5.0 LAND, SOILS, GEOLOGY AND HYDROGEOLOGY

5.1 INTRODUCTION

This chapter assesses and evaluates the potential impacts of the development on the land, soil, geological and hydrogeological aspects of the proposed development site and the surrounding area. In assessing likely potential and predicted effects, account is taken of both the importance of the attributes and the predicted scale and duration of the likely environmental effects.

5.2 METHODOLOGY

5.2.1 Criteria for rating of effects

This chapter evaluates the effects, if any, which the development will have on Land, Soils, Geology and Hydrogeology as defined in the Environmental Protection Agency (EPA) '*Draft Guidelines on the Information to be contained in Environmental Impact Assessment Reports*' (EPA, 2017) as well as in line with Article 94 and Schedule 6 of the Planning and Development Regulations 2001 (as amended) and Article 5 and Annex IV of the EIA Directive (2011/92/EU, as amended). The Draft EPA document entitled '*Advice Notes for Preparing Environmental Impact Statements*' (EPA, 2015) is also followed in this geological and hydrogeological assessment and classification of environmental effects. Due consideration is also given to the guidelines provided by the Institute of Geologists of Ireland (IGI) in the document entitled '*Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements*' (IGI 2013). Finally, the document entitled 'Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes' by the Transport Infrastructure Ireland (TII) formerly National Roads Authority (NRA) (TII, 2009) is referenced where the methodology for assessment of impact is appropriate.

The rating of potential environmental effects on the land, soil, geological and hydrogeological environment is based on the standard EIAR impact predictions table included in Chapter 1 which takes account of the quality, significance, duration and type of effect characteristic identified (in accordance with impact assessment criteria provided in the Draft EPA Guidelines (2017) publication).

The duration of each effect is considered to be either momentary, brief, temporary, short-term, medium term, long-term, or permanent. Momentary effects are considered to be those that last from seconds to minutes. Brief effects are those that last less than a day. Temporary effects are considered to be those which are construction related and last less than one year. Short term effects are seen as effects lasting one to seven years; medium-term effects lasting seven to fifteen years; long-term effects lasting fifteen to sixty years; and permanent effects lasting over sixty years.

The TII (2009) criteria for rating the magnitude and significance of impacts on the geological related attributes and the importance of hydrogeological attributes at the site during the EIA stage are also relevant in assessing the impact and are presented in Tables 1-5 in Appendix 5.1.

The principal attributes (and effects) to be assessed include the following:

- Geological heritage sites within the vicinity of/ within the perimeter of the proposed development site;
- Landfills, industrial sites in the vicinity of the site and the potential risk of encountering contaminated ground;
- The quality, drainage characteristics and range of agricultural use(s) of subsoil around the site;
- Quarries or mines in the vicinity and the potential implications (if any) for existing activities and extractable reserves;
- The extent of topsoil and subsoil cover and the potential use of this material on site as well as any requirement to remove it off-site as waste for disposal (D) or recovery (R) options;
- High-yielding water supply wells/ springs in the vicinity of/ within the site boundary to within a 2km radius and the potential for increased risk presented by the proposed development;
- Classification (regionally important, locally important etc.) and extent of aquifers underlying the site boundary area;
- Increased risks presented to the groundwater bodies by the proposed development associated with aspects such as, for example, the removal of subsoil cover, removal of aquifer (in whole or part thereof), spatial drawdown in water levels, alteration in established flow regimes, and changes in local/ regional groundwater quality;
- Natural hydrogeological/ karst features in the area and potential for increased risk presented by the activities at the site; and
- Groundwater-fed ecosystems and the increased risk presented by operations both spatially and temporally.

5.2.2 Sources of Information

Desk-based geological information on the substrata (both Quaternary deposits and bedrock geology) underlying the extent of the site was obtained through accessing databases and other public archives where available. Data was sourced from the following:

- Geological Survey of Ireland (GSI) - on-line mapping, Geo-hazard Database, Geological Heritage Sites & Sites of Special Scientific Interest, Bedrock Memoirs and 1: 100,000 mapping;
- Teagasc soil and subsoil database;
- Ordnance Survey Ireland - aerial photographs and historical mapping;
- Environmental Protection Agency (EPA) – website mapping and database information;
- National Parks and Wildlife Services (NPWS) – Protected Site Register; and
- Clare County Council - illegal landfill information.

Site-specific data was derived from the following sources:

- *Ground Investigation Report, Art Datacentre, Lands East of Ennis Town Co. Clare.* Ground Investigation Ireland (GII) (May 2021);
- *Report on the Geophysical Investigation for the Project Art Data Centre, Ennis, Co.* Clare. Apex Geophysics (Apex). Report Reference – AGP21033_Phase III_01. (January 2022).
- *Engineering Planning Report – Drainage and Water Services* - Art Data Centre. Clifton Scannell Emerson Associates, CSEA (January 2022);
- *Flood Risk Assessment -Art Data Centre*, CSEA (January 2022);

- *Construction Environmental Management Plan* - Art Data Centre, CSEA (January 2022);
- Various design site plans and drawings; and
- Consultation with site engineers/ planners/ architects.

5.2.2.1 Site Investigation Works

Site investigations were carried out by Ground Investigations Ireland (GII) during April-May 2021. These investigations included the following:

- Excavation of thirty-one (31) no. trial pits (TPs) across the proposed development area to examine existing soil conditions and whether any infill or imported material is present on site (maximum depths up to 3.30 metres below ground level (mbgl) with refusals on boulders or rockhead).
- Drilling of twenty-one (21) no. bedrock boreholes; (PBH periphery boreholes and BH geotechnical boreholes; 80 mm diameter, depths up to 25 mbgl to characterise the site in terms of subsoil cover, depth to bedrock, and prevalence of weathered and/ or competent bedrock spatially).
- Logging of the arisings from each trial pit in accordance with BS5930:2015, noting any field evidence of potential impact by hazardous substances.
- Collection of soil samples from each of the trial pit arisings including samples selected for laboratory analysis focusing on potential contamination and the classification of the materials for waste disposal options. Other soil testing included 47 no. soil samples selected for laboratory analysis for pH and sulphate as part of characterising the subsoil aggressivity to concrete, spatially.
- Waste Acceptance Criteria (WAC) sampling with an asbestos fibre survey of samples collected at selected trial pit locations.
- Collection of 4 no. groundwater samples for laboratory analysis -including for hydraulically up-gradient [control] sampling points (eastern site boundary) and down-gradient sampling points at the southwestern site boundary line.

The location of all completed trial pits and boreholes at which representative samples were collected is presented in Figure 5-1 Site Investigation Exploratory Hole Map (GII, 2021) below.

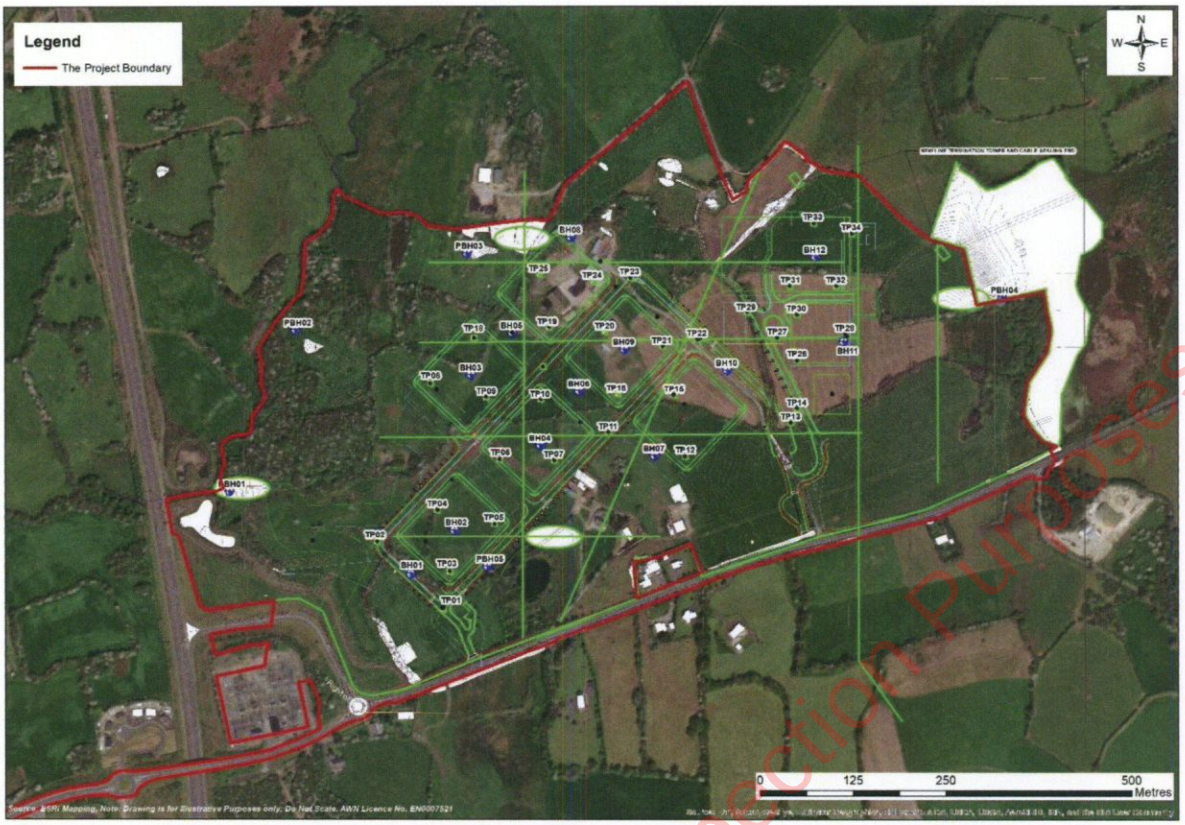

Figure 5-1 *Site Investigation Exploratory Hole Map (GII, 2021)*

Trial pit and borehole logs are included in the GII site investigation report which include a description of the lithologies observed in each excavation, depth to bedrock, refusals, type of bedrock and rock quality distribution (RQD) to borehole termination depth.

Representative samples were collected from arisings at trial pits and transferred directly into laboratory-supplied containers which were then clearly labelled to identify the sample location and depth (metres below ground level). Standard sampling techniques were used to collect the samples and designed to reduce the risk of any cross contamination between sampling events. Appendix 5.2 presents tables with the soil and groundwater analytical test results.

5.2.2.2 Geophysical Survey

APEX Geophysics Limited (AGL) carried out a geophysical survey in May-June 2021 as part of the ground investigation for the proposed development. The underlying objectives of the geophysical survey were to identify any potential underground karst conduits/ water-bearing strata within the overall study area including features which could potentially be discharging to Tooreen Lough and/ or to pond features located to the north, south and east of the site. In addition, the aims of the survey were to provide information on the subsurface conditions across the site. A summary of the geophysical interpretation is presented in Figure 5.15 below.

Further geophysical investigations were carried out in November 2021 (Phase II) & January 2022 (Phase III) for the proposed development to further examine the presence of karst features in selected areas. The objectives of the Phase II & Phase III geophysical survey were to examine the extent of the identified karst features / potentially water-bearing strata within the overall study area. Furthermore, to establish

any potential flow paths discharging to Tooreen Lough and/ or to pond and spring features located to the north, south and east of the site.

The geophysical findings along with the borehole data provides key information with regard to the interpretation of subsurface anomalies present across the site and how these may potentially interact with interpreted groundwater movement patterns. The geology identified provide input to the hydrogeological conceptual site model (CSM) cross sections presented in Figures 5.16-5.21.

5.3 RECEIVING ENVIRONMENT

The receiving environment is discussed in terms of land geology, soils, hydrogeology and site history including potential for existing and historical contamination.

5.3.1 General Description of the Site

5.3.1.1 Site Setting

The site comprises approx. 58 hectares (ha) and is located to the east of Ennis in the townland of Tooreen and Cahernalough, Co Clare. The lands are bordered to the south by the R352 (Tulla Road) and to the west by the M18 national route. The lands are traversed by a [Gas Networks Ireland, GNI] transmission gas pipeline and overhead powerlines connecting to the existing Ennis 110kv Substation that adjoins the western boundary.

The site location map for the proposed development is presented in Figure 5.2 below.

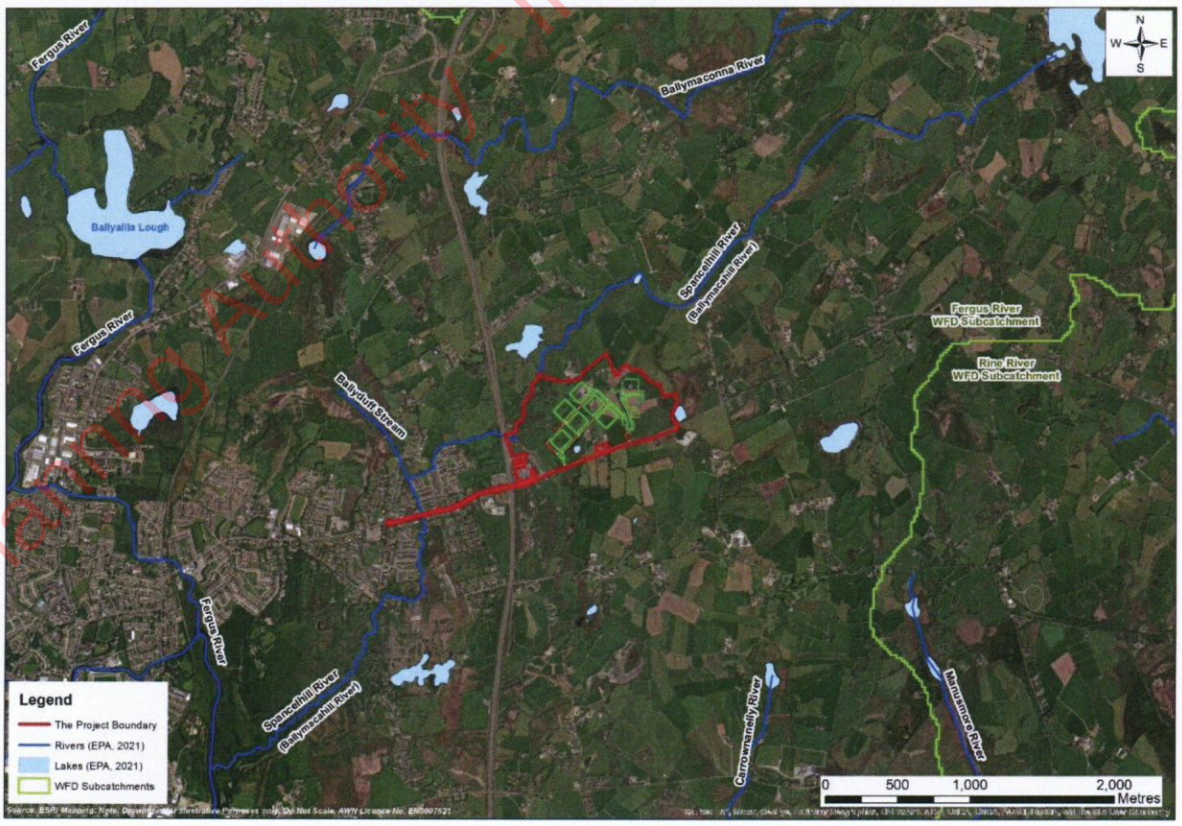

Figure 5-2 *Site Location with site layout (AWN, 2021)*

5.3.1.2 Land Use

The site is predominantly in agricultural use currently with the exception of a few residential properties. The site comprises of a series of irregularly shaped fields divided by hedgerows and ditches typical of an agricultural setting. The site contains a number of existing dwellings and farm outbuildings. A number of these will be retained and some demolished as part of the proposed site development.

Immediately beyond the southwest corner of the site boundary lies an existing ESB substation. The town of Ennis is located approx. 3.5 Km farther to the southwest. The western proposed development boundary is bounded by the M18 national route and the southern site boundary is bounded by the R352 road.

According to the EPA (2021) there are no licensed activities within the site boundary of the proposed development or directly adjacent to it. There are two licensed activities listed by the EPA as 'currently active' (i.e. west of the proposed development and located in Ennis, Gort Road Industrial Estate) as follows:

- Paclene Limited (P0144-01) -Licence issued in 2017; and
- Essidev S.A. (P0061-03) -Licence issued in 2015.

Both of these premises are licensed units and are located >3 Km downgradient (i.e. west) of the proposed development; there are no licensed activities located upgradient (i.e. east) of the proposed site.

Consultation with Clare County Council has confirmed that there are no known illegal/ historic landfills within 500 metres of the proposed site boundary.

Historical Ordnance Survey Ireland (OSi) maps (https://geohive.ie/) were examined for the purpose of an environmental due diligence. O.S. maps are available from 1830s-1930s (the historic 6" maps) and 1900 from the historic 25" maps. The historic maps indicate that the subject site was greenfield up to the present day (refer Figure 5-3 below).

There is no evidence to indicate industrial processes have been undertaken within the subject site boundary which appears to have always been used for agricultural purposes (for example grazing, storing cattle). This land use has not materially changed from the 1830s to 2005 and to present day (refer also Figure 5-4 below).

Figure 5-3 *Historic 6" mapping (Note: Site marked with red star; Source: OSi,)*

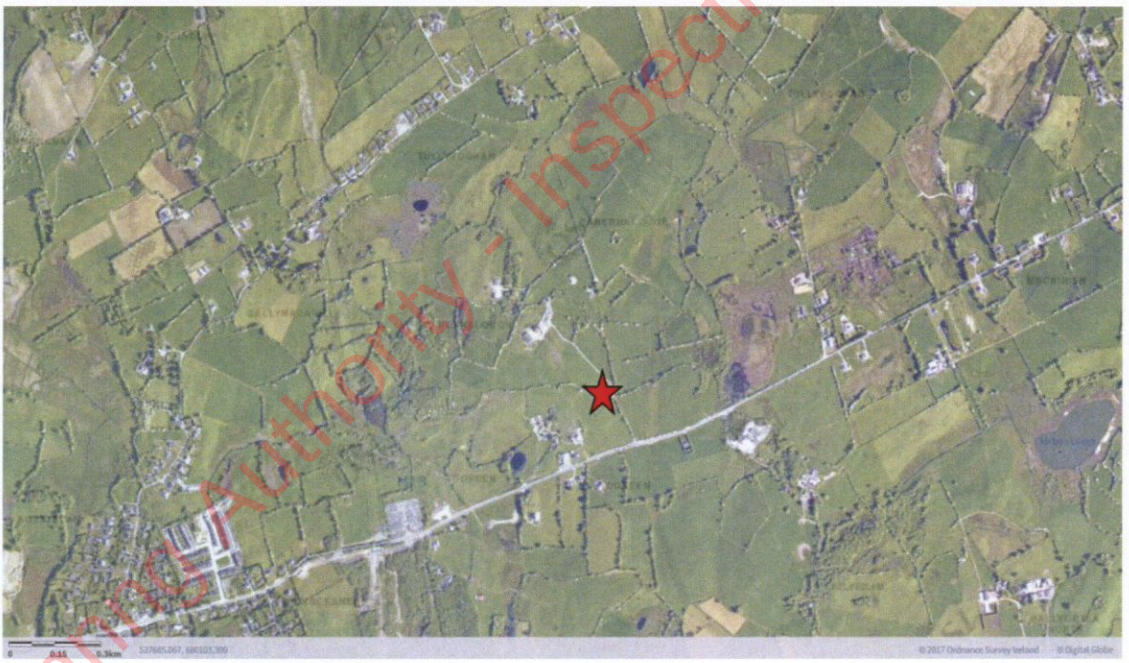

Figure 5-4 *Aerial 2005 Map (Site marked with red star; Source: OSi,)*

5.3.1.3 Topography

The topographical gradient across the development boundary is quite variable mostly due to the drumlin type features present. Overall, the ground level generally falls from east to west/ southwest with an elevation of approx. +15mOD (metres above Ordnance Datum) in the west and +46mOD in the east.

Additional detail on topographical gradients and general terrain elevations across the proposed development is presented in Chapter 6 Hydrology, Section 6.3.2.

5.3.1.4 Regional & Local Hydrology

Regional surface water drainage comprises the Ballymacahill River which runs to the north/ west of the development site boundary and which generally flows in a NE to S/SW direction. The river is also known as the Spancelhill (EPA, 2021) and converges with the River Fergus farther to the SW which in turn ultimately discharges into the Shannon Estuary.

Additional detail on the regional drainage (i.e. Ballymacahill River which converges with the River Fergus c. 3.0Km farther to the SW which subsequently discharges into the Shannon Estuary at the Lower River Shannon Special Area of Conservation (SAC)) and local surface water patterns (which comprise a feature lake, a number of ponds, swallow holes and spring discharges, the latter as streams to the main watercourse, Ballymacahill River) is discussed in Chapter 5 Hydrology, Section 6.3.3.

Regional and local hydrology is intrinsically connected to the hydrogeological setting within the proposed development.

5.3.2 Soils

The GSI/ Tegasc (2021) mapping shows that the soil type beneath the local area is composed of a range of lithologies. The principal soil types are described as follows:

- To the eastern boundary, the site is composed of AminPDPT - Poorly drained mineral soils with peaty topsoil, derived from mainly non-calcareous parent materials. Peaty gleys are included in this category.
- As the site extends to the west, the site is composed of BminDW - Deep well drained mineral soil derived from mainly calcareous parent materials. Grey, brown podzolics and brown earths (medium high base status) are included in this category and BminSW - Shallow well drained mineral soil, derived from mainly calcareous parent material which extends to the western boundary. Renzinas and lithosols are included in this category.
- A section of the southern boundary is composed of BminSRPT.

