A83 Rest and Be Thankful

LTS EIAR VOLUME 4, APPENDIX 12.2 - GEOLOGY, SOILS AND GROUNDWATER METHODOLOGY

Transport Scotland

A83AAB-AWJ-EAC-LTS_GEN-RP-LE-000272

A12-2. Geology, Soils and Groundwater Methodology

A12-2.1. Introduction

A12-2.1.1. The assessment has been carried out in accordance with the guidance contained in the Design Manual for Roads and Bridges (DMRB), LA 109 Geology and Soils and LA 113 Road Drainage and the Water Environment. This appendix aims to detail the methodology that has been used to assess impact to groundwater, Groundwater Dependent Terrestrial Ecosystems (GWDTE) and Peat soils. Guidance on peat assessment is not provided within LA 109, therefore the assessment has been carried out in line with relevant guidance and professional judgement, as discussed further in A12-1.1.8.

A12-2.1.2. This Appendix provides the methodology for the following assessments:

- change to, or loss of, class 3 and Class 4 peat or carbon rich soils
- groundwater pollution of the Croe Water from routine runoff in the operational phase
- direct loss or changes to groundwater aquifers and groundwater dependant features
- groundwater pollution resulting from construction activities:
  - Groundwater pollution from accidental spillages (i.e. vehicles/plant spills or leakages of fuels, oils, lubricants, coolants etc.) and
  - Increased turbidity caused by excavation works.
- loss or changes to GWDTEs
- potential for increased groundwater flood risk.

A12-2.1.3. Consequential impacts on sites designated for their conservation value, groundwater dependent habitats and associated fauna have been discussed in Chapter 11: Biodiversity. Pollution impacts on surface waters and flooding,

including groundwater flooding have been discussed in Chapter 19: Road Drainage and the Water Environment.

Items Scoped Out

A12-2.1.4. As part of the DMRB Stage 3 scoping exercise, 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 works and has been detailed within the ground investigation report.

Sources of Information

A12-2.1.5. The following sources of information have been used as part of this assessment:

- British Geological Survey (BGS) 1:50,000 and 1:10,000 superficial and bedrock geology mapping [Accessed: 15/04/2024]
- Scotland's environment web map – Aquifer Classifications [Accessed: 15/04/2024
- National Soil Map of Scotland [Accessed: 15/04/2024]
- Carbon and peatland Map 2016[Accessed: 15/04/2024]
- Land Capability for Agricultural in Scotland [Accessed: 15/04/2024]
- BGS Groundwater Vulnerability Map of Scotland 1:100 000 scale (Version 2, 2015)
- Coal Authority online interactive map data [Accessed: 15/04/2024]
- BGS 'Directory of Mines and Quarries' (D.G. Cameron et al (2020). Directory of Mines and Quarries. Nottingham. BGS)
- Ordnance Survey (OS) raster mapping on 1:25k scale
- OS Terrain 50 Mapping.

A12-2.1.6. The information in the assessment on GWDTE has used survey information collected as part of the UKHab and National Vegetation Classification (NVC)

surveys which has been undertaken by the Ecology team, as detailed within Chapter 11 Biodiversity.

A12-2.2. Assessment Methodology

A12-2.2.1. The assessment of significance of impacts in relation to groundwater has been based on the guidance provided DMRB LA 113 Road drainage and the water environment. The assessment of the significance of impacts in relation to peat has been based on guidance in the National Planning Framework 4 (NPF4), Policy 5.

Peat

A12-2.2.2. The assessment of peat is not outlined within DMRB LA 109 and therefore the assessment of impacts to peat has been carried out in line with the relevant guidance (NPF4 policy 5). The following surveys were undertaken to inform the assessment that has been completed:

- a peat depth survey showing colour coded peat depths
- a peat depth survey showing interpolated peat depths
- peatland condition assessment/ mapping
- NVC habitat mapping (as part of Chapter 11: Biodiversity)

A12-2.2.3. Areas of peat, carbon rich soils and priority peatland have been identified through comparison and collation of data from the BGS superficial geology mapping, peatland mapping and data from NVC mapping.

A12-2.2.4. As part of Volume 4, Appendix 12.4 - Outline Peat Management Plan, the volume of peat loss underneath the Proposed Scheme has been quantified by using peat depths gained from available survey data.

A12-2.2.5. An assessment of the likely net effects of the development on climate emissions and loss of carbon has been made using information from the GI and the peat depth surveys. An estimate of total volume of peat to be excavated has been made, and using the James Hutton Institute Soil Maps, an estimate of carbon loss has been made.

A12-2.2.6. Impacts on indirect loss of peat because of hydrological changes has been assessed qualitatively. Further information has been provided in Volume 4, Appendix 12.4 - Outline Peat Management Plan.

