A83 Rest and Be Thankful

LTS EIAR VOLUME 4, APPENDIX 12.3 - GEOLOGY, SOILS AND GROUNDWATER BASELINE

Transport Scotland

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A12.3. Geology, Soils and Groundwater Baseline

A12.3.1. Topography

A12.3.1.1. The Proposed Scheme is situated within Glen Croe, an upland glaciated U-shaped glen featuring steep sides and a relatively flat base. Phases of glacier advance and retreat have resulted in erosion forming the steep glen sides with subsequent deposition of material on the glen floor and sides.

A12.3.1.2. The glen is orientated northwest-southeast with Croe Water flowing southeast towards where it discharges into Loch Long at Ardgartan. The elevation of the glen bottom ranges from ~85m above ordnance datum (AOD) at the southeast extent of the Proposed Scheme, to ~240m AOD at the northern extent. On the eastern side of the glen are steep slopes leading up to the summits of Beinn Luibhean and The Cobbler, which have elevations of 858m AOD, and 884m AOD, respectively. The western side of the glen features slopes leading to Ben Donich and Beinn an Lochain, which have summit elevations of 847m AOD, and 901m AOD, respectively.

A12.3.1.3. The Preliminary Sources Study Report (PSSR) (Jacobs Aecom (2022). Access to Argyll and Bute (A83) Preliminary Sources Study Report) has used current OS mapping to show that the hillside terrain is characterised by steep, uneven slopes with numerous channels of varying size and incision level, which provide drainage pathways towards the glen floor. The most noteworthy channel is situated between Beinn Luibhean and The Cobbler and accommodates Croe Water. The Croe Water flows southwest from Coire Croe through a hangingm, before reaching the floor of Glen Croe where it proceeds to flow southeast towards Loch Long.

A12.3.1.4. At the northern extent of the Proposed Scheme is Loch Restil, located at the toe of the eastern slopes of Beinn an Lochain, immediately west of the A83 Trunk Road to the north of the Rest and Be Thankful car park. The loch drains to the north, initially across relatively flat land and then more steeply, particularly at Easan Dubh Fall.

A12.3.2. Geology

A12.3.2.1. The information below is summarised from the PSSR for the Proposed Scheme, where further baseline information on geology is discussed. Although geology has been scoped out of this assessment baseline geological information has been provided to help provide context to the groundwater assessment.

A12.3.3. Bedrock Geology

A12.3.3.1. As determined from available BGS mapping, the majority of the Proposed Scheme area is underlain by Neoproterozoic metamorphic bedrock. An extensive igneous intrusion underlies part of the Scheme at its south-east extent and numerous igneous dykes are also present within the study area. Bedrock is noted to be at or near the ground surface at numerous locations close to the Proposed Scheme, typically across areas of steep hillside.

A12.3.3.2. Bedrock comprises the Beinn Bheula Schist Formation of Neoproterozoic age, which is part of the Southern Highland Group. Pelite, semipelite and psammite lithologies are dominant across the Proposed Scheme and wider area, with metawackes recorded underlying the nearby hillsides of Beinn an Lochain and Ben Donich.

A12.3.3.3. An extensive igneous intrusion of the Siluro-Devonian South of Scotland Granitic Suite situated between Beinn Luibhean and The Cobbler. The exposure stretches from the A83 in the south-west, north-easterly up to Coire Croe and into Glean Leacann Sheileach.

A12.3.3.4. The intrusion is recorded to comprise Pyroxene-Mica Diorite. Localised smaller intrusions of Intrusion-Breccia and Tuffisite, Tonalite and Meladiorite associated with the same granitic suite, are recorded both within and at the extents of the main intrusion, and under the superficial deposits from the A83.

A12.3.3.5. Numerous igneous dyke suites are recorded in the west of the study area comprising the following:

- North Britain Siluro-Devonian Calc-Alkaline Dyke Suite, predominantly on the east-facing slopes of Beinn an Lochain and Ben Donich, and also at High Glencroe along the B828 and where the B828 meets the A83.

- Central Scotland Late Carboniferous Tholeiitic Dyke Swarm, predominantly orientated east-west and exposed from Loch Fyne to Beinn an Lochain, approximately 500m north-west of the Proposed Scheme.
- Mull Dyke Swarm of the North Britain Paleogene Dyke Suite. Variable orientation and predominantly on the east-facing slopes of Beinn an Lochain and Ben Donich.
- Scottish Highland Siluro-Devonian Calc-Alkaline Minor Intrusion Suite, which includes a felsic intrusion along the south-eastern facing slopes of Beinn an Lochain, approximately 380m southwest of the study area.

