Chapter 14
Land, Soils, Geology & Hydrogeology

Contents

14 Land, Soils, Geology & Hydrogeology

14.1 Introduction

This Chapter of the Environmental Impact Assessment Report (EIAR) has considered the potential land, soils, geology and hydrogeology impacts associated with the Construction and Operational Phases of the BusConnects Galway: Cross-City Link (University Road to Dublin Road) (hereafter referred to as the Proposed Scheme). Chapter 4 (Proposed Scheme Description) of this EIAR 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 in the surface water environment are not considered in this assessment but are considered separately in Chapter 13 (Water) of this EIAR. The impact of the production of excess material for removal off site is discussed in Chapter 17 (Waste & Resources) of this EIAR.

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 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 geological heritage and hydrogeology

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 the land, soils, geology and hydrogeology have been assessed by classifying the importance of the relevant attributes and quantifying the likely magnitude of any effect on these attributes.

14.2.1 Study Area

The land, soils, geology and hydrogeology study area for the Proposed Scheme includes the Proposed Scheme and extends to a radius of 250m either side of the Proposed Scheme boundary which is in accordance with the 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)).

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:

- 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); and
- Guidelines for the Preparation of Soil, Geology and Hydrogeology Chapters of Environmental Impact Statements (Institute of Geologists of Ireland (IGI) 2013) (hereafter referred to as the IGI Guidelines).

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. As the Proposed Scheme comprises transport scheme the NRA guidelines are considered more relevant and have been used in precedence to the IGI guidelines. The IGI guidelines have been used to supplement the NRA guidelines.

In addition, the assessment has been prepared with reference to 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 2022);
- Environmental Impact Assessment of National Road Schemes – A Practical Guide (NRA 2008b);
- S.I. No. 350/2014 - European Union (Water Policy) Regulations 2014;
- S.I. No. 9/2010 - European Communities Environmental Objectives (Groundwater) Regulations 2010, as amended by:
  - S.I. No. 389/2011 - European Communities Environmental Objectives (Groundwater) (Amendment) Regulations 2011;
  - S.I. No. 149/2012 - European Communities Environmental Objectives (Groundwater) (Amendment) Regulations 2012; and
  - S.I. No. 366/2016 - European Union Environmental Objectives (Groundwater) (Amendment) Regulations 2016.
- S.I. No. 272/2009 - European Communities Environmental Objectives (Surface Waters) Regulations 2009 as amended by:
  - S.I. No. 327/2012 - European Communities Environmental Objectives (Surface Waters) (Amendment) Regulations 2012; and
  - S.I. No. 386/2015 - European Union Environmental Objectives (Surface Waters) (Amendment) Regulations 2015.

- S.I. No. 722/2003 - European Communities (Water Policy) Regulations 2003 as amended by:
  - S.I. No. 413/2005 - European Communities (Water Policy) (Amendment) Regulations 2005;
  - S.I. No. 219/2008 - European Communities (Water Policy) (Amendment) Regulations 2008; and
  - S.I. No. 93/2010 - European Communities (Water Policy) (Amendment) Regulations 2010.
- S.I. No 122/2014 - European Communities (Drinking Water) Regulations 2014 as amended by:
  - S.I. No. 464/2017 - European Union (Drinking Water) (Amendment) Regulations 2017.
- SI No. 293/1988 - European Communities (Quality of Salmonid Waters) Regulations 1988;
- SI No. 261/2018 - European Union (Water Policy) (Abstractions Registration) Regulations 2018;
- Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (hereafter referred to as the Water Framework Directive (WFD));
- Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration (hereafter referred to as the Groundwater Directive);
- Water Services Acts (2007 – 2017);
- 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 in October 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.

Source	Name	Description
	Including OSI Galway Maps from 1949-1952, 1978 and 1991	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	Geological maps of the site area produced by the GSI and available on GSI online map viewer.
	Bedrock Mapping	
	Aggregate Potential Mapping	
	Mineral Localities	
	Geotechnical viewer	
	Groundwater Mapping	
	Groundwater Levels	
	National Landslide Database	
	Karst Database	
	Active Quarries and pits	
	County Geological Sites (CGS) and Geological Heritage Areas	
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)	Archaeological Monuments	This dataset provides all recorded archaeological monuments (NMS 2019)
Department of Communications,	State Mining and Prospecting Facilities	A booklet contains a list of all current and prospecting mining facilities.

Source	Name	Description
Energy and Natural Resources (DCENR)	Historic Mine Sites – Inventory and Risk Classification	(DCENR 2019)

14.2.3.2 Scheme Walkover

A scheme walkover survey was carried out on 11 October 2021 to inform and verify the review of publicly available datasets.

The findings of the scheme walkover survey including photos and scheme walkover survey notes are included in Appendix 14.1 of Volume 4 of this EIAR.

14.2.3.3 Ground Investigation

Both an intrusive and geophysical ground investigation have been carried out as part of this project. These intrusive ground investigations were carried out for the purpose of investigating the stability of the soils to inform the scheme design. The information obtained from the ground investigations were also used in the preparation of the NIS and EIAR. The investigations were carried out between October 2021 and April 2022. The reports from both investigations are presented in Appendix 14.2a and 14.2b of Volume 4 of this EIAR and are used in the assessment of the site-specific conditions in Section 14.3.3. It is noted that the ground investigation was not carried out within any zones of notification to National Monuments Service and therefore no archaeological monitoring of the ground investigation was carried out.

Additionally, a number of historical ground investigations conducted within the study area have been used in the assessment of the baseline conditions. These historical reports are presented in Table 14.2. These reports are publicly available from the ‘EXT GSI Geotechnical Sites layer’ of the GSI Spatial Resources Map Viewer (GSI, 2019a).

Table 14.2: Existing Ground Investigations

GSI Report ID	Title	Year	Author	Location	Scope
2010	Galway Waterworks	1971	The Cementation Co. Ltd	Galway City	5 cable percussion boreholes
1347	Nora Barnacle Court	1991	IGSL	Nora Barnacle Court	2 trial pits and 2 rotary coreholes
7196	Car Park Site	2008	IGSL	Newtownsmith	3 cable percussion boreholes and 3 rotary coreholes.
1362	Roches Store	1989	IGSL	Corrib Shopping Centre	25 boreholes with cable percussion with rotary follow on.

GSI Report ID	Title	Year	Author	Location	Scope
4937	Galway City Council buildings	2002	IGSL	Galway City Council Buildings	3 Cable Percussive Boreholes, 7 Rotary coring boreholes and 5 Dynamic Probes.
1350	McDonagh – Galway	1987	IGSL	Merchants Road/ Victoria Place	20 cable percussion boreholes with rotary follow on.
1353	Texaco Garage	1972	N/A	Lough Atalia	5 cable percussion boreholes with rotary follow on and 6 trial pits.

14.2.4 Appraisal Method for the Assessment of Impacts

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. This has been undertaken in accordance with the NRA and IGI Guidelines as outlined in the following sections.

14.2.4.1 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. These assist the assessor by establishing the sensitivity of the environment and level of investigation required.

14.2.4.2 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 Determination of Likely Significant 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 14.3);
- Box 4.3: Criteria for Rating Site Attributes – Estimation of the Importance of Hydrogeology Attributes (Table 14.4:);
- The magnitude of impacts should be defined in accordance with the criteria provided in the NRA Guidelines. This is outlined in (Table 14.5).
- Box 5.1: Criteria for Rating Site Attributes at Environmental Impact Assessment (EIA) Stage – Estimation of Magnitude of Impact on Soil / Geology Attribute (Table 14.6: Table 14.7);
- Box 5.3: Criteria for Rating Site Attributes at EIA Stage – Estimation of Magnitude of Impact on Hydrogeology Attributes (Table 14.7); and
- Box 5.4: Rating of Significant Environmental Impacts at EIA Stage (Table 14.8).

The NRA Guidelines criteria uses the similar significance terminology as the EPA Guidelines (EPA, 2022). 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 14.3: Criteria for Rating the Importance of Identified Geological Features (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.	Contaminated soil on site with previous heavy industrial usage Large recent landfill site for mixed wastes

	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.	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
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 14.4: 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

Importance	Criteria	Typical Example
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
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

Table 14.5: Definition of Magnitude of Impact (Table 5.1 (NRA, 2008))

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and / or soft organic soil underlying route is significant on a national or regional scale.	Geological feature rare on a regional or national scale (NHA) Large existing quarry or pit Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and / or soft organic soil underlying route is significant on a local scale.	Contaminated soil on site with previous heavy industrial usage Large recent landfill site for mixed wastes Geological feature of high value on a local scale (CGS) Well drained and / or highly fertility soils Moderately sized existing quarry or pit Marginally economic extractable mineral resource
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and / or soft organic soil underlying route is	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
	moderate on a local scale.	
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 14.6: Criteria for Rating Soil and Geology Impact Significance and Magnitude at EIA Stage (Table C4 (IGI, 2013) and Box 5.1 (NRA, 2008))

Magnitude of Impact	Criteria	Typical Example
Large Adverse	Results in loss of attribute	Loss of high proportion of future quarry or pit reserves Irreversible loss of high proportion of local high fertility soils Removal of entirety of geological heritage feature Requirement to excavate / remediate entire waste site Requirement to excavate and replace high proportion of peat, organic soils and / or soft mineral soils beneath alignment
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Loss of moderate proportion of future quarry or pit reserves Removal of part of geological heritage feature Irreversible loss of moderate proportion of local high fertility soils Requirement to excavate / remediate significant proportion of waste site Requirement to excavate and replace moderate proportion of peat, organic soils and / or soft mineral soils beneath alignment
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Loss of small proportion of future quarry or pit reserves Removal of small part of geological heritage feature Irreversible loss of small proportion of local high fertility soils and / or high proportion of local low fertility soils Requirement to excavate / remediate small proportion of waste site

Magnitude of Impact	Criteria	Typical Example
		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

Table 14.7: Criteria for Rating Hydrogeological Impact Significance and Magnitude at EIA Stage (Box 5.1 NRA, 2008)

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

Magnitude of Impact	Criteria	Typical Example
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 14.8: Rating of Environmental Impacts at EIA Stage (NRA, 2009)

		Magnitude of Impact			
		Negligible	**Small**	**Moderate**	**Large**
Importance of Attribute	Extremely High	Imperceptible	Significant	Profound	Profound
	Very High	Imperceptible	Significant / Moderate	Profound / Significant	Profound
	High	Imperceptible	Moderate / Slight	Significant / Moderate	Severe / Significant
	Medium	Imperceptible	Slight	Moderate	Significant
	Low	Imperceptible	Imperceptible	Slight	Slight / Moderate

14.2.4.4 Mitigation Measures, Residual Impacts and Final Impact Assessment

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

14.2.5 Consultation

As part of a pre-application scoping process, a number of national and local government agencies were contacted. The Geological Survey of Ireland (GSI) provided responses that were directly relevant to this chapter these are summarised below:

- Recommended and encouraged that the assessment reference the various publicly available datasets and attribute them correctly to ‘Geological Survey Ireland’;
- Highlighted that the county geological site St. Augustine’s Well is within the vicinity of the Proposed Scheme;
- Highlighted that the Proposed Scheme is underlain by a “Regionally Important Aquifer - Karstified (conduit)” and a “Poor Aquifer - Bedrock which is

Generally Unproductive except for Local Zones," and the Groundwater Vulnerability map indicates both 'High' and 'Extreme' groundwater vulnerability;

- Recommended the use of the Groundwater Viewer to identify areas of High to Extreme Vulnerability in your assessments, as any groundwater-surface water interactions that might occur would be greater in these areas and referred to the Groundwater Protection Response main report;
- Referred specifically to the availability of the online datasets of bedrock mapping, subsoils mapping, geotechnical ground investigation database and geohazards mapping;
- Requested for a copy of the ground investigation data for inclusion in the geotechnical report database; and
- That any rock cut slopes are not covered in soil and vegetated or alternatively photographs or access for documenting exposures be arranged.

