8. Geology, Soils and Groundwater

8.1. Introduction

8.1.1. This Chapter presents the Design Manual for Roads and Bridges (DMRB) Stage 3 assessment of the potential impacts of the Proposed Scheme in relation to impacts on geology, soils and groundwater.

8.1.2. Construction and operational impacts from the Proposed Scheme (described in Volume 2, Chapter 4: The Proposed Scheme) are discussed and assessed.

8.1.3. Construction impacts are generally considered to be short-term impacts which occur during the construction phase only. Operational impacts are considered long-term or permanent impacts affecting receptors after the construction phase is complete. It is recognised that many operational impacts are initiated by construction activities e.g. excavation of cuttings, however, the full effect of the impact may only manifest itself in the long term.

8.1.4. This assessment is supported by:

- Volume 3, Figure 8.1 National Vegetation Classification
- Volume 3, Figure 8.2 Groundwater Dependent Terrestrial Ecosystems
- Volume 4, Appendix 8.1 Geology Soils and Groundwater Cuttings Assessment and
- Volume 4, Appendix 8.2 National Vegetation Classification.

Scoping Summary

8.1.5. Following scoping consultation with the A83 Environmental Steering Group (ESG), it has been agreed that the construction and operation of the Proposed Scheme is not predicted to result in significant effects upon most Geology, Soils and Groundwater sub-topics when taking into account good design and environmental management embedded into the Proposed Scheme design and subsequent construction contract requirements.

8.1.6. Volume 4, Appendix 6.1 is the Summary of EIA Scoping, with consultation feedback provided in Volume 4, Appendix 6.2, Summary of Scoping Consultation Responses.

8.1.7. The following potential impacts have been scoped out:

- Peat or carbon-rich soils
- Groundwater pollution
- Potential for increased groundwater flood risk and
- Contaminated land.

8.1.8. Following SEPA feedback, the potential impact upon groundwater dependent terrestrial ecosystems (GWDTE) is the focus of the Chapter 8 assessment, discussed in the following sections.

Policy

8.1.9. National Planning Framework 4 (NPF4) applies to developments in Scotland. Specific to this assessment, Policy 22 – Flood Risk and Water Management is relevant in terms of sustainable water management and protection of the water environment, including groundwater. NPF4 Policy 5 – Soils is relevant to carbon rich soils, including peat, emphasising minimisation of disturbance.

8.1.10. SEPA's Groundwater Protection Policy for Scotland references the Water Framework Directive, regulated by SEPA via the Water Environment (Controlled Activities) (Scotland) Regulations 2005 (as amended). Relative to the Proposed Scheme, this outlines that groundwater is a resource which must be managed in a sustainable manner, including regarding influence from developments that could affect groundwater inputs to surface watercourses and wetlands (and their ecosystems). Controls should be included that are proportionate to the level of risk and ensure dependent communities are protected.

8.2. Approach and Methods

8.2.1. The methodology follows guidance set out in DMRB documents LA113: Road Drainage and the Water Environment (LA 113) and LA104: Environmental Assessment and Monitoring (LA 104). The various criteria applied and assessment of significance has been based on these guidance documents.

Assessment Criteria

8.2.2. The assessment of significance of impacts in relation to GWDTE has been based on the guidance provided DMRB documents LA 113 and LA 104 and considering SEPA LUPS-GU31: Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems (Version 3, 2017).

Importance/sensitivity

8.2.3. The evaluation of importance/sensitivity of GWDTE receptors is based on groundwater dependency and any designated area locations, using the criteria shown in Table 8.1.

Magnitude of Impact

8.2.4. Magnitude has been determined by considering the extent of GWDTE loss and adverse effects on integrity of an attribute, in keeping with the DMRB Standards and using the criteria shown in Table 8.2.

Table 8.1 - Importance/sensitivity

Sensitivity	Description
Very High	GWDTE located within designated areas
High	GWDTE with potential highly groundwater dependency, not located within designated areas
Medium	GWDTE with potential moderate groundwater dependency, not located within designated areas

Sensitivity	Description
Low	Habitats confirmed not to be GWDTE
Negligible	Unproductive (hydrogeological) strata

Table 8.2 - Magnitude of impact

Magnitude of Impact (change)	Typical Description
Major Adverse	Major loss of, or extensive change to GWDTE
Moderate Adverse	Partial change or loss of integrity of GWDTE
Minor Adverse	Minor direct or indirect effects of GWDTE
Negligible	No loss or alteration of characteristics, features or elements; no observable impact

Significance

8.2.5. The evaluation of significance has been derived by combining the sensitivity of the affected attributes and the magnitude of the impacts using the matrix recommended in LA 104. The significance matrix is detailed in Table 8.3.

