CHAPTER 7

LAND AND SOILS

7.0 LAND AND SOILS

7.1 INTRODUCTION

This chapter assesses and evaluates the potential impacts of the proposed development at Fosterstown North, Swords, Co. Dublin on the land, soil, geological and hydrogeological aspects of the proposed development site and the surrounding area. The proposal is for a seven year permission for a development comprising a Strategic Housing Development of 645 residential units, a community facility, a childcare facility, 5 commercial units, car and cycle parking, landscaping, public and communal open space, road upgrades and vehicular access and associated internal roads, pedestrian and cycle paths and all associated site and infrastructural works.

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. A detailed description of the development is provided in Chapter 2 of this EIAR and for brevity will not be repeated in full here.

This chapter was completed by Marcelo Allende (BSc BEng) a Water Resources Engineer with over 15 years of experience in environmental consultancy and water resources studies. He is an Environmental Consultant with AWN Consulting, a member of the International Association of Hydrogeologists (Irish Group) and a member of Engineers Ireland (MIEI). He has prepared hydrological and hydrogeological impact assessments for numerous EIARs for a range of projects including commercial, residential, industrial, pharmaceutical and data centre developments.

7.2 STUDY METHODOLOGY

7.2.1 Criteria for Rating Impacts

This chapter evaluates the effects, if any, which the proposed 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 7.1.

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 2 km 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.

7.2.2 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
- Fingal County Council (FCC) - illegal landfill information.

Site-specific data was derived from the following sources:

- Report on a Site Investigation for a Development at Swords Co. Dublin IGSL, 2005 (included as Appendix 7.2)
- Various design site plans and drawings; and
- Consultation with site engineers/ planners/ architects.

7.3 THE EXISTING RECEIVING ENVIRONMENT (BASELINE SITUATION)

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

7.3.1 General Description of the Site

7.3.1.1 Site Setting and Topography

The subject lands are contained within the Fosterstown Masterplan area, consisting of the southern portion of the designated land. The site is located in Fosterstown North, Swords, Co. Dublin and is bound to the north by a greenfield site, to the east by the R132 and to the south and west by the Boroimhe residential development. The subject site is located 2 km north of Dublin Airport and 1 km south of Swords main street. The total site area is approximately 4.6 hectares and is currently greenfield in nature. The site falls from the existing high point in the southwest corner with a level of 47.88 metre above ordinance datum (mAOD) Malin to the low point in the northeast corner of the site with a level of 36.75 mAOD Malin. The site slopes sharply to the northeast with an average slope of 1:34. There is an existing watercourse (Gaybrook Stream) along the entirety of the northern boundary of the site which flows from west to east. The site is accessed by a gate from the R132 (Refer to Figure 7.1 below).

Figure 7.1: Site Location

An assessment of site history using historical maps (OSI, 2022) indicates that the wider site has been in agricultural use since the earliest mapping available (1837-1842).

7.3.1.2 Area of Geological Interest and Land Use

The immediate surroundings of the site are primarily taken up with residential land use to the west and south. Notable neighbouring land-uses within 1 km include Airside Retail Park 200 m to the west and the Pavilions Shopping Centre 900 m to the North.

According to the EPA website, there are a number of EPA licensed facilities in the locality with Arch Chemicals (vacated site with current IEL Licence P0060-01 still active) 1.4 km to the north and MSD Ireland 1.4 km (Licence Number P1106-01) to the east. There are no licensed waste sites in the vicinity (1 km) of the subject site.

GSI (Geological Survey of Ireland) online mapping was reviewed to identify sites of geological heritage for the site and surrounding area. There is no evidence of any site which could be considered suitable for protection under this programme or recorded in the Fingal County Development Plan for 2017-2023. The nearest recorded site i.e., Feltrim Quarry 2.6 km to the south east

7.3.1.3 Soils

Teagasc soil mapping (2022) indicates that the soils at the site consist primarily of deep well drained mineral soil (BminDW) and deep poorly drained mineral soils (BminPD), both derived from mainly calcareous parent materials. Figure 7.2 below presents the soils map indicating the soil lithologies discussed above.

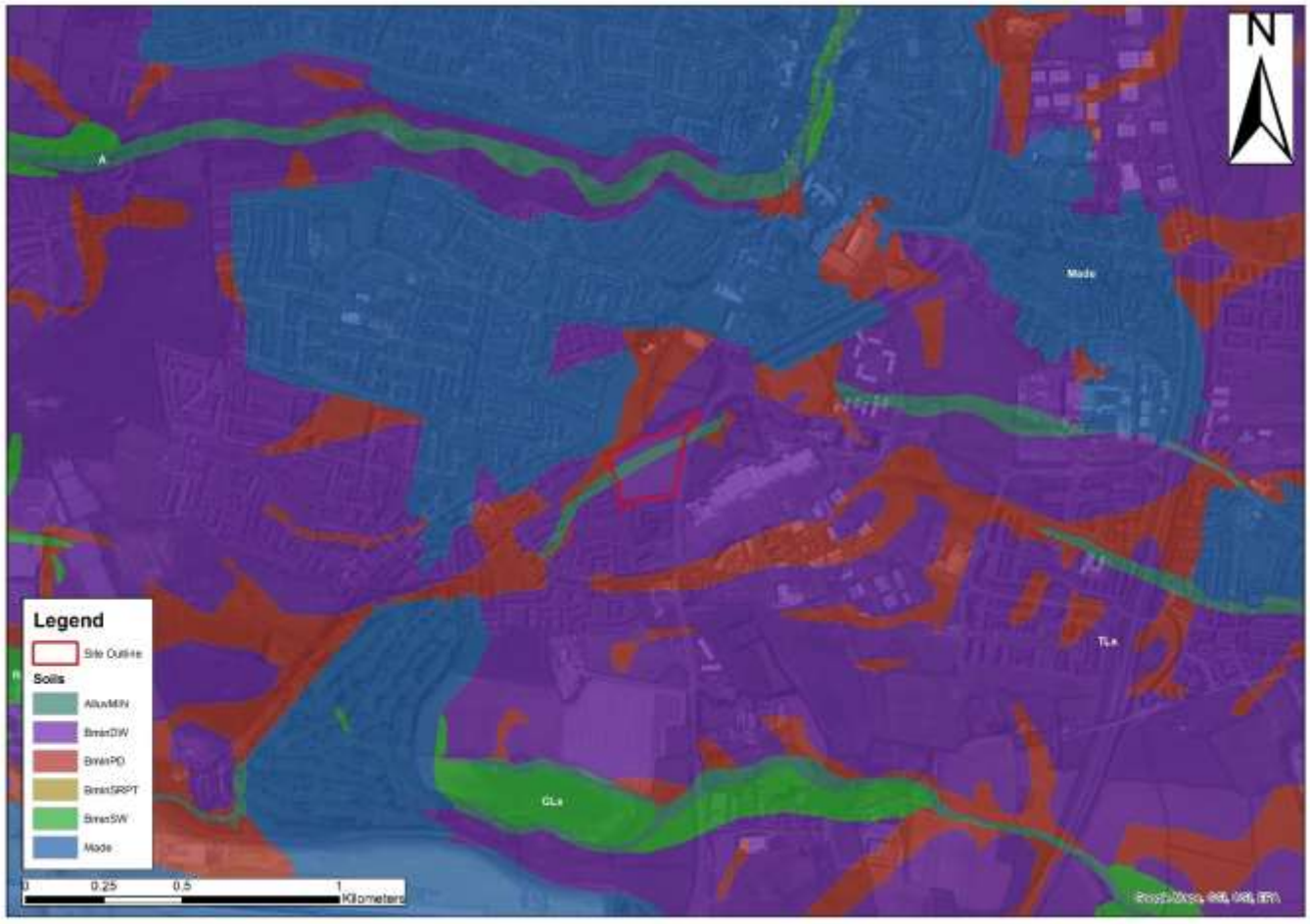


Figure 7.2: Soil Map (Teagasc/IGI, 2022)

7.3.1.4 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 mapping database of the subsoils in the area of the proposed development site indicates three (3) no. principal soil type, as shown in Figure 7.3 below. The subsoil types present across the site are:

- LIMESTONE till Carboniferous (TLs). A large section of the site is composed of limestone TILL. This till is made up of glacial CLAYs which are less permeable than alluvium subsoils.
- Gravels Derived from Limestone (GLs)are seen to the north east of the site; and,
- Alluvium (A) deposits to the north of the site associated with the Gaybrook Stream.

Figure 7.3: Subsoil Map (GSI, 2022)

According to historical site investigations carried out by IGSL (2005) (see Appendix 7.2), it is confirmed the presence of glacial till deposits underlying shallow more recently deposited soils. The glacial tills consist of firm to stiff brown gravelly clay overlying hard grey black gravelly clay. The black till is noted between 2.0 and 3.0 metres and was penetrated by rotary drilling to 15.0 metres. Rock was not encountered. The glacial material is locally referred to as brown and black boulder clay. The findings on this site are typical of the North County Dublin area.

7.3.1.5 Bedrock Geology

Inspection of available GSI data shows that the bedrock geology underlying the site and surrounding area is dominated by rocks of Carboniferous Age. The site and local area is underlain by argillaceous bioclastic limestone, shale of the Malahide Formation. There is no evidence of springs or karstification in this area according to the GSI Karst database.

7.3.1.6 Regional Hydrogeology

The GSI classifies the principal aquifer types as:

Bedrock Aquifer

- Lk - Locally Important Aquifer - Karstified.
- Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones.
- Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive.
- Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones.
- Pu - Poor Aquifer - Bedrock which is Generally Unproductive.
- Rkd - Regionally Important Aquifer (karstified diffuse).

Gravel Aquifer

- Lg - Locally Important Aquifer - Sand & Gravel.
- Rg - Regionally Important Aquifer - Sand & Gravel.

Reference to the GSI National Draft Bedrock Aquifer Map for the Site (refer to Figure 7.4 below) indicates that the Site is underlain by a Locally Important Bedrock Aquifer (Ll), which is described by the GSI as bedrock as being “moderately productive only in local zones”.

Figure 7.4: Bedrock Aquifer classification (GSI, 2022)

7.3.1.7 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 / fractures, the main feature that protects groundwater from contamination, and therefore the most important feature in the protection of groundwater, is the subsoil (which can consist solely of or of mixtures of peat, sand, gravel, glacial till, clays or silts).

The GSI presently classifies the aquifer vulnerability in the region of the Site as 'Low' (refer to Figure 7.5 below). As can be seen from Table 7.1 below, a Low vulnerability with clayey subsoil denotes a depth to bedrock of >10 m, indicating a good protection of the underlying aquifer by low permeability subsoil.

Table 7.1 below presents the GSI vulnerability mapping guidelines with specific reference to subsoil thickness and characteristics.

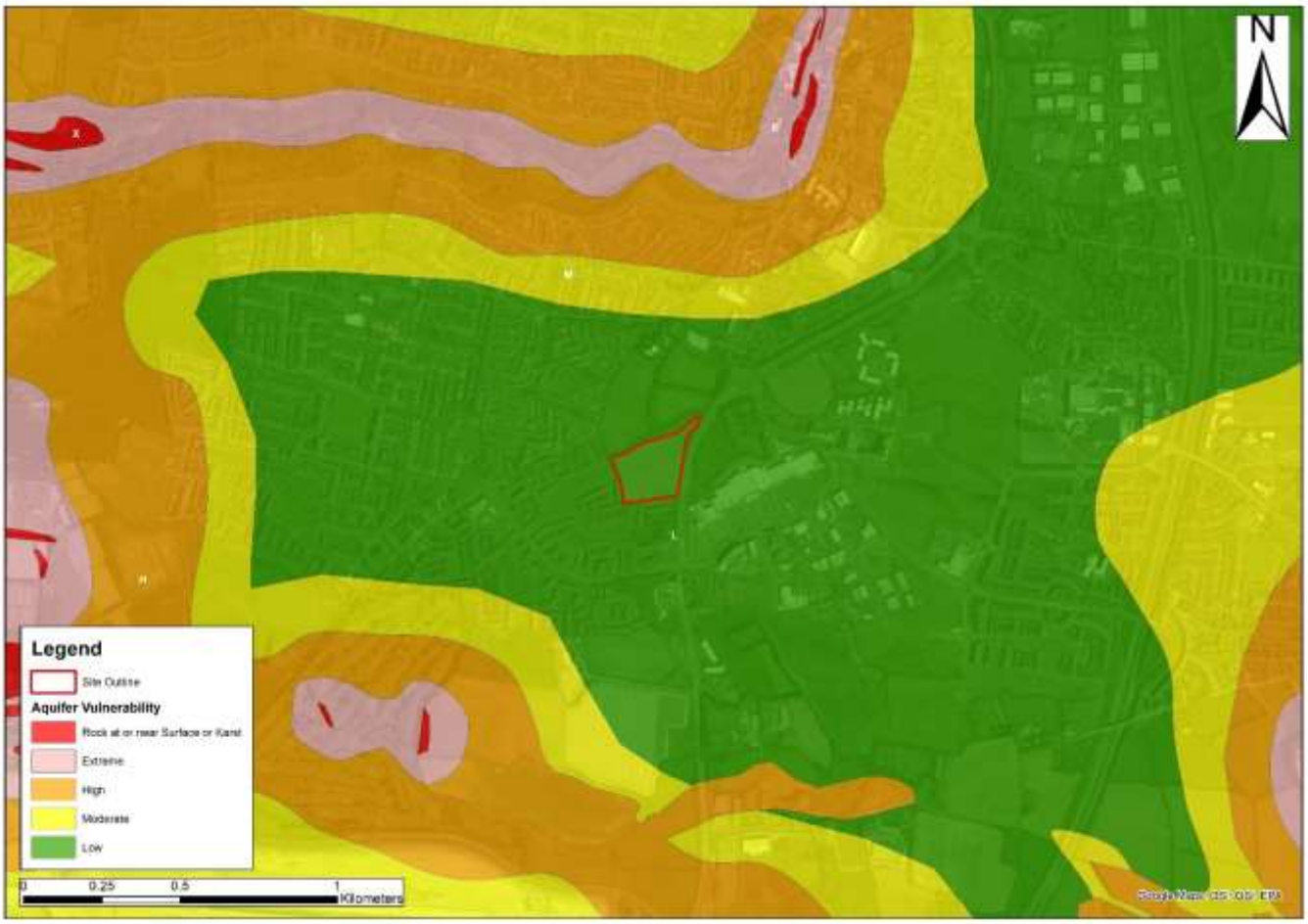


Figure 7.5: Aquifer Vulnerability (GSI, 2022)

Table 7.1: Vulnerability Mapping Guidelines (Source: GSI, 2022)

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

This classification has been confirmed by the historical site investigations carried out by IGSL in 2005 (included as Appendix 7.2). Bedrock was not encountered during drillings up to 15 mbgl.

7.3.1.7 Groundwater Wells

The GSI Well Card Index is a record of wells drilled in Ireland. This Index shows a number of wells in the vicinity of the site. While much useful information can be obtained from this Index, it is important to note that it is by no means exhaustive, as it requires individual drillers to submit details of wells in each area.

The well card data presented in Table 7.2 below shows the occurrence of recorded wells within a 2km radius of the site area, information regarding the depth to bedrock, and hence the depth of overburden is noted for each well where available. See Figure 7.6 below for locations. From the GSI well card data presented in Table 7.2, it can be seen that abstractions of up to 385 m3/day are obtained from the bedrock gravel aquifer at well 2923NEW019, which is located approx. 900m to the north from the site. In the surrounding area of the site, yield class would be 'Good' as it can be seen in the boreholes located in Swords and Seatown East townland c. 2 Km to the northeast of the site.

Figure 7.6: GSI Well Search Map (GSI, 2022)

Table 7.2 :GSI Well Card Data for the Site location and Surrounding Areas (Source: GSI, 2022)

GSI Name	Type	Depth (mbgl)	Depth to Bedrock (mbgl)	Easting (Irish Grid)	Northing (Irish Grid)	Location Accuracy	Townland	Usage	Yield Class	Yield (m3/d)
2923NEW063	Spring			319,130	248,860	Within 10 m	Lissenhall Little			
2923NEW044	Borehole	15.2		319,800	247,270	Within 50 m	Seatown East	Agricultural and domestic	Good	218
2923NEW045	Borehole	33.5		319,650	247,150	Within 50 m	Seatown East	Agricultural and domestic	Good	381
2923NEW018	Borehole	46.9	1.5	318,150	246,700	Within 500 m	Swords	Industrial	Good	110
2923NEW019	Borehole	33.5		318,300	246,570	Within 500 m	Swords		Good	385
2923NEW020	Borehole	27.4		318,050	246,550	Within 500 m	Swords		Good	220
2923NEW038	Spring			317,910	246,340	Within 20 m	Forrestfields			
2923NEW039	Spring			318,490	245,780	Within 20 m	Crowcastle			
2923NEW021	Borehole	36.6		318,050	245,350	Within 200 m	Nevinstown West	Agricultural and domestic	Poor	38

7.3.1.7 Groundwater Quality

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.

