# 9 Geology, Peat, Hydrology & Hydrogeology

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# 9 Geology, Peat, Hydrology & Hydrogeology

## 9.1 Executive Summary

9.1.1 This chapter considers the potential significant effects on important hydrological, hydrogeological, geological and peat features associated with the Proposed Development.

9.1.2 The assessment is based upon comprehensive baseline data, comprising desk study information, hydrological field surveys, peat depth surveys, peat slide hazard risk assessment surveys, outline peat management plan, watercourse crossing assessment and private water supply assessment of important and legally protected soil and water features and is based on standard Environmental Impact Assessment (EIA) guidance.

9.1.3 The Proposed Development area supports the following sensitive receptors: relatively limited areas of peat and Annex 1 habitat blanket bog and wet heath, two areas of low peat slide risk which were not considered to be of significant consequence, protected mammals (otter and water vole), limited optimal fish and invertebrate habitat, a small area within a surface water Drinking Water Protection Area (DWPA), Scottish Water mains pipeline infrastructure, and one private water supply (PWS) catchment potentially connected to the existing western access track. These are all considered to be of Negligible to Minor significance of effect with the exception of the Glenalla Farm PWS, which is assessed as Minor/Moderate (not significant) significance of effect, and a section of the northern access track along the Balbeg Burn, which is assessed as moderate significance of effect due to its high sensitivity and the proximity of the watercourse to the track.

9.1.4 Standard good practice and mitigation measures adopted will include: embedded mitigation in scheme design and good practice measures such as the production of a drainage management plan, a water quality monitoring plan, including the PWS, and appointment of an Ecological Clerk of Works (ECoW) to oversee the implementation of the ecological and hydrological mitigation measures. Habitat enhancement opportunities as detailed in an outline habitat management plan will also be implemented. Following the application of the standard good practice guidance and additional mitigation, including water quality monitoring, an emergency response plan and method statements for additional runoff and sediment management for the PWS and Balbeg Burn track sections, no significant adverse direct and/or indirect effects on soil or water features as a result of the Proposed Development are anticipated.

9.1.5 As set out in Chapter 3, two prospective access routes (northern and western) have been identified, although only one route to site will be selected and utilised. Given that it is not certain at this stage which route will be used, the potential effects associated with construction and operation of both options have been assessed together. This results in some aspects such as development footprint area and estimated peat excavation volumes being over-stated, given that numbers reflected in the assessment are based on cumulated figures for both access routes. A qualitative review has identified that the level of impacts and significance of effects would not be materially different depending on which route is selected. Crucially, the assessment has also identified no significant residual effects even when considering both access routes combined. It therefore follows that impacts will if anything be less than has been assessed.

## 9.2 Introduction

9.2.1 This Chapter has been undertaken by Fluid Environmental Consulting (Fluid) and assesses the potential geology, peat, hydrological and hydrogeological impacts of the Proposed Development approximately 4.8 km south of Straiton, South Ayrshire, Scotland.

9.2.2 The Chapter presents the current environmental setting (baseline) for the related environmental topics and associated links to other chapters such as Ecology and Nature Conservation (Chapter 8) due to their potential dependence on the water environment and also consultee responses. Desk-based and site-based surveys including peat surveys have been carried out to inspect and identify all hydrogeological, hydrological and geological features.

9.2.3 The assessment identifies the potential effects of the scheme and assesses the significance of these effects based on the magnitude of the impact and the sensitivity of the receptor(s). Impacts are assessed based on the risk of: sedimentation and erosion; pollution; alteration of natural drainage patterns, run-off volumes and rates; flood risk and alteration of the geological environment through the dewatering and excavation of peat. Mitigation, management and monitoring measures are then discussed and the residual effects relevant to geology, hydrology and hydrogeology determined.

9.2.4 The Proposed Development will comprise nine wind turbines up to 200 m blade tip height when vertical, with an associated on-site energy storage system (Figure 1.1). Two access routes have been identified, one from the north utilising a forestry track currently under construction at the time of writing and the other from the west where there is an existing track. Both routes will require some upgrading and have been appropriately assessed. However, only one route will be utilised for construction and operation access. The site covers approximately 540 hectares (ha) of land with proposed infrastructure comprising the above-noted site access routes (both options included in the site area but only one to be used), nine turbines, a substation, anemometry mast, a temporary gatehouse and construction compound, an energy storage area and up to five borrow pit search areas. Depending on the access route selected (northern or western) there will be approximately 5.7 to 6.2 km of new track constructed, and approximately 2.2 to 2.8 km of existing track upgraded. Approximately 0.2 km of the new track is proposed to be floated, with the remainder excavated.

9.2.5 Where appropriate in this chapter, the term 'main development area' is used to refer to the site area where the turbines, crane pads, energy storage system, and the tracks and cabling between turbines and other infrastructure. The two proposed access routes to the main development area are referred to as the northern and western access route options.

9.2.6 The Study Area encompasses the whole of the Proposed Development area and a wider area essentially related to the surface water catchments connected to the site.

9.2.7 This Chapter is supported by the following Technical Appendices:

Technical Appendix 9.1: Good Practice Methods;

Technical Appendix 9.2: Peat Survey Report;

Technical Appendix 9.3: Outline Peat Management Plan;

Technical Appendix 9.4: Peat Landslide Hazard Risk Assessment;

Technical Appendix 9.5: Watercourse Crossing Inventory; and

Technical Appendix 9.6: Private Water Supply Assessment.

9.2.8 Further detail on the Proposed Development is provided in Chapter 3 of this EIA Report.

## 9.3 Legislation, Policy and Guidelines

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

### *Legislation*

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

9.3.3 Key legislative drivers relating to the water environment which have been considered within this assessment are listed below. With regard to legislation of the European Union, this Chapter has regard to the relevant legislation as it has been incorporated into UK or Scots Law.

- Control of Pollution Act 1974;
- Environmental Protection Act 1990;
- Environment Act 1995;
- Water Framework Directive 2000/60/EC (WFD) 2000;
- Groundwater Daughter Directive 2006/118/EC;
- Water Environment and Water Services (Scotland) Act (WEWS Act) 2003;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended in 2018) (CAR);
- The Environmental Liability (Scotland) Regulations 2009;
- The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017 (amends and revokes the Private Water Supplies (Scotland) Regulations 2006);
- The Public Water Supplies (Scotland) Amendment Regulations 2017 (amends the Public Water Supplies (Scotland) Regulations 2014);
- The Flood Risk Management (Scotland) Act 2009;
- The Waste Management Licensing (Scotland) Regulations 2011;
- Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017;
- Water Supply (Water Quality) Regulations (2016) - BS EN 15975-2:2013 Security of drinking water supply; and,
- Guidelines for risk and crisis management – Part 2: Risk Management 2013.

9.3.4 The Water Framework Directive (WFD) has been implemented in Scotland through the Water Environment and Water Services (Scotland) Act 2003 (WEWs Act) and the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended in 2018) (CAR). The primary objective of the Directive was for all surface and coastal water bodies to achieve good chemical and ecological status, and ground water bodies to achieve good quantitative and chemical status, by 2015 or 2021. This required assessment of a much wider set of water quality parameters than had previously been used. SEPA have published River Basin Management Plans (RBMPs) which detail the current and target status of water bodies, and the means of achieving these targets (as last assessed in 2008 and 2014) with a specific program of measures for each water body which remains non-compliant to be completed by 2021, 2027 or in the longer term.

### *Planning Policy*

9.3.5 Planning policy relevant to the Proposed Development is detailed in Chapter 5.

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

- effects on hydrology, the water environment and flood risk;
- impacts on carbon rich soils, using the carbon calculator;
- it also states that the planning system should: 'promote protection and improvement of the water environment, including rivers, lochs, estuaries, wetlands, coastal waters and groundwater, in a sustainable and co-ordinated way' (paragraph 194); and
- 'Development management decisions should take account of potential effects on landscapes and the natural and water environment, including cumulative effects' (paragraph 202).

9.3.7 SPP 2014 also includes parts of the the site in Group 2: Areas of significant protection due to the presence of carbon rich soils, deep peat and priority peatland habitat.

9.3.8 SPP is under review and as noted in Chapter 5, a consultation draft of the new National Planning Framework 4 (NPF4) was published in Novemeber 2021 (after completion of this assessment). When finalised, NPF4 will become the single national planning policy document, replacing both NPF3 and SPP and it will have Development Plan status when it comes into force.

9.3.9 The following Planning Advice Notes are also relevant to the assessments made in this Chapter:

- Planning Advice Note 61: Planning and SUDS, 2001; and
- Planning Advice Note 79: Water and Drainage, 2006.

### *Guidance*

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

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

- GPP1: General guide to the prevention of pollution (EA, SEPA & EHSNI, January 2020);
- GPP2: Above ground oil storage tanks (EA, SEPA & EHSNI, January 2018);
- GPP4: Treatment and disposal of sewage where no foul sewer is available (EA, SEPA & EHSNI, November 2017);
- GPP5: Works and maintenance in or near water (EA, SEPA & EHSNI, February 2017);
- PPG6: Working at construction and demolition sites (EA, SEPA & EHSNI, 2012);
- GPP8: Safe storage and disposal of used oils (EA, SEPA & EHSNI, July 2017);
- PPG21: Pollution incidence response planning (EA, SEPA & EHSNI, June 2021); and
- PPG26: Storage and handling of drums and intermediate bulk containers (EA, SEPA & EHSNI, 2006).

**SEPA Guidelines**

- Managing River Habitats for Fisheries (SEPA 2002);
- Indicative River & Coastal Flood Map (Scotland) (SEPA January 2014, updated April 2018);
- Regulatory Position Statement: Waste Water Drainage (SEPA, 2008);
- Regulatory Position Statement – Developments on peat (SEPA, 2010);
- Temporary Construction Methods, WAT-SG-29 (SEPA, 2009);
- Flood Risk and Planning Briefing Note (SEPA, 2014);
- Position Statement: The role of SEPA in natural flood management (SEPA, Feb, 2012);
- Technical flood risk guidance for stakeholders, version 10 (SEPA, July 2018);
- Environmental Standards for River Morphology, WAT-SG-21 (SEPA, July 2012);

- Land Use Planning System Guidance Note 4 (LUPS GU4) - Planning guidance on on-shore windfarm developments (SEPA, September 2017);
- Land Use Planning System Guidance Note 31 (LUPS-GU31)- Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems (SEPA, November 2017);
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 as amended in 2018 - A practical guide (SEPA, 2011 as amended in 2018);
- River Crossings, Engineering in the water environment: good practice guide (SEPA,2010);
- Methodology for the Water Framework Directive, Scotland and Northern Ireland Forum for Environmental Research, Project WFD 28 Final Report (SEPA, 2004); and
- The River Basin Planning Strategy for the Scotland River Basin District (SEPA, 2009/2015).

**Other Relevant Guidance**

- Control of water pollution from constructions sites. Guidance for consultants and contractors C532 (CIRIA, 2001);
- Environmental good practice on site C650 (CIRIA, 2010);
- Control of water pollution from linear construction projects: technical guidance C648 (CIRIA, 2006);
- SUDS Manual C697 (CIRIA, 697);
- Groundwater Control – design and practice C515 (CIRIA 2016);
- Good practice during windfarm construction (Scottish Renewables, SNH, SEPA & Forestry Commission Scotland, 4th Edition 2019);
- Code of Practice for the sustainable use of soils on construction sites (DEFRA, 2009);
- Guidance on Road Construction and Maintenance Forests and Water Guidelines Fifth Edition (Forestry Commission, 2011);
- A Handbook of Environmental Impact Assessment, 5th Edition (SNH, 2018);
- Design Guidance on River Crossings and Migratory Fish, Scottish Executive, 2000;
- South Ayrshire Local Development Plan (LDP1) and Local Development Plan 2 (LDP2), South Ayrshire Council, adopted September 2014 and submitted to the Scottish Government's Department of Planning and Environmental Appeals for Examination on 12 December 2020 respectively;
- Peatland Survey. Guidance on Developments on Peatland. Scottish Government, Scottish Natural Heritage, SEPA 2017;
- Peat Landslide Hazard and Risk Assessments: Good practice Guide for Proposed Electricity Generation Developments, Scottish Government, Second Edition, 2017;
- Private Water Supplies: Technical Manual, Scottish Executive, 2006;
- Protecting private water supplies during forestry activities – Guidance, the Forestry & Water Scotland initiative, 2017;
- Managing Forest Operations to Protect the Water environment Practice Guidance, Forestry Commission, 2018;

- Forestry Operation near Private Water Supplies Guidance, Forestry and Water Scotland, September 2018;
- Practice guide for forest managers to assess and protect Groundwater Dependent Terrestrial Ecosystems, UK Forestry Standards, January 2018;
- Special Requirements for Civil Engineering Contracts for the Prevention of Pollution, Version 2, SEPA, 2006;
- UK Technical Advisory Group on the WFD, UK Environmental Standards and Conditions Final Report, November 2013; and
- SNH Carbon and Peatland Map, SNH, 2016.

## 9.4 Methodology

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

- a review of the relevant legislation, guidelines and policy;
- consultation with Scottish Water, SEPA, South Ayrshire Council and potential private water supply users potentially connected to the site;
- a desk study to identify any existing information;
- a site visit to confirm information obtained through the desk study and define particular site characteristics such as surface water catchments, the drainage network and the extent and characteristics of peatland habitat;
- a further site visit to undertake a risk assessment of private water supplies potentially connected to the site with an Enforcement Officer, Environmental Health, South Ayrshire Council;
- a review of the ecological information and mapping undertaken by Avian Ecology;
- definition of the likely effects of the project on the hydrological, hydrogeological and geological environment;
- assessment of the likely significance (as described in the EIA Regulations) of those effects based on the sensitivity of the receiving environment and the likely magnitude of the impact;
- discussion of the proposed mitigation measures to reduce or remove any significant effect; and
- determination of the residual effects of the development subsequent to the implementation of the recommended mitigation measures.

## 9.5 Consultation

9.5.1 Consultation was undertaken at various stages of the planning phase of the Proposed Development and fed back into the design.

9.5.2 The details of who has been consulted, when the consultation took place and the responses provided is summarised in Table 9.1.

**Table 9.1 – Consultations in Relation to Geology, Peat, Hydrology and Hydrogeology**

| Consultation | Comments / Information Provided | Applicant Action |
|---|---|---|
| ECU Scoping Opinion<br><br>Scottish Government<br><br>March 2021 | *Knockgardner Site of Special Scientific Interest (SSSI), designated for geological fossiliferous exposure, lies approximately 2.7 km north-west of the site.*<br><br>*Any borrow pits should be considered in the EIA.*<br><br>*Scottish Water provided information on whether there are any drinking water protected areas or Scottish Water assets on which the development could have any significant effect. Scottish Ministers request that the company contacts Scottish Water (via EIA@scottishwater.co.uk) and makes further enquires to confirm whether there any Scottish Water assets which may be affected by the development, and includes details in the EIA report of any relevant mitigation measures to be provided.*<br><br>*Scottish Ministers request that the Company investigates the presence of any private water supplies which may be impacted by the development. The EIA report should include details of any supplies identified by this investigation, and if any supplies are identified, the Company should provide an assessment of the potential impacts, risks, and any mitigation which would be provided.*<br><br>*Scottish Ministers request the Company now review Marine Scotland's generic scoping guidelines for both onshore wind farm and overhead line development which outline how fish populations can be impacted during the construction, operation and decommissioning of a wind farm development and informs developers as to what should be considered, in relation to freshwater and diadromous fish and fisheries, during the EIA process. https://www2.gov.scot/Topics/marine/Salmon-TroutCoarse/Freshwater/Research/onshoreren).6 In addition to identifying the main watercourses and waterbodies within and downstream of the proposed development area, developers should identify and consider, at this early stage, any areas of Special Areas of Conservation where fish are a qualifying feature and proposed felling operations particularly in acid sensitive areas.* | Considered in 9.7 Geology and Designated Sites and 9.8<br><br>Included in Table 9.11<br><br>See further consultation with Scottish Water in Table 9.1 below.<br><br>Included in Technical Appendix 9.6<br><br>Addressed in Chapter 8 and Technical Appendix 8.3 |
| ECU Scoping Opinion<br><br>South Ayrshire Council<br><br>4th March 2021 | *The development should not adversely affect the private water supplies in the area.*<br><br>*A report is required detailing how existing supplies will be maintained both qualitatively and quantitatively and sources and connections not adversely affected. Under the Scottish legislation, if a house does not have an adequate piped supply of wholesome water available within the house, it would fail to meet the tolerable standards.*<br><br>*Environmental Health may be forced to take action to issue a formal Closing or Demolition Order or have the house brought up to the tolerable standard, via the 1987 Housing Act.*<br><br>*There would be no recourse to connect to mains water for most of the properties listed and unlisted.* | Assessed in Technical Appendix 9.6<br><br>Addressed in Technical |

| Consultation | Comments / Information Provided | Applicant Action |
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| | a) *Prior to consent being granted, a water management plan covering water control and the means of drainage from all hard surfaces, structures and borrow pit sites within the site shall be submitted for approval of the planning authority and following approval shall be implemented by the company. For the purposes of this condition "hard surfaces" includes internal access tracks, construction and lay-down areas, turbine pads and crane pads. The details to be submitted shall include the means of protecting surface water and ground water and controlling surface water run-off. The management plan as approved shall then be implemented in full. Evidence MUST include a timeously prepared risk assessment in accordance with EN15975-2:2013 – Guidelines for risk and crisis management – Part 2:" Risk Management".* | Appendix 3.1 and 9.1<br><br>Assessed in Technical Appendix 9.6. |
| | b) *Prior to consent being granted, the applicant shall submit to the planning authority a site-specific hydrogeological report (not desk top study), which has been physically carried out by officers or reporters on site, and which contains a review of the risks to all private water sources, their catchment areas, their abstraction points, the private water supplies, the supply lines, and private water user properties, that have the potential to be affected by the development, during development and in the future. The list of private water properties, supplies, supply lines, sources, abstraction points and catchments must include those which are not situated within the marked development boundary areas, but whose private water source catchment areas have the potential to originate within the marked development boundary areas, and thus have the potential to be affected by the development in the future. The Work shall not commence on site prior to the written approval of the Planning Authority being obtained.* | Assessed in Technical Appendix 9.6 |
| | c) *The report should include a field survey of all private water user properties, supplies, sources, abstraction points and their potential catchment areas, and focus on the effects of the development on the quality and quantity of water supplied to all private water users both within and out-with the boundary of the proposed site that have the potential to be affected by the development. The field survey should be carefully designed as to promote meaningful response rates and should include qualitative research carried out through direct consultation with South Ayrshire Council Environmental Health, private water supply property owners, users, tenants, landowners, and other Relevant parties. It is required that field visits be carried out once agreement has been reached with South Ayrshire Council Environmental Health.* | Assessed in Technical Appendix 9.6 |
| | d) *A conceptual site model should be included as this is key to developing a robust assessment of all risks to all potentially affected private water supplies. Attention should also be given to possible leachate generation, and any other type of run off or fluid leakage at any Borrow Pit excavations, including possible contamination during development phase, or in the future, through blasting, for the same reasons as previously covered. The* | Assessed in Technical Appendix 9.6 |

| Consultation | Comments / Information Provided | Applicant Action |
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| | *conceptual site model does not replace the need for documenting procedures, or methodologies for proper site investigation or remediation, in accordance with regulatory requirements. The conceptual site model should include illustrative as well as written representations of the processes, and potential impacts to support informed decision making.*<br><br>*Reason: In order to maintain a secure an adequate quantity and quality water supply to all properties with private water supplies that may be affected by the development, now and in the future.*<br><br>*e) Prior to consent being granted, all private water supply user properties, their private water supply lines, sources, abstraction points and potential catchment areas are to be identified and shown as marked on maps, to scale, on minimum of 1:25000, in order to assess risk to catchment areas of the sources that private water supply water is potentially drawn from. This is to give realistic comparison to the siting's of the proposed development, construction, turbines, structures, (including battery storage compounds), over ground / underground cabling, access tracks etc.*<br><br>*Reason: In order to maintain a secure and adequate quantity and quality water supply to all properties with private water supplies that may be affected by the development, now and in the future*<br><br>*f) Forestry – Removal, Harvesting, Replanting, Compensatory Planting: Prior to consent being granted, in relation to all forestry works and development, all private water supply user properties, their private water supply pipes and lines, sources, abstraction points and potential catchment areas are to be identified and shown as marked on maps, to scale, on minimum of 1:25000, as part of the development risk assessment, in order to assess risk to catchment areas of the sources that private water supply water is potentially drawn from. This is to give realistic comparison to the siting of removal plans, lay down areas, vehicle park areas, replanting, potential chemical contamination, and all associated forestry works in relation to private water supplies.*<br><br>*Reason: In order to maintain a secure and adequate quality water supply to all properties with private water supplies that may be affected by the development, now and in the future.*<br><br>*g) Emergency Action Plan - An EAP should be submitted stating clearly who would be responsible, when they would be required to take action, where this would be implemented and what action and mitigation would be implemented for any emergencies arising. The EAP should detail who the emergency contacts would be 24/7, with contact telephone numbers and email addresses, to be provided to private water supply users South Ayrshire Council Planning department.*<br><br>*Reason: In order to maintain a secure and adequate quality and quantity of private water supply to all properties with private water* | Assessed in Technical Appendix 9.6<br><br>Assessed in Technical Appendix 3.1, 9.1 and Technical Appendix 9.6<br><br>Assessed in Technical Appendix 9.6<br><br>Assessed in Technical Appendix 3.1, Technical Appendix 9.1 and Technical Appendix 9.6 |

