11 Hydrology, Hydrogeology and Geology

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11 Hydrology, Hydrogeology & Geology

11.1 Executive Summary

11.1.1 This chapter considers the potential effects of the Proposed Development on hydrological, hydrogeological and geological resources.

11.1.2 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.

11.1.3 Surface water drainage from the site flows into the River Nethan to the south and the Logan Water to the north (itself flowing into the River Nethan), ultimately draining into the River Clyde to the north-east of the site.

11.1.4 Six new water crossings and one upgraded water crossing will be required, where access tracks will need to traverse the on-site watercourses. Additionally, there are a number of existing water crossings which will be maintained for use in the Proposed Development (refer to Appendix 11.3 and Appendix 3.3).

11.1.5 Site geology comprises sedimentary bedrock sequences overlain largely by peat and till. A localised area in the southwest of the site is identified as Class 1 Peat according to the SNH Carbon and Peatlands Map 2016. However, detailed peat surveys identified variable thicknesses of peat across the site, with approximately 32% of probes recording peaty or organo-mineral soils (peat depth <0.5 m) rather than peat. Localised deep peat (>1 m) was identified.

11.1.6 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 siting all except one turbine, all turbine hardstandings, all except two short stretches of new track, and all other infrastructure.

11.1.7 A peat slide risk assessment has identified low risks at all turbine and other infrastructure locations, except one turbine which was assessed as negligible risk and one borrow pit search area which was assessed as medium risk.

11.1.8 Potential construction and operational effects arising from the Proposed Development (in the absence of mitigation) include changes to the groundwater flow regime, the risk of pollution of watercourses (including due to peat slide, and increased erosion following forestry felling) resulting in adverse effects on water quality, and effects on the integrity of watercourse banks.

11.1.9 Mitigation measures to avoid or reduce potential impacts, include developing and implementing a Construction Environmental Management Plan (CEMP) (refer to Appendix 3.1 Draft CEMP), key-hole forestry felling and re-planting, felling works in accordance with good practice e.g. UK Forestry Standard, undertaking pre-construction site investigations to inform micro-siting and avoid sensitive receptors where possible, surface water quality monitoring, and implementing a Peat Management Plan and a Habitat Management Plan to restore peatland habitat. Additionally, any features of geological interest exposed during excavations will be observed and recorded, and post-construction, the Applicant proposes to install an information board or similar at the Birkenhead Burn Site of Special Scientific Interest (designated for geological interests).

11.1.10 Outline drainage design provisions and water crossing designs have been developed to ensure appropriate control of run-off, and continuous greenfield flows. Detailed designs will be agreed with SEPA and SLC in advance of construction.

11.1.11 Following implementation of committed mitigation measures, the significance of residual effects on geology, surface water and groundwater is considered to be minor or negligible and therefore not significant. No cumulative effects are predicted.

11.2 Introduction

11.2.1 This chapter assesses the potential impacts of the Proposed Development on hydrology, hydrogeology and geological 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.

11.2.2 For the purposes of this assessment, watercourses have been identified as those which appear on the Ordnance Survey (OS) 1:50,000 scale maps (refer to Figure 11.2). However, on-site observations of field drains and other man-made features have also been made and the presence of these has been taken into account in the design of the scheme and any mitigation measures.

11.3 Legislation, Policy and Guidelines

Legislation

11.3.1 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.

11.3.2 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.

11.3.3 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.

11.3.4 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).

11.3.5 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.

11.3.6 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)*.

11.3.7 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.

11.3.8 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.

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

Planning Policy

11.3.10 Chapter 5 sets out the planning policy framework that is relevant to the Environmental Impact Assessment (EIA). The policies set out below include those from the South Lanarkshire Local Development Plan (LDP, 2015). This section also considers the relevant aspects of Scottish Planning Policy (SPP), Planning Advice Notes and other relevant guidance. Of relevance to the hydrological, hydrogeological and geological assessment presented within this chapter are the following policies and advice notes:

- LDP, Policy 2, Climate Change;
- LDP, Policy 4, Development management and placemaking;
- LDP, Policy 17, Water environment and flooding;
- LDP, Policy 18, Waste;
- PAN 51: Planning, Environmental Protection and Regulation (Scottish Executive, 2006);
- PAN 69: Planning and Building Standards Advice on Flooding;
- PAN 79: Water and Drainage (Scottish Executive, 2006) and
- Scottish Planning Policy (Scottish Government, 2014).

Guidance

11.3.11 The following relevant guidance has been considered as part of the assessment of hydrology, hydrogeology, flood risk and drainage:

- Temporary Construction Methods, WAT-SG-29 (SEPA, 2009);
- Position Statement: The role of SEPA in natural flood management (SEPA, 2012);
- Flood Risk and Planning Briefing Note (SEPA, 2014)
- SEPA Pollution Prevention Guideline (PPG) 1: Understanding your environmental responsibilities - good environmental practices (2013);
- SEPA Guidance for Pollution Prevention (GPP) 5: Works and maintenance in or near water (2017);
- SEPA Supporting Guidance (SAT-SG-75) – Sector Specific Guidance: Construction Sites (2018);
- Technical flood risk guidance for stakeholders, version 12 (SEPA, May 2019);
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 as amended in 2018 - A practical guide (SEPA, 2011 as amended in 2019);
- Land Use Planning System Guidance Note 4 (LUPS GU4) - Planning guidance on on-shore windfarm developments (SEPA, September 2017);
- Land Use Planning System Guidance Note 31 (LUPS-GU31) - Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems (SEPA, October 2014);

- Special Requirements for Civil Engineering Contracts for the Prevention of Pollution v2 (SEPA, 2006);
- SEPA Policy 19 Groundwater Protection Policy for Scotland (Version 3, 2009);
- SEPA Policy 41 'A Planning Authority Protocol Development at Risk of Flooding: Advice and Consultation' (SEPA, 2016);
- CIRIA C532: 'Control of Water Pollution from Construction Sites - Guidance for Consultants and Contractors' (CIRIA, 2001);
- PPG6: Working at Construction and Demolition Sites (Environment Agency, 2010 – 2nd Edition 2012);
- Good practice during wind farm construction, 3rd edition (Scottish Renewables, Scottish Natural Heritage, SEPA, Forestry Commission Scotland and Historic Scotland, 2015);
- SEPA Guidance Note 4: Planning advice on wind farm developments, LUPS-GU4 (SEPA, 2017);
- Guidance on Developments on Peatland - Site Surveys (SNH, SEPA and The James Hutton Institute, 2017).
- Developments on Peatland: Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste (Scottish Renewables and SEPA. 2014); and
- BS5930:2015 - Code of Practice for Site Investigation (British Standards Institute, 2015).

11.4 Consultation

11.4.1 Consultation was undertaken with a number of statutory and non-statutory consultees, in order to obtain information and advice prior to completing the EIA. In order to facilitate initial consultation on the project, consultees were provided with information on the Proposed Development and the proposed scope of survey and assessment work.

11.4.2 Table 11.1 summarises the consultation responses and provides information on where and how they have been addressed in the assessment, where relevant. Copies of relevant consultee correspondence are included in Appendix 4.2 EIA Scoping Opinion and 4.3 Further Consultation.