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

- FenPeat – which indicates wetland areas with organic material.
- AlluvMin – mineral alluvium.
- BminSP – shallow poorly-drained mineral soil, derived mainly from calcareous parent materials. Surface water gleys and groundwater gleys are included in this category.
- Lac - Lacustrine Deposits (undifferentiated).

Figure 5-5 below presents the soils map indicating the soil lithologies discussed above.

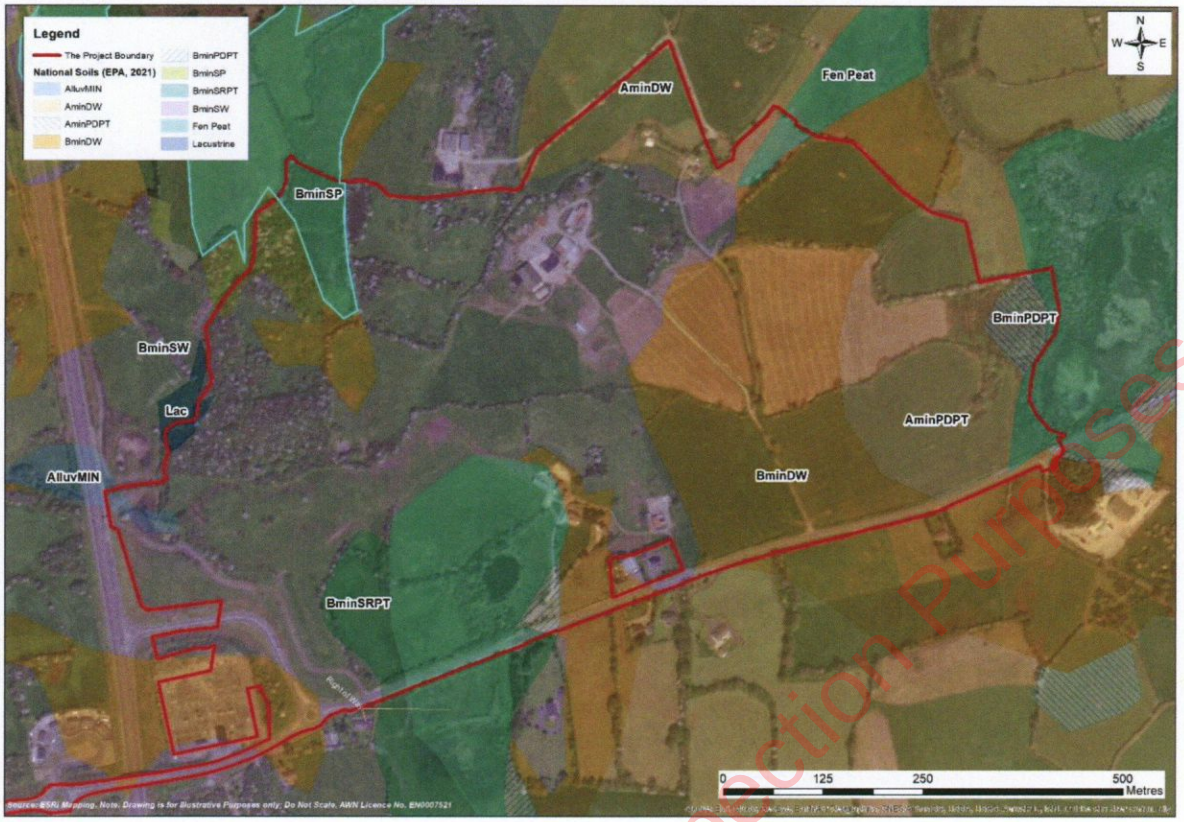

Figure 5-5 *Soils Map (Source: EPA/ Teagasc, 2021)*

5.3.3 Subsoils

The Quaternary geological period extends from about 1.5 million years ago to the present day and can be sub-divided into the Pleistocene Epoch, which covers the Ice Age period, and which extended up to 10,000 years ago and the Holocene Epoch, which extends from that time to the present day.

The GSI/ Teagasc mapping database of the subsoils in the area of the proposed development site indicates four (4) no. principal soil types, as shown in Figure 5-6 below. The subsoil types present across the site are:

- LIMESTONE till Carboniferous (TLs). A large section of the eastern boundary of the site is composed of limestone TILL. This till is made up of glacial CLAYs which are less permeable than alluvium subsoils.
- SANDSTONE till Devonian (TLs). A large section of the eastern and northern boundaries of the site are composed of sandstone TILL. This till is made up of glacial CLAYs which are less permeable than alluvium subsoils.
- Karstified bedrock outcrop or subcrop (KaRck). The majority of the western section of the subject site is composed of karstified bedrock. This indicates that the limestone bedrock is heavily karstified in this area and is close to the surface. Refer to Sections 5.3.4 & 5.3.6 below which describes the bedrock geology and aquifer vulnerability for the site and surrounding area.
- Fen Peat – which indicates wetland areas comprising organic material.

The EPA (2021) has classified this area as agricultural land used primarily for pasture farming activities.

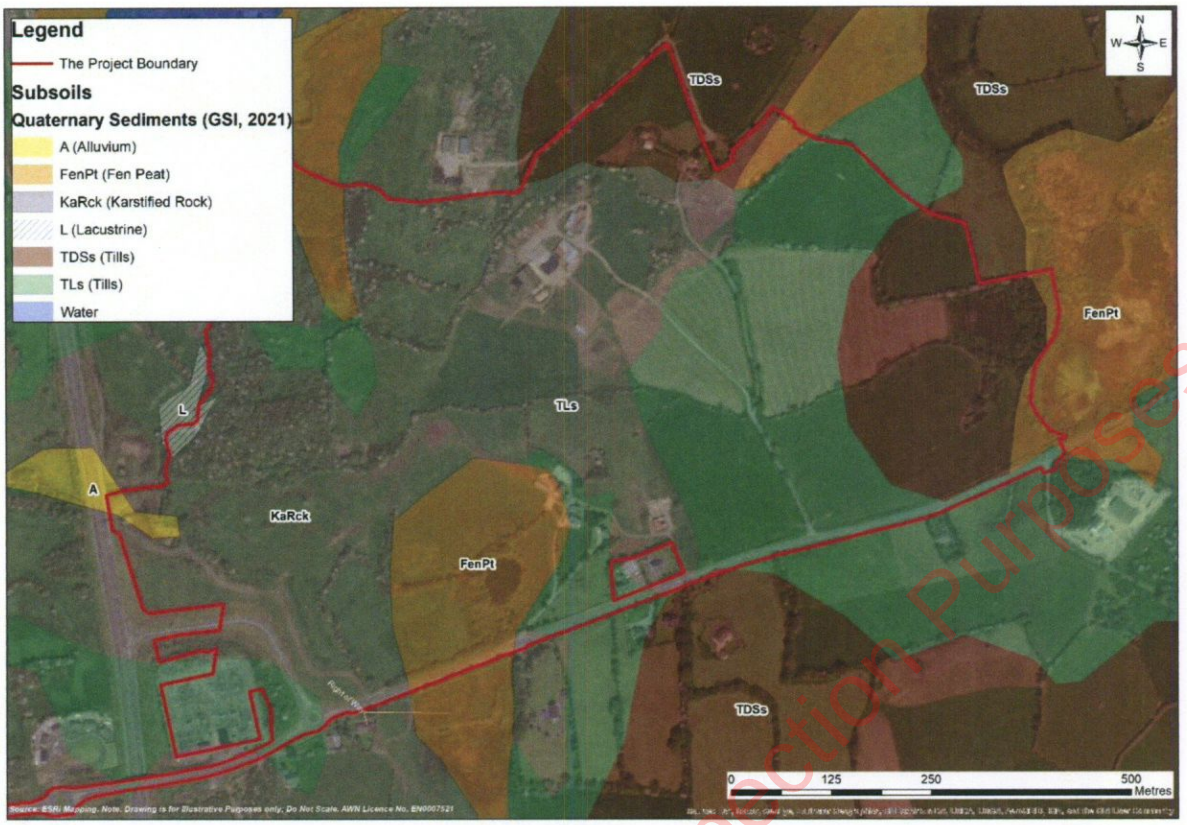

Figure 5-6 *Subsoils Map (Source: GSI, 2021)*

Recent investigations undertaken by GII confirm rockhead close to the surface within the west of the site and at local highs across the site. Generally, recorded depth to bedrock (dtb) increases towards the east. The depth of overburden varies to match this with sandy clayey GRAVELS reported to a depth of 2.00 metres below ground level (mbgl) noted along the western section; similar GRAVEL material is noted to 5.00 mbgl to the eastern section of the site (GII, 2021).

The geotechnical/ environmental site investigations were completed in April and May 2021 within the proposed development boundary in order to better characterise the subsoils, nature of the bedrock and where feasible local groundwater conditions. The thirty-four (34) no. trial pits (referenced as TP01 to TP34) were excavated using a 14-ton tracked excavator. The twenty-one (21) no. boreholes (referenced PBH01 to PBH05 & BH01 to BH13) were drilled using a rotary core rig to a depth between 5.0 mbgl to 25.0 mbgl. Water strikes are detailed in the trial pit logs, however due to the water flush drilling method used for the rotary coring there is no detail on groundwater strikes recorded on the borehole logs. The trial pit and borehole logs are available in the GII site investigation report. The soil profile is highly variable across the site and can generally be summarised as follows:

- Topsoil 0.0 m to >0.3 mbgl
- Subsoil 0.3 m to >11.5 mbgl
- Weathered Limestone Bedrock/ Bedrock 1.00 m to >25.0 mbgl

Figure 5-1 above presents the locations of completed trial pits and borehole. Trial pit and borehole logs (GII, 2021) are presented in the site investigation report. Furthermore, a detailed hydrogeological CSM is provided under Section 5.3.18 below.

5.3.4 Bedrock Geology

Inspection of the available GSI (2021) records (Data Sheet 14 and on-line mapping database) shows that the bedrock geology of the site and the surrounding area is dominated by rocks from the Tournaisian to Chadian – Arundian stage which is part of the Dinantian Series of the Carboniferous Era. The site is located over crinoidal & cherty limestone & dolomite referred to as the Tubber Formation (Rock Unit code: CDTUBB) (refer to Figure 5-7 below).

The regional area is highly geologically variable with mainly limestone bedrock. GSI maps do show the site as overlying the Tubber formation which is bordered to the east by a thin formation called Cregmahon Member. This unit is bounded by Waulsortian Limestones. The Tubber Formation is bounded by the Burren Formation to the west. The Burren Formation is made up of pale grey clean skeletal limestone.

The GSI (2021) bedrock geology map (100K structural database) indicates no structural faults in the study area.

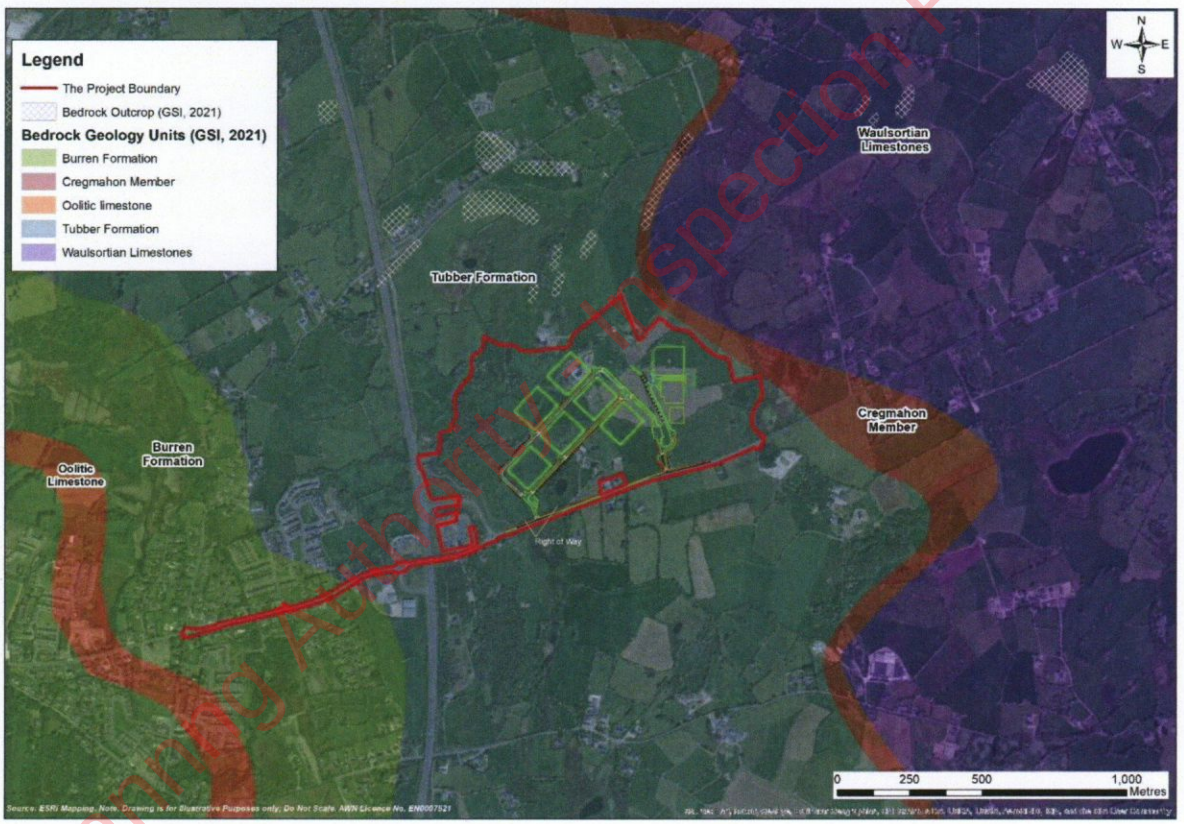

Figure 5-7 *Bedrock Geology Map with the proposed site layout (Source: GSI, 2021)*

Site investigations (GII, 2021) indicate bedrock depth is highly varied throughout the site with rockhead recorded at 0.60 mbgl at BH06 (western section of the site), 2.30 mbgl at BH08 (centre of the site) and 6.20 mbgl at PBH04 (eastern section of the site). The depth to bedrock is shallow across the site especially in the western and centre sections while bedrock is deeper along the eastern boundary owing to the thicker subsoils present. However, the bedrock surface is observed as undulating across the site and there are localised points with shallow bedrock for example within the eastern section of the site. Section 5.3.18 presents the CSM for the subject site. Bedrock was not encountered at any of the trial pits (with refusal also noted).

5.3.5 Regional Hydrogeology

The GSI has devised a system for classifying the bedrock aquifers in Ireland. The aquifer classification for bedrock depends on a number of parameters including, the area extent of the aquifer (km^2), well yield (m^3/d), specific capacity ($m^3/d/m$) and groundwater transmissivity (mm^3/d). There are three main classifications: regionally important, locally important and poor aquifers. Where an aquifer has been classified as regionally important, it is further subdivided according to the main groundwater flow regime within it. This sub-division includes regionally important fissured aquifers (Rf) and regionally important karstified aquifers (Rk). Locally important aquifers are sub-divided into those that are generally moderately productive (Lm) and those that are generally moderately productive only in local zones (Ll). Similarly, poor aquifers are classed as either generally unproductive except for local zones (Pl) or generally unproductive (Pu).

The bedrock aquifers underlying the subject site according to the GSI National Draft Bedrock Aquifer Map are classified crinoidal & cherty limestone & dolomite. GSI mapping has shown the site overlies one aquifer class which is Regionally Important Aquifer (Rkc) which indicates that the aquifer bedrock is dominated by karst environment with conduit flow (refer to Figure 5-8 below).

'Karstification' is the process whereby limestone is slowly dissolved away by percolating waters. It most often occurs in the upper bedrock layers and along certain fractures, fissures and joints, at the expense of others. Karstification frequently results in the uneven distribution of permeability through the rock, and the development of distinctive karst landforms at the surface (e.g., swallow holes, caves, dry valleys), some of which provide direct access for recharge/surface water to enter the aquifer. The landscape is characterised by largely underground drainage, with most flow occurring through the more permeable, solutionally-enlarged, interconnected fissure/conduit zones, which may be several kilometres long. Groundwater velocities through fissures/conduits may be high and aquifer storage is frequently low. Groundwater often discharges as large springs (>2,000 m^3/d), which range from regular and dependable to highly variable ('flashy'). There is strong interconnection between surface water and groundwater. The degree of karstification ranges from slight to intense.

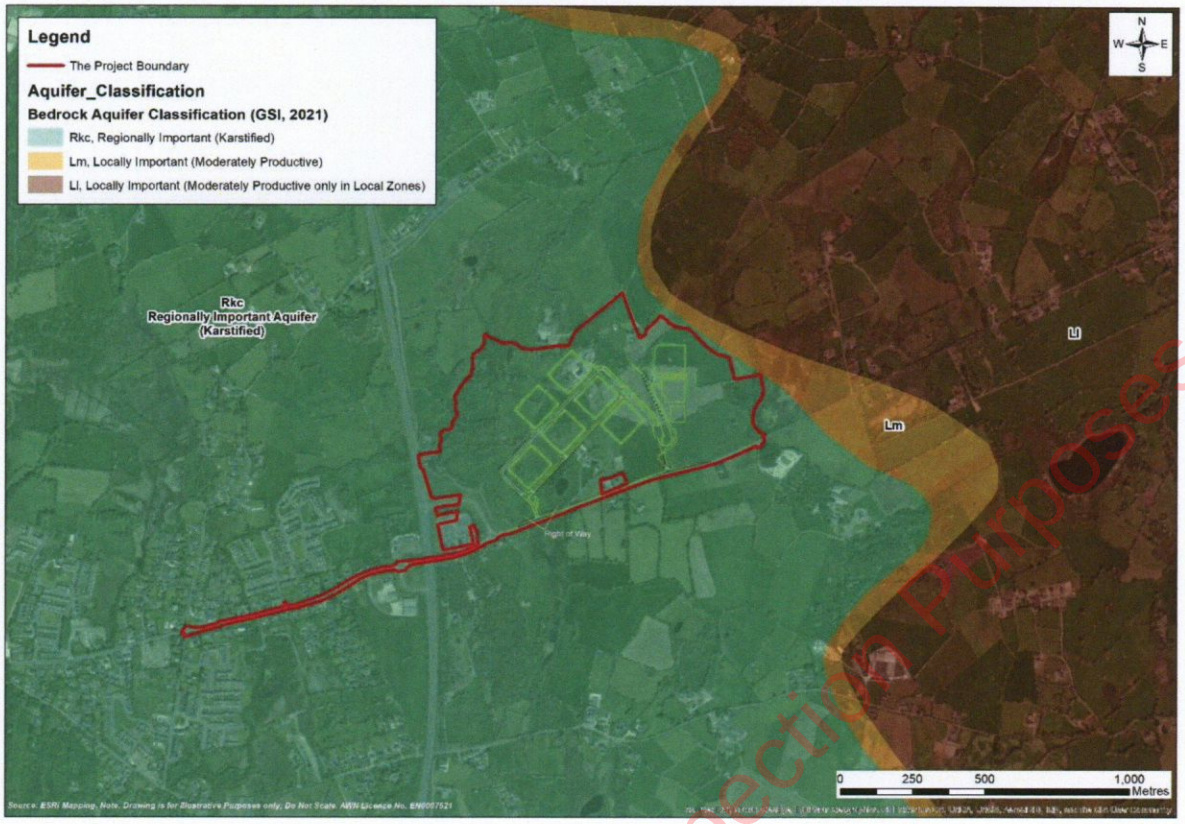

Figure 5-8 *Aquifer Classification Map with the proposed site layout (Source: GSI, reviewed 2021)*

5.3.6 Aquifer Vulnerability

Aquifer vulnerability is a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated generally by human activities. Due to the nature of the flow of groundwater through bedrock in Ireland, which is almost completely through fissures, the main feature that protects groundwater from contamination, and therefore the most important feature in protection of groundwater, is the subsoil (which can consist solely or of mixtures of peat, sand, gravel, glacial till, clays or silts).

The GSI currently classifies the aquifer vulnerability in the region as Extreme (E) to the south-western and western boundary. Aquifer vulnerability decreases to the east of the proposed development site. The eastern section of the site is classified as High (H) to Moderate (M). As can be seen from Table 5. 1 below an Extreme vulnerability with clayey subsoil denotes a depth to bedrock of 0-3 mbgl with High vulnerability categorised as 3-5 mbgl while subsoil thickness increases under the Moderate category.

The aquifer vulnerability class in the region of the site is presented below as Figure 5-9.

