10 Geology, Peat, Hydrology, Hydrogeology

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10 Geology, Peat, Hydrology and Hydrogeology

10.1 Executive Summary

10.1.1 This chapter assesses the potential impacts of the Proposed Development on geology, peat, hydrology and hydrogeology resources. This includes detailed consideration of potential impacts on surface watercourses, groundwater and the local geology in and around the site and any potential impacts on flood risk in the local area. Potential impacts on peat deposits, and risks associated with peat slide, are also assessed.

10.1.2 A combination of desk study and field survey work was undertaken to identify and characterise the geological, hydrological and hydrogeological receptors which could be subject to impacts from construction, operation and decommissioning of the Proposed Development. Field survey work included a peat depth survey, watercourse crossing survey and National Vegetation Classification (NVC) survey to identify potential groundwater dependent terrestrial ecosystems (GWDTE). This has also been expanded upon through consultation, as part of the EIA process for the Proposed Development.

10.1.3 Surface water drainage from the site flows into local watercourses including the Skelmorlie Water and the Noddsdale Water, which themselves flow westward, ultimately draining into the Firth of Clyde.

10.1.4 24 new water crossings will be required, where access tracks will need to traverse watercourses. One existing watercourse crossing will need to be upgraded.

10.1.5 The site is mainly underlain by the Kelly Burn Sandstone Formation and is overlain by diamicton till, with the exception of the north-north-eastern section of the site where the bedrock is exposed.

10.1.6 Some localised pockets of peat are recorded on published geological mapping and a peat depth survey has identified minimal peat (all instances at a depth of less than 1 m) across the Proposed Development area, with the majority of probes (96.5 %) identifying either peaty soils or no peat. A Peat Slide Hazard and Risk Assessment (PSHRA) has been completed alongside the peat survey work and is presented in Appendix 10.2.

10.1.7 Potential construction, operational and decommissioning effects arising from the Proposed Development (in the absence of mitigation) include changes to groundwater flow; removal of, and impact on, peat; pollution impact from silt-laden runoff and chemical contaminated runoff; impact from soil compaction; impact on integrity of banking; direct discharge of untreated foul drainage;; impact on fluvial geomorphology; impact on fluvial flood risk on-site and downstream; and impact on surface water drainage.

10.1.8 Standard mitigation measures to avoid or reduce potential impacts include infrastructure design to minimise impacts on geology and hydrology; following best practice procedures as outlined in a Construction Environmental Management Plan (CEMP); implementing an Outline Peat Management Plan (PMP), to be developed into a Detailed PMP; and implementing a Water Quality Monitoring Programme.

10.1.9 Following implementation of standard and additional mitigation measures, the significance of residual effects on geological, hydrological and hydrogeological receptors is considered to be **negligible** or **minor** and therefore not significant. No cumulative effects are anticipated due to a lack of cumulative wind farm developments in the study area.

10.2 Introduction

10.2.1 This chapter outlines the potential geological, hydrological and hydrogeological effects of the Proposed Development and an assessment is provided based on the sensitivity of the receptor and the magnitude of the impact, giving the significance of the effect. Where appropriate, standard and additional mitigation measures to enhance, prevent, minimise or control identified effects are presented. These include both design mitigation (such as the avoidance of areas of deeper peat or

sensitive watercourses where possible), construction mitigation (such as implementation of a CEMP, correct management of excavated peat and protection of banking) and operation mitigation (such as appropriate drainage design and maintenance). Following the implementation of the mitigation measures there are no significant adverse effects on geological, hydrological or hydrogeological receptors.

10.2.2 The assessment identifies the potential effects of the Proposed Development and assesses the significance of these effects based on the magnitude of the impacts and the sensitivity of the receptors. Effects are assessed based on the risk of sedimentation and erosion; pollution; alteration of natural drainage patterns, runoff volumes and rates; flood risk; and alteration of the geological environment through the dewatering, disturbance and excavation of peat. Mitigation, management and monitoring measures are then discussed and the residual effects relevant to geology, hydrology and hydrogeology determined.

10.2.3 Further detail on the infrastructure of the Proposed Development is provided in Chapter 3 of this EIA Report and information regarding the consideration given to geological and hydrological receptors during the iterative design process of the Proposed Development is given in Chapter 2 of this EIA Report.

10.3 Legislation, Policy and Guidelines

10.3.1 In regard to hydrology, management of water-borne pollution, and protection of natural heritage areas, the Scottish Environment Protection Agency (SEPA) have 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 phases of the site development.

Legislation

10.3.2 There is a range of environmental legislation that the Proposed Development must adhere to throughout the development life cycle. Relevant legislation and guidance documents have been reviewed and taken into account as part of this geological, hydrological and hydrogeological assessment.

10.3.3 Regulation of activities relating to the water environment in Scotland is the responsibility of the SEPA and the relevant local authorities.

10.3.4 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.

10.3.5 The European Commission (EC) Groundwater Directive provides specific measures to protect groundwater against pollution and deterioration. This Directive is implemented in Scotland 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.

10.3.6 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 River Basin Management Plan for the Scotland River Basin District: 2015 - 2027 (Scottish Government, 2015) provides updated improvement objectives for water bodies and protected areas for the period 2015 to 2027. The classification system covers all rivers, lochs, and transitional, coastal and groundwater bodies.

10.3.7 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).

10.3.8 The key legislative drivers relating to the water environment which have been considered within this assessment are listed below:

- Control of Pollution Act 1974 (UK Government,1974);
- The Pollution Prevention and Control (Scotland) Regulations 2012;
- Environmental Protection Act 1990 (amended Scotland 2001);
- Environment Act 1995 (UK Government, 1995);
- Water Framework Directive 2000/60/EC (WFD) 2000;
- Groundwater Daughter Directive 2006/118/EC;
- Water Environment and Water Services (Scotland) Act (WEWS Act) 2003;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended in 2018 (CAR));
- The Environmental Liability (Scotland) Regulations 2009;
- The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017 (amends and revokes the Private Water Supplies (Scotland) Regulations 2006);
- The Public Water Supplies (Scotland) Amendment Regulations 2017 (amends the Public Water Supplies (Scotland) Regulations 2014;
- The Flood Risk Management (Scotland) Act 2009;
- The Waste Management Licensing (Scotland) Regulations 2011; and
- Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017.

Planning Policy

10.3.9 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, using the carbon calculator.

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).

10.3.10 The following Planning Advice Notes are also relevant to the assessments made in this chapter:

- Planning Advice Note (PAN) 61: Planning and SUDS, 2001;
- Planning Advice Note (PAN) 50: Controlling the Environmental Effects of Surface Mineral Workings, (Scottish Government, 1996); and
- Planning Advice Note (PAN) 79: Water and Drainage, 2006.

10.3.11 The North Ayrshire Council (NAC) Local Development Plan 2 (LDP2) (NAC, 2019) identifies considerations relevant to onshore wind developments, as well as Nationally Designated Sites related to hydrology and peat. These include:

- Policy 16: Protection of our Designated Sites;
- Policy 22: Water Environment Quality;
- Policy 23: Flood Risk Management;
- Policy 29: Energy Infrastructure Development; and
- Policy 34: Protecting Peatland and Carbon Rich Soils.

