Chapter 9 Hydrology, Geology and Hydrogeology

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List of Abbreviations

Abbreviation	Description
AOD	Above Ordnance Datum
BFI	Base Flow Index
BGS	British Geological Society
CAR	Controlled Activities (Scotland) Regulations
CC	Climate Change
CEMP	Construction Environmental Management Plan
CIRIA	Construction Industry Research and Information Association
DTM	Digital Terrain Model
ECoW	Environmental Clerk of Works
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
FEH	Flood Estimation Handbook

Abbreviation	Description
GIS	Geographical Information System
GPP	Guidance for Pollution Prevention
GWDTE	Groundwater Dependent Terrestrial Ecosystems
HC	Highland Council
IoH	Institute of Hydrology
JHI	James Hutton Institute
LUPS	Land Use Planning System
MSS	Marine Scotland Science
NE	Natural Environment
PAN	Planning Advice Notes
PMP	Peat Management Plan
PPG	Pollution Prevention Guidelines
PPP	Pollution Prevention Plan
PWS	Private Water Supply
QMED	Annual Median Flood Flow
RBMP	River Basin Management Plans
SAAR	Standard Average Annual Rainfall
SAC	Special Area of Conservation
SEPA	Scottish Environment Protection Agency
SIFSS	Soil Information for Scottish Soils
SNH	Scottish Natural Heritage
SPP	Scottish Planning Policy
SPR	Standard Percentage Runoff
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage Systems
SW	Scottish Water
TWI	Topographic Wetness Index
WFD	Water Framework Directive

9. Hydrology, Geology & Hydrogeology

9.1. Executive Summary

9.1.1. This chapter considers the potential impacts of the Proposed Development on the hydrology, geology and hydrogeological environment including peat. The assessment study area is larger in extent than the Proposed Development and includes the upper and lower reaches of watercourse catchments. The assessment has taken into account Scoping Direction and Gate Check responses and is supported by four Appendices.

9.1.2. A desktop assessment and series of site investigations have been undertaken to identify and characterise the hydrological, geological and hydrogeological environment within the vicinity of the Proposed Development.

9.1.3. Deep peat and areas of Class 1 & Class 2 peat are present within the site boundary and were identified as a key sensitivity. An extensive peat depth and condition survey campaign was undertaken to reduce impacts on peat as far as possible through site design and avoidance. The peat slide risk assessment demonstrates that there is low risk, with the Proposed Development having been characterised in the lowest peat slide risk categories. The peat management plan demonstrates that there are opportunities to reuse all excavated peat as part of the site reinstatement.

9.1.4. The sensitivity of receptors has been assigned through the completion of the baseline assessment. The significance of residual effect has been determined taking into account embedded mitigation, standard good practice and any additional mitigation.

9.1.5. The mitigation measures to avoid or reduce impacts on the identified receptors, include the implementation of a Construction Environmental Management Plan (CEMP), specific mitigation relating to peat management and maintaining water flow to groundwater dependent terrestrial ecosystems (GWDTE).

9.1.6. Drainage management provisions and a watercourse crossing assessment have been presented to demonstrate appropriate control and treatment of run-off and to maintain flows within the watercourses. Detailed design of the drainage will be agreed with the Scottish Environment Protection Agency (SEPA) and The Highland Council prior to the commencement of construction.

9.1.7. It has been concluded that with good practice, design and construction of the Proposed Development delivered through a skilled team of competent workers, with mitigation and compliance monitored in collaboration with SEPA and The Highland Council and other engaged stakeholders, residual effects are considered to be not significant in terms of the EIA Regulations

9.2. Introduction

9.2.1. This chapter provides an assessment of the potential effect of Lethen Wind Farm (the Proposed Development) on the hydrological, geological and hydrogeological environment and the likely significant environmental effects resulting from the construction and operation of the proposed turbines and associated infrastructure. The Proposed Development site boundary is referred to as “the site”.

9.2.2. The assessment is also supported by the following I appendices:

- Appendix 9.1: Watercourse Crossing Assessment;
- Appendix 9.2: Peat Slide Risk Assessment;

- Appendix 9.3: Peat Management Plan; and
- Appendix 9.4: Borrow Pit Assessment Report.

9.2.3. The assessment is supported by the following figures:

- Figure 9.1 - Hydrological Overview;
- Figure 9.2 - Flow Accumulation;
- Figure 9.3 - Topographic Wetness Index;
- Figure 9.4 – Carbon and Peatland Soils;
- Figure 9.5 - Predominant Soils;
- Figure 9.6 – Peat Probing Locations and Interpolation; and
- Figure 9.7 – Potential Groundwater Dependent Terrestrial Ecosystems (GWDTE).

9.3. Legislation, Policy and Guidelines

International Legislation and Policy

9.3.1. The assessment takes into account the requirements of the Water Framework Directive (2000/60/EC) (WFD). The WFD aims to protect and enhance the quality of surface freshwater (including lakes, rivers and streams), groundwater, GWDTE, estuaries and coastal waters. The key objectives of the WFD relevant to this assessment are:

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

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

- discharges to all wetlands, surface waters and groundwaters;
- disposal to land;
- abstractions from all wetlands, surface waters and groundwaters;
- impoundments (dams and weirs) of rivers, lochs, wetlands and transitional waters; and
- engineering works in inland waters and wetlands.

National & Regional Legislation and Policy

9.3.3. The assessment takes into account the following legislation and policy:

- The Water Environment and Water Services (Scotland) Act 2003;
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended);
- The Water Environment (Miscellaneous) (Scotland) Regulations 2017;
- Flood Risk Management (Scotland) Act 2009;
- The Water Supply (Water Quality) (Scotland) Regulations 2010;
- Private Water Supplies (Scotland) Regulations 2006;
- The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017;
- Part IIa of the Environment Protection Act 1990;
- Waste Management Licensing Regulations 1994;
- Pollution Prevention and Control Regulations (Scotland) Regulations 2012;
- Scottish Planning Policy (2014); and

- Scottish Environment Protection Agency (SEPA) Policies:
  - No. 19 Groundwater Protection Policy for Scotland;
  - No. 22 Flood Risk Assessment Strategy;
  - No. 41 Development at Risk of Flooding: Advice and Consultation;
  - No. 54 Land Protection Policy; and
  - No. 61 Control of Priority & Dangerous Substances & Specific Pollutants in the Water Environment.

Local Policy

- Highland Wide Local Development Plan (2012):Policy 55 -Peat and Soils;
- Policy 63 – Water Environment; and
- Policy 66 – Surface Water Drainage.

Other Guidance and Good Practice

9.3.4. **Table 9.1** lists other key guidance and good practice documentation relevant to assessment.

Table 9.1. Guidance and Best Practice

Topic	Source of Information
Scottish Government Planning Advice Notes (PANs)	PAN 50 (1996), Controlling the Environmental Effects of Surface Mineral Workings PAN 51 (2006), Planning, Environmental Protection and Regulation PAN 1/2013 (2013), Environmental Impact Assessment PAN 61 (2001), Planning and Sustainable Urban Drainage Systems Flood Risk (2015), Planning Advice PAN 79 (2006), Water and Drainage
SEPA Guidance for Pollution Prevention (GPPs) and Pollution Prevention Guidelines (PPGs)	GPP1 (2020), Understanding your environmental responsibilities – good environmental practices GPP2 (2018), Above Ground Oil Storage Tanks GPP4 (2017), Treatment and Disposal of Wastewater Where there is no Connection to the Public Foul Sewer GPP5 (2018), Works and maintenance in or near water PPG6 (2012), Working at Construction and Demolition Sites GPP 8 (2017), Safe Storage and Disposal of Used Oils GPP 13 (2017), Vehicle Washing and Cleaning GPP 21 (2021), Pollution Incident Response Planning GPP 22 (2018), Dealing with Spills GPP 26 (2019), Safe Storage - Drums and Intermediate Bulk Containers
SEPA Position Statements (Published)	WAT-PS-06-02: SEPA (2015), Culverting of Watercourses, Version 2 WAT-PS-07-02: SEPA (2012), Bank Protection, Version 2 WAT-SG- 78: SEPA (2012), Sediment Management Authorisation, Version 1 WAT-SG-23: SEPA (2008), Engineering in the Water Environment, Good Practice Guide - Bank Protection Rivers and Lochs, Version 1 WAT-SG-25: SEPA (2010), Engineering in the Water Environment, Good Practice Guide, Construction of River Crossings, Version 2

Topic	Source of Information
	WAT-SG-26: SEPA (2010), Engineering in the Water Environment, Good Practice Guide, Sediment Management, Version 1
	WAT-SG-31: SEPA, (2006), Special Requirements for Civil Engineering Contracts for the Prevention of Pollution, Version 2
Construction Industry Research and Information Association (CIRIA)	CIRIA C692 (2010), Environmental Good Practice on Site (third edition)
	CIRIA C753 (2015), The SuDS Manual
	CIRIA C532 (2001), Control of Water Pollution from Construction Sites
	CIRIA C648 (2006), Control of Water Pollution from Linear Construction Projects
	CIRIA (2019), Culvert, Screen and Outfall Manual
Other Guidelines	Scottish Natural Heritage (SNH) and Scottish Renewables Joint Publication (2019). Good Practice During Wind Farm Construction Version 4
	FCE, SNH (2010). Floating Roads on Peat
	Scottish Renewables, Joint Publication (2012). Development of Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimization of Waste
	SEPA, The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended). A Practical Guide, Version 8.5, July 2021
	Scottish Government, SNH, SEPA (2017). Peatland Survey Guidance on Developments on Peatland, on-line version only
	SEPA Land Use Planning Guidance CC1 (LUPS-CC1) (2019). Climate change allowances for flood risk assessment in land use planning. Issue 1
	SEPA Land Use Planning Guidance Note 4 (2017). Planning Guidance on On-Shore Windfarm Developments, Version 9
	SEPA Land Use Planning Guidance Note 31 (2017). Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems, Version 3
	SNIFFER (2009). WFD95 A Functional Typology for Scotland

Consultation

9.3.5. The scoping and consultation responses relating to the hydrological, geological and hydrogeological environment are summarised in **Table 9.2** below.

Table 9.2 – List of Consultee Responses

Consultee	Consultation Response	Applicant Action
Energy Consents Unit (ECU) (April 2021)	SEPA are affected by a significant cyber – attack – standing advice and SEPA's planning guidance should be followed.	Standing advice such as pollution prevention and mitigation, watercourse crossing and peat management, 50 m buffers and LUPS buffers have been followed throughout the chapter and supporting appendices.
	Scottish Water provided information on whether there are any drinking water protected areas or Scottish Water assets on which the development could have any significant effect. Scottish Ministers request contacts is made with Scottish Water to confirm any Scottish Water assets which may be affected by the development, and include details in the EIA Report of any relevant mitigation measures to be provided.	Confirmed in Public Water Supply Section (**paragraph 9.7.37**) that there are no Scottish Water assets or catchments within the site.
	Scottish Ministers request that any private water supplies which may be impacted by the development are investigated. The EIA Report should include details of any supplies identified by this investigation, and if any supplies are identified, an assessment of the potential impacts, risks, and any mitigation should be provided.	Refer to Private Water Supply Section (**paragraphs 9.7.38–9.7.42**) for the assessment of private water supplies.
	In addition to identifying watercourses and waterbodies, any Special Areas of Conservation (SACs) where fish are a qualifying feature should be included and assessed.	There are no SACs downstream of the Proposed Development but the effect on fisheries interests including the River Findhorn have been assessed.
	There is a requirement for a Peat Landslide and Hazard Assessment following the correct guidance.	Reference to guidance followed is contained in **Appendix 9.2.**
The Highland Council (THC) (March 2021)	Full assessment of the impact on peat required and must include probing on all areas where development is proposed including micro-siting limits.	Refer to Soils and Peat Section (**paragraphs 9.7.45–9.7.55**), **Figure 9.6, Appendices 9.2 and 9.3**.
	Carbon balance calculations including payback period to be included in EIA Report.	Refer to **Appendix 3.3**.
	EIA Report to include direct and indirect impacts on geology including demonstrating minimisation of use of raw materials in favour of secondary aggregates and recycled and renewable materials. Expect information on borrow pits including, location, size reinstatement profile.	Refer to **Appendix 9.4**.
	Describe site hydrology and hydrogeology to include: • impacts on watercourses	Refer to Public Water Supply section (**paragraph 9.7.37**) and Private Water Supply section (**paragraphs 9.7.38– 9.7.42**).

