407.62	6393620.09
87	Debris	Medium	498671.59	6405511.5
90	Possible Debris	Medium	498311.99	6394662.17
102	Possible debris	Medium	498267.34	6393862.75
121	Linear Debris	Medium	497834.03	6430902.59
126	Linear Debris	Medium	497899.31	6395125.33
127	Linear Debris	Medium	497808.31	6394651.85
133	Linear Debris	Medium	498987.44	6443815.26
135	Possible Debris	Medium	497089.34	6431077.84
143	Linear Debris	Medium	497084.81	6421066.66
154	Debris	Medium	498979.07	6443812.46
156	Debris	Medium	498979.17	6443807.59

Anomalies with High Archaeological Potential

One target identified from the sidescan data within the geophysical survey area has been classified as of high archaeological potential. Target **HA68** was recorded at UTM30N 498407.62 mE, 6393620.09mN, and is that of a previously unrecorded wreck. The geophysical dimensions associated with this target measure 24.09 in length by 7.82 m in width, and the remains are 2.4 m proud of the seabed. Magnetometer target 124 was identified 20 m to the east.

Anomalies with Medium Archaeological Potential

In total 18 targets of medium archaeological potential were identified within the geophysical survey area along the transmission works cable route.

Target **HA17** was recorded at UTM30N 497470.56mE, 6392102.62mN. It is a dark and light reflector with geophysical dimensions of 5.32 m long, 1.35 m wide and 0.06 m high, indicating it is almost totally buried.

Target **HA20** was recorded at UTM30N 497753.5mE, 6391816.63mN. It is a dark and light reflector representing linear debris with geophysical dimensions of 22.61 m long, 2.53 m wide and 0.11 m high. There are no magnetometer targets within 150 m of this target.

Target **HA28** was recorded at UTM30N 497963.84mE, 6392176.34mN. It is a dark and light reflector representing linear debris with geophysical dimensions of 11.62 m long, 1.31 m wide and 0.1m high. No magnetic anomalies have been identified in proximity to this target.

Target **HA33** was recorded at UTM30N 497567.7mE, 6392092.86mN. It is a dark and light reflector representing linear debris with geophysical dimensions of 2.41m long, 2.14m wide and 1.32m high. No magnetic anomalies have been identified in proximity to this target.

Target **HA52** was recorded at UTM30N 498347.52mE, 6392925.68mN. It is a dark and light reflector representing debris with geophysical dimensions of 11.01m long, 4.53m wide and 0.94m high. No magnetic anomalies have been identified in proximity to this target.

Target **HA61** was recorded at UTM30N 498398.56mE, 6393553.55mN. It is a dark and light reflector representing debris with geophysical dimensions of 12.76m long, 5.15m wide and 0.54m high. It is 45m south of the wreck identified by Headland Archaeology (Target **HA68**) and Gardline Survey, and may be associated debris. Magnotometer target 124 is located 75 m to the northeast of this target.

Target **HA63** was recorded at UTM30N 498309.52mE, 4394597mN. It is a dark and light reflector representing debris with geophysical dimensions of 4.43m long, 1.56m wide and 0.58m high. No magnetic anomalies have been identified in proximity to this target.

Target **HA87** was recorded at UTM30N 498671.59mE, 6405511.5mN. It is a light and dark reflector and appears to be circular, with geophysical dimensions of 1.47m long, 1.35m wide and 0.01m high. No magnetic anomalies have been identified in proximity to this target.

Target **HA90** was recorded at UTM30N 498311.99mE, 6394662.17mN. It is a light and dark reflector and represents linear debris, with geophysical dimensions of 4.26m long, 1.79m wide and 0.61m high. No magnetic anomalies have been identified in proximity to this target.

Target **HA102** was recorded at UTM30N 498311.99mE, 6394662.17mN. It is a light and dark reflector and represents possible debris, with geophysical dimensions of 12.89m long, 1.93m wide and 0.18m high.

Target **HA121** was recorded at UTM30N 497834.03mE, 6430902.59mN. It is a dark reflector and represents possible debris, with geophysical dimensions of 5.96m long, 3.14m wide and 0.13m high. No magnetic anomalies have been identified in proximity to this target.

Targets **HA126** and **HA127** are similar in appearance and represent linear debris. Target **HA126** was recorded at UTM30N 497899.31mE, 6395125.33mN. It is a dark reflector with geophysical dimensions of 3.19m long, 1.22m wide and 0.22m high. No magnetic anomalies have been identified in proximity to this target. Target **HA127** was recorded at UTM30N 497808.31mE, 6395125.33mN, with geophysical dimensions of 3.02m long, 1.19m wide and 0.18m high. A magnetic anomaly was identified 68 m to the northwest of this target.

Target **HA133** was recorded at UTM30N 498987.44mE, 6443815.26mN. It is a light and dark reflector and represents debris, with geophysical dimensions 8.09m long, 1.5m wide and 0.18m high. No magnetic anomalies have been identified in proximity to this target.

Target **HA135** was recorded at UTM30N 497834.03mE, 6430902.59mN. It is a dark reflector and represents possible debris, with geophysical dimensions of 4.57m long, 2.16m wide and 0.43m high. No magnetic anomalies have been identified in proximity to this target.

Target **HA143** was recorded at UTM30N 497084.81mE, 6421066.66mN. It is a light and dark reflector and represents possible debris, with geophysical dimensions of 5.99m long, 2.14m wide and 0.32m high. No magnetic anomalies have been identified in proximity to this target.

Target **HA154** was recorded at UTM30N 498979.07mE, 6443812.46mN. It is a light and dark reflector and represents possible debris, with geophysical dimensions of 7.35m long, 3.07m wide and 0.13m high. No magnetic anomalies have been identified in proximity to this target.

Target **HA156** was recorded at UTM30N 498979.17mE, 6443807.59mN. It is a light and dark reflector and represents possible debris, with geophysical dimensions of 8.1m long, 0.68m wide and 0.16m high. No magnetic anomalies have been identified in proximity to this target.

Anomalies with Low Archaeological Potential

In total 149 targets were identified by headland archaeology to be of low archaeological potential (Figure 2). This classification was based on the shape, strength of reflection and in most cases uniqueness on the seabed in relation to the surrounding seabed characteristics. In some instances targets that are likely to be of geological origin have been included to help illustrate the character of these targets and similarities with the majority of the Gardline Geosurvey anomalies interpreted as boulders. Although their dimensions and characteristics are varied, the majority of low potential targets were relatively small (<2m) and/or isolated objects of unknown origin. From the sidescan sonar survey it is possible to take measurements of these potential anomalies, their height, shape and relationship to the surrounding seabed. It has been ascertained that these targets do not reflect any characteristics suggesting anthropogenic origin and thus they are for the most part categorised as 'natural features', particularly when the geological characteristics of the surrounding seabed is taken into account. The majority of these low archaeological potential targets fall within the nearshore area, from the 20m water depth contour south to the landfall options. However it was also found that clusters of low archaeological targets correspond with clusters of magnetometer.

Magnetometer Targets Within the Transmission Works Development Area

The magnetometer data was assessed in order to identify possible targets of cultural heritage interest. A total of 133 magnetic anomalies were identified within the survey area. Of these two targets were found to correlate with sidescan targets identified as high and medium archaeological potential by Headland Archaeology. High potential target **HA68,** recorded at UTM30N 498407.62 mE, 6393620.09mN, positively identified as a previously unrecorded wreck, bore a strong magnetic anomaly (Magnetic Target 124) 20 m to the east. Medium potential target **HA127,** recorded at UTM30N 497808.31mE, 6395125.33mN, could be associated with a magnetic anomaly identified 68 m to the northwest. A large number of the magnetometer targets related to low potential geophysical targets identified by both Headland Archaeology and Gardline Geosurvey as boulders and geological features such as rock outcrop.

Geological Data

The nature of the seabed morphology and geology as indicated in the report produced by Gardline Geosurvey Limited (2011) is confirmed in the results of the sub-bottom profiler data. The sub-bottom data was assessed using the Pinger source as this data was regarded as the most useful in identifying targets or objects at an appropriate resolution to the depths most likely to reveal features such as wreck remains or associated debris as well as palaeoenviromental features.

The results of the geotechnical assessment carried out by Headland Archaeology's geoarchaeologist has highlighted that the potential discovery of palaeotopographical features and the presence of relict submerged landscape surfaces and deposits within the development area is unlikely.

Archaeological Potential

Shallow seismic survey

From an archaeological point of view, it is important to note that palaeotopographical features represent both zones of potential human habitation and areas of potential for the survival of evidence. The edges of palaeo-channels are likely to accumulate fluvial gravels that early humans would regularly exploit and where the remains of tool making activities may reside.

Table 5. General geological sequence for the export cable route.

Units	Description	Thickness (approx.)
Holocene	Silty and gravelly sands to sandy gravels.	<2m
Holocene/ Quaternary Forth Formation	Gravelly clays and sands.	<5m to 40m
Quaternary - Forth Formation	Interbedded marine clays, silty clays and silts, with rare gravel	<5m to 30m
Quaternary – St Abbs Formation	Glaciomarine silty and gravelly clays.	Generally <10m, locally up to 20m
Quaternary – Wee Bankie Formation	Hard sandy and gravelly Till, with interbedded fluvial sands and gravelly sands. Locally coarse sands and gravels in erosion channels	<5m to 40m
Permo-Triassic Bedrock	Generally sandstones and/or mudstones.	Unknown
Upper Devonian Bedrock	Sandstone, locally conglomeratic at base.	Unknown
Lower Devonian Bedrock	Sandstone, locally conglomeratic, overlying siltstone and mudstone	Unknown

The topmost deposits identified in the seismic survey are sands of varying depths which represent Holocene deposits. No features or remains of archaeological significance have been identified in these mobile and highly variable deposits. These are underlain by soft, clay deposits which again identified no evidence of archaeological significance. Underneath this are solid bedrock deposits of Lower Cretaceous to Devonian age.

No objects or debris of archaeological significance were identified in the sub-bottom profiling geophysical data. Borehole evidence taken from piezocone penetration tests (CPT) and vibrocores within the

proposed development area suggest that there is little potential for the survival of palaeoenvironmental evidence such as organic materials e.g. peats and organic due to the burial environment and highly mobile seabed. Any potential deposits that have survived with palaeoenvironmental remains are likely to have been re-deposited through glacial movement and thus will not be in a primary context. The presence of flints and lithic artefacts on and in the seabed remains a possibility.

Further borehole study may allow for a more definitive account of the sediment composition. It is thought that targeting those areas where the thin Holocene deposits are exposed as well as older formations and thus possible fluvial or terrestrial past landscapes surfaces would be the best direction for further analysis (Offshore Geotechnical Investigations and Historic Environmental Analysis, 2011). It is in these past landscapes where the potential evidence for human exploitation and occupation lies.

