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, soils, geology and hydrogeology as a result of the Construction and Operational Phases of the Belfield / Blackrock 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 process 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 250 metres (m) 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 will be 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:

- Stradbrook Road to Booterstown Avenue;
- Booterstown Avenue to Nutley Lane;
- Merrion Road - Nutley Lane to Ballsbridge;
- Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street); and
- Nutley Lane - R138 to Merrion Road.

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 (Bing 2019)
Teagasc	Teagasc Soils Data	Surface soils classification and description
Geological Survey Ireland (GSI)	Quaternary Mapping	
	Bedrock Mapping	

Source	Name	Description
	Aggregate Potential Mapping	Geological maps of the site area produced by the GSI and also available on GSI online map viewer.
	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
R1110	Phoenix Terrace	1989	IGSL	Junction of Rock Rd. and Phoenix Terrace	3 Percussion Boreholes (Shell and Auger)
R1098	Site Development	1990	IGSL	Opposite Blackrock college	8 Trial pits
R5002	Residential / Commercial Development	Unknown	Unknown	Merrion Road, Dublin.	2 Cable Percussion (Shell and Auger)
R519	Office development	1974	Site Investigations Ltd.	Merrion Road, Dublin.	6 Percussion Boreholes (Shell and Auger)
R741	Merrion Centre	1981	Site Investigations Ltd.	Merrion Road, Dublin.	12 Cable Percussive Boreholes
R1465	Embassy of the Netherlands	1996	IGSL	Merrion Road, Dublin.	1 Percussion borehole (Shell and Auger) and 2 Trial pits
R3483	Commercial and Underground Carpark Development	Unknown	Unknown	Royal Dublin Society (RDS) Simmonscourt	5 Percussion boreholes (Shell and Auger, 2 Cable Percussive and Rotary Coring boreholes
R7023	Project Rainbow House	2006	IGSL	Ballsbridge.	4 Rotary Holes

GSI Report ID	Title	Year	Author	Location	Scope
R435	Flats Complex	Unknown	Unknown	Montague Lane	4 boreholes (non-specified)
R771	Baggot Street Bridge House	1975	Irish Soils Laboratories Ltd.	Lower Baggot street	3 Percussion boreholes (Shell and Auger)

The scheme specific ground investigations carried out to inform the Proposed Scheme and EIAR are listed in Table 14.3 and the factual reports provided in Appendix 14.2 Ground Investigation Report 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
Bus Connect Detailed Stage 1 Lot 1 Route 14	Ground Investigations Ireland	January 2021	Merrion Road and Nutley Lane	3 Trial Pits
Bus Connect Detailed Stage 1 Lot 1 Route 15	Ground Investigations Ireland	January 2021	Merrion Road and Rock Road	3 Trial Pits 6. Cable Percussion boreholes 3 Groundwater monitoring wells

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 (BCIDC-ARP-GEO_HV-1415_ML_00-DR-CR-9001 in Volume 3 of this EIAR) have been used in the assessment.

14.2.3.4 Scheme Walkover

An initial scheme walkover survey was carried out on 20 February 2020 and 31 January 2022 to inform and verify the review of publicly available datasets.

The findings of the Proposed 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 Environmental Impact Assessment (EIA) Stage – Estimation of Magnitude of Impact 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 Soils and 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 (County Geological Site) 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

Importance	Criteria	Typical Example
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 features (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. cSAC or 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 – 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 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 Soils 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

Magnitude of Impact	Criteria	Typical Example
		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 5.3 (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 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, 2008)

		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, residential and recreational. Moving away from the City Centre there are also marine, agricultural and 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
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
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 1:500,000k 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
	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)	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

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 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, both Dublin City Council (DCC) and Dun Laoghaire Rathdown Council (DLR) also maintain databases 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. Again, 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 is available at the EPA Ryewater 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
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 in order 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 2019), Google (Google 2019), Bing (Bing 2019) and the Corine Land Cover maps (EPA 2018). The historic land use is based on the following OSI (OSI 2019) 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 Stradbrook Road to Booterstown Avenue

The Corine Land Cover 2018 (EPA 2018) classifies the land between Stradbrook Road and Mount Merrion Avenue as continuous urban fabric. The land between Mount Merrion Avenue and Booterstown Avenue is classified as discontinuous urban fabric.

The OSI 6-inch mapping shows that the study area between Stradbrook Road and Booterstown Avenue comprises a mix of agricultural land and urban development with a higher density of urban development closer to Blackrock Village. Much of the land on the eastern side of the Proposed Scheme was tidal, flooded or marsh land. The Dublin and Kingstown Railway runs parallel to the Proposed Scheme along the seafront. A gravel pit is located at Temple Hill.

The OSI 25-inch mapping shows a significant increase in urban development within the study area, particularly in Blackrock Village. A tramway is located along Newtown Avenue, Blackrock Main street, Rock Road. A tramway depot is located on Newtown Avenue. A graveyard is located at Temple Hill.

It should be noted that the 1995 OSI aerial photography is in black and white and of poor resolution. Significant urban development is evident in the area, including Frascatti Road which bypasses Blackrock Village and the construction of the Frascati and Blackrock shopping centres.

The 2000 OSI aerial photography shows no notable change in land use from the 1995 OSI aerial photography.

The 2005 OSI aerial photography imagery shows no notable change in land use from the 2000 OSI aerial photography.

The 2019 Google Maps aerial imagery shows no notable change in land use from the OSI 2005 aerial photography.

14.3.3.1.2 Booterstown Avenue to Nutley Lane

The Corine Land Cover 2018 (EPA 2018) classifies the land between Booterstown Avenue and Nutley Lane as discontinuous urban fabric. The Elm Park Golf & Sports Club is located to the west of the Proposed Scheme between Elm Park and Nutley Lane and is classified as sports and leisure facilities.

Historically, the OSI 6-inch mapping shows that the study area between Booterstown Avenue and Nutley Lane comprised agricultural land with scattered residential properties. The land on the eastern side of the Proposed Scheme between Booterstown Avenue and Strand Road was tidal, flooded or marsh land. The Dublin and Kingstown Railway runs parallel to the Proposed Scheme along the seafront.

The OSI 25-inch mapping shows an increase in urban development within the study area. A tramway is located along Rock Road. A graveyard is located at Bellevue Avenue.

It should be noted that the 1995 OSI aerial photography is in black and white and of poor resolution. Significant urban development is evident in the area particularly residential development around Booterstown Avenue and St. Vincent's University Hospital south of Nutley Lane.

The 2000 OSI aerial photography shows no notable change in land use from the 1995 OSI aerial photography.

The 2005 OSI aerial photography imagery shows construction at Elm Park Green. No other notable change in land use is evident.

The 2019 Google Maps aerial imagery shows the Elm Park Green development completed. No other notable change in land use is evident.

14.3.3.1.3 Merrion Road - Nutley Lane to Ballsbridge

The Corine Land Cover 2018 (EPA 2018) classifies the land between Nutley Lane and Shrewsbury Road as discontinuous urban fabric. Between Shrewsbury Road and Ballsbridge, the land use is classified as industrial and commercial units.

The OSI 6-inch mapping shows that the study area between Nutley Lane and Simmonscourt Road comprises predominantly agricultural land with scattered residential development. The density of development is greater between Simmonscourt Road and Ballsbridge. Historic gravel pits were located at Shrewsbury Park and at Serpentine Avenue. A railway line runs parallel to the east of the Proposed Scheme.

The OSI 25-inch mapping shows an increase in residential, industrial and commercial development within the study area including the Royal Dublin Society's (RDS) Agricultural Premises. The Royal Dublin Society's Branch Railway extends between the RDS and the Kingstown and Bray Branch railway line to the east of the Proposed Scheme. A tramline was present along Merrion Road and a tramline depot was situated on Shelbourne Road. The gravel pit located at Shrewsbury Park was expanded.

It should be noted that the 1995 OSI aerial photography is in black and white and of poor resolution. Significant urban development is recorded in the study area.

The 2000 OSI aerial photography shows no notable change in land use from the 1995 OSI aerial photography, with the exception of the development of the Intercontinental Hotel Dublin at Simmonscourt Road.

The 2005 OSI aerial photography imagery shows no notable change in land use from the 2000 OSI aerial photography.

The 2019 Google Maps aerial imagery shows no notable change in land use from the OSI 2005 aerial photography.