Table 11.1 – Consultation Responses

Consultee - Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
SLC – 2 September 2020	Scoping	SLC's Scoping response indicated that the following information should be provided in the EIA Report: A Flood Risk Assessment satisfying the requirements of the SLC Developer Design Guidance (2020). A Sustainable Drainage System designed in accordance with the SLC Developer Design Guidance (2020).	Flood risk is discussed in paragraphs 11.6.52 to 11.6.55. Outline information on the proposed drainage strategy is provided in Chapter 3 Proposed Development.

Consultee - Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
SEPA – 28 July 2020	Scoping	SEPA's Scoping response indicated that the following information should be provided in the EIA Report: Map and assessment of engineering activities in or impacting on the water environment, flood risk assessment and info on CAR applications.	Details of proposed new and altered water crossings are provided in Appendix 11.3. Flood risk is discussed in paragraphs 11.6.52 to 11.6.55.
		Map and assessment of impacts upon Groundwater Dependent Terrestrial Ecosystems (GWDTE) and buffers.	A map of potential GWDTE identified from an NVC survey is provided in Figure 11.6. Potential effects on GWDTE are discussed in paragraphs 11.6.29 to 11.6.35.
		Information on any water abstractions including proposed operating regime.	Arrangements for water abstractions are discussed in paragraph 11.8.20.
		Peat depth survey and table detailing re-use proposals.	A Peat Slide Hazard Risk Assessment and an outline Peat Management Plan are provided in Appendices 11.1 and 11.2, respectively.
		Information on borrow pits including management plan and pollution prevention measures.	Proposed borrow pits are discussed in Chapter 3 Proposed Development and paragraphs 11.6.48 to 11.6.51.
		Schedule of mitigation including pollution prevention measures.	Mitigation measures are set out in Section 11.8 and summarised in the schedule of mitigation in Chapter 18.
		Information on forest removal.	Proposed forest removal and forestry management is discussed in Chapter 16 Forestry and within this chapter as appropriate.
		Map of proposed waste, water and surface water drainage layout.	Outline information on the proposed drainage strategy is provided in

Consultee - Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
			Chapter 3 Proposed Development.
		Decommissioning statement. Site specific comment: Advised that the locations for some of the turbines and associated infrastructure might need to be modified as they are likely to be on deep peat	Outline decommissioning proposals are provided in Chapter 3 Proposed Development and effects are assessed in this chapter as appropriate. Extensive design iteration works have been undertaken to avoid siting infrastructure on deep peat wherever possible, as discussed in this chapter and in Appendix 11.2 Outline Peat Management Plan.
SEPA – July to September 2020	Consultation relating to peat surveys	SEPA was consulted following initial peat surveys, to provide initial findings and seek feedback on the proposed approach for Phase 2 surveys. SEPA indicated that the initial surveys were not considered to be sufficient to robustly inform site design, and that any proposed infrastructure on peat deeper than 0.5 m should be moved to an area with less peat unless valid reasons or mitigation measures could be provided. Advice was given on potential re-siting of some turbines and infrastructure, and supplementing the available data with further surveys. SEPA was further consulted with respect to the proposed approach for 'Phase 1b' surveys to supplement the initial survey data as suggested. The approach was welcomed and following review of findings from the Phase 1b surveys and subsequent design iteration, SEPA concerns regarding infrastructure being sited on deep peat had been satisfied.	Consultation feedback from SEPA helped to guide the approach to the various stages of peat survey, as well as design iteration to minimise impacts on peat (refer to Paragraphs 11.5.7 to 11.5.14 and Appendix 11.1 Peat Slide Hazard Risk Assessment).

Consultee - Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
		Ongoing consultation was maintained prior to and following Stage 2 peat surveys.	
SEPA – 27 October 2020	Consultation relating to private water supplies	SEPA provided information on activities registered or licensed under the Controlled Activities Regulations in the vicinity of the site. No private water supplies were identified.	No action required.
NatureScot – 11 August 2020	Scoping	NatureScot advises that: Detailed peat surveys of the site (including access routes where necessary), measuring the peat deposit to full depth, should be undertaken in accordance with Scottish Government guidance. The results should be used to inform a peat slide assessment and peat management plan. The mapped area of Class 1 peat within the wind farm site extends into the adjacent SPA / SSSI. This does not mean that the proposal is unacceptable, but the applicant will need to demonstrate in the EIA Report that any significant effects on the qualities of the area can be substantially overcome by siting, design or other mitigation. The final siting and design of the proposed development and how this may affect peatland must be fully described and assessed in the EIA Report. Given the general dominance of commercial forestry within the site, we would encourage the applicant to consider the relocation of Turbine 3 from the class 1 peat to a less sensitive area.	 A peat depth survey has been undertaken and is reported, together with a Peat Slide Hazard Risk Assessment and an outline Peat Management Plan, in Appendix 11.1 and 11.2, respectively. Extensive design iteration works have been undertaken to avoid siting infrastructure on deep peat wherever possible, as discussed in this chapter and in Appendix 11.2 Outline Peat Management Plan. Refer to the Project Design information in Section 11.8, as well as Appendix 11.2 Outline Peat Management Plan. Following extensive peat surveys and design iteration, T3 and its hardstanding are sited on an area with peat depth <1 m thickness.

Consultee - Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
		Construction works, such as excavation for turbine foundations, could expose features of geological interest (Patrick Burn Formation and fossil material). There is an expectation that such temporary bedrock exposure would be examined and recorded and we would therefore encourage the applicant to appoint a Geological Clerk of Works to assist with this.	The Applicant is committed to realising benefits related to increased geological knowledge, understanding and interest gained during construction works. This is discussed further in Section 11.8.
The Coal Authority – 20 July 2020	Scoping	The Coal Authority reports that part of the proposed application site falls within a Development High Risk area, however as it is not the part of the proposed application site where the turbines will be installed, a coal mining risk assessment is not required.	Scoped out.

11.5 Assessment Methodology and Significance Criteria

Consultation

11.5.1 As noted in Section 11.4, consultation has been undertaken with SEPA, NatureScot (formerly SNH), the Coal Authority and SLC. Responses and relevant considerations are noted in Table 11.1.

Study Area

11.5.2 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 11.1). This does not include a 1 km area around the existing access road to the site, given that no substantial works are anticipated to be required along this road, which could give rise to effects on geological, hydrological or hydrogeological resources.

11.5.3 Efforts have been made, via consultations, site survey work and review of OS mapping, to identify any private water supplies (PWS) for an area within 1 km of the proposed new infrastructure.

11.5.4 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 hydrological and geological assessment.

Desk Study

11.5.5 Baseline conditions have been established primarily through desk-based research which has included:

- consultation with SEPA, NatureScot, the Coal Authority and SLC;

- 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; and
- review of drainage / surface water and hydrogeological characteristics and groundwater resource.

