7 SOILS, GEOLOGY AND HYDROGEOLOGY

7.1 INTRODUCTION

1 This chapter evaluates the impacts on soils, geology and hydrogeology arising from the proposed development as set out in Chapter 6**, Volume 3B** of the Environmental Impact Statement (EIS). The information contained within this chapter is concerned with the description of the geological and hydrogeological character of the Cavan Monaghan Study Area (CMSA).

2 The soils, geology and hydrogeology evaluation of the CMSA considers an area in excess of 500m either side of the proposed route alignment. The geological material existing along the alignment has been generated by the deposition of detritus over millions of years. The geological material underlying the study area, both the glacial mineral subsoil and the bedrock are concealed below ground. The nature, extent and complexity of the geological material are detailed, from the surface downwards through the mineral subsoil to the bedrock.

3 The potential impacts on the ground conditions and on the existing soil, geology and groundwater conditions are considered for both the construction, operational and decommissioning phases of the proposed development. Mitigation measures that will form part of the proposed development are described and any residual environmental impacts identified and their significance evaluated.

4 Chapter 6**, Volume 3B** of the EIS describes the full nature and extent of the proposed development including elements of the overhead line (OHL) design and the towers. It provides a factual description, on a section by section basis, of the entire line route. The principal construction works proposed as part of the development are set out in Chapter 7**, Volume 3B** of the EIS and are included in the outline Construction Environmental Management Plan (CEMP) (refer to Appendix 7.1, **Volume 3B Appendices** of this EIS).

7.2 METHODOLOGY

5 This chapter has been prepared using the recommendations set out in the Environmental Protection Agency's (EPA) *Guidelines on the Information to be contained in Environmental Impact Statements* (March 2002). The guidelines and recommendations of the Institute of Geologists of Ireland (IGI) publication *Geology in Environmental Impact Statements – A Guide* (IGI 2002) and *Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements* (IGI 2013) were also taken into account in the preparation of this chapter.

6 The information contained in this chapter has been divided into sub-sections, so as to describe the various aspects pertaining to soil, geology and hydrogeology. In the preparation of this chapter, relevant information was collated and evaluated. The information sources are detailed further in this chapter.

7 The principal objectives of this chapter are to identify:

- Geological and groundwater factors which might affect the technical viability of the proposed development;
- Impacts that the proposed development may have on soils, geology and groundwater, geological heritage and on contaminated land along the proposed route and in the adjacent area, including worst case scenario;
- Constraints that these features may place on the proposed development;
- Mitigation measures which may be required to minimise any adverse impacts related to the proposed development; and
- Evaluation of significance of any residual impacts.

8 The information included in this chapter is considered to meet the data requirements suggested in the EPA's *Guidelines on the Information to be contained in Environmental Impact Statements* (March 2002).

9 The following is a list of published geological references and data used in this chapter:

- An Foras Talúntais (1980). General *Soil Map of Ireland*;
- EPA and (GSI) (2009). *Historic Mine Sites - Inventory and Risk Classification;*
- GSI (1997), *1:100,000 scale Sheet 8 – Bedrock Geological Map of the Carboniferous of Monaghan–Carlingford*;
- GSI(2001), *1:100,000 scale Sheet No. 13–Bedrock Geological Map of County Meath*;
- Historical Geological 6 inch: 1 mile maps;
- Historical OSi 6" and 25" maps;
- Meehan, R.T., Warren, W.P. and Gallagher, C.J.D. (1997). *The sedimentology of a late Pleistocene drumlin near Kingscourt, Ireland*;

- Meehan, R.T. (1999). *Directions of ice flow during the last glaciation in counties Meath, Westmeath and Cavan, Ireland.* GSI, Dublin;

- Morris, J. (1984). *The Metallic Mineral Deposits of the Lower Palaeozoic Longford-Down Inlier*, *in the Republic of Ireland.* GSI, Dublin;

- Morris, J.H., Steed, G.M. and Wilbur, D.G., (1986). *The Lisglassan-Tullybuck Deposit, County Monaghan*. GSI, Dublin;

- OSi 1:50,000 scale maps, Sheets 28B, 35, 42 and 43; and

- Rudland, D.J., Lancefield, R.M. and Mayell, P.N. (2011). *Contaminated Land Risk Assessment, A Guide to Good Practice.* CIRIA C552 London.

10 Numerous online datasets were referenced in relation to the soil, subsoil and geology in the CMSA including data from the GSI, Department of Communications, Energy and Natural Resources (DCENR) and the EPA. Consultation was undertaken with statutory and non-statutory organisations, which include details on consultation with the GSI (refer to Chapter 3**, Volume 3B** of the EIS for details on scoping and statutory consultation).

11 The scoping opinion received from An Bord Pleanála (the Board) (refer to Appendix 1.3**, Volume 3B Appendices** of the EIS) identified the following issues as being relevant to this chapter of the EIS:

- An assessment of potential soil erosion, particularly where it affects priority habitats, designated conservation areas, and in the vicinity of surface water bodies; and

- Submission of a construction method statement, identifying areas of particular sensitivity which require specific construction mitigation measures, including areas of peat.

12 Site visits of the CMSA were conducted in February 2009, July 2009, April 2011 and June 2013 to September 2013. Site walkover and site investigation surveys were conducted where access was granted by the landowner. Fieldwork focused on verifying the accuracy of national datasets. Site specific details were recorded and included logging of subsoil types, vegetation indicators, springs, drainage details and general trafficability of soils. Where access was granted to proposed tower locations, subsoil deposits and selected exposures / sections were logged according to the British Standard Institute *Code of Practice for Site Investigations* (BS 5930:1999).

13 Whilst all projects and developments that require an Environmental Impact Assessment (EIA) are of a scale or nature that they have the potential to have an impact on the environment, with respect to the construction of a transmission line, and the use of temporary access routes and stringing areas, the impact on the soils, geology and hydrogeological environment is considered low in comparison to other linear projects such as road or pipeline developments.

14 In this chapter, the potential impact on the geological environment resulting from the proposed development is evaluated and mitigation measures are proposed to reduce any significant impacts. Based on the mitigation measures proposed, the significance of the residual impact on the geological environment is predicted.

15 Criteria for evaluating impact levels are shown in **Table 7.1**. Terminology for impact significance and duration follows that set out in the EPA's *Guidelines on the Information to be contained in Environmental Impact Statements* (March 2002). The magnitude of any effects considers the likely scale of the predicted change to the baseline conditions resulting from the predicted effect and takes into account the duration of the effect, i.e. temporary or permanent. Definitions of the magnitude of any effects are also provided in **Table 7.1**.

Table 7.1: Impact Magnitude Definitions

Magnitude	Criteria
Very High	An impact, which obliterates sensitive characteristics of the soil or geology environment.
High	Fundamental change to ground conditions, groundwater quality or flow regime.
Moderate	Measureable change to ground conditions, groundwater quality or flow regime.
Low	Minor change to ground conditions, groundwater quality or flow regime.
Negligible	No measureable impacts on ground conditions, groundwater quality or flow.