Multibeam Data

The processed bathymetric data has enabled the cross referencing of geophysical targets identified by both Gardline Geosurvey Ltd. and Headland Archaeology as well as providing a good illustration of the relief of the survey site area. The multibeam data has been particularly useful in identifying the relationship between identified targets and areas of the seabed highlighting clear geological characteristics or, indeed, targets of potential cultural heritage interest.

Seabed areas with characteristics such as sand ripples, mega ripples, gravel ridges, boulder fields and outcropping bedrock have been identified across the site and show the area to be highly dynamic. The sediment movement on the seabed could likely cover and cause the burial of potential debris and wrecks.

6.5 RESULTS 0F THE ARCHAEOLOGICAL ASSESSMENT OF GEOTECHNICAL SURVEY DATA

Introduction

This report is prepared on behalf of Beatrice Offshore Windfarm Ltd. (BOWL) and presents the results of an archaeological and palaeoenvironmental assessment of marine geotechnical survey data in connection with the proposed Beatrice Offshore Windfarm offshore transmission cable route in the outer Moray Firth.

Aims and Objectives

The aim of this report is to provide an archaeological assessment of the palaeoenvironmental potential of sediments affected by the planned offshore export cable. This will be undertaken through the examination of the geotechnical data (namely borehole logs) that have been taken to date. This assessment will provide specific site data that will add to the findings of the desk based assessment (see Volume 1) and aid in identifying potential impacts of the transmission cable on any sediments of palaeoenvironmental and archaeological interest.

The specific objectives of the assessment are:

- to review available data in respect of seabed and sub-seabed deposits likely to be of palaeoenvironmental interest.
- to identify any deposits of palaeoenvironmental potential, particularly peats or organic silts.

RESULTS

Geotechnical Data Assessment

A total of 40 CPT tests were taken at 31 locations along the proposed Beatrice transmission cable route. The CPT penetration reached a maximum depth of 5.36m at station CPT 10, whilst the minimum depth of penetration was 0.32m at station CPT 5. Vibrocore recovery reached a maximum depth of 4.70m at station VC 28A, and a minimum of 0.32m at station VC 29 (Gardline, 2011). Both sets of core logs indicate a highly variable sediment stratigraphy across the cable route with the sediments within the boreholes chiefly comprised of minerogenic materials of sands, silts and clays. No organic materials such as peats were recorded in any of the borehole records.

The borehole records show a sedimentological record that is principally made-up of medium dense to very dense sand (including gravelly sands and silty sands) which is underlain by clay and silt lithostratigraphic units across the transmission cable route. The upper part of the sequence (top 2m), which is thought to be of Holocene date consists largely of sands and stiff gravelly clays. Underlying these deposits are sediments of probable Devensian age, which show little variation to those above; again consisting mainly of sands and stiff clays.

Palaeoenvironmental potential of the material

The borehole records show a lithology which consists principally of sands and clays from both the Holocene and Quaternary deposits. The presence of shell fragments within some of the deposits found in the vibrocores, such as VC's 6–16, and single CPT23 indicates there is some palaeoenvironmental potential within the recorded strata. Such fossil marine fauna can provide palaeoclimate data (e.g. temperature) from glacial and interglacial events. This data could then be used to give an approximate date for these deposits in terms of what period of the Devensian they relate to.

The sedimentary sequences recorded from the export cable route hold low potential for palaeoenvironmental reconstruction. The dominance of sands, clays and silts within the area means that conditions for the preservation of microfossils such as pollen and macrofossils such as seeds and fruits are not ideal and there is also the potential for significant reworking of materials in the Holocene sands from the highly mobile environment in which it sits. There is some potential for the presence of micro-fauna such as ostracods to be present within the sands and clays, while shell fragments were also observed in one CPT and twenty-two vibrocores, particularly in the uppermost (Holocene to modern) parts of the sequences. Such fossil marine fauna can provide palaeoclimate data (e.g. temperature) from glacial and interglacial events. This data then has potential to provide such information for the Devensian and Early Pleistocene and may for comparison with fauna from other such deposits around the Scottish coastline, such as the Errol Beds (Peacock, 1975).

Those deposits relating to the Holocene period are seen to consist almost entirely of sands. Again some fossilized marine fauna are recorded and these could be used to provide some limited palaeoenvironmental data for the area for this period. No organic sediments such as peats or organic silts were found to be present at any depths within the CPT and VC boreholes; therefore there is no potential for

palaeoenvironmental data from proxies such as pollen. The absence of organic sediments such as peats also indicates that the potential for the presence of organic archaeological artefacts is also low; although the presence of residual flints and lithic artefacts remains a possibility.

7 CONCLUSIONS

Although no wrecks have been identified from the UKHO SeaZone and NMRS datasets within the proposed Inner Study Area, there is some potential to encounter cultural heritage assets. There are eight recorded live wrecks within the Outer Study Area. The NMRS database records more than 1,500 wrecks as having been lost in the Moray Firth/ North Sea area, the majority of which the precise locations are unknown. The relatively large number of recorded maritime losses in the area of the transmission cable route suggests a medium potential for the discovery of unrecorded cultural heritage assets, particularly along the coast in the vicinity of the cable landfall around Portgordon.

The mitigation strategy for Beatrice Offshore Wind Farm Transmission Works will be addressed in the Environmental Statement. Points to remember are that prevention and avoidance are key factors when considering the potential survival of archaeological remains. The preferred method of mitigation for archaeological remains is preservation in situ where possible.

The archaeological geophysical assessment undertaken for Beatrice Offshore Wind Farm Transmission Works has identified a single target of high archaeological potential. This target has been positively identified as previously unrecorded wreck remains of unknown origin. The wreck could represent any one of a large number of vessels known to have been lost in the Moray Firth without known or reliable coordinates. A temporary exclusion zone of 100m should be implemented around this wreck to protect it from damage during construction/ operation.

Eighteen targets of medium potential of possible anthropogenic origin were identified by Headland Archaeology within the transmission works area. This has been deduced from the survey data evidence as well as the characteristics displayed by the targets. Pending further investigation of these targets it is proposed that a 50m exclusion zone is employed on all the anomalies classified as displaying medium archaeological potential (Illustrated in Figures 1-4).

In addition, the archaeological geotechnical assessment concluded that there was low potential for the survival of palaeoenvironmental remains within the Inner study Area, while the potential for the survival of unrecorded archaeological features and deposits was low.

8 MITIGATION

The mitigation strategy for Beatrice Offshore Wind Farm Transmission Works will be addressed in the Environmental Statement. Points to remember are that prevention and avoidance are key factors when considering the potential survival of archaeological remains. The preferred method of mitigation for archaeological remains is preservation in situ where possible.

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temporary exclusion zone of 100m should be implemented around this wreck to protect it from damage during construction/ operation.

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Designated wreck data was downloaded from Historic Scotland's website © Historic Scotland

Offshore Sites and Monuments Record information derived from NMRS data © Crown Copyright RCAHMS

Wrecks and Obstructions information derived from SeaZone data © Copyright UKHO

Wrecks information taken from www.wrecksite.eu

APPENDIX A. GAZETTEER AND CONCORDANCE OF CULTURAL HERITAGE ASSETS WITH KNOWN LOCATIONS WITHIN THE OFFSHORE STUDY AREA.

HA	Name	SeaZone ID	NMRS ID	Status	Description	DD Long/ DD Lat	UTM30NmE / UTM30NmN
HA1001	Sunbeam (Possibly)	00897	-	Live	Sunbeam was a British Merchant sailing vessel (Schooner)of 132grt. On the 4th July 1915 when 17 miles S by E from Wick, Scotland she was captured by German submarine U-25 and sunk by gunfire. Found by multi-beam in a general depth of 42 m. LENGTH 25MTRS, WIDTH 10MTRS, HT 2.5MTRS. NO MAGNETIC ANOMALY. HIGLY DEGRADED		496719.788 6439047.215
HA1002	Day Jet	00895		Dead	Aircraft ditched in the Moray Firth not found by survey		498924.265 6428676.953
HA1003	Unknown Craft	02119	101775	Live	A small wreck, about 20 metres (65 feet) long, was examined on the 21 November 1987. The least echosounder depth was 74 in a general depth of 77 metres. The side scan sonar indicated a height of 2.6 metres. Found by echo-sounder		497031.018 6422183.054
HA1004	Unknown Craft	02116	101773	Dead	August 1986. Possible wreckage is reported by a local fishing skipper.		498756.869 6418503.008
HA1005	John Dunkin	02096	101769	Live	John Dunkin FV was a British Strath Class Trawler of 215 tons built in 1918 by Fleming & Ferguson, Paisley, Yard No 448 as the PEKIN. From 1918 to 1921 she was owned by the		497192.683 6417336.96

					Admiralty but from May 1919 she was loaned to the United States Navy for post war mine clearing (based at Kirkwall). She was renamed JOHN SUNKIN. Sold for mercantile use 1921. Official Number 143875. Purchased by John Boyle, Glasgow in 1931 and purchased by W. Livingstone, Aberdeen in 1940. In 1941 she was sunk by German bombing 13 miles N by E of Buckie. One crewman was lost. This trawler sank 13 miles N by E from Buckie on11/02/194S. The wreck of the JOHN DUNCAN was reported at 57 53 50N, 003 02 34W by a local fishing skipper.		9
HA1006	Unknown Aircraft	02117	101711	Live	On 6 August 1986 the wreck of an aircraft was reported by a local fishing skipper at 57 50 00N, 003 02 36W, position unreliable.		497335.503 6410124.405
HA1007	Pharon	02103	202207	Dead	Fishing Vessel, approximate location, reported sinking 10/05/1981		496730.233 6395306.391
HA1008	Bpt No 31	02068	None	Live	This British battle target practice has been located within the intertidal zone. The wreckage lies in an area of 7 m x 2 m and orientated N- S. Metal ribs are exposed 0.3 m above the sand during low water. Other wreckage less than 1 m in size lies 25 m to the east.		496876.409 6391921.638

APPENDIX B. RECORDED MARITIME LOSSES

(Vessels known to have been lost in the vicinity of the proposed wind farm offshore transmission route, with absent or poor positional information).

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
Unknown	202211	-	-	Buckie; North Sea	Ridley, G (1992) Dive Scotland: the northern isles and east coast, Revision London Page(s): 83, no. 1856
Unknown	101766	16/11/1931	Battle Practice [Practice] Target [Target]	'On the S side of Spey Bay, 2.2km ENE of Portgordon, in front of Spey Bay Golf Course, and about 300m E of the sandy promontory of Norrie Scalp'	The site was located, but not fixed on the 25 February 1986. Wreckage lies in the charted position over an area 7 x 2m approximately in size, and the keel is orientated 000/180 degrees. Metal ribs are exposed to a height of approximately 0.3 m above the sand and dry at low water. Other wreckage, less that 1 metre in size, lies 25 m further east. Report by HMS BEAGLE.
Ephratah	209610	29/11/1905	wooden lugger (20TH CENTURY	near the entrance to Portnockie [Portknockie] harbour	(Classified as wooden lugger built in 1901. The Ephratach was stranded near the entrance to Portnockie [Portknockie] harbour. The location assigned to this record is essentially arbitrary.