Site Visit

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

- During peat depth survey work in summer 2020 (see below), 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 project engineers visited the site on several occasions, initially as part of early peat survey work, then to examine proposed water crossing locations to ensure their suitability for siting crossings, input to the design iteration process, and inform outline water crossing design.
- Habitat and vegetation surveys were undertaken in September 2019 and July 2020, providing information relevant to the identification of habitats which could represent groundwater dependent terrestrial ecosystems (GWDTE).

Peat Depth Survey

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

11.5.8 A peat depth survey was therefore undertaken in three phases. Initially, a 'Phase 1' peat survey programme was undertaken, focusing on the vicinity of proposed turbine and new infrastructure locations, which had been devised as part of a design iteration process taking account of a range of physical and environmental constraints, including desk study findings relating to peat. 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), due to the likelihood of substantial historical peat disturbance at the site, the considerable physical restrictions on accessing areas of dense forestry, the re-use of substantial existing forest road infrastructure, and the other established technical and environmental constraints guiding the layout iteration process.

11.5.9 This initial Phase 1 survey demonstrated that, in the main, proposed turbine and infrastructure locations were practical and made the most of existing forest roads. However, some localised deep peat was identified, prompting design changes to move infrastructure to areas of interpreted shallower peat. It was also concluded that there were gaps in the data obtained from the Phase 1 survey, requiring additional survey effort to further inform the design iteration process, prior to completing detailed Phase 2 survey work at confirmed 'design chill' infrastructure locations.

11.5.10 Therefore, a 'Phase 1b' survey programme was undertaken, seeking to gain peat depth data at and in the vicinity of proposed infrastructure locations where no data was available from Phase 1, as well as extending the coverage of survey points around proposed infrastructure locations, to aid in micro-siting or indeed more substantial re-siting of infrastructure where deeper peat was identified.

11.5.11 Following completion of Phase 1b surveys, the site design was further reviewed, and changes were made to avoid or minimise siting infrastructure on areas of deeper peat. A 'design chill' was arrived at, and Phase 2 surveys were subsequently undertaken, comprising 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, met masts, construction compounds, laydown area, and borrow pit search areas.

11.5.12 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 and plus additional probes, generally every 10 m where feasible, to a minimum of 50 m from the turbine location to the north, south, east and west. Additional points around proposed turbine locations were taken where initial results indicated peat (>0.5 m depth) may be present;
- Approximately five probes at each proposed turbine hardstanding area (centre and four outside corners);
- Every 50 m along proposed new access tracks, plus approximately 10 m either side of each probe, perpendicular to the route of the track (repeated for stretches of track which were re-routed following initial probing which identified deeper peat);
- A minimum of five probes at the location of the proposed substation, temporary compound, temporary laydown area and within the proposed borrow pit search areas; and
- Several probes at or in the vicinity of the two proposed met mast locations.

11.5.13 Consultation was maintained with SEPA throughout the peat survey programme (refer to Table 11.1), to set out the proposed survey strategy, provide preliminary findings, and seek feedback. Although the above survey approach does diverge from the relevant guidance for the reasons set out in Paragraph 11.5.8, it was agreed with SEPA that the surveys were appropriate and suitable for informing site design and assessment work.

11.5.14 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. The data were subsequently used to inform a Peat Slide Risk Assessment (PSRA) and development of an outline Peat Management Plan (PMP); refer to Appendices 11.1 and 11.2 respectively.

Assessment of Potential Effect Significance

11.5.15 The sensitivity characteristics of hydrological, hydrogeological and geological resources have been guided by the matrix presented in Table 11.2, which lists indicative criteria.

Table 11.2 - Sensitivity Criteria (Hydrology, Hydrogeology and Geology)

Sensitivity	Description
High	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.
Medium	Areas containing features of designated regional importance, for example, Regionally Important Geological and Geomorphological Sites (RIGS) considered worthy of protection for their educational, research, historic or aesthetic importance. Moderately permeable superficial deposits allowing some limited transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of Moderate Ecological Status. Significant peat deposits. Moderate risk of flooding. Land capable of supporting Mixed Agriculture i.e. Class 3.2, 4.1 and 4.2.
Low	Geological features not currently protected and not considered worthy of protection. Low permeability superficial deposits likely to inhibit the transport of contaminants. Wetland/watercourse of Poor or Bad Ecological 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.

11.5.16 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.

11.5.17 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 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 11.3. Impacts from aspects of decommissioning are considered to be the same as or lesser than for construction.

Table 11.3 - Magnitude of Change Criteria (Hydrology, Hydrogeology and Geology)

Magnitude of Change	Guidance Criteria
High	Total loss of, or alteration to key features of the baseline resource such that post development characteristics or quality would be fundamentally and irreversibly changed, for example, extensive excavation of peatland or watercourse realignment.

Magnitude of Change	Guidance Criteria
Medium	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.
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, for example short term compaction from machinery movements.

11.5.18 Using these criteria, potential effects resulting from the Proposed Development have been assessed. These effects are presented in Section 11.7. Details of generic and site-specific mitigation measures are given in Section 11.8, with the remaining residual effects detailed in Section 11.9.

11.5.19 The significance of the 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, was developed to provide a consistent framework for evaluation. This is shown in Table 11.4 below.

Table 11.4 – Significance of Effect Matrix

Sensitivity of Receptor	Magnitude of Change			
	High	**Medium**	**Low**	**Negligible**
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

11.5.20 The guideline criteria for the various categories of effect are provided in Table 11.5.

Table 11.5: Significance Criteria (Hydrology, Hydrogeology and Geology)

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 groundwaters of moderate vulnerability, or changes resulting in loss of conservation values to geological or aquatic habitats or designated areas.

Significance	Definition	Guidance Criteria
Minor	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.
Negligible	No detectable change to the environment.	No effects on geological resources, drainage patterns, surface and groundwater quality or aquatic habitats.

11.5.21 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.

11.5.22 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.

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

Requirements for Mitigation

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

Assessment of Residual Effect Significance

11.5.25 An assessment of any predicted significant residual effects on sensitive geological, hydrological or hydrogeological receptors is presented within this chapter (Section 11.9).

Limitations to Assessment

11.5.26 No water quality monitoring or intrusive investigations, other than peat depth survey work as described in paragraphs 11.5.7 to 11.5.14, 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.

11.6 Baseline Conditions

Designated Sites

11.6.1 There are no internationally designated Special Areas of Conservation within the study area.

11.6.2 There are three nationally designated Sites of Special Scientific Interest (SSSI) within the study area:

- Birkenhead Burn SSSI is within the site boundary, in the northeast corner approximately 75 m from the proposed T19 location. It is designated for its palaeontology interest, with exposed bedrock yielding important vertebrate fossil-bearing rocks.

- Birk Knowes SSSI is also within the site boundary, in the northwest. It is designated for similar palaeontology interest to Birkenhead Burn.
- Muirkirk Uplands SSSI is located immediately northwest of the site and is designated for its blanket bog habitat, upland assemblage, and bird interests

11.6.3 Birk Knowes SSSI is more than 500 m from any proposed infrastructure and is considered highly unlikely to be affected by the Proposed Development.

