7.0 Soils, Geology and Hydrogeology

7.1. Introduction

This Chapter describes the existing soils, geology and hydrogeological environment of the site of the proposed development of The National Maternity Hospital at St. Vincent's University Hospital campus, Elm Park, Dublin 4, and its immediate surroundings.

The proposed National Maternity Hospital building will be located at the eastern side of the hospital campus and comprises the construction of a building that rises to 5 and 6 storeys above ground level, with one partial basement level, plus additional ancillary plant areas at the roof level. The proposed development also includes an extension to the existing multi-storey car park at the north of the campus. The proposed development will be constructed in a sequential manner that allows for the continual operation of the hospital campus and, as such, includes the phased demolition of existing buildings at St. Vincent's University Hospital campus to facilitate clearing the site for the proposed development and the construction of temporary accommodation to facilitate construction sequencing (including a single storey temporary canteen, catering staff changing facilities, household services store and carpenters workshop). The full detail of the nature and extent of the proposed development is set out in Chapter 2 of this EIS and the Draft Construction Management Plan is appended to same.

The Chapter describes and assesses the likely impacts on the soils, geology and hydrogeology associated with both the construction and operational phases of the proposed development.

Measures to mitigate the likely impacts of the development are proposed and residual impacts described. The Chapter initially sets out the methodology used, describes the baseline data available for the existing soils, geology and hydrogeology environment and examines the potential and predicted impacts of the proposal and associated mitigation measures.

All figures referred to below are presented in Appendix 7.1.

7.2. Methodology

This Chapter has been prepared in accordance with the following guidelines:

- Environmental Protection Agency (EPA) Revised *Guidelines on the Information to be contained in Environmental Impact Statements*[1];
- EPA *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements*[2]; and
- Institute of Geologists of Ireland *Guidelines for the Preparation of Soils, Geology and Hydrogeology Chapters of Environmental Impact Statements*[3].

7.2.1. Application of Methodology

The potential impact of the proposed development on the soils, geology and hydrogeology environment has been assessed by classifying the importance of the relevant geological and hydrogeological features and quantifying the likely magnitude of any impact on these attributes. This allows the significance of the impact on the relevant feature to be determined.

This impact assessment methodology is in accordance with the guidance outlined in *Guidelines for the Preparation of Soil, Geology and Hydrogeology Chapters of Environmental Impact Statements* published by the Institute of Geologists of Ireland in 2013[3].

The document outlines a 13 step methodology which is divided across 4 distinct elements:

- Initial Assessment;
- Direct and Indirect Site Investigation;
- Mitigation Measures, Residual Impacts and Final Impact Assessment; and
- Completion of the Soils, Geological and Hydrogeological Sections of the EIS.

The Initial Assessment of the site is outlined in Section 7.3 '*Receiving Environment*' and presents a description of the past and present uses of the site and other neighbouring sites. This Section also describes the nature of the site based on both site specific and neighbouring site investigation data, obtained internally and from publically available sources.

Section 7.3.10 '*Site Specific Baseline Information*' and the sections therein contain discussion on the site specific data available for the site including information from numerous site specific ground investigations carried out. This, along with other sections from within Section 7.3 '*Receiving Environment*' looks at the regional setting of the site and corresponds to the second element of the methodology, direct and indirect site investigation and studies.

The outcome from examining this available data is the Conceptual Site Model which is briefly outlined in Section 7.3.10.5. The Conceptual Site Model is a summary of conditions at a site. Based on the derived Conceptual Site Model, the site is classified as a Type A environment according to the guidelines.

Section 7.4 outlines the characteristics of the proposed development and Section 7.5 lists the possible impacts associated with the development of the site.

Section 7.7.3 outlines the '*Do Nothing Scenario*', while Section 7.6 outlines the '*Mitigation Measures*' associated with the works.

7.2.2. Study Area

The geological/hydrogeological environment has been reviewed within a distance of 2km from the campus boundary in accordance with the requirements of the Institute of Geologists of Ireland Guidelines[3]. Figure 7.1 shows the 2km zone of interest relative to campus boundary.

7.2.3. Site Visits

Campus walkovers have been carried out at various stages of the design development including site monitoring during the most recent phase of ground investigation.

7.2.4. Consultation

Publically available datasets relating to the soils, geology and hydrogeology have been consulted as part of the preparation of this Chapter.

7.3. Receiving Environment

The existing environment is discussed in terms of geomorphology (landscape and topography), superficial and solid geology and groundwater/hydrogeology.

Regional information generally refers to an area within 2km of the campus. The study area refers to the St. Vincent's University Hospital Campus in which the proposed development is located (Figure 7.1).

7.3.1. Baseline Data Collection

The information presented in this Chapter is based on information obtained from three main sources:

- Desk study information;
- Previous/historic Environmental Impact Assessments for other projects in the vicinity of the proposed development; and
- Previous/ historic ground investigation information in the vicinity of the proposed development.

7.3.1.1. Desk Study Information

A desk study was carried out as a preliminary assessment of the ground conditions of the campus. Relevant published or pre-existing available information was reviewed in addition to the sources listed below:

- Bedrock geology, Geological Survey of Ireland (GSI);
- Karst Database, GSI;
- Teagasc Subsoils Map, GSI;
- National Landslide Database, GSI;
- Draft bedrock aquifer map, GSI;
- Draft gravel aquifer map, GSI;
- Groundwater Recharge Map, GSI;
- Locations of Groundwater Wells and Springs, GSI;
- Drinking Water Protection Areas, GSI;
- Groundwater Vulnerability, GSI;
- Water Frame Work Directive Groundwater Bodies, GSI;
- Directory of Active Quarries, Pits and Mines in Ireland, GSI;
- Historical and Current Pits and Quarries, GSI;
- Aggregate Potential Mapping, GSI;
- Geological Heritage Area, GSI;
- Historical Maps, Ordnance Survey of Ireland;
- Discovery Series Map No. 50, Ordnance Survey of Ireland;

- Waste Licence and Permits, EPA;
- Integrated Protection and Pollution Control Licenses, EPA;
- Natural Heritage Areas and Proposed Natural Heritage Areas (pNHA), The National Parks and Wildlife Service;
- Special Areas of Conservation, The National Parks and Wildlife Service;
- Special Protection Areas (SPA), The National Parks and Wildlife Service; and
- Rainfall data, Met Éireann.

7.3.1.2. Previous / Historic Environmental Impact Statements

The following Environmental Impact Statements from other projects in the vicinity of the proposed development were reviewed as part of the baseline data collection phase:

- *St Vincent's New Private Hospital Environmental Impact Statement, 2006[4];*
- *St Vincent's Hospital Redevelopment, Environmental Impact Statement, 1998[5]; and*
- *RTE Project 2025, Environmental Impact Statement, 2009[6]*

7.3.1.3. Previous / Historic Ground Investigations

A number of site investigations were reviewed as part of the baseline data collection phase. These investigations are within the vicinity of the Campus and are sourced from:

- Health Service Executive;
- St Vincent's University Hospital;
- St Vincent's Private Hospital;
- Geological Survey of Ireland Online Mapping; and
- Arup's Archive.