Guidance

10.3.12 A review plan for the Pollution Prevention Guidelines (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.

10.3.13 The PPGs and the 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 wind farm 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);
- GPP4: Treatment and disposal of sewage where no foul sewer is available (EA, SEPA & EHSNI, November 2017);
- GPP5: Works and maintenance in or near water (EA, SEPA & EHSNI, January 2017);
- PPG6: Working at construction and demolition sites (EA, SEPA & EHSNI, 2012);
- GPP8: Safe storage and disposal of used oils (EA, SEPA & EHSNI, July 2017);
- GPP21: Pollution incidence response planning (EA, SEPA & EHSNI, 2017); and
- GPP26: Safe storage of Drums and Intermediate Bulk Containers (IBCs) (NIEA, SEPA, NRW, 2018).

10.3.14 The following SEPA Guidelines are also relevant:

- SEPA Guidance Note 31: Guidance on assessing the impacts of development proposals on groundwater abstractions and Groundwater Dependent Terrestrial Ecosystems (SEPA, 2017);
- Indicative River and Coastal Flood Map (Scotland) (SEPA January 2014, updated April 2018);
- Regulatory Position Statement: Waste Water Drainage (SEPA, 2008);
- Regulatory Position Statement – Developments on peat (SEPA, 2010);
- Temporary Construction Methods, WAT-SG-29 (SEPA, 2009);
- Sector Specific Guidance: Construction Sites WAT-SG-75 (SEPA, 2018);
- 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);

- Environmental Standards for River Morphology, WAT-SG-21 (SEPA, July 2012);
- 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);
- Methodology for the Water Framework Directive, Scotland and Northern Ireland Forum for Environmental Research, Project WFD 28 Final Report (SNIFFER, 2004);
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 as amended in 2018 - A practical guide (SEPA, 2011 as amended in 2019);
- The River Basin Planning Strategy for the Scotland River Basin District (SEPA, 2009/2015);
- Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and Minimisation of Waste (SEPA & Scottish Renewables, 2012); and
- Developments on Peat and Off-Site Uses of Waste Peat (SEPA, 2017).

10.3.15 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);
- Control of water pollution from linear construction projects: technical guidance C648 (CIRIA, 2006);
- SUDS Manual C753 (CIRIA, 2015);
- Groundwater Control – design and practice C515 (CIRIA, 2016);
- 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);
- Adapting to climate change: UK Climate Projections (DEFRA, 2009);
- Guidance on Road Construction and Maintenance Forests and Water Guidelines Fifth Edition (Forestry Commission, 2011);
- A Handbook of Environmental Impact Assessment, 5th Edition (SNH, 2018);
- Design Guidance on River Crossings and Migratory Fish, Scottish Executive, 2012;
- NAC LDP2 2019 – NAC;
- Peatland Survey. Guidance on Developments on Peatland. Scottish Government, Scottish Natural Heritage, (SEPA 2017);
- Peat Landslide Hazard and Risk Assessments: Good practice Guide for Proposed Electricity Generation Developments, Scottish Government, Second Edition, 2017;

- Private Water Supplies: Technical Manual, Scottish Executive, 2006;
- Special Requirements for Civil Engineering Contracts for the Prevention of Pollution, Version 2, (SEPA, 2006);
- UK Technical Advisory Group on the WFD, UK Environmental Standards and Conditions Final Report, November 2013; and
- SNH Carbon and Peatland Map (2016).

10.4 Consultation

10.4.1 The following consultation responses (Table 10.1) were received as a Scoping Opinion for the Proposed Development. Those consulted who provided responses relevant to this Chapter include NAC and SEPA.

Table 10.1 - Consultations in Relation to Hydrology, Hydrogeology, Geology and Peat

Consultee	Consultation Response	Key Actions
SEPA, 26 August 2019	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 proposed buffers, details of any flood risk assessment and details of any related CAR applications.	A site layout plan, including all relevant buffer zones, has been generated (refer to Figure 10.1). Flood risk within the site area has been assessed in Section 10.6.
	b) Map and assessment of impacts upon Groundwater Dependent Terrestrial Ecosystems (GWDTE) and buffers.	A map of potential GWDTE identified through the NVC survey, undertaken as part of the assessment outlined in Chapter 7 of the EIA Report, has been generated (refer to Figure 10.5).
	c) Map and assessment of impacts upon groundwater abstractions and buffers.	A map of the identified groundwater abstractions has been provided (refer to Figure 10.6) and an assessment of the impact of the Proposed Development upon them in Section 10.6.
	d) Peat depth survey and table detailing re-use proposals.	Several peat depth surveys and their outcome are detailed in Section 10.6. An Outline PMP has been provided (Appendix

Consultee	Consultation Response	Key Actions
		10.1) which outlines peat re-use proposals.
	e) Map and table detailing forest removal, if required.	No forest removal is proposed.
	f) Map and site layout of borrow pits.	The layout of the potential borrow pit is detailed in Figure 1.2.
	g) Schedule of mitigation including pollution prevention measures.	Chapter 17 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.
	h) Borrow Pit Site Management Plan of pollution prevention measures.	A Borrow Pit Site Management Plan has been provided in Appendix 3.2.
	i) Map of proposed waste water drainage layout.	There will be no foul or waste water drainage on site.
	j) Map of proposed surface water drainage layout.	Outline drainage arrangements are discussed in Chapter 3 and Section 10.8 and is provided in the Outline Drainage Strategy (Appendix 3.1).
	k) 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.

Consultee	Consultation Response	Key Actions
	l) Decommissioning statement.	Refer to Chapter 3 of this EIA Report for a statement on decommissioning. The environmental effects of decommissioning are considered to be no greater than the construction effects but experienced over a much shorter time period. Decommissioning would be undertaken in line with best practice processes and methods current at the time and will be managed through an agreed Decommissioning Environmental Management Plan with the appropriate authorities.
	The EIA Report must include a comprehensive site-specific Outline Peat Management Plan. Furthermore, detailed information on flood risk is not required if all watercourse crossings are designed to accommodate a 1 in 200 year flood event and if other infrastructure is located well away from watercourses.	An Outline PMP has been provided (Appendix 10.1). All watercourse crossings will be designed to accommodate a 1 in 200 year flood event.

Consultee	Consultation Response	Key Actions
NAC, 17 September 2019	NAC advises that the following key issues need to be addressed in the EIA process The EIA Report should provide an assessment of all engineering activities in, or impacting on, the water environment. This must include proposed buffers, details of any flood risk assessment and details of any related Controlled Activities Regulations (CAR) applications. There must also be an assessment and mapping of impacts upon Groundwater Dependent Terrestrial Ecosystems, groundwater abstractions, and buffers. The provided maps should include information regarding borrow pits, forest removal, proposed waste water drainage, surface water drainage layouts, and proposed water abstractions. Further details should be provided regarding the proposed operating regime, a decommissioning statement, and a schedule of mitigation including pollution prevention measures and a Borrow Pit Site Management Plan. A comprehensive Outline Peat Management Plan including a peat depth survey and information regarding its re-use should be provided. Confirmation should be provided that all watercourse crossings are designed to accommodate a 1 in 200 year flooding event and that other infrastructure is located well away from watercourses.	Refer to this chapter and the key actions given in response to SEPA comments above.

10.5 Assessment Methodology and Significance Criteria

10.5.1 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.