The WFD requires 'Good Water Status' for all European waters to be achieved through a system of river basin management planning and extensive monitoring. 'Good status' means both 'good ecological status' and 'good chemical status'.

Presently, the groundwater body in the region of the site (Swords GWB, EU Code IE_EA_G_011) is classified by the most recent WFD groundwater status (2013-2018) as 'Good'. The WFD environmental risk score of the Swords groundwater body is 'Not at risk' of not achieving Good status.

7.3.1.8 Economic Geology

The Extractive Industry Register (www.epa.ie) and the GSI mineral database was consulted to determine whether there were any mineral sites close to the proposed development. There are no active quarries located in the immediate vicinity with the nearest quarry located approximately 2.1 km to the southeast which is classified as the Feltrim Quarry.

7.3.1.9 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 recorded sites on the development site with the nearest heritage site is located approximately 2.1 km to the southeast (Feltrim Quarry). A full audit has not yet been completed for Dublin; however, there is no evidence of any site which could be considered suitable for protection under this programme or recorded in the South Dublin County Development Plan 2016-2022.

7.3.1.10 Radon

According to the EPA (now incorporating the Radiological Protection Institute of Ireland) the site location is a Low Radon Area where is it estimated Less than 1% of the homes in this 10km grid square are estimated to be above the Reference Level of 200 Bq/m3.

7.3.1.11 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 15km to the west, referred to as the Clonee event which occurred on 2nd March 2014. 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 ~50 km 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.

7.3.1.12 Areas of Conservation

According to the NPWS (2022) on-line database there are no special protected area on or in the vicinity of the subject site. The closest Natura 2000 European sites are the Malahide Estuary Special Area of Conservation (SAC), Special Protection Area (SPA) and Proposed Natural Heritage Area (pNHA) which are located c. 2.3 Km to the northeast of the subject site..

7.3.1.12 Conceptual Site Model

According to baseline information for the receiving environment and historical site investigations carried out by IGSL in 2005 a Conceptual Site Model (CSM) was developed in order to identify any likely Source-Pathway-Receptor linkages relating to the site and the proposed development:

- The total site area is approximately 4.6 hectares and is currently a greenfield. The site falls from the existing high point in the southwest corner with a level of 47.88 metre above ordinance datum (mAOD) Malin to the low point in the northeast corner of the site with a level of 36.75 mAOD Malin. The site slopes sharply to the northeast with an average slope of 1:34;
- During the site investigations undertaken by IGSL in 2005, bedrock was not encountered even at maximum depths of 15.0 mbgl;
- The findings confirm the presence of glacial till deposits underlying shallow more recently deposited soils. The glacial tills consist of firm to stiff brown gravelly clay overlying hard grey black gravelly clay. The black till is noted between 2-3 mbgl up to 15.0 mbgl.
- Therefore, the bedrock aquifer is protected by low permeability cohesive deposits (Clay). Site investigations confirmed that the aquifer would have 'Low' vulnerability.
- The groundwater body in the region of the site (Dublin GWB) is classified under the WFD Risk Score system as currently 'Under Review'. Previously (2013-2018) the Dublin GWB was given 'Good Status'.

Review of the hydrogeology and geology in the surrounding region indicates that there are no sensitive receptors such as groundwater-fed wetlands, 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 in the subject area. Collection and analysis of representative soil samples for a wide range of parameters shows no evidence of contamination.

7.3.1.13 Rating of Importance of Geological and Hydrogeological Attributes

Based on the TII methodology (2009) (See Appendix 7.1), criteria for rating site importance of geological features, the importance of the bedrock and soil features at this site is rated as 'Low Importance' with low quality, significance or value on a local scale.

Based on the TII methodology (2009) (See Appendix 7.1) the importance of the hydrogeological features at this site is rated as 'Low Importance' based on the assessment that the attribute has a low quality significance or value on a local scale.

The aquifer is a Locally Important aquifer but is not widely used for public water supply, or generally for potable use. However, it should be considered that there would be an indirect hydrological connection between the site and Malahide Estuary protected sites (SAC, SPA, NHA). The Natura Impact Statement submitted as part of the application details the findings of the Stage 2 Appropriate Assessment conducted to further examine the potential direct and indirect impacts of the Proposed Development on the aforementioned European Sites.

Where potentially significant adverse impacts were identified, a range of mitigation and avoidance measures have been recommended to offset them. As a result of the Appropriate Assessment, it has been concluded that, with the

implementation of the mitigation measures detailed in this Chapter, the Proposed Development will not adversely affect the integrity of the above European Sites (or any other).

7.4 CHARACTERISTICS OF THE PROPOSED DEVELOPMENT

The proposed development comprises a Strategic Housing Development of 645 no. residential units (comprising 208 no. 1 bedroom units, 410 no. 2 bedroom units, and 27 no. 3 bedroom units), in 10 no. apartment buildings, with heights ranging from 4 no. storeys to 10 no. storeys, including undercroft / basement levels (for 6 no. of the buildings). The proposals include 1 no. community facility in Block 1, 1 no. childcare facility in Block 3, and 5 no. commercial units (for Class 1-Shop, or Class 2- Office / Professional Services or Class 11- Gym or Restaurant / Café use, including ancillary takeaway use) in Blocks 4 and 8.

The development includes a total of 363 no. car parking spaces (63 at surface level and 300 at undercroft / basement level). 1,519 no. bicycle parking spaces are provided at surface level, undercroft / basement level, and at ground floor level within the blocks. Bin stores and plant rooms are located at ground floor level of the blocks and at undercroft / basement level. The proposal includes private amenity space in the form of balconies / terraces for all apartments. The proposal includes hard and soft landscaping, lighting, boundary treatments, the provision of public and communal open space including 2 no. playing pitches, children's play areas, and an ancillary play area for the childcare facility.

The proposed development includes road upgrades, alterations and improvements to the Dublin Road / R132, including construction of a new temporary vehicular access, with provision of a new left in, left out junction to the Dublin Road / R132, and construction of a new signalised pedestrian crossing point, and associated works to facilitate same. The temporary vehicular access will be closed when vehicular access to the lands is made available from the lands to the north. The proposal includes internal roads, cycle paths, footpaths, vehicular access to the undercroft / basement car park, with proposed infrastructure provided up to the application site boundary to facilitate potential future connections to adjoining lands.

The development includes foul and surface water drainage, green roofs and PV panels at roof level, 5 no. ESB Substations and control rooms (1 no. at basement level and 4 no. at ground floor level within Blocks 2, 4, 7, and 8), services and all associated and ancillary site works and development.

The activities associated with the proposed Project which are relevant to the land, soils, geology and hydrogeological environment are detailed in Table 7.3 below.

Table 7.3: Summary of Site Activities

Phase	Activity	Description
Construction	Discharge to Ground	Stormwater run-off percolating to ground at the construction site.
	Earthworks: Excavation of Superficial Deposits	Cut and fill will be required to facilitate construction of the proposed project, basements and associated ancillary services. Excess material which cannot be re-used on-site will be disposed off-site at a suitably licensed facility in accordance with the Construction and Demolition Waste Management Plan (C&D WMP). The level of the maximum depth of excavation required to facilitate installation of services, basements and foundations, as specified by Waterman Moylan is c. 38.8 mAOD. There will be no excavation of bedrock required; therefore, no aquifer dewatering required. Subsoil stripping and localised stockpiling of soil will be required during construction. It is estimated that approximately 10,000 m3 of topsoil and 56,000 m^3 of subsoils will be excavated to facilitate construction of the proposed project. It is anticipated that a small amount of the excavated topsoil will be reused onsite for landscaping purposes Approximately 66,000 m^3 of material will be removed from site. Suitable excavated material will be reused for site levelling, roads, car parking areas, berms and other landscaping purposes. Material removed from site may be re-used

Phase	Activity	Description
		off-site for beneficial use on other sites with appropriate planning / waste permissions / derogations (e.g. in accordance with Article 27 of the European Communities (Waste Directive) Regulations 2011) as amended, or will be reused, recovered and / or disposed off-site at appropriately authorised waste facilities
	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.
Operation	Increase/ Decrease in hardstanding area	Altering of local recharge (percolation to ground) only due to the modification in hard standing area. There will be an increase in hardstanding area of c. 3.18 Ha.
	Storage of hazardous Material	No bulk fuel or chemical storage at the Site. Only potential for minor fuel leaks from parked cars, service vehicles, HGV deliveries, etc.

As outlined in Table 7.3, the activities required for the construction phase of the proposed project 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 project, and ancillary services.

The potential geological and hydrogeological impacts during the construction and operational phases are presented below. Remediation and mitigation measures included in the design of the proposed Project to address these potential impacts are presented in Section 7.3.

7.5 POTENTIAL IMPACT 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 7 and 8 (Water) of the EIAR. Remediation and mitigation measures included in the design of this project to address these potential impacts are presented in Section 7.8 below.

7.5.1 Construction Phase

In the absence of mitigation, the following potential effects to land, soil and groundwater (hydrogeology) have been considered.

7.5.1.1 Excavations and Infilling

The risk of contaminated soils being present onsite is low given its current greenfield condition. 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 excavation for foundations for the main buildings will require the excavation of topsoil (made ground), and subsoil (cohesive deposits). The level of the maximum excavation depth would be c. 38.8 mAOD. Therefore, it is very unlikely that bedrock could be exposed due to planned earthworks as its depth is presumably >15 mbgl.

Excavated material could be reused on site for infilling and landscaping works where possible. Import of fill may be required. Historical site investigation 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.

No groundwater is expected to ingress to the excavation area. However, given the characteristics of the subsoil it is expected during the excavation works that localised dewatering of the subsoils will be required to address perched groundwater.

It can be expected to encounter minor ingress of rainfall in the excavation during the construction phase.

7.5.1.2 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.

During construction of the development, there is a risk of accidental pollution incidences from the following sources if not adequately mitigated:

- 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 by the EPA 'Low' which has been confirmed by historical site investigations carried out in the subject site. Any soil stripping will also further reduce the thickness of subsoil and the natural protection they provide to the underlying aquifer; however, bedrock is assumed to be below the maximum projected excavation depths.

The potential impacts on the geological and hydrogeological environment during the construction phase and in absence of mitigation is expected be short term-slight/moderate-negative.

7.5.2 Operational Phase

There are no discharges to ground included in the design and no abstractions from the aquifer. The proposed development site includes car parking area at the site. Leakage of petrol/ diesel fuel may occur from these areas; run-off may contain a worst-case scenario of 70 litres for example.

There will be an increase in hardstanding area (c. 3.18 Ha) associated with the development area. This will have a minor effect on local recharge to ground; however, the impact on the overall hydrogeological regime will be insignificant.

The Site of the proposed Project is zoned for mixed Use, general development, opportunity/proposals and is not being used for agricultural purposes. There will be no local loss of agricultural soil, and no impact to mineral resources in the area as a result of the proposed Project.
The potential impacts on the geological and hydrogeological environment in absence of mitigation is expected be long term-slight/moderate-negative.

7.6 'DO NOTHING' IMPACT

Under the Do Nothing Scenario no construction works will take place and potential impacts from construction activities will not occur (i.e., increase of sediments loading in run-off or accidental spills and leaks). Impacts due to potential leakage of petrol from car parking areas during operational phase will also not occur. The hydrogeological environment will remain as per the baseline and will change in accordance with trends within the wider area (including influences from new developments in the surrounding area, etc.). Therefore, this scenario can be considered neutral in terms of land, soils, geology and hydrogeology.

7.7 AVOIDANCE, REMEDIAL & MITIGATION MEASURES

The design has taken account of the potential impacts of the development on the hydrology environment local to the area where construction is taking place and containment of contaminant sources during operation. Measures have been incorporated in the design to mitigate the potential effects on the hydrology. These are described in Sections 7.7.1 and 7.7.2 below.

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

In addition, these measures are proposed in line with the findings of the NIS in order to avoid any risk of adverse impact on the integrity of the European Sites in Malahide Estuary (or any other).

7.7.1 Construction Phase

In order to reduce impacts on the soils and geology environment, a number of mitigation measures will be adopted as part of the construction works on site. The measures will address the main activities of potential impact which include:

- Control of soil excavation/ infill and export from site;
- Fuel and chemical handling, transport and storage; and
- Control of water during construction.

L&S CONST 1: Construction & Environmental Management Plan (CEMP)

A Construction Environmental Management Plan (CEMP) has been prepared by Waterman Moylan (2022) for the proposed development and is included with the planning documentation. In advance of work starting on site, the works Contractor will prepare a detailed CEMP. The detailed CEMP will set 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.

As a minimum, the CEMP will be formulated in accordance with 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.

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

L&S CONST 2: 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 to excavate c. 66,000 m3. Suitable soils could be reused on site as backfill, 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.

According to onsite investigations, the bedrock vulnerability is 'Low' throughout 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 and thus may even decrease the groundwater vulnerability.

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. 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. 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 protocol during construction. It is anticipated that any stockpiles will be formed within the boundary of the site and there will be no direct link or pathway from this area 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.

Dust suppression measures (e.g., damping down during dry periods), vehicle wheel washes, road sweeping, and general housekeeping will ensure that the surrounding environment are free of nuisance dust and dirt on roads.

L&S CONST 3: Source of Fill and Aggregate

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.

There will be no impact to mineral resources in the area as a result of the Proposed Development.

L&S CONST 4: Fuel and Chemical Handling

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. Oil and fuel storage tanks shall be stored in designated areas at locations at least 50m from any body of water, and these areas 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. Spill kits will be kept on site at all times and all staff trained in their appropriate use. Spill kits will contain 10 hr terrestrial oil booms (80mm diameter x 1000mm) and a plastic sheet, upon which contaminated soil can be placed to prevent leaching to ground water

Refuelling of construction vehicles and the addition of hydraulic oils or lubricants to vehicles will take place in a designated area (or where possible off the site) which will be away from surface water gulleys, the existing open ditch 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. Any refuelling and maintenance of equipment will be done at designated bunded areas with full attendance of plant operative(s) within contained areas at least 50m from any watercourse.

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.

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 will be outlined in the detailed CEMP. All personnel working on the site will be suitably trained in the implementation of the procedures. Method statements for dealing with accidental spillages will be provided the Contractor for review by the Employer's Representative.

L&S CONST 5: 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.

There may be localised pumping of surface run-off from the excavations during and after heavy rainfall events to ensure that the trenches are kept relatively dry. 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 localised perched water. Due to the very low permeability of the Dublin Boulder Clay and the relative shallow nature for excavations, infiltration to the underlying aquifer is not anticipated.

Any run-off will be intercepted on site, where the ground falls towards adjoining properties or public roads/footpaths. This will be achieved with open drains or French drains and collected for treatment based on the conditions of a FCC and/or Irish Water licence, prior to pumping to the surface sewer network. During any discharge of surface water from the basement/excavations, the quality of the water will be improved through the provision of settlement tanks and will be regularly monitored visually for hydrocarbon sheen and suspended solids. Periodic laboratory testing of discharge water samples will be carried out in accordance with the requirements of Fingal County Council before discharge to the surrounding drainage network.

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, 50 m buffer zone between machinery and watercourses/ stormwater sewer/ drainage ditch, refuelling of machinery off site) and hydrocarbon interceptors. Designated parking at least 50m from any watercourse. The site compound will be located at least 50m from any watercourse. Contractor to prepare a site plan showing the location of all surface water drainage lines and proposed discharge points to the sewer. The plan will include the location of all surface water protection measures, including monitoring points and treatment facilities

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 localised perched water. 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 Dublin Boulder Clay and the relative shallow nature for excavations, infiltration to the underlying aquifer is not anticipated. Based on GSI information and historical site investigations, it is not anticipated that there will be rock removal required for the proposed single storey basements in the development, for building foundations, for service trenches or for any other works.

The temporary storage of soil will be carefully managed. Stockpiles will be tightly compacted to reduce runoff and graded to aid in runoff collection. This will prevent any potential negative impact on the stormwater drainage and the material will be stored away from any surface water drains. Movement of material will be minimised to reduce the degradation of soil structure and generation of dust. Excavations will remain open for as little time as possible before the placement of fill. This will help to minimise the potential for water ingress into excavations. Soil from works will be stored away from existing drainage features to remove any potential impact.

Weather conditions will be considered when planning construction activities to minimise the risk of run-off from the site and the suitable distance of topsoil piles from surface water drains will be maintained.

Given the current greenfield condition of the subject site, no contamination is expected to be encountered during excavation works on site. Nonetheless, all excavated materials will be visually assessed for signs of possible contamination such as staining or strong odours. Should any unusual staining or odour be noticed, samples of this soil will be analysed for the presence of potential contaminants 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 segregated and appropriately disposed of by a suitably permitted/licensed waste disposal contractor.