Peat Stability and Landslide Hazard Risk Assessment

A12-2.2.7. Due to the presence of areas of peat within the study area and historic landslides, a peat stability and landslide hazard assessment has been undertaken, where sufficient information is available. This is included within Volume 4, Appendix 12.4 - Outline Peat Management Plan. This assessment has been undertaken general accordance with the Peat Landslide Hazard and Risk Assessments : Best Practice Guide for Proposed Electricity Generation Developments.

Direct loss or change to Groundwater aquifers and supported water supplies.

A12-2.2.8. This assessment has been carried out in line with the methodology laid out within DMRB LA 113 for a simple assessment.

A12-2.2.9. Impacts to groundwater mainly take place where road cuttings are located across the Proposed Scheme. Where a large cut intercepts the groundwater table, it may cause drawdown of the surrounding groundwater table and dewatering to nearby receptors.

A12-2.2.10. In line with DMRB LA 113 the status of all regional groundwater bodies within the vicinity of Proposed Scheme have been determined. A conceptual model has been developed to express the current understanding of the characteristics and processes inherent in the groundwater regime and how this influences the behaviour of groundwater. This included groundwater interaction with surface water.

A12-2.2.11. Groundwater levels and hydraulic conductivity values have been estimated based on existing ground investigation data.

A12-2.2.12. All recorded groundwater dependant features within 250m of the Proposed Scheme have been identified at this stage. This includes private and public

water supplies, springs, superficial and bedrock aquifers, GWDTEs and groundwater fed surface water features.

A12-2.2.13. A cuttings assessment has been undertaken (Appendix 12.3) which estimates the likely drawdown created by road cuttings throughout the Proposed Scheme (and the extent of this drawdown). All groundwater associated features that fall within this area of drawdown (i.e. radius of influence) have been identified as those features likely to be impacted by the Proposed Scheme.

A12-2.2.14. Once the impacted receptors were identified the conceptual understanding of these receptors was refined. The assessment of impact has then been carried out in line with the methodology provided within Table A12-2.2 and Table A12-2.3 below.

Groundwater pollution from routine runoff during construction

A12-2.2.15. DMRB LA 113 Appendix C, specifies procedures for the simple assessment of pollution impacts from routine runoff on groundwater quality, known as 'Method C'.

A12-2.2.16. The Method C assessment of potential routine runoff impacts on groundwater takes the form of a risk assessment using the Source-Pathway-Receptor (S-P-R) model utilised in contaminated land investigations. Nine parameters relating to source and pathway are considered in turn and assigned a risk category as detailed in Table A12-2.1.

A12-2.2.17. The risk of adverse impact at each proposed groundwater discharge has been determined by multiplying the risk factor attributed to each parameter by the weighting factor and adding the resultant scores to establish the overall risk score for each discharge. This has then been evaluated against the following risk ratings:

- overall risk score < 150 – Low Risk of Impact
- overall risk score 150-250 – Medium Risk of Impact
- overall risk score > 250 – High Risk of Impact.

Table A12-2.1: Routine Runoff Groundwater Assessment Parameters

Source / Pathway	Weight	Parameter	Low Risk	Medium Risk	High Risk
Source	10	Traffic Flow	≤50,000 AADT	>50,000 AADT to <100,000 AADT	≥100,000 AADT
Source	10	Rainfall Depth (annual averages)	≤740mm	>740mm to <1060mm	≥1060mm
Source	10	Drainage area ratio	50	>50 to <150	≥150
Pathway	15	Infiltration method	“continuous” shallow linear (e.g. unlined ditch, swale, grassed channel	“Region” shallow infiltration system (e.g. infiltration basin)	“point” systems (e.g. chamber soakaways, deep shafts)

Source / Pathway	Weight	Parameter	Low Risk	Medium Risk	High Risk
Pathway	20	Unsaturated zone	Depth to water table ≥15 m or unproductive strata	Depth to water table <15 m and >5 m	Depth to water table ≤5 m
Pathway	20	Flow type	Dominantly intergranular flow	Mixed fracture and intergranular flow	Flow dominated by fractures/ fissures
Pathway	5	Unsaturated zone clay content	≥15 % clay minerals	<15 % to 1 % clay minerals	≤ 1 % clay minerals
Pathway	5	Organic Carbon	≥15 % soil organic matter	<15 % to >1 % soil organic matter	≤1% soil organic matter
Pathway	5	Unsaturated Zone spoil pH	pH ≥8	pH <8 to >5	pH≤5

A12-2.2.18. Available ground investigation data has been used to determine the groundwater table and aquifer properties in the vicinity of the proposed groundwater discharges, where appropriate.