Impact Assessment Methodology

10.5.2 The assessment has been undertaken primarily using a qualitative assessment based on professional judgement and statutory and general guidance, but also a quantitative assessment using site specific data in terms of peat depth. It incorporates:

- a review of relevant legislation, guidelines and policy;
- a desk study to identify any existing information;
- site visits to confirm information obtained through the desk study and to define site characteristics, such as surface water catchments, the drainage network, watercourse crossing locations and the extent of peat land habitat;

- a review of the ecological information and mapping undertaken by ITPE ecologists;
- definition of the likely effects of the project on the geological, hydrological and hydrogeological environment;
- assessment of the likely significance (as described in the EIA regulations) of those effects based on the sensitivity of the receiving environment and the likely magnitude of the impact;
- discussion of the proposed mitigation measures to reduce or remove any significant effect;
- determination of the residual effects of the development subsequent to the implementation of the committed mitigation measures; and
- any cumulative effects.

Study Area

10.5.3 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 proposed turbines and other infrastructure (see Figure 10.1).

10.5.4 Efforts have been made, via consulting the Drinking Water Quality Regulator for Scotland (DWQRS) Private Water Supply (PWS) map, to identify any PWS within 500 m of the Proposed Development boundary.

10.5.5 The criteria for defining the study area have been established based on professional judgement and experience of the technical authors with regard to likely access and working areas, consultation with SEPA and with due consideration to the relevant guidance on hydrological and geological assessment.

Desk Study

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

- consultation with SEPA as described in Table 10.1 above;
- SNH Carbon and Peatland Map (2016);
- identification of the locations and characteristics of catchments and principal watercourses and waterbodies as shown on 1:50,000 scale OS mapping (Figure 10.1) 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 and climate;
- review of James Hutton Institute 1:25,000 Soil Map of Scotland;
- review of online British Geological Survey (BGS) geological mapping of the area;
- review of hydrogeological characteristics and groundwater resource; and
- review of Private Water Supply records held by DWQRS.

Site Visit

10.5.7 Peat survey work has been undertaken by members of the ITPEnergised Environmental Planning team. Data obtained from the peat depth surveys were used to plot the presence and distribution of peat across the proposed infrastructure development areas at the site, create a contour plan, and feed into detailed design iteration.

10.5.8 Stage 1 peat depth probing was undertaken by a team of surveyors during 2013. The surveys were undertaken with the aim to supplement available peat depth data from the SNH Carbon and

Peatland Map (2016) and entailed a low-resolution site survey to provide a 100 m x 200 m grid of peat probe depth data.

10.5.9 A Stage 2 peat depth probing exercise and site survey was subsequently undertaken on 12th - 13th November 2019 and 14th January 2020. This included a visual inspection of watercourses within or in the close vicinity of the Proposed Development and where crossings are proposed; a visual assessment of gradients and drainage pathways across the site; an assessment of potential PWS on site; peat probing at proposed infrastructure locations; and an inspection of the ground conditions.

10.5.10 Peat probing was undertaken during the Stage 2 exercise to inform the PSHRA (Appendix 10.2) and also to produce a more detailed peat depth profile at each proposed turbine and hardstanding location, along the route of the proposed access tracks, the substation compound, meteorological mast and borrow pit search area. The following pattern of probing was adopted for Stage 2:

- probe at each proposed turbine location with a 10 m spaced cross-grid out to 50 m from the turbine centre to the north, south, east and west;
- at least four peat probes at each proposed turbine hardstanding area;
- a 50 m x 50 m grid of peat probes across the construction compound, substation and borrow pit search area; and
- 50 m along proposed access tracks, plus 10 m either side of each probe perpendicular to the route of the track.

10.5.11 Peat sampling was collected using a hand auger at proposed turbine and infrastructure locations where the depth of peat allowed. Peat samples were collected and dispatched to Envirolab laboratory and tested for moisture content, bulk density, and carbon content, in order to help characterise the peat at different locations and depths across the site. Further detail is provided in Appendix 10.2.

10.5.12 The data were subsequently used to inform the final design freeze. For example, the locations of the turbines, substation compound and the design of the turbine hardstandings have all been modified in order to reduce the impact of the Proposed Development on peat resources (see Chapter 2 of the EIA Report). The data was further used to inform the Outline PMP and the PSHRA; refer to Appendices 10.1 and 10.2 respectively.

10.5.13 An NVC survey was undertaken by Whytock in October 2019. This survey work included identification of habitats which may be groundwater dependent, in accordance with SEPA guidance document LUPS-GU4

Significance Criteria

10.5.14 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, Hydrogeology and Soils)

Sensitivity	Description
High	Areas containing geological, geomorphological or hydrological features considered to be of national interest, for example Aquatic Natura 2000 sites, SACs, SSSIs. Private water supply abstraction for human or stock consumption (surface water or groundwater) Public drinking water supply abstraction (surface water or groundwater) Highly permeable superficial deposits allowing free transport of contaminants to groundwater and surrounding surface waters.

Sensitivity	Description
	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. Private water supply abstraction not for human or stock consumption (surface water or groundwater) 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. No private or public supply abstractions (surface water or groundwater) 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.

10.5.15 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 visits and the professional judgement of the assessment team.

10.5.16 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 10.3. Consent is being sought for a project lifetime of 30 years and impacts from aspects of decommissioning are considered to be the same as or lesser than those for construction.

Table 10.3 – Magnitude of Change Criteria (Geology, Hydrology, Hydrogeology and Soils)

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 fundamentally

Impact Magnitude	Guideline Criteria
	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

10.5.17 Using these criteria, potential effects have been assessed for the Proposed Development. These effects are presented in Section 10.9.

10.5.18 Further information on standard and site-specific mitigation is set out in Section 10.8. Residual effects of the project have been predicted in Section 10.11, taking into account the aforementioned mitigation measures and additional mitigation measures.

10.5.19 The significance of the predicted effects has been assessed in relation to the sensitivities of the baseline resource.

10.5.20 A matrix of significance was developed to provide a consistent framework for evaluation and is presented in Table 10.4.

10.5.21 Guideline criteria for the various categories of effect are included in Table 10.5.

Table 10.4 – Significance of Effect Matrix

		Sensitivity			
		High	**Medium**	**Low**	**Not Sensitive**
Magnitude	**High**	**major**	**major**	**moderate**	**minor**
	Medium	**major**	**moderate**	**minor**	**minor**
	Low	**moderate**	**minor**	**minor**	**negligible**
	Negligible	**minor**	**minor**	**negligible**	**negligible**

Table 10.5– Significance Criteria (Geology, Hydrology, Hydrogeology and Soils)

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
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

10.5.22 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 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.

10.5.23 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.

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

Requirements for Mitigation

10.5.25 Committed mitigation measures are presented within this chapter 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. To a large extent, mitigation has been embedded or incorporated into the design process through appropriate siting

of infrastructure, buffering of sensitive receptors, and stipulating good construction practice in a CEMP (refer to Section 10.8).

Assessment of Residual Effect Significance

10.5.26 An assessment of any predicted significant residual effects on sensitive geological, hydrological or hydrogeological receptors is presented within this chapter in Section 10.11.

Limitations to Assessment

10.5.27 No water quality monitoring or intrusive investigations, other than peat depth survey work as described in Section 10.5, have been undertaken.

10.6 Baseline Conditions

Geography, Topography and Geomorphology

10.6.1 The Proposed Development site occupies a rural setting east of Skelmorlie, in North Ayrshire. The site comprises of a mixture of agricultural fields and pasture, open upland moor and freshwater habitat.

10.6.2 Deciduous woodland covers the steep banks of Skelmorlie Water, albeit broader along the lower reaches and sparser along the upper reaches. In contrast, the hill slopes are open and the land is used for hill sheep farming. Small fields of semi-improved pasture are set across the hill slopes and this regular pattern transitions into a more open landscape to the north of the site, where the grasses are largely unimproved.

