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PEEL WIND FARMS (YELL) LTD

Beaw Field Wind Farm

Appendix 15.1: Flood Risk Assessment

March 2016

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PEEL WIND FARM (YELL) LTD

Beaw Field Wind Farm

Technical Appendix 15.1: Flood Risk Assessment

March 2016

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1 INTRODUCTION

1.1 General

1.1.1 Wardell Armstrong LLP has been commissioned to undertake a Flood Risk Assessment (FRA) on behalf of Peel Wind Farms (Yell) Ltd, relating to an application under section 36 of the Electricity Act 1989 for the proposed Beaw Field Wind Farm, Yell, Shetland Islands.

1.1.2 This FRA considers both the potential flood risk to the Site and the potential for the Proposed Development to contribute to offsite flood risk. A qualitative impact assessment has been undertaken using a combination of professional judgement, legislation and other statutory policy and guidance. Annex A contains the Scottish Environment Protection Agency's (SEPA) flood risk assessment checklist for the Site.

1.2 National Planning Policy

1.2.1 The Scottish Planning Policy (SPP), published on the 23rd June 2014, sets out the national planning polices which reflect Scottish Ministers' priorities for the operation of the planning system and for the development and use of land.

1.2.2 Paragraph 255 under the 'Managing Flood Risk and Drainage' policy requires that the planning system promotes a precautionary approach to flood risk from all sources, taking into account the predicted effects of climate change. Flood avoidance, flood reduction and the use of Sustainable Drainage Systems (SuDS) should also be promoted. Paragraph 256 under the same policy also states that developments, which would probably be affected by flooding or would cause an increase in the probability of flooding elsewhere, should be prevented.

1.2.3 Table 1 defines the flood risk classification within the SPP.

Table 1: Flood Risk Classification

Type of Flooding	Flood Risk Classification	Description
Rivers and Coastal Flooding	Little or No Risk	Annual probability of coastal or watercourse flooding is less than 0.1% (1:1000 years). No constraints due to coastal or watercourse flooding.
	Low to Medium Risk	Annual probability of coastal or watercourse flooding is between 0.1% and 0.5% (1:1000 to 1:200 years). Suitable for most development. A flood risk assessment may be required at the upper end of the probability range (i.e. close to 0.5%), and for essential infrastructure and the most vulnerable uses. Water resistant materials and construction may be required. Generally not suitable for civil infrastructure. Where civil infrastructure must be located in these areas or is being substantially extended, it should be designed to be capable of remaining operational and accessible during extreme flood events.

Table 1: Flood Risk Classification		
Type of Flooding	**Flood Risk Classification**	**Description**
	Medium to High Risk	Annual probability of coastal or watercourse flooding is greater than 0.5% (1:200 years). May be suitable for: residential, institutional, commercial and industrial development within built-up areas provided flood protection measures to the appropriate standard already exist and are maintained, are under construction, or are a planned measure in a current flood risk management plan; essential infrastructure within built-up areas, designed and constructed to remain operational during floods and not impede water flow; some recreational, sport, amenity and nature conservation uses, provided appropriate evacuation procedures are in place; and job-related accommodation, e.g. for caretakers or operational staff. Generally not suitable for: civil infrastructure and the most vulnerable uses; additional development in undeveloped and sparsely developed areas, unless a location is essential for operational reasons, e.g. for navigation and water-based recreation, agriculture, transport or utilities infrastructure (which should be designed and constructed to be operational during floods and not impede water flow), and an alternative, lower risk location is not available; and new caravan and camping sites. Where built development is permitted, measures to protect against or manage flood risk will be required and any loss of flood storage capacity mitigated to achieve a neutral or better outcome. Water-resistant materials and construction should be used where appropriate. Elevated buildings on structures such as stilts are unlikely to be acceptable.
Surface Water Flooding	N/A	Infrastructure and buildings should generally be designed to be free from surface water flooding in rainfall events where the annual probability of occurrence is greater than 0.5% (1:200 years). Surface water drainage measures should have a neutral or better effect on the risk of flooding both on and off the site, taking account of rain falling on the site and run-off from adjacent areas.

