SECTION 13: Land and Soil

13.1 Introduction

This Section describes the likely significant effects of the Proposed Development on land and soils (i.e. soils, geology and hydrogeology). It should be noted that land-use and land-take is assessed separately in **Section 16, Material Assets**. The following aspects are particularly relevant to the land and soils assessment:

- **Design**: Features of the proposed WwTP upgrades (particularly the proposed stormwater storage tank) will have to consider the particular ground conditions, groundwater regimes and the properties of the underlying soils and groundwaters to ensure that these do not have any deleterious effects.
- **Construction**: Excavations both above and below the water table will require special consideration in terms of both the stability of the excavations and the logistics behind facilitating the works, i.e. dewatering.
- **Operation:** Subsoils, bedrock and groundwater will not have any impact upon the Proposed Development once operational.

The soils and geology element of this assessment was drafted by Deirdre O'Hara. She is a Senior Geotechnical Engineer with over 24 years' experience in geotechnics from project inception to post construction stage. Working from the Castlebar Office, Deirdre is currently team leader for the geotechnical requirements of the Dublin, Cork and Castlebar offices, preparing the soils & geology Sections for major road projects, design and project management of large site investigation contracts and following through with this information to design earthworks for large infrastructure projects, including roads, bridges, railways, flood alleviation, water and wastewater pipelines and treatment plants and motorway service areas.

The hydrogeological element of this assessment was drafted by Kieran O'Dwyer who is a Technical Director with J. B. Barry and Partners and has over 40 years' experience in the field of environmental and hydrogeological consultancy. He holds a BE from UCD and is Member of the Institution of Engineers Ireland (MIEI) and International Association of Hydrogeologists (IAH). He is the overall project manager responsible for the coordination of this EIAR. He was formerly a director with K. T. Cullen and Co. Ltd (Environmental Consultants) and a Regional Director with WYG Ireland. Kieran has been responsible for the Land Soils and Hydrogeology element of numerous Environmental Impact Assessments (including TII tranche 4 motorway service areas (3 No.), NRA Tranche 4 Motorway Service Areas (5 No. oral hearings), Ringsend Wastewater Treatment Plant Upgrade Project and Greater Dublin Drainage (GDD) project and has presented specialist evidence at numerous planning oral hearings.

13.2 Assessment Methodology

13.2.1 General

The following section outlines the legislation and guidelines considered, and the adopted methodology for preparing this Section and undertaking the land and soils assessment.

13.2.2 Guidance and Legislation

The Land and Soils assessment was prepared in accordance with the following guidelines:

- Guidelines for the Preparation of Soils, Geology and Hydrogeology Sections of Environmental Impact Statements by the Institute of Geologists of Ireland (IGI, 2013);
- Guidelines on the information to be contained in Environmental Impact Assessment Report by the Environmental Protection Agency (EPA, 2022); and
- Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, National Road Authority (2009).

The 1996 Waste Management Act (as amended) is relevant to this section of the EIAR. In summary the act implements the EU Council Directive 99/31/EC (the Landfill Directive) on the landfilling of waste. Classification of waste material that may be taken off-site for disposal is based on the Commission Decision of 18th December 2014, amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC of the European parliament and Council (2014/955/EEC) [the List of Waste (LoW)]. These enable waste to be classified as either hazardous, non-hazardous or minor (either hazardous or non-hazardous). The legislation pertaining to groundwater and the Water Framework Directive which are also applicable for this portion of the EIAR is referenced in **Section 14, Water.**

13.2.3 Study Area

The primary assessment focuses on a study area of 250 m beyond the site boundary for the Proposed Development in accordance with the NRA Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (2009). Although, consideration was also given to potentially significant impacts which could arise at a greater distance away from the site.

13.2.4 Site Visit

Site walkovers and intrusive site investigation surveys were conducted where access was possible. Site specific details were recorded, which included observation of subsoil types, vegetation indicators, drainage details and general trafficability/access around the site.

13.2.5 Categorisation of Baseline

As part of the desk study that was undertaken to establish the baseline conditions (i.e. soils, geological and hydrogeological environment), the following sources of information were reviewed:

- Bing Maps (2022). Aerial photography;
- Environmental Protection Agency (2022). EPA Online web-viewer mapping[7] including;
- Water Bodies and Water Framework Directive;
- CORINE 2018 Mapping; and
- Soils and Subsoils Mapping.
- Google Earth (2022). Aerial photography;
- Geological Survey of Ireland (GSI) (2022). Online web-viewer mapping[8] including;
- Quaternary Geology & Geomorphology Mapping;
- Bedrock Geology Mapping;
- Geoheritage Feature Mapping
- Landslide Susceptibility Mapping;
- Karst Feature Mapping;
- Historic and Active Mine & Quarries Mapping;
- Groundwater Aquifer Classification Mapping;
- Groundwater Wells and Springs Mapping; and
- Groundwater Vulnerability Classification Mapping.
- Ordnance Survey Ireland (OSI) Geohive (2022) Online web-viewer mapping[9] including;
- 6 Inch Colour (1829-41)
- 6 Inch B&W (1829-41)
- 25 Inch B&W (1897-1913)

[7] Available at: https://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228, Accessed 30-05-2022
[8] Available at: https://gis.epa.ie/EPAMaps/, Accessed 30-05-2022
[9] Available at: https://webapps.geohive.ie/mapviewer/index.html, Accessed 30-05-2022

- Aerial photography (1995, 2000, 2005-2012, 2013-2018)

13.2.6 Project Specific Ground Investigations

Whiteford Geoservices Ltd on behalf of Uisce Éireann, Limerick WWTP Upgrade Projects Castletroy Wastewater Treatment Plant (WWTP), Site Investigation - Factual Report No. P2099-21C Dated - February 2022 (**Appendix 13B**).