A12.3.4. Structural Geology

A12.3.4.1. As well as information on the distribution of material that constitutes the bedrock geology, available BGS maps also include information relevant to the Proposed Scheme on structural geology. The Beinn Bheula Schist Formation (Southern Highland Group) has experienced significant deformation and metamorphism as a result of the Grampian Event of the Caledonian Orogeny. BGS mapping (Sheet 37E) indicates the typical dip of the bedrock is between 15 - 40 degrees, however locally in the study area, dips are shown to range from 7 - 80 degrees. Folding within the Southern Highland Group is suggested to form part of the Aberfoyle Anticline (BGS mapping Sheet 37E).

A12.3.4.2. The mapping (Sheet 37E) indicates the western section of the study area is heavily faulted, with normal faults predominantly trending northeast-southwest. Two faults are shown to cross through the northern end of the Proposed Scheme, trending northeast-southwest, which comprise:

- inferred fault with unknown displacement crosses the Proposed Scheme at NGR 223102 707365 and
- inferred fault with unknown displacement crosses the Proposed Scheme at NGR 223295 707363.

A12.3.4.3. Few faults are mapped within the eastern part of the study area (Sheet 38W), however, there is potential for unnamed faults to be present.

A12.3.5. Superficial Geology

A12.3.5.1. BGS mapping (shown in Volume 3, Figure 12.1 Superficial Geology) indicates the majority of the Proposed Scheme are underlain by Glacial Till deposits. Alluvium, Hummocky/Glacial deposits and River Terrace Deposits are also

present within the area of the Proposed Scheme. The upper slopes and summits of the surrounding mountains of Ben Donich, Beinn Luibhean and The Cobbler, have no mapped deposits, indicating that superficial deposits are thin or completely absent.

A12.3.5.2. Made Ground is not recorded with the area of the Proposed Scheme, however, engineered fill will be present locally in association with the A83 and potentially present associated with local forest tracks and car parks. Surface peat is not recorded by BGS mapping.

A12.3.5.3. The Glacial Till, which underlies all the Proposed Scheme within Glen Croe and extends up into to Coire Croe to the east, typically comprises unsorted and unstratified drift with generally over-consolidated, heterogenous mixtures of clay, sand, gravel, and boulders varying widely in size and shape. The Till is also likely to underly the Alluvium and River Terrace Deposits.

A12.3.5.4. Hummocky/Glacial deposits underly the northern extents of Proposed Scheme and they predominantly comprise rock debris, clayey till and poorly- to well-stratified sand and gravel.

A12.3.6. Soils

A12.3.6.1. The soil units underlying the Scheme are summarised from the 1:250,000 national soil map. The distribution of soils within the study area is dependent on the geology, topography and drainage regime of the area.

A12.3.6.2. The Proposed Scheme is entirely underlain by peaty podzol soils, which are described as peaty gleyed podzols with peaty gleys with dystrophic semi-confined peat. Podzols are typically free-draining acid soils developed under aerobic conditions. They are generally nutrient-deficient and heavily leached in the upper horizons, with an accumulation of iron/aluminium oxides (‘ironpan’) or organic material at lower levels within the soil profile. Peaty podzols, such as the soils underlying the Proposed Scheme, have a peat-rich surface horizon.

A12.3.6.3. The peaty podzols soils underly the majority of the glen bottoms in the local area and also extend up the steep-sided hills to the northeast and southwest of the Scheme. In addition, peaty ranker soils are also found on the slopes at higher elevations, which comprise an organic or organo-mineral surface horizon but lack subsoil.

A12.3.6.4. The summits of the hills near the Proposed Scheme comprise subalpine podzols, which comprise a mixture of podzols, rankers and peaty soils.

A12.3.6.5. The 1:250,000 Land Capability for Agriculture (LCA) map shows the Proposed Scheme is underlain by Class 6.1 and 6.2 which is land capable of rough grazing due to intractable physical limitations; the semi-natural vegetation provides grazing of high and moderate value, respectively.

A12.3.7. Peat

A12.3.7.1. Peatlands hold large stocks of poorly protected carbon and excavation of peat will result in large carbon losses from the excavated peat and also the areas affected by drainage. Therefore, further assessment of the impacts relating to the removal of peat is required, which will utilise data collected from recent peat probing surveys. Peat deposits underlying the proposed scheme are shown in Volume 3, Figure 12.4 Peat Classifications underlying the Proposed Scheme.

A12.3.7.2. Volume 4, Appendix 12.6 Outline Peat Management Plan (PMP) considers the carbon impact of peat removal from the environment of the Proposed Scheme (excluding the Biodiversity Net Gain (BNG) and Natural Capital (NC) enhancement areas where no construction works are taking place) by multiplying carbon storage by weight by the estimated volume of peat removed. Using the study area (circaa 316,650 m^2) and a nominal peat depth peat of 15cm, the estimated conservative total of peat to be excavated was calculated to be approximately 47,450 m^3. Multiplying this by the unit carbon storage total equates to approximately 850 tonnes of carbon stored in the soil within the Prosed Scheme footprint which stands to be excavated or otherwise disturbed in the course of construction. Impacts on indirect loss of peat resulting from hydrological changes have been assessed qualitatively.