| Consultation | Comments / Information Provided | Applicant Action |
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| | *supplies that may be affected by the development and to minimise impacts on groundwater quality and hydrology.*<br><br>*h) Specific concerns relating to private water supplies are as follows:*<br><br>*There is no clear indication of the proposed access road to the site entrance, and no clear indication of the proposed site entrance and access road point. It is not acceptable to add this information at a later date.*<br><br>*Assessment Methodology - has been a desk top study of the development area, and with a good working knowledge of the area. This is not acceptable or sufficient information to allow informed decisions.*<br><br>*Mitigation - states that this "will evolve" - there is no clear indication of what potential problems could occur, where, when, how, and how these will be dealt, and by whom and when. There is no indication of severity of problems that could occur, nor of future ones that could arise and of procedures in place to deal with them. There is not sufficient information provided to allow informed decisions.*<br><br>*Discussions on hydrogeological matters, abstractions and water monitoring deal with SEPA enforced legislation, and do not touch at all on private water supplies, sources, properties that use them nor the catchments for these supplies, which leaves them vulnerable. Environmental Health, South Ayrshire Council are the enforcement agency for private water supply legislation within South Ayrshire Council areas. Informed decisions cannot be made, due to complete lack of information required.*<br><br>*Discusses specific procedures are to be developed for fuel handling & storage, and emergency spill and mentions ECoW. Best practise is also mentioned, but nothing specific is offered or demonstrated. There is not enough information to make an informed decision*<br><br>*Environmental Health requires a substantially greater amount of information before an informed decision can be realised with regard to private water supply users, owners, properties, supply lines, source abstractions*<br><br>*There is not enough information given to allow informed decisions from Environmental Heath, who require to be consulted regarding forestry at all stages, to allow for decisions to be made regarding the safety, quality and quantity of private water supplies, their catchments, their abstraction points, supply lines and the properties who use them.*<br><br>*The request for information is not solely based on private water supplies that rely on only surface water for their catchment or supply.*<br><br>*There are many private water supply users in the area within the marked boundary proposed, and also out with the marked* | Assessed in Technical Appendix 9.6 and Figure 9.6 |

| Consultation | Comments / Information Provided | Applicant Action |
|---|---|---|
| | *boundary proposed, who take their private water supply from surface waters, and whose catchment areas for abstraction may well have a threat to the water quality and quantity imposed upon them, including well into the future. The areas around Straiton are now flagged on Environmental Health South Ayrshire Councils water drought list, and properties have been experiencing difficulties, including supplies running dry, at certain times of the year in the past three years. Emergency bottled water has had to be delivered to some private water supply properties due to this occurring, in accordance to the Scottish Governments aid to assist emergency drinking water supplies to private water supply users.* | |
| ECU Scoping Opinion<br><br>Scottish Water<br><br>March 2021 | *Scottish Water provided information on whether there are any drinking water protected areas or Scottish Water assets on which the development could have any significant effect. Scottish Ministers request that the company contacts Scottish Water (via EIA@scottishwater.co.uk) and makes further enquires to confirm whether there any Scottish Water assets which may be affected by the development, and includes details in the EIA report of any relevant mitigation measures to be provided.*<br><br>*According to Scottish Water records, the development proposals impact on existing Scottish Water assets.*<br><br>*A review of the records indicates that there are no Scottish Water drinking water catchments or water abstraction sources, which are designated as Drinking Water Protected Areas under the Water Framework Directive, in the area that may be affected by the proposed activity.* | Discussed in Section 9.7 and Figure 9.6 |
| ECU Scoping Opinion<br><br>Ayrshire Rivers Trust (ART) and Girvan District Salmon Fishery Board<br><br>March 2021 | *The proposed wind farm development has the potential to impact on the water environment due to its close proximity to important tributaries of the Water of Girvan, notably the Palmullan and Genoch Burns.*<br><br>*To fully understand the impacts the development may potentially have on the ecology of the receptor watercourses and present a contemporary reflection of the current species, a fully quantitative electrofishing survey should be undertaken in order to identify in detail, the distribution and abundance of the fish populations.*<br><br>*Freshwater Pearl Mussels assessment should be considered as an integral component of any pre development and ongoing monitoring as they are present within the catchment.*<br><br>*ART and the River Girvan District Salmon Fishery Board would like to be consulted on issues that concern watercourses such as on water crossings, electrofishing monitoring and potential opportunities for ecological enhancement.*<br><br>*In summary, up-to-date baseline surveys should be completed for fish, macroinvertebrates, FWPM, water voles and otters at very least.* | Addressed within Section 9.7 and 9.8, Chapter 8 and Technical Appendix 8.3<br><br>Chapter 8 and Technical Appendix 8.3 |

| Consultation | Comments / Information Provided | Applicant Action |
|---|---|---|
| | *The Environmental Impact Assessment should assess the following potential effects on watercourses from the initial site preparation stages, through construction and operational activities of the windfarm:*<br><br>*1. Forest Felling and subsequent effects of this activity e.g. acidification of watercourses, rates of surface drainage run-off, sediment-laden surface drainage water, sediment mobilisation and deposition, input of hydrocarbons and organic matter etc.*<br><br>*2. Construction activities – impediment to fish movement. Construction activities should not impede movement of any migratory or resident fish populations. New water crossings (temporary or permanent) should only be installed using SEPA design and best practice guidelines. The River Girvan DSFB and Ayrshire Rivers Trust should be consulted beforehand to assist with the design and necessary mitigation measures. There is an opportunity for the development to have a positive impact on the water environment by upgrading old crossings within the development that may prevent or hinder fish migration.*<br><br>*3. Construction/operation activities - increased silt loading to watercourses. Potential impacts may arise from soil stripping, track construction and vehicle/plant movements, dewatering on receptor watercourses and abstraction of water from watercourses. Sediment loading and water borne sediment transport off site may increase, potentially reducing water quality. Altered flow regimes within the watercourses crossing or fed from the development area may lead to unknown impacts on many species. These points must be adequately considered.*<br><br>*4. The CEMP should include provision for continuous monitoring of fish and macroinvertebrates and water quality parameters.* | Assessed in Appendix 3.3 and section 9.7 and 9.8.<br><br>Technical Appendix 3.1 and 9.5<br><br>Technical Appendix 9.1<br><br>Technical Appendix 3.1 |
| ECU Scoping Opinion<br><br>Nature Scot<br><br>March 2021 | *Carbon-rich soils, deep peat and priority peatland habitat*<br><br>*There are areas of class 1 peat within the application site, as identified in section 7.2.8 of the accompanying scoping report (ITP Energised, October 2020). Class 1 areas are nationally important carbon-rich soils, deep peat and priority peatland habitat and are likely to be of high conservation value.*<br><br>*While Scottish Planning Policy identifies such areas as 'areas of significant protection', the location of a proposal in the mapped area does not, in itself, mean that the proposal is unacceptable, or that carbon rich soils, deep peat and priority peatland habitat will be adversely affected. However, the assessment of impacts of the proposal must demonstrate that any significant effects on the qualities of the area can be substantially overcome by siting, design or other mitigation. We recommend early engagement with SEPA with regard to the reuse and disposal of excavated peat.*<br><br>*Nature Scotland note, and welcome, that a peat probing survey has been carried out on the site. To inform the assessment of impacts and identification of appropriate mitigation, we advise that peat surveys of* | Addressed within Section 9.7 and 9.8, Technical Appendix 9.2, 9.3 and 9.4, and Chapter 8 |

| Consultation | Comments / Information Provided | Applicant Action |
|---|---|---|
| | *the site, measuring the peat deposit to full depth, should be undertaken in accordance with the Scottish Government's Peatland Survey 2017: Guidance on Developments on Peatland.*<br><br>*The results should also be used to inform a peat slide assessment. We recommend early engagement with SEPA with regard to excavated peat reuse and disposal.*<br><br>*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. How significant effects will be mitigated must also be fully described. We would also find it helpful for mapping to be included in the EIA Report which shows the location of all access roads, infrastructure, borrow pits and turbine pads overlain onto separate NVC and peat maps. We welcome the Applicant's commitment to avoid peat where ever possible, where not, utilise suitable mitigation and look to reuse peat in line with SEPA's guidance where appropriate.*<br><br>*Our previous advice of 30 May 2019 stated that "We do not consider that the any of the sites (SAC and SSSIs) noted by the Applicant to be connected to the proposed development site. Therefore, we are satisfied that they do not require further consideration and can be scoped out of the EIA".*<br><br>*We welcome the Applicant's intention to develop a Habitat Management Plan (HMP) for the development and recommend a draft of this is submitted with the EIA Report. The Habitat Management Plan should make provision for mitigation of, or compensation for, significant impacts of the development and measures to enhance the natural heritage interest of the area.*<br><br>*The relationships between this plan and the proposed Windfarm Forest Plan should be made clear so that a unified, holistic approach to the management of habitats and land present on the site are presented for comment.*<br><br>*Consideration of habitat enhancement to the condition and quality of the remnant areas of riparian native woodland, and hence watercourse condition, identified at the northern edge of the application area, would be a key concern for this site.*<br><br>*A number of protected species are present (bats, water vole, badger, potential red squirrel and otter) and may be impacted by the development proposals and we therefore welcome the surveys carried out to date to identify the potential scope and scale of any such impacts. Terrestrial mammal surveys for bat, otter, red squirrel, badger, water vole all appear to be satisfactory but no information is available for pine marten despite it previously being confirmed as species of conservation interest for this site.*<br><br>*We advise that the EIA should include a map of the NVC habitat survey results (including all GWDTE) with the wind farm boundary, proposed turbines, tracks and infrastructure layout overlain. A similar map showing peat and peatland habitats should be produced showing their relationship with the fore mentioned site infrastructure.* | Outline HMP provided in Technical Appendix 8.6<br><br>Assessed in Chapter 8 and Figure 9.8 |

| Consultation | Comments / Information Provided | Applicant Action |
|---|---|---|
| ECU Scoping Opinion<br><br>Fisheries Management Scotland March 2021 | *Potential for such developments to impact on migratory fish species and the fisheries they support, FMS have developed, in conjunction with Marine Scotland Science, advice for DSFBs and Trusts in dealing with planning applications. We would strongly recommend that these guidelines are fully considered throughout the planning, construction and monitoring phases of the proposed development.* | Addressed within Chapter 8 |
| SEPA | Although SEPA missed the scoping stage, SEPA scoping advice on wind energy development is available on our SEPA website (https://www.sepa.org.uk/media/144547/lups-l-14-windfarm-scoping-letter.pdf). We'd encourage the applicant to refer to Appendix 1 of this as the assessment is undertaken to ensure appropriate information is presented with the EIA Report to address our requirements.<br><br>SEPA understand following advice from consultees that information regarding peat, GWDTE and private water supplies will be presented along with the EIA - these issues are covered in SEPA scoping advice. SEPA also expect that Chapter 9 Geology, Peat, Hydrology and Hydrogeology assess the impacts of the development on the water environment (including engineering works within and near the water environment). SEPA have reviewed the 'Hydrogeological Note on GWDTE' and while we note a lot of the habitats are not considered to be groundwater fed we would still expect the habitat to be protected by mitigation to maintain the hydrological connectivity.<br><br>Site Layout – Access Routes<br><br>The proposed northern site access route (shown in Figure 10b) directly overlaps the Cawin Burn and Balbeg Burn and also crosses habitats which have been confirmed within the 'Hydrogeological Note on GWDTE' to be groundwater dependent. In order to minimise the impacts of the development, SEPA request that the 'alternative access' from the west be utilised to access the site instead. This appears to be located further from water features and would therefore avoid the physical impacts, potential run off issues and GWDTE associated with the northern route. This may also reduce borrow pit requirements. Upgrading works associated with this would require to meet the current good practice guidance and windfarm infrastructure requirements. If the northern route is to be pursued, SEPA recommend this is subject to further discussions with us prior to submission of the application.<br><br>Site Layout – Turbine Development Area<br><br>SEPA welcome that the site design has generally avoided deep peat (Figure 10a) however it appears the locations of wind turbines 6, 7 and 9 could be adjusted to further reduce the impacts of the development on peat and recommend this is explored. We also | Noted<br><br>Assessed in Technical Appendix 9.2, 9.3, 9.4, 9.6 and shown in figures 9.6to 9.12<br><br>Included in Section 9.7<br><br>Much of the access track to the north is existing access track.<br><br>The Applicant has assessed both access options within the Environmental Impact Assessment.<br><br>These locations have been adjusted accordingly as per Figure 9.10 |

| Consultation | Comments / Information Provided | Applicant Action |
|---|---|---|
| | request that where access tracks cross areas of peat >1 m deep that floating road construction methods are adopted. We also note that wind turbine 1 is within 50 m of a watercourse and recommend this is adjusted outwith the buffer. | |

## 9.6 Assessment and Significance Criteria

9.6.1 The significance of any effects of the Proposed Development on baseline conditions is assessed as part of the impact assessment in this Chapter. The combination of the sensitivity of the receptor and the magnitude of the potential impact combine to determine the significance of that effect.

9.6.2 There are no published guidelines or criteria for assessing and evaluating effects on hydrology, hydrogeology, geology, peat or soil within the context of an EIA. The assessment will be based on a methodology derived from generic EIA regulation guidance, IEMA guidance and the SNH publication A Handbook on Environmental Impact Assessment (SNH 2013). The methodology is also based upon relevant SEPA guidance including Assigning Groundwater Assessment Criteria for Pollutant Inputs (SEPA 2010). The methodology sets a list of criteria for evaluating the environmental effects, as follows:

- The type of impact (i.e. whether it is positive, negative, neutral or uncertain).
- The probability of the impact occurring based on the scale of certain, likely, or unlikely.
- Sensitivity criteria are based on both the likely impact on a receptor due to a particular activity, as well as the importance of the resource under consideration or designated value of the receptor (e.g. an area of international significance has a higher value and therefore higher sensitivity than other areas of lower status). The sensitivity criteria used for this site are presented in Table 9.2. The sensitivity of a receptor is its ability to absorb the anticipated impact without perceptible change resulting.
- The magnitude of the potential impact criteria is presented in Table 9.3. The magnitude of the potential impact in relation to the resource that has been evaluated is quantified using the scale high, medium or low and includes the consideration of timing, scale, size and duration of a potential impact.

9.6.3 The sensitivity and magnitude of potential impact criteria described in this section were considered appropriate for the conditions and environments prevailing at the Proposed Development.

**Table 9.2 Sensitivity Criteria**

| Sensitivity of Environment | Definition |
|---|---|
| Very High | Environment is very sensitive and would respond in a major way to impacts.<br><br>Private water supply abstraction for human or stock consumption (surface water or groundwater).<br><br>Public drinking water supply abstraction (surface water or groundwater).<br><br>Surface water classified under the WFD as 'high' (or equivalent older chemical or biological monitoring designation). |

| Sensitivity of Environment | Definition |
|---|---|
| | Groundwater classified under the WFD as 'good'.<br><br>Watercourse designated under the Freshwater Fish Directive, or known to have fish spawning grounds.<br><br>Groundwater vulnerability to pollution class 5.<br><br>Internationally or nationally designated sites (e.g. Ramsar, SPA, SAC, SSSI, National Nature Reserves, Marine Nature Reserves).<br><br>Habitats listed in Regional Biodiversity Action Plans or Annex I habitats.<br><br>Internationally important species. |
| High | Environment is sensitive and would respond in a moderate way to impacts.<br><br>Private water supply abstraction not for human or stock consumption (surface water or groundwater).<br><br>Public non-drinking water supply abstraction (surface water or groundwater).<br><br>Surface water classified under the WFD as 'good' (or equivalent older chemical or biological monitoring designation).<br><br>Watercourse known to support important fishery population.<br><br>Groundwater vulnerability to pollution class 4.<br><br>Sites designated at a regional level.<br><br>Deep, unmodified peatland >1 m in depth.<br><br>Other water dependent habitats. |
| Medium | Environment is not very sensitive and responds in a minimum way to impacts.<br><br>Surface water classified under the WFD as 'moderate' (or equivalent older chemical or biological monitoring designation).<br><br>Sites designated at a local level.<br><br>Deep, modified peatland or shallow peatland.<br><br>Groundwater vulnerability to pollution class 3 or 2. |
| Low | Environment is not sensitive and responds in a negligible way to impacts.<br><br>Surface water classified under the WFD as 'poor or bad' (or equivalent older chemical or biological monitoring designation). |

| Sensitivity of Environment | Definition |
|---|---|
| | Groundwater classified under the WFD as 'poor'.<br><br>Groundwater vulnerability to pollution class 1.<br><br>No private or public supply abstractions (surface water or groundwater).<br><br>No peat or peaty/organic rich soils less than 0.5 m in depth.<br><br>No designated fisheries. |

**Table 9.3 Magnitude of Potential Impact Criteria**

| Magnitude of Potential Impacts | Definition |
|---|---|
| Very High | Impact resulting in loss of feature or use.<br>Fundamental (long-term or permanent) changes to surface water, groundwater and geology (in terms of quantity, quality and morphology). |
| High | Impact resulting in integrity of feature or use being impacted, or loss of part of feature or use.<br>Substantial but non-fundamental and short to medium term changes to the surface water, groundwater and geology (in terms of quantity, quality and morphology). |
| Medium | Impact on feature or use.<br>Detectable but non-substantial and temporary changes to the surface water, groundwater and geology (in terms of quantity, quality and morphology). |
| Low | Impact but of insufficient magnitude to affect feature or use.<br>No perceptible changes to the surface water, groundwater and geology (in terms of quantity, quality and morphology). |

9.6.4 The combination of the sensitivity and magnitude of potential impact combine to provide a matrix categorisation of significance (major, moderate, minor and negligible). These are presented in Table 9.4.

**Table 9.4 Significance of Effect**

| Magnitude of Potential Impact | Sensitivity | | | |
|---|---|---|---|---|
| | Very High | High | Medium | Low |
| Very High | Major | Major | Major | Moderate |
| High | Major | Major | Moderate | Minor |
| Medium | Moderate | Moderate | Minor | Minor |
| Low | Minor / Moderate | Minor | Minor | Negligible |

9.6.5 To assess the likely impacts of the Proposed Development it is considered that best practice techniques are standard. A description of best practice methods that will be employed are presented in Appendix 9.1. The levels of significance determined therefore assume these practices will be implemented and that only those impacts that result in a Major or Moderate effect significance are considered to require additional management or mitigation. These standards are in accordance with EIA Regulations; however, it should be recognised that the tables are a guide and that professional judgement must also be used in the assessment.

## 9.7 Environmental Context

### *Design Iteration*

9.7.1 As described in Chapter 2the Proposed Development has gone through 23 iterative design changes, from August 2020 to July 2021. Design development has included reduction of the number of turbines, more sympathetic positioning for landscape and visual effects, routing of the site tracks to utilise existing tracks where possible and minimise watercourse crossings, and the positioning of turbine locations to minimise impacts to the deeper peat deposits and peatland habitats.

### *Study Area*

9.7.2 The Study Area for the assessment encompasses the whole of the site and a wider area essentially related to the surface water catchments connected to the site as this is the area of potential hydrological connection.

9.7.3 Within this Chapter the Proposed Development boundary, within which all infrastructure is to be located, is referred to as the 'development area'. Further detail on the current Proposed Development is provided in Chapter 3 of this EIA Report.

### *Desk Study*

9.7.4 The assessment was predominantly based on a desk study with site visits for verification. The desk study involved collating and assessing the relevant information from the following sources.

**Table 9.5 Summary of Information Sources for Desk Study**

| Topic | Source of Data and Information |
|---|---|
| Climate<br><br>Rainfall | Centre for Ecology and Hydrology (CEH): National River Flow Archive (NRFA) website for river flow data (accessed September 2020 and September 2021): http://www.ceh.ac.uk/data/nrfa/data/search.html and https://nrfa.ceh.ac.uk/data/search respectively<br><br>Meteorological Office website for rainfall data (accessed September 2020): http://www.metoffice.gov.uk/climate/uk/averages/<br><br>Scottish Environment Protection Agency (SEPA) Rainfall data for Scotland (accessed September 2020): https://www2.sepa.org.uk/rainfall/ |
| Topography<br><br>Elevation, Relief | Ordnance Survey Mapping 1:50,000 and 1:25,000 scale<br><br>Google Maps aerial images |
| Geology<br><br>Solid and Drift | British Geological Survey (BGS) Geology mapping Ayr Sheet 14W and Carrick Sheet 8W Bedrock 1:50,000 scale (2008 and 1981 respectively).<br><br>BGS Geology mapping Ayr Sheet 14W and Carrick Sheet 8W Superficial with simplified bedrock 1:50,000 scale (2009 and 1995 respectively). |

| Topic | Source of Data and Information |
|---|---|
| | https://webapps.bgs.ac.uk/data/maps/maps.cfc?method=viewRecord&mapId=10715 accessed September 2021.<br><br>BGS Geological Mapping and Interactive Map and Boreholes database http://www.bgs.ac.uk/discoveringGeology/geologyOfBritain/viewer.html accessed September 2021. |
| Soil | Scotland's Soils website http://www.soils-scotland.gov.uk/<br><br>SNH Carbon and Peatland Map (2016).<br><br>The James Hutton Institute Soil Information for Scottish Soils http://sifss.hutton.ac.uk/SSKIB_Stats.php accessed September 2021. |
| Groundwater<br><br>Hydrogeology, Aquifer Properties, Source Protection Zones and Groundwater Levels | SEPA - Consultation and published sources on their website (accessed September 2021) (www.sepa.org.uk)<br><br>SEPA Water Environment Hub (accessed September 2021) https://www.sepa.org.uk/data-visualisation/water-environment-hub/<br><br>SEPA River Basin Interactive Map for Water Framework Directive classifications<br><br>Baseline Scotland Groundwater Chemistry Data, accessed September 2020 http://www.bgs.ac.uk/research/groundwater/quality/baselineScotland/southernScotlandData.html<br><br>BGS Hydrogeology map viewer, accessed September 2021 http://mapapps2.bgs.ac.uk/geoindex/home.html<br><br>Hydrogeological Map of Scotland (Scale 1:625,000) (Institute of Geological Sciences, 1988)<br><br>Scottish Aquifer Properties Interim Report (BGS, NERC and Sniffer, June 2006).<br><br>A GIS of aquifer productivity in Scotland explanatory notes (BGS, 2004).<br><br>Groundwater Vulnerability Map of Scotland (http://data.gov.uk/dataset/groundwater-vulnerability-map-of-scotland) (accessed September 2020) |
| Surface Water<br><br>Surface Water Features, Flood Risk, Water Quality, Recreational Waters and Fisheries | SEPA - Consultation and published sources on their website (accessed September 2021) (www.sepa.org.uk)<br><br>SEPA Water Environment Hub (accessed September 2021) https://www.sepa.org.uk/data-visualisation/water-environment-hub/<br><br>SEPA River Basin Interactive Map for Water Framework Directive classifications |

| Topic | Source of Data and Information |
|---|---|
| | SEPA Indicative River and Coastal Flood Map (accessed September 2020) http://www.sepa.org.uk/flooding/flood_extent_maps/view_the_map.aspx2020<br><br>http://map.sepa.org.uk/floodmap/map.htm (accessed September 2021)<br><br>https://scottishepa.maps.arcgis.com/apps/webappviewer/index.html?id=b3cfd390efa44e3b8a72a07cf5767663&showLayers=FloodMapsBasic_5265;FloodMapsBasic_5265_0;FloodMapsBasic_5265_1;FloodMapsBasic_5265_2;FloodMapsBasic_5265_3;FloodMapsBasic_5265_4;FloodMapsBasic_5265_5;FloodMapsBasic_5265_6;FloodMapsBasic_5265_7;FloodMapsBasic_5265_8;FloodMapsBasic_5265_9;FloodMapsBasic_5265_10;FloodMapsBasic_5265_11 (accessed September 2021)<br><br>Scotland Drinking Water Protected Area for surface water, Scottish Government Website Maps (2014) accessed September 2021. https://www.gov.scot/publications/drinking-water-protected-areas-scotland-river-basin-district-maps/ |
| Designated Areas | Multi-Agency Geographic Information for the Countryside (MAGIC) website http://www.magic.defra.gov.uk/ (accessed September 2021). |

**Site Visits and Field Work**

9.7.5 A site visit for baseline inspection was undertaken by Lucy Parker of Fluid on 10 May to 12 May 2021 to inspect the overall site water features and determine construction constraints through the identification of major hydrological and hydrogeological receptors (Figures 9.1 and 9.6). The site visit included an assessment of site drainage patterns, potential properties reliant on Private Water Supplies (PWS) and identification of potential source to receptor pathways.