13.2.7 Impact Assessment

The likely significant effects have been assessed by classifying the importance of the relevant attributes and quantifying the magnitude of any likely effects on these attributes. It should be noted that for the purpose of this assessment, likely significant effects and potential impacts are used interchangeably as this assessment has been undertaken drawn on the NRA guidelines (2009).

The assessment has also been undertaken in accordance with the EPA guidelines on the preparation of an EIAR (2022), along with the IGI guidance which outlines a 13-step methodology that is divided across four distinct elements:

- Initial Assessment (Steps 1 to 5);
- Direct and Indirect Site Investigation and Initial Impact Assessment (Steps 6 to 9);
- Mitigation Measures, Residual Impacts and Final Impact Assessment (Steps 10 to 12); and
- Completion of the Soils, Geological and Hydrogeological Sections of the EIAR (Step 13).

Initial Assessment

The 'Initial Assessment' presents a description of the past and present uses of the land across the study area which may have a bearing on the Proposed Development. This includes a detailed description of the nature of the ground conditions within the planning boundary based on existing literature as well as site specific and neighbouring site investigation data.

Direct and Indirect Site Investigation

The information gathered on the baseline environment during ground investigations corresponds to the second element of the methodology, 'Direct and Indirect Site Investigation and Studies'. **Section 13.4** provide discussion on the data available from the site-specific ground investigations (GI) carried out in relation to the Proposed Development. This element will conclude with a detailed impact assessment.

Mitigation Measures, Residual Impacts and Final Impact Assessment

The outcome from examining this available data is a Conceptual Site Model (CSM). The CSM is a summary of geological conditions beneath the Proposed Development that considers the likely significant effects of the Proposed Development.

Completion of the Soils, Geological and Hydrogeological Sections of the EIAR

This section has been prepared iteratively whilst undertaking the first three elements. Upon finalisation of the preceding steps, this information has been documented accordingly (i.e. as part of this Section) which corresponds to the final element of the methodology 'Completion of the Soils, Geological and Hydrogeological Sections of the EIAR'.

13.2.8 Impact Assessment Methodology.

The existing baseline environment is described in terms of its attributes. Data were gathered from desk studies, site visits and public consultation.

- Importance criteria were selected for attributes that reflect the hydrological and hydrogeological environments. The attribute importance was evaluated on the basis of the existing baseline

data and the criteria in Table 13.1: Criteria Rating for Attribute Importance – Soils and Geology, and Hydrogeology (NRA, 2009).

- The impacts of the Proposed Development (during both the Construction Phase and Operational Phase) on these attributes were described and considered in terms of duration, the proportion of the attribute that was impacted. The magnitude of the impact was assessed based on the criteria described in Table 13.2: Rating Criteria for Estimation Magnitude of Impact on Geological and Hydrogeological Attributes (NRA, 2009) Rating Criteria for Estimation Magnitude of Impact on Geological and Hydrogeological Attributes.
- The significance of the impact was then assessed using the criteria in Table 13.3: Rating Significance of Impacts (NRA, 2009)
- Mitigation measures to minimise these impacts were proposed and the residual impacts following mitigation were then reassessed.

Table 13.1: Criteria Rating for Attribute Importance – Soils and Geology, and Hydrogeology (NRA, 2009)

Importance	Criteria	Typical Examples	
		Soils and Geology	Hydrogeology
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. SAC or SPA status.
Very high	Attribute has a high quality or value on a regional scale.	Geological feature rare on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource.	Regionally Important Aquifer with multiple wellfields. 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.	Contaminated soil on site with previous heavy industrial usage Large recent landfill site for mixed wastes. Geological feature of high value on a local scale (County Geological Site). Well drained and/or highly fertility soils. Moderately sized existing quarry or pit.	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 Examples	
		Soils and Geology	Hydrogeology
		Marginally economic extractable mineral resource.	
Medium	Attribute has a medium quality or value 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.	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.	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.	Poor Bedrock Aquifer. Potable water source supplying <50 homes.

Table 13.2: Rating Criteria for Estimation Magnitude of Impact on Geological and Hydrogeological Attributes (NRA, 2009)

Magnitude	Criteria	Typical Examples	
		Soils and Geology	Hydrogeology
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.	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 >2% annually.
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.	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.

Magnitude	Criteria	Typical Examples	
		Soils and Geology	Hydrogeology
		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.	Potential medium risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >1% annually.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute.	Loss of small proportion of future quarry or pit reserves. Removal of small part of geological heritage feature. Irreversible loss of small proportion of local high fertility soils and/or high proportion of local low fertility soils. Requirement to excavate / remediate small proportion of waste site. Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils.	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 >0.5% annually.
Negligible	Results in an impact on attribute but not of sufficient magnitude to affect either use or integrity.	No measurable changes in attributes.	Calculated risk of serious pollution incident <0.5% annually.
Minor Beneficial	Results in minor improvement of attribute quality.	Minor enhancement of geological heritage feature.	
Moderate Beneficial	Results in moderate improvement of attribute quality.	Moderate enhancement of geological heritage feature.	
Major Beneficial	Results in major improvement of attribute quality.	Major enhancement of geological heritage feature.	