Consultee	Consultation Response	Applicant Action
	• water supplies • water quality and quantity • watercourses, lochs & groundwater • measures to prevent erosion, sedimentation & discolouration • monitoring proposals inc. contingency plans • consideration of impacts of high rainfall.	For water quality and quantity refer to Hydrological Regime section (**paragraphs 9.7.19– 9.7.25**) & Water Quality section (**paragraph 9.7.33**). Refer to Mitigation section (**paragraphs 9.8.1– 9.8.56**). Refer to Monitoring Section (**paragraphs 9.13.1-9.13.6**). Refer to Modifying Influences section (**paragraphs 9.7.68–9.7.70**). Impact of high rainfall during both construction and operation will also be fully considered within the site specific Construction Environment Management Plan (CEMP).
	Contact SEPA to determine if a CAR license is required.	A CAR licence will be required, and this would be applied for post consent.
	All watercourse crossings should be identified and include schematic table and photographs and dimensions in EIA Report.	Refer to **Appendix 9.1**.
	Need for water abstractions for concrete works should be identified, if using a private water source details are required.	Scoped out – not required.
	Private water supplies including pipework which could be affected should be identified and details provided to ensure protection of source and infrastructure. PWS information supplied by THC is not definitive and an onsite search should also be carried out.	Refer to Private Water Supply Assessment (**paragraphs 9.7.38 – 9.7.42**). It is confirmed that there are no sources or delivery infrastructure within the site boundary. The developable area has been traversed during peat probing and hydrology and ecology site visits and no evidence of any additional private water supplies was identified.
Scottish Water (April 2021)	Records indicate that there are no Scottish Drinking Water Protected Areas or water abstractions sources in the area.	Confirmed in Public Water Supply section (**paragraph 9.7.37**) that there are no Scottish Water assets or Drinking Water Protected Areas within the site.
	Scottish water will not accept any surface water connections into their combined sewer system.	Scoped out, no connections to the combined sewer network are proposed.
SEPA (April 2020)	All maps must be based on adequate scale with which to access the information they are showing.	Refer to supporting **Figures 9.1 to 9.7.**

Consultee	Consultation Response	Applicant Action
	Each of the maps must show all permanent and temporary infrastructure.	All infrastructure has been included on supporting **Figures 9.1 to 9.7.**
	Layout should be designed to avoid the extent of work in previously undisturbed ground.	Existing tracks have been utilised where possible. Floating track is also proposed to minimise ground disturbance.
	Site layout must be designed to reduce the impact on the water environment and a 50m buffer should be applied except for watercourse crossings and tracks leading to them. The buffers should be demarked on a map.	Refer to **paragraph 9.8.7**and **Table 9.13** which confirm that there is a minimum 50 m buffer from infrastructure and **Figure 9.1** which shows the mapped buffers.
	Reference should be made to SEPAs standing advice for flood risk.	Refer to Flood risk Assessment section (**paragraphs 9.7.26–9.7.31**) and Mitigation Section (**paragraphs 9.8.4– 9.8.8**) and (**paragraphs 9.8.5–9.8.56**) which outline how flood risk will be minimised. Further detail would be provided following detailed design post consent.
	Watercourse crossings should be designed to accommodate 1 in 200 year flow.	Refer to **Appendix 9.1**. Watercourse crossings will be sized to 1 in 200 year flow as a minimum.
	SEPA would welcome the opportunity to prove advice on Phase 2 peat probing before it is completed. A proportionate approach focusing on areas of deep peat can be taken.	SEPA was consulted on phase 1 and phase 2 peat surveys and advice was followed.
	A detailed map of peat depths should be included.	Refer to **Figure 9.6** and figures within **Appendix 9.2**.
	A table detailing quantities of acrotelmic, catotelmic and amorphous peat which will be excavated for each element and where it will be re-used during reinstatement.	Refer to **Appendix 9.3**.
	The application should include proposals for peatland restoration of the wider site. Consideration should be given to what enhancement opportunity there might be for this large site for example removal of any redundant watercourse crossings or improvements to well used informal crossings.	Refer to **Appendix 8.3**
	Groundwater dependent terrestrial Ecosystems (GWDTE) are protected under the Water Framework Directive and therefore the layout and design of the development must avoid impact on such areas. Assessment Guidance should be followed.	Refer to GWDTE section (**paragraphs 9.7.61– 9.7.65**).

Consultee	Consultation Response	Applicant Action
	Borrow pits should only be used in line with Scottish Planning Policy. The EIA Report submission for borrow pits should include information in accordance with PAN 50. A map of proposed borrow pits must be submitted. SEPA provided a list of information such as location, size, depth and dimension that should be provided for each borrow pit, how much peat will be disturbed, details for restoration etc.	Scottish Planning Policy has been followed when selecting borrow pit locations. Refer to **Appendix 9.4.**
	A schedule of mitigation supported by site specific maps and plans must be submitted. They should include details of best practice pollution prevention and construction technique and regulatory requirements. They should set out the daily responsibilities of the Environmental Clerk of Works (ECoWs) and how site inspections will be recorded and any proposal for a planning monitoring enforcement officer.	Outline mitigation measures have been included in the Mitigation sections (**paragraphs 9.8.4 – 9.8.56**) and further details including site plans and ECoW responsibilities would be provided post consent.
	Authorisation is required under The Water Environment (Controlled Activities) Regulations 2011 (CAR).	This would be applied for before construction commences refer to Licencing Requirements section (**paragraphs 9.14.1 and 9.14.2**).
SEPA (June 2021)	Upgrade of existing track requested in favour of new track.	Upgrade of existing track has been favoured wherever possible (as detailed in **Chapter 3**).
	Sufficient probing to be able to demonstrate that the impacts on peat have been minimised.	Refer to **Figure 9.6** and **Table 9.12**. A total of 2654 peat probes were carried out.
	Plans should show which sections of track are floating.	Refer to **Appendix 9.3** for confirmation of which section of track are floating and **Chapter 3.**
	For PWS content if there is no excavation proposed within 250m of an existing groundwater abstraction, and if this is the case then it would be helpful if the EIA Report confirmed so.	There are no PWS within the LUPS buffers. Refer to **Table 9.10** for further information on distances between the site boundary and PWS.
Marine Scotland Science (MSS) (April 2021)	The presence of large areas if deep peat deposits should be assessed and appropriate mitigation measures given.	The Proposed Development has been designed to avoid deep peat as far as possible. **Refer to Figure 9.6**.
	An outline of the potential impacts on fish populations and water quality within and downstream of the proposed development area should be provided.	Refer to **Chapter 8** for assessment of impact on fish populations. Water quality will be monitored throughout construction and the start of operation of the Proposed

Consultee	Consultation Response	Applicant Action
		Development. Outline mitigation has been provided and this will be expanded on in a site specific CEMP post consent.
	Any potential cumulative impacts on the water quality and fish populations associated with adjacent (operational and consented) developments including wind farms, hydro schemes, aquaculture and mining.	Refer to Cumulative Effects Section (**paragraphs 9.12.1– 9.12.3**).
	Post consent a water quality and fish population monitoring plan (WQFMP). Full details of proposed monitoring programmes using guidelines issued by MSS and accompanied by a map outlining the proposed sampling and control sites in addition to the location of all turbines and associated infrastructure.	It is confirmed that this would be produced and agreed post consent. Refer to section Monitoring (**paragraphs 9.13.1 - 9.13.6**) for outline monitoring plan.
	A decommissioning and restoration plan outlining proposed mitigation/monitoring for water quality and fish population.	A decommissioning plan would be produced prior to decommissioning and would include details of water monitoring.
NatureScot (March 2021)	Scottish Planning Policy affords significant protection to carbon rich soils, deep peat soils and expect the EIAR to demonstrate how any significant effects can be overcome by siting, design or other mitigation.	The layout has been designed to avoid deep peat as far as possible refer to **Figure 9.6**. **Figure 9.1** shows that large areas of Class 1 peat have been heavily modified by man-made drainage. Opportunities to restore peat are outlined in **Appendix 9.3** & **Appendix 8.3**.
	Layout should be determined through hydrological assessment and peat probing results.	The layout has been ground truthed and SEPA consulted to discuss peat probing. Hydrological buffers have been applied as part of the embedded mitigation.
	Where impacts cannot be avoided they should be minimised and the EIA Report should identify opportunities to mitigate and/or compensate this.	Opportunities to restore peat are included in **Appendix 9.3** and the **Appendix 8.3**.
	Details of all mitigation including peat management plan should be included in the EIA Report.	Refer to Mitigation section (**paragraphs 9.8.4– 9.8.56**) and **Appendix 9.3**.
	The Carbon and Peatland 2016 map shows that the wind farm and part of the access is within an area mapped as nationally important Class 1 peat. This mapping is indicative and the EIA Report should include site specific peat and vegetation surveys to confirm quality and distribution of peatland.	Refer to **Chapter 8** for vegetation surveys. For peat refer to **Figure 9.6** and Soils and Peat section (**paragraphs 9.7.45– 9.7.55**).
	Peat survey work should conform to the Peatland Survey 2017 “Guidance on Developments on Peatland.” Peat Slide Risk Assessment should follow the latest	Refer to **Appendix 9.2** which outlines guidance followed.

Consultee	Consultation Response	Applicant Action
	2017 guidance "Peat landslide hazard and risk assessments: best practice guide for proposed electricity generation developments."	
RSPB (March 2021)	Recommend carbon calculator used as early as a possible in the planning process to inform layout and micro-siting	Refer to **Appendix 9.5**.
Findhorn and Lossie Rivers Trust (March 2021)	Fish access to Tomlachlan Burn and Leonach Burn upper reaches is limited and both watercourses contain isolated trout populations. As such watercourse crossings should be minimised and follow SEPA guidelines from construction including accommodating 1 in 200 year flood events. Fish migration should be accommodated in the design. Bridges should be single span. Culverts should be sunk into the riverbed to allow fish and sediment passage. Additional flood relief culverts should be included in the design.	Refer to **Appendix 9.1**.
	High quality measures to control silt and pollution run-off paramount importance during construction	Drainage management measures are provided in **paragraphs 9.8.15 - 9.8.27** that are based on industry good practice. Detailed design of drainage will be undertaken post consent
	Request a water quality, invertebrate and fisheries monitoring plan is developed with at least one year of baseline monitoring included.	The Monitoring Section (**paragraphs 9.13.1– 9.13.6**) confirms that monitoring will take place during all phases of development.

9.4. Assessment Methods and Significance Criteria

Effects to be Assessed

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

- changes to existing drainage patterns;
- effects on baseflow;
- effects on run-off rates;
- effects on erosion and sedimentation;
- effects on groundwater and surface water quality (including GWDTEs);
- effects on groundwater levels;
- effects on water resources;
- effects on impediments to flow;
- flood risk;
- pollution risk;
- effects on local geology; and
- effects on hydrological integrity of peat bodies.

9.5. Methodology

Overview

9.5.1. The assessment has involved the following:

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

Baseline Assessment

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

- describe surface water hydrology, including watercourses, springs and waterbodies;
- identify existing catchment pressures (e.g. point source and diffuse pollution issues);
- identify all private drinking water abstractions and public water supplies within 3 km of the site boundary;
- identify all flooding risks;
- describe the hydromorphological conditions of watercourses;
- collect information relating to recreational and fisheries resources;
- collate hydrological flow and flooding data for the immediate area and main downstream watercourses;
- collect soil, geological and hydrogeological information;

- confirm surface water catchment areas and watersheds; and
- confirm the extent and nature of peat deposits across the site of the Proposed Development.

9.5.3. Published information consulted for the baseline is outlined in **Table 9.3** below.

Table 9.3: Baseline Information Sources

Topic	Sources of Information
Topography	5 m contour data derived from Digital Terrain Model (DTM) data 1:10,000 OS Raster Data 1:50,000 OS Raster Data
Designated Nature and Conservation Sites	In-house Designated Site Database. NatureScot, SiteLink website, http://gateway.snh.gov.uk/sitelink/searchmap.jsp
Solid and Superficial Geology	BGS Geology of Britain Viewer, http://mapapps.bgs.ac.uk/geologyofbritain3d/index.html
Soils and Peat	James Hutton Institute (JHI), Soil Information For Scottish Soils (SIFSS), http://sifss.hutton.ac.uk/ Scotland's Soils Interactive Map, Carbon and Peatland 2016 and National Soil Map of Scotland, http://soils.environment.gov.scot/
Climate	Met Office, https://www.metoffice.gov.uk/public/weather/climate/gcv3mcrf9 Flood Estimation Handbook (FEH): FEH Web Service, https://fehweb.ceh.ac.uk/ Flood Modeller Suite, https://www.floodmodeller.com/
Surface Water Hydrology	1:10,000 OS Raster Data 1:50,000 OS Raster Data Flood Estimation Handbook (FEH): FEH Web Service, https://fehweb.ceh.ac.uk/ Flood Modeller Suite, https://www.floodmodeller.com/
Flooding	Flood Risk Management Map (SEPA) https://map.sepa.org.uk/floodmaps
Water Quality	SEPA, Water Classification Hub, https://www.sepa.org.uk/data-visualisation/water-classification-hub SEPA, Water Environment Hub, https://www.sepa.org.uk/data-visualisation/water-environment-hub/
Water Resources	PWS information provided by The Highland Council. Scottish Water
Hydrogeology	Scotland's Environment Web Interactive Map, https://map.environment.gov.scot/sewebmap/ BGS Geology of Britain Viewer, http://mapapps.bgs.ac.uk/geologyofbritain3d/index.html BGS Geoindex Onshore https://mapapps2.bgs.ac.uk/geoindex/home.html SEPA, Water Classification Hub, https://www.sepa.org.uk/data-visualisation/water-classification-hub/

Effects Evaluation

9.5.4. The likely significant environmental effects of the Proposed Development have been defined by taking account of the two main factors: the sensitivity of the receiving environment and the potential magnitude should that impact occur. The sensitivity of the receiving environment i.e. its baseline quality as well as its ability to absorb the effect without perceptible change is defined in **Table 9.4** below.

Table 9.4: Definition of Sensitivity of the Receiving Environment

Sensitivity	Definition
High	The receptor/resource has little ability to absorb change without fundamentally altering its present character or is of international or national importance.
Medium	The receptor/resource has moderate capacity to absorb change without significantly altering its present character; or is of medium/regional importance.
Low	The receptor/resource is tolerant of change without detriment to its character, is of low or local importance.

9.5.5. The magnitude of impact includes the timing, scale, size and duration of the impact. For the purposes of this assessment the magnitude of impact criteria are defined in **Table 9.5** below.

Table 9.5: Magnitude of Impact

Magnitude	Criteria	Definition
Substantial	Total loss of or major/substantial alteration to key elements/features of the baseline (pre-development) conditions such that the post development character/composition/attributes will be fundamentally changed.	Fundamental (long term or permanent) changes to geology, hydrology, water quality and hydrogeology.
Moderate	Loss or alteration to one or more key elements/features of the baseline conditions such that post development character/composition/attributes of the baseline will be materially changed.	Material but non-fundamental and short to medium term changes to the geology, hydrology, water quality and hydrogeology.
Slight	A minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible/detectable but not material. The underlying character/composition/attributes of the baseline condition will be similar to the pre-development circumstances/situation.	Detectable but non-material and transitory changes to the geology, hydrology, water quality and hydrogeology.
Negligible	Very little change from baseline conditions. Change barely distinguishable, approximating to a 'no change' situation.	No perceptible changes to the geology, hydrology, water quality and hydrogeology.

9.5.6. Based on the successful implementation of good practice, design and receptor specific mitigation measures, the sensitivity of the receiving environment together with the magnitude of the effect defines the significance of the effect as outlined in **Table 9.6** below.

