13. GEOLOGY AND SOILS

13.1 Introduction

This section considers the impact the Scheme will have on the soils and geology of the study area, and considers mitigation measures. It considers the solid and drift geology, made ground and ground water.

The aims of the section are to identify:

- Impacts the Scheme may have on significant features and agricultural land;
- Mitigation measures to moderate or negate the impacts of the Scheme; and
- Constraints these features may place on the proposed scheme.

This section has been prepared using existing data; a detailed ground investigation to supplement this data will be undertaken prior to construction.

13.2 Methodology

The significance of an impact depends upon the nature of the impact, its magnitude and duration and the sensitivity or importance of the receptors. The Design Manual for Roads and Bridges Volume 11, Section 3, Part 11 – Geology and Soils, does not prescribe any method for assessing the impact of the Scheme therefore the following criteria have been used.

The sensitivity is scaled on the basis of the relative importance of the receptor as defined in Table 13.1.

Table 13.1: Scale of Importance of Geological Features (continued over)

Importance	*Criteria*	*Examples*
Very High	Attribute with a high quality and rarity, regional or national scale and limited potential for substitution.	Geological Site of Special Scientific Interest. Regionally Important Geological Site (RIGS); or aquifer within the zone of influence of a public water supply borehole; or supplying SSSI.
High	Attribute with a high quality and rarity, local scale and limited potential for substitution.	Other exposed geological feature of major or educational value; or mineral reserve allocated on Local Minerals Plan.
Medium	Attribute with medium quality and rarity, local scale and limited potential for substitution.	Other areas of potential mineral resources.

Importance	Criteria	Examples
Low	Attribute with a low quality and rarity, local scale and limited potential for substitution.	Other areas of superficial geology or geomorphological feature.
Negligible	Attribute with negligible quality and rarity, local scale and limited potential for substitution	

The magnitude of impact is defined wherever possible as shown in Table 13.2.

Table 13.2: Magnitude of Impact

Scale of Impact	Example
Severe	Loss of exposed geological features.
Moderate	Quarrying of rock for imported fill, or substantial changes due to cuttings.
Slight	Superficial disturbance to geology; changes in geomorphology due to river diversion works.
Negligible	Changes to made ground deposits.

To assess the significance of the impact on the geology and soils, the sensitivity and importance values are combined in a matrix table as shown in Table 13.3.

Table 13.3: Significance Matrix

Magnitude of Effect	Sensitivity of Receptor				
	Very High	*High*	*Medium*	*Low*	*Negligible*
Severe	Substantial	Substantial	Moderate	Minor	Negligible
Moderate	Moderate	Moderate	Minor	Minor	Negligible
Slight	Moderate	Minor	Minor	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

13.3 Consultations

Consultations for the ES have been carried out and responses relevant to this section are summarised in Table 13.4. In addition to these, the results of other

consultations have also been included where appropriate. The consultations were carried out with statutory and non-statutory authorities.

Table 13.4: Summary of Consultations

Consultee	Consultee Comment
South Ayrshire Council	Details of previous ground investigations provided.
Health and Safety Executive	No comments relating to this section.
Scottish Environment Protection Agency	One record of an old council run landfill site at Helenton Mains. No groundwater abstraction records. From previous SEPA-SAC correspondence SEPA raised concerns over pollution of watercourses. SUDS must be included in the Scheme.
Historic Scotland	Symington Main Street is a conservation area.
Transport Scotland	Good practice to be adopted during site works and excavation of soils and minerals.
Scottish Executive Environment and Rural Affairs Department	The land is all classed as Non Less Favoured Area and graded 3(1) and 3(2) under the Land Capability for Agriculture Scotland. Whilst there will be minimal impact on the agricultural interest of the area care should be taken to mitigate impacts on individual farms and maintain the productivity of the land.
Scottish Natural Heritage	No comments relating to this section. Bats in trees to be considered during works.
The Coal Authority	The current scheme would have no impact on the future extraction of fireclay. Their report mentions a worked seam of coal at 120m bgl (below ground level) but states that ground movements should now have ceased. No further mining concerns.
Mineral Valuer	Underground mining subsidence is a risk and, prior to any development, precautions should be taken to reduce the risk.

