Glenvernoch Wind Farm

Environmental Impact Assessment Report
Volume I
Chapter 12: Hydrology, Geology and Hydrogeology

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Introduction

12.1 This chapter of the Environmental Impact Assessment Report (EIAR) assesses the impacts on the hydrological, geological and hydrogeological environment at Glenvernoch Wind Farm, the "Proposed Development" and the likely significant environmental effects resulting from the construction and operation of the proposed turbines and associated infrastructure. The red-line boundary is referred to as "the Site".

12.2 The assessment is also supported by the following Technical Appendix:

- Technical Appendix 12.1: Schedule of Watercourse Crossings (SWX);
- Technical Appendix 12.2: Soil and Peat Management Plan (SPMP);
- Technical Appendix 12.3: Peat Landslide Hazard Risk Assessment (PLHRA); and
- Technical Appendix 12.4: Private Water Supply Risk Assessment (PWSRA).

12.3 The assessment is supported by the following figures:

- Figure 12.1: Hydrology Overview;
- Figure 12.2: Bedrock Geology;
- Figure 12.3: Superficial Geology;
- Figure 12.4: Groundwater Dependent Terrestrial Ecosystems;
- Figure 12.5: Predominant Soils;
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12.4 The assessment has been carried out by Eleni Evrygeni, who has over 2 years experience undertaking hydrology and soils related assessments. The assessment has been reviewed by Sam Wainwright, who has over 10 years experience in hydrology, hydrogeology, soils and carbon reporting. The assessment has been approved by Stuart Bone, a Chartered Environmentalist and member of the Chartered Institute of Water and Environmental

Management. Stuart has over 25 years experience in the coordination and management of EIAs, including for renewable energy development.

12.5 This chapter and its associated figures and appendices are not intended to be read as a standalone assessment, and reference should be made to the introductory chapters of this EIA, including Chapter 3: Project Description and Construction Methods.

Legislation and Policy Context

Policy Context

12.6 The assessment takes account the requirements of the Water Framework Directive (2000/60/EC) (WFD). The WFD aims to protect and enhance the quality of surface freshwater (including lakes, rivers and streams), groundwater, groundwater dependent terrestrial ecosystems (GWDTE), estuaries and coastal waters.

12.7 The key objectives of the WFD relevant to this assessment are:

- To prevent deterioration and enhance aquatic ecosystems; and
- To establish a framework of protection of surface freshwater and groundwater.

12.8 The WFD resulted in The Water Environment and Water Services (Scotland) Act 2003, which gave Scottish Ministers powers to introduce regulatory controls over water activities in order to protect, improve and promote sustainable use of Scotland's water environment. These regulatory controls in the form of The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) or CAR, made it an offence to undertake the following activities without a CAR authorisation:

- Discharges to all wetlands, surface waters and groundwaters (replacing the Control of Pollution Act 1974);
- Disposal to land (replacing the Groundwater Regulations 1998);
- Abstractions from all wetlands, surface waters and groundwaters;
- Impoundments (dams and weirs) of rivers, lochs, wetlands and transitional waters; and
- Engineering works in inland waters and wetlands.

12.9 Under the Water Environment (Miscellaneous) (Scotland) Regulations 2017 amendments were made to CAR and the Proposed Development will require a construction runoff licence for water management across the entirety of the Proposed Development site prior to any construction works taking place, including enabling works. A Pollution Prevention Plan (PPP) would be prepared in support of any licensing requirements.

National Legislation and Policy

12.10 The assessment takes account of the following national legislation and policy:

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

- Water Environment and Water Services (Scotland) Act 2003;
- Wildlife Management and Muirburn Bill 2024;
- National Planning Framework 4 (NPF4) 2023;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended);
- Water Environment (Miscellaneous) (Scotland) Regulations 2017;
- Flood Risk Management (Scotland) Act 2009;
- The Public Water Supplies (Scotland) Regulations 2014;
- Private Water Supplies (Scotland) Regulations 2006;
- The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017;
- Part IIA of the Environment Protection Act 1990;
- Waste Management Licensing (Scotland) amendment Regulations 2016
- Pollution Prevention and Control (Scotland) Regulations 2012;
- SEPA Technical Flood Risk Guidance for Stakeholders – Version 12, May 2019. SS-NFR-P-002;
- SEPA Land Protection. Reference EP054;
- SEPA Policy No. 19 Groundwater Protection Policy for Scotland;
- SEPA Policy No. 41 Development at Risk of Flooding: Advice and Consultation; and
- SEPA Policy No. 61 Control of Priority & Dangerous Substances & Specific Pollutants in the Water Environment.

12.11 The following development plan policies were also taken account during the assessment:

- Dumfries and Galloway Council Local Development Plan 2 (LDP2) 2019:
  - OP1: Development Considerations;
  - OP2: Design Quality and Placemaking;
  - OP3: Developer Contributions;
  - NE11: Supporting the Water Environment;
  - NE12: Protection of Water Margins;
  - NE14: Carbon Rich Soil;
  - NE15: Protection and Restoration of Peat Deposits as Carbon Sinks;
  - IN1: Renewable Energy;
  - IN2: Wind Energy;
  - IN7: Flooding and Development; and
  - IN8: Surface Water Drainage and Sustainable Drainage Systems (SuDS).

Other Guidance and Good Practice

12.12 Table 12.1 below lists other key guidance and good practice documentation which have been considered as part of this assessment.

Table 12.1 Guidance and good practice

Topic	Source of information
Scottish Government Planning Advice Notes (PAN's)	▪ PAN 50: Controlling the Environmental Effects of Surface Mineral Workings; ▪ PAN 51: Planning (revised 2006), Environmental Protection and Regulation; ▪ PAN 1/2013: Environmental Impact Assessment; ▪ PAN 61: Sustainable Urban Drainage Systems; ▪ Flood Risk: planning advice; ▪ PAN 79: Water and Drainage; ▪ Onshore Wind Turbine: planning advice; and ▪ Wind farm developments on peat land: planning advice.
SEPA Guidance for Pollution Prevention (GPPs) and Pollution Prevention Guidelines (PPGs)	▪ PPG 1: Understanding your Environmental; Responsibilities - Good Environmental Practices ▪ GPP 2: Above Ground Oil Storage Tanks; ▪ GPP 4: Treatment and Disposal of Wastewater Where there is no Connection to the Public Foul Sewer; ▪ GPP 5: Works and Maintenance in or Near Water; ▪ PPG 6: Working at Construction and Demolition Sites; ▪ PPG 7: Safe Storage - The Safe Operation of Refuelling Facilities; ▪ GPP 8: Safe Storage and Disposal of Used Oils; ▪ GPP 13: Vehicle Washing and Cleaning; ▪ GPP 21: Pollution Incident Response Planning; ▪ GPP 22: Dealing with Spills; and ▪ GPP 26: Safe Storage - Drums and Intermediate Bulk Containers.
SEPA Position Statements (Published)	▪ WAT-PS-06-02: SEPA (2015), Culverting of Watercourses, Version 2; ▪ WAT-PS-07-02: SEPA (2012), Bank Protection, Version 2; ▪ WAT-SG- 78: SEPA (2012), Sediment Management Authorisation, Version 1; ▪ WAT-SG-23: SEPA (2008), Engineering in the Water Environment, Good Practice Guide - Bank Protection Rivers and Lochs, Version 1; ▪ WAT-SG-25: SEPA (2010), Engineering in the Water Environment, Good Practice Guide, Construction of River Crossings, Version 2;

Topic	Source of information
	▪ WAT-SG-26: SEPA (2010), Engineering in the Water Environment, Good Practice Guide, Sediment Management, Version 1; ▪ WAT-SG-75: SEPA (2011), Water Run-Off from Construction Sites September 2021; and ▪ WAT-SG-31: SEPA, (2006) Special Requirements for Civil Engineering Contracts for the Prevention of Pollution, Version 2.
Construction Industry Research and Information Association (CIRIA)	▪ CIRIA C692 Environmental Good Practice on Site (third edition); ▪ CIRIA C753 SuDS Manual (2015) ▪ CIRIA C532 Control of Water Pollution from Construction Sites; ▪ CIRIA C648 Control of Water Pollution from Linear Construction Projects; and ▪ CIRIA C689 Culvert Design and Operation Guide.
Other Guidelines	▪ SNH and Scottish Renewables Joint Publication, (2019) Good Practice During Wind Farm Construction Version 4; ▪ NatureScot, Advising on peatland, carbon – rich soils and priority peatland habitats in development management (2023); ▪ FCE, SNH, (2010), Floating Roads on Peat; ▪ Scottish Renewables, Joint Publication (2012), Development of Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimization of Waste; ▪ SEPA, The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended), A Practical Guide, Version 9.4, July 2024; ▪ Scottish Government, Scottish Natural Heritage, SEPA (2017) Peatland Survey Guidance on Developments on Peatland, on-line version only; ▪ SEPA Land Use Planning Guidance CC1 (LUPS-CC1) (2019). Climate change allowances for flood risk assessment in land use planning. Version 4; ▪ SEPA Land Use Planning Guidance Note 4 (2017): Planning Guidance on On-Shore Windfarm Developments, Version 9; ▪ SEPA Land Use Planning Guidance Note 31 (2017): Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and

Topic	Source of information
	Groundwater Dependent Terrestrial Ecosystems, Version 3; and ▪ SNIFFER. 2009. WFD95 A Functional Typology for Scotland.

Scoping and Consultation

12.13 Table 12.2 summarises the consultation responses relating to the geological, hydrological and hydrogeological environment.

Table 12.2 Scoping and consultation response relating to hydrology, geology and hydrogeology

Organisation	Response relevant to hydrology	Comment
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.	This information is considered further within the Section Water Resources (paragraphs 12.88 - 12.90). Private Water Supplies (PWS) are also shown in Figure 12.1. and considered in detail in Technical Appendix 12.4: PWSRA.
	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.	The site does not contain any notable areas of forestry. Designated Sites are considered further within the Section Designated Sites (paragraph 12.43) and Fisheries and Recreation Section (paragraphs 12.81 -12.82)
	Where there is a demonstrable requirement for peat landslide hazard and risk assessment (PLHRA), the assessment should be undertaken as part of the EIA process to provide Ministers with a clear understanding of whether the risks are acceptable and capable of being controlled by mitigation measures. The Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Second Edition), published at http://www.gov.scot/Publications/2017/04/8868, should be followed in the preparation of the EIA report, which should contain such an assessment and details of mitigation measures.	Technical Appendix 12.3: PLHRA, has been produced and provided with the EIA.

Organisation	Response relevant to hydrology	Comment
Marine Directorate – Science Evidence Data and Digital (MD-SEDD)	Marine Directorate – Science Evidence Data and Digital (MD-SEDD) provide generic scoping guidelines for 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 or overhead line development and informs developers as to what should be considered, in relation to freshwater and diadromous fish and fisheries, during the EIA process. 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.	This information is considered further within the Section Designated Sites (paragraph 12.39) and Fisheries and Recreation Section (paragraphs 12.81-12.82) and Chapter 9: Ecology.
Scottish Water (SW)	SW confirmed that there are no Scottish Water drinking water catchments or water abstraction sources, which are designated as Drinking Water Protected Areas (DWPA) under the Water Framework Directive, in the area which may be affected by the proposed development.	Noted.
NatureScot	River Bladnoch SAC is designated for the qualifying interest Atlantic salmon. The proposed development will have connectivity with the River Bladnoch SAC due to drainage and water flow from the site entering the SAC indirectly through the Glassoch Burn. Potential impacts on its qualifying interest will need to be considered. The qualifying interest is sensitive to disturbance to the river habitat, including silt and sediment entering the watercourse and smothering gravel beds, suspended solids in the water column, pollution events, and changes in water quality and water chemistry.	The River Bladnoch SAC is considered further within the Section Designated Sites (paragraph 12.43) and Section Issues Scoped Out (paragraph 12.118).
	According to the Carbon and Peatland 2016 map, there is Class 1 and Class 2 peatland present on the site of the proposed development. The Scoping Report makes no mention of peatland, and there are no proposals to carry out any survey work. An assessment of the impacts of the proposal on peatland must be included in the EIA Report. We would expect the wind farm to be designed to ensure that there are no direct or indirect hydrological impacts on Class 1 or Class 2 peatland from the construction of the development.	Peat and Peatland is considered further within the Sections Peat and Soils (paragraphs 12.96 – 12.97), Peat Survey Results (paragraphs 12.98-12.102) and with the likely adverse effects considered in paragraphs (12.149 – 12.162). Carbon Soils and Pe depths are also shown in Figures 12.7 and assessed further in Technical Appendices 12.2: SPMP and 12.3: PLHRA
SEPA	The EIA submission must contain a scaled plan of sensitivities, for example peat, GWDTE, proximity to watercourses, overlain with proposed development. This is necessary to ensure the EIA process has informed the layout of the development to	Other responses addressed throughout this chapter, supporting figures and associated Technical Appendices.

