13. Geology, Hydrology (including flood risk) and Hydrogeology

13.1 Introduction

13.1.1 This chapter of the EIA Report assesses the potential effects of the Proposed Development with respect to Geology, Hydrology (including flood risk) and Hydrogeology. The chapter should be read in conjunction with the development description provided in **Chapter 3 – Description of the Proposed Development** and with respect to relevant parts of **Chapter 11 – Ecology**, of the EIA Report, where common receptors have been considered and where there is an overlap or relationship between the assessment of effects.

13.2 Limitations of this assessment

13.2.1 Whilst there are some information gaps, as listed below, none significantly affect the ability to undertake this assessment of effects:

- flow monitoring and water quality surveys have not been undertaken on the Development Site;
- no monitoring data is available regarding groundwater levels across the Development Site, although the extensive coverage of peat at the higher elevations is taken to indicate the presence of shallow groundwater; and
- whilst abstractions in the area have been identified through discussion with the Scottish Environment Protection Agency ('SEPA'), East Ayrshire Council ('EAC') and Dumfries and Galloway Council ('DGC'), not all details of these abstractions are known, e.g., historic abstraction quantities or water quality. However, sufficient information has been obtained to approximate their catchment areas for consideration in respect to the Development Site. Due to the limited overlap of the abstraction catchments with the Development Site, no further information is considered necessary.

13.2.2 In summary, there are considered to be no limitations that affect the robustness of the assessment of the potential effects of the Proposed Development with respect to Geology, Hydrology (including flood risk) and Hydrogeology.

13.3 Relevant legislation, planning policy, technical guidance

Legislative context

13.3.1 The key legislative drivers relating to the Geology, Hydrology (including flood risk) and Hydrogeology that have been considered in this assessment include the following (in chronological order, oldest first):

- Control of Pollution Act 1974 (as amended);
- Agriculture Act 1986;
- Environment Protection Act 1990;

- Water Resources Act 1991;
- Environment Act 1995;
- Pollution Prevention and Control Act 1999;
- Water Environment and Water Services (Scotland) Act 2003 (WEWS), as amended by the Environment (EU Exit) (Scotland) (Amendment etc.) Regulations 2019 (Environment Regulations 2019);
- Landfill (Scotland) Regulations 2003 (as amended);
- Water Environment (Register of Protected Areas) (Scotland) Regulations 2004;
- Nature Conservation (Scotland) Act 2004;
- Private Water Supplies (Scotland) Regulations 2006;
- Environmental Liability (Scotland) Regulations 2009, as amended by the Environment (EU Exit) (Scotland) (Amendment etc.) Regulations 2019;
- Flood Risk Management (Scotland) Act 2009;
- Water Quality (Scotland) Regulations 2010;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 ('CAR') (as amended);
- Waste Management Licensing (Scotland) Regulations 2011;
- Water Environment (Drinking Water Protected Areas) (Scotland) Order 2013;
- Water Environment (River Basin Management Planning: Further Provision) (Scotland) Regulations 2013;
- Water Act 2014;
- Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017;
- Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, as amended; and
- Environment Act 2021.

13.3.2 The requirements of various EU Directives such as the Water Framework Directive ('WFD') (2000/60/EC), the European Liability Directive (2004/35/EEC) and the Groundwater Daughter Directive (2006/118/EEC) have been transposed into domestic legislation by the Environment (EU Exit) (Scotland) (Amendment etc.) Regulations 2019. Previously the WFD and now the Environment Regulations 2019 and supporting domestic legislation establish a legal framework for the protection, improvement and sustainable use of surface waters, transitional waters, coastal waters and groundwater resources.

13.3.3 The regulation of activities relating to the water environment is implemented through CAR. This covers activities including abstraction, discharges, impoundments and engineering works that could impact on a watercourse. Depending on the size and nature of the activity, General Binding Rules ('GBRs') need to be followed, the activity registered, or a full licence obtained.

Planning policy context

National policies

13.3.4 National Planning Framework 4 ('NPF4') was adopted in February 2023 and sets the long-term context for development planning in Scotland. It contains policies with relevance to this Geology, Hydrology (including flood risk) and Hydrogeology assessment, including Policies 5 (Soils – including in relation to peat) and 22 (Flood risk and water management – including in relation to sustainable drainage systems ('SuDS')), and provides support for renewable technologies such as wind farms via Policy 11 (Energy). These policies are summarised at the head of **Table 13.1** and referred to within **Chapter 5 – Planning Policy Context**, of the EIA Report.

13.3.5 National planning policy is supported by Planning Circulars, Planning Advice Notes ('PANs') and Specific Advice Sheets ('SASs'), and Ministerial / Chief Planning Letters to Planning Authorities, which set out detailed advice from the Scottish Government in relation to planning issues. The PANS and SASs considered most relevant to the Proposed Development are also summarised in **Table 13.1** (in chronological order, oldest first).

13.3.6 The following publications are also relevant to this assessment:

- The Carbon and Peatland Map 2016, published by Scottish Natural Heritage (SNH, now NatureScot) on 29 June 2016 and identifies areas considered likely to host Scotland's nationally important resource of deep peat, carbon rich soils and priority peatlands habitats; and
- In June 2016, the Scottish Government published its draft Peatland and Energy Policy Statement, which provides the basis from which the Scottish Government and its agencies will act in developing and implementing policies in relation to peatland and energy. This policy is a material consideration for new energy developments and the impact they may have on peatland habitats.

Development Plan policies

13.3.7 The statutory development plan applicable to the Development Site comprises the East Ayrshire Local Development Plan (East Ayrshire LDP, adopted April 2017) together with statutory Supplementary Planning Guidance ('SPG'), including that for Wind Energy Development (adopted December 2017) and the DGC LDP2 (adopted October 2019). In addition, the East Ayrshire Local Development Plan 2 (East Ayrshire LDP2, 2023) is currently under Examination and once adopted will supersede the LDP, and so is also considered relevant here. The East Ayrshire LDP and East Ayrshire LDP2 policies particularly relevant to water are listed in **Table 13.1**. The Wind Energy Development SPG requires such development proposals to demonstrate that they have been designed to minimise any detrimental impact on the water environment.

Table 13.1 Planning policy issues relevant to Geology, Hydrology (including flood risk) and Hydrogeology

Policy reference	Policy issue	Considered in Section
National planning policies		
NPF4 2022, Policy 5 (Soils)	Development proposals on peatland, carbon-rich soils and priority peatland habitat will only be supported for the generation of energy from renewable sources that optimises the contribution of the area to greenhouse gas emissions reductions targets. Where development is proposed on peatland, carbon-rich soils or priority peatland habitat, a detailed site-specific assessment will be required to identify the following: i. the baseline depth, habitat condition, quality and stability of carbon-rich soils; ii. the likely effects of the development on peatland, including on soil disturbance; and iii. the likely net effects of the development on climate emissions and loss of carbon. This assessment should inform careful project design and ensure, in accordance with relevant guidance and the mitigation hierarchy, that adverse impacts are first avoided and then minimised through best practice. A Peat Management Plan ('PMP') will be required to demonstrate that this approach has been followed, alongside other appropriate plans required for restoring and / or enhancing the site into a functioning peatland system capable of achieving carbon sequestration.	13.5, 13.8 and 13.10
NPF4 2022, Policy 11 (Energy)	Development proposals for all forms of renewable, low-carbon and zero emissions technologies will be supported. These include wind farms including repowering, extending, expanding and extending the life of existing wind farms. In addition, project design and mitigation will demonstrate how the impacts effects on hydrology, the water environment and flood risk are addressed.	13.8
NPF4 2022, Policy 22 (Flood risk and water management)	Development proposals will not increase the risk of surface water flooding to others, or itself be at risk. They will manage all rain and surface water through SuDS, which	13.5 and 13.8

Policy reference	Policy issue	Considered in Section
	should form part of and integrate with proposed and existing blue-green infrastructure. All proposals should presume no surface water connection to the combined sewer. Development proposals should also seek to minimise the area of impermeable surface. Furthermore, development proposals which create, expand or enhance opportunities for natural flood risk management, including blue and green infrastructure, will be supported.	
Scottish Government Controlling the Environmental Effects of Surface Mineral Workings (PAN 50), October 1996	This PAN gives good practice advice for planners and developers on the more significant environmental effects arising from mineral working operations, including borrow pits.	13.8 and 13.10
Scottish Government Planning and Sustainable Urban Drainage Systems (PAN 61), July 2001	This PAN gives good practice advice for planners and developers on the use of SuDS and complements the Sustainable Urban Drainage Systems Design Manual for Scotland and Northern Ireland.	13.8
Scottish Government, SNH, SEPA: Peatland Survey 2017: Guidance on Developments on Peat Land	This guidance defines a consistent sampling methodology to quantify and qualify the peat material on site and provides advice as to how to publish peat surveys as part of a developer's wider site investigations.	13.8 and see **Chapter 6 – Carbon Balance and Peat Management**
Development plan policies		
East Ayrshire LDP		
Policy RE3: Wind Energy Proposals Over 50 m In Height	This policy states that *development may be appropriate in some circumstances within these areas in cases where it can be demonstrated that any significant adverse effects on the environmental characteristics of these areas can be substantially overcome by siting, design or other mitigation and where the proposal is acceptable in terms of all applicable renewable energy criteria set out in Schedule 1".* Schedule 1 is the Renewable Energy Assessment Criteria and includes the *"Effects on hydrology, the water environment, flood risk and groundwater dependent terrestrial ecosystems".*	13.10
Policy ENV 11: Flood Prevention	This policy indicates that EAC will take a precautionary approach to flood risk from all sources and will promote	13.5, 13.8 and 13.10

Policy reference	Policy issue	Considered in Section
	flood avoidance in the first instance. In regard to surface water flooding, it states within The Flood Risk Framework that "*all developments should be designed to be free from surface water flooding in rainfall events where the annual probability of occurrence is greater than 0.5%. Mitigation measures should not have an adverse effect on the risk of flooding off site, taking account of rain falling on the site and run-off from adjacent areas".* In addition, development proposals should "*minimise impermeable surfaces and incorporate sustainable drainage systems, with adequate maintenance arrangements, to avoid increased surface water flooding".*	
Policy ENV12: Water, Air and Light and Noise Pollution	This policy states that there will "*be a presumption against any development that will have an adverse impact on the water environment in terms of pollution levels and the ecological value of water habitats ….. or which have the potential to, cause significant adverse impacts on water bodies as a result of morphological changes to water bodies such as engineering activities in the form of culverts or changes to the banks or bed.* *Where developments are proposed on or close to existing water bodies, design solutions should explore how best to maintain their water quality ……. and manage surface water through sustainable drainage systems (SuDS)".*	13.8 and 13.10
EAC LDP2		
Policy NE12: Water, Air and Light and Noise Pollution	This policy states that there will "*be a presumption against any development that will have an adverse impact on the water environment in terms of pollution levels and the ecological value of water habitats. Developments must not harm the biodiversity of the water environment.* *Where developments are proposed on or close to existing water bodies, design solutions should explore how best to maintain their water quality".*	13.8 and 13.10
Policy RE1: Renewable Energy	This policy states that "*Proposals for…. renewable energy…are encouraged and*	13.10

Policy reference	Policy issue	Considered in Section
	will be supported…where they are acceptable when assessed against all relevant criteria set out in the Renewable Energy Assessment Criteria". These criteria include *"Effects on hydrology, the water environment, flood risk and groundwater dependent terrestrial ecosystems".*	
Policy CG1: Flood Risk Management	This policy states that *"The Council will take a precautionary approach to flood risk from all sources and will promote flood avoidance in the first instance. Flood storage and conveying capacity will be protected and development will be directed away from functional flood plains and undeveloped areas of medium to high flood risk."*	13.5 and 13.7
DGC LDP2		
Policy NE6: Sites of National Importance for Biodiversity and Geodiversity	This policy states "*developments that affects Sites of Special Scientific Interest, (not designated as International Sites), and other national nature conservation designations will only be permitted where it will not adversely affect the integrity of the area or the qualities for which it has been designated, or any such adverse effects are clearly outweighed by social, environmental or economic benefits of national importance".*	13.5 and 13.10
Policy NE11: Supporting the Water Environment	This policy states that "*development which would result in deterioration in the status of a water body, or which would likely impede the improvements in water body status as set out in the Solway Tweed River Basin Management Plan (2015) or any update or adopted review of it will not be permitted unless there are exceptional justifying circumstances. This includes minor watercourses draining into the water bodies identified in the Solway Tweed plan*." It also states that "*development proposals should not normally include the culverting of any water body"* and "*permission could [only] be granted if the Council is satisfied that there would be acceptable mitigation measures to protect habitats, passage of fauna, and river form and flow*."	13.8 and 13.10

Policy reference	Policy issue	Considered in Section
Policy NE15: Protection and Restoration of Peat Deposits as Carbon Sinks	This policy states that "*developments proposed affecting peat deposits not already designated for habitat conservation reasons may be permitted in the following circumstances:* *(a) in areas of degraded peatland where:* • *The deposits have been significantly damaged by human activity; and* • *The conservation value is low; and* • *Restoration to functioning peatland is not possible.* *In all such cases appropriate site restoration measures to something other than functioning peat land will be required; or* • *(b) where renewable energy generating development is proposed and it can be demonstrated (in accordance with the Scottish Government's 'carbon calculator' or other equivalent independent evidence) that the balance of advantage in terms of climate change mitigation lies with the energy generation proposal."*	13.8 and 13.10
Policy IN7: Flooding and Development	This policy states that "*where a proposed development could lead to an unacceptable flood risk, it may be that a Flood Risk Assessment ('FRA') is able to clarify to the satisfaction of the Council and SEPA that the level of risk both on and off site would be acceptable. For any site a Drainage Impact Assessment ('DIA') may be required to ensure that surface water flows are properly taken into account in the development design".*	13.7 and 13.8
Policy IN8: Surface Water Drainage and SuDS	This policy states that "…*Sustainable Drainage Systems ('SuDS') will be a required part of all proposed development as a means of treating the surface water and managing flow rates and must form part of any planning permission in principle proposal…* *…details of the proposed SuDS should show how they will:* • *ensure the system is designed to avoid flood risk from exceedance flows; …*	13.8

Policy reference	Policy issue	Considered in Section
	• *be based on a unified approach to cover surface water drainage from on-site roads and from the remainder of the site; [and] …* • *contribute positively to the biodiversity, general amenity and water quality of the area of the proposal.*"	

Technical guidance

13.3.8 Relevant policy and general guidance utilised includes the following (in alphabetical order, by lead author organisation and then report number or chronological, oldest first):

- British Standards:
  - BS6031: 2009 Code of Practice for Earth Works (2009);
  - BS59302:199+A22010 Code of Practice for Site Investigations (2010);
  - BVS10175:2011 Code of Practice for Investigation of Potentially Contaminated Sites (2011).
- Construction Industry Research and Information Association (CIRIA) reports:
  - Report C532: Control of Water Pollution from Construction Sites (2001);
  - Report C624: Development and Flood Risk - Guidance for the Construction Industry (2004);
  - Report C648: Control of Water Pollution from Linear Construction Projects (2006);
  - Report C649: Control of Water Pollution from Linear Construction Projects - Site Guidance (2006);
  - Report C698: Site Handbook for the Construction of SuDS (2007);
  - Report C741: Environmental Good Practice on Site Guide, Fourth Edition (2015);
  - Report C750: Groundwater Control - Design and Practice, second edition (2016);
  - Report C753: The SuDS Manual (2015); and
  - Report C786: Culvert, Screen and Outfall Manual (2019).
- Department for Food, Environment and Rural Affairs (Defra) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009);
- Forestry Commission ('FC'), Forestry Commission Scotland ('FCS', now Forestry Land Scotland, 'FLS')[73] and co-authored reports:
  - FC Forestry Practice Guide: Whole-Tree Harvesting: A Guide to Good Practice (1997);
  - FCS and SNH Floating Roads on Peat (2010);

[73] FLS was formed on 1 April 2019, to take over some of the responsibilities of FCS.

- FC Forests and Water Guidelines, 5th Edition (2011);
- FC Forests and Soil Guidelines (2011); and
- FC The UK Forestry Standard (2017).

- Ministry of Agriculture, Forestry and Food (MAFF) Good Practice Guide for Handling Soils (2000);
- Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) A Functional Wetland Typography for Scotland (2009);
- SEPA lead author publications:
  - Regulatory Position Statement - Developments on Peat (February 2010);
  - Guidance on Developments on Peatland – Site Surveys, Scottish Government, SNH and SEPA (2017);
  - Guidance: Life Extension and Decommissioning of Onshore Wind Farms (2016);
  - Guidance WST-G-052: Development on Peat and Off-site Uses of Waste Peat (2017);
  - Planning Information Note 3: Flood Risk Advice for Planning Authorities (August 2017);
  - Technical Flood Risk Guidance for Stakeholders (June 2022);
  - Flood Risk Standing Advice for Planning Authorities and Developers (November 2020);
  - CAR: A Practical Guide (2022); and
  - CAR Flood Risk Standing Advice for Engineering, Discharge and Impoundment Activities (undated).
- SEPA Land Use Planning System Guidance Notes (LUPS-GU):
  - No. 4: Planning Guidance on On-shore Windfarm Developments (2017);
  - No. 24: SEPA Flood Risk and Land Use Vulnerability Guidance (2018);
  - No. 27: Use of Trees Cleared to Facilitate Development on Afforested Land (2014);
  - No. 31: Guidance on Assessing the Impacts of Windfarm Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems (2017); and
  - No. 50 - Controlling the Environmental Effects of Surface Mineral Workings.
- SEPA Policies:
  - No. 19: Groundwater Protection Policy for Scotland (2009); and
  - No. 41: Development at Risk of Flooding: Advice and Consultation (Oct 2016).
- SEPA Guidance for Pollution Prevention ('GPP') Notes and former (now discontinued) Pollution Prevention Guidance ('PPG') Notes:
  - GPP 1 Understanding your Environmental Responsibilities – Good Environmental Practices (October 2020);
  - GPP 2: Above Ground Oil Storage Tanks (January 2018);

- GPP 3: Use and Design of Oil Separators in Surface Water Drainage Systems (March 2022);
- GPP 4: Treatment and Disposal of Wastewater where there is no Connection to the Public Foul Sewer (November 2017);
- GPP 5: Works and Maintenance in or near Water (February 2018);
- PPG 6: Working at Construction and Demolition Sites (2012);
- GPP 8: Safe Storage and Disposal of Used Oils (July 2017);
- GPP 13: Vehicle Washing and Cleaning (April 2017);
- PPG 18: Managing Fire Water and Major Spillages (June 2000);
- GPP 20: Dewatering of Underground Ducts and Chambers (January 2018);
- GPP 21: Pollution Incident Response Planning (June 2021); and
- GPP 26: Safe Storage of Drums and Intermediate Bulk Containers (February 2019).

- SEPA Position Statements (PS) and Supporting Guidance (SG), namely:
  - WAT-PS-06-02 Culverting of Watercourses (June 2015);
  - WAT-PS-07-02 Bank Protection (April 2012);
  - WAT-PS-10-01 Assigning Groundwater Assessment Criteria for Pollutant Inputs (August 2014);
  - WAT-SG-21: Bank Protection Environmental Standards for River Morphology (July 2012);
  - WAT-SG-23: Engineering in the Water Environment, Good Practice Guide, Bank Protection Rivers and Lochs, Version 1 (April 2008);
  - WAT-SG-25: Engineering in the Water Environment, Good Practice Guide, River Crossings, Version 2 (November 2010);
  - WAT-SG-26: Engineering in the Water Environment, Good Practice Guide, Sediment Management, Version 1 (June 2010);
  - WAT-SG-29: Engineering in the Water Environment, Good Practice Guide, Temporary Construction Methods, Version 1 (March 2009);
  - WAT-SG-31: Prevention of Pollution from Civil Engineering Contracts: Special Requirements, Version 2 (June 2006);
  - WAT-SG-75: Sector Specific Guidance: Construction Sites (February 2018); and
  - WAT-SG-78: Sediment Management Authorisation (December 2012).
- Scottish Government publications:
  - River Crossings and Migratory Fish: Design Guidance (2012);
  - Scotland's Zero Waste Plan (June 2010);
  - PAN 1/2013 – Environmental Impact Assessment (August 2013);
  - Online Planning Advice on Flood Risk (June 2015); and

- Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Second Edition) (April 2017).

