Fred. Olsen Renewables

Chapter 10

Hydrology, Geology & Hydrogeology

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Glossary

Term	Definition
Abstraction	The process of and the location of the removal or diversion of water from the natural environment, by a variety of means including pumps, pipes, boreholes and wells.
Acrotelm	The acrotelm is one of two distinct layers in undisturbed peat bogs. It overlies the catotelm.
Aquifer	A geological formation, group of formations or part of a formation that can store and transmit water in significant quantities.
Baseflow	The component of the river flow that is derived from groundwater sources rather than surface run-off. The Base Flow Index (BFI) value provided by the Flood Estimation Handbook (FEH) is a measure of the proportion of a catchments long-term runoff that derives from stored sources.
Buffer area	An area which protects the receptor such as watercourses from pollutants and sediment from the adjacent land.
Catotelm	The lower, water-saturated zone of a mire/peat bog.
Environmental Clerk of Works	The Environmental Clerk of Works will carry out pre-construction surveys during the construction of the Proposed Development and monitor construction compliance with agreed mitigation and management requirements
Environmental Impact Assessment	Environmental Impact Assessment (EIA) is a means of drawing together, in a systematic way, an assessment of the likely significant environmental effects arising from a Proposed Development.
Environmental Impact Assessment Report	A document reporting the findings of the EIA and produced in accordance with the Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017 Regulation 5.
Groundwater	Water located beneath the ground surface in soil pore spaces and in the fractures of rock formations.
Headwaters	A tributary stream of a river close to or forming part of its source. Normally wet flushes, bogs or springs at the head of first-order streams.

Term	Definition
Hydrological regime	The statistical pattern of a river's constantly varying flow rate.
Overland flow	Water passing rapidly over or through the surface layer of soil.
Peak flow	The maximum flow recorded during a high flow event.
Peat	A largely organic substrate formed of partially decomposed plant material.
Precipitation	Deposition of moisture including dew, hail, rain, sleet and snow.
Private water supply	Any water supply which is not provided by a water company and is not connected to mains supply. Most private water supplies are situated in more remote, rural parts of the country and may just serve one property or several properties through a network of pipes.
Return period	Is a measure of the rarity of an event: the longer the return period, the rarer the event.
Riparian corridor	Land immediately adjoining the aquatic zone of a watercourse and influenced by it.
Runoff	Surface runoff is the flow of water over the surface that can result due to the surrounding soils lacking the capacity to infiltrate further water or due to the surface water flowing off infrastructure such as access tracks and hardstandings.
Sedimentation	The tendency for particles in suspension to settle out of the fluid in which they are entrained.
Standard Percentage Runoff	The percentage of rainfall that is likely to contribute to runoff. For example, an SPR value of 50 % would suggest that half of the rainfall during an event will contribute to runoff.
Study area	Area including the Proposed Development and surrounding landscape where information was collected as shown on Figure 10.1.
Surface water catchment	The area from which runoff would naturally discharge to a defined point of a river.
The Applicant	Fred. Olsen Renewables Limited
The Proposed Development	The Proposed Windy Standard 1 Repower as described in Chapter 5 of the EIAR.
The Proposed Development Area	The project development area within the red line boundary (application area). As shown in Figure 1.2.
Topography	The physical features of a geographical area.
Water resources	The supply of groundwater and surface water in a given area.

List of Abbreviations

Abbreviation	Description
AOD	Above Ordnance Datum
BFI	Base Flow Index
BGS	British Geological Society
CAR	Water Environment (Controlled Activities) (Scotland) Regulations 2011
CEMP	Construction Environmental Management Plan
CIRIA	Construction Industry Research and Information Association
DGC	Dumfries & Galloway Council
DTM	Digital Terrain Model
ECoW	Environmental Clerk of Works
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
FEH	Flood Estimation Handbook
GIS	Geographical Information System
GPP	Guidance for Pollution Prevention
GWDTE	Groundwater Dependent Terrestrial Ecosystems
IoH	Institute of Hydrology
JHI	James Hutton Institute
LDP	Local Development Plan
NVC	National Vegetation Classification
PAN	Planning Advice Note
PPG	Pollution Prevention Guidelines
PWS	Private Water Supply
RBMP	River Basin Management Plan
SAAR	Standard Average Annual Rainfall
SEPA	Scottish Environment Protection Agency
SIFSS	Soil Information for Scottish Soils
SPP	Scottish Planning Policy
SPR	Standard Percentage Runoff
SSSI	Site of Special Scientific Interest
SuDS	Sustainable Drainage System
TWI	Topographic Wetness Index
WFD	Water Framework Directive
WTW	Water Treatment Works

10.1 INTRODUCTION

10.1.1 This chapter of the Environmental Impact Assessment Report (EIAR) assesses the impacts on the hydrological, geological and hydrogeological environment at Windy Standard I Repower (Proposed Development), and the likely significant environmental effects resulting from the decommissioning of Windy Standard I, construction and operation of the proposed turbines and associated infrastructure. The area within the red line boundary contained within figure 1.2 of the EIAR is referred to as the Proposed Development Area within this chapter.

10.1.2 The assessment is supported by the following figures provided in Volume 3 of the EIAR:

- Figure 10.1: Hydrology Overview;
- Figure 10.2: Predominant Soils;
- Figure 10.3: Carbon and Peatland;
- Figure 10.4: Interpolated Peat Depth;
- Figure 10.5: Superficial Geology;
- Figure 10.6: Bedrock Geology; and
- Figure 10.7: Groundwater Dependant Terrestrial Ecosystems (GWDTE).

10.1.3 This assessment was undertaken by The Natural Power Consultants (Natural Power) on behalf of Fred. Olsen Renewables Limited (the "Applicant"). Natural Power has an established reputation in providing assessment of hydrological, geological and hydrogeological considerations discussed in this chapter. This chapter was produced by an Environmental Consultant with over three years of experience with support provided by the Associate Technical Director (Environment) and Principal Environmental Consultant who combined have over 30 years' experience in delivery of EIA for renewable energy developments.

10.2 LEGISLATION AND POLICY CONTEXT

Policy Context

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

10.2.2 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 CAR authorisation:

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

10.2.3 Under the Water Environment (Miscellaneous) (Scotland) Regulations 2017 amendments were made to CAR and the Proposed Development will require a construction runoff permit (formerly known as a construction site license) for water management across the entirety of the site prior to any construction works taking place, including enabling works. No work will be able to commence on site until a runoff permit has been agreed with the Scottish Environment Protection Agency (SEPA).

National Legislation and Policy

10.2.4 The assessment takes account of 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 Private Water Supplies (Scotland) Regulations 2006;
- Water Intended for Human Consumption (Private Water Supplies (Scotland) Regulations 2017;
- Part IIA of the Environment Protection Act 1990;
- Waste Management Licensing (Scotland) amendment Regulations 2016;
- Pollution Prevention and Control (Scotland) Regulations 2012;
- Scottish Planning Policy (SPP) 2014;
- SEPA Policy No. 19 Groundwater Protection Policy for Scotland 2009;
- SEPA Policy No. 41 Development at Risk of Flooding: Advice and Consultation 2016;
- SEPA Position Statement on Land Protection (Reference EP054); and
- SEPA Policy No. 61 Control of Priority & Dangerous Substances & Specific Pollutants in the Water Environment.

Draft NPF 4 Scotland 2045

10.2.5 The Scottish Government published the draft National Planning Framework on the 10th November 2021 and laid it before Parliament at the same time to allow the consultation process and the Parliamentary process to run together. It is considered further in Chapter 2: Policy Context.

10.2.6 The draft NPF4 will supersede NPF3 and SPP and Part 3 – National Planning Policy will become part of the local statutory development plan.

10.2.7 The planning policy overview provided above is therefore subject to the adoption of the final NPF4 and the Applicant proposes to update the policy position at the appropriate time as part of this application.

10.2.8 Policy 13 (Flood risk) and 33 (Soils) of NPF4 have been considered accordingly in the completion of the assessment.

Regional Policy

10.2.9 The assessment takes account of the following policy:

- Dumfries and Galloway Council Local Development Plan 2 (LDP) 2019;
  - Policy NE11: Supporting the Water Environment;
  - Policy NE14: Carbon-Rich Soil; and
  - Policy IN7: Flooding and Development.

Other Guidance and Good Practice

10.2.10 Table 10.1 lists other key guidance and good practice documentation which has been considered as part of this assessment.

Table 10.1: Guidance and good practice

Topic	Source of information
Scottish Government Planning Advice Notes (PAN's)	• PAN 50 (1996) Controlling the Environmental Effects of Surface Mineral Workings • PAN 51 Planning (revised 2006), Environmental Protection and Regulation • PAN 1/2013 Environmental Impact Assessment • PAN 61 (2001) Planning and Sustainable Urban Drainage Systems • PAN 79 (2006) Water and Drainage
Scottish Environment Protection Agency (SEPA) Guidance for Pollution Prevention (GPPs) and Pollution Prevention Guidelines (PPGs)	• GPP 1 (2020): Understanding your Environmental Responsibilities - Good Environmental Practice • GPP 2 (2018): Above Ground Oil Storage Tanks • GPP 4 (2017): Treatment and Disposal of Wastewater Where there is no Connection to the Public Foul Sewer • GPP 5 (2018): Works and Maintenance in or Near Water • PPG 6 (2011): 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-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 • 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 • WAT-SG- 78: SEPA (2012), Sediment Management Authorisation, Version 1
Construction Industry Research and Information Association (CIRIA)	• CIRIA C692 Environmental Good Practice on Site (fourth edition) (2015) • CIRIA C753 SuDS Manual (2015) • CIRIA C532 Control of Water Pollution from Construction Sites (2001) • CIRIA C648 Control of Water Pollution from Linear Construction Projects (2006) • CIRIA C786F Culvert, Screen and Outfall Manual (2019)
Other Guidelines	• 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 Minimisation of Waste • SEPA, The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended), A Practical Guide, Version 9.1, March 2022 • River Crossings and Migratory Fish: Design Guidance, A Consultation Paper, The Scottish Executive • SEPA Land Use Planning Guidance CC1 (LUPS-CC1) (2022). Climate change allowances for flood risk assessment in land use planning. Version 2 • 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

10.3 STAKEHOLDER CONSULTATION

10.3.1 The scoping responses relating to the hydrological, hydrogeological and geological environment are summarised in Table 10.2.

Table 10.2: Scoping responses relating to hydrology, hydrogeology and geology

Organisation	Relevant Response	Comment
Scottish Environment Protection Agency (SEPA)	• The site should be designed to avoid sensitive receptors and incorporate appropriate distances. We welcome the buffers proposed to hydrological features summarised in Table 14.1.	Section 10.11 presents the mitigation through design which details the distances between the hydrological features and proposed infrastructure.
	• We welcome the initial information to demonstrate the project will be designed to avoid development on deep peat (Figure 14.1: Interpolated Peat Depth). We recommend the proposed Phase 2 peat surveys further inform site design to	10.7.53 to 10.7.64 details the peat and soil depth surveys results (Phase 1 and Phase 2) and the depths measured at proposed infrastructure locations.