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
Jane Smith	284085	01/05/1858	SLOOP (19TH CENTURY)	'On Port Gourdon Rocks'	En route from Sunderland to Spey with coals, went ashore on the Banffshire coast.
Zephyr	285569	30/05/1870	Brig (18TH CENTURY)	Between Toy and Abroath	The ZEPHYR of Aberdeen was stranded on Port Gourdon [Portgordon] rocks during foggy weather, reported full of water, and likely to become a wreck: crew landed. Materials being saved. Registration: Aberdeen. Built 1851. 174grt. Length: 30m. Beam: 7m. The location assigned to this record remains unverified.
Lady Albemarle	284084	01/05/1858	SCHOONER (19TH CENTURY)	'On Port Gourdon Rocks'	Classified as schooner: no cargo specified, but date of loss cited as 1 May 1858). Violet: this vessel stranded at Portgordon. The location assigned to this record is essentially tentative.
Caledonian	248222	09/01/1852	Ketch (20th Century)	Caledonia; Portgordon	CALEDONIAN, of Macduff, schooner, 111 ton, 7 men, Newcastle to Macduff, coal, wind NNE fore 11, hazy, snow, 9.45 am, no exams vessel age 6. Wrecked by stress of weather at the Burn of Tynet [Tugnet]. Registration: banff. Built 1845. 111 tons burthen. Length: 22m. Beam: 6m.

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					The location assigned to this record is essentially tentative.
The Flower of Enzie	297903	16/02/1898	SCHOONER (19TH CENTURY)	Port Gordon; 'Outside The West Pier'; North Sea	Port Gordon [Portgordon], 8th Feb. The FLOWER OF ENZIE (schnr.), of Banff, Reid, from Sunderland to this place, with coals, when nearing this harbour to-day, during a northerly gale, struck the ground, broached to, and drove ashore outside the West pier: crew saved. Source: LL, No. 16,795, London, Tuesday, February 11 1868. NMRS, MS/829/72 (no. 11386). The location assigned to this record is essentially tentative.
Fancy	209563	18/11/1845	Lugger (19th Century)	'Near Portgordon'; Port Gordon Harbour; North Sea	16 February 1898 FANCY, 13 years, not reg. wood fishing lugger, 6 ton, none on board, master and owner J. Farquhar, Port Gordon [Portgordon], Banffshire. Moored in Port Gordon [Portgordon] Harbour. Ballast. Wind NW10. Near Port Gordon [Portgordon]. The location assigned to this record is essentially tentative.

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
Unknown	208874	-	-	Buckie; Portgordoun; 'Back Of Portgourdoun Pier'; North Sea	The location assigned to this record is essentially tentative
Laurel	282856	08/12/1851	Craft (19th Century)	Spey Bay; North Sea	Spey, 8th Dec. The LAUREL, of this port, lying in the Bay, (loaded with salt), for Newcastle, whilst the master was absent on shore, was run ashore by the crew during a violent gale, and it is feared will not be got off without damage. The location assigned to this record is essentially tentative.
James and Mary	209121	03/10/1860	Schooner (19th Century	Buckie; Garmouth; Dallachy; Spey Bay; North Sea	3rd October 1860, JANE AND MARY, 12 yrs old, schooner, 67 tons, 5 crew, carrying coals, stranded, total loss, 5 lives lost, wind WNW11, 1 mile E of Speymouth. The location assigned to this record is essentially tentative
Unknown	209654	03/09/1907	Lugger (20th Century)	Buckie; Portgordon; Buckpool; Gollachy; 'Midway Between Buckpool And Portgordon'; North	Classified as wooden lugger, in ballast: date of loss cited as 3 September 1907). Jessie M Bruce: this vessel stranded midway between Buckpool and Portgordon. The location assigned to this

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
				Sea	record is essentially tentative.
Deana	247206	03/03/1850	Brig (19th Century)	Buckie; North Sea	Wrecked 3 March 1850. DEANA [Diana] of Dundee, brig, 93 tons, 6 men, Dundee to Dublin, potatoes. Northerly wind force 12, thick squally sleet 11.30pm low water, age of vessel = 32, class AE at Lloyds, 500 = value of vessel, 500 = value of cargo. (Wrecked) Buckie, wrecked at Tugnet Beach 2m from. In running up the Moray Firth the wind suddenly chopped to north and blew a perfect hurricane; no lights seen, draft 10 feet; heading W.W.W. Built at Perth, of oak. ? 1832. ? 1845. J. Turpie, Master. D. Crofts = owner. The location assigned to this record is essentially tentative.
Industry	248221	09/01/1852	Schooner (19th Century)	near West Haven	9 January 1852 INDUSTRY, of Bealy [Beauly], schooner, 83 ton, 6 men, Newcastle to Cromarty, for orders with coals, wind NNE force 11, hazy, snow, 2 am, high water, master exam, vessel age 6, Lloyds A1. Place - Speymouth. Wrecked by stress of weather at Tugnet, The location assigned to this record is

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					essentially tentative
PiloHelen	286470	27/09/1861	Brig (19th Century)	Garmouth; Kingston; North Sea	Dundee, 27th Sept. The HELEN, which was wrecked at Garmouth (Spey) 22nd Sept., was bound to that port with wood. Classified as brig, with cargo of wood: date of loss cited as 22 September 1861. The location assigned to this record is essentially tentative.
Unknown	209728	02/01/1917	Iron trawler	'wrecked off Buckie'	This vessel was built at North Shields, being launched in 1897, and owned by Kelsall Bross and Beeching of Hull. She was requisitioned in November 1914, and converted to a minesweeper. She was lost on 2 January 1917, being wrecked off Buckie.
Osprey	209306	26/11/1865	Wooden Smack (19th Century)	Buckie, New Town; Newtown; North Sea	26 November 1865, OSPREY, 3 yrs old, sloop, 15 tons, 3 crew, stranded, total loss, 3 lives lost, wind F12, Newtown, Buckie, Banff. (Classified as wooden smack, with cargo of flagstones: date of loss cited as 26 November 1865). Osprey: this vessel was lost at Buckie. (Rebuilt: 1865). Registration: Inverness. Built 1862. 16grt.

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					Length: 13m. Beam: 4m.
Ceres	282480	17/08/1849	Brig (19th Century)	River Spey; Spey Bay; North Sea	Aberdeen, 15th Aug. The CERES, (brig), coal-laden, in taking the harbour of Speymouth, 30th ult., got aground, and remains. The location assigned to this record is essentially tentative.
The Marquis of Huntley	272858	23/02/1835	Craft	; 'In The River Spey'; 'On The Sands Beyond The Broadhill'; Spey Bay; North Sea	Aberdeen, 31st Jan. `The MQS. OF HUNTLEY, Geddes, from Sunderland, was driven on shore in the River Spey, during a violent gale on the 19th inst., and is totally wrecked. Crew, and part of the cargo and materials saved.' (Classified as sloop, with cargo of coal: date of loss cited as 19 January 1835). The location assigned to this record is essentially arbitrary.
Violet	282938	23/09/1952	Craft	River Spey; Spey Bay; North Sea	Speymouth, 20th Sept. The VIOLET, of Spey, in leaving the harbour, got on shore, and will have to discharge. Source: The Marine List, LL, No. 12,014, London, Thursday September 23 [1852]. NMRS, MS/829/72 (no. 8803). The location assigned to this record is

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					essentially tentative.
Fisher	248225	09/01/1952	Wooden Smack (19th Century)	'0.75 Miles From Tugnet'; River Spey; Spey Bay; North Sea	9 January 1852 FISHER, of Leith, smack, 35 ton, 4 men, Leith to Carra, Orkney, wood and staves, wind NNE force 11, hazy, thick snow, 9.45am, tide ? full, no exams, vessel age 7, not classed, place - Speymouth. Wrecked by stress of weather at Tugnet, ? (Classified as smack with cargo of wood: date of loss cited as 9 January 1852). Fisher: this vessel stranded in Spey Bay, 0.75 miles from Tugnet. The location assigned to this record is essentially tentative
James Clark	249974	25/12/1854	Schooner (19th Century)	River Spey; Spey Bay; North Sea	25 December 1854, JAMES CLARK, of Belfast, schooner, 90 ton, 5 men, Wick to ?, herrings, wind WSW force 10, thick with rain and snow, stranded, River Spey, at the mouth of, by stress of weather. Considerable damage. Had to discharge. The location assigned to this record is essentially arbitrary.
Scottish Chief	267249	16/05/1877	Craft (19th Century)	Bar Of Spey; River Spey; Spey Bay; North	SCOTTISH CHIEF, of Banff, Invergordon to Alloa, stranded, 16th Apl., Bar of Spey,

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
				Sea	Moray firth. The loss of this vessel is not cited by I G Whittaker (1998); she may have been refloated.
Nelly	273204	29/07/1833	Craft (19th Century)	'Upon The West Bank'; River Spey; North Sea	`On the evening of the 29th ult., while the NELLY, Scorra, of Sunderland, was entering the River Spey, with the wind from the NE, the vessel missed her stays, and was thrown upon the West Bank. She became a wreck; but the crew was saved, and the cargo and rigging got ashore.' Source: Durham County Advertiser, 23.8.1833, No.990, p.3. The location assigned to this record is essentially arbitrary.
Adventurer	274646	14/09/1838	Craft (19th Century)	River Spey; Spey Bay; North Sea	Banff, 8th Sept. `The ADVENTURER, Beverley, from Miramichi to Sunderland, was totally wrecked yesterday at Speymouth: crew saved.'). The location assigned to this record is essentially tentative.
Haidee	283393	17/08/1856	Schooner (19th Century)	River Spey; Spey Bay; 'On The Bar'; 'Near Speymouth'; North	Classified as schooner, with cargo of wheat: date of loss cited as 17 August 1856). Haidee: this vessel was wrecked

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
				Sea	near Speymouth. Capt. Kissock. (Pre Feb 1853?) Registration: Aberdeen. Built 1846. 55 tons burthern. Length: 20m. Beam: 4m.
Brothers	287327	01/11/1961	Craft (19th Century)	'Near The Old Mouth Of The Spey'; 'At The Old Mouth Of [The] Spey'; River Spey; Spey Bay; North Sea	The BROTHERS, drove ashore near the old mouth of the Spey yesterday: crew saved. Should the weather moderate, the vessel and cargo may be saved. (No classification or cargo specified: date of loss cited as 1 November 1861). The location assigned to this record is essentially arbitrary.
Holdness	247518	08/10/1850	Schooner (19th Century)	'On The West Side Of The Entrance To The River At Speymouth'; River Spey; North Sea	HOLDENESS [Holderness] of Hull, schooner 83 tons, 4 men, London to Wick. Hoops, flags and powder, N and NNE frequent showers, driven by wind and sea with anchors and a hedge down towards a rocky shore; slipped at HW and ran for River Spey, but owing to strong fresh down that river, got stranded, every exertion made. (Classified as schooner, with cargo of hoops and flags: date of loss cited as 8 October 1850). The location assigned to this record is essentially tentative.