The land soils geology and hydrogeology assessment accounts for the above recommendations and the highlighted datasets have been consulted during the assessment.

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 and IGI Guidelines.

14.3.2 Regional Overview

The regional geomorphology, topography, soils and subsoils, bedrock geology and hydrogeology are discussed in this section. The study area ranges from University College Hospital Galway in the west to Corbett Commercial Centre in the east, the study area is shown on Figure 14.1 in Volume 3 of this EIAR.

14.3.2.1 Regional Topography, Geomorphology and Land Use

As shown on Figure 14.1 in Volume 3 of this EIAR, the OSI 10m contour mapping shows the topography of the study area is generally relatively low-lying between 0 and 10mOD. One exception to this is a feature at approximately 20mOD, which runs north-east to south-west orientated and extends from Galway Harbour to the Galway Greyhound Stadium.

Geomorphology is the study of the landforms which comprise the earth's surface, the processes which have modified and shaped it in the past and which continue to modify and shape it at the present time. The topography is heavily influenced by the geomorphology of the area.

To set the scene in a geological context a study area greater than the Proposed Scheme study area is considered. The geomorphology of this wider region within which the corridor study area is located reflects the last period of glacial history. The latest geomorphological features formed during the last major period of glaciation. During this time extensive ice sheets covered the region. Much of the surrounding landscape has also been shaped and rounded due to erosion as a result of the movement of these icesheets, this can be seen in the regional area as Galway City is surrounded by Streamlined Bedrock, Drumlins and Meltwater channels.

Glacial till was deposited at the base of the ice sheets during melt periods, these deposits can be found both within the study area and in the wider surroundings.

The geomorphological features present in the study area can be seen on Figure 14.1 in Volume 3 of this EIAR and the features within the study area are described below:

- 3 No. Drumlins – oval or elongated hills formed by the movement of ice sheets across rock debris or till, the majority of which are located surrounding Lough Atalia, with one located at University College Hospital Galway, one located from Galway Ceannt Train Station to the Galway Greyhound Stadium (the feature mentioned above at 20mOD) and the other underlying Galway Harbour Enterprise Park;

The River Corrib traverses the west of the study area. It flows in a north to south direction, it enters the north-west of the study area and flows south where it enters the Corrib Estuary in Galway Bay to the south-east and outside of the study area.

In the west of the study area the river splits into three channels north of a weir referred to as salmon weir. The western-most channel is named the Eglington Canal which flows along canal road and feeds into Gaol River and the St. Clare River then re-joins the river in the southwest of the study area. The central channel makes up the River Corrib which flows from the north to the south through the site.

The eastern-most channel is referred to as Middle River which splits off and later re-joins the east side of the River Corrib before it enters Corrib Estuary. The eastern and western channels were constructed to allow boats to pass up the river.

Lough Atalia is located to the east of study area. It is an estuarine lagoon connected directly to the Corrib Estuary within Galway Bay approximately 0.7km east of the mouth of the River Corrib.

The Corine land mapping (EPA) classifies the land use in the majority of the study area as a dis-continuous to continuous urban fabric with the north-east and the Galway Harbour area classified as industrial land use.

14.3.2.2 Regional Soils (Teagasc)

The Teagasc national indicative soil map classifies the soils of Ireland into simplified categories. Soil information is categorised from the Irish Forest Soils (IFS) project, which indicates the predominant soil type for each area, and the drainage characteristics of the soil. The Teagasc soil database is available on the GSI public data viewer and can be seen on Figure 14.2 in Volume 3 of this EIAR. The main soils within the study area are listed in Table 14.9 along with their importance with respect to drainage and fertility, as determined by Box 4.1 in the NRA Guidelines (NRA 2008a).

The majority of the Proposed Scheme and the study area is underlain by made ground, that is soils which have been anthropogenically altered and generally used for development. Notwithstanding the Teagasc database, as the Proposed Scheme comprises an area that is currently developed all the soil within the boundary will be made ground.

Also, in the study area are, low permeability soils such as alluvium are present along the River Corrib in the north-west of the study area. Marine Sediment is present along the north shore and southern shore of Lough Atalia. Deep well drained mainly basic soils (labelled as 'BminDW - Grey Brown Podzolics / Brown Earths Basic') are present in the south of the study area north east of Galway Harbour and in the north-east of the study area at Corbett Commercial Centre. Deep well drained mainly acidic soils are present in the centre of the study area south of Galway Greyhound Stadium (labelled as 'AminDW - Acid brown earths / Podzolics'). There is also one pocket of peaty poorly drained mineral to the east of Galway Harbour Enterprise Park (labelled as 'BminPDPT - Peaty Gleys Basic Parent Materials Basic') and one pocket north east of Galway Harbour Enterprise Park of shallow well drained mainly basic soils (labelled as BminSW - Renzinas / Lithosols).

Table 14.9: Soils within the Study Area

Soil Type	Notes / Description	Location	Importance	Justification for Importance Rating
Made Ground - Made	Associated with urban development	Widespread under the Proposed Scheme	Low	Poorly drained and / or low fertility soils
Alluvium - AlluvMIN	Typically found along current and historic watercourses	Along the River Corrib and its tributaries – east of Galway Retail Park	Medium	Moderately drained and / or moderate fertility soils
Marine/Estuarine sediments - MarSed	Typically found along the coast	Adjacent to Lough Atalia	Medium	Moderately drained and / or moderate fertility soils
Topsoil – BminPDPT	Peaty Gleys with Basic	East of Galway Harbour	Medium	Moderately drained and / or moderate fertility soils

Soil Type	Notes / Description	Location	Importance	Justification for Importance Rating
	parent material	Enterprise Park		
Topsoil - BminDW	Deep well drained (Mainly basic)	South of the study area north at Galway harbour and to the north-east of the study area at Corbett Commercial Centre.	High	Well drained and / or high fertility soils
Topsoil - AminDW	Deep well drained (Mainly acidic)	At the centre of the study area south-west of Galway Greyhound Stadium	High	Well drained and / or high fertility soils
Topsoil – BminSW	Shallow well drained (mainly basic)	North-east of Galway Harbour Enterprise park	High	Well drained and / or high fertility soils

14.3.2.3 Regional Subsoils (GSI Quaternary Classification)

Quaternary sediments are the most recently deposited geological strata. A joint project between the GSI and the Geological Survey of Northern Ireland (GSNI) produced an All-Ireland Quaternary geology map at 1:500,000 scale and is available on the GSI public data viewer. The subsoils within the area are shown on Figure 14.3 in Volume 3 of this EIAR and are listed in and the other at the Galway Harbour Enterprise Park .

Table 14.10 below; along with their importance with respect to feature quality and significance, as determined by Box 4.1 of the NRA Guidelines (NRA 2008a).

The Proposed Scheme and the majority of the study area are underlain by urban soils. Fen peat is present along the banks of the River Corrib in the north-west of the study area east of Galway Retail Park. Estuarine silts and clays are present at the north shore of Lough Atalia within the study area south of Corbett Commercial Centre and to the north-east of Galway Harbour Enterprise Park. Till derived from limestone is present in the south of the study area north of Galway Harbour and at Galway Harbour Enterprise Park and to the north-east of the study area at Corbett Commercial Centre. It is expected that this till underlies the made ground. There are two isolated area of bedrock outcropping in the study area, one south of Gaol Road and the other at the Galway Harbour Enterprise Park .

Table 14.10: Subsoils within the Study Area

Subsoil Type	Description	Location	Importance	Justification for Importance Rating
Made Ground – Urban	Associated with urban development	Widespread under the Proposed Scheme	Low	Low value on a local scale
Fen Peat-FenPt	Typically found along current and watercourses	Along the River Corrib and its tributaries, east of Galway Retail Park	Moderate	Volume of peat and/or soft organic soil underlying the route is moderate on a local scale
Glacial till – TLs	Till derived from limestones	South of the study area north of Galway harbour ad at Galway Harbour Enterprise Park and to the north-east of the study area at Corbett Commercial Centre	Low	Abundant within the study area and has a low value on a local scale
Estuarine silts and clays – Mesc	Found adjacent to estuaries, combination of Estuarine silts and clays	Adjacent to Lough Atalia and north of Galway Harbour Enterprise Park	Low	Low value on a local scale

14.3.2.4 Regional Bedrock Geology

The bedrock geology of the study area according to the GSI 100k bedrock mapping can be seen on Figure 14.4 in Volume 3 of this EIAR and is listed in Table 14.11 along with their importance with respect to feature quality and significance as determined by Box 4.1 in the NRA Guidelines (NRA 2008a).

The bedrock geology of the region comprises the metagabbro and orthogneiss suite to the west of the study area from University College Hospital Galway to the Corrib Shopping Centre and to the south of the study area underlying Galway Harbour Enterprise Park. The Burren Formation is present to the east of the study area from the Corrib Shopping Centre to the Corbett Commercial Centre.

The Burren Formation is described as pale grey, clean, skeletal limestone i.e. a limestone which is abundant in fossils and without impurities. This bedrock was deposited during the Carboniferous Period and is the youngest of the bedrock types within the study area.

An unconformity separates the limestones from the older igneous metagabbro and orthogneiss suite to the west of the study area. This unconformity is highlighted on Figure 14.4 in Volume 3 of this EIAR. Unconformities are typically buried erosional surfaces that can represent a break in the geologic record. It called an unconformity because the ages of the layers of rock that are abutting each other are discontinuous. An expected age of layer or layers of rock are missing due to the erosion and, some period in geologic time is not represented.

