10 Geology, Soils and Groundwater

10.1 Introduction

10.1.1 This chapter presents the results of the geology, soils and groundwater assessment undertaken as part of the Design Manual for Roads and Bridges (DMRB) Stage 3 Environmental Impact Assessment (EIA) for Project 8 – Dalwhinnie to Crubenmore of the A9 Dualling Programme, hereafter referred to as the Proposed Scheme, as described in **Chapter 5**.

10.1.2 This includes assessment of potential impacts related to superficial and solid geology, designated geological sites, geodiversity features, mineral extraction, soils, potential contamination, groundwater and associated receptors, including Groundwater Dependent Terrestrial Ecosystems (GWDTE), groundwater abstractions and private water supplies (PWS).

10.1.3 The assessment is supported by the following appendices presented in **Volume 2** of this report:

- **Appendix 10.1:** Peat Survey Information
- **Appendix 10.2:** Groundwater Dependent Terrestrial Ecosystems
- **Appendix 10.3:** Groundwater Abstractions and Private Water Supplies
- **Appendix 10.4:** Potential Contamination Sources
- **Appendix 10.5:** Preliminary Peat Landslide Risk Assessment
- **Appendix 10.6:** Outline Peat Management Plan

10.1.4 Supporting considerations related to the assessment have also been addressed separately within **Chapter 8**, **Chapter 11** and **Chapter 12**, and associated appendices in **Volume 2**, with regards agricultural land use, ecology, hydrology, fluvial geomorphology, drainage and flooding. National and local planning policies which are relevant to geology, soils and groundwater are described in **Chapter 19**, together with an assessment of the Proposed Scheme compliance against these.

10.2 Approach and Methods

Scope and Guidance

10.2.1 This EIA has been undertaken using the guidance contained in DMRB Volume 11 Section 3 Part 11 *'Geology and Soils'* (The Highways Agency et al., 1993), taking into account updated guidance on contaminated land within *'The Model Procedures for the Management of Land Contamination'* (Environment Agency, 2004) where appropriate, and DMRB Volume 11 Section 3 Part 10 HD 45/09 *'Road Drainage and the Water Environment'* (The Highways Agency *et al.*, 2009).

10.2.2 Consideration of soil includes potential impacts in terms of conservation value and impacts on peaty soils and peat. Potential agricultural productivity of the soils is also considered, though impacts in relation to general agricultural land use interests and land-take are assessed in **Chapter 8**. Made ground is included in the assessment of potential contamination sources, while earthworks volumes and 'cut and fill balance' of the Proposed Scheme is described in **Chapter 5**.

10.2.3 For groundwater, the assessment considers potential impacts on quality, level, flow, GWDTE and groundwater-related changes to surface water, groundwater abstractions and PWS. Impacts in relation to fluvial geomorphology, surface water quality, drainage and flooding are assessed in **Chapter 11**.

Study Area

10.2.4 The assessment covers a study area extending to 250m from the permanent and temporary works boundaries of the Proposed Scheme. For GWDTE, the study area extends to at least 100m from the permanent and temporary works boundaries, and up to 250m where required.

10.2.5 Impacts on groundwater abstractions and PWS have been assessed to a distance of 850m from the temporary and permanent works boundaries of the Proposed Scheme. This was considered to correspond to the minimum study areas applied for groundwater abstractions under The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR).

Baseline Data Collection

10.2.6 Baseline conditions described cover the following aspects:

- Superficial and solid geology
- Designated geological receptors and features of geodiversity interest
- Mineral extraction
- Soils and peat
- Groundwater and associated receptors, including GWDTE, abstractions and PWS
- Potential contamination sources.

10.2.7 Baseline conditions were determined through desk-based data assessments, consultation with statutory and non-statutory bodies and landowners, ground investigations and field surveys.

Desk-based Assessment

10.2.8 The desk-based assessment included a review of the following information:

- Ordnance Survey (OS) historical maps (sourced from Envirocheck Reports) dating back to 1856 for information on former land use, potential contamination and information on PWS
- British Geological Survey (BGS) data including BGS Geological Maps, BGS Hydrogeological and Groundwater Vulnerability Maps, BGS borehole logs and BGS publications
- James Hutton Institute (JHI) published soil maps, thematic data and derived information, including the National Soil Map of Scotland (1981)
- Scottish Environment Protection Agency (SEPA) Groundwater Vulnerability Maps, interactive River Basin Management Plan map and Scottish Wetland Inventory
- Scottish Natural Heritage (SNH) designation database (SNH, 2016a) and Carbon and Peatland Map (SNH, 2016b)
- Previous assessments, including the Strategic Environmental Assessment (SEA) and Addendum Reports for the A9 Dualling Programme (Transport Scotland, 2013 and 2014a), DMRB Stage 1 Preliminary Engineering Services Report (Transport Scotland, 2014b) and Geotechnical Preliminary Sources Study Report (PSSR) (CFJV, 2016).

Field Surveys

10.2.9 Several site walkovers were conducted by the CH2M Fairhurst Joint Venture (CFJV) to obtain information on the baseline geology, soil, groundwater, potential contamination conditions and PWS locations where possible. These were also supplemented by the following field surveys:

- Phase 1 Habitat Surveys (CH2M, June to September 2014)
- Preliminary ecological peat probing surveys (CFJV, August 2014)
- National Vegetation Classification (NVC) Surveys (MacArthur Green, June to July 2015)
- Detailed peat probing and sampling surveys (CFJV, July to August and December 2016)

Consultations

10.2.10 Consultations were undertaken with the following:

- Cairngorms National Park Authority (CNPA) and The Highland Council (THC) for information on potential contamination sources, PWS and any additional relevant information
- SEPA for information on groundwater abstractions and potential contaminated land uses
- SNH for information on the location, extent and boundaries of environmental sensitivities and geodiversity features in the vicinity of the Proposed Scheme
- HighWater (Scotland) Ltd and private landowners/ residents via questionnaire, for additional information on groundwater abstractions or PWS, their source, location, type and use.

Ground Investigations

10.2.11 Intrusive ground investigations (GI) were conducted by Raeburn Drilling and Geotechnical Ltd (Raeburn) between August and December 2015 (referred to as the 'Advanced GI') and between December 2016 and April 2017 (referred to as the 'Preliminary GI'). Both phases consisted of boreholes, trial pit excavations and peat probes, in addition to groundwater and ground gas monitoring, and selected chemical testing of soil, groundwater and surface water samples.

10.2.12 The results of the Advanced GI and Preliminary GI are presented in the *'A9 Dualling – Glen Garry to Dalraddy, Project 8 Dalwhinnie to Crubenmore Report on Ground Investigation'* (Raeburn, March 2017) and *'A9 Dualling – Dalwhinnie to Crubenmore Project 8, Report on Preliminary Ground Investigation'* (Raeburn, June 2017), respectively.

Impact Assessment

10.2.13 The potential impacts in relation to geology, soils, groundwater and potential contamination have been assessed individually as per the methodologies provided below. The criteria outlined are based on those that have been applied to similar schemes in Scotland and are designed to comply with DMRB Stage 3 EIA requirements.

Geology and Soils

10.2.14 For superficial and solid geology, soils, designated geological receptors, features of geodiversity interest and mineral extraction, the sensitivity and magnitude criteria in **Table 10-1** and **Table 10-2** were applied. The impact significance was then determined using **Table 10-3**.

10.2.15 In relation to soils and peat, the criteria for defining sensitivity has been initially informed based on environmental designations, SNH priority peatland and Land Capability for Agriculture (LCA) categories, but refined based on field survey data where possible. Soil conservation value is recognised based on rarity, representivity and diversity within the Cairngorms National Park

(CNP) context (Towers *et al.*, 2005), with overall functional value afforded indirect cross-topic consideration in the context of potential ecology, geodiversity and carbon storage impacts.

Table 10-1: Sensitivity Criteria for Geology and Soils

Sensitivity	Assessment Criteria
High	Areas containing geological or geomorphological features considered to be of a national interest such as Sites of Special Scientific Interest (SSSI), candidate SSSI or Geological Conservation Review (GCR) sites Presence of extensive areas of economically important minerals valuable as a national resource Presence of high quality topsoil or soils (typically indicated by LCA Class 1 and Class 2) Areas of peatland within designated sites such as SSSI, Special Area of Conservation (SAC) or Special Protection Area (SPA) with national or European importance and/ or SNH priority peatland Class 1 (nationally important carbon-rich and peaty soils, deep peat and priority peatland habitat likely to be of high conservation value) and Class 2 (nationally important carbon-rich and peaty soils, deep peat and priority peatland habitat likely to be of potentially high conservation value and restoration potential)
Medium	Areas containing geological features of designated regional importance considered worthy of protection for their educational, research, historic or aesthetic importance, such as Local Geodiversity Sites (LGS)/ Regionally Important Geological Sites (RIGS) of national/ regional importance Presence of areas of economically important minerals of regional value Presence of medium quality topsoil or soils (typically indicated by LCA Class 3 and Class 4) SNH priority peatland Class 3 (dominant vegetation cover is not priority peatland habitat but is associated with wet and acidic type. Occasional peatland habitats can be found. Most soils are carbon-rich and peaty soils, with some areas of deep peat)
Low	Sites and geological features not currently identified as SSSI, GCR or LGS/ RIGS but that may require protection in the future Presence of mineral areas or resource of local importance only Presence of low quality topsoil or soils (typically indicated by LCA Class 5 and Class 6) SNH priority peatland Class 5 (soil information takes precedence over vegetation data and there is no peatland habitat recorded, but all soils may be carbon-rich and deep peat)
Negligible	Geological features not currently protected and unlikely to require protection in the future No exploitable minerals or geological resources Presence of very low quality topsoil or soils (typically indicated by LCA Class 7). SNH priority peatland Class 4 (areas unlikely to be associated with peatland habitats or wet and acidic type, and unlikely to include carbon-rich or peat soils), Class 0 (mineral soils where peatland habitats are not typically found), Class -1 (unknown soil types) and Class -2 (non-soil (i.e. loch, built up area, rock and scree))

Table 10-2: Impact Magnitude Criteria for Geology and Soils

Magnitude	Assessment Criteria
Major	Partial (greater than 50%) or total loss of a geological site or mineral deposit, or where there would be complete severance of a site such as to affect the value of the site/ resource Major or total loss of topsoil, soils or peatland, or where the value of the area would be severely affected
Moderate	Loss of part of a geological/ geodiversity site or mineral deposit, major severance, major effects to the setting, or disturbance such that the value of the site would be affected, but not to a major degree Partial loss of topsoil, soils or peatland, or where the value of the area would be affected, but not to a major degree
Minor	Small effect on a geological/ geodiversity site or mineral deposit (up to 15%) or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected Partial loss of topsoil, soils or peatland, or where soils will be disturbed but the value of the area would not be affected
Negligible	Very slight change from geological, mineral and soil baseline conditions

Table 10-3: Matrix for Determination of Impact Significance for Geology and Soils

Sensitivity	Magnitude			
	Major	**Moderate**	**Minor**	**Negligible**
High	Large	Moderate/ Large	Moderate	Slight
Medium	Moderate/ Large	Moderate	Slight/ Moderate	Neutral/ Slight
Low	Moderate	Slight/ Moderate	Neutral/ Slight	Neutral
Negligible	Slight	Neutral/ Slight	Neutral	Neutral

Groundwater

10.2.16 For groundwater, the assessment considers sensitivity in the context of the known or anticipated hydrogeological conditions, including potential groundwater receptors. The sensitivity and magnitude criteria for this are shown in **Table 10-4** and **Table 10-5** respectively. The impact significance was then determined using the matrix as shown in **Table 10-6**.

10.2.17 The criteria for defining the magnitude of impact on the quality, level and flow of groundwater is based primarily on the type of proposed road profile (cutting, widening or embankment) facing the receptor, vulnerability of the groundwater to disruption, estimates of drawdown and potential zones of dewatering influence in accordance with *'CIRIA C750 Groundwater Control: Design and Practice, Second Edition'* (CIRIA, 2016) using the Sichardt formula (Powers *et al.*, 2007). Impacts on the quality, level and flow of groundwater may also have effects on GWDTE, surface water, groundwater abstractions and PWS.

10.2.18 For GWDTE, the sensitivity criteria have been based on analysis of NVC Surveys findings (MacArthur Green, 2015) against *'Land Use Planning System Guidance Note 31 (LUPS-GU31) Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and GWDTE (Version 2)'* (SEPA, 2014a). These were used to identify NVC communities as 'potentially' groundwater dependent or not, but with additional hydrogeological and ecological consideration of 'likely' dependence undertaken to refine this where possible.

Table 10-4: Sensitivity Criteria for Groundwater

Sensitivity	Assessment Criteria
Very High	Groundwater aquifer(s) with very high productivity and/ or Water Framework Directive (WFD) good groundwater quality and quantity status Exploitation of groundwater resource is extensive for public, private domestic and/ or agricultural use (i.e. feeding ten or more properties) and/ or industrial supply Important sites of nature conservation dependent on groundwater as per importance criteria attributed in **Chapter 12** or groundwater is considered likely to support wetland vegetation which is highly groundwater dependent Surface water features with hydrological importance to designated sensitive ecosystems of national/ international importance
High	Groundwater aquifer(s) with moderate/ high productivity and/ or WFD good groundwater quality and quantity status Exploitation of groundwater resource is not extensive (i.e. private domestic and/ or agricultural supply feeding less than ten properties) Local areas of nature conservation dependent on groundwater as per importance criteria attributed in **Chapter 12**, or groundwater is considered likely to support wetland vegetation which is moderately groundwater dependent Surface water features with hydrological importance to sensitive ecosystems of regional importance
Medium	Groundwater aquifer(s) with low productivity and/ or WFD variable groundwater quality and quantity status No current known exploitation of groundwater as a resource and aquifer(s) properties make potential exploitation appear unlikely Minor areas of nature conservation with a degree of groundwater dependency, as per importance criteria attributed in **Chapter 12** Surface water features with some but limited hydrologic importance to sensitive or protected ecosystems of authority area importance

Sensitivity	Assessment Criteria
Low	Groundwater aquifer(s) with very low productivity and/ or WFD poor groundwater quality and quantity status No known past or present exploitation of groundwater aquifer(s) as a resource Areas of vegetation with no groundwater dependency Surface water features with minimal/ insignificant hydrological importance to sensitive ecosystems of less than authority area importance

Table 10-5: Impact Magnitude Criteria for Groundwater

Magnitude	Assessment Criteria
Major	Major or long term change to groundwater aquifer(s) flow, water level, quality or available yield Groundwater resource use is irreparably impacted upon, with a major or total loss of an existing supply or supplies Changes to water table level or quality would result in a major or total change in or loss of a groundwater dependent area, where the value of a site would be severely affected Changes to groundwater aquifer(s) flow, water level and quality would result in major changes to groundwater base flow contributions to surface water and/ or alterations in surface water quality, resulting in a major shift away from baseline conditions such as change to WFD status
Moderate	Moderate changes to groundwater aquifer(s) flow, water level, quality or available yield Groundwater resource use is impacted slightly, but existing supplies remain sustainable Changes to water table level or quality would result in partial change in or loss of a groundwater dependent area, where the value of the site would be affected, but not to a major degree Changes to groundwater aquifer(s) flow, water level and quality would result in moderate changes to groundwater base flow contributions to surface water and/ or alterations in surface water quality, resulting in a moderate shift from baseline conditions that may be long-term or temporary
Minor	Minor changes to groundwater aquifer(s) flow, water level, quality or available yield Changes to water table level, quality and yield result in little discernible change to existing resource use Changes to water table level or quality would result in minor change to groundwater dependent areas, but where the value of the site would not be affected Changes to groundwater aquifer(s) flow, water level and quality would result in minor changes to groundwater base flow contributions to surface water and/ or alterations in surface water quality, resulting in a minor shift from baseline conditions (equivalent to minor but measurable change within WFD status)
Negligible	Very slight change from groundwater baseline conditions, approximating to 'no change' conditions

Table 10-6: Matrix for Determination of Impact Significance for Groundwater

Sensitivity	Magnitude			
	Major	**Moderate**	**Minor**	**Negligible**
Very High	Very Large	Large/ Very Large	Moderate/ Large	Neutral
High	Large/ Very Large	Moderate/ Large	Slight/ Moderate	Neutral
Medium	Large	Moderate	Slight	Neutral
Low	Slight/ Moderate	Slight	Neutral	Neutral

Potential Contamination

10.2.19 The assessment of potential contamination has focused on the potential for impacts on receptors as a direct consequence of the Proposed Scheme encountering contamination, within the context of a preliminary conceptual site model (CSM). A receptor can be a person (construction or maintenance workers, road users or local residents), the water environment (groundwater and surface water features), ecological receptors (GWDTE, agricultural land or livestock) and/ or property receptors (structures, buried concrete, services and PWS).

10.2.20 The preliminary CSM represents an outline of potential 'pollutant linkages' (PL) that may be present between a source of contamination, pathways by which it may move and ultimately, affected receptors. Should any element of that linkage (contaminant, pathway or receptor) be

missing or removed, the contamination is considered unlikely to represent a potential risk or impact. The potential receptors and pathways were compiled based on the definitions in Part IIA of the Environmental Protection Act 1990, as provided in Statutory Guidance (Scottish Executive, 2006).

10.2.21 Potential contamination sources are identified in the baseline information and the pollutant linkages used in the assessment of these are provided in **Table 10-7**, with individual references for each linkage, PL1 to PL24, during construction and operation.

