Chapter 14
Land, Soils, Geology & Hydrogeology

Contents

14. Land, Soils, Geology & Hydrogeology

14.1 Introduction

This Chapter of the Environmental Impact Assessment Report (EIAR) considers the potential impacts on land, soil, geology, and hydrogeology as a result of the Construction and Operational Phases of the Lucan to City Centre Core Bus Corridor Scheme (hereafter referred to as the Proposed Scheme). Chapter 4 (Proposed Scheme Description) includes a full description of the Proposed Scheme.

During the Construction Phase, the potential land, soils, geology and hydrogeology impacts associated with the development of the Proposed Scheme have been assessed. This includes the potential for contamination of soils and groundwater, and the loss of natural soils from excavation activities associated with utility diversions, road resurfacing, and road realignments.

During the Operational Phase, the potential land, soils, geology and hydrogeology impacts associated with changes to water supply and the pollution of groundwater and watercourses have been assessed.

Potential impacts on the surface water environment are not considered in this assessment but are considered separately in Chapter 13 (Water).

The assessment has been carried out according to best practice and guidelines relating to land, soils, geology and hydrogeology assessment, and in the context of similar large-scale infrastructural projects.

An assessment is made of the likely significant impacts associated with the Construction and Operational Phases of the Proposed Scheme on these resources. Measures are presented to mitigate or eliminate the impacts of the Proposed Scheme on the soils, subsoils, bedrock, geological resources and heritage and hydrogeology.

The aim of the Proposed Scheme when in operation is to provide enhanced walking, cycling and bus infrastructure on this key access corridor in the Dublin region, which will enable and deliver efficient, safe, and integrated sustainable transport movement along the corridor. The objectives of the Proposed Scheme are described in Chapter 1 (Introduction). The Proposed Scheme which is described in Chapter 4 (Proposed Scheme Description) has been designed to meet these objectives.

The design of the Proposed Scheme has evolved through comprehensive design iteration, with particular emphasis on minimising the potential for environmental impacts, where practicable, whilst ensuring the objectives of the Proposed Scheme are attained. In addition, feedback received from the comprehensive consultation programme undertaken throughout the option selection and design development process have been incorporated, where appropriate.

14.2 Methodology

The following Sections outline the legislation and guidelines considered, and the adopted methodology for defining the baseline environment and undertaking the assessment in terms of land, soils, geology and hydrogeology.

The potential impacts of the Proposed Scheme on land, soils, geology and hydrogeology have been assessed by classifying the importance of the relevant attributes and quantifying the likely magnitude of any impact on these attributes.

14.2.1 Study Area

The land, soils, geology and hydrogeology study area for the Proposed Scheme extends 250m (metres) either side of the Proposed Scheme boundary which is in accordance with the Institute of Geologists of Ireland (IGI) Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements (hereafter referred to as the IGI Guidelines) (IGI 2013).

The Proposed Scheme has been divided into sub-sections for ease of presentation and due to the volume of information available. The sub-sections of the Proposed Scheme are as follows:

- Section 1: N4 Junction 3 to M50 Junction 7 – N4 Lucan Road;
- Section 2: M50 Junction 7 to R148 Con Colbert Road – R148 Palmerstown bypass and Chapelizod bypass; and
- Section 3: R148 Con Colbert Road to City Centre – St. John's Road West.

14.2.2 Relevant Guidelines, Policy and Legislation

The main documents that have been followed for the preparation of the land, soils, geology and hydrogeology assessment are:

- IGI Guidelines (IGI 2013); and
- National Roads Authority (NRA) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (hereafter referred to as the NRA Guidelines) (NRA 2008a).

Though the NRA is now known as Transport Infrastructure Ireland (TII), for the purpose of this Chapter the guidelines mentioned above are referred to as the NRA Guidelines.

In addition, the assessment has been prepared using the following guidelines and legislation:

- Environmental Protection Agency (EPA). Guidelines on the Information to be Contained in Environmental Impact Assessment Reports (hereafter referred to as the EPA Guidelines) (EPA 2017);
- European Commission, Environmental Impact Assessment of Projects Guidance on the preparation of the Environmental Impact Assessment Report (2017);
- Environmental Impact Assessment of National Road Schemes – A Practical Guide (NRA 2008b);
- Strive Report Series No. 100. Evaluating the Influence of Groundwater Pressures on Groundwater-Dependent Wetlands. Strive EPA Programme 2007 - 2013 (EPA 2011); and
- Environmental Research Centre Report Series No. 12. A Framework for the Assessment of Groundwater-Dependent Terrestrial Ecosystems under the Water Framework Directive. Strive EPA Programme 2007 – 2013 (EPA 2008).

14.2.3 Data Collection and Collation

Data was compiled from publicly available datasets, the findings of ground investigations, design information, a scheme walkover survey, and other sources, as outlined below.

14.2.3.1 Publicly Available Datasets

The publicly available datasets listed in Table 14.1 have been acquired and consulted in the assessment of the baseline conditions. All datasets were accessed throughout 2020 and 2021.

Table 14.1: Publicly Available Datasets

Source	Name	Description
Ordnance Survey Ireland (OSI)	Current and historical ordnance survey maps	Current and historical survey maps produced by the OSI.
OSI	Aerial photography	Current and historical survey maps produced by the OSI.
Google	Aerial photography	Current aerial imagery produced by Google.
Bing	Aerial photography	Current aerial imagery produced by Bing.
Teagasc	Teagasc Soils Data	Surface soils classification and description.
Geological Survey Ireland (GSI)	Quaternary Mapping	

Source	Name	Description
	Bedrock Mapping	Geological maps of the site area produced by the GSI and available on GSI online map viewer.
	Aggregate Potential Mapping	
	Mineral Localities	
	Geotechnical viewer	
	Groundwater Mapping	
	Groundwater Levels	
	National Landslide Database	
	Karst Database	
	Active Quarries and pits	
	County Geological Sites (CGS) and Geological Heritage Areas	
	GSI, Memoirs	
EPA	Corine Land Cover 2018	These datasets are based on interpretation of satellite imagery and national in-situ vector data.
	Designated Natural Heritage Area (NHA). Special Protections Area (SPA), Special Area of Conservation (SAC) sites.	
	River Network Map	
	EPA Hydro Net	Reports of groundwater level monitoring points.
National Parks and Wildlife Service (NPWS)	Mapping within the area of the Proposed Scheme	This dataset provides information on national parks, protected sites and nature reserves.
National Monuments Service (NMS)	State Mining and Prospecting Facilities	This dataset provides all recorded archaeological monuments.
Department of Communications, Energy and Natural Resources (DCENR)	Minerals Ireland	A booklet contains a list of all current and prospecting mining facilities.
	Historic Mine Sites – Inventory and Risk Classification	Department of the Environment, Climate and Communications

14.2.3.2 Ground Investigation

The details of the historical ground investigation reports located within the study area which have been used in the assessment of the baseline conditions are presented in Table 14.2. These reports are publicly available from the Geological Survey of Ireland (GSI) Spatial Resources Map Viewer 'EXT GSI Geotechnical Sites layer' (GSI, 2019a).

Table 14.2: Existing Ground Investigations

GSI Report ID	Title	Year	Author	Location	Scope
R121	Lucan Bypass	1985	IGSL	Ballydowd, Lucan	12 rotary boreholes
R123	Retail Park	1991	Horgan Lynch and Partners	Kennelsfort Road Junction	4 cable percussive boreholes and 2 trial pits
R122	McDonalds Restaurant	1991	Horgan Lynch and Partners	Kennelsfort Road Junction	2 cable percussive boreholes and 2 trial pits
R954	St. Laurance Road Chapelizod	1984	IGSL	St. Laurance Road Chapelizod	8 cable percussive boreholes

GSI Report ID	Title	Year	Author	Location	Scope
R716	Dublin Rapid Transit Project	1982	SIL	Tallaght to Heuston	7 cable percussive boreholes and 22 trial pits
R951	Con Colbert Road	1983	IGSL	Con Colbert Road	3 cable percussive boreholes
R75	New School	1983	IGSL	Inchicore	3 cable percussive boreholes
R2531	Proposed New Bridge	1987	SIL	Islandbridge	8 cable percussive boreholes
R4851	Heuston Station	2001	IGSL	Heuston Station	5 cable percussive boreholes
R160	Quarryvale Site Investigation	1995	Site Investigations Ltd.	Lucan Road / Fonthill Road	14 rotary corings
R3844	Pedestrian Footbridge	Unknown	Unknown	N4 Road, Lucan, Co.Dublin.	3 trial pits
R524	Palmerstown-Ballydowd Road Scheme	1970	Glover Site Investigations Ltd.	Route Palmerstown-Ballydowd	12 cable percussion boreholes
R956	Kylemore Road	1984	IGSL	Kylemore Road, Dublin	12 cable percussion boreholes
R53	Chapelizod By-Pass / Ballyfermot Hill	1988	IGSL	Chapelizod, Dublin	4 cable percussion boreholes
R953	Chapelizod By-Pass	1984	IGSL	St.Laurence's Road, Chapelizod	12 cable percussion boreholes
R1048	Long meadows	1986	IGSL	Longmeadows, Ballyfermot	4 cable percussion boreholes
R955	Proposed Footbridge Chapelizod	1989	IGSL	The Ranch Ballyfermot	4 cable percussion boreholes
R7412	Dublin underground EIS	Unknown	IGSL	Dublin Co Dublin	27 cable percussion boreholes, 119 rotary core drillings, five trial pits and 12 window samples
R341	St John's Road Bridge	Unknown	Unknown	St.John's Road Bridge, Kilmainham	One borehole non-specified
R881	Liffey Bridge	1977	Geotechnical Consulting Services Ltd.	50m east of Sean Heuston Bridge	21 cable percussion boreholes
R7552	DART underground	Unknown	Unknown	DART underground office, Heuston Station.	174 boreholes non specified

The scheme-specific ground investigations carried out to inform the Proposed Scheme and EIAR are listed in Table 14.3 and the factual reports are included in Appendix A14.2 Ground Investigations in Volume 4 of this EIAR. These provide useful verification for the data already compiled relating to the baseline environment.

Table 14.3: Scheme-Specific Ground Investigations

Title	Contractor	Year	Location	Scope
Lucan to City Centre Core Bus Corridor Scheme	Causeway Geotech	December 2020	Lucan to City Centre	6 cable percussive and 1 rotary follow on borehole, 6 window samples, 1 slit trench and groundwater monitoring from one standpipe.

14.2.3.3 Design Information

The design information as provided in Chapter 4 (Proposed Scheme Description) and Chapter 5 (Construction) as well as the Plan and Profile Drawings BCID-ACM-GEO-CS-0006-XX-00-DR-CR-9001 in Volume 3 of this EIAR) have been used in the assessment.

14.2.3.4 Scheme Walkover

A scheme walkover survey was carried out on 14 January 2020 and 7 July 2021 to inform and verify the review of publicly available datasets.

The findings of the scheme walkover survey including photos and scheme walkover survey notes are included in Appendix A14.1 Scheme Walkover Summary in Volume 4 of this EIAR.

14.2.4 Appraisal Method for the Assessment of Impacts

The impact assessment for this Chapter has been carried out in accordance with the NRA Guidelines (NRA 2008a) and the IGI Guidelines (IGI 2013).

The likely significant impacts have been assessed by classifying the importance of the relevant attributes and quantifying the magnitude of any likely significant impacts on these attributes, as outlined below:

14.2.4.1 Baseline – Initial Assessment

In order to identify and quantify the likely significant impacts of the Construction Phase and Operational Phase of the Proposed Scheme, it is first necessary to undertake a detailed study of the (baseline) geological and hydrogeological environment of the study area for the Proposed Scheme.

The existing land, soils, geology and hydrogeology conditions in the study area have been interpreted from review of existing data, consultation, scheme walkover surveys and from Proposed Scheme specific ground investigations.

This assessment includes the development of a preliminary Conceptual Site Model (CSM), which describes the ground conditions expected throughout the study area of the Proposed Scheme based on existing literature. Also, as part of this initial assessment, the preliminary generic type of geological / hydrogeological environment is determined. The IGI Guidelines (IGI 2013) provide five types of environments as examples (Types A to E), as described in Step 3 of the IGI Guidelines.

14.2.4.2 Baseline – Direct and Indirect Site Investigation

Information gathered on the baseline environment during specific ground investigations for the Proposed Scheme corresponds to the second element of the methodology, ‘Direct and Indirect Site Investigation and Studies’.

As part of the second element, relevant site investigations and studies close to the Proposed Scheme are gathered and assessed. Then, the preliminary CSM is refined accordingly.

14.2.4.3 Gradation of Impacts

The NRA Guidelines (NRA 2008a) provide criteria and examples for determining likely significant impacts. The relevant tables from the NRA Guidelines (NRA 2008a) are as follows:

- Box 4.1: Criteria for Rating Site Attributes – Estimation of Importance of Soil and Geology Attributes (Table 14.4);
- Box 4.3: Criteria for Rating Site Attributes – Estimation of the Importance of Hydrogeology Attributes (Table 14.5);
- The magnitude of impacts should be defined in accordance with the criteria provided in the NRA Guidelines. This is outlined in (Table 14.6);
- Box 5.1: Criteria for Rating Site Attributes at EIA Stage – Estimation of Magnitude on Soil/ Geology Attribute (Table 14.7);
- Box 5.3: Criteria for Rating Site Attributes at EIA Stage – Estimation of Magnitude of Impact on Hydrogeology Attributes (Table 14.8); and
- Box 5.4: Rating of Significant Environmental Impacts at EIA Stage (Table 14.9).

The NRA Guidelines criteria uses similar significance terminology as the EPA Guidelines (EPA 2017). However, it has intermediate steps to justify using that terminology:

- Step 1: Quantify the importance of a feature for geology (Box 4.1) and hydrogeology (Box 4.3);
- Step 2: Estimate the magnitude of the impact on the feature from the Proposed Scheme (Box 5.1, Box 5.3); and
- Step 3: Determine the significance of the impact on the feature from the matrix (Box 5.4) based on the importance of the feature and the magnitude of the impact

Table 14.4: Criteria for Rating the Importance of Identified Geological Attributes (Table C2 (IGI 2013) and Box 4.1 (NRA 2008))

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 (CGS) Well drained and / or highly 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

Table 14.5: Criteria for Rating the Importance of Identified Hydrogeological Attributes (Box 4.3 NRA,2008).