Table 9.6: Significance Matrix

Magnitude of Change					
Sensitivity		Substantial	Moderate	Slight	Negligible
	High	**Major**	**Major/Moderate**	**Moderate**	Moderate/Minor
	Medium	**Major/Moderate**	**Moderate**	Moderate/Minor	Minor
	Low	**Moderate**	Moderate/Minor	Minor	Negligible

9.5.7. An overall judgement is made on the nature of the receptor (sensitivity) and the likely change (magnitude) resulting from the Proposed Development. This judgement is based on evaluations of the individual aspects of value, susceptibility, size and scale, geographical extent, duration and reversibility. There are four main levels of hydrological effect that are used in this EIA Report; Major, Moderate, Minor and Negligible. Two intermediate combinations are also used for determining hydrological effects: Major/Moderate and Moderate/Minor. The evaluation of potential effects makes allowance for the use of professional judgement and experience.

9.5.8. Those effects considered to be **Major** and **Major/moderate** and some **Moderate** effects by virtue of the more sensitive receptors and the greater magnitude of change, are considered to be **Significant Effects** significant in terms of The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017**.** Some **Moderate,** and all **Moderate/Minor, Minor** and **Negligible** effects are considered to be **not significant effects**. Where a Moderate effect is deemed to be not significant this was decided based on there being High receptor sensitivity, but a Slight or Negligible magnitude of change, meaning changes to baseline conditions are deemed to be only very little or minor.

9.5.9. It should be noted that significant effects need not be unacceptable or necessarily adverse and may be reversible.

9.6. Assumptions and Limitations

9.6.1. The fieldwork carried out covered the main hydrological features within the site. Representative locations and features such as watercourses, peat bodies and geological information were assessed, and this information is interpreted for any areas not visited.

9.6.2. Private water supply information within 3 km of the site has been provided by THC. However, there may be additional private water supplies which THC has not been made aware of.

9.6.3. The assessment of effects has been made based on the finalised layout with the assumption that any micro-siting during detailed design will not result in the movement of infrastructure into areas of higher impact as presented within the 50 m watercourse buffers or deeper peat provided in **Figure 9.1**.

9.6.4. The information presented in this assessment is based on desk studies and site investigations on the Proposed Development layout. There is the potential that further constraints may be identified during the pre-construction detailed design stage. Should further constraints be identified these will be assessed and appropriately mitigated prior to construction.

9.7. Baseline Conditions

9.7.1. This subsection presents the information gathered on the existing topographical, hydrological, hydrogeological and geological conditions within the site. The site is defined in **Figure 9.1** provided in Volume 2 of the EIA Report.

Site Area

9.7.2. The Proposed Development is located within The Highland Council (THC) local authority area, approximately 10 km north-west of Grantown-on-Spey. The Proposed Development will be located in an area of open moorland.

9.7.3. The Proposed Development includes the installation of 17 wind turbines and associated foundations, on-site access tracks, crane hardstands, construction of ancillary infrastructure (two temporary construction compounds), substation, electrical infrastructure, three borrow pits, and a permanent meteorological mast.

9.7.4. A topographic high is reached on the south-eastern site boundary at Carn nan Garbha of 418 m Above Ordnance Datum (AOD).

9.7.5. The hydrological study area is larger in extent than the Proposed Development and includes the upper and lower reaches of watercourse catchments with the extent of the catchment shown in **Figure 9.1** in Volume 2 of the EIA Report. Designated sites and relevant developments are considered from the perspective of assessing any potential hydrological linkages or cumulative effects.

Site Investigations

9.7.6. The phase 1 peat depth survey and hydrological walkover were undertaken in November 2018. Weather conditions were windy and occasionally showery. Further surveys, including watercourse crossing assessment, detailed peat probing and geotechnical investigation works, were undertaken in June and July 2021. Weather conditions were dry and sunny. A final site visit to carry out further detailed peat probing and watercourse crossing assessment to further refine the layout prior to design freeze was made during September 2021 and weather conditions were dry and cloudy.

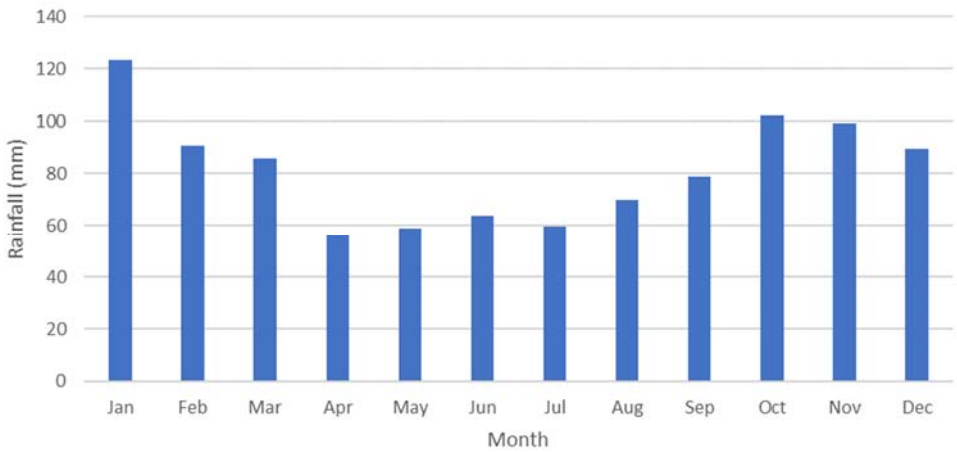
Climate

9.7.7. The standard average annual rainfall (SAAR) for the site has been derived from the FEH Web Service as ranging from 867 – 971 mm based on the site catchments. To put this into context, rainfall in Scotland varies from under 800 mm a year on mainland eastern Scotland in areas such as Fife to over 3000 mm on the mainland Western Highlands.

9.7.8. The Met Office 1981-2010 average annual rainfall total from the Aviemore Climate Station (228 m AOD) is 977.1 mm with an average of 162.8 days of rainfall days greater than 1 mm recorded. The Aviemore Climate Station is positioned approximately 20 km south of the Proposed Development and remains at a reasonably comparable altitude giving a good idea of rainfall totals expected at the site.

9.7.9. The highest rainfall totals as shown in **Graph 9.1**, are typically experienced during the winter months and January and November had average annual rainfall totals of 123.5 mm and 99.1 mm recorded respectively. The lowest rainfall totals are typically recorded during the spring months as May and April saw an average annual rainfall total of 55.9 mm and 58.8 mm recorded respectively.

Graph 9.1: Average monthly rainfall data for climate period 1981-2010: Aviemore Climate Station



Designated Sites

9.7.10. There are two designated sites within 5 km of the Proposed Development. These are Carn na Tri-tighearnan Site of Special Scientific Interest (SSSI) / Special Area of Conservation (SAC) which lies to the north-west of the site, and the River Spey SAC which lies to the south and west of the site (**Table 9.7**).

Table 9.7: Designated Sites within 5 km of the Proposed Development (PD)

Site	Designation	Distance from PD	Designation Criteria	Hydrologically connected to the PD
Carn na Tri-tighearnan	SAC/SSSI	4.5 km	Blanket bog, subalpine dry heath.	Not connected to the Proposed Development. In separate sub catchments of the River Findhorn on the opposite side of the river valley.
River Spey	SAC	4.6 km	Atlantic salmon, freshwater pearl mussel, otter, sea lamprey.	Not connected to the Proposed Development. The watercourses within the site flow into the River Findhorn which is not within the catchment of the River Spey.

Surface Water Hydrology

9.7.11. Hydrologically, the Proposed Development lies within the watershed of the River Findhorn which discharges into the Moray Firth at Findhorn on the north coast. **Figure 9.1** in Volume 2 of the EIA Report shows a hydrological overview of the Proposed Development.

9.7.12. The upper catchment and headwaters of the Tomlachlan Burn is situated entirely within the Proposed Development boundary. The two main tributaries of the Tomlachlan Burn are the Caochan Gortach and the Allt Laoigh. The Proposed Development is bounded to the west by the Leonach Burn. The watercourses are characterised by moorland riparian habitat, meandering channels with gravel, boulder, and bedrock riverbed materials.

9.7.13. The catchment sizes for the Tomlachlan Burn and Leonach Burn are comparable with areas of 28.39 km^2 and 27.84 km^2 respectively.

9.7.14. The Leonach Burn flows in a northerly direction joining the River Findhorn approximately 2.4 km downstream at British National Grid (BNG) 292112 840547. The Tomlachlan Burn also flows in a northerly direction joining the River Findhorn at a slightly lower location, approximately 4.4 km downstream at BNG 293889 842183.

9.7.15. During the site visits surveyors noted areas of moorland drainage across the site, where it was observed that small, unmapped artificial drainage channels are commonplace. This artificial drainage will have impacted the pre-existing natural hydrology of the site.

Tomlachlan Burn

9.7.16. The Tomlachlan Burn rises on the steep north-eastern slopes of Cnapan a' Choire Odhar Bhig and Carn Allt Laoigh. The Allt Laoigh and Caochan Gortach tributaries form the upper catchment of the Tomlachlan Burn.

9.7.17. The riparian zone of the Allt Laoigh is a mixture of moorland and in places small conifers. The Allt Laoigh and Caochan Gortach have a generally V-shaped valley (see **Photograph 9.1** and **9.2** below).

Photograph 9.1 & 9.2: Photographs showing the Allt Laoigh (left), and the Caochan Gortach (right)

Leonach Burn

9.7.18. The Leonach Burn has a broad channel with a potentially wide flood plain in places, particularly in the area where the watercourse forms the north-western boundary of the Proposed Development. The Leonach Burn riparian zone is generally hummocky moorland (as seen in **photograph 9.3**). The main stem of the Leonach Burn is meandering and is closely bounded on the eastern side by an existing track.

Photograph 9.3: Photograph showing the main stem of the Leonach Burn (view south from BNG NH 91868 37066)

Hydrological Regime

Flow Estimation

9.7.19. Peak flows (up to 200 year + climate change (CC)) have been estimated for the key catchments described above using the FEH Rainfall Runoff (FEH RR) method for a range of return periods, with the results presented in **Table 9.8** below. Catchment descriptors were derived from the FEH Web Service and used for calculating peak flows for the identified catchments. Catchment boundaries have been used in their entirety, as opposed to their delineation along the site boundary area, which would otherwise generate potentially unrepresentative results. The annual median flood flow (QMED) is presented as the greenfield run-off rate.

9.7.20. The Q200+CC is the 200-year return period flow plus a 20% uplift for climate change (CC) as per SEPA Land Use Planning Guidance CC1 (LUPS-CC1) (2019) Climate change allowances for flood risk assessment in land use planning.

Table 9.8: Estimated Peak Run-off for Site-Catchments Calculated using the Methodology Prescribed by the FEH RR Method.

Catchments	Area (km2)	Method	Estimated peak run-off (m3 s-1) for stated return period							
			2 (QMED)	5	10	25	50	100	200	200+CC
Leonach Burn	27.8	FEH RR	15.21	21.83	26.01	32.50	38.56	44.37	51.42	61.70
Tomlachlan Burn	28.4	FEH RR	12.71	18.11	21.50	27.05	32.02	36.80	42.60	51.12

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

9.7.22. The BFI values for the catchments within the site range from 0.30 to 0.36. This indicates approximately a third of streamflow within the site is derived from stored sources such as groundwater. For the site catchments groundwater contribution to flow is low. The SPR values for these catchments range from 50 % to 55 %, indicating that approximately half of the rainfall during a rainfall event contributes to run-off.

9.7.23. **Figure 9.2** in Volume 2 of the EIA Report provides information on the flow direction of the surface run-off within the Proposed Development. Flow accumulation is based on the 5 m resolution DTM of the area occupied by the Proposed Development. The flow accumulation represents the volume of water that would flow into each 5 m cell of the DTM, assuming that all water becomes run-off and there was no interception, evapotranspiration or infiltration. The volume of accumulation is represented in colour scale with higher flow accumulations being darker in shade to areas with lower flow accumulation. This figure illustrates the influence of topography on the accumulation and direction of surface water run-off across the Proposed Development.

9.7.24. **Figure 9.3** in Volume 2 of the EIA Report provides information on how the topography influences the surface saturation of the peat and soils across the Proposed Development. The analysis of the DTM derived a topographic wetness index (TWI). The TWI is a dimensionless index, defined by the equation: ln (a/tan b) where a = area draining through a point from an

upslope contributing area and tan b is the local slope angle. The index provides results on the hydrological similarity of peat. All points with the same value of the index are assumed to respond in a similar hydrological manner. High index values will tend to saturate first and will therefore indicate potential subsurface or high surface runoff areas.

9.7.25. As shown in **Figure 9.3**, the TWI for the Proposed Development has identified those areas where water will accumulate on site and result in saturation of the surrounding peat. The highest values (18 plus) in the TWI form linear channels or where areas have a tendency to become saturated, are shown in blue and drier areas where there may be less tendency for the ground to saturate, are shown in yellow and orange. The dark blue linear channels are considered to show achievable flow rates that are likely to occur throughout the year or during extreme rainfall events. The lighter blue is likely to represent areas of the Proposed Development where the topography allows the accumulation and saturation of peat and soils from subsurface or surface during prolonged and/or intense rainfall events. Whilst it is recognised that other areas of the Proposed Development are likely to become saturated, it is expected that any saturation will be dependent upon climatic conditions such as the intensity and duration of rainfall. **Figure 9.3** suggests that away from the watercourses, riparian corridors, man-made drainage channels and flatter ground, that the areas of the Proposed Development where peat depths are shallower (>1 m) is generally quite dry with TWI at the lower end of the range.

Flood Risk

Fluvial Flooding Sources

9.7.26. Flood information available on the SEPA Flood Map indicates that that fluvial flood risk within the catchments of Tomlachlan Burn and Leonach Burn are at high – 0.5 % (1 in 200 year) likelihood of fluvial (watercourse) flooding in any given year. High risk areas are confined within the riparian zones of the main channel.

Pluvial Flooding Sources

9.7.27. Site wide, few small and scattered patches of medium and high likelihood pluvial (surface water) flooding are indicated on the SEPA Flood Map, however these are limited in spatial extent and primarily occur on the bank of main stem and tributaries of the Tomlachlan Burn and Leonach Burn with very few areas of likelihood mapped areas away from watercourses.

