13 Geology and Soils

13.1 Introduction

13.1.1 This chapter presents the Design Manual for Roads and Bridges (DMRB) Stage 2 assessment of the route options in relation to the impacts on geology, soils and groundwater. This includes impacts to bedrock and superficial geology, mineral extraction, soils, contaminated land, groundwater and associated receptors including licenced abstractions and private water supplies (PWS).

13.1.2 Geological impacts can occur due to excavating or masking exposures of rocks or superficial geological deposits of particular scientific interest, particularly if the features of interest are not reproduced elsewhere in the area. Impacts can also include restrictions on existing or potential commercial exploitation of resources, and conversely previous exploitation of resources can impose constraints on a route option; for example, where land has become unstable due to mining or has been contaminated by previous land uses. It is also recognised that rock exposures can deliver environmental benefit, such as improved access to, and exposure of, new areas of geological interest.

13.1.3 During construction, there is an inherent risk of spillage or leakage of fuel or oil from storage tanks or construction plant. Without suitable mitigation measures, these pollutants could enter aquifers and degrade water quality. Construction work can lead to dewatering and also to contamination of superficial and bedrock aquifers.

13.1.4 Similarly, once a new road is opened, runoff from the road surface may contain elevated concentrations of pollutants, such as oils, suspended solids, metals and, in winter, salt and engine coolants (e.g. ethylene glycol), which may find their way into the groundwater system. Groundwater flows can also be intercepted or altered by new cuttings and other significant changes to landform.

13.2 Approach and Methods

Scope and Guidance

13.2.1 This assessment has been undertaken using the guidance contained in DMRB Volume 11, Section 3, Part 11, Geology and Soils (Highways Agency, Scottish Executive, Welsh Assembly Government and The Department for Regional Development Northern Ireland, 1993) (hereafter referred to as DMRB Geology and Soils), taking into account updated guidance on contaminated land risk assessment where appropriate (paragraph 13.2.13), and DMRB, Volume 11, Section 3, Part 10, HD45/09 Road Drainage and the Water Environment (Highways Agency, Scottish Executive, Welsh Assembly Government and The Department for Regional Development Northern Ireland, 2009) (hereafter referred to as HD45/09).

13.2.2 Consideration of soils includes contaminated land and made ground (included in the assessment of contaminated land). Agricultural soil quality is considered as part of the assessment reported in Chapter 17 (People and Communities: Community and Private Assets), with mitigation included to address the potential deterioration of soils due to disturbance (and subsequent storage/reuse) at construction stage.

Study Area

13.2.3 The assessment covers a study area extending to a corridor of 250m from the outermost edge of the route options. For Groundwater Dependant Terrestrial Ecosystems (GWDTE), a study area extending up to 100m from the outermost edge of was used. Impacts on groundwater abstractions have been assessed to a distance of 850m from the outermost edge of the route options as corresponding to the minimum study area applied for groundwater abstractions under The Water Environment (Controlled Activities) (Scotland) (Regulations) 2011 (Controlled Activities Regulations (CAR)).

Determination of Baseline Conditions

13.2.4 Baseline conditions cover the following aspects:

- bedrock and superficial geology;
- features of geological and geomorphological importance;
- mineral extraction;
- groundwater environment including abstractions; and
- contaminated land.

13.2.5 Baseline conditions were determined through a desk-based assessment, consultation with statutory and non-statutory bodies and landowners and ground investigations (GI) undertaken in 2008 by Soil Mechanics.

Desk-based Assessment

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

- British Geological Society (BGS) data, including BGS Drift and Solid Geological Maps, BGS borehole logs, BGS Hydrogeological and Groundwater Vulnerability Maps (BGS 1988ab) and other relevant BGS publications.
- Ordnance Survey (OS) historical maps dating back to 1874 for information on former land use, potential contamination and physical hazards and information on PWS.
- SEPA's Interactive River Basin Management Plan (RBMP) (SEPA 2016).
- Scottish National Heritage (SNH) Natural Spaces website (SNH 2016) (spatial data on designations) https://gateway.snh.gov.uk/natural-spaces/index.jsp Last Accessed 07/08/2017.
- Inverness Trunk Link Road Ground Investigation – Enhanced Factual Report on Ground Investigation (GI) (Soil Mechanics 2008).

Consultation

13.2.7 Written consultation has been undertaken with a number of statutory and non-statutory bodies. These include the following:

- Information on licenced groundwater abstractions (via the CAR Regulations 2011) and on former and current contaminated land use from SEPA.
- Information on the location and extent of environmental sensitivities in the vicinity of the route options and to establish any future development constraints from SNH.
- Information on former and current contaminated land use, Private Water Supplies (PWS), licensed fuel storage and any additional relevant information from The Highland Council.

13.2.8 Further information on the consultation process is provided in Chapter 7 (Overview of Environmental Assessment).

Ground Investigation

13.2.9 Information from a GI across the study area, carried out by Soil Mechanics in 2008 (Soil Mechanics 2008) was reviewed. Drilling logs for 17 borehole locations plus additional trial pits were available. These were distributed linearly along the Inverness Trunk Link Road and along a short section of the A96 Aberdeen to Inverness Trunk Road at the northern end of the study area.

Impact Assessment

13.2.10 The impacts in relation to geology, hydrogeology and contaminated land have been assessed individually using the criteria provided in this section. The overall impact of each route option is then determined through a combination of these impacts, and for the purposes of this assessment is based on impacts of Slight/Moderate and above significance. Impacts of Slight/Moderate and above significance are highlighted as at these levels it is considered that mitigation would be required.

Geology

13.2.11 For bedrock and superficial geology, features of geological importance and mineral extraction the sensitivity and magnitude criteria provided in Tables 13.1 and 13.2 were used to assign sensitivity and magnitude. The impact significance was then determined in line with Table 13.3.

Table 13.1: Sensitivity Criteria for Geology Assessment

Likelihood	Definition
High	Areas containing unique or rare geological or geomorphological features considered to be of national interest e.g. Site of Special Scientific Interest (SSSI) and Geological Conservation Review (GCR).
Medium	Areas containing features of designated regional importance considered worthy of protection for their educational, research, historic or aesthetic importance e.g. Regionally Important Geological Sites (RIGS). Geological resources of national/regional importance.
Low	Features not currently identified as SSSI, GCR or RIGS but that may require specific protection in the future. Geological resources of local importance.
Negligible	Features not currently protected and unlikely to require specific protection in the future. No exploitable geological resources.

Table 13.2: Magnitude Criteria for Geology Assessment

Magnitude	Definition
High	Partial (greater than 50%) or total loss of a site, or where there would be complete severance of a site such as to affect the value of the site.
Medium	Loss of part (between approximately 15% and 50%) of a site, major severance, major effects to the setting, or disturbance such that the value of the site would be affected, but not to a major degree.
Low	Small effect on a site (up to 15%) or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected.
Negligible	Very slight change from baseline condition. Change hardly discernible, approximating to 'no change' conditions.