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
Thomas and Mary	270542	12/01/1810	Craft (19th Century)	Garmouth; Kingston; North Sea	The THOMAS AND MARY, from Gothenburgh to London, was driven on shore at Garmouth, near Aberdeen, 18th ult., where she lost anchors, cables, and helm, and has landed her cargo in order to repair. The loss of this vessel is not cited by I G Whittaker (1998), presumably on account of her successful recovery.
Alabama	253896	26/10/1884	Ketch (19th century)	Buckie Harbour; North Sea	26th October 1884, ALABAMA, age unknown, registered N. Shields, wooden ketch, 29 tons, 3 crew. Master and Owner G. Geddes, Nether Buckie, Banff. Was drawn up on the beach for repairs. (Classified as wooden ketch: no cargo specified, but date of loss cited as 26 October 1884). The location assigned to this record is essentially arbitrary
Alexander and Helen	252271	08/02/1859	Lugger (19th Century)	Buckie; North Sea	8 February 1889. ALEXANDER AND HELEN. 7 years. Not reg. Wood lugger. 24 ton. 7 men. Master J. Falconer. Owner A. Sim, Cullen, Banffshire. Buckie to fishing. Ballast. 1 dead. Wind N9. Cluny, Banffshire. (Classified as wooden lugger, in ballast: registration number cited as BF 742, and

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					date of loss as 8 February 1889). Alexander & Helen: his vessel stranded at Cluny, Banff. The location assigned to this record is essentially tentative
Zypher	260652	26/08/1881	Lugger (19th Century)	'Near The Entrance To Cluny Harbour'; 'Near Buckie New Harbour'; North Sea	26 August 1881, ZYPHER, 4 yrs old, not registered, wooden lugger, 18 tons, 7 crew, Master and Owner A. Slater, Porteasie, Banffshire, departed Fraserburgh for fishing, in ballast, wind ENE10, stranded, total loss, near the entrance to Cluny Harbour, Banffshire. (Classified as wooden lugger, in ballast, registration cited as BF 171, and date of loss as 26 August 1881). (Location entered as NJ c. 427 660 [N57 40.8 W2 57.8]). The location assigned to this record is essentially tentative
Jane	247248	30/03/1850	Schooner (19th Century)	Beechee; Banff; Gordonsburgh; West Muck; Middle Muck; East Muck; North Sea	Wrecked 30 March 1850, JANE of Berwick, schooner. 38 tons, 4 men, Sunderland to Port Gordon, Coal, wind = SSE, force 11, weather clear, 2pm high water, master/mate with examination = 0. Vessel estimated value of loss = 350. Cargo estimated value of loss = 45. (Wrecked at) Beechee, Banff. Wrecked on [the] Muck Rocks, blowing a fearful

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					gale at the time. Classified as schooner with cargo of coal: date of loss cited as 30 March 1850). Jane: [this vessel was] wrecked on Muck Rock, Banff. Capt. Nicholson. The location assigned to this record is essentially arbitrary.
Helen	286015	29/12/1870	Smack (19th Century)	Cluny Harbour; North Sea	Buckie, 29th Dec. The HELEN (smack), of Inverness, from Clasnach, Burghead, to this port, with stones and staves, broached to as she was making this harbour to-day, drove on the rocks and remains. The location assigned to this record is essentially tentative.
Ann	209307	18/06/1866	Lugger (19th Century)	'Entrance Of Buckie Harbour'; Cluny Harbour; North Sea	18 April 1866, ANN, 6 yrs old, lugger, 13 tons, 9 crew, departed Invergordon for Buckie carrying mussels, stranded, total loss, 1 life lost, wind N6, entrance of Buckie Harbour. (Classified as lugger, with cargo of mussels: date of loss cited as 18 April 1886). Ann: this vessel stranded at the entrance to Buckie harbour.

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
Endeavour	209483	15/10/1894	Lugger (19th Century)	Cluny Harbour; 'Near [The] Entrance To Buckie Harbour'; North Sea	15 October 1894. ENDEAVOUR, 11 years, not reg. wood lugger. 20 ton. 8 men. Master J. Jappy. Owner W. Marshall & Co., Buckie. Buckie to fishing. Wind ENE6. Near entrance to Buckie Harbour. (Classified as wooden lugger, in ballast: registration cited as BF 1223, and date of loss as 15 October 1894). Endeavour: this vessel stranded near [the] entrance to Buckie harbour. The location assigned to this record is essentially tentative.
Leah	286299	09/09/1864	Craft (19th Century	Cluny Harbour; North Sea	The LEAH, of Fehmern, Mackeprang, from Buckie to Konigsberg, with herrings, grounded on the bar while trying to get out of Buckie harbour on the 2nd Sept., when bad weather coming on she filled and sunk. Cargo since saved in a damaged state. The location assigned to this record is essentially tentative.
Iona	209480	16/12/1895	Schooner (19th Century)		16 December 1893, IONA, 20 years, of Fraserburgh. Wood schooner. 99 ton. 5 men. Master G. Cummine. Owner A. Stephen, Fraserburgh. Middlesboro' to Buckie. Salt. Wind WSW5. Rocks outside North Pier, entrance to Buckie Harbour.

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					(Classified as wooden schooner, with cargo of salt: date of loss cited as 16 December 1893). Iona: this vessel struck the N pier at Buckie harbour and is recorded as lying 20 yards outside the harbour, with masts above water. Registered: Fraserburgh. Built 1874. 111grt. Length: 27m. Beam: 7m. The location assigned to this record is essentially tentative
Olive	209347	16/06/1878	Schooner (19th Century)	'Outside Buckie Harbour'; North Sea	15 June 1878, OLIVE, 18 yrs old, of Inverness, wooden schooner, 87 tons, 5 crew, Master G. Wood, Owner J. McWilliam, Buckie, departed Buckie for Sunderland, in ballast, wind NE4, stranded, outside Buckie Harbour, Banffshire. (Classified as wooden schooner, in ballast: date of loss cited as 15 June 1878). Olive: this vessel stranded outside Buckie Harbour. Capt. Wood. Registration: Inverness. Built 1860. 87grt. Length: 22m. Beam: 6m. (The location assigned to this record is essentially arbitrary

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
Look Out	298233	14/03/1871	Craft (19th Century)	Buckie, South Harbour; Cluny Harbour; North Sea	Peterhead, 14th Mar. The LOOK OUT, of Buckie, which sunk in South Harbour, has discharged her cargo of herrings, and is now on the beach. The location assigned to this record is essentially tentative
George	209470	18/11/1893	Lugger (19th Century)	Cluny Harbour; Cluney Harbour; North Sea	18 November 1893, GEORGE, 10 years, not reg. Wood fishing lugger. 3 ton. 5 men. Master and owner G. Murray, Buckie. Moored in Cluny Harbour, Banffshire. Ballast. Wind NNE10. Cluny Harbour. (Classified as wooden lugger, in ballast: registration cited as BF 1255, and date of loss as 18 November 1893). George: this vessel was driven from moorings and wrecked in Cluny [Buckie] harbour. Capt. Murray. Registration: Buckie. Built 1869. 3grt. Length: 7m. (The location assigned to this record is essentially tentative.
Young Bird	209472	18/11/1893	Lugger (19th century)	'Outside Cluny Harbour'; Buckie Harbour; Muck Rocks; North Sea	18 November 1893, YOUNG BIRD, 1 year, not reg. Wood fishing lugger. 2 ton. 6 men. Master and owner J. Muray, Buckie. Moored at Cluny, Banffshire.

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					Ballast. Wind NNE10. Outside Cluny Harbour. (Classified as wooden lugger, in ballast: date of loss cited as 18 November 1893). Young Bird: this vessel stranded outside Cluny [Buckie] Harbour. Capt. Murray. Not registered. Built 1892. 2 tons [unspecified]. The location assigned to this record is essentially arbitrary
Unknown	209611	26/01/1906	Lugger (20th Century)	'Buckie, Harbour, Outside The North Pier'; Cluny Harbour; North Sea	(Classified as wooden lugger, in ballast: date of loss cited as 26 January 1906). Gowan Brae: this vessel stranded outside [the] North Pier, [at] Buckie [harbour]. Capt. Campbell. Not Registered. Built 1894. 31 tons [unspecified]. The location assigned to this record is essentially tentative.
Unknown	265165	15/08/1874	Craft (19th Century)	Portlessie; Buckie; North Sea	Banff, 15th August 1874. A heavy gale from the NNE sprung up here this morning, and a number of herring fishing boats were in great danger, causing them to run for Macduff harbour from all quarters. Unfortunately, however, on account of its being ebb tide, they could

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					not enter, and had to wait in a cluster at the harbours' mouth for the flood tide. The Banff and Macduff lifeboat, the JOHN & SARAH, belonging to the National Institution, was quickly taken afloat to the assistance of the fishing boats and has been helping them all day. Three boats were wrecked, but happily all hands were saved by the lifeboat. One man had a narrow escape, for he got into the water and it was with great difficulty that he was rescued. At Portlessie [Portessie] one fishing boat was lost, with her crew of five men, and seven other boats are missing at the present time. [Report received incomplete]. NMRS, MS/829/70 (no. 4136). (The location assigned to this record is essentially arbitrary
Town of Liverpool	256692	19/11/1875	Sloop (19th century)	Strathline; Findochty; '2.5 Miles East Of Buckie'; North Sea	19 November 1875, TOWN OF LIVERPOOL, 40 yrs old, of Banff, wooden smack, 36 tons, 3 crew, Master and Owner K. Gordon, Macduff, departed Middlesborough for Macduff carrying coal, wind NE11, stranded 2.5 miles E. of Buckie, Banffshire.

