The background is a vibrant yellow. It is decorated with several abstract geometric shapes in shades of blue, teal, and white. These include circles, semi-circles, and rounded rectangular shapes, some of which are layered or overlapping. The shapes are scattered across the page, creating a modern and dynamic visual effect.

Appendix A14.2
Ground Investigation
Report

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1 Introduction

1.1 Project Overview

The BusConnects Dublin - Core Bus Corridors Infrastructure Works (herein after called the ‘CBC Infrastructure Works’) involves the development of continuous bus priority infrastructure and improved pedestrian and cycling facilities on 16 radial core corridors in the Greater Dublin Area (GDA), across the local authority jurisdictions of Dublin City Council (DCC), South Dublin County Council (SDCC), Dún Laoghaire-Rathdown County Council (DLRCC), Fingal County Council (FCC), and Wicklow County Council (WCC). Overall, the CBC Infrastructure Works encompasses the delivery of approximately 230km of dedicated bus lanes and 200km of cycle tracks along 16 of the busiest corridors in Dublin.

In June 2018, the National Transport Authority (NTA) published the Core Bus Corridors Project Report. The report was a discussion document outlining proposals for the delivery of a CBC network across Dublin. The ‘Blanchardstown to City Centre CBC’ (hereinafter also known as the ‘Proposed Scheme’) is identified in this document as forming part of the Radial Core Bus Network.

The BusConnects radial Core Bus Corridor network is shown in Figure 1.

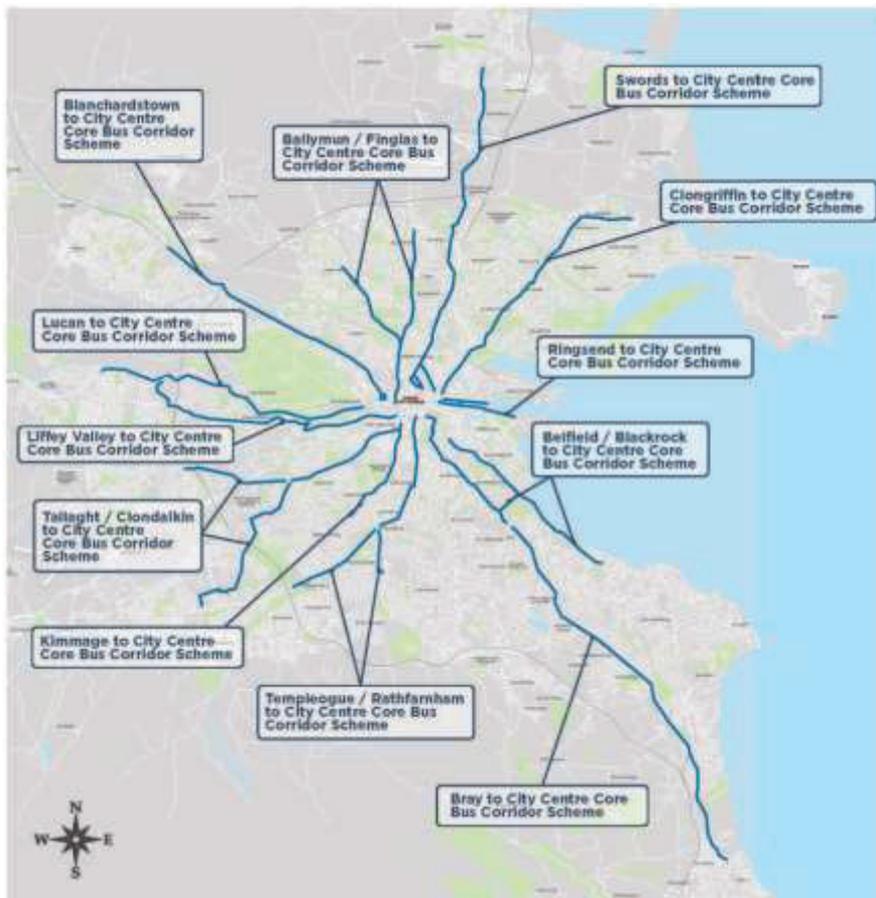


Figure 1: BusConnects Radial CBC Network

This Ground Investigation Report (GIR) has been prepared to inform the Preliminary Design stage of the Proposed Scheme.

The Proposed Scheme commences at Junction 3 (Blanchardstown / Mulhuddart) southbound off-slip from the N3. The Proposed Scheme proceeds along the R121 Blanchardstown Road South into the Blanchardstown Shopping Centre.

From a new terminus to the north-west of Blanchardstown Shopping Centre the Proposed Scheme is routed onto the N3 Navan Road via the Snugborough Road junction and follows the N3 and Navan Road as far as the junction with the Old Cabra Road. From here, the Proposed Scheme is routed along Old Cabra Road, Prussia Street, Manor Street and Stoneybatter to the junction with King Street North. The core bus corridor is then routed via Blackhall Place as far as the junction with Ellis Quay, where it joins the prevailing traffic management regime on the North Quays. At the Stoneybatter / Brunswick Street North junction, cyclists proceed along Brunswick Street North, George's Lane and Queen Street as far as Ellis Quay/Arran Quay.

Refer to Figure 2 for overall layout of the Blanchardstown to City Centre CBC.

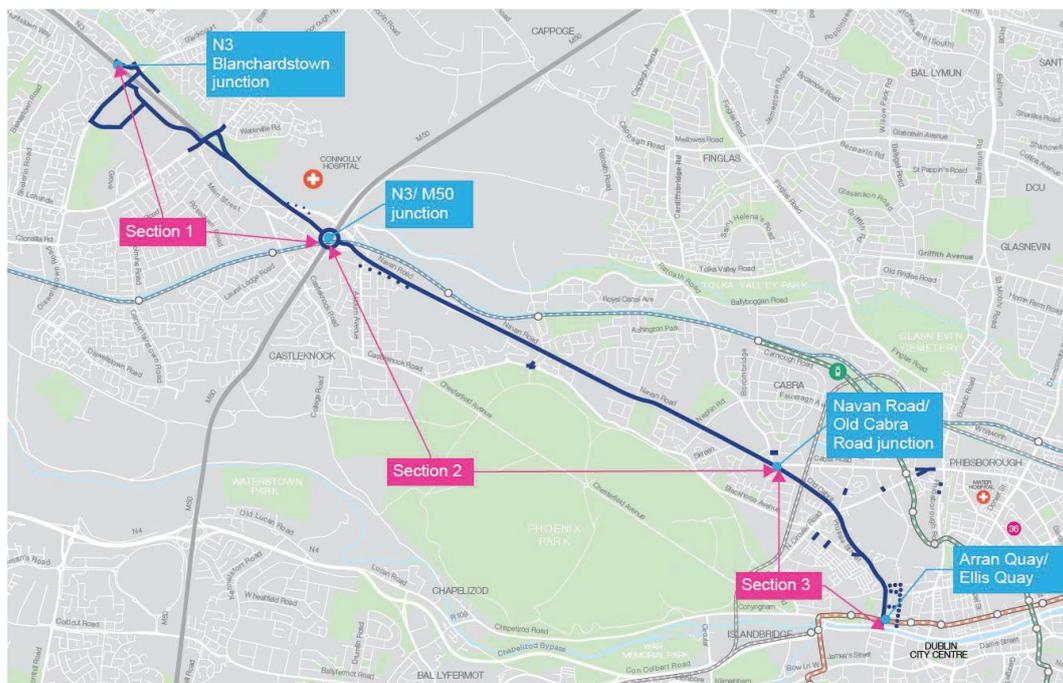


Figure 2: Blanchardstown to City Centre CBC

The Proposed Scheme has been broken into five sections as follows:

- N3 Blanchardstown Junction to Snugborough Road
- Snugborough Road to N3/M50 Junction
- N3/M50 Junction to Navan Road/Ashtown Road Junction
- Navan Road/Ashtown Road Junction to Navan Road/Old Cabra Road Junction
- Navan Road/Old Cabra Road Junction to Ellis Quay

1.2 Scope and Objective of the Report

This GIR has been prepared in accordance with IS EN 1997-1:2005 ‘Eurocode 7: Geotechnical Design – Part 1: General Rules’ and IS EN 1997-2: 2007 ‘Eurocode 7: Geotechnical Design – Part 2: Ground Investigation and testing’. This GIR contains information for the Proposed Scheme only.

The purpose of the GIR is to:

- Present a review of desk study and existing ground investigation information relevant to the project.
- Summarise details of the existing ground investigations undertaken and the available geotechnical information.
- Present the interpreted ground conditions and material properties for the main geological units encountered across the scheme.

This GIR has been prepared for the purposes of informing the preliminary design only and is not intended to be used for detailed design.

1.3 Geotechnical Category of the Project

The project has been identified as a Geotechnical Category 2 scheme in accordance with IS EN 1997-1:2004. Geotechnical Category 2 is defined as a project which includes “conventional types of geotechnical structures, earthworks and activities, with no exceptional geotechnical risks, unusual or difficult ground conditions or loading conditions”.

1.4 Study Area

The study area includes the proposed alignment and the immediate surrounding area, as shown in the site location plans presented in Appendix A.

Structures in the study area are listed below:

- Retaining Walls
 - Retaining Wall 01 (RW01), 270m long and max 3.0m height approximate ITM coordinates 706861:E, 739684:N
 - Retaining Wall 03 (RW03), 100m long and max 4.0m height approximate ITM coordinates 709301:E, 737937:N
 - Retaining Wall 07A (RW07A), 100m long and max 1.5 height approximate ITM coordinates 710202:E, 737440:N
 - Retaining Wall 07B (RW07B), 250m long and max 3.0m height approximate ITM coordinates 710202:E, 737440:N
 - Retaining Wall 09 (RW09), approximate ITM coordinates 708752:E, 738337:N. RW09
- Bridges
 - Tolka River Bridge Widening (BR01), approximate ITM coordinates 708240:E, 738731:N

- Mill Road Bridge Widening (BR02), approximate ITM coordinates 707796:E, 739014:N

1.5 Symbols and Abbreviations

The following symbols and abbreviations are used to define the ground properties:

NMC – Natural moisture content, as encountered on-site in the soil, in %

MC – Moisture content, in %

LL – Liquid Limit, in %

PL – Plastic Limit, in %

I_p - the soils plasticity index

c_u – undrained shear strength, in kPa

f' – effective angle of shearing resistance, in degrees

f'_p – peak effective angle of shearing resistance, in degrees

f'_{cv} is the soils constant volume angle of shearing resistance, in degrees

f'_{dil} is the contribution to ϕ'_{pk} from soil dilatancy, in ° (degrees)

c' – drained cohesion, in kPa

γ – unit weight density, in kN/m³

γ' – submerged unit weight density, in kN/m³

γ_{sat} – submerged unit weight density, in kN/m³

γ_b – bulk unit weight density, in kN/m³

m_v – Coefficient of volume compressibility, in m²/MN

E – Young modulus, Elastic modulus, in MPa

E_{uv} – Undrained elastic modulus, in MPa

E'_v – Drained Young modulus, in MPa

M – Constrained modulus, in MPa

u – Poisson's ratio, unitless

SPT – Standard Penetration Test, results expressed using “N”

N – uncorrected SPT readings, in blows/300mm.

CBR – California Bearing Ratio, results expressed in %

DCP – Dynamic Cone Penetrometer

DPH – Dynamic Probe Heavy, results expressed using “N₁₀₀”

DPSH – Dynamic Probe Super-Heavy, results expressed using “N₁₀₀”
N₁₀₀ - in blows/100mm.

2 Existing Information

2.1 Sources of Information

The site setting and geotechnical information for the site were interpreted from both publicly available information and from the site specific ground investigation carried out from October 2020 to March in 2021 by GII Ltd. (Project No:9754-07-20 R5, Rev D, 18.June.2021). The project specific ground investigation report is given in Appendix D.

The publicly available sources of information reviewed are as follows:

- Geological Survey of Ireland (GSI) (www.gsi.ie):
 - Bedrock map;
 - Quaternary Sediments;
 - Quaternary Geomorphology;
 - GeoUrban Unconsolidated Sediments;
 - GeoUrban Depth to Bedrock;
 - Groundwater Aquifer;
 - Groundwater Recharge Map;
 - Groundwater well database;
 - Groundwater vulnerability;
 - Subsoil Permeability Map
 - Karst landforms database;
 - Mineral locations map;
 - Quarry locations map;
 - Historical Geotechnical boreholes.
- Environmental Protection Agency (EPA) Map Viewer (<https://gis.epa.ie/EPAMaps/>):
 - Soils (National);
 - Subsoils (National);
 - River Waterbodies
- Aerial images and mapping:
 - Ordnance Survey of Ireland (<http://map.geohive.ie/mapviewer.html>) mapping;
 - Bing maps (www.bing.com/maps) aerial photography and mapping (licensed); and
 - Google maps (www.google.com/maps) aerial photography online mapping.
- Rivers of Dublin (C.L. Sweeney, 1991)

2.2 Topography

The EPA contour map shows that the alignment slopes from approximately 60m OD at Blanchardstown Road down to 40m OD at Old Cabra Road.

Then, the elevation continues dropping further reaching the 10m OD contour close to River Liffey.

2.3 Geological Maps and Memoirs

2.3.1 Quaternary Sediments

The GSI Quaternary Geomorphology map shows several glacial features, the majority of which are noted at the northern part of the proposed route. A glaciofluvial terrace is present under the N3 at Blanchardstown, immediately north and south of Junction 3. An historic meltwater channel underlies the River Tolka. Hummocky sands and gravels intersect the CBC at the Junction of Blanchardstown Road South and Blakestown Way to the west of Blanchardstown Shopping Centre. Another glaciofluvial terrace intersects the CBC at Junction 2 of the N3 and extends east and west underlying the Tolka River Valley Park and the green urban area north east of Main Street in Blanchardstown. A localised pocket of hummocky sands and gravels is recorded underlying the N3 at Talbot Court south of the N3/M50 Junction. Going further south, a glaciofluvial terrace is present east of the N3/M50 Junction underlying New River Road to River Road. The last glacial feature (glaciofluvial terrace) intersects the CBC along the R805 between King Street North and Blackhall Court.

The GSI Quaternary Subsoil map shows that the alignment is underlain mainly by Till derived from Limestone with localised areas of Gravels derived from Limestone and Alluvium. Along the River Tolka pockets of Gravels derived from Limestone, Alluvial deposits and bedrock subcrop/outcrop are noted. Gravels derived from Limestone intersect the CBC west of Blanchardstown Shopping Centre, at St. Brigid's Church Blanchardstown, at Talbot Court south of the N3/M50 Junction and on the eastern side of the N3/M50 Junction. There is a large pocket of Alluvium which intersects the CBC west of Nephin Road, Cabra. Moving further south towards city centre Gravels derived from Limestone are recorded along King Street North. A pocket of alluvium intercepts the CBC at Hendrick Street to Ellis Quay and the area underlying Croppies Acre Memorial Park. Urban fill is recorded from King Street North to the River Liffey.

The Geological Survey of Ireland (GSI) Quaternary map is presented in Appendix A.

2.3.2 Solid Geology

The GSI Bedrock Geology 100k map states that the rock type along the examined route is calcareous Shale of Tober Colleen Formation and Limestone of Lucan Formation (locally known as Calp Limestone). The Tober Colleen Formation is shown at two locations along the proposed route. The first location is north east of Blanchardstown Shopping Centre.

The second location extends from approximately Mill Road underpass to N3/M50 Junction. The Lucan Formation is shown to be present along the remaining part of the proposed route. The GSI Bedrock Geology 100k map shows two faults crossing the examined route.

The former is noted close to Blanchardstown Shopping Centre and the latter at M50 Junction. An anticline fold structure is shown to intersect the CBC adjacent to Talbot Court south of the Navan Road. The GSI Depth to Bedrock map presents rockhead to typically range from 0 to 10m BGL apart from the northern and southern ends of the alignment where it increases up to 15 and 20m BGL, respectively.

There are no karst features identified within Proposed Scheme in the GSI karst database.

The GSI Bedrock Geology map is presented in Appendix A.

2.4 Historical Maps and Aerial Photos

Historical maps of the site and surrounding area available from the Ordnance Survey of Ireland, have been reviewed to provide historical information for the project. The maps can be viewed online with Ordnance Survey Ireland's map viewer (<http://map.geohive.ie/mapviewer.html>). The following maps have been studied:

- Ordnance Survey of Ireland (OSI) 6-inch mapping series, 1:5000, 1837-1842.
- Ordnance Survey of Ireland (OSI) 25-inch mapping series, 1:5000, 1888-1913.
- Ordnance Survey of Ireland (OSI) 6-inch Cassini mapping series, 1:5000, 1830-1930.
- Ordnance Survey of Ireland (OSI) 1995 aerial photography
- Ordnance Survey of Ireland (OSI) 2000 aerial photography
- Ordnance Survey of Ireland (OSI) 2005 aerial photography

N3 Blanchardstown Junction to Snugborough Road

Historically, the OSI 6-inch mapping (between 1837 and 1842) shows agricultural land with a small number of scattered developments. Three gravel pits are located on the eastern bank of the River Tolka and to the north of Snugborough Road. Another gravel pit is located beneath the current footprint of the Snugborough Road bridge over the N3.

The OSI 25-inch mapping (between 1888 and 1913) shows no notable increase in development within the study area, however the 6-inch Cassini shows a small increase in development including the Coolmine Cottages to the north of the N3 Junction 3.

It should be noted that the 1995 OSI aerial photography is in black and white and of poor resolution.

Significant urban development is recorded in the study area with large housing estates located to the north west of the R121 (Blanchardstown Road South) and to the north east of the Tolka River. The construction of the Blanchardstown Centre is also evident.

The 2000 OSI aerial photography shows an increase in residential development to the north and west of the N3 Junction 3 as well as the constructed Blanchardstown Centre.

The 2005 OSI aerial photography imagery shows further residential development to the north and west of the N3 Junction 3.

The 2019 Google Maps aerial imagery shows no notable change in land use from the OSI 2005 aerial photography.

Snugborough Road to N3/M50 Junction

Historically, the OSI 6-inch mapping (between 1837 and 1842) shows agricultural land with scattered developments mostly in the vicinity of Blanchardstown Village. Four gravel pits are located in the River Tolka Valley Park on the northern bank of the River Tolka and south of Waterville Road. A corn mill was located on the northern bank of the River Tolka at the Mill Road. A worsted mill was located on the northern bank of the Royal Canal on the Old Navan Road. A quarry was located at Ashleigh Green and another quarry was located under the footprint of the N3/M50 Junction roundabout.

The OSI 25-inch mapping (between 1888 and 1913) shows an increase in residential development around Blanchardstown Village and an increase in industrial development around the Royal Canal. The Midland Great Western Railway runs parallel with the Royal Canal west of the N3/M50 Junction. A corn mill was located on the northern bank of the River Tolka at the Mill Road. A Margarine factory was located on the northern bank of the Royal Canal at the Old Navan Road. Disused gravel pits were located on the northern side of the River Tolka at the eastbound N3 slip road and beneath the current footprint of the N3. A gravel pit was located on the northern bank of the River Tolka south of Waterville Road. A quarry was located beneath the footprint of the N3.

It should be noted that the 1995 OSI aerial photography is in black and white and of poor resolution. Significant urban development is recorded in the study area south of the N3. The construction of the M50 is also evident.

The 2000 OSI aerial photography shows an increase in residential development to the south of the N3. A construction site is evident in the land around Tory Square. Connolly Hospital occupies a significant area of land to the north of the N3. The construction of the M50 north and southbound is completed.

The 2005 OSI aerial photography imagery shows further development to the north of the N3 north of Waterville Road and within the grounds of Connolly Hospital.

The 2019 Google Maps aerial imagery shows an increase in road infrastructure around the N3/M50 Junction. Landscaping of Waterville Park is completed with the installation of a pond.

N3/M50 Junction (Junction 6) to Navan Road/Ashtown Road Junction

Historically, the OSI 6-inch mapping (between 1837 and 1842) shows agricultural land with scattered developments. A quarry was located west of Phoenix Park Avenue. An oil mill was located on Mill Lane.

The OSI 25-inch mapping (between 1888 and 1913) shows very little increase in residential development in the study area with notable development in commercial and industrial uses. South of the Navan Road the land use changed from agricultural land to the Phoenix Park Club Racecourse. The Ashtown Oil Mills are located at Mill Lane. The Midland Great Western Railway runs along the bank of the Royal Canal which is within the study area between the N3/M50 Junction (Junction 6) and the Navan Road/Ashtown Road Junction.

The 6-inch Cassini mapping shows further industrial development west of Mill Lane with a Polish factory and Ashtown Tin Box Manufactory. A burial ground was located on River Road east of the M50.

It should be noted that the 1995 OSI aerial photography is in black and white and of poor resolution. Significant urban development is recorded in the study area south of the N3/M50 Junction. The construction of the M50 is also evident.

The 2000 OSI aerial photography shows an increase in residential development to the south of the N3 between the N3/M50 Junction and Castleknock Manor and industrial and commercial development west of Ashtown Road. The Phoenix Racecourse buildings have been demolished and the land within the study area returned to grassland.

The 2005 OSI aerial photography imagery shows some further development in the study area the most notable of which being the construction site west of Castleknock Road on the site of the former Phoenix Racecourse.

The 2019 Google Maps aerial imagery shows an increase in road infrastructure around the N3/M50 Junction and the increase in development west of Castleknock Road.

Navan Road/Ashtown Road Junction to Navan Road/Old Cabra Road Junction

Historically, the OSI 6-inch mapping (between 1837 and 1842) shows agricultural land with scattered dwellings.

The OSI 25-inch mapping (between 1888 and 1913) shows a slight increase in mixed development throughout the study area. A graveyard was located on the Navan Road at St Joseph's School for Deaf Boys and a military cemetery was located south of Slemish Road

The 6-inch Cassini mapping shows further development particularly between Baggot Road and the Navan Road/Old Cabra Road Junction. The military cemetery is still evident south of Slemish Road.

It should be noted that the 1995 OSI aerial photography is in black and white and of poor resolution. Significant urban development is recorded in the study area. Undeveloped areas include Phoenix Park and Pope John-Paul Park as well as a number of sports grounds.

The 2000 OSI aerial photography shows an increase in residential development east of Kinvara Avenue and commercial development west of Dunard Road.

The 2005 OSI aerial photography imagery shows some no notable further development in the study area compared to the 2000 OSI aerial photography.

The 2019 Google Maps aerial imagery no notable further development in the study area compared to the 2005 OSI aerial photography.

Navan Road/Old Cabra Road Junction to Ellis Quay

Historically, the OSI 6-inch mapping (between 1837 and 1842) shows agricultural land with scattered dwellings between the Navan Road/Old Cabra Road Junction and the North Circular Road. Between the North Circular Road and Brunswick Street North there is an increase in the density of development and between Brunswick Street North and Ellis Quay the area comprises predominantly urban development.

The OSI 25-inch mapping (between 1888 and 1913) shows a significant increase in urban development in the study area, particularly to the south of the Old Cabra Road between North Circular Road and Brunswick Street. The Amiens Street & North Wall Branch railway line transects the Proposed Scheme east of the Navan Road/Old Cabra Road Junction. A tramway transects the Proposed Scheme at North Circular Road. A sawmill was located on Brunswick Street North. A Scavenging Depot and Destructor and a Malt House were located on Stanley Street. A tramway ran from the Scavenging Depot and Destructor on Stanley Street, along North Brunswick Street, Georges Lane and down Queen Street and onto Ellis Quay. A tramway also ran along Ellis Quay. A graveyard was located south of Kings Street North and another west of Ard Ri Place. A cattle market and abattoir were located on the North Circular Road

The 6-inch Cassini mapping shows significant development between the Navan Road/Old Cabra Road Junction and the North Circular Road. The cattle market and abattoir identified on North Circular Road in the OSI 25-inch mapping are also identified on the Cassini mapping.

It should be noted that the 1995 OSI aerial photography is in black and white and of poor resolution. The photo shows an increase in residential development south of the Old Cabra Road Junction and in the place of the cattle market off North Circular Road.

The 2000 OSI aerial photography shows some no notable further development in the study area compared to the 2000 OSI aerial photography.

The 2005 OSI aerial photography imagery shows some no notable further development in the study area compared to the 2000 OSI aerial photography.

The 2019 Google Maps aerial imagery no notable further development in the study area compared to the 2005 OSI aerial photography

Historical maps of the site and surrounding area is presented in Appendix A.

2.5 Records of Mines and Mineral Deposits

The GSI Bedrock Active and Historic Pits and Quarries database states that there are multiple historic quarries and pits which intersect or are near the alignment between Blanchardstown Road and the M50. There are no active quarries or pits shown near the alignment.

The GSI Mineral Localities database states that there are no mineral localities within proximity to the alignment with the closest one approximately 850m offset.

GSI Mineral Localities map is presented in Appendix A.

2.6 Land Use Information

N3 Blanchardstown Junction to Snugborough Road

The Corine Land Cover 2018 classifies the land use of the study area between the N3 Blanchardstown Junction to Snugborough Road as a discontinuous urban fabric, with sections being described as industrial-commercial units and green urban areas. The green urban areas include the Tolka Valley Park and Millennium Park located within the study area and the industrial and commercial units area include for the Blanchardstown Shopping Centre. The N3 itself is classified as road and rail network.

Snugborough Road to N3/M50 Junction

The Corine Land Cover 2018 classifies the land use of the study area between Snugborough Road and the N3/M50 Junction as predominantly discontinuous urban fabric. Green urban areas include the Tolka Valley Park and the N3 itself is classified as road and rail network.

N3/M50 Junction (Junction 6) to Navan Road/Ashtown Road Junction

The Corine Land Cover 2018 classifies the land use to the south of the Navan Road between the N3/M50 Junction (Junction 6) and the Navan Road/Ashtown Road Junction as predominately discontinuous urban fabric with a large area north of Deerpark Drive classified as green urban areas. The area to the north of the Navan Road is classified as land principally occupied by agriculture with significant areas of natural vegetation.

Navan Road/Ashtown Road Junction to Navan Road/Old Cabra Road Junction

The Corine Land Cover 2018 classifies the land use in the study area between Navan Road/Ashtown Road Junction and Navan Road/Old Cabra Road as predominately discontinuous urban fabric. The area to the south of Blackhorse Avenue is classified as green urban areas.

Navan Road/Old Cabra Road Junction to Ellis Quay

The Corine Land Cover 2018 classifies the land use in the study area between Navan Road/Old Cabra Road Junction and the railway line as predominately discontinuous urban fabric.

The land use between the railway line and Ellis Quay is predominately continuous urban fabric with an area of green urban fabric to the east at TU Dublin, Grangegorman Campus.

2.7 Archaeological and Historical Sites

The National Inventory of Architectural Heritage (NIAH) database states that there are

- Nine NIAH sites within 30m of the alignment north of Old Cabra Road, these include three bridges, two church/chapel, one gate lodge, one workhouse, one gates/railings/walls, one post box.
- 89 No. NIAH sites within 30m of the alignment south of Old Cabra Road

The National Monuments (DAHG) database states that there are three DAHG sites within 30m of the alignment, these include one Mill, one House – 18th/19th century and one bowling green.

2.8 Hydrology and Hydrogeology

The GSI Groundwater Aquifer map states that the proposed alignment is mainly underlain by a locally important aquifer described as bedrock which is moderately productive only in local zones. The northern part of the proposed alignment is also underlain by a poor aquifer where bedrock is generally unproductive except for local zones. A fault crosses the proposed route between Snugborough and Blanchardstown Road. According to the relevant GSI map the groundwater vulnerability varies highly. The groundwater vulnerability is classified as low at the southern section of the proposed alignment changing to moderate at approximately the corner of Cabra and Old Cabra Road. North to Ashtown Roundabout it appears as high. Extreme groundwater vulnerability is noted northwest to Phoenix Park Avenue, at M50 Roundabout, around Mill Road, close to Snugborough Road and at the northern section of the proposed route. Areas where rock at or near surface are sporadically presented at the northern part of the proposed alignment. Based on the relevant GSI map the subsoil permeability is typically classified as low. High subsoil permeability is noted in a localised area between M50 Roundabout and Snugborough Road. The GSI Wells and Springs map shows a feature (borehole) approximately 350m east of Stoneybatter. Another well, also presented as borehole, is noted around 850m south of the M50 Roundabout.

The GSI Groundwater vulnerability map, Subsoil Permeability map, Wells and Spring maps and Groundwater Aquifer map is presented in Appendix A.

2.9 Contaminated Land

The works will mostly be carried out in made ground since most of the alignment is classified as discontinuous urban fabric, with sections being described as industrial-commercial units and green urban areas.

Also, there are multiple historic quarries and pits close to the alignment and made ground is mentioned in the recent and historical boreholes.

In the recent ground investigation carried out from October 2020 to March 2021 by GII Ltd. (Project No:9754-07-20 R5, Rev D, 18.June.2021), geo-environmental testing was undertaken on 22 No. samples, in natural ground and made ground, from eight ground investigation locations. No signs of contamination were noted on borehole, trial pit and slit trench logs and all environmental test results suggest an 'Inert' Waste Acceptance Criteria (WAC) classification.

However, the ground investigations do not cover the whole alignment and contamination is a possibility. Potential sources are listed below and presented in Appendix A.

- Circle K (Blanchardstown, Ashtown, Brady's,)
- Navan road parkway station
- Phoenix industrial estate
- Gowan (Navan Road)
- Train line
- Go Station
- Maxol (Navan Road)
- MSL Motors
- Park Rite
- Tramline
- The park motor centre
- Prussia auto centre
- Polycar Ireland
- James Gas Station
- Old quarry/gravel pits
- Old Ford site
- Old worsted
- Old oil mill
- Old factories

2.10 Seismicity of the Area

Ireland lies in an area of very low tectonic activity with few seismic events in the last 30 years. From the data collected by the Irish National Seismic Network (INSN) the following number of seismic events have been registered since 1980 in Ireland and nearby areas in the UK:

32 No. Negligible ($M_L \leq 1.0$);

50 No. Micro ($1.0 < M_L \leq 1.9$);

24 No. Minor ($2.0 < M_L \leq 3.9$);

2 No. Light ($4.0 < M_L \leq 4.9$);

1 No. Moderate ($5.0 < M_L \leq 5.9$) – $M_L=5.4$ in Lleyn Peninsula, Wales, 1984.

Where M_L is the Richter magnitude scale of the earthquake.

Based on the information above it is considered that the area presents a low risk for seismic events affecting the planned development and therefore there is no further assessment required regarding seismicity of the site.

3 Field and Laboratory Studies

3.1 Historical Ground Investigation

Historical Ground investigations have been carried out on the site between 1970 and 2006. Some historical ground investigation years are unknown.

The ground investigations available for the site are listed in the table below. 40m offset from the centreline was adopted to use select historical ground investigation data.

Table 1: Historical ground investigations (GSI)

GSI Report ID	Title	Year	Author	Location	Used GI
R67	Housing Development	1980	Irish Soils Laboratories Ltd.	Blakestown Section 2A Blanchardstown Dublin 15	1 Trial pits
R5614	River Tolka Flood Alleviation Works	Unknown	Unknown	Finglas Dublin 15	2 Cable Percussion boreholes 2 Atterberg and Moisture Content 2 PSD
R461	Greater Dublin Drainage Scheme	1968	Unknown	Grand Canal to Blanchardstown Dublin 15	2 boreholes (drilling type unspecified)
R717	North Eastern Pipeline	1984	Site investigations Ltd.	Brown's barn – Abbotstown Co. Dublin	1 Trial Pits, 2 Cable Percussion Boreholes,
R5619	Commercial Development	Unknown	Unknown	Phoenix Park Racecourse	4 Cable Percussion Boreholes and 2 Trial Pits

GSI Report ID	Title	Year	Author	Location	Used GI
					4 Atterberg and Moisture Content 2 PSD.
R5709	Commercial Development	Unknown	Unknown	Black Hall Place Dublin 7	2 Cable Percussion Boreholes
R3743	Development	Unknown	Unknown	Black Hall Place Dublin 7	2 Cable Percussion Boreholes
R3880	Law Society Premises	Unknown	Unknown	Blackhall Place Smithfield Dublin 7	4 Cable Percussion Boreholes
R838	Lark Homes Apartments, Ellis Quay.	1990	IGSL	Ellis Quay Dublin	5 Boreholes
R2161	Proposed new Liffey bridge	1999	IGSL	River Liffey Blackhall Place Dublin	1 Percussion Borehole 1 PSD 2 UCS 2 Point Load
R745	Housing at Queen Street	1984	Site Investigations Ltd.	Queen Street Dublin 7	1 Cable Percussion Borehole and 2 Trial Pits.
R3919	Residential Development	Unknown	Unknown	Queen Street Dublin 7	5 Cable Percussion boreholes 2 Atterberg and Moisture Content 5 PSD

GSI Report ID	Title	Year	Author	Location	Used GI
R210	Leisure Centre Blanchardstown	1996	IGSL	Blanchardstown Dublin	2 Trial Pits
R742	Redevelopment at Benburb Street	1985	Site Investigations Ltd.	Benburb Street	6 Boreholes
R2158	Arran Quay Terrace	1999	IGSL	Arran Quay Terrace, Dublin	6 Boreholes
R6617	Blanchardstown Hotel and Apartment Complex	2006	IGSL	Blanchardstown S.C	6 Boreholes 6 Atterberg and Moisture Content 3 PSD

3.2 Recent Ground Investigation

This section details the recent ground investigation carried out from October 2020 to March in 2021 by GII Ltd. (Project No:9754-07-20 R5, Rev D, 18.June.2021).

Table 2, 3, and 4 summarise the exploratory holes, in situ testing and laboratory testing for the 2021 ground investigations, respectively. A specific assessment of the results will be presented in further sections.

Table 2: Summary of exploratory holes carried out for the recent ground investigation

Exploratory Hole Type	Quantity
Trial Pit	13 no.
Cable Percussive Borehole	5 no.
Rotary Core Borehole	6 no.
*2 No of standpipe was installed to 1 cable percussive followed by rotary core and a rotary core borehole.	

Table 3: Summary of in situ testing carried out for the recent ground investigation

In situ Testing	Quantity
Standard Penetration Test	51 no.

Table 4: Summary of laboratory testing carried out for the recent ground investigation

Laboratory Testing	Quantity
Moisture Content	9 no.
Particle Size Distribution	7 no.
Atterberg Limits	7 no.
Organic Matter	2 no.
Geo - Environmental Testing (WAC Assessment)	22 no.
Unconfined Compressive Strength	11 no
Point Load	22 no

4 Preliminary Geotechnical Design Parameters

This section provides an interpretation of the ground conditions across the alignment and outlines the methodology used to derive the different parameters. Results from previous works and published papers on Dublin Boulder Clays (Long & Menkiti, 2007a, Long & Menkiti, 2007b) and Irish Glacial soils (Hanrahan, 1977) are used to compare the obtained values and, in some cases, where the available data is limited, to derive the relevant values. Similarly, for the bedrock, published values for Limestone bedrock was researched in rock mechanics literature (Goodman 1989, Wyllie 2005) and used.

4.1 Topsoil

Topsoil is encountered in most of the exploratory locations and generally described brown to greyish brown to dark greyish brown slightly sandy slightly gravelly with occasional to frequent rootlets. The general thickness of the topsoil is 0 to 0.6m.

No interpretation is required for Topsoil. Wherever encountered within the earthworks footprint, it will be removed.

4.2 Made Ground

The made ground is encountered at 52 No. out of 78 No. ground investigation locations. From the descriptions, it is likely reworked glacial till. Waste material, such as brick, concrete and plastic, is recorded in 25 No. of the 52 No. made ground locations. Made ground that does not contain waste could potentially be reused as fill, subject to an assessment of the material properties at each area of excavation.

The thickness of the made ground except Navan Road/Old Cabra Road Junction to Ellis Quay section is variable from 0.4m to 5m but is typically 2m. Thickness of made ground at Navan Road/Old Cabra Road Junction to Ellis Quay section is variable from 4m to 7.8m but is typically 2.5m.

A general description of the made ground, except for the Navan Road/Old Cabra Road Junction to Ellis Quay section, is brown to greyish brown to brownish grey to grey, slightly sandy slightly gravelly to gravelly Clay with some angular to subangular cobbles, occasional boulders, occasional rootlets. Occasional fragments of plastic, rope, concrete, wood, cloth, tarmacadam, brick and organic matter noted in a few exploratory locations. At some locations the made ground is described as brown gravelly clayey fine to coarse Sand with occasional angular to subrounded cobbles, rootlets and occasional fragments of metal, plastic and red brick.

The description of the made ground at Navan Road/Old Cabra Road Junction to Ellis Quay, based on historical ground investigation data, is that it comprises red brick, silt and gravel.

Due to the variability of the thickness and composition of the made ground, more ground investigation is recommended for detail design.

4.2.1.1 Classification

The laboratory testing for made ground is presented in Appendix C.

The Natural Moisture Content (NMC) is determined from ten samples and Atterberg limits are determined from six samples. The NMC of the made ground ranges from 6% to 38%. The average NMC for the made ground is 14%. The average liquid limit is 37% with a minimum limit of 30% and maximum of 54%. The average plastic limit is 21% with a minimum limit of 17% and a maximum of 28%. The average plasticity index is 16% with a minimum plasticity index of 12% and a maximum of 26%. Cohesive made ground is described as low to high plasticity clay.

The PSD test was carried out for two samples. The PSD curves for the cohesive deposits have a fines content greater than 6% and 52% passing the 0.063mm sieve, with 20% to 83% gravel.

4.2.1.2 Unit Weight

In accordance with BS8002:2015, a unit weight of 17kN/m³ is above the groundwater table and 18kN/m³ below the groundwater table adopted for made ground to be conservative.

4.2.1.3 Standard Penetration Tests

In total, ten Standard Penetration Tests (SPT) were carried out on the made ground. The range of SPT 'N' values recorded are presented in Appendix B.

The SPT 'N' values typically ranged from 4 to 10, with an average of 5. SPT results of R05-CP03 are refusal due to existence of bricks. Base on this SPT values of R05-CP03 are ignored.

4.2.1.4 Undrained Shear Strength

Laboratory testing was not conducted on samples of made ground. Therefore, reference was made to Table 9 of BS5930:2015 and Stroud and Butler (1975), the undrained shear strength has been estimated based on the following:

- $c_u = f_l \times N$ (kPa) (f_l has conservatively been taken as 5.5kPa based on the range of plasticity index test results).

The undrained shear strength (c_u) is determined as 25kPa.

4.2.1.5 Effective Stress Parameters

Laboratory testing was not conducted on samples of made ground.

To be conservative an effective angle of shearing resistance of made ground accepted as alluvium.

4.2.1.6 Soil Stiffness

The soil undrained stiffness (E_u) can be calculated based on the relationship with undrained shear strength. Jamiolkowski (1979) suggests a value of E_u between 200 c_u and 1000 c_u . In the examined case the E_u will be calculated as follows:

$$E_u' = 200 \times c_u = 4\text{MPa}$$

The drained stiffness (E') can be approximated by taking 80% of this value which leads to a value of

$$E' = 3\text{MPa}$$

4.3 Cohesive Deposits

4.3.1 Glacial Till Deposits

Local glacial till deposits are known as Dublin Boulder Clay which is a subdivision of Till derived from Limestone. It is encountered in the majority of the exploratory locations, except some parts of the Navan Road/Old Cabra Road Junction to Ellis Quay section.

A general description of the glacial till is firm to very stiff, brown to light brown to greyish brown to light grey to grey, slightly sandy to sandy, slightly gravelly to gravelly Clay with occasional cobbles. The thickness of the glacial till is variable between 0.3 m to 10m. The typical thickness of the glacial till is 2.5m.

4.3.1.1 Classification

The laboratory testing for glacial till deposits are presented in Appendix B

The Natural Moisture Content (NMC) and Atterberg limits were determined for 15 No. samples. The NMC of the glacial till deposits ranges from 10% to 34%. The average NMC for the alluvial material is 14%. The average liquid limit is 32% with a minimum limit of 20% and maximum of 62%. The average plastic limit is 17% with a minimum limit of 10% and a maximum of 39%. The average plasticity index is 15% with a minimum plasticity index of 8% and a maximum of 25%. Cohesive material is described as high plasticity silt and low to high plasticity clay.

The PSD test was carried out for seven samples. The PSD curves for the cohesive deposits have a fines content greater than 26% and 64% passing the 0.063mm sieve, with 15% to 46% gravel.

4.3.1.2 Unit Weight

In accordance with BS8002:2015, a clay with high to very high undrained shear strength, like the one examined herein, has a weight density which typically varies from 18 to 24kN/m³. A value of 21kN/m³ is adopted.

4.3.1.3 Standard Penetration Tests

In total, 23 No. Standard Penetration Tests (SPT) were carried out on the cohesive deposits in boreholes. The range of SPT 'N' values recorded are presented in Appendix B.

The SPT 'N' values ranged from 28 to refusal, except for a value of 11 within the first 5m of a borehole at Auburn Avenue.

4.3.1.4 Undrained Shear Strength

Laboratory testing was not conducted on samples of cohesive deposits. Therefore, reference was made to Table 9 of BS5930:2015 and Stroud and Butler (1975), the undrained shear strength has been estimated based on the following:

- $c_u = f_l \times N$ (kPa) (f_l has conservatively been taken as 5.5kPa based on the
- A general undrained shear strength (c_u) for the alignment and a specific undrained shear strength (c_u) for Auburn Ave are determined.
- The general undrained shear strength (c_u) for the alignment is determined as 165kPa
 - The undrained shear strength (c_u) at Auburn Ave is 60kPa

4.3.1.5 Effective Stress Parameters

Laboratory testing was not conducted on samples of cohesive deposits.

Long and Menkiti (2007) report a value of 44° for the peak compressive angle of shearing resistance (ϕ'_p) for all formations of the Dublin Boulder Clay. Long and Mentiki (2007) also report a value of 36° for the critical state angle of shearing resistance (ϕ'_{cs}). This value of ϕ'_{cs} compares favourably with the findings of Lehane and Faulkner (1998) and Farrell and Wall (1990) who report values of 34°±1° and 35° respectively. In all cases a $c' = 0$ kPa is recommended.

Taking the above into account, a value of $\phi'_p = \phi'_{cs} = 32^\circ$ is chosen for preliminary design.

4.3.1.6 Soil Stiffness

For stiff consolidated clays, the soil undrained stiffness (E_u) can be calculated based on the relationship with undrained shear strength. Jamiolkowski (1979) suggests a value of E_u between 500 c_u and 1000 c_u . In the examined case the E_u will be calculated as follows:

- $E_u = 500 \times c_u = 80\text{MPa}$
- $E_u = 500 \times c_u = 30\text{MPa}$

The drained stiffness (E') can be approximated by taking 80% of this value which leads to a value of approximately 64MPa and 24MPa.

4.3.1.7 In-situ Stress

No in situ testing or laboratory testing in which K_0 is directly or indirectly measured was carried out as part of the GI. Long & Menkiti (2007) recommended a K_0 value in the range of 1.0 to 1.5 for design. Taking the above into account a value of 1.5 is chosen.

4.3.2 Alluvial Deposits

There are alluvial deposits at the Tolka River Bridge Widening and possibly at the old Phoenix Park Racecourse.

The thickness of the alluvium is 2.8m at the Tolka River Bridge Widening and the material is described as very soft to soft, brown, slightly sandy/gravelly Clay.

Alluvium was recorded in the historical borehole logs in the old Phoenix Park Racecourse. It is described as soft to very soft, brown to dark brown, slightly peaty gravelly Clay with cobbles and boulders. The thickness of the alluvium in this area is variable between 1.5 to 1.7m. Recent ground investigations did not record any alluvium. This suggests that the alluvium was removed for the construction of the road. There may be alluvium outside of the earthworks footprint of the existing road.

4.3.2.1 Classification

The laboratory testing for alluvium deposits is presented in Appendix C

The Natural Moisture Content (NMC) and Atterberg limits were determined for one sample. The NMC of the alluvium deposits is 20%. The liquid limit is 24%. The plastic limit is 15%. The plasticity index is 9%. Alluvium deposit is described as low plasticity clay.

4.3.2.2 Unit Weight

In accordance with BS8002:2015, a unit weight of 17kN/m³ is recommended for alluvial deposits above the groundwater table and 18kN/m³ below the groundwater table.

4.3.2.3 Standard Penetration Tests

In total, two Standard Penetration Tests (SPT) were carried out on the alluvium deposits in boreholes. The range of SPT 'N' values recorded are presented in Appendix B.

The SPT 'N' values are 3 and 6.

4.3.2.4 Undrained Shear Strength

Laboratory testing was not conducted on samples of cohesive deposits. Therefore, reference was made to Table 9 of BS5930:2015 and Stroud and Butler (1975), the undrained shear strength has been estimated based on the following:

- $c_u = f_l \times N$ (kPa) (f_l has conservatively been taken as 5.5kPa based on the range of plasticity index test results).

The undrained shear strength (c_u) is determined as 20kPa.

4.3.2.5 Effective Stress Parameters

Laboratory testing was not conducted on samples of alluvium. Therefore, reference was made to Section 4.3.1.4 of BS8002:2015.

An effective angle of shearing resistance of 27° is recommended for alluvial deposits based on the available plasticity index test results.

4.3.2.6 Soil Stiffness

The soil undrained stiffness (E_u) can be calculated based on the relationship with undrained shear strength. Jamiolkowski (1979) suggests a value of E_u between 200 c_u and 1000 c_u . In the examined case the E_u will be calculated as follows:

$$E_u' = 200 \times c_u = 4\text{MPa}$$

The drained stiffness (E') can be approximated by taking 80% of this value which leads to a value of $E' = 3\text{MPa}$

4.4 Granular Deposits

Granular deposits are encountered at Blanchardstown Shopping Centre, Tolka River Bridge Widening, old Phoenix Park Racecourse and most of the Navan Road/Old Cabra Road Junction to Ellis Quay section.

Description of granular deposits at Blanchardstown Shopping Centre is Dense brownish grey sandy clayey Gravel. The thickness of the granular deposit is 0.6m.

The description of granular deposits at Tolka River Bridge Widening is grey, slightly clayey, sandy/gravelly, medium to coarse sub angular to sub rounded Gravel/Sand. The total thickness of the granular deposit is 16m. This description is based on the driller's description and these materials may include more cohesive material than is recorded.

Description of granular deposits at old Phoenix Park Racecourse is dense grey angular to subangular fine to coarse Gravel with some angular to subangular cobbles. The total thickness of the granular deposit is 0.5m.

Description of granular deposits at the Navan Road/Old Cabra Road Junction to Ellis Quay section is dense to very dense, brown to greyish brown, fine to coarse slightly sandy Gravel / gravelly Sand. Thickness of the granular deposit is variable between 1m to 11m with an average of 5m thickness.

4.4.1 Classification

The laboratory testing for granular deposits are presented in Appendix B.

The Natural Moisture Content (NMC) and Atterberg limits were determined for one sample. The NMC of the granular deposits is 10%.

The PSD test was carried out for six samples. The PSD curves for the granular deposits have a fines content less than 5% passing the 0.063mm sieve, with 75% to 95% gravel.

4.4.2 Unit Weight

Based on the available GI results, this stratum is typically described as gravel or sand below groundwater level. Most of the SPT N values are above 30 which, according to BS5930, corresponds to a dense layer. This leads to a γ value ranging between 19 to 23kN/m³ (BS8002: 2015). A value of 20kN/m³ is adopted.

4.4.3 Standard Penetration Tests

In total 34 No. Standard Penetration Tests (SPT) were carried out on the granular deposits in boreholes. The range of SPT 'N' values recorded are presented in Appendix B.

The SPT 'N' values typically ranged from 28 to refusal. In two areas SPT values are less than 28;

- Tolka River Bridge Widening. SPT values are 19 between 12mbgl and 16mbgl
- N3/M50 Junction. SPT value is 23 at 10m

4.4.4 Effective Stress Parameters

Peck *et al* established a relationship between the SPT N and critical state friction angle ($\phi'_{cv,k}$) for coarse grained soils. Following from that a graph was introduced correlating the above parameters. Several SPT tests were completed within the Granular Deposits. The results ranged from 28 to above 50 (refusal). The factual report of the site specific ground investigation mentions that the lower values occurred due to blowing conditions. Thus, they will be ignored. The remaining SPT N values vary from 28 to above 50 with the majority of them exceeding a value of 30. This value is selected for the preliminary design. An SPT N value of 30 according to the graph mentioned above, corresponds to a $\phi'_{cv,k}$ of approximately 36°.

A $\phi'_{cv,k}$ value of 32° is selected for preliminary design. Due to the nature of this layer (coarse-grained) $c' = 0$ kPa.

4.4.5 Soil Stiffness

For the estimation of the stiffness the following empirical relationship will be used:

$E' = 1.5 \text{ SPT N (in MPa)}$ which leads to an E' of 45MPa.