10.6.3 The land-use typically comprises a mix of forestry and hill sheep farming in the upland areas, with smaller areas of improved pasture in the more fertile lowlands.

10.6.4 The majority of the site has relatively gentle topography, with an overall fall from east/north-east (where the site ascends the slopes of Rigg Hill) to south-west. At the eastern corner of the site area, the elevation is approximately 245 m AOD. From there, the land falls gently to a level of approximately 40 m AOD in the western extent of the site area. A gorge runs through the site following the course of the Skelmorlie Water and bisecting the site from north-east to south-west. The slopes of this valley represent the highest gradients experienced over the site.

Geology and Soils

10.6.5 There are no geological Sites of Special Scientific Interest (SSSIs) nor Geological Conservation Review (GCR) sites within the study area.

10.6.6 BGS online mapping for the area shows that the bedrock geology underlying the site comprises mostly Late Devonian sedimentary sandstone of the Kelly Burn Formation. A small section of Kinnesswood Formation (sandstone) can also be found along the southern boundary. The sedimentary rock is locally intruded by felsite, basalt and micrrogabbro dykes.

10.6.7 The bedrock geology, as shown on BGS 1:50,000 scale mapping, is shown on Figure 10.2

10.6.8 BGS mapping shows that the bedrock is overlain by superficial deposits of Devensian diamicton till across approximately two-thirds of the site area. Localised areas in the north and also south-east of the site area are underlain by superficial deposits of peat. Two small areas of alluvium (consisting of clay, silt, sand and gravel) can be found along the course of the Skelmorlie Water, limited to the western extent of the site area. The north-eastern section of the site contains no superficial deposits and the bedrock is exposed.

10.6.9 The superficial geology as shown on BGS 1:50,000 scale mapping is shown on Figure 10.3.

10.6.10 No historical British Geological Survey (BGS) borehole records were available for the site.

10.6.11 As shown on the James Hutton Institute 1:25,000 scale soil map, it is noted that soils across most of the site are classified as either poorly drained noncalcareous or very poorly drained peaty gley (acidic, organic rich soils), with a small portion of blanket peat located on the site boundary to the

north-east. Along the Skelmorlie Water, the soil is found to be mixed bottom land composed of a wide range of soil types, including immature soils and alluvial soils. Towards the south-eastern extent of the site area, there is a localised area of freely drained brown soils.

Mining

10.6.12 Following consultation with the BGS Mining Plans Portal, no mining activity has been conducted within the site boundary, or the immediate vicinity. The closest mine working is located approximately 3.5 km to the east of the site, at Muirshiel Mine.

10.6.13 The First Edition Ordnance Survey (OS) map six inch to the mile (refer to Figure 9.7), surveyed in 1855, illustrates two old sandstone quarries in the northern extent of the site area. The Second Edition 25 inch to the mile OS map, published in 1897, shows no sign of the old quarries in this area, indicating that the quarries were no longer in use by this point in time. These quarries are not considered in this assessment due to the significant amount of time which has passed since their last use.

Peat

10.6.14 SNH Carbon and Peatland Map (2016) shows that the majority of the site is identified as mineral soils with no peatland vegetation, with the exception of the north of the site area which is classified as Class 3 ("dominant vegetation cover is not priority peatland habitat but is associated with wet and acidic type") peatland habitat and the south-east of the site area which is classified as Class 4 ("area unlikely to be associated with peatland habitats or wet and acidic type"). Therefore, no areas of the site are classified as nationally important peatland habitat (Class 1 or 2).

10.6.15 Peat depth surveys were undertaken as described in Section 10.5 to identify the extent, depth and nature of peat across the site where infrastructure is proposed. Peat was found to be present in a localised area in the northern extent of the site area, with most of the site being void of any discernible peat. The peat depths recorded on-site ubiquitously varied from nil to 1 m.

10.6.16 The locations and depths of the peat probes are illustrated in Figures 10.4a and 10.4b.

10.6.17 The Guidance on Developments on Peatland – Site Surveys (Scottish Government, SNH and SEPA, 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 in 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 %; and
- **Deep peat**: a peat soil with a surface organic layer greater than 1.0 m deep.

10.6.18 Of the 884 probes advanced within the site boundary during all the peat depth surveys, the peat depth was zero at 537 (60.8 %) and less than 0.5 m at 316 probes (35.7 %), the latter defined as peaty or organo-mineral soil. At 31 probes (3.5 %), peat depth between 0.5 m and 1.0 m was recorded. No probes recorded peat depth over 1.0 m (i.e. deep peat).

10.6.19 Full details of the peat depth survey, risk assessment and peat management plan are provided in Appendices 10.1 and 10.2

Geology and Soils Baseline Summary

10.6.20 Due to a lack of geological features that are protected or considered worthy of protection and only thin, superficial peat deposits present on site, the sensitivity of the baseline geological resources at this site are considered to be low.

Hydrogeology

Groundwater Body and Productivity

10.6.21 The groundwater body beneath the study area is indicated by SEPA to comprise the Wemyss Bay groundwater (ID 150531). This groundwater body was classified by SEPA in 2018 as having an overall status of 'good'.

10.6.22 The entire area of groundwater encompassed by the site boundary is classified as a Drinking Water Protected Area.

10.6.23 Hydrogeology mapping data from the BGS shows the bedrock beneath the study area to comprise a moderately productive aquifer where there is significant intergranular flow.

10.6.24 Following consultation with SEPA during the production of the Scoping Report for the Proposed Development, it was advised that the bedrock aquifer is Intergranular/Fractured, High Productivity Aquifer (IHF). It was also advised that there is an Intergranular, Low Productivity Drift Aquifer towards the centre of the site which has a vulnerability classification 4, which indicates that the aquifer will be vulnerable to pollutants which are not readily absorbed or transformed. Till, where present, is anticipated to be relatively low permeability, inhibiting groundwater flow. Peat and peat soils would also be expected to inhibit groundwater flow

Potential Groundwater Dependent Terrestrial Ecosystems (GWDTE)

10.6.25 Habitats indicative of GWDTE were identified during NVC survey work (see Figure 10.5 for a summary of potential GWDTE within the site area and Chapter 7 for further detail).

10.6.26 Within the site, habitats indicative of potentially high groundwater dependency were identified mainly along the banks of surface watercourses (namely the Skelmorlie Water which bisects the site area, running from east to west), drains and minor tributaries.

10.6.27 Habitats indicative of potentially moderate groundwater dependence were identified across much of the rest of the site area, largely comprising rush pasture communities.

10.6.28 With superficial glacial till superficial geology across much of the site likely to inhibit groundwater flow, there is limited potential for substantial groundwater to be present near the surface, feeding the observed habitats. Furthermore, given the pattern of wetland habitats identified, the habitats may be mainly or entirely surface-water dependent, with those within the high potential GWDTE category being located along surface watercourses and drainage routes (refer to Figure 10.5). Water contained within the peat soils across the site is considered to be rainwater fed.

10.6.29 The areas of high potential GWDTE to the south-east of turbine T9 are located in an area where the bedrock is exposed (refer to Figure 10.3). Although the high potential GWDTE here is also localised along surface watercourses, there is a higher chance that habitats in this area may be groundwater fed, due to a lack of superficial geology which inhibits groundwater flow. Further investigation and pre-construction surveys will be undertaken to assess and confirm the groundwater dependency of this area. Mitigation, through the micro-siting of infrastructure (where possible) or stipulation of appropriate construction methodology and monitoring to suitably protect groundwater, will be utilised if groundwater dependency is confirmed.