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					(Classified as sloop, with cargo of coal: date of loss cited as 19 November 1875). Town of Liverpool: this vessel stranded at Strathline (Buckie?) and is expected to be come a wreck. ON: 17,995. Registration: Banff.
Unknown	273204	29/07/1833	Craft (19th century)	'Upon The West Bank'; River Spey; North Sea	(No classification or cargo specified: date of loss cited as 29 July 1833). Nelly: this vessel stranded at Speymouth. Capt. Scorra. Registration: Sunderland? (Location of loss cited as N57 40.67 W3 6.00). I G Whittaker 1998.
Unknown	101807	1974/1976	Aircraft/ Helicopter	North Sea	A helicopter is reported to have crashed '10 or 12 years ago', ie - 1974/76. Report by HMS FOX. 23 July 1986. The wreck of a helicopter was reported by a local fishing skipper at 57 50 55.5N, 002 50 08W. Decca - (n brit) red f 3.0-3.4, purple c 57.4-57.8. Report by HMS BULLDOG. 8 October 1987. A sonar contact was obtained at 57 50 52N, 002 50 08W. The dimensions are consistent with it being a

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					helicopter. Decca - [n scot] red f 2.91, green c 38.94, purple b 57.62. The least echosounder depth was 91 in a general depth of 95 metres. The side scan sonar indicated a height of 4 metres. Report by HMS FOX. Hydrographic Office 1995.
Unknown	103029	-	Aircraft	Beatrice Field Oil Export Pipeline; North Sea	8 December 1987. Wreckage was located close to the Beatrice Field oil export pipeline at 57 54 46N, 003 22 57W. The wreckage extends over an area of approximately 30 to 40 metres square. Video of the wreckage was checked by Department of Transport, Farnborough, and the vessel is considered the remains of a military aircraft - probably World War II vintage. The estimated observed position was decca (n scot) red g 6.05, green a 44.32, purple a 59.58. The site was not detected during previous surveys and may now have been exposed by seabed movement..
Ellen	209542	29/11/1897	Lugger (19th Century)	Buckie; North Sea	29 November 1897 ELLEN, 17 years, not reg., wood fishing lugger. 4 ton, none on

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					board. Master and owner D. Flett, Findochty, Banffshire. Moored at Findochty. Ballast. Collided with several unregistered fishing boats, names unknown. Wind NNE10. Findochty. (Classified as wooden lugger, in ballast: date of loss cited as 29 November 1897). Ellen: [this vessel was in] collision and sank while moored at Findochty, Banff. Not registered. Built 1820. 4 tons [unspecified]. The location assigned to this record is essentially arbitrary
Linnet	272760	19/02/1836	Craft (19th Century)	harbor of Macduff	Aberdeen, 19th Feb. `The LINNET, Carruthers, of Sunderland, is stranded in the harbor of Macduff. The OSPREY, Hawlin, of this port, went to pieces 17th inst., near Thurso. The DSS [Duchess]. OF GORDON, Colville, of this port, is on shore in that neighbourhood. The DSS [Duchess]. OF GORDON, of Port Gordon [Portgordon], Geddes, has sustained much damage in the harbor of Findochty. A sloop and a schooner are reported to have come on shore, bottom upwards, between Banff and Portsoy, and all

Name	NMRS ID	Date Lost or Reported	Type	Location	Description
					hands lost.'

APPENDIX C. LEGISLATIVE FRAMEWORK AND GUIDANCE

International and European Conventions for Marine Cultural Heritage

International law is represented by customary law and the conventions to which the UK are party. The United Nations Convention on the Law of the Sea 1982 (UNCLOS 1982); the UNESCO Convention on the Protection of the Underwater Cultural Heritage 2001 (UNESCO 2001); and the European Convention on the Protection of the Archaeological Heritage (Revised) 1992 (the Valletta Convention) are all relevant in this regard.

UNCLOS 1982 was ratified the UK in 1997. Article 303 stipulates that 'states have the duty to protect objects of an archaeological and historical nature found at sea and shall co-operate for this purpose'. Article 303 also provides for coastal states to exert a degree of control over the archaeological heritage to 24 nautical miles, though no measures have been introduced to implement this right.

The Valletta Convention, ratified by the UK in 2000 and brought into force in 2001, bounds Scotland to implement protective measures for archaeological heritage within the jurisdiction, including sea areas. Insofar as the state exerts jurisdiction over the Continental Shelf, then it would appear that the provisions of the Valletta Convention apply to those jurisdictions.

The UNESCO Convention 2001 is a comprehensive attempt to codify the law internationally in respect of the underwater archaeological heritage. Although the UK abstained in the vote on the final draft of the Convention, it has stated that it supports most of the articles, particularly the provisions in the Annex governing the conduct of archaeological investigations.

The International Council on Monuments and Sites (ICOMOS) Charter on the Protection and Management of Underwater Cultural Heritage 1996 (the Sofia Charter) includes a series of statements regarding best practice, intending 'to ensure that all investigations are explicit in their aims, methodology and anticipated results so that the intention of each project is transparent to all'. The UK is a member of ICOMOS.

UK Legislation

Marine (Scotland) Act 2010

The Marine Scotland Act 2010 contains a new power which allows Scottish Ministers to designate Marine Protected Areas (MPAs). This provides greater flexibility for Ministers to use area-based measures to conserve marine biodiversity as well as nationally important historic assets such as historic shipwrecks. The new power broadens the scope of what types of historic asset can be protected if they are of national importance and allows Scottish Ministers to target protection and management according to the preservation objectives of each Historic MPA.

The Protection of Military Remains Act 1986

Under the Protection of Military Remains Act 1986 the Ministry of Defence has powers to protect vessels that were in military service when they were wrecked. The MOD can designate named vessels as Protected

Places even if the position of the wreck is not known. In addition, the MOD can designate Controlled Sites around wrecks whose position is known. In the case of Protected Places, the vessel must have been lost after the 4th August 1914, whereas in the case of a wreck protected as Controlled Sites, no more than 200 years must have elapsed since loss (MOD 2001).It is an offence to tamper with, damage, move or remove sensitive remains. However, diving, salvage and excavation are all prohibited on Controlled Sites, although licences for restricted activities can be sought from the MOD. Additionally, it is an offence to carry out unauthorized excavations for the purpose of discovering whether any place in UK waters contains remains of a vessel which has crashed, sunk or been stranded while in military service. It is worth noting that under the Protection of Military Remains Act 1986, all aircraft that have crashed in military service automatically constitute a Protected Place.

Ancient Monuments and Archaeological Areas Act 1979

The main legislation concerning archaeological remains in the UK is the Ancient Monuments and Archaeological Areas Act 1979. This Act primarily deals with land sites but there is provision to designate sites of vessels in territorial waters as Scheduled Monuments. Monuments are defined by the AMAA 1979 as including buildings, structures, works, caves, excavations, vehicles, vessels, aircraft or other movable structures. Monuments can only be scheduled if they are of national importance. Section 53extends the AMAA 1979 to monuments situated in, on or under the seabed within UK territorial waters. Once a monument has been scheduled, visiting or diving on the site is not necessarily restricted. It is, however, an offence to demolish, destroy, alter or repair the monument without prior authorisation, in the form of Scheduled Monument Consent.

Merchant Shipping Act 1995

The Merchant Shipping Act 1995 (MSA 1995) is used to regulate the reporting and disposal of wreck, including wreck of archaeological interest found or recovered from UK waters, or found or recovered outside UK waters but brought within those waters. Within the context of the MSA 1995, wreck refers to flotsam, jetsam, derelict and lagan found in or on the shores of the sea or any tidal water. It includes ships, aircraft and hovercraft, parts of these, their cargo and equipment. All wreck that is found or taken into possession must be notified to the Receiver of Wreck by the finder. The wreck is then delivered to the Receiver, or, more commonly, held by the finder to the order of the Receiver. The ownership and disposal of wreck is decided according to procedures contained within the MSA 1995. Provision is made for original owners to come forward to claim their property. Ownership of unclaimed wreck from within territorial waters lies with the Crown or in a person to whom rights of wreck have previously been granted by the Crown. The Receiver has a duty to ensure that finders who report their finds as required receive an appropriate salvage payment. In the case of material considered to be of historic or archaeological importance, a suitable museum is asked to buy the material at the current valuation and the finder receives the net proceeds of the sale as a salvage payment. If the right to, or the amount of salvage cannot be agreed, either between owner and finder or between competing salvors, the Receiver will hold the wreck until the matter is settled, either through amicable agreement or by court judgement.

APPENDIX D. GEOPHYSICAL SURVEY SPECIFICATIONS & SUITABILITY FOR ARCHAEOLOGICAL ASSESSMENT

4.1 Survey Specifications & Suitability for Archaeological Assessment

The following outlines the methodology used by Guardline during the geophysical survey of the cable route area referred to as the 'Inner Study Area'.

4.1.1 Guardline's Survey Methodology and Specifications

The geophysical data was acquired by Gardline Geosurvey Limited onboard survey vessel MV Ivero between 25th May 2011 and 15 June 2011, and by Titan Environmental Surveys Ltd onboard the Titan Endeavour. The vessel surveyed to the 10m water depth contour along both Route Options A and B. The nearshore approaches within the 10m contour were acquired by Titan Environmental Surveys Ltd. The Titan Endeavour agreed to reach the 5m depth contour, plus 500m overlap to ensure sufficient overlap with the offshore vessel. The marine survey data was used to inform Gardline Geosurvey Ltd and their consultants Senergy, on the likely seabed conditions along the proposed cable route. The geodetic parameters used throughout the survey were WGS84 UTM zone 30 North. The techniques employed included Single and multi-beam echo sounder, sidescan sonar, pinger, magnetometer, vibrocore and CPT equipment was used during this survey

4.1.1.1 Survey Parameters

The marine geophysical survey undertaken by Gardline was initiated with a view to satisfying a number of requirements (eg. geological, engineering etc.) of the proposed development. The proposed Beatrice Export Cable Routes A and B are 64.770km and 64.650km long. Both options have a common route, which only deviates at KP 53.850 for the approaches to the two landing points. The survey corridor width and number of survey
lines varies according to water depth and is as follows (Gardline, 2011).

- The corridor consists of a centreline between KP 0.000 and KP 6.500. The Beatrice site approach zone consists of eighteen survey lines at 100m intervals in the northeast of the zone, tapering to six lines at 100m intervals in the southwest.
- The Beatrice site approach zone lies between KP 6.500 and KP 11.500 of the export route. Between KP 11.500 and KP 24.000 the survey corridor consists of a centreline and three lines either side offset by 100m, 200m and 300m.
- Between KP 24.000 and KP 49.000 the survey corridor consists of a centreline and four lines either side offset by 100m, 200m, 300m and 400m. Between KP 49.000 and KP 53.850 the survey corridor consists of a centreline and three lines either side offset by 100m, 200m and 300m.
- From KP 53.850 Option A and B begin to separate; the survey corridor consists of two centrelines, one for A and B. Centerline A has three lines offset 100m, 200m and 300m to the left and one line offset 100m to the right. Centerline B has three lines either side offset at 100m, 200m and 300m. From KP 59.000 to KP 62.00 the survey corridor consists of two centrelines both with five lines either side offset at 50m, 100m, 150m, 200m and 250m.
- From KP 62.000 the survey corridor was surveyed by Titan Environmental Surveys.