Table 13.3: Rating Significance of Impacts (NRA, 2009)

Importance Of Attribute	Magnitude Of Impact			
	Negligible	Small Adverse	Moderate Adverse	Large Adverse
Extremely High	Imperceptible	Significant	Profound	Profound
Very High	Imperceptible	Significant/ Moderate	Profound/ Significant	Profound
High	Imperceptible	Moderate/ Slight	Significant/ Moderate	Profound/ Significant
Medium	Imperceptible	Slight	Moderate	Significant
Low	Imperceptible	Imperceptible	Slight	Slight/Moderate

13.3 Baseline Conditions

13.3.1 Introduction

As noted in **Section 13.2.7**, the existing soils, geology and hydrogeology in the study area have been interpreted from both desk study information and from project-specific site investigations. The current baseline represents the 'Do Nothing Scenario' and a conservative approach assumes no major changes to the baseline condition of the site over time.

13.3.2 Site Location

Castletroy WwTP is situated on the banks of the Lower River Shannon, approximately 3km north-east of Limerick City, adjacent to the University of Limerick campus. The site is bordered by the Lower River Shannon to the north, a vegetive buffer of trees and parkland to the east, and a University of Limerick car park and the rowing club facilities to the south and west, respectively (See Figure 13-1 below). The proposed works are within the site of the existing WwTP and as such, the character of the site is considered urban/developed.

Figure 13-1: Site Location Plan

13.3.3 Topography

The topography of the site is characterised as being locally flat to slightly mounded. Elevations across the site range from a minimum of 5.7 mOD at the perimeter to a maximum of 7.2 mOD towards the centre. The wider topography in the region is similar.

13.3.4 Quaternary Geology

Quaternary geology are superficial deposits of quaternary-aged material which overlie the bedrock geology. The GSI's quaternary geology maps indicate the site predominantly underlain by estuarine silts and clays. A secondary unit of gravels derived from limestone is also shown along the southern boundary of the site.

This unit is also depicted as a feature within the GSI's geomorphology mapping and is described as a glacial deposit of Hummocky Sand and Gravel.

The CORINE 2018 landcover mapping show the site and most of the study area as comprising Artificial Surfaces (CORINE 2018 code: 121), described as industrial, commercial and transport units. The remaining minor areas present within the 250m study area include Agriculture (CORINE 2018 code: 231) pastures located across of the river to the north and (inland) Wetlands (CORINE 2018 code: 411) to the southwest. The surrounding areas, beyond the study zone, are dominated by Artificial Surfaces (CORINE 2018 code: 112) described as discontinuous urban fabric.

EPA subsoil mapping is consistent with above, showing the study area to comprise units of Man Made underlain by Estuarine Sediments (silts/clays) and a localised deposit of Glaciofluvial sands and gravels.

A copy of the quaternary geology mapping is reproduced as **Map Figure 13-1** in **Volume 3 Appendix 13A** of this EIAR.

13.3.5 Bedrock Geology

The GSI's bedrock geology maps (1:100k scale) indicate the site is underlain by undifferentiated Visean Limestones. Other bedrock units in the vicinity of the site include Rathkeale Formation, Lough Gur Formation, Waulsortian Limestones and volcaniclastic rocks.

A copy of the bedrock geology mapping is reproduced as **Map Figure 13-2** in **Volume 3, Appendix 13A** of this EIAR.

13.3.6 Economic Geology

There are currently no registered quarries in proximity to the study area. The closest commercial quarry sites are Gooig Pit and Belcar Quarry, located approximately 8.0 km from the site.

13.3.7 Geohazards

A review of the GSI karst feature mapping indicates there are no karst features within the study area. The closest recorded karst features include a swallow hole (3.7 km from the site) and two turloughs (8.8 km from the site), located in the townlands of Mountcatherine and Ballycummin, respectively.

A review of the GSI landslide susceptibility mapping shows the site and surrounding areas are designated low, or inferred low, risk of landslide susceptibility. For completeness, a copy of the landslide susceptibility mapping is reproduced as **Map figure 13-3** in **Volume 3, Appendix 13** A of this EIAR.

13.3.8 Geological Heritage

A review of the mapping data associated with the GSI Report titled Geological Heritage of County Limerick (Meehan et al., 2021), indicates there are no County Geological Sites (CGS) identified within the study area. The closest geological heritage feature to the proposed site is located approximately 6.6 km to the southwest, which consists of a good representative exposure of carboniferous limestone within a road cutting along the N18 Limerick Southern Ring Road near Junction 2.

The Geological Heritage Sites outside the study area are not considered sensitive to the development due to their distance from the Proposed Development site.

13.3.9 Historical Land Use

The Proposed Development is located within the site of the existing Uisce Éireann Castletroy WwTP which has been in place since the early 1990s. A review of the available historical mapping and aerial photographs using geohive.ie (accessed 20/10/2022) indicate the site prior to the WwTP was used for agricultural pasture.

13.3.10 Contaminated Land Potential

The ground investigation carried out by Whiteford Geoservices Ltd, identified deposits of made ground across the site which extended to a depth of up to 2.6 m below existing ground. While no visual and olfactory observations relating to contamination were made, the made ground deposits were described as containing concrete, plastic, timber fragments and steel rebar. These components are consistent with construction and demolition (C&D) waste. While this material is typically considered chemically inert, further environmental sampling and testing of the made ground will be required to ensure the excavated spoil is appropriately disposed of to the correctly licenced facility.

13.3.11 Hydrogeology

Groundwater flow in the bedrock aquifers is expected to be concentrated in upper fractured and weathered zones. Available data from site investigations indicate groundwater levels are approximately 4-5 m below existing ground level. Groundwater flow directions are expected be a generally flow towards the Lower River Shannon where it will discharge as baseflow. There is likely a direct hydraulic connection between the saturated gravel deposits and the water in the river. The flow will be from the gravels to the river. In areas where the hydraulic connection between bedrock groundwater and surface waters is low due to low permeability deposits, groundwater flow paths are likely to be longer and to be parallel, rather than at an angle, to the rivers.