The contractor will appoint a suitably qualified person to act as Ecological Clerk of Works (ECoW) to oversee the implementation of measures for the prevention of pollution to the receiving surface water environment. Measures such as silt fencing, straw bales and trenches will be inspected regularly by the ECoW to ensure they are effective and in good repair. Should any measures be damaged or ineffective, they will be repaired or replaced as per the instruction of the ECoW.

Temporary cut off trenches will be excavated along the north of the Site in advance of stripping topsoil; to intercept sediment laden surface water flows prior to their reaching the Gaybrook Stream. These cut off trenches will be connected to a temporary settlement pond. Straw bales will be placed within the cut off trenches at strategic locations and at the outfall from the settlement pond.

7.7.2 Operational Phase

L&S OPER 1: Sustainable Urban Drainage

There are no discharges to ground included in the design and no abstractions from the aquifer. In the event of an accidental leakage of oil from the parking areas, this will be intercepted by the drainage infrastructure proposed and any releases to drainage will be mitigated through hydrocarbon interceptors.

7.8 PREDICTED IMPACTS OF THE PROPOSED DEVELOPMENT

7.8.1 Construction Phase

The implementation of mitigation measures outlined above 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 7.1) for rating the magnitude and significance of impacts on the geological and hydrogeological related attributes, the magnitude of impact is considered **negligible**.

7.8.2 Operational Phase

The implementation of mitigation measures outlined above 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 7.1) for rating the magnitude and significance of impacts on the geological and hydrogeological related attributes, the magnitude of impact is considered **negligible**.

7.9 CUMULATIVE IMPACTS OF THE PROPOSED DEVELOPMENT

This section considers the potential cumulative impacts or effects on the hydrological environment of the proposed development with other existing, planned and permitted developments in the locality.

Cumulative impacts or effects are changes in the environment that result from numerous human-induced, small-scale alterations. The cumulative impact (as far as practically possible) of the proposed development with any/all relevant existing or permitted developments as set out in Appendix 2.1 (Relevant Planning History). The likelihood of cumulative effects are discussed in Sections 7.9.1 and 7.9.2 below for construction and operational phases.

7.9.1 Construction Phase

3 no. relevant planning applications from a lands and soils perspective have been identified within the 500m and 1,000m radius of the subject site. The first application relates to the permitted Strategic Housing Development to the northern part of the Fosterstown Masterplan lands. The remaining 2 no. applications do not relate to any significant form of residential or commercial development. All developments are required to ensure they do not have an impact on the receiving water environment in accordance with the relevant legislation (European Communities Environmental Objectives (Groundwater) Regulations (S.I. 9 of 2010 and S.I. 266 of 2016) such that they would be required to manage runoff and fuel leakages. As such, it can be concluded that the in-combination effects of surface water arising from the Proposed Development taken together with that of other developments will not be significant based on the low potential chemical and sediment loading.

The residual cumulative impact on geology and hydrogeology for the construction phase is anticipated to be neutral, imperceptible, and short term for the construction phase, once appropriate mitigation measures to manage water quality runoff in compliance with legislative requirement are put in place for each development.

7.9.2 Operational Phase

The existing and permitted projects set out in Appendix 2.1 (Relevant Planning History) have been considered in this assessment. Accidental releases from fuel storage/unloading could contaminate groundwater or soil environments unless mitigated adequately i.e. bunded tanks and delivery areas. Localised accidental discharge of hydrocarbons could occur in car parking areas and along roads unless diverted to surface water drainage system with petrol interceptors. However, all developments are required to ensure they do not have an impact on the receiving water environment in accordance with relevant legislation (European Communities Environmental Objectives (Groundwater) Regulations (S.I. 9 of 2010 and S.I. 366 of 2016). As such, they would be required to manage runoff and fuel leakages.

The residual cumulative impact on geology and hydrogeology for the operational phases is anticipated to be neutral, imperceptible and long-term, once appropriate mitigation measures to manage water quality runoff in compliance with legislative requirement are put in place for each development.

7.10 MONITORING

7.10.1 Construction Phase

Routine inspections of construction activities will be carried out on a daily basis by the contractor staff to ensure all controls to prevent environmental impact, relevant to the construction activities taking place at the time, are in place. Environmental inspections will ensure that the works are undertaken in compliance with the Project CEMP and that the requirements of the Conditions of Planning, the NIS and associated documentation are being adhered to during construction.

The Contractor will develop their own site inspection programme, which will include an inspection procedure and relevant forms to record any issues. Only suitably-trained staff will undertake environmental site inspections. The Project Ecologist will keep records of works undertaken. Regular inspection of surface water run-off and sediments controls e.g. silt traps will be carried during the construction phase.

In addition, soil sampling will be carried out to confirm disposal options for excavated soils in order to avoid contaminated run-off. Regular inspection of construction/mitigation measures will be undertaken e.g. concrete pouring, refuelling, etc.

7.10.2 Operational Phase

No future soil or groundwater monitoring is proposed as part of the proposed project as no bulk chemical storage on site. Petrol interceptors will be maintained and cleaned out in accordance with the manufacturer's instructions. Maintenance of the surface water drainage system and foul sewers as per normal urban developments is recommended to minimise any accidental discharges to ground.

7.11 REINSTATEMENT

Not applicable to land, soils, geology and hydrogeology.

7.12 INTERACTIONS

The most significant interactions with land, soils, geology and hydrogeology in between water and hydrology. Due to the inter-relationship between groundwater and surface water the discussed impacts are considered applicable to Chapter 8. The mitigation measures that will be put in place at the proposed development will ensure that the impact of the proposed development complies with all surface and groundwater legislative limits and therefore the

predicted impact is short-term, negative and imperceptible with respect to the construction phase and long-term, neutral and imperceptible with respect to the operational phase.

7.13 DIFFICULTIES ENCOUNTERED IN COMPILING

There were no difficulties encountered when compiling this assessment.

7.14 REFERENCES

European Communities Environmental Objectives (Groundwater) Regulations, 2010 (S.I. No. 9 of 2010 S.I. No. 366 of 2016).

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

APPENDIX 7.1: CRITERIA FOR RATING THE MAGNITUDE AND SIGNIFICANCE OF IMPACTS AT EIA STAGE NATIONAL ROADS AUTHORITY (NRA-TII, 2009)

Table 1 Criteria for Rating Site Attributes – Estimation of Importance of Soil and Geology Attributes (NRA)

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale. Volume of peat and/or soft organic soil underlying route is significant on a national or regional scale.	Geological feature rare on a regional or national scale (NHA). Large existing quarry or pit. Proven economically extractable mineral resource
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying route is significant on a local scale.	Contaminated soil on site with previous heavy industrial usage. Large recent landfill site for mixed wastes. Geological feature of high value on a local scale (County Geological Site). Well drained and/or high fertility soils. Moderately sized existing quarry or pit. Marginally economic extractable mineral resource.
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying route is moderate on a local scale	Contaminated soil on site with previous light industrial usage. Small recent landfill site for mixed wastes. Moderately drained and/or moderate fertility soils. Small existing quarry or pit. Sub-economic extractable mineral resource.
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying route is small on a local scale.	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils. Uneconomically extractable mineral resource.

Table 2 Criteria for Rating Site Attributes – Estimation of Importance of Hydrogeological Attributes (NRA)

Importance	Criteria	Typical Examples
Extremely High	Attribute has a high quality or value on an international scale	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. SAC or SPA status.
Very High	Attribute has a high quality or value on a regional or national scale	Regionally Important Aquifer with multiple well fields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – NHA status. Regionally important potable water source supplying >2500 homes. Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer. Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer. Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer Potable water source supplying <50 homes

Table 3 Criteria for Rating Impact Significance at EIS Stage – Estimation of Magnitude of Impact on Soil/ Geology Attribute (NRA)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute	Loss of high proportion of future quarry or pit reserves. Irreversible loss of high proportion of local high fertility soils. Removal of entirety of geological heritage feature. Requirement to excavate/remediate entire waste site. Requirement to excavate and replace high proportion of peat, organic soils and/or soft mineral soils beneath alignment.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Loss of moderate proportion of future quarry or pit reserves. Removal of part of geological heritage feature. Irreversible loss of moderate proportion of local high fertility soils. Requirement to excavate/remediate significant proportion of waste site. Requirement to excavate and replace moderate proportion of peat, organic soils and/or soft mineral soils beneath alignment.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Loss of small proportion of future quarry or pit reserves. Removal of small part of geological heritage feature. Irreversible loss of small proportion of local high fertility soils and/or high proportion of local low fertility soils. Requirement to excavate/remediate small proportion of waste site. Requirement to excavate and replace small proportion of peat, organic soils and/or soft mineral soils beneath alignment.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	No measurable changes in attributes
Minor Beneficial	Results in minor improvement of attribute quality	Minor enhancement of geological heritage feature
Moderate Beneficial	Results in moderate improvement of attribute quality	Moderate enhancement of geological heritage feature
Major Beneficial	Results in major improvement of attribute quality	Major enhancement of geological heritage feature

Table 4 Criteria for Rating Impact Significance at EIS Stage – Estimation of Magnitude of Impact on Hydrogeological Attribute (NRA)

Magnitude of Impact	Criteria	Typical Examples
Large Adverse	Results in loss of attribute and /or quality and integrity of attribute	Removal of large proportion of aquifer. Changes to aquifer or unsaturated zone resulting in extensive change to existing water supply springs and wells, river baseflow or ecosystems. Potential high risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >2% annually.
Moderate Adverse	Results in impact on integrity of attribute or loss of part of attribute	Removal of moderate proportion of aquifer. Changes to aquifer or unsaturated zone resulting in moderate change to existing water supply springs and wells, river baseflow or ecosystems. Potential medium risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >1% annually.
Small Adverse	Results in minor impact on integrity of attribute or loss of small part of attribute	Removal of small proportion of aquifer. Changes to aquifer or unsaturated zone resulting in minor change to water supply springs and wells, river baseflow or ecosystems. Potential low risk of pollution to groundwater from routine run-off. Calculated risk of serious pollution incident >0.5% annually.
Negligible	Results in an impact on attribute but of insufficient magnitude to affect either use or integrity	Calculated risk of serious pollution incident <0.5% annually.

Table 5 Rating of Significant Environmental Impacts at EIS Stage (NRA)

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

APPENDIX 7.2: IGSL SITE INVESTIGATION REPORT

SWORDS DEVELOPMENT
DUBLIN

Clifton Scannell Emerson
Consulting Engineers

CONTENTS

APPENDICES

FOREWORD

Notes on Site Investigation Procedure

The following notes should be read in conjunction with the report. Any modifications to the procedures outlined below are indicated in the main text.

GENERAL

The recommendations made and opinions expressed in the Report are based on the "Boring Records, an examination of samples and results of the site and laboratory tests. No responsibility can be held for conditions which have not been revealed by the boreholes, for example, between borehole positions. Whilst the report may express an opinion on a possible configuration of strata both between borehole positions and below the maximum depth of the investigation, this is for guidance only and no liability can be accepted for its accuracy.

BORING TECHNIQUE

Unless otherwise stated the 'Shell and Auger' technique of soft ground boring has been employed. Whilst this technique allows the maximum data to be obtained on strata conditions, a degree of mixing of some layered soils, (e.g. thin layers of coarse and fine granular material) is inevitable. Specific attention is drawn to this factor where evidence of such a condition is available.

GROUND WATER

The ground water conditions entered on the Boring Records are those appertaining at the time of the investigation. The normal rate of boring does not usually permit the recording of an equilibrium water level for any one water strike. Moreover, ground water levels are subject to variations caused by seasonal effects or changes in local drainage conditions. The table of each Boring Record shows the ground water level at the quoted borehole and casing depths, usually at the start of the day's work. The word "none" indicates that ground water was sealed off by the borehole casing.

GAS MONITORING

Unless otherwise stated gas monitoring is carried out using a GA2000 infra red gas detector. The gases monitored for and levels noted are recorded and plotted on the relevant test data sheets. Unless stated otherwise no monitoring is carried out for gas pressure or to calculate gas flow rates.

ROUTINE SAMPLING

Undisturbed samples of predominantly cohesive soils are obtained in a 102mm diameter open-drive sampler, complying with the requirements of the British Standard Code of Practice B.S. 5930. Large disturbed samples of granular soils, or of soils in which undisturbed sampling is not possible or appropriate, are taken from the boring tools and sealed into polythene bags. Small disturbed samples are taken at frequent intervals and sealed into 0.5 kg glass jars or polythene bags for subsequent visual classification. Where encountered in sufficient quantity, samples of groundwater are taken.

Unless otherwise stated in the main text, disturbed soil samples may not be at their natural water content.

REPORT ON A SITE INVESTIGATION FOR A DEVELOPMENT AT SWORDS CO.DUBLIN FOR CLIFTON SCANNELL EMERSON ASSOCIATES CONSULTING ENGINEERS

Report No. 10741 JUNE 2005

I Introduction

A major new residential development is proposed for a site on the N1, south of Swords in County Dublin.

A comprehensive investigation of sub soil conditions in the area has been ordered by the project-consulting engineers, Clifton Scannell Emerson Associates, on behalf of the project development company.

The programme of the investigation included the construction of twelve boreholes, eight trial pits and two rotary cored drill holes to establish geotechnical criteria on which to base foundation design. Work was carried out in accordance with BS 5930, Code of Practice for Site Investigations (1999).

A programme of laboratory testing to confirm geotechnical soil parameters followed site operations.

This report includes all factual data pertaining to the project and comments on the geotechnical findings relative to foundation design for the proposed housing development.

II Fieldwork

The site is located West of the N1 Dublin to Belfast Road, just South of Swords Village. Exploratory locations are indicated on the site plan enclosed in Appendix V. The site was greenfield, sloping downwards in a northerly direction towards a stream. At the time of investigation the surface was dry and firm, some isolated soft damp surface zones were observed.

a.Boreholes

The twelve exploratory holes were bored with conventional 200mm cable-tool methods using a Dando Exploratory Rig.

Detailed geotechnical records are contained in Appendix I to this report - the records give details of stratification, sampling, in-situ testing and groundwater. Note is also taken of any obstructions to normal boring requiring the use of the heavy chisel for advancement. It was not possible to recover undisturbed samples because of the high stone/cobble content of the strata encountered.

Top soil generally covers the site, varying from 300 to 500mm in thickness. At BH 7, however the surface consists of clayey fill material to a depth of 1.40 metres.

Below the top soil and fill, in the majority of locations a stratum of firm to stiff brown sandy gravelly clay is encountered. This stratum extends to depths varying from 2.10 to 3.30 metres where very stiff to hard grey black gravelly clay is noted. Both the brown and black clay strata typically contain cobble and boulder particles. Boreholes continued to termination in the black gravelly clay at final depths ranging from 5.40 to 10.00 metres.

At BHs 5, 8 and 12, however, a stratum of soft (wet) brown sandy gravelly clay was encountered from below the top soil to respective depths of 1.20, 2.20 and 1.40 metres, where more competent material is encountered.

The final borehole depths are not indicative of bedrock, refusal followed a period of chiselling on cobble or boulder material in the gravelly clay.

The brown and black gravelly clay encountered is the glacial till deposition of the region, locally referred to as brown and black boulder clay.

Ground water was noted as seepage in the majority of boreholes, generally at the brown/black clay interface. Ground water was sealed off in the black clay which was dry throughout.

b. Rotary Drilling

A truck mounted top drive rotary drilling rig was used to penetrate the hard black glacial till to the specified depth of 15.00 metres at two locations. Detailed core logs have been prepared and are presented in Appendix II. These records give a full geological description of the material encountered.

The holes were drilled, each to a depth of 15.00 metres adjoining BHs 2 and 4. Rock was not encountered, holes were terminated in hard grey black gravelly clay (glacial till or boulder clay).

c. Trial Pits.

Trial pits were excavated over the site area in eight locations using a JCB excavator. The work was carried out under geotechnical engineering supervision, the findings were carefully recorded and samples were recovered for laboratory examination and analysis. Detailed Trial Pit Logs have been prepared and are included in Appendix III.

The records generally confirm borehole findings, top soil overlies firm to stiff brown gravelly clay, with hard grey black gravelly clay noted at depths generally between 2.00 and 3.00 metres. Water seepage was observed at the brown/black clay interface in some of the trial excavations. Excavation sides remained stable throughout the investigation period. Trial pits were backfilled with the excavated arisings.

Samples were recovered at intervals and returned to the IGSL laboratory for analysis.

III Testing

(a) In-Situ :

Standard penetration tests were carried out at approximate 1.00 metre intervals in the geotechnical boreholes to measure relative in-situ soil strength. N values are noted in the right hand column of the boring records, representing the blow count required to drive the standard sampler 300mm into the soil, following initial seating blows. Where full test penetration was not achieved the blow count for a specific penetration is recorded, or refusal is indicated where appropriate.

