Chapter 8

Soils and Geology

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Chapter 8 Soils and Geology

8.1 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 impacts of the proposed road development are outlined, and residual impacts are described. The chapter initially sets out the methodology used (Section 8.2), describes the existing environment for soils and geology (Section 8.3), examines the predicted impacts of the proposed development (Section 8.4), proposes mitigation measures (Section 8.5), and identifies residual impacts (Section 8.6).

8.2 Methodology

8.2.1 Legislation and Guidelines

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

- *Environmental Impact Assessment of Projects: Guidance on the preparation of the Environmental Impact Assessment Report* (European Commission, 2017);
- *Guidelines on the Information to be contained in Environmental Impact Statements*, (EPA, 2002);
- *Advice notes on Current Practice (in the preparation of Environmental Impact Statements),* (EPA, 2003);
- *Environmental Impact Assessment of National Road Schemes - A Practical Guide, Revision 1* (TII, 20 November 2008); and
- *Transport Infrastructure Ireland Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes* (TII 2008).

The following Guidance documents which are currently in draft form have also been consulted:

- *Draft Guidelines on the Information to be Contained in Environmental Impact Assessment Reports* (EPA, August 2017); and
- *Draft Advice Notes for Preparing Environmental Impact Statements,* (EPA, September 2015).

8.2.2 Consultation

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

- Geological Survey of Ireland (GSI);
- Department of Housing, Planning and Local Government;
- Department of Agriculture, Food and the Marine;
- Department of Communications, Climate Action and the Environment;
- The Environmental Protection Agency;
- Local Authorities – In particular the Environment and Water Services Sections of Limerick City & County Council.

Consultation with other specialists on the project team has also been undertaken throughout the development of the project.

8.2.3 Study Area and Baseline Data Collection

Data compilation of available published information was completed during the Constraints and Route Selection studies. Additional information has been compiled from the following sources:

- Relevant pre-existing information from earlier schemes;
- Feedback from consultations with statutory consultees, interested organisations and affected third parties;
- Site inspections between 2014 and 2018;
- Findings of ground investigations (boreholes, rotary drill holes, trial pits and probes and in-situ and laboratory test data) along the proposed road.

8.2.4 Site Inspections

Several site inspections were undertaken at various locations along the length of the proposed road development in order to assist in the identification and assessment of the environmental impact of the proposed road development on the geological environment and on features of geological interest. The inspections augmented existing information sources and aerial photographs and enabled planning of the ground investigations.

8.2.5 Ground Investigations

Ground investigations were undertaken in several phases during the development of the Foynes to Limerick Road between October 2016 and January 2019. The scope of the investigations was to determine the soil, bedrock and groundwater conditions and to establish the presence of any contaminants along the corridor. The results of these ground investigations are illustrated in Figures 8.1 to 8.24 of Volume 3 of the EIAR.

8.2.6 Impact Assessment Methodology

The potential impact of the proposed road development 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 8.1 whilst the rating criteria for quantifying the magnitudes of impacts are outlined in Table 8.2.

The rating of potential environmental effects on the soils and geology environment are based on the assessment criteria presented in Table 8.3 which take account of both the importance of an attribute and 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, *Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports* (August 2017).

The impact assessment methodology is in accordance with the guidance outlined in Section 5.4 of the TII's Guidelines on Procedures for Assessment & Treatment of Geology, Hydrology & Hydrogeology for National Roads (TII, 2008). Impact categories, impact duration and type/nature of impacts have been taken into account in this assessment as per those guidelines.

Limitations in the Methodology and Gaps in Information

There were no limitations in the methodology or significant gaps in information which affected the assessment.

Table 8.1 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 high fertility soils. Moderately sized existing quarry or pit. Marginally economic extractable mineral resource.
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. Sub-economic extractable mineral resource.
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.