11.6.4 Birkenhead Burn SSSI is nearer to proposed infrastructure, but will not be directly impacted by the development as a result of suitable demarcation and controls proposed to be put in place (refer to paragraph 11.8.6).

11.6.5 The Muirkirk Uplands SSSI is more than 350 m from any proposed turbines. It is nearer to one of the proposed borrow pit search areas, and the potential for indirect effects is therefore considered in the assessment.

Geology (including Soils)

11.6.6 BGS online mapping for the area shows that the bedrock geology underlying most of the site comprises sedimentary rock formations, principally sandstone, mudstone and wacke. The majority of the site is underlain by the Patrick Burn Formation wacke, with the northeast area being underlain by a series of sedimentary strata including Blaeberry Formation mudstone, Dunside Formation sandstone, Leaze formation sandstone, Birkenhead Sandstone, Slot Burn Formation mudstone, siltstone and sandstone. The Ponesk Burn Formation wacke underlies the far southern extent of the main body of the site.

11.6.7 Several igneous intrusions are evident, mainly in the southern part of the site. These include the South of Scotland Granitic Suite (microdiorite and felsite) and the Mull Dyke Swarm (micro-gabbro).

11.6.8 A fault in the northeast site area separates the Patrick Burn Formation from the other sedimentary strata noted above, and there are several smaller faults in the northeast site area. Another fault in the southeast separates the Patrick Burn Formation from the Ponesk Burn Formation.

11.6.9 The existing access road to the site is underlain by similar sedimentary strata and localised igneous intrusions, with Swanshaw Sandstone, Upper Limestone Formation, and Passage Formation rocks towards the east end of the road near the M74.

11.6.10 The bedrock geology as shown on BGS 1:50,000 scale mapping is shown on Figure 11.3.

11.6.11 BGS mapping shows that bedrock across most of the site area Is overlain by peat. Localised areas in the northeast, east and south are shown as having till overlying bedrock, with no peat. This is expected to comprise poorly sorted sand, gravel, cobbles and boulders in a clay matrix. The routes of watercourses onsite have either little or no superficial material over bedrock, or alluvial deposits comprising clays, silts, sands and gravels.

11.6.12 The existing access road to the site traverses areas mainly underlain by till, or with bedrock at or near the surface.

11.6.13 In respect of the soil resource across the site, it is noted that soils across most of the site area are classified as blanket peat. Soils in the southeast and a swathe across the north are classified as podzols, and areas in the southeast and northwest are gleys and brown soils.

11.6.14 The superficial geology as shown on BGS 1:50,000 scale mapping is shown on Figure 11.4.

Coal Mining Risk

11.6.15 The main site area has not been subject to historical coal mining and is not in a coal mining risk area. Only the eastern-most stretch of the existing access road, near the M74, is within a mining risk area.

11.6.16 Several Mining Risk Assessments have been undertaken for other proposed developments using the same existing access road. These have identified no mining-related risks and no required mitigation

measures. Mining hazards are therefore not considered further in this assessment. The Coal Authority provided a Scoping response which supports this approach, noting that no turbines would be installed on the localised part of the proposed application that site falls within a Development High Risk area, therefore a coal mining risk assessment is not required (refer to Table 11.1).

Peat

11.6.17 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 deep peat. Swathes of land in the southeast, northwest and north are defined as Class 4, or areas unlikely to be associated with peatland habitats and unlikely to include carbon-rich soils. Localised areas in the southwest and east are Class 0, mineral soils. The area at Nutberry Hill in the southwest, extending southwest to the site boundary, is defined as Class 1 peat, defined as "nationally important carbon-rich soils, deep peat and priority peatland habitat; areas likely to be of high conservation value".

11.6.18 Peat depth surveys were undertaken as described in paragraphs 11.5.7 to 11.5.14, in consultation with SEPA and guided by *Guidance on Developments on Peatland - Site Surveys* (2017) and the *Good Practice during Wind Farm Construction Guidance* (although diverging from the guidance somewhat due to access restrictions and other factors as set out in the above-noted paragraphs), to identify and characterise peat deposits that may be present around proposed turbines and associated infrastructure.

11.6.19 The locations and findings of the peat probes are illustrated on Figure 11.5.

11.6.20 *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.

11.6.21 The peat depth survey identified areas of deep peat concentrated around the central, low-lying valley between Nutberry Hill and Standingstone Hill, the far north of the site, and the far southwest. The remaining areas surveyed were found to have peat depths generally less than 0.5 m, therefore defined as peaty soil.

11.6.22 Of 1,362 probes advanced during the peat depth survey, the peat depth was 0.5 m or less, defined as peaty or organo-mineral soil, at 442 probes (32.5%). The peat depth was between 0.5 and 1.0 m at a further 555 probes (40.7%). Deep peat, i.e. peat depth greater than 1.0 m, was recorded at the remaining 365 probes (26.8%).

11.6.23 Full details of the peat depth survey, together with a Peat Slide Risk Assessment, are provided in Appendix 11.1. An outline Peat Management Plan is provided as Appendix 11.2.

11.6.24 Laboratory testing results from samples of peat taken during peat depth surveys identified moisture contents generally within or slightly below the typical values for peat of 85 to 95% for half of the 12 samples, while moisture contents were well below this range in the other half. Carbon contents were recorded as being substantially below the typical value of 55% for peat in the same six samples which exhibited low 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 Appendix 11.1 for further detail.

11.6.25 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

11.6.26 The groundwater body beneath the site is indicated by SEPA to comprise the North Glengavel groundwater. This groundwater body was classified by SEPA in 2018 as having an overall status of good.

11.6.27 Hydrogeology mapping data from the BGS shows the bedrock beneath the main site area to comprise a low productive aquifer in which flow is virtually all through fractures and other discontinuities.

11.6.28 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).

Potential Groundwater Dependent Habitats

11.6.29 Habitats indicative of GWDTE were identified during National Vegetation Classification survey work (see Figure 11.6 for a summary of potential GWDTE within the main site area and see Chapter 7 Ecology and Figure 7.3 for further detail).

11.6.30 Habitats indicative of potential groundwater dependency were identified almost entirely along the banks of surface watercourses (namely the Birkenhead Burn, Eaglin Burn, River Nethan, Logan Water, and several small, unnamed watercourses). Given the nature of the Proposed Development site as plantation woodland, and the pattern of wetland habitats identified, it is clear that the habitats are highly modified and likely to be mainly or entirely surface-water dependent, being located along surface watercourses.

11.6.31 An area around Eaglinside in the east of the site, outside and down-slope of the plantation forestry and in a low-lying area between two watercourses, also exhibits habitats indicative of potentially moderate groundwater dependency. However, as noted above, the bedrock underlying the site is low permeability, with very little groundwater anticipated to be present at shallow depths, except potentially within localised fractures. Perched groundwater is expected to be present within the superficial geological deposits, however this is interpreted as being localised and discontinuous.

11.6.32 The above-noted area around Eaglinside, where habitats suggesting potential groundwater dependency, is interpreted as collecting surface water flow, shedding from the forested hillsides.