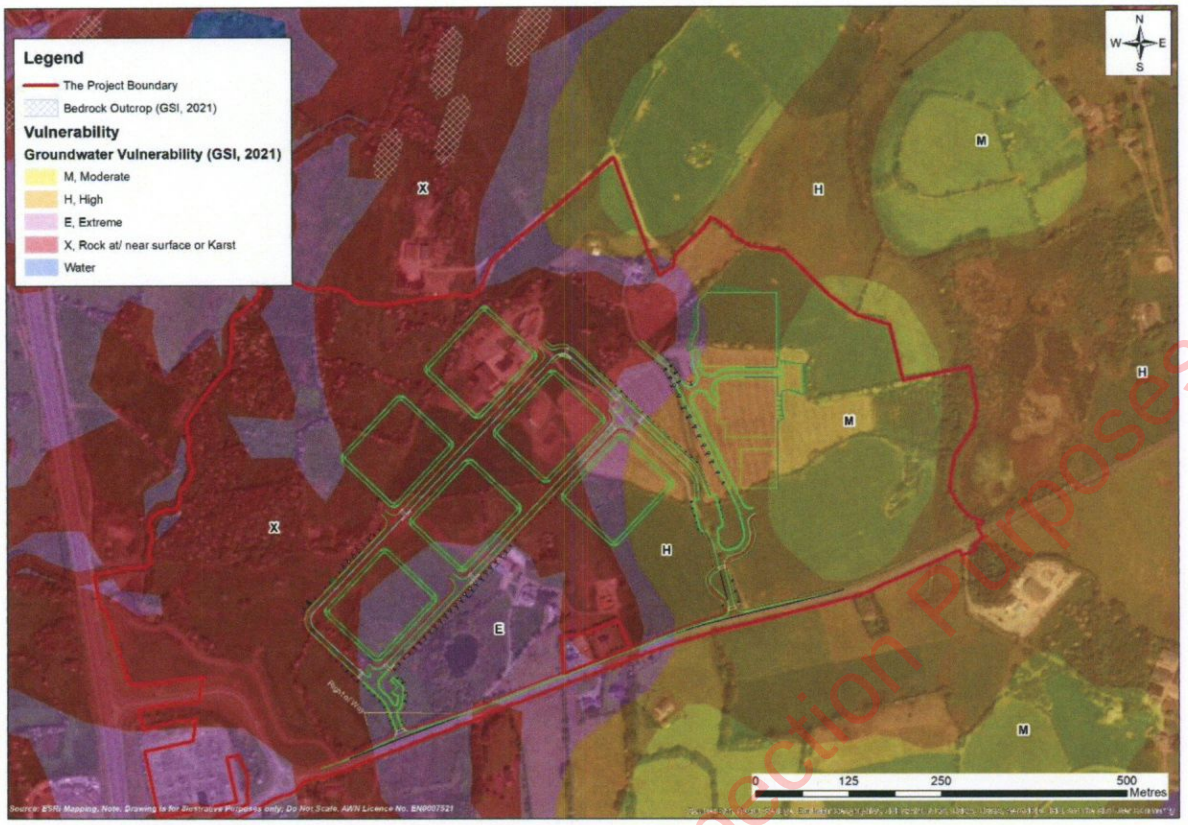

Figure 5-9 *Aquifer Vulnerability Map with the proposed site layout (Source: GSI, 2021)*

Table 5.1 below presents the GSI vulnerability mapping guidelines with specific reference to subsoil thickness and characteristics.

Table 5. 1 *Vulnerability Mapping Guidelines (Source: GSI, 2021)*

Vulnerability Rating	Hydrogeological Condition				
	Subsoil Permeability (type) and Thickness			Unsaturated Zone	Karst Features
	High Permeability (sand/gravel)	Moderate Permeability (e.g. sandy subsoil)	Low Permeability (e.g. clayey subsoil, clay, peat)	(Sand/ gravel aquifers only)	(<30 m radius)
Extreme (E)	0 - 3 m	0 - 3 m	0 - 3 m	0 - 3 m	-
High (H)	> 3 m	3 - 10 m	3 - 5 m	> 3 m	n/a
Moderate (M)	n/a	> 10 m	5 - 10 m	n/a	n/a
Low (L)	n/a	n/a	> 10 m	n/a	n/a

Notes: (1) n/a: Not applicable

(2) Precise permeability values cannot be given at present

(3) Release point of contaminants is assumed to be 1-2 below ground surface

The site investigations carried out by GII (2021) confirmed that the depth to bedrock throughout the site ranges from 0.6 m bgl at BH06 (western section section)), 2.30 mbgl at BH08 (centre of the site) and 6.20 mbgl at PBH04 (eastern section of the site), overlaid with low to medium permeability GRAVELS; therefore, the site-specific

vulnerability can be more accurately described as generally 'Extreme' at the western section and 'High' to 'Moderate' throughout the rest of the site expect for localised topographic highs where rock head is close to the surface.

Furthermore, when reviewing recharge map on the GSI web viewer, this confirms that the eastern section of the site is karst environment as there is high volumes of recharge potential located here, refer to Figure 5-10 below. Recharge volumes for the proposed development site and surrounding are range from 175 mm/year to 660 mm/yr.

Figure 5-10 *Recharge map with proposed site layout (Source: GSI, 2021)*

5.3.7 Groundwater Flooding

Groundwater flooding occurs when storage in the underground aquifer is full and rainfall (recharge) cannot discharge quick enough, causing the water table to rise above the ground surface. According to the Geological Survey of Ireland (GSI), groundwater flooding in Ireland occurs mainly on the limestone lowlands to the west of the Shannon. The prevalence of groundwater flooding in the western counties is fundamentally linked to bedrock geology. The limestone bedrock in these areas has been dissolved over time in a process known as karstification, creating a subterranean network of water-bearing fractures and conduits with limited storage capacity. Surface drainage systems are frequently absent within well-developed karst landscapes. Instead, the groundwater conduit flow system acts as the main drainage mechanism for the region.

The following site-specific data was used to determine the potential of groundwater flooding across the site:

1. CFRAM flood maps.

2. Topography.
3. Walk over survey to assess water level marks and review of historical photographs of surface water features, including lakes.
4. Review of contemporary borehole logs drilled through both the overburden and the underlying bedrock.

These data have been used to assess the potential for groundwater flooding.

The topographical gradient is quite variable across the proposed development. Overall, the elevation falls from east to west/ southwest with detailed elevation of approx. +15mOD (meters above Ordnance datum) in the west and +46mOD in the east. The topography (presence of low-lying depressions) and presence of springs and discharge points (sinkholes) is crucial in determining where groundwater flooding occurs within the proposed development boundary.

There are four water features of significance either within the site boundary or along the site boundary where flooding historically occurs (see Figure 5-13, below). These are; Tooreen Lough to the south (within the proposed development area), Ardnamurry Lough farther to the east (outside of the site boundary line), and two pond features located to the north and north-east -both within the proposed development. These features discharge to ground at nearby sink holes also identified on Figure 5-13, below. All four areas are likely to be a combination of groundwater contribution and ponding rainfall. The latter two (i.e. ponds to the north/ northeast) are seen to continue to discharge during dry spells as observed on site (April/ May 2021). All four features are located in [locally] low lying depressions within the landscape.

All of these water features have been observed to expand in terms of lateral extent seasonally with autumn/ winter flooding and this footprint is generally followed by recession during drier conditions in summertime. This filling and emptying/ lowering of water levels is likely based on exceedance of storage capacity of the karst conduit system in wetter months in addition to pluvial components.

In terms of bedrock geology, groundwater flooding is more susceptible in areas where karstification is more prominent than where competent limestone bedrock prevails. Defining the geological setting in which the full site boundary lies is based on a combination of data provided by studies carried out by the GSI as well as based on the site-specific exploratory hole drilling and geophysical studies. Karst limestone with the presence of dolomite as the dominant bedrock geology has been identified in the western and south-western section of the site while more competent limestone rock is interpreted to prevail from the boundary with the karst in the west towards the centre of the site and extending eastwards.

Furthermore, the existing recorded sinkhole/ springs/ seepages/ will be retained as part of the site development proposals -these features are part of the existing groundwater-surface water system here and this controlled natural interaction between both will be maintained. Refer to Figure 5-13 and Conceptual Site Model (CSM) Section 5.3.18 below.

5.3.8 Groundwater Wells and Flow Direction

The GSI Well Card Index is a record of wells drilled in Ireland, water supply and site investigation boreholes. It is noted that this record is not comprehensive as licensing of wells is not currently a requirement in the Republic of Ireland. This current index does not show any wells drilled or springs at the site or surrounding area with the nearest recorded wells located 0.5 km to the east of the site (associated with the

Balseskin Reception Centre). None of the wells listed are categorised as domestic use. The site is not located near any public groundwater supplies or group schemes. There are no groundwater source protection zones in the immediate vicinity of the site. However, there is a private well located to the south of the proposed development site which is currently in use. The closest is c. 3.5 km to the west of the site (Drumcliff Springs PWS) and the proposed site is outside of the zone of contribution of this supply.

Figure 5-11 below presents the GSI well search for the area surrounding the site (note this source does not include all wells) and Table 5.2 below summarises the details of recorded wells present within this search area.

Regional groundwater flow would most likely be to the south – southeast towards the Shannon Estuary. Local groundwater flow has been interpreted as flowing south-southwest (i.e., towards the Ballymacahill River) based on the local topography and drainage pattern.

Table 5.3 below shows the water level in metres above ordinance datum (mAOD) recorded in 2021. Appendix 5.3 presents the logger data collected at selected boreholes and surface water features across the proposed development site.

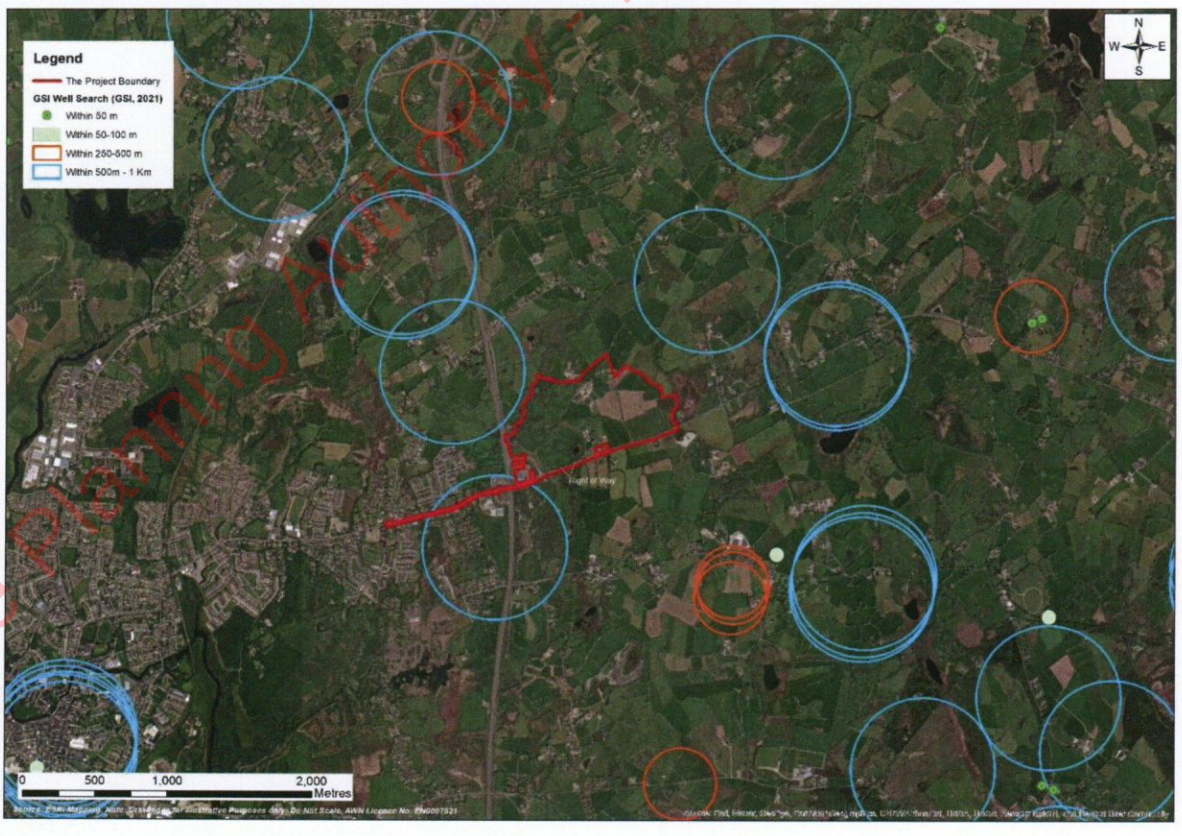

Figure 5-11 *GSI Well Search Map (Source: GSI, 2021)*

Table 5.2 *GSI Well Card Index (Source: GSI, 2021)*

GSI Name	Type	Depth to bedrock (m)	EASTING	NORTHING	TOWNLAND	COUNTY	Use	Yield Class	Yield m3/day
1117NEW077	Borehole	0.9	139900	182290	KILVOYDAN NORTH	Clare	Domestic use only	Failure	38.2
1417NWW020	Borehole		140540	180230	CRANAGHER	Clare	Agri & domestic use	Poor	
1417NWW029	Dug well		140610	180260	CRANAGHER	Clare		Failure	
1417SWW079	Borehole		140700	177000	MOYRIESK	Clare	Agri & domestic use		
1417SWW080	Borehole		140620	177030	MOYRIESK	Clare	Agri & domestic use		
1117SEW011	Borehole	4.9	133620	177170	CLONROAD BEG	Clare	Agri & domestic use	Moderate	
1117SEW123	Unknown		138730	178660	BALLYORTLA NORTH	Clare	Industrial use		
1417SWW085	Unknown		140620	178230	BALLYCRIGHAN	Clare			
1117NEW047	Borehole	6.1	136380	181840	BAREFIELD	Clare	Agri & domestic use	Poor	27.3
1117SEW003	Borehole		138420	178470	CREGGAUN	Clare	Agri & domestic use	Poor	
1117SEW004	Borehole	5.8	138430	178430	CREGGAUN	Clare	Agri & domestic use	Poor	
1117SEW007	Borehole	3.4	138410	178360	CREGGAUN	Clare	Agri & domestic use	Poor	136.2
1117SEW027	Borehole	3.4	138070	177070	KNOCKHOGAN	Clare	Agri & domestic use	Poor	86.4
1417NWW001	Borehole	2.4	140490	180310	CRANAGHER	Clare	Agri & domestic use		
1117NEW011	Borehole	15.2	138730	181770	CLOONKERRY	Clare	Agri & domestic use		
1117NEW012	Borehole	11.9	135000	182400	CLOONTEEN	Clare	Agri & domestic use	Poor	27.3
1117NEW052	Dug well	3.1	136380	181800	BAREFIELD	Clare	Agri & domestic use	Poor	21.8
1117NEW053	Borehole		139140	180050	MUCKINISH	Clare	Agri & domestic use		
1117NEW054	Borehole	0	139140	180020	MUCKINISH	Clare	Agri & domestic use	Poor	11
1117NEW055	Borehole	4.9	136140	180690	BALLYDUFF	Clare	Agri & domestic use	Poor	27.3
1117NEW056	Borehole	3.4	136140	180660	BALLYDUFF	Clare	Agri & domestic use	Poor	21.8
1117NEW057	Borehole	6.1	138240	180560	TULLYVAUGHAN	Clare	Agri & domestic use	Poor	16.4
1117NEW063	Borehole		135250	181480	BALLYMALEY	Clare	Agri & domestic use		38.2
1117SEW001	Borehole		139340	178500	BALLYORTLA	Clare	Agri & domestic use		
1117SEW002	Borehole	1.8	139330	178450	BALLYORTLA	Clare	Agri & domestic use	Poor	
1117SEW005	Dug well	4.3	136780	178710	KNOCKANEAN	Clare	Agri & domestic use	Poor	131
1117SEW006	Borehole	4.9	136480	179930	BALLYMACAHILL	Clare	Agri & domestic use	Poor	
1117SEW008	Borehole	2.7	139320	178420	BALLYORTLA	Clare	Agri & domestic use	Poor	32.7
1117SEW010	Borehole	3.1	133810	177420	CLONROAD BEG	Clare	Agri & domestic use	Moderate	15000
1117SEW014	Borehole	9.1	133800	177380	CLONROAD BEG	Clare	Agri & domestic use	Moderate	28.8
1117SEW015	Borehole	7.8	133810	177340	CLONROAD BEG	Clare	Agri & domestic use	Poor	0.07
1117SEW016	Borehole	6.1	133800	177320	CLONROAD BEG	Clare	Agri & domestic use	Good	28.8
1117SEW017	Borehole	2.1	133810	177270	CLONROAD BEG	Clare	Agri & domestic use	Moderate	8.64
1117SEW029	Borehole	3	139750	177170	FINANAGH	Clare	Agri & domestic use	Poor	
1417NWW065	Borehole	2.1	141500	180500	KNOCKANOURA	Clare	Agri & domestic use	Poor	10.9
1417SWW001	Borehole	5.5	141060	177290	MOYRIESK	Clare	Domestic use only	Moderate	54.5
1417SWW009	Borehole	0.9	140620	177670	MOYRIESK	Clare	Agri & domestic use	Poor	32.7
1417SWW010	Borehole	3	140690	176420	DRIM	Clare	Agri & domestic use	Poor	32.7

Table 5.3 *Site-specific Groundwater Levels. Overburden wells are represented with A after the number i.e. PBH01A. The remaining wells are screened in bedrock.*

Location ID	Ground elevation (mAOD)	Borehole Base of Well Screen Depth (mBGL)	Borehole Base of Well Screen Depth (mAOD)	SWL (mBGL) 05/05/2021	SWL as mAOD 05/05/2021
PBH01	7.97	15.00	-7.03	1.39	+6.58
PBH01A	7.97	5.00	+2.97	1.18	+6.79
PBH02	12.06	10.00	+2.06	3.69	+8.37
PBH03	15.13	12.00	+3.13	1.61	+13.52
PBH04	30.32	15.20	+15.12	2.73	+27.59
PBH04A	30.32	5.00	+25.32	2.30	+28.02
PBH05	14.66	15.30	-0.64	+0.02 (sl. Artesian)	+14.68
PBH05A	14.66	6.50	+8.16	0.6060	+14.11
BH01	11.87	14.00	-2.13	4.66	+7.21
BH02	13.88	14.00	-0.12	N/A	-
BH04	19.46	11.50	+7.96	N/A	-

BH09	21.46	9.90	+11.56	N/A	-

Note: Site-specific groundwater levels. Overburden wells are represented with the suffix 'A'; the other PBH wells are screened in bedrock.

5.3.9 Soil Quality

There are no legislative threshold values for soils in Ireland. As such soil samples were compared to a Generic Assessment Criteria (GAC) derived to be protective of human health, water bodies (including groundwater) and also ecology for a resident and commercial/industrial end use.

Generic Assessment Criteria in the UK has been derived using the Contaminated Land Exposure Assessment (CLEA) model to be protective of human health for a number of different land uses. LQM (Land Quality Management) and the CIEH (Chartered Institute of Environmental Health) developed a document in July 2009 detailing their own research and derivation of their own 'LQM GACs'. A total of 82 substances including many organic substances had LQM GACs derived, for the standard land uses of residential, commercial/industrial and allotments. This was updated in 2015 following further research and the derived results are now called LQM/CIEH Suitable 4 Use Level (S4UL). The LQM/CIEH S4ULs are intended for use in assessing the potential risks posed to human health by contaminants in soil and as transparently derived and cautious "trigger values" above which further assessment of the risks or remedial action may be needed. For each contaminant S4ULs have been derived for six land use scenarios based on assessing exposure pathways in each planning scenario. In this instance the commercial scenario has been considered. Soil type and soil organic matter (SOM) has an influence on the behaviour of contaminants. S4ULs have been derived for three SOM contents (1%, 2.5% and 6%) to cover the likely range in soils. A prudent approach has been taken by considering the lower 1% SOM content.

The UK values do not have any legal standing within the Republic of Ireland and no statutory guidance for assessing the significance of soil contamination currently exists. However, the values do provide a means of placing the data within context when considering magnitude of risk and have been used in that capacity for this assessment.

In total, ten (10) soil samples were collected throughout the trial pitting exercise and sent to Element Environmental Laboratory in the UK for analysis of a range of parameters to examine the soil quality and to investigate any present and/or past contamination occurred across the subject site. Full laboratory result tables for the soil and groundwater samples are presented in Appendix 5.2.

The soil samples were analysed by Element Environmental in Deeside, UK for the following parameters:

- Metals (As, Cd, Cr, Se, Cu, Ni, and Zn);
- Total Petroleum Hydrocarbons Criteria Working Group (TPH CWG);
- Polycyclic Aromatic Hydrocarbons (PAHs);
- Mineral oil;
- A range of Voltaile Organic Compounds (VOC);
- BTEX compounds (benzene, toluene, ethylbenzene and xylenes) and methyl tert-butyl ether (MTBE); and,
- Leachable component of a range of organic and inorganic parameters.
- Waste Acceptance Criteria (WAC) for inert waste landfills in accordance with the 2002 European Landfill Directive (2002/33/EC). This suite of parameters includes the following (carried out on 2 samples).

For this assessment, the soil results were compared to the Generic Assessment Criteria (GAC) concentrations. GACs are soil concentrations that have been derived for a defined set of generic assumptions and are used as trigger values in determining whether further risk management action is required in cases where detailed quantitative risk assessment is not being undertaken. There are no published Generic Assessment Criteria for soils in the Republic of Ireland. Instead, reliance is often placed on criteria from the UK and the Netherlands.

Soil sample analysis are summarised below. Detailed tables are presented in Appendix 5.2. These tables exhibit the soil quality across the site from the ten representative samples taken across the subject site.

Metals

All metal parameter concentrations recorded values below the most conservative threshold value for the LQM/CIEH for HHRA (Human Health Risk Assessment) Residential Threshold at 1% SOM. See Table 1 in Appendix 5.2.

