11 Geology, Hydrology and Hydrogeology

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11 Geology, Hydrology and Hydrogeology

11.1 Executive Summary

11.1.1 The site comprises the island of Faray, an uninhabited island to the north and west of Eday and south-southeast of Westray in the Orkney Islands. The site boundary encompasses the island of Faray as well as extending approximately 500 m east into the sea. The smaller island Holm of Faray is immediately to the north. Faray is approximately 17 km northeast of Orkney Mainland, and approximately 25 km from Kirkwall. The island comprises open fields of improved pasture, a number of abandoned buildings and a jetty. The current land use is sheep farming.

11.1.2 The topography of the island comprises two fairly low hills rising to just over 30 m Above Ordnance Datum. The ground level gently falls away from the two hills with the steepest slope being near the coast to the west of the southern hill. The Proposed Development site contains a network of drainage ditches that mainly follow old field boundaries.

11.1.3 Ordnance Survey (OS) mapping shows two springs located in the centre of the site at Grid References HY 52937, 36808 and HY 52937, 36762 from which a small stream flows towards the west into the sea. OS mapping also shows a number of caves and geos located along the coastline. There are no major surface watercourses within the study area.

11.1.4 There are six abandoned wells located within the site area, according to OS mapping. These are located in the central and northern parts of the island. The wells have been confirmed to be abandoned by Orkney Islands Council. There are no active Private Water Supplies (PWS) within the study area (DWQR, 2019) and there is no potential for hydrogeological continuity with any potential off-site areas where groundwater could be abstracted.

11.1.5 Site geology comprises sedimentary bedrock, overlain in the west southwest by superficial glacial till, along with localised blown sand and marine beach deposits (sand gravel and boulders). The remainder of the site is shown as having little or no superficial cover over bedrock. No peat has been identified at the site, from desk study and targeted peat survey work.

11.1.6 Likely construction and operational effects include siltation or pollution of the water environment from surface runoff, and effects on groundwater quality and flow regime. Standard / embedded mitigation measures include appropriate design to minimise potential impact on minor surface watercourses, pre-construction site investigation works, and implementation of a Construction Environmental Management Plan (CEMP) and Drainage Strategy. These mitigation measures are considered to be robust and implementable and will result in no significant effects on the hydrological, hydrogeological and geological receptors.

11.1.7 The likely effects on hydrological, geological and hydrogeological receptors, taking account of the standard mitigation measures, have been assessed as **negligible** to **minor** (not significant).

11.1.8 No additional mitigation is proposed or considered necessary, beyond the standard / embedded mitigation noted above. The significance of residual effects on hydrological, geological and hydrogeological receptors is therefore considered to be **negligible** to **minor** (not significant).

11.1.9 No cumulative effects on hydrology, hydrogeology and geology are predicted.

11.1.10 It should be noted that this chapter presents the assessment of effects on terrestrial geology, surface water and groundwater. Likely effects on the marine environment, relating to the proposed new extended slipway and landing jetty, have also been assessed and are discussed in Chapter 17.

11.2 Introduction

11.2.1 This chapter outlines the potential geological, hydrological and hydrogeological effects of the construction and operation of the Proposed Development. An assessment is provided based on the value of the receptor and the magnitude of the impact giving the significance of the effect. Where appropriate, mitigation measures to enhance, prevent, minimise or control identified effects are presented.

Statement of Competence

11.2.2 The assessment has been carried out by Jenny Hazzard (BSc (Hons), MSc, PIEMA) who has over 20 years consultancy experience in geology, peat, hydrogeology and hydrology.

11.3 Legislation, Policy and Guidelines

11.3.1 With regard to hydrology, management of water-borne pollution and protection of natural heritage areas, the Scottish Environment Protection Agency (SEPA) has statutory obligations in terms of the management and control of pollution into water resources in Scotland. Where careful design has avoided sensitive receptors, it would be reasonable to assume that the adoption of the SEPA's Good practice Guidelines will, in general, prevent pollution to acceptable standards and make the majority of any 'significant' effects unlikely. Specific mitigation measures may be required in certain areas or at certain times of the site development.

Legislation

11.3.2 There is a range of environmental legislation that the Proposed Development must adhere to throughout its life cycle. Relevant legislation and guidance documents have been reviewed and taken into account as part of this geological, hydrogeological and hydrological assessment. Key legislative drivers relating to the water environment which have been considered within this assessment are listed below:

- Control of Pollution Act 1974;
- Environmental Protection Act 1990;
- Environment Act 1995;
- Water Framework Directive 2000/60/EC;
- Groundwater Daughter Directive 2006/118/EC;
- Water Environment and Water Services (Scotland) Act (WEWSA) 2003;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended in 2018) (CAR);
- The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017 (amends and revokes the Private Water Supplies (Scotland) Regulations 2006);
- The Flood Risk Management (Scotland) Act 2009; and
- The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017.

11.3.3 The Water Framework Directive has been implemented in Scotland through WESWA and CAR. The primary objective of the Directive is for all surface and coastal water bodies to achieve good chemical and ecological status, and ground water bodies to achieve good quantitative and chemical status, by 2015 or 2021. This required assessment of a much wider set of water quality parameters than had previously been used. SEPA has published River Basin Management Plans (RBMPs) which detail the current and target status of water bodies, and the means of achieving these targets.

Planning Policy

11.3.4 Scottish Planning Policy (SPP) (Scottish Government, 2014) identifies the range of considerations likely to be relevant to the determination of energy projects, including onshore wind developments (Paragraph 169). These include:

- effects on hydrology, the water environment and flood risk; and

- impacts on carbon rich soils.

11.3.5 It also states that the planning system should '*promote protection and improvement of the water environment, including rivers, lochs, estuaries, wetlands, coastal waters and groundwater, in a sustainable and co-ordinated way*' (paragraph 194); and '*Development management decisions should take account of potential effects on landscapes and the natural and water environment, including cumulative effects*' (paragraph 202).

11.3.6 With respect to flooding, SPP paragraph 255 promotes a precautionary approach to flood risk from all sources and states that the planning system should prevent development which would have a significant probability of being affected by flooding or would increase the probability of flooding elsewhere. Policy 264 sets out aspects to be taken into account for development management, in respect of flood risk. This includes consideration of the design and use of the proposed development. Policy 266 notes that Flood Risk Assessments should be required for development in the medium to high category of flood risk (annual probability of coastal or watercourse flooding is greater than 0.5% or 1:200 years).

11.3.7 The following Planning Advice Notes, issued by the then Scottish Executive, are also relevant to the assessments made in this chapter:

- Planning Advice Note 50: Controlling the Environmental Effects of Surface Mineral Workings, 1996 (in respect of borrow pit workings);
- Planning Advice Note 61: Planning and Sustainable Urban Drainage Systems, 2001; and
- Planning Advice Note 79: Water and Drainage, 2006.

11.3.8 The Orkney Local Development Plan (Orkney Islands Council, 2017), identifies considerations relevant to onshore wind developments, as well as Nationally Designated Sites related to geology and peat (Policies 7 and 9) These include:

- Section D, Policy 7: Onshore Wind Development; and
- Section D, Policy 9: The Water Environment.

11.3.9 Full details of relevant planning policy can be found in Chapter 5.

Guidance

11.3.10 A review plan for Pollution Prevention Guidance documents (PPGs) is currently underway by Natural Resources Wales (NRW), the Northern Ireland Environment Agency (NIEA) and the Scottish Environment Protection Agency (SEPA), replacing them with a replacement guidance series: Guidance for Pollution Prevention (GPPs). GPPs provide environmental good practice guidance for the whole UK, and environmental regulatory guidance directly to Northern Ireland, Scotland and Wales only.

11.3.11 The PPGs and GPPs include the documents referred to below, which are the principal documents used for guidance on preventing contamination of surface water from construction activities. Those relevant to this Proposed Development include:

- PPG1: General guide to the prevention of pollution (EA, SEPA & EHSNI, 2013);
- GPP2: Above ground oil storage tanks (EA, SEPA & EHSNI, January 2018);
- GPP5: Works and maintenance in or near water (EA, SEPA & EHSNI, January 2017);
- PPG6: Working at construction and demolition sites (EA, SEPA & EHSNI, 2012); and
- GPP21: Pollution incidence response planning (EA, SEPA & EHSNI, 2017).

11.3.12 The following SEPA Guidelines are also relevant:

- SEPA Supporting Guidance (SAT-SG-75) – Sector specific guidance: construction sites (SEPA, 2018);

- Temporary Construction Methods, WAT-SG-29 (SEPA, 2009);
- Flood Risk and Planning Briefing Note (SEPA, 2014);
- Position Statement: The role of SEPA in natural flood management (SEPA, Feb, 2012);
- Technical flood risk guidance for stakeholders, version 12 (SEPA, May 2019);
- Land Use Planning System Guidance Note 4 (LUPS GU4) - Planning guidance on on-shore windfarm developments (SEPA, September 2017);
- Land Use Planning System Guidance Note 31 (LUPS-GU31)- Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems (SEPA, October 2014);
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 as amended in 2018 - A practical guide (SEPA, 2011 as amended in 2019);
- River Crossings, Engineering in the water environment: good practice guide (SEPA,2010);
- Development of a groundwater vulnerability screening methodology for the Water Framework Directive, Project WFD28 Final Report (SEPA 2004); and
- The River Basin Planning Strategy for the Scotland River Basin District (SEPA, 2009/2015).

11.3.13 Other relevant guidance includes:

- Control of water pollution from constructions sites. Guidance for consultants and contractors C532 (CIRIA, 2001);
- Environmental good practice on site C650 (CIRIA, 2010);
- Good practice during windfarm construction (Scottish Renewables, SNH, SEPA & Forestry Commission Scotland, 4th Edition 2019);
- Code of Practice for the sustainable use of soils on construction sites (DEFRA, 2011);
- Private Water Supplies: Technical Manual, Scottish Executive, 2006;
- Special Requirements for Civil Engineering Contracts for the Prevention of Pollution, Version 2, (SEPA, 2006); and
- UK Technical Advisory Group on the WFD, UK Environmental Standards and Conditions Final Report, November 2013.

11.4 Consultation

11.4.1 The following consultation responses were received during the Scoping process for the Proposed Development.

Table 11.1 – Consultations in Relation to Geology, Hydrology and Hydrogeology

Consultee	Consultation Response	Key Actions
SEPA	SEPA advise that the following key issues need to be addressed in the EIA process.	
	a) Map and assessment of all engineering activities in or impacting on the water environment including	A site layout plan, including buffer zones around watercourses, has been generated (refer to Figure 11.1). Flood risk within the site area is considered as stated in section 11.6.

Consultee	Consultation Response	Key Actions
	proposed buffers, details of any related CAR applications.	
	b) Map and assessment of impacts upon Groundwater Dependent Terrestrial Ecosystems and buffers.	A map showing identified areas of potential GWDTE, with buffers, is provided as Figure 11.4. Paragraphs 11.6.34 to 11.6.38 provide discussion on GWDTE, including assessment of whether areas are likely to actually be groundwater fed rather than surface- or rainwater-fed. Likely effects on groundwater are assessed as set out in Sections 11.9 and 11.11.
	c) Map and assessment of impacts upon groundwater abstractions and buffers.	There are no active groundwater abstractions (Private Water Supplies) within 250 m of the Proposed Development.
	d) Assessment of any peat and if applicable table detailing re-use proposals.	Targeted peat surveys at proposed turbine locations have been conducted and have identified no peat, which is consistent with desk study findings. This is discussed in sections 11.5 and 11.6.
	e) Map and site layout of borrow pits	Proposed borrow pit search areas are shown in Figures 11.1 and 11.4.
	f) Schedule of mitigation including pollution prevention measures	Chapter 18 of the EIA Report provides a schedule of all committed mitigation measures. A Construction Environmental Management Plan (CEMP) will be developed, outlining pollution prevention measures (an outline CEMP can be found in Appendix 3.1).
	g) Borrow Pit Site Management Plan of pollution prevention measures/	Two borrow pit search areas are shown on Figures 11.1 and 11.4. The search area and proposed borrow workings are described in Chapter 3. An outline CEMP, including borrow pit management measures, is included as Appendix 3.1. If the proposed Development is granted consent, a Borrow Pit Management Plan will be produced, including additional details to be agreed prior to commencement of construction.

Consultee	Consultation Response	Key Actions
	h) Map of proposed waste water drainage layout	There will be no foul/waste water drainage on site.
	i) Map of proposed surface water drainage layout	Outline drainage arrangements are discussed in Chapter 3 and Section 11.8 and would be developed further as part of a detailed Drainage Strategy to be agreed with SEPA and OIC prior to commencement of construction.
	j) Map of proposed water abstractions including details of the proposed operating regime	There is no intention to abstract groundwater or surface water from the proposed development site. Should water abstraction be determined as a requirement, this would be regulated under the CAR licensing regime and any necessary licence would be sought from SEPA prior to the commencement of any operations on site.
	k) Decommissioning statement	The Applicant is seeking in-perpetuity consent for the Proposed Development. In the event of decommissioning, or replacement of turbines, it is anticipated that the levels of effect would be similar but of a lesser level than those during construction. Decommissioning would be undertaken in line with best practice processes and methods at that time and will be managed through an agreed Decommissioning Environmental Management Plan.
SEPA	Site Specific Comments	
	It should be confirmed that the wells on the island are no longer used to provide drinking water.	Onsite wells have been confirmed by Orkney Islands Council as being abandoned, as discussed in section 11.6.
	Provided watercourse crossings are designed to accommodate the 1 in 200 year event and other infrastructure is located well away from watercourses, SEPA does not foresee a need for detailed information on flood risk.	There are no substantial surface watercourses on the site and no major water crossings are therefore proposed. This is discussed in section 11.8.

Consultee	Consultation Response	Key Actions
	Any infrastructure required on the coast may need to take into account the estimated 1 in 200 year coastal flood level for the area of 3.5 m Above Ordnance Datum.	The online SEPA Indicative River & Coastal Flood Map illustrating the areas where there is a 0.5 % or greater probability of being flooded in any given year, i.e. the 1:200-year flooding event, in the vicinity of the site has been reviewed. Mapping indicates that areas of coastal flood risk are limited to the immediate vicinity of the coast, with no coastal flood risk identified at any proposed infrastructure locations. This is discussed in section 11.6.
Orkney Islands Council (OIC)	OIC notes that Soil Survey of Scotland mapping indicates that Faray is underlain by peaty gleys, and the application should therefore be accompanied by a peatland management plan.	The SNH Carbon and Peatland Map 2016 identifies 'Class 0' soils on site (not peat), and 1:50,000 scale BGS geological mapping identifies no peat on site. Site reconnaissance, review of aerial photography, and habitat survey work has identified no peat at the site. Targeted peat surveys at proposed turbine locations have been conducted and have identified no peat, which is consistent with desk study findings. It is therefore considered that a peatland management plan is not required. Further information is provided in sections 11.5 and 11.6.
	If on-site borrow pits are proposed, then an assessment of associated impacts should be included.	Two borrow pit search areas are shown on Figures 11.1 and 11.4. The search area and proposed borrow workings are described in Chapter 3. An outline CEMP, including borrow pit management measures, is included as Appendix 3.1. If the Proposed Development is granted consent, a Borrow Pit Management Plan will be produced, including additional details to be agreed prior to commencement of construction.

11.5 Assessment Methodology and Significance Criteria

11.5.1 The following section sets out the approach that was followed to collect relevant baseline information and the methodology for assessing impacts and the significance of effects.

Study Area

11.5.2 The study area incorporates the site boundary, which itself comprises the island of Faray, adjacent coastline, and a limited area of sea (Sound of Faray) to the east of the island. Given that the site is an island, the study area does not extend to a buffer area beyond the site boundary, as would typically be the case (for example to consider potential effects on watercourses downstream of the site, off-site Private Water Supplies, etc.)

Desk Study

11.5.3 Baseline conditions have been established primarily via desk-based research and has included the following:

- consultation with SEPA as described in Table 11.1 above;
- identification of the locations and characteristics of catchments and principal watercourses and waterbodies as shown on 1:50,000 scale OS mapping which may be affected by construction activities;
- identification of SEPA/WFD watercourse and waterbody classifications;
- review and collation of pertinent information on surface hydrology, flooding, climate etc.;
- review of geological mapping of the area, British Geological Survey, Geology of Britain Viewer, 1:50,000 scale;
- review of hydrogeological characteristics and groundwater resource;
- review of Private Water Supply records held by the Drinking Water Quality Regulator for Scotland (DWQR) and Orkney Islands Council; and
- review of coastal erosion maps supplied by Dynamic Coast Scotland.

Site Visit

11.5.4 The findings of the desk study have been supported by a site reconnaissance survey of surface watercourses and ground conditions which was undertaken on the 18th August 2020. This included a visual inspection of watercourses where works are likely to occur within or in the close vicinity of the Proposed Development, and an inspection of the ground conditions. An engineering site visit was conducted on the 9th March 2020. The engineering site visit was to obtain an appreciation of the potential marine access to the island and to ground truth the initial site layouts. A walk over of all turbine positions was completed to check the terrain and constraints matched the desktop study. A review of possible borrow pit search areas was also completed.

Targeted Peat Depth Survey

11.5.5 As outlined in Section 11.6 below, the desk study identified a low likelihood of any substantial peat or carbon-rich soils being present at the site. However, as part of the site reconnaissance, targeted peat depth probing was undertaken at proposed turbine locations. This identified no discernible peat at any of the turbine locations, confirming expected site conditions based on the desk study. No further peat survey work was considered to be warranted.

Significance Criteria

11.5.6 The characterisation of geological, hydrological and hydrogeological sensitivities has been guided by the matrix presented in Table 11.2 which lists the characterisation criteria.

Table 11.2 – Geological, Hydrological and Hydrogeological Sensitivity

Sensitivity	Description
High	Areas containing geological, geomorphological or hydrological features considered to be of international or national interest, for example Aquatic Natura 2000 sites, SACs, SSSIs. Highly permeable superficial deposits allowing free transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of High or Good Ecological Potential. Raised or blanket bog. High risk of flooding.
Medium	Areas containing features of designated regional importance, for example Regionally Important Geological and Geomorphological Sites (RIGS), considered worthy of protection for their educational, research, historic or aesthetic importance. Moderately permeable superficial deposits allowing some limited transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of Moderate Ecological Potential. Significant peat deposits. Moderate risk of flooding.
Low	Geological features not currently protected and not considered worthy of protection. Low permeability superficial deposits likely to inhibit the transport of contaminants. Wetland/watercourse of Poor or Bad Ecological Potential or no WFD classification. Thin superficial peat deposits. Low risk of flooding.

11.5.19 The criteria for sensitivity have been developed based on a hierarchy of factors relating to quality of the aquatic and geological environment including international and national designations, water and soil quality information, watercourse status from the WFD review work undertaken to date by SEPA, consultations, site reconnaissance and the professional judgement of the assessment team.

11.5.20 The prediction and assessment of effects on hydrology, hydrogeology and geology has been undertaken using a series of tables to document the various potential impacts from aspects of the construction works and operations. Effects have been predicted for the Proposed Development based on the guideline criteria for impact magnitudes set out in Table 11.3.

Table 11.3 – Impact Magnitude

Impact Magnitude	Guideline Criteria
High	Total loss of, or alteration to, key features of the baseline resource such that post development characteristics or quality would be

Impact Magnitude	Guideline Criteria
	fundamentally and irreversibly changed e.g. extensive excavation of peatland or watercourse realignment.
Medium	Loss of, or alteration to, key features of the baseline resource such that post development characteristics or quality would be partially changed e.g. instream permanent bridge supports or partial excavation of peatland.
Low	Small changes to the baseline resource, which are detectable, but the underlying characteristics or quality of the baseline situation would be similar to pre-development conditions e.g. culverting of very small watercourses/drains.
Negligible	A very slight change from baseline conditions, which is barely distinguishable, and approximates to the 'no-change' situation e.g. short-term compaction from machinery movements.

11.5.21 The significance of the predicted effects has been assessed in relation to the sensitivities of the baseline resource and magnitude of predicted impacts. A matrix of significance was developed to provide a consistent framework for evaluation and is presented in Table 11.4. Guideline criteria for the various categories of effect are included in Table 11.5.

Table 11.4 - Effect Significance Matrix

	Sensitivity			
Magnitude	**High**	**Moderate**	**Low**	**Not Sensitive**
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Minor
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Minor	Negligible	Negligible

Table 11.5 - Effect Significance Categories

Significance	Definition	Guideline Criteria
Major	A fundamental change to the environment	Changes in water quality or quantity affecting widespread catchments or groundwater reserves of strategic significance, or changes resulting in substantial loss of conservation value to geological or aquatic habitats and designations.
Moderate	A larger, but non-fundamental change to the environment	Changes in water quality or quantity affecting part of a catchment or groundwaters of moderate vulnerability, or changes resulting in loss of conservation value to geological or aquatic habitats or designated areas.

Significance	Definition	Guideline Criteria
Minor	A small but detectable change to the environment	Localised changes resulting in minor and reversible effects on soils, surface and groundwater quality or habitats.
Negligible	No detectable change to the environment	No effects on geological resources, drainage patterns, surface and groundwater quality or aquatic habitat.

11.5.22 In the above classification, fundamental changes are those which are permanent, either adverse or beneficial, and would result in widespread change to the baseline environment. For the purposes of this assessment, those effects identified as being major or moderate have been evaluated as significant environmental effects.

11.5.23 These matrices have been used to guide the assessment, although they have been applied with a degree of flexibility, since the evaluation of effects will always be subject to location-specific characteristics which must be taken into account. For this reason, the evaluation of the significance of effects in particular will not always correlate exactly with the cells in the relevant matrix, especially where professional judgement and knowledge of local conditions may result in a slightly different interpretation of the impact concerned.

11.5.24 Cumulative effects have been accounted for through the prediction and evaluation of effects cumulatively with those which could arise as a result of the construction and operation of other developments (operational, consented or in planning) within the study area.

Requirements for Mitigation

11.5.25 Proposed mitigation measures are presented within this chapter (Section 11.8 and 11.10) where the potential to affect sensitive geological, hydrological or hydrogeological receptors has been predicted. These may include temporary effects from construction or permanent/longer-term effects associated with the operational phase of the Proposed Development and its associated infrastructure.

Assessment of Residual Effect Significance

11.5.26 An assessment of any predicted significant residual effects on sensitive geological, hydrological or hydrogeological receptors, taking account of committed mitigation measures, is presented within this chapter (Section 11.11).

Limitations to Assessment

11.5.27 No water quality monitoring has been undertaken, although this is not considered warranted at this stage and would not materially affect the impact assessment.

11.6 Baseline Conditions

Geography, Topography and Geomorphology

11.6.1 The Proposed Development site occupies a remote island and coastal setting approximately 1.4 km west of the coast of the Island of Eday. The island comprises open fields of improved pasture, a number of abandoned buildings and a jetty. The current land use is sheep farming.

11.6.2 The island's topography is characterised by two fairly low hills. The southern of the two rises to 32 m Above Ordnance Datum (AOD), whilst the northern hill rises to 31 m AOD. The ground level gently falls away from the two hills with the steepest slope being near the coast to the west of the southern hill. Slope gradients are generally gentle throughout the site area.

11.6.3 Surface water is mainly rainwater derived and flows through a number of drainage channels. There are two springs located in the centre of the site at Grid References HY 52937, 36808 and HY 52937, 36762 from which a small stream flows towards the west into the sea. A small pond is located at Grid Reference HY 53126, 36789.

Land Use, Historical Developments and Man-Made Features

11.6.4 Grazing sheep is the primary land use currently. The remains of past farms and houses are evident on the island, but there are no inhabitants.

11.6.5 Historical mapping from the late 1800s shows approximately eight to ten farmhouses on the island, as well as a school in the north (Grid Reference HY 53065 37075), and a burial ground towards the west (Grid Reference HY 52775 36784).

11.6.6 The island was abandoned shortly after World War II and is now used only for grazing sheep. As noted above, the former farms and structures are still evident but are disused and in a derelict state.

11.6.7 There are six abandoned wells located within the site area, according to OS mapping. These are located in the central and northern parts of the island as shown on Figure 11.1. The wells were previously used for agricultural purposes and presumably for drinking water, when the island was inhabited, but have since been abandoned.

Designated Sites

11.6.8 There are no geological Sites of Special Scientific Interest (SSSI) located within or adjacent to the site boundary.

11.6.9 The Faray and Holm of Faray SSSI is within the site boundary, generally along the coastline of Faray and extending inland from the western shore in the central part of the island. The Faray and Holm of Faray Special Area of Conservation (SAC) is largely coincident with the SSSI, but extends further out into the sea. Both designations are for grey seal and are not considered to be directly relevant to the assessment of geological, hydrological and hydrogeological effects. These designations are discussed further in Chapter 8 Ecology.

11.6.10 There are no Geological Conservation Review sites (GCR) within the Study Area, the nearest being on the shores of Eday to the east and south of the Proposed Development site.

11.6.11 There are no Local Nature Conservation Sites (LNCS) within the Study Area.

Surface Water

11.6.12 There are no major surface watercourses, classified by SEPA under the WFD, within the study area.

11.6.13 The Proposed Development site contains a network of drainage ditches that mainly follow old field boundaries as seen in Figure 11.1.

11.6.14 Surface water within the site is predominantly derived from rainwater and field drainage, draining to the sea at the northern site boundary. However, there are also two springs located at Grid References HY 52937, 36808 and HY 52937, 36762 from which small streams flow towards the west into the sea as seen on Figure 11.1.

11.6.15 The site visit on the 9th March 2020 also confirmed a lack of any major watercourses on site, with only the above-noted minor field drains and spring-derived streams observed.

11.6.16 The Sound of Faray is immediately east of the island of Faray (with the site boundary extending into the Sound), whilst the Sound of Rapness forms the western site boundary. The coastal water body at this location is classified by SEPA as having an overall condition of High (2014).

11.6.17 Based on the presence of minor surface watercourses and drainage ditches in the study area, and taking account of the small scale of the site in the context of the coastal water body, the sensitivity of hydrological resources is considered to be **low**.

Flood risk

11.6.18 The online SEPA Indicative River & Coastal Flood Map illustrating the areas where there is a 0.5 % or greater probability of being flooded in any given year, i.e. the 1:200-year flooding event, in the vicinity of the site has been reviewed.

11.6.19 This map indicates that there are no areas of fluvial flood risk (i.e. flooding from rivers) nor surface water flood risk within the study area.

11.6.20 The mapping indicates that areas of coastal flooding could occur at the margins of the site area, only in the immediate vicinity of the coast with no evident flood risk extending inland.

11.6.21 Based on the absence of identified fluvial and surface water flood risk, and the coastal flood risk being restricted to the immediate coastline outside any proposed infrastructure locations, there is a low risk of flooding affecting the Proposed Development. Given that all site drainage is to the sea adjacent to the site, and that operational drainage will be appropriately designed in accordance with relevant guidance and in consultation with SEPA, there is considered to be no risk of the Proposed Development resulting in any downstream flooding risk. Flood risk is therefore scoped out of further consideration in the assessment.

Geology

11.6.22 Based on BGS digital mapping, the bedrock geology underlying the western part of the site comprises the Upper Stromness Flagstone Formation, with the Sacquoy Sandstone Member occurring on the northeast coast of the island at the Point of Tobar. Most of the eastern part of the site is underlain by the Lower Eday Sandstone Formation, with the Middle Eday Sandstone occurring on the eastern edge of the island. The Lower and Middle Eday Sandstone Formations are separated by the Eday Flagstone. The rocks comprise sandstones, siltstones and shales (Mykura, 1976). Bedrock geology is shown on Figure 11.2.

11.6.23 Based on BGS digital mapping, the bedrock in the west and southwest margins of the site is overlain by superficial glacial till deposited during the Late Devensian Stage, along with localised blown sand and marine beach deposits (sand gravel and boulders). The remainder of the site is shown as having little or no superficial cover over bedrock. Superficial geology is shown on Figure 11.3.

11.6.24 The Scottish Natural Heritage (SNH) Carbon and Peatlands Map (SNH, 2016) identifies the entire island as an area of Class 0, defined as mineral soil, with peatland habitats not typically found on such soils.

11.6.25 The 1:20,000 scale Soil Survey of Scotland map (Macaulay Institute for Soil Research, 1981) identifies the soil resource at the site as being non-calcareous gleys with peaty gleys.

11.6.26 During a site visit on 18th August 2020, targeted peat depth survey work was undertaken at the proposed turbine locations. This did not comprise a full peat depth survey in line with relevant Scottish Government, SEPA and SNH guidance, given that desk study work, ecology surveys, and review of aerial photography had identified a low potential for any substantial peat to be present at the site.

11.6.27 Peat probes advanced at approximately each proposed turbine location identified no discernible peat. A thin covering of organic topsoil was locally present, however no soils which could be described as peat were observed.

11.6.28 Photographs 1 to 3 below illustrate the grassland nature of the proposed turbine locations, with no vegetation/land cover suggestive of peat deposits.

Photograph 1 – Approximate Turbine 1 Location

Photograph 2 – Approximate Turbine 3 Location

Photograph 3 – Approximate Turbine 6 Location

11.6.29 Overall, the sensitivity of geological resources at the site is assessed as **low**, and further consideration of effects on geological resources is scoped out of the assessment.

Hydrogeology

Hydrogeology Mapping

11.6.30 The groundwater body at this location is the Orkney Groundwater, classified by SEPA as having an overall status of Good. The Hydrogeology Map of Scotland identifies the bedrock underlying the site as being a moderately productive aquifer classified as "Middle Old Red Sandstone – Aquifers in which flow is dominantly in fissures and other discontinuities".

11.6.31 There is potential for localised groundwater within the thin superficial deposits and/or the upper weathered bedrock, and the presence of six abandoned wells indicates that there is groundwater near enough the surface to be exploited. Two springs also represent groundwater seepage reaching the surface in the west of the island.

11.6.32 A desk study supported by site reconnaissance and information from the landowner as well as confirmation from OIC has confirmed that the wells are no longer in use and have been abandoned.

Private Water Supplies

11.6.33 There are no active Private Water Supplies (PWS) within the study area (DWQR, 2019). As noted above, the observed former wells on the site are confirmed as being no longer in use.

Groundwater Dependent Terrestrial Ecosystems (GWTDEs)

11.6.34 A Phase 1 Habitat survey and classification of habitats based on National Vegetation Classification (NVC) was conducted in May 2020. For further detail on this survey work and findings, refer to Chapter 8 Ecology.

11.6.35 Most of the site is characterised by open fields of improved pasture used for sheep farming, with little natural or semi-natural vegetation present. Dominant habitats were identified as semi-improved acid grassland and improved grassland, which are not indicative of potential groundwater dependence based on SEPA's Land Use Planning System Guidance Note 31 – Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems (SEPA, 2017).

11.6.36 A localised area of marshy grassland, identified in the above-noted guidance as potentially moderately groundwater dependent, was recorded in the western site area. The bedrock is a moderately productive aquifer, dominated by fracture flow. The identified springs within and immediately adjacent to this area of marshy grassland are likely the result of fracture flow reaching the surface, providing water that sustains the habitat in the immediate vicinity. This habitat is therefore interpreted as being GWDTE.

11.6.37 A second localised area of marshy grassland was observed in the south of the site. This is immediately adjacent to a field drain, and follows the route of the drain, suggesting it is more likely to be sustained at least in part by surface water, rather than being true GWDTE.

11.6.38 The identified areas of marshy grassland (potentially moderately dependent GWDTE) are illustrated on Figure 11.4.

Summary of Hydrogeological Sensitivity

11.6.39 The aquifer underlying the site is moderately productive and overlying superficial deposits are thin and discontinuous. The presence of springs and abandoned wells indicates the presence of groundwater near the surface at least locally on the island, with groundwater flow likely to be dominated by fracture flow. There are no active PWS on the island, and there is no potential for hydrogeological continuity with any potential off-site areas where groundwater could be abstracted. The sensitivity of groundwater as a receptor is assessed as **medium**.

Coastal Erosion

11.6.40 Through review of coastal erosion maps supplied by Dynamic Coast Scotland, it is observed that little coastal erosion has occurred surrounding and adjacent to the site from 1890 to present day (Dynamic Coast Scotland, 2019). Mapping shows localised areas where erosion has occurred up to a maximum of 20 m over that period, and it is noted that the historical mapping review and site walkover undertaken as part of the cultural heritage assessment identified some evidence of localised erosion where heritage assets were exposed or being eroded (refer to Chapter 10). However, recorded areas of erosion over 10 m in the 1890 to present day period are short stretches of coastline, with most areas exhibiting lesser or no erosion, and in some areas, accretion.

11.6.41 Projected coastal erosion maps, displaying future erosion until 2050, show that there is not predicted to be any substantial coastal erosion surrounding and adjacent to the site (Dynamic Coast Scotland, 2019). Therefore, there is considered to be a low risk of coastal erosion affecting the Proposed Development.

11.7 Receptors Brought Forwards for Assessment

11.7.1 The following receptors have been taken forward for assessment:

- hydrogeology (groundwater), encompassing GWDTEs; and

- surface water.

11.7.2 The following receptors have been scoped out of further assessment:

- designated sites;
- potential contaminated land from historic land use;
- flood risk;
- superficial geology (soils);
- bedrock geology;
- private water supplies; and
- coastal erosion.

11.8 Standard Mitigation

Project Design

11.8.1 A summary of the hydrological influences on the project layout are given below with full details of the project design provided in Chapter 2. The design of the infrastructure seeks to help maintain or even improve the local hydrology.

11.8.2 A 6m buffer was implemented for all drainage ditches located on site and shown in Figure 11.1 and infrastructure designed out with the ditches where possible, taking account of other constraints and suitable turbine spacing.

11.8.3 There are no substantial surface watercourses on the site and no major water crossings are therefore proposed. Drainage ditch crossings will be pre-cast concrete pipe culverts with cast in-situ headwalls (if required) and will be designed in accordance with SEPA Good Practice Guidance (2010). In some instances, it may be more appropriate to divert drainage ditches around new infrastructure, rather than incorporating ditch crossings. In all cases, the design will seek to maintain greenfield flow conditions.

Construction

Construction Environmental Management Plan

11.8.4 With specific reference to the SEPA 'Guidelines for Water Pollution Prevention from Civil Engineering Contracts' and 'Special Requirements', the contractor will produce a CEMP which contains a construction method statement that includes:

- a detailed breakdown of the phasing of construction activities;
- a pollution risk assessment of the site and the proposed activities;
- identification of all Controlled Waters that may be affected by the works and temporary discharge points to these drainage ditches and the marine environment;
- planning and design of appropriate pollution control measures during earthworks and construction;
- management of the pollution control system, including dewatering of excavations away from drainage ditches and the marine environment;
- contingency planning and emergency procedures; and
- on-going monitoring of construction procedures to ensure management of risk is maintained.

11.8.5 While it is acknowledged that best practice to minimise run-off would be to undertake construction and dismantling during the driest period of the year, and this aligns with the intention to not undertake construction works during winter (refer to Chapter 8 Ecology). However, given the location of the Proposed Development on Orkney, there are likely to be significant periods of rainfall throughout the year. Therefore, site management will check the local weather forecast daily and prime all site staff to ensure that everyone is aware of their responsibilities to maintain the pollution control system during wet weather.

Pre-Construction Site Investigations

11.8.6 Detailed pre-construction site investigations would be conducted, focusing on areas where construction is proposed to be undertaken to inform suitable micro-siting of the turbines and associated infrastructure.

11.8.7 Targeted monitoring and assessment of the groundwater levels and flows beneath the site would also be carried out to inform micro-siting and to assist in the detailed design of infrastructure, the selection of appropriate materials for use during the construction process, and the requirement for any additional measures required to ensure protection of groundwater during construction. This will help to clarify whether identified areas of potential GWDTE are in fact groundwater fed and if any micro-siting or additional protective measures are required to minimise impacts to groundwater quality and flow in these areas.

Pollution Impact from Chemical Contaminated Runoff

11.8.8 All fuel and other chemicals will be stored in accordance with best practice procedures, including in a designated fuelling site located at a safe distance from existing drainage ditches and in appropriate impermeable bunded containers/areas which will be defined within the CEMP. These will be designed to capture any leakage, whether from a tank or from associated equipment such as filling and off-take points, sighting gauges etc., all of which will be located within the bund.

11.8.9 Oil booms and soakage pads will be maintained in all work areas and spill kits kept in all vehicles to enable a rapid and effective response to any accidental spillage or discharge. All construction staff will be trained in the effective use of this equipment.

11.8.10 Construction vehicles and plant will be regularly maintained and all maintenance, fuelling and vehicle washing will be undertaken on appropriate impermeable surfaces away from drainage ditches in order to minimise risks of leaks to soil and surface waters.

11.8.11 The contractor will develop a method statement to address the transport, transfer, handling and pouring of liquid concrete at foundations.

11.8.12 Cement, grout and unset concrete will not be allowed to enter the water environment. No operations involving concrete transfer between vehicles or into vehicles will take place within 30 m of water bodies. As noted in Chapter 3, it is likely that concrete batching will be undertaken on site. The mobile concrete batching plant will be sited away from watercourses and ditches, within an enclosed or shielded area. The plant will incorporate a suitable wastewater collection and treatment system to minimise potential pollution impacts on local ditches/watercourses. Environmental controls specific to the concrete batching plant will be incorporated into the CEMP.

11.8.13 All vehicles used for delivery of concrete will only be washed out at locations to be agreed with SEPA. Excess concrete or wash-out liquid will not be discharged untreated to drains or drainage ditches on site or at compounds. Drainage from washout facilities will be collected and treated or removed to an appropriate treatment point/licensed disposal site.

11.8.14 The requirement for dewatering will be minimised in all locations by timely and efficient excavation of the foundation void and subsequent concrete pouring and backfilling.

Operation

Surface Water Drainage

11.8.15 Prior to construction, a detailed Drainage Strategy (DS) will be developed and agreed with SEPA and OIC. The DS would detail the site drainage design, including the type of surface to be used for the access track, the soft engineering and habitat enhancement measures proposed to slow surface water flows and any necessary ponds, swales, cross drains and bunds, to ensure that runoff from hard surfaces will be controlled. Should the detailed DS incorporate the existing site drainage into the Proposed Development drainage, then this will be agreed with SEPA.

11.9 Likely Effects

Construction

11.9.1 The construction phase includes all activities prior to the operation of the Proposed Development, i.e. up to the point at which the turbines begin generating electricity. The following outlines the likely effects identified, with respect to geology, hydrology and hydrogeology.

Pollution Impact from Silt-laden Runoff

11.9.2 Surface runoff containing silt, particularly during and after rainfall events, has the potential to enter the field drains and ephemeral ponds located on site. Silt laden surface water runoff is predicted to arise from excavations, exposed ground and any temporary stockpiles. This has the potential to temporarily impact on the water quality and hydrological and ecological function of the receiving watercourses.

11.9.3 The drainage ditches on site have been buffered by 6 m where possible. However, due to other constraints and the requirement to maintain suitable turbine spacing, several crossings or ditch diversions will be required. Ditch crossings will comprise pipe culverts, designed in accordance with SEPA Good Practice Guidance (2010). Existing drainage ditches will only be incorporated into the detailed DS with agreement of SEPA (refer to paragraph 11.8.15).

11.9.4 A suitable buffer has been applied around the coastline, with all proposed infrastructure (with the exception of the new extended slipway and landing jetty) above the 3 m AOD contour.

11.9.5 The sensitivity of the surface water receptors is low and the magnitude of impact is low with the implementation of the mitigation described in Section 11.8, resulting in an adverse, direct, temporary, short-term effect of **negligible to minor** significance (not significant).

Pollution Impact from Chemical Contaminated Runoff

11.9.6 Pollutants such as oils, fuel and cement may be mobilised through mechanical leaks or spillage and carried in surface drainage. Unless managed appropriately, the pollutants could be washed into watercourses, impacting on freshwater quality and ecological value.

11.9.7 The sensitivity of the surface water receptors is low and the magnitude of impact is low with the implementation of the mitigation described in Section 11.8, resulting in an adverse, direct, temporary, short-term effect of **negligible to minor** significance (not significant).

Impact on Groundwater Quality and Flow Regime

11.9.8 The introduction of turbine foundations has the potential to divert groundwater flows within superficial geology, and to impact groundwater quality as a result of alkaline leachate from concrete foundations. The potential requirement for dewatering of excavations during construction could locally reduce groundwater quantity.

11.9.9 There is anticipated to be limited, perched groundwater within localised superficial deposits at the site, with near-surface deposits having potential to allow transmission of groundwater. Therefore, dewatering of excavations would likely result in localised drawdown of the water table. The potential for groundwater within the bedrock to be near the surface in localised areas also cannot be ruled out, given the presence of habitats indicative of at least some potential groundwater dependence, and the moderately productive aquifer status (though noting that flow is likely to be restricted to fissures and other discontinuities).

11.9.10 SEPA guidance (SEPA, 2017) indicates there should not be deep excavations within 250m, or shallow excavations within 100m, of GWDTE without further detailed risk assessment. However, the driver for this guidance is the Groundwater Directive i.e. it is the groundwater that the guidance seeks to protect, not the habitat. The identified marshy grassland habitat is a useful as an indicator of groundwater being at/near the surface and therefore susceptible to impact from construction-related drawdown, pollution etc., but the habitat is not in itself a sensitive receptor.

11.9.11 The groundwater resource at the Proposed Development site is assessed as having moderate sensitivity, due to the moderately productive aquifer status, but absence of active PWS. Deep excavations within or close to the identified GWDTE area could result in localised water table drawdown, potentially affecting the groundwater flow that sustains the marshy grassland. However, given the interpretation of likely fracture flow, this potential is limited. Even with excavation of the shallow bedrock, fractures providing flow pathways would be expected to continue to significant depth and would therefore continue to provide that flow pathway to the surface. Therefore, there is low potential for the groundwater flow regime to be substantially affected, and suitable construction good practice can be employed to minimise potential for impact to groundwater quality via leaks/spills etc.

11.9.12 The sensitivity of groundwater resource at the site is moderate, and the magnitude of impact is low with the implementation of the mitigation described in Section 11.8, resulting in a direct adverse, short-term effect of **minor** significance (not significant).

Operation

Surface Water Drainage

11.9.13 The permanent access tracks and crane hardstandings for the wind turbines could result in additional surface water flows, potentially resulting in soil erosion and silt-laden runoff, which could pollute watercourses, ditches and ponds.

11.9.14 Taking account of the standard mitigation described in Section 11.8 (in particular the detailed DS to be developed and agreed with SEPA and OIC to ensure appropriate control of runoff from hard surfaces), there is the likelihood of a negligible magnitude impact, on low sensitivity surface water receptors. Therefore, there is potential for an adverse indirect, long-term effect of **negligible** significance (not significant).

Long-Term Changes to Groundwater Flow Regime

11.9.15 The presence of turbine foundations, access tracks and other infrastructure has the potential to interrupt groundwater flow; for example, impermeable concrete foundations can act as barriers to flow. However, given the nature of the superficial geology at the site, groundwater is anticipated to be limited to perched water in localised till and sand deposits. Groundwater flow within bedrock is indicated to likely be restricted to fissures and other discontinuities, and this flow is very unlikely to be impacted by foundations, which would be within superficial deposits.

11.9.16 Taking account of standard mitigation measures set out in Section 11.8, the magnitude of impact is assessed as low, on a moderate sensitivity receptor. There is therefore likely to be an adverse, indirect, long-term effect of **minor** significance (not significant).

Decommissioning

11.9.17 The Applicant is seeking in-perpetuity consent for the Proposed Development. In the event of decommissioning, or replacement of turbines, it is anticipated that the levels of effect would be similar but of a lesser level than those during construction. Decommissioning would be undertaken in line with best practice processes and methods at that time and will be managed through an agreed Decommissioning Environmental Management Plan.

11.10 Mitigation and Enhancement

11.10.1 No significant environmental effects have been identified following the implementation of the mitigation outlined in Section 11.8 and no further mitigation is required.

11.11 Residual Effects

11.11.1 Residual effects are as per the assessment of likely effects in section 11.9.

11.12 Cumulative Effects

11.12.1 There are no proposed or operational wind farms within the study area, or which are directly hydrologically connected to the Proposed Development site. Therefore, no cumulative effects on hydrology, hydrogeology and geology are predicted.

11.13 Summary

11.13.1 The site comprises the island of Faray, an uninhabited island to the north and west of Eday and south-southeast of Westray in the Orkney Islands. The site boundary encompasses the island of Faray as well as extending approximately 500 m east into the sea. The site comprises open fields of improved pasture used for sheep farming, with generally gentle topography. The site contains several relic structures, namely former farms and cottages, and an old road/track. A network of drainage ditches generally follows field boundaries. There are no permanent surface watercourses on site, although there are several disused wells across the island, and localised springs in the west-central area.

11.13.2 Site geology predominantly comprises till over Upper Stromness Flagstone Formation. There is no discernible peat on site.

11.13.3 The aquifer underlying the site is moderately productive and overlying superficial deposits are thin and discontinuous. The presence of springs and abandoned wells indicates the presence of groundwater near the surface at least locally on the island, with groundwater flow likely to be dominated by fracture flow. There are no active private water supplies on the island or within 1 km of the site, and there is no potential for hydrogeological continuity with any potential off-site areas where groundwater could be abstracted.

11.13.4 The drainage ditches on site have been buffered by 6 m with no infrastructure proposed within those buffers apart from ditch crossings which were unavoidable due to other constraints and required turbine spacing.

11.13.5 Likely construction and operational effects include siltation or pollution of the water environment from surface runoff, and effects on groundwater quality and flow regime.

11.13.6 Standard/embedded mitigation measures include design and layout decisions taken through the design iteration process, including appropriate buffering of drainage ditches. Standard good construction and design practice has also been considered as standard mitigation, including detailed pre-construction site investigations, agreement and implementation of a CEMP, appropriate design of the proposed drainage ditch crossings, and development of a detailed Drainage Strategy for the site. These mitigation measures are considered to be robust and implementable and as a result there will be no significant effects on the hydrological, hydrogeological and geological receptors.

11.13.7 The likely effects on hydrological, geological and hydrogeological receptors, taking account of the standard mitigation measures, have been assessed as **negligible** to **minor** (not significant).

11.13.8 No additional mitigation is proposed or considered necessary, beyond the standard / embedded mitigation noted above. The significance of residual effects on hydrological, geological and hydrogeological receptors is therefore considered to be **negligible** to **minor** (not significant).

11.13.9 No cumulative effects on hydrology, hydrogeology and geology are predicted.

Table 11.6 - Summary Table – Hydrology, Hydrogeology and Geology

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Construction					
Pollution from silt-laden runoff	Negligible to Minor (non-significant)	Adverse	No additional mitigation than the standard mitigation identified.	Negligible to Minor (non-significant)	Adverse
Pollution from chemical contaminated runoff	Negligible to Minor (non-significant)	Adverse		Negligible to Minor (non-significant)	Adverse
Effect on groundwater quality and flow	Minor (non-significant)	Adverse		Minor (non-significant)	Adverse
Operation					
Change in surface water drainage	Negligible (non-significant)	Adverse	No additional mitigation than the standard mitigation identified.	Negligible (non-significant)	Adverse
Long-term changes to groundwater flow regime	Minor (non-significant)	Adverse		Minor (non-significant)	Adverse

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