

Part Two

2/3 Geology and Soils

2/3.1 Introduction

This section assesses the effects of the scheme on geology and soils.

The UK has, for its size, the most varied geology in the world. Both geology and soils play an important part in determining the environmental characteristics of a region. The underlying geology has a major influence on landform, and rocks provide the parent material from which soils are created. The nature of the rock helps to determine not just the nature and chemistry of soil formed, but also the rate at which it forms. This in turn strongly affects the vegetation that will grow naturally and the type of agriculture or horticulture that can be sustained.

Road schemes may have a direct effect on the geology and soils of a locality. Impacts can affect both the environment and potential future commercial exploitation of resources. Conversely, ground conditions may impose constraints on a proposed road scheme, for example, where land has become unstable due to mining or has been contaminated by previous land uses.

This section presents baseline conditions in terms of the solid strata and covering drift deposits. The assessment focuses on predicted impacts in relation to mineral extraction, agricultural soils and contaminated land. The assessment relates primarily to impacts occurring during excavations, i.e. during the construction phase. Any associated impacts on land use, notably on agricultural land use are addressed in [Section 2/2](#) on Land Use.

2/3.2 Methods

The study area for the assessment of geology and soils extends approximately 250m either side of the proposed route.

The assessment was undertaken by means of consultations, a desk study and site investigations.

Consultations were undertaken with a number of statutory and non-statutory bodies in Scotland holding records pertinent to the assessment of geological impacts. These include the following:

- Scottish Natural Heritage, for statutory designated sites (SSSIs) of geological or geomorphological importance;
- Fife Council, for records of regionally important geological sites (RIGS) and information on contaminated sites;
- British Geological Survey (BGS), for information on local geology, soils and mineral workings;
- Scottish Environment Protection Agency, for contaminated sites, waste disposal sites and industrial processes;
- The Coal Authority, for current and historical coal mining activities; and
- Scottish Coal Company, for current and proposed mining operations.

The desk-based study that was undertaken expanded on the Stage 2 study undertaken in 1994 and went beyond the recommended scope of DMRB, Volume 11. The study

was supplemented by a ground investigation undertaken in 2000 along the route corridor, which concentrated on identifying the extent of shallow coal workings and the geotechnical characterisation of the ground. Materials encountered were described in detail to facilitate the identification of potentially contaminated ground.

2/3.3 Baseline Conditions

The geological interest of the study area has been defined according to the following system:

- High sensitivity – areas containing geological or geomorphological features considered to be of national interest, for example, Sites of Special Scientific Interest;
- Medium sensitivity – areas containing features of designated regional importance, for example RIGS, considered worthy of protection for their educational, research, historic or aesthetic importance; and
- Low sensitivity – features not currently protected and considered not worthy of protection.

No geological Sites of Special Scientific Interest, Regionally Important Geological Sites or other designated sites of geological value have been identified in the area. No other features of special importance to geology have been identified. The local geology is of low geological sensitivity.

The solid geological succession and drift deposits are described below to provide context to the assessment of mineral extraction, agricultural soils and contaminated land. No additional assessment was considered necessary with respect to solid geology or drift deposits.

The baseline conditions are described for the following aspects of ground conditions:

- solid geological succession;
- drift (superficial) deposits;
- mineral extraction;
- contaminated land; and
- agricultural soils.

Solid Geological Succession

The strata underlying the route are indicated on published maps to be part of the Lower Coal Measures of the Carboniferous age and to be dipping westwards. The strata are described as cyclical sequences of sandstones, siltstones and mudstones with some coal seams. This description was confirmed by the results of the ground investigation.

There are a number of named coal seams cropping out in and around the study area, namely the Coalsnaughton Coal, the Mill Coal, the Glenfuir Coal and the Colinburn Coal. The location of outcrops is shown in [Figure 2/3.1](#). The Coalsnaughton Coal outcrops twice in the western half of the scheme, while the Mill Coal outcrops both at the extreme western end of the scheme and to the west of Longannet Road. The Glenfuir Coal and Colinburn Coal outcrop at the eastern end of the scheme.

Drift (Superficial) Deposits

The drift deposits across the majority of the study area are indicated to be “clay, silt and clay”, with the exception of the extreme north eastern area around the A985, where

“boulder clay” deposits are indicated ([Figure 2/3.1](#)). This distribution was confirmed during the ground investigation, when two to three metres of silts and clays, with occasional sand, were recorded directly overlying bedrock in all but one borehole. Borehole 412, adjacent to the existing A985 at the north eastern end of the scheme, encountered boulder clay to a depth of 2.7m.

No made ground deposits are shown in records on or adjacent to the route. However, historical land use and the results of the ground investigation indicate that made ground does exist beneath parts of the study area. This is most likely to be associated with embankments at the extreme western end of the study area, and the existing A985 and Longannet Road at the eastern end of the study area.

The drift deposits are shown as less than 5 metres deep along the whole route.

