15 Soils and Geology

15.1 Introduction

This chapter considers and assesses the likely significant impacts with regard to Soils and Geology associated with both the construction and operational phases of the proposed road development. Measures to mitigate the likely significant adverse impacts of the proposed road development are proposed, and residual impacts described. The chapter initially sets out the methodology used (Section 15.2), describes the existing soils and geology environment (Section 15.3), examines the predicted impacts of the proposed scheme (Section 15.4), proposes mitigation measures (Section 15.5) and identifies residual impacts (Section 15.6).

15.2 Methodology

15.2.1 Legislation and Guidelines

This chapter is prepared having regard to the requirements of Section 50 Sub-section (2 and 3) of the Roads Act 1993 as amended, and with the following guidance:

- Environmental Protection Agency (EPA) Guidelines on Information to be contained in Environmental Impact Statements (EPA, 2002).
- Environmental Protection Agency (EPA) Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (EPA, 2003).
- National Roads Authority (NRA 2008) Environmental Impact Assessment of National Road Schemes – A Practical Guide.
- National Roads Authority (NRA 2009) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.
- Institute of Geologists of Ireland (IGI) Geology in Environmental Impact Statements – A Guide (IGI 2002).

15.2.2 Consultation

Consultation was carried out with the relevant bodies as detailed below. Consultees contacted for the purposes of the study were:

- Geological Survey of Ireland (GSI).
- Department of Environment, Heritage and Local Government (DoEHLG).
- Local Authority – in particular the Environment and Water Services Sections of Kildare County Council.

Consultation with the other specialists on the project team is on-going.

15.2.3 Study Area and Baseline Data Collection

The study area extends 250 m beyond the CPO line for the proposed road development.

The preliminary ground investigation programme for the proposed road development was completed in June 2013. The scope of this investigation which is relevant to geology includes:

- Shell and auger boreholes.
- Rotary core boreholes.
- Trial pits.
- Groundwater level monitoring.
- Geotechnical and environmental testing on soil and groundwater samples.

Additional ground investigation information from the "Upper Liffey Valley Regional Sewerage Scheme" was also available at the time of writing this chapter.

All the information available has been used to describe and evaluate the soils and geological environment in the vicinity of the proposed road development. However, it should be noted that the information stated is based on the investigations undertaken and that the actual ground conditions can only be fully established upon excavation. In addition, the boreholes can only give information at a location and differing conditions may occur between boreholes.

The assessment of the likely significant impacts of the proposed road development on soils and geology has considered the following specific topics:

- Soils (range of agricultural uses, fertility and drainage characteristics).
- Requirements for treatment and/or handling of soft, unstable or contaminated soils, subsoils or other geological materials.
- Requirements for excavation, disposal and/or recovery of soils, subsoils or other geological materials which may be unsuitable for re-use in construction of earth structures or present a risk to human health and/or the environment.
- Economic Geology (mines, pits and quarries).
- Geological Heritage.

15.2.4 Impact Assessment Methodology

The potential impact of the proposed scheme on the soils and geology environment has been assessed by classifying the importance of the relevant attributes and quantifying the likely magnitude of any impact on these attributes. The rating criteria for assessing the importance of geological features within the study area are outlined in Table 15.1 whilst the rating criterion for quantifying the magnitude of impacts is outlined in Table 15.2 below.

The rating of potential environmental impacts on the soils and geology environment are based on the matrix presented in Table 15.3 below which takes account of both the importance of an attribute and the magnitude of the potential environmental impacts of the proposed road development on it. These impact ratings are in accordance with impact assessment criteria provided in the EPA publication Guidelines on the Information to be contained in Environmental Impact Statements (EPA, 2002).

This impact assessment methodology is also in accordance with the guidance outlined in Section 5.4 of the NRA Guidance (2009). Impact categories, impact duration and type/nature of impacts have been taken into account in this assessment as per those guidelines.

Following the assessment of impacts, specific mitigation measures have been developed in the course of the road design phase to avoid, reduce and, if possible, remedy any negative impacts on the soils and geology. These are described in Section 15.5 below. Residual impacts which are the final or designed impacts which result after mitigation measures have been fully established are described in Section 15.6 below.