Refer to Section 7.3.10.1 for further details.

7.3.2. Topography and Geomorphology

The proposed development is located in an urban setting within the St. Vincent's University Hospital campus. The elevation ranges from about 4 m OD to 10 m OD (Malin) sloping downwards towards the north east, however the ground profile has been levelled in areas of existing buildings, roads and car parks.

Where there is green space it is typically underlain by made ground. The main proposed buildings will have a finished floor level similar to the existing buildings at this location of 6 m OD.

7.3.3. Regional Soils and Sub-soils

Within the Dublin City area, the overburden generally comprises made ground overlying glacial drift deposits with areas of estuarine and alluvial sediments associated with existing and historic water bodies. These deposits in turn overlie limestone bedrock at depth.

Drift is a general term applied to all mineral material (clay, silt, sand, gravel and boulders) transported by a glacier and deposited directly as till, by or from the ice, or as fluvioglacial deposits by running water emanating from the glacier.

During the Pleistocene epoch of the Quaternary (the most recent geological time period) two glaciations covered the Dublin region.

These glaciations gave rise to the deposition of the till stratum generally referred to as the Dublin Boulder Clay and were presumably not continuous. Local withdrawal and re-advance of the ice sheet led to the formation of fluvioglacial sediments (gravel and sand lenses) and glaciomarine sediments (stiff/firm laminated clays, silts, and sands). The glacial deposits can exhibit significant lateral and vertical variations in grain size distributions over short distances.

Reference to Farrell and Wall (1990)[7] reveals that the glacial drift is comprised of brown and black boulder clays. This glacial till material is generally described as intermittent layers of hard to stiff brown/black sandy gravelly clay with many cobbles and boulders and dense to very dense sandy gravel with cobbles and boulders. The brown boulder clay is generally found to cover the black or directly above bedrock and is hence considered to be the result of weathering of the black boulder clay. Brown boulder clay is usually a firm to stiff sandy gravelly clay, while black boulder clay is generally stiffer than the brown clay. Both clays are of low plasticity, and water bearing sand and gravel deposits are often encountered within this material.

The GSI Subsoil Map indicates that the subsoil is limestone till. The Teagasc Topsoil Map indicate that the soils of the area are predominantly made ground, see Figure 7.2.

7.3.4. Regional Bedrock Geology

Carboniferous limestone is the predominant rock type in the study area with granite to the south as shown in Figure 7.3. The limestone is part of the Calp Formation described as a varied dark grey to black basinal limestone and shale in several different formations that are undifferentiated on the geological map.

The limestone was deposited in a shallow marine environment. Cyclical changes in the depth of the water and depositional conditions led to marked changes in the rock properties such as thickness, variations in the sand and clay content, and the inclusion of shale and mudstone layers that are occasionally weathered to clay (Farrell and Wall (1990)[7] and Skipper et al. (2005)[8]).

Weathering and erosion during the Tertiary period and during the glaciations gave the Carboniferous bedrock an irregular top of rock surface profile. Sea level variations and/or tectonic activities gave rise to drainage channels that cut into the bedrock. Due to the thick cover of glacial till overlying the bedrock and the consequential lack of bedrock exposure, very little information is available on faulting within the Carboniferous bedrock.

It is suggested by Nolan (1985)[9] that the overall fault pattern observed in the vicinity of Dublin indicates the predominance of strike directions North East-South West, with subordinate faults striking North West-South South East and East North East-West South West to East-West. The major regional geological faults are shown on Figure 7.3.

The bedrock level generally decreases in a north east direction from a maximum of 40mOD to a minimum of -40mOD as shown in the GSI Bedrock Surface Height Map, see Figure 7.4.

The GSI Karst Database indicates that there are no identified karst features present in the 2km zone of interest. The only karst feature in the Dublin area is a spring in St. Doolaghs which is 10km north of the Campus, and hence is not considered relevant to this assessment.

7.3.5. Aggregate Potential, Historic and Active Pits and Quarries

7.3.5.1. Aggregate Potential

The Minerals Section of the GSI provides dataset of Aggregate Potential Mapping of identified sand, gravel and rock resources that are considered useful to be aggregates in the construction industry.

This dataset indicates that the campus has a moderate to very high aggregate potential and a low to moderate crushed rock aggregate potential.

However, due to the urban setting the practicality and likelihood of these sources being utilised by the extractive industry is low and hence the aggregate potential will not be considered further in this assessment.

7.3.5.2. Historic and Active Pits and Quarries

The GSI Aggregate Potential Mapping also maintains a database of quarry activities for planning development considerations, in particular environmental and culturally sensitive sites. Aspects relevant to this Chapter include the environmental impact of historic and currently active pits and quarries to the aquifers and ultimately groundwater. Old pits and quarries have potentially been backfilled with unknown materials.

The OSI Historic Map data indicates that there are eight locations of historic pit and quarry activities within the 2km zone of interest, see Figure 7.5. However, due to their size (less than 200m in diameter) and distance from the campus (over 1km north and west of the campus) it is not considered that these pits will have an impact on the groundwater beneath the campus due to the general trend of groundwater flow towards the rivers and the sea and not south towards the campus.

7.3.5.3. Historic and Active Mines

There are no current or existing mines in the 2 km study area[10].

7.3.6. Regional Hydrogeology

The study area is located within the Eastern River Basin District which includes the River Liffey and its tributaries. The proposed development will be located within the Dublin Urban Groundwater Body which covers some 470 km^2 and includes most of Dublin City and extends westwards to include parts of counties Kildare and Meath.

The Dublin Urban Groundwater Body is underlain by Carboniferous limestone, shales and some sandstones. The bedrock aquifers tend to be dominated by fissure or fracture flow with very little to no flow in the matrix and tend to be associated with limited storage capacity.

Groundwater within the Dublin Urban Groundwater Body generally flows in an eastward direction discharging to the closest river or stream or directly into Dublin Bay.

Studies carried out under the Water Framework Directive[11] have concluded that the groundwater within the Dublin Urban Groundwater Body is presently of 'Good' Status.

The objective up to 2015 is to protect this 'Good' Status recognises that the quality of the groundwater in the Dublin Urban Groundwater Body is at risk due to point and diffuse sources of pollution that are normally found in an urban environment such as contaminated land and leaking sewer networks.

7.3.6.1. Groundwater Resources & Aquifer Classification

The GSI has devised a system for classifying the aquifers in Ireland based on the hydrogeological characteristics, size and productivity of the groundwater resource to produce the National Groundwater Aquifers Map. The three main classifications are Regionally Important Aquifers, Locally Important Aquifers and Poor Aquifers.

Each of these types of aquifer is further subdivided and has a specific range of criteria associated with it such as the transmissivity (m^2/day), productivity, yield and the potential for springs.