11.6.33 Given the nature of the on-site land use and associated modified habitats, as well as the site geology and anticipated absence of substantial groundwater except perched water contained in peat and superficial deposits, it is considered that surface water flow along water features and shedding from the hillsides is likely to be sustaining the habitats identified.

11.6.34 Based on the above considerations, it is concluded that on-site and adjacent habitats identified as being potentially groundwater dependent, are in fact fed largely or entirely by surface water.

11.6.35 It is therefore considered that GWDTE are not present at the Proposed Development site, and impacts on GWDTE are not considered further.

Private Water Supplies

11.6.36 SLC and SEPA were consulted regarding the presence of PWS in the vicinity of the proposed turbines and associated infrastructure.

11.6.37 SEPA provided information on registered or licensed activities within a 3.5 km radius of the site centre. No PWS were identified.

11.6.38 SLC identified a record of a PWS at Blackhill, approximately 260 m east of the site boundary and over 400 m from the nearest proposed infrastructure (T20). No information was available regarding the source of this supply or its use, however the property is known to be abandoned and there is no evidence of an active PWS at this location.

11.6.39 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. The online interactive map held by the Drinking Water Quality Regulator for Scotland (DWQR) shows no PWS within the study area, and no evidence of potential PWS has been observed during site survey work. The only record of a possible historical PWS, understood to no longer be active, is more than 250 m from any proposed infrastructure. An assessment of effects on PWS is therefore not considered further within this chapter.

Summary of Groundwater Sensitivity

11.6.40 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

11.6.41 As shown on Figure 11.2, there are a number of watercourses within the study area (1 km buffer around proposed new infrastructure), with the two largest being the River Nethan in the south and the Logan Water in the north. These are described further below:

River Nethan and Tributaries

- The River Nethan rises within the forest at the western edge of the site and flows from southwest to northeast. It forms the southern boundary of the main body of the site and traverses the northern part of the spur where T20 and T21 are located, towards the east.
- The Eaglin Burn rises in the northwest of the site on the west side of Standingstone Hill and drains south to the River Nethan.
- The Pockmuir Burn rises at the southwest edge of the forest near Hare Craig, flowing northeast under the existing access road to the site, continuing on to follow approximately the southeast boundary of the site spur near T21, eventually draining into the River Nethan just east of the site boundary near Cumberhead Farm.
- Numerous additional unnamed tributaries to the River Nethan rise on the slopes of Nutberry Hill, Standingstone Hill and Tod Law, flowing southeast into the Nethan.

Logan Water and Tributaries

- The Logan Water rises on the eastern slope of Spirebush Hill to the west of the site, flowing north/northeast and following approximately the western site boundary to the Logan Reservoir, which it bypasses via an aqueduct, re-joining the main channel on the north side of the dam which forms the northeast extent of the reservoir. The Logan Water continues flowing north/northeast beyond the reservoir, turning east and then south to join the River Nethan some 3 km northeast of the site boundary.
- The Birkenhead Burn rises on the northwest slopes of Standingstone Hill, in the north of the site just inside the western site boundary. It flows eastward across the northern extent of the site, joining the Logan Water some 2 km to the east.
- Long Burn rises on the northeast slope of Nutberry Hill in the southwest part of the site, flowing northeast then turning northwest, to join the Logan Water near Logan Reservoir, some 500 m north of the site boundary.
- Several unnamed tributaries of the Logan Water and Long Burn rise on the north and west slopes of Nutberry Hill, draining to the northwest.

11.6.42 There is a series of hill features – Priesthill Height, Nutberry Hill and Standingstone Hill – effectively dividing the site, with the areas northwest of the high points draining north and west to the Logan Water, either directly or via Long Burn, the Birkhenhead Burn, or other small tributaries. The areas southeast of the high points drain southeast to the River Nethan, directly or via the Eaglin Burn or small tributaries. Black Hill, at the south of the southeast site spur, forms another divide, with the far southern extents of the site draining south/southeast from there to the Pockmuir Burn.

11.6.43 All site drainage is eventually to the River Nethan via the above routes. Beyond the immediate site area, the River Nethan continues to flow generally east and north, under the M74 near Lesmahagow and into the River Clyde near Crossford.

11.6.44 The River Nethan water was classified by SEPA in 2018 as Moderate quality, and the Logan Water was classified by SEPA as Good in 2018.

11.6.45 The existing access road to the site crosses several additional watercourses, including the Hagshaw Burn, Shiel Burn, and Alder Burn. Given that no substantial works are proposed, affecting this access road, those watercourses are not considered further in the assessment.

11.6.46 For the purposes of this assessment and taking account of the Moderate to Good status of the local watercourses, the sensitivity of baseline hydrological resources at this site is considered to be high.

Water Crossings

11.6.47 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 Appendix 11.3 and Appendix 3.3), which will be used and have been assessed as not likely to require any substantial upgrading works. Nine of these are on forestry tracks within the main body of the site. Eight are on the main access road into the site, between the site boundary and the western edge of the proposed Douglas West Extension Wind Farm site. Four additional existing crossings (one which may require upgrade or replacement) on existing roads within the proposed Douglas West Extension Wind Farm site, which are also proposed to be used to access the Proposed Development. The proposed use of existing and proposed infrastructure within the Douglas West Extension site is discussed further in Appendix 3.3.

11.6.48 A further one existing water crossing will be upgraded to ensure it is suitable for the required loads. Six new water crossings will be required. The proposed new and upgraded crossings are briefly outlined below, with further details provided in the water crossing schedule, Appendix 11.3.

- NWC1 is a proposed new crossing of a drainage ditch which discharges into the upper reaches of the River Nethan, on the track leading to T1. A piped watercourse crossing will be formed at the new track crossing point.
- NWC2 is a proposed new crossing of the upper reaches of Long Burn, on the track leading to T9. A piped watercourse crossing will be formed at the new track crossing point.
- NWC3 is another proposed new crossing of the upper reaches of Long Burn, downstream of NWC2, on the track leading to T10. A piped watercourse crossing will be formed at the new track crossing point.
- NWC4 is a proposed new crossing of an unnamed stream discharging to the Eaglin Burn, on the track to T12. It may be possible to avoid this crossing being required through micro-siting, otherwise a piped watercourse crossing will be formed at the new track crossing point.
- NWC5 is a historical existing crossing of the Birkenhead Burn, where the proposed new track from T16 meets the existing track which will be used to reach T19. The historical existing water crossing is not considered to be suitable for the Proposed Development, therefore it will be upgraded via installation of a piped watercourse crossing.

- NWC6 is a proposed new crossing of an unnamed tributary to the River Nethan, on the track to T17. A piped watercourse crossing will be formed at the new track crossing point.
- NWC7 is a proposed new crossing of the River Nethan, on the track to T20. A bottomless arch culvert will be formed over the watercourse at the new track crossing point.