14.3.3.1.4 Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)

The Corine Land Cover 2018 (EPA 2018) classifies the land between Ballsbridge and Lansdowne Road as industrial and commercial units. The land between Lansdowne Road and the Grand Canal is classified as discontinuous urban fabric. The area between the Grand Canal and Merrion Square is classified as continuous urban fabric.

Historically, the OSI 6-inch mapping shows that the study area between Ballsbridge and the Grand Canal comprises a mixture of agricultural and urban development. Trinity College Botanic Gardens is located at Northumberland Road. Industrial uses include the Calico printing factory, located at Pembroke Place, the Hammersmith (Iron) works located at the current location of Hume House Pembroke Road and a hat manufactory located on Mespil Road.

The OSI 25-inch mapping shows a significant increase in urban development within the study area. The land between Ballsbridge and the Grand Canal underwent significant residential development during this period (1888 to 1913). Industrial land use included a tramway along Pembroke Road and Baggot Street, a tramway depot on Shelbourne Road, Hammersmith works on Pembroke Street and two laundries on Mespil Road.

It should be noted that the 1995 OSI aerial photography is in black and white and of poor resolution. Urban development is recorded in the study area including development of the Trinity College Botanic Gardens at Northumberland Road and the former lawn tennis grounds at Pembroke Row.

The 2000 OSI aerial photography shows no notable change in land use from the 1995 OSI aerial photography.

The 2005 OSI aerial photography imagery shows no notable change in land use from the 2000 OSI aerial photography.

The 2019 Google Maps aerial imagery shows little change in land use from the OSI 2005 aerial photography. The aerial mapping shows construction works at the intersection of Baggot Street Lower and Fitzwilliam Street Upper.

14.3.3.1.5 Nutley Lane - R138 to Merrion Road

The Corine Land Cover 2018 (EPA 2018) classifies the land use within the Nutley Lane area as discontinuous urban fabric and artificial non-agricultural vegetated areas used for sport and leisure facilities where the Elm Park Golf & Sports Club is located.

The OSI 6-inch mapping shows predominantly agricultural land with scattered residential development. A railway is located within 200m to the north-east of Nutley Lane.

The OSI 25-inch mapping shows an increase in residential development within the study area.

It should be noted that the 1995 OSI aerial photography is in black and white and of poor resolution. Significant urban development is recorded in the study area. Areas recorded as being relatively undeveloped are pockets of parklands including the Elm Park Golf & Sports Club south of Nutley Lane and parts of St. Vincent's University Hospital.

The 2000 OSI aerial photography shows no notable change in land use from the 1995 OSI aerial photography.

The 2005 OSI aerial photography imagery shows an increase in development of the St. Vincent's University Hospital site.

The 2019 Google Maps aerial imagery shows no notable change in land use from the OSI 2005 aerial photography.

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 Stradbrook Road to Booterstown Avenue

The Proposed Scheme will continue at Stradbrook, which according to the OSI 10m contours is at an elevation between 10mOD and 20mOD and gradual falls towards Booterstown Avenue. The EPA river network map shows the Proposed Scheme passing over the Brewery Stream on the Temple Road and the Priory Stream along the Frascati Road.

The GSI database identifies hummocky sands and gravels within Blackrock on the Stradbrook Road and at the Booterstown Avenue junction on the Rock Road.

14.3.3.2.2 Booterstown Avenue to Nutley Lane

The Proposed Scheme will continue at an elevation between 0mOD and 10mOD. The EPA river network map shows the Proposed Scheme passing over the Booterstown Stream at Trimleston Avenue and the Elm Park Stream near Merrion House.

The GSI database identifies a glacial meltwater channels associated with the Elm Park Stream.

14.3.3.2.3 Merrion Road - Nutley Lane to Ballsbridge

The Proposed Scheme will continue from Nutley Lane to Ballsbridge at a similar elevation between 0mOD and 10mOD. The EPA river network map shows the Proposed Scheme passing over the River Dodder via Ballsbridge.

No geomorphological features were identified along this Section of the study area according to the GSI.

14.3.3.2.4 Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)

The Proposed Scheme will continue from Ballsbridge to Merrion Square at a similar elevation of between 0mOD and 10mOD. The EPA river network map shows the Proposed Scheme passing over the Grand Canal at McKenny's bridge.

No geomorphological features were identified along this Section of the study area according to the GSI.

14.3.3.2.5 Nutley Lane - R138 to Merrion Road

The Proposed Scheme will begin at the R138 Nutley Lane, which according to the Ordnance Survey Ireland (OSI) 10m contours is at an elevation between 10mOD and 20mOD. The EPA river network map shows no interactions with rivers or streams within this Section of the study area.

No geomorphological features were identified along this Section of the study area according to the GSI.

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 Stradbrook Road to Booterstown Avenue

The soils across this Section of the study area from Stradbrook Road to Booterstown Avenue are underlain predominantly by made ground. Localised pockets of poorly drained mineral soils (BminPD) mainly basic and deep well drained mineral soils (BminDW) are located near Stradbrook Road.

Shallow well drained mineral soils mainly basic (BminSW) and shallow well drained mineral soils mainly acidic (AminSW) are located in Blackrock Park.

14.3.3.3.2 Booterstown Avenue to Nutley Lane

The soils across this Section of the study area from Booterstown Avenue to Nutley Lane are predominantly underlain by made ground. Localised pockets of poorly drained mineral mainly basic soils (BminPD), deep well drained mineral soils (BminDW) and alluvium mineral (AlluvMin) deposits are located within Elm Park. Marine sediments are identified near Booterstown Avenue.

14.3.3.3.3 Merrion Road - Nutley Lane to Ballsbridge

The soil across this Section of the study area from Merrion Road to Ballsbridge is underlain by Made Ground which is present in varying forms of hardstanding materials including road pavements and footpaths. There are localised pockets of mineral alluvium (AlluvMin) along Merrion Road between Shrewsbury Road and Ailesbury Road and also along the banks of the River Dodder.

14.3.3.3.4 Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)

The soil across this Section of the study area from Pembroke Road, Baggot Street and Fitzwilliam Street is underlain by made ground which is present in varying forms of hardstanding materials including road pavements and footpaths.

14.3.3.3.5 Nutley Lane - R138 to Merrion Road

The soil across this Section of the study area from R138 to Merrion Road is underlain by made ground which is present in varying forms of hard standing materials including road pavements, footpaths and so forth.

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
Topsoil - BminPD	Poorly drained (Mainly Basic)	Stradbrook Road, Elm Park	Low	Poorly drained and / or low fertility soils
Alluvium - AlluvMIN	Typically found along current and historic watercourses	Elm Park and along Merrion Road between Shrewsbury Road and Ailesbury Road and also along the banks of the River Dodder	Medium	Moderately drained and / or moderate fertility soils
Marine Sediments - MarSed	Typically found along the coast	Booterstown Avenue	Medium	Moderately drained and / or moderate fertility soils
Topsoil - BminSW	Shallow well drained (Mainly basic)	Blackrock Park,	High	Well drained and / or high fertility soils
Topsoil - BminDW	Deep well drained (Mainly basic)	Stradbrook Road, Elm Park	High	Well drained and / or high fertility soils
Topsoil - AminSW	Shallow well drained (Mainly acidic)	Blackrock Park	High	Well drained and / or high 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), alluvium, estuarine silts and clays and marine beach sands, and gravels as discussed below.

14.3.3.4.1 Stradbrook Road to Booterstown Avenue

The subsoils encountered within the study area for this Section of the Proposed Scheme are predominantly till derived from limestones. Additionally, there are localised pockets of gravels derived from limestones, rock outcropping or subcropping and estuarine silts and clays.

The localised pockets of gravel derived from limestones are located around Stradbrook Road and Booterstown Avenue. Rock outcropping is located along the Rock Road at two locations, the first near the Frascati Road and Mount Merrion Avenue junction and the second rock outcropping near Willow Terrace to Booterstown Avenue. Estuarine silts and clays are located along the Rock Road from Ben Inagh Park to Booterstown Avenue.

14.3.3.4.2 Booterstown Avenue to Nutley Lane

The subsoils encountered within the study area for this Section of the Proposed Scheme are predominantly underlain by till derived from limestones. Additionally, there are localised pockets of gravels derived from limestones, rock outcropping or subcropping, estuarine silts and clays, alluvium and marine beach sands.