(Source: EPA's *Guidelines on the Information to be contained in Environmental Impact Statements* (March 2002))

16 Impact ratings may have negative, neutral or positive application where:

- Positive impact – A change which improves the quality of the environment;
- Neutral impact – A change which does not affect the quality of the environment; and
- Negative impact – A change which reduces the quality of the environment.

17 Terms relating to the duration of impacts are as described in the EPA's *Guidelines on the Information to be contained in Environmental Impact Statements* (March 2002) as:

- Temporary Impact - lasting one year or less;
- Short term Impact - lasting one to seven years;
- Medium term Impact - lasting seven to fifteen years;
- Long term Impact - lasting fifteen to sixty years; and
- Permanent Impact - lasting over sixty years.

18 A qualitative approach was used in this evaluation, generally following the significance classification in **Table 7.2** and through professional judgement. The significance of a predicted impact is based on a combination of the sensitivity or importance of the attribute and the predicted magnitude of any effect. Effects are identified as beneficial, adverse or negligible, temporary or permanent and their significance as major, moderate, minor or not significant (negligible).

Table 7.2: Assessment Criteria

Sensitivity	Magnitude				
	Very High	**High**	**Medium**	**Low**	**Negligible**
High	Major	Major	Moderate	Moderate	Minor
Medium	Major	Moderate	Moderate	Minor	Negligible
Low	Moderate	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Minor	Negligible	Negligible	Negligible

19 In order for a potential impact to be realised, three factors must be present. There must be a source or a potential effect, a receptor which can be adversely affected and, a pathway or connection which allows the source to impact the receptor. Only when all three factors are present can an effect be realised.

7.2.1 Legislative and Policy Context

20 An evaluation of the proposed development was carried out in relation to relevant European and National legislation and other statutory policies and guidance. The following legislation was considered as part of this consolidated impact evaluation:

- *Consolidated EIA Directive 2011/92/EU;*
- *European Communities (Water Policy) Regulations 2003* [S.I. No. 722 of 2003];

- *Waste Management Acts 1996-2014*;
- *European Communities Environmental Objectives (Groundwater) Regulations 2010* [S.I. No. 9 of [2010]; and
- *European Communities (Environmental Impact Assessment) (Amendment) Regulations, 2001 [S.I. No. 538/2001].*

7.3 CHARACTERISTICS OF THE PROPOSED DEVELOPMENT

21 The main potential impacts on the soils, geology and hydrogeology in the CMSA occur during the construction phase. Details of the potential impacts are included in **Section 7.5**. Overall, the construction programme is anticipated to last approximately three years. The proposed development entails the construction of towers as individual sites separated by approximately 340m. In general the phases of construction can be broken down into the following: site preparation (including laying of temporary rubber matting or aluminium road panels, removal of fences and erection of temporary fencing where required), establishment and operation of materials storage yard, all activities associated with modifications to existing 110kV transmission OHLs, installation of tower foundations, erection of tower, guard poles, tree lopping, stringing of conductors, commissioning of the line and reinstatement of land.

7.4 EXISTING ENVIRONMENT

7.4.1 Topography and Geomorphology

22 Refer to Figures 7.1 – 7.4, **Volume 3C Figures** of the EIS. The topography of the alignment varies approximately from:

- 150m and 180m Above Ordnance Datum (AOD) in the northern section (Towers 103-153);
- 180m and 205m AOD in the central area (Towers 154 - 169); and
- 100m to 180m AOD in the southern section (Towers 170 - 236).

23 The morphology was shaped principally during the last glacial cycle (the Midlandian), with subsequent modification throughout the post glacial Holocene period. Most of the Quaternary sediments in the CMSA were deposited during the glaciation, directly from the huge ice sheets.

24 The geomorphology of the CMSA is predominantly made up of drumlins and ribbed (Rogen) moraines. Drumlins take a variety of forms with the majority elongated in the direction of ice flow. Some drumlins have sharp crests, whereas others are more whaleback in profile. These

drumlins typically have a steeper stoss[19] than leeside due to the retreating ice. Although most drumlins are composed of glacial till or tills, a small number are rock-cored. The majority of drumlins on the route are diamation[20] drumlins with occasional rock cored drumlins to the south of Tower 200.

25 Rogen 'ribbed' moraines underlie the drumlins and are aligned transverse to the ice flow direction. Some of ridges were streamlined and overprinted by subsequent drumlin development, while others remained unaffected.

26 Lakes, alluvial flats, lacustrine deposits and peaty soils occur, in the interdrumlin hollows, and occupy the lowest points of the landscape.

7.4.2 Soils

27 The CMSA varies in terms of its soil, subsoil and bedrock geology. There are a range of soils in the CMSA between the townlands of Clonturkan and Lemgare.

28 The principal soil groups are:

- AminPD – Deep poorly drained mineral soil, derived from mainly non-calcareous parent materials. Surface water gleys and groundwater gleys are included in this category;
- AminDW – Deep well drained mineral soil, derived from mainly non-calcareous parent materials. Acid brown earths and Brown podzolics will be included in this category; and
- AminSW – Shallow well drained mineral soil, derived from mainly non-calcareous parent materials. Lithosols and regosols are included in this category.

29 The following soil groups also occur but are less widespread and found in minor formations:

- AminPDPT – Poorly drained mineral soils with peaty topsoil, derived from mainly non-calcareous parent materials. Peaty gleys are included in this category;
- AminSP – Shallow poorly drained mineral soil, derived from mainly non-calcareous parent materials. Surface water and groundwater gleys are included in this category;
- AlluvMIN – Alluvial undifferentiated; and
- Lac – Lacustrine deposits (undifferentiated).

[19] Stoss – The up-ice side of the hill from which an advancing ice-sheet moved.
[20] Diamation –Poorly / unsorted sorted material i.e. boulder clay or till.

30 Alluvial soils are evident along the course of the main surface water features in the CMSA. In particular, alluvial soils are evident along the River Dromore and its tributaries. Cutover peat (Cut) is evident in the CMSA. Small areas of cutover peat are distributed throughout the CMSA and correspond with inter drumlin hollows.

7.4.3 Geology

7.4.3.1 Quaternary Geology

31 The Quaternary geological period extends from about 1.5 million years ago to the present day and can be sub divided into the Pleistocene Epoch, which covers the ice age period to 10,000 years ago, and the Holocene Epoch, which extends from 10,000 years ago to the present day. Refer to Figures 7.1 – 7.4, **Volume 3C Figures** of the EIS.

32 The Pleistocene Epoch in Ireland began when there was a significant cooling of the Earth's climate. It was characterised by alternating extended periods of very cold conditions during which time much of the country was covered by an ice sheet. The ice sheet in Ireland was formed by a number of coalescing ice domes, from which the ice flowed outwards in a radial pattern. As the ice travelled over the ground, it eroded the underlying bedrock, which resulted in the formation of sediment beneath and within the ice sheet. The particle size distribution of the sediment varied greatly and ranged from clay particles to large boulders. This material has been labelled glacial till or boulder clay and is the most widespread soil type in Ireland. If conditions were suitable, sediment was also deposited as distinct bands of sand, gravel, silt and clay. Glacial till can range in thickness from less than 1m thick to tens of metres in depth.

