10 GEOLOGY, HYDROGEOLOGY, HYDROLOGY AND PEAT

10.1 Introduction

10.1.1 This section of the Environmental Impact Assessment (EIA) Report describes the existing geological, hydrogeological, hydrological and peat conditions within the Proposed Development, and identifies and assesses the potential impacts that may be caused by the Proposed Development. This includes preparation, construction works, restoration of construction works, operation and decommissioning. Mitigation measures that may be employed to ameliorate any adverse effects are set out.

10.1.2 This Chapter is supported by a number of Technical Appendices which provide additional in-depth information on relevant aspects of the site. These appendices are:

- 10.1 Peat Slide Risk Assessment
- 10.2 Peat Management Plan
- 10.3 Borrow Pit Assessment
- 10.4 Groundwater-Dependent Terrestrial Ecosystems Assessment
- 10.5 Drainage Impact Assessment and Watercourse Crossing Inventory

10.1.3 Key findings are summarised within this Chapter.

10.2 Scope and Methodology

10.2.1 The assessment is undertaken through a desk study and site inspection of existing geological, hydrogeological, hydrological and peat-related features on and surrounding the Proposed Development. The existing conditions are described and potential risks that may be associated with the Proposed Development are identified and assessed. This includes potential risks from rock extraction to form aggregate, damage to groundwater-dependent areas, natural or induced instability in peat, damage to watercourses and flood risk.

10.2.2 A number of data sources were considered in writing this chapter; the main sources are detailed below:

- Ordnance Survey topographical mapping, current and historical;
- British Geological Survey geological mapping, superficial and bedrock;
- British Geological Survey online borehole database;
- Centre for Ecology and Hydrology Flood Estimation Handbook Web Service;
- Scotland's Soils mapping; and
- Scottish Environment Protection Agency's *A functional wetland typology for Scotland.*

Effects Evaluation

10.2.3 The significance of potential effects has been classified taking into account three principal factors:

- the **sensitivity** of the receiving environment;

- the potential **magnitude** of the effect; and
- the **likelihood** of that effect occurring.

10.2.4 This approach is based on guidance contained within the joint NatureScot (formerly Scottish Natural Heritage (SNH))/Historic Environment Scotland (HES) publication Environmental Impact Assessment Handbook v5.

Receptor Sensitivity

10.2.5 The sensitivity of a receptor represents its ability to absorb the anticipated effect without resulting perceptible change. Four levels of sensitivity have been used, as defined in **Table 10.1**.

Table 10.1 Sensitivity Ratings

Sensitivity	Definition
Very High	The receptor has very limited ability to absorb change without fundamentally altering its present character, is of very high environmental value and/or is of international importance e.g., Special Areas of Conservation (SAC), RAMSAR sites.
High	The receptor has limited ability to absorb change without significantly altering its present character, is of high environmental value and/or is of national importance e.g., National Nature Reserves (NNR), Sites of Special Scientific Interest (SSSI).
Moderate	The receptor has moderate capacity to absorb change without significantly altering its present character, has moderate environmental value and/or is of regional importance e.g., Geological Conservation Review sites.
Low	The receptor is tolerant of change without detriment to its present character, is of low environmental value and/or of local importance e.g., Local Nature Reserves, Local Geodiversity Sites.

Effect Magnitude

10.2.6 The magnitude of effects includes the timing, scale, size and duration of the potential effect. Four levels of magnitude have been used, as defined in **Table 10.2**.

Table 10.2 Magnitude Ratings

Magnitude	Definition
Substantial	Substantial changes, over a significant area, to key characteristics or to the geological/hydrogeological/peatland classification or status for more than 2 years.
Moderate	Noticeable but not substantial changes for more than 2 years or substantial changes for more than 6 months but less than 2 years, over a substantial area, to key characteristics or to the geological/hydrogeological/peatland classification or status.
Slight	Noticeable changes for less than 2 years, substantial changes for less than 6 months, or barely discernible changes for any length of time.
Negligible or No Change	Any change would be negligible, unnoticeable or there are no predicted changes.

Likelihood of Effect

10.2.7 The likelihood of an effect occurring is evaluated to three levels: **unlikely**, **possible** or **likely**.

Effects Significance

10.2.8 The findings in relation to the three criteria discussed above have been brought together to provide an assessment of significance for each potential effect. Potential effects are concluded to be of **major**, **moderate**, **minor** or **negligible** significance. Potential effects are assessed taking into account the proposed mitigation measures. The assessment concludes with a review of various effects to determine if they would be significant in terms of the *Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017*. Effects assessed as **major** or **moderate** are deemed to be significant; those assessed as **minor** or **negligible** are deemed to be not significant.

Table 10.3 Effects Significance Matrix

Sensitivity	Magnitude	Likelihood	Significance
Very High	Substantial	Likely	**Major**
		Possible	**Major**
		Unlikely	**Moderate**
	Moderate	Likely	**Major**
		Possible	**Moderate**
		Unlikely	**Moderate**
	Slight	Likely	**Moderate**
		Possible	Minor
		Unlikely	Minor
	Negligible/No Change	Likely	Minor
		Possible	Negligible
		Unlikely	Negligible
High	Substantial	Likely	**Major**
		Possible	**Major**
		Unlikely	**Moderate**
	Moderate	Likely	**Moderate**
		Possible	**Moderate**
		Unlikely	Minor
	Slight	Likely	Minor
		Possible	Minor
		Unlikely	Minor
	Negligible/No Change	Likely	Minor
		Possible	Negligible
		Unlikely	Negligible
Moderate	Substantial	Likely	**Major**
		Possible	**Moderate**
		Unlikely	Minor
	Moderate	Likely	**Moderate**
		Possible	Minor
		Unlikely	Minor
	Slight	Likely	Minor
		Possible	Minor
		Unlikely	Negligible
	Negligible/No Change	Likely	Negligible
		Possible	Negligible
		Unlikely	Negligible

Sensitivity	Magnitude	Likelihood	Significance
Low	Substantial	Likely	**Moderate**
		Possible	Minor
		Unlikely	Negligible
	Moderate	Likely	Minor
		Possible	Minor
		Unlikely	Minor
	Slight	Likely	Minor
		Possible	Negligible
		Unlikely	Negligible
	Negligible/No Change	Likely	Negligible
		Possible	Negligible
		Unlikely	Negligible

10.2.9 In addition to the sensitivity, magnitude and likelihood of an effect, effects can be adverse or beneficial, temporary or long-term, direct or indirect, single or cumulative.

Limitations and Uncertainties

10.2.10 There were no desk-based gaps, but some potential limitations on the field surveys, as discussed below.

10.2.11 The site visit followed a standard 'reconnaissance level' walkover survey to obtain an overview of the conditions present within the site at the time of the visit. A reconnaissance level survey involves walking through and around an area to gather visual information concerning elements such as slope, rock outcrop, ground wetness and bogginess, nature and type of watercourses, and the presence or absence of groundwater seepages or spring points. No ground investigation was undertaken as part of the site visits. As a result, information is limited to detail that can be gathered from a visual survey of this kind. Uncertainties may arise as a result of preceding weather conditions; e.g. very wet preceding conditions may cause an over-estimation of the watercourse nature or ground bogginess than would be considered 'normal' for the area.

10.2.12 The information gathered has been combined with information derived from surveys to map peat depths, as well as details from other disciplines including vegetation and archaeological surveys, and photography to give as full a picture of the site conditions as possible. All reasonable attempts were made to ensure that good coverage of the site was included. However, it is possible, from the type of survey undertaken or the areas visited during the surveys, that some information was not collected.

10.2.13 The reconnaissance survey was undertaken on 9 and 10 September 2020. The weather was dry and breezy with stronger wind later in the day. Additional surveys to gather peat depth and condition data were undertaken in June and October 2020 and May 2021.

10.3 Consultation Undertaken

10.3.1 Consultation was undertaken with several statutory and non-statutory consultees and interested parties, including the Scottish Government, The Highland Council, the Scottish Environment Protection Agency, NatureScot, Scottish Water and local stakeholders. Responses with relevance to geology, hydrogeology, hydrology and peat are provided in **Table 10.4.Error! Reference source not found.**

Table 10.4 Consultee Responses relevant to Geology, Hydrogeology, Hydrology and Peat

Name of Stakeholder/ Consultee	Key concerns	Response
Energy Consents Unit (ECU)	Contact Scottish Water and make further enquiries to confirm Scottish Water assets which may be affected. Details, including mitigation, to be included in EIA Report.	Scottish Water contacted and no assets that may be affected.
	Investigate the presence of any private water supplies potentially impacted. EIA Report to include details of any supplies identified, and an assessment of impacts, risks and mitigation.	Private Water Supplies have been identified in **Section 10.4.55** and assessed in **Section 10.7**
	Peat landslide hazard and risk assessment required to be undertaken as part of EIA process. This should be completed in accordance with The Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Second Edition).	Peat landslide has been assessed in **Appendix 10.1: Peat Slide Risk Assessment**.
	Mitigation measures suggested for any significant environmental impacts identified to be presented as a conclusion to each chapter.	Mitigation measures have been outlined in **Section 10.8**.
The Highland Council	EIA Report should include physical characteristics of whole development, land use requirements over construction, operation, decommissioning phases; incl. borrow pits, local road improvements, off site conservation measures, etc.	Characteristics of the Proposed Development are described in **Section 10.4**. Effects on construction, operation and decommissioning phases are assessed in **Section 10.7**.
	Description of likely decommissioning process and environmental effects in description and also technical chapters.	
	EIA Report should address water environment, geology, soils and peat environmental effects.	
Scottish Environment Protection Agency (SEPA)	Map and assessment of all engineering activities in or impacting on the water environment including proposed buffers, details of any flood risk assessment and details of any related Controlled Activities Regulations (CAR) applications.	Impacts on the water environment are assessed in **Section 10.7** and **Appendix 10.5**
	Map and assessment of impacts upon GWDTEs and buffers. Go straight to NVC stage of habitat assessment. Re-consult SEPA once done to establish which GWDTEs are	GWDTE are assessed in **Appendix 10.4**

Name of Stakeholder/ Consultee	Key concerns	Response
	most important and whether any further assessment is required.	
	Peat depth survey and table detailing re-use proposals.	Peat depth and peat management is assessed in **Appendix 10.2**.
	Map and site layout of borrow pits	Borrow pits are assessed in **Appendix 10.3**.
	Schedule of mitigation including pollution prevention measures.	Mitigation measures have been outlined in **Section 10.8.**
	Quarry or Borrow Pit Site Management Plan of pollution prevention measures.	Borrow pits are assessed in **Appendix 10.3.**
	Consider whether the existing watercourse crossings are fit for purpose and if relevant outline proposals for new improved structures.	Drainage impacts and watercourse crossings are assessed in **Appendix 10.5**.
	Where the existing track is within 50 m of the top of the bank of the adjacent river then improvement and widening works, and any new passing places, should be located on the opposite side of the track to the river. Use 50 m buffer from watercourses unless shown to be the best overall environmental outcome, discuss with SEPA if becomes necessary.	
	Watercourse crossings to be traditional style bridges or bottomless arched culverts designed to accommodate 1:200 year flow plus an allowance for climate change.	
	If all other infrastructure is located well away from watercourses, no need for detailed flood risk assessment on other aspects.	
	Access tracks to avoid large loops or long spurs, or the same watercourse being crossed multiple times.	
	Include peatland restoration in Draft Habitat Management Plan; consider enhancing riparian corridors with tree planting and removing old redundant watercourse engineering works.	Peatland restoration discussed in **Appendix 10.2**. Outline Habitat Management Plan is discussed in **Appendix 8.5**.
	Consult with SEPA following Phase 1 peat probing and first design workshop, prior to the commencement of Phase 2.	Two consultation calls have been held with SEPA to discuss the design evolution

Name of Stakeholder/ Consultee	Key concerns	Response
		particularly with relation to peatland.
	Management of surplus soils or peat may require exemption under Waste Management Licencing Regulations.	Noted. No surplus soils or peat are anticipated. Peat reuse/minimising waste addressed in Technical **Appendix 10.2 Peatland Management Plan.**
	Crushing or screening will require permit under the Pollution Prevention and Control Regulations.	Noted. Any required permits would be put in place before works commence.
NatureScot	EIA Report to address how a wind farm can be constructed without compromising the national interests of Class 1 & 2 peatland on site.	Peat distribution has been identified in **Section 10.4.17** and assessed in **Section 10.7**, **Appendix 10.1** and **Appendix 10.2.**
	Mitigate through siting, design and other measures to be considered in EIA Report. Mitigation may include options for habitat restoration to mitigate loss or damage to peatland.	
	Peat depth and peat slide risk assessment: Peat depths to be mapped and identified. Turbines to avoid areas of deep peat. EIA Report to explore opportunities to reduce any impacts on deep peat.	
	Potential release of CO_2 during disturbance of peat to be addressed in Construction Environmental Management Plan (CEMP).	CO_2 emissions are considered in the Carbon Calculator, **Chapter 16**. A CEMP would be produced by the appointed contractor.
	EIA Report to provide info on potential CO_2 emissions and 'payback' timescales as part of description of Site with reference to the Scottish Government Carbon Calculator tool.	CO_2 and Carbon Calculator discussed in **Chapter 16.**
	Decommissioning and Redevelopment Plan (DRP) to be included in EIA Report. Restoration to include removal of new tracks and restoration of existing tracks to pre-wind farm width unless benefit to retention of tracks for other purposes e.g., recreation or may damage natural heritage interests.	Decommissioning assessed in **Section 10.7.**
Kyle of Sutherland	The EIA Report should include: Hydrology	Addressed throughout this chapter.

