Chapter 7
Hydrology, Geology, Hydrogeology, Water Resources and Peat

Introduction

7.1 This chapter reports the assessment of the likely effects of the proposed Glenmuckloch to Glenglass Reinforcement Project (GGRP) on hydrology, geology, hydrogeology, water resources and peat. It details the baseline environment, based on desk-based studies and a comprehensive field survey conducted from November 2020 to June 2022. A description of likely effects and their significance, together with mitigation measures is also provided, including an assessment of cumulative effects.

7.2 This chapter should be read alongside **Chapter 8: Ecology** due to interactions between both chapters in terms of the potential effects of water quality on fish and other species/habitats and potential effects on Ground Water Dependent Terrestrial Ecosystems (GWDTEs), which are considered within this chapter. The assessment is based on the project description and construction methods described in **Chapter 4: Development Description**. Planning policies of relevance to this assessment are provided in **Chapter 5: Planning Policy**.

7.3 This chapter is supported by the following technical appendices:

- Appendix 7.1: Watercourse Crossings and Buffers;
- Appendix 7.2: Catchment Delineation to Access Tracks;
- Appendix 7.3: Peat Survey Report;
- Appendix 7.4: Peat Management Plan; and
- Appendix 7.5 Peat Landslide Hazard and Risk Assessment.

Scope of the Assessment

Effects Assessed in Full

7.4 The following key issues were identified for consideration in the assessment reported in this chapter:

- Effects on surface and ground water quality during construction;
- Effects on channel morphology (bank erosion and channel form) during construction;
- Effects on hydrology, run-off rates and flood risk during construction and operation;
- Direct and indirect disturbance of peat during construction; and
- Cumulative effects during construction on water quality, hydrology and peat.

Effects Scoped Out

7.5 On the basis of the work undertaken, the professional judgement of the EIA team, experience from other relevant projects and policy guidance or standards, and feedback received from consultees, the following topic areas have been 'scoped out' of detailed assessment:

- Effects on bedrock geology during both construction and operation. The geology is not anticipated to be affected by the GGRP.
- Effects on private water supplies (PWS), public water supplies and services, groundwater abstractions and GWDTEs during both construction and operation. There are no abstractions for PWS or licenced groundwater abstractions within 1km of the connection. There are no GWDTEs within 250m of the GGRP infrastructure. Cognisance of nearby Scottish Water services and pipework will be required during detailed design and prior to and during construction works and all pipework will be avoided.
- Operational effects on surface water quality and PWS.

[1] References to all legislation relate to legislation as amended and in force at the time of writing of this chapter.

Assessment Methodology

Legislation and Guidance

Legislation

7.6 This assessment is carried out in accordance with the principles contained within the following legislation[1]:

- The Flood Risk Management (Scotland) Act 2009;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR);
- Water Framework Directive (2000/60/EC) (WFD), and Water Environment and Water (Scotland) Act 2003 (WEWS Act);
- Pollution Prevention and Control (Scotland) Regulations 2012;
- The Electricity Work (Environmental Impact Assessment) (Scotland) Regulations 2017 ('the 2017 EIA Regulations');
- Control of Pollution Act 1974 Part II: Pollution of Water;
- The Scotland River Basin District (Standards) Directions 2014;
- The Public Water Supplies (Scotland) Regulations 2014;
- European Drinking Water Directive (Council Directive 98/83/EC);
- Private Water Supplies (Scotland) Regulations 2006;
- The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017;
- The Water Environment (Drinking Water Protected Areas) (Scotland) Order 2013;
- Groundwater Daughter Directive (2006/118/EC) (GWDD);
- The Scotland River Basin District (Status) Directions 2014; and
- The Waste Management Licensing (Scotland) Regulations 2011.

Guidance

7.7 This assessment is carried out in accordance with the principles contained within the following documents:

- The Scottish Environmental Protection Agency (SEPA)'s Guidance for Pollution Prevention (GPPs) and Pollution Prevention Guidelines (PPGs), including:
  - GPP1: Understanding your environmental responsibilities – good environmental practices;
  - GPP2: Above ground oil storage tanks;
  - GPP4: Treatment and disposal of wastewater where there is no connection to the public foul sewer;
  - GPP5: Works and maintenance in or near water;
  - PPG6: Working at construction and demolition sites;
  - GPP8: Safe storage and disposal of used oils;
  - GPP21: Pollution incident response planning;

  - GPP22: Dealing with spills; and
  - GPP26: Safe storage – drums and intermediate bulk containers.
- Scottish Government Planning Advice Notes (PANs) and Guidance (including PAN 51 Planning, Environmental Protection and Regulation; PAN 1/2013 Environmental Impact Assessment, as amended and PAN 79 Water and Drainage);
- Scottish Executive: River crossings & migratory fish: Design guidance, 2012;
- Scottish Natural Heritage, Constructed tracks in the Scottish Uplands, 2nd edition, 2015.
- SEPA: Technical Flood Risk Guidance for Stakeholders, version 13 (SEPA, June 2022);
- SEPA: Water Environment (Controlled Activities) (Scotland) Regulations 2011 - A Practical Guide, Version 9.1 March 2022;
- SEPA: Position Statement to support the implementation of the Water Environment (Controlled Activities) (Scotland) Regulations 2005, WAT-PS-06-02: Culverting of Watercourses - Position Statement and Supporting Guidance, Version 2, June 2015.
- SEPA: Engineering in the Water Environment Good Practice Guide – River Crossings, WAT-SG-25, 2010;
- SEPA: Engineering in the Water Environment Good Practice Guide – Temporary Construction Methods, WAT-SG-29, 2009;
- SEPA: Sector Specific Guidance: Water Run-off from Construction Sites, WAT-SG-75, 2021;
- SEPA: Policy No. 19, Groundwater protection policy for Scotland, 2009;
- SEPA: Special requirements for civil engineering contracts for the prevention of pollution, WAT-SG-31, 2006;
- SEPA: Land Use Planning System, SEPA Guidance Note 31: Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems, 2017;
- SEPA: Flood Risk and Land Use Vulnerability Guidance, version 4, July 2018;
- SEPA: Climate change allowances for flood risk assessment in land use planning, Land Use Planning System SEPA Guidance. Version 2, March 2022;
- SEPA (2010) Regulatory Position Statement - Developments on Peat (SEPA, 2010);
- Forestry Commission (2017) The UK Forestry Standard;
- CIRIA: The SUDS Manual (C753) 2015;
- CIRIA: Control of water pollution from linear construction projects. Technical guidance (C648) 2006;
- CIRIA: Control of water pollution from linear construction projects. Site guide (C649) 2006;
- CIRIA: Control of water pollution from construction sites: Guidance for consultants and contractors (C532) 2001;
- CIRIA: Groundwater Control – design and practice (second edition) (C750) 2016;
- Dumfries and Galloway Council (DGC) Local Development Plan 2 (LDP2): Policy IN7: Flooding and Development, October 2019;
- DGC: Flooding and Development Supplementary Guidance, February 2020;
- Peatland Survey. Guidance on Developments on Peatland. Scottish Government, Scottish Natural Heritage (SEPA 2017);
- Good Practice during Windfarm Construction[2] (Scottish Renewables, SNH, SEPA & Forestry Commission Scotland, 4th Edition 2019);
- Scottish Government (2017) Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments (Second Edition). Scottish Government;
- Code of Practice for the sustainable use of soils on construction sites (DEFRA, 2009); and
- Marine Scotland: Freshwater and diadromous fish and fisheries associated with onshore wind farm and transmission line developments: generic scoping guidelines (Scottish Government, June 2021).

Consultation

7.8 In undertaking the assessment, consideration has been given to the scoping responses and other consultation as undertaken as detailed in **Table 7.1**.

Table 7.1: Consultation Responses

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
Dumfries and Galloway Council, 2 December 2020	Formal Scoping Consultation	The Council's Flood Risk Management Team was unable to provide a response to this request at this time. Notwithstanding, the following advice was provided: ■ Surface runoff from the site should be managed during and after construction. Runoff should mimic that of existing conditions and not be increased. ■ The rate of runoff into the watercourses which are located within the site should be considered. Any significant increase may increase the flood risk downstream.	Surface water runoff will be managed using standard Sustainable Drainage Systems (SuDS) which will attenuate runoff to greenfield rates. There is not anticipated to be an increase in flood risk, but this is assessed and reported in this chapter.
Nith District Salmon Fishery Board (NDSFB), 12 November 2020	Formal Scoping Consultation	Noted that potential impacts on the aquatic environment can occur during construction activities during installation of the OHL towers and line (e.g. sediment leaching/run-off from construction areas and during earthworks.) Recommended that a series of aquatic surveys be conducted to compliment the environmental protection measures intended to support the construction of the proposed project. These surveys should include aquatic invertebrates and fish found in the watercourses along the intended route of the powerline. Surveys should be conducted before any construction activity commences to establish a baseline, repeated during the construction phase and repeated post completion, where a comparison can be made and assessment of any impacts is possible.	Noted. Buffers from watercourses and other mitigation measures (e.g. SuDS) will be in place during construction to reduce the risk of sediment entering the water environment. Aquatic surveys will be incorporated into the project's CEMP and delivered before, during and post-construction.
SEPA, 11 Feb 2020 SEPA, 22 March 2021	Formal Scoping Consultation – referred to same consultation response issued on 22 March 2021. Routeing and Consultation Document (RCD) Consultation	SEPA notes that provided the works are subject to proper assessment, management and mitigation, SEPA's interests should not be compromised by the proposed activities.	Noted.
		The information outlined in the following (and detailed further in the appendix of the response from SEPA) must be submitted in support of the application to avoid delay and potential objection: ■ Map and assessment of all engineering activities in or impacting on the water environment including proposed buffers, details of any flood risk assessment. SEPA recommend a minimum buffer of 50m around each loch or watercourse. ■ Map and assessment of impacts upon GWDTEs and buffers. ■ Map and assessment of impacts upon groundwater abstractions (including PWS) and buffers. ■ Peat depth survey and table detailing re-use proposals, if encountered. ■ Map and table detailing forest removal. ■ Map and site layout of borrow pits or stockpile areas of imported stone to be used for access tracks.	A map of engineering activities is provided in **Figure 7.2**. The map shows all water environment features, including groundwater abstraction (including PWS) and GWDTEs (if any), and buffers. The assessment of engineering activities is reported in this chapter, subject to scoping in / scoping out as discussed above. No GWDTES were identified in the study area. A peat depth survey is provided in **Appendix 7.3** and reuse proposals described in **Appendix 7.4**. Impact of forest removal on water environment is discussed in the effects assessment, with further

[2] Whilst this document focusses primarily on wind farm developments, as this document provides good, recent and relevant guidance of the requirements and considerations for constructing infrastructure in remote and rural locations with a variety of land uses including forestry and peatland, it is also considered applicable to the Glenmuckloch to Glenglass Reinforcement Project.