** relative to the total volume of inert soil disposed of and/or recovered*

Table 8.2 Criteria for Rating the Impact Magnitude at EIAR 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. Irreversible loss of high proportion of local high fertility soils. Removal of entirety of geological heritage feature. Requirement to excavate / remediate entire waste site. Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment.
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. Removal of part of geological heritage feature. Irreversible loss of moderate proportion of local high fertility soils. Requirement to excavate / remediate significant proportion of waste site. Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils beneath alignment.
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. Removal of small part of geological heritage feature. Irreversible loss of small proportion of local high fertility soils and/or high proportion of local low fertility soils. Requirement to excavate / remediate small proportion of waste site. Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment.
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 8.3 Significance of Effects

Significance	Description
Imperceptible	An effect capable of measurement but without significant consequences
Not Significant	An effect which causes noticeable changes in the character of the environment but without significant consequences
Slight Effects	An effect which causes noticeable changes in the character of the environment without affecting its sensitivities
Moderate Effects	An effect that alters the character of the environment in a manner that is consistent with existing or emerging baseline trends
Significant	An effect which, by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
Very Significant	An effect which by its character, magnitude, duration or intensity significantly alters most of a sensitive aspect of the environment
Profound Effect	An effect which obliterates sensitive characteristics

8.3 Existing Environment for Soils & Geology

The following sections provide an overview of the regional geological environment with details of available site investigation information within the EIAR study area. Bedrock geology, sub-soils and geological features of importance such as karst features are documented here. The results of the ground investigations undertaken for the proposed road development are also illustrated in Figures 8.1 to 8.24 of Volume 3 of the EIAR.

Overburden deposits generally consist of glacial till, derived from limestone with a number of areas of soft ground that are typically shallow, less than 4m deep, but which extend up to 6m deep in two localised areas. (Ardaneer at approximate Ch.1+300 and Ch.29+050 north of Rathkeale).

Bedrock is generally Limestone, with Mudstone noted to the North of Rathkeale (Ch.28+750 to 29+150), at Gortnagrour (Ch.58+350 to 58+550) and at Rower More (Ch.59+850 to 61+150m). Bedrock was generally encountered between depths of 0.3m and 6.5m.

Bedrock was noted to be karstified limestone in a number of areas underlying the proposed road development. However, no karst surface depressions have been observed and no recorded features exist within 2km of the proposed road development on the GSI database. Geophysical surveys identified a number of anomalies (potential areas of karstification) in the bedrock and additional rotary core holes were undertaken at these locations.

A number of rotary core logs across the site indicated small voids, areas of clay infill, and large inflows of water but there was no evidence of instability in areas investigated for concern in relation to potential cavities under the proposed road foundation. Notably, the cutting at Mulderricksfield near Barrigone (Ch.5+150 to 6+400) contains evidence of voids and soil infilling within the bedrock at various depths from 5m to 11m.

8.4 Predicted Impacts for Soils & Geology

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 250m of the proposed road development and follows the requirements of the Transport Infrastructure Ireland (TII 2008) *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*.

8.4.1 Do Nothing Scenario

In the case where the road would not be developed, there would be no resulting impacts on the Soils or Geology along the proposed road development. The impact would therefore be neutral.

8.4.1 Do Something Scenario (Construction Phase Impacts)

8.4.1.1 Deep Cuttings

Table 8.4 shows the significant cuttings deeper than 7m and describes the soils, subsoil and bedrock and whether water was encountered during site investigations.

Table 8.4 Areas of Deep Cut

From Ch.	To Ch.	Length (m)	Max. Cut Depth (m)	Soil type / Stratum
1+350	1+750	400	8	Glacial Till / Limestone
5+150	6+400	1,250	19	Glacial Till / Limestone (Groundwater encountered)
52+400	56+000	3,600	11	Glacial Till / Limestone (Groundwater encountered)
60+000	60+500	500	9	Glacial Till / Limestone

The total volume of cut material within the proposed road development amounts to approximately 3.0 million m^3 of which rock will amount to 1.9 million m^3 (63%). Of the soils to be excavated, 300,000m^3 (27%) is expected to be unsuitable for reuse and will be used, instead, for non-structural fill in landscaping and drainage features. Thus, a net volume of 2.7 million m^3 of cut material will be available for embankment construction within the proposed road development.