4.4.6 In-situ Stress

No in situ testing or laboratory testing in which K_0 is directly or indirectly measured was carried out as part of the GI.

In situ stress is determined with the approach presented in BS EN 1997-1:2004+A1:2013

$$K_0 = 1 - \sin\phi = 0.45^*$$

* ϕ value is presented above as $\phi'_{cv,k}$

4.5 Bedrock

Bedrock was encountered in some of the historical ground investigations and all the recent ground investigation locations, apart from at the Tolka River Bridge Widening. The top of the bedrock is variable between 0.3m to 9.5m below ground level.

The bedrock is mainly described as medium strong to strong grey/dark grey fine to medium grained laminated Limestone, locally interbedded with weak black fine grained laminated Mudstone or Clay. Some of the bedrock is described as medium strong to strong thinly laminated dark grey fine grained calcareous Mudstone with occasional specs of pyrite, locally interbedded with grey fine grained Limestone.

Depth to bedrock map presented in “GeoUrban Depth to Bedrock (GSI)” is usually consistent with the top of the bedrock determined from the borehole logs, except at the Tolka River Bridge Widening. The depth to bedrock on the GeoUrban Depth to Bedrock (GSI) map is 3m to 5m below ground level. However, the top of the rock in the borehole is deeper than 35m.

4.5.1 Rock Mass Description and Characteristics

TCR (Total Core Recovery) is variable between 93% to 100% with an average 97%. The SCR (Solid Core Recovery) ranges between 14% to 100% with an average of 66%.

The RQD (Rock Quality Designation) ranges between 7% and 100% with average of 50%.

Fracture sets were described as Closely to Very closely spaced, locally Non Intact and medium spaced. Condition of the fractures are generally described as planar smooth with variable fracture angles, generally 10° to 30° and 40° to 60°.

The Fracture Index (FI) ranges from Mostly Non Intact (>25) to 1 with an average of 10.

4.5.2 Unit Weight

11 No. Unconfined Compressive Strength (UCS) tests were carried out on rock samples and Bulk Density were measured for each sample as a part of the test. Test results are is presented in Appendix C.

Based on the available GI results, the γ value is between 25kN/m³ to 28kN/m³. A value of 26kN/m³ is adopted.

4.5.3 Rock Strength

11 No. Unconfined Compressive Strength tests (UCS) and 22 No. Point Load tests were carried out on rock samples.

UCS test result range is between 15MPa to 59MPa.

Point Load Testing ($I_{s(50)}$) was determined on axial and diametral samples. The relationship $UCS = f^* I_{s(50)}$ (MPa), where $f = 20$ (although may range between 20 and 24) is commonly used for Dublin Basin (Lucan Formation) Limestones and 23 for mudstone. To be conservative 20 is adopted for all samples. Point load test results ($I_{s(50)}$) are ranging between 0.8 to 8 (UCS=16MPa to 160MPa).

A value of 20MPa is adopted for Intact Uniaxial Compressive Strength.

Test results are is presented in Appendix C.

4.6 Stratigraphic Profile

The stratigraphic profile for the Proposed Scheme is summarised in Table 5, Table 6 and Table 7. In each profile the Cohesive Deposits and Granular Deposits are interbedded.

Table 5: Summary of stratigraphic profile for the Proposed Scheme except Navan Road/Old Cabra Road Junction to Ellis Quay and Tolka River Bridge Widening

Stratum	Typical Depth (m BGL)	Typical Thickness (m)
Topsoil	0.0	0.0 to 0.2
Made Ground	0.0 to 0.2	1 to 3
Cohesive Deposits	0.2 to 3	3 to 8
Granular Deposits	0.2 to 8	0.0 to 0.5

Stratum	Typical Depth (m BGL)	Typical Thickness (m)
Bedrock	4 to 8	N/A

Table 6: Summary of stratigraphic profile for the Navan Road/Old Cabra Road Junction to Ellis Quay

Stratum	Typical Depth (m BGL)	Typical Thickness (m)
Topsoil	0.0	0.0 to 0.4
Made Ground	0.0 to 0.2	0 to 5
Cohesive Deposits	0.2 to 5	0 to 2
Granular Deposits	2 to 7	2 to 6
Bedrock	2 to 8	N/A

Table 7: Summary of stratigraphic profile for Tolka River Bridge Widening

Stratum	Depth (m BGL)	Thickness (m)
Alluvium	0.0	2.8m
Cohesive Deposits	2.8	5.4
	15.7	3
	27.4	7.6
Granular Deposits	8.2	7.5
	18.7	7.6
	35	N/A

4.7 Groundwater

4.7.1 Summary of Groundwater Conditions

Groundwater data is presented in Table 8.

Table 8: Groundwater level data

Borehole	Date	Groundwater Level (m BGL)	Standpipe / Water strike/Observation Reading
R5-RC01	09.04.2021	5.69	Standpipe
R5-CP04	09.04.2021	3.02	Standpipe
R838/B61972	13.02.1990	3	Water Strike
R838/B61973	20.02.1990	3.8	Water Strike
R838/B61974	19.02.1990	3	Water Strike
R838/B61976	22.02.1990	3.75	Water Strike
R5614/B135148	1.05.2004	6.3	Water Strike
R5619/B135217	28.11.2003	2	Ground Water Observation
R5619/B135218	29.11.2003	1.5	Ground Water Observation
R5709/B135926	7.04.2004	11.50	Ground Water Observation
R5709/B135927	05.04.20004	13.50	Ground Water Observation
R2161/B81466	27.0.1999	3	Ground Water Observation

Based on these groundwater measures, groundwater level for preliminary design should be taken as 2m below ground level.

4.8 Summary of Preliminary Design Parameters

A summary of the interpreted characteristic parameters for each stratum is presented in Table 9.

Table 9: Summary of Interpreted Characteristic Parameters

Stratum	γ (kN/m ³)	K_0	c_u (kPa)	ϕ (°)	c' (kPa)	UCS (MPa)	E_u (MPa)	E' (MPa)
Topsoil	No geotechnical parameters will be provided for these layers							
Made Ground	17	-	20	25	0	N/A	4	3
Alluvium Deposits	17	-	20	25	0	N/A	4	3
Glacial Till Deposits	21	1.5	165	32	0	N/A	80	64
Granular Deposits	20	0.45	N/A	32	0	N/A	N/A	52.5
Limestone/Mudstone	26		N/A	-	-	20	N/A	550

5 Geotechnical Risk Register

This geotechnical risk register in Appendix F has been completed based on available existing information including that gained from compilation of this GIR.

It highlights the geotechnical risks and the consequence of those risks occurring. It contains proposed measures to mitigate the risks.

It does not cover health and safety risks unless specifically related to the geotechnical works. Risk control measures will, whenever possible, reduce all risks to an acceptable 'low' level.

The following risk ratings have been adopted:

Low Risk (LOW): No action required by Designer or Contractor

Medium Risk (MED): Action required unless good reason not to e.g. design change or construction mitigation measure

High Risk (HIGH): Action required e.g. design change

Geotechnical Risk Register is given in Appendix F.

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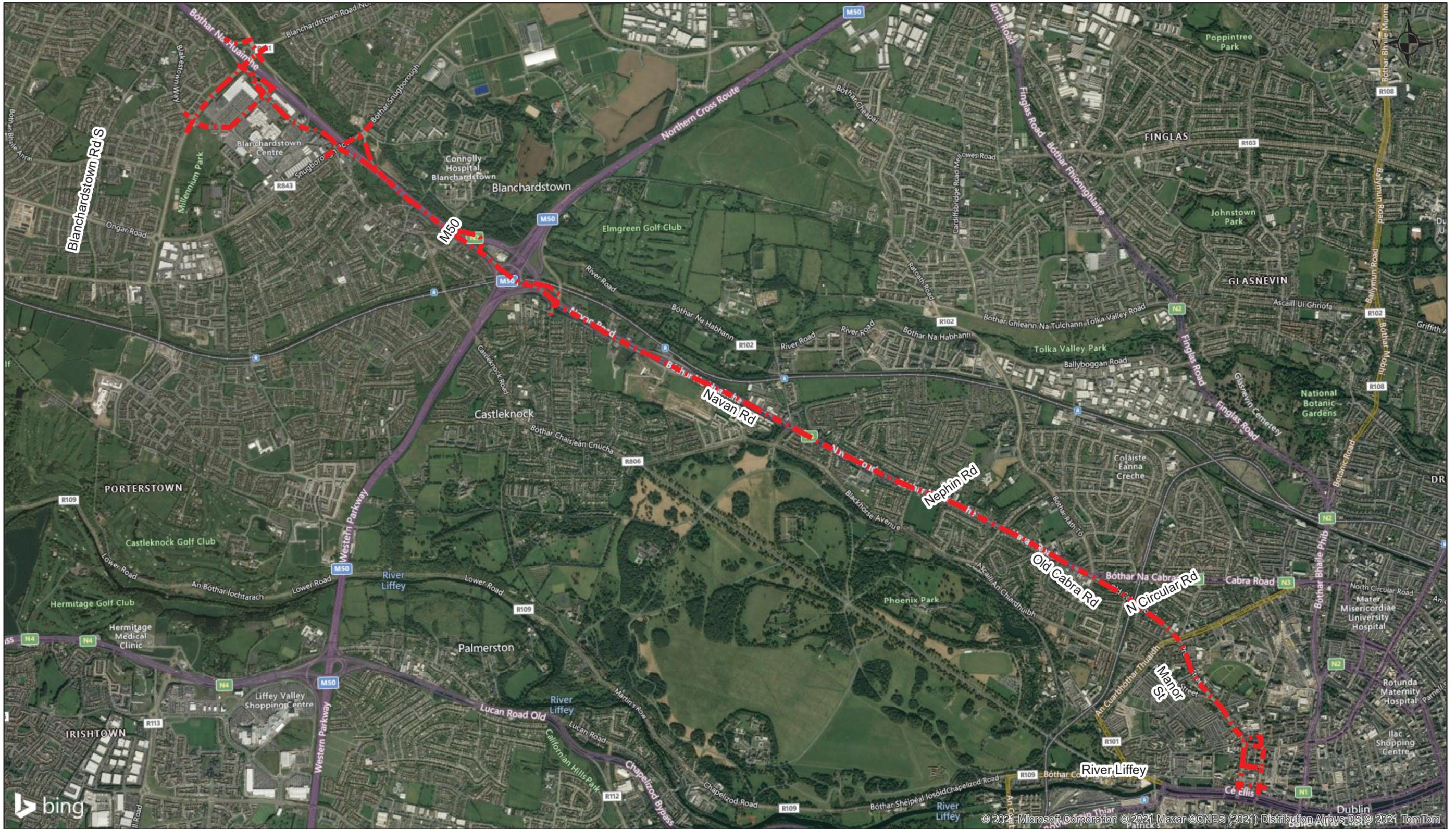
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Appendix A

Ground Investigation Layout
Plan and Geological Survey
Ireland Maps



Legend

— Alignment

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**Blanchardstown to City Centre
Core Bus Corridor**

Aerial View (Bing Map)

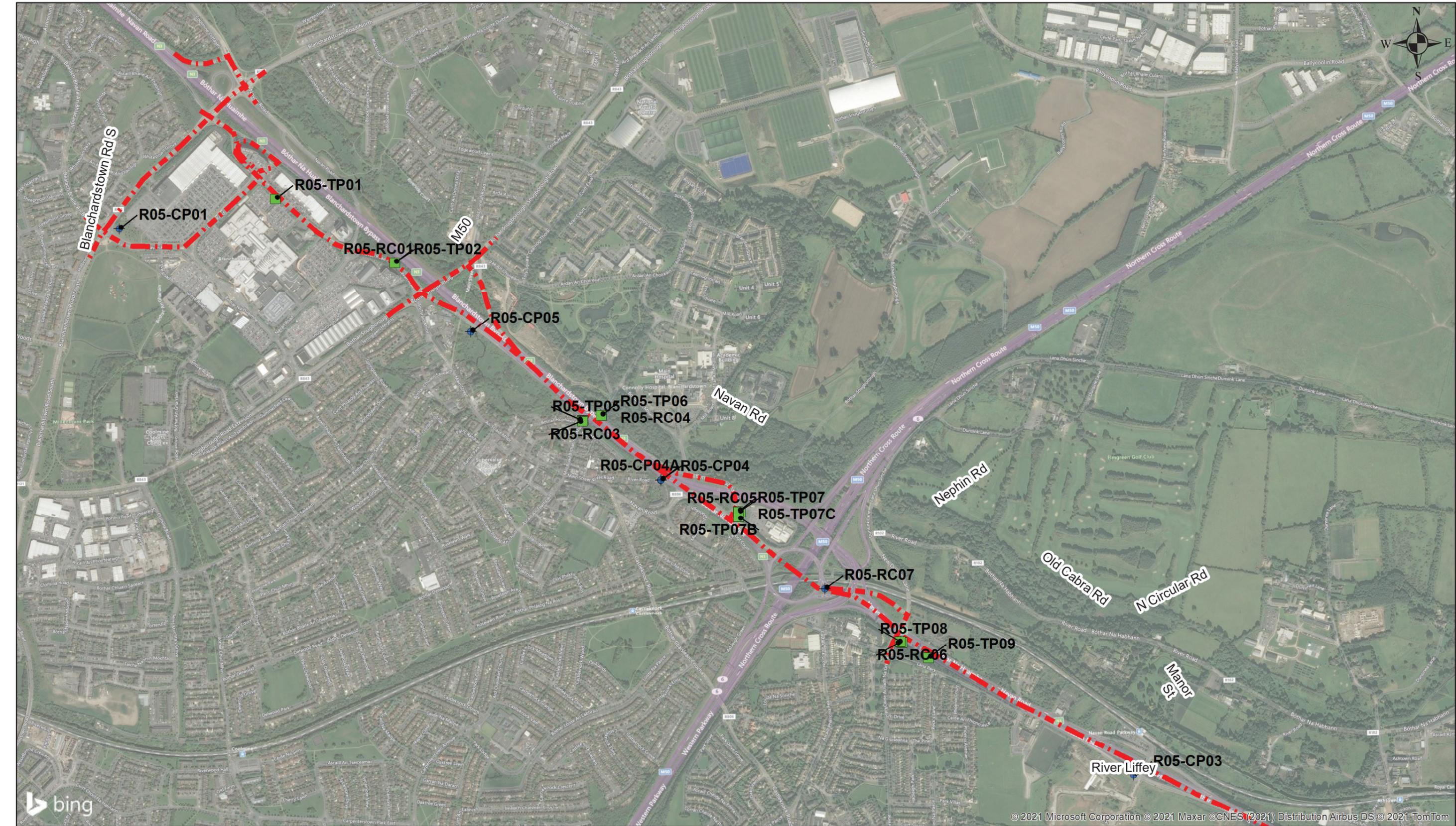
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FIGURE **A01**



- Legend**
- GI Type**
- ◆ BH
 - TP
 - - - Alignment

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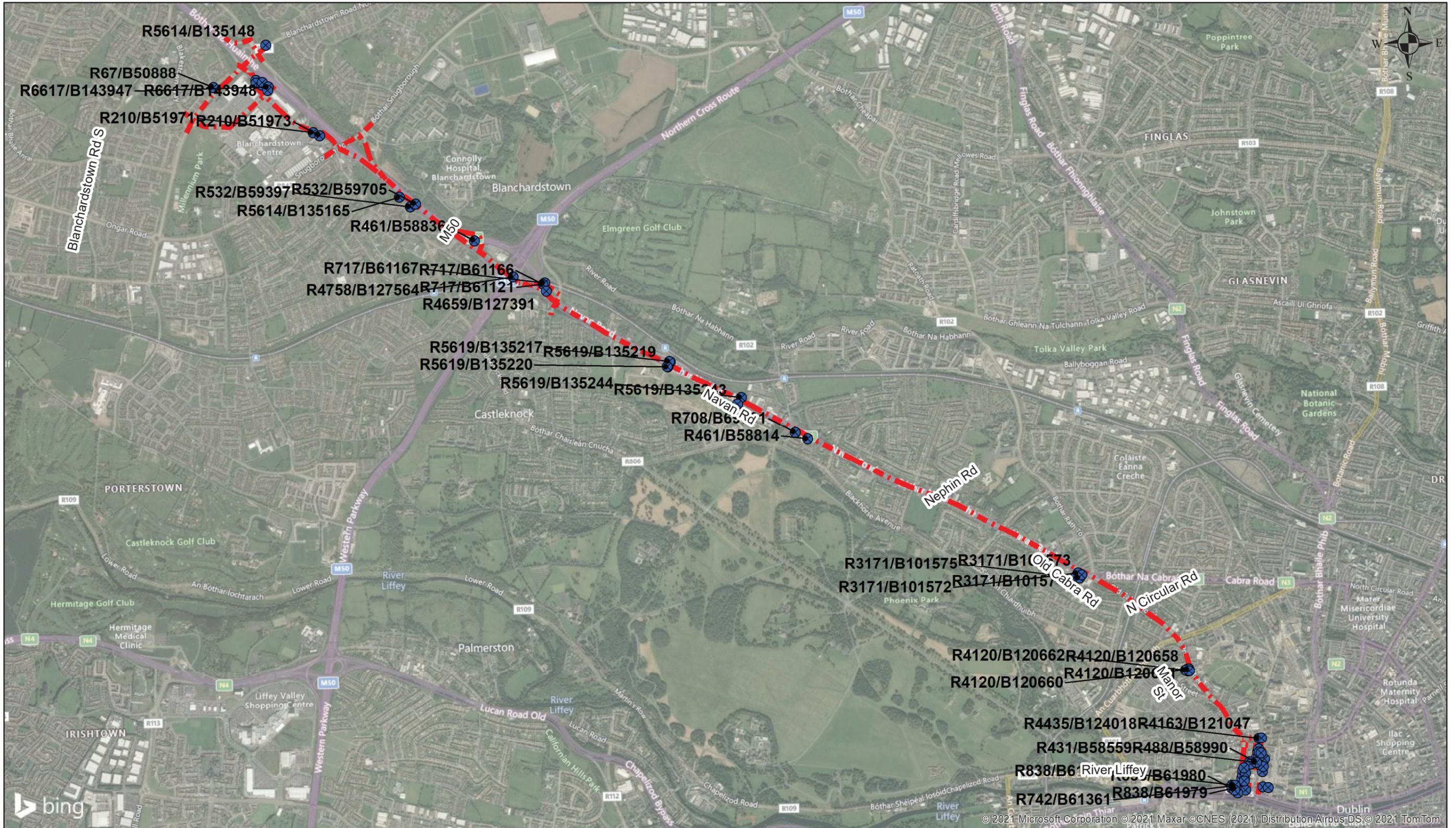
**Blanchardstown to City Centre
Core Bus Corridor**

**Site Specific Ground Investigation
Location Plan**



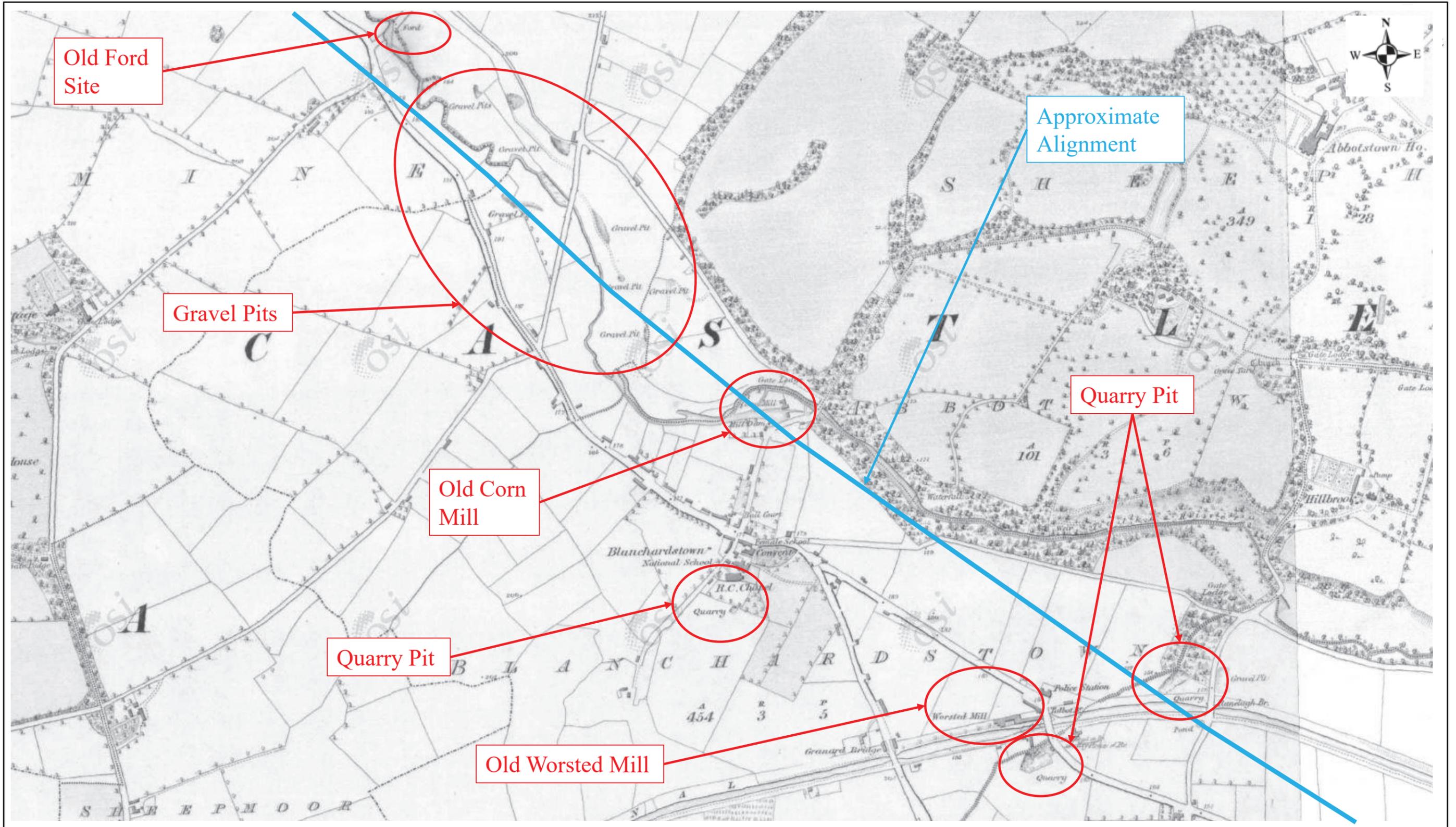
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FIGURE **A02**



Legend

- Historical Ground Investigation (GSI) - 20m Offset
- - - Alignment

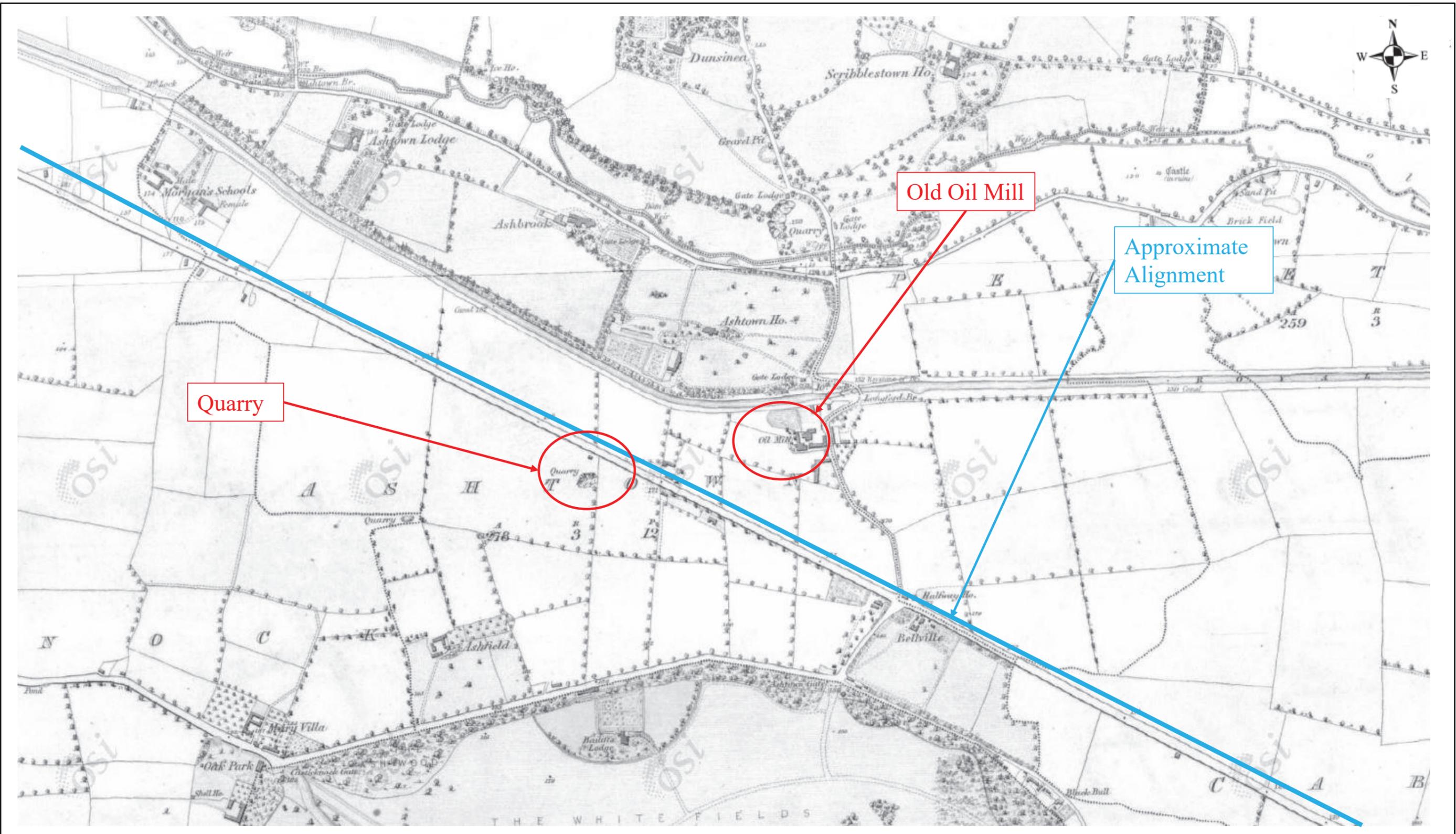


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**Blanchardstown to City Centre
Core Bus Corridor**

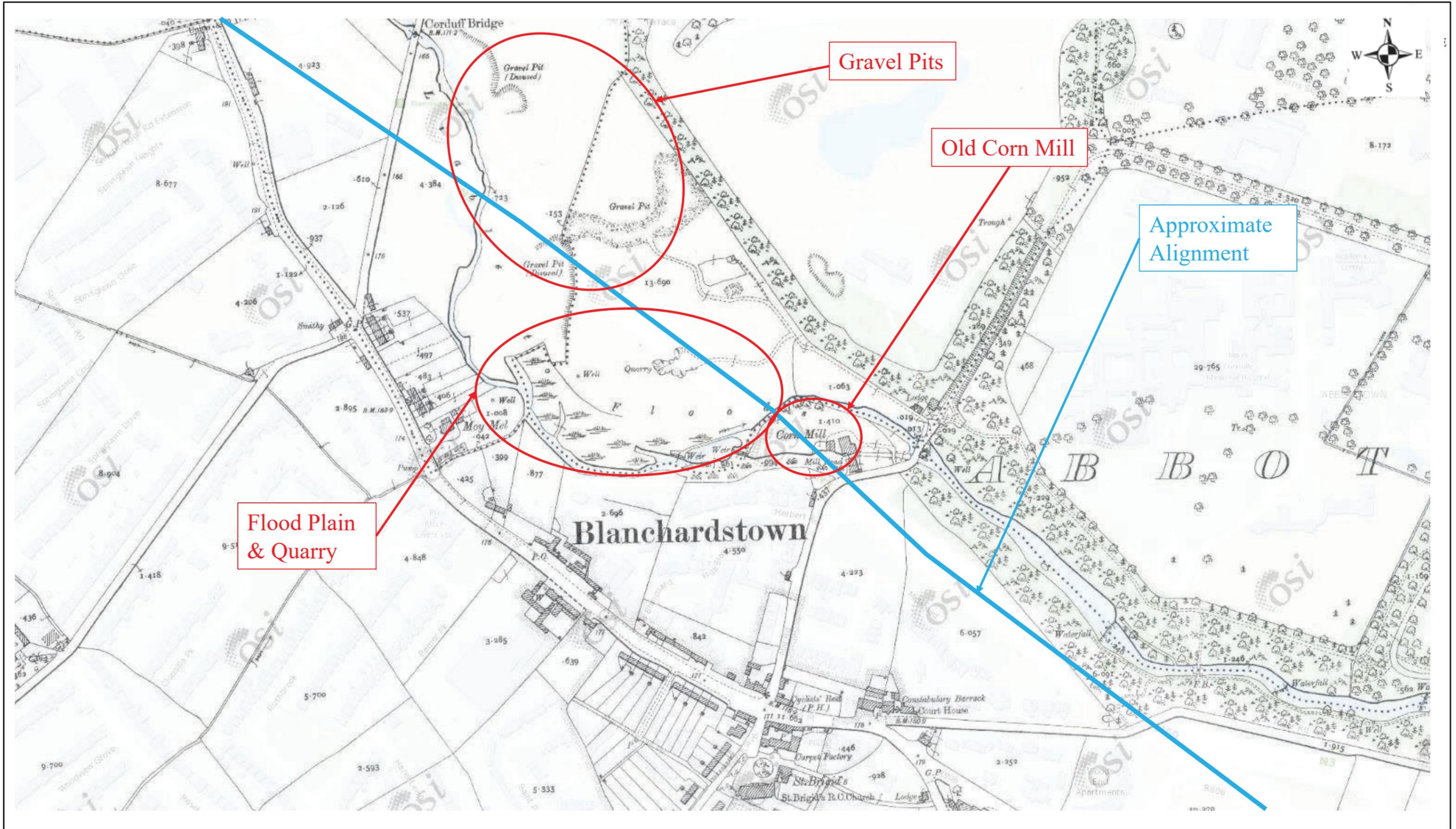
Historic Map 6 Inch
(1837 - 1842)



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**Blanchardstown to City Centre
 Core Bus Corridor**

Historic Map 6 Inch
 (1837 - 1842)



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Blanchardstown to City Centre Core Bus Corridor

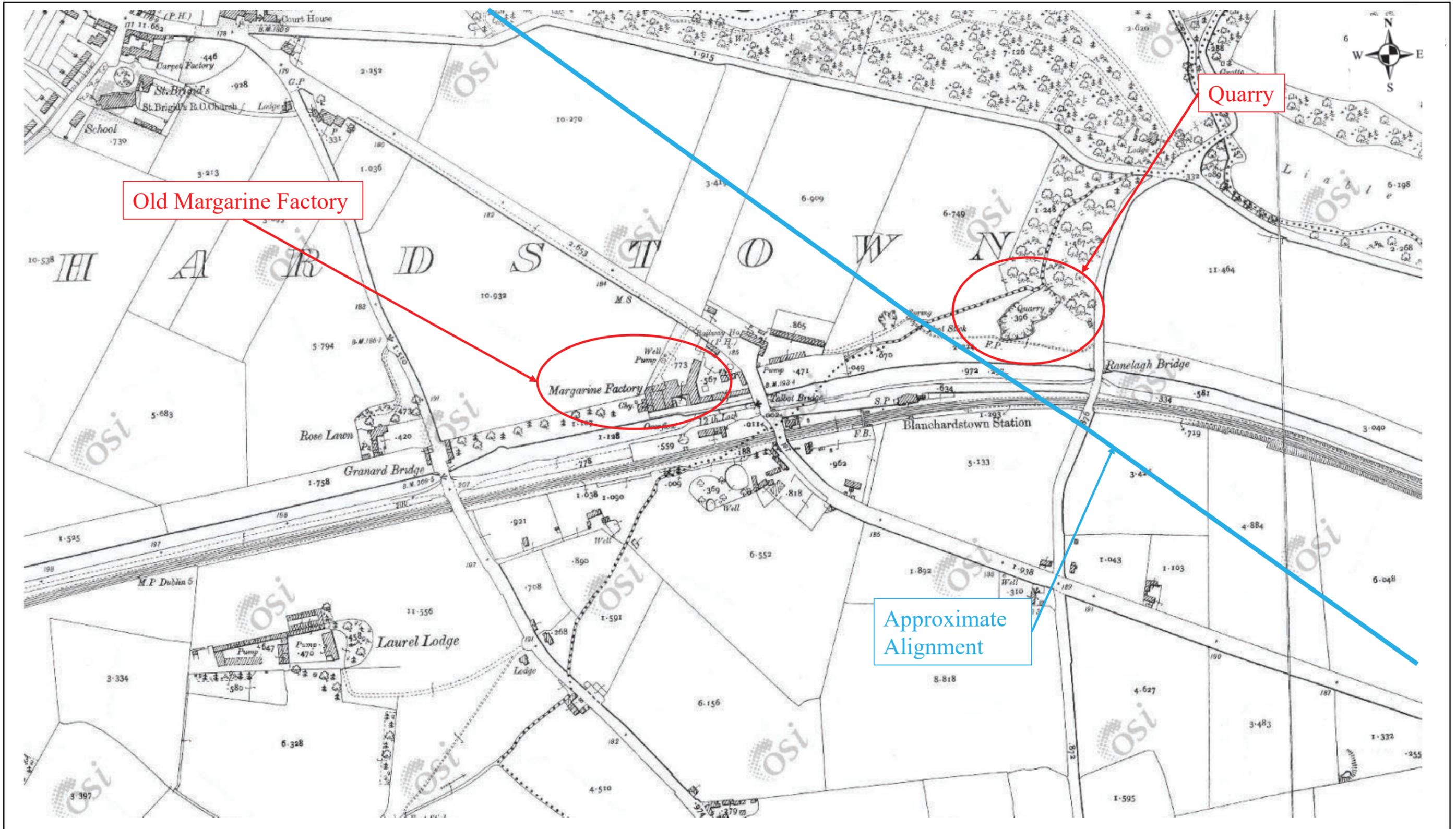
Historic Map 25 Inch
(1888 - 1913)

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Not to Scale

268401

FIGURE **A06**

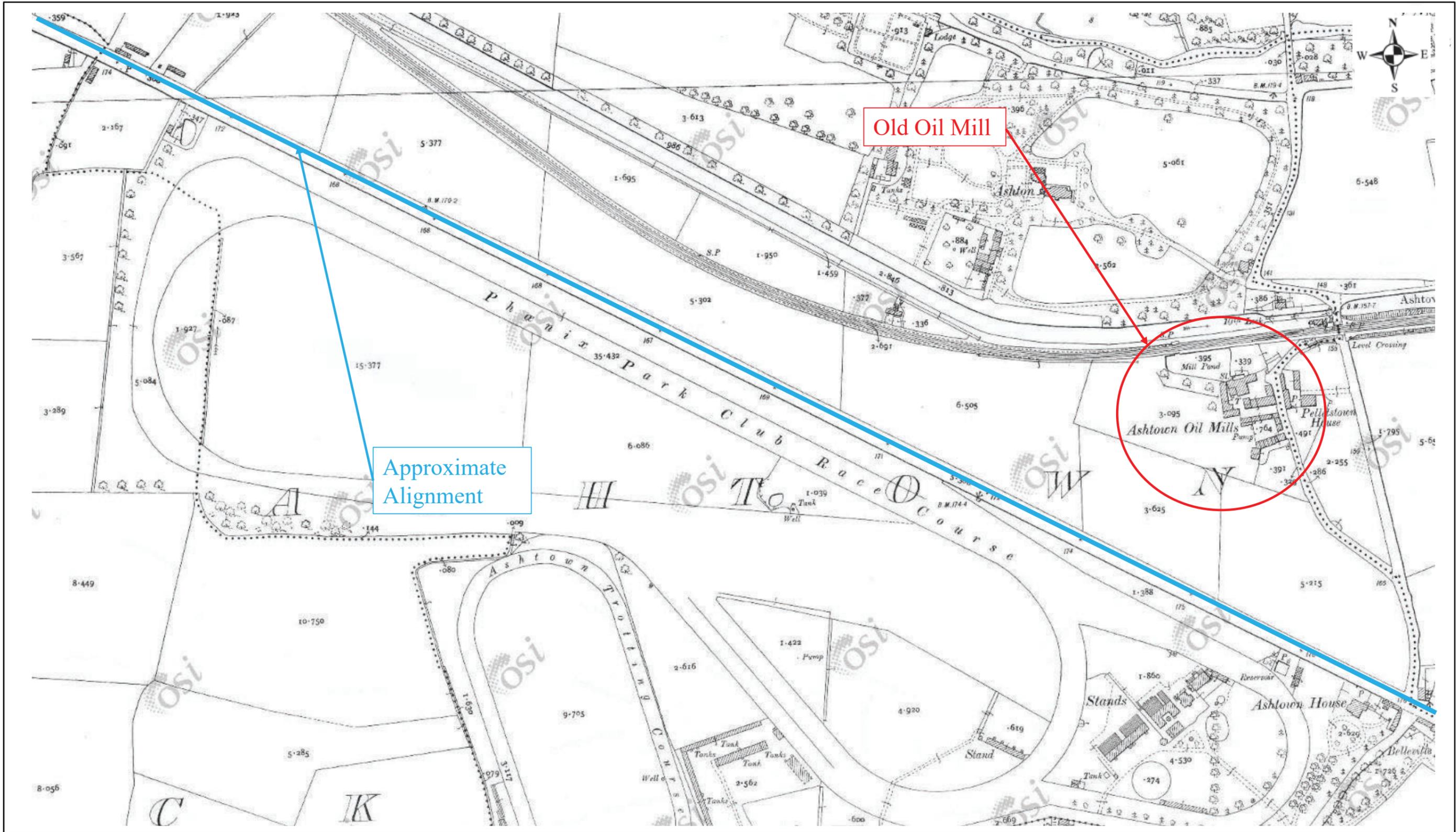


Legend

COPYRIGHT

**Blanchardstown to City Centre
Core Bus Corridor**

Historic Map 25 Inch
(1888 - 1913)



Legend

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**Blanchardstown to City Centre
 Core Bus Corridor**

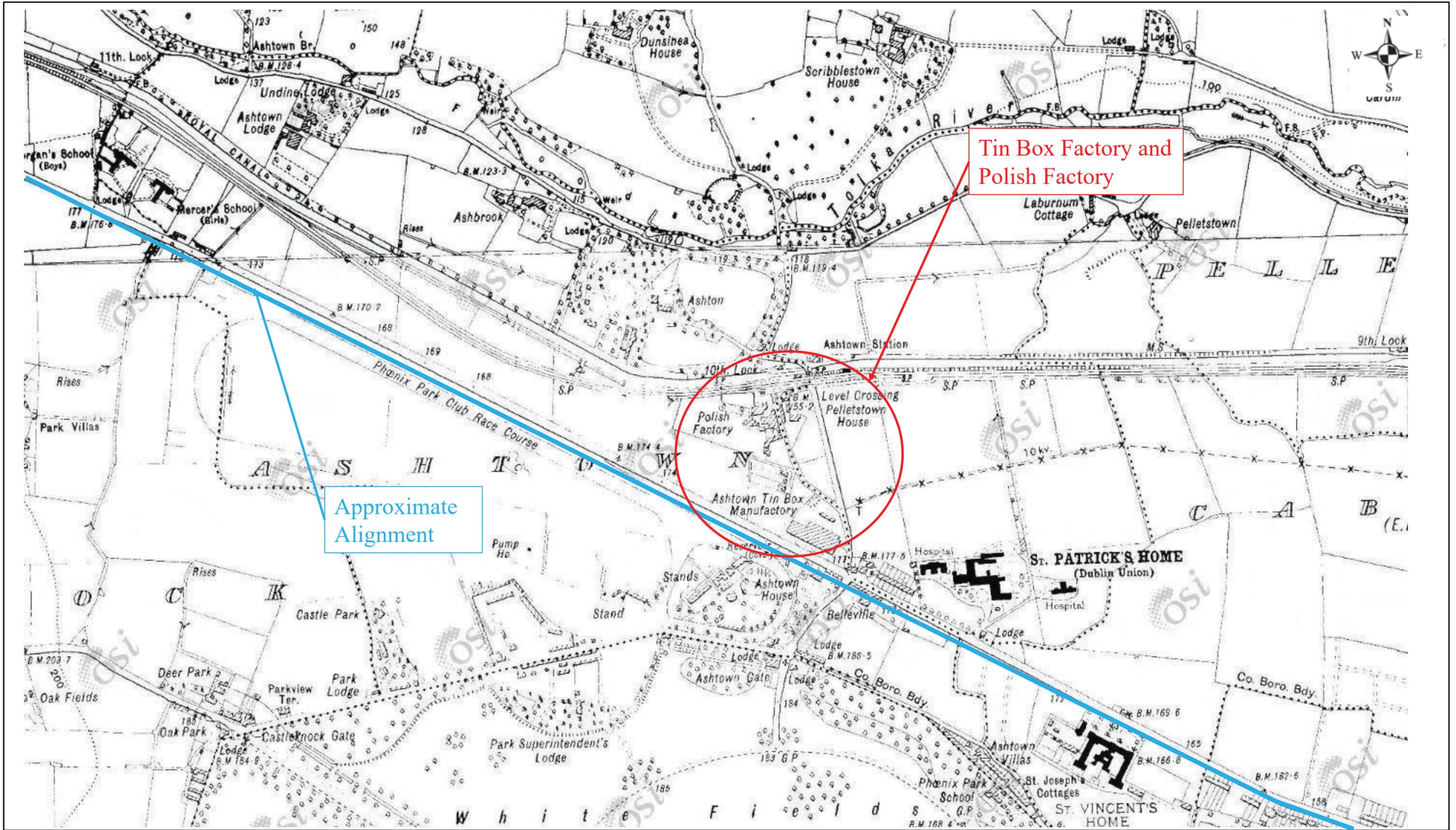
Historic Map 25 Inch
 (1888 - 1913)

ARUP

Not to Scale

268401

FIGURE **A08**



Legend

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Blanchardstown to City Centre
Core Bus Corridor

6 Inch Cassini
(1830-1930)

ARUP

Not to Scale

268401

FIGURE A09



Legend

— Alignment

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**Blanchardstown to City Centre
Core Bus Corridor
EPA 20m Contour Map**

ARUP

1:27,500



268401

FIGURE A10

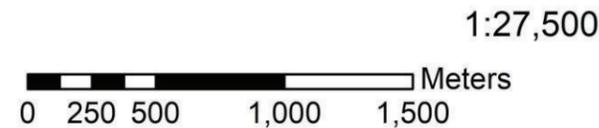


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Legend

- - - Alignment
 - A, Alluvium
 - Ag, Alluvium (gravelly)
 - Embankment
 - GCh, Gravels derived from chert
 - GLs, Gravels derived from Limestones
 - Landfill
 - Rck, Bedrock outcrop or subcrop
 - TLs, Till derived from limestones
 - Urban
- Water

ARUP

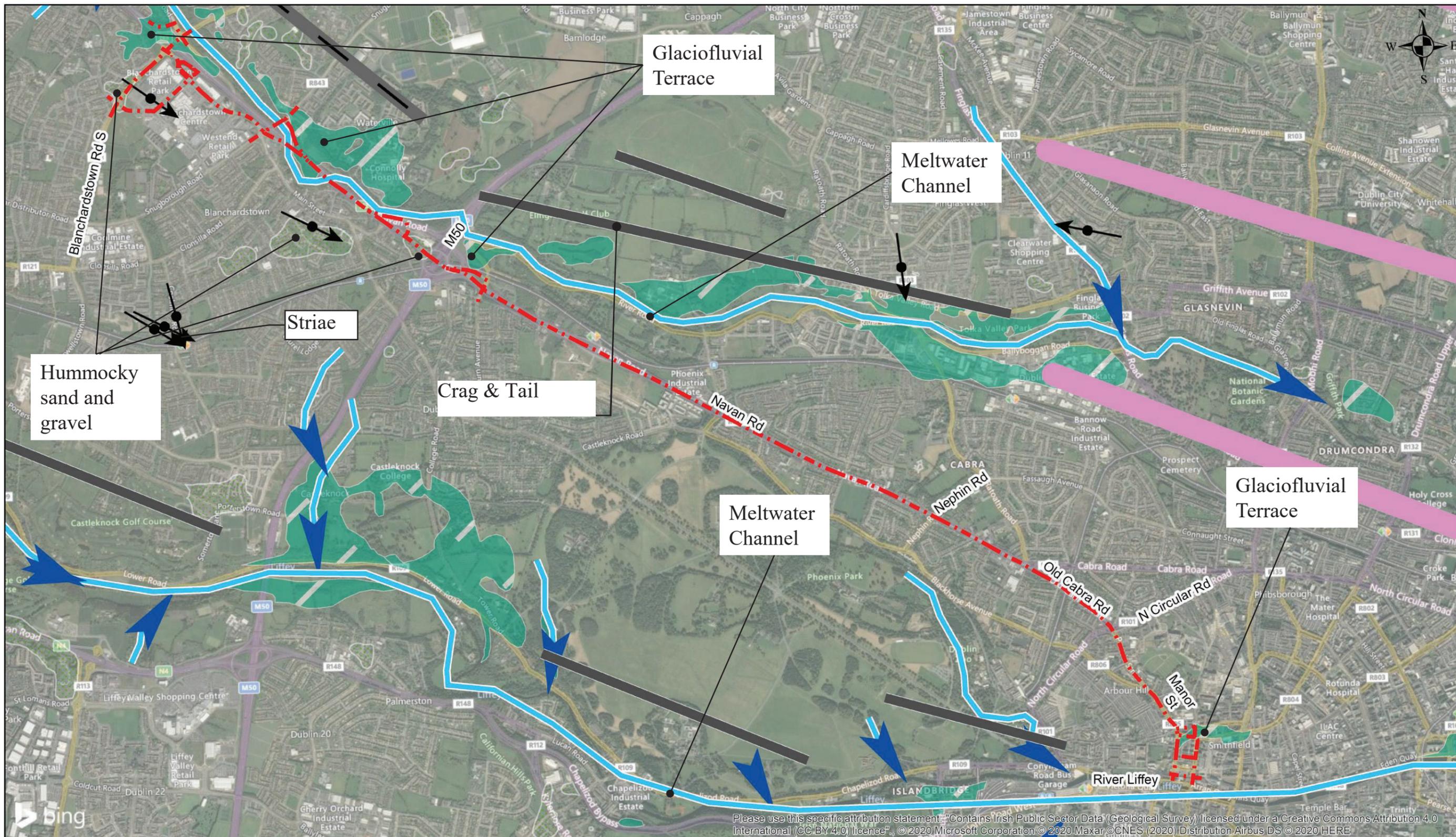


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Blanchardstown to City Centre Core Bus Corridor Quaternary Sediments

268401

FIGURE **A11**



Legend

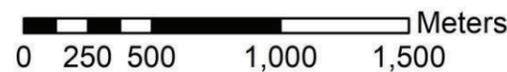
— Alignment

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**Blanchardstown to City Centre
Core Bus Corridor
Quaternary Geomorphology**