A12-2.2.19. The sensitivity of groundwater aquifers have been identified and their sensitivity evaluated through review of BGS superficial and bedrock geology, aquifer productivity, groundwater vulnerability mapping and review of the WFD groundwater body status.

Groundwater pollution from construction

A12-2.2.20. Accidental spillage during construction has the potential to allow pollutants to migrate through the unsaturated zone of an aquifer to the saturated part of the aquifer below. Excavation of the overlying material, particularly where cuttings are proposed in areas of permeable drift deposits with shallow groundwater, could increase the vulnerability of localised aquifers to contaminants and cause an increase in turbidity.

A12-2.2.21. DMRB LA 113 Road Drainage and the Water Environment, specifies procedures for the assessment of pollution impacts from accidental spillages on groundwater within Appendix D. The sensitivity of the groundwater has been evaluated based on the aquifer productivity classification, the magnitude of impact has been evaluated qualitatively based on a review of groundwater vulnerability mapping and current design plans which identify areas where construction activities and cuttings are proposed.

A12-2.2.22. Pollution impacts that have been considered are those that fall into either Category 1 or 2 incident, as defined by the Environment Agency in their Common Incident Classification System (CICS) CICS 4/01. The risk is the calculated for these incidents that are considered to have potential to be serious using Highways England (now National Highways) water risk assessment too (HEWRAT).

A12-2.2.23. To perform the risk calculation the following data for each outfall or soakaway is used:

- the length of road which drains to the outfall or soakaway
- the annual average daily traffic (AADT) two-way flow for each section of road
- the percentage of the AADT flow that comprises heavy goods vehicles (HGVs).

Groundwater Dependent Terrestrial Ecosystems

A12-2.2.24. The impact of groundwater changes related to the Proposed Scheme GWDTEs has been assessed in line with Scottish Environment Protection Agency (SEPA) land use planning system (LUPS) Guidance Note 31.

A12-2.2.25. Additionally, the requirements laid out within the Water Framework Directive (WFD) have been met. This included the completion of a NVC survey which included the location of all GWDTEs within 100m of any excavations <1m in depth, and within 250m of any excavation >1m in depth.

A12-2.2.26. The assessment of GWDTEs follows the approach within Appendix B of DMRB LA 113, considering Scottish requirements (SEPA LUPS). This involved:

- Identification of any flow paths between potential GWDTEs and potential impacts from the Proposed Scheme. This involved review of their landform, hydrogeology and surface water characteristics and the conceptual model detailed in the groundwater assessment section above, in relation to the locations of potential GWDTEs.
- A screening exercise was carried out to screen out NVC communities within the study area where there was a lack of hydrogeological connectivity between the NVC community and the Proposed Scheme, or where groundwater or ground condition data indicated groundwater interactions with the vegetation were highly unlikely.
- The baseline groundwater dependency of each of the remaining GWDTE habitat polygons was reviewed and revised, based on qualitative assessment of the local ecology, topography, hydrology, and hydrogeology.

The sensitivity of each GWDTE habitat was assigned based on the revised groundwater dependency.

- Those NVC communities considered to have a dependency on groundwater were progressed to impact assessment. The impact assessment considered direct losses under the footprint of the Proposed Scheme, indirect loss due to groundwater drawdown in the vicinity of proposed road cuttings and indirect impacts to GWDTEs downslope of the Proposed Scheme due to changes in subsurface flows.
- Where significant impacts are predicted outline mitigation measures have been proposed. The residual effect on each GWDTE habitat has been evaluated taking this mitigation into consideration.

A12-2.3. Assessment Criteria

Importance/ sensitivity

A12-2.3.1. Importance/ sensitivity of relevant attributes of the soils, peat and groundwater receptors and evaluation of the magnitude of the impact has been undertaken. Importance/ sensitivity has been evaluated taking into account quality, rarity, scale and substitutability and, where relevant, is in keeping with the DMRB Standards using the criteria shown in Table A12-2.2 below.

Table A12-2.2: Importance/ sensitivity

Sensitivity	Description
Very High	**Soils & Peat:** • Soils directly supporting an EU designated site (e.g. SAC, SPA, Ramsar) • Areas of peatland designated as part of SSSIs, with national importance. **Groundwater:** • Public water supply or large private water supply serving >10 properties and/or • GWDTE located within designated areas
High	**Soils & Peat:** • Soils directly supporting a UK designated site (e.g. SSSI) • Class 1 priority peatland, carbon rich and peaty soils. **Groundwater:** • WFD Good overall status groundwater body • BGS High productivity aquifer • Groundwater vulnerability classes 4a and 4b • Private water supply serving 2-10 properties and/or • GWDTE with potential highly groundwater dependency, not located within designated areas.