Table 10-7: Potential Pollutant Linkages for Potential Contamination

Pollutant Linkage	Receptor	Pathway
Construction		
PL1	Human Health (construction workers)	Ingestion, inhalation and dermal contact with soil, soil dust and fibres (asbestos), deep and shallow groundwater and surface water
PL2		Migration of ground gases into shallow pits or site buildings
PL3	Human Health (local residents and transient traffic (foot, road and rail)) Property (Scheduled Monuments (SM), buildings)	Ingestion, inhalation and dermal contact with wind-blown dust created during excavation works
PL4		Migration of ground gases into homes or workplaces through preferential pathways created during construction posing a potential asphyxiation/ explosion risk
PL5	Water Environment (superficial groundwater)	Leaching and migration of contaminants
PL6	Water Environment (bedrock groundwater)	Migration of contaminants or contaminated shallow groundwater into the deeper rock aquifer
PL7	Water Environment (surface water) Ecological Receptors (GWDTE) Property (PWS and services)	Migration/ mobilisation of contaminated shallow groundwater through drift deposits or made ground
PL8	Water Environment (surface water)	Runoff from contaminated source(s)
PL9		Migration of contaminated bedrock groundwater towards surface water receptor
PL10		Discharge of intercepted contaminated groundwater during passive or active dewatering
PL11	Ecological receptors (agricultural land/ livestock)	Inhalation, ingestion and direct contact with contaminated soils, soil dust, fibres (asbestos) and water
PL12	Property (SM, buried concrete and services)	Direct contact with made ground, superficial deposits, groundwater and bedrock materials
Operation		
PL13	Human Health (maintenance workers)	Ingestion, inhalation and dermal contact with soil, soil dust, fibres (asbestos), deep and shallow groundwater, surface water in the long-term during routine maintenance e.g. drainage inspections
PL14		Migration of ground gases into confined spaces e.g. service pits, accommodation buildings creating an asphyxiation/explosion risk
PL15	Human Health (local residents and transient traffic (foot, road and rail)) Property (SM and buildings)	Ingestion, inhalation and dermal contact with wind-blown dust from contaminated soils re-used within road features such as embankments and landscaped areas
PL16		Migration of ground gases into homes or workplaces through preferential pathways remaining following construction thus posing a potential asphyxiation/ explosion risk
PL17	Water Environment (superficial groundwater)	Leaching and migration of contaminants
PL18	Water Environment (bedrock groundwater)	Migration of contaminated shallow groundwater into the deeper rock aquifer
PL19	Water Environment (surface water) Ecological Receptors (GWDTE) Property (PWS and services)	Migration of shallow groundwater through drift deposits or made ground

Pollutant Linkage	Receptor	Pathway
PL20	Water Environment (surface water)	Runoff from contaminated source(s)
PL21		Migration of contaminated shallow groundwater through drainage channels and associated granular bedding materials or engineered structures
PL22		Discharge of intercepted contaminated groundwater
PL23	Ecological receptors (agricultural land/ livestock)	Inhalation, ingestion and direct contact with contaminated soils/ water
PL24	Property (buried concrete and services)	Direct contact with made ground, superficial deposits, groundwater and bedrock materials

10.2.22 For the purposes of this assessment, the preliminary CSM disregards those pollutant linkages that are incomplete and cannot pose a risk to identified receptors. Where a complete pollutant linkage exists, a generic qualitative risk assessment has been undertaken.

10.2.23 The output of the assessment cannot be reported in terms of 'sensitivity'. Instead, it is reported as the 'likelihood' of a complete pollutant linkage being present, which is defined within CIRIA C552 '*Contaminated Land Risk Assessment: A Guide to Good Practice'* (CIRIA, 2001), *'CLR11 – Model Procedures for the Management of Land Contamination'* (Environment Agency, 2004) and summarised in **Table 10-8**. The magnitude, or consequence, of the effect on likely receptors is outlined in **Table 10-9** and overall risk (significance), taking account of both likelihood and consequence, is identified with reference to the matrix in **Table 10-10**.

Table 10-8: Likelihood Criteria for Potential Contamination

Likelihood	Assessment Criteria
High Likelihood	There is a complete pollution linkage and an event that either appears very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution
Likely	There is a complete pollution linkage and all the elements are present and available, which means that it is probable that an event will occur Circumstances are such that an event is not inevitable, but possible in the short-term and likely over a long-term
Low Likelihood	There is a complete pollution linkage and the circumstances are possible under which an event could occur However, it is by no means certain that even over a longer period such an event would take place, and is less likely in the shorter term
Unlikely	There is a complete pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long-term

Table 10-9: Impact Magnitude (Consequence) Criteria for Potential Contamination

Consequence	Assessment Criteria
Severe	Short-term (acute) damage to human health (significant harm) Pollution of sensitive water resources as a result of short-term exposure Damage to a particular ecosystem as a result of acute exposure Catastrophic damage to buildings/ property/ services/ Scheduled Monument (SM)
Medium	Long-term (chronic) damage to human health (significant harm) Pollution of sensitive water resources as a result of chronic exposure A significant change in a particular ecosystem, or organism forming part of such an ecosystem Substantial damage to buildings/ property/ services/ SM
Mild	No appreciable impact on human health based on the potential effects on the critical human health receptor Pollution of non-sensitive water resources Damage to ecological systems with no significant impairment Significant damage to sensitive buildings/ structures/ SM/ services or the environment

Consequence	Assessment Criteria
Minor	Harm (not necessarily significant), which may result in financial loss or require expenditure to resolve Non-permanent health effects to human health No appreciable pollution Easily repairable effects or damage to ecological systems Easily reparable damage to buildings, structures, SM and services

Table 10-10: Matrix for Determination of Impact Significance (Risk) for Potential Contamination

Consequence	Likelihood			
	High likelihood	**Likely**	**Low likelihood**	**Unlikely**
Severe	Very high	High	Moderate	Moderate/ Low
Medium	High	Moderate	Moderate/ Low	Low
Mild	Moderate	Moderate/ Low	Low	Very Low
Minor	Moderate/ Low	Low	Very Low	Very low

Limitations to Assessment

10.2.24 Information obtained from both the Advanced and Preliminary GI works has been used in the assessment. In areas where no data is available, geological and hydrogeological information has been extrapolated or used from the nearest available data points. Groundwater and ground gas monitoring for the Preliminary GI is scheduled for completion by April 2018. Monitoring results available from between April and August 2017 have been taken into account in the assessment.

10.2.25 Groundwater abstraction and PWS features have been identified based on information supplied by THC, SEPA, HighWater (Scotland) Ltd, landowner/ resident consultations, historical or current mapping and site walkovers (CFJV, 2017). Additional consultation on some supplies may be required as part of the detailed design and pre-construction activities.

10.2.26 In certain conditions, groundwater dewatering effects have the potential to cause differential ground settlement. This is a geotechnical consideration, outwith the scope of this assessment. However, mitigation is included for a detailed assessment of this to be completed prior to construction in areas of excavation located nearby existing infrastructure, properties or structural cultural heritage receptors. This assessment shall be supported by the complete groundwater monitoring dataset from the Preliminary GI, as well as additional data from Detailed GI, both scheduled for completion in 2018.

10.2.27 The identification of potential contamination sources has been reliant on the accuracy of historical mapping and available GI information. Potential sources not encountered during GI or identified through desk-based assessment and consultation to date are not reported. The assessment of historical quarrying activity has also been based on desk-based review of historical mapping. It is possible that quarrying works could have been undertaken and the void backfilled between the recorded years of mapping, such that no map evidence exists.

10.3 Baseline Conditions

Geology

10.3.1 As shown in **Drawing 10.1** in **Volume 3** of this report, BGS mapping indicates the superficial deposits within the study area to variably include made ground, peat, alluvium, alluvial fan, river terrace deposits, glaciofluvial deposits, diamicton till and hummocky glacial deposits.

10.3.2 The solid geology throughout the majority of the study area comprises Precambrian Psammite of the Gaick Psammite Formation; recorded as predominantly quartzose psammite with scattered biotite flakes and laminae. BGS mapping also indicates the Loch Laggan Psammite and Falls of Phones Semipelite Formations in the north, as shown in **Drawing 10.2** (**Volume 3**). These strata comprise micaceous and feldspathic psammite, and gneissose but locally schistose, respectively. The axis of a synclinal fold additionally runs along and adjacent to the existing A9 carriageway between ch. 30,550 and ch. 32,500, with an Ordovician igneous intrusion site (pegmatite) present beneath the existing A889 Dalwhinnie junction. Faulting is present to west in Glen Truim and in Crubenmore in the north, but does not cross the Proposed Scheme area.

10.3.3 These conditions have broadly been substantiated by GI information, as summarised below. Findings in relation to peat are described in **Appendix 10.1** (**Volume 2**) and the soils sub-section.

Made Ground

10.3.4 Made ground or possible made ground has been encountered at several locations during the Advanced and Preliminary GI works, predominantly within southern portions of the study area adjacent to the existing A9 carriageway and the existing A889 Dalwhinnie junction. Isolated areas were also encountered near the Scottish and Southern Energy (SSE) Aqueduct (chainage (ch.) 23,800 and ch. 24,500), and north of Cuaich (ch. 26,200 and ch. 26,800).

10.3.5 The materials encountered ranged from 0.10 to 3.20m in thickness, and were described to vary between clayey, sandy, gravelly topsoil with pockets of peat or sandy gravelly or silty clay, sand and gravel. Concrete, cobbles, boulders, fragments of tarmac, brick, timber, metal, plastic and glass were also observed, together with a strong hydrocarbon odour between 1.20 and 1.70m below ground level (bgl) in one location (ch. 21,250) and an organic odour from decomposing vegetation at 1.50m bgl in another (ch. 21,450).

10.3.6 Based on **Table 10-1**, made ground is considered to be of **negligible** sensitivity. However, each occurrence has been reviewed as a potential contamination source in **Appendix 10.4** (**Volume 2**) and their locations are shown in **Drawings 10.30** to **10.38** (**Volume 3**).

Superficial Geology

10.3.7 Superficial deposits identified from available GI include alluvium and river terrace deposits (underlying the River Truim floodplain and various watercourses), and alluvial fans (fanning out from watercourses including Allt Coire Chuirn, Allt Cuaich and Allt Garbh). Alluvium and river terrace deposits were described to vary between clayey, silty or gravelly fine to coarse sand and silty sandy fine to coarse gravel, with variable cobble and boulder content. Alluvial fans were described as sandy gravelly silt and silty sandy fine to coarse gravel with variable cobble content. The thickness of the alluvial units varies between 0.50 and 16.60m.

10.3.8 Glaciofluvial deposits, diamicton till and hummocky glacial deposits have also been observed across the study area. These have predominantly been recorded as granular, varying between clayey gravelly fine to coarse sand, silty sandy fine to coarse gravel and sandy slightly gravelly silt,

with variable cobble and boulder content. The thickness of the glacial superficial units varies from 0.40m near Dalwhinnie, to over 20.00m near Cuaich.

10.3.9 Based on the criteria in **Table 10-1** and, with the exception of specific areas of alluvial fan, the superficial deposits are considered to be of **negligible** sensitivity.

Solid Geology

10.3.10 The available GI information has identified bedrock at depths between 0.10 and 23.20m bgl, predominantly composed of interlayered psammite, semi-pelite, quartzite and schist, with heavy fracturing and partial or distinct weathering. Fractured and weathered granite has also been encountered locally around Dalwhinnie and near Dalannach. Depth to rockhead appears generally shallower in the southern and northern portions of the study area, and deeper in central areas around Cuaich; consistent with greater superficial thicknesses. However, this is likely to be variable across the Proposed Scheme given the metamorphic and likely folded nature of the rock.

10.3.11 Based on **Table 10-1**, solid geology in the study area is considered to be of **negligible** sensitivity.

Designated Geological Receptors and Features of Geodiversity Interest

10.3.12 No geological SSSI or GCR sites are present within the study area. However, the Drumochter Hummocky Moraines are a regionally important landform assemblage and candidate LGS (Barron *et al.*, 2011), while consultation with SNH highlighted 'impressive' alluvial fan at Allt Coire Chuirn as an important site of geodiversity interest (Transport Scotland, 2014a). Three rock exposures were also identified on the existing A9 within the Proposed Scheme area.

10.3.13 Details of these features are provided below and shown in **Drawing 10.3** (**Volume 3**).

Drumochter Hummocky Moraines

10.3.14 The lower slopes and edges of the valley bottoms through the Pass of Drumochter, adjacent to the south of the Proposed Scheme, contain numerous examples of bouldery moraine that formed during the Loch Lomond Stadial (the period between deglaciation and the start of the Holocene). The moraines are associated with meltwater channels that were eroded parallel to ice margins and take the form of ridge fragments and mounds, which mark standstills in the glacial retreat.

10.3.15 Two main groups of moraine can be distinguished in the area based on previous studies (Lukas 2002, Lukas et al, 2004) and field visits (CFJV, 2016); smaller ridges and mounds (5m to 20m wide, up to 150m long and up to 5m high) and larger ridges and mounds (up to 140m wide, 260m long and up to 10m high). Both are typically confined to the lowermost 50m of slopes, bordering the valley floors, and the length and abundance of moraine ridges usually increases upslope, with mounds dominating on steep slope sections.

10.3.16 The locations of the features as illustrated in **Drawings 10.3** and **10.10** (**Volume 3**) have been informed through previous mapping of ridges, mounds and terraces undertaken by Lukas (2003 and 2004). The moraines are of importance because the landform assemblage through the Pass of Drumochter is commonly cited to contain textbook examples of the hummocky moraine formed during the Loch Lomond Stadial, albeit their origin and age remain an active field of research (Barron *et al*, 2011). Taken together, the features provide an important record of glacial recession across the district.

10.3.17 The Drumochter Hummocky Moraines have been identified as a candidate LGS (Barron *et al.*, 2011) and are therefore considered to be of **medium** sensitivity, based on **Table 10-1**.

Allt Coire Chuirn Alluvial Fan

10.3.18 As illustrated in **Drawing 10.1** (**Volume 3**), a large area of alluvial fan is present underlying the Proposed Scheme within the 180m southern tie-in to Project 7 – Glen Garry to Dalwhinnie, and southward of this. The largest parts of the fan are situated within, or at the margins of, the Drumochter Hills SSSI, SAC and SPA, associated with the Allt Coire Chuirn and Allt Coire Bhotie watercourses. Deposits extend both east and west from the existing A9, fanning out from these and other minor watercourses between them.

10.3.19 The alluvial fan is likely to have formed during deglaciation in the early Holocene, representing debris transported by melting glaciers and snow melt. Qualitative catchment analysis in **Appendix 11.4** (**Volume 2**) indicates there is currently ample sediment and debris flow supply from the upper catchments, which is transported through steep channels and deposited where the slopes reduce on the fan. The fan is largely contained within the channel, which helps contribute to active morphological processes and further sediment production. There also appears to be morphological evidence for avulsion events (the formation of new or alternate river channels) associated with Allt Coire Chuirn; with either high flow distributaries or additional channels present to the north of it, which diverge from the main channel at the fan apex.

10.3.20 The catchment analysis and field visits (CFJV, 2016) identified several unvegetated bar locations along the banks of and near the fan apex on Allt Coire Chuirn, as illustrated in **Drawing 10.10** (**Volume 3**). Although frequently obscured by slumping, some of these reveal stratigraphic cross-sections through the upper parts of the fan and terrace sediments.

10.3.21 Taken together, the fan area, soils and landform, active morphology and stratigraphic insight from some partial exposure areas, provides a basis for studying the local present-day and longer-term fan formation, together with the river and morphological processes. Although it is not currently identified as a GCR, LGS, RIGS or SSSI geological qualifying feature, the area may require protection in the future and has previously been described by SNH as regionally important (Transport Scotland, 2014a). Based on this and the criteria in **Table 10-1,** the Allt Coire Chuirn alluvial fan is therefore considered to be of **medium** sensitivity.

Allt Cuaich Catchment

10.3.22 The other main alluvial fan present in the study area is a relatively large, low-angle deposit at Allt Cuaich (ch. 25,900), as shown in **Drawings 10.3** and **10.11** (**Volume 3**). Allt Cuaich has a large catchment and flows in a south-west then westerly direction from Loch Cuaich (4.10km east of the A9) and is a major contributor to the SSE Tummel Hydropower Scheme.

10.3.23 Qualitative catchment analysis in **Appendix 11.4** (**Volume 2**) and field visits (CFJV, 2016) indicates there is extensive upstream sediment supply to Allt Cuaich, which is transported through terrace-confined channels. There is also evidence of bar development and bank erosion, with engineered measures using stone gabions, indicating erosion risks up and downstream of where it crosses the Proposed Scheme.

10.3.24 The lower reaches of the catchment where Allt Cuaich joins the valley of the River Truim are relatively featureless, though comprise an obvious fan landform in which its former primary and secondary channels are clearly visible in the floodplain morphology. There are no fan exposures, but river cliff sections (in the form of hillslope failures) are present on the northern bank of Allt Cuaich, on the upstream side of the existing A9. These have been documented by Merrit in *'The Quaternary of the Central Grampian Highlands Field Guide'* (Quaternary Research Association, 2004) as partially vegetated exposures through morainic deposits, with many pebbles, cobbles and boulders of psammite. Although probably of local provenance, Merrit notes there is also

proportions of grey granite, granodiorite and mica schist clasts visible, which were almost certainly derived from the south-west of the region near Rannoch Moor.

10.3.25 Based on **Table 10-1**, the alluvial fan at Allt Cuaich is considered to be of **negligible** sensitivity, as it is not currently protected and is unlikely to require protection in the future. However, the river cliff sections and observations made by Merritt (2004) in the catchment do provide some important indicators that support regional glacial retreat pattern interpretations. As such, the catchment is considered to be of overall **low** sensitivity based on the criteria in **Table 10-1**.

Rock Exposures

10.3.26 As illustrated in **Drawing 10.3** (**Volume 3**), three areas of exposed rock are present within existing road cuttings on the A9. Field mapping visits (CFJV, 2016) have recorded these as follows:

- **P08-RE01:** Grey greenish and brown medium strong to strong psammite, which is medium grained and very thinly to medium bedded, with minor toppling failures and one instance of possible faulting. Southbound carriageway (ch. 26,525 and ch. 26,960), approximately 4.00m to 10.00m in height and 90 to 100% exposure with limited or absent soil or vegetative cover.
- **P08-RE02:** Dark purple/ black and dark purple/ grey strong to very strong psammite with quartz veins and lenses, and variable foliation (repetitive layering) visible in the rock face. Northbound carriageway (ch. 26,550 to ch. 26,875), approximately 2.00m to 5.00m in height and 80% exposure due to limited local soil or vegetative cover.
- **P08-RE03:** Dark purple/ grey and purple/ grey strong to very strong psammite with local dark and light pink pegmatite intrusions, some quartz and felsite veins along a locally deformed and folded rock face. Southbound carriageway (ch. 26,550 to ch. 26,875), approximately 3.00m to 10.00m in height and 80 to 90% exposure due to limited soil or vegetative cover.

10.3.27 Based on the criteria in **Table 10-1**, the exposures are considered to be of **negligible** sensitivity, as they are not currently protected and are unlikely to require protection in the future. The rock types and structures exposed are also widespread across the region and similar exposures exist elsewhere.

Mineral Extraction

10.3.28 BGS mapping and mineral resources publications (BGS, 2014) indicate that there are no records of historic or current coal mining within the study area. However, historical mapping indicated three historic gravel or sand pits within 250m of the Proposed Scheme. The location of these sites are detailed in **Appendix 10.4** (**Volume 2**) and are likely to indicate local historical sand and gravel extraction. A review of BGS mineral resources publications (BGS, 2014) did not indicate any specific current or future mineral resource.

10.3.29 Based on this, the locale and history of the study area, potential future exploitation and mineral resource could be expected to remain similarly limited and of local importance only. As such, this is considered to be of **low** sensitivity based on the criteria in **Table 10-1**.

Soils

10.3.30 The soils present within the study area have been identified using BGS mapping, the National Soil Map of Scotland (1:250,000 Scale) (JHI, 1981), LCA maps (JHI, 1983), available GI and publications related to Scotland's soils and their conservation value (Towers *et al.*, 2005).