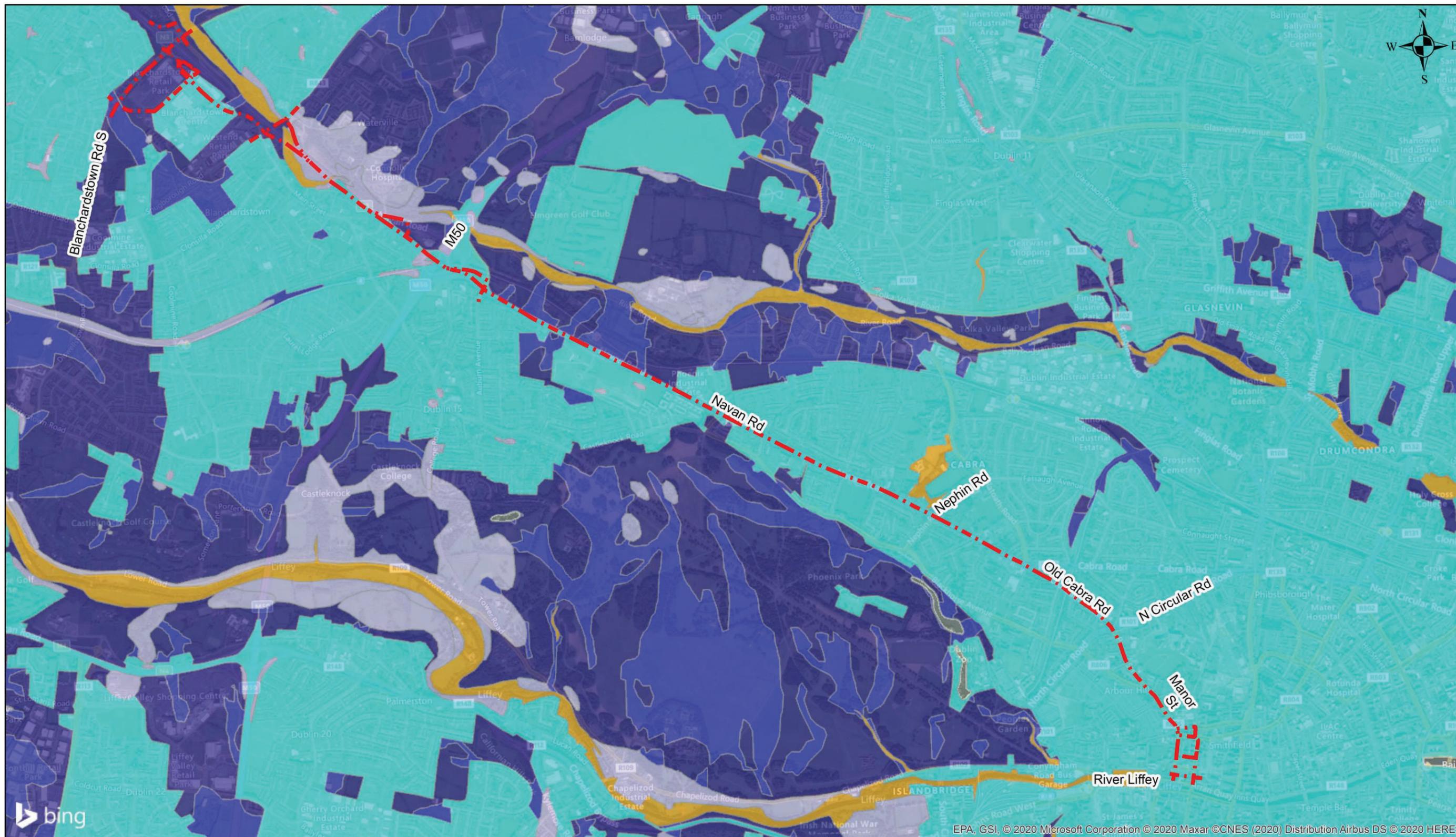
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1:27,500



268401

FIGURE A12



bing

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Legend

- - - Alignment
- Alluvium
- BminDW - Till derived chiefly from limestone
- BminPD - Till derived chiefly from limestone
- BminSW - Bedrock at Surface - Calcareous
- Made Ground

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**Blanchardstown to City Centre
Core Bus Corridor**

**GSI Groundwater Subsoils
(Teagasc)**

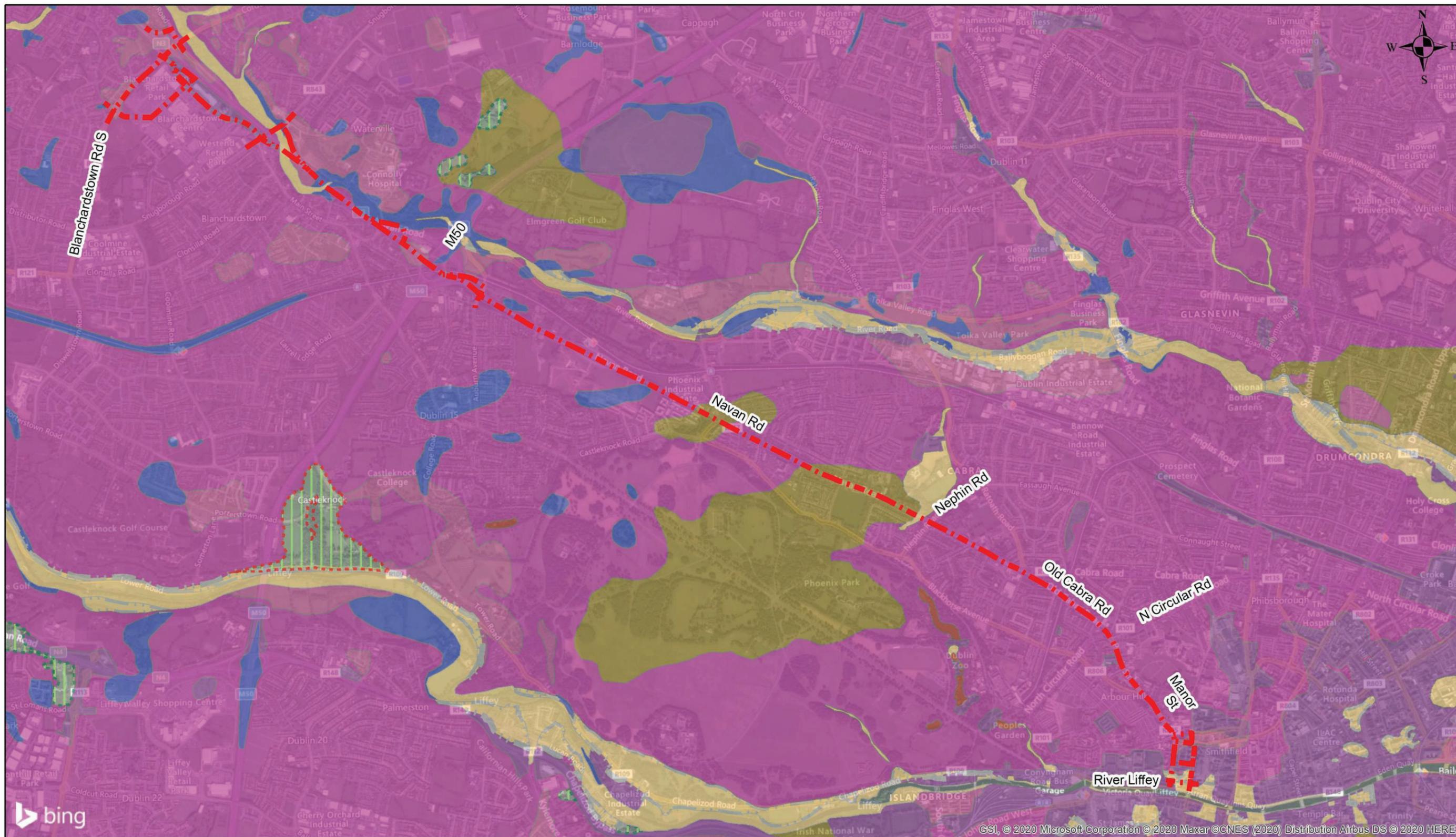
ARUP

1:27,500



268401

FIGURE A13



bing

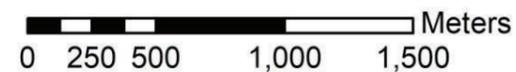
GSI, © 2020 Microsoft Corporation © 2020 Maxar © CNES (2020) Distribution Airbus DS © 2020 HERE

Legend

- - - Alignment
- A - Gravelly
- TLs - Limestone till (Carboniferous)
- GLs - Limestone sands and gravels (Carboniferous)
- TwGLs - Interstratified till with gravel derived from Lower Carboniferous Limestone
- Rck - Bedrock at surface

ARUP

1:27,500



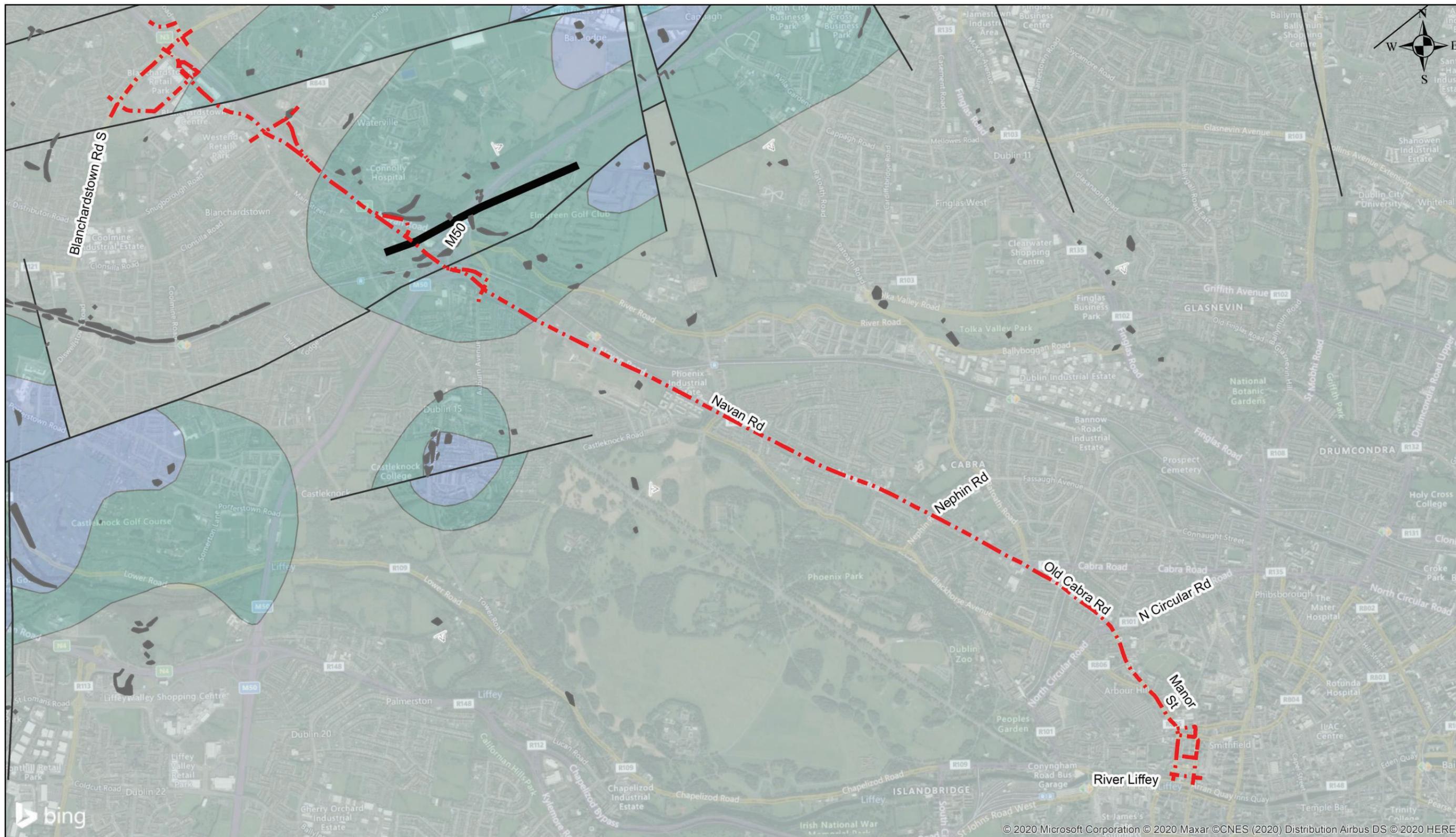
**Blanchardstown to City Centre
Core Bus Corridor**

**GSI GeoUrban
Unconsolidated Sediments**

268401

FIGURE A14

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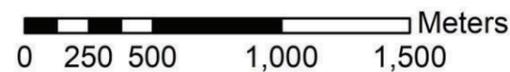


Legend

- - - Alignment
- Strike and dip of bedding, right way up
- Bedrock Outcrops 100 ITM 2018
- Anticlinal Axis
- Fault
- Synclinal Axis
- Boston Hill Formation
- Lucan Formation
- Tober Colleen Formation
- Waulsortian Limestones

ARUP

1:27,500



**Blanchardstown to City Centre
Core Bus Corridor**

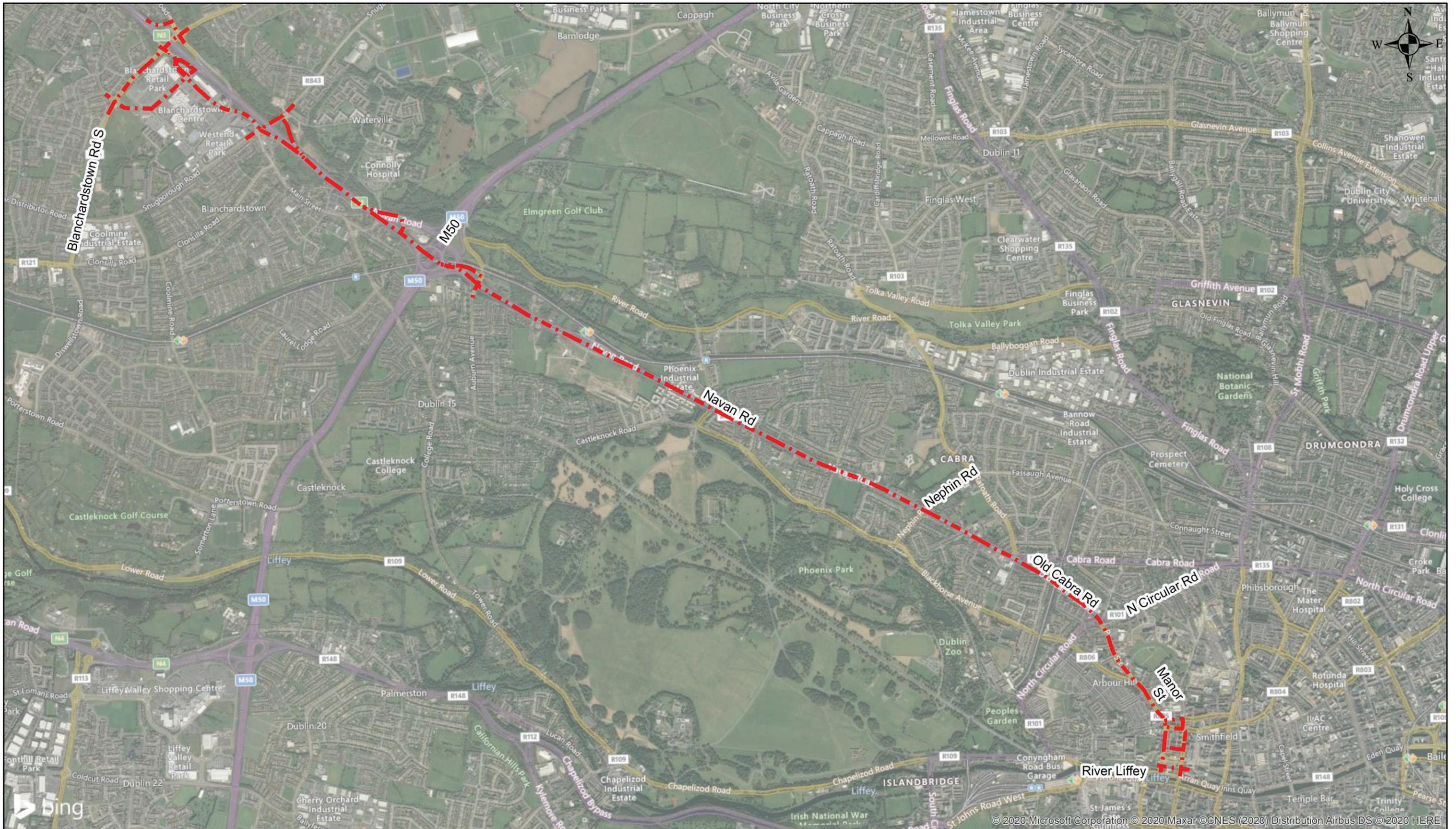
**GSI Bedrock
Geology 100k**

268401

FIGURE A15

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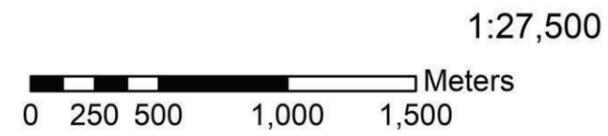
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Legend

- - - Alignment
- Borehole
- ▽ Cave
- ∇ Dry Valley
- ⊗ Enclosed Depression
- ⊕ Spring
- ⋯ Superficial Solution Features
- ⊖ Swallow Hole
- ⊞ Turlough

ARUP



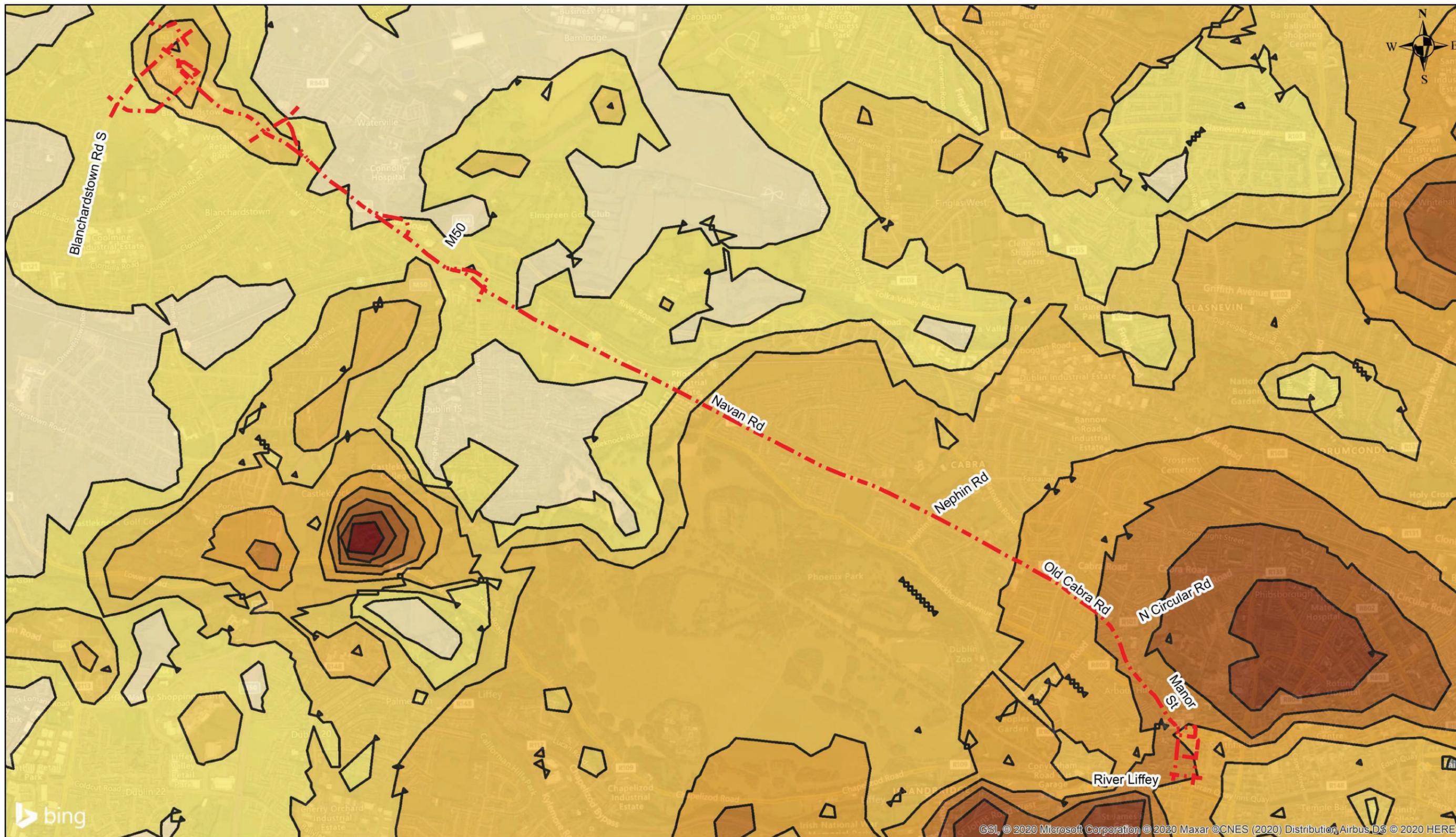
**Blanchardstown to City Centre
Core Bus Corridor
GSI Karst
Features**

268401

FIGURE A16

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Legend

- - - Alignment
- 0 to 1m
- 1 to 3m
- 3 to 5m
- 5 to 10m
- 10 to 15m
- 15 to 20m
- 20 to 25m
- 25 to 30m
- 30 to 45m

1:27,500



**Blanchardstown to City Centre
Core Bus Corridor**

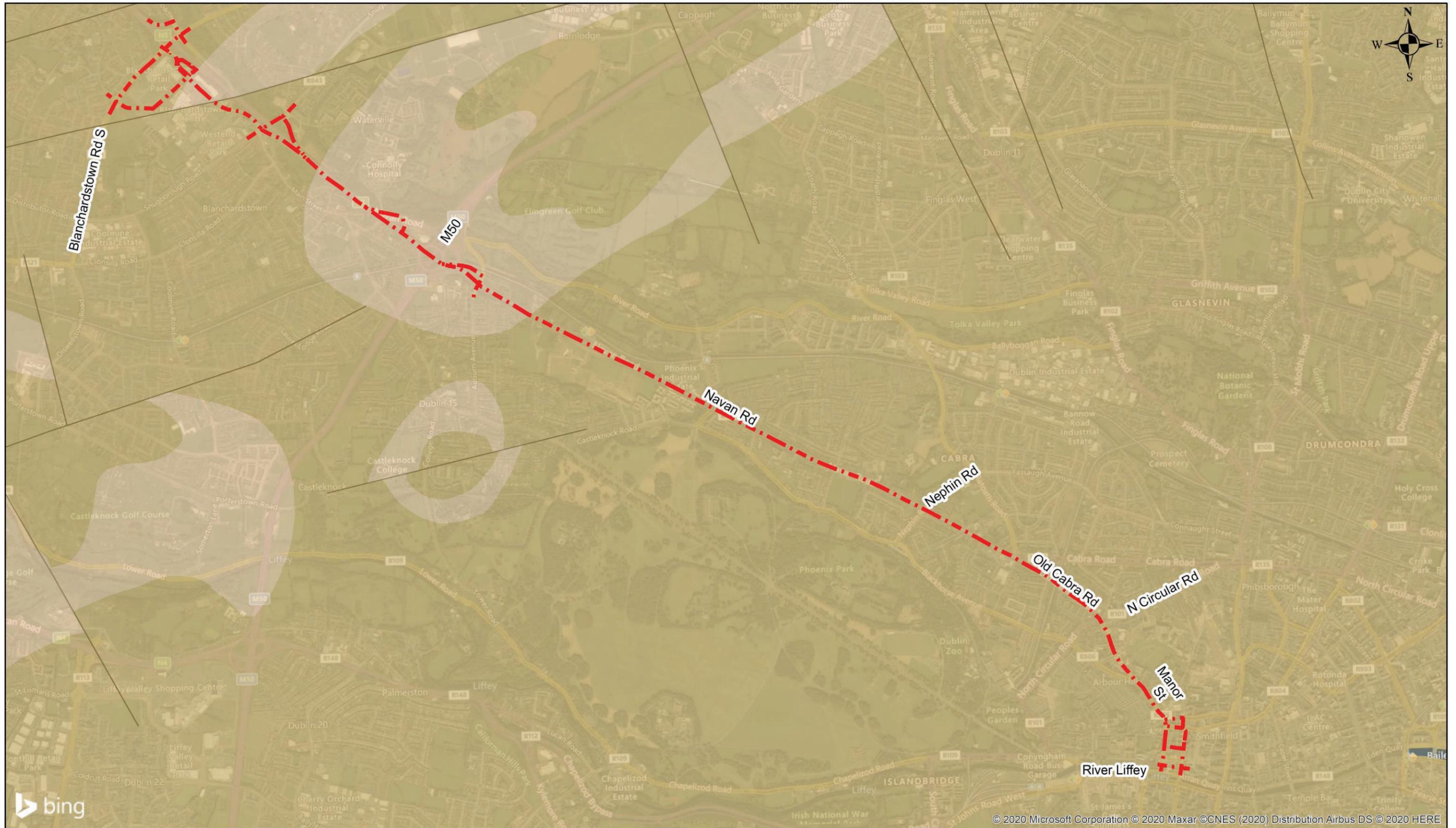
**GSI GeoUrban
Depth to Bedrock (Dublin County)**

268401

FIGURE A17

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Legend

- - - Alignment
- LI - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- PI - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Bedrock Aquifer Faults

ARUP

1:27,500



**Blanchardstown to City Centre
Core Bus Corridor**

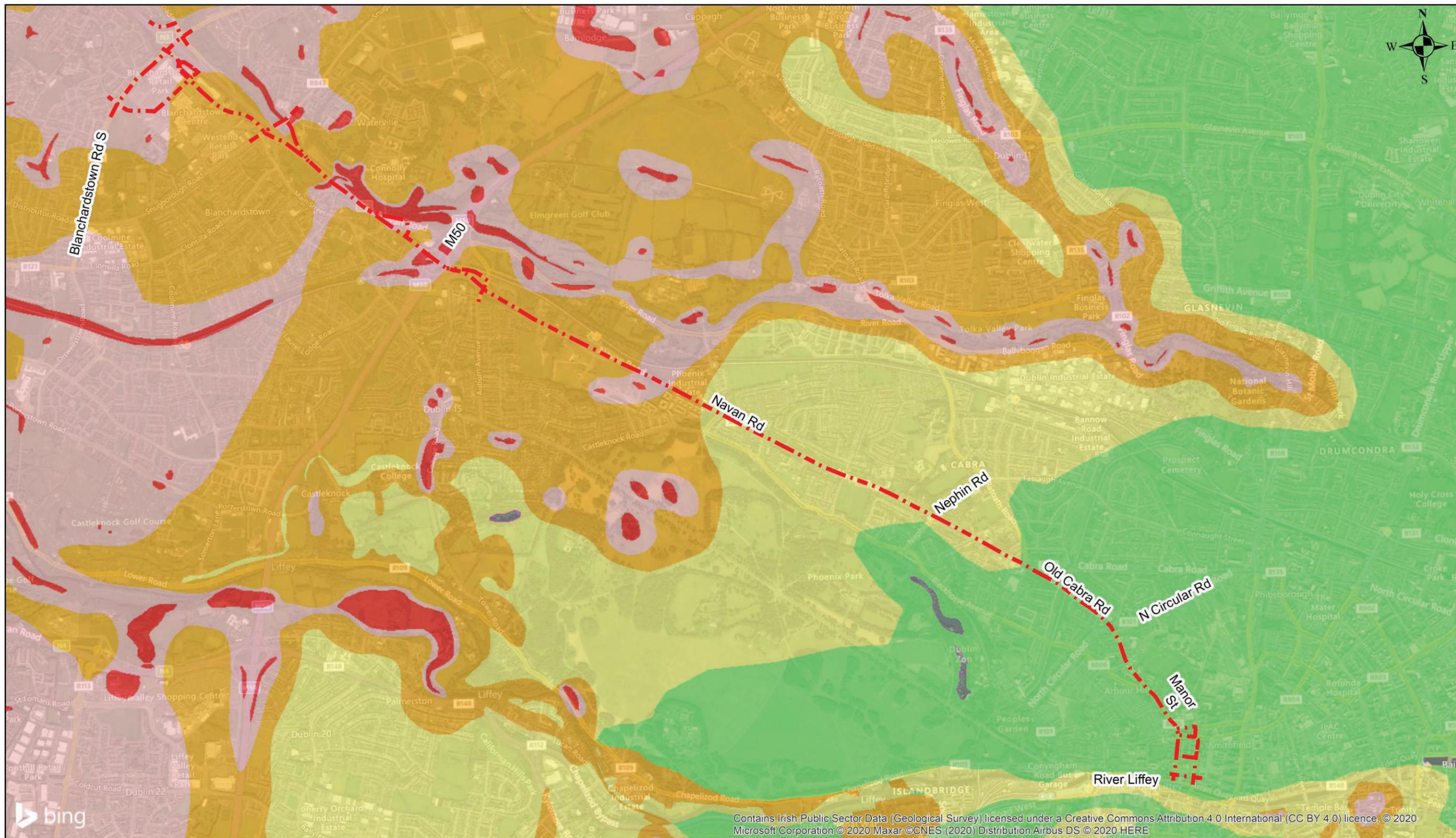
**GSI Groundwater
Aquifer**

268401

FIGURE A18

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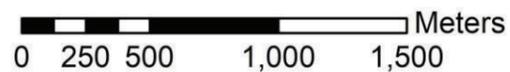
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Legend

- - - Alignment
- National Groundwater Vulnerability Ireland**
- █ Rock at or near Surface or Karst
- █ Extreme
- █ High
- █ Moderate
- █ Low
- █ Water



1:27,500



**Blanchardstown to City Centre
Core Bus Corridor
GSI Groundwater
Vulnerability**

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FIGURE **A19**

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Legend

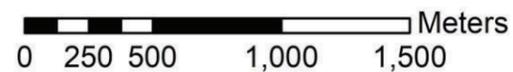
- - - Alignment
- Groundwater Wells and Springs

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**Blanchardstown to City Centre
Core Bus Corridor
GSI GW Wells
& Springs**

ARUP

1:27,500



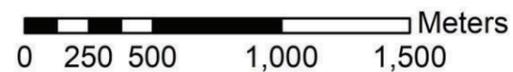
268401

FIGURE A20



Legend

- - - Alignment
- River Network and River Flow Direction Arrows
- Lake Segments
- Estimated Historic Rivers and Streams



1:27,500

**Blanchardstown to City Centre
Core Bus Corridor**
Rivers of Dublin &
EPA Waterbodies

268401

FIGURE A21

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Legend

- - - Alignment
- National Groundwater Recharge Ireland**
- Annual Recharge (mm)**
- 1401-2000 mm
- 1001-1400 mm
- 901-1000 mm
- 801-900 mm
- 701-800 mm
- 601-700 mm

- 551-600 mm
- 501-550 mm
- 451-500 mm
- 401-450 mm
- 351-400 mm
- 301-350 mm
- 251-300 mm
- 201-250 mm
- 151-200 mm
- 101-150 mm
- 51-100 mm
- 1-50 mm
- 0 mm
- Water



**Blanchardstown to City Centre
Core Bus Corridor
Groundwater Recharge**

268401

FIGURE A22

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bing

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Legend

- - - Alignment
- Subsoil Permeability**
- High
- Medium
- Low
- Water
- Not mapped

ARUP

1:27,500



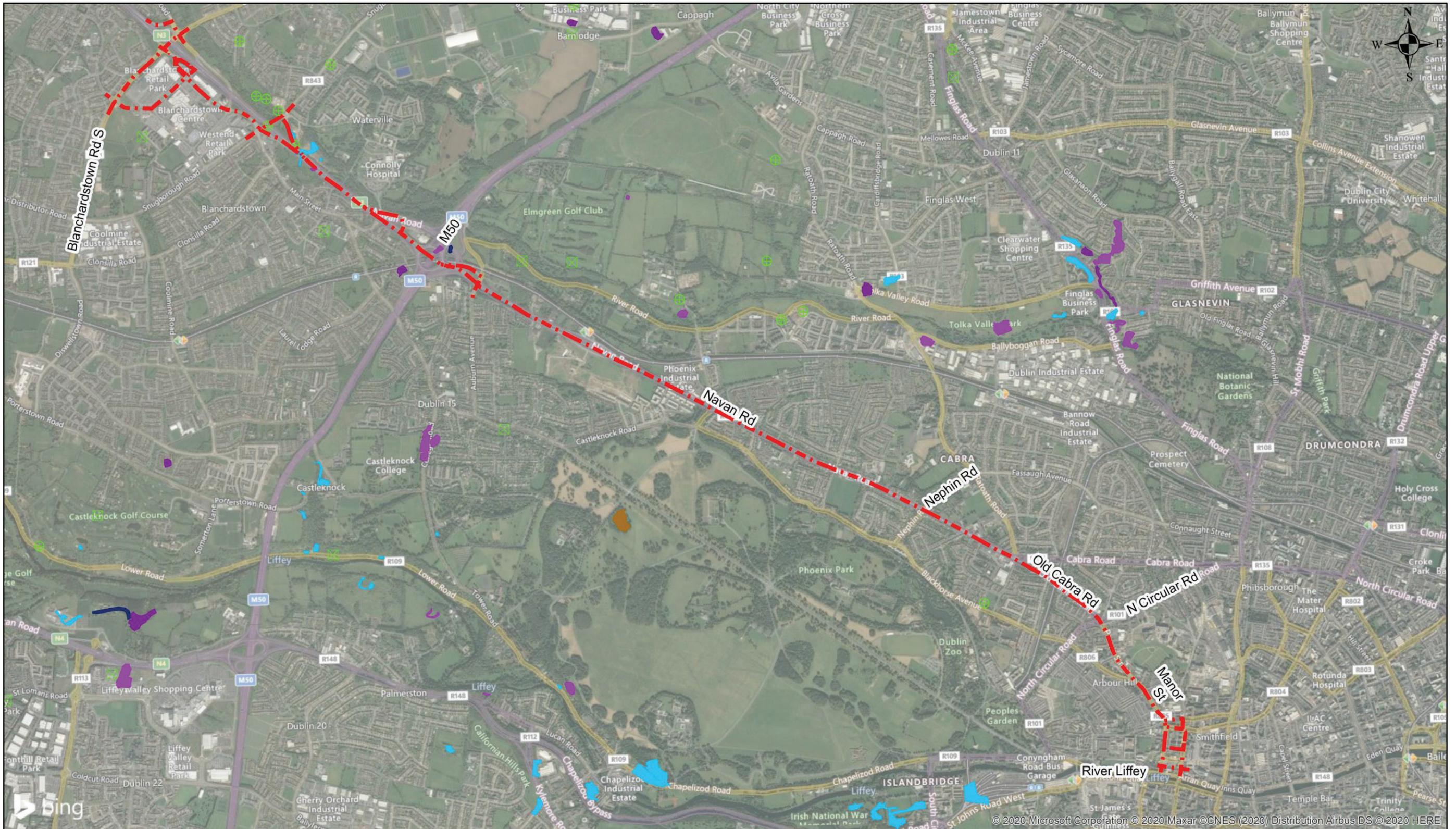
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Blanchardstown to City Centre Core Bus Corridor

Subsoil Permeability

268401

FIGURE **A23**

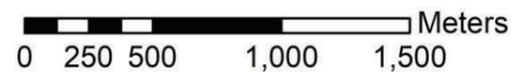


Legend

- - - Alignment
- ⊕ Pit
- ⊗ Quarry
- Early to Mid-20thC: Pits
- Mid-19thC: Pits
- Mid-20thC: Quarries
- Early to Mid-20thC: Quarries
- Mid-19thC: Quarries

ARUP

1:27,500



**Blanchardstown to City Centre
Core Bus Corridor**

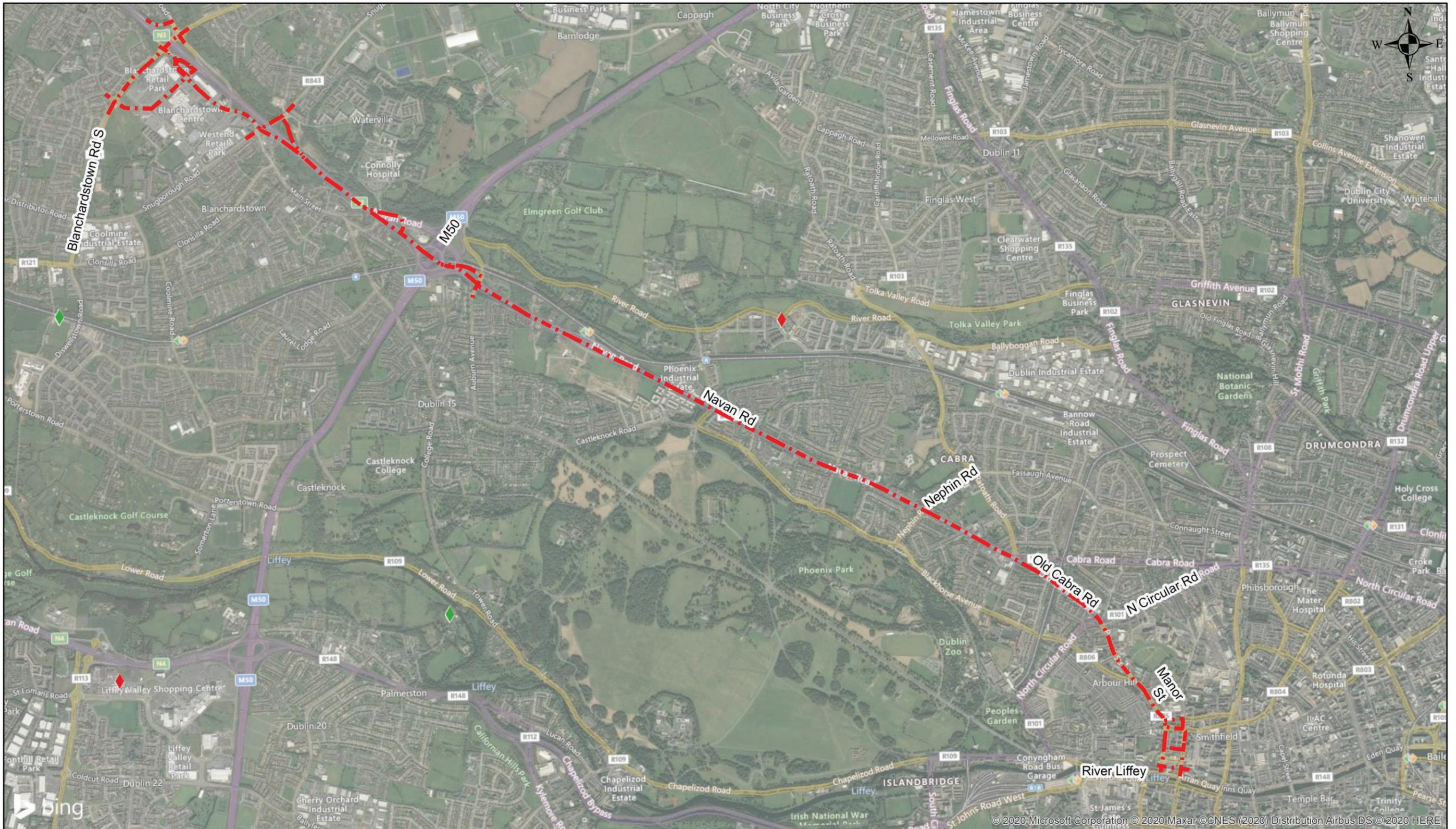
**GSI Active and Historic
Pits & Quarries**

268401

FIGURE A24

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Legend

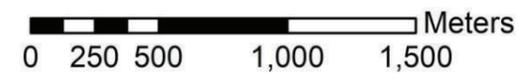
- · — · Alignment
- ◆ Metallic
- ◆ Non-metallic

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**Blanchardstown to City Centre
Core Bus Corridor
GSI Mineral
Localities**

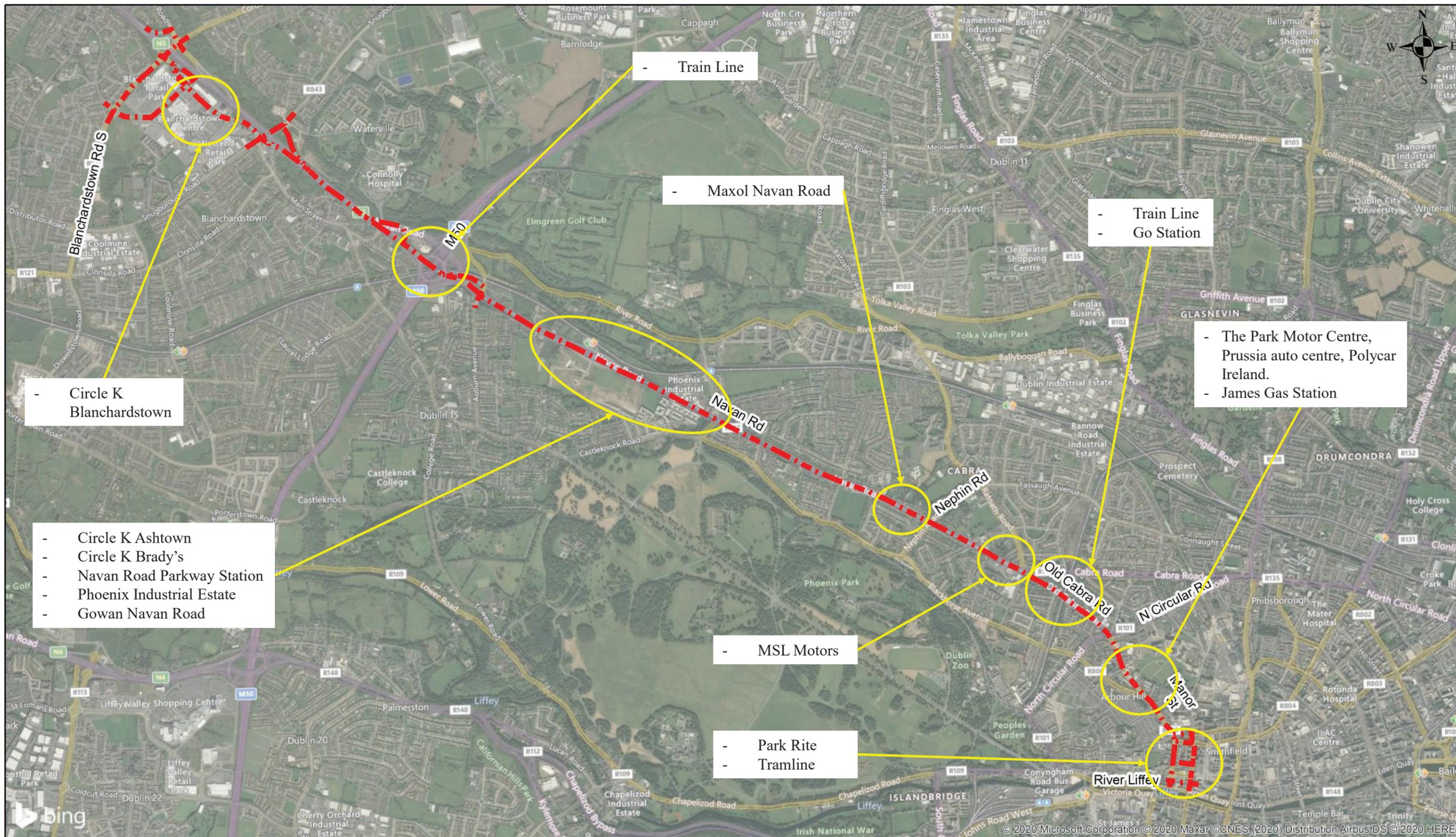
ARUP

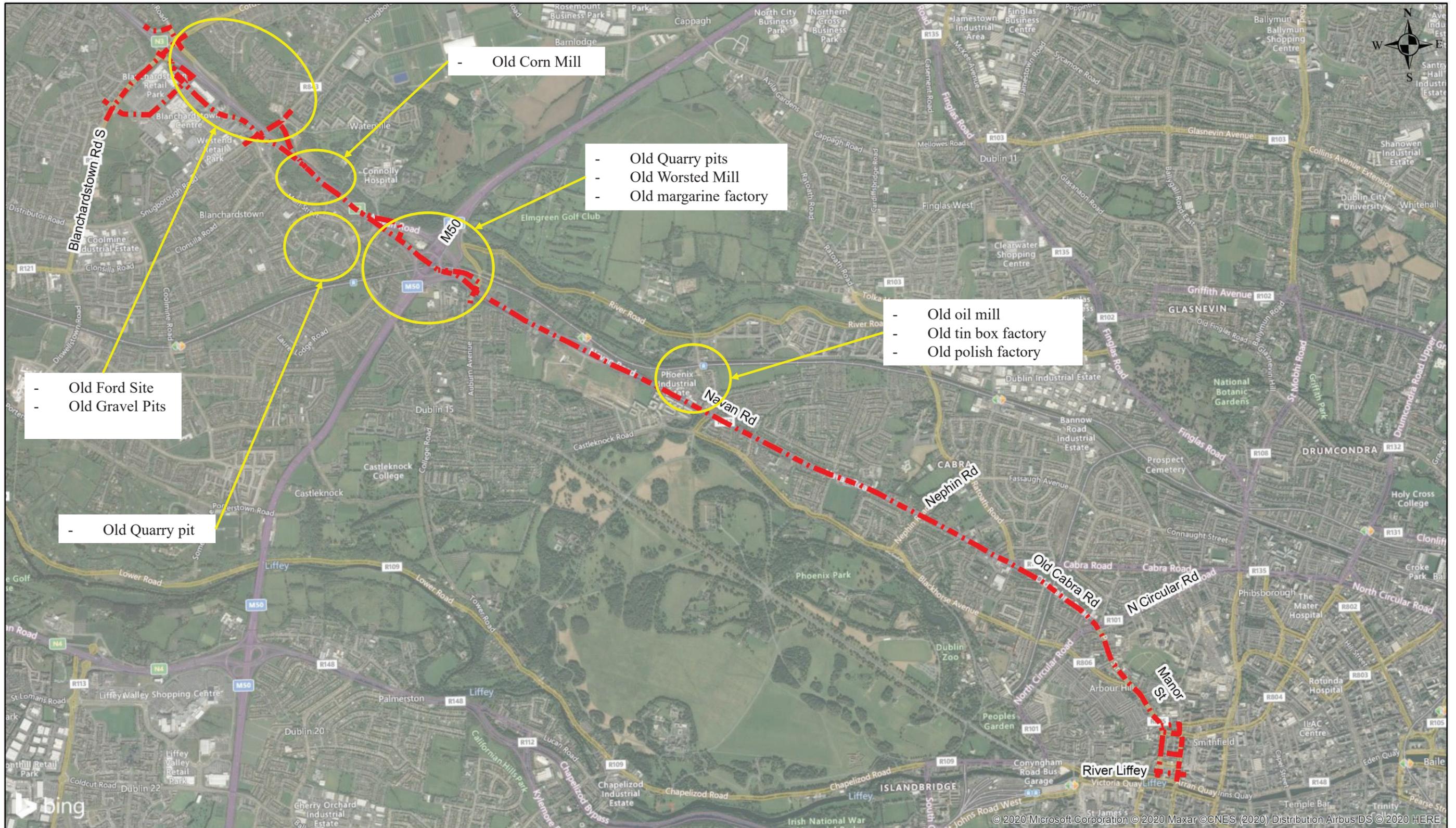
1:27,500



268401

FIGURE A25

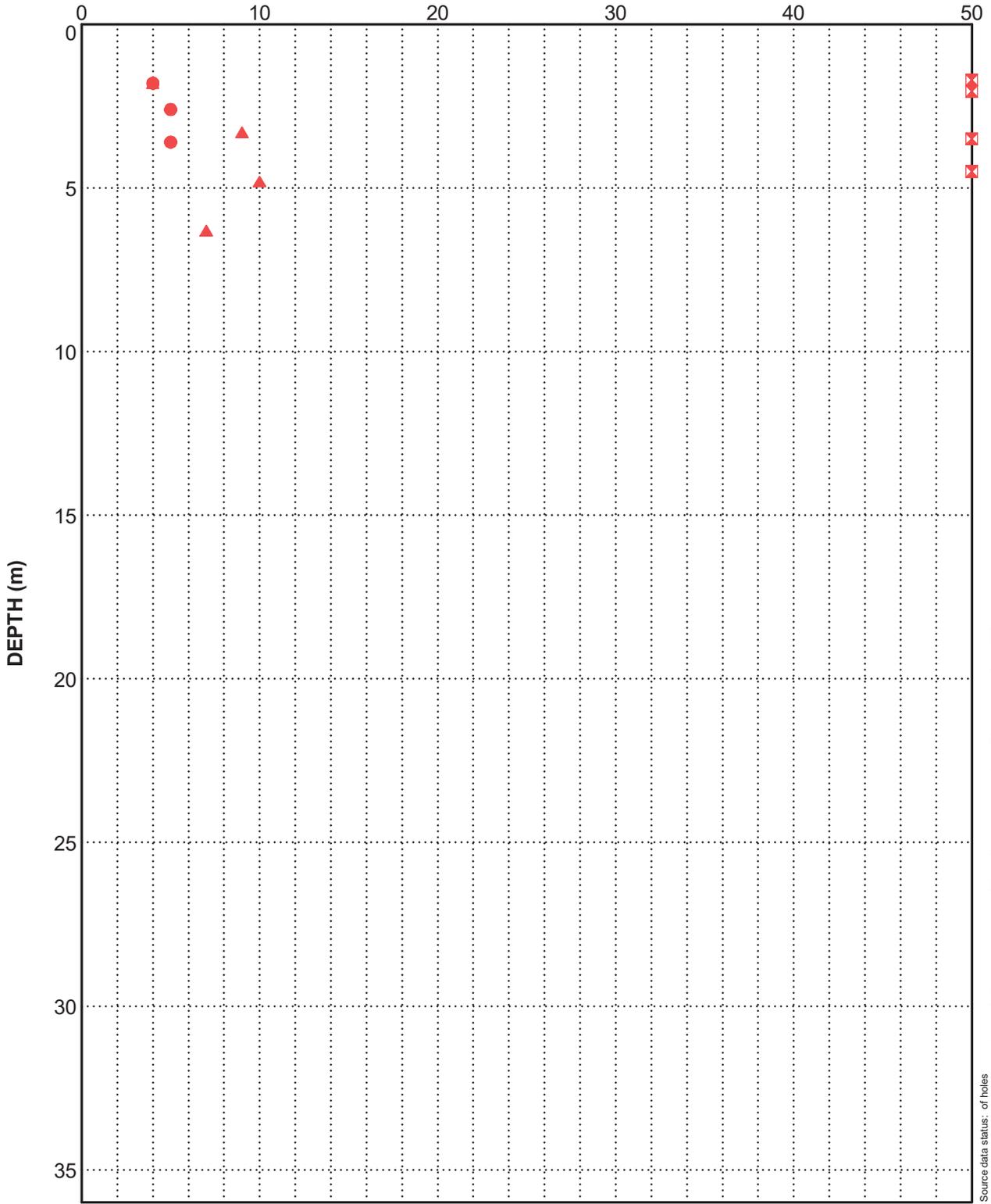




Appendix B

In-Situ Testing Figures

SPT N VALUE* (blows/300mm)