Sensitivity	Description
Medium	**Soils & Peat:** • Soils supporting non-statutory designated sites (e.g., Local Nature Reserves (LNR), LGS's; Sites of Nature Conservation Importance (SNCIs)) • Class 2 and 3 priority peatland areas, carbon rich and peaty soils. **Groundwater:** • BGS Moderate and Low productivity aquifers • Groundwater vulnerability classes 2 and 3 • Private water supply serving a single property and/or • GWDTE with potential moderately groundwater dependency, not located within designated areas.
Low	**Soils & Peat:** • Soils supporting non-designated notable or priority habitats and/or • Class 4 and 5 peatland areas and unclassified areas (class 0, -1 and -2) **Groundwater:** • WFD Poor overall status groundwater body • BGS very low productivity aquifers • Groundwater vulnerability classes 1 and 0 and/or • Habitats confirmed not to be GWDTE.
Negligible	**Groundwater:** • Unproductive strata.

Magnitude of Impact

A12-2.3.2. Magnitude has been determined by considering the extent of loss / gain and effects on integrity of an attribute in keeping with the DMRB Standards and using the criteria shown in Table A12-2.3.

Table A12-2.3: Magnitude of impact

Magnitude of Impact (change)	Typical Description
Major Adverse	**Soils & Peat** Major or total loss of topsoil, soils, or peatland, or where the value of the area would be severely affected. **Groundwater:** • Loss of, or extensive change to, an aquifer • Loss of regionally important water supply • Potential high risk of pollution to groundwater from routine runoff – risk score >250 (groundwater quality and runoff assessment) • Calculated risk of spillages to groundwater >2% annually (spillage assessment) • Major loss of, or extensive change to GWDTE • Reduction in waterbody WFD classification and/or • Loss or significant damage to major structures through subsidence or similar effects.

Magnitude of Impact (change)	Typical Description
Moderate Adverse	**Soils & Peat:** Partial loss / reduction of one or more soil function(s) and restriction to current or approved future use but (e.g. through degradation, compaction, erosion of soil resource.) **Groundwater:** • Partial loss or change to aquifer • Degradation of regionally important public water supply or loss of significant commercial/ industrial/ agricultural supplies • Potential medium risk of pollution to groundwater from routine runoff – risk score 150 – 250 • Calculated risk of pollution from spillages to groundwater >1% annually and <2% annually • Partial change or loss of integrity of GWDTE • Contribution to reduction in water body WFD classification and/or • Damage to major structure through subsidence or similar effects or loss of minor structures.

Magnitude of Impact (change)	Typical Description
Minor Adverse	**Soils & Peat:** Temporary loss / reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource.) **Groundwater:** • Potential low risk of pollution to groundwater from routine runoff – risk score <150 • Calculated risk of pollution from spillages to groundwater >0.5% annually and <1% annually • Minor effects on an aquifer • Minor direct or indirect effects of GWDTE • Minor effects on abstractions and/or • Minor effects on structures.
Negligible	**Soils & Peat:** No discernible loss / reduction of soil function(s) that restrict current or approved future use. **Groundwater (see chapter 19):** No loss or alteration of characteristics, features or elements; no observable impact in either direction.
Minor beneficial	**Soils & Peat** No discernible loss/ reduction of peatland and restoration or enhancement of peatland is undertaken. **Groundwater** No measurable impact upon an aquifer and/or groundwater receptors and risk of pollution from spillages <0.5%.

Magnitude of Impact (change)	Typical Description
Moderate beneficial	**Soils & Peat** No discernible loss/ reduction of peatland and restoration or enhancement of peatland within the SSSI is undertaken. **Groundwater** • Calculated reduction in existing spillage risk by 50% or more to an aquifer (when existing spillage risk <1% annually) • Reduction of groundwater hazards to existing structures • Reductions in waterlogging and groundwater flooding.
Major Beneficial	**Groundwater** • Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is >1% annually • Contribution to improvement in water body WFD classification • Improvement in water body catchment abstraction management Strategy (CAMS) (or equivalent) classification and • Support to significant improvements in damaged GWDTE.

Significance

A12-2.3.3. 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 DMRB LA 104 Environmental assessment and monitoring. The significance matrix is detailed in table A12-2.4 below.

Table A12-2.4: Significance Matrix

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

A12-2.4. Limitations and Assumptions

A12-2.4.1. This assessment has relied upon the accuracy and level of detail of the documented data sources listed within A12-1.1.5.

A12-2.4.2. The scale of various mapping datasets, such as groundwater vulnerability and soils mapping, is such that only broad characterisation of these attributes and high-level assessment of potential impacts has been possible at this stage. Both the aquifer productivity and groundwater vulnerability data only provide a guide to aquifer conditions at a 1:100,000 scale.

A12-2.4.3. The assessment has been undertaken based upon the most recent ground investigation data available.