The results of the tests are summarised as follows:

STRATUM	N VALUE RANGE	COMMENT
Fill (BH 7)	9	Firm
Upper soft clay (BHs 5, 8 and 12)	1 to 6	Soft
Brown Gravelly Clay	8 to 32	Firm to Stiff
Black gravelly Clay	30 to 81	Stiff to very hard

Numerous limited penetration SPT tests and refusals were recorded on cobbles or boulders in the hard black clay and also at the base of the respective boreholes.

(b) Laboratory :

All geotechnical samples from the boreholes and trial pits have been returned to the IGSL laboratory for initial visual inspection, a schedule of testing was prepared and tests as appropriate carried out.

The geotechnical tests consisted of the following.

a. Classification (Liquid and Plastic Limits)
b. Grading Analysis (Wet sieve and Hydrometer)
c. Sulphate and pH determination
d. California Bearing ratio (CBR

Classification
The liquid and plastic limits were established for samples of the brown and black gravelly clay (glacial till). Values are tabulated with relevant moisture contents, falling mainly into the CL zone of the standard Casagrande Classification. The results are very closely grouped, indicating soil of uniform origin, of high sensitivity and of low plasticity .

Grading
Particle size distribution curves were established for samples of the brown and black clay using wet sieve analysis for the coarse material and hydrometer analysis for the finer particles. The resulting graphs have fairly straight-line characteristics, typical of the heterogeneous nature of the local glacial clay deposits.

Sulphate and pH
Chemical tests indicate low sulphate concentrations and near neutral pH. No special precautions are indicated to protect foundation concrete.

CBR

Disturbed samples from the trial pits had CBR values established to assist in pavement design. Testing was carried out in accordance with Road Note 29, using the light compaction hammer. CBR values range from 0.80 to 21.7% . An increasing CBR value with depth of test is noted.

Environmental testing of the sub soils was not carried out as part of this project. The materials encountered were mainly original soils. One thin layer of fill was of clay composition, with no evidence of extraneous material.

IV Discussion

The investigation has been carried out to obtain geotechnical data at a proposed housing development in Swords, County Dublin. A comprehensive investigation was scheduled by Clifton Scannell Emerson Associates on behalf of the site developers. This included boreholes, coreholes and trial pits with a follow up programme of laboratory analysis to confirm soil parameters.

The findings confirm the presence of glacial till deposits underlying shallow more recently deposited soils. The glacial tills consist of firm to stiff brown gravelly clay overlying hard grey black gravelly clay. The black till is noted between 2.00 and 3.00 metres and was penetrated by rotary drilling to 15.00 metres. Rock was not encountered.

The glacial material is locally referred to as brown and black boulder clay. The findings on this site are typical of the North County Dublin area.

Some soft material (typically damp) was noted at Boreholes 5, 8 and 12. The soft material extends to a maximum depth of 2.20 metres at BH 8. One shallow area of fill was noted at BH 7 to a depth of 1.40 metres.

House Foundations

Over the majority of the site foundations for traditional housing can be placed on the brown gravelly clay (brown boulder clay) at a nominal depth of 0.80 to 1.00 metres. The lower range of test results indicates an allowable bearing pressure of 100 kN/sq.m. for reinforced strip footings.

The depth to a suitable formation in the brown gravelly clay must be increased where soft zones are encountered. This can typically be to about 1.50 metres as indicated by BHs 5, 7 and 12 and in excess of 2.00 metres in the area of BH 8.

Where excavation depth exceeds about 1.50 metres the use of trench fill techniques should be considered.

The glacial till is over-consolidated and consequently settlement under the above recommended load will be very low, with negligible differential movement anticipated.

The heterogeneous nature of the glacial sub soils is emphasised and variation from hard clay to dense gravel can occur randomly. Careful visual examination of excavated formation is advised to ensure uniformity and suitability of the founding medium. The firm to stiff brown boulder clay should be readily identified by an experienced site foreman or engineer. Any unsuitable material, including upper top soil, soft clay , fill and organic material should be removed and replaced by low grade concrete.

Heavy Loads
The forgoing assumed that traditional house construction is proposed. Should heavier loads be envisaged (apartments or commercial structures) the use of the hard black lodgement till (found at an average depth of 2.50 metres) can be considered as a founding medium. Field and laboratory tests indicate an allowable bearing pressure of 350 kN/sq,m, for strip or pad foundations founded in this material.

Ground Water
Ground water was noted in some locations, generally as a seepage at the brown/black clay interface. The lower black till is highly impermeable. Water ingress into shallow foundation excavations is unlikely. Some soft surface zones were noted and softening of the surface can be expected in winter conditions. The glacial till is sensitive to moisture content variation, excavations should not be exposed to rainfall, either rapid placement of foundation concrete or blinding of foundations following excavation is advised.

Excavation Stability

While vertical excavations in the boulder clay will remain stable in the short term, statutory safety regulations prohibit personnel entering unsupported excavations greater than 1.20 metres deep, irrespective of soil type. This may be particularly relevant to deep service excavations or to areas considered for trench fill.

Roads and Pavements
CBR tests give a range of values from 1 to 4 per cent in the upper soils (0.50 metres BGL). Tests in the stronger underlying soils (2.00 metres) reflect an increase in CBR value to above 16%.

For estate roads we would suggest a preliminary design CBR of about 3% at a depth of about 0.80 metres. Additional CBR tests on the actual road network at construction stage can confirm this proposed design value.

SUMMARY

Traditional shallow reinforced strip footings are recommended over most of the site area. An allowable bearing pressure of 100 kN/sq.m. is recommended, formation depth will generally not exceed 1.00 metre. Isolated soft areas are present which will necessitate deepening foundations to 1.50 to 2.00 metres, this may necessitate the use of trench fill methods. Visual assessment of excavations is advised to ensure uniformity and suitability of the founding medium.

IGSL/JC
JUNE 2005

Appendix I – Cable Tool Borehole Records

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Swords Housing Development

BOREHOLE NO: BH1
Sheet 1 of 1

CLIENT :

ENGINEER : Clifton Scannell Emerson Associates

GROUND LEVEL (mOD) -
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 7.50
CASING DEPTH (m) 7.50

DATE STARTED: 07/06/2005
DATE COMPLETED: 08/06/2005

CO-ORDINATES : E -
N -

BORED BY: J O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLES SAMPLE TYPE	SAMPLES DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	Topsoil									
	Firm brown sandy gravelly CLAY with cobbles and boulders			0.50						
1					080	B	1.00	C	N=13	
2					081	B	2.00	C	N=13	
3	Firm to stiff grey brown sandy gravelly CLAY			2.90	082	B	3.00	C	N=18	
	Hard black sandy gravelly CLAY with cobbles and boulders			3.50						
4					083	B	4.00	C	N=49	
5					084	B	5.00	C	N=62	
6					085	B	6.00	C	N=49	
7					086	B	7.00	C	N=58/ 225mm	
	End of Borehole at 7.50 m			7.50						
8										
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
4.50	4.70	0.75	
7.30	7.50	2.00	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
2.80	2.80	3.00	-	-	Seepage

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
08/06/2005	7.50	0.00	-	Borehole dry at end of boring

Remarks:

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Swords Housing Development

BOREHOLE NO: BH2
Sheet 1 of 1

CLIENT :

ENGINEER : Clifton Scannell Emerson Associates

CO-ORDINATES : E -
N -

GROUND LEVEL (mOD) -
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 7.50
CASING DEPTH (m) 7.50

DATE STARTED: 31/05/2005
DATE COMPLETED: 31/05/2005

BORED BY: J O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLE TYPE	SAMPLES DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	Topsoil			0.30						
	Firm brown sandy gravelly CLAY with cobbles and boulders				5686	B	1.00	C	N=10	
1										
					5687	B	2.00	C	N=13	
2				2.50						
	Very stiff to hard black sandy gravelly CLAY with cobbles and boulders				5688	B	3.00	C	N=57	
3										
					5689	B	4.00	C	N=64	
4										
					5690	B	5.00	C	N=33/ 150mm	
5										
					5691	B	6.00	C	N=87/ 235mm	
6										
					5692	B	7.00	C	N=68/ 225mm	
7										
	End of Borehole at 7.50 m			7.50						
8										
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
3.00	7.30	1.00	.
7.30	7.50	2.00	.

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
2.30	2.30	3.00	-	-	Seepage

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
31/05/2005	7.50	0.00	-	Borehole dry at end of boring

Remarks:

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Swords Housing Development

BOREHOLE NO: BH3
Sheet 1 of 1

CLIENT :

ENGINEER : Clifton Scannell Emerson Associates

GROUND LEVEL (mOD) -
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 8.00
CASING DEPTH (m) 8.00

DATE STARTED: 17/05/2005
DATE COMPLETED: 17/05/2005

CO-ORDINATES : E -
N -

BORED BY: J O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLE TYPE	SAMPLES DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	Topsoil									
	Firm to stiff brown sandy gravelly CLAY with occasional cobbles and boulders			0.30						
1					5601	B	1.00	C	N=8	
2	Very stiff to hard black sandy gravelly CLAY with occasional cobbles and boulders			2.10	5602	B	2.00	C	N=22	
3					5603	B	3.00	C	N=46	
4					5604	B	4.00	C	N=68	
5					5605	B	5.00	C	N=81	
6					5606	B	6.00	C	N=72	
7					5607	B	7.00	C	N=66/ 225mm	
8	Obstruction			7.95	5608	B	8.00	C	N=50/ 150mm	
	End of Borehole at 8.00 m			8.00						
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
5.00	5.60	1.00	.
7.30	7.50	1.00	.
7.90	8.00	2.00	.

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
1.80	1.70	2.10	-	-	Seepage

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
17/05/2005	8.00	0.00	-	Borehole dry at end of boring

Remarks:

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Swords Housing Development

BOREHOLE NO: BH4
Sheet 1 of 1

CLIENT :
ENGINEER : Clifton Scannell Emerson Associates

GROUND LEVEL (mOD) -
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 7.00
CASING DEPTH (m) 7.00

DATE STARTED: 03/06/2005
DATE COMPLETED: 03/06/2005

CO-ORDINATES : E -
N -

BORED BY: J O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES: REF. NUMBER	SAMPLES: SAMPLE TYPE	SAMPLES: DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	Topsoil									
	Firm to stiff brown sandy gravelly CLAY with occasional cobbles and boulders			0.50						
1					071	B	1.00	C	N=12	
2					072	B	2.00	C	N=21	
	Stiff to very stiff black sandy gravelly CLAY with cobbles and boulders			2.80						
3					073	B	3.00	C	N=30	
4					074	B	4.00	C	N=70/ 295mm	
5					075	B	5.00	C	N=51/ 225mm	
6					076	B	6.00	C	N=25/ 75mm	
7	End of Borehole at 7.00 m			7.00	077	B	7.00	C	N=R	
8										
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
2.80	2.90	0.50	
4.30	4.50	0.75	
5.20	5.40	0.75	
6.70	7.00	2.00	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
-	-	-	-	-	Dry

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
03/06/2005	7.00	0.00	-	Borehole dry at end of boring

Remarks:

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Swords Housing Development

BOREHOLE NO: BH5
Sheet 1 of 1

CLIENT :

ENGINEER : Clifton Scannell Emerson Associates

CO-ORDINATES : E -
N -

GROUND LEVEL (mOD) -
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 8.00
CASING DEPTH (m) 8.00

DATE STARTED: 13/05/2005
DATE COMPLETED: 13/05/2005

BORED BY: J O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES: REF. NUMBER	SAMPLES: SAMPLE TYPE	SAMPLES: DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	Topsoil			0.20						
	Soft brown sandy CLAY				45	B	1.00	C	N=4	
1				1.20						
	Stiff brown sandy gravelly CLAY with occasional cobbles and boulders				46	B	2.00	C	N=32	
2				2.30						
	Very stiff to hard sandy gravelly CLAY with occasional cobbles and boulders				47	B	3.00	C	N=48	
3					48	B	4.00	C	N=65	
4					49	B	5.00	C	N=60	
5					50	B	6.00	C	N=61/ 225mm	
6					51	B	7.00	C	N=25/ 75mm	
7										
8	Obstruction			7.95	52	B	8.00	C	N=R	
	End of Borehole at 8.00 m			8.00						
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
2.30	2.90	1.00	
4.50	4.80	1.00	
6.30	6.50	0.75	
7.50	8.00	2.00	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
1.20	1.10	1.80	-	-	Seepage

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
13/05/2005	8.00	0.00	-	Borehole dry at end of boring

Remarks:

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Swords Housing Development

BOREHOLE NO: BH6
Sheet 1 of 1

CLIENT :

ENGINEER : Clifton Scannell Emerson Associates

GROUND LEVEL (mOD) -
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 8.10
CASING DEPTH (m) 8.10

DATE STARTED: 20/05/2005
DATE COMPLETED: 20/05/2005

CO-ORDINATES : E -
N -

BORED BY: J O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLE TYPE	SAMPLES DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	Topsoil									
	Firm to stiff brown sandy gravelly CLAY with occasional cobbles and boulders			0.30						
1					5629	B	1.00	C	N=8	
2					5630	B	2.00	C	N=10	
3	Very stiff to hard black sandy gravelly CLAY with occasional cobbles and boulders			3.00	5631	B	3.00	C	N=32	
4					5632	B	4.00	C	N=70	
5					5633	B	5.00	C	N=55	
6					5634	B	6.00	C	N=49/ 150mm	
7					5635	B	7.00	C	N=62/ 225mm	
8	Obstruction			7.95	5636	B	8.00	C	N=50/ 150mm	
	End of Borehole at 8.10 m			8.10						
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
6.00	6.40	1.75	.
7.90	8.10	2.00	.

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
2.00	1.90	3.30	-	-	Seepage

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
20/05/2005	8.10	0.00	6.40	At end of boring

Remarks:

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Swords Housing Development

BOREHOLE NO: BH7
Sheet 1 of 1

CLIENT :

ENGINEER : Clifton Scannell Emerson Associates

CO-ORDINATES : E -
N -

GROUND LEVEL (mOD) -
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 10.00
CASING DEPTH (m) 10.00

DATE STARTED: 18/05/2005
DATE COMPLETED: 18/05/2005

BORED BY: J O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLE TYPE	SAMPLES DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	MADE GROUND consisting of brown clay fill				5609	B	1.00	C	N=9	
1										
	Firm brown sandy gravelly CLAY with occasional cobbles and boulders			1.40						
2					5610	B	2.00	C	N=18	
	Very stiff to hard black sandy gravelly CLAY with occasional cobbles and boulders			2.20						
3					5611	B	3.00	C	N=54	
4					5612	B	4.00	C	N=66/ 225mm	
5					5613	B	5.00	C	N=49/ 150mm	
6					5614	B	6.00	C	N=50/ 150mm	
7					5615	B	7.00	C	N=50/ 150mm	
8					5616	B	8.00	C	N=R	
9					5617	B	9.00	C	N=R	
10	End of Borehole at 10.00 m			10.00	5618	B	10.00	C	N=R	

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
4.40	4.70	0.75	.
5.30	5.50	1.00	.
6.40	6.80	1.25	.
9.50	10.00	2.00	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
10.00	10.00	-	-	-	Dry

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type
18/05/2005	10.00	1.00	10.00	SP

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
18/05/2005	10.00	0.00	-	Borehole dry at end of boring

Remarks:

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Swords Housing Development

BOREHOLE NO: BH8
Sheet 1 of 1

CLIENT :

ENGINEER : Clifton Scannell Emerson Associates

CO-ORDINATES : E -
N -

GROUND LEVEL (mOD) -
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 5.40
CASING DEPTH (m) 5.40

DATE STARTED: 30/05/2005
DATE COMPLETED: 30/05/2005

BORED BY: J O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLE TYPE	SAMPLES DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	Topsoil									
	Very soft to soft brown sandy gravelly CLAY with cobbles and boulders			0.30						
1					5676	B	1.00	C	N=1	
2					5677	B	2.00	C	N=6	
	Stiff to very stiff black sandy gravelly CLAY with cobbles and boulders			2.20						
3					5678	B	3.00	C	N=23	
4					5679	B	4.00	C	N=47	
5					5680	B	5.00	C	N=R	
	Obstruction - Possible rock/boulder			5.10						
	End of Borehole at 5.40 m			5.40	5681	B	5.40			
6										
7										
8										
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
5.10	5.40	2.50	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
4.80	4.80	-	4.30	20	Slow

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type
30/05/2005	5.00	1.00	5.00	SP

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
30/05/2005	5.40	0.00	-	Borehole dry at end of boring

Remarks:

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Swords Housing Development

BOREHOLE NO: BH9
Sheet 1 of 1

CLIENT :