- SNH lead author publications:
  - Guidelines on the Environmental Impacts of Wind Farms and Small-Scale Hydroelectric Schemes (2001);
  - Constructed Tracks in the Scottish Uplands (June 2013);
  - Siting and Designing Wind Farms in the Landscape Version 3a (2017);
  - A Handbook on Environmental Impact Assessment (2018).
- Scottish Renewables (SR) lead publications:
  - SR and SEPA Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste (January 2012); and
  - SR, SNH, SEPA, FCS, Historic Environment Scotland (HES), Marine Scotland Science (MSS) and Association of Environmental and Ecological Clerks of Works (AEECoW), 'Good Practice During Wind Farm Construction', Fourth edition (2019).
- Local and Regional Land Drainage Byelaws.

13.4 Data gathering methodology

Study area

13.4.1 Both desk study and survey data for this chapter of the EIA Report have been gathered with respect to a defined Study Area. The Study Area is focussed on the Development Site and a 2 km buffer area immediately beyond it (**Figure 13.1**). Data for beyond the Study Area have also been collected where catchment areas for distant water features may intersect the Study Area, such as those for downgradient properties / infrastructure at risk of flooding, conservation sites and the Afton Water Reservoir. It should be noted that the Study Area covers two Local Authority areas, namely EAC to the north and DGC to the south.

Desk study

13.4.2 The appraisal of existing (baseline) conditions for the purposes of this assessment has involved the collection and interpretation of a wide range of data and information from published material, plus consultations relating to the local and wider hydrological environment with statutory bodies, principally SEPA, EAC and DGC. The data collected, and other sources of information, are listed in **Table 13.2.** The assessment is also inter-related with, and uses information from, other Chapters of this EIA Report, such as **Chapter 11 – Ecology**, of the EIA Report.

Table 13.2 Sources of desk study information for Geology, Hydrology (including flood risk) and Hydrogeology

Source	Data
Ordnance Survey (OS) 1:50,000 Landranger Sheet 77 Dalmellington & New Galloway	Topography and features

Source	Data
OS 1:25,000, Explorer Sheet 328: Sanquhar & New Cumnock **OS 1;10,000 Raster map**	
Centre for Ecology and Hydrology ('CEH') National River Flow Archive (NRFA) **www.ceh.ac.uk/data/nrfa/index.html** **https://www.ceh.ac.uk/services/flood-estimation-handbook** **Meteorological Office (Met. Office) rainfall data** **https ://www.metoffice.gov.uk/** **Met. Office Glenlee climate station data** **https://www.metoffice.gov.uk/research/climate/maps-and-data/uk-climate-averages/gcv12y3xn** **SEPA rainfall data (Drumjohn Gauging Station)** **https://www2.sepa.org.uk/rainfall** **UK Climate Projections 2018 (UKCP18)** **https://www.metoffice.gov.uk/research/collaboration/ukcp**	Climate
British Geological Survey ('BGS') 1:625000 Hydrogeological Map of Scotland (1988) **BGS 1:10000 DiGMap BG 2009** **BGS online mapping** **http://mapapps.bgs.ac.uk/geologyofbritain/home.html** **BGS borehole data** **http://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSBoreholes** **BGS GeoSure and EnviroSure reports** **GCR sites** **https://sitelink.nature.scot/home** **BGS / Natural Environment Research Council ('NERC'). A GIS of Aquifer Productivity in Scotland. Explanatory Notes. Commissioned Report CR/04/047N** **http://nora.nerc.ac.uk/504764/1/CR-04-047N_SEPA%20Aq%20productivity.pdf** **BGS aquifer classification map layer on Scotland's Environment website** **https://map.environment.gov.scot/sewebmap/** **SEPA / BGS / Scotland and North Ireland Forum for Environmental Research ('SNIFFER') Vulnerability of Groundwater in the Uppermost Aquifer (Scotland)** **BGS Groundwater Vulnerability (Scotland)** **http://www.bgs.ac.uk/discoverymetadata/13603084.html**	Geology, ground conditions and hydrogeology

Source	Data
National Soil Map of Scotland (Macaulay Institute for Soil Research) **https://soils.environment.gov.scot/maps/soil-maps/national-soil-map-of-scotland** **The Carbon and Peatland 2016 Map for Scotland** **https://soils.environment.gov.scot/maps/thematic-maps/carbon-and-peatland-2016-map/**	Soils and peat
River Network Map – CEH NRFA **www.ceh.ac.uk/data/nrfa/index.html**	Hydrology and flows
SEPA Flood Maps **http://map.sepa.org.uk/floodmap/map.htm** **Landmark 1 in 75, 1 in 100 and 1 in 1000-year flood maps**	Flood risk
Scottish Government The River Basin Management Plan ('RBMP') for Scotland River Basin District 2015-2027 **The river basin management plan for the Scotland river basin district 2015 - 2027 (sepa.org.uk)** **Scottish Government interactive mapping** **https://map.environment.gov.scot/sewebmap/?layers=riverClass** **SEPA interactive mapping facility for the RBMP** **https://www.sepa.org.uk/data-visualisation/water-classification-hub/** **SEPA data request: information on river water quality**	RBMP and water quality
Licenced sites data download from the SEPA website: **https://www.sepa.org.uk/environment/environmental-data/** **SEPA interactive mapping facility for licenced sites** **https://map.environment.gov.scot/sewebmap/?layers=licensedSites** **Scottish Government Drinking Water Protection Areas ('DWPAs')** **https://www.gov.scot/publications/drinking-water-protected-areas-scotland-river-basin-district-maps/** **SEPA data request: information regarding CAR licences** **EAC and DGC data request: private water supplies ('PWSs')**	CAR licences and PWSs
NatureScot information on protected areas **https://sitelink.nature.scot/** **Scottish Government interactive mapping** **https://map.environment.gov.scot/sewebmap/**	Wetlands and peatlands

Source	Data
Ecology surveys - as per Chapter 11 – Ecology of the EIA Report	

13.4.3 A summary of the organisations that have supplied data on request, together with the nature of that data, is as follows:

- SEPA:
  - rainfall records;
  - river water quality data; and
  - CAR licence data.
- Local authorities – EAC and DGC:
  - location and details regarding PWSs.

Site surveys

13.4.4 A number of ecological and peat surveys have been undertaken at the Development Site, including a National Vegetation Classification '(NVC') survey and associated ground truthing, a Phase 1 habitat survey and ground truthing, and a peat depth survey.

13.4.5 The NVC survey desk study and ground truthing were completed in 2016 covering the Development Site and a 250 m buffer. The survey included recording the presence of wetland habitats (Groundwater Dependent Terrestrial Ecosystems, ('GWDTEs')) and is described in full in **Chapter 11 – Ecology** of the EIA Report. The survey mapped the dominant NVC habitats and included the identification of any habitats of conservation importance.

13.4.6 A Phase 1 habitat survey was undertaken in 2017 covering the access track area with an additional 100 m buffer. A ground truthing survey was completed during a site visit on the 20th to 23rd July 2020. The results of the habitat survey are discussed further in **Section 13.5**.

13.4.7 A peat depth probing survey was carried out in 2015 to inform the Peat Management Plan (PMP) and Peat Landslide Risk Assessment ('PLRA'). The survey undertaken is described in full in **Appendix 13B - Peat Landslide Risk Assessment**. During the survey, 479 peat depth measurements were taken with recorded depths of between 0 and 3 m in depth, with 27% of peat depths being > 0.5 m. The peat depths have been interpolated into a depth map covering the Development Site and this is described in **Section 13.8** and **Figures 13.6** and **13.7**.

13.5 Baseline conditions

Introduction

13.5.1 This section, with the support of overarching **Figures 13.2** to **13.4**, characterises the local Geology, Hydrology (including flood risk) and Hydrogeology environment so that the most likely effects of the Proposed Development can be determined, and appropriate additional mitigation identified and assessed. The description utilises the data sources listed in **Table 13.2**.

Topography

13.5.2 The Development Site covers an area of approximately 127 hectares (ha) and is located in East Ayrshire, approximately 6 km to the south-west of New Cumnock, and centred on the coordinates E 225830, N 660670.

13.5.3 The ground elevation rises from 190 m Above Ordnance Datum (mAOD) at the main site access at Pencloe (coordinates E 261970, N 609790) within the Glen Afton valley up to Strandlud Hill (531 mAOD) (coordinates E 258210, N 606080) in the south-west of the Development Site. The Development Site is located within an area of upland commercial forestry plantation.

Rainfall

13.5.4 The SEPA average annual rainfall (2011-2022) at the Drumjohn gauging station, 12 km south-west of the Development Site and at an elevation of about 200 mAOD, is 1825 mm, with the average monthly totals shown in **Table 13.3**.

13.5.5 The average annual rainfall based on the meteorological data for the Met. Office Glenlee climate station (1981-2010) is 1721 mm. Glenlee is 25 km to the south of the Development Site and at a lower elevation of 55 mAOD, hence its lower rainfall.

Table 13.3 Average monthly rainfall (based on Drumjohn gauging station data for 2003 – 2022)

Month	Rainfall depth (mm)
January	190
February	161
March	125
April	84
May	102
June	104
July	109
August	139
September	141
October	204
November	220
December	202
TOTAL	1783

Geology

13.5.6 The bedrock geology (**Figure 13.2**) of the Development Site mainly comprises sandstone / siltstone turbidite rocks of the Kirkcolm Formation of the Ordovician Leadhills Supergroup. To the north of the Development Site are wacke sandstones, siltstones and

sporadic conglomerates of the Tappins Group, Marchburn Formation. The boundary between the two formations is thrusted towards the south-east and is coincidental with the Carcow Burn. In addition, the bedrock is truncated by north-west to south-east trending structural faults.

13.5.7 To the south of the Development Site, the bedrock comprises the Blackcraig and Galdenoch Formation, massive greywackes and conglomerates with the type locality occurring on the Afton Water, downstream from the Afton Dam. The boundary between this formation and the Kirkcolm Formation to the north trends north-east to south-west and lies broadly along a line just south of the peaks Meikle Hill (coordinates E 261270, N 607600), Auchincally Hill (coordinates E 260160, N 606710) and Milray Hill (coordinates E 259190, N 605690).

13.5.8 A borehole drilled in 1990 and called '*Balcomie Road 5 Crail*' is located just to the east of the Lochingerroch Burn (coordinates E 261800, N 608000), 800 m to the south-east of the Development Site access road boundary line. This borehole is identified on the BGS Onshore Geoindex online mapping, but the borehole records and scanned log are confidential and have not been obtained.

13.5.9 The lower slopes of the hills within the Development Site comprise Devensian diamicton till superficial deposits (**Figure 13.3**), whilst the base of the steep valley bottoms of tributaries are overlain by alluvium (silt, sand and gravel). In areas of higher ground, the superficial deposits are thin / absent or covered in peat, such as on the peaks of Strandlud Hill, Auchincally Hill and Meikle Hill.

13.5.10 There are no Geological Conservation Review ('GCR') sites, i.e., sites of geological and geomorphological features of national and international importance within the Development Site or Study Area.

Soils and land use

13.5.11 The National Soil Map of Scotland shows that the Development Site is predominantly covered in blanket peat although the northern flank of Strandlud Hill and much of the access route is covered by peaty gleys. Small areas of brown soil, derived from greywacke and shale bedrock, are present within the valley bottoms of streams, such as Carcow Burn. The Carbon and Peatland 2016 Map for Scotland shows areas of Class 3 peatland on the northern flank of Strandlud Hill located to the north-west of the Development Site. All other peat deposits within the Development Site, including the access route, are described as peat soil, which is not considered a priority peat class. Soils in this area are associated with a high to moderate soil runoff risk.

13.5.12 Historical mapping and other information show that the Development Site has remained an area of predominantly forestry land. Several historical quarries and disused pits are present across the Development Site mostly dating from approximately 1930 onwards, a number of which are still identifiable on aerial mapping whilst others are completely overgrown or infilled. The most prominent feature is a former quarry located alongside the access track (coordinates E 259797, N 606762).

Hydrogeology

13.5.13 The Ordovician bedrock beneath the Development Site is classed as a Class 2C low productive aquifer where flow is virtually all through fractures and other discontinuities. As a result, the bedrock can locally yield only small amounts of groundwater with short and localised flow paths. Borehole yields are typically low, with an overall mean of 0.6 l/s, with the groundwater residing in a near-surface weathered zone and secondary fractures. Superficial deposits also comprise a low productivity aquifer.

13.5.14 The Upper Nithsdale (ID150663) WFD bedrock groundwater body beneath part of the Development Site and access track is classified as having a Poor overall status due to

legacy mining and quarrying. The Galloway (ID150694) WFD groundwater body located beneath the Development Site on Strandlud Hill is classified as having Good overall status. The Upper Nithsdale WFD Sand and Gravel (ID150771) groundwater body is a 200 m wide area located along the length of the Afton Water to the east of the Development Site and has a Good overall status. Whilst this feature is limited in extent, it has the potential to hold groundwater, although it does not seem to have been utilised within the area.

13.5.15 The Development Site is located within the Upper Nithsdale and Galloway groundwater DWPAs. There are no SEPA groundwater quality monitoring locations within the Study Area.

13.5.16 In terms of other water features in the Study Area, a spring is identified on OS mapping at coordinates E 262140, N 609410, 170 m to the west of Lochingerroch Farm on the Afton Road and 70 m east of the Lochingerroch Burn. The spring exists on diamicton till and is likely to be a local flush on the slopes of the ground rising to Boltcraig Hill (coordinates E 262870, N 607630) to the south, developed from shallow groundwater from lateral flows in the superficial deposits.

Hydrology

13.5.17 The Development Site is drained by various watercourses that flow into the River Nith approximately 6 km to the north, albeit via extensively modified drainage, or north-east into the Afton Water (**Figure 13.4**). The tributaries comprise the following (from west to east of the Development Site): the Small Burn flowing into the Connel Burn (River Nith) and four tributaries to the Carcow Burn, namely Glenhastel Burn, Auchincally Burn, Glenshalloch Burn and an unnamed tributary at the headwaters of the burn, henceforth referred to as the Monquhill Burn. The Carcow Burn flows to the north-east into the Afton Water, which flows from the Afton Reservoir approximately 5 km to the south-east of the Development Site north to meet the River Nith north of New Cumnock at coordinates E 262150, N 614020. The Lochingerroch Burn flows directly into the Afton Water and drains the area east of the proposed access trackway at Pencloe.

13.5.18 The Afton Water (ID10614) (River Nith catchment) WFD surface water body which extends over and beyond the Development Site is classified as of Good overall ecological potential status whilst the downstream River Nith (ID10612) WFD surface water body is classified by SEPA as being of Moderate overall status.

13.5.19 The higher elevations in the south western part of the Development Site on Strandlud Hill drain to the south-west into Bitch Burn. This burn flows south into the Water of Deugh (ID10563) (River Dee (Solway) catchment) WFD surface water body at coordinates E 257830, N 604980 (approximately 800 m south-west of the Development Site), which is classified by SEPA as of Poor overall ecological potential status within this catchment area.

13.5.20 Approximately 19 km south and downstream of the Development Site boundary, the Water of Deugh is dammed to form Carsfad Loch (coordinates E 226075, N 658598). This loch is a stand-by reservoir used for emergency abstraction only by Scottish Water. The Proposed Development therefore lies within the surface water catchment of Carsfad Reservoir.

13.5.21 Two small ponds have been identified on OS mapping, namely on the top of Strandlud Hill (coordinates E 258290, N 606210) and on a small tributary to Carcow Burn (coordinates E 258930, N 606510), 280 m south-west of Monquhill (coordinates E 259080, N 606860). The Strandlud Hill pond sits on up to 1 m thick peat 50 m north-west of the proposed access road, whilst the Carcow pond is situated on till 200 m south-east of the road. Both ponds are small, approximately 1 m by 1 m, and the pond on the small tributary of the Carcow Burn is square in shape and likely to be man-made.

13.5.22 There are two river gauging stations reasonably close to the Development Site. These are on the Nith River at Hall Bridge, approximately 8 km to the north-east of the Development Site, and on the Afton Water, just north of the Afton Reservoir and approximately 3.5 km to the south-east of the Development Site. Details for the gauges are given in **Table 13.4.**

Table 13.4 River flow gauging station data

Station no.	River	Location	Coordinates	Catchment area km^2	Operating period
79003	Nith	Hall Bridge	E 268400, N 612900	155	01/1959 - N/A
79001	Afton Water	Afton Reservoir	E 263100, N605000	9	01/1965 - 12/1981
Note: Details of the flow gauging stations are from https://nrfa.ceh.ac.uk/data/search					

13.5.23 The Development Site is located within a surface water DWPA associated with the Afton Water catchment. Although there are no SEPA surface water ecological quality survey locations available within the Study Area, SEPA indicates[74] that two downstream locations, both with high or good indicative quality samples, at the following locations:

- Location 122986 on the River Nith upstream of Kirkconnel at coordinates E 272120, N 612390; and
- Location 123103 on the Water of Deugh, downstream of A713 at 'Greenwell' Bridge (above Carsphairn) at coordinates E 255600, N 594300.

Flood risk

13.5.24 The SEPA Flood Risk Maps have been used to identify different flood zone areas and the extent of flooding possible within the Development Site area as well as in downstream catchments (**Figure 13.4**). Within the Development Site there is a high[75] to medium[76] likelihood from surface water (pluvial) flooding along the areas of the tributaries, but other than watercourse crossings no permanent infrastructure is proposed to be located in these areas. Surface flooding is also indicated as a high likelihood within the forestry areas within the Development Site, particularly along drainage routes, but again this is not near any proposed infrastructure.

13.5.25 Within the nearby Afton Water there is a high to medium likelihood of river flooding. The flood plain along the Afton Water is over 200 m wide in places. In addition, an area of high likelihood flooding is also associated with the Carcow Burn to the north of the Development Site.

13.5.26 Potential downstream properties at risk of flooding are small rural properties downstream of the Development Site, such as Burnfoot (coordinates E 261700, N 610100) on Afton Road at the confluence of Carcow Burn and Afton Water and larger settlements further downstream, such as Connel Park (coordinates E 260810, N 612820) located on the Connel Burn.

[74] Note: Ecological data confirmed with SEPA via a data request (F0191950) received on the 14th September 2020.

[75] High likelihood: A flood event is likely to occur in the defined area on average once in every ten years (1:10). Or a 10% chance of happening in any one year.

[76] Medium likelihood: A flood event is likely to occur in the defined area on average once in every two hundred years (1:200). Or a 0.5% chance of happening in any one year.

CAR licences

13.5.27 CAR licenses within 2 km of the Development Site boundary are shown in **Table 13.5** and **Figure 13.4**. A total of eight licenses are recorded and comprise of a range of activities including hunting and related service activities, sewage and refuse disposal and PWSs.

13.5.28 With respect to the PWS licences, licences CAR/R/1144851 and CAR/R/1154945 are located over 1 km to the south of the Development Site boundary and are associated with activities at the Brockloch Rig Wind Farm. Furthermore, licence CAR/R/1144851 is a discharge on the Polwhat Burn and although downstream of the Development Site on the Water of Deugh, it is not directly in hydraulic continuity with it. Licence CAR/S/1155616 is located at Lochingerroch Farm 270 m to the east of the Development Site access track and boundary at Pencloe and is a discharge of sewage effluent from a treatment system serving the property to land via a soakaway. Licence CAR/S/1081880 is located at Ashmark Farm 1.25 km to the north-west of the Development Site and is a simple licence associated with hunting and related service activities. There are no non-PWS licensed abstractions within the Study Area.

Private water supplies

13.5.29 Further details regarding the registered PWSs within 2 km of the Development Site boundary were requested from EAC and are shown in **Table 13.6** and **Figure 13.4**.

13.5.30 All the PWSs are for domestic use. The closest supply to the Development Site is the type B supply at Lochbrowan. This property is located approximately 200 m to the east of the Development Site's access area on the Glen Afton public road. EAC records indicate that the surface water supply is on the eastern side of the Afton Water and sources its water from a tributary approximately 160 m to the south-east of the property. This unnamed tributary flows from higher ground, draining the western flank of Lochbrowan Hill.

13.5.31 The Blackcraig Farm and Dalhanna Farm supplies are similarly on the eastern side of the Afton Water (south and north respectively of the site access on the Afton Road). The Blackcraig Farm supply takes its water from the Langlee Burn approximately 160 m to the east of the farm, and which drains the higher ground of Quintin Knowe and Laglass Hill (coordinates E 264950, N 608710) to the east, just outside of the Study Area. EAC records indicate that the Dalhanna Farm supply is from a spring source located on the northern bank of the Dalhanna Burn, approximately 100 m to the south-east of the farm.