A12.3.7.3. The 1:250,000 national soil map of Scotland indicates the Proposed Scheme footprint and a 250m buffer is underlain by peaty podzol soils described as ‘peaty gleyed podzols with peaty gleys and dystrophic semi-confined peat’.The Carbon and Peatland Map 2016 (Carbon and Peatland Map 2016 (Scottish Government, 2016)) indicates the Proposed Scheme and buffer is underlain by Class 3 and Class 5 peat. A summary of the Carbon and Peatland Map importance classes is presented in Table 12.3.7-1.

Table 12.3.7-1 - Peat deposits extent and classification description

Class	Description	Study area presence
Class -2	Non-soil (e.g., loch, built-up area, rock and scree).	Loch Restil, located west of the A83 in the northern part of the study area.
Class -1	Unknown soil type.	N/A All peat in the study area is classified.
Class 0	Mineral soil - Peatland habitats are not typically found on such soils.	Upper slopes and summits of Beinn Luibhean and The Cobbler, in addition to Beinn an Lochain and Ben Donich.
Class 1	Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas likely to be of high conservation value.	On northeast-facing slopes of Ben Donich, ~800m south-west of the Proposed Scheme.
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 soils, with some areas of deep peat.	Predominantly underlies the eastern side of the Croe Glen and majority of the Proposed Scheme.
Class 4	Area unlikely to be associated with peatland habitats or wet and acidic type. Area unlikely to include carbon-rich soils.	Mid-upper slopes of Beinn Luibhean, The Cobbler, Beinn an Lochain and Ben Donich.
Class 5	Soil information takes precedence over vegetation data. No peatland habitat recorded. May also include areas of bare soil. Soils are carbon-rich and deep peat.	Predominantly underlies the western side of the Croe Glen and most of the Proposed Scheme.

A12.3.7.4. In the 27 exploratory holes from the preliminary ground investigation report (Raeburn Drilling & Geotechnical Limited (2023). Access to Argyll & Bute (A83). Report of Preliminary Ground Investigation) spread across Glen Croe, peat was predominantly found as:

- ‘Dark brown plastic pseudofibrous peat with wood fragments and plant material’ at depths between ground level and 2.00 m bgl (below ground level) in various boreholes.
- ‘Dark brown plastic amorphous peat’ was noted between 4.20 m and 5.00 m bgl and 5.15 m bgl and 5.50 m bgl in one of the boreholes (AAB-BH1022).

- Peat with no further description was noted between 4.60 m bgl and 6.10 m bgl in borehole AAB-BH1022A.
- 'Very peaty slightly gravelly sandy topsoil' was observed between ground level and 0.20 m bgl in other boreholes (AAB-TP1003, AAB-TP1006, and AAB-TP1009).

A12.3.7.5. Peat was also found within sand and gravel:

- 'Gravelly silty peaty sand' was identified between ground level and 3.70 m bgl in several boreholes.
- 'Gravelly very silty sand with pockets of peat' was noted between 0.50 m and 1.10 m bgl in one borehole (AAB-BH1013) and between 2.50 m bgl and 3.00 m bgl and 6.50 m bgl and 7.50 m bgl in another (AAB-BH1026).
- Gravel also contained peat, predominantly in the form of 'sandy, silty gravel with pockets of spongy pseudofibrous peat' or 'very sandy clayey slightly peaty gravel' at depths of 0.30 m bgl to 4.20 m bgl in specific boreholes.

A12.3.7.6. The eight exploratory boreholes and trial pits from the report on Ground Investigation (November 2023) were situated within the Croe Water glen, east of the Croe Water and west of the existing A83.

A12.3.7.7. These boreholes were generally noted as having 'dark brown' peaty sandy topsoil' down to a maximum depth of 0.40 m bgl.

A12.3.7.8. Deeper peat layers were found in two locations:

- Borehole AAB-MTS-1002 had 'dark brown and black sandy amorphous peat' between 0.20 m bgl and 0.50 m bgl.
- Borehole AAB-MTS-1007 contained 'reddish brown very gravelly silty fine to coarse sand with low cobble content, along with pockets of sandy amorphous and rooty peat' between 0.15 m bgl and 0.75 m bgl.

A12.3.7.9. The locations of boreholes, trial pits and water sampling points from the GI can be seen in the two 2023 GI reports.

A12.3.7.10. Geochemical testing will be required on any peat encountered to assess its potential corrosivity to steel and/or concrete. In addition, as the removal of substantial areas of peat is assumed likely for the Proposed Scheme, a PMP has been produced and represents an environmental constraint to the Proposed Scheme (Volume 4, Appendix 12.4 Outline Peat Management Plan).

A12.3.7.11. At present the identified peat deposits are considered to be either Class 3 or Class 5 which have an environmental sensitivity of Medium. No Class 1 deposits have been identified within the Proposed Scheme. Loch Restil in the north of the study area is non-soil (Class -2). The peat classifications originate from the Carbon and Peatland Map 2016 and any future GI will be used to refine the assessment.