Organisation	Response relevant to hydrology	Comment
	firstly avoid, and then reduce then mitigate significant impacts on the environment. If much of the site is peatland and/or wetland, we suggest you may wish to go straight to carrying out NVC survey without carrying out Phase 1 Habitat Surveys. The EIA report should explain how GWDTEs found on the proposal site will be protected. Appendix 1 mentions in detail what is required. In summary: Site layout: Please refer the applicant to our attached scoping advice for wind farms which sets out our full requirements for the EIA. a) Map and assessment of all engineering works within and near the water environment including buffers, details of any flood risk assessment and details of any related applications made under the Controlled Activities Regulations (CAR). With relation to flood risk, if, having considered the site and potential for flood risk, it appears that the only apparent issue could relate to design of the watercourse crossing, then provided crossings are designed to accommodate the 1 in 200 year event and other infrastructure is located well away from watercourses it is unlikely that there will be a need for detailed information on flood risk. b) Map and assessment of impacts upon Groundwater Dependent Terrestrial Ecosystems and buffers. Where it is clear that much of the site is likely to be peatland and/or wetland, we suggest you may wish to go straight to carrying out NVC survey without carrying out Phase 1 and Sniffer assessments (see appendix for details). c) A map demonstrating all GWDTE and existing groundwater abstractions are outwith a 100m radius of all excavations shallower than 1m and outwith 250m of all excavations deeper than 1m and proposed groundwater abstractions. d) Peat depth survey and table detailing re-use proposals. Where much of the site is on peat, we expect the application to be supported by a comprehensive site specific Peat Management Plan. e) Map and table detailing forest removal if on afforested area. Note that habitat survey information is not required for areas which are heavily forested or recently felled. f) Map and site layout of borrow pits. g) Schedule of mitigation including pollution prevention measures.	See Technical Appendices: 12.1: Schedule of Watercourse Crossings; 12.2: Soil and Peat Management Plan (SPMP); 12.3: Peat Landslide Hazard Risk Assessment (PLHRA); and 12.4: Private Water Supply Risk Assessment (PWSRA). Figures: 12.1: Hydrology Overview; 12.7: Peat Depth & Condition; 2.4: Groundwater Dependent Terrestrial Ecosystems.

Organisation	Response relevant to hydrology	Comment
	h) Quarry or Borrow Pit Site Management Plan of pollution prevention measures. i) Map of proposed waste water drainage layout. j) Map of proposed surface water drainage layout. k) Map of proposed water abstractions including details of the proposed operating regime. l) Decommissioning statement.	

Extent of the Study Area

12.14 The Proposed Development and the Site are defined in Chapter 3: Project Description and Construction Methods of this EIA Report.

12.15 The extent of the Study Area for the assessment encompasses sensitive hydrology, hydrogeology, geology, and soil receptors within the footprint of the Proposed Development and are based upon professional judgement and experience of assessing similar developments in similar environments.

12.16 It is considered that at distances in excess of 5km, the Proposed Development is unlikely to have a hydrological or water quality effect, as attenuation and dilution of substances is likely to occur. In addition, areas down-catchment from the Proposed Development will be included in the Study Area where there is potential for cumulative effects to occur, through the interaction between other windfarm developments with the Proposed Development.

12.17 The GWDTE Study Area comprises a 250 m buffer of the Proposed Development where excavations are likely to be greater than 1 m, and within 100 m of excavations less than 1 m.

12.18 The planning application includes an allowance for micro siting of the wind farm infrastructure if planning permission is granted the Applicant will commission detailed ground investigations and geotechnical surveys to determine the ground conditions. A 100m micro siting allowance is sought for the wind turbines (with restrictions in place to safeguard constraint buffers as applicable) and all other new elements of the Proposed Development.

Assessment Methodology and Significance criteria

Effects to be assessed

12.19 The greatest risk of the proposed development affecting the geological, hydrological and hydrogeological environment will occur during the construction phase, with effects reduced during the operational and decommissioning phase. Taking this into account the following issues will be addressed during all phases of development of the proposed development:

- Geomorphology and geology – geomorphological characteristics of the Site and changes to geological structures or effects on designated sites;
- Soils and peat – changes to soil and peat characteristics related to erosion, compaction and soil quality, changes to peat stability within and immediately adjacent to the Site;
- Hydrogeology – changes to groundwater infiltration and groundwater levels, water quality and wetland characteristics; and
- Hydrology – changes to drainage regime and associated alteration to surface water runoff rates and volumes, erosion/sedimentation and water quality characteristics across the Site and the wider catchment, including designated sites. Also, changes to water resources such as public and private water supplies (PWS).

Methodology

Overview

12.20 The likely significance of environmental effect was determined through a standard method of assessment based on SNH (2018) Environmental Impact Assessment Handbook. The assessment has involved the following:

- Detailed desk studies and site visits to establish baseline conditions of the area;
- Evaluation of the likely significant environmental effects of the Proposed Development and the impacts that these could have on the current site conditions;
- Identification of embedded good practice measures to avoid and mitigate against any identified adverse effects resulting from the Proposed Development;
- Evaluation of the likely significant environmental effects with consideration of the potential embedded mitigation measures, taking account of the sensitivity of the baseline features, the potential magnitude of these effects and the probability of these effects occurring; and
- The residual significance of the environmental effects following the consideration of additional mitigation measures.

Baseline Assessment

12.21 A desktop survey to establish the baseline conditions was undertaken in order to:

- Describe surface water hydrology, including watercourses, springs and waterbodies;
- Identify existing catchment pressures (e.g. point source and diffuse pollution issues);
- Identify all private drinking water abstractions and public water supplies within 3 km of the Site;
- Identify all flooding risks;
- Describe the hydromorphological conditions of watercourses;
- Collect information relating to recreational and fisheries resources;

- Collate hydrological flow and flooding data for the immediate area and main downstream watercourses;
- Collect soil, geological and hydrogeological information;
- Confirm surface water catchment areas and watersheds; and
- Confirm the extent and nature of peat and peatlands across the site.

12.22 Table 12.3 outlines the information sources used to characterise baseline conditions at the site and in the surrounding area.

Table 12.3 Baseline information sources

Topic	Sources of Information
Topography	5m contour data derived from Digital Terrain Model (DTM) data and Ordnance Survey (OS) mapping
Designated Nature and Conservation Sites	NatureScot, https://map.environment.gov.scot/sewebmap/ Magic Map, DEFRA, https://magic.defra.gov.uk/magicmap.aspx
Solid and Superficial Geology	BGS Geology of Britain Viewer, http://mapapps.bgs.ac.uk/geologyofbritain3d/index.html
Soils and Peat	James Hutton Institute (JHI), Soil Information for Scottish Soils (SIFSS), http://sifss.hutton.ac.uk/ Scotland's Soils Interactive Map, Carbon and Peatland 2016 and National Soil Map of Scotland http://soils.environment.gov.scot/
Climate	Met Office, https://www.metoffice.gov.uk/public/weather/climate/gcv3mcrf9 Flood Estimation Handbook (FEH): FEH Web Service, https://fehweb.ceh.ac.uk/
Surface Water Hydrology	1:10,000, 1:25,000 & 1:50,000 OS Vector & Raster Data Flood Estimation Handbook (FEH): FEH Web Service, https://fehweb.ceh.ac.uk/
Flooding	1:10,000, 1:25,000 & 1:50,000 OS Raster Data Flood Estimation Handbook (FEH): FEH Web Service, https://fehweb.ceh.ac.uk/ Flood Modeller Suite, https://www.floodmodeller.com/ Indicative River and Coastal Flood Map (SEPA) http://map.sepa.org.uk/floodmap/map.htm
Water Quality	SEPA, River Basin Management Plans, Web Mapping Application, https://informatics.sepa.org.uk/RBMP3/
Water Resources	Private water supply (PWS) information provided by Dumfries and Galloway Council (DGC) and consultation with OS mapping. Responses to PWS questionnaires sent to local residents included on the PWS database provided by the Council. Abstraction and discharge license information obtained from SEPA Scottish Water abstractions were gathered in January 2024, directly from SW's asset database under an agreement between SW and WSP.

Topic	Sources of Information
Hydrogeology	Scotland's Environment Web Interactive Map, https://map.environment.gov.scot/sewebmap/ BGS Geology of Britain Viewer, https://www.bgs.ac.uk/map-viewers/bgs-geology-viewer/ SEPA, River Basin Management Plans, Web Mapping Application, http://gis.sepa.org.uk/rbmp/ BGS Groundwater Vulnerability (Scotland), Version 2 https://nora.nerc.ac.uk/id/eprint/17084/1/OR11064.pdf SEPA Land Use Planning System Guidance Note 31 (LUPS-GU31) https://www.sepa.org.uk/media/144266/lups-gu31-guidance-on-assessing-the-impacts-of-development-proposals-on-groundwater-abstractions-and-groundwater-dependent-terrestrial-ecosystems.pdf

Sensitivity

12.23 Sensitivity has been determined on the basis of the receptor's ability to absorb the anticipated effect without perceptible change resulting. Three levels of sensitivity have been used, as shown in Table 12.4 Sensitivity of Receptors Criteria. Evaluation of sensitivity of hydrology, hydrogeology, geology and soils requires a considerable degree of judgement, based on defined characteristics and values, and calling on professional experience, which is accordingly applied during evaluation.

Table 12.4 Sensitivity of Receptors Criteria

Sensitivity	Definition
High	Receptor has 'High' or 'Good' Water Framework Directive (WFD) overall status and/or water quality status for surface water or groundwater body. Receptor is a designated site protected under national or international legislation, such as Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC), or Special Protection Area (SPA). Receptor contains Geological Conservation Review (GCR) sites designated as SSSIs or Candidate SSSIs. Receptor contains areas of regionally important economic mineral deposits. Receptor supports key species and habitats sensitive to changes in suspended sediment concentrations and turbidity, such as salmon or freshwater pearl mussels. Receptor supports GWDTE evaluated as potentially highly groundwater dependent. Receptor contains a range of hydromorphological features with very little modification. Receptor is a watercourse or floodplain, with a possibility of direct flood risk to populated areas, which are sensitive to increased flood risk by the possible increase in water levels. Receptor provides clear flood alleviation benefits. Receptor is used for abstraction or storage for public water supply or PWS, or supplies to commercial or public activities irrespective of size. Receptor (peat) is present and is >1.0 m in depth. Receptor is classed as a high productivity aquifer (class 1A or 2A).

Sensitivity	Definition
Medium	Receptor has 'Moderate' WFD overall status and/or water quality status for surface water or groundwater body. Receptor contains GCR sites with Local Geodiversity Site (LGS) status. Receptor contains areas of locally important economic mineral deposits. Receptor supports GWDTE evaluated as potentially moderately groundwater dependent. Receptor contains limited hydromorphological features and a limited range of fluvial processes, such areas may have been subject to past modification such as straightening, bank protection and culverting or other anthropogenic pressures. Receptor is a watercourse or floodplain, with a possibility of direct flood risk to high value agricultural areas, which are moderately sensitive to increased flood risk by the possible increase in water levels. Receptor provides limited flood alleviation benefits. Receptor used for abstraction or storage for agricultural/industrial use (non-domestic). Receptor (peat) is present and is >0.4, but only rarely >1m in depth. Local or regional ecological status/locally important fishery. Receptor is classed as a moderate or low productivity aquifer (class 1B or 2B).
Low	Receptor has 'Poor' or 'Bad' WFD overall status and/or water quality status for surface water or groundwater body. Receptor contains GCR sites without SSSI (or Candidate SSSI) designation or LGS status, and non GCR sites with potential geodiversity interest. Receptor supports no key species and habitats sensitive to changes in suspended sediment concentrations and turbidity. Receptor supports GWDTE based on National Vegetation Classification (NVC) mapping, with local water sources not considered as predominantly groundwater. Receptor contains no hydromorphological diversity and/or are identified as 'heavily modified water bodies' or 'artificial water bodies'. Receptor is a watercourse or floodplain which passes through low value agricultural areas, less sensitive to increased flood risk by the possible increase in water levels. Receptor provides limited flood alleviation benefits. Receptor does not support any water abstractions. Receptor (peat) is rarely present and is typically <0.4 m. Receptor is classed as a very low productivity aquifer (class 1C or 2C). Sporadic fish presence.

Magnitude

12.24 The magnitude of change has been assessed taking account of the timing, scale, size, duration and reversibility of the likely effect. Four levels of magnitude have been used in this assessment, as shown in Table 12.5 Magnitude of Change Citeria.

Table 12.5 Magnitude of Change Criteria

Magnitude	Definition
Major	Long-term (≥12 months) or permanent change in surface water quality, resulting in a change in WFD status and/or prevention of attainment of target status of 'Good'. Results in loss of feature(s) and failure of hydromorphological elements (morphology, quantity and dynamics of flow) resulting from the works. Loss or damage to existing habitats. Replacement of natural bed and/or banks with artificial materials. Extensive change to channel planform. Loss of floodplain due to construction within flood risk area. Permanent loss of water supply. Major or total loss of a geological site or mineral deposits or where the value of the receptor would be severely affected. Major or total loss of soils or peatland deposits or where the value of the receptor would be severely affected. Long-term (≥12 months) or permanent change in groundwater quality, resulting in a permanent change in WFD status and/or prevention of attainment of target status of 'Good'. Major loss of an aquifer in terms of water level or yield, with total loss of or major changes to dependent abstractions/habitats. Major change or total loss of a GWDTE, where the value of the Site would be severely affected.
Moderate	Mid-term (≥6 months) change in local surface water quality, potentially resulting in a temporary change of WFD status (or equivalent status at local scale) or preventing attainment of target overall status of 'Good' during this period. Results in adverse change on integrity of hydrological feature(s) or loss of part of feature/moderate shift away from baseline conditions. Failure of one or more hydromorphological elements (morphology, quantity and dynamics of flow) resulting from the works. Some damage or loss to habitat due to the modifications. Replacement of the natural bed and/or banks with artificial material. Floodplain reduction due to extensive increases in impermeable area within catchment and/or drainage design which would result in an increase in peak flood level. Temporary loss of water supply. Partial loss of a geological site or mineral deposit, with major change to the settings, or where the value of the receptor would be affected. Partial loss of soils or peatland deposits or where the value of the receptor would be affected. Mid-term (≥6 months) change in local groundwater quality, not affecting overall WFD status. Changes to an aquifer in terms of water level or yield, with small changes to nearby dependent abstractions/habitats. Partial change or loss of a GWDTE, where the value of the Site would be affected.