The deep cuttings along the proposed road development may result in a minor positive educational benefit in terms of the enhancement of geological heritage features where geological strata are exposed to view.

8.4.1.2 Construction Dewatering

In areas of significant cuts, temporary drainage will be required to allow excavation in a dry environment, locally lowering the ground water table where necessary. The impact of this drainage is addressed in Chapter 9 (Hydrogeology). Where glacial till is located, the dewatering will be minimal, whereas in areas with porous bedrock this may be more significant.

In areas of karstification any change in the normal groundwater patterns may cause potential instabilities. Such lowering of the water table during construction in karst areas could potentially lead to localised instabilities. However, based on the findings

of the ground investigations, construction dewatering will not be required in any potential karst areas.

Table 8.4 details the deep cuttings within the proposed road development. Potential impacts for groundwater at these cuttings are addressed in Chapter 9 Hydrogeology.

8.4.1.3 Slope Stability in Soil Cuttings

Cuttings through glacial till and rock vary along the proposed road development up to a maximum depth of 19m. The major cut slopes will consist of an upper layer of typically 3m depth of glacial till and gravels overlying bedrock which is weathered in the upper several metres and becomes more solid at depth. The glacial till and gravel layers are generally dry and above groundwater level such that seepage from slopes which can lead to erosion and instability of slopes is not expected.

8.4.1.4 Rock Excavation Methods

In areas of significant cut, as listed in Table 8.4 above, limestone rock will be encountered which requires removal. The method of removal can include a variety of construction methods from digging the material out with a bucket of an excavator for the upper weathered layers, use of a rock-breaker, or blasting for the higher strength rock at deeper levels, which can have noise and vibration impacts associated with it, as discussed in Chapter 12 Noise and Vibration of this EIAR.

Blasting is likely to be employed at the 19m deep cut at Mulderricksfield (Ch.5+150 to 6+400) and potentially at the lowest levels of cut at Ballycannon (Ch.52+400 to 56+000). At the other two smaller cuttings at Ardaneer (Ch.1+350 to 1+750) and Islandea (Ch.60+000 to 60+500) there is less likelihood that blasting could be required, but this possibility is assumed in the assessment of construction noise and vibration impacts.

8.4.1.5 Karst

Some karst limestone is expected to be encountered in the proposed cutting of up to 19m depth at Mulderricksfield near Barrigone (Ch.5+150 to 6+400m). Standard design and construction measures are anticipated including mass concrete filling of any cavities found in the road formation or at the bridge foundations for the new Cooper's Lane. Otherwise no special measures will be required.

8.4.1.6 High Embankments

Table 8.5 shows the significant embankments higher than 7m and describes the underlying soils.

Table 8.5 Areas of High Embankment

From Ch.	To Ch.	Length (m)	Max. Fill Height (m)	Underlying Soil
2+400	3+400	1000	12	Shallow Alluvium & Glacial Till
4+300	5+100	800	9.5	Glacial Till
20+000	20+500	500	8.0	Glacial Till
22+000	24+000	2,000	7.5	Glacial Till
25+400	29+200	3,800	11	Glacial Till
50+000	51+300	1,300	9.5	Glacial Till

From Ch.	To Ch.	Length (m)	Max. Fill Height (m)	Underlying Soil
56+000	60+000	4,000	10	Glacial Till & localised Alluvium at River Greanagh
60+500	61+500	1,000	9	Glacial Till & localised Alluvium at River Maigue
61+500	64+000	2,500	11	Glacial Till

The total volume of fill material required for embankments and soft-ground replacement amounts to approximately 4 million m^3.

8.4.1.7 Soft Ground Improvement

Localised areas of soft, highly compressible or organic soil are present alongside some of the main watercourses where close to sea level, mainly at the crossings of the River Greanagh and Maigue in Section D, as well as close to a small lake at Blossomhill to the northeast of Rathkeale. Such soils will not be suitable as foundations for the proposed road.