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
		■ Schedule of mitigation including pollution prevention measures.	details on felling provided in **Chapter 4: Development Description**. There are no borrow pits proposed as part of the development. Stone from quarries offsite will be used for track upgraded and temporarily stored in laydown areas. Pollution prevention measures are described in the Mitigation section within this chapter and summarised in the **Schedule of Mitigation** (**Appendix 3.3**).
		SEPA note the following specific comments: ■ Based on the information provided it seems unlikely that any development will take place within 250 m of a groundwater supply source; if this is the case it would be helpful if the EIA Report provides evidence to confirm this. ■ Provided watercourse crossings are designed to accommodate the 1 in 200 year event and other infrastructure is located well away from watercourses there is no need for detailed information on flood risk.	There are no groundwater supply sources within 250m of the GGRP (see **Figure 7.2**). Watercourse crossings have been designed for a 1 in 200 year event and infrastructure is located away from watercourses using appropriate buffers.
		SEPA note the following regulatory requirements: ■ Authorisation is required under The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR) to carry out engineering works in or in the vicinity of inland surface waters (other than groundwater) or wetlands. ■ The management of surplus peat may require an exemption under the Waste Management Licensing (Scotland) Regulations 2011. Proposed crushing or screening will require a permit under the Pollution Prevention and Control (Scotland) Regulations 2012. ■ A Controlled Activities Regulations (CAR) construction site licence will be required for the management of surface water run-off from a construction site, including access tracks, which: – is more than 4 hectares, – is in excess of 5km, or – includes an area of more than 1 hectare or length of more than 500m on ground with a slope in excess of 25˚. Site design may be affected by pollution prevention requirements and hence SEPA strongly encourage the applicant to engage in pre-CAR application discussions with a member of the regulatory services team in the local SEPA office. Below these thresholds, it will be necessary to comply with CAR General Binding Rule 10 which requires, amongst other things, that all reasonable steps must be taken to ensure that the discharge does not result in pollution of the water environment.	Engineering in the water environment has been minimised. **Appendix 7.1** and **Figure 7.2** provides information on new and existing watercourse crossings and comments on the level of CAR authorisation required. A Peat Management Plan (**Appendix 7.4**) has been prepared which identifies the volumes of peat to be excavated in association with proposed infrastructure and which provides suitable reuse recommendations and mitigation measures. A CAR construction site licence will be required for the GGRP. This will be applied for in advance of construction in line with SEPA's Sector Specific Guidance: Construction Sites (WAT-SG-75). SPEN will engage with SEPA in pre-CAR application discussions with a member of the regulatory services team in advance of construction.
SEPA, Email exchange and phone call, 21 June 2021 Alex Candlish (Senior Planning Officer – Linear Infrastructure Projects, SEPA)	Post Scoping Consultation to discuss proposed watercourse buffers.	SEPA's detailed scoping requirements (above) recommend*: "A minimum buffer of 50m around each loch or watercourse. If this minimum buffer cannot be achieved each breach must be numbered on a plan with an associated photograph of the location, dimensions of the loch or watercourse and drawings of what is proposed in terms of engineering works."* The recommended minimum buffer was discussed on a phone-call with SEPA. The route of the GGRP contours along the base of a slope, with multiple watercourses running off the hillside. This makes positioning towers 50m away from all watercourses extremely challenging. SEPA agreed in principle that the applicant can use smaller buffers for smaller watercourses for OHL towers as per the table set out below: **Width of Watercourse (top of bank)** / **Width of Buffer Strip (either side)** Less than 1m – 6m 1-5m – 6-12m 5-15m – 12-20m 15m + – 20m + *Source: SEPA (2017) Background Paper on the Water Environment, LUPS-BP-GU2b* SEPA note that additional columns should be added to the table to describe the type of tower/pole (which will affect depth of excavation required for construction) and whether the watercourse is upgradient or downgradient of a tower. SEPA note that the recommended 50m buffer is mainly for protection of the water environment (i.e., to reduce pollution/silt/sediment run-off during construction) and is not a flood risk issue for tower/pole construction. As the official response (SEPA letter, 22 March 2019) mentions a minimum 50m buffer around each watercourse or loch, SEPA would welcome a pre-application note on the buffers the applicant has applied and the justification to avoid problems once the full EIA is submitted. SEPA does not envisage a problem provided the buffers are sensible, justified and because OHL towers are considered 'essential infrastructure' in terms of flood risk.	Watercourse buffers are described in the baseline assessment, **Appendix 7.1** and shown on **Figure 7.2.** **Appendix 7.1** provides the width of buffers achieved (where a 50m buffer could not be achieved), type of infrastructure, and whether watercourse is up or downgradient of the infrastructure.
SEPA, Email, 30 November 2021 Susan Haslam, (Senior Planning Officer)	Post Scoping Consultation, (following consultation event)	SEPA notes that in relation to their water environment interests it looks like the towers will be located well away from the larger watercourses such as the River Nith and Kello Water and note that more detailed versions of the plans should be provided to demonstrate suitable buffers between construction works and towers near the smaller watercourses, such as at T21, T25 and T39. Other issues relate to impacts on peat and GWDTEs. Excavations should be shown to avoid areas of deep peat and good quality wetland habitats. SEPA note it would be helpful if the plans submitted with the application confirmed the method of access – removable boards, temporary floated tracks, temporary cut tracks etc – as this affects the level of impact.	Noted. Buffers from the smaller watercourses are detailed in **Appendix 7.1**. Peat probing data and NVC/ GWDTE data were collected for the baseline assessment and were fed into early iterations of the proposed design, in order to avoid deep peat and wetland habitats. The types of access tracks proposed are confirmed in the **Chapter 4 – Development Description**.
SEPA, Email, 7 September 2022 Susan Haslam, Senior Planning Officer)	Gatecheck Consultation	SEPA note that the configuration of the spur track to T21 and excavations for the tower itself needs to include a 50m buffer to the nearby watercourses. Similarly, SEPA request that T39 excavations are 50m from the local watercourse. SEPA also request that sets of layout plans showing peat probing results and NVC habitat survey results are provided. SEPA note that it would be helpful if the plans submitted confirmed which new tracks will be permanent and which will be temporary and whether they will be of a floating or cut construction.	Due to design constraints and span lengths a 50m buffer is not achievable for these smaller watercourses. Justification for buffers for smaller watercourses are set out in **Appendix 7.1. Appendix 7.1** also provides details of potential effects and additional mitigation that is required. Peat probing results and NVC survey habitat results are shown in **Figure 7.7** and **Figure 8.4** with the layout overlain.

Consultee and Date	Scoping/Other Consultation	Issue Raised	Response/Action Taken
			The new tracks are all temporary, with the exception of the track to the Glenmuckloch substation..
Scottish Water, 27 January 2020	Formal Scoping Consultation	Scottish Water noted that the development will affect existing Scottish Water assets. Any potential conflicts with Scottish Water assets should be identified in the EIA, and the Scottish Water Asset Impact Team should be contacted, if necessary. If identified, any conflict with assets may be subject to restrictions on proximity of construction. Scottish Water notes that there are no Scottish Water drinking water catchments or water abstraction sources, which are designated as Drinking Water Protected Areas under the Water Framework Directive, in the area that may be affected by the proposed activity. Scottish Water also notes that surface water connections into their combined sewer system will not be accepted.	Further consultation was undertaken with Scottish Water and maps of assets were provided. These are discussed in the baseline assessment. There are no plans to discharge surface water to the combined sewer system.
Marine Scotland, 5 February 2020	Formal Scoping Consultation	Marine Scotland notes that the River Nith catchment supports important salmon and trout populations and advises SPEN to consider the potential effect of the development on water quality and fish populations within and downstream of the development area, both during construction and operation.	Standard mitigation to protect Fisheries resources have been embedded into the project design, potential effects on fish have been scoped out of further consideration in **Chapter 8: Ecology**. Effects on water quality are considered in this chapter.
		Marine Scotland also advised SPEN to consider the potential effect of mining, forestry and proposed felling operations on water chemistry and aquatic biota.	Noted – considered in this chapter.
		Marine Scotland recommended consulting their generic scoping guidelines in relation to the potential impacts on water quality and fish populations associated with the proposed development.	The Marine Scotland (2021) guidance was consulted in relation to assessing and mitigating the potential effects on water quality.
		Marine Scotland also notes that site specific mitigation measures to avoid and/or minimise potential impacts on the water quality and fish populations should be discussed in the EIA.	Potential impacts on water quality are addressed within this chapter. Current best practice construction techniques and relevant guidance have been followed. All embedded and site specific mitigation measures relevant to this chapter are set out in the mitigation section within this chapter and summarised in the **Schedule of Mitigation** (**Appendix 3.3**).
Scottish Natural Heritage (SNH), 16 March 2020	Formal Scoping Consultation	SNH recommends that all potentially affected peatland habitats with the survey corridor be mapped to National Vegetation Classification (NVC) standards. SNH notes that the NVC is more sensitive to the hydrological variation that occurs in blanket bog than the Phase 1 classifications, which will be important in determining construction methods and mitigation measures.	NVC habitat mapping is covered in **Chapter 8: Ecology** and **Appendix 8.2**.
Dumfries and Galloway Council (D&GC), Environmental Health Officer, 8 June 2021	Response to Data Request for Private Water Supply Information	Private water supply data (properties and source supply locations) were requested from DGC within a search area comprising a 1km buffer either side of the proposed OHL route. DGC responded to confirm that there are no PWS supplies or users within the search area.	Data used to inform the baseline assessment.
SEPA, 18 Nov 2020	Response to Data Request for	SEPA responded to note that there are two CAR abstraction licences within the search area, as follows:	Data used to inform the baseline assessment. . Both of these are more than 1km from the GGRP
	groundwater abstractions	■ CAR/S/1093136 - Glenmuckloch SCM, Lagrae Road, Kirkconnel - for an abstraction of groundwater from the void created by opencast coalmining. The abstraction point location is the centre of the void, at NGR NS 7028 1554. SEPA note that this opencast site has ceased operating and the abstraction is no longer in use. The final void was to be left unrestored and allowed to naturally fill with water to create a reservoir which would naturally spill into an adjacent watercourse when full. ■ CAR/L/1144415 - Glenmuckloch Pumped Storage Hydro, Kirkconnel - The plan was to use the final void reservoir as the "lower" reservoir and create a new void "upper" reservoir further up the hill. Stored water would be transferred to the upper reservoir by pump and then the hydro scheme would operate by transferring water from one to the other. The pumped storage hydro scheme has not been constructed.	infrastructure and not considered further.
The Scottish Government Energy Consents Unit December 2020	Scoping Opinion	Scottish Ministers consider that, where there is a demonstrable requirement for peat landslide hazard risk assessment (PLHRA), the assessment should be undertaken as part of the EIA process to provide Scottish Ministers with a clear understanding of whether the risks are acceptable and capable of being controlled by mitigation measures. Scottish Ministers note that the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Scottish Government, 2017) should be followed.	A PLHRA was undertaken in line with the Scottish Government (2017) best practice guide and is appended as **Appendix 7.5**.

Study Area

7.9 The GGRP is located entirely within the River Nith catchment (see **Figure 7.1**). The proposed OHL crosses the River Nith, the Kello Water and several small tributaries (i.e., Guttie Burn, Thwarter Burn and Barr Burn, as well as numerous other smaller watercourses).

7.10 The study area for the hydrology assessment comprises the GGRP infrastructure and hydrologically connected watercourses and catchments. The study area for the peat assessment comprises the GGRP infrastructure plus offsets. The study area for the Private Water Supply/GWDTE assessment comprises 100m and 250m buffer zones from the infrastructure (see **Figure 7.2**).

Desk Based Research and Data Sources

7.11 The following data sources have informed the assessment:

- Ordnance Survey mapping at 1:10,000 and 1:25,000 scales;
- British Geological Survey (BGS) mapping at 1:50,000 scale;
- Scottish Soil mapping at 1:250,000 scale;
- NatureScot (2016) Carbon and Peatland Mapping at 1:250,000 scale.
- Aerial imagery of the site and surrounds;
- Flood Estimation Handbook (FEH) Web-service (fehweb.ceh.ac.uk);
- SEPA Flood Maps (map.sepa.org.uk/floodmap/map.htm);
- SEPA Water Classification Hub (www.sepa.org.uk/data-visualisation/water-classification-hub/); and
- Scotland's Environment Website and Interactive Map (map.environment.gov.scot/sewebmap/).