Table 15.1: Criteria for Rating Site Importance

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale Volume of peat and/or soft organic soil underlying route is significant on a national or regional scale.	Geological feature rare on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource.
High	Attribute has a high quality, significance or value on a local scale Degree or extent of soil contamination is significant on a local scale Volume of peat and/or soft organic soil underlying route is significant on a local scale.	Contaminated soil on site with previous heavy industrial usage. Large recent landfill site for mixed wastes. Geological feature of high value on a local scale (County Geological Site). Well drained and/or highly fertile soils.
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying route is moderate on a local scale.	Contaminated soil on site with previous light industrial usage. Small recent landfill site for mixed wastes. Moderately drained and/or moderate fertility soils. Small existing quarry or pit.
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying route is small on a local scale.	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils Uneconomically extractable mineral resource.

Table 15.2: Criteria for rating impact magnitude at EIS stage – Estimation of magnitude of impact on soil/geology attribute

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute.	Loss of high proportion of future quarry or pit reserves.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute.	Loss of moderate proportion of future quarry or pit reserves.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Loss of small proportion of future quarry or pit reserves.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity.	No measurable changes in attributes.
Minor Beneficial	Results in minor improvement of attribute quality.	Minor enhancement of geological heritage feature.
Moderate Beneficial	Results in moderate improvement of attribute quality.	Moderate enhancement of geological heritage feature.
Major Beneficial	Results in major improvement of attribute quality.	Major enhancement of geological heritage feature.

Table 15.3: Rating of Significant Environmental Impacts at EIS Stage

Importance of Attribute	Magnitude of Impact			
	Negligible	Small	Moderate	Large
Very High	Imperceptible	Significant/ moderate	Profound/ Significant	Profound
High	Imperceptible	Moderate/ slight	Significant/ Moderate	Severe/ significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/ moderate

15.3 Receiving Environment

15.3.1 Introduction

The following sections provide an overview of the regional geological environment with details of available site investigation information within the EIS study area. Bedrock geology, subsoils and geological features are discussed below and shown in **Figures 15.1 to 15.3 V3**. Geological features of importance such as karst features and geological heritage areas, and sites of significance such as quarries, contaminated land and landfills were assessed, but are not present in the study area.

15.3.2 Regional Overview of Agricultural Soils, Subsoil and Solid Geology

The landscape of Kildare principally reflects the erosional and depositional legacy of the last period of glaciation, which ended some 10,000 years ago following the Devensian period. Glacial erosion of pre-existing topographic features and deposition of glacial drift deposits, mainly till (boulder clay) resulted in a fairly typical post-glacial topography. The post-glacial landscape also reflects the effects of fluvial processes that have altered the topography, since the ice sheet retreat.

The soils in this area include topsoil, made ground, alluvium and drift. Drift is a general term applied to all mineral material (clay, silt, sand, gravel and boulders) transported by a glacier and deposited directly by, or from, the ice, or as fluvio-glacial deposits deposited by water from the ice. It generally applies to deposits laid down during the Pleistocene (Quaternary) glaciations. Drift can also be included under Holocene (Quaternary) deposits.

The drift geology of the area principally reflects the depositional process of the last glaciation. Typically during the ice advance boulder clays were deposited subglacially as lodgement till over the eroded rock head surface, whilst moraine granular deposits were laid down at the glacier margins. Subsequently, with the progressive retreat of the ice sheet from the region, granular fluvio-glacial deposits were laid down in places by melt waters discharging from the front of the glacier. The drift geology of the area is shown on **Figure 15.1. V3**.

The overburden geology of Kildare is described in 'Soils of County Kildare' (National Soil Survey of Ireland). The soil map of Kildare shows the area to lie on grey brown Podzolics, a leached soil which is a characteristic of the flat to undulating topography of the area. The podzols are usually formed from calcareous parent material.

The 1:100,000 GSI bedrock geology map (Sheet 16) shows the overburden in this area to overlie Carboniferous limestone at depth. More specifically it is shown to overlie the Waulsortian and Rickardstown Formations, which are described as a massive unbedded limestone and a cherty often dolomitised limestone, respectively. The bedrock geology of the area is shown on **Figure 15.2. V3**. A series of parallel faults running in a northwest-southeast direction are indicated in this region.

15.3.3 Solid Geology, Subsoils and Agricultural Soils

The proposed scheme primarily traverses open undulating agricultural land. The topography of the site is generally low-lying flat with a canal crossing, two river crossings and local high points created by embankments of made ground at the proposed M7 Osberstown Interchange and the railway crossing.