Groundwater Wells and Springs

There are no source protection areas associated with groundwater protection schemes. There is no public water supply well (or group scheme wells) within 1.5 km. The site also does not lie within any source protection area associated with groundwater protection schemes.

A review of the GSI Wells and Springs feature mapping identified several wells in the vicinity (1.5 km) of the study area. These are summarised in Table 13.4: GSI Groundwater Well Data and illustrated on **Map Figure 13-4** in **Volume 3, Appendix 13A** of this EIAR.

Table 13.4: GSI Groundwater Well Data

No.	GSI Name	Well Type	Townland	Source Use	Yield Class	Yield (m3/day)
1	1415SEW001	Borehole	Newcastle	-	Moderate	54.5
2	1415SEW065	Borehole	Gilloge	Other	-	7.0
3	1415SEW064	Borehole	Gilloge	Other	-	13.1
4	1415SEW063	Borehole	Gilloge	Other	-	15.2
5	1415SEW062	Borehole	Gilloge	Other	-	16.4

Groundwater Aquifers

The bedrock aquifer underlying the study area and the wider surrounding region is classified as Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive. There are other minor areas classified as Ll - Locally important aquifer which is moderately productive only in local zones.

A copy of the groundwater aquifer mapping is reproduced **as Map Figure 13-5 in Volume 3, Appendix 13A** of this EIAR.

Groundwater Vulnerability

The GSI have developed a system to classify aquifer vulnerability as shown in Table 13.5: GSI Vulnerability Mapping Guidelines.

It must be noted that groundwater vulnerability classification is not a measure of the impact on groundwater quality but rather the degree of protection afforded to the underlying aquifer and consequently the risk to the groundwater quality in the event of a release of a contaminant. The GSI classification of the vulnerability of an aquifer is based on the thickness and the permeability of overburden. The greater the thickness and permeability, the greater the protection to the groundwater in the underlying aquifer. Aquifer vulnerability is a measure of the likelihood with which the groundwater could be contaminated by human activity. Aquifer vulnerability depends on the intrinsic geological and hydrogeological characteristics of the aquifer. For example, bedrock with a thick, low permeability, clay-rich overburden is less vulnerable than bedrock with a thin, high permeability, gravelly overburden.

Bedrock aquifer vulnerability under the site has been classified by the GSI as low. The vulnerability of the Lg gravel aquifer is likely to be highly dependent on the thickness of the overlying soil and the depth to groundwater. The results of the site investigations carried out confirmed this classification (**Section 14.4.2**).

A copy of the GSI groundwater vulnerability mapping is reproduced as **Map Figure 13-6 in Volume 3, Appendix 13A of** this EIAR.

Table 13.5: GSI Vulnerability Mapping Guidelines

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High Permeability (e.g. sand/gravel)	Medium Permeability (e.g. sandy subsoil)	Low Permeability (e.g. clayey subsoil, clay, peat)	Sand/gravel aquifers only	(<30m radius)
	0-1 m	0-1 m	0-1 m	0-1 m	
Extreme (E)	1-3.0 m	1-3.0 m	1-3.0 m	1-3.0 m	-
High (H)	>3.0 m	3.0-10.0 m	3.0-5.0 m	>3.0 m	N/A
Moderate (M)	N/A	>10.0 m	5.0-10.0 m	N/A	N/A
Low(L)	N/A	N/A	10.0 m	N/A	N/A

Notes: N/A = not applicable

Precise permeability values cannot be given at present.

Release of point contaminants assumed to be 1-2 m below ground surface.

*X=rock at or near surface, also associated with a point recharge feature and for a 15m radius around a swallow hole, and 10m buffer of a sinking stream

Groundwater Recharge

The GSI Groundwater recharge map across the area indicates low recharge rates to the bedrock aquifers across the entire area. The ability of the bedrock to accept recharge is based generally on the permeability of the weathered zone of bedrock likely extending 3.0 - 5.0m below the bedrock surface. This is due to the fact that the bedrock offers very little primary porosity with storage occurring predominantly within fractured and weathered zones. Recharge caps are applied to the Locally Important and Poor Aquifers due to their inability to accept large volumes of water. The recharge to the Locally Important aquifer is in the order of 100 to 200mm/year. A copy of the GSI groundwater recharge mapping is reproduced as **Map Figure 13-7 in Volume 3, Appendix 13A** of this EIAR.

Groundwater Dependent Ecosystems

The site is surrounded by the Lower River Shannon SAC which covers the Lower Shannon Estuary. Further details on the conservation areas impacted in this development are provided in **Section 11, Biodiversity**. Groundwater flowing beneath the site will discharge to the Shannon as base flow. The contribution of base flow from the site to the Shannon will be extremely low in comparison to the overall Shannon Catchment groundwater contribution to base flow.

13.3.12 Initial Assessment of Attribute Importance

The criteria for rating site importance of a geological feature is based on the Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National project site Schemes published by the NRA (2009) which is reproduced in the IGI guidelines. Initial assessment is based on the findings of the information listed above. This rating was used to create Table 13.6: Initial Assessment of Attribute Importance..

Table 13.6: Initial Assessment of Attribute Importance.