13.5.32 The Laglaff Farm supply is also derived from a spring, approximately 250 m to the south-east of the farm, and on the south-western bank of the tributary draining higher ground (369 mAOD) at Ashmark Hill (coordinates E 260860, N 609360).

13.5.33 None of the PWS's surface water or groundwater catchments are in hydrological connection with the Development Site. In addition, SEPA or the local authorities record no groundwater quality water data available from within the Study Area.

Table 13.5 CAR licences within the Study Area

Licence no.	Coordinates	Site name	Description	Licence type	Start date
CAR/R/1053321	E 262215, N 609752	Lochbrowan Farm	PWS	Registration	12/06/2009
CAR/R/1053322	E 263421, N 608157	Blackcraig Farm	PWS	Registration	12/06/2009
CAR/R/1053320	E 261903, N610721	Dalhanna Farm	PWS	Registration	12/06/2009
CAR/R/1186042	E 260231, N 610314	Laglaff Farm	PWS	Registration	18/09/2019
CAR/R/1144851	E 257420, N 603790	Polwhat Burn, Carsphairn Forest	A sewage and refuse disposal, sanitation and similar activity	Registration	10/03/2016
CAR/R/1155616	E 262294, N 609448	Lochingerroch Farm, Afton Road, New Cumnock	Discharge (sewage)	Registration	24/03/2017
CAR/R/1154945	E 258977, N 604709	Crossing between B54 and B55 Engineering Works, Back Strand	Trackway associated with the wind farm crossing a watercourse called the Back Strand	Registration	01/03/2017
CAR/S/1081880	E 261135, N 610658	Ashmark Farm, New Cumnock, Ayrshire	Hunting and related service activities at Ashmark Farm	Simple Licence	10/09/2014

Note: Licenced data confirmed with SEPA via a data request (F0191950) received on 14 September 2020. It should be also noted that licence numbers CAR/R/1144851 and CAR/R/1154945 were not recorded within the SEPA data request. Licenced sites data have been downloaded from the SEPA website: https://www.sepa.org.uk/environment/environmental-data/ and checked as correct (1st March 2023).

Table 13.6 PWS within the Study Area

Source name / licence no.	Coordinates*	Location description	PWS class / type[77]	Properties
Lochbrowan / CAR/R/1053321	E 262200, N609760	Approximately 200 m to the east of the Development Site entrance off the public road, ~35 m north of the Afton Water.	Type B / Surface Water	1
Blackcraig Farm / CAR/R/1053322	E 263420, N 608160	Approximately 2 km south-east of the Development Site, ~320 m east of the Afton Water.	Type B / Surface Water	1
Dalhanna Farm / CAR/R/1053320	E 261870, N 610700	Approximately 1 km north of the Development Site, ~200 m east of the Afton Water.	Type B / Groundwater Water	1
Laglaff Farm / CAR/R/1186042	E 260220, N 610340	Approximately 1.7 km north-west of the Development Site, on a tributary to the Connel Burn.	Type B / Groundwater Water	1

Conservation sites

13.5.34 Whilst there are no statutory or non-statutory designated biodiversity sites within the Study Area, there are numerous Local Nature Conservation Sites ('LNCSs'), such as the Connel Burn / Benty Cowan LNCS (coordinates E 257400, N 608300)[78] (**Figure 13.4**). In addition, much of the length of Afton Road bordering the Development Site boundary where the site access leaves Afton Road and travels towards Pencloe Farm (coordinates E 261850, N 609520) is also a LNCS (Glen Afton) (coordinates E 262300, N 609700). Glen Afton is classed as an upland glen with riparian woodland and small walled pastures covering the valley floor and lower slopes, with semi-improved pastures and grass moorland on the upper slopes. Afton Uplands LNCS (coordinates E 264400, N 607100) is located approximately 200 m east of the Development Site.

13.5.35 The Scottish Wildlife Trust's ('SWT's') Knockshinnoch Nature Reserve (Knockshinnoch Lagoons) is an open water and marshland environment important for birdlife in the Nith Valley. This reserve is located on the Connel Burn at coordinates E 260890, N 613410, just south of the confluence with the River Nith, approximately 6.5 km from the Development Site (along the course of the Connel Burn).

13.5.36 Ancient woodlands are located at Bolt Wood (coordinates E 263220, N 607600), Carcow Wood (coordinates E 261630, N 610040) and at an unnamed location (coordinates E 261440, N 611370) on the Afton Water.

13.5.37 Conservation sites which exist further downstream of the Development Site after the tributaries meet the River Nith include the Nith Estuary National Scenic Area (NSA),

[77] Type A supplies are those which supply 50 or more people, or 10 m^3 water or more a day, and any PWS which is used in a commercial or public activity. The Type B classification relates to smaller, domestic supplies. Type A supplies are governed by Human Consumption (Private Supplies) (Scotland) Regulations 2017.

[78] EAC, July 2016. State of the Environment Report Chapter 3 - Ecology and Nature Conservation, Ironside Farrar / ECOS Countryside Services LLP.

Upper Solway Flats and Marshes Ramsar site and Site of Special Scientific Interest ('SSSI'), Solway Firth Special Protection Area ('SPA') and Special Area of Conservation ('SAC'), and the Caerlaverock National Nature Reserve ('NNR'). These sites are located where the River Nith meets the coast south of Dumfries, approximately 50 km downstream of the Development Site.

GWDTEs

13.5.38 Present in the Study Area are habitats that are regarded as potential GWDTEs. The NVC survey undertaken on the Development Site in 2016[79] indicated the presence of species that potentially have some groundwater dependency. For example, a mosaic of potential GWDTE habitats (76 areas in total) has been identified during the survey across the higher elevations of the Development Site. These are predominantly in areas along forestry-cleared areas for firebreaks, tracks, and drainage, as well as along the Connel Burn valley in the west of the Development Site.

13.5.39 An assessment of the potential GWDTEs based on their topography, geology and hydrogeology (**Appendix 13A**) has subsequently indicated that there are no truly groundwater-dependent habitats present, or groundwater dependency is low. In the most part, the presence of peat and / or till and low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitats identified is limited, with the majority of the supply coming instead from surface or very near-surface infiltration and surface runoff.

Future baseline

13.5.40 Changes could potentially occur to the Study Area in the future in relation to climate change and land use. **Section 13.7** below defines the years for which the assessment needs to be carried out and the developments / changes that need to be considered within the assessment.

13.5.41 The conditions at the Development Site will be affected by climate change in the future, which could affect the amount and intensity of rainfall. The UK Climate Projections 2018 (UKCP18) produced by the Meteorological Office Hadley Centre provides information regarding potential future climate in Scotland and includes predictions for the East Ayrshire and Dumfries and Galloway areas for the west of Scotland. The central estimate under a high emission (Representative Concentration Pathway – RCP of 8.5) scenario predicts an increase in annual mean temperature of 1.2°C by the end of the 2050s. The high emissions scenario also has a central estimate of a 10% decrease in summer precipitation, with an increase of 12 % in winter, by the end of the 2050s. These changes could alter the hydrological characteristics of the Development Site and wider catchment areas over time.

13.5.42 Given the nature of the terrain and distance from any major urban areas, any future land use change in the area from its current rural nature is unlikely over the lifespan of the Proposed Development. The local authority development plans give no indication of future major developments in the area.

13.6 Consultation

13.6.1 **Table 13.7** provides a summary of the issues regarding the Proposed Development that have been raised by consultees and a reference to the responses provided in this chapter

[79] Although no further NVC surveys have been undertaken since this date, the ecology has been confirmed to still be accurate by walkovers undertaken on the 7th March 2023.

and elsewhere. The responses were collected for the formal EIA Scoping Opinion which was issued by EAC in April 2020 and is presented in full in **Appendix 4A**.

Table 13.7 Summary of issues raised during consultation regarding Geology, Hydrology (including flood risk) and Hydrogeology

Issue raised	Consultee(s)	Response and how considered in this chapter	Considered in Section
General	DGC	No comment owing to the Development Site being outwith the DGC's administrative area.	N/A
	SEPA	Consideration should be given to the following water environment-related key issues in the EIA process, and this must be reflected in the documents supporting the application: • Map and assessment of all engineering activities in or impacting on the water environment including proposed buffers, details of any flood risk assessment and details of any related CAR applications. • Map and assessment of impacts upon GWDTEs and buffers. • Map and assessment of impacts upon groundwater abstractions and buffers. • Schedule of mitigation including pollution prevention measures. • Borrow pit Site Management Plan (SMP) of pollution prevention measures (including a map and site layout of borrow pits). • Map of proposed water abstractions including details of the proposed operating regime. • Decommissioning statement. **Collected data/information and mapping have been compiled into a single or composite 'water environment' map for describing the current water regime receptors and constraints to inform the assessment and to provide a basis for identifying potential impacts and formulating appropriate design mitigation.**	13.8 13.10

Issue raised	Consultee(s)	Response and how considered in this chapter	Considered in Section
	SEPA	The following Regulatory requirements are considered relevant: • Authorisation is required under CAR to carry out engineering works in or in the vicinity of inland surface waters (other than groundwater) or wetlands. A CAR construction site licence will be required for management of surface water run-off from a construction site, including access tracks, which: ➢ is more than 4 hectares; ➢ is in excess of 5 km; or ➢ includes an area of more than 1 hectare or length of more than 500 m on ground with a slope in excess of 25˚. See SEPA's Sector Specific Guidance: Construction Sites (WAT-SG-75) for details. Site design may be affected by pollution prevention requirements and hence SEPA strongly encourages the applicant to engage in pre-CAR application discussions with a member of the regulatory services team in your local SEPA office. Below these thresholds the applicant will need to comply with CAR GBR 10 which requires, amongst other things, that all reasonable steps must be taken to ensure that the discharge does not result in pollution of the water environment. The detail of how this is achieved may be required through a planning condition. **Specific environmental measures embedded into the development proposals are considered within Section 13.8. This includes CAR watercourse crossing and construction site licence authorisations.**	13.8
	Scottish Nature Heritage (SNH)	Consideration should be given by the applicant to the SNH "general pre-application/scoping advice to developers of onshore wind farms" which can be found at: https://www.nature.scot/professional-advice/planning-and-development/planning-and-development-advice/renewable-energy/onshore-wind-energy/advice-wind-farm-development. This provides guidance on issues that developers and their consultants should consider for wind farm developments and includes information on recommended survey methods, sources of	13.3

Issue raised	Consultee(s)	Response and how considered in this chapter	Considered in Section
		further information and guidance and data presentation. Attention should be given to the full range of advice included in the guidance. The checklist in Annex 1 sets out SNH expectations of what should be included in the Environmental Statement ('ES'). **A list of technical guidance used is shown in Section 13.3 and includes the relevant SNH publications.**	
Baseline site surveys	EAC	Consideration needs to be given to the Geology, Hydrology (including flood risk) and Hydrogeology consultations to help form an informed baseline and subsequently a better-informed EIA Report. This will help to fully understand any potential contamination risks so that the siting of infrastructure is proposed in assessed and understood locations. No specific descriptions of the surveys to be carried out is given. **The list of consultations and responses is given within this Table 13.7. Appropriate information has been drawn from ecology surveys and records to inform this chapter.**	13.6
Sediment loading in watercourses	SWT	Consideration to impacts of sediment loads in the Connel Burn and other watercourses is required. The SWT is concerned about impacts on the Connel Burn in particular as it flows into the SWT's Knockshinnoch Reserve, but the impact on sediment loads in the other watercourses would also need to be considered. **The hydrological impacts on the Connel Burn and flows into the SWT's Knockshinnoch Reserve are assessed in Section 13.10 and within Table 13.17.**	13.10
Flood risk	SEPA	It is noted that provided watercourse crossings are designed to accommodate the 1 in 200-year event and other infrastructure is located well away from watercourses, SEPA does not foresee from current information a need for detailed information on flood risk. **A description of how flood zones are avoided and assessed is given under Section 13.8.**	13.8
Abstractions	SEPA	Note that based on the information provided to date it seems unlikely that any development will take place within 250 m of a groundwater supply source. If this is the	13.7

Issue raised	Consultee(s)	Response and how considered in this chapter	Considered in Section
		case, then SEPA request that evidence is provided within the EIA. **Abstractions have later been assessed and mainly 'scoped out', and the rationale is given in Section 13.7 and the associated source / pathway / receptor model and risk given within Table 13.9.**	
	Scottish Water (SW)	SW advises that the proposed development falls partly within a drinking water catchment where a SW abstraction (designated as a DWPA) is located. SW notes that reference to the fact the site falls partly within a DWPA should be made in future documentation and that any site-specific risks and mitigation measures will need to be assessed in the EIA Report. SW states that according to its records there is no public SW, water or wastewater infrastructure within the vicinity of the Proposed Development therefore it would advise the applicant to investigate private water supply options if required. SW states that it is unable to reserve capacity at its water supply and wastewater treatment works for the Proposed Development. Noted again that the Proposed Development falls partly within a drinking water catchment where a SW abstraction is located. Carsfad supplies the Lochinvar Water Treatment Works ('WTW'), and it is essential that water quality and water quantity are protected and that it should be notified in the event of an incident occurring. It is a relatively large catchment, and the proposed activity is in the upper reaches of the catchment, therefore the activity is likely to be low risk. **The Afton Water and Afton Reservoir are described within the baseline and the former is identified as a receptor for assessment. The Carsfad supply of the Lochinvar WTW and its possible hydrological connection to the impacted area at the Proposed Development is considered within Section 13.7.**	13.5 13.7
PWSs	EAC	Consideration of the source and receptor and the pathway taken between the two must be considered when assessing risk to such features. The catchment within which the source is located must be given when	13.7 Table 13.9

Issue raised	Consultee(s)	Response and how considered in this chapter	Considered in Section
		assessing risk to such features. PWSs should only be 'scoped out' if the evidence demonstrates that at no point is the source, its catchment, pathway or receptor at risk from any infrastructure or construction activity associated with the Proposed Development. If it is found that PWS impacts will need to be scoped in, then details of any mitigation and /or contingency measures that may be required should be provided in the EIA Report and the EAC's Environmental Health Service should be contacted to gather information about potential PWSs throughout this area. **The source / pathway / receptor model for PWSs is considered within Section 13.7, and specific source catchments and Zones of Influence ('ZoIs') are indicated within Table 13.9.**	
Habitat disturbance	SNH	An assessment of impacts of hydrological changes (particularly related to groundwater) on habitats should also be included. Access tracks are the elements that will result in the greatest land take, habitat fragmentation and, potentially, hydrological disruption. Consideration to the track construction methods within the EIA Report, along with the rationale for their type and location, and all direct and indirect impacts assessed, should be given. **The consideration of the development proposals design in the protection of the environment are given within Section 13.8. The assessment of hydrological changes relevant to conservation sites and potential GWDTEs is undertaken within Section 13.10.**	13.8 13.10
LNCSs	SWT	The Scoping Report fails to mention the overlap of the site boundary with LNCSs. **LNCSs identified within the Study Area are described within the baseline.**	13.5
	EAC	EAC notes that "*whilst the scoping report states that there are no statutory or non-statutory designated biodiversity sites within 2km of the proposed development site, much of the main application site area (where the turbines are proposed) is designated a Local Nature Conservation Site (LNCS) as Connel Burn / Benty Cowan LNCS"*. Further to LNCSs EAC mentions that "*much of the length of Afton Road where deliveries*	13.5 13.10

Issue raised	Consultee(s)	Response and how considered in this chapter	Considered in Section
		would be transported along and bordering the site boundary where access leaves Afton Road and travels towards Pencloe Farm is also designated a LNCS. Afton Uplands LNCS is also located approximately 200 m east of the application site. Impacts on these LNCS will need to be considered in the EIA". **LNCSs identified within the Study Area are described within the baseline and included within the assessment.**	
GWDTEs	SEPA	It is noted that a NVC survey was undertaken in 2017 and that whilst this indicated the presence of species that have some groundwater dependency, an assessment of the GWDTEs based on their topography, geology and hydrogeology indicated that there are no truly groundwater dependent habitats present. However, it is recommended that conditions at the location of the two turbine bases, the construction compound, access track and any borrow pits are assessed for GWDTE's. Regardless of whether wetland habitats are groundwater-fed, surface-fed, or subsurface-fed, mitigation will be required to determine hydrological connectivity post-development. SEPA recommends that the site is walked over post-felling and any areas of springs or flushes identified are marked and avoided. **The importance of hydrological connectivity post-development to potential GWDTEs is recognised within the scope of the assessment and the water environment related to all potential GWDTES within the appropriate buffers of the Proposed Development buffers has been assessed on this basis.**	13.7 13.10
Reinstatement of deep peat	SWT	The removal of forestry on the site may allow for the reinstatement of some areas of deep peat on site. **Reinstatement of peat is considered within Section 13.8.**	13.8
Borrow pit locations	EAC	There is no indication on the plans as to location of borrow pits and these are not mentioned throughout the Scoping Report other than in paragraph 2.3.1, where they are listed as potential elements of the project description. If borrow pits are proposed, the EIA Report should include information on the location, size and nature of these borrow pits, including details of the	13.8

Issue raised	Consultee(s)	Response and how considered in this chapter	Considered in Section
		depth of the borrow pit floor and the borrow pit final reinstated profile. The impact of such features (including dust, blasting and impacts on water) should be appraised as part of the overall impact of the scheme. Information on the proposed depth of excavations compared to the actual topography, the proposed restoration profile, proposed drainage and settlement traps, turf and overburden removal and storage for reinstatement should be included in the EIA Report. **No borrow pits are planned for the Development Site and all stone will be imported. However, deeper excavations associated with turbine foundations etc. are considered in the assessment.**	
Decommissioning and restoration	EAC	Consideration to decommissioning and restoration should be given. An assessment of the likely impacts of decommissioning of the proposed development on all the environmental topics should form part of the EIA Report, where it is judged that such works have the potential to impact on those topic areas. This is required to enable a reasonable idea as to what the impacts may be and what possible mitigation would be required to address any impacts. **Impacts during decommissioning are likely to be similar to those during the construction phase and it is therefore proposed that decommissioning effects are 'scoped out' of the EIA.**	13.7
Migratory Salmonoids	Nith District Salmon Fishery Board ('NDSFB')	Makes reference to the lack of fisheries surveys within the Ecology chapter of the Scoping Report. NDSFB require a baseline survey to have taken place prior to development taking place to allow for mitigation measures to be put in place to protect fish. **The requirement for a baseline survey to have taken place prior to development taking place is mentioned within Section 13.7.**	13.7

13.7 Scope of the assessment

Spatial scope

13.7.1 The spatial scope of the assessment of Geology, Hydrology (including flood risk) and Hydrogeology covers the Study Area (including 2 km buffer area) described in **Section 13.4**, on the basis that the majority of the effects on the water environment due to the

Proposed Development are considered unlikely to extend beyond this area. The only theoretical receptors identified outside this Study Area are downgradient properties / infrastructure at risk of flooding, conservation sites and the Afton Water Reservoir, on the basis that any wind farm-inspired changes in the surface and groundwater environment could theoretically affect their flood risk, water support and water supply respectively.

Temporal scope

13.7.2 In line with the general methodology of the EIA Report (outlined in **Chapter 4 – Approach to Preparing the EIA Report**), the temporal scope of the assessment of Geology, Hydrology (including flood risk) and Hydrogeology covers the construction, operational and decommissioning periods. These phases would comprise the activities listed in **Chapter 3 – Description of the Proposed Development**.

Potential receptors

13.7.3 The receptors that are identified as requiring impact assessment (i.e., 'scoped in') are located in **Figure 13.5** and **Table 13.8** and are ordered in the table broadly in accordance with their first appearance in the **Section 13.5** baseline i.e. groundwater, surface water and then composite receptors. The features are referred to by means of the one- or two-letter category character and two-digit sequential number codes.

13.7.4 It is important to note that this chapter examines potential changes of the Proposed Development on the water environment supporting potential GWDTEs and conservation sites, not the habitats themselves, which is instead a matter for **Chapter 11 – Ecology**.