Magnitude	Definition
Minor	Short-term (≥1 month) change in local surface water quality, resulting in minor temporary changes such that ecology is affected for short-term. Equivalent to a temporary minor, but measurable, change within WFD status class. Potential failure in one of hydromorphological elements (morphology, quantity and dynamics of flow) resulting from the works. Results in minimal shift away from baseline conditions or partial loss or damage to habitat due to modifications. Floodplain changes due to limited increases in impermeable area within catchment and/or drainage design which would result in a minor increase in peak flood level. Temporarily reduced quality and quantity of water supply. Small loss to a geological site or mineral deposit, such that the value of the receptor would not be affected. Small loss of soils or peatland, or where soils will be disturbed but the value not affected. Short-term (≥1 month) change in local groundwater quality. Small change to an aquifer in terms of water level or yield, with little discernible change to dependent abstractions/habitats. Small change to or loss of a GWDTE, where the value of the Site would not be affected
Negligible	Negligible change to surface water quality, very slight temporary change in water quality with no discernible change to watercourse ecology. No alteration to hydromorphological elements. Some change on feature(s), but of insufficient level to affect the use/integrity, approximating to a 'no change' situation. Floodplain variations of negligible change. No anticipated change to water supply. Minimal or no change to a geological site or mineral deposit. Minimal or no change to soils or peatland deposits. Negligible change to groundwater quality, very slight temporary change in local water quality. Minimal or no change to an aquifer in terms of water level or yield, with no discernible change to dependent abstractions/habitats.

Probability

12.25 The probability of the occurrence of an effect has been evaluated as being high, medium, or low during the phase of work being assessed. Professional judgment is used to determine the probability of occurrence.

12.26 Taking into account the implementation of good practice measures and embedded mitigation as part of the design and construction of the Proposed Development, the probability of an effect occurring will be reduced.

Significance

12.27 The findings of the three criteria considered in the evaluation of an effect has been used via a matrix for each potential effect (Table 12.6) to assess the significance of an effect.

Table 12.6 Significance of Effect Criteria

Sensitivity	Magnitude	Probability	Significance of Effect
High	Major	High	Major
		Medium	Major
		Low	Moderate
	Moderate	High	Moderate
		Medium	Moderate
		Low	Minor
	Minor	High	Minor
		Medium	Minor
		Low	Minor
	Negligible	High	Minor
		Medium	Negligible
		Low	Negligible
Medium	Major	High	Major
		Medium	Moderate
		Low	Minor
	Moderate	High	Moderate
		Medium	Minor
		Low	Minor
	Minor	High	Minor
		Medium	Minor
		Low	Negligible
	Negligible	High	Negligible
		Medium	Negligible
		Low	Negligible
Low	Major	High	Moderate
		Medium	Minor
		Low	Negligible
	Moderate	High	Minor
		Medium	Minor
		Low	Minor
	Minor	High	Minor
		Medium	Negligible
		Low	Negligible
	Negligible	High	Negligible
		Medium	Negligible
		Low	Negligible

12.28 Through the assessment, potential effects are concluded to be of major, moderate, minor, or negligible significance. Major and moderate effects are considered significant and minor and negligible effects are considered not significant. Effects are considered adverse unless stated otherwise.

Limitations of the Assessment

12.29 Baseline conditions have been established from a variety of sources, including historical data, but due to the dynamic nature of certain aspects of the environment, conditions are likely to change during the construction and operation of the Proposed Development.

12.30 The fieldwork followed standard 'reconnaissance' field methods in which watercourses were visited close to planned access routes and peat probing was completed on a representative sampling basis initially, followed by a targeted approach within a refined Developable Area as the design evolved. Following the provision of the infrastructure design, specific infrastructure locations were visited for peat probe survey and stability assessment.

12.31 It is recognised that the equipment employed to determine peat depth will also pass through other soil types before 'refusal depth', thus peat depth results incorporate all soil through which probing rods pass, such as podzols, and gleys. This is a conservative approach to ensure soil depths are accurately gauged but is anticipated to provide an overestimate of peat depths, given visual evidence from the Site and the fact that the mapping indicates peat overlying other soil types.

12.32 It is assumed that information received by third parties, including the register of PWS provided by Dumfries and Galloway is complete and up to date.

12.33 It is assumed that the design, construction and completed stages of the Proposed Development will satisfy minimum environmental standards, consistent with contemporary legislation, practice, and knowledge.

Baseline Conditions

12.34 This subsection presents the information gathered on the current environmental baseline conditions within the site and its immediate surroundings.

Topography

12.35 The Proposed Development is in Dumfries and Galloway, Scotland. The topography of the Site is gently undulating, with the lowest points being located adjacent to the A714 close to the River Cree at approximately 50m Above Ordnance Datum (AOD). There are several small hills within the central areas of the Site rising to 90m AOD and 100m AOD, with the highest peak to the north-west of the Site at Glenvernoch Fell (180m AOD).

Geomorphology

12.36 The landscape within the proposed development is open moorland used as rough grazing. The site is bounded in the east by a convex slope break which separates the site from the valley basin of the River Cree and in the west by forested or upland areas which interfluve with catchments over the watershed.

12.37 Within the Site itself there are broad terraces interspersed between bedrock outcrops and moraines (photograph 12.1 & 12.2). Watercourses at the site (described in paragraphs 12.44-12.51) connect basins with channel orientation being controlled by the chaotic assemblage of bedrock and moraine structures.

12.38 Bedrock outcrops are convex (whale-back) shaped typically running as a series of discontinuous terraces, and were generally glacially smoothed. These were most prevalent in the south of the site and were interspersed by small basins containing peat, organic soil, sand and gravel. In the north and west of the Site the landscape became a patchwork of well drained sand and gravel moraines covered with semi-improved grassland interspersed between more boggy areas (photograph 12.3). There was extensive evidence of historical drainage and grips in these wet areas which usually containing a flow of water (photograph 12.4)

Climate

12.39 The standard average annual rainfall (SAAR) for the site has been derived from the FEH Web Service as ranging from 1351-1388mm based on the site catchments. To put this into context, rainfall in Scotland varies from under 800mm per year on mainland eastern Scotland in areas such as Fife, to over 3000mm on the mainland Western Highlands.

12.40 The Met Office 1991-2020 annual rainfall total from the Glenlee climate station is 1,781mm with 186 days of rainfall greater than 1mm recorded. This climate station is located approximately 25km north-west of the proposed development at an elevation of 55m AOD. According to the 1991-2020 average for Glenlee climate station, the highest rainfall totals are recorded during the winter months from October through to January as shown in Chart 12.1.

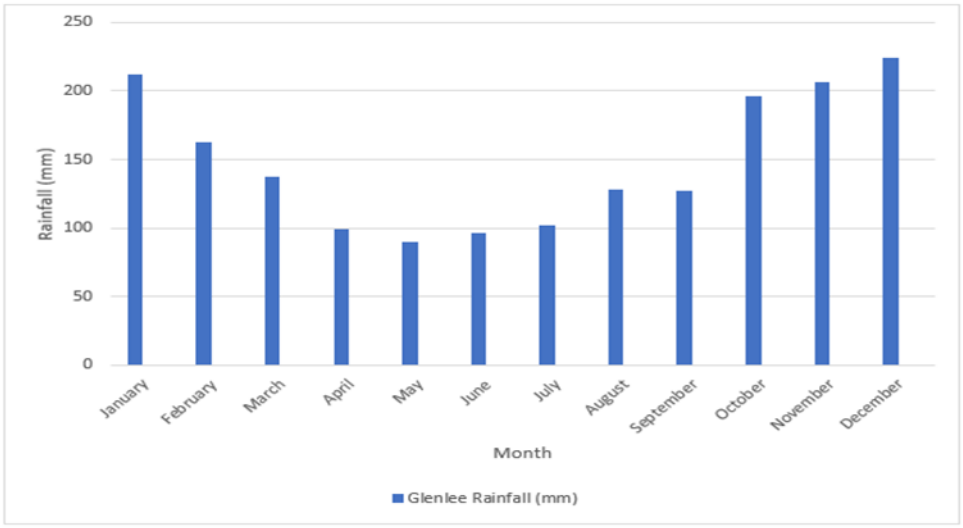
Photograph 12.1 Bedrock outcrop abutting flat basin containing peat / organic soil (NX 34725 72453)

Photograph 12.2 Large areas of exposed scoured bedrock in the south of the proposed development (NX 35603 71345)

Photograph 12.3 Improved grassland atop moraines with wetter areas in between (NX 35216 73954)

Photograph 12.4 Example of a typical moorland grip / artificial drainage ditch within the Site (NX 34568 72343)

Chart 12.1 Average monthly rainfall data for climate period 1991-2020



12.41 This precipitation data provides an understanding of seasonal variations that will be anticipated in the region area, with Glenlee Met Office station at an altitude within the range across the Site.

12.42 Longer-term trends for Scotland indicate that weather may become more variable leading to hotter and drier summers and milder and wetter autumn/winters. It is also anticipated that there will be an increase in extreme temperatures and drought in summer and an increase in frequency and intensity of precipitation events.

Designated Sites

12.43 A review of NatureScot and DEFRA records indicates that there are no statutory designated sites within the Proposed Development. There are a few designations which lie outside of the site, but within 5km of the site boundary. A summary of the designated sites can be found in Table 12.7.

Table 12.7 Designated sites in proximity of the site boundary

Designated Site	Location	Reason for Designation	Hydrological connection to Proposed Development
Wood of Cree SSSI	Located 320m southeast of the Site, separated from the Site by A714 and River Cree.	Biological	Not hydrologically connected to the Proposed Development.
Galloway Oakwoods SAC	Located 320m southeast of the Site, separated from the Site by A714 and River Cree.	Biological	Not hydrologically connected to the Proposed Development.
River Bladnoch SAC	Located 1km west of the Site.	Mixed - The site is designated for Atlantic Salmon.	The Proposed Development would have connectivity with the River Bladnoch SAC due to drainage and water flow from the Site entering the SAC indirectly through the Glassoch Burn which is located on the west border of the Site. However, Glassoch Burn is located 700m west of the Proposed Development and west of the Top of the Fell (184m AoD) while the Proposed Development is located on the east side of the Top of Fell, on the far side of the watershed. Therefore, due to the topography, they are not hydrologically connected.

Surface Water Hydrology

12.44 The majority of the Site is located within the catchment of the River Cree and a very small part to the east border within the River Bladnoch catchment. The River Cree catchment has an area of approximately 368km^2 and the River Bladnoch has a catchment area of approximately 335km^2.

12.45 The River Cree runs almost parallel and close to the eastern boundary of the Site and discharges into Wigtown Bay, south of Newton Stewart.

12.46 Watercourses or their tributary catchments within the site, which are sub-catchments to the River Cree, are the Boughty Burn, Clachaneasy Burn and Castle Stewart Burn. In addition to the natural watercourses, there is an extensive network of artificial ditches (also known as drains or grips). Some of these man-made features are also shown as watercourses on OS mapping. Further information on these artificial ditches in relation to natural watercourses is presented in Technical Appendix 12.1 Schedule of Watercourse Crossings.

12.47 The Boughty Burn drains the north part of the Site. The headwaters of Boughty Burn are sourced from Butter Cairn (164m AOD) and a forest area east of Loch Quie. The Boughty Burn joins the River Cree ~1km downstream of Bargrennan.

12.48 The Clachaneasy Burn and its tributaries drain the north and central part of the Site. The headwaters of Clachaneasy Burn are sourced from Craigie, on Glenvernoch Fell (184 m AoD). The Clachaneasy Burn joins the River Cree 700m downstream from the River Cree and Boughty Burn confluence.

12.49 The Castle Stewart Burn is a tributary of River Cree which drains the central and southern watershed of the Site (Photograph 12.5). The headwaters of the burn are sourced from a forest area east of Glassoch Fell and the catchment drains predominately from open moorland. The Castle Stewart Burn joins the River Cree 4km downstream from the point where the Site crosses the noted watercourse.

Photograph 12.5 Castle Stewart Burn (NX 35834 71555)

12.50 The morphology of the Boughty Burn, Clachaneasy Burn and Castle Stewart Burn are typical upland moorland watercourses, being narrow channels originating from areas of overland flow convergence such as flushes or areas of depression storage in headwater areas. The watercourses are generally on steep to moderate gradients with a fast discharge, step-pool reach, and consequently incised into the superficial sediments with a peat or vegetated bed. Further downstream the watercourses are slightly more sinuous and are plane-bed or plane riffle reaches with gravel, cobble and boulder beds.