Table 13.3: Matrix for Determination of Impact Significance for Geology Assessment

Sensitivity / Magnitude	Negligible	Low	Medium	High
High	Slight	Moderate	Moderate/Substantial	Substantial
Medium	Negligible/Slight	Slight/Moderate	Moderate	Moderate/Substantial
Low	Negligible	Negligible/Slight	Slight/Moderate	Moderate
Negligible	Negligible	Negligible	Negligible/Slight	Slight

Contaminated Land

13.2.12 In line with industry standards the assessment focuses on the potential for impacts on receptors as a consequence of encountering contaminated land using a conceptual site model (CSM) developed for the route options. A receptor can be a person (including construction workers), the water environment, flora, fauna or building/structures. The CSM represents a network of relationships between potential sources of contamination from within the study area and exposure of the receptors through different pathways. The potential receptors and pollutant pathways (PPs) (Table

13.4) have been compiled based on the legal definitions used in Part IIA of the Environment Protection Act 1990, as provided in the Statutory Guidance (Scottish Executive 2006).

13.2.13 Historical sources of contaminated land have been identified in the baseline information.

13.2.14 The PPs and type of receptors used within the assessment are provided in Table 13.4, with individual references for linkages (PP1 to PP22).

Table 13.4: Potential Pollutant Pathways and Receptors

Pollutant Pathway (PP)	Receptor	Pathway
Construction		
PP1	Human Health (Construction)	Ingestion, inhalation and dermal contact with soils, soil dust, deep and shallow groundwater and surface water.
PP2		Migration of ground gases into shallow pits or site buildings.
PP3	Off-site Receptors (Local residents and transient traffic (foot, road and rail traffic)).	Ingestion, inhalation and dermal contact with wind-blown dust created during excavation works.
PP4		Migration of ground gases into homes or workplaces through preferential pathways created during construction posing a potential asphyxiation/explosion risk.
PP5	Groundwater – Superficial Aquifers	Leaching and migration of contaminants.
PP6	Groundwater – Bedrock Aquifers	Migration of contaminants or contaminated shallow groundwater into the deeper rock aquifer.
PP7	Surface Waters	Migration of contaminated shallow groundwater through superficial deposits or made ground.
PP8		Runoff from contaminated source(s).
PP9		Migration of contaminated bedrock groundwater towards surface water receptor.
PP10		Discharge of intercepted contaminated groundwater during passive or active dewatering.
PP11	Ecological Receptors (water dependant habitats and agricultural land/livestock)	Inhalation, ingestion and direct contact with contaminated soils/water.
Operational		
PP12	Human Health (Operational)	Ingestion, inhalation and dermal contact with soils, soil dust, deep and shallow groundwater, surface water in the long term during routine maintenance activities e.g. drainage inspections.
PP13		Migration of ground gases into confined spaces e.g. service pits, accommodation buildings creating an asphyxiation/explosion risk.
PP14	Off-site Receptors	Ingestion, inhalation and dermal contact with wind-blown dust from contaminated soils reused within road features such as embankments and landscaped areas.
PP15		Migration of ground gases into homes or workplaces through preferential pathways remaining following construction thus posing a potential asphyxiation/explosion risk.
PP16	Groundwater – Superficial Aquifers	Leaching and migration of contaminants.
PP17	Groundwater – Bedrock Aquifers	Migration of contaminated shallow groundwater into the deeper rock aquifer.
PP18	Surface Water	Migration of shallow groundwater through superficial deposits or made ground.
PP19		Runoff from contaminated source(s).

Pollutant Pathway (PP)	Receptor	Pathway
PP20		Migration of contaminated shallow groundwater through drainage channels and associated granular bedding materials or engineered structures.
PP21		Discharge of intercepted contaminated groundwater.
PP22	Ecological Receptors	Inhalation, ingestion and direct contact with contaminated soils/water.

13.2.15 For the purposes of this assessment, the CSM disregards those pathways that are incomplete and therefore cannot pose a risk to any of the identified receptors. Where a source, pathway and receptor combination exists this is referred to as a complete pollutant linkage, and a generic qualitative risk assessment has been undertaken.

13.2.16 Potential impacts are discussed in terms of likelihood as shown in Table 13.5 and magnitude/consequence as shown in Table 13.6. The generic qualitative risk assessment is then undertaken based on the matrix shown in Table 13.7.

Table 13.5: Likelihood Criteria for Contaminated Land Assessment

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

Table 13.6: Magnitude (Consequence) Criteria for Contaminated Land Assessment

Magnitude	Definition
Severe	Short-term (acute) damage to human health (significant harm). Pollution of sensitive water resources as a result of short-term exposure. Damage to a particular ecosystem as a result of acute exposure. Catastrophic damage to buildings/property.
Medium	Long-term (chronic) damage to human health (significant harm). Pollution of sensitive water resources as a result of chronic exposure. A significant change in a particular ecosystem, or organism forming part of such an ecosystem.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings/structures/services or the environment.
Minor	Harm (not necessarily significant), which may result in financial loss or require expenditure to resolve. Non-permanent health affects to human health. Easily reparable damage to buildings, structures and services.

Table 13.7: Matrix for Determination of Generic Qualitative Risk Assessment for Contaminated Land

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

Groundwater

13.2.17 The assessment considers groundwater sensitivity in the context of hydrogeological conditions, including groundwater resources. Criteria for the definition of groundwater sensitivity and magnitude are shown in Tables 13.8 and 13.9.

13.2.18 The criteria for the definition of the magnitude of impact on abstraction quality and yield are based primarily on the type of road profile (e.g. cutting, embankment or transition cutting-embankment) facing the abstraction. However, where appropriate, the vulnerability of groundwater flow to sub-surface disruptions is also considered to refine the magnitude of impact.

13.2.19 The impact significance for groundwater aspects was then determined using the matrix as shown in Table 13.3.

Table 13.8: Sensitivity Criteria for Groundwater

Sensitivity	Definition
High	Local aquifer(s) are a valuable resource because of high quality and yield, or extensive exploitation for public, private domestic and/or agricultural (i.e. feeding ten or more properties) and/or industrial supply. Important sites of nature conservation dependent on groundwater as per sensitivity criteria attributed within Chapter 12 (Ecology and Nature Conservation).
Medium	Local aquifer(s) are of limited value either because of some quality impairment or because exploitation of local groundwater is not extensive (i.e. private domestic and/or agricultural supply feeding less than 10 properties). Local areas of nature conservation known to be sensitive to groundwater impacts as per sensitivity criteria attributed within Chapter 12 (Ecology and Nature Conservation).
Low	Poor groundwater quality and/or low permeability make exploitation of groundwater unlikely. Minor areas of nature conservation with a degree of groundwater dependency as per sensitivity criteria attributed within Chapter 12 (Ecology and Nature Conservation).
Negligible	Very poor groundwater quality and/or very low permeability make exploitation of groundwater unfeasible. No known past or existing exploitation of this water body. Changes to groundwater are irrelevant to local ecology.