13.4 Baseline

The baseline information was obtained from the following:

- British Geological Survey (BGS)
- Existing Geological Survey Mapping
- Existing Hydrogeological Mapping

This chapter has drawn on numerous other sources of information, which have not been listed here.

There are no specific geological features that are of statutory designated importance along the route of the Scheme.

13.4.1 Geomorphology

The existing A77 dual carriageway is generally straight and climbs gently northwards from the Dutch House roundabout to a plateau at Symington before descending towards Spittalhill. At Symington the road reaches 90m AOD (Above Ordnance Datum) and drops to 39m AOD at Dutch House roundabout to the south and 82m AOD at Spittalhill to the north. The road is generally at-grade with minor embankments and cuttings at Symington and Spittalhill respectively.

Under the current Scheme proposals, the topography of the road will only be affected locally. At Symington and Bogend Toll the proposed grade-separated junctions will introduce embankments and bridges but elsewhere the proposed link roads and re-alignments are expected to involve only at-grade works. The existing A77 will remain unchanged with the exception of new diverge and merge tapers at Symington.

The main topographical features of the study area are the existing A77 and various residential areas along its route. There are also two watercourses in the vicinity, the Pow Burn and Dow's Burn.

The Pow Burn, at its nearest point, runs approximately 250m to the east of the A77. Dow's Burn runs southwestward in the vicinity of Brocket and Dutch House roundabout and is culverted beneath the A77 at Brocket.

At Bogend Toll the land is generally flat with the A77 in a minor cutting. At Symington the A77 is on a minor embankment. The link roads associated with the grade-separated junctions will generally cross flat or only slightly undulating land.

13.4.2 Agricultural Soils

The agricultural land of the study area is classified by the Macaulay Institute Land Capability for Agriculture Survey as Class 3(1) and 3(2).

13.4.3 Made Ground

Made ground has been found across the study area to depths of 1.1m bgl. The deposits are associated with the existing A77 and both current and former developments.

13.4.4 Superficial

Geological Survey of Scotland drift geology maps were consulted. The drift geology under the entire site is Glacial Till. Occasional drumlins are present to the east and west of the carriageway along the route.

The BGS report agrees that the superficial deposits at site are expected to consist mostly of Glacial Till. It also reports a thin spread of alluvium of soft clays, peat, sands and gravels overlying the glacial till in places.

Previous ground investigations corroborate these reports, encountering Glacial Till/Boulder Clay across the site. The upper one or two metres of the Glacial Till is expected to be weathered and softer than the remainder of the deposit.

13.4.5 Solid Geology

Geological Survey of Scotland solid geology maps were consulted. The site is underlain by a variety of coal measures and basalts. Basalt lavas of the Millstone Grit age underlie the northern section of the route to Whitelees. Southwards and to Hansel Village the geology changes to Productive Coal Measures of the Carboniferous, Westphalian age. At Hansel Village there is a ribbon of Dalmeny basalt, an igneous intrusion. This is succeeded by Barren Red Coal Measures, comprising red sandstones and marls, which then underlie the site to its southern extent.

The Inchgotrick fault runs northeast - southwest to the north of the study area. Within the study area a fault is shown crossing the route at Whitelees, running northwest – southeast. BGS states that a number of faults pass across the site in the coal measures strata.

Previous studies have found that rock is at or near surface at Whitelees, Jeanfield and south east of Symington. BGS reports that the depth to bedrock is not generally expected to exceed 5 metres but could range from 2m bgl to 10m bgl.

Of the coal measures identified as underlying the site, only the Productive Coal Measure have seams that may have been mined. Previous studies (Ref: Envirocheck report dated 31st August 2006, The Coal Authority Mining report dated 15th August 2006) have concluded that subsidence due to workings would not be anticipated to present a problem due to the seams' depth, thickness and nature.

The Mineral Valuer states that shallow unrecorded workings could be present between Helentongate and Jeanfield (i.e. near Symington) and that it would be inadvisable to carry out development in the area without precautions first being taken to reduce the risk of subsidence. The GeoReport provided by BGS also highlights shallow mining as possible towards the north east of the site.