Positioning

The primary positioning for the survey was provided by Fugro Starfix DGPS service which used Aberdeen, Rogaland and Leidschendam as reference stations. Secondary navigation utilised the EGNOS (European Geostationary Navigation Overlay Service) satellite based augmentation system (SBAS).

Sidescan

An Edgetech dual channel sidescan sonar system was used to scan the seabed to either side of the ship's track. This has frequencies of 120kHz to 410kHz and range of 75/125m per channel.

Magnetometer/Gradiometer
A Geometrics G882 Caesium Vapour Marine Magnetometer was used for this part of the survey. The system uses a towed 'fish' with a total magnetic field sensor and CM221 Larmor counter. The unit provides absolute readings of total magnetic field, with a resolution of 0.004nT/Hz RMS.

Sub-Bottom Profiler
One monotrace analogue seismic system was deployed to investigate and map the shallow
soil units this being the GeoAcoustics 4 element sub-towed pinger. This has a firing rate of 350ms and band pass filter of 2.5-4.5kHz.

Echo Sounder
A heave compensated, dual frequency echo sounder was used to determine water depths
within the survey area. This was a Recorder Simrad EA400 with transducer frequencies 38 and 200kHz, a digital output of 200kHz and heave compensator MRU5. The echo sounder was operated using the mean speed of sound. Single beam echo sounder data have been used to validate the multi-beam echo sounder data, but have not been charted in this report.

An EM3002D multi-beam echo sounder that is permanently installed on MV Ivero was used to provide swathe bathymetry data. This is dual head mounted with transducer frequency of 293kHz and 307kHz. The data acquisition software used is Simrad SIS and general water depths of 10m to 100m.

4.1.2 Archaeological Suitability of the Survey Methodology and Specifications

The following assesses the suitability of the specifications for each survey method for archaeological assessment and takes into consideration the guidelines presented in the English Heitage MoRPHE Guidance (2006) for marine archaeological geophysical survey.

After reviewing the methods of data collection utilised by Gardline Geosurvey it is thought that the survey 'tracks' or 'lines' are sufficient enough to provide accurate coverage of the BOWL survey area. As mentioned previously a further 26 lines were added to each phase for more detailed coverage.

The survey techniques employed, and equipment used, were again found to be adequate for the detail needed for an archaeological geophysical survey assessment such as this. The GPS was operated in conjunction with all the survey techniques described above and as such provided accurrate and true track co-ordinate information.

4.1.2.1 Sidescan Sonar

The sidescan sonar data was rated with regard to its suitability for the purpose of identifying and interpreting cultural heritage remains. Data of high frequency and short range will better distinguish the structure of any identified maritime losses such as wrecks and aircraft and may enable the discrimination between geological and archaeological features. However, data acquired at low frequency at larger ranges may only identify the outline of wrecks and may not be able to distinguish the presence of any associated debris.

The quality of sidescan data acquired within the proposed development area has been rated as good for the identification of any visible cultural heritage remains on the seabed such as wreck remains or debris (typically >2m). The system is capable of a minimum of 125kHz and a maximum of 445 kHz and was operated in dual frequency mode at a maximum range scale of 200m per channel throughout the survey area. Line spacing for the survey was taken at 150m intervals for the main lines and 500m for the cross lines meaning that the entire survey area was covered by at least one survey line and often more than one.

The main challenge faced during review of geophysical survey data is the problem of accuracy. The survey was conducted using DGPS and corrected navigation was available to the mairitme archaeologists during the data review. However, there remain some inherent difficulties when using certain geophysical techniques which do not give precise measurements even when the location of the survey instrument has been precisely established. Inaccuracy is partly due to perspective shifts between playbacks as the sonar receiver will sense the echos from the seabed at slightly different angles during different playbacks. However, these errors are not likely to be significant and any archaeological evidence identified can be cross referenced and an accurate co-ordinate attained (mitigation of a maximum of 10m). The size of the object at this level of accuracy is deemed sufficient for locational purposes and any possible construction exclusion zones which might be put in place by way of mitigation.

4.1.2.2 Magnetometer

The magnetometer data was taken with a Geometrics G882 Caesium Vapour Marine Magnetometer across all tracks in the survey towed at a known distance behind the sidescan sonar fish. The data quality and results were found to be of a good standard for archaeological assessment.

4.1.2.3 Sub-bottom Profiling (or Seismic)

The seismic data collected during the survey was found to be of good quality for the purpose of archaeological assessment of the geophysical data. Again the survey was taken along each individual transect in order to give a good representation of the geological sediments and any evidence of archaeological remains on or beneath the seabed. The boomer system quality was seen to be inadaquate for the Beatrice survey and as such the Geospark system was solely used with depth capablility of 400m/s below the seabed. The results showed no evidence of archaeological features of interest in the seabed substrates.

A total of 40 CPT tests were taken at 31 locations along the proposed Beatrice transmission cable route which has enabled the local stratigraphy and sediment history to be revealed and is dicussed in depth in Volume 1 and Volume 3. The sub-bottom data was taken using the Geospark 200 sparker source. The data produced from this was regarded as the most useful in identifying targets or objects at an appropriate resolution to the depths most likely to reveal features such as wreck remains or associated debris.

4.1.2.5 Echo Sounder/Multibeam Echo Sounder

The multibeam equipment used and data acquired on the BOWL development is rated as good quality for geophysical survey assessment. The relief, features and depth of the seabed is visible on the survey data, along with ridges and valley remains in the south of the area.

APPENDIX E. GEOPHYSICAL TARGETS IDENTIFIED BY HEADLAND ARCHAEOLOGY

1. Sidescan targets

HA No.	Description	Potential	Geophysical Length	Geophysical Width	Geophysical Height	DDM_Long	DDM_Lat	UTM30NmE	UTM30NmE
1	Possible Natural Feature	Low	5.25	1.88	0.25	-2 57.8535	57 51.5697	497866.21	6394513.54
2	Possible Natural Feature	Low	4.11	1.12	0.43	-2 57.6964	57 41.3738	497710.61	6394149.91
3	Possible Natural Feature	Low	2.91	2.07	0.22	-2 57.6460	57 41.1969	497661.06	6393821.61
4	Possible Natural Feature	Low	3.82	2.25	0.12	-2 57.7109	57 41.0785	497725.91	6393601.57
5	Possible Natural Feature	Low	8.72	5.15	0.45	-2 57.6392	57 41.0506	497653.66	6393544.93
6	Possible Natural Feature	Low	2.59	3.17	0.42	-2 57.5112	57 41.2341	497527.52	6393890.56
7	Possible Natural Feature	Low	1.41	1.45	0.27	-2 57.4524	57 40.9789	497468.41	6393415.93
8	Possible Natural Feature	Low	2.85	1.28	0.29	-2 58.0767	57 41.2911	498089.22	6393996.33
9	Possible Natural Feature	Low	2.3	1.53	0.22	-2 57.6902	57 41.4943	497704.88	6394373.86
10	Possible Natural Feature	Low	1.98	1.08	0.34	-2 57.9981	57 40.2380	498008.6	6392041
11	Possible Natural Feature	Low	3.21	1.31	0.06	-2 58.0439	57 40.2789	498059.54	6392078.9
12	Possible Natural Feature	Low	2.56	1.9	0.12	-2 58.0440	57 40.2790	498055.63	6392118.84
13	Possible Natural Feature	Low	2.03	2.08	0.07	-2 57.9965	57 40.2730	498007.93	6392106.68
14	Possible Natural Feature	Low	2.08	1.79	0.16	-2 58.0449	57 40.5304	498056.3	6392583.49
15	Possible Natural Feature	Low	1.46	1.23	0.14	-2 57.9735	57 40.2315	497985.01	6392029.59
16	Possible Natural Feature	Low	2.37	1.59	0.11	-2 57.2081	57 40.2081	497946.05	6391987
17	Linear debris	Medium	5.32	1.35	0.06	-2 57.4563	57 40.2704	497470.56	6392102.62
18	Possible Natural Feature	Low	2.32	0.87	0.57	-2 57.3294	57 40.2181	497348.04	6392005.13
19	Possible Natural Feature	Low	3.37	2.85	0.87	-2 57.8512	57 40.1510	497864.24	6391881.5
20	Linear debris	Medium	22.61	2.53	0.11	-2 57.7436	57 40.1162	497753.5	6391816.63
21	Possible Natural Feature	Low	2.85	1.95	0.89	-2 57.7335	57 40.1612	497745.45	6391901.07
22	Possible Natural Feature	Low	1.78	1.58	0.5	-2 57.5591	57 40.0493	497573.63	6391692.08
23	Possible Natural Feature	Low	2.42	1.45	0.15	-2 58.0518	57 40.2041	498062.56	6391979.12