The metagabbro and orthogneiss suite is described as an igneous undifferentiated quartz-diorite gneiss, a granitic gneiss and metagabbro i.e. a fine to coarse grained metamorphosed intrusive rock.

Table 14.11: Rock Formations within the Study Area

Formation	Description	Location	Importance	Justification for Importance Rating
The Burren Formation	Pale grey clean skeletal limestone – Carboniferous.	East of the study area from the Corrib Shopping Centre to the Corbett Commercial Centre	Low	Low value on a local scale
Meta-Gabbro and ortho-gneiss	An Undifferentiated Quartz-Diorite Gneiss, Quartz Diorite Gneiss & Granitic Gneiss and Metagabbro and Related Lithologies. Coarse to fine grained metamorphic rock.	West of the study area from University College Hospital Galway to the Corrib Shopping Centre and to the south of the study area underlying Galway Harbour Enterprise Park	Low	Low value on a local scale

14.3.2.5 Regional Aquifer Type and Classification

The GSI has devised a system for classifying both bedrock and gravel aquifers in Ireland based on the hydrogeological characteristics, size and productivity of the groundwater resource. The aquifers within the study area can be seen in Figure 14.5 in Volume 3 of this EIAR and are listed in Table 14.12 below along with their importance with respect to feature quality and significance as determined by Box 4.1 in the NRA Guidelines (NRA 2008a).

The metagabbro and orthogneiss suite to the west and south of the study area is classified as a Poor Aquifer, bedrock which is generally unproductive except for local zones (Pl). The limestones of the Burren Formation in the east and north-east of the study area are classified as a Regionally Important Aquifer with karstified (conduit) groundwater flow (Rkc).

Table 14.12: GSI Bedrock Aquifers within the Study Area

Aquifer Type	Description	Location	Importance	Justification for Importance Rating
Regionally Important Aquifer	Bedrock which regionally important and is Karstified conduits (Rkc)	East of St Brendan's Court; Eyre Square; and Fairgreen Road	High	Regionally important aquifer which is important on a regional scale
Poor Aquifer	Bedrock which is generally unproductive except for local zones (PI)	West of St Brendan's Court; Eyre Square and Fairgreen Road, underlying Galway Harbour Enterprise Park	Low	Regionally poor aquifer which has low importance on a regional scale

Groundwater bodies (GWBs) were delineated and described by the GSI in 2004 as Water Framework Directive (WFD) groundwater management units to manage and protect groundwater and linked surface waters. There are 3 no. GWBs present within the study area:

- The Maam-Clonbur GWB located in the west of the study area to the west of the River Corrib;
- The Clare-Corrib GWB located in the centre to the north of the study area from the Corrib Shopping centre northwards; and
- The Clarinbridge GWB located in the east of the study area surrounding Lough Atalia.

The Maam-Clonbur GWB is underlain by igneous and metamorphic bedrocks. According to the GWB descriptions, groundwater levels in these bedrocks are approximately 0 – 8m below ground level (mbgl). Groundwater flow is expected to be concentrated in fractured and weathered zones which are reported to be typically less than 3m thick with shallow flow and short flow paths dominating. Hydraulic gradients are expected to be greater than 0.01.

The Clarinbridge and Clare-Corrib GWB predominantly covers the limestone bedrock within the study area, the Clarinbridge GWB also covers the metagabbro and orthogneiss bedrocks in the centre of the study area. According to the GWB descriptions, groundwater flow is through a shallow epikarstic layer and in a zone of interconnected enlarged fissures and conduits that extends up to approximately 30m below the epikarstic layer. Groundwater flow paths can be up to several kilometres long but shorter paths are noted as well due to the highly karstified nature of the GWB.

Transmissivity is a measure of the rate of groundwater flow through an aquifer and is dependent on aquifer thickness. Transmissivity ranges from

0.2m^2/d to 10^2/d within the Maam-Clonbur GWB and from 1m^2/d to greater than 1,000m^2/d in the Clarinbridge GWB.

14.3.2.6 Regional Aquifer Vulnerability

Groundwater vulnerability is a relative measure of the ease with which groundwater may be contaminated by human activity. It is based on the aquifer's intrinsic geological and hydrogeological characteristics. The vulnerability is determined by the thickness and permeability of overlying deposits and the depth to the bedrock aquifer. For example, bedrock with a thick, low permeability, clay-rich overburden is less vulnerable than bedrock with a thin, high permeability, gravelly overburden.

Within the study area as shown on Figure 14.6 in Volume 3 of this EIAR, groundwater vulnerability ranges from moderate to extreme vulnerability. In the south-east areas of the study area moderate vulnerability is found in the area surrounding Lough Atalia except at Galway Harbour Enterprise Park where it is also high, extreme or rock at or near surface. Areas of high vulnerability are observed to underlie the majority of the rest of the study area. In addition to the area at Galway Harbour Enterprise Park there are six areas of 'extreme [vulnerability] to rock at or near surface', four in the west of the study area and west of the River Corrib, two in the east north of Moneenageisha Road.

14.3.2.7 Regional 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 2020). However, there is one Geological Heritage feature which is a karst feature, 'Saint Augustine's Well' located approximately 100m east of the Proposed Scheme on College Road. This well is present on the shore of Lough Atalia. It is recorded as a freshwater karst spring that flows into Lough Atalia.

The source of water is understood to be 1.9km north-east of the spring and outside of the study area, at the Terryland River. The karst feature can be seen on Figure 14.4 in Volume 3 of this EIAR and is listed in Table 14.13 along with its importance with respect to feature quality and significance as determined by Box 4.1 in the NRA Guidelines (NRA 2008a).

Table 14.13: GSI Regional Karst Features within Study Area

Karst feature	Description	Location	Importance	Justification for Importance Rating
St. Augustine's Well	Bedrock Freshwater Karst spring on the shore of a tidal lagoon	100m south-east of the Proposed Scheme on Lough Atalia North shore	High	Feature which is important on a local scale

14.3.2.8 Regional Recharge

Recharge is the amount of effective rainfall that replenishes the aquifer. It is a function of the effective rainfall (i.e. rainfall minus evaporation and run off), transpiration (uptake by plants) and the aquifer characteristics.

Groundwater recharge for the Poor aquifer (under the west and centre of the study area) is capped at 100mm/yr which reflects the low permeability of the aquifer and its limited capacity for water storage. The recharge for the Regionally Important Aquifer ranges from 101mm/yr to 700mm/yr, this recharge value is dependent on the overlying subsoil type. The regional groundwater recharge is shown on Figure 14.7 in Volume 3 of this EIAR.

14.3.2.9 Regional Groundwater Abstractions

Based on available data sources from the GSI there are no Public Water Supply or National Federation of Group Water Scheme groundwater source protection areas within the regional study area.

According to the GSI database, there are six groundwater wells recorded within the study area. Details of the abstraction are summarised in Table 14.14 along with its importance with respect to feature quality and significance as determined by Box 4.1 in the NRA Guidelines (NRA 2008a) and is presented on Figure 14.5 in Volume 3 of this EIAR.

Table 14.14: GSI Groundwater Abstractions

Abstraction feature	Description	Location	Importance	Justification
1121NEW005 – borehole	Ballinfoyle Group scheme. Domestic use only – good yield at 141.8m^3/d	50m to the north-east of the Proposed Scheme	Medium	Locally important abstraction points which is important on a local scale
121NEW011 - borehole	Unknown	50m north of Fairgreen Road of the Proposed Scheme	Medium	Conservatively assumed to be a locally important abstraction point which is important on a local scale
1121NEW015 – borehole	Unknown	10m south of Fairgreen Road of the Proposed Scheme	Medium	Conservatively assumed to be a locally important abstraction point which is important on a local scale
1121NEW014 - borehole	Unknown	50m south of Fairgreen Road of the Proposed Scheme	Medium	Conservatively assumed to be a locally important abstraction point which is important on a local scale

Abstraction feature	Description	Location	Importance	Justification
1121NEW012 - borehole	Unknown	10m south of Fairgreen Road along the Proposed Scheme	Low	Abstraction point associated with a poor aquifer which is likely to have a low importance on a regional scale
1121NE016 - borehole	Unknown	60m south of Fairgreen Road at the Proposed Scheme	Low	Abstraction point associated with a poor aquifer which is likely to have a low importance on a regional scale

14.3.2.10 Regional Environmentally Sensitive Sites

Protected Areas

The National Parks and Wildlife Services (NPWS) is responsible for the designation of environmentally protected sites in Ireland and maintains a publicly available database of these sites. These sites include Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Natural Heritage Areas (NHAs). In addition to these sites, the NPWS also maintains a database of proposed Natural Heritage Areas (pNHAs). These features are assessed in this Chapter relation to soil, geology and hydrogeological impacts and are assessed fully in Chapter 15 (Archaeological Cultural Heritage and Architectural Heritage). The protected areas in the study area are shown on Figure 14.5 in Volume 3 of this EIAR and are listed in Table 14.15 along with their importance with respect to feature quality and significance as determined by Box 4.1 in the NRA Guidelines (NRA 2008a).

Table 14.15: Ecologically Sensitive Sites within the Study Area

Abstraction feature	Description	Location	Importance	Justification
The Lough Corrib SAC and pNHA	This is classified as a SAC as it supports a number of species that are listed on Annex I / II of the EU habitats directive.	West of the study area and underlies the Proposed Scheme at the River Corrib	Extremely High	Attribute has a high quality or value on an international scale
The Galway Bay Complex (Lough Atalia) SAC and pNHA	This area includes the coastal waters of inner Galway Bay and Lough Atalia. This is classified as a SAC as it supports a number of species that are listed on Annex I / II of the EU habitats directive.	East of the study area south of the Proposed Scheme at Lough Atalia and Galway Harbour	Extremely High	Attribute has a high quality or value on an international scale

Abstraction feature	Description	Location	Importance	Justification
The Inner Galway Bay SPA	This area includes the coastal waters of the Corrib Estuary, inner Galway Bay and Lough Corrib. This is designated a SPA under the EU Birds Directive as it is of special conservation interest for a number of bird species.	East of the study area south of the Proposed Scheme at Lough Atalia and Galway Harbour	Extremely High	Attribute has a high quality or value on an international scale

These protected sites do not contain groundwater dependant habitats in the vicinity of the site development. While these sites may not be groundwater dependent, they will receive groundwater flow from within the study area.

14.3.2.11 Regional Soft and / or Unstable Ground

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

- Ground investigation data; and
- Scheme walkover survey.

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.

14.3.2.12 Regional Contaminated Land

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

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

- CORINE land cover mapping (EPA 2018);
- Teagasc soil map (Teagasc et al. 2017);
- EPA Maps (EPA 2019);
- OSI mapping (OSI 2019);
- The information provided by the design team; and
- Local authority archives and databases.