The localised pockets of gravel derived from limestones and rock outcropping are located around Booterstown Avenue. Estuarine silts and clays are located from Booterstown Avenue to Merrion House. Alluvium deposits are located around Merrion House and Elm Park apartments along the Merrion Road and again at the Nutley Lane junction with Merrion Road. Marine beach sands are located along the Merrion Road between the junctions with Strand Road and Nutley Lane.

14.3.3.4.3 Merrion Road - Nutley Lane to Ballsbridge

The subsoils encountered within the study area for this Section of the Proposed Scheme are predominantly alluvium deposits. Additionally, there are localised pockets of till derived from limestones identified from Simmonscourt road to Ballsbridge.

14.3.3.4.4 Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)

The subsoils encountered within the study area for this Section of the Proposed Scheme are predominantly made ground, alluvium and till derived from limestones.

Alluvium deposits are encountered from Ballsbridge to Pembroke Junction. Till derived from limestones are located from Pembroke Road to Baggot Street Upper before encountering made ground deposits for the rest of the Proposed Scheme.

14.3.3.4.5 Nutley Lane - R138 to Merrion Road

The subsoils encountered within the study area for this Section of the Proposed Scheme are predominantly tills derived from limestones. Additionally, there are localised pockets of alluvium at the Nutley Lane junction to the Merrion Road.

Table 14.17: Subsoils Within the Study Area

Subsoil Type	Notes / 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	Ballsbridge to Pembroke Junction and the Nutley Lane junction to the Merrion Road	Low	Low value on a local scale
Glacial gravels - GLs	Gravels derived from limestones	Stradbrook Road and Booterstown Avenue.	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	Along the Rock Road	Low	Low value on a local scale
Estuarine - Mesc	Estuarine Silts and clays	Rock Road from Ben Inagh Park to Booterstown Avenue	Medium	Medium value on a local scale
Marine sands - Mbs	Marine beach sands	Merrion Road between the junctions with Strand Road and Nutley Lane	Medium	Medium value on a local scale

14.3.3.5 Bedrock Geology

The bedrock geology of the study area, as classified by the GSI 1:100,000k 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.

The underlying bedrock of the study area is predominantly comprised of the Lucan Formation. A summary of the bedrock geology along the Proposed Scheme is presented in Table 14.18.

14.3.3.5.1 Stradbrook Road to Booterstown Avenue

The bedrock encountered within the study area for this Section of the Proposed Scheme comprises of the Lucan Formation (locally known as Calp Limestone), Ballysteen Formation and Type 2p microcline porphyritic granite.

The underlying geology from Stradbrook Road to the Rock Road at Ben Inagh Park is underlain by Type 2p microcline porphyritic granite. From Ben Inagh Park to Willow Terrace the Proposed Scheme is underlain by the Ballysteen Formation. From Willow Terrace to Booterstown Avenue the Proposed Scheme is underlain by the Lucan Formation.

Two faults are noted within the study area for this Section. The first is located at the contact between the Ballysteen Formation and Lucan Formation and the second at the contact between the Ballysteen Formation and the Type 2p microcline porphyritic granite.

14.3.3.5.2 Booterstown Avenue to Nutley Lane

The bedrock encountered within the study area for this Section of the Proposed Scheme comprises of the Lucan Formation (locally known as Calp Limestone).

No structural bedrock features were identified along this Section.

14.3.3.5.3 Merrion Road - Nutley Lane to Ballsbridge

The bedrock encountered within the study area for this Section of the Proposed Scheme comprises of the Lucan Formation (locally known as Calp Limestone).

No structural bedrock features were identified along this Section.

14.3.3.5.4 Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)

The bedrock encountered within the study area for this Section of the Proposed Scheme comprises of the Lucan Formation (locally known as Calp Limestone).

No structural bedrock features were identified along this Section.

14.3.3.5.5 Nutley Lane - R138 to Merrion Road

The bedrock encountered within the study area for this Section of the Proposed Scheme comprises of the Lucan Formation (locally known as Calp Limestone).

No structural bedrock features were identified along this Section.

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
Ballysteen Formation	Dark muddy limestone, Shale - Carboniferous	From Ben Inagh Park to Willow Terrace	Low	Low value on a local scale
Type 2p microcline porphyritic	Granite with microcline phenocrysts - Caledonian	From Stradbrook Road to the Rock Road at Ben Inagh Park is underlain by Type 2p microcline porphyritic granite	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 14.23.

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 of the Soils expected to be encountered by the Proposed Scheme from Stradbrook Road to Booterstown Avenue

Strata	General Extent / Location	Depth Range (mBGL)	Thickness Range (m)
Topsoil	Green areas – including parks, large estates and golf courses	0 to 0.8	0.0 to 0.8
Made Ground	Widespread	0 to 3.3	0.7 to 3.7
Glacial Till (Brown and Black Boulder Clay with lenses of fluvioglacial sands and gravels)	Widespread	0.3 to 5.8	0.7 to 4.4
Bedrock	Widespread along the proposed scheme	N/A	N/A

Table 14.20: Summary of Ground Conditions of the Soils expected to be encountered by the Proposed Scheme from Booterstown Avenue to Nutley Lane

Strata	General Extent / Location	Depth Range (mBGL)	Thickness Range (m)
Topsoil	Green areas – including parks, large estates and golf courses	0 to 0.2	0 to 0.2
Made Ground	Widespread	0 to 3.5	0 to 3.4
Glacial Till (Brown and Black Boulder Clay with lenses of fluvioglacial sands and gravels)	Widespread	0.2 to 6.4	0.2 to 2.8
Estuarine Silts and Clays with Marine Sands	Near the coast	0 to 2.7	0 to 1.2
Bedrock	Widespread along the proposed scheme	6.4	N/A

Table 14.21: Summary of Ground Conditions of the Soils expected to be encountered by the Proposed Scheme on Merrion Road (Nutley Lane to Ballsbridge)

Strata	General Extent / Location	Depth Range (mBGL)	Thickness Range (m)
Topsoil	Green areas – including parks, large estates and golf courses	0 to 0.3	0 to 0.3
Made Ground	Widespread	0 to 2	0 to 1.7
Glacial Till (Brown and Black Boulder Clay with lenses of fluvioglacial sands and gravels)	Widespread	0.2 to 12.3	1.0 to 7.8
Bedrock	Widespread along the proposed scheme	16 to 18.8	N/A

Table 14.22: Summary of Ground Conditions of the Soils expected to be encountered by the Proposed Scheme from Ballsbridge to Merrion Square

Strata	General Extent / Location	Depth Range (mBGL)	Thickness Range (m)
Made Ground	Widespread	0 to 2.10	2.1 to 2.2

Strata	General Extent / Location	Depth Range (mBGL)	Thickness Range (m)
Glacial Till (Brown and Black Boulder Clay with lenses of fluvioglacial sands and gravels)	Widespread	2.10 to 4.3	2.2
Bedrock	Widespread along the proposed scheme	5 to 10	N/A

Table 14.23: Summary of Ground Conditions of the Soils expected to be encountered by the Proposed Scheme on Nutley Lane (R138 to Merrion Road)

Strata	General Extent / Location	Depth Range (mBGL)	Thickness Range (m)
Topsoil	Green areas – including parks, large estates and golf courses	0 to 0.25	0 to 0.25
Made Ground	Widespread	0-25 to 1.8	0 to 1.55
Glacial Till (Brown and Black Boulder Clay with lenses of fluvioglacial sands and gravels)	Widespread	0.25 to 9.95	0.95 to 7.75
Bedrock	Widespread along the proposed scheme	10	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 14.24 along with their importance as determined by Box 4.1 of the NRA Guidelines (NRA 2008a).

Table 14.24: Soft Soils Within the Study Area

Feature	Description	Location	Importance	Justification for Importance Rating
Alluvium - AlluvMIN (soils) / A (subsoils)	Typically found along current and historic watercourses	Elm Park and along Merrion Road between Shrewsbury Road and Ailesbury Road and also along the banks of the River Dodder	Low	Volume of soft soil underlying the study area is small and of a local scale.
Marine Sediments - MarSed	Typically found along the coast	Booterstown Avenue	Low	Volume of soft soil underlying the study area is small and of a local scale.