33 The CMSA was glaciated on at least two occasions but the majority of the sediments present today are as a result of the last glaciation, which was at its maximum some 24,000 years ago. Most of the Quaternary sediments were deposited during the Ice Age itself, either directly from the huge ice sheets or by meltwater from the ice sheets. Ice sheets in the study area moved from north-west to south-east.

34 Till derived from various rock formations is the principal material encountered along the alignment. Till is an unsorted sediment derived from the transportation and deposition of, by, or from a glacier. Glacial till is composed of a heterogeneous mixture of clay, sand, gravel and boulders. With reference to the EPA online mapping (http://maps.epa.ie/), the subsoils comprise primarily of tills derived from Lower Palaeozoic shales / sandstone (TLPSsS) are also present. Areas of outcrop / sub-outcrop along the alignment are delineated as bedrock at the surface as shown on Figures 7.1 - 7.4, **Volume 3C Figures** in the EIS.

35 The following subsoil groups also occur along the alignment, but are less dominant:

- A – Alluvial undifferentiated;
- Rck – Bedrock at or near surface; and
- CUT – Cutover Peat.

36 A summary of the proposed towers locations within each subsoil group is outlined in **Table 7.3** and shown in Figures 7.1 – 7.4, **Volume 3C Figures** of the EIS.

Table 7.3: Subsoil Classifications at Towers Locations

Subsoil Group[21]	No. of Towers within subsoil category	% of Towers within subsoil category
Alluvium (Undifferentiated)	2	1.49%
Bedrock at or near surface	24	17.91%
Cutover Peat	7	5.22%
Till	101	75.37%
TOTAL	**134**	**100%**

7.4.3.2 Bedrock Geology

37 Refer to Figures 7.5 – 7.8, **Volume 3C Figures** of the EIS. Reference to the relevant geological information in the *Bedrock Geological Map of Monaghan – Carlingford* (GSI, 1997) *Bedrock Geological Map of County Meath* (GSI, 2001), indicates that the bedrock geology along the alignment is varied.

[21]Based on GSI Data www.gsi.ie.

38 Reference to the published geological map for this area including the 1:100,000 scale *Sheet No. 13 – Bedrock Geological Map of County Meath* (GSI, 2001) indicates that this area is by Ordovician-Silurian age deposits (510 million years to 410 million years ago) located between the townlands of Lemgare and Clonturkan (Towers 103 - 236).

39 The Lower Palaeozoic (Ordovician-Silurian) rocks form part of a stretch of rocks that extend from the County Down coast to County Longford and are known as the 'Longford Down Inlier'. These rocks are a series of sandstones, siltstones and shales with small amounts of volcanic tuffs and lavas. The rocks of the Longford-Down Inlier are deformed into tight isoclinal folds with associated strong cleavage, thrust faults and shear zones.

40 The Ordovician / Silurian rocks are part of the 'Central Belt' which comprises of greywacke and mudstone varying in age from the Ordovician (Llanvirn) to Silurian (Llandovery). Volcanic and intrusive dolerite dykes occur within the Ordovician / Silurian deposits. The dolerite dykes are orientated north-west south-east through the CMSA.

41 The different geological formations that make up the CMSA include the following:

- The Slieve Glah Formation (Towers 103–104) is comprised of grey / dark grey slaty siltstone, mudstone, and thin bedded turbidite with occasional thicker bedded greywacke and pale grey metabentonite beds.

- The Lough Avaghon Formation (Towers 105-154 and 157) is comprised of grey, fine to coarse-grained massive quartz intermediate and quartz-felsic igneous rich turbiditic greywacke, microconglomerate and amalgamated beds.

- The Mullanalt Member (Towers 155 - 156) of the Lough Avaghon Formation is comprised of very finely laminated grey coloured laminated siltstone, siltstone-mudstone and non-laminated siltstone with interspersed thicker fine grained buff to pale grey greywacke.

- The Oghill Formation (Towers 158-162) is comprised of grey / grey green massive greywacke, microconglomerate and amalgated beds and subordinated turbiditic greywacke and local infaulted dark grey and black pyritic, occasionally graptolitic shale / mudstone.

- The Shercock Formation (Towers 163-193) is comprised of grey to green-grey quartz felsic igneous, white mica rich, fine to coarse grained medium thick bedded turbidite and massive sandstone.

- The Laragh Formation (Towers 194-195) is comprised of olive-green, pale to dark grey and black, pyritic, graptolitic shale/mudstone/slate with dark grey / black chert / silicified mudstone.

- The Taghart Mountain Formation (Towers 196–198 and 221-229) is comprised of pale grey to dark grey, quartz-mica rich turbiditic greywacke, massive sandstone and amalgamated beds. The formation is unfossiliferous.

- The Castlerahan Formation (Towers 199-220 and 230-236) is comprised of dark grey to black massive quartzo-greywacke, with micro conglomerates.

42 Finer grained variety of gabbro (type of rock), were intruded as thin sheets (dykes and sills), associated with the Slieve Gullion central intrusive complex. Areas of dolerite are not identified underlying tower locations but may be unmapped and encountered during site works.

43 The distribution of geological units, along the alignment is based on published information from the GSI. They are shown on Figures 7.5 – 7.8, **Volume 3C Figures** of the EIS. The composition and the characteristics of the various rock units are discussed herein.

7.4.3.3 Karst Features

44 The Karst database held by the GSI was consulted. This database holds records of locations and types of reported Karst features. No recorded Karst features from the GSI database exist within 1km of the proposed route alignment. No pure limestones are mapped along the line route.

7.4.3.4 Depth to Bedrock

45 Rock outcrop or close to surface rock occurs in a number of areas (17% of towers) north of Castleblayney and north-east of Shercock. Deeper quaternary deposits occur on the backslopes and crests of drumlins. Additional information was obtained from the GSI well database which is included in **Appendix 7.1, Volume 3C Appendices** of the EIS.

7.4.4 Hydrogeology

46 The evaluation of the groundwater environment is concerned with water contained below the ground surface, within the soil and bedrock environment. Soils and bedrock along the CMSA are widely variable in their hydrogeological characteristics. Ordovician greywackes and shales beneath the northern end of the OHL route are generally of low permeability, and lack groundwater except at shallow depth in the transition zone / upper weathered bedrock. The alluvial and sand and gravel parent materials that occur along parts of the CMSA are

moderately permeable. Glacial clays are generally of low permeability, although they may be locally interspersed with more permeable granular deposits.

47 The CMSA is underlain by Ordovician and Silurian greywacke, shale, sandstone and mudstone. These strata generally have a low permeability and are of negligible importance for groundwater supplies. Groundwater is present in these strata but it is likely that quantities are low and groundwater generally is limited to fractures and to the upper weathered zone of the strata. There are no existing public water supply boreholes in close proximity to the proposed development. Additional information was obtained from the GSI well database which is included in **Appendix 7.1, Volume 3C Appendices** of the EIS.

7.4.4.1 Aquifer Classification

48 Silurian Metasediments and Volcanics along the line route between the townlands of Clonturkan and Lemgare are classified mainly as Poor Aquifers (Pl) – unproductive except for local zones and Poor Aquifers (Pu). A summary of the aquifer classification is included in **Table 7.4**. Refer to Figures 7.9 - 7.12, **Volume 3C Figures** of the EIS for aquifer maps.