9.7.6 A first round of depth of penetration (peat) probing was carried out across the whole site where peat may be present based on review of the soils and superficial geology maps. This was carried out on a 100m grid system in August 2020 and on a 10m grid system around the areas proposed for infrastructure with a micro-siting allowance and 50m along access tracks in May 2021, resulting in a total of 4,182 depth probes and 41 cores to verify the probe depth.

9.7.7 A site walkover for peat slide risk assessment was undertaken by Dr Andy Mills, a peatland geomorphologist with 25 years' experience of assessing peat environments, on 23 September 2020. The ground conditions and land use have not changed since the site walkover and therefore the site walkover remains valid.

9.7.8 A GPS linked photographic record of approximately 700 photos of hydrological, hydrogeological, geological, topographical and ecological features has also been obtained.

**Limitations of Assessment**

9.7.9 The fieldwork was undertaken in a range of weather conditions however, the nature of some hydrological features may not manifest themselves at all times and may be a result of extreme weather conditions. Whilst the best care has been undertaken to visit the site in different weather conditions, there is a potential that some small, minor features may be missed as a result of their ephemeral or temporary nature.

## *Existing Environment*

9.7.10 The following section describes the baseline hydrological, hydrogeological and geological conditions contained within and surrounding the project site. This includes the physical characteristics as well as designated water bodies, water dependent habitats, their quality and their use.

**Land Use**

9.7.11 The site is located to the south of Straiton, south-west of Dalmellington and east of Girvan in South Ayrshire. Access to the site is from either the north or west along the mostly existing forestry access tracks.

9.7.12 The majority of the main development area lies within a working farm with the open fells used for rough grazing of cattle and sheep. The western access track option follows an existing commercial forestry track while the northern access option runs through farmland and an existing commercial forestry road..

9.7.13 The fells have been extensively cut with drains, although these are more apparent on aerial photography than on the ground, where they are generally overgrown. There is no evidence of cutting of peat, quarrying, or burning.

**Topography**

9.7.14 The main development area comprises land ranging from 120 m Above Ordnance Datum (AOD) along the Water of Girvan in the east and 220 m AOD along the Palmullan Burn in the north to 313 m AOD at Big Benyaw summit and 286 m AOD at Knockronal summit in the central area and 315 m AOD at Knockbuckle and 306 m AOD at Clashverains summit in the south.

9.7.15 The northern access track option runs approximately north to south between Cawin Hill to the east and Black Hill of Knockgardner to the west and ranges between 140 m AOD in the north near the Calwin Burn to 220 m AOD as it crosses the Cawin Burn/ Balbeg Burn watershed. The south-western slopes of Cawin Hill are particularly steep.

9.7.16 The western track option runs west to east on the north side of the Palmullan Burn between Knockinculloch to the west and Back Hill / Glenalla Fell to the north. The western track ranges from 180m AOD where it joins the northern access track to 300m AOD in the west and crosses a number of tributaries of the Palmullan Burn.

9.7.17 The northern access track is mostly within the Cawin Burn and Balbeg Burn catchments and crosses the Cawin Burn three times and the Balbeg Burn once.

9.7.18 The main development area of the site generally slopes down to the north and the north-east toward the Palmullan Burn and Water of Girvan. The majority of development area is within the Water of Girvan catchment, with the main watercourses within the main development area being the Sheil Burn and Palmullan Burn along the northern section of the main development area.

**Geomorphology**

9.7.19 The site comprises undulating uplands over moderate slopes with gentle summits and local craggy areas (e.g. Big and Wee Benyaw). There are knolls and hollows or valleys on the top of summits. Some areas of drainage grips were observed within the upland valleys. Ridge and furrows were observed within the commercial forestry areas usually with a drainage ditch around each coup.

**Meteorological Summary**

9.7.20 There are no Met Office stations within close proximity to the Proposed Development, however the nearest four stations are:

**Table 9.6 Meteorological Data**

| Meteorological Office Station Name | Annual Average Rainfall (mm) (1981 – 2010 average) | Distance and Direction from Site |
|---|---|---|
| Prestwick RNAS | 938.8 | ~28 km north |
| Drumalbin (South Lanarkshire) | 900.3 | ~55 km north-west |
| Eskdalemuir | 1742.1 | ~85 km west |
| Galashiels (Scottish Borders) | 808.9 | ~115 km north-east |

9.7.21 The National River Flow Archive indicates the River Girvan catchment upstream of Girvan (Station 82001 - Girvan at Robstone) to have an average annual rainfall of 1,368 mm and where the site is located to have an average annual rainfall of between 1,200 mm and 1,400 mm. The average annual rainfall across Scotland is 1,570.9 mm, therefore the site is considered to have a moderate average annual rainfall compared to the rest of Scotland.

9.7.22 The MORECS data indicates a potential annual evaporation rate of 350 mm to 450 mm in the region.

**Soils**

9.7.23 The distribution of soils over the site is generally controlled by the underlying geology, the topography and the drainage regime. The soil mapping is presented in Figure 9.2.

9.7.24 A review of available Scottish soil mapping indicates the majority of the site to be underlain by mineral gleys with the higher altitude areas being underlain by brown earths. The southern section shows some peat deposits, the eastern extreme shows alluvial soils and there is a localised section of Humus-iron podsols in the central area of the site.

9.7.25 The peat deposits are shown in the southern section of the site around Clashverain summit and the low gradient sections between Clashverain summit and Big Benyaw summit.

9.7.26 Alluvial soils shown along the western boundary are associated with the Water of Girvan and its relatively flat valley base.

**Peat**

9.7.27 The SNH carbon and Peatland Map 2016 presented in Figure 9.3 shows Class 1 soils (Peat soils: Nationally important carbon rich soils, deep peat and priority peatland habitat) in two localised plateau areas located between Clashverain summit and Big Benyaw summit. Class 3 soils (predominantly peaty soils: dominant soil is not considered to be priority peatland habitat, but is associated with wet and acidic type. Occasional peatland habitats can be found, most soils are carbon-rich soils, with some areas of deep peat) are shown around and between Knockcronal summit and Big Benyaw summit in the southern area and to the east of Cawin Hill in the northern area. Areas of Class 5 soil (Peat Soil: Soil information takes precedence over vegetation data, no peatland habitat recorded, may include areas of bare soil. Soils are carbon-rich and deep peat) are shown in the southern section of the site on and around Clashverain summit and between Clashverain summit and Big Benyaw summit and Knockcronal summit. Very localised areas of Class 5 soil are shown around Cawin Hill, within the connecting corridor area, to the west of Knockcronal summit and at the foot of the hills in the eastern section near the water of Girvan valley base.

9.7.28 Peat surveys were undertaken as described in Paragraph 9.7.6, with full details presented in Technical Appendix 9.2.

9.7.29 Peat cover is sporadic, typically concentrated in valley floors between gentle ridges and spurs or in large flat areas on the summits. The site is not typical of blanket peatland environments and lacks geomorphological features associated with the best quality sites (such as bog pools and hummock and gully complexes). What peat there is appears to be in good condition with no signs of erosion.

9.7.30 The maximum peat depth recorded on site was 4.9 m and the minimum was 0 m or no peat present. The average peat depth across the whole site was recorded to be 0.28 m. The peat distribution is very localised within pockets and on plateaus around the hill summits with the exception of the flat saddle area in the east of the site, which has been avoided during the design. The deepest peat depths were recorded on a small plateau to the south of Knockcronal summit and the west of Clashverains and on the plateaus to the south and south-east of Big Benyaw summit.

9.7.31 Peat depths varied from 0.5 m to 4.9 m in the areas where peat was present, but large parts of the site had thin organic or mineral soils as little as 0.05 m in depth. Only the peat areas (>0.5 m) are likely to be of interest to NatureScot and SEPA during consultation as the thin soils appeared to lack high quality habitat.

9.7.32 The SNH Carbon and Peatland Map (2016) presented in Figure 9.3 shows the peat distribution similar to that on the soils mapping and determined through the detailed peat survey presented in Technical Appendix 9.2.

**Peat Landslide Hazard Risk Assessment (PLHRA)**

9.7.33 A site walkover for peat slide risk was undertaken 23 September 2020 and a peat landslide hazard risk assessment has been undertaken by Dr Andy Mills, a peatland geomorphologist with 25 years' experience of assessing peat environments. The ground conditions and land use have not changed since the site walk over and therefore it remains valid.

9.7.34 The purpose of the field visit was to verify geomorphology and terrain mapping undertaken as part of the desk study for the PLHRA, to identify ground conditions local to the preliminary turbine locations and to provide an indicative peat slide risk assessment for consideration in the wind farm design.

9.7.35 The Proposed Development lies on gentle to moderate slopes falling from Clashverains (306 m AOD) and Knockbuckle (315 m) at the southern limit of the site to the north towards the Water of Girvan. Turbine infrastructure is generally located above 200 m on rolling slopes in the southern half of the site. Knockcronal, a distinct topographic high (286 m AOD) in the middle of the site sits adjacent to Big Benyaw (313 m AOD), the latter a prominent craggy summit. Slopes steepen fairly rapidly to the north of Knockcronal and Big Benyaw, and only the access track is proposed to traverse this area.

9.7.36 Much of the site lacks geomorphological features typical of blanket bog uplands, primarily due to the thin peat and organic soils that dominate the site. Exceptions are two areas with localised Sphagnum lawns and pools in a saddle between Clashverains and a small topographic high underlying Turbine 3 and in the saddle above Craiganstirrup. Here the ground surface is sufficiently gentle in slope that deeper deposits have developed and habitats are of higher quality. These are the areas identified as Class 1 on the Carbon and Peatland 2016 Map, which provides a relatively good fit with ground conditions for this site. There is minor patterning of the deeper peat consistent with the macrotopography found in good quality blanket bogs. Elsewhere, where peat is thinner, the terrain is largely planar with little evidence of gullying and shallow water flow suggested by Juncus flushes that drain towards the minor watercourses.

9.7.37 There was no evidence of peat landslides or incipient instability at the locations visited. Furthermore, there was no evidence of subsurface pipe networks or other hydrological features associated with instability.

9.7.38 Factor of Safety and Landslide Susceptibility calculations have been undertaken using the detailed peat depth data, the findings of field survey and mapping and the results of the desk study. A stability constraints map is presented in Technical Appendix 9.4.

9.7.39 The conclusion of the indicative peat slide risk assessment is:

- None of the infrastructure overlaps with a Factor of Safety less than 1.4, except a very minor section of track near the site entrance, however this does not influence the consequence assessment;
- None of the infrastructure overlaps with peat slide hazard risk susceptibilities of Moderate or higher.

9.7.40 A review of the landslide susceptibility approach for peat slides indicates that the majority of the areas of the site with peat have a 'Low' or 'Very Low' likelihood of instability, with only small pockets of 'Moderate' instability.

9.7.41 Areas of 'Moderate' likelihood are typically located on moderate slopes, adjacent to drains and in areas of deeper peat. There are no areas identified with 'High' or 'Very High' landslide susceptibility.

9.7.42 Review of the proposed layout indicates four areas of overlap between infrastructure and areas of landslide susceptibility of Moderate (or higher):

- A 17 m section of cut and fill track adjacent to the turning head between Turbines 8 and 9 where prevailing slopes are very gentle (< 4°) and peat is shallow (c. 0.65 m).
- A 13 m section comprising the tip of the same turning head and a small area of hardstanding for the met mast located in a gentle hollow to the west of Clashverains; since this source is part of the same infrastructure element as that for the preceding source zone, the two locations are combined in the runout assessment.
- A small area on the northern side of the proposed borrow pit along the forestry access track – review of this location indicates no peat, with only thin organic soils (<0.2 m) and therefore this location is excluded as a potential peat landslide source.
- A small area at the proposed gatehouse compound location within forestry at the entrance to the western access track from the existing road – shallow peat (c. 0.55 m) in this area has already been ploughed and disrupted by forestry activities.

9.7.43 A consequence assessment has been undertaken by determining the potential for landslides sourced at infrastructure locations with a Moderate natural likelihood of peat instability to impact the receptors.

9.7.44 In order to determine the likelihood of impact on watercourses and infrastructure, 'runout pathways' have been defined that show the estimated maximum footprint of the landslide. Only two were identified based on the source and runout zones shown on Figure 9.4.10.

- Runout from source zone 1 (T8 to T9 junction and met mast track) will not reach local watercourses even if occurring over the full 0.5 km runout length shown on the map, only non-priority open fell habitats will be affected.
- Runout from source zone 2 (western gatehouse option) will not affect good quality habitats (since there are none under the afforested canopy) and is unlikely to affect local watercourses due to the screening effect of the existing treeline.

9.7.45 Runout zone 1 crosses the turning head between Turbines 8 and 9. It is important that good engineering practice and careful monitoring of ground conditions (see section 6 of Technical Appendix 9.4) is applied during construction in order to minimise health and safety incidents associated with potential instability at this location.

**Peatland Habitat**

The Proposed Development will result in the direct loss of 0.47 ha of blanket bog and wet modified bog and a further 1.26 ha via indirect effects associated with potential drying out. This equates to 3.54 % of the habitats present within the site boundary, excluding those present within habitat mosaics.

**Geology**

9.7.46 Digital solid and drift geological maps were sourced from the British Geological Survey Digimap (1:50,000 scale) website and reviewed to provide geological information on the proposed wind farm site. The geology was further reviewed using the British Geological Survey Bedrock and Superficial Deposits 1:50,000 scale mapping for Ayr Sheet 14W (2008) and (2009) respectively and Carrick Sheet 8W (1995 and 1981 respectively).

Superficial Geology

9.7.47 No superficial or drift deposits are shown across the majority of the site and on hill summits, with the exception of the south-east of Big Benyaw summit where localised peat deposits are shown.

9.7.48 The superficial deposits of the site are shown to be dominated by glacial till deposits where drift deposits are present on lower slope reaches. The glacial till comprises a diamicton of poorly sorted sand, gravel and clay and is relatively impermeable.

9.7.49 Localised alluvial deposits are located within the valley bottoms around the headwaters of watercourses, along watercourses and in the lower reaches of watercourses where they join the Water of Girvan wide valley bottom or flood plain, also underlain by alluvial deposits.

Solid Geology

9.7.50 The British Geological Survey Bedrock 1:50,000 scale map for bedrock Sheet 14W Ayr (2009) and Sheet 8W Carrick (1995) is presented in Figure 9.5

9.7.51 The mapping shows majority of the main development area including Knockcronal summit, to be underlain by Duneaton Volcanic Formation or the Carrick Volcanic Formation. The Duneaton Volcanic Formation, which underlies the Knockronal summit, comprises basaltic-andesite igneous bedrock formed approximately 393 to 419 million years ago in the Devonian Period.

9.7.52 The Big Benyaw summit in the centre of the main development area is underlain by Carrick Volcanic Formation comprising igneous basalts and basaltic andesites formed approximately 393 to 419 million years ago in the Devonian Period, as is much of Cawin Hill adjacent to the existing northern forestry track and where borrow pit search area A is proposed.

9.7.53 The Clashverains summit on the southern boundary of the main development area is underlain by the Southern Midland Valley Felsite Sills comprising igneous andesitic-rock formed approximately 359 to 444 million years ago in the Devonian and Silurian Periods, as is a small eastern section of the existing western forestry track.

9.7.54 The south-western section and northern section of the main development area is underlain by Swanshaw Sandstone formation/greywacke conglomerate formation, as is much of the existing western and northern forestry track. The Swanshaw Sandstone formation comprises bedrock formed approximately 393 to 427 million years ago in the Devonian and Silurian Periods when the local environment was previously dominated by rivers. These sedimentary rocks are fluvial in origin. They are detrital, ranging from coarse- to fine-grained and form beds and lenses of deposits reflecting the channels, floodplains and levees of a river or estuary (if in a coastal setting).

9.7.55 The extreme north-western section of the existing northern forestry track, north of the Straiton Fault, is underlain by the Drumyork Flags Formation, Blair Shale Formation and the Knockgardner Sandstone Formation. These comprise sandstone, siltstone and mudstone sedimentary rocks formed between approximately 433 to 444 million years ago in the Silurian Period when the local environment was dominated by deep seas.

9.7.56 Given the variable nature of the sedimentary, metamorphic and igneous rock deposits, there may be some variability in their engineering properties, their porosity to groundwater and weathered zones. Typically, more foliated high mica content metamorphosed mudstones and siltstones are less competent as an aggregate material due to their softness and friability.

9.7.57 Outcrops of bedrock were observed in sections of the site walkover including: the knolly summits within the main development area, steep slopes, around borrow pit search area A along the existing

northern access track, some watercourse channels and along sections of the existing access track cuttings.

9.7.58 There are no known existing BGS borehole records available to view within 0.5km of the development area.

9.7.59 The bedrock geology is shown on Figure 9.5.

Structural Geology

9.7.60 The dip of the Swanshaw sandstone is generally inclined to the south-east with some to the north-west indicating these beds are likely to be folded.

9.7.61 There are several geological faults within the site. The main geological fault is the Straiton Fault in the north of the site that trends south west to north-east across the site with the downthrow to the south-east. A north-west to south-east trending fault with the downthrow to the south-west cuts through the Cawhill and another, younger, roughly east to west orientated fault cross cuts this fault and has a downthrow to the north.

Quarries and Mining

9.7.62 No evidence of significant mining is known in the Proposed Development site or was observed during the site visits.

9.7.63 On review of the aerial imagery there are two borrow pits associated with the existing commercial forestry areas: NS 3790 0390 and NS 36105 01880. These borrow pits have the potential to have been back filled with man-made materials, although no significant man-made material was observed during the site walkover.

9.7.64 A borrow pit was observed on the northern side of the Palmullan Burn (NGR NS 37350 01126) where alluvial, fluvial and glacial superficial deposits have been extracted, most likely for agricultural purposes for walls and access tracks.

9.7.65 Some historical burnt mounds were observed on the upper reaches of the Knockoner Burn and tributaries.

9.7.66 To the north-west of the site, near Knockgardner a disused pit and quarry are shown on the Ordnance Survey mapping at the location of the Knockgardner SSSI designated for a geological exposure of fossiliferous strata.

**Hydrogeology**

9.7.67 The hydrogeological regime is presented within Figure 9.7 which illustrates bedrock aquifer geology in relation to the superficial geology that lies on top of it. The Swanshaw Sandstone formation, Drumyork Flags Formation, Blair Shale Formation and the Knockgardner Sandstone Formation mostly in the northern section of the development area are part of the Lanark Group. The Lanark Group is classified as a Moderately productive aquifer, described as regional aquifer of sandstones, in places flaggy, with siltstones, mudstones and conglomerates and interbedded lavas. They can locally yield up to 12 l/s.

9.7.68 Carrick Volcanic Formation, Duneaton Volcanic Formation and Southern Midland Valley Felsite Sills predominantly in the main development area section of the site are described as Unnamed Extrusive Rocks of Silurian to Devonian age and are classified as Low productivity aquifers with small amounts of groundwater in near surface weathered zone and secondary fractures. They can have rare springs yielding up to 2 l/s.

9.7.69 In summary, the sedimentary rocks predominantly located in the north of the development area are classified as Moderately productive aquifer with some local yields and the igneous rock underlaying the majority of the main development area are classified as low productivity aquifers.

9.7.70 The peat deposits have the potential to act as a localised perched aquifer where located above relatively impermeable glacial till deposits.

9.7.71 Local alluvial deposits associated with watercourse channels and floodplains are likely to provide more permeable routes for aquifer recharge and discharge, however, these are highly localised drift deposits.

9.7.72 The underlying geology is unlikely to provide groundwater in significant exploitable quantities, however there may be localised users or receptors reliant on localised groundwater supplies.

Groundwater Vulnerability to Pollution

9.7.73 The BGS Hydrogeological Map of Scotland shows that the majority of the northern section of the development area and the surrounding area are underlain by the Lanark Group, a Moderately productive aquifer and the southern area is mostly underlain by un-named extrusive rocks that are a Low productivity aquifer.

9.7.74 The vulnerability of the Lanark Group (Swanshaw Sandstone formation, Drumyork Flags Formation, Blair Shale Formation and the Knockgardner Sandstone) is classified as 5 (highly vulnerable based on a scale of 5 being the highest vulnerability and 1 the least vulnerable) equating to being vulnerable to most pollutants, with rapid impact in many scenarios to those pollutants not readily adsorbed or transformed.

9.7.75 The vulnerability of the extrusive igneous rocks (Carrick Volcanic Formation, Duneaton Volcanic Formation and Southern Midland Valley Felsite Sills) is classified as 4a (moderately vulnerable) equating to being vulnerable to those pollutants not readily adsorbed or transformed and that pollution incidents will have a rapid travel time through or over the rocks if a pathway is available.

9.7.76 The vulnerability classification can be attributed to the transmission of rainfall and run-off from the surface to groundwater and the subsequent ease of movement of pollutants through the fracture dominated rocks. This assessment is based on the generic consideration of soil and rock types and does not indicate that the risks to local groundwaters are high. As the underlying bedrock is likely to have low fracturing and low to no intergranular permeability there is assumed a low attenuation capacity below the soil layer. However, it is likely to have a low permeability clay and peat overlying the bedrock affording some protection to the groundwater.

9.7.77 The SEPA web based interactive map indicates the Proposed Development area is on the Girvan bedrock and localised sand and gravel aquifers which is a SEPA Groundwater Drinking Water Protected Area (DWPA). It should be noted that the whole of Scotland is classified as a groundwater DWPA.