Organisation	Relevant Response	Comment
	minimise impacts on peat (particularly around Turbine 1 and 2 which are in proximity of greater depths that the other wind turbines).	
	• It is our preference that the developer utilises existing infrastructure (e.g. existing access roads) as far as possible. We therefore welcome the commitment to do this.	Chapter 5: Project Description details the infrastructure reuse.
Scottish Water	• The proposed activity falls within Carsfad Reservoir that supplies Lochinvar Water Treatment Works (WTW) and it is essential that water quality and water quantity in the area are protected. • It is a relatively large catchment and the activity is sufficient distance from the intake that it is likely to be low risk, however care should be taken and water quality protection measures must be implemented.	Please refer to Figure 10.1 which presents the site catchments. Baseline hydrological characteristics are presented in paragraphs 10.7.13 to 10.7.19 Mitigation measures are presented in Table 10.16: Assessment of Construction Effects with the assessment of construction and operational effects presented in Sections 10.13 and 10.15, respectively.
Marine Scotland Science	• River Dee (Kirkcudbright) – protection of resident Brown trout populations using an integrated, strategically designed water quality and fish population monitoring programme.	Outline mitigation measures are presented in Section 10.11. Section 10.17 details an outline water quality monitoring programme. A detailed monitoring strategy would be produced post consent and agreed with DGC in consultation with Marine Scotland Science (MSS) and SEPA.
Galloway Fisheries Trust	• Concerns relating to the River Dee catchment and the associated Brown trout populations.	Outline mitigation measures are presented in Section 10.11. Section 10.17 details an outline water quality monitoring programme. Details relating to fish populations and surveys can be found in Chapter 9: Ecology.

10.4 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

Effects to be assessed

10.4.1 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 phases. Taking this into account the following issues will be addressed during all phases 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 (including private water supplies);
- Effects on impediments to flow;
- Flood risk;
- Pollution risk;
- Effects on local geology; and
- Effects on hydrological integrity of peat bodies.

10.5 METHODOLOGY

Overview

10.5.1 The assessment has involved the following:

- Detailed desk studies and site visits 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

10.5.2 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;
- Identify all flooding risks;
- Describe the hydromorphological conditions of watercourses;
- Collect information relating to recreational and fisheries resources;
- Collate hydrological flow and flooding information 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.

10.5.3 Published information consulted for the baseline is outlined in Table 10.3.

Table 10.3: Baseline information sources

Topic	Sources of Information
Topography	10 m contour data derived from Digital Terrain Model (DTM) data
Designated Nature and Conservation Sites	NatureScot, https://map.environment.gov.scot/sewebmap/
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) http://map.sepa.org.uk/floodmap/map.htm
Water Quality	SEPA, WFD Classification, Web Mapping Application, SEPA, Water Classification Hub, https://www.sepa.org.uk/data-visualisation/water-classification-hub
Water Resources	Private water supply information provided by DGC
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, River Basin Management Plans, Web Mapping Application, http://gis.sepa.org.uk/rbmp/

Effects Evaluation

10.5.4 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 of change should that identified impact occur. The sensitivity of the receiving environment i.e. its baseline quality as well as its ability to absorb the impact without perceptible change is defined in Table 10.4.

Table 10.4: Definition of sensitivity of the receiving environment

Sensitivity	Definition
High	National importance. Receptor with a high quality and rarity, local scale and limited potential for substitution/replacement or receptor with a medium quality and rarity, regional or national scale and limited potential for substitution / replacement.
Medium	Regional importance. Receptor with a medium quality and rarity, local scale and limited potential for substitution/replacement or receptor with a low quality and rarity, regional or national scale and limited potential for substitution / replacement.
Low	Local importance. Receptor with a low quality and rarity, local scale. Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character.

10.5.5 The magnitude of impact includes the timing, scale, size and duration of the likely significant environmental effects. For the purposes of this assessment the magnitude of impact criteria area defined in Table 10.5.

Table 10.5: Magnitude of Change

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.

10.5.6 Assuming the successful implementation of good practice and design mitigation measures, the sensitivity of the receiving environment together with the magnitude of the change defines the significance of the effect as outlined in Table 10.6.

Table 10.6: Significance Matrix

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

10.5.7 Potential effects are therefore concluded to be Major, Moderate, Minor or Negligible. Effects considered as being Major or Major/Moderate are considered significant in terms of The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017.

10.6 DISCLAIMER

10.6.1 The fieldwork carried out was a standard reconnaissance level walkover survey covering the main hydrological features within the Proposed Development Area. Representative locations and features such as watercourses, peat bodies and geological information were assessed, and this information is interpreted for any areas not visited.

10.6.2 Private water supply information within 3 km of the Proposed Development has been provided by Dumfries and Galloway Council (DGC) and is as accurate as this information allows.

10.6.3 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.

10.7 BASELINE CONDITIONS

10.7.1 This subsection presents the information gathered on the existing topographical, hydrological, hydrogeological and geological conditions within the Proposed Development and the study area. The study area is defined in Figure 10.1 provided in Volume 3 of the EIAR.

Proposed Development Area

10.7.2 The Proposed Development is located within Carsphairn Forest, near Carsphairn in Dumfries and Galloway and will be a replacement to the existing Windy Standard I Wind Farm, as detailed in Chapter 5: Project Description. Habitat is considered typical of this area, comprising of open moorland and areas of forestry plantation, with existing infrastructure associated with the Windy Standard I Wind Farm. This infrastructure has affected the scope of the surveys because of health and safety concerns (paragraph 10.7.57), with underground cabling being present, existing infrastructure being proposed to be decommissioned and areas restored unless they are to be retained as part of the Proposed Development.

10.7.3 The Proposed Development will consist of the decommissioning and restoration of the existing Windy Standard I Wind Farm, with the erection, 35-year operation, and subsequent decommissioning of up to 8 wind turbines, with tip heights of up to 200 m, associated turbine foundations and transformers, 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, a construction compound, and temporary borrow pits (see Figure 10.1). It should be noted that the substation and the tracks are already situated in the Proposed Development area as part of the existing infrastructure, with the existing Windy Standard I Wind Farm site access point being used. The sections of the existing tracks will be upgraded to accommodate the Proposed Development.

10.7.4 The Proposed Development lies along the ridge tops between approximately 480 m and 700 m above sea level; with steep slopes to the south, leading down to small water courses that drain north towards the Water of Deugh.

10.7.5 The hydrological study area is larger in extent than the Proposed Development and includes the lower reaches of watercourse catchments that are present within the Proposed Development. The extent of the catchments are shown in Figure 10.1 in Volume 3 which outline the extent of the study area. Designated sites and relevant developments, shown in Figure 1.1 in Volume 3, are considered from the perspective of assessing any potential hydrological linkages or cumulative effects.

Site Investigations

10.7.6 The phase 1 peat depth survey and hydrological walkover were undertaken in April to May 2020. Weather conditions were described as heavy showers with dry period towards the end of the survey period. Further hydrological surveys including additional focused peat probing were undertaken in March 2022. Weather conditions were dry with sporadic showers.

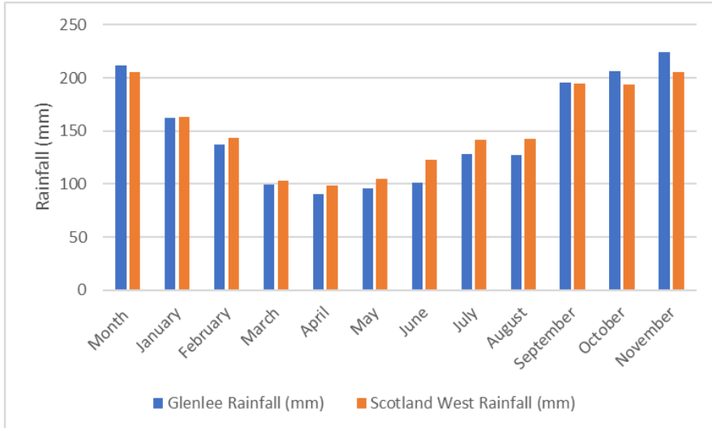
Climate

10.7.7 The standard average annual rainfall (SAAR) for the Proposed Development has been derived from the Flood Estimation Handbook (FEH) Web Service as ranging from 1959 - 2012 mm based on the catchments covered by the Proposed Development Area. 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.

10.7.8 The Met Office 1981-2010 annual rainfall total from the Glenlee Climate Station (55 m Above Ordnance Datum (AOD)) is 1720.9 mm with 178.5 days of rainfall days ≥ 1 mm recorded, compared to 1818.5 mm and 196.9 days for the Scotland West region.

10.7.9 The Glenlee Climate Station is positioned approximately 23 km northeast of the Proposed Development and at a lower elevation compared to the Proposed Development. However, the comparison with the regional Met Office and FEH data provides a good indication of both rainfall totals and patterns expected at the Proposed Development.

10.7.10 The highest rainfall totals as shown in Graph 10.1 are typically experienced during the winter months through September to January. The lowest totals rainfall is typically recorded during the Spring months from April to May.



Graph 10.1: Average monthly rainfall data for climate period 1981-2010

Designated Sites

10.7.11 To the south and hydrologically connected to the Proposed Development, the River Dee is designated as a Site of Special Scientific Interest (SSSI) and a Special Protection Area (SPA) for the Dragonfly assemblage, various goose species, and the lowland acid grassland habitat. The SSSI/SPA is approximately 23 to 30 km downstream from the Proposed Development

10.7.12 In addition, within 5 km of the Proposed Development, Loch Doon is listed as a SSSI and is not hydrologically connected because it is within the catchment of the River Doon that is not hydrologically connected with the Proposed Development.

Surface Water Hydrology

Water of Deugh

10.7.13 Hydrologically, the Proposed Development lies within the catchment of the Water of Deugh that is a tributary to the Water of Ken, both of which are within the greater catchment of the River Dee. The Water of Deugh is 6.54 km in length, with a catchment of 7 km^2. The majority of the catchment is comprised of forestry plantation and open moorland with the main stem following the Proposed Development eastern boundary.

10.7.14 An example of the watercourses found within the Proposed Development Are a are shown in Plate 10.1.

10.7.15 Figure 10.1: Hydrology Overview in Volume 3 shows distribution of hydrological features across and adjacent to the Proposed Development. There are multiple burns which supply the Water of Deugh situated in and around the Proposed Development.

Source: Natural Power

Plate 10.1: Headwaters of Water of Deugh looking upstream at NS 62281 02101

Fingland Burn

10.7.16 The north west of the Proposed Development predominately drains into the Fingland Burn, with the existing wind farm being situated within the catchment of Trostan Burn, a small tributary which joins the headwaters of Fingland Burn at NS 60837 02281. The catchment area is approximately 4 km^2 with a watercourse length of 4.9 km.

10.7.17 A photograph of the Fingland Burn is shown in Plate 10.2.

Source: Natural Power

Plate 10.2: Upstream view of Fingland Burn at NS 60948 02212

Polwhat Burn

10.7.18 The Polwhat Burn is sourced from Brockloch Rig (518 m AOD) and Polwhat Rig (595 m AOD) and joins the Water of Deugh outside the Proposed Development area. The catchment area is 4.5 km^2, with the land use consisting of plantation forestry.