Coastal Flooding Sources

9.7.28. The Proposed Development is located approximately 19 km from the nearest coast and due to this distance along with the topographical position, approximately 320 m AOD within the site it is presumed that it will not be affected by tidal flooding.

Groundwater Flooding Sources

9.7.29. Flooding can also result from high groundwater levels if the water table rises above the surface level. Groundwater flooding can occur in a variety of geological settings including river valleys with thick deposits of alluvium and river gravels. Groundwater flooding happens in response to a combination of already high groundwater levels (usually during mid- or late-winter) and intense or unusually lengthy storm events. Such flooding also often lasts much longer than flooding caused by a river over-flowing its banks.

9.7.30. Groundwater flooding is often associated with the shallow unconsolidated sedimentary aquifers that overlie non-aquifers. Such aquifers are susceptible to flooding as the storage capacity within these deposits is often limited and direct rainfall recharge can be relatively high, subsequently increasing the water levels within the groundwater and providing a good hydraulic connection with adjacent river networks. Due to the nature of the superficial geology (as discussed in **Section 9.7.58** below), it is unlikely that there will be any widespread significant groundwater flooding risk within the site. The risk of groundwater flooding is likely to be limited to areas of well-sorted fluvial deposits including alongside watercourses.

9.7.31. Groundwater flooding is difficult to predict as it rarely follows a consistent pattern. The response time between rainfall and groundwater flooding is also relatively long.

Flooding from Artificial Drainage Systems

9.7.32. Aerial photography and site survey observations indicate that the hydrology of the site has been altered by a network of man-made drainage channels. These artificial drainage channels will act to increase peak run-off rates and downstream fluvial flood risk within the Tomlachlan Burn and Leonach Burn catchments. Some of the drainage ditches towards the north of the site looked more recent with running water and the drainage channels towards the south of the site looked more established often choked with vegetation. The drainage ditches were evident in both the Tomlachlan Burn and Leonach Burn catchments and the areas they cover are shown on **Figure 9.1** within **Appendix 9.2**.

Water Quality

Water Quality WFD Classification

9.7.33. Two waterbodies are classified under the Scottish Government's Water Framework Directive (WFD) (2000/60/EC) classification directions; The Scotland River Basin District (Standards) Directions 2014, and The Scotland River Basin District (Status) Directions 2014. The classified waterbodies are summarised in **Table 9.9** below. Current WFD status classifications discussed below are derived from information available within SEPA's Water Classification Hub. The projected status classifications for 2021 and 2027 are derived from SEPA's Water Environment Hub. Waterbody status classifications can be either: High; Good; Moderate; Poor; or Bad.

Table 9.9: WFD Classification of Waterbodies within the Vicinity of the Proposed Development

Water Body	Waterbody ID	Current Overall Status (2018)	Overall Ecology (2018)	Overall Hydrology (2018)	Projected Overall Status (2021)	Predicted Overall Status (2027)
Tomlachlan Burn	23005	Good	Good	High	Good	Good
Leonach Burn	23006	Good	Good	High	Good	Good
Strathnairn, Speyside and Cairngorms	150709	Good	Good	Good	Good	Good

Effects of Peat

9.7.34. As discussed in later sections of this EIA Report, blanket peat (modified by man-made drainage) is present within the Proposed Development area and as such will exert an influence on the water quality within surface and groundwater bodies, particularly during storm events or prolonged dry spells where peat is noted to be eroded or degraded. Effects within the UK are most commonly associated with discolouration arising from high levels of dissolved iron and dissolved organic carbon (DOC), of which the concentrations for the latter have been noted to increase steadily across Europe since the 1970s and is a trend which is predicted to continue (Xu et al. 2020). Whilst the mechanism facilitating these increases is highly speculated, the ultimate removal of DOC is a major component of potable water treatment particularly in catchments dominated by superficial peat.

Water Resources

Water Resources WFD Classification

9.7.35. The WFD classified Tomlachlan Burn, and Leonach Burn have a WFD classification of High for overall hydrology, reflecting the absence of abstractions within the catchment.

9.7.36. Although the overall WFD hydrology classification indicates a high quality of environmental/ecological flows within the site catchments, peak (flood) flows are likely to be modified by the presence of artificial drainage as discussed above in **Section 9.7.32**.

Public Water Supply

9.7.37. Scottish Water confirmed that there are no Scottish Water assets or abstractions with the site. The Proposed Development is also not within a Drinking Water Protected Area and therefore Scottish Water assets will not be considered further in this EIA Report.

Private Water Supply

9.7.38. Highland Council were consulted regarding the presence of PWS (Private Water Supplies) within a 3 km search area from the site boundary. A response was received, and there are five PWS supplies within the search area, they are listed in **Table 9.10** below.

9.7.39. In order to determine the potential risks to PWS, a source-pathway-receptor approach has been adopted to screen whether a hydrological connection could exist between the Proposed Development and the water supply. Where PWS abstraction could be conceivably "hydrologically connected" (either by means of overland or groundwater flow) then further, more detailed assessment was undertaken to qualify the level of risk. Based on the hydrological and hydrogeological setting of the Proposed Development (as presented in this EIA), it is considered that only PWS abstractions within the Proposed Development Area or within 3 km of the Development Boundary could be hydrologically connected.

9.7.40. The results of the screening identified three of the five PWS which could be hydrologically connected to the Proposed Development. Consultation with owner of these three PWS was undertaken through the submission of a questionnaire, requesting details concerning the supply location, the location of delivery infrastructure and general anecdotal information on temporal changes in water quality and quantity. In accordance the LUPS Guidance Notes 4 and 31 (SEPA, 2017) the PWS groundwater abstractions have been identified and are considerably outside (>2 km) their relevant buffer zones of i) of 100 m from roads, tracks and trenches <1m in excavation depth and ii) and 250 m from turbine or other foundations >1 m in excavation depth. The summary of the assessment of the five water supplies is presented in **Table 9.10** below.

Table 9.10: PWS within 3 km Search Area

PWS Supply name	Easting	Northing	PWS Type	Potential for hydrological connectivity with Proposed Development?	PWS supply distance to Site boundary (km)	Scope in/out	Notes
PWS Tirriemore Farm	297240	837452	Groundwater Spring	No – no further actions	2.6	Out	Hydrological connectivity highly unlikely
PWS Banchor	291177	840717	Groundwater Spring	No – no further action	2.1	Out	Hydrological connectivity highly unlikely

PWS Supply name	Easting	Northing	PWS Type	Potential for hydrological connectivity with Proposed Development?	PWS supply distance to Site boundary (km)	Scope in/out	Notes
PWS Dunearn	293335	841151	Groundwater Spring	Yes – letter & questionnaire sent	1.8	Out	PWS abstraction location confirmed and is in a separate sub-catchment to the Proposed Development
Dunearn Farm	293346	841162	Groundwater Spring	Yes – letter and questionnaire sent	2.5	Out	PWS abstraction location confirmed and is in a separate sub-catchment to the Proposed Development
Dunearn Lodge	294028	840078	Groundwater Spring	Yes – letter and questionnaire sent	2.5	Out	PWS abstraction location confirmed and is in a separate sub-catchment to the Proposed Development

9.7.41. Two PWS have been scoped out following initial screening: PWS Tirriemore Farm; and PWS Banchor. The abstractions of these two PWS are highly unlikely to be located in an area which may be hydrologically connected to the Proposed Development. PWS Banchor is separated from the Proposed Development by the River Findhorn, and it is likely to be served by a spring on the forested hillside above Banchor. PWS Tirriemore Farm is likely to be served by a spring on the south-eastern slopes of Carn a' Cheatraimh Mhoir.

9.7.42. The locations of the abstractions of the remaining PWS were established through letter and questionnaire which confirmed that the remaining properties are served by two groundwater springs. Additional properties to those in the table above were identified (Dulsie Cottage and Drumlochan House) are also served by the Dunearn PWS. The groundwater spring at PWS Dunearn/Dunearn Farm is within a sub-catchment of the Leonanch Burn topographically separate from the Proposed Development and it is therefore highly unlikely that there is hydrological connectivity. The groundwater spring supplying Dunearn Lodge is within a topographically separate catchment of Tomlachlan Burn on the slopes of the Hill of Aitnoch and again it is therefore highly unlikely that there is hydrological connectivity.

Fisheries and Recreation

9.7.43. The watercourses and waterbodies within the Proposed Development area discharge into the River Findhorn. The Tomlachlan Burn, and Leonach Burn which drain the site along with the River Findhorn have sensitive populations of trout. The River Findhorn is popular for salmon fishing and sea trout (https://www.fishpal.com/Scotland/Findhorn/).

9.7.44. Further information on fish populations and fisheries can be found in **Chapter 8: Ecology** of this EIA Report.

Soils and Peat

9.7.45. Peat is a soft to very soft, highly compressible, highly porous organic material that can consist of up to 90 – 95% water, with 5 – 10% solid material. Unmodified peat consists of two layers; a surface acrotelm which is usually 10 – 30 cm thick, highly permeable and receptive to rainfall. Decomposition of organic matter within the acrotelm occurs aerobically and rapidly. The acrotelm generally has a high proportion of fibrous material and often forms a crust in dry conditions.

9.7.46. A second layer, or catotelm, lies beneath the acrotelm and forms a stable colloidal substance which is generally impermeable. As a result the catotelm usually remains saturated with little groundwater flow. Peat is thixotropic, meaning that the viscosity of the material decreases when stress is applied. The thixotropic nature of peat may be considered less important where the peat has been modified through artificial drainage or natural erosion and is drier but will be significant when the peat body is saturated.

9.7.47. The distribution of soils across the Proposed Development is dependent upon land use, geology, topography and hydrological regime of the area. Information on the site soils has been provided by the James Hutton Institute, specifically from its online soil information for Scottish soils (SIFSS) portal and is summarised in **Table 9.11**.

Table 9.11: Summary of Soil Types

Soil Association	Parent Material	Component Soils
Dulsie (soil mapping units – 175)	Partially sorted gravelly fine sands derived from acid schists and granites	Peaty gleys with peaty gleyed podzols
Arkaig (soil mapping units– 25, 30)	Drifts derived from schists, gneisses, granulites and quartzites	Humus-iron podzols with peaty gleyed podzols Peaty gleyed podzols, podzolic rankers with peaty rankers
Organic Soils (soil mapping unit 4)	Organic deposits	Dystrophic blanket peat

9.7.48. The above soils information indicates that peaty gleys, peaty and humus-iron podzols and peat are present in the area occupied by the Proposed Development.

9.7.49. **Appendix 9.2** provides details on the methodologies adopted and fieldwork undertaken to assess the potential for peat slides and **Appendix 9.3** outlines the approximate volumes of peat that will be excavated and reinstated, based on the survey results and the infrastructure. The following section provides a summary of the peat depths recorded during field surveys.

Peat Survey Results

9.7.50. A phase 1 peat depth survey was carried out on the Proposed Development during November 2018. The methods employed were in line with Scottish Government guidance[1]. The survey was undertaken on a 100 m grid pattern within the survey boundary and a total of 1118 survey location points were probed. Further detailed probing of infrastructure elements was undertaken during June, July and September 2021. Detailed survey was focussed to areas where peat was greater in depth than 0.5 m or where a better understanding of peat depth in the areas close to deep peat were required. The infrastructure layout was refined following each individual site visit. A further 1536 locations were measured for peat depth during detailed site survey. A summary of the peat depth survey is provided in **Table 9.12** below.

Table 9.12 Phase 1 and Detailed Peat Depth Survey

Peat Depth Range (m)	Count	Percentage of Points
<=0.5	1318	49.7
>0.5-1.0	501	18.9
>1.0-1.5	274	10.3
>1.5-3.0	431	16.2
>3.0	130	4.9
Total	**2654**	**100**

9.7.51. A map displaying the range of peat depths across the Proposed Development is presented in **Figure 9.6** in Volume 2 of the EIA Report. Peat depths recorded were predominately within the range of <= 0.5 m (49.7% of total surveyed points). In terms of spatial coverage, the steeper slopes at the southern end of the Proposed Development recorded the shallower peat depths. Within the surveyed area pockets of deeper peat within the range of 1.5 to greater than 3 m were identified within the north-eastern and central section of the Proposed Development.

9.7.52. In line with current guidance[1], peat is defined as an organic soil which contains 60% organic matter and exceeds 0.5 m in thickness. 50.3% of the recorded depths across the Proposed Development are greater than 0.5 m.

9.7.53. The Carbon and Peatland map (2016) shows that areas of the Proposed Development sit within Class 1 of NatureScot's carbon soil classification, which is identified as a potentially nationally important resource (**Figure 9.5** in Volume 2 of the EIA Report). However, there are areas across much of the site that contain lower classifications within the northern end at Carn Mòr and to the south. Generally, areas of deep peat observed during the Phase 1 Peat survey coincide with areas identified as Class 1 soils. There is an area of Class 0 (mineral soils) within the northern section at Carn Mòr and the southern section also contains large, scattered pockets of Class 4 and Class 5 soils.

9.7.54. The Proposed Development sits within open moorland habitat which is managed for grouse. The land management has altered the natural forming peatland structure in areas with muirburn undertaken in small patches across the site.

9.7.55. The natural peat deposits have been modified by a network of artificial drainage (as outlined above in **Paragraph 9.7.15**). This artificial drainage network will have lowered the water table in the vicinity of drainage ditches, this can result in a loss of peat forming conditions, continuous

[1] The Scottish Government (2017), Guidance on Developments on Peatland

subsidence, and net-carbon losses[2]. Therefore, the areas indicated as Class 1 soils appear to be in a more degraded condition than indicated by the Carbon and Peatland map (2016).

Geology

Bedrock Geology

9.7.56. According to the 1:50,000 scale British Geological Survey (BGS) Bedrock Geology Sheet, the majority of the Proposed Development is underlain by an assemblage of rock from the Slochd Pssammite Formation – Migmatitic Pelite and Migmatitic Semipelite which is a metamorphic bedrock formed approximately 850 to 1000 million years ago in the Tonian Period. The rock would have been sedimentary in origin but has undergone low grade metamorphism. The western area of the Proposed Development around the Leonach Burn is underlain by rock from the Flichity Semipelite Formation - Semipelite, Migmatitic. Metamorphic Bedrock formed approximately 850 to 1000 million years ago in the Tonian Period. This rock would also be derived from sedimentary rocks formed in shallow seas but altered by high grade regional metamorphism.