Gradients remained moderate. Bank condition was variable, with evidence of erosion more apparent lower in the catchments, primarily as a result of agricultural pressure.

Photograph 12.6: Unnamed tributary (0.57km2 catchment area), drains the southeast part of the Site. The headwaters of the tributary are sourced south of Knockville. (NX 36643 71994).

Photograph 12.7: Unnamed tributary (2.97km2 catchment area) which flows from the southwest to the northeast part of the Site. The headwaters of the tributary are sourced west of Loch Quie (NX 34548 72573).

12.51 There are several tributaries of the River Cree within the Site which cross the Proposed Development and drain from southwest to northeast until drainage into the River Cree (see Photographs 12.5 – 12.8).

Photograph 12.8 Unnamed tributary (2.26km^2 catchment area) which flows from the southwest to the northeast part of the Site. The headwaters of the tributary are sourced between Craigie and Glenvernoch Fell (NX 34548 72573).

Hydrological Regime

Flow Conditions

12.52 There are no river gauging stations within the site. According to the UK Centre for Ecology and Hydrology (CEH) National River Flow Archive[1] the nearest river gauging station to the Site is the Cree at Newton Stewart (NX 412 653), situated approximately 8 km to the south. Discharge records for this gauging station are available from 1963 to 2022.

12.53 The mean annual flow of the Cree at Newton Stewart is 15.7 m3/s, with a Q_{95} of 1.1 m^3/s and a Q10 of 39.5 m^3/s. Wintertime discharge (December to March) is typically highest, with a Q50 of 12 m^3/s and summertime (June to September) of 4.5 m^3/s.

12.54 Long term trend analysis provided by CEH between 1980 and 2012 indicates that whilst mean annual and annual maximum flow remain relatively constant, the annual minimum flow (low flow) and daily maximum have an increasing trend.

Flow Estimation

12.55 In the absence of any river gauge information for the proposed development, peak flows have been estimated for the key catchments using the FEH Rainfall Runoff (FEH RR) and Institute of Hydrology Report 124 (IH124) methodologies for a range of return periods, with the results presented in Table 12.8. Catchment descriptors were derived from the FEH Web Service and used for calculating peak flows for the identified catchments above. Catchment boundaries have been used in their entirety, as opposed to their delineation along the site and are shown in Figure 12.1: Hydrology Overview.

12.56 As per SEPA Land Use Planning Guidance CC1 (LUPS-CC1), it is predicted that there will be increases in rainfall intensity due to climate change which will increase the severity and frequency of flooding on small watercourses. This will subsequently increase the peak runoff flows in these small catchments. The climate change uplift required for the Solway River Basin region for total change to the year 2100 is a 53% increase in peak river flows and a 38% increase in peak rainfall intensity.

12.57 Base Flow Index (BFI) and Standard Percentage Runoff (SPR) data for the catchments covering the proposed development was also taken from the FEH Web Service. The BFI is a measure of the proportion of a catchment's long-term runoff that derives from stored sources, with the BFI ranging from 0.1 in relatively impermeable catchments to 0.99 in highly permeable catchments. The SPR values represent the percentage of rainfall that is likely to contribute to runoff.

[1] Centre for Ecology & Hydrology, National River Flow Archive. 2024. 81002 – Cree at Newton Stewart. Available at https://nrfa.ceh.ac.uk/data/station/info/81002 (accessed 07/05/2024).

Table 12.8 Estimated peak runoff for site catchments calculated using the methodology prescribed by the FEH RR and IHI24 methods

Catchment	Area (km^2)	Method	Estimated peak runoff (m^3/s) for stated return period						
			QBAR	QMED	1	30	100	200	200^{CC}
Boughty Burn	1.3	FEH RR	-	1.35	1.18	2.65	3.57	4.06	5.60
		IHI24	1.48	-	1.30	2.91	3.92	4.45	6.15
Castle Stewart Burn	3.5	FEH RR	-	4.94	4.30	9.64	13.01	14.79	20.40
		IHI24	4.70	-	4.09	9.17	12.37	14.07	19.41
Clachaneasy Burn	5.6	FEH RR	-	7.24	6.30	14.13	19.05	21.66	29.89
		IHI24	6.94	-	6.04	13.54	18.26	20.76	28.65
Unnamed burn (Knockville)	0.5	FEH RR	-	1.03	0.90	2.02	2.72	3.09	4.27
		IHI24	0.88	-	0.77	1.73	2.33	2.65	3.66

12.58 The BFI for the site catchments ranges from 0.197 to 0.335. This indicates that around a quarter of the catchment's long-term runoff is derived from stored sources.

12.59 The SPR for the site catchments ranges from 50.52% to 59.66% indicating that around half of the rainfall during a rainfall event contributes to runoff.

12.60 The BFI and SPR values show that the site is located on moderately impermeable catchments indicating the infiltration capacity of the catchments is low and that rainfall is likely to be quickly reflected in surface water discharge.

Flood Risk

12.61 National Planning Framework 4 (NPF4) was published by the Scottish Government on the 13th of February 2023. It is the national strategy for Scotland which sets out the spatial principles, regional priorities, national developments and national planning policy for Scotland. NPF4 replaces NPF3 and the Scottish Planning Policy.

12.62 NPF4 Policy has an emphasis on tackling the climate and nature crises (Policy 1). Climate mitigation and adaptation (Policy 2) is another important theme with the intent of this policy being "To encourage, promote and facilitate development that minimises emissions and adapts to the current and future impacts of climate change".

12.63 The following assessment has been undertaken to comply with the updated policies of NPF4 and outline the results of the assessment for determining flood risk.

Fluvial flooding sources

12.64 Flood information available on the SEPA Flood Map indicates that areas of fluvial flooding within the Site are largely limited to the lower tributary of the Clachaneasy Burn. This is identified as having a high likelihood of fluvial (watercourse) flooding in any given year and is mainly constrained to the immediate riparian zone.

12.65 Within the Study Area, the River Cree which runs parallel to the east boundary of the Site and two small Lochs (Loch Quie and Loch Swad) to the southwest are identified as having a high likelihood of fluvial flooding. Whilst outside the Study Area, Newton Stewart is also identified by SEPA as a Potentially Vulnerable Area (PVA) on account of historic flooding from the River Cree, with significant flooding experienced in 2012 and 2015. A Flood Prevention Scheme (FPS) is currently being progressed by D&GC.

12.66 The future flood maps indicate there would be a slight increase in the flood risk area extent within the Study Area on the River Cree, but remain largely unchanged for the Clachaneasy Burn within the site.

Pluvial flooding sources

12.67 Flood information available on the SEPA Flood Map indicates that rare and very small, isolated areas have been highlighted as having a medium to high likelihood of pluvial (surface water) flooding.

12.68 Within 1km of the Site, pluvial flood risk is present as isolated areas or adjacent to small / minor watercourses.

Coastal flooding sources

12.69 The Proposed Development is located approximately 22km from the nearest coast and due to this distance along with the topographical position, the Proposed Development will not be affected by coastal flooding.

12.70 None of the rivers which are located within the Site are tidally influenced.

Groundwater flooding sources

12.71 Flooding can also result from high groundwater levels if the water table rises above the surface level. Groundwater flooding can occur in a variety of geological settings including river valleys with thick deposits of alluvium and river gravels. Groundwater flooding happens in response to a combination of already high groundwater levels (usually during mid or late winter).

12.72 Groundwater flooding is often associated with the shallow unconsolidated sedimentary aquifers that overlie sediments with no / very low permeability. Such aquifers are susceptible to flooding as the storage capacity within these deposits is often low, which combined with high direct rainfall recharge, can subsequently increase the water levels within the groundwater and providing a good hydraulic connection with adjacent river networks.

12.73 Flood information available on the SEPA website (map shows where groundwater could influence the duration and extent of flooding from other sources) indicates that there are no areas within the Site identified as being at risk from groundwater flooding. Within the Study Area, the River Cree is identified as being at low risk of groundwater flooding.

12.74 Groundwater flooding is difficult to predict as it rarely follows a consistent pattern. The response time between rainfall and groundwater flooding is also relatively long. The SEPA website indicates that the remainder of the site is not at risk of groundwater flooding.

Flooding from artificial drainage systems

12.75 There is evidence of artificial drainage within the site associated with historic upland moorland habitat management. There is the potential that this artificial drainage could cause some localised flooding by reducing depression storage and encouraging runoff.

12.76 The extent of the artificial drainage network within the proposed development was relatively minor, being constrained to isolated flat / boggy areas.

Flooding from other sources

12.77 SEPA's controlled Reservoirs inundation map[2] has been reviewed and confirmed that the Site is not located in the modelled extent of flood waters should any reservoirs within the catchment fail. There are also no sewers or canals within the Site.

Water quality

12.78 Several waterbodies within the vicinity of the site have been classified under SEPA's River Basin Management Plans (RBMP). The RBMP are one of the requirements of the Water Framework Directive (WFD) (2000/60/EC) and are the plans designed for protecting and improving the water environment. Table 12.9 details the classified watercourses, water bodies and groundwater bodies associated with the Proposed Development.

Table 12.9 RBMP classification of watercourses within the Study Area.

Water Body	Waterbody ID	Current Overall Status (2020)	Anticipated Classification (2027)	Anticipated Classification (Long Term)	Summary of Pressures
River Cree (u.s Minnoch Conf)	10521	Moderate	Good	Good	Unknown pressure on water animals and plants
River Cree (u/s Newton Stewart)	10520	Good	Good	Good	None
Water of Minnoch (River Cree to Water of Trool)	10527	Moderate	Moderate	Good	Acid rain
River Bladnoch (u/s Black Burn)	10509	Moderate	Moderate	Good	Acid rain

[2] SEPA Reservoir Maps - Reservoirs Map (sepa.org.uk), SEPA

12.79 For water bodies that have not been classified, the normal convention is to assume a classification based on downstream or adjacent water bodies unless there are specific indications to the contrary.

12.80 In relation to this assessment, it is considered that the higher the WFD status, the higher the sensitivity of the water body. To prevent any deviation from 'good status' for receiving watercourses, the objective is to keep construction phase and post-development runoff to pre-development levels, in terms of both quality and quantity, whilst recognising that natural variability in flow values and water quality do occur. Measures to ensure this are discussed in the assessment sections below.

Fisheries and Recreation

12.81 The River Cree is recognised as having potential to support fish populations (including salmonids). Fish populations could also be present in minor watercourses, and tributaries of the noted tributaries. Further details and species information is available in Chapter 9 Ecology of this EIA report.

12.82 Further details regarding the good practice measures to avoid sedimentation of watercourses, that could potentially have adverse effects on fisheries are outlined in the Erosion and Sedimentation section in this chapter. Implementation of these good practice measures will also ensure the conservation of the local fish populations in accordance with the provisions of Schedule 9 of the Electricity Act 1989.

Water resources

Water use authorisations

12.83 Based on SEPA's register of water abstraction and discharges, there are several registered discharges within 3 km of the site, but none of these could be plausibly impacted by the development on account of intervening distance and topography.

12.84 There is one registered activity (CAR/R/1013843, Authorisation Activity: Agriculture – other than irrigation) ~2.8 km to the south east of the Site which could be an abstraction. However, due to the intervening distance and topography, there is no plausible hydrological connection.

Public water supply

12.85 There are no Scottish Water abstractions that were identified as being potentially hydrologically connected within the Site.

12.86 SW scoping response confirmed that the Site is not located within SW Drinking Water Protected Areas (DWPAs).

12.87 According to the Scottish Government website, there are no SEPA DWPA for surface water, within 3km of the Proposed Development; however, the Proposed Development is located within SEPA DWPA for groundwater.

Private water supplies

12.88 Private water supplies (PWS) were identified through consultation with D&GC and review of the council held Register of PWS. Aerial imagery and OS maps were also interrogated to identify any additional potentially unregistered PWS. In total, 27 (no.) PWS were identified within the Study Area and 3 within the proposed development (Figure 12.1 Hydrology Overview).

12.89 Identified PWS were evaluated following the 'source-pathway-receptor' framework approach, considering the potential for qualitative or quantitative impacts based on the hydrological/hydrogeological setting of the abstraction and its position in relation to proposed development infrastructure. The assessments of PWS represent a standard approach and has been completed in accordance with industry guidance and best practice, including SEPA LUPS 31.

12.90 The assessment of PWS is presented in Technical Appendix 12.4: Private Water Supplies Risk Assessment (PSWRA).

Bedrock Geology & Structural Features

12.91 BGS Geological mapping (2024) 1:50,000 (Figure 12.2) indicates the Site and Study Area are underlain by Lower Palaeozoic rocks comprising of the following primary bedrock formations (noted within the Site from north to south):

- Kirkcolm Formation – wacke;
- Moffat Shale Group – mudstone;
- Portpatrick Formation – wacke;
- Glenwhargen Formation – wacke.

12.92 These formations date from the Ordovician period and comprised of marine turbiditic sedimentary rocks belonging to the Leadhills Supergroup. Stratification ranges from steeply dipping to vertical, with the units divided into major structural tracks orientated south west to north east. Faulting coincident to these is common, with several faults identified within the Site. The most notable of these is the Leadhills Fault (reverse /thrust fault, down throw to north). The Fardingmullach Fault (fault, down throw to north) is also mapped on the southern boundary of the Site.