49 The Quaternary sediments play an important role in the groundwater flow regime of the region. The permeability of the glacial tills, which occur along the alignment, is variable but generally of poor permeability.

7.4.4.2 Groundwater Flow Direction

50 In general terms it would be expected that the groundwater gradient would follow the topographic variation in an area. Flow paths and distance is dependent on the characteristics of the aquifer type. Most groundwater flow is confined to the upper 10m of weathered bedrock and will discharge to the nearest watercourse. An evaluation of the topographic contours displayed on the Ordnance Survey 1:50,000 scale Discovery Series Map for the region indicates that the predominant groundwater flow direction in the CMSA is likely to be towards the local streams.

7.4.4.3 Water Usage

51 Water usage within the CMSA is primarily supplied by Monaghan County Council from their surface water abstractions at the Lough Bawn, Lough Namachree, Lough Graghlone, Lough Toome and Muckno Lough. There are no public water supplies within 200m of the proposed line route.

52 Along the alignment a number of private wells are used by individual landowners. A search of the GSI well database shows there are a number of wells in the area with uses varying from private to agricultural use. The GSI Well Database is a record of reported wells drilled in Ireland. Refer to **Appendix 7.1, Volume 3C Appendices** of the EIS.

Table 7.4: Aquifer Definitions

Aquifer Code[22]	Aquifer Description	% of Towers located within Aquifer type
PI	Poor Aquifer Bedrock which is generally unproductive except for local zones	100%

53 The GSI Well Card Index is a record of wells drilled in Ireland. This index shows a number of wells in the vicinity of the proposed development. While much useful information can be obtained from this index, it is important to note that it is by no means exhaustive, as it requires individual drillers to submit details of wells in each area.

54 The well card shows the occurrence of recorded wells within the CMSA, information regarding the depth to bedrock, and hence the depth of overburden is noted for each well. See **Appendix 7.1, Volume 3C Appendices** of the EIS, for locations.

55 The well card data shows there are a large number of wells in the CMSA with uses varying from domestic to agricultural use. It shows that the wells recorded in the CMSA range from 0.2m to generally 121.9m Below Ground Level (BGL). The groundwater yield also varies throughout the CMSA; the majority of yield is poor to moderate. More detail on the depth to bedrock in the vicinity of each route is provided in the **Appendix 7.1, Volume 3C Appendices** of the EIS**.**

7.4.4.4 Groundwater Vulnerability

56 The formerly entitled DoEHLG, EPA and GSI have produced guidelines on groundwater vulnerability mapping that aim to represent the intrinsic geological and hydrogeological characteristics that determine how easily groundwater may be contaminated by human activities. Vulnerability depends on the quantity of contaminants that can reach the groundwater, the time taken by water to infiltrate to the water table and the attenuating capacity of the geological deposits through which the water travels.

[22] Based on GSI Data www.gsi.ie.

57 The DoEHLG, EPA and GSI vulnerability mapping guidelines allow for the assignment of vulnerability ratings from 'extreme' to 'low', depending upon the subsoil type and thickness. With regard to sites where low permeability subsoils are present, the following thicknesses of unsaturated zone are specified in **Table 7.5**.

Table 7.5: Groundwater Vulnerability Categories

Vulnerability Rating[23]	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High Permeability (Sand and Gravel)	Medium Permeability (Sandy Subsoil)	Low Permeability (Clayey Subsoil/ Peat)	Sand and Gravel aquifers only	<30 radius
Extreme	0 – 3.0m	0 – 3.0m	0 – 3.0m	0 – 3.0m	-
High	>3.0m	3.0 -10.0m	3.0 – 5.0m	> 3.0m	N/A
Moderate	N/A	>10.0m	5.0-10.0m	N/A	N/A
Low	N/A	N/A	>10m	N/A	N/A

Notes: N/A Not Applicable; Precise Permeability values cannot be given at present; Release point of contamination is assumed to be 1-2m below ground surface. The principal vulnerability classes included are high and moderate. All sand and gravel subsoils are classified as high.

58 The principal vulnerability class is extreme. Refer to Figures 7.13 – 7.16, **Volume 3C Figures** of the EIS.

[23] Based on GSI Classification system.

Table 7.6: Groundwater Vulnerability along the Line Route

Groundwater Vulnerability[24]	Number of Towers	% Towers in each Vulnerability category
Extreme Vulnerability with rock at Surface (<1m)	26	19.40%
Extreme	47	35.07%
High	15	11.19%
Moderate	33	24.63%
Low	13	9.7%
TOTAL	**134**	**100**

7.4.5 Areas of Geological Heritage Importance

59 The GSI provides scientific appraisal and interpretative advice on geological and geomorphological sites, and is responsible for the identification of important sites that are capable of being conserved as Natural Heritage Area (NHA). The National Parks and Wildlife Service (NPWS) of the Department of Arts, Heritage and the Gaeltacht (DAHG) have the responsibility of designation and management of sites, with appropriate advice from GSI.

60 At present, the GSI has compiled a list of sites proposed for designation as Natural Heritage Areas (pNHAs). The GSI has also determined a secondary list of County Geological Sites (CGS), which may be considered for protection at local authority functional control level (i.e. may be included in county development plans).

61 The GSI was consulted as part of the route selection process with regard to areas that may have geological or geomorphological importance. According to the GSI, there are three sites of geological interest in County Monaghan, which lie near the line route (see **Table 7.7**). Refer to Figures 7.17– 7.20, **Volume 3D Figures** of the EIS.

[24] Based on GSI Data www.gsi.ie.

Table 7.7: Geological Heritage Areas along the Line Route

Site Name[25]	Location	Distance from Tower location	IGH Theme
Carrickatee Hill CGS	Grid Ref. 273400, 314800)	2.35km west of line route	IGH4 Cambrian-Silurian Theme
Lemgare CGS	Grid Ref. 280400, 328100	60m north-east of line route	IGH 6 Mineralogy Theme
Tassan CGS	Grid Ref. 279100, 326100	0.15 km south-east of the line route	IGH 6 Mineralogy Theme

62 **Carrickatee Hill** with excellent and most extensive exposures of andesitic agglomerate of the Carrickatee Formation. The site represents the best exposed example of mid / late Ordovician volcanism within the Moffat Shale Group south of the Orlock Bridge Fault in Ireland. The site is proposed for CGS designation under the Irish Geological Heritage (IGH) 4 Cambrian-Silurian Theme. The site is located approximately 2.35 km west of Tower 154.

63 The **Lemgare** site presents pits and an adit with disseminated ankerite/ siderite in arenite or in veins, also quartz, galena, sphalerite and barite. The Lemgare site is potentially the most easily accessible representative of the lead mines in this region, though it was never very productive. Pyromorphite and wolfenite were also found making this site one of few localities for this mineralogy. The site is proposed for CGS designation under the IGH 6 Mineralogy Theme. The site - boundary is located approximately 60 m north-east of Tower 108. Based on the IGH site audit, the mine features are poorly preserved and insufficiently interesting to require any designation for the site. However, the presence of rare wulfenite means Lemgare warrants CGS status.