ENGINEER : Clifton Scannell Emerson Associates

GROUND LEVEL (mOD) -
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 7.50
CASING DEPTH (m) 7.50

DATE STARTED: 12/05/2005
DATE COMPLETED: 12/05/2005

CO-ORDINATES : E -
N -

BORED BY: J O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLES SAMPLE TYPE	SAMPLES DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	Topsoil									
	Firm to stiff brown sandy gravelly CLAY with occasional cobbles and boulders			0.40						
1					38	B	1.00	C	N=7	
2	Very stiff to hard black sandy gravelly CLAY with occasional cobbles and boulders			2.10	39	B	2.00	C	N=28	
3					40	B	3.00	C	N=49	
4					41	B	4.00	C	N=68/ 225mm	
5					42	B	5.00	C	N=47/ 150mm	
6					43	B	6.00	C	N=63	
7					44	B	7.00	C	N=55/ 225mm	
	Obstruction			7.45						
	End of Borehole at 7.50 m			7.50						
8										
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
3.60	4.00	1.00	
5.80	6.20	1.50	
7.10	7.50	2.00	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
7.50	7.50	-	-	-	Dry

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
12/05/2005	7.50	0.00	-	Borehole dry at end of boring

Remarks:

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Swords Housing Development

BOREHOLE NO: BH10
Sheet 1 of 1

CLIENT :

ENGINEER : Clifton Scannell Emerson Associates

GROUND LEVEL (mOD) -
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 9.00
CASING DEPTH (m) 9.00

DATE STARTED: 19/05/2005
DATE COMPLETED: 19/05/2005

CO-ORDINATES : E -
N -

BORED BY: J O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLES SAMPLE TYPE	SAMPLES DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	Topsoil									
	Firm brown sandy gravelly CLAY with occasional cobbles and boulders			0.30						
1					5619	B	1.00	C	N=13	
2					5620	B	2.00	C	N=18	
	Stiff black sandy gravelly CLAY with occasional cobbles and boulders (moist)			2.30						
3					5621	B	3.00	C	N=34	
	Very stiff to hard black sandy gravelly CLAY with occasional cobbles and boulders			3.50						
4					5622	B	4.00	C	N=46	
5					5623	B	5.00	C	N=R	
6					5624	B	6.00	C	N=57	
7					5625	B	7.00	C	N=61/ 225mm	
8					5626	B	8.00	C	N=66/ 225mm	
9					5627	B	9.00	C	N=25/ 75mm	
	Obstruction			9.15						
	End of Borehole at 9.00 m			9.20						
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
5.00	5.30	1.25	Continues chiseling
8.80	8.40	2.50	
9.10	9.20	2.00	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
2.30	2.20	3.50	-	-	Seepage

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type
19/05/2005	9.00	1.00	9.00	SP

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
19/05/2005	9.20	0.00	-	Borehole dry at end of boring

Remarks:

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.

CONTRACT : Swords Housing Development

BOREHOLE NO: BH11
Sheet 1 of 1

CLIENT :

ENGINEER : Clifton Scannell Emerson Associates

CO-ORDINATES : E -
N -

GROUND LEVEL (mOD) -
BOREHOLE DIAMETER (mm) 200
BOREHOLE DEPTH (m) 8.50
CASING DEPTH (m) 8.50

DATE STARTED: 01/06/2005
DATE COMPLETED: 01/06/2005

BORED BY: J O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLES SAMPLE TYPE	SAMPLES DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	Topsoil									
	Firm brown sandy gravelly CLAY with cobbles and boulders			0.30						
1					055	B	1.00	C	N=8	
2					056	B	2.00	C	N=12	
3					057	B	3.00	C	N=17	
	Very stiff to hard black sandy gravelly CLAY with cobbles and boulders			3.30						
4					058	B	4.00	C	N=51	
5					059	B	5.00	C	N=67	
6					060	B	6.00	C	N=68/ 220mm	
7					061	B	7.00	C	N=R	
8					062	B	8.00	C	N=R	
	End of Borehole at 8.50 m			8.50						
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
3.30	6.50	0.50	.
6.50	8.50	3.00	.

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
3.10	3.10	3.50	-	-	Seepage

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type
01/06/2005	8.00	1.00	8.00	SP

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
01/06/2005	8.50	0.00	-	Borehole dry at end of boring

Remarks:

REPORT NO: 10741	GEOTECHNICAL BORING RECORD	IGSL Ltd.
CONTRACT : Swords Housing Development		BOREHOLE NO: BH12 Sheet 1 of 1
CLIENT :	GROUND LEVEL (mOD) -	DATE STARTED: 02/06/2005
ENGINEER : Clifton Scannell Emerson Associates	BOREHOLE DIAMETER (mm) 200	DATE COMPLETED: 02/06/2005
CO-ORDINATES : E - N -	BOREHOLE DEPTH (m) 8.00	BORED BY: J O'Hara
	CASING DEPTH (m) 8.00	

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES REF. NUMBER	SAMPLE TYPE	SAMPLES DEPTH (m)	SPT TYPE	FIELD TEST RESULTS	STAND PIPE DETAILS
0	Topsoil									
	Soft brown sandy CLAY with gravel			0.30						
1					063	B	1.00	C	N=6	
	Firm brown gravelly CLAY			1.40						
2					064	B	2.00	C	N=15	
3					065	B	3.00	C	N=32	
	Very stiff black sandy gravelly CLAY with cobbles and boulders			3.20						
4					066	B	4.00	C	N=74/ 295mm	
5					067	B	5.00	C	N=63/ 225mm	
6					068	B	6.00	C	N=50/ 150mm	
7					069	B	7.00	C	N=R	
8	End of Borehole at 8.00 m			8.00	070	B	8.00	C	N=R	
9										
10										

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
5.20	5.35	0.50	.
6.25	6.30	0.75	.
7.00	8.00	2.00	.

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
3.00	3.00	3.50	-	-	Seepage

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
02/06/2005	8.00	0.00	-	Borehole dry at end of boring

Remarks:

Appendix II – Rotary Core Records

REPORT NO.	10741	GEOTECHNICAL CORE LOG RECORD	IGSL Ltd.

CONTRACT: Swords Housing Development

DRILLHOLE NO : RC2
SHEET: Sheet 1 of 2

CLIENT:
ENGINEER: Clifton Scannell Emerson Associates

CORE DIAMETER (mm):
GROUND LEVEL (mOD):

DATE STARTED: 12/05/2005
DATE COMPLETED: 12/05/2005

CO-ORDINATES:

INCLINATION (Degrees): 90
FLUSH:

DRILLED BY: C. Carrington
LOGGED BY: C. Carrington,

DOWNHOLE DEPTH (m)	CORE RUN DEPTH (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing (mm) 0 250 500	UCS (MPa)	POINT LOAD Is(50) MPa	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SPT (N value)	STANDPIPE DETAILS	GEOTECHNICAL DESCRIPTION
										0.20			Topsoil
													Brown sandy gravelly CLAY with cobbles
										2.70			Black sandy gravelly CLAY with cobbles and boulders
													Continued next sheet

REMARKS:

INSTALLATION DETAILS
Installation Type :
Depth to Response Zone top (m) :
Depth to Response Zone bottom (m) :
Comments :

REPORT NO.	10741	GEOTECHNICAL CORE LOG RECORD	IGSL Ltd.

CONTRACT: Swords Housing Development

DRILLHOLE NO : RC2
SHEET: Sheet 2 of 2

CLIENT:
ENGINEER: Clifton Scannell Emerson Associates

CORE DIAMETER (mm):
GROUND LEVEL (mOD):

DATE STARTED: 12/05/2005
DATE COMPLETED: 12/05/2005

CO-ORDINATES:

INCLINATION (Degrees): 90
FLUSH:

DRILLED BY: C. Carrington
LOGGED BY: C. Carrington,

DOWNHOLE DEPTH (m)	CORE RUN DEPTH (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing (mm) 0 250 500	UCS (MPa)	POINT LOAD Is(50) MPa	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SPT (N value)	STANDPIPE DETAILS	GEOTECHNICAL DESCRIPTION
9													Black sandy gravelly CLAY with cobbles and boulders
10													
11													
12													
13													
14													
15										15.00			End of Borehole at 15.00 m
16													

REMARKS:

INSTALLATION DETAILS
Installation Type :
Depth to Response Zone top (m) :
Depth to Response Zone bottom (m) :
Comments :

REPORT NO.	10741	GEOTECHNICAL CORE LOG RECORD	IGSL Ltd.

CONTRACT: Swords Housing Development

DRILLHOLE NO : RC4
SHEET: Sheet 1 of 2

CLIENT:
ENGINEER: Clifton Scannell Emerson Associates

CORE DIAMETER (mm):
GROUND LEVEL (mOD):

DATE STARTED: 13/05/2005
DATE COMPLETED: 13/05/2005

CO-ORDINATES:

INCLINATION (Degrees): 90
FLUSH:

DRILLED BY: C. Carrington
LOGGED BY: C. Carrington,

DOWNHOLE DEPTH (m)	CORE RUN DEPTH (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing (mm) 0 250 500	UCS (MPa)	POINT LOAD Is(50) MPa	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SPT (N value)	STANDPIPE DETAILS	GEOTECHNICAL DESCRIPTION
										0.20			Topsoil
													Brown sandy gravelly CLAY ith obbes
										2.50			Black sandy gravelly CLAY with cobbles and boulders
													Continued next sheet

REMARKS:

INSTALLATION DETAILS
Installation Type :
Depth to Response Zone top (m) :
Depth to Response Zone bottom (m) :
Comments :

REPORT NO.	10741	GEOTECHNICAL CORE LOG RECORD	IGSL Ltd.

CONTRACT: Swords Housing Development

DRILLHOLE NO : RC4
SHEET: Sheet 2 of 2

CLIENT:
ENGINEER: Clifton Scannell Emerson Associates

CORE DIAMETER (mm):
GROUND LEVEL (mOD):

DATE STARTED: 13/05/2005
DATE COMPLETED: 13/05/2005

CO-ORDINATES:

INCLINATION (Degrees): 90
FLUSH:

DRILLED BY: C. Carrington
LOGGED BY: C. Carrington,

DOWNHOLE DEPTH (m)	CORE RUN DEPTH (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing (mm) 0 250 500	UCS (MPa)	POINT LOAD Is(50) MPa	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SPT (N value)	STANDPIPE DETAILS	GEOTECHNICAL DESCRIPTION
9													Black sandy gravelly CLAY with cobbles and boulders
10													
11													
12													
13													
14													
15										15.00			End of Borehole at 15.00 m
16													

REMARKS:

INSTALLATION DETAILS
Installation Type :
Depth to Response Zone top (m) :
Depth to Response Zone bottom (m) :
Comments :

Appendix III – Trial Pit Records

REPORT NO. 10741	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Swords Housing Development	Trial Pit No.:	TP1
		Sheet:	Sheet 1 of 1
CLIENT:		Excavation Method:	JCB
ENGINEER:	Clifton Scannell Emerson Associates	Date Started:	23/05/2005
CO-ORDINATES:	E - N -	Date Completed:	23/05/2005
		Ground Level (mOD):	-

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	Topsoil		0.30							
	Firm to stiff light brown sandy slightly gravelly CLAY					8573	CBR	0.50		
1.0						8574	B	1.10		
	Firm to stiff dark brown sandy gravelly CLAY with occasional sub-rounded to sub-angular cobbles and boulders		1.20		▽					
2.0										
	Very stiff to hard black sandy gravelly CLAY with occasional cobbles and boulders		2.90			8575	B	3.00		
3.0										
	End of Trial Pit at 3.50 m		3.50							
4.0										

Groundwater Conditions: Seepage at 2.4m

Stability: Stable throughout excavation

Remarks:

REPORT NO. 10741	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Swords Housing Development	Trial Pit No.:	TP2
		Sheet:	Sheet 1 of 1
CLIENT:		Excavation Method:	JCB
ENGINEER:	Clifton Scannell Emerson Associates	Date Started:	23/05/2005
CO-ORDINATES:	E - N -	Date Completed:	23/05/2005
		Ground Level (mOD):	-

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	Topsoil									
	Firm brown sandy gravelly CLAY with occasional sub-angular to sub-rounded cobbles and boulders		0.30			8570	CBR	0.50		
1.0						8571	B	1.10		
	Very stiff to hard black sandy gravelly CLAY with occasional cobbles and boulders		1.80		▽					
2.0										
						8572	B	2.40		
3.0										
	End of Trial Pit at 3.20 m		3.20							
4.0										

Groundwater Conditions: Seepage at 1.8m

Stability: Stable throughout excavation

Remarks:

REPORT NO. 10741	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Swords Housing Development	Trial Pit No.:	TP3
		Sheet:	Sheet 1 of 1
CLIENT:		Excavation Method:	JCB
ENGINEER:	Clifton Scannell Emerson Associates	Date Started:	23/05/2005
		Date Completed:	23/05/2005
CO-ORDINATES:	E - N -	Ground Level (mOD):	-

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	Topsoil									
	Firm light brown sandy CLAY		0.40			8585	CBR	0.50		
1.0	Stiff brown sandy gravelly CLAY with occasional sub-rounded to sub-angular cobbles and boulders		0.90			8586	B	1.40		
2.0										
3.0										
	Very stiff to hard sandy gravelly CLAY with ocasional cobbles and boulders		3.10			8587	B	3.20		
	End of Trial Pit at 3.60 m		3.60							
4.0										

Groundwater Conditions: No groundwater encountered

Stability: Stable throughout excavation

Remarks:

REPORT NO. 10741	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Swords Housing Development	Trial Pit No.:	TP4
		Sheet:	Sheet 1 of 1
CLIENT:		Excavation Method:	JCB
ENGINEER:	Clifton Scannell Emerson Associates	Date Started:	23/05/2005
CO-ORDINATES:	E - N -	Date Completed:	23/05/2005
		Ground Level (mOD):	-

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	Topsoil									
	Firm to stiff brown sandy gravelly CLAY with occasional sub-rounded to sub-angular cobbles and boulders		0.30			8576	CBR	0.50		
1.0						8577	B	1.10		
2.0	Very stiff to hard black sandy gravelly CLAY with occasional cobbles and boulders		2.00			8578	B	2.20		
3.0										
	End of Trial Pit at 3.40 m		3.40							
4.0										

Groundwater Conditions: No groundwater encountered

Stability: Stable throughout excavation

Remarks:

REPORT NO. 10741 — TRIAL PIT RECORD — IGSL Ltd.

CONTRACT:	Swords Housing Development	Trial Pit No.:	TP5
CLIENT:		Sheet:	Sheet 1 of 1
ENGINEER:	Clifton Scannell Emerson Associates	Excavation Method:	JCB
		Date Started:	23/05/2005
CO-ORDINATES:	E - N -	Date Completed:	23/05/2005
		Ground Level (mOD):	-

Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples Ref. No.	Samples Type	Samples Depth (m)	Vane Test (KPa)	Hand Penetrometer (KPa)
Topsoil									
Firm to stiff brown sandy gravelly CLAY with occasional sub-rounded to sub-angular cobbles and boulders and occasional sand lenses		0.40			8567	CBR	0.50		
					8568	B	1.00		
Very stiff to hard black sandy gravelly CLAY with occasional sub-rounded to sub-angular cobbles and boulders		2.00		▽	8569	B	2.30		
End of Trial Pit at 3.40 m		3.40							

Groundwater Conditions: Seepage at 2.0m

Stability: Stable throughout excavation

Remarks:

REPORT NO. 10741	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Swords Housing Development	Trial Pit No.:	TP6
		Sheet:	Sheet 1 of 1
CLIENT:		Excavation Method:	JCB
ENGINEER:	Clifton Scannell Emerson Associates	Date Started:	23/05/2005
CO-ORDINATES:	E - N -	Date Completed:	23/05/2005
		Ground Level (mOD):	-

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples Ref. No.	Samples Type	Samples Depth (m)	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0	Topsoil									
	Firm light brown sandy slightly gravelly CLAY		0.40			8582	CBR	0.50		
	Firm brown sandy gravelly CLAY with occasional sub-rounded to sub-angular cobbles and boulders		0.80			8583	B	1.40		
1.0					▽					
2.0										
					▽					
3.0	Very stiff to hard black sandy gravelly CLAY with occasional cobbles and boulders		3.10			8584	B	3.20		
	End of Trial Pit at 3.50 m		3.50							
4.0										

Groundwater Conditions: Seepage at 1.8m and 2.8m

Stability: Slightly unstabel from 1.8m

Remarks:

REPORT NO. 10741	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Swords Housing Development	Trial Pit No.:	TP7
		Sheet:	Sheet 1 of 1
CLIENT:		Excavation Method:	JCB
ENGINEER:	Clifton Scannell Emerson Associates	Date Started:	23/05/2005
CO-ORDINATES:	E - N -	Date Completed:	23/05/2005
		Ground Level (mOD):	-

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	Topsoil									
	Firm to stiff brown sandy gravelly CLAY with occasional sub-rounded to sub-angular cobbles and boulders and occasional sand lenses		0.30			8579	CBR	0.50		
1.0						8580	B	1.20		
2.0										
	Very stiff to hard black sandy gravelly CLAY with occasional cobbles and boulders		2.20			8581	B	2.50		
3.0										
	End of Trial Pit at 3.40 m		3.40							
4.0										

Groundwater Conditions: No groundwater encountered

Stability: Stable throughout excavation

Remarks:

REPORT NO. 10741	TRIAL PIT RECORD	IGSL Ltd.