The known potential sources of contamination relevant to the Proposed Scheme identified within the study area are detailed in

Table 14.16 along with their importance as determined by Box 4.1 of the NRA Guidelines (NRA 2008a).

Table 14.16: Summary of Potential Sources of Contaminated Land Adjacent to the Proposed Scheme

Feature	Description	Location	Importance	Justification for Importance Rating
Petrol Station	College Road Service Station (CRSS) petrol station identified along the Proposed Scheme	College Road	Medium	Contaminated soil on site with previous light industrial usage
Historic Petrol Station	Previous petrol station with overground tanks identified along the Proposed Scheme	Headford Road	Medium	Contaminated soil on site with previous light industrial usage
Galway Ceannt Train Station	OSi 25-inch mapping	Eyre Square	Medium	Contaminated soil on site with previous light industrial usage
Historical Mill	OSi 6-inch mapping	Earls Island	Medium	Contaminated soil on site with previous light industrial usage
Historical Infirmary	OSi 6-inch mapping	Bothar na mBan	Medium	Contaminated soil on site with previous light industrial usage
Historical Foundry	OSi 6-inch mapping	Dock Road	Medium	Contaminated soil on site with previous light industrial usage
Historical Saw Mill	OSi 25-inch mapping	Dock Road	Medium	Contaminated soil on site with previous light industrial usage
Galway Harbour Enterprise Park	Enterprise Park hosting industrial park. Identified on the 1995 OSi Aerial photograph	Galway Harbour Enterprise Park	High	Contaminated soil on site with industrial usage

There are no EPA licensed facilities within the regional study area.

14.3.2.13 Regional Mineral / Aggregate Resources

Considering the location of the Proposed Scheme in an 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);
- GSI active quarries (GSI 2019d); and
- GSI APM pits and quarries (GSI 2016c).

A summary of the aggregate resources identified in the study area are outlined in Figure 14.8 in Volume 3 of this EIAR and Table 14.17 along with their importance as determined by the Box 4.1 of the NRA Guidelines (NRA 2008a).

According to the GSI, there is no granular aggregate potential, mineral localities active quarries or historic pits within the study area.

Table 14.17: GSI Aggregate Potential for the Study Area

GSI Aggregate Potential Type	Potential	Location	Importance	Justification for Importance Rating
Crushed rock aggregate potential	Very Low potential	Underlying the River Corrib	Low	Uneconomically extractable mineral resource
Crushed rock aggregate potential	Low potential	West of Saint Brendan's Court, Eyre Square, and Fairgreen Road and continuing until the River Corrib. There are also areas under Earls Island, University Road and northeast of Galway Harbour Enterprise Park	Low	Uneconomically extractable mineral resource
Crushed rock aggregate potential	Moderate potential	West of University Road and an area underlying Galway Harbour Enterprise Park	Low	Sub-economic extractable mineral resource
Crushed rock aggregate potential	High potential	East of Saint Brendan's Court; Eyre Square, underlying Galway harbour Enterprise Park, Fairgreen Road and north-east of both the Moneenageisha Road and the Dublin Road.	Low	Considering the sites urban setting the potential to extract mineral resource is considered very low.

14.3.2.14 Regional Geological Heritage Areas

Geological Heritage Areas are designated as part of the Irish Geological Heritage Programme, a partnership with GSI and the Department of Housing, Local Government and Heritage. The aim of the Programme was to identify, document and protect the wealth of geological heritage in Ireland.

A review of the Geological Heritage Areas (GHAs) within the study area has indicated the presence of two county geological sites (the 2020 county audit did not recommend them as pNHAs). These sites are presented on Figure 14.4 in

Volume 3 of this EIAR and listed in Table 14.18 and Table 14.13 along with their importance as determined by the Box 4.1 of the NRA Guidelines (NRA 2008a).

Table 14.18: GSI Geological Heritage Sites

Geological Heritage Site	Description	Location	Importance	Justification for Importance Rating
Shantalla Sliding Rock– Site Code: GC009	A Landmark outcrop with historical significance in suburban estate amenity park, it is comprised of the Metagabbro. There is also a Stone cross with a plinth made from Carboniferous limestone;	O'Conaire Road	High	Geological feature of high value on local scale (County Geological Site)

14.3.3 Site Specific Environment

The following section discusses the site-specific conditions 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 2020), Google (Google 2020), Bing (Bing 2020) and the Corine Land Cover maps (EPA 2018). The historic land use is based on the following OSI (OSI 2020) 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 mapping produced between 1945-1962;
- OSI mapping Produced between 1977-1980;
- OSI mapping between 1991 and 1992
- OSI 1995 aerial photography;
- OSI 2000 aerial photography;
- OSI 2005 aerial photography; and
- Corine Land Cover map.

The OSI 6-inch mapping shows that the area underlying the Proposed Scheme was comprised of a both historical development and green-fields.

The historical development was concentrated along the banks of the River Corrib and continued east to Eyre Square. The areas to the far west and far east of the

scheme are described as agricultural. There is a flood plain noted at the north of Lough Atalia.

The OSI 25-inch mapping shows an increase in historical developments in the city particularly east of the River Corrib. The areas surrounding Lough Atalia are shown as agricultural land. There is a flood plain noted at the north of Lough Atalia.

The OSI Galway City maps were also consulted for the Lough Atalia area. The maps from 1945 to 1962 show the area as a tidal flood plain including labelling it as liable to flooding and much of the coast here is listed as mud. The 1977 to 1980 OSi mapping for this area show that the area has been developed and the natural coastline is no-longer indicated on the maps. This suggests that development in these areas took place between 1962 and 1977.

The OSI Aerial 1995 shows that the area underlying the Proposed Scheme has undergone a significant level of infrastructure, urban and residential development.

The OSI Aerial from 2000 to 2020 photographs shows little change in the area underlying the Proposed Scheme from 1995.

14.3.3.2 Local Geology

The following site-specific ground investigations have been completed at the site:

- Apex Geophysics Ltd, 2021. Non-intrusive geo-physical survey, Galway Busconnects – Cross City Link carried out in the east of the Proposed Scheme to collect information on the buried services at College Road Service Station and on the ground profile; and
- Causeway Geotechnical Ltd, 2021. Intrusive ground investigation, Galway Busconnects - Cross City Link carried out mostly in the east of the Proposed Scheme to collect information to inform the design of earth works and collect geoenvironmental information around College Road Service Station. One location was drilled in the west on St Brendan's Avenue to collect information on the strata in that area.

An interpreted generalised stratigraphy base on the results of the 2021 ground investigations is presented in Table 14.19 below. The location of the boreholes and window samples from 2021 referred to in the text below are shown on the 'Exploratory Hole Location Plan' in Appendices 14.2a and 14.2b of Volume 4 of this EIAR. Copies of the logs for the boreholes within the study area are presented in Appendices 14.2a and 14.2b of Volume 4 of this EIAR.

Table 14.19: General Stratigraphy for the East of the Proposed Scheme and at St. Brendan's Avenue based on 2021 Ground Investigation

Stratum	Description	Depth to Top of Stratum (m BGL)	Thickness of Stratum (m)
Topsoil / Bitmac / Concrete	Topsoil with roots and fragments of plastic	0	0.1 - 0.4

Stratum	Description	Depth to Top of Stratum (m BGL)	Thickness of Stratum (m)
Made Ground	Underlying Service Station forecourt – Brown to Grey silty sandy angular to subangular fine to coarse GRAVEL with high cobble content and fragments of plastic. Sand is fine to coarse. Cobbles are subangular. Underlying Lough Atalia reclaimed area - Firm becoming stiff sandy gravelly Clay with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse. Cobbles are subangular.	0 – 0.1	0.3 – 2.0
Sub-Soils	Soft to stiff brown to grey sandy gravelly CLAY. Sand is fine to coarse. Gravel is subangular to subrounded fine to coarse. 0.3m thick sand lens noted within WS106. Sand described as dark grey gravelly fine to coarse SAND. Gravel is subangular to subrounded fine to coarse.	0.6 – 1.0	0.7 – 1.9
	Grey to brown sandy silty subangular to subrounded fine to coarse GRAVEL with low to medium cobble content. Sand is fine to coarse. Cobbles are subangular to subrounded.	2.5 – 4.0	0.3 – 3.3
	Very soft to soft grey to brown slightly clayey SILT with organic fibres.	1.65	0.45
	Very soft to soft dark brown-black fibrous Peat	2.1	0.8 – 2.8
Weathered Bedrock	The Burren Formation – medium strong grey massive Limestone partially weathered with close fracture spacing. Also described as grey sandy subangular fine to coarse Gravel – possible weathered bedrock in places.	5.1 – 5.8	0.7-1.6
Bedrock	East of Proposed Scheme The Burren Formation –medium strong massive grey Limestone, with local areas of partial weathering and clay deposits along rare joint surfaces.	2.3 – 6.7	Unknown
	West of Proposed Scheme Orthogneiss metagabbro suite – medium to strong dark grey Gabbro with grey to white diorite vein intrusions. Partially weathered with	2.5	Unknown

Stratum	Description	Depth to Top of Stratum (m BGL)	Thickness of Stratum (m)
	slightly reduced strength occasional fractures with orange brown discolouration.		

14.3.3.3 Made Ground

The made ground found in the site investigation was variable. The made ground present underlying the College Road Service Station (CRSS) forecourt was engineered fill. This was found in BH103WS, BH103, BH102, BH102A and WS104. This material was described as a brown to grey silty sandy angular to subangular fine to coarse gravel with high cobble content and fragments of plastic. Sand is fine to coarse. Cobbles are subangular. The madeground ranges from 0.3 to 2.0m in thickness.

The made ground found underlying the Lough Atalia reclaimed area was defined as a firm becoming stiff sandy gravelly clay with low cobble content. Sand is fine to coarse. Gravel is subangular fine to coarse. Cobbles are sub-angular. This material was likely re-worked natural material sourced from the surrounding area.

During the investigation no visual or olfactory evidence of contamination was noted in the made ground. Photo-ionisation detector (PID) readings were taken throughout the investigation and were at measurable level underlying the service station forecourt with readings ranging from 0.1ppm to 0.8ppm. The PID readings outside of the service station forecourt were below the detection limit. Geo-environmental testing was carried out on the made ground, this is further discussed in Section 14.3.3.8 below.

14.3.3.4 Silt and Peat

Silt and peat deposits have been located in WS101 and BH104 only.

These deposits are located to the north of the study area at the Lough Atalia reclamation area. They are described as very soft to soft grey to brown slightly clayey Silt with organic fibres and very soft to soft dark brown-black fibrous Peat.