Feature	Importance	
	Ranking	Justification
Loss of overburden	Low	Relatively small area and of low commercial value
Overburden sealing	Low	Volume of material for removal is low on local scale
Excavation of soft soils	Low	Volume of soft alluvial soil/peat is small
Impact of dewatering	Medium	Dewatering volumes anticipated to be relatively small/moderate due to the permeability of the underlying bedrock; inflow from gravels limited by use of physical cut-off barriers (Assume piles penetrate gravel and into rock)
Impact on bedrock aquifer	Medium	Locally Important Aquifer
Impact on groundwater flow and level in aquifer	Medium	Groundwater flow may be affected temporarily on a local scale.
Pollution from Construction Activities	Low	Potential pollution is low on a local scale

13.4 Direct and Indirect Site Investigation and Studies

13.4.1 Ground Investigation

A ground investigation was carried out to establish subsurface conditions at the proposed project site by Whiteford Geoservices Ltd in 2021. A summary of the ground investigation carried out is provided in Table 13.7.

Table 13.7: 2021 Ground Investigation Summary

Contractor	Description of Investigation	Details of Investigation

Whiteford Geoservices Ltd	Limerick WWTP Upgrade Projects Castletroy Waste Water Treatment Plant (WWTP) Site Investigation – Factual Report	3 No. Cable percussion boreholes 2 No. Rotary cored follow-on boreholes 3 No. Trial pits 1 No. Window sample 2 No. Dynamic probes 21 No. Standard penetration tests 2 No. Standpipes

Fieldwork for the geotechnical investigation was carried out between July 2021 and December 2021 by Whiteford Geoservices Ltd. An extract from the GI layout plan is shown in Figure 13-2 below.

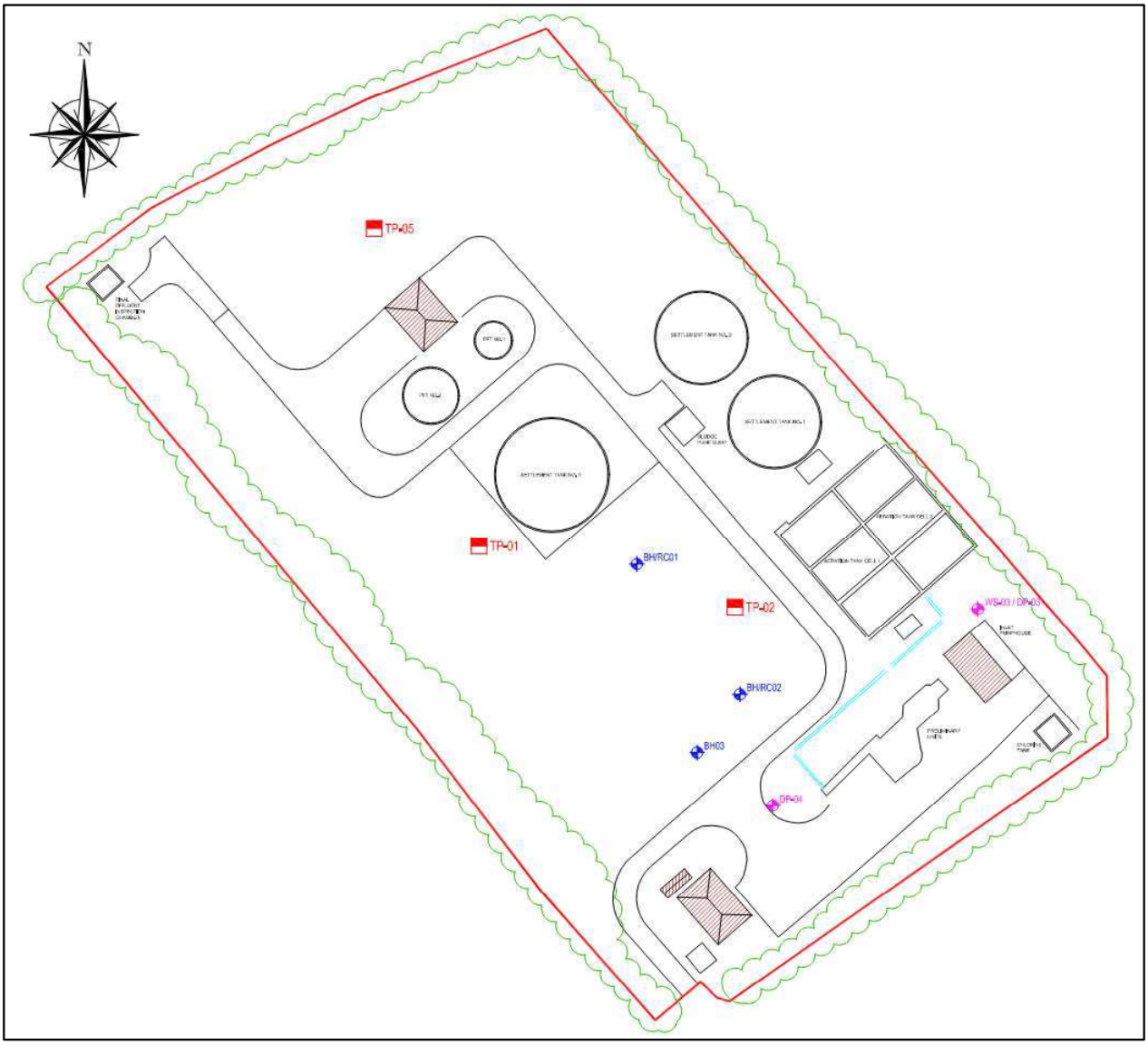

Figure 13-2: Ground Investigation Layout Plan

13.4.2 Encountered Ground Conditions

Topsoil

Topsoil was encountered across all the exploratory holes ranging in thickness from 0.2 to 0.4 m, with an average thickness of 0.3 m.