Name of Stakeholder/ Consultee	Key concerns	Response
District Salmon Fishery Board and Kyle of Sutherland Fisheries	Water quality data (i.e., turbidity, pH, dissolved organic carbon, acid neutralising capacity etc)	Current water quality status is summarised in Table **10.9**. Baseline water quality data would be collected prior to works beginning on site.
	Peat slide risk assessment	See **Appendix 10.1**
	Risk assessment of tracks and watercourse crossings relating to the possibility that they may become vectors for water pollution	Watercourse crossings assessed in **Appendix 10.5**
	Possibility of drainage channels in peat bog – map and include in assessment as any other watercourse	Drainage impacts are assessed in **Appendix 10.5** and peat assessed in **Appendix 10.2**
Scottish Water	No objection	N/A
Marine Scotland	It is important to avoid and/or reduce the possibility of impacts from mechanisms including: increased sediment transport and deposition; pollution incidents; altered hydrological pathways; removal or degradation of fish habitat, including spawning areas; reduction in food supply and obstructions to upstream and downstream migration of fish	Impacts from sediment pollution and alterations to hydrological pathways are assessed in **Section 10.7**
	The EIA should include: A description of the water quality of waterbodies which could be impacted and how the development may impact on these pre-construction conditions	Waterbodies have been identified in **Section 10.4.43** and assessed in **Section 10.7**.
	Proposals for monitoring during construction, post-construction and decommissioning.	Water Monitoring has been outlined in **Table 10.12** and **Figure 10.8**.
RSPB	Impacts on carbon rich soils should be assessed using carbon calculator early in the planning process to determine the 'carbon payback period' over the operational life of the development, and inform micro-siting.	CO_2 and Carbon Calculator discussed in **Appendix 10.2**.
	The design should avoid deep peat (>50cm).	Peat has been assessed in Technical **Appendices 10.1** and **10.2**
	Any area for peatland restoration should be assessed for suitability and agreed with the planning authority in consultation with NatureScot.	

Statutory and Planning Context

10.3.2 In preparing this section of the EIA Report, consideration has been given to relevant planning guidance at all levels. This includes, but is not limited to, the following:

- The European Water Framework Directive (2000/60/EC) and associated daughter Directives including the Groundwater Directive (2006/118/EC);
- The European Mining Waste Directive (2006/21/EC);
- The Environmental Protection Act 1990 (as amended);
- The Water Environment and Water Services (Scotland) Act 2003;
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 as amended;
- The Pollution Prevention and Control (Scotland) Regulations 2012;
- The Water Environment (Oil Storage) (Scotland) Regulations 2006;
- Scottish Planning Policy 2014;
- Scottish Government's Planning Advice Note 51: planning, environmental protection and regulation (2006);
- SEPA's Position Statement WAT-PS-10-01: Assigning Groundwater Assessment Criteria for Pollutant Inputs (2014); and
- SEPA's Guidance for Pollution Prevention, with particular reference to:
    - GPP 1: Understanding your environmental responsibilities – good environmental practice;
    - GPP 5: Works and maintenance in or near water; and
    - PPG 6: Working at construction and demolition sites.

10.4 Existing Environment

Meteorology and Climate

10.4.1 The Proposed Development is situated in the Scottish Highlands, located approximately centrally within the UK Meteorological (Met) Office's Northern Scotland regional climatic area. Much of northern Scotland is exposed to the rain-bearing westerly winds, particularly along the west coast. As the Proposed Development is centrally located, it is afforded some protection from the prevailing wet weather by the higher ground to the west.

10.4.2 Much of the northern Scotland climatic area constitutes high ground (i.e. more than 200 m above sea level). As westerly winds from the Atlantic move east over Scotland and reach higher altitudes, they cool and produce rainfall; for this reason, areas of higher altitude in this region have higher average annual rainfall. The highest average annual rainfall in the region occurs over the higher, west-facing slopes. The western half of the climatic region receives an average annual rainfall of at least 1,700 mm. The wettest part of the region is immediately north-west of Fort William on the west coast, which receives over 4,000 mm per year.

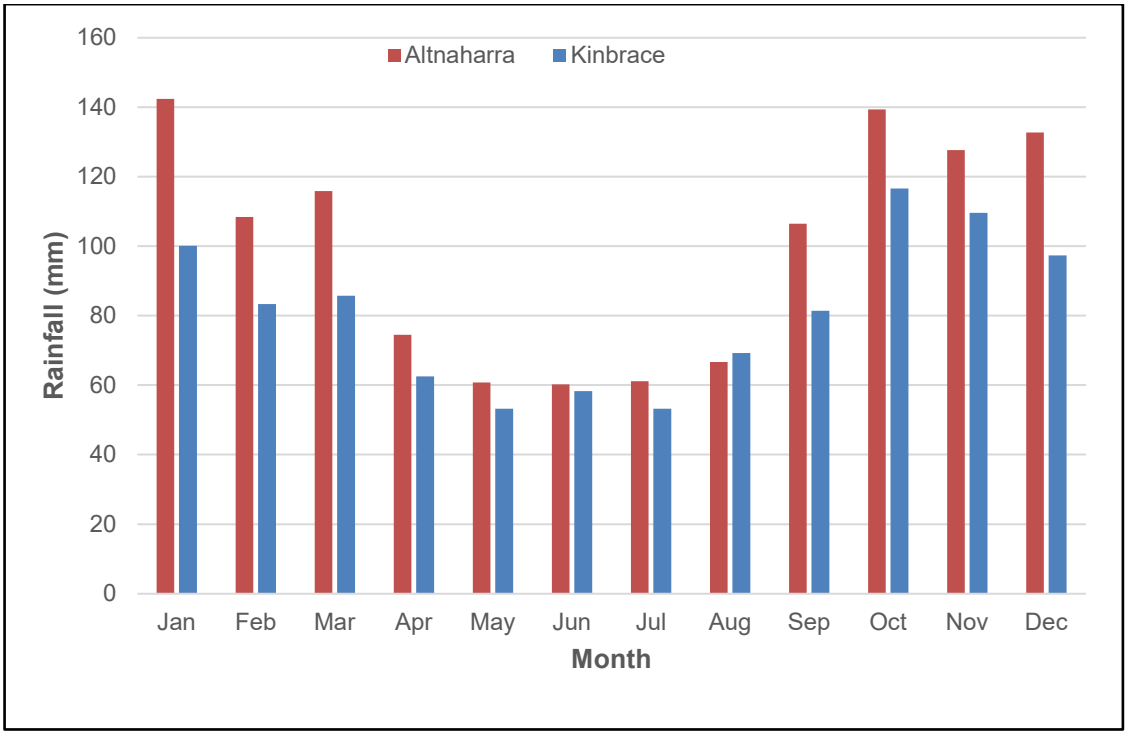
10.4.3 The Proposed Development is afforded some protection from rain-producing westerly winds by the north-west Highlands. However, the Proposed Development is located on high ground (i.e. greater than 200 m above sea level), is centrally located within northern Scotland, and most of the turbine area lies on the western slopes of Leathad Chleansaid, so it still receives significant rainfall.

10.4.4 Snowfall in northern Scotland is generally confined to the months from November to April. The average number of days of snowfall in northern Scotland varies from less than 30 per year along the west coast to 100 days over the Grampians to the south-east. The Proposed Development's central location means that it is likely to experience snowfall intermediate between these two end-points.

Rainfall

10.4.5 The Proposed Development lies between (and slightly south of) the Altnaharra Stand Alone Weather Station (SAWS) and Kinbrace climate monitoring stations[97]. Rainfall amounts are likely to be similar to the patterns observed at Altnaharra and Kinbrace.

10.4.6 Average annual rainfall for the climate monitoring station at Altnaharra SAWS, located approximately 17 km north-north-west of the Proposed Development, is 1,196 mm. The altitude at this monitoring station is 81 m above sea level. Average annual rainfall for the climate monitoring station at Kinbrace, located approximately 25 km north-east of the Proposed Development, is 971 mm. The altitude at this monitoring station is 103 m above sea level. **Graph 10.1** shows the average rainfall distribution through the year for both Altnaharra SAWS and Kinbrace monitoring stations.



Graph 10.1: Monthly rainfall averages at Altnaharra SAWS and Kinbrace monitoring stations. Averages cover the period 1981-2010 (Met Office, 2021).

[97] Met. Office (2021). UK Climate. https://www.metoffice.gov.uk/public/weather/climate (accessed January 2021)

Geology

10.4.7 Geological information is derived from the BGS GeoIndex online geological mapping and the Geological Survey of Scotland, 1:50,000 geological map series[98][99][100]. Additional information has been derived from Johnstone & Mykura (1989) and Trewin (2002). Geological mapping is provided in **Figures 10.1a** and **b**.

Bedrock Geology

10.4.8 The majority of the site and the immediate surrounding area is underlain by the Loch Coire Formation of the Moine Supergroup, comprising metasedimentary bedrock of Neoproterozoic age. This bedrock is made up of migmatitic psammite with migmatitic semipelite, sedimentary rocks that have undergone moderate-grade metamorphism. An intrusion of the Loch Coire Granite rocks of Ordovician age runs the extent of the north-eastern edge of the site forming the higher ground of Leathad Chleansaid and the hills immediately north. This is a silica-rich igneous intrusion comprising foliated leucogranite that has undergone partial metamorphism and shearing.

10.4.9 Two small amphibolite dykes of Neoproterozoic age are located just outside the application boundary; both are small in footprint.

10.4.10 There are no mapped faults within the site. However, the wider region has been subject to extensive faulting, mainly by compression (thrust) faults associated with the continental collision and mountain building episode known as the Caledonian Orogeny in the Cambrian and Ordovician periods. A branch of the regionally important Naver Thrust Fault crosses the proposed access route approximately 3 km from the public road and continues to the north-west and east-south-east.

Mineral Extraction

10.4.11 There are no mapped mineral occurrences or mineral extraction sites within the site. Some previous exploration for metal resources including copper and nickel has been undertaken in the region[101]. No extraction of rock aggregate or mineral resources has been recorded within the site.

10.4.12 There are five quarries (disused) within 3 km of the site. Details are provided in **Table** 10.5.

[98] BGS (2000). Lairg. Scotland Sheet 102E. Solid and Drift Geology. 1:50,000 Provisional Series. British Geological Survey, Keyworth, Nottingham

[99] BGS (2004). Loch Naver. Scotland Sheet 108E. Bedrock. 1:50,000 Geology Series. British Geological Survey, Keyworth, Nottingham

[100] BGS (2021). GeoIndex online geological mapping. British Geological Survey. Available at: http://mapapps2.bgs.ac.uk/geoindex/home.html (accessed September 2021)

[101] BGS (2021). GeoIndex online geological mapping. British Geological Survey. Available at: http://mapapps2.bgs.ac.uk/geoindex/home.html (accessed September 2021)

Table 10.5 Former Quarries near the Site (OS 1:25,000 maps)

No	Source location	Commodity	Status	Distance & direction from the site
1	NC 5922 1804	Unknown	Disused, flooded	1.1 km W
2	NC 5967 1449	Unknown	Disused	2.4 km SW
3	NC 5964 1461	Unknown	Disused	2.3 km SW
4	NC 5957 1501	Unknown	Disused	2.1 km SW
5	NC 5948 1511	Unknown	Disused	2.1 km SW

Superficial Geology

10.4.13 The site is mainly covered by peat deposits, with these indicated to blanket the flatter and lower-lying areas of the turbine area and much of the surrounding region.

10.4.14 Much of the higher ground on the top and steeper slopes of Leathad Chleansaid have no superficial deposits. Other parts of the turbine area and most of the access area are underlain by undifferentiated till and moraine deposits consisting of diamicton, sand and gravel. Diamicton is a very variable glacial sediment deposited in the Pleistocene consisting of unsorted material ranging in size from clay to boulders, usually with a matrix of clay to sand.

10.4.15 Alluvium is also present within the site, principally located within and adjacent to river channels. Alluvium is a mixture of clay, silt, sand and gravel deposited by a watercourse in the Holocene.