* correction for overburden pressure applied to all data on this plot

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R05-CP01
- R05-CP03
- R2161/B81466
- Made Ground
- Rock
- Granular Deposits

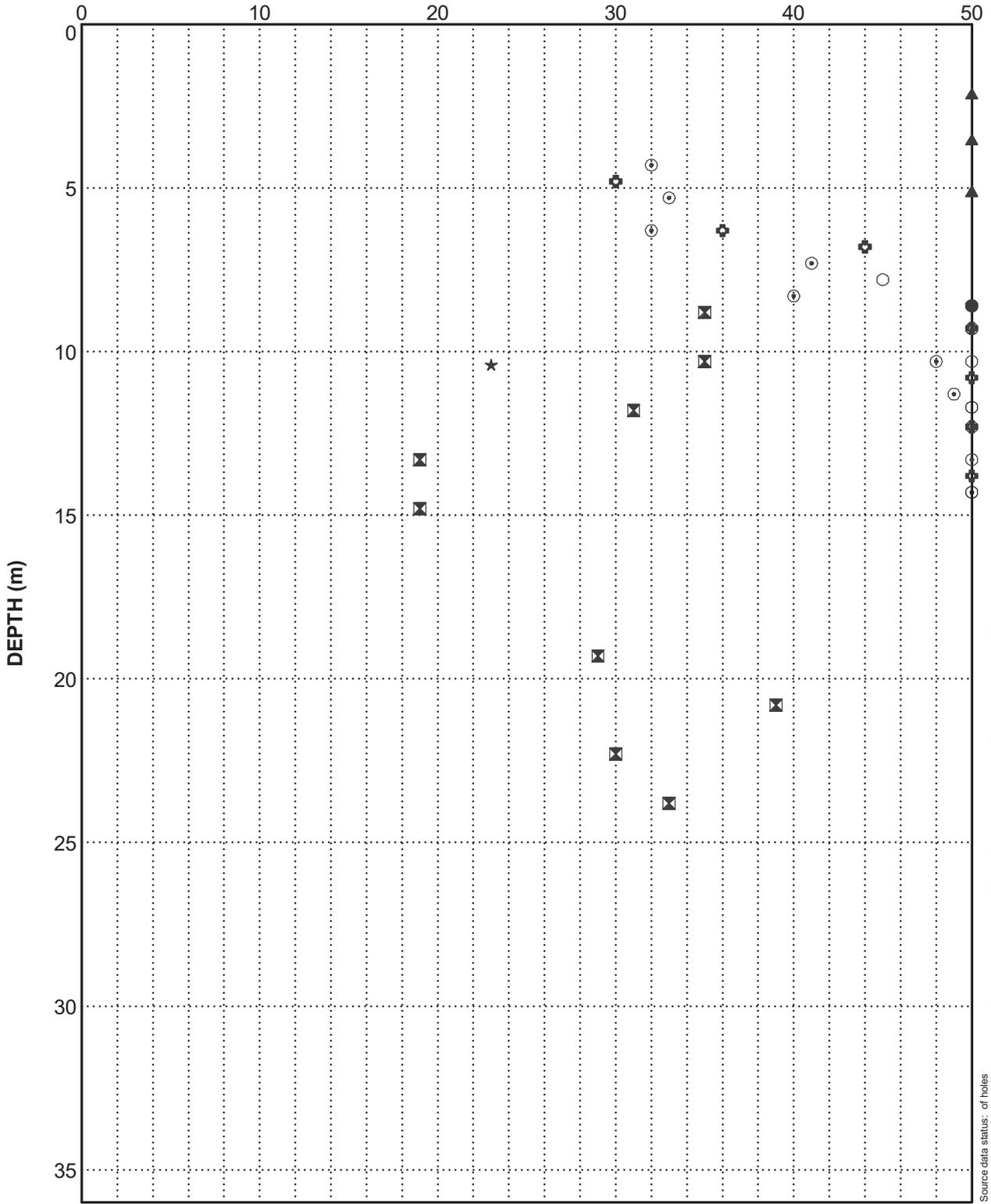
Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 67% of holes

gINT v10.00.01.07 Licenced to Arup
 Project : c:\users\ezgur.alper\desktop\job_sherlock\arup\job_268401-00_bus_connects\gint\05\02_gint\05.gpj (Template : 3.0); Library : \\global\europa\dublin\jobs2_civils\ground engineering\1.0 technical\personal folders\ozgur.alper\gint\arup_uklib_3-0-002-8.gpj
 gINT output page 1 of 1. Made 28Jun21 20:22

**Bus Connect
 STANDARD PENETRATION TESTS
 Blanchardstown to City Centre Core
 Bus Corridor
 Made Ground
 268401-00**

FIGURE B01

SPT N VALUE* (blows/300mm)



* correction for overburden pressure applied to all data on this plot

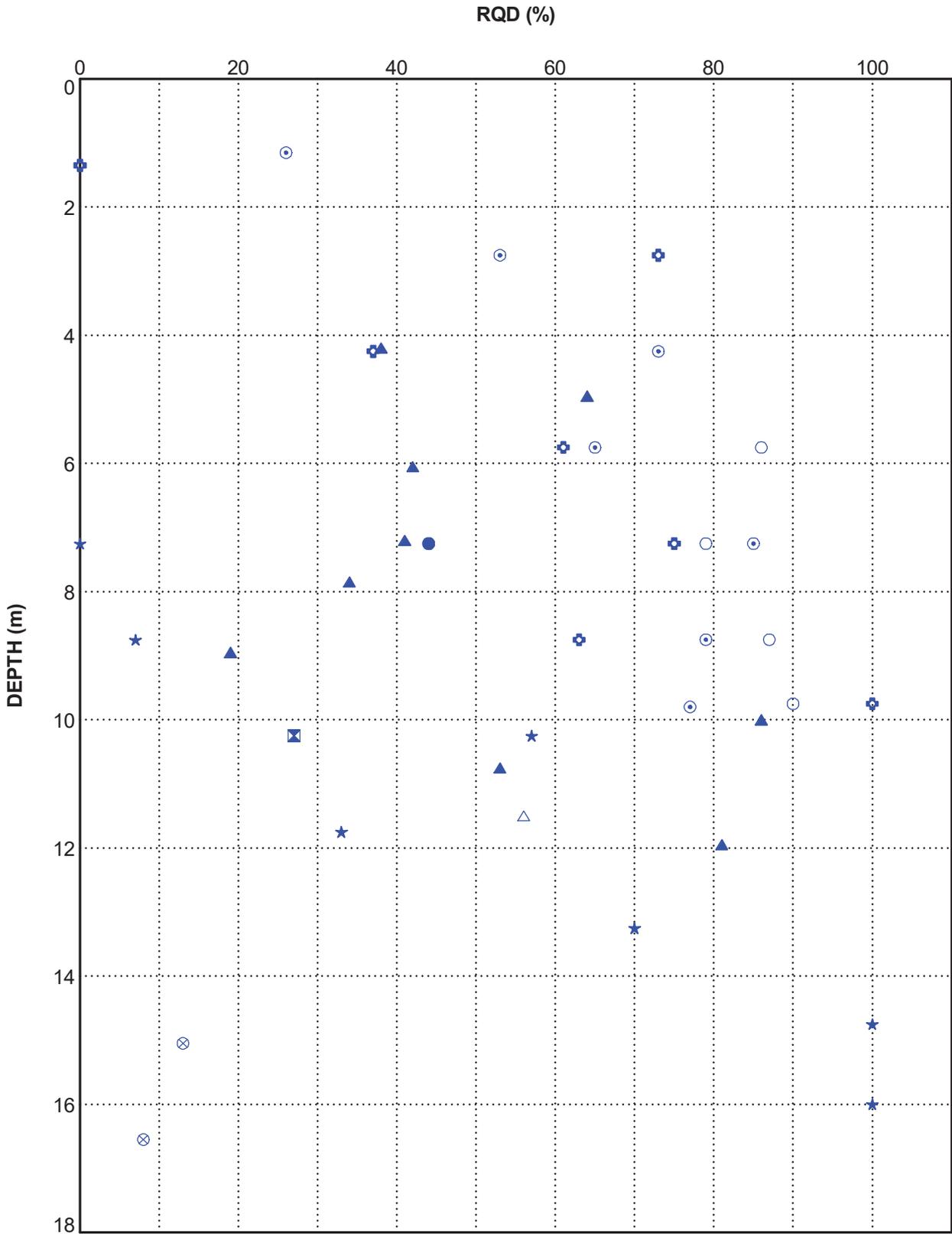
Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 57% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R05-CP03
- ⊗ R05-CP05
- ▲ R05-RC01
- ★ R05-RC07
- ⊙ R2158/B81329
- ⊕ R2158/B81330
- R2161/B81466
- Made Ground
- Rock
- Granular Deposits

**Bus Connect
 STANDARD PENETRATION TESTS
 Blanchardstown to City Centre Core
 Bus Corridor
 Granular Deposits
 268401-00**

FIGURE B04

gINT v10.00.01.07 Licensed to Arup
 Project : c:\users\ozgur.alper\desktop\busall_routes_sgs3.gpj (Template : 3.0); Library : \\global\europelublin\obs2_civils\ground engineering\1.0 technical\personal folders\ozgur.alper\gint\arup_uklib_3-0-002-8.glb
 Graph : 3.4.32.D - RQD (m) (1 of 1) (1 of 1)
 gINT output page 1 of 1. Made 28/05/21 00:24



Source data status: of holes
 Database check status: Full check (A) = 0%; Partial/selective check (B) = 0%; Minimum check (C) = 0%; Unchecked (U) = 100% of holes
 Primary filters: ([POINT].[HOLE_CLST] = 'R05')
 Range filters: Include Top; [GEOI].[Depth]; [GEOI].[GEOI_BASE]; [GEOI].[GEOI_GEOI]; [GEOI].[GEOI_GEOI] = 'RcX'

- Topsoil
- Rock
- Granular Deposits
- Made Ground
- Cohesive Deposits
- R05-CP01
- ⊠ R05-CP03
- ▲ R05-CP04
- ★ R05-RC01
- ⊙ R05-RC03
- ⊕ R05-RC04
- R05-RC05
- △ R05-RC06
- ⊗ R05-RC07

**Bus Connect
 ROCK QUALITY DESIGNATION
 Blanchardstown to City Centre Core
 Bus Corridor**

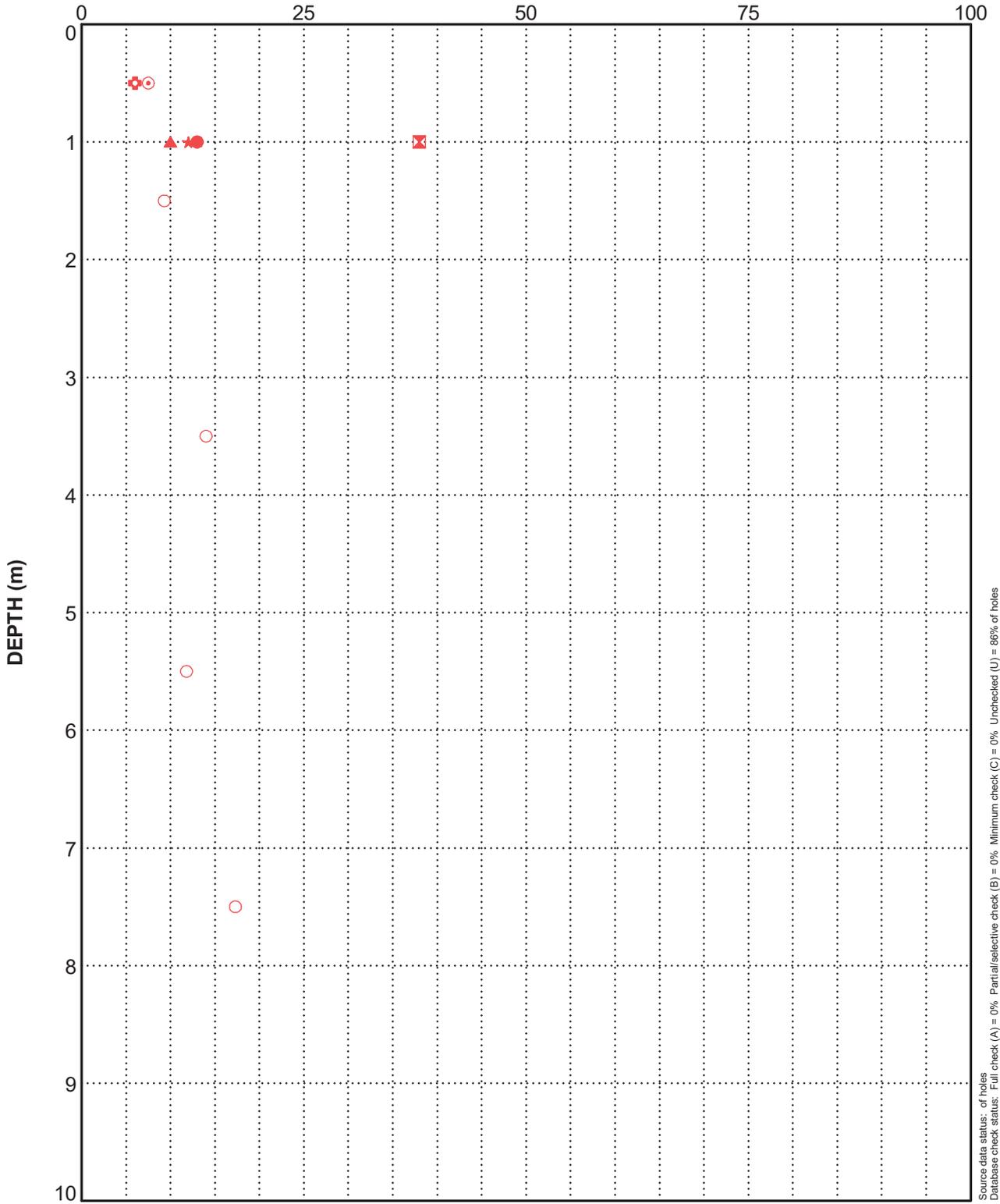
268401-00

FIGURE **B05**

Appendix C

Laboratory Testing Figures

MOISTURE CONTENT (%)



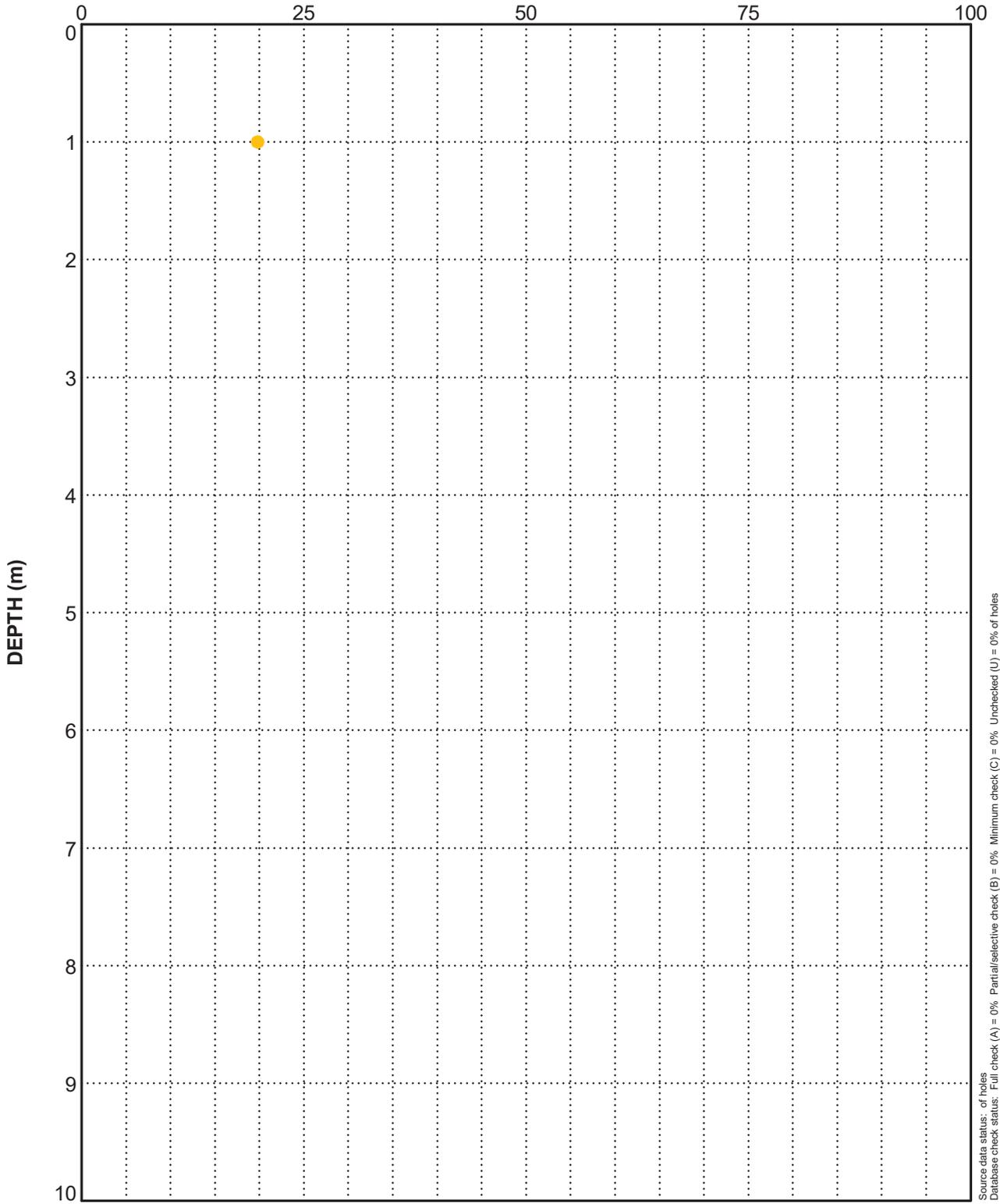
Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 86% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- Made Ground
- Rock
- Granular Deposits
- R05-TP01
- ⊠ R05-TP05
- ▲ R05-TP06
- ★ R05-TP07B
- ⊙ R05-TP08A
- ⊕ R05-TP09
- R5614/B135148

**Bus Connect
 MOISTURE CONTENT
 Blanchardstown to City Centre Core
 Bus Corridor
 Made Ground**

FIGURE C01

MOISTURE CONTENT (%)



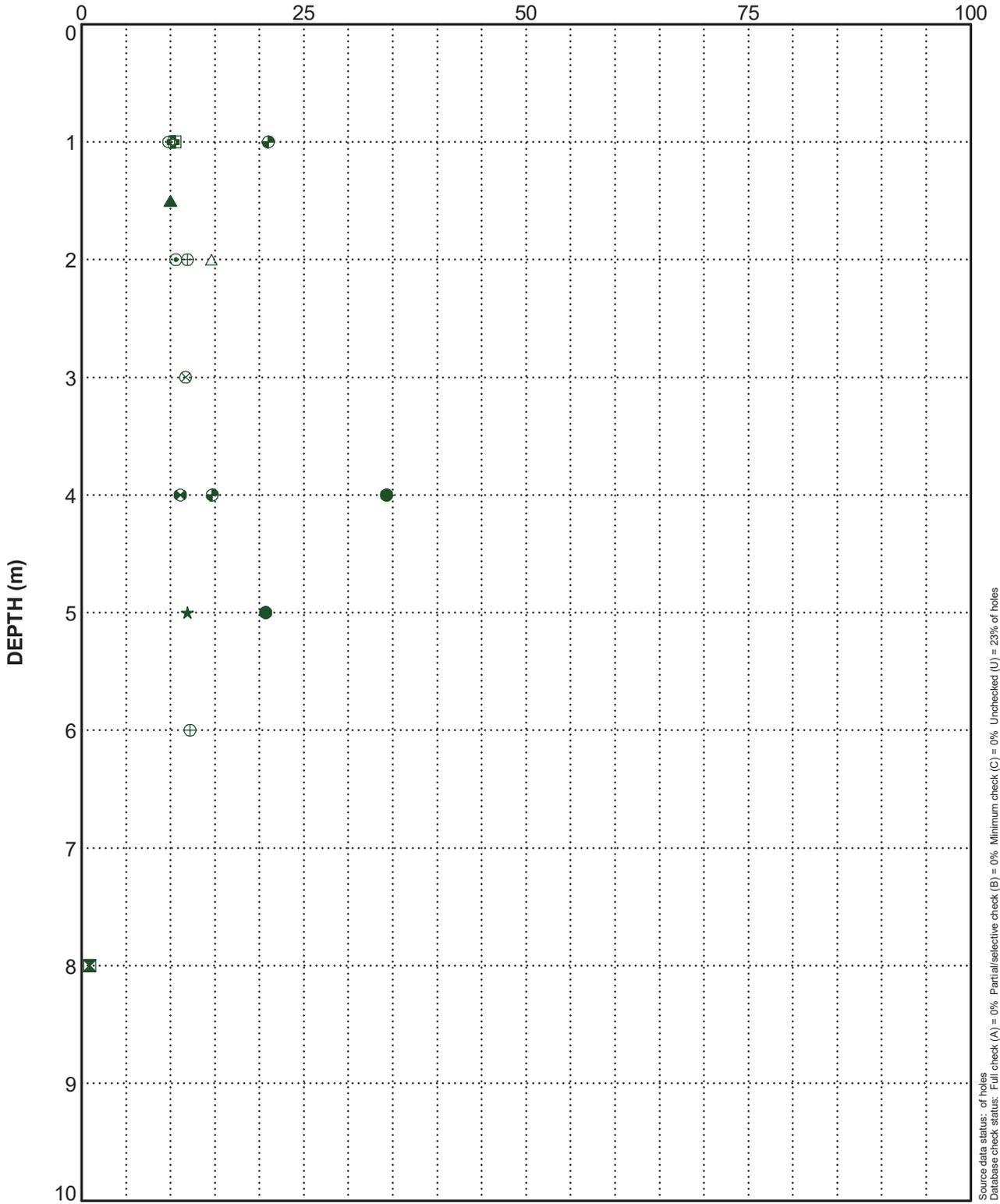
Source data status: of holes
Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 0% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R5619/B135218
- Made Ground
- Rock
- Granular Deposits

Bus Connect
MOISTURE CONTENT
Blanchardstown to City Centre Core
Bus Corridor
Alluvium

FIGURE C02

MOISTURE CONTENT (%)



Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Undchecked (U) = 23% of holes

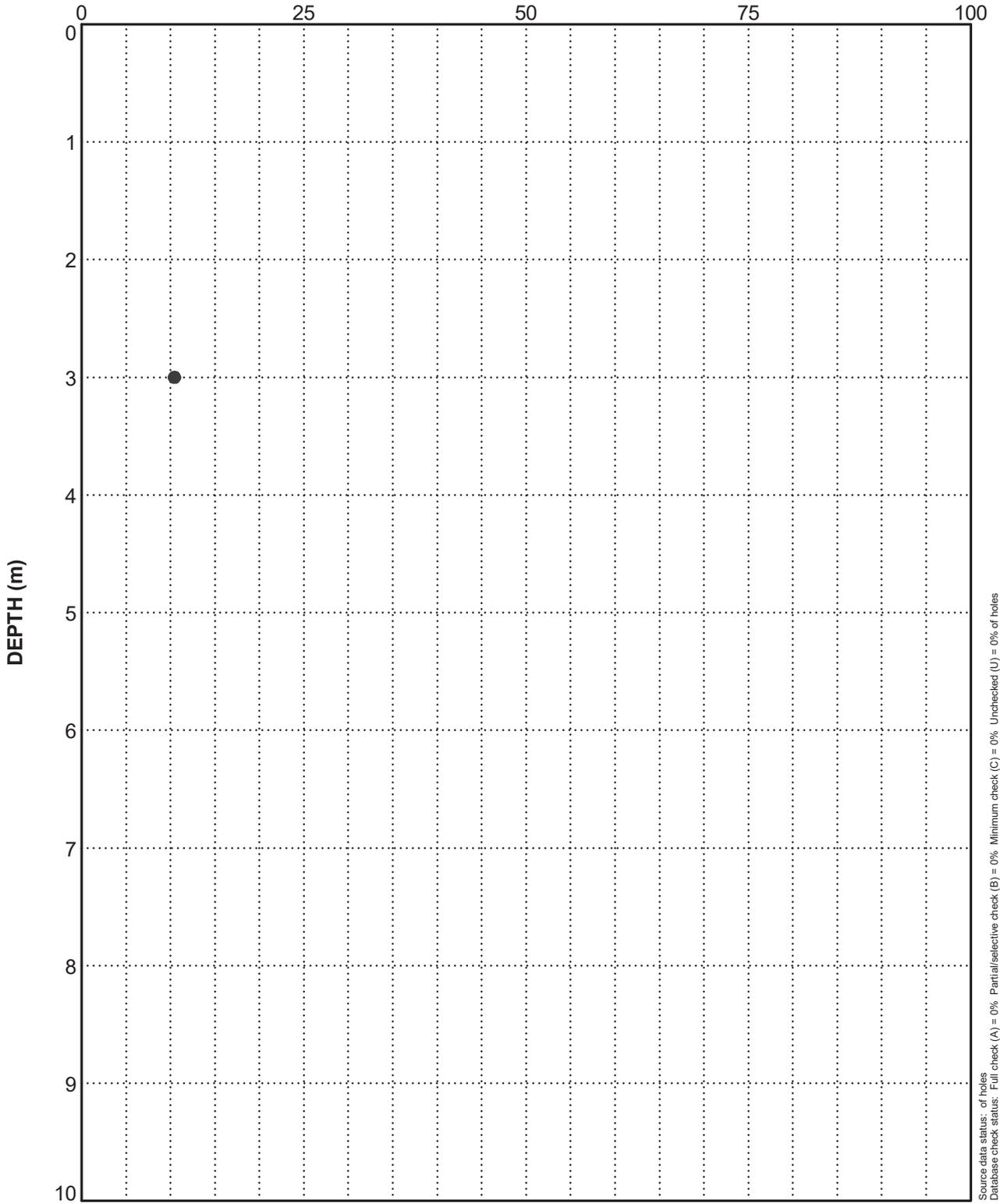
- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R05-CP01
- ⊗ R05-RC06
- ▲ R05-TP08A
- ★ R3919/B118005
- ⊕ R5619/B135217
- ⊕ R5619/B135219
- R5619/B135220
- △ R6617/B143943
- ⊗ R6617/B143944
- ⊕ R6617/B143945
- R6617/B143946
- Made Ground
- Rock
- Granular Deposits
- ⊗ R6617/B143947
- ⊕ R6617/B143948

**Bus Connect
 MOISTURE CONTENT
 Blanchardstown to City Centre Core
 Bus Corridor
 Glacial Till Deposits**

FIGURE C03

268401-00

MOISTURE CONTENT (%)



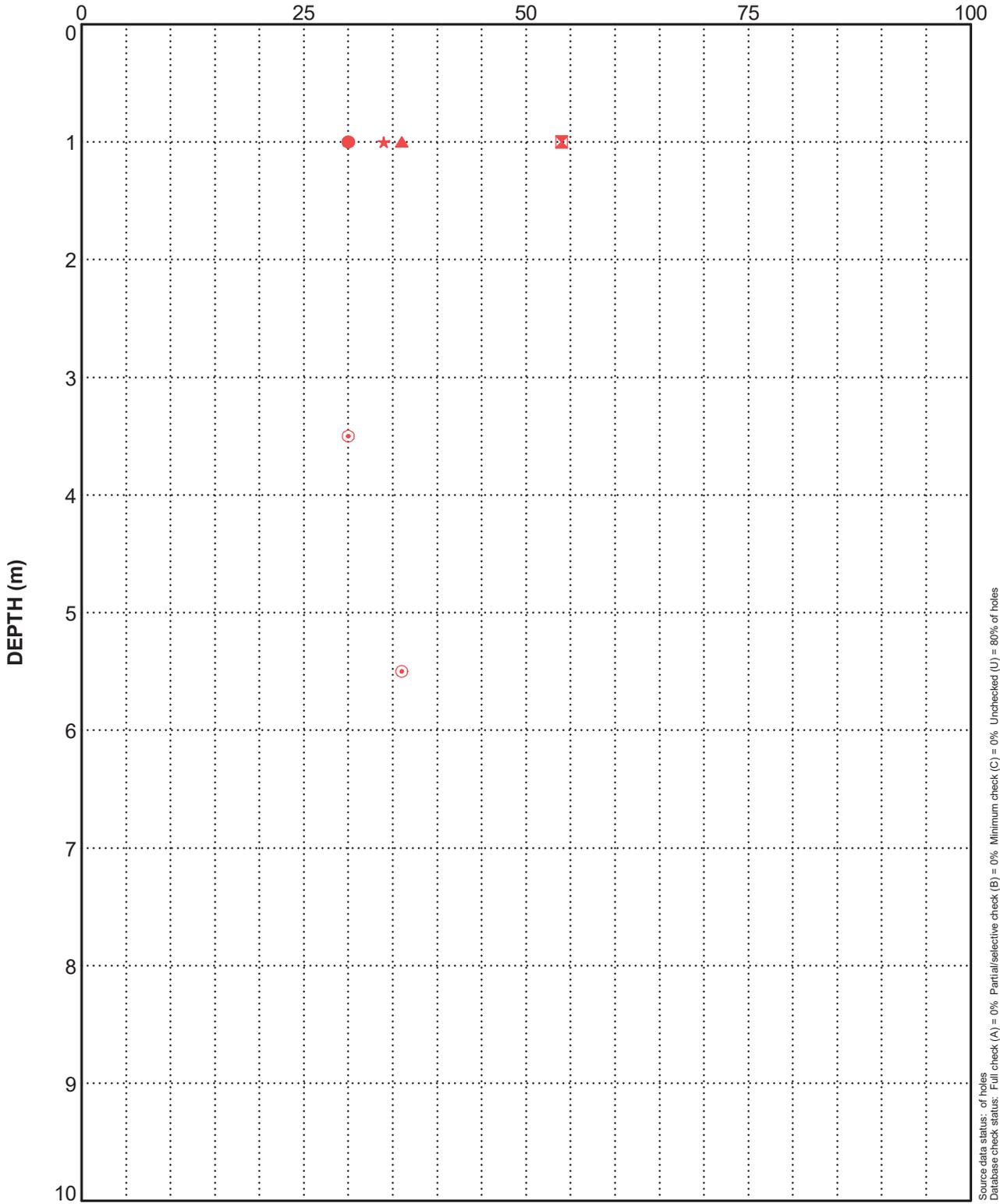
Source data status: of holes
Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 0% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R3919/B118003
- Made Ground
- Rock
- Granular Deposits

Bus Connect MOISTURE CONTENT Blanchardstown to City Centre Core Bus Corridor Granular Deposits

FIGURE C04

LIQUID LIMIT (%)



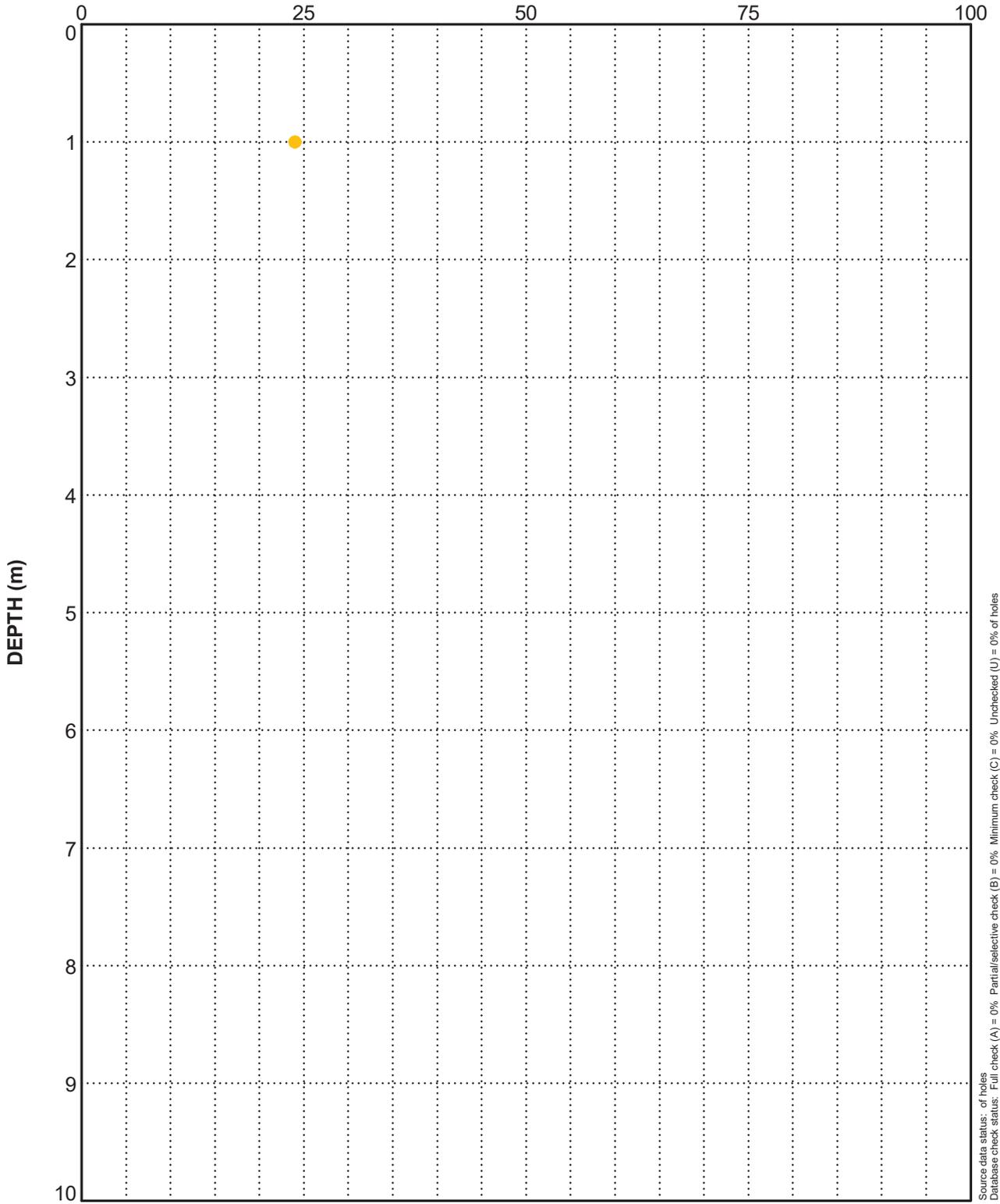
Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 80% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R05-TP01
- ⊗ R05-TP05
- ▲ R05-TP06
- ★ R05-TP07B
- ⊙ R5614/B135148
- Made Ground
- Rock
- Granular Deposits

**Bus Connect
 LIQUID LIMIT
 Blanchardstown to City Centre Core
 Bus Corridor
 Made
 Ground**

FIGURE C05

LIQUID LIMIT (%)



Source data status: of holes
Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 0% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R5619/B135218
- Made Ground
- Rock
- Granular Deposits

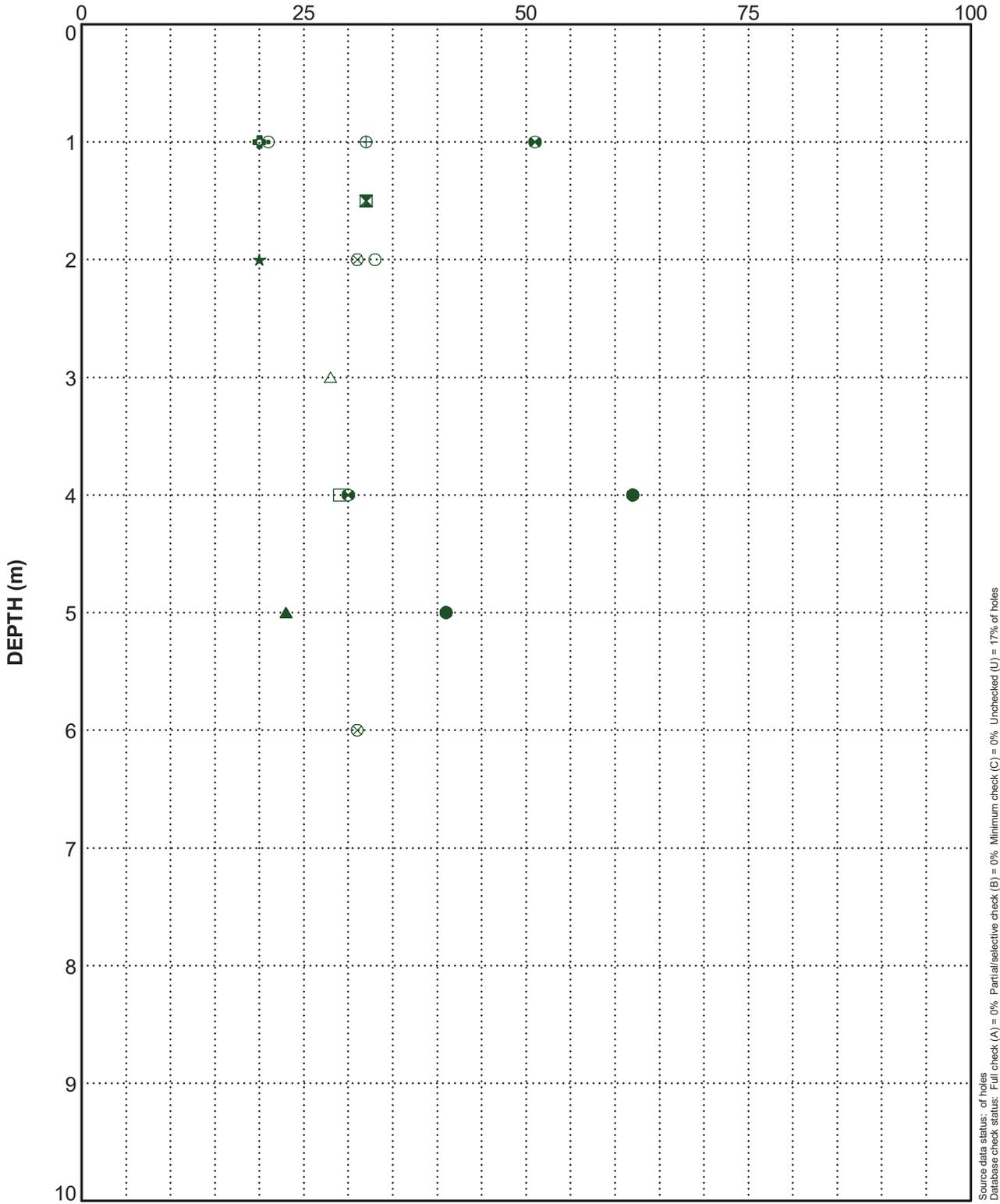
gINT v10.00.01.07 Licenced to Arup
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gINT output page 1 of 1. Macro 28Jun21 20:39

Bus Connect
LIQUID LIMIT
Blanchardstown to City Centre Core
Bus Corridor
Alluvium

FIGURE C06

268401-00

LIQUID LIMIT (%)



Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 17% of holes

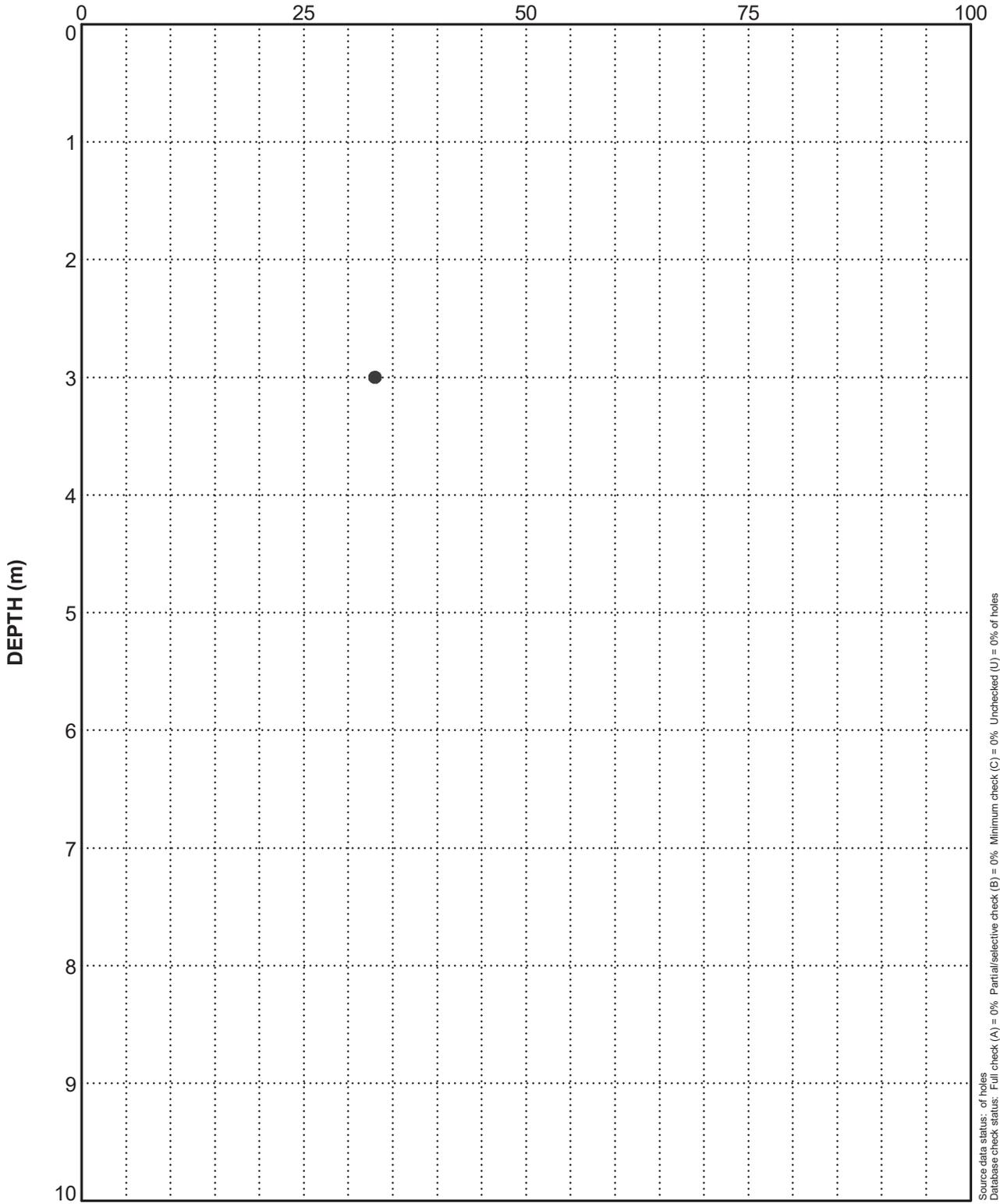
- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- Made Ground
- Rock
- Granular Deposits
- R05-CP01
- ⊗ R6617/B143948
- ⊠ R05-TP08A
- ▲ R3919/B118005
- ★ R5619/B135217
- ⊙ R5619/B135219
- ⊕ R5619/B135220
- R6617/B143943
- △ R6617/B143944
- ⊗ R6617/B143945
- ⊕ R6617/B143946
- R6617/B143947

**Bus Connect
 LIQUID LIMIT
 Blanchardstown to City Centre Core
 Bus Corridor
 Glacial Till Deposits**

FIGURE C07

268401-00

LIQUID LIMIT (%)



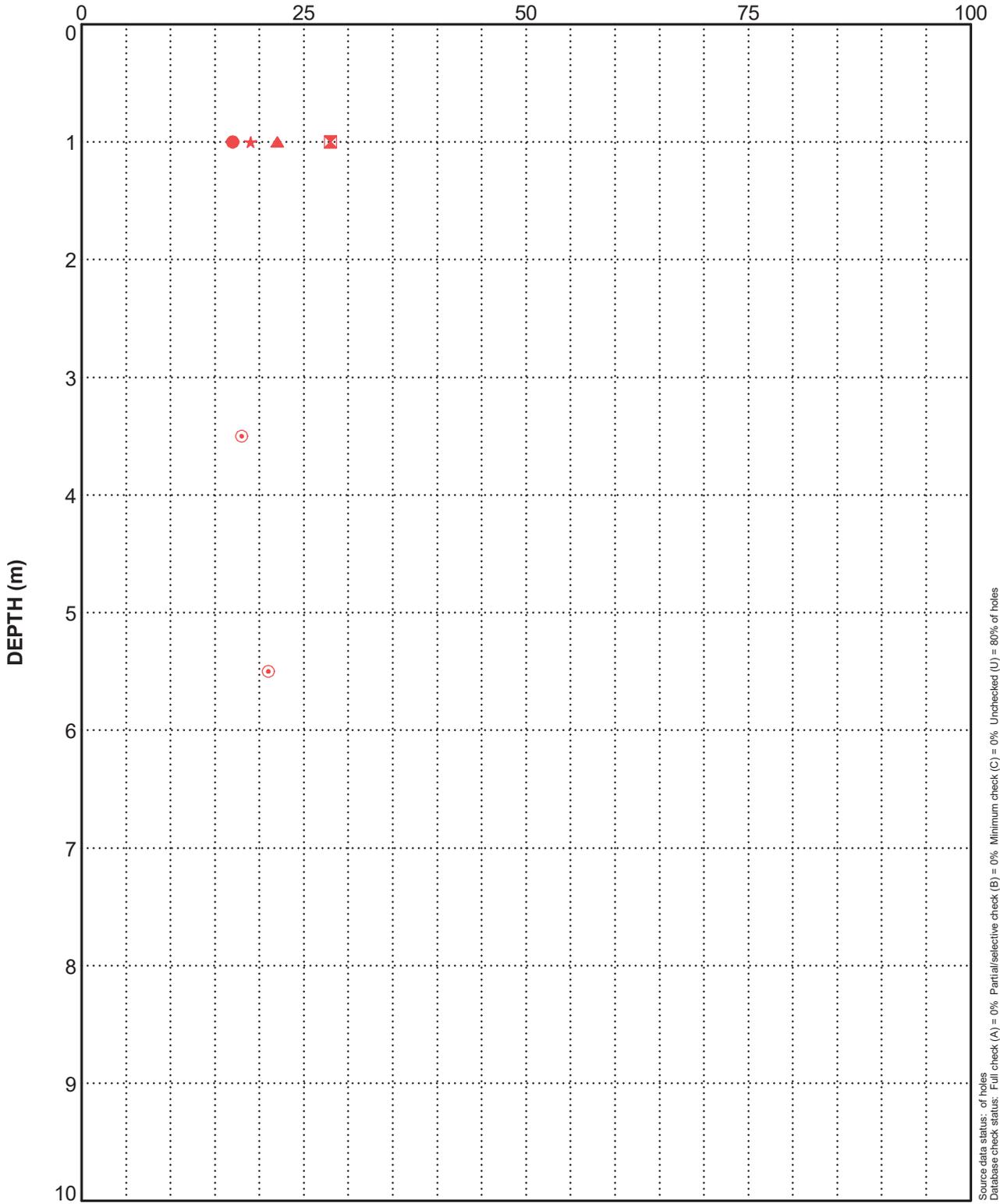
Source data status: of holes
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- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R3919/B118003
- Made Ground
- Rock
- Granular Deposits

**Bus Connect
LIQUID LIMIT
Blanchardstown to City Centre Core
Bus Corridor
Granular Deposits**

FIGURE C08

PLASTIC LIMIT (%)