SEPA Groundwater Classification

9.7.78 A search of the SEPA Water Environment Hub (https://www.sepa.org.uk/data-visualisation/water-environment-hub/, accessed September 2021) database was undertaken to provide information on the groundwater body in the region of the site.

9.7.79 The database indicates that the site is underlain by the Girvan groundwater body (ID: 150607 and 139.6 $km^2$ in area), part of the Scotland basin which has been classified by SEPA as Good quality overall with good water flows and levels and good water quality.

9.7.80 To the north of the site is underlain by the Crosshill groundwater classified by SEPA as Good and to the south is underlain by the South Ayrshire Hills groundwater body that is also classified by SEPA as Good.

Peat Hydrogeology

9.7.81 Peat does not form part of the aquifer classification, but the upper layer (acrotelm) can act as a porous and relatively permeable layer, storing and transmitting water. There is substantial variability in the reported extents of drainage effect in peat. It is noted that the commercial forestry areas either side of the existing access tracks have undergone ridge and furrow drainage and in the clearances are a series of linear drainage features or ditches.

9.7.82 It was found that+ both the acrotelmic and catotelmic peat deposits on site contained fine fibres but generally only the acrotelmic peat contained coarse fibre with both wet in nature. Diffuse wet areas were noted on the surface of the peat where the peat surface vegetation was intact.

9.7.83 It is likely that most groundwater flow takes place in the shallow subsurface (acrotelmic layer of peat) and that catotelm layer, glacial drift deposits or bedrock may form a relatively "impermeable" floor to this shallow groundwater system.

9.7.84 Although there are a number of studies detailing the effect on the hydrology of peatland disturbance from drain cutting (e.g. Boelter 1972; Gilman 1994; Armstrong 2000), little research is apparent within systems due to be disturbed that have already undergone significant historical disturbance. Nayak et al. (2008) provide a useful summary of research on impacts of drainage on peat hydrology (Table 9.6) across varying hydraulic conductivity.

**Table 9.7 Reported Extents of Drainage Effect for Peats with Different Hydraulic Conductivity**

| Extent of drainage around site of disturbance (m) | Saturated hydraulic conductivity (mm/d) | Literature Source |
|---|---|---|
| 1.5 | 9.0 | Coulson et al. 1990 |
| 2.0 | 10.3 | Burke 1961 |
| 2.0 | 9.0 | Stewart and Lance 1991 |
| 2.3 | 9.0 | Stewart and Lance 1991 |
| 5.0 | 6.0 | Boelter 1972 |
| 3.0-9.0 | - | Scottish Government (2011) |
| 15.0 | 810 | Prevost et al. 1997 |
| 30.0 | 1,500 | Gilman 1994 |
| 50.0 | 34,560 | Boelter 1972 |
| 50.0 | - | Godwin & Bharucha 1932 |

9.7.85 The vertical and lateral variations of hydraulic conductivity within peat deposits are highly variable as the material is very heterogeneous.

9.7.86 The impact of drainage within peatland habitats is related to the depth of the drain, distance from the drain and hydraulic conductivity of the peat at that location (Boelter 1972; Armstrong 2000). Although the drains, or other vertical cuttings (e.g. tracks) allow both increased surface and subsurface movement of water, drainage on a horizontal axis is limited. Degree of drying out is greatest at the edge of the cutting with rapidly decreasing impacts as distance from the edge increases with hydraulic conductivity of the peat also playing an important role.

9.7.87 A publication by the Scottish Government (2011) undertaken by a collaboration of Aberdeen University, Glasgow University, The University of Edinburgh, The James Hutton Institute and Forest Research presents research in to the permeability and potential drawdown effects of drainage and excavations associated with wind farm developments applicable for the carbon calculator (Carbon Implications Of Windfarms Located On Peatlands - Update Of The Scottish Government Carbon Calculator Tool, page 26, 30 September 2011). The report assessed the potential drawdown of

shallow groundwater levels by drainage in peat using data from the existing Cross Lochs, Farr and Exe Head Wind Farms. The total extent in drainage from all three wind farms ranged from an average of 3 m to 9 m. Consultation with two of the authors of the report, S. Waldron and Graves indicated that the drawdown of groundwater in peat from drainage is generally less than 10 m taking a conservative approach.

**Groundwater Dependent Terrestrial Ecosystems**

9.7.88 The site has been mapped based on the National Vegetation Classification (refer to Chapter 8). These categories allow those habitats that are assessed as potentially Ground Water Dependent Terrestrial Ecosystems (GWDTE) on site to be identified and their actual dependency of groundwater to be subsequently determined.

9.7.89 The NVC survey undertaken for the site and access track options identified several potentially highly and moderately GWDTEs and potentially highly GWDTEs (as shown in Figure 8.7). In accordance with SEPA's LUPS GU31 guidance (2017) on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems, these habitats' hydrogeological regime can be assessed to determine if these potential GWDTEs are truly groundwater dependent or not.

9.7.90 The majority of the potential GWDTEs identified onsite by the NVC survey are not considered to be groundwater dependent for the following hydrogeological reasons:

- The majority of the site is underlain by a low productivity aquifer bedrock with limited groundwater resource. The exception to this is the northern part of the main site area and most of the two access track routes which are on glacial till overlying a moderately productive aquifer. The glacial till deposits are relatively impermeable and act as an aquitard layer between any groundwater in the bedrock reaching the habitat at the surface.
- Glacial till is not present on and around the hill summits on the site, however, these higher altitude areas are part of the groundwater recharge zones where precipitation and surface water have the potential to be infiltrated into the bedrock.
- More permeable alluvial superficial deposits are shown in areas associated with watercourses and would be treated as watercourse crossings to allow drainage to continue.

9.7.91 The hydrogeological regime is presented within Figure 9.7 which illustrates bedrock aquifer geology in relation to the superficial deposits that lie on top of it. The lower flanks of the hills or the discharge zones are shown to be mostly covered with relatively impermeable glacial till deposits limiting the groundwater from reaching the surface.

9.7.92 The majority of the potential GWDTEs identified by the NVC survey can be ruled out as being truly groundwater dependant due to the hydrogeological regime indicating that they are peatland, perched wetlands or perched flushes on the upland areas of the development area dominated by precipitation and /or surface water rather than groundwater. The area is knolly with plateaus, hollows and valleys which when underlain by relatively impermeable strata can become waterlogged.

9.7.93 Areas that may have some groundwater influences are the discharge zones at lower altitudes and where glacial till is not present. These are mostly only located in areas associated with watercourses where alluvium is present, such as the Balbeg Burn, Pallmullan Burn or the unnamed tributary to the Cawin Burn and will have a significant amount of surface water dependency also. The only exception to this is one area around the existing forestry track to the north of Glenalla Farm which has the potential to have some groundwater and surface water influence based on the hydrogeological regime. The potential true GWDTEs identified from the NVC survey in combination with the hydrogeological regime are presented within Figure 9.8.

9.7.94 No infrastructure other than access track and watercourse crossings are located within these areas that have been identified as having some likely groundwater influence. All track in these areas will

be designed to allow the continuation of shallow groundwater and surface water flow so there will be no significant impact to any potential GWDTEs or wetlands.

**Hydrology**

9.7.95 The site is entirely within the Water of Girvan catchment.

9.7.96 The site can be split into five main sub-catchments or tributaries feeding the Water of Girvan (Figure 9.6):

- The Palmullan Burn (1,074 ha) in the central, southern and western section of the development area directly or via the Knockoner Burn, Sheil Burn and other un-named tributaries;
- The Genoch Burn (178 ha) in the south-eastern section of the main development area;
- The Tairlaw Burn (918 ha) in the extreme south-eastern section of the main development area via the Pulreoch Burn;
- the Cawin Burn (342.5 ha) in the northern section of the development area for the northern access route;
- the Balbeg Burn (422.7ha) in the northern and central sections of the development area for the northern access route; and
- The Lady Burn (732.6Ha) in the extreme western section of the development area via the Sheil Burn for the western access track.

9.7.97 These tributaries generally all flow to the east to join the Water of Girvan to the east of the site with the exception of the Lady Burn that flows north-west and then north-east to join the Water of Girvan south-west of Crosshill. The Water of Girvan flows north to north-west and ultimately discharges to the sea at Girvan.

9.7.98 The extreme eastern section of the development drains directly into the Water of Girvan, however there is no infrastructure proposed within this area.

9.7.99 The north of the study area is bordered by the Palmullan Burn and the eastern side of the study area is flanked by Genoch Burn.

9.7.100 The forestry areas were observed to have linear ridge and furrow drainage within the coups and most coups have a catch drain down gradient of each coup.

9.7.101 The high-altitude moorland is observed on the aerial imagery to have two localised areas of grip drainage around Clashverains and Big Benyaw summits. There may be some potential for peat restoration by the blocking of these drains and water retention to increase the shallow groundwater levels within these peaty soils.

9.7.102 There are no known significant waterbodies within or connected to the site.

9.7.103 There are no flow records for the watercourses on the site as all the catchments on the site are less than 10 $km^2$ in area.

9.7.104 No substantial bodies of standing water are present within the site boundary and the Proposed Development has been designed to avoid watercourses insofar as practicable.

9.7.105 Watercourses and other water features that are present on 1:50,000 scale mapping are shown on figures as dark blue lines with a 50 m buffer.

River Flow

9.7.106 The size, topography, land use and geology of the area suggest that the catchments on site have the potential to be flashy. This means that flow in them will respond rapidly to rainfall and flood conditions could potentially occur with very little, or no, warning. Base flows in the watercourses are unlikely to dry up as the peatlands will sustain them due to steady seepage from the low permeability deposits. There may be some potential for very localised groundwater influence to the

base flow from the underlying bedrock weathered zone of the low productivity aquifer bedrock and moderate productivity aquifer.

9.7.107 The Base Flow Index (BFI) may be thought of as a measure of the proportion of the river run-off that derives from stored sources; the more permeable the rock, superficial deposits and soils in a catchment, the higher the baseflow and the more sustained the river flow during periods of dry weather. The BFI for the Water of Girvan catchment is 0.33. In the upper reaches nearer the site the BFI is 0.42 indicating that the catchment is relatively impermeable and only a small proportion of groundwater flow contributes to the baseflow.

9.7.108 There are no readily available flow records for the watercourses on site. The nearest readily available flow data is for the Water of Girvan at Robstone (Station ID 8001, NGR NX 216 996, 9.1 m AOD) where the river is 15 m wide and catchment size is 245.5 $km^2$. The mean flow is 6.88 $m^3/s$ recorded between 1963 and 2019.

Flooding

9.7.109 The SEPA Flood Maps have been produced following a consistent, nationally-applied methodology for catchment areas equal to or greater than 3 $km^2$ using a Digital Terrain Model (DTM) to define river corridors and low-lying coastal land. The maps are indicative and designed to be used as a strategic tool to assess flood risk at the community level and to support planning policy and flood risk management in Scotland.

9.7.110 The Proposed Development infrastructure is not located within or in close proximity to a SEPA flood risk area.

9.7.111 A review of the SEPA Flood Risk Management Mapping indicates that the Cawin Burn, Balbeg Burn and Palmullan Burn have associated areas of medium to high-risk fluvial flood zones along the alignment of the watercourses within the valley bottoms.

9.7.112 The Water of Girvan to the east of the site and downstream of the site has a significantly wide medium to high risk fluvial flood plain which is wider than 3 m in places.

9.7.113 The SEPA Flood Maps indicate that there are small areas of potential surface water flooding within the site, mostly adjacent to watercourses, their headwaters, or depressions on the higher altitude sections of the site where water can accumulate.

9.7.114 During the site visits the watercourses were observed in low flow conditions during a relatively prolonged dry period, however it was possible to observe the potential water depths and flood plains due to the river geomorphology. The majority of the minor watercourses would break their main channel banks however the flood waters stayed mostly within the immediate steep channel valleys getting significantly deeper and faster flowing rather than significantly wider. During storm events, many of the minor or ephemeral drains would act like small watercourses aiding fast run-off and the hollows would act as basins to retain some water. The main watercourses, The Palmullan Burn, Balbeg Burn and Cawin Burn were observed to have more substantial and wider flood plains in particularly along sections of the Palmullan Burn. The Water of Girvan was observed to have a significant flood plain associated with it.

9.7.115 The total footprint area of the Proposed Development (all infrastructure, both access track options and up to 2 m of widening along each existing access track option) is 20.47ha and is unlikely to materially increase the probability of flooding elsewhere or significantly increase surface run-off rates providing appropriate drainage is installed. It is noted that the actual development footprint will be less than this because only one of the two access route options will be selected and used.

9.7.116 Based on the inclusion of both access route options and assuming all existing tracks are widened by up to 2 m, the proportion of total land take for each main catchment is less than 1.5 percent of each catchment area (Cawin Burn 0.41%, Balbeg Burn 0.46 %, Palmullan Burn 1.21 %, Genoch Burn 0.008 %, Tairlaw Burn 0.004 % and Lady Burn 0.061 %). The majority of the land take will be semi-permeable hard standing for access tracks, crane pads, construction areas and remain as peat for the temporary laydown areas and reinstated borrow pits. The only permanent impermeable surfaces within each main catchment will be the turbine bases, the substation and energy storage

facility, and the permanent meteorological mast and therefore the total proportion of impermeable land take for each catchment is negligible for all catchments, with the exception of the Palmullan Burn as the impermeable land take is calculated to be less than 0.5 %.

9.7.117 Flood Risk Assessments may be required for bridge design for the main watercourse crossings shown on the 1:50,000 scale Ordnance Survey mapping, particularly if structures within the flood plain cannot be avoided. Watercourse crossings will be in accordance with SEPA guidance and allow the conveyance of a 0.5 % AP (200 year) flow event plus climate change. Main watercourse crossings will allow fish, water vole and otter passage.

9.7.118 Flood risk sensitivity is considered low as the Proposed Development infrastructure will not be positioned within or near a flood plain, with the exception of access track crossings of main watercourses, and the Proposed Development design has minimised the amount of land take, hard surfacing and watercourse crossings as far as reasonably practicable. Additionally, mitigation will be put in place to control and attenuate run-off during all phases of the Proposed Development.

9.7.119 Several properties (receptors) in the vicinity of the site have been identified at risk of flooding from the Water of Girvan based on SEPA's mapping. SEPA mapping does not include any mapping of catchments of less than 3 $km^2$ and as such there may be potential for some minor localised flooding to occur around these small watercourses, particularly in areas where confluences with other burns are located.

9.7.120 From Ordnance Survey mapping, there are no known sensitive receptors in close vicinity to the development area and given that the development area is located on hill slopes at the top of the catchment, it is unlikely that the Proposed Development would have an adverse impact on local fluvial flood risk.

Watercourse Crossings

9.7.121 Up to nine new watercourse crossings will be constructed for the wind farm development. Three of these new watercourse crossings are required for the main development area.

9.7.122 Six new watercourse crossings would be required for the extension of the existing western forestry track and five new watercourse crossings would be required for the extension of the existing northern forestry track. Only one of the western and northern access routes will be utilised for the Proposed Development.

9.7.123 The three new watercourse crossings on the main development area are of main watercourses shown on 1:50,000 OS mapping. Additional crossings of small ephemeral or diffuse drainage lines may require culvert crossing.

9.7.124 Of the six new watercourse crossing required for the extension of the existing western forest, two are main watercourses shown on 1:50,000 OS mapping and four are minor watercourse crossings shown on 1:25,000 OS mapping or not shown on mapping.

9.7.125 Of the five new watercourse crossings required for the extension of the existing northern forestry track, five are shown on 1:50,000 scale OS mapping and should be considered as main watercourse crossings, however, on examination in the field, one crossing crosses an existing culverted wet area and another crosses a wet area that has been drained by grips and has no defined channel. It is therefore concluded that there are just three new main watercourse crossings required for the northern access route option..

9.7.126 The existing western forestry track has six existing watercourse crossings all of culvert construction. There are also numerous track drainage small culverts along the existing track.

9.7.127 The existing and recently constructed northern forestry track has seven watercourse crossings, all of culvert construction and all with the exception of one are crossing the Cawlin Burn or its tributaries.

9.7.128 Watercourse crossings will be installed in accordance with SEPA guidance and allow the conveyance of a 0.5 % AP (200 year) flow event plus climate change. Main watercourse crossings will allow fish,

water vole and otter passage as recommended within the ecological assessment presented in Chapter 8.

9.7.129 The watercourse crossing locations are shown on Figures 9.6a to 9.6c. The details of the crossings are presented within Technical Appendix 9.5.

Water Quality

9.7.130 SEPA has introduced water monitoring and classification systems that will provide the data to support the aim of the WFD (2000/60/EC): "that all water bodies are of good ecological status, or similar objective, by 2015, or by 2027 if earlier achievement would be disproportionately costly".

9.7.131 The classification system covers all rivers, lochs, transitional, coastal and groundwater bodies, and is based on a new ecological classification system with five quality classes (High, Good, Moderate, Poor and Bad). The classification system 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 water bodies). Small water bodies (rivers with <10 km² catchment, lochs <0.5 km²) are not classified under the WFD and, therefore, do not have target objectives under the River Basin Management Plan.

9.7.132 SEPA's online Water Environment Hub was consulted to find further information on current hydrological conditions. It should be noted that the online SEPA River Basin Management Plan interactive map and results gathered in 2014 have since been replaced by SEPA's Water Environment Hub.

9.7.133 The Palmullan Burn is a river (ID: 10463), in the Water of Girvan catchment of the Scotland's river basin district with a main stem of 8 km in length. The SEPA water classification for the Palmullan Burn is High with all factors (water quality, water flow and level, physical conditions, access for fish migration and freedom of invasive species) being of High classification with high confidence.

9.7.134 All other catchments within the site are less than 10 $km^2$ in area and therefore are not classified under SEPA's RBMP.

9.7.135 The Water of Girvan to the north-east and downstream of the site, Lindsayston Burn to Palmullan Burn (ID: 10455) has a main stem of approximately 27.4 km in length and is classified as Moderate overall classification. This is due to physical modifications of the beds, banks and shores being altered. It has High classification for access to fish migration and freedom of invasive species and good classification for water quality, water flow and level. The targets are to improve the Moderate physical conditions to Good by 2027.

9.7.136 The Water of Girvan to the south-east of the site, downstream of Loch Bradan to Palmullan Burn (ID: 10456) has a main stem 8.1 km in length and is classified as Moderate. It has High classification for access to fish migration and freedom of invasive species and Good classification for water quality, water flow and level, and physical condition. The water body has been designated as a heavily modified water body on account of physical alterations that cannot be addressed without a significant impact on water storage for public drinking water. Loch Bradan, which discharges to the Water of Girvan upstream of the site, is a public water drinking water supply.

9.7.137 SEPA have no water quality information available on the individual watercourses within the Proposed Development area readily available via online searches.

9.7.138 It is likely that the water quality within the site catchments is of Good to High quality as a result of the natural landscape and geomorphology and current land uses that have minimal impact to the catchment.

9.7.139 Field water quality measurements were recorded during the site visits in May 2021 and are presented in Table 9.8 and the locations shown on Figure 9.6a to 9.6c. The water quality results generally exhibit good water quality which is acidic in nature and has some colouration, typical of drainage in upland moorlands.

**Table 9.8 Field Water Quality Measurements Summary**

| Location | pH | Temp | Electrical Conductivity | Total Dissolved Solids (ppm) | Turbidity (NTU) | Flow Estimate (l/s) | Colour |
|---|---|---|---|---|---|---|---|
| WQ1<br>NX 599150 237535 | 5.95 | 8.6 | 60 | 30 | 0.49 | ~2 | Straw yellow, some particulates |
| WQ2<br>near T9<br>NX 36725 99560 | 5.91 | 7.8 | 56 | 28 | 1.23 | ~4 | Clear, slight yellow / brown |
| WQ3<br>near T1<br>NX 36866 99915 | 6.35 | 9.5 | 57 | 25 | 2.07 | ~6 | Clear, slight yellow / brown |
| WQ4<br>T1 to T2<br>NX 36935 99865 | 6.72 | 10.1 | 52 | 26 | 1.25 | ~6 | Clear, slight yellow / brown |
| WQ5<br>Shiel Burn<br>NX 37352 99942 | 6.79 | 10.1 | 70 | 35 | 0.25 | ~5 | Clear, slight yellow / brown |
| WQ6<br>Cawlin Burn<br>NS 36280 03553 | 6.63 | 8.8 | 103 | 52 | 3.00 | ~2 | Clear, slight yellow / brown |
| WQ7, Tributary to Cawlin Burn<br>NS 36495 03287 | 6.98 | 11.3 | 124 | 57 | 0.00 | ~0.5 | Clear, slight yellow / brown |
| WQ8, Tributary to Balbeg Burn<br>NS 36625 02877 | 6.87 | 10.7 | 66 | 33 | 0.0 | ~2 | Clear,<br>yellow / brown |

| Location | pH | Temp | Electrical Conductivity | Total Dissolved Solids (ppm) | Turbidity (NTU) | Flow Estimate (l/s) | Colour |
|---|---|---|---|---|---|---|---|
| WQ9, Balbeg Burn<br>NS 37287 02460 | 6.62 | 12.1 | 59 | 29 | 0.79 | ~8 | Clear, slight yellow / brown |
| WQ10<br>Palmullan Burn<br>NS 37368 01167 | 6.80 | 13.1 | 67 | 33 | 0.11 | ~60 | Clear, slight yellow |

**Private and Public Water Supplies and Abstractions**

Public Water Supply

9.7.140 The Tairlaw Burn and its catchment to the south-east of the site is shown to be a Surface Water Drinking Water Protection Area (DWPA) until its confluence with the Girvan Water. The very extreme south-eastern corner of the development area and a small section of Turbine 6 and its crane pad footprint drains into this catchment via drainage to the Pulreoch Burn which is a tributary of the Tairlaw Burn.

9.7.141 The River Stinchar to the south-west of the site is a surface water DWPA. The River Stinchar catchment is within a separate catchment from the site.

9.7.142 The Loch Brandan Reservoir to the south-east of the site is a Scottish Water drinking water reservoir and therefore is a surface water drinking water protection area (DWPA). Loch Brandan is upstream of the site and therefore is not hydrologically connected to the site.

9.7.143 Linfern Loch to the south-west of the site is also a Scottish Water drinking water reservoir and therefore is a surface water drinking water protection area (DWPA). Linfern Loch is upstream of the site and therefore is not hydrologically connected to the site.