A12.3.8. Groundwater

Hydrogeology

A12.3.8.1. The BGS Aquifer Productivity map indicates the superficial Alluvium and River Terrace Deposits would form moderate to high productivity aquifers (Class IMH) with intergranular flow (with expected yields of 1 to >10 l/s). This productivity classification is most likely where the deposits are predominantly sands and gravels. However, given the heterogeneity of the deposits, areas will likely be dominated by silts and clays, which will have lower productivity. In addition these units are likely to have a high degree of hydraulic continuity with the nearby surface watercourse.

A12.3.8.2. Although Hummocky/Glacial deposits in some areas can be highly productive, in Scotland Hummocky/Glacial deposits and till are mapped interchangeably, hence they are both mapped as non-significant aquifers (Class NSA) with a typical sustainable yield of <0.1 L/s. However, locally these deposits may be highly permeable and have the potential to form local aquifers with perched groundwater.

A12.3.8.3. The BGS Aquifer Productivity mapping shows that the Beinn Bheula Schist bedrock is classed as a low-productivity aquifer (Class FL). Flow is fracture-dominated and there are small amounts of groundwater in the near-surface weathered zone and secondary fractures. The bedrock has a typical sustainable yield of 0.1 L/s to 1 L/s.

A12.3.8.4. The unnamed igneous intrusion is also categorised as a low-productivity aquifer (Class FVL). Flow is fracture-dominated and there are small amounts of groundwater in the near-surface weathered zone and secondary fractures. The bedrock has a typical sustainable yield of <0.1 L/s.

A12.3.8.5. A summary of the aquifer classifications and their sensitivity, which was determined using the DMRB guidance (Appendix 12.2), is provided in Table 12.3.8-2.

A12.3.8.6. The superficial Alluvium and River Terrace Deposits have moderate to high productivity and high Class 4a vulnerability, which both indicate the deposits should be classified as having high sensitivity.

A12.3.8.7. The Hummocky Glacial Deposits, Glacial Till, Unnamed Igneous Intrusion and Beinn Bheula Schist all have low productivity, which would indicate they have low sensitivity. However, both the superficial deposits and bedrock have groundwater vulnerability designations of Class 4 or 5, which would indicate high sensitivity. Due to at least one of these aspects indicating high sensitivity aquifers, both the superficial Hummocky Glacial Deposits and Glacial Till and the bedrock aquifers are considered as having high sensitivity.

Table 12.3.8-2 - Groundwater aquifer sensitivity

Aquifer	Geology	Aquifer Vulnerability	Aquifer Productivity	WFD waterbody status	Sensitivity
Superficial Aquifer	Alluvium	Class 4a (Vulnerable to those pollutants not readily adsorbed or transformed – may have low permeability soil).	Class IMH. Intergranular Flow: Moderate to High Productivity. Typical sustainable yield from suitable borehole(s): 1 to >10 litres/second.	Good	High
Superficial Aquifer	River Terrace Deposits	Class 4a (Vulnerable to those pollutants not readily adsorbed or transformed – may have low permeability soil).	Class IMH. Intergranular Flow: Moderate to High Productivity. Typical sustainable yield from suitable borehole(s): 1 to >10 litres/second.	Good	High
Superficial Aquifer	Glacial Till	Class 4a (Vulnerable to those pollutants not readily adsorbed or transformed – may have low permeability soil).	Class NSA. Not a significant aquifer. Typical sustainable yield from suitable borehole: <0.1 L/s.	Good	High
Superficial Aquifer	Hummocky Glacial Deposits	Class 4a (Vulnerable to those pollutants not readily adsorbed or transformed – may have low permeability soil).	Class NSA. Not a significant aquifer. Typical sustainable yield from suitable borehole: <0.1 L/s.	Good	High
Bedrock Aquifer	Unnamed Igneous Intrusion	Where there is no superficial cover: Class 5 (vulnerable to most pollutants, with rapid impact in many scenarios). With superficial cover: Class 4a (Vulnerable to those pollutants not readily adsorbed or transformed – may have low permeability soil).	Class FVL. Fracture flow with very low productivity. Typical sustainable yield from suitable borehole: <0.1 L/s.	Good	High
Bedrock Aquifer	Beinn Bheula Schist	Where there is no superficial cover: Class 5 (vulnerable to most pollutants, with rapid impact in many scenarios). With superficial cover: Class 4a (Vulnerable to those pollutants not readily adsorbed or transformed – may have low permeability soil).	Class FL. Fracture flow with low productivity. Typical sustainable yield from suitable borehole: 0.1 to 1 L/s.	Good	High

Groundwater Observations

A12.3.8.8. Groundwater levels were monitored within 43 exploratory holes during the preliminary ground investigation carried out throughout the Proposed Scheme area (Raeburn Drilling & Geotechnical Limited (2023). Access to Argyll & Bute (A83). Report of Preliminary Ground Investigation) shows a summary of the groundwater monitoring data. Groundwater levels are generally shallow and range from 0.2 to 11.1 mbgl across the area of the Proposed Scheme.