Soil Conservation

10.3.31 As illustrated in **Drawings 10.4** and **10.5** (**Volume 3**), the majority of the study area is underlain by peaty gleyed and peaty podzols, with humus-iron podzols and peaty gleys with blanket peat and peaty podzols or rankers also present. The River Truim valley is underlain by mineral and peaty alluvial soils between ch. 24,300 and ch. 29,700, with humus-iron podzols and alluvial soils northward of these at Crubenmore. Dystrophic basin and valley peat (peat formed in topographic basins and valleys and fed by mineral-poor water) is also present within, and adjacent to, the east of the Proposed Scheme between ch. 22,100 and ch. 22,700 at Dalwhinnie, and peaty gleys with blanket peat and peaty podzols are shown north and southward of this.

10.3.32 These soil types are derived from metamorphic rock or fluvioglacial sands and gravels, and in the case of peats, accumulations of organic material. Some of the soils are rare within Scottish, European and/ or CNP contexts; including peaty gleys and peat (Towers *et al.*, 2005). Rare soils in a Scottish context, but common in the CNP, are subalpine and alpine soils associated with some montane environments of the Drumochter Hills SSSI, SAC and SPA (Gauld *et al.*, 2003). However, these are located outwith the Proposed Scheme extents.

10.3.33 Previous studies of soil conservation value in the CNP (Bruneau *et al*., 2003; Towers *et al.*, 2005) generated conservation index values of less than 100 (humus-iron podzols and peaty gleys), between 100 and 200 (peaty gleyed and peaty podzols, mineral and peaty alluvial soils) and greater than 200 (peat) for those present within the study area. These respectively indicate the soils are of **low**, **moderate** and **high** soil conservation interest.

10.3.34 This correlates well with the typical properties of the soil types (drainage, carbon content, nutrient levels) (JHI, 1986; Bruneau *et al*., 2003; Bruneau, 2006; CNPA, 2015); though is based solely on their rarity, representivity and diversity. In real terms, it is recognised that the overall conservation (functional) value will vary, with soils providing a range of ecological services and functions at a local scale and within wider environmental frameworks.

Agricultural Productivity

10.3.35 Some of the study area is currently utilised for sheep grazing or herding, with parts also used for sporting interest and grouse drives associated with the Phoines, North and South Drumochter Estates, described in **Chapter 8**. As shown on **Drawings 8.7** to **8.12** (**Volume 3**), the predominant LCA Classes are 6.1, 6.2 and 6.3 (rough grazing). LCA Classes 5.1 and 5.2 (improved grassland) are present to the west of southern (ch. 22,200 to ch. 22,800) and northern stretches (ch. 27,000 to ch. 29,400 and ch. 30,600 to ch. 31,050). However, no prime agricultural land has been identified.

10.3.36 Based on **Table 10-1**, soils within the study area are therefore considered to be of **low** sensitivity in terms of potential agricultural productivity.

Peat

10.3.37 As shown in **Drawings 10.1**, **10.4** and **10.5** (**Volume 3**), BGS mapping identifies two areas of peat 130m east of the A9 at ch. 24,800, and adjacent to the west at ch. 25,600 near Cuaich, while soil mapping shows complex peaty soils with peat across the study area, and basin peat to the east at Dalwhinnie. Class 1 and Class 2 priority peatland (nationally important carbon-rich, peaty soils and deep peat) are shown on SNH Carbon and Peatland mapping (SNH, 2016) to the west, across southern portions of the Proposed Scheme, to the east and west at Dalwhinnie, and to the east beyond the SSE Aqueduct near Cuaich, as shown in **Drawing 10.6** (**Volume 3**).

10.3.38 Based on this information, field surveys were undertaken and considered alongside Phase 1 Habitat (CH2M, 2014) and NVC Surveys (MacArthur Green, 2015) to develop an understanding of peaty soil and peat presence, depth and characteristics. These surveys and their findings are described in **Appendix 10.1** (**Volume 2**), and were used to create a peat depth model for the Proposed Scheme and adjacent areas, as shown in **Drawing 10.12** to **10.20** (**Volume 3**).

10.3.39 Ecology surveys identified several peatland and heathland habitats, with peat-forming vegetation types including mire, blanket mire and wet heaths, or mosaics of these as shown in **Drawings 12.13** to **12.30** (**Volume 3**). A feature morphologically resembling a raised bog (but ecologically identified as blanket bog) is also present to the west of the 180m southern tie-in to Project 7 – Glen Garry to Dalwhinnie, with a possible low dome perched on a low terrace above the River Truim floodplain. Dry heaths and other semi-natural vegetation such as grasslands and woodland are also present.

10.3.40 Peaty soils and topsoil (less than 0.50m thickness) are predominant in areas of dry and wet heath and mosaics of these and acid grassland transitions on hummocky ground or steeper and drier slopes, with discontinuous and localised shallow peat (between 0.50m and 1.00m thickness) also present in these and mire mosaics on gentler slopes, flatter ground or hollows. Deep peat (greater than 1.00m thickness) is located within and adjacent to the Proposed Scheme at Dalwhinnie, and surrounding it in pockets elsewhere within areas of mire, blanket mire or mosaics of these and wet heath. Peat depths across the Proposed Scheme ranged from 0.00 to 4.95m, with the deepest areas observed to be generally outwith the permanent and temporary works boundaries.

10.3.41 The basic peat characteristics are considered in **Appendix 10.1** (**Volume 2**). This identifies the majority of areas to be affected by artificial drainage channels of varying continuity and length; associated with existing or recent infrastructure and areas of grouse habitat or grouse drives. As a result, the majority of areas in the Proposed Scheme extents may be considered as degraded (drained or modified). However, some areas to the east of Dalwhinnie and to the east and west at Cuaich appear sufficiently wet and contain local bog pools indicating good peat condition. Many of the habitats and vegetation identified are also recognised under Annex 1 of the European Council Habitats Directive 92/43/EEC (Council of the European Communities, 1992), the Scottish Biodiversity List (Scottish Government, 2013) and Cairngorms Nature Action Plan (CNPA, 2013), while additionally being present within or connected to habitats in the Drumochter Hills SSSI, SAC and SPA in southern extents.

10.3.42 Based on the above and the criteria in **Table 10-1**, peaty soils and peat identified across the Proposed Scheme would therefore generally be considered to vary between **medium** and **high** sensitivity for one or more reasons (such as locally good condition, presence and role in notable habitats, conservation interest, priority peatland class or designated sites); though lower quality or impacted areas of dry heath and grasslands may reasonably be considered **medium** or **low** sensitivity. The key area of sensitivity is considered to be within and adjacent to the Proposed Scheme at Dalwhinnie (ch. 22,000 to ch. 23,700) where peat soils, shallow peat and deep peat correspond to an expanse of wet heath/ mire mosaic to the east and west, and an area of drained, but locally good condition, blanket mire to the east.

Groundwater

10.3.43 The groundwater characteristics of the study area are summarised below, based on information obtained from BGS and SEPA publications, available GI information and previous reports.

Hydrogeology

10.3.44 The SEPA River Basin Management Plan (RBMP) interactive map (SEPA, 2017) indicates the study area is underlain by the Upper Spey Bedrock and localised sand and gravel aquifer, with River Truim floodplain to the west being underlain by the Truim Valley sand and gravel aquifer, corresponding to fluvial deposits shown on BGS mapping. The WFD classification from 2008 for groundwater in both the superficial and bedrock deposits is 'good' with 'high' confidence for both quantity and quality, with no trend for pollutants and no current pressures.

10.3.45 As shown in **Drawing 10.7** (**Volume 3**), the majority of glacial deposits (till and hummocky glacial deposits) within the study area are not a significant aquifer. Glaciofluvial and fluvial deposits (alluvium, alluvial fan and river terrace deposits) are moderate to high or high in productivity with intergranular flow. The Gaick Psammite Formation bedrock is classified as a very low productivity aquifer, with the Falls of Phones Semipellite Formation in the north being low productivity, as shown in **Drawing 10.8** (**Volume 3**). Within these rocks, groundwater storage and flow is likely to be limited to near surface weathered zones and fractures.

10.3.46 Groundwater flow in the superficial deposits is likely to follow surface topography towards local surface watercourses. However, flows may be locally complex and influenced by the presence of peat, shallow rock and man-made features associated with the existing A9, the Beauly to Denny Power Line (BDL), SSE Aqueduct, Highland Main Line railway (HML) and some access tracks. Groundwater emergence, seepage and through-flow has also been observed to be locally significant in the east of the study area, with several spring and flush areas identified, as shown in **Drawings 10.21** to **10.29** (**Volume 3**).

10.3.47 The flow direction of bedrock groundwater is unconfirmed, but is likely to follow the direction of local surface watercourses and may be locally discontinuous due to fracturing and folding.

10.3.48 Based on the criteria in **Table 10-4**, the hydrogeological characteristics and sensitivity of the superficial and solid geology units within the study area are summarised in **Table 10-11**. This is based on combined consideration of their productivity, WFD classifications for quality and quantity, and available GI information related to monitored groundwater levels and quality. As such, the sensitivities assigned are applicable to groundwater quality, levels and flow.

Table 10-11: Hydrogeological Characteristics and Sensitivity of Superficial and Solid Geology Units

Geological Unit		Geological Characteristics	Hydrogeological Characteristics	Sensitivity
Made Ground		Clayey sandy, gravelly topsoil, sandy gravelly clay and sand with concrete, cobbles, boulders and pockets of peat.	Assumed poor groundwater potential due to localised occurrence and surface/ near surface location, likely variable permeability and perched nature.	Low
Peat		Variable from insignificant to strongly decomposed and of variable type, condition, fibre and water content.	Low value in terms of water resource and productivity, but likely variable permeability and variable water contents from rainfall, run-off and groundwater but influenced by artificial drainage in several locations.	Medium
Fluvial Deposits	Alluvium	Clayey, silty or gravelly fine to coarse sand and silty sandy fine to coarse gravel.	Moderate to high or high productivity with intergranular flow and good quality and quantity status within the Upper Spey bedrock and localised sand and gravel aquifers and Truim Valley sand and gravel aquifer. Groundwater within alluvial deposits would also be expected to be hydraulically connected to surface waters.	High
	River Terrace Deposits	Clayey, silty or gravelly fine to coarse sand and silty sandy fine to coarse gravel.		High
	Alluvial Fan Deposits	Sandy gravelly silt and silty fine to coarse gravel.		High

Geological Unit		Geological Characteristics	Hydrogeological Characteristics	Sensitivity
Glaciofluvial Deposits		Clayey, silty and sandy fine to coarse gravel.	Moderate to high or high productivity with intergranular flow and good quality and quantity status in the Upper Spey bedrock and localised sand and gravel aquifers and Truim Valley sand and gravel aquifer. Groundwater in glaciofluvial deposits would also be expected to be hydraulically connected to surface waters.	High
Glacial Deposits	Till	Clayey silty sandy fine to coarse gravel and sandy gravelly silt.	Although mapped and present within the Upper Spey bedrock and localised sand and gravel aquifers with good quality and quantity status, glacial deposits of till and hummocky glacial deposits are predominantly identified as not being a significant aquifer. This may because of their variable permeability, but they have been recorded as predominantly granular and therefore may therefore be locally connected to surface waters, with groundwater presence also likely to be heavily influenced by rainfall and snowmelt. This may be because of their variable permeability.	Medium
	Hummocky Glacial Deposits	Clayey, silty and sandy fine to coarse gravel or clayey, silty gravelly sand.		Medium
Falls of Phones Formation		Semipelite, mainly gneissose but locally schistose	Low productivity with fracture flow and, despite good quality and quantity status within the Upper Spey bedrock and localised sand and gravel aquifers, limited spatial extent within study area.	Medium
Gaick Psammite and Loch Laggan Psammite Formation		Psammite and quartzose psammite	Very low productivity with fracture flow, but good quality and quantity status within the Upper Spey bedrock and localised sand and gravel aquifers.	Medium

Groundwater Abstractions and Private Water Supplies

10.3.49 Based on consultation undertaken with THC and SEPA, one groundwater abstraction (comprising three wells) and three PWS source locations were identified in the study area, supplying properties at Dalwhinnie (including domestic use water for Dalwhinnie Distillery), Cuaich and Crubenmore.

10.3.50 Consultation was undertaken with landowners, Scottish Water and HighWater (Scotland) Ltd to obtain additional information on these and establish if any other such features may be present. The information obtained is described in **Appendix 10.3** (**Volume 2**) and summarised in **Table 10-12**. The sensitivity of each feature has been assigned based on the criteria in **Table 10-4**.

Table 10-12: Groundwater Abstractions and Private Water Supplies

Feature ID	Feature Type	Chainage	Source of Information	Landowner Response	Sensitivity
ABS 8.1	Spring	ch. 30,700	THC/ Landowner	THC/ landowner consultation identified an active PWS sourced from a spring, supplying Crubenmore Lodge, Truim Cottage, Crubenmore Cottage and Crubenmore Chalet for domestic use	High
ABS 8.5	Wells	ch. 23,100	SEPA/ Scottish Water	SEPA/ Scottish Water consultation identified an active groundwater abstraction from three wells, which is the public supply for domestic use to the village of Dalwhinnie and the Dalwhinnie Distillery and Visitor Centre. Dalwhinnie Distillery separately abstracts surface water for commercial use outwith the study area.	Very High
ABS 8.23	-	ch. 23,000	THC/ Landowner	THC indicated the presence of a PWS at Dalwhinnie Beag, but the landowner believes this property is serviced by the mains and it is therefore assumed to be inactive	N/A

Feature ID	Feature Type	Chainage	Source of Information	Landowner Response	Sensitivity
ABS 8.24	Spring	ch. 25,800	THC/ Landowner	THC/ landowner consultation identified an active PWS sourced from a spring, supplying five residential units at the Cuaich farm settlement for domestic and agricultural use	High

10.3.51 The location of the abstraction and PWS features are shown in **Drawings 10.21** to **10.29** (**Volume 3**). These also identify additional natural spring and flush features based on ecological surveys or current mapping. However, these have not been identified as existing PWS sources.

10.3.52 Surface water abstractions have also been identified as being associated with the SSE Aqueduct. However, these are described and assessed, where necessary, in **Chapter 11**.

Groundwater Monitoring

10.3.53 Groundwater has been encountered in boreholes and trial pits during the Advanced and Preliminary GI, with water strikes between 0.50 and 11.00m in superficial deposits and between 1.10m and 15.00m in bedrock. Several areas were also recorded as dry.

10.3.54 Groundwater monitoring data has been collected from 22 borehole locations between January and December 2016 for the Advanced GI, and from 50 borehole locations between April and August 2017 for the Preliminary GI. The data collected indicates water levels ranging from ground level (ch. 24,000) to 13.60m bgl (ch. 29,900), but typically within 3.00m bgl. Piezometric levels have varied between 309.43m (ch. 29,100 in the River Truim valley north of Cuaich) and 400.55m (ch. 20,025 towards Drumochter) Above Ordnance Datum (AOD).

10.3.55 Tests conducted during previous GI for the existing dual carriageway at Crubenmore identified permeability estimates between 5 x 10^{-7} and 9 x 10^{-7} metres per second (m/s) for superficial glacial soils and at least 1 x 10^{-4} m/s for bedrock. Similar tests from the Preliminary GI identified estimates of between 1.48 x 10^{-7} and 2.47 x 10^{-7} m/s in glacial soils. Taken together, the data suggest permeability of the geology across the Proposed Scheme is likely to be variable, with lower and higher permeability bands present; which also corresponds to indications from particle size distribution tests and published literature values (Freeze and Cherry, 1979; Wheeler, 2009; Natural England, 2010).

Groundwater Quality

10.3.56 The BGS publication *'Scotland's aquifers and groundwater bodies – OR/15/028'* (BGS, 2015) provides an outline of groundwater quality in the Precambrian bedrock underlying the Proposed Scheme. It describes the groundwater as weakly mineralised, with variable redox conditions, calcium as a dominant cation and bicarbonate as a dominant anion, and with nitrate concentrations between 0.15 to 17.46 milligrams per litre (mg/l). The study area is not located in a Nitrate Vulnerable Zone, but is within a Drinking Water Protection Zone.

10.3.57 Consultation with SEPA indicates there are 31 discharge consent records within the study area, primarily associated with discharge of septic tank effluent to soakaways and occasionally land or surface watercourses. Details of these are provided in **Appendix 10.4** (**Volume 2**).

10.3.58 The results of available soil leachate and groundwater chemical analysis have been compared against water quality standards for drinking water, surface water and GWDTE in accordance with SEPA Position Statement WAT-PS-10-01 *'Assigning Groundwater Assessment Criteria for Pollutant Inputs'* (SEPA, 2014c). This identified elevated concentrations of lead, mercury, zinc, ammoniacal nitrogen and nitrate in the soil leachate analysis. Groundwater results identified localised elevated mercury, nickel, nitrate, polycyclic aromatic hydrocarbons (PAH) and total petroleum

hydrocarbons (TPH), with ammoniacal nitrogen generally slightly elevated across all borehole locations. The criteria most frequently exceeded were for surface water, but with most nitrate concentrations in soil leachate and groundwater identified to exceed GWDTE thresholds.

Groundwater Dependent Terrestrial Ecosystems

10.3.59 As described in **Appendix 12.3** (**Volume 2**), NVC Surveys (MacArthur Green, 2015) identified a number of habitats which may be groundwater dependent; including wet heaths, mires, flushes, springs, rush pasture and grasslands, or mosaics of these. The location and extents of the areas based on the groundwater dependence ratings in *'LUPS-GU31 Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and GWDTE (Version 2)'* (SEPA, 2014a) are illustrated in **Drawings 10.21** to **10.29** (**Volume 3**).

10.3.60 Two-hundred and eighteen of the habitats were identified to require further assessment within the study area, and the vegetation details of each and consideration of their likely dependence on groundwater is presented in **Appendix 10.2** (**Volume 2**). This identifies that groundwater is unlikely to be a contributory source to some 62 of the habitats – particularly those comprising existing road verge, embankment or cut slopes, and where the wet vegetation are fragmented or discontinuous parts of these, associated with surface water features or run-off. A total of 79 have also been assessed as being likely to have only a low dependency on groundwater inputs due to their topographic setting, the likely influence of surface water and run-off, presence in areas of floodplain or association with ombrotrophic areas of peatland.

10.3.61 Several areas of wet heath (NVC M15), mire (NVC M6, M25) and local rush pasture (NVC M23) however, have been recorded as dominant or sub-dominant communities in multiple habitat areas and considered likely to be dependent on groundwater to varying degrees. In this respect, 58 have been identified to have moderate dependence on groundwater input, 14 have been identified to have moderate/ high dependence on groundwater input, and 5 have been identified to have a high dependence on groundwater input. These are located to the east and west of the Proposed Scheme; where either the topographic setting and presence of faulting or folding correspond to potential or evidenced increased groundwater supply from fractured bedrock via emergence, seepage and through-flow from spring heads (NVC M32) and soligenous (NVC M15a) or base-enriched (NVC M10 and M11) flushings, or the hydrogeological conditions are such that permeable and/ or productive superficial soils may support GWDTE presence.