8.2.6. Where multiple outcomes are indicated in Table 8.3 (e.g. Neutral / Slight), professional judgement has been applied based on the Proposed Scheme context to provide a single outcome.

Table 8.3 - Significance Matrix

Environmental Value (Sensitivity)	Magnitude of Impact - Major	Magnitude of Impact - Moderate	Magnitude of Impact - Minor	Magnitude of Impact - Negligible	Magnitude of Impact - No Change
Very High	Very Large	Large / Very Large	Moderate / Large	Slight	Neutral

Environmental Value (Sensitivity)	Magnitude of Impact - Major	Magnitude of Impact - Moderate	Magnitude of Impact - Minor	Magnitude of Impact - Negligible	Magnitude of Impact - No Change
High	Large / Very Large	Moderate / Large	Slight / Moderate	Slight	Neutral
Medium	Moderate / Large	Moderate	Slight	Neutral / Slight	Neutral
Low	Slight	Slight	Neutral / Slight	Neutral / Slight	Neutral
Negligible	Slight	Neutral / Slight	Neutral / Slight	Neutral	Neutral

Information Sources

8.2.7. Baseline conditions, future baseline conditions and the assessment of potential impacts were informed by the primary sources of information listed below:

- Medium Term Strategy Options Assessment for the A83, published by Transport Scotland in January 2023
- British Geological Survey's GeoIndex Onshore website and Hydrogeological Maps of Scotland informed geological and hydrogeological commentary
- Ordnance Survey (OS) 1:25,000 scale digital mapping informed surface hydrology and slope commentary
- National Vegetation Classification (NVC) surveys undertaken during 2023-24 for the A83 Rest and Be Thankful Project and
- SEPA LUPS-GU31 which identifies potential GWDTE from NVC communities.

Method

8.2.8. Cuttings have been assessed for groundwater interaction, including extent of drawdown (radii of influence) beyond the excavation footprint. These methods and outcomes are fully detailed in Volume 4, Appendix 8.1 Geology, Soils and Groundwater Cuttings Assessment.

8.2.9. National Vegetation Classification (NVC) survey data has been applied, with an extended survey zone that includes the Proposed Scheme. The NVC data and survey area is shown on Volume 3, Figure 8.1, National Vegetation Classification. Details on the methodology for this survey is provided in Volume 4, Appendix 8.2 National Vegetation Classification.

8.2.10. Potential GWDTE were initially identified from NVC data using SEPA LUPS-GU31 guidance. 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 8.4.

8.2.11. Potential GWDTE of ongoing concern, where groundwater dependency is considered valid, have been discussed in more detail, followed by assessment of potential effects, relevant mitigation and residual effects.

Study Area

8.2.12. The Study Area includes the eastern slopes and valley floor of Glen Croe, as depicted on Volume 3, Figure 8.1 National Vegetation Classification, with survey area of 250m from the Proposed Scheme boundary.

8.2.13. Volume 3, Figure 8.2 Groundwater Dependent Terrestrial Ecosystems shows the Proposed Scheme, including a 100m buffer for context in relation to likely Proposed Scheme effects.

Limitations

8.2.14. The groundwater data available for the Proposed Scheme is currently limited, with GI works underway to reduce uncertainty. Professional judgement has been applied in order to apply a cautious but realistic approach and appropriate values applied in groundwater-related calculations, based on known information and local conditions.

8.2.15. GI data shall be reviewed to verify findings and assessment outcomes reported, to ensure the basis for GWDTE assessment remains valid.

8.3. Baseline Conditions

8.3.1. As determined from BGS GeoIndex mapping, the majority of the Proposed Scheme area is underlain by Neoproterozoic metamorphic bedrock (Beinn Bheula Schist Formation). An extensive igneous intrusion underlies part of the Proposed Scheme, where the Croe Water flows to the valley floor, with numerous igneous dykes are also present. 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. Glacial Till, which generally underlies the Proposed Scheme, 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 local Alluvium and River Terrace Deposits.

8.3.2. The Hummocky Glacial Deposits, Glacial Till, Unnamed Igneous Intrusion and Beinn Bheula Schist all have low groundwater productivity.

8.3.3. 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.

8.3.4. The current A83 Trunk Road and Old Military Road (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 excavations, which may emerge on the lower slopes of Glen Croe, potentially seasonally.