Feature	Description	Location	Importance	Justification for Importance Rating
Estuarine - Mesc	Estuarine Silts and clays	Rock Road from Ben Inagh Park to Booterstown Avenue	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 will likely 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 as listed in Table 14.3; 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 14.25 along with their importance as determined by Box 4.1 of the NRA Guidelines (NRA 2008a).

Soil analysis was carried out on samples retrieved during the ground investigations at depths ranging from 0.5 to 3.5m BGL.

The main findings of the soil analysis carried out along the Proposed Scheme are as follows (and summarised in Table 14.26):

- Asbestos was not detected in any of the recorded results during the scheme specific GI carried out by GII.
- Elevated concentrations of Total Organic Carbon (TOC), Antimony (Sb), Chromium (Cr) and Molybdenum (Mb) were recorded in the samples described as requiring disposal to non-hazardous licecnsed landfill.
- Elevated concentrations of Total Petroleum Hydrocarbons (TPH), pH, Antimony (Sb) and Total Organic Carbon (TOC) were recorded in the samples described as requiring disposal to non-hazardous licensed landfill.

Table 14.25: Summary of Potential Sources of Contaminated Land Adjacent to the Proposed Scheme

Feature	Description	Location	Importance	Justification for Importance Rating
Dublin and Kingstown Railway	Industrial (6-inch OSI Mapping) – Temple Hill to Ballsbridge	Temple Hill to Ballsbridge	Medium	Degree or extent of soil contamination is moderate on a local scale
D & S. E. R. Kingstown and Bray Branch (Railway)	Industrial (25-inch OSI Mapping) – Temple Hill to Ballsbridge	Temple Hill to Ballsbridge	Medium	Degree or extent of soil contamination is moderate on a local scale
Gravel Pit	Gravel Pit (6-inch OSI Mapping and 25-inch Mapping) – Shrewsbury Park	Shrewsbury Park	Medium	Degree or extent of soil contamination is moderate on a local scale
Gravel Pit	Gravel Pit (6-inch OSI Mapping) – Serpentine Avenue	Serpentine Avenue	Medium	Degree or extent of soil contamination is moderate on a local scale

Feature	Description	Location	Importance	Justification for Importance Rating
Royal Dublin's Society's Agricultural Premises	Agricultural (25-inch Mapping) – Simmonscourt Road and Anglesea Road	Simmonscourt Road and Anglesea Road	Medium	Degree or extent of soil contamination is moderate on a local scale
Royal Dublin Society's Branch Railway	Industrial (25-inch Mapping) – Ballsbridge Park	Ballsbridge Park	Medium	Degree or extent of soil contamination is moderate on a local scale
Tramway	Industrial (25-inch Mapping) – Newtown Avenue (Blackrock) to Merrion Square East	Newtown Avenue (Blackrock) to Merrion Square East	Medium	Degree or extent of soil contamination is moderate on a local scale
Tramway depot	Industrial (25-inch Mapping) – Ballsbridge	Ballsbridge	Medium	Degree or extent of soil contamination is moderate on a local scale
Printing Factory	Industrial (6-inch OSI Mapping) – Pembroke Place	Pembroke Place	Medium	Degree or extent of soil contamination is moderate on a local scale
Hammersmith Works	Industrial (6-inch OSI Mapping and 25-inch Mapping) – Hume House	Hume House	Medium	Degree or extent of soil contamination is moderate on a local scale
Hat Manufactory	Industrial (6-inch OSI Mapping) – Mespil Road	Mespil Road	Medium	Degree or extent of soil contamination is moderate on a local scale
Two Laundries	Industrial (6-inch OSI Mapping) – Mespil Road	Mespil Road	Medium	Degree or extent of soil contamination is moderate on a local scale
Gravel Pit	Gravel Pit (6-inch OSI Mapping and 25-inch Mapping) – Temple Hill	Temple Hill	Medium	Degree or extent of soil contamination is moderate on a local scale
Graveyard	Graveyard (25-inch Mapping) – Temple Hill	Temple Hill	Medium	Degree or extent of soil contamination is moderate on a local scale
Tramway depot	Industrial (25-inch Mapping) – Newtown Avenue	Newtown Avenue	Medium	Degree or extent of soil contamination is moderate on a local scale
Graveyard	Graveyard (25-inch Mapping) – Bellevue Avenue	Bellevue Avenue	Medium	Degree or extent of soil contamination is moderate on a local scale
Service station	Petrol station (2005 Aerial photography) – Merrion Road	Merrion Road	Medium	Degree or extent of soil contamination is moderate on a local scale
Contaminated soils from Trial Pits from recent Site Investigations	Non-Hazardous classed samples for Waste acceptance criteria along the Proposed Scheme for high levels of Total Organic Carbon (TOC), Antimony (Sb), Chromium (Cr) and Molybdenum (Mb)	Stradbrook Road to Merrion Road(R14-TP01, R15-CP06,CP07,CP03, TP01)	Medium	Degree or extent of soil contamination is moderate on a local scale
Contaminated soils from Trial Pits from recent Site Investigations	Hazardous classed samples for Waste acceptance criteria along the Proposed Scheme for high levels of Total Petroleum Hydrocarbons (TPH), pH, Antimony (Sb) and Total Organic Carbon (TOC)	Stradbrook Road to Booterstown Avenue (R15-CP07,CP02,TP02)	Medium	Degree or extent of soil contamination is moderate on a local scale

There are no EPA licensed facilities within the study area.

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 no non-metallic mineral locations within the study area.

14.3.3.10.1 Stradbrook Road to Booterstown Avenue

The crushed rock aggregate potential along this Section of the study area ranges from low to very high. In areas of shallower rock, such as along the coastline from Monkstown to Booterstown, the crushed rock aggregate potential is very high.

The granular aggregate potential along the Stradbrook road is generally high. There is a section of low to moderate granular aggregate potential at Booterstown Avenue.

14.3.3.10.2 Booterstown Avenue to Nutley Lane

The crushed rock aggregate potential along this Section of the study area ranges from very low to very high. The crushed rock aggregate potential from Booterstown Avenue to Trimlestown Avenue ranges from high to very high and from Trimlestown Avenue to Nutley lane the crushed rock aggregate potential is generally moderate with areas of low potential noted around Nutley Avenue.

The granular aggregate potential for this Section of the study area ranges from very low to very high.

Low granular aggregate potential is associated with Elm Park stream. Moderate aggregate potential was noted from Saint Mary's Home to Ailesbury Park and very high potential is noted around Nutley Lane.

14.3.3.10.3 Merrion Road - Nutley Lane to Ballsbridge

The crushed rock aggregate potential along this Section of the study area ranges from low to moderate. The crushed rock aggregate potential mapping from Nutley Lane to Serpentine Avenue is variable, the mapping generally shows areas of moderate potential along the southern extents of Merrion Road and areas of low aggregate potential north of Merrion Road.

The granular aggregate potential is generally very high within this Section of the study area. The granular aggregate potential decreases to moderate near Sydenham Road and reduces to low near Serpentine Avenue.

14.3.3.10.4 Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)

The GSI aggregate potential mapping shows the crushed rock aggregate potential along this Section of the study area ranges from low to moderate.

The crushed rock aggregate potential from the American Embassy to the Northumberland Road is low. The remaining Sections of the study area have moderate crushed rock aggregate potential and the crushed rock aggregate potential around James Street East is low.

The granular aggregate potential along Pembroke Road ranges from low to high.

14.3.3.10.5 Nutley Lane - R138 to Merrion Road

The GSI aggregate potential mapping shows the crushed rock aggregate potential along this Section of the study area ranges from low to moderate.

Areas of low crushed rock aggregate potential are identified at the beginning of the Proposed Scheme at the R138 to the Merrion Shopping Centre before passing into an area of moderate crushed rock aggregate potential.

The granular aggregate potential is very high around the Merrion Shopping Centre within this Section of the study area.

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 14.26 along with their importance as determined by the Box 4.1 of the NRA Guidelines (NRA 2008a).