9.7.144 Consultation has been undertaken with Scottish Water and a 1000 mm mains trunk pipeline from Loch Brandan to Straiton village roughly follows the line of the Water of Girvan on the southern or lefthand side.

9.7.145 The relevant Surface Water DWPAs and indicative Scottish Water mains pipeline route are shown on Figure 9.6.

Abstractions

9.7.146 In Scotland, water abstractions between 10 $m^3$/day and 50 $m^3$/day are required to be registered. Abstractions that have the potential to cause a significant impact or larger abstractions require an abstraction licence.

9.7.147 An information request was requested from SEPA with regards to licenced abstractions. No response has been received from SEPA at the time of writing (November 2021).

9.7.148 There are no known registered water abstractions within the Proposed Development area or within the near vicinity of the Proposed Development area.

Private Water Supplies (PWS)

9.7.149 Numerous properties within the vicinity of the site were identified to have the potential to be reliant on PWS. This area of South Ayrshire is considered to be a drought-stricken area by SAC and SEPA. Therefore, a thorough risk assessment of the PWS has been undertaken in collaboration with Constance Lobban, Enforcement Officer, Environmental Health, SAC.

9.7.150 The full PWS risk assessment is presented in Technical Appendix 9.6, summarised below and shown on Figure 9.6.

9.7.151 Prior to a site visit, potential properties reliant on PWS were identified from Ordnance Survey mapping and aerial imagery:

- Onsite: Linfairn;
- Close proximity to the site, within 600 m: Glenlinn, Palmullan Cottage, Knockskae, Glenalla Farm (approximately 250 m from access track), Dalmorton Farm, Dalmorton House and Dalrowan Cottage; and
- Greater than 600 m to 1000 m distance: Dyke properties x2, Bennan Farm properties x3, High Genoch, Genoch, Tairlaw Toll, Balbeg Holiday Cottages, Craigfad, Craig, Culloch, Knochgarden and Threethorns.

9.7.152 Consultation was undertaken with the Enforcement Officer at SAC Environmental Health Department to further identify the potential properties reliant on PWS. A list of nine properties with registered PWS was provided. These included: Knockskae, Glenalla Farm, LInfairn, Genoch, Little Garroch, Dalmorton Farm, Duncawin, Threethorns Farm, Knockgardner Farm.

9.7.153 A PWS questionnaire was sent to these properties to find out further information on their private water supplies. In addition, Lucy Parker, Principal Consultant, Fluid Environmental Consulting and an Enforcement Officer, Environmental Health, SAC undertook site visits on 9 and 10 June 2021 to the relevant shortlisted properties that had the potential to be connected to the development area to assess the source, condition and risk to the PWS.

9.7.154 Private water supplies that were established to not be hydrologically connected to the Proposed Development are not discussed here.

9.7.155 One PWS, located at Glenalla Farm NGR NS 34600 00258, was identified to be potentially hydrologically connected to the Proposed Development (the existing western forestry track). Glenalla Farm is reliant on an abstraction of surface water originating from springs on the adjacent hill with several surface water drains entering it, including surface water drainage from the Glenalla Farm track. The surface water abstraction point is located 240 m from the nearest Proposed Development infrastructure: (the existing western forestry access track which forms part of the western access route option). The springs at the top of the watercourse are located approximately 150 m from the existing western forestry track with forestry plantation in between. Whilst there is a considerable distance between the Proposed Development area and the supply, there are multiple sources to this private water supply and a potential risk, albeit low, from the existing western access track run-off to the supply, especially if widening is required.

**Fish and Other Water Dependent Species**

9.7.156 Details of the surveys, status of watercourses, and an assessment of the potential impact to fish or other water dependent species and any required mitigation is presented in Chapter 8. The following summary text is provided for context of watercourse sensitivity.

Fish

9.7.157 The habitats throughout the survey area provide suitable areas of moderate to good quality habitat for salmonids and brown trout and areas of suitable spawning habitat. In some instances, upstream habitats become unsuitable and inaccessible, due to natural or man-made to barriers, such as waterfalls or piped culverts.

9.7.158 Functional fish habitat within the study area is relatively restricted within watercourses of the site, with the Palmullan Burn along the northern site boundary and the Water of Girvan, along the eastern development area boundary providing the highest quality fish habitat, including for migratory and non-migratory salmonid species at all stages of their life.

9.7.159 The fish habitat survey (Linfairn Wind Farm, 2014) recorded potentially suitable fish habitat restricted to potential parr habitat along Balbeg and Palmullan Burn, and a small section of potential fry habitat along Balbeg Burn.

9.7.160 The Water of Girvan is known to support populations of Atlantic salmon and brown trout.

9.7.161 No designated site for nature conservation, designated by virtue of its fish interests, is located within 2 km of the site and no records of fish were identified during the desk study within 2 km of the site.

9.7.162 Embedded mitigation, including the adoption of culverts which allow free passage, together with good practice construction measures, adoption of a fish monitoring plan and pollution prevention controls (as detailed within Chapter 8) are considered adequate to avoid any potentially significant adverse effects upon local fish populations.

Invertebrates and Freshwater Pearl Mussel

9.7.163 There are records of freshwater pearl mussel in the upper reaches of the Water of Girvan.

9.7.164 Freshwater pearl mussel habitat surveys were therefore carried out and an assessment for the suitability of watercourses within the site for freshwater pearl mussel was undertaken and is detailed in Technical Appendix 8.3.

9.7.165 The Palmullan Burn is considered to be high quality fish habitat, suitable of supporting migratory and non-migratory salmonid species at all stages in their life cycle from spawning to adulthood. The combined areas of gravel and faster riffle sections, combined with access opportunities for migratory salmonids mean sections of the Palmullan Burn are also suitable for freshwater pearl mussel.

9.7.166 No designated site for nature conservation, designated by virtue of its invertebrate qualifying interests, is located within 2 km of the site and no existing records of any invertebrate species listed as an EPS or afforded special protection under the provisions of the Wildlife and Countryside Act 1981 (as amended) were identified during the desk study within 2 km of the site

Otter

9.7.167 Three otter records were returned from SWSEIC for within 2 km of the site and otter spraint was recorded on Palmullan Burn and the Water of Girvan during the Linfairn Wind Farm surveys.

9.7.168 No signs of otter were recorded during the current field surveys but suitable habitat is present within and along the boundaries of the site.

Water Voles

9.7.169 No designated site for nature conservation, designated by virtue of its terrestrial mammal interests, is located within 2 km of the site and no existing records of water vole were identified during the desk study within 2 km of the site. Field signs for water vole were found in three locations within the south western part of the site.

9.7.170 The three main new watercourses crossings required for the main development area, and the new crossings for the site access (two main new crossings if the western access track option is selected and three main new crossings if the northern access track option is selected) will be of a design so as to maintain hydraulic connectivity and allow the free passage of fish and other wildlife beneath. Watercourse crossings will also be of sufficient size so as not to restrict or concentrate flows downstream and to convey flows during periods of heavy rainfall (e.g. 1 in 200-year event plus climate change allowance).

**Designated Sites**

9.7.171 The relevant designated sites are shown on Figure 9.1.

9.7.172 There are no international or national designations located within the Proposed Development site or within 500 m of the Proposed Development infrastructure.

9.7.173 There are a number of designated sites within the vicinity of the Proposed Development site which are listed below:

- Knockgardner SSSI for geological exposure of fossilferous strata 0.28 ha, approximately 0.5 km north-west of the site boundary.
- Auchalton SSSI for biology 5.39 ha, approximately 2.2 km north-west of the site boundary.
- Blair Farm SSSI for geology 0.33 ha, approximately 3.0 km north-west of the site boundary.

9.7.174 The Knockgardner SSSI, located approximately 3 km south-west of Straiton, shows the best and most fossiliferous exposure of the Knockgardner Formation, which consists of thinly bedded, grey-green turbidites. This is the only lithological unit in the Girvan area which has yielded fossils of probable Wenlock age, dating from approximately 426 million years ago. This is a vital locality for the determination of probable Wenlock age rocks in the Girvan district and thus the distribution of Silurian strata in Scotland.

9.7.175 The Dalmellington Moss, Ness Glen, Loch Doon, Knockgardner, Auchalton, Bogton Loch and Merrick Kells SSSIs are all within 10 km of the closest part of the Proposed Development. While there are natural heritage interests of national importance on these sites, these are unlikely to be affected by the proposal given the geographic separation distance, and that these SSSIs are not directly hydrologically connected to the development site. Therefore, the objectives of designation and the overall integrity of the areas will not be compromised.

9.7.176 The whole site is located just outside the buffer of the Galloway & Southern Ayrshire Biosphere (GSAB) (527,514 ha in area).

### *General Site Conceptualisation*

9.7.177 The majority of the main development area and much of the western access track option are characterised by low permeability extrusive igneous rocks bedrock (Carrick Volcanic Formation, Duneaton Volcanic Formation and Southern Midland Valley Felsite Sills) allowing very limited infiltration of rainfall and therefore run-off rates will be relatively high and flashy for this hilly site with valleys. Localised low permeability superficial deposits of peat are present in the saturated upland hollows and valleys of blanket bog, wet heath and mire habitats will also limit groundwater recharge increasing run-off rates and limiting groundwater discharge by forming a capping layer. Localised low permeability glacial till on the bottom of slopes will limit any localised shallow groundwater discharge.

9.7.178 The northern section of the development area and much of the northern track option is underlain by moderately permeability bedrock (Swanshaw Sandstone Formation) which is mostly overlain by glacial till acting as a capping layer limiting rainwater infiltration and groundwater discharge.

9.7.179 Active peatland habitat is present only in very localised upland sections of the main development area, with peat depths ranging from not present to a maximum of 4.9 m. The Proposed Development will result in the direct loss of 0.47 ha of blanket bog and wet modified bog and a further 1.26 ha via indirect effects associated with potential drying out. This equates to 3.54 % of the habitats present within the site boundary, excluding those present within habitat mosaics.

9.7.180 The entire development area is within the Water of Girvan Catchment, mainly via the Palmullan Burn which runs through the development area and by other tributaries: the Genoch Burn in the east, the Pulreoch to the Tairlaw Burn in the extreme southeast, Balbeg Burn in the north, the Cawin burn in the extreme north and the Shiel Burn to the Lady Burn in the extreme west.

9.7.181 The water quality in the surface watercourses on site is classified as, or generally considered to be, either good or high and many of the larger watercourses have the potential to support migratory fish.

9.7.182 The main development area is characterised by upland moorland used for rough grazing with commercial forestry along the northern and western forestry track.

9.7.183 The Tairlaw Burn catchment is a surface water drinking water protection area (DWPA).Tairlaw Burn and its catchment are therefore highly sensitive and associated Scottish Water infrastructure is also present within the western section of the development area along the Water of Girvan flood plain.

### *Site Sensitivities*

9.7.184 The assessment of significance of effects is based on the magnitude and sensitivity criteria described above. Sensitive receptors identified for the site are:

- *peatland habitats;*
- *surface watercourses including:*
  - *The Tairlaw Burn Catchment (very high) – a surface water drinking water protection area;*
  - *Lower reaches of Palmullan Burn and Balbeg Burn and the Water of Girvan (high sensitivity) for migratory fish: salmonids and brown trout and potential suitable habitat for fresh water pearl mussel;*
  - *Watercourses of the main development area (medium sensitivity) as linked to high sensitivity habitats downstream;*
  - *Watercourses for otter and water vole in the south-western section of the main development area.*
- *The Glenalla Farm potable private water supply and associated catchment; and*
- *Groundwater supplying dependent habitats along the small sections of the access track.*

9.7.185 Based on the assessment criteria defined in Table 9.4, a summary of the site sensitivities is presented in Table 9.9.

**Table 9.9 - Site Sensitivity Summary**

| Hydrologically Sensitive Receptors | | Sensitivity as habitats | Rationale/Designations |
|---|---|---|---|
| Terrestrial | Mire<br><br>Peat | *High | UK BAP, Habitat Regs, Section 42 |
| | Active Blanket Bog<br><br>Upland Heathland | *Very High | Annex I Habitats under EU habitats directive |
| | Shallow Peat (>0.5 m to 1.0 m) | Medium | Guidance on Developments on Peatland - Site Surveys |
| | Deep Peat (>1.0 m) | High | Guidance on Developments on Peatland - Site Surveys |
| | Very Deep Peat (>2.0 m) | Very High | Guidance on Developments on Peatland - Site Surveys |
| Groundwater | Shallow Groundwater | High | Maintains water dependent habitats and peat saturation |
| | Deep Groundwater | Low | Limited resource and no identified dependent users |
| Surface Watercourses | Tairlaw Burn | Very High | Surface Water DWPA. |
| | Glenalla Farm potable PWS, upper reaches of Palmullan Burn | Very High | Drinking Water Regulations |
| | Water of Girvan<br><br>Lower Reaches of Palmullan Burn) and Balbeg Burn | High | High value for Atlantic salmon, brown trout, otter and potentially freshwater pearl mussel with useful habitat in accessible reaches. |
| | Watercourses within main development area (including Knockoner Burn and Shiel Burn) | Medium | Watercourses not suitable for migratory fish directly. They are linked to high value habitat downstream however distance and dilution will reduce the sensitivity. |

*Note: although the various habitat classifications of peat, mire and blanket bog have high to very high sensitivity as habitats, this Chapter assesses peat as a material or resource so the sensitivity is determined by the Guidance of Developments on Peatland – Site Surveys 2017, reflected in Table 9.2. The effects on habitat are assessed within Chapter 8.

## 9.8 Potential Effects

9.8.1 This section describes the potential effects of the Proposed Development based upon an assessment of the activities which will occur during the construction, operation and decommissioning phases of the Proposed Development, in relation to the sensitive areas of the site, prior to mitigation and management, and assuming that best practice methods are employed (refer to Technical Appendix 9.1). The purpose of this assessment is to identify likely significant adverse effects on the environment and whether specific mitigation and management measures can reduce these effects.

9.8.2 As set out in Chapter 3 and discussed elsewhere in this chapter, two prospective access routes (northern and western) have been identified, although only one route to site will be selected and utilised. Given that it is not certain at this stage which route will be used, the potential effects associated with construction and operation of both options have been assessed together. This results in some aspects such as development footprint area and estimated peat excavation volumes being over-stated, given that numbers reflected in the assessment are based on cumulated figures for both access routes combined. A qualitative review has identified that the level of impacts and significance of effects would not be materially different depending on which route is selected. Crucially, the assessment has also identified no significant residual effects even when considering both access routes combined. It therefore follows that impacts will if anything be less than has been assessed.

### *Potential Impacts*

9.8.3 The assessment of potential effects considers the magnitude of the potential impacts and the sensitivity of the receptors. Possible hydrological, hydrogeological and geological impacts resulting from the construction, operation and decommissioning of wind farms are related to five main factors:

- **Erosion and Sediment Transport** – Unmanaged erosion/sediment deposition and suspended solids generated from ground disturbance and new infrastructure could travel directly by surface run-off or cause modification to stream channel morphology, with resulting smothering of habitats/effect on both terrestrial and aquatic flora and fauna, especially fish. Unacceptable levels of sediment could also affect water abstracted for drinking supply. This could result from:
  - slides of incorrectly stored excavated materials;
  - direct disturbance of the banks and beds of watercourses during watercourse crossing construction, repair and/or upgrade works or during cable installation within the watercourse bed;
  - pumping of standing water required for dewatering of excavations such as turbine bases, borrow pits or as required for drainage management purposes;
  - run-off from exposed ground, excavations and material stockpiles (aggregate and excavated/overburden peat and soil), cable trenches and tracks;
  - run-off from tracks, bridges and culverts crossings at watercourse and drain crossings;
  - run-off from recently reinstated areas (road verges, borrow pits etc); and
  - movement of stockpiled material.
- **Potential Polluting events affecting Groundwater and Surface Water Quality –** Oil/Fuel/Chemical pollution (from for instance, accidental spillage or incorrect transport or storage during concrete preparation and refuelling procedures, or from leaching of concrete

from turbine bases and installations) could affect both terrestrial and aquatic flora and fauna and also on human activities such as water abstracted for drinking supply. These could include:

- cement wash out areas, storage areas and other areas where cement grout or concrete is being applied;
- plant washing and vehicle wheel wash areas;
- fuel and chemical storage/refuelling areas;
- leaking/vandalised plant and equipment; and
- sewage and waste water from construction compound and permanent control building amenities.

- **Alteration of Natural Drainage Patterns/Run-off Volumes and Rates –** Any alteration of natural drainage could disturb natural surface and subsurface water flows to either water dependent habitats or to water supply abstraction points, unless properly managed. Tracks and other hardstand areas could provide new preferential pathways and interfere with the retention of flows within catchments. Inappropriate water crossings could result in blockages and flooding, with the potential to exacerbate erosion. Storage of peat or other excavated material in inappropriate locations could result in an alteration to water flows and in an increase in peat slide risk in hazard prone areas.
- **Increase in the Magnitude or Frequency of Flood Events –** the alteration of areas on floodplains may result in flood waters extending further or deeper elsewhere and/or increase the frequency of such events. In some cases, this could result in risk to human life/health, damage to infrastructure, devaluing of land and change to ecological systems.
- **Alteration of the Geological Environment –** The excavation of the subsoil required to build the site infrastructure such as turbine bases and access roads and will result in an alteration of the geological environment; in particular any underlying peat may be removed and will need to be managed appropriately. Peatland habitats take 1,000s of years to develop and appropriate restoration plans are required to ensure a net balance or net positive balance.

9.8.4 The potential impacts of the Proposed Development are summarised below in Table 9.10. It is noted that the impacts listed in Table 9.10 are only potential and their inclusion does not necessarily indicate that they will occur.

**Table 9.10 Summary of Potential Impacts on Hydrology/Hydrogeology and Peatlands Arising from Wind Farm Developments**

| Potential Receptors | Activities and Potential Impacts | | |
|---|---|---|---|
| | Construction Phase | Operation Phase | Decommissioning Phase |
| Surface water hydrology and channel morphology | Works next to or near watercourses or diversion of watercourses:<br><br>change in flow velocities<br><br>increased erosion and subsequent changes in bed and bank stability | Use of vehicles and machinery:<br><br>increase in surface run-off from soil compaction<br><br>run-off from access roads | Earthworks:<br><br>pollution from suspended material<br><br>disturbance of contaminated soil and subsequent pollution of water courses<br><br>peat slide and bog burst |

| Potential Receptors | Activities and Potential Impacts | | |
|---|---|---|---|
| | **Construction Phase** | **Operation Phase** | **Decommissioning Phase** |
| | increased flood risk | | |
| | Use of vehicles and machinery:<br><br>increase in surface run-off from soil compaction | Site drainage:<br><br>rapid transfer of rainwater to watercourses via drains | Use of vehicles and machinery to remove turbines and associated infrastructure:<br><br>temporary increase in surface run-off from soil compaction |
| | Earthworks:<br><br>increased sedimentation of watercourses<br><br>peat slide and bog burst | | |
| Surface water quality | Earthworks:<br><br>pollution from suspended material<br><br>disturbance of contaminated soil and subsequent pollution of watercourses<br><br>peat slide and bog burst | Materials management:<br><br>pollution from maintenance work spills or leaks of fuel or oil | Earthworks:<br><br>pollution from suspended material<br><br>disturbance of contaminated soil and subsequent pollution of water courses<br><br>peat slide and bog burst |
| | Materials management:<br><br>pollution from spills or leaks of fuel, oil and construction material | Use of machinery:<br><br>sediment-loading of watercourses | Materials management:<br><br>pollution from spills or leaks of fuel, oil and construction material |
| Groundwater hydrology | Earthworks and site drainage:<br><br>reduction in water table<br><br>changes to groundwater | Physical presence of turbine foundations:<br><br>possible minimal alteration of groundwater flow | Earthworks and site drainage:<br><br>reduction in water table<br><br>changes to groundwater distribution and flow |
| | | | Physical presence of turbine foundations:<br><br>possible minimal alteration of groundwater flow |
| Groundwater quality | Earthworks and site drainage: | Materials management: | Earthworks and site drainage: |

| Potential Receptors | Activities and Potential Impacts | | |
|---|---|---|---|
| | Construction Phase | Operation Phase | Decommissioning Phase |
| | disturbance of contaminated soil and subsequent pollution of watercourses | contamination from spills or leaks of fuel and oil | disturbance of contaminated soil and subsequent pollution of watercourses |
| | Materials management:<br><br>contamination from spills or leaks of fuel and oil | | Use of vehicles and machinery to remove turbines and associated infrastructure:<br><br>contamination from spills or leaks of fuel or oil |
| Geological Environment | Earthworks and site drainage:<br><br>reduction in water table resulting in the drying out of peat<br><br>excavation and removal of peat<br><br>loading and destabilisation of peat and peat slide/bog burst | Site drainage:<br><br>Continued dewatering of peat<br><br>Peat slide | Earthworks and site drainage:<br><br>reduction in water table resulting in the drying out of peat<br><br>excavation and removal of peat<br><br>loading and destabilisation of peat and peat slide/bog burst |

*(Summarised from Environment Agency (2002) Scoping Guidelines on the Environmental Impact Assessment (EIA) of Projects. Environment Agency (EA), Bristol)*

9.8.5 During the development and lifetime of the Proposed Development, some of the activities and associated impacts set out in Tale 9.10 could, if not properly managed, have the potential to lead to significant effects on the water and peatland environment.

9.8.6 The main construction activities are listed in Chapter 3 and described in Technical Appendices 3.1 and 9.1and the site layout is shown in Figures 1.1 and 9.1.

### *Good Practice and Standard Mitigation Methods*

9.8.7 Following good practice guidance, the assessment process assumes the application of standard mitigation measures as presented in Technical Appendix 9.1. A range of measures have already been applied as part of the iterative design development process (see Chapter 2), to avoid the higher value areas of blanket bog, waterbodies and watercourses.

9.8.8 In the design phase, wherever possible, all the Proposed Development infrastructure has been sited with an objective to maintain at least a 50 m 'buffer zone' between turbine locations and natural main watercourses (shown on 1:50,000 scale OS mapping) and to avoid active peatland where possible taking into account other constraints.

9.8.9 The number of new watercourse crossings has been minimised and all new or upgraded crossings will be designed to convey 1 in 200 year plus climate change flows.

9.8.10 Further detailed ground investigation will be undertaken post consent to develop the detailed design and to assess potential options for alternative foundation designs to further reduce the

disturbance of peat. During the detailed design and construction phase, sections of track will be surveyed and micro-sited to optimise the distance where possible from water features and minimise peat disturbance and peat slide hazard.