10.3.62 Based on the criteria in **Table 10-4**, the sensitivity of individual GWDTE in the study area are presented in **Appendix 10.2** (**Volume 2**). These are considered to vary between **medium** and **very high** sensitivity based on their likely groundwater dependence. Those determined to have no dependency on groundwater input are considered **low** sensitivity and are assessed further as part of the ecological impact assessment in **Chapter 12**.

Surface Water Features

10.3.63 All surface water features in the study area are described in **Chapter 11** and shown in **Drawings 11.1** to **11.7** (**Volume 3**). These are expected to have a groundwater baseflow component, and groundwater may be a contributor to local flooding mechanisms.

10.3.64 The principal surface watercourse is the River Truim, flowing northwards through the Glen Truim valley, before its confluence with the River Spey. The River Truim is located to the west and along the length of the Proposed Scheme and forms part of the River Spey SAC, which is designated for the protection of freshwater pearl mussel, sea lamprey, Atlantic salmon and otter. There are also several watercourse tributaries to the River Truim which cross under the existing A9.

10.3.65 In addition to these features, there also several other major and minor watercourse tributaries, predominantly to the River Truim, which cross under the Proposed Scheme. Based on **Table 10-4** and the corresponding sensitivity criteria in **Chapter 11** and **Chapter 12**, surface watercourse features within the study area are considered to vary between **low** and **very high** sensitivity.

10.3.66 Samples were retrieved following the Preliminary GI at 13 surface watercourse locations – including the River Truim, Allt Coire Bhathaich, Allt Cuaich, Allt Garbh and others across the Proposed Scheme. The results of subsequent chemical testing have been compared against water quality standards for drinking water, surface water and GWDTE. This identified that the majority of concentrations were below the criteria, with the exception of ammoniacal nitrogen and locally, nitrate, which exceeded the drinking water and surface water standards.

Potential Contamination

10.3.67 Thirty-one principal potential contamination sources have been identified within the study area as part of the assessment, together with 22 individual occurrences of made ground or visual/ olfactory indications of contamination. Details of these are provided in **Appendix 10.4** (**Volume 2**) and each has been assigned a reference (prefixed 'DC') to assist identification and assessment. The locations of each potential source and occurrence of made ground are shown in **Drawings 10.30** to **10.38** (**Volume 3**).

10.3.68 Available soil sample chemical testing results have been compared against published generic assessment criteria for residential, commercial and open space end uses (DEFRA, 2014; LQM/ CIEH, 2015) to assess potential risks to construction/ maintenance workers, transient site users and local residents during construction. Potential exposure pathways to end users and local residents during operation are likely to be limited, but may remain valid along access tracks and for maintenance workers during inspection or repair activities.

10.3.69 The vast majority of samples analysed did not identify contaminant concentrations in excess of the criteria. However, comparison of the soil results against the residential assessment criteria identified three isolated exceedances for arsenic (51 to 85 mg/kg at 0.10 to 0.50m depth) at two locations – ch. 21,400 (near the existing A889 Dalwhinnie junction) and ch. 22,600 (near the proposed Dalwhinnie junction) – both in areas of peat. None are attributable to any particular source area and the concentrations were below the open space or commercial criteria.

10.3.70 Ground gas data has been collected from 22 borehole locations on up to 12 occasions between January and December 2016 for the Advanced GI, and on up to eight occasions from 50 borehole locations between April and August 2017 for the Preliminary GI. As ground gases may pose risks to human receptors working below ground or in confined spaces during construction, the data was compared to published assessment criteria (HSE, 2011; CIRIA, 2007; BS8485, 2015) for elevated methane, carbon dioxide, carbon monoxide, hydrogen sulphide and depleted oxygen.

10.3.71 Isolated raised detections of methane (between 1.0 and 50.6% volume/ volume (v/v)) have been recorded in three monitoring locations, with the concentrations observed to exceed the safety threshold of 1% v/v. Each borehole location is situated to the west of the Proposed Scheme at ch. 22,900, ch. 29,000 and ch. 30,200 at Dalwhinnie and in the River Truim valley. The installations are screened in, across or nearby areas of peat or natural alluvial materials; suggesting these may be the potential source. All other detected concentrations of methane elsewhere are less than the safety threshold of 1% v/v.

10.3.72 Carbon dioxide concentrations also exceed the short term (15 minutes) occupational exposure limit (1.5% v/v) in 36 boreholes and the long term (8 hour) exposure limit (0.5% v/v) in 41 boreholes across the Proposed Scheme, with detected concentrations ranging between 0.1 and 13.3% v/v. Depleted oxygen concentrations below 19% v/v have been observed in 38 boreholes

on one or more occasion, with levels considered to be very low (less than 16% v/v) in several instances and frequently coinciding with higher methane or carbon dioxide levels.

10.3.73 Carbon monoxide and hydrogen sulphide were predominantly below the monitoring equipment's level of detection (0.1 part per million (ppm)), with any isolated detections all being below their respective short and long term exposure limits.

10.4 Potential Impacts

Embedded Mitigation

10.4.1 Throughout the DMRB Stage 3 design development process described in **Chapter 4**; a number of environmentally-led workshops considered each aspect of the developing design and made recommendations for certain features to be included or aspects of the design to be reconsidered. Where included, these aspects have been defined as 'embedded mitigation'.

10.4.2 For geology, soils and groundwater features; the approach to achieving a first-level of embedded mitigation for the Proposed Scheme was to avoid or minimise impacts on receptors. This was achieved through the following:

- layout and positioning of infrastructure to avoid or minimise disturbance of soils of high conservation value, priority peatland, deep peat and potential GWDTE
- where avoidance has not been possible, local level assessments were completed where possible, to determine local solutions such as earthworks extent reductions to minimise potential impacts and inform management plans for storage, re-instatement and re-use
- layout and positioning of infrastructure to avoid or minimise disturbance of designated and non-designated geological receptors or features of geodiversity interest
- incorporation of access tracks with cross-drainage where relevant, to alleviate potential spring and flush overland or shallow groundwater flow disruption
- watercourse diversions, culverts and drainage to re-direct and maintain hydrological regimes across the Proposed Scheme as far as practicable.

Potential Impact Assessment

10.4.3 When assessing potential impacts from the Proposed Scheme, construction and operational phases have been considered together, as the majority of construction impacts (such as removal of excavated material) will be permanent and extend through operation. Where differences are predicted between construction and operation, these have been assessed for each phase in turn.

10.4.4 There are several ways that the Proposed Scheme may impact on geology, soils or groundwater features during construction and operation. These include:

- excavation or masking of bedrock or superficial deposit exposures or sites of specific scientific or geodiversity interest, particularly if the features are not reproduced elsewhere in the area
- constraint or limitation to existing or potential commercial exploitation of mineral resources
- excavation, removal or sealing of local soil resources, such as soils of high conservation interest or potentially productive agricultural soils
- excavation or removal of peat, with resultant carbon release and potential permanent loss, unless environmentally beneficial re-use or restoration can be achieved

- impacts on groundwater during construction and operation, through dewatering or aspects of infrastructure which may impede or alter local hydrological regimes and groundwater flows
- spillage or leakage of fuels or oils from storage tanks or construction plant which, without suitable mitigation measures, can enter aquifers and subsequently migrate
- groundwater change may impact peat, GWDTE, surface water, abstractions or PWS; GWDTE are also susceptible to loss, drawdown, dewatering or increases in upwelling
- during operation, surface run-off may contain elevated pollutant concentrations such as oils, suspended solids, metals, salt and anti-freeze agents, leading to pollution of groundwater.

10.4.5 A key aspect of the impact assessment has been to identify areas of excavation for the Proposed Scheme, as shown in **Drawings 10.10** to **10.38** (**Volume 3**) and summarised in **Table 10-13**. Only excavations equal to or greater than 1.00m depth are identified, and widening of existing cuttings have been labelled as 'widening' and new cuttings labelled as 'cutting'.

Table 10-13: Excavation Areas and Depths (equal to or greater than 1.00m depth)

Earthwork Ref.[1]	Cutting/ Widening	Chainage (approx.)	Maximum Excavation Depth (m bgl)	Local Groundwater Depth Range (m bgl)	Local Bedrock Depth Range (m bgl)	Likelihood to Intercept Groundwater	Likelihood to Intercept Bedrock
Mainline, Junction and Access Tracks							
MC02	Widening	ch. 45 to ch. 20,140	2.67	2.00 to 3.55	2.65 to 9.00	Likely	Low
MC07	Widening	ch. 20,140 to ch. 20,520	4.41	1.80 to 7.00	3.20	Likely	Likely
MC08	Widening	ch. 20,520 to ch. 20,735	3.67	0.90 to 2.20	5.50	Likely	Low
MC09	Widening	ch. 20,780 to ch. 21,260	3.37	1.50	1.10 to 6.00	Likely	Low
MC11	Widening	ch. 23,700 to ch. 24,120	4.29	0.10 to 7.70	7.40 to 9.15	Likely	Low
MC14	Widening	ch. 24,160 to ch. 24,870	6.26	0.70 to 9.00	8.55 to 9.80	Likely	Low
MC15	Widening	ch. 24,870 to ch. 25,320	6.91	2.20 to 15.00	14.15 to 23.20	Likely	Low
MC17	Widening	ch. 25,475 to ch. 25,620	1.07	1.50 to 3.20	14.15	Low	Low
MC21	Widening	ch. 26,050 to ch. 27,460	9.75	0.00 to 6.97	0.50 to 6.70	Likely	Likely
MC26	Widening	ch. 28,600 to ch. 28,710	1.97	1.26 to 5.60	1.90	Likely	Likely
MC27	Widening	ch. 29,740 to ch. 30,170	5.16	1.10	10.80 to 16.00	Likely	Low
MC28	Widening	ch. 29,770 to ch. 29,980	6.87	Dry	10.80 to 16.00	Low	Low
MC29	Widening	ch. 30,300 to ch. 30,500	5.25	1.40	2.60 to 8.50	Likely	Likely
JC01	Cutting	ch. 22,400 to ch. 22,700	7.00	0.20 to 7.10	2.50 to 8.80	Likely	Likely
AC01	Widening	ch.25 to ch.50 (tie-in)	1.20	1.00 to 3.60[2]	4.30 to 9.60	Likely	Low
AC42	Cutting	ch. 25,550 to ch. 25,650	1.28	2.00 to 2.70	-	Low	Low
AC45	Cutting	ch. 25,675 to ch. 25,725	4.39	2.00 to 2.70	-	Likely	Low
AC43	Cutting	ch. 25,550 to ch. 25,650	1.47	2.00 to 2.70	-	Low	Low
AC44	Cutting	ch. 25,625 to ch. 25,675	2.35	2.00 to 2.70	-	Likely	Low
AC48	Cutting	ch. 26,750 to ch. 25,800	4.93	2.00 to 2.70	17.05	Likely	Low
AC62	Cutting	ch. 27,500 to ch. 27,600	4.46	0.40 to 2.80	4.90	Likely	Low
AQC01	Cutting	ch. 23,400 to ch. 23,700	3.80	0.30 to 13.80	10.00	Likely	Low
SuDS Basins							
SuDS 207	Cutting	ch. 20,720	1.25	2.12 to 5.10	5.60	Low	Low
SuDS 213	Cutting	ch. 21,325	1.80	0.80 to 2.30	-	Likely	Low
SuDS 214	Cutting	ch. 21,420	1.40	0.50 to 3.10	6.10	Likely	Low
SuDS 222	Cutting	ch. 22,200	2.62	1.10 to 1.70	2.50	Likely	Low
SuDS 225	Cutting	ch. 22,500	2.30	0.55 to 1.00	-	Likely	Low
SuDS 233	Cutting	ch. 23,250	2.50	0.80 to 3.30	12.50	Likely	Low
SuDS 254	Cutting	ch. 25,400	4.35	1.60 to 2.80	-	Likely	Low
SuDS 258	Cutting	ch. 25,800	1.50	2.00 to 2.70	17.05	Low	Low

Earthwork Ref.[1]	Cutting/ Widening	Chainage (approx.)	Maximum Excavation Depth (m bgl)	Local Groundwater Depth Range (m bgl)	Local Bedrock Depth Range (m bgl)	Likelihood to Intercept Groundwater	Likelihood to Intercept Bedrock
SuDS 282	Cutting	ch. 28,200	1.60	Dry	8.25	Low	Low
SuDS 306	Cutting	ch. 30,600	2.30	Dry	9.00	Low	Low
Compensatory Flood Storage Areas (CSA)[3]							
CSA 213	Cutting	ch. 21,300	1.50[3]	0.20 to 0.56	2.50	Likely	Low
CSA 217	Cutting	ch. 21,700	1.50[3]	1.80 to 3.10	2.20	Low	Low
CSA 221	Cutting	ch. 22,100	1.50[3]	0.70	-	Likely	Low
CSA 254	Cutting	ch. 25,400	1.50[3]	1.90	-	Low	Low
CSA 279	Cutting	ch. 27,900	1.50[3]	Dry	4.00	Low	Low
CSA 284	Cutting	ch. 28,400	1.50[3]	1.00 to 2.40[2]	-	Likely	Low
CSA 289	Cutting	ch. 28,900	1.50[3]	1.30 to 6.80[2]	7.40	Likely	Low
CSA 305	Cutting	ch. 30,500	1.50[3]	Dry	9.00	Low	Low

Table Notes:

1. Earthworks references, SuDS basins and compensatory flood storage areas are illustrated on **Drawings 10.21** to **10.38** (**Volume 3**)
2. Groundwater level information based on water strike data or nearby locations
3. Each flood storage area will be subject to detailed design, be terraced in nature and depths of excavation will vary. However, the assessment has been based on these typically involving removal and setting aside of soils/ peat turves to a maximum depth of 0.50m and removal of a further 1.00m of material, prior to re-instatement of the soils/ peat turves to create an area 1.00m lower than existing ground level.

10.4.6 Cuttings for the mainline of the Proposed Scheme predominantly relate to widening of existing cuts on sloping ground; which is likely to have lesser effects on baseline groundwater conditions. However, Sustainable Drainage System (SuDS) basins, compensatory flood storage areas, access tracks and the proposed Dalwhinnie junction and underpass will require new cuttings.

10.4.7 Additionally, temporary excavations below embankments for the removal of silt and peat may occur, while there are 19 filter drain networks associated with 14 permanent SuDS basins, 13km of pre-earthworks drainage ditches, 5km of watercourse diversions, 62 proposed culverts (extensions or replacements), seven changes to existing structures (demolition and replacement) and six new structures, including a retaining wall (ch. 30,600 to ch. 30,800) proposed.

Geology

Superficial Geology

10.4.8 Made ground, fluvial and glacial superficial deposits of **negligible** sensitivity (alluvium, river terrace deposits, glaciofluvial deposits, till and hummocky glacial deposits) within the study area are likely to be impacted by the construction of all widenings, cuttings, access tracks, SuDS basins, drainage, structures, culverts and watercourse diversions as part of the Proposed Scheme.

10.4.9 The reduction in extent of these deposits as a result of the construction activities is considered to be of **minor** magnitude because of their widespread occurrence in the region and the country, and therefore minimal percentage loss. There is also the potential for these deposits to be re-used within the Proposed Scheme. As a result, the overall impact significance is considered to be **Neutral** for both construction and operation.

Solid Geology

10.4.10 Bedrock of **negligible** sensitivity is considered likely to be intercepted by mainline widenings MC07, MC26 and MC29, and cutting JC01 for the proposed Dalwhinnie junction, as identified in **Table 10-13**. Due to the widespread occurrence of the rock types in the region and the country, these are expected to represent a **minor** magnitude of impact on the solid geology, resulting in

an impact significance of **Neutral** for construction and operation. There is also the potential for excavated rock deposits to be re-used in the Proposed Scheme.

10.4.11 The use of blasting in excavation areas likely to encounter bedrock cannot be ruled out at this stage, which may impact upon the existing rock structure and have the potential to generate new fractures, extend existing ones and have indirect impacts on groundwater flow pathways. The impacts of blasting on such flow paths are considered in the groundwater assessment. However, based on the anticipated depth of rock cut at the locations identified in **Table 10-13** and the structural geology present (including faulting and folding), the impacts of blasting on the solid geology is expected to be of **minor** magnitude and **Neutral** significance for both construction and operation.

10.4.12 Mainline widening MC21 is additionally considered likely to intercept bedrock, but is discussed further in the geodiversity sub-section in relation to existing rock exposures.

Designated Geological Receptors and Features of Geodiversity Interest

Drumochter Hummocky Moraines

10.4.13 The Drumochter Hummocky Moraines candidate LGS (Barron *et al*, 2011), which is of **medium** sensitivity, is unlikely to be directly impacted by construction or operation of the Proposed Scheme. Hummocky glacial deposits underlie large parts of the study area; however, the estimated extents of the moraine ridge and mound landform assemblage are outwith the permanent and temporary works boundaries, meaning no direct disturbance will occur.

Allt Coire Chuirn Alluvial Fan

10.4.14 An access track is proposed to follow the alignment of an existing track that was constructed for the BDL development in the area of Allt Coire Chuirn near Drumochter, with alluvial fan deposits here being of **medium** sensitivity. Assuming the existing track infrastructure stays in place, the works proposed would comprise up-grading to make it permanent, up-grading an additional track at the southern extent which connects down to the A9 carriageway and a new crossing structure over Allt Coire Chuirn.

10.4.15 Shallow widening, embankment and drainage upgrades would therefore be required and may intercept alluvial fan deposits and soil (peaty gleys and peaty podzols with blanket peat some humus-iron podzols) in the area. Within and between the 180m southern tie-in to Project 7 – Glen Garry to Dalwhinnie and ch. 20,200; mainline widenings, drainage, culverts and watercourse crossings may also intercept these at Allt Coire Bhotie and other minor watercourses as shown in **Drawing 10.10** (**Volume 2**).

10.4.16 Most works are reasonably distanced from, and would avoid direct disturbance of observed partial exposure areas near the Allt Coire Chuirn fan apex and along its length, while interception of fan deposits and soils across the wider area is likely to result in only very slight additional direct disturbance of these and the local landform (additional to that of the existing track and other infrastructure).

10.4.17 Some additional disturbance is therefore considered likely as a result of the Proposed Scheme, but such that the soils and geodiversity value of the area would not be affected. Based on

Table *10-2*, this is therefore considered to represent an impact of overall **minor** magnitude and **Slight/ Moderate** significance during construction and operation. In terms of hydromorphology in the area (sediment regime, channel morphology and fluvial processes), impacts during construction and operation are identified and assessed in **Chapter 11**.