Table 14.26: GSI Aggregate Potential for the Study Area

GSI Aggregate Potential Type	Potential	Location	Importance	Justification
Crushed rock aggregate potential	Low potential	Nutley Avenue, Northumberland Road and the Merrion Shopping Centre	Low	Uneconomically extractable mineral resource
Crushed rock aggregate potential	Moderate potential	Trimlestown Avenue to Nutley Lane and along the Merrion Road	Medium	Sub-economic extractable mineral resource
Crushed rock aggregate potential	High potential	Booterstown Avenue to Trimlestown Avenue	Medium	Extractable mineral resource
Crushed rock aggregate potential	Very High potential	Along the coastline from Monkstown to Booterstown to Trimlestown Avenue	High	Marginally extractable mineral resource
Granular aggregate potential	Low potential	Avondale Court and Monkstown Valley, Elm Park stream and near Serpentine Avenue	Low	Uneconomically extractable mineral resource
Granular aggregate potential	Moderate potential	Booterstown Avenue, Saint Mary's Home to Ailesbury Park and near Sydenham Road	Medium	Sub-economic extractable mineral resource
Granular aggregate potential	High potential	Stradbrook Road	Medium	Extractable mineral resource
Granular aggregate potential	Very High potential	Nutley Lane and the Merrion Shopping Centre	High	Marginally extractable mineral resource

14.3.3.11 Geological Heritage Areas

The Geological Heritage Areas (2019c) within the study area are presented on Figure 14.10 in Volume 3 of this EIAR and detailed in Table 14.27 along with their importance as determined by the Box 4.1 of NRA Guidelines (NRA 2008a).

Table 14.27: Geological Heritage Areas

Feature	Description	Location	Importance	Justification
Blackrock Breccia (DLR003)	A small area of rocks exposed in the intertidal zone beside Blackrock dart station	Blackrock Dart Station	High	Geological feature of high value on a local scale (County Geological Site)

14.3.3.12 Aquifer Type and Classification

The GSI Bedrock Aquifer mapping (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 14.28 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 14.28: 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 (Pl)	Bedrock which is generally unproductive except for local zones.	South of Booterstown	Low	Low yielding aquifer

14.3.3.13 Groundwater Vulnerability

Groundwater vulnerability 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 Stradbrook Road to Booterstown Avenue

Groundwater vulnerability ranges moderate to extreme rock at or near the surface. The high to extreme rock at or near the surface occurs along the coastline adjacent to the Proposed Scheme.

14.3.3.13.2 Booterstown Avenue to Nutley Lane

Groundwater vulnerability ranges from moderate to extreme. The high vulnerability to extreme rock at or near the surface occurs along the coastline adjacent to the Proposed Scheme.

14.3.3.13.3 Merrion Road - Nutley Lane to Ballsbridge

Ground water vulnerability ranges low to moderate. Groundwater vulnerability is low from Nutley Lane to Ailesbury Road before passing into an area of moderate groundwater vulnerability from Ailesbury Road to Serpentine Avenue. After Serpentine Avenue the groundwater vulnerability returns to low in Ballsbridge.

14.3.3.13.4 Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)

Groundwater vulnerability is generally low with a small area of moderate groundwater vulnerability. Groundwater vulnerability is low from Ballsbridge to the American Embassy before entering a small zone of moderate vulnerability from the American Embassy to Lansdowne House and continuing to low groundwater vulnerability for the remainder of the Proposed Scheme.

14.3.3.13.5 Nutley Lane - R138 to Merrion Road

Groundwater vulnerability ranges low to moderate. Groundwater vulnerability is low from the R138 to the Merrion Shopping Centre before passing into an area of moderate groundwater vulnerability at the Merrion Shopping Centre.

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 51 millimetres (mm) 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 Special Protection Area (SPA), Special Areas of Conservation (SAC), National Heritage Area (NHA) or proposed National Heritage Area (pNHA) are listed in Table 14.29 along with their importance as determined by the NRA Guidelines Box 4.3.

Table 14.29: Groundwater Dependent Habitats along the Proposed Scheme

Designated Site	Description	Importance	Justification for Importance rating
Grand Canal pNHA	n/a	n/a	The canals are protected by a liner from water ingress or leakage and therefore not considered to be connected to surrounding groundwater.
South Dublin Bay and River Tolka Estuary SPA	n/a	n/a	The SPA is not considered to be a groundwater dependent habitat.
Booterstown Marsh and South Dublin pNHA	n/a	n/a	The pNHAs are not considered to be a groundwater dependent habitat.
South Dublin Bay SAC	n/a	n/a	The SAC is not considered to be a groundwater dependent habitat.

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 14.30 for completeness. Features with an importance ranking of medium or higher are summarised in Table 14.31 and the impact of the Proposed Scheme on these features will be assessed in Section 14.4.

Table 14.30: 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	Topsoil - BminPD	Poorly drained (Mainly Basic)	Stradbrook Road, Elm Park	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	Ballsbridge to Pembroke Junction and the Nutley Lane junction to the Merrion Road	Low	Low value on a local scale
Subsoils quality and significance	Glacial gravels - GLs	Gravels derived from limestones	Stradbrook Road and Booterstown Avenue.	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	Along the Rock Road	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	Ballysteen Formation	Dark muddy limestone, Shale - Carboniferous	From Ben Inagh Park to Willow Terrace	Low	Low value on a local scale
Bedrock quality and significance	Type 2p microcline porphyritic	Granite with microcline phenocrysts - Caledonian	From Stradbrook Road to the Rock Road at Ben Inagh Park is underlain by Type 2p microcline porphyritic granite	Low	Low value on a local scale
Soft Soils	Alluvium - AlluvMIN (soils) / A (subsoils)	Typically found along current and historic watercourses	Elm Park and along Merrion Road between Shrewsbury Road and Ailesbury Road and also along the banks of the River Dodder	Low	Volume of soft soil underlying the Proposed Scheme is small and of a local scale.
Soft Soils	Marine Sediments - MarSed	Typically found along the coast	Booterstown Avenue	Low	Volume of soft soil underlying the Proposed Scheme is small and of a local scale.
Soft Soils	Estuarine - Mesc	Estuarine Silts and clays	Rock Road from Ben Inagh Park to Booterstown Avenue	Low	Volume of soft soil underlying the Proposed Scheme is small and of a local scale.
Economic Geology	Crushed rock aggregate potential	Low potential	Nutley Avenue, Northumberland Road and the Merrion Shopping Centre	Low	Uneconomically extractable mineral resource
Economic Geology	Granular aggregate potential	Low potential	Avondale Court and Monkstown Valley, Elm Park stream and near Serpentine Avenue	Low	Uneconomically extractable mineral resource
Aquifer	Poor Aquifer (Pl)	Bedrock which is generally unproductive except for local zones	South of Booterstown	Low	Low yielding aquifer

Category	Feature	Description	Location	Importance	Justification
Groundwater Dependant Habitat	Grand Canal	n/a	Grand Canal	n/a	The canals are protected by a liner from water ingress or leakage and therefore not considered to be connected to surrounding groundwater.
Groundwater Dependant Habitat	South Dublin Bay and River Tolka Estuary SPA	n/a	South Dublin Bay and River Tolka Estuary	n/a	The SPA is not considered to be a groundwater dependent habitat.
Groundwater Dependant Habitat	Booterstown Marsh and South Dublin pNHA	n/a	Booterstown and South Dublin Bay	n/a	The pNHAs are not considered to be a groundwater dependent habitat.
Groundwater Dependant Habitat	South Dublin Bay SAC	n/a	South Dublin Bay	n/a	The SAC is not considered to be a groundwater dependent habitat.