Total Petroleum Hydrocarbon Criteria Working Group (TPH CWG)

All parameters recorded below the laboratory's limit of detection (LOD) for all soil samples collected across the subject site. Therefore, there are no exceedances recorded when these concentrations were compared to the most conservative threshold i.e., LQM/CIEH for HHRA Residential Threshold at 1% SOM.

PAHs

All parameters recorded below the laboratory's LOD for all samples collected across the subject site. Therefore, there are no exceedances recorded when these concentrations were compared to the most conservative threshold i.e., LQM/CIEH for HHRA Residential Threshold at 1% SOM.

Waste Acceptance Criteria (WAC) Analysis

Two (2) no. samples were analysed and compared against Waste Acceptance Criteria (WAC) set out by the adopted EU Council Decision 2003/33/EC which established criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 and Annex II of Directive 1999/31/EC (2002). There was no fill material noted during trial pit excavations with all samples being recorded as original clay subsoil.

The WAC analysis identifies that the representative samples are suitable for classification as Category A – Inert. Based on the laboratory results and parametric concentrations obtained from the site investigation, material from the sample locations would be acceptable at inert waste facilities (Category A). It should be noted that waste facilities develop facility specific criteria also and this should be considered should any soil/ material to be removed from site in the future. The comparison tables for the analysed samples against current WAC criteria can be seen in Table 2 in Appendix 5.2.

Asbestos

There were no asbestos containing materials (ACM) identified in any of the trial pit or soil samples taken.

5.3.10 Groundwater Quality

5.3.10.1 Regional Scale

The Water Framework Directive (WFD) Directive 2000/60/EC, was adopted in 2000 as a single piece of legislation covering rivers, lakes, groundwater and transitional (estuarine) and coastal waters. In addition to protecting said waters, its objectives include the attainment of 'Good Status' in water bodies that are of lesser status at present and retaining 'Good Status' or better where such status exists at present. 'Good Status' was to be achieved in all waters by 2015, as well as maintaining 'high status' where the status already exists. The EPA co-ordinates the activities of the River Basin Districts, local authorities and state agencies in implementing the directive, and operates a groundwater quality monitoring programme undertaking surveys and studies across the Republic of Ireland.

Presently, the groundwater body in the region of the site (Ennis GWB) is classified under the WFD Risk Score system (EPA, 2021) as 'under review" for the WFD cycle (2013-2018). The Ennis GWB was given a classification of "Good" for the last WFD cycle (2013-2018).

5.3.10.2 Local Scale

AWN carried out groundwater monitoring on selected groundwater monitoring wells located along the boundary of the proposed development site. Four (4) no. groundwater samples were taken across the site. 2 no. upgradient groundwater wells (PBH04 & PBH04A) and 2 no. downgradient groundwater wells (PBH01 & PBH01A) were sampled. PBH01 is a deep well which is screened within bedrock, while PBH01A is a shallow well screened in overburden. PBH04 is a deep well which is screened within bedrock, while PBH04A is a shallow well screened in overburden. The groundwater flow is considered to be in a west to southwesterly direction towards the Ballymacahill (also referred to Spancelhill) River which is located along the southwestern boundary of the proposed development. The groundwater wells are screened in the underlying limestone rock to a depth of c. 15 mbgl for the bedrock wells (PBH01 & PBH04) and c. 5.0 mbgl for the overburden wells (PBH01A & PBH04A). Refer to Figure 5-1Er above for borehole locations. Borehole logs and well installation details are presented in the site investigations report (GII, 2021) at the end of this report.

A total of four (4) no. groundwater samples were collected across the site; one groundwater sample from each bedrock borehole. These groundwater samples were sent to Element Environmental Laboratory in the UK for analysis of a range of parameters to examine the groundwater quality and to investigate any present and/or past contamination occurred across the subject site. Appendix 5.2 presents tables with the soil and groundwater analytical test results.

The groundwater samples were analysed for the following parameters;

- TPH CWG,
- Metals (As, Ba, Br, Cd, Cr, Pb, Se, Cu, Ni, Mn, V and Zn,), and
- Chloride, Potassium, Magnesium, Sulphate, Sodium, Orthophosphate, Ammoniacal Nitrogen, Nitrate, Nitrite, Fluoride, Total Suspended Solids, Alkalinity, Total Hardness and Bicarbonate.

Groundwater samples were collected using best practice (BS1995:5930) guidelines for water sampling including sufficient well volume purging (i.e. achieved as a result of the

combined pumping tests) prior to sample collection and following adequate aquifer formation recharge to each test well sampled.

Groundwater results were compared with Groundwater Threshold Value (Groundwater Directive S.I. No. 9 of 2010 and amendment; S.I. No. 366 of 2016) and EPA Interim Guidelines for groundwater where available.

The analytical testing was undertaken by Element Environmental (UK) Forensics Limited, a United Kingdom Accreditation Service (UKAS) accredited laboratory located in Deeside, England. The laboratory is accredited under UKAS 4225 as well as to ISO/IEC 17025:2005.

The reported analytical results for the groundwater samples are presented in Appendix 5.2 and compared primarily with the relevant Groundwater Regulations S.I. No. 9 of 2010, SI No. 366 of 2016 and EPA Interim Guideline Values (IGVs), 2003. A brief summary of principal results is presented below.

Field Measurements

Field parameters were measured at PBH01 to PBH05, inclusive. In general, there were no exceedances recorded for field parameters at any of the groundwater monitoring locations. It was noted that two groundwater wells contained elevated pH.

There were slight exceedances recorded at PBH03 & PBH04A monitoring locations of available threshold values for pH. PH concentrations were recorded at 10.90 and 9.60 units, respectively. These concentrations slightly exceed the EPA IGV upper threshold value for pH of 9.5 units (refer to Table 3 in Appendix 5.2).

Metals

Table 4 in Appendix 5.2 summarises the metal parameter concentrations recorded at each of the four (4) no. wells during the groundwater sampling round. These measurements are assessed against the available Groundwater Regulations SI No. 9, 2010 (& 366 of 2016) as well as the EPA's Interim Guideline Values (IGVs) where available also.

The majority of the metal analysis suite recorded a concentration below the laboratory's LOD. There were no exceedances above Groundwater Regulations SI No. 9, 2010 (& 366 of 2016) or EPA's Interim Guideline Values (IGVs) other than a slight exceedance of zinc at PBH04 (Deep). Zinc is naturally occurring in soils and the slightly elevated values recorded are most likely due to sediment in the sample.

Hydrocarbons

Table 5 in Appendix 5.2 summaries the results of Hydrocarbon testing. In summary, there were no exceedances across the hydrocarbon suite of parameters in any of the four (4) no. groundwater samples.

General Suite

Table 6 in Appendix 5.2 summarises the general suite of parameters analysed at Element Environmental (UK) Limited. The table also included the results for polychlorinated biphenyls (PCBs). There was no exceedance of current regulatory thresholds.

5.3.11 Economic Geology

The GSI (2021) mineral database was consulted to determine whether there were any mineral sites close to the study area. There are no active quarries in a 3 km radium from the proposed development site.

While the origins of the suppliers of general construction materials and data centre components are not known at this stage, in relation to supply of sand, aggregate, stone and cement, which will comprise a significant proportion of HGV traffic generated during the construction phase, 3 quarries have been identified for consideration. These options are further discussed in Chapter 12 Traffic and Transport of this EIA Report.

5.3.12 Geological Heritage

The Geological Survey of Ireland (GSI) Public Viewer (www.gsi.ie/mapping) was reviewed to identify sites of geological heritage for the site and surrounding area. There are no geological heritage sites (audited & unaudited) in a 3 km radius of the proposed development site. The nearest geological site is Kilbreckan (CE0225). This site is located approx. 3.8 km south of the proposed development site. Kilbreckan Mine is situated between Ennis and Quin. It was worked intermittently for silver and lead from 1834 until 1856.

5.3.13 Radon

According to the EPA (now incorporating the Radiological Protection Institute of Ireland), Ennis is a High Radon Area (27.8 %) where is it estimated that more than twenty per cent of the homes in this 10km grid square are estimated to be above the Reference Level. This is the highest of the five radon categories which are assessed by the EPA.

5.3.14 Geohazards

Much of the Earth's surface is covered by unconsolidated sediments which can be especially prone to instability. Water often plays a key role in lubricating slope failure. Instability is often significantly increased by man's activities in building houses, roads, drainage and agricultural changes. Landslides, mud flows, bog bursts (in Ireland) and debris flows are a result. In general, Ireland suffers few landslides. Landslides are more common in unconsolidated material than in bedrock, and where the sea constantly erodes the material at the base of a cliff and leads to recession of the cliffs. Landslides have also occurred in Ireland in recent years in upland peat areas due to disturbance of peat associated with construction activities. The GSI landslide database was consulted and the nearest landslide to the proposed development was approx. 7.6 km to the southeast of the site, referred to as the Ayleacotty 2009 (event ID - GSI_LS09-0004) which occurred on 23rd August 2009 where a steep railway bank collapsed. There have been no recorded landslide events at the site. Due to the local topography and the underlying strata, there is a negligible risk of a landslide event occurring at the site.

In Ireland, seismic activity is recorded by the Irish National Seismic Network. The Geophysics Section of the School of Cosmic Physics at the Dublin Institute for Advanced Studies (DIAS) has been recording seismic events in Ireland since 1978. The station configuration has varied over the years. Currently there are five permanent broadband seismic recording stations in Ireland and operated by DIAS. The seismic data from the stations comes into DIAS in real-time and are studied for local and regional events. Records since 1980 show that the nearest seismic activity to the

proposed location was in the Irish sea (1.0 – 2.0 Ml magnitude) and ~55km to the south in the Wicklow Mountains. There is a very low risk of seismic activity to the proposed development site. There are no active volcanoes in Ireland so there is no risk from volcanic activity.

5.3.15 Areas of Conservation

According to the NPWS (2021) on-line database there are no special protected area on or in the vicinity of the subject site. The closest European listed sites are as follows;

- Lower River Shannon Special Area of Conservation (SAC) (site code 002165) - circa. 2.1 km to the southwest of the site.
- Ballyallia Lake SAC and proposed National Hertiage Area (pNHA) (site code: 000014) - circa. 2.3 km to the west of the subject site.
- Ballyallia Lake Special Protection Area (SPA) (site code: 004041) - circa. 2.8 km to the northwest of the subject site.
- Newpark House (Ennis) pNHA (site code: 000061) - circa. 1.6 km to the southwest of the site.

The site would have direct hydrological connection with the Lower River Shannon (SAC) (site code 002165) - circa. 2.1 km to the southwest of the site through the local drainage network and the Ballymacahill (also referred to Spancelhill) River. This waterbody is located along the western boundary of the site. This waterbody is further discussed in Chapter 6 Hydrology of this EIA Report.

Figure 5-12 below presents the location of these protected areas in the context of the subject site.

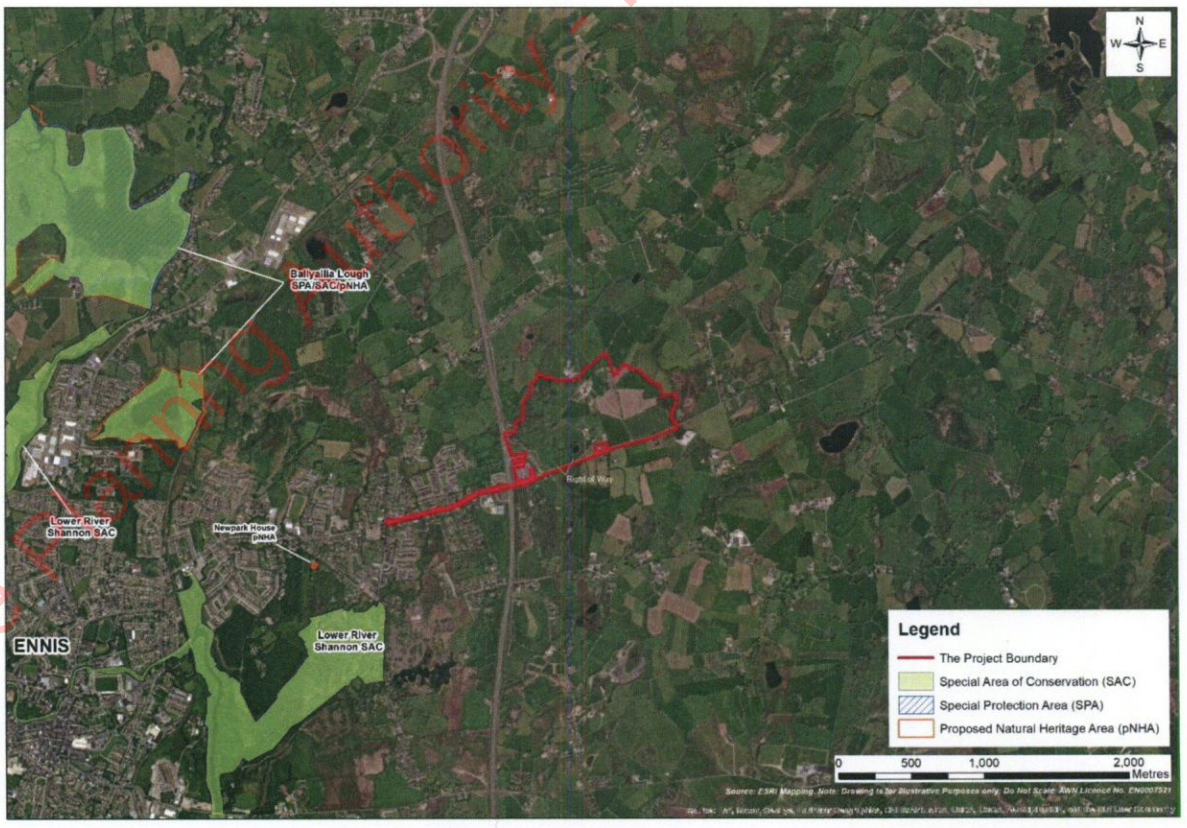

Figure 5-12 *Natura Sites in the Context of the Subject Site (Source: NPWS, 2021)*

5.3.16 Karst Features

According to the GSI (GSI, 2021) website, there are no recorded karst features within the site boundary. However, based on the initial site walkover carried out by AWN in April 2021 it was established that there are a number of karst features within the site boundary and in adjacent lands which transports water into the site. These are described below:

1. Ardnamurray Lough and the southern sinkhole which are located adjacent to the site. The lough drains along the Tulla Road and into lands south of this road. A sinkhole is located within this land. This karst feature is connected to underground conduits which direct water towards the proposed development site and the main spring located within the site boundaries. This is further discussed below in groundwater-surface water interactions.
2. One of the two pond features (north ponds) is believed to be attributed to groundwater water levels with some surface water influence. These extend and recede based on the seasonal rainfall changes through the year.
3. The second pond feature (north-eastern ponds) is believed to be attributed to surface water influence. These extend and recede based on the seasonal rainfall changes through the year. Based on recent geophysical data (January 2022), the northeast pond is an ephemeral surface water feature with no groundwater influence. Based on the geophysical survey (Line R17/ R18) undertaken here, there is approx. 5 to 7m of overburden comprising Peat/Clay/Silt hence the feature is a capture point for arterial run-off from elevated areas with levels controlled by rainfall, very slow infiltration to ground and evaporation effects.
4. There are two (2) no. springs located across the proposed development site – one is located to the north-western section of the site and the second is located in the western section of the site (southwest of the proposed DC 6 building). Refer to Figure 5-13 below. These springs are dependent on water levels across the site and seasonal changes.
5. There is one (1) no. sinkhole located west from Toureen Lough. There is a small overland stream from Toureen Lough to this sinkhole. It is believed that this sinkhole discharges through a spring located along the Ballymacahill (also referred to Spancelhill) River.

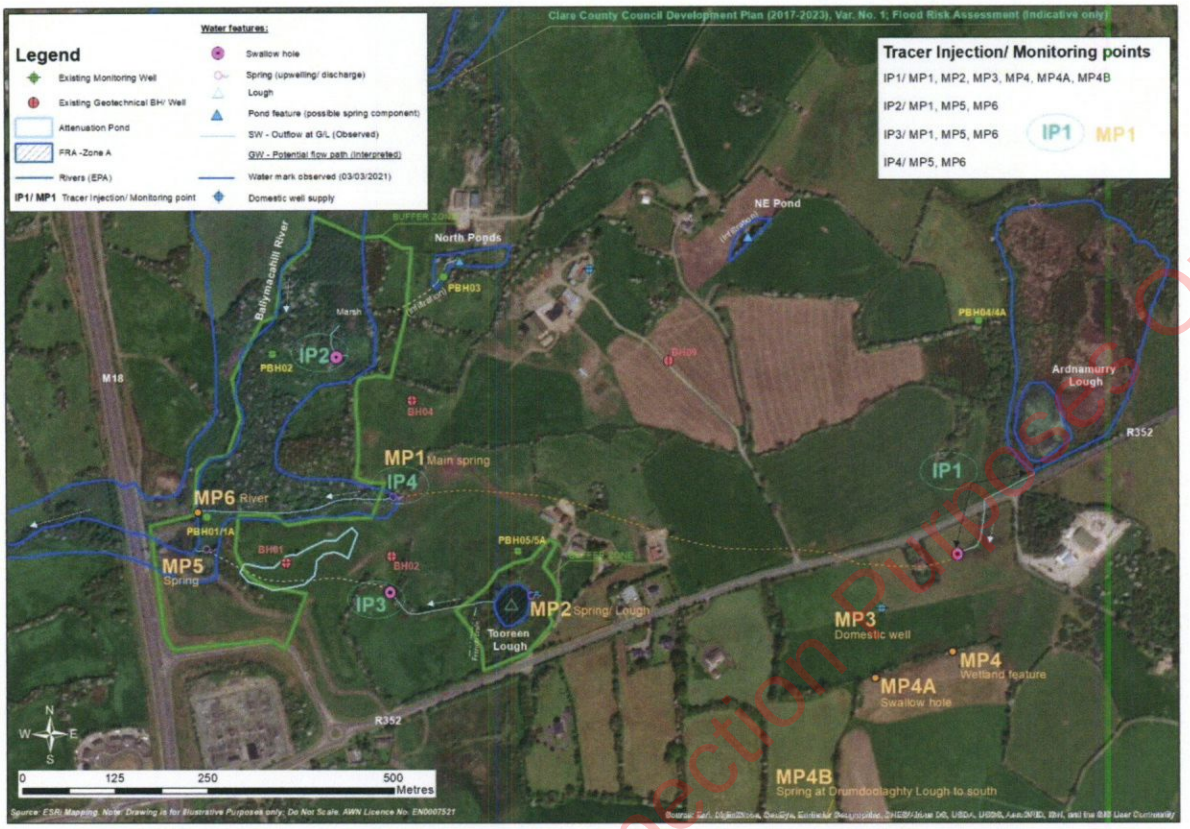

Figure 5-13 *Internal and local karst features across the site with the proposed Site Layout.*

5.3.16.1 Interactions between Groundwater & Surface water features

Regarding surface water-groundwater interactions, the following additional field works were completed in December 2021 and January 2022:

- Extensive geophysical survey profiles to more accurately define the extent of weathered and/ or more competent Limestone, as well as the likely flow orientation for groundwater at the site. Refer to Apex report (2022).
- Groundwater and surface water quality testing as part of assessing the hydrochemistry for the site and possible similarities in water type(s) (refer **Appendix 5.2**).
- Continuous datalogging of groundwater levels spatially for a nominal period which now includes the high winter water levels (refer **Appendix 5.3**).
- Dye tracer testing using recorded injection points (swallow holes) and likely discharge points in the wider site area (refer **Appendix 5.4**).

With regard to surface water features in context of groundwater, there are five (no.) main surface water features located within/ at the site boundary, and presented in Appendix A, as follows; Ardnamurry Lough, Tooreen Lough, Northeast Pond, North Ponds, and Ballymacahill River. These are discussed briefly below.

Ardnamurry Lough drains from north of the R352 Tulla Road and into lands immediately south, ultimately discharging under sufficient head into a swallow hole (IP1). Based on the successful dye tracing exercise completed on 17/12/2021, this swallow hole has been proven to directly connect with the [main] spring (IP4) located north of the proposed DC6 structure. It is interpreted from the tracer test that the discharged water is flowing below ground in a W to WNW direction, and to the north of

Tooreen Lough where no breakthrough was recorded. Groundwater flow is within the gravels and the upper weathered limestone (with confirmation on local geology provided by additional geophysical surveys in December 2021 and January 2022). There is no notable heavily karstified rock between the swallow hole and this spring which indicates that the groundwater flow is predominantly within the gravels and top of the limestone rock. From this spring, the water travels along a drainage ditch which flows in the direction of the Ballymacahill River, but which may also include likely discharge to ground in the western site extent.

Tooreen Lough is not connected to the afore-mentioned swallow hole located south of Tulla Road. No emergence of dye was noted here including on 17/12/2021. Tooreen Lough is likely fed by a smaller 'spring' which is located adjacent to the water feature. Tooreen Lough is directly connected to a nearby swallow hole which regulates the water levels in the lough (see also **Appendix 5.3** hydrograph for SP2). Continuous datalogging of water levels in Tooreen Lough indicates a range from +14.24 mAOD (May 2021) to +14.51 mAOD (December 2021), i.e. very little variation in water levels due to the nearby swallow hole from which Tooreen Lough water discharges to the west towards the Ballymacahill River. No connection is recorded between this swallow hole (IP3) and the main spring (IP4).