CONTRACT:	Swords Housing Development	Trial Pit No.:	TP8
		Sheet:	Sheet 1 of 1
CLIENT:		Excavation Method:	JCB
ENGINEER:	Clifton Scannell Emerson Associates	Date Started:	23/05/2005
CO-ORDINATES:	E - N -	Date Completed:	23/05/2005
		Ground Level (mOD):	-

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Vane Test (KPa)	Hand Penetrometer (KPa)
						Ref. No.	Type	Depth (m)		
0.0	Topsoil									
	Firm brown sandy gravelly CLAY with occasional sub-rounded to sub-angular cobbles		0.30			8564	CBR	0.50		
1.0						8565	B	1.00		
	Very stiff to hard black sandy gravelly CLAY with occasional sub-rounded to sub-angular cobbles and boulders		1.80							
2.0						8566	B	2.30		
3.0										
	End of Trial Pit at 3.30 m		3.30							
4.0										

Groundwater Conditions: No groundwater encountered

Stability: Stable throughout excavation

Remarks:

Appendix IV – Laboratory Test Records

Summary of Classification Tests

BS1377:Part 2:1990, clauses 3.2, 4.3, 5.3 & 5.4

BH/TP No.	Sample No.	Depth (m)	Sample Type	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index	<425μm %	Preparation	Description	Classification
BH2	5686	1.00	D	18	36	18	18	65	WS	Mottled grey brown sandy gravelly CLAY	C I
BH3	5601	1.00	D	14	35	19	16	60	WS	Mottled grey brown sandy gravelly CLAY	C L
BH3	5604	4.00	D	9.3	24	16	8	60	WS	Grey black slightly sandy slightly gravelly CLAY	C L
BH5	OO47	3.00	D	7.9	29	15	14	50	WS	Mottled grey brown sandy gravelly CLAY	C L
BH6	5629	1.00	D	16	36	20	16	58	WS	Brown sandy gravelly CLAY with root hairs	C I
BH6	5632	4.00	D	13	30	14	16	57	WS	Grey black slightly sandy slightly gravelly CLAY	C L
BH7	5611	3.00	D	9.3	31	15	16	55	WS	Grey black sandy gravelly CLAY	C L
BH8	5676	1.00	D	24	44	20	24	78	WS	Mottled grey brown sandy gravelly CLAY with roots	C I
BH8	5678	3.00	D	13	30	15	15	67	WS	Grey black slightly sandy slightly gravelly CLAY	C L
BH10	5622	4.00	D	13	32	15	17	53	WS	Dark grey slightly sandy gravelly CLAY	C L
BH11	OO55	1.00	D	15	33	17	16	58	WS	Brown sandy gravelly CLAY with root hairs	C L
BH11	OO58	4.00	D	10	28	15	13	59	WS	Grey black slightly sandy slightly gravelly CLAY	C L
BH11	OO61	7.00	D	7.7	28	14	14	57	WS	Grey black slightly sandy slightly gravelly CLAY	C L

Notes: NAT - tested as received WS - Wet sieved (425μm) NP - Non Plastic

IGSL	Contract: Swords Housing Development				Contract No. 10741
	Compiled By	Date	Checked By	Date	Page
	D CONNOLLY	28/06/2005			of

Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

particle size	% passing	
75	100.0	COBBLES
63	100.0	
50	100.0	
37.5	98.0	
28	94.0	
20	90.2	GRAVEL
14	89.3	
10	86.3	
6.3	82.8	
5	80.7	
3.35	76.2	
2	71.4	
1.18	67.3	
0.6	62.3	SAND
0.425	59.9	
0.3	57.3	
0.15	51.4	
0.063	42.2	
0.04	39.7	
0.03	36.4	
0.02	33.0	SILT/CLAY
0.013	28.3	
0.009	26.2	
0.005	21.8	
0.002	16.1	

Contract No: 10741

Contract: Swords Housing Development

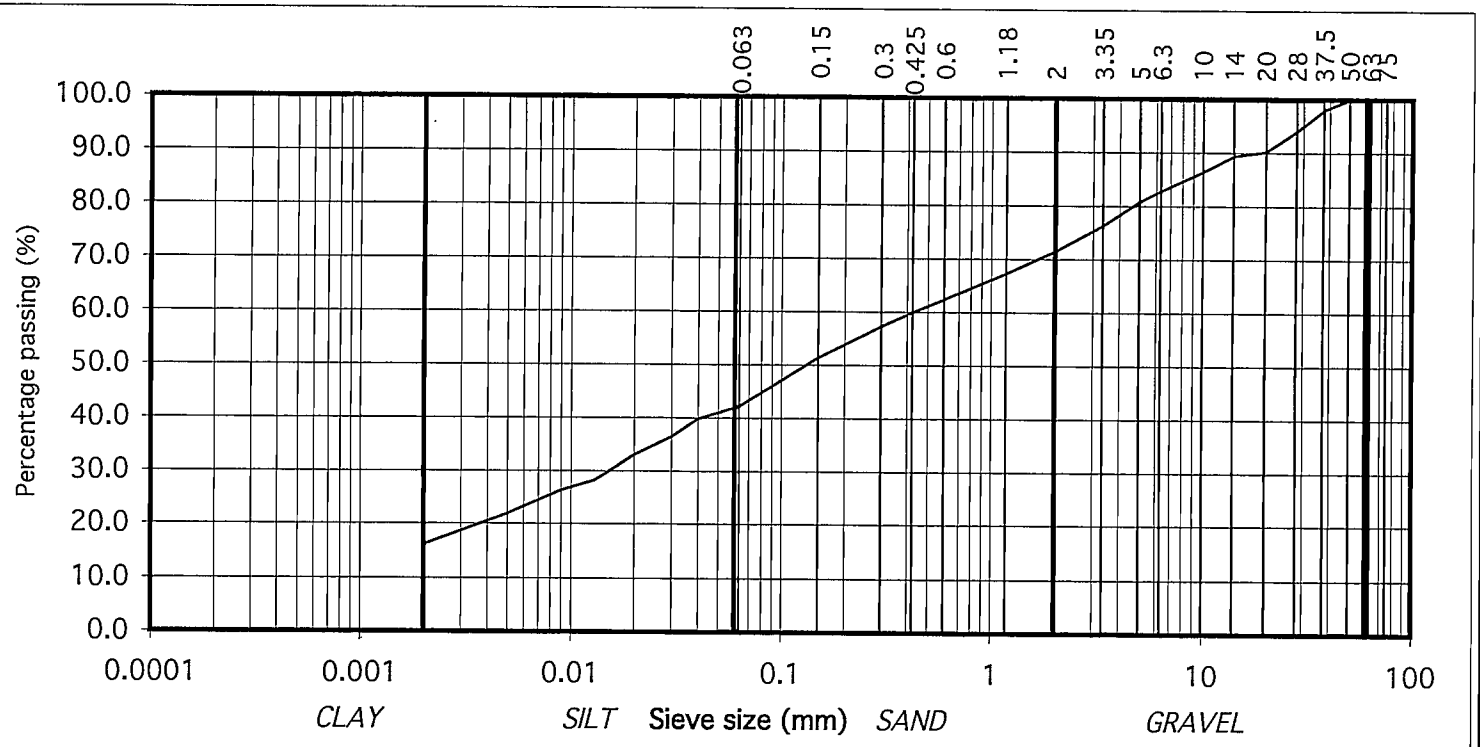
BH/TP No: BH3

SAMPLE No.: 5604

DEPTH (m): 4.00

TEST METHOD: Wet sieve and hydrometer

DESCRIPTION: Grey black slightly sandy, slightly gravelly, CLAY



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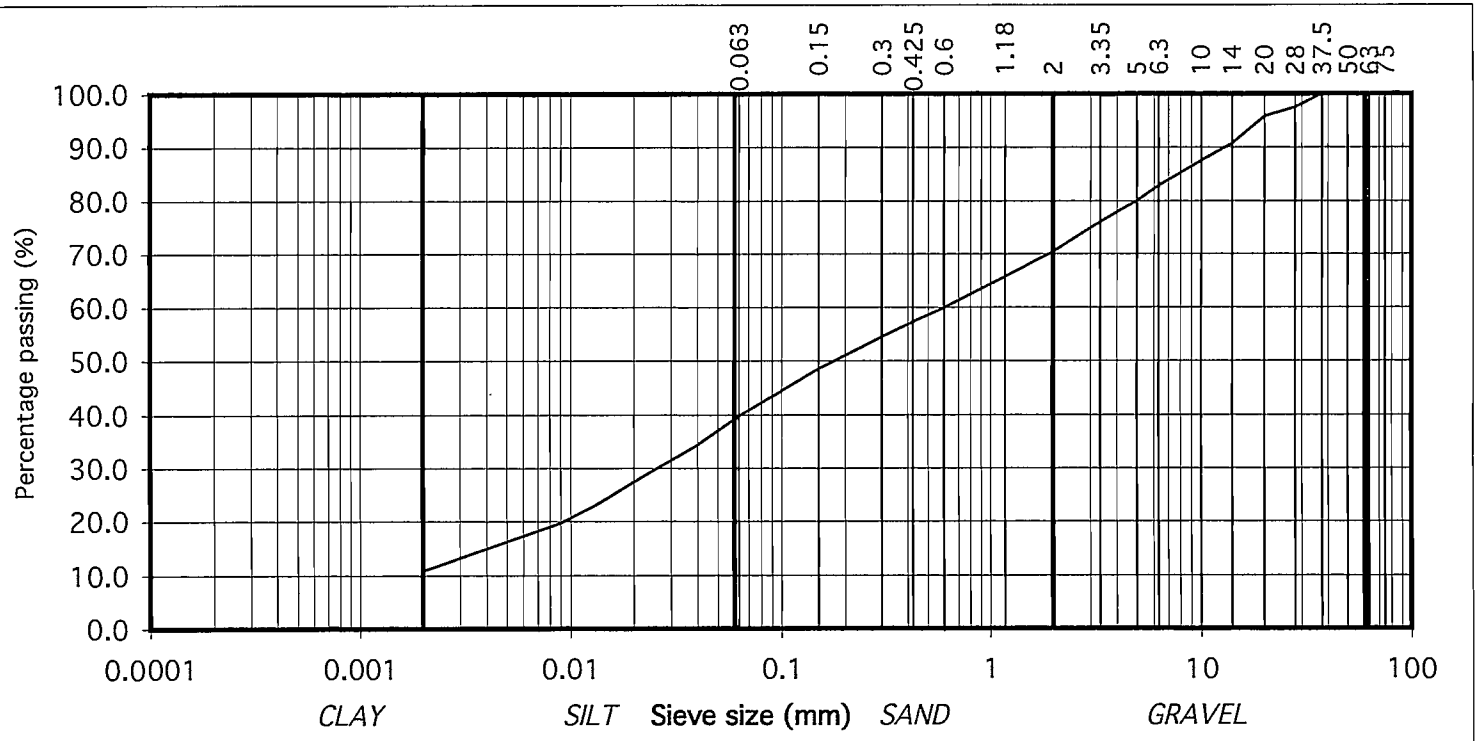
Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

particle size	% passing	
75	100.0	COBBLES
63	100.0	
50	100.0	
37.5	100.0	
28	97.5	
20	95.8	GRAVEL
14	90.8	
10	87.5	
6.3	82.9	
5	79.9	
3.35	76.0	
2	70.4	
1.18	65.7	
0.6	59.9	SAND
0.425	57.3	
0.3	54.5	
0.15	48.5	
0.063	39.7	
0.04	34.4	
0.03	31.5	
0.02	27.4	SILT/CLAY
0.013	22.9	
0.009	19.7	
0.005	16.2	
0.002	10.8	

Contract No:	10741
Contract:	Swords Housing Development
BH/TP No:	BH6
SAMPLE No.:	5632
DEPTH (m):	4.00
TEST METHOD:	Wet sieve and hydrometer
DESCRIPTION:	Grey black slightly sandy, slightly gravelly, CLAY



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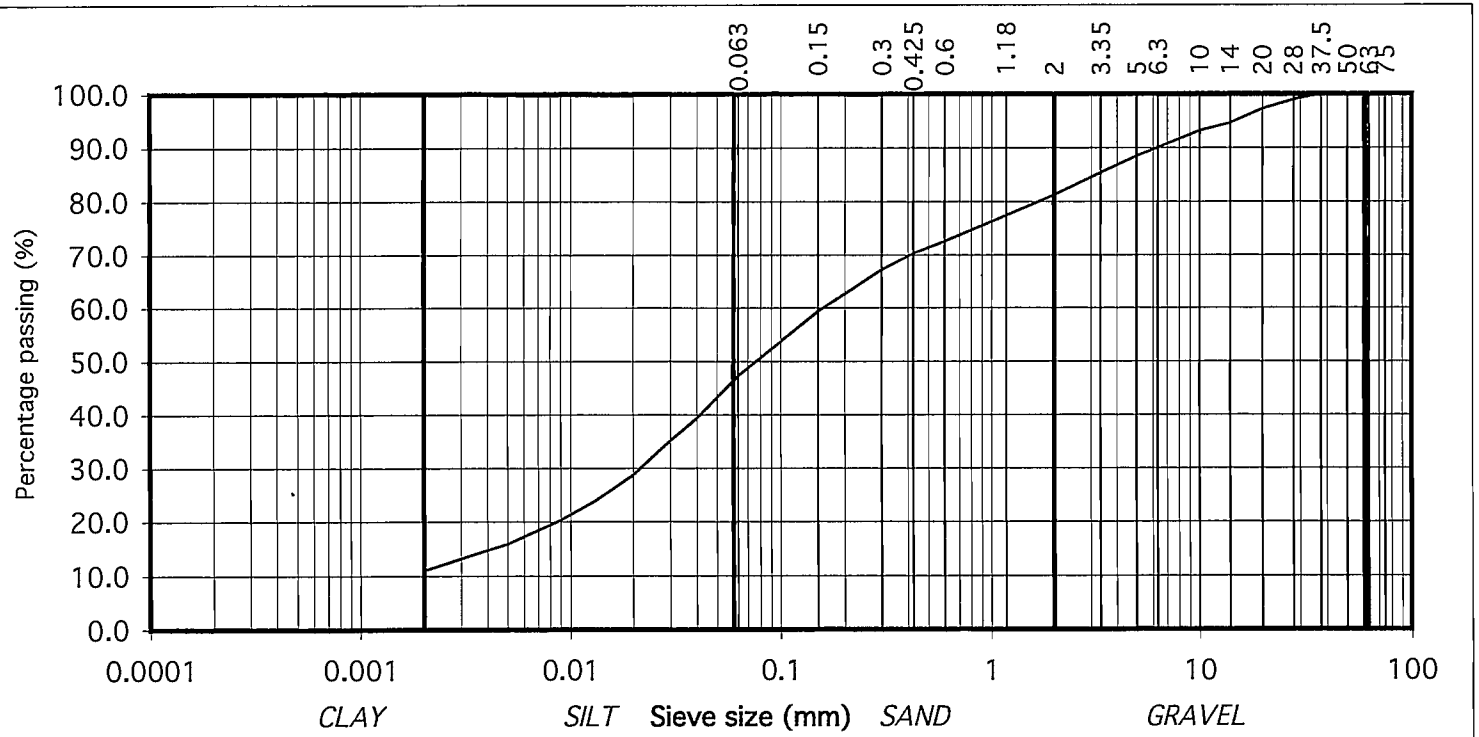
Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

particle size	% passing	
75	100.0	COBBLES
63	100.0	GRAVEL
50	100.0	
37.5	100.0	
28	98.9	
20	97.2	
14	94.6	
10	93.2	
6.3	90.1	
5	88.4	
3.35	85.4	
2	81.2	SAND
1.18	77.4	
0.6	72.5	
0.425	70.2	
0.3	67.2	
0.15	59.3	
0.063	47.3	SILT/CLAY
0.04	39.3	
0.03	35.1	
0.02	28.7	
0.013	23.7	
0.009	20.3	
0.005	15.8	
0.002	10.9	

Contract No: 10741
Contract: Swords Housing Development
BH/TP No: BH7
SAMPLE No.: 5616
DEPTH (m): 8.00
TEST METHOD: Wet sieve and hydrometer
DESCRIPTION: Grey slightly sandy, slightly gravelly, SILT/CLAY