Due to hydrogeological properties of the underlying bedrock, the bedrock aquifer is related by rock units. The aquifers in the 2km zone of interest are detailed in Table 7.1

Table 7.1: Bedrock Aquifers in 2km Zone of Interest

Bedrock Unit	Bedrock Aquifer Class
Calp Formation	LI: Locally Important Aquifer - Bedrock which is moderately productive only in local zones
Granite (Type 2b)	PI: Poor Aquifer – Bedrock which is generally unproductive except for local zones

The bedrock aquifer underlying the proposed development is classified as a 'Locally Important Aquifer', see Figure 7.6 and is associated with the Calp Formation. In aquifers classified as Locally Important, there is the potential for contamination and deterioration of local water supplies and springs through changing groundwater flow paths during earthworks and dewatering. 'Poor Aquifers' are not present beneath the proposed development.

There are no major sand and gravel aquifers identified in the GSI National Sand and Gravel Aquifer Map within the study area.

The general groundwater flow within the aquifer is eastwards towards Dublin Bay and the River Liffey, however groundwater flow pathways are generally short, discharging to the closest stream or river.

The GSI have delineated certain areas nationwide as groundwater Source Protection Areas in order to provide protection for groundwater resources, in particular group water schemes and public water supplies. A Source Protection Area is delineated according to the hydrogeological characteristics of the aquifer, the pumping rate and the recharge in the area.

Activities which may impact on groundwater are tightly controlled within the Source Protection Area. According to the GSI database, there are no Source Protection Areas located within the 2km zone of interest.

The GSI databases and maps were consulted to identify any wells in the area. According to the GSI and EPA, there are three wells within the study area, see Figure 7.6. One at Lansdowne Road Stadium to the north, one in Elm Park Golf Club to the west and one within the Campus. Due to the distance of the two off-Campus wells they shall not be considered further in this assessment. Upon a review of desk study information and the site walkover the well on Campus is deemed inactive or destroyed.

7.3.6.2. Aquifer Vulnerability

Aquifer or groundwater vulnerability is the ease with which the groundwater may be contaminated by human activity and depends upon the aquifer's intrinsic geological and hydrogeological characteristics. The vulnerability is determined by the permeability and thickness of overlying subsoil. For example, bedrock with a thick, low permeability, clay-rich overburden is less vulnerable than bedrock with a thin, high permeability overburden.

The vulnerability of the aquifers located within the study area are classified by the GSI as ranging from ‘Low’ to ‘Extreme’ vulnerability, see Figure 7.7.

The majority of the study area is low to moderate vulnerability. Areas of high to extreme vulnerability are in areas with minimal overburden cover such as the River Dodder and the coast line to the south east of the Campus. The Campus is classed as low to medium.

7.3.6.3. Groundwater Recharge Characteristics

Average annual rainfall at Dublin Airport between 1981 and 2010 was 758 mm/yr (Met Éireann12, data accessed in January 2015). Average monthly rainfall is greatest between October and January. Groundwater recharge ranges from 100-200 mm/yr depending on subsoil permeability, saturated soil and the capacity of the aquifer to accept infiltrating water.

Precipitation as measured by Met Éireann at Dublin Airport comprises part of the study area. The 30-year average rainfall for the Dublin area is 758 mm/yr. The yearly rainfall values for Dublin Airport from 2003 to 2014 are summarised in Table 7.2.

Table 7.2: Annual rainfall and potential evapo-transpiration (Monteith) measured at Dublin Airport

Year	Dublin Airport Rainfall (mm/yr)	Potential Evapotranspiration (Monteith) (mm/yr)	Effective Rainfall (mm/yr)
2016	714	571	143
2015	878	551	327
2014	927	547	380
2013	764	550	214
2012	849	473	375
2011	672	578	96
2010	643	515	128
2009	920	521	399
2008	942	531	411
2007	784	531	253
2006	741	597	144
2005	680	526	154
2004	752	563	189
2003	643	558	85

Monthly potential evapotranspiration data is also collected (Penman method[13]) at Dublin Airport. This monthly data for the period between 2003 and 2014 is also presented in Table 7.2. The data shows that the rate of potential evapo-transpiration has not varied appreciably since 2003.

Potential or effective rainfall is the amount of rainfall which is available to infiltrate the ground and which will not evaporate or be taken up by plants. It is determined by subtracting evapotranspiration from rainfall. The annual effective rainfall is also summarised in Table 7.2.

The amount of effective recharge the study area receives will influence the groundwater levels of the study area.

A large proportion of this potential recharge will be rejected as the bedrock in the area is generally a poor aquifer and does not have the necessary capacity for storage to hold all of the recharge. Thus, the proportion of run-off to streams is likely to be higher in areas where the aquifer is poor. The majority of the study area is given a rating of 50 – 100 mm/yr by the GSI, see Figure 7.8.

7.3.7. Surface Water Bodies

There are a number of rivers and streams that flow generally eastwards towards Dublin Bay in the Region, most notably the River Dodder to the northwest of the campus. The Elm Park stream runs past the southern edge of the campus towards Merrion Strand.

The Nutley Stream previously passed between the houses of Nutley Road and Nutley Avenue and passed the entrance to St. Michael's College Grounds towards the sea. However, the stream was diverted south eastward in 1960 as it left the RTE grounds, to Nutley Lane and across the Elm Park Golf Course to join the channel of the Elm Park Stream.[14] The rivers are shown in Figure 7.8.

7.3.8. Protected Features

7.3.8.1. Geological Heritage Areas

Geological Heritage Areas are designated as part of the Irish Geological Heritage Programme; a partnership with the GSI and the Department of Environment, Heritage and Local Government. The aim of the programme was to identify, document and protect the wealth of geological heritage in Ireland. Though there are no Geological Heritage Areas in the 2km zone of interest there is one County Geological Site as detailed in Table 7.3.

Table: 7.3 Geological Heritage Areas in 2km Zone of Interest

Geological Heritage Area	GSI Description	GSI Justification for being included as GHA	Status	Distance from Site
Dodder	A weir built on natural exposures of thick limestone beds in the channel of the River Dodder	Within the constraints of Dublin City's sparsely visible geology, this is a valuable resource	County Geological Site	1500m

Considering the distance the weir is from the campus and the nature of the development it is not considered further in this assessment.

7.3.8.2. Groundwater Dependent Terrestrial Eco-systems

The National Parks and Wildlife Service online database was consulted to establish whether any ecologically protected sites which are dependent on groundwater exist in the vicinity.

A full assessment of the ecological features in the region of the proposed development is outlined in *Chapter 9, 'Flora and Fauna'*, while this Section will deal with those which may be influenced by changes in the groundwater regime. Table 7.4 depicts features which have been identified within the 2km radius of the campus.

Table 7.4: Protected Features within 2km of the Campus

Protected Features	Site Code	Location
South Dublin Bay pNHA, SAC and SPA	000210 (pNHA/SAC) 004024 (SPA)	South Dublin Bay
Booterstown Marsh pNHA (Including in South Dublin Bay SAC and SPA).	001205	Booterstown

The following is key information from the EPA[15] synopsis of the sites. The South Dublin Bay and River Tolka Estuary SPA comprises a substantial part of Dublin Bay. It includes the intertidal area between the River Liffey and Dun Laoghaire, and the estuary of the River Tolka to the north of the River Liffey, as well as Booterstown Marsh. A portion of the shallow marine waters of the bay is also included. Groundwater from the aquifer will eventually discharge to the SAC.