In the context of the buffer zone applied, the nearest GPS surveyed historical high-water mark for Tooreen Lough of approx. +14.6mAOD has not been reached/ surpassed since May 2021 including where site-wide observed water levels have increased in recent [winter time] months.

The northeast pond is an ephemeral surface water feature with no groundwater influence. Based on the geophysical survey (Line R17/ R18) undertaken here, there is approx. 5 to 7m of overburden comprising Peat/Clay/Silt hence the feature is a capture point for arterial run-off from elevated areas with levels controlled by rainfall, very slow infiltration to ground and evaporation effects.

The north ponds, in contrast, are surface water features with likely groundwater influence. Based on the geophysical survey (Line R26), there is approx. 1.0-1.5 metres of overburden (sandy gravelly Clay – clayey sandy Gravel) below the top pond which discharges into the second pond to the immediate SW. This second pond discharges to ground with ultimate flow towards the nearby marshy area and the Ballymacahill River.

The Ballymacahill River is the principal drainage feature in the area and flowing in a N-S/SW to W direction. Based on additional extensive geophysical surveys in the area, and assessment of monitored groundwater levels, then it is likely that the river receives baseflow from the underlying rock together with composite discharge from key water features listed above.

As part of the potential linkages between surface and groundwater systems, additional water quality was completed on 13/01/2022 with testing of major anions and cations completed on select groundwater and surface water samples. **Appendix 5.2** presents the tabulated water quality data as well as trilinear plots for reference (plots are also grouped into groundwater and surface water to aid comparison).

In summary, the plotted analytical data indicate a hydrochemical facies calcium-bicarbonate ($Ca^{2+}Mg^{2+}HCO_{3-}$) type water for the majority of the [groundwater and surface water] samples tested. This is representative of the type of limestone till and bedrock in the area of the proposed development and further indicates the hydraulic connectivity potential between all waters present at the subject site.

As part of the examination of surface water and groundwater interactions, a number of dye tests were carried out including on 05/05/2021 and 19/09/2021 however due in large to the low flow rates observed at the main spring and swallow holes then no dye breakthrough was noted. However, on 17/12/2021, following excavation works at the swallow hole to the south of the R352, which created a significant discharge to ground (i.e. approx. 20-30 l/sec inflow rate), the injection of 250g of Fluorescein dye (and de-ionised water) was observed on site at IP4 within <2 hours as presented in **Appendix 5.4**.

It is noted that the silt laden water resulting from the swallow hole excavation works was also observed at the main spring and sooner than the dye -this is due in effect to the rapid 'slug of water' effect associated with the sudden release of water to ground at the time of excavation.

As mentioned above, dye was not observed within Tooreen Lough during any of the tests completed, indicating a more northern flow path to the north of the lough.

Continuous data loggers have been installed at selected locations across the site and have monitored groundwater/ surface water levels since May 2021 to present. These loggers will continue to capture fluctuations in groundwater levels over summer (low) and winter (high) seasons.

Based on the continuous monitoring data, the following is of note:

- It is apparent that the groundwater levels are directly related to the meteoric recharge within the wider site area, with increased variations in logged groundwater levels relative to heavy rainfall events (typically associated with the wetter winter season).
- Temporal artesian conditions are noted at periphery monitoring boreholes PBH03 (deep, screened within the gravels and the underlying bedrock), PBH05 (deep, screened within the underlying bedrock) and PBH05A (shallow, screened within the gravels). PBH05 & PBH05A are located directly north of Tooreen Lough and the hydrographs correlate well to that of the lough (SP2) indicating the influence of groundwater on the lough levels.
- Groundwater levels in the western side of the site are heavily influenced by local meteoric recharge conditions. The west of Ireland (similar to the other parts of the country) experienced a dry summer/ autumn which coincides with the low, relatively consistent groundwater levels noted in the western side of the site. In comparison to the current winter (high water table) season, groundwater levels have begun to rise due to the increase in rainfall.

Appendix 5.3 presents hydrographs for all monitored groundwater and surface water. Figure 5-13b below presents the site drainage and monitoring network for reference.

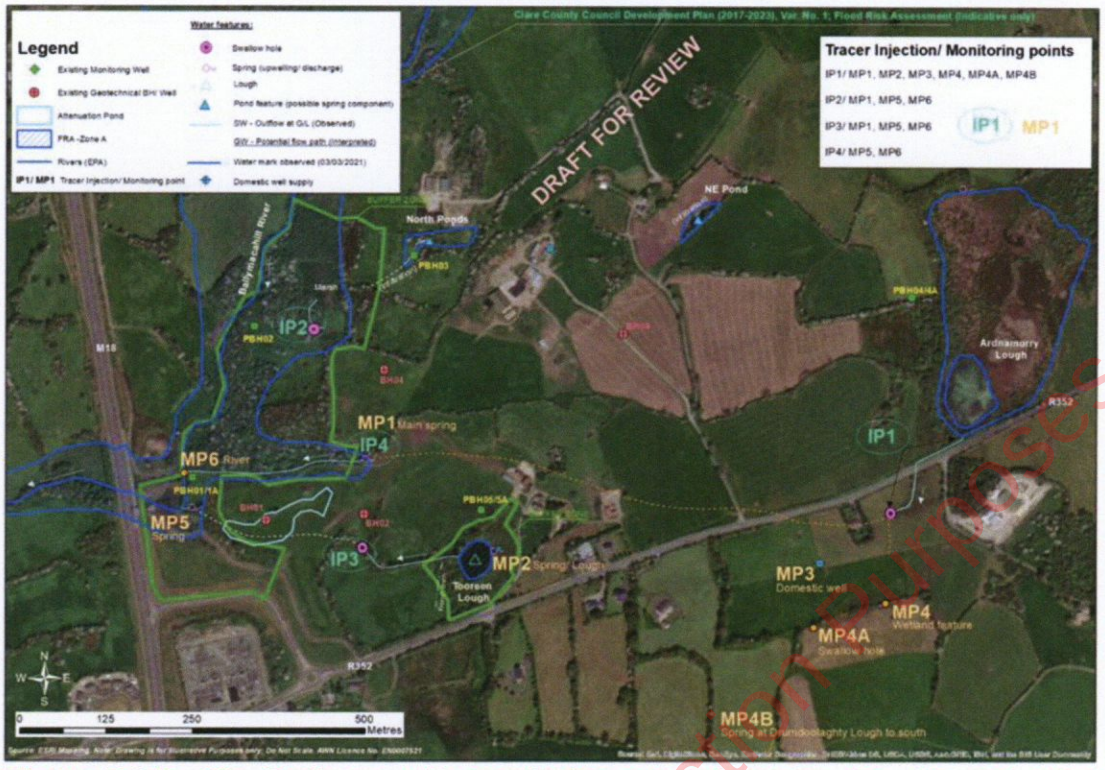

Figure 5-14b *Site Drainage with monitoring network across the site and nearby areas.*

Inserts 5.1 to 5.8 below show karst/ drainage features on site.

Insert 5.1 *Toureen Lough – view is N-W*

Insert 5.2 *Ardnamurry Lough -View is to E (discharge is to south crossing beneath the R352 road to Right Hand Side)*

Insert 5.3 *Pond to north-east (view is W-E) with existing wall to the Right Hand Side*

Insert 5.4 *Ponds to the north -saturated (03/03/2021) -view is to North.*

Insert 5.5 *Spring discharge (main) which flows directly to Ballymacahill River.*

Insert 5.6 *Spring discharge (main, second view) and flows directly to Ballymacahill River.*

Insert 5.7 *Swallow hole located to south of R352 (i.e discharge from Ardnamurry Lough)*

Insert 5.8 *Swallow hole located to south of proposed DC6 building and connected to Toureen Lough stream flow.*

5.3.17 Ecological Receptors

As outlined in Chapter 7 (Biodiversity), there are a number of water habitats which are water fed/ maintained. These are described in Section 7.3.2.1. International and national habitats which are dependent on '*no measurable change in the natural water environment'* are summarised as follows:

Table 6.1 *Ecological attributes within the site boundary*

Alluvial woodland [*91E0] (WN5 Riparian Woodland and WN6 Wet Willow-Alder-Ash Woodland) GW fed	International
Cladium Fen [*7210] (FS1) GW fed	International
Alkaline fen [7230] (PF1 – Rich Fen and Flush)	National
Molinia Meadows [6410] (GS4 Wet Grassland) GW fed	National

The above habitats are presented in Figure 5-15 below and Figure 7.8 of Chapter 7 (Biodiversity) of this EIA Report which shows the level of ecological importance of habitats at the development site. It is noted that an area of International Importance (alluvial woodland) is present at the edge of Fen habitat at Tooreen Lough and along the eastern boundary. Furthermore, the Reed and Large Sedge swamp (Cladium Fen) area is located along the eastern boundary of the proposed development site. Further information on the habitats is discussed in Chapter 7 (Biodiversity) of this EIA Report. There are no specific groundwater dependent species identified i.e. the habitats present requiring flooding only.

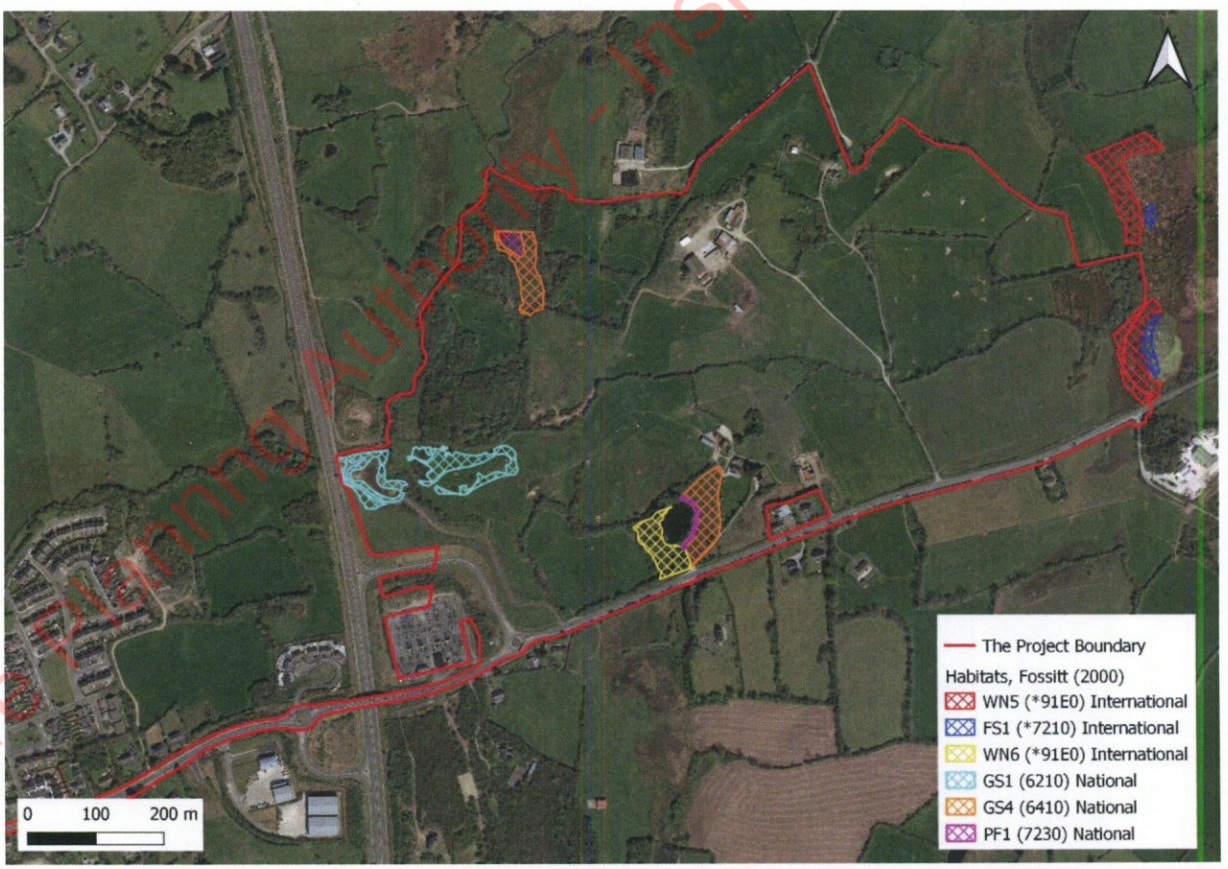

Figure 5-15 *Ecological Features of International and National Importance located within the site boundary*

Fen type habitat was located in two different areas. These are considered of National Importance according to their species composition and structure.

The small area of rich fen and flush, located in the far northwest of the proposed development site, described as a wetland/pond feature, corresponded to a depression between wooded areas, and are naturally relatively species-rich vegetation communities. It is likely to have formed as a consequence of a lake infilling and can be described as a topogenous fen (i.e. forming in a valley or depression). A more-species-poor fen community occurs bordering on the landward side of reed and tall sedge swamp vegetation at Tooreen Lough.

Fen habitats located within these two particular areas corresponded to the description of the Annex I habitat Alkaline fen [7230], which are described as '*Wetlands mostly or largely occupied by peat- or tufa-producing small sedge and brown moss communities developed on soils permanently waterlogged, with a soligenous or topogenous base-rich, often calcareous water supply, and with the water table at, or slightly above or below, the substratum…*' within the Interpretation Manual of European Union Habitats (European Commission, 2013). The examples of rich fen and flush habitats within these two areas are considered to be of National Importance.

The areas of oak-ash-hazel woodland and immature woodland in the northwest, Tooreen Lough, the alluvial woodland (*91E0), Molinea meadows (6410) and alkaline fen (7230) surrounding Tooreen Lough and in the north-west, and calcareous grassland (6210) adjacent to the attenuation pond by the M18 Motorway, will be protected under the 'Ecological Buffer Space' as designated by Clare County Development Plan Variation No. 1. These areas will be retained, protected from development and will not be directly impacted from the development.

The wetland in the north of the site will also not be impacted by the proposed hardstand footprint of the development.

5.3.18 Conceptual Site Model (CSM)

The subsoil underlying the site is classified as clayey GRAVELS (generally low to moderate permeability) and the underlying varied limestone aquifer which is classified as a Regionally Important Aquifer. The aquifer vulnerability is considered to be 'Extreme' to 'High' vulnerability across the majority of the site while a section of the eastern boundary is classed as 'Moderate' aquifer vulnerability. This was confirmed during the site investigations.

The geology of the site can be described into two sections – the western and eastern section:

Western Section of the Site

- The underlying geology of this section is made up of weathered / fissured DOLOMITE underlain by competent LIMESTONE at greater depth (generally greater than 7 metres below ground level). Refer to Figure 5-17, below. This is based on the available data, geophysical data and site investigations carried out across the site.
- This DOLOMITE bedrock is highly weathered and fissured with some silt and clay infilled voids.
- Within this unit, there are areas where there is highly karstified LIMESTONE rock. These features are usually located approx. 7 to 10 metres below ground level (m bgl).

- Competent LIMESTONE rock unit is underlying this dolomitised rock which is presented in Figure 5-17,Figure 5-18 and Figure 5-19.

Eastern Section of the Site

- The underlying geology of the centre and eastern sections of the proposed development site is mainly made up of strong competent LIMESTONE rock. This is presented in Figure 5-20and Figure 5-21 below.
- This bedrock is generally very strong, massive, grey, fine to medium grained LIMESTONE.

The depth of bedrock across the site is generally shallow – 0.90 m bgl to 6.20 m bgl. Site investigations (GII, 2021) indicate bedrock depth is highly varied throughout the site with rockhead recorded at 0.60 mbgl at BH06 (western section of the site), 2.30 mbgl at BH08 (centre of the site) and 6.20 mbgl at PBH04 (eastern section of the site). The depth to bedrock is shallow across the site especially in the western and centre sections while bedrock is deeper along the eastern boundary owing to the thicker subsoils present. However, the bedrock surface is observed as undulating across the site and there are localised points with shallow bedrock for example within the eastern section of the site.

Groundwater levels range from 0.6060 m bgl (PBH05A) to 4.66 m bgl (BH01) while slightly artesian conditions were noted at PBH05 (deep well screened in bedrock) as the static water level was +0.02 metres above ground level (m agl). The regional groundwater flow is in a western to southwestern direction towards the Ballymacahill (also referred to Spancelhill) River and the Shannon Estuary.

Local drainage within the development boundary is less defined. Surface water features within the site boundary comprise a series of ponds to the north with variable seepage to ground, and Toureen Lough to the south near the R352. As mentioned in Section 5.3.17 above, there are a number of karst features within and adjacent to the proposed development site. Spring discharges have been identified mainly to the west of the site and include a spring to the immediate east of Tooreen Lough discharging to this feature, and a spring to the NW of the lough which receives groundwater from a swallow hole located farther east and south of the R352 road (this water is discharged from the Ardnamurry Lough wetlands located adjacent to the eastern site boundary line -refer to Figure 5-13 above). It is likely, under increased local water levels [head] at the lake, that Tooreen Lough ultimately discharges into the Ballymacahill River under gradient flow observed in the field as both at surface and possibly through gravelly subsoils located between the lough and the river. Local drainage would also typically follow the topographical decline in gradient recorded from east to west/ southwest (refer also to Figure 5-13 above). Refer to Section 5.3.15 for a discussion on groundwater – surface water interactions across the proposed development site based on recent site investigations.

Site walkovers conducted by AWN in March/ April/ May 2021 included a visual inspection of the local drainage network and features across site. These features are encapsulated in Figure 5-13 above and include some seepages/ springs with intermittent or ephemeral characteristics which discharge into what are surface streams that ultimately discharge towards the Ballymacahill River running along the western/ southwestern boundary of the site.

The majority of these hydrological and hydrogeological features are located in the south-western section of the site where the karstified limestone and weathered dolomite is located. According to the geophysical survey (APEX, 2021), there is a zone

of karstified rock and dolomitised rock underlying the majority of the south-western section, refer to Figure 5-16 below. Bedrock is close to or at the surface to allow the springs and swallow holes to form across the proposed development site.

Review of the hydrogeology and geology in the immediate surrounding region indicates that there are no sensitive receptors such as groundwater dependent SACS/NHAs, Council Water Supplies/ Group Water Schemes or geological heritage sites which could be impacted by this development. No evidence of disposal of waste material was identified the location area proposed for excavation. Collection and analysis of representative soil and groundwater samples for a wide range of parameters shows no evidence of contamination. The review of the groundwater quality data collected on site found that the groundwater beneath the site is of good quality. Groundwater quality results are presented as Appendix 5.2.

Six (6) no. local geological cross sections can be seen in Figure 5-17 to Figure 5-22 below based on the available data such as geophysical survey report, site investigations borehole logs and supplementary site walkovers. The relevant borehole logs were used to construct the Conceptual Site Model (CSM) for the proposed development. These are presented in the cross-sections below in Figure 5-17 to Figure 5-22.