Made Ground

Made Ground was encountered in all exploratory holes ranging in thickness from 1.25 to 2.3 m, with an average thickness of approximately 1.7 m. It is described as firm, brown, slightly sandy, very gravelly CLAY with many sub-angular to sub-rounded cobbles and boulders and occasional concrete, plastic, timber, and steel re-bar. The latter components typical of Construction & Demolition (C&D) waste.

Peat

Peat was encountered in all boreholes underlying, or interbedded with, the soft silt and clay at depths between 3 and 4 m bgl. The strata ranged in thickness from 0.6 to 1 m, with an average of 0.8 m. It is described as very soft, blackish brown PEAT.

Soft silt and clay

Soft silt and clay were encountered in all the exploratory holes underlying made ground at depths of between 1.5 and 2.5 m bgl. The strata ranged in thickness from 0.7 to 2.3 m (reoccurring sequence, interbedded with PEAT), with an average of 1.4 m. It is described as soft, dark grey, slightly sandy, slightly gravelly SILT / CLAY with occasional sub-angular to sub-rounded cobbles.

Granular Glacial Till

Granular glacial till was encountered in all the exploratory holes underlying peat / soft silt and clays and overlying cohesive glacial till or bedrock. The top of the unit ranged from 4.5 to 5 m bgl, with a strata thickness ranging from 4 to 5.4 m.

The granular glacial till is generally described as loose to very dense, grey/brownish grey, silty, slightly sandy, clayey GRAVEL with many/occasional cobbles and boulders. Sand is described as fine to coarse, gravel is described as fine to coarse, angular to sub-rounded of mixed lithologies. The majority of this material will remain in-situ.

Cohesive Glacial Till

Cohesive glacial till was encountered in BH/RC02 at a depth of 9 to 11 m bgl underlying the granular glacial till, just above rockhead. It is described as very stiff to hard, brownish grey, slightly sandy, very gravelly CLAY with many cobbles and boulders. This material will remain in-situ.

Bedrock

The bedrock encountered at the site is described as weak to medium strong, fine grained, LIMESTONE. Rotary cored boreholes, RC01 and RC02, reported top of rock at depths of 10.4 and 11 m bgl, respectively. Rotary coring extended to maximum depth 25.1 m bgl.

The upper surface of the rockhead is described as distinctly weathered and closely fractured, tending to less weathered and increased fracture spacing with depth. Laboratory testing reports the UCS rock strength to range from 19 to 42 MPa, with an average value of 28 MPa. Rock excavation is not envisaged as part of the development works.

13.5 Likely Significant Effects

13.5.1 Do Nothing Scenario

In accordance with EC Guidance and after reviewing the baseline data, the ‘do nothing’ scenario (i.e. if nothing is done) will result in no effect on the land and soils. Also, this situation is not likely to change over time and the likely significant effect on the land and soils can be considered negligible.

13.5.2 Assessment of Effects during Construction

The potential effects of the Proposed Development on the geological features identified are listed below and discussed in the following sections thereafter:

- Loss of overburden
- Sealing of overburden
- Excavation of soft soils
- Impact of dewatering
- Impact on bedrock aquifer
- Pollution from Construction Activities

Table 13.8: Summary of Impacts on Geological Attributes

Feature	Importance		Magnitude of Impact		Significance of Impact
	Ranking	Justification	Ranking	Justification	
Loss of overburden	Low	Relatively small area and of low commercial value	Small Adverse	Limited excavation and disposal. Excavation footprint minimised through construction practices	Imperceptible
Sealing of overburden	Low	Volume of material for removal is low on local scale	Small Adverse	Limited excavation and disposal	Imperceptible
Excavation of soft soils	Low	Volume of soft alluvial soil/peat is small	Small Adverse	Only a small proportion soils beneath the tank foundations will require excavation	Imperceptible
Impact on bedrock aquifer	Medium	Locally Important Aquifer	Negligible	Excavation in overburden only	Imperceptible
Impact of dewatering	Medium	Dewatering volumes anticipated to be relatively small/moderate due to the permeability of the underlying bedrock; inflow from gravels limited by use of physical cut-off barriers (Assume piles penetrate gravel and into rock)	Small Adverse	Localised dewatering for a relatively short duration	Slight
Pollution from construction activities	Medium	Potential pollution is low on a local scale	Small Adverse	Limited construction traffic and construction activities	Slight

Loss of Overburden

It is expected that the topsoil and overburden at the proposed stormwater storage tank site will be excavated to allow for construction of the proposed works and hardstanding for vehicular access. During the storage and transport of excavated material off-site there is the potential for silt or mud to enter adjacent water

courses. Given the relatively small quantity which will be removed, it is not considered to be a resource of any regional significance.

The overburden material is generally comprised of made ground overlying soft silt and clay. These materials are of low commercial value. The materials are not considered suitable for re-use as an engineered fill without further mechanical or chemical (lime) treatment. It is anticipated that excavated topsoil will be reused for landscaping throughout the site, where possible.

Made Ground with evidence of C&D waste was encountered during the site investigation. Any waste material encountered during construction, will be tested and removed to a suitably licensed facility. See **Section 15, Resource and Waste Management**.

The assessed importance is low with magnitude of impact being small adverse, resulting in a rating of significance of the impact as imperceptible (NRA, 2009).

The rating significance of the impact is of neutral quality, of imperceptible significance, irreversible and of permanent duration (EPA, 2022)

Sealing of Overburden

During earthworks, heavily loaded large earthmoving vehicles will travel through the proposed storm water tank and WwTP site, causing ground vibrations, unwanted compaction and disturbance of natural ground on unfinished surfaces. These works are expected to have a low importance given that the volume of the material for removal is low on a local scale.