Field Survey

7.12 The field survey was undertaken by a team of two with the appropriate experience of assessing hydrology, hydrogeology, geology, soil, and peat for energy infrastructure routes in upland, rural environments. Peat and hydrology surveys were carried out on the following dates to inform the assessment:

- 19-20 November 2020 – initial survey of proposed tracks and towers to provide constraints feedback to design. Dry winter conditions.
- 24-27 November 2020 – initial survey of proposed tracks and towers to provide constraints feedback to design. Wet winter conditions.
- 20-22 April 2021 – initial survey of proposed tracks and towers to provide constraints feedback to design. Sunny and dry conditions.
- 24 August 2021 –survey of remaining route and areas where design had changed. Sunny and dry conditions.
- 4 October 2021 –survey at proposed substation in the north. Dry and overcast.
- 7 February 2022 - survey of possible route realignment change in southern part of the route and overview of potential GWDTEs. Winter (light snow) conditions.
- 15 June 2022 - survey of proposed substation and accesses in the north. Sunny, dry, and warm conditions.
- 28 July 2022 – survey at proposed location of T39 and T40 and tracks, due to route alignment changes. Sunny, dry, and warm conditions.
- 18 August 2022 - survey of revised track alignments from T5 – T1. Weather was overcast with light drizzle, but had followed an extremely dry period.

7.13 The peat survey followed current guidance in Scotland[3]. Areas of infrastructure (includes tower footprints, working areas) were sampled at a systematic 10m grid and the alignment of the proposed access track route centreline was probed at 50m intervals. This includes areas of existing track which were to be widened. Additionally, an offset (predominantly 10m but up to 30m) from the centreline was sampled either side of the track. The proposed Glenmuckloch Substation was sampled at a 25m grid over a wider area to allow for micrositing. Cores were taken at representative locations.

7.14 All watercourses and other hydrological features were surveyed in the field, with data collected in a standard proforma to inform the hydrology and watercourse crossing assessment.

Assessing Significance

Sensitivity

7.15 The criteria used to assess the sensitivity of water and geological features is summarised in **Table 7.2**. The sensitivity or the vulnerability of the water and geological features was determined in terms of the physical attributes and processes encompassed by surface water hydrology (including flood risk), morphology and water quality.

Table 7.2: Criteria for Determining the Importance/Sensitivity of the Water Environment and Geological Environment

Sensitivity of Receptor	Typical Indicators
High	■ Receptor is of national or international value (i.e., Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC), Special Protection Area (SPA), and RAMSAR). ■ Overall water quality classified by SEPA as high and salmonid spawning grounds present. ■ Abstractions for public water supply. ■ Groundwater classified under the WFD as 'good' or groundwater resource with numerous sensitive users/receptors ■ The flooding of property (or land use of great value) that has been susceptible to flooding in the past.
	■ Watercourse floodplain/hydrological feature that provides critical flood alleviation benefits. ■ Natural channel and of high morphological diversity. ■ Receptor supports GWTDE confirmed as highly groundwater dependent. ■ Class 1 or 2 priority peatland.
Medium	■ Receptor is of regional or local value (e.g. local Nature Reserve). ■ Overall water quality classified by SEPA as good or moderate, salmonid species may be present, and may be locally important for fisheries. ■ Smaller watercourse lying upstream of larger river that is an SSSI, SAC, SPA or RAMSAR. May be subject to improvement plans by SEPA. ■ Abstractions for private water supplies. ■ Groundwater resource with sensitive users/receptors. ■ Environmental equilibrium copes well with natural fluctuations but cannot absorb some changes greater than this without altering part of its present character. ■ The flooding of property (or land use of great value) that may be susceptible to flooding. ■ Watercourse/floodplain/hydrological feature that provide some flood alleviation benefits. ■ Semi-natural channel, with morphological diversity. May have some minor morphological constraints. ■ Receptor supports GWTDE confirmed as moderately groundwater dependent. ■ Unmodified active peatland. ■ Deep (>1.0m depth) peat unless minor area.
Low	■ Receptor is of low environmental importance (e.g., water quality classified by SEPA as bad or poor, fish sporadically present or restricted). ■ Not subject to water quality improvement plans by SEPA. ■ Environmental equilibrium is stable and is resilient to changes which are considerably greater than natural fluctuations, without detriment to its present character. ■ No abstractions for public or private water supplies. ■ No significant groundwater resource and no identified sensitive users/receptors. ■ No flooding of property or land use of great value. ■ Watercourse/floodplain/hydrological feature that provides minimal flood alleviation benefits. ■ Heavily engineered or artificially modified watercourses, which may dry up during summer months. ■ No GWDTE confirmed as either moderately or highly groundwater dependent. ■ No or shallow peat (0.5m to <1.0m depth) and/or modified peat.

Magnitude

7.16 The magnitude of change has been assessed based on the criteria presented in **Table 7.3**. These criteria are based on professional judgement and experience of other similar studies.

Table 7.3: Criteria for Determining the Magnitude of Change to the Water Environment and Geological Environment

Significance Effect	Description/Typical Example
Major	■ Fundamental (long-term or permanent) to substantial changes to hydrology, water quality, peat, geology or hydrogeology (in terms of quantity, quality and morphology). ■ A >10% change in average or >5% change in flood flows.

[3] Scottish Government, Scottish Natural Heritage, SEPA (2017) Peatland Survey. Guidance on Developments on Peatland, on-line version only (https://www.gov.scot/publications/peatland-survey-guidance/)

Significance Effect	Description/Typical Example
	■ The extent of 'high risk' areas (classified by the Risk Framework contained in SPP – i.e. at risk from flooding by 1 in 200-year or greater event) will be significantly increased. ■ Change that would render water supply unusable for longer than month. ■ Change resulting in total loss of feature or integrity of feature or use.
Moderate	■ Material, but temporary changes to the hydrology, water quality, peat, geology or hydrogeology (in terms of quantity, quality and morphology). ■ A >5% change in average and minimal change in flood flows. Extent of 'high risk' areas (1 in 200-year - SPP) will be moderately increased/or decreased. ■ Change that would render water supply unusable for days or weeks with no alternative.
Minor	■ Detectable but non-material changes to the hydrology, water quality, peat, geology or hydrogeology (in terms of quantity, quality and morphology). ■ A >1% change in average flows and no increase in flood flows. ■ Change that would render water supply unusable for short period (days) or for longer period if alternative supply put in place.
None	■ No perceptible changes to the hydrology, water quality, peat, geology or hydrogeology (in terms of quantity, quality and morphology). ■ A <1% change in average and no change in flood flows. ■ No change in water supply or minor change (days) where alternative is put in place.

Significance

7.17 The predicted significance of the effect was determined through a standard method of assessment based on professional judgement, considering both sensitivity and magnitude of change as detailed in **Table 7.4** below. Effects can either be adverse or beneficial. Major and moderate effects are considered significant in the context of the EIA Regulations.

Table 7.4: Significance Criteria

	Sensitivity of Receptor		
Magnitude of Change	**High**	**Medium**	**Low**
Major	Major	Major – Moderate	Moderate
Moderate	Moderate	Moderate	Minor
Minor	Minor	Minor	Minor – None
None	None	None	None

Assessment Limitations

7.18 The assessment was based on existing, available data, supplemented by hydrology and peat survey of the GGRP infrastructure locations and surrounding watercourses. The data collected reflects environmental conditions at the time of the site visits.

7.19 There is a small section of access track towards Tower 7 which was amended at a late stage and for which it was not possible to acquire peat depth data. Based on the slope angle in this area (>10° and frequently >15°) and on the relationship between peat depth and slope in this part of the site (peat is only found in pockets on the gentler slopes above), the likelihood of encountering peat in this area is considered to be very low.

7.20 It is considered that there is sufficient information to enable an informed decision to be taken in relation to the identification and assessment of likely significant environmental effects on hydrology, geology, hydrogeology, water resources and peat.

Existing Conditions

Climate

7.21 The average annual temperature within south-western Scotland is around 8.0 to 9.4 °C (Met Office website). The average annual rainfall on the site is approximately 1520mm (Flood Estimation Handbook Web-service).

Topography

7.22 The topography of the site and surrounds is shown in **Figure 7.2**, based on 50cm LiDAR ground elevation data. The highest point along the centreline of the OHL is around 342m AOD (Above Ordnance Datum) in the south-west part of the study area (between towers 3 and 4). Ground levels along the OHL route generally slope from the south to the north towards the River Nith, with a minimum elevation as low as 160m AOD (between towers 34 and 35) within the River Nith valley. Ground levels to the north of the River Nith rise-up again, reaching ~240m AOD at the Glenmuckloch Substation. The routeing also passes over the Kello Water river valley, where ground elevations drop to ~200m AOD (between towers 16 and 17).

Watercourses and Surface Water

7.23 The OHL passes over several watercourses, with other watercourses located nearby. These are shown in **Figure 7.1, Figure 7.2** and **Table 7.5** and are described below. Watercourses are described moving south to north along the OHL route, with the three larger watercourses described first, followed by smaller tributary channels.

Table 7.5: Main Watercourses and Catchments within the Study Area,

Watercourse	ID	X	Y	Catchment Area[1] (km^2)	Average flow[2] (m^3/s)
River Nith	1	271100	613150	168.4	5.86
Kello Water	2	272900	609550	23.1	Ungauged
Euchan Water	3	272200	606550	17.1	Ungauged
Polmeur Burn	4	272200	612300	3.4	Ungauged
Polbroc Burn	5	272550	610350	1.4	Ungauged
Lagrae Burn	6	270650	614050	1.0	Ungauged
Guttie Burn	7	272550	610250	1.0	Ungauged
Thwarter Burn	8	273350	608950	0.7	Ungauged

[1] Area represents the total catchment area at or close to the OHL crossing location, according to the FEH Web-service or as derived from 50cm LiDAR data.

[2] Average flow derived from available SEPA gauge data (Gauge ID - 79003).

7.24 The Euchan Water is a large watercourse south of the OHL which flows north-east towards its confluence with the River Nith. At its closest, the Euchan Water is approximately 54m south of the OHL (south of tower 1) and has a catchment area of approximately 17.1km^2 (just upstream of its confluence with Feuchaw Burn). Several tributaries of the Euchan Water on the north side of the valley are crossed by the OHL, including three unnamed tributaries and the Barr Burn, which are described below:

- The first unnamed tributary of the Euchan Water flows north-east towards the larger watercourse, crossing beneath the OHL approximately 20m south of tower 3.
- The second and third unnamed tributaries flow south-east towards the Euchan Water, sourced from the slopes of Black Hill; the tributaries cross beneath the OHL between towers 4 and 5.
- The Barr Burn flows north-east towards its confluence with the Euchan Water, passing beneath the OHL ~55m north of tower 9. Where it passes beneath the OHL routeing, the Barr Burn has a catchment area of ~0.4km^2.