Bow Burn

10.7.19 The Bow Burn drains the south of the Proposed Development Area and features a catchment area of 17 km^2 that is comprised of commercial forestry plantation. The watercourse length is approximately 10.05 km that flows westward into the Water of Deugh.

Hydrological Regime

Flow Estimation

10.7.20 Peak flows have been estimated for the key catchments described above using the Institute of Hydrology Report 124 (IH124) methodologies for a range of return periods, with the results presented in Table 10.7 Catchment descriptors were derived from the FEH Web Service and used for calculating peak flows for the identified catchments above.

10.7.21 As per SEPA Land Use Planning Guidance CC1 (LUPS-CC1)[1] it is anticipated that peak flows and peak rainfall intensities will increase that will subsequently increase the peak flows for in the catchments. As the Proposed Development is located within the Solway River Basin, this will result in a 53% increase in peak river flows and a 38% in peak rainfall intensity.

10.7.22 It should be noted the Water of Deugh (HW) referred to in Table 10.7 is relating to the headwater catchment within the Proposed Development Area and not the entire Water of Deugh catchment. The main Water of Deugh catchment is referred to as Water of Deugh (MC).

[1] SEPA (2019), LUPS-CC1, Land Use Planning System, Climate change allowances for flood risk assessment in land use planning

Table 10.7: Estimated peak flows

Catchment	Area (km^2)	Estimated peak runoff (m^3/s) for stated return periods						
		2	5	10	25	50	100	200
Water of Deugh (HW)	6.96	10.83	13.21	16.90	21.55	25.83	31.31	37.85
Fingland Burn	4.07	6.31	7.69	9.84	12.54	15.04	18.22	22.033
Polwhat Burn	4.48	7.48	9.13	11.67	14.88	17.84	21.62	26.14
Bow Burn	17.04	19.80	24.15	30.89	39.37	47.21	57.21	69.17
Water of Deugh (MC)	76.55	85.79	104.65	133.88	170.65	204.59	247.96	299.82

Catchment Characteristics

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

10.7.24 The BFI for the Proposed Development catchments ranges from 0.275 to 0.344 indicating that around a third of the catchment's long-term runoff is derived from stored sources. The SPR for the Proposed Development catchments ranges from 50.88 % to 55.80 % indicating that around half of the rainfall during a rainfall event contributes to runoff. The BFI and SPR values show that the Proposed Development is located on relatively impermeable catchments.

Flood Risk

10.7.25 The assessment has been carried out in accordance with Scottish Planning Policy (SPP). The document states that:

> *'Planning authorities must take the probability of flooding from all sources – (coastal, fluvial (watercourse), pluvial (surface water), groundwater, sewers and blocked culverts) and the risks involved into account when preparing development plans and determining planning application.' (SPP, page 58)*

10.7.26 The Flood Risk Management (Scotland) Act 2009 sets in place a statutory framework for delivering a sustainable and risk-based approach to managing flooding. The main elements of flood risk management relevant to the Proposed Development is assessment of flood risk as well as undertaking structural and non-structural flood management measures.

10.7.27 As highlighted in paragraphs 10.2.6 to 10.2.8, Policy 13 of NPF4 outlines the flood risk considerations for developments. This includes the placement of development outside of the future functional flood plain and consideration for managing runoff.

10.7.28 As outlined in the following paragraphs, the relevant factors for assessing flood risk have been taken into account, measures to mitigate and sustainably manage the flood risk within the Proposed Development are provided in paragraph 10.11.1 to 10.11.63.

10.7.29 As highlighted above, all potential sources of flooding must be considered for the Proposed Development. A summary of the potential sources of flooding is presented below.

Fluvial flood risk

10.7.30 The Water of Deugh, specifically down stream of the confluence of the Water of Deugh and the Sheel Burn, is at high 10% (1 in 10) likelihood of fluvial (watercourse) flooding in any given year. The risk areas are generally contained in the river channel extent.

10.7.31 Fingland Burn, specifically after the Crooked Lane confluence points, is at high 10% (1 in 10) likelihood of fluvial (watercourse) flooding in any given year. The risk areas are generally contained in the river channel extent.

10.7.32 The Polwhat Brun is at high 10% (1 in 10) likelihood of fluvial (watercourse) flooding in any given year, however this is primarily localised upstream of the confluence point with the Water of Deugh. The risk areas are generally contained in the river channel extent.

10.7.33 The Bow Burn, specifically after the Hog Hill Burn and Clennoch Burn confluence points, is at high 10% (1 in 10) likelihood of fluvial (watercourse) flooding in any given year. The risk areas are generally contained in the river channel extent.

10.7.34 The SEPA future flood maps[2] show the risk of fluvial flooding remains largely contained within the existing extents currently mapped.

Pluvial flood risk

10.7.35 A review of SEPA Flood Risk Management Map[2] indicates that scattered small areas throughout the commercial forestry as well as being contained within the riparian corridors of the Fingland Burn and Polwhat Burn are at high – 10% (1 in 10) likelihood of pluvial (surface-water) flooding in any given year.

Coastal flood risk

10.7.36 The Proposed Development is located approximately 40 km from the nearest coast and due to this distance along with the topographical position of Proposed Development turbines and infrastructure, approximately 600 m AOD within the Proposed Development Area, it is presumed that it will not be affected by tidal flooding.

Groundwater flood risk

10.7.37 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.

10.7.38 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.

10.7.39 Groundwater flooding is often associated with the shallow unconsolidated sedimentary aquifers that overlay 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

[2] SEPA (2019) Flood Hazard and Flood Risk Information. https://map.sepa.org.uk/floodmaps/FloodRisk/ Date Accessed: 04/08/2022

and providing a good hydraulic connection with adjacent river networks. The SEPA Flood Risk Management Map indicates that the Proposed Development Area has no risk of groundwater flooding.

Infrastructure flood risk

10.7.40 Drainage features, including trackside drainage and watercourse crossings, associated with the existing scheme have the potential to cause localised flooding as a result of blockages restricting water flow or failures to attenuate runoff. No evidence of poorly performing existing drainage were encountered as part of the survey visits.

Water Quality

Water quality WFD Classification

10.7.41 Three surface waterbodies are classified under the Scottish Government's 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 10.8 below. In addition to surface waterbodies, groundwater body is provided Table 10.8. WFD classifications discussed below are derived from SEPA's Water Classification Hub[3].

Table 10.8: WFD classification of surface waterbodies within the vicinity of the Proposed Development

Water Body	Waterbody ID	Current Overall Status (2020)	Overall Ecology (2020)	Overall Hydrology (2020)	Projected Overall Status (2027)	Predicted Overall Status (Long Term)
Water of Deugh	10563	Poor	Poor	Moderate	Good	Good
Bow Burn	10565	Poor	Poor	Good	Good	Good
Galloway (Groundwater)	150694	Good	-	-	Good	Good

10.7.42 WFD classified waterbodies are considered in the River Basin Management Plan (RBMP) for the Scotland River Basin District: 2015-2027. The RBMPs are designed to protect and improve the water environment.

Water Resources

Water Resources WFD Classification

10.7.43 The classified surface waterbody within the Proposed Development Area (Water of Deugh) has a WFD classification of "moderate" for overall hydrology, there are abstractions and storage within the catchment for hydroelectricity generation meaning flows associated with the watercourse have been modified.

10.7.44 The Water of Deugh has a "poor" overall ecology status due to the presence of fish barriers on the watercourse also associated with the hydroelectricity generation.

10.7.45 Additionally, the Bow Burn has a WFD classification of "good" for overall hydrology, with hydroelectricity generation being present. This relates to the "poor" overall ecology status as the activity provides a barrier to fish.

10.7.46 The underlying groundwater body (Galloway) is classified under the River Basin management Plan (RBMP) as having "good" overall status.

Public Water Supply

10.7.47 Carsfad Reservoir which feeds the Lochinver Water Treatment Works is located within the Water of Ken catchment which is part of the greater catchment of the River Dee, approximately 12 km downstream from the Proposed Development.

Private Water Supply

10.7.48 DGC were contacted about the presence of Private Water Supplies (PWS) both within the Proposed Development and within a 3 km buffer zone of the Proposed Development boundary. The local authority confirmed there are no registered PWS within the Proposed Development Area or within the 3 km search area. This application is for a repower of an existing Wind Farm and it is known that there are no additional unregistered PWS within the Proposed Development boundary.

10.7.49 Although there are no PWS located within the main Proposed Development and within a 3 km buffer zone of the Proposed Development boundary, there are PWS located within the Study Area (which incorporates the access track). These supplies have been presented below in Table 10.9

Table 10.9: Private Water Supplies within 3 km of Proposed Development Boundary

Property ID	PWS ID	Property Name	Type of Supply	Domestic (D)/ Agricultural (A)	Property within Catchment Occupied by Proposed Access Track (to be Upgraded)	Distance from Upgraded Access Track (km)
1	A	Brownhill	Groundwater Spring	D and A	No	1.7
2	B	Waterhead	Borehole	D	Yes	0.3
3	C	Netherbow	Surface Watercourse	D	Yes	0.5
3	D	Knockengorroch Taigh- Na Sithidhean	Groundwater Spring	D and A	Yes	0.5
4						
5	E	House at Brockloch Forest	Groundwater Well	D and A	No	0.4
6		Brockloch Cottage				
7		Four Winds				
8		Brockloch Farm				
9	F	Woodhead	Groundwater Spring	D	No	1.2
10	Uninhabited	Knockower	Groundwater Well	Currently not in use	No	-
11	G	Stroma	Groundwater Spring	D and A	No	1.2
12		Drumjohn				

[3] SEPA (2015) Water Classification Hub. https://www.sepa.org.uk/data-visualisation/water-classification-hub/ Date Accessed: 04/08/2022

Property ID	PWS ID	Property Name	Type of Supply	Domestic (D)/ Agricultural (A)	Property within Catchment Occupied by Proposed Access Track (to be Upgraded)	Distance from Upgraded Access Track (km)
13	H	Lamford	Groundwater Spring	D	No	2.3
14	I	Meadowhead	Groundwater Spring	D and A	No	2.5
15	J	Bridgend	Groundwater Spring	D and A	Yes	2.0
16		Holm of Daltallochan				
18	K	Lamloch	Surface Watercourse	D and A	No	1.4

Source: Dumfries and Galloway Council

10.7.50 Four PWS sources have been considered further as a result of the source and properties being located within the same catchment of and in proximity to the existing access road to be upgraded. These supplies are: Waterhead (B), Netherbow (C) Taigh- Na-Sithidhean, Knockengorroch (D), and Bridgend (J). Paragraphs 10.7.69 and 10.7.70 below provide more information on the hydrogeological characteristics of the site and surrounding area. Based on this information it is likely that the hydrogeological catchments are constrained by the same topographic controls as the surface water catchments. Therefore, any properties not located within the catchments occupied by the access track have not been considered further. As a result of this, the remaining four PWS will be assessed.