12.93 In addition to the sedimentary bedrock units, the following minor more recent intrusive igneous bedrock units are also identified.

- North Britain Siluro-Devonian Calc-alkaline dyke suite – felsite;
- North Britain Siluro-Devonian Calc-alkaline dyke suite – lamprophyre;
- Unnamed Igneous Intrusion, late Silurian to early Devonian – granite; and
- Unnamed Igneous Intrusion, late Silurian to early Devonian – diorite.

12.94 These igneous rocks are orientated south west to north east and likely to be associated with the Arran or Mull volcanic complexes. There may be minor fracturing and deformity locally around these units.

Superficial Geology

12.95 Superficial geology mapping (2024) 1:50,000 (Figure 12.3) indicates that the majority of the Site has no superficial geology mapped. However, discrete areas of glacial till (Devensian) (Diamicton), areas of peat and small pockets of alluvium (silt and gravel). Hummocky (moundy) glacial deposits (Diamicton, Sand and Gravel) are noted.

Peat and Soils

12.96 The James Hutton Institute National Soil Map of Scotland indicates that the majority of the Site is underlain by blanket peat with peaty rankers, with pockets of blanket peat with brown earths, peaty podzols with peaty gleys, brown earths and mineral alluvial soils with peaty alluvial soils.

12.97 The NatureScot Carbon and Peatland Map indicates that the Study Area is underlain by:

- Class 0 mineral soils (*Peatland habitats are not typically found on such soils*). These soils underlie the majority of the north-east part of the Site;
- Class 1 (*Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas likely to be of high conservation value*). These soils are located in the middle area of the Site, between Graigengillan, Knockwhirn, Furmiston and Quantans Hill;
- Class 2 (*Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas of potentially high conservation value and restoration potential*). These soils are located in the middle area of the Site, between Knockwhirn, Furmiston and Quantans Hill;
- Class 3 (*Dominant vegetation cover is not 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*). These soils are located at the south-west of the Site and to the north-eastern extent;
- A small area of Class 4 (*an area unlikely to be associated with peatland habitats or wet and acidic type. Area unlikely to include carbon-rich soils*). These soils are located in the middle part of the Site; and
- Small areas of Class 5 soils (*Soil information takes precedence over vegetation data. No peatland habitat recorded. May also include areas of bare soil. Soils are carbon-rich and deep peat*). These soils are located in the southwest, middle and northeast part of the Site.

Peat Survey Results

12.98 Peat depth surveys (Appendix 12.2: SPMP (EIAR Volume 4) and Figure 12.7: Peat Depth & Condition (EIAR Volume 3a)) comprising the collection of a total of 4406 peat depth probes indicated that most of the site either has no peat present, or were mostly shallow peat soil (<0.4 m thickness). The identified peat depths are summarised as follows:

- 3,160 samples (72%) were on land with no peat or where organic/mineral soil was <0.4 m deep (Low sensitivity);
- 714 samples (16%) were on land with peat between >0.4m and 1.0 m deep (Medium sensitivity); and
- 532 samples (12%) were on land with peat >1m deep (High sensitivity).

12.99 Table 2.1 (Appendix 10.2 SPMP shows that the highest proportion (72%) of recorded depths fell within the ≤0.4m range with the next highest proportion (16%) within the >0.4 - ≤1.0m. Nearly 90% of locations surveyed encountered no peat, organic peat soil, or peat depths <1.0 m in thickness. The avoidance of peat in this manner through site selection and design has been a primary consideration in the design evolution and a key requirement of the mitigation hierarchy approach advocated by NPF4, Policy 5, Soils.

12.100 Deep peat (>1 m) and very deep peat (>2 m) was encountered comparatively infrequently and represented only a small proportion of the depths recorded (<12%). These areas of deep peat were generally localised to flat expanses at higher elevations in the west of the Site. The most notable occurrences of deep peat were coincident with the area of Class 1 Peat north of Loch Quie in the central west of the Site.

12.101 The majority of the Site situated on organic/mineral soil <0.4 m. Many areas are covered by the NVC communities M17: *Trichophorum cespitosum – Eriphorum vaginatum*, *Cladonia* sub-community M17b, M25: *Molinia caerulea – Potentilla erecta* mire, *Erica tetralix* sub-community M25a and M19: *Calluna vulgaris – Eriophorum vaginatum*. Most of the bog vegetation was highly modified by sheep and cattle grazing, trampling and also by artificial drainage. Further information on the occurrence of peatland habitats and the potential for these to raise matters of National Interest is discussed in Chapter 9: Ecology.

Photograph 12.9: Area of habitat containing the most continuous area of deep peat within the Site (NX 34170 72961)

Photograph 12.10: shallow drainage ditches and fugitive juvenile conifers contributing to drained / modified status of the peat (NX 33993 72901)

12.102 Technical Appendix 12.3: Peat Landslide Hazard Risk Assessment (PLHRA) provides details on the methodologies adopted and fieldwork undertaken to assess the potential for peat slides and Technical Appendix 12.2: Soil and Peat Management Plan (SPMP) outlines the approximate volumes of peat that will be excavated and reinstated, based on the survey results and the infrastructure.

Hydrogeology

12.103 The British Geological Survey GeoIndex Onshore 1:625,000 scale online mapping indicates that the Site is underlain by the following primary hydrogeological units:

- Kirkcolm Formation;
- Crawford Group and Moffat Shale Group; and
- Portpatrick Formation and Glenwhargen Formation;

12.104 These units are all identified as low productivity aquifers, which are highly indurated greywackes with limited amounts of groundwater near the surface weathered zone and secondary fractures. Aquifers underlying the Site are considered unlikely to support public water supplies, or to have the potential to do so.

12.105 The Site is underlain by the Galloway Groundwater body which is classified by SEPA, under the WFD, (ID: 150694) as having a 'Good' quantitative and qualitative status.

12.106 According to the BGS Groundwater Vulnerability guidance, the Site lies within Groundwater Vulnerability classes 5 and 4. Vulnerability class 5 indicates that the groundwater body is vulnerable to most pollutants, with rapid impact in many scenarios; while classes 4a and 4b are vulnerable to those pollutants not readily adsorbed or transformed, with 4b more likely to have low permeability (clay) soils.

12.107 Whilst there is the potential for highly localised impacts in the event of pollution, point source impacts are unlikely to affect the WFD status of the regional Groundwater body due to significant heterogenuity within the aquifer.

12.108 The site walkover corroberated the hydrogeological information presented above, identifying gleyed / saturated soils which are likely to be waterlogged on account of limited infiltration capacity of the bedrock. Where present and the soil structure allows, water may move through shallow superfical soils but will be constrained by topography. No notable springs or seepages were encountered.

Groundwater Dependent Terrestrial Ecosystems (GWDTE)

12.109 Regions of the Site have been surveyed using the National Vegetation Classification (NVC) system and an associated map was produced, see Chapter 9: Ecology. This map was reviewed for GWDTE in accordance with SEPA LUPS-GU31 guidance (2017). This was used to determine the NVC communities that indicate the potential presence of GWDTE. SEPA's LUPS-GU31 guidance requires assessment of potential GWDTE located within 250 m of excavations greater than 1 m and within 100 m of excavations less than 1 m.

12.110 NVC surveys were undertaken by EnergieKontor's Ecology team. NVC communities within the Study Area (250 m of the Proposed Development) that are indicative of potentially supporting GWDTE, are displayed in Table 12.10. Further details about these follow below:

- M6 *Carex echinate-Sphagnum fallax/denticulatum* mire is common throughout the uplands from Cornwall north to Shetland. They are the most widespread soligenous

mires in the British uplands. These mires appear in wet hollows, gullies and along streams (JNCC, 2004).

- M23 *Juncus effusus / acutiflorus-Galium palustre* rush-pasture community occur over a variety of moist, moderately acid to neutral, peaty and mineral soils in the cool and rainy lowlands of western Britain. It is a community of gently-sloping ground around the margins of soligenous flushes, as a zone around topogenous mires and wet heaths, and especially widespread in ill-drained, comparatively unimproved or reverted pasture (JNCC, 2004).
- M25 *Molinia caerulea-Potentilla erecta* mire and *Erica tetralix* sub-community M25a, is a community of moist, but well aerated, acid to neutral peats and peaty mineral soils in the wet and cool western lowlands of Britain. It occurs over gently-sloping ground, marking out seepage zones and flushed margins of sluggish streams, water-tracks and topogenous mires, but also extends onto the fringes of ombrogenous mires (JNCC, 2004).
- MG9 *Holcus lanatus – Deschampsia cespitosa* grassland, (mesotrophic grassland/rush-pasture), is generally found in saturated areas, often subject to periodic inundation).
- MG10 *Holcus lanatus-Juncus effusus* rush-pasture is a vegetation type of damp acid to neutral soils on level to gently sloping ground in enclosed pastures, and in neglected situations such as ditches, pond sides and roadside verges. This community is widespread in lowland Britain, and it also occurs at low altitudes in most upland areas (JNCC, 2004).

Table 12.10 NVC communities and potential groundwater dependency (within the Study Area)

NVC Community	Potential Level of GW Dependency
M6: *Carex echinate – Sphagnum fallax/denticulatum* mire.	High
M23: *Juncus effusus/acutiflorus – Galium palustre* rush-pasture.	High
M25: *Molinia caerulea – Potentilla erecta* mire and *Erica tetralix* sub-community M25a.	Moderate
MG9: *Holcus lanatus – Deschampsia cespitosa* grassland.	Moderate
MG10: *Holcus lanatus – Juncus* effusus rush-pasture.	Moderate

12.111 The majority of these communities, where present, are often associated with surface water moving from the surrounding hills downslope to eventually form or join surface water channels. The hydrogeology within the Site indicates that the aquifers underneath the Site are highly indurated, with limited amounts of groundwater near the surface, very low primary permeability and consequentially low infiltration capacity. As a result, surface water and hill runoff are likely to be the dominant soil water factors and the groundwater dependency of these habitats is considered Low. Further details are included in Figure 12.4: GWDTE.

12.112 The majority of the potential GWDTE habitats identified are considered to be ombrotrophic / surface water fed. Using a precautionary approach, GWDTE receptors will be assessed

as Medium sensitivity receptors, although they are unlikely to be critically dependent on groundwater.

Modifying Influences & Climate Change

12.113 Information regarding climate change was obtained from the UK Climate Projections (UKCP18) website (Met Office, 2020). The UKCP18 is a climate analysis tool which features comprehensive projections for different regions of the UK. General climate change trends projected over UK land for the 21st century show an increased chance of warmer, wetter winters and hotter, drier summers along with an increase in the frequency and intensity of weather extremes. This is seen in the Probabilistic (25 km), Global (60 km), Regional (12 km) and Local (2.2 km) projections.

12.114 Warmer and wetter winters suggest less snow and more rain. This will create increased risk for flood events, and issues with water quality as less precipitation will be held in its frozen state during the winter season. If climate predictions are correct, summer months will become drier. This will create pressure on the needs of water abstractions and on sensitive ecosystems that rely on aquatic habitats. Evidence also suggests that although the summer months will have an average decrease in rainfall, summer storms will be more frequent and intense. This may lead to more extreme flow values during and immediately following such events, with consequential flooding and water quality issues. This is of key importance for the hydrological environment during summer construction periods.

12.115 It is suggested that increased temperatures in the summer could also increase evapotranspiration and potentially cause desiccation of peat (Scottish Government, 2008). The desiccation could result in the peat being more susceptible to erosion due to increased intensity in summer storms and increased rainfall during the winter months. As peat and peat dominant soils are composed of vegetation remains, they contain a high proportion of carbon compared to other soils. This should be considered when working around the areas where peat is recorded.

Future Baseline

12.116 Without the Proposed Development, the main change to the future baseline would be as a result of climate change. Climate change studies predict a decrease in summer precipitation and an increase in winter precipitation alongside slightly higher annual average temperatures. This suggests that there may be greater pressures on PWS in the summer months in the future. Storms are predicted to be of greater intensity, therefore, peak fluvial flows associated with extreme storm events may also increase in volume and velocity.

12.117 The widespread occurrence of artificial ditches and the reduced permeability of the degraded bog habitats mean that potential increases in rainfall as depicted in Modifying Influences (as a result of climate change), could continue to increase soil erosion and place additional stresses upon nearby water resources.

Issues Scoped Out

12.118 Designated Sites (Wood of Cree SSSI and Galloway Oakwoods SAC) are not hydrologically connected to the Proposed Development.

12.119 The River Bladnoch SAC is hydrologically connected to the Site on account of one of its tributaries, the Glassoch Burn, rising at Glenvernoch Fell, situated in the north west of the proposed development boundary. Figure 12.1 Hydrology Overview illustrates the primary watersheds draining the proposed development, and location of proposed development infrastructure in relation to these. Figure 12.1 Hydrology Overview demonstrates that none of the proposed development infrastructure will be situated within the Glassoch Burn and therefore, there is no plausible means of impacts. On account of this hydrological discontinuity between the proposed development infrastructure and the Glassoch Burn, there is no consequential connectivity with the River Bladnoch SAC. All Designated Sites have been scoped out and will not be considered further in this section of the EIA.