Private Water Supplies

10.6.30 DWQRS mapping of PWS across Scotland was consulted to establish the presence of PWS in the study area. To establish whether a PWS receptor was sensitive to impacts from the Proposed Development, SEPA Guidance Note 31 (2017) was utilised. A groundwater abstraction is considered sensitive if:

- located within 250 m of excavations deeper than 1 m; or
- located within 100 m of excavations shallower than 1 m.

10.6.31 Table 10.6 outlines the PWS study area.

Table 10.6 – Private Water Supplies within the Study Area

ID	Name	Easting	Northing	Type of Abstraction
PWS 1	Fardens Farm Skelmorlie	221250	666550	Groundwater
PWS 2	Meigle	220570	664985	Surface water
PWS 3	Green Glades	219615	664845	Groundwater
PWS 4	Ashcraig Estate Skelmorlie	219562	665710	Groundwater
PWS 5	South Lodge Ashcraig	219450	665150	Groundwater
PWS 6	Dykes Farm Skelmorlie	219450	665250	Groundwater
PWS 7	Thirdpart Area Skelmorlie	219350	665150	Groundwater

10.6.32 As shown in Figure 10.6, all PWS identified as groundwater abstractions within the study area are outwith the sensitivity criteria highlighted above for groundwater abstractions and are therefore not considered further within this assessment.

10.6.33 PWS 1, Fardens Farm Skelmorlie, is within 250 m of the proposed infrastructure, including the hardstanding for turbine T7 and a portion of access track. However, as noted in Chapter 3 of the EIA Report, the excavations for these structures will be shallower than 1 m. Therefore, the PWS lies outwith the sensitivity criteria highlighted above for groundwater abstractions and is not considered further within this assessment.

10.6.34 The surface PWS 2, Meigle, on the Skelmorlie Water at Meigle is further than 250 m from any proposed infrastructure and is approximately 1.4 km downstream the Skelmorlie Water from where the watercourse exits the site boundary. Given the significant distance between the Proposed Development and PWS, this PWS is not considered further within this assessment

10.6.35 No other wells, springs or features suggesting the potential presence of groundwater abstractions have been identified from a review of OS mapping, within the site boundary or study area.

10.6.36 No evidence of further potential PWS has been observed during site survey work.

Hydrogeology Baseline Summary

10.6.37 As described in the above paragraphs, the site is underlain by moderately productive bedrock aquifer where there is significant intergranular flow with a vulnerability classification 4, which indicates that the aquifer will be vulnerable to pollutants which are not readily absorbed or transformed.

10.6.38 Although habitats indicative of potential groundwater dependency have been identified on-site, these have been assessed as likely to be largely surface water fed.

10.6.39 Overall, the sensitivity of baseline hydrogeological resources beneath this site is considered to be medium.

Hydrology

10.6.40 The Skelmorlie Water is the dominant watercourse spanning the site area, entering the north-east of the site boundary and bisecting the site as it flows in a south-westerly direction to exit the site in its western extent.

10.6.41 Two smaller watercourses flow across a small portion of the north-eastern extent of the site boundary before feeding into the Skelmorlie Water. These are Rigghill Burn and Fank Burn, both of which rise approximately 1 km outwith the site boundary to the north-east, and flow in a south-westerly direction to enter the site and flow for approximately 700 m, continuing in a south-westerly direction, before feeding into the Skelmorlie Water.

10.6.42 The Meigle Burn bisects the site in its south-western extent before feeding into the Skelmorlie Water, just preceding the drainage of the Skelmorlie Water into the Firth of Clyde Inner, approximately 1.5 km to the west of where the Skelmorlie Water exits the site boundary. An unnamed watercourse forms part of the site's western boundary, flowing from north to south down Fardens Glen and feeding into the Skelmorlie Water.

10.6.43 Virtually all drainage from the main body of the site is anticipated to flow to the Skelmorlie Water, either directly, via the above four watercourses, or via the many minor field drains which crisscross the site. The south-eastern extent of the site area has the potential to drain into the Outerwards Reservoir and onwards into the Noddsdale Water. However, no infrastructure is proposed in this drainage area and therefore no effects are anticipated to the Outerwards Reservoir and Noddsdale Water catchment area.

10.6.44 The watercourses on the site are not classified under the Water Framework Directive (WFD) by SEPA, though they ultimately flow into the Firth of Clyde Inner (ID: 2000360) which has a 2014 SEPA classification of overall status of 'good'. Although the Skelmorlie Water and the unnamed watercourse of Fardens Glen form part of the Skelmorlie Glen SSSI, they are not the target of this designation.

10.6.45 As noted above, all the watercourses on-site, and into which the site (where proposed infrastructure is located) drains, form part of the wider catchment of the Skelmorlie Water and ultimately the Firth of Clyde Inner.

10.6.46 The principal watercourses principal watercourses as shown on 1:50,000 scale OS mapping are shown on Figure 10.1.

10.6.47 Some of the proposed access tracks to turbines would require new watercourse crossings to be constructed. 24 new watercourse crossings are proposed, with one existing crossing on the farm track in the south-west of the site required to be upgraded (WC1). The locations of these proposed water crossings are shown on Figures 10.7a and 10.7b. Indicative water crossing designs and further details concerning the watercourses at crossing points are included in Appendix 10.3.

Hydrology Baseline Summary

10.6.48 For the purposes of this assessment, taking into account the lack of WFD classification for all watercourses within the study area and the 1.5 km of watercourse which separates the site from downstream impact on the Firth of Clyde Inner, the sensitivity of baseline hydrological resources at the site is considered to be low.

Flood Risk

10.6.49 The SEPA Indicative River & Coastal Flood Map (SEPA, 2019) shows most of the site as being outside any area of identified flood risk. The immediate banks of the Skelmorlie Water are shown as being at up to a high risk of flooding over a length of approximately 1.5 km of the watercourse. However, this risk classification generally does not extend more than 50 m from the edge of the watercourse and all proposed infrastructure is outwith 50 m of all watercourses, as part of the iterative design process (refer to Figure 10.1 and Chapter 2).

10.6.50 Highly localised areas of up to high risk of surface water flooding are shown on the map, along the course of Skelmorlie Water, Rigghill Burn, Fank Burn and the unnamed watercourse of Fardens Glen. These areas of surface water flood risk are essentially confined to the width of the watercourses themselves.

10.6.51 The map demonstrates that there is no risk of coastal flooding to the site, primarily due to the elevation of the site which lies above the 31 m AOD contour.

Flood Risk Baseline Summary

10.6.52 Considering the extremely localised nature of flood risk around watercourses, around which proposed infrastructure has been avoided through the iterative design process (refer to Chapter 2), the sensitivity of the site with respect to flooding is considered to be low.

10.7 Receptors Brought Forward for Assessment

10.7.1 As discussed above, the only receptors considered in Section 10.6 which have been scoped out of further assessment are Private Water Supplies.

10.8 Standard Mitigation

Project Design

10.8.1 As already noted, following CIEEM guidance, the assessment process assumes the application of standard mitigation measures. A range of measures have already been applied as part of the iterative design process (see below and Chapter 2) to avoid areas of peat, waterbodies and watercourse where practicable.