Table 13.9: Magnitude Criteria for Groundwater

Magnitude	Definition
High	Major permanent or long-term change to groundwater quality or available yield. Existing resource use is irreparably impacted upon. Changes to quality or water table level would have an impact upon local ecology.
Medium	Changes to the local groundwater regime are predicted to have a slight impact on resource use. Minor impacts on local ecology may result.
Low	Changes to groundwater quality, levels or yields do not represent a risk to existing resource use or ecology.
Negligible	Very slight change from groundwater baseline conditions approximating to a 'no change' situation.

Limitations to Assessment

13.2.20 The exact abstraction locations of PWS are not currently known. Figures 13.1 to 13.2, however, show indicative locations based on OS map and consultation with The Highland Council. Detailed

consultation with landowners in relation to PWS has not yet taken place and, therefore, all PWS may not have been identified at this stage.

13.2.21 There is some apparently anomalous information in the 2008 GI data set reviewed (Soil Mechanics 2008). This relates to confusion over the location of one groundwater monitoring installation, and unusual and unexplained groundwater levels recorded in a second monitoring installation. However, the majority of this GI data appears reliable and these anomalies do not represent a serious limitation to the assessment at this stage.

13.2.22 This assessment relies on the accuracy and level of detail of documented sources used. For example, the identification of potential contamination sources relies on the accuracy of historical mapping and the information available through GI.

13.2.23 Groundwater dewatering effects, if unmitigated, have the potential to generate differential ground settlement. Potential for ground settlement is not considered at DMRB Stage 2, but may form part of the DMRB Stage 3 assessment once further GI and engineering detail is available.

13.2.24 Historical quarrying is based on a desk-based review of OS maps. It is possible that quarrying works could have been undertaken and the void backfilled between the recorded years of mapping.

13.2.25 The above limitations are typical of a DMRB Stage 2 assessment, and the assessment reported in this chapter is considered of an appropriate level of detail, in line with the DMRB guidance. Further detailed work should be undertaken at DMRB Stage 3 to inform the design of the preferred route option.

13.3 Policies and Plans

13.3.1 Part 6 (Appendices), Appendix A8.1 (Planning Policy Context for Environmental Assessment) describes the planning policies and guidance from national to local level which are relevant to Geology and Soils. An assessment of the compliance of the route options against all development plan policies relevant to this environmental topic is reported in Part 6 (Appendices), Appendix A8.2 (Assessment of Development Plan Policy Compliance) and a summary overview is provided in Chapter 8 (Policies and Plans).

13.4 Baseline Conditions

Geology

Solid Geology

13.4.1 Bedrock geology within the study area is comprised primarily of the Hillhead Sandstone Formation, which is described as a red and grey, planar-bedded, quartzose, sandstone with interbeds of micaceous siltstone and silty mudstone (BGS website 2016). The southern portion of the study area is underlain by the Inshes Flagstone Formation, which is comprised of flaggy sandstones with rare grey calcareous mudstones and limestones.

13.4.2 Information from a GI across the study area undertaken in 2008 (Soil Mechanics 2008 and Scott Wilson 2009) was reviewed. The majority of the boreholes were between 10m and 15m in depth and terminated in superficial deposits. However, two boreholes in the centre of the study area recorded sandstone bedrock at between 5m and 11m depth, two boreholes in the north of the study area recorded sandstone bedrock at between 21m and 29m depth and, at the southern end of the study area, boreholes up to around 15m in depth did not record bedrock.

13.4.3 As per definitions in Table 13.1, bedrock present within the study area is considered to be of negligible sensitivity.

Drift Geology

13.4.4 Drift deposits within the study area include: made ground; alluvium; a variety of Flandrian and late Devensian raised marine deposits; and late Devensian glacial deposits.

13.4.5 Made ground is expected to be locally derived and generally limited to areas of existing road or railway embankment. As per the definitions in Table 13.1, made ground is considered to be of negligible sensitivity.

13.4.6 Alluvial deposits within the study area are generally located underlying the flood plains of existing burns. They are normally comprised of soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. As per the definitions in Table 13.1, alluvial deposits are considered to be of negligible sensitivity.

13.4.7 Raised marine deposits are located in the north of the study area, approximately along the line of the A96 Aberdeen to Inverness Trunk Road, and are comprised of a mixture of gravel and sand, which is commonly silty. Gravel is typically cobble grade and poorly sorted, while sand is mainly medium-grained. As per definitions in Table 13.1, these deposits are considered to be of negligible sensitivity.

13.4.8 Late Devensian raised tidal flats are described as silt, clay and fine-grained sand with lenses of gravel, and are located north of Smithton, in the eastern portion of the study area. As per definitions in Table 13.1, these deposits are considered to be of negligible sensitivity.

13.4.9 Tidal flats are normally composed of a consolidated soft silty clay, with layers of sand, gravel and peat. They are located in the north of the study area adjacent to the Moray Firth. As per definitions in Table 13.1, these deposits are considered to be of negligible sensitivity.

13.4.10 Glacial deposits within the study area include glaciofluvial sheet deposits, glaciomarine silts, hummocky glacial deposits and till.

13.4.11 Based on the 2008 phase of GI, the superficial deposits recorded were similar across the study area and were predominantly sands and gravels, clayey in places. Occasional clay layers between 1m and 5m thick were recorded, with more clay deposits encountered at the northern end of the study area. These superficial deposits are likely to be glaciofluvial and raised marine deposits in origin and are expected to be highly permeable.

13.4.12 As per definitions in Table 13.1, these deposits are considered to be of negligible sensitivity.

Mineral Extraction

13.4.13 There are no records of historic or current coal mining activity within the study area.

13.4.14 Although quarrying, sand and gravel extraction is common in the region, no current or historical activity has been identified within the study area.

Contaminated Land

13.4.15 There are 27 current and 4 historical potentially contaminated land sources or activities identified within the study area. Fifteen of these are subject to current licencing by SEPA. Details of the identified contamination sources are provided in Table 13.10 and locations shown on Figures 13.1 and 13.2.