10.7.51 The extent of the upgrade work required to the existing track is currently not confirmed. Paragraphs 10.7.69 and 10.7.70 provide more information on the hydrogeological characteristics of the site and surrounding area. Based on this information it is likely that the hydrogeological catchments are constrained by the same topographic controls as the surface water catchments.

10.7.52 PWS (B) Waterhead source is a deep groundwater source drilled to 100m bgl and is protected from surface water derived contamination with a 5m thick bentonite seal. This means that the source of the water in the borehole would is highly unlikely impacted by the Proposed Development. In addition, the source is outside the SEPA LUPS 31 buffers of 100 m and 250 m.

Soils and Peat

10.7.53 The distribution of soils across the Proposed Development is dependent upon land use, geology, topography and hydrological regime of the Proposed Development Area, as well as the existing land use which has been modified due to the presence of existing hardstanding. Information on the Proposed Development Area soils has been obtained from Scotland's Environment Website[4] which brings together data from public organisations across Scotland including the British Geological Society (BGS), James Hutton Institute (JHI), NatureScot and SEPA.

10.7.54 Figure 10.2 in Volume 3 of the EIAR shows the distribution of soils across the Proposed Development according to the National Soil Map of Scotland. Soil types expected to occur within the Proposed Development Area primarily include blanket peat, peaty gleys, mineral gleys, peaty podzols, and mineral podzols. Blanket peat is typically found at the lower elevations around the Water of Deugh. Higher elevations, such as the Black Hill and Jedburgh Knees areas, are predominantly peaty gleys. Polwhat Rig features mineral gleys stretching around the source of Fingland Burn. Peaty podzols can be found on Millaneoch Hill and Wedder Hill which are situated towards the south eastern boundary of the Proposed Development. Mineral podzol soils are located to the south between Windy Standard and Jedburgh Knees.

10.7.55 The Carbon and Peatland 2016 map[5] provides information on the likely presence and nature of peat across the Proposed Development Area. As shown in Figure 10.3 in Volume 3, much of the area is mapped as Class 5 (peat soil– no peatland vegetation). An area to the south of the Proposed Development Area at Polwhat Rig is mapped as Class 3 occasional peatland habitat with predominantly peaty soil with some peat soil, with Class 0 mineral soils mapped along the source of Fingland Burn. The Millaneoch Hill features Class 4 (heath with some peat) and Class 3 (occasional peatland habitat). It should be noted that small pockets of Class 1 and Class 2, both nationally important, are located at Lamb Hill, on the eastern boundary, and on the western slope of Trostan Hill.

10.7.56 Given that the Proposed Development is a repower of the existing Windy Standard I Wind Farm, much of the infrastructure already exist and will be upgraded with the current footprint expanded. It has been confirmed during the peat probing that no peat will require to be excavated as part of the Proposed Development, therefore a peat slide risk assessment and peat management plan is not required.

Peat Survey Results

10.7.57 The phase 1 (100 m grid) peat depth walkover survey at the Proposed Development Area was undertaken in April and May 2020 in line with Scottish Government guidance[6]). The survey was undertaken on a 100 m grid spacing, excluding a 50 m buffer of existing infrastructure. The buffer was created to avoid probing areas with existing cables that pose a Health and Safety risk to the surveyors.

10.7.58 The requirement for detailed Phase 2 peat depth survey across the entirety of the Proposed Development was scoped out due to the lack of peat encountered during the Phase 1 survey. Focussed peat probing was carried out in some identified areas (including near T1 and T2) due to the proximity to depths greater than 0.5 m identified through the 100m grid probing. This additional phase 2 peat depth surveying was undertaken at T1, T2 and selected infrastructure, using a 10 m by 10 m grid, to confirm placement or repowering infrastructure had avoided areas of peat.

10.7.59 In addition, where applicable peat data associated with adjacent wind farm developments (existing Windy Standard II and consented Windy Standard III) have been used to supplement the most recent data. These results were collected in 2014 and have been included in the results in Table 10.9.

10.7.60 The interpolated peat depths are provided in Figure 10.4 in Volume 3 of the EIAR. A breakdown of points from all phases of probing in each category of peat depth is provided in Table 10.10 below.

Table 10.10: Total number of peat depths surveyed within each category

Peat Depth Range (m)	Results	% of Points Surveyed
≤0.3	346	55.6
>0.3 – ≤0.5	116	18.6
>0.5 – ≤1.0	100	16.1
>1.0 – ≤1.5	28	4.5
>1.5 – ≤2.0	26	4.2

[4] Scotland's Environment https://map.environment.gov.scot/sewebmap/ Date Accessed: 04/08/2022

[5] Scotland's Soils (2016) https://soils.environment.gov.scot/maps/thematic-maps/carbon-and-peatland-2016-map/ Date Accessed: 04/08/2022

[6] Scottish Government, Scottish Natural Heritage, SEPA (2017), Peatland Survey, *Guidance on Developments on Peatland.* On-line version only

Peat Depth Range (m)	Results	% of Points Surveyed
>2.0 – ≤2.5	5	0.8
>2.5	1	0.2
Total	**622**	**100**

10.7.61 Table 10.10 indicates that the majority (55.6%) of the locations surveyed exhibited depths ≤0.3 m or less, with 18.6% greater than 0.3 m but less than or equal to 0.5 m. Less than 10% of the surveyed locations recorded a depth greater than 1 m. The average recorded depth across the entire Proposed Development Area was 0.45 m. In line with guidance peat depths of less than 0.5 m have been categorised as peat soils with peat deposits being >0.5 m in depth[6 7]. Mean infrastructure peat/peaty soil depths are provided in Table 10.11.

Table 10.11: Recorded depths at infrastructure elements

Infrastructure Element	Mean Peat Depth* (m)
Turbines	
T1**	0.2
T2**	0.2
T3	0.1
T4	0.2
T5	0.2
T6	0.2
T7	0.2
T8	0.1
Ancillary infrastructure	
BP W (NS 58586 02140)	0.6
BP SW (NS 58778 00975)	0.4
BP – T7 (NS 61468 02707)	0.3
BP – T2 (NS 60863 03395)	
Main Construction Compound	0.3
On Site Construction Compound	0.2
Upgraded Access track segments	
Site entrance to T5	0.4
T5 to T4	0.3
T4 to T6	0.2
T4 to T3	0.2
T3 to T8	0.2
T8 to T7	0.2
T7 to T2	0.2
T2 to T1	0.3
T1 to Grid Connection Point 02	0.4

10.7.62 Owing to the lack of peat, cores were unable to be collected at the areas highlighted through scoping as requiring further investigation, specifically T1 and T2. This was due to these locations featuring depths below 0.5 m and is therefore, as previously mentioned, classified as peat soils.

10.7.63 The Main Construction Compound is located in area that has been felled and heavily modified. Therefore, a peat depth of 0.3 m has been used.

10.7.64 As a result of the Proposed Development being underlain by thin soils rather than peat the requirement for a peatslide risk assessment and peat management plan has been scoped out.

Geology

10.7.65 The following information regarding the underlying geology of the Proposed Development has been obtained from digital data available from the BGS online geology mapping.

10.7.66 As shown in Figure 10.5 in Volume 3, the majority of the Proposed Development Area is mapped with no superficial deposits present at topographic highs, however within the valleys both Till (glacial deposit) and Peat (organic material) are featured. Additionally, superficial deposits of Alluvium, which encompasses silt, sand and gravel, can be found in the valley bottoms running parallel with the mapped watercourses.

10.7.67 The bedrock is primarily comprised of the Blackcraig Formation and the Kirkcolm Formation. The Blackcraig Formation is located in the northern section of the Proposed Development Area, near Gallow Rig Moss, and is described as massive wacke and conglomerate. This formation interfingers the Kirkcolm Formation, with the lithology describing a sandstone/siltstone turbidite sequence. These rock units can be attributed to a deep sea environment with sediment originating from a continental shelf. There is a thin rock formation in the Millaneoch Hill area referred to as the Galdenoch Formation that is similar to the Blackcraig Formation and Kirkcolm Formation.

10.7.68 The bedrock features multiple igneous intrusions that are dykes in nature, with compositions being primarily intermediate to mafic. The largest intrusion is located on the northern slope of Windy Standard and is categorised as a dioritic dyke associated with the North Britain Siluro-Devonian Calc-Alkaline Dyke Suite.

Hydrogeology

10.7.69 The following information was obtained from digital data available from the British Geological Survey GeoIndex Onshore 1:625,000 scale online mapping. The Proposed Development is mapped as a low productivity aquifer where flow is primarily all through fractures and other discontinuities. There may also be shallow groundwater storage within sand and gravel deposits in valley basins, however productivity will be limited by the small lateral and vertical extent.

10.7.70 It is expected that groundwater within the Proposed Development flows from high to low elevation, with the water table predominantly below ground level, and reflecting the shape of the topography. Where topography is relatively flat and overlain by peat deposits, piping may be present where water flows through eroded conduits at the interface between peat and weathered bedrock. Some notable groundwater flow may be present within a weathered bedrock zone at the interface of the soil/peat and solid bedrock.

Groundwater Dependent Terrestrial Ecosystems

10.7.71 A review and assessment of GWDTE of the Proposed Development has been undertaken with details provided in the following sections.

10.7.72 As per the SEPA's Land Use Planning Guidance Note 31 a buffer search distance of 250 m from all proposed new Proposed Development infrastructure was adopted for all elements deemed to require excavations >1 m below ground level (bgl); this was applied to turbine foundations and borrow pits. A 100 m buffer was applied to all access tracks, including existing tracks which may be subject to local widening and typically may require excavations <1

[7] JNCC Report 445 (2011), Towards an assessment of the state of UK Peatlands, Accessed 01/10/2021

m bgl.. National Vegetation Classification (NVC) habitat data (refer to Chapter 9: Ecology) and SEPA's list of potential groundwater dependent communities was used to identify potential GWTDE within the Proposed Development. For a habitat to be designated as a GWDTE there is the requirement for hydraulic connectivity between the groundwater body and the habitat.

10.7.73 Review of the NVC data highlighted a number of potential GWDTEs using the list of communities identified in the SEPA guidance document LUPS-GU 31[8]. It is acknowledged in this document that the listed communities 'may be considered GWDTEs only in certain hydrogeological settings'. The identified potentially groundwater dependent NVC communities are summarised as follows in Table 10.12 below.

Table 10.12: NVC communities and potential groundwater dependency (within 250 m and 100 m buffer zones)

NVC Community	Potential Level of GW Dependency
M23 - *Juncus effusus/acutiflorus - Galium palustre* rush-pasture	High
M25 - *Molinia caerulea - Potentilla erecta* mire	Moderate
MG9 – *Holcus lanatus – Deschampsia cespitosa* grassland	Moderate

10.7.74 An assessment of the groundwater dependency of the identified habitats has been undertaken based on the following sources of information: topography, soils, geology, hydrogeology and hydrology findings from the desk study and on-site survey.