Soils and Peat

10.4.16 The Soil Survey of Scotland digital soils mapping shows site soils mainly consist of peat, peaty gleys and peaty podzols, with some humus-iron podzols[102][103]. Further details on site soils are provided in **Table 10.6** and soil distribution is shown on **Figure 10.2Error! Reference source not found.**.

10.4.17 The Soil Survey mapping does not identify extensive blanket peat within the site, although blanket peat is identified adjacent to and near the turbine area to the west, north and north-east.

[102] James Hutton Institute (1981) The 1:250 000 National soil map of Scotland. Available at: http://map.environment.gov.scot/Soil_maps/?layer=1 (accessed January 2021)

[103] James Hutton Institute (1982). 1:250 000 soil map of Scotland, Northern Scotland. Available at: https://www.hutton.ac.uk/learning/natural-resource-datasets/soilshutton/soils-maps-scotland#Soil%20map%20table (accessed July 2020)

Table 10.6: Soil Types within the Site

Soil Assoc.	Parent Material	Component Soils	Landforms	Vegetation	Area %
Arkaig	Drifts derived from schists, gneisses, granulites and quartzites principally of the Moine Series	Peaty gleys with blanket peat with peaty podzols	Undulating lowlands and uplands with gentle and strong slopes: non-rocky	Bog and northern bog heather moor; blanket and northern blanket bog; moist Atlantic heather moor	91.8
		Peaty podzols with blanket peat with peaty gleys	Hummocky valley and slope moraines: often bouldery	Bog and northern bog heather moor; blanket and northern blanket bog; moist Atlantic heather moor	7.8
Organic soils	Organic deposits	Blanket peat	Uplands and northern lowlands with gentle and strong slopes	Blanket and northern blanket bog; upland and flying bent bog; deer-grass bog; sedge mires	0.4

10.4.18 The site is underlain by nationally important carbon-rich soil, deep peat and priority peatland habitat according to the Carbon and Peatland 2016 map[104]. The peat in the turbine area has been assigned carbon and peatland Classes 1 and 2. Class 1 indicates areas likely to be of high conservation value; Class 2 indicates areas of potentially high conservation value and restoration potential. Class 1 peat is located primarily in the western half of the turbine area, indicating that the peat in this area is in better condition than the peat in the eastern half of the turbine area. The areas of each carbon and peatland class within the site are provided in **Table 10.7** and shown on **Figure 10.2**.

Table 10.7 Carbon and Peatland Classes present within the Site

Peatland class	Description	Area %
Class 1	Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas likely to be of high conservation value.	56.6
Class 2	Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas of potentially high conservation value and restoration potential.	42.9
Class 5	Soil information takes precedence over vegetation data. No peatland habitat recorded. May also show bare soil. All soils are carbon-rich soil and deep peat.	0.6

10.4.19 There is widespread evidence of modification to peatland areas to the west of the turbine area within the commercial forestry, and to a smaller extent within the turbine area for

[104] NatureScot (2016). Scotland's Soils: Carbon and Peatland 2016. https://map.environment.gov.scot/Soil_maps/?layer=10# (accessed June 2021)

improved drainage. Some peatland restoration works were observed in an area immediately south-east of the turbine area, consisting of series of dams in peat channels and ditches, during the walkover survey in September 2020. A photograph of the works is provided in **Appendix 10.2**.

10.4.20 The turbine area is subject to grazing by red deer. A number of signs of deer activity, including droppings and poaching around watercourses and boggy areas, were observed during the walkover survey.

10.4.21 NatureScot's Peatland ACTION peat depth dataset[105] indicates that peat depth records for nearby areas (approximately 700 m west of the turbine area) have peat and peaty soil records ranging from <0.5 to 4.0 m. Depths are mainly between <0.5 and 2.0 m.

10.4.22 Three phases of peat depth surveying have been undertaken by RSK across the land within the application boundary. Full details are provided in **Appendix 10.1**.

10.4.23 Peat depth and peat condition surveys were undertaken in June 2020 across the turbine area and in October 2020 and May 2021 for areas of proposed infrastructure and within the access area. The peat depth surveys and reconnaissance survey confirm that peat across the turbine area is in a near-natural condition consisting of a patchwork of peaty soils, shallow peat and deeper peat reflecting the underlying topography.

10.4.24 Very deep peat (>2.5 m) is primarily located in the south-western half of the turbine area, and in some isolated areas in the eastern part of the turbine area. Peaty soils and shallow peat cover the steeper slopes in the north-eastern part of the turbine area.

10.4.25 Directly west and south-west of the turbine area and outwith the application boundary, peatland has been considerably disrupted by the plantation of coniferous forestry and is no longer in near-natural condition. Drainage ditches have been excavated throughout the forested areas in an attempt to improve the ground for tree growth. Much of the forestry has recently been clear-felled, resulting in additional disruption to the ground conditions from the felling works. This may have had some influence on the south-western part of the turbine area, as some peat in this area shows signs of active erosion.

10.4.26 More details of peat depth and peat depth variation are provided in **Appendix 10.2**. An overview map of the peat depth distribution within the site is provided in **Figure 10.3**.

Geomorphology

10.4.27 The turbine area lies on the south-western slope of Leathad Chleansaid, a prominent ridge extending south-east from the higher ground of Creag Riabhach na Greighe. The highest point within the turbine area is immediately south of the summit at Sròn Leathad Chleansaid, where the application boundary reaches an elevation of 335 m above Ordnance Datum (AOD). From the ridge crest, the ground slopes south-east towards the Allt nan Con-uisge and east towards the River Brora. The lowest ground is located along the Allt nan Con-uisge in the south-eastern part of the turbine area, at 195 m AOD. The access area to the west falls to an elevation of 140 m AOD when it joins the A836 adjacent to the River Tirry.

[105] SNH (2016). Scotland's Soils: Carbon and Peatland 2016. https://map.environment.gov.scot/Soil_maps/?layer=10# (accessed June 2021)

Hydrogeology

10.4.28 The region is underlain by the Moine Supergroup low productivity aquifer, with small amounts of groundwater in the near-surface weathered zone and secondary fractures. The Loch Coire granite, in the north-eastern section of the site, is also classed as a low productivity aquifer with small amounts of groundwater in the near-surface weathered zone and secondary fractures, with rare springs[106].

10.4.29 The superficial deposits covering the site have a range of potential permeabilities, and their productivity will depend on their composition and connectivity locally, with pockets of sand and gravel having high permeability and clay and silt having low permeability. Alluvial deposits may contain significant groundwater, but its value would be restricted by the small size of the deposits.

10.4.30 The peat bodies will also hold some groundwater, although peaty gleys are known to have poorly drained characteristics. Flow within peat is known to be extremely slow, although it can contribute some limited baseflow to local burns.

10.4.31 Regional groundwater flow will tend to mimic the natural topography, flowing south and west towards the Allt nan Con-uisge.

10.4.32 No springs or seepage lines were identified within the site.

Groundwater Vulnerability

10.4.33 The groundwater in the site has been assigned vulnerability Class 4b[107].

10.4.34 Groundwater vulnerability classes range from Class 1 (vulnerable only to persistent activity; very slow travel time) to Class 5 (vulnerable to individual events; rapid travel time). Class 4 is subdivided into 4a (more vulnerable) and 4b (less vulnerable).

10.4.35 Class 4 is defined as 'Vulnerable to those pollutants not readily adsorbed or transformed'. Class 4a may have low permeability soil and is less likely to have clay present in superficial deposits; Class 4b is more likely to have clay present in superficial deposits.

Groundwater-Dependent Terrestrial Ecosystems

10.4.36 A habitat mapping exercise was completed as part of the ecology baseline assessment, which was used to identify potential groundwater-dependent terrestrial ecosystems (GWDTE) within the site. The results of the habitat mapping exercise are discussed in **Chapter 8 Ecology**.

10.4.37 GWDTE are defined by UKTAG (2004) as: *"A terrestrial ecosystem of importance at Member State level that is directly dependent on the water level in or flow of water from a groundwater body (that is, in or from the saturated zone). Such an ecosystem may also be dependent on the concentrations of substances (and potentially pollutants) within that groundwater body, but there must be a direct hydraulic connection with the groundwater body."*

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[106] Scottish Government (2021). Groundwater classification. Available at: https://map.environment.gov.scot/sewebmap/ (accessed September 2021)

[107] Ó Dochartaigh, B., Doce, D., Rutter, H. and MacDonald, A. (2011). British Geological Survey, User Guide: Groundwater Vulnerability (Scotland) GIS dataset, Version 2. http://nora.nerc.ac.uk/id/eprint/17084/1/OR11064.pdf

10.4.38 In line with the guidance provided in UKTAG (2004)[108], a dual approach to identifying GWDTE has been used. This involves detailed study of vegetation communities in order to determine the potential level of groundwater dependency, combined with detailed hydrogeological study in order to identify locations where groundwater reaches the surface and is able therefore to provide a source of water to associated habitats.

10.4.39 National Vegetation Classification (NVC) communities identified by SEPA as potentially highly or moderately groundwater-dependent, depending on the hydrogeological setting, are listed in SEPA's publication *Planning guidance on on-shore windfarm developments*"[109]. The potentially groundwater dependent NVC communities identified in the Proposed Development are:

- M15: *Scirpus cespitosus – Erica tetralix* wet heath;
- M23: *Juncus effusus/acutiflorus – Galium palustre* rush-pasture; and
- M25: *Molinia caerulea – Potentilla erecta* mire.

10.4.40 The list of NVC communities provided in SEPA Appendix 4[110] indicates that M15 and M25 are potentially moderately groundwater-dependent and M23 is potentially highly groundwater-dependent in Scottish situations, depending on the hydrogeological setting. The UKTAG updated Annex 1[111] identifies M15 and M23 as potentially moderate and M25 as potentially low groundwater dependency in Scottish situations.

10.4.41 GWDTE have been assessed separately. Details are provided in **Appendix 10.4**.

Hydrology

10.4.42 The Proposed Development lies across two catchment areas: the River Brora and the River Tirry catchments. The catchment areas are shown on **Figure 10.4**.

10.4.43 Most of the Proposed Development lies within the River Brora catchment, but the northern-most part of the turbine area and most of the access area are drained by the River Tirry catchment.

10.4.44 The Catchment Wetness Index, PROPWET, of the Proposed Development catchments ranges from 0.590 to 0.700, indicating the area is wet for 59-70 % of the time. The catchments have a relatively low Baseflow Index, indicating that groundwater contribution is of limited importance to local watercourses. The Standard Percentage Runoff is relatively high, indicating that 54-56 % of rainfall is converted into surface runoff from rainfall events.

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[108] *Ibid.*

[109] SEPA (2017). Planning guidance on on-shore windfarm developments. Scottish Environment Protection Agency, Land Use Planning System Guidance Note 4 (LUPS-GU4). Available at: https://www.sepa.org.uk/media/136117/planning-guidance-on-on-shore-windfarms- developments.pdf

[110] *Ibid*.

[111] UKTAG (2009). Guidance on the identification and risk assessment of groundwater dependent terrestrial ecosystems: Update to Annex 1. UK Technical Advisory Group on the Water Framework Directive. Available at: https://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/UKTAG%20guidance%205%20ab%20ANNEX%201%20updated%205%20October%202009.pdf.

10.4.45 Catchment statistics are derived from the Flood Estimation Handbook Web Service[112]. Full catchment statistics are provided in **Table 10.8**.

Table 10.8: Catchment Statistics for the Site

Catchment Name	Catchment Wetness Index (PROPWET)	Base Flow Index (BFI HOST19)	Standard Percentage Runoff (SPR HOST)	Area %
River Brora	0.590	0.335	55.44 %	86
River Tirry	0.700	0.289	54.62 %	14

River Brora Catchment

10.4.46 The River Brora catchment, from the confluence with the Corrish Burn, has a total area of 66.5 km^2 and drains 86 % of the site.

10.4.47 The Allt nan Con-uisge provides the main drainage for the turbine area. It is located within the broad valley south-west of Leathad Chleansaid and drains south-east into the River Brora approximately 800 m upstream of Dalnessie. A number of minor tributaries and drainage ditches drain into the Allt nan Con-uisge from the slopes of Leathad Chleansaid and the low, poorly defined hills to the south-west of the main channel.

10.4.48 The River Brora provides the drainage for the eastern end of the turbine area, including the lower slopes of Sròn Leathad Chleansaid. The River Brora heads mainly south-east, to reach the North Sea at Brora.

10.4.49 The River Brora catchment is characterised as near-natural upland moorland land use. Parts of its headwater areas show substantial and extensive peatland erosion, although these are not mainly in or near the site. The main watercourses have natural or near-natural conditions with generally high levels of sinuosity, although some changes for hydro-electric power generation have been implemented which result in localised changes to the hydromorphology. The weir system at Dalnessie forms the main artificial change near the Proposed Development.