15.3.3.1 Soil and Subsoil

The GSI Subsoils map describes the soils of the area as till derived from limestone. The soils map of Kildare specifies an overburden of grey-brown podzols. There may also be limited areas of alluvium near the River Liffey crossings.

In order to determine the likely ground conditions in and around the proposed road development, a preliminary ground investigation was undertaken by Site Investigations Ltd. on behalf of Arup from April to June 2013. The site investigation locations are indicated on **Figure 15.3 V3 Sheets 1-5**.

The results of this investigation indicate the presence of topsoil, made ground, glacial till and fluvio-glacial granular deposits overlying limestone bedrock.

A thin layer of topsoil (0.1–0.5 m) was evident in the majority of trial pits and boreholes. Made ground was encountered in six locations, all close to the proposed M7 Osberstown Interchange, and found to contain traces of red brick, plastic and timber within a sandy gravelly clay matrix. The glacial till primarily comprises firm to stiff brown to brown/grey sandy gravelly silty clay, with low cobble count, and generally overlies the granular deposits. The granular deposits consist of grey silty sandy gravel and silty gravelly sand, where the gravel is described subangular to subrounded, and are more extensive close to the proposed M7 Osberstown Interchange and River Liffey. A summary of the soil and subsoil profile inferred from the ground investigation is outlined in Table 15.4.

Table 15.4: Geological Feature Importance within Study Area

Strata	Depth to top of strata* (m BGL†)	Thickness* (m)	Notes
Topsoil	0.0	0.1 – 0.5	Observed in majority of explorations
Made ground	0.0 – 0.3	0.2 – 1.4	Observed in six locations, all close to proposed M7 Osberstown Interchange Contains traces of red brick, plastic and timber within a sandy gravelly clay matrix
Glacial Till	0.1 – 4.5	0.3 – 5.3	Brown to brown/grey sandy gravelly silty CLAY with low cobble count
Fluvio-glacial sand and gravel	0.1 – 8.2	0.2 – 14.7	Grey silty sandy GRAVEL and silty gravelly SAND; gravel is subangular to subrounded

** Figures quoted are indicative only*

† BGL – Below Ground Level

15.3.3.2 Solid Geology

The study area is underlain by Waulsortian and Rickardstown limestone, as illustrated in **Figure 15.2. V3.** The 1:100,000 GSI bedrock geology map (Sheet 16) indicates that rockhead is likely to be several meters below the overburden. Rock is unlikely to be removed as there are no major excavations associated with the proposed scheme.

In total, 12 no. rotary coreholes were continued from cable percussive boreholes as part of the ground investigation works (**Figure 15.3 V3 Sheets 1-5**).

A moderately strong, thinly bedded, light grey to grey fine grained limestone was encountered in 11 no. rotary cores at 6–14.8 m Below Ground Level (BGL); bedrock was not reached in 1 no. rotary core, which was advanced to 14.5 m BGL.

15.3.4 Soft, unstable, contaminated land and geohazards

15.3.4.1 Soft Ground

The 1:100,000 GSI soil and subsoil maps (Sheet 16) indicate the presence of alluvial deposits along the banks of the River Liffey. Alluvial deposits are typically associated with the lower parts of a river course (i.e. low energy environment) and may comprise clay, silt, sand and gravels, as well as organic material. These deposits are characterised by high compressibility and, as such, may provide poor foundation conditions.

Alluvial deposits, in the form of loose very silty fine sand, were encountered in the region bounded by the two proposed river crossings. It should be noted that these deposits are highly variable over short distances.

15.3.4.2 Unstable Ground and Geohazards

The GSI has developed a database of historical landslides in Ireland. This database was consulted and no recorded events lie within the study area.

15.3.4.3 Legacy Landfills

In 1996 the Environmental Protection Agency (EPA) began licensing certain activities. These include landfills, transfer stations, hazardous waste disposal and other significant waste disposal and recovery activities. There are no waste licenced facilities in the study area.

Large-scale industrial and agriculture activities have been licensed by the EPA since 1994. Originally this licencing system was known as Integrated Pollution Control (IPC), but was amended by the Protection of the Environment Act, 2003 and is currently referred to as the Integrated Pollution Prevention Control (IPPC) licence. There is one IPPC licenced facility, Boran Plastic Packaging Limited (P0819-01), close to the study area. This facility is located at the end of the proposed tie-in to the existing M7 Motorway, approximately 250 m southeast of the existing M7 bridge which crosses over Canal Road.