9.7.57. There are no apparent registered geologically derived Sites of Special Scientific Importance within the site boundary or with a 500 m buffer.

Superficial Geology

9.7.58. According to the 1:50,000 scale BGS Superficial Drift Sheet the solid bedrock is likely to be overlain primarily by peat, with alluvium and assemblages of glaciofluvial deposits comprising sands, gravels and silts. Alluvium and glaciofluvial deposits are found alongside the banks and valleys of the Tomlachlan Burn, and the Leonach Burn. There are areas of glacial till on the northern slopes of Carn Allt Laoigh, Cnapan a' Choire Odhair Bhig, and Carn Mor.

Hydrogeology

9.7.59. Bedrock underlying the site is classified as a low productivity aquifer comprising metamorphic rock. Flow is virtually all through fractures and other discontinuities. It is likely that there are small amounts of groundwater in near surface weathered zones and secondary fractures.

9.7.60. Where well sorted fluvially deposited superficials are present, groundwater flows may be more significant. However, the majority of the site is overlain with relatively lower permeability peat and glacial tills.

Groundwater Dependent Terrestrial Ecosystems

9.7.61. SEPA's wind farm planning guidance[3] states a National Vegetation Classification (NVC) survey should be undertaken to identify wetland areas that might be dependent on groundwater. If potential GWDTE are identified within (a) 100 m of proposed excavations less than 1m deep (e.g. roads, tracks and trenches), or (b) within 250 m of excavations deeper than 1m (e.g. excavated tracks, borrow pits and foundations), then it is necessary to assess how the potential GWDTE may be affected by the Proposed Development.

9.7.62. SEPA's wind farm planning guidance[4] has been used to inform the Proposed Development design. Areas of potential GWDTE have been identified and assessed accordingly. In line with SEPA guidance, an NVC survey data has been used to identify areas of possible GWDTE and site works have then been completed to assess whether the potential GWDTE is sustained by groundwater or not.

[2] UUCN UK, 2014, Impacts of Artificial Drainage on peatlands, Committee Peatland programme Briefing note No.3

[3] SEPA Land Use Planning Guidance Note 4, 2017. Planning Guidance on On-Shore Windfarm Developments, Version 9

[4] SEPA Land Use Planning Guidance Note 31, 20170. Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems, Version 3

9.7.63. An NVC survey has been undertaken to classify the habitats on the Proposed Development and is summarised in **Chapter 8**. The survey indicated that there are habitats with the potential to be dependent on groundwater (**Figure 9.7**).

9.7.64. The ecological surveying carried out by Natural Power and reported in **Chapter 8**, shows that the vast majority of the potential GWDTE areas (M15, with much smaller areas of M23, M25) are associated with land management impact (overgrazing/artificial drainage) or are features in connection to either surface water features or ombrogenous (rain-fed) habitats along surface water pathways and areas of topographic wetness as a result of flow convergence. The retention of surface water in areas of reduced topographic gradient is also likely to be exacerbated by the low permeability of the underlying indurated bedrock as well as the spatially discontinuous overlying peat. The buffers to GWDTE specified in SEPA guidance need not apply to these communities given that they are interpreted as not in fact being sustained by groundwater.

9.7.65. Other potential GWDTE areas were associated with several discrete acidic flushes (M6), often associated with the watercourses that drain the Proposed Development area. As these habitats are often identified in conjunction with seeps, sills or runnels; upslope / upstream presence of ombrotrophic bog / mire (wet heath or blanket bog); situated away from likely groundwater rises (flat areas, topographic highs); or where they are situated in a watercourse, floodplain, or other ponding locations, likely dependency will be no more than moderate and is likely to be low[5].

Carbon Balance

9.7.66. A carbon balance assessment has been produced (**Appendix 3.3**) to give an indication of the Proposed Development's impact on the existing peat on site and to assess the potential effects in terms of carbon dioxide (CO_2) emissions against the total potential carbon savings attributed to the Proposed Development. The assessment quantifies the gains over the life of the project against the release of CO_2 during construction, including loss of peat bog and construction of roads/tracks and other infrastructure. The latest version of the Carbon Calculator (v.1.6.1) that was available before the application is submitted has been used. It is not expected for there to be any requirement for the Carbon Balance assessment to be amended post submission should any further update of the Carbon Calculator occur.

9.7.67. The carbon balance assessment also takes into consideration reductions in any existing carbon losses as a result of peatland habitat restoration prescriptions.

Modifying Influences

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

9.7.69. Warmer and wetter winters suggest less snow and more rain. This will create increased risk for flood events, and issues with water quality as less precipitation will be held in its frozen state during the winter season. If climate predictions are correct, summer months will become drier. This will create pressure on the needs of water abstractions and on sensitive ecosystems that rely on aquatic habitats. Evidence also suggests that although the summer months will have an average decrease in rainfall, summer storms will be more frequent and intense. This may

[5] Botaaneco. 2016. GWDTE Decision Tool. Available at https://drive.google.com/file/d/1_q0Tjh9TfzLFUdDoczt7SPdZLMv8w1L/view

lead to more extreme flow values during and immediately following such events, with consequential flooding and water quality issues. This is of key importance for the hydrological environment during summer construction periods.

9.7.70. It is suggested that increased temperatures in the summer could also increase evapotranspiration and potentially cause desiccation of peat. The desiccation could result in the peat being more susceptible to erosion due to increased intensity in summer storms and increased rainfall during the winter months. As peat and peat dominant soils are composed of vegetation remains, they contain a high proportion of carbon compared to other soils.

Receptor Baseline Sensitivity

9.7.71. On the basis of the baseline surveys and available information**, Table 9.4** above identifies the criteria for assigning the sensitivity of receptors as outlined in **Table 9.13** below with justification for their categorisation.

Table 9.13: Receptor Sensitivity

Receptor	Sensitivity	Comment
Surface Water		
Tomlachlan Burn	High	Classified under RBMP as having "good" overall status. Watercourses of high status are of national importance in achieving good water quality status targets. The watercourses draining the Proposed Development support water quality in downstream fisheries.
Leonach Burn	High	Classified under RBMP as having "good" overall status. Watercourses of high status are of national importance in achieving good water quality status targets. The watercourses draining the Proposed Development support water quality in downstream fisheries.
Allt Laoigh	Medium	Not classified under RBMP but drains into Tomlachlan Burn. The watercourses draining the Proposed Development support water quality in downstream fisheries.
Caochan Gortach	Medium	Not classified under RBMP but drains into Tomlachlan Burn. The watercourses draining the Proposed Development support water quality in downstream fisheries.
Flood Risk		
The Proposed Development	Low	Only very limited areas of the Proposed Development fall within the flood inundation envelope (i.e. only at lower catchment watercourse crossing locations). Increase in impermeable area within the catchments can increase flood risk within well designed drainage and mitigation.
Downstream of Proposed Development	Low	Downstream watercourses are at potential risk of flooding and any changes to the hydrological environment that results in additional flow could exacerbate the likelihood of flooding. A network of existing artificial drainage will act to increase this risk.
Water Resources		
PWS	High	No PWS have been identified as being hydrologically connected to the Proposed Development as per the baseline conceptual site model presented in **Section 9.7**.

Receptor	Sensitivity	Comment
		Notwithstanding, whilst individual PWS of are low national or regional importance, they are of very high local importance to the PWS User. Due to the remote nature of these PWS, permanent alternative provisions via a utilities provider is likely to be unfeasible. As such, PWS are allocated as having high sensitivity."
Fisheries and Recreation		
Fisheries Interests with the River Findhorn Catchment	Medium	River Findhorn is an important river for Salmon fishing and relies on good water quality.
Soils		
Site soils and peat < 0.5 m depth	Low	49.7 % of the surveyed soils are less than 0.5 m deep and therefore not classified as peat and of local significance
Site soils and peat > 0.5 m depth	High	There several areas identified as consisting of Class 1 and Class 2 soils which are considered to be of national importance
Hydrogeology and Groundwater		
Groundwater within peat	Medium	Owing to the low permeability of the underlying bedrock across most of the Proposed Development, the peat may host a shallow superficial aquifer which is vulnerable to pollutants that are not readily absorbed or transformed.
Underlying Groundwater	Low	Low productivity and unlikely to support any significant volumes of groundwater.
GWDTE	Medium	Vast majority of potentially GWDTE habitats are ombrotrophic / surface water fed. Discrete areas of acid flushes (M6), likely to be partially sustained by groundwater and are therefore moderately dependent.

9.8. Identification and Evaluation of Effects

Proposed Development Interactions

9.8.1. The Proposed Development will introduce physical changes which have the potential to alter the hydrological characteristics within the site. During the construction phase and to a lesser extent during the operational phase potential sources of pollution will be present. Hydrological surveys have been undertaken to establish the existing on-site baseline conditions and associated areas downstream to assess the likely significant environmental effects of the Proposed Development on the identified receptors, the significance of these effects on the receptors and the potential for mitigation to reduce the significance of the identified effects.

Effects Evaluation

Construction / Operation / Decommissioning (as required)

9.8.2. The Proposed Development will consist of the erection, 35 year operation, and subsequent decommissioning of up to 17 wind turbines, with tip heights of up to 185 m. The Proposed Development includes associated turbine foundations and transformers, battery storage, hardstanding areas for erecting cranes at each turbine location, a series of on-site tracks connecting each turbine, underground cables linking the turbines to the grid connection, an

on-site substation, construction compounds, three borrow pit search areas, and a permanent meteorological mast.

9.8.3. Typically, the construction phase will involve a period of earthworks inclusive of track construction and excavations for forming turbine bases. Following this, the turbine bases and infrastructure will be installed and finally the turbines will be transported to site and erected.

Mitigation by Design

9.8.4. A summary of the hydrological influences on the Proposed Development layout are given below with full details of the Proposed Development's design provided in **Chapter 3: Project Description**, of the EIA Report. Due to the nature of the environment occupied by the Proposed Development it is important that the design and infrastructure helps maintain or even improve the local hydrology and peat. Poor design of development infrastructure can result in significant implications to the hydrological environment, soils and ecology.

9.8.5. From the phase 1 peat survey and detailed site survey it is known that there are pockets of deep peat underlying the Proposed Development, whilst taking into account other constraints, the layout has been designed to avoid deep peat (>0.5 m) as far as possible. **Figure 9.6** shows that with the exception of Turbine 2 that the 16 other turbines have all been located on peat <0.5 m depth.

9.8.6. The hydrological desktop study and site visits have identified a relatively flat upland hydrological environment of open moorland which includes hydrological pathways and features both natural watercourses and man-made artificial drainage ditches associated with it. A series of buffer distances have been adopted to help reduce effects of the Proposed Development on the hydrological environment.

9.8.7. A 50 m buffer was implemented for all identified natural hydrological features. Infrastructure has been sited outside these buffers except where access necessitates. Watercourse crossings associated with the new access track required as part of the Proposed Development have been minimised as far as practicable.

9.8.8. **Table 9.14** confirms that all turbines and infrastructure associated with the Proposed Development are located outside the buffer limits. Distances were calculated using the functionalities provided within QGIS. Watercourses are linear features that were identified from the OS 1:10,000 raster data.

Table 9.14: Distance from Turbine to Nearest Watercourse

Turbine ID	Turbine distance from watercourse (m)(inclusive of 50 m buffer)
1	460
2	211
3	245
4	377
5	154
6	628
7	350
8	362
9	255
10	127

Turbine ID	Turbine distance from watercourse (m)(inclusive of 50 m buffer)
11	100
12	135
13	223
14	203
15	81
16	73
17	67

9.8.9. Other 'mitigation by design' considerations for the Proposed Development are as follows:

- The layout of new tracks has been designed to minimise impacts on the hydrological environment and as far as possible to avoid sensitive receptors such as watercourses, GWDTE and deep peat.
- A number of new watercourse crossing locations will be required for the Proposed Development in areas which do not utilise areas of existing track (**Appendix 9.1: Water Crossing Assessment**). The crossings will be constructed in a manner that minimises the impact of hydrological disturbance on the site and allows free passage of aquatic species. Where possible, utilising existing crossings will minimise the impact of disturbance on the hydrological environment. The number of new and existing watercourse crossings required is nine in total.
- Borrow pits and their search areas associated with the Proposed Development have been located across the site to minimise transportation movements of stone. They are located close to the proposed infrastructure and will be restored after use. All of the proposed borrow pits and search areas are located outside the 50 m buffer of watercourses. Further details are provided in **Appendix 9.4: Borrow Pit Assessment Report**.
- The design of linear infrastructure elements will be done to avoid modifying surface water and groundwater flow pathways. This includes the use of permeable materials for track construction, sections of floating track, adoption of a site-wide drainage strategy integrating the use of regular cross drains and soakaways.

Mitigation Measures

9.8.10. Full details of the assumed good practice construction management and mitigation measures will be provided in a site-specific CEMP which would be prepared post consent as part of the conditions of discharge process. A summary of the measures that are likely to be included within the CEMP, are described below and have been assumed to be part of the proposals when the potential effects and their significance are reported. Any additional mitigation, specific to the Proposed Development, but still considered good practice is also provided in further detail in **paragraph 9.8.55 to 9.8.56**.

Outline Construction and Environmental Management Procedures

9.8.11. A number of the mitigation measures described in the following paragraphs can also be adopted during the operational phase of the Proposed Development. To avoid duplication of text, the reference to what stage the measures can be adopted is provided.