A12.3.8.9. Observations indicate the presence of shallow groundwater within both the superficial and bedrock aquifers.

A12.3.8.10. In five exploratory holes where Glacial Till deposits overly the bedrock, groundwater was only observed within the bedrock aquifer.

Table 12.3.8-3 - Summary of groundwater level monitoring data

Groundwater presence	Superficial Geology	Bedrock Geology	Average (m) superficial deposit thickness	Minimum (m) superficial deposit thickness	Maximum (m) superficial deposit thickness	Average (mbgl) groundwater levels	Minimum (mbgl) groundwater levels	Maximum (mbgl) groundwater levels
Within both superficial and bedrock aquifers	Alluvium underlain by Glacial Till	Beinn Bheula Schist	10.5	3.7	15.9	2.6	5.8	0.2
Within both superficial and bedrock aquifers	Hummocky glacial underlain by glacial till	Beinn Bheula Schist	15.9	15.9	15.9	2.6	3	2.4
Within both superficial and bedrock aquifers	Made Ground underlain by glacial till**	Beinn Bheula Schist	3.3	2	4.5	1.8	2.8	0.8
Within both superficial and bedrock aquifers	Peat underlain by glacial till**	Beinn Bheula Schist	2.1	1.1	3.1	0.6	2.1	0.2

Groundwater presence	Superficial Geology	Bedrock Geology	Average (m) superficial deposit thickness	Minimum (m) superficial deposit thickness	Maximum (m) superficial deposit thickness	Average (mbgl) groundwater levels	Minimum (mbgl) groundwater levels	Maximum (mbgl) groundwater levels
Within both superficial and bedrock aquifers	River terrace deposits underlain by till	Beinn Bheula Schist	12.1	12.1	12.1	1.6	1.8	1.4
Within both superficial and bedrock aquifers	Glacial till	Beinn Bheula Schist	6.8	2.1	14.7	2.5	7.5	0.2
Within bedrock aquifer only	Made Ground underlain by glacial till**	Beinn Bheula Schist	2.1	2.1	2.1	3.2	3.9	2.5
Within bedrock aquifer only	Glacial till	Beinn Bheula Schist	1.2	0.2	1.9	5.7	11.1	1.2

**Superficial deposits are not mapped by BGS, but GI descriptions note there are deposits overlying the bedrock.

Groundwater Vulnerability

A12.3.8.11. The BGS Groundwater Vulnerability report indicates that the groundwater within the superficial deposits underlying the Proposed Scheme is designated as Class 4a, meaning the groundwater is vulnerable to those pollutants not readily adsorbed or transformed and may have low permeability soil.

A12.3.8.12. Groundwater within the bedrock aquifer, where there is no superficial cover, is designated as Class 5, meaning it is vulnerable to most pollutants, with rapid impact in many scenarios. Where superficial deposits overly the bedrock, the bedrock groundwater is designated as Class 4a, meaning it is vulnerable to those pollutants not readily adsorbed or transformed and may have low permeability soil.

Water Framework Directive Status

- South of the Rest and Be Thankful car park, the Proposed Scheme is underlain by the Cowal and Lomond groundwater body, as defined by SEPA (Scottish Environmental Protection Agency (2015). Water Classification Hub), whereas north of the car park it is underlain by the Oban and Kintyre groundwater body. Both groundwater bodies are defined as having a 'good' condition and 'good' water quality.

A12.3.9. Public Water Supplies

A12.3.9.1. The PSSR confirmed there are no known public water supplies in the area.

A12.3.10. Private Water Supplies

A12.3.10.1. Argyll and Bute Council have provided the locations of all private water supplies within the council area. Two private water supplies have been in proximity of the Proposed Scheme, including Roadmans Cottage (NN 24437 05555) and High Glen Croe (NN 23337 06965). These private water supplies are both within 250m of the OMR improvements.

A12.3.10.2. Both private water supplies are confirmed as surface water (stream) sources, with no groundwater-fed supplies identified, therefore, impacts to these receptors are assessed within Chapter 19: Road Drainage and the Water Environment.

A12.3.11. Groundwater Dependent Terrestrial Ecosystems (GWDTE)

A12.3.11.1. GWDTE are types of wetland which are specifically protected under the WFD and can include: fens, springs, flushes, seepages, quaking bog, wet

woodland, marshy grassland and some types of wet heath, reedbed and swamp. In Scotland, SEPA have identified these based on NVC values, with a large number of potentially moderate or high dependency communities listed in SEPA Land Use Planning System Guidance Note 31 (LUPS-GU31).

A12.3.11.2. A UKHab survey has been undertaken for the study area, within 250m of the Proposed Scheme, which identified potential GWDTE in the study area. For further details on habitats, please refer to Chapter 11: Biodiversity, Volume 3, Figure 11.2: Terrestrial Habitats (UKHab) and Figure 11.3: Terrestrial Habitats (NVC).