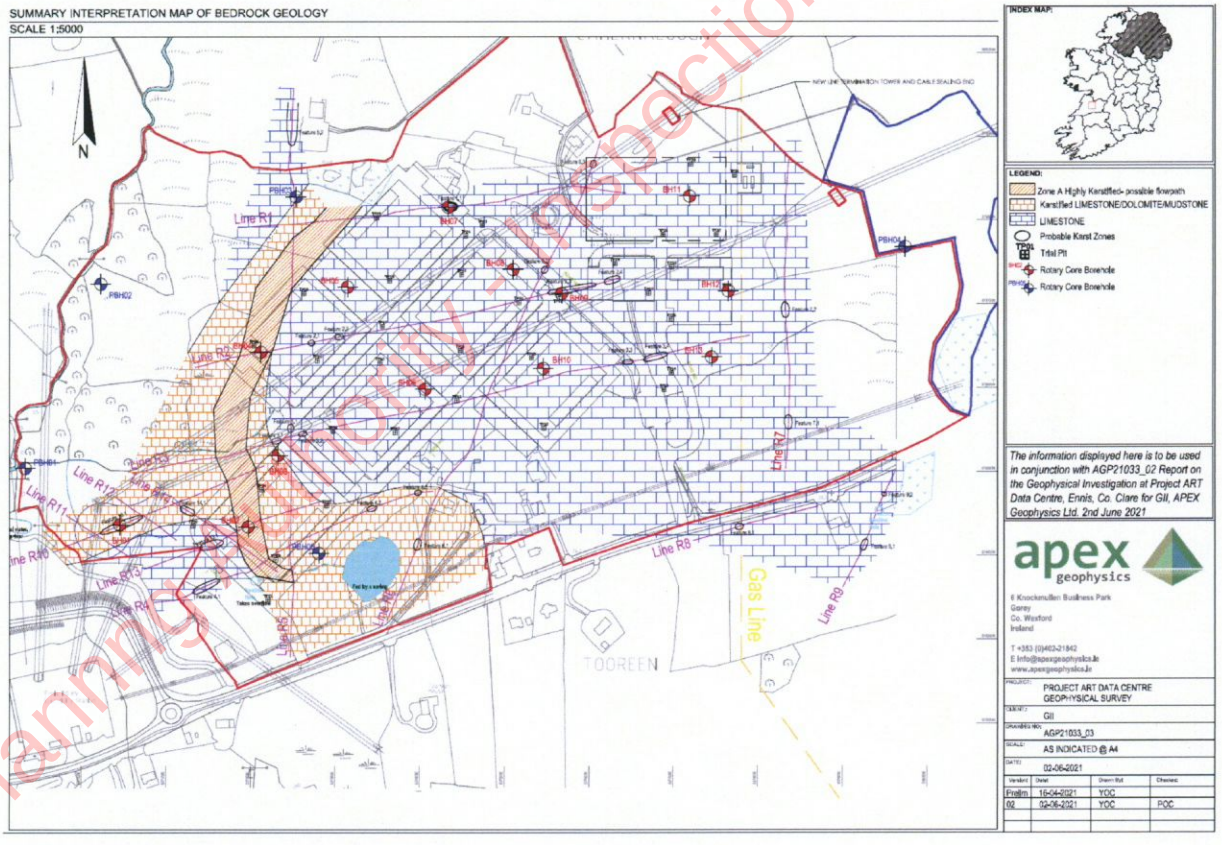

Figure 5-16 *Geophysical survey – interpretation map of the bedrock geology (Apex, 2021).*

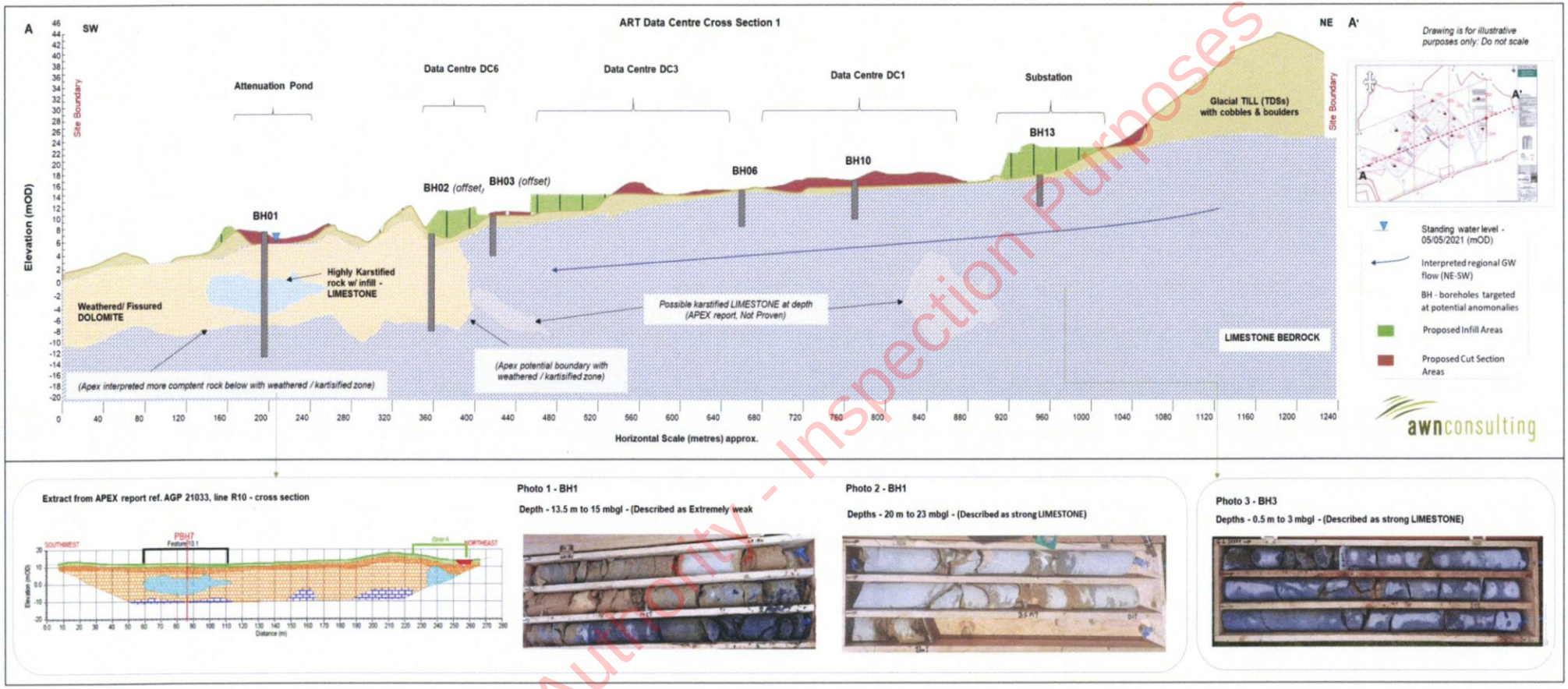

Figure 5-17 *Local Cross Section A-A' with view from SW to NE.*

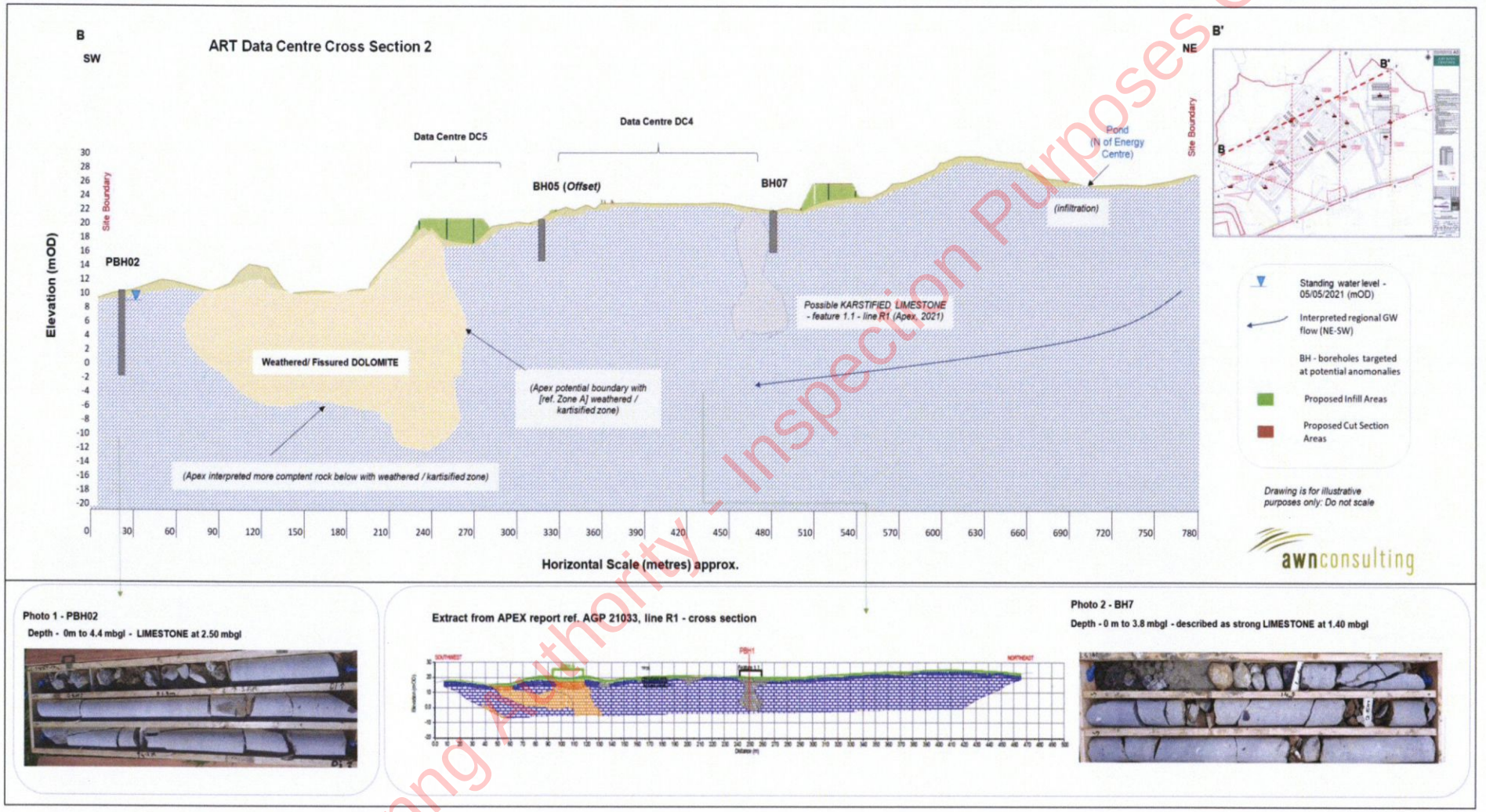

Figure 5-18 *Local Cross Section B-B' with view from SW to NE.*

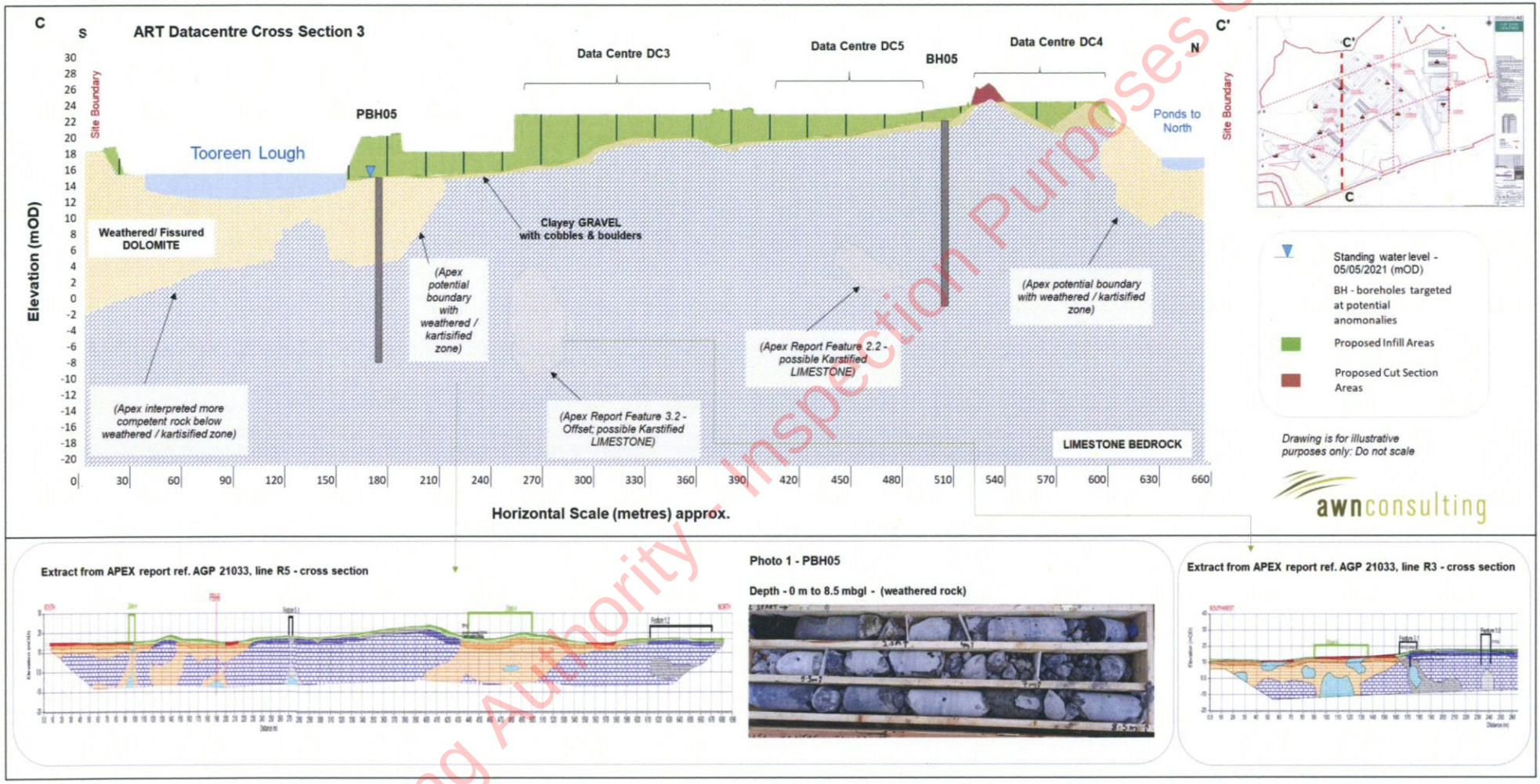

Figure 5-19 *Local Cross Section C-C' with view from S to N.*

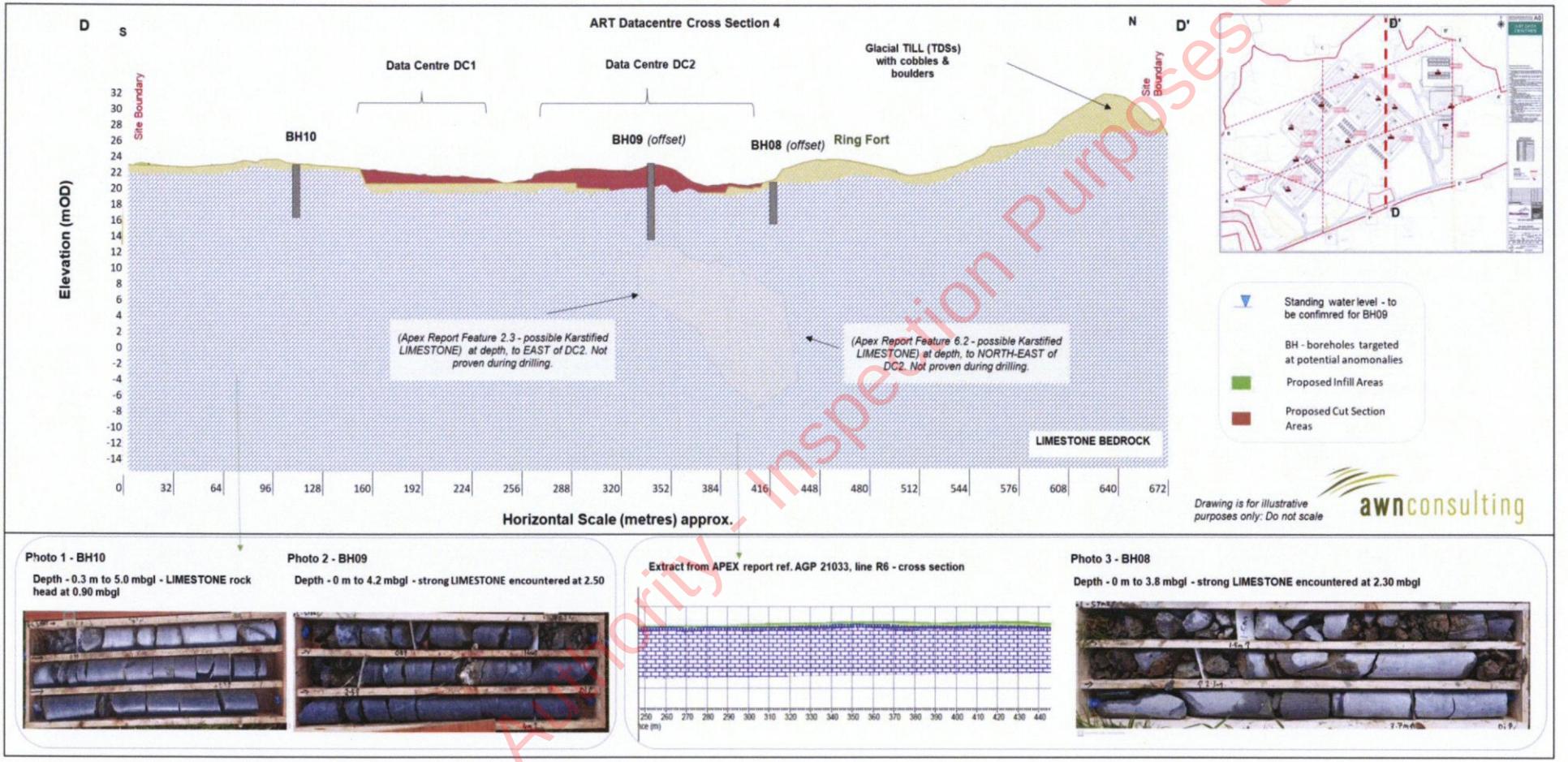

Figure 5-20 *Local Cross Section D-D' with view from S to N.*

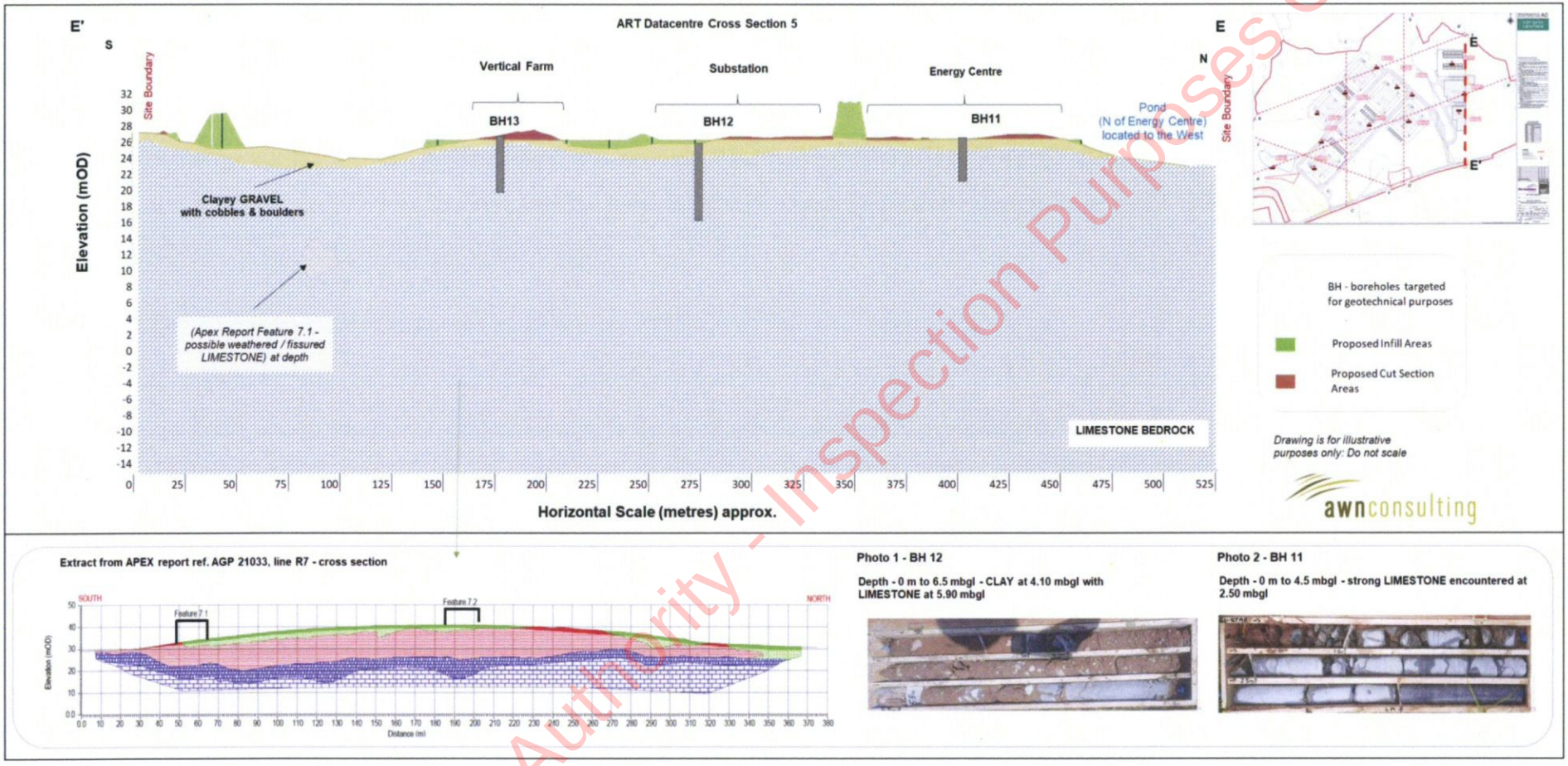

Figure 5-21 *Local Cross Section E-E' with view from S to N.*

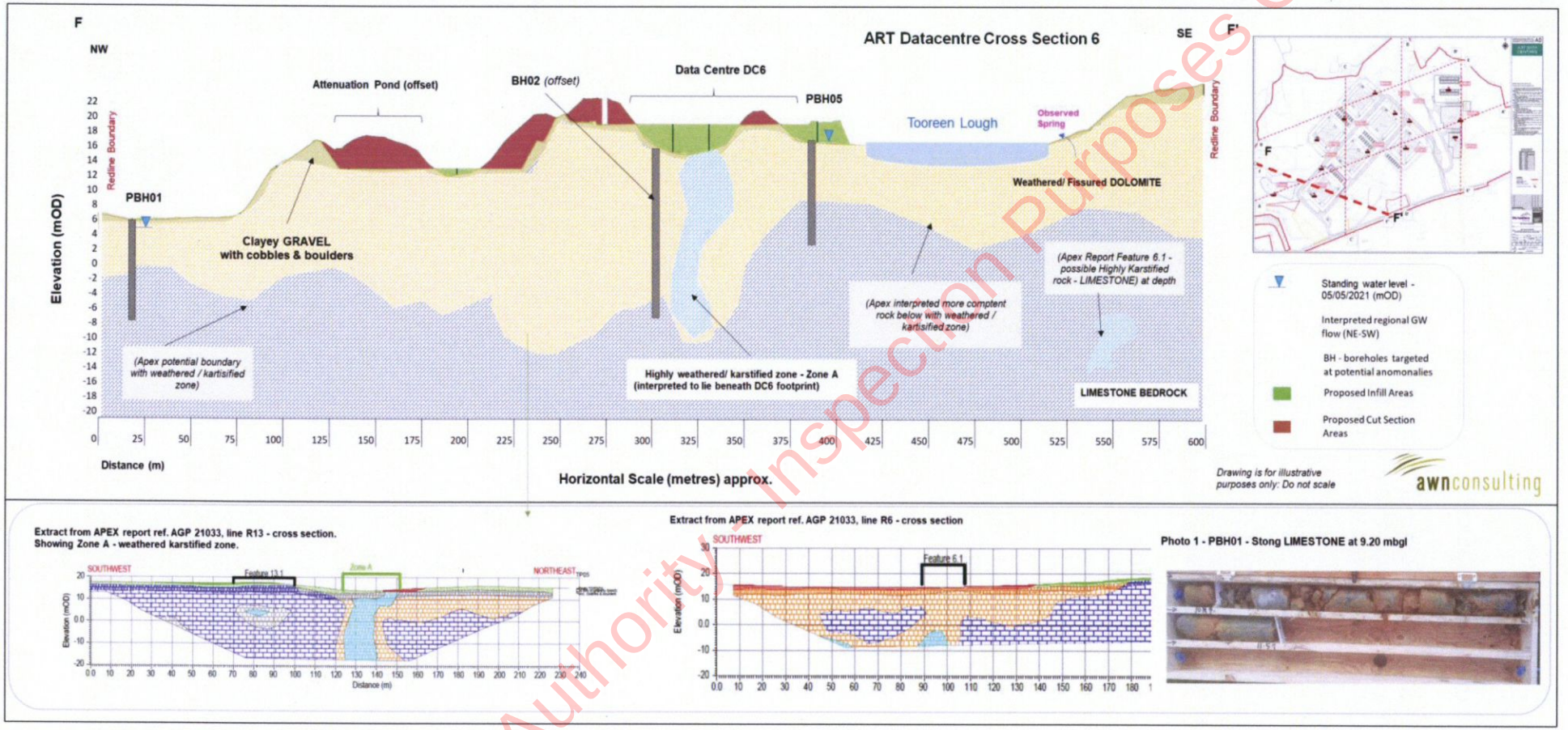

Figure 5-22 *Local Cross Section F-F' with view from NW to SE.*

5.3.19 Rating of Importance of Geological and Hydrogeological Attributes

Based on the TII (previously NRA) methodology (2009) (See Appendix 5.1), criteria for rating site importance of geological features, the importance of the bedrock and soil features at this site is rated as *'Medium Importance'* with medium significance or value on a local scale. This is due to the existence of well drained and/or high fertility soils across the site.