Table 13.10: Potentially Contaminated Land Sources

ID	Land Use	Source of Information	Dates Present	Location (distance from route)	Comments
GC01	Canstore, Homebase	The Highland Council	Current	Inverness Retail Park	Potential land contamination associated with contemporary land use. Information from The Highland Council (ref IN-GAR-1272). Data retrieved from Trading Standards File I314.
GC02	Filling Station, Tesco	The Highland Council / SEPA	Current	West of Smithton	Information from The Highland Council (ref IN-GAR-1250). Data retrieved from Trading Standards File I300. PPC/B/1003178
GC03	Aberdeen to Inverness Railway Line	OS maps	1855 - present	North-west of Smithton, north end of study area	Made Ground associated with the Aberdeen to Inverness Railway Line, which runs parallel to the A96 A96 Aberdeen to Inverness Trunk Road at the northern end of the study area. It is known to have opened in 1855 and is in current use.
GC04	Highland Railway Line	OS maps	1906 - present	Crosses route at Cradlehall	Made Ground associated with the Highland Railway Line which crosses the middle of the route at Cradlehall.
GC05	Inverness to Lossiemouth Fuel Pipeline	A96 DMRB Stage 2 assessment (Jacobs 2014)	Current	North-west of Smithton, north end of study area	Pipeline which runs along the A96 Aberdeen to Inverness Trunk Road at the northern end of the study area.
GC06	Stratton Farm Petrol Tank	The Highland Council	Current	North-west of Smithton	Information from The Highland Council (ref IN-GAR-1065). Data retrieved from Trading Standards File BP331.
GC07	Smithton Junction – Made Ground	A96 DMRB Stage 2 assessment (Jacobs 2014)	1971 – present	North-west of Smithton	Made Ground located to the south-east of Smithton Junction roundabout
GC08	Existing A9 Inverness to Perth Trunk Road	OS maps	1981 - present	Crosses route at Inshes	Made Ground associated with the A9 Inverness to Perth Trunk Road.
GC09	Existing A96 Aberdeen to Inverness Trunk Road	OS maps	1971 – present	Crosses route at Smithton Junction	Made Ground associated with the A96 Aberdeen to Inverness Trunk Road.
GC10	Thrashing Mill	OS maps	1874 - 1880	North-west of Smithton	Potential land contamination associated with historical land use.
GC11	Smithy	OS maps	1874 - 1907	Inshes	Potential land contamination associated with historical land use.
GC12	Filling Station, Tesco	A96 DMRB Stage 2 assessment	Current	Inshes Retail Park	Potential land/groundwater contamination (CAR Licence - PPC - ID:33)

ID	Land Use	Source of Information	Dates Present	Location (distance from route)	Comments
		(Jacobs 2014)/ SEPA			PPC/N/0060058 Information from The Highland Council (ref IN-GAR-1245). Data retrieved from Trading Standards File I254.
GC13	Inshes Sewage Treatment Plant	A96 DMRB Stage 2 assessment (Jacobs 2014)	Current	Inshes	Potential land/groundwater contamination.
GC14	Sewage Treatment Effluent (STE) discharge	SEPA	Current	Castlehill House, Inshes, Inverness	STE to land, potential land/groundwater contamination CAR/R/1115826
GC15	Pollution Prevention and Control	SEPA	Current	Beechwood Park, Inverness	Lifescan, Inverness Medical Ltd No further details available. PPC/B/1003237
GC16	Dry Cleaners	SEPA	Current	Tesco, Inshes Retail Park, Inverness	Johnsons Dry Cleaners (licence details unknown) Potential land/groundwater contamination associated with use/storage of chemicals PPC/B/1012904
GC17	Pollution Control	SEPA	Current	Ashton Farm, Inverness	JA Munor & Sons, GWR-BH1 No further details available CAR/R/1007680
GC18	STE discharge	SEPA	Current	1, 2 & 3 West Park, Inshes, Inverness	STE to land, potential land/groundwater contamination CAR/R/1086267
GC19	STEdischarge	SEPA	Current	Inshbeag, Inshes, Inverness	STE to soakaway, potential groundwater contamination CAR/R/1080504
GC20	STEdischarge	SEPA	Current	2 Dell of Inshes, Inshes, Inverness	STE to Land, Inshes, Inverness CAR/R/1126570
GC21	STEdischarge	SEPA	Current	Ardachy, Dell of Inshes, Inverness	Plot SW of Ardachy, Dell of Inshes, STE to soakaway CAR/R/1032782
GC22	STEdischarge	SEPA	Current	The Brambles, Stratton, Inverness	STE to soakaway, Stratton, Inverness CAR/R/1065258
GC23	Waste Management	SEPA	Current	Culloden Road, Inverness	Inverness Campus No further details available WML/XC/1109174
GC24	Waste Management	SEPA	Current	Stratton Farm, Inverness	Stratton Farm, Inverness No further details available WMX/N/0036120
GC25	Waste Management	SEPA	Current	Benview Pet Cemetery, Inverness	Benview Pet Cemetary Potential land/groundwater contamination WML/N/0050004
GC26	Radioactive Substances Act	SEPA	Current	Raigmore Hospital, Inverness	Raigmore Hospital Potential contamination associated with use/storage

ID	Land Use	Source of Information	Dates Present	Location (distance from route)	Comments
					of radioactive materials RSA/A/1029537 RSA/R/1029538
GC27	Works / Depot	The Highland Council	1962 - 1992	Inshes Retail Park	Information from The Highland Council (ref IN-TRN-1030).
GC28	Fuel Tank	The Highland Council	Current	Police HQ, Perth Road, Inverness	Information from The Highland Council (ref IN-GAR-1186). Data retrieved from Trading Standards File I169.
GC29	Sheep Wash	The Highland Council	1964 - 1984	South-east of Inverness College	Information from The Highland Council (ref IN-SHP-1017).

Hydrogeology

13.4.16 BGS hydrogeological maps indicate that the study area is underlain by the Middle Old Red Sandstone, a moderately productive aquifer comprised of fine to medium grained sandstones, in places flaggy, with siltstones, mudstones, conglomerates and interbedded lavas. Locally it yields small amounts of groundwater and is represented in this region by the Hillhead Sandstone Formation and the Inshes Flagstone Formation. Nearer the coast, the study area is underlain by Quaternary sands and gravels of glaciofluvial origin, which form terraced and gently sloping and moundy terrain. Groundwater potential is dependent on the thickness of the saturated deposits but can yield up to 10-15 l/s.

13.4.17 SEPA characterises the bedrock aquifer as the 'Inverness aquifer' and classifies it as having an overall status of Good (2013 assessment) with no trend in pollutants.

13.4.18 SEPA characterises the superficial deposits (with the exception of the glacial till) as the 'Inverness and Ardersier Coastal aquifer', which has also been classified Good overall status (2013 assessment) with no trend in pollutants.

13.4.19 Groundwater flow within the superficial deposits is likely to follow surface topography towards the local surface watercourses. The direction of flow of any bedrock groundwater is unconfirmed, but is expected to be generally to the north-west, towards the coast.