Table 14.31: 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	Alluvium - AlluvMIN	Typically found along current and historic watercourses	Elm Park and along Merrion Road between Shrewsbury Road and Ailesbury Road and also along the banks of the River Dodder	Medium	Moderately drained and / or moderate fertility soils
Soil Fertility	Marine Sediments - MarSed	Typically found along the coast	Booterstown Avenue	Medium	Moderately drained and / or moderate fertility soils
Soil Fertility	Topsoil - BminSW	Shallow well drained (Mainly basic)	Blackrock Park,	High	Well drained and / or high fertility soils
Soil Fertility	Topsoil - BminDW	Deep well drained (Mainly basic)	Stradbrook Road, Elm Park	High	Well drained and / or high fertility soils
Soil Fertility	Topsoil - AminSW	Shallow well drained (Mainly acidic)	Blackrock Park	High	Well drained and / or high fertility soils
Subsoils quality and significance	Estuarine - Mesc	Estuarine Silts and clays	Rock Road from Ben Inagh Park to Booterstown Avenue	Medium	Medium value on a local scale
Subsoils quality and significance	Marine sands - Mbs	Marine beach sands	Merrion Road between the junctions with Strand Road and Nutley Lane	Medium	Medium value on a local scale
Potential Sources of Contamination	Railway	Industrial (6-inch OSI Mapping, 25-inch mapping, aerial photography	Temple Hill to Ballsbridge	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Gravel Pits (3 No.)	Gravel Pit (6-inch OSI Mapping and 25-inch Mapping)	Shrewsbury Park, Serpentine Avenue and Temple Hill	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Royal Dublin's Society's Agricultural Premises	Agricultural (25-inch Mapping)	Simmonscourt Road and Anglesea Road	Medium	Degree or extent of soil contamination is moderate on a local scale

Category	Feature	Description	Location	Importance	Justification
Potential Sources of Contamination	Royal Dublin Society's Branch Railway	Industrial (25-inch Mapping)	Ballsbridge Park	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Tramway	Industrial (25-inch Mapping)	Newtown Avenue (Blackrock) to Merrion Square East	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Tramway depot (2 No.)	Industrial (25-inch Mapping)	Ballsbridge and Newtown Avenue	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Printing Factory	Industrial (6-inch OSI Mapping)	Pembroke Place	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Hammersmith Works	Industrial (6-inch OSI Mapping and 25-inch Mapping)	Hume House	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Hat Manufactory	Industrial (6-inch OSI Mapping)	Mespil Road	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Laundries (2 No.)	Industrial (6-inch OSI Mapping)	Mespil Road and Bellevue Avenue	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Graveyard (2 No.)	Graveyard (25-inch Mapping)	Temple Hill	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Service station	Petrol station (2005 Aerial photography)	Merrion Road	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Contaminated soils from Trial Pits from recent Site Investigations	Non- Hazardous classed samples for Waste acceptance criteria along the Proposed Scheme for high levels of Total Organic Carbon (TOC), Antimony (Sb), Chromium (Cr) and Molybdenum (Mb)	Stradbrook Road to Merrion Road (R14-TP01, R15-CP06,CP07,CP03,TP01)	Medium	Degree or extent of soil contamination is moderate on a local scale
Potential Sources of Contamination	Contaminated soils from Trial Pits from recent Site Investigations	Hazardous classed samples for Waste acceptance criteria along the Proposed Scheme for high levels of Total Petroleum Hydrocarbons (TPH), pH, Antimony (Sb) and Total Organic Carbon (TOC)	Stradbrook Road to Booterstown Avenue (R15-CP07,CP02,TP02)	Medium	Degree or extent of soil contamination is moderate on a local scale
Economic Geology	Crushed rock aggregate potential	Moderate potential	Trimlestown Avenue to Nutley lane and along the Merrion Road	Medium	Sub-economic extractable mineral resource
Economic Geology	Crushed rock aggregate potential	High potential	Booterstown Avenue to Trimlestown Avenue	Medium	Extractable mineral resource

Category	Feature	Description	Location	Importance	Justification
Economic Geology	Crushed rock aggregate potential	Very High potential	Along the coastline from Monkstown to Booterstown to Trimlestown Avenue	High	Marginally extractable mineral resource
Economic Geology	Granular aggregate potential	Moderate potential	Booterstown Avenue, Saint Mary's Home to Ailesbury Park and near Sydenham Road	Medium	Sub-economic extractable mineral resource
Economic Geology	Granular aggregate potential	High potential	Stradbrook Road	Medium	Extractable mineral resource
Economic Geology	Granular aggregate potential	Very High potential	Nutley Lane and the Merrion Shopping Centre	High	Marginally extractable mineral resource
Aquifer	Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Widespread	Medium	Locally important aquifer which supplies the local area
County Geological Site	Blackrock Breccia	A small area of rocks exposed in the intertidal zone beside Blackrock dart station	Blackrock Dart Station	High	Geological feature of high value on a local scale (County Geological Site)

14.3.5 Conceptual Site Model

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

The Proposed Scheme is predominantly underlain by made ground over glacial till with lenses of fluvioglacial sands and gravels over limestone bedrock. The relevant subsections of the Proposed Scheme are presented in Table 14.32 to Table 14.36 along with the fill height (average and maximum), cut height (average and maximum) and the soils and geology at each earthwork areas.

Table 14.32: Conceptual Site Model- Stradbrook Road to Booterstown Avenue

Subsection	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
Section 1a Stradbrook Road to Mount Merrion Avenue (Ch. A0000 to A1250)	1,250	At Grade	0.4	0.1	0.1	0	According to R15-CP04 the stratigraphy consists of a 0.6m thick layer of topsoil over boulder clay (BC). Inferred Road pavement and foundation on possible reworked or natural BC. The exploratory location didn't record Made Ground (MG). Yet, it is believed that MG will be present along existing alignment.	0.5	Works are largely retaining existing alignments and longitudinal alignments of road centreline largely retained along section. Cut indicated due to longitudinal recambering on Frascati Road.
Section 1b Mount Merrion Avenue to Phoenix Terrace (Ch. A1250 to A1600)	350	At Grade	0.1	0.1	0.1	0	According to R15-CP03 the stratigraphy consists of a 1.7m thick layer of MG over BC. The lower MG is likely to be reworked BC. Part of the south-western section (Mount Merrion Avenue to Ben Inagh Park) is underlain by Granite. Inferred Road pavement and foundation on possible reworked or natural BC.	1	Longitudinal alignment of road centreline largely retained along section. Section includes widening and retention wall at Blackrock Park.
Reinforced Concrete Retaining Wall at Blackrock Park	100	Structure	No Cut / Fill due to existence of structure				Based on desk study information the area is underlain by made ground / possible reworked boulder clay and glacial till.	1	A new 90m long reinforced concrete retaining wall is proposed along Rock Road, adjacent to Blackrock Park. The maximum height of the wall will be 3.9m. Demolition of the current wall and construction of a new wall will facilitate carriageway widening along the Rock Road
Blackrock College Entrance gates and railings relocation	n/a	Structure	No Cut / Fill due to existence of structure				Based on desk study information the area is underlain by made ground / possible reworked boulder clay and glacial till.	1	The main entrance gates and boundary railings, at Blackrock College on Rock Road (DLR RPS 99, NIAH 2484) will be repositioned to facilitate land take which will accommodate a bus and cycle lane.
Section 1c Phoenix Terrace to Willow Terrace (Ch. A1600 to A2000)	400	At Grade	1.1	0.5	0.1	0	R15-TP02 was excavated and R15-CP02 was drilled at this section. The former exploratory location was completed at 2.4m BGL and the latter at 0.7m BGL. Both exploratory locations recorded MG part of which is likely to be reworked BC. Based on desk study information the stratigraphy consists of MG over BC over Limestone. Inferred Road pavement and foundation on possible reworked or natural BC.	2	Longitudinal alignment of road centreline largely retained along section. Widening works proposed into Blackrock Clinic and Blackrock College with full road construction.
Reinforced Concrete Retaining Wall at Castledawson Avenue	n/a	Structure	No Cut / Fill due to existence of structure				Based on R15-TP02 and R15-CP02 desk study information the area is underlain by made ground / possible reworked boulder clay and glacial till.	1 to 2	An in-situ reinforced concrete (RC) spreadfoot foundation retaining wall, 30m in length and 0.8m in height will be installed at Castledawson Avenue.

Subsection	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
Section 1d Willow Terrace to Booterstown Avenue (Ch. A2000 to A2400)	400	At Grade	0.2	0.1	0.1	0	Based on desk study information the stratigraphy consists of MG over BC and / or Estuarine Silts and Clays over Limestone. Inferred Road pavement and foundation on possible reworked or natural BC.	2	Longitudinal alignment of road centreline largely retained along section. Cut indicated due to longitudinal recambering and removal of central medians on the Rock Road.

Table 14.33: Conceptual Site Model – Booterstown Avenue to Nutley Lane

Subsection	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
Section 2 - Booterstown Avenue to Nutley Lane (Ch. A2400 to A4000)	1,600	At Grade	0.9	0.1	0.2	0	Three boreholes (R15-CP05, 06, 07A) were drilled and one trial pit (R15-TP01) was excavated along this section. The exploratory locations encountered MG over Estuarine Silts and Clays over Marine Beach Sands or BC. The GI results are consistent with the findings of the desk study. The rock type along Section 2 is Limestone. Inferred Road pavement and foundation on possible reworked or natural BC or MG.	2	Longitudinal alignment of road centreline largely retained along section. Fill and cut indicated due to longitudinal recambering and removal of central medians on the Merrion Road. Widening at St. Vincent's.