Ground investigation is proposed to investigate the possible presence of shallow mine workings (see Section 13.6).

13.4.6 Landfill Sites and Contaminated Soils

There are no records of any licensed burial sites in the vicinity of the Scheme.

SEPA reported one record of an old landfill site at Helenton Mains.

Other potential sites of contamination have been identified as the former radio station between Jeanfield and Helentongate and the industrial area just north of Symington Road North. This is believed to have previously been the site of a petrol station. Balbir's Restaurant is also thought to be on the site of an old filling station. Potential contaminated areas will be targeted during the proposed ground investigation to determine the nature and presence, if any, of contaminants.

13.4.7 Landslips

There are no records of any landslips in the area.

13.4.8 Groundwater

The Hydrogeological Map of Scotland shows that the nature of the aquifers underlying the site varies from north to south. To the south, the aquifers, the Coal Measures of Westphalian age, are classified as locally important. The hydrogeological map states that large volumes of water have been pumped from mine workings in this type of rock in the past but boreholes for water supply have not been developed as yields are low and water quality is poor. A band of impermeable rocks with no groundwater potential is then shown to lie beneath the mid section of the route, coinciding with the igneous solid geology. To the north, the aquifers are classified as highly productive with moderate (5 l/s maximum) borehole yields. In both the northern and southern aquifers, the flow is stated as being predominantly through fissures and discontinuities in the rock mass rather than inter-granular.

The Groundwater Vulnerability Map of Scotland classes the ground as weakly and moderately permeable for the majority of the study area. Towards the northern end of the section there is a zone classified as highly permeable. Superficial deposits are indicated to be of substantial thickness and of low permeability.

A water well was sunk at Kerrix Road which is recorded to have pumped 3.5 gallons per minute. The well was in a sand and gravel strata at approximately 12ft bgl. The British Geological Survey website held no other information on aquifers, water wells or water well levels for the study area.

Groundwater is also considered in Chapter 12 – Water Resources.

13.4.9 Planning Year 2009 – No proposal

No change is anticipated.

13.4.10 Future Baseline Conditions 2023 – No proposal

No change is anticipated.

13.5 Environmental Effects

The main aspect of the Scheme is the creation of two grade-separated junctions at Symington and Bogend Toll. This will involve the construction of two bridges over the existing A77 and approach embankments to the bridges.

13.5.1 Effects of Construction

The construction of the Scheme will have an adverse impact on the topography of the area due to the embankment construction and the construction of structures as well as slight excavation of existing ground.

Loss of agricultural soils will result from the construction of the Scheme directly under the permanent works. Recovery of topsoil will be possible if stored correctly. The contractor's working areas, compound and plant movements could lead to further loss or damage to the agricultural soils.

Construction of embankments will lead to varying magnitudes of consolidation with regards to the underlying deposits. As the underlying soil is generally Glacial Till, not likely to settle by a large amount, this is considered a negligible adverse impact.

The footings for the bridges are likely to be founded in the Glacial Till or on the bedrock, which is relatively shallow at Symington. The foundations are likely to be spread footings or piles.

Excavations, for foundations, below the water table will be unstable in areas of drift deposits, which may result in the need for the removal of water by pump at certain locations.

The potential for shallow unrecorded mine workings at the Symington bridge location was highlighted by the Mineral Valuer. If such workings exist, these would have to be grouted before any construction could occur. The grouting operations would aim to fill all voids resulting from the historic workings and provide a competent founding condition for the bridge. In some cases old mine workings contain water. This would be flushed out as part of any grouting works. If required the grouting would have a beneficial effect of the stability of the area, however the impacts during construction would depend on the Contractor's working methods.

It is anticipated that if any contamination is encountered in the made ground it will not be very mobile (due to the anticipated ground conditions) but leachate from contaminated soils may have an adverse effect on the water quality of ground water and surface water.

13.5.2 Effects of Operation

Once the Scheme has been constructed, there will be no discernible operational service effects associated with the geology and soils in the vicinity of the Scheme.

13.5.3 Future Baseline Conditions 2023 – No proposal

No change is anticipated.