These deposits are likely Estuarine deposits associated with Lough Atalia and are not wide-spread but are likely to be found in the historic footprint of the Lough that existed prior to reclamation.

14.3.3.5 Gravel

The gravel deposits typically underlie the clay deposits apart from BH102, BH103WS, WS104 where they are overlain by the madeground and WS101 and WS104 where the peat and silt deposits are interbedded between the clay and gravel.

The gravels appear to be in hydraulic connectivity with the underlying limestone bedrock aquifer. No visual or olafactory evidence of contamination was noted within the gravel.

14.3.3.6 Limestone Bedrock

The Buren Formation limestone bedrock was found to be underlying the east of site. This was found in BH101, BH102, BH103, BH104 and BH105. This bedrock is likely to form part of the regional bedrock Locally Important Aquifer.

14.3.3.7 Orthogneiss/Metagabbro Bedrock

The orthogneiss/metagabbro suite bedrock was found to be underlying the centre of the study area at BH106 on St. Brendan's Avenue. The Orthogneiss metagabbro bedrock was medium to strong dark grey Gabbro with grey to white diorite vein intrusions. Partially weathered with slightly reduced strength occasional fractures with orange brown discolouration. This bedrock forms part of the Poor Aquifer to the west of the study area which is generally unproductive except for local zones.

14.3.3.8 Soil Contamination

Considering that the Proposed Scheme will pass though the forecourt of the CRSS and because it is located in the vicinity of Lough Atalia and the Galway Bay Complex SAC a detailed assessment of the contamination in the soil has been carried out in that area. The assessment has followed the methodology presented in the Environmental Protection Agency's "Guidance on the management of Contaminated Land and Groundwater at EPA licensed sites". The assessment is presented in the Appendix 14.3 of Volume 4 of this EIAR.

The results of this assessment show:

- The site has been previously a print works and a filling station has been operated on the site since the 1960's. A detailed ground investigation was carried out which did not prove any significant soil or groundwater contamination from the storage of fuels on the site.
- Based on the results of the ground investigation cadmium and hydrocarbons are present in groundwater under the CRSS that is likely to originate from made ground under the CRSS. It is possible that cadmium and hydrocarbons originating from the made ground under CRSS is the source of elevated cadmium and hydrocarbons in the seepages on the banks of Lough Atalia.

14.3.3.9 Local Hydrogeology

During the 2021/2022 intrusive ground investigation, groundwater strikes were observed in the gravel deposits, the limestone bedrock and the orthogneiss. Groundwater was monitored by hand and using loggers during the 2021/2022 ground investigation in six standpipes installed in either the gravel deposits or the limestone bedrock between the 27th of January 2022 and the 07th of February 2022.

A hydrograph presenting groundwater levels recorded in the east of the Proposed Scheme is presented in Appendix 14.4 of Volume 4 of this EIAR and groundwater contours are presented in the Land Contamination Remedial Strategy in Appendix 14.5 of Volume 4 of this EIAR. In summary groundwater in the east of the Proposed Scheme is present 1.4 to 2.0 mbgl in the gravel and limestone and the groundwater in these layers is in continuity. The groundwater in both strata respond quickly to recharge. The groundwater in the gravel is likely to drain to the lough via seepages on the bank of Lough Atalia and via limestone into the base of the lough.

The groundwater level measured in the orthogneiss metagabbro suite was measured at 1.6mBGL.

14.3.3.10 Groundwater Quality

A comparison of the groundwater quality in the east of the Proposed Scheme against water quality standards is presented in Appendix 14.6 of Volume 4 of this EIAR. A summary of the comparison is presented above in Section 14.3.3.8 and the Land Contamination Remedial Strategy in Appendix 14.5 of Volume 4 of this EIAR.

14.3.4 Summary of the 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 14.20 for completeness.

Features with an importance ranking of medium or higher are summarised in Table 14.21 and the impact of the Proposed Scheme on these features is assessed in Section 14.4.

Table 14.20: Summary of Land, Soils, Geology and Hydrogeology Features with Low Importance Within the Study Area

Category	Feature	Description	Location	Importance	Justification
Soils (Teagasc soil classification)	Made Ground - Made	Associated with urban development	Widespread under the Proposed Scheme	Low	Poorly drained and / or low fertility soils
Subsoil deposits (GSI Quaternary Classification)	Made Ground - Urban	Associated with urban development	Widespread under the Proposed Scheme	Low	Low value on a local scale
	Glacial till - TLs	Till derived from limestones	South of the study area north of Galway harbour and at Galway	Low	Low value on a local scale

Category	Feature	Description	Location	Importance	Justification
			Harbour Enterprise park and to the north-east of the study area at Corbett Commercial Centre		
	Estuarine silts and clays - Mesc	Found adjacent to estuaries, combination of Estuarine silts and clays	Adjacent to Lough Atalia and north of Galway Harbour Enterprise Park	Low	Low value on a local scale
Bedrock Geology	Burren Formation	Pale grey clean skeletal limestone – Carboniferous.	East of the study area from the Corrib Shopping Centre to the Corbett Commercial Centre	Low	Low value on a local scale
	Meta-Gabbro and ortho-gneiss	An Undifferentiated Quartz-Diorite Gneiss, Quartz Diorite Gneiss & Granitic Gneiss and Metagabbro and Related Lithologies. Coarse to fine grained metamorphic rock.	West of the study area from University College Hospital Galway to the Corrib Shopping Centre and to the south of the study area underlying Galway Harbour	Low	Low value on a local scale
Mineral / Aggregate Resources	Crushed rock aggregate potential	Very Low potential	Underlying the River Corrib	Low	Uneconomically extractable mineral resource
	Crushed rock aggregate potential	Low potential	West of Saint Brendan's Court, Eyre Square, and Fairgreen Road and continuing	Low	Uneconomically extractable mineral resource

Category	Feature	Description	Location	Importance	Justification
			until the River Corrib.		
	Crushed rock aggregate potential	Moderate potential	West of University Road and an area underlying Galway harbour Enterprise Park	Low	Uneconomically extractable mineral resource
	Crushed rock aggregate potential	High potential	East of Saint Brendan's Court; Eyre Square, underlying Galway harbour Enterprise Park, Fairgreen Road and north-east of both the Moneenageisha Road and the Dublin Road.	Low	Uneconomically extractable mineral resource
Aquifer Type and Classification	Poor Aquifer	Bedrock which is generally unproductive except for local zones (PI)	West of St Brendan's Court; Eyre Square and Fairgreen Road, underlying Galway Harbour Enterprise Park Enterprise Park.	Low	Low yielding aquifer
Abstraction points	1121NEW012 - borehole	Unknown	10m south of Fairgreen Road along the Proposed Scheme	Low	Abstraction point associated with a poor aquifer which is likely to have a low importance on a regional scale
	1121NE016 - borehole	Unknown	60m south of Fairgreen	Low	Abstraction point

Category	Feature	Description	Location	Importance	Justification
			Road at the Proposed Scheme		associated with a poor aquifer which is likely to have a low importance on a regional scale

Table 14.21: Summary of Land, Soils, Geology and Hydrogeology Features with Medium to Extremely High Importance within the Study Area

Category	Feature	Description	Location	Importance	Justification
Soils (Teagasc soil classification)	Alluvium - AlluvMIN	Typically found along current and historic watercourses	Along the River Corrib and its tributaries – just North of Dyke Road	Medium	Moderately drained and / or moderate fertility soils
	Marine/Estuarine sediments - MarSed	Typically found along the coast	Adjacent to Lough Atalia	Medium	Moderately drained and / or moderate fertility soils
	Topsoil – PDPT Peaty Gleys Basic	Peaty Gleys with Basic parent material	East of Galway Harbour Enterprise Park	Medium	Moderately drained and / or moderate fertility soils
	Topsoil - AminDW	Typically found along current and historic watercourses	Along the River Corrib and its tributaries – east of Galway Retail Park	High	Well drained and / or high fertility soils
	Topsoil - BminDW	Deep well drained (Mainly basic)	South of the study area north at Galway harbour and to the north-east of the study area at Corbett Commercial Centre.	High	Well drained and / or high fertility soils
	Topsoil – BminSW	Shallow well drained (mainly basic)	North-east of Galway Harbour	High	Well drained and / or high fertility soils

Category	Feature	Description	Location	Importance	Justification
			Enterprise park		
Subsoil deposits (GSI Quaternary Classification)	Fen Peat-FenPt	Typically found along current and watercourses	Along the River Corrib and its tributaries, east of Galway Retail Park	Medium	Volume of peat and/or soft organic soil underlying the route is moderate on a local scale
Groundwater Abstraction points	1121NEW005 – borehole	Ballinfoyle Group scheme. Domestic use only – good yield at 141.8m^3/d	50m to the north-east of the Proposed Scheme	Medium	Locally important abstraction points which is important on a local scale
	121NEW011 - borehole	Unknown	50m north of Fairgreen Road of the Proposed Scheme	Medium	Conservatively assumed to be a locally important abstraction point which is important on a local scale
	1121NEW015 – borehole	Unknown	10m south of Fairgreen Road of the Proposed Scheme	Medium	Conservatively assumed to be a locally important abstraction point which is important on a local scale
	1121NEW014 - borehole	Unknown	50m south of Fairgreen Road of the Proposed Scheme	Medium	Conservatively assumed to be a locally important abstraction point which is important on a local scale
Environmentally Sensitive Areas	The Lough Corrib SAC and pNHA	This is classified as a SAC as it supports a number of species that are listed on Annex I / II of the EU habitats directive	West of the study area and underlies the Proposed Scheme at the River Corrib	Extremely High	Attribute has a high quality or value on an international scale
	The Galway Bay	This area includes the	East of the study area	Extremely High	Attribute has a high quality or

Category	Feature	Description	Location	Importance	Justification
	Complex (Lough Atalia) SAC and pNHA	coastal waters of inner Galway Bay and Lough Atalia. This is classified as a SAC as it supports a number of species that are listed on Annex I / II of the EU habitats directive;	south of the Proposed Scheme at Lough Atalia and Galway Harbour		value on an international scale
	The Inner Galway Bay SPA	This area includes the coastal waters of the Corrib Estuary, inner Galway Bay and Lough Corrib. This is a SPA under the E.U. Birds Directive, of special conservation interest for a number of bird species; and	East of the study area south of the Proposed Scheme at Lough Atalia and Galway Harbour	Extremely High	Attribute has a high quality or value on an international scale
Contaminated Land	Petrol Station	College Road Service Station (petrol station) identified along the Proposed Scheme	College Road	Medium	Contaminated soil on site with previous light industrial usage
	Historic Petrol Station	Previous petrol station with overground tanks identified along the Proposed Scheme	Headford Road	Medium	Medium value on a local scale
	Galway Ceannt Train Station	OSi 25-inch mapping	Eyre Square	Medium	Medium value on a local scale