Table 13.8 Potential water receptors requiring further impact assessment

Reference no.	Receptor	Location
Aquifers and associated WFD groundwater bodies		
GW01	Bedrock aquifer and Upper Nithsdale WFD groundwater body	Beneath and beyond the Development Site
GW02	Bedrock aquifer and Galloway WFD groundwater body	Beneath and beyond the Development Site
Watercourses and associated WFD surface water bodies		
W01	Afton Water WFD surface water body	Within the Development Site
W02	River Nith WFD surface water body	Downstream of the Development Site
W03	Water of Deugh watercourse and WFD surface water body	Downstream of the Development Site
W04	Small Burn (Connel Burn) (River Nith) watercourse	Downstream of the Development Site
W05	Connel Burn (River Nith) watercourse	Downstream of the Development Site
W06	Glenhastel Burn (Carcow Burn) (Afton Water) watercourse	Across the Development Site
W07	Auchincally Burn (Carcow Burn) (Afton Water) watercourse	Downstream of the Development Site
W08	Monquhill Burn (Carcow Burn) (Afton Water) watercourse	Across the Development Site
W09	Glenshalloch Burn (Carcow Burn) (Afton Water) watercourse	Across the Development Site
W10	Carcow Burn and smaller tributaries (Afton Water)	Within and downstream of the Development Site
W11	Bitch Burn (Water of Deugh) watercourse	Downstream of the Development Site
W12	Lochingerroch Burn watercourse	East of the Development Site
Ponds		
P01	Pond on Strandlud Hill	E 258290, N 606210
P02	Pond on small tributary to Carcow Burn	E 258930, N 606510

Reference no.	Receptor	Location
Conditions supporting conservation sites and potential GWDTEs		
C01	Connel Burn / Benty Cowan LNCS	E 257400, N 608300
C02	Glen Afton LNCS	E 262300, N 609700
C03	Afton Uplands LNCS	E 264400, N 607100
C04	Knockshinnoch Nature Reserve	E 260890, N 613410
C05	Potential GWDTEs	Within the Development Site

13.7.5 Given the nature of the Proposed Development, it is the watercourse receptors that have initially been identified as most likely to be most affected. This is due to both the density of the watercourses on site and because of the need for a number of watercourse crossings.

13.7.6 The risk to watercourses has also been a focus of the consultation comments (**Table 13.7**). For example, SWT has indicated that consideration needs to be given to sediment loading in the Connel Burn and other watercourses. There are concerns about impacts on the Connel Burn in particular as it flows into the SWT's Knockshinnoch Reserve, and its associated habitats forms the Connel Burn / Benty Cowan LNCS.

13.7.7 In addition, NDSFB has stated that it requires a fisheries baseline survey[80] to have taken place prior to development taking place to allow for mitigation measures to be put in place to protect fish. Even though the River Nith is approximately 6 km north of the Development Site, the Connel Burn is an upstream tributary, and the river is considered a receptor within the assessment.

13.7.8 The risk to conservation sites has also been a focus of the consultation comments from SNH, SWT and EAC (**Table 13.7**). Furthermore, whilst SEPA recognises that there may be no true GWDTEs present, further investigation is required of specific construction areas and general hydrological connectivity post-development, and so potential GWDTEs have been retained in the assessment.

13.7.9 The following theoretical receptors have been 'scoped out' from further assessment because the potential effects are not considered likely to be significant:

- The underlying solid geology comprises a variety of sedimentary lithologies that outcrop across parts of the Study Area, but the geology is not considered to be of local or regional importance and no features of geological interest have been designated, e.g., GCR sites. Furthermore, disturbance of the geology during project construction would be minimal, sufficient only to establish building, track and turbine foundations, and with no borrow pits proposed. On this basis, any geological effect would be insignificant, and it is proposed that geology is 'scoped out' as a receptor.
- The superficial aquifer and Upper Nithsdale Sand and Gravel WFD groundwater body lies to the east of the Development Site along Glen Afton. This is approximately 4 km

[80] This survey was undertaken in September 2020 (NDSFB, 2020) and found fish populations with both species and diversity consistent with those found at similar watercourses and altitudes throughout the Nith catchment with sampling locations on the Carcow Burn, Glenshalloch Burn, Connel Burn and Afton Water. No freshwater pearl mussels were found at any of the sampling locations. Water quality within the burns was typical for surface water catchments at the time of sampling.

from Monquhill and is not considered a receptor due to its distant location in relation to the project construction areas.

- An area of Class 3 peatland is located on the northern flank of Strandlud Hill but is not considered as a receptor due to its location in relation to the project construction areas. Disturbance to this area of peatland would be minimal, and so peat soils is 'scoped out' as a receptor.
- Groundwater within the peatlands is not identified as an aquifer by the BGS and so is not regarded as a receptor in this assessment. However, this groundwater is still taken account of in the assessment in terms of its role in supporting the mosaic of peatlands and potential GWDTEs.
- The spring to the west of Lochingerroch Farm is likely to be fed from shallow groundwater flow within superficial deposits and from higher ground to the south of the Development Site. The proposed trackway at Pencloe is approximately 250 m to the west of the spring and separated by the Lochingerroch Burn which would act as a hydraulic divide. Therefore, no pathway connection is possible, and no associated risk is likely to exist, and so the spring is 'scoped out' as a receptor.
- The Afton Reservoir is located at the head of the Afton Water and upstream of the Carcow Burn confluence with this watercourse. The reservoir is approximately 3 km to the south-east of the Development Site and geographically separated from the Development Site by elevated topography forming a hydrological divide. On the basis of there being no possible hydrological connection with the Proposed Development, Afton Reservoir has been 'scoped out' as a receptor.
- The Proposed Development also falls within the DWPA of the SW Carsfad Loch supply, over 20 km to the south of the Development Site. This is a large catchment, and the Development Site is in the upper reaches of the catchment, and therefore any activity in this area is considered to be very low risk and Carsfad Loch has been 'scoped out' as a receptor.
- SEPA flood risk mapping indicates that there is currently no risk of flood risk issues potentially affecting the Proposed Development's infrastructure and watercourse crossing locations. However, it is the potential effect of the Proposed Development on the downstream flood risk that is of more concern. Unmitigated, elevated run-off from the Development Site could potentially be discharged to the fluvial network and give rise to flashier hydrographs and potentially increased incidences of flooding downstream. However, the increase in impermeable area and forestry clearance would be minor, and design and adoption of standard best practice would ensure that construction and post-development run-off would not exceed pre-development rates. Furthermore, there are few property receptors immediately downstream, with no major settlements along the route of the Carcow Burn and other tributaries. SEPA also does not foresee from the current information available a need for detailed information on flood risk, and therefore flood risk has been 'scoped out' from further assessment.
- The non-PWS SEPA CAR licences (namely CAR/R/1144851, CAR/R/1155616, CAR/R/1154945 and CAR/S/1081880) are 'scoped out' from further assessment as these non-abstraction activities would not be impacted by the Proposed Development.
- The four CAR abstractions and PWSs, namely Lochbrowan, Blackcraig, Dalhanna and Laglaff Farms (namely CAR/R/1053320 – 22 and CAR/R/1186042), are all beyond the surface water and groundwater catchments underlying the Development Site, and so have also been 'scoped out'. Detailed justification for this approach is given in **Table 13.9.**

- All ancient woodlands are located outside of the Development Site, with the closest being the Carcow Wood, located 200 m to the north-west of the access trackway at Pencloe. Drainage is away from the woodland site towards the north-east and the Afton Water at this location. Woodland receptors are in any case not sensitive to the water environment beyond the local environment, and as such have been 'scoped out' as receptors.
- All conservation sites located downstream from of the Study Area, namely the Nith Estuary NSA, Upper Solway Flats and Marshes Ramsar site and SSSI, Solway Firth SPA and SAC and the Caerlaverock NNR, have been 'scoped out' as receptors due to their distance from the Development Site (minimum distance of 50 km) and the potential for the intervening dilution of any contamination.

Potential significant effects

13.7.10 The potential significant hydrological and hydrogeological effects that are taken forward for assessment are summarised in **Table 13.10.**

13.7.11 The main potential hydrological / hydrogeological effects associated with the Proposed Development relate to the construction phase, in particular from tracks and watercourse crossings. The assessment presented later identifies the location and the nature of the effect from this construction and upgrading activities, in particular the potential for the generation of silt-laden runoff. Measures to be adopted during construction to mitigate against these negative impacts on the water environment are then prescribed.

13.7.12 Other activities of relevance include the construction of wind turbine foundations and crane pads, the control building and substation compound. The effects of these activities, such as the leaching of concrete residues to the water environment and changes in the runoff / recharge characteristics, are also addressed in the assessment. Again, mitigation measures are outlined that would reduce negative impacts.

13.7.13 The temporary compound, substation and battery storage are to be located at Monquhill close to the Carcow Burn, on sloping ground that drains towards the burn. Mitigation would be required during construction to protect this watercourse.

13.7.14 Impacts during decommissioning would likely be less than those during the construction phase. Mitigation similar to that implemented during the construction and operational phases (updated to reflect changes in legislation / guidance) would also help ensure that the significance of such effects is minimised, and it is therefore proposed that consideration of decommissioning effects is 'scoped out' of the assessment.

Table 13.9 CAR abstractions and PWSs source / pathway / receptor model and associated risk

Source Name	Source	Pathway	Receptor	Risk
Lochbrowan Farm	From an unnamed tributary draining the western flank of Lochbrowan Hill to the east of the Afton Water.	Hydrologically unconnected to the western side of the Glen Afton or tributaries associated with the Development Site.	The water supply is on the eastern side of the Afton Water and sources its water from a tributary approximately 160 m to the south-east of the property.	No pathway connection possible and no associated risk.
Blackcraig Farm	The Langlee Burn drains the higher ground of Quintin Knowe and Laglass Hill to the east of Afton Water.	Hydrologically unconnected to the western side of the Glen Afton or tributaries associated with the Development Site.	The supply takes its water from the Langlee Burn, approximately 160 m to the east of Blackcraig Farm (just outside of the Study Area).	No pathway connection possible and no associated risk.
Dalhanna Farm	Hydrogeological catchment associated with elevated ground on Dalhanna Hill to the north of Dalhanna Farm.	Associated with possible superficial deposits or fractures within shallow bedrock with short/shallow flow paths.	A groundwater spring source located on the northern bank of the Dalhanna Burn, approximately 100 m to the south-east of Dalhanna Farm.	No pathway connection possible and no associated risk.
Laglaff Farm	Hydrogeological catchment associated with elevated ground at Ashmark Hill separating the PWS catchment and the Carcow Burn catchment area.	Associated with possible superficial deposits, lithological controls and / or fractures within shallow bedrock with short / shallow flow paths.	A groundwater spring, approximately 250 m to the south-east of the farm, and on the south-western bank of an unnamed tributary draining higher ground at Ashmark Hill.	No pathway connection possible and no associated risk.

Table 13.10 Potentially significant Hydrology and Hydrogeology effects

Activity	Effects	Receptors
Excavation of turbine foundations and turbine placement.	Ground disturbance from excavations and foundation works leads to sediment loading and / or the remobilisation of existing contamination resulting in the pollution of watercourses. Contamination of soils, surface waters and groundwater due to accidental release of pollutants during works. Excavation and fill leads to disruption of surface and near-surface flow paths and changes to the drainage regime, most typically increased runoff. Dewatering interception of groundwater leading to a loss of water resource and disruption of groundwater support (baseflow) to watercourses.	Aquifers and associated WFD groundwater bodies Watercourses and associated WFD surface water bodies Water conditions supporting conservation sites (including GWDTEs and ponds)
Laydown of construction compounds.	Contamination of soils, surface waters and groundwater due to accidental release of pollutants during works. Reduced infiltration capacity results in increased runoff, and reduced recharge to groundwater, leading to loss of water resource and disruption of baseflow to watercourses.	Aquifers and associated WFD groundwater bodies Watercourses and associated WFD surface water bodies Water conditions supporting conservation sites (including GWDTEs and ponds)
Forest felling.	Forest felling and ground disturbance leads to sediment and nutrient loading and / or the remobilisation of existing contamination resulting in the pollution of watercourses. Contamination of soils, surface waters and groundwater due to accidental release of pollutants during works. Forest felling leads to disruption of surface and near-surface flow paths and changes to the drainage regime, most typically increased runoff. Forest felling leads to breakdown of peat structure and disturbance of peat hydrology.	Aquifers and associated WFD groundwater bodies Watercourses and associated WFD surface water bodies Water conditions supporting conservation sites (including GWDTEs and ponds)

Activity	Effects	Receptors
Peat working.	Ground disturbance leads to sediment loading and / or the remobilisation of existing contamination resulting in the pollution of watercourses. Contamination of soils, surface waters and groundwater due to accidental release of pollutants during works. Peat disturbance leads to disruption of surface and near-surface flow paths and changes to the drainage regime, most typically increased runoff. Peat disturbance leads to breakdown of peat structure and disturbance of peat hydrology.	Aquifers and associated WFD groundwater bodies Watercourses and associated WFD surface water bodies Water conditions supporting conservation sites (including GWDTEs and ponds)
Material stockpiling / removal.	Ground disturbance from excavations leads to sediment loading and / or the remobilisation of existing contamination resulting in the pollution of watercourses. Contamination of soils, surface waters and groundwater due to accidental release of pollutants during works. Excavation and fill leads to disruption of surface and near-surface flow paths and changes to the drainage regime, most typically increased runoff. Dewatering interception of groundwater leading to a loss of water resource and disruption of groundwater support (baseflow) to watercourses.	Aquifers and associated WFD groundwater bodies Watercourses and associated WFD surface water bodies Water conditions supporting conservation sites (including GWDTEs and ponds)
Watercourse crossings.	Bank and bed disturbance leads to sediment loading, changes in morphology and pollution of watercourses. Contamination of watercourses due to accidental release of pollutants during works.	Watercourses and associated WFD surface water bodies
Track and crane pad placement.	Ground disturbance from excavations and placement leads to sediment loading and / or the remobilisation of existing contamination resulting in the pollution of watercourses.	Aquifers and associated WFD groundwater bodies Watercourses and associated WFD surface water bodies

Activity	Effects	Receptors
	Contamination of soils, surface waters and groundwater due to accidental release of pollutants during works. Track and crane pad placement leads to disruption of surface and near-surface flow paths and changes to the drainage regime, most typically increased runoff. Dewatering interception of groundwater leading to a loss of water resource and disruption of groundwater support (baseflow) to watercourses.	Water conditions supporting conservation sites (including GWDTEs and ponds)
Construction of control building and substation compound.	Ground disturbance from excavations leads to sediment loading and / or the remobilisation of existing contamination resulting in the pollution of watercourses. Contamination of soils, surface waters and groundwater due to accidental release of pollutants during works. Control building and substation compound placement leads to disruption of surface and near-surface flow paths and changes to the drainage regime, most typically increased runoff.	Aquifers and associated WFD groundwater bodies Watercourses and associated WFD surface water bodies Water conditions supporting conservation sites (including GWDTEs)
Operational facilities and activities.	Exposed ground leads to continued sediment loading and / or the remobilisation of existing contamination resulting in pollution of watercourses. Contamination of soils, surface waters and groundwater due to accidental release of pollutants during maintenance activities. Contamination of soils, surface waters and groundwater due to chemical leaks and concrete leaching. Continuation of flow disruption, reduced infiltration capacity and peat disruption effects.	Aquifers and associated WFD groundwater bodies Watercourses and associated WFD surface water bodies Water conditions supporting conservation sites (including GWDTEs and ponds)

Note: For each activity an effect will often impact many different types of receptors. Effects and receptors have only been listed above due to the large number possible linkages involved.

13.8 Environmental measures embedded into the development proposals

13.8.1 Embedded mitigation proposals are those mitigation measures that are inherent to the Proposed Development. Embedded mitigation includes all mitigation usually assumed to be in place during construction, operation and decommissioning, and is generally regarded as industry standard or Best Practice. The rationale for this approach is explained earlier in **Chapter 4 – Approach to Preparing The Environmental Impact Assessment Report**. Construction and environmental management plans are introduced in **Chapter 3 – Description of the Proposed Development**, whilst an overview of some of the general (not project specific) environmental management considerations is also included in **Chapter 3 – Description of the Proposed Development** of the EIA Report. Water-related embedded mitigation measures are presented below.

Design evolution

13.8.2 A qualitative, preliminary feasibility assessment for the potential location of the Proposed Development's wind turbines and infrastructure was undertaken as part of a desk-based study. The purpose of this study was to identify potential significant constraints that may be posed by the baseline conditions of the Study Area, so that the construction plan and layout of the Proposed Development (as described in **Chapter 3 – Description of the Proposed Development** and **Figure 3.1**) could be developed / refined to account for these constraints, and so minimise the potential risks and impacts to certain receptors during construction and operation.

13.8.3 A review of the baseline information for the Study Area (**Section 13.5**) identified potential development constraints associated with the Proposed Development. This led to areas being discounted for the siting of turbines, access tracks and other infrastructure, and areas being considered for development only if appropriate mitigation could be provided.

13.8.4 The preliminary constraints map generated as part of the feasibility process identified areas of the Study Area with the key constraints, which were used to help determine potential locations for the wind turbines, access tracks and other site infrastructure. To establish an indicative wind farm layout, buffer zones were placed around specific areas of the Development Site where significant constraints were identified to exclude these from the possible areas of the Proposed Development. Maps of hydrological constraints showing the Proposed Development layout are presented in **Figure 13.6** (including main access track) and **Figure 13.7** (main part of Development Site).

Avoidance of flood zones

13.8.5 The study identified potential significant fluvial flood constraints within certain areas of the Development Site. As a precaution, all areas identified as being located within a 1 in 100-year fluvial flooding zone were considered to be unsuitable for development. Policy 22 within NPF4 (2023) states that development proposals will not increase the risk of surface water flooding to others, or itself be at risk, will seek to minimise the area of impermeable surface, and manage all rain and surface water through sustainable urban drainage systems ('SuDS').

Watercourse buffer zones

13.8.6 A 50 m buffer zone was applied to the watercourse network (those showing on 1:50,000 OS mapping) (**Figures 13.6** and **13.7**). As well as providing further reassurance regarding

flood risk, this considers the risk of pollution to watercourses and the surface water abstraction from construction activities and provides a buffer to reduce the risk of uncontrolled run-off to watercourses. The buffer zone is unsuitable for development, with the exception of watercourse crossings where appropriate mitigation is provided (see later).

Avoidance of steep gradients

13.8.7 Parts of the Study Area where steep slopes at or greater than 7° were mapped and identified as a significant constraint due to potential peat slide risks and enhanced runoff. These areas, along with other areas identified as having historic peat slides, have been avoided for construction of turbines, as well as for access tracks and other infrastructure.

Avoidance of deep peat deposits

13.8.8 Potential significant constraints were identified in areas of the Development Site where peat was shown to be deeper than 1 m (**Figures 13.6** and **13.7**, also see **Chapter 6 – Carbon Balance and Peat Management**). Avoiding such areas serves to minimise the volume of peat needing to be excavated, and excavation of this depth of peat could also have significant local influences on hydrology and associated habitats. As such, every effort was made to avoid siting turbines in areas of relatively deep peat deposits, with only the north-eastern turbine (Turbine 1, T1) being located in areas of peat depth greater than 1 m. Micro-siting during construction for this turbine would aim to focus development on areas of shallower peat.

Conservation site buffer zones

13.8.9 The Development Site layout aimed to minimise incursions of SEPA (LUPS-GU31) 100 m (shallow excavation, <1 m deep) and 250 m (deep excavation, >1 m deep) buffer areas (**Figures 13.6** and **13.7**) around the potential GWDTEs identified earlier.

Micrositing

13.8.10 The Development Site layout is shown on **Figure 13.1**. It is proposed that the route of the access tracks and positions of individual turbines and other wind farm components would be microsited up to 50 m if unforeseen ground conditions are encountered in order to reduce potential environmental impacts.

Construction Site Licence

13.8.11 Under CAR, a proposed construction site in Scotland may need to obtain a Construction Site Licence (CSL) (2022) prior to commencing work. A CSL for the Proposed Development is likely to be required since the construction site is greater than 4 hectares (4 ha) in area and include trackways of greater than 5 km in length. This licence application requires the holder to adhere to a Pollution Prevention Plan ('PPP') that SEPA has reviewed and must consider the potential impacts of construction on the water environment. Further details of SEPA's requirements for a PPP to accompany a CSL is provided in guidance document WAT-SG-75 (SEPA, 2018).