The principal class of activity for this IPPC licence is ‘Surface Coatings’ which is described as the manufacture or use of coating materials in processes with a capacity to make or use at least 10 tonnes per year of organic solvents, and powder coating manufacture with a capacity to produce at least 50 tonnes per year.

Consultation has confirmed that there are no legacy landfills in the study area.

15.3.5 Mineral/aggregate resources along and in the vicinity of the proposed road development

The EPA, the GSI and the Exploration & Mining Division of the Department of Communication, Marine & Natural Resources undertook a joint project to develop an inventory and risk characterisation of historic mines sites. On completion of this project a database was compiled which indicates that no mines or mining activity are within the study area.

15.3.6 Geological Heritage Areas

There are no geological heritage areas within the study area, as confirmed by consultation with the GSI.

15.3.7 Summary of Geological Feature Importance

The Geological Features encountered along the proposed road development within the 250 m EIS study area are presented in Table 15.5. They have been rated in accordance to NRA Guidelines.

Table 15.5: Geological Feature Importance within Study Area

Importance	Feature	Criteria
High	Agricultural land: Well drained and/or highly fertile soils	Attribute has a high quality, significance or value on a local scale
Low	Made Ground: Recent site for construction and demolition wastes	Degree or extent of soil contamination is minor on a local scale
Low	Alluvial soil: Poorly drained and/or low fertility soils	Soft organic soil underlying route is small on a local scale

15.4 Predicted Impacts on Soils and Geology

15.4.1 Impact Assessment Methodology

An analysis of the predicted impacts of the proposed road development on soils and geology during construction and operation is presented in the following sections. The assessment considered geological features identified within 250 m of the CPO line of the proposed road development.

An impact assessment was undertaken under the following considerations:

- **Magnitude of Impacts:** The magnitude of each impact was considered from negligible to large adverse.

  Negligible impacts are impacts that result in an impact on an attribute, but of insufficient magnitude to affect either use or integrity. A large adverse impact results in loss of attribute and/or quality and integrity of an attribute.

- **Significance of Impacts:** The significance of each impact was considered as having either an imperceptible, slight, moderate, significant, severe or profound impact.

- **Duration of Impacts:** The duration of each impact was considered to be either temporary, short-term, medium-term, long-term or a permanent impact.

Temporary impacts are considered to be those which are construction related and last less than one year. Short-term impacts were seen as impacts lasting one to seven years. Medium-term impacts are impacts lasting seven to fifteen years. Long-term impacts are impacts lasting fifteen to sixty years and permanent impacts are impacts lasting over sixty years.

15.4.2 Do Nothing Scenario

In the case where the proposed road development was not to be developed there would be no resulting impacts on the soils or geology along the site of the proposed road development. The impact would therefore be neutral.

15.4.3 Do Something Scenario – (Construction and Operational)

The predicted impacts should the proposed road development be constructed are outlined in the text below and summarised in Table 15.7 - Predicted Geological Impacts during Construction Phase.

15.4.3.1 Construction Phase

The predicted soils and geology impacts during the construction phase are presented in this section. These impacts also relate to and interact with other chapters within the EIS namely:

- Chapter 4: *Description of the Proposed Scheme.*
- Chapter 5: *Transportation.*
- Chapter 11: *Noise and Vibration.*
- Chapter 12: *Air Quality.*
- Chapter 16: *Hydrogeology.*
- Chapter 18: *Resource and Waste Management.*

Specific interactions are listed below, further detail is provided in the relevant chapters.

Dewatering

The proposed route predominately comprises fill or at-grade earthworks activities, with minor components of cut generally no greater than 1.5 m. The most significant cut section along the proposed scheme occurs at the railway crossing, where a pre-cast reinforced concrete structure will be jacked into place beneath the railway. This requires construction dewatering to allow excavations in a 'dry' environment. It appears that groundwater levels, measured from standpipes, are shallow in this region and above the proposed formation level.

Local dewatering will also be required during construction for a range of activities that may include the construction of foundations for bridges and culverts and the construction of some pipelines crossing beneath the motorways or deep manholes. The impact of construction dewatering is discussed in greater detail in Chapter 16 *Hydrogeology*.