13.4.20 The hydrogeological characteristics of superficial and bedrock units are summarised in Table 13.11.

Table 13.11: Hydrogeological characteristics of superficial and bedrock units

Geological Unit		Geological Characteristic	Hydrogeological Characteristic	Sensitivity
Superficial	Made Ground	Composed of clay, sand and gravel (predominantly engineered fill).	Very poor groundwater potential due to surface/close surface location and possible low permeable nature.	Low
	Alluvial Deposits	Composed of variable sediments including clay, silt, sand, gravel and peat.	Local groundwater potential. Groundwater system is expected to be hydraulically connected to surface water.	Medium
	Raised Tidal Flat Deposits	Silt, clay and fine–grained sand with lenses of gravel.	Local groundwater potential.	Medium
	Raised Marine (Including Ardersier Silts Formation)	Glaciomarine sand and gravel.	Local groundwater potential.	Medium
	Glaciofluvial Sheet Deposits	Sands and gravel, with local lenses of silt	Local groundwater potential.	Medium
	Glacial Deposits (Till)	Heterogeneous deposits.	Poor groundwater potential due to generally low and variable permeable nature.	Low
	Hummocky Glacial Deposits	Complex deposits composed of rock debris, clayey till and poorly to well-stratified sand and gravel.	Poor groundwater potential due to generally low and variable permeable nature.	Low
Bedrock	Middle Old Red Sandstone (Inshes Flagstone Formation and Hillhead Sandstone Formation)	Principally sandstone and mudstones with notable successions of conglomerates, shales and siltstones but also igneous intrusions.	Moderate groundwater potential.	High

Groundwater Flow

13.4.21 Very few water strikes were recorded during drilling (Soil Mechanics 2008), but frequent standing water levels were measured, both during drilling and prior to drilling at the start of the day. These indicate potential groundwater levels around 1.5m to 4m below ground level across the study area, with some indication of increasing depths towards the north.

13.4.22 A period of daily groundwater level monitoring was carried out in 5 boreholes with monitoring installations in the superficial deposits between August and December 2008. Three were located in the south, one in the centre and one in the north of the study area. The available monitoring data indicates groundwater levels generally ranging between 0.3m and 2.9m below ground level during this period, with a range of level variation of around 0.5m across the period.

Groundwater Abstractions

13.4.23 Two licenced groundwater abstractions, one known PWS and two further potential PWSs have been identified within the study area. These are shown on Figures 13.1 and 13.2 and are summarised in Table 13.12. As it is unclear at this stage what the status of these supplies are all PWS have been provisionally assessed to be of medium sensitivity, as per definitions shown in Table 13.8.

Table 13.12: Groundwater abstractions

ID	Type	Source of Information	Location (distance from route)	Comments
GA01	Licenced groundwater abstraction	SEPA	Raigmore Hospital, Inverness (<500m)	CAR/S/1116312
GA02	Licenced groundwater abstraction	SEPA	Gleneircht, West of Culloden / North of Smithton (<850m)	Identified as a Registration, assumed to be an abstraction 10-50 m^3/day CAR/R/1141869
GA03	PWS	Consultation	South of Inshes / south-east end of study area (<250m)	No further details available
GA04	Wells and Springs	OS maps	Stratton (<500m)	Spring (SP01), no further details available. Unknown if in use
GA05	Wells and Springs	OS maps	West of Raigmore Hospital, Inverness (<850m)	King Duncan's Well (historical) Unknown if in use

Groundwater Quality

13.4.24 Baseline Scotland: groundwater chemistry of the Old Red Sandstone aquifers of the Moray Firth area (BGS, 2010) describes the groundwater in the Old Red Sandstone as generally moderately mineralised, with calcium as a dominant cation, bicarbonate as a dominant anion and with samples taken suggesting nitrate concentrations ranging from 0.05 mg/l to 8 mg/l. The study area lies within a groundwater Drinking Water Protected Area (DWPA) (all groundwater bodies in Scotland have protected designation). The study area does not lie within a surface water DWPA or a Nitrate Vulnerable Zone (NVZ).

Ecological Receptors with Potential Groundwater Component

13.4.25 No ecological receptors with potential groundwater component have been identified within the study area.

Surface Water Features

13.4.26 A number of surface water features are present within the study area. These are detailed in Chapter 14 (Road Drainage and the Water Environment) of this report and are shown on Figures 14.1 to 14.3. The same sensitivity criteria attributed for quality and flow parameters within Chapter 14 (Road Drainage and the Water Environment) have been used in this chapter.

13.5 Impact Assessment

Potential Impacts - Construction and Operation

13.5.1 To aid comparative assessment, this section presents the impacts considered to be common to all route options under consideration for the proposed Scheme, followed by those that are specific to each of the route options.

13.5.2 The potential impacts are assessed prior to the implementation of mitigation. Potential mitigation is then identified and described in Section 13.6 (Potential Mitigation).

13.5.3 Construction and operational phases have been considered together as the majority of construction impacts (such as removal of excavated material or dewatering due to road cuttings) would extend throughout the operational phase. Where differences in impacts are predicted between the construction and operational phases, these impacts have been assessed for each phase in turn.

13.5.4 There are a variety of ways in which road development schemes can impact on geological resources, as follows:

- excavating or masking exposures of bedrock or drift geological deposits of specific scientific interest if the features of interest are not reproduced elsewhere in the area;
- constraint/limitation to existing or potential commercial exploitation of resources;
- effects on underlying groundwater aquifers, for example, through the dewatering of aquifers as a result of construction works involving excavation;
- risk of spillage or leakage of fuel or oil from storage tanks or construction plant, which, without suitable mitigation measures, can enter aquifers;
- effects of changes to groundwater flow or quality on secondary receptors, such as groundwater abstractions, surface water or GWDTEs; and
- surface water runoff from the operational carriageway may contain elevated concentrations of pollutants, such as oils, suspended solids, metals (e.g. copper and zinc) and, in winter, salt and antifreeze agents (e.g. ethylene glycol), leading to pollution of the aquifers.

Impacts Common to All Route Options

13.5.5 A key aspect of the impact assessment is to identify areas of temporary or permanent excavations. Information on proposed excavated areas is provided in Table 13.13 and shown on Figures 13.1 to 13.2 (Proposed Cuttings). It should be noted that only cuttings deeper than 1m are included.

Table 13.13: Cutting Depths Common to all Route Options

Name	Approximate Chainage	Approx Maximum Excavation Depth (mbgl)	Likelihood to Intercept Bedrock	Likelihood to Intercept Groundwater
Cutting 1	Section B3–B2, ch100 to ch240	2.1	Low	Possibly
Cutting 7	Lane Gain / Lain Drop ch300 to ch500	6.5	Low	Likely
Cutting 8	Lane Gain / Lane Drop ch600 to ch840	5.45	Low	Likely

Geology

Bedrock Geology

13.5.6 Because of the widespread presence of these bedrock deposits elsewhere in the region and country the potential percentage loss is minimal and any impact on these deposits is expected to be of negligible magnitude. This therefore results in an overall impact of Negligible significance during both construction and operation phases.

Drift Geology

13.5.7 Soil and Drift deposits within the study area are likely to be affected by the proposed cuttings and other earthworks during construction of the route options. The reduction in the extent of soil and drift deposits, including made ground, as a result of these construction activities is considered to be of low magnitude because of the widespread presence of these deposits elsewhere in the region and in the country. Potential excavation of peat cannot be ruled out at this stage but would be expected to be localised and minimal, also generating a low magnitude of impact. This results in a potential impact of Negligible significance during both construction and operation phases.