Construction Environmental Management Plan

13.8.12 In accordance with the Good Practice during Wind Farm Construction guidance (SR, SNH, SEPA, FCS, HES, MSS and AEECoW, 2019), engineering activities that would

involve the construction of river crossings or drainage systems are avoided where possible to ensure that the Development Site and surface water system remain in a near as natural a state as possible. However, there are circumstances where this in not achievable due to the nature of the Proposed Development and restrictions on the number of options for access. Prior to the commencement of construction activities, a Construction Environmental Management Plan ('CEMP') would therefore be produced that would follow Best Practice guidance, as well as incorporating specific recommendations made in this EIA Report, and would therefore account for potential risks and ensure minimal effects on the Development Site Hydrology and Hydrogeology during construction. No works would be undertaken unless agreed in the CEMP.

13.8.13 The CEMP would include or be accompanied by a Water Management Plan ('WMP'), a PPP and a Pollution Incident Response Plan ('PIRP') for construction activities at the Development Site. The WMP would set out the specific details of surface water drainage, management of dewatered groundwater from excavations and watercourse crossings. The PPP would set out specific measures to protect Hydrology and Hydrogeology receptors from pollution arising from construction activities and a programme for inspection and monitoring to ensure the effectiveness of these measures. The PIRP would describe the response plan for pollution incidents, should accidental spillages occur despite the control measures in place.

Track design

13.8.14 On areas of peat depths greater than 1 m, floating roads are proposed. In a floating road, the weight of the road is supported by the peat beneath, thereby avoiding the need to construct foundations extending through to the underlying solid stratum. The floating roads would be constructed in line with the good practice guidance produced by FCS and SNH (2010) and SR, SNH, SEPA, FCS, HES, MSS and AEECoW (2019), and would include the use of geogrids and geotextiles. The geotextile used would be selected to maintain load distribution, ensure separation of aggregate and peat, and prevent peat rutting, erosion and drainage. Aggregate choice would be sensitive to peat geochemistry and would be of sufficient grade to allow infiltration through to the geotextile, as shown in **Figure 3.3**.

13.8.15 Even with floating roads, some interruption of surface and near-surface flows can occur. The track layout has therefore been designed to minimise the total track length, and to avoid, where possible, intersecting catchment areas in a manner that could significantly interrupt flow paths. Cross-drainage would be provided in areas where access tracks unavoidably intersect dominant flow pathways, as discussed below.

13.8.16 On areas of steeper gradient or where there are concerns about slope stability, the use of floating roads may not be appropriate and cut tracks would be considered. These would need to be cut all the way through the peat, thereby potentially increasing disturbance of the local hydrology. However, there is little coincidence of steep slope and deep peat on site, so the extent of these access tracks will be minimised.

Drainage design

13.8.17 The need for drainage on the access track network would be considered for all parts of the track network separately since slope and wetness vary considerably across the Development Site. In flat areas, drainage of floating roads is not required as it can be assumed that rainfall on to the access track would infiltrate to the ground beneath the access track or along the verges. Track-side drainage would be avoided where possible, to prevent any local reductions in the water table or influences on the access track

structure and compression (the latter can occur where a lower water table reduces the ability of the peat to bear weight, increasing compression).

13.8.18 Where access tracks are to be placed on slopes, lateral drainage would be required on the upslope side of the access track. The length of drains would be minimised, to prevent either pooling on the upslope side or, at the other extreme, creating long flow paths along which rapid run-off could occur. Regular cross-drains would be required to allow flow to pass across the access track as recommended in SR, SNH, SEPA, FCS, HES, MSS and AEECoW (2019) guidance, with a preference for subsequent re-infiltration on the downslope side, rather than direct discharge to the drainage network.

13.8.19 Check dams may be implemented in drainage ditches where necessary to reduce flow velocities to aid in the sedimentation of silt from suspension and to also direct water into the cross drains so that natural flow paths are maintained as far as possible.

13.8.20 The ditch design would be considered in line with the recommendations of the SR, SNH, SEPA, FCS, HES, MSS and AEECoW (2019) guidance, including the use of flat-bottomed ditches to reduce the depth of disturbance.

13.8.21 Cross-drainage may be by culverts or pipes beneath the access track, again in line with the SR, SNH, SEPA, FCS, HES, MSS and AEECoW (2019) guidance. Drainage would be installed before or during access track construction, rather than afterwards, to ensure that the access track design is not compromised. The cross drainage would flow out into shallow drainage, which would allow diffuse re-infiltration to the peat on the downslope side. The cross drains would flow out at ground level and not be hanging culverts. The avoidance of steep gradients for the access tracks would also reduce the risk of erosion occurring at cross-drain outflows.

13.8.22 In instances of drainage close to surface watercourses, discharge from the drainage may be to surface water rather than re-infiltration. In these situations, best practice control measures including sediment settlement would be undertaken before the water is discharged into surface water systems. The discharges would be small and collected from only a limited area, rather than draining a large area to the same location. Sufficient attenuation storage would also be incorporated into site drainage systems to ensure that discharge rates to watercourses do not exceed pre-development rates and taking into account potential increases in peak rainfall intensity due to climate change i.e., allowing for up to the 1% Annual Exceedance Probability (‘AEP’) event including the appropriate allowances for climate change covering the lifetime of the Proposed Development.

13.8.23 Although drainage would be provided in areas of disturbance as required, areas of hardstanding would be minimised so that this need is reduced. This includes careful design of construction compounds and minimising the size of crane pads at each turbine location.

13.8.24 The details of proposed site drainage measures would be set out in the WMP for the Development Site, which would accompany the CEMP. As the Development Site area considerably exceeds 4 ha, discharges from construction phase site surface water drainage systems would be subject to a CAR construction run-off licence from SEPA. The WMP would be subject to approval by SEPA through the CAR licence application process.

Cable trench design

13.8.25 Cables would be run alongside access tracks. The trenches would be installed at the minimal depth practical, although this may reach 0.5 – 1 m deep, a typical cable trench cross section being displayed in **Figure 3.6**. They would be dug and left open for the minimum time possible to ensure that they do not create open drainage routes. The cables would be laid directly into the trenches and a sand surround applied prior to the

overburden being replaced. The trenches would be backfilled as far as possible with excavated peat, to minimise the change to flow paths. Where other material is used to backfill the trenches, clay cut-off barriers would be installed across the trench to prevent them creating preferential flow paths.

13.8.26 Cable laying methods that do not require a dug trench would be considered. FCS and SNH (2010) suggest that it may be possible to inset the cable in peat flanks alongside the edges of the floating roads, so that they are protected but do not need to be dug into the ground, disturbing the peat and associated flow paths.

Watercourse crossings design

13.8.27 The number of watercourse crossings has been minimised, but due to the number of watercourses and preferential flow pathways, and limitations regarding access locations, it is not possible for the Proposed Development to take place without some crossings. The types of watercourse crossing available typically comprise bridges, culverts and causeways. Bridges in general are the preferred solution due to their lesser hydrological and ecological effects, but where there are small or indistinct channels with little topographic variability culverts are more appropriate.

13.8.28 Adherence to WAT-SG-25 (SEPA, 2010)[i], River Crossings and Migratory Fish: Design Guidance (Scottish Government, 2012) and CIRIA Report C786: Culvert, Screen and Outfall Manual (2019) helps to minimise potential hydrological (including morphological) effects. All watercourse crossings would be designed to convey a 1 in 200-year return period flood event with an allowance for climate change, and each watercourse / flow pathway crossing has been considered individually with respect to topography and hydrology. The proposed locations and types of watercourse and flow path crossings are shown in **Figure 13.6** and summarised in **Table 13.11**.

Table 13.11 Types of watercourse and flow path crossings

Crossing no.	Location	Receptor code	Coordinates	Type	Comments
RX1	On proposed track crossing Monquhill Burn (tributary to the Carcow Burn)	W01	E 259027, N 606772	Simple culvert	Proposed
RX2	On existing track crossing an unnamed tributary to the Carcow Burn	W01	E 259272, N 606963	Simple culvert	Upgraded
RX3	On existing track crossing the Carcow Burn	W01	E 259322, N 606982	Simple culvert	Upgraded
RX4	On existing track crossing the Glenhastel Burn	W03	E 259482, N 606740	Simple culvert	Upgraded
RX5	On existing track crossing the	W05	E 260860, N 607361	Simple culvert	Upgraded

Crossing no.	Location	Receptor code	Coordinates	Type	Comments
	Glenshalloch Burn				
RX6	On existing track crossing an unnamed tributary of the Glenshalloch Burn	W05	E 260957, N 608294	Simple culvert	Upgraded

13.8.29 Five simple culvert type upgrades to existing crossings and one new culvert crossing are proposed using a cross sectional area that would not impede flow of water. The design of culverts would be to at least CIRIA Report C786: 'Culvert, Screen and Outfall Manual' (2019) standard and the culvert structure would not affect either the channel or banks. The existing alignment of the watercourses would remain unchanged. The Solway Tweed RBMP (2015) states that even for minor watercourses culverting permission would only be granted if EAC is satisfied that there are acceptable mitigation measures to protect habitats, passage of fauna, and river form and flow.

13.8.30 The culverts would require some level of authorisation under CAR. According to CAR, a Practical Guide (2022), registration is required for *"single-track roads and single-track railways, footpaths and / or cycle routes, where the affected watercourse is not more than 2m wide"*. Registration is also required for bottomless arch culverts over wider watercourses where no part of the structure encroaches on the channel bed and provided the total length of structures on both banks does not exceed more than 20 m. Pipe or box culverts and / or a bridge for watercourses exceeding 2 m in width would require a Simple Licence.

13.8.31 All turbine cables need eventually to lead to the control building that is proposed to be located at coordinates E 259224, N 606934. This means that the cables from turbines to the south-west of the control building would need to be brought to the north-east along the existing track and crossing Monquhill Burn (tributary to the Carcow Burn). This would require cable trenching to leave the access tracks to cross the watercourse. The WAT-SG-25 (SEPA, 2010) discusses cable crossings and identifies boring beneath the channel as having the least impact on watercourses. Directional drilling would therefore possibly be required to pass the cable beneath the Monquhill Burn and to ensure that there is no influence on the watercourse. GBR7 would be adhered to in laying the cable beneath the watercourse. A full geotechnical assessment would be undertaken at the detailed design stage following consent.

Excavations and associated drainage

13.8.32 Where possible, excavations required to facilitate the construction of foundations for the wind turbines, service trenches and each crane base would be designed so that they can freely drain by gravity. Cut-off drains would be installed around the excavation areas to prevent surface run-off entering the excavations. The turbine footprint is ~ 0.05 ha based on a 25 m diameter foundation which would be excavated to a depth of ~2-3 m depending on ground conditions (**Figure 3.4**).

13.8.33 Measures based on Best Practice guidelines from SEPA would be adopted during construction to prevent pollution, with all contractors aware of a pre-planned pollution incident response procedure, as detailed in GPP21. The turbine foundation design

minimises excavation requirements in accordance with BS6031: 2009 Code of Practice for Earth Works.

13.8.34 Turbine construction would need to adopt mitigation measures to prevent contaminants entering the shallow groundwater system. The main potential groundwater effect arising from the construction of the wind turbine foundations and adjacent crane pads is the risk of leaching concrete residues into the water environment. Given the dominant soil type and areas of peat distribution, the near-surface groundwater at the Development Site is likely to be acidic. Therefore, to minimise the potential of concrete leaching and alkaline pollution of groundwater, suitable sulphate-resistant concrete would be used. The foundation design would be checked with SEPA and, if necessary, the foundation excavations would incorporate an adequate barrier to prevent the mitigation of any on-site pollutants to the underlying groundwater.

13.8.35 Should ground conditions occur during excavation where gravity drainage is not possible (i.e., where low permeability rock or superficial deposits are present) the excavations would be dammed and drained by pumping. These dewatering activities would be undertaken in accordance with Best Practice (including WAT-SG-29 on Temporary Construction Methods), which would be detailed in the CEMP to be agreed by SEPA and the ECoW prior to commencement of construction works.

13.8.36 The design for the dewatering would ensure collection and settling of suspended sediment i.e., use of silt traps, fences, straw bales or lagoons. Any water removed from the excavation would be treated and pumped to a bunded and vegetated settlement and infiltration swale, downgradient of the excavation and away from watercourses, and there would be no discharge of water directly into a watercourse. The potential for infiltration would need to be carefully assessed due to the prevalence of saturated conditions across the Development Site. Should this be an issue, a number of these swales could be used with a wide spatial distribution to prevent oversaturation. If large volumes of water are expected from dewatering, other SuDS elements such as french drains could also be utilised (subject to ground conditions). Should local topography or ground conditions prove unsuitable for construction of either infiltration swales or settlement lagoons, the use of portable silt trap devices such as 'Siltbuster' type tanks could be considered for removal of elevated suspended solids from water pumped from excavations. These activities would be designed and implemented in consultation with SEPA on a foundation-specific basis following completion of detailed ground investigations and micrositing prior to construction.

13.8.37 The locations of swales or settlement lagoons, where required, would be on stable areas of shallow slope, to reduce the risk of failure. The size of the settlement lagoons would be appropriate to the amount of dewatering, but if large quantities of dewatering are anticipated, the potential for more than one lagoon or the use of portable silt trap devices would be considered on a foundation-by-foundation basis. If any discharge to surface watercourses is required, the water would be treated beforehand and the need for any consent from SEPA agreed (it is expected that in most cases the activities would be covered by GBR3 and / or GBR15).

13.8.38 No borrow pits have been proposed within the Development Site and all supply of crushed aggregate and rock during the construction phase would be imported onto the Development Site. Within deeper excavations, any required dewatering during rock removal, based on the status of the aquifer (low permeability), is anticipated to involve small volumes of water and limited impacts to groundwater resources. Similar controls to those detailed above would be employed to prevent contamination of surface waters with suspended sediment. The dewatering of excavations at greater than 10 m^3/day would require CAR Registration, while over 50 m^3/day would require a CAR licence. Abstractions smaller than 10 m^3/d would comply with GBR3.

Peat excavations and storage

13.8.39 Surface run-off from stockpiles of excavated peat, whether temporarily stored prior to backfilling or permanent stored in peat storage areas, has the potential to affect surface water quality due to the transportation of suspended solids in surface water run-off. Therefore, Best Practice measures e.g., SR, SNH, SEPA, FCS, HES, MSS and AEECoW (2019) guidance would be implemented to ensure that peat is appropriately stored.

13.8.40 During the design phase of the Proposed Development the selection of appropriate turbine sites has avoided wherever possible, areas where substantial peat thicknesses have been identified. This helps to reduce the volumes of peat that are required to be excavated for the construction of concrete foundation slabs and therefore the need to manage materials. However, it has not been possible to avoid all areas where peat overlies the solid geology. Consequently, mitigation measures would be adopted to prevent changes which have the potential to influence water quality.

13.8.41 Surface run-off from stockpiled materials excavated has the potential to affect surface water quality if these are inappropriately excavated and stored. The peat storage areas would be located at a distance from any watercourses and would be contained to prevent sediment or nutrient run-off from eventually reaching downstream watercourses.

13.8.42 The storage of peat during construction would minimise slumping and maintain stratification, where possible using water derived from dewatering activities to keep the peat adequately saturated to prevent desiccation and degradation. It is anticipated that all excavated peat can be re-used on site, and so it is not expected that any peat would need disposal or long-term storage by way of a waste management licence. Neither is it expected that there would need to be storage of peat spoil for a period greater than one year and thus no requirement for a permit in accordance with the Landfill (Scotland) Regulations 2003.

13.8.43 The upper levels of the peat and turf excavated for the turbine bases can be used for resurfacing following construction (in non-hardstanding areas), thus maintaining the hydrological and biological characteristics of the location. This resurfacing would aim to restore a flat surface around the turbine, preventing mounding. This would help to re-establish hydraulic continuity of the replaced peat and turf with surrounding saturation levels, thereby reducing the possibility of peat drainage and desiccation.

13.8.44 Policy NE15 of LDP2 (**Table 13.1**) states that proposed developments affecting peat deposits not already designated for habitat conservation reasons may be permitted provided renewable energy generating development is proposed and it can be demonstrated that the balance of advantage in terms of climate change mitigation lies with the energy generation proposal (**Chapter 6 –Carbon Balance and Peat Management**). In such a case, appropriate site restoration measures to something other than functioning peat land would be required. The removal of forestry on the Development Site may allow for the reinstatement of some areas of deep peat.

Forest felling

13.8.45 Detailed Construction Method Statements (‘CMSs’) would be produced for all aspects of site work, including a series covering forestry activities. This documentation would require approval from EAC (following consultation with SEPA) prior to commencement of site works.

13.8.46 Forest operational planning at a site level is the key to ensuring that siltation and erosion are minimised. Before any harvesting operations commence, there would be a need to assess the vulnerability of the Development Site to erosion, including the upslope and downslope routing of water, the condition of watercourses, and any pre-existing

deficiencies in the drainage system that are contributing to active erosion. A harvesting CMS, including contingencies for possible events such as severe weather, would be developed. The harvesting CMS would describe how the Development Site would be set out and worked to reduce the risk of adverse effects. This would cover the selection of the appropriate matching of harvesting machinery to ground conditions and the identification of techniques to minimise disturbance and afford protection to watercourses and previously unidentified GWDTEs. The timing of operations to avoid adverse weather and ground conditions, and mitigation measures as per the Forests and Water Guidelines, in support of the UK Forestry Standard, would be identified in the harvesting CMS. The Guidance includes many of the water management mitigation described elsewhere in this section. With respect to acidification of surface waters, and also in line with the UK Forestry Standard, no more than 20% of any catchment greater than 100 ha in a Nitrate Vulnerable Zone ('NVZ') would be felled. This would be supplemented by an assessment of the contribution of the proposed forest felling to acidification and the recovery process as required.

13.8.47 The harvesting CMS would also be informed by an agreed sediment loss CMS. Prior to felling, areas would be risk-assessed and mapped to identify the sensitivity of the ground to sediment generation and corresponding requirements for mitigation. The risk assessment criteria would include the 50 m watercourse buffer, areas with high densities of watercourses, steep ground, poorly drained organic soils, proximity to water bodies and existing drains and plough lines. The main output from this risk assessment would be a sediment loss control map.

13.8.48 Prior to operations, priority areas would be marked on the ground, and all contractors would be required to undertake an induction detailing all aspects contained in the CMS. The operational controls to be employed would depend on the assessed compartment priorities, ranging from standard forestry best practice following the UK Forestry Standard on standard priority areas of relatively gentle and accessible slopes, with freely draining, mineral soils and comparatively few watercourses, to extensive operational controls (dry weather working, brash mats, band-tracks, drainage interception) on high priority areas of deep peat and / or steeper gradients, poorly draining soils and numerous watercourses. Contingency planning would also be put in place, and if necessary, silt traps would be used as a final backstop to address sedimentation of watercourses. These traps would be monitored twice daily when required, which should be sufficient for the specific cause of the sedimentation to be identified and any associated mitigation measures to take effect.

13.8.49 The harvesting CMS would also take account of a forest residue CMS. This CMS would include a number of measures that would protect peat during tree harvesting. These measures include the use of brash mats to support harvesting and excavation machinery as well as to protect underlying peat from rutting, compaction and erosion, and the leaving of the mats and tree stumps in situ where there is no infrastructure post-harvesting, to minimise ground disturbance associated with their digging out.

13.8.50 Although the proposed area of felling is minimal (see **Appendix 3A - Forestry Assessment**) it requires compensatory planting as it would be taken as permanent felling. There is some risk of windblow to the tree crop adjacent to the track, but this would reduce the amount of felling required. Alternatively, it would be possible to fell the areas adjacent to the track and replant.

13.8.51 SEPA's guidance on GBRs and the Forests and Water Guidelines and UK Forestry Standard set out an extensive range of guidelines for ensuring risks to the aquatic environment from forestry operations are minimised. The Guidance includes many of the water management mitigation measures described elsewhere in this section. However, whilst the UK Forestry Standard also makes reference to the need for watercourse buffer zones (20 m width for larger watercourses, less than the 50 m being adopted for the Proposed Development), in this case these buffers are not exclusion zones, so much as a

managed forest standoff zone. This zone aims to ensure that later forest management practices, such as pesticide application, do not affect the water environment.

Site working practices

13.8.52 Site activities during construction and operation have been identified to have potential effects on the water environment. These can be controlled by the implementation of pollution prevention and control measures and Best Practice, based on the guidance outlined earlier.