10.8.2 A summary of the geological and hydrological influences on the project infrastructure layout are given below with full details of the project design provided in Chapter 2. Due to the nature of the environment occupied by the Proposed Development, it is imperative that the design of the infrastructure helps to maintain or even improve the local hydrology. Poor design of wind farm infrastructure can result in significant implications for the hydrological environment with secondary effects on peat stability and ecology.

10.8.3 Based on the findings of the peat depth, where practicable, the infrastructure has been sited outside areas of deeper peat and away from areas identified as potentially at risk from peat slides. The design has sought to minimise peat excavation whilst having cognisance to the long-term durability of the infrastructure required.

10.8.4 A 50 m buffer was implemented for all watercourses shown on OS 1:50,000 scale mapping, except where watercourse crossings are required. Figure 10.1 confirms that all turbines are located outwith the 50 m watercourse buffers.

10.8.5 The number of watercourse crossings have been minimised as far as possible, although recognising that various crossings of small drains are unavoidable.

10.8.6 The temporary construction compound, substation compound, met mast and borrow pit search area have also been located further than 50 m from watercourses.

Peat Reuse and Management

10.8.7 Where peat is required to be excavated, it will be reused and managed in line with the guidance document, 'Developments on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste' (a joint publication by Scottish Renewables and SEPA, 2012).

10.8.8 It is proposed that peat which has been excavated for construction of the Proposed Development will be reused on site. An outline PMP has been compiled and can be found as Appendix 10.1.

Pre-Construction

10.8.9 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.

10.8.10 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 and selection of appropriate materials for use during the construction process.

Construction

Water Quality Monitoring Programme

10.8.11 A Water Quality Monitoring Programme will be implemented before and during construction to record the existing water condition and ensure no deterioration to water quality during construction.

Pollution Impact from Silt-laden Runoff

10.8.12 With specific reference to the SEPA 'Guidelines for Water Pollution Prevention from Civil Engineering Contracts' and 'Special Requirements', the contractor will produce a Construction Environmental Management Plan (CEMP) which will set out standard good construction practices and contain a construction method statement that includes:

- a detailed breakdown of the phasing of construction activities;
- detailed pre-construction site investigations focusing on areas where construction is proposed to be undertaken to inform suitable micro-siting of the turbines and associated infrastructure;
- 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 watercourses;
- planning and design of appropriate pollution control measures during earthworks and construction;
- storage of all fuel and other chemicals in accordance with best practice guidance;
- borrow pit management measures;
- ensuring that concrete batching is undertaken only at a designated area at the temporary construction compound, 100 m from the nearest watercourse;
- management of the pollution control system, including dewatering of excavations away from watercourses;
- contingency planning and emergency procedures; and
- on-going monitoring of construction procedures to ensure management of risk is maintained.

10.8.13 All earth moving works or similar operations will be carried out in accordance with BSI Code of Practice for Earth Works BS6031:1981.

10.8.14 Prior to construction, a detailed Drainage Strategy (DS) would be developed and agreed with SEPA and NAC. 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 and borrow pit excavations would be controlled. The DS would also detail the dimensions and final design of the new and upgraded water crossings, which would be designed to maintain continuous flows.

10.8.15 All watercourse crossings, site discharges, and temporary water abstraction would be regulated under the CAR licensing regime and all necessary licences would be sought from SEPA prior to the commencement of any operations onsite.

10.8.16 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 in North Ayrshire, 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.

10.8.17 Where topography dictates that working platforms are needed, these will be formed to ensure that surface water drains away from watercourses.

Pollution Impact from Chemical Contaminated Runoff

10.8.18 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 watercourses 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.

10.8.19 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.

10.8.20 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 in order to minimise risks of leaks to soil and surface waters.

10.8.21 A concrete batching plant will be present on site. The contractor will develop a method statement to address the transport, transfer, handling and pouring of liquid concrete at foundations.

10.8.22 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 waterbodies.

10.8.23 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 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.

10.8.24 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.

Impact from Soil Compaction

10.8.25 The proposed access tracks have been designed to use the shortest amount of track possible, while respecting topographical constraints. The tracks will be designed to spread load over the underlying soils thus minimising the compaction of underlying soils.

Impact on Integrity of Banking

10.8.26 Field drains and fencing will be constructed and maintained where necessary during construction to uphold the integrity of watercourse banks. Detailed intrusive site investigation work will be undertaken prior to construction to ensure design and installation of new watercourse crossings would be suitable to local ground conditions. When constructing watercourse crossings, good construction practice measures as set out in the CEMP will be fully implemented.

Direct Discharge of Untreated Foul Drainage

10.8.27 Welfare facilities will either connect directly to the foul sewer, self-contained storage tanks or to a septic tank, subject to approval from Scottish Water and SEPA.

10.8.28 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

10.8.29 Prior to construction, a Detailed Drainage Strategy (DS) would be developed and agreed with NAC and SEPA. 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 run off from hard surfaces and borrow pit excavations would be controlled. The DS would also detail the

dimensions and final design of the proposed watercourse crossings, which would be designed to maintain continuous flows.

Acidification

10.8.30 Potential effects from acidification will be mitigated through an appropriately designed drainage system to be agreed with NAC and SEPA.

Fluvial Geomorphology

10.8.31 The detailed design for the watercourse crossings, and the requirements for Controlled Activities Regulations authorisations or licences, will be agreed with SEPA prior to construction in order to ensure that impacts on fluvial geomorphology are minimised and acceptable to SEPA.

Decommissioning

10.8.32 At the end of the Proposed Development's operational lifespan of 30 years, it will be decommissioned, unless subject to a successful new planning application for repowering. It is expected that decommissioning will take approximately 12 months. The environmental effects of decommissioning are considered to be the same or less than those during construction, and over a shorter time period.

10.8.33 Prior to decommissioning, a Decommissioning Environmental Management Plan (DEMP) will be produced to reflect then current legislation and policy and will be agreed with the relevant statutory authorities.

10.9 Potential Effects

10.9.1 The potential effects resulting from the Proposed Development, subsequent to the standard mitigation procedures outlined above, are detailed below. Effects have been separated into those which occur during the construction and operation phases individually. The consent being sought for the Proposed Development is for 25 years. The effects arising from decommissioning are considered to be the same or less significant than those arising from the construction phase.

Construction

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

Changes to Groundwater Flow

10.9.3 Excavations would be required to form turbine foundations, and shallower excavations would be required to form platforms for the temporary construction compound, substation, met mast, the borrow pit search area, and to construct access tracks. These excavations would result in localised changes to groundwater conditions, including potential requirement for dewatering of excavations. There is anticipated to be perched groundwater within peat deposits at the site, and therefore dewatering of excavations would likely result in localised drawdown of the water table and resultant dewatering of peat in the vicinity. Water table drawdown is likely to be localised to the area of excavations, recovering following completion of construction. The potential magnitude of impact is therefore assessed as low.

10.9.4 Given that there are only thin, superficial layers of peat located on site, with an absence of peat with a depth greater than 1 m, the sensitivity of the receptor (groundwater and shallow peat deposits) is medium (refer to Section 10.6).

10.9.5 The potential for construction phase, changes to the groundwater flow regime, including localised dewatering of peat is therefore assessed as a direct, short-term, temporary effect of **minor** adverse significance (not significant).

Effects on Groundwater Dependent Terrestrial Ecosystems

10.9.6 Although most habitats identified as potentially groundwater dependent have been assessed as likely surface-water fed, there is potential for some localised habitats which are in fact groundwater dependent, signifying shallow groundwater which has the potential to be impacted by the Proposed Development. The sensitive receptor is the groundwater resource, not the habitats themselves (the habitats simply acting as an indicator of groundwater dependence and not necessarily sensitive in their own right). Potential effects on shallow groundwater flow are outlined in the above paragraphs, and measures to protect against contamination of groundwater during construction are set out in the discussion of standard mitigation.