9.8.11 Standard mitigation also includes adherence to current environmental protection policies and guidance, including but not limited to:

- Good Practice During Wind Farm Construction (SNH, 4th edition 2010);
- Constructed tracks in the Scottish uplands (SNH, 2015b);
- WAT-SG-75 (SEPA, 2018);
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) A Practical Guide (SEPA, Version 8.4 October 2019); and
- LUPS-GU31 (SEPA, 2017).

9.8.12 A Site Construction Environmental Management Plan (CEMP) will be developed, in consultation with stakeholders (i.e. SEPA, SNH and SAC) to include:

- Appointment of a suitably qualified and experienced Ecological Clerk of Works (ECoW) and Hydrological Clerk of Works (HCoW) to oversee application of the CEMP;
- Site Water Management Plan (SWMP);
- Outline Peat Management Plan (PMP); see Technical Appendix 9.3;
- Materials Management Plan (MMP; to include a Waste Policy/Management Plan); and,
- Habitat Management Plan (HMP); see Technical Appendix 8.6.

9.8.13 A pre-construction ecological survey programme of habitats and watercourse crossing points will be undertaken (refer to Chapter 8), to feed into the final micro-siting process.

9.8.14 Method Statements will be used during construction, to include current good practice and prescribed use of low noise and vibration plant to limit fish avoidance behaviours when working near watercourses.

9.8.15 An Operational Site Management Plan (OSMP) will be developed, to include an HMP and maintenance task Method Statements.

9.8.16 The good practice techniques that will be employed by the Applicant during the construction and operation of the wind farm are detailed in Technical Appendix 9.1. These techniques have been assumed to be adopted as part of the Proposed Development when undertaking the assessment of potential effects and are considered the standard that will be applied rather than specific mitigation. This list is not exhaustive and guidance and good practice literature will be used. Mitigation measures (refer to Section 9.9) are over and above these standards and will be specific to the source-pathway-receptor identified at risk.

### *Assessment of Potential Effects*

9.8.17 The following tables describe those elements of the Proposed Development with the main potential for impacts on hydrology, hydrogeology and geology, including hydrological/hydrogeological impacts on peat. A magnitude of potential impact has been assigned to these based on their location and activity and the duration of impacts, whether the impacts are long term or short term. This magnitude of potential impact takes into account the good practice and standard mitigation methods described in Technical Appendix 9.1.

9.8.18 The assessment of magnitude of potential impacts of the individual items of infrastructure feeds into the assessment of likely significant effects of the infrastructure in each catchment and the assessment of the whole Proposed Development.

**The Proposed Development**

9.8.19 The main development area comprises the central section of the development area from the watercourse crossing of the Palmullan Burn and to the south.

9.8.20 The main development area comprises the following, noting that areas are indicative and based on a candidate turbine model and associated crane pads etc:

- Nine turbines and Crane Pads (up to 7,176 $m^2$ for each turbine base and associated crane pad area excavated. Therefore, requires a total land take of up to 60,734 $m^2$).
- Met Mast (Irregular shape, 1,023 $m^2$).
- Construction Compound (5,000 $m^2$)
- Two Gatehouse options (2,500 $m^2$)
- Substation (5,000 $m^2$)
- Energy Storage Facility (10,000 $m^2$)
- Access tracks associated with the development comprise tracks to and between turbines and other infrastructure within the main development area, and two access options to the main development area (northern and western routes), only one of which will be selected and used. As the final decision of access route has not yet been made, both options are considered in the assessment. The total length of proposed access track, including both options (and therefore acknowledged as being greater than will be the case in practice) is approximately 12.5km (55,997 $m^2$ area), comprising:
- New excavated, width of 5 m and approximate length of 7.55 km which includes bellmouths, passing places and turning areas (42,879 $m^2$);
- New Floated width of 5 m and approximate length of 0.25 km which includes bellmouths, passing places and turning areas (1,092 $m^2$);
- Existing Track widened by up to 2 m wide (worst case scenario) strip on one side of 4.95km length of existing 3 m wide track (12,006 $m^2$).

9.8.21 Cable routing will be laid in trenches along the edges of tracks 0.5 m deep and 1 m wide or under the access track (no additional permanent land take).

9.8.22 Five borrow pit search areas have also been identified (A, B, C, D and E) (45,927 $m^2$ in total), with three of these (B, C and D) on the main development area and one each on the northern (A) and western (E) access route options. Depending on which access route option is selected, only one of the latter two borrow pit areas would be used.

***Table 9.11 - Inventory of the Proposed Development Infrastructure and their Associated Magnitude of Potential Impact of Causing Sedimentation, Pollution, Alteration of Natural Water Flows, Excavation of Peat, Peat Slide Risk and Changes to Peat Hydrology.***

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| T1<br><br>6,695 $m^2$ | NGR 236759 599643 | *Gradient: Low to moderate.*<br><br>*Drains towards the un-named tributary of the Knockoner Burn to the Palmullan Burn downstream..*<br><br>*Watercourse proximity: 48 m main watercourse. Crane pad located on a two minor drains that will require culverted.*<br><br>*Average peat depth: 0.38 m.*<br><br>*Estimated volume of peat excavated: 1,983 $m^3$.*<br><br>*Peat landslide susceptibility: Negligible to low.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout otter and freshwater pearl mussel (Chapter 8).* | *Low to medium for water quality, main watercourse close just within 50 m.*<br><br>*Low to medium for drainage alteration.*<br><br>*Medium for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Low for peat slide risk (Technical Appendix 9.4)* |
| T2<br><br>6,695 $m^2$ | NGR 237131 599863 | *Gradient: Low to moderate.*<br><br>*Drains towards the Shiel Burn to the Palmullan Burn downstream.*<br><br>*Watercourse proximity: 50 m main watercourse. Crane pad located on a minor drain to Shiel Burn that will require culverted.*<br><br>*Average peat depth: 0.13 m.*<br><br>*Estimated volume of peat excavated: 31 $m^3$.*<br><br>*Peat landslide susceptibility: Negligible to low.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids,* | *Low for water quality, no main watercourse close.*<br><br>*Low to medium for drainage alteration.*<br><br>*Low for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Low for peat slide risk (Technical Appendix 9.4)* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| | | *brown trout and otter and freshwater pearl mussel (Chapter 8).* | |
| T3<br><br>6,695 m5 $m^2$ | NGR 237491 599614 | *Gradient: Low.*<br><br>*Drains towards the un-named tributaries of the Shiel Burn and Knockoner Burn to the Palmullan Burn downstream.*<br><br>*Watercourse proximity: over 50 m main watercourse.*<br><br>*Average peat depth: 0.24 m.*<br><br>*Estimated volume of peat excavated: 3 $m^3$.*<br><br>*Peat landslide susceptibility: Negligible.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for water quality, no main watercourse close.*<br><br>*Low for drainage alteration.*<br><br>*Low for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Low for peat slide risk (Technical Appendix 9.4)* |
| T4<br><br>6,695 $m^2$ | NGR 237838 599922 | *Gradient: Low to moderate.*<br><br>*Drains towards the un-named tributaries of the Shiel Burn to the Palmullan Burn downstream.*<br><br>*Watercourse proximity: over 50 m main watercourse.*<br><br>*Average peat depth: 0.12 m.*<br><br>*Estimated volume of peat excavated: 31 $m^3$.*<br><br>*Peat landslide susceptibility: Negligible to low.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for water quality, no main watercourse close.*<br><br>*Low for drainage alteration.*<br><br>*Low for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Low for peat slide risk (Technical Appendix 9.4)* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| T5<br><br>6,695 $m^2$ | NGR 237972 599514 | *Gradient: Low to moderate.*<br><br>*Drains towards the un-named tributaries of the Shiel Burn to the Palmullan Burn downstream.*<br><br>*Watercourse proximity: over 50 m main watercourse. Located in area of artificial grips.*<br><br>*Average peat depth: 0.24 m.*<br><br>*Estimated volume of peat excavated: 0 $m^3$ (peat depth <0.5 m therefore considered peaty/organic soil, not peat, as per Peat Landslide Hazard and Risk Assessments: Good practice Guide, Scottish Government, 2017).*<br><br>*Peat landslide susceptibility: Negligible.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities</u>:*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for water quality, no main watercourse close.*<br><br>*Low for drainage alteration.*<br><br>*Low for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Negligible for peat slide risk (Technical Appendix 9.4)* |
| T6<br><br>6,695 $m^2$ | NGR 238202 599132 | *Gradient: Low.*<br><br>*Drains towards the un-named tributaries of Shiel Burn to Palmullan Burn downstream.*<br><br>*Also drains to un-named minor drains to Pulreoch Burn and to the Tairlaw Burn downstream.*<br><br>*Watercourse proximity: over 50 m main watercourse. Crane pad located on a two minor drains.*<br><br>*Average peat depth: 0.33 m.*<br><br>*Estimated volume of peat excavated: 417 $m^3$.*<br><br>*Peat landslide susceptibility: Negligible to low*<br><br>*GWDTEs: Negligible* | *Low for water quality, no main watercourse close.*<br><br>*Low to medium for drainage alteration.*<br><br>*Medium for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Low for peat slide risk (Technical Appendix 9.4)* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| | | *Other sensitivities:*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | |
| T7<br><br>6,693 $m^2$ | NGR 237720 599172 | *Gradient: Low to moderate.*<br><br>*Drains towards the unnamed tributaries of the Knockoner Burn to the Palmullan Burn downstream.*<br><br>*Watercourse proximity: over 50 m main watercourse. Crane pad located on a minor drain.*<br><br>*Average peat depth: 0.2 m.*<br><br>*Estimated volume of peat excavated: 41 $m^3$.*<br><br>*Peat landslide susceptibility: Negligible to low.*<br><br>*GWDTEs: Negligible*<br><br>*Other sensitivities:*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for water quality, no main watercourse close.*<br><br>*Low to medium for drainage alteration.*<br><br>*Low for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Low for peat slide risk (Technical Appendix 9.4)* |
| T8<br><br>7,176 $m^2$ | NGR 237249 599234 | *Gradient: Low to moderate.*<br><br>*Drains towards the unnamed tributary of the Knockoner Burn to the Palmullan Burn downstream.*<br><br>*Watercourse proximity: over 50 m main watercourse.*<br><br>*Average peat depth: 0.36 m*<br><br>*Estimated volume of peat excavated: 440 $m^3$ (peat depth <0.5 m therefore considered peaty/organic soil, not peat, as per Peat Landslide Hazard and Risk Assessments: Good practice Guide, Scottish Government, 2017).* | *Low for water quality, no main watercourse close.*<br><br>*Low for drainage alteration.*<br><br>*Medium for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| | | *Peat landslide susceptibility: Negligible to low.*<br><br>*GWDTEs: Negligible*<br><br>*Other sensitivities:*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for peat slide risk (Technical Appendix 9.4)* |
| T9<br><br>6,695 $m^2$ | NGR 236820 599164 | *Gradient: Low to moderate.*<br><br>*Drains towards the un-named tributary of the Knockoner Burn to the Palmullan Burn downstream.*<br><br>*Watercourse proximity: Turbine footprint over 50 m from watercourse. Crane hardstanding footprint approximately 31 m from main watercourse. Eastern section of crane pad on area with artificial grip drainage.*<br><br>*Average peat depth: 0.36 m.*<br><br>*Estimated volume of peat excavated: 269 $m^3$*<br><br>*Peat landslide susceptibility: Negligible to low.*<br><br>*GWDTEs: Negligible*<br><br>*Other sensitivities:*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low to medium for water quality, main watercourse close, just within 50 m.*<br><br>*Low for drainage alteration.*<br><br>*Medium for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Low for peat slide risk (Technical Appendix 9.4)* |
| Met Mast<br><br>Irregular<br><br>1,023 $m^2$ | NGR 237043 599071 | *Gradient: Low.*<br><br>*Drains towards the un-named tributary of the Knockoner Burn to the Palmullan Burn downstream.*<br><br>*Watercourse proximity: Over 50 m.*<br><br>*Average peat depth: 0.43 m.* | *Low for water quality, no main watercourse close.*<br><br>*Low for drainage alteration.*<br><br>*Medium for peat disturbance.* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| | | *Estimated volume of peat excavated: 106 $m^3$*<br><br>*Peat landslide susceptibility: Negligible to medium.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for groundwater disturbance as located on impermeable geology*<br><br>*Low for peat slide risk based on runout volume calculations (Technical Appendix 9.4)* |
| Construction Compound<br><br>Rectangular 100 m x 50 m<br><br>5,000 $m^2$ | NGR 237874 600244 | *Gradient: Low.*<br><br>*Drains to minor un-named tributaries to the Palmullan Burn downstream.*<br><br>*Watercourse proximity: Over 50 m from watercourse. Southern boundary near small drain.*<br><br>*Average peat depth: 0.07 m.*<br><br>*Estimated volume of peat excavated: 0 $m^3$ (peat depth <0.5 m therefore considered peaty/organic soil, not peat, as per Peat Landslide Hazard and Risk Assessments: Good practice Guide, Scottish Government, 2017).*<br><br>*Peat landslide susceptibility: Negligible.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for water quality.*<br><br>*Low for drainage alteration.*<br><br>*Negligible for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Negligible for peat slide risk (Technical Appendix 9.4)* |
| Energy Storage Facility<br><br>Rectangular 200 m x 50 m<br><br>10,000 $m^2$ | NGR 237967 599367 | *Gradient: Low to moderate.*<br><br>*Drains to un-named tributaries and Shiel Burn to the Palmullan Burn downstream.* | *Low to medium for water quality.*<br><br>*Low to medium for drainage alteration.* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| | | *Watercourse proximity: Over 50 m from watercourse. In area of artificial grip drainage.*<br><br>*Average peat depth: 0.32 m.*<br><br>*Estimated volume of peat excavated: 576 $m^3$*<br><br>*Peat landslide susceptibility: Negligible to low.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Medium for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Low for peat slide risk (Technical Appendix 9.4)* |
| Substation<br><br>Rectangular 100 m x 50 m<br><br>5,000 $m^2$ | NGR 238261 599385 | *Gradient: Low.*<br><br>*Drains to un-named tributaries to Shiel Burn to the Palmullan Burn downstream. The north eastern corner drains towards un-named tributaries of the Genoch Burn.*<br><br>*Watercourse proximity: Over 50 m from watercourse.*<br><br>*Average peat depth: 0.28 m.*<br><br>*Estimated volume of peat excavated: 0 $m^3$ (peat depth <0.5 m therefore considered peaty/organic soil, not peat, as per Peat Landslide Hazard and Risk Assessments: Good practice Guide, Scottish Government, 2017).*<br><br>*Peat landslide susceptibility: Negligible .*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for water quality.*<br><br>*Low to medium for drainage alteration.*<br><br>*Negligible for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Negligible for peat slide risk (Technical Appendix 9.4 PSHRA)* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| Borrow Pit A<br><br>Irregular<br><br>10,639 $m^2$ | NGR 237115 602773 | *Gradient: Very steep.*<br><br>*Drains towards the Balbeg Burn*<br><br>*Watercourse proximity: Over 50 m from watercourse.*<br><br>*Average peat depth: 0 m.*<br><br>*Estimated volume of peat excavated: 0 $m^3$*<br><br>*Peat landslide susceptibility: Negligible .*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Water of Girvan and Balbeg Burn has the potential to support salmonids, brown trout otter and fresh water pearl mussel (Chapter 8).* | *Low for water quality.*<br><br>*Low for drainage alteration.*<br><br>*Negligible for peat disturbance.*<br><br>*Medium for groundwater disturbance as located on moderate aquifer*<br><br>*Negligible for peat slide risk (Technical Appendix 9.4)* |
| Borrow Pit B<br><br>Irregular<br><br>6,627 $m^2$ | NGR 237422 600931 | *Gradient: Moderate to steep*<br><br>*Drains towards the Palmullan Burn*<br><br>*Watercourse proximity: Over 50 m from watercourse.*<br><br>*Average peat depth: 0.08 m.*<br><br>*Estimated volume of peat excavated: 0 $m^3$ (peat depth <0.5 m therefore considered peaty/organic soil, not peat, as per Peat Landslide Hazard and Risk Assessments: Good practice Guide, Scottish Government, 2017).*<br><br>*Peat landslide susceptibility: Negligible.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for water quality.*<br><br>*Low for drainage alteration.*<br><br>*Negligible for peat disturbance.*<br><br>*Low to medium for groundwater disturbance as northern corner located on moderate aquifer*<br><br>*Negligible for peat slide risk (Technical Appendix 9.4)* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| Borrow Pit C<br><br>Irregular<br><br>12,726 $m^2$ | NGR 237434 600063 | *Gradient: Low to moderate*<br><br>*Drains towards the Shiel Burn to the Palmullan Burn downstream.*<br><br>*Watercourse proximity: Over 50 m from watercourse.*<br><br>*Average peat depth: 0.07 m.*<br><br>*Estimated volume of peat excavated: 24 $m^3$*<br><br>*Peat landslide susceptibility: Negligible as minimal peat.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for water quality.*<br><br>*Low for drainage alteration.*<br><br>*Low for peat disturbance.*<br><br>*Low for groundwater disturbance.*<br><br>*Negligible for peat slide risk (Technical Appendix 9.4)* |
| Borrow Pit D<br>Irregular<br><br>3,920 $m^2$ | NGR 237332 599240 | *Gradient: Moderate*<br><br>*Drains towards the*<br><br>*Drains towards the un-named tributary of the Knockoner Burn to the Palmullan Burn downstream.*<br><br>*Watercourse proximity: Over 50 m from watercourse.*<br><br>*Average peat depth: 0.13 m.*<br><br>*Estimated volume of peat excavated: 0 $m^3$ (peat depth <0.5 m therefore considered peaty/organic soil, not peat, as per Peat Landslide Hazard and Risk Assessments: Good practice Guide, Scottish Government, 2017).*<br><br>*Peat landslide susceptibility: Negligible.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>* | *Low for water quality.*<br><br>*Low for drainage alteration.*<br><br>*Negligible for peat disturbance.*<br><br>*Low for groundwater disturbance.*<br><br>*Negligible for peat slide risk (Technical Appendix 9.4)* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| | | *Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | |
| Borrow Pit E<br><br>Irregular<br><br>12,015 $m^2$ | NGR 235257 600487 | *Gradient: Moderate*<br><br>*Drains towards un-named drains andthe the upper reaches of the Palmullan Burn.*<br><br>*Watercourse proximity: Over 50 m from watercourse.*<br><br>*Average peat depth: 0.05 m.*<br><br>*Estimated volume of peat excavated: 11 $m^3$*<br><br>*Peat landslide susceptibility: Negligible as minimal peat.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for water quality.*<br><br>*Low for drainage alteration.*<br><br>*Negligible for peat disturbance.*<br><br>*Low for groundwater disturbance.*<br><br>*Negligible for peat slide risk (Technical Appendix 9.4)* |
| Gatehouse – compound (north)<br><br>50 m x 50 m<br><br>2,500 $m^2$ | NGR 237152 604424 | *Gradient: Low*<br><br>*Drains towards the Cawin Burn*<br><br>*Watercourse proximity: Over 50 m from watercourse.*<br><br>*Average peat depth: 0 m.*<br><br>*Estimated volume of peat excavated: 0 $m^3$*<br><br>*Peat landslide susceptibility: Negligible.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for water quality.*<br><br>*Low for drainage alteration.*<br><br>*Negligible for peat disturbance.*<br><br>*Low for groundwater disturbance.*<br><br>*Negligible for peat slide risk (Technical Appendix 9.4)* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| Gatehouse – compound (western)<br><br>50 m x 50 m<br><br>2,500 $m^2$ | NGR 234174 601040 | *Gradient: Moderate*<br><br>*Drains towards the un-named tributary of Sheil Burn (western) to the Lady Burn downstream.*<br><br>*Watercourse proximity: Over 50 m from watercourse.*<br><br>*Average peat depth: 0.41 m.*<br><br>*Estimated volume of peat excavated: 440 $m^3$*<br><br>*Peat landslide susceptibility: Negligible to medium*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter (Chapter 8).* | *Low for water quality.*<br><br>*Low for drainage alteration.*<br><br>*Medium for peat disturbance.*<br><br>*Low for groundwater disturbance.*<br><br>*Negligible to low for peat slide risk based on runout calculations (Technical Appendix 9.4)* |
| New Excavated Track<br><br>7.75km<br><br>42,879 $m^2$ | Main development area | *Gradient: Low to steep*<br><br>*Drains towards unnamed tributaries to Knockoner Burn or Sheil Burn or Palmullan Burn downstream.*<br><br>*Watercourse proximity: over 50 m main watercourse, with exception of watercourse crossings.*<br><br>*Watercourse Crossings: 3 No. New main crossings*<br><br>*Average peat depth: 0.14 m*<br><br>*Estimated volume of peat excavated: 1,151 $m^3$.*<br><br>*Peat landslide susceptibility: Negligible (where there is no peat), to medium (at turning area between T8 and T9).*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>* | *Low for water quality.*<br><br>*Low for drainage alteration.*<br><br>*Negligible to low for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Low for peat slide risk based on runout calculations (Technical Appendix 9.4)* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| | | *Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | |
| | Western Access Route Option | *Gradient: Low to steep.*<br><br>*Drains mostly to un-named tributariesof the upper reaches of the Palmullan Burn and approximately 0.2km via un-named tributaries to Sheil Burn (western) and the Lady Burn downstream.*<br><br>*Watercourse proximity: Over 50 m with exception of crossings.*<br><br>*Watercourse Crossings: 6No.*<br><br>*2No. Main. 4No. minor*<br><br>*Average peat depth: 0 m*<br><br>*Estimated volume of peat excavated: 0 $m^3$.*<br><br>*Peat landslide susceptibility: Negligible.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low to medium for water quality.*<br><br>*Low to medium for drainage alteration.*<br><br>*Negligible for peat disturbance.*<br><br>*Low to medium for groundwater disturbance as located on moderately permeable geology*<br><br>*Negligible for peat slide risk (Technical Appendix 9.4)* |
| | Northern Access Route Option | *Gradient: Low to steep*<br><br>*Drains towards the Balbeg Burn and un-named tributaries of the Pallmullan Burn.*<br><br>*Watercourse proximity: over 50 m main watercourse, with exception of watercourse crossings and approximate 0.35km new track along the Balbeg Burn (34 m at closest).*<br><br>*Watercourse Crossing: 5 No. new.*<br><br>*3 No. Main, 2 No. Minor.*<br><br>*Average peat depth: 0 m* | *Low to medium for water quality.*<br><br>*Low to medium for drainage alteration.*<br><br>*Negligible for peat disturbance.*<br><br>*Low to medium for groundwater disturbance as located on impermeable and moderately permeable geology* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| | | *Estimated volume of peat excavated: 0 m³.*<br><br>*Peat landslide susceptibility: Negligible.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Negligible for peat slide risk (Technical Appendix 9.4)* |
| New Floated Track<br><br>0.25km<br><br>1,092 m² | Main development area | *Gradient: Low*<br><br>*Drains towards unnamed tributaries to Knockoner Burn to the Pallmullan Burn downstream.*<br><br>*Watercourse proximity: over 50 m main watercourse, with exception of watercourse crossing.*<br><br>*Watercourse Crossings: 1 No.Main*<br><br>*Average peat depth: 0.61 m*<br><br>*Estimated volume of peat excavated: 0 m³ (track to be floated).*<br><br>*Peat landslide susceptibility: Negligible to medium.*<br><br>*GWDTEs: Negligible*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for water quality.*<br><br>*Low for drainage alteration.*<br><br>*Low for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Low for peat slide risk based on run-off calculations (Technical Appendix 9.4)* |
| Existing track (widened)<br><br>12,006 m² | Western Access Route Option | *Gradient: Low to steep.*<br><br>*Drains towards mostly un-named tributaries of the upper reaches of the Palmullan Burn and approximately 0.2km drains towards un-named tributaries to Sheil Burn (western) to Lady Burn downstream.* | *Low to medium for water quality.*<br><br>*Low to medium for drainage alteration.*<br><br>*Low for PWS source quality and quantity changes.* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| | | *Glenalla Farm potable PWS abstraction point within the catchment, approximately 235 m downgradient of track. Top of catchment approximately 150 m from track.*<br><br>*Watercourse proximity: Over 50 m with exception of crossings.*<br><br>*Watercourse Crossings: 6No.*<br><br>*3No. Main. 3No. minor*<br><br>*Average peat depth: 0.05 m*<br><br>*Estimated volume of peat excavated: 81 $m^3$.*<br><br>*Peat landslide susceptibility: Negligible as minimal peat.*<br><br>*GWDTEs: Track crosses very small section of highly GWDTE associated with minor watercourse valley.*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Low for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology*<br><br>*Negligible for peat slide risk (Technical Appendix 9.4)*<br><br>*Negligible to low for GWDTEs* |
| | Northern Access Route Option | *Gradient: Low to steep.*<br><br>*Drains towards the Cawin Burn in the north and Balbeg Burn in the south.*<br><br>*Watercourse proximity: Over 50 m with exception of crossings and approximately 1.3km track along the Cawin Burn and 0.45km track along the Balbeg Burn (20 m at closest).*<br><br>*Existing PWS piping crossing.*<br><br>*Watercourse Crossings: 6No.*<br><br>*2No. New Main crossings, bottomless arch/box.*<br><br>*4No. New minor crossings, culverts.* | *Low to medium for water quality, main watercourse close just within 50 m.*<br><br>*Low to medium for drainage alteration.*<br><br>*Negligible for PWS source, low for supply pipe.*<br><br>*Negligible for peat disturbance.*<br><br>*Low for groundwater disturbance as located on impermeable geology* |