13.8.53 The site induction for contractors would include a specific session on good practice to prevent and control water pollution from construction activities. Contractors would be made aware of their statutory responsibilities under CAR. As discussed earlier, a PPP and PIRP would be prepared for the Proposed Development, the latter in line with GPP 21, and all contractors would be briefed on these plans, with copies made available on site. Equipment to contain and absorb spills would also be readily available.

13.8.54 Fuel and oil may enter the groundwater by migration vertically into the underlying groundwater or by run-off into nearby surface waters, if accidentally released or spilled during storage and refuelling. To minimise potential releases into the water environment, fuel would be stored in either a bunded area or a self-bunded above-ground storage tank ('AST') kept on site during the course of the construction phase in accordance with CAR and other SEPA Pollution prevention guidelines, and GBR9. The bunded area would have a capacity of 110 % of the fuel tank. All stores would be located at least 50 m from any watercourses.

13.8.55 In areas where there is a potential for hydrocarbon residues from run-off / isolated leakages, such as in plant storage areas and around fuel storage tanks and in refuelling zones in the proposed temporary site compound, surface water drainage would be directed to a hydrocarbon interceptor prior to discharge. The interceptor would filter out hydrocarbon residues from drainage water and retain hydrocarbon product in the event of a spillage to prevent release into surface waters at the discharge point and deterioration of downstream water quality.

13.8.56 Plant and machinery used during the construction phase would be maintained to minimise the risks of oils leaks or similar. Maintenance and refuelling of machinery would be undertaken off-site or within designated areas of temporary hardstanding. In these designated areas contingency plans would be implemented to ensure that the risk of spillages is minimised. Placing a drip tray beneath a plant and machinery during refuelling and maintenance would contain small spillages.

13.8.57 The main potential hydrological effects during the operational phase of the Proposed Development relate to the servicing of the turbines and storage of oils and lubricants typically involved in this process, which may be accidentally released into the water environment.

13.8.58 At the control building the small quantity of sewage arising from the infrequent visits of maintenance staff would likely discharge into a septic tank connected to a soakaway. Water extraction for welfare facilities (non-potable) would be provided via mains water supply where available, and if not by a water harvesting and UV filter system.

13.8.59 The potential risks posed to surface water and groundwater quality, specifically related to the operational period, are likely to be limited and localised based on the planned works and the nature and volume of substances required. Any potential risk to the environment would be identified by the operator prior to servicing being undertaken. The operator would ensure a site-specific risk assessment is completed and that control measures are implemented to ensure all environmental risks are minimised. However, as a pre-requisite

the storage, use and disposal of oils would be done in accordance with Best Practice and SEPA guidance (GPP 8) (see earlier).

13.8.60 Potential ongoing effects in relation to infrastructure remaining on the Development Site during operations (including the turbine locations and access tracks) were addressed during the discussion of construction mitigation above. Ongoing maintenance would be carried out, for example, to maintain drainage and settlement ponds.

Summary

13.8.61 A range of environmental measures have been embedded into the development proposals as outlined above. A summary of how these embedded measures relate to each of the receptor groups in the assessment is presented in **Table 13.12**.

Table 13.12 Summary of the embedded environmental measures

Receptor	Changes and effects	Embedded measures
Aquifers and associated WFD groundwater bodies	Soil compaction and the introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels, leading to a loss of water resource.	Minimising areas of hardstanding. Drainage design. WMP. CEMP.
	Dewatering during construction leading to a decline in groundwater levels.	Best Practice guidelines e.g., WAT-SG-29. Dewatering and associated drainage consistent with requirements of GBRs 3 and 15. WMP. CEMP.
	Site activities during construction, operation and decommissioning resulting in the release of pollutants and the subsequent contamination of groundwater, leading to a loss of water resource.	Best Practice guidelines. PPP. PIRP in accordance with GPP 21 Fuel storage in accordance with *CAR* and GBR9. Hydrocarbon interceptors. Regular vehicle maintenance in designated hardstanding areas Oil storage in accordance with GPP 8. CEMP.
Watercourses and associated WFD surface water bodies	Soil compaction and the introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, leading to changes in watercourse flow, quality and morphology.	Avoidance of steep gradients. Avoidance of deep peat deposits. Avoidance of flood zones. Watercourse buffer zones. Minimising areas of hardstanding. Drainage design. WMP. CEMP. Cable trench design. Watercourse crossings design. Adherence to forestry CMSs.
	Disruption of flow paths and changes to drainage regime	Avoidance of steep gradients. Avoidance of deep peat deposits.

Receptor	Changes and effects	Embedded measures
	during construction and throughout operation can be associated with increases in runoff and less on-site water retention, leading to changes in watercourse flow and morphology.	Avoidance of flood zones. Watercourse buffer zones. Minimising areas of hardstanding. Drainage design. WMP. CEMP. Cable trench design. Watercourse crossings design. Adherence to forestry CMSs.
	Disruption of ground during construction leading to increased sediment loading, leading to changes in watercourse quality and morphology.	Avoidance of steep gradients. Avoidance of deep peat deposits. Avoidance of flood zones. Watercourse buffer zones. Minimising areas of hardstanding Drainage design. WMP. CEMP. Cable trench design. Watercourse crossings design. Adherence to forestry CMSs.
	Dewatering and / or drainage during construction disrupting groundwater support (baseflow), leading to changes in watercourse flow.	Avoidance of flood zones. Watercourse buffer zones. Best Practice guidelines e.g., WAT-SG-29. Dewatering and associated drainage consistent with requirements of GBRs 3 and 15. WMP. CEMP.
	Discharge to surface water of groundwater intercepted during construction, leading to changes in watercourse flow, quality and morphology.	Avoidance of flood zones. Watercourse buffer zones. Best Practice guidelines e.g., WAT-SG-29. Dewatering and associated drainage consistent with requirements of GBRs 3 and 15. WMP. CEMP.
	Site activities during construction and operation resulting in the release of pollutants and the subsequent contamination of surface waters, leading to changes in watercourse quality and morphology.	Avoidance of flood zones. Watercourse buffer zones. Best Practice guidelines. PPP. PIRP in accordance with GPP 21 Fuel storage in accordance with *CAR* and GBR9. Hydrocarbon interceptors. Regular vehicle maintenance in designated hardstanding areas. Oil storage in accordance with GPP 8. CEMP.
Water conditions supporting ponds, conservation sites and	Soil compaction and the introduction of areas of hardstanding during construction and throughout operation	Conservation site buffer zones. Minimising areas of hardstanding. Drainage design. WMP.

Receptor	Changes and effects	Embedded measures
GWDTEs (groundwater)	reducing recharge and groundwater levels, leading to reduced groundwater support.	CEMP.
	Dewatering during construction lowering groundwater levels, leading to reduced groundwater support.	Conservation site buffer zones. Best Practice guidelines e.g., WAT-SG-29. Dewatering and associated drainage consistent with requirements of GBRs 3 and 15. WMP. CEMP.
	Site activities during construction and operation resulting in the release of pollutants and the subsequent contamination of groundwater, leading to polluted groundwater support.	Conservation site buffer zones. Best Practice guidelines. PPP. PIRP in accordance with GPP 21 Fuel storage in accordance with *CAR* and GBR9. Hydrocarbon interceptors. Regular vehicle maintenance in designated hardstanding areas. Oil storage in accordance with GPP 8. CEMP.
	Physical disturbance of the peat and groundwater throughflow, leading to reduced groundwater support.	Avoidance of deep peat deposits. Conservation site buffer zones. CEMP. PMP.
Water conditions supporting ponds, conservation sites and GWDTEs (surface water)	Soil compaction and the introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, leading to changed / polluted surface water support.	Avoidance of steep gradients. Avoidance of deep peat deposits. Conservation site buffer zones. Avoidance of flood zones. Watercourse buffer zones. Minimising areas of hardstanding. Drainage design. WMP. CEMP. Cable trench design. Watercourse crossings design. Adherence to forestry CMSs
	Disruption of flow paths and changes to drainage regime during construction and throughout operation increasing runoff and reducing on-site water retention, leading to changed surface water support.	Avoidance of steep gradients. Avoidance of deep peat deposits. Conservation site buffer zones. Avoidance of flood zones. Watercourse buffer zones. Minimising areas of hardstanding. Drainage design. WMP. CEMP. Cable trench design. Watercourse crossings design. Adherence to forestry CMSs.
	Disruption of ground during construction resulting in	Avoidance of steep gradients. Avoidance of deep peat deposits.

Receptor	Changes and effects	Embedded measures
	increased sediment loading, leading to polluted surface water support.	Conservation site buffer zones. Avoidance of flood zones. Watercourse buffer zones. Minimising areas of hardstanding. Drainage design. WMP. CEMP. Cable trench design. Watercourse crossings design. Adherence to forestry CMSs.
	Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses leading to reduced surface water support.	Conservation site buffer zones. Avoidance of flood zones. Watercourse buffer zones. Best Practice guidelines e.g., WAT-SG-29. Dewatering and associated drainage consistent with requirements of GBRs 3 and 15. WMP. CEMP.
	Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading, leading to changed and polluted surface water support.	Conservation site buffer zones. Avoidance of flood zones. Watercourse buffer zones. Best Practice guidelines e.g., WAT-SG-29. Dewatering and associated drainage consistent with requirements of GBRs 3 and 15. WMP. CEMP.
	Site activities during construction and operation resulting in the release of pollutants and the subsequent contamination of surface waters, leading to polluted surface water support.	Avoidance of flood zones. Watercourse buffer zones. Best Practice guidelines. PPP. PIRP in accordance with GPP 21 Fuel storage in accordance with *CAR* and GBR9. Hydrocarbon interceptors. Regular vehicle maintenance in designated hardstanding areas. Oil storage in accordance with GPP 8. CEMP.

13.9 Assessment methodology

13.9.1 The generic project-wide approach to the assessment methodology is set out in **Chapter 4 – Approach to Preparing the EIA Report**. This section describes how the methodology is applied and adapted as appropriate to address the specific needs of this Hydrology and Hydrogeology assessment.

13.9.2 The current and future baseline presented in **Section 13.5** provide the benchmark against which the potential impact of the Proposed Development, alone and cumulatively with other wind farm developments, is assessed.

13.9.3 The significance of the effects resulting from the Proposed Development is primarily determined by reference to the value (importance) of a given water feature and the magnitude of change. In terms of the Hydrology and Hydrogeology, the key types of effects relate to water quantity (level and flow) and quality. However, depending on the effects on surface water flows, there may also be effects on immediate and downstream morphology and sediment dynamics.

13.9.4 The assessment presented in **Section 13.10** is therefore based on both receptor value and the nature and magnitude of the impact as a result of the Proposed Development. All mitigation considered necessary is identified and residual effects with this mitigation in place determined.

13.9.5 **Table 13.13** provides a summary of the criteria that are used in the assessment of the feature value and introduces the concept of receptor type (a group of receptors whose value is assessed using the same criteria). However, with the 'scoping out' of both abstractions and flood risk, water use, and flood risk receptor groups are no longer included in the summary, so that only the aquatic environment receptor group remains. The assessment criteria are semi-quantitative and therefore professional judgement is required in the assessment.

Table 13.13 Summary of value of Hydrology and Hydrogeology receptors

Value	Criteria	Receptor type*	Examples
High	Features with a high yield, quality or rarity with little potential for substitution.	Aquatic environment	Conditions supporting a site with an international conservation designation (e.g., SAC), where the designation is based specifically on aquatic features. WFD surface water body (or part thereof) with overall High status, also any associated upstream non-reportable WFD surface water body or non-WFD surface water body. WFD surface water body (or part thereof) with High status for morphology.
Medium	Features with a medium yield, quality, or rarity, with a limited potential for substitution.	Aquatic environment	Conditions supporting a site with a national conservation designation (e.g., SSSI), where the designation is based specifically on aquatic features. WFD surface water body (or part thereof) with overall Good status / potential, also any associated upstream non-reportable WFD surface water body or non-WFD surface water body. WFD groundwater body (or part thereof) with overall Good status.
Low	Features with a low yield, quality or rarity, with some potential for substitution.	Aquatic environment	Conditions supporting a site with a local conservation designation, where the designation is based specifically on aquatic features, or an undesignated but highly / moderately water-dependent

Value	Criteria	Receptor type*	Examples
			ecosystem, including a LNCS and a GWDTE. WFD surface water body (or part thereof) with overall Moderate or lower status / potential, also any associated upstream non-reportable WFD surface water body or non-WFD surface water body. Groundwater body (or part thereof) with overall Poor status.
Very Low	Commonplace features with very low yield or quality with good potential for substitution.	Aquatic environment	Conditions supporting an undesignated and low water-dependent ecosystem, including a GWDTE, ancient woodland and pond. Non-reportable WFD surface water body (or part thereof), or non-WFD surface water body, not associated with any downstream WFD surface water body. Non-reportable WFD groundwater body (or part thereof), or non-WFD groundwater body including non-abstraction springs.
	Water use does not support human health, and of only limited economic benefit.	Water use	Unlicensed well shown on OS mapping.

*Receptor types map onto the receptor lists as follows:

- aquatic environment – refers to aquifers and WFD groundwater bodies, watercourses and WFD surface water bodies, conditions supporting designated conservation sites and GWDTEs.

13.9.6 The magnitude of change on water receptors is independent of the value of the receptor, and its assessment is semi-quantitative and again reliant in part on professional judgement. **Table 13.14** provides examples of how various levels of change have been determined with respect to water features.

Table 13.14 Summary of Hydrology and Hydrogeology magnitude of change

Magnitude	Criteria	Receptor type	Example*
High	Results in major change to feature, of sufficient magnitude to affect its use / integrity.	Aquatic environment	Deterioration in river flow regime, morphology or water quality, leading to sustained, permanent or long-term breach of relevant conservation objectives ('Cos') or non-temporary downgrading (deterioration) of WFD surface water body status (including downgrading of individual WFD elements) or dependent receptors (including conservation sites), or resulting in the inability of the surface water body to attain Good status in line with the measures identified in the RBMP. Deterioration in groundwater levels, flows or water quality, leading to non-temporary downgrading of status of WFD groundwater body or dependent receptors (including conservation sites and GWDTEs), or the inability of the groundwater body to attain Good status in line with the measures identified in the RBMP.
Medium	Results in noticeable change to feature, of sufficient magnitude to affect its use / integrity in some circumstances.	Aquatic environment	Deterioration in river flow regime, morphology or water quality, leading to periodic, short-term and reversible breaches of relevant COs, or potential temporary downgrading of surface water body status (including potential temporary downgrading of individual WFD elements), or dependent receptors (including conservation sites), although not affecting the ability of the surface water body to achieve future WFD objectives. Deterioration in groundwater levels, flows or water quality, leading to potential temporary downgrading of status of WFD groundwater body or dependent receptors (including conservation sites and GWDTEs), although not affecting the ability of the groundwater body to achieve future WFD objectives.
Low	Results in minor change to feature, with insufficient magnitude to affect its use / integrity in most circumstances.	Aquatic environment	Slight change in river flow regime or water quality, but remaining generally within COs, and with no short-term or permanent change to WFD surface water body status (of overall status or element status) or dependent

Magnitude	Criteria	Receptor type	Example*
			receptors (including conservation sites). Slight deterioration in groundwater levels, flows or water quality, but with no short-term or permanent downgrading of status of WFD groundwater body or dependent receptors (including conservation sites and GWDTEs).
Very Low	Results in little or no change to feature, with insufficient magnitude to affect its use / integrity	Aquatic environment	None or very slight change in river flow regime or water quality, and no consequences in terms of COs or surface water body status or dependent receptors (including conservation sites). No or very slight change in groundwater levels or quality, and no consequences in terms of status of WFD groundwater body or dependent receptors (including ponds, conservation sites and GWDTEs).
		Water use	No or very slight change in water availability or quality and no change in ability of the water user to exercise licensed rights or continue with small private abstraction.

*For the purposes of this assessment of change, relevant WFD elements for surface water body classification include:

- all biological quality elements e.g., fish, macrophytes, invertebrates;
- all physico-chemical quality elements e.g., dissolved oxygen, phosphate;
- hydromorphological supporting elements;
- Priority Hazardous Substances;
- Priority Substances;
- Specific Pollutants; and, for Artificial and Heavily Modified Water Bodies,
- the mitigation measures assessment.

For the purposes of this assessment of change, relevant WFD characteristics for groundwater body classification are quantity (groundwater level regime) and chemistry (conductivity and source of pollutants), as determined by the following tests:

- Water balance (quantitative);
- DWPAs (chemical);
- General Quality Assessment (chemical);
- Saline and other intrusions (quantitative and chemical);
- Surface water (quantitative and chemical); and
- GWDTEs (quantitative and chemical).

13.9.7 The EIA Regulations require that a final judgement is made about whether the effects are likely to be significant. The significance of water-related effects is derived by considering both the value of the feature and the magnitude of change. In this assessment, effects are significant or not significant according to the matrix in **Table 13.15** with *'Major'* and

'Moderate' effects taken to be *'Significant'*. Significance can be *'Beneficial'*, *'Adverse'* or *'Neutral'*.

Table 13.15 Significance evaluation matrix relating to hydrology and hydrogeology

		Magnitude of change			
		High	Medium	Low	Very Low
Value	High	Major (Significant)	Major (Significant)	Moderate (Probably significant)	Minor (Not significant)
	Medium	Major (Significant)	Moderate (Probably significant)	Minor (Not significant)	Negligible (Not significant)
	Low	Moderate (Probably significant)	Minor (Not significant)	Negligible (Not significant)	Negligible (Not significant)
	Very Low	Minor (Not significant)	Negligible (Not significant)	Negligible (Not significant)	Negligible (Not significant)

Note: 'Significant' effects are those identified as 'Major'. 'Moderate' effects would normally be deemed to be 'significant'. However, there may be some exceptions, depending on the environmental topic and the application of professional judgment.

13.9.8 It is important to recognise that *'significant'* effects on Hydrology and Hydrogeology receptors in the water environment do not necessarily mean that the same outcomes would occur in respect of the same receptors that may also be ecology receptors. Indeed, because of the different value and magnitude criteria used by the two assessments, it is possible that effects assessed as *'Not significant'* in one environmental topic assessment, e.g., Hydrology and Hydrogeology, can still sit alongside effects assessed as *'Significant'* in another environmental topic assessment, e.g., ecology, and vice-versa.

13.10 Assessment of Hydrology and Hydrogeology effects

Aquifers and associated WFD groundwater bodies (GW01 and GW02)

13.10.1 Based on the water environment baseline presented in **Section 13.5**, **Section 13.7** identified that the potential effects due to the Proposed Development on two aquifers and their associated WFD groundwater bodies required consideration as part of the assessment, namely the local bedrock aquifer and Upper Nithsdale WFD groundwater body (GW01) and, the bedrock aquifer and Galloway WFD groundwater body (GW02) (**Table 13.8** and **Figure 13.5**).

13.10.2 Proposed works that would overlie these WFD groundwater bodies include the following:

- GW01: Upgrades to the existing access route from Pencloe to proposed turbine T1 and the new proposed access trackway to the battery storage compound, temporary construction compound and control building and substation compound located at Monquhill. Other works include the proposed new access trackway and turbine T1 and associated crane pads and blade laydown areas, together with associated land clearance, peat workings, forest felling, material storage and operational activities; and

- GW02: Proposed access trackway from proposed turbines T1 to T2 and associated infrastructure, including crane pads and blade laydown areas.

13.10.3 **Table 13.12** indicates that loss or contamination of the groundwater resource could occur as a result of the following:

- Soil compaction and the introduction of areas of hardstanding during construction and throughout operation, reducing recharge and groundwater levels;
- Dewatering during construction, leading to a decline in groundwater levels; and
- Site activities during construction and operation resulting in the release of pollutants and the subsequent contamination of groundwater.

13.10.4 The local bedrock aquifer is of low productivity and its associated WFD groundwater body, the Upper Nithsdale, is of Poor overall status, and therefore it is considered to be of low value (**Table 13.13**). The Galloway WFD groundwater body has Good overall status and so is considered as being of medium value.

13.10.5 Mitigation that looks to protect the aquifers and WFD groundwater bodies includes adherence to the WMP and CEMP, BS6031: 2009 Code of Practice for Earth Works, WAT-SG-29 on Temporary Construction Methods and any dewatering CAR registration or licence requirements (**Section 13.8** and **Table 13.12**). The limited extent of the proposed works compared to the area of both the Development Site and the aquifers, the low permeability of the aquifers, and the anticipated effectiveness of the embedded environmental measures combine to limit the magnitude of change to the aquifers and WFD groundwater bodies baseline condition.