10.9.7 The potential for construction phase changes to the groundwater flow regime and/or localised pollution of the groundwater resource, where potential GWDTE have been identified, is assessed as a direct, short-term, temporary effect of **minor** adverse significance (not significant).

Removal of, and Impact on, Peat

10.9.8 Although there is a lack of deep peat (peat with a depth of greater than 1 m) on-site, there would be a requirement for excavation of shallow peat deposits at turbine T8 and small sections of the access track located to the north of the Skelmorlie Water (refer to Figures 10.4a and 10.4b). Further detail on the estimated volume of peat to be excavated, and the management of excavated peat, is given in Appendix 10.1.

10.9.9 The excavation of localised peat deposits to allow construction of the Proposed Development is assessed as an impact of low magnitude, on a low sensitivity receptor, resulting in a direct, permanent effect of **minor** adverse significance (not significant) in the absence of mitigation.

Pollution Impact from Sediment Runoff/Transport

10.9.10 Surface runoff containing silt and other sediments, particularly during and after rainfall events, has the potential to enter the watercourses and field drains on and adjacent to the site. Silt and sediment laden surface water runoff are 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 watercourse at and downstream of the works in the absence of any mitigation.

10.9.11 However, as noted in Section 10.8, a minimum buffer of 50 m around all watercourses has been maintained in siting infrastructure except where watercourses need to be crossed, and good construction practice measures would be set out in a CEMP and fully implemented to minimise the risk of pollution to surface watercourses.

10.9.12 The magnitude of change, prior to any additional mitigation, is therefore considered to below, on a low sensitivity receptor. Therefore, there is potential for a direct, temporary, short-term effect of **minor** adverse significance (not significant).

Pollution Impact from Chemical Contaminated Runoff

10.9.13 Pollutants such as oils, fuel and cement may be mobilised through mechanical leaks and spillage and carried in surface drainage. Unless managed appropriately the pollutants could be washed into watercourses, impacting on their freshwater quality and ecological value. However, as noted in Section 10.8, a minimum buffer of 50 m around all watercourses has been maintained in siting infrastructure except where watercourses need to be crossed, and good construction practice measures would be set out in a CEMP and fully implemented to minimised the risk of pollution to surface watercourse.

10.9.14 The magnitude of change, prior to any additional mitigation, is therefore considered to be negligible, on a low sensitivity receptor. Therefore, there is potential for a direct, temporary, short-term effect of **negligible** adverse significance (not significant).

Impact on the Integrity of Banking

10.9.15 Permanent new watercourse crossings would be required at 24 locations and at one additional location the existing water crossing would need to be upgraded.

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

10.9.17 The banks of the watercourse where water crossings are proposed are generally low-gradient and shallow, thereby reducing the potential for bank collapse. Furthermore, as noted in Section 10.8, detailed intrusive site investigation work will be undertaken prior to construction to ensure design and installation of new watercourse crossings is suitable to the local ground conditions, and good construction practice measures set out in the CEMP will be fully implemented.

10.9.18 The potential magnitude of impact is therefore negligible, on low sensitivity receptors, resulting in potential for a direct, permanent effect of **negligible** adverse significance (not significant) prior to the implementation of any additional mitigation measures.

Compaction of Soils

10.9.19 There is potential for construction of permanent tracks and movement of construction vehicles and plant to result in soil compaction, reducing the ability of water to permeate the ground and increasing the potential for contaminated or sediment-laden surface runoff. Reduced permeability in soils also reduces the site's flood storage capacity, which could increase the potential for localised flooding incidents.

10.9.20 Taking account of the standard mitigation set out in Section 10.8, the magnitude of change prior to any additional, specific mitigation is low. The sensitivity of the on-site and adjacent watercourses, and flood risk, is low, and therefore there is potential for an indirect, temporary, short-term effect of **minor** adverse significance (not significant).

Direct Discharge of Untreated Foul Drainage

10.9.21 Unless appropriately sited and managed, there is potential for direct discharge of untreated foul sewage from welfare facilities from site compounds during construction. However, as noted in Section 10.8, all welfare facilities will either connect directly to the foul sewer, self-contained storage tanks or to a septic tank, subject to approval from Scottish Water and SEPA.

10.9.22 Taking account of standard mitigation, the magnitude of change prior to any additional mitigation is negligible on a receptor with a low sensitivity. Therefore, there is potential for an in-direct, temporary, short-term effect of **negligible** adverse significance (not significant).

Operation

Surface Water Drainage (Increased Rate of Surface Water Runoff)

10.9.23 The access tracks and crane hardstandings for the wind turbines could result in an increased rate of surface water runoff from the site, increasing downstream flood risk and potentially resulting in soil erosion and silt-laden runoff, which could pollute watercourses, ditches and ponds. However, as set out in Section 10.8, a Detailed DS would be developed and agreed with SEPA and NAC to ensure that runoff from hard surfaces would be appropriately controlled.

10.9.24 The magnitude of change, prior to any additional mitigation, is therefore low, on low sensitivity receptors (local watercourses and flood risk). Therefore, there is potential for an indirect, long-term effect of **minor** adverse significance (not significant).

Long-term Changes to Groundwater Flow Regime and Dewatering of Peat

10.9.25 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. This could result in the drying of peat deposits.

10.9.26 Taking account of the standard mitigation measures set out in Section 10.8, the magnitude of impact is assessed as low, on a low sensitivity receptor. Therefore, there is potential for an indirect, long-term effect of **minor** adverse significance (not significant) in the absence of any additional, specific mitigation.

Impacts on Fluvial Geomorphology

10.9.27 If new watercourse crossings are not designed properly to ensure continuous flows, this could potentially adversely affect the geomorphology of watercourses by reducing heterogeneity. However, as noted in Section 10.8, a Detailed DS would be developed and agreed with SEPA and NAC, including detail of the dimensions and final design of the new and upgraded water crossings. All watercourse crossings would be regulated under the CAR licensing regime and all necessary licences would be sought form SEPA prior to the commencement of any operations on site.

10.9.28 The magnitude of change, prior to any additional mitigation, is negligible, on a low sensitivity receptor. Therefore, there is potential for a direct, permanent effect of **negligible** adverse significance (not significant).

Impact on Fluvial Flood Risk On-site and Downstream

10.9.29 The Proposed Development has the potential to generate increased runoff through introduction of hardstanding areas, and to increase flood risk through creation of new water crossings. As described in Section 10.8, a suitable Detailed DS would be developed and implemented, and all water crossings would be regulated under the CAR licencing regime and would be designed to allow continuous flow.

10.9.30 There is therefore potential for a negligible magnitude impact on a low sensitivity receptor, resulting in a direct, long-term effect of **negligible** adverse significance (not significant).

Decommissioning

10.9.31 Potential effects of decommissioning the development are similar to those encountered in the construction phase, however, generally with less magnitude, as the level of site activity is lower. As noted in Section 10.8, a DEMP will be produced to ensure good practice during decommissioning activities. Furthermore, discussions will be held with NAC and the appropriate Regulatory Authorities prior to decommissioning to agree an appropriate Decommissioning Strategy informed by legislature and guidance current at the time.