Booterstown Marsh which is part of the above mentioned SPA is also a SAC and pNHA which lies approximately 5km south of Dublin City. The marsh overlies glacial tills which in turn lie on black limestone.

The protected features receive their base flow from surface water rivers and streams and are not expected to receive base flow from the groundwater.

Neither of these features are groundwater-dependent but they are likely to be hydraulically connected to groundwater. However, considering their distance from the campus, the dilution will be enough to mitigate any contamination that may occur. This indicates that the South Dublin Bay SAC and Booterstown Marsh will not be considered further in this assessment.

7.3.9. Regional Potential for Contaminated Land

A review of the existing and surrendered, licenced and illegal, waste relevant activities from the EPA website as well as historical land use from the OSI website has been carried out to identify any potential contamination sources present in the area. This will allow the identification of any potentially contaminating activities within the study area.

7.3.9.1. Waste Licences and Permits

The EPA has licensed waste related activities, including landfills, transfer stations, hazardous waste disposal, other significant waste disposal and recoveries activities, since 1996. According to records, there are no current or historic licenced waste facilities within the 2km study area.

7.3.9.2. Integrated Pollution and Prevention Control and Industrial Emission Licenses

The EPA introduced the system of Integrated Pollution and Prevention Control licencing in 2004 by controlling the emission, including air, water, waste and noise, from various industrial activities and also ensuring that the responsible sectors use the best available technology. According to the EPA records, there is one surrendered licenced Integrated Pollution and Prevention Control facilities within the study area: Smurfit Paper Mills. However, this location is 1.5km North West of the proposed development and on the far side of the Dodder River and is therefore not considered to be relevant to the proposed development and is not considered any further.

7.3.9.3. Illegal Dumping

According to the EPA publication entitled *"Nature and Extent of Unauthorised Waste Activities"*[16] there are no unauthorised landfill site recorded within the 2km study area.

7.3.9.4. Potential Historic Contamination

Previous industrial activities could be a source of land contamination to current development. The OSI identified a number of historic land uses based on the historic maps, such as the six-inch and twenty-five-inch maps, for planning purposes.

The data is classified by industry type and recorded brief land use at each site from approximately 1840 to 1970. The database indicates that there are numerous activities within the study area. However, there are no activities identified within the campus itself with a tramway being on the northern border.

The Ordnance Survey of Ireland 6-inch map (1829-41) shows that the campus, particularly in the locations of the proposed development, was predominately a grassed area belonging to Elm Park Estate. The Ordnance Survey of Ireland 25-Inch map (1897-1913) shows that no change occurred. The campus remained part of the Elm Park Estate until St. Vincent's University Hospital relocated from St. Stephen's Green to the current location in 1970[17].

7.3.10. Site Specific Baseline Information

7.3.10.1. Site Investigation Data

A preliminary assessment of ground conditions on the campus was carried out, based on existing data from previous projects in the area. The historic site investigations carried out on and close to the St. Vincent's University Hospital campus are detailed in Table 7.5.

Table 7.5: Summary of Site Investigations at St. Vincent's University Hospital

ID	Year	Title	Contractor	Brief Description
PJ67	1967	Dodder Valley Drainage Scheme	PJ Hegarty's and Sons	2 shell and auger holes along the northern boundary of the campus
CI68	1968	St. Vincent's Hospital	Cementation Ireland	3 boreholes under footprint of original main building
SI71	1971	St. Vincent's Hospital	Site Investigations Ireland	6 shell and auger holes near the mortuary.
SI81	1981	Merrion SC	Site Investigations Ireland	10 boreholes on the site of the Merrion SC
SI97	1997	New Building	Site Investigations Ireland	11 boreholes, 6 trial pits and 6 slit trenches campus wide.
GE07	2007	SVPH	GES	5 boreholes and 5 trial pits for the new private hospital
GE08	2008	SVPH_Enviro	GES	2 rotary cores and 15 window samples at the new private hospital
GL09	2009	New Ward Block	Glover	2 boreholes, 4 trial pits and an infiltration pit near the mortuary
IG10	2010	Tunnel Works	IGSL Ltd.	Some investigation around the tunnel between main and private hospital
IG14	2014	National Maternity Hospital	IGSL Ltd.	4 Geobore S roles and 4 trial pits in the area of the proposed development main buildings

7.3.10.2. Soils and Geology

The geology beneath the campus is generally comprised of made ground, overlying glacial till and limestone bedrock as detailed in Table 7.6.

Table 7.6: Summary of Ground Conditions at St. Vincent's University Hospital

Age	Strata#	Average Thickness	Average Top of Strata	
		(m)	m BGL	m OD
Recent	Made Ground	1– 2	0	6
Quaternary	Brown Boulder Clay^	2 – 3	2	4
	Black Boulder Clay^	9 – 20	5	1
Carboniferous	Limestone Rock		18 – 36	-12 - -30

 # Not all stratum encountered in all area

^ May include lenses of sand and gravel

Made Ground

A layer of made ground or fill was found across the Campus in numerous boreholes and trial pits. The material encountered is generally described as silty gravelly clay with bricks, concrete and boulders, varying in thickness from 0.15 m to 3 m in some areas. The made ground was observed to contain small amounts of plastic, ash, cinders, brick and wire in isolated locations.

Brown Boulder Clay (Glacial Till)

The made ground is generally underlain by brown boulder clay (Glacial Till) which is a well graded material characterised by sand, gravel and occasional cobbles/boulders embedded in a stiff silt/clay matrix. Where made ground was not observed, brown boulder clay was observed from beneath the topsoil. This material was observed down to depths of 6m BGL.

Black Boulder Clay (Glacial Till)

Underlying the brown boulder clay is a stiff to very stiff grey gravelly clay representative of the black boulder clay and was identified at depths of 6m BGL. Due to the variation in rock head it can extend to up to 36m BGL.

Sandy Gravel Lenses

Sandy gravel layers are non-uniformly deposited across the campus, with thicknesses ranging from 0.25 m to 0.75 m at varying depths below ground level inter layered with the glacial till. These lenses can be a significant source of perched water.

Bedrock

The rock encountered in the project specific site investigation was described as a strong to medium strong limestone predominantly argillaceous limestone with local mudstone/shale layers. Discontinuities (mainly in the form of jointing within the rock mass) are widely to closely spaced, smooth to rough, planar. Apertures are tight to open, clay smeared, commonly calcite-veined. Bedding was identified as being mainly sub-horizontal.

The top of rock level varies across the campus from -6m OD south of the proposed main buildings to -26 m OD to the north of the proposed main buildings and is deeper in general relative to the depth to bedrock indicated on the GSI's rock head map see Figure 7.4. The material recovered in the borehole where rock was deepest (-26 mOD) consisted of heavily fractured rock and sand at depth which may be indicative of faulting or a pre-glacial channel/depression in the bedrock.