A12.3.11.3. Designated sites cited for GWDTE are of highest sensitivity, the Beinn an Lochain Site of Special Scientific Interest (SSSI) (site code 163) is within the Study Area, designated for the presence of siliceous scree, tall herb ledge and upland assemblage, rather than potential GWDTE features. This location is shown on Volume 3, Figure 11.1: Designated Sites.

A12.3.11.4. The NVC dataset indicates a large number of potential moderate or high dependency GWDTE habitats in the Study Area, including within Beinn an Lochain SSSI.

A12.3.11.5. Potential GWDTE in the wider Study Area including a 250m buffer around the Proposed Scheme, based on NVC communities identified by SEPA LUPS-GU31 are calcareous grassland (CG10 and CG11), mire habitats (M6, M10, M21, M23, M25 and M26), mesotrophic grassland (MG9, MG10 and MG11) and woodland (W1 and W4), with some communities formed of mosaics with other NVC communities. These include both potentially moderate and high groundwater dependency groups. A slightly smaller set of these potential GWDTE are found within the area of the Proposed Scheme boundary; calcareous grassland (CG10 and CG11), mire habitats (M6, M10, M23 and M25), mesotrophic grassland (MG9 and MG10) and woodland (W1 and W4).

A12.3.11.6. Information on these communities is outlined in Table 12.3.11-4 with reference to typical characteristics and locations identified on Volume 3, Figure 11.4b Terrestrial Habitats (National Vegetation Classification), on which Page 1 is the overview, with Pages 2-6 providing mapping in more detail, from north to south.

A12.3.11.7. Water conditions in the Study Area are dictated by wet climatic conditions of western Scotland, with water being rapidly shed from the steep eastern slopes of Glen Croe, with gradients slackening towards the valley floor. Frequent

surface water channels transfer runoff downslope, with flush zones and sheet flow transferring overland surface flows outwith channels, especially during prolonged or intense rainfall events. Groundwater flows may infiltrate within superficial deposits and historic debris flows material, flowpaths are likely to be dictated by the topography.

A12.3.11.8. The current A83 trunk road and OMR alignments cross these slopes and are likely to act as shallow groundwater barriers, intercepting and transferring flows into the surface water system and passing downslope via drainage channels. Deeper flows are unlikely to be altered by these existing excavations, which may emerge on the lower slopes of Glen Croe, potentially seasonally.

A12.3.11.9. To inform the typical setting and likely groundwater dependency of particular vegetation communities in the Study Area, the following Joint Nature Conservation Committee (JNCC) documents were reviewed; Illustrated Guide to British Upland Vegetation, Field Guide to Mires and Heaths, Field Guide to Woodland and Guidelines for the Selection of Biological SSSIs; Lowland Grasslands. These sources have been used to outline characteristic settings provided in Table 12.3.11-4, which notes a revised groundwater dependency value, in the context of the Proposed Scheme, following this desktop review process.

Table 12.3.11-4 Potential GWDTE NVC in the Study Area (shown on Figure 8.1)

NVC Code	NVC Name	SEPA LUPS-GU31 Potential Groundwater Dependency Value (Revised Value)	Characteristic Setting	Location(s) relative to the Proposed Scheme
CG10	Festuca ovina - Agrostis capillaris - Thyme praecox Grassland	High (Low)	Community found on shallow, brown, silty soils with slight acidic-neutral pH, can be flushed with base-rich water and this may differentiate this community where base-rich flushed slopes against locally dominant acidic soil/rock conditions. Widespread in British uplands. (JNCC Illustrated Guide to British Upland Vegetation)	Small number of locations (3), between A83 and OMR on steep gradients, with exposed bedrock above (Volume 3, Figure 11.4b National Vegetation Classification; Pages 1-2)
CG11	Festuca ovina - Agrostis capillaris – Alchemilla alpina Grassland	High (Low)	Similar community to CG10 but generally found on high slopes (above 600m above ordnance datum (AOD)). Generally maintained by grazing. Widespread in uplands but scarce (JNCC Illustrated Guide to British Upland Vegetation)	Single location, between A83 and OMR on steep gradients, with exposed bedrock above (Volume 3, Figure 11.4b National Vegetation Classification; Pages 1-2)