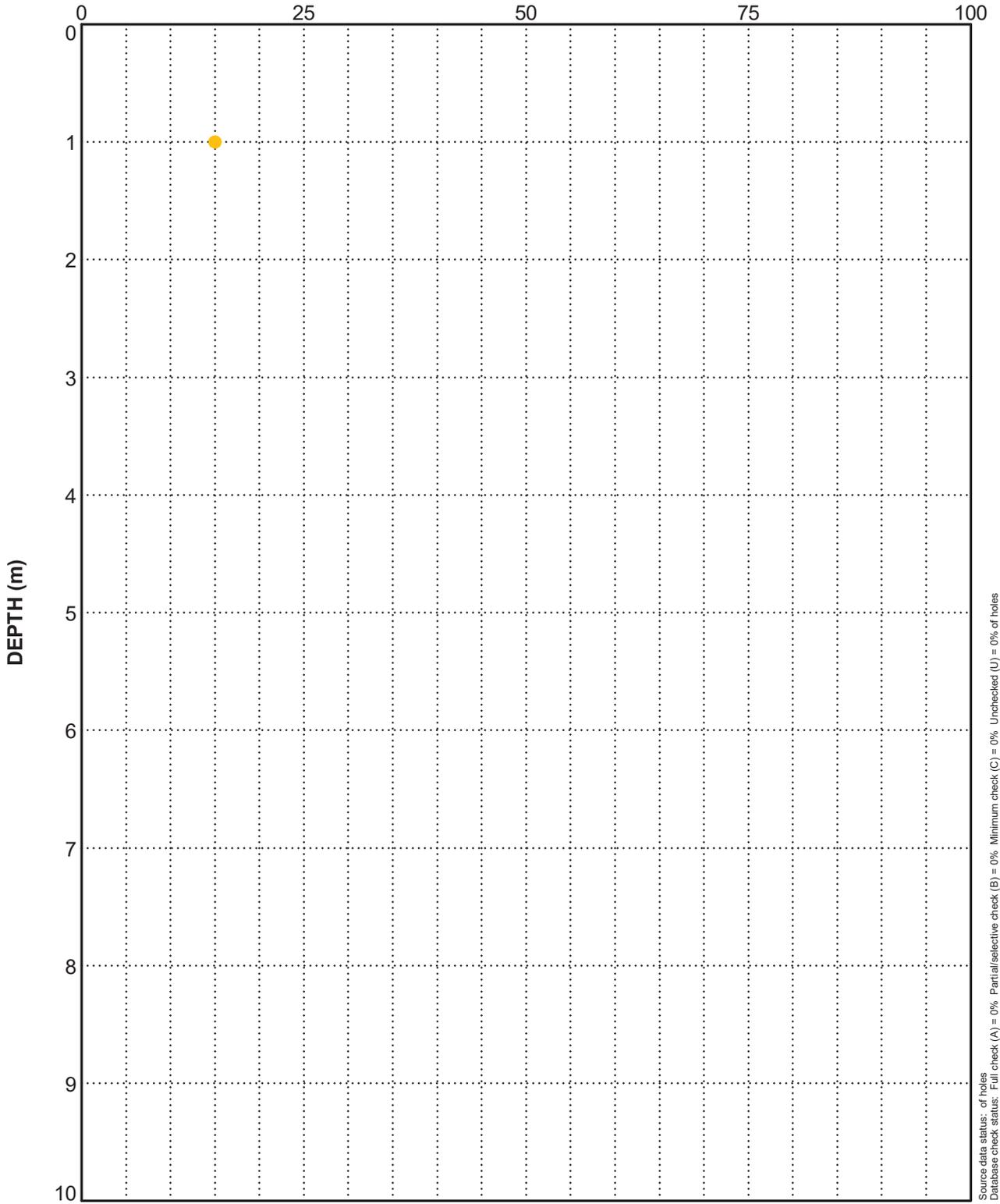
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- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R05-TP01
- ⊠ R05-TP05
- ▲ R05-TP06
- ★ R05-TP07B
- ⊙ R5614/B135148
- Made Ground
- Rock
- Granular Deposits

**Bus Connect
 PLASTIC LIMIT
 Blanchardstown to City Centre Core
 Bus Corridor
 Made Ground**

FIGURE C09

PLASTIC LIMIT (%)



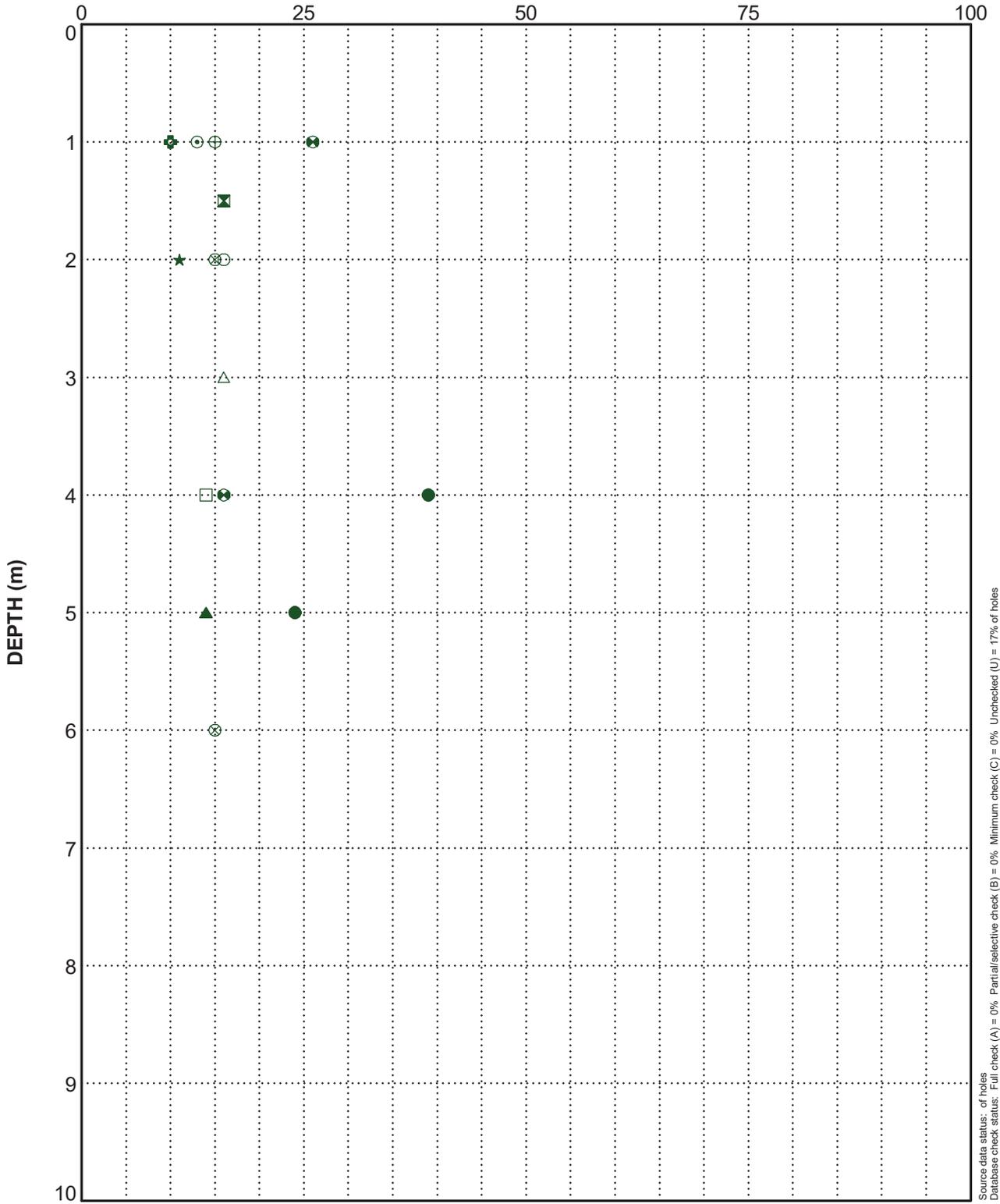
Source data status: of holes
Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 0% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R5619/B135218
- Made Ground
- Rock
- Granular Deposits

**Bus Connect
PLASTIC LIMIT
Blanchardstown to City Centre Core
Bus Corridor
Alluvium**

FIGURE C10

PLASTIC LIMIT (%)



Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Undchecked (U) = 17% of holes

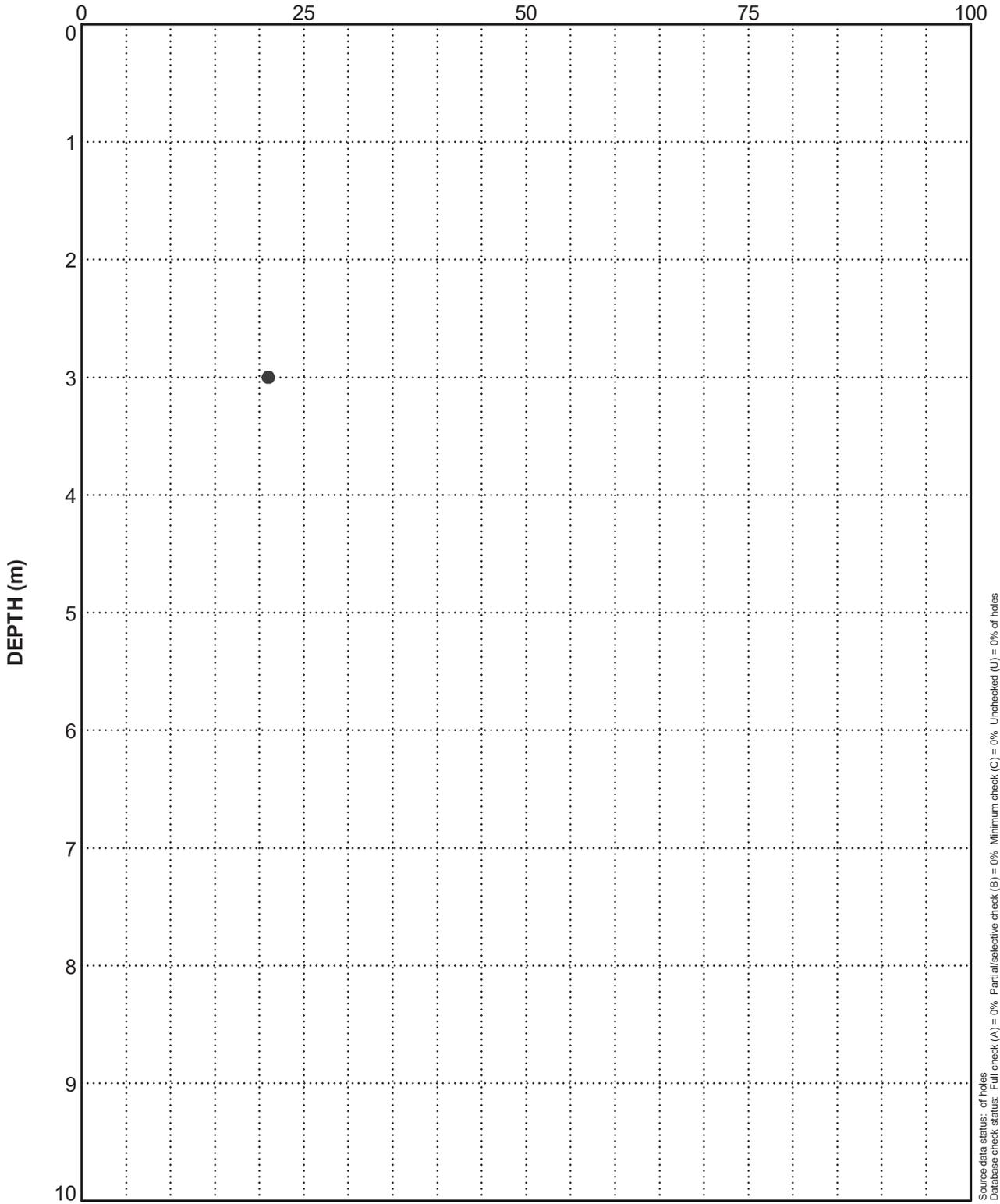
- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R05-CP01
- ⊗ R05-TP08A
- ▲ R3919/B118005
- ★ R5619/B135217
- ⊙ R5619/B135219
- ⊕ R5619/B135220
- R6617/B143943
- △ R6617/B143944
- ⊗ R6617/B143945
- ⊕ R6617/B143946
- R6617/B143947
- Made Ground
- Rock
- Granular Deposits
- ⊗ R6617/B143948

**Bus Connect
 PLASTIC LIMIT
 Blanchardstown to City Centre Core
 Bus Corridor
 Glacial Till Deposits**

FIGURE C11

268401-00

PLASTIC LIMIT (%)

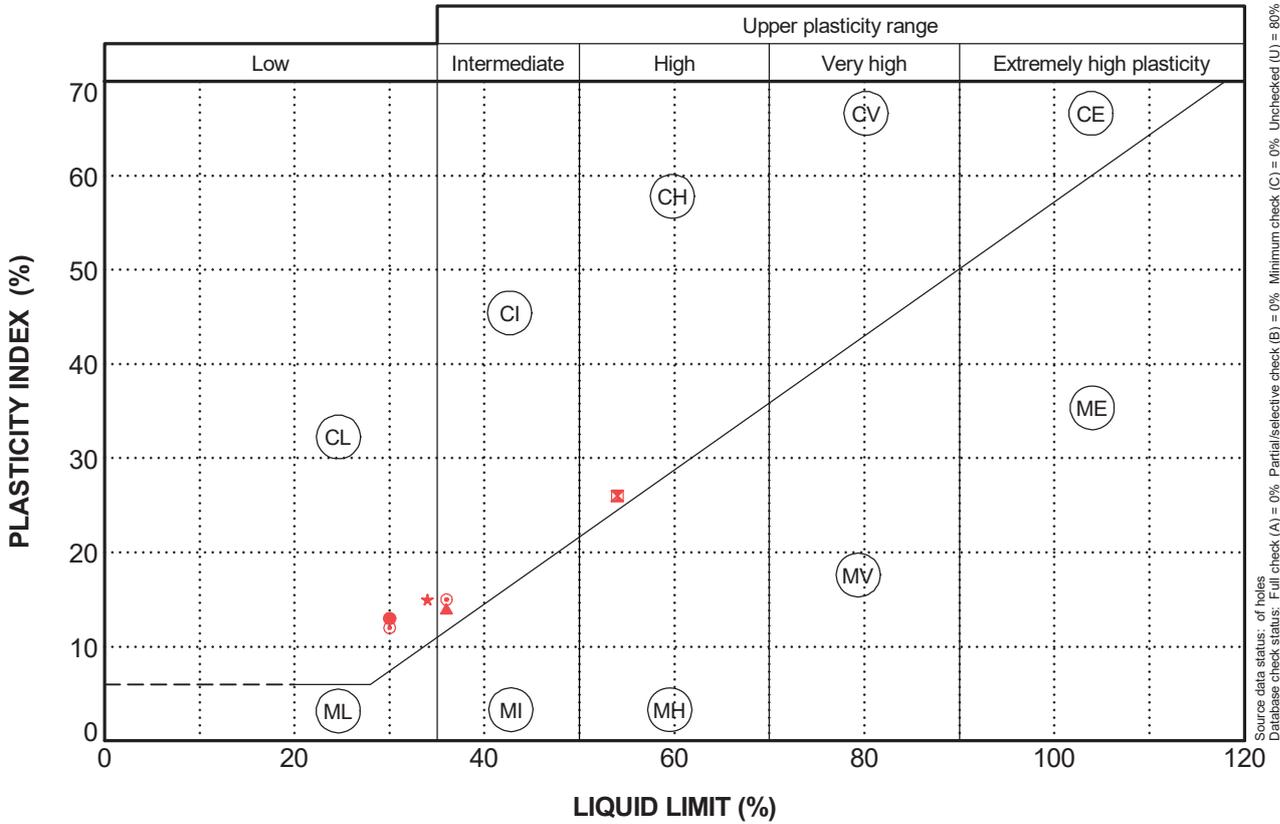


Source data status: of holes
Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 0% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R3919/B118003
- Made Ground
- Rock
- Granular Deposits

**Bus Connect
PLASTIC LIMIT
Blanchardstown to City Centre Core
Bus Corridor
Granular Deposits**

FIGURE C12

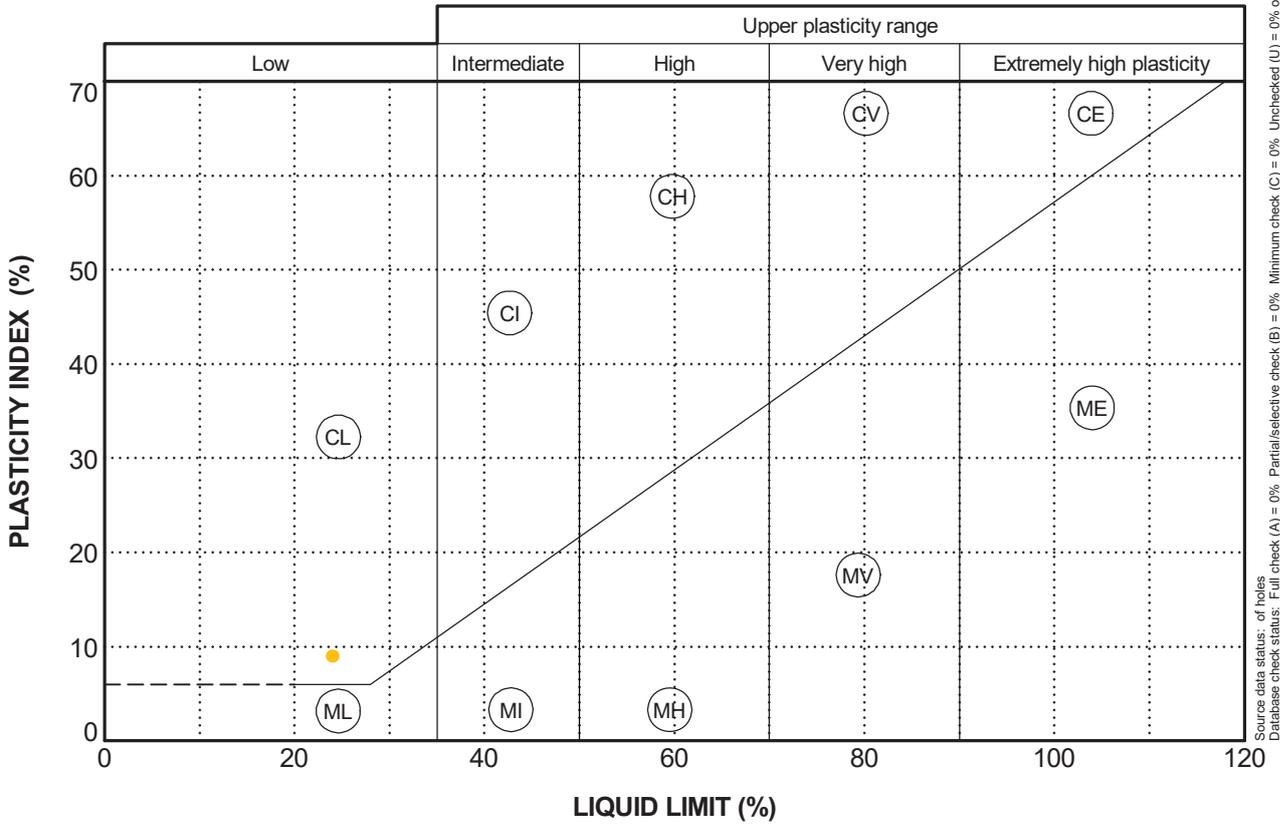


Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 80% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R05-TP01
- R05-TP05
- R05-TP06
- R05-TP07B
- R5614/B135148
- Made Ground
- Rock
- Granular Deposits

**Bus Connect
 PLASTICITY CHART
 Blanchardstown to City Centre Core
 Bus Corridor
 Made Ground**

FIGURE C13

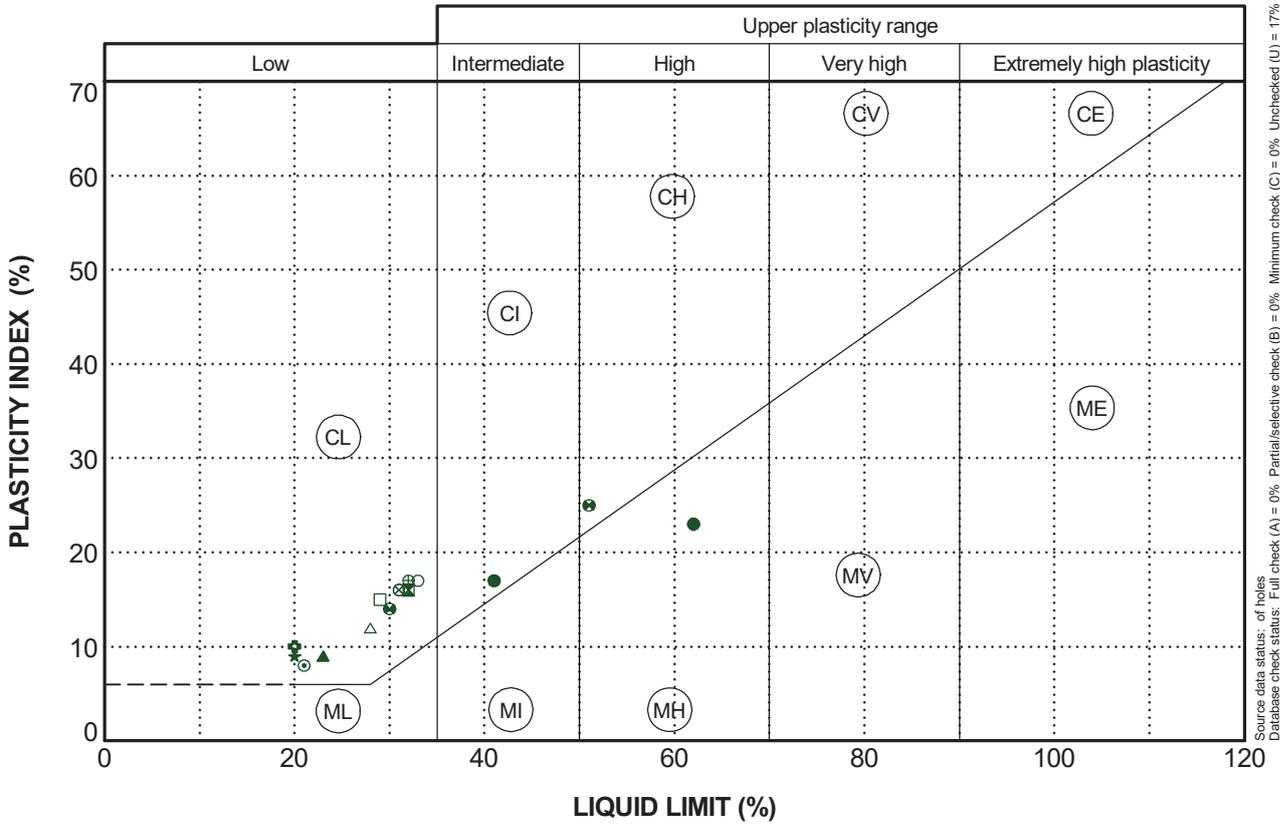


Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 0% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R5619/B135218
- Made Ground
- Rock
- Granular Deposits

**Bus Connect
 PLASTICITY CHART
 Blanchardstown to City Centre Core
 Bus Corridor
 Alluvium**

FIGURE C14

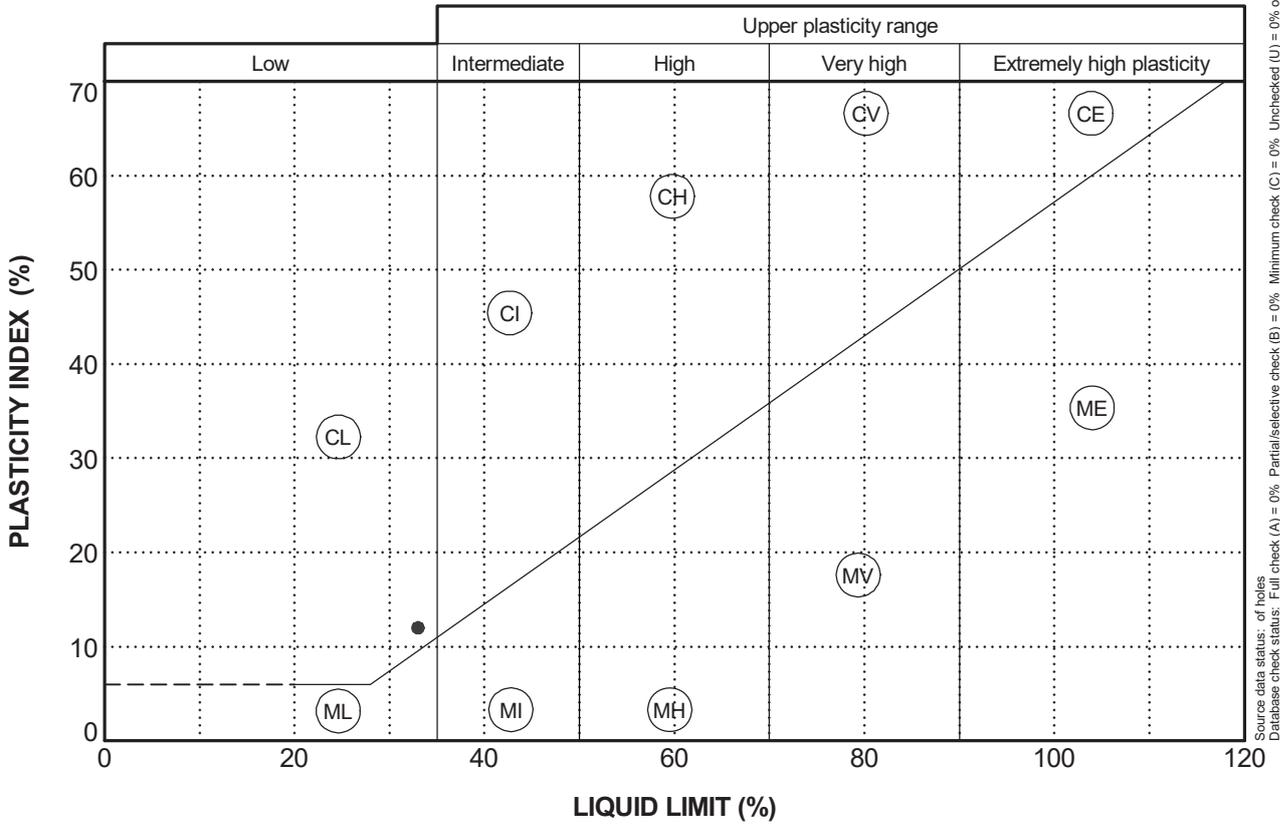


Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 17% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- Made Ground
- Rock
- Granular Deposits
- R05-CP01
- ⊗ R6617/B143948
- ⊠ R05-TP08A
- ▲ R3919/B118005
- ★ R5619/B135217
- ⊙ R5619/B135219
- ⊕ R5619/B135220
- R6617/B143943
- △ R6617/B143944
- ⊗ R6617/B143945
- ⊕ R6617/B143946
- R6617/B143947

**Bus Connect
 PLASTICITY CHART
 Blanchardstown to City Centre Core
 Bus Corridor
 Glacial Till Deposits**

FIGURE C15



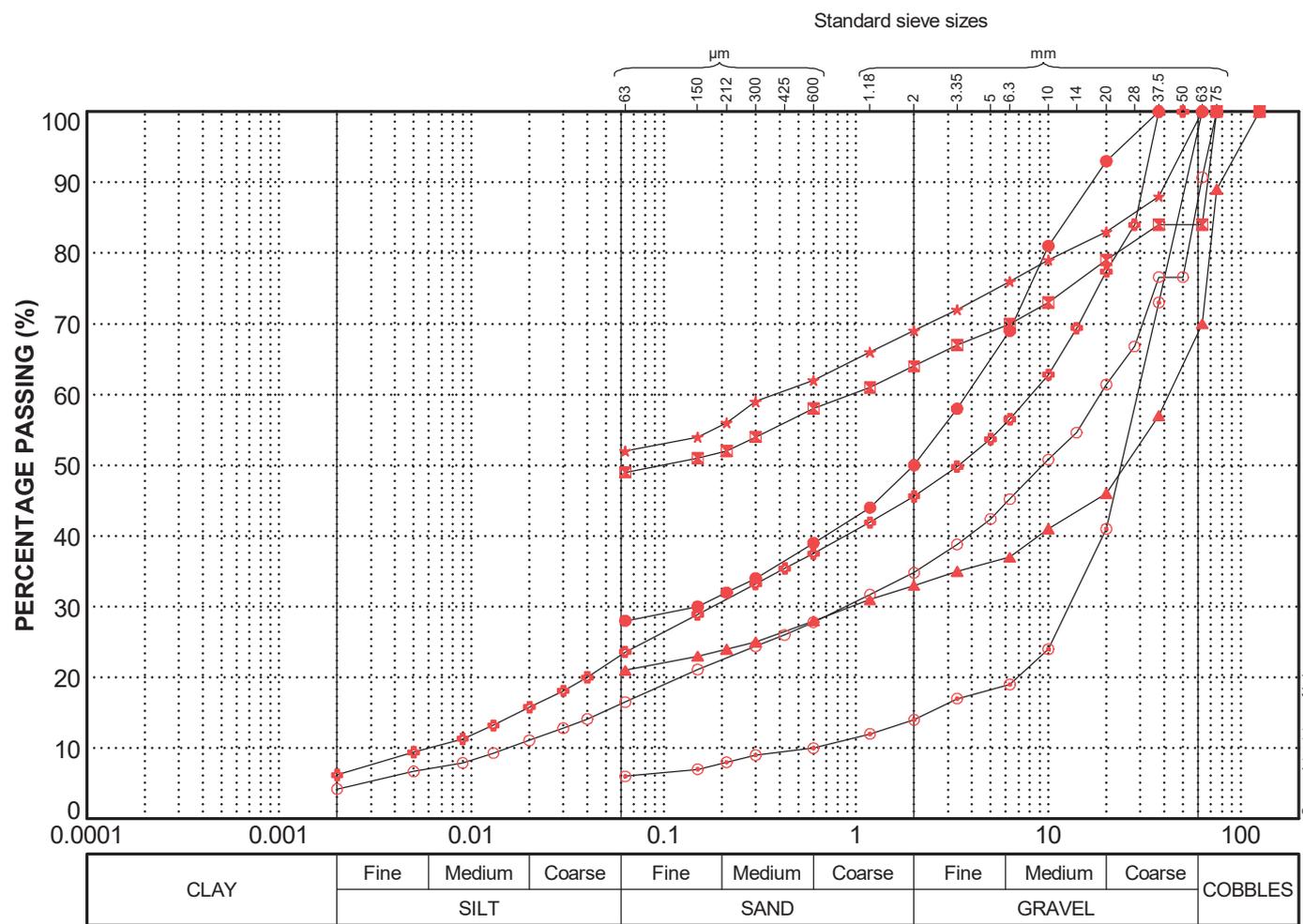
Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Unchecked (U) = 0% of holes

- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- R3919/B118003
- Made Ground
- Rock
- Granular Deposits

**Bus Connect
 PLASTICITY CHART
 Blanchardstown to City Centre Core
 Bus Corridor
 Granular Deposits**

FIGURE C16

gINT v10.00.01.07 Licensed to Arup
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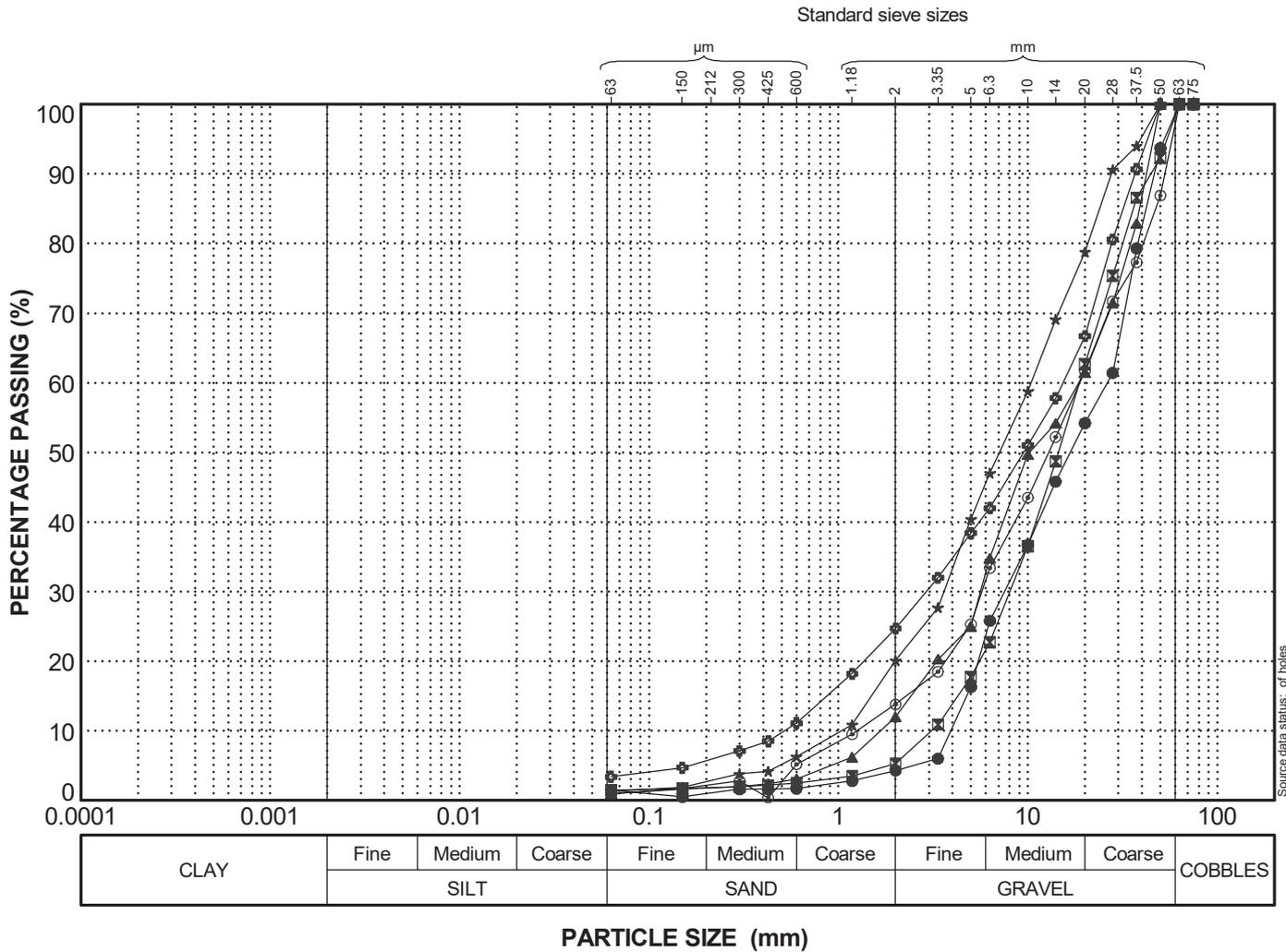
Source data status: of holes
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- R05-TP01, 1.00m
- R05-TP05, 1.00m
- ▲ R05-TP06, 1.00m
- ★ R05-TP07B, 1.00m
- ⊙ R05-TP09, 0.50m
- ⊕ R5614/B135148, 1.50m
- R5614/B135148, 7.50m

- Topsoil
- Made Ground
- Alluvium Deposits
- Rock
- Glacial Till Deposits
- Granular Deposits

Bus Connect
PARTICLE SIZE DISTRIBUTION
Blanchardstown to City Centre Core
Bus Corridor
Made Ground
268401-00

FIGURE C17



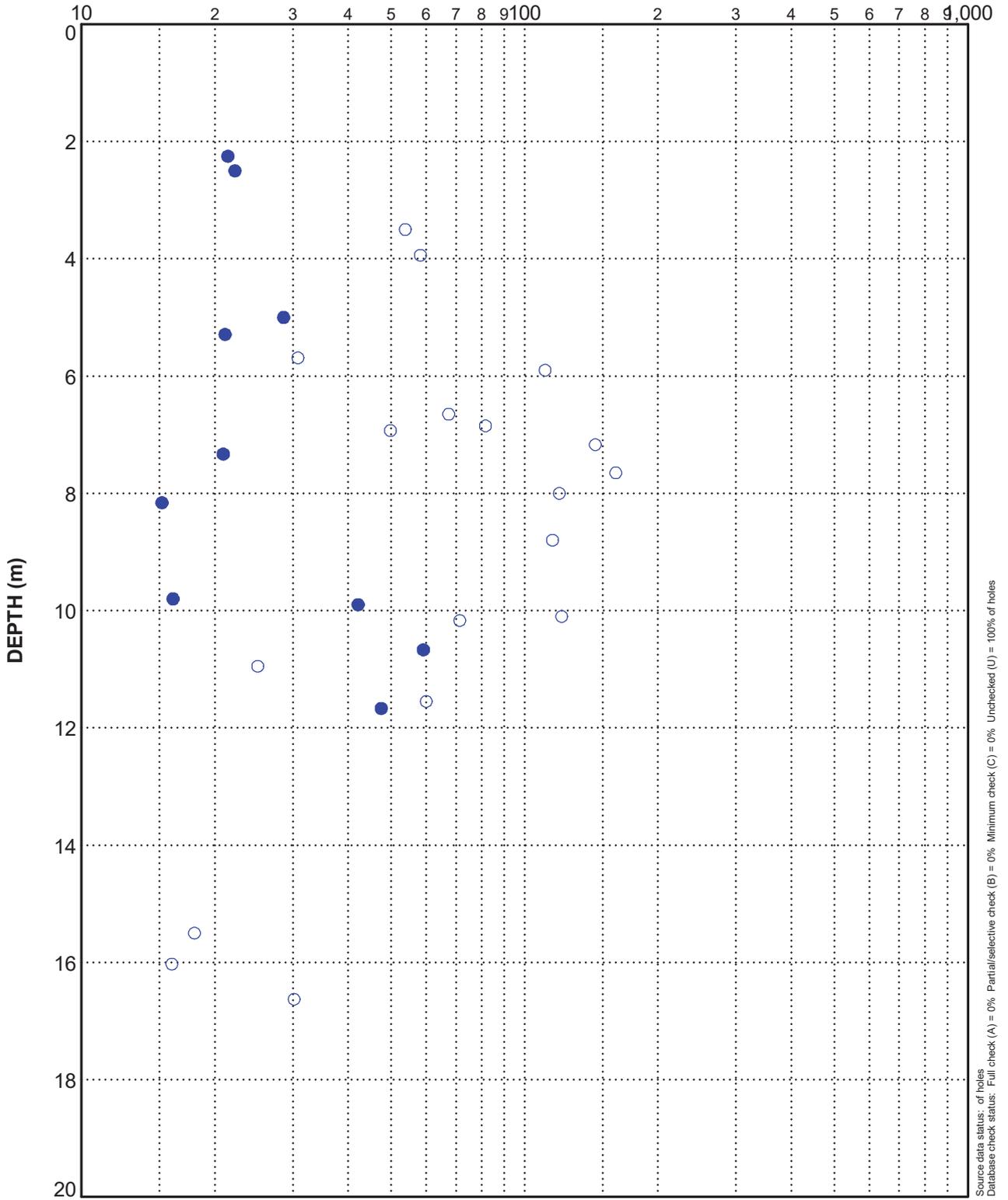
- R2161/B81466, 9.00m
- ☒ R3919/B118003, 3.00m
- ▲ R3919/B118004, 3.50m
- ★ R3919/B118005, 2.50m
- ⊙ R3919/B118006, 5.00m
- ⊕ R3919/B118007, 4.00m

- Topsoil
- Made Ground
- Alluvium Deposits
- Rock
- Glacial Till Deposits
- Granular Deposits

Bus Connect
PARTICLE SIZE DISTRIBUTION
Blanchardstown to City Centre Core
Bus Corridor
Granular Deposits
268401-00

FIGURE C19

UNIAXIAL COMPRESSIVE STRENGTH (MPa)



Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Undchecked (U) = 100% of holes

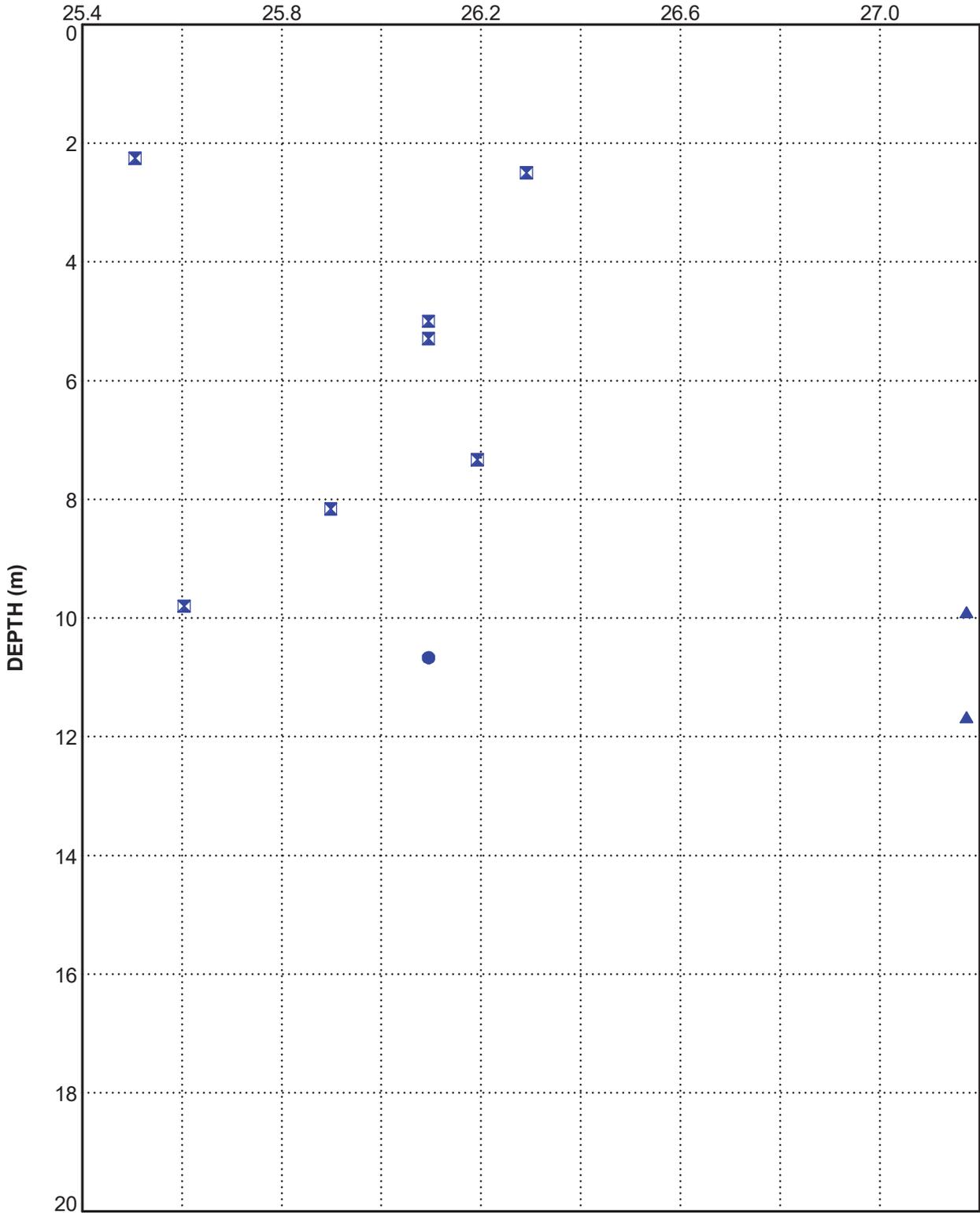
- Topsoil
- Alluvium Deposits
- Glacial Till Deposits
- Made Ground
- Rock
- Granular Deposits

**Bus Connect
 POINT LOAD INDEX
 Blanchardstown to City Centre Core
 Bus Corridor
 Rock**

FIGURE C20

268401-00

BULK UNIT WEIGHT (kN/m³)



Source data status: of holes
 Database check status: Full check (A) = 0% Partial/selective check (B) = 0% Minimum check (C) = 0% Undchecked (U) = 100% of holes

- Topsoil
- Rock
- Glacial Gravel
- R05-CP03
- R05-RC04
- R05-RC06
- Made Ground
- Glacial Till Deposits

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 gINT output page 1 of 1. Made 28May21 01:11

Bus Connect BULK UNIT WEIGHT Blanchardstown to City Centre Core Bus Corridor Rock

FIGURE **C21**

Appendix D

Factual Ground Investigation Report

National Transport Authority
**Blanchardstown to City Centre
Core Bus Corridor Scheme**
Factual Ground Investigation Report

268401-00

Issue | 21 December 2021

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 268401-00

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Ground Investigations Ireland
Bus Connect Detailed Stage 1 Lot 1
Route 5
National Transport Authority
Ground Investigation Report
June 2021





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Engineer	Arup
Client	NTA
Project No	9754-07-20 R5
Document Title	Ground Investigation Report

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B	Final	M Sutton	A McDonnell	A McDonnell	Dublin	20 April 2021
C	Final	M Sutton	A McDonnell	A McDonnell	Dublin	14 May 2021
D	Final	M Sutton	A McDonnell	A McDonnell	Dublin	18 June 2021

Ground Investigations Ireland Ltd. present the results of the fieldworks and laboratory testing in accordance with the specification and related documents provided by or on behalf of the client. The possibility of variation in the ground and/or groundwater conditions between or below exploratory locations or due to the investigation techniques employed must be taken into account when this report and the appendices inform designs or decisions where such variation may be considered relevant. Ground and/or groundwater conditions may vary due to seasonal, man-made or other activities not apparent during the fieldworks and no responsibility can be taken for such variation. The data presented and the recommendations included in this report and associated appendices are intended for the use of the client and the client's geotechnical representative only and any duty of care to others is excluded unless approved in writing.



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GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

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APPENDICES

Appendix 1	Site Location Plan
Appendix 2	Trial Pit Records
Appendix 3	Borehole Records
Appendix 4	Laboratory Testing
Appendix 5	Groundwater Monitoring



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1.0 Preamble

On the instructions of Arup, a site investigation was carried out by Ground Investigations Ireland Ltd., between October 2020 and March 2021 at the site of the proposed bus corridor along Route 5: Blanchardstown to the City Centre.

2.0 Overview

2.1. Background

It is proposed to construct a new Bus Connects Core Bus Corridor on several commuter routes into Dublin City Centre. Route 5 is proposed to run between Blanchardstown and the City Centre.

2.2. Purpose and Scope

The purpose of the site investigation was to investigate subsurface conditions utilising a variety of investigative methods in accordance with the project specification. The scope of the work undertaken for this project included the following:

- Visit project site to observe existing conditions
- Carry out 13 No. Trial Pits to a maximum depth of 2.2m BGL
- Carry out 5 No. Cable Percussion boreholes to maximum depth of 5.2m BGL with rotary follow on to a maximum depth of 35.2m BGL
- Carry out 6 No. Rotary Core Boreholes to a maximum depth of 17.3m BGL
- Carry out 2 Window samples to take environmental samples.
- Installation of 2 No. Groundwater monitoring wells
- Geotechnical & Environmental Laboratory testing
- Factual Report

3.0 Subsurface Exploration

3.1. General

During the ground investigation a programme of intrusive investigation specified by the Consulting Engineer was undertaken to determine the sub surface conditions at the proposed site. Regular sampling and in-situ testing was undertaken in the exploratory holes to facilitate the geotechnical descriptions and to enable laboratory testing to be carried out on the soil samples recovered during excavation and drilling.

The procedures used in this site investigation are in accordance with Eurocode 7 Part 2: Ground Investigation and testing (ISEN 1997 – 2:2007) and B.S. 5930:2015.

3.2. Trial Pits

The trial pits were excavated using a 3T tracked excavator at the locations shown in the exploratory hole location plan in Appendix 1. The locations were checked using a CAT scan to minimise the potential for encountering services during the excavation. The trial pits were sampled, logged and photographed by a Geotechnical Engineer/Engineering Geologist prior to backfilling with arisings. Notes were made of any services, inclusions, pit stability, groundwater encountered and the characteristics of the strata encountered and are presented on the trial pit logs which are provided in Appendix 2 of this Report. At a number of locations trial pits refused at shallow depths due to obstructions. In some locations a second, third or fourth attempt was made at a different location. These additional pits are labelled with A, B or C after the trial pit reference on the logs.