10.10 Additional Mitigation

10.10.1 In addition to the standard mitigation set out in Section 10.8, the following additional mitigation measures would be implemented in the construction and operation of the Proposed Development. Although no significant potential effects have been identified (refer to Section 10.9), the following measures are proposed to further minimise the potential for adverse effects to arise.

10.10.2 Where excavation of localised, shallow peat is required for construction of turbines and other infrastructure, excavated peat would be re-used on-site as set out in Appendix 10.1.

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

10.10.4 Where topography dictates that working platforms are needed, these would be formed to ensure that surface water drains away from watercourses.

10.10.5 To avoid unnecessary compaction and disturbance to site soils, working areas and corridors would be established and demarcated, with construction operatives appropriately inducted and trained to avoid work outside the designated work areas. Further detail is provided in Appendix 10.1.

10.10.6 Where pre-construction, detailed site investigation work confirms groundwater dependence (rather than habitats being surface-water fed as has been assessed as the likely scenario at much of the site), then additional mitigation measures such as micro-siting out of GWDTE where possible, or inclusion of targeted additional groundwater protection and monitoring during construction, will be implemented.

10.11 Residual Effects

10.11.1 No significant potential effects on geological, hydrological and hydrogeological receptors have been predicted when taking account of standard mitigation as set out in Section 10.8. However, some additional, specific mitigation measures are proposed as described in Section 10.910, to further reduce effects.

10.11.2 Taking account of the above-noted mitigation commitments, all residual effects on geological, hydrological and hydrogeological receptors are assessed as being **negligible** or **minor**, and not significant.

10.12 Cumulative Assessment

10.12.1 There are no proposed or operational wind farms which are directly geologically or hydrologically connected to the area affected by the Proposed Development Site.

10.12.2 Therefore, there is no potential for an in-combination direct, permanent, long-term effect of any significance, and therefore no additional mitigation measures over and above those committed to in this chapter are considered necessary to address potential cumulative effects on geology, hydrology and hydrogeology.

10.12.3 No significant residual effects are predicted resulting from the construction, operation or decommissioning of the Proposed Development in isolation, and there is considered to be **negligible** potential for significant cumulative effects to arise due to the lack of further development within the study area.

10.13 Summary

10.13.1 The Proposed Development is located within the catchment of the Skelmorlie Water and ultimately the Firth of Clyde Inner, with drainage across the majority of the site being to the Skelmorlie Water which bisects the site area from north-east to south-west. The Skelmorlie Water and three other watercourses on-site have no WFD classification.

10.13.2 The bedrock beneath the site is typically sandstone, with the majority of the site being underlain by the Kelly Burn Sandstone Formation. This in turn is covered by diamicton till, with the exception of the north-north-eastern section of the site where the bedrock is exposed.

10.13.3 Habitats indicative of potential groundwater dependence have been identified across much of the site. Given the pattern of wetland habitats identified, it is likely that the majority of habitats identified as high potential GWDTE are mainly or entirely surface-water dependent, with those within the high potential GWDTE category being located along surface watercourses and drainage routes. Water contained within the peat soils across the site is considered to be rainwater fed. Further investigation and pre-construction surveys will be undertaken to assess and confirm the groundwater dependency of this area. Mitigation, through the micro-siting of infrastructure and/or additional targeted groundwater protection measures and monitoring, will be utilised if groundwater dependency is confirmed.

10.13.4 No sensitive PWS have been identified within the study area.

10.13.5 A peat depth field survey has identified peat in the northern extent of the site area, at depths no greater than 1 m at all probes. The SNH Carbon and Peatland Map (2016) demonstrates that Class 3 and Class 4 peatland habitat is found within the site boundary and therefore no peatland classed as a nationally important resource is located on site.

10.13.6 A PSHRA has identified negligible or low risk of peat slide across the site (refer to Appendix 10.2).

10.13.7 Potential construction and operational effects include changes to groundwater flow (including where potential GWDTE have been identified); removal of, and impact on, peat; pollution impact from silt-laden runoff and chemical contaminated runoff; impact from soil compaction; impact on integrity of banking; direct discharge of untreated foul drainage;; impact on fluvial geomorphology; impact on fluvial flood risk on-site and downstream; and impact on surface water drainage.

10.13.8 The iterative design process for the Proposed Development has ensured standard mitigation, including appropriate buffering of sensitive watercourses, minimising the need for new watercourse crossings, and avoidance of areas of deep peat or elevated peat slide risk in siting turbines. 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, and appropriate design of watercourse crossings, regulated under the CAR licensing regime.

10.13.9 Potential effects on geological, hydrological and hydrogeological receptors, taking account of the above-noted standard mitigation, have been assessed as **negligible** to **minor**, and therefore not significant. However, some additional specific mitigation measures have been proposed to further reduce effects. These include: appropriate management and re-use of peat onsite in accordance with a Detailed PMP; minimising the requirement for dewatering; ensuring that working platforms are formed so that surface runoff drains away from watercourses; and establishing and demarcating working areas and corridors.

10.13.10 The significance of residual effects on geological, hydrological and hydrogeological receptors are considered to be **minor** or **negligible** and therefore not significant. A summary of the residual effects on geology, hydrology and hydrogeology at the site are shown in Table 10.7.

Table 10.7 – Summary of Effects

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Construction and Decommissioning					
Changes to groundwater flow	**Minor**	Adverse	No specific mitigation beyond standard mitigation.	**Minor**	Adverse
Effects on groundwater (changes to flow and localised pollution) at areas of GWDTE	**Minor**	Adverse	Where pre-construction, detailed site investigation work confirms groundwater dependence, then additional mitigation measures such as micro-siting out of GWDTE where possible, or inclusion of targeted additional groundwater protection and monitoring during construction, will be implemented.	**Minor**	Adverse
Removal of, and impact on, peat	**Minor**	Adverse	Appropriate management and on-site re-use of peat (PMP). Restriction of works to set construction areas and corridors.	**Minor**	Adverse
Pollution impact from sediment runoff/transport	**Minor**	Adverse	Form any working platforms to ensure runoff away from watercourse. Restriction of works to set construction areas and corridors.	**Minor**	Adverse

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Pollution impact from chemical contaminated runoff	**Negligible**	Adverse	No specific mitigation beyond standard mitigation.	**Negligible**	Adverse
Impact on the integrity of banking	**Negligible**	Adverse	No specific mitigation beyond standard mitigation.	**Negligible**	Adverse
Compaction of soils	**Minor**	Adverse	Restriction of works to set construction areas and corridors.	**Minor**	Adverse
Direct discharge of untreated foul drainage	**Negligible**	Adverse	No specific mitigation beyond standard mitigation.	**Negligible**	Adverse
Operation					
Surface water drainage (increased rate of surface water runoff)	**Minor**	Adverse	No specific mitigation beyond standard mitigation.	**Minor**	Adverse
Long-term changes to groundwater flow regime and dewatering of peat	**Minor**	Adverse	No specific mitigation beyond standard mitigation.	**Minor**	Adverse
Impacts on fluvial geomorphology	**Negligible**	Adverse	No specific mitigation beyond standard mitigation.	**Negligible**	Adverse

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Impact on fluvial flood risk on-site and downstream	**Negligible**	Adverse	No specific mitigation beyond standard mitigation.	**Negligible**	Adverse

Table 10.8 – Summary of Cumulative Effects

Receptor	Effect	Cumulative Developments	Significance of Cumulative Effect	
			Significance	Beneficial/ Adverse
No significant cumulative effects are predicted				

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