7.3.10.3. Contamination

The made ground in the area is likely to have been deposited in an uncontrolled manner. Chemical testing to assess potential disposal options of the made ground in the area of the proposed main building indicate that the material tested ranges from material suitable for disposal to a licensed facility or inert landfill (3 samples) to material suitable for disposal to non-hazardous landfill (4 samples). Additionally, hotspots of contamination could exist, particularly in areas of oil tanks and chemical storage. Elevated levels of molybdenum, antimony, selenium, sulphates, and total dissolved solids were encountered in a number of the samples of the made ground, which is consistent with a brownfield site.

7.3.10.4. Groundwater Regime

The groundwater regime of the campus generally consists of isolated groundwater in the gravelly lenses of the overburden and the main water table in the bedrock. Infiltrated rainwater will also be present in the made ground deposits, sitting on top of the low permeability boulder clay.

The glacial deposits tend to be dominated by the extensive and low permeability Boulder Clay. While these deposits hold a small amount of water their low permeability nature restricts groundwater movement through them.

Groundwater is commonly present within glacial sand and gravel lenses, however, these deposits are generally of limited extent and connection.

The glacial deposits serve as a confining unit for the water held within the bedrock beneath.

Thus, the groundwater within the overburden and the groundwater within bedrock are not extensively hydraulically connected. The piezometric head of the bedrock groundwater can be artesian.

The groundwater flow in the bedrock is dominated by fracture flow with very little water flowing through the rock matrix. There tends to be a weathered zone present at the top of the bedrock and groundwater can be present here. The limestones tend to be quite unproductive unless a water bearing fracture network is encountered.

The range of permeability of the overburden and bedrock is well established in the Dublin region. Typical regional permeability's of the strata derived from Arup's local experience, tests on Arup supervised site investigations within Dublin City and published papers are summarised in Table 7.7.

Table 7.7: Summary of Strata Permeability

Strata	Permeability	Reference
Made Ground	$1x10^{-5}$ m/s	Equivalent to a sand/gravel mixture (conservative as some of the made ground is a clay material).
Glacial Till	$1x10^{-9}$ to $1x10^{-11}$ m/s.	Long and Menkiti (2006 and 2007)[18]
Sand and Gravel Lenses	$1x10^{-3}$m/s to $2x10^{-06}$ m/s	Arup Projects in Dublin
Limestone	$1x10^{-4}$ m/s to $6x10^{-09}$ m/s	Arup Projects in Dublin

The excavation for the proposed development does not extend into this low permeability boulder clay. Because of this, the Locally Important Aquifer is protected from any activities related to the development by a thick layer of relatively impermeable boulder clay and is therefore not considered further in this assessment.

Groundwater levels

The hydrogeological conditions vary greatly across the St. Vincent's University Hospital Campus and from one pit/borehole to the next. Groundwater is typically between 1.0m and 2.0m below ground level however in some cases as shown in Table 7.8 it can be within 0.5m of ground level. Additionally, artesian pressures were encountered in one standpipe in the rock and one standpipe in a gravel layer.

Table 7.8: Summary of Ground Water Levels at St. Vincent's University Hospital

Investigation	BH	Strata	Response Zone		Max Water Level		Avg Water Level	
ID	ID	Description	m BGL	m OD	m BGL	m OD	m BGL	m OD
IG14	RC141	Glacial Till	6.50	-0.33	0.00	6.17	0.00	6.17
IG14	RC142	Weather Rock	32.50	-26.78	Artesian	Artesian	Artesian	Artesian
IG14	RC143	Gravel	14.50	-8.47	Artesian	Artesian	Artesian	Artesian
IG14	RC144	Glacial Till	7.00	1.40	1.60	4.00	1.60	4.00
GL09	BH01	Glacial Till	5.50	-1.76	2.33	1.41	2.33	1.41
GL09	BH02	Glacial Till	5.10	-1.04	1.23	2.83	1.76	2.30
GE08	BH01	Made Ground	2.5/0	6.34	1.20	7.64	1.22	7.62
GE08	BH02	Made Ground	2.50	6.31	1.21	7.60	1.23	7.58
GE08	BH03	Made Ground	2.50	6.39	1.14	7.75	1.16	7.73
GE08	BH04	Made Ground	2.30	6.74	1.60	7.47	1.60	7.47
GE08	BH05	Made Ground	2.10	5.83	2.01	5.92	2.01	5.92
GE08	BH06	Made Ground	2.50	6.50	0.89	8.11	0.95	8.05
GE08	BH07	Made Ground	2.40	4.84	1.07	6.17	1.10	6.14
GE08	BH08	Made Ground	2.00	5.17	1.04	6.13	1.09	6.08
GE08	BH09	Made Ground	2.50	4.81	1.11	6.20	1.20	6.10
GE08	BH10	Made Ground	2.50	5.30	0.98	6.20	1.00	6.18
GE08	BH11	Made Ground	2.50	6.20	1.13	5.70	1.44	7.26
GE08	BH13	Made Ground	2.50	6.47	1.21	7.76	1.23	7.74
GE08	BH14	Made Ground	2.60	6.00	1.06	7.54	1.06	7.54
GE08	BH15	Made Ground	2.50	6.16	1.66	7.00	1.66	/7.0
GE07	BH01	Glacial Till	9.00	-1.55	1.74	5.71	1.79	5.66
GE07	BH02	Glacial Till	9.00	-1.91	1.32	5.77	1.38	5.71
GE07	BH03	Glacial Till	9.00	-1.56	1.10	6.34	1.20	6.24
GE07	BH04	Glacial Till	5.00	3.04	1.09	6.95	1.14	6.90
GE07	BH05	Glacial Till	8.00	-0.34	1.30	6.36	1.34	6.32
SI97	BH01	Glacial Till	8.50	-0.63	2.10	5.77	2.17	5.71
SI97	BH02	Glacial Till	8.30	-0.04	1.84	6.42	2.12	6.14
SI97	BH03	Glacial Till	8.15	-0.50	1.92	5.73	2.09	5.57
SI97	BH04	Glacial Till	8.0	-0.48	1.20	6.32	1.35	6.17
SI97	BH05	Glacial Till	8.15	-1.34	0.82	5.99	0.89	5.61
SI97	BH06	Glacial Till	6.00	2.34	2.67	5.67	2.74	5.61
SI97	BH08	Gravel	8.50	0.55	2.06	6.99	2.08	6.97
SI97	BH09	Glacial Till	7.50	-1.60	0.20	5.7	0.20	5.70
SI97	BH10	Glacial Till	8.00	-3.69	0.05	4.27	0.05	4.27

Groundwater Quality

The ground investigations for the St. Vincent's Private Hospital by GES in 2007 included readings of the temperature, pH and electric conductivity of the water found in the standpipes in the glacial till, see Table 7.9.

Similar tests were carried out for the boreholes by GES in 2008 but these were all in the made ground which was suspected to be contaminated and are therefore not discussed as they are not representative of the overall ground conditions.

Likewise, the chemical test results from the GES 2007 and 2008 site investigations are not considered representative and are therefore not discussed further. No other groundwater samples have been tested on the campus.