The extent and depth of soft or organic soils is limited typically to 4m and maximum 6m deep, for which the most economical solution is full excavation and replacement with acceptable fill. The class of fill to be used will depend upon the location of the groundwater table.

As described in Chapter 4, a volume of 300,000m^3 is estimated to be required to be replaced under the road formation. The volume of unsuitable earthworks material is expected to be about 10% of the total excavated materials. This will include the upper layers of weathered soils generally along the site and some localised soft spots beneath the road formation that will be excavated and replaced with stronger material. This is a small proportion compared to most similar road construction projects and can be utilised for non-structural fill purposes within the proposed road development. All unsuitable material from excavations, including soft ground beneath embankments, will be deposited on site, for the outer slopes of embankments and in landscaping works. There will be no requirement to export waste soil materials from the works site.

8.4.1.8 Contaminated Soils and Waste

The Ground Investigations included checks for possible contaminated soils or waste deposits within the footprint of the proposed road development, especially in proximity to a few known risk locations. It is not expected that such materials will be encountered in the works. Nonetheless, there is always a potential small risk of unforeseen contaminated materials being encountered on site during excavations, which would require disposal at a suitable facility off-site. The volume of such materials would be very small, and appropriate provisions in the works contract will ensure that all necessary precautions are applied to ensure the safe disposal of such material in accordance with the relevant regulations.

8.4.1.9 Importation and Deposition of Materials

The proposed road development will require excavation of materials from cuts and deposition of materials for embankments.

The total volume of fill material required of approximately 4.0 million m^3 exceeds the available 2.7 million m^3 of cut material within the site and the 0.3 million m^3 of unsuitable material which will be reused, resulting in an overall earthworks deficit. Thus, a net import of 1.15 million m^3 of fill material will be required as outlined in Table

4.20 within Chapter 4 of this EIAR. In addition to the general fill material to be imported, road foundation construction will require 150,000m^3 of capping material requirement which could largely be sourced from rocks obtained from cuttings in Sections A and D or could be imported from quarries in the region. In the context of the earthworks deficit on the proposed road development, the capping material will add to the volume of material to be imported to the site.

The overall project earthworks fill deficit including capping is circa 1.3 million m^3. This is a significant volume of material to be sourced from quarries in the region. The construction contractor may develop borrow pits in suitable locations within the lands to be acquired for the proposed road so that up to 0.5 million m^3 of cut material can be used to partially offset the net import volume required. The borrow pits can then be used to deposit unsuitable materials. Any such excavations within the proposed road boundaries will likely be limited to a few locations coinciding with the small number of large cuttings along the route, primarily in the Ardaneer area (Km 1.5) and Mulderricksfield area (Km 5 to 6) on Section A, or Ballycannon area (Km 52 to 55) in Section D. Any environmental impacts at these excavation locations would generally be as described in this EIAR for the proposed road at those locations.

The potential existing quarry sources in the region for import material are discussed in Chapter 4 Section 4.16.8, while the proposed haul routes to the site along the main National and Regional Road network are detailed in section 4.16.9. Only suitably registered quarries on the EPA's Extractive Industries Register will be used.

The predicted impact on soils and geology of importation of material to the site is considered to be moderate to large in the context of the scale of loss of the reserves of the existing available quarries in the region as defined in Table 8.2. This is likely to result in a slight to moderate impact on the existing Soils and Geology.

8.4.2 Operational Phase Impacts for Soils & Geology

No impacts on soils and geology are expected during the operational phase of the proposed road development.

8.5 Mitigation Measures for Soils & Geology

No mitigation measures are required for impacts on soils and geology during the construction and operational phases of the proposed road development. Efforts have been made, insofar as possible, to source infill material from within the proposed cuttings, in order to minimise the volume of material imported from quarries in the region.

8.6 Residual Impacts for Soils & Geology

The predicted impact on soils and geology of importation of material to the site is considered to be slight to moderate.

The deep cuttings along the proposed road development may result in a minor positive educational benefit in terms of the enhancement of geological heritage features where geological strata are exposed to view.