8.3.5. Initial groundwater data from Ground Investigations, ongoing at time of writing, indicate groundwater levels generally in excess of 1.5m below ground level in the Study Area. These depths are likely to be at the extremity or beyond the root zone of many potential GWDTE species (with notable exception of wet woodland or larger shrubs) in the Study Area, with a higher degree of reliance upon soil moisture content nearer to surface provided from other sources. The water table level at the Croe Water floodplain is likely to be near to surface during prolonged wet conditions, such as winter season.

8.3.6. In summary, the primary inputs of water in the Study Area are considered to be surface flows and direct precipitation, with groundwater providing a minor contribution, which may exhibit some seasonal variation but will be influenced by the existing road corridors. These factors combine and lead to much of the Study Area hosting vegetation communities which thrive in wet climatic locations with high soil moisture content.

Potential GWDTE

8.3.7. 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.

8.3.8. A slightly smaller set of these potential GWDTE are found within the smaller 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).

8.3.9. Information on these communities is outlined in Table 8.4 with reference to typical characteristics and locations identified on Volume 3, Figure 8.1 National Vegetation Classification (on which Page 1 is the overview, with Pages 2-5 providing mapping in more detail, from north to south).

8.3.10. Table 8.4 notes a revised groundwater dependency value, in the context of the Proposed Scheme, following this desktop review process.

Table 8.4 - 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), upslope on steep gradients, with exposed bedrock above (Volume 3, Figure 8.1 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
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, upslope on steep gradients, with exposed bedrock above (Volume 3, Figure 8.1 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, upslope and downslope (Volume 3, Figure 8.1 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
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 No.), upslope and downslope, with exposed bedrock above (Volume 3, Figure 8.1 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 (Volume 3, Figure 8.1 National Vegetation Classification Pages 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, upslope and downslope (Volume 3, Figure 8.1 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, upslope and downslope (Volume 3, Figure 8.1 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
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 8.1 National Vegetation Classification Page 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, lower gradients, generally upslope (Volume 3, Figure 8.1 National Vegetation Classification; Pages 1-2, 4-5)

NVC Code	NVC Name	SEPA LUPS-GU31 Potential Groundwater Dependency Value (Revised Value)	Characteristic Setting	Location(s) relative to the Proposed Scheme
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, lower gradients, generally downslope (Volume 3, Figure 8.1 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 8.1 National Vegetation Classification; Pages 1, 4-5)

NVC Code	NVC Name	SEPA LUPS-GU31 Potential Groundwater Dependency Value (Revised Value)	Characteristic Setting	Location(s) relative to the Proposed Scheme
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 8.1 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 8.1 National Vegetation Classification; Pages 1, 3)

8.3.11. Following review of entries in Table 8.4, 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 within Table 8.1. As these have no potential for significant effects (based on Table 8.3), these locations are not considered further in this assessment.

8.3.12. 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 8.4, 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 water inputs on M10 habitats on the lower slopes.

8.3.13. The subsequent stages of the GWDTE assessment focus upon the M10 locations to establish the significance level of effect. Within Volume 3, Figure 8.2, Groundwater Dependent Terrestrial Ecosystems displays the three locations of M10 habitat (including M10 and M10 mosaic) on Pages 1 and 2.

M10 Community

8.3.14. The M10 mires typically occupy sloping flush zones, often below a springhead or more diffuse groundwater emergence.

8.3.15. The M10 habitats in the Study Area occupy steep slopes above and below the OMR and are subject to existing groundwater modification from both the OMR and due to the presence of the upslope A83, from which diffuse road drainage may be contributing to the wet slope conditions. These polygons are also in close proximity to surface channels and observed flush zones.

8.3.16. Thus, local soil moisture input is likely to be dominated by surface water sources, rather than groundwater input, with groundwater seepage possibly having a varying seasonal input (as discussed in general terms above). Plate 8.1 shows one of the M10 locations, with others sharing similar slope characteristics.

Plate 8.1 M10 Community, taken above OMR at NGR 223467 707084, looking north east towards A83. A83 vehicle restraint barrier and embankment visible in mid-ground, immediately above the steeply sloping M10 area, with evidence of local flush zones adjacent to a small channel.

8.4. Embedded Mitigation

8.4.1. Good practice design is considered as embedded mitigation and would include typical requirements for constructing infrastructure, including slope drainage, road drainage, minimising excavation extents and dewatering, to gain regulatory approval. Further information is provided in Volume 2, Chapter 4: The Proposed Scheme. Embedded mitigation measures most applicable to this discipline are identified in Table 8.5.