12.120 Technical Appendix 12.4: Private Water Supply Risk Assessment identified twenty seven private water supplies situated within 3 km of the proposed development boundary. Following a screening assessment of the information obtained from D&GC, questionnaire information returned by PWS users, and a site-specific conceptual site model (CSM), twenty five properties were deemed as not plausibly connected to the proposed development and therefore not at risk of impact. These properties have been scoped out of further assessment within the EIA.

12.121 Due to intervening distance and topography with the Proposed Development precluding the possibility of any adverse effects, the SEPA abstraction (CAR/R/1013843) is scoped out of requiring further assessment in this section of the EIA.

12.122 It is acknowledged that there are no surface water DWPAs within the Study Area; however, the Proposed Development is located within a DWPA for groundwater. With the assumption that design mitigation and CEMP are implemented, and on account that the majority of Scotland is classified as a DWPA for groundwater and that groundwater is already being considered as part of this assessment, significant effects to the groundwater DWPA, specifically, are not anticipated and have therefore been scoped out.

12.123 Geology is typical of wider area with no designated sites of geological interest located within the proposed development or in a location downstream that could be impacted by the proposed development, and therefore is scoped out.

Receptor Sensitivity

12.124 On the basis of the baseline surveys and available information, Table 12.11 below presents the sensitivity of the identified receptors based on the criteria outlined earlier in Table 9.4.

Table 12.11 Receptor Sensitivity

Receptor	Sensitivity	Comment
Surface water quality		
Surface Water	High	None of the on-site watercourses are designated under RBMP, however, receiving watercourses downstream are classified as having Good and Moderate status. The River Cree and Water of Minnoch are designated under RBMP. From the on-site watercourses, the Castle Stewart Burn (tributary of River Cree) and the unnamed tributaries of River Cree drain into River Cree. The watercourses draining the proposed development also support water quality in downstream fisheries.
Fisheries and recreation		
River Cree	Medium	The River Cree represents a regionally important fish supporting watercourse.
Flooding		
Flooding	Medium	There is no areas of fluvial flood risk within the Site and sensitivity is considered low. Within the wider Study Area, the fluvial flood envelope associated with the River Cree is primarily agricultural land and would also be considered of low sensitivity. However, Newton Stewart is situated just outside the Study Area and has a history of flooding, and is identified by SEPA as a PVA. To accommodate for this and in line with the precautionary principle, flood sensitivity is considered to be Medium. Risks associated with all other types of flooding (surface water, groundwater, etc) are low.
Groundwater		
Ordovician sedimentary aquifers (RBMP Galloway)	Low	The Proposed Development is located within the Galloway groundwater body which is classified by SEPA, under the WFD as having a 'Good' quantitative and qualitative status. However, on account of the aquifers low productivity, and likely limited vertical and lateral extent, groundwater is considered to be of Low sensitivity. The potential importance of groundwater to surface water baseflow or private water supplies is recognised in both of these receptors being afforded high sensitivity.
Water Resources		
PWS	High	Private Water Supplies are of low regional importance, but high in a local context from the perspective of the PWS User. Two PWS (Knockville [ID 26] and Clachaneasy [ID 27] have been identified as plausibly connected to the Proposed Development and subject to a risk assessment presented in Technical Appendix 12.4.
Soils and Peat		
Peat is present and is >1.0 m in depth	High	12 % of total survey peat probes were on land with peat >1m deep.
Peat is present and is >0.4, but only rarely >1m in depth	Medium	16 % of total survey peat probes were on land with peat between >0.4m and 1.0 m deep.

Receptor	Sensitivity	Comment
Peat is rarely present and is typically <0.4 m	Low	72 % of total survey peat probes were on land with no peat or where organic/mineral soil was <0.4 m deep.
Geology		
Geology	Low	Geology is typical of wider area with no designated sites of geological interest located within the proposed development or in a location downstream that could be impacted by the proposed development.
GWDTE		
GWDTE	Medium	Available information does not suggest a strong groundwater component associated with identified possible GWDTE within the site. Notwithstanding, localised hydrogeological conditions may partially nourish some of the identified habitats in combination with surface waters. Whilst not of national or regional importance, such habitats are still protected under the WFD.

Potential Effects

12.125 The assessment of effects is based on the project description as outlined in Chapter 3: Project Description and Construction Methods. Unless otherwise stated, potential effects identified are considered to be negative and adverse. The assessments are based on the criteria for sensitivity, magnitude, probability and significance provided in the Significance Criteria section of this chapter, including Tables 12.4 to 12.6.

12.126 The assessment assumes the integral measures described the Good Practice Mitigation section below have been incorporated into the scheme design. These measures along with those presented within the other chapters would be used to inform a site-specific Construction Environmental Management Plan (CEMP) that would be prepared post-consent, prior to construction.

12.127 Additional mitigation is considered as additional measures beyond the design principles and good practice. The application of such measures is separately noted and residual effects evaluated.

Embedded Mitigation

12.128 Detailed constraints advice was provided during the iterative layout design process for the wind turbines and associated infrastructure. At various stages during the determination of the design, fieldwork was undertaken to provide feedback to the design team. This approach identified Site constraints in order to minimise a number of potential effects (such as minimising development infrastructure close to or crossing water features and undertaking initial peat depth and stability studies to avoid deeper peat areas). Due to the iterative design process using peat depth constraints as a key component for new infrastructure locations, the deeper peat locations where more sensitive amorphous catotelmic material is predicted were avoided, where practicable. These are discussed

further in Technical Appendix 12.2: Soil and Peat Management Plan (SPMP) and Chapter 3: Project Description and Construction Methods.

12.129 As part of the Applicant's commitment to promote opportunities for beneficial effects, the EIA is accompanied by Technical Appendix 9.4 Biodiversity and Restoration Enhancement Plan (BREP) that includes measures associated with biodiversity net gain. As well as measures to restore degraded peatland through upland drain blocking (among other measures), the prescriptions include the integration of natural flood management (NFM) measures across the Site, that would be apprised and integrated post-consent. NFM proposals would seek to improve the hydrological regime by attenuating peak flows, potentially providing a benefit to downstream flood risk.

12.130 During the detailed design and construction phases, turbines and hardstandings could be microsited to avoid deeper peat. Sections of track would be surveyed and microsited, within 100m, to optimise the distances from the waterbodies (Table 12.11) and peat, taking into account local topography and local characteristics. Further details of where and why micrositing will be beneficial throughout the Site are provided in Technical Appendix 12.2: Soil and Peat Management Plan (SPMP)and Technical Appendix 12.3: Peat Landslide Hazard Risk Assessment (PLHRA).

12.131 As part of the layout design strategy, watercourse crossings were minimised. Where access necessitates watercourse crossings, construction features have been limited in these buffers as far as possible, for example, minimising access tracks running parallel to watercourses and trying to avoid track junctions being constructed in these zones. A total of ten watercourse crossings have been identified. These watercourse crossings are discussed further in Technical Appendix 12.1 Schedule of Watercourse Crossings, including local channel characteristics and suitability for migratory fish, shown in Figure 12.1 Hydrology Overview.

12.132 Hydromorphological processes such as erosion and deposition have been identified and presented in Technical Appendix 12.1 Schedule of Watercourse Crossings, with recommendations made to minimise adverse effects relating to construction of crossing structures.

12.133 All engineering activities associated with water crossings are subject to CAR, and subject to SEPA approval. Post-consent, detailed design information would be provided by the Principal Contractor to support this process.

12.134 A number of additional, smaller watercourse crossings have also been identified during fieldwork, these watercourses are not mapped on OS 1:50,000 scale mapping and comprise crossings of flush zones and small headwater channels. These crossings would have structures installed appropriate to local conditions and would be anticipated to be designed as over-sized circular culverts or layers of pipes for flush zones.

Good Practice Mitigation

12.135 A contractual management requirement of the successful Principal Contractor would be the development and implementation of a comprehensive and site-specific Construction

Environmental Management Plan (CEMP). This document would detail how the successful Principal Contractor would manage the works in accordance with all commitments and mitigation detailed in the EIA, statutory consents and authorisations, and industry best practise and guidance such as CIRIA, Pollution Prevention Guidance (PPG) and Guidance for Pollution Prevention (GPP).

12.136 It is expected that the following will be included within the CEMP and would ensure the works are undertaken in accordance with good practice guidance;

- During construction there would be heavy plant and machinery required and as a result it is appropriate to adopt best working practices and measures to protect the water environment, including those set out in Pollution Prevention Guidance (PPG1);
- In accordance with PPG2 any above ground on-site fuel and chemical storage would be bunded;
- Emergency spill response kits would be maintained during the construction works (GPP21);
- A vehicle management system would be put in place wherever possible to reduce the potential conflicts between vehicles and thereby reduce the risk of collision (GPP21);
- A speed limit would be used to reduce the likelihood and significance of any collisions;
- Plant nappies would be placed under stationary vehicles which could potentially leak fuel / oils;
- Any water contaminated with silt or chemicals would not be discharged directly or indirectly to a watercourse without prior treatment; and
- Water for temporary site welfare facilities would either be brought to site or a local surface water or groundwater abstraction would be identified. Any water abstraction would be made in accordance General Binding Rules or an authorisation would be obtained from SEPA in accordance with the Controlled Activity Regulations (CAR); and
- Foul water would either be collected in a tank and collected for offsite disposal at an appropriately licensed facility or discharged to a septic tank or soakaway in accordance with the CAR.

12.137 The CEMP would include a Pollution Prevention Plan (PPP) and provide details of the proposed surface water drainage management arrangements for the proposed development to avoid and minimise impacts on soils, peat, geology, groundwater, surface water and PWS. The key components of the PPP are as follows;

- **Surface Water Drainage Management**: A sustainable drainage system (SuDS) will be designed and implemented to minimise, where possible, any change to the hydrology and groundwater conditions within the site. The SuDS will utilise a series of surface water drainage management techniques that will mitigate any adverse impact on the hydrology of the site.

- **Water Quality Treatment**: A surface water treatment system will be implemented for the treatment of surface water run-off from the site during the construction phase prior to flows entering receiving watercourses. All temporary and permanent SuDS from the site will have a minimum three stages of treatment. A single stage of treatment is considered as any of the following;
  - Conveyance through a swale.
  - Filtration of water through filter media (e.g. check dam).
  - Detention in settlement ponds / behind dam in overland breakout.
  - Filtration / settlement across vegetated ground
- Clean water (groundwater, natural overland flows, watercourses, etc.) and dirty water (from access tracks, hardstands and cut slopes) will be as far as practicably possible kept separate. Reducing the volume of water entering the surface water treatment system will significantly improve the performance of the treatment. Where appropriate, a cut off ditch will be installed to ensure that surface water run-off can be directed around areas of work and consequently reduce volumes of silt laden construction run-off.
- Potential causes of pollution will be managed at their source. Areas stripped of vegetation will be kept to a minimum. Stripped vegetation will be reinstated on slopes as soon as possible after removal. Where necessary, biodegradable matting will be utilised on cut slopes to prevent washing of fines into the surface water treatment system.
- Good quality stone will be used in access track and hardstand construction. Construction material will be specified in accordance with the Specification for Highway Works (SHW). SHW compliant material does not permit the use of large quantities of fine material and therefore all material imported to site will not be heavily laden with silt / fines. Regular inspections and testing of material will ensure the construction material is compliant with the SHW.
- **Source Control**; Potential causes of pollution will be controlled at source. Flows from excavations and hardstand areas will discharge into swales. Check dams will be installed in the swales at regular intervals to provide a level of attenuation, reduce water velocity, and promote settlement of suspended solids and silt.
- **Buffer Zones**;
  - Wind turbine centres are located a minimum of 50m from watercourses. A 10m buffer zone will be employed for all main watercourses in accordance with GPP5: Works or maintenance in or near water (2017). Where this is impossible at watercourse crossing locations, works will be in accordance with the relevant guidance outlined in paragraphs 12.126 to 12.129.
  - Washing out of concrete mixer lorries will be strictly controlled and limited to a designated wash area a minimum of 50m away from any watercourse. Where a` potential risk is identified of an accidental concrete spillage into a watercourse, cut off ditches and diversion dams will be installed to channel potential spillages and run-off water to a suitable collection area. In accordance with GPP5: Works or maintenance in or near water (2017), contaminated water shall not be pumped or

allowed to flow into the water environment without treatment. Collected effluent shall be pumped out and disposed of off-site in compliance with the Waste Management Licensing (Scotland) Regulations 2011. Residual solidified concrete within the containment area would be broken up and disposed of off-site in accordance with the pertinent regulations, prior to reinstatement of the area.

  - Any dewatering from excavations will be via surface silt traps, check dams, and temporary settlement ponds to reduce potential silt entering receiving watercourses. No dewatering or outflows will be permitted within the 10m buffer zones.