Contaminated Land

13.5.8 A number of potential pollution sources, migration pathways and potential receptors that may be at risk as a result of the route options have been identified. Potential risks have been assessed where complete pollutant linkages have been identified between contamination sources and receptors. There are two ways in which construction of the route options could impact contaminated land:

- direct disturbance of potentially contaminated land sites as a result of construction of the route options (i.e. sources are within the route options footprint); and
- indirect disturbance of potentially contaminated land sites as a result of construction of the route options (i.e. potential pathways which exist within the route options footprint).

Construction Phase – Direct Disturbance

13.5.9 Direct disturbance with two potentially contaminated land sites has the potential to impact human and water receptors as summarised in Table 13.14.

Table 13.14: Construction – Potential Direct Contaminated Land Impacts On or Adjacent to All Route Options

Source Ref	Source Name	Pollutant Pathway (PP)	Magnitude	Likelihood	Significance
GC04	Highland Railway Line	PP1 and PP3	Mild	Likely	Moderate / Low
GC08	Existing A9 Inverness to Perth Trunk Road	PP1 and PP3	Mild	Likely	Moderate / Low

Construction Phase – Indirect Disturbance

13.5.10 Indirect disturbance may occur where proposed cuttings intercept groundwater, as they can draw contaminated groundwater towards the cutting.

13.5.11 Three cuttings (Cutting 1, 7 and 8) common to all options have been identified as having the potential to intercept groundwater. Two of the proposed cuttings have the potential to intercept groundwater from the existing A9 Inverness to Perth Trunk Road (GC08). This is expected to result in a mild magnitude of impact and a Moderate/Low significance of impact.

9.1.1 Construction personnel could be at risk, through pathway PP1, of direct contact with contaminated groundwater. The potential of this event occurring has been assessed as being likely with an impact magnitude of medium, resulting in a potential impact of **Moderate** significance.

Operational Phase – Direct Disturbance

13.5.12 The same potentially contaminated land sources have the potential to generate an impact during the operational phase, but with a reduced likelihood, with the exception of where made ground has potentially been re-used on-site, as summarised in Table 13.15.

Table 13.15: Operation – Potential Indirect Contaminated Land Sources Impacts on Water Receptors Common to All Route Options

Source Ref	Source Name	Pollutant Pathway (PP)	Magnitude	Likelihood	Significance
GC04	Highland Railway Line	PP12 and PP14	Mild	Low	Low
GC08	Existing A9 Inverness to Perth Trunk Road	PP12 and PP14	Mild	Low	Low
n/a	Made Ground re-used along the route	PP16 to PP20	Medium	Likely	Moderate

Operational Phase – Indirect Disturbance

13.5.13 Groundwater intercepted by proposed cuttings will need to be drained and discharged (PP21). As during the construction phase, any groundwater contamination originating from GC08 has the potential to impact on the receiving water environment, but with a reduced likelihood due to lower rates of discharge. Potential impact significance is therefore proportional to but one level lower than during construction, i.e. Low significance.

13.5.14 Maintenance personnel could be at risk of having direct contact with contaminated groundwater, through pathway PP12. The potential of this event occurring has been assessed as being of low likelihood with an impact magnitude of medium, resulting in potential impact of **Moderate/Low** significance.

Groundwater

Groundwater Quality

13.5.15 In the event of accidental spillage during the construction or operational phases, potential contamination may migrate from the ground surface through the unsaturated zone, reaching the underlying aquifers and impairing groundwater quality, unless appropriate measures for control of discharge and drainage are in place.

13.5.16 The potential magnitude of impact from accidental spillages for all route options is considered to be medium for drift groundwater and low for bedrock groundwater, based on potential for attenuation and dilution of contamination before it reaches bedrock groundwater. The potential impact assessment from accidental spillages on these aquifers is provided in Table 13.16. Hydrogeological units are groupings of geological units with similar hydrogeological characteristics, as summarised in Table 13.16.

Table 13.16: Potential Impact of Accidental Spillages on Key Hydrogeological Units during both Construction and Operation Phases

Hydrogeological Unit	Sensitivity	Magnitude	Significance
Drift Aquifers – Alluvium, Raised Tidal Flat Deposits, Raised Marine Deposits, Glaciofluvial Sheet Deposits	Medium	Medium	Moderate
Drift Aquifers – Made Ground, Glacial Till, Hummocky Glacial Deposits	Low	Medium	Slight / Moderate
Bedrock – Middle Old Red Sandstone	High	Low	Moderate

13.5.17 Potential impacts of accidental spillages on surface water features are discussed in Chapter 14 (Road Drainage and the Water Environment).

Groundwater Flow

13.5.18 As shown in Table 13.13, three proposed cuttings common to all options have the potential to intercept groundwater within the drift deposits. This is expected to create a much localised dewatering effect within the drift deposits, which have a hydrogeological sensitivity ranging from

low to medium at these locations. The impact magnitude is assessed as low, resulting in a potential impact ranging from Slight to Slight/Moderate significance during both construction and operation phases.

13.5.19 The construction of embankments may result in localised compaction of drift deposits, which could affect local groundwater flow. This would result in localised impacts of negligible magnitude for groundwater within the drift deposits resulting in potential impacts ranging from Negligible to Negligible/Slight during both construction and operation phases.

13.5.20 No impact is expected on bedrock groundwater as a result of the cuttings and embankments common to all options, resulting in a Negligible significance of impact.

Abstractions

13.5.21 No abstractions have been identified in close vicinity to the route options.

Groundwater Effects on Surface Water

13.5.22 Potential surface water impairment or a reduction in baseflow contribution as a result of changes to the groundwater environment, have been assessed based on the proximity of surface water features to areas where impacts on the groundwater environment may potentially occur.

13.5.23 Scretan Burn (SWF 03) is located in the vicinity of Cutting 1 and Cutting 8. Scretan Burn (SWF 03) is expected to be relatively sensitive to baseflow reductions due to its small size. The degree of impact on this surface water feature is conservatively assessed to be medium, to reflect a potential reduction of surface water flow. This results in an overall significance of impact of slight/moderate.

Ecological Receptors with a Potential Groundwater Component

13.5.24 No ecological receptors with potential groundwater component have been identified within the study area.

Additional Impacts for Option 1A

13.5.25 Additional impacts for Option 1A relate to two additional cuttings as summarised in Table 13.17 and shown on Figures 13.1.

Table 13.17: Cutting Depths for Option 1A

Name	Approximate Chainage	Approximate maximum Excavation Depth (mbgl)	Likelihood to Intercept Bedrock	Likelihood to Intercept Groundwater
Cutting 2	Section B4-B5, ch300 to ch440	1.0	Low	Low
Cutting 3	Section B4-B5, ch1000	5.6	Low	Likely

Geology

13.5.26 No additional impacts on geology are anticipated for Option 1A.

Contaminated Land

Direct Disturbance

13.5.27 Additional direct disturbance of potentially contaminated land for Option 1A is summarised in Table 13.18 for both construction and operational phases.