Table 14.34: Conceptual Site Model – Merrion Road - Nutley Lane to Ballsbridge

Subsection	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
Section 3 - Nutley Lane to Ballsbridge (Ch. A4000 to A5700)	1,700	At Grade	0.1	0	0	0.1	R14-TP01 recorded a 0.3m thick layer of topsoil over a 1.7m thick layer of MG over Sand (possible Alluvium). The records of the TP are consistent with the findings of the desk study. The desk study shows that this section crosses areas which are typically underlain by Alluvium. Yet, there is a section between River Dodder and Serpentine Avenue which is underlain by BC. Based on desk study information the rock type is Limestone. Inferred Road pavement and foundation on possible reworked or natural BC.		Longitudinal alignment of road centreline largely retained along section. Fill indicated is localised instance at approach to Ballsbridge on Merrion Road.

Subsection	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
Merrion Gates Archway Relocation	n/a	Structure	No Cut / Fill due to existence of structure				Based on desk study information the area is underlain by made ground / possible reworked boulder clay and glacial til.	1	The existing cut stone masonry archway located outside the Telford Nursing Home on the Merrion Road at Merrion Gates will be carefully dismantled and re-erected at the back of the proposed footpath, along with the adjacent wall and railings.
Bloomfield Gate Archway Relocation	n/a	Structure	No Cut / Fill due to existence of structure				Based on desk study information the area is underlain by made ground / possible reworked boulder clay and glacial till.	1	The existing cut stone masonry archway (referred to as the Bloomfield Gate) located outside the GNI Above AGI between the old Gowan Motors site and St. Vincent's University Hospital will be carefully dismantled and re-erected in an adjacent area.

Table 14.35: Conceptual Site Model - Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)

Subsection	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
Section 4 - Ballsbridge to Merrion Square (Ch. A5700 to A7390)	1,690	At Grade	0.2	0.1	0.2	0	Based on desk study information the stratigraphy consists of MG over BC and / or Alluvium. The Alluvium is mainly recorded towards Ballsbridge. The area is underlain by Limestone. Inferred Road pavement and foundation on possible reworked or natural BC.	2	Longitudinal alignment of road centreline largely retained along section. Fill indicated due to longitudinal recambering on approach to Baggot Bridge. Cut indicated to removal of medians at junctions.
Pembroke Kiosk Relocation	n/a	Structure	No Cut / Fill due to existence of structure				Based on desk study information the area is underlain by made ground / possible reworked boulder clay and glacial till.	2	The existing kiosk located at the junction of Pembroke Road, Lansdowne Road and Northumberland Road will be carefully dismantled and re-erected at its new location at the same junction. The kiosk will be set back, to facilitate a new junction layout at this location. The existing kiosk has a basement, below the structure.
Sloped Walkway at Grand Canal	n/a	Structure	No Cut / Fill due to existence of structure				Based on desk study information the area is underlain by made ground / possible reworked boulder clay and glacial till.	2	A proposed 42m long sloped walkway will be constructed from the McCartney Bridge, alongside the Grand Canal pNHA. The ramped walkway will require a minor retaining wall of maximum height 0.9m along its length, with the top of the wall protruding 150mm above the proposed surface of the ramp, to act as a continuous upstand (upward projection).

Table 14.36: Conceptual Site Model – Nutley Lane - R138 to Merrion Road

Subsection	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
Section 5 - Nutley Lane (Ch. B0000 to B0830)	830	At Grade	1.4	0	0.5	0.1	R15-TP03 and TP04 were excavated along this section. The former TP encountered topsoil over BC while the latter a 1.8m thick layer of MG. The desk study showed also that the northern part of this section is underlain by Alluvium. Based on desk study information the rock type is Limestone. Inferred Road pavement and foundation on possible reworked or natural BC.	1	Longitudinal alignment of road centreline largely retained along section. Fill indicated due to widening works into Elm Park Golf & Sports Club. Cut indicated due to widening into existing embankment at St. Vincent's University Hospital

14.3.5.1 Environment Type

The environment across the study area has been categorized 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 in Appendix A5.1 in Volume 4 of this EIAR.

14.4.1.1 Stradbrook Road to Booterstown Avenue

- The main construction activities at this Section will include reconstitution, widening and resurfacing of roads, cycle paths and footpaths, wall removal, new kerbs, new road marking, relocation of and new bus stops and landscaping works. Boundary walls, fences and gates will be constructed where required. Works in the verges is expected as a result of realignment works on cycle paths and footpaths.
- The existing boundary wall to Blackrock Park will be demolished and a new 90m long reinforced concrete (RC) retailing wall constructed.
- The main construction compound will be located in Booterstown Car Park within Blackrock Park, along the R118, opposite Willow Terrace.
- An in-situ RC spreadfoot foundation retaining wall, 30m in length and 0.8m in height will be installed at Castledawson Avenue.

14.4.1.2 Booterstown Avenue to Nutley Lane

- The main construction activities at this Section will include reconstitution, widening and resurfacing of roads, cycle paths and footpaths, wall removal, relocation of bus stops, new kerbs, new road marking and landscaping works. Boundary walls, fences and gates will be constructed where required.
- While no widening works are proposed along Booterstown Marsh, approximately 44m of new boundary wall is proposed to be set back into the proposed Natural Heritage Areas (pNHA) associated with the Booterstown Marsh.
- An in-situ RC spreadfoot foundation retaining wall, 24m in length and 0.9m in height will be installed at St Mary's Nursing Home along the Merrion Road.
- The existing archway at Merrion Gates, forming part of the boundary wall at the Telford Nursing Home will be carefully dismantled and re-erected along the proposed back of footway, along with the adjacent wall and railings.
- The existing masonry archway (referred to as the Bloomfield Gate) located outside the Gas Networks Ireland (GNI) operated Above Ground Installation (AGI) between the old Gowan Motors site and St.

Vincent's University Hospital will be carefully dismantled and re-erected in an adjacent area. A new gateway and boundary treatment will be constructed at the GNI site.

- The Electricity Supply Board (ESB) sub-station located between Gowan Motors and St. Vincent's University Hospital will be de-commissioned, and a new sub-station constructed within the hospital lands.

14.4.1.3 Merrion Road - Nutley Lane to Ballsbridge

- The main construction activities at this Section will include reconstitution, widening and resurfacing of roads, cycle paths and footpaths, new kerbs, relocation of bus stops, new road marking and landscaping works.

14.4.1.4 Ballsbridge to Merrion Square (Pembroke Road, Baggot Street and Fitzwilliam Street)

- The main construction activities at this Section will include reconstitution, widening and resurfacing of roads, cycle paths and footpaths, new kerbs, relocation of bus stops, new road marking and landscaping works.
- The works also include upgrading the current access ramp from the McCartney Bridge to the Grand Canal on the northwestern corner. This will include a 42m long concrete ramp and associated small retaining wall and railings over this distance.

14.4.1.5 Nutley Lane - R138 to Merrion Road

- The main construction activities along this Section includes 900m carriageway widening works, 250m carriageway narrowing works, and the realignment of cycle paths and footpaths. Works in the verges is expected as a result of realignment works on cycle paths and footpaths.
- There are various services along this section which will need protection / diversion as part of the works. These works include a 280m length diversion of medium pressure gas main along Nutley Lane, to facilitate widening works along this section

14.4.1.6 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 be implemented 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 14.3.5 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 14.37.

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

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, in order to ensure a robust assessment, only the maximum magnitude or “worst case” of the impact of the Proposed Scheme is considered.

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. There are a number of ways this could happen:

- 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, washed down water from exposed aggregate surfaces, cast-in-place concrete from concrete trucks, fuels, lubricants 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 construction stage.
- 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 the construction works may mobilise pollution contained in the soils into the nearby 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.
- 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. Topsoil will be encountered when establishing the Construction Compound at Blackrock Park, along the R118 opposite Willow Terrace, and in various areas where widening into verges is required.