Allt Cuaich Catchment

10.4.19 Soils (peaty podzols with some humus-iron podzols and peat) and **negligible** sensitivity alluvial fan deposits at Allt Cuaich are likely to be intercepted by cuttings for access at the Cuaich farm settlement, SuDS basins, drainage, watercourse diversions and underpass beneath the mainline as shown in **Drawing 10.11** (**Volume 2**). However, these are likely to avoid direct disturbance of the upstream and otherwise **low** sensitivity catchment geodiversity interest features such as river cliff sections.

10.4.20 Impacts on the hydromorphology (sediment regime, channel morphology and fluvial processes) during construction and operation are identified and assessed in **Chapter 11**. However, based on these and the criteria in **Table 10-2**, there is considered likely to be an overall impact of **minor** magnitude and **Neutral/ Slight** significance during construction and operation.

Rock Exposures

10.4.21 Based on **Table 10-13**, no earthworks or aspects of the Proposed Scheme anticipated to intercept bedrock were identified on, or within proximity to existing rock exposures P08-RE02 (psammite with quartz veins, lenses and layering) or P08-RE03 (psammite with pegmatite intrusions, deformations and folding). However, widening MC21 is likely to intercept rock exposure P08-RE01 (medium grained psammite), which is of **negligible** sensitivity. There is likely to be a **major** magnitude of impact, relative to the proportion of exposure loss defined in **Table 10-2**, resulting in an impact of **Slight** significance.

Mineral Extraction

10.4.22 Mineral extraction has occurred historically within the study area, inferred as likely to have been local sand and gravel deposit extraction. Potential future exploitation of similar resources cannot be ruled out, but due to their widespread occurrence they are considered to be of **low** sensitivity.

10.4.23 The impact magnitude is therefore considered to be **minor** based on the minimal percentage loss of potential local resources and the criteria in **Table 10-2**, resulting in an impact of **Neutral/ Sight** significance during construction and operation.

Soils

Soil Conservation

10.4.24 Soils of **low** (humus-iron podzols and peaty gleys), **medium** (peaty podzols, mineral and peaty alluvial soils) and **high** (peat) conservation interest are likely to be impacted by the construction of widenings, cuttings, access tracks, SuDS basins, drainage, structures, culverts, watercourse diversions and compensatory flood storage across the Proposed Scheme extents.

10.4.25 The impact on the conservation interest of the soils as a result of the construction activities is considered to be of **minor** magnitude. This equates to partial losses and soil disturbance across the Proposed Scheme, but where their overall rarity, representivity and diversity is unlikely to be significantly diminished and conservation value in the area and region will not be significantly affected. There is also the potential for the soils to be re-used within the Proposed Scheme or re-instated. The impact significance in terms of conservation interest is therefore considered to be **Neutral/ Slight** to **Moderate** for both construction and operation.

Agricultural Productivity

10.4.26 Temporary and permanent land-take impacts in relation to agricultural land use interests of the Phoines, North and South Drumochter Estates are assessed in **Chapter 8**. Based on this, an approximate and combined 109.55 ha of agricultural land area and **low** sensitivity soil in terms of agricultural productivity, may be disturbed through construction.

10.4.27 Due to the wider distribution of the soils and areas that are actively under some form of sheep grazing or herding use, this is considered to represent an impact of **minor** magnitude in terms of agricultural soil productivity. There is also the potential for soils to be re-used as part of the Proposed Scheme or re-instated. The overall impact significance is therefore considered to be **Neutral/ Slight** during construction and operation.

Peat

10.4.28 The Proposed Scheme has been designed at this stage to avoid and/ or minimise interaction with areas of peat and minimise potential excavation volumes, as detailed within the Outline Peat Management Plan (OPMP) in **Appendix 10.6** (**Volume 2**). However, some areas have proven to be unavoidable and will be disturbed during the construction of widenings, cuttings, tracks, SuDS, drainage, structures, culverts, watercourse diversions and compensatory flood storage areas.

10.4.29 Based on the dimensions and anticipated design nature for each Proposed Scheme element, and utilising the peat depth model shown in **Drawings 10.12** to **10.20** (**Volume 3**), the volumes of peaty soil/ topsoil, shallow peat and deep peat (including separation as acrotelm and catotelm) estimated to be excavated during construction are summarised in **Table 10-14**.

Table 10-144: Estimated Peaty Soil/ Topsoil and Peat Volumes to be Excavated

Proposed Scheme Element	Estimated Excavation Volume[1] (m^3)			Estimated Acrotelm-Catotelm Excavation Volume[2] (m^3)	
	Peaty Soil/ Topsoil	Shallow Peat	Deep Peat	Acrotelm	Catotelm[3]
Mainline Alignment	51,260	18,940	3,234	2,788	19,387
Dalwhinnie Junction	16,036	15,636	7,844	2,609	20,871
SSE Aqueduct Diversion	1,792	3,573	798	539	3,832
Access Tracks	6,655	2,164	23	282	1,903
Permanent SuDS Basins	4,590	884	0	118	766
Drainage (Filter and Pre-earthworks)	4,845	1,801	672	387	2,082
Watercourse Diversions	6,760	4,038	1,512	874	4,676
Compensatory Flood Storage Areas	0	66	37	40	63
Totals	**91,938**	**47,102**	**14,120**	**7,637**	**53,580**

Table Notes:

1. Estimated volumes are residual (i.e. net excavation volumes after any re-instatement at the point of excavation has been accounted for, as further detailed in **Appendix 10.6** (**Volume 2**). Volumes also assume that the existing BDL access track is not re-instated prior to construction.

2. Acrotelm and catotelm are defined in **Appendix 10.1** (**Volume 2**) and quantities are based upon the measured thickness of acrotelm in the field in shallow and deep peat as described in **Appendix 10.6** (**Volume 2**). If the top 0.50m were to be treated as acrotelm (as suuggested in **Appendix 10.6** (**Volume 2**)), the volume estimated for this would increase and that for catotelm would decrease.

3. Based on data presented in **Appendix 10.1** (**Volume 2**), no evidence of nearly complete to completely decomposed (amorphous) peat has been observed based on von Post classifications, but of the calculated catotelm quantities, approximately 16% (equivalent to **8,573m^3**) may be strongly decomposed.

10.4.30 At a broad scale, the excavation volumes correspond to disturbance of approximately 1.64 ha of Class 1 and 24.10 ha of Class 2 priority peatland areas in the central and southern extents of the Proposed Scheme near Dalwhinnie and the Drumochter Hills, with 6.47 ha Class 3 and 7.59 ha

Class 5 in the north. At a local scale, they correlate to the permanent and temporary disturbance of natural and semi-natural peaty soil or peat-based habitat such as blanket mire, mire, wet heath, mosaics of these, dry heath and grasslands, as described in **Chapter 12**.

10.4.31 Based on these considerations and the criteria in **Table 10-2**, the magnitude of direct disturbance impacts from the Proposed Scheme in relation to peaty soils and peat are therefore anticipated to be **minor** to **moderate** overall. This equates to partial disturbance and loss of individual peatland areas of varying sensitivity throughout, but predominantly where it is considered their value would either not be affected, or would be, but not to a major degree. The key area of higher magnitude impact is located within and adjacent to the Proposed Scheme at the proposed Dalwhinnie junction (ch. 22,000 to ch. 23,700), where several proposed scheme elements and winter resilience planting directly intercept or border a large area of degraded, but locally good condition blanket mire to the east. Overall, direct impacts are therefore anticipated to be of **Slight/ Moderate** to **Moderate** significance during construction and operation.

10.4.32 Areas of excavation within and adjacent to peat may also lead to dewatering of acrotelm layers, oxidation, drying and shrinkage of the catotelm, while dense tree planting for winter resilience may dry out peat mass margins via water uptake. Based on estimates of potential dewatering extents for peat (JNCC, 2005; CIRIA, 2016), published literature and typical peat permeabilities (Stewart and Lance, 1991; Nayak *et al.*, 2008; Dargie, 2009; Scottish Government, 2011c); the magnitude of these impacts is anticipated to be **minor**, resulting in impacts of **Slight/ Moderate** significance for the majority of the Proposed Scheme and **Moderate** significance in the vicinity of Dalwhinnie junction (ch. 22,300 to ch. 23,600) and to the east, north of Cuaich (ch. 26,200 to ch. 26,500).

10.4.33 A Preliminary Peat Landslide Risk Assessment for the Proposed Scheme has identified risks across the majority of it and adjacent areas to be negligible or slight. However, localised areas assessed to be of moderate risk have been highlighted. The location of these are detailed in **Appendix 10.5** (**Volume 2**) and illustrated in **Drawing 10.5.15** to **10.5.18** (**Volume 3**).

Groundwater

10.4.34 Potential impacts on groundwater level and flow are outlined below, followed by consideration of impacts that may apply to groundwater quality, GWDTE, surface water features, groundwater abstractions and PWS.

Groundwater Flow

10.4.35 Several areas of mainline widening or other cutting have the potential to intercept groundwater as identified in **Table 10-13**. This is expected to result in lowering of groundwater levels and alter local flow directions in these areas. The excavations are anticipated to be predominantly formed in coarse granular till and hummocky glacial deposits (**medium** sensitivity) to the east and west, but also alluvium and alluvial fan (**high** sensitivity) in southern extents towards Drumochter and in central areas near and north of Cuaich.

10.4.36 Due to the nature of the existing topography across the Proposed Scheme and that the majority of cuttings relate to widening of existing ones to the east, the impacts on groundwater level and flow in superficial deposits are assessed to be of predominantly **minor** magnitude. This equates to potential impacts of **Slight** significance on groundwater in glacial deposits (till and hummocky glacial) and **Slight/ Moderate** significance on groundwater in fluvial deposits (alluvium and alluvial fan) during construction and operation. The magnitude of potential impacts is assessed to be higher for the Dalwhinnie junction (JC-01) and SSE aqueduct diversion (AQC01) due to the depth of excavations, potential drawdown and greater likelihood for flow patterns to be locally

altered. Potential groundwater level and flow impacts in these areas are therefore assessed to be of **moderate** magnitude and **Moderate** significance.

10.4.37 Bedrock groundwater may be intercepted in five areas of widening or cutting underlain by the Gaick Psammite Formation (**medium** sensitivity) through Dalwhinnie and north of Cuaich, while the requirement for rock blasting cannot be ruled out at this stage. Based on the location of the areas, the depth of potential rock cut, the structural geology (including faulting and folding) and the criteria in **Table 10-5**, the potential impacts on levels and flow of bedrock groundwater are considered to be of **minor** magnitude and **Slight** significance during construction and operation.

10.4.38 The construction of embankments across the Proposed Scheme may also result in excavation or compaction of shallow soil and superficial deposits below their footprint, while pre-earthworks drainage during construction, and filter drains during operation could create localised drawdown of shallow groundwater. These are assessed to result in localised impacts of **negligible** to **minor** magnitude and **Neutral** to **Slight** significance on groundwater levels and flow.

Groundwater Quality

10.4.39 Based on groundwater vulnerability mapping shown in **Drawing 10.9** (**Volume 3**), all groundwater within the study area may be vulnerable to accidental spillages during construction or operation, and subsequent contamination impact on groundwater in the underlying superficial deposits or bedrock. The areas at highest risk are those in the vicinity of widenings and cuttings anticipated to intercept groundwater in **Table 10-13** and other receptors such as GWDTE, groundwater abstractions or PWS. The magnitude of potential impacts is assessed as moderate on both superficial deposits (**medium** to **high** sensitivity) and bedrock (**medium** sensitivity), resulting in groundwater quality impacts of **Moderate** to **Moderate/ Large** significance.

10.4.40 SuDS basins and filter drains could also act as pathways for contamination to enter groundwater. However, at least two levels of treatment for mainline and junction drainage will be provided (one level for access tracks), while filter drains and SuDS basins are proposed to be lined. This is anticipated to prevent ingress of potential contaminants to groundwater and provide attenuation before discharging to surface waters. As such, impacts of **negligible** magnitude and **Neutral** significance are expected on groundwater quality in superficial soils and bedrock with respect to these features.

Groundwater Dependent Terrestrial Ecosystems

10.4.41 The Proposed Scheme has been designed at this stage to avoid and/ or minimise disturbance of GWDTE as far as practicable. However, almost all proposed infrastructure is located within 100m of areas with at least a degree of groundwater dependence. Several have therefore proven to be unavoidable and are likely to be impacted.

10.4.42 The quantified extent of areas directly affected due to the permanent and temporary works are detailed in an assessment for each GWDTE habitat in **Appendix 10.2** (**Volume 2**), together with consideration of potential indirect effects from areas of mainline widening or other cutting that have the potential to intercept groundwater from **Table 10-13**. The magnitude and significance of impact for each area is based on combined consideration of the potential direct and indirect effects where relevant, together with assessment of the potential drawdown at the receptor against the intervening topography and the nature of the likely local water supply mechanisms to the habitat being assessed.

10.4.43 Based on these aspects and the criteria in **Table 10-5**, the magnitude of potential impacts on the individual GWDTE (**medium** to **very high** sensitivity) are assessed to vary from **negligible** to **major** across the Proposed Scheme; with direct loss, temporary disturbance and/ or drawdown effects

throughout, but mainly where the value of individual areas would either not be affected, or would be, but not to a major degree. For the 156 GWDTE assessed, this results in potential impacts ranging from **Neutral** to **Slight** significance for 26 habitat areas (17%), **Slight/ Moderate** to **Moderate** significance for 26 habitat areas (17%), **Moderate/ Large** to **Large** significance for 29 habitat areas (18%) and **Large/ Very Large** significance for six habitat areas (4%). No potential direct or indirect impacts are anticipated in relation to the remaining 69 habitat areas (44%).

10.4.44 The impacts identified are predominantly in relation to habitat mosaics considered to have only a low dependence on groundwater throughout the Proposed Scheme. However, several areas with a dominant or sub-dominant cover of wet heath, mire, rush pasture or discrete flush or spring features assessed to have moderate or high groundwater dependence may also be affected. Partial and local complete permanent loss of some areas is therefore anticipated due to the Proposed Scheme footprint, while disturbance within the wider land made available during construction works may result in temporary, but in many cases reversible, effects.

10.4.45 Known flush and spring features (**high** to **very high** sensitivity) within the east of the study area are predominantly avoided in a direct sense. However, several flushes are present within and at the margins of the Drumochter Hills SAC in southern extents, where overland flow from or associated with these or similar features is diffuse. The access track proposed on the alignment of the existing BDL track bisects moderate and highly groundwater dependent habitats (**high** to **very high** sensitivity) in this area; running perpendicular to the flow direction across sloping ground.

10.4.46 Barrier effects to this flow are presently evident, with frequent ponding and gathering of water on the upslope side of the existing track. However, as the proposed track upgrades include up-gradient ditches for the interception of the flow and transmittal of this via check-dams, then cross-track culverts to the down-gradient side; this barrier effect will be removed. Based on **Table 10-5**; the magnitude of potential impacts is therefore considered to be **negligible** to **minor**, with beneficial impacts of **Neutral/ Slight** to **Moderate/ Large** significance.

10.4.47 The ecological importance of the habitats in the study area are outlined in **Chapter 12**, with regards conservation interest, environmental designations and the significance of ecological loss or disturbance of these. This identifies that the majority of impacts occur within or along the edge of more extensive habitat mosaics, within or adjacent to the existing A9 corridor, and where vegetation composition, structure and processes are already predominantly affected by land management, drainage or infrastructure. Several are therefore not considered to represent the best habitat examples, with **Table 12-20** in **Chapter 12** noting that ecological loss and disturbance may only be locally potentially significant in relation to wet heath and blanket mire GWDTE types.

Groundwater Effects on Surface Water

10.4.48 Lowering of groundwater levels or dewatering in excavations can affect nearby surface water features that interact with groundwater, by affecting this as a possible baseflow component.

10.4.49 There are several minor watercourse crossings along the Proposed Scheme, with the majority described in **Chapter 11** as being little more than heavily-engineered road drainage channels, draining the land on the upstream side to the east. Although their narrow size and lower flow make them vulnerable to reductions in baseflow and they are likely to be locally important in terms of cross-carriageway hydrology; these are identified in **Appendix 11.1** (**Volume 2**) to have minimal hydrological importance to sensitive ecosystems and are therefore considered to be of **low** sensitivity. The majority of these will also be replaced or diverted by the drainage network planned for the Proposed Scheme, with excavations for this considered unlikely to have significant dewatering effects. This is also considered to be applicable to excavations for culverts and watercourse diversions.

10.4.50 For other minor and major watercourses however, an assessment of potential impacts as a result of interaction with widenings and cuttings which are anticipated to intercept groundwater is summarised in **Table 10-15**. Surface watercourses are identified as per the feature referencing in **Chapter 11** and are illustrated in **Drawings 11.1** to **11.7** (**Volume 3**).

10.4.51 Where groundwater is not anticipated to be encountered in areas of excavation from **Table 10-13**, the potential impact is assigned as being of **negligible** magnitude and **Neutral** significance. Otherwise, the magnitude of impact is based on consideration of potential drawdown at the receptor against the intervening topography, size of the feature and its ecological sensitivity.