Mineral Extraction

BGS maps indicate that there are no coal workings recorded by The Coal Authority, shallow or deep, in the vicinity of the proposed road. However, unrecorded shallow coal workings were commonly encountered in the boreholes sunk for this study across the Kincardine area. Several were located on or close to the proposed route.

A number of disused mine shafts are also indicated in the area, with four being shown close to the proposed road line ([Figure 2/3.1](#)). The results of the ground investigation and examination of selected borehole logs obtained from the British Geological Survey confirm extensive shallow workings on the Mill Coal beneath the proposed road line and indicate possible workings of the Glenfuir Coal at the north eastern end of the scheme.

The potential exists for subsidence to occur above shallow workings that have not been treated previously or undergone complete collapse and settlement.

Written correspondence received from the Scottish Coal Company in 1995 detailed proposals for working the Upper Hirst Coal Seam immediately to the south of the study area at a depth of approximately 450m. This seam has been worked extensively in the locality from Scottish Coal Company's Longannet Mine. A meeting between Babbie and Scottish Coal Company in January 2001 confirmed that this mining has now been completed. Subsequent monitoring of ground subsidence over a period of one year has indicated that the extent of subsidence concurred with predictions and had ceased by the end of the monitoring period. The degree of subsidence was relatively minor (up to 0.3m).

Contaminated Land

Written communications from the Scottish Environment Protection Agency and Fife Council did not identify any areas of known contaminated land in the study area. The following features and activities with potential for producing contaminated ground were identified from examination of historical maps and are illustrated on [Figure 2/3.1](#):

- extensive evidence of coal mining activity, including a number of abandoned shafts close to the road line;
- The Union Roperie Works (believed to be a wire rope factory) appears on the 1896 map approximately 30m north of the road line. It was “disused” by 1914 and the buildings largely demolished by 1938. The remaining buildings were labelled “works” in 1960. This was extended and indicated to be a “Pre-cast Concrete

Works” on maps from 1973. The site is currently vacant and the buildings largely demolished;

- Kincardine sewage treatment works to the south of the route appeared on the 1973 map; and
- the western end of the route passes over the former north-south access to the pier and slipway, to the east of the existing bridge. The earlier map editions indicated the access to be on an embankment.

No visual or other evidence of ground contamination was found during the ground investigation. Materials encountered were generally natural deposits, although some surface materials gave evidence of being reworked and contained some inert materials, particularly brick fragments.

Agricultural Soils

Soils in the study area comprise those of the Stirling/Duffus/Pow/Carbrook Association and the Dreghorn Association. Soils beneath the majority of the study area are from the former Association and comprise non-calcareous gleys, some peaty gleys and peat. Immediately north of this soil type are soils of the Dreghorn Association, which underlie the extreme north eastern end of the scheme in the vicinity of the A985. This soil type is formed from raised beach sands and gravels derived from Carboniferous rocks with some Old Red Sandstone material. Within the study area the soils of the Dreghorn Association are brown forest soils with some gleys.

Landform in the study area tends to be raised beach terraces with gentle slopes, supporting arable crops with some permanent pasture, rush pasture and sedge mire.

Prime agricultural land, which is protected by national, regional and local planning policy guidelines, comprises Classes 1, 2 and 3₁ quality land. Land capability for agriculture within the study area is mainly Class 3₂ (non-prime agricultural land), although a small area towards the east of the study area is Class 3₁. Class 3 land is capable of average production but high yields of certain crops, principally cereals and grasses. Grass leys are common. Further details on agricultural soil capability and its use are provided in [Section 2/2](#).

2/3.4 Mitigation

The need for a number of mitigation measures was identified during the investigative works and from the desk study undertaken during the design stage of the proposed road. The measures relate to the previous coal workings in the locality, potential ground contamination and soil quality.

Without adequate treatment, part of the proposed road could be affected by uncontrolled subsidence. It is essential that any such subsidence along the line of the proposed route is adequately treated prior to construction to ensure ground stability beneath and adjacent to the new road. The extensive shallow coal workings that lie along the proposed route and the deep mine shafts immediately adjacent will therefore be appropriately treated prior to construction. The required treatment will include the stabilisation, by grouting, of shallow workings that could cause subsidence in the vicinity of the scheme, and the stabilisation of any shafts not previously treated that are close enough to the route to be a stability risk.

Further subsidence associated with deep mining adjacent to the route is predicted to be negligible.

Although the results of the recent ground investigation suggest that no hazardous materials will be encountered during the required earthworks, procedures to be adopted in the event of potentially hazardous ground being encountered will be covered by the Employer's Requirements for the Works. The method statements will be submitted to the appropriate regulatory authorities, and compliance will be monitored by the Employer's Representative. Potentially contaminated materials will be tested and removed in a controlled manner in accordance with the Duty of Care Regulations.

The Employer's Requirements will include measures to prevent any contaminated runoff or contaminated groundwater produced by the works, entering and polluting the local drainage system that discharges into the Firth of Forth. Any contaminated waters produced would be removed for off-site disposal at an appropriate facility in accordance with waste management regulations, or treated on-site and discharged in compliance with a Consent to Discharge issued by the Scottish Environment Protection Agency.