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. (candidate Special Area of Conservation (cSAC) or Special Protection Area (SPA) status
Very High	Attribute has a high quality or value on a regional or national scale	Regionally important aquifer with multiple well fields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – Natural Heritage Area (NHA) status Regionally important potable water source supplying >2500 homes Inner source protection area for regionally important water source
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer Groundwater provides large proportion of baseflow to local rivers Locally important potable water source supplying >1000 homes Outer source protection area for regionally important water source Inner source protection area for locally important water source
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer

Importance	Criteria	Typical Example
		Potable water source supplying >50 homes Outer source protection area for locally important water source
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer Potable water source supplying <50 homes

Table 14.6: Definition of Magnitude of Impact (Table 5.1 (NRA 2008))

Magnitude of Impact	Description
Imperceptible	An impact capable of measurement but without noticeable consequences
Slight	An impact that alters the character of the environment without affecting its sensitivities
Moderate	An impact that alters the character of the environment in a manner that is consistence with existing or emerging trends
Significant	An impact which by its character, magnitude, duration, or intensity alters a sensitive aspect of the environment
Profound	An impact which obliterates all previous sensitive characteristics

Table 14.7: Criteria for Rating Soil and Geology Impact Significance and Magnitude at EIA stage (Table C4 (IGI 2013) and Box 5.1 (NRA 2008))

Magnitude of Impact	Criteria	Typical Example
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 14.8: Criteria for Rating Hydrogeological Impact Significance and Magnitude at EIA stage (Box 5.1 NRA 2008)

Magnitude of Impact	Criteria	Typical Example
Large Adverse	Results in loss of attribute and/or quality and integrity of attribute	Removal of large proportion of aquifer

Magnitude of Impact	Criteria	Typical Example
		Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems Potential high risk of pollution to groundwater from routine run-off Calculated risk of serious pollution incident during operation >2% annually
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Removal of moderate proportion of aquifer Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems Potential medium risk of pollution to groundwater from routine run-off Calculated risk of serious pollution incident during operation >1% annually
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Removal of small proportion of aquifer Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems Potential low risk of pollution to groundwater from routine run-off Calculated risk of serious pollution incident during operation >0.5% annually
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident during operation <0.5% annually

Table 14.9: Rating of Environmental Impacts at EIA Stage (NRA 2009)

		Magnitude of Impact			
		Negligible	Small	Moderate	Large
Importance of Attribute	Extremely High	Imperceptible	Significant	Profound	Profound
	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

14.2.4.4 Mitigation Measures, Residual Impacts and Final Impact Assessment

The third element of the recommended steps builds on the outcome of the preceding two elements, by identifying mitigation measures to address potential significant or profound impacts and then assessing the significance of any residual impacts. Mitigation by design measures which have been incorporated into the design for the Proposed Scheme are also considered in Section 14.5.

The final impact assessment includes a description of any residual impacts. The significance of any residual impact is determined based on the same methodology and reported.

14.3 Baseline Environment

14.3.1 Introduction

This Section describes the existing conditions and important features in terms of the land, soils, geology and hydrogeology within the study area of the Proposed Scheme. A regional overview is followed by a description of site-specific baseline conditions and a CSM. Features are then identified, and their importance ranked in accordance with the NRA Guidelines (NRA 2008a).

14.3.2 Regional Overview

The regional geomorphology, topography, soils and subsoils, bedrock geology and hydrogeology are discussed in this Section for the majority of County Dublin, including the City Centre and extends north to Swords and to Bray in County Wicklow in the south of the region.

14.3.2.1 Regional Topography and Geomorphology

The topography of the region is dominated by the Wicklow Mountains to the south with undulating topography to the north, west and east with localised highs generally synonymous with outcropping rock or near surface bedrock. There is a gradual drop in elevation across the region from west to east approaching the coast.

The landscape of the Greater Dublin Area (GDA) principally reflects the erosional and depositional legacy of the last period of glaciation, which ended some 10,000 years ago following the Devensian geological period. Glacial erosion of pre-existing topographic features and deposition of thick glacial drift deposits, mainly till (boulder clay), resulted in a rather subdued post-glacial topography.

The post-glacial landscape also reflects the effects of fluvial (river) processes that have altered the topography, with the River Liffey and its tributaries dominating the region, since the ice sheet retreat. The topography of the area reflects the geomorphology, showing topographic lows moving eastwards to the sea near Dublin City, becoming steeper to the west, north and south towards the Dublin and Wicklow Mountains.

There are a large number of geomorphology features across the region including mega scale glacial lineation in the north of the region, streamlined bedrock, numerous meltwater channels, hummocky sands and gravel deposits, drumlins, eskers and glaciofluvial terraces throughout the region (refer to Figure 14.1 in Volume 3 of this EIAR).

The post-glacial landscape also reflects the effects of fluvial (river) processes that have altered the topography, albeit only to a small extent in the region, since the ice sheet retreat. The coastline within the region is characterised by sandy beaches and rock outcrops.

The land uses in the region are mainly comprised of urban developments including but not limited to; industrial, commercial, residentialand recreational. Moving away from the City Centre there are also marine, agriculturaland forested areas in the region.

14.3.2.2 Regional Soils (Teagasc Classification)

Soils comprise the unconsolidated geological deposits which overlie the subsoil (i.e. the topsoil). The main soils within the region, as classified by Teagasc (Teagasc *et al*. 2017) are presented on Figure 14.2 in Volume 3 of this EIAR and have been listed in Table 14.10. The majority of Dublin is underlain by made ground with areas of alluvial, estuarine, and marine deposits present that may be associated with recent and ancient water bodies. To the north of the region, there are soils which are deep and well drained as well as poorly drained soils derived from basic parent material. To the south of the region the soil is derived from acidic material.

Table 14.10: Summary of Soil Types Within the Region

Soil Code	Description	Location
AeoUND	Aeolian undifferentiated	Coast
AlluvMin	Alluvial (min)	Along river courses and meltwater channels
AminDW	Deep well drained mineral soil (mainly acidic)	South towards Bray
AminPD	Mineral poorly drained (mainly acidic)	South towards Bray
AminPDPT	Peaty Gleys Acidic	Near Wicklow mountains
AminSP	Surface water gleys / ground water gleys shallow	South towards Bray
AminSW	Shallow well drained mineral soil (mainly acidic)	South towards Bray
AminSRPT	Shallow rocky peaty, non-peaty mineral complexes (mainly acidic)	Near Wicklow mountains
BktPT	Blanket Peat	Near Wicklow mountains
BminDW	Deep well drained mineral soil (mainly basic)	North near Swords
BminPD	Mineral poorly drained (mainly basic)	North near Swords
BminPDPT	Peaty gleys basic parent materials basic	Near Wicklow mountains
BminSP	Surface water gleys/ groundwater gleys shallow	South towards Newcastle
BminSPPT	Peaty gleys shallow	Near Wicklow mountains
BminSRPT	Lithosols peats	Near Wicklow mountains

Soil Code	Description	Location
BminSW	Renzinas/Lithosols	Dublin outskirts
Cut	Raised bog cutaway/cutover	Near Wicklow mountains
FenPT	Fenpeat	Near Wicklow mountains
Lac	Lacustrine sediments	South near Wicklow mountains
Made	Made ground	Dublin City and outskirts
MarSands	Marine sands and gravels	Coast
MarSed	Marine / estuarine sediments	Coast
Scree	Scree	Near Wicklow mountains

14.3.2.3 Regional Subsoils (GSI Quaternary Classification)

Superficial deposits (subsoil) comprise the unconsolidated geological deposits which overlie the solid geology. The subsoils within the region, as classified by the GSI Quaternary mapping (GSI 2016a) are presented on Figure 14.3 in Volume 3 of this EIAR and have been listed in Table 14.11.

During the Pleistocene epoch of the Quaternary, two glaciations covered County Dublin and County Wicklow which gave rise to the deposition of glacial till. Typically, during the ice advance, boulder clays were deposited sub-glacially as lodgement till over the eroded bedrock surface, whilst moraine granular deposits were laid down at the glacier margins.

Subsequently, with the progressive retreat of the ice sheets from the region, granular fluvio-glacial deposits were laid down in places by melt waters discharging from the front of the glacier which are generally encountered as sand and gravel lenses within the glacial till deposits. The glacial deposits can exhibit significant lateral and vertical variations in grain size distributions over short distances.

This glacial till is the predominant subsoil of the region and described as till derived from limestones. The subsoils of the region may also be comprised of made ground where major development has occurred. More recent alluvial deposits (silts and clays and sands and gravels) may be present along historic and recent watercourses.

To the east of the region, along the coast the subsoils consist of estuarine silts and clays and marine beach sands. Outcropping and sub cropping rock and till derived from granites and metamorphic rock are present to the south and west of the region where the topography rises towards the Dublin Mountains and Bray.

Table 14.11: List of Subsoils (Quaternary) Within the Region

Soil Type	Description	Location
A	Alluvium	Along river channels and meltwater channels
Ag	Alluvium (gravelly)	Along river channels and meltwater channels
As,	Alluvium (sandy)	Along river channels and meltwater channels
Asi	Alluvium (silty)	Along river channels and meltwater channels
BktPt	Blanket Peat	Near Wicklow Mountains
Cut	Cut over raised peat	Near Wicklow Mountains
AcEsk	Eskers comprised of gravels of acidic reaction	Tallaght / Ballymount
GCh	Gravels derived from chert	North West Dublin
GLPSsS	Gravels derived from Lower Paleaozoic sandstones and shales	Howth
GLs	Gravels derived from limestones	Dublin City
GMp	Gravels derived from metamorphic rocks	South towards Bray
GGr	Gravels derived from granite	South Dublin
Rck	Bedrock outcrop or subcrop	Localised pockets within Dublin City / near Wicklow Mountains
Scree	Scree	Near Wicklow Mountains
L	Lacustrine sediments	South near Wicklow mountains
Mbs	Marine beach sands	Coast
Mesc	Esturine silts and clays	Portmarnock

Soil Type	Description	Location
TdlMr	Tidal Marsh	Bull Island
IrSTCSsS	Irish Sea Till derived from Cambrian sandstones and shales	Bray South
IrSTLPSsS	Irish Sea Till derived from Lower Paleozoic sandstones and shales	Bray South
IrSTLs	Irish Sea Till derived from limestones	South towards Bray
TCSsS	Till derived from Cambrian sandstones and shales	Bray South
TGr	Till derived from granites	South Dublin
TLPSsS	Till derived from Lower Paleozoic sandstones and shales	South Dublin
TLs	Till derived from limestones	Dublin City
TMp	Till derived from metamorphic rocks	Near Wicklow Mountains
TQz	Till derived from quartzites	South towards Bray
Ws	Windblown sands	Coast
Wsd	Windblown sands and dunes	Coast
Dam	Dam	Tallaght
Embankment	Embankment	Sandyford
Landfill	Landfill	Near Blanchardstown
Urban	Urban (made ground)	Dublin City and outskirts

14.3.2.4 Regional Bedrock Geology

The bedrock geology of the region, as classified by the GSI 1:500,000 Bedrock Geology Map (GSI 2018) are presented on Figure 14.4 in Volume 3 of this EIAR and have been listed in Table 14.12. The region is predominantly underlain by Carboniferous Limestones. The majority of the Dublin City area was a deep marine basin known as the Dublin Basin where these sedimentary rocks were deposited.

To the south of the region, stretching from Dún Laoghaire on the coast in a south to south-west direction and located beneath much of the Dublin and Wicklow Mountains, are the older Caledonian granites known as the Leinster Granite. This is a large intrusion of igneous rock which occurred during the Devonian Period mountain building event known as the Caledonian Orogeny.

The oldest rocks in the region are the Cambrian and Ordovician Metasediments which extend from Loughlinstown towards Bray with the Cambrian Bray Head Formation dominating the Bray to Greystones area and synonymous with the Quartzite of the Sugar Loaf.

The structural geology within the region is highly variable and complex. A series of parallel faults running mainly in a north-west to south-east direction are indicated in the north of the region between Blanchardstown and Dublin Airport. Additional faulting in this area is indicated in a north / north-west to south / south-east direction with associated fold axes both synclinal and anticlinal running in a north-east to south-west direction. The contact between the Lucan formation and the Leinster Granite is characterised by a west-east trending fault. The south of the region is dominated by metamorphic intrusions and north-west / south-east trending faults within the Leinster Granite. The south-eastern section of the region around Bray and Shankill is heavily faulted and folded with a number of west-east thrust faults and numerous north-west / south-east synclinal fold axis.

The depth to bedrock within the region ranges from one metre below ground level (mBGL) in the south-west of the region near Tallaght and the north-west near Blanchardstown to potentially greater than 25mBGL in the Dublin City Centre area and up to 45mBGL in Dublin Port. The bedrock level ranges from 80 metres above Ordnance Datum (mOD) towards the mountainous and inland parts of the region to approximately -40mOD near Dublin Port.

Table 14.12: Rock Formation Within the Region.

Geological Period	Formation	Description	Location
Carboniferous	Visean basinal limestone “Calp”	(Calp) Dark-grey argillaceous and cherty limestone and shale	Central and north County Dublin

Geological Period	Formation	Description	Location
	Waulsortian mudbank	Pale grey massive limestone	North-west near the N2 and N3 National Roads, Malahide and Swords
	Courceyan Limestone	Argillaceous dark-grey bioclastic limestone and subsidiary shale	North-west
	Upper Devonian -Lower Carboniferous Old Red Sandstone	Sandstone, conglomerate and siltstone	North of Swords
Caledonian Orogeny (Mountain Building Era)	Type 2p microcline porphyritic	Granite with microcline phenocrysts	South near Bray
Caledonian Orogeny (Mountain Building Era)	Caledonian Granite	Granite, granodiorite	South near Bray
Silurian	Silurian sandstone, greywacke and shale	Mudstone, greywacke and conglomerate	South-west
Ordovician	Middle to Upper Ordovician basic volcanics	Basalt-andesite, tuff, slate and mudstone	North-west
	Lower to Middle Ordovician slate	Slate, schist and minor greywacke	South-west
	Lower to Middle Ordovician acid volcanics	Rhyolite and rhyolitic tuff	South-west
	Lower to Middle Ordovician basic volcanics	Basalt- andesite, tuff and shale	South-west
Cambrian	Cambrian Greywacke	Greywacke and Shale	Bray

14.3.2.5 Regional Aquifer Type and Classification

The aquifers of the region (groundwater bearing bodies), as classified by the National Draft Bedrock Aquifer Map (GSI 2019b) are presented on Figure 14.5 in Volume 3 of this EIAR and have been listed in Table 14.13. The GSI (GSI 2019b) has devised a system for classifying the aquifers in Ireland based on the hydrogeological characteristics, size, and productivity of the groundwater resource. The aquifer classes and sub-classes are shown in the National Draft Bedrock Aquifer Map. There are three principal types of aquifer, corresponding to whether they are major, minor, or unproductive resources whereby:

- Regionally Important Aquifers are capable of supplying regionally important abstractions (e.g. large public water supplies), or excellent yields (>400 metres cubed per day (m^3/d));
- Locally Important Aquifers are capable of supplying locally important abstractions (e.g. smaller public water supplies, group schemes), or good yields ($100m^3/d$ to $400m^3/d$); and
- Poor Aquifers are capable of supplying small abstractions (e.g. domestic supplies), or moderate to low yields ($<100m^3/d$).

The lower permeability glacial till soils which overlay the bedrock (gravelly clay / boulder clay), slow infiltration and restrict recharge to bedrock aquifers. The glacial till is not classified as an aquifer by the GSI.

Under the WFD, the regional hydrogeology has been assessed using the GSI groundwater viewer (GSI 2019b). The regional groundwater bodies (GWB) in the area are (refer to Figure 14.5 in Volume 3 of this EIAR):

- Dublin GWB;
- Swords GWB;
- Kilcullen GWB; and
- Wicklow GWB.