Table 7.9: Summary of Groundwater Characteristics from St. Vincent's Private Hospital

Investigation	BH	Strata	Response Zone		Temperature	pH	EC
ID	ID	Description	m BGL	m OD	°C		µS/cm
GE07	BH01	Glacial Till	9.00	-1.55	14.80	7.66	699
GE07	BH02	Glacial Till	9.00	-1.91	14.60	7.58	592
GE07	BH03	Glacial Till	9.00	-1.56	14.70	7.73	710
GE07	BH04	Glacial Till	5.00	3.04	13.40	7.32	757
GE07	BH05	Glacial Till	8.00	-0.34	14.80	7.70	596

7.3.10.5. Conceptual Site Model

The proposed development is located within a Type A environment, as defined by the IGI Guidelines. The definition of a Type A environment is:

Type A – *Passive geological / hydrogeological environments e.g. areas of thick low permeability subsoil, areas underlain by poor aquifers, recharge areas, historically stable geological environments;*

The bedrock is a Locally Important Aquifer but is confined by a substantial thickness (averaging approximately 12 m) of low permeability glacial till.

The glacial sands and gravels that are present within glacial deposits on the campus are permeable, water-bearing and latterly discontinuous. Because the glacial till or boulder clay has a lower permeability than the glacial sands and gravels, water which infiltrates through the sands and gravels will accumulate and act as small reservoirs or perched water tables within the glacial till.

Regional groundwater flow in the bedrock and glacial till will be towards the Dublin Bay in the east. Figure 7.9 shows a conceptual site model for the proposed development.

7.3.11. Importance of Features

As part of the assessment of the receiving environment the importance of the following features have been ranked in Table 7.10 based on the guidance of the Institute of Geologists of Ireland[3].

Table 7.10: Importance of features

Feature	Importance	
	Ranking	Justification
Soils	Low	Not regionally unique
Geology	Low	Not regionally unique

As the aquifer is protected by a thick layer of low permeability glacial till, ground water in the made ground and gravel lenses is not connected to any important features, neither needs to be assessed further.

7.4. Characteristics of the Proposed Development

A detailed description of the proposed development and construction work is provided in Chapter 2, *'Description of the Development'* and the '*Draft Construction Management Plan'* appended to same.

The construction works for the proposed development in relation to soils, geology and hydrogeology are as follows:

- Deep excavation for the construction of a single storey basement. The base of the excavation is expected to be in glacial till;
- Cut and cover excavation for multi storey car park entrance ramp;
- Shallow excavations for pad foundations for the main buildings and the extension to the car park;
- Secant pile walls and/or sheet pile walls to aid the construction of the basement and other excavations;
- Pavement reconstruction involving utility service redirection;
- Small cut and fill type earthworks may be required for some civil infrastructure;
- Disposal of groundwater encountered in the excavation such as the water contained in gravel lenses; and

- Typical site drainage measures such as sump pits and drainage trenches.

This is a non-exhaustive list and other options may be considered during the detailed design.

7.4.1. Activities/Environment Matrix

The following assessments are required by the Activities/Environment Matrix in the Institute of Geologists of Ireland guidelines corresponding to the proposed development conditions (Type A):

- Earthworks; and
- Excavations of materials below the water table.

Lowering of groundwater levels by pumping or drainage shall not be considered due to the installation of a secant pile wall.

Table 7.11 outlines the required activities based on the environmental type and different activities which will be undertaken on campus and the works which have been carried out to address those activities.

Table 7.11: Details of works required under the IGI Guidelines

Work required under Activity and Type Class (based on IGI guidelines)	Details of Works completed on the Site
Earthworks	
Invasive site works to characterise the nature, thickness, permeability and stratification of soils, subsoils.	The conceptual ground model is derived from site specific site investigations both from this development and from various previous projects.
Excavation of materials below the water table	
Site works to characterise nature, thickness, permeability and stratification of soils and subsoils e.g. trial pits, augering.	Bedrock geology and characteristics are generally fully understood. Proposed works are not expected to encounter bedrock.
Works to determine groundwater level, flow direction and gradient; e.g. monitoring in standpipes, piezometers, or boreholes.	Standpipes were installed in 2 boreholes during the recent site investigation and a desk study of previous standpipe installations was undertaken, see Table 7.8.
Characterisation of groundwater chemistry and quality.	Desk study of previous groundwater samples as detailed in Table. 7.9

7.5. Potential Impact of the Proposed Development

This Section will describe the impacts associated with the proposed development pre-mitigation.

Both direct and indirect impacts will be addressed for the construction and operation of the scheme. The nature, extent and duration of the impacts will also be described.

7.5.1. Construction Phase

The magnitude and significance of the impacts during the construction stage are summarized in Table 7.12 and discussed in detail in the sections below.

Table 7.12: Magnitude and Significance of Impacts at Construction Stage

Impact		Significance	
Description	**Magnitude**	**Soils (Low)**	**Geology (Low)**
Excavation of Inert Soils	Negligible	Imperceptible	Imperceptible
Contamination of Soils	Small Adverse	Imperceptible	Imperceptible
Contamination of Groundwater	Small Adverse	Imperceptible	Imperceptible
Lowering of Groundwater Table	Negligible	Imperceptible	Imperceptible
Change in Groundwater Flow	Negligible	Imperceptible	Imperceptible

7.5.1.1. Excavation of Inert Soils

Soil will be excavated as part of the earthworks for basement construction works and auxiliary activities resulting in a permanent negative impact on the soils, geology and hydrogeology. However, the magnitude of this impact is negligible due to the impact on the attribute being insufficient in magnitude to affect either use or integrity or any of the important features. As a result, its significance is imperceptible for all important features.

7.5.1.2. Contamination of Soils

There is a risk of localised contamination from construction materials leeching into the underlying soils by exposure, dewatering or construction related spillages resulting in a permanent negative impact on the soils, geology and hydrogeology. Therefore, the magnitude of this impact is small adverse as it may result in the requirement to excavate/remediate small proportion of contamination or result in a low risk of pollution to the soils and groundwater. As a result, its significance is Imperceptible for all important features.

7.5.1.3. Potential Impacts on Hydrogeology

Groundwater Quality

The aquifer beneath the campus is protected by approximately 12m of low permeability boulder clay and no excavations will take place into the bedrock. For this reason, there will be no impacts on the groundwater contained within the bedrock aquifer.

There is a risk of localised contamination from construction materials leeching into the groundwater resulting in a permanent negative impact on the hydrogeology.

Therefore, the magnitude of this impact is small adverse as it may result in the requirement to extract/treat a small proportion of contamination or result in a low risk of pollution to the groundwater. As a result, its significance is Imperceptible for all important features.

Groundwater Flows and Levels

Due to the proximity of the proposed basement excavation to existing buildings, piled retaining walls will be required in places to construct the proposed basement and prevent movement. Temporary pile walls may be required for other excavations across the campus. These pile walls can be constructed as secant pile walls and/or sheet pile walls to act as a cut off to groundwater flow negating the requirement for dewatering.

However, a secant pile wall will act as a barrier to flow resulting in a temporary negative impact on the groundwater flow. The magnitude of the impact is negligible as it will have no impact on any local features such as wells and springs. The significance of this impact is therefore imperceptible.