64 **Tassan** was the largest and most productive of the Monaghan district lead mines. Production appears to have commenced in the late 1840s from two NNW-SSE-trending, east-dipping lodes. The ore consisted of argentiferous galena (PbS) and sphalerite (ZnS) in a quartz-calcite matrix. The site is largely grassed over apart from a large solid waste heap that marks the eastern boundary of the site on the west shore of Tassan Lough. The site is proposed for CGS designation under the IGH 6 Mineralogy Theme. The site boundary is located approximately 170 m south-east of Tower 117.

7.4.6 Current and Historical Mining Sites

65 A number of historical mines are located along the line route in County Monaghan. These relate to number of small metallic mineral deposits located in the Monaghan – Castleblayney

[25] Based on GSI Data www.gsi.ie.

area of County Monaghan detailed in the EPA's *Historic Mine Sites - Inventory and Risk Classification* (2009) as follows:

> "*Most are lead deposits though one, near Clontibret, is unique in Ireland in having produced mainly antimony. Most were short-lived operations, exploited mainly in the 19th century, while others amounted to little more than prospects abandoned after limited exploration. Morris (1984) produced the first comprehensive review of the mines of the district, including site descriptions. The latter have been used as a basis for selecting sites for work under the HMS-IRC project. Only those sites with potentially significant remaining mine waste or mine structures were considered, namely Clontibret, Coolartragh, Hope Mine, Lemgare and Tassan. The site at Coolartragh has largely disappeared in recent years after expansion of a working quarry. The Lemgare site includes the traces of adits and the heavily overgrown ruins of some buildings but no mine waste of significance".*

66 No other major mines were noted in the CMSA. The nearest historical mine is located at Lemgare (see **Section 7.4.5**). There are no active mines, quarries or sand and gravel pits located under the alignment.

7.4.7 Contaminated Land

67 An evaluation was undertaken to determine the presence and extent of potentially contaminated land which is based on the identification of potential sources pathways and receptors along the line route. If all three elements (source, pathway and receptor) are present, there is a contaminant linkage and there is a potential for the contamination to represent a risk to the receptor(s) and for the site to be considered as contaminated.

68 A number of sites have been identified as having a potential for land contamination in the immediate area of the proposed alignment. The identified sites have not been fully investigated and, where a potential for contamination has been identified but no evidence of actual contamination has been confirmed (such as a pit/quarry which may or may not have been infilled), "a worst case" analysis has been adopted. The evaluation has been undertaken on the assumption that all of the sites are contaminated unless there is evidence to the contrary.

69 The distance to the nearest tower has been used, as the OHL will have no impact on the underlying ground conditions. On a precautionary basis, sites within 200m of the route of the proposed development have been considered, refer to **Table 7.8** .

Table 7.8: Potential Contaminated Land Sites within 200m of the Proposed Overhead Line Route

Tower and Associated Development	Approximate Distance (m) and Direction From Nearest Tower	Description
107	120m south-east of Tower 107	Reclaimed land (borrow pit) – Possibly related to Disused Lead Mine (Lemgare)
108	125m north-east of Tower 108	Disused Lead Mine (Lemgare) and associated infrastructure
117	170 m south-east of Tower 117.	Disused Lead Mine (Tassan) and associated infrastructure
131	70m north-west of Tower 131	Reclaimed land (gravel pit)
153	120m south of Tower 153	Reclaimed land (gravel pit)
172	170m west of Tower 172	Reclaimed land (borrow pit)
180	Tower Base for Tower 180	Reclaimed land (borrow pit)
182	120m west and south-west of Tower 182	Reclaimed land (borrow pit)
140	200m north of Tower 140	Railway land Ballybay to Castleblayney (Great Northern Railway)
199	Tower Base for Tower 199	Reclaimed land (quarry)
216	100m west of Tower 216	Reclaimed land (quarry)

(Source: Aerial Sources and Historical Maps)

70 A review was undertaken of potentially contaminated land sites located in close proximity to the route of the proposed development. The detailed reviews are based on an evaluation of historical Ordnance Survey plans of the sites; LiDAR (Light Detection and Ranging) and aerial photographs of all the sites listed in **Table 7.8** and, a site walkover in July / August 2013 where access was granted.

71 In addition to specific sites, it should be noted that there is a general potential for pollution from agricultural chemicals on present and past agricultural land, and from buried material which may occur almost anywhere along the proposed development.

7.4.7.1 Former Mining Areas –Towers 107, 108 and 117

72 Towers 107, 108 and 117 are located near former mines, adjacent to the Monaghan/ Armagh border. The metal deposits in the Monaghan District are epigenetic vein deposits, typically containing lead and zinc but also including antimony-arsenic-gold deposits detailed in *The Metallic Mineral Deposits of the Lower Palaeozoic Longford-Down Inlier*, *in the Republic of Ireland* (Morris 1984). Galena (PbS) is the dominant sulphide in lead vein deposits, accompanied by sphalerite (ZnS), barite ($BaSO_4$) and chalcopyrite ($CuFeS_2$). The host vein is generally composed of ferroan carbonate. The antimony-gold deposits consist of veins with isolated pods of stibnite (SbS_2) in altered andesitic greywacke that contains disseminated pyrite

(FeS_2) and gold-bearing arsenopyrite ($FeAsS_2$) detailed in *The Metallic Mineral Deposits of the Lower Palaeozoic Longford-Down Inlier*, *in the Republic of Ireland* (Morris 1984). Most veins dip steeply and trend north north-west as detailed in the *Historic Mine Sites - Inventory and Risk Classification* (EPA, 2009). Most of the mining sites were abandoned by the 1900s. The 25" OS maps from 1927 indicates the presence of an abandoned lead mine over 200m to the north of Tower 108.

73 The soil map indicates rock near surface at the site is underlain by Silurian/ Ordovician metasediments, a sequence of thick greywacke with thin bands of slate and mudstone. Contaminants associated with mines typically include heavy metals, hydrocarbons and sulphates. Whilst there are plausible contaminant linkages, such linkages have existed ever since the mines were operational in the 1900s. Since the closure of the mines, there have been no additional contaminant sources and impacts. If there are any present this would be limited to residual contaminants from the operation of the mines. A study of historical mines *Historic Mine Sites - Inventory and Risk Classification (EPA, 2009)* was undertaken by the EPA between 2006 and 2009 into the historic mines in Monaghan including Lemgare. No spoil heaps at the Lemgare site were identified during the EPA sampling.

7.4.7.2 Former Railway - Tower 140

74 Tower 140 is located close to an abandoned railway embankment which runs west to east, less than 200m north of the proposed tower location. The railway is marked as level with the surrounding topography and the former railway has since been removed from the field. The former railway was a branch off the Great Northern Railway serving the Castleblayney to Ballybay area.

75 The geological map shows that the site is underlain by superficial deposits consisting of till derived from sandstones and shales. The superficial deposits are underlain by Ordovician/ Silurian Metasediments. The thickness of the superficial deposits as mapped by the GSI are >3m in this location (high vulnerability, low permeability).