13.10.6 The magnitude of change to these aquifers and WFD groundwater bodies with respect to the soil compaction and hardstanding (groundwater levels), turbine foundation dewatering works (groundwater levels) and site activities (groundwater quality) is therefore very low (**Table 13.14).**

13.10.7 On this basis, the level of effect on the aquifers and WFD groundwater bodies is negligible adverse (**not significant**) (**Table 13.15**).

Watercourses and associated WFD surface water bodies (W01 - W012)

13.10.8 Based on the water environment baseline presented in **Section 13.5**, **Section 13.7** identified that potential effects due to the Proposed Development on three WFD surface water bodies and their associated watercourses within the Study Area required consideration as part of the assessment. These comprise the main rivers, namely the Afton Water (W01) and its associated tributaries (Carcow Burn (W10) and its tributaries, the Glenhastel, Auchincally, Monquhill and Glenshalloch Burns (W06, W07, W08 and W09 respectively) and the Lochingerroch Burn (W12)); the River Nith (W02) and its associated tributaries (Small Burn and Connel Burn, W04 and W05 respectively); and the Water of Deugh (W03) and an associated tributary (Bitch Burn, W11) (**Table 13.8** and **Figure 13.5**).

13.10.9 Proposed works that would be in the catchments of the watercourses and WFD surface water bodies include the following:

- W01: The existing access route through Pencloe Forest to T(turbine)1, in addition to the new proposed access track to the battery storage compound, temporary construction compound and control building and substation compound. The proposed T1 and associated crane pads and blade laydown areas also need to be considered, as well as upgrades to the existing watercourse crossings RX2 – RX6 (**Table 13.11**) and the proposed watercourse crossing RX1. Other works would comprise associated

land clearance, peat workings, forest felling, material storage and operational activities;

- W02: There are no proposed works within the surface water body catchment; and
- W03: Proposed access track from T1 to T2 plus proposed T2 infrastructure including crane pads and blade laydown areas and associated forest felling.

13.10.10 **Table 13.12** indicates that changes in flow and morphology and also sediment loading, and pollution of watercourses and WFD surface water bodies could occur as a result of the following:

- soil compaction and the introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading;
- disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention;
- disruption of ground during construction leading to increased sediment loading;
- dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses;
- discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading; and
- site activities during construction and operation resulting in the release of pollutants and the subsequent contamination of surface waters.

13.10.11 The Afton Water, River Nith and the Water of Deugh constitute the WFD surface water bodies, and are of Good, Moderate and Poor overall status respectively. In terms of water resources, the main WFD watercourse bodies (W01, W02 and W03) and, by association, their tributaries and other nearby watercourses (W06 – W10 and W12; W04 and W05; and W11 respectively) are considered of medium, low and low value respectively, based on their current WFD status (**Table 13.13**).

13.10.12 Mitigation that looks to protect surface watercourses is extensive (**Section 13.8** and **Table 13.12**). It includes a 50 m buffer zone applied to the entire river network, careful access track, cable trench drainage and watercourse crossing design and adherence to numerous relevant protocols, including the WMP and CEMP, SR, SNH, SEPA, FCS, HES, MSS and AEECoW (2019) 'Good Practice During Wind Farm Construction' Guidance, the WAT-SG-25 (SEPA, 2010) 'River Crossings Good Practice Guide', WAT-SG-29 on 'Temporary Construction Methods' and any dewatering CAR registration or licence requirements, and forest felling mitigation as per the Forests and Water Guidelines in support of the UK Forestry Standard. Any dewatering would necessitate the use of silt traps, fences, straw bales, settlement lagoons, swales and SuDS, and any discharge to surface water would require consent from SEPA and would be subject to conditions attached to the consent. Other pollution prevention and emergency response planning such as the PIRP are also relevant.

13.10.13 The assessment of the magnitude and level / significance of effects are considered on a watercourse-by-watercourse basis below. Recognising that some of the watercourses are tributaries of others, the assessment for the downstream watercourses has also taken account of activities in the upstream tributaries, and so the assessment progresses from the headwaters downstream, starting in the Afton Water catchment.

13.10.14 The watercourse crossings of the existing and proposed access trackway would be located on the Glenhastel Burn (W06, one crossing) and Glenshalloch Burn (W09, two crossings) within reasonably steep terrain. Despite this, the anticipated effectiveness of

the embedded environmental measures means that the magnitude of change on the watercourses with respect to the disruption and / or pollution of their flow (surface water flow and quality) and geomorphology is very low (**Table 13.14**). On this basis, the level of effect on these two watercourses is negligible adverse (**not significant**) (**Table 13.15**).

13.10.15 The proposed access trackway also passes through the catchment of another tributary to the Carcow Burn, the Auchincally Burn (W07). The trackway would be approximately 70 m to the south of the headwaters of this watercourse and the anticipated effectiveness of embedded environmental measures with respect to the disruption and / or pollution of its flow (surface water flow and quality) and its geomorphology is therefore very low (**Table 13.14).** On this basis, the level of effect on this watercourse is negligible adverse (**not significant**) (**Table 13.15**).

13.10.16 The Monquhill Burn (W08) joins the Carcow Burn in its upper reaches, and the proposed new watercourse crossing to the southwest of the proposed control building and substation compound, temporary compound and battery store area and limited forest felling could lead to disruption of this tributary's flow paths, changes to drainage regime, increased sediment loading, and changing watercourse morphology. However, embedded environmental measures mean that the magnitude of change on the Monquhill Burn watercourse with respect to the disruption and / or pollution of its flow (surface water flow and quality) and its geomorphology is anticipated to be low (**Table 13.14**). On this basis, the level of effect on this watercourse is minor adverse (**not significant**) (**Table 13.15**).

13.10.17 The upper reaches of the Carcow Burn are also the focus of much of the Development Site infrastructure, including the northern proposed turbine T1, associated crane pad, extended sections of associated tracks, control building and substation, temporary construction compound, two watercourse crossings and some limited forest felling. The watercourse crossings comprise two upgrades to existing crossings, one at an unnamed tributary to the Carcow Burn and one on the Carcow Burn itself. The northern proposed turbine T1 is located over 300 m away from the burn, and the proposed control building and substation compound, temporary construction compound, battery store and associated track are located outside of the Carcow Burn's 50 m buffer zone. Nevertheless, the anticipated effectiveness of the embedded environmental measures means that the magnitude of change on the watercourse with respect to the disruption and / or pollution of the Carcow Burn's flow (surface water flow and quality) and its geomorphology is low (**Table 13.14).** On this basis, the level of effect on this watercourse is minor adverse (**not significant**) (**Table 13.15**).

13.10.18 Lochingerroch Burn (W12) is also a tributary of Afton Water. Whilst there are no proposed watercourse crossings of this burn, at Pencloe, where the trackway joins the minor road, drainage is to the north-east into the burn. The distance between the trackway and the watercourse is approximately 120 m at its minimum and the anticipated effectiveness of embedded environmental measures means that the magnitude of change on the watercourse with respect to the disruption and / or pollution of its flow (surface water flow and quality) and its geomorphology is therefore very low (**Table 13.14**). On this basis, the level of effect on this watercourse is negligible adverse (**not significant**) (**Table 13.15**).

13.10.19 The Afton Water (W01) WFD surface water body comprises all these catchments and so contains the northern proposed turbine T1 and associated crane pad, extended sections of associated tracks, control building and substation, temporary- construction compound, all six watercourse crossings of the Proposed Development and some limited forest felling. However, it has already been demonstrated how the level of effect on the individual catchments is no greater than minor adverse. With the increased dilution effects at the larger scale the magnitude of change on the WFD surface water body with respect to the disruption and / or pollution of its flow (surface water flow and quality) and its geomorphology is therefore very low (**Table 13.14**). On this basis, the level of effect on this WFD surface water body is negligible adverse (**not significant**) (**Table 13.15**).

13.10.20 The proposed access trackway passes through the catchment of the Small Burn (W04) tributary to the Connel Burn (W05) which flows into the River Nith (W02) over 6 km to the north. However, the trackway passes approximately 160 m to the south-east of the Small Burn and the configuration of the topography means that surface flow paths towards the burn are convoluted and lengthy. Furthermore, the nearest northern proposed T1 and associated crane pad are some 300 m to the south-west of the burn. This and the anticipated effectiveness of the embedded environmental measures means that the magnitude of change on the watercourse with respect to the disruption and / or pollution of its flow (surface water flow and quality) and its geomorphology is very low (**Table 13.14**). On this basis, the level of effect on this watercourse (W04) and the downstream Connel Burn (W05) and larger scale River Nith WFD (W02) is negligible adverse (**not significant**) (**Table 13.15**).

13.10.21 The Bitch Burn (W11) catchment contains the southern proposed T2 and associated tracks and limited forest felling. The nearest infrastructure is approximately 300 m east of an unnamed tributary to Bitch Burn, outside of the watercourse 50 m buffer zone. The proposed T2 location is approximately 500 m north-east and north of Bitch Burn and the larger scale Water of Deugh (W03) respectively. Although the slope on the southern aspects of Strandlud Hill is steep, the area is currently forested and no major drainage channels are visible. This, together with the absence of watercourse crossings and the anticipated effectiveness of embedded environmental measures, indicates that the magnitude of change on both the Bitch Burn (W11) and the Water of Deugh (W03) with respect to the disruption and / or pollution of their flow (surface water flow and quality) and geomorphology is very low (**Table 13.14**). On this basis, the level of effect on the watercourse and WFD water body is negligible adverse (**not significant**) (**Table 13.15**).

Ponds (P01 – P02)

13.10.22 Based on the water environment baseline presented in **Section 13.5**, **Section 13.7** identified that the potential effects due to the Proposed Development on two ponds required consideration as part of the assessment, namely a pond on Strandlud Hill and a pond on a small tributary flowing into Carcow Burn (P01 and P02 respectively) (**Table 13.8** and **Figure 13.5**).

13.10.23 The pond on Strandlud Hill (P01) is located on relatively flat terrain on the top of the hill, and whilst the nearest infrastructure, the proposed access track, is approximately 50 m away, it appears to be downgradient of the water feature. The pond on a small tributary flowing into Carcow Burn (P02) is 200 m from the proposed access track and also separated by forestry. The tributary's catchment is also unlikely to drain areas impacted by the proposed works.

13.10.24 **Table 13.12** indicated that derogation or contamination of the ponds could occur as a result of the following:

- soil compaction and the introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels and / or increasing runoff and sediment loading;
- disruption of ground and flowpaths and changes in drainage regime during construction and throughout operation increasing runoff and sediment loading;
- dewatering during construction associated with the excavation of the turbine foundations leading to a decline in groundwater levels and baseflow; and
- site activities during construction and operation resulting in the release of pollutants and the subsequent contamination of groundwater and surface water.

13.10.25 In terms of the assessment, all ponds are considered of very low value (**Table 13.13**).

13.10.26 The majority of the mitigation presented in **Section 13.8** and **Table 13.12** is relevant to the protection of the ponds, in particular the avoidance of development on steep gradients and adherence to the WMP and CEMP, BS6031: 2009 Code of Practice for Earth Works, WAT-SG-29 on Temporary Construction Methods and any dewatering CAR registration or licence requirements. The absence of any proposed works near the ponds, the low permeability of the local aquifer and the anticipated effectiveness of the embedded environmental measures combine to limit the magnitude of change to the ponds.

13.10.27 The magnitude of change to the ponds with respect to the soil compaction and the introduction of areas of hardstanding (groundwater levels and surface water flow / quality), disruption of ground and flowpaths and changes in drainage regime (surface water flow / quality), turbine foundation and any dewatering and discharge works (groundwater levels and surface water flows), and site activities (groundwater and surface water quality) is therefore very low (**Table 13.14**). On this basis, the level of effect on the ponds is negligible adverse (**not significant**) (**Table 13.15**).

Conditions supporting conservation sites (C01 – C04) and GWDTEs (C05)

13.10.28 Based on the water environment baseline presented in **Section 13.5**, **Section 13.7** identified that the potential effects due to the Proposed Development on four conservations sites required consideration as part of the assessment, namely the Connel Burn / Benty Cowan (C01), Glen Afton (C02) and Afton Uplands (C03) LNCSs and the Knockshinnoch Nature Reserve (C04), together with the mosaic of on-site potential GWDTEs (C05) (**Table 13-8** and **Figure 13.5**).

13.10.29 Only the Connel Burn / Benty Cowan LNCS (C01) overlaps the Development Site boundary, whilst the Glen Afton LNCS (C02) and Knockshinnoch Nature Reserve (C04) are downstream of the Development Site. The Afton Uplands LNCS (C03) forms the upland heath on higher topography to the east of the Afton Glen and to the east of the Development Site. The on-site potential GWDTEs (C05) are predominantly in areas along forestry-cleared areas for firebreaks, tracks and drainage, as well as along the Connel Burn valley in the west of the Development Site.

13.10.30 Proposed works in close vicinity to the GWDTEs (C05) include the access trackway to the battery storage compound, temporary construction compound and control building and substation compound areas located at Monquhill as well as proposed turbines T1 and T2 and associated crane pads, blade laydown areas and access trackways. The existing watercourse crossings RX2 and RX3 and the proposed watercourse crossing RX1 (**Table 13.11**) are also located in close proximity to the identified GWDTEs. Other works would comprise associated land clearance, peat workings, forest felling and material storage.

13.10.31 **Table13.12** indicated that derogation or contamination of these sites could occur as a result of the following:

- soil compaction and the introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels and increasing runoff and sediment loading;
- disruption of ground and flow paths and changes in drainage regime during construction and throughout operation increasing runoff and sediment loading;
- dewatering and / or drainage during construction associated with the excavation of the turbine foundations leading to a decline in groundwater levels and baseflow;

- discharge to surface water of groundwater intercepted during construction leading to increased flows and sediment loading; and
- site activities during construction and operation resulting in the release of pollutants and the subsequent contamination of groundwater and surface water.

In addition, the on-site potential GWDTEs (C05) could also be affected by physical disturbance of the peat and associated groundwater throughflow as a result of excavation works and peat stockpiling / removal.

13.10.32 Being LNCSs and potentially being water-dependent, C01 – C04 are all considered of low value (**Table 13.13**). The C05 GWDTEs are of a very low value because of their assessed low groundwater dependency.

13.10.33 Mitigation that minimises effects on water conditions supporting the conservation sites is extensive (**Section 13.8** and **Table 13.12**). In particular, it includes minimising incursions of SEPA (LUPS-GU31) 100 m (shallow excavation, <1 m deep) and 250 m (deep excavation, >1 m deep) buffer areas. The majority of the other mitigation presented in **Section 13.8** is relevant to the protection of the quantity and quality of the surface water and groundwater support and maintaining the peat structure. This includes restricting development on steep gradients and within deep peat deposits, adherence to the WMP and CEMP and careful infrastructure design. The embedded environmental measures discussed earlier (**Section 13.8**) with respect to watercourses are also relevant.

13.10.34 The assessment of effects on these conservation sites and GWDTEs is presented on a site-by-site basis below. With respect to the on-site Connel Burn / Benty Cowan LNCS (C01), such mitigation means that the magnitude of change on the conditions supporting this LNCS is low (**Table 13.14**).On this basis, the level of effect is negligible adverse (**not significant**) (**Table 13.15**).

13.10.35 The Glen Afton LNCS (C02) and the Afton Uplands LNCS (C03) are adjacent to the Development Site. The upgradient location and distance of the conservation sites from the majority of the proposed site infrastructure and the anticipated effectiveness of the embedded environmental measures combine to limit the magnitude of change to these receptors. The magnitude of change on the conditions supporting these LNCSs is therefore very low (**Table 13.14**). On this basis, the level of effect is negligible adverse (**not significant**) (**Table 13.15**) for both.

13.10.36 The Knockshinnoch Nature Reserve (C04) is 5 km downgradient of the Development Site, but the Connel Burn (W05) connects the two locations and would be the potential pathway of any albeit diluted effects. The distance of the conservation site from the Proposed Development, the intervening dilution and the anticipated effectiveness of the embedded environmental measures within the upgradient catchment combine to limit the magnitude of change to the reserve. The magnitude of change on the conditions supporting the conservation site is assessed as very low (**Table 13.14**). On this basis, the level of effect is negligible adverse (**not significant**) **(Table 13.15**).

13.10.37 Some of the potential GWDTEs (C05) sit within the SEPA LUPS-GU31 infrastructure buffers (**Figures 13.6** and **13.7**), with details provided in **Table 13.16**. However, the majority of the mitigation presented in **Section 13.8** is relevant to the protection of the quantity and quality of the surface water support and maintaining the peat structure, in particular the avoidance of development, where possible on steep gradients, and within deep peat deposits, adherence to the CEMP and careful infrastructure design. For the potential GWDTEs the magnitude of change is therefore very low (most habitats) to medium (those with infrastructure within SEPA buffers) (**Table 13.14**), and the level of effect is negligible adverse (**not significant**) (**Table 13.15)**.

Summary

13.10.38 A summary of the results of the assessment of the Hydrology and Hydrogeology is provided in **Table 13.17**.

Table 13.16 Identification of areas of potential GWDTEs impacted by Development Site infrastructure

Area no. (*)	Area description	NVC	Brief description	Surface hydrology description from GWDTE Assessment	Assessed groundwater dependency	Description of impacts
73, 80	Southern T2 and associated pad	M6b	Areas associated with areas along forestry-cleared areas for firebreaks. The area is not covered by peat or till and the habitat is likely to be maintained by surface water flow on thin soils on bedrock and on steep ground.	The presence of low permeability bedrock outcrop ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff / infiltration.	Low	Estimated 1,200 m^2 of habitat removal beneath the turbine pad. Minimal changes to recharge and runoff patterns.
42, 43, 77	Northern T1 and associated pad	M6 and M6b, M20 and M23	Areas associated with areas along forestry-cleared areas for firebreaks and existing trackways. The area is covered by peat and the habitat is likely to be maintained by surface water flow and rainwater.	The presence of low permeability bedrock outcrop ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff / infiltration.	Low	No removal of habitat required. Minimal changes to recharge and runoff patterns.
3, 10, 48, 88, 90, 99, 102, 118	Compound and sub-station areas	M23a, M23b	Areas associated with areas along forestry-cleared areas for firebreaks and existing trackways, open areas around existing buildings and watercourses. The area is covered by peat and the habitat is likely to be maintained by surface water flow and rainwater.	The presence of till and low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff / infiltration and surface runoff from the adjacent track and in the vicinity of the Monquhill and Carcow Burn.	Low	Estimated 1,600 m^2 of habitat removal beneath the turbine pad. Minimal changes to recharge and runoff patterns.

Area no. (*)	Area description	NVC	Brief description	Surface hydrology description from GWDTE Assessment	Assessed groundwater dependency	Description of impacts
13, 41, 42, 43, 44, 45, 46, 73,74, 77, 80, 91, 106, 112, 113, 115 and 116	Strandlud Hill trackway	M20, M6, M6b, M6d, M23	Strandlud Hill cleared upland area and areas associated with areas along forestry-cleared areas for firebreaks. The area is covered by peat or till and in some areas greywackes and mudstones of the Leadhills Supergroup without superficial deposits. The habitat is likely to be maintained by surface water flow on thin soils on bedrock and on steep ground.	The presence of till and low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff / infiltration	Low	Estimated 630 m of trackway (estimated 3,150 m^2 with a 5 m wide track) requiring the removal of habitat. Minimal changes to recharge and runoff patterns.
9, 10,12, 14, 15, 16, 47, 91, 92, 93, 94, 97, 98, 100, 111, 113, 115, 118	Monquhill Burn trackway	M20, M6, M6d, M23a, M23b, M25a	The Monquhill Burn area and areas associated with areas along forestry-cleared areas for firebreaks. The area is covered by peat or till and in some areas greywackes and mudstones of the Leadhills Supergroup without superficial deposits. The habitat is likely to be maintained by surface water flow on thin soils on bedrock and on steep ground.	The presence of till and low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff / infiltration	Low	Estimated 80 m of trackway (estimated 400 m^2 with a 5 m wide track) requiring the removal of habitat. Minimal changes to recharge and runoff patterns.
3, 4, 10, 48, 50, 84, 85, 86, 87, 88, 90, 99, 102, 114, 118	Carcow Burn trackway	M20, M6, M6d, M23, M23a, M25, M25a, M25b	The Carcow Burn area and areas associated with areas along forestry-cleared areas for firebreaks. The area is covered by peat or till. The habitat is likely to be maintained by surface water flow on thin soils on bedrock and on steep ground.	The presence of till and low permeability bedrock ensures that any groundwater levels are local and perched. Therefore, wider-scale groundwater supply to the habitat is limited, with the majority of the supply coming instead from surface or very near-surface runoff / infiltration	Low	No trackway impacts due to the existing trackway and requiring no removal of habitat. Minimal changes to recharge and runoff patterns.