Table 14.13: Aquifer Types Within the Region

Aquifer Type	Location	Description	Code
Locally Important	North and centre of the region	Bedrock which is moderately productive only in local zones	(Ll)

	Bray (south-eastern extent of the region	Gravel	(Lg)
Poor Aquifer	Most of southern extent of the region	Bedrock which is generally unproductive except for local zones	(Pl)

14.3.2.6 Regional Aquifer Vulnerability

Aquifer vulnerability of a groundwater body is the term used to describe the intrinsic geological and hydrogeological characteristics which determine the ease with which a groundwater body may be contaminated by human activities.

The vulnerability is determined by the travel time and the attenuation capacity of the overlying deposits. The groundwater vulnerability is determined mainly by the permeability and thickness of the subsoils that underlay the topsoil. For example, bedrock with a thick, low permeability overburden is less vulnerable than bedrock with a thin high permeability, gravel overburden.

The GSI aquifer vulnerability classification guidelines (GSI 2019b), which are outlined in Table 14.14, demonstrate that the aquifers are most at risk in areas where subsoils are thin or absent and where karst features such as swallow holes are present. This is due to the ability of potential contaminants to reach the aquifer in a relatively short period and with little or no contaminant attenuation due to the thin or absent overburden. The regional groundwater vulnerability varies significantly across the region, ranging from Rock at Surface (X) to Low (L) vulnerability.

Table 14.14: Aquifer Vulnerability (GSI 2019b)

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High Permeability (Sand / Gravel)	Moderate Permeability (e.g. Sandy Subsoil)	Low Permeability (e.g. Clayey Subsoil, Clay, Peat)	Sand / Gravel Aquifers Only)	(<30m Radius)
Rock at or close to surface (X)	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Extreme (E)	0m – 3.0m	0m – 3.0m	0m – 3.0m	0m – 3.0m	Not applicable
High (H)	>3.0m	3.0m – 10.0m	3.0m – 5.0m	>3.0m	Not applicable
Moderate (M)	Not applicable	>10.0m	5.0m – 10.0m	Not applicable	Not applicable
Low (L)	Not applicable	Not applicable	>10.0m	Not applicable	Not applicable

14.3.2.7 Regional Recharge

Recharge is the amount of rainfall that replenishes the aquifer. It is a function of the effective rainfall, the permeability and thickness of the subsoil and the aquifer characteristics. The GSI Groundwater Recharge mapping for the region indicates annual annual groundwater recharge across the region ranges from approximately 1mm/yr (millimetre per year) to 600mm/yr as shown on Figure 14.6 in Volume 3 of this EIAR.

14.3.2.8 Regional Groundwater Abstractions

Groundwater resources describe any large spring, well or boreholes which are used as a groundwater abstraction source by domestic, agricultural, commercial, industrial, local authority or group water scheme users.

The GSI keeps a record of groundwater wells drilled (GSI 2019b). However, the record does not state which wells are currently used for abstraction.

In addition to these abstractions, Dublin City Council (DCC) also maintains a database of groundwater and surface water abstractions. However, this data is not available to the public. The EPA have also launched a register of water abstractions, whereby people who abstract 25m^3 (cubic metres) of water or more per day are required to register their water abstraction. However, this data is not available to the public.

Source Protection Zones (SPZ) reports have been produced by the GSI (GSI 2019b) in conjunction with the EPA for groundwater sources, particularly public water supplies, group water schemes or important industrial supplies.

The reports aim to guide development planning and regulation to provide protection to groundwater sources. To date no SPZ reports have been produced with regard to any sites within the study area.

Groundwater is not used extensively for residential or industrial purposes in the area. The majority of potable water used within the region is abstracted elsewhere and piped to the region, and therefore groundwater abstraction is not considered further in this Chapter.

14.3.2.9 Groundwater Quality and Levels

Based on professional experience and previous ground investigations in the area, groundwater levels are generally within 5m of the surface in Dublin City and are closer to the surface near rivers and streams. Historical groundwater monitoring is available from a monitoring borehole at the GSI Beggar's Bush Office, Dublin 4 (monitored from 1990 to 2000). Groundwater level monitoring has commenced at Beggar's Bush since August 2018 with the data available online (GSI 2019e). Beggar's Bush lies approximately 2 kilometres (km) south-east of the City Centre. There is an inactive EPA monitoring borehole located in Goatstown, Dublin 14 which is approximately 6km south of the City Centre (monitored from 1997 to 2006). The results from both monitoring points show that the groundwater levels have a seasonal range over their entire monitoring record of 0.55m and 0.27m respectively.

The hydro-chemical analyses of groundwater within the Dublin GWB are available at the EPA Rye water monitoring stations at Carton House, near Maynooth, County Kildare. The limestone groundwater quality is very hard water (350 milligrams per litre (mg/l) to 480mg/l of Calcium carbonate ($CaCO_3$)), with a high alkalinity (300mg/l to 350mg/l ($CaCO_3$)) and conductivities (550 micro siemens per centimetre (µS/cm) to 900µS/cm). The pH is relatively neutral ranging from 6.5 to 7.5.

Further to the south where the region is underlain by granites of the Maulin Formation, the groundwater is softer and less mineralised with hardness values of 100mg/l ($CaCO_3$) to 150mg/l ($CaCO_3$), alkalinity of <50mg/l ($CaCO_3$) and conductivity values of 300µS/cm to 500µS/cm and a lower pH range of 6 to 7.

14.3.2.10 Regional Hydro-Ecology Designated Sites

Designated protected sites within Ireland compiled by the National Parks and Wildlife Service (NPWS) such as Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) could be groundwater dependent habitats and therefore an impact on the hydrogeology could be an impact on a designated site. Further information regarding the designated sites within the region are provided in Chapter 12 (Biodiversity). Only the hydrogeology related impacts on groundwater dependant designated sites are assessed within this Chapter.

14.3.2.11 Regional Geological Heritage

The basic designation for wildlife is the Natural Heritage Area (NHA). This is an area considered important for the habitats present or which holds species of plants and animals whose habitat needs protection. The GSI is compiling a list of geological / geomorphological sites in need of protection through NHA designation (not available at the time of writing). However, these sites will be compiled from the existing database of County Geological Sites (CGS) (GSI 2019c), as listed in Table 14.15.

Table 14.15: Designated Sites Within the Region.

Designation Code	Designated Site
CGS, SPA	North Bull Island
CGS	Glasnevin Cemetery
CGS	Phoenix Park
CGS	River Poddle
CGS	Greenhills Esker
CGS	Dodder Terraces
CGS	Belgard Quarry
CGS	Killiney Bay
CGS	Enniskerry Delta

Designation Code	Designated Site
CGS	GPO (General Post Office)
CGS	Museum Building, Trinity College Dublin
CGS	Oscar Wilde Statue
CGS	51 St. Stephens Green
CGS	Dublin City Walls
CGS	Temple Bar Street Well
CGS	Guinness Wells
CGS	Kippure
CGS	Lucan Esker
CGS	Liffey Valley Centre road sections
CGS	N4 Lucan cutting
CGS	Ballinascorney Quarry
CGS	Newcastle Buried channel
CGS	Carrickgollogan
CGS	Ballycorus
CGS	Killiney Hill
CGS	White Rock, Killiney
CGS	Ballybetagh Bog
CGS	Dalkey Island
CGS	Killiney Bay
CGS	The Scalp
CGS	Three Rock Mountain
CGS	Blackrock Breccia
CGS	Dalkey Hill
CGS	Murphystone Quarry
CGS	Enniskerry Delta
CGS	Glencullen River
CGS, pNHA	River Dargle Valley
CGS, SAC	Bray Head

14.3.3 Site Specific Environment

The following Section discusses the site-specific conditions (refer to Figure 14.7 to Figure 14.15 in Volume 3 of this EIAR) within the study area for the Proposed Scheme as defined in Section 14.2.1. Where applicable the importance of the attributes for which the impact of the Proposed Scheme is to be assessed are reported in this Section.

14.3.3.1 Current and Historic Land Use

The current and historic land use is discussed to give context to any potential changes to land, soils, geology, and hydrogeology that have the potential to influence the importance of a feature and the magnitude of any impacts. The current land use is based on current aerial imagery and mapping available from Ordnance Survey Ireland (OSI) (OSI 2021), Google (Google 2021), Bing (Bing 2021) and the Corine Land Cover maps (EPA 2018). The historic land use is based on the following OSI (OSI 2021) historic aerial imagery and historic maps:

- OSI 6-inch mapping produced between 1837 and 1842;
- OSI 25-inch mapping produced between 1888 and 1913;
- OSI 6-inch Cassini mapping produced between 1830 and 1930s;
- OSI 1995 aerial photography;
- OSI 2000 aerial photography; and
- OSI 2005 aerial photography.

14.3.3.1.1 Section 1: N4 Junction 3 to M50 Junction 7 – N4 Lucan Road

The Corine Land Cover 2018 classifies the land use within the study area north of the N4 Junction 3 as non-irrigated arable land and immediately to the east at the Hermitage Golf Club which includes the land at the Hermitage Clinic the land use is designated for sports and leisure facilities. Also, in the north of the study area, from the Old Lucan Road to the M50 Junction 7 the land use immediately adjacent to the Proposed Scheme is classified as 'discontinuous urban fabric' and road and rail networks and associated lands. In the most northern extent of the study area, the land use adjacent to the River Liffey is classed as Broad-leafed Forest. Land use south of the N4 Junction 3 is classified as discontinuous urban fabric with industrial and commercial units surrounding the area of the Liffey Valley Shopping Centre.

The OSI 6-inch mapping shows that the study area for this section of the Proposed Scheme was predominately used as agricultural land with intermittent residential and farm buildings connected by various roads and tracks. Several gravel pits and quarries are recorded throughout the site, the most significant of these is located in the vicinity of Quarryvale and Cursis Stream near Fonthill Road, south of the Proposed Scheme.

The OSI 25-inch mapping shows that some subsequent development is recorded within the study area. A large proportion of the gravel pits and quarries previously recorded are no longer shown or are now shown as disused, with only three new gravel pits being recorded within the vicinity of the study area. The large quarry in the vicinity of Quarryvale and Cursis Stream is shown as disused, with some residential development recorded in the surrounding area. The Fonthill Power Station at Fonthill is also indicated north of the present N4 which was a gravel pit in the OSI 6-inch mapping.

On the 6-inch Cassini mapping, the majority of gravel pits and quarries are no longer recorded. Only three features were noted and shown as pits within the study area.

It should be noted that the OSI 1995 aerial photography is in black and white and of poor resolution. There are no gravel pits or quarries visible. The N4 Lucan Road is shown immediately to the north of the quarry previously recorded at Cursis Stream. This quarry now appears to have been infilled and is no longer visible. The Fonthill Power Station building is stillvisible; however, a welding supply shop is recorded as being present at this location since the 1970s.

The OSI 2000 aerial imagery of the area to the south of the study area and west of the N4 / M50 Interchange shows significant development. This includes the construction of various residential and commercial buildings, such as the existing Liffey Valley Shopping Centre and significant junction realignment works at the existing Liffey Valley Interchange.

From the OSI 2005 aerial imagery the construction of various residential and commercial buildings previously recorded to the south of the Proposed Scheme and to the west of the N4 / M50 Interchange is now shown as complete with no other significant changes noted.

The 2019 Google Maps shows the area has gone under some development including the construction of the new foot and cycle bridge to the south of the Hermitage Golf Club. The Hermitage Medical Clinic is now recorded directly to the east of the previously named Fonthill Power Station.

14.3.3.1.2 Section 2: M50 Junction 7 to R148 Con Colbert Road – R148 Palmerstown bypass and Chapelizod bypass

The Corine Land Cover 2018 classifies the land use within the study area as discontinuous urban fabric. There are areas classed as green urban areas north of the Proposed Scheme along the R148 adjacent to the River Liffey, including Californian Hills Park and the western section of the Irish National War Memorial Park where Con Colbert Road begins. Gaels-Drumfinn Avenue Park, East Timor Park and the Oval are green urban areas south of the Proposed Scheme.

The OSI 6-inch mapping shows that the study area for this section of the Proposed Scheme was predominantly used as agricultural land with occasional wooded areas and intermittent residential and farm buildings connected by various roads and tracks. The urbanisation of Palmerstown and Chapelizod appears to have commenced and typically comprises small to medium sized buildings, gardens, wooded areas, and interconnecting tracks. An

unnamed road follows the route of the existing Old Lucan Road, coinciding with the route of the Proposed Scheme at Chapelizod and Palmerstown.

The OSI 25-inch mapping shows the area surrounding the Proposed Scheme between the existing R833 Sarsfield Road and the River Liffey is labelled as Liable to Flood. It has four potential drainage trenches running north to south. The feature marked 'Stream under Ground' is no longer shown. However, the map appears to indicate that a watercourse may intersect the Proposed Scheme to the north-east where the existing R148 Chapelizod Bypass passes over the R112 Kylemore Road. An increased number of water features comprising wells, pumps and springs are now recorded throughout the area, predominantly to the west of Chapelizod.

The 6-inch Cassini mapping shows some further development within this section of the study area, including a chocolate factory at Palmerstown and 10kV power lines crossing the Proposed Scheme at Chapelizod and Palmerstown. A 38kV powerline is also recorded as crossing the Proposed Scheme approximately 200m to the west of the N4 / M50 Interchange. There is a historic mill race running from Northcliffe to the Chapelizod Industrial Estate. A number of historic industries were encountered along this section of the study area including historic quarries and distillery.

From the OSI 1995 aerial imagery to the west of Kilmainham significant development is recorded, comprising the construction of the R148 Chapelizod Bypass, the M50 Motorway, N4 Lucan Road, and the N4 / M50 Interchange. This development includes several structures which pass over St Laurence's Road, Chapelizod Hill Road, the R112 Kylemore Road. Significant residential development is recorded at Chapelizod and Palmerstown.

From the OSI 2000 aerial imagery to 2019 Google Maps Imagery no major developments have been observed except for further minor developments along this section of the study area.

14.3.3.1.3 Section 3: R148 Con Colbert Road to City Centre – St. John's Road West

The Corine Land Cover 2018 classifies the land use within the study area as discontinuous urban fabric, with the Irish War Memorial Park classed as a green urban area. From east of the R111 South Circular Road to the Frank Sherwin Bridge the land use is classified as continuous urban fabric, with discontinuous urban fabric encountered south of Con Colbert Road and south of St John's Road West.

The OSI 6-inch mapping shows that the study area for this section of the Proposed Scheme was urbanised from Con Colbert Road to the Frank Sherwin Bridge. The area north of Con Colbert Road was used as agricultural land with gravel pits located at Islandbridge. The area south of Con Colbert Road was urbanised at this point as Inchicore. Heuston Station was not yet constructed. The eastern extent of the study area between Aston Quay and Kilmainham shows some signs of development during this period, which includes an iron works, the Seán Heuston Bridge, various hospital buildings, a Royal Artillery Barracks - including a 'Magazine' which is adjacent to a gravel pit, and Bully's Acre Grave Yard.

The OSI 25-inch mapping shows three additional gravel pits north of Con Colbert Road underlying the Irish National Memorial Park and the Great Southern and Western Railway running along the present Con Colbert Road. There is a scavenging depot to the south of Islandbridge along with the Bully's Acre Graveyard. Goods sheds, granaries and cattle pens were recorded west of Kingsbridge Terminus now named Heuston Station.

The 6-inch Cassini mapping shows further development south of Con Colbert Road along with a burial site recorded at the Irish National War Memorial Park. The historic scavenging depot is presently overlain by a football ground. The Garda Siochana Headquarters is located at the site of the previous Royal Hospital. There are no gravel pits or quarries recorded.