Category	Feature	Description	Location	Importance	Justification
	Historical Mill	OSi 6-inch mapping	Earls Island	Medium	Medium value on a local scale
	Historical Infirmary	OSi 6-inch mapping	Bothar na mBan	Medium	Medium value on a local scale
	Historical Foundry	OSi 6-inch mapping	Dock Road	Medium	Medium value on a local scale
	Historical Saw Mill	OSi 25-inch mapping	Dock Road	Medium	Medium value on a local scale
	Galway Harbour Enterprise Park	Enterprise Park hosting industrial park. Identified on the 1995 OSi Aerial photograph	Galway Harbour Enterprise Park	High	Contaminated soil on site with industrial usage
Geological Heritage Area	Shantalla Sliding Rock	Landmark outcrop with historical significance in suburban estate amenity park, it is comprised of the Murvey Granite and Metagabbro. There is also a Stone cross with a plinth made from Carboniferous limestone;	O'Conaire Road	High	Geological feature of high value on local scale
Geological Heritage Area and Karst feature	St. Augustine's Well	Freshwater karst spring on the shore of a saline tidal lagoon which was a historic holy well visited for its apparent curative properties;	100m south-east of the Proposed Scheme on Lough Atalia North shore	High	Feature which is important on a local scale
Aquifer type and classification	Regionally Important aquifer	Bedrock which regionally important and	East of Saint Brendan's Court; Eyre Square;	High	Regionally important aquifer which is important

Category	Feature	Description	Location	Importance	Justification
		is Karstified conduits (Rkc)	and Fairgreen Road		on a regional scale

14.3.5 Conceptual Site Model

A Conceptual Site Model (CSM) has been developed for the Proposed Scheme based on the ground investigation data and all publicly available data.

The CSM summarises the important geological and hydrogeological features near the Proposed Scheme. The subsections of the Proposed Scheme listed in Chapter 5 (Construction) of this EIAR are presented in Table 14.22 to Table 14.24 along with the proposed works, expected groundwater levels and the soils and geology at each earthwork area.

The Proposed Scheme is located across Galway City. The west of the Proposed Scheme is in the catchment of the River Corrib which flows southwards and is crossed via Salmon Weir Bridge in the west of the site. The east side of the Proposed Scheme is in the catchment of Lough Atalia which is adjacent to the site boundary at its closest point. Both are tidal features and are Special Areas of Conservation (SAC).

The area of the Proposed Scheme is developed and covered by a layer of made ground seen to be 0.3 to 2.0m thick in places. The made ground has been proven in two areas to overlie a layer of clay which ranges from (but is not limited to) 0.1 to 3.5m in thickness. In the eastern area beneath the clay there is a 0.4 to 3.3m layer of gravels and then bedrock. In the western area of the Proposed Scheme, it is likely that the clay layer directly overlies the bedrock.

There are two types of bedrock observed underlying the Proposed Scheme limestone bedrock in the eastern and centre area of the Proposed Scheme and the orthogneiss/metagabbro bedrock underlying the centre and west of the Proposed Scheme. The Limestone bedrock is a Regionally Important aquifer. The orthogneiss/metagabbro bedrock is a poor aquifer where the bedrock is generally unproductive.

Due to the presence of hardstanding and clay under the made ground it is likely that the amount of recharge to the underlying bedrock is low under the Proposed Scheme. Limestone is likely to receive the majority of its recharge outside of the study area. Notwithstanding this there is evidence that in discreet locations in the east of the Proposed Scheme surface water can infiltrate into the gravel and limestone bedrock groundwater. The recharge to the orthogneiss/metagabbro is likely to be minimal.

The water level in the limestone was recorded to be approximately 1.4 to 2.0m below the surface in the east and 1.6m in the west. The limestone bedrock in the east is believed to be in hydraulic connectivity with the overlying gravel deposit. The regional groundwater flow in the limestone and gravels, where they are present, is to the east or south-east towards Lough Atalia. Groundwater flow in

the orthogneiss/metagabbro is likely to be minimal and is likely to discharge locally to the River Corrib or Galway Harbour.

There is a recorded karst feature present within the limestone bedrock, St. Augustine's well. This is a karst spring present 100m south-east of the Proposed Scheme on the shore of Lough Atalia. It is understood that its catchment area is located 1.9km to the north of the city at the Terryland River to the north of the Proposed Scheme and outside of the 250m study area. In the vicinity of the spring the limestone aquifer vulnerability is classed as medium. In addition, over 0.9m-1.5m of low permeability clay was proven above the bedrock 450m to the north of the spring (WS105 and WS106) hence the spring is not likely to receive any significant recharge from the area of the Proposed Scheme.

Table 14.22: Conceptual Site Model – Section A University Road to Eyre Square, Woodquay and Headford Road

Subsection	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Expected Ground Conditions	Range of Thickness (m)	Additional Notes
			Max	Avg	Max	Avg			
A1 - University Road	500	At Grade	3.5	<0.5	<0.5	<0.5	Road pavement and foundation (Made ground) overlying Clay overlying bedrock - metagabbro & orthogneiss suite. Metagabbro & orthogneiss suite comprising a Poor Aquifer – Bedrock is Generally Unproductive. Groundwater level range recorded from 3.0mBGL to 3.4mBGL	Made ground: 2.3 to 3.0 Clay: 1.5 to 3.0 Gravels: N/A Bedrock: N/A	Localised pavement reconstruction, Drainage works and construction of a petrol interceptor.
A2 - Gaol Road and Cathedral	-	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction, landscaping works and Drainage works. Proposed Construction compound location.
A3 - Salmon Weir Bridge	85	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction works.
A4 - Newtownsmith/Waterside	130	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction and drainage works.
A5 - St. Vincent's Avenue / Walsh's Terrace	310	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction and drainage works.
A6 - Dyke Road / Headford Road	420	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction and drainage works.
A7 - St. Francis St / Eglinton Street / Williamsgate	390	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction and drainage works.
A8 - Woodquay / Daly's Place Mary Street	260	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction, landscaping works and Drainage works.

Table 14.23: Conceptual Site Model – Section B Eyre Square to Dock Road, Bothar na mBan to College Road

Subsection	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Expected Ground Conditions	Range of Thickness (m)	Additional Notes
			Max	Avg	Max	Avg			
B1 - Bóthar na mBan/St. Brendan's Avenue	250	At Grade	<0.5	<0.5	<0.5	<0.5	Road pavement and foundation (Madeground) overlying Glacial Till (boulder Clay) overlying bedrock: Metagabbro & orthogneiss suite north of Saint Brendan's Avenue (confirmed from 2021 GI) The Burren Formation - Limestone south of Saint Brendan's Avenue (as inferred from Historic GI and GSI mapping) Metagabbro & orthogneiss suite comprising a Poor Aquifer – Bedrock is Generally Unproductive. The Burren Formation comprising a Regionally Important Aquifer – Bedrock productive on a regional scale	Made ground: 1.2 to 2.5 Clay: 0.9 to 3.5 Gravels: 0.3-0.4 Bedrock: N/A	Localised pavement reconstruction works, road realignment. Demolition of two residential properties.
B2 - Prospect Hill	220	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction works, junction realignment.
B3 - Eyre Square North/Eyre Square East/Eyre Square South	-	At Grade	<0.5	<0.5	<0.5	<0.5			Localised road, pavement reconstruction and landscaping works.
B4 - Victoria Place/ Merchant's Road/ Queen Street	405	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction works.
B5 - Forster Street	155	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction works
B6 - College Road/Forster Street/Fairgreen Road/Bóthar Uí hEithir junction	-	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction works
B7 - Bóthar Uí hÉithir	175	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction works
B8 - Fairgreen Road	275	At Grade	<0.5	<0.5	<0.5	<0.5			Localised pavement reconstruction works

Subsection	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Expected Ground Conditions	Range of Thickness (m)	Additional Notes
			Max	Avg	Max	Avg			
							Groundwater strike recorded at 5.7mBGL in Metagabbro & orthogneiss unit Groundwater Level strike recorded from 4.35 4.4mBGL in the Limestone		

Table 14.24: Conceptual Site Model – Section C College Road to Dublin 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			
C1 - College Road (to junction with Lough Atalia Road)	885	At Grade	<0.5	<0.5	<0.5	<0.5	Road pavement and foundation (Madeground) overlying Glacial Till (boulder Clay) and Pockets of organic Silt and Peat interbedded with the Glacial Till adjacent to Lough Atalia (Estuarine Deposits) overlying bedrock: The Burren Formation - Limestone	Made ground: 0.3-2.0 Clay: 0.1-1.9 Gravel: 0.3 – 3.3 Bedrock: N/A	Localised pavement reconstruction and junction reconstruction works.
C2 - College Road/Lough Atalia Road junction	120	At Grade	3.5	1.2	<0.5	<0.5			Realignment and update of Junction and Localised pavement reconstruction.
C3 - College Road (to junction at Moneenageisha)	195	At Grade	1.9	0.7	<0.5	<0.5			Significant widening on west of College Road adjacent to College Road Service Station petrol station, Localised junction treatments
C4 - Moneengeisha junction	-	At Grade	<0.5	<0.5	<0.5	<0.5			Update of existing Junction and Localised pavement reconstruction.
C5 - R338 Dublin Road	370	At Grade	<0.5	<0.5	0.8	<0.5			Installation of inbound and outbound bus lanes, Pavement reconstruction and Localised junction entry treatments.

Subsection	Length (m)	Dominant Earthworks Type	Cut (m)		Fill (m)		Ground Conditions	Average Thickness of Made Ground (m)	Additional Notes
			Max	Avg	Max	Avg			
							The Burren Formation comprising a Regionally Important Aquifer – Bedrock productive on a regional scale Groundwater Level recorded from 1.5mBGL to 2.1 mBGL.		

14.3.5.1 Environment Type

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

Type A environment – This is located to the centre and west of the study area which corresponds to the underlying regional poor aquifer which is generally unproductive except for local zones (PI). The Type A environment to the west of the study area represents a passive geological / hydrogeological environment – examples include areas of thick low permeability subsoils, areas underlain by poor aquifers, recharge areas and historically stable geological environments.

Type B environment – This is located to the centre and east of the study area, it corresponds to the underlying regionally important bedrock aquifer which is Karstified. The Type B environment to the east of the study area represents a naturally dynamic hydrogeological environments examples include areas of groundwater discharge areas, areas underlain by regionally important aquifers, nearby spring rises, areas underlain by permeable subsoils.

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 considering any proposed mitigation are presented in Section 14.6.

14.4.1 '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.