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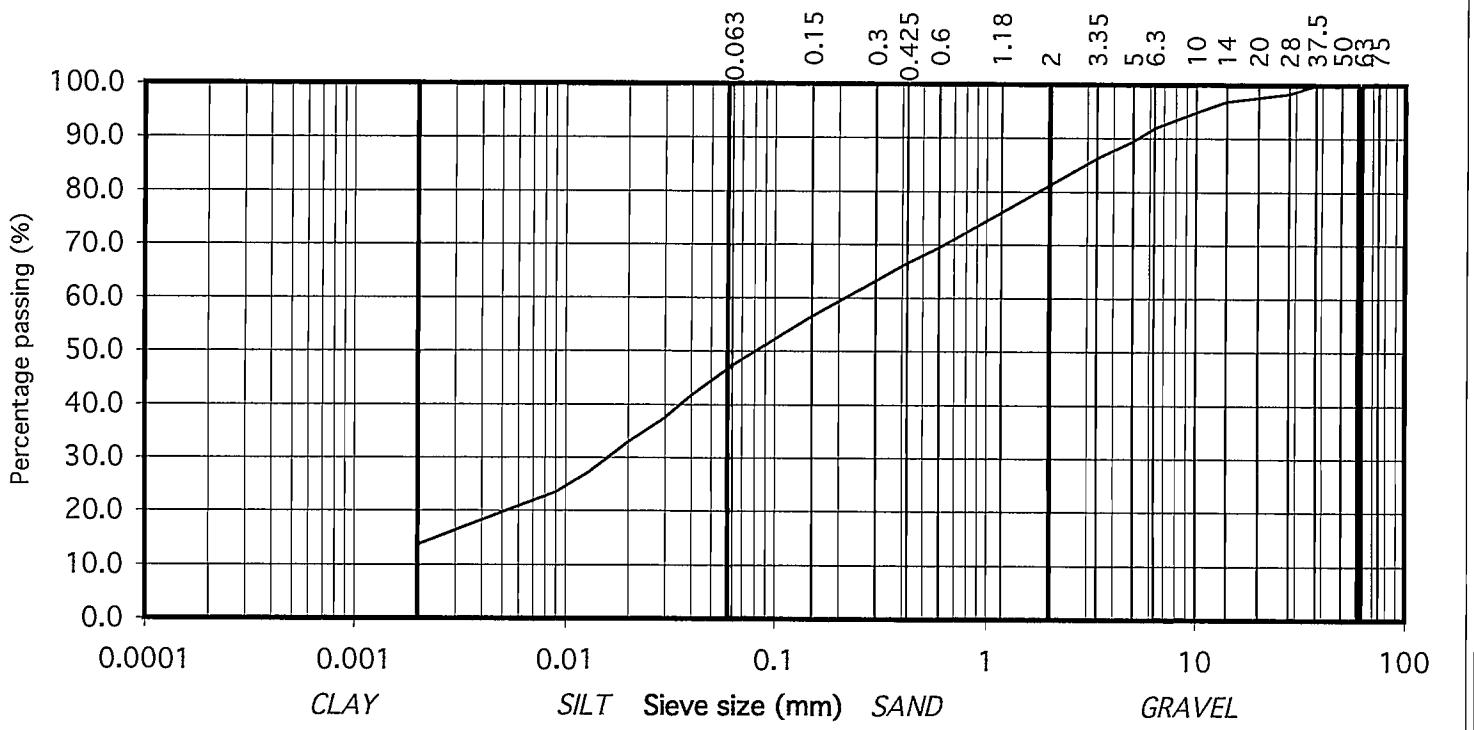
Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

particle size	% passing	
75	100.0	COBBLES
63	100.0	
50	100.0	
37.5	100.0	
28	98.3	
20	97.5	GRAVEL
14	96.9	
10	94.9	
6.3	91.9	
5	89.5	
3.35	86.2	
2	81.1	
1.18	76.0	
0.6	69.4	SAND
0.425	66.5	
0.3	63.2	
0.15	56.6	
0.063	47.2	
0.04	41.6	
0.03	37.5	
0.02	32.9	SILT/CLAY
0.013	27.2	
0.009	23.5	
0.005	19.7	
0.002	13.6	

Contract No:	10741
Contract:	Swords Housing Development
BH/TP No:	BH8
SAMPLE No.:	5678
DEPTH (m):	3.00
TEST METHOD:	Wet sieve and hydrometer
DESCRIPTION:	Grey black slightly sandy, slightly gravelly, CLAY



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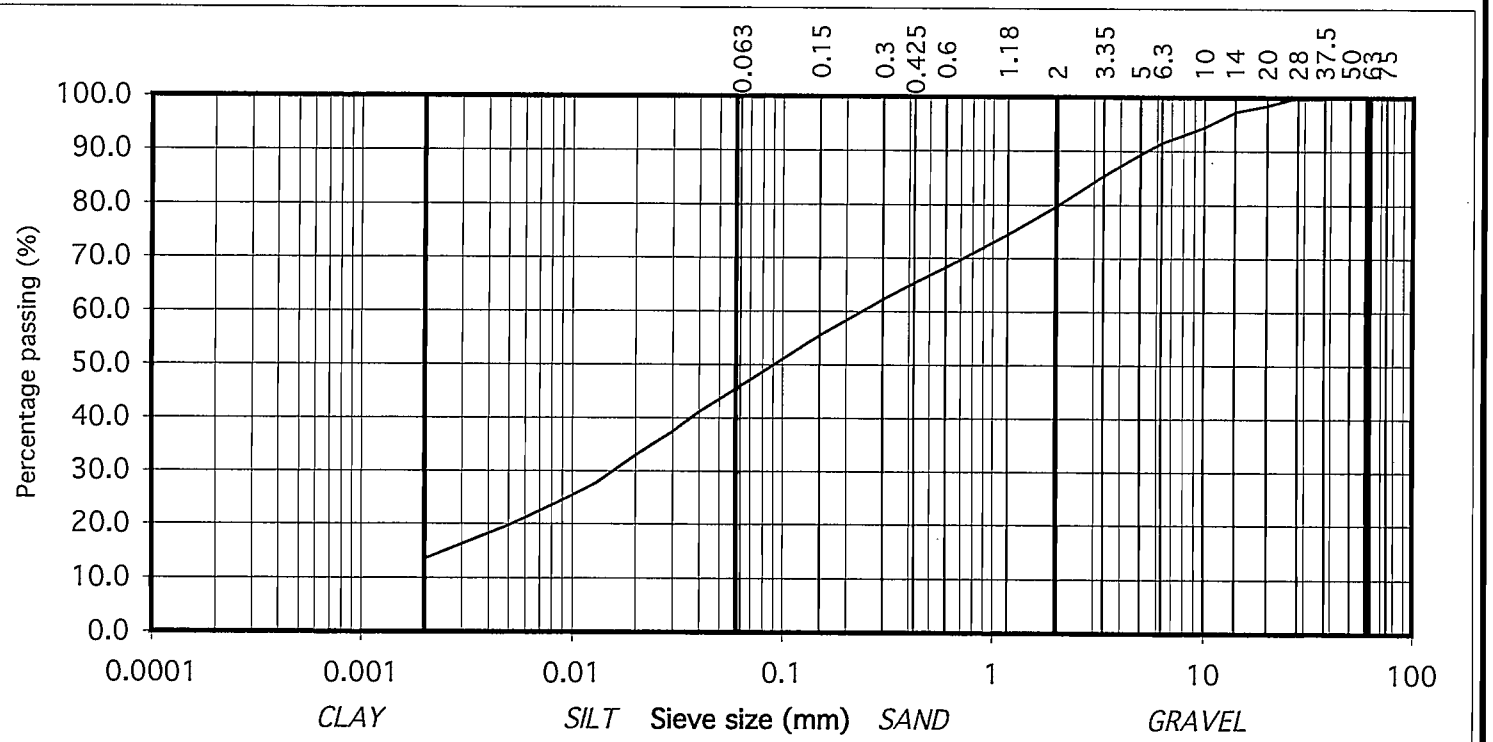
Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

particle size	% passing	
75	100.0	COBBLES
63	100.0	
50	100.0	
37.5	100.0	
28	100.0	
20	98.4	GRAVEL
14	97.2	
10	94.3	
6.3	91.5	
5	89.3	
3.35	85.3	
2	79.6	
1.18	74.4	
0.6	68.2	SAND
0.425	65.3	
0.3	62.2	
0.15	55.5	
0.063	46.0	
0.04	41.0	
0.03	37.3	
0.02	32.9	SILT/CLAY
0.013	27.8	
0.009	24.4	
0.005	19.7	
0.002	13.4	

Contract No: 10741
Contract: Swords Housing Development
BH/TP No: BH9
SAMPLE No.: 0040
DEPTH (m): 3.00
TEST METHOD: Wet sieve and hydrometer
DESCRIPTION: Dark grey brown slightly sandy, slightly gravelly, SILT/CLAY



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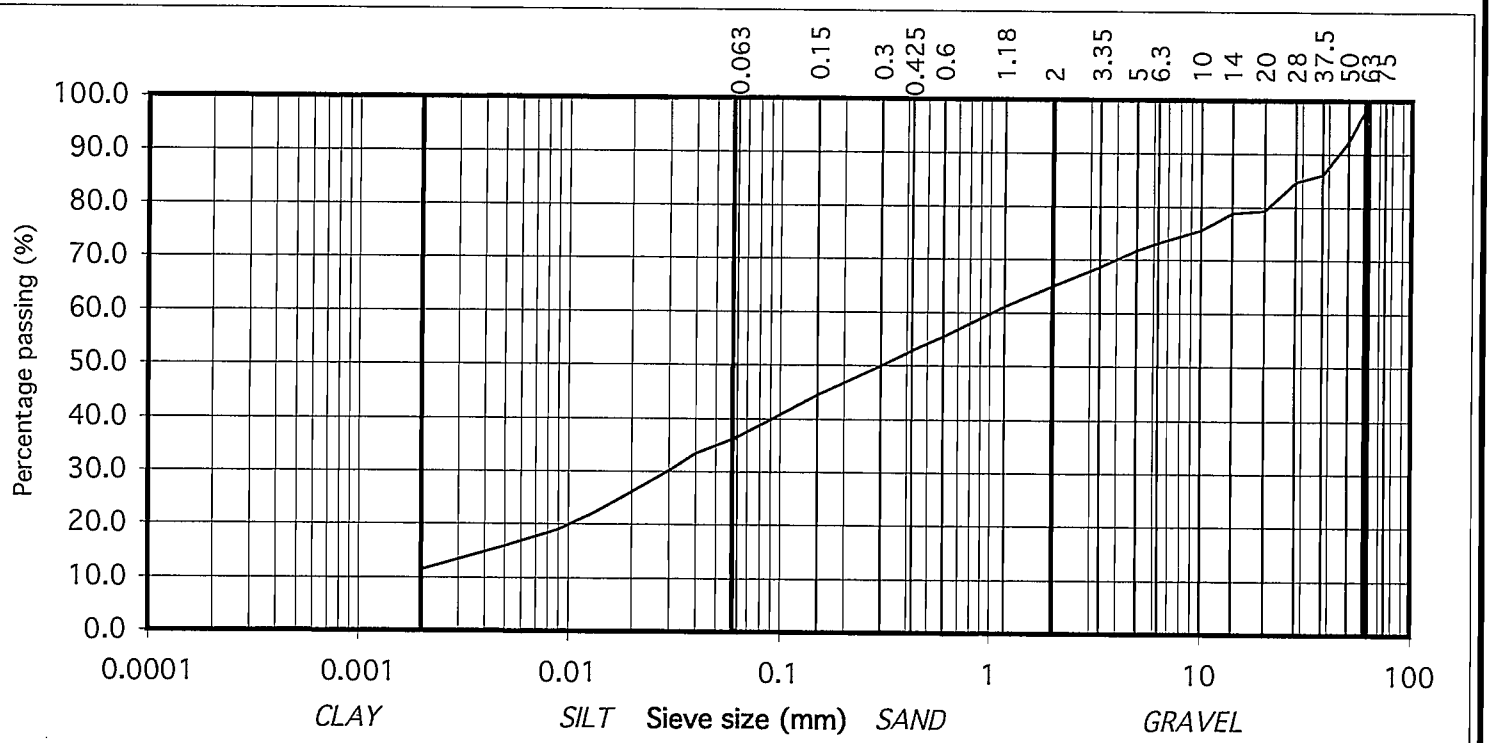
Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

particle size	% passing	
75	100.0	COBBLES
63	100.0	GRAVEL
50	92.3	
37.5	86.1	
28	84.6	
20	79.2	
14	78.8	
10	75.5	
6.3	73.1	
5	71.6	
3.35	68.6	
2	65.0	SAND
1.18	61.1	
0.6	55.4	
0.425	52.8	
0.3	50.0	
0.15	44.4	
0.063	36.5	SILT/CLAY
0.04	33.3	
0.03	30.1	
0.02	26.0	
0.013	21.9	
0.009	19.0	
0.005	15.8	
0.002	11.4	

Contract No:	10741
Contract:	Swords Housing Development
BH/TP No:	BH10
SAMPLE No.:	5622
DEPTH (m):	4.00
TEST METHOD:	Wet sieve and hydrometer
DESCRIPTION:	Dark grey slightly sandy, gravelly, CLAY



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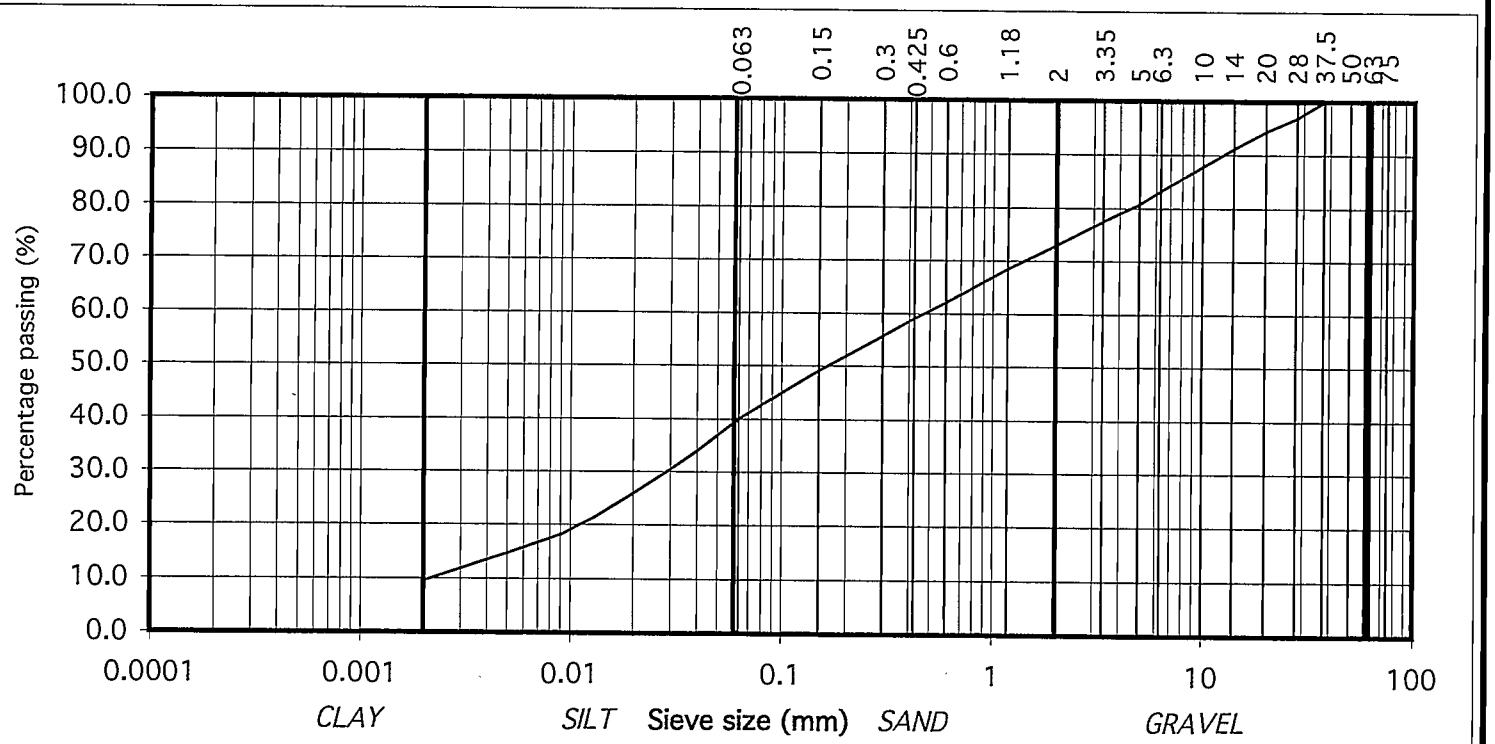
Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

particle size	% passing	
75	100.0	COBBLES
63	100.0	
50	100.0	
37.5	100.0	
28	96.9	
20	94.3	GRAVEL
14	91.1	
10	87.8	
6.3	83.2	
5	80.6	
3.35	77.4	
2	72.8	
1.18	68.4	
0.6	62.1	SAND
0.425	59.0	
0.3	55.7	
0.15	49.1	
0.063	40.0	
0.04	33.8	
0.03	30.3	
0.02	25.8	SILT/CLAY
0.013	21.4	
0.009	18.2	
0.005	14.6	
0.002	9.5	