From the OSI 1995 aerial imagery the most significant developments within this section of the study area are the construction of the Frank Sherwin Bridge, the widening of St John's Road (now recorded as St John's Road West / R148 Con Colbert Road) and the construction of a significant junction passing over the existing Dublin–Cork Main Line to the south of Islandbridge. Kingsbridge Railway Terminus was renamed Heuston Station in 1966. Dr Steevens' Hospital located to the south of Heuston Station closed in 1987 and is now the headquarters of the Health Service Executive. The Garda Siochana Headquarters became the Irish Museum of Modern Art in 1984. Bully's Acre Graveyard is a green area overlain by trees.

From the OSI 2000 aerial imagery to 2005 OSI Aerial Imagery the most significant change in land use was remodeling works at the entrance to Heuston Station. Residential redevelopment of the former Ordnance Depot and Clancy Barracks and the factory to the west of Bully's Acre Burial Ground was also undertaken.

14.3.3.2 Geomorphology and Topography

The geomorphology and topography are discussed in order to give context to any potential changes to land, soils, geology, and hydrogeology that could influence the importance of a feature and the magnitude of any impacts. The geomorphology (GSI 2016a) and the topography are shown on Figure 14.7 in Volume 3 of this EIAR.

14.3.3.2.1 Section 1: N4 Junction 3 to M50 Junction 7 – N4 Lucan Road

The Proposed Scheme begins at the N4 Junction 3 which according to the OSI 10m contours is at an elevation of 50mOD, rising to 60mOD at the Hermitage Golf Club and gradually falling to 50mOD at the M50 Junction 7.

The geomorphology within this section of the study area is characterised by a northward trending glacial meltwater channel north of the N4 Junction 3 associated with the Hermitage stream, which is a tributary of the River Liffey. There is a deglacial landform comprised of hummocky sands and gravels along and adjacent to the alignment of the N4 from Junction 3 to Junction 2. There is another glacial meltwater channel north of the Old Lucan Road which follows the alignment of the Quarryvale stream which runs into the River Liffey.

14.3.3.2.2 Section 2: M50 Junction 7 to R148 Con Colbert Road – Palmerstown bypass and Chapelizod bypass

The Proposed Scheme continues at an elevation of between 50mOD and 60mOD and gradually falls to between 40mOD and 30mOD along the Chapelizod Bypass and to 20mOD at the Con Colbert Road.

The geomorphology within this section of the study area is characterised by a deglacial landform comprised of hummocky sands and gravels on the Old Lucan Road near the Palmerstown Village Industrial estate and at the Chapelizod Bypass north and south of the R112 Kylemore Road. There is a glacial meltwater channel following the alignment of the River Liffey and a glaciofluvial terrace south of the River Liffey between the Chapelizod Bypass and St Laurence's Road.

14.3.3.2.3 Section 3: R148 Con Colbert Road to City Centre – St. John's Road West

The Proposed Scheme continues at an elevation of 20mOD at Con Colbert Road and gradually falls to 10mOD at the Frank Sherwin Bridge where the Proposed Scheme terminates.

The geomorphology within this section of the study area is characterised by a glacial meltwater channel following the alignment of the River Cammock south of Con Colbert Road and the River Liffey north of Con Colbert Road to the Frank Sherwin Bridge. There is a glaciofluvial terrace present south of the River Liffey at Islandbridge. There is another glacial meltwater channel associated with an unnamed historic river to the west of Parkgate Street along with hummocky sands and gravels west of the R111 South Circular Road. The Creosote stream runs from north of the Irish National War Memorial Park into the River Liffey.

14.3.3.3 Soils (Teagasc Soil Classification)

The majority of the soils expected to be encountered within the study area are made ground comprising varying forms of hard standing materials including road pavements and footpaths. However, there are topsoil and other soils present within the study area for which there are a number of classifications on the Teagasc Soil Map (Teagasc *et al*. 2017). The main soils within the study area, as classified by Teagasc (Teagasc *et al*. 2017) are presented on Figure 14.8 in Volume 3 of this EIAR and are listed in Table 14.16 along with their importance with respect to drainage and fertility as determined by Box 4.1 in the NRA Guidelines (NRA 2008a). Where these soils are important features with respect to possible soft soils or contamination their importance is detailed in Section 14.3.3.8 and Section 14.3.3.9.

14.3.3.3.1 Section 1: N4 Junction 3 to M50 Junction 7 – N4 Lucan Road

The underlying soils within the study area from the N4 Junction 3 to the M50 Junction 7 are predominately classed as made ground. There are significant deposits of topsoils (BminDW and BminPD) north of the Lucan Retail Park, south of the Hermitage Golf Club and north and south of the Proposed Scheme from N4 Lucan Road Junction 3 to the M50 Junction 7. There is topsoil (BminSW) underlying the area north of the Lucan Retail Park, south of the Hermitage Golf Club, north and south of N4 Junction 2 and to the north and south-west of the M50 Junction 7. There is an area of alluvium encountered following the alignment of the River Liffey which is within the study area at Fonthill.

14.3.3.3.2 Section 2: M50 Junction 7 to R148 Con Colbert Road – Palmerstown bypass and Chapelizod bypass

The underlying soils within the study area from the M50 Junction 7 to the start of Con Colbert Road are predominately made ground. There are deposits of topsoils (BminDW and BminPD) north of the Old Lucan Road and south of the River Liffey at the Californian Hills Park and along the Chapelizod Bypass. There is topsoil (BminSW) underlying the area south of the River Liffey from the M50 Junction 7 to Palmerstown and north of the Chapelizod Bypass. Alluvium is encountered following the alignment of the River Liffey from north of the M50 Junction 3 to Con Colbert Road south of the R109 Lower Road.

14.3.3.3.3 Section 3: R148 Con Colbert Road to City Centre – St. John's Road West

The underlying soils within the study area from Con Colbert Road to Frank Sherwin Bridge are predominately made ground. Deposits of topsoils (BminDW and BminPD) are present at the western side of the Irish National War Memorial Park and along the alignment of the River Cammock south of the Inchicore Road and at Military Road. There is topsoil (BminSW) underlying the area south of the River Liffey at the Irish National War Memorial Park. Alluvium is encountered along the alignment of the River Liffey from north of Con Colbert Road to Frank Sherwin Bridge south of the R148 Chapelizod Bypass and R109 Lower Road, as well as following the alignment of the Cammock River south of Inchicore Road and Military Road.

Table 14.16: Soils Within the Study Area

Soil Type	Notes / Description	Location	Importance	Justification for Importance Rating
Made Ground - Made	Associated with urban development	Widespread	Low	Poorly drained and / or low fertility soils
Alluvium - AlluvMIN	Typically found along current and historic watercourses	River Liffey, Cammock River	Low	Moderately drained and / or moderate fertility soils
Topsoil - BminSW	Shallow well drained (mainly basic)	South of the River Liffey at the Irish National War Memorial Park	High	Well drained and / or high fertility soils
Topsoil - BminDW	Deep well drained (mainly basic)	North of the Old Lucan Road and south of the River Liffey at the Californian Hills Park and along the Chapelizod Bypass, western side of the Irish National War Memorial Park and along the alignment of the River Cammock south of Inchicore Road and Military Road.	High	Well drained and / or high fertility soils
Topsoil - BminPD	Poorly drained (mainly basic)	North of the Old Lucan Road and south of the River Liffey at the Californian Hills Park and along the Chapelizod Bypass	Low	Poorly drained and / or low fertility soils

14.3.3.4 Subsoil Deposits (GSI Quaternary Classification)

Superficial deposits (subsoil) comprise the unconsolidated geological deposits which overlie the solid geology. The subsoils within the study area, as classified by the GSI Quaternary mapping (GSI 2016a), are presented on Figure 14.9 in Volume 3 of this EIAR and are listed in Table 14.17 along with their importance with respect to feature quality and significance as determined by Box 4.1 of the NRA Guidelines (NRA 2008a). Where these subsoils are important features with respect to possible soft soils or contamination, their importance is detailed in Section 14.3.3.8 and Section 14.3.3.9.

The main subsoils encountered within the study area are predominately glacial tills. Additionally, there are areas of made ground (Urban), alluvial deposits, gravels and shallow bedrock as discussed below.

14.3.3.4.1 Section 1: N4 Junction 3 to M50 Junction 7 – N4 Lucan Road

The subsoils encountered within the study area for this section of the Proposed Scheme are predominately glacial till derived from Limestone. There are gravels derived from Limestone adjacent to the alignment of the N4 Junction 3 to Junction 2. There are bedrock outcrops and sub outcrops at Ballyowen Lane, St Edmunds Square, the Liffey Valley Shopping Centre, and between N4 Junction 2 and the M50 Junction 7. The River Liffey alignment is within the study area east of the Hermitage Golf Club and south of the R109 Lower Road. Alluvium is encountered along the River Liffey riverbank at this location.

14.3.3.4.2 Section 2: M50 Junction 7 to R148 Con Colbert Road – Palmerstown bypass and Chapelizod bypass

The subsoils encountered within the study area for this section of the Proposed Scheme are predominately glacial till derived from Limestone. There are gravels derived from limestone at Lucan Road north of the R148 Palmerstown Bypass near Palmerstown Village industrial estate and at the Chapelizod Bypass north of the R112 Kylemore Road, which relate to hummocky sands and gravels deposits. There is urban (made ground) encountered along the R148 Chapelizod Bypass to Con Colbert Road and alluvium present following the alignment of the River Liffey from north of the M50 Junction 7 to Con Colbert Road south of the R109 Lower Road.

14.3.3.4.3 Section 3: R148 Con Colbert Road to City Centre – St. John's Road West

The subsoils encountered within the study area for this section of the Proposed Scheme are predominately urban (made ground) with glacial till derived from limestones encountered west of the Irish National War Memorial Park, south of Con Colbert Road, at the Inchicore / South Circular Road junction and south of St John's Road West. Gravels derived from limestones are encountered south of Con Colbert Road at West Terrace which relate to hummocky sands and gravels deposits. Alluvium deposits are recorded along the alignment of the River Liffey and Cammock River.

Table 14.17: Subsoils Within the Study Area

Subsoil Type	Description	Location	Importance	Justification for Importance Rating
Made Ground – Urban	Associated with urban development	Widespread	Low	Low value on a local scale
Alluvium – A	Typically found along current and historic watercourses	River Liffey, Cammock River	Low	Low value on a local scale
Glacial gravels – GLs	Gravels derived from limestones	N4 Junction 3 to Junction 2, Lucan Road near Palmerstown Village industrial estate and at the Chapelizod Bypass north of the R112 Kylemore Road, south of Con Colbert Road at West Terrace	Low	Low value on a local scale
Glacial till – TLs	Till derived from limestones	Widespread	Low	Low value on a local scale
Rock – Rck	Bedrock outcrop or subcrop	Ballyowen Lane, St Edmunds Square, the Liffey Valley Shopping Centre and the M50 Junction 7	Low	Low value on a local scale

14.3.3.5 Bedrock Geology

The bedrock geology of the study area, as classified by the GSI 1:100,000 Bedrock Geology Map (GSI 2018) are presented on Figure 14.10 in Volume 3 of this EIAR and have been listed in Table 14.18 along with their importance with respect to feature quality and significance as determined by Box 4.1 in the NRA Guidelines (NRA 2008a). Where the bedrock is an important feature with respect to economic geology its importance is detailed in Section 14.3.3.10.

14.3.3.5.1 Section 1: N4 Junction 3 to M50 Junction 7 – N4 Lucan Road

The bedrock encountered within the study area for this section of the Proposed Scheme comprises of the Lucan Formation, Tober Colleen Formation, Walsortian Limestones and Ballysteen Formation at the N4 Junction 3 to the M50 Junction 7. The Tober Colleen Formation, Walsortian Limestones and Ballysteen Formation surround the N4 Junction 3. From east of N4 Junction 2 to the M50 Junction 7 the bedrock encountered comprises of the Lucan Formation with the Tober Colleen Formation recorded north of the M50 Junction 7. There are bedrock outcrops and sub outcrops at Ballyowen Lane, St Edmunds Square, the Liffey Valley Shopping Centre, and the M50 Junction 7.

There is a north-west / south-east trending anticlinal axis at the N4 Junction 3 which comprises the Ballysteen formation in the centre and the Waulsortian and Tober Colleen Formations on the outer limbs of the axis. There is a north-south normal trending fault running through the Hermitage Golf Club to the southern side of the study area.

14.3.3.5.2 Section 2: M50 Junction 7 to R148 Con Colbert Road – Palmerstown bypass and Chapelizod bypass

The bedrock encountered within the study area for this section of the Proposed Scheme comprises of the Lucan Formation with an area north of the M50 Junction 7 comprised of the Tober Colleen Formation.

No major structural bedrock features were identified along this section of the study area.

14.3.3.5.3 Section 3: R148 Con Colbert Road to City Centre – St. John's Road West

The bedrock encountered within the study area for this section of the Proposed Scheme comprises of the Lucan Formation.

No major structural bedrock features were identified along this section of the study area.

Table 14.18: Rock Formations Within the Study Area

Formation	Description	Location	Importance	Justification for Importance Rating
Lucan	(Calp) Dark limestone and shale - Carboniferous	Widespread	Low	Low value on a local scale
Tober Colleen Formation	Calcareous shale, limestone conglomerate - Carboniferous	N4 Junction 3, north of the M50 Junction 7	Low	Low value on a local scale
Ballysteen Formation	Dark muddy limestone, shale - Carboniferous	N4 Junction 3	Low	Low value on a local scale
Walsortian Limestones	Massive unbedded lime - mudstone - Carboniferous	N4 Junction 3	Low	Low value on a local scale

14.3.3.6 Ground Investigation

A summary of the ground conditions encountered by historical ground investigations adjacent to the Proposed Scheme and the scheme-specific ground investigations (listed in Section 14.2.3.2) are presented in Table 14.19 to Table 14.21.

The data presented in the tables are indicative and strata depth and presence will vary by location. The historical ground investigation data was carried out for purposes and projects other than this EIAR. Therefore, although the

historical ground investigation data provides useful indication of ground conditions, the quality of the data cannot be verified.