7.25 The Kello Water is another large watercourse which is crossed by the OHL (between towers 16 and 17). The Kello Water flows in a north-easterly direction towards its confluence with the River Nith. At their confluence, the Kello Water has a catchment area of approximately 31.1km^2; the catchment area of the Kello Water where the OHL crosses the watercourse is ~23.1km^2. Several tributaries of the Kello Water are located near or are crossed by the proposed OHL routeing, including Thwarter Burn, Quintin's Burn, Guttie Burn, Polbroc Burn and a few unnamed tributaries and/or field drains. These are described below:

- Sourced from the eastern slope of Black Hill, Thwarter Burn flows in a north-easterly direction beneath the OHL, eventually turning north-west towards its confluence with the Kello Water. The OHL crosses the burn between towers 12 and 13. The burn has a catchment area of approximately 0.7km^2 downstream of the OHL at its confluence with Quintin's Burn.
- Quintin's Burn, also sourced from the eastern slope of Black Hill, flows in a north-easterly direction east of the OHL routing, before splitting into two branches. The eastern branch of Quintin's Burn flows east beneath the OHL (south of tower 14) towards its confluence with Thwarter Burn some 290m east of the OHL centreline. The western branch of Quintin's Burn flows north towards its direct confluence with the Kello Water ~130m west of the OHL.
- An unnamed tributary to the Kello Water originates along the eastern slope of Polshag Hill and flows east towards the larger watercourse. The confluence of the two watercourses is located~170m east of the OHL, which crosses over the unnamed tributary some 130m north-west of tower 17. At its confluence with the Kello Water, the unnamed tributary has a catchment area of approximately 0.5km^2.
- Guttie Burn is sourced from the north-eastern slope of Polshag Hill, south-east of the OHL and flows north-east towards its confluence with Polbroc Burn. The OHL crosses over the Guttie Burn and its two tributaries between towers 20 and 22. At its confluence with Polbroc Burn, the Guttie Burn has a catchment area of approximately 1.0km^2.
- Polbroc Burn is sourced near Mynwhirr Hill south-west of the OHL. The burn flows north-east towards its confluence with the Kello Water, passing beneath an existing access track ~100m south-west of the OHL before continuing to flow north-east beneath the OHL, approximately 70m south-east of tower 23. At its confluence with Guttie Burn, Polbroc Burn has a catchment area of approximately 1.4km^2.
- A network of field drains run through Libry Moor. The OHL crosses over Libry Moor in a north-west direction

7.26 The River Nith is a large watercourse, flowing east around the OHL route and then eventually south into the Solway Firth. The River Nith has a catchment area of approximately 168.4km^2 where it flows beneath the OHL (between towers 34 and 35). The watercourse has a channel width of approximately 14m where it is crossed by the OHL. A SEPA flow gauge (79003) on the River Nith located just upstream of where the OHL routeing crosses the watercourse indicates that the River Nith has an average daily flow of 5.86m^3/s. Several tributaries of the River Nith are located near or are crossed by the proposed OHL routeing, including Polmeur Burn, Birk Burn, an unnamed tributary and Lagrae Burn. These are described below:

- Polmeur Burn originates south-west of the OHL and flows north and east towards its confluence with the River Nith. The OHL crosses the Polmeur Burn approximately 40m north of tower 27, after which the burn flows adjacent to the eastern side of the OHL and then turns east towards the River Nith. The catchment area of the Polmeur Burn at its confluence with the River Nith is approximately 3.4km^2.
- A small tributary (field drain) of the Polmeur Burn flows east beneath the OHL just south of the A76, between towers 30 and 31.
- The Birk Burn originates west of the proposed OHL routeing and flows in an easterly directly towards its confluence with the River Nith. The OHL crosses over the Birk Burn ~118m south of tower 33, where it has a catchment area of ~0.3km^2.
- A small tributary to the River Nith flows southwards adjacent to the OHL from tower 40 to 35. The unnamed watercourse originates in the wooded area south of tower 40 and flows south through the woods, on the eastern side of the public road. The watercourse passes beneath the road and then flows adjacent to OHL before turning south-west and flowing beneath the railroad tracks to join the River Nith. The OHL crosses the watercourse proximately 84m south-west of tower 36, where it has a catchment area of ~0.3km^2.
- Lagrae Burn originates on the south-east slope of Nethertown Hill and flows south-east towards its confluence with the River Nith. An unnamed tributary of the Lagrae Burn flows in a south-westerly direction close to the proposed Glenmuckloch Substation in the north.

Hydrology and Flood Risk

7.27 The SEPA flood maps show the likely extent of flooding for high, medium and low likelihood for fluvial, pluvial (surface water) and tidal flows.

7.28 Review of the online SEPA flood maps indicates flooding from fluvial sources along the banks of the River Nith, the Kello Water and the Euchan Water, with floodplains contained to areas directly adjacent to riverbanks:

- River Nith: the predicted 200-year flood extent at the OHL crossing location is ~120m wide and extends south of the main channel to the ~164m AOD contour. Both of the proposed OHL towers on either side of the River Nith are set back by over 50m from the edge of 200-year floodplain and are at elevations of 170m AOD (tower 34) and 182.7m AOD (tower 35). These towers are located well above the predicted floodplain and are not considered to be at flood risk. The Glenmuckloch Substation sits at an elevation of ~240m AOD and is not predicted to be at flood risk.
- Kello Water: the predicted 200-year flood extent at the OHL crossing location is ~55m wide and is largely constrained within the valley to the ~210m AOD contour. Towers 16 and 17 are set well back (>70m) and above the predicted flood extent, at elevations of 248.9 and 229.3m AOD. These towers are located well above the predicted floodplain and are not considered to be at flood risk
- Euchan Water: the predicted 200-year flood extent south of the OHL crossing location is ~55m wide and part of the public road to the south of the OHL is shown to be at flood risk up to the ~296m contour. Tower 2 is the closest to the floodplain and is ~20m north of the flood extent at an elevation 297.0m AOD. The towers and working areas are ouwith the floodplain of the Euchan Water but flooding of the public road south of the OHL should be considered during emergency planning for the construction works.

Existing Site Drainage and Surface Water Flooding

7.29 A flow pathway analysis was undertaken in GIS, based on the available topographic data (0.5m resolution LiDAR data and OS map 10m contours) to assess existing drainage pathways and overland flow routes in the vicinity of the OHL and associated infrastructure (see **Appendix 7.2**).

7.30 Existing ground levels either side of the Euchan Water slope towards the watercourse; hence any surface water runoff in the vicinity of the watercourse would flow towards the Euchan Water. This includes existing surface water runoff pathways flowing south-east beneath the OHL between towers 1 and 9 and unnamed tributaries and the Barr Burn.

7.31 North of Barr Burn (just north of tower 10), ground levels slope north and north-east towards the Kello Water and River Nith, respectively. Any surface water runoff originating north of tower 10 is thus considered likely to flow north or north-east towards either watercourse, with surface water flowing towards the OHL from the west. This includes surface water draining into both Thwarter and Quintin's Burns, which flow beneath the OHL and towards the Kello Water.

7.32 North of the Kello Water and south of Polbroc Burn, ground levels slope north-east towards the Kello Water; hence surface water is considered likely to flow north-east towards the OHL between towers 17 and 23. This includes surface water draining into Guttie and Polbroc Burns, which have catchment areas of 1.0 and 1.4km^2 respectively, with catchment areas measured just upstream of the confluence of the two burns.

7.33 North of Polbroc Burn (just north of tower 23), ground levels slope north-east and east towards the River Nith. Any surface water runoff is thus considered likely to flow north-east or east towards the large watercourse, including surface water draining into Polmeur Burn (3.4km^2 catchment) and Birk Burn (0.3km^2 catchment). Surface water would thus flow in a north-east or east direction beneath the OHL between towers 24 and 34.

7.34 North of the River Nith (north of tower 35), ground levels slope south towards the River Nith. Any surface water originating directly north of the River Nith is considered likely to flow south towards the watercourse, flowing beneath the OHL between towers 35 and 40. This includes surface water draining into the unnamed tributary north of the River Nith, which drains a catchment area of 0.3km^2.

7.35 SEPA online flood maps indicate that pluvial (surface water) flooding is generally contained either within watercourses of directly along their banks. With the exception of a small area of predicted surface water flooding south of tower 40, there is no predicted surface water flooding beneath or adjacent to the proposed OHL or at the Glenmuckloch Substation indicated on the SEPA flood maps.

Watercourse crossings

7.36 The proposed access tracks that will be used during the construction of the GGRP infrastructure will require 39 watercourse crossings; this includes small watercourses and drains mapped in the field and watercourses shown on Ordnance Survey 1:10,000 maps. The tracks require 21 new watercourse crossings and utilises 18 existing crossings on existing tracks.

7.37 Details of all the proposed access track crossings are provided in **Appendix 7.1**. The proposed OHL spans both large watercourses (e.g., the River Nith and the Kello Water) and smaller tributaries (e.g., named burns and unnamed tributaries), with catchment areas ranging from ~0.3 to 168.4km^2. Catchment areas draining to each watercourse crossing were calculated based on watershed analysis in GIS software using the LiDAR topographic data. The catchment areas of larger watercourses were extracted from the Centre for Ecology and Hydrology Flood Estimation Handbook web-service.

Water Supplies, Discharges, Abstractions and Services

7.38 There are no PWS within a 1km buffer from the GGRP infrastructure, based on information provided by DGC in June 2021, who confirmed they had no registered PWS within the PWS search area.

7.39 SEPA provided a list of groundwater abstractions close to the GGRP. There are no licenced groundwater abstractions within 1km of the GGRP. The nearest licenced abstraction is over 1.5km north of the OHL route, associated with a former abstraction from the former opencast mine at Glenmuckloch.

7.40 Available data on Scottish Water utilities in the area (i.e., water and waste-water mains and distribution networks) show that there are several areas where Scottish Water pipework is close to the proposed OHL route, as described below:

- South of the OHL, Scottish Water drawings indicate a 63mm pipe for 'natural water' running along the north side of the public road to the Glenglass substation. The pipework is located just to the south of tower 2 and should be considered during detailed design and during construction checks. However, it is understood that this pipe is no longer in use, as it was associated with the former Euchan Filter Station House, which is no longer operational.
- North of tower 23, Scottish Water drawings show a 200mm diameter surface water pipe beneath the existing road which bounds the eastern side of Libry Moor (known as the Heads of Valley road). The pipe runs along the west side of the road. Proposed access tracks to towers 23 to 27 come off the road and the pipe should be considered during detailed design and construction checks.
- North of tower 30, Scottish Water drawings show a 200mm pipe which crosses Polmeur Burn and runs along the southern side of the A76. There is also Scottish Water pipework running along the northern side of the A76.
- There is Scottish Water pipework north of the A76 around Rigg Farm and along the road north of Rigg Farm, which will be used for construction access.
- North of the River Nith, there are two small 63mm Scottish Water pipes running approximately parallel to the river, one of which is close to the working areas of tower 35.
- There is a covered reservoir at Corserig (NGR 271990 610450), which is understood to be a Scottish Water asset. The reservoir is over 330m from the nearest OHL tower (tower 22) and over 110m from an existing track that will be used during construction. Given the distance from the proposed OHL infrastructure and the covered reservoir at Corserig (>330m), the GGRP is not considered to have an effect on this asset and it is not considered further.

7.41 Cognisance of the Scottish Water services and pipework will be required during detailed design and prior to and during construction works and all pipework will be avoided.

Water Quality and Protected Areas

7.42 Under the terms of the Water Framework Directive (WFD), all river basin districts require to be characterised, a process which requires SEPA to produce an initial assessment of the impact of all significant pressures acting on the water environment.

7.43 Surface water bodies are defined as being whole or parts of rivers, canals, lochs, estuaries or coastal waters. The main purpose of identifying water bodies is so that their status can be described accurately and compared with environmental objectives.

7.44 The WFD applies to all surface waters, but for practical purposes SEPA has defined a size threshold above which a river or loch qualifies automatically for characterisation. Rivers must have a catchment area of 10km^2 or more. In addition to these larger water bodies, smaller waters have been characterised where there is justification by environmental concerns and to meet the requirements of regulatory legislation such as for drinking water supplies.

7.45 Classification of status by SEPA considers water quality, hydromorphology, biological elements including fish, plant life and invertebrates, and specific pollutants known to be problematic. The classification grades through High, Good, Moderate, Poor and Bad status. This provides a holistic assessment of ecological health. Heavily modified waterbodies, which can no longer be considered to be natural, are classified on the basis of 'ecological potential'.