Based on the TII methodology (2009) (See Appendix 5.1) the importance of the hydrogeological features at this site is rated as '*Very High Importance'* based on the assessment that the attribute has a high-quality significance or value on a local scale. This assessment is based on the presence of the underlying aquifer which is a Regionally Important Aquifer. In addition, there would be direct or at least an indirect hydrogeological connection between the site and any protected sites (Natura Sites - SAC, SPA, NHA).

5.4 CHARACTERISTICS OF THE PROPOSED DEVELOPMENT

The proposed development is c. 60 hectares and comprises:

- Six (6) no. data centres buildings (DC1 to DC6).
- A gas-powered Energy Centre and Above Ground Installation (AGI).
- A new 110kV substation, two drop down masts and underground grid connection.
- Fibre connection.
- Connection and upgrade of foul sewer and mains supply extending along the existing R352.
- Undergrounding of two of the existing overhead 110kv circuits.
- Associated Infrastructure: including roads and an attenuation pond.
- Demolition (one house and a number of farm buildings).

The proposed development occupies c. 60 ha for the total development site. The proposed development represents an overall increase in hardstanding surfaces of approx. 17.3 hectares. The rest of the site comprises landscaping and undeveloped areas. The site layout reserves c. 10 ha of lands as ecological buffer zones. These indicated buffer zones can be seen in Figure 2.1 in Chapter 2 were delineated following assessment undertaken as part of the area assessment within the Clare County Development Plan 2017 – 2023 (Variation No. 1). Further assessment has been undertaken by the project ecologist to protect ecology during construction and operation of the proposed development.

It is noted that a significant proportion of the site is unpaved, and recharge will continue as current. In addition, where there is no storage of bulk fuel i.e., generator yards, SuDS measures have been incorporated in the design to facilitate recharge to ground.

5.4.1.1 Fuel Storage

In the event of a loss of power supply, the emergency generators are designed to automatically activate and provide power to the data storage facility. The generators will be supplied by low sulphur diesel. Fuel oil for the emergency generators is the only required bulk chemical required on site. Located within the services yard of three of the six datacentres, it is proposed to have up to 7 bunded above ground bulk storage tanks for fuel oil (440m^3 for three (3 no.) data storage facilities), distribution pumps, overground delivery pipeline to the belly tanks for diesel fired standby generators within each data storage facility.

The proposed Energy Centre will have back-up fuel storage with up to 20 fully bunded above ground bulk storage tanks for fuel oil (total of 1,440 m^3 of fuel oil). The total fuel store will be 2,900 m^3 (or 2,494 tonnes). All bunds will be capable of containing 110% of the volume of the largest drum/tank within the bund or 25% of the total volume of the substance stored and will designed in accordance with the EPA's guidelines for the storage and transfer of materials for scheduled activities (EPA, 2004).

The site is traversed by a high-pressure Gas Networks Ireland gas pipeline running in a S-N direction to the east of the development site. An AGI will be constructed to facilitate supply for the Energy Centre.

The redline boundary includes c. 2.1 km of the existing Tulla Road for connection to sewer.

Two of the 110kV overhead circuits which currently traverse the site will be brought underground to the [existing] Ennis substation as they come on to the site on the eastern side.

Further details of the proposed development are described in Chapter 2 Description of the Proposed Development. The details of the construction and operation of the development in terms of Land, Soils Geology and Hydrogeology is detailed in the Table 5.4 below.

Table 5.1 *Summary of site activities*

Phase	Activity	Description
Construction	Discharge to Ground	Run-off percolating to ground at the construction site.
	Earthworks: Excavation of Superficial Deposits	Excavations and infilling across the site are required for the site preparation and levelling works, to achieve foundation level and facilitate construction, along with arising from the installation of underground services. The project engineers have estimated that c. 111,424 m^3 of material will require excavation for the Data Centre site. This volume comprises topsoil, subsoils, and (eventually) bedrock. It is envisaged that the majority of this material will be reused on site as part of the site levelling works. This will be used as back fill and to establish the proposed landscaping berms. The estimates will be refined prior to commencement of construction. In addition to this there is a net import of suitable engineering fill up to c. 135,600 m^3 for the Data Centre site. These estimates will be refined prior to commencement of construction. Excavation of the proposed attenuation pond to the southwest of the site (proposed lowest surface water capture point within the main development site). The removal of localised overburden material will be required during preparation of the foundations and platform for the proposed structures. The foundations for the main buildings will be a mix of pad foundations and pile foundations to bedrock as required based on identified ground conditions.
	Storage of soils/aggregates	Aggregate materials such as sands and gravels will be stored in clearly marked receptacles within a secure compound area to prevent contamination. Temporary storage of spoil will be managed to prevent accidental release of dust and uncontrolled surface water run-off which may contain sediment and solid matter. Materials will be sent off site for recycling where possible and, if not suitable for recycling, materials will be disposed of to an appropriate permitted/licensed waste disposal facility.
	Storage of hazardous Material	Temporary storage of fuel required for on site for construction traffic. Liquid materials i.e., fuel storage will be located within temporary bunded areas, doubled skinned tanks or bunded containers (all bunds will conform to standard bunding specifications - BS8007-1987) to prevent spillage. These will be stored within the contractor yard.
	Localised Temporary Dewatering	There is no major dewatering works planned during the construction of the data centre site. According to site investigations, levels of groundwater from the aquifer beneath the site would range from approx. 2.73 mbgl (northeast of the site) to approx. 1.39 mbgl (southeast). Therefore, local groundwater ingress can be expected if excavations below c. 2.0 mbgl into rock are required to the southeast of the site, based on the Section 5.3.18 CSM above. It is also expected during the excavation works that localised dewatering of the subsoils will be required to address perched groundwater.
	Increase in hard standing area	The proposed surface water networks for the development collect runoff from roofs, roads and other hard standing areas in a sealed system of pipes and gullies. The proposed development represents an overall increase in hardstanding surfaces of c. 17.3 hectares.

Phase	Activity	Description
		The proposed surface water drainage service to the development comprises various drainage components including positive stormwater networks, attenuation systems and several Sustainable Drainage Systems (SuDS) elements. The proposed surface water drainage was designed in accordance with the SuDS Manual 2015. The developed area of the site is 17.3 ha and attenuation has been designed on site for the 1:100 yr. flood event including consideration of a 20 % allowance for climate change. An overflow subsurface pipeline will discharge at current discharge rates (greenfield) to the Ballymacahill (also referred to Spancelhill) River. Drainage will be to a single lined attenuation pond with an upgradient oil interceptor. An attenuation volume of 15,900 m^3 is designed as part of the proposed development. A continuous datalogger has been installed at the location of the proposed attenuation system/ pond - the reference groundwater monitoring well is BH01 (geotechnical borehole). It is recorded that the difference in water levels at BH01 over the full monitoring period 04/05/2021 to 13/01/2022 was 1.82 metres and this is shown on the hydrograph to lie approx. 2.55m below the proposed basin lower elevation of +12.23mAOD. The water level at this borehole (BH01) location ranged from +7.86 mAOD (September 2021) to +9.68 mAOD (January 2022). Reference is also made here to data reviewed from EPA long-term monitoring wells in Pure-Bedded Limestone (Height Fort Hire station – IE_SH_G_0052_3600_012) in the Limerick area which indicated a variation over the previous 3 months of lowest of approx. +13.37mOD to highest of approx. +13.95mOD; variation of ~0.58m between 25/10/2021 and 18/11/2021. Based on a year's monitoring data, there is a variation of 1.20 metres for 2021 when comparing winter and summer water levels, with +13.00mAOD the lowest recorded value and +14.20mAOD the highest value.

Phase	Activity	Description
Operation	Storage of hazardous Material	The site is traversed by a high-pressure Gas Networks Ireland gas pipeline. An AGI will be constructed to facilitate supply for the energy centre. In the event of a loss of power supply, the emergency generators are designed to automatically activate and provide power to the data storage facility. The generators will be supplied by low sulphur diesel. Fuel oil for the emergency generators is the only required bulk chemical required on site. Three of the six datacentres in their service yard, will have up to 7 bunded above ground bulk storage tanks for fuel oil (440 m^3 for three data storage facilities), distribution pumps, overground delivery pipeline to the belly tanks for diesel fired standby generators within each data storage facility. The energy centre will have back up fuel storage with up to 20 bunded above ground bulk storage tanks for fuel oil (total of 1,440 m^3 of fuel oil). The total fuel store will be 2900 m^3 or 2,494 tonnes. All bunds will be capable of containing 110% of the volume of the largest drum/tank within the bund or 25% of the total volume of the substance stored and will designed in accordance with the EPA's guidelines for the storage and transfer of materials for scheduled activities (EPA, 2004). As the oil is only for emergency use and testing, refuelling requirement is low and as such the potential for any leak/spill during delivery and offloading is low. A dedicated tanker unloading area will be provided at each of these service yards which will be surrounded by a drainage channel to capture any run-off. A class 1 oil-water full retention separator will be installed to capture any oil in the run-off from the pad. A standard operating procedure for fuel unloading will be in place at the site and tanks will be fitted with high level alarms to prevent overfilling. The risk to the aquifer is considered low due to the design measures in place for containment, delivery and distribution and use of oil interceptors on the stormwater system downgradient of the offloading area and prior to discharge from the site.

The projected volumes of strip, cut and fill are presented in Table 5.5 below:

Table 5.2 *Projected Earthwork Volumes*

	Volume (m^3)
Cut (incl. Utility Trenches)	111,424
Fill	241,303
Net imported material (granular material, concrete, capping, asphalt, topsoil)	135,600

It is predicted that the majority of the spoil generated during site preparation/levelling will be removed from site with some top soil and spoil used in landscaped and bermed areas.

Chapter 14 Waste Management of this EIA Report contains a detailed description of waste management relating to construction of the proposed development. A detailed Construction and Demolition Waste Management Plan will be prepared prior to construction to ensure best practice is followed in the management of waste from the proposed development.

As outlined in Table 5.4 the activities required for the construction phase of the proposed development represents the greatest risk of potential impact on the

geological environment. These activities primarily pertain to the site preparation, excavation, levelling and infilling activities required to facilitate construction of the proposed development.

5.4.2 Do Nothing Scenario

The proposed development land is currently agricultural land; the land is zoned 'enterprise' provides for the use and development of land for high end research and development, business science and technology-based industry, financial services, call centres/telemarketing, software development, data centres, enterprise and incubator units, small/medium manufacturing or corporate office in high quality campus/park type development.' It is likely that the land use will change over time even if this development does not go ahead. The associated impact of any such development will be similar to the proposed development for the underlying land soils and hydrogeological regime.

5.5 POTENTIAL IMPACTS OF THE PROPOSED DEVELOPMENT

An analysis of the potential impacts of the proposed development on the land, soils, geology and hydrogeological environment during the construction and operation is outlined below. Due to the inter-relationship between soils, geology and hydrogeology and surface water (hydrology) the following impacts discussed will be considered applicable to both Chapter 5 and 6 (Hydrology) of the EIAR. Remediation and mitigation measures included in the design of this project to address these potential impacts are presented in Section 5.6 below.

5.5.1 Construction Phase

5.5.1.1 Excavation and Infilling

Due to the lack of previous development at the site and the historical residential and agricultural use at the site, the risk of contaminated soils being present onsite is low and this was confirmed by onsite soil sampling and analysis. Nonetheless material, which is exported from site, if not correctly managed or handled, could impact negatively on human beings (onsite and offsite) as well as water and soil environments.

The levelling of the ground and excavation for foundations for the main buildings will require the excavation of topsoil, subsoil and bedrock (where encountered).

Excavated material will be reused on site for infilling and landscaping works where possible. Import of c. 135,600 m^3 of fill will be required.

Site investigation and laboratory analysis has not identified any existing contamination. However, if contaminated soil/water is encountered, it will be required to be removed by a licensed waste contractor.

Therefore, groundwater ingress is not expected, and localised dewatering will not be required during the construction phase – mainly in the eastern section of the building within the competent limestone rock. Minor groundwater strikes may be encountered but this groundwater volume would be minor given the ground condition and nature of the bedrock (competent limestone rock). However, minor groundwater strikes may be encountered but this groundwater volume would be minor given the ground condition and nature of the bedrock. Minor groundwater ingress is expected in the south-western section of the site where the majority of weathered dolomite and karstified limestone bedrock is located. Bedrock is close or at the surface in these areas. Minor dewatering

operations will not impact the flow regime of the karst features. It is expected during the excavation works that localised dewatering of the subsoils will be required to address perched groundwater. There will little to no dewatering required in areas of the competent limestone bedrock. Refer to Section 5.3.18 CSM above.

5.5.1.2 Accidental Spills and Leaks

As with all construction projects there is potential for water (rainfall and/or groundwater) to become contaminated with pollutants associated with construction activity. Contaminated water which arises from construction sites can pose a significant short-term risk to groundwater quality for the duration of the construction if contaminated water is allowed percolate to the aquifer. The potential main contaminants include:

- Suspended solids (muddy water with increase turbidity) – arising from excavation and ground disturbance;
- Cement/concrete (increase turbidity and pH) – arising from construction materials;
- Hydrocarbons (ecotoxic) – accidental spillages from construction plant or onsite storage;
- Wastewater (nutrient and microbial rich) – arising from accidental discharge from on-site toilets and washrooms.

Accidental spillages which are not mitigated may result in localised contamination of soils and groundwater underlying the site, should contaminants migrate through the subsoil's and impact the underlying groundwater. Groundwater vulnerability at the site is currently classified as a 'Extreme' to the southwestern section and 'Moderate' to 'High' throughout the rest of the site. Any soil stripping will also further reduce the thickness of subsoil and the natural protection they provide to the underlying aquifer.

5.5.1.3 Potential Blockage of Swallow Holes & Springs

During construction for Data Centre DC6 there is potential for the existing swallow hole that receives water from Tooreen Lough stream flow to become blocked if silt laden run-off is allowed to discharge to it directly.

Similar to the swallow hole at DC6, the main spring located to the immediate north of DC6 may also potentially be impacted from adjacent earthworks (sediment run-off for example) if not protected adequately during construction works.

5.5.1.4 Loss of agricultural land

There will be local loss of agricultural soil however, the area of development is small in the context of the overall agricultural land available in the region. The entire site is also zoned for development. Within the overall context of Ireland's available farmland, the loss is negligible. There will be no impact to mineral resources in the area as a result of the proposed development.

5.5.1.5 Summary of Construction Phase Impacts

A summary of construction phase impacts for the proposed development (with and without mitigation) following EPA (2017) EIA guidelines is provided below.

The magnitude of the impact for the construction phase without mitigation (design) measures is *Temporary* in duration with a *Significant impact* rating to the underlying aquifer and karst features present across the proposed development site.

However, with the implementation of design measures and mitigation measures (Section 5.6 below) for the proposed development site the impact of the construction phase is *Temporary* in duration with an *Imperceptible impact* rating.

5.5.2 Operational Phase

5.5.2.1 Discharge to Ground

There are no discharges to ground included in the design and no abstractions from the aquifer.

5.5.2.2 Increase in hardstanding

The increase in hardstanding (17.3 ha) will result in an increase in run-off rate and potential downgradient flooding, if not adequately attenuated on site. As described in Section 6.4.2.3 above, the design has incorporated adequate attenuation for a 1: 100-year flood event including correction for climate change effects.

Incorporation of hard stand area on previous greenfield area and the use of SUDs techniques will have a minor effect on local recharge to ground; however, the impact on the overall groundwater regime will be insignificant considering the proportion of the site area in relation to the total aquifer area. It is noted that a significant proportion of the site is unpaved, and recharge will continue as current. In addition, where there is no storage of bulk fuel i.e., generator yards, SuDS measures have been incorporated in the design to facilitate recharge to ground.

5.5.2.3 Accidental Spill and Leaks

The development includes the storage and use of diesel fuel which has the potential to have water quality impacts if a leak/ spill occurs and is not adequately mitigated. The design incorporates containment measures and measures for treatment of any spills/ leaks (described in Section 5.6 below).

Any accidental petrol emissions during storage, transfer, or delivery or leakage in the car parks could cause localised contamination if the emissions enter the soil and groundwater environment without adequate mitigation. However, it is noted that any accidental discharge will more likely impact stormwater drainage due to the hardstand and drainage infrastructure proposed and any releases to drainage will be mitigated through petrol interceptors.

5.5.2.4 Summary of the Operational Phase Impacts

A summary of operational phase impacts for the proposed development (with and without mitigation) following EPA (2017) EIA guidelines is provided below.

The magnitude of the impact for the operational phase without mitigation and design measures is *Temporary* in duration with a *Significant impact* rating to the underlying aquifer and karst features present across the proposed development site.

However, with the implementation of design and mitigation measures for the proposed development site the impact of the operation phase is *Long-term* in duration with an *Imperceptible impact* rating.

5.6 REMEDIAL AND MITIGATION MEASURES

The design has taken account of the potential impacts of the development on the land, soils, geology and hydrogeological environment local to the area where construction is taking place]. Measures (including full containment of oil storage areas) have been incorporated in the design to mitigate the potential effects on the surrounding soils, geology and hydrogeology. These are described below.

Due to the inter-relationship between soils, geology, hydrogeology, ecology and hydrology, the following mitigation measures discussed will be considered applicable to all. Waste Management is also considered an interaction in some sections.

5.6.1 Construction Phase

In order to reduce the potential for any adverse impacts on the existing hydrological environment, a number of mitigation measures will be adopted as part of the construction works on site.

A Construction Environmental Management Plan (CEMP) and Construction Surface Water Management Plan (SWMP) for the site are included with the planning documentation. The contractor will be obliged to work to implement the mitigation measures outlined in the CEMP and SWMP (refer to Chapter 13 of this EIA Report). The CEMP sets out the overarching vision of how the construction of the proposed development will be managed in a safe and organised manner by the Contractor.

The CEMP will be a live document and it will go through a number of iterations before works commence and during the works. It will set out requirements and standards which must be met during the construction stage and will include the relevant mitigation measures outlined in the EIA Report and any subsequent planning conditions relevant to the proposed development.

The SWMP follows best international practice including but not limited to:

- CIRIA, (2001), Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors, (C532) Construction Industry Research and Information Association;
- CIRIA (2002) Control of water pollution from construction sites: guidance for consultants and contractors (SPI56) Construction Industry Research and Information Association
- CIRIA (2005), *Environmental Good Practice on Site* (C650); Construction Industry Research and Information Association
- BPGCS005, Oil Storage Guidelines;
- Eastern Regional Fisheries Board, (2006), Fisheries Protection Guidelines: Requirements for the Protection of Fisheries Habitat during Construction and Development Works at River Sites;
- CIRIA 697, The SUDS Manual, 2007; and
- UK Pollution Prevention Guidelines (PPG) UK Environment Agency, 2004.