10.7.75 The composition of the underlying geology determines the groundwater throughflow (i.e. intergranular or fracture flow mechanism), which will influence the water supply to the GWDTE habitat communities. Within low permeability bedrock, groundwater flow is typically limited to fault lines, fractures and/or the weathered bedrock zone and will therefore only be present where these features exist. Porous bedrock or superficial deposits demonstrating small interconnected pore spaces are likely to support intergranular groundwater flows.

10.7.76 For this assessment the determination of habitats within the buffers identified to be overlaying and/or in the immediate vicinity of permeable or highly faulted geological features or where it cannot be ruled out that a habitat is subject to a degree of groundwater contribution have been considered as groundwater dependent habitats and assigned either Moderate Dependency or High Dependency. Where available evidence indicates that a habitat is most likely ombrotrophic (rain fed) with no significant groundwater recharge, these habitats have been assigned Low Dependency.

10.7.77 The aquifer properties of the identified solid bedrock is likely to be of low productivity and unlikely to support any significant volumes of groundwater with no springs identified during the surveys. The GWDTE clusters have been defined as set out in Table 10.13 and shown in Figure 10.7 of Volume 3 of the EIAR. The potential GWDTE have been grouped (clustered) based on their potential groundwater dependency, location and underlying geology.

[8] SEPA (2017), Land Use Planning System, Guidance Note 31, *Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems*

Table 10.13: GWDTE Screening Assessment

GWDTE Cluster ID	Potential GWDTE habitats as per LUPS-GU31	Bedrock Geology	Superficial Geology	Hydrogeology	Potential GW Dependency (as per LUPS-GU31)	Actual GW Dependency
1	M23	Kirkcolm Formation - Wacke	Peat	Bedrock: Low Productivity Aquifer	High	Low
2	M23	Kirkcolm Formation - Wacke	Till, Devensian – Diamicton	Bedrock: Low productivity aquifer	High	Low
3	M25/M23	Kirkcolm Formation - Wacke	No mapped deposits	Bedrock: Low productivity aquifer	Moderate	Low
4	M23b	Kirkcolm Formation - Wacke	No mapped deposits	Bedrock: Low productivity aquifer	High	Low
5	MG9	Kirkcolm Formation - Wacke	Peat	Bedrock: Low productivity aquifer	Moderate	Low

10.7.78 The habitats are characterised as follows:

- Ombrotrophic Surface Wetlands – including areas of M23 (Clusters 1 and 2) and M25/M23 (Cluster 3). These areas have been assessed as non-GWDTE due to absence of evidence for underlying highly permeable deposits, which are likely to impede drainage and encourage standing water. Water tables are likely maintained by direct rainfall inputs and surface water runoff from adjacent areas. As such, these habitats have been assigned as having a likely "Low" actual groundwater dependency in Table 10.13.
- Rush Pasture - including areas of M23b (Cluster 4). This area has been assessed as non-GWDTE due to absence of evidence for underlying highly permeable deposits, which are likely to impede drainage and encourage standing water. Water tables are likely to be maintained by direct rainfall inputs and surface water runoff from adjacent areas. For instance, potential GWDTE habitat is located to the immediate south of existing infrastructure with a drainage ditch present. It is likely that this, combined with the surrounding commercial forestry, is surface water fed. Therefore, this habitat has been assigned as having a likely "Low" actual groundwater dependency in Table 10.13.
- Improved Grassland – including areas of MG9 (Cluster 5). This has been assessed as non-GWDTE due to the absence of evidence for underlying highly permeable deposits, which are likely to impede drainage and encourage standing water. Water tables are likely to be maintained by direct rainfall inputs and surface water runoff from adjacent areas. In this case, the community is located adjacent to the access track for nearby overhead line cable route, with commercial forestry located to its south. Commercial forestry features an extensive artificial drainage system, therefore it is likely this MG9 community is supported directly by rainfall or surface water runoff. This habitat has been assigned as having a likely "Low" actual groundwater dependency in Table 10.13.

10.8 MODIFYING INFLUENCES

10.8.1 Information regarding climate change was obtained from the UK Climate Projections (UKCP18) website[9]. 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.

10.8.2 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 water reliant ecosystems. Evidence also suggests that although the summer months will have an average decrease in rainfall, summer storms will be more frequent and intense. This may lead to more extreme flow values during and immediately following such events, with consequential flooding and water quality issues. This is of key importance for the hydrological environment during summer construction periods.

10.8.3 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.

10.9 IDENTIFICATION AND EVALUATION OF EFFECTS

Proposed Development Interactions

10.9.1 The Proposed Development will introduce physical changes which have the potential to alter the hydrological characteristics within the Proposed Development Area. 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

Basis of Assessment

10.9.2 The Proposed Development will consists of the decommissioning and restoration of the existing Windy Standard I Wind Farm, erection, 35-year operation, and subsequent decommissioning of eight wind turbines, with tip heights of 200 m. The Proposed Development includes associated infrastructure, such as construction compound and temporary borrow pits.

10.9.3 The decommissioning of the existing Windy Standard 1 will require removal or existing infrastructure including wind turbines and the restoration of the area. The decommissioning process, including waste and spoil management and the reinstatement would be detailed by the appointed contractor. Decommissioning would adhere to the correct environmental regulations and any required permits would be obtained prior to decommissioning commencing. It is expected that the impacts of decommissioning would be less than construction of the Proposed Development.

10.9.4 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 the Proposed Development and erected.

[9] Met Office, UK CLimated Projections (UKCP), https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index Accessed 02/02/2022

Mitigation by Design

10.9.5 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 4: Site Design and Design Evolution. 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. Poor design of development infrastructure can result in significant implications to the hydrological environment, soils and ecology. The design has incorporated the existing infrastructure which will reduce the impact of the Proposed Development.

10.9.6 The findings of the peat depth survey (paragraph 10.7.53 - 10.7.62 and Figure 10.4 in Volume 3) show that the infrastructure has, as far as possible, taken into account other constraints and have been sited outside areas of deeper peat. The soil depths within the Proposed Development Area are shown to be in a shallow range (≤0.5 m) when considering the turbine, associated infrastructure and access track areas.

10.9.7 The Proposed Development islocated in an upland hydrological environment which includes both natural hydrological pathways and drainage and mitigation associated with the existing Windy Standrad I Wind Farm, The Proposed Development will require a larger landtake and therefore a series of set-back (buffer) distances have been adopted to help reduce effects of the Proposed Development on the hydrological environment. A 50 m buffer was implemented to maintain the distance between infrastructure and nearby hydrological features to ensure adequate space is available for water management features as required.

10.9.8 Table 10.14 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 the Quantum Geographic Information System (QGIS) package. Watercourses are linear features that were identified from the OS 1:10,000 raster data.

Table 10.14: Distance from Turbine to nearest watercourse

Turbine ID	Turbine distance from watercourse (inclusive of 50 m buffer)
1	488
2	347
3	114
4	101
5	196
6	315
7	523
8	275

10.9.9 Other embedded mitigation integrated as part of the design of the Proposed Development is as follows:

- Borrow pits and search areas associated with the Proposed Development are either previously used or in areas that have been previously developed. Nevertheless, the search areas are outside the 50 m buffer of mapped watercourses. This is shown in Figure 10.1: Hydrology Overview.
- The layout of tracks is based on the current track layout, with upgrading of existing infrastructure being the primary focus.

- The design of linear infrastructure elements will avoid modifying surface water and groundwater flow pathways. This includes the use of permeable materials for track construction, adoption of a site-wide drainage strategy integrating the use of regular cross drains and soakaways, and the use of regular clay plugs within buried structures such as cable trenches; and
- A single watercourse crossing, location between T4 and the junction to T3 or T8 (located at NGR NS 61818 01791 and presented in Figure 10.1 of Volume 3 of the EIAR), will be required for the Proposed Development. As shown in Plate 10.3, the crossing is located on headwater channel of the Fingland Burn. There is an existing crossing, with the channel featuring surface run off becoming more defined. During the time of the survey, the watercourse issues approximately 5 m south from the crossing to become the Fingland Burn, however the overgrown vegetation did not allow an assessment of the nature of the culvert. Nevertheless, the crossing will be designed to maintain flows up to the 1 in 200 years plus climate change event. As the crossing is an engineering activity in the water environment, the structure will require authorisation under the Water Environment (Controlled Activities) (Scotland) Regulations 2011.

Plate 10.3: Watercourse crossing location – emergence point of the Fingland Burn

10.9.10 If the need for the creation of further new or upgraded crossings is required, crossings should be constructed in a manner that minimises the impact of hydrological disturbance on the Proposed Development and allows free passage of aquatic species.

10.10 RECEPTOR BASELINE SENSITIVITY

10.10.1 On the basis of the baseline surveys and available information, Table 10.4 above identifies the criteria for assigning the sensitivity of receptors as outlined in Table 10.15 below with justification for their categorisation.

Table 10.15: Receptor Sensitivity

Receptor	Sensitivity	Comment
Surface Water		
Water of Deugh	High	The Water of Deugh is classified as having poor overall status (as of 2020) as part of SEPA's RBMP and a 2027 classification aim of Good status.
Bow Burn	High	The Bow Burn is classified as having poor overall status (as of 2020) as part of SEPA's RBMP and a 2027 classification aim of Good status.
Fingland Burn	Medium	Not designated as part of SEPA's RBMP.
Polwhat Burn	Medium	Not designated as part of SEPA's RBMP.
River Dee	High	The River Dee is classified as having moderate overall status (as of 2020) as part of SEPA's RBMP and a 2027 classification aim of Moderate status. The River Dee is designated as a SSSI.
Carsfad Reservoir	High	Reservoir supplies Lochinvar WTW
Bridgend	High	
Netherbow	High	
Waterhead	High	
Waterhead	High	
Flood Risk		
The Proposed Development	Medium	Downstream watercourses are at potential risk of flooding. Given the steep topography within the Proposed Development Area any changes to the hydrological regime that results in additional flow could exacerbate the likelihood of flooding.
Downstream of the Proposed Development	Medium	Downstream watercourses are at potential risk of flooding. Given the steep topography within the Proposed Development Area any changes to the hydrological regime that results in additional flow could exacerbate the likelihood of flooding.
Soils Geology & Hydrogeology		
Site soils and peaty soils < 0.5 m depth	Low	Geology is typical of wider area with no designated sites of geological interest located within the study area.

Low	Very limited areas of the Proposed Development fall within the flood inundation envelope with areas at risk of flooding contained to the river channel extent. Proposed infrastructure is placed along ridge line tops.
Low	The majority of soils (75% of probed locations) are less than 0.5 m deep and therefore classified as peaty soil.

Geology	Low	Bedrock and superficial aquifers are mapped as low productivity and are unlikely to supply significant volumes of groundwater except for areas on fractures or fault lines. Notwithstanding, bedrock groundwater characterised as good quality status.
Hydrogeology and groundwater	Low	Available information does not suggest a strong groundwater component associated with identified possible GWDTE within the Proposed Development. Notwithstanding, localised hydrogeological conditions may partially nourish some of the identified habitats in combination with surface waters. Whilst not of national or regional importance, such habitats are still protected under the WFD.
		Available information does not suggest a strong groundwater component associated with identified possible GWDTE within the Proposed Development. Notwithstanding, localised hydrogeological conditions may partially nourish some of the identified habitats in combination with surface waters. Whilst not of national or regional importance, such habitats are still protected under the WFD.