24	Possible Natural Feature	Low	3.93	1.7	0.45	-2 57.5793	57 40.0579	497593.76	6391707.97
25	Possible Natural Feature	Low	2.92	2.67	1.26	-2 57.4214	57 40.0565	497435.76	6391706.21
26	Possible Natural Feature	Low	3.02	1.63	0.12	-2 57.9881	57 40.2371	497999.45	6392041.13
27	Possible Natural Feature	Low				-2 57.9709	57 40.3824	497982.88	6392313.71
28	Possible Natural Feature	Medium	11.62	1.31	0.1	-2 57.9523	57 40.3100	497963.84	6392176.34
29	Possible Natural Feature	Low	1.71	1.42	0.27	-2 58.2227	57 40.6594	498233.32	6392824.33
30	Possible Natural Feature	Low	1.8	1.22	0.67	-2 58.1137	57 40.3994	498124.89	6392341.6
31	Possible Natural Feature	Low	1.41	0.81	0.23	-2 58.0363	57 40.4673	498048.62	6392467.56
32	Possible Natural Feature	Low	4.69	1.78	0.42	-2 57.6473	57 40.8260	497660.99	6393133.19
33	Linear debris	Medium	2.41	2.14	1.32	-2 57.5535	57 40.2649	497567.7	6392092.86
34	Possible Natural Feature	Low	3.43	1.33	0.46	-2 57.8878	57 41.4690	497901.37	6394325.97
35	Possible Natural Feature	Low	4.77	0.52	0.18	-2 57.4361	57 40.9192	497451.73	6393306.02
36	Possible Natural Feature	Low	3.39	0.87	0.3	-2 57.5863	57 41.6801	497602.82	6394718.63
37	Possible Natural Feature	Low	2.71	3.63	1.33	-2 57.5075	57 41.2375	497522.38	6393895.19
38	Possible Natural Feature	Low	1.75	1.4	0.31	-2 57.4584	57 40.9871	497475.49	6393433.37
39	Possible Natural Feature	Low	1.05	2.99	0.27	-2 57.3439	57 40.7427	497360.24	6392976.71
40	Possible Natural Feature	Low	3.3	1.12	0.12	-2 57.5240	57 41.3011	497539.97	6394015.28
41	Possible Natural Feature	Low	5.16	1.93	0.31	-2 57.3828	57 40.8954	497398.74	6393261.59
42	Possible Natural Feature	Low	4.36	1.47	0.28	-2 57.5413	57 41.9976	497557.69	6395307.63
43	Possible Natural Feature	Low	3.76	1.78	0.94	-2 57.3499	57 41.2342	497366.06	6393891.71
44	Possible Natural Feature	Low	3.84	1.2	0.13	-2 57.7952	57 40.7010	497809.25	6392900.14
45	Possible Natural Feature	Low	2.79	1.32	0.36	-2 58.0073	57 41.4502	498019.62	6394291.09
46	Possible Natural Feature	Low	5.18	0.79	0.53	-2 58.0302	57 41.8557	498042.97	6395043.4
47	Possible Natural Feature	Low	2.38	1.1	0.12	-2 57.8887	57 41.4740	497902.09	6394336.12
48	Possible Natural Feature	Low	2.36	1.21	0.08	-2 57.5640	57 40.3330	497577.28	6392217.91
49	Possible Natural Feature	Low	2.8	1.08	0.27	-2 57.8251	57 41.1456	497840.17	6393725.79
50	Possible Natural Feature	Low	8.85	1.71	0.57	-2 57.8547	57 41.5971	497868.56	6394564.15
51	Boulder Field	Low				-2 58.4788	57 41.7600	498488.01	6394864.87
52	Linear debris	Medium	11.01	4.53	0.94	-2 58.3360	57 40.7144	498347.52	6392925.68
53	Possible Natural Feature	Low	2.02	0.45	0.26	-2 57.8906	57 41.4683	497903.68	6394326.32

54	Possible Natural Feature	Low	3.61	1.57	0.36	-2 58.6761	57 41.6541	498030.36	6394710.61
55	Possible Natural Feature	Low	1.21	0.84	0.48	-2 57.8881	57 41.4713	497901.88	6394330.29
56	Possible Natural Feature	Low	4.69	0.98	0.34	-2 58.0132	57 41.7989	498025.4	6394936.67
57	Possible Natural Feature	Low	3.57	1.68	0.24	-2 57.8851	57 41.4691	497898.47	6394328.03
58	Possible Natural Feature	Low	2.82	2.63	0.33	-2 58.4364	57 41.6651	498477.59	6394688.71
59	Linear Debris Chain/Rope	Low	98.11	0.25	0.02	-2 58.3172	57 41.4106	498327.48	6394218.68
60	Linear Debris Chain/Rope	Low	64.68	0.21	0.06	-2 58.3986	57 41.3485	498411.04	63941110.97
61	Linear debris	Medium	12.76	5.15	0.54	-2 58.3890	57 41.0521	498398.56	6393553.55
62	Possible Natural Feature	Low	2.83	0.82	0.51	-2 58.2930	57 41.0823	498304.42	6393608.92
63	Possible Natural Feature	Medium	4.43	1.56	0.58	-2 58.2978	57 41.6155	498309.52	6394711.45
64	Possible Natural Feature	Low	5.99	1.37	0.28	-2 58.2166	57 41.3594	498229.99	6394123.83
65	Possible Natural Feature	Low	3.68	0.44	0.32	-2 58.2400	57 41.4787	498250.83	6394343.69
68	Wreck	High	24.09	7.82	2.38	-2 58.3972	57 41.0879	498407.62	6393620.09
70	Possible Natural Feature	Low	4.09	0.89	0.15	-2 58.3999	57 47.243	498308.33	6404995.04
71	Linear debris	Low	8.65	2.71	0.05	-2 58.2572	57 47.4392	498272.9	6405405.67
72	Linear debris	Low	3.7	1.54	0.08	-2 58.2567	57 47.4405	498276.88	6405435.86
73	Possible Natural Feature	Low	3.05	1.18	0.27	-2 58.4302	57 44.9909	498442.96	6400860.56
74	Possible Natural Feature	Low	5.44	2.19	0.4	-2 58.5166	57 44.0553	498527.37	6399122.98
75	Possible Natural Feature	Low	1.83	1.18	0.13	-2 58.2972	57 43.8536	498310.93	6398751.18
76	Possible Natural Feature	Low	3.86	2.13	0.36	-2 58.2438	57 43.3947	498257.1	6397898.91
77	Possible Natural Feature	Low	1.8	0.93	0.09	-2 58.3587	57 42.8247	498370.25	6396841.15
78	Possible Natural Feature	Low	4.61	1.12	0.13	-2 58.8384	57 45.8450	498847.89	6402443.67
79	Possible Natural Feature	Low	2.34	0.99	0.12	-2 58.2548	58 06.9636	498286.83	6441631.75
81	Possible Natural Feature	Low	1.46	2.07	0.41	-2 58.1025	58 06.8447	498135.15	6441411.11
82	Possible Natural Feature	Low	4.74	3.89	0.04	-2 57.0681	58 03.2994	497114.31	6434826.9
83	Possible Natural Feature	Low	1.96	1.67	0.26	-2 57.6234	57 57.8209	497657.29	6424667.38
84	Possible Natural Feature	Low	2.92	0.91	0.31	-2 58.8632	57 45.5741	498872.75	6401940.82
85	Possible Natural Feature	Low	3.03	1.34	0.81	-2 58.6144	57 46.3542	498626.67	6403392.53
86	Possible Natural Feature	Low	2.96	1.08	0.55	-2 58.6539	57 47.1783	498665.18	6404919.56
87	Possible Natural Feature	Medium	1.47	1.35	0.1	-2 58.6594	57 47.4975	498671.59	6405511.5

88	Possible Natural Feature	Low	2.16	2.91	0.21	-2 58.5715	57 48.2810	498584.07	6406965.66
89	Possible Natural Feature	Low	2.94	2.01	0.15			498357.1	6396610.28
90	Possible Natural Feature	Medium	4.26	1.79	0.61	-2 58.3015	57 41.6502	498311.99	6394662.17
91	Possible Natural Feature	Low	1.12	0.97	0.06	-2 58.4501	57 42.6989	498460.63	6396608.18
92	Possible Natural Feature	Low	1.34	1.22	0.17	-2 58.3528	57 42.5465	498362.95	6396325.51
93	Possible Natural Feature	Low	4.04	1.24	0.38	-2 58.4834	57 43.5291	498491.4	6398148.79
94	Possible Natural Feature	Low	4.69	5.19	0.15	-2 59.4015	58 08.4094	499410.85	6444308.95
95	Possible Natural Feature	Low	1.64	2.74	0.13	-2 58.4994	58 06.9780	498526.44	6441658.59
96	Possible Natural Feature	Low	1.58	1.32	0.2	-2 57.4950	57 41.0896	497511.19	6393622.93
97	Possible Natural Feature	Low	2.64	2.43	0.05	-2 57.7751	57 58.5484	497806.91	6426016.98
98	Possible Natural Feature	Low	2.19	2.08	0.27	-2 58.6542	57 47.1826	498667.35	6404925.9
99	Possible Natural Feature	Low	4.03	0.59	0.03	-2 58.2670	57 41.5941	498278.31	6394555.72
100	Possible Natural Feature	Low	2.47	2.4	0.18	-2 58.2937	57 41.4750	498305.64	6394337.26
101	Possible Natural Feature	Low	3.47	1.67	0.22	-2 58.2572	57 41.2189	498268.12	6393861.63
102	Possible Natural Feature	Medium	12.89	1.93	0.18			498267.34	6393862.75
103	Possible Natural Feature	Low	1.46	1.19	0.11	-2 57.5355	58 02.2224	497572.67	6432834.37
104	Possible Natural Feature	Low	2.34	1.44	0.25	-2 58.0142	57 57.5261	498042.48	6424120.67
105	Possible Natural Feature	Low	2.55	1.87	0.14	-2 57.9057	57 58.2863	497935.61	6425531.01
106	Possible Natural Feature	Low	2.34	1.09	0.17	-2 57.7644	57 58.5498	497798.47	6426017.69
107	Linear Debris	Low	5.71	1.66	0.26	-2 57.8793	57 58.6959	497910.47	6426290.85
108	Possible Natural Feature	Low	3.15	2.64	0.18	-2 57.7974	57 59.5374	497829.61	6427852.28
109	Possible Natural Feature	Low	3.33	1.05	0.11	-2 57.5777	58 00.1953	497614.06	6429073.29
110	Possible Natural Feature	Low	2.46	0.84	0.21	-2 58.7586	57 48.209	498771.11	6406724.69
111	Possible Natural Feature	Low	4.99	1.01	0.17	-2 58.7334	57 49.0230	498744.86	6408342.47
112	Possible Natural Feature	Low	5.12	2.47	0.46	-2 58.8603	57 45.5928	498869.07	6401976.24
113	Possible Natural Feature	Low	4.21	1.77	0.62	-2 58.9535	57 46.6105	498962.57	6403866.32
114	Possible Natural Feature	Low	4.64	2.1	0.33	-2 58.8530	57 47.5495	498863.58	6405605.9
115	Possible Natural Feature	Low	3.91	1.23	0.24	-2 58.7560	57 48.1484	498768.51	6406721.22
116	Possible Natural Feature	Low	4.61	1.35	0.11	-2 58.8327	57 45.8339	498842.9	6402426.51
117	Possible Natural Feature	Low	1.86	1.81	0.35	-2 57.8814	57 58.7028	497911.84	6426303.7