10.4.50 The catchment has an average altitude of 293 m AOD.

River Tirry Catchment

10.4.51 The River Tirry catchment has a total area of 163.3 km^2 and drains 14 % of the site.

10.4.52 The Abhainn Sgeamhaidh drains the northernmost part of the turbine area, around A' Chleansaid and the slopes below Creag Dhubh. It flows mainly south-west to join the River Tirry west of the A836 before it reaches Loch Shin.

10.4.53 The Fèidh Osdail provides the drainage for the access area. This watercourse drains west and joins the River Tirry near the junction where the access area leaves the A836.

10.4.54 The River Tirry catchment is primarily under commercial forestry and upland moorland, with agricultural land in the south-western part of the catchment. There are a number of small lochs within the catchment, and it has an average altitude of 227 m AOD.

[112] CEH (2021). Flood Estimation Handbook Web Service. Centre for Ecology and Hydrology. https://fehweb.ceh.ac.uk/ (subscription service, accessed September 2021)

10.4.55 The Brora and Tirry catchments are not entirely independent. The weir at Dalnessie and associated artificial channel provide a cross-link from the River Brora into the River Tirry catchment via the Fèidh Osdail. This was established to support the hydro-electric scheme downstream of Loch Shin during periods of high flow in the River Brora.

Water Quality

Surface Waterbodies

10.4.56 SEPA's Water Classification[113] and Water Environment Hubs[114] have been consulted to determine the existing baseline water quality for the main watercourses and waterbodies within the Proposed Development catchment areas. The details are summarised in **Table 10.9**. The River Brora is designated as a heavily modified waterbody due to the physical alterations put in place to support hydro-electric power generation.

Table 10.9 Baseline Surface Water Quality Status - Summary

Waterbody Name and ID	Status		Pressures
River Brora – Balnacoil to source (ID 20060)	**Condition in 2014**	Overall: Good Water flows & levels: Good Physical condition: Good Water quality: Good	Designated as a heavily modified waterbody on account of physical alterations that cannot be addressed without a significant impact on water storage for hydroelectricity generation.
	Classification in 2018	Overall: Good ecological potential Biology (fish): High Hydromorphology: Moderate	
River Tirry – whole of catchment above Rhian (ID 20100)	**Condition in 2014**	Overall: Poor Water flows & levels: High Physical condition: Good Water quality: High	Barrier to fish migration due to hydroelectricity generation. This will be addressed from 2015-2021 by SEPA and the responsible business.
	Classification in 2018	Overall: Poor Biology (fish): Poor Hydromorphology: Good	
Fèith Osdail (ID 20102)	**Condition in 2014**	Overall: Poor Water flows & levels: High Physical condition: Good Water quality: High	Barrier to fish migration due to hydroelectricity generation. This will be addressed from 2015-2021 by SEPA and the responsible business.
	Classification in 2018	Overall: Poor Biology (fish): Poor Hydromorphology: Good	

[113] SEPA (2021a). Water Classification Hub. Scottish Environment Protection Agency. https://www.sepa.org.uk/data-visualisation/water-classification-hub/ (accessed July 2021)

[114] SEPA (2021b). Water Environment Hub. Scottish Environment Protection Agency. https://www.sepa.org.uk/data-visualisation/water-environment-hub/ (accessed July 2021)

Groundwater

10.4.57 Scotland's Environment groundwater classification map (2021)[115] was also consulted for groundwater quality information. The Northern Highlands groundwater body has been classified as 'Good'.

Receiving waterbodies

10.4.58 SEPA's Water Classification[116] and Water Environment Hubs[117] have also been consulted to determine the existing baseline water quality for the site's receiving waterbodies. The details are summarised in **Table 10.10**.

10.4.59 The River Brora catchment drains south-east into the sea, into the Helmsdale to Brora coastal water body.

10.4.60 River Tirry drains south-south-east into Loch Shin.

Table 10.10 Receiving Waterbody Quality Status - Summary

Waterbody Name and ID	Status		Pressures
Loch Shin (ID 100065)	**Condition in 2014**	Overall: Poor Water flows & levels: Good Physical condition: Good Water quality: Poor	Designated as a heavily modified waterbody on account of physical alterations that cannot be addressed without a significant impact on water storage for hydroelectricity generation.
	Classification in 2018	Overall: Poor ecological potential Biology (fish): Not available Hydromorphology: Bad	
Helmsdale to Brora coastal water body (ID 100175)	**Condition in 2014**	Overall: Good Water flows & levels: Not available Physical condition: High Water quality: Good	None.
	Classification in 2018	Overall: Good Biology (fish): Not available Hydromorphology: High	

Water Resources

10.4.61 There are no public water supplies or foul drainage infrastructure within 2 km of the turbine area. No Scottish Water drinking water catchments or water abstraction sources coincide with the Proposed Development.

[115] Scottish Government (2021). Scotland's Environment Web. https://map.environment.gov.scot/sewebmap/?layers=groundwaterClassification (accessed November 2021)

[116] SEPA (2021a). Water Classification Hub. Scottish Environment Protection Agency. https://www.sepa.org.uk/data-visualisation/water-classification-hub/ (accessed July 2021)

[117] SEPA (2021b). Water Environment Hub. Scottish Environment Protection Agency. https://www.sepa.org.uk/data-visualisation/water-environment-hub/ (accessed July 2021)

10.4.62 The properties at Dalnessie make use of a groundwater abstraction via a borehole at NGR NC 6309 1524. The borehole is housed in an enclosed building with fully protected headworks. The private water supply (PWS) is located 1 km downstream of the turbine area, although the access area passes approximately 175 m to the west of the supply source. See **Table 10.11** for more information. The PWS location is shown on **Figure 10.5**.

10.4.63 No additional PWS or water supply assets were identified within the site or within 2 km of the application boundary, following consultation with THC's Environmental Health Department, SEPA and Scottish Water.

10.4.64 The Ordnance Survey mapping identifies a well approximately 350 m west of Dalnessie (NC 6278 1526); however, upon inspection during the site visit in June 2020, no PWS infrastructure was identified at this location. Consultation with residents at Dalnessie indicated that there is no PWS present at this location.

Table 10.11 Private Water Supplies within or near the Proposed Development

Supply Name	Source Location	Source Type	Properties Served	Distance to Project Boundary	Linkage?
PWS Dalnessie	NC 6309 1524	Ground water	3	108 m E	This PWS is located downstream of the turbine area, 120 m from the River Brora.

Flood Risk

10.4.65 SEPA's Indicative Flood Map[118] was consulted to gain an overview of the likelihood of flooding within the site. Flood risk within the site is shown to be minimal, with some localised regions of river (fluvial) and surface water (pluvial) flood risk.

10.4.66 River flood risk is largely confined to the main channels of the Allt nan Con-uisge and River Brora. The main channel of the River Brora has a high likelihood of flooding, defined as having a 10 % chance of a flooding in a given year[119]. The Allt nan Con-uisge also has a high likelihood of flooding, although the upper reaches are not indicated to be at risk of flooding.

10.4.67 Additionally, there are a few very small localised regions of surface water flooding, located near the Alt nan Con-uisge in its middle reaches.

10.5 Designated Sites

10.5.1 There are no mapped designated sites within 3 km of the application boundary [120].

[118] SEPA (2021c). Flood Map. Scottish Environment Protection Agency. http://map.sepa.org.uk/floodmap/map.htm (accessed July 2021)

[119] *ibid*

[120] NatureScot (2021a). SiteLink. https://sitelink.nature.scot/home (accessed July 2021)

10.6 Influence on Design

10.6.1 The importance of geology, hydrogeology, hydrology and peat has been recognised throughout the Proposed Development design process. Key constraints that have had a considerable influence on design are:

- Peatland and peat depth;
- Watercourses and waterbodies; and
- Potential GWDTE.

10.6.2 Other constraints that were considered but were not considered relevant for the Proposed Development include PWS and public water supply infrastructure. The recorded PWS at Dalnessie is 1 km downstream of the turbine area and no public water supply infrastructure has been identified within the Proposed Development where ground works would be required. There are no relevant designated sites.

10.6.3 The Scoping layout of turbines was identified as requiring changes following the first phase of peat depth surveys, as a number of the turbines were located in areas of deep peat. Subsequent phases of design have made use of the detailed local peat depth data collected through the peat depth surveys to ensure that significant infrastructure (turbines, crane pads, etc.) is located in areas with peat preferably less than 1.0 m in depth. Tracks have for the most part been confined to areas of peat less than 1.5 m in depth. Track sections crossing deeper peat have been minimised as far as possible within the constraints of the development and engineering requirements.

10.6.4 Watercourse crossings have been kept to a practical minimum, with only five regulated crossings required for the Proposed Development. Two of these are existing crossings on the access track, one of which would require upgrading and the other would require replacement by a more suitable structure. Two of the required new crossings are on small headwater channels, with the third as a crossing of the mainstem of the Allt nan Con-uisge.

10.6.5 Potentially sensitive wetland habitats have been avoided where possible. The balance of constraints has meant that this has not been easy to accommodate, as peatland areas were considered to be of higher priority. Other constraints, including ecology and landscape and visual impact, were important considerations that required balancing with peatland, hydrology and wetland habitats.

10.6.6 Key infrastructure development iterations are shown on **Figure 10.6**.

10.7 Predicted Impacts

Development Characteristics

10.7.1 The construction phase of the Proposed Development would involve a number of different elements. **Chapter 2** of the EIA Report describes the scheme elements in detail. The elements with particular relevance to geology, hydrogeology, hydrology and peat are as follows:

- Construction of access routes and watercourse crossings;
- Excavation and construction of turbine foundations and associated crane hardstandings;
- Creation of construction compounds and laydown areas;

- Excavation of borrow pits and processing of excavated rock;
- Installation of permanent meteorological mast and LiDAR compounds;
- Installation of drainage features around long-term infrastructure;
- Batching of concrete (if required);
- Temporary welfare facilities and site utilities including water supply and foul water disposal;
- Excavation, handling and temporary storage of peat and soils.

10.7.2 During operation of the Proposed Development, activities with particular relevance to geology, hydrogeology, hydrology and peat are as follows:

- Surface water drainage, including treatment and discharge of surface drainage;
- Maintenance of tracks and trackside drainage;
- Long-term drainage around long-term infrastructure;
- Additional extraction and processing of rock for necessary maintenance.

Effects During Construction

Physical Changes to Overland Drainage and Surface Water Flows

10.7.3 Changes to overland drainage patterns would arise principally from construction of the access track network with subsidiary effects from construction of the turbine foundations, crane hardstandings and ancillary infrastructure.

10.7.4 The access tracks would require installation of trackside drainage and cross-drains to protect the tracks from water damage. Constructed drains would be no longer and deeper than necessary to provide the required track drainage. Cross-drains would be installed at an appropriate frequency to minimise concentration of flows from above the track, where cross-slopes are present, and to prevent diversion of flows between sub-catchment areas, to minimise changes to the hydrological regime. All drainage infrastructure would be designed with suitable capacity for a rainfall intensity of a 1-in-200 year storm event, plus allowance for climate change.

10.7.5 All long-term and temporary drainage infrastructure would be established on a running basis ahead of excavation works. This includes temporary bunding and cut-off drains around turbine bases, hardstanding areas and borrow pits. Where possible, trackside drainage would be laid up to 100 m ahead of track construction works on a running basis.

10.7.6 A number of watercourses would be crossed by the access track. Five crossings of regulated watercourses have been identified and details are provided in **Appendix 10.5**. Four of these crossings would be new structures. One minor, unregulated watercourse would also require a crossing to be installed. These crossings would be designed with sufficient capacity for a rainfall intensity of a 1-in-200 year storm event, plus allowance for climate change.

10.7.7 All necessary permissions required for watercourse crossing works would be obtained prior to commencement of associated works.

10.7.8 The receptor, surface watercourses within the site, is considered to be of **moderate** sensitivity. With appropriate mitigation measures in place, as described, the magnitude of effect is considered to be **slight**. The likelihood of effect is considered to be **likely**.

10.7.9 The effect of physical changes to overland drainage from construction works is assessed as **minor**, long-term, adverse and not significant.

Particulates and Suspended Solids

10.7.10 All development work involving earthmoving operations would generate loose sediment, which could potentially gain access to surface watercourses and waterbodies through entrainment in surface runoff. This could potentially have an adverse effect on the downstream watercourses through damage to fish spawning habitat and changes to dissolved oxygen and nutrient levels in watercourses and waterbodies. Surface water from the areas surrounding the turbine bases, all hardstanding areas (including crane pads, substation, construction compounds and laydown areas) and borrow pits would be prevented from entering the working areas by appropriate use of peripheral bunding and cut-off drains. These would help to divert clean water around and away from the working areas.