Contract No:	10741
Contract:	Swords Housing Development
BH/TP No:	BH11
SAMPLE No.:	0058
DEPTH (m):	4.00
TEST METHOD:	Wet sieve and hydrometer
DESCRIPTION:	Grey black slightly sandy, slightly gravelly, CLAY



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Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

particle size	% passing	
75	100.0	COBBLES
63	100.0	
50	100.0	
37.5	100.0	
28	95.8	
20	92.4	GRAVEL
14	91.1	
10	87.2	
6.3	81.6	
5	78.7	
3.35	73.3	
2	68.7	
1.18	64.8	
0.6	59.7	SAND
0.425	57.2	
0.3	54.2	
0.15	48.3	
0.063	40.3	
0.04	33.4	
0.03	30.2	
0.02	25.7	SILT/CLAY
0.013	20.9	
0.009	18.3	
0.005	15.1	
0.002	9.9	

Contract No: 10741

Contract: Swords Housing Development

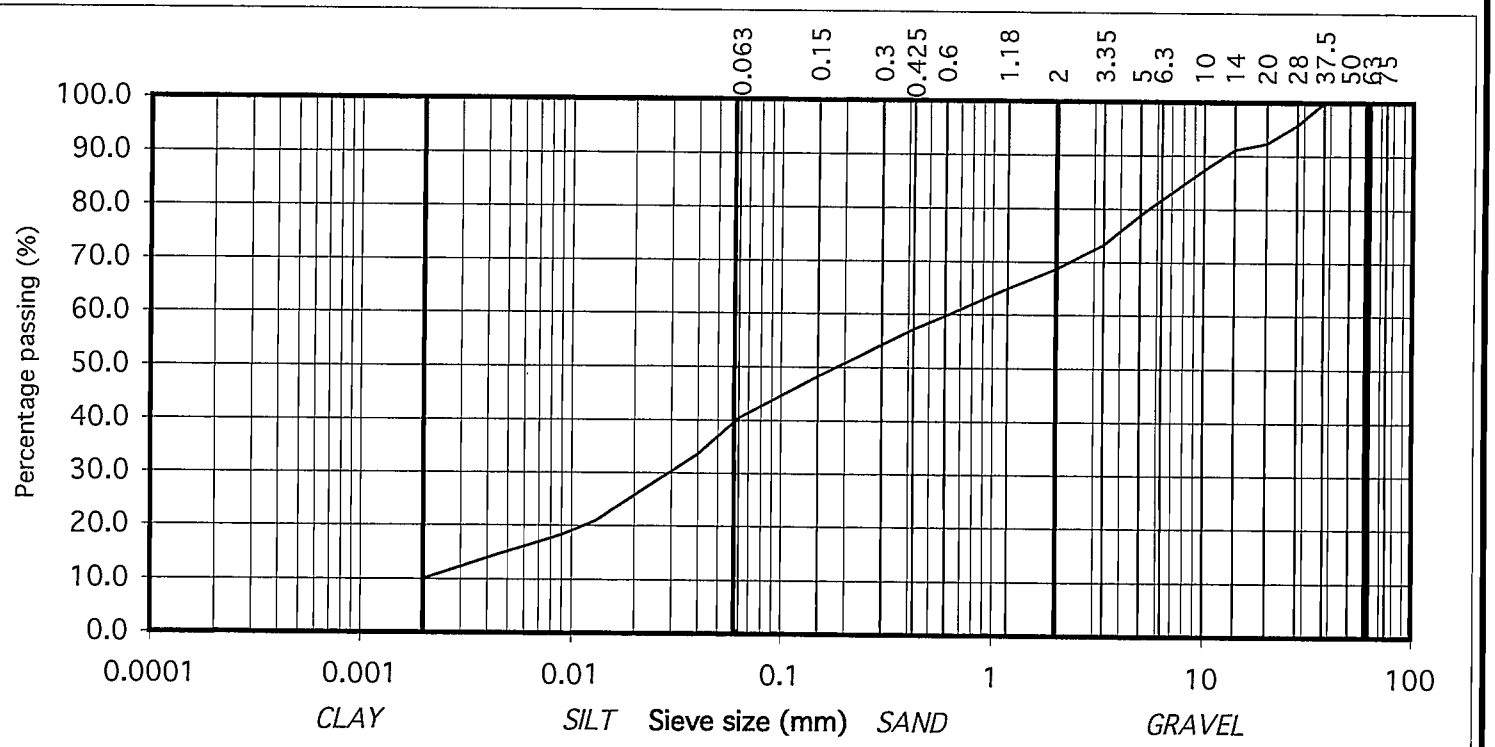
BH/TP No: BH11

SAMPLE No.: 0061

DEPTH (m): 7.00

TEST METHOD: Wet sieve and hydrometer

DESCRIPTION: Grey black slightly sandy, slightly gravelly, CLAY



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REPORT NO.	SULPHATE ANALYSIS								IGSL
CONTRACT:	Swords Housing Development							CONTRACT NO	10741
BH/TP NO.	DEPTH (M)	SAMPLE NO.	SAMPLE TYPE	TEST CODE	% Passing 2mm	SULPHUR TRIOXIDE		(so3 X 1.2)	pH
						WATER SO3 g/L	TOTAL SOIL so3 %	TOTAL SOIL so 4 %	VALUE
BH3	1.00	5601	D	S	80		0.032	0.038	7.8
BH5	3.00	0047	D	S	65		0.082	0.098	7.8
BH6	1.00	5629	D	S	69		0.047	0.056	7.8
BH7	1.00	5609	D	S	74		0.039	0.047	7.5
BH8	1.00	5676	D	S	86		0.026	0.031	7.6
BH11	1.00	0055	D	S	73		0.033	0.040	8.0

TEST CODE: W = WATER S = SOIL A = AQUEOUS SOIL EXTRACT(2:1)

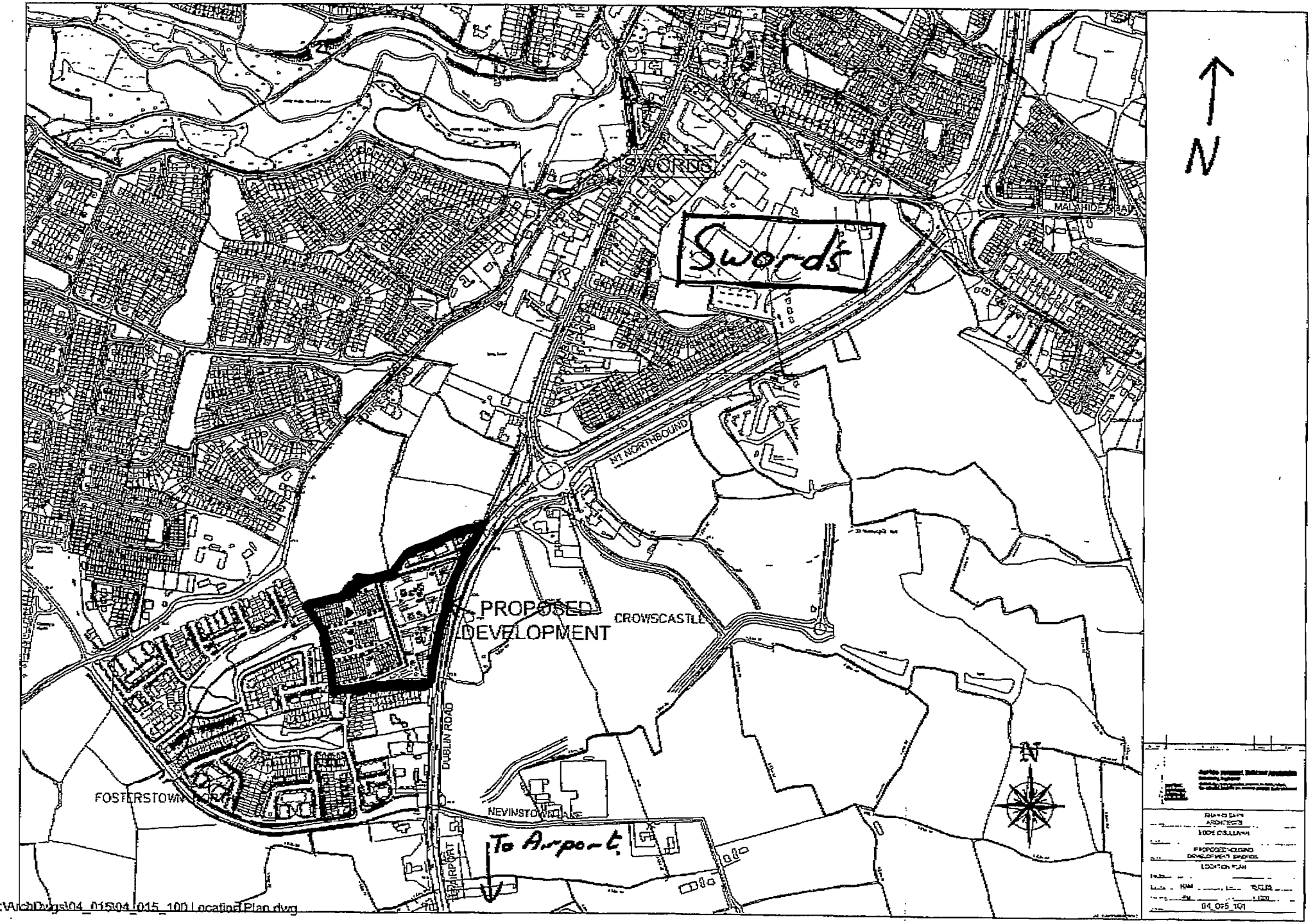
Report No.	CALIFORNIA BEARING RATIO	I.G.S.L.

Contract: Swords Housing Development DATE: 28/6/05 CONTRACT No 10741

Location	Sample No.	Depth of Sample	Sample Description	Water Content %	Test Code	Water Content Top %	Water Content Bottom %	Bulk Density Mg/M3	% Passing 20mm	C.B.R. Top %	C.B.R. Base %	C.B.R. Average %
TP1	8573	0.50	Brown sandy gravelly SILT/CLAY with root hairs	23	L/St	23	22	1.95	96.2	3.7	3.6	3.7
TP2	8570	0.50	Mottled grey brown sandy gravelly SILT/CLAY	20	L/St	20	20	2.01	97.8	0.8	0.8	0.8
TP2	8572	2.40	Grey black sandy gravelly SILT/CLAY	11	L/St	11	11	2.19	89.0	20.3	16.0	18.1
TP3	8585	0.50	Mottled orange brown sandy gravelly SILT/CLAY	26	L/St	26	27	1.92	94.6	2.3	1.7	2.0
TP4	8576	0.50	Mottled grey brown sandy gravelly SILT/CLAY	15	L/St	15	16	2.15	79.0	4.0	4.1	4.0
TP5	8567	0.50	Brown sandy gravelly SILT/CLAY with root hairs	22	L/St	24	24	1.91	98.5	3.0	1.5	2.2
TP5	8569	2.50	Grey black sandy gravelly SILT/CLAY	9.7	L/St	9.8	9.6	2.19	98.4	19.2	13.5	16.3
TP6	8582	0.50	Mottled brown sandy gravelly SILT/CLAY with roots	23	L/St	23	23	1.91	100.0	1.2	1.7	1.5
TP7	8579	0.50	Mottled grey brown sandy gravelly SILT/CLAY	15	L/St	15	15	2.07	87.1	2.8	1.0	1.9
TP8	8564	0.50	Mottled grey brown sandy gravelly SILT/CLAY	18	L/St	17	18	2.08	100.0	1.6	1.1	1.3
TP8	8566	2.30	Grey black sandy gravelly SILT/CLAY	9.6	L/St	9.8	9.5	2.18	89.4	21.7	21.7	21.7

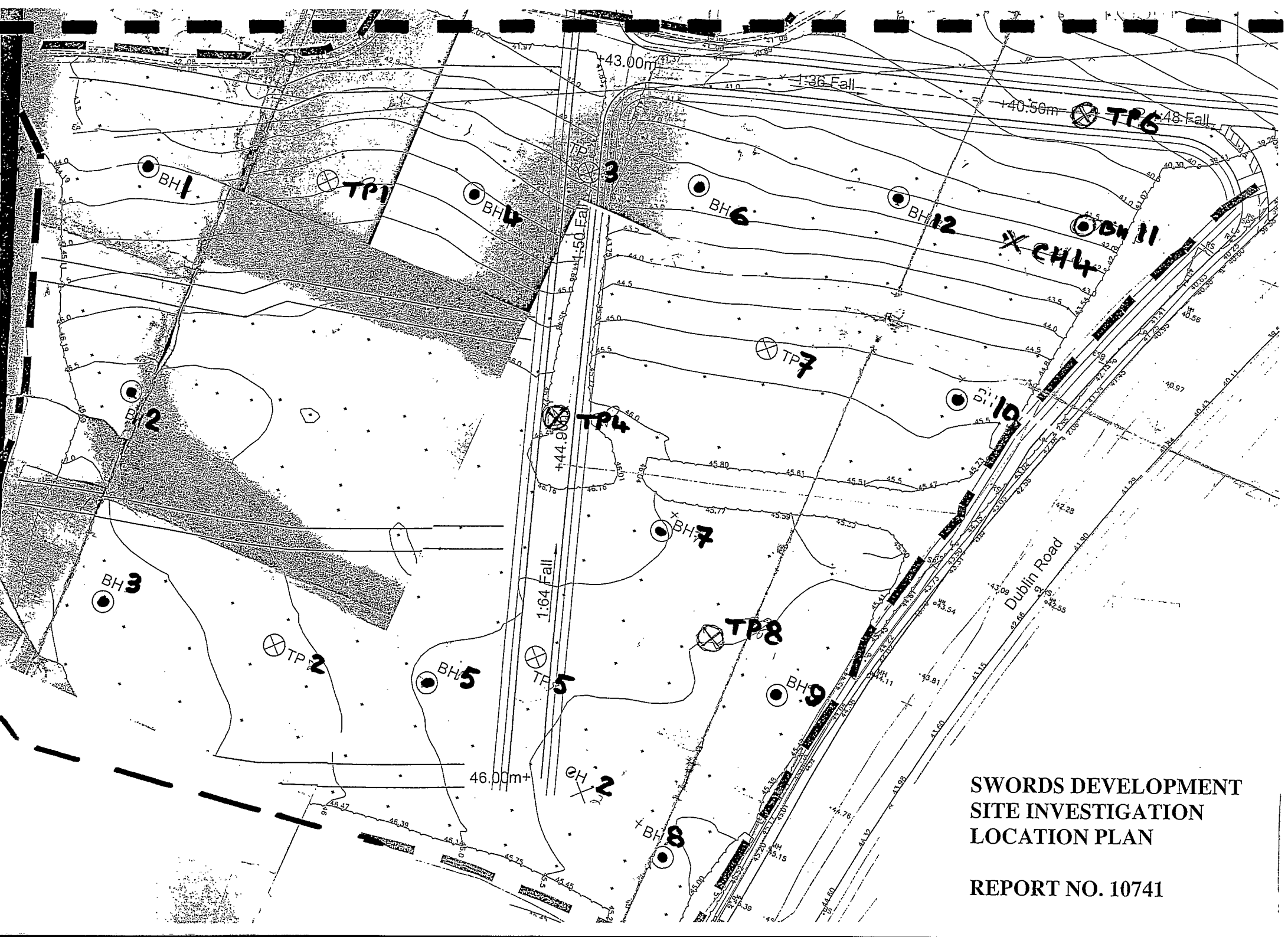
Test Code: U.-Undisturbed Sample L.-2.5Kg. Rammer A/5.-5% Air Voids Ratio V.- Vibrating Hammer
D.-Dynamic Compaction H.-4.5Kg. Rammer A10.-10% Air Voids Ratio M.- Method Number
St.-Static compaction RN29.- Road Note 29 (St. 95% H.)

Appendix V – Site Plan



W:\ArchDwgs\04_015\04_015_100 Location Plan.dwg

16/03/2005 18:15 USER: 04_015_101



SWORDS DEVELOPMENT
SITE INVESTIGATION
LOCATION PLAN

REPORT NO. 10741

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