| Infrastructure | Location | Description | Magnitude of Impact |
|---|---|---|---|
| | | *Average peat depth: 0.01 m.*<br><br>*Estimated volume of peat excavated: 0 $m^3$ (peat depth <0.5 m therefore considered peaty/organic soil, not peat, as per Peat Landslide Hazard and Risk Assessments: Good practice Guide, Scottish Government, 2017).*<br><br>*Peat landslide susceptibility: Negligible*<br><br>*GWDTEs: Track crosses section of moderate GWDTEs associated with the Balbeg Burn valley.*<br><br>*<u>Other sensitivities:</u>*<br><br>*Lower reaches of watercourses in catchment potentially support salmonids, brown trout and otter and freshwater pearl mussel (Chapter 8).* | *Negligible for peat slide risk (Technical Appendix 9.4)*<br><br>*Negligible to low for GWDTEs* |

### *Assessment of Construction Effects*

9.8.23 Following the methodology in Tables 9.3 to 9.5, the significance of effect has been determined by considering the magnitude of predicted impact (determined in Table 9.11) and the sensitivity of the receptor (Table 9.10).

**Erosion / Sedimentation**

9.8.24 One general potential impact of construction of site facilities, turbines and tracks, watercourse crossings, dewatering of turbine foundations and passive road drainage, is disturbance to soils and a consequent rise in the sediment loads observed in rivers and streams. Potential impacts may occur from the following:

- construction of new excavated and floating track and widening of existing track. The excavated track will involve stripping and stockpiling of material to expose underlying soils or bedrock, potentially increasing run-off and the potential for transportation of sediment;
- new or upgraded watercourse crossings and drainage and rainfall run-off diversion increasing the potential for increased run-off of silt and debris;
- removal and stockpiling of material for each turbine foundation base and crane hardstanding, which could result in increased silt run-off;
- dewatering of shallow groundwater and direct rainfall into excavations (potentially containing silt and other debris), which may result in transportation of fine sediments into watercourses. This would be compounded by increased movement over and around these disturbed environments;

- extreme rainfall events which could result in the overflowing of existing on-site drainage and resulting erosion and sediment transport, as well as the potential failure of pollution prevention measures to operate under high run-off flow conditions;
- vehicle movements around the site transporting silt off site;
- peat slide and bog burst; and
- peat storage and reuse.

Effect Assessment

9.8.25 The potential impacts that occur from erosion and sedimentation during the construction period have the potential to cause or have an effect on the water quality, natural drainage pattern, peat disturbance and peat slide.

Water Quality

9.8.26 Infrastructure within the site has been located, in so far as possible, over 50 m from main watercourses, with the exception of where tracks approach watercourse crossings, minor sections of Turbines 1 and 9, and some sections of track on the northern route.

9.8.27 The sensitivity of the Tairlaw Burn catchment is very high as it is a surface water drinking water protection area. There is a very small section of T6 at the top of the Pulreoch Burn catchment, however any effects are likely to be of relatively short duration, there is no direct pathway and the effects will be significantly diluted. Therefore, the significance of effect is **Minor/Moderate** (not significant).

9.8.28 The sensitivity of the un-named tributaries, the Shiel Burn and the Knockoner Burn within the main development area is medium as they are deemed unsuitable for migratory fish habitats (Chapter 8) and any effect on these watercourses water quality will be diluted downstream. The magnitude of potential impacts on water quality due to sedimentation and erosion during construction are low for the majority of the site and medium in specific areas where there are a number of drains, steep slopes and borrow pits where there is ephemeral drainage and areas where minor drainage can potentially connect directly to watercourses. Therefore, the significance of effect will be at most Minor (not significant) for the main development area.

9.8.29 The sensitivity of the Palmullan Burn, Balbeg Burn and Water of Girvan catchment is high due to the presence of Brown Trout salmonids otter and potentially freshwater pearl mussel suitable habitats. The magnitude of potential impacts on water quality due to sedimentation and erosion during construction are low for the majority of the site and medium in specific areas along the Balbeg Burn where the access track is within 50m of a high sensitivity watercourse and there is potential to connect directly with the watercourse. Therefore, the significance of effect will be at most **Minor** (not significant) **to Moderate** (significant) for the track along the Balbeg Burn.

9.8.30 Additional specific mitigation will be required around the structures on steep slopes and potentially directly connected to the most sensitive watercourses, such as the section of existing and new access track within 50m of the Balbeg Burn.

9.8.31 The sensitivity of the Glenalla Farm Private water supply abstraction catchment is very high as it is used as a potable supply. The magnitude of potential impacts on water quality due to sedimentation and erosion during construction are low for the section of access track widening due to minimal activities, no direct pathway being present and the distance between the source and receptor. Therefore, the significance of effect will be at most **Minor/Moderate** (not significant).

9.8.32 A forestry felling plan has been completed which includes a corridor along access track sections through forestry and wider areas at both gatehouses and borrow pit E. The felling will have the potential to increase sediment loading and acidification to the nearby watercourses, the Palmullan Burn (High sensitivity) and the Cawin Burn (Medium sensitivity). The magnitude of impact due to forest felling is low to medium depending on proximity to watercourse and assuming best practice

is adopted along with the Forest and Water guidelines. The significance of effect will be at most **Minor** (not significant).

Drainage Alteration

9.8.33 Design parameters for watercourse crossings will be developed in consultation with SEPA following detailed engineering assessment, and will be provided in either the Construction Method Statement (CMS), or any required application for CAR licencing.

9.8.34 On the basis that any watercourse crossings will be of small to medium size, the magnitude of potential impact, and potential impacts of stream crossing design in causing erosion and sedimentation, using good practice techniques, is assessed as Low. All watercourse crossings are at medium to high sensitivity locations, so the effect significance is at most **Minor** (not significant).

9.8.35 Trenches (~1 m in depth) will be dug for the laying of electrical cables linking the turbines to the site substation. Where trenches are constructed on slopes the flow of water could lead to the erosion of soils. The removal of material and stockpiling could also lead to sedimentation of the local watercourses which have a Low to High sensitivity. However, standard cabling practice includes the rapid excavation and re-instatement of cables, thus there will be minimal exposed trench to allow for water flow causing erosion or sedimentation. Based on use of good practice cable installation, the magnitude of any potential impact of sediments due to erosion is assessed as a maximum of Low so the effect significance is at most **Minor** (not significant)**.**

9.8.36 Water management will be by the use of diversion ditches around the structures to prevent water entry into open foundation bases. However, some dewatering is still likely to be required. Dewatering fluids will be directed into surface silt traps and discharged via settlement ponds and other sediment control structures onto surrounding vegetation to reduce the effect of dewatering and to avoid the sedimentation of low to very high sensitivity watercourses. The magnitude of any potential impact of disposal of dewatering fluids is assessed as Low, thus the significance of these effects is at most **Minor** (not significant)**.**

9.8.37 As vehicles on site may be travelling over newly constructed roads or areas of exposed sediment, they may transport mud and silt away from site and onto public roads, where it may be washed into low to high sensitivity watercourses. However, experience has shown that the majority of such mud is shaken off the wheels before the vehicle reaches the public road. If necessary, wheel washes should be used. The magnitude of any potential impact of vehicles transporting sediment is Negligible to Low, thus the significance of these effects will be at most **Minor** (not significant).

Peat Disturbance

9.8.38 Infrastructure within the site has been located to try to avoid the peat where possible taking into account other constraints.

9.8.39 The potential erosion of peat can increase the potential for further peat disturbance by washing away peat deposits or exposing peat deposits to drying out or oxidising. The significance of effect of sediment disturbance by erosion is at most **Minor** (not significant).

Peat Slide

9.8.40 Infrastructure has been located as far as possible to avoid areas of peat slide or bog burst likelihood and peat slide risk taking into account other constraints. The risk of peat slide can be increased by erosion removing the top vegetative layer or acrotelm that has higher tensile strength, increasing the amount of water passing over or through the catotelmic layer of peat, increasing the wetting and drying of peat and production of cracks. There are two small areas of the site where the magnitude of impact of a landslide is moderate however the runout analysis has shown that the sensitivity of the receptors is low and therefore the significance of effect of erosion resulting in a peat slide is at most **Minor** (not significant).

Erosion / Sedimentation Summary

9.8.41 In summary,for erosion and sedimentation, based on the effect significance criteria developed in regard to hydrology for the potential effects on geology, surface water and groundwater, the likely effect significance using good practice techniques, is mostly assessed as **Negligible to Minor** (not significant) for erosion and sedimentation with the exception of Glenalla Farm private water supply source being **Minor/Moderate** due to it being of very high sensitivity and the track section along the Balbeg Burn being **Moderate** due it being of high sensitivity and having a section of existing and new track within 50m.

**Pollution**

9.8.42 Pollution of watercourses could potentially occur through the following pathways:

- Oil and chemical spills from:
  - oil leakages during vehicle movements or when on standby;
  - refuelling areas such as the compound; and/or
  - chemical/fuel storage areas.
- Leakage of cement powder or liquid concrete during pouring. Concrete is highly alkaline (high pH) and changes in the pH balance could affect the water quality and the species that depend on baseline conditions.
- Improper management of on-site waste.
- Poor sanitary plumbing.
- Poor water storage.
- Sedimentation and erosion (as previously discussed).

9.8.43 There will be no oil filled cables running across the site.

Effect Assessment

9.8.44 The potential impacts that occur from erosion and sedimentation have the potential to cause or have an effect on water quality.

Water Quality

9.8.45 Even taking into account the application of good practice (Technical Appendix 9.1), appropriate cement pouring and waste storage, there is still a small risk of potential fuel, cement or waste spillage on site due to the number of vehicles, turbine foundations and potential leaks or accidents. The magnitude of impact of a fuel/oil, cement or chemical spillage and of contamination due to sanitary plumbing is Low.

9.8.46 However, with the exception of the Tairlaw Burn catchment and the Glenalla Farm potable PWS catchment which is classified as Very High sensitivity, the sensitivity of on-site receptors is assessed as being Low to High for watercourses – high for watercourses with suitable migratory fish habitats (Palmullan Burn, Balbeg Burn and Water of Girvan), medium for main watercourses without suitable fish habitat (all main watercourses within the main infrastructure area or watercourse directly linked to the Palmullan Burn) and low for minor drains not directly linked to a high sensitivity watercourse.. Therefore, the likely effect on surface water from pollution is mostly assessed as **Minor** significance (not significant) with the exception of the Glenalla Farm private water supply being assessed as **Minor/Moderate** (not significant) and the section of access track within 50m of the Balbeg Burn being assessed as **Moderate** (significant). No additional mitigation above good practice methods are likely to be required, with the exception of the section of track along the Balbeg Burn. The significance of effect on areas within the Tairlaw Burn catchment is **Minor/Moderate** (not significant) due to distance, no direct pathway and dilution factor., The significance of effect on the Glenalla Farm PWS catchment is **Minor/Moderate** (not significant) and it would therefore be

standard practice to not consider any additional mitigation above good practice methods to be warranted. However, additional mitigation has been specifically requested by South Ayrshire Council (Section 9.7)

**Alteration to Natural Drainage Patterns/ Run-off Volumes and Rates**

9.8.47 The development of tracks and cable trenches has the potential to alter natural drainage on the site by the development of preferential flow pathways or blocking natural flow pathways. If constructed against the topographic gradient, roads could act as barriers to run-off resulting in the ponding of water. If constructed in line with the gradient, the development of preferential flow down the roadway could occur.

9.8.48 Excavated infrastructure, such as turbine foundations, crane pad areas and borrow pits have the potential to alter natural drainage patterns on site and run-off volume and rates by intercepting drainage.

9.8.49 If drains are diverted they could alter water dependent habitat conditions which could remove or significantly alter valuable habitat and reduce the capacity of surface water attenuation within the catchment.

9.8.50 Groundwater levels in peat could potentially be reduced in the immediate vicinity of site infrastructure. With regard to turbine bases and cable trenches this water level reduction will be temporary during excavation and concrete pouring/ cable installation.

Effect Assessment

9.8.51 The potential impacts that occur from the alteration to natural drainage patterns, run-off volumes and rates have the potential to cause or have an effect on the water quality, natural drainage and peat slide.

Water Quality

9.8.52 The water quality aspects related to the alteration of natural drainage are those related to sediment release and erosion and are discussed above (paragraph 9.8.24 to 9.8.41) so are not duplicated here.

Natural Drainage

9.8.53 The most significant effects that are likely to occur on natural drainage are mainly from the larger areas of land disturbance associated with the Proposed Development infrastructure such as borrow pits, construction compounds and some turbine foundations and crane hardstandings.

9.8.54 Where excavated track is required against the topographic gradient and parallel with a watercourse it could act as a dam reducing the natural drainage of water into the watercourse and any drainage from this track could potentially be sediment laden and effect the water quality. One section of existing and new excavated track is parallel with the Balbeg Burn (high sensitivity) and within 50 m of this watercourse making drainage alteration magnitude medium and therefore this section of track has an effect that is of **Moderate** significance (significant) and therefore additional monitoring and mitigation is required.

9.8.55 Where floating track crosses watercourses or drains these locations will be watercourse crossings to allow the continuation of the watercourse's natural run-off (Section 9.6, Technical Appendix 9.6) and therefore the effect is of **Minor** significance (not significant).

9.8.56 There are a few minor drains and areas of slower natural run-off, the impact magnitude of altering or crossing these is low and therefore the effect significance is **Minor** (not significant).

9.8.57 The run-off rates on site are relatively fast based on the presence of low permeability bedrock and superficial deposits, and steep slopes. The inclusion of semi-permeable hardstanding (<1.5% of each catchment) and impermeable turbine foundations (<1.0% of each catchment) is unlikely to significantly increase run-off rates and therefore the effects of run-off increase is considered to be of **Minor** significance (not significant).

Peat Slide

9.8.58 Infrastructure has been located as far as possible to avoid areas of peat, or peat slide likelihood and peat slide risk taking into account other constraints. The risk of peat slide can be increased by the alteration of natural drainage as this can remove the top vegetative layer or acrotelm that has higher tensile strength, increasing the amount of water passing over or through the catotelmic layer of peat, increasing the wetting and drying of peat and production of cracks. New drains can also introduce additional water to slopes or dewater them which can lead to changes in the geotechnical properties of the peat and therefore the potential for peat slides. The significance of effect of peat disturbance by drainage alteration is **Negligible** (not significant)**,** where no peat is present, to **Minor** (not significant)**.**

9.8.59 In summary for the alteration to natural drainage patterns/ run-off volumes and rates, based on the effect significance criteria developed in regard to hydrology for the potential effects on geology, surface water and groundwater, the likely effect from alteration of natural drainage patterns, run-off volumes and rates, prior to mitigation and management, is assessed as **Minor** to **Minor/Moderate** (not significant). The majority of sections are Minor with the exception of the track widening within the catchment of the Glenalla Farm PWS abstraction and sections of the new access track and existing access track to be widened within 50 m of the Balbeg Burn which are **Minor/Moderate** (not significant).

**Watercourse Crossings**

9.8.60 Good practice with regard to avoiding or minimising stream crossings has been adopted through the reduction in the number of locations where access tracks cross watercourses and that where possible locations already used as crossing points have been reused as discussed in Chapter 3. As well as during construction, these watercourse crossings may require ongoing maintenance to ensure they do not become blocked and prevent the passage of fish, water vole or otters as well as posing a flood risk.

9.8.61 In Scotland, works in, over or under a watercourse or works altering or repairing any structure in, over or under a watercourse must be authorised by SEPA through the Controlled Activities Regulations. SEPA will be notified of all of these works and the appropriate General Binding Rules, authorisations or licences will be applied for. It is likely for the site that a complex licence will need to be applied for.

Effect Assessment

9.8.62 New and replacement water crossings will be required for the development as summarised in Section 9.7 and detailed in Technical Appendix 9.5, some being crossings of main watercourses shown on 1:50,000 scale Ordnance Survey mapping or directly linked to a watercourse shown on 1:50,000 scale Ordnance Survey mapping, and some being minor or small crossings shown on 1:25,000 scale OS mapping or deemed to be similar to those shown on 1:25,000 scale OS mapping based on site observations.

9.8.63 There may be additional crossings of ephemeral drains. These are of low sensitivity and are not supporting fish habitats directly.

9.8.64 All the main 1:50,000 scale watercourse crossings will be designed to allow fish passage and the maintenance of the natural substrate and will be installed with suitable mammal passage.

9.8.65 On the basis that the majority of crossing work will be on watercourses (of Low to High sensitivity), and will require authorisation by SEPA, the magnitude of potential impacts of stream crossing design in impeding water flows are assessed as Low due to the requirement for suitable design. The effect significance before mitigation is therefore assessed as **Minor** (not significant) for the minor crossings. The main watercourse crossings will require more detailed assessment to determine an appropriate design to avoid disturbing the peat substrate, disturbing active erosional zones, reducing the flow channel, flood plain volume and to minimise works within the watercourse. These will also require authorisation by SEPA. With appropriate good practice design the magnitude of impeding flows or sediment entering the watercourse is Low and therefore the significance of effect is **Minor** (not significant).

**Increase in the Magnitude of Frequency of Flood Events**

9.8.66 The development area has minimal flood risk areas based on SEPA flood mapping. There are some localised areas of surface water flooding mostly near waterbodies and some localised risk of fluvial flood directly adjacent to the watercourses on site. The proportion of land take for each catchment is minimal and therefore will not increase run-off rates significantly.

Effect assessment

9.8.67 The potential impacts that occur from an increase in the magnitude of frequency of flood events have the potential to cause or have an effect on the water quality, natural drainage pattern, peat disturbance; and peat slide.

9.8.68 The track network and turbine layout has been designed to avoid, as far as is practicable, areas that have been identified as at risk of flooding as shown on SEPA flood mapping and based on site observations. The northern access track parallel with the Balbeg Burn has been designed to avoid the flood plain associated with the Balbeg Burn down gradient of it based on the SEPA flood maps.

9.8.69 The flood risk onsite and downstream of the site is considered to be of low risk and no sensitive receptors to flooding were identified on site or in the near vicinity, although there would be the potential for impact on the high sensitivity watercourses or peat, therefore, the significance of effect for flooding is **Minor** (not significant).

9.8.70 Flood risk assessment for at least the main watercourse crossings will be required for appropriate design and will be undertaken post-consent.

**Alteration of the Geological Environment**

9.8.71 The construction of the Proposed Development will involve the excavation of soils, peat, drift deposits and bedrock in varying amounts. Of these, peat is designated when it forms blanket bog habitat (see Chapter 8) and is also protected due to its ability to store carbon (See Chapter 3 and Chapter 17). The sensitivity of peatland to disturbance is high and the quality is low to moderate, it is therefore assigned a sensitivity of low to high.

Effect assessment

9.8.72 The potential impacts that occur from alteration of the geological environment have the potential to cause or have an effect on the water quality, natural drainage pattern, peat disturbance and peat slide.

9.8.73 Over the whole of the site, conservative estimates for the volume of peat that will be excavated (including footprints and a wider distance for slope batters) are:

- *Total volume of peat which will be excavated = ~ 5,600 $m^3$.*
- *Total volume of acrotelm which will be excavated = ~921 $m^3$.*
- *Total volume of catotelm which will be excavated = 4,675 $m^3$.*

9.8.74 Generally, across the site where peat is present, the track will be floated, and these areas would have a low magnitude of impact. Where there is a requirement for excavation of infrastructure (tracks, crane hardstandings, borrow pits, substation and met mast) and peat is present, the magnitude of impact would be medium for peat depth 0.5 m to 1.0 m, high for deep peat (1.0 m to 2.0 m) and very high for very deep peat (>2.0 m) as a larger volume of peat would be disturbed and in accordance with guidance.