Table 14.19: Summary of Ground Conditions Expected to be Encountered by the Proposed Scheme Along the N4 Junction 3 to M50 Junction 7 Section

Strata	General Extent / Location	Top of Strata (mBGL)	Thickness of Strata (m)
Topsoil	Green areas – including parks, large estates and golf courses	0	0.1 to 0.4
Made Ground	Not found in all locations	0 to 0.4	0 to 4.3
Glacial Till (Brown Boulder Clay) with lenses of sand and gravel	Widespread	0.2 to 3.8	0.6 to 1.6
Glacial Till (Black Boulder Clay) with lenses of sand and gravel	Widespread	2.5 to 2.8	0 to 3.5
Bedrock	Widespread	3.5 to 14.4	N/A

Table 14.20: Summary of Ground Conditions Expected to be Encountered by the Proposed Scheme Along the M50 Junction 7 to R148 Con Colbert Road Section

Strata	General Extent / Location	Depth Range (mBGL)	Thickness Range (m)
Topsoil	Green areas – including parks, large estates and golf courses	0	0 to 0.40
Made Ground	Not found in all locations	0 to 0.4	0.6 to 11.2
Glacial Till (Brown Boulder Clay) with lenses of sand and gravel	Widespread	0.3 to 3	1 to 2.6
Glacial Till (Black Boulder Clay) with lenses of sand and gravel	Widespread	2.3 to 5	1.6 to 8.5
Bedrock	Widespread	7.6	N/A

Table 14.21 Summary of Ground Conditions Expected to be Encountered by the Proposed Scheme Along the R148 Con Colbert Road to the City Centre Section

Strata	General Extent / Location	Depth Range (mBGL)	Thickness Range (m)
Topsoil	Green areas – including parks, large estates and golf courses	0	0 to 0.3
Made Ground	Not found in all locations	0 to 0.3	0.3 to 4.6
Glacial Till (Brown Boulder Clay) with lenses of sand and gravel	Widespread	0.9 to 4.6	1.2 to 8.7
Glacial Till (Black Boulder Clay) with lenses of sand and gravel	Widespread	7 to 9.6	0 to 20.4
Bedrock	Widespread	7.6	N/A

14.3.3.7 Karst

Karst is a type of geological feature characterised by caves, caverns and other types of underground drainage resulting from the dissolution of the underlying bedrock. This typically occurs in areas of high rainfall with soluble rock.

There are no karst features identified within the study area in the GSI karst database (GSI 2019b). Consequently, the risk of karst is deemed negligible due to the geology of the region not being known to contain karst features and will not be further assessed.

14.3.3.8 Soft and / or Unstable Ground

Soft soils consist of peat, fine grained alluvium or very soft cohesive material. Their presence within the study area could result in an impact if they require excavation and are therefore considered important features. Various sources of information were consulted in establishing these areas within the study area namely:

- Teagasc soil map (Teagasc *et. al* 2017);
- GSI Quaternary Map (GSI 2016a);

- Ground investigation data;
- Scheme walkover survey; and
- GSI Landslide Events (GSI 2017).

The GSI database (GSI 2017) shows no recorded landslide events within the study area and therefore unstable ground is not considered further in this assessment.

The soft soils identified within the study area are detailed in Table 14.22 along with their importance as determined by Box 4.1 of the NRA Guidelines (NRA 2008a).

Table 14.22: Soft Soils Within the Study Area

Feature	Description	Importance	Justification for Importance Rating
Alluvium - AlluvMIN (soils) / A (subsoils)	Typically found along current and historic watercourses	Low	Volume of soft soil underlying the study area is small and of a local scale.

14.3.3.9 Contaminated Land

Considering the location of the Proposed Scheme in the urban environment, there are likely to be some sources of contamination within the made ground throughout the study area. Therefore, the assessment of contaminated land is focused on the footprint and directly on either side of the Proposed Scheme unless there is likely to be a pathway connecting the possible source of contamination to the footprint of the Proposed Scheme.

Various sources of information were consulted in assessing the Proposed Scheme for locations of potential contaminated land:

- CORINE land cover mapping (EPA 2018);
- Teagasc soil map (Teagasc *et al*. 2017);
- EPA (EPA 2019);
- OSI mapping (OSI 2019);
- The design information as listed in Section 14.2.3.3;
- The scheme specific ground investigations carried out to inform the Proposed Scheme and this EIAR, as listed in Table 14.3. These provide useful verification for the data already compiled relating to the baseline environment; and
- Local authority archives and databases as listed in Table 14.1.

The known potential sources of contamination relevant to the Proposed Scheme identified within the study area are detailed in Table 14.23 along with their importance as determined by Box 4.1 of the NRA Guidelines (NRA 2008a).

Soil analysis was carried out on a sample retrieved during the ground investigations at a depth of 0.5m BGL.

- Asbestos was not detected in the recorded results during the scheme specific GI carried out by Causeway Geotechnical.

- The sample was classified as Inert.

Table 14.23: Summary of Potential Sources of Contaminated Land Adjacent to the Proposed Scheme

Feature	Description	Importance	Justification for Importance rating
Gravel Pit	Quarry (6-inch OSI Mapping) - North and South of N4	Medium	Degree or extent of soil contamination is moderate on a local scale
Gravel Pit	Quarry (6-inch OSI Mapping) - South of N4 Junction 2	Medium	Degree or extent of soil contamination is moderate on a local scale
Historical Fonthill Power Station	Industrial (25-inch OSI Mapping) - North of N4 near Hermitage Golf Course	Medium	Degree or extent of soil contamination is moderate on a local scale

Feature	Description	Importance	Justification for Importance rating
Gravel Pit	Quarry (6-inch OSI Mapping) - North of N4	Medium	Degree or extent of soil contamination is moderate on a local scale
Gravel Pit	Quarry (25-inch OSI Mapping) - Irish National War Memorial Park	Medium	Degree or extent of soil contamination is moderate on a local scale
Scavenging Depot	Islandbridge	Medium	Degree or extent of soil contamination is moderate on a local scale
Burial Ground	Islandbridge	Medium	Degree or extent of soil contamination is moderate on a local scale
Army Barracks	Islandbridge	Medium	Degree or extent of soil contamination is moderate on a local scale
Great Southern and Western Railway	Con Colbert Road to Heuston Station	Medium	Degree or extent of soil contamination is moderate on a local scale
Creosote Stream	Historic contamination from creosote leaching from rail sleepers related to Inchicore railway works	Medium	Degree or extent of soil contamination is moderate on a local scale
Petrol Station	Various petrol stations along the route (Hermitage, Palmerstown, Parkway West and Kilmanhaim)	Medium	Degree or extent of soil contamination is moderate on a local scale

A summary of the facilities within the study area along with their importance as determined by the NRA Guidelines Box 4.1 (NRA 2008a) is presented in Table 14.24.

Table 14.24: List of EPA Licensed Facilities Within the Study Area

Name	Description	Importance	Justification for Importance Rating
Diageo Ireland (St. James Gate)	IEL – Licenced: St. James Gate, Dublin 8	Medium	Light industrial usage

14.3.3.10 Mineral / Aggregate Resources

Considering the location of the Proposed Scheme in the urban environment, there are unlikely to be many opportunities to extract mineral or aggregate resources, however the following datasets were consulted in order to assess the impact of the Proposed Scheme on the economic geology of the study area:

- GSI: aggregate potential mapping (GSI 2016b, GSI 2016c);
- GSI: mineral localities (GSI 2014); and
- GSI active quarries (GSI 2019d).

No active pits, mines or quarries were identified within the study area. There are two non-metallic mineral locations within the study area.

The crushed rock aggregate potential is highly variable from the N4 Junction 3 to the Frank Sherwin Bridge. The granular aggregate potential is highly variable as discussed below. A summary of the aggregate resources identified in the study area (refer to Figure 14.11 and Figure 14.12 in Volume 3 of this EIAR) are outlined in Table 14.25.

14.3.3.10.1 Section 1: N4 Junction 3 to M50 Junction 7 – N4 Lucan Road

The GSI aggregate potential mapping shows the crushed rock aggregate potential is low to very high. There is an area of low potential south of the N4 Junction 3 with areas of moderate potential north of N4 Junction 3 and Junction 2 at Woodville, Esker lane, Hermitage Road and around M50 Junction 7. Areas of high crushed rock aggregate potential are encountered north and south of the Proposed Scheme between the N4 Junction 3 and Junction 2, north and south of the Proposed Scheme east of N4 Junction 2 and north, south and at the M50 Junction 7. There are areas of very high potential at the N4 Junction 3 and Junction 2, Ballyowen Lane, north and south of the N4 Junction 2 and the M50 Junction 7.

The GSI aggregate potential mapping shows the granular aggregate potential within this section of the study area is low north-west of the N4 Junction 3 and moderate north and south of the Proposed Scheme from the Hermitage Golf Club to the N4 Junction 2.

14.3.3.10.2 Section 2: M50 Junction 7 to R148 Con Colbert Road – Palmerstown bypass and Chapelizod bypass

The GSI aggregate potential mapping shows the crushed rock aggregate potential is predominately moderate with an area of low potential north and south of the Proposed Scheme to the west of the junction between the Chapelizod Bypass and Con Colbert Road. Areas of high crushed rock aggregate potential are encountered at the M50 Junction 7, north of the industrial estate on the south side of the Old Lucan Road in Palmerstown Village, along the alignment of the River Liffey and in the area of Palmerstown Drive. There are areas of very high potential at the M50 Junction 7 and following the alignment of the River Liffey from north of Riverdale Avenue to north of Palmerstown Drive.

The GSI aggregate potential mapping shows the granular aggregate potential within this section of the study area range from very low to very high along the alignment of the River Liffey in the alluvium and gravelly alluvium deposits. There is an isolated pocket of low and moderate potential north-east of the industrial estate on the south side of the Old Lucan Road in Palmerstown Village where hummocky sands and gravels deposits are noted and an area of very high potential at the intersection of the R112 Kylemore Road and Le Fanu Road.

14.3.3.10.3 Section 3: R148 Con Colbert Road to City Centre – St. John's Road West

The GSI aggregate potential mapping shows the crushed rock aggregate potential ranges from low to moderate from Con Colbert Road to Frank Sherwin Bridge with an area of high potential surrounding Richmond Park east of Inchicore.

The GSI aggregate potential mapping shows the granular aggregate potential within this section of the study area is low to moderate. There are sections of very high potential along the alignment of the River Liffey at the Irish National War Memorial Park and Islandbridge. The granular aggregate potential along the alignment of the Cammock River is very low with an area of low to high potential at the Inchicore Road.

Table 14.25: GSI Aggregate Potential for the Study Area

GSI Aggregate Potential Type	Potential	Location	Importance	Justification for Importance Rating
Crushed rock aggregate potential	Low potential	South of the N4 Junction 3, Con Colbert Road to Frank Sherwin Bridge	Low	Uneconomically extractable mineral resource
Crushed rock aggregate potential	Moderate potential	North of N4 Junction at Woodville, Esker lane, Hermitage Road and between the N4 Junction 1 and Junction 2, Con Colbert Road to Frank Sherwin Bridge	Medium	Sub-economic extractable mineral resource
Crushed rock aggregate potential	High potential	North and south of the Proposed Scheme between the N4 Junction 3 and Junction 2, north and south of the Proposed Scheme east of N4 Junction 2 and at the M50 Junction 7. The M50 Junction 7, north of the industrial estate on the south side of the Old Lucan Road in Palmerstown Village, along the alignment of the River Liffey and in the area of Palmerstown Drive. Richmond Park east of Inchicore	Medium	Extractable mineral resource
Crushed rock aggregate potential	Very High potential	N4 Junction 3 and Junction 2, Ballyowen Lane, north and south of the N4 Junction 2, the M50 Junction 7 and following the alignment of the River Liffey from north of Riverdale Avenue to north of Palmerstown Drive	High	Marginally extractable mineral resource
Granular aggregate potential	Very Low potential	River Liffey, Cammock River	Low	Uneconomically extractable mineral resource
Granular aggregate potential	Low potential	North-east of the industrial estate on the south side of the Old Lucan Road in Palmerstown Village north-	Low	Uneconomically extractable mineral resource

GSI Aggregate Potential Type	Potential	Location	Importance	Justification for Importance Rating
		west of the N4 Junction 3, River Liffey, Inchicore Road		
Granular aggregate potential	Moderate potential	North and south of the Proposed Scheme from the Hermitage Golf Club to the N4 Junction 2. River Liffey, north-east of the industrial estate on the south side of the Old Lucan Road in Palmerstown Village. Inchicore Road	Medium	Sub-economic extractable mineral resource
Granular aggregate potential	High potential	River Liffey, Inchicore Road	Medium	Extractable mineral resource
Granular aggregate potential	Very High potential	River Liffey and the intersection of the R112 Kylemore Road and Le Fanu Road	High	Marginally extractable mineral resource

14.3.3.11 Geological Heritage Areas

The Geological Heritage Areas (GSI 2019c) within the study area are presented on Figure 14.10 in Volume 3 of this EIAR and detailed in Table 14.26 along with their importance as determined by Box 4.1 of the NRA Guidelines (NRA 2008a).

Table 14.26: Geological Heritage Areas

Name (Code)	Description	Location	Importance	Justification for Importance rating
Liffey Valley Centre Road Sections (SC007)	The site includes roadside exposures of Calp limestones near the junction to Liffey Valley Shopping Centre. The bedrock consists of beds of dark grey-black, fine-grained limestone, with interbeds.	Liffey Valley	High	Geological feature of high value on a local scale (CGS)
Phoenix Park (DC009)	This site forms an extensive 707 hectare natural landscape within the confines of Dublin city. The complexity of the site in terms of its glacial form and the manipulation of this is unusual.	Phoenix Park	High	Geological feature of high value on a local scale (CGS)
Guinness Wells (DC005)	This site comprises two borehole wells dug within the Guinness brewery complex. For historical, technical and cultural importance, the wells within Dublin City are unusual.	Guinness Wells, St James Gate, Dublin 8	High	Geological feature of high value on a local scale (CGS) Only one well (Cooperage well) is in use

14.3.3.12 Aquifer Type and Classification

The GSI Bedrock Aquifer mapping (GSI 2019b) for the study area (Figure 14.13 in Volume 3 of this EIAR) indicates that there are two aquifer types within the study area as summarised in Table 14.27 along with their importance as determined by Box 4.3 of the NRA Guidelines (NRA 2008a).

The GSI Gravel Aquifer mapping (GSI 2019b) show there are no gravel aquifers within the study area.

Table 14.27: Aquifer Types Within the Study Area

Aquifer Type	Description	Location	Importance	Justification for Importance Rating
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Widespread	Medium	Locally important aquifer which supplies the local area
Poor Aquifer (PI)	Bedrock which is generally unproductive except for local zones	Widespread	Low	Poor aquifer

14.3.3.13 Groundwater Vulnerability

Groundwater vulnerability (GSI 2019b) within the study area ranges from ‘extreme’ where bedrock is close to or at the surface to ‘low’ vulnerability in areas where thick subsoil deposit is present as shown on Figure 14.14 in Volume 3 of this EIAR.

14.3.3.13.1 Section 1: N4 Junction 3 to M50 Junction 7 – N4 Lucan Road

The GSI groundwater vulnerability mapping shows the groundwater vulnerability along this section of the study area is predominately high to extreme at the N4 Junction 2. Where bedrock outcrops or subcrops are noted, the groundwater vulnerability is extreme with areas of Rock at or near surface north of the N4 Junction 3, around Ballyowen Lane, east of N4 Junction 2 and along the M50 Junction 7. There is an area of low to moderate vulnerability surrounding the N4 Junction 3.

14.3.3.13.2 Section 2: M50 Junction 7 to R148 Con Colbert Road – Palmerstown bypass and Chapelizod bypass

The GSI groundwater vulnerability mapping shows the groundwater vulnerability along this section of the study area is predominately moderate with areas ranging from high to extreme with Rock at or near surface north of Palmerstown Drive along the alignment of the River Liffey. An area of low vulnerability west of the junction with the Chapelizod bypass and Con Colbert Road.

14.3.3.13.3 Section 3: R148 Con Colbert Road to City Centre – St. John's Road West

The GSI groundwater vulnerability mapping shows the groundwater vulnerability along this section of the study area is predominantly moderate with low potential encountered along Con Colbert and St John's Road West. There is an area of high vulnerability at the Irish National War Memorial Park and Inchicore.