NVC Code	NVC Name	SEPA LUPS-GU31 Potential Groundwater Dependency Value (Revised Value)	Characteristic Setting	Location(s) relative to the Proposed Scheme
M6	Carex echinata - Sphagnum recurvum Mire	High (Low)	Generally associated with surface water including ponding locations, within depressions and on floodplain. Common throughout UK uplands, the most widespread soligenous mires in the British uplands. (JNCC Illustrated Guide to British Upland Vegetation)	Extensive presence, between A83 and OMR, plus downslope of OMR (Volume 3, Figure 11.4b National Vegetation Classification; Pages 1-5)
M10	Carex dioica - Pinguicula vulgaris Mire	High (Moderate)	Base-rich mire often occupying sloping flush zones. Found in northern and western uplands of UK, often below springhead or more diffuse groundwater emergence, where constantly irrigated – often linked with calcareous rock in Scotland. (JNCC Illustrated Guide to British Upland Vegetation)	Small number of locations (3), between A83 and OMR, plus downslope of OMR. With exposed bedrock above (Volume 3, Figure 11.4b National Vegetation Classification; Pages 1-2)

NVC Code	NVC Name	SEPA LUPS-GU31 Potential Groundwater Dependency Value (Revised Value)	Characteristic Setting	Location(s) relative to the Proposed Scheme
M21	Narthecium ossifragum - Sphagnum papillosum valley mire	High (Low)	This community usually found in waterlogged valleys below 200mAOD. It occurs on peat, usually less than 1.5m deep. Wetness is maintained by a high water-table and by streams flowing through the vegetation. Unlike blanket and raised mires, valley mires are sustained by water moving laterally through the peat as well as that supplied by rain. (JNCC Illustrated Guide to British Upland Vegetation)	Single location within the wider survey area, on Croe Water floodplain, downslope of OMR (Volume 3, Figure 11.4b National Vegetation Classification Pages 1, 2-3)

NVC Code	NVC Name	SEPA LUPS-GU31 Potential Groundwater Dependency Value (Revised Value)	Characteristic Setting	Location(s) relative to the Proposed Scheme
M23	Juncus effusus/acutiflorus - Galium palustre Rush-pasture	High (Low)	Usually occurs on shallow, poorly-drained slopes, including flush zones and on margins of wet heath. Occurs over a variety of moist, moderately acid to neutral, peaty and mineral soils in the cool and rainy lowlands of western Britain. It is a community of gently sloping ground around the margins of soligenous flushes, as a zone around topogenous mires and wet heaths, especially widespread in ill-drained, comparatively unimproved or reverted pasture. (JNCC Illustrated Guide to British Upland Vegetation)	Extensive presence, generally downslope of OMR, also within Beinn an Lochain SSSI (Volume 3, Figure 11.4b National Vegetation Classification; Pages 1-5)

NVC Code	NVC Name	SEPA LUPS-GU31 Potential Groundwater Dependency Value (Revised Value)	Characteristic Setting	Location(s) relative to the Proposed Scheme
M25	Molinia caerulea - Potentilla erecta Mire	Moderate (Low)	Generally associated with bog and wet heath, with low groundwater dependency. Grassland of shallow wet peats on concave slopes, peaty mineral soils and wet gleyed muds. It can cover huge areas of ill-drained hillsides, fill the level floors of glens and valleys, or occur in narrow linear stands along the sides of streams. It is widely distributed in lowland Great Britain, especially in the west. (JNCC Illustrated Guide to British Upland Vegetation)	Extensive presence, between the A83 and OMR, plus downslope of OMR (Volume 3, Figure 11.4b National Vegetation Classification; Pages 1-5)
M26	Narthecium ossifragum - Sphagnum papillosum valley Mire	Moderate (Low)	Peats or peaty soils that are enriched with base-rich water, usually over calcareous rocks. It occurs on flushed slopes or around open water, typically within mosaics of other wet grasslands and mires. This is a sub-montane type of vegetation. (JNCC Illustrated Guide to British Upland Vegetation)	Single location within the wider survey area, as part of M23/M26 mosaic south of Loch Restil (Volume 3, Figure 11.4b National Vegetation Classification; Page 1-2)

NVC Code	NVC Name	SEPA LUPS-GU31 Potential Groundwater Dependency Value (Revised Value)	Characteristic Setting	Location(s) relative to the Proposed Scheme
MG9	Holcus lanatus - Deschampsia cespitosa Grassland	Moderate (Low)	Mesotrophic grassland/rush-pasture, generally found in saturated areas, often subject to periodic inundation. Characteristic of permanently moist and periodically inundated soils throughout the British lowlands. (JNCC Illustrated Guide to British Upland Vegetation)	Extensive presence on lower gradients, generally between A83 and OMR and at Beinn an Lochain SSSI (Volume 3, Figure 11.4b National Vegetation Classification; Pages 1-2, 4-6)
MG10	Holcus lanatus - Juncus effusus Rush-pasture	Moderate (Low)	Mesotrophic grassland/rush-pasture, often found in areas with poor drainage and/or high soil moisture. Vegetation type of damp acid to neutral soils on level to gently sloping ground in enclosed pastures, also in neglected situations such as ditches, pond sides and roadside verges. This community is widespread in lowland Great Britain, it also occurs at low altitudes in most upland areas. (JNCC Illustrated Guide to British Upland Vegetation)	Extensive presence on lower gradients, between A83 and OMR, downslope of OMR and at Beinn an Lochain SSSI (Volume 3, Figure 11.4b National Vegetation Classification; Pages 1-5)