7.46 In terms of the study area, the following watercourses are large enough to be classified[4]:

- The River Nith upstream of Sanquhar (Waterbody ID 10611) was classified as 'Moderate ecological potential' in 2020;
- The River Nith downstream of Sanquhar (Waterbody ID 10610) was classified as 'Moderate ecological potential' in 2020;
- The Kello Water (Waterbody ID 10616) was classified as 'Good' in 2020; and
- The Euchan Water (Waterbody ID 10617) was classified as 'Good' in 2020.

7.47 There are no surface water-related designated sites within or close to the GGRP infrastructure, however the Polhote and Polneul Burns Site of Specific Scientific Interest (SSSI) and the Lagrae Burn SSSI are both located near the proposed OHL. Further information on the SSSIs can be found in the **Geology and Soils** section below, as they are geological designations.

7.48 Scottish Water has indicated that there are no Scottish Water drinking water catchment or water abstractions sources designated as Drinking Water Protected Areas under the Water Framework Directive in the study area.

7.49 According to information provided by Marine Scotland in their Scoping Response of 5 February 2020, the River Nith catchment supports important salmon and trout populations.

Geology and Soils

7.50 The solid bedrock geology mapping (**Figure 7.3**) shows the majority of the proposed GGRP infrastructure to be underlain by solid bedrock comprised of greywackes or sedimentary coal measures, with igneous extrusions and intrusions. From south to north the bedrock of the GGRP comprises:

- Kirkcolm Formation (Ordovician): sedimentary rocks of marine origin comprised of coarse- to fine-grained slurries of debris from the continental shelf flowing into a deep-sea environment.
- Poltallan Member (Ordovician): igneous rocks of volcanic (extrusive) origin; gaseous and poor-to-rich in silica which form flows of pyroclastic deposits.
- Scottish Lower Coal Measures (Carboniferous): sedimentary rocks of fluvial, palustrine and shallow-marine origin; cyclic alternations of mudstone, siltstone and sandstone with common coal seams at some levels; rocks are detrital and form deposits reflecting channels and floodplains.
- Unnamed Igneous Intrusion (unknown age): igneous rocks of magmatic (intrusive) origin with poor silica content; rocks form intruded batholiths, plutons, dykes and sills.
- Scottish Middle Coat Measures (Carboniferous): sedimentary rocks of fluvial, palustrine and shallow-marine origin; cyclic alternations of mudstone, siltstone and sandstone with common coal seams at some levels; rocks are detrital and form deposits reflecting channels and floodplains.
- Scottish Upper Coal Measures (Carboniferous): sedimentary rocks of fluvial, palustrine and shallow-marine origin; cyclic alternations of mudstone, siltstone and sandstone with common coal seams at some levels; rocks are detrital and form deposits reflecting channels and floodplains.

7.51 As noted earlier, the GGRP is located near the Polhote and Polneul Burns SSSI, with the SSSI approximately 1.2km west of the proposed OHL at its closest (near tower 29). The SSSI is a geological designation important for Carboniferous age rock exposures within the two stream valleys. The SSSI is the best exposure of Carboniferous age rocks which form the lower part of the

[4] https://www.sepa.org.uk/data-visualisation/water-classification-hub/

Sanquhar Coalfield, containing small marine invertebrate fossils of interest. Also, of scientific interest, the exposure contains the junction between the Upper Carboniferous rocks and older underlying Ordovician rocks.

7.52 The GGRP is also located close to the Lagrae Burn SSSI, which is approximately 200m from the northern end of the OHL at its closest. The Lagrae Burn SSSI is a geological designation important for Upper Carboniferous exposures within the stream valley. The SSSI exposes the strata from the upper layers of the Scottish Coal Measures to the sandstones of the 'Barren Red' Measures.

7.53 There are no structural geology features located within the study area.

7.54 The superficial geology mapping (**Figure 7.4**) shows the majority of the GGRP infrastructure is underlain by peat or drift deposits, with alluvium along the river valleys. From south to north the superficial geology of the study area comprises:

- Alluvium comprising silt, sand and gravel: found near Euchan Water just south of tower 1;
- Peat comprising accumulated (and detrital) organic material: found near Barr Burn (from towers 6 and 11);
- Glacial Till diamicton: found near the Kello Water, the Guttie and Polbroc Burns and within the southern part of Libry Moor (between towers 13 to 26; and towers 28 to 29); also found north of the River Nith from tower 33 to the Glenmuckloch Substation; and
- Glaciofluvial Deposits comprising gravel, sand and silt: found on the southern side of the River Nith (from towers 26 to 28 and from towers 29 to 33).

7.55 Scottish Soil mapping (**Figure 7.5**) shows that the study area is underlain by a variety of soil types, including (described from south to north):

- Peaty gleys: covers much of the study area including an area near the Euchan Water (near tower 1) and the central part of the route around Quintin's Burn, Guttie Burn, Polbroc Burn and Polmeur Burn and within Libry Moor (between towers 13 and 29);
- Humus-iron podzols: found near the Euchan Water (south of tower 2 to just north of tower 5); also found within the Kello Water river valley (between towers 16 and 17);
- Peaty podzols: found along the western side of Drumbuie Moorhead (between towers 5 and 7 and at tower 12);
- Non-calcareous mineral gleys: found along the eastern side of Drumbuie Moorhead (between towers 8 and 11); also found north of Polmeur Hill to the northern extent of the route (from tower 29 to the Glenmuckloch Substation); and
- Brown earths: a small section found along the River Nith (between towers 34 and 35).

7.56 The NatureScot (2016) Carbon and Peatland Mapping (**Figure 7.6**) indicates that carbon-rich soils, deep peat and small areas of priority peatland habitat are likely present in localised areas along the OHL route, including the following classes:

- Class 1 (pink): Nationally important carbon-rich soils, deep peat and priority peatland habitat (i.e., land covered by peat-forming vegetation or vegetation associated with peat formation); there is one small area of Class 1 priority peatland habitat located within the upper catchment of the Barr Burn. The OHL infrastructure avoids the Class 1 peat and at its closest (tower 8) is approximately 35m west.
- Class 3 (blue): Dominant vegetation cover is not priority peatland habitat but is associated with wet and acidic soils, where most soils are carbon-rich with some areas of deep peat; there are extensive areas of Class 3 peatland throughout the study area, stretching from Drumbuie Moorhead to land both south and north of the Kello Water (between tower 12 and tower 19) and land around the Polmeur Burn and Polmeurhill Wood (between towers 27 and 28).
- Class 5 (green): No peatland habitat recorded, but soils are carbon-rich and deep peat is present; there are extensive areas of Class 5 peatland throughout the study area, including land either side of the Euchan Water (near tower 1) and a large stretch of land around Hunter's Hill and all of Libry Moor (between towers 19 and 26).

Peat

7.57 Detailed peat depth surveys were undertaken where peat was shown to be likely based on the Carbon and Peatland (2016) map at proposed tower locations and along proposed access tracks. Probing was also carried out in areas which were not classed as peatland, and it was noted that some areas of peat were found. Cores were taken in representative locations. Full details of the peat survey are provided in **Appendix 7.3** and used to inform the peat management plan (**Appendix 7.4**).

7.58 Whilst peat is absent across much of the GGRP infrastructure, the initial peat survey encountered several areas of deep peat, particularly on Barr Moor. The results from the early phases of the surveys were used to feed into the design and the requirements for further peat depth surveying. Deep peat and Class 1 peat were avoided during early iterations of the design.

7.59 The Scottish Government guidance document on peat landslide hazard and risk assessment (Scottish Government, 2017) defines peat as a soil greater than 0.5m in depth, with an organic matter content of more than 60%. Soils of less than 0.5m depth are classified as organo-mineral soils. This is further evidenced by JNCC (2011)[5], SNH (Bruneau, et al, 2014)[6] and the James Hutton Institute (2019)[7]. Depths of 1m or greater are considered to be "deep peat", according to the same guidance.

7.60 A total of 2,908 probes were collected across the survey periods and the results are summarised below and in **Table 7.6**.

- 80.4% of probes were recorded as having a peat depth of less than 50cm across the peat survey. These probes are classified as organo-mineral soils and not formally considered to be peat.
- 90.5% of probes were recorded as having a peat depth of less than 100cm across the peat survey.
- 9.5% of the probes were recorded as having a peat depth of over 100cm across the peat survey. These probes are classified as 'deep-peat'.

7.61 A total of 37 cores were taken across the surveys; the location of the cores and results are discussed in **Appendix 7.3** and summarised below:

- 19 of the 37 cores (51%) were in areas which contained peat. It was not possible to delineate the acrotelm layer in all the cores. When possible, it was determined that the acrotelm layer was up to 30cm deep.
- Generally, the substrate material beneath the peat was mixed, with the cores containing peat having either a clay, rock/gravel or bedrock base.

Table 7.6: Summary of peat probe data

Peat depth range (cm)	Number of probes	Percentage of total probes
< 50	2,337	80.4%
50 - 99	296	10.2%
100 - 199	224	7.7%
200 - 299	46	1.6%
300 - 399	5	0.2%
Total	2,908	100%

7.62 The spatial distribution of peat depths over the route connection and infrastructure is shown in **Figure 7.7**. Peat was not recorded at the majority of the connection infrastructure, with depths <0.5m at over 80% of probe locations. Approximately 10% of probe locations recorded peat between 0.5m and 1m. Areas of deep peat (>1.0m in depth) were recorded at the following main locations along the route:

- Localised, modified peat in forestry near towers 1 and 2, with depths up to 1.3m;
- Unmodified peat up to 1.7m close to tower 5;
- Large areas of unmodified deep peat up to 3.7m in the area around towers 8 to 11 and their associated construction areas and access tracks;

[5] Joint Nature Conservation Committee, (2011). Towards an assessment of the state of UK Peatlands, JNCC report No. 445.
[6] Bruneau, P.M.C & Johnson, S.M. (2014). Scotland's peatland - definitions & information resources. Scottish Natural Heritage Commissioned Report No 701
[7] James Hutton Institute (JHI) (2019). Organic Soils. Website: https://www.hutton.ac.uk/learning/exploringscotland/soils/organicsoils. James Hutton Institute.

- Very small area of peat bog at tower 32. With one depth >1m recorded at 1.3m;
- Large, isolated pocket of undisturbed peat up to 3.2m deep between towers 33 and 34;
- An area of peat bog south-west of tower 40 with a number of depths and cores > 1m recorded; and
- An area of peat bog north-west of the proposed substation at the northern limit of the survey, with depths up to 2.9m.

7.63 Observations of peatland condition were also made during the surveys. The entire site appears to have been influenced by recent or historic human activity. Along the route there are areas of peat with a depth greater than 1m, as described above. These are predominantly concentrated in the southern part of the route on Barr Moor (between towers 8-11). A small area in the northern part of the route, near Rigg Farm (between towers 33 and 34), was also found to have deep peat; this area is well constrained with the peat located in a topographic hollow and was avoided during route design iterations. Photographs of typical peat observed at the site are provided in **Appendix 7.3**.

7.64 The forested areas of Libry Moor are comprised of commercial plantation and the ground had been heavily disturbed in the process of creating the forest. This is also the case in the southern part of the site near Glenglass substation which has previously been commercial forestry. Areas of peat within existing or previously forested areas have been heavily impacted by the implemented drainage network; with a series of deep drainage ditches ranging from 0.5 to 1.0m wide and 1.0 to 1.5m deep.

7.65 As recommended by NatureScot, all potentially affected peatland habitats with the survey corridor are mapped to National Vegetation Classification (NVC) standards, which are more sensitive to the hydrological variation that occurs in blanket bog than the Phase 1 classifications. The results of the NVC surveys are presented in **Figure 8.4** in **Chapter 8: Ecology.**

Groundwater

7.66 The majority of the OHL routeing is underlain by greywackes and sedimentary coal measures, which are classified as having low and moderate aquifer productivity respectively. The low productivity aquifers of the Kirkcolm Formation (greywackes) have limited groundwater in the near surface weathered zone and secondary fractures only. The moderate productivity aquifers of the Scottish Coal Measures are regional, cyclic multi-layered aquifers with low yields from the sandstone layers.