118	Possible Natural Feature	Low	3.03	1.81	0.21	-2 57.8757	57 58.5371	497906.22	6425996.09
119	Possible Natural Feature	Low	17.81	1.58	0.37	-2 57.8501	57 57.8606	497881.59	6424737.05
120	Possible Natural Feature	Low	2.34	0.93	0.08	-2 57.9222	57 57.6385	497950.15	6424326.8
121	Linear Debris	Medium	5.96	3.14	0.13	-2 57.8002	58 01.1820	497834.03	6430902.59
122	Possible Natural Feature	Low	2.14	1.11	-0.07	-2 58.4431	57 45.5158	498456.56	6401833.07
123	Possible Natural Feature	Low				-2 58.2590	57 43.8851	498276.29	638806.96
124	Possible Natural Feature	Low	3.68	1.07	0.23	-2 58.0919	58 06.8402	498126	6441403.22
125	Linear Debris	Low	7.48	2.6	0.29	-2 58.2039	58 07.2245	498236.85	6442115.91
126	Linear Debris	Low	3.19	1.22	0.22	-2 57.8853	57 41.9000	497899.31	6395125.33
127	Linear Debris	Medium	3.02	1.19	0.18	-2 57.7949	57 41.6449	497808.31	6394651.85
128	Possible Natural Feature	Low	2.33	0.086	0.15	-2 57.3999	57 57.4511	497433.89	6423981.08
129	Possible Natural Feature	Low	3.13	1.36	0.06	-2 57.3337	57 58.6212	497371.22	6426152
130	Possible Natural Feature	Low	2.81	128	0.13	-2 57.1892	58 00.0581	497239.48	6428818.95
131	Possible Natural Feature	Low	2.98	2.01	0.16	-2 58.1874	57 48.6489	498204.92	6407648.24
132	Possible Natural Feature	Low	2.54	1.11	0.25	-2 58.2225	57 42.6152	498235.05	6396450.71
133	Linear Debris	Medium	8.09	1.5	0.18	-2 58.9662	58 08.1409	498987.44	6443815.26
134	Possible Natural Feature	Low	1.39	0.78	0.07	-2 58.1128	58 07.2188	498147.74	6442105.72
135	Possible Natural Feature	Medium	4.57	2.16	0.43	-2 57.0435	58 01.2755	497089.34	6431077.84
136	Possible Natural Feature	Medium	2.26	0.88	0.09	-2 57.3409	57 58.6170	497379.11	6426144.86
137	Possible Natural Feature	Low	4.4	1.66	0.13	-2 58.2285	57 48.4525	498243.9	6407283.62
138	Possible Natural Feature	Low	2.68	1.47	0.23	-2 58.8323	57 41.8323	498035.95	6394998.73
139	Possible Natural Feature	Low	2.05	1.34	0.07	-2 58.0689	57 42.6478	498081.99	6396514.08
140	Possible Natural Feature	Low	3.37	1.59	0.22	-2 57.8336	57 41.4619	497846.38	6394312.91
141	Possible Natural Feature	Low	1.66	1.34	0.14	-2 57.8955	57 41.6904	497908.34	6394737.28
142	Possible Natural Feature	Low	2.97	1.85	0.24	-2 57.4027	57 57.4321	497437.42	6423946.17
143	Possible Natural Feature	Medium	5.99	2.14	0.32	-2 57.0389	58 01.2681	497084.81	6421066.66
144	Possible Natural Feature	Low	4.97	1.78	0.16	-2 58.1897	57 48.6301	498208.12	6407613.57
145	Possible Natural Feature	Low	2.47	0.97	0.21	-2 58.2986	57 47.2167	498314.28	6404991.37
146	Possible Natural Feature	Low	2.1	1.08	0.03	-2 56.8134	58 00.7215	496864.54	6430051.96
147	Possible Natural Feature	Low	3.42	1.47	0.11	-2 58.0630	57 43.4251	498076.32	639953.31

148	Possible Natural Feature	Low	3.28	1.19	0.21	-2 57.8501	57 41.5718	497865.1	6394518.86
149	Possible natural feature	Low	2.84	1.31	0	-3 02.9600	58 10.0517	502902.51	6447362.73
150	Possible natural feature	Low	2.65	1.24	0.3	-2 57.7322	57 42.1561	497747.71	6395602.08
151	Possible natural feature	Low	7.44	0.78	0.03	-3 03.0170	58 10.0975	502957.98	6447448.13
152	Possible natural feature	Low	4.35	0.68	0.13	-3 02.9826	58 10.0580	502926.64	6447375.32
153	Possible natural feature	Low	1.71	2.22	0.02	-2 58.5886	58 08.1730	498614.69	6443876.17
154	Debris	Medium	7.35	3.07	0.13	-2 58.9604	58 08.1387	498979.07	6443812.46
155	Possible natural feature	Low	2.7	0.27	0.07	-2 58.9098	58 08.1105	498930.24	6443759.87
156	Debris	Medium	8.1	0.68	0.16	-2 58.9625	58 08.1371	498979.17	6443807.59
157	Possible natural feature	Low	3.34	0.53	0.2	-2 57.9371	57 40.7189	497950.26	6392934.48
158	Possible natural feature	Low	3.75	0.91	0.15	-3 01.9339	58 10.3100	501896.21	6447841.44
159	Possible natural feature	Low	1.78	0.47	0.11	-3 02.4733	58 10.3505	502424.92	6447916.38
160	Possible natural feature	Low	3.38	0.61	0.28	-3 07.0469	58 12.3154	506902.51	6451568.42
161	Possible natural feature	Low	7.89	0.67	0.13	-2 58.9649	58 08.1378	498983.71	6443809.08
162	Possible natural feature	Low	2.63	0.34	0.57	-2 57.5177	57 41.2707	497533.36	6393958.62
163	Possible natural feature	Low	1.83	0.17	0.46	-2 57.8185	57 42.8985	497833.47	6396978.74
164	Possible natural feature	Low	10.41	4.9	0.26	-2 57.7003	57 41.9839	497715.7	6395281.82
165	Possible natural feature	Low	2.85	0.19	0.56	-2 57.5150	57 41.2730	497530.59	6393962.94
166	Possible natural feature	Low	2.33	0.52	0.24	-2 57.7233	57 43.0732	497739.48	6397302.82
167	Possible natural feature	Low	4.47	2.17	0.25	-2 57.8376	57 42.2017	497852.63	6395683.08
168	Possible natural feature	Low	3.21	0.65	0.23	-2 57.5130	57 41.2703	497528.36	6393958.25

2. Magnetometer targets

ID	UTM30NmE	UTM30NmN
1	501626	6445828
2	500586	6446618
3	498407	6442923
4	497883	6440493
5	497303	6437811
6	497115	6437504
7	497268	6434089
8	497066	6434054
9	497387	6434019
10	497066	6433977
11	497275	6433963
12	496996	6433942
13	496884	6433901
14	497492	6433747
15	497401	6433726
16	497087	6433649
17	497289	6433642
18	497415	6433516
19	497296	6433391
20	497429	6433272
21	496930	6432832
22	497443	6432846
23	497450	6432769
24	497457	6432567
25	497345	6432406

26	497450	6427992
27	497855	6427999
28	497862	6427930
29	497673	6427867
30	497562	6427818
31	497673	6427818
32	497757	6427699
33	497436	6419780
34	498351	6404283
35	498777	6403962
36	498672	6403823
37	498295	6403334
38	498895	6403082
39	498930	6402286
40	498588	6401720
41	498749	6401441
42	498700	6401099
43	498693	6400987
44	498393	6400917
45	498847	6400785
46	498176	6400785
47	498442	6400659
48	498546	6400540
49	498539	6400484
50	498127	6400324
51	498309	6400219
52	498588	6400100
53	498581	6400030
54	498574	6399989
55	498410	6399919
56	498609	6399898
57	498497	6399898
58	498784	6399842
59	498456	6399758
60	498560	6399123

61	498735	6399025
62	498421	6398871
63	497932	6398773
64	498686	6398313
65	498679	6398110
66	498050	6398075
67	498257	6397796
68	498449	6397523
69	498232	6397433
70	498211	6397356
71	498162	6397314
72	497743	6397286
73	498316	6397209
74	498225	6397209
75	498211	6397076
76	498239	6397049
77	497967	6396532
78	498211	6396455
79	497932	6396266
80	498176	6396120
81	498134	6396120
82	497659	6396036
83	498127	6395994
84	497897	6395980
85	498106	6395896
86	498085	6395533
87	498037	6395519
88	497841	6395519
89	498047	6395359
90	498197	6395156
91	498023	6395065
92	498176	6394877
93	498002	6394856
94	498162	6394688
95	497743	6394674

96	498483	6394430
97	498400	6394409
98	497960	6394381
99	498141	6394346
100	498197	6394297
101	498037	6394297
102	497942	6394255
103	498085	6394206
104	498183	6394199
105	498127	6394192
106	497827	6394206
107	497876	6394192
108	497925	6394178
109	497729	6394185
110	497785	6394178
111	498124	6394154
112	497869	6394122
113	498078	6394108
114	497918	6394115
115	498120	6394046
116	497663	6394028
117	497705	6394025
118	497562	6394025
119	497499	6393983
120	497555	6393955
121	497446	6393934
122	497387	6393899
123	497366	6393759
124	498431	6393630
125	497834	6393459
126	497841	6393319
127	497960	6393208
128	497862	6392425
129	497771	6392013
130	498148	6391888

131	497499	6391706
132	498050	6391622
133	498026	6391559

APPENDIX F. CPT AND VIBROCORE LOCATIONS

CPT No	UTM30NmE	UTM30nmN
1	506584	6451388
2	505236	6449576
3	502209	6447486
3A	502210	6447487
4	502674	6446770
5	501380	6445609
5A	501383	6445612
6	499031	6443658
6A	499031	6443657
7	498335	6441903
7A	498334	6441898
8	497312	6439329
9	497058	6436606
10	497188	6433840
11	497274	6432043
12	497355	6430149
12A	497354	6430151
13	497483	6427329
14	497623	6424308
15	497661	6423470
16	497840	6419570
17	498007	6415883
17A	498010	6415882
18	498049	6415022
19	498083	6414303
20	498098	6413704
21	498191	6411783
22	498227	6411082
23	498297	6409510
23A	498297	6409509
24	498432	6406676
25	498556	6403947
26	498633	6402531

27	498644	6402227
28	498594	6401832
29	498244	6398906
29A	498244	6398906
30	497887	6395948
31	498147	6394424
31A	498146	6394422

VC No	UTM30NmE	UTM30NmN
1	506577.47	6451387.11
1A	506575.76	6451386.96
2	505237.39	6449582
3	502208.42	6447490.37
3A	502207.72	6447489.18
4	502671.7	6446773.58
5	501379.13	6445618.25
6	499031.75	6443657.99
7	498332.76	6441897.48
7A	498329.49	6441900.7
8	497311.64	6439327.48
9	497059.42	6436608.02
10	497183.42	6433844.45
11	497265.53	6432045.98
12	497346.99	6430152
13	497481.59	6427330.42
14	497624.29	6424311.86
15	497663.56	6423472.45
15A	497660.37	6423476.21
16	497842.84	6419571.32
17	498013.83	6415879.35
18	498055.06	6415007.48
19	498086.75	6414299.78
20	498102.82	6413699.26
21	498197.71	6411782.85
22	498230.68	6411079.95

23	498299.53	6409511.09
24	498434.81	6406678.08
24A	498435.27	6406676.98
25	498557.22	6403943.92
26	498632.01	6402534.7
27	498644.25	6402227.58
28	498591.78	6401830.46
28A	498593.91	6401831.65
29	498242.45	6398904.83
30	497887.13	6395944.77
30A	497883.53	6395943.16
31	498148.36	6394420.3