76 The earliest OS 6" plan for 1841 shows the site undeveloped. The railway was not constructed until 1864. The OS 25" map dated 1927 shows that the line had been developed as a single track railway. The section was decommissioned in 1953.

77 Contaminants associated with railway lines typically include ash (heavy metals), hydrocarbons, creosote from sleeper treatment and sulphates from track ballast and herbicides. Many of the contaminants associated with railway land are volatile and are likely to have evaporated, and the heavier fractions such as metals and Polycyclic Aromatic Hydrocarbons (PAHs) are sealed within the track route by organic matter.

78 Whilst there are plausible contaminant linkages, such linkages have existed ever since the railway was constructed in the 1860s. Since the closure of the railways in the 1950s and 1960s there have been no additional contaminant sources and impacts, if any, would be limited to residual contaminants present from the operation of the railway. It is likely that the majority of the mobile contaminants would have migrated from the site over the past 50 years and that any residual contaminants are present in immobile forms. Accordingly, it is considered unlikely that there are any sources of significant residual contamination associated with the former railway line remaining on the site.

79 Tower 140 will be located to the south of the former railway lines and the footprint of the tower will not include the former railway line.

7.4.7.3 Disused Quarries and Soil Excavation areas - Towers 131, 153, 172, 180, 182, 199 and 216

80 The excavations appear to be minor excavations undertaken in the last 20 years for use in construction activities in the local area. Pits appear to be localised and limited in real extent (<0.5 acres) with the exception of Tower 182. The excavations shown appear to be disused and due to the distance from the tower locations, it is considered that they will not be disturbed by and do not pose a contamination risk to the proposed development. Potential sources of contaminants include the disposal of agricultural related waste material in the excavations. Contamination has occurred in Ireland where open excavations were backfilled with waste materials. Based on the site walkovers and aerial photographs there is no visual evidence of contamination. In the absence of excavation of the former quarries/ pits (the potential ‘source’ of any contamination) for the tower construction, it is concluded that the construction works will not disturb any potential contamination and that the works will not alter the existing ground conditions. As the construction of the tower would not affect the excavations, it is considered that any contaminant pathways will not be realised as part of the proposed development.

7.5 POTENTIAL IMPACTS

7.5.1 Do Nothing

81 The Do Nothing alternative describes the circumstance where no development occurs. Under a ‘Do-Nothing’ scenario, no likely significant implications arise in respect of soil, geology or hydrogeology.

7.5.2 Construction Phase

82 During the preparation of the EIS, there were a number of constraints in terms of site access, however, notwithstanding these constraints, a robust evaluation of the likely significant effects of all aspects of the proposed development, both in respect of the line and the towers, has been

undertaken for the purpose of preparing this EIS. This section should be read in conjunction with the construction methodology as outlined in Chapter 7, **Volume 3B** of the EIS. The proposed development will have potential impacts on the soil, geology and hydrogeology of the CMSA. Impacts of the construction works on the surface water environment in relation to silt runoff are considered in **Chapter 8** of this volume of the EIS.

83 The significance of potential impacts associated with contaminated land has been evaluated broadly based on guidelines in *Contaminated Land Risk Assessment, A Guide to Good Practice (CIRIA,* 2011). Potentially contaminated land has been identified along the proposed development. However, no significant potential contamination risk was identified along the line route. The potentially contaminated land sites identified along the line route do not pose a significant risk of contamination or a constraint to the proposed development. Accordingly, it is concluded that the sites of potentially contaminated land in proximity to the proposed development would not be disturbed by the construction process and do not pose a constraint to the proposed development. If contamination is unexpectedly encountered mitigation measures are incorporated (See **Section 7.6**).

84 The construction phase of the proposed development will impact on the ground and geological conditions through the use of temporary access routes and excavations required for the tower bases. The extent of the excavations required for the tower bases will vary depending on the precise geological conditions at each tower. The working area for construction of a 400 kV tower will extend to 30 x 30m all around the footprint of the base of the tower, with the exception of Towers 166 and 168. Towers 166 and 168 have larger working areas proposed to account for additional excavations required to stabilise ground adjacent to the foundation locations. The minimum width of these working areas is proposed to be 41m at Tower 168 and 34m at Tower 166. As noted in Chapter 7, **Volume 3B** of the EIS, tower foundations typically range from 2m to 3.5m in depth to the invert level of the foundation and anywhere from 2 x 2 metres squared, to 9 x 9 metres squared, in plan area depending on tower type. Each of the four corners of the tower stubs (i.e. lower part of the tower leg) will be separately anchored below ground in a block of concrete. The standard ESB practice is to use a concrete pipe lining in the foundation holes as an integral part of the foundation. Approximately 10,500m^3 of material will be excavated as part of the proposed development in the CMSA.

85 It is considered that the construction works only, would have minor effects on the geomorphology of the area, as the tower and the material storage yard construction would not materially change the local slopes and topography.

86 The tower locations have been selected to avoid known areas of lacustrine deposits, intact peat and cutover peat, where possible. Intact peat was not identified at any tower location along the line route. Cashel Bog and other intact / high ecological value peatlands have been avoided.

Accordingly, it is considered that the excavations required for the construction of the principal elements of the proposed development (towers bases) would have no adverse impacts on the more sensitive peat ecosystem. Cutover peat is mapped at seven tower locations (Towers 104, 105, 119, 120, 122, 163 and 187) with most areas reclaimed for agricultural land use. In the unlikely event that piled foundations may be required at these locations; the potential soil geology and hydrogeology impacts are not significant. Mitigation measures are outlined in **Section 7.6** .

87 It is considered that the vast majority of excavated material will consist of subsoil and naturally excavated soils and rock. The surplus excavated material from tower excavations will be approximately 10,500m^3. Assuming a worst case scenario, all material will be taken off site and deposited at an appropriately licensed/ permitted waste management site. As it is anticipated that the excavated materials would comprise natural uncontaminated soils, there would be no contamination restrictions on the ability of licensed/ permitted waste management sites to accept the materials. Mitigation measures will be in place should contamination be encountered as outlined in **Section 7.6**.

88 The ground conditions in the vicinity of the proposed development are considered to be of low sensitivity with no Groundwater Dependent Terrestrial Ecosystem (GWDTE) in close proximity of the line. Impacts on the existing ground conditions would be restricted to the tower locations. The magnitude of the impacts at the tower locations is considered to be low.

89 Impacts on the existing ground conditions will be restricted to the tower locations, temporary access routes, guarding locations and stringing locations. The magnitude of the impacts at the tower locations is considered to be low. Temporary access tracks will comprise of aluminium road panels or rubber matting. Placing of temporary access tracks will be required at a number of tower locations. Potential impacts may arise where temporary access routes cross areas of cutover peat and alluvial soils. Approximately 19 type 2 temporary access tracks (i.e. temporary rubber matting or aluminium road panels) may be required on the CMSA line route where temporary access routes traverse cutover peat, lacustrine or alluvial soils and if weather conditions are very poor (refer to Chapter 7, **Volume 3B** of the EIS). It is not proposed to use stone roads or timber sleepers as part of the proposed development. Mitigation measures are detailed in **Section 7.6**.