7.67 Superficial quaternary alluvial deposits (near Euchan Water) and glaciofluvial deposits (near the River Nith) are classified as having high superficial deposit aquifer productivity, as these deposits have significant sand and gravel content. However, variations in permeability and thickness of the deposits will affect their aquifer productivity.

7.68 The superficial deposits of glacial till found along a large part of the route are classified as having low superficial deposit aquifer productivity with limited or local potential.

7.69 The groundwater bodies underlying the study area are the Upper Nithsdale waterbody (ID 150663) in the southern part of the route and the Sanquhar water body (ID 150518), north of tower 20; both of which were classified by SEPA as having an overall classification of 'Poor' in 2020.

7.70 SEPA groundwater flood maps suggest that the site is not at risk of groundwater flooding. It is likely that groundwater levels within the study area are controlled by water levels within the proximal large watercourses (i.e., River Nith, Kello Water and Euchan Water). Groundwater monitoring is normally undertaken as part of the site investigations. If locally raised groundwater levels are identified during site investigations, suitable mitigation measures would need to be employed.

Groundwater Dependent Terrestrial Ecosystems (GWDTEs)

7.71 The ecology surveys identified several NVC communities that are associated with potential GWDTEs (these are described in **Chapter 8: Ecology** and **Appendix 8.2**). However, following a walkover survey by ecologists and hydrologists and due to their topographic and hydrological setting, none were considered to be GWDTEs.

Future Baseline in the Absence of the Development

7.72 If the GGRP did not proceed, the existing baseline conditions described above would not be expected to change significantly. The main change in the baseline is related to climate change (see below).

7.73 It is noted that the predicted flood risk is the best-available prediction at the time of assessment. Hydrological analyses changes over time, as the prediction of peak flows is based on the time-series of flow and rainfall data which change as more data becomes available. Hence, the extent of flooding may change over time, given the potential for events exceeding design conditions and the inherent uncertainty associated with estimating hydrological parameters for any given site and the effects of climate change.

Implications of Climate Change

7.74 The 2018 climate change projections (UKCP18) for the Solway River Basin indicate that the study area will experience hotter, drier summers and milder, wetter winters.

7.75 Scottish Planning Policy states that "planning system should promote a precautionary approach to flood risk from all sources, including coastal, water course (fluvial), surface water (pluvial), groundwater, reservoirs and drainage systems (sewers and culverts), taking account of the predicted effects of climate change" (SPP, 255). The National Planning Framework 4[8] (NPF4) notes "Development proposals will be sited and designed to adapt to current and future risks from climate change"

7.76 In 2019, SEPA published guidance on climate change in Scotland which provides a regional based approach. The guidance was updated in March 2022 and is based on UKCP18 predictions[9]. For river catchments over 50km^2, the peak (200-year return period) design flow should be increased by 53% in the Solway River Basin to account for projected climate change increases to the year 2100. In addition, the peak rainfall intensity allowance in the Solway River Basin is +38% to the year 2100. Thus, this part of Scotland is likely to get wetter with higher peak flows in the rivers in the future.

7.77 In the absence of the GGRP, climate change may result in an increase in the magnitude of fluvial and groundwater flooding and the increase in rainfall could affect the operation of existing drainage and sewer systems.

7.78 Any site drainage and watercourse crossing designs will consider future estimates of increased precipitation and flows and will follow an adaptive approach.

7.79 In addition, increased winter rainfall could result in an increased risk of subsidence and compression of soils, with changes in ground moisture leading to ground movements due to shrink-swell behaviour.

Project Design Considerations

7.80 During initial design, a buffer of 50m from all watercourses was recommended for GGRP infrastructure and construction activities. However, given the number of small watercourses and drains, a 50m buffer was not achievable for all watercourses due to the spacing of OHL towers required to meet span widths. Smaller buffers for smaller watercourses were achieved for some OHL towers, with buffer width based on SEPA (2017)[10] guidance and project consultation (**Table 7.1**). Details of buffers achieved are set out in **Appendix 7.1** and discussed below. In summary, there will be no construction activity or infrastructure within 10m of any watercourse and with larger buffers for the larger watercourses.

7.81 All infrastructure components were designed to avoid deep peat and priority peatland habitats, where possible. Constraint feedback following initial peat survey led to track and tower repositioning to avoid areas of deep peat and the Class 1 peatland area.

Infrastructure Location Allowance

7.82 A 50m Infrastructure Location Allowance (ILA) will be used for the project infrastructure (i.e., 50m either side of all infrastructure; refer to **Chapter 4: Development Description**). However, it should be noted that micrositing of infrastructure within the ILA closer to watercourses or water features will not be undertaken. Micrositing within the ILA will be undertaken to move infrastructure further away from sensitive water features and deeper peat, where possible. The ILA does not apply to the Glenmuckloch substation.

Embedded Mitigation

7.83 A number of good practice pollution prevention and control measures will be put in place during felling operations and construction. These will be embedded into the project design and reflect best practice guidance and recognised industry standards, as well as SPEN's recent experience of constructing overhead lines. Many of the measures mitigate several potential effects (e.g.,

[8] National Planning Framework 4 (NPF4) will be coming into operation early in 2023. If it is passed through government, it will supersede Scottish Planning Policy (SPP)
[9] SEPA (2022). Climate change allowances for flood risk assessment in land use planning. Land Use Planning System. SEPA Guidance. Version 2, March 2022

[10] SEPA (2017) Background Paper on the Water Environment, LUPS-BP-GU2b

mitigation to minimise sedimentation and pollution such as Sustainable Drainage Systems (SuDS) which can also serve to attenuate surface water run-off and minimise flood risk).

7.84 Embedded mitigation measures that are incorporated into project design are described in detail in **Appendix 3.3: Schedule of Mitigation** and include:

- Measures to reduce effect on increased flood risk and increased run-off;
- Measures to reduce sedimentation and erosion;
- Measures to reduce pollution and accidental spillage;
- Measures to be put in place at watercourse crossings;
- Peat management measures; and
- Measures to reduce sedimentation, erosion and pollution during forestry felling.

7.85 A detailed assessment of drainage flow paths was carried out to identify catchment areas that could drain towards construction access tracks from upgradient areas (see **Appendix 7.2**). Surface water runoff from these areas will flow towards the access tracks during heavy rainfall events and will need to be managed to avoid contamination and pollution. The drainage assessment was used to identify areas where embedded SuDS mitigation will be required (see **Appendix 7.2**). Drainage measures for access tracks includes (but is not limited to):

- Appropriately sized culverts passing under the access tracks that do not restrict flow and allow small watercourses, intercepted field drains and ephemeral streams/surface water flow to pass under the tracks;
- Drainage ditches on the upslope side to intercept and divert 'clean' surface water run-off draining towards the tracks; and
- Ditches in the form of swales parallel to the downslope side of access tracks to capture run-off and sedimentation from the access tracks. These will be used to treat and attenuate surface water run-off before discharge.

7.86 Construction of watercourse crossings on minor watercourses of the access tracks will follow general good practice and GBRs as outlined in **Appendix 3.3.** The type of temporary bridges proposed for new crossings are:

- Narrow burns: a mat of timbers will be used, supported by steel beams; and
- Larger watercourses: a steel plate decking including safety barriers either side will be used, supported by main support beams with steel cross members.

7.87 Neither of these bridging solutions will affect the bed and banks of watercourses. Fording of watercourse will be avoided. Design and implementation of crossings will follow best practice, including recommendations in SEPA (2010) Engineering in the Water Environment Good Practice Guide – River Crossings.

7.88 During construction, temporary construction SUDS will be put in place at each watercourse crossing to ensure no sedimentation from construction works or pollution from plant or machinery can enter the watercourse. This could be a series of settlement ponds or settlement tanks and silt fences. An area of 20m width either side of the watercourse and 20m upstream and downstream of the crossing (i.e., a 40m x 40m area) will allow for sufficient temporary SUDS to be put in place during construction as embedded mitigation. This will be sufficient for all crossings and is likely to be an over-estimate of the area required for small watercourses and will allow the contractor space to incorporate the amount of SuDS/settlement ponds required at each location, even in an emergency situation.

7.89 A Construction Site Licence (CSL) will be required from SEPA under the CAR Regulations in advance of the construction works which will include a detailed Pollution Prevention Plan (PPP) to ensure that any discharges of water run-off from the site to the water environment do not cause pollution. This will be prepared, and authorisation sought from SEPA, before construction commences. The drainage assessment and recommendations described in **Appendix 7.2** will feed into the PPP.

7.90 Prior to construction and on completion of ground investigations and micro-siting, a site waste management plan shall be produced, including for site soil and peat management good practice. It will ensure that excavated peat is appropriately managed and re-used.

7.91 A Construction and Environmental Management Plan (CEMP) will also be developed and agreed with DGC and SEPA in advance of the works. The CEMP will establish a framework to ensure that health and safety and environmental best practices are adopted throughout the works. The CEMP will include the approved PPP and Peat Management Plan. An outline CEMP is provided as **Appendix 4.1**.

7.92 The assessment of effects is undertaken assuming that embedded mitigation is an integral part of project design. Additional mitigation is identified during the assessment to address localised site or issue specific likely significant adverse effects and is described within the '**Proposed Mitigation**' section below.

Assessment of Effects

7.93 The assessment of effects is based on the project description as outlined in **Chapter 4: Project Description**. Unless otherwise stated, potential effects identified are considered to be negative.

Construction Effects

Predicted Construction Effects

7.94 The following construction effects have been assessed in full:

- Effects on surface and ground water quality;
- Effects on channel morphology (bank erosion and channel form);
- Effects on hydrology, run-off rates and flood risk; and
- Direct and indirect disturbance of peat during construction.

7.95 The sensitivity of receptors (within the study area) has been assessed in **Table 7.7**, using the criteria found in **Table 7.2**.

Table 7.7: Sensitivity of Receptors

Receptor	Sensitivity	Comment
Watercourses / Surface Water Bodies: Major watercourses: River Nith, Kello Water and Euchan Water All tributaries: Feuchaw Burn, Barr Burn, Thwarter Burn, Quintin's Burn, Guttie Burn, Polbroc Burn, Polmeur Burn, Birk Burn, Lagrae Burn and unnamed tributaries.	High	All watercourses drain either directly or indirectly to the River Nith catchment, which is known to support important salmon and trout populations. The sensitivity of all watercourses is thus considered high. The River Nith was classified by SEPA as of 'moderate' ecological potential. The Kello Water and the Euchan Water were both classified by SEPA as 'good'. The Lagrae Burn flows through the Lagrae Burn SSSI (a geological designation). The SSSI is upstream of the proposed GGRP infrastructure.
Groundwater	Low	The study area is located on low to moderate productivity aquifers, with the groundwater quality classified by SEPA as 'poor'.
Peat	Low to Medium	Low where modified (non-active peatland) or shallow peat (0.5 to <1m depth) is present. Medium where deep unmodified peat (>1m depth) is present (e.g. on Barr Moor near towers 8-11). There is no proposed infrastructure on NatureScot Class 1 priority peatland habitat. The majority of the peat deposits are modified by forestry activities/ agriculture and are NatureScot Class 3, 4 or 5.

7.96 The activities that will occur during the construction phase that may have an impact on the water environment and peat include: site clearance and vegetation (forestry) removal; use of heavy plant machinery; increase of hardstanding areas; construction and upgrading of temporary access tracks; construction of the Glenmuckloch Substation; watercourse crossings; associated earthworks/excavation/re-profiling; storage of materials; and laydown/scaffolding areas and construction traffic on access tracks.