NVC Code	NVC Name	SEPA LUPS-GU31 Potential Groundwater Dependency Value (Revised Value)	Characteristic Setting	Location(s) relative to the Proposed Scheme
MG11	Inland wet grassland, Festuca rubra – Agrostis stolonifera - Potentilla anserina Grassland	Moderate (Low)	Characteristic of lowland areas frequently inundated with fresh or brackish water in floodplains or on the coast. (JNCC Guidelines for the Selection of Biological SSSIs; Lowland Grasslands)	Single location, within the wider survey area, immediately downslope of A83 (Volume 3, Figure 11.4b National Vegetation Classification; Pages 1, 4-5)
W1	Salix cinerea – Galium palustre woodland	Moderate (Low)	A community of wet mineral soils on the margins of standing or slow-moving water and in moist hollows, mainly in the lowlands. Often occurs as a narrow fringe or scattered fragments around surface water features. (JNCC Field Guide to Woodland)	Multiple locations, Croe Water riparian zone on Beinn Luibhean slope and on valley floor floodplain (Volume 3, Figure 11.4b National Vegetation Classification; Pages 1, 3-5)

NVC Code	NVC Name	SEPA LUPS-GU31 Potential Groundwater Dependency Value (Revised Value)	Characteristic Setting	Location(s) relative to the Proposed Scheme
W4	Betula pubescens - Molinia caeruleae Woodland	High (Low)	Wet woodland, often found on poorly drained or seasonally wet soils, including base-poor flushes, valley floors and floodplain. Community of moist, moderately acidic, though not necessarily highly oligotrophic, peaty soils. It is characteristic of thin or drying ombrogenous peats which are isolated from the influence of base-rich or eutrophic groundwaters, also found on peaty gleys flushed by rather base-poor and nutrient-poor water. (JNCC Field Guide to Woodland)	Single location, Croe Water riparian zone on Beinn Luibhean slope (Volume 3, Figure 11.4b National Vegetation Classification; Pages 1, 3)

A12.3.11.10. Following review of entries in Table 12.3.11-4, the majority of locations initially identified as potential GWDTE (based on SEPA LUPS-GU31) are considered non-dependent upon groundwater inputs, due to a combination of local slope characteristics and setting; these are typically areas of poor drainage, surface water ponding or adjacent to surface water features, some of which may be receiving flows from upslope exposed rock faces. Although there is acknowledged uncertainty in relation to local groundwater flows (and seasonal variation), the dominant inputs in the Study Area are unlikely to be groundwater. These have thus been recorded with revised groundwater dependency values of low, with an associated low sensitivity/importance, following the criteria provided in Volume 4, Appendix 12.2 Geology, Soils and Groundwater Methodology (Table A12-2.2).

A12.3.11.11. General levels of low groundwater dependency are further demonstrated by the average groundwater level data provided in Table 12.3.8-3, generally exceeding 1.5 mbgl, likely to be at the extremity or beyond the near-surface root zone of many potential GWDTE species (with notable exception of wet woodland or large shrubs) in the Study Area, with a higher degree of reliance upon soil moisture content nearer to surface provided from other sources.

A12.3.11.12. It is anticipated that groundwater may contribute a greater input to specific zones, particularly where sub-surface flows may emerge on the lower slopes of Glen Croe following rainfall events. The water table level at the Croe Water floodplain is likely to be near to surface during prolonger wet conditions, such as the winter season. However, this is considered a relatively low contributing factor to overall water inputs, including within Beinn Lochain SSSI.

A12.3.11.13. The M10 habitat (including M10 mosaic habitat) was identified by the Ecological survey team as of greater concern than other NVC communities in terms of potential for groundwater dependency. M10 has a revised groundwater dependency value of moderate recorded in Table 12.3.11-4, reflecting a reduced level of potential for groundwater dependency in the local setting, resulting in medium sensitivity/importance. This medium value takes account of uncertain groundwater conditions, including potential for deeper flowpaths that could be contributing (with varying seasonality) to support M10 habitats on the lower slopes of eastern Glen Croe.

A12.3.12. Future Baseline

A12.3.12.1. Without the Proposed Scheme or any future land use changes, the soils, peat, groundwater and geology of the area are unlikely to change.

A12.3.13. Sub-Topics Scoped Out of the Assessment

A12.3.13.1. As part of the EIA scoping exercise conducted with the A83 ESG, agricultural soils and geology have been scoped out of this assessment. This was due to a lack of identified receptors. Contaminated land has also been scoped out at this stage due to a lack of identified sources of contamination. However, a contaminated land risk assessment will be carried out as part of the proposed ground investigation (GI) works and will be assessed within the ground investigation report.

A12.3.13.2. Potential for increased groundwater flood risk (construction and operational impacts). Groundwater flooding impacts have been discussed in Chapter 19: Road Drainage and the Water Environment.