10.11 MITIGATION MEASURES

10.11.1 A number of planning, design and construction proposals have been identified during the assessment. Full details of the industry good practice construction management and mitigation measures will be provided in a Construction Environmental Management Plan (CEMP) which would be prepared and agreed with DGC post consent as part of a planning condition. A summary of the measures included within the CEMP are described below and have been assumed to be part of the proposals when the residual effects and their significance are assessed. Any additional mitigation, specific to the Proposed Development, but still considered good practice is also provided in further detail in paragraph 10.11.3 to 10.11.49.

10.11.2 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.

Outline Construction and Environment Management Procedures

10.11.3 A site-specific CEMP will provide details on industry good practice measures to be put in place to manage activities in such a manner as to prevent or minimise effects on the surface and groundwater environment. The CEMP will be prepared prior to commencement of the decommissioning of WSI and construction and will include information as follows:

- Drainage – all runoff derived from construction activities and Proposed Development infrastructure will not be allowed to directly enter the natural drainage network. All runoff 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 or upgraded to accommodate storm flows based on a 1 in 200-year event (plus climate change) to help maintain the existing hydrological regime;
- Storage – all soil stockpiles as well as 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;
- 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 – only emergency maintenance to construction plant will be carried out within the Proposed Development area in designated areas, 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 for sewage to be disposed of appropriately. Given the low permeability of the underlying bedrock and limited extent of soils, its likely such waste would be tankered off-site and treated elsewhere under Duty of Care;
- 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;
- Monitoring Plan – to provide environmental compliance, activities undertaken as part of the Proposed Development will be monitored throughout the construction phase. Water quality monitoring will also occur throughout each phase of the Proposed Development and will help to maximise the effectiveness of mitigation measures whilst monitoring effects on the hydrological environment. Full details on the monitoring requirements will be agreed with SEPA, DGC and Marine Scotland Science;
- Contingency Plans – plans will provide information on emergency equipment and where it is available on the Proposed Development 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; and
- Training – All relevant staff personnel will be trained in both normal operating and emergency procedures and be made aware of highly sensitive areas on the Proposed Development.

10.11.4 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.

Runoff and Sediment Management

10.11.5 The following measures will be adopted to appropriately attenuate and treat runoff during decommissioning of WSI and construction and operation of the Proposed Development.

10.11.6 The Proposed Development drainage system will convey water away from construction activities as well as the Proposed Development infrastructure. However, due to the nature of the works on the Proposed Development and the negligible infiltration and storage capacity of the underlying peat and bedrock there is significant potential for sediment and other pollutants to become entrained in the surface runoff.

10.11.7 There is an existing drainage network in place associated with the existing infrastructure, however the Proposed Development will be using and bolstering this existing infrastructure.

10.11.8 To reduce this potential, prior to the commencement of work and during construction, plans showing the Proposed Development drainage and hydrologically sensitive areas should be regularly checked to review potential for runoff and ponding of water within the Proposed Development Area to make sure that runoff patterns are well known.

10.11.9 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 of the suggested control measures regular inspection and maintenance is necessary, particularly after prolonged heavy rainfall.

10.11.10 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 runoff will be dependent upon the permeability of the terram geotextile material and the size and source of the clean stone.

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

10.11.12 If required, flocculents could also be used to treat runoff. Flocculents are very effective at removing suspended sediment from water but they can also have effects on water chemistry. As such, SEPA will be consulted prior to the use of flocculents and only considered as a last resort. If their use is proposed, SEPA will be consulted, and a method statement agreed prior to use. This method statement must detail the type of floc, how dosing is controlled, record keeping (dates used, location, volume/weight used etc) and how the precipitated silt will be disposed of.

10.11.13 Access tracks crossing slopes will disrupt surface flow that consequently will collect in drains constructed upslope of the tracks. Cross-drains 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 runoff from more silty runoff 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 runoff and the diversion of flows between catchments. Such cross drains need to be strong enough to withstand the expected traffic loadings.

10.11.14 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) would be incorporated into the track base at regular intervals to allow more flow to pass through the track and maintain the current flow regime. It is recommended that such pipes are 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 and the hydrological regime.

10.11.15 Prior to track construction and upgrade, site operatives and the Environmental Clerk of Works (ECoW) 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.

10.11.16 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 back into the soils.

10.11.17 Drainage from the construction compound, welfare facilities, borrow pits and concrete wash out areas will be collected and treated separately from the Proposed Development drainage, as the runoff 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.

Pumping and Dewatering of Excavations

10.11.18 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 The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended) 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 following techniques:

10.11.19 Due to the expected low permeability of the Proposed Development area soils it is expected that the potential for groundwater ingress would be low. The ingress of surface water into the excavations will be minimised through the use of upgradient drainage measures e.g. cut-off ditches. 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 runoff before discharging back into the natural drainage network.

10.11.20 Due to low permeability of the underlying soils the throughput rate of runoff 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.

10.11.21 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. Any sediment within the treated water will be deposited amongst the rough surface vegetation, away from sensitive habitats or watercourses.

10.11.22 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.

10.11.23 To maximise the efficiency of the settlement measures 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

10.11.24 Throughout the decommissioning of the existing Windy Standard I, and 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 to so that the surface and groundwater environment is not adversely affected.

10.11.25 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 minimise the likelihood of bursts or leak 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 prevent spillages; and
- Standing machinery to have drip trays placed underneath to prevent oil and fuel leaks causing pollution.

Refuelling

10.11.26 A fuel bowser will be used for refuelling on the access tracks or hardstanding. The bowser driver shall be responsible for ensuring that refuelling of mobile plant does not take place within 50 m of a watercourse. The bowser driver will receive extra training on spill prevention and response.

10.11.27 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 Site induction training or toolbox talks. Special attention will be paid to spillage control at watercourses.

Vehicle Maintenance and Management

10.11.28 All plant used during the decommissioning of the existing Windy Standard I and 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.

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

- Drip trays will be placed underneath vehicles during maintenance;
- As a precautionary measure, measures such as silt fencing or entrapment matting can 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; and
- Standing machinery and plant 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 at a central designated area, on an impermeable surface, which will be located at least 50 m away from any watercourses.

Concrete Works

10.11.30 Concrete would be required for the construction of the wind turbine foundations. The following section provides good practice measures that are required to be implemented to prevent detrimental effects to the hydrological environment.

10.11.31 Care will be taken during the transportation of concrete to the turbine and building foundations using good practice measures. Freshly mixed concrete and/or dry cement powder will not be allowed to enter any watercourse. This will be implemented by:

- Locating turbines, concrete batching (if considered) or wash out areas 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 at the Proposed Development;
- 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 the Proposed Development, this will be done in the predetermined wash-out areas;
- A designated concrete wash out will be constructed within the Proposed Development at a location agreed with the relevant consultees to protect the watercourses. The design and construction of these wash out areas will be agreed with SEPA; and
- Wash out areas will be continually monitored, and findings recorded to prevent a rise in effluent levels and avoid a spill over into the environment.

Welfare Facilities/Foul Water

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

- Any sewage associated with the temporary construction compound and welfare facilities will be collected in appropriately sized interceptor tanks and shall be located at the construction compound. All wash basins, toilets and shower areas shall also be connected to an interceptor tank; and
- The interceptor tanks and the tanks within any Proposed Development 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.

Proposed Development Area Drainage

10.11.33 The following section discusses the conventional Site drainage measures to be upgraded or installed during the decommissioning of WSI and construction and operation of the Proposed Development.

10.11.34 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 runoff through the drainage system and allowing sediment to settle before water is discharged from the drainage system.

10.11.35 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 runoff and allowing sediment and/or pollutants to settle.

10.11.36 To reduce the impact of the Proposed Development on the natural hydrological regime, the site drainage will mimic greenfield runoff response through the use of sustainable drainage practices.

10.11.37 Sustainable Drainage Systems (SuDS) will be taken into consideration as part of the water management and details of the proposed SuDS regime would be included in the CEMP that will be as agreed with DGC post-consent as contained within planning conditions).

10.11.38 SuDS are used to attenuate rates of runoff 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.

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

10.11.40 Access tracks crossing slopes will disrupt surface flow that consequently will collect in drains constructed upslope of the tracks. Cross-drains and/or water bars 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 runoff from more-silty runoff 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 runoff and the diversion of flows between catchments. Such cross drains need to be strong enough to withstand the expected traffic loadings.

10.11.41 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) would be incorporated into the track base at regular intervals to allow

more flow to pass through the track and maintain the current flow regime. It is recommended that such pipes are surrounded by free draining material that is wrapped in a separator geotextile. The number of pipes and associated dimensions will be dependent upon the hydrological regime.

10.11.42 Prior to track construction, site operatives will identify any 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.

10.11.43 Due to the poor permeability of the surrounding soils and bedrock, it is also recommended that drains and/or cut-off drains are 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 runoff entering the excavations and minimise any subsequent contamination.

10.11.44 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.

10.11.45 Drainage from the construction compounds, welfare facilities, borrow pits and concrete wash out areas will be collected and treated separately from the main drainage required to facilitate the construction and operation of the Proposed Development, as the runoff 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.

10.11.46 Mitigation will follow industry good practice. All mitigation and drainage will be subject to detailed design and approved by SEPA prior to construction with the ECoW ensuring compliance. The Proposed Development will also be subject to a construction runoff permit. Further suggested measures include ensuring the detailed design includes buffer areas indicating “no construction zones” whereby the micrositing of infrastructure is not permitted. This will also include construction activities, stockpile storage areas, refuelling areas to ensure these are not located within buffers of watercourses.

10.11.47 The upgrade of the existing watercourse crossing will be appropriately designed so that it does not alter the natural drainage, hinder the passage of aquatic fauna and can accommodate flow for a 1:200 year plus climate change event. The watercourse crossing will be designed with edge upstands or bunds e.g. sandbags or silt fences to prevent sediment laden runoff 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.

Emergency Water Management Measures

10.11.48 A large volume of oils and chemicals will be stored on the Proposed Development 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 the operational phase.

10.11.49 The appropriate storage of oils, chemicals and maintenance of Site plant has been discussed above. However, despite these measures, accidents may still occur and these can have significant impacts upon the quality of the surface and groundwater environment. The following emergency procedures can be implemented to allow protection of the surface and groundwater environment during the construction and operation of the Proposed Development:

- All relevant on-site staff to be trained in both normal operating and emergency procedures and be made aware of highly sensitive areas in the Proposed Development Area. The staff training and implementation of procedures will be overseen by the Infrastructure Contractor. These measures should be carried out effectively to minimise the risk of a pollution incident;
- Contingency plans should provide information on where emergency equipment is available on site (i.e. spill kits and absorbent materials), and that provide advice 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 contingency plans specific to the Proposed Development need to 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; and
- The emergency procedures can 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.