7.97 The design of construction access sought to use existing access tracks as much as possible to avoid new watercourse crossings and land take. However, given the hydrological setting of the OHL routeing (along the slopes of the River Nith and Kello Water valleys), there are a number of named and unnamed watercourses which were unavoidable. New temporary watercourse

crossings, upgrade of existing watercourse crossings and stringing of the OHL over watercourses could potentially impact channel morphology during construction.

7.98 The OHL crosses many small (<2m wide) watercourses and several large named watercourses also require to be crossed, namely: the River Nith, Kello Water, Guttie Burn, Polbroc Burn, Polmeur Burn and Lagrae Burn. Details of stringing the OHL over watercourses is described in **Chapter 4** and no works will take place within the watercourses. Scaffolding is required for the stringing of the OHL across the River Nith (and adjacent railway line).

7.99 In their initial scoping consultation, SEPA recommended a minimum buffer of 50m around each loch/ watercourse (**Table 7.1**). This was achieved for most of the larger watercourses (e.g. River Nith and Kello Water). However given the constraints of the site and after further consultation, SEPA agreed in principle that the applicant can use smaller buffers for smaller watercourses (as per the SEPA (2017)[11] planning guidelines. The guidelines define a buffer strip as *"an area of land where no development is permitted and is maintained in permanent vegetation that helps to control soil and water quality and has other environmental benefits*". SEPA (2017) recommend a buffer strip of a minimum of 6m on either side of a watercourse and should be proportional to the bank width, with wider rivers having a larger buffer strip than a narrow burn. SEPA recommend the following minimum buffer widths for development (**Table 7.8**).

Table 7.8: SEPA (2017) Guidelines For Recommended Minimum Buffer Widths on Watercourses

Width of Watercourse (top of bank)	Width of Buffer Strip (either side)
Less than 1m	6m
1-5m	6-12m
5-15m	12-20m
15m +	20m +

source: SEPA (2017) Background Paper on the Water Environment, LUPS-BP-GU2b

7.100 There are 28 locations where a 50m buffer from permanent and temporary infrastructure could not be achieved. These 50m buffer encroachments are detailed and assessed in **Table 2** of **Appendix 7.1**. The locations are labelled A - AA and are shown in **Figure 7.2**.

7.101 In all cases the recommended minimum buffer widths shown in **Table 7.8** have been achieved. A minimum buffer of 10m was applied to all water features for both temporary infrastructure (access tracks, construction working areas, laydown areas and scaffolding works). However, an assessment of the potential effect of not achieving the 50m buffer and recommendations for any additional mitigation (if required) is provided on a site specific basis in **Table 2** (**Appendix 7.1**).

7.102 There are 21 new crossings of watercourses/drains for temporary access tracks required for the construction of the OHL (see **Appendix 7.1**). Most of these are small watercourses (<2m wide) identified on site. None of the new crossings will require authorisation under the CAR Regulations (see **Appendix 7.1**) as most of the new crossings are on minor watercourses and will be covered by SEPA's GBRs.

7.103 There are 18 watercourses that are crossed by existing tracks to be used during construction. These crossings will need to be maintained and/or improved depending on their condition. The need for upgrade will be reviewed in detail at each crossing prior to construction. A CAR authorisation is not likely to be required for minor upgrade works to existing track crossings, however this will be verified prior to construction in consultation with SEPA. Of the 18 existing crossings, 14 are on minor watercourses which will not require any authorisations under CAR to upgrade, although GBRs and good practice will be followed. Existing crossings ID19, 20, 24 and 33 are not on minor watercourses, therefore upgrading works may require authorisation under CAR.

Effects during construction on surface and ground water quality

7.104 The potential effects on surface water quality during construction are as follows:

- Pollution of surface waters caused by the release of sediment to watercourses from excavated material during construction of OHL towers and the Glenmuckloch Substation, heavy plant movement on the access tracks, working areas and laydown areas and the felling of forestry/vegetation.
- Pollution of surface waters caused by the release of hydrocarbon pollution resulting from accidental oil or fuel leaks or spillages. There is also a risk posed by concrete (and other construction material) spillages during the formation of foundations and hardstanding areas at the tower bases.
- Pollution/sediment run-off during construction of new temporary watercourse crossings for access tracks.

7.105 The potential effects on groundwater quality during construction are as follows:

- The risk of hydrocarbon pollution of groundwater resulting from accidental oil or fuel leaks from construction traffic and construction works. There are also potential pollution effects caused by silt and sediment disturbed during construction infiltrating into the groundwater and concrete spillages.

7.106 Risks to surface water quality will be greatest during construction when works involve the exposure of bare earth which could result in increased erosion and sedimentation. The increase in sediment concentration in runoff from construction areas and access tracks may result in excessive levels of suspended sediment in watercourses. This can have an indirect effect on watercourse ecology and fish (see **Chapter 8**).

7.107 Felling can result in increased surface water run-off and sediment run-off. Direct felling of an area of 35.1ha of forestry is required for the OHL wayleave corridor, substation, and access tracks. There is an additional predicted 22.5ha to be felled (or lost) as a result of future windthrow (refer to **Chapter 4**). It is noted that effects associated with the windthrow felling area are indirect effects.

7.108 Pollutants can enter the watercourses in the event of accidental spills or leaks from machinery and vehicles and in the event of an accidental release of concrete or other building materials. Pollutants could enter watercourses directly or via overland flow pathways. Shallow groundwater could also be affected.

7.109 With the embedded mitigation measures detailed in **Appendix 3.3** and summarised above in place, the magnitude of the effect of increased sediment/silt runoff causing a deterioration in surface water quality in waterbodies and watercourses within and downstream of the site during construction is considered to be **minor** and temporary and the significance of the effect is **minor**.

7.110 Embedded mitigation measures to minimise the risk of pollution and accidental spillage will minimise the likelihood and severity of such incidents happening; however, there is still a residual risk. The magnitude of effect of pollution of surface water and groundwater caused by the release of hydrocarbon pollution and concrete resulting from accidental oil or fuel leaks or spillages is considered to be of short duration and **minor** and the significance of the effect is **minor**.

Effects during construction on channel morphology (bank erosion and channel form)

7.111 The effect on channel morphology (bank erosion and channel form) during construction is assessed to be of **negligible** magnitude, as embedded mitigation measures, including a minimum 10m buffer zone and environmentally sensitive bridge design, have been incorporated into the project design. This will result in a significant of effect of **none**.

Effects during construction on run-off rates, flood risk and groundwater levels/recharge

7.112 In accordance with the Risk Framework within Scottish Planning Policy (SPP), new development should be limited to areas outside the medium risk 200-year (0.5% Annual Probability (AP)) functional floodplain. National Planning Framework 4 (NPF4) defines a flood risk area as one that lies within the 200-year floodplain, including an appropriate allowance for future climate change. Floodplains were avoided during the routeing and design process.

7.113 The OHL routeing is considered 'essential infrastructure' under the SEPA Flood Risk and Land Use Vulnerability Guidance, which notes that essential infrastructure can be in medium to high risk flood areas (i.e., >0.5% AP) if a flood risk location is required for operational reasons and an alternative lower-risk location is not available.

7.114 Review of SEPA flood maps indicated that none of the OHL towers are within or close to the edge of the 200-year floodplains (medium likelihood flood) of major watercourses within the study area (see discussion in **paragraph 7.28**). In the southern part of the connection, parts of the public road south of the OHL (towers 1 and 2) are within or close to the predicted floodplain of the Euchan Water. This should be considered during emergency planning for the construction works. Tower 40 is located just north of an area of

[11] SEPA (2017) Background Paper on the Water Environment, LUPS-BP-GU2b

predicted surface water flood risk, associated with a low lying area of land upgradient of the Stank Burn. The tower is located on higher ground, north of the flood risk area, however the potential for surface water ponding during heavy rainfall events in this area of the OHL will be considered and avoided during construction.

7.115 Compaction of soils and increased areas of hardstanding reduces the infiltration rate leading to a greater rate and volume of surface water runoff. Clear felling forestry and other vegetation can also lead to an increase in surface water runoff rates. This results in a "flashier" catchment response and could increase flood risk downstream. While the magnitude of the change would not be anticipated to be great due to the small area of semi-permeable surfaces compared to the total catchment areas, SEPA and DGC highlighted in their consultation responses that there should be no increase in flood risk as a result of the project and that runoff should mimic that of existing conditions and should not be increased.

7.116 The construction of infrastructure, such as access tracks, could affect (block or realign) natural flow pathways, resulting in changes to the local runoff rate and volume and potentially resulting in the change in contributing catchment areas. This would also have an effect on the rate and volume of water reaching receiving watercourses and other downstream receptors.

7.117 Changes to the rate and volume of infiltration due to the construction of infrastructure could also affect recharge rates to the groundwater body. Excavations for tower foundations during construction could also result in local changes to groundwater levels, as water would tend to fill up the excavated areas and could modify local shallow groundwater flow paths.

7.118 The GGRP design incorporates SuDS and other embedded good practice mitigation measures to minimise the risk of increased run-off and flood risk (see **Appendix 3.3** for details) and the discharge of attenuated surface water runoff from the working areas and access tracks into the watercourses will be limited to greenfield runoff rates entering each watercourse from the site at present.

Table 7.9: Summary of land take within each main river catchment

Main watercourse	Extent of OHL connection within catchment	Total area of land take (ha and km^2)	Watercourse catchment downstream of OHL infrastructure (km^2)	% of catchment area
Euchan Water	Towers 1 to 9, and ancillary development	2.23 ha / 0.02 km^2	36.6 km^2	0.06%
Kello Water	Towers 10 to 23, and ancillary development	2.81 ha / 0.03 km^2	30.7 km^2	0.09%
River Nith	Towers 24 to 40,Glenmuckloch Substation, and ancillary development	2.96 ha / 0.03 km^2	188.9 km^2	0.02%

7.119 The catchment area of three main watercourses downstream of the OHL infrastructure are given in **Table 7.9**. The total area of hardstanding or semi-permeable surfaces proposed within each catchment are 2.23ha, 2.81ha and 2.96ha, which represents 0.06%, 0.09% and 0.02% of the total catchment area of the Euchan Water, Kello Water and River Nith, respectively. Thus the increase in run-off rates and flood risk during construction with good practice in place is considered to be of **negligible** magnitude and the significance of the effect is **none**.

7.120 The effect of site clearance, felling and construction on run-off rates and flood risk is considered to be of **negligible** magnitude and significance will be **none** on watercourses downstream of the connection.

7.121 Excavations for tower foundations require excavation to a depth of 4m and 5m for line and angle towers, respectively. Excavations could temporarily impact local groundwater levels and local recharge. The effect is considered to be of short duration and reversible and is considered to be of **minor** magnitude and **minor** significance.

Direct and indirect disturbance of peat during construction

7.122 The alteration of the geological environment by the excavation of the subsoil and peat required to build the infrastructure such as tower bases, the Glenmuckloch Substation, laydown and working areas, access tracks and forestry removal will result in some alteration of the geological environment. In particular, any underlying topsoil and peat may be temporarily removed and will need to be managed appropriately.

7.123 Activities, or effects of activities, that have the potential to alter the geological environment include:

- earthworks and site drainage;
- reduction in water table resulting in the drying out, oxidation and potential erosion of peat;
- excavation and removal of peat;
- the disturbance and loading of peat by vehicle tracking; and,
- forest felling activities.