Based on the findings of the assessment the College Road Service Station there is currently an impact on groundwater due to activities occurring in the area. However, this is localised to a limited in extent and only comprises metals which are naturally occurring and occasional low levels of hydrocarbons, hence the current impact is categorised as a negative small to moderate effect on the groundwater quality. Hence the current significance on the Regionally Important Aquifer is considered to be a negative slight/moderate impact to a negative significant/moderate impact.

There is an elevated concentration of cadmium noted in all boreholes under the College Road Service Station (CRSS). Cadmium is recorded in the seepage discharging into Lough Atalia and is likely to originate from the made ground under the CRSS including the area within the boundary of the Proposed Scheme. Also, low levels of hydrocarbons have been recorded in the groundwater under the site and in the seepage on the bank of Lough Atalia. The impact of both of these contaminants on water quality on the shore of the Lough is negative but the area affected is small. Considering the sensitivity of the Lough the significance of this do-nothing impact is negative significant and long-term.

14.4.2 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) of this EIAR.

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

A Construction Environmental Management Plan (CEMP) is provided in Appendix 5.1 in Volume 4 of this EIAR.

14.4.2.1 Section A – University Road to Eyre Square, Woodquay and Headford Road

- The construction activities in this section will include localised pavement reconstruction including footpath widening and additional pedestrian crossings, localised landscaping works, localised drainage works, localised entry treatments and installation of a bus gate at the entrance of Fisheries Field and the Salmon Weir-bridge.
- Notably, the proposed construction compound has been identified in this section at the carpark at Gaol Road and Galway Cathedral.

14.4.2.2 Section B – Eyre Square, Foster Street, Dock Road, Bothar na Mban, Bothar Ui hEithir and Fairgreen Road

- The generalised construction activities in this section will include localised pavement reconstruction works including road realignment, entry treatment installation, footpath widening and additional pedestrian crossings, upgrading signalised junctions, removal of carriageway space and surfacing of roads;
- The demolition of two residential properties on St Brendan's Avenue; and
- A portion of the existing wall outside the entrance to Galway County Hall will be removed to facilitate junction realignment.

14.4.2.3 Section C – College Road to Dublin Road

- The generalised construction activities Localised pavement reconstruction works including footpath widening, provision of entry treatments, provision of new landscaped areas, new priority pedestrian crossings and the installation of a bus-gate on College Road;
- The realignment and update of the College Road/Lough Atalia Road Junction, with a reduced junction footprint. This will include the removal of the existing traffic islands, and the College Road approach to the junction realigned to route through the existing grassed area between College Road and Lough Atalia Road;

- The works proposed on College Road (between Lough Atalia Road and Moneenageisha) comprise significant carriageway widening on the western side of College Road at the College Road Service Station (Circle K petrol Station) on College Road, this is to facilitate the construction of an additional outbound bus lane and inbound cycle track;
- The works at College Road Service Station to accommodate the Proposed Scheme will involve temporary acquisition of the entire College Road Service Station property. The works will include the complete removal of two of the six underground fuel storage tanks and existing pumping stations and excavation of up to approximately 200m^3 of contaminated soil and stone. Approximately 170m^3 classified as suitable for disposal to a non-hazardous waste facility and 30m^3 suitable for disposal to an inert waste facility;
- The volume of contaminated soil to be disposed of and replaced by clean fill shall be confirmed by verification testing of soil and ground as detailed in the Land Contamination Remedial Strategy (Appendix 14.5 of Volume 4 of this EIAR);
- There will be removal of two existing retaining walls and construction of same at Moneenageisha Court and at Bay View House. This is to accommodate the additional outbound bus lane;
- Surface water drainage gullies will be relocated to the new kerb edge and will connect back to the new drainage network, this drainage network will involve an attenuation tank, petrol interceptor and a drainage pipe. The drainage pipe will drain into Lough Atalia; and
- Installation of inbound and outbound bus lanes, pavement reconstruction and localised junction entry treatments.

14.4.3 Construction Phase

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

The Proposed Scheme could have the following potential impacts on the land, soils, geology and hydrogeology as discussed below and summarised in Table 14.25:

- Loss or damage of topsoil;
- Removal of hardstanding and excavation of potentially contaminated soils which could have the following impacts:
  - mobilisation of contamination into the regionally important aquifer; and
  - mobilisation of contamination into the Lough Atalia and Galway Bay Complex SAC;
- Spills from temporary storage of hazardous substances associated with the operation of plant e.g. fuels; and
- Dewatering.

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 or Damage of Topsoil

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

- There is the potential for materials on site to be spilled resulting in the pollution of the topsoil. For example, raw or uncured concrete and grouts, 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 the Construction Phase.
- Materials that are stockpiled incorrectly can be exposed to erosion and weathering which reduces the quality of the resource.
- Excavations in areas of contaminated ground during the construction works may cause mixing of contaminated and clean soil or 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.

The impacts of the Proposed Scheme on topsoil will only affect the topsoil within and in the immediate vicinity of the redline boundary. The topsoil within the redline is of low importance as the majority of the soils within the redline boundary are considered to be made ground. In addition, where soils were highlighted as not comprising made ground they are should be recorded as made ground because they are currently covered by roads or pavements etc. Hence all the soil within the Proposed Scheme is considered to be made ground and have a low importance.

Considering the potential impacts above, and dependant on the volume of topsoil that could be impacted, the magnitude of the effect on topsoil has the potential to be negative permanent small to moderate. However, as these soils are low importance the resulting significance of this impact will be an imperceptible to slight.

The impact of the production of excess material for removal off site is discussed in Chapter 17 (Waste & Resources) of this EIAR.

14.4.3.2 Mobilisation of Contamination into the Regionally Important Aquifer

During the construction exposure of locations of contamination and excavation of contaminated soil may potentially lead to contaminants being mobilised during rainfall and washed down into the underlying Regionally Important Aquifer.

One potential sources of contamination relevant to the Proposed Scheme has been identified within the study area, the College Road Service Station. This has been investigated and demonstrated to be currently impacting the Regionally Important Aquifer (refer to Appendix 14.5 of Volume 4 of this EIAR). In addition is it possible that localised 'hot spots' could be uncovered during the works.

Prior to the construction samples of any material to be excavated for reuse or disposal will be tested for contamination. During construction, areas of the site will be stripped of hard standing, and the contaminated soil removed. 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.

In addition, at the College Road Service Station two underground fuel tanks and fuel dispensers will be decommissioned. These activities could expose more contamination and allow it to drain down to the aquifer.

Considering the size of the College Road Service Station and that it has already been subject to an investigation the scale of any additional soil contamination is likely to be small. However, the removal of the tanks and decommissioning the fuel dispensers could, if not carried out correctly introduce some fuels to spill (for more information on decommissioning. Refer to Appendix 14.5 of Volume 4 of this EIAR). This could potentially result in an adverse moderate temporary effect on groundwater quality. Hence the overall significance is of this impact is significant/moderate.

The groundwater abstraction (1121NEW005) is located up-hydraulic gradient of the Proposed Scheme and the College Road Service Station. As a result, groundwater abstractions will not be affected. Hence the nature of any effect on groundwater quality will be negligible resulting in an imperceptible impact.

Several groundwater abstractions are shown in the city centre (1121NEW011, 1121NEW014 and 1121NEW015) but are not located directly downstream of the College Road Service Station. However, the Proposed Scheme does pass close to the area of the abstractions (Fairgreen Road). Their use is unknown however they are conservatively assumed to be of medium importance. If contamination was uncovered in that area of the Proposed Scheme it could present a risk to water quality in the abstractions. Groundwater vulnerability is classed as moderate in the area. Figure 14.3 shows they are underlain by till. The ground investigation proved clay (till) approximately 1km to the northeast of the site. Consequently, provided that the clay is not disturbed the abstractions are not considered likely to be susceptible to contamination from the Proposed Scheme. Therefore, the magnitude of any impact is negligible, and the significance will be imperceptible.

Similar to the groundwater abstraction the St Augustine's Well GHA is not located down hydraulic gradient of the College Road Service Station. However, the Proposed Scheme does pass over area between the well and its source (College Road, between the Galway City Council Office and the Galway Greyhound Stadium). Consequently, if contamination was uncovered in that area of the Proposed Scheme it could present a risk to water quality in the well. Groundwater vulnerability is classed as moderate in the area. Figure 14.3 in Volume 3 of this EIAR shows they are underlain by till. The ground investigation proved clay (till) approximately 0.5km to the northeast of the site. Consequently, provided that the clay is not disturbed the well is not considered likely to be susceptible to contamination from the Proposed Scheme. Therefore, the magnitude of any effect is negligible, and the significance of impacts are imperceptible.

14.4.3.3 Mobilisation of Contamination into the SAC

The removal of hardstanding on the central and eastern sections of the Proposed Scheme will result in a small increase in infiltration which could mobilize contamination into the underlying Regionally Important Aquifer, which could increase the amount of contaminants draining to Lough Atalia and Galway Bay Complex SAC. Considering the amount of dilution afforded by Lough Atalia and the short distance between the Proposed Scheme and the Lough the magnitude of this effect is considered to be a small adverse and temporary. However, as Lough Atalia is of extremely high importance, the resulting significance of the impact is considered to be adverse significant and temporary in the absence of mitigation.

14.4.3.4 Temporary Storage of Hazardous Substances

During the construction stage there is a risk of pollution to the groundwater in the Regionally Important Aquifer by the spillage of fuels or chemicals used on the plant operated on site which could then escape to Lough Atalia SAC and Galway Bay Complex or River Corrib SAC.

The risks from hazardous substances are identical to those highlighted above for the mobilization of contamination in the Regionally Important Aquifer (Section 14.4.3.2). Hence the significance of this adverse impact on the Regionally Important Aquifer is deemed to be negative significant/moderate and temporary.

The significance of the impacts on the groundwater abstractions (1121NEW0051121NEW011, 1121NEW014 and 1121NEW015) and St Augustine's Well are considered to be imperceptible considering the presence of low permeability clay (till) beneath the Proposed Scheme protecting the aquifer (See Section 14.4.3.2).

14.4.3.5 Dewatering

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 reversible small change in the groundwater levels and flow within the regionally important aquifer underlying the Proposed Scheme.

Since the pumping is expected to be limited, localised and temporary, the magnitude of this impact is considered to be negligible. As the importance of the Regionally Important Aquifer is high, the resulting significance is imperceptible.

14.4.4 Operational Phase

The impact assessment for the Operational Phase is outlined in terms of impact analysis of the Proposed Scheme on the local environment from a land, soils, geology and hydrogeology perspective. As the surface water drains directly to the Lough Atalia and Galway Bay Complex SAC, this provides a potential pathway for contaminants, this is further assessed in Chapter 13 (Water) of this EIAR.