Table 10-15: Potential Indirect Groundwater Impacts on Surface Water Features

Surface Water Feature Ref.	Surface Water Feature Name	Chainage (approx.)	Nearest Earthworks Ref.	Sensitivity	Magnitude	Significance
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	MC02	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	MC07	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	MC08	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	MC09	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	SuDS 213	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	SuDS 214	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	JC01	Very High	Minor	Moderate/ Large
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	SuDS 225	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	MC14	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	MC15	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	SuDS 254	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	MC21	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	MC26	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	MC27	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	MC29	Very High	Negligible	Neutral
MW 8.1	River Truim	ch. 25,350 to ch. 31,050	CSA305	Very High	Negligible	Neutral
MW 8.5	Allt Coire nan Cisteachan	ch. 20,650 to ch. 20,800	MC08	Very High	Minor	Moderate/ Large
MW 8.5	Allt Coire nan Cisteachan	ch. 20,650 to ch. 20,800	MC09	Very High	Minor	Moderate/ Large
MW 8.6	Allt Coire Uilleim	ch. 21,400 to ch. 21,440	SuDS 214	Very High	Negligible	Neutral
MW 8.8	Allt Coire Bhathaich	ch. 22,175 to ch. 22,290	SuDS 222	Very High	Negligible	Neutral
MW 8.8	Allt Coire Bhathaich	ch. 22,175 to ch. 22,290	JC01	Very High	Negligible	Neutral
MW 8.9	Unnamed (tributary of River Truim)	ch. 22,950 to ch. 23,800	SuDS 233	Very High	Minor	Moderate/ Large
MW 8.9	Unnamed (tributary of River Truim)	ch. 22,950 to ch. 23,800	AQC01	Very High	Minor	Moderate/ Large
MW 8.12	Unnamed (tributary of River Truim)	ch. 25,280 to ch. 25,350	MC15	Very High	Negligible	Neutral
MW 8.12	Unnamed (tributary of River Truim)	ch. 25,280 to ch. 25,350	SuDS 254	Very High	Negligible	Neutral
MW 8.13	Unnamed	ch. 25,250 to ch. 25,400	MC15	Very High	Negligible	Neutral
MW 8.13	Unnamed	ch. 25,250 to ch. 25,400	SuDS 254	Very High	Negligible	Neutral
MW 8.14	Allt Cuaich	ch. 25,950 to ch. 26,250	AC44	Very High	Negligible	Neutral
MW 8.14	Allt Cuaich	ch. 25,950 to ch. 26,250	AC45	Very High	Minor	Moderate/ Large

Surface Water Feature Ref.	Surface Water Feature Name	Chainage (approx.)	Nearest Earthworks Ref.	Sensitivity	Magnitude	Significance
MW 8.14	Allt Cuaich	ch. 25,950 to ch. 26,250	AC48	Very High	Minor	Moderate/ Large
MW 8.14	Allt Cuaich	ch. 25,950 to ch. 26,250	SuDS 258	Very High	Negligible	Neutral
MW 8.16	Unnamed (tributary of River Truim)	ch. 26,450 to ch. 26,800	MC21	Low	Moderate	Slight
MW 8.18	Dalannach (tributary of Allt Garbh)	ch. 27,730 to ch. 27,850	AC62	Low	Moderate	Slight
MW 8.18	Dalannach (tributary of Allt Garbh)	ch. 27,730 to ch. 27,850	MC21	Low	Negligible	Neutral
MW 8.19	Unnamed	ch. 27,650 to ch. 28,050	AC62	High	Negligible	Neutral
MW 8.21	Unnamed (tributary of River Truim)	ch. 30,500 to ch. 30,610	MC29	Low	Minor	Neutral
W 8.1	Unnamed (tributary of River Truim)	ch. 20,750	MC02	Low	Moderate	Slight
W 8.2	Unnamed (tributary of River Truim)	ch. 20,950 to ch. 21,350	MC08	High	Negligible	Neutral
W 8.2	Unnamed (tributary of River Truim)	ch. 20,950 to ch. 21,350	MC09	High	Minor	Slight/ Moderate
W 8.3	Unnamed (tributary of River Truim)	ch. 20,900 to ch. 21,050	MC09	Low	Negligible	Neutral
W 8.4	Unnamed (tributary of River Truim)	ch. 20,350 to ch. 20,400	SuDS 213	High	Moderate	Moderate/ Large
W 8.4	Unnamed (tributary of River Truim)	ch. 20,350 to ch. 20,400	SuDS 214	High	Moderate	Moderate/ Large
W 8.7	Unnamed (tributary of River Truim)	ch. 21,950 to ch. 22,140	SuDS 222	High	Moderate	Moderate/ Large
W 8.7	Unnamed (tributary of River Truim)	ch. 21,950 to ch. 22,140	CSA 221	High	Minor	Slight/ Moderate
W 8.12	Unnamed (tributary of River Truim)	ch. 24,850 to ch. 24,950	MC15	Low	Major	Slight/ Moderate
W 8.13	Unnamed (drainage from SSE aqueduct)	ch. 25,100 to ch. 25,370	MC15	Very High	Major	Very Large
W 8.14	Unnamed (field drainage channel)	ch. 25,800	MC17	Low	Minor	Neutral
W 8.14	Unnamed (field drainage channel)	ch. 25,800	AC42	Low	Negligible	Neutral
W 8.14	Unnamed (field drainage channel)	ch. 25,800	AC44	Low	Minor	Neutral
W 8.14	Unnamed (field drainage channel)	ch. 25,800	AC45	Low	Moderate	Slight
W 8.14	Unnamed (field drainage channel)	ch. 25,800	AC48	Low	Negligible	Neutral
W 8.14	Unnamed (field drainage channel)	ch. 25,800	SuDS 254	Low	Negligible	Neutral
W 8.16	Unnamed (mill lade from Allt Cuaich)	ch. 25,950 to ch. 26,150	AC44	High	Negligible	Neutral
W 8.16	Unnamed (mill lade from Allt Cuaich)	ch. 25,950 to ch. 26,150	AC45	High	Negligible	Neutral
W 8.16	Unnamed (mill lade from Allt Cuaich)	ch. 25,950 to ch. 26,150	AC48	High	Minor	Slight/ Moderate
W 8.16	Unnamed (mill lade from Allt Cuaich)	ch. 25,950 to ch. 26,150	SuDS 258	High	Negligible	Neutral
W 8.17	Unnamed (field drainage channel)	ch. 26,200 to ch. 26,350	MC21	High	Minor	Slight/ Moderate
W 8.19	Unnamed (tributary of River Truim)	ch. 26,900	MC21	Low	Moderate	Slight/ Moderate
W 8.19a	Unnamed (field drainage channel)	ch. 27,150 to ch. 27,300	MC21	Very High	Moderate	Large/ Very Large

Surface Water Feature Ref.	Surface Water Feature Name	Chainage (approx.)	Nearest Earthworks Ref.	Sensitivity	Magnitude	Significance
W 8.22	Unnamed (tributary of River Truim)	ch. 27,450	MC21	Very High	Moderate	Large/ Very Large
W 8.25	Unnamed (field drainage channel)	ch. 28,550	MC26	High	Minor	Slight/ Moderate
W 8.26	Unnamed (field drainage channel)	ch. 28,800	MC26	High	Negligible	Neutral
W 8.34	Unnamed (tributary of W 8.1)	ch. 20,180 to ch. 20,210	MC02	Low	Minor	Neutral
W 8.34	Unnamed (tributary of W 8.1)	ch. 20,180 to ch. 20,210	MC07	Low	Moderate	Slight
W 8.38	Unnamed (tributary of W 8.1)	ch. 20,300 to ch. 20,350	MC07	Very High	Moderate	Large/ Very Large
W 8.39	Unnamed (tributary of W 8.1)	ch. 20,400 to ch. 20,430	MC07	Very High	Moderate	Large/ Very Large
W 8.40	Unnamed (tributary of W 8.1)	ch. 20,450 to ch. 20,480	MC07	Very High	Moderate	Large/ Very Large
W 8.41	Unnamed (tributary of W 8.1)	ch. 20,510 to ch. 20,550	MC08	Very High	Minor	Moderate/ Large
W 8.42	Unnamed (tributary of W 8.1)	ch. 20,630	MC08	Low	Moderate	Slight
W 8.44	Unnamed (tributary of River Truim)	ch. 20,850 to ch. 20,900	MC09	Low	Minor	Neutral
W 8.47	Unnamed (tributary of River Truim)	ch. 20,970 to ch. 21,000	MC09	Low	Moderate	Slight
W 8.67	Unnamed (ephemeral tributary of River Truim)	ch. 22,300 to ch. 22,400	JC01	Low	Minor	Neutral
W 8.72	Unnamed (intake for SSE Aqueduct)	ch. 22,600 to ch. 22,660	JC01	Low	Major	Slight/ Moderate
W 8.78	Unnamed (intake for SSE Aqueduct)	ch. 22,700 to ch. 22,750	JC01	Low	Major	Slight/ Moderate
W 8.80	Unnamed (intake for SSE Aqueduct)	ch. 22,950	JC01	Low	Negligible	Neutral
W 8.80	Unnamed (intake for SSE Aqueduct)	ch. 22,950	SuDS 233	Low	Negligible	Neutral
W 8.87	Unnamed (intake for SSE Aqueduct)	ch. 23,400 to ch. 23,430	AQC01	Low	Major	Slight/ Moderate
W 8.88	Unnamed (intake for SSE Aqueduct)	ch. 23,450 to ch. 23,500	AQC01	Low	Major	Slight/ Moderate
W 8.89	Unnamed (intake for SSE Aqueduct)	ch. 23,550 to ch. 23,600	AQC01	Low	Minor	Neutral
W 8.89	Unnamed (intake for SSE Aqueduct)	ch. 23,550 to ch. 23,600	MC11	Low	Minor	Neutral
W 8.90	Unnamed (ephemeral channel)	ch. 23, 680 to ch. 23,710	AQC01	Low	Minor	Neutral
W 8.90	Unnamed (ephemeral channel)	ch. 23,680 to ch. 23,710	MC11	Low	Moderate	Slight
W 8.91	Unnamed (ephemeral channel)	ch. 23,950 to ch. 24,400	MC11	Low	Moderate	Slight
W 8.92	Unnamed (ephemeral channel)	ch. 24,100 to ch. 24,150	MC11	Low	Moderate	Slight
W 8.93	Unnamed (ephemeral channel)	ch. 24,210 to ch. 24,300	MC11	Low	Moderate	Slight
W 8.93	Unnamed (ephemeral channel)	ch. 24,210 to ch. 24,300	MC14	Low	Moderate	Slight
W 8.94	Unnamed (ephemeral channel)	ch. 24,275	MC14	Low	Moderate	Slight
W 8.95	Unnamed (ephemeral channel)	ch. 24,325	MC14	Low	Moderate	Slight
W 8.97	Unnamed (ephemeral channel)	ch. 24,500 to ch. 24,550	MC14	Low	Major	Slight/ Moderate

Surface Water Feature Ref.	Surface Water Feature Name	Chainage (approx.)	Nearest Earthworks Ref.	Sensitivity	Magnitude	Significance
W 8.98	Unnamed (ephemeral channel)	ch. 24,600 to ch. 24,660	MC14	Low	Major	Slight/ Moderate
W 8.103	Unnamed (ephemeral channel)	ch. 25,550	MC15	Low	Moderate	Slight
W 8.107	Unnamed (drainage channel)	ch. 26,000 to ch. 26,025	AC44	Medium	Negligible	Neutral
W 8.107	Unnamed (drainage channel)	ch. 26,000 to ch. 26,025	AC45	Medium	Negligible	Neutral
W 8.107	Unnamed (drainage channel)	ch. 26,000 to ch. 26,025	AC48	Medium	Minor	Slight
W 8.107	Unnamed (drainage channel)	ch. 26,000 to ch. 26,025	SuDS 258	Medium	Negligible	Neutral
W 8.139	Unnamed (ephemeral drainage channel)	ch. 27,800 to ch. 27,850	AC62	Low	Negligible	Neutral
W 8.153	Unnamed (drainage channel)	ch. 28,410 to ch. 28,460	MC28	High	Negligible	Neutral
W 8.154	Unnamed (field drainage channel)	ch. 28,550	MC28	High	Negligible	Neutral
W 8.172	Unnamed (tributary to River Truim)	ch. 29,650 to ch. 29,680	MC28	High	Negligible	Neutral
W 8.177	Unnamed (tributary to River Truim)	ch. 30,200	MC27	Low	Minor	Neutral
W 8.177	Unnamed (tributary to River Truim)	ch. 30,200	MC29	Low	Negligible	Neutral
W 8.177	Unnamed (tributary to River Truim)	ch. 30,200	MC28	Low	Negligible	Neutral
W 8.178	Unnamed (tributary to River Truim)	ch. 30,200 to ch. 30,350	MC27	Low	Negligible	Neutral
W 8.178	Unnamed (tributary to River Truim)	ch. 30,200 to ch. 30,350	MC29	Low	Minor	Neutral
W 8.183	Unnamed (tributary to River Truim)	ch. 30,900	MC29	Low	Minor	Neutral

Groundwater Abstractions and Private Water Supplies

10.4.52 Given its distance from the Proposed Scheme, intervening topography and the presence of the River Truim; no potential impacts on the quality or yield of the PWS source or supply network at Crubenmore (ABS 8.1) (**high** sensitivity) are anticipated.

10.4.53 The PWS at the Cuaich farm settlement (ABS 8.24) (**high** sensitivity) is understood to be conveyed to the farm properties via a pipe network that crosses under the existing A9 at approximate ch. 25,900. The spring source, tank and an associated intake near the SSE aqueduct will be avoided and are unlikely to be affected indirectly given their distance from the Proposed Scheme and the intervening topography. However, the supply valve and pipe network may be intercepted by cuttings for proposed access and other works at the farm settlement, with disruption to the supply network potentially affecting both quantity and quality. Based on **Table 10-5**, this is considered to equate to an impact of **major** magnitude and **Large/ Very Large** significance.

10.4.54 The groundwater abstractions for Dalwhinnie Water Treatment Works (ABS 8.5) (**very high** sensitivity) comprise three shallow wells (2.00 to 3.00m in depth) situated adjacent to the River Truim, which are considered likely to have a groundwater as well as surface water component. Potential permanent or indirect groundwater impacts, in terms of yield or quality, are considered unlikely – as the wells are situated at least 500m down and cross-gradient, outwith the estimated zones of dewatering influence for Dalwhinnie junction (JC-01) and the SSE Aqueduct diversion (AQC01). The low productivity superficial and solid geology within these cuttings is also unlikely to be in hydraulic continuity with the moderate to high productivity strata present where the wells are located. Notwithstanding, the wells may be vulnerable to temporary disturbance from work within or adjacent to the River Truim and from pollution incidents during construction. This is particularly of relevance in the vicinity of the proposed Dalwhinnie junction and associated link road to the existing A889. Based on **Table 10-5**, the magnitude of impacts related to this are assessed as **minor** on yield and **moderate** on quality, resulting in a potential impact of **Moderate/ Large** to **Large/ Very Large** significance during construction.

Potential Contamination

10.4.55 A number of potential contamination sources have been identified in the study area, as shown in **Drawings 10.30** to **10.38** (**Volume 3**). An assessment of each source is presented in **Appendix 10.4** (**Volume 2**) in the context of a preliminary CSM and with reference to the pollutant linkages identified in **Table 10-7**. Based on the criteria in **Table 10-8** to **Table 10-10**, the CSM evaluates the level of potential risk (significance) that may be present in relation to impacts from each source, as a direct result of construction or operation activities associated with the Proposed Scheme.

10.4.56 In this respect, there are considered to be two potential ways in which the Proposed Scheme may interact with potential contamination, as follows:

- direct disturbance of potential contamination sources (i.e. those within the Proposed Scheme footprint or permanent and temporary works boundaries)
- indirect disturbance of nearby potential contamination sources as a result of construction of the Proposed Scheme (i.e. interception within areas of excavation).

10.4.57 Direct interaction may occur with potential sources including the existing A9 carriageway (DC-01), former electricity pylons (DC-02), made ground at Dalannach (DC-10), a former quarry/ sand pit (DC-11), occurrences of made ground (DC-32 to DC-52), potential radon hazard areas (DC-15) and raised levels of ground gas (DC-53). Based on the preliminary CSM assessment, this interaction is considered likely to occur for these sources and may affect human receptors (PL1 to PL4), with

minor to **medium** consequence and potential impacts of **Low** to **Moderate** significance during construction. Direct interaction with the same sources may also occur during operation via PL13 to PL16, with similar consequence, but lower likelihood. Resultantly, potential impacts during operation would be proportionately lower and range between **Very Low** and **Moderate/ Low** significance.

10.4.58 Where areas of made ground or other material is excavated and temporarily stored during construction (including materials from demolished structures), these may additionally represent potential risks to human health (PL1 and PL3), the water environment and ecological receptors such as groundwater, surface water, GWDTE, agricultural land and livestock (PL5 to PL9 and PL11) or property receptors such as local abstractions or PWS (PL7), buried concrete and services (PL12). In the absence of mitigation, the potential of this occurring has been assessed as likely, and of **mild** to **medium** consequence during construction. Potential risks to the same receptors during operation are also possible (PL13, PL15, PL17 to PL21, and PL23 to PL24) if the materials were re-used, and are assessed to be of similar consequence, but lower likelihood. Potential impacts are therefore identified to be of **Moderate/ Low** to **Moderate** significance during construction and **Very Low** to **Moderate/ Low** significance during operation.

10.4.59 Indirect impacts may occur where areas of widening and cutting intercept groundwater during construction, as they could draw local potential contaminated water towards them or mobilise potential contaminated water within or adjacent to the footprint. This may then impact human health (PL1 and PL13), surface water, GWDTE or PWS receptors through migration (PL7) and require discharge during construction (PL10) and operation (PL22). Potential sources in relation to this principally include former electricity pylons (DC-03), the existing BDL (DC-04), Dalwhinnie Service Station (DC-08a-b), septic tank effluent discharges to soakaways or land (DC-12a-f, DC-22, DC-23, DC-24, DC-27 and DC-28) and localised inorganic and organics recorded in groundwater chemical testing results.

10.4.60 Dewatering effects from the excavations for the Proposed Scheme are likely to be predominantly localised and greatest during construction, with longer-term interception of water managed by the detailed design of the excavation areas. The CSM assessment for the source areas, based on the potential for excavations in proximity to draw in or mobilise contaminated groundwater is presented in **Appendix 10.4** (**Volume 2**). During construction, the potential impacts are assessed to be of **Very Low** to **Moderate/ Low** significance, but with some source areas (including DC-08a-b) identified to have potential impacts of **Moderate** significance, based on evidence for potential or actual contamination presence and the proximity of sensitive receptors. Similar potential impacts during operation are proportional in terms of consequence, but of lesser likelihood. As such, comparable impacts of between **Very Low** and **Moderate/ Low** significance are expected.

10.5 Mitigation

10.5.1 Based on the impact assessment, Standard Mitigation measures for the Proposed Scheme followed by Project Specific Mitigation considerations are detailed in **Table 10-16**. These measures take into account best practice, current legislation and guidance to further avoid, reduce or off-set the potential impacts identified where possible.

10.5.2 The Standard Mitigation measures are based upon those being applied across the A9 Dualling Programme and will be developed by the Contractor alongside the Project Specific Mitigation and relevant management systems to structure, monitor, control and communicate implementation, including a Construction Environmental Management Plan (CEMP).