1.2.4 The Flood Risk Management (Scotland) Act 2009 (FRM 2009) was enacted on 16th June 2009, repealing the Flood Prevention (Scotland) Act 1961. The FRM 2009 includes measures for a framework for coordination and cooperation between organisations involved in flood management and details additional responsibilities for SEPA, Scottish Water and Local Authorities in relation to flood management. The FRM 2009 also requires SEPA to provide an assessment of flood risk and measures to assist in the preparation of flood risk management plans. SEPA has done this in the form of interactive maps available on its website.[1]

[1] Scottish Environment Protection Agency (2015). *SEPA Flood Maps* [online]. Accessed December 2015. Available at: http://map.sepa.org.uk/floodmap/map.htm

2 SITE DESCRIPTION AND LOCATION

2.1 Site Location

2.1.1 The Site is located on the south of Yell which is the largest of the Shetlands North Isles, see Figure 1.1. The Site is shown on Figure 1.2. The nearest postcode is ZE2 9AU. Further details of the Site are provided in Table 2.

Table 2: Site Summary	
Site Name	Beaw Field Wind Farm
Site Address	Yell, Shetland Islands
National Grid Reference of Site	HU 50639 81972
Approximate Site Area	1,158ha
Existing Land Use	Pastoral grassland and moorland
Proposed Land Use	Wind Turbines and associated infrastructure
Local Planning Authority	Shetland Island Council (SIC)
Scottish Environment Protection Agency Region	SEPA North

2.1.2 The Site is approximately 4km northeast of Ulsta and 1km northwest of Burravoe. The Site is centred on the Burn of Hamnavoe and the nearest settlements are Hamnavoe, Burravoe, Gossabrough and Ulsta.

2.1.3 The land within the Site is wholly owned by the Burravoe Estate and is tenanted by approximately 35 crofters, with the predominant land use being agricultural (permanent pasture). In the past, peatland drainage modification has taken place within the Site and peat cutting is active within the Site.

2.1.4 The Site is characterised by undulating hilly terrain. The topography ranges from approximately 200m Above Ordnance Datum (AOD) at the Hill of Arisdale in the north, to less than 10m AOD in the south however, the majority of the Site lies between 80m to 150m AOD, with the summit of Beaw Field at 120m AOD. The majority of the Site is heather moorland, which has been heavily grazed to habitats that are characterised by degraded blanket bog habitat and moorland pastures. In-bye crofting land is typically found on lowering lying land close to settlements.

2.2 Existing Drainage Regime

2.2.1 The Burn of Arisdale flows north to south along the western boundary of the Site and discharges into the Hamna Voe (bay). The Burn of Hamnavoe and its tributaries (including the Burn of Evrawater) drain the centre area of the Site and flows in a general north to south direction and discharges into Hamna Voe near the settlement of Hamnvoe. In the east of the Site there is a network of lochs and adjoining

watercourses, which discharge into the Bay of Whinnifirt. The Green Burn flows in a general northeast direction and discharges into the Wick of Gossabrough.

2.3 Geology and Ground Conditions

2.3.1 Peat depths across the peat study area vary from 0m to 4.35m, with an arithmetic average across the Site of 1.24m.

2.3.2 The soils that underlie the majority of the Site are blanket peat of the organic soils association[2]. Blanket peat tends to be waterlogged for long periods of the year. To the South of the Site and north of the settlements Hamnavoe and Burravoe is an area of noncalcareous gleys of the Arkaig soil association[2]. Along the Burn of Arisdale and the Hill of Arisdale are podzols soils of the Durnhill soil association[2]. Ground conditions are likely to exhibit variable rates of infiltration with lower rates occurring where superficial deposits (soil and superficial geology) with high percentage of clay predominate.

2.3.3 Available geological mapping of superficial deposits from the British Geological Society (BGS)[3] indicates that the Site is underlain by a mosaic of peat and glacial till.