General Site Pollution Control

9.8.12. A site-specific CEMP will facilitate the implementation of industry good practice measures in such a manner as to prevent or minimise effects on the surface and groundwater environment. The CEMP will include information as follows:

- Drainage – all run-off derived from construction activities and site infrastructure will not be allowed to directly enter the natural drainage network. All run-off will be adequately treated via a suitably designed drainage scheme with appropriate sediment and pollution management measures. The Proposed Development is situated in an upland hydrological area and it is imperative that the drainage infrastructure is designed to accommodate storm flows based on a 1 in 200-year event plus climate change to help maintain the existing hydrological regime.
- Storage – all equipment, materials and chemicals will be stored well away from any watercourses. Chemical, fuel and oil stores will be sited on impervious bases with a secured bund at a designated location (likely to be construction compounds).
- Vehicles and Refuelling – standing machinery will have drip trays placed underneath to prevent oil and fuel leaks causing pollution. Where practicable, refuelling of vehicles and machinery will be carried out in designated areas, on an impermeable surface, and well away from any watercourse.
- Maintenance – maintenance to construction plant will be carried out in designated zones, on an impermeable surface well away from any watercourse or drainage, unless vehicles have broken down necessitating maintenance at the point of breakdown, where special precautions will be taken.
- Welfare Facilities – on-site welfare facilities will be adequately designed and maintained to allow the appropriate disposal of sewage. This may take the form of an on-site septic tank with soakaway, or tankering and off-site disposal depending on the suitability of the Proposed Development for a soakaway. Any discharge requirements will comply with relevant requirements under SEPA's CAR.
- Cement and Concrete – fresh concrete and cement are very alkaline and corrosive and can be lethal to aquatic life. The use of wet concrete in and around watercourses will be avoided and carefully controlled through implementation of the buffer zones where applicable and good practice construction methods.
- Monitoring Plan – all activities undertaken as part of the Proposed Development will be monitored throughout the construction phase to monitor environmental compliance. Water quality monitoring, will also occur throughout each phase of the Proposed Development and will help to maximise the effectiveness of embedded mitigation measures whilst monitoring effects on the hydrological environment. The frequency and duration of monitoring will be agreed following discussion with SEPA and other relevant authorities.
- Contingency Plans – a site specific Emergency Response Plan will be implemented to allow plans to be put in place to manage a spill or other pollution incident. The plans will ensure that emergency equipment is available on site i.e., spill kits and absorbent materials, advice on action to be taken and who should be informed in the event of a pollution incident.
- Training – All relevant staff personnel will be trained in both normal operating and emergency procedures and be made aware of highly sensitive areas on site.

9.8.13. Further details regarding the pollution prevention and mitigation measures that will be adopted during the construction and operation of the Proposed Development are detailed in the following paragraphs.

Run-off and Sediment Management

9.8.14. The following measures will be adopted to appropriately attenuate and treat run-off during, construction and operation of the Proposed Development:

9.8.15. The Proposed Development drainage system will convey water away from construction activities and built infrastructure, however, due to the nature of the works at the Proposed Development with negligible infiltration and storage capacity of the underlying peat and bedrock, there is potential for sediment and other pollutants to become entrained in the surface run-off.

9.8.16. To reduce this potential, prior to the commencement of and during construction, plans showing site drainage and hydrologically sensitive areas (watercourse buffers, deep peat, GWDTE) will be regularly checked to review potential for run-off and ponding of water within the Proposed Development so that that run-off patterns are well known.

9.8.17. The drainage systems installed within the Proposed Development will also have sediment management measures incorporated into their design to help reduce or wholly mitigate effects on the hydrological environment. The type of sediment management will depend on the volume of construction activities occurring in particular areas within the Proposed Development. For all the suggested control measures, regular inspection and maintenance is necessary, particularly after prolonged heavy rainfall.

9.8.18. Silt traps will be installed within the Proposed Development drainage system. Silt traps could take the form of terram fences or clean stone, however, the ability of the silt traps to successfully treat run-off will be dependent upon the permeability of the terram geotextile material and the size and source of the clean stone.

9.8.19. The ability of the silt traps to effectively treat run-off will depend upon the volume of run-off within the drainage channel, the type of material used and the frequency of monitoring and replacement of the measures.

9.8.20. If required, flocculents could also be used to treat run-off. Flocculents are very effective at removing suspended sediment from water but they can also have effects on water chemistry. As such, these would be used with caution and only if deemed necessary by SEPA, who would be consulted prior to their use.

Pumping and Dewatering of Excavations

9.8.21. All pumping operations e.g., removal of water from turbine base excavations, will be carried out in line with good practice and where necessary in line with the requirements of CAR prior to the works being undertaken. Suitable measures to minimise the impact of the pumped water on the hydrological environment shall be taken. These measures shall include, but are not limited to, the techniques discussed in the following paragraphs.

9.8.22. Due to the expected low permeability across the majority of the Proposed Development peat and soils it is expected that the potential for groundwater ingress would be low. However, there remains the possibility for groundwater ingress at the interface between the peat layers and the substrate layer as well as through potential peat pipes and other sub-surface features. The time that excavations are open will be kept to a minimum to prevent water ingress, as well as secondary impacts on up-slope soils/peat due to dewatering upslope. The ingress of surface water into the excavations will be minimised using up gradient drainage measures e.g., cut-off ditches that will also prevent shallow throughflow entering excavations. It is recognised that water can still enter the excavation and would need to be removed. This can be achieved by allowing the water to gravity drain to a designated area before being pumped from the excavation to a predesigned settlement lagoon or other suitable silt treatment area. The settlement lagoons would attenuate and treat run-off before discharging back into the natural drainage network, mimicking natural flow patterns as far as possible.

9.8.23. Owing to the peat and peaty soils on site, the throughput rate of run-off within the settlement treatment areas would be reduced to give longer settlement time within the excavations and settlement tanks. If required, a series of settlement lagoons or other silt treatment measures can be deployed to allow maximum settlement of sediment during the construction period.

9.8.24. The treated water from the settlement lagoons or other silt treatment measures will not be discharged directly into watercourses but directed onto vegetated surfaces where appropriate. Sediment will be removed from site and the treated water will be deposited amongst the rough surface vegetation, away from sensitive habitats or watercourses.

9.8.25. To reduce the likelihood of erosion channels being formed by the discharge from the sediment treatment outfalls it is recommended that the water is discharged at a slow rate or spread evenly across a surface. For discharge onto rough vegetation to be effective the discharge must be spread efficiently, and the vegetation, soils and topography be carefully considered to determine an appropriate discharge location. For example, filtering the water through a length of pipe with multiple discharge points will allow attenuation as well as diffuse dispersion, thus reducing the erosive potential of the run-off.

9.8.26. The discharge can also utilise silt traps, silt fencing or other attenuation measures. The utilisation of such measures could help to prevent the formation of erosion channels.

9.8.27. To maximise the efficiency of the settlement measures e.g., Siltbusters or other holding lagoons or tanks, the sediment sludge that collects at the base will be removed as required.

Storage of Fuels / Chemicals and Bunding Arrangements

9.8.28. Throughout construction, and to a lesser extent during the operational phase of the Proposed Development, a number of oils and chemicals will be used. Such materials will be used and stored in a safe manner in the construction compound(s), compliant with General Binding Rule 26, 27 and 28 to protect the surface and groundwater environment.

9.8.29. The following measures will be adopted to protect the surface and groundwater environment from the inappropriate storage and use of substances hazardous to the environment:

- All equipment, materials and chemicals to be stored away from any watercourses. Chemicals, fuel and oil will be stored in tanks of sufficient strength and structural integrity to reduce the chances of bursting or leaking in ordinary use. They will also be sited on impervious bases within a secured bund of 110% of the storage capacity;
- Where oil is stored in a bunded area, oil residue can build up. This residue build-up will reduce the storage capacity of the bund and will be removed regularly. The residue will be disposed of by a specialist contractor;
- Locks shall be fitted to all fuel storage tanks or containers and there shall be a nominated trained person to oversee the refuelling and delivery to minimise the risk of spillage;
- Standing machinery to have drip trays placed underneath to prevent oil and fuel leaks causing pollution.

Refuelling

9.8.30. External fuel delivery lorries will only be allowed as far as the site compounds where there will be a bunded refuelling/fuel storage area constructed on an impervious base. Delivery lorries will transfer fuel to the on-site fuel tank or truck located within the bunded refuelling area to minimise the amount of fuel being driven around the Proposed Development and minimise external drivers accessing the Proposed Development.

9.8.31. A designated fuel truck/bowser will be used for refuelling on the access tracks or hardstand. The driver shall be responsible for refuelling of mobile plant and ensuring that it does not take place within 50 m of a watercourse or any other sensitive receptor. The bowser driver will receive suitable training on spill prevention and response.

9.8.32. The refuelling bowser shall be equipped with a mobile spillage control kit containing oil absorbent booms and mats. All site personnel will be trained in their use as part of the Proposed

Development induction training or toolbox talks. Special attention will be paid to spillage control at/near watercourses.

Vehicle Maintenance and Management

9.8.33. All plant used during the construction of the Proposed Development will be in suitable condition and fit for purpose to carry out the works and will be maintained as per manufacturers guidelines.

9.8.34. Maintenance of construction plant to be carried out only in designated areas, on an impermeable surface away from any watercourse or drainage. Only if vehicles have broken down will maintenance be permitted outwith a designated area, and this would only be carried out after implementing special precautions. Such precautions include, but are not limited to the following:

- Ensure that drip trays are placed underneath vehicles during maintenance.
- As a precautionary measure, and if deemed appropriate, silt fencing or entrapment matting would be placed downstream of the maintenance area.
- All heavy construction plant will be inspected daily by the operating personnel and any defects or issues resolved immediately prior to starting works. All heavy construction plant shall be issued with spill-kits. Should a spillage occur, larger spill kits shall also be positioned at various areas within the Proposed Development which will be highlighted to all operatives during the site induction.
- Standing machinery and plant will have industry standard drip trays (or similar, e.g. plant nappies – open metal drip trays are not permitted) placed underneath to prevent oil and fuel leaks causing pollution.

Concrete Works

9.8.35. Concrete would be required for the construction of the wind turbine foundations and foundations for the substation/control room building. The use of concrete as part of watercourse crossing construction would be minimised as far as practical, favouring non-cementitious material. The following section provides good practice measures that are required to be implemented to prevent detrimental effects to the hydrological environment.

9.8.36. Care will be taken during the transportation of concrete to the turbine and building foundations and will be carried out following good practice measures. Freshly mixed concrete and/or dry cement powder will not be allowed to enter any watercourse. This will be avoided by the following actions:

- Turbines, concrete batching or wash out areas will be located at least 50 m from watercourses.
- Concrete wagons will only be permitted to wash-out into specifically designed wash-out areas and predetermined at agreed locations site wide.
- The drivers will be informed at their site induction of the location of the designated wash-out areas and issued with a location map.
- Loads will be managed and assessed with regards to the size of vehicle and ground conditions whilst keeping at appropriate speed limits to avoid spillage.
- Tools and equipment will not be cleaned in watercourses. Should it be necessary to clean tools and equipment on site, this will be done in the predetermined wash-out areas.
- A designated concrete wash-out area will be constructed within the Proposed Development at a location agreed with the relevant consultees to protect watercourses. The design and construction of these wash out areas will be agreed with SEPA.
- Wash out areas will be continually monitored, and findings recorded to reduce the chances of effluent spilling over into the environment.

Site Drainage

9.8.37. The following section discusses the conventional site drainage measures that can be installed during the construction and operation of the Proposed Development.

9.8.38. Surface drainage ditches will be installed alongside tracks only where necessary. The length, depth and gradient of individual drains will be minimised to avoid intercepting large volumes of diffuse overland flow and generating high velocity flows during storm events. Sediment traps, settlement ponds and buffer strips will be incorporated into the drainage system as necessary and will serve the dual purpose of attenuating peak flows, by slowing the flow of run-off through the drainage system and allowing sediment to settle before water is discharged from the drainage system.

9.8.39. As well as utilising sediment traps, structures such as v-notched weirs and/or check dams will be installed within the drainage channels. Such structures will throttle the flow within the channel, thus reducing erosive potential of any run-off and allowing sediment and/or pollutants to settle.

9.8.40. To reduce the impact of the Proposed Development on the natural hydrological regime, the site drainage will mimic greenfield run-off response using sustainable drainage practices.

9.8.41. Sustainable Drainage Systems (SuDS) will be integrated into the water management and details of the proposed SuDS regime would be included in the CEMP and Pollution Prevention Plan (PPP) that will be produced as part of the application that would be made to SEPA for a construction run-off permit.

9.8.42. SuDS are used to attenuate rates of run-off from development sites and can also have water purification benefits. The implementation of SuDS as opposed to conventional drainage systems provides several benefits by:

- reducing peak flows to watercourses and potentially reducing risk of flooding downstream;
- reducing the volumes and frequency of water flowing directly to watercourses;
- improving water quality by removing pollutants;
- reducing potable water demand through rainwater harvesting; and
- replicating natural drainage patterns, including the recharge of groundwater so that base flows are maintained.

9.8.43. Whilst it is understood that the scope for SuDS measures is limited as a result of the hydrological environment, the installed drainage measures will adopt the principles highlighted above.

9.8.44. Access tracks crossing slopes will disrupt surface flow that consequently will collect in drains constructed upslope of the tracks. Cross-drains and/or waterbars will be constructed at regular intervals to conduct this surface flow below or across the track where it will be discharged back into the drainage system, although all efforts will be made to segregate this run-off from more-silty run-off originating from track surfaces and other exposed construction areas, thus reducing the silt load and volume discharging to all silt treatment areas. Regular discharge points will limit the concentration of surface run-off and the diversion of flows between catchments. Such cross drains need to be strong enough to withstand the expected traffic loadings.

9.8.45. During storm events there is likely to be some ponding on the uphill side of tracks, as percolation alone is unlikely to be able to accommodate surface flows. To minimise this ponding, small diameter cross drains or perforated pipes (similar to plastic pipe field drains) will be incorporated into the track base at regular intervals to allow more flow to pass through the track and maintain the current flow regime. Such pipes will be surrounded by free draining material that is wrapped in a separator geotextile. The number of pipes and associated dimensions will be dependent upon the width of the flush/boggy area, proximity to GWDTE and the hydrological regime.

9.8.46. Prior to track construction, site operatives will identify flush areas, depressions or zones which may concentrate water flow. These sections will be spanned with plastic pipes to help maintain hydraulic conductivity under the road and reduce water flow over the road surface during heavy precipitation.

9.8.47. Due to the poor permeability of the surrounding peat, peaty soils and bedrock, drains and/or cut-off drains will be installed on the upstream/upgradient sides of the turbine foundations, crane hardstands, and other excavations required across the Proposed Development. The purpose of this will be to help reduce the volume of surface water run-off entering the excavations and minimise any subsequent contamination.