3.3. Window Sampling

The window sampling was carried out at the locations R5-CP01A and R5-CP03A shown in the location plan in Appendix 1 using a Tecopsa SPT Tec 10 percussion drilling rig. The window sample boreholes were undertaken to replace environmental samples that were previously taken from R5-CP01 and R5-CP03 and not tested. The window sampling consists of a 1m long steel tube with a cutting edge and an internal plastic liner which is mechanically driven into the ground utilising a 50kg weight falling a height of 500mm. Upon completion of the 1m sample, the tube is withdrawn and the plastic liner removed and sealed for logging and sub sampling by a Geotechnical Engineer/Engineering Geologist. The tube is replaced in the borehole and a subsequent 1m sample can be recovered. Occasionally outer casing or a reduced diameter tube is utilised to enable the window sample to progress in difficult drilling conditions. Geotechnical or environmental soil samples can be recovered from each of the liners following logging. The window sample records are provided in Appendix 3 of this Report.

3.4. Cable Percussion Boreholes

The Cable Percussion Boreholes were drilled using a Dando 2000 drilling rig with regular in-situ testing and sampling undertaken to facilitate the production of geotechnical logs and laboratory testing.

The standard method of boring in soil for site investigation is known as the Cable Percussion method. It consists of using a Shell in non cohesive soils and a clay cutter in cohesive soils, both operated on a wire cable. Very hard soils, boulders and other hard obstructions are broken up by chiselling and the fragments removed with the Shell. Where ground conditions made it necessary, the borehole was lined with 200mm diameter steel casing. While the use of the Cable Percussion method of boring gives the maximum data on soil conditions, some mixing of laminated soil is inevitable. For this reason, thin lenses of granular material may not be noticed. Disturbed samples were taken from the boring tools at suitable depths, so that there is a representative sample at the top of each change in stratum and thereafter at regular intervals down the borehole until the next stratum was encountered. The disturbed samples were then sealed and sent to the laboratory where they were visually examined to confirm the description of the relevant strata.

Standard Penetration Tests were carried out in the boreholes. The results of these tests, together with the depths at which the tests were taken are shown on the accompanying borehole records. The test consists of a thick wall sampler tube, 50mm external diameter, being driven into the soil by a monkey weighing 63.5kg and with a free drop of 760mm. For gravels and glacial till the driving shoe was replaced by a solid 60° cone. The Standard Penetration Test number referred to as the 'N' value is the number of blows required to drive the tube 300mm, after an initial penetration of 150mm. The number gives a guide to the consistency of the soil and can also be used to estimate the relative strength/density at the depth of the test and also to estimate the bearing capacity and compressibility of the soil.

At the location of R5-CP04 the cable percussion drilling refused at a shallow depth therefore another attempt was made adjacent to the first attempt and labelled CP04A.

The cable percussion borehole logs are provided in Appendix 3 of this Report.

3.5. Rotary Boreholes

The rotary coring was carried out by a track mounted T44 Beretta rig at the locations shown on the location plan in Appendix 1. The rotary boreholes were completed from the ground surface or alternatively, where noted on the individual borehole log, from the base of the cable percussion borehole where a temporary liner was installed to facilitate follow-on rotary coring.

The T44 Beretta is equipped with rubber tracks which allow for short travel on pavement surfaces avoiding any damage to the surface. The T44 Beretta utilises a triple tube core barrel system operated using a wireline drilling process. The outer barrel is rotated by the drill rods and at its lower end, carries the coring bit. The inner barrel is mounted on a swivel so that it does not rotate during the process. The third barrel or liner is placed within the second one to retain the core intact and to preserve as much as possible the fabric of the drilling stratum. The core is cut by the coring bit and passes to the inner liner. The core is brought up to the surface within the inner barrel on a small diameter wire rope or line attached to the "overshoot" recovery tool which is then placed into a core box in order of recovery. A drilling fluid, typically air mist or water flush is passed from the surface through hollow drill rods to the drill bit, and is used to cool the drill bit. Temporary casing is used in some situations to support unstable ground or to seal off fissures or voids. It should be noted that the rotary coring can only achieve limited recovery in overburden, particularly granular or weakly cemented strata due to the flushing medium washing away the cohesive fraction during coring. The recovery achieved, where required is noted on the borehole logs and core photographs are provided to allow assessment of the core recovered. The rotary borehole logs are provided in Appendix 3 of this Report.

3.6. Surveying

The exploratory hole locations have been recorded using a KQ GEO Technologies KQ-M8 System which records the coordinates and elevation of the locations to ITM or Irish National Grid as required by the project specification. The coordinates and elevations are provided on the exploratory hole logs in the appendices of this Report.

3.7. Groundwater Monitoring Installations

Groundwater Installations were installed upon the completion of the boreholes to enable sampling and the determination of the equilibrium groundwater level. The typical groundwater monitoring installation consists of a 50mm uPVC/HDPE slotted pipe with a pea gravel response zone and bentonite seal installed to the Engineers specification. The standpipe and finished with a durable steel cover fixed in place with a concrete surround. The installation details are provided on the exploratory hole logs in the appendices of this Report.

3.8. Laboratory Testing

Samples were selected from the exploratory holes for a range of geotechnical and environmental testing to assist in the classification of soils and to provide information for the proposed design.

Environmental & Chemical testing as required by the specification, including the specified by ARUP based on suite E testing and organic matter content was carried out by Element Materials Technology Laboratory in the UK.

Geotechnical testing consisting of moisture content, Atterberg limits, Particle Size Distribution (PSD), hydrometer, tests were carried out in NMTL's Geotechnical Laboratory in Carlow or Pro Soils Laboratory in the UK.

Rock strength testing including Point Load (I_{s50}) and Unconfined Compressive Strength (UCS) testing was carried out in Pro Soils Geotechnical Laboratory in the UK.

The results of the laboratory testing are included in Appendix 4 of this Report.

4.0 Ground Conditions

4.1. General

The ground conditions encountered during the investigation are summarised below with reference to insitu and laboratory test results. The full details of the strata encountered during the ground investigation are provided in the exploratory hole logs included in the appendices of this report.

The sequence of strata encountered were variable across the site and are generally comprised;

- Topsoil / Surfacing
- Made Ground
- Granular Deposits
- Cohesive Deposits
- Bedrock

TOPSOIL: Topsoil was encountered in the majority of the exploratory holes and was present to a maximum depth of 0.2m BGL. Concrete surfacing was present in R05-TP02 to a depth of 0.11m BGL

MADE GROUND: Made Ground deposits were encountered from the surface or beneath the Topsoil and were present to depths of between 0.25 and 5.0m BGL across the proposed route. It should be noted that a number of the trial pits refused within the made ground. The Made Ground deposits were described generally as *brown sandy gravelly CLAY with occasional cobbles*. The secondary sand and gravel constituents varied across the site. At some locations *occasional fragments of concrete, red brick, wood, tarmacadam and plastic* were encountered within the made ground. Also, some, occasional or frequent cobble and boulder content was encountered where noted on the exploratory hole logs.

Tarmacadam obstruction was encountered in R05-TP07 and TP07A with a concrete obstruction encountered in TP07B. Tarmacadam was also encountered in RC05-TP07C between 0.5 and 0.7m BGL with angular to sub angular Gravel fill below.

COHESIVE DEPOSITS: Cohesive deposits were encountered beneath the Made Ground or topsoil and were described typically *brown or grey sandy gravelly CLAY with occasional cobbles and boulders*. The secondary sand and gravel constituents varied across the site and with depth, with granular lenses occasionally present in the glacial till matrix. The strength of the cohesive deposits was typically firm to very stiff and generally increased with depth in the majority of the exploratory holes however R05-CP05 encountered very soft and soft deposits to a depth of 2.8m BGL. These deposits had some, occasional or frequent cobble and boulder content where noted on the exploratory hole logs.

GRANULAR DEPOSITS: Generally minimal granular deposits were encountered within some boreholes however a significant depth of granular material was found within R05-CP05. It should be noted that the rotary drilling technique can wash away finer material so this should be considered where poor recovery is noted on the borehole logs.

The granular deposits were typically described as *Grey / brown sandy sub rounded to sub angular fine to coarse GRAVEL or fine to coarse SAND*. The secondary sand/gravel and silt/clay constituents varied across the site and with depth while occasional or frequent cobble and boulder content also present where noted on the exploratory hole logs.

Based on the SPT N values the deposits are typically medium dense and become dense with depth. The driller noted blowing sands or gravels during drilling in R05-CP05.

BEDROCK: The rotary core boreholes recovered Medium strong to strong grey/dark grey fine to medium grained laminated LIMESTONE locally interbedded with weak black fine grained laminated Mudstone or Clay. This is typical of the Calp Formation, which is noted on the geological mapping of the proposed site. Rare visible pyrite veins were noted during logging which are typically present within the Calp Limestone. The depth to rock generally varies from 0.3m BGL in R05-RC05 to 10.6 mBGL in R05-RC07 however, rock was not encountered in R05-CP05 at a depth of 35.20m BGL where the borehole was terminated. The total core recovery is good, typically 100% with some of the uppermost runs dropping to 80 or 90%. The SCR and RQD both are relatively poor in the upper weathered zone, often recovered as non-intact, however both indices show an increase with depth in each of the boreholes.

4.2. Groundwater

No groundwater was noted during the investigation however we would point out that these exploratory holes did not remain open for sufficiently long periods of time to establish the hydrogeological regime and groundwater levels would be expected to vary with the time of year, rainfall, nearby construction and other factors. For this reason, standpipes were installed in R05-RC01 and R05-RC04 to allow the equilibrium groundwater level to be determined. The groundwater monitoring is included in Appendix 5 of this Report.

4.3. Laboratory Testing

4.3.1. Geotechnical Laboratory Testing

The geotechnical testing carried out on soil samples recovered from R05-CP01 generally confirm the descriptions on the logs with the primary constituent of the cohesive deposits found to be SILT of intermediate to high plasticity. A sample from TP08A at 1.5 m shows the primary constituent to be Gravel however the material is described as CLAY based on material behaviour encountered when on site. The Particle Size Distribution tests confirm that generally the cohesive deposits are well-graded with percentages of sands and gravels ranging between 12% and 47% generally with fines contents of 26 to 64%

The Particle Size Distribution tests carried out on the made ground deposits show they are either cohesive or granular and generally well graded. The particle size distribution tests on the cohesive made ground deposits from TP01, TP05 and TP07A generally gave percentages of sand and gravel ranging between 15% to 50%, with fines contents of 28% to 52%. The Particle Size Distribution tests carried out on the granular made ground deposits from TP06 and TP09 gave percentages of sands between 8% to 12%, gravel between 37% to 86%, with fines contents of 6% to 21%.

4.3.2. Environmental Laboratory Testing

A Total of 29 samples were analysed for a Suite of testing specified by ARUP based on suite E according to engineers Ireland.

The possibility for contamination, not revealed by the testing undertaken should be borne in mind particularly where Made Ground deposits are present, or the previous site use or location indicate a risk of environmental variation.

The results from the completed laboratory testing is included in Appendix 4 of this report.

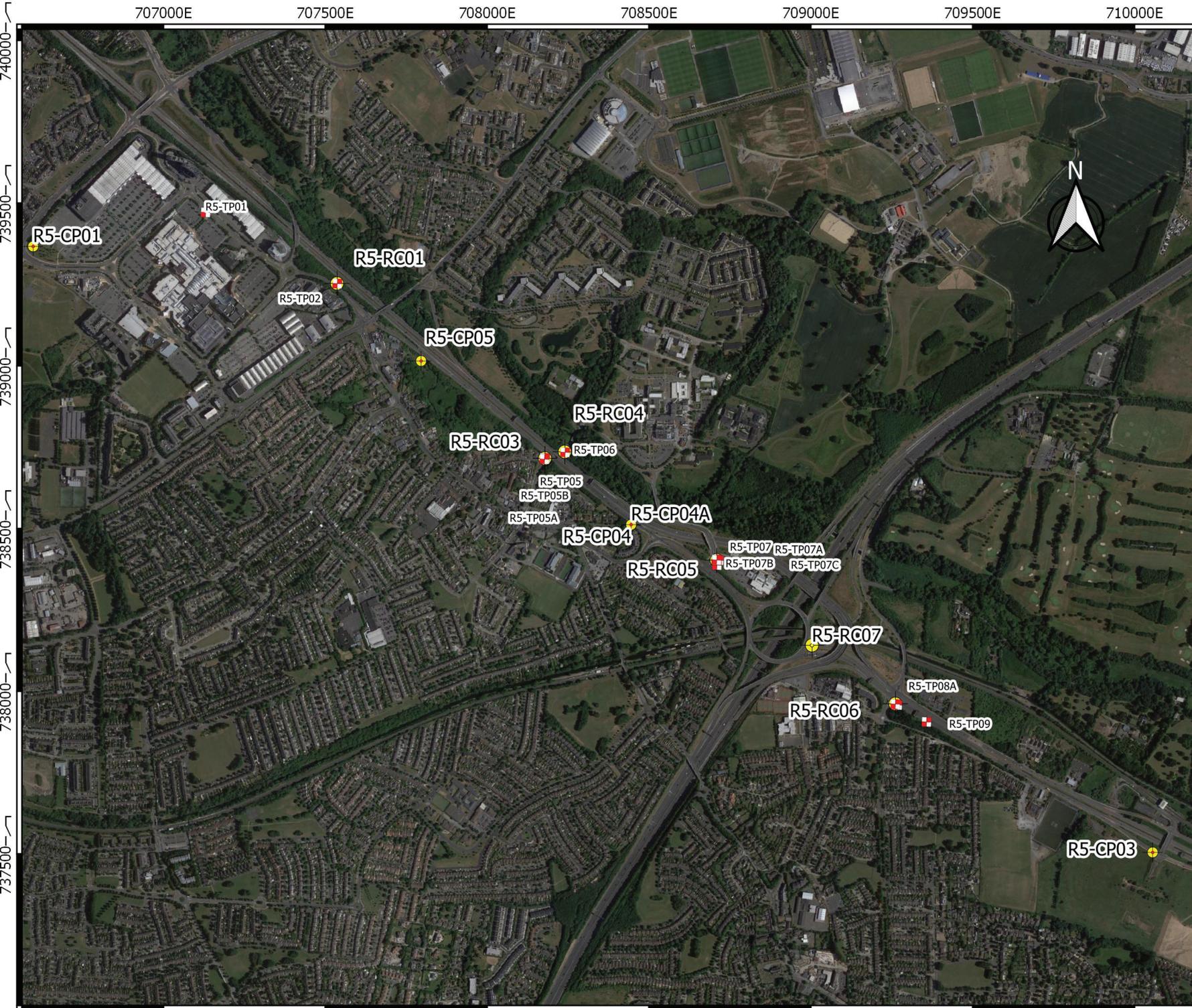
4.3.3. Rock Laboratory Testing

The rock testing carried out on samples recovered from the boreholes reported Unconfined Compressive Strength (UCS) values ranging between 16.1 and 59.1 MPa while the point load testing gave I_{s50} values ranging between 0.80 to 8.03 MPa. These results correlate to the strength descriptions ranging between of Weak to Strong and confirming the variability of this stratum and the descriptions on the logs.

The results from the completed laboratory testing is included in Appendix 4 of this report.

APPENDIX 1 - Site Location Plan





-  Trial Pit
-  Rotary Borehole
-  CP + Rotary Borehole



Client:

ARUP

Project Code:

9754-07-20 R5

Project Title:

Bus Conects Lot 1 - Route 5

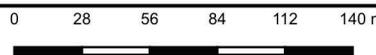
Drawing Title:

As Bult Investigation Locations
- Overview



GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Ground Investigations Ireland Ltd.
Catherinstown House,
Hazelhatch Road,
Newcastle, Co. Dublin
www.gii.ie 01-6015175/5176



Drawn By:
MS

Date:
25/03/2021

706600E 706700E 706800E 706900E 707000E 707100E 707200E 707300E 707400E 707500E 707600E 707700E 707800E 707900E

-  Trial Pit
-  Rotary Borehole
-  CP + Rotary Borehole



Client:

ARUP

Project Code:

9754-07-20 R5

Project Title:

Bus Conects Lot 1 - Route 5

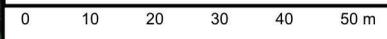
Drawing Title:

As Bult Investigation Locations
- Map 1



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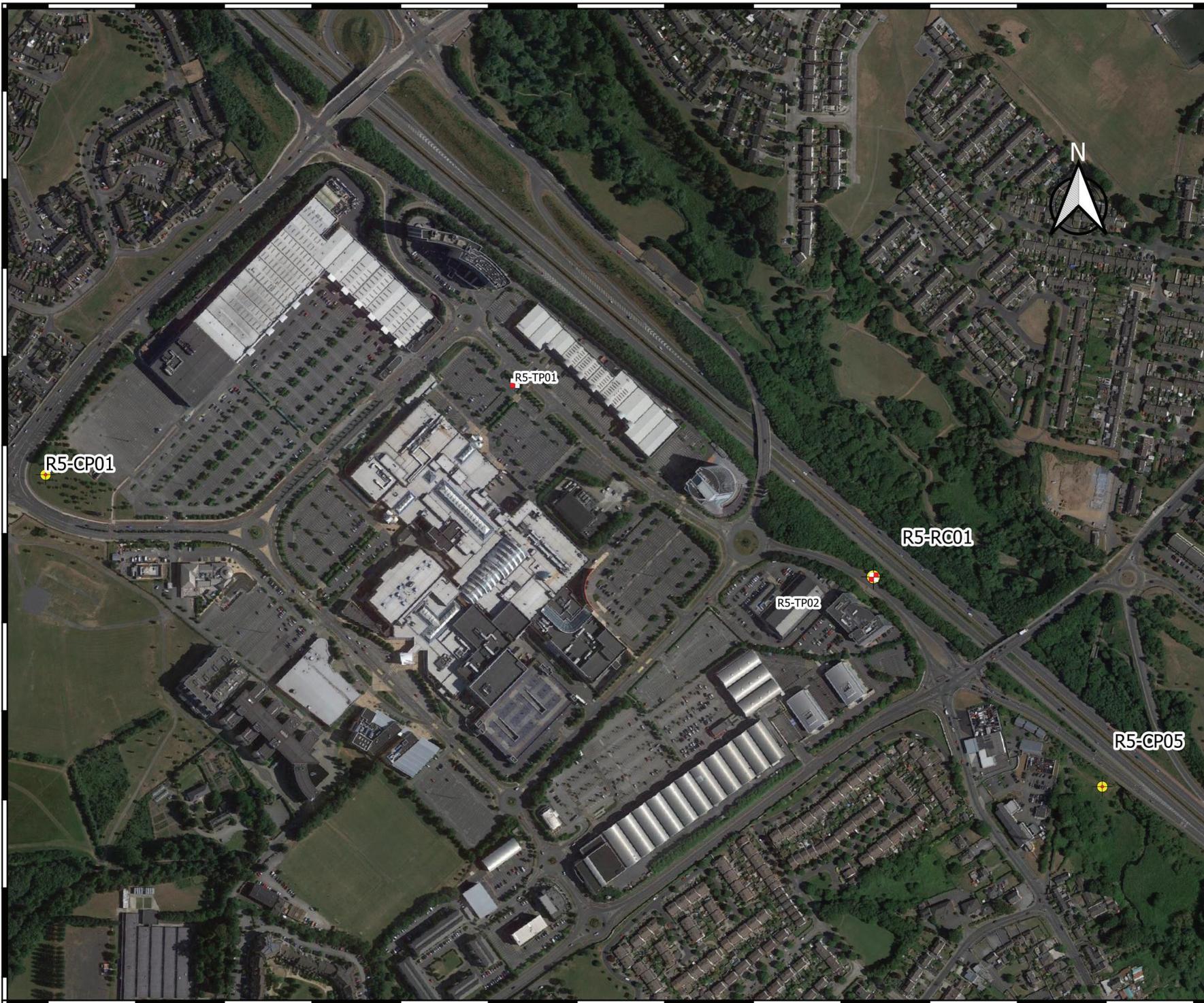


Drawn By:
MS

Date:
25/03/2021

706600E 706700E 706800E 706900E 707000E 707100E 707200E 707300E 707400E 707500E 707600E 707700E 707800E 707900E

738800 738900 739000 739100 739200 739300 739400 739500 739600 739700 739800



708150E

708200E

708250E

738750

738700



-  Trial Pit
-  Rotary Borehole
-  CP + Rotary Borehole



Client:

ARUP

Project Code:

9754-07-20 R5

Project Title:

Bus Conects Lot 1 - Route 5

Drawing Title:

As Bult Investigation Locations - Map 2



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Drawn By:
MS

Date:
25/03/2021

708150E

708200E

708250E

708450E

708500E

708550E

708600E

708650E

708700E

738500

738450

738400

738350

738300

708450E

708500E

708550E

708600E

708650E

708700E



-  Trial Pit
-  Rotary Borehole
-  CP + Rotary Borehole



Client:

ARUP

Project Code:

9754-07-20 R5

Project Title:

Bus Conects Lot 1 - Route 5

Drawing Title:

As Bult Investigation Locations - Map 3



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Drawn By:
MS

Date:
25/03/2021



-  Trial Pit
-  Rotary Borehole
-  CP + Rotary Borehole



Client:
ARUP

Project Code:
 9754-07-20 R5

Project Title:
 Bus Conects Lot 1 - Route 5

Drawing Title:
 As Bult Investigation Locations
 - Map 4



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Drawn By: MS	Date: 25/03/2021
-----------------	---------------------

709000E 709100E 709200E 709300E 709400E 709500E 709600E 709700E 709800E 709900E 710000E

APPENDIX 2 – Trial Pit Records





Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.60m (L) x 0.40m (W) x 1.60m (D)	Ground Level (mOD) 59.98	Client National Transport Authority	Job Number 9754-07-20
	Location 707130 E 739469 N	Dates 17/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50	EN			59.58	0.40	MADE GROUND: Brown slightly sandy slightly gravelly Clay with frequent rootlets		
1.00 1.00	B T			58.68	0.90	MADE GROUND: Brown slightly sandy gravelly Clay with some angular to subangular cobbles and occasional boulders. Gravel is angular to subangular fine to coarse		
1.50 1.50	B EN			58.38	1.30 (0.30)	Stiff grey slightly sandy gravelly CLAY with some angular to subangular cobbles and occasional boulders. Gravel is angular to subangular fine to coarse		
					1.60	Obstruction: presumed boulder Complete at 1.60m		

Plan 	Remarks Trial pit terminated at 1.60m BGL due to an obstruction on a presumed boulder Trial pit stable No groundwater encountered during excavation Trial pit backfilled upon completion	
		Scale (approx) 1:25



Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.25m (L) x 0.40m (W) x 1.10m (D)	Ground Level (mOD) 55.94	Client National Transport Authority	Job Number 9754-07-20
	Location 707536.8 E 739250.1 N	Dates 23/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50	B EN T			55.83	(0.11)	CONCRETE		
0.50				55.73	(0.10)	MADE GROUND: Grey sandy angular to subangular fine to coarse Gravel with occasional rootlets		
0.50				55.39	(0.34)	Stiff brown slightly sandy gravelly CLAY with occasional angular to subangular cobbles and boulders. Gravel is angular to subangular fine to coarse. Possible Made Ground.		
1.00	B T EN				0.55	Very stiff brown slightly sandy gravelly CLAY with occasional angular to subangular cobbles and boulders. Gravel is angular to subangular fine to coarse		
1.00				54.84	(0.55)			
1.10					1.10	Obstruction: presumed boulders		
						Complete at 1.10m		

Plan	Remarks							
	<p>Trial pit terminated at 1.10m BGL due to an obstruction on presumed boulders Trial pit stable No groundwater encountered during excavation Trial pit backfilled upon completion</p>							
	Scale (approx)	1:25	Logged By	PC	Figure No.	9754-07-20.R5-TP02		



Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.50m (L) x 0.30m (W) x 1.60m (D)	Ground Level (mOD) 46.78	Client National Transport Authority	Job Number 9754-07-20
	Location 708177.1 E 738714.5 N	Dates 16/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50 0.50	EN T			46.58	(0.20) 0.20	Brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets		
1.00 1.00	B T			45.88	(0.70) 0.90	MADE GROUND: Greyish brown slightly sandy slightly gravelly Clay with some angular to subangular cobbles, occasional boulders and occasional rootlets. Gravel is angular to subangular fine to coarse		
1.50	EN			45.23 45.18	1.55 1.60	MADE GROUND: Grey subangular to subrounded fine to coarse Gravel (surrounding pipe) Trial pit terminated at 1.60m BGL due to service encountered Complete at 1.60m		

Plan	Remarks Trial pit terminated at 1.60m BGL due to service encountered Trial pit stable No groundwater encountered during excavation Trial pit backfilled upon completion					
	<table border="1"> <tr> <td>Scale (approx)</td> <td>Logged By</td> <td>Figure No.</td> </tr> <tr> <td>1:25</td> <td>PC</td> <td>9754-07-20.R05-TP05</td> </tr> </table>	Scale (approx)	Logged By	Figure No.	1:25	PC
Scale (approx)	Logged By	Figure No.				
1:25	PC	9754-07-20.R05-TP05				



Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.40m (L) x 0.30m (W) x 0.40m (D)	Ground Level (mOD) 46.66	Client National Transport Authority	Job Number 9754-07-20
	Location 708178.7 E 738712.8 N	Dates 16/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				46.46	0.20	Brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets		
				46.26	0.20	MADE GROUND: Brown slightly sandy gravelly Clay with frequent angular cobbles. Gravel is angular to subangular fine to coarse		
					0.40	Obstruction: presumed rock		
						Complete at 0.40m		

Plan	Remarks
	<p>Trial pit terminated at 0.40m BGL due to an obstruction on presumed rock</p> <p>Trial pit stable</p> <p>No groundwater encountered during excavation</p> <p>Trial pit backfilled upon completion</p>

Scale (approx)	Logged By	Figure No.
1:25	PC	9754-07-20.R05-TP05A



Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.50m (L) x 0.30m (W) x 0.90m (D)	Ground Level (mOD) 46.70	Client National Transport Authority	Job Number 9754-07-20
	Location 708176.9 E 738710.5 N	Dates 16/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.90 0.90	B EN			46.50 45.80	(0.20) 0.20 (0.70) 0.90	Brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets Firm greyish brown slightly sandy gravelly CLAY with frequent angular to subangular cobbles. Gravel is angular to subangular fine to coarse Obstruction: presumed rock Complete at 0.90m		

Plan 	Remarks Trial pit terminated at 0.90m BGL due to an obstruction on presumed rock Trial pit stable No groundwater encountered Trial pit backfilled upon completion		
	Scale (approx) 1:25	Logged By PC	Figure No. 9754-07-20.R05-TP05B



Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.50m (L) x 0.30m (W) x 2.00m (D)	Ground Level (mOD) 45.00	Client National Transport Authority	Job Number 9754-07-20
	Location 708240.6 E 738731.7 N	Dates 16/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50 0.50	EN T			44.80	0.20	Dark greyish brown slightly sandy slightly gravelly TOPSOIL with frequent rootlets		
1.00 1.00	B T				(1.50)	MADE GROUND: Brown gravelly clayey fine to coarse Sand with occasional angular to subangular cobbles, rootlets and occasional fragments of metal, plastic and red brick		
1.50	EN			43.30	1.70	Brown sandy clayey angular to subangular fine to coarse GRAVEL with some angular to subangular cobbles (possible weathered rock)		
2.00 2.00	B T			43.00	2.00	Obstruction: boulder or possible rock Complete at 2.00m		

Plan	Remarks Trial pit terminated at 2.00m BGL due to obstruction on a boulder or possible rock Trial pit stable No groundwater encountered during excavation Trial pit backfilled upon completion	
		Scale (approx) 1:25



Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.70m (L) x 0.30m (W) x 0.25m (D)	Ground Level (mOD) 53.48	Client National Transport Authority	Job Number 9754-07-20
	Location 708708.4 E 738402.6 N	Dates 17/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20	B			53.38 53.23	(0.10) 0.10 (0.15) 0.25	Brown slightly sandy slightly gravelly TOPSOIL MADE GROUND: Grey slightly sandy gravelly Clay with occasional angular to subrounded cobbles and occasional rootlets Obstruction: Tarmacadam Complete at 0.25m		

Plan	Remarks Trial pit terminated at 0.25m BGL due to an obstruction on tarmacadam Trial pit stable No groundwater encountered during excavation (Surface water run off can be seen in pit on photograph) Trial pit backfilled upon completion	
Scale (approx) 1:25	Logged By PC	Figure No. 9754-07-20.R05-TP07



Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.70m (L) x 0.30m (W) x 0.70m (D)	Ground Level (mOD) 53.22	Client National Transport Authority	Job Number 9754-07-20
	Location 708715.6 E 738400 N	Dates 17/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50 0.50	B T			53.02	(0.20) 0.20	Brown slightly sandy slightly gravelly TOPSOIL		
					(0.50)	MADE GROUND: Grey slightly sandy gravelly Clay with some angular to subrounded cobbles, occasional rootlets and occasional fragments of plastic and rope		
				52.52	0.70	Obstruction: Tarmacadam Complete at 0.70m		

Plan	Remarks Trial pit terminated at 0.70m BGL due to an obstruction on tarmacadam Trial pit stable No groundwater encountered during excavation Trial pit backfilled upon completion					
	<table border="1"> <tr> <td>Scale (approx)</td> <td>Logged By</td> <td>Figure No.</td> </tr> <tr> <td>1:25</td> <td>PC</td> <td>9754-07-20.R05-TP07A</td> </tr> </table>	Scale (approx)	Logged By	Figure No.	1:25	PC
Scale (approx)	Logged By	Figure No.				
1:25	PC	9754-07-20.R05-TP07A				



Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.80m (L) x 0.50m (W) x 1.65m (D)	Ground Level (mOD) 53.56	Client National Transport Authority	Job Number 9754-07-20
	Location 708709.8 E 738385.1 N	Dates 17/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50 0.50	EN T			53.36	0.20	Greyish brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets		
1.00 1.00	B T				(1.45)	MADE GROUND: Grey slightly sandy gravelly Clay with frequent angular to subrounded cobbles, occasional boulders, rootlets and occasional fragments of concrete, plastic, tarmacadam and wood		
1.50	EN			51.91	1.65	Obstruction: Concrete Complete at 1.65m		

Plan	Remarks Trial pit terminated at 1.65m BGL due to an obstruction on concrete Trial pit stable No groundwater encountered during excavation Trial pit backfilled upon completion
---	---

Scale (approx) 1:25	Logged By PC	Figure No. 9754-07-20.R05-TP07B
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Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 2.00m (L) x 0.70m (W) x 1.30m (D)	Ground Level (mOD) 53.48	Client National Transport Authority	Job Number 9754-07-20
	Location 708709.3 E 738400.6 N	Dates 23/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50	B			53.28	(0.20)	Greyish brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets		
				52.98	(0.30)	MADE GROUND: Grey slightly sandy gravelly Clay with some angular to subrounded cobbles, occasional rootlets and occasional fragments of plastic		
1.00	T			52.78	(0.20)	TARMACADAM		
				52.38	(0.40)	MADE GROUND: Compacted dark grey sandy angular to subangular fine to coarse Gravel		
1.30	B			52.18	(0.20)	MADE GROUND: Compacted light grey angular to subangular fine to coarse Gravel with occasional angular to subangular cobbles		
					1.30	Complete at 1.30m		

Plan	Remarks Trial pit terminated at 1.30m BGL Trial pit stable No groundwater encountered during excavation Trial pit backfilled upon completion	
		Scale (approx) 1:25



Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.60m (L) x 0.50m (W) x 0.60m (D)	Ground Level (mOD) 53.18	Client National Transport Authority	Job Number 9754-07-20
	Location 709267.3 E 737955.2 N	Dates 18/02/2021	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				52.98	(0.20) 0.20	Brown sandy TOPSOIL with occasional rootlets		
				52.58	(0.40) 0.60	MADE GROUND: Light brown slightly gravelly sandy Clay with occasional cobbles and occasional pockets of fine sand		
						Services encountered at 0.60m BGL Terminated at 0.60m		

Plan 	Remarks Trial pit terminated due to services encountered at 0.60m BGL Trial pit stable No groundwater encountered during excavation Trial pit backfilled upon completion	
		Scale (approx) 1:25



Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.80m (L) x 0.50m (W) x 2.20m (D)	Ground Level (mOD) 53.23	Client National Transport Authority	Job Number 9754-07-20
	Location 709261.2 E 737957.9 N	Dates 18/02/2021	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50 0.50	B EN			53.03	(0.20) 0.20	Brown sandy TOPSOIL with occasional rootlets		
					(0.60)	MADE GROUND: Dark grey angular to subangular fine to coarse Gravel with many angular cobbles and boulders		
1.50 1.50	B EN			52.43	0.80	Stiff light brown slightly sandy gravelly CLAY with many angular to subangular cobbles of Limestone and occasional angular boulders		
2.20	EN			51.03	(1.40) 2.20	Terminated at 2.20m		

Plan 	Remarks Trial pit terminated at 2.20m BGL No groundwater encountered during excavation Trial pit stable Trial pit backfilled upon completion	
		Scale (approx) 1:25



Machine : 3T Tracked Excavator Method : Trial Pit	Dimensions 1.70m (L) x 0.45m (W) x 1.40m (D)	Ground Level (mOD) 52.38	Client National Transport Authority	Job Number 9754-07-20
	Location 709357.4 E 737903.1 N	Dates 18/02/2021	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50 0.50	B EN			52.18	(0.20) 0.20	Dark brown sandy TOPSOIL with occasional rootlets		
1.40 1.40	B EN			50.98	(1.20) 1.40	MADE GROUND: Brown clayey sandy angular to sub angular Gravel with many angular to subangular cobbles and occasional boulders		
						Services encountered at 1.40m BGL Terminated at 1.40m		

Plan	Remarks Trial pit terminated due to services encountered at 1.40m BGL Trial pit stable No groundwater encountered during excavation Trial pit backfilled upon completion	
		Scale (approx) 1:25

Bus Connects Route 5 – Trial Pit Photographs

TP01



Bus Connects Route 5 – Trial Pit Photographs

TP01



Bus Connects Route 5 – Trial Pit Photographs

TP02



Bus Connects Route 5 – Trial Pit Photographs

TP02



Bus Connects Route 5 – Trial Pit Photographs

TP05



Bus Connects Route 5 – Trial Pit Photographs

TP05



Bus Connects Route 5 – Trial Pit Photographs

TP05A



Bus Connects Route 5 – Trial Pit Photographs

TP05A



Bus Connects Route 5 – Trial Pit Photographs

TP05B



Bus Connects Route 5 – Trial Pit Photographs

TP05B



Bus Connects Route 5 – Trial Pit Photographs

TP06



Bus Connects Route 5 – Trial Pit Photographs

R5-RC04 (Inspection Pit)



***Note:** above photo taken at the location of TP06 on a subsequent day when the area was cleared to create space for the rotary core rig



Bus Connects Route 5 – Trial Pit Photographs

TP07



Bus Connects Route 5 – Trial Pit Photographs

TP07



Bus Connects Route 5 – Trial Pit Photographs

TP07A



Bus Connects Route 5 – Trial Pit Photographs

TP07B



Bus Connects Route 5 – Trial Pit Photographs

TP07B



Bus Connects Route 5 – Trial Pit Photographs

TP07C



Bus Connects Route 5 – Trial Pit Photographs

TP07C



Bus Connects Route 5 – Trial Pit Photographs

TP08A



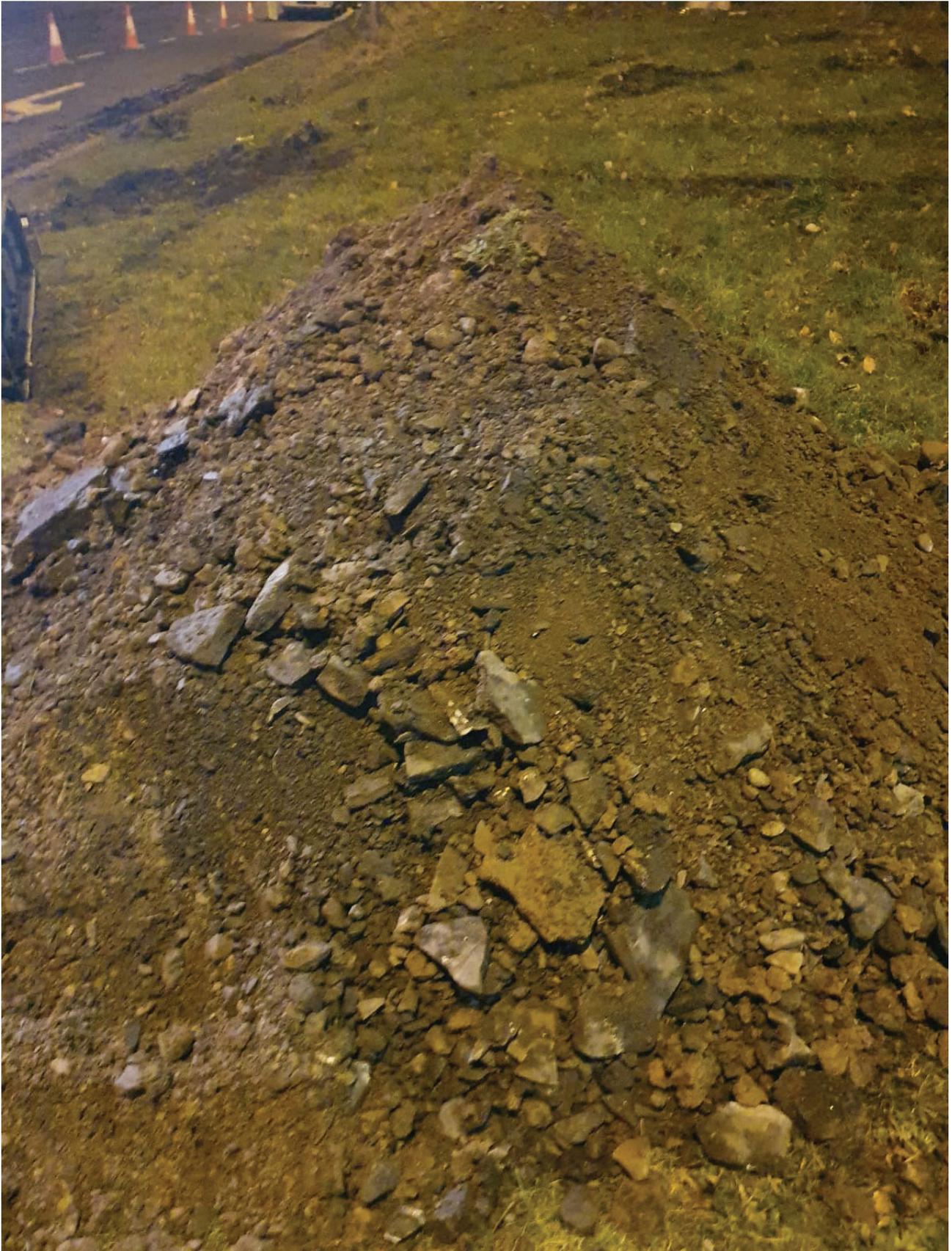
Bus Connects Route 5 – Trial Pit Photographs

TP08A



Bus Connects Route 5 – Trial Pit Photographs

TP08A



Bus Connects Route 5 – Trial Pit Photographs

TP09



TP09



APPENDIX 3 – Borehole Records





Machine : Dando 2000 + Beretta T44	Casing Diameter 200mm cased to 5.20m 96mm cased to 8.00m	Ground Level (mOD) 65.64	Client National Transport Authority	Job Number 9754-07-20
Method : Cable Percussion with Rotary follow on	Location 706597.5 E 739366.5 N	Dates 03/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50	EN				65.44	(0.20) 0.20	Brown slightly sandy slightly gravelly TOPSOIL.		
1.00	B					(1.40)	MADE GROUND: Brown slightly sandy slightly gravelly Clay with occasional fragments of cloth.		
1.00	T			1,0/1,1,1,1					
1.20-1.65	SPT(C) N=4								
1.50	EN				64.04	1.60	MADE GROUND: Grey slightly sandy slightly gravelly Clay with occasional fragments of wood and organic matter.		
2.00-2.45	SPT(C) N=5			1,0/1,1,2,1					
2.00	B								
2.00	T								
2.50	EN					(1.80)			
3.00-3.45	SPT(C) N=5			2,1/2,1,1,1					
3.00	B				62.24	3.40	Soft grey slightly sandy slightly gravelly clayey SILT.		
3.00	T					(0.60)			
3.50	EN								
4.00-4.45	SPT(C) N=31			2,3/6,7,8,10	61.64	4.00	Very stiff grey slightly sandy slightly gravelly clayey SILT.		
4.00	B					(0.30)			
4.00	T				61.34	4.30	Very stiff light grey mottled brown slightly sandy gravelly clayey SILT		
5.00				3,18/50		(0.70)			
5.00-5.16	TCR	SCR	RQD	B	60.64	5.00	Medium strong thinly to thickly laminated grey fine grained argillaceous LIMESTONE with occasional calcite veining. Distinctly weathered		
5.00				SPT(C) 50/10					
5.00				T					
6.50	100	14	9	MNI		(2.40)	5.00m-6.70m BGL - Mostly Non Intact		
6.70									
7.40	100	70	44	16	58.24	7.40	6.70m-7.40m BGL - Two fracture sets. F1: Very closely spaced, 10° to 20°, planar smooth. F2: Very closely to closely spaced, 50° to 70°, planar smooth		
8.00				5	57.64	(0.60)	Medium strong to strong thinly to thickly laminated grey fine grained argillaceous LIMESTONE with occasional calcite veining. Partially weathered		
							7.40m-7.80m BGL - F1: Closely spaced, 20° to 40°, planar smooth		
							Complete at 8.00m		

Remarks Cable percussion drilling refusal at 5.20m BGL Rotary Core follow on from 5.00m BGL due to slight collapse at base of the cable percussion hole Borehole complete at 8.00m BGL on engineers Instruction No groundwater encountered during drilling (Rotary drilling with water flush may conseal water strike) Borehole backfilled upon completion Chiselling from 5.20m to 5.20m for 1 hour.	Scale (approx)	Logged By
	1:50	JS & PC
	Figure No. 9754-07-20.R05-CP03	



Machine : Dando 2000 + Beretta T44	Casing Diameter 200mm cased to 4.00m 96mm cased to 11.00m	Ground Level (mOD) 55.65	Client National Transport Authority	Job Number 9754-07-20
Method : Cable Percussion with Rotary follow on	Location 710056.5 E 737504.1 N	Dates 02/11/2020-19/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50	EN				55.55	0.10	Brown slightly sandy slightly gravelly TOPSOIL.		
1.00	B					(0.90)	MADE GROUND: Dark grey sandy gravelly Clay with many cobbles.		
1.00	T			8,11/11,17,22	54.65	1.00	MADE GROUND: Brownish grey sandy gravelly CLAY with some sub-angular cobbles and fragments of crushed brick.		
1.20-1.55	SPT(C) 50/200								
1.50	EN								
2.00-2.04	SPT(C) 50*/40			50/					
2.00	B								
2.00	T								
2.50	EN					(3.00)			
3.00-3.34	SPT(C) 50/190			12,13/13,23,14					
3.00	B								
3.00	T								
3.50	EN								
4.00				14,11/10,21,19					
4.00-4.34	TCR	SCR	RQD	B	51.65	4.00	OVERBURDEN: Poor recovery - recovery consists of dense grey subangular to subrounded fine to coarse GRAVEL with occasional cobbles. Driller's notes - Made Ground: Brown sandy gravelly Clay with some cobbles		
4.00				SPT(C) 50/190					
4.00				T		(1.00)			
5.00-5.45	35			4,4/7,7,8,9	50.65	5.00	OVERBURDEN: Poor recovery - recovery consists of grey subangular to subrounded fine to coarse Gravel with occasional cobbles. Driller's notes: Brown sandy gravelly CLAY with some cobbles		
5.00				SPT(C) N=31					
6.50-6.95	23			3,4/4,8,8,8		(3.00)			
6.50				SPT(C) N=28					
8.00-8.45	20			12,12/8,5,7,30	47.65	8.00	Dense grey angular to subangular fine to coarse GRAVEL with some angular to subangular cobbles		
8.00				SPT(C) N=50		(0.50)			
8.50	82	51	21		47.15	8.50	Medium strong to strong thinly laminated grey fine grained LIMESTONE interbedded with medium strong thinly laminated dark grey fine grained calcareous MUDSTONE. Partially to distinctly weathered		
9.50						(2.50)	8.50m-10.40m BGL - F1: Very closely to closely spaced, 10° to 30°m planar smooth with clay staining		

Remarks Cable percussion drilling refusal at 4.00m BGL. Rotary follow on from 4.00m BGL No groundwater encountered during drilling (Rotary drilling with water flush may conseal water strike) Borehole complete at 11.00m BGL on engineers instruction. Borehole backfilled upon completion Chiselling from 2.00m to 2.20m for 1 hour. Chiselling from 4.00m to 4.00m for 1 hour.	Scale (approx)	Logged By
	1:50	JS & PC
	Figure No. 9754-07-20.R05-CP03	



Machine : Dando 2000 + Beretta T44 Flush : Core Dia : 64 mm Method : Cable Percussion with Rotary follow on	Casing Diameter 200mm cased to 4.00m 96mm cased to 11.00m	Ground Level (mOD) 55.65	Client National Transport Authority	Job Number 9754-07-20
	Location 710056.5 E 737504.1 N	Dates 02/11/2020-19/11/2020	Project Contractor Ground Investigations Ireland	Sheet 2/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.40	100	54	27							
11.00				3		44.65	11.00	10.40m-11.00m BGL - F1: Very closely to medium spaced, 10° to 20°, planar smooth Complete at 11.00m		

Remarks	Scale (approx) 1:50	Logged By JS & PC
	Figure No. 9754-07-20.R05-CP03	



Machine : Dando 2000 + Beretta T44 Flush : Water Core Dia : 64 mm Method : Cable Percussion with Rotary follow on	Casing Diameter 200mm cased to 1.00m 96mm cased to 12.70m	Ground Level (mOD) 50.32	Client National Transport Authority	Job Number 9754-07-20
	Location 708444.7 E 738509.8 N	Dates 04/12/2020	Project Contractor Ground Investigations Ireland	Sheet 1/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.00						50.12	(0.20) 0.20	TOPSOIL		
1.00-1.04	18				50/50 SPT(C) 50*/40 50/0 B	49.32	1.00	Poor recovery, recovery consists of: Dark grey slightly sandy gravelly CLAY with occasional cobbles and boulders. Gravel is medium to coarse, sub-angular to sub-rounded. (Drillers notes: Gravelly CLAY with boulders).		
1.00						(1.40)				
2.20 2.40	100	41	24			47.92	2.40	Weak to medium strong dark grey massive fine to medium grained LIMESTONE interbedded with firm dark grey slightly silty slightly sandy gravelly CLAY. Gravel is fine to coarse, sub-angular to sub-rounded. Distinctly weathered.		
						(1.65)				
3.70	100	53	38			46.27	4.05	Weak to medium strong dark grey massive fine to medium grained LIMESTONE with widely spaced, thin beds of firm dark grey slightly silty slightly sandy gravelly CLAY. Gravel is fine to coarse, sub-angular to sub-rounded. Partially to distinctly weathered.		
4.70	100	90	64							
5.20	100	58	42	6			(4.35)	2.40m - 8.40m BGL: Fracture set 1: 20-30 degrees, discontinuities are rough, undulating with clay, closely spaced. Fracture set 2: 60-65 degrees, discontinuities are rough to stepped, undulating with clay and iron staining, medium spaced.		
6.90	100	43	41							
7.50	100	61	34							
8.20 8.40	90	53	19			41.92	8.40	Medium strong dark grey massive fine grained LIMESTONE with clay and iron staining on surfaces. Partially weathered.		
9.70 10.00										

Remarks Borehole completed at 12.70m BGL. on engineers instruction. Borehole backfilled on completion. No groundwater encountered during drilling (Rotary drilling with water flush may conseal water strike) Chiselling from 1.00m to 1.00m for 1 hour.	Scale (approx) 1:50	Logged By JD/JS
	Figure No. 9754-07-20.R05-CP04	



Machine : Dando 2000 + Beretta T44 Flush : Water Core Dia : 64 mm Method : Cable Percussion with Rotary follow on	Casing Diameter 200mm cased to 1.00m 96mm cased to 12.70m	Ground Level (mOD) 50.32	Client National Transport Authority	Job Number 9754-07-20
	Location 708444.7 E 738509.8 N	Dates 04/12/2020	Project Contractor Ground Investigations Ireland	Sheet 2/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.30	100	86	86	4		37.62	12.70 (4.30)	8.40m - 12.70m BGL: Fracture set 1: 0-10 degrees, discontinuities are smooth to rough, undulating, with clay and iron smearing, very closely to closely spaced. Fracture set 2: 30-40 degrees, discontinuities are stepped, undulating, with clay and iron staining, closely spaced.		
11.20	100	76	53							
12.70	100	87	81							
12.70								Complete at 12.70m		