Table 10-16: Standard and Project-Specific Mitigation Commitments – Geology, Soils and Groundwater

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
Standard A9 Mitigation					
SMC-G1	Throughout Proposed Scheme	Pre-Construction	Prior to construction, consultation will be undertaken with the relevant local authorities and SEPA regarding works in relation to land affected by contamination to support the obligations set out in 'Planning Advice Note 33: Development of Contaminated Land' (Scottish Government, 2000). Any remedial action undertaken in relation to land affected by contamination will be carried out under the appropriate remediation licencing.	To reduce impacts from contaminated land sources.	Consultation with THC (and SEPA as required).
SMC-G2	Throughout Proposed Scheme	Pre-Construction	Prior to construction and where potential contamination has been identified, further site investigations sufficient to determine the extent and type of contaminants present will be undertaken as necessary to inform identification of appropriate construction methods and any additional mitigation.	To determine the extent and type of contaminants present and to inform identification of appropriate construction methods and any additional mitigation.	None required
SMC-G3	Throughout Proposed Scheme	Pre-Construction & Construction	Prior to construction, appropriate health and safety and waste management procedures for working with potentially contaminated soils will be established. Waste management procedures will take account of inter alia: Waste Management Licence (Scotland) Regulations 2011 (as amended by the Waste Management Licensing (Scotland) Amendment Regulations 2016), HSE Guidance Note MS31 (HSE, 2012) and the Health and Safety Commission Approved Code of Practice and Guidance Note. These procedures will be implemented as appropriate during construction.	To ensure appropriate health and safety and waste management procedures for working with potentially contaminated soils are followed.	None required
SMC-G4	Throughout Proposed Scheme	Construction & Post-Construction/ Operation	Risks to construction and maintenance staff working with/near contaminated land will be mitigated by the implementation of **Mitigation Item SMC-G3** in combination with the adoption of appropriate systems of work, including personal protective equipment (PPE) as a last resort. In the event that unrecorded contamination is encountered, works should be stopped and the working procedures reassessed to confirm the working methods remain appropriate. Construction staff will be trained to identify asbestos containing material.	To reduce impacts from contaminated land sources and confirm the safety of construction and maintenance staff.	None required
SMC-G5	Throughout Proposed Scheme	Construction	Appropriate training will be provided for personnel involved in earthworks activities to enable implementation of a watching brief to identify presence of previously unidentified contamination.	To identify potential presence of previously unidentified contamination.	None required
SMC-G6	Throughout Proposed Scheme	Pre-Construction & Construction	Where required, landowner consultation and site visits will be undertaken to confirm the location of septic tanks and associated infrastructure. Where septic tanks are located within the LMA they will be relocated subject to discussion and agreement with the affected landowner(s).	To mitigate the loss of any septic tanks.	Approval from landowners
SMC-G7	Throughout Proposed Scheme	Construction	To prevent cross contamination and pollution from piling works undertaken in areas of land affected by contamination, the Contractor will undertake a Piling Risk Assessment and adhere to appropriate guidance including the 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention, National Groundwater and Contaminated Land Centre Report NC/99/77'.	To prevent cross contamination and pollution from piling works undertaken in areas of land affected by contamination.	None required

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
SMC-G8	Throughout Proposed Scheme	Construction	Excavated soils deemed unsuitable for reuse will be assessed in line with the 'Waste Classification: Guidance on the Classification and Assessment of Waste' (Technical Guidance WM3) (Natural Resources Wales, SEPA, Northern Ireland Environment Agency, Environment Agency, May 2015) to determine whether they are hazardous or non-hazardous. This will establish the most appropriate and cost effective waste stream for the waste materials.	To determine whether disposed soils are hazardous or non-hazardous.	None required
SMC-G9	Throughout Proposed Scheme	Pre-Construction	To maximise the reuse of site-won materials on-site (and minimise the need for disposal of waste in line with the principles of the "Waste Hierarchy") whilst ensuring that no risks are posed to human health nor the water environment a soil reuse assessment will be undertaken prior to construction. The soil reuse assessment will identify any potential risks posed to both human health and the water environment from potentially contaminated soils reused throughout the proposed scheme.	To identify any potential risks posed to human health and the water environment. In addition, this mitigation item would maximise re-use of site-won materials on-site and minimise the need for disposal of waste in line with the principles of the "Waste Hierarchy" through re-use of excavation arisings (refer to **Mitigation Item SMC-M3**).	None required
SMC-G10	Throughout Proposed Scheme	Construction	Where peat is encountered during construction, it will be excavated, stored and re-used if possible, taking cognisance of 'Development on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste' (Scottish Renewables and SEPA, 2012) and The Waste Management Licensing (Scotland) Regulations 2011. This will be captured in a Peat Management Plan that will be developed by the Contractor. **Does not apply to Project 8, more specific mitigation required for this Scheme.**	To comply with relevant waste management practices under The Waste Management Licensing (Scotland) Regulations 2011 and reduce impacts on peatlands.	Consultation with SEPA
SMC-G11	Throughout Proposed Scheme	Pre-Construction & Construction	Where concrete materials are proposed to be used, appropriate guidance such as 'Building Research Establishment (BRE) SD1:2005' and 'British Standard (BS) BS8500' should be followed to ensure that ground conditions are appropriate for the use of concrete at each given location.	To ensure that ground conditions are appropriate for the use of concrete at each given location.	None required
SMC-G12	Contamination sources: DC-15 and DC-53	Pre-Construction, Construction & Post-Construction/ Operation	Where potential pollutant pathways for ground gas have been identified, a ground gas monitoring programme will be developed prior to construction in adherence to 'BS 8485:2015 - Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings''. This will include an assessment of gassing issues following receipt of additional ground gas monitoring results at selected boreholes. Appropriate working methods will be developed and adopted during below ground site construction works (including piling works and excavations). This should include as a minimum, gas monitoring undertaken prior to any entry into excavations, confined spaces or below ground structures and use of PPE as a last resort. If ground gas issues are identified during construction, further post construction monitoring will be undertaken and/or appropriate gas protection measures will be incorporated into the final design.	To mitigate against potential impacts on human health during construction and Off Site Receptors (Local residents, transient traffic (foot, road and rail traffic) in the surrounding area) due to ground gas.	None required

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
SMC-G13	Throughout Proposed Scheme	Construction	Unless it can be demonstrated by the Contractor via a Quantitative Risk Assessment that no water quality impacts will occur due to leaching from SuDS retention ponds and detention basins, operational SuDS features will be lined.	To mitigate against potential impacts on water quality due to leaching from SuDS features.	SEPA
SMC-G14	Throughout Proposed Scheme	Construction	Storage of excavated soils and made ground will be minimised on site (spatially and in duration) and storage areas will be appropriately lined, with adequate drainage management in place.	To ensure that no polluted water percolates into the ground or contaminated run-off is generated.	None required
SMC-G15	Throughout Proposed Scheme	Pre-Construction	Risk assessments will be undertaken before explosives can be used on site.	To minimise or control the impact of blasting on bedrock geology.	None required
n/a (note)	*n/a*	*n/a*	*Further to the above, the implementation of Mitigation Items detailed in Chapter 11 (Road Drainage and the Water Environment) and the measures detailed in Chapter 16 (Air Quality).*	*To mitigate the water pollution risk to groundwater and avoid the creation of a statutory nuisance associated with dust and air pollution when working with contaminated land.*	*n/a*
Project Specific Mitigation					
P08-G1	Throughout Proposed Scheme	Pre-Construction & Construction	Prior to construction, a suitably qualified and experienced (or team of suitably qualified and experienced) Environmental Clerk of Works (EnvCoW) shall be appointed by the Contractor to oversee implementation of mitigation and monitoring relating to soils, potential contamination, groundwater, PWS and the management of waste materials. A qualified and experienced Ecological Clerk of Works (ECoW) shall also be appointed prior to construction, to oversee and provide specific inputs to the implementation of proposed mitigation and monitoring relating to peat and GWDTE.	To oversee implementation of mitigation and monitoring relating to soils, potential contamination, groundwater, PWS, the management of waste materials, peat and GWDTE.	None required
P08-G2	ch. 22,400 to ch. 22,700 ch.26,050 to ch.27,460	Design, Pre-Construction & Construction	Naturalistic rock cutting may be possible in areas of widening and cutting identified as being likely to intercept bedrock, the extent of which shall be determined during the detailed design by the Contractor, following risk assessment (**Mitigation Item SMC-G15**). During construction, rock mapping and inspections shall be undertaken by a suitably qualified and experienced engineering geologist appointed by the Contractor in those areas determined, with the cuts being profiled to be as natural as possible with no visible engineered elements.	To review stability and minimise the requirement for meshing or other stabilisation measures within final rock cut profiles.	None required
P08-G3	ch.-500 to ch.20,800	Construction	During construction or delivery of upgrades to the existing BDL track, the Contractor shall minimise disturbance of the natural soil profile and landform across the area of Allt Coire Chuirn as far as is practicable. Damage to partial alluvial fan exposure areas at bar locations on Allt Coire Chuirn shall be avoided through set-backs as required and appropriate working procedures shall be adopted as per **Mitigation Items SMC-W1** to **SMC-W5** and **SMC-W13** to **SMC-W17** in **Chapter 11** in relation to in-channel works and hydromorphology.	To minimise additional potential disturbance to soils and landform across the area, partial exposures and active channel morphology	Consultation with SNH

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
P08-G4	Throughout Proposed Scheme	Pre-Construction & Construction	The Contractor shall develop a Soil Management Plan prior to construction, for implementation during construction, with cognisance of the requirements identified in relation to peaty soils and peat (**Mitigation Item P08-G6**) and adopting principles from the 'Scottish Soil Framework' (Scottish Government, 2009) and other voluntary or industry regulated Codes of Practice, including 'Promoting the Sustainable Reuse of Greenfield Soils in Construction' (SEPA, 2010) and the 'Construction Code of Practice for the Sustainable Use of Soils on Construction Sites' (DEFRA, 2009).	To document and ensure that soil resources and soils of conservation value are excavated, managed, re-used and replaced sustainably and appropriately	Consultation with SEPA
P08-G5	Throughout Proposed Scheme	Design, Pre-Construction & Construction	Where peat conditions and depths permit, the Contractor shall consider and include appropriate design measures (such as floated access tracks and piled or bridged solutions for embankments or structures) to further avoid and/ or minimise peat excavation and disturbance. This shall take account of the unique peat characteristics and follow guidance on the design, duration and timing of construction, the sequencing of construction and hydrology set out in 'Floating Roads on Peat: A Report into Good Practice in Design, Construction and Use of Floating Roads on Peat with particular reference to Wind Farm Developments in Scotland' (SNH/ FCS, 2010) and others, as necessary.	To reduce peaty soil and peat disturbance and resultant excavation volumes	None required
P08-G6	Throughout Proposed Scheme	Pre-Construction, Construction & Post-Construction	Prior to construction, the Contractor shall refine the OPMP (**Appendix 10.6** (**Volume 2**)) of the ES) for implementation prior to, during and following construction as the Construction stage Peat Management Plan (PMP). The Construction stage PMP shall adopt the principles and outline best practice measures detailed in the OPMP, with refinements made by the Contractor to include the establishment of detailed site-specific method statements related to construction techniques and locations, estimated excavation volumes, excavation procedures, temporary works activities, temporary storage, transportation, handling, proposed peat re-use areas and activities within those. Monitoring requirements and timescales for prior to, during and following construction, particularly with regards re-use and restoration works, shall be established and implemented by the Contractor as necessary, with all refinements made taking cognisance of best practice in 'Development on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste' (Scottish Renewables and SEPA, 2012) and others, as necessary.	To comply with relevant waste management practices under The Waste Management Licensing (Scotland) Regulations 2011 and manage, reduce and monitor impacts on peat and peaty soils	Consultation with SNH, SEPA and CNPA required to agree on the Construction stage Peat Management Plan (PMP) and any proposed peat re-use
P08-G7	Throughout Proposed Scheme	Pre-Construction, Construction & Post-Construction	Through adoption and refinement of the OPMP, the Contractor shall identify and propose environmentally beneficial re-uses of peat that is excavated during construction. Provisional candidate areas for this have been identified as detailed in the OPMP (**Appendix 10.6** (**Volume 2**) of the ES) and illustrated in **Drawings 10.39** to **10.47** (**Volume 3**), though the Contractor may identify additional areas to this within the LMA or elsewhere, by agreement prior to or during construction. Following re-use, dedicated monitoring of water table and vegetation in the re-use areas adopted shall be undertaken by the Contractor (**Mitigation Item P08-G6**) and the requirements for additional treatment work such as but not limited to, seeding, compaction, tapering and removal of invasive species, established on an ongoing basis in consultation with SEPA, SNH and CNPA.	To provide mitigation for peat excavation and disturbance	See **Mitigation Item P08-G6**

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
P08-G8	Throughout Proposed Scheme	Design, Pre-Construction & Construction	Temporary storage of excavated peat shall be avoided wherever possible by transporting it to identified re-use locations as soon as is practicable, and the time spent in storage shall be kept to a minimum where possible. Where this is not possible during construction, the Contractor shall take account of the Preliminary Peat Landslide Risk Assessment findings (**Appendix 10.5** (**Volume 2**) of the ES), undertake additional quantitative assessment where necessary and identify appropriate storage areas for excavated peat, including, varying or additional to those provisionally highlighted in **Drawings 10.39** to **10.47** (**Volume 3**).	To minimise peat volumes in storage and the likelihood of drying.	See **Mitigation Item P08-G6**
P08-G9	Throughout Proposed Scheme	Pre-Construction & Construction	Where excavated peat does require temporary storage, the areas for this shall avoid being near watercourses through appropriate set backs. Areas of GWDTE assessed as likely moderate and/ or highly dependent on groundwater in **Appendix 10.2** (**Volume 2**) of the ES shall also be avoided where possible – particularly areas of or containing discrete M6, M10, M11 and M15a flushes and M32 or M37 springs identified on **Drawings 10.21** to **10.29** (**Volume 3**). Where possible, peat will be extracted and relocated as 300mm to 500mm deep turves. If peat turves need to be stored for any length of time, they will be stored vegetation side up, stacked no more than 1.00m high, and monitored during all weather conditions and kept wet as necessary to prevent them from drying out.	To minimise peat volumes in storage, the likelihood of drying and potential effects on GWDTE	See **Mitigation Item P08-G6**
P08-G10	Throughout Proposed Scheme	Design, Pre-construction, Construction & Post-Construction	For temporary construction-stage SuDS and related drainage, the Contractor shall avoid areas of peat and areas of GWDTE assessed as being likely moderate and/ or highly dependent on groundwater in **Appendix 10.2** (**Volume 2**) of the ES. This shall be achieved through micrositing during detailed design and the use of above-ground solutions requiring no or limited excavation, such as siltbusters, where possible during construction. Areas of peat or GWDTE habitat which are unavoidable and in which excavation is required for temporary SuDS and drainage shall be re-instated by the Contractor as soon as possible following the completion of construction works. Such re-instatement shall return the areas to their former habitat type as far as is practicable using species appropriate to the environment and of local provenance.	To reduce peaty soil and peat disturbance, resultant excavation volumes and re-instate those areas which are temporarily disturbed	See **Mitigation Item P08-G6**
P08-G11	Throughout Proposed Scheme	Design, Construction & Post-Construction	For temporary haul roads or access tracks required during construction, the Contractor shall avoid areas of peat and areas of GWDTE assessed as being likely moderate and/ or highly dependent on groundwater in **Appendix 10.2** (**Volume 2**) of the ES. Where unavoidable, floated track construction shall be considered where conditions and depths permit, with guidance from 'Floating Roads on Peat: A Report into Good Practice in Design, Construction and Use of Floating Roads on Peat with particular reference to Wind Farm Developments in Scotland' (SNH/ FCS, 2010) and others, as necessary. All temporary haul roads and access tracks created during construction shall be fully re-instated by the Contractor following construction.	To reduce peaty soil and peat and GWDTE disturbance, resultant excavation volumes and re-instate those areas which are temporarily disturbed	See **Mitigation Item P08-G6**

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
P08-G12	Throughout Proposed Scheme	Design, Pre-Construction, Construction and Post-Construction	Where potential peat landslide or bog burst risks have been identified in the Preliminary Peat Landslide Risk Assessment and Preliminary Risk Register in **Appendix 10.5** (**Volume 2**) of the ES, the Contractor shall undertake additional quantitative assessment of these prior to construction and follow guidance within 'Peat Landslide Hazard and Risk Assessments: Best Practice for Proposed Electricity Generation Developments' (Scottish Executive, 2006) for the implementation of additional micrositing of Proposed Scheme elements during detailed design, and to determine and implement any required mitigation such as catch ditches, fences, walkovers and inspections during and following construction.	To identify and mitigate against potential peat landslide risks	Consultation with SNH, SEPA and CNPA
P08-G13	Throughout Proposed Scheme	Pre-Construction	A number of widening or other cuttings have been identified as having the potential to intercept groundwater. Volumes of groundwater drainage will need to be considered in the context of potential groundwater abstraction CAR licenses prior to construction commencing.	To comply with CAR license requirements and protect the water environment	Consultation with and approval from SEPA
P08-G14	Throughout Proposed Scheme	Design, Pre-Construction & Construction	A detailed assessment will be undertaken for areas of widening or cutting anticipated to result in groundwater-related impacts on GWDTE and surface water receptors. This shall be completed prior to construction using all available GI data, including additional groundwater monitoring and testing data from the Preliminary and Detailed GI. If impacts are confirmed as significant, a specific GWDTE monitoring and mitigation plan will be developed, with drainage designs, groundwater exclusion, containment or other control measures determined by the Contractor during detailed design and implemented during construction to reduce drawdown at sensitive receptors where appropriate and practicable. Drainage and pumping from excavations will be carefully monitored during construction, with additional mitigation such as redirecting abstracted water to affected receptors implemented as necessary.	To check GWDTE and surface water risks, assess changes in groundwater level and quality and ensure that GWDTE and surface waters are protected	Consultation with SEPA
P08-G15	Throughout Proposed Scheme	Design, Pre-Construction & Construction	A differential settlement assessment shall be undertaken by the Contractor prior to construction in excavation areas identified as having the potential to intercept groundwater and which are located in the vicinity of existing structures and infrastructure. This shall be completed using all available GI data, including additional groundwater monitoring data from the Preliminary and Detailed GI. Should potential settlement risks be identified, mitigation measures shall be implemented by the Contractor during construction where necessary and may include monitoring of groundwater level variations, implementation of condition surveys and monitoring of infrastructure.	To determine if adjacent or surrounding infrastructure is at risk of settlement and implement mitigation where required	None required
P08-G16	Throughout Proposed Scheme	Pre-Construction & Construction	The Contractor shall review areas of groundwater likely to be intercepted by excavations and implement treatment as required prior to discharge. This shall be completed using all available GI data, including additional groundwater monitoring and testing data from the Preliminary and Detailed GI; in the preparation of discharge licensing considerations. Containment facilities and discharge locations for abstracted groundwater during construction shall be defined by the Contractor taking water quality characteristics into account.	To determine treatment and discharge requirements for intercepted groundwater	Consultation with SEPA
P08-G17	Throughout Proposed Scheme	Construction	Any excavations within or alongside areas of deep peat or blanket bog habitat should be bunded with sheets of plastic or metal sheet pilings to assist retaining water and preventing local drainage of the adjacent or surrounding peat mass margins where practicable.	To minimise dewatering of areas of peat	None required