9.8.48. The constructed drainage system will not discharge directly to any natural watercourse, but will discharge to buffer strips, trenches or SuDS measures, preferably on flatter, lower lying ground. These buffers will act as filters and will minimise sediment transport, attenuate flows prior to discharge and maximise infiltration of water back into the soils and peat.

9.8.49. Drainage from the construction compounds, welfare facilities, borrow pits and concrete wash out areas will be collected and treated separately from the main site drainage, as the run-off from these areas is more likely to be contaminated and therefore will require treatment. Appropriate treatment, such as oil interceptors and treatment for high alkalinity, will be installed.

9.8.50. All mitigation and drainage will be subject to detailed design and approved by Scottish Water and SEPA prior to construction with the ECoW ensuring compliance. The Proposed Development will also be subject to a construction site licence.

9.8.51. New watercourse crossings will be required, along with upgrading of some of the existing watercourse crossings, as part of the access tracks associated with the Proposed Development (see **Appendix 9.1: Watercourse Crossing Assessment**). The crossings will be appropriately designed so that they do not alter the natural drainage, hinder the passage of aquatic fauna and can accommodate flow at a minimum of 1:200yr + CC event. All watercourse crossings will be designed with edge upstands or bunds e.g. sandbags or silt fences to prevent sediment laden run-off from construction plant movement from directly entering watercourses. Relevant CAR Authorisation from SEPA will be sought for construction of the crossings that are required over watercourses that are displayed on the 1:50,000 OS Landranger maps.

Welfare Facilities / Foul Water

9.8.52. The following measures will be adopted for the design of the foul water drainage system:

- Any sewage associated with the temporary construction compounds, control buildings and welfare facilities will be collected in appropriately sized interceptor tanks and shall be located at the construction compounds. All wash basins, toilets and shower areas shall also be connected to an interceptor tank.
- The interceptor tanks and the tanks within any site portable toilets, which shall be situated not less than 50 m from any watercourse, will be emptied regularly by a suitably licensed contractor. Sewerage from these facilities will be disposed offsite in accordance with waste management legislation.
- The discharge volumes will be small however it will comply with the requirements of the CAR and in consultation with SEPA.

Emergency Water Management Measures

9.8.53. A significant volume of oils and chemicals will be stored on-site during the construction phase and to a lesser extent the operational phase. Site traffic will also be present in significant numbers during the construction phase of the Proposed Development, with traffic volumes significantly reduced during wind farm operation.

9.8.54. The appropriate storage of oils, chemicals and maintenance of site plant has been discussed above. However, despite these measures, accidents can happen, and these can have significant impacts upon the quality of the surface and groundwater environment. The following emergency procedures will be implemented to provide additional protection to the surface and groundwater environment during wind farm construction and operation:

- All relevant on-site staff to be trained in both normal operating and emergency procedures and be made aware of highly sensitive areas on site. The staff training, and implementation of site procedures will be overseen by the infrastructure contractor so that these measures are carried out effectively to minimise the risk of a pollution incident.
- Contingency plans will be designed that clearly highlight the location of emergency equipment available on site (i.e. spill kits and absorbent materials), training on correct use and that advice is provided on actions to be taken and who would be informed, in the event of a pollution incident.
- Contingency planning procedures must be regularly reviewed to include changes to site operations that were not foreseen during design.
- The procedures set out in site contingency plans will be prepared in conjunction with the assessment of the risk of a pollution incident occurring and the measures to be taken to minimise pollution. The location of the procedures will be publicised, and it is essential that they are set out clearly so that they can easily be understood and acted upon.
- The emergency procedures will include the following:
  - containment measures;
  - emergency discharge routes;
  - list of appropriate equipment and clean-up materials;
  - maintenance schedule for equipment;
  - details of trained staff, location, and provision for 24-hour cover;
  - details of staff responsibilities;
  - notification procedures to inform the relevant environment protection authority;
  - audit and review schedule;
  - telephone numbers of statutory and local water company; and
  - list of specialist pollution clean-up companies and their telephone numbers.

9.9. Potential Effects

Description of Potential Construction Effects

9.9.1. The potential for effects on the hydrological environment is greatest during the construction phase due to the high levels of activity on-site and when there is greatest change to the existing environment. The construction of the Proposed Development is discussed in the following paragraphs. This information has taken account of the embedded mitigation and management measures outlined in **Section 9.6**.

9.9.2. The evaluation of construction effects is provided in **Table 9.15** below. The table assumes the successful implementation of the embedded mitigation measures provided in **Section 9.8**.

Pollution Incidents

9.9.3. During the construction phase, several potential pollutants will be present on-site, including oil, fuels, chemicals, unset cement and concrete, waste and wastewater from construction activities and staff welfare facilities. Many of these potential pollutants will be located or stored within the two construction compounds located within the catchments discussed in **paragraph 9.7.11 to 9.7.18**. In addition, there is the potential for contamination of the hydrological and terrestrial environment caused by spillages along the access tracks and construction areas.

Erosion and Sedimentation

9.9.4. Soil and sediment generation may occur in areas where the ground has been disturbed, particularly where surface run-off has been concentrated. Drainage ditches are particularly prone to this problem, due to the high velocities of surface water run-off passing through the drainage

network. Considerable sediment generation is expected where the ground has been excavated for the Proposed Development infrastructure.

9.9.5. Sediment transport in watercourses can result in high turbidity levels which can impact on the water quality, particularly affecting the ecological potential of the watercourses. High turbidity in watercourses can reduce the light and oxygen levels in the watercourses, while sediment deposition can smother plant life and spawning grounds. Sediment deposition can also reduce the flood storage capacity of the watercourses and block culverts, resulting in an increased flood risk.

9.9.6. As a result of construction operations, all catchments with new and upgraded infrastructure present are vulnerable to erosion and sedimentation.

Increase in Run-off

9.9.7. Turbine bases, hardstand areas and access tracks will act as impermeable areas, restricting the natural movement of water within the hydrological environment, potentially resulting in increased rates of run-off into the onsite catchments.

9.9.8. Localised increases in run-off could cause issues for downstream flood storage capacity and/or pollution incidents. Increases in the volume of run-off entering watercourses could also cause erosion and sedimentation, therefore having detrimental effects on surface water hydrology.

Modification of Drainage Patterns

9.9.9. The interception of diffuse overland flow by the Proposed Development infrastructure and associated drainage may disrupt the natural drainage regime of the area, concentrating flows and potentially diverting flows from one catchment to another. This may have implications for water quality and on flood issues downstream of the Proposed Development.

9.9.10. Potential GWDTE and other surface water dependent habitats such as watercourses and riparian zones present a potential engineering constraint and the necessary precautions should be taken to avoid them where possible and maintain them where avoidance is not possible. This should include bespoke drainage arrangements that maintain surface water flows and prevent dewatering of adjacent habitat.

9.9.11. Construction of the Proposed Development may have the following potential effects on the quantity and quality of groundwater supplying GWDTEs and to a lesser extent in the case of the Proposed Development PWS sources:

- Turbine foundations and hardstand areas located up-gradient from GWDTE, and other sensitive habitats could disrupt shallow groundwater flow from dewatering and diversion of flow paths;
- Turbine foundations and hardstand areas located down-gradient from GWDTE, and other sensitive habitats could cause temporary lowering of the water table from dewatering;
- Access tracks, drainage ditches and cable trenches located up-gradient from GWDTE could disrupt and divert shallow groundwater flow-paths;
- Infrastructure located directly over peat and wetland habitats could contaminate and lower the quality of groundwater through pollution and sedimentation; and
- Runoff from construction areas may infiltrate into shallow groundwater aquifers and contaminate and lower the quality of groundwater through pollution and sedimentation.

Impediments to Surface Water Flow

9.9.12. The construction of watercourse crossings may restrict flow in the various channels and reduce hydraulic capacity, resulting in an increase in flood risk, and promotion of erosion and

sedimentation. In addition, poorly designed watercourse crossings may impede the migration of fish and mammal movement in the riparian corridor.

Degradation of Water Quality

9.9.13. The risk from pollution via the accidental and uncontrolled release of sediment due to increased exposed soil and peat as well as via leakages and spillages remains a risk despite embedded mitigation. The pouring of concrete and cement may also impact the chemical balance of shallow groundwater.

Modification of Groundwater Flows and Levels

9.9.14. Deep excavations, such as those required for the turbine foundations, are likely to disrupt the shallow groundwater systems and bedrock geology. Surface water ingress is minimised by utilising upgradient cut-off drains or other drainage measures. The installation of cut-off drains has the potential to lower local groundwater levels within surrounding peat dominated soils.

9.9.15. Access tracks have the potential to disrupt flow pathways, such as interrupting shallow groundwater flow or altering the hydrological regime. The presence of existing tracks at the Proposed Development will minimise hydrogeological disturbance.

Peat Instability

9.9.16. Peat slides do occur naturally, however, because of the remote nature of most peatlands, the frequency of natural events may be under reported. As a result, peat slides and their causes are poorly understood, although it is recognised that they are the result of multiple causes.

9.9.17. A peat slide occurs when a portion of the peat mass becomes detached and flows downhill, usually as blocks of solid peat rafted upon a slurry of semi-liquid peat. A peat slide may have a significant effect on river water quality and ecology, particularly fish stocks. The land affected by peat slides usually re-vegetates quite rapidly, although the original balance of vegetation species is unlikely to be re-established as a consequence of the changes in local topography and drainage patterns. Where peat habitats or future restoration have been identified, peat instability can have serious and detrimental effects.

9.9.18. **Appendix 9.2** has identified there is a low/negligible risk for peat instability within the Proposed Development. A geotechnical engineer would normally be employed onsite during construction to undertake advance inspection, carry out regular monitoring and provide advice whilst work is ongoing. The creation and management of a geotechnical risk register will form an important aspect of the development.

Compaction of soils

9.9.19. The movement of construction traffic within the Proposed Development is likely to cause localised compaction of the ground surface, leading to changes in both the hydrological and hydrogeological regime. The impacts of compaction are likely to be highly localised but will damage the vegetation and result in a reduction in the soil permeability and rainfall infiltration, thereby increasing the potential for flood risk and erosion.

Assessment of Potential Construction Effects

9.9.20. **Table 9.15** below identifies the likely construction effects on the identified receptors and their significance assuming the successful implementation of embedded mitigation and good practice measures.

Table 9.15: Assessment of Construction Effects

Potential Effects	Identified Receptor(s)	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effects
Water Quality				
Pollution incidents				
Erosion and sedimentation	Tomlachan Burn	High	Slight	Moderate
Acidification	Leonach Burn	High	Slight	Moderate
Increase in run-off	Allt Laoigh	Medium	Slight	Moderate/Minor
Modifications to surface drainage pattern	Caochan Gortach	Medium	Slight	Moderate/Minor
Impediments to surface water flow				
Flood Risk				
Increase in run-off	The Proposed Development	Low	Slight	Minor
Modifications to surface drainage patterns				
Impediments to surface water flow	Downstream of Proposed Development	Low	Slight	Minor
Compaction of soil				
Water Resources				
Pollution incidents	PWS abstractions that are hydrologically unconnected to site (Tirriemore Farm & Banchor)			
Modification to surface drainage patterns		High	Slight	Moderate
Impediments to surface water flow	PWS sources that are located within separate sub catchment of site (Dunearn, Dunearn Farm, Dunearn Lodge)			
Modification of groundwater flows and levels		High	Slight	Moderate
Compaction of soils				

Potential Effects	Identified Receptor(s)	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effects
Fisheries and Recreation				
Pollution incidents				
Erosion and sedimentation				
Acidification	River Findhorn Catchment	Medium	Slight	Moderate/Minor
Increase in run-off				
Modification to surface drainage pattern				
Impediments to surface water flow				
Soils				
Pollution incidents				
Modifications to surface drainage patterns				
Modification of groundwater flows and levels	Site soils and peat	High	Slight	Moderate
Compaction of soils				
Peat Instability				
Hydrogeology and Groundwater				
Pollution incidents	Underlying groundwater aquifers	Low	Slight	Minor
Modification of groundwater flows and levels	Groundwater within peat	High	Slight	Moderate
Compaction of soils	Groundwater Dependent Terrestrial Ecosystems	Medium	Moderate	Moderate

Description of Potential Operational Effects

9.9.21. The effects of the Proposed Development will be substantially lower during the operational phase. The following paragraphs discuss the potential effects that are predicted to occur during the operational phase of the Proposed Development.

Pollution Incidents

9.9.22. The potential risk of pollution is substantially lower during operation than during construction because of the reduced levels of activity in the operational phase. Most potential pollutants will have been removed when construction was completed; however, lubricants for turbine gearboxes, and transformer oils may be stored on-site and there is the risk of possible fuel leaks from maintenance vehicles whilst on-site.

Erosion and Sedimentation

9.9.23. Levels of erosion and sedimentation during operation will be much lower than construction as there will be no excavations or bare exposed ground. Some erosion and sedimentation are still possible on the access tracks and drainage ditches as a result of scouring during extreme rainfall events. Similarly, there could be some short term increases to erosion and sedimentation around new stream crossings as watercourses reach new equilibrium primarily within the construction and early in the operational phases of the Proposed Development.

Modification of Surface Drainage Patterns

9.9.24. Modification of surface run-off will occur as a result of the construction of the new infrastructure associated with the Proposed Development. The operational effects can result in changes to volume and/or changes to run-off rate.

Impediments to Surface Water Flows

9.9.25. During the operational phase impediments to flows can generally occur as a result from blockages to watercourse crossings, ditches and watercourses themselves, resulting from vegetation and erosion debris.

Degradation of Water Quality

9.9.26. The risk from pollution via leakages and spillages is substantially lower during operation than during construction because of the decreased levels of activity in the operational phase. Most potential pollutants would have been removed when construction is complete; however, lubricants for turbine gearboxes, transformer oils and possible fuel leaks from maintenance vehicles would remain.

Modification of Groundwater Flow and Levels

9.9.27. Cut and floating tracks and their drainage, as well as turbine foundations and hardstands will potentially alter the water table within the upslope and downslope peat and upper bedrock aquifers, which can also have implications for the long-term functionality of peatland environments. Backfilled cable trenches can also provide preferential flow pathways for groundwater.