11.6.49 The locations of the existing and proposed water crossings are shown on Figure 11.2 and within Appendix 3.3.

Borrow Pit Search Areas

11.6.50 As shown on Figure 11.2, three borrow pit search areas have been identified:

- The southern borrow pit search area is immediately west of the existing track leading into the main body of the site, east of T1. It is effectively an extension of an existing quarry, considered likely to be a suitable location for winning stone through excavating into the hillside above the existing track. It is well sited to provide stone for constructing tracks in the southern part of the site, being located near the entrance into the main body of the site.
- The central borrow pit search area is immediately east of the existing track leading to T3, and is also an extension of an existing quarry. Similarly, to the southern search area, this is considered to be a suitable location for winning stone through excavating into the hillside above the existing track.
- The northern borrow pit search area is immediately northwest of the existing track near T12. This is considered likely to be a suitable option in the northern part of the site, to win stone for construction works in this area and therefore limit haul distances.

11.6.51 It is proposed that the actual borrow pit(s) would be located within the identified search areas, however, would only require using a relatively small portion of the search areas.

11.6.52 The bedrock geology at all the borrow pit search areas is wacke of the Patrick Burn Formation, considered to have potential for providing suitable rock for site construction, as evidenced by the existing small quarries at two of the search areas. As set out in Chapter 3 Proposed Development, 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.

11.6.53 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 Appendix 11.2 Outline Peat Management Plan.

Flooding

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

11.6.55 This map indicates that areas of fluvial flood risk (flooding from rivers) are confined to the channels of the River Nethan, Pockmuir Burn and Birkenhead Burn, and the immediate vicinity of these watercourses.

11.6.56 This map identifies very limited, localised areas with a risk of surface water flooding, all following the channels of the minor watercourses on site.

11.6.57 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 Proposed Development site, and the sensitivity of the site to flooding, is considered to be low.

Contaminated Land

11.6.58 Historically, the main body of the site has largely been undeveloped moorland, with historical maps from the mid-1800s to 1955 showing no development onsite except small-scale lead mines, disused from at least the early 1900s, on the banks of the River Nethan south of Nutberry Hill. Given the very limited scale of this historical land use, the time elapsed, and the absence of any proposed infrastructure in the immediate vicinity (the nearest being T4, over 100 m away), there is not considered to be a material risk associated with any potential residual contamination.

11.6.59 The 1950 map edition shows a small quarry on the north side of the track, running along the north of Birkenhead Burn, in close proximity to the west of the proposed location of T19. The area is now occupied by mature woodland and an existing track. There is potential that the quarry may have been at least partially backfilled with unknown materials, however given its small scale and relatively remote location, it is considered likely that any backfill would have comprised reworked soils and rock, rather than any more potentially contaminative material. The quarry is no longer shown on the 1955 map edition. Therefore, given its small scale, the time elapsed since any potential backfilling, and the absence of any proposed new infrastructure at the location of the former quarry, it is not considered to represent a potentially significant contamination risk.

11.6.60 With no potentially significant contamination sources identified within the main body of the site, and no substantial disturbance proposed to the existing access road into the site, contaminated land will not be considered further within this assessment.

11.7 Potential Effects

11.7.1 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

11.7.2 The construction phase includes all activities prior to the operation of 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.

Direct Impacts on Geological SSSIs

11.7.3 Two SSSIs designated for their geological interest (vertebrate fossil-bearing rocks) are located within the site boundary. The Birk Knowes SSSI is more than 500 m from any proposed infrastructure and is considered highly unlikely to be affected by the Proposed Development. Birkenhead Burn SSSI is nearer to proposed infrastructure (approximately 75 m from T19) but is an exposure within a steep watercourse valley which would be demarcated to prevent access or damage in the course of the construction works.

11.7.4 The magnitude of change is none. There is therefore no effect assessed on the Birk Knowes and Birkenhead Burn SSSIs.

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

11.7.5 Surface run-off containing silt and other sediments, particularly during and after rainfall events, has the potential to enter the watercourses and field drains on-site. Silt and sediment laden surface water run-off is predicted to arise from excavations, exposed ground and any temporary stockpiles.

11.7.6 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.

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

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

Pollution Impact from Forestry Felling

11.7.9 The on-site forestry will be felled where required to construct site infrastructure, in line with a Wind Farm Forest Plan, which differs very little from the Baseline (i.e. without wind farm) Forest Plan (refer to Chapter 16 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.

11.7.10 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

11.7.11 As discussed in Section 11.6, there is anticipated to be little groundwater at shallow depth beneath the site, limited to perched groundwater within peat deposits, and localised areas of till with higher proportions of sand and gravel content. Groundwater within the bedrock is anticipated to be minimal, with flow restricted to fissures and other discontinuities.

11.7.12 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 energy storage compound, the temporary construction compounds, and the temporary laydown area. However, given the anticipated absence of substantial groundwater within the superficial deposits, any changes to groundwater flow would be highly localised.

11.7.13 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.

Indirect Impacts on the Muirkirk Uplands SSSI

11.7.14 Excavations and dewatering during construction of the Proposed Development have the potential to temporarily lower groundwater levels, as discussed above. However, the zone of influence is likely to be restricted to the immediate vicinity of excavations, given the interpreted low permeability of deposits. With the nearest turbine sited over 350 m from the boundary of the SSSI, and the nearest proposed infrastructure to the SSSI being a borrow pit search area (which would be subject to detailed investigation to identify a specific location suitable for extraction of rock without adversely affecting the SSSI), the potential impact is considered to be negligible to low, on a high sensitivity receptor, resulting in an indirect, temporary, short-term effect of **minor to moderate** adverse significance in the absence of mitigation.

Removal of and Impact on Peat

11.7.15 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 2 Site Selection and Design). This has resulted in the following:

- Only one of 21 turbines (T7) has been sited on an area with peat depth slightly greater than 1 m (therefore defined as deep peat).
- All turbine hardstandings (including the T7 hardstanding) are on areas with peat thickness less than 1 m, or in the case of the T11 hardstanding, equal to 1 m.

- Both met masts, the substation compound, both temporary construction compounds, the temporary laydown area, and all borrow pit search areas, are sited within areas where the average peat depth is less than 1 m.
- All sections of new track, except two, are sited across areas with peat depth less than 1 m. The short stretch of track from the existing track to T11 (approximately 0.32 km length) crosses an area with average peat depth of 1.3 m. The approximately 0.09 km length of new track required to straighten a bend in the existing track immediately west of met mast 2 crosses an area with average peat depth of 2.1 m. Given the existing track at this location, the option of re-using existing infrastructure by straightening the bend, even over a short stretch of deep peat, was considered preferable to building a longer stretch of entirely new track in a slightly different location.

11.7.16 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 11.2.

11.7.17 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

11.7.18 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 11.1. This has identified low peat landslide risk at all proposed turbine, hardstanding and other infrastructure locations except T13, which has been assessed as negligible risk, and the southern borrow pit search area, which has been assessed as medium risk.

11.7.19 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).

11.7.20 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

11.7.21 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.

11.7.22 Permanent new watercourse crossings will be required at six 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 one, which will comprise a bottomless arch culvert. Further details are provided in Appendix 11.3 Watercourse Crossing Schedule.

11.7.23 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

11.7.24 Unless appropriately sited and managed, there is potential for direct discharge of untreated foul sewage from welfare facilities from site compounds during construction.