2.3.4 Available geological mapping[3] of the bedrock geology from the BGS shows that the Site is underlain by metamorphic rocks. The metaphoric bedrock underlying the Site is a low productive aquifer[4] where the groundwater is in the near surface weathered zone and secondary fractures. According to BGS[5], across the Site the groundwater vulnerability is Class 4, which means the groundwater is vulnerable to those pollutants that are not readily adsorbed or transformed. The bedrock is classified by SEPA as the 'Yell' aquifer.

2.4 The Proposed Development

2.5 Description of the Proposed Development & Surface Water Drainage Strategy

2.5.1 The Proposed Development comprises 17 wind turbines with associated hardstanding areas; new access tracks; watercourse crossings; underground cabling; borrow pits; transformer cabin; met mast; radio communications tower; and

[2] Soil Survey of Scotland Staff (1981) Soil maps of Scotland at a scale of 1:250000 Macaulay Institute for Soil Research, Aberdeen.
[3] British Geological Survey (2015) Geology of Britain Viewer [online]. Available at: http://mapapps.bgs.ac.uk/geologyofbritain/home.html
[4] British Geological Survey (2015) Geoindex Onshore: Hydrogeology 1:625,000 Scale Map [online]. Available at: http://mapapps2.bgs.ac.uk/geoindex/home.html
[5] British Geological Survey (2011) Groundwater Vulnerability (Scotland) GIS Dataset, Version 2.

construction compound. The new impermeable area associated with the Proposed Development is, by proportion, extremely limited. Access tracks, hardstanding areas and turbine crane pads would be made from permeable aggregate substrate and runoff would percolate in to the surrounding vegetation, thus maintain the existing greenfield runoff response to rainfall. In addition, drainage ditches would collect flow from the access track and where natural drainage channels are present, the access track would be designed, via culverts, to convey the flow through the access track. This would maintain the hydraulic connectivity either side of the access track.

2.5.2 The borrow pits have been designed with perimeter drainage ditches, which would redirect clean runoff around the borrow pits. The clean water ditches would be built with rock weirs every 15m along the length of the ditch. Dirty water ditches within the borrow pits extraction area would transport flow to settlement lagoons where the water will be treated. The clean water from the settlement lagoons would be discharged to ground and would be allowed to infiltrate into the surrounding peatland.

2.5.3 The careful maintenance of peat cover around turbine footprints and inspection for uncontrolled erosion, would also reduce the potential for erosion and channel formation.

2.5.4 Following development, surface runoff would continue to drain either by infiltration or by overland flow routes into the surrounding watercourses. There would be no perceivable changes to the flow within these watercourses as a result of the Proposed Development.

2.5.5 Wind farm developments have a minimal requirement for onsite personnel. Once installed, nearly all systems are automated or remotely controlled and require little or no direct human intervention or coordination. Maintenance visits are typically restricted to one or two visits per year, or as demanded by evident failures, depreciation in efficiency or manufacturer's warranty.

2.5.6 Safe access would be afforded to the Site via a new access track which connects to the B9081. In the unlikely event that floodwater affected the Site, any personnel present would be able to exit via this route to either Burravoe or Hamnavoe.

2.5.7 All proposed watercourse crossings have been designed to have capacity for the Q_{200} Greenfield runoff rate. Appendix 3.2 of the Environmental Statement details the proposed watercourse crossings.

2.6 Vulnerability Classification

2.6.1 The vulnerability classification of a development is defined by the SPP and by SEPA in their Land Use Vulnerability Guidance (2012). Wind turbine developments are classed as essential utility infrastructure, which includes wind turbines and substations. As set out in the SPP and SEPA's guidance, essential utility infrastructure can be located within all flood zones. SEPA flood mapping shows that there is little to no risk of fluvial or pluvial flooding to the Proposed Development and, therefore, the Proposed Development may be permitted in terms of flood risk.