Soil Handling and Storage

10.11.50 The construction of roads, turbine foundations and crane hardstanding areas as well as the establishment of the borrow pit will require the stripping of soils and its temporary storage. The following paragraphs present the mitigation measures required to minimise impact on underlying soils.

10.11.51 Topsoil will be stripped and handled with care and kept vegetation side up such that damage to the living vegetation mat is prevented or minimised as far as possible.

10.11.52 This material will be stored upright adjacent to the working area but sited away from watercourses and drains, as far as is practicable. Surface water would ideally be directed away from construction activity to avoid silty run off entering watercourses or ecologically sensitive areas. The stored mounds will be limited in height to 1.5 m to minimise the risk of instability and compaction of lower layers. Subsoil and peaty soil that is stripped and stored will be kept separate from the topsoil.

10.11.53 The excavation of soils is to be undertaken in such a manner as to avoid cross contamination between distinct horizons. The different soil horizons will be kept and stored separately for use at a later date.

10.11.54 During and after excavation, the storage, haulage and reuse of excavated material will planned in advance to minimise material movement around the site. Immediate reuse is preferred to temporary storage (where possible). Further details are provided in the following paragraphs.

10.11.55 The following will also be considered in the handling and storage of excavated soils:

- Sediment Discharges – implementation of a buffer zone to minimise impacts to watercourses and water supplies, undertaking of water quality monitoring particularly after heavy rainfall, and insurance that culverts or bridging of watercourses are of sufficient size and spacing with appropriate erosion mitigation measures; and

- Contaminant discharges – follow Pollution Prevention Guidance (PPGs), refuel and store oils and fuels in designated areas.

10.11.56 Excavation is expected to be limited due to the use of infrastructure associated with existing development. Therefore, infrastructure will be upgraded or developed in areas where no peat is located. Any micrositing would not be permitted into areas of peat.

10.11.57 Further details on the measures to appropriately manage the excavation, storage and reinstatement of excavated material is provided in the following paragraphs.

Temporary Storage of Excavated Material

10.11.58 Excavated material that is stockpiled on site for further use should be managed to prevent silty run-off or losses due to drying out and wind. The temporary storage of excavated material, including peaty soil shall seek to minimise the disturbance through minimising haul distance between temporary storage sites.

10.11.59 The suitability of temporary storage areas will be confirmed prior to works taking place and the following key control measures will be considered:

- Soil will be stripped and stored within the pre-identified areas to maximise the success of safe storage and swift and successful reinstatement;
- If space does not allow storage and the surplus is to be stored elsewhere on the site, the ECoW will be consulted in advance to agree appropriate areas;
- Separate areas will be created for the different layers and topsoil will not be mixed with subsoil layers;
- Stacked topsoil will not exceed a height that enables the topsoil to breakdown. The maximum height for stacked material will be agreed in advance with a maximum height likely to be 1.5 m.
- Storage areas will be located away from watercourses (minimum of 50 m, where practical) protected from run-off from adjacent areas;
- Storage areas should be reinstated to their original condition on completion of their use for storage;
- If soil storage is being carried out on sensitive habitats, consideration will be given to storage on top of a geotextile mat and storage duration shall be minimised;
- Good practice will be adopted in order to minimise the amount of compaction or other disturbance of the general structure of the superficial deposits;
- Other site works will not impact on stored soil (e.g. construction traffic will not track over stored soils);
- If significant soil erosion is occurring from storage piles during periods of heavy rain action will be taken to cover the stockpiles, where practical. The silt fencing or other mitigation around the base of the stockpile will be monitored and replaced as necessary;
- In periods of dry weather check the need for watering to reduce dust and potential nuisance;
- A silt fence will be constructed at the base of the stockpile using a suitable geotextile if required;
- Construct drainage channels to direct surface water away from stockpiles and prevent erosion at the base; and
- Construct drainage channels to direct water through settlement ponds.

Site Reinstatement

10.11.60 So far as is reasonably practicable, all disturbed areas which require reinstatement will be reinstated with the same vegetation types as exist at present, thereby ensuring minimum disruption to the surrounding landscape.

10.11.61 The reinstatement and storage of any excavated materials will involve replacement of previously stripped soils, vegetated layers or turves. Timing of reinstatement works will also consider adjacent construction activities which may disturb any reinstatement works already carried out.

10.11.62 The longer the stripped turves are stored for, the more they will degrade and become unsuitable for successful reinstatement. Therefore, the amount of time between the construction activities and subsequent reinstatement will be minimised as much as practically possible.

10.11.63 The fundamental aspects of reinstatement are summarised as follows:

- Stripped soil, including peat will be reinstated, including landscaping of infrastructure verges, as close to where it was removed as possible. This will help to maintain a local seed base and the local geological/hydrological characteristics;
- Subsoil, topsoil and turfs replaced in same order as removed;
- During periods of dry weather, exposed soils/peaty soils shall be kept moist through a programme of periodic wetting or through natural precipitation;
- Unless otherwise agreed, turfs will be reinstated following the works and orientated vegetation side up;
- Reinstatement will be carried out as soon as is possible following stripping to ensure integrity of material is maintained;
- Where turfs are not available, areas will be left to re-vegetate naturally. If there is not sufficient turf to completely cover an area, then turf will be spread in smaller sections to offer some protection and spread the seed bank rather than leave larger exposed areas;
- Any soil found to be contaminated will not be used for reinstatement but disposed of off-site to a licensed or exempted facility, if necessary;
- The reinstatement of the construction areas will be undertaken to a high standard, using the existing soil and vegetation material wherever possible, in accordance with industry good practice; and
- If re-vegetation is not successful and has not occurred within an agreed period of time and following consultations with NatureScot re-seeding using a native species mix may be considered.

10.12 POTENTIAL DECOMMISIONING AND CONSTRUCTION EFFECTS

10.12.1 The potential for significant environmental 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 is considered in the mitigation and management measures outlined in the mitigation measure section below.

Pollution Incidents

10.12.2 During the construction phase, a number of potential pollutants will be present onsite, including oil, fuels, chemicals, unset cement and concrete, waste and waste water from construction activities and staff welfare facilities. Most potential pollutants will be located or stored within the construction compound. 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

10.12.3 Soil and sediment generation may occur in areas where the ground has been disturbed, particularly where surface runoff has been concentrated. Drainage ditches are particularly prone to this, due to the high velocities of surface water runoff passing through the drainage network. Considerable sediment generation is expected where the ground has been excavated for the Proposed Development infrastructure.

10.12.4 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.

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

Increase in Runoff

10.12.6 Turbine bases, hardstanding 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 runoff into the onsite catchments.

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

Modification of Surface Drainage Patterns

10.12.8 The interception of diffuse overland flow by the Proposed Development 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 on flood issues downstream of the Proposed Development.

Impediments to Surface Water Flow

10.12.9 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.

Modification of Groundwater Flows and Levels

10.12.10 The impact of construction on GWDTE was determined to be low, as areas with the potential were assessed to be fed by other water sources. Nevertheless, the upgrading of infrastructure associated with the existing development, and with the areas in which new development will occur being out with GWDTE, there is no potential of effect on GWDTE by construction.

Compaction of Soils

10.12.11 The movement of construction traffic within the site 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.

10.13 ASSESSMENT OF DECOMMISIONING AND CONSTRUCTION EFFECTS

10.13.1 Table 10.16 identifies the likely construction effects on the identified receptors and their significance assuming the successful implementation of good practice and mitigation measures. The assessment is based on the criteria outlined in Section 10.5.

Table 10.16: Assessment of Construction Effects

Potential Effect	Identified Receptor(s)	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation			Additional Mitigation	Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Effect	Significance of Effect		Sensitivity	Magnitude of Effect	Significance of Effect
Surface Waters								
• Pollution incidents • Erosion and sedimentation • Changes in Water Quality • Increase in Runoff • Modifications to Surface Drainage Pattern • Impediments to Surface Water Flow	Water of Deugh	High	Slight	Moderate	None	-	-	-
	Bow Burn	Medium	Slight	Moderate/Minor	None	-	-	-
	Fingland Burn	Medium	Slight	Moderate/Minor	None	-	-	-
	Polwhat Burn	Medium	Slight	Moderate/Minor	None	-	-	-
	River Dee SSSI	High	Negligible	Moderate/Minor	None	-	-	-
	Carsfad Loch	High	Negligible	Moderate/Minor	None	-	-	-
Water Resources								
• Pollution incidents • Modifications to Surface Drainage Patterns • Impediments to Surface Water Flow • Modification of Groundwater Flows and Levels • Compaction of Soil	Bridgend	High	Negligible	Moderate/Minor	None	-	-	-
	Knockengorroch - Taigh-Na-Sithidhean,	High	Negligible	Moderate/Minor	None	-	-	-
	Netherbow	High	Negligible	Moderate/Minor	None	-	-	-
	Waterhead	High	Negligible	Moderate/Minor	None	-	-	-
Flood Risk								
• Increase in runoff • Modifications to Surface Drainage Patterns • Impediments to Surface Water Flow • Compaction of Soil	The Proposed Development	Low	Negligible	Minor/Negligible	None	-	-	-
	Watercourses downstream of the Proposed Development	Medium	Slight	Moderate/Minor	None	-	-	-

Potential Effect	Identified Receptor(s)	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation			Additional Mitigation	Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Effect	Significance of Effect		Sensitivity	Magnitude of Effect	Significance of Effect
Soils								
• Pollution incidents • Modifications to Surface Drainage Patterns • Modification of Groundwater Flows and Levels • Compaction of Soils	Site soils and peaty soils < 0.5 m depth	Low	Negligible	Minor / Negligible	None	-	-	-
Geology								
• Excavation and removal required for construction	On-site Geology	Low	Negligible	Minor / Negligible	None	-	-	-
Hydrogeology and Groundwater								
• Pollution incidents • Modification of groundwater flows and levels • Compaction of Soils	Hydrogeology and groundwater	Low	Negligible	Minor/Negligible	None	-	-	-
	GWDTE	Low	Negligible	Minor/Negligible	None	-	-	-

10.14 POTENTIAL OPERATIONAL EFFECTS

10.14.1 The effects of the Proposed Development are expected to be substantially lower during the operational phase. The following paragraphs discuss the potential effects that may occur during the operational phase of the Proposed Development.

Pollution Incidents

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

Erosion and Sedimentation

10.14.3 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 is still possible on site tracks and drainage ditches as a result of scouring during extreme rainfall events. Similarly, there could be some erosion and sedimentation around new stream crossings as watercourses reach new equilibrium.

Modification of Surface Drainage Patterns

10.14.4 Modification of surface runoff will occur as a result of the construction of the new infrastructure associated with the Proposed Development. The operational effects are likely to result in changes to volume and/or changes to runoff rate.

10.14.5 Poorly designed site tracks and associated drainage could allow surface water to travel through a catchment much faster than if it were to travel as diffuse overland flow. This could result in an increase in runoff rates, peak flows and influence response times during storm events. The utilisation of many of the existing tracks reduces the magnitude of the changes expected to the drainage regime.