10.7.11 During excavation works for turbine foundations, cut sections of track, cut areas for hardstandings and borrow pits, silt fencing or appropriate alternative sediment control protection would be installed on the downhill side of the excavation to prevent inadvertent discharge of silty water into any watercourse within the site. Pre-construction installation of long-term drainage would provide an additional level of sediment control.

10.7.12 All engineering work adjacent to watercourses, including track construction and installation of watercourse crossings, would have appropriate sediment control measures established prior to any groundworks. Vegetation would be retained along watercourse banks to act as additional protection. The main watercourse crossings for the site would not require any in-stream works.

10.7.13 Minor in-stream works would be required for the crossing of the minor watercourse noted above. This work would be undertaken using a temporary dam to control flow whilst the culvert pipe is installed. Over-pumping would only be used if flow conditions require this.

10.7.14 For areas of larger excavation, such as turbine bases and crane pads or borrow pit excavations, temporary water control measures may be used. These may include use of temporary settlement ponds or the use of proprietary treatment systems such as Siltbusters, as appropriate.

10.7.15 Construction activities would be restricted during periods of wet weather, particularly for any work occurring within 20 m of a watercourse or within areas of identified deeper peat, to minimise mobilisation of sediment in heavy rainfall. The following 'stop' conditions are recommended to guide construction activity (**Table 10.10.12**)[121]:

Table 10.10.12: Recommended 'Stop' Conditions for Earth Moving Activities

'Stop' rule	Requirements
High intensity rainfall	Rainfall during construction greater than 10 mm per hour
Long duration rainfall	Rainfall in the preceding 24 hours greater than 25 mm

[121] CH2M & Fairhurst (2018). Outline Peat Management Plan. Appendix 10.6, A9 Dualling – Dalwhinnie to Crubenmore, DMRB Stage 3 Environmental Impact Assessment. https://www.transport.gov.scot/media/41104/appendix-a106-outline-peat-management-plan.pdf, Table 10.2 (accessed January 2021)

'Stop' rule	Requirements
7-day cumulative rainfall (1)	Preceding 7 days of rainfall greater than 50 % of the monthly average
7-day cumulative rainfall (2)	Preceding 7 days of rainfall greater than 50 mm

10.7.16 Monitoring of rainfall for 'stop' conditions would require access to a suitable local source of data, such as the Met. Office's monitoring stations at Altnaharra SAWS and Kinbrace, or a site-specific rainfall station, to allow identification of these conditions being exceeded in order to allow appropriate action to be taken.

10.7.17 Any water collecting within excavations would be pumped out prior to further work in the excavation. This water may require treatment to remove suspended solids prior to discharge to ground.

10.7.18 Vegetation cover would be re-established as quickly as possible on track verges and cut slopes, by re-laying of excavated peat acrotelm (the vegetated upper layer of the peat), to improve slope stability and provide erosion protection. Additional methods, including hydroseeding and/or use of a biodegradable geotextile, would be considered if necessary, in specific areas and areas of particular sensitivity.

10.7.19 All necessary permissions relating to construction works, plus accompanying pollution prevention plans, would be obtained prior to any construction work beginning within the Proposed Development. All the management and control measures, including emergency response procedures, would be set out in a Construction Environmental Management Plan (CEMP) produced by the appointed Contractor prior to any works beginning. This would be a live document and would be updated as required throughout construction.

10.7.20 A water quality monitoring programme would be established at key locations around the Proposed Development. Monitoring would begin prior to any construction works, to allow pre-construction baseline quality to be determined. Details are provided in Error! Reference source not found..

10.7.21 The receptor, surface watercourses within the site, is considered to be of **moderate** sensitivity. With appropriate mitigation measures in place, as described, the magnitude of effect is considered to be **slight**. The likelihood of effect is considered to be **likely**.

10.7.22 The effect of particulates and suspended solids from construction works is assessed as **minor**, temporary, adverse and not significant.

Water Contamination from Fuels, Oils or Foul Drainage

10.7.23 Spillage of fuels, oils, wet concrete or concrete washout water could have an adverse effect on surface water quality, and major spillages could have a potential influence on the River Brora system downstream of the site, with smaller potential influences on the River Tirry system as a result of the smaller infrastructure footprint in this catchment.

10.7.24 Oil and fuel storage and handling within the Proposed Development would be undertaken following published guidance, in particular *Guidance on Pollution Prevention 2 – Above ground oil storage tanks*[122] and in compliance with the *Water Environment (Oil Storage)*

[122] SEPA (2018). Above ground oil storage tanks: GPP 2. gpp-2-pdf-jan-2018.pdf (netregs.org.uk) (accessed January 2022).

(Scotland) Regulations 2006. The details would be contained in the CEMP and are summarised as follows:

- Risk assessments would be undertaken and all Hazardous Substances and Non-Hazardous Pollutants that would be used and/or stored within the site would be identified. Hazardous substances likely to be within the site include oils, fuels, hydraulic fluids and anti-freeze. No non-hazardous pollutants have been identified as likely to be used within the site. Herbicides would not be used.
- All deliveries of oils and fuels would be supervised.
- All storage tanks would be located within impermeable, bunded containers where the bund is sufficient to contain 110 % of the tank's capacity. For areas containing more than one tank, the bund would be sufficient to contain 110% of the largest tank's capacity or 25 % of the total capacity, whichever is the greater.
- Any valve, filter, sight gauge, vent pipe or other ancillary equipment would be located within the containment area.
- Waste oil would not be stored within the site but would be removed to dedicated storage or disposal facilities.
- Management procedures and physical measures would be put in place to deal with spillages, such as spill kits and booms.
- Maintenance procedures and checks would ensure the minimisation of leakage of fuels or oils from plant.
- Refuelling and servicing would be undertaken in a designated area or location with adequate precautions in place, such as a dedicated impermeable surface with lipped edges to contain any contaminants.
- Where vehicle maintenance is necessary in the field, owing to breakdown, additional precautions would be taken to contain contaminants, such as spill trays or absorbent mattresses.
- The access track would be designed and constructed to promote good visibility where possible and two-way access where visibility is restricted, to minimise risk of vehicle collisions.
- If concrete batching within the site is required, this would take place in one designated location within one of the proposed construction compounds. This location would be at least 250 m from the nearest watercourse. Protective bunding would be installed around the batching area to ensure that contaminated runoff is contained. Dedicated drainage would be installed to ensure that water from the batching area can be suitably treated to reduce alkalinity and suspended sediment load prior to discharge or removed from the site by tanker for treatment and disposal offsite at a suitably licensed facility.

Foul Drainage Provision

10.7.25 There are no plans to provide a foul drainage network within the site.

10.7.26 Welfare facilities for use during construction would have a suitably sized holding tank and waste water would be removed by tanker for disposal at a suitably licensed disposal facility.

Spillage and Emergency Procedures

10.7.27 The Spillage and Emergency Procedures would form part of the CEMP and would be prominently displayed at the site and staff would be trained in their application. The Site Spillage and Emergency Procedures document would incorporate guidance from the relevant SEPA Guidance Notes.

10.7.28 In the event of any spillage or discharge that has the potential to be harmful to or to pollute the water environment, all necessary measures would be taken to remedy the situation. These measures would include:

- Identifying and stopping the source of the spillage;
- Containing the spillage to prevent it spreading or entering watercourses, by means of suitable material and equipment;
- Absorbent materials, including materials capable of absorbing oils, would be available within the site to mop up spillages. These would be in the form of oil booms and pads and, for smaller spillages, quantities of proprietary absorbent materials. Sand bags would also be readily available for use to prevent spread of spillages and create dams if appropriate;
- Where an oil/fuel spillage may have soaked into the ground, the contaminated ground would be excavated and removed from the site by a licensed waste carrier to a suitable disposal facility;
- The emergency contact telephone number of a specialist oil pollution control company would be displayed within the site; and
- Sub-contractors would be made aware of the guidelines for handling of oils and fuels and of the spillage procedures at the site.

10.7.29 SEPA would be informed of any discharge or spillage that may be harmful or polluting to the water environment. Written details of the incident would be forwarded to SEPA no later than 14 days after the incident, in line with SEPA's requirements.

10.7.30 A water quality monitoring programme would be established at key locations around the Proposed Development. Monitoring would begin prior to any construction works, to allow pre-construction baseline quality to be determined. Details are provided in Error! Reference source not found..

10.7.31 The receptor, surface watercourses within the site, is considered to be of **moderate** sensitivity. With appropriate mitigation measures in place, as described, the magnitude of effect is considered to be **moderate**. The likelihood of effect is considered to be **unlikely**.

10.7.32 The effect of water contamination from fuels, oils, concrete batching or foul drainage from construction works is assessed as **minor**, temporary, adverse and not significant.

Changes in or Contamination of Water Supply to Vulnerable Receptors

10.7.33 Vulnerable receptors that have the potential to be affected by the site construction works have been identified. These include one private water supply and a number of potential GWDTE. No relevant designated sites have been identified within the site or within 2 km of the planning application boundary.

Groundwater-dependent terrestrial ecosystems

10.7.34 A detailed assessment of the interaction between the Proposed Development works and potential GWDTE has been undertaken. Three potentially groundwater-dependent NVC communities have been identified within the site: M15 wet heath, M23 rush-pasture and M25 mire. M15 and M25 have potentially moderate groundwater dependency and M23 has potentially high groundwater dependency in Scottish situations, dependent on the hydrogeological setting. Information from the ecology surveyors indicated that both habitat types were of relatively low quality in all parts of the site.

10.7.35 The potentially groundwater-dependent habitats are widely distributed within the turbine area, and this has meant that it has been impossible to avoid them. Some areas of each of the three habitat types are located within 100 m of excavations less than 1 m in depth and/or within 250 m of excavations deeper than 1 m.

10.7.36 The potentially groundwater-dependent habitats have been assessed specifically within the context of the Proposed Development, taking into account the local bedrock and superficial geology, peat distribution and local observations. No groundwater discharges were identified at any location within the site. The superficial deposits, consisting of peat and clay-dominated diamicton till, would act to insulate the groundwater in the bedrock from the ground surface, effectively preventing groundwater discharge at surface. The bedrock is noted to have very limited groundwater potential and no indications of groundwater at surface were apparent during any of the site surveys.

10.7.37 It is determined, as a result of the above, that none of the three potentially groundwater-dependent communities within the site is actually groundwater-dependent in this area but rely on a mix of surface water, shallow throughflow in surface vegetation and rainwater.

10.7.38 Details of the GWDTE assessment are provided in **Appendix 10.4**.

10.7.39 The potential GWDTE within the site are considered to be of **low** sensitivity as a result of the absence of any hydrogeological linkage and the low quality of the habitats. With appropriate mitigation measures in place, as described, the magnitude of effect is considered to be **moderate**. The likelihood of effect is considered to be **likely**.

Private Water Supplies

10.7.40 One private water supply (PWS) has been identified that has potential to be at risk from the Proposed Development, as it is located within 250 m of proposed works and is also downslope of the works area.

10.7.41 The PWS source is a borehole housed within an enclosed building with fully protected headworks. The only proposed construction works within 250 m are track construction and trackside drainage, both of which involve limited excavation. The nearest deeper excavation works are at least 1 km distant and on a slope facing north rather than directly upslope of the PWS borehole. It is unlikely that any chance to the groundwater quality or quantity would arise from the proposed excavation works.

10.7.42 There would be a low potential for overland drainage to reach the PWS building. In order to prevent this, all track works within 250 m of the PWS would have additional surface water and sediment protection measures put in place prior to any groundworks in the area. These will include:

- Installation of a soil bund on the downslope side of the track route, to capture and divert any runoff away from the PWS;
- At least two lines of silt fencing downslope of the bund, to ensure that any runoff from the bund does not lead to sediment transfer towards the PWS;
- Regular monitoring of the PWS source for the duration of all construction works upslope of the source. Monitoring would begin at least one month prior to construction works taking place within 500 m of the PWS and would continue for at least two months following reinstatement of all works within 500 m of the PWS source. Monitoring of the source would be undertaken daily while construction works are active within 500 m of the source. Full details of the required monitoring

would be provided within the Pollution Prevention Plan prepared to accompany the Construction Runoff Permit for the Proposed Development.

10.7.43 The PWS is considered to be of **high** sensitivity. With appropriate mitigation measures in place, as described, the magnitude of effect is considered to be **slight**. The likelihood of effect is considered to be **unlikely**.

10.7.44 The effect of changes in or contamination of water supply to vulnerable receptors (designated sites, GWDTE and PWS) from construction works is assessed as **minor**, temporary, adverse and not significant.