9.8.75 The deepest average area of peat to be extracted for the infrastructure is 0.43 m at the met mast location. Further information on the peat survey and peat volume assessment is presented in Technical Appendix 9.2 and 9.3.

9.8.76 Therefore, the significance of effect prior to specific mitigation and management, is assessed as **Minor** (not significant).

9.8.77 The peat landslide susceptibility is negligible to medium, however the magnitude assessed by runout calculations is negligible to low. The effect of potential peat slide on watercourses will therefore be of **Minor** significance (not significant) during construction phase.

**Summary of Construction Effects**

9.8.78 Based on the effect significance criteria developed in regard to hydrology, hydrogeology and geology for the potential effects on surface water, groundwater and the geological environment, the likely effect from the various potential impacts, using good practice techniques, is assessed as **Negligible** to **Moderate**.

9.8.79 The following infrastructure elements will require additional mitigation as they have been evaluated to have a potential Moderate significance of effect (significant), or a Minor/Moderate significance of effect (not significant) but additional mitigation has been specifically requested by South Ayrshire Council. These are considered in combination with the other elements that also have a significant effect either on a catchment basis, the whole of the site, or the particular sensitive receptor as appropriate. It is considered that elements with significance of effect of Minor or less do not combine to produce a greater significance of effect:

*Water Quality and drainage alteration:*

- *Northern existing and new track sections within 50 m of the Balbeg Burn and Cawin Burn (significance is Moderate); and*
- *Existing western Forestry track which may be widened near Glenalla Farm Potable PWS abstraction catchment (significance is only Minor/Moderate but an agreement has been reached with SAC that additional mitigation is necessary).*

## *Assessment of Operational Effects*

**Erosion / Sedimentation**

9.8.80 During the operation and maintenance of the Proposed Development the water environment will be subject to fewer potential adverse effects than during the construction phase. Access tracks will be complete and no regular substantial works on the site will be expected during the life of the facility other than periodic monitoring and maintenance. The potential for any additional sedimentation is low, therefore the likely effect from erosion and sediment transport, prior to mitigation and management, is considered to be Low on all receptors, thus the overall significance is **Minor** (not significant).

**Pollution**

9.8.81 A number of possible operational effects on the water environment have been identified including the potential for spillage of oil and fuels from vehicles used for accessing and traversing across the site. However, vehicle use will be minimal and the likely effects from pollution, on all receptors, prior to mitigation and management, are assessed to be Low, therefore the overall significance is **Minor** (not significant)**.**

**Alteration to Natural Drainage Patterns/ Run-off Volumes and Rates**

9.8.82 Although the nine turbine bases and associated crane hardstanding and the substation are permanent, they represent only a small change to the hydrological characteristics of the site. The total area of all combined will be small in relation to the overall catchment areas. Therefore, the potential effects predicted for interference to natural drainage patterns by tracks and other infrastructure is considered to be Low on all receptors. The overall significance is also **Minor** (not significant).

9.8.83 There is potential for the water crossings of smaller streams to become blocked if not maintained. Due to the terrain and size of the crossings, this could result in minor flooding. All of these streams are classified as low to high sensitivity due to their receiving waters. The likely magnitude of

potential effects on natural water flows due to unmaintained stream crossings in the operational phase, prior to mitigation and management, is assessed as Low at the site of the stream crossings and Negligible downstream, thus the overall significance is **Minor** (not significant).

**Alteration of the Geological Environment**

9.8.84 No further earthworks or additional land take should be required, therefore no excavation of the peat would be necessary during the operation period. There is a potential for natural peat slide or bog burst albeit low within the Proposed Development area and infrastructure may have the potential to trigger a peat slide during the operation period due to a longer term effect from changes to the peat characteristics (drainage, loading, etc). The infrastructure and the wider area will be regularly monitored for features of movement, cracking, subsidence, bulging or slides. Therefore, the overall significance is **Minor** (not significant).

### *Assessment of Decommissioning Effects*

9.8.85 The significance of effects of decommissioning are similar to the construction phase and can be assessed as detailed below.

9.8.86 Erosion / Sedimentation and PollutionMethod statements, pollution controls and management plans and mitigation applied to protect the watercourses will ensure protection of the site soil and water resource. The significance is assessed to be **Minor** (not significant) for the majority of the site.

Drainage Alteration

9.8.87 The risk of drainage alteration during decommissioning is considered to be of **Minor** significance (not significant).

Geological Alteration

9.8.88 No additional land take should be required other than potential temporary reopening of the construction compound areas which will be re-opened. Therefore, there will be no significant further disturbance of peat other than some marginal areas which would be undertaken to improve the peat habitat and the peat slide risk will remain low so that the significance is **Minor** (not significant).

## 9.9 Mitigation

9.9.1 From the assessment of potential effects, those elements of the site which have demonstrated a potential effect significance of higher than Minor during the construction phase have additional mitigation and management requirements above and beyond the standard good practice.

9.9.2 Specific mitigation for each type of effect is presented below.

**Erosion / Sedimentation, Pollution, and Drainage Alteration - Water Quality**

9.9.3 The western section of existing forestry track, potentially to be widened above the potential catchment for the Glenalla Farm potable PWS, will be monitored before, during and after the construction period on foot to avoid disturbing the Glenalla Farm access track which also drains into the water supply abstraction watercourse. A monitoring and contingency plan will be developed and approved by SAC prior to construction commencing.

9.9.4 The section of the existing and new northern forestry access track within 50 m of the high sensitivity Balbeg Burn will require careful drainage management, extra sediment control measures, potential dust suppression, splash control and monitoring due to its close proximity to the Balbeg Burn.

9.9.5 All watercourse crossings will require monitoring for blockages or any erosional scouring, especially along the existing northern access track where there are several existing piped culvert crossings of the Cawin Burn.

9.9.6 The other areas of site that have a Minor/Moderate significance of effect in relation to water quality will also be subject to HCOW advice during construction. The HCOW will provide advice on drainage

control and sediment management as well as on dewatering and other aspects potentially affecting the water environment.

## 9.10 Residual Effects

9.10.1 Assuming the additional mitigation measures outlined in Section 9.7 and 9.9, detailed in Technical Appendix 9.1, 9.3, 9.4, and 9.5, 9.6 Chapter 9 and Technical Appendix 3.1, and to be set out in a detailed Drainage Strategy and water quality monitoring plan, including Glenalla Farm, (to be produced and agreed with the planning authority and SEPA pre-construction) are adhered to, the residual significant effect can be reassessed as: at most **Minor (not significant)** for the construction, operation and decommissioning of the Proposed Development.

## 9.11 Cumulative Assessment

9.11.1 Table 9.12 lists the wind farm developments which are within 10 km of the site and therefore considered in the cumulative assessment. There is no publicly available documentation for Dersalloch or Hadyard Hill wind farms, reflecting the historic nature of these operational wind farms. As such, only documentation which supports the Carrick and Craiginmoddie wind farm applications is considered.

**Table 9.12 – Operational and Scoped Developments within 10 km of the Proposed Development**

| Site | Planning Reference Number | Description of the Proposed Development | Approximate Distance and Direction from the Application Site |
|---|---|---|---|
| Carrick Wind Farm | ECU00002063 (Scoping) | Application at scoping for up to 17 turbines, with tip height to 200 m. It is understood that the application is now likely to proceed with 13 turbines. | Adjacent to the site<br><br>Within Palmullan Burn and Tairlaw Burn catchment of the Water of Girvan catchment |
| Dersalloch Wind Farm | 05/01209/DEEM | Consent for 23 turbines at 125 m to tip. Operational 2016 | 3.5 km to the north-east<br><br>Potentially with Water of Girvan catchment. |
| Hadyard Hill Wind Farm | 03/01745/DEEM | Consent for 51 turbines at 101 m to tip. Operational 2006, | 6.9 km to the west<br><br>River Stinchar, Penwhapple reservoir, Penwhapple Burn and Water of Girvan catchment |
| Craiginmoddie Wind Farm | 21/00069/DEEM | Application submitted in January 2021 for 14 turbines up to 200 m to tip. Decision pending. | 3.5 km to the west<br><br>River Stinchar catchment |

9.11.2 The only wind farm development considered to be near enough to the Proposed Development that cumulative effects may arise is the Carrick Wind Farm which is at the scoping stage. Scottish Power Renewables intends to apply to the Scottish Ministers for consent under Section 36 of the Electricity Act 1989 at the end of 2020 to construct and operate a wind farm in Carrick Forest, South Ayrshire.

This is anticipated to comprise up to 13 wind turbines with blade tip heights of up to 200 metres, associated onsite infrastructure and an Energy Storage Facility (i.e. battery).

9.11.3 Review of the scoping documentation for the application revealed that impacts on freshwater invertebrates (including freshwater pearl mussel) and the designated sites Merrick Kells SAC and Auchalton SSSI can be scoped out due to lack of hydrological connectivity with these features and flood risk was scoped out as the design will avoid flood risk areas.

9.11.4 The Carrick Wind Farm site falls within the hydrological catchment of the Palmullan Burn, Tairlaw Burn as part of the Girvan Water catchment and the Auchengairn Burn, Dalquhairn Burn and Linfern Loch catchment as part of the River Stinchar catchment. The Tairlaw Burn and the Linfern Loch, Linfern Loch Burn and Upper reaches of the River Stinchar are surface water DWPAs. Much of the Carrick Wind Farm area is covered in forestry. The Carrick wind farm Scoping Report states that the SNH Carbon and Peatland Map (2016) indicates that Class 5 (peaty soil, no peatland vegetation) is predominant across the site and there are some pockets of Class 1 (peat soil; peatland) and class 3 (*predominantly peaty soil with some peat soil; peatland with some heath)* peat and a large section of Class 1 peat in the south-east.

9.11.5 Further information on the final design and the hydrological, hydrogeological, geological and peat studies and assessment of the Carrick Wind Farm proposal is not available at present. Based on publicly available information, it is unlikely that the combined footprint areas will be large enough to significantly effect run-off rates or flood risk. The Proposed Development has been carefully designed to utilise existing tracks, avoid peat where possible, and there are no significant peat slide hazard risk areas or forestry areas to be felled.

9.11.6 It is considered that with standard best practice and mitigation detailed in this assessment, the potential for cumulative effects with Carrick Wind Farm to occur with regards to hydrological, hydrogeological, geological and peat features is low.

9.11.7 The potential for cumulative effects on aquatics and habitats is considered further in Chapter 8, and in Technical Appendix 3.2.

9.11.8 There are not considered to be any significant cumulative effects on hydrological, hydrogeological or geological receptors due to other relevant projects in the vicinity based on the limited information available at the time of writing.

## 9.12 Summary

9.12.1 This assessment establishes the current baseline conditions from desk studies and site surveys and identifies sensitives receptors in relation to hydrology, hydrogeology, geology and peat within the Proposed Development area and the wider area potentially connected to the Proposed Development.

9.12.2 The assessment was informed by a desk study, a peat penetration depth survey, an outline peat management plan, a peat slide hazard site walkover and risk assessment, a hydrology site walkover, a private water supply assessment and watercourse crossing assessment enabling the determination of the likely hydrological, hydrogeological, geological and peat effects of the Proposed Development.

9.12.3 The desk study consisted of data gathering from the British Geological Survey, Soil Mapping Scotland, SNH Carbon and Peatland Map 2016, Centre for ecology and hydrology (CEH), SEPA's environmental hub and flood risk mapping, SAC, Scottish Water, biological records centre, publicly available hydrological and geological information available online and a review of documentation which supported the previous Linfairn Wind Farm application.

9.12.4 Notable sensitive hydrological, hydrogeological and geological features within the Proposed Development area and the wider area potentially connected to the Proposed Development are:

- *some localised peat deposits, up to 4.4m in depth within the main development area – avoided by site design where possible;*

- *two localised areas of low peat slide risk which were considered to be insignificant when considering the run-out zones and consequences;*
- *some localised Annex 1 habitats (blanket bog and wet heath);*
- *some otter and water vole evidence in the south-western area;*
- *some localised potential GWDTEs along the watercourses and downgradient of localised sections of the existing northern and western access track options;*
- *on site watercourses of good quality;*
- *on site watercourses with limited fish or invertebrate habitat, with the exception of the lower reaches of the Palmullan, Genoch and Balbeg Burn and the Water of Girvan along north-eastern site boundary;*
- *a Scottish Water mains pipeline within the north-eastern site boundary area or Water of Girvan valley;*
- *the extreme south-eastern area of the site is within the Tairlaw Burn surface water Drinking Water Protection Area (DWPA) catchment;*
- *several properties are reliant on private water supplies (PWSs) in the vicinity –following a private water supply assessment one property, Glenalla Farm, was deemed to have a PWS source potentially hydrologically connected to the existing western access track of the Proposed Development; and*
- *an estimted total of 6,500m$^3$ of peat will be excavated for the construction of the Proposed Development (noting that this includes the estimated volume for both access route options and is therefore an overestimate given that only one will be selected, although volumes for both options are minimal), all of which can be reused for habitat restoration on site as presented in the outline peat management plan.*

9.12.5 Embedded mitigation, in terms of scheme design to avoid the most valuable and sensitive features, such as watercourse buffers, PWS catchments, deep peat and minimising watercourse crossings and good practice measures, to include production of an outline peat management plan, drainage management plans, water quality monitoring plan, habitat management plan, production of a CEMP, the appointment of an ECoW, will be implemented. With adoption of these standard best practices no potentially significant adverse direct and/or indirect effects on hydrological and geological features are anticipated, with exception of Moderate effects for a section of the northern access track along the Balbeg Burn. Additionally, there is a potential Minor/Moderate (not significant) effect on Glenalla Farm PWS, and South Ayrshire Council has specifically requested additional mitigation relating to this potential effect.

9.12.6 Assuming the additional mitigation measures outlined in Section 9.7 and 9.9, detailed in Technical Appendix 9.1, 9.3, 9.4, and 9.5, 9.6, Chapter 9 and Technical Appendix 3.1, and to be set out in a detailed Drainage Strategy and Water Quality Monitoring Plan including Glenalla Farm PWS (to be produced and agreed with the planning authority and SEPA pre-construction) and additional sediment control and ECoW monitoring are adhered to, the residual significant effects can be reassessed as: at most Minor (not significant) for the construction, operation and decommissioning of the Proposed Development.

**Table 9.12 – Summary of Effects**

| Description of Effect | Significance of Potential Effect | | Mitigation Measure | Significance of Residual Effect | |
|---|---|---|---|---|---|
| | Significance | Beneficial/ Adverse | | Significance | Beneficial/ Adverse |
| Construction | | | | | |
| Erosion and Sedimentation | | | | | |
| Water Quality | Minor to Minor / Moderate | Adverse | Additional sediment control measures at the vulnerable locations.<br><br>Additional mitigation for the Glenalla Farm PWS catchment through monitoring and sediment control. | Minor (not significant)<br><br>Minor/ Moderate (not significant) | Adverse |
| Drainage Alteration | Minor | Adverse | None required | Minor (not significant) | Adverse |
| Peat Slide | Negligible to Minor | Adverse | None required | Negligible to Minor (not significant) | Adverse |
| Pollution | | | | | |
| Water Quality | Minor to Minor/ Moderate | Adverse | Additional sediment control measures at the vulnerable locations. | Minor (not significant) | Adverse |

| Description of Effect | Significance of Potential Effect | | Mitigation Measure | Significance of Residual Effect | |
|---|---|---|---|---|---|
| | Significance | Beneficial/ Adverse | | Significance | Beneficial/ Adverse |
| | | | Additional mitigation for the Glenalla Farm PWS catchment through monitoring and sediment control | Minor/ Moderate (not significant) | |
| Natural Drainage Alteration | | | | | |
| Water Quality | Minor | Adverse | None required | Minor (not significant) | Adverse |
| Peat slide | Negligible to Minor | Adverse | None required | Negligible to Minor (not significant) | Adverse |
| Watercourse Crossings | | | | | |
| Impeding Flows and sediment entering the watercourses | Minor | Adverse | None required | Minor (not significant) | Adverse |
| Increase in the Magnitude of Flood Frequency Events | | | | | |
| Increase in the magnitude of flood frequency events | Minor | Adverse | None required | Minor (not significant) | Adverse |

| Description of Effect | Significance of Potential Effect | | Mitigation Measure | Significance of Residual Effect | |
|---|---|---|---|---|---|
| | Significance | Beneficial/ Adverse | | Significance | Beneficial/ Adverse |
| Geological Alteration | | | | | |
| Disturbance of peat | Minor | Adverse | Peat reuse as per the peat management plan | Minor (not significant) | Adverse |
| Peat Slide | Minor | Adverse | None required | Minor (not significant) | Adverse |
| Operation | | | | | |
| Erosion and Sedimentation | | | | | |
| Water Quality | Minor | Adverse | None required | Minor (not significant) | Adverse |
| Pollution | Minor | Adverse | None required | Minor (not significant) | Adverse |
| Natural Drainage Alteration | | | | | |
| Alteration of natural drainage patterns | Minor | Adverse | None required | Minor (not significant) | Adverse |

| Description of Effect | Significance of Potential Effect | | Mitigation Measure | Significance of Residual Effect | |
|---|---|---|---|---|---|
| | Significance | Beneficial/ Adverse | | Significance | Beneficial/ Adverse |
| Flood Risk | Minor | Adverse | None required | Minor (not significant) | Adverse |
| Geological Alteration | | | | | |
| Peat Slide | Minor | Adverse | None required | Minor (not significant) | Adverse |
| Decommissioning | | | | | |
| Erosion and Sedimentation | | | | | |
| Water Quality | Minor | Adverse | None required | Minor (not significant) | Adverse |
| Drainage Alteration | Minor | Adverse | None required | Minor (not significant) | Adverse |
| Peat Slide | Negligible to Minor | Adverse | None required | Negligible to Minor (not significant) | Adverse |
| Pollution | | | | | |

| Description of Effect | Significance of Potential Effect | | Mitigation Measure | Significance of Residual Effect | |
|---|---|---|---|---|---|
| | Significance | Beneficial/ Adverse | | Significance | Beneficial/ Adverse |
| Water Quality | Minor | Adverse | None | Minor (not significant) | Adverse |
| Natural Drainage Alteration | | | | | |
| Water Quality | Minor | Adverse | None required | Minor (not significant) | Adverse |
| Peat slide | Negligible to Minor | Adverse | None required | Negligible to Minor (not significant) | Adverse |
| Geological Alteration | | | | | |
| Disturbance of peat | Minor | Beneficial | Any peat disturbance would be for restoration purposes only | Minor (not significant) | Beneficial |
| Peat Slide | Minor | Adverse | None required | Minor (not significant) | Adverse |

## 9.13 References


Control of Pollution Act 1974;

Environmental Protection Act 1990;

Environment Act 1995;

Water Framework Directive 2000/60/EC (WFD) 2000;

Groundwater Daughter Directive 2006/118/EC;

Water Environment and Water Services (Scotland) Act (WEWS Act) 2003;

Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended in 2018 (CAR);

The Environmental Liability (Scotland) Regulations 2009;

The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017 (amends and revokes the Private Water Supplies (Scotland) Regulations 2006);

The Public Water Supplies (Scotland) Amendment Regulations 2017 (amends the Public Water Supplies (Scotland) Regulations 2014;

The Flood Risk Management (Scotland) Act 2009;

The Waste Management Licensing (Scotland) Regulations 2011;

Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017;

Water Supply (Water Quality) Regulations (2016) - BS EN 15975-2:2013 Security of drinking water supply;

Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended in 2018) (CAR);

Scottish Planning Policy (SPP) June 2014;

Planning Advice Note 61: Planning and SUDS, 2001;

Planning Advice Note 79: Water and Drainage, 2006

PPG1: General guide to the prevention of pollution (EA, SEPA & EHSNI, 2013);

GPP2: Above ground oil storage tanks (EA, SEPA & EHSNI, January 2018);

GPP4: Treatment and disposal of sewage where no foul sewer is available (EA, SEPA & EHSNI, November 2017);

GPP5: Works and maintenance in or near water (EA, SEPA & EHSNI, January 2017);

PPG6: Working at construction and demolition sites (EA, SEPA & EHSNI, 2012);

GPP8: Safe storage and disposal of used oils (EA, SEPA & EHSNI, July 2017);

GPP21: Pollution incidence response planning (EA, SEPA & EHSNI, 2017);

PPG26: Storage and handling of drums and intermediate bulk containers (EA, SEPA & EHSNI, 2006).

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Temporary Construction Methods, WAT-SG-29 (SEPA, 2009)

Flood Risk and Planning Briefing Note (SEPA, 2014)

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Technical flood risk guidance for stakeholders, version 10 (SEPA, July 2018).

Environmental Standards for River Morphology, WAT-SG-21 (SEPA, July 2012).

Land Use Planning System Guidance Note 4 (LUPS GU4) - Planning guidance on on-shore windfarm developments (SEPA, September 2017).

Land Use Planning System Guidance Note 31 (LUPS-GU31)- Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems (SEPA, 2014).

The Water Environment (Controlled Activities) (Scotland) Regulations 2011 as amended in 2018 - A practical guide (SEPA, 2011 as amended in 2018).

River Crossings, Engineering in the water environment: good practice guide (SEPA,2010).

Methodology for the Water Framework Directive, Scotland and Northern Ireland Forum for Environmental Research, Project WFD 28 Final Report (SEPA, 2004);The River Basin Planning Strategy for the Scotland River Basin District (SEPA, 2009/2015).

Control of water pollution from constructions sites. Guidance for consultants and contractors C532 (CIRIA, 2001);

Environmental good practice on site C650 (CIRIA, 2010);

Control of water pollution from linear construction projects: technical guidance C648 (CIRIA, 2006);

SUDS Manual C697 (CIRIA, 697);

Groundwater Control – design and practice C515 (CIRIA 2016);

Scottish Renewables, SNH, SEPA & Forestry Commission Scotland (2019); Good practice during windfarm construction, 4th Edition;

Code of Practice for the sustainable use of soils on construction sites (DEFRA, 2009);

Guidance on Road Construction and Maintenance Forests and Water Guidelines Fifth Edition (Forestry Commission, 2011);

A Handbook of Environmental Impact Assessment, 5th Edition (SNH, 2018);

Design Guidance on River Crossings and Migratory Fish, Scottish Executive, 2000;

South Ayrshire Local Development Plan, South Ayrshire Council, September 2021

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