13.5.4 Significance of Environment Effect

The significance of the effects relating to geology and soils are based on Table 13.3 and are summarised in Table 13.5. The impact on water quality is separately assessed in Chapter 12 Water Resources.

Table 13.5: Significance of effects

Feature	*Potential Impact / Effect*	*Magnitude of Effect*	*Sensitivity / Importance of Receptor*	*Significance of Impact*
Geomorphology	Change to the landscape	Slight	Low	Negligible
Agricultural Soils	Loss of soils	Slight	Low	Negligible
Drift Deposits	Compaction of	Slight	Low	Negligible

Feature	Potential Impact / Effect	Magnitude of Effect	Sensitivity / Importance of Receptor	Significance of Impact
	superficial geology			
Bedrock	Changes to solid geology	Slight	Negligible	Negligible
Mine workings	Possible grouting of shallow mine workings	Moderate	Low	Minor
Groundwater	Contamination of groundwater	Slight	Medium	Minor

13.6 Mitigation

During construction the Contractor's working practices could have an adverse impact on the agricultural soils, water quality and groundwater. Mitigation measures to be taken during construction cannot be assessed as part of this assessment because they depend on the Contractor's operational constraints and method of working. However the preparation and implementation of an Environmental Method Statement, which the Contractor will produce, will provide the framework to minimise adverse impact on the soils and groundwater and will include:

- Stripping topsoil from Contractor's working areas;
- Location and management of stockpiled materials;
- Silt management plan to deal with run-off and dewatering of excavations, which will include water quality standards and rates of discharges into watercourse;
- Pollution control measures to deal with leachate from contaminated soils; and
- Identification, excavation and either the safe containment or disposal of contaminated soils, which include frequency of chemical testing of potentially contaminated soils.

Prior to commencing any work, the Contractor will obtain the consent of the controlling authorities, in particular SEPA, to the Environmental Method Statement.

The presence of shallow unrecorded mine workings near Symington, as identified by the Mineral Valuer, will be investigated by a number of rotary exploratory holes. The investigation will be undertaken prior to construction and will aim to determine whether any workings exist, their location and their potential effect on the Scheme. Any drilling into coal workings should be carried out in accordance with the requirements of The Coal Authority. The ground investigation Contractor should take all measures required to minimise adverse impact on the soils, bedrock and groundwater.

The need for grouting to stabilise the area will be determined from the findings of the investigation. Should grouting be required the Contractor shall consult and

comply with the requirements of SEPA on matters relating to hazards from grout residue. To contain any water flushed out from the workings the Contractor shall employ bunds and will then discharge of the water in accordance with SEPA requirements. The Contractor shall also comply with the Specification for the works, which will contain all necessary criteria to minimise adverse impacts from the grouting works.

Reference should also be made to other chapters, in particular Chapter 5 – Disruption due to Construction, Chapter 6 Ecology and Nature Conservation and Chapter 12 Water Resources, which outline additional measures that will need to be incorporated into an Environmental Method Statement.

It is anticipated that there will be no significant change in groundwater levels due to site works and that there will be no long-term adverse effects.

Ground investigation and testing prior to the construction of the Scheme will be targeted to identify whether any of the soils likely to be encountered during construction would be considered contaminated. Appropriate mitigation measures can be based on the findings of the investigation.

It is anticipated that if any contamination is encountered in the made ground it will not be very mobile and can be safely encapsulated in the permanent works. If this cannot be achieved then it will be removed to a licensed waste disposal facility.

No mitigation measures have been identified for the operation of the Scheme.

13.7 Residual Impacts

Residual impacts comprise minor to negligible adverse impacts on: the geomorphology, agricultural soils, superficial deposits, bedrock, hydrology and hydrogeology.

13.8 Summary

This chapter has considered the impact of the Scheme on the geology and soils in the area. It has concluded that there are minor to negligible adverse impacts on the geomorphology, agricultural soils, superficial deposits, bedrock, hydrology and hydrogeology.

If shallow mine workings are encountered during the ground investigation, grouting may be required to ensure the stability of the area. Grouting of mine workings would likely have minor impacts on the bedrock and hydrogeology of the area.

Appropriate mitigation will be required, primarily during construction, to ensure that potential impacts are minimised wherever possible.