3 FLOOD RISK

3.1 Flood Risk from External Sources

3.1.1 Potential sources of flooding are fluvial (rivers), tidal waters, pluvial (surface water), groundwater, sewers/drains and from artificial sources such as canals or reservoirs. An assessment of the flood risk associated with each potential source of flooding is discussed in the following sections and is summarised in Table 3.

Tidal Flooding

3.1.2 The local rivers are non-tidal and the Site is not located in a coastal zone. The Site is not located in an area at risk of tidal flooding; therefore there is no risk of flooding from this source.

Fluvial Flooding

3.1.3 The Site is shown to be wholly within an area of little to no risk (less than 0.1% annual probability, Table 1), of fluvial flooding as shown on SEPA's flood map[1]. The risk of fluvial flooding to the proposed turbine is, therefore, considered to be low.

Groundwater Flooding

3.1.4 Groundwater flooding can occur when groundwater levels rise up through permeable strata and exceed ground levels. The presence of clay material in the overlying superficial till deposits can inhibit the upward movement of groundwater, together with the relatively steep topography of the Site, and thus hydraulic gradients, are unlikely to lead to a risk of groundwater flooding within the Site.

3.1.5 Perched water tables occur when an impermeable layer impedes the downward movement of water and is able to contain water above the main water table. The risk of such features affecting the Proposed Development is considered medium due to the potential of shallow rock below superficial deposits. However, the proposed

drainage features to the access roads and hardstandings would ensure effective drainage of any perched ground water, which could affect the development. The risk of groundwater flooding is, therefore, considered to be low.

Flooding from Sewers and Drains

3.1.6 Flooding from artificial drainage systems occurs when flow entering a system, such as an urban storm water drainage system or water main, exceeds its discharge capacity. The system becomes blocked or it cannot discharge due to a high water level in the receiving watercourse. There is a water main that crosses the Site meaning that there is a risk that it may burst however, the main is owned and maintained by Scottish Water and the proposed development is at a higher level than this main, therefore the risk of flooding to the Proposed Development from this source is considered to be low.

Pluvial Flooding (Surface Water Flooding)

3.1.7 On land where there is an impermeable surface or where the ground infiltration capacity is exceeded by rainfall, there is a potential for ponding of surface water runoff, which can lead to localised flooding. Across the Site the areas of high, medium and low pluvial flood risk[1] tend to be associated with watercourse floodplains and lochs and lochans.

3.1.8 The proposed turbines are shown to be wholly within an area at little to no risk (less than 0.1% annual probability) of pluvial flooding as shown on SEPA's flood map[1]. The risk of flooding to the proposed turbines from this source is, therefore, considered to be low.

Flooding from Artificial Sources

3.1.9 There are no artificial waterbodies (e.g. reservoirs) upslope and close to the Site, which could act as a source of flooding to the Site. It is considered, therefore, that there is no flood risk to the Site from artificial sources.

3.2 Summary of Flood Risk to the Proposed Development

Table 3: Sources of Flood Risk			
Flood Source	**Potential Presence at Site**	**Potential Risk**	**Description**
Tidal	No	None	The local rivers are non-tidal and the proposed turbines are not located in a coastal zone. The Site is not affected by tidal water.
Fluvial	Yes	Low	The proposed turbines are wholly within an area of little to no risk (less than 0.1% annual probability) of fluvial flooding.
Groundwater	Yes	Low	The likely presence of clay material in the superficial cover (till deposits) would inhibit the upward movement of groundwater.
Sewers	Yes	Low	A water main crosses the Site, however it is maintained by Scottish Water and the development is at a higher level than this main.
Pluvial/Overland Flow	Yes	Low	The proposed turbines are wholly within an area of little to no risk (less than 0.1% annual probability) of pluvial flooding.
Artificial Sources	No	None	There are no artificial waterbodies in the vicinity of the proposed turbine that could act as a source of flooding.