- All surface water drainage management measures being implemented will be checked regularly and action taken to ensure functionality. Any sign of silt laden water entering a watercourse will be reported immediately to the Principal Contractor, the source of the silt identified and further remedial measures undertaken.
- **Flow control measures**;
  - Attenuated flows will be discharged over existing vegetation prior to discharging into receiving watercourses, as per the existing drainage regime for the site. Rate and volume of run-off will be attenuated using settlement ponds receiving flows from newly constructed hardstand areas.
  - Attenuation features will also reduce flow velocities and allow settlement of fines prior to discharge. Flow rates will also be reduced through the integration of swales and check dams.
  - Access tracks and hardstand areas are to be constructed from unbound aggregate and are therefore not fully impermeable, thus helping to reduce run-off rates.
  - Cross drains, where required, will be provided with associated sumps and check dams. The cross drains will provide a means for flows to pass from a swale on the uphill side of the access track to the downhill side of the access track and would help maintain existing flow patterns. In cases where the access tracks run significantly downhill, grips will be constructed in the surface of the access tracks to divert any run-off flowing down the access track into the swale. Excavated access tracks will incorporate swales with check dams to overland breakouts over vegetation.
  - If used, floating access tracks will follow the principles of minimum disturbance of the vegetated layer. Stone / geotextile will be laid directly onto existing vegetation. No swales will be constructed alongside floating access track, water will run-off directly off the access track onto existing vegetation. Flow balancing pipes, in the form of perforated pipes will be provided at existing flush locations and at regular intervals along the sections of floating access track.
  - Existing overland flow routes and channels will be maintained and buried cable trenches would also be designed in a way to avoid modifying shallow flow patterns.

- **Private Water Supplies** will be safeguarded through the implementation of good practice with regards to pollution prevention as well as erosion and sedimentation. Whilst adverse impacts are not anticipated, a Private Water Supply Monitoring and Method Statement (PWSM&MS) will be prepared post consent to support the CEMP. The PWSM&MS will contain emergency response and contingency arrangements associated with temporary water supplies.

12.138 The adoption of the CEMP would reduce the probability of an incident occurring and also reduce the magnitude of any incident due to a combination of good site environmental management procedures, including minimised storage of soil, soil management, staff training, contingency equipment, and emergency plans.

12.139 The implementation of the CEMP would be managed on site by a suitably qualified and experienced Environmental Clerk of Works (ECoW), with support from other environmental professionals as required. The ECoW would have authority to stop any works that are or have potential to impair soils, geology, or the water environment. Additional surface water quality and groundwater monitoring strategies for the pre-construction, construction and post-construction phases should also be established.

12.140 It is anticipated that the Proposed Development would be subject to a construction site licence under CAR and, as such, the detailed design of proposed drainage works would be subject to licensing requirements and compliance with regulations. Specific requirements would be agreed in consultation with principal contractor and SEPA and set out in the Construction Site License application.

Construction Phase

12.141 The potential for effects on the hydrology, geology and hydrogeology environment is greatest during the construction phase due to the high levels of activity on-site and when there is greatest change to the existing environment. The potential effects associated with the construction of the Proposed Development is discussed and assessed in the following sections.

12.142 The evaluation of construction effects is provided in this Section. The assessment results assume the successful implementation of the embedded and good practice mitigation measures previously outlined.

Pollution Incidents

12.143 During the construction phase a number of potential pollutants would be present on site to facilitate civil engineering activities, including oil, fuels, chemicals, unset cement and concrete, and waste and wastewater from construction activities. With chemicals and oil being stored and used onsite, along with concrete batching, there is the potential for an incident. Any pollution incident occurring on the Site could have a detrimental effect on the water quality of the nearby surface waters, groundwater and/or soil, thereby also indirectly affecting ecology.

12.144 Requirements for soil excavation, transport and storage may lead to additional sedimentation issues at locations where new track, crane hardstandings or foundation construction activities are necessary.

12.145 The adoption of the applicable good practice measures would reduce the probability of an incident occurring and also reduce the magnitude of any incident due to a combination of good Site environmental management procedures, including minimised storage volumes, staff training, contingency equipment and emergency plans. Key measures identified to reduce potential for pollution include:

- Application of a 50m buffer zone from mapped OS 1:10,000 and OS 1:50,000 scale watercourses, except where a watercourse crossing is required;
- Secure oil and chemical storage in over-ground bunded areas, limited to the minimum volume required to serve immediate needs with specified delivery and refuelling areas;
- Emergency spill kits retained onsite with regular briefings and training for site operatives on emergency response arrangements;
- Special measures at concrete batching plants with pre-cast structures used where appropriate;
- Cessation of work and development of measures to contain and/or remove pollutant should an incident be identified; and
- A surface water quality monitoring programme is recommended, to commence 12 months prior to construction and continue into the early operational period. During construction, this would include an adaptive monitoring system enabling early investigation of parameters outwith expected ranges, with prompt alerts to the construction team to amend any work activities causing an adverse effect.

12.146 In addition, the substantial dilution factor when comparing Site watercourse flows with downstream flow characteristics, taking account of enlarged catchment areas and confluences, would be expected to further reduce any potential effect downstream. This would be particularly notable for the large hydrological systems of River Cree.

12.147 This site will require a Construction Site Licence, this pre-construction application process will involve descriptions of pollution control methods and specific detailed design features to gain SEPA approval.

12.148 Taking into account the design and embedded mitigation, the effects are assessed as follows:

- The magnitude of pollution effect on site watercourses (listed in Technical Appendix 12.1 Schedule of Watercourse Crossings (High sensitivity) is considered Moderate and of Low probability to occur, giving an overall significance of **Minor** (not significant) Adverse effect;

- The magnitude of pollution effect on groundwater (Low sensitivity) is considered Minor and of Moderate probability to occur, giving an overall significance of **Minor** (not significant) Adverse effect;
- The magnitude of the impact of pollution on fisheries (River Cree) (Medium sensitivity) is considered Moderate and of Low probability to occur, giving an overall significance of **Minor** adverse effect (not significant);
- The magnitude of the impact of pollution on Clachaneasy and Knockville PWS (High Sensitivity) is considered Negligible and of Low Probability to occur, giving an overall significance of **Negligible** adverse effect (not significant); and
- The magnitude of the impact of a pollution incident on GWDTE (Medium sensitivity) is considered to be Minor and of Low probability to occur, resulting in a **Negligible Adverse** effect (not significant).

Disturbance, Loss and Compaction of Soils and Peat

12.149 In its regulatory position statement, SEPA (2010) states that "developments on peat should seek to minimise peat excavation and disturbance to prevent the unnecessary production of waste soils and peat". The key items of infrastructure which influence this effect are the dimensions, location and type of new access tracks, turbine foundations and crane hardstandings. Other features which would also be considered for excavation requirements include the substation and construction compound.

12.150 Modifications made during the layout design process has led to an avoidance of areas where deeper peat has been identified. Technical Appendix 12.2: Soil and Peat Management Plan (SPMP) evaluates the likely volumes of soil and peat excavated during construction and opportunities for reuse of this material. It also identifies measures for the management of peat throughout the construction process. It is recognised that the initial priority is to reduce the volume of peat excavated, followed by appropriate reuse of any peat and soil excavated, as per the principle of the 'mitigation and waste hierarchy'. The extensive dataset of peat depth data collected for the peat stability study has been used to inform this assessment.

12.151 Three sub-categories of peat have been distinguished, with estimated quantities for topsoil and acrotelmic peat, fibrous catotelmic and amorphous catotelmic peat at defined threshold depths, with a total anticipated peat excavation volume of 57,300 m^3. Due to the iterative design process using peat depth constraints as a key component for new infrastructure locations, the deeper peat locations where more sensitive amorphous catotelmic material is predicted have been avoided, where practicable. A precautionary threshold depth of 1.00m has been applied for this material, based on Site peat core data, with an anticipated excavation volume of 500 m^3. The infrastructure likely to lead to excavation of amorphous catotelmic peat, at a threshold depth of 1.00m or greater, are generally related to the ancillary infrastructure around turbine locations such as the blade laydown areas, crane hardstandings, turning heads and crane boom assembly areas, as well as specific access track sections. Peat habitats M17b and M19 within the Site are considered to be of high sensitivity. Loss and degradation of peat can result in the release

of carbon dioxide and result in habitat loss; for which opportunities to avoid or reduce excavation have been noted within Technical Appendix 12.2: SPMP.

12.152 Compaction may also damage the vegetation and result in a reduction in soil permeability and rainfall infiltration, particularly on peat, thereby increasing the potential for longer-term erosion from surface water runoff. This would be most likely caused by tracking of heavy plant machinery.

12.153 Stockpiled and unvegetated/exposed areas of soils are also at risk of desiccation and wind and water erosion, also potentially causing soil loss.

12.154 The removal of peat and dewatering of excavations may also result in a drawdown of the water table in adjacent areas, results in localised drying and increased risk of erosion and soil loss.

12.155 The design principles and adoption of the applicable good practice measures summarised in Technical Appendix 12.2: SPMP would reduce the soil losses, compaction of soil and dewatering effects, with the combination of planning infrastructure on very shallow soils, minimising excavation, promoting local reuse of suitable material, identifying catotelmic/amorphous peat in-situ and the majority of vehicle movements being restricted to new access tracks or clearly demarcated construction areas. This combination of measures resulting in any notable effect being very localised and temporary in nature. Site monitoring would identify any areas where soil effects are noted and enable a fast response to minimise effect. Key measures identified to minimise loss and compaction of soils and peat include:

- Reducing excavation depth and footprint required for Site infrastructure by site investigation and consequential design evolution;
- Limiting storage of soil and peat to a maximum height of <2m;
- Appropriate re-use of excavated material for reinstatement and profiling of track verges on disturbed ground; and
- Limiting movements to specific corridors avoiding sensitive receptors such as deep peat and priority peatland habitat.

12.156 With peat excavation and reuse opportunities refined, based on pragmatic good practice measures, approximately 56,770 m^3 of peat could be re-used as part of the sites reinstatement. Although not included in this total. further volumes should also be targeted for retainment in infrastructure adjoining basins and hollows which is another proven method of on-site successful peat re-use. Further details are presented in Technical Appendix 12.2: SPMP.

12.157 Taking into account the design and embedded mitigation resulting in an excess of material excavated, the effect of loss and compaction of soils is assessed as follows:

- The magnitude of effect of compaction and loss of peat and peatland <0.4 m thickness (Low sensitivity) is considered to be Moderate and of High probability to occur, giving an overall significance of **Minor** Adverse effect;

- The magnitude of effect of compaction and loss of peat and peatland 0.4 m to 1.0 m thickness (Medium sensitivity) is considered to be Moderate and of Medium probability to occur, giving an overall significance of **Minor** Adverse effect.
- The magnitude of effect of compaction and loss of peat and peatland >1 m thickness (High sensitivity) is considered to be Moderate and of Low probability to occur, giving an overall significance of **Minor** Adverse effect.

Peat Stability

12.158 Peat slides are a natural occurrence that can occur without human interference, but issues such as removal of slope support or increased loading upon slopes can either increase the likelihood of an event occurring or can increase the scale of any failure that does occur.

12.159 Peat slides affect soil (and associated habitats) and potentially downstream surface water systems where soil inundation can lead to sedimentation reducing water quality and modification to drainage patterns. The various receptors of a peat stability failure have been separated for this evaluation.

12.160 The inherent design principles and adoption of the applicable good practice measures summarised in the Outline CEMP would reduce the effect of peat instability. Key measures identified to minimise peat stability risk include the following, with further details provided in Technical Appendix 12.3: Peat Landslide Hazard Risk Assessment (PLHRA):

- Avoidance of removal of slope support;
- Avoidance of heavy loading on slopes;
- Good drainage practice to ensure flows not concentrated onto slopes or into excavations;
- Restricting earthmoving activities during and immediately after intense and prolonged rainfall events; and
- Creating and managing of geotechnical risk register or similar management system throughout the detailed design and construction phases.

12.161 Taking into account the design and embedded mitigation, the effect on peat stability is assessed as follows:

- The magnitude of effect of a peat stability failure on soil loss (High sensitivity) is considered Minor and of Low probability to occur, giving an overall significance of **Minor** Adverse effect (not significant).
- The magnitude of effect of a peat stability failure on surface water sedimentation (High sensitivity) is considered Moderate and of Low probability to occur, giving an overall significance of **Minor** Adverse effect (not significant).
- The magnitude of effect of a peat stability failure on surface water drainage patterns (High sensitivity) is considered to be Moderate and of Low probability to occur, giving an overall significance of **Minor** Adverse effect (not significant).

12.162 Although there is no significant effect identified, specific mitigation measures have been provided in Technical Appendix 12.3: PLHRA in order to ensure stability concerns in relation

to potential magnitude and watercourse receptors within localised areas of elevated concern are adequately managed.

Erosion and Sedimentation

12.163 Soil erosion, loss of soil and sediment generation may occur in areas where the ground has been disturbed during construction, including in situations where: engineering activities occur close to watercourses, such as at watercourse crossings; where higher velocity surface water flows may occur due to local slopes and drainage design; and where forestry felling is occurring. Surface water passing through the drainage network, efficiently draining the new infrastructure, could exhibit high localised flows, increasing the potential for bank erosion.

12.164 Sediment transport in watercourses can result in high turbidity levels which affect the ecology, particularly fish stocks, by reducing the light and oxygen levels in the water. Sediment deposition can further affect watercourses by potentially smothering plant life, invertebrates and spawning grounds and can reduce the flood storage capacity of channels and block culverts, resulting in an increased flood risk. Whilst there are no areas of substantial forestry within the Site, it is recognised that extensive felling of forestry can lead to long-term increases in run-off from previously afforested slopes and shorter term increases in sediment loading. There is also potential for acidification and nutrient loading as a result of deforestation and post-felling forestry waste management.