The permeability of the glacial tills is low enough that during the construction phase any significant discharges of groundwater into the excavation will be from the gravel lenses and once drained will not be recharged. Therefore, dewatering will not be necessary to carry out the excavation and any temporary negative impact on ground water levels will be negligible. The significance of this impact is therefore imperceptible.

7.5.1.4. Other Impacts

The excavation and disposal of soil will create dust and odours across the campus. The excavation may cause settlement of surrounding soils which may lead to settlement of existing structures.

Based on the desk study and site investigation information within the study area, the made ground that was tested was generally considered to be inert or non-hazardous although hotspots of contamination may be encountered. The excavation of any hotspots of contamination will be a permanent positive impact on the environment. Therefore, the magnitude of this impact is minor beneficial due to a minor improvement to the attributes quality. As a result, the significance of this impact is not applicable for all important features.

7.5.2. Operational Phase

The magnitude and significance of the impacts during the operational stage are summarized in Table 7.13 discussed in detail in the sections below.

Table 7.13: Magnitude and Significance of Impacts at Operational Stage

Impact		Significance	
Description	Magnitude	Soils (Low)	Geology (Low)
Excavation of Inert Soils	Negligible	Imperceptible	Imperceptible
Contamination of Soils	Small Adverse	Imperceptible	Imperceptible
Change in Groundwater Flow	Negligible	Imperceptible	Imperceptible

7.5.2.1. Excavation of Inert Soils

Soil will be excavated as part of the earthworks for basement and auxiliary activities resulting in a permanent negative impact on the soils, geology and hydrogeology.

However, the magnitude of this impact is negligible due the impact on the attribute being insufficient in magnitude to affect either use or integrity of any of the important features. As a result, its significance is Imperceptible for all important features.

7.5.2.2. Contamination of Soils

There is a risk of localised contamination from chemicals leeching into the underlying soils by spillages and leaks resulting in a permanent negative impact on the soils, geology and hydrogeology. Therefore, the magnitude of this impact is small adverse as it may result in the requirement to excavate/remediate small proportion of contamination or result in a low risk of pollution to the soils and groundwater. As a result, its significance is Imperceptible for all important features.

7.5.2.3. Impacts on Hydrogeology

During the operational phase of the development the aquifer will not be impacted as the basement and other excavations will not extend into the bedrock which comprises the aquifer and there will be approximately 6m of low permeability boulder clay between the basement and the aquifer.

During the operational phase of the development the groundwater level and flow will be impacted. The basement and other structures constructed below ground level may act as a barrier to flow and may cause an increase in groundwater levels immediately to the south of the proposed structure in question. The permanent negative impact on groundwater flow by the basement acting as a barrier to flow are negligible due to the limited groundwater flow in the low permeability glacial till. Therefore, the significance of this impact is imperceptible.

The change in flow could result in a temporary rise in groundwater levels during periods of extended rainfall to the south of the structures in question. The potential for this to cause groundwater flooding is addressed in the Flood Risk Assessment, see Appendix 8.1.

7.5.2.4. Other Impacts

There are no other impacts related to the operational stage.

7.6. Mitigation Measures

7.6.1. Construction Phase

Dust and odour suppression systems may be required during construction to manage any impacts. Haul roads will be wetted down during dry weather and road sweepers employed to ensure the surrounding roads are kept clean.

Appropriate foundation construction techniques will be adopted to comply with the requirements of statutory bodies in terms of noise, vibration, soil and groundwater contamination and disposal of contaminated material. Material not suitable for use as fill from excavation phases shall be transported off site for disposal or recovery at appropriately licensed or permitted sites.

Material derived from excavations that could be re-used as engineering fill would have to be shown to be suitable for such use and subject to appropriate control and testing according to the specifications. These excavated soil materials will be stockpiled in a correct way to minimise the effects of weathering. Care would be required in re-working this material to minimise dust generation, groundwater infiltration and generation of runoff. Any surplus suitable material excavated that is not required elsewhere on the scheme shall be used for other projects where possible.

Earthworks operations shall be carried out such that surfaces shall be designed with adequate falls, profiling and drainage to promote safe run-off and prevent, leeching, ponding and flooding. Run-off will be controlled through erosion and sediments control structures appropriate to minimise the water effects in outfall areas. Care will be taken to ensure that the bank surfaces are stable to minimise erosion.

Excavations in the made ground will be monitored by an appropriately qualified person to ensure that should a hotspot of contamination be encountered it is identified, segregated and disposed of appropriately as soon as possible.

Any identified hotspots shall be segregated and stored in an area where there is no possibility of runoff generation or infiltration to ground or surface water drainage. Care will be taken to ensure that the hotspot does not cross contaminate clean soils elsewhere on site.

Where a considerable amount of wastewater is generated or required to be pumped during the earthworks, there should be installation of appropriate site drainage, such as sumps, temporary ditches, sedimentation tanks, etc. to contain construction wastewater within the site and to ensure that it is treated properly before being discharged to the public sewer system.

Should contaminated groundwater be encountered during dewatering, groundwater treatment will be employed to ensure that the discharged groundwater fulfils the requirements of the discharge license issued by the relevant local authority.

Water pollution will be minimised by the implementation of good construction practices. Such practices will include adequate bunding for oil containers, wheel washers and dust suppression on site roads, and regular plant maintenance. The Construction Industry Research and Information Association, provides guidance on the control and management of water pollution from construction sites in their publication '*Control of Water Pollution from Construction Sites, Guidance for Consultants and Contractors*' (Masters-Williams et al, 2001). A contingency plan for pollution emergencies will also be developed by the Contractor prior to work and regularly updated, which would identify the actions to be taken in the event of a pollution incident.

The Construction Industry Research and Information Association document recommends that a contingency plan for pollution emergencies will address the following:

- Containment measures;
- Emergency discharge routes;
- List of appropriate equipment and clean-up materials;
- Maintenance schedule for equipment;
- Details of trained staff, location, and provision for 24-hour cover;
- Details of staff responsibilities;
- Notification procedures to inform the relevant environmental protection authority;
- Audit and review schedule;
- Telephone numbers of statutory water undertakers and local water company; and
- List of specialist pollution clean-up companies and their telephone numbers.

7.6.2. Operational Phase

There are no mitigation measures required for the operational phase.

7.7. Predicted Impact of the Proposed Development

Upon application of the mitigation measures outlined in Section 7.6 the magnitude of any impacts both in the construction and operational phase are negligible as detailed in Table 7.14 and Table 7.15. As a result, the significance of all the impacts is imperceptible.

7.7.1. Construction Phase

The magnitude and significance of the impacts during the construction stage are summarized in Table 7.14.

Table 7.14: Residual Magnitude and Significance of Impacts at Construction Stage

Impact		Significance	
Description	Magnitude	Soils (Low)	Geology (Low)
Excavation of Inert Soils	Negligible	Imperceptible	Imperceptible
Contamination of Soils	Negligible	Imperceptible	Imperceptible
Contamination of Groundwater	Negligible	Imperceptible	Imperceptible
Lowering of Groundwater Table	Negligible	Imperceptible	Imperceptible
Change in Groundwater Flow	Negligible	Imperceptible	Imperceptible

7.7.2. Operational Phase

The magnitude and significance of the impacts during the operational stage are summarized in Table 7.15.