Remarks	Scale (approx)	Logged By
	1:50	JD/JS
	Figure No. 9754-07-20.R05-CP04	



Machine : Dando 2000 Method : Cable Percussion	Casing Diameter 200mm cased to 1.00m	Ground Level (mOD) 50.39	Client National Transport Authority	Job Number 9754-07-20
	Location 708445.1 E 738511.3 N	Dates 04/12/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
1.00-1.04 1.00	SPT(C) 50*/40 50/0 B			50/50	50.19 49.39	(0.20) 0.20 (0.80) 1.00	<p>TOPSOIL</p> <p>Brown slightly sandy gravelly CLAY with some subangular to subrounded cobbles and boulders. Gravel is subangular to subrounded fine to coarse</p> <p>Refusal at 1.00m</p>		

Remarks Refusal at 1.00m due to obstruction, Possible rock or boulder. Borehole backfilled on completion. No groundwater encountered during drilling. Chiselling from 1.00m to 1.00m for 1 hour.	Scale (approx) 1:50	Logged By JD/JS
	Figure No. 9754-07-20.R05-CP04A	



Machine : Dando 2000 + Bereta T44	Casing Diameter 200mm cased to 4.80m 96mm cased to 35.20m	Ground Level (mOD) 46.78	Client National Transport Authority	Job Number 9754-07-20
Method : Cable Percussion with Rotary follow on	Location 707796.1 E 739014.4 N	Dates 07/12/2020	Project Contractor Ground Investigations Ireland	Sheet 1/4

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.50	B					(1.50)	Soft greyish brown slightly sandy gravelly CLAY. Gravel is fine to coarse, sub-angular.		
1.00-1.45 1.00	SPT(C) N=6 B			1,1/2,1,1,2	45.28	1.50	Very soft brown slightly sandy slightly gravelly CLAY. Gravel is fine to coarse, sub-angular.		
2.00-2.45 2.00	SPT(C) N=3 B			1,0/1,0,1,1	43.98	2.80	Firm to stiff greyish brown slightly sandy gravelly CLAY. Gravel is fine to coarse, sub-angular.		▼1
3.00	B			Water strike(1) at 3.00m, rose to 2.70m in 20 mins. 2,2/2,3,3,4	43.33	3.45	Very stiff greyish brown slightly sandy gravelly CLAY with occasional sub-rounded cobbles. Gravel is fine to coarse, sub-angular.		▽1
3.00-3.45	SPT(C) N=12			4,5/6,8,13,14 SPT(C) N=41		(1.25)			
4.00-4.45	TCR	SCR	RQD	FI					
4.20	50				42.08	4.70	Poor recovery, recovery consists of: Dark brown slightly sandy gravelly CLAY with occasional boulders. (Drillers notes: Gravelly CLAY with boulders).		
5.20	33					(3.50)			
6.70-7.08 6.70	13			7,7/6,8,36 SPT(C) 50/225					
8.20-8.65 8.20	30			8,7/8,6,9,12 SPT(C) N=35	38.58	8.20	Poor recovery, recovery consists of: Grey slightly clayey medium to coarse sub-angular to sub-rounded GRAVEL with occasional cobbles.		
9.70-10.15 9.70				7,6/7,8,9,11 SPT(C) N=35	37.78	9.00	Poor recovery, recovery consists of: Grey sandy fine to coarse, sub-rounded GRAVEL., (Driller notes Gravel)		

Remarks Borehole completed at 35.20m BGL.on engineers instruction From 20.2 to 21.7 and 24.7 to 26.2 Driller notes blowing sand Borehole backfilled on completion. Groundwater encountered at 3.00m BGL Chiselling from 4.70m to 4.80m for 1 hour.	Scale (approx)	Logged By
	1:50	JS
	Figure No. 9754-07-20.R05-CP05	



Machine : Dando 2000 + Bereta T44 Flush : Core Dia: 64 mm Method : Cable Percussion with Rotary follow on	Casing Diameter 200mm cased to 4.80m 96mm cased to 35.20m	Ground Level (mOD) 46.78	Client National Transport Authority	Job Number 9754-07-20
	Location 707796.1 E 739014.4 N	Dates 07/12/2020	Project Contractor Ground Investigations Ireland	Sheet 2/4

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
11.20-11.65 11.20	26				9,8/8,7,9,7 SPT(C) N=31	35.58	(2.20) 11.20	Poor recovery, recovery consists of: Grey sandy fine to coarse, sub-rounded GRAVEL., (Driller notes Gravel with clay)		
12.70-13.15 12.70	20				4,5/4,4,5,6 SPT(C) N=19	34.08	(1.50) 12.70	Poor recovery, recovery consists of: Grey medium to coarse, sub-rounded to sub-angular GRAVEL. (Driller notes Gravel with clay)		
14.20-14.65 14.20	13				5,5/4,5,4,6 SPT(C) N=19	31.08	(3.00) 15.70	Poor recovery, recovery consists of: Dark brown sandy CLAY. (Driller notes sandy Clay)		
15.70-16.15 15.70	26				6,8/4,5,4,6 SPT(C) N=19	28.08	(3.00) 18.70	Poor recovery, recovery consists of: Dark brown fine to coarse SAND.(Driller notes Sand)		
17.20-17.65 17.20	23				7,9/6,8,9,7 SPT(C) N=30					
18.70-19.15 18.70	6				9,8/6,7,8,8 SPT(C) N=29					

Remarks	Scale (approx)	Logged By
	1:50	JS
	Figure No. 9754-07-20.R05-CP05	



Machine : Dando 2000 + Bereta T44 Flush : Core Dia: 64 mm Method : Cable Percussion with Rotary follow on	Casing Diameter 200mm cased to 4.80m 96mm cased to 35.20m	Ground Level (mOD) 46.78	Client National Transport Authority	Job Number 9754-07-20
	Location 707796.1 E 739014.4 N	Dates 07/12/2020	Project Contractor Ground Investigations Ireland	Sheet 3/4

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
20.20-20.65 20.20	10				7,7/8,9,10,12 SPT(C) N=39			20.2 to 21.7 Driller notes blowing sand		
21.70-22.15 21.70	26				9,7/6,7,9,8 SPT(C) N=30		(6.30)			
23.20-23.65 23.20	23				8,8/6,9,7,11 SPT(C) N=33					
24.70-25.15 24.70	30				9,7/10,11,14,12 SPT(C) N=47	21.78	25.00	24.7 to 26.2 Driller notes blowing sand		
26.20	50						(2.40)	Poor recovery, recovery consists of: Brown clayey gravelly Cobbles with occasional boulders. (Driller notes Clay with boulders)		
27.70-28.08 27.70	50				9,11/8,12,30 SPT(C) 50/225	19.38	27.40	Very stiff brown slightly sandy gravelly CLAY with occasional cobbles and boulders. Gravel is fine to coarse, sub-angular to sub-rounded.		
29.20-29.50 29.20	13				7,9/14,36 SPT(C) 50/150		(4.80)			

Remarks	Scale (approx)	Logged By
	1:50	JS
	Figure No. 9754-07-20.R05-CP05	



Machine : Dando 2000 + Bereta T44 Flush : Core Dia: 64 mm Method : Cable Percussion with Rotary follow on	Casing Diameter 200mm cased to 4.80m 96mm cased to 35.20m	Ground Level (mOD) 46.78	Client National Transport Authority	Job Number 9754-07-20
	Location 707796.1 E 739014.4 N	Dates 07/12/2020	Project Contractor Ground Investigations Ireland	Sheet 4/4

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
30.70-31.08 30.70					8, 11/10, 13, 27 SPT(C) 50/225					
	50									
32.20-32.43 32.20					12, 15/50 SPT(C) 50/75	14.58	32.20	Very stiff dark grey slightly sandy gravelly CLAY with occasional cobbles and boulders. Gravel is fine to coarse, sub-angular to sub-rounded.		
	50									
33.70-33.70 33.70					25/50 SPT(C) 25*/0 50/0		(2.80)			
	30									
35.20						11.78 11.58	35.00 (0.20) 35.20	Grey slightly clayey medium to coarse sub-angular GRAVEL.		
								Complete at 35.20m		

Remarks	Scale (approx)	Logged By
	1:50	JS
	Figure No. 9754-07-20.R05-CP05	



Machine : Beretta T44 Flush : Water Core Dia: 64 mm Method : Rotary Cored	Casing Diameter 96mm cased to 16.50m	Ground Level (mOD) 55.93	Client National Transport Authority	Job Number 9754-07-20
	Location 707536.4 E 739250.3 N	Dates 27/11/2020-30/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.00	15	0	0				(2.00)	Poor recovery, recovery consists of MADE GROUND: grey/brown clayey angular to sub-angular fine to coarse Gravel with occasional fragments of concrete. Driller notes: Clay fill.			
2.00 2.00-2.12	20	0	0		20,50/ SPT(C) 70*/115	53.93	2.00	Poor recovery, recovery consists of dark grey slightly clayey sub-angular to sub-rounded fine to coarse GRAVEL with occasional sub-angular to sub-rounded cobbles. Driller notes: Clayey sandy GRAVEL.			
3.50 3.50-3.52	35	0	0		50/ SPT(C) 50*/20		(4.30)				
5.00-5.10 5.20	77	15	0		17,50/ SPT(C) 67*/95						
6.20 6.50 6.80	100	30	0	11 NI		49.63	6.30	Weak to medium strong dark grey thinly laminated calcareous MUDSTONE. Distinctly to partially weathered. 6.20m - 6.80m BGL Fracture set 1: 40-50 degrees, discontinuities are planar smooth with clay smearing, closely spaced. 6.80m - 7.80m Non-Intact			
7.80 8.00	100	63	7	25			(3.70)	7.80m - 9.50m Fracture set 1: 20-30 degrees, discontinuities are planar to undulating smooth, clean, very closely to closely spaced. Fracture set 2: 80-90 degrees, undulating rough with some oxidation along fracture surfaces.			
9.50 10.00				NI				9.50m - 10.0m Non-Intact			

Remarks Borehole complete 16.50m on engineers instruction. Standpipe installed, sealed from 16.50m to 7.00m BGL with bentonite, slotted from 7.00m to 1.00m with a pea gravel surround, sealed from 1.00m to GL with a cement bentonite surround and a flush cover. No groundwater encountered during drilling (Rotary drilling with water flush may conceal water strike)	Scale (approx)	Logged By
	1:50	Tmcl
	Figure No. 9754-07-20.R05-RC01	



Machine : Beretta T44 Flush : Water Core Dia: 64 mm Method : Rotary Cored	Casing Diameter 96mm cased to 16.50m	Ground Level (mOD) 55.93	Client National Transport Authority	Job Number 9754-07-20
	Location 707536.4 E 739250.3 N	Dates 27/11/2020-30/11/2020	Project Contractor Ground Investigations Ireland	Sheet 2/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
11.00	100	73	57	8		45.93	10.00	Medium strong dark grey thinly laminated calcareous MUDSTONE. Partially weathered. 10.0m - 14.0m Fracture set 1: 0-20 degrees, undulating to stepped rough, clean, close to medium spacing. Fracture set 2: 50-60 degrees, planar smooth, clay staining, closely spaced.			
	100	50	33			(4.00)					
12.50				4				Medium strong to strong dark grey thinly laminated calcareous MUDSTONE. Unweathered. 14.0m - 16.50m Fracture set 1: 20-30 degrees, stepped smooth, clean.			
	100	87	70			41.93	14.00				
14.00	100	100	100	1				Complete at 16.50m			
15.50	100	100	100			39.43	16.50				
16.50											

Remarks	Scale (approx)	Logged By
	1:50	Tmcl
	Figure No. 9754-07-20.R05-RC01	



Machine : Beretta T44 Flush : Water Core Dia: 64 mm Method : Rotary Cored	Casing Diameter 96mm cased to 10.10m	Ground Level (mOD) 46.58	Client National Transport Authority	Job Number 9754-07-20
	Location 708178.6 E 738712.8 N	Dates 17/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.30				NI		46.38 46.28	(0.20) 0.20 0.30	Brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets		
0.70	90	40	26	20			(1.00)	MADE GROUND: Brown slightly sandy gravelly Clay with frequent angular cobbles. Gravel is angular to subangular fine to coarse		
1.30						45.28	1.30	Weak to medium strong thinly laminated dark grey fine grained calcareous MUDSTONE. Distinctly weathered 0.30m-0.70m BGL - Mostly Non Intact 0.70m-1.30m BGL - F1: Very closely spaced, 60° to 80°, undulating smooth		
2.00				6				Medium strong to strong thinly laminated dark grey fine grained calcareous MUDSTONE with occasional specs of pyrite. Partially to distinctly weathered 1.30m-3.00m BGL - F1: Very closely to closely spaced, 60° to 80°, undulating smooth		
3.00	100	76	53							
3.50				4						
4.60	100	77	73					3.00m-4.60m BGL - F1: Closely to medium spaced, 60° to 80°, undulating smooth		
5.00				NI						
5.30								4.60m-5.30m BGL - Mostly Non Intact		
6.50	100	79	65				(8.80)			
8.00				3						
	100	100	85							
9.50								5.30m-10.10m BGL - F1: Closely to medium spaced, 10° to 40°, undulating smooth to rough		
	100	91	79							
	100	95	77							

Remarks Borehole complete at 10.10m BGL on engineers instruction. Borehole backfilled upon completion No groundwater encountered during drilling (Rotary drilling with water flush may conceal water strike)	Scale (approx)	Logged By
	1:50	PC
	Figure No. 9754-07-20.R05-RC03	



Machine : Beretta T44 Flush : Water Core Dia: 64 mm Method : Rotary Cored	Casing Diameter 96mm cased to 10.10m	Ground Level (mOD) 46.58	Client National Transport Authority	Job Number 9754-07-20
	Location 708178.6 E 738712.8 N	Dates 17/11/2020	Project Contractor Ground Investigations Ireland	Sheet 2/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.10						36.48	10.10	Complete at 10.10m		

Remarks	Scale (approx)	Logged By
	1:50	PC
Figure No.		
9754-07-20.R05-RC03		



Machine : Beretta T44 Flush : Water Core Dia: 64 mm Method : Rotary Cored	Casing Diameter 96mm cased to 10.00m	Ground Level (mOD) 45.40	Client National Transport Authority	Job Number 9754-07-20
	Location 708240 E 738732.9 N	Dates 17/11/2020	Project Contractor Ground Investigations Ireland	Sheet 1/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.70	68	0	0	MNI		44.70	(0.70)	Brownish grey angular to subangular fine to coarse GRAVEL with occasional angular to subangular cobbles			
0.70							Weak thinly laminated dark grey fine grained calcareous MUDSTONE. Distinctly weathered				
2.00	100	73	73	3		43.15	(1.55)	0.70m-2.25m BGL - Mostly Non Intact			
2.25							Medium strong to strong thinly laminated dark grey fine grained calcareous MUDSTONE. Partially to distinctly weathered with occasional calcite veining				
3.50	100	48	37	MNI				2.25m-4.50m BGL - F1: Closely to medium spaced, 20° to 50°, undulating rough with occasional clay infilling/staining			
4.50							4.50m-5.00m BGL - Mostly Non Intact				
5.00	100	73	61	3				5.00m-9.00m BGL - F1: Closely to medium spaced, 40° to 60°, undulating smooth to rough with occasional clay infilling/staining			
6.50							9.00m-9.50m BGL - Mostly Non Intact				
8.00	100	63	63	MNI				9.50m-10.00m BGL - F1: Closely spaced, 10°			
9.00											
9.50	100	100	100	1							
10.00											

Remarks
Borehole complete at 10.00m BGL on engineers instruction.
50mm slotted standpipe installed from 3.40m to 1.00m BGL with pea gravel surrounds, plain standpipe installed from 1.00m BGL to ground level with bentonite surrounds and flush cover
No groundwater encountered during drilling (Rotary drilling with water flush may conceal water strike)

Scale (approx)
1:50

Logged By
PC

Figure No.
9754-07-20.R5-RC04



Machine : Beretta T44		Casing Diameter 96mm cased to 10.00m		Ground Level (mOD) 45.40		Client National Transport Authority		Job Number 9754-07-20	
Flush : Water		Location 708240 E 738732.9 N		Dates 17/11/2020		Project Contractor Ground Investigations Ireland		Sheet 2/2	
Core Dia: 64 mm									
Method : Rotary Cored									

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
						35.40	10.00	to 20°, undulating smooth to rough with occasional clay staining Complete at 10.00m			

Remarks	Scale (approx)	Logged By
	1:50	PC
Figure No. 9754-07-20.R5-RC04		



Machine : Beretta T44 Flush : Water Core Dia: 64 mm Method : Rotary Cored	Casing Diameter 96mm cased to 10.00m	Ground Level (mOD) 53.43	Client National Transport Authority	Job Number 9754-07-20
	Location 708709.3 E 738399.7 N	Dates 03/12/2020	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
2.00	12					51.43	(2.00)	Poor recovery, recovery consists of: MADE GROUND: Grey slightly clayey fine to coarse angular Gravel with rare concrete fragments. (Gravel is of limestone mostly). Drillers notes: Clay fill.		
3.50	23					49.93	(1.50)	Poor recovery, recovery consists of: Grey/brown clayey angular medium to coarse Gravel. (Drillers notes: Yellow brown boulder CLAY).		
4.30	73	40	33			49.13	(0.80)	Grey/brown clayey angular medium to coarse GRAVEL. Possible weathered bedrock. (Drillers notes: Yellow brown boulder CLAY).		
5.00				7				Medium strong to strong dark grey extremely to very closely laminated fine to medium grained LIMESTONE with some calcite rich veins and clay smearing. Partially weathered.		
5.30										
6.30	100	90	86	3				4.30m - 10.0m BGL: Fracture set 1: 30-40 degrees, discontinuities are rough to stepped, undulating with clay smearing, very closely to medium spaced. Fracture set 2: 5-20 degrees, discontinuities are rough to stepped, undulating, clean, closely to medium spaced.		
6.50										
8.00	93	86	79	5			(5.70)			
9.10	100	95	87							
9.40										
9.50	100	100	90	3						
10.00						43.43	10.00			

Remarks Borehole complete at 10.00m BGL on engineers instruction. Borehole backfilled on completion. No groundwater encountered during drilling (Rotary drilling with water flush may conseal water strike)	Scale (approx)	Logged By
	1:50	JS
	Figure No. 9754-07-20.R05-RC05	



Machine : Beretta T44 Flush : Water Core Dia: 64 mm Method : Rotary Cored	Casing Diameter 96mm cased to 12.00m	Ground Level (mOD) 53.12	Client National Transport Authority	Job Number 9754-07-20
	Location 709261.5 E 737958.4 N	Dates 04/03/2021	Project Contractor Ground Investigations Ireland	Sheet 1/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
2.00 2.00-2.25	33				2,2/3,47 SPT(C) 50/100	52.92	(0.20) 0.20	Brown sandy TOPSOIL with occasional rootlets		
							(0.60)	MADE GROUND: Dark grey angular to subangular fine to coarse Gravel with many angular cobbles and boulders		
						52.32	0.80	Stiff light brown slightly gravelly sandy CLAY with many angular to subangular cobbles of Limestone and occasional angular boulders		
							(1.40)			
3.50 3.50-3.95	23				3,3/2,2,3,4 SPT(C) N=11	50.92	2.20	Poor recovery. Recovery consists of grey slightly clayey angular to subangular fine to coarse Gravel with finer material washed away by flush (Firm) Driller's notes: Light brown boulder Clay		
							(2.80)			
5.00 5.00-5.45	39				6,6/10,12,14,14 SPT(C) N=50	48.12	5.00	Very stiff greyish brown slightly sandy gravelly CLAY with frequent cobbles and occasional boulders of Limestone		
							(4.60)			
6.50 6.50-6.80	87				10,10/15,35 SPT(C) 50/150					
							(4.60)			
8.00 8.00-8.16	87				7,18/50 SPT(C) 50/10					
9.50 9.50-9.52 9.60	83				25/50 SPT(C) 25*/10 50/10	43.52	9.60	Medium strong to strong thinly laminated to thinly bedded dark grey fine to medium grained argillaceous LIMESTONE. Partially weathered with occasional calcite		

Remarks Borehole completed in R05-TP08A. Stratigraphic details from 0.00m - 2.20m BGL as per R05-TP08A Borehole complete at 12.00m BGL on engineers instruction No groundwater encountered during drilling (Rotary drilling with water flush may conseal water strike)	Scale (approx)	Logged By
	1:50	PC
	Figure No. 9754-07-20.R05-RC06	



Machine : Beretta T44	Casing Diameter 96mm cased to 12.00m	Ground Level (mOD) 53.12	Client National Transport Authority	Job Number 9754-07-20
Flush : Water	Location 709261.5 E 737958.4 N	Dates 04/03/2021	Project Contractor Ground Investigations Ireland	Sheet 2/2
Core Dia: 64 mm				
Method : Rotary Cored				

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
10.50	93	67	57	1				veining 9.60m-10.80m BGL - F1: Medium to widely spaced, 0° to 10°, undulating smooth with occasional clay infill		
11.00				MNI			(2.40)	10.80m-11.50m BGL - Mostly Non Intact. Recovery indicates two fracture sets - F1: Closely spaced, 0° to 10°, undulating smooth with brown staining. F2: One subvertical fracture, 80° to 90°, undulating smooth to rough with brown staining and clay infill		
11.50	100	67	56	2				11.50m-12.00m BGL - F1: Medium spaced, 0° to 10°, undulating smooth with brown staining		
12.00						41.12	12.00	Complete at 12.00m		

Remarks	Scale (approx)	Logged By
	1:50	PC
	Figure No. 9754-07-20.R05-RC06	



Machine : Beretta T44 Flush : Water Core Dia: 64 mm Method : Rotary Cored	Casing Diameter 96mm cased to 17.30m	Ground Level (mOD) 57.59	Client National Transport Authority	Job Number 9754-07-20
	Location 709003.9 E 738138.2 N	Dates 12/03/2021-14/03/2021	Project Contractor Ground Investigations Ireland	Sheet 1/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
2.30						57.39	(0.20)	Brown slightly sandy slightly gravelly TOPSOIL		
2.30-2.75	30				3,5/7,11,15,10 SPT(C) N=43		(2.10)	Poor recovery. Recovery consists of brown/grey clayey angular to subrounded fine to coarse Gravel with occasional cobbles of mudstone and limestone with finer material washed away by flush. Driller's notes: Brown boulder Clay		
3.80						55.29	2.30	Poor recovery. Recovery consists of grey clayey subangular to subrounded fine to coarse Gravel with occasional cobbles of limestone with finer material washed away by flush (very stiff). Driller's notes: Brown boulder Clay.		
3.80-4.25	21				4,6/5,8,10,13 SPT(C) N=36					
5.30							(7.70)			
5.30-5.62	44				16,9/25,19,6 SPT(C) 50/170					
6.80										
6.80-7.20	31				12,11/15,17,12,6 SPT(C) 50/250					
8.30										
8.30-8.75	13				7,8/10,9,15,12 SPT(C) N=46					
9.80										
9.80-10.25	19				5,5/7,6,4,6 SPT(C) N=23					
10.00										

Remarks Borehole complete at 17.30m BGL on engineers instruction. No groundwater encountered during drilling (Rotary drilling with water flush may conseal water strike)	Scale (approx) 1:50	Logged By PC
	Figure No. 9754-07-20.R05-RC07	



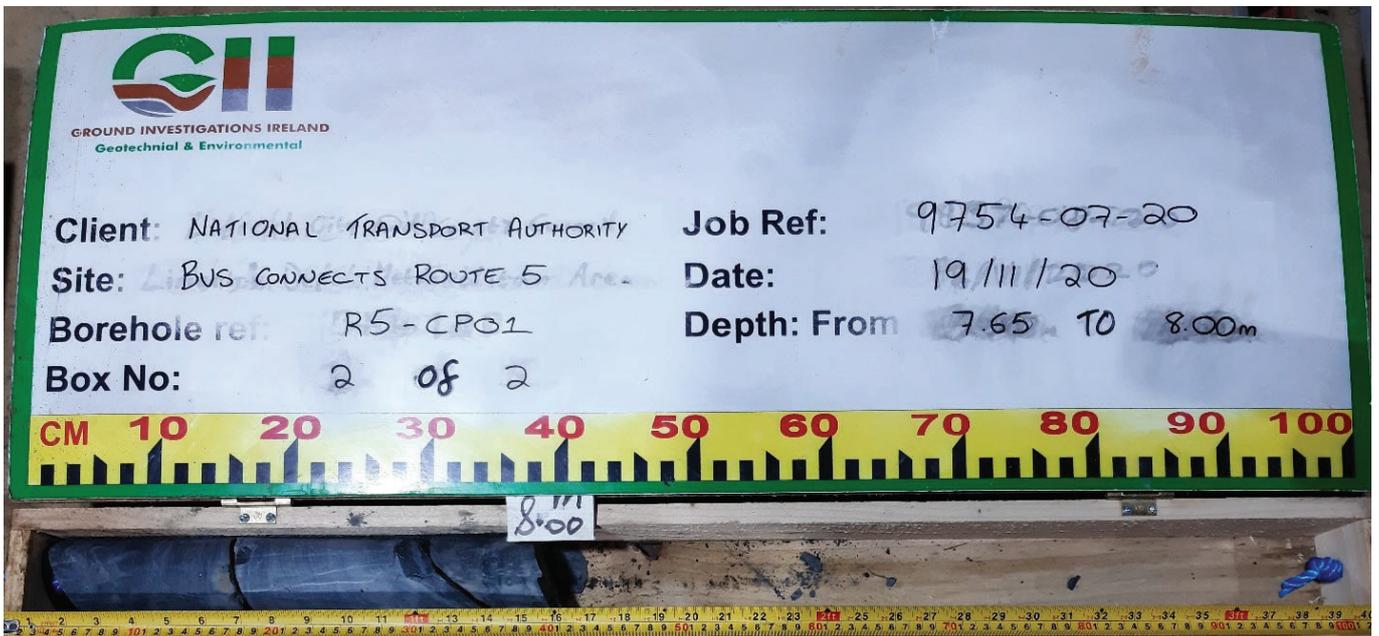
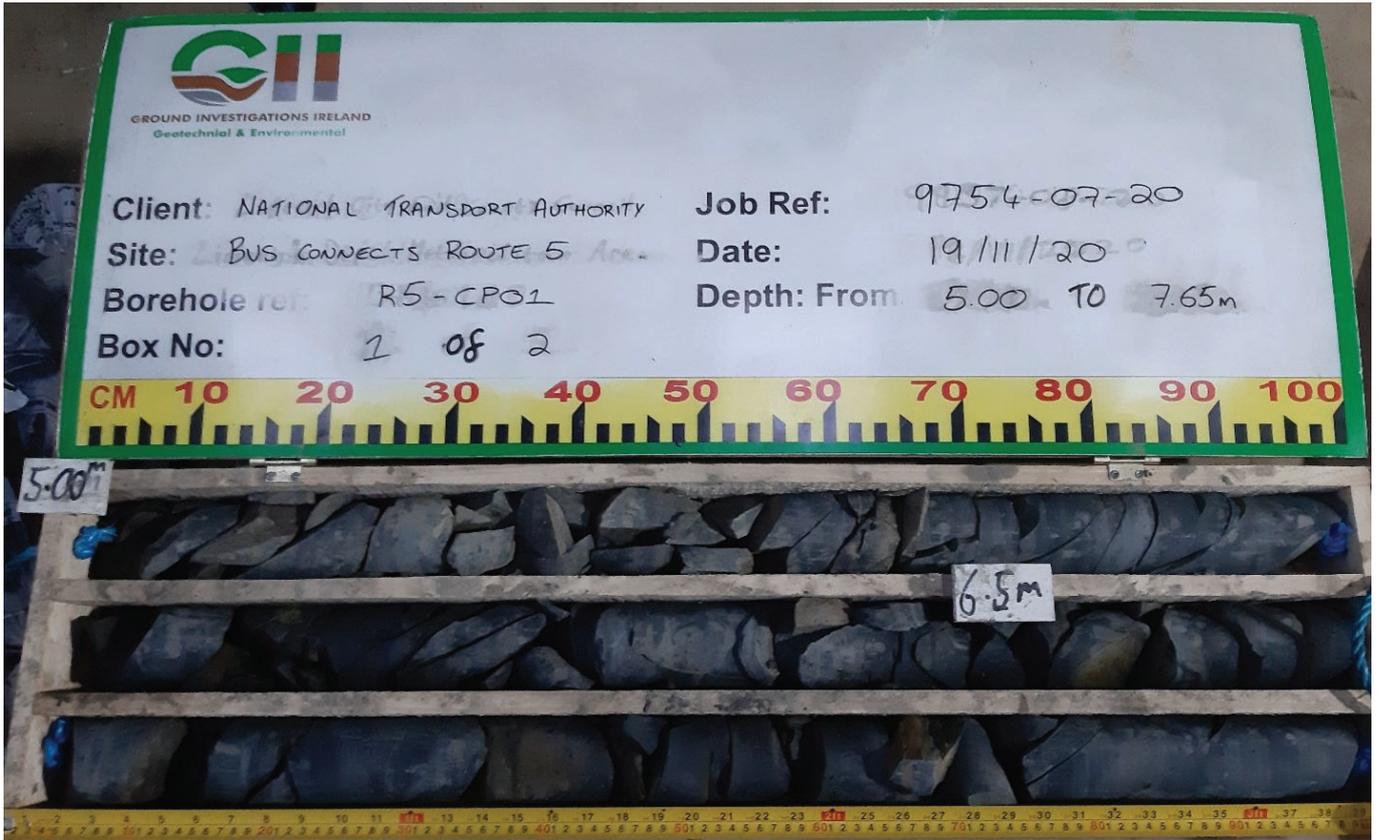
Machine : Beretta T44 Flush : Water Core Dia: 64 mm Method : Rotary Cored	Casing Diameter 96mm cased to 17.30m	Ground Level (mOD) 57.59	Client National Transport Authority	Job Number 9754-07-20
	Location 709003.9 E 738138.2 N	Dates 12/03/2021- 14/03/2021	Project Contractor Ground Investigations Ireland	Sheet 2/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
11.30	100	11		NI		47.59	10.00 (0.60)	Possible weathered rock recovered as grey angular to subangular fine to coarse Gravel of limestone and mudstone		
12.80	100	10		NI		46.99	10.60	Weak to medium strong thinly laminated dark grey MUDSTONE interbedded with weak to medium strong thinly laminated to thinly bedded grey fine grained LIMESTONE. Distinctly weathered with occasional calcite veining		
14.30	100	14	7				(5.10)	10.00m-15.00m BGL: Mostly Non Intact		
15.00	100	30	13							
15.80	100	48	8	19		41.89	15.70 (1.60)	Medium strong thinly laminated dark grey MUDSTONE. Partially to distinctly weathered with occasional calcite veining and rare specs/bands of pyrite		
17.30						40.29	17.30	Complete at 17.30m		

Remarks	Scale (approx)	Logged By
	1:50	PC
	Figure No. 9754-07-20.R05-RC07	

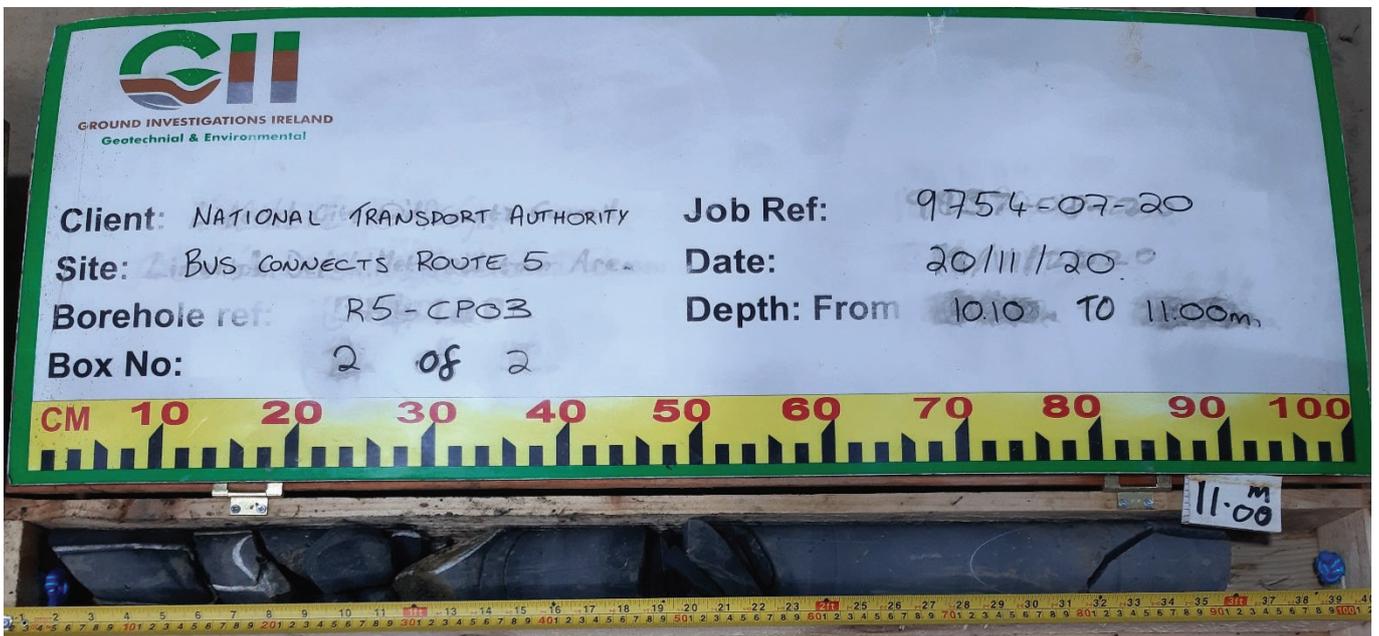
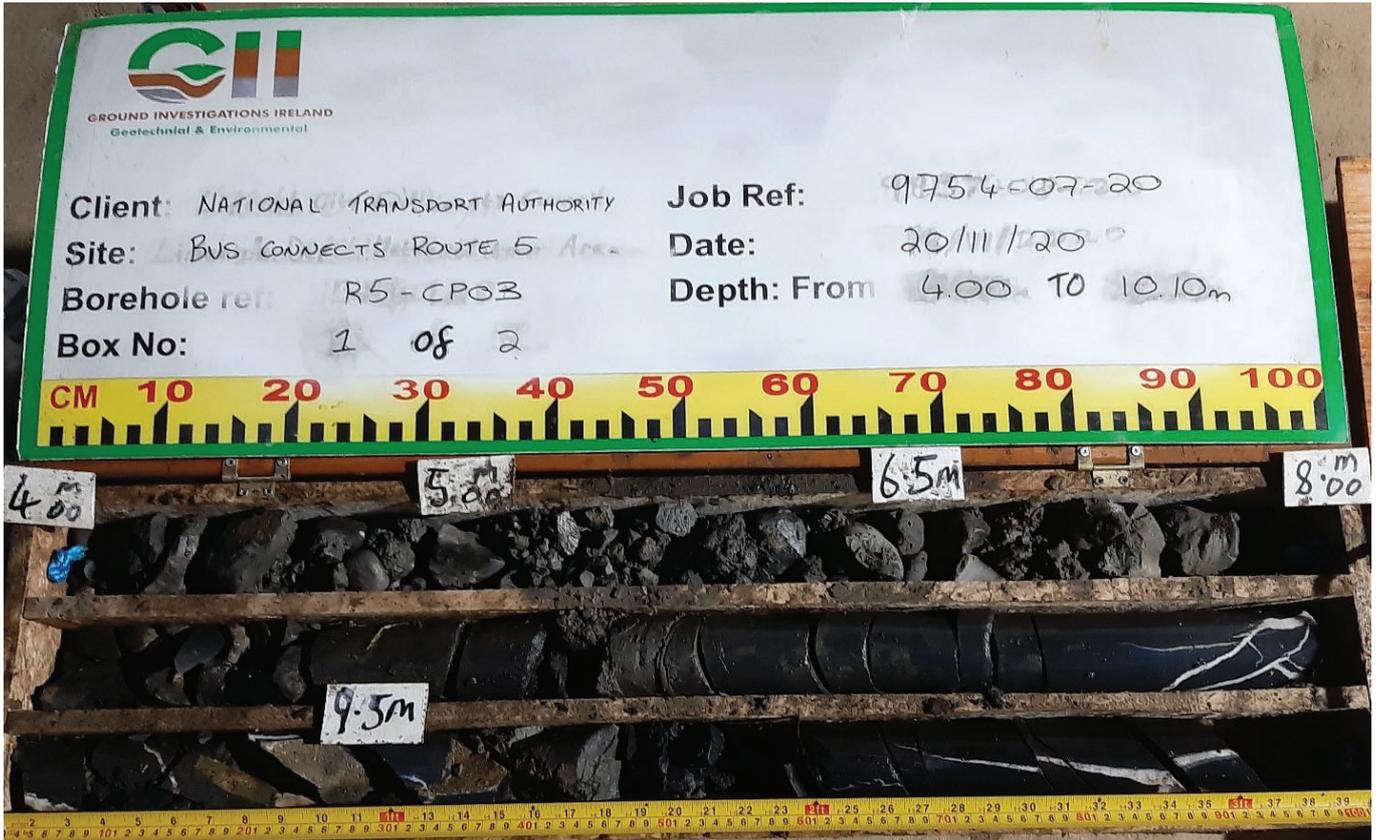
Bus Connect Route 5 – Rotary Core Photographs

R05-CP01



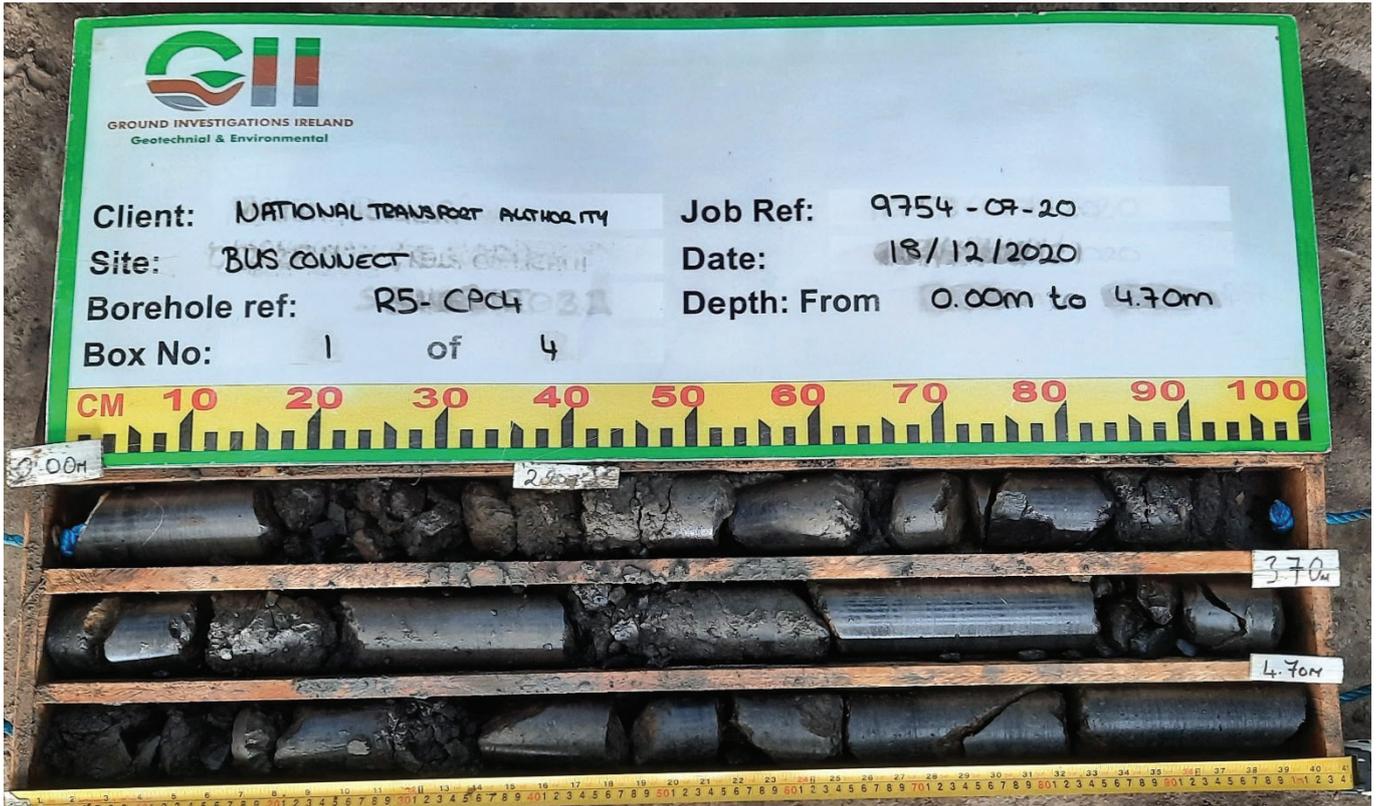
Bus Connect Route 5 – Rotary Core Photographs

R05-CP03



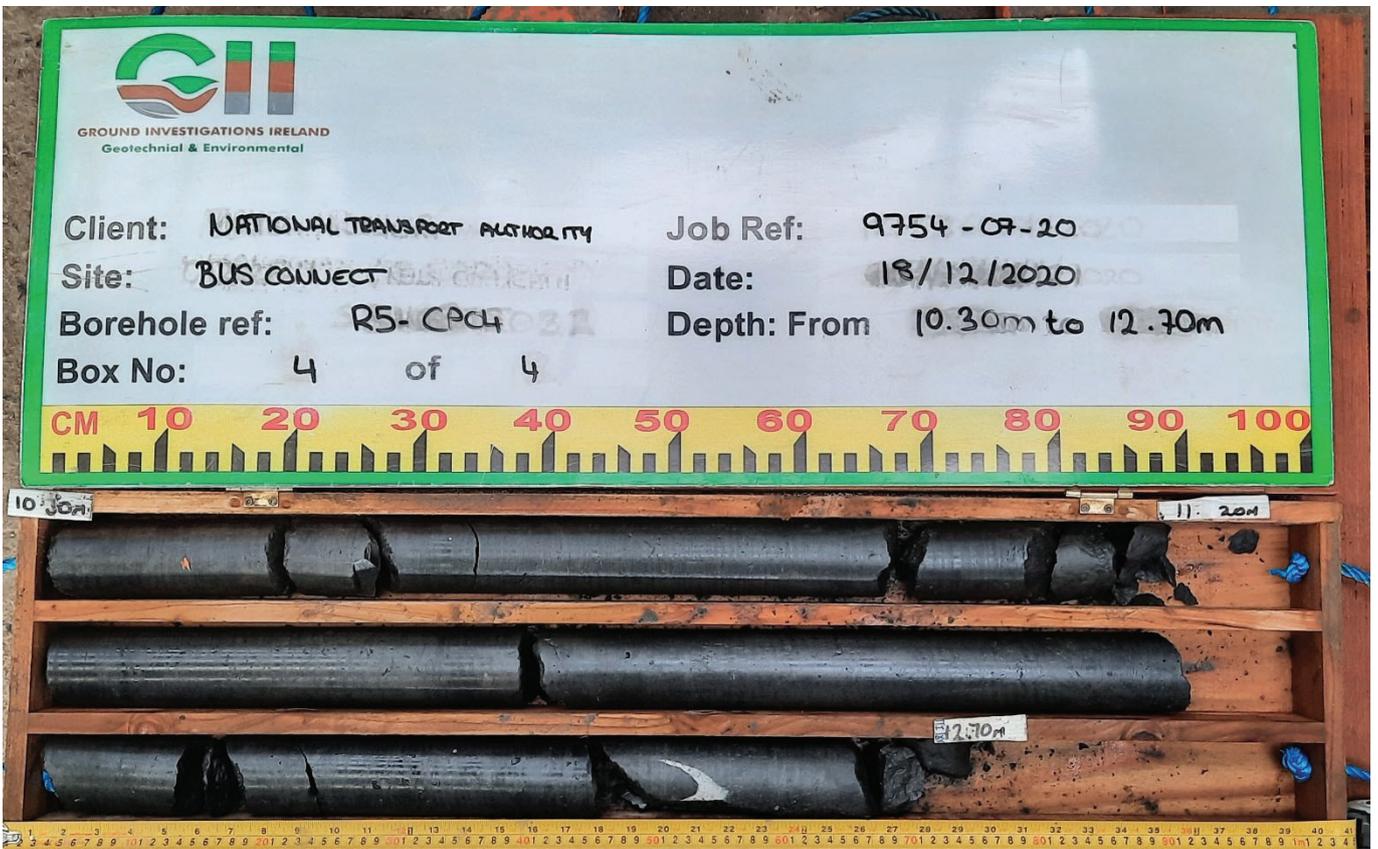
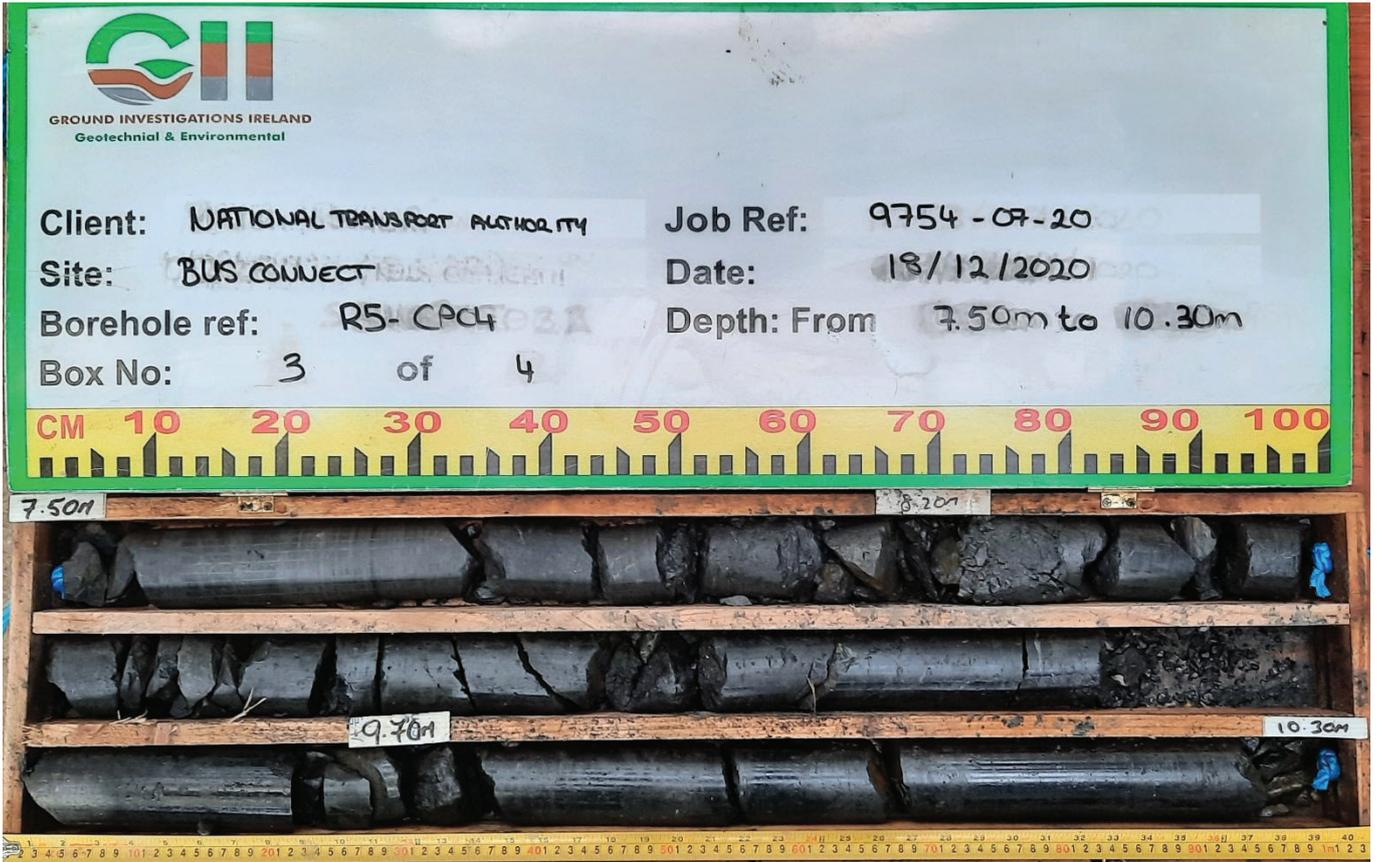
Bus Connect Route 5 – Rotary Core Photographs