90 The OHL alignment passes close to two proposed County Geological Sites (CGSs) namely the former Lemgare Mine and Tassan Mine. The alignment does not go through the sites and hence these sites will not be affected by the proposed development. The nearest tower is located approximately 60m from the Lemgare CGS within an agricultural field. The geological interest at the site is the bedrock exposures, mine audits and spoil heaps however many of the features have been removed during the ensuing 100 years. The potential impacts were

discussed with the GSI and mitigation measures are proposed in **Section 7.6**. No significant impact was identified in consultation with the GSI.

91 During the construction phase, the digging of foundations for the towers may lead to an increase in soil erosion. In addition topsoil, subsoil removal and rock excavation will be required. Topsoil removal has the potential for silt and clay to be removed by rainfall and surface water runoff. Siltation of nearby watercourses may be a potential impact and careful removal and storage of subsoil should be considered. Any topsoil that is removed will be used for regrading at a later stage. Potential impacts and mitigation measures in relation to soil erosion are addressed in **Sections 7.6** and **7.7**.

92 Alterations to existing transmission OHL structures will be required on the Lisdrum – Louth 110kV line and the Louth – Rathrussan 110 kV line, to ensure there are adequate electrical safety clearances maintained between the proposed 400 kV circuit and the existing 110 kV lines. No significant potential impacts arise from these construction works. Mitigation measures in relation to soil erosion are addressed in **Section 7.7**.

93 During the construction phase, machinery on site will include diesel powered trucks, excavators and the use of either a derrick or mobile crane. The potential impacts to the underlying soil and geology from the proposed development could derive from accidental spillages of fuels, oils and solvents, which could impact the soil, bedrock and groundwater quality, if allowed to infiltrate to ground during construction.

94 The proposed development has the potential to impact locally on groundwater flow and quality. All impacts that are realised would be of a temporary nature for the construction period. The principal potential impacts include a reduction in groundwater level and modification in groundwater flow as a result of dewatering, deterioration in groundwater quality as a result of suspended solids and contaminant (oils and chemicals), spills/ leaks during construction and operation.

95 The evaluation of the significance of potential impacts on groundwater is based on the source-pathway-receptor approach and is determined from a combination of the sensitivity of the receptor and the magnitude of any impact. Groundwater receptors include poorly productive aquifers, GWDTE and water abstraction boreholes. No tower is located within 200m of a public water supply or the inner source protection of public groundwater supply schemes.

96 The tower excavations will vary between approximately 2m and 3.5m in depth, subject to the precise ground conditions at each tower location. In low lying areas groundwater may be encountered in excavations. If excavations for tower bases encounter groundwater, such

inflows may need to be pumped, resulting in short term localised drawdown of the water table and discharges to the surface water channels.

97 Due to the limited drawdown and pumping required, it is considered that any significant impacts on the groundwater level will be realised only in close proximity to the point of abstraction. Any impacts will be restricted to the short period of pumping. Drawdown decreases exponentially away from the point of abstraction. The majority of the tower locations are remote from properties and hence it is unlikely that any dewatering of the excavations would impact on existing wells and boreholes as these tend to be located in close proximity to the user's property however, a precautionary approach will be followed where groundwater is encountered in excavations. The need for dewatering to construct the tower footings will be confirmed at the construction stage. Where groundwater is identified in excavations within 100m of houses, monitoring and evaluation of groundwater and water levels will be undertaken.

98 Water pumped from the excavations may contain suspended solids and contaminants. In the absence of any treatment, the disposal of this water to ground or to the surface water system could cause deterioration in water quality of the receiving system. Mitigation measures are outlined in **Section 7.6** .

99 There may be a risk of soil and groundwater pollution from site traffic through the accidental release of oils, fuels and other contaminants from vehicles. Mitigation measures are outlined in **Section 7.6**.

100 The significance of potential impacts associated with contaminated land has been evaluated based on guidelines in *Contaminated Land Risk Assessment, A Guide to Good Practice (CIRIA,* 2011). No significant potential contamination risk was identified at the proposed construction materials storage yard based on site observations and soil sampling.

7.5.2.1 Construction Material Storage Yard

101 The construction phase of the proposed development will impact on the ground and geological conditions through the use of construction material storage yard however only minor excavations are proposed at the site. It is considered that the construction works would have minor effects on the geomorphology of the area, as the construction materials storage yard would not materially change the local slopes and topography. The site was extensively modified as part of the N2 by pass. While a potential turlough was marked near the site (Sheedy-Skeffinton et al, 1996), no evidence of a turlough was noted at the site or in the surrounding area in January 2014 or during the *Wetland Survey County Monaghan* (Foss & Crushell, 2011). It should be noted that the entire low lying area to the east was also modified to accommodate the N2 by-pass.

102 During the construction phase, machinery on site will include diesel powered trucks, excavators and a crane. The potential impacts to the underlying soil and geology from the proposed development could derive from accidental spillages of fuels and oils, which could impact the soil, bedrock and groundwater quality, if allowed to infiltrate to ground during construction. The proposed construction materials storage yard is located within a Regionally Important Karst Aquifer however the site is underlain by deep subsoil and made ground and does not pose a significant risk to the groundwater. Mitigation measures are proposed in **Section 7.6.**

103 During the construction phase, the construction materials storage yard may lead to an increase in soil erosion. Siltation of nearby watercourses may be a potential impact and careful removal and storage of subsoil will be completed to mitigate against this. Topsoil will be used for regrading at a later stage.

7.5.3 Operational Phase

104 Due to the nature of the proposed development, there will be machinery periodically on the site at a given time. This may lead to occasional accidental emissions, in the form of oil, petrol or diesel leaks, which could cause contamination if they enter the soil and bedrock environment.

105 It is not proposed to discharge wastewater to groundwater and therefore potential impacts do not arise.

7.5.4 Decommissioning

106 The proposed development will become a permanent part of the transmission infrastructure. The expected lifespan of the development is in the region of 50 to 80 years. This will be achieved by routine maintenance and replacement of hardware as required. There are no plans for the decommissioning of the OHL. In the event that part of, or the entire proposed infrastructure is to be decommissioned, all towers, equipment and material to be decommissioned will be removed off site and the land reinstated. Impacts would be expected to be less than during the construction phase and would be of short term duration.

7.6 MITIGATION MEASURES

107 In identifying the route of the proposed development, 'avoidance of impact' measures were employed.

7.6.1 Construction Phase

108 Measures to minimise the impact of the proposed development on local geology include reuse of in situ material and importation of additional material from local sources. The placement of

towers has avoided areas of intact peat, therefore the hydrology of peat masses in the general vicinity of the alignment will not be affected.

109 It is proposed to mitigate the potential impacts on the Lemgare CGS, which is located approximately 60m from the nearest tower. Soils and bedrock will be encountered during the site investigation works / construction of the towers. The GSI have been consulted at all stages of the application. The mitigation measures include the following:

- Continued consultation with the GSI;
- Limiting excavation by only excavating the required footprint;
- Maintaining an adequate distance from Lemgare CGS; and
- The GSI will be notified about any significant new section / feature that is exposed within the tower footprint.