* GWDTE assessment NVC reference number – larger areas of GWDTE indicated only. A 100 m buffer for the existing and new trackway has been used.

Table 13.17 Summary of significance of adverse effects

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Bedrock aquifer and Upper Nithsdale WFD groundwater body (GW01)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels, and resulting in loss of water resource	Low	Very low	Negligible (NS)	Limited extent of proposed works compared to area of both Development Site and aquifer, low permeability of aquifer, and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to baseline condition
Dewatering during construction leading to a decline in groundwater levels and possibly and resulting in loss of water resource	Low	Very low	Negligible (NS)	Limited extent of proposed works compared to area of both Development Site and aquifer, low permeability of aquifer, and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to baseline condition
Site activities during construction, operation and decommissioning resulting in release of pollutants and subsequent contamination of groundwater, and resulting in loss of water resource	Low	Very low	Negligible (NS)	Limited extent of proposed works compared to area of both Development Site and aquifer, low permeability of aquifer, and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to baseline condition
Bedrock aquifer and Galloway WFD groundwater body (GW02)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels, and resulting in loss of water resource	Medium	Very low	Negligible (NS)	Limited extent of proposed works compared to area of both Development Site and aquifer, low permeability of aquifer, and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to baseline condition

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering during construction leading to a decline in groundwater levels and possibly and resulting in loss of water resource	Medium	Very low	Negligible (NS)	Limited extent of proposed works compared to area of both Development Site and aquifer, low permeability of aquifer, and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to baseline condition
Site activities during construction, operation and decommissioning resulting in release of pollutants and subsequent contamination of groundwater, and resulting in loss of water resource	Medium	Very low	Negligible (NS)	Limited extent of proposed works compared to area of both Development Site and aquifer, low permeability of aquifer, and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to baseline condition
Afton Water WFD surface water body (W01)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Medium	Very low	Negligible (NS)	Some proposed works in catchment but anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Medium	Very low	Negligible (NS)	Some proposed works in catchment but anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Medium	Very low	Negligible (NS)	Some proposed works in catchment but anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Medium	Very low	Negligible (NS)	Some proposed works in catchment but anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Discharge to surface water of groundwater intercepted during construction, and increasing flows and sediment loading	Medium	Very low	Negligible (NS)	Some proposed works in catchment but anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Medium	Very low	Negligible (NS)	Some proposed works in catchment but anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
River Nith WFD surface water body (W02)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Discharge to surface water of groundwater intercepted during construction and increasing flows and sediment loading	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Water of Deugh watercourse and WFD surface water body (W03)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to WFD surface water body
Small Burn watercourse (W04)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Connel Burn watercourse (W05)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to watercourse
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to watercourse
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to watercourse

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to watercourse
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to watercourse
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Low	Very low	Negligible (NS)	Limited extent of proposed works, anticipated effectiveness of embedded environmental measures and dilution combine to limit magnitude of change to watercourse
Glenhastel Burn watercourse (W06)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Auchincally Burn watercourse (W07)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Monquhill Burn watercourse (W08)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Medium	Low	Minor (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Medium	Low	Minor (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Glenshalloch Burn watercourse (W09)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Carcow Burn and smaller tributaries (W10)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Medium	Low	Minor (NS)	Some proposed works but anticipated effectiveness of embedded environmental measures limit magnitude of change to watercourse
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Medium	Low	Minor (NS)	Some proposed works but anticipated effectiveness of embedded environmental measures limit magnitude of change to watercourse
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Medium	Low	Minor (NS)	Some proposed works but anticipated effectiveness of embedded environmental measures limit magnitude of change to watercourse

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Medium	Low	Minor (NS)	Some proposed works but anticipated effectiveness of embedded environmental measures limit magnitude of change to watercourse
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading	Medium	Low	Minor (NS)	Some proposed works but anticipated effectiveness of embedded environmental measures limit magnitude of change to watercourse
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Medium	Low	Minor (NS)	Some proposed works but anticipated effectiveness of embedded environmental measures limit magnitude of change to watercourse
Bitch Burn watercourse (W011)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Low	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Lochingerroch Burn watercourse (W012)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation increasing runoff and sediment loading, and changing watercourse flow and morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and less on-site water retention, and changing watercourse flow and morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Disruption of ground during construction leading to increased sediment loading, and changing watercourse morphology	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Dewatering and / or drainage during construction disrupting groundwater support (baseflow) to watercourses, and changing watercourse flow	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Site activities during construction and operation resulting in release of pollutants and the subsequent contamination of surface waters	Medium	Very low	Negligible (NS)	Limited extent of proposed works and anticipated effectiveness of embedded environmental measures combine to limit magnitude of change to watercourse
Pond on Strandlud Hill (P01)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels and / or increasing runoff and sediment loading, and resulting in changed water support and increased sediment loading for site	Very low	Very low	Negligible (NS)	Distance, the low permeability of the aquifer and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the pond
Disruption of ground and flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Very low	Very low	Negligible (NS)	Distance, the low permeability of the aquifer and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the pond
Dewatering and / or drainage during construction reducing groundwater levels and disrupting groundwater support (baseflow) to	Very low	Very low	Negligible (NS)	Distance, the low permeability of the aquifer and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the pond

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
watercourses, and resulting in changed water support for site				
Site activities during construction and operation resulting in release of pollutants and subsequent contamination of groundwater and surface waters, and leading to polluted water support for site	Very low	Very low	Negligible (NS)	Distance, the low permeability of the aquifer and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the pond
Pond on Carcow Burn tributary (P02)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels and / or increasing runoff and sediment loading, and resulting in changed water support and increased sediment loading for site	Very low	Very low	Negligible (NS)	Distance, the low permeability of the aquifer and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the pond
Disruption of ground and flow paths and changes to drainage regime during construction and throughout operation can be associated with increases in runoff and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Very low	Very low	Negligible (NS)	Distance, the low permeability of the aquifer and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the pond
Dewatering and / or drainage during construction reducing groundwater levels and disrupting groundwater support (baseflow) to watercourses, and resulting in changed water support for site	Very low	Very low	Negligible (NS)	Distance, the low permeability of the aquifer and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the pond

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Site activities during construction and operation resulting in release of pollutants and subsequent contamination of groundwater and surface waters, and leading to polluted water support for site	Very low	Very low	Negligible (NS)	Distance, the low permeability of the aquifer and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the pond
Connel Burn / Benty Cowan LNCS (C01)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels and / or increasing runoff and sediment loading, and resulting in changed water support and increased sediment loading for site	Low	Low	Negligible (NS)	The anticipated effectiveness of the embedded environmental measures limit magnitude of change to the LNCS
Disruption of ground and flow paths and changes to drainage regime during construction and throughout operation increasing runoff and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Low	Low	Negligible (NS)	The anticipated effectiveness of the embedded environmental measures limit magnitude of change to the LNCS
Dewatering and / or drainage during construction leading to a decline in groundwater levels and baseflow, and resulting in changed water support for site	Low	Low	Negligible (NS)	The anticipated effectiveness of the embedded environmental measures limit magnitude of change to the LNCS
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Low	Low	Negligible (NS)	The anticipated effectiveness of the embedded environmental measures limit magnitude of change to the LNCS

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Site activities during construction and operation resulting in release of pollutants and subsequent contamination of groundwater and surface waters, and leading to polluted water support for site	Low	Low	Negligible (NS)	The anticipated effectiveness of the embedded environmental measure limit magnitude of change to the LNCS
Glen Afton LNCS (C02)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels and / or increasing runoff and sediment loading, and resulting in changed water support and increased sediment loading for site	Low	Very low	Negligible (NS)	Distance and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
Disruption of ground and flow paths and changes to drainage regime during construction and throughout operation increasing runoff and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Low	Very low	Negligible (NS)	Distance and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
Dewatering and / or drainage during construction leading to a decline in groundwater levels and baseflow, and resulting in changed water support for site	Low	Very low	Negligible (NS)	Distance and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Low	Very low	Negligible (NS)	Distance and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Site activities during construction and operation resulting in release of pollutants and subsequent contamination of groundwater and surface waters, and leading to polluted water support for site	Low	Very low	Negligible (NS)	Distance and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
Afton Uplands LNCS (C03)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels and / or increasing runoff and sediment loading, and resulting in changed water support and increased sediment loading for site	Low	Very low	Negligible (NS)	Distance and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
Disruption of ground and flow paths and changes to drainage regime during construction and throughout operation increasing runoff and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Low	Very low	Negligible (NS)	Distance and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
Dewatering and / or drainage during construction leading to a decline in groundwater levels and baseflow, and resulting in changed water support for site	Low	Very low	Negligible (NS)	Distance and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Low	Very low	Negligible (NS)	Distance and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Site activities during construction and operation resulting in release of pollutants and subsequent contamination of groundwater and surface waters, and leading to polluted water support for site	Low	Very low	Negligible (NS)	Distance and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
Knockshinnoch Nature Reserve Conservation Site (C04)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels and / or increasing runoff and sediment loading, and resulting in changed water support and increased sediment loading for site	Low	Very low	Negligible (NS)	Distance, intervening dilution and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
Disruption of ground and flow paths and changes to drainage regime during construction and throughout operation increasing runoff and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Low	Very low	Negligible (NS)	Distance, intervening dilution and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
Dewatering and / or drainage during construction leading to a decline in groundwater levels and baseflow, and resulting in changed water support for site	Low	Very low	Negligible (NS)	Distance, intervening dilution and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Low	Very low	Negligible (NS)	Distance, intervening dilution and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Site activities during construction and operation resulting in release of pollutants and subsequent contamination of groundwater and surface waters, and leading to polluted water support for site	Low	Very low	Negligible (NS)	Distance, intervening dilution and the anticipated effectiveness of the embedded environmental measures combine to limit magnitude of change to the LNCS
On-site potential GWDTEs (C05)				
Soil compaction and introduction of areas of hardstanding during construction and throughout operation reducing recharge and groundwater levels and / or increasing runoff and sediment loading, and resulting in changed water support and increased sediment loading for site	Very low	Very low - Medium	Negligible (NS)	Turbine, pad and trackways within a minority of potential GWDTE catchments, but anticipated effectiveness of embedded environmental measures limit magnitude of change to potential GWDTEs
Disruption of ground and flow paths and changes to drainage regime during construction and throughout operation increasing runoff and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Very low	Very low - Medium	Negligible (NS)	Turbine, pad and trackways within a minority of GWDTE catchments, but anticipated effectiveness of embedded environmental measures limit magnitude of change to potential GWDTEs
Dewatering and/or drainage during construction leading to a decline in groundwater levels and baseflow, and resulting in changed water support for site	Very low	Very low - Medium	Negligible (NS)	Turbine, pad, trackways, compound and sub-station areas within a minority of potential GWDTE catchments, but anticipated effectiveness of embedded environmental measures limit magnitude of change to potential GWDTEs
Discharge to surface water of groundwater intercepted during construction increasing flows and sediment loading, and resulting in changed surface water support and increased sediment loading for site	Very low	Very low - Medium	Negligible (NS)	Turbine, pad, trackways, compound and sub-station areas within a minority of GWDTE catchments, but anticipated effectiveness of embedded environmental measures limit magnitude of change to potential GWDTEs

Receptor and summary of predicted effects	Sensitivity/ importance/ value of receptor[1]	Magnitude of change[2]	Significance[3]	Summary rationale
Site activities during construction and operation resulting in release of pollutants and subsequent contamination of groundwater and surface waters, and leading to polluted water support for site	Very low	Very low - Medium	Negligible (NS)	Turbine, pad, trackways, compound and sub-station areas within a minority of GWDTE catchments, but anticipated effectiveness of embedded environmental measures limit magnitude of change to potential GWDTEs

4. The value of a receptor is defined using the criteria set out in **Section 13.9** above and is defined as very low, low, medium and high.
5. The magnitude of change on a receptor resulting from activities relating to the development is defined using the criteria set out in **Section 13.9** above and is defined as very low, low, medium and high.
6. The significance of the environmental effects is based on the combination of the sensitivity/importance/value of a receptor and the magnitude of change and is expressed as major (significant), moderate (probably significant) or minor/negligible (not significant, NS), subject to the evaluation methodology outlined in **Section 13.9**.

13.11 Assessment of cumulative effects

13.11.1 As mentioned in **Section 13.9**, consideration has been given as to whether any of the Hydrology and Hydrogeology receptors that have been taken forward for assessment in this chapter are likely to be subject to cumulative effects because of equivalent effects generated by other existing, consented (but not yet built) and proposed developments for which applications have been submitted.

13.11.2 In terms of cumulative residual effects on the water environment, consideration has been given to other wind farm developments that would impact upon the Afton Water, the River Nith and the Water of Deugh immediately downstream of the Proposed Development. The assessment presented here therefore assesses a zone of influence comprising the spatial area of the affected catchments and within a 10 km radius of the Proposed Development (**Volume 2, Figure 9.8**). It is reasonable to assume that mitigation and good practice, similar to the type outlined in this chapter, would also be applied to other wind farms located in the same WFD surface water bodies (C03, A02 and A06) or wider catchments (E01 – E06, C01 – C02, C04 – C06, A01 and A03 – A05), ensuring no cumulative significant downstream effects. Nevertheless, as the construction phase for some of the wind farms may overlap with that of the Proposed Development, a precautionary approach to condition a Water Quality Monitoring Plan (WQMP) to identify any construction phase changes in water quality is recommended. This water quality monitoring is discussed further in Section 13.12.

13.11.3 The Manfield Mains wind farm site (E07) is located within a separate surface water catchment to the Proposed Development, such that no other cumulative effects are possible.

13.11.4 In addition to wind farm developments, Scottish Power Energy Networks ('SPEN') will construct the infrastructure (overhead line) to connect between the control building of the Proposed Development and the consented Enoch Hill Wind Farm SPEN substation. With implementation of similar, effective, pollution control and mitigation measures at both sites however, including the employment of an ECoW, the cumulative magnitude of impact of this with the wind farm developments in the Afton Water catchment is low (**not significant**).

13.11.5 Beyond this radius, any effects to the catchments further downgradient are considered to be sufficiently attenuated to negate a measurable impact.

13.11.6 It is reasonable to assume that mitigation and good practice, similar to the type outlined in this chapter, would also be applied to the other wind farms located in the same WFD surface water bodies (C03, A02 and A06) or wider catchments (E01 – E06, C01 – C02, C04 – C06, A01, A03 – A05), ensuring no cumulative significant downstream effects. Nevertheless, as the construction phase for some of these wind farms may overlap with that of the Proposed Development, a precautionary approach to condition a Water Quality Monitoring Plan ('WQMP') to identify any construction phase changes in water quality is recommended. This water quality monitoring is discussed further in **Section 13.12**.

13.11.7 The Manfield Mains wind farm site (E07) is located within a separate surface water catchment from the Proposed Development, such that no other cumulative effects are possible.

13.11.8 In addition to wind farm developments, SPEN will construct the infrastructure (overhead line) to connect between the control building of the Proposed Development and the consented Enoch Hill Wind Farm SPEN substation. However, with the implementation of similar, effective pollution control and mitigation measures at both sites, including the employment of an ECoW, the cumulative magnitude of impact of this with the wind farm developments in the Afton Water catchment is low (**not significant**).

Table 13.18 Wind farm developments within 10 km of the Proposed Development

Name	Status	Location relative to Proposed Development
E01: Brockloch Rig Extension	Existing	1.4 km south, within the Water of Deugh catchment
E02: Afton	Existing	3.2 km east, located within the Afton Water catchment
E03: Brockloch Rig	Existing	3.8 km south, within the Water of Deugh catchment
E04: High Park Farm	Existing	6.8 km north-east, north-east of the Afton Water catchment
E05: Hare Hill	Existing	7.1 km north-east, north-east of the Afton Water catchment
E06: Hare Hill Extension	Existing	7.6 km north-east, north-east of the Afton Water catchment
E07: Manfield Mains	Existing	9.6 km north-west, catchment completely outwith of the Proposed Development
C01: Pencloe	Consented	0.8 km east, located within the Afton Water catchment
C02: South Kyle	Consented	0.9 km south-west, within the Water of Deugh and River Nith catchment
C03: Enoch Hill	Consented	1.1 km west, located within River Nith catchment
C04: Benbrack	Consented	5.7 km south-west, within the Water of Deugh catchment
C05: Windy Rig	Consented	6.5 km south-east, within the Water of Deugh catchment
C06: Over Hill	Consented	8.1 km north-east, catchment completely outwith of the Proposed Development
A01: Pencloe Variation	Application	0.8 km east, located within the Afton Water catchment
A02: Enoch Hill Variation	Application	1.1 km west, located within River Nith catchment
A03: Brockloch Rig Phase III	Application	2.6 km south, within the Water of Deugh catchment
A04: Sanquhar II	Application	5.1 km east, within the Water of Deugh catchment
A05: North Kyle	Application	6.5 km north-west, catchment completely outwith of the Proposed Development
A06: Greenburn	Application	7.6 km north-west, located within River Nith catchment

13.12 Consideration of optional additional measures

2.1.1 Although no significant effects have been identified upon any hydrological or hydrogeological receptor as a result of the construction or operation of the Proposed Development, it is sensible to consider implementing some further precautionary measures to minimise any lesser effects. These measures have been identified through the iterative process of scheme design and would be in addition to those outlined and assessed in **Section 13.8.** The additional measures outlined below have not been included in the significance assessment presented earlier (**Section 13.10** and **Table 13.17**).

13.12.1 To establish whether there are any effects on surface water quality, both in the immediate vicinity of the control building and substation compound and elsewhere on the Development Site, a WQMP would be developed if consent was granted in consultation with SEPA. Additional remedial action would be taken if pollution relating to the construction and operation of the Proposed Development was identified.

13.12.2 The WQMP would be used to establish whether there are any effects on surface water quality within and immediately downstream of the Proposed Development and would be supervised by the ECoW during the construction phase.

13.13 Conclusions of significance evaluation

13.13.1 The summary of the significance of predicted hydrological and hydrogeological effects presented in **Table 13.17** indicates that, based on the environmental baseline and embedded mitigation described in **Sections 13.5** and **13.8** respectively, there are no likely significant adverse effects related to the Proposed Development in isolation. **Section 13.11** indicates that there are no cumulative water effects with consented developments within the Development Site or wider Study Area or in the same surface catchments.

13.14 Implementation of environmental measures

13.14.1 **Table 13.19** describes the environmental measures embedded within the Proposed Development and the means by which they would be implemented i.e., they would be secured through the CAR authorisation process and planning conditions.

Table 13.19 Summary of environmental measures to be implemented relating to Hydrology and Hydrogeology

Environmental measure	Responsibility for implementation	Compliance mechanism	EIA Report section reference
Pre-construction works: detailed design of watercourse crossings and cable trenching	Geotechnical and design teams	Approval of watercourse crossing design through CAR authorisation process.	13.8
Construction and maintenance of bunding and other works	Site management	Agreed construction method statements followed on site, secured by planning condition.	13.8
Construction and maintenance of watercourse crossings	Site management	Agreed construction method statements followed on site, secured by planning condition.	13.8
Micrositing of tracks, turbines and other infrastructure during construction	ECoW	Agreed construction method statements followed on site, secured by planning condition.	13.8
Implementation of best practice in construction in relation to drainage, soil handling and other potential sources of pollution (e.g., oil)	Site management	Agreed construction method statements and best practice guidance followed on site, secured by planning condition and CAR authorisation process.	13.8
Implementation of best practice in operation, including preventing spills and maintenance of infrastructure	Site management	Ongoing monitoring.	13.8
Design and implementation of water quality monitoring in surface watercourses- baseline and construction phases. Targeted monitoring to continue through operational phase.	ECoW	Secured by planning condition.	13.8