During the operational phase, the following items have been highlighted that could have a potential impacts the environment:

- Reduction in recharge to the aquifer;
- Impact of the made ground under College Road Service Station on the Regionally Important Aquifer; and
- Contamination of the aquifer from road runoff.

These potential impacts are assessed in detail below and summarised in Table 14.26.

14.4.4.1 Reduction in Recharge to the Regionally Important Aquifer

The centre and eastern sections of the Proposed Scheme will have a limited surface area for aquifer recharge as the Proposed Scheme is mainly comprised of roads and footpaths. Surface water run-off will be collected in surface water drainage systems and will outfall to the Lough Atalia and Galway Bay Complex SAC without draining to ground. Consequently, the Proposed Scheme could reduce recharge to the Regionally Important Aquifer in the centre and east of study area. The areas underlying the Proposed Scheme are generally described as having a relatively low recharge and largely comprise roads which already impede recharge. Consequently, the magnitude of the reduction in recharge is anticipated to be negligible and the significance is imperceptible.

14.4.4.2 Impact of the Made Ground Under College Road Service Station on the Regionally Important Aquifer

The made ground under the College Road Service Station is currently having a small adverse on the groundwater quality under the site and potentially Lough Atalia**.** Consequently, the significance of the do-nothing effect is considered to long-term significant**.** The Proposed Scheme includes the removal of some of the made ground to facilitate the development of the Proposed Scheme and the decommissioning of the tanks and fuel dispensers. The area will then be capped with low permeability road surfacing which will reduce the infiltration. This will permanently remove the source from under the permanently acquired part of the Proposed Scheme and reduce infiltration through any residual soil left. This will comprise a permanent beneficial impact both on the Regionally Important Aquifer

and on Lough Atalia and Galway Bay Complex SAC. The extent of this permanent beneficial impact is rated as minor to major and will depend on the degree of contamination remaining under the adjacent portion of College Road Service Station which is outside of the permanently acquired part of the Proposed Scheme.

14.4.4.3 Contamination of the Aquifer from Road Runoff

Road runoff has the potential to contain small amounts of contamination from motor vehicles that use it. The proposed drainage shall be collected by a sealed system of drains that shall drain to the current surface water system or to Lough Atalia following treatment. Hence the run-off will not drain to the aquifer and consequently, the significance of this permanent negative impact on groundwater quality is considered to be imperceptible.

Table 14.25: Summary of Potential Construction Phase Impacts

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Loss or Damage of Topsoil									
Topsoil	BminDW - Deep well drained (Mainly basic)	Between Lough Atalia and the Dublin Road. There is also one pocket underlying the Wellpark Retail centre. Not likely to be under the Proposed Scheme.	High	Loss or damage of topsoil	Negative	Permanent	Negligible	Negligible	Imperceptible
Alluvium - AlluvMIN	Typically found along current and historic watercourses	Along the River Corrib and its tributaries – just North of Dyke Road. Not likely to be under the Proposed Scheme.	Medium	Loss or damage of fertile soil	Negative	Permanent	Negligible	Negligible	Imperceptible
Marine/Estuarine sediments - MarSed	Typically found along the coast	Adjacent to Lough Atalia Not likely to be under the Proposed Scheme.	Medium	Loss or damage of fertile soil	Negative	Permanent	Negligible	Negligible	Imperceptible
Removal of hardstanding and excavation of potentially contaminated soils									
Regionally Important aquifer	Bedrock which regionally important and is Karstified conduits (Rkc)	East of Saint Brendan's Court; Eyre Square; and Fairgreen Road	High	Loss or damage of proportion of aquifer through pollution.	Negative	Temporary	Local	Moderate	Significant/moderate
Ecologically Sensitive Area	The Galway Bay Complex (Lough Atalia) SAC and pNHA	East of the study area south of the Proposed Scheme at Lough Atalia and Galway Harbour	Extremely High	Damage of SAC through pollution	Negative	Temporary	Local	Small	Significant
Groundwater abstraction (1121NEW005)	Group water Scheme abstraction	North east of the study area	Medium	Impact on water quality	Negative	Temporary	Negligible	Negligible	Imperceptible

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
121NEW011 - borehole	Unknown	50m north of Fairgreen Road of the Proposed Scheme	Medium	Impact on water quality	Negative	Temporary	Negligible	Negligible	Imperceptible
1121NEW015 – borehole	Unknown	10m south of Fairgreen Road of the Proposed Scheme	Medium	Impact on water quality	Negative	Temporary	Negligible	Negligible	Imperceptible
1121NEW014 - borehole	Unknown	50m south of Fairgreen Road of the Proposed Scheme	Medium	Impact on water quality	Negative	Temporary	Negligible	Negligible	Imperceptible
St Augustine's Well	Geological Heritage Feature	Approximately 100m east of College Road	High	Pollution of the water in the well	Negative	Temporary	Negligible	Negligible	Imperceptible
Spills from temporary storage of hazardous substances associated with the operation of plant									
Regionally Important aquifer	Bedrock which regionally important and is Karstified conduits (Rkc)	East of Saint Brendan's Court; Eyre Square; and Fairgreen Road	High	Loss or damage of proportion of aquifer through pollution.	Negative	Temporary	Local	Moderate	Significant/moderate
Ecologically Sensitive Area	The Galway Bay Complex (Lough Atalia) SAC and pNHA	East of the study area south of the Proposed Scheme at Lough Atalia and Galway Harbour	Extremely High	Damage of SAC through pollution	Negative	Temporary	Local	Small	Significant
	The Lough Corrib SAC and pNHA	East of the study area south of the Proposed Scheme at Lough Atalia and Galway Harbour	Extremely High	Damage of SAC through pollution	Negative	Temporary	Local	Small	Significant
Groundwater abstraction (1121NEW005)	Group water Scheme abstraction	North east of the study area	Medium	Impact on water quality	Negative	Temporary	Negligible	Negligible	Imperceptible

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
121NEW011 - borehole	Unknown	50m north of Fairgreen Road of the Proposed Scheme	Medium	Impact on water quality	Negative	Temporary	Negligible	Negligible	Imperceptible
1121NEW015 – borehole	Unknown	10m south of Fairgreen Road of the Proposed Scheme	Medium	Impact on water quality	Negative	Temporary	Negligible	Negligible	Imperceptible
1121NEW014 - borehole	Unknown	50m south of Fairgreen Road of the Proposed Scheme	Medium	Impact on water quality	Negative	Temporary	Negligible	Negligible	Imperceptible
St Augustine's Well	Geological Heritage Feature	Approximately 100m east of College Rd	High	Pollution of the water in the well	Negative	Temporary	Negligible	Negligible	Imperceptible
Dewatering									
Regionally Important aquifer	Bedrock which regionally important and is Karstified conduits (Rkc)	East of Saint Brendan's Court; Eyre Square; and Fairgreen Road	High	Change to groundwater regime	Negative	Temporary	Local	Negligible	Imperceptible

Table 14.26: Summary of Potential Operational Phase Impacts

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Reduction in recharge to the Regionally Important Aquifer									
Regionally Important aquifer	Bedrock which regionally important and is Karstified conduits (Rkc)	East of St Brendan's Court; Eyre Square; and Fairgreen Road	High	Reduction in recharge	Negative	Permanent	Across the east of the Scheme	Negligible	Imperceptible
Impact of the made ground under College Road Service Station on the Regionally Important Aquifer									
Regionally Important aquifer	Bedrock which regionally important and is Karstified conduits (Rkc)	East of St Brendan's Court; Eyre Square; and Fairgreen Road	High	Loss or damage of proportion of aquifer through pollution	Positive	Permanent	Local	Minor/major	n/a
Ecologically Sensitive Area	The Galway Bay Complex (Lough Atalia) SAC and pNHA	East of the study area south of the Proposed Scheme at Lough Atalia and Galway Harbour	Extremely High	Damage of SAC through pollution	Positive	Permanent	Local	Minor/major	n/a
Contamination of the aquifer from road runoff									

Feature	Description	Location	Importance	Impact	Quality	Duration	Scale	Magnitude	Significance
Regionally Important aquifer	Bedrock which regionally important and is Karstified conduits (Rkc)	East of St Brendan's Court; Eyre Square; and Fairgreen Road	High	Loss or damage of proportion of aquifer through pollution	Negative	Permanent	Across the east of the Scheme	Negligible	Imperceptible

14.5 Mitigation and Monitoring Measures

The following sections outline the mitigation and monitoring measures associated with the significant 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 14.25.

14.5.1 Construction Phase

14.5.1.1 Mobilisation of Contamination into the Regionally Important Aquifer

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

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

Samples of ground suspected of contamination will be tested for contamination by the appointed contractor during the 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.

14.5.1.2 Spills from Temporary Storage of Hazardous Substances

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 to minimise the risk of spills and contamination of soils and waters include:

- Employing only 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 shall 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;
- All concrete mixing and batching activities will be located in areas away from watercourses and drains;
- Potential pollutants to be adequately secured against vandalism;
- Provision of proper containment of potential pollutants according to codes of best practice;
- Thorough control during the entire Construction Phase to ensure that any spillage is identified at early stage and subsequently effectively contained and managed; and
- Spill kit to be provided and to be kept close to the storage area. Staff to be trained on how to use spill kits correctly.

An Environmental Incident Response Plan will be implemented by the appointed contractor, which will identify the actions to be taken in the event of a pollution incident. It will address 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 5.1 CEMP in Volume 4 of this EIAR.

Sediment control methods are outlined in the Surface Water Management Plan in Appendix 5.1 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.

14.5.1.3 Mobilisation of Contamination into the SAC

The mitigation measures presented above in Section 14.5.1.1 for the Regionally Important Aquifer are directly relevant to the SAC. These mitigation measures will reduce the impact from the Proposed Scheme to negative, short-term but negligible hence the significance of the impact will be imperceptible.

14.5.1.4 Monitoring

As detailed in the Land Contamination Remedial Strategy (Appendix 14.5 of Volume 4 of this EIAR) a groundwater and surface water risk assessment shall be carried out by a competent geoenvironmental expert during the detailed design to establish a concentration of cadmium and hydrocarbons in the soil that do not present a risk to the quality of water entering Lough Atalia.

Soil, groundwater and surface water verification testing shall be carried out by the contractor during the construction stage to confirm the findings of the cadmium and hydrocarbon in the groundwater and surface water risk assessment.

14.5.2 Operational Phase

No significant adverse impacts were highlighted hence no mitigation is proposed.

14.5.2.1 Monitoring

No monitoring is proposed for the operational phase.

14.6 Residual Impacts

14.6.1 Construction Phase

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

14.6.2 Operational Phase

Based on the assessment in Section 14.4 it is expected that there will be no significant adverse 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) of this EIAR.

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