Peat Instability

9.9.28. It is recognised that natural peat failure may still occur during the operational phase of the Proposed Development however risks have been identified as low/negligible. The risk of instability during operation will be addressed through the implementation of appropriate embedded mitigation during construction and an ongoing appraisal of peat slide will be carried out across the area throughout the operation of the Proposed Development

Compaction of Soils

9.9.29. The compaction of soils/peat will be significantly reduced during the operational phase as a result of significantly reduced traffic movements.

Assessment of Potential Operational and Ongoing Effects

9.9.30. **Table 9.16** below identifies the likely operational and ongoing effects on the identified receptors and their significance assuming the successful implementation of the good practice/ embedded mitigation measures.

Table 9.16: Assessment of Operational Effects

Potential Effects	Identified Receptor(s)	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effects
Water Quality				
Pollution incidents				
Erosion and sedimentation	Tomlachan Burn	High	Negligible	Moderate/Minor
Acidification	Leonach Burn	High	Negligible	Moderate/Minor
Increase in run-off	Allt Laoigh	Medium	Negligible	Minor
Modifications to surface drainage pattern	Caochan Gortach	Medium	Negligible	Minor
Impediments to surface water flow				
Flood Risk				
Increase in run-off	The Proposed Development	Low	Slight	Minor
Modifications to surface drainage patterns				
Impediments to surface water flow	Downstream of Proposed Development	Low	Negligible	Negligible
Compaction of soil				
Water Resources				
Pollution incidents	PWS sources that are hydrologically unconnected to site (Tirriemore Farm & Banchor)			
Modification to surface drainage patterns		High	Negligible	Moderate/Minor
Impediments to surface water flow	PWS sources that are located within separate sub catchment of site			
Modification of groundwater flows and levels		High	Negligible	Moderate/Minor

Potential Effects	Identified Receptor(s)	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation		
		Sensitivity	Magnitude of Impact	Significance of Effects
Compaction of soils	(Dunearn, Dunearn Farm, Dunearn Lodge)			
Fisheries and Recreation				
Pollution incidents				
Erosion and sedimentation				
Acidification	River Findhorn Catchment	Medium	Negligible	Minor
Increase in run-off				
Modification to surface drainage pattern				
Impediments to surface water flow				
Soils				
Pollution incidents	Site peat and soils	High	Slight	Moderate
Modifications to surface drainage patterns				
Modification of groundwater flows and levels				
Compaction of soils				
Peat Instability				
Hydrogeology and Groundwater				
Pollution incidents	Underlying groundwater aquifers	Low	Slight	Minor
Modification of groundwater flows and levels	Groundwater within peat	High	Slight	Moderate
Compaction of soils	Groundwater Dependent Terrestrial Ecosystems	Medium	Slight	Moderate/Minor

9.10. Additional Mitigation

9.10.1. As part of the peat management and habitat management plan implementation, detailed mapping of the man-made drainage ditches would be carried out post consent and opportunities to restore the areas identified through the NatureScot Carbon and Peatland Soils mapper would be explored. Following the consent of the Proposed Development, a detailed assessment of the potential natural flood management (NFM) measures would be undertaken in an attempt to restore peat that further reduces downstream flood risk. This would include hydrological modelling as part of the outline and detailed design to determine the likely benefit that the implemented measures would provide on reducing flood risk to the Proposed Development and areas of flood risk immediately downstream. Following the completion of this assessment and agreement of the proposed NFM measures with all relevant stakeholders (including SEPA and THC Flooding Team), the NFM strategy would be implemented. It is hoped that engagement with the local community would facilitate involvement in both the planning and implementation phases of the NFM strategy. It is anticipated the NFM system would be implemented during the operational phase.

9.10.2. The location of GWDTE have been avoided, where possible, though the infrastructure design process. However, it has not been possible to avoid all such features due to a range of other environmental, and technical constraints that have to be considered during the design process. It is important to note that many of the acid flush habitats (particularly M6c/d), whilst being sensitive to local changes to hydrology, are botanically species-poor and also frequently occurring in riparian zones across the site. However, where it has not been possible to avoid these features, a mitigation strategy will be implemented to further avoid/reduce direct and indirect impacts on GWDTE habitats and the hydrological conditions supporting them. The approach will include a commitment to micro-site infrastructure (within the agreed limits) to further avoid these features prior to and during the wind farm construction phase under the advice of an onsite ECoW. Also, prior to construction, location-specific detailed designs for infrastructure drainage will be developed, to avoid/minimise impacts on these habitats and a much as possible. Further details would be provided in the CEMP prior to construction. The CEMP will also set out that the perturbation of local ground and surface water hydrology supporting these habitats is minimised through appropriate environmental design and construction methods.

9.11. Assessment of Residual Effects

Construction

9.11.1. Taking account of the above additional peatland restoration and natural flood management mitigation described in **Paragraph 9.10.1** and **Appendix 9.3**, it is considered that the magnitude of impact on peat/peat soil receptors in the construction phase would be reduced from slight to negligible, with the residual significance of effect therefore assessed as minor/moderate.

9.11.2. With the implementation of additional mitigation relating to bespoke infrastructure design to maintain shallow groundwater flows, as set out in **Paragraph 9.1.2**, the magnitude of impact on GWDTE in the construction phase would be reduced from slight to negligible, with the residual significance of effect therefore assessed as minor/moderate.

9.11.3. All other residual effects for the construction phase are assessed as being unchanged from the potential effects as set out in **Table 9.16.**

Operation

9.11.4. Taking account of the above additional peatland restoration and natural flood management mitigation described in **Paragraph 9.10.1** and **Appendix 9.3**, it is considered that the magnitude of impact from flood risk on the Proposed Development site itself would reduce from slight to

negligible, with the residual significance of effect therefore assessed as minor/negligible. The magnitude of impact from flood risk on downstream receptors is assessed as negligible even without this additional mitigation and that categorisation and the resultant significance of effect (negligible) would not materially change although a slight reduction of impact and effect can be expected.

9.11.5. Taking account of the above additional peatland restoration and natural flood management mitigation described in **Paragraph 9.10.1** and **Appendix 9.3**, it is considered that the magnitude of impact on peat/peat soil receptors in the operational phase would be reduced from slight to negligible, with the residual significance of effect therefore assessed as minor/moderate.

9.11.6. With the implementation of additional mitigation relating to the maintenance of bespoke infrastructure to maintain shallow groundwater flows, as set out in **Paragraph 9.10.2**, the magnitude of impact on GWDTE in the operational phase would be reduced from slight to negligible, with the residual significance of effect therefore assessed as minor.

9.11.7. All other residual effects for the operational phase are assessed as being unchanged from the potential effects as set out in **Table 9.16.**

9.12. Cumulative Effects

9.12.1. The application of a hydrological catchment methodology enables a logical evaluation of the potential for cumulative effects of the hydrological environment. There is one wind farm within 5 km of the Proposed Development, Tom nan Clach Wind Farm.

9.12.2. Off-site cumulative hydrological effects are primarily related to changes in water quality and increases in flood risk. Mitigation has been presented in **Section 9.8 and 9.10** to adequately protect on-site hydrological receptors and therefore will be suitable to ensure the protection of those situated downstream, and should not contribute to or exacerbate any effects arising from other developments, land uses or activities. With regards to flood risk specifically, the design of the drainage will mimic the existing hydrological and greenfield regime of the Proposed Development area. Opportunities for natural flood management through peatland restoration have also been identified.

9.12.3. It is concluded that following the successful implementation of the mitigation outlined in **Section 9.8 and 9.10**, cumulative impacts of the Proposed Development during construction and during operation will be negligible.

9.13. Monitoring

9.13.1. A programme of surface water quality monitoring will be finalised post consent, prior to construction. A breakdown of the proposed monitoring methodologies has been provided to consider sensitivities of the on-site and downstream environments.

9.13.2. The details of any required monitoring will be discussed and agreed with SEPA, and THC prior to commencement. The extent and the frequency of the monitoring will be proportionate to the level of activity on-site during the construction, operation and decommissioning of the Proposed Development. Appropriate monitoring is important to:

- provide reassurance that established in-place mitigation measures are effective and that the Proposed Development is not having any significant adverse effect upon the environment;
- indicate whether further investigation is required and, where pollution is identified, the need for additional mitigation measures;
- reduce or remove any impacts on the water environment; and
- understand the long-term effects of the Proposed Development on the natural environment.

9.13.3. A baseline surface water monitoring programme will be undertaken prior to the commencement of construction works. The establishment of a baseline is very important as it provides a suite of parameters against which to compare samples taken during the Proposed Development's lifetime, and with which to assess any impacts and the requirement for any appropriate remedial measures. However, due to the variance in climatic conditions, recording like for like water quality prior to and during construction is likely to be unusual. Therefore, it is also recommended that control sites, situated outside the area affected by the Proposed Development infrastructure, are also established at the same time.

9.13.4. A suitably qualified ECoW will be employed throughout the construction of the Proposed Development. The appointed ECoW can provide advice to the contractors about how environmental effects can be minimised, and what methods can be employed to reduce effects on water quality, soils and associated habitats.

9.13.5. Monitoring will be undertaken throughout construction of the Proposed Development. The monitoring will help to identify areas where infrastructure is having a negative effect on peat and soils and utilise the appropriate methods to prevent further deterioration and/or promote further enhancement.

9.13.6. All construction management and water management techniques are agreed prior to construction. The techniques would be agreed following consultation with SEPA, and THC. In conjunction with this, there should be a programme of visual monitoring to ensure that the designed drainage system is compliant with the requirements under CAR with respect to GBR 10 and in particular; clauses d, g and h.

9.14. Licensing Requirements

9.14.1. SEPA recently amended the requirements under CAR brought in by the Water Environment (Miscellaneous) (Scotland) Regulations 2017 to impose the need for individual sites to require a site-specific runoff permit relating to surface water drainage, rather than individual activities required to adhere to the regulations. This requirement is linked to specific criteria for a construction site, including access tracks, of >4 hectares, or >5 km or which includes any area >1 hectare or >500 m on ground with slope >25º.

9.14.2. It is acknowledged that to support the site licence application, further information on the drainage and environmental management requirements is likely to be required. It should be acknowledged within this chapter of the assessment that the information relating to good practice has been provided, but that the level of detail to support a CAR licence application would follow post-determination of the application.

9.15. Decommissioning

9.15.1. During decommissioning of the Proposed Development, potential impacts on the hydrological, hydrogeological and geological environment are expected to be less than those encountered during the construction phase and therefore "not significant". No specific mitigation measures are therefore identified.

9.15.2. The decommissioning of the Proposed Development would adhere to the latest legislative and guidance requirements at the time.

9.16. Summary

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

9.16.2. The potential effects on the hydrological, geological and hydrogeological environment have considered, pollution incidents, erosion and sedimentation, changes in water quality, changes to water resources i.e., modification of surface water and groundwater flows, modification of natural drainage patterns, impediments to flow and flood risk, peat instability and compaction of soils.

9.16.3. Following the identification and assessment of the key receptors, considering the potential effects listed above, mitigation and good practice measures have been incorporated into the design, including extensive buffer areas and avoidance of siting infrastructure on deep peat wherever possible. In addition, a site-specific CEMP as well as detailed design of infrastructure and associated mitigation will be implemented to protect the groundwater and surface water resources from pollution and minimise changes to the hydrological environment.

9.16.4. The impact assessment has considered the hydrological regime, highlighting that the principal effects will occur during the construction phase. Following the successful design and implementation of mitigation measures the significance of construction effects on all identified receptors are as assessed as not significant. The assessment of predicted operational effects has determined that the significance of effects on all receptors is not significant. Table 9.17 below summarises the likely significant environmental effects of the Proposed Development.

9.16.5. Good practice design and construction of the Proposed Development delivered through a skilled team of competent workers, with mitigation and compliance monitored in collaboration with SEPA and THC and other engaged stakeholders, will result in residual effects that are considered to be not significant in terms of the EIA Regulations.

Table 9.17Summary of Effects

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/Adverse		Significance	Beneficial/Adverse
Construction					
Detrimental impacts to on-site and downstream water quality during	Moderate & Minor/Moderate	Adverse	Nothing additional to embedded mitigation	Moderate & Moderate/Minor	Adverse
Increases to on-site and downstream flood risk as a result of poor construction practices (including poor construction of watercourse crossings).	Minor	Adverse	Nothing additional to embedded mitigation	Minor	Adverse
Impacts on peat as a result of interrupting surface and sub-surface drainage pathways.	Moderate	Adverse	Additional mitigation presented in Technical **Appendix 9.3** Peatland restoration provides opportunities for natural flood management	Moderate/Minor	Adverse
Impacts on peat stability during excavation	Moderate	Adverse	Nothing additional to embedded mitigation	Moderate	Adverse
Degradation or damage to GWDTE as a result of interrupting surface and sub-surface drainage pathways.	Moderate	Adverse	Use of bespoke infrastructure design to maintain shallow groundwater flows. Specific GWDTE information to be included in the CEMP	Moderate/Minor	Adverse
Operational					
Increases to on-site and downstream flood risk as a result of degradation of infrastructure and/or poor maintenance/monitoring of infrastructure.	Minor (on-site) Negligible (downstream)	Adverse	Additional mitigation presented in Technical **Appendix 9.3** Peatland restoration provides opportunities for natural flood management	Minor/Negligible (on-site) Negligible (downstream)	Adverse

Description of Effect	Significance of Potential Effect		Mitigation Measure	Significance of Residual Effect	
	Significance	Beneficial/Adverse		Significance	Beneficial/Adverse
Impacts on peat as a result of interrupting surface and sub-surface drainage pathways.	Slight	Adverse	Additional mitigation presented in Technical **Appendix 9.3** Peatland restoration provides opportunities for natural flood management.	Negligible	Adverse
Impacts on peat stability as a result of infrastructure	Slight	Adverse	Nothing additional to embedded mitigation	Slight	Adverse
Degradation or damage to GWDTE as a result of interrupting surface and sub-surface drainage pathways.	Moderate/Minor	Adverse	Maintenance of bespoke drainage during operation to maintain flows to be outlined in the CEMP	Minor	Adverse

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