3.3 Flood Risk from the Proposed Development

3.3.1 It is generally considered that soil stripping during construction of turbine foundations, together with the creation of hardstanding areas, transformer cabins and construction compound, can cause a slight change to the pattern of surface water runoff. However, the additional impermeable area created by the proposed turbine foundations (4080m^2) represents approximately 0.035% of the Site area, and the construction phase would be relatively short (24 months) in comparison to the operational phase (25 years). Notwithstanding this, mitigation measures would be put in place during construction to contain and slow down surface water runoff from the areas surrounding the turbines. After construction, the stripped soils would be restored and the ground would be re-vegetated. In addition any water storage tanks associated with the concrete batching plant would be protected from potential hazards that may cause a large scale release of water into the surrounding area. It is considered, therefore, that there would be no increase in surface water runoff from the Site, and hence no increase in flood risk to areas beyond the Site.

3.3.2 The Proposed Development includes six watercourse crossings. Where possible bridging of these watercourse has been proposed. Where bridging was found to be impracticable, culverts have been proposed. All watercourse crossings have been

designed to have capacity for a 1 in 200 year flood event based on the estimated contributing area.

Floodplain Storage

3.3.3 The Site is located in an area at little or no risk (less than 0.1% annual probability) of fluvial or pluvial flooding. There would, therefore, be no impact on the flood storage capacity of the floodplains associated with the surrounding watercourses if the development were permitted and thus there is no requirement for compensatory floodplain storage.

3.4 Residual Risks

3.4.1 There is always a possibility of a flood in excess of that allowed for in the designed capacity of watercourse crossings and mitigation measures which might conceivably cause some flooding to the Proposed Development. However, such an event would have a very low probability of occurrence and the risk of flooding to the Proposed Development is, therefore, considered to be extremely low.

3.4.2 It is, therefore, considered that the residual risks associated with flooding are not significant.

4 SUMMARY AND CONCLUSION

4.1.1 The proposed turbines are located in an area at little to no risk (less than 0.1% annual probability) of fluvial and pluvial flooding according to SEPA flood maps. The FRA shows that Proposed Development is not at risk of flooding from artificial sources; and the risk of flooding from fluvial, pluvial/runoff, sewers and groundwater is considered to be low.

4.1.2 The vulnerability classification of wind turbine developments is 'essential utility infrastructure,' which is an appropriate development type within all flood zones. The SEPA flood map shows that there is little to no risk of fluvial or pluvial flooding to the proposed turbines. There are no local site-specific conditions that would adversely affect SEPA's published flood risk categorisation. There would be no significant increase in flood risk to areas beyond the Site boundary as a result of the Proposed Development. The Site is considered suitable, in terms of flood risk, for the type of development required to construct and operate the wind farm.

4.1.3 The proposed development would have minimal impact on the areas existing surface water drainage regime, and where the development may affect the existing regime,

careful surface water mitigation measures would be put in place to ensure a minimal impact.

Flood Risk Assessment (FRA) Checklist

(ES-NFR-F-001 - Version 10 - Last updated 17/2/14

This document should be attached within the front cover of any flood risk assessments issued to Local Planning Authorities (LPA) in support of a development proposal which may be at risk of flooding. The document will take only a few minutes to complete and will assist SEPA in reviewing FRAs, when consulted by LPAs. This document should not be a substitute for a FRA.