11.7.25 The magnitude of change, prior to mitigation, is medium, on a high sensitivity receptor. Therefore, there is likely to be a direct, temporary, medium-term effect of **major** adverse significance on watercourses prior to the implementation of mitigation measures.

Operation

Surface Water Drainage

11.7.26 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.

11.7.27 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

11.7.28 If watercourse crossings are not designed properly to ensure continuous flows, this could potentially adversely affect the geomorphology of the streams by reducing heterogeneity.

11.7.29 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

11.7.30 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.

11.7.31 Discussions will be held with SLC and the appropriate Regulatory Authorities prior to decommissioning to agree an appropriate Decommissioning Strategy.

11.8 Mitigation

Project Design

11.8.1 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 Proposed Development):

- Existing tracks have been incorporated into the site design as far as possible, minimising the requirement for new road construction. This has resulted in only 8.79 km of new track being proposed, with 18.36 km of existing or upgraded track to be used. It has also resulted in only six new water crossings and one upgraded water crossing being required, with the other water crossings being existing and 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, and a small number of other exceptions described below.
    - The extreme northern corner of the southern borrow pit search area extends into the 50 m buffer around a tributary of the River Nethan. This is a result of following the shape of the

existing track, and in practice excavation would not occur within close proximity to the watercourse.

- The far eastern edge of the southern part of the central borrow pit search area extends into the 50 m buffer around a tributary to the River Nethan. This is a result of following the location of existing borrow pit workings and the shape of the proposed new track alignment as it crosses the small watercourse (via an existing crossing). As above, in practice excavation would not occur within close proximity to the watercourse.
- A short stretch of track (approximately 0.26 km long) leading to T19 is marginally inside the 50 m buffer around the Birkenhead Burn. This is an existing track and the only works proposed here would be minor upgrading/widening.

11.8.2 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.

11.8.3 Replanting of felled forestry will be key-holed i.e. areas left unplanted will be minimised to include only those areas required for turbine and infrastructure construction and suitable buffer areas.

11.8.4 Areas of deep peat have been avoided in siting all except one turbine, all turbine hardstandings, all except two short stretches of new track, and all other infrastructure. Specific examples of proposed infrastructure being re-sited or re-aligned to reduce impacts on peat are noted below.

- The substation, control room and energy compound, and several turbines, were re-sited based on peat survey findings, to ensure that they were not located on areas of deep peat.
- T19 and associated access track were initially sited further north, however early peat surveys identified some of the deepest peat on site at and around this location (peat depths over 3 m). Therefore, the T19 location and associated track alignment were moved south to an area of shallower peat and the far northern area was excluded from consideration for siting any infrastructure.
- T20 and associated access track were also initially located to the north of the minor road to Logan Farm (refer to Chapter 2). Following initial peat probing works this turbine was removed and relocated on a new parcel of land identified to the south of the minor road to Logan Farm which is free from deep peat.
- The track section linking T17 and T18 was initially further west, however Stage 2 peat surveys identified peat depths over 3.0 m in this area, becoming shallower to the east. The track section was therefore moved east and the revised track alignment was re-probed to confirm peat depths generally less than 1.0 m.

11.8.5 The three proposed infrastructure elements where deep peat could not be avoided are described below.

- T7, the only turbine sited on peat marginally deeper than 1 m, was sited with careful consideration of other constraints, including a 50 m buffer around a minor watercourse to the north, steep slopes, and the requirement to maintain adequate spacing between turbines. Following detailed pre-construction site investigations, there may be an opportunity to micro-site the turbine in order to reduce the volume of peat requiring excavation.
- The stretch of new track from the existing track, westward to T11, was routed to reach T11 from the existing track (using existing infrastructure preferentially to constructing a new track elsewhere), following the land contours, and avoiding pockets of even deeper peat immediately north and south. T11 itself, where this stretch of track leads, was sited on the

shallowest peat identified in this vicinity (<0.5 m), taking account of other constraints and required spacing between turbines.

- The short stretch of new track required to straighten a sharp bend in the existing track west of met mast 2 crosses a limited stretch of deep peat. No other suitable options for routing new track in the vicinity could be identified, and it was considered preferable to make use of the existing track and only require this short stretch of new/straightened track, rather than building a longer stretch of new track on peat potentially nearly as deep.

11.8.6 No infrastructure is proposed in or near areas of identified medium or higher peat landslide risk except the southern borrow pit search area. 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. If a suitable specific excavation location within the southern borrow pit search area cannot be identified, then no excavation will take place within that search area.

11.8.7 Although no effect on the on-site geological SSSIs is predicted, the Birkenhead Burn SSSI area will be demarcated during construction works to ensure no accidental access to the area by construction plant which could cause damage. Additionally, bedrock which is exposed by excavation works will be examined and recorded for the purposes of furthering geological interest and understanding. Post-construction, the Applicant proposes to install an information boards or similar in the vicinity of the Birkenhead Burn SSSI, in consultation with NatureScot and SLC, to provide information about the geological/palaeontological interests that can be observed in the area.

Pre-construction Site Investigations

11.8.8 In order to determine the 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 unsuitable areas, such as areas of contamination (unlikely), areas of deeper peat wherever possible, or where there are significant groundwater flows.

11.8.9 The investigations will also include targeted monitoring and assessment of the groundwater levels and flows beneath the site. This will allow for micro-siting of the features of the Proposed Development 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

11.8.10 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.

11.8.11 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 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.

11.8.12 If it is not possible to avoid routing tracks over localised areas of deep peat, as may be the case for short stretches of track which have been routed to make best use of existing track infrastructure in the immediate vicinity, those localised stretches of track over deep peat 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.

11.8.13 Any peat excavated will be re-used on site as set out in the Outline Peat Management Plan (Appendix 11.2).

11.8.14 Peatland restoration is proposed in two areas of the site, one which has been degraded by historical drainage and self-seeding of conifers, and a second area which is currently forested and due to be felled and left as open land. Habitat management measures including removal of self-seeded conifers and blocking of 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, are proposed. Further detail is provided in Appendix 7.5 Outline Habitat Management Plan.

11.8.15 The proposed peatland restoration methods are well established and can be considered to have a high potential for success. SPR has been at the forefront of blanket bog restoration, developing new techniques to restore these habitats which are effective and scalable to meet the challenges of biodiversity, climate change, water quality and natural flood management. Between 2010 and 2019, SPR has implemented 1500 ha of peatland restoration from commercial forestry across its projects. This work transcends wind farms, with the techniques now being adopted by other organisations including Forestry and Land Scotland, RSPB and NatureScot to assist with their own restoration ambitions and objectives. In 2017, SPR was invited by the International Union for Conservation of Nature (IUCN) to act as lead authors of a new technical report for their Commission of Inquiry into Peatlands which was published in 2019. This report describes the historical work done by SPR and other organisations to restore blanket bog from forestry, the methods which have been developed and their efficacy at achieving restoration objectives. The report can be viewed here:

https://www.iucn-uk-peatlandprogramme.org/resources/commission-inquiry/commission-inquiry-peatlands-update-2017-20

Water Quality

11.8.16 The appointed Contractor will undertake pre-construction baseline water quality sampling and analysis at the River Nethan, Birkenhead Burn, Long Burn, and Eaglin Burn, and will implement a programme of regular monitoring and analysis of the water quality of the watercourses throughout the construction period.