14.3.3.14 Groundwater Recharge

The rate of groundwater recharge corresponds to the soil type as shown in Figure 14.8 and Figure 14.15 in Volume 3 of this EIAR. The study area predominately has an annual recharge range of 51mm (millimetres) to 100mm in urban areas. Where there is topsoil or alluvium present instead of made ground the annual recharge is typically 1mm to 50mm.

14.3.3.15 Hydro-Ecology

Groundwater dependent habitats within the study area that have the status of SPA, SAC, NHA or proposed pNHA (NPWS 2020) are listed in Table 14.28.

Table 14.28: Groundwater Dependent Habitats Within the Study Area

Designated Site	Description	Location	Importance	Justification for Importance Rating
Liffey Valley pNHA (000128)	Proposed Natural Heritage site running along the River Liffey	Liffey Valley	Very High	Very high value on a local scale

14.3.4 Summary of Features of Importance

The importance ranking of the features, based on Box 4.1 of the NRA Guidelines (NRA 2008a), established for the baseline conditions is summarised below.

Features with an importance ranking of low are not considered further as they will not result in a significant impact according to Box 5.4 of the NRA Guidelines (NRA 2008a) and are summarised in Table 14.29 for completeness. Features with an importance ranking of medium or higher are summarised in Table 14.30 and the impact of the Proposed Scheme on these features will be assessed in Section 14.4.

Table 14.29: Summary of Land, Soils, Geology and Hydrogeology Features with Low Importance Within the Study Area

Category	Feature	Description	Location	Importance	Justification
Soil Fertility	Made Ground - Made	Associated with urban development	Widespread	Low	Poorly drained and / or low fertility soils
Soil Fertility	Alluvium - AlluvMIN	Typically found along current and historic watercourses	River Liffey, Cammock River	Low	Moderately drained and/or moderate fertility soils
Soil Fertility	Topsoil - BminPD	Poorly drained (mainly basic)	North of the Old Lucan Road and south of the River Liffey at the Californian Hills Park and along the Chapelizod Bypass	Low	Poorly drained and / or low fertility soils
Subsoils quality and significance	Made Ground - Urban	Associated with urban development	Widespread	Low	Low value on a local scale
Subsoils quality and significance	Alluvium - A	Typically found along current and historic watercourses	River Liffey, Cammock River	Low	Low value on a local scale
Subsoils quality and significance	Glacial gravels - GLs	Gravels derived from limestones	N4 Junction 3 to Junction 2, Lucan Road near Palmerstown Village industrial estate and at the Chapelizod Bypass north of the R112 Kylemore Road, south of Con Colbert Road at West Terrace	Low	Low value on a local scale
Subsoils quality and significance	Glacial till - TLs	Till derived from limestones	Widespread	Low	Low value on a local scale
Subsoils quality and significance	Rock - Rck	Bedrock outcrop or subcrop	Ballyowen Lane, St Edmunds Square, the Liffey Valley Shopping Centre and the M50 Junction 7	Low	Low value on a local scale
Bedrock quality and significance	Lucan	(Calp) Dark limestone and shale - Carboniferous	Widespread	Low	Low value on a local scale
Bedrock quality and significance	Tober Colleen Formation	Calcareous shale, limestone conglomerate - Carboniferous	N4 Junction 3, north of the M50 Junction 7	Low	Low value on a local scale
Bedrock quality and significance	Ballysteen Formation	Dark muddy limestone, shale - Carboniferous	N4 Junction 3	Low	Low value on a local scale
Bedrock quality and significance	Walsortian Limestones	Massive unbedded lime-mudstone - Carboniferous	N4 Junction 3	Low	Low value on a local scale
Soft Soils	Alluvium - AlluvMIN (soils) / A (subsoils)	Typically found along current and historic watercourses	River Liffey	Low	Volume of soft soil underlying the route is small and of a local scale
Economic Geology	Crushed rock aggregate potential	Low potential	South of the N4 Junction 3, Con Colbert Road to Frank Sherwin Bridge	Low	Uneconomically extractable mineral resource
Economic Geology	Granular aggregate potential	Very Low potential	River Liffey, Cammock River	Low	Uneconomically extractable mineral resource
Economic Geology	Granular aggregate potential	Low potential	North-east of the industrial estate on the south side of the Old Lucan Road in Palmerstown Village north-west of the N4 Junction 3, River Liffey, Inchicore Road	Low	Uneconomically extractable mineral resource
Aquifer	Poor Aquifer (Pl)	Bedrock which is generally unproductive except for local zones	Widespread	Low	Low yielding aquifer

Table 14.30: Summary of Land, Soils, Geology and Hydrogeology Features with Medium to Extremely High Importance Within the Study Area

Category	Feature	Description	Location	Importance	Justification
Soil Fertility	Topsoil - BminSW	Shallow well drained (mainly basic)	South of the River Liffey at the Irish National War Memorial Park	High	Well drained and / or high fertility soils
Soil Fertility	Topsoil - BminDW	Deep well drained (mainly basic)	North of the Old Lucan Road and south of the River Liffey at the Californian Hills Park and along the Chapelizod Bypass, western side of the Irish National War Memorial Park and along the alignment of the River Cammock south of Inchicore Road and Military Road.	High	Well drained and/or high fertility soils
Potential Sources of Contamination	Gravel Pit	Quarry (6-inch OSI Mapping)	North and south of N4	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Gravel Pit	Quarry (6-inch OSI Mapping)	South of N4 Junction 2	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Historical Fonthill Power Station	Industrial (25-inch OSI Mapping)	North of N4 near Hermitage Golf Club	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Gravel Pit	Quarry (6-inch OSI Mapping)	North of N4	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Gravel Pit	Quarry (25 – inch OSI Mapping)	Irish National War Memorial Park	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Scavenging Depot	Islandbridge	Islandbridge	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Burial Ground	Islandbridge	Islandbridge	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Army Barracks	Islandbridge	Islandbridge	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Great Southern and Western Railway	Con Colbert Road to Heuston Station	Con Colbert Road to Heuston Station	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Creosote Stream	Historic contamination from Creosote leaching from rail sleepers related to Inchicore railway works	Inchicore railway works	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Petrol Station	Various petrol stations along the route	(Hermitage, Palmerstown, Parkway West and Kilmanhaim)	Medium	Degree or extent of soil contamination is moderate on a local scale

Category	Feature	Description	Location	Importance	Justification
Licenced Facility	Diageo Ireland (St. James Gate)	IEL – Licenced - St. James Gate, Dublin 8	St. James Gate, Dublin 8	Medium	Light industrial usage
Economic Geology	Crushed rock aggregate potential	Moderate potential	North of N4 Junction at Woodville, Esker lane, Hermitage Road and between the N4 Junction 1 and Junction 2, Con Colbert Road to Frank Sherwin Bridge	Medium	Sub-economic extractable mineral resource
Economic Geology	Crushed rock aggregate potential	High potential	North and south of the Proposed Scheme between the N4 Junction 3 and Junction 2, north and south of the Proposed Scheme east of N4 Junction 2 and at the M50 Junction 7. The M50 Junction 7, north of the industrial estate on the south side of the Old Lucan Road in Palmerstown Village , along the alignment of the River Liffey and in the area of Palmerstown Drive. Richmond Park east of Inchicore	Medium	Extractable mineral resource
Economic Geology	Crushed rock aggregate potential	Very High potential	N4 Junction 3 and Junction 2, Ballyowen Lane, north and south of the N4 Junction 2 , the M50 Junction 7 and following the alignment of the River Liffey from north of Riverdale Avenue to north of Palmerstown Drive	High	Marginally extractable mineral resource
Economic Geology	Granular aggregate potential	Moderate potential	North and south of the Proposed Scheme from the Hermitage Golf Club to the N4 Junction 2. River Liffey, north-east of the industrial estate on the south side of the Old Lucan Road in Palmerstown Village. Inchicore Road	Medium	Sub-economic extractable mineral resource
Economic Geology	Granular aggregate potential	High potential	River Liffey, Inchicore Road	Medium	Extractable mineral resource
Economic Geology	Granular aggregate potential	Very High potential	River Liffey and the intersection of the R112 Kylemore Road and Le Fanu Road	High	Marginally extractable mineral resource
County geological site	Phoenix Park (DC009)	This site forms an extensive 707 hectare natural landscape within the confines of Dublin city. The complexity of the site in terms of its glacial form and the manipulation of this is unusual.	Phoenix Park	High	Geological feature of high value on a local scale (CGS)
County geological site	Liffey Valley Centre Road Sections (SC007)	The site includes roadside exposures of Calp limestones near the junction to Liffey Valley Shopping Centre. The bedrock consists of beds of dark grey-black, fine-grained limestone, with interbeds	Liffey Valley	High	Geological feature of high value on a local scale (CGS)
County geological site	Guinness Wells (DC005)	This site comprises two borehole wells dug within the Guinness brewery complex. For historical, technical and cultural importance, the wells within Dublin City are unusual	Guinness Wells, St James Gate, Dublin 8	High	Geological feature of high value on a local scale (CGS)
Aquifer	Locally Important Aquifer	Bedrock which is moderately productive only in local zones	Widespread	Medium	Locally important aquifer which supplies the local area

Category	Feature	Description	Location	Importance	Justification
Groundwater dependant habitat	Liffey Valley (000128)	Proposed Natural Heritage site running along the River Liffey	Liffey Valley	Very High	Very high value on a local scale

14.3.5 Conceptual Site Model

A Conceptual Site Model (CSM) was developed based on all publicly available data along with project specific data that was provided.

The Proposed Scheme is predominantly underlain by made ground over alluvium (where present associated with water courses) over glacial till over limestone bedrock. The relevant subsections of the Proposed Scheme are presented in Table 14.31 to Table 14.33 along with the fill height (average and maximum) cut height (average and maximum) and the expected soils and geology at each earthworks area.

Table 14.31: Conceptual Site Model - N4 Junction 3 to M50 Junction 7

Sub-section	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
N4 Jct 3 Ballyowen Road to Hermitage Golf Course (Ch A0 - A500)	500	At Grade	0	0	0	0	Based on desk study information area is underlain by made ground and glacial till	0.5	Lucan Road: Widening on Lucan Road localised pavement reconstruction N4 Outbound off-ramp: Pavement reconstruction works from widening on outbound N4 off ramp. Segregated cycle track at grade on Ballyowen Road.
The Ballydowd Pedestrian and Cycle Bridge	50	Structure	No cut/fill due to existence of structure				Based on desk study information area is underlain by made ground, glacial till and bedrock. Road embankment fill material on reworked boulder clay /boulder clay. Up to 1.9 m of made ground (reworked boulder clay encountered in R6-CP05) Rock inferred to be at about 4 m bgl in the area of testholes. Soft pockets of Glacial till present likely due to increased weathering from ground water and shallow rock). Historical report near existing pedestrian bridge has presumed shallow bedrock (within 0.25 to 2 m bgl)	0.5	The Ballydowd Pedestrian and Cycle Bridge (Structure Reference: 03) will be constructed over the N4 at Junction 3, parallel to Ballyowen Road bridge. The existing pedestrian bridge will be removed and replaced with a wider structure, accommodating the new two-way cycle track and pedestrian footpath across the N4.
Liffey Valley Pedestrian Bridge	42.8	Structure	No cut/fill due to existence of structure				Based on desk study information area is underlain by made ground, glacial till and bedrock. Road embankment fill material on reworked boulder clay /boulder clay. Up to 1.9 m of made ground (reworked boulder clay encountered in R6-CP05) Rock inferred to be at about 4 m bgl in the area of testholes. Soft pockets of Glacial till present likely due to increased weathering from ground water and shallow rock). Historical report near existing pedestrian bridge has presumed shallow bedrock (within 0.25 to 2 m bgl)	0.5	The Liffey Valley Pedestrian Bridge will be constructed over the N4 to connect the new bus stops on Old Lucan Road with the new bus stops on N4 and Liffey Valley Bus Interchange. A new pedestrian ramp and steps will be constructed on both sides of the bridge. This will require the construction of a retaining wall (RW02) on the south side of the bridge.

Sub-section	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
Hermitage Golf Club Retaining Wall (RW01)	306.4	Structure	No cut/fill due to existence of structure				Limited GI carried out. Results of GI and GSI soil maps indicate Gravels grading to Glacial till with increasing chainage. WS01, and WS02 indicated gravels although shallow refusal. Approximately 1 m of Made ground encountered in CP01 comprising reworked boulder Clay, underlying strata was Glacial Till	1.5	A piled retaining structure has been proposed to minimise the removal of mature trees along the N4 carriageways. The retaining wall will be clad to match the masonry cladding of the existing retaining wall. The existing retaining wall is to be demolished and replaced to facilitate the required widening.
Hermitage Medical Clinic Gravity Retaining Wall (RW05)	83	Structure	No cut/fill due to existence of structure				Limited GI carried out. Results of GI and GSI soil maps indicate Gravels grading to Glacial till with increasing chainage. WS01, and WS02 indicated gravels although shallow refusal. Approximately 1 m of Made ground encountered in CP01 comprising of reworked boulder Clay, underlying strata was Glacial Till	1.5	This wall will be approximately 83m in length with a maximum retained height of 1.5m. The wall is required to facilitate carriageway widening of the slip road. It will be formed by a gravity retaining structure with a combined boundary wall. The boundary wall will have a minimum height of 2.0m and finished with a masonry stone cladding to match the masonry cladding of the existing boundary wall.
N4 Retaining Wall (RW02)	140	Structure	No cut/fill due to existence of structure				Based on desk study information area is underlain by made ground and glacial till	1.5	RW02 - Masony clad retaining wall, maximum height of 4.4m
Hermitage Golf Club to N4 Junction 2 off ramp (Ch A500 to A1300)	800	Cut	1.5	0.75	0	0	Limited GI carried out. Results of GI and GSI soil maps indicate Gravels grading to Glacial till with increasing chainage. WS01, and WS02 indicated gravels although shallow refusal. Approximately 1 m of Made ground encountered in CP01	1.5	N4 Inbound: Widening at Hermitage Golf Club for two-way cycle track, removal and reconstruction of secant piled retaining wall and masonry boundary wall, removal of

Sub-section	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
							comprising of reworked boulder Clay, underlying strata was Glacial Till		existing and planting of new trees, and new golf screen netting supported with an independent structure. N4 Outbound: Localised pavement works on N4 outbound direction.
Junction 2 off ramp to Old Lucan Road (Global Ch A1300 to A1650/ Local Ch E0 to E305 & F0 to F149)	455	At Grade	0	0	0	0	Based on ground investigation information area is underlain by made ground and glacial till.	0.5	Traffic lanes narrowed, two-way cycle track provided, and footway relocated
N4 Junction 2 to proposed pedestrian bridge at Liffey Valley Bus Interchange bus stop (Global Ch A1650 to A2150/ Local Ch G0 to G522)	520	At Grade	0	0	0	0	Based on desk study information area is underlain by made ground and glacial till	0.5	Old Lucan Road: New two way cycle track at grade. N4 inbound on-ramp: At grade widening for pavement reconstruction for bus lane
Liffey Valley Interchange to M50 Junction (Global Ch A2100 - A2550/ Local Ch H0 to H295)	450	Cut	3.5	2	0	0	Based on desk study information area is underlain by made ground, glacial till and bedrock. Road embankment fill material on reworked boulder clay /boulder clay. Up to 1.9 m of made ground (reworked boulder clay encountered in R6-CP05) Rock inferred to be at about 4 m bgl in the area of testholes. Soft pockets of Glacial till present likely due to increased weathering from ground water and shallow rock). Historical report near	0.5	Old Lucan Road: New two way cycle track at grade on Old Lucan Road. New cycle links at existing bridge from Old Lucan Road to segregated cycleway at the N4. Minor retaining walls may be required for new links.