Table 8.5 – Embedded Mitigation Measures

Mitigation Reference	Embedded Mitigation Measures
GSG-Embed1	The footprint of the existing OMR has been utilised as much as possible, which minimises both the land take required and cuttings into the hillside, hence reducing the potential impact on soils (including carbon rich soils such as peat) and groundwater receptors.
GSG-Embed 2	It is proposed to retain existing OMR filter drains and ditches, as agreed in principle with SEPA during the A83 ESG January 20204 consultation meeting, to minimise engineering interventions as a proportionate approach for the OMR to be used as a temporary route.

8.5. Potential Impacts

Construction Impacts on GWDTE

8.5.1. Potential GWDTE locations have been considered in the context of local characteristics and available data, to establish likely level of groundwater dependency and establish sensitivity, magnitude and significance values. The existing OMR and upslope A83 linear features are already likely to act as barriers to shallow groundwater flows on this slope.

8.5.1. GWDTE within the Study Area may be impacted through direct loss of habitat under the footprint of the Proposed Scheme through severance of habitat and through changes to the groundwater regime supporting the habitat. This could result in altered vegetation in corridors close to infrastructure, known as indirect loss.

8.5.2. The Proposed Scheme involves a short section of carriageway widening, plus associated geotechnical and drainage upgrades to improve slope stability and transfer of flow. The Proposed Scheme involves shallow excavations (cuttings) and the groundwater drawdown effect would reduce with distance from the Proposed Scheme, with associated low radii of influence values all estimated as less than 2m, as presented in Volume 4, Appendix 8.1, Geology, Soils and Groundwater Cuttings Assessment (Table A8-1-3).

8.5.3. The M10 areas in the northern part of the Study Area have no adjacent lane widening proposed, with the Proposed Scheme extending into the southern M10 habitat to achieve improvements to slope stability and scour mitigation to local watercourses (south east of MTS Cutting 34, as depicted on Volume 3, Figure 8.2 Groundwater Dependent Terrestrial Ecosystems). With acknowledgement of SEPA guidance (LUPS-GU31), groundwater conditions within 100m of the Proposed Scheme are considered to be potentially affected, with wider influence constrained by the steep topography and input from the anticipated radii of influence value (with acknowledgement of limitations of theoretical calculations and limited groundwater data available currently).

8.5.4. Any change in groundwater inputs to the local M10 communities would be of very limited horizontal and vertical extent, with some temporary effects, if dewatering was necessary. None of these excavation radii of influence overlap with M10 NVC habitat, as shown on Volume 3, Figure 8.2, Groundwater Dependent Terrestrial Ecosystems. In the wider context, no changes are expected to overall water inputs at the base of Glen Croe or to the overall Croe Water system.

8.5.5. Little direct or indirect effects on GWDTE (including M10) are predicted to occur as a result of the construction of the Proposed Scheme. The sensitivity is considered Medium, with magnitude of change considered to be Negligible, with a Slight adverse (non-significant) effect.

Operational Impacts on GWDTE

8.5.6. GWDTE information noted for construction impact is also valid for the operational phase, with little indirect or direct effect on GWDTE due to the Proposed Scheme being limited to the existing OMR and very limited radii of influence values on groundwater from excavations.

8.5.7. For the operational phase, the magnitude of change to GWDTE is considered to also be Negligible, with a Slight adverse (non-significant) effect.

8.6. Mitigation

8.6.1. Mitigation measures to ensure sufficient protection of groundwater, GWDTE and peat are identified in Table 8.6. These include measures specifically requested by SEPA as part of their Scoping Response, as recorded in Volume 4, Appendix 6.2.

Table 8.6 - Mitigation Measures

Mitigation Reference	Mitigation Measures
GSG1	Implementation of a Dewatering Management Plan (DMP) would be required for any dewatering activities being carried out. This document would outline how to remove excess water from the construction site and minimise environmental impacts, enabling groundwater recharge whilst taking account of local slope stability. Any dewatering activities will be compliant with industry standards and best practice and the PMP. Working areas are to be kept to a minimum for construction of the project to reduce habitat loss.