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
P08-G18	Throughout Proposed Scheme	Pre-Construction, Construction & Post-Construction	A groundwater monitoring network shall be established within and adjacent to areas of GWDTE identified to be at potential risk of impact following **Mitigation Item P08-G14**, with monitoring completed in accordance with 'LUPS-GU31 Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems, Version 2' (SEPA, 2014). Such monitoring shall involve groundwater level and quality readings, as well as repeated NVC surveys based on the GWDTE monitoring and mitigation plan developed in **Mitigation Item P08-G14** and in consultation with SEPA.	To monitor GWDTE risks, assess changes in groundwater level and quality and ensure that GWDTE are protected	Consultation with SEPA
P08-G19	Throughout Proposed Scheme	Pre-Construction, Construction & Post-Construction	The Contractor shall establish a Groundwater and Surface Water Management Plan with associated monitoring programme prior to construction, to be adhered to during construction, and post construction, as required by the relevant regulatory bodies. This shall be prepared with cognisance of **Mitigation Items SMC-W1** to **SMC-W17** detailed in **Chapter 11** and monitoring requirements related to GWDTE where necessary (**Mitigation Item P08-G14**).	To document and ensure that mitigation and monitoring measures are in place to protect the water environment and associated receptors	Consultation with SEPA
P08-G20	Throughout Proposed Scheme	Construction	To maintain hydrological connectivity between and within wetland habitats, particularly springs, flushes and GWDTE; works around areas containing discrete M10, M11 and M15a flushes and M32 or M37 springs, shall be carried out carefully, with a buffer zone of at least 10m from such features within the LMA marked out on the ground where necessary and as far as possible, additional works micrositing during construction to avoid them. Any works within the buffer zone shall be supervised by a suitably qualified and experienced ECoW appointed by the Contractor and shall be planned to maintain unpolluted water flows.	To mitigate and control potential effects on GWDTE during construction	Consultation with SEPA
P08-G21	Drumochter Estate Access Track (former Beauly to Denny Power Line track)	Design, Construction & Post-Construction	For construction and delivery of upgrades to the former BDL track at Drumochter, trackside drainage will include a lateral channel cut along the uphill side of the track to intercept natural run-off and shallow flush and groundwater flow. This shall be conducted under the track at regular intervals through cross-drains. Within the LMA, the trackside drain shall be broad and shallow with moderate gradients to prevent scouring, and flows from this drainage will be treated and controlled by filtration through check dams and dispersal trenches. During operation, drains associated with the track shall be inspected periodically and cleaned out as necessary.	To maintain hydrological connectivity between up-gradient and down-gradient GWDTE and prevent/ alleviate overland water flow disruptions	None required
P08-G22	Dalwhinnie Water Treatment Works Groundwater Abstractions (ABS 8.5)	Pre-Construction & Construction	The groundwater abstractions at Dalwhinnie Water Treatment Works (ABS 8.5) shall be monitored by the Contractor for yield and quality during the construction phase in consultation with Scottish Water. Works proposed nearby to the River Truim and up-stream of the abstraction locations, shall have due regard of **Mitigation Items SMC-W6, SMC-W7, SMC-W8, SMC-W11** (**Chapter 11**) and **SMC-S1** (**Chapter 21**) in relation to protection of the water environment, service disruption and implementation of a Pollution Incident Control Plan. Specific monitoring and mitigation requirements for the abstractions, including corrective action in response to significant effects on yield or quality, should they occur, will be determined and implemented by the Contractor via a specific monitoring plan and mitigation strategy in consultation with SEPA and Scottish Water.	To monitor and safeguard yield/ quality of abstractions	Consultation with Scottish Water and SEPA

Mitigation Item	Approximate Chainage/ Location	Timing of Measure	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required
P08-G23	Cuaich Farm Settlement PWS (ABS 8.24)	Pre-Construction & Construction	Additional surveys shall be undertaken by the Contractor prior to construction, to confirm the exact location and extent of the PWS supply network within the LMA for the Cuaich farm settlement (ABS 8.24). If impacts to the network are confirmed, the Contractor shall incorporate protective measures to ensure the infrastructure does not get damaged during construction or in the long-term by the Proposed Scheme. If this is not possible, an alternative source of water and/ or replacement/ diverted network shall be put in place. Specific monitoring and mitigation requirements for the supply will be determined and implemented by the Contractor in consultation and communication with landowners, residents, THC and SEPA.	To protect existing PWS or provide an alternative, replacement or diverted supply network	Consultation with landowner, residents, THC and SEPA
n/a (note)	*n/a*	*n/a*	*Further to the above, Mitigation Items P08-E5, P08-E6, P08-E11, P08-E19, P08-E20, P08-E21, P08-E22 and P08-E25 detailed in Chapter 12 will be implemented in relation to temporary works and sensitive peatland and GWDTE habitats, and habitat re-instatement and restoration works within the Outline Habitat Management Plan (OHMP) in Appendix 12.11 (Volume 2) of the ES.* *The implementation of Mitigation Items detailed in Chapter 11 will also mitigate water pollution-related risks to groundwater and GWDTE.*	*To reduce temporary impacts on peatland or GWDTE habitats and deliver specific mitigation measures to re-instate and restore notable habitats that are impacted*	*n/a*

Monitoring Requirements

10.5.3 Standard and Project Specific Mitigation commitments will be monitored prior to, during and following construction via the CEMP (**Mitigation Item SMC-S1** in **Chapter 21**) and additional plans as required. This shall include all aspects related to soil, geodiversity, groundwater, GWDTE, surface water, groundwater abstractions and PWS as necessary and outlined in **Table 10-16**.

10.5.4 Aspects related to peat stability shall be subject to monitoring during and following construction, as identified by the Preliminary Peat Landslide Risk Assessment in **Appendix 10.5** (**Volume 2**) and requirements will be further defined by the Contractor following additional quantitative assessment prior to construction commencing. Peat re-use and potential habitat re-instatement, restoration or creation shall also be monitored during and following construction in accordance with recommendations in the OPMP and OHMP in **Appendix 10.6** and **12.11** (**Volume 2**); both of which shall be further developed by the Contractor prior to construction in consultation and agreement with SEPA, SNH and CNPA.

10.5.5 Suitably qualified and experienced EnvCoWs and ECoWs will be appointed to oversee mitigation and monitoring implementation, as well as emerging issues during construction (**Mitigation Item P08-G1**). Monitoring details, frequencies and reporting requirements for all aspects will be agreed with SEPA, SNH, CNPA and others as required, and will be tailored by the Contractor to provide meaningful indications of the ongoing works, impacts and mitigation implementation.

10.6 Residual Impacts

10.6.1 Following implementation of mitigation and associated monitoring; potential impacts in relation to geology, soils and groundwater for the Proposed Scheme will be avoided, reduced or off-set as far as is practicable. Residual impacts are those that remain once the measures have been implemented, and are summarised in **Table 10-17** with reference to the standard and/ or project-specific mitigation proposed for them from **Table 10-16**.

10.6.2 No residual impacts are expected in relation to the Drumochter Hummocky Moraines or the PWS feature at Crubenmore (ABS 8.1), while potential impacts on superficial geology, solid geology, mineral extraction, geodiversity features in the Allt Cuaich catchment, rock exposures P08-RE02 and P08-RE03, some GWDTE and surface water features are expected to remain as Neutral or Neutral/ Slight, with no specific mitigation considered necessary. These aspects are therefore excluded from **Table 10-17** for clarity.

Table 10-17: Residual Impacts – Geology, Soils and Groundwater

Receptor/ Aspect	Sensitivity	Pre-Mitigation Impact Significance	Mitigation	Post-Mitigation Residual Impact Significance
Designated Geological Receptors and Features of Geodiversity Interest				
Allt Coire Chuirn Alluvial Fan	Medium	Slight/ Moderate	Residual impacts on the Allt Coire Chuirn alluvial fan geodiversity interest are likely to be Slight through minimisation of disturbance to the natural soil profile and landform as far as practicable, avoidance of damage to partial fan exposure areas through appropriate set-backs (**Mitigation Item P08-G3**) and working procedures identified in **Chapter 11** in relation to hydromorphology (**Mitigation Items SMC-W3** to **SMC-W13**).	Slight
Rock Exposure (P08-RE01)	Negligible	Slight	Loss of existing rock exposure P08-RE01 has the potential to be offset by the provision of a larger and enhanced exposure. The extent of this will be determined during the detailed design and a requirement will be placed on the Contractor for a suitably qualified and experienced engineering geologist to be on site while rock is cut for the Proposed Scheme, to conduct logging and inspections, and to ensure rock cuts are profiled to be as natural as possible with no visible engineered elements (**Mitigation Item P08-G2**).	Neutral/ Slight
Soils				
Soil Conservation	Medium to High	Neutral/ Slight to Moderate	The establishment of a Soil Management Plan (**Mitigation Item P08-G4**), for implementation during construction, combined with standard measures in relation to materials management (**Mitigation Items SMC-G9** and **SMC-M3** (**Chapter 18**)) will ensure that soil resources, soils of conservation interest or low agricultural productivity are excavated, managed, re-used and re-instated sustainably and appropriately; with residual impacts of Neutral to Slight significance. It is also anticipated that the Soil Management Plan will be linked directly to landscape and ecology mitigation proposals in relation to habitat re-instatement, restoration and creation outlined in **Appendix 12.11** (**Volume 2**) and **Drawings 6.1** to **6.8** (**Volume 3**), with consideration of the soil-base for certain habitats within these (i.e. dry heath, wet heath, acid or species-rich grasslands) being an important consideration.	Neutral to Slight
Agricultural Soil Productivity	Low	Neutral/ Slight		Neutral
Peat	Low to High	Slight/ Moderate to Moderate	The OPMP in **Appendix 10.6** (**Volume 2**) demonstrates how unnecessary disturbance of peaty soils and peat has been minimised through design development and that there are ways in which these may be beneficially re-instated or re-used as part of the Proposed Scheme. This includes re-use as part of the landscaping strategy, re-use in candidate habitat re-instatement, restoration and creation areas (**Drawings 10.39** to **10.47** (**Volume 3**)) or selected SuDS basins and compensatory flood storage areas, which offer opportunities for the extent of peatland habitats within the locality to be maintained, or locally, improved. This will be subject to agreement with and subsequent refinement by the Contractor in consultation with SEPA, SNH and CNPA. However, together with construction methods to further avoid or limit impacts where possible (**Mitigation Items P08-G5**), and other mitigation and monitoring related to peat stability and dewatering (**Mitigation Items P08-G6** to **P08-G12** and **P08-G17**), residual impacts are expected to remain as Slight/ Moderate in the short-term and reduce to Slight to Slight/ Moderate in the longer term. This is expected reduce further still and deliver ecological benefits once habitat re-instatement, restoration and creation measures through appropriate re-use of peat become firmly established.	Slight to Slight/ Moderate
Groundwater				
Groundwater Levels and Flow	Low to High	Slight to Moderate	Mitigation for potential impacts on groundwater levels and flow includes provision of appropriate construction and operation-stage drainage, combined with control measures and monitoring prior to and during construction (**Mitigation Items P08-G13** to **P08-G20**). Optimising the drainage design and adoption of these measures where possible may reduce impacts slightly. However, residual impacts of Slight to Slight/ Moderate significance are expected to remain in superficial soils and bedrock at a local scale in vicinity of cuttings JC01 at Dalwhinnie junction and AQC01 for the SSE Aqueduct diversion.	Slight to Slight/ Moderate

Receptor/ Aspect	Sensitivity	Pre-Mitigation Impact Significance	Mitigation	Post-Mitigation Residual Impact Significance
Groundwater Quality	Low to High	Slight to Moderate/ Large	Residual impacts with regards groundwater quality are expected to be Slight during construction and Neutral during operation due to pollution prevention mitigation (**Mitigation Items SMC-W1** to **SMC-W17** in **Chapter 11**); including adherence to SEPA Pollution Prevention Guidelines and otherwise, provision of appropriate construction and operation-stage drainage. These would also mitigate against pollution risks to groundwater and associated receptors, through reducing the potential for pollutant release and preventing run-off from entering groundwater.	Neutral to Slight
GWDTE	Medium to Very High	Neutral/ Slight to Large/ Very Large	Embedded mitigation has minimised encroachment into notable habitats such as GWDTE. However, the Proposed Scheme infrastructure will result in some local permanent and irreversible habitat loss of these, while construction activities will result in unavoidable temporary impacts to surface vegetation, soils and local disruption of groundwater levels and flows. The OHMP in **Appendix 12.11** (**Volume 2**) and **Drawings 6.1** to **6.8** (**Volume 3**) detail outline measures and proposals to re-instate and restore GWDTE habitat types such as wet heaths, mires and grasslands, as well as local wet/ riparian woodland proposals. These measures are anticipated to provide some compensation for habitat losses, together with re-instatement and restoration of areas temporarily affected as far as practicable following construction (**Mitigation Items P08-G10** and **P08-G11**). The OPMP in **Appendix 10.6** (**Volume 2**) also outlines candidate areas for peat re-use in the re-instatement, restoration or creation of wet heath and mire type habitats, as well as potential opportunities for creation of wetland-based habitat within SuDS basins and compensatory flood storage areas (**Mitigation Item P08-G6**). A detailed assessment will be undertaken for areas of widening or cutting anticipated to result in indirect groundwater-related impacts on GWDTE (**Mitigation Item P08-G14**). If impacts are confirmed as significant, groundwater exclusion, containment or other control measures will be considered and implemented during construction to reduce drawdown at sensitive receptors where appropriate and to maintain groundwater flows where possible. This will be further supplemented by a specific GWDTE monitoring and mitigation plan (**Mitigation Item P08-G14** and **P08-G18**) and further micrositing during detailed design and construction where possible (**Mitigation Item P08-G20**). At this stage, residual impacts are therefore expected to be variable on individual areas, but of Neutral/ Slight to Slight/ Moderate significance in several instances due to the majority of direct disturbance being compensated for, re-instated or restored. Residual indirect hydrogeological effects may vary between Slight and Moderate, with locally Neutral/ Slight to Moderate/ Large beneficial effects to some habitats associated with drainage upgrades for the BDL access track.	Neutral/ Slight to Large/ Very Large
Surface Water	Low to Very High	Neutral to Very Large	Groundwater intercepted via road cuttings and widenings will be returned to the same down-gradient catchments during the operational phase through appropriate drainage design and the retention of existing watercourse crossings, where possible. This is expected to compensate for some indirect losses of or alterations in baseflow to surface waters, but local residual impacts of Neutral/ Slight to Slight/ Moderate significance on some surface waters and minor tributaries may remain. A detailed assessment prior to construction will be undertaken of the cuttings predicted to result in indirect groundwater-related impacts on surface water features. If impacts are confirmed, additional mitigation measures may need to be put in place prior to and during construction, such as re-directing abstracted groundwater to the surface water receptor or the relevant catchment (**Mitigation Item P08-G14**).	Neutral/ Slight to Slight/ Moderate
Groundwater Abstractions and Private Water Supplies				
Dalwhinnie Water Treatment Works Groundwater Abstractions (ABS 8.5)	Very High	Moderate/ Large to Large/ Very Large	Monitoring of the Dalwhinnie Water Treatment Works groundwater abstraction wells (ABS 8.5) for yield and quality will be undertaken during construction (**Mitigation Item P08-G22**), while appropriate in-channel, pollution prevention, service disruption working practices (**Mitigation Items SMC-W1** to **SMC-W17** in **Chapter 11**) and a Pollution Incident Control Plan (**Mitigation Item SMC-S1** in **Chapter 21**) will be implemented. Specific monitoring and mitigation requirements for the abstractions, including corrective action (such as the provision of an alternative supply) in response to significant effects on yield or quality, should they occur, will be determined by the Contractor in consultation with Scottish Water and SEPA. After implementation of these measures, residual impacts would be expected to reduce to Neutral.	Neutral

Receptor/ Aspect	Sensitivity	Pre-Mitigation Impact Significance	Mitigation	Post-Mitigation Residual Impact Significance
Cuaich Farm Settlement PWS (ABS 8.24)	High	Large/ Very Large	Additional surveys shall be undertaken prior to construction, to confirm the location of the PWS ABS 8.24 network. If impacts to the network are confirmed, protective measures during construction to protect this shall be incorporated, or an alternative source of water and/ or replacement/ diverted network shall be put in place with a specific monitoring and mitigation plan (**Mitigation Item P08-G23**). After implementation of these measures, residual impacts would be expected to reduce to Neutral.	Neutral
Potential Contamination				
Potential Contamination Sources	N/A	Very Low to Moderate	Following implementation of standard mitigation measures for the A9 Dualling Programme (**Mitigation Items SMC-G1** to **SMC-G14**) in relation to potential contamination sources, residual impacts are expected to reduce to Low during construction and Very Low during operation.	Very Low to Low

10.6.3 In summary, with the Proposed Scheme in place and taking the identified mitigation measures into account, residual impacts in relation to groundwater levels and flows in glacial deposits and bedrock at Dalwhinnie are expected to be significant at a local scale during construction and operation.

10.6.4 Peat excavation and GWDTE habitat loss or disturbance during construction are also identified to be locally significant. However, it is noted that the vast majority of effects will occur along the edge of more extensive peatland or wetland habitat mosaics within or adjacent to the existing A9 corridor, where areas have already been affected by existing land management, drainage or infrastructure, and the consideration and implementation of additional micrositing, appropriate construction methods and control measures is likely to further minimise or avoid effects on areas in better condition. During operation, the residual impacts on these aspects are expected to reduce and be further off-set, once measures for and ecological benefits from landscaping, beneficial peat re-use and habitat re-instatement, restoration and creation become established in the longer term. Residual effects in terms of permanent GWDTE habitat loss will be localised and significant only at the local scale, with **Chapter 12** also stating that no significant residual ecological habitat loss or disturbance is expected following the implementation of mitigation.

10.6.5 All other residual impacts on geology, soils and groundwater receptors are not predicted to be significant, and in some instances, may carry consequential benefits for local rock exposures and ecology as summarised in **Table 10-17**.

10.7 Summary of Combined Impacts

10.7.1 Some of the geology, soils and groundwater receptors may be subject to residual effects that, in combination with others for different environmental topics, could contribute to cumulative impacts during construction or operation. These include soils of conservation interest, peaty soils and peat (direct and indirect disturbance, habitat fragmentation or loss), geodiversity features (direct disturbance and landscape/ visual effects), GWDTE (groundwater flow impacts, habitat fragmentation or loss and pollution risks), surface water features (dewatering or groundwater flow impact from multiple widenings/ cuttings, geomorphological change, flood risk changes and pollution risks) and properties (private water supplies and land-take, noise or visual effects).

10.7.2 Such potential cumulative impacts of the Proposed Scheme in relation to different environmental topic-specific impacts on single receptors are considered in **Chapter 20**. However, based on the above assessment and review of the residual impacts and mitigation measures proposed in other Chapters, no significant adverse cumulative impacts of the Proposed Scheme have been identified in relation to geology, soils and groundwater receptors.

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