5.6.1.1 Control of Soil Excavation

Site preparation, excavations and levelling works required to facilitate construction of foundations, access roads and the installation of services will require c. 135,600 m^3 of imported material. A total of c. 111,424 m^3 will be excavated during the construction phase. Suitable soils will be reused on site as backfill in the grassed areas, where possible. Contractors shall be required to submit and adhere to a method statement

indicating the extent of areas likely to be affected and demonstrating that this is the minimum disturbance necessary to achieve the required works.

Topsoil and subsoil will be excavated to facilitate the construction of the proposed data centre buildings, energy centre building, substation, and other ancillary works. It is envisioned that soil/stones (topsoil & subsoil) arising on the site will be removed from the site and disposed of as a waste or, where appropriate, as a by-product by a licensed contractor. Soil tested and classified as hazardous or non-hazardous in accordance with the EPA *Waste Classification – List of Waste & Determining if Waste is Hazardous or Non-Hazardous* publication, HazWasteOnline tool or similar approved method. The material will then need to be classified as inert, non-hazardous, stable non-reactive hazardous or hazardous in accordance with *EC Decision 2003/33/EC*.

According to onsite investigations, the bedrock vulnerability is 'Moderate' to 'High' to the central and north-eastern section and 'Extreme' throughout the rest of the site (e.g., towards the south-western section of the site). Removal and reinstatement of subsoil cover will not alter the vulnerability category of the underlying bedrock. The deposition of infill soil would increase the overburden thickness (refer to Table 5.5 above) and thus may even decrease the groundwater vulnerability.

To facilitate the construction of the proposed sewer connection, it is proposed that approx. 2.1Km of the existing Tulla Road will be excavated. As a conservative measure, it is envisioned that the tarmacadam, concrete, and subsoils will be contaminated. Soil tested and classified as hazardous or non-hazardous in accordance with the EPA *Waste Classification – List of Waste & Determining if Waste is Hazardous or Non-Hazardous* publication, HazWasteOnline tool or similar approved method. The material will then need to be classified as inert, non-hazardous, stable non-reactive hazardous or hazardous in accordance with *EC Decision 2003/33/EC*. The material which is considered hazardous from this alignment for the sewer connection will be removed by a licensed contractor to a registered landfill facility.

Temporary storage of soil will be carefully managed in such a way as to prevent any potential negative impact on the receiving environment and the material will be stored away from any open surface water drains. No soil storing will be allowed within 30 metres of the open water where sufficient working areas are available within the site boundaries, which is in line with Inland Fisheries Ireland guidelines. Movement of material will be minimised in order to reduce degradation of soil structure and generation of dust.

Although there is no evidence of historical contamination in the proposed development area, all excavated materials will be visually assessed for signs of possible contamination such as staining or strong odours. Site investigations classified the subsoils as 'inert'. Should any unusual staining or odour be noticed, samples of this soil will be analysed for the presence of possible contaminants in order to ensure that historical pollution of the soil has not occurred. Should it be determined that any of the soil excavated is contaminated, this will be disposed of by a licensed waste disposal contractor.

Stockpiles have the potential to cause negative impacts on air and water quality. The effects of soil stripping and stockpiling will be mitigated against through the implementation of appropriate earthworks handling protocols during construction. Stockpiles will be formed within the boundary of the site and there will be no direct link or pathway from storage areas to any surface water body. Overburden material will be protected from exposure to wind by storing the material in sheltered parts of the site, where possible.

5.6.1.2 Sources of Fill and Aggregates

All fill and aggregate for the proposed development will be sourced from reputable suppliers. All suppliers will be vetted for:

- Aggregate compliance certificates/declarations of conformity for the classes of material specified for the proposed development;
- Environmental Management status; and
- Regulatory and Legal Compliance status of the Company.

5.6.1.3 Fuel and Chemical Handling

Any fuels or chemicals (including hydrocarbons or any polluting chemicals) will be stored in a designated, secure bunded area(s) within the designated contractor's compound to prevent any seepage of potential pollutants into the underlying subsoil and bedrock.

All mobile fuel bowsers shall carry a spill kit and operatives must have spill response training. All fuel containing equipment such as portable generators shall be placed on drip trays. All fuels and chemicals required to be stored on-site will be clearly marked. Care and attention will be taken during refuelling and maintenance operations. Particular attention will be paid to gradient and ground conditions, which could increase risk of discharge to waters.

To minimise any impact on the underlying subsurface strata from material spillages, all oils, solvents and paints used during construction will be stored within temporary bunded areas within the contractor's compound. Oil and fuel storage tanks shall be bunded to a volume of 110% of the capacity of the largest tank/container within the bunded area(s) (plus an allowance of 30 mm for rainwater ingress). Drainage from the bunded area(s) shall be diverted for collection and safe disposal.

Refuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles will take place in a designated area within the contractor's compound which will be away from surface water gullies or drains. In the event of a machine requiring refuelling outside of this area, fuel will be transported in a mobile double skinned tank. An adequate supply of spill kits and hydrocarbon adsorbent packs will be stored in this area. All relevant personnel will be fully trained in the use of this equipment. Guidelines such as '*Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors*' (CIRIA 532, 2001) will be complied with.

Where feasible, all ready-mixed concrete will be brought to site by truck. A suitable risk assessment for wet concreting will be completed prior to works being carried out which will include measures to prevent discharge of alkaline wastewaters or contaminated storm water to the underlying subsoil. Wash down and washout of concrete transporting vehicles will take place at an appropriate facility offsite and no washing of concrete from vehicles will be done on site.

In the case of drummed fuel or other chemical which may be used during construction, containers should be stored in a dedicated internally bunded chemical storage cabinet and labelled clearly to allow appropriate remedial action in the event of a spillage.

Emergency response procedures are required to be outlined in the detailed CEMP. All personnel working on the site will be suitably trained in the implementation of the procedures, and upskilled where necessary.

5.6.1.4 Accidental Spills

A robust and appropriate Spill Response Plan and Environmental Emergency Plan will be prepared prior to works commencing and they will be communicated, resourced and implemented for the duration of the works. Emergency procedures/ precautions and spillage kits will be available and construction staff will be trained and experienced in emergency procedures in the event of accidental fuel spillages.

Machinery activities on site during the construction phase may result in contamination of runoff/ surface water. Potential impacts could arise from accidental spillage of fuels, oils, paints etc. which could impact surface water if allowed to infiltrate to runoff to surface water systems and/or receiving watercourses. However, implementation of the mitigation measures detailed below will ensure that this does not occur.

Concreting operations carried out near surface water drainage points during construction activities could lead to discharges to a watercourse. Concrete (specifically, the cement component) is highly alkaline and any spillage to the underlying subsoil and aquifer bedrock would be detrimental to water quality and local fauna and flora. However, employment of the mitigation measures highlighted above and within the CEMP will ensure that any impact will be mitigated.

5.6.1.5 Protection of Hydrological / Hydrogeological Water Features

This section describes the specific mitigation measures implemented during construction for the protection of the existing identified surface water features and maintaining the existing surface water drainage system. Given the interconnectivity between the identified surface water features and groundwater type features in what is a karst environment then all mitigation measure which apply to hydrogeology will also apply to hydrology (Refer to Chapter 6, Section 6.6).

These measures will be implemented in association with the measures described above to ensure the protection of all hydrological [and hydrogeological] attributes. Mitigation measures are further discussed in the CEMP and SWMP for the development.

Tooreen Lough

There will be no construction works carried out within Tooreen Lough. There will be no oil or subsoil storage in the vicinity of this feature. An ecological buffer of at least 10 metres applies to this feature.

It is proposed that that overland stream discharging from Tooreen Lough will be culverted. The culvert will be designed in accordance with *Section 50 of the Arterial Drainage Act, 1945*, as amended and the overground pipe will be adequately designed for winter flows. This will ensure continued conveyance of existing flows without any upgradient or downgradient impacts on flow or water quality. The culvert will be adequately sized for current and future flow conditions.

Ardnamurry Lough

There are no construction activities planned for this area and this feature is located upgradient and outside of the redline boundary, along the eastern boundary of the proposed development. Therefore, no mitigation measures are needed for this feature.

Swallow Hole (Receiving water from Tooreen Lough) located south of DC6

Prior to commencement of construction works, the discharge stream from Tooreen Lough and swallow hole will be clearly delineated and marked. The swallow hole will be surrounded by a concrete ring with chamber and accessed by a manhole cover to avoid blockage during works on the site. This swallow hole will be monitored daily to ensure it is free flowing. i.e. ensuring no change to the existing flow regime there.

Main Spring located north of DC6

Prior to commencement of construction works, the spring and areas around this feature will be clearly delineated and marked. There are no proposed construction works within this spring area and a buffer zone of at least 10 metres will be implemented to ensure that the integrity of the spring is protected. Therefore, maintaining the flow and water quality of this spring. Daily to weekly monitoring of the spring in terms of flow and water quality will be recorded during construction phase works.

Furthermore, provision of exclusion zones and barriers (e.g. silt fences) between earthworks, stockpiles and temporary surfaces will be provided to prevent sediment washing into the existing drainage systems and hence protecting the integrity of this feature.

Pond located North of the Energy Centre

There are no construction activities proposed within this feature. It is proposed that the Energy Centre will be built up by infill material and a retaining wall will be built to protect the pond feature. An existing [field dividing] wall is in place and will be protected throughout the construction phase works.

Karst Features - conduits/ flow paths

The building foundations will be a combination of both pad and piled foundations. The subsurface design is based on the nature of the soils and geology identified in the site investigation undertaken in May-June 2021 and presented in Figures 5.16 - 5.21. In areas where karst features (including clay/sand/gravel infilled cavities and/or clay/water infilling of fissures/ voids) were interpreted beneath buildings (DC5 and DC6), then the design of the piling methodology proposed including pile depths/ pile spacing will allow for effective bridging of the existing karst terrain including any such clay/ water infilled features; this approach will ensure no change to the existing groundwater flow regime across the site. Relevant subsurface designs are provided within the planning drawings provided with planning (Drawing reference ART-CSE-ZZ-XX-DR-C-1800).

Further geophysical surveys were carried out across proposed structure DC6 to examine the degree of karstified rock and the potential for clay/water infilled conduits underlying this data centre building. The findings of the geophysical survey (Apex, 2022) fed into the overall foundation design and the construction methodology, i.e. the use of piling as discussed below. The foundation and piling methodology are designed such as to maintain as far as possible the existing groundwater movement at depth at the site. This relates to both the more competent geology as reported by Apex for the general mid to eastern portion of the site as well as to the more weathered and dolomitised limestone rock reported to lie mostly within the western extent and over which DC6, and a portion of DC5, will lie.

Groundwater movement is observed from continuous dataloggers (installed to date for approximately 9 months) to flow east to west as indicated in the hydrographs presented in Appendix 5.3 and this would be expected given the degree of weathering reported

during the geophysical survey work and spatially across the site boundary. The western part of the proposed development site ties in with the Ballymacahill River and so this is considered as potentially the comparatively more saturated area. The additional geophysical survey near the river has also confirmed the extent of the weathering farther west and towards the river where not previously surveyed.

Piling foundation design has considered the importance of ensuring the continuity of groundwater flow at depth across the site with the key objective of negating/ limiting the impacts otherwise associated with groundwater mounding potential upgradient of other pile types. Refer to drawings 3108-AST-ZZ-00-DR-S-0101 DC6 - Summary Interpretation Map of Soils -Phase I & II, and 3108-AST-ZZ-00-DR-S-0102 DC6 - Summary Interpretation Map of Bedrock Geology -Phase I & II both of which present detailed plan and sections for the DC6 structure in particular.

The piling design has adopted the foundation strategy of piled foundations using 500mm diameter CFA (Continuous Flight Auger methodology), which in turn supports the superstructure using a grillage of pile caps and reinforced concrete ground beams. This construction is located just below the finished floor levels of the buildings (including within engineered site infill) with only the piling columns extending down through the existing site level and into the rock strata below. This methodology also 'minimises' below ground disturbance which is an important attribute in karst terrain. One can see from the sections presented in drawings 3108-AST-ZZ-00-DR-S-0101 and 3108-AST-ZZ-00-DR-S-0102 for DC6 -where the bedrock is highly weathered and therefore acting as a 'porous medium' for groundwater movement - that the spacing (linear m) of the bored piles will not interfere with any groundwater flows. The use of CFA as a piling methodology is very different to other contiguous methodologies such as secant or sheet piling in that the CFA will not create a 'barrier' to the natural/ existing flow regime but rather ensure that the natural hydraulic conditions are maintained. The piling column lateral separation has been set as far apart as possible – ranging from 3 metres to 12 metres below DC6 and therefore prevents any upgradient mounding effects. Furthermore, the CFA piling operation itself, restricts 'concrete overfill', within the supporting rock strata.

Therefore, the piling below the footprint of DC6 (and DC5) will have negligible impact on groundwater movement potential beneath the data centre building(s).

Ponds located North of the DC4

There are no construction phase activities proposed within these two (2) no. features. However, the proposed Data Centre building DC4 is located in close proximity. It is proposed that the DC4 structure will be 'built up' using engineered infill material.

As previously discussed, there will be no stockpiling of subsoil/ rock matrix by this feature as well as fuel storage -fuel will be adequately stored in effective bunds located within the contractor compound. Provision of exclusion zones and barriers (e.g. silt fences) between earthworks, stockpiles and temporary surfaces to prevent sediment washing into the existing drainage systems like this feature and hence protecting the integrity of this attribute.

5.6.1.6 Control of Water during Construction

Care will be taken to ensure that exposed soil surfaces are stable to minimise erosion. All exposed soil surfaces will be within the main excavation site, which limits the potential for any offsite impacts.

Should any discharge of construction water be required during the construction phase, discharge will be to foul sewer. Pre-treatment and silt reduction measures on site will include a combination of silt fencing, settlement measures (silt traps, 20 m buffer zone between machinery and watercourses, refuelling of machinery off site) and hydrocarbon interceptors.

Any minor ingress of groundwater and collected rainfall in the excavation will be pumped out during construction. It is estimated that the inflow rate of groundwater will be low and limited to the northeast of the site. It is therefore proposed that the water be discharged via the existing stormwater sewer network. Extensive monitoring will be adopted to ensure that the water is of sufficient quality to discharge to the sewer. The use of slit traps and an oil interceptor (if required) will be adopted if the monitoring indicates the requirements for the same with no silt or contaminated water permitted to discharge to the sewer. There may be localised pumping of surface run-off from the excavations during and after heavy rainfall events to ensure that the excavations are kept relatively dry. Due to the very low permeability of the subsoils and the relative shallow nature for excavations, infiltration to the underlying aquifer is not anticipated.

The management of surface water runoff is further discussed in Chapter 6 Section 6.6 and the project-specific Surface Water Management Plan (SWMP) attached to this EIA Report.

5.6.2 Operational Phase

5.6.2.1 Emergency Response Procedures

As normal for a development site of this type, all staff will be suitably trained in emergency response procedures and standard operating procedures (SOPs) to respond to an on-site fuel spillage incident. All employees will be provided with such equipment, information, training and supervision as is necessary to implement the emergency response procedures and SOPs.

5.6.2.2 *Environmental Procedures*

Containment measures are included within the design to reduce potential for environmental impact. There will be comprehensive emergency response procedures and SOPs to respond to chemical/ oil spillage of all types. All employees will be provided with such equipment, information, training and supervision as is necessary to implement the emergency response procedures and SOPs.

5.6.2.3 Fuel Storage

The provision of spill kit facilities and training of operatives in use of same; should be undertaken at the operational stage in order to manage any leaks from fuel storage and vehicles resulting in soil and/or groundwater quality impacts:

All bunds will be capable of containing 110% of the volume of the largest drum/tank within the bund or 25% of the total volume of the substance stored and will designed in accordance with the EPA's guidelines for the storage and transfer of materials for scheduled activities (EPA, 2004). As oil is only required for emergency operation only and testing, refuelling requirement is very low therefore the risk from tanker movement is low. A dedicated tanker unloading area will be provided at each of these service yards which will be surrounded by a drainage channel to capture any run-off. A class 1 oil-water full retention separator will be installed to capture any oil in the run-off from

the pad. A standard operating procedure for fuel unloading will be in place at the site and tanks will be fitted with high level alarms to prevent overfilling.

The storage of fuel oil for the emergency generators should be restricted to the generator yard, the bulk fuel tanks, and belly tanks should be bunded, and the over ground delivery pipeline double-lined. The final design for the diesel storage will be contained within a bunded area in line with the requirements of the *Guidance to Storage and Transfer of Materials for Scheduled Activities* (EPA, 2005).

In terms of the risk to the underlying aquifer (with connectivity to surface water features) this is considered low due to the mitigation in place for containment, delivery and distribution and use of oil interceptors on the stormwater system downgradient of the off-loading area and prior to discharge from the site.

5.6.2.4 Management of Surface water during Operation

The proposed development will provide full attenuation for increase in hardstand area in compliance with the requirements of the Greater Dublin Strategic Drainage Study. The proposed surface water drainage service to the development comprises various drainage components including positive stormwater networks, attenuation systems and several Sustainable Drainage Systems (SuDS) elements. The proposed surface water drainage was designed in accordance with the SuDS Manual 2015. This is further detailed in Chapter 6 Hydrology of this EIA Report.

5.6.2.5 Protection of Surface Water Features

Intermittent and on-going inspection and maintenance of the swallow hole south of DC6 discharge from Tooreen lough will be undertaken to ensure free flowing discharge to Ballymacahill River along the western boundary of the proposed development.

5.7 CUMULATIVE IMPACT ASSESSMENT

The cumulative impact of the proposed development with any/all relevant other planned or permitted developments (as described in Chapter 3 Appendix 3.1)) are discussed below.

5.7.1 Construction Phase

The potential for impact on land, soils and groundwater during construction primarily arises from accidental leaks and spills to ground or dewatering. The proposed development does not require dewatering and with the proposed mitigation in place (as outlined in Section 5.6) for management of accidental discharges, the effect due to construction in this area is considered to be a *neutral* on quality and an *imperceptible* significance. Contractors for the proposed development will be contractually required to operate in compliance with the CEMP which includes the mitigation measures outlined in this EIA report. The other developments considered, which are identified in Chapter 3 and Appendix 3.1 will also have to incorporate measures to protect soil and water quality in compliance with legislative standards for receiving water quality. As a result, there will be no cumulative potential for change in soil quality or the natural groundwater regime. The cumulative impact is considered to be *neutral and imperceptible*.

5.7.2 Operation Phase

Overall, there will be a local change in recharge to ground pattern due to the increase in hardstand from these proposed and planned developments. However, based on the overall size of the underlying aquifer and measures to protect soil and water quality there will be no overall change on the groundwater body status. The operation of the proposed development is concluded to have a *long-term, imperceptible* significance *with a neutral* impact on soil and water quality.

The proposed development includes design measures to protect against any accidental discharges to ground e.g. adequate containment measures for oil storage, use of hardstand in loading areas and drainage through oil interceptors. As such the impact will be *neutral* and *imperceptible* in relation to soil and water. The other developments considered, which are identified in Chapter 3 and Appendix 3.1, will be required to manage sites in compliance with legislative standards for receiving water quality. As such the cumulative or in-combination impacts are concluded to be *neutral* and *imperceptible* in relation to soil and water.

Overall, there will be a loss of agricultural land which is in line with the zoning of the area therefore the cumulative impact on land is considered to be *long-term neutral* and *not significant.*

5.8 RESIDUAL IMPACTS OF THE PROPOSED DEVELOPMENT

5.8.1 Construction Phase

The implementation of mitigation measures outlined above (Section 5.6) will ensure that the predicted impacts on the geological and hydrogeological environment do not occur during the construction phase and that the residual impact will be **short-term-imperceptible-neutral**. Following the TII criteria (refer to Appendix 5.1) for rating the magnitude and significance of impacts on the geological and hydrogeological related attributes, the magnitude of impact is considered **negligible**.

5.8.2 Operational Phase

The implementation of the design and mitigation measures highlighted above (Section 5.6) will ensure that the predicted impacts on the geological and hydrogeological environment do not occur during the operational phase and that the residual impact will be **long-term-imperceptible-neutral**. Following the TII criteria (refer to Appendix 5.1) for rating the magnitude and significance of impacts on the geological and hydrogeological related attributes, the magnitude of impact is considered **negligible**.

5.9 MONITORING OR REINSTATEMENT

5.9.1 Construction Phase

During construction phase the contractor will be obliged to undertake monitoring in compliance with the SWMP and CEMP this will include:

- Regular inspection of surface water run-off and sediments controls e.g. silt traps will be carried during the construction phase.
- Weekly checks will be carried out to ensure surface water drains are not blocked by silt, or any other items, and that all soil storage is located at least 10 metres from the nearest surface water receptors. A regular log of inspections

will be maintained, and any significant blockage or spill incidents will be recorded for root cause investigation purposes and updating procedures to ensure incidents do not re-occur.

- Regular inspection of construction mitigation measures will be undertaken e.g. concrete pouring, refuelling etc.
- Regular monitoring of the silt traps/ trenches/ fences around established buffer zones to ensure on-going protection of all hydrological and hydrogeological water attributes.
- Soil sampling to confirm disposal options for excavated soils.

5.9.2 Operational Phase

There will be no requirement for groundwater monitoring as there is no likely discharge to ground. Maintenance of the surface water drainage system and foul sewers as per normal urban developments is recommended to minimise any accidental discharges to ground.