Table 13.18: Potential Direct Contaminated Land Impacts for Option 1A

Source Ref	Source Name	Pollutant Pathway (PP)	Magnitude	Likelihood	Significance
GC20	STE discharge	PP1 and PP3	Medium	Likely	Moderate
GC21	STE discharge	PP1 and PP3	Medium	Likely	Moderate
GC20	STE discharge	PP12 and PP14	Medium	Low	Moderate / Low
GC21	STE discharge	PP12 and PP14	Medium	Low	Moderate / Low

Indirect Disturbance

13.5.28 No additional indirect contaminated land impacts for Option 1A are anticipated.

Groundwater

Groundwater flow and associated groundwater receptors

13.5.29 As shown in Table 13.17, one additional cutting has the potential to intercept groundwater specifically for Option 1A. This is expected to create a local dewatering effect within the drift deposits (low to medium sensitivity) around this location, with an impact magnitude of medium. This results in an overall potential impact of Slight/Moderate to Moderate significance during both construction and operation phases.

13.5.30 Bedrock groundwater is not anticipated to be intercepted by cuttings for Option 1A.

13.5.31 The impact assessment (both construction and operation phases) for groundwater related receptors affected by Option 1A is shown in Table 13.19.

Table 13.19: Additional Potential Impacts on Groundwater Related Receptors for Option 1A

Receptor	Nearest Cutting/Widening	Sensitivity	Potential Impact Magnitude	Impact Significance
Abstractions				
none	n/a	n/a	n/a	n/a
Ecological receptors with potential groundwater component				
none	n/a	n/a	n/a	n/a
Groundwater effects on surface water				
Stream, Tributary to Cairnlaw Burn	Section B4-B5, ch300 to ch440	Medium	Medium	Moderate

Additional Impacts for Option 1B

13.5.32 Additional impacts for Option 1B relate to two additional cuttings as summarised in Table 13.20 and shown on Figures 13.2.

Table 13.20: Cutting Depths for Option 1B

Name	Approximate Chainage	Approximate maximum Excavation Depth (mbgl)	Likelihood to Intercept Bedrock	Likelihood to Intercept Groundwater
Cutting 4	Section B4-B5, ch340 to ch520	1.7	Low	Low
Cutting 5	Section B4-B5, ch1060 to ch1100	1.1	Low	Low

Geology and Groundwater

13.5.33 No additional impacts on geology and groundwater are anticipated for Option 1B.

Contaminated Land

Direct Disturbance

13.5.34 Additional direct disturbance of potentially contaminated land for Option 1B is summarised in Table 13.21 for both construction and operational phases.

Table 13.21: Potential Direct Contaminated Land Impacts for Option 1B

Source Ref	Source Name	Pollutant Pathway (PP)	Magnitude	Likelihood	Significance
GC20	STEdischarge	PP1 and PP3	Medium	Likely	Moderate
GC21	STEdischarge	PP1 and PP3	Medium	Likely	Moderate
GC20	STEdischarge	PP12 and PP14	Medium	Low	Moderate / Low
GC21	STEdischarge	PP12 and PP14	Medium	Low	Moderate / Low

Indirect Disturbance

13.5.35 No additional indirect contaminated land impacts for Option 1B are anticipated.

Additional Impacts for Option 2A

13.5.36 Impacts for Option 2A relate to two additional cuttings as summarised in Table 13.22 and shown on Figures 13.1.

Table 13.22: Cutting Depths for Option 2A

Name	Approximate Chainage	Approximate maximum Excavation Depth (mbgl)	Likelihood to Intercept Bedrock	Likelihood to Intercept Groundwater
Cutting 2	Section B4–B5, ch320 to ch440	1.1	Low	Low
Cutting 6	Section B4–B5, ch820 to ch940	1.3	Low	Low

13.5.37 Option 2A would have the same potential additional impacts as Option 1A for contaminated land. Table 13.18 and paragraphs 13.5.27 to 13.5.28 provide a description of the potential impacts. There are no additional impacts relating to groundwater.

Additional Impacts for Option 2B

13.5.38 Additional impacts for Option 2B relate to two additional cuttings as summarised in Table 13.23 and shown on Figures 13.1.

Table 13.23: Cutting Depths for Option 2B

Name	Approximate Chainage	Approximate maximum Excavation Depth (mbgl)	Likelihood to Intercept Bedrock	Likelihood to Intercept Groundwater
Cutting 4	Section B4–B5, ch340 to ch520	1.7	Low	Low
Cutting 5	Section B4–B5, ch1060 to ch1100	1.1	Low	Low

13.5.39 The same additional impacts for Option 2B are expected as for Options 1B.

Additional Impacts for Option 3A

13.5.40 Additional impacts for Option 3A relate to two additional cuttings as summarised in Table 13.24 and shown on Figures 13.1.

Table 13.24: Cutting Depths for Option 3A

Name	Approximate Chainage	Approximate maximum Excavation Depth (mbgl)	Likelihood to Intercept Bedrock	Likelihood to Intercept Groundwater
Cutting 2	Section B4–B5, ch320 to ch440	1.1	Low	Low
Cutting 6	Section B4–B5, ch820 to ch940	1.3	Low	Low

13.5.41 There are no additional impacts on geology, contaminated land and groundwater associated with Option 3A.

Additional Impacts for Option 3B

13.5.42 Additional impacts for Option 3B relate to two additional cuttings as summarised in Table 13.25 and shown on Figures 13.2.

Table 13.25: Cutting Depths for Option 3B

Name	Approximate Chainage	Approximate maximum Excavation Depth (mbgl)	Likelihood to Intercept Bedrock	Likelihood to Intercept Groundwater
Cutting 4	Section B4–B5, ch340 to ch520	1.7	Low	Low
Cutting 5	Section B4–B5, ch1060 to ch1100	1.1	Low	Low

13.5.43 There are no additional impacts on geology, contaminated land and groundwater associated with Option 3B.

13.6 Potential Mitigation

13.6.1 At DMRB Stage 2, the design has not been sufficiently developed to allow mitigation measures to be considered in detail. The objective of this section is to identify potential 'generic' or 'anticipated' mitigation taking into account best practice, legislation and guidance. This potential mitigation is taken into account in the subsequent summary of route options assessment (see below) to provide a basis for comparative assessment and selection of a preferred route option to be taken forward to DMRB Stage 3.

13.6.2 Potential mitigation measures are described below for each sub heading.

Geology

13.6.3 The excavation of peat deposits cannot be ruled out at this stage. Excavation, storage and any off-site removal, if required, should be undertaken with cognisance of 'Development on Peatland: Guidance on the Assessment of Peat Volumes, Reuse of Excavated Peat and the Minimisation of Waste' (Scottish Renewables and SEPA 2012) and should comply with relevant waste management practices under The Waste Management Licensing (Scotland) Regulations 2011 (Scottish Government 2011).

13.6.4 Potential geological impacts for all of the route options are of Negligible significance and therefore mitigation measures are not required.