Potentially adverse impacts on soil quality will be minimised by the adoption of soil handling procedures by the contractor relating to handling in wet conditions, stockpiling and import of soils for earthworks. The measures will be aimed at retaining soils in a condition suitable for plant growth and for agricultural production in line with pre-existing land quality. Individual soil types and areas of differing land capability will be identified prior to excavation, stored separately and restored back to their parent area. All procedures will be included in the Contract Documents.

Should any further geo-technical investigations be required, an environmental appraisal of these investigations will be undertaken to avoid any disturbance to sensitive environmental features including those relating to agriculture, ecology and cultural heritage, as identified in Sections [2/2](#), [2/5](#) and [2/8](#). The environmental appraisal will be undertaken prior to commencement of the investigations.

A summary of the mitigation measures and the level of mitigation associated with each is provided in Table 2/3.1.

Table 2/3.1 Summary of Measures Employed to Address Potential Impacts on Geology, Soils and Contaminated Land

Type of Measure	Description
Prevent	<p>Stabilisation of shallow mine workings and deep mine shafts along and adjacent to the route to prevent subsidence.</p> <p>The adoption of procedures (under the Employer's Requirements for the Works) to deal with any hazardous ground being encountered and the removal of potentially contaminated materials to prevent the release of contaminated materials into the environment.</p> <p>Removal and disposal off-site of any contaminated waters to prevent contaminated run-off or groundwater produced by the works, entering and polluting the drainage system which discharges to the Firth of Forth.</p>
Reduce	Adoption of soil handling procedures during construction to reduce potentially adverse impacts on soil quality.
Offset	None provided.
Enhance	None provided.

2/3.5 Predicted Impacts

The magnitude of predicted impacts on solid and drift geology has been defined as follows:

- high magnitude – where there would be 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 magnitude – where there would be loss of part (between approximately 15% to 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 magnitude – where there would be a minimal 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; and
- negligible magnitude – very slight change from baseline condition. Change hardly discernible, approximating to a ‘no change’ conditions.

The significance of impacts was then determined by reference to both the sensitivity of the site and the magnitude of impact, according to the system shown in Table 2/3.2.

Table 2/3.2 Assessment of Significance Criteria for Impacts on Geology

Site sensitivity	Magnitude of impact			
	High	Medium	Low	Negligible
High	Substantial	Substantial	Moderate	Slight
Medium	Moderate	Moderate	Slight	Negligible
Low	Slight	Negligible	Negligible	Negligible

No sites or features identified to be designated geological interest will be affected by the scheme. The geology in the locality is of low sensitivity and therefore predicted effects will be of negligible or no significance to geology.

Materials Balance

Construction of the road will require a net import of material. It is estimated that there will be excavation of approximately 85,050m³ of material. Of this, 48,200m³ is estimated to be acceptable fill for re-use within the scheme, and an estimated 3,350m³ of rock and 12,500m³ of topsoil that may also be re-used within the scheme. The remaining 21,000m³ of material is anticipated to be unacceptable for re-use and will require export and disposal offsite. In order to construct the proposed embankments, it is estimated that there will be a need for the import of approximately 243,400m³ of material (comprising 20,400m³ for capping and 223,000m³ of fill).

The Contractor will be responsible for both the disposal and the import of material, and this must be undertaken in accordance with Duty of Care requirements. The source of material will be determined by the Contractor. However, a source of fill (Pulverised Fuel Ash) is available at Longannet Power Station adjacent to the proposed scheme, and it is possible that this will be used.

All material to be used or reused during construction will be stockpiled in a designated area within the site boundary. Any topsoil requiring stockpiling will be handled in a manner to retain its potential to support plant growth and either returned to agricultural production or reseeded or replanted for landscape or ecological purposes. No discernible impact on soil capability is envisaged, such that no effect on soil resources is envisaged.

Subsidence

Although there is no evidence from past monitoring in the vicinity of the proposed scheme of ongoing subsidence, the presence of shallow mine workings presents a risk, however slight, of future subsidence in the immediate vicinity. The stabilisation of shallow mine workings beneath the scheme prior to construction will reduce the risk of future local subsidence, and is therefore a slight positive impact.

Contaminated Land

The results of the recent ground investigation suggest that no hazardous materials will be encountered during the required earthworks. However, if any contaminated land requiring remediation were encountered, it will be contained and/or removed in a safe and controlled manner as discussed above. The treatment of contamination of soils and water resources will be to the standards required by SEPA. Any removal of potentially hazardous material is likely to constitute a net positive impact as this will remove the risk of any future contamination.

Agricultural Soils

The removal, disturbance and storage of soil will affect approximately 12 hectares of land (to be confirmed on finalisation of the landscaping proposals), comprising mainly Class 3₂ agricultural land. This is not prime quality agricultural land, and impacts on soil quality will be minimised by adoption of appropriate soil handling procedures. Further details on the impacts on agricultural land capability and land use are discussed in [Section 2/2](#).