The assessed importance is low given that the volume of the material for removal is low, magnitude of impact is small adverse, resulting in a rating of significance of the impact as imperceptible (NRA, 2009).

The rating significance of the impact is of neutral quality, of imperceptible significance, reversible and of permanent duration (EPA, 2022).

Excavation of Soft Soils

Limited soft soils will require excavation and replacement when encountered at the base of excavations for the proposed stormwater storage tank. These are expected to be localised and minor in extent. Given the relatively small quantity of soils, it is considered to be a small adverse impact that does not have any regional significance.

The assessed importance is low with magnitude of impact being small adverse, resulting in a rating of significance of the impact as imperceptible (NRA, 2009).

The rating significance of the impact is of neutral quality, of imperceptible significance, irreversible and of permanent duration (EPA, 2022).

Impact on Bedrock Aquifer

The bedrock is classified as a Locally Important Aquifer which is generally moderately productive. Based on the currently proposed excavation levels, excavation within the bedrock in not envisaged to construct the stormwater storage tank and as such, no impact is anticipated. Dewatering is dealt with separately.

The assessed importance is medium with magnitude of impact being negligible, resulting in a rating of significance of the impact as imperceptible (NRA, 2009).

The rating significance of the impact is of neutral quality, of imperceptible significance, irreversible and of permanent duration (EPA, 2022).

Impact of Dewatering

Due to the relatively high-water table in the area (approximately 3-4m below ground level), dewatering works are envisaged. However, the utilisation of physical cut-off barriers in the form of earth retention systems (e.g. sheet or secant piling), will assist in reducing the groundwater inflows and as such, limited the amount of groundwater pumping required.

Discharge from the dewatering process will be passed to a suitably sized settlement pond or a proprietary silt removal system located within the working area, before discharge to the Lower River Shannon or the local sewer network. Any discharge to either sewer or watercourse would be subject to a discharge licence. Dewatering is considered to be a small adverse impact and the significance of this impact is moderate/slight.

The assessed importance is medium with magnitude of impact being small adverse, resulting in a rating of significance of the impact as slight (NRA, 2009).

The rating significance of the impact is of neutral quality, of slight significance, reversible and of temporary duration (EPA, 2022)

Pollution from Construction Activities

Potential impacts during the construction phase include the potential for leakage or spillage of construction related materials on site. For example, raw or uncured concrete and grouts, wash 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. Similarly accidental spillages have the potential migrate downwards into the underlying groundwater. The low vulnerability will restrict the infiltration of such contaminants. The natural groundwater flow in the shallow sediments will be towards the Lower River Shannon where it discharges as baseflow.

The assessed importance is medium with magnitude of impact being small adverse, resulting in a rating of significance of the impact as slight (NRA, 2009).

The rating significance of the impact is of negative quality, significant but unlikely, reversible and of temporary duration (EPA, 2022)

13.5.3 Assessment of Effects During Operation

Soil and Groundwater Pollution

The potential impacts on land and soils during the operational phase will be limited to accidental spillage of potentially polluting substances including fuel, oils, paints, incoming wastes and raw materials. All potential impacts on land and soils from the operation of the Proposed Development will be of Slight significance.

The pipes and tanks will convey and store wastewater and storm water which are potentially polluting. The pipes and tanks will be constructed in accordance with best practice measures and constructed with appropriate engineering supervision. Consequently, the risk of a leak from the Proposed Development impacting on soils, geology and hydrogeology is considered to be low. As such, effects on soils, geology and hydrogeology will be negligible and the effect of the Proposed Development is considered to be Imperceptible during operation.

The assessed importance is medium with magnitude of impact being small adverse, resulting in a rating of significance of the impact as slight (NRA, 2009).

The rating significance of the impact is of negative quality, significant, reversible and of temporary duration (EPA, 2022)

13.6 Mitigation Measures and Monitoring

13.6.1 Mitigation During Construction

General

The proposed construction techniques shall comply with the requirements of statutory bodies (Building Control Amendment Regulations, Health Service Executive inspections, Uisce Éireann inspections and compliance with Employers Requirements).

Precautionary measures will be taken to contain any areas within the planning boundary at risk of contaminated run-off in addition to the following:

- Potential pollutants shall be adequately secured against vandalism and will be provided with proper containment according to the relevant codes of practice. Any spillages will be immediately contained, and contaminated soil shall be removed from the Proposed Development and properly disposed of in an appropriately licensed facility.
- Dust generation shall be kept to a minimum through the wetting down of haul roads as required and other dust suppression measures.
- Any stockpiles of earthworks and site clearance material shall be stored on impermeable surfaces and covered with appropriate materials.
- Silt traps shall be placed in gullies to capture any excess silt in the run-off from working areas.
- Soil and water pollution will be minimised by the implementation of good housekeeping (daily site clean-ups, use of disposal bins, etc.) and the proper use, storage and disposal of these substances and their containers.

Removal of potentially contaminated soils

Excavations in made ground will be monitored by an appropriately qualified person to ensure that any evidence of contamination (e.g. asbestos, hydrocarbons, etc) encountered are identified, segregated and appropriately stored in an area where there is no possibility of run-off generation or infiltration to ground or surface water drainage. Care will be taken to ensure no cross-contamination with clean soils elsewhere throughout the site.