Sub-section	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
							existing pedestrian bridge has presumed shallow bedrock (within 0.25 to 2 m bgl)		N4 Inbound: At grade widening for pavement reconstruction at bus stop laybys only. The traffic lanes redesignated within existing carriageway extents and provision of bus stops. N4 outbound : 135m long 2.5 - 3.5m high retaining wall (RW02) & widening for pavement reconstruction for interchange and new bridge foundations. At Liffey Valley Shopping Centre, the existing pedestrian bridge ramp on the south side will be removed. The residual terrace will remain and be replanted accordingly.

Table 14.32: Conceptual Site Model - M50 Junction 7 to Con Colbert Road

Area	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
M50 Junction to Kennelsfort Road (Global Ch Ref: A2550 - A3600/ Local Ch Ref I200 to J750)	1,050	At Grade	0	0	0	0	Based on desk study information area is underlain by made ground and glacial till	0.5	Old Lucan Road: New two-way cycle track at grade & footway reconfigured.
Kennelsfort Road Junction and Pedestrian Bridge to The Oval Junction to the start of	700	At Grade	0	0	0	0	Based on ground investigation information area is underlain by made ground, glacial till and bedrock. R6-CP09 located in field south of Kennelsfort Bridge ramp had 3 m of very soft Made Ground (reworked boulder clay) overlying very soft sandy	0.5	Old Lucan Road: New two-way cycle track at grade & footway reconfigured. R148 Palmerstown bypass Inbound/ outbound: pavement works throughout for

Area	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
the R148 Chapelizod Bypass (Global Ch Ref A3600 - A4300/Local Ch Ref J750 to L300)							gravelly clay. Stiff sandy gravelly clay at 4.8 m, Possible bedrock at 4.8 m bgl		junction reconfiguration / bus stop laybys, removal of left turn slip lanes at Kennelsfort Road & Old Lucan Road junctions, and provision of left turn lane at Kennelsfort Road junction & right turn lane at The Oval junction.
Chapelizod Bypass - Old Lucan Road to before Chapelizod Hill Road (Global Ch A4300 - A5550)	1,250	At Grade	0	0	0	0	Based on desk study information area is underlain by made ground and glacial till	0.5	
Chapelizod Hill Road Bridge		Structure	No cut/fill due to existence of structure				Based on ground investigation information area is underlain by made ground and glacial till. Road embankment fill material on reworked boulder clay embankments. Historical logs and R6-CP10, and R6-CP11 indicated firm becoming stiff to very stiff reworked boulder clay which is possibly an engineered embankment fill. Concrete was noted in R6-CP-10 and historical logs	0.5	The bridge is an insitu box structure with an internal span of 9.8m and a vertical clearance of minimum 5.2m on the southern side. The existing bridge will be widened by 6.0m, with the provision of a new portal frame.
Chapelizod Hill Retaining Walls (RW03 & RW04)	80	Structure	No cut/fill due to existence of structure				Based on ground investigation information area is underlain by made ground and glacial till. Road embankment fill material on reworked boulder clay embankments. Historical logs and R6-CP10, and R6-CP11 indicated firm becoming stiff to very stiff reworked boulder clay which is possibly an engineered embankment fill. Concrete was noted in R6-CP-10 and historical logs	0.5	RW03 is a contiguous piled wall, finished in precast concrete to retain proposed bus stop and footway – 38m in length with a maximum retained height of 4.5m; RW04 is a retaining wall formed of soil nails with a shotcrete facing, with a supplementary insitu reinforced concrete facing with a pattern profile finish – 68m in length with a maximum height of 1.95m.
Chapelizod Bypass Chapelizod Hill Road Bus Stop (Global Ch A5550 - A5700)	150	Cut	7	2	0	0	Based on ground investigation information area is underlain by made ground and glacial till. Road embankment fill material on reworked boulder clay embankments. Historical logs and R6-CP10, and R6-CP11 indicated firm becoming stiff to very stiff reworked boulder clay which is possibly an engineered embankment fill. Concrete was noted in R6-CP-10 and historical logs	0.5	Inbound: New bridge structure (ST02) adjacent to existing; Piled wall (RW03) to bus stop and reinforced earth embankment to proposed access ramp and stairs.

Area	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
									Outbound: (RW04) soil nailed wall to proposed bus stop, footway and associated access ramp and stairs.
Chapelizod Hill Road Bus Stop to Con Colbert Road (Global Ch A5700 - A7550)	1,900	At Grade	0	0	0	0	Based on desk study information area is underlain by made ground and glacial till	0.5	Inbound/outbound: Minor works including signage and possible removal of cycle stamps on carriageway

Table 14.33: Conceptual Site Model - Con Colbert Road to Frank Sherwin Bridge

Area	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
Con Colbert Road to Heuston Station (Global Ch A7550 - A9618)	2,100	At Grade	0	0	0	0	Based on desk study information area is underlain by made ground and glacial till	0.5	Inbound/outbound: At grade widening for cycle track, reconfiguring footways, local widening for bus stop laybys, relocating central medians and junction modifications

14.3.5.1 Environment Type

The environment across the study area has been categorised in accordance with the IGI Guidelines. It has been classified as:

Type A environment which corresponds to a passive geological / hydrogeological environment – examples include areas of thick low permeability subsoils, areas underlain by poor aquifers, recharge areas, historically stable geological environments.

14.4 Potential Impacts

This section presents potential impacts that may occur due to the Proposed Scheme, in the absence of mitigation. This informs the need for mitigation or monitoring to be proposed (refer to Section 14.5). Predicted 'residual' impacts taking into account any proposed mitigation is presented in Section 14.6.

14.4.1 Characteristics of the Proposed Scheme

A detailed description of the Proposed Scheme and construction activities are provided in Chapter 4 (Proposed Scheme Description) and Chapter 5 (Construction).

This Section outlines the key design features, characteristics and construction activities of the Proposed Scheme of relevance to land, soils, geology and hydrogeology.

A Construction Environmental Management Plan (CEMP) is provided in Appendix A5.1 in Volume 4 of this EIAR.

14.4.1.1 Section 1: N4 Junction 3 to M50 Junction 7 – N4 Lucan Road

- The Ballydowd Pedestrian and Cycle Bridge will be constructed over the N4, along the east side of Ballyowen Road, and will replace the existing pedestrian bridge. A minor retaining wall will be constructed along the eastern side of Ballyowen Road, adjacent to the Ballydowd Pedestrian and Cycle Bridge;
- A piled boundary wall will be constructed along the northern verge of Lucan Road;
- The existing stone wall boundary of the Hermitage Golf Club, Sureweld Limited and Hermitage Medical Clinic will be taken down. The stone will be set aside for reuse. New retaining/ boundary walls with stone facing to match existing, will be built along the boundary of the Hermitage Golf Club, Sureweld and the Hermitage Clinic. Construction of sports netting of 15m in height will be included along part of the golf club boundary;
- At the Hermitage Medical Clinic, a new retaining structure will be constructed, RW05, which will be approximately 83m in length and maximum 1.5m in retained height. A minor blockwork gravity retaining wall will be constructed along the N4 westbound slip road.
- The Construction Compound LU1a will be located northeast of the N4 Junction 2, with access / egress from Old Lucan Road;
- The Construction Compound LU1b will be located between N4 National Road and the Old Lucan Road, with access / egress from the N4 and the Old Lucan Road;
- The Liffey Valley Pedestrian Bridge will be constructed over the N4 to connect the new bus stops on N4 and Liffey Valley Bus Interchange. As part of the structural works, a new ramp and steps will be constructed on either side of the Liffey Valley Pedestrian Bridge, incorporating a retaining wall (RW02) on the south side of the Liffey Valley Pedestrian Bridge, approximately 135.0m in length and maximum 2.6m in retained height; and
- Some minor utility diversions and/ or protections will be required.

14.4.1.2 Section 2: M50 Junction 7 to R148 Con Colbert Road – Palmerstown bypass and Chapelizod bypass

- At this section, widening and narrowing of discrete sections of the carriageway along the Old Lucan Road, between M50 and the junction of the Oval with Palmerstiwn Bypass, including a section of Kennelsfort Road Lower.

- Along the Chapelizod Hill Road, the road and bridge will be widened to facilitate construction of bus lay-bys in each direction. As part of the structural works, a new pedestrian ramp and stair access will be constructed on each side of the Chapelizod Hill Road Bridge, incorporating two retaining walls (RW03 and RW04) approximately 38.0m and 68m in length and maximum 4.5m and 1.9m in retained height, respectively.
- Construction Compound LU2 will be located north of Palmerstown Bypass, between Kennelsfort Road Junction and the Oval Junction, with access / egress from Palmerstown Drive; and
- Some minor utility diversions and/ or protections will be required.

14.4.1.3 Section 3: R148 Con Colbert Road to City Centre – St. John's Road West

- The construction activities within this section will comprise widening and narrowing of discrete sections, reconstruction, and resurfacing of the roads, footpaths, and cycle tracks, and new kerbs.
- Construction Compound LU3 will be located within Liffey Gaels Park, south of Chapelizod Bypass, at the Con Colbert Road Junction, with access / egress from Con Colbert Road; and
- Some minor utility diversions and/ or protections will be required.

14.4.1.4 Operational Phase

The impact assessment for the Operational Phase has been outlined in terms of impact analysis of the Proposed Scheme on the local environment from a land, soils, geology and hydrogeology perspective. This is outlined in the following Sections.

14.4.2 'Do Nothing' Scenario

In the Do Nothing scenario the Proposed Scheme would not to be developed and there would be no resulting impacts on the land, soils, geology and hydrogeology along the route of the Proposed Scheme. The impact would therefore be neutral.

14.4.3 Construction Phase

The potential land, soils, geology and hydrogeology impacts during the Construction Phase for the relevant construction activities described in Section 14.4.1 are presented in this Section, along with their impact significance. These potential impacts also relate and interact with other environmental factors which are described within the EIAR. Specific interactions are outlined in Section 14.1.

The Proposed Scheme will have the following potential impacts on the land, soils, geology and hydrogeology as discussed below and summarised in Table 14.34:

- Loss or damage of topsoil;
- Excavation of potentially contaminated ground;
- Loss of future quarry or pit reserve;
- Loss or damage of proportion of Geological Heritage Area;
- Loss or damage of proportion of aquifer;
- Change to groundwater regime; and
- Loss or damage of a groundwater dependent habitat.

Though the magnitude of the impact may vary depending on the scale of activities and location of the Proposed Scheme relative to the impacted important feature, only the maximum magnitude of the impact of the Proposed Scheme is discussed.

14.4.3.1 Loss and damage of topsoil

Topsoil is a non-renewable resource which if removed or damaged can result in a permanent irreversible negative impact. The potential ways in which this can occur as a result of the Proposed Scheme are as follows:

- There is the potential for materials on site to be spilled resulting in the pollution of the topsoil. For example, raw or uncured concrete and grouts, wash down water from exposed aggregate surfaces, concrete and mortars from ready mix trucks, fuels, lubricants, oils, and hydraulic fluids for equipment used on the development site, bitumen and sealants used for waterproofing concrete surfaces can all potentially impact on soils and groundwater during the Construction Phase;

- These excavated soil materials will be stockpiled using appropriate methods to minimise the impacts of weathering. Materials that are stockpiled incorrectly can be exposed to erosion and weathering which reduces the quality of the resource;

- Excavations in areas of contaminated ground during the construction works may mobilise pollution contained in the soils into the nearby uncontaminated topsoil;

- Permanent damage of topsoil through waterlogging, sealing, washout of fines and erosion. This would be due to the trafficking of plant, regrading of slopes, laying of hardstanding surfaces and storage of materials in areas not intended to be paved as part of the Proposed Scheme; and

- Excavation and disposal of topsoil instead of its reuse or reinstatement.

Topsoil will be encountered in numerous areas across the Proposed Scheme as discussed in Section 14.3.3.3. Where topsoil is stripped to accommodate the works outlined above, all of the above impacts are likely to occur at these locations.

The magnitude of these impacts of Proposed Scheme on the topsoil is small adverse as it results in a permanent irreversible loss of a small proportion of locally high fertility topsoil and / or a high proportion of locally low fertility topsoils within the study area. As the topsoil is of high importance the resulting significance of this permanent small adverse impact is slight.

14.4.3.2 Excavation of potentially contaminated land

The excavation of made ground results in the production of excess material that requires placement elsewhere within the Proposed Scheme or removal off-site and / or the mobilisation of possible contaminants. The entirety of the Proposed Scheme will encounter made ground as discussed in Section 14.3.3.1 and Section 14.3.3.3.

Exposure of locations of contamination and excavation of contaminated soil may potentially lead to a risk to the surrounding environment or underlying soil if not dealt with in an appropriate manner in accordance with the Environmental Protection Agency guidance on Land Contamination. The underlying soil could be impacted from the exposure of previous buried hazardous material, in an unlicensed dumping site for example.

Potential sources of contamination relevant to the Proposed Scheme identified within the study area are detailed in Table 14.23 and include historic gravel pits, Historic Fonthill Power Station (now Sureweld Limited), a burial ground, railway works, army barracks, scavenging depot and the Creosote Stream.

The magnitude of this impact is small adverse as it results in the excavation of a small proportion of contaminated land. As the potential contaminated ground is of medium importance the resulting significance of the permanent small adverse impact is slight.

14.4.3.3 Loss of future quarry or pit reserve

The excavation of soil and rock during construction can diminish future quarry and pit reserves which have been shown to have been utilised in the past in the area such as the quarries either side of the N4 or the historic quarry that is now the Irish War Memorial Gardens in Islandbridge. This can result in a permanent irreversible loss of the in-situ characteristics of the land, soils and geology area.

The magnitude of this impact is negligible as it results in an insufficient permanent irreversible change on a local scale to affect the integrity of the land and soils as a potential future quarry or pit reserve above the Do Nothing scenario. As the aggregate potential is of medium to high importance the resulting significance of this negligible impact is imperceptible and will not be considered further.

14.4.3.4 Loss or damage of proportion of Geological Heritage Area

The sealing, contamination or excavation of soil and rock during construction can diminish the value of Geological Heritage Areas. This can result in a permanent irreversible loss of the in-situ characteristics of the land, soils, geology and hydrogeology of the area. As noted in Table 14.26 three County Geological Sites are present with the study area of the Proposed Scheme.

The Phoenix Park, Guinness Well and Liffey Valley Centre Road Sections County Geological Sites are removed from any direct or indirect impacts from the Proposed Scheme due to their distance from any proposed construction activities. The magnitude of this impact is negligible as it results in an insufficient permanent irreversible change on a local scale to affect the integrity of these County Geological Sites. The resulting significance of this permanent negligible impact is imperceptible and will not be considered further.