The groundwater underlying the proposed scheme will be treated in the Environmental Impact Statement as a Regionally Important aquifer (RKd) due to the absence of any continuous aquitard between the gravels and the bedrock aquifer where the route is underlain by the Rickardstown Formation (see Chapter 16 - *Hydrogeology*).

Groundwater seepage may result in erosion and instability of the slope over time. The significance of this impact is considered to be Slight.

Excavation

Bedrock was encountered at 6.0 to14.8 m BGL during the ground investigation and no bulk excavation in rock is envisaged along the proposed scheme. If large capacity piles are used at the river structures, this may result in some excavation of rock to form the piles.

Excavation of glacial till will be required at the railway crossing, where there is a slight risk of an impact on slope stability. However, the significant of this impact is considered Slight due to the relatively shallow nature of the excavation.

Fill

The proposed scheme comprises extended areas requiring the placement of fill material as part of the road construction. The placement of fill will require the importation and deposition of imported fill/reuse on site of fill material from within the site to make up ground levels which will lead to a localised change in ground level and topography. The deposition of fill material may impact on the soils and geology environment by compressing the existing subsoil and potentially impacting on the groundwater flow.

Earthworks

The proposed road development shall require the excavation and importation of material from cut and fill sections along the proposed scheme. The construction traffic associated with the excavation and importation is discussed in Chapter 4 – *Description of the Proposed Scheme*.

Earthworks quantities along the proposed scheme are subdivided into a number of earthworks sections based upon natural physical boundaries such as railway embankments, canals and rivers. The estimated quantities of imported and exported fill within these areas are outlined in Table 15.6.

Table 15.6: Summary of Estimated Material Requirement

Earthworks area	Import Fill (m^3)	Export Fill (m^3)
Sallins Bypass: Ch. 0+000 to 1+050	36,500	4,500
Sallins Bypass: Ch. 1+050 to 1+250	71,000	2,500
Sallins Bypass: Ch. 1+250 to 1+580	119,000	1,000
Sallins Bypass: Ch. 1+580 to 1+980	33,000	4,000
Sallins Bypass: Ch. 1+980 to 3+050	0	7,000
Sallins Bypass: Ch. 3+050 to 3+650	11,500	3,500
M7 Osberstown Interchange	263,000	5,000
Sallins Link Road & Roundabout	137,500	4,500
Clane Road & Roundabout	0	3,000
Osberstown Road	31,500	1,000
Total Scheme	***703,000***	***36,000***

In total, estimated quantities of fill along the proposed road development are: 703,000 m^3 for importation and 36,000 m^3 for exportation. Therefore, the proposed road development is estimated to have a net deficit of 667,000 m^3, and the significance of the impact on geology for removal of materials off-site is considered to be slight.

Surplus materials which are not reused within the proposed road development will be disposed of in an appropriate manner based on the nature of the material in accordance with the Waste Management Act, 1998–2006. Imported material will be sourced from within earthworks areas, wherever possible, to minimise the construction traffic. Material will be sourced from quarries registered under Section 261 of the Planning and Development Act 2000. The impact of soils and geology from importing materials to the proposed scheme is considered to be slight.

Legacy landfills

There are four legacy landfills identified through consultation in the area close to the study area. There is no impact predicted on these landfills as they are distant from the proposed scheme. The locations of the legacy landfills are presented n Figure 15.2

15.4.3.2 Operational Phase

The predicted impacts associated with the proposed scheme are outlined in Table 15.8. The operational phase of the proposed road development will have an overall neutral long-term impact on the soils and geology along the route. Potential impacts from the operational phase of the M7 Osberstown Interchange and R407 Sallins Bypass apply to all features of the proposed scheme and are as follows:

- The soil and groundwater quality within and around the proposed bypass may be at risk, during operation, from contamination from wastewater or hydrocarbon spills, accidents, chemical and residue spillages.

This indicates that the significance rating on the soils and geology from the operational phase of the proposed scheme will be Imperceptible according to the NRA Guidelines criteria (NRA, 2009b).

15.5 Mitigation Measures

15.5.1 Construction Mitigation Measures

15.5.1.1 Effects of Construction Dewatering

Where slopes become unstable due to high groundwater table and inflow during construction, pumping locations shall be constructed in order to drain the water table below the level of the granular material and/or cut level for the duration of the construction, in addition to monitoring the slope stability. This will prevent water flowing from the slope surface causing erosion. Long term gravity drainage measures will be employed to retain the groundwater levels below the road level. The impact and mitigation of wells affected by this drawdown is further discussed in Chapter 16 – *Hydrogeology*.