The magnitude of the impacts of the Proposed Scheme on topsoil will be small adverse as it will result 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 medium importance the resulting significance of this small adverse impact is slight.

14.4.3.2 Excavation of potentially contaminated land

The excavation of made ground will result in the production of excess material requires placement elsewhere in 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 EPA guidance on Land Contamination (EPA 2013). 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 14.25 and include historic quarries, printing factory, railways, tramways and tramway depots, the RDS, Hammersmith works, hat manufactory, graveyards, laundries and a petrol station.

The magnitude of this impact is small adverse as it results in the excavation of a small proportion 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. This can result in a permanent irreversible loss of the in-situ characteristics of the land, soils and geology area. There are no notable existing or historic quarries with the study area of the Proposed Scheme.

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 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.

Since there is no works planned directly adjacent to the Blackrock Breccia, the magnitude of this impact is considered negligible. As the importance of the Geological Heritage Area is high, the resulting significance is imperceptible and therefore 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 result 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 in 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 mobilisation 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 and 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.

Table 14.37: Summary of Potential Construction Phase Impacts

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Loss or damage of topsoil									
Topsoil	BminSW BminDW AminSW	Elm Park and along Merrion Road between Shrewsbury Road and Ailesbury Road and also along the banks of the River Dodder, Blackrock Park, Stradbrook Road, Elm Park	High	Loss or damage of topsoil	Negative	Permanent	Local	Small adverse	Slight
Marine Sediments	MarSed and Marine Sands and Gravels – MarSands	Booterstown Avenue	Medium	Loss or damage of sediments	Negative	Permanent	Local	Small adverse	Slight
Subsoils	Estuarine silts and clays Marine Sands	Rock Road from Ben Inagh Park to Booterstown Avenue	Medium	Loss or damage of subsoils	Negative	Permanent	Local	Small adverse	Slight
Excavation of potentially contaminated ground									
Potential Sources of Contamination	Railway	Temple Hill to Ballsbridge	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Gravel Pits (3 No.)	Shrewsbury Park, Serpentine Avenue and Temple Hill	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Royal Dublin's Society's Agricultural Premises	Simmonscourt Road and Anglesea Road	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Royal Dublin Society's Branch Railway	Ballsbridge Park	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Tramway	Newtown Avenue (Blackrock) to Merrion Square East	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Tramway depot (2 No.)	Ballsbridge and Newtown Avenue	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Printing Factory	Pembroke Place	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Hammersmith Works	Hume House	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Hat Manufactory	Mespil Road	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Laundries (2 No.)	Mespil Road and Bellevue Avenue	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Graveyard (2 No.)	Temple Hill	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Potential Sources of Contamination	Service station	Merrion Road	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Non- Hazardous classed samples for Waste acceptance criteria along the Proposed Scheme from recent site investigation	Stradbrook Road to Merrion Road (R14-TP01, R15-CP06,CP07,CP03,TP01)	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Potential Sources of Contamination	Hazardous classed samples for Waste acceptance criteria along the Proposed Scheme from recent site investigation	Stradbrook Road to Booterstown Avenue (R15-CP07,CP02,TP02)	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight
Loss of future quarry or pit reserve									
Crushed rock aggregate	Moderate potential	Trimlestown Avenue to Nutley lane and along the Merrion Road	Medium	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible
Crushed rock aggregate	High potential	Booterstown Avenue to Trimlestown Avenue	Medium	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible
Crushed rock aggregate	Very high potential	Along the coastline from Monkstown to Booterstown to Trimlestown Avenue	High	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible
Granular aggregate	Moderate potential	Booterstown Avenue, Saint Mary's Home to Ailesbury Park and near Sydenham Road	Medium	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible
Granular aggregate	High potential	Stradbrook Road	Medium	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible
Granular aggregate	Very high potential	Nutley Lane and the Merrion Shopping Centre	High	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible
Loss or damage of proportion of Geological Heritage Area									
County Geological Site	Blackrock Breccia	Blackrock Dart Station	High	Loss or damage of proportion of Geological Heritage Area	Negative	Permanent	Local	Negligible	Imperceptible
Loss or damage of proportion of aquifer through excavation									
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Widespread	Medium	Loss or damage of proportion of aquifer through excavation.	Negative	Permanent	Local	Negligible	Imperceptible
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Widespread	Medium	Loss or damage of proportion of aquifer through pollution.	Negative	Temporary	Local	Moderate Adverse	Moderate

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Change to groundwater regime									
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Widespread	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible

14.4.4 Operational Phase

14.4.4.1 Contamination

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 any of the 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 14.30.

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 shall be 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 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 reuse.

Samples of ground suspected of contamination will be tested for contamination during the detailed 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 include:

- Employing only a competent and experienced 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 will be considered in the design of the Construction Compound. 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 kits will be provided and 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 such aspects as 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 to be 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 14.38: 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 Significance
Loss or damage of topsoil											
Topsoil	BminSW BminDW AminSW	Elm Park and along Merrion Road between Shrewsbury Road and Ailesbury Road and also along the banks of the River Dodder, Blackrock Park, Stradbrook Road, Elm Park	High	Loss or damage of topsoil	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Marine Sediments	MarSed and Marine Sands and Gravels – MarSands	Booterstown Avenue	Medium	Loss or damage of sediments	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Subsoils	Estuarine silts and clays Marine Sands	Rock Road from Ben Inagh Park to Booterstown Avenue	Medium	Loss or damage of subsoils	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Excavation of potentially contaminated ground											
Potential Sources of Contamination	Railway	Temple Hill to Ballsbridge	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Gravel Pits (3 No.)	Shrewsbury Park, Serpentine Avenue and Temple Hill	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Royal Dublin's Society's Agricultural Premises	Simmonscourt Road and Anglesea Road	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Royal Dublin Society's Branch Railway	Ballsbridge Park	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Tramway	Newtown Avenue (Blackrock) to Merrion Square East	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Tramway depot (2 No.)	Ballsbridge and Newtown Avenue	Medium	Excavation of 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 Significance
Potential Sources of Contamination	Printing Factory	Pembroke Place	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Hammersmith Works	Hume House	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Hat Manufactory	Mespil Road	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Laundries (2 No.)	Mespil Road and Bellevue Avenue	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Graveyard (2 No.)	Temple Hill	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Service station	Merrion Road	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Non- Hazardous classed samples for Waste acceptance criteria along the Proposed Scheme from recent site investigation	Stradbrook Road to Merrion Road(R14-TP01, R15-CP06,CP07,CP03,TP01)	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Potential Sources of Contamination	Hazardous classed samples for Waste acceptance criteria along the Proposed Scheme from recent site investigation	Stradbrook Road to Booterstown Avenue (R15-CP07,CP02,TP02)	Medium	Excavation of contaminated ground	Negative	Permanent	Local	Small adverse	Slight	Negligible	Imperceptible
Loss of future quarry or pit reserve											
Crushed rock aggregate	Moderate potential	Trimlestown Avenue to Nutley Lane and along the Merrion Road	Medium	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Crushed rock aggregate	High potential	Booterstown Avenue to Trimlestown Avenue	Medium	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 Significance
Crushed rock aggregate	Very high potential	Along the coastline from Monkstown to Booterstown to Trimlestown Avenue	High	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Granular aggregate	Moderate potential	Booterstown Avenue, Saint Mary's Home to Ailesbury Park and near Sydenham Road	Medium	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Granular aggregate	High potential	Stradbrook Road	Medium	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Granular aggregate	Very high potential	Nutley Lane and the Merrion Shopping Centre	High	Loss of future quarry or pit reserve	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Loss or damage of proportion of Geological Heritage Area											
County Geological Site	Blackrock Breccia	Blackrock Dart Station	High	Loss or damage of proportion of Geological Heritage Area	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Loss or damage of proportion of aquifer through excavation											
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Widespread	Medium	Loss or damage of proportion of aquifer through excavation.	Negative	Permanent	Local	Negligible	Imperceptible	Negligible	Imperceptible
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Widespread	Medium	Loss or damage of proportion of aquifer through pollution.	Negative	Temporary	Local	Moderate Adverse	Moderate	Negligible	Imperceptible
Change to groundwater regime											
Locally Important Aquifer (LI)	Bedrock which is moderately productive only in local zones	Widespread	Medium	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible	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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