Increased Flood Risk

10.7.45 The Proposed Development infrastructure is not at risk of flooding from any source.

10.7.46 The drainage infrastructure installed around long-term Proposed Development infrastructure would be designed to minimise concentration of flows. This would be achieved by:

- Use of cut-off drains to divert runoff around necessary 'hard' infrastructure such as turbine bases and hardstanding areas.
- Use of regular cross-drains underneath access tracks. These would be installed in line with the natural terrain, making use of low points where runoff would naturally be focused.
- Use of a slight gradient on installed 'hard' infrastructure to encourage drainage into a filter drain or swale, for infiltration into vegetated areas and as shallow through-flow.
- Long-term drainage would be installed ahead of related construction works or excavations taking place, to ensure that drainage can be controlled appropriately. For tracks, the required trackside drainage would be put in place ahead of access track construction, on a rolling basis as the track development progresses.
- Any areas which have to be left unvegetated during the construction phase, such as turbine foundations, hardstanding areas and borrow pits, would have settlement ponds put in place to attenuate flow until vegetation can be re-established at the end of the construction period.

10.7.47 In line with best practice guidance, runoff during construction of the Proposed Development would not be greater than natural pre-development runoff. Details are provided in **Appendix 10.5**.

10.7.48 The receptors, infrastructure and property downstream of the site, are considered to be of **high** sensitivity. With appropriate mitigation measures in place, as described, the magnitude of any increased flood risk is considered to be **negligible**. The likelihood of effect is considered to be **unlikely**.

10.7.49 The effect of increase in flood risk resulting from the construction works is assessed as **negligible** and not significant.

Physical Removal of Bedrock

10.7.50 Bedrock and superficial materials would require to be removed to form turbine foundations, platforms for construction of hardstanding areas and, particularly, to facilitate development of borrow pits in order to provide aggregate for the Proposed Development construction works.

10.7.51 These works would require permanent modification to the natural geology at the site. As the footprint of the works within the site is small, overall changes to the geological character of the site would be limited. There are no areas designated for geological characteristics within or adjacent to the Proposed Development.

10.7.52 Rock testing would be undertaken on appropriate samples from the two proposed borrow pit areas to determine their suitability for unbound track and hardstanding construction. This would include testing to determine likely degradation patterns during the lifespan of the Proposed Development. Should the tests identify problems with parts of the rock within the borrow pit footprints, care would be taken to ensure that unsuitable material is not used for construction but would be retained for use in borrow pit restoration.

10.7.53 The bedrock receptor is considered to be of **low** sensitivity. The magnitude of effect is considered to be **slight**. The likelihood of effect is considered to be **likely**.

10.7.54 The effect of physical removal of bedrock from construction works is assessed as **minor**, long-term, adverse and not significant.

Modification to Groundwater Flow Paths

10.7.55 Physical changes to the shallow subsurface as a result of all excavation work have potential to interrupt shallow groundwater flow paths. This would include proposed cut-and-fill track sections, turbine foundations, hardstanding areas, met masts, substation, laydown area, construction compounds and cable trenches.

10.7.56 Physical changes to the deeper subsurface (>5 m below ground surface) have potential to interrupt deeper groundwater flow paths. This would include borrow pit excavations and some turbine foundation areas.

10.7.57 The superficial deposits are noted to be low productivity aquifers, although some groundwater would be present within the peat bodies and occasionally in parts of the glacial till and alluvium. There is likely to be some limited groundwater flow via weathered zones and fracture networks within the bedrock.

10.7.58 Groundwater monitoring boreholes would be established within the two proposed borrow pit areas prior to any construction work beginning, to a depth at least 1 m below the deepest expected excavation. Groundwater level monitoring would be undertaken to determine whether groundwater is present within the proposed borrow pit areas and, if it is, at what level the seasonally highest groundwater table stands. Any groundwater within borrow pit areas would be managed in line with best practice, with discharge via a settlement pond to allow any entrained sediment to be removed prior to discharge. Any required discharge licence would be obtained prior to excavation commencing.

10.7.59 Excavation of cable trenches could lead to groundwater flow between catchments if the trenches act as preferential flow paths. This can be avoided by laying cables in disturbed ground adjacent to access tracks. In areas where cable routes cross up or down notable slopes, clay bunds or alternative impermeable barrier would be placed for every 0.5 m change in elevation along the length of the trench to minimise in-trench groundwater flow.

10.7.60 The groundwater receptor is considered to be of **moderate** sensitivity. With appropriate design constraints and mitigation measures in place, as described, the magnitude of effect is considered to be **slight**. The likelihood of effect is considered to be **likely**.

10.7.61 The effect of modification to groundwater flow paths from construction works is assessed as **minor**, long-term, adverse and not significant.

Soil Erosion and Compaction

10.7.62 Proposed construction activity, particularly plant and vehicle movements, soil stripping and stockpiling, would affect the nature of the soils at the site. Plant movements would act to compact soils through movements over unstripped ground. All activity requiring removal, transport and stockpiling of soils would have potential to lead to soil erosion and loss of structure, resulting in overall soil degradation.

10.7.63 All proposed traffic routes would be clearly demarcated and vehicles would not be permitted access outwith these areas.

10.7.64 Only tracked or low ground pressure vehicles would be permitted access to unstripped ground.

10.7.65 Soil stripping would be undertaken with care and would be restricted to as small a working area as practicable. Topsoil would be removed and laid in a storage bund, up to 2 m in height, on unstripped ground adjacent to the specific working area. It would be attempted to retain the turf layer vegetation-side-up where possible, although ground conditions may make this challenging. Subsoils and superficial geological deposits would be removed subsequently and laid in storage bunds, also up to 2 m in height, clearly separated from the topsoil bund. Care would be taken to maintain separate stockpiles for separate soil types in order to preserve the soil quality.

10.7.66 For work within areas of peat, acrotelmic peat (the uppermost 0.5 m) would be removed as for the topsoil. It would be attempted to retain the acrotelm vegetation-side-up where possible, although ground conditions may make this challenging. The underlying catotelmic peat would be stored in bunds up to 1 m in height. Catotelmic peat is sensitive to handling, and loses its internal structure easily, so would be transported as short a distance as possible to its storage location. Excavation of catotelmic peat has been limited by careful infrastructure design and avoidance of areas of deeper peat where possible.

10.7.67 Limited smoothing or ‘blading’ of stockpiled soils and catotelmic peat would be undertaken to help shed rainwater and prevent ponding of water on the stockpile. Bunds on notably sloping ground would have sediment control measures installed near the base, on the downslope side, to collect and retain any sediment mobilised by rainfall.

10.7.68 Excavated soil and peat would be used for restoration and rehabilitation at the end of the construction period, in order to promote fast re-establishment of vegetation cover on worked areas and areas of bare soil or peat that are not required for the operational phase of the Proposed Development. Some of the excavated peat would be reserved for peatland restoration in parts of the turbine area. Soils and peat would be stored for as short a time as practicable, in order to minimise degradation through erosion and desiccation.

10.7.69 Should prolonged periods of dry weather occur, a damping spray would be employed to maintain surface moisture on the soil and peat bunds. This would help to maintain vegetation growth in the turves and to retain the soil structure.

10.7.70 The receptor, soils and peat at the site, is considered to be of **moderate** sensitivity. The magnitude of effect is considered to be **slight**. The likelihood of effect is considered to be **likely**.

10.7.71 The effect of soil erosion and compaction from the construction works is considered to be **minor**, temporary, adverse and not significant.

Peat Instability

10.7.72 Construction activity on peatland can affect the natural stability of the peat deposits in areas near to or associated with construction works. Particular risk areas are associated with works at or near breaks in slope, areas where natural peat instability has been recorded and locations where the peat has degraded through, for example, erosion processes, drying out or overgrazing.

10.7.73 A detailed Peat Slide Risk Assessment (PSRA) has been undertaken for the Proposed Development and is provided in **Appendix 10.1**. The key effects assessment findings are provided below.

10.7.74 The PSRA found that the majority of the Proposed Development has a negligible or low risk of natural or induced peat landslide. Four areas adjacent to proposed infrastructure, and five areas within or adjacent to the turbine area but more distant from proposed infrastructure, were identified as potentially having a moderate or high risk of peat instability. The areas were appraised in greater detail, taking into account location-specific details including information gathered from the reconnaissance survey and the peat depth surveys. Mitigation measures have been recommended to control the peat landslide hazard. For these areas, the peat landslide hazard can be controlled by use of good construction practice and micrositing.

10.7.75 The receptors for peat landslide hazard are the peatland habitat, the water environment including surface water and groundwater, Proposed Development infrastructure, and construction personnel.

10.7.76 The peatland habitat, water environment and Proposed Development infrastructure receptors are considered to be of **high** sensitivity. Construction personnel are considered to be a **very high** sensitivity receptor.

10.7.77 With appropriate design constraints and mitigation measures in place, as described in **Appendix 10.1**, the magnitude of effect is considered to be **slight**. The likelihood of effect is considered to be **unlikely**.

10.7.78 For all receptors, the effect of peat instability is assessed as **minor**, long-term, adverse and not significant.

Effects During Operation

Physical Changes to Overland Drainage and Surface Water Flows

10.7.79 No additional changes to overland drainage and surface water flows are anticipated during the operational phase of the Proposed Development. Trackside and infrastructure drainage would remain in place during the Proposed Development's operation. A monitoring and maintenance programme would be put in place for the drainage infrastructure, to include regular visual inspection of drainage ditches, crossing structures

and cross-drains to check for blockages, debris or damage that might impede water flow. Any identified blockage, including build-up of sediment that may lead to future blockage, or damage to structures would be remediated immediately. Where practicable, routine maintenance would be undertaken during dry weather; where this is not practicable, additional sediment control measures may need to be established to manage silty water arising from the work.

10.7.80 The receptor, surface watercourses within the site, is considered to be of **moderate** sensitivity. With appropriate mitigation measures in place, as described, the magnitude of effect is considered to be **negligible**. The likelihood of effect is considered to be **unlikely**.

10.7.81 The effect of physical changes to overland drainage from operational works is assessed as **negligible** and not significant.

Particulates and Suspended Solids

10.7.82 The main operational phase work of the Proposed Development would involve track and hardstanding maintenance and repair. Regular monitoring of the track and hardstanding condition would be undertaken, particularly following periods of heavy or prolonged rainfall and after snowfall and clearance, if relevant. Any sections of the track showing signs of excessive wear would be repaired as necessary with suitable rock from either the borrow pits or external sources.

10.7.83 The drainage network would also be subject to regular monitoring to ensure that it remains fully operational, as water build-up can cause considerable damage to unbound track construction.

10.7.84 All bridge structures would have appropriate splash control measures as part of their design, to prevent silty water splashing into the watercourse from vehicle movements. These splash controls would be monitored regularly to ensure they remain effective and have not become damaged in any way.

10.7.85 The receptor, surface watercourses within the site, is considered to be of **moderate** sensitivity. With appropriate mitigation measures in place, as described, the magnitude of effect is considered to be **slight**. The likelihood of effect is considered to be **possible**.

10.7.86 The effect of particulates or suspended solids from operational works is assessed as **minor**, temporary, adverse and not significant.

Water Contamination from Fuels, Oils or Foul Drainage

10.7.87 The risk of water contamination from fuels or oils is considerably lower during operation of the Proposed Development than during construction as there are significantly decreased levels of activity on the turbine area. The majority of potential pollutants would no longer be present within the Proposed Development. Lubricants for turbine gearboxes, transformer oils and maintenance vehicle fuels would remain present in small quantities. There are no plans for herbicide use during operation; physical cutting of vegetation would be the preferred form of management, where required.

10.7.88 The pollution prevention plan and spillage and emergency procedures, as set out above, would remain in force throughout the operational phase of the Proposed Development. There are no plans for concrete batching during the operational phase.

10.7.89 It is anticipated that welfare facilities at the substation control building would use either a suitably sized holding tank with waste water removed from the Proposed Development by tanker for disposal at a licensed disposal facility, in line with construction phase proposals, or a waste treatment package plant with associated discharge would be installed as a longer-term alternative. All relevant water environment authorisations would be put in place should there be any requirement for these.

10.7.90 The receptor, surface watercourses within the site, is considered to be of **moderate** sensitivity. With appropriate mitigation measures in place, as described, the magnitude of effect is considered to be **negligible**. The likelihood of effect is considered to be **unlikely**.

10.7.91 The effect of water contamination from fuels or oils from operational works is assessed as **negligible** and not significant.

Changes in or Contamination of Water Supply to Vulnerable Receptors

10.7.92 Only minor works would take place within the Proposed Development during the operational phase, to allow necessary maintenance activities to be undertaken. No additional effects on GWDTE are anticipated from the operational phase.

10.7.93 Long-term drainage infrastructure would be put in place alongside the proposed access track within 250 m of the PWS source at Dalnessie, to cut any potential linkage between the track and the PWS. The drainage in this area would be subject to routine monitoring and maintenance as required to ensure it remains operational.

10.7.94 The potential GWDTE within the site are considered to be of **low** sensitivity. With appropriate mitigation measures in place, as described, the magnitude of effect is considered to be **negligible**. The likelihood of effect is considered to be **unlikely**.