Engineering design solutions will be provided (e.g. gabions, soil nails, structural retention systems, etc.) as required during construction to deal with ground instability.

15.5.1.2 Excavation in Glacial Till

Seepage from excavations in glacial till shall be mitigated by the use of an appropriate drainage system such as herringbone drains on the slope surface with suitable angle employed to maintain slope stability during construction of the railway crossing.

15.5.1.3 Excavation Methods

No rock excavation is envisaged during the construction phase of the works.

15.5.1.4 Earthworks

Importation of materials from outside site will be minimised, in-so-far as possible, by ensuring that materials arising within the site area are used to the greatest extent possible. Where necessary, naturally occurring materials will be processed to reduce moisture content and/or improve grading in order to maximise suitability for use. Inevitably, materials will be encountered which cannot reasonably be processed into unstable fill material. These materials are generally suitable for other activities such as landscaping within the site area. Any surplus material remaining which cannot be incorporated into the works will be disposed of off-site at suitably licenced tips.

If encountered, contaminated soils will be excavated and disposed of off-site in accordance with the Waste Management Acts, 1998–2006, and associated regulations and guidance provided in the NRA's Guidelines for the Management of Waste from National Road Construction projects (National Roads Authority, 2008).

15.5.2 Operational Mitigation Measures

With appropriate design and construction, no specific operational mitigation measures are required.

15.6 Residual Impacts

The residual impacts are those that will occur after the proposed mitigation measures have taken effect and are shown in Table 15.7 and 15.8 below.

15.6.1 Summary of Impact Assessment

An assessment of the predicted impacts, mitigation measures and residual impacts during construction and operation are shown in Table 15.7 and 15.8 below.

Table 15.7: Predicted Geological Impacts during Construction Phase

Feature			Impact Assessment Construction				
Name	**Importance**	**Chainage**	**Magnitude of Impact**	**Criteria for impact Assessment**	**Significance of Impact**	**Mitigation Measure**	**Residual Impact**
Agricultural land: Well drained and/or highly fertile soils	High	Widespread	Moderate adverse	Attribute has a high quality, significance or value on a local scale	Moderate / slight	N/A	N/A
Made Ground: Recent site for construction and demolition wastes	Low	Degree or extent of soil contamination is minor on a local scale	Small adverse		Imperceptible		
Alluvial soil: Poorly drained and/or low fertility soils	Low	Soft organic soil underlying route is small on a local scale; associated with river crossings and water bodies.	Small adverse		Imperceptible		
Inert soil and Subsoil strata	Low	Widespread	Small adverse	Net requirement for material. Material will need to be imported to this phase of proposed road development	Slight	Material will be sourced from registered local quarries	Groundwater seepages may result in erosion and instability of the slope over time. The significance of the impact is considered to be slight.

Table 15.8: Predicted Geological Impacts during Operational Phase

Feature			Impact Assessment Operational					
Name	**Importance**	**Chainage**	**Magnitude of Impact**	**Criteria for Impact Assessment**	**Significance of Impact**	**Duration of Impact**	**Mitigation Measure**	**Residual Impact**
Agricultural land: Well drained and/or highly fertile soils	High	Widespread	Small adverse	Potential for leakage or spillage of oil or fuel during the operational phase. Soils and geology contaminated by such activities would act as new sources of contamination on site.	Slight	Permanent	With appropriate design and construction no specific operational mitigation measures are required.	Imperceptible
Alluvial soil: Poorly drained and/or low fertility soils	Low	Soft organic soil underlying route is small on a local scale; associated with river crossings and water bodies.	Small adverse	Potential for leakage or spillage of oil or fuel during the operational phase. Soils and geology contaminated by such activities would act as new sources of contamination on site.	Slight	Permanent	With appropriate design and construction no specific operational mitigation measures are required.	Imperceptible
Inert soil and Subsoil strata	Low	Widespread	Small adverse	Potential for leakage or spillage of oil or fuel during the operational phase. Soils and geology contaminated by such activities would act as new sources of contamination on site.	Slight	Permanent	With appropriate design and construction no specific operational mitigation measures are required.at location	Imperceptible

15.7 References

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