The contractor will be required to carry out a waste characterisation of the material that will be taken off site for disposal. A waste acceptance criteria (WAC) analysis and asbestos levels should be determined on any material that will be taken off site for disposal. All wastes in the European Waste Catalogue are classified by a unique 6-digit code. In this case (waste soil/stones), two List of Wastes (LoW) Codes are applicable to material that may be taken off site for disposal during the construction phase:

- 17 05 03* -Soil and stones containing hazardous substances;
- 17 05 04 -Soils and stones other than those mentioned in 17 05 03.

Any soil samples that contain asbestos should be subjected to full quantification analysis. Uncontaminated soil materials can be brought to a soil recovery facility. Soil recovery facilities are licensed to accept only uncontaminated natural soil and stone. Any materials exceeding soil trigger levels determined by *Table 3.3 - Summary of Maximum Concentrations and/or Trigger Levels in Soil & Stone for Soil Recovery Facilities* (EPA, 2020), or containing invasive species, will be disposed of at an appropriately licenced landfill facility.

The Site Manager will ensure that a Waste Management Plan is in place to ensure that these criteria are followed. The acceptance of this material at a licenced soil recovery facility will be subject to the approval of the facility operator.

Loss of Overburden

Excavated material will, where possible, be retained and reused on site as construction fill. It is anticipated that all of the excavated topsoil may be reused in landscaping throughout the site. Based on the ground

investigation data, the majority of the overburden material within the stormwater storage tank footprint is unlikely to be suitable for re-use as an engineered fill without additional mechanical working (drying out) or chemical amelioration (lime or cement stabilisation).

If this is feasible, the appointed contractor will need to ensure acceptability of the material for reuse and oversee the appropriate handling, processing and segregation of the material. This material would have to be shown to be suitable for re-use and subject to appropriate control and testing according to the Earthworks Specification(s). These excavated soil materials will need to be stockpiled using an appropriate method to minimise the impacts of weathering. Care will be taken in reworking this material to minimise dust generation, groundwater infiltration and generation of runoff.

Sealing of Overburden

Earthworks haulage will be along agreed predetermined routes along existing national, regional and local routes. Where compaction occurs due to truck movements and other construction activities on unfinished surfaces, remediation works will be undertaken to reinstate the ground to its original condition. Where practicable, compaction of any soil or subsoil which is to remain in situ along the sites will be avoided.

Earthworks operations shall be carried out such that surfaces shall be designed with adequate falls, profiling and drainage to promote safe runoff and prevent ponding and flooding. Runoff will be controlled through erosion and sediment control structures appropriate to minimise the water impacts in outfall areas. Care will be taken to ensure that the bank surfaces are stable to minimise erosion.

Groundwater Quality

Excavated soils will be segregated and stored in an area where there is no possibility of runoff generation or infiltration to ground or surface water drainage. Should contaminated materials be encountered, care will be taken to ensure no cross-contamination with clean soils elsewhere throughout the site.

Groundwater Flow

Dewatering will be required for the construction below the groundwater table. Extracted groundwater would be passed to a suitably sized settlement pond or a propriety fines removal system, along with any other treatment as required by Limerick County and City Council before discharge to the Lower River Shannon, or local drainage network. Any discharge to either sewer or watercourse would be subject to a WWDA.

13.6.2 Mitigation During Operation

No mitigation has been proposed with respect to effects from operation of the Proposed Development in relation to land and soils.

13.6.3 Monitoring During Construction

Excavations in made ground will be monitored by an appropriately qualified person to ensure that any contaminated material is identified, segregated and disposed of appropriately. Any identified hotspots shall be segregated and stored in a bunded area where there is no possibility of runoff generation or infiltration to ground or surface water drainage. Care will be taken to ensure that the hotspot does not cross-contaminate clean soils elsewhere.

Any excavation shall be monitored during earthworks to ensure the stability of side slopes and to ensure that the soils excavated for disposal are consistent with the descriptions and classifications according to the waste acceptance criteria testing.

Ground settlement, horizontal movement and vibration monitoring will be implemented during the works to ensure that construction activities do not exceed the design limitations of nearby existing WwTP infrastructure.

Water quality monitoring will be carried out at all discharge points as per the requirements of the issued Wastewater discharge authorisations (WWDA)

13.6.4 Monitoring During Operation

Ongoing monitoring of the infrastructure for leaks shall be carried out during operation. If leaks are detected, the system should include measures for the management of any resulting contamination of the surrounding soils.

13.7 Residual Effects

An overall analysis of the impacts in light of the proposed mitigation measures concludes that all of the potential impacts (both construction and operational impacts) are predicted to be reduced to neutral quality, imperceptible significance.

13.7.1 Cumulative Effects

There are no projects or plans identified in proximity that have the potential to result in cumulative impacts with regards to Land and Soils.

13.8 References

British Standards Institution (1990) BS1377: Part 4 “Methods of test for soils for civil engineering purposes. Compaction-related tests”

British Standards Institution (2015) BS5930: “Code of practice for ground investigations”

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Department of Environment and Local Government, Environmental Protection Agency and Geological Survey of Ireland (1999) “Groundwater Protection Schemes document”

Department of Environment, Heritage and Local Government (2006) “Best Practice Guidelines on Preparation of Waste Management Plans for Construction and Demolition Projects”

Guidelines for the Preparation of Soils, Geology and Hydrogeology Sections of Environmental Impact Statements by the Institute of Geologists of Ireland (IGI, 2013)

Guidelines on the information to be contained in Environmental Impact Assessment Report by the Environmental Protection Agency (EPA, 2022)

Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, National Road Authority (2009).

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Geological Survey of Ireland (2018) Spatial Resource Mapping, GSI Spatial Resources Viewer, http://dcenr.maps.arcgis.com/apps/MapSeries/index.html?appid=a30af518e87a4c0ab2fbde2aaac3c228

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