10.7.95 The PWS source is considered to be of **high** sensitivity. The magnitude of effect is considered to be **negligible.** The likelihood of effect is considered to be **unlikely**.

10.7.96 The effect of changes in or contamination of water supply to vulnerable receptors from operational works is assessed as **negligible** and not significant.

Increased Flood Risk

10.7.97 Infrastructure drainage would remain in place during the Proposed Development's operational phase. A regular monitoring and maintenance programme for the drainage infrastructure would be implemented to ensure that it remains fully operational and in good condition. Where practicable, routine maintenance would be undertaken during dry weather, to help ensure that drainage operation during wet weather is fully functional.

10.7.98 Post-development runoff would be designed such that there is no change from natural pre-development runoff.

10.7.99 The receptors, infrastructure and property downstream of the site, are considered to be of **high** sensitivity. With appropriate mitigation measures in place, as described, the magnitude of any increased flood risk is considered to be **negligible**. The likelihood of effect is considered to be **unlikely**.

10.7.100 The effect of increase in flood risk resulting from operational works is assessed as **negligible** and not significant.

Physical Removal of Bedrock

10.7.101 Although most physical removal of bedrock would have occurred during construction, the ongoing requirement for track and hardstanding maintenance would require some extraction of rock from the borrow pit sites during the operational phase of the Proposed Development. These operations would be very limited in nature.

10.7.102 The bedrock receptor is considered to be of **low** sensitivity. The magnitude of effect is considered to be **negligible**. The likelihood of effect is considered to be **likely**.

10.7.103 The effect of physical removal of bedrock from operational works is assessed as **negligible** and not significant.

Modification to Groundwater Flow Paths

10.7.104 There is a minor ongoing requirement for additional rock extraction at the borrow pit sites during operation of the Proposed Development, for track and hardstanding maintenance. These operations would be limited in nature.

10.7.105 The groundwater receptor is considered to be of **moderate** sensitivity. The magnitude of effect is considered to be **negligible**, the likelihood of effect is assessed as **likely**.

10.7.106 The effect of modification to groundwater flow paths from operational works is assessed as **negligible** and not significant.

Soil Erosion and Compaction

10.7.107 There are no soil stripping or stockpiling activities planned for the operational phase of the Proposed Development.

10.7.108 Ongoing monitoring and maintenance work at the Proposed Development would require vehicle activity onsite. This would be much reduced from the construction phase and would mostly involve significantly lighter vehicles than heavy construction plant. The ongoing vehicle activity would have some effect on soil and peat compaction below access tracks, although at a significantly lower level than during construction of the Proposed Development.

10.7.109 The receptor, soils and peat within the site, is considered to be of **moderate** sensitivity. The magnitude of effect is considered to be **slight**. The likelihood of effect is considered to be **possible**.

10.7.110 The effect of soil erosion and compaction from operational works is considered to be **minor**, temporary, adverse and not significant.

Peat Instability

10.7.111 No changes to the proposed infrastructure are anticipated during the operational phase of works. Therefore, the effect of natural or induced peat instability during operational works is assessed as **no change**.

Effects during Decommissioning

10.7.112 Potential effects of decommissioning the Proposed Development are similar to those encountered in the construction phase, generally with lower magnitude as the level of Proposed Development activity is lower.

10.7.113 Discussions will be held with the applicant and the appropriate regulatory authorities prior to decommissioning to agree an appropriate decommissioning strategy.

Indirect and Secondary Effects

10.7.114 No indirect or secondary effects relating to hydrology, hydrogeology, geology or peat have been identified for the Proposed Development.

Cumulative Effects

10.7.115 There are thirteen planned, under construction and operational wind farm developments within 20 km of the Proposed Development. These are shown on **Figure 6A3.1.1** and listed in **Table 10.13.**

Geology and Soils

10.7.116 Effects on geology and soils are very localised and effects do not transmit over any noticeable distance. As no other developments lie within 1 km of the Proposed Development, there are no cumulative effects relating to geology or soils.

Hydrogeology

10.7.117 Effects on hydrogeology are confined to shallow groundwater found within the same hydrological catchment as the Proposed Development.

10.7.118 There are no cumulative developments located within the River Brora catchment.

10.7.119 The proposed Strath Tirry Wind Farm development is located within the River Tirry catchment, which includes a small part of the turbine area and most of the proposed access track to the turbine area. The works for the turbine area include two turbines and a short section of track, within the Abhainn Sgeamhaidh subcatchment. The proposed access track to the turbine area is mostly located within the Fèith Osdail subcatchment. The proposed Strath Tirry Wind Farm development is also located in the Fèith Osdail subcatchment.

10.7.120 There is potential for cumulative effects on shallow groundwater from the upgrading work for the proposed access track to the turbine area and the works required for the proposed Strath Tirry Wind Farm development. However, as the works for the Proposed Development are confined to widening of the existing access track for the area in close proximity to the proposed Strath Tirry Wind Farm development, combined with the low productivity classification of the bedrock, it is unlikely that there would be any discernible effect on shallow groundwater as a result of both developments.

10.7.121 Assuming that appropriate groundwater management is used at both developments, cumulative effects on hydrogeology are considered to be **negligible** and not significant**.**

Hydrology

10.7.122 Effects on hydrology are generally confined to developments located within the same hydrological catchment as the Proposed Development or that drain into the same receiving waterbodies.

Table 10.13: Developments Considered for Cumulative Effects

Development	Status	Distance from Proposed Development (km)	Catchment (and receiving waterbody)
Strath Tirry	Application	3.47 km	River Tirry (Loch Shin)
Creag Riabhach	Under Construction	10.3 km	River Vagastie (Loch Naver)
Lairg II	Consented	12.1 km	River Shin (Dornoch Firth)
Garvary	Application	14.4 km	River Shin (Dornoch Firth)
Braemore	Consented	15.1 km	River Grudie/River Shin (Dornoch Firth)
Achany Extension (formerly Glencassley site)	Application	15.6 km	River Cassley (River Shin and Dornoch Firth)
Sallachy	Application	16.3 km	Loch Shin
South Kilbraur	Application	17.5 km	Allt nan Sgeith, Culmaily Burn (Brora to Hilton of Cadboll coastal)

10.7.123 There are no other proposed developments located within the River Brora catchment or draining into the same receiving waterbody (Helmsdale to Brora coastal waterbody).

10.7.124 The proposed Strath Tirry Wind Farm development is located within the Fèith Osdail subcatchment of the River Tirry catchment, together with most of the proposed access track to the turbine area

10.7.125 The proposed Sallachy Wind Farm development is located within watercourse catchments that drain into the Loch Shin receiving waterbody, together with Strath Tirry Wind Farm development and the elements of the Proposed Development within the River Tirry catchment.

10.7.126 It is assumed that best practice construction methods would be used for all developments.

10.7.127 Works within the River Tirry catchment for the Proposed Development are minor, including two turbines, a short section of new track and most of the proposed access track into the turbine area which would require upgrading. While it is possible that both developments would be under construction at the same time, the track upgrading work is limited in nature as compared with construction of new track.

10.7.128 Assuming that best practice construction methods, including best practice surface water and sediment management techniques, are put in place for both developments, cumulative effects on the River Tirry are considered to be **minor**, temporary, adverse and not significant.

10.7.129 The proposed Sallachy Wind Farm development is located over 15 km away from the Proposed Development. As Loch Shin is a large waterbody, impacts on Loch Shin as a receiving waterbody are considered to be **negligible.**

10.7.130 As a result, cumulative impacts arising from the Proposed Development are considered to be **not significant.**

10.8 Mitigation

10.8.1 While outlined and accounted for within the assessment above, this section provides a detailed summary of the mitigation that would be adopted for the Proposed Development.

Mitigation by Design

10.8.2 All excavation works requiring removal of bedrock or superficial deposits have been kept to a practical minimum by good site design.

10.8.3 Owing to local ground conditions effects on groundwater flow are not anticipated.

10.8.4 Access tracks are anticipated to be constructed using established cut-and-fill construction methods. Areas of peat have been avoided where possible, with access track sections within areas of deeper peat kept to a practical minimum.

Mitigation Commitments

Soil and Peat

10.8.5 Soil stripping would be undertaken with care and would be restricted to as small a working area as practicable. Topsoil would be removed and laid in a storage bund, up to 2 m in height, on unstripped ground adjacent to the working area. It would be attempted to retain the turf layer vegetation-side-up where possible, although ground conditions may make this challenging. Subsoils and superficial geological deposits would be removed subsequently and laid in storage bunds, also up to 2 m in height, clearly separated from the topsoil bund. Care would be taken to maintain separate bunds for separate soil types in order to preserve the soil quality.

10.8.6 For work within areas of peat, acrotelmic peat (the uppermost 0.5 m) would be removed as for the topsoil. It would be attempted to retain the acrotelm vegetation-side-up where possible, although ground conditions may make this challenging. The underlying catotelmic peat would be stored in bunds up to 1 m in height. Catotelmic peat is sensitive to handling, and loses its internal structure easily, so would be transported as short a distance as possible to its storage location. Excavation of catotelmic peat has been limited by careful infrastructure design.

10.8.7 Limited smoothing or ‘blading’ of stockpiled soils and catotelmic peat would be undertaken to help shed rainwater and prevent ponding of water on the stockpile. Bunds on notably sloping ground would have sediment control measures installed near the base, on the downslope side, to collect and retain any sediment mobilised by rainfall.

10.8.8 Excavated soil and peat would be used in restoration and rehabilitation at the end of the construction period, in order to promote fast re-establishment of vegetation cover on worked areas and areas of bare soil or peat that are not required for the operational phase of the Proposed Development. Soils and peat would be stored for as short a time as practicable, in order to minimise degradation through erosion and desiccation.

10.8.9 Should prolonged periods of dry weather occur, a damping spray would be employed to maintain surface moisture on the soil and peat bunds. This would help to maintain vegetation growth in the turves and to retain the soil structure.

10.8.10 Construction work would make use of current best practice guidance relating to developments in peatland areas. A risk management system, such as a geotechnical risk

register, would be compiled and maintained at all stages of the project and developed as part of the post-consent detailed design works, and would be updated as new information becomes available.

10.8.11 Micrositing would be used to avoid possible problem areas identified during ground investigation or other detailed design works. This would be assisted by additional verification of peat depths, to full depth, in any highlighted areas where construction work is required. Track drainage would be installed in accordance with published good practice documentation and would be minimised in terms of length and depth in order to minimise concentration of flows.

10.8.12 Construction activities would be restricted during periods of wet weather, particularly for any work occurring within 20 m of a watercourse or within areas of identified deeper peat. Careful track design would ensure that the volume and storage timescale for excavated materials would be minimised as far as practicable during construction works.

10.8.13 Vegetation cover would be re-established as quickly as possible on track and infrastructure verges and cut slopes, by re-laying of excavated peat acrotelm, to improve slope stability and provide erosion protection. Additional methods, including hydroseeding and/or use of a biodegradable geotextile, would be considered if necessary in specific areas.

10.8.14 During construction members of project staff would undertake advance inspections and carry out regular monitoring for signs of peat landslide indicators. A geotechnical specialist would be on call to provide advice if required by conditions within the site.

10.8.15 Construction staff would be made aware of peat slide indicators and emergency procedures. Emergency procedures would include measures to be taken in the event that an incipient peat slide is detected.

Surface Watercourses and Groundwater

10.8.16 Silt fencing or appropriate alternative sediment control protection would be installed on the downhill side of excavations to prevent inadvertent discharge of silty water into or towards any watercourse within the site.

10.8.17 All engineering works adjacent to watercourses, including access tracks and watercourse crossing structures, would have appropriate sediment control measures established prior to any groundworks.

10.8.18 Vegetation would be retained along watercourse banks to act as additional protection to the watercourses.

10.8.19 A water quality monitoring programme would be established. Details would be agreed with SEPA but are anticipated to include at least the following:

- Visual checks for entrained sediment;
- In situ measurements of pH, temperature, specific conductivity.

10.8.20 In situ measurement of turbidity and dissolved oxygen may be recommended for locations with particular sensitivity, such as the River Brora downstream from the Proposed Development.

10.8.21 Pre-construction monitoring would be undertaken on a monthly basis for a minimum period of three months prior to any work taking place within the Proposed Development.

10.8.22 During construction, the monitoring would be undertaken by the Environmental Clerk of Works (ECoW) or suitably experienced alternative individual. Any change from baseline conditions of pH and/or specific conductivity would potentially indicate an incident and additional investigation would be required in order to identify the origin of the change. Control locations (WQ2 and 6; **Figure 10.7**) are intended to help differentiate between incidents arising within the site and incidents that are unrelated to the site.

10.8.23 Recommended frequency of monitoring for the different locations are provided in Error! Reference source not found. below. Monitoring locations are shown on **Figure 10.7**.