12.165 Requirements for soil excavation, transport and storage may lead to additional sedimentation issues at locations where new track, widened existing track, crane hardstandings or foundation construction activities are necessary.

12.166 The adoption of the applicable good practice measures would reduce the probability of an incident occurring and also reduce the magnitude of any incident due to a combination of good site environmental management procedures, including additional precautions when operating machinery close to watercourses, soil management, staff training, contingency equipment and emergency plans.

12.167 Key measures identified to reduce erosion and sedimentation include:

- Vegetation clearance would be scheduled only as needed, buffer strips would be retained as vegetated features and revegetation encouraged with native species;
- Silt traps would be employed and maintained in appropriate locations;
- Temporary interception bunds and drainage ditches would be constructed upslope of excavations such as turbine foundations to minimise surface runoff ingress and in advance of excavation activities;
- Excavation and earthworks would be suspended during and immediately following periods of heavy rainfall in order to minimise sediment generation and soil damage; and
- A surface water quality monitoring programme is recommended, to commence 12 months prior to construction and continue into early operational period. During

construction, this would include an adaptive monitoring system enabling early investigation of parameters outwith expected ranges, with prompt alerts to the construction team to amend any work activities causing an adverse effect.

12.168 In the case of pollution incident effects, good practice site environmental management measures and the dilution factor involved would be expected to reduce any potential sedimentation effect downstream.

12.169 Taking into account the design and embedded mitigation, the effects are assessed as follows:

- The magnitude of sedimentation effect on surface water (Listed in Table 12.11 and Technical Appendix 12.1 Schedule of Watercourse Crossings) (High sensitivity) is considered to be Minor and of Medium probability to occur, giving an overall significance of **Minor** Adverse effect (not significant);
- The magnitude of sedimentation effect on groundwater (Galloway Groundwater) (Low sensitivity) is Minor and the probability is considered to be Low, which results in an overall **Negligible** Adverse effect (not significant);
- The magnitude of sedimentation effects on Clachaneasy and Knockville PWS (High Sensitivity) is considered Negligible and of Low Probability to occur, giving an overall significance of **Negligible** adverse effect (not significant); and
- The magnitude of sedimentation effect on fisheries (River Cree) (Medium sensitivity) is considered Minor and of Low probability to occur, giving an overall significance of **Negligible** Adverse effect (not significant).

Modification of Surface Water Drainage Patterns

12.170 Surface flows could be impeded by construction activity in or adjacent to stream channels, poor choice of watercourse crossing locations or inadequately designed crossing structures. Blockages could be caused by inadequate control of earthmoving plant, sedimentation and poor waste management, all of which could lead to flooding upstream.

12.171 Turbine bases and other constructed impermeable surfaces would restrict the infiltration of rainfall into the soil and underlying superficial deposits, resulting in localised increased volumes of surface runoff. The interception of diffuse overland flow by new access tracks and their drains could disrupt the natural drainage regime of the Site by concentrating flows and influencing drainage in soils.

12.172 The track design includes an upgrade to five existing crossing structures, for watercourses that are subject to CAR regulation (as shown on OS 1:50,000 mapping). Table 12.11 summarises these watercourse crossings, with further details in Technical Appendix 12.1: Schedule of Watercourse Crossings.

12.173 There would be a requirement for minor watercourse crossings (i.e. representing minor watercourses not shown on OS 1:50,000 mapping), typical crossing locations and

suggested structures are also provided in Technical Appendix 12.1: Schedule of Watercourse Crossings.

12.174 The adoption of the applicable good practice measures would reduce the impact of modification to surface water drainage patterns, with artificial drainage installed only where necessary and would, wherever practical, be installed in advance of ground being cleared of vegetation. All structures would be designed and constructed following good practice techniques and would be of sufficient capacity to receive storm flows with an allowance for increased flows due to climate change.

12.175 Key measures identified to minimise alterations to surface water drainage patterns include:

- Minimising the number of watercourse crossings through site layout and design;
- Application of sustainable drainage techniques to increase peak lag time and implementation of cross-drains at appropriate intervals and frequent discharge points to reduce scour potential;
- Minimising the size and duration of in-channel works; and
- Appropriate design of crossing structures to ensure sufficient capacity to convey 1:200-year storm flows and enable mammal and fish passage.

12.176 The area of impermeable surface created would be very small in comparison with sub-catchment areas, as only the turbine, hardstandings and control building bases would be designed as impermeable, with the unbound tracks likely to act as semi-permeable features with limited infiltration potential.

12.177 As outlined in Technical Appendix 9.4 BREP, prescriptions associated with appraising and implementing natural flood management measures have the potential provide a beneficial effect associated with improving the hydrological regime of the site as well as flood risk.

12.178 Taking into account the design and embedded mitigation, the effect is assessed as follows:

- The magnitude of impact on surface water drainage patterns (watercourses which are listed in Table 12.11 and Technical Appendix 12.1: Schedule of Watercourse Crossings) (High sensitivity) is considered Minor and of Medium probability to occur, giving an overall significance of **Minor** Adverse effect (not significant);
- The magnitude of impact on flood risk receptors (Medium sensitivity) is considered Minor and of Low probability to occur, giving an overall significance of Negligible (not significant); and
- The magnitude of surface flow modification effects on Clachaneasy and Knockville PWS (High Sensitivity) is considered Negligible and of Low Probability to occur, giving an overall significance of **Negligible** adverse effect (not significant).

Modification of Groundwater Levels and Flows

12.179 Deep excavations, such as those required for the turbine foundations could disrupt shallow groundwater systems. Groundwater controls, such as physical cut-offs or dewatering, would be utilised to prevent the excavations filling with water. This would result in the lowering of groundwater levels in the immediate vicinity of the excavations and alterations to flow paths during dewatering activities. access tracks could interrupt shallow groundwater flow. There may be some infiltration of water through the access tracks, but the majority of the water would enter the surface water drainage system and would be discharged downslope of the access track at discrete points.

12.180 Cable trenches, particularly if backfilled with more permeable material than surrounding soil, can create preferential pathways for groundwater flow, resulting in local lowering of groundwater level.

12.181 Soil water conditions at the Site are likely to be primarily influenced by surface water and direct rainfall, with groundwater having minimal influence, and this influence decreasing at higher altitude.

12.182 It is possible that there would be local lowering of the water table close to track corridors, resulting in a localised corridor of altered vegetation and ecology. Turbine foundations excavations would permanently alter groundwater flows at the coincident locations, however it would be expected that natural conditions of groundwater level and flow would recur close to these locations.

12.183 The adoption of the applicable good practice measures would reduce potential for lowering effects upon groundwater systems, with the effects of dewatering likely to be very local and temporary, with groundwater expected to return to former levels quickly following cessation of construction activities. The key concerns for good groundwater management involve careful decisions involving locations of drainage and dewatering activity and ensuring such activities are undertaken sympathetically and minimised in terms of extent and time to avoid excessive influence on groundwater levels and flows. Key measures identified to minimise alterations to groundwater levels and flows include:

- Drainage systems, typically consisting of french drains (using a gravel layer as water conduit, rather than pipework, running downhill to a soakaway zone designed to enable water to percolate back into soil), would be installed at hardstanding locations where applicable;
- Dewatering activity would be limited to the minimum necessary duration; and
- Access tracks crossing GWDTE would have appropriate drainage measures applied to maintain current groundwater conditions.

12.184 Taking into account the design and embedded mitigation, the effect is assessed as follows:

- The magnitude of effect on groundwater levels and flows (Galloway Groundwater and Kirkcolm, Crawford Group and Moffat Shale Group and Portpatrick and

Glenwhargen Formations) (Low sensitivity) is considered Minor and of Low probability to occur, giving an overall significance of **Negligable** (not significant);

- The magnitude of effect on GWDTE (Medium sensitivity) is considered Minor and of Medium probability to occur, giving an overall significance of **Minor** Adverse (not significant);
- The magnitude of effect on groundwater levels and flow for Clachaneasy and Knockville PWS (High Sensitivity) is considered Negligible and of Low Probability to occur, giving an overall significance of **Negligible** adverse effect (not significant).

Operation Phase

12.185 Many of the effects identified during construction would not be expected to lead to significant effects during the operational phase, this includes effects associated with pollution as well as erosion and sedimentation. Operational phase effects on PWS are also not anticipated.

12.186 This section sets out the likely operational effects of the Proposed Development.

Modification of Surface Water Drainage Patterns

12.187 Surface water drainage patterns may be altered by a new permanent drainage system that would serve the proposed development.

12.188 However, the adoption of the applicable good practice measures would incorporate a sustainable drainage strategy that minimises disturbance of existing hydrological system to reduce adverse effect on surface water drainage patterns.

12.189 Furthermore, prescriptions associated with appraising and implementing natural flood management measures outlined in Technical Appendix 9.4 BREP have the potential to provide a beneficial effect associated with improving the hydrological regime of the site as well as flood risk.

12.190 Taking into account the design and embedded mitigation, the effect is assessed as follows:

- The magnitude of impact on surface water drainage patterns (watercourses which are listed in Table 12.11 and Technical Appendix 12.1: Schedule of Watercourse Crossings) (High sensitivity) is considered Minor and of Low probability to occur, giving an overall significance of **Negligible** Adverse effect (not significant);
- The magnitude of impact on flood risk receptors (Medium sensitivity) is considered Minor and of Low probability to occur, giving an overall significance of **Negligible** (not significant).

Modification of Groundwater Levels and Flows

12.191 Groundwater levels may be influenced by the drainage features of the Proposed Development and may also be influenced by local alterations in groundwater regime,

such as where foundations or track construction leads to changes in level or flow. Such issues are more likely to become apparent in the operation phase than during construction, where corridors of altered vegetation may occur adjacent to access tracks and other locations where the natural regime has changed.

12.192 However, the adoption of the applicable good practice measures would incorporate a sustainable drainage strategy that minimises disturbance of natural groundwater systems to reduce adverse effect on groundwater levels and flows. Good practice sustainable drainage measures would minimise any effect upon GWDTE.

12.193 Taking into account the design and embedded mitigation, the effect is assessed as follows:

- The magnitude of effect on groundwater levels and flows (Galloway Groundwater and Kirkcolm, Crawford Group and Moffat Shale Group and Portpatrick and Glenwhargen Formations) (Low sensitivity) is considered Minor and of Medium probability to occur, giving an overall significance of **Minor** Adverse (not significant).
- The magnitude of effect on GWDTE (Medium sensitivity) is considered Minor and of Medium probability to occur, giving an overall significance of **Minor** Adverse (not significant).

Residual Effects & Additional Mitigation Measures

12.194 Mitigation is considered as additional measures beyond the design principles and good practice, the application of such measures are separately noted and residual effects evaluated.

12.195 No significant adverse effects have been identified, and therefore there are no residual effects.

Cumulative Effects and Interaction of Effects

12.196 Cumulative developments which are operational are not considered to have the potential to lead to in-combination effects with the Proposed Development. This is because the potential for significant effects on hydrology, hydrogeology, geology and soils are considered greatest during construction. Therefore, developments (consented and in planning) within the same catchment as the Proposed Development and within a distance of 5 km from the Proposed Development are:

- Blair Hill Wind Farm (2 km south east of the Proposed Development)

12.197 Off-site cumulative hydrological effects are primarily related to changes in water quality and increases in flood risk. Good practice measures have been presented in the Construction and Operation Section to protect on-site hydrological receptors adequately and therefore will be suitable to ensure the protection of those situated downstream, and should not contribute to or exacerbate any effects arising from other developments, land uses or activities. It is considered that the addition of the Proposed Development (with Minor magnitude and therefore no significant residual effects) would not give rise to

significant cumulative effects when considered in combination with those developments; Even if these other developments present potentially significant effects on the receiving hydrology, hydrogeology, geology and soil environment.

12.198 Furthermore, the differing construction programming and activities that would be anticipated to occur across various developments reduce the probability that water quality and flow issues would be coincident across the catchments.

12.199 It is concluded that following the successful implementation of CEMP and the good practice measures outlined in the Construction and Operation Section, cumulative impacts of the Proposed Development during construction and during operation will be **Negligible**.

Summary

12.200 An assessment has been carried out of the likely impacts of the proposed development on the geological, hydrological, hydrogeological, geological environment. The assessment has considered site preparation, construction and operation of the proposed development.

12.201 The potential effects have considered:

- Pollution incidents;
- Erosion and sedimentation;
- Modification of surface water and groundwater flows;
- Modification of surface drainage patterns (including flood risk);
- Disturbance, compaction and loss of peat and peatlands; and
- Peat instability.

12.202 Following the identification and assessment of the key receptors, taking into account the potential effects listed above, a comprehensive suite of mitigation and good practice measures has been incorporated into the design, including extensive buffer areas. In addition, a site-specific CEMP as well as detailed design of infrastructure and associated mitigation will be implemented to protect the groundwater and surface water resources from pollution and minimise changes to the hydrological environment.

12.203 The effects are with reference to the criteria identified in Tables 12.4, 12.5 and 12.6 and the mitigation measures from the applicable sections of text above. Following the implementation of good practice measures and specific mitigation measures outlined, no significant effects are predicted for the hydrology, hydrogeology, geology and soils receptors.