Table 7.15: Residual Magnitude and Significance of Impacts at Operational Stage

Impact		Significance	
Description	Magnitude	Soils (Low)	Geology (Low)
Excavation of Inert	Negligible	Imperceptible	Imperceptible
Contamination of Soils	Negligible	Imperceptible	Imperceptible
Change in Groundwater Flow	Negligible	Imperceptible	Imperceptible

7.7.3. Do Nothing Scenario

The do nothing scenario potentially leaves contaminated ground in-situ.

7.8. Monitoring

Any excavation will also be monitored during site clearance to ensure the stability of side slopes and to ensure that the soils excavated for disposal are consistent with the descriptions and classifications according to the waste acceptance criteria testing carried out as part of the site investigations.

7.9. Reinstatement

Reinstatement of site compounds, construction access roads and associated works area will be made to a similar finish to existing conditions. In general, the main areas of excavation will be occupied by the proposed new structures and infrastructure.

7.10. Interactions and Potential Cumulative Impacts

7.10.1. Interactions

Description of the Proposed Development

This Chapter is referenced in Chapter 2 in relation to outlining the scope and nature of the development.

Traffic and Transportation

The excavation and removal of soils from the site during the construction phase of the project will have an impact on the traffic levels around the campus. During the construction phase, vehicles to and from the site will contribute to an additional traffic impact, in particular additional truck movements, see Chapter 6.

Hydrology

The introduction of a basement and foundations may create a barrier to groundwater flow in the made ground which may lead to localised increases in groundwater levels which in turn could impact on groundwater flooding, see Chapter 8.

Noise and Vibration

During construction, there will be a number of earthworks related activities which will lead to noise and vibration. Similarly, there will be noise and vibrations associated with the truck movements involved in the removal of the excavated soils off site. Details of the noise and vibration mitigation measures are given in the '*Noise and Vibration* Chapter' of this EIS, see Chapter 11.

Air Quality

The excavation of soils across the campus may lead to the generation of dust and odours should excavated soils be found to contain contamination. Details of the air quality mitigation measures are given in the '*Air Quality and Climate Chapter*', see Chapter 12.

Resource and Waste Management

When soils are excavated with an intention to dispose of them, these soils become a waste and as such are governed by the relevant Waste Legislation. Soils will then be disposed of to appropriate disposal facilities. Details of the waste management are given in the 'Waste Management Chapter', see Chapter 10.

7.10.2. Potential Cumulative Impacts

A number of other developments as detailed in Table 7.15. have been considered in regard to potential cumulative impacts. There is no potential cumulative impact associated with the soils and geology.

A potential cumulative impact to the hydrogeology would be a barrier to groundwater flow. However, none of the developments with basements are close enough to the proposed development with the RTE development being a minimum of 700m to the west of the proposed development. Therefore, there is no potential cumulative impacts associated with the proposed development and those listed in Table 7.16.

Table 7.16: Planning Applications and Developments Considered for Cumulative Potential Impacts

Reg. Ref	Location	Status
3034/13	Bethany House, Junction of Park Avenue & Gilford Road, Dublin 4	Final Grant: 06/05/2014
3704/14	Saint John's House, 202, Merrion Road, Dublin 4	Final Grant: 24/04/2015
4057/09	The RTE Campus, N11 Stillorgan Road, Donnybrook, Dublin 4	Final Grant: 24/10/2010 (10 year permission)
2876/15	RDS lands, Ballsbridge, Dublin 4	Final Grant: 02/09/2015
2221/16	Former AIB Bank Centre lands, Junction of Merrion Road and Serpentine Avenue, Ballsbridge, Dublin 4	ABP: 04/10/2016
3467/16	RDS Lands (approx. 16.2 hectares), Ballsbridge Dublin 4	Final Grant: 08/11/2016
2220/16	St. Mary's Centre Nursing Home, 185-201, Merrion Road, Dublin 4	Final Grant: 12/05/2016
3304/16	Block A, Elm Park, Merrion Road, Dublin 4	Final Grant: 11/10/2016
3094/16	RTE Campus, Stillorgan Road, and Nutley Lane, Donnybrook, Dublin 4	Final Grant: 25/11/2016
2210/16	Greenfield, Lands off Greenfield Park, Donnybrook, Dublin 4 (on lands measuring approx.1.35 hectares)	ABP Grant: 06/12/2016
1593/02 4653/06	Merrion Road, Dublin 4	Semi Occupied development.
National Transport Authority Merrion Gates Proposal	Merrion Road, Dublin 4	Submission stage – extended until 31/01/2017

7.11. References

1. EPA (2015). Environmental Protection Agency Revised Guidelines on the Information to be contained in Environmental Impact Statements. Draft.
2. EPA (2015). Environmental Protection Agency Advice Notes on Current Practice in the Preparation of Environmental Impact Statements. Draft.
3. IGI (2013). Guidelines for the preparation of soils, geology and hydrogeology chapters of environmental impact statements. Institute of Geologists of Ireland.
4. Arup (2006). Environmental Impact Statement: St. Vincent's New Private Hospital
5. Arup (1998). Environmental Impact Statement: St Vincent Hospital Redevelopment
6. Arup (2009). RTE Project 2025 Environmental Impact Statement: Soils and Geology
7. Farrell E.R. and Wall D. (1990). Soils of Dublin. Trans Institute Engineers of Ireland.
8. Skipper J., Follett B., Menkiti C.O., Long M. and Clark-Hughes J. (2005). The engineering geology and characterisation of Dublin boulder clay. Quarterly Journal of Engineering Geology and Hydrogeology, vol. 38, p171-187.
9. Nolan S. (1986). The Carboniferous geology of the Dublin area. Unpublished PhD thesis. University of Dublin.
10. Geological Survey of Ireland (2001). Directory of Active Quarries, Pits and Mines in Ireland (3rd Edition). Department of Public Enterprise
11. Watermaps (2015). Water Framework Directive Watermaps Map Viewer [ONLINE] Available at: http://www.wfdireland.ie/maps.html [Accessed January, 2015].
12. Met Éireann (2015). [ONLINE] Available at: www.met.ie [Accessed January, 2015].
13. Monteith, J. L. 1965. "Evaporation and Environment." In: The state and movement of water in living organism. 19th Symp. Soc. Exptl. Biol. P. 205-234.
14. Sweeney C.L. (1991). The Rivers of Dublin. Dublin Corporation.
15. National Parks and Wildlife Service (2015). Protected Sites in Ireland. [ONLINE] Available at: http://www.npws.ie/protected-sites. [Accessed 18 November 15].
16. EPA (2005). Nature and Extent of Unauthorised Waste Activities. EPA, Johnstown Castle Estate, Wexford, Ireland.
17. St. Vincent's Foundation (2013). St. Vincent's Foundation Newsletter for the Friends of St. Vincent's, Issue 8.
18. Long, M. & Menkiti, C. O. (2007). Geotechnique 57, No. 7, 595–611