10.8.24 Groundwater monitoring boreholes would be established within the two proposed borrow pit areas prior to any construction work beginning, to a depth at least 1 m below the deepest expected excavation. Groundwater level monitoring would be undertaken to determine whether groundwater is present within the borrow pit areas and, if it is, at what level the seasonally highest groundwater table stands. Any groundwater within a borrow pit area would be managed in line with best practice, with discharge via a settlement pond to allow any entrained sediment to be removed prior to discharge. Any required discharge licence would be obtained prior to excavation commencing.

10.8.25 All works through and adjacent to wetland areas would be supervised by the ECoW.

Table 10.14 Water Quality Monitoring Locations and Recommended Monitoring Frequency by Phase of Development (Figure 10.7)

ID	Location	Monitoring schedule
WQ1	Tributary to Abhainn Sgeamhaidh south of Turbine T16.	**Baseline:** Monthly, min. 3 months **Construction:** Twice daily during all construction work at Turbines T15 & T16 and access tracks; otherwise monthly.
WQ2	Tributary to Allt nan Con-uisge south of Turbine T11.	**Baseline:** Monthly, min. 3 months **Construction:** Twice daily during all construction work at Turbines T16, T15, T14, T11 and T10, and access tracks; otherwise monthly.
WQ3 (Control)	Tributary to Allt nan Con-uisge west of Turbine T11.	
WQ4	Allt nan Con-uisge south of Turbine T08.	**Baseline:** Monthly, min. 3 months **Construction:** Twice daily during all construction work at Turbines T16, T15, T14, T13, T11, T10, T09, T08, T04 and T03, compounds and access tracks; weekly during all borrow pit BP2 operations; otherwise monthly.
WQ5	Allt nan Con-uisge east of Turbine T01.	**Baseline:** Monthly, min. 3 months **Construction:** Twice daily during all construction work at all turbines, compounds and access tracks; weekly during all borrow pit BP1 and BP2 operations; otherwise monthly.
WQ6 (Control)	River Brora east of Turbine T01	

Drainage Infrastructure

10.8.26 Trackside drainage would be no longer or deeper than necessary to provide the required track drainage.

10.8.27 Cross-drains under tracks would be installed at an appropriate frequency to mimic natural drainage patterns and to minimise concentration of flows.

10.8.28 All drainage infrastructure would be designed with a capacity suitable for a rainfall intensity of a 1-in-200 year storm event plus allowance for climate change.

10.8.29 Where track sections cross wetland or bog areas, cross-drainage would be provided within the track construction to ensure continuity of flow. This may take the form of a drainage layer within the track, suitably closely-spaced drainage pipes, or both as appropriate. These would be determined on a case-by-case basis to suit each individual area.

10.8.30 All required licences for watercourse crossings and construction works would be in place prior to works within the Proposed Development beginning.

10.8.31 All long-term and temporary drainage infrastructure would be established on a running-basis ahead of excavation works. This includes temporary bunding and cut-off drains around turbine bases, hardstanding areas and borrow pits. Where possible, trackside drainage would be laid up to 100 m ahead of track construction works on a running basis.

10.8.32 Temporary water control measures would be implemented as necessary adjacent to larger areas of excavation. These would include borrow pit sites and may also include turbine base excavations and hardstanding areas. These measures would take the form of temporary settlement ponds, filter drains or proprietary treatment measures such as Siltbusters. Detail would be provided within the Pollution Prevention Plan(s) required for the Construction Runoff Permit and suitability would be determined following appropriate onsite soil tests.

10.8.33 All earthmoving activity would be restricted during periods of wet weather, particularly for work occurring within 20 m of a watercourse, to minimise mobilisation of sediment in heavy rainfall. The ‘stop’ conditions provided in **Table 10.10.12** are recommended to guide all earthmoving activity at all stages of the Proposed Development.

10.8.34 Long-term drainage infrastructure would have a monitoring and maintenance programme established, to include regular visual inspection of drainage infrastructure to check for blockages, debris or damage that may impede flow. Remediation would be undertaken immediately. Routine maintenance would be scheduled where possible for dry weather.

Excavations

10.8.35 Any water collecting within excavations would be pumped out prior to further work within the excavation. The water is likely to require treatment to remove suspended solids prior to discharge to ground.

10.8.36 Cable trenches would be laid in disturbed trackside material. In areas where cable routes cross up or down steep slopes, clay bunds or alternative impermeable barrier would be placed for every 0.5 m change in elevation along the length of the trench to minimise in-trench groundwater flow.

10.8.37 Vegetation cover would be re-established as quickly as possible on all areas of stripped ground, once activity involving these areas is complete. This would include track verges, screening bunds, cut slopes and much of the site during decommissioning and restoration works. Where possible this would be achieved using excavated peat acrotelm. Additional measures including hydroseeding and/or use of a biodegradable geotextile would be considered if insufficient peat turf is available and for areas of particular sensitivity that require immediate protection.

10.8.38 Rock testing would be undertaken on appropriate samples from the borrow pit areas to determine its suitability for unbound track and hardstanding construction. This would include testing to determine likely degradation patterns during the lifespan of the development. Should the tests identify problems with parts of the rock within the borrow pit footprints, care would be taken to ensure that unsuitable material is not used for construction but would be retained for use in borrow pit restoration.

10.8.39 Any unused or remaining unsuitable aggregate material, plus any spare rock material arising from hardstanding or track reinstatement, may be used to reinstate the borrow pits to a suitable profile, and capped with soil or turf to promote re-establishment of natural vegetation cover.

10.8.40 Only tracked or low ground pressure vehicles would be permitted access to unstripped ground.

Development Traffic

10.8.41 Tracks and hardstanding areas would be monitored on a regular basis, particularly following periods of heavy or prolonged rainfall or after snow clearance. Any sections of track or hardstanding showing signs of excessive wear would be repaired as necessary with suitable rock from the borrow pits or external sources.

10.8.42 The bridge structures at watercourse crossings would have appropriate splash control measures as part of their design, to prevent silty water splashing into the watercourses from vehicle movements. The splash controls would be monitored regularly to ensure they remain effective and have not become damaged in any way.

10.8.43 Routine monitoring checks of project infrastructure, including track and hardstanding surfaces and all drainage infrastructure, would be undertaken on a quarterly basis throughout operation of the Proposed Development. Monitoring would involve visiting all aspects of the infrastructure and undertaking a visual inspection to identify the following:

- areas where track surfaces or hardstanding areas were showing evidence of erosion or surface damage;
- any areas where surface water was ponding or collecting on tracks or hardstanding areas;
- any areas where drainage infrastructure was damaged, blocked or inadequate.

10.8.44 Any areas of track or hardstanding surface showing signs of damage, erosion or excessive wear would be repaired as necessary. Drainage features would be repaired, reinstated or replaced as necessary to ensure continued efficient operation.

10.8.45 Site-specific mitigation, including track drainage segregation to avoid ‘flushing’ from excavation works, and micrositing to avoid specific higher sensitivity areas, would be identified and established where appropriate.

10.8.46 All traffic routes would be clearly demarcated and vehicles would not be permitted access outwith these areas.

Pollution Prevention

10.8.47 Oil and fuel storage and handling on site would be undertaken in compliance with SEPA's Guidance on Pollution Prevention 2 – Above ground oil storage tanks and with the Water Environment (Oil Storage) (Scotland) Regulations 2006.

- Risk assessments would be undertaken and all Hazardous Substances and Non-Hazardous Pollutants that would be used and/or stored within the site would be identified. Hazardous substances likely to be within the site include oils, fuels, hydraulic fluids and anti-freeze. No non-hazardous pollutants have been identified as likely to be used within the site. Herbicides would not be used.
- All deliveries of oils and fuels would be supervised.
- All storage tanks would be located within impermeable, bunded containers where the bund is sufficient to contain 110 % of the tank's capacity. For areas containing more than one tank, the bund would be sufficient to contain 110% of the largest tank's capacity or 25 % of the total capacity, whichever is the greater.
- Any valve, filter, sight gauge, vent pipe or other ancillary equipment would be located within the containment area.
- Waste oil would not be stored within the site but would be removed to dedicated storage or disposal facilities.
- Management procedures and physical measures would be put in place to deal with spillages, such as spill kits and booms.
- Maintenance procedures and checks would ensure the minimisation of leakage of fuels or oils from plant.
- Refuelling and servicing would be undertaken in a designated area or location with adequate precautions in place, such as a dedicated impermeable surface with lipped edges to contain any contaminants.
- Where vehicle maintenance is necessary in the field, owing to breakdown, additional precautions would be taken to contain contaminants, such as spill trays or absorbent mattresses.
- The access track would be designed and constructed to promote good visibility where possible and two-way access where visibility is restricted, to minimise risk of vehicle collisions.
- If required, concrete batching for construction would take place in one designated location within one of the proposed construction compounds. This location would be at least 250 m from the nearest watercourse. Protective bunding would be installed around the batching area to ensure that contaminated runoff is contained. Dedicated drainage would be installed to ensure that water from the batching area can be suitably treated to reduce alkalinity and suspended sediment load prior to discharge or removed from the site by tanker for treatment and disposal at a licensed offsite facility.
- Washing-out of concrete mixers and tankers would take place at a designated location within the construction compound with an impermeable surface and dedicated drainage, to ensure that the water is captured for treatment or offsite disposal at a licensed facility.

10.8.48 It is anticipated that construction-phase welfare facilities would use a suitably sized holding tank with waste water removed from the site by tanker for disposal at a licensed disposal facility. Operational-phase welfare facilities may use a similar procedure or

would install a waste treatment package plant with associated discharge. All relevant water environment authorisations would be put in place should there be any requirement for these.

10.8.49 The Site Spillage and Emergency Procedures would be prominently displayed at the site office and staff would be trained in their application. The Procedures document would incorporate guidance from the relevant SEPA Guidance Notes.

10.8.50 In the event of any spillage or discharge that has the potential to be harmful to or to pollute the water environment, all necessary measures would be taken to remedy the situation. These measures would include:

- Identifying and stopping the source of the spillage;
- Containing the spillage to prevent it spreading or entering watercourses by means of suitable material and equipment;
- Absorbent materials, including materials capable of absorbing oils, would be available within the site to mop up spillages. These would be in the form of oil booms and pads and, for smaller spillages, quantities of proprietary absorbent materials.
- Sand bags would also be readily available for use to prevent spread of spillages and create dams if appropriate.
- Where an oil/fuel spillage may have soaked into the ground, the contaminated ground would be excavated and removed from the site by a licensed waste carrier to a suitable landfill facility.
- The emergency contact telephone number of a specialist oil pollution control company would be displayed within the site.
- Sub-contractors would be made aware of the guidelines for handling of oils and fuels and of the spillage procedures at the site.

10.8.51 SEPA would be informed of any discharge or spillage that may be harmful or polluting to the water environment. Written details of the incident and its resolution would be forwarded to SEPA no later than 14 days after the incident.

10.8.52 All works through and adjacent to wetland areas will be supervised by the Environmental Clerk of Works.

10.9 Summary of Residual Effects

10.9.1 This assessment is based on a site-specific risk assessment method following recommended environmental impact assessment techniques. Potential effects, both positive and negative, long-term or temporary, adverse or beneficial, to the geological, hydrogeological, hydrological and peat regime have been considered. These effects are summarised in **Table 10.15**.

Table 10.15: Summary of Residual Effects

Effect	Phase	Assessment consequence	Effect significance
Physical changes to overland drainage and surface water flows	Construction	Minor, long-term and adverse.	Not Significant
	Operation	Negligible	Not Significant

Effect	Phase	Assessment consequence	Effect significance
Particulates and suspended solids	Construction	Minor, temporary and adverse.	Not Significant
	Operation	Minor, temporary and adverse.	Not Significant
Water contamination from fuels, oils, concrete batching or foul drainage	Construction	Minor, temporary and adverse.	Not Significant
	Operation	Negligible	Not Significant
Changes in or contamination of water supply to vulnerable receptors	Construction	Minor, temporary and adverse.	Not Significant
	Operation	Negligible	Not Significant
Increased flood risk	Construction	Negligible	Not Significant
	Operation	Negligible	Not Significant
Physical removal of bedrock	Construction	Minor, long-term and adverse.	Not Significant
	Operation	Negligible	Not Significant
Modification to groundwater flow paths	Construction	Minor, long-term and adverse.	Not Significant
	Operation	Negligible	Not Significant
Soil erosion and compaction	Construction	Minor, temporary and adverse.	Not Significant
	Operation	Minor, temporary and adverse.	Not Significant
Peat instability	Construction	Minor, long-term and adverse.	Not Significant
	Operation	No change.	Not Significant
Hydrology, hydrogeology, geology and soils cumulative effects	Construction	Minor, temporary and adverse	Not Significant
	Operation	Negligible	Not Significant

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