Development Proposal						
Site Name		Beaw Field Wind Farm				
Grid Reference	Easting:	450737	Northing:	1182595		
Local Authority		Shetland Islands Council				
Planning Reference number (if known)						
Nature of the development		Infrastructure	If residential, state type:			
Size of the development site		1158 Ha				
Identified Flood Risk	Source:	Other	Source name:	None		
Supporting Information						
Have clear maps / plans been provided within the FRA (including topographic and flood inundation plans)		Yes				
Has a historic flood search been undertaken?		Yes				
Is a formal flood prevention scheme present?		No	If known, state the standard of protection offered			
Current / historical site use		Crofting, peat cutting				
Hydrology						
Area of catchment		N/A	km^2			
Qmed estimate			m^3/s	Method:	Select from List	
Estimate of 200 year design flood flow			m^3/s			
Estimation method(s) used *		Select from List	If other (please specify methodology used):			
			If Pooled analysis have group details been included		Select from List	
Hydraulics						
Hydraulic modelling method		Select from List	Software used:	Select from List		
If other please specify		N/A				
Modelled reach length			m			
Any structures within the modelled length?		Select from List	Specify, if combination			
Brief summary of sensitivity tests, and range:						
variation on flow (%)			%			
variation on channel roughness						
blockage of structure (range of % blocked)			%	Reference CIRIA culvert design guide R168, section 8.4		
boundary conditions:		**Upstream**			**Downstream**	
(1) type		Flow			Select from List	
	Specify if other			Specify if other		
(2) does it influence water levels at the site?		Select from List			Select from List	
Has model been calibrated (gauge data / flood records)?		Select from List				
Is the hydraulic model available to SEPA?		Select from List				
Design flood levels	200 year		m AOD	200 year plus climate change		m AOD

Flood Risk Assessment (FRA) Checklist

(ES-NFR-F-001 - Version 8 - Last updated 26/04/2010)

Coastal						
Estimate of 200 year design flood level		N/A	m AOD			
Estimation method(s) used		Select from List	If other (please specify methodology used):			
Allowance for climate change (m)			m			
Allowance for wave action etc (m)			m			
Overall design flood level			m AOD			
Development						
Is any of the site within the functional floodplain? (refer to SPP para 203)		No		If yes, what is the net loss of storage		m^3
Is the site brownfield or greenfield		Greenfield				
Freeboard on design water level (m)			m			
Is the development for essential civil infrastructure or vulnerable groups?		No		If yes, has consideration been given to 1000 year design flood?	Select from List	
Is safe / dry access and egress available?		Vehicular and Pedestrian		Min access/egress level		m AOD
If there is no dry access, what return period is dry access available?			years			
If there is no dry access, what is the impact on the access routes?	Max Flood Depth @ 200 year event:	N/A	m	Max Flood Velocity:		m/s
Design levels	Ground level	N/A	m AOD	Min FFL:		mAOD
Mitigation						
Can development be designed to avoid all areas at risk of flooding?		Yes				
Is mitigation proposed?		Yes				
If yes, is compenstory storage necessary?		No				
Demonstration of compensatory storage on a "like for like" basis?		No				
Should water resistant materials and forms of construction be used?		No				
Comments						
Any additional comments:						

Approved by:	**Rachel Graham**
Organisation:	**Wardell Armstrong**
Date:	**02/10/2015**

Note: Further details and guidance is provided in 'Technical Flood Risk Guidance for Stakeholders' CLICK HERE

**** ReFH not accepted by SEPA for flow estimates in Scotland. Any use of this method should be validated by the use of other, accepted methods.***

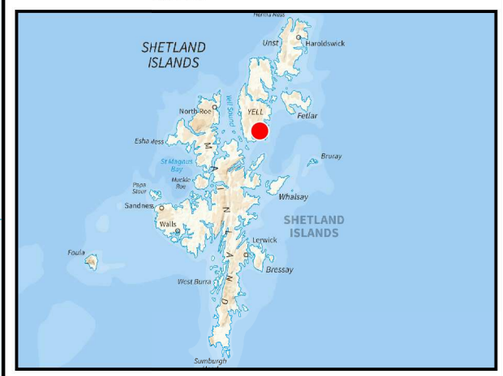
SHETLAND ISLANDS

Key

Site Location

Northern Scotland

Shetland Islands



Beaw Field Wind Farm

N

PEEL

TITLE:

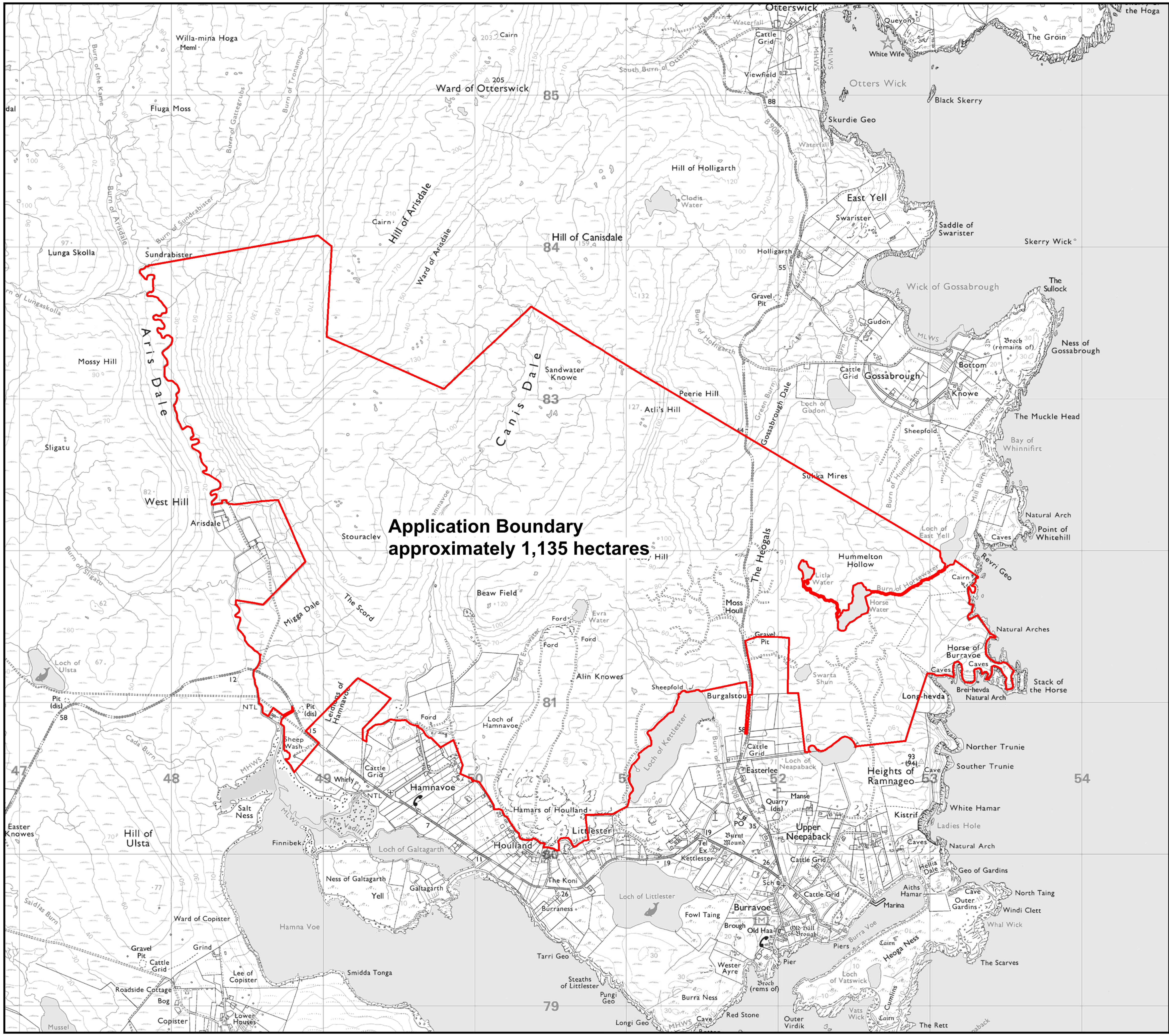
Site Location
Figure 1.1

Scale: 1:250,000 @ A3

Date: 27/01/2016

Ordnance Survey Developer Partner

Ref:



Key

Application Boundary

Beaw Field Wind Farm

N

PEEL

TITLE:

Application Boundary

Figure 1.2

Scale: 1:25,000 @ A3

Date: 26/01/2016

Ordnance Survey Developer Partner

Ref: