

Breackerie Wind Farm

Environmental Impact Assessment Report Volume I Chapter 10: Hydrogeology, Hydrology and Peat

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10 HYDROGEOLOGY, HYDROLOGY AND PEAT

10.1 Introduction

- 10.1 This chapter considers the potential effects of Breackerie Wind Farm (the 'proposed development') on hydrogeology, hydrology and peat.
- 10.2 This chapter is also supported by the following figures as contained within Volume 2: Figures:
- Figure 10.1: Superficial Geology
 - Figure 10.2: Bedrock Geology
 - Figure 10.3: Soils Mapping
 - Figure 10.4: Regional Hydrogeology
 - Figure 10.5: Groundwater Vulnerability
 - Figure 10.6: Hydrological Features
 - Figure 10.7: Private Water Supplies
- 10.3 The chapter is supported by a number of Technical Appendices (as set out within Volume 4: Technical Appendices), comprising:
- Technical Appendix 10.1: Outline Water Crossing Inventory
 - Technical Appendix 10.2: Outline Peat Management Plan
 - Technical Appendix 10.3: Outline Peat Landslide Hazard Risk Assessment (PLHRA); and
 - Technical Appendix 10.4: Phase I Peat Survey
- 10.4 Other relevant chapters include Chapter 8: Ecology.
- 10.5 The author of this Chapter, Stuart Clarke Bsc (Hons) MSc, has approximately 10 years of relevant experience in ground conditions baseline assessments and associated preparation of EIA Chapters relating to ground conditions (including peat) for a range of infrastructure and renewable energy developments across Northern Ireland and Scotland.
- 10.6 The reviewer of this Chapter, David Gemmell BSc (Hons) MSc, a chartered Environmentalist and Scientist, has approximately 19 years of relevant experience in in ground conditions baseline assessments and associated preparation of EIA Chapters relating to ground conditions (including peat) for a range of infrastructure, mining and renewable energy developments across Western Australia, the UK and particularly Scotland.

10.2 Legislation, Policy and Guidance

Legislation

- 10.7 Regulation of activities relating to the water environment in Scotland is the responsibility of the Scottish Environment Protection Agency (SEPA) and the relevant local authorities.
- 10.8 The European Union (EU) *Water Framework Directive* (WFD) has been implemented in Scotland through the *Water Environment and Water Services (Scotland) Act 2003* (WEWSA). This Act introduced a regulatory system for the water environment with SEPA as the lead authority working alongside the public, private and voluntary sectors. The Act ensures that all human activities with the potential to cause a harmful effect on the water environment can be controlled by establishing a framework for co-ordinated controls on water abstraction and impoundment, engineering works affecting watercourses, and discharges to the water environment.
- 10.9 The EC Groundwater Directive provides specific measures to protect groundwater against pollution and deterioration. This Directive is implemented through the *Water Environment (Controlled Activities) (Scotland) Regulations 2011* (CAR) (as amended), introduced under WEWSA to provide the main regulatory controls for protecting the water environment from harm. CAR introduced specific controls for activities affecting watercourses and waterbodies and which encompass the following activities relevant to the Proposed Development:
- discharges to all wetlands, surface waters and groundwaters; and,
 - engineering works in inland waters and wetlands.
- 10.10 SEPA maintains water monitoring and classification systems that provide the data to support the aim of the WFD, namely that all waterbodies would have good ecological status, or similar objective, by 2015. The classification system covers all rivers, lochs, transitional, coastal and groundwater bodies, and is based on an ecological classification system with five quality classes: High, Good, Moderate, Poor and Bad. It has been devised following EU and UK guidance and is underpinned by a range of biological quality elements, supported by measurements of chemistry, hydrology (changes to levels and flows) and morphology (changes to the shape and function of waterbodies).
- 10.11 The *Water Resources (Scotland) Act 2013* makes provisions for the development of Scotland's water resources through improved water quality, the creation of contracts for non-domestic sewerage services, protection of the public sewer network and the maintenance of private sewerage works.
- 10.12 The relevant legislation relating to flood prevention is the *Flood Risk Management (Scotland) Act 2009*, which replaces the *Flood Prevention (Scotland) Act 1961* (as amended).
- 10.13 UK legislation on contaminated land is principally contained in Part IIA of the *Environmental Protection Act 1990* (EPA). This legislation endorses the principle of a 'suitable for use' approach to contaminated land, where remedial action is only required if there are unacceptable risks to health or the environment, taking into account the use of the land and its environmental setting.
- 10.14 The *Environment Act 1995* creates a system whereby local authorities must identify and, if necessary, arrange for the remediation of contaminated sites. The provisions are set out in Section 57, which inserts Part IIA into the EPA 1990. In addition to these requirements, the operation of the regime is subject to regulation and statutory guidance.

- 10.15 The Contaminated Land (Scotland) Regulations 2000 (as amended) sets out the responsibilities of authority and SEPA in the identification and management of contaminated land.

Policy

- 10.16 Chapter 5: Renewable Energy and Planning Policy of the EIA Report sets out the planning policy framework that is relevant to the EIA process and the proposed development. The policies set out include those from the Argyll and Bute Local Development Plan (LDP), National Planning Framework 4 (NPF4) and other relevant guidance.
- 10.17 NPF4 contains policies with relevance to Geology, Hydrology and Hydrogeology including Policy 5 (Soils), which states the following:
- Development proposals on peatland, carbon-rich soils and priority peatland habitat will only be supported for the generation of energy from renewable sources that optimises the contribution of the area to greenhouse gas emissions reductions targets. Where development is proposed on peatland, carbon-rich soils or priority peatland habitat, a detailed site specific assessment will be required to identify the following:
 - the baseline depth, habitat condition, quality and stability of carbon-rich soils;
 - the likely effects of the development on peatland, including on soil disturbance; and
 - the likely net effects of the development on climate emissions and loss of carbon.
 - This assessment should inform careful project design and ensure, in accordance with relevant guidance and the mitigation hierarchy, that adverse impacts are first avoided and then minimised through best practice. A Peat Management Plan (PMP) will be required to demonstrate that this approach has been followed, alongside other appropriate plans required for restoring and / or enhancing the site into a functioning peatland system capable of achieving carbon sequestration.
- 10.18 The following policies within the Argyll and Bute LDP are also considered to be of relevance to the geological, hydrological and hydrogeological assessment presented within this chapter:
- Policy LDP Strat 1: Sustainable Development (Part K);
 - Policy LDP 3: Supporting the Protection, Conservation and Enhancement; and
 - Policy LDP 10: Maximising our Resources and Reducing our Consumption.
- 10.19 Additional detailed policies are found within Supplementary Guidance (SG) provided with the Argyll and Bute Local Development Plan:
- Policy SG LDP ENV 7 Water Quality and the Environment; and
 - Policy SG LDP ENV 11: Protection of Soil and Peat Resources.

Guidance

10.20 The following relevant guidance has been considered as part of the assessment of hydrogeology, hydrology and peat:

- SEPA (2009) - Temporary Construction Methods (WAT-SG-29);
- SEPA (2017) Guidance for Pollution Prevention (GPP) 5: Works and maintenance in or near water;
- SEPA (2021) Supporting Guidance (WAT-SG-75) – Sector Specific Guidance: Water Run-Off from Construction Sites;
- SEPA (2016) The Water Environment (Controlled Activities) (Scotland) Regulations (as amended) - A Practical Guide;
- SEPA (2017) Land Use Planning System Guidance Note 4 (LUPS GU4) - Planning guidance on on-shore windfarm developments;
- SEPA (2006) WAT-SG-31 Special Requirements for Civil Engineering Contracts for the Prevention of Pollution;
- SEPA (2009) Policy 19 Groundwater Protection Policy for Scotland (Version 3);
- CIRIA (2001) C532: 'Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors';
- SEPA (2012) PPG6: Working at Construction and Demolition Sites;
- NatureScot (2019) Good Practice During Wind Farm Construction;
- NatureScot (2023) Advising on peatland, carbon-rich soils and priority peatland habitats in development management;
- Scottish Government, SNH, SEPA (2017) Guidance on Developments on Peatland - Peatland Survey (2017); and
- Developments on Peatland: Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste (Scottish Renewables and SEPA, 2014).

10.3 Consultation

- 10.21 As part of the Scoping exercise, a consultation exercise was undertaken to inform the design of the proposed development and to seek agreement on potential significant environmental effects that result from the proposed development as well as the scope of any assessment work required as part of this EIA.
- 10.22 The Scoping Opinion was received from the Scottish Government Energy Consents Unit (ECU) on 9th September 2022.
- 10.23 Consultation relevant to the geology, hydrology and hydrogeology assessment was undertaken with NatureScot, Argyll and Bute Council and SEPA who commented on aspects of methodology, sources of information, scope of assessment and cumulative development. A summary of these consultation responses is provided in Table 10.1.

Table 10.1: Consultation Responses

Consultee	Date Received	Consultation Response	Where and how is this addressed?
NatureScot	25 th July 2022	NatureScot's response indicated that part of the Machrihanish Coast and South Kintyre Geological Conservation Review designation overlaps the north of the site. It was therefore strongly recommended that no infrastructure is placed within this area.	It is considered that there will be no impact on the designated area from the proposed turbines and / or infrastructure, given their distance from the development area.
SEPA	7 th July 2022	SEPA indicated that the following items must be submitted with the EIA:	
		a) Map and assessment of all engineering works within and near water environment including buffers, details of any Flood Risk Assessment and details of any CAR related operations	a) Details of proposed new and altered water crossings are provided in Technical Appendix 10.1. Flood risk is discussed in paragraphs 10.107 to 10.110.
		b) Map and assessment of GWDTEs and buffers	b) A map of potential GWDTE's identified from an NVC survey and associated buffers is provided in Chapter 8: Ecology and Technical Appendix 8.3: Habitat Survey Report including GWDTE Assessment. Potential effects on GWDTE are discussed in paragraphs 10.74 to 10.77.
		c) Map and assessment of impact upon groundwater abstractions and buffers	c) A map of private water supply (PWS) abstractions provided in consultation with Argyll and Bute Council and associated buffers is provided as Figure 10.7. Potential effects on PWS are discussed in paragraphs 10.78 to 10.83.
		d) Peat depth survey and table detailing re-use proposals	d) An outline Peat Management Plan and an outline Peat Slide Risk Assessment are provided in Technical Appendices 10.2 and 10.3, respectively.
		e) Map and table detailing forestry removal	e) Proposed forest removal and forestry management is discussed in Chapter 14: Forestry and within this chapter as appropriate.

Consultee	Date Received	Consultation Response	Where and how is this addressed?
		f) Map and site layout of borrow pits	f) Proposed borrow pits are discussed in Chapter 3: Project Description and paragraphs 10.100 to 10.106.
		g) Schedule of mitigation including pollution prevention measures	g) Mitigation measures are set out in Section 10.7 and summarised in the Schedule of Mitigation in Chapter 16.
		h) Borrow pit site management plan of pollution prevention measures	h) Proposed borrow pits are discussed in Chapter 3: Project Description and paragraphs 10.100 to 10.106.
		i) Map of proposed wastewater drainage layout	i) Outline information on the proposed drainage strategy is provided in Chapter 3: Project Description.
		j) Map of proposed surface water drainage layout	i) Outline information on the proposed drainage strategy is provided in Chapter 3: Project Description.
		k) Map of proposed water abstractions including details of the proposed operating regime	k) Arrangements for water abstractions are discussed in paragraph 10.161.
		l) Decommissioning Statement	l) Outline decommissioning proposals are provided in Chapter 3: Project Description and effects are assessed in this chapter as appropriate.
		Peat: Deep peat classified as over 1m. The EIA must demonstrate how the layout has been designed to avoid areas of deep peat. We would welcome the chance to review proposed layout and peat probing data in advance of the finalised EIA.	Extensive design iteration works have been undertaken to avoid siting infrastructure on deep peat wherever possible, as discussed in this chapter and in Technical Appendix 10.2 Outline Peat Management Plan.
Argyll and Bute Council	1 st December 2022	Consultation relating to private water supplies. Argyll and Bute Council provided information on activities registered or licensed under the Controlled Activities Regulations in the vicinity of the site.	A map of private water supply (PWS) abstractions provided in consultation with Argyll and Bute Council and associated buffers is provided as Figure 10.7. Potential effects on PWS are discussed in paragraphs 10.78 to 10.83.

Consultee	Date Received	Consultation Response	Where and how is this addressed?
SEPA	16 th December 2022	Consultation relating to results of the Phase 2 peat survey were undertaken via an online meeting with subsequent written feedback received via e-mail on the 16th December 2022. SEPA indicated that they were reasonably satisfied that deep peat had been avoided as far as possible, given the constraints of the site. SEPA indicated that they would expect the Peat Management Plan to contain detail on peat types, volumes and planned reuses. They also stated that they would be looking for the proposals to be designed to minimise disturbance using mitigation such as floating roads etc. where possible.	Consultation feedback from SEPA has helped to guide the approach to design iteration and to minimise any impacts on peat (refer to Paragraphs 10.61 to 10.69 and Technical Appendix 10.2 Outline Peat Management Plan).
SEPA	12 July 2023	SEPA feedback on an Environmental Impact Assessment (EIA) Gatecheck Report. SEPA confirmed that they were reasonably satisfied that deep peat has been avoided as much as possible, given the constraints of the site and that no changes to the proposed layout have been made since previous discussions in December 2022. They reiterated the need to minimise impacts on peat where possible by reducing the extent of new tracks and the number of new water crossings required. No concerns were raised in relation to GWDTE's given the sites commercial forestry operations. It was recommended that a 250m buffer should be put in place around any PWS.	Consultation feedback from SEPA has helped to guide the approach to design iteration and to minimise any impacts on peat (refer to Paragraphs 10.61 to 10.69 and Technical Appendix 10.2 Outline Peat Management Plan)

10.4 Assessment Methodology and Significance

Scope of Assessment

Consultation

- 10.24 As noted in the previous Section, consultation has been undertaken with NatureScot, Argyll and Bute Council and SEPA. Responses and relevant considerations are noted in Table 10.1.

Study Area

- 10.25 The study area has incorporated the area within the site boundary and this assessment also considers any potential hydrological and hydrogeological effects up to 1 km from any proposed infrastructure (see Figure 3.1).
- 10.26 The location of private water supplies (PWS) within 1 km of the proposed new infrastructure have been identified following consultations with Argyll and Bute Council, site survey work and a review of available OS mapping.
- 10.27 The criteria for defining the study area have been established based on the professional judgement and experience of the assessment team with regard to likely access and working areas, and with due consideration to the relevant guidance on hydrogeological, hydrological and geological assessment.

Desk Study

- 10.28 Baseline conditions have been established primarily through desk-based research which has included:
- Consultation with SEPA, NatureScot and Argyll and Bute Council;
 - 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 classification;
 - Review of on-line SEPA flood mapping;
 - Review and collation of pertinent information on surface hydrology, flooding, climate, etc.;
 - Review of on-line British Geological Survey (BGS) geological mapping of the area, and the SNH Carbon and Peatlands Map 2016;
 - Review of drainage / surface water and hydrogeological characteristics and groundwater resource;
 - Review of NatureScots Sitelink map to identify any protected areas that may be located on or in the vicinity of the site, such as Sites of Special Scientific Interest (SSSI) which include sites that are designated as a result of their geology and Geological Conservation Review sites (GCR); and
 - Review of publicly available historical mapping.

Site Visit

10.29 Several site survey visits have been undertaken by members of the assessment team as described below:

- During peat depth survey work in winter 2022 / 2023, the site was visited and surveyed extensively, with observations made of site terrain, vegetation, the nature of watercourses and their banks, ground conditions, and the nature and condition of existing infrastructure (e.g. tracks).
- The existing and proposed water crossings were inspected (where located) during the peat survey work.
- Habitat and vegetation surveys were undertaken between 29th August 2022 and 2nd September 2022, providing information relevant to the identification of habitats which could represent groundwater dependent terrestrial ecosystems (GWDTE).

Peat Depth Survey

10.30 Based on a desk study review of published geological mapping, it was anticipated that peat could be present across much of the site, with some localised areas interpreted as likely having no peat deposits (mainly on hilltops/steep slopes and along watercourse banks).

10.31 Peat depth surveys have been undertaken at the site over the course of three phases. A 'Phase 1' peat survey was initially undertaken by Envirocentre in June 2022. These works focused on what was known as the 'developable' area of the site, which was identified on the basis of observations around the practicalities of wind farm construction within the wider main site boundary, including consideration of topography, ground conditions and visibility.

10.32 Due to the extensive cover of dense plantation forestry, it was considered appropriate to diverge from the relevant guidance on peat surveys (Guidance on Developments on Peatland - Site Surveys (2017), which recommends a 100 m grid of peat probe locations as an initial high-level survey strategy across an entire development site). As such, a hybrid survey grid was adopted with probe locations being identified from an initial 100m grid in areas that appeared to be accessible on the basis of available information. These locations included visible forestry clearings, firebreaks and open areas to the side of forestry tracks. Additional potentially accessible locations were also identified elsewhere within the survey extent, at varying intervals, to provide good spatial coverage of the site.

10.33 In total 506 locations were probed. Of the probed locations, 40.5% were less than 0.5m in depth, primarily located in the south and north-east of the site, with some isolated areas in the west. Areas of shallow peat (up to 1m) are located within the east and north-west of the site, accounting for 27.3% of surveyed locations. Deeper peat (1.0m – 3.0m) was present at 30.6% of the surveyed locations, mainly located within the centre and west of the site, with some isolated areas in the east. Very deep peat (>3.0m) was present at 1.6% of the surveyed locations, in the west of the site.

10.34 Following completion of Phase 1 survey, the site design was reviewed, and changes were made to avoid or minimise siting infrastructure on areas of deeper peat. A 'design chill'

was subsequently arrived at and a Phase 2 survey was undertaken by RPS in December 2022. The Phase 2 survey comprised detailed surveys at each proposed turbine and hardstanding location, along all proposed new access tracks, and at other proposed infrastructure locations including the site substation, construction compounds and borrow pit search areas.

- 10.35 The pattern of peat probing in relation to proposed turbine locations and other infrastructure elements can be broadly described as follows:
- Probe at each proposed turbine location plus an additional probe, approximately 25m from the turbine location to the north, south, east and west;
 - Probes advanced on a grid at approximate 25m centres across the area of each proposed turbine hardstanding and crane pad area;
 - Probes advanced at 50 m centres along the proposed routes of new access tracks; and
 - Probes advanced on a grid at approximate 25m centres at the location of the proposed substation, the proposed construction compound and within each of the proposed borrow pit search areas.
- 10.36 A third phase of peat probing, using the probing patterns described above was completed in February 2023 following the amendment of the positions of two turbine locations and the re-alignment of a proposed access track. These changes were required to be undertaken as a result of consultation with the site landowners rather than the findings from previous phases of peat probing works.
- 10.37 Data obtained from the peat depth surveys were subsequently used to plot the presence and distribution of peat across the proposed development areas, create a peat contour plan, and feed into detailed design iteration. The data was subsequently used to develop an outline Peat Management Plan (PMP) and inform an outline Peat Slide Risk Assessment (PSRA); refer to Appendices 10.2 and 10.3 respectively.
- 10.38 Following completion of the second phase of peat probing works, SEPA were consulted to allow the preliminary peat survey findings to be provided and to seek their feedback on the proposed development layout and its potential impact upon peat. On the basis of these discussions SEPA confirmed that the surveys undertaken were appropriate and that they were reasonably satisfied that deep peat had been avoided as far as possible, given the constraints of the site (see Table 10.1 for further details).

Assessment of Significance

Sensitivity

- 10.39 The sensitivity characteristics of geological hydrological and hydrogeological resources have been guided by the matrix presented in Table 10.2, which lists indicative criteria.

Table 10.2 - Sensitivity Criteria (Geology, Hydrology and Hydrogeology)

Sensitivity	Definition and Examples
<i>High</i>	Areas containing geological, geomorphological or hydrological features considered to be of national interest, for example, Aquatic Natura 2000 sites, Special Areas of Conservation, Sites of Special Scientific Interest. Highly permeable superficial deposits allowing free transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of High or Good Ecological Status. Raised or blanket bog. High risk of flooding. Land capable of supporting Arable Agriculture i.e. Class 1, 2 and 3.1.
<i>Medium</i>	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 Status. Significant peat deposits. Moderate risk of flooding. Land capable of supporting Mixed Agriculture i.e. Class 3.2, 4.1 and 4.2.
<i>Low</i>	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 Status or no WFD classification. Thin superficial peat deposits. Low risk of flooding. Land capable of supporting improved grassland or rough grazing only i.e. Class 5.1 to 7.

- 10.40 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, waterbody status from the WFD review work undertaken to date by SEPA, consultations, site visits, and the professional judgement of the assessment team.

Magnitude

- 10.41 The prediction and assessment of the magnitude 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 and operational phases of the Proposed Development. Impacts have been predicted based on the guidance criteria for the magnitude of change set out in Table 10.3. Impacts from aspects of decommissioning are considered to be the same as or lesser than those for construction.

Table 10.3: Magnitude of Effects Criteria (Geology, Hydrology and Hydrogeology)

Magnitude	Criteria
<i>High</i>	Total loss of, or alteration to key features of the baseline resource such that post development characteristics or quality would be fundamentally and

Magnitude	Criteria
	<i>irreversibly changed, for example, extensive excavation of peatland or watercourse realignment.</i>
Medium	<i>Loss of, or alteration to key features of the baseline resource such that post development characteristics or quality would be partially changed, for example, in-stream permanent bridge supports or partial excavation of peatland.</i>
Low	<i>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.</i>
Negligible	<i>A very slight change from baseline conditions, which is barely distinguishable, and approximates to the 'no change' situation, for example short term compaction from machinery movements.</i>

- 10.42 Using these criteria, potential effects resulting from the proposed development have been assessed. These effects are presented in Section 10.6. Details of generic and site-specific mitigation measures are given in Section 10.7, with the remaining residual effects detailed in Section 10.8.

Significance of Effects

- 10.43 The significance of predicted effects has been assessed in relation to the sensitivities of the baseline resource. A matrix of significance, based on the combination of magnitude of change and sensitivity of receptor, has been developed to provide a consistent framework for evaluation. This is shown in Table 10.4 below.

Table 10.4: Significance of Effects Matrix

	Sensitivity			
Magnitude	High	Medium	Low	Negligible
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

- 10.44 The guideline criteria for the various categories of effect are provided in Table 10.5.

Table 10.5: Significance Criteria (Geology, Hydrology and Hydrogeology)

Significance	Definition	Guidance 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 large, but non-fundamental change to the environment.	Changes in water quality or quantity affecting part of a catchment or

Significance	Definition	Guidance Criteria
		groundwaters of moderate vulnerability, or changes resulting in loss of conservation values to geological or aquatic habitats or designated areas.
<i>Minor</i>	A small but detectable change to the environment.	Localised changes resulting in minor and/or reversible effects on soils, surface and groundwater quality or habitats.
<i>Negligible</i>	No detectable change to the environment.	No effects on geological resources, drainage patterns, surface and groundwater quality or aquatic habitats.

10.45 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 in terms of the EIA Regulations and, therefore, are those which may have an adverse effect on the status of waterbodies, watercourses, groundwater or geological resources.

10.46 These matrices have been used to guide the assessment, though 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.

10.47 Cumulative effects have been accounted for through the prediction and evaluation of effects at a catchment-wide level.

Requirements for Mitigation

10.48 Committed mitigation measures are presented within this chapter (Section 10.7) 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

10.49 An assessment of any predicted significant residual effects on sensitive geological, hydrological or hydrogeological receptors is presented within this chapter (Section 10.8).

Limitations

10.50 No water quality monitoring or intrusive investigations, other than peat depth survey work as described in paragraphs 10.61 to 10.69, have been undertaken. This is not considered to represent a significant limitation to the assessment of effects, as detailed intrusive site

investigation works and water quality monitoring would, as is typical, be undertaken prior to and during construction to inform detailed engineering design, micro-siting, and environmental protection and control measures to be implemented.

10.5 Baseline Conditions

Designated Sites

- 10.51 Reference to the NatureScot Site Link map indicates that there are no designated sites located within the study area.
- 10.52 Two areas of the Machrihanish Coast and South Kintyre Geological Conservation Review site are indicated to be located within 3km of the development site. An area is shown to be located approximately 2km north of nearest turbine (T3), while a second area is shown to be located approximately 1.2km east of the start of the proposed site access track but 3km east of the nearest turbine location (T10). Given their distances from the proposed infrastructure locations these areas are considered highly unlikely to be affected by the proposed development and have therefore been discounted.

Geology (including Soils)

- 10.53 BGS online mapping for the area shows that the bedrock geology underlying the site is complex. The majority of the site is underlain by metamorphic bedrock of the Stonefield Schist Formation, Glen Sluan Schist Formation and Beinn Bheula Schist Formation, which comprise pelite, semipelite and gritty psammite. Locally, a band of meta-limestone of the Loch Tay Limestone Formation is shown to run through the centre of the site in a north – south direction. An Amphibolite and hornblende schist intrusion is shown to be present within this band. Further metamorphic rock of the Green Beds Formation (Metavolcaniclastic sedimentary rock) are shown to underlie eastern parts of the site, generally within the area of the proposed access track.
- 10.54 Two areas of igneous bedrock are also shown to be located beneath the eastern part of the site with rock of the Clyde Plateau Subsuite (microgabbro) shown within the area of the proposed access track and the eastern borrow pit search area and rock of the Clyde Plateau Volcanic Formation (lava / basalt) shown in the area at the start of the proposed access track.
- 10.55 Igneous basalt and trachyandesite dykes (Dinantian Dykes) are also shown to be present in the northern and southern parts of the site.
- 10.56 A thrust fault is shown to be located in the central part of the site. This fault separates the Glen Sluan Schist Formation and Beinn Bheula Schist Formation in the northern part of the site and follows the eastern edge of the Loch Tay Limestone Formation. The same fault also passes through the eastern part of the site, separating the Glen Sluan Schist Formation and the Green Beds Formation. There are also several smaller faults in the eastern site area.
- 10.57 The bedrock geology as shown on BGS 1:50,000 scale mapping is shown on Figure 10.1.

- 10.58 BGS mapping shows that bedrock across most of the site area is overlain by Till. This is expected to comprise poorly sorted sand, gravel, cobbles and boulders in a clay matrix. The routes of watercourses onsite are shown to have little or no superficial material over bedrock. A small area of alluvial deposits, anticipated to comprise clays, silts, sands and gravels, are shown to be located in the vicinity of Homeston Burn, which is located at the start of the proposed access track in the far eastern part of the site.
- 10.59 In respect of the soil resource across the site, it is noted that soils in the western, northern, and north-eastern parts of the site are classified as blanket peat. Soils in central and eastern parts of the site are classified as peaty gleys podzols while soils at the start of the access track in the far eastern part of the site are classified as gleys and mineral alluvial soils.
- 10.60 The superficial geology as shown on BGS 1:50,000 scale mapping is shown on Figure 10.2 and soils mapping for the site area is shown on Figure 10.3.

Peat

- 10.61 The SNH carbon and peatland mapping (2016) defines most of the site as Class 5 peat, where no peatland habitat is recorded, but where soils are carbon-rich and comprise deep peat. Central and southern areas of the site are defined as Class 4, or areas unlikely to be associated with peatland habitats and unlikely to include carbon-rich soils. A localised area in the central part of the site is classified as Class 3, or areas containing peaty soil.
- 10.62 Peat depth surveys were undertaken as described in paragraphs 10.61 to 10.69, in consultation with SEPA and guided by Guidance on Developments on Peatland - Site Surveys (2017) to identify and characterise peat deposits that may be present around proposed turbines and associated infrastructure.
- 10.63 The locations and findings of the peat probes are illustrated within Technical Appendix 10.2: Outline Peat Management Plan.
- 10.64 The Guidance on Developments on Peatland - Site Surveys (2017) uses the definition of peat, deep peat and organo-mineral (peaty) soils which is presented in the Joint Nature Conservation Committee (JNCC) report 445 Towards an Assessment of the State of UK Peatlands (2011). This definition, which has been used within this chapter, is summarised below:
- **Peaty (or organo-mineral) soil:** a soil with a surface organic layer less than 0.5 m deep;
 - **Peat:** a soil with a surface organic layer greater than 0.5 m deep which has an organic matter content of more than 60 %;
 - **Deep peat:** a peat soil with a surface organic layer greater than 1.0 m deep.
- 10.65 The peat depth survey works undertaken at the site have identified that areas of deep peat are limited to the western area of the site and isolated areas in the east.

- 10.66 Of 1,068 probes advanced during the peat depth surveys, approximately 51 % of the peat probe results recorded peat to a depth less than 0.5m with 74% recording peat to a depth less than 1.0m. The remaining area of the site is covered with deposits either between 1.0 and 2.0m (approx. 16% of the results) 2.0 and 3.0m (approx. 8% of the results) and more than 3.0m (approx. 1% of the results). The maximum recorded depth of approximately 5.0m was recorded in the western area of the site.
- 10.67 Full details of the peat depth survey, together with an outline Peat Slide Risk Assessment, are provided in Technical Appendix 10.3. An outline Peat Management Plan is provided as Technical Appendix 10.2.
- 10.68 Laboratory testing results from samples of peat taken during peat depth surveys (one sample per turbine location except T13) identified moisture contents generally above the typical values for peat of 85 to 95% for the 12 samples, with the exception of T10 (the result of 0.1% for T6 is considered to be anomalous). Carbon contents were recorded as being below the typical value of 55% for peat in all 12 samples with the highest carbon contents correlating with the highest moisture contents. This suggests that materials in at least some areas of the site may be considered peaty or organo-mineral soils, rather than peat. Refer to Technical Appendix 10.3 for further details.
- 10.69 Overall, the sensitivity of the baseline geological resources at this site are considered to be medium, given the presence of peat across the site, although of variable depth and degraded by drainage and forestry activity.

Hydrogeology

- 10.70 The groundwater body beneath the site is indicated by SEPA to comprise part of the Campbeltown groundwater body. This groundwater body was classified by SEPA in 2020 as having an overall status of good.
- 10.71 Hydrogeology mapping data from the BGS shows that the bedrock beneath the main site area to comprise a low productive aquifer in which flow is virtually all through fractures and other discontinuities.
- 10.72 Peat and peaty soils would be expected to contain perched groundwater but would also be expected to inhibit groundwater flow. Till and alluvial deposits, where present, are anticipated to be of variable permeability, depending on the proportion of clays and silts relative to coarser components (sand, gravel, cobbles and boulders).
- 10.73 Regional hydrogeology and vulnerability mapping for the site is shown on Figures 10.4 and 10.5.

Potential Groundwater Dependent Habitats

- 10.74 Three areas of potential GWDTE were identified during National Vegetation Classification survey work at the site (see Chapter 8: Ecology and Figure 8.3 for further detail).
- 10.75 The first area is situated within the north-western part of the site, the second area is located out with the site boundary but within the southern buffer zone, and the third area is situated on the eastern site margin and adjacent to the proposed site entrance.

- 10.76 The first location is located over 1 km from the nearest proposed turbine base (T1) and associated infrastructure and is therefore considered unlikely to be impacted by the proposed development. The second area is considered to be isolated from impacts within the site boundary primarily because of its distance from the nearest proposed turbine / infrastructure feature (approximately 500m south-west of T13) but also because of the buffering effect of an intervening watercourse (a tributary of the Lecknacreive Burn known as Allt Dearg) which flows along the site boundary in between the GWDTE area and the nearest turbine / infrastructure feature (T13). The third potential GWDTE is located in proximity to the proposed access track at the site entrance but is situated approximately 2km east of the nearest turbine bases (T10 and T11). This GWDTE is noted to be situated in a low-lying area that is situated in between two watercourses that are located to the areas east and west. The area is also located in proximity to the point where a ditch, that drains the land to the east, flows into the eastern watercourse (Homeston Burn). On this basis, it is considered that groundwater draining towards the GWDTE area from the east and west is likely intercepted by the watercourses that are situated either side of it. As a result, it is considered that the vegetation encountered in this area is most likely to be a result of surface water and is not dependent on a groundwater source.
- 10.77 Based on the above it is considered that GWDTEs will not be affected by the proposed development. As such, impacts on GWDTE are not considered further in this assessment.

Private Water Supplies

- 10.78 Argyll and Bute Council were consulted with regard to the presence of Private Water Supplies (PWS) located in the vicinity of the proposed turbines and associated infrastructure. Records for five PWS located within 2.0 km of the site have been provided.

Site Reference	Site Name	Class	Co-ordinates	Source Type
AABMK0436	Kilwhipnach Farm	B	167453, 616556	Spring
AABMK0450	Largiebaan Cottage	B	161329, 614415	Burn
AABMK0772	Lochorodale	B	166268, 615276	Spring
AABMK0501	MACC Machrihanish	A1	163442, 617400	Burn
AABMK0501	MACC Machrihanish	A1	163702, 617428	Burn

- 10.79 Of these, two PWS records are shown to be located within the northern part of the development site (MACC Machrihanish), with the remaining three records relating to PWS situated out with the site boundary. These are known as Lochorodale (situated adjacent to the north-eastern site boundary), Largiebaan Cottage (1.75km west) and Kilwhipnach Farm (950m north-east).
- 10.80 Although located within the development site boundary, both records associated with the MACC Machrihanish PWS are indicated to be located approximately 1.7km from the nearest proposed infrastructure (T2). On this basis, these are considered unlikely to be impacted by the proposed development. It is also considered that the Largiebaan Cottage and Kilwhipnach Farm PWS are also unlikely to be impacted by the proposed development due to their distance from the nearest proposed infrastructure (Largiebaan Cottage – 2.4km (T4) and Kilwhipnach Farm – 2.5km (T10)).

- 10.81 The PWS at Lochorodale is indicated to be the closest water supply to the proposed infrastructure and will be situated approximately 800m from T10. Given the distance, it is considered that this PWS is unlikely to be impacted by the Proposed Development. It is also noted that the PWS is likely to be isolated from impacts because of the buffering effect of an unnamed watercourse that flows along the deep valley of Achnabraad Glen, which is situated in between the water supply location and the nearest infrastructure.
- 10.82 No wells, springs or other features suggesting the potential presence of a PWS have been identified from a review of OS mapping, within the site boundary or within 1 km of any proposed turbines or other new infrastructure. In addition, no evidence of potential PWS has been observed on site during the course of the site survey work.
- 10.83 An assessment of effects on PWS is therefore not considered further within this chapter.

Summary of Groundwater Sensitivity

- 10.84 Taking account of the low productivity aquifer underlying the site, generally low permeability superficial deposits, the absence of GWDTE interpreted as being present at the site and the absence of PWS in the study area, the sensitivity of baseline hydrogeological resources beneath this site is considered to be low.

Watercourses

- 10.85 As shown on Figure 10.6, there are a number of watercourses within the study area. The largest of these is Lecknacreive Burn, which flows through the centre of the development site in a southerly direction towards Breackerie Water located approximately 500m beyond the southern site boundary.
- 10.86 Lecknacreive Burn rises in the northern part of the site and is formed at the confluence of two tributaries called Allt Brandon and Allt a' Ghilleann Duibh in the area between T3 and T6. Allt Brandon and Allt a' Ghilleann Duibh, drain from southern and eastern sides of 'The Slate' hill and generally flow in a south easterly direction. Both watercourses are shown to traverse the route of the access track that is proposed to be constructed between T3 and T6.
- 10.87 Allt Seilich also rises in the northern part of the site and on the southern side of 'The Slate' hill, draining in a south-easterly direction towards the Lecknacreive Burn. No infrastructure is proposed to be constructed in proximity to this watercourse.
- 10.88 Allt Airighe Glaise rises in the western part of the site on the northern side of Achnaslishaig Hill, draining in an easterly direction towards the Lecknacreive Burn. The area in which this watercourse rises is shown to be located in the vicinity of the proposed access track that is to be constructed between T5 and T9.
- 10.89 Allt na h-Earba rises in the south-western part of the site on the eastern side of Achnaslishaig Hill, draining in an easterly direction towards the Lecknacreive Burn. The area in which this watercourse rises is indicated to be located in the vicinity of T9.
- 10.90 Numerous additional unnamed tributaries to the Lecknacreive Burn rise on the slopes of Achnaslishaig Hill in the west and Cnoc Odhar in the south. One of these tributaries known

as Allt Achadh nan Clach is shown to flow from the slope of Cnoc Odhar is shown to traverse the existing access track in the area between T12 and T13.

- 10.91 Two further watercourses, Allt Criche and Allt Mor, are shown to rise on the northern side of Achnaslishaig Hill, draining in a westerly direction towards Breackerie Water. Allt Criche is indicated to traverse the route of two access tracks that will link T2 and T1 with T4. No infrastructure is proposed to be constructed in proximity to Allt Mor.
- 10.92 Homeston Burn is located along the eastern site boundary and flows in a southerly direction towards Connieglen Water, which is situated approximately 1.0km beyond the south-eastern boundary. An unnamed tributary of Homeston Burn flows along Achnabraad Glen, which is situated along the site's north-eastern boundary. A number of additional smaller unnamed tributaries are noted to rise on the northern side of Cnoc nan Gabhar in the south-east of the site and the southern slope of an unnamed area of high ground and flow into the main tributary. Both the main tributary and the additional tributaries that rise from Cnoc nan Gabhar are shown to traverse the existing access track (the route of which is to be modified in places) that leads from the proposed site entrance to the main development site.
- 10.93 There are a number of hill features – The Slate, Achnaslishaig Hill, Cnoc Odhar, Cnoc nan Gabhar – which effectively surround the site. Water subsequently drains from these high points into the Lecknacreive Burn and the tributary within the Achnabraad Glen situated along the sites north-eastern boundary either directly or via a series of smaller tributaries.
- 10.94 Both the Connieglen Water and Breackerie Water were classified by SEPA in 2020 as being in Good condition.
- 10.95 For the purposes of this assessment and taking account of the Good status of the local watercourses, the sensitivity of baseline hydrological resources at this site is considered to be high.
- 10.96 The hydrological features described above are highlighted on Figure 10.6.

Water Crossings

- 10.97 The road and tracks providing access to the turbines and other infrastructure will require to cross watercourses at a number of locations. The site design has sought to maximise the use of existing water crossings on roads and tracks already in place and in use for forestry operations. A number of existing water crossings have been identified (refer to Technical Appendix 10.1), which will be used and have been assessed as not likely to require any substantial upgrading works. Five of these are on forestry tracks within the main body of the site (primarily on the southern access track leading to T11, T12 and T13) and five are situated on the main access road into the site, between the eastern site boundary and the main body of the site. One of these existing water crossings (NWC1), located close to the main site entrance, will require to be upgraded to ensure it is suitable for the required loads.

10.98 In total, nine new / upgraded water crossings will be required. The proposed new and upgraded crossings are briefly outlined below, with further details provided in the water crossing schedule, Technical Appendix 10.1.

- NWC1 is an existing crossing of Homeston Burn on the existing access track close to the main site entrance. The current crossing is not considered to be suitable for the proposed development and will be upgraded via installation of a new / upgraded bridge.
- NWC2 is a proposed new crossing of an unnamed tributary of Homeston Burn, which flows through Achnabraad Glen on the track that links T8 with the main access track. A piped circular culvert watercourse crossing will be formed at the new track crossing point.
- NWC3 is a proposed new crossing of Allt a' Ghilleann Duibh on the track between T6 and T3. A piped circular culvert watercourse crossing will be formed at the new track crossing point.
- NWC4 is a proposed new crossing of an unnamed tributary of Allt Brandon on the track between T6 and T3. A piped circular culvert watercourse crossing will be formed at the new track crossing point.
- NWC5 is a proposed new crossing of Allt Brandon on the track between T6 and T3. A new bridge will likely be required at this watercourse crossing due to the incised nature of the watercourse at the track crossing point.
- NWC6 is a proposed new crossing of Allt Criche on the track between T1 and T4. A piped circular culvert watercourse crossing will be formed at the new track crossing point.
- NWC7 is a proposed new crossing of Allt Criche on the track between T2 and T4. A piped circular culvert watercourse crossing will be formed at the new track crossing point.
- NWC8 is a proposed new crossing of Allt Airighe Glaise on the track between T5 and T9. A piped circular culvert watercourse crossing will be formed at the new track crossing point.
- NWC9 is a proposed new crossing of an unnamed tributary on the track between T5 and T9. A piped circular culvert watercourse crossing will be formed at the new track crossing point.

10.99 The locations of the existing and proposed water crossings are shown in Figure 3.1.

Borrow Pit Search Areas

10.100 As shown on Figure 3.1, four borrow pit search areas have been identified:

10.101 The north western borrow pit search area is immediately west of the existing track that passes through the main body of the site. It appears to be an extension of an existing borrow pit and is considered likely to be a suitable location for winning stone. It is well sited to provide stone for constructing tracks in the northern and north-eastern parts of the site.

10.102 The eastern borrow pit search area is immediately south of the existing track that leads to the main body of the site. It is an extension of an existing quarry and is considered to be

a suitable location for winning stone through excavating into the hillside in this area of the site. It is well sited to provide stone for constructing tracks across the development site as a whole, given its location on the main access track.

- 10.103 The southern borrow pit search area is immediately east of the existing track near T12. It appears to be an extension of an existing borrow pit and is considered likely to be a suitable location for winning stone. It is well sited to provide stone for constructing tracks in the southern and eastern parts of the site.
- 10.104 The south-western borrow pit search area is immediately west of an existing track that leads to the main body of the site. It is an extension of an existing quarry and is considered to be a suitable location for winning stone through excavating into the hillside in this area of the site. It is well sited to provide stone for constructing tracks in the western part of the site.
- 10.105 The bedrock geology at the north western borrow pit search area is reported to comprise limestone of the Loch Tay Limestone Formation, although it is located close to the inferred boundary with psammite and pelite rock of the Beinn Bheula Schist Formation. The south western and southern borrow pit search areas are also reported to comprise rock of the Beinn Bheula Schist Formation. The eastern borrow pit search area is reported to comprise rock of the microgabbro of the Clyde Plateau Subsuite. All of the borrow pit search areas are considered to have potential for providing suitable rock for site construction, as evidenced by the existing presence of quarries / borrow pits at each of these locations. As set out in Chapter 3: Project Description, intrusive site investigation work will be undertaken to further characterise the rock, identify its suitability, and allow a specific excavation location or locations within the search areas to be confirmed prior to commencement.
- 10.106 Following excavation, the borrow pit area(s) will be restored using site-won soils in accordance with relevant good practice guidance. Further information on the use of excavated peat for restoration of borrow pits is given in Technical Appendix 10.2 Outline Peat Management Plan.

Flooding

- 10.107 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.
- 10.108 This map indicates that areas of fluvial flood risk (flooding from rivers) are confined to the channels and immediate vicinity of the tributary that flows within the Achnabraad Glen in the north eastern part of the site and Homeston Burn located on the eastern site boundary.
- 10.109 This map identifies very limited, localised areas with a risk of surface water flooding, all following the channels of the minor watercourses on site.
- 10.110 With the only flood risk being associated directly adjacent to the onsite watercourses, remote from any proposed infrastructure except water crossing points, the risk of flooding on the site, and the sensitivity of the site to flooding, is considered to be low.

Contaminated Land

- 10.111 Historically, the main body of the is shown to have largely comprised undeveloped moorland, with historical maps from the mid-1800s to 1955 showing no development onsite with the exception of a small curling pond situated adjacent to Homeston Burn in the eastern part of the site.
- 10.112 No potential sources of contamination are shown to be present on-site on the available historical maps. More recent development is noted to have taken place on site with the construction of a number of access tracks throughout the site. The development of these access tracks is considered to be associated with the current use of the site for commercial forestry activities. It is considered that the four disused borrow pits / quarries that are currently present on site are likely to have been formed for the purposes of generating material for the construction of these access tracks. On this basis, these features are not considered to represent a significant source of contamination.
- 10.113 With no potentially significant contamination sources identified within the main body of the site, contaminated land will not be considered further within this assessment.

10.6 Identification and Evaluation of Key Effects

- 10.114 The potential effects resulting from the proposed development are detailed below. Effects have been separated into those which occur during the construction, operation and decommissioning phases individually.

Construction Effects

- 10.115 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 paragraphs outline the potential effects identified, with respect to geology, hydrology and hydrogeology during this phase.

Pollution Impact from Sediment Run-off / Transport and / or Chemical Contaminated Run-off

- 10.116 Surface run-off containing silt and other sediments, particularly during and after rainfall events, has the potential to enter the watercourses and drains on-site. Silt and sediment laden surface water run-off is predicted to arise from excavations, exposed ground and any temporary stockpiles.
- 10.117 Silt and sediment laden run-off has the potential to impact on the water quality and hydrological and ecological function of receiving watercourses at and downstream of the works in the absence of any mitigation.
- 10.118 Additionally, pollutants such as oils, fuel and cement may be mobilised through mechanical leaks or spillage and carried in surface drainage. Unless managed appropriately, these pollutants could be washed into watercourses, impacting on freshwater quality and ecological value.

- 10.119 The magnitude of change, prior to mitigation, is considered to be medium, on a high sensitivity receptor. Therefore, there is potential for a direct, temporary, short-term effect of **major adverse** significance prior to implementation of mitigation measures on watercourses.

Pollution Impact from Forestry Felling

- 10.120 On-site forestry will be felled where required to construct site infrastructure, in line with a Wind Farm Forest Plan, (refer to Chapter 14: Forestry). Removal of mature trees may lead to direct impacts on the water environment through forestry material and brash entering local watercourses, and loss of structure of the underlying soils, with increased risk of erosion.
- 10.121 In the absence of mitigation, the magnitude of change is potentially high, on a high sensitivity receptor. Therefore, there is potential for a direct, temporary, medium-term effect of **major adverse** significance prior to the implementation of mitigation measures.

Changes to Groundwater Flow

- 10.122 As discussed in Section 10.5, there is anticipated to be little groundwater at shallow depth beneath the site. It is considered that any shallow groundwater will be limited to perched groundwater within peat deposits, and localised areas of till / alluvium containing higher proportions of sand and gravel content. Groundwater within the bedrock is anticipated to be minimal, with flow restricted to fissures and other discontinuities.
- 10.123 Excavations will be required to form turbine foundations and borrow pit workings, and shallower excavations will be required to form platforms for the substation and the temporary construction compounds. However, given the anticipated absence of substantial groundwater within the superficial deposits, any changes to groundwater flow would be highly localised.
- 10.124 There is therefore a potential low magnitude impact on a low sensitivity receptor, resulting in a direct, temporary, short-term effect of **negligible adverse** significance in the absence of mitigation.

Removal of and Impact on Peat

- 10.125 Variable thicknesses of peat have been identified across the site. Extensive design iteration work has been undertaken, seeking to avoid siting infrastructure on areas of deep peat wherever possible, while taking account of other environmental and physical constraints (refer to Chapter 4: Design Evolution). This has resulted in the following:
- Four (T1, T9, T12 and T13) of the 13 turbines are sited on 'peaty soil' rather than peat, i.e. average peat depth less than 0.5 m thick.
 - Five (T2, T3, T8, T10 and T11) of the 13 turbines are sited on peat recorded at depths between 0.5 m and 1.0 m, therefore defined as peat, but not deep peat.
 - Four (T4, T5, T6 and T7) of the 13 turbines are sited on deep peat, with the average thickness recorded at 1.58 m. Following detailed pre-construction site investigations,

there may be an opportunity to micro-site the turbines in order to reduce the volume of peat requiring excavation.

- All other infrastructure elements (compounds, substation and borrow pit search areas) are sited on areas with peat depth less than 1.0 m.
- All proposed new track sections are sited on areas with peat depth less than 1.0 m except for some sections in the west and a short section in the centre, although care has been made to avoid peat depths greater than 2.0m, particularly between T5 and T7. The requirement for peat excavation at these locations will be minimised where possible (e.g. by constructing sections of floating road).

10.126 It is clear that there will be a requirement for excavation of some peat to allow construction of turbine foundations, hardstandings, new track, and other infrastructure elements. Further detail on the estimated volume of peat to be excavated, and the management of excavated peat, is given in Appendix 10.2.

10.127 In the absence of mitigation, there is a potential medium magnitude impact on a medium sensitivity receptor, resulting in a direct, permanent effect of **moderate adverse** significance.

Peat Landslide Impact on Watercourses

10.128 Construction on peat soils, and associated activities including localised removal of forestry, can result in destabilisation of peat deposits on slopes and lead to slope failure, with subsequent potential for peat and soils to reach watercourses downslope and cause pollution/sedimentation and changes to fluvial geomorphology. A detailed assessment of peat landslide risk has been undertaken as presented in Appendix 10.3. This has identified low peat landslide risk at all proposed turbine, hardstanding and other infrastructure locations.

10.129 It should be noted that proposed turbines and hardstandings would not be constructed on peat, rather any peat within the footprints of turbines and hardstandings would be excavated to allow construction on a suitable founding stratum (i.e. bedrock).

10.130 In the absence of mitigation, the overall potential magnitude of impact from peat landslide resulting from construction activities at the site is assessed as low, on a high sensitivity receptor, resulting in a direct, temporary, short-term effect of **moderate adverse** significance.

Impact on the Integrity of Banking

10.131 Construction activities on or close to the sides of watercourses can detrimentally affect the structural integrity of burn banks, either through direct damage to bankside material or indirect loosening of soil structure thus impacting on the localised morphology and water quality of the watercourse through erosion or even collapse of the banking.

10.132 Permanent new watercourse crossings will be required at eight locations, with one additional existing watercourse crossing requiring upgrading. Subject to detailed pre-construction site investigation works, it is anticipated that these new and upgraded crossings will comprise installation of pipe culverts at all except two, which will comprise a

bottomless arch culvert. Further details are provided in Appendix 10.1 Watercourse Crossing Schedule.

- 10.133 There is potential for a high magnitude impact on high sensitivity receptors, therefore, there is potential for a direct, permanent effect of **major adverse** significance prior to the implementation of mitigation measures.

Direct Discharge of Untreated Foul Drainage

- 10.134 Unless appropriately sited and managed, there is potential for direct discharge of untreated foul sewage from welfare facilities from site compounds during construction.
- 10.135 The magnitude of change, prior to mitigation, is low, on a high sensitivity receptor. Therefore, there is likely to be a direct, temporary, medium-term effect of **moderate adverse** significance on watercourses prior to the implementation of mitigation measures.

Operational Effects

Surface Water Drainage

- 10.136 The access track and crane hardstandings for the wind turbines, and any un-restored areas of felling and borrow pit excavations, could result in an increased rate of surface water run-off from the site, increasing downstream flood risk and potentially resulting in soil erosion and silt-laden run-off, which could pollute watercourses, ditches and ponds.
- 10.137 The magnitude of change, prior to mitigation, is high, on a high sensitivity receptor. Therefore, there is potential for a direct, long-term effect of **major adverse** significance prior to the implementation of mitigation measures.

Fluvial Geomorphology

- 10.138 If watercourse crossings are not designed properly to ensure continuous flows, this could potentially adversely affect the geomorphology of the streams by reducing heterogeneity.
- 10.139 The magnitude of change, prior to mitigation, is medium, on a high sensitivity receptor. Therefore, there is potential for a direct, permanent effect of **major adverse** significance prior to the implementation of mitigation measures.

Decommissioning Effects

- 10.140 Potential effects of decommissioning the Proposed Development are similar to those encountered in the construction phase, however, generally with less magnitude as the level of site activity is lower.
- 10.141 Discussions will be held with Argyll and Bute Council and the appropriate Regulatory Authorities prior to decommissioning to agree an appropriate Decommissioning Strategy.

10.7 Mitigation Measures and Monitoring

Project Design

10.142 The following considerations have been taken into account in the iterative design of the proposed development (note that full details of the project design are provided in Chapter 3: Project Description):

- Existing tracks have been incorporated into the site design as far as possible and where slope gradients will allow, minimising the requirement for new road construction. It has resulted in nine new water crossings and one upgraded water crossing being required, with the other water crossings being existing, with no substantial upgrading works considered to be required.
- A 50 m buffer has been maintained around all surface watercourses, except where watercourse crossings are required.

10.143 Rigorous construction environmental management procedures will be implemented in line with a Construction Environmental Management Plan (CEMP) (see below) to ensure appropriate protection of the above-noted watercourses, and all other surface water receptors.

10.144 Areas of deep peat have been avoided in the siting of all except four turbines / hardstanding areas (T4, T5, T6 and T7), some sections of new access track situated in the west of the site and a short section in the centre, although care has been made to avoid peat depths greater than 2.0m, particularly between T5 and T7.

10.145 No infrastructure is proposed to be constructed in or near areas of medium or high peat landslide risk. Further detailed investigation will be undertaken pre-construction (see below), to clarify the risks and confirm mitigation or micro-siting to address any risks higher than negligible, as appropriate.

Pre-Construction Site Investigations

10.146 To determine ground and groundwater conditions across the site, pre-construction site investigations will be conducted. These investigations will focus on areas where construction is proposed to be undertaken and will allow the turbines and the associated infrastructure to be micro-sited away from any areas considered to be unsuitable, such as areas of contamination (unlikely), areas of deeper peat wherever possible, or where there are significant groundwater flows.

10.147 The investigations will also include targeted monitoring and assessment of the groundwater levels and flows beneath the site. This will allow for micro-siting and to assist in the detailed design of infrastructure and selection of appropriate materials for use during the construction process. Investigations within the borrow pit search areas will allow appropriate selection of specific extraction areas, to avoid or minimise any adverse effects associated with quarrying activities.

Construction

Peat

- 10.148 The pre-construction site investigations noted above, and observations during construction, will inform micro-siting, if required and appropriate, to minimise peat slide risk and the volume of peat to be extracted as far as possible.
- 10.149 The borrow pit search areas represent relatively broad zones, within which only a proportion will actually be excavated to win stone for the site's construction. No excavation will occur until further site investigations have been undertaken to assess the suitability of the areas and refine the assessment of peat slide risk. For example, areas of deeper peat, if found to be present within the search areas would be avoided, thereby reducing the peat slide risk. If it is determined that no suitable excavation site within any given search area can be identified, then no excavation will occur at that search area.
- 10.150 If it is not possible to avoid routing tracks over localised areas of deep peat, as is the case for stretches of track that are proposed to be constructed in the western part of the site between T5 and T7, these would be floated to avoid the requirement for excavation of peat. This would involve placing of a geotextile membrane on existing topsoil and vegetation followed by aggregate layers. Floating roads would be designed to ensure suitability for site traffic during construction and operation.
- 10.151 Any peat excavated will be re-used on site as set out in the Outline Peat Management Plan (Technical Appendix 10.2).
- 10.152 Peatland restoration is proposed to be undertaken in two locations. Firstly, it is proposed within an area comprising actively eroding peat hags, which is located at the top of 'The Slate' in the north-western corner of the developable area. Secondly, a forestry to bog restoration area of approximately 30.96ha is proposed to the south of turbine 2. Habitat management measures including removal of self-seeded Sitka spruce, the blocking of gullies / drains using residual forestry materials and/or excavated peat from elsewhere on the site to raise the water table and promote restoration of bog habitats and reprofiling / revegetation of the peat hags are proposed to be undertaken. Further detail is provided in the updated Technical Appendix 8.5: Outline Habitat Management Plan, dated 13th November 2024.

Water Quality

- 10.153 The appointed Contractor will undertake pre-construction baseline water quality sampling and analysis of the principal surface water receptors Lecknacreive Burn, Breackerie Water and Homeston Burn and their key tributaries. The Contractor will implement a programme of monthly monitoring and analysis of the water quality of these watercourses during the construction period to ensure that they are not being impacted by the construction works. The full scope of monitoring will be detailed within the CEMP.

Pollution Impact from Sediment Run-off / Transport and / or Chemical Contaminated Run-off

- 10.154 With specific reference to the SEPA 'Guidelines for Water Pollution Prevention from Civil Engineering Contracts' and 'Special Requirements', the Contractor will produce a CEMP prior to the commencement of construction activities 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 water environment receptors that may be affected by the works and temporary discharge points to these watercourses;
 - Planning and design of appropriate pollution control measures during felling, earthworks and construction;
 - Management of the pollution control system, including dewatering of excavations (if required) away from watercourses;
 - Contingency planning and emergency procedures; and
 - On-going monitoring of construction procedures to ensure management of risk is maintained.
- 10.155 All earthmoving works or similar operations will be carried out in accordance with BSI Code of Practice for Earth Works BS6031:1981.
- 10.156 All watercourse crossings and site discharges will be regulated under the CAR licensing regime and all necessary licences will be sought from SEPA prior to the commencement of any operations on site.
- 10.157 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, given the location of the proposed development site, 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 or suspend sensitive operations during adverse weather conditions.
- 10.158 All fuel and other chemicals will be stored in accordance with best practice procedures, including being kept within a designated fuelling site located at a safe distance from existing watercourses and in appropriate impermeable bunded containers/areas, which will be defined within the outline 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 bunded area.
- 10.159 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.

- 10.160 Construction vehicles and plant will be regularly maintained and all maintenance, fuelling and vehicle washing will be undertaken on appropriate impermeable surfaces away from watercourses to minimise risks of leaks to soil and surface waters.
- 10.161 Concrete batching will be undertaken in a designated area within a temporary construction compound. The Contractor will develop a method statement to address the on-site batching of concrete and the transport, transfer, handling and pouring of liquid concrete at foundations. It is likely that water will require to be abstracted to facilitate any on-site batching processes. A separate CAR licence application for any water abstractions required will be made to SEPA at the appropriate point prior to the commencement of construction.
- 10.162 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 watercourses and water bodies.
- 10.163 Any 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 to drains or watercourses on site or at compounds. Drainage from washout facilities will be collected and treated or removed to an appropriate treatment point / licensed disposal site.
- 10.164 Where topography dictates that working platforms are needed, these will be formed to ensure that surface water drains away from watercourses.
- 10.165 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.

Pollution Impact from Forestry Felling

- 10.166 Felling works will be undertaken in accordance with standard forestry best practices. This includes appropriate buffering of watercourses and management of riparian zone vegetation, implementation of a suitable drainage plan, keeping watercourses and buffer areas clear of brash as far as practicable, removing any accidental blockages, and employing methods to minimise soil damage and subsequent erosion. Further information on forestry management is provided in Chapter 14: Forestry.

Impact on Integrity of Banking

- 10.167 During the construction phase, construction staff will be instructed to maintain a sufficient distance from the watercourses located on site in order to ensure there is no incursion towards the burn.
- 10.168 Where the proposed bottomless arch culvert crossings are proposed to be constructed (NWC1 and NWC5), the design will follow best practice to prevent impact on the integrity of the banking of watercourses. Detailed design will be included within a Construction Method Statement to be agreed with Argyll and Bute Council and SEPA and detailed watercourse crossing designs will be regulated under the CAR licensing regime.

Direct Discharge of Untreated Foul Drainage

- 10.169 Welfare facilities will either connect directly to self-contained storage tanks or to a septic tank, subject to approval from SEPA.
- 10.170 If self-contained or septic tanks are to be used, these will be maintained and emptied on a regular basis by a suitably licensed contractor.

Operation

Surface Water Drainage

- 10.171 The proposed track and hardstanding design principles for the Proposed Development are presented in Chapter 3: Project Description.
- 10.172 Prior to construction, a detailed Drainage Strategy (DS) will be developed and agreed with SEPA and Argyll and Bute Council. The DS will detail the site drainage design, including the type of surface to be used for new access tracks, 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 run-off from hard surfaces will be controlled. The DS will also detail the dimensions and final design of proposed watercourse crossings which will be designed to maintain continuous flows.

Fluvial Geomorphology

- 10.173 The detailed design for the watercourse crossings, and the requirements for CAR authorisations or licences, will be agreed with SEPA prior to construction in order to ensure that any potential impacts are minimised.

Decommissioning

- 10.174 Potential effects of decommissioning the Proposed Development are similar to those encountered in the construction phase, however, generally with less magnitude as the level of site activity is lower.

10.8 Residual Effects

Construction

Pollution Impact from Sediment Run-off / Transport and / or Chemical Contaminated Run-off

- 10.175 The committed mitigation measures, including buffering of watercourses, implementation of a suitable CEMP and a surface water monitoring programme during construction, are considered to reduce the magnitude of impact to negligible, resulting in a direct, temporary, short-term residual effect of **minor adverse** significance.

Pollution Impact from Forestry Felling

- 10.176 The committed mitigation measures, including implementation of a suitable CEMP, following best practice felling practices, and a surface water monitoring programme during construction, are considered to reduce the magnitude of impact to negligible resulting in a direct, temporary, medium-term residual effect of **minor adverse** significance.

Changes to Groundwater Flow

- 10.177 The committed mitigation measures, including pre-construction site investigations to inform detailed foundation and infrastructure design and micro-siting, are considered to reduce the magnitude of impact to negligible, resulting in a direct, temporary, short-term residual effect of **negligible** significance.

Removal of and Impact on Peat

- 10.178 The committed mitigation measures, including design iteration to avoid deep peat wherever possible (and floating tracks where not possible to avoid), implementation of a Peat Management Plan, and Habitat Management Plan to restore peatland habitat, are considered to reduce the magnitude of impact to low, resulting in a direct, permanent residual effect of **minor adverse** significance.

Peat Landslide Impact on Watercourses

- 10.179 The committed mitigation measures, including pre-construction site investigations to inform detailed infrastructure design, micro-siting and appropriate geotechnical controls, are considered to reduce the magnitude of impact to negligible, resulting in a direct, temporary, short-term residual effect of **minor adverse** significance.

Impact on the Integrity of Banking

- 10.180 The committed mitigation measures, including appropriate water crossing designs regulated by CAR and agreed with SEPA and Argyll and Bute Council, and the implementation of a suitable CEMP, are considered to reduce the magnitude of impact to negligible, resulting in a direct, permanent residual effect of **minor adverse** significance.

Direct Discharge of Untreated Foul Drainage

- 10.181 The committed mitigation measures, including appropriate management of foul drainage to be agreed with SEPA, are considered to reduce the magnitude of impact to negligible, resulting in a direct, temporary, medium-term residual effect of **minor adverse** significance.

Operation

Surface Water Drainage

- 10.182 The committed mitigation measures, including implementing a suitable detailed Drainage Strategy in agreement with SEPA and Argyll and Bute Council, are considered to reduce the magnitude of impact to negligible, resulting in a direct, long-term effect of **minor adverse** significance.

Fluvial Geomorphology

- 10.183 The committed mitigation measures, including appropriate water crossing designs regulated by CAR and agreed with SEPA and Argyll and Bute Council, are considered to reduce the magnitude of impact to negligible, resulting in a direct, permanent residual effect of **minor adverse** significance.

Decommissioning

- 10.184 Residual effects of decommissioning the Proposed Development are similar to those encountered in the construction phase, however, generally with less magnitude as the level of site activity is lower.

10.9 Cumulative Effects

- 10.185 This assessment has concluded that there will be no significant effects on geological resources associated with the proposed development. As such, no significant cumulative effects on geological resources associated with the proposed development, in combination with other similar local developments currently operational, consented or in planning, are predicted.
- 10.186 In terms of hydrology and hydrogeology, no operational and / or proposed wind energy projects are located within the catchments of the watercourses that flow through or in proximity to the proposed development area. As such, it is considered that the combined effect on hydrology will be minor and no additional mitigation measures over and above those committed to in this chapter are considered necessary to address potential cumulative effects on hydrology or hydrogeology.

10.10 Summary

- 10.187 Eastern and central parts of the proposed development area, in which most of the site infrastructure is proposed to be located, is situated within the Breackerie Water catchment. Site drainage from these areas reach Breackerie Water via the Lecknacreeve Burn, which itself receives drainage from the other on-site and adjacent watercourses, including Allt Brandon, Allt a'Ghilleann Duibh, Allt Seilich, Allt Airighe Glaise, Allt na h-Earba, Allt Criche and Allt Mor. The far western part of the Proposed Development area, which includes the existing main access track, is located within the Connieglen Water catchment. Site drainage from this area reaches Connieglen Water via Homestone Burn and an unnamed tributary that flows along Achnabrad Glen, located on the site's north-eastern boundary. Both Breackerie Water and Connieglen Water are classified by SEPA as having good water quality.
- 10.188 The rock beneath the site is typically metamorphic with localised igneous intrusions, forming a low productivity aquifer. Superficial deposits largely comprise peat and till (typically low permeability), with an area of alluvial deposits located in the vicinity of Homeston Burn, in the far eastern part of the site.
- 10.189 Detailed peat surveys identified variable thicknesses of peat across the site, with approximately 51% of probes recording peaty or organo-mineral soils (peat depth <0.5 m)

rather than peat. Localised deep peat (>1 m) was identified with the thickest peat deposits recorded in the western part of the site (maximum peat thickness 5.0m).

- 10.190 Extensive design iteration works were undertaken to avoid siting turbines or other infrastructure on deep peat wherever possible. This has resulted in areas of deep peat being avoided in the siting of all except four turbines / hardstanding areas (T4, T5, T6 and T7), some sections of new access track situated in the west of the site and a short section in the centre, although care has been made to avoid peat depths greater than 2.0m, particularly between T5 and T7.
- 10.191 A peat slide risk assessment has identified low risks at all turbine and other infrastructure locations.
- 10.192 Potential construction and operational effects include changes to the groundwater flow regime, the risk of pollution of watercourses resulting in adverse effects on water quality, excavation of peat, peat slide risk, and effects on the integrity of watercourse banks.
- 10.193 The mitigation measures set out in this chapter will be drawn together into a Construction Environmental Management Plan prior to the commencement of construction activities. These mitigation measures are considered to be robust and implementable and will reduce the potential impacts on peat resources and watercourses which have been identified as medium to high - negligible. As such, the significance of residual effects on geology, surface water and groundwater, following the implementation of these mitigation measures, is considered to be **minor** or **negligible** and therefore **not significant**. Potential effects, mitigation measures and residual effects are summarised in Tables 10.6 and 10.7.

Table 10.6: Construction Summary Table

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial / Adverse		Significance	Beneficial / Adverse
Pollution from sediment run-off and/or chemical contaminated run-off	Major	Adverse	50 m buffer around watercourses wherever possible. Water quality monitoring. CEMP and construction site management.	Minor	Adverse
Pollution from forestry felling	Major	Adverse	Key-hole felling and re-planting. Felling works in accordance with standard good forestry practice. Buffering of watercourses, management of riparian zone vegetation, drainage plan, brash control in watercourses and buffer areas, removing any accidental blockages, minimising soil damage.	Minor	Adverse
Changes to groundwater flow regime	Negligible	Adverse	Pre-construction site investigation. CEMP and construction site management.	Negligible	Adverse
Removal of and impact on peat	Moderate	Adverse	Pre-construction site investigation. Avoidance of deep peat for borrow pit excavations. Micro-siting infrastructure where required and appropriate, if unexpected deeper peat is identified. Implementation of Peat Management Plan. Implementation of Habitat Management Plan.	Minor	Adverse
Peat landslide impact on watercourses	Moderate	Adverse	Pre-construction site investigation to inform detailed design and geotechnical control measures.	Minor	Adverse

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial / Adverse		Significance	Beneficial / Adverse
			Avoidance of peat for borrow pit excavations. Micro-siting infrastructure where required and appropriate.		
Loss of bank integrity	Major	Adverse	Suitable water crossing design, regulated by CAR. CEMP and construction site management.	Minor	Adverse
Pollution from foul drainage	Moderate	Adverse	50 m buffer around watercourses wherever possible. Water quality monitoring. CEMP and construction site management. Suitable foul drainage management in agreement with SEPA.	Minor	Adverse

Table 10.7: Operation Summary Table

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial / Adverse		Significance	Beneficial / Adverse
Surface water drainage including downstream flood risk	Major	Adverse	50 m buffer around watercourses wherever possible. Detailed Drainage Strategy to be developed and agreed with SEPA and Argyll and Bute Council. To detail drainage design to slow surface water flows	Minor	Adverse

			and ensure that run-off from hard surfaces will be controlled. Appropriate design of water crossings to maintain continuous flows.		
Alteration to fluvial geomorphology	Moderate	Adverse	Appropriately designed drainage and watercourse crossings.	Minor	Adverse

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