Impediments to Surface Water Flows

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

Modification of Groundwater Flow and Levels

10.14.7 Tracks and their drainage as well as turbine foundations and hardstandings 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.

10.15 ASSESSMENT OF PREDICTED OPERATIONAL EFFECTS

10.15.1 Table 10.17 identifies the likely operational and ongoing effects on the identified receptors and their significance assuming the successful implementation of good practice and mitigation measures. The assessment is based on the criteria outlined in Section 10.5.

Table 10.17: Assessment of Predicted Operational Effects

Potential Effect	Identified Receptor(s)	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation			Additional Mitigation	Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Effect	Significance of Effect		Sensitivity	Magnitude of Effect	Significance of Effect
Surface Waters								
• Pollution incidents • Erosion and sedimentation • Changes in Water Quality • Increase in Runoff • Modifications to Surface Drainage Pattern • Impediments to Surface Water Flow	Water of Deugh	High	Negligible	Moderate/Minor	None	-	-	-
	Bow Burn	Medium	Negligible	Minor	None	-	-	-
	Fingland Burn	Medium	Negligible	Minor	None	-	-	-
	Polwhat Burn	Medium	Negligible	Minor	None	-	-	-
	River Dee SSSI	High	Negligible	Moderate/Minor	None	-	-	-
	Carsfad Loch	High	Negligible	Moderate/Minor	None	-	-	-
Water Resources								
• Pollution incidents • Modifications to Surface Drainage Patterns • Impediments to Surface Water Flow • Modification of Groundwater Flows and Levels • Compaction of Soil	Bridgend	High	Negligible	Moderate/Minor	None	-	-	-
	Knockengorroch - Taigh- Na-Sithidhean,	High	Negligible	Moderate/Minor	None	-	-	-
	Netherbow	High	Negligible	Moderate/Minor	None	-	-	-
	Waterhead	High	Negligible	Moderate/Minor	None	-	-	-
Flood Risk								
• Increase in runoff • Modifications to Surface Drainage Patterns • Impediments to Surface Water Flow	The Proposed Development	Low	Negligible	Minor/Negligible	None	-	-	-
	Watercourses downstream of the	Medium	Negligible	Minor	None	-	-	-

Potential Effect	Identified Receptor(s)	Potential Effect Assuming Implementation of Standard Good Practice and Embedded Mitigation			Additional Mitigation	Potential Effect Assuming Implementation of Additional Mitigation		
		Sensitivity	Magnitude of Effect	Significance of Effect		Sensitivity	Magnitude of Effect	Significance of Effect
	Proposed Development							
Soils								
• Pollution incidents • Modifications to Surface Drainage Patterns • Modification of Groundwater Flows and Levels	Site soils and peat < 0.5 m depth	Low	Negligible	Minor/Negligible	None	-	-	-
Hydrogeology and Groundwater								
• Pollution incidents • Modification of groundwater flows and levels	Hydrogeology and groundwater	Low	Negligible	Minor/Negligible	None	-	-	-
	GWDTE	Low	Negligible	Minor/Negligible	None	-	-	-

10.16 CUMULATIVE EFFECTS AND INTERACTION OF EFFECTS

10.16.1 The application of a hydrological catchment methodology enables a logical evaluation of the potential for cumulative effects of the hydrological environment. A cumulative impact is considered to be the impact on a hydrological, hydrogeological or geological receptor arising from the Proposed Development in combination with other developments which are likely to affect surface water, groundwater or geology. Developments (operational, consented and in planning) within the same catchment as the Proposed Development and within a distance of 10 km from the Proposed Development have been considered. Cumulative impacts are considered using the same methodology as for impacts of the Proposed Development in isolation.

10.16.2 The Proposed Development is adjacent to the operational Windy Standard II and consented Windy Standard III. These developments will make use of the same site access. Additionally, consented Shepherds Hill Wind Farm and Wind Rig, currently under construction, are within the upper Water of Deugh catchment.

10.16.3 Off-site cumulative hydrological effects are primarily related to changes in water quality and increases in flood risk. Mitigation has been presented in Section 10.11 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, as outlined in Section 10.7.

10.16.4 The construction of the Proposed Development would take place at the same time as the decommissioning of the existing Windy Standard I. The cumulative effect of both the construction of the repowering scheme and decommissioning and restoration of the operational scheme will be assessed as a co-ordinated operation.

10.16.5 It is concluded that following the successful implementation of the mitigation outlined in 10.11, cumulative impacts of the Proposed Development during construction and during operation will be **negligible**.

10.17 MONITORING

10.17.1 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 take into account sensitivities of the on-site and downstream environments.

10.17.2 The details of monitoring will be discussed and agreed with SEPA, MSS and DGC prior to commencement of development, secured by planning condition. The extent and the frequency of the monitoring will be proportionate to the level of activity on the Site during the decommissioning of WSI, 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 impact upon the environment;
- Indicate whether further investigation is required and, where pollution is identified, the need for additional mitigation measures to prevent, reduce or remove any effects on the water environment; and
- Understand the long-term effects of the Proposed Development on the natural environment.

10.17.3 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 time.

10.17.4 A suitably qualified ECoW will be employed throughout the construction phase, including the decommissiong and restoration associated with the existing Wind Farm, of the Proposed Development. The appointed ECoW can provide advice to the workers on-site about how environmental effects shall be minimised, and what methods should be employed to reduce effects on water quality, soils and associated habitats.

10.17.5 Monitoring will be undertaken throughout construction phase of the Proposed Development. The monitoring will help to identify areas where infrastructure is having a negative effect on peaty soils and utilise the appropriate methods to prevent further deterioration and/or promote further enhancement. Furthermore, monitoring will continue into the operational phase of the Proposed Development to assess the water quality beyond construction activities.

10.17.6 All construction management and water management techniques will be agreed with DGC prior to construction. in consultation with SEPA, GFT and MSS. In conjunction with this, there will be a programme of visual monitoring to ensure that the designed drainage system is compliant with the requirements under CAR with respect to General Binding Rule (GBR) 10[10].

10.18 LICENCING REQUIREMENTS

10.18.1 SEPA 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.

10.18.2 It is acknowledged that to support the 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 runoff permit application is not required to support this application.

10.19 RESIDUAL EFFECTS

10.19.1 The residual effects represent the overall likely significant effect of the Proposed Development on the environment taking account of practical and available mitigation measures.

10.19.2 This has identified that there will be no significant environmental effects from the Proposed Development on the hydrological, hydrogeological and geological environment and therefore it can be concluded that no significant residual effects will take place.

10.20 DECOMMISSIONING

10.20.1 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.

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

10.21 FUTURE BASELINE

10.21.1 Without the Proposed Development, the recorded baseline scenario for the hydrological, geological and hydrogeological of the Site has the potential to change due to climate change scenarios. This includes, but is not limited to:

- An increase in intense rainfall events that have the potential to increase the risk of flooding to receptors downstream of the Proposed Development; and
- Prolonged periods of drier, warmer weather reducing water flows in watercourses.

10.21.2 The Proposed Development is a repowering project and will be situated on the footprint of the existing Wind Farm which reduces the need to develop on untouched land. This limits the impact of the Proposed Development on the surrounding environment.

10.21.3 The adoption of permanent drainage as part of the Proposed Development will also seek to mitigate pressures on the water environment through the incorporation of sustainable design features as well as impacts of peatland habitat improvement which will have been proven to attenuate peak flows and improve water quality.

10.22 SUMMARY

10.22.1 An assessment has been carried out of the likely significant effects of the Proposed Development on the hydrological, hydrogeological and geological environment. The assessment has considered the Site preparation, decommissioning of WSI, construction and operation of The Proposed Development.

10.22.2 The potential effects on the hydrological, geological and hydrogeological environment have considered:

- Pollution Incidents;
- Erosion and sedimentation;
- Modification of surface water and groundwater flows;
- Modification of natural drainage patterns;
- Impediments to flow and flood risk;
- Excavation of material, including rock, soils
- Compaction of soils.

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

10.22.4 Table 10.18 summarises the likely significant environmental effects of the Proposed Development. The impact assessment has taken into account the hydrological regime, highlighting that the principal effects will occur during the construction. Assuming the successful design and implementation of mitigation measures the significance of construction effects on all identified receptors is considered to be of minor or no significance. The assessment of predicted ongoing and operational effects has also determined that the significance of effects on all receptors to be of minor/moderate minor or negligible significance. The assessment of predicted ongoing and operational effects has also determined that the significance of effects on all receptors to be of minor or negligible significance.

[10] SEPA (2021), The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended), A Practical Guide, version 9.1

Table 10.18: Summary of Likely Significant Environment Effects of the Proposed Development

Likely Significant Impact	Mitigation Proposed	Means of Implementation	Significance of Residual Effect
Construction Phase			
Detrimental impacts to on-site and downstream water quality	Appropriate drainage design that incorporates sediment management measures to attenuate and treat runoff from construction activities. Appropriate storage and handling of potential pollutants. Refuelling of construction plant in designated areas. Adoption and agreement on emergency measures should significant effects occur.	Preparation of detailed CEMP prior to construction. Hydrological elements of the CEMP can include, but not limited to the following: • A Drainage Management Plan; • Pollution Prevention and Incident Response Plan Watercourse crossing assessment (detailed design prior to construction); and • Water quality monitoring programme.	Moderate Minor / Negligible Minor
Detrimental effects to on-site and downstream fisheries as a result of changes to water quality			
Increases to on-site and downstream flood risk as a result of poor construction practices (including poor construction of watercourse crossings)			
Modification of groundwater flows and levels with consequential impacts on GWDTEs	Appropriate drainage design that incorporates sediment management measures to attenuate and treat runoff from construction activities. Measures will be designed to encourage water retention within peat/soils. Appropriate design of tracks, watercourse crossings etc in areas of flushes.	Preparation of detailed CEMP prior to construction. Hydrological elements of the CEMP can include, but not limited to the following: • Drainage Management Plan; • Water quality / habitat monitoring programme.	Moderate/ Minor Minor/ Negligible Minor
Operational Phase			
Detrimental impacts to on-site and downstream water quality through degradation of The Proposed Development infrastructure such as unmaintained drainage or track surfaces.	Appropriate drainage design that incorporates sediment management measures to attenuate and treat runoff from Wind Farm infrastructure.	Operational drainage and monitoring plan (designed prior to construction). Plan can detail the appropriate monitoring methods, including:	Moderate / Minor Minor / Negligible
Detrimental effects to on-site and downstream fisheries as a result of changes to water quality (as described above)	Appropriate storage and handling of potential pollutants. Adoption of a long-term monitoring programme to monitor functionality of drainage management measures as well as degradation of infrastructure (including the removal of blockages from watercourse crossings).	Visual monitoring and completion of checklists signed off by SEPA; Regular water quality monitoring for a period post construction to determine potential long terms effects of Wind Farm on water quality.	Minor
Increases to on-site and downstream flood risk as a result of degradation of infrastructure and/or poor maintenance/monitoring of infrastructure			Minor / Negligible Minor

10.22.5 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, DGC and other engaged stakeholders, will result in a risk that is not significant in terms of the EIA Regulations.