Mitigation Reference	Mitigation Measures
GSG2	GI works shall include additional groundwater data, due to be reported in 2025, which shall reduce uncertainty. Data with relevance to M10 habitats shall be reviewed against previous findings to verify the assessment outcome. On the basis that uncertainty remains, groundwater level and water quality monitoring shall be undertaken by Design Team or Appointed Contractor in accordance with SEPA LUPS- GU31 guidance, including locations both upslope and downslope of the Proposed Scheme covering the period preceding construction until post-construction, across a number of seasons. Ecological monitoring would be undertaken, in parallel, for any change to M10 community in comparison to baseline as part of this process. This data shall be used to update and refine the M10 habitat assessment. Should outcomes emerge that indicate these habitats are subject to a residual effect greater than current assessment, proportionate design adaptations shall be considered in latter design stages, taking into account challenging ground conditions and slope instability. If feasible, these could include sub-surface cross-drains, to enable shallow groundwater pathways to continue supply to downslope habitats. This approach will ensure any effect upon GWDTE, based on emerging information, does not exceed slight adverse significance, as currently reported. SEPA shall be consulted at all above stages. This measure was identified during the EIA Screening / Scoping, refer to Volume 4, Appendix 6.1 Summary of EIA Scoping.

Mitigation Reference	Mitigation Measures
GSG3	Following outcome of pre-construction Ground Investigation reporting, likely arisings and management of carbon rich soils (including peat) shall be incorporated into the relevant section of the Construction Environmental Management Plan (CEMP) as an Outline Peat Management Plan (PMP). Any encountered material shall be treated sensitively to minimise moisture and carbon loss, with appropriate handling, temporary storage and reuse plans identified and agreed with SEPA. This item is identified as a mitigation measure specifically in response to a request from SEPA.

8.7. Residual Effects

8.7.1. Other than GWDTE, all other geology, soils and groundwater sub-topics were agreed to be scoped out, as not considered likely to result in a significant adverse effect.

8.7.2. Essential mitigation shall involve review of GI information to verify groundwater dependency and magnitude of effect upon M10 habitats and potentially monitoring or application of additional drainage measures, if emerging data suggests applicable. Therefore, the magnitude of both the residual construction and operational impacts are anticipated to remain as Negligible, with Slight adverse (non-significant) effects as shown in Tables 8-7 and 8-8.

Table 8.7 - Residual construction effects

Reference	Pre-Mitigation Effect – Magnitude	Pre-Mitigation Effect – Significance	Mitigation Measures	Post-Mitigation Effect – Magnitude	Post-Mitigation Effect - Significance
GWDTE	Negligible	Slight	GSG1 Review of GI groundwater data, potentially GWDTE monitoring or sub-surface drainage measures	Negligible	Slight

Table 8.8 - Residual operational effects

Reference	Pre-Mitigation Effect – Magnitude	Pre-Mitigation Effect – Significance	Mitigation Measures	Post-Mitigation Effect – Magnitude	Post-Mitigation Effect - Significance
GWDTE	Negligible	Slight	GSG1 Review of GI groundwater data, potentially GWDTE monitoring or sub-surface drainage measures	Negligible	Slight

8.7.3. GWDTE has been assessed, with specific focus on M10 habitat from NVC mapping, which was established as the potential GWDTE receptor with most likely dependency upon groundwater by the Ecology team. This habitat was recorded in a small number of locations on steep slopes above and below the Proposed Scheme, as depicted on Volume 3, Figure 8.2 Groundwater Dependent Terrestrial Ecosystems. Following review of site characteristics, existing features and available GI information, no residual significant effects are predicted for GWDTE (including M10) in relation to potential impacts of construction and/or operation of the Proposed Scheme.

8.7.4. It is acknowledged that there is uncertainty in relation to shallow groundwater flowpaths based on current knowledge. Therefore, following receipt of GI data, the GWDTE assessment of M10 habitats shall be reviewed. With potential for the development of a monitoring programme in accordance with SEPA LUPS GU-31, should sufficient concern about effects upon these specific GWDTE emerge. Following collation of further data, this may establish a further requirement to include appropriate local measures to enable shallow groundwater flowpaths to continue to supply downslope habitats in the pre-construction design stage, in consultation with SEPA. This approach will ensure any effect upon GWDTE, based on emerging information, does not exceed slight adverse significance.

Compliance with Planning Policy

8.7.5. The results of the assessment undertaken are considered to demonstrate that the Proposed Scheme is compliant with SEPA's Groundwater Protection Policy for Scotland, applying a proportionate and risk-based approach to assess and protect GWDTE. It is also considered compliant with National Planning Framework 4, specifically Policy 22 – Flood Risk and Water Management.

8.7.6. Peat management will be outlined within the CEMP as a mitigation measure, including further data collection to minimise any disturbance and ensure compliance with National Planning Framework 4 Policy 5 - Soils.