7.124 In the absence of detailed foundation design and ground investigations for foundations, calculations in **Appendix 7.4** assume that the majority of peat and/or soil will be removed for the tower foundations, working areas, and temporary track construction (other than where floated). This may result in an over estimation of the peat / soil volumes likely to be excavated and it is likely that the peat / soil volumes excavated will be less.

7.125 The detailed peat volumes excavated for the OHL route and associated infrastructure (including the Glenmuckloch Substation are presented in **Appendix 7.4** and summarised below.

7.126 Based on comparison of layout footprints with the peat model generated from peat depth data, approximately 8,200m^3 of peat will be excavated, of which c. 2,500m^3 will be acrotelmic and 5,700m^3 will be catotelmic. That excavated for tower foundations, the Glenmuckloch substation and its associated permanent track require reuse elsewhere and total c. 600m^3 of acrotelm and c. 1,300m^3 of catotelm. The remainder (c. 1,900m^3 of acrotelm, c. 4,400m^3) will be sidecast at the point of excavation and directly reinstated once the towers are constructed and tracks removed. Of the c.1,900m^3 to be permanently excavated, c. 1,200m^3 will be used to reinstate a level ground surface in three sections of floated track totalling 760m in length over three locations (see **Figure 7.4.3, Appendix 7.4**). In these areas, primary consolidation arising from track construction and secondary compression under vehicle loading are estimated to lead to c. 0.4m reduction in ground surface under the tracks. Peat reinstatement will prevent these areas from becoming surface drainage pathways. The remaining c. 700m^3 of peat will be used to tie in the northern margin of the Glenmuckloch Substation, linking two areas of deep peat to the west and to the east of its proposed location.

7.127 In additional to the temporary and permanent excavation of peat, approximately 21,100m^3 of soil will be excavated to support temporary working areas, access tracks and the substation. Of this, approximately 430m^3 will be permanently excavated for tower foundations and 3,750m^3 for the Glenmuckloch Substation. The remainder will be directly reinstated post-construction.

7.128 Temporary storage of any soils or peat will be close to where it is to be reused, within the working areas and not located on existing peat deposits or within 25m of a watercourse or sensitive ecological habitats.

7.129 Adherence to the Outline PMP will enable the excavated soil and peat to be appropriately managed and re-used onsite. Prior to construction and on completion of ground investigations and micro-siting within the ILA, the Outline PMP will be refined and agreed with SEPA and NatureScot, including specification of temporary storage areas.

7.130 Construction work on peat has the potential to cause peat instability, which may affect both peat soils (and their inherent carbon stores), peatland habitats and nearby watercourses, infrastructure or land uses. A peat landslide hazard and risk assessment (PLHRA) has been undertaken and is documented in **Appendix 7.5**. The assessment has calculated the likelihood of peat landslides, the potential consequences should they occur and the associated risks to receptors. Two potential source locations of Moderate likelihood were identified at Tower 28 and the approaching temporary access track. The primary receptor identified was the Polmeur Burn, which is hydrologically connected to the River Nith (c. 2km downstream), leading to a Low risk from debris ingress (the Nith is not designated).

7.131 Additional mitigation of peat landslide risk will be achieved through excavation of the access track section (rather than floating) and tower working area, isolating the downslope area above the Polmeur Burn from drainage for the duration of construction. Drainage management will be designed to prevent water build up on the downslope side of the works, and regular monitoring of the slopes above and below this area will be undertaken throughout the construction period. It is anticipated that these mitigation measures will reduce the likelihood of instability to Low, and therefore the risk to Negligible.

7.132 Prior to construction and on completion of ground investigations and micro-siting, a site waste management plan shall be produced, including for site soil and peat management good practice. It will ensure that excavated peat is appropriately managed and re-used.

7.133 Assuming embedded mitigation measures detailed above are incorporated into project design and are effective, the magnitude of the effect on peat (as an excavated soil) is **none** for the majority of the GGRP as peat is not present or **minor** (for peat

loss/disturbance) where shallow or modified/not active peatland peat is present and **none** (for peat instability). Overall, the significance of the effect on peat loss/disturbance is **minor**.

Proposed Additional Mitigation

7.134 With embedded mitigation measures incorporated into project design, including SuDS pollution control and attenuation measures, there are no significant effects on hydrology, water quality or channel morphology. Details of the embedded mitigation summarised in this chapter and in **Appendix 3.3** will be set out in detail prior to construction in the PPP, CEMP and construction method statements. The PPP will require approval by SEPA to obtain a CAR Construction Site Licence. The PPP will also contain details of the location specific additional mitigation for relevant infrastructure comprising the GGRP and the contractor will be legally obliged to comply with the pollution control and drainage measures agreed in the PPP, CEMP, construction method statement and Construction Site Licence.

7.135 Additional mitigation and SuDS (e.g. silt fences, settlement ponds) will be installed around the following working areas and access tracks during construction to reduce the risk of sediment/silt run-off to the water environment during construction:

- T1 working area near small drainage ditch;
- T3 working area near small, unnamed watercourse;
- T9 working area upgradient of the Barr Burn;
- T12 working area upgradient of Thwarter Burn;
- T14 working area upgradient of Quintin's Burn;
- T21 working area and temporary access track upgradient of Guttie Burn;
- Access track to T22 close to unnamed watercourse;
- Access track to T22 and scaffolding required for OHL stringing across public road upgradient of Polbroc Burn;
- T23 working areas and access tracks near drainage ditches within Libry Moor;
- T24 working areas and access track near drainage ditches;
- T26 working area near drainage ditches;
- T27 working area and access track upgradient of Polmeur Burn;
- T28 working area near drainage ditches;
- T30 working area and scaffolding required for OHL stringing across A76 upgradient of unnamed tributary of Polmeur Burn;
- T33 working area upgradient of Birk Burn;
- Scaffolding required for OHL stringing across River Nith;
- Access track to T40 upgradient of Stank Burn; and
- Glenmuckloch Substation upgradient of unnamed watercourse/ditch.

7.136 Dewatering and physical cut-offs will be avoided where possible and drainage measures will be designed to minimise the effect on the lowering of the groundwater table. Permanent physical cut-offs will be avoided.

7.137 Any excavated peat will be stored appropriately nearby and re-used as soon as possible for reinstatement. Further ground investigation will be undertaken for the foundation and temporary track locations to determine the most suitable foundation and temporary track type so that the volumes of excavated peat can be reduced further.

7.138 An ECoW (or equivalent) will be on site throughout the construction to monitor the effectiveness of the embedded and additional mitigation measures.

7.139 Cognisance of Scottish Water services and pipework will be required during detailed design and prior to and during construction works.

Residual Construction Effects

7.140 With embedded mitigation and additional site-specific mitigation, the significance of residual construction effects is either minor or none and is summarised in **Table 7.10**.

Operational Effects

Predicted Operational Effects

7.141 The likely operational effects of the GGRP are associated with the permanent infrastructure (e.g. tower bases, Glenmuckloch substation and access track to the substation) and any required maintenance work during operation, which will be infrequent.

7.142 During operation, the increase in hardstanding areas (tower legs, Glenmuckloch Substation and track) within the rivers' catchments could result in a very slight increase in the rate and volume of surface water runoff, leading to an increase in flood risk in watercourses downstream. However, given the size of the areas of hardstanding compared to the catchment areas of the downstream watercourses, the magnitude of the effect on flood risk downstream is considered to be **negligible** with an effect significance of **none**.

Proposed Additional Mitigation

7.143 No additional mitigation is proposed during operation.

Residual Operational Effects

7.144 The magnitude of the effect on flood risk downstream during operation is considered to be **negligible** with an effect significance of **none.**

Cumulative Construction and Operation Effects

7.145 There are a number of wind farm developments and proposed OHL connections within the River Nith catchment area, which all drain (directly or indirectly) into the River Nith. The proposed Glenglass Substation is located at the southern extent of the GGRP and drains into the Euchan Water, a tributary of the Nith. Assuming these wind farm schemes, OHLs and substations have all been designed and constructed in line with Scottish Planning Policy (SPP), National Planning Framework 4[12] and national guidelines with respect to SuDS and pollution control, there will be no cumulative effect on downstream catchments.

Table 7.10: Summary of Residual Construction and Operational Effects

Effect	Significance before additional mitigation, but including embedded mitigation measures (e.g. SuDS)	Additional Mitigation	Significance after mitigation
Construction			
Effect on water quality of downstream watercourses and waterbodies	Minor	Additional mitigation/ SUDS (e.g. silt fences, settlement ponds) will be put in place during the construction of: ■ T1 working area near drainage ditch ■ T3 working area near small, unnamed watercourse ■ T9 working area upgradient of the Barr Burn ■ T12 working area upgradient of Thwarter Burn	Minor

[12] National Planning Framework 4 (NPF4) will be coming into force in February 2023 and will supersede Scottish Planning Policy (SPP)

Effect	Significance before additional mitigation, but including embedded mitigation measures (e.g. SuDS)	Additional Mitigation	Significance after mitigation
		■ T14 working area upgradient of Quintin's Burn ■ T21 working area and temporary access track upgradient of Guttie Burn ■ Access track to T22 close to unnamed watercourse ■ Access track to T22 and scaffolding required for OHL stringing across public road upgradient of Polbroc Burn ■ T23 working areas and access tracks near drainage ditches within Libry Moor ■ T24 working areas and access track near drainage ditches ■ T26 working area near drainage ditches ■ T27 working area and access track upgradient of Polmeur Burn ■ T28 working area near drainage ditches (with additional monitoring for stability, both up and downslope of the tower works and linked access track) ■ T30 working area and scaffolding required for OHL stringing across A76 upgradient of unnamed tributary of Polmeur Burn ■ T33 working area upgradient of Birk Burn ■ Scaffolding required for OHL stringing across River Nith ■ Access track to T40 upgradient of Stank Burn ■ Glenmuckloch Substation upgradient of unnamed watercourse/ditch	
Effects on channel morphology (bank erosion and channel form)	None	n/a	None
Effects on run-off rates, flood risk	None	n/a	None
Effects on ground-water levels and local recharge	Minor	Avoid dewatering and physical cut-offs as much as possible.	None
Peat loss/disturbance	Minor.	Appropriate peat excavation, storage and re-use/reinstatement. Further ground investigation to review foundation and track options	Minor
Peat instability	Minor.	Appropriate construction methodologies, selection of peat/soil storage locations and drainage management.	None
Operation			
Effects on hydrology, run-off rates, flood risk	None	n/a	None

Interrelationship between Effects

7.146 Excessive levels of suspended sediment in watercourses as a result of construction activities can have an indirect effect on watercourse ecology and fish (see **Chapter 8**). However, with embedded mitigation (e.g. management of construction runoff including appropriately sized SuDS, timing of excavation works and pollution control measures) and additional site-specific mitigation, there is considered to be no significant residual effect on water quality of the downstream watercourses.

Further Survey Requirements and Monitoring

7.147 Mitigation of residual peat instability risks will be supported by good practice construction measures and by monitoring at 3 and 12 months post construction, and peat reinstatement. Further details are provided in **Appendix 7.5, Section 6.4**.

7.148 Satisfactory implementation of the PMP in order to mitigate peat loss / disturbance will be assured by monitoring both during and after construction (at 3 and 12 months after construction and peat reinstatement works have been completed). Further details are provided in **Appendix 7.4, Section 5.5**.

7.149 An ECoW (or equivalent) will be on site throughout the construction to monitor the effectiveness of the embedded and additional mitigation measures.

Summary of Significant Effects

7.150 There are no likely significant (**moderate** or **major**) effects prior to mitigation of GGRP on geology, hydrology, hydrogeology, water resources and peat.

7.151 All likely effects prior to mitigation were either of **none** or **minor** significance, assuming embedded good practice mitigation measures are in place during construction.

7.152 With additional mitigation, the likely residual effects were either of **none** or **minor** significance.