Pollution Impact from Silt-laden Run-off and Chemical Contaminated Run-off

11.8.17 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 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 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.

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

11.8.19 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.

11.8.20 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 South Lanarkshire, 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.

11.8.21 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.

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

11.8.23 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.

11.8.24 Concrete batching will be undertaken at a designated area at the temporary construction compound at the main site entrance, over 100 m from the nearest watercourse (a small drain). 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. A limited amount of water abstraction will be required to facilitate the on-site batching process. 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.

11.8.25 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.

11.8.26 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.

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

11.8.28 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

11.8.29 Felling works will be undertaken in accordance with standard good forestry 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 16.

Impact on Integrity of Banking

11.8.30 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.

11.8.31 Where the proposed bottomless arch culvert crossing is being constructed (NWC7), 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 SLC and SEPA and detailed watercourse crossing designs will be regulated under the CAR licensing regime.

Direct Discharge of Untreated Foul Drainage

11.8.32 Welfare facilities will either connect directly to self-contained storage tanks or to a septic tank, subject to approval from SEPA.

11.8.33 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

11.8.34 The proposed track and hardstanding design principles for the Proposed Development are presented in Chapter 3.

11.8.35 Prior to construction, a detailed Drainage Strategy (DS) will be developed and agreed with SEPA and SLC. 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

11.8.36 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.

11.9 Residual Effects

Construction

Direct Impacts on Geological SSSIs

11.9.1 No effect on the SSSIs is predicted. However, the mitigation/enhancement measures set out above, including observation and recording of exposures of geological interest during excavation works, and installation of an information board or similar at the Birkenhead Burn SSSI site, will result in an indirect, long-term residual effect of **minor** beneficial significance.

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

11.9.2 The committed mitigation measures, including buffering of watercourses, implementation of a suitable CEMP (refer to Appendix 3.1 Draft CEMP), and a surface water monitoring programme during construction, are considered to reduce the magnitude of impact to negligible to low, resulting in a direct, temporary, short-term residual effect of **minor to moderate** adverse significance.

Pollution Impact from Forestry Felling

11.9.3 The committed mitigation measures, including implementation of a suitable CEMP (refer to Appendix 3.1 Draft CEMP) and good practice felling practices, and a surface water monitoring

programme during construction, are considered to reduce the magnitude of impact to negligible to low, resulting in a direct, temporary, medium-term residual effect of **minor to moderate** adverse significance.

Changes to Groundwater Flow

11.9.4 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.

Indirect Impacts on the Muirkirk Uplands SSSI

11.9.5 The committed mitigation measures, including pre-construction site investigations to inform detailed extraction sites within the borrow bit search areas, foundation and infrastructure design and micro-siting, are considered to reduce the magnitude of impact to negligible, resulting in an indirect, temporary, short-term residual effect of **minor** significance.

Removal of and Impact on Peat

11.9.6 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

11.9.7 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 to low, resulting in a direct, temporary, short-term residual effect of **minor to moderate** adverse significance.

Impact on the Integrity of Banking

11.9.8 The committed mitigation measures, including appropriate water crossing designs regulated by CAR and agreed with SEPA and SLC, and 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

11.9.9 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

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

Fluvial Geomorphology

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

Decommissioning

11.9.12 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.

11.10 Cumulative Assessment

11.10.1 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.

11.10.2 In terms of hydrology and hydrogeology, a number of operational and proposed wind energy projects in the vicinity lie partially within the catchment of the River Nethan. A proportion of the drainage from these wind farms are likely to drain into the River Nethan, although flows are also likely to be distributed to other watercourses as well. All of these wind farms either have or will be required to prepare their own drainage strategies to protect all receiving watercourses from pollution and increased run-off. Therefore, with negligible or minor predicted residual effects on the River Nethan from the Proposed Development, 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.

11.11 Summary

11.11.1 The Proposed Development site is located within the Clyde River catchment, with site drainage reaching the Clyde via the River Nethan, which itself receives drainage from the other on-site and adjacent watercourses, the Eaglin Burn, Birkenhead Burn, Long Burn, and Logan Water. The River Nethan is classified by SEPA as having moderate water quality, but the Logan Water is classified as good quality, therefore the surface water resources at the site are precautionarily considered within the assessment to have good water quality.

11.11.2 The rock beneath the site is typically sedimentary with localised igneous intrusions, forming a low productivity aquifer. Superficial deposits largely comprise peat and till (typically low permeability).

11.11.3 A localised area in the southwest of the site is identified as Class 1 Peat according to the SNH Carbon and Peatlands Map 2016. However, detailed peat surveys identified variable thicknesses of peat across the site, with approximately 32% of probes recording peaty or organo-mineral soils (peat depth <0.5 m) rather than peat. Localised deep peat (>1 m) was identified.

11.11.4 Extensive design iteration works were undertaken to avoid siting turbines or other infrastructure on deep peat wherever possible. Specific examples include re-siting several turbines, the substation, control room and energy storage compound, and tracks including the stretch between T17 and T18. This has resulted in areas of deep peat being avoided in siting all except one turbine, all turbine hardstandings, all except two short stretches of new track, and all other infrastructure.

11.11.5 A peat slide risk assessment has identified low risks at all turbine and other infrastructure locations, except one turbine which was assessed as negligible risk and one borrow pit search area which was assessed as medium risk.

11.11.6 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.

11.11.7 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, to negligible to low. Therefore, 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 Table 11.6.

Table 11.6 – Construction Summary Table

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Direct effects on geological SSSIs	None	N/A	Demarcation of Birkenhead Burn SSSI during construction to ensure no accidental access to this area by plant. Geological observation and recording of exposures during excavation. Installation of information board or similar at Birkenhead Burn SSSI.	Minor	Beneficial
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 to Moderate	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 to Moderate	Adverse
Changes to groundwater flow regime	Negligible	Adverse	Pre-construction site investigation. CEMP and construction site management.	Negligible	Adverse
Indirect effect on the Muirkirk Uplands SSSI	Minor to Moderate	Adverse	Pre-construction site investigation. CEMP and construction site management.	Minor	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

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/ Adverse		Significance	Beneficial/ Adverse
Peat landslide impact on watercourses	Moderate	Adverse	Pre-construction site investigation to inform detailed design and geotechnical control measures. Avoidance of peat for borrow pit excavations. Micro-siting infrastructure where required and appropriate.	Minor to Moderate	Adverse
Loss of bank integrity	Major	Adverse	Suitable water crossing design, regulated by CAR. CEMP and construction site management.	Minor	Adverse
Pollution from foul drainage	Major	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 11.7 – 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 SLC. To detail drainage design to slow surface water flows and ensure that run-off from hard surfaces will be controlled. Appropriate design of water crossings to maintain continuous flows.	Minor	Adverse
Alteration to fluvial geomorphology	Moderate	Adverse	Appropriately designed drainage and watercourse crossings.	Minor	Adverse

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