14.4.3.5 Loss or damage of proportion of aquifer

The removal of a proportion of an aquifer can reduce its ability to provide baseflow to groundwater dependant habitats and or water supplies and results in an irreversible loss of the in-situ characteristics of the land, soils, geology and hydrogeology. Likewise, the mobilisation of contaminants into the aquifer either through accidental spillage or disturbance of contaminated ground during excavation will reduce the quality of the groundwater within the aquifer.

The underlying limestone bedrock is defined as a locally important aquifer,where there is anticipated to be minimal excavation into the limestone rock as part of the Proposed Scheme. The magnitude of this impact is negligible as it results in no measurable change which may affect the integrity of the underlying aquifer. As the aquifer is a locally important aquifer of medium importance the resulting significance of this negligible impact is imperceptible and will not be considered further.

In addition to the above impact, potential pollutants from routine run-off during construction or mobilisaton of pollution from the disturbance of contaminated ground during construction activities (particularly excavations) have the potential to alter the groundwater quality temporarily in the study area. The magnitude of this impact is moderate adverse as it results in a temporary potential medium risk of pollution to groundwater. As the aquifer is a locally important aquifer of medium importance the resulting significant of this temporary moderate adverse impact is moderate.

14.4.3.6 Change to groundwater regime

Localised pumping of excavations may be required as part of the Construction Phase in order to allow works to be carried out in dry excavations. This could lead to a temporary change in the groundwater levels and flow within the locally important aquifer underlying the Proposed Scheme.

Since the pumping is expected to be limited, localised and temporary, the magnitude of this impact is considered negligible. As the importance of the locally important aquifer is medium, the resulting significance is imperceptible and therefore will not be considered further.

14.4.3.7 Loss or damage of a groundwater dependent habitat

Localised pumping of excavations is expected to be required as part of the Construction Phase at structures and trenches in order to allow works to be carried out in dry excavations. This could lead to a temporary change in the groundwater levels and base flow to groundwater dependant habitats.

Since the pumping is expected to be limited, localised and temporary, the magnitude of this impact is considered negligible. The importance of the Liffey Valley proposed National Heritage Area (pNHA) is very high and the resulting significance is imperceptible.

The Liffey Valley pNHA is located downgradient of the Proposed Scheme. There is a 1.5m deep cutting proposed 360m south of the pNHA, a 3.5m deep cutting proposed 250m south of the pNHA and a 4.5m deep cutting proposed 730m south of the pNHA. Any drawdown from the excavation is expected to be limited, localised, not extending into the boundary of the pNHA site, and temporary. There is a risk of pollutants entering the groundwater as a result of spillages or accidents where mitigation measures are not implemented. Therefore, the magnitude of this potential impact is considered moderate adverse. As the importance of the Liffey Valley pNHA is very high the resulting significance of the potential impact is significant.

Table 14.34: Summary of Potential Construction Phase Impacts

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Loss or damage of topsoil									
Topsoil - BminSW & BminDW	Widespread in green areas including parks across the site	South of the River Liffey at the Irish National War Memorial Park	High	Loss or damage of topsoil	Negative	Permanent	Local	Small adverse	Slight
Excavation of potentially contaminated ground									
Potential Sources of Contamination	Graveyard	Islandbridge	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Gravel Pit	North and south of N4	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Magazine	Islandbridge	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Railway	Inchicore	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Gravel Pit	South of the N4 Junction 2	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Historical Fonthill Power Station	Fonthill	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Gravel Pit	North of the N4 and Irish National War Memorial Park	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Scavenging Depot	Islandbridge	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Creosote Stream-Inchicore railway works	Inchicore	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Petrol Stations along the route	Various petrol stations along the route (Hermitage, Palmerstown, Parkway West and Kilmainham)	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Licensed Facilities	Diageo, St. James Gate	St. James Gate	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Loss of future quarry or pit reserve									
Crushed rock aggregate	Moderate to high potential	North and south of the Proposed Scheme between the N4 Junction 3 and Junction 2 and at the M50 Junction 7. Along the alignment of the River Liffey and in the area of Palmerstown	Medium	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible
Crushed rock aggregate	Very high potential	N4 Junction 3 and Junction 2, Ballyowen Lane, the M50 Junction 7 and following the alignment of the	High	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
		River Liffey from north of Riverdale Avenue to north of Palmerstown Drive. North and south of the Proposed Scheme from the Hermitage Golf Club to the N4 Junction 2. Richmond Park east of Inchicore. Intersection of Kylemore Road and Le Fanu Road and along the alignment of the River Liffey at the Irish National War Memorial Park and Islandbridge							
Granular aggregate	Moderate to high potential	North and south of the Proposed Scheme from the Hermitage Golf Club to the N4 Junction 2. River Liffey, north-east of the industrial estate on the south side of the Old Lucan Road in Palmerstown Village. Inchicore Road	Medium	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible
Granular aggregate	Very high potential	River Liffey and the intersection of the R112 Kylemore Road and Le Fanu Road.	High	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible
Change to Groundwater Regime									
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones- Widespread	Widespread	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible
Loss or Damage of Proportion of Aquifer									
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones- Widespread	Widespread	Medium	Loss or damage of proportion of aquifer through pollution.	Negative	Temporary	Local	Moderate Adverse	Moderate
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones- Widespread	Widespread	Medium	Loss or damage of proportion of aquifer through excavation.	Negative	Permanent	Local	Negligible	Imperceptible
Loss or Damage of Proportion of Geological Heritage Area									
Phoenix Park	County geological site (DC009)	Phoenix Park	High	Loss or damage of proportion of Geological Heritage Area	Negative	Permanent	Local	Negligible	Imperceptible

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Guinness Wells	County geological site (DC005)	Guinness Wells	High	Loss or damage of proportion of Geological Heritage Area	Negative	Permanent	Local	Negligible	Imperceptible
Liffey Valley Centre Road Sections	County geological site (DC005)	Liffey Valley Centre Road Sections	High	Loss or damage of proportion of Geological Heritage Area	Negative	Permanent	Local	Negligible	Imperceptible
Loss or Damage of a Groundwater Dependant Habitat.									
Groundwater dependant habitat	Liffey Valley (000128)	Liffey Valley	Very High	Loss or damage to proportion of proposed Natural Heritage Area	Negative	Temporary	Local	Moderate adverse	Significant

14.4.4 Operational Phase

The Operational Phase has the potential to lead to occasional accidental leakage of oil, petrol or diesel, allowing contamination of the surrounding environment. While the likelihood of an accidental spillage may increase in comparison to the Do Nothing scenario, the magnitude of the impact is negligible.

Therefore, the significance of the impact is imperceptible on land, soils, geology and hydrogeology.

14.5 Mitigation and Monitoring Measures

The following sections outline the mitigation and monitoring measures associated with the impacts identified in Section 14.4 for both the Construction and the Operational Phases of the Proposed Scheme. A summary of the pre-mitigation and post-mitigation impacts is contained in Table 14.35.

14.5.1 Construction Phase

14.5.1.1 Loss or Damage of Topsoil

Excavated topsoil will be stockpiled using appropriate methods to minimise the effects of weathering. Care will be taken in reworking this material to minimise dust generation, groundwater infiltration and generation of runoff.

All topsoil or subsoil is assessed for re-use within the Proposed Scheme by the appointed contractor ensuring the appropriate handling, processing and segregation of the material. Where practical the removal of topsoil from the Proposed Scheme will be avoided. All earthworks will be undertaken in accordance with TII Specification for Road Works (SPW) Series 600 Earthworks (TII 2013) and project-specific earthworks specifications, ensuring that all excavated material and imported material is classified using the same methodology to allow maximum opportunity for the reuse of materials on site.

The impact of the production of excess material for removal off site is discussed in Chapter 18 (Waste & Resources).

14.5.1.2 Excavation of Potentially Contaminated Ground

The appointed contractor will ensure that excavations shall be kept to a minimum, using shoring or trench boxes where appropriate. For more extensive excavations, a temporary works designer shall be appointed by the appointed contractor to design excavation support measures in accordance with all relevant guidelines that minimises the excavation of contaminated ground.

The appointed contractor will be responsible for regular testing of excavated soils to monitor the suitability of the soil for resue.

Samples of ground suspected of contamination will be tested for contamination during the deatiled ground investigation and ground excavated from these areas will be disposed of to a suitably licensed or permitted sites in accordance with the current Irish waste management legislation.

Any dewatering in areas of contaminated ground shall be designed by the appointed contractor to minimise the mobilisation of contaminants into the surrounding environment.

14.5.1.3 Pollution of Soil and Groundwater

Good construction management practices, as outlined in the CIRIA guidance Control of Water Pollution from Construction Sites – Guidance for consultants and contractors (Masters-Williams *et al*., 2001) will be employed by the appointed contractor to minimise the risk of transmission of hazardous materials as well as pollution of adjacent watercourses and groundwater. The construction management of the site will take account of these recommendations to minimise as far as possible the risk of soil, groundwater and surface water contamination.

Measures to be implemented by the appointed contractor to minimise the risk of spills and contamination of soils and waters should include:

- Employing only competent and experience workforce, and site-specific training of site managers, foremen and workforce, including all subcontractors, in pollution risks and preventative measures;
- Ensure that all areas where liquids (including fuel) are stored, or cleaning is carried out, are in designated impermeable areas that are isolated from the surrounding area and within a secondary containment system, e.g. by a roll-over bund, raised kerb, ramps or stepped access;
- The location of any fuel storage facilities shall be considered in the design of all Construction Compounds. These are to be designed in accordance with relevant guidelines and codes of best practice and will be fully bunded;
- Good housekeeping at the site (daily site clean-ups, use of disposal bins, etc.) during the entire Construction Phase;
- Potential pollutants to be adequately secured against vandalism;
- Provision of proper containment of potential pollutants according to codes of best practice;
- Thorough control during the entire Construction Phase to ensure that any spillage is identified at early stage and subsequently effectively contained and managed; and
- Spill kit to be provided and to be kept close to the storage area. Staff to be trained on how to use spill kits correctly.

An Environmental Incident Response Plan will be implemented by the appointed contractor, which will identify the actions to be taken in the event of a pollution incident. It will address containment measures, emergency discharge routes, a list of appropriate equipment and clean-up materials and notification procedures to inform the relevant environmental protection authority. Refer to Appendix A5.1 CEMP in Volume 4 of this EIAR.

Sediment control methods are outlined in the Surface Water Management Plan in Appendix A5.1 CEMP in Volume 4 of this EIAR, and these will be implemented by the appointed contractor.

The CEMP also addresses good construction management practices that will be employed to prevent the risk of pollution of the existing land, soils, geology and hydrogeology during construction.

14.5.2 Operational Phase

With the implementation of the proposed design, no additional mitigation measures for land, soils, geology and hydrogeology are considered necessary for the operation of the Proposed Scheme.

In the Operational Phase the infrastructure will be maintained by the local authority and will be subject to their management procedures to ensure that the correct measures are taken in the event of any accidental spillages and this will reduce the potential for any impact.

14.6 Residual Impacts

14.6.1 Construction Phase

With the efficacious implementation of the above mitigation measures, there will be no significant residual impacts on land, soils, geology or hydrogeology as a result of the construction of the Proposed Scheme.

Table 14.35: Summary of Predicted Construction Phase Impacts Following the Implementation of Mitigation and Monitoring Measures

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Pre-Mitigation Magnitude	Pre-Mitigation Significance	Post-Mitigation Magnitude	Post-Mitigation Magnitude
Loss or damage of topsoil											
Topsoil - BminSW & BminDW	Widespread in green areas including parks across the site	South of the River Liffey at the Irish National War Memorial Park	High	Loss or damage of topsoil	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Excavation of potentially contaminated ground											
Potential Sources of Contamination	Graveyard	Islandbridge	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Gravel Pit	North and south of N4	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Magazine	Islandbridge	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Railway	Inchicore	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Gravel Pit	South of the N4 Junction 2	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Historical Fonthill Power Station	Fonthill	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Gravel Pit	North of the N4 and Irish National War Memorial Park	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Scavenging Depot	Islandbridge	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Creosote Stream	Inchicore	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Petrol Stations along the route	Various petrol stations along the route (Hermitage, Palmerstown, Parkway West and Kilmainham)	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Pre-Mitigation Magnitude	Pre-Mitigation Significance	Post-Mitigation Magnitude	Post-Mitigation Magnitude
Licensed Facilities	Diageo, St. James Gate	St. James Gate	Medium	Excavation of potentially contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Loss of future quarry or pit reserve											
Crushed rock aggregate	Moderate to high potential	North and south of the Proposed Scheme between the N4 Junction 3 and Junction 2 and at the M50 Junction 7. Along the alignment of the River Liffey and in the area of Palmerstown	Medium	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Crushed rock aggregate	Very high potential	N4 Junction 3 and Junction 2, Ballyowen Lane, the M50 Junction 7 and following the alignment of the River Liffey from north of Riverdale Avenue to north of Palmerstown Drive North and south of the Proposed Scheme from the Hermitage Golf Club to the N4 Junction 2. Richmond Park east of Inchicore Intersection of Kylemore Road and Le Fanu Road and along the alignment of the River Liffey at the Irish National War Memorial Park and Islandbridge.	High	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Granular aggregate	Moderate to high potential	North and south of the Proposed Scheme from the Hermitage Golf Club to the N4 Junction 2. River Liffey, north-east of the industrial estate on the south side of the Old Lucan Road in Palmerstown Village. Inchicore Road	Medium	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Granular aggregate	Very high potential	River Liffey and the intersection of the R112 Kylemore Road and Le Fanu Road.	High	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Pre-Mitigation Magnitude	Pre-Mitigation Significance	Post-Mitigation Magnitude	Post-Mitigation Magnitude
Change to Groundwater Regime											
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones-Widespread	Widespread	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible	Negligible	Imperceptible
Loss or Damage of Proportion of Aquifer											
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones-Widespread	Widespread	Medium	Loss or damage of proportion of aquifer through pollution.	Negative	Temporary	Local	Moderate Adverse	Moderate	Negligible	Imperceptible
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones-Widespread	Widespread	Medium	Loss or damage of proportion of aquifer through excavation.	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Loss or Damage of Proportion of Geological Heritage Area											
Phoenix Park	County geological site (DC009)	Phoenix Park	High	Loss or damage of proportion of Geological Heritage Area	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Guinness Wells	County geological site (DC005)	Guinness Wells	High	Loss or damage of proportion of Geological Heritage Area	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Liffey Valley Centre Road Sections	County geological site (DC005)	Liffey Valley Centre Road Sections	High	Loss or damage of proportion of Geological Heritage Area	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Loss or Damage of a Groundwater Dependant Habitat.											
Groundwater dependant habitat	Liffey Valley (000128)	Liffey Valley	Very High	Loss or damage to proportion of proposed Natural Heritage Area	Negative	Temporary	Local	Moderate adverse	Significant	Negligible	Imperceptible

14.6.2 Operational Phase

No significant residual impacts on land, soils, geology and hydrogeology as a result of the operation of the Proposed Scheme.

No significant residual impacts have been identified either in the Construction or Operational Phases of the Proposed Scheme, whilst meeting the scheme objectives set out in Chapter 1 (Introduction).

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