R05-CP04



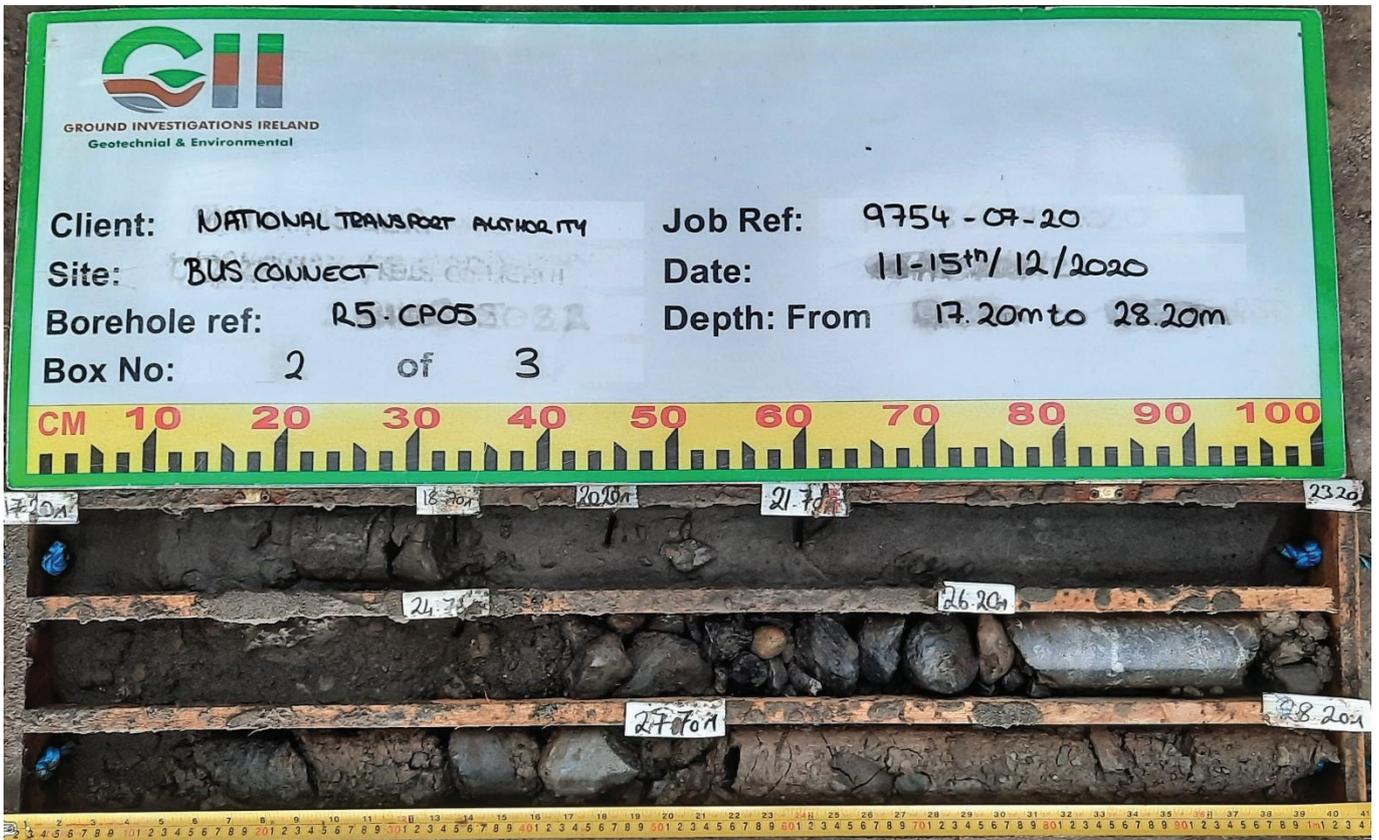
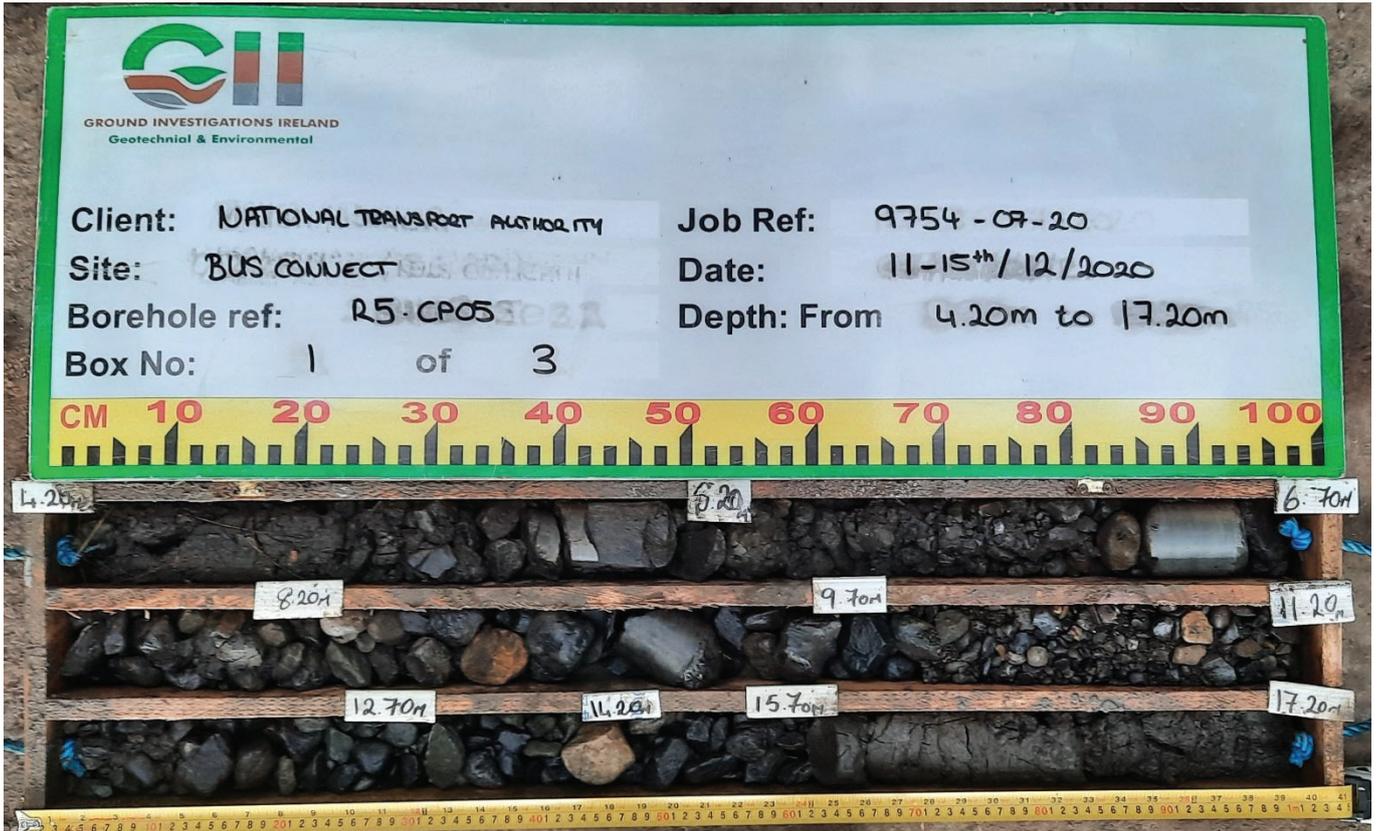
Bus Connect Route 5 – Rotary Core Photographs

R05-CP04



Bus Connect Route 5 – Rotary Core Photographs

R05-CP05



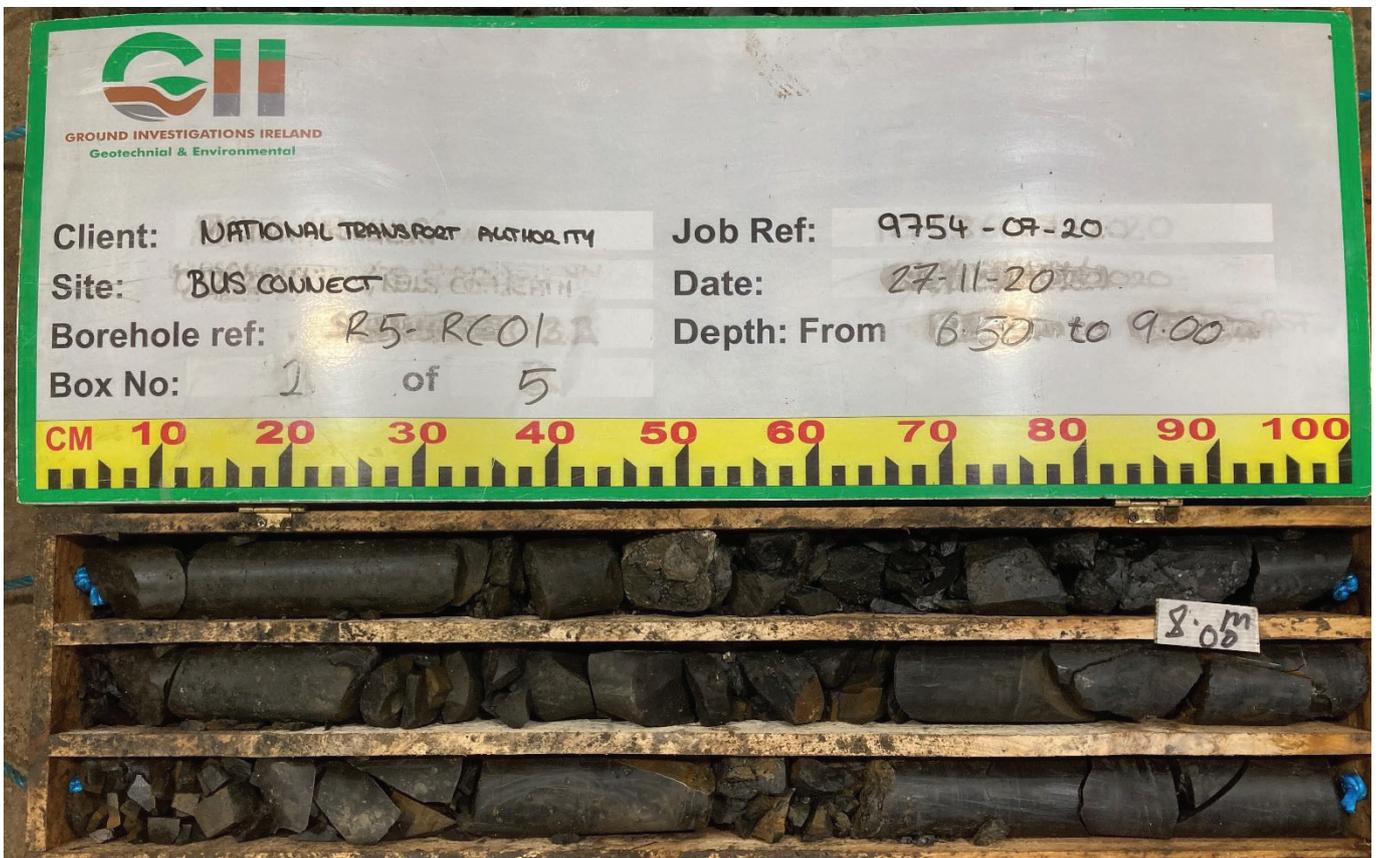
Bus Connect Route 5 – Rotary Core Photographs

R05-CP05



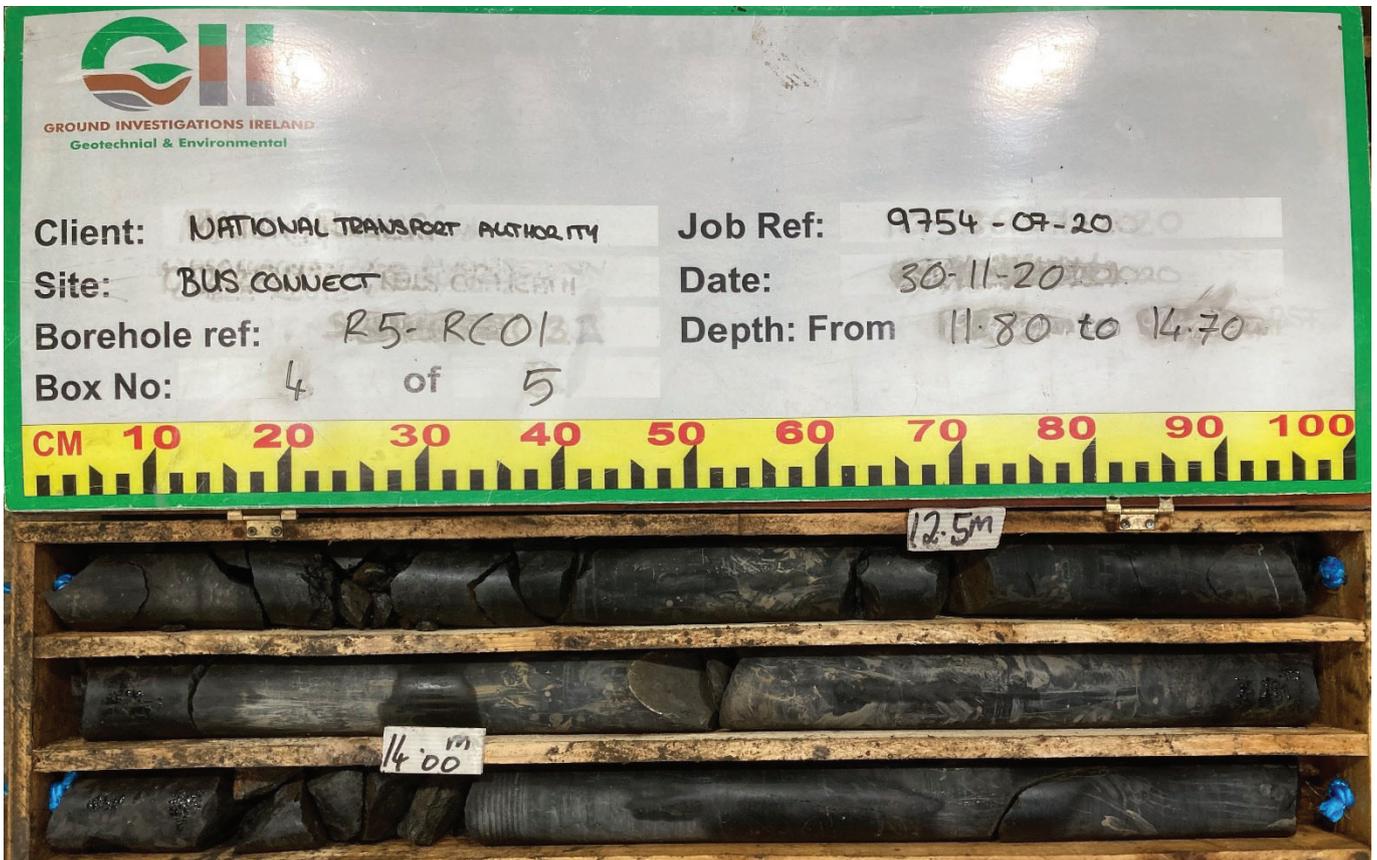
Bus Connects Route 5 – Rotary Core Photographs

R05-RC01



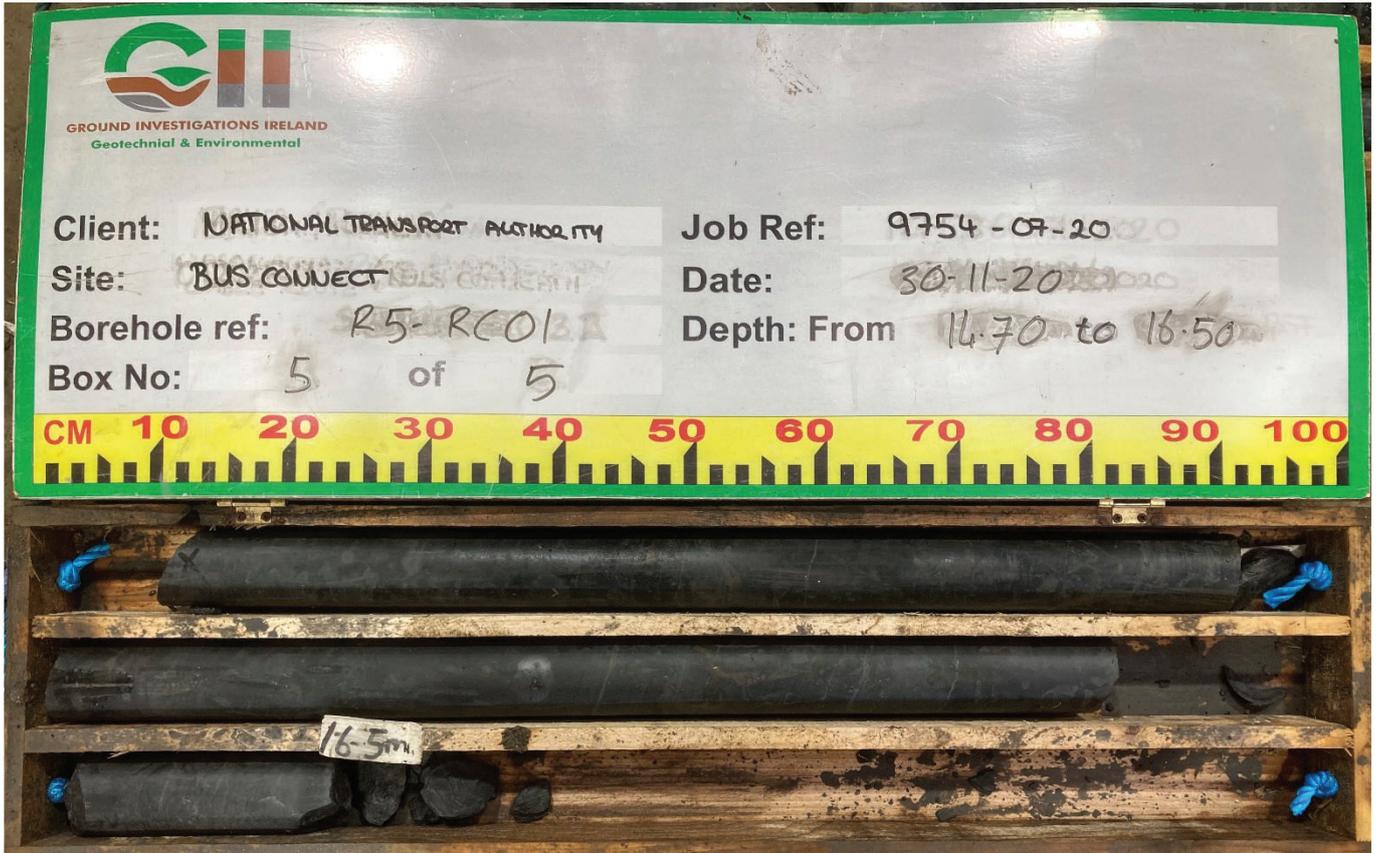
Bus Connects Route 5 – Rotary Core Photographs

R05-RC01



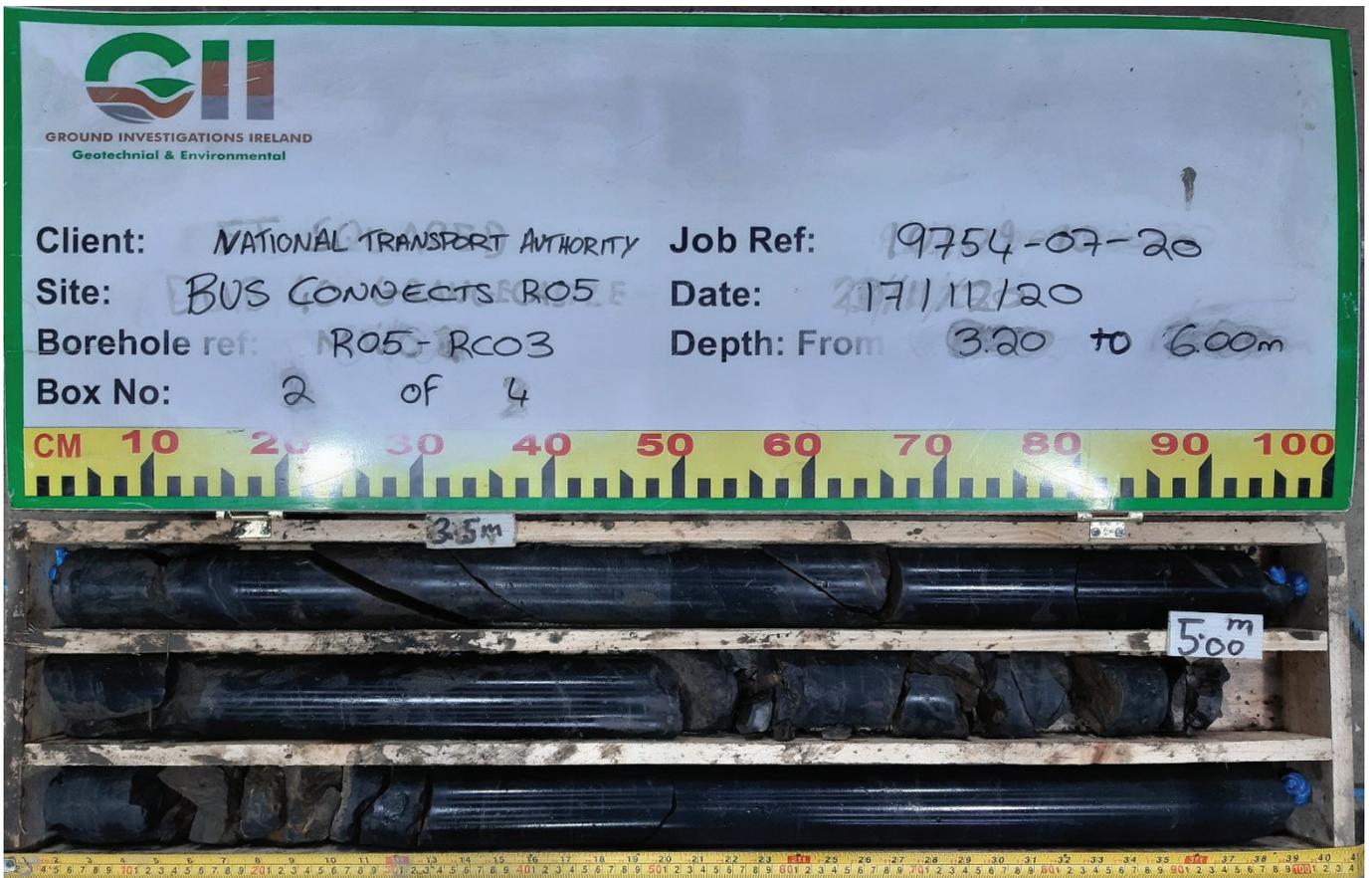
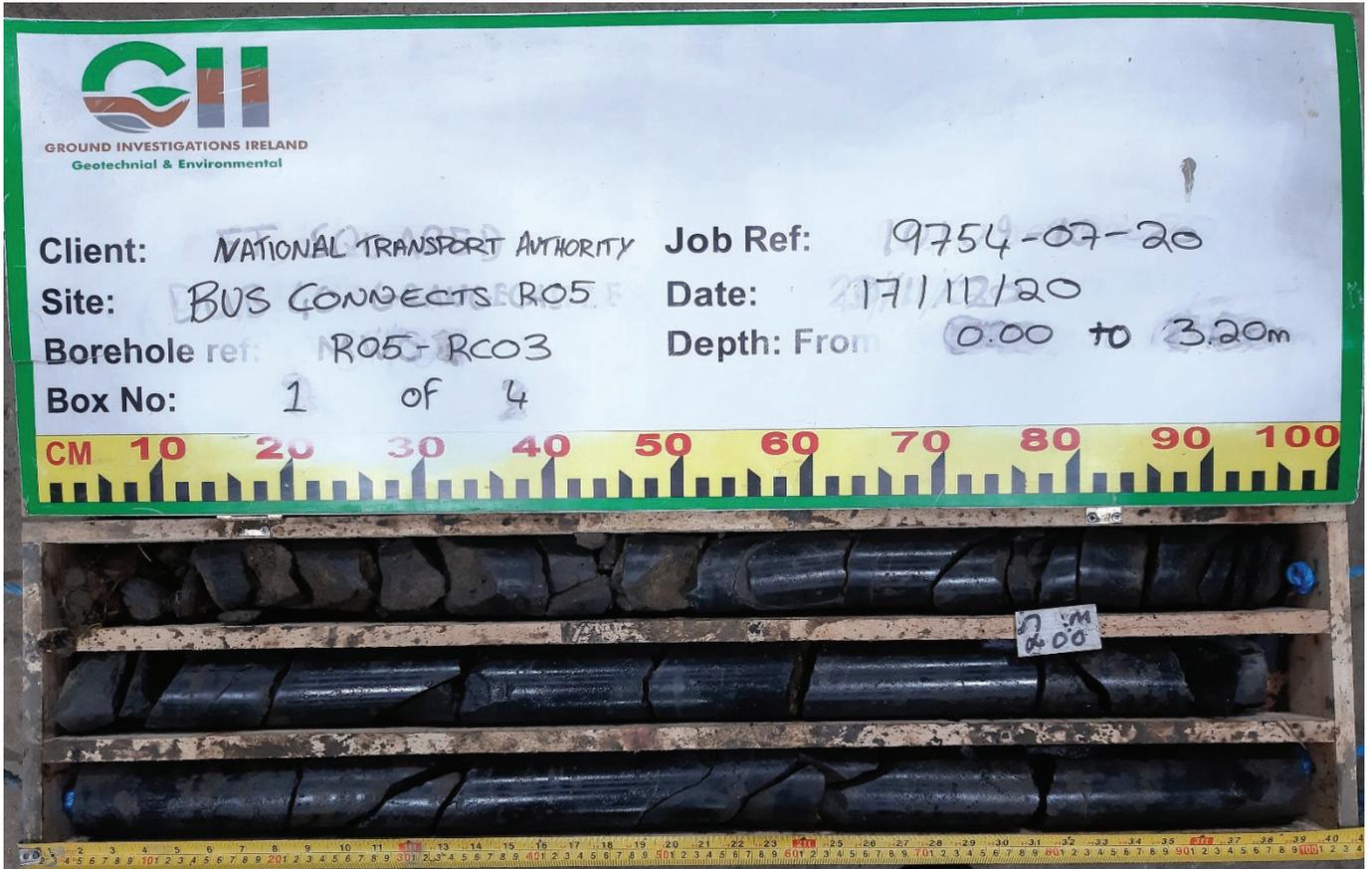
Bus Connects Route 5 – Rotary Core Photographs

R05-RC01



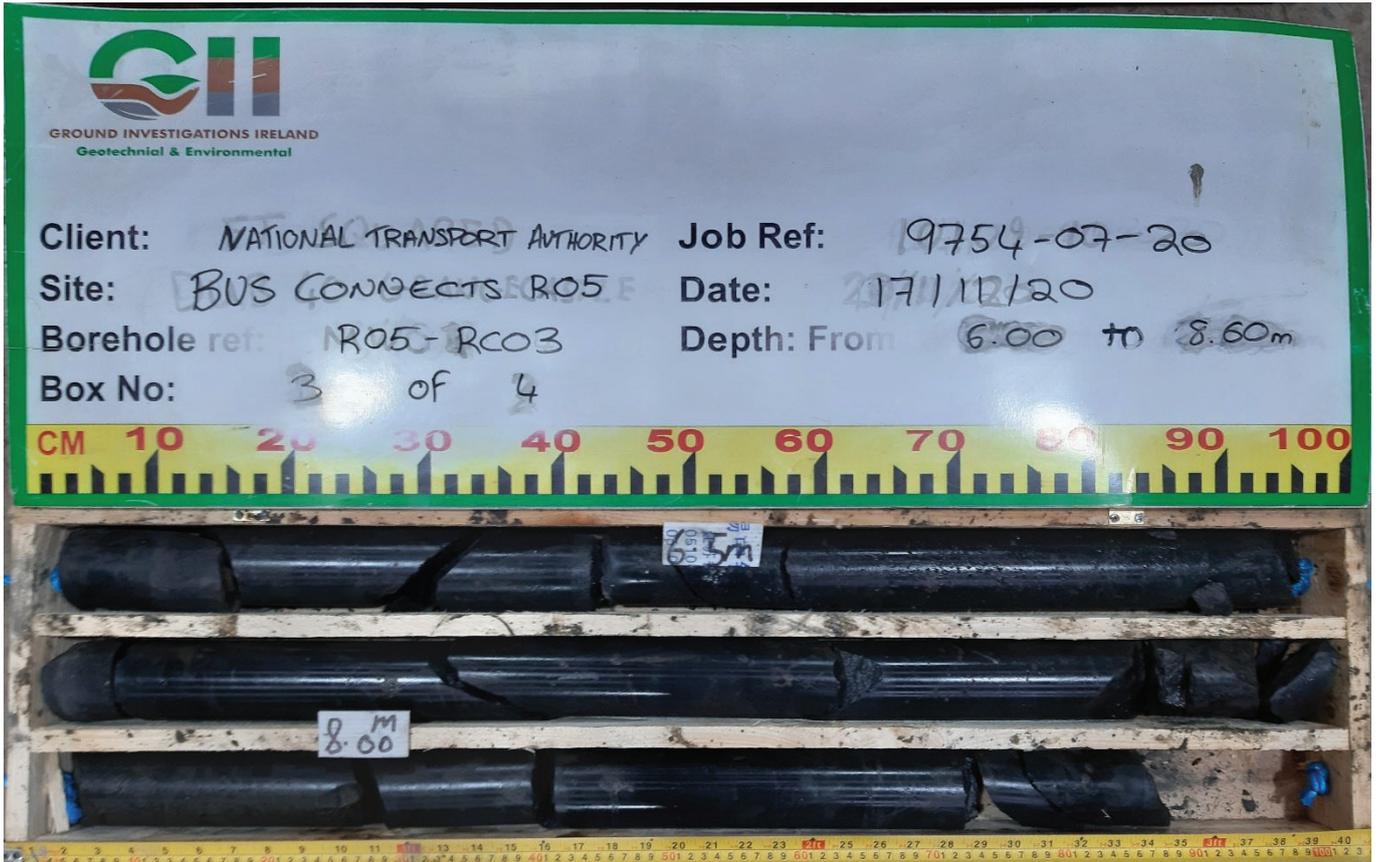
Bus Connects Route 5 – Rotary Core Photographs

R05-RC03



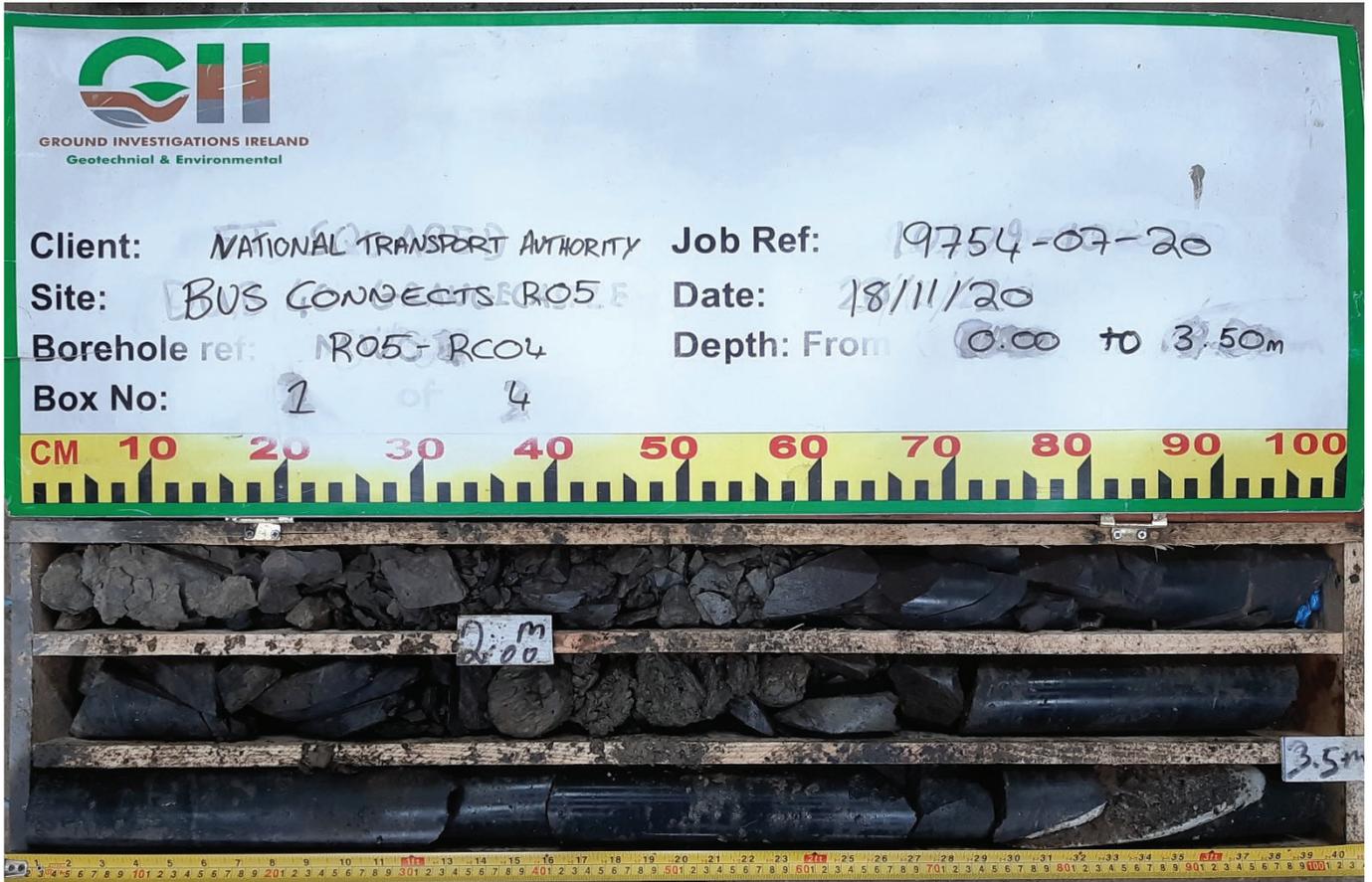
Bus Connects Route 5 – Rotary Core Photographs

R05-RC03



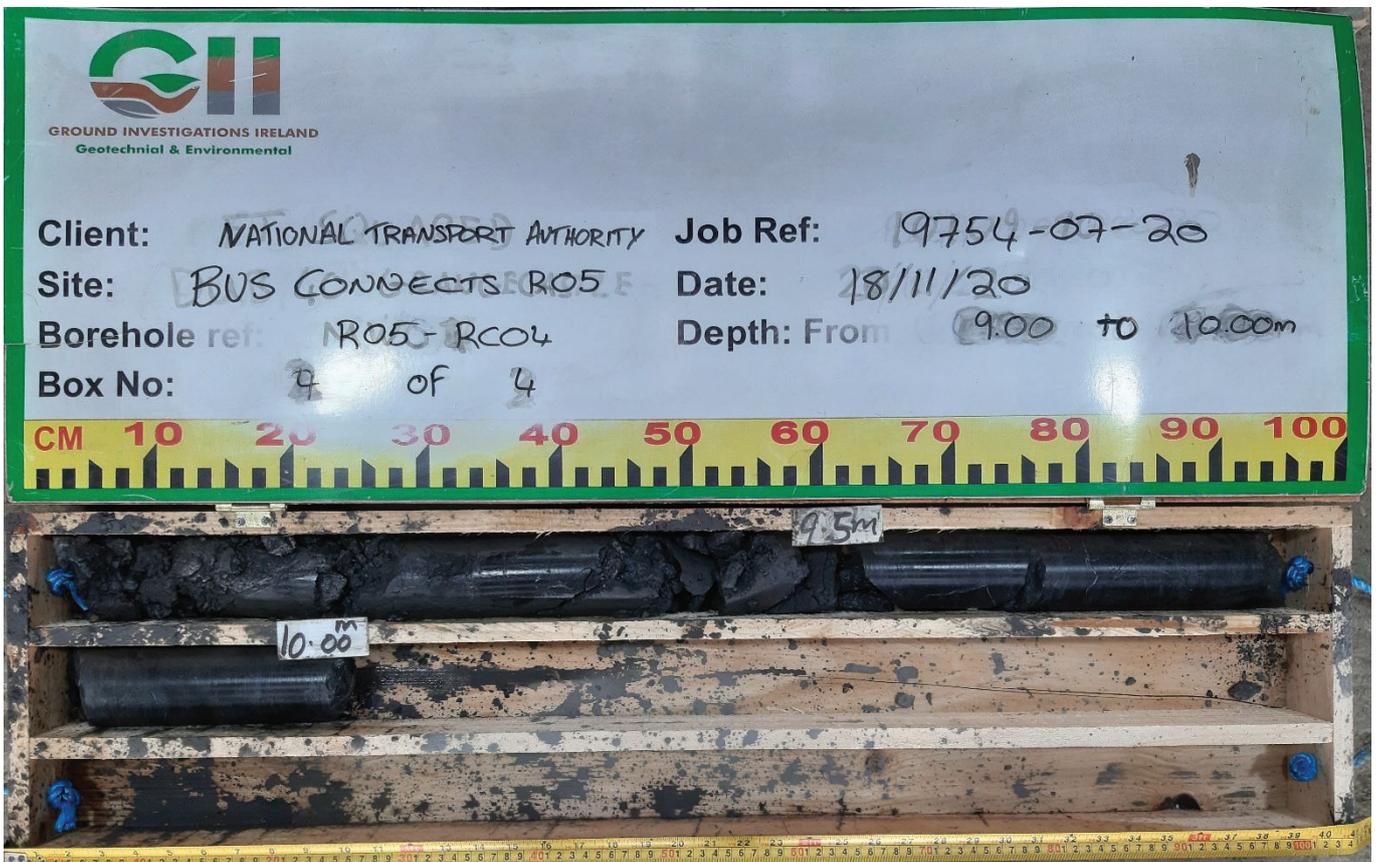
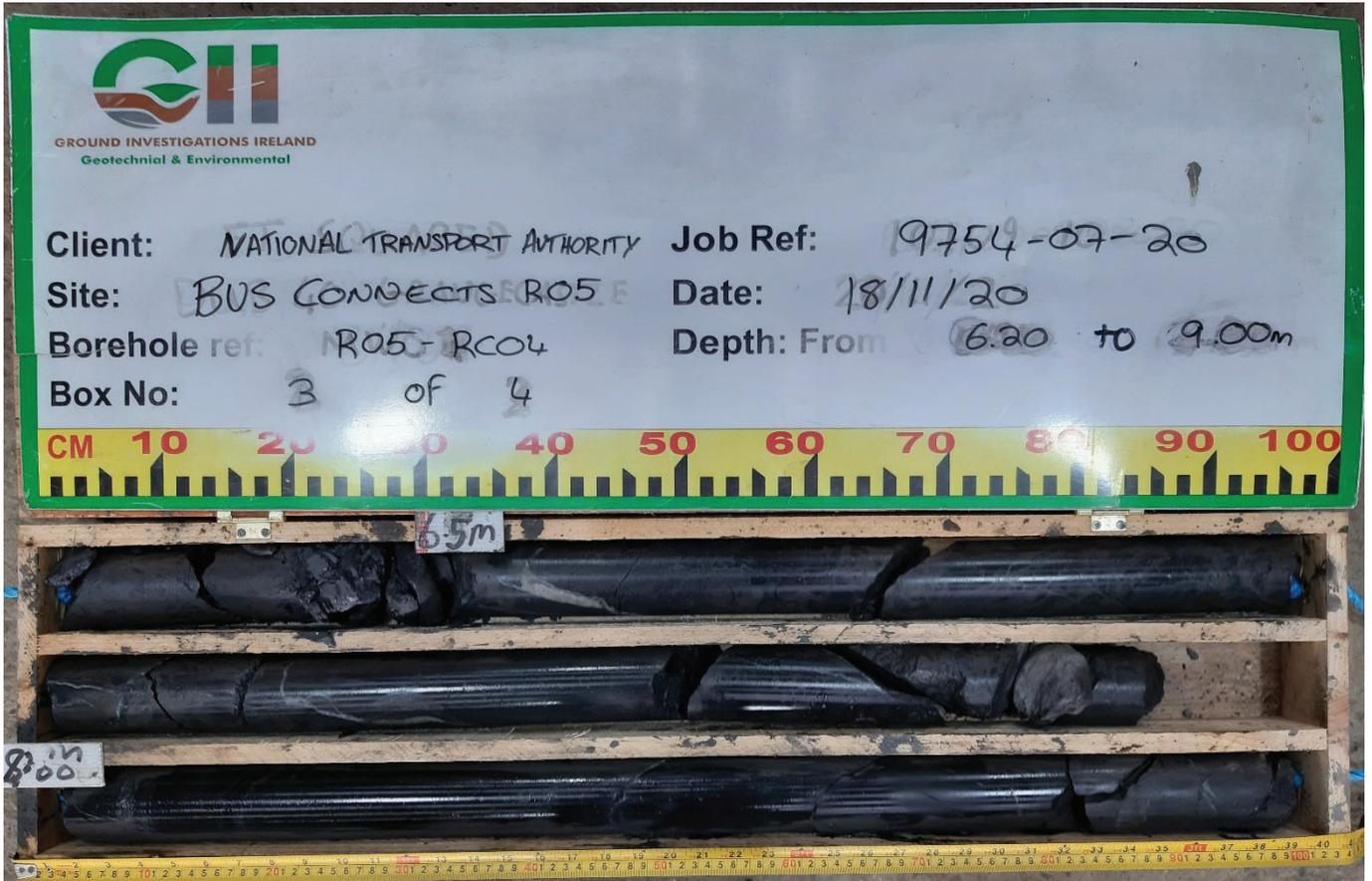
Bus Connects Route 5 – Rotary Core Photographs

R05-RC04



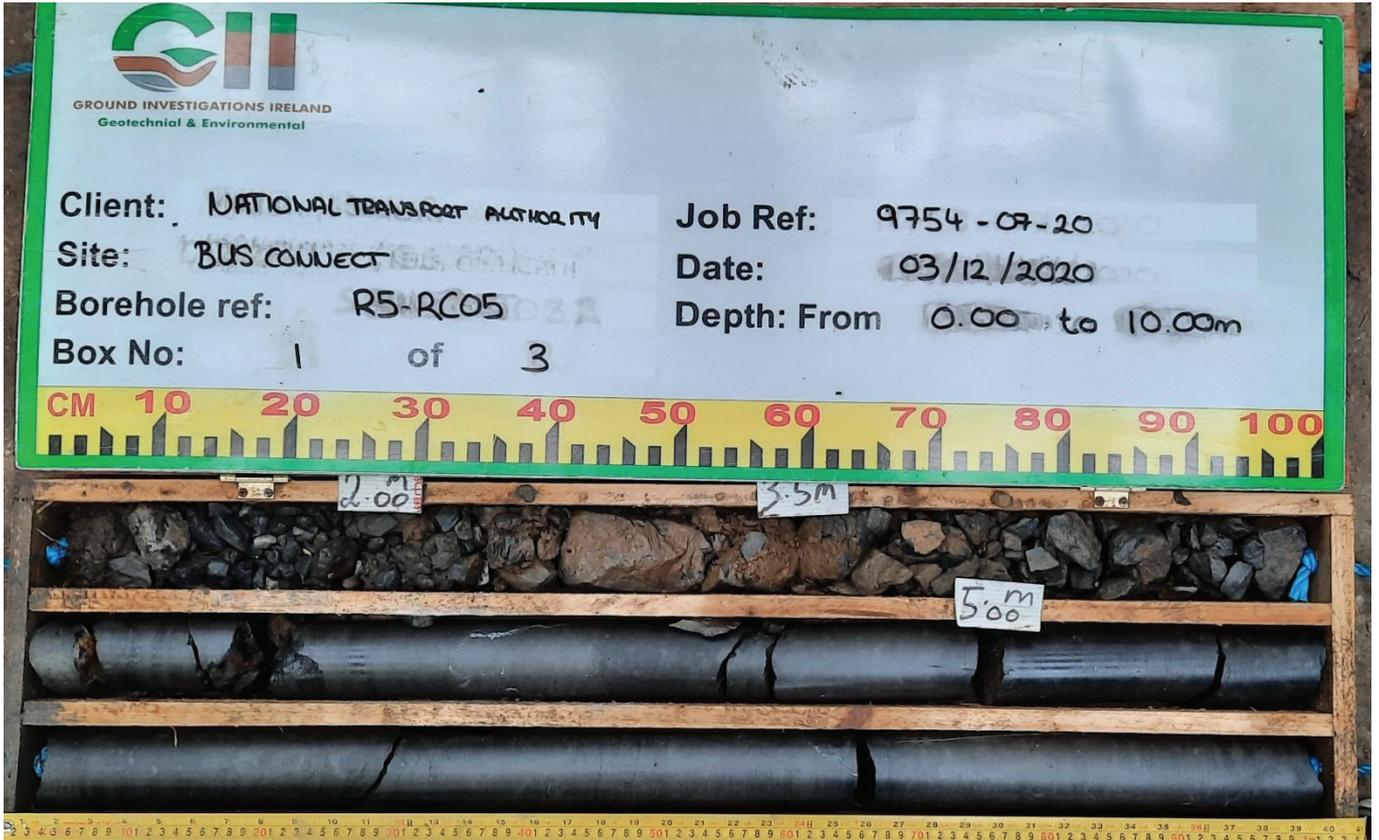
Bus Connects Route 5 – Rotary Core Photographs

R05-RC04



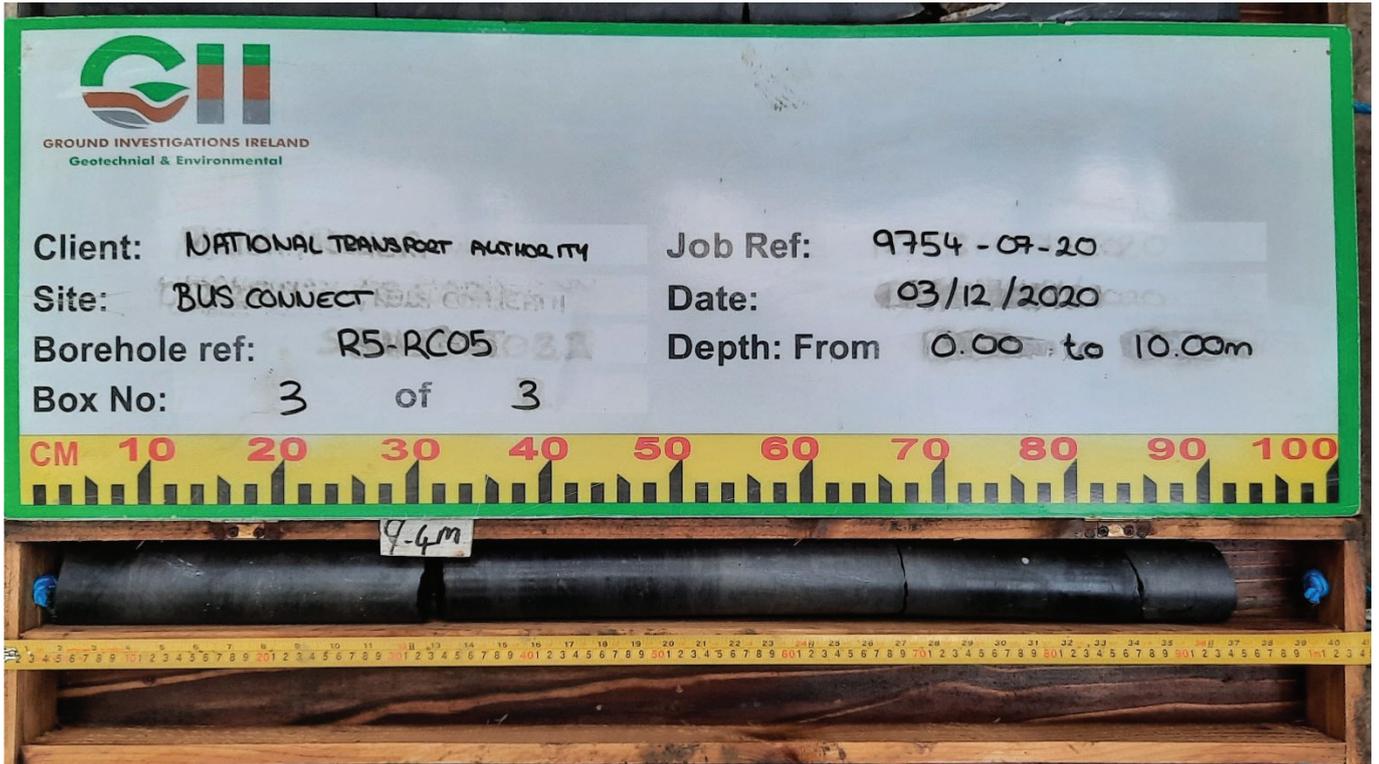
Bus Connects Route 5 – Rotary Core Photographs

R05-RC05



Bus Connects Route 5 – Rotary Core Photographs

R05-RC05



Bus Connects Route 5 – Rotary Core Photographs

R05-RC06