110 All construction waste will be stored, managed, moved, reused or disposed of in an appropriate manner by appropriate contractors in accordance with *Waste Management Act 1996 (as amended)* (refer to Chapter 7, **Volume 3B** of the EIS). Excess soils / subsoils will be disposed of at licensed / permitted waste management facilities. Excess steel will be disposed of / recovered offsite at a licensed waste disposal site. All waste material will require the necessary waste permits and documentation as part of the construction programme and the CEMP. An outline CEMP has been included in **Appendix 7.1, Volume 3B** of the EIS, and forms part of the application documentation. All relevant mitigation measures set out in the EIS are included in the outline CEMP and will be incorporated into the final CEMP.

111 Excavated soil and subsoil will be stored adjacent to the excavation area. Excavated material will be reused in situ where possible. Typically $34m^3$ of soil / rock will be excavated at each intermediate tower location with approximately $230m^3$ of soil / rock excavated from angle towers. In the event no material is suitable / wanted for reuse by landowners, subsoil will be disposed of at a licensed / permitted facility, in accordance with the *Waste Management Acts* and associated regulations. Where subsoil is retained, an evaluation by the onsite ecologist is required to minimise potential ecological impacts. Typically subsoil is reused by landowners, however, assuming a worst case scenario, surplus material will be disposed of at licensed / permitted facility. Further details of the facilities considered are provided at **Appendix 7.2, Volume 3C Appendices** of the EIS.

112 All excavated materials will be visually evaluated for signs of possible contamination such as staining or strong odours. In the event that any unusual staining or odour is noticed, samples of this soil will be analysed for the presence of possible contaminants in order to ensure that

historical pollution of the soil has not occurred. Should it be determined that any of the soil excavated is contaminated, this will be disposed of pursuant to the provisions of the *Waste Management Acts* and associated regulations. As noted above, any contaminated material that may potentially be encountered would be disposed of at a licensed facility, in accordance with the *Waste Management Acts* and associated regulations.

113 To minimise any potential impact on the underlying subsurface strata from any material spillages, all oils and fuels used during construction will be stored on a temporary proprietary bunded surface (i.e. contained bunded plastic surface). These will be moved to each tower location as construction progresses. Refuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles will take place away from surface water gullies or drains. No refuelling will be allowed within 50m of a stream / river. Spill kits and hydrocarbon absorbent packs will be stored in this area and operators will be fully trained in the use of this equipment.

114 Controlling working practices by, for example, minimising land take, avoiding repetitive handling of soils, minimising vehicle movements off road and limiting the size of stockpiles will reduce the compaction and erosion of material. Once all works are complete, the access route and the construction areas which have been disturbed around the towers during the tower foundation installation and tower erection phases are reinstated. Any impacts are considered likely to be minor and of short term nature.

115 Any vehicles utilised during the operational phase will be maintained on a weekly basis and checked daily to ensure any damage or leakages are corrected. The potential impacts are limited by the size of the fuel tank of the largest plant / vehicles used on the site. Precautions will be taken to avoid spillages. These include:

- Use of secondary containment e.g. bunds around oil storage tanks;
- Use of drip trays around mobile plant;
- Supervising all deliveries and refuelling activities; and
- Designating and using specific impermeable refuelling areas isolated from surface water drains.

116 The majority of the tower locations are remote from dwellings and hence it is unlikely that short term dewatering of the excavations would impact on existing wells and boreholes. Where it is necessary to dewater to construct the tower foundations in close proximity of wells, monitoring will be carried out of wells within 100m of the tower locations.

117 Water pumped from the excavations may contain suspended solids. Standard methods of dewatering including ejectors, well points or submersible pumps will be used. Settlement may be required to reduce the suspended solids concentrations to protect the quality of the receiving water system. Settlement will be undertaken by a standard water filtration system to control the amount of sediment in surface water runoff. Direct discharge to stream or rivers will not be permitted.

118 The mitigation measures outlined in relation to soils, geology and hydrogeology will be implemented as part of the CEMP. This plan will incorporate the mitigation measures indicated in the EIS, and any others deemed necessary, and shall provide details of intended construction practice for the proposed development (see Chapter 7, **Volume 3B** of the EIS). An outline CEMP can be found in Appendix 7.1, **Volume 3B Appendices** of the EIS.

7.7 RESIDUAL IMPACTS

119 The nature of the development dictates that the greatest potential impact for geological impact (including soil, subsoil and bedrock) associated with the proposed development will be in the construction phase. It is predicted that the geological impacts associated with the construction phase of the development is negligible and short term.

120 With regard to the operational phase of the development, no significant impacts on the local geological or hydrogeological environment are predicted. Application of the identified mitigation measures for the predicted impact on soils geology and hydrogeology will ensure that the residual impact is negligible.

7.8 INTERRELATIONSHIPS BETWEEN ENVIRONMENTAL FACTORS

121 The potential for interrelationships arises with the environmental topics of water and flora and fauna. Soils, geology and hydrogeology have an important interrelationship with the water and ecological environment, as a determinant of water chemistry, river flow regimes, water storage capacity and watercourse location. It also has an impact on water quality through the ability of bedrock and surface deposits to filter potential pollutants. Potential ecological impacts could occur through the mishandling of soils or through the deposition of excavated soils in ecologically sensitive areas. These potential impacts have been identified in **Section 7.5** and mitigation measures have been proposed in **Section 7.6**.

122 An evaluation was undertaken based on the identification of potential sources, pathways and receptors along the line route. If all three elements (source, pathway and receptor) are present, there is a linkage and there is a potential impact to the receptor(s). In terms of surface water and ecology, there are no cSACs or groundwater dependent terrestrial ecosystems (GWDTE) in close proximity to the line route.

123 This chapter should be read in conjunction with **Chapters 6** and **8** of this volume of the EIS and Chapter 7, **Volume 3B** of the EIS.

7.9 CONCLUSIONS

124 The subsoil underlying the alignment is primarily composed of unsorted till deposits while minor quantities of soft sediments including peat and alluvial deposits are also located along the proposed alignment. The construction phase of the proposed development will impact on geological conditions through the use of temporary access routes and excavations required for the tower bases.

125 The nature of transmission line development dictates that the greatest potential impact for geological impact (including soil, subsoil and bedrock) associated with the development will be in the construction phase. During construction the potential impacts to the underlying soil and geology from the proposed works could derive from accidental spillages of fuels, which could impact the soil, bedrock and groundwater quality, if allowed to infiltrate to ground. As described in Section 7.7, application of the identified mitigation measures for the predicted impact on soils geology and hydrogeology will ensure that the residual impact is negligible.

126 The tower locations have been selected to avoid known areas of lacustrine deposits, intact peat and cutover peat where possible. Intact peat was not identified at any tower location along the line route including Cashel Bog. Accordingly, it is considered that the excavations required for the construction of the principal elements of the proposed development will have no adverse impacts on the more sensitive peat ecosystem.

127 No significant adverse effects are predicted on the geological or hydrogeological environment as a result of the construction and operational phases of the proposed development.

128 The predicted impact on the soils and geology is considered to be long term and negligible.