Contaminated Land

13.6.5 Mitigation measures in relation to contaminated land cannot be defined at this stage in the absence of site specific GI and site surveys. A phase of GI and testing should be undertaken in order to determine the nature of potential contaminated materials present along the route options.

13.6.6 Where significant contamination is confirmed, a risk assessment should be undertaken as part of DMRB Stage 3, and mitigation, if required, specified on a site specific basis. Mitigation measures are likely to include:

- storage of excavated made ground material using bunded facilities and development of re-use criteria;
- removal of contaminated soils from site;
- consolidation for treatment ex-situ; and/or
- treatment in situ (of soil and/or water).

13.6.7 During construction, adequate personal protective equipment (PPE) should be adopted to protect workers from direct interaction with any potentially contaminated soil, contaminated groundwater or asbestos.

13.6.8 Waste management procedures including production and adherence to a Waste Management Plan should be put in place during construction.

Groundwater

Groundwater Quality

13.6.9 Chapter 14 (Road Drainage and the Water Environment), provides details on anticipated mitigation to address potential impacts on surface waters, including adherence to SEPA Pollution Prevention Guidelines (PPGs) during construction and appropriate Sustainable Drainage Systems (SUDS) during operation. In respect of groundwater, these measures would also:

- mitigate against pollution by reducing the potential for pollutant release and preventing any contaminated runoff produced by the works from entering groundwater via the unsaturated zone; and
- protect groundwater receptors against impacts on water quality.

13.6.10 Road drainage aspects of the proposed Scheme (such as filter drains or SUDS basins) may also be lined, depending on the location of these in relation to sensitive groundwater receptors. This would be established during the DMRB Stage 3 assessment.

Groundwater Flow and Associated Groundwater Receptors

13.6.11 A phase of GI should be undertaken in order to obtain additional information on groundwater conditions, especially in cutting areas and where groundwater receptors are present and may be impacted. This additional information will be used to confirm excavation areas expected to intercept groundwater, and confirm the level of impact on associated receptors such as surface water features. It will inform specific mitigation measures where required.

13.6.12 Further consultation with landowners on PWS should take place as part of the DMRB Stage 3 assessment and, if required, site surveys should be undertaken.

13.6.13 This updated assessment and the mitigation measures proposed should be placed within the context and potential requirement of obtaining groundwater abstraction CAR licencing for these activities.

13.7 Summary of Route Options

13.7.1 This section provides a summary of the DMRB Stage 2 assessment of potential impacts for the route options taking into account the anticipated potential mitigation as described in Section 13.6 (Proposed Mitigation).

Geology

13.7.2 The potential impacts in relation to geology are common to all of the route options and include potential impacts of Negligible significance on bedrock and drift deposits.

13.7.3 No potential mitigation measures are expected for geology. Therefore, the level of residual impacts for all route options would be expected to be the same as the potential impacts reported above.

Contaminated Land

13.7.4 Table 13.26 provides a summary of the potential direct and indirect impacts on potential contaminated land sources of Moderate/Low significance in the absence of mitigation.

Table 13.26: Summary of potential impacts on contaminated land

Significance	Direct / Indirect impact	Option					
		1A	1B	2A	2B	3A	3B
Moderate	Direct	2	2	2	2	0	0
	Indirect	1	1	1	1	1	1
Moderate/low	Direct	5	5	5	5	2	2
	Indirect	3	3	3	3	3	3
TOTAL	Direct	7	7	7	7	2	2
	Indirect	4	4	4	4	4	4

13.7.5 Direct interaction may occur between three potentially contaminated land sources for all of the route options. Options 3A and 3B have the fewest potential impacts.

13.7.6 Although the potential impacts associated with contaminated land sources are expected to vary between the route options, the implementation of mitigation measures in relation to contaminated land issues could be expected to reduce residual impacts to a significance of Low or Very Low for all route options. Nevertheless, it should be noted that detailed mitigation appropriate for each route option cannot be determined at this stage.

Groundwater

Groundwater Quality

13.7.7 Potential impacts on groundwater quality are common to all route options and include potential impacts of Moderate significance on Middle Old Red Sandstone and alluvium, raised tidal flat deposits, raised marine deposits and glaciofluvial sheet deposits; and a Slight / Moderate significance on made ground, glacial till and hummocky glacial deposits.

13.7.8 The implementation of appropriate mitigation measures to protect the water environment against pollution incidents has the potential to reduce the residual impacts on groundwater quality to a significance of Slight or below for all aquifers and for all route options.

Groundwater Flow

13.7.9 All route options are expected to have potential impacts of

- Slight/Moderate significance on groundwater flow within superficial aquifers;
- Negligible/Slight to Slight/Moderate significance on drift groundwater;
- Negligible significance on bedrock groundwater.

13.7.10 These are also expected to be Residual Impacts.

Groundwater Abstraction and Ecological Receptors with potential groundwater component

13.7.11 No impact is expected on groundwater abstractions and ecological receptors with potential groundwater component.

Surface water features

13.7.12 All route options are expected to impact indirectly on groundwater baseflow feeding into Scretan Burn (SWF 03) with a significance of Slight / Moderate. In addition, a Moderate significance of impact is expected on the groundwater baseflow feeding into Tream tributary to Cairnlaw Burn (SWF 08) for Options 1A, 1B, 2A and 2B. Further investigations would be required at Stage 3 assessment to confirm the potential level of impact on these surface waters. Should the level of impact remain of significance, options for mitigation measures will be considered.

13.7.13 These are also expected to be Residual Impacts.

Overall summary

13.7.14 It is expected that all of the potential impacts, with the exception of surface water and groundwater flow, can be reduced to Slight significance or below with adequate mitigation. These should be ascertained at DMRB Stage 3.

13.7.15 The variations in impacts between the route options related to geology, contaminated land and groundwater aspects are not considered sufficient to inform identification of a preferred route.

13.8 Scope of DMRB Stage 3 Assessment

13.8.1 In accordance with DMRB Geology and Soils, further assessment of the preferred option should be undertaken to refine the identification of any significant impacts on geology and contaminated land and groundwater.

13.8.2 The Stage 3 assessment for Geology, Soils and Groundwater would be undertaken in accordance with the guidance set out in DMRB Volume 11, Section 3, Part 11 (Highways Agency, Scottish

Executive, Welsh Assembly Government and The Department for Regional Development Northern Ireland 1993) and DMRB Volume 11 Section 3 Part 10 HD 45/09 (Highways Agency, Scottish Executive, Welsh Assembly Government and The Department for Regional Development Northern Ireland 2009) and would include the following:

- Review of the scheduled GI dataset;
- Detailed assessment of dewatering effects in proposed areas of cuttings;
- Further consultation with land owners and potential surveys to identify and mitigate private water supplies potentially at risk;
- Assessment of GWDTE in line with the updated Land Use Planning System SEPA Guidance Note 31 (October 2014) where required; and
- Input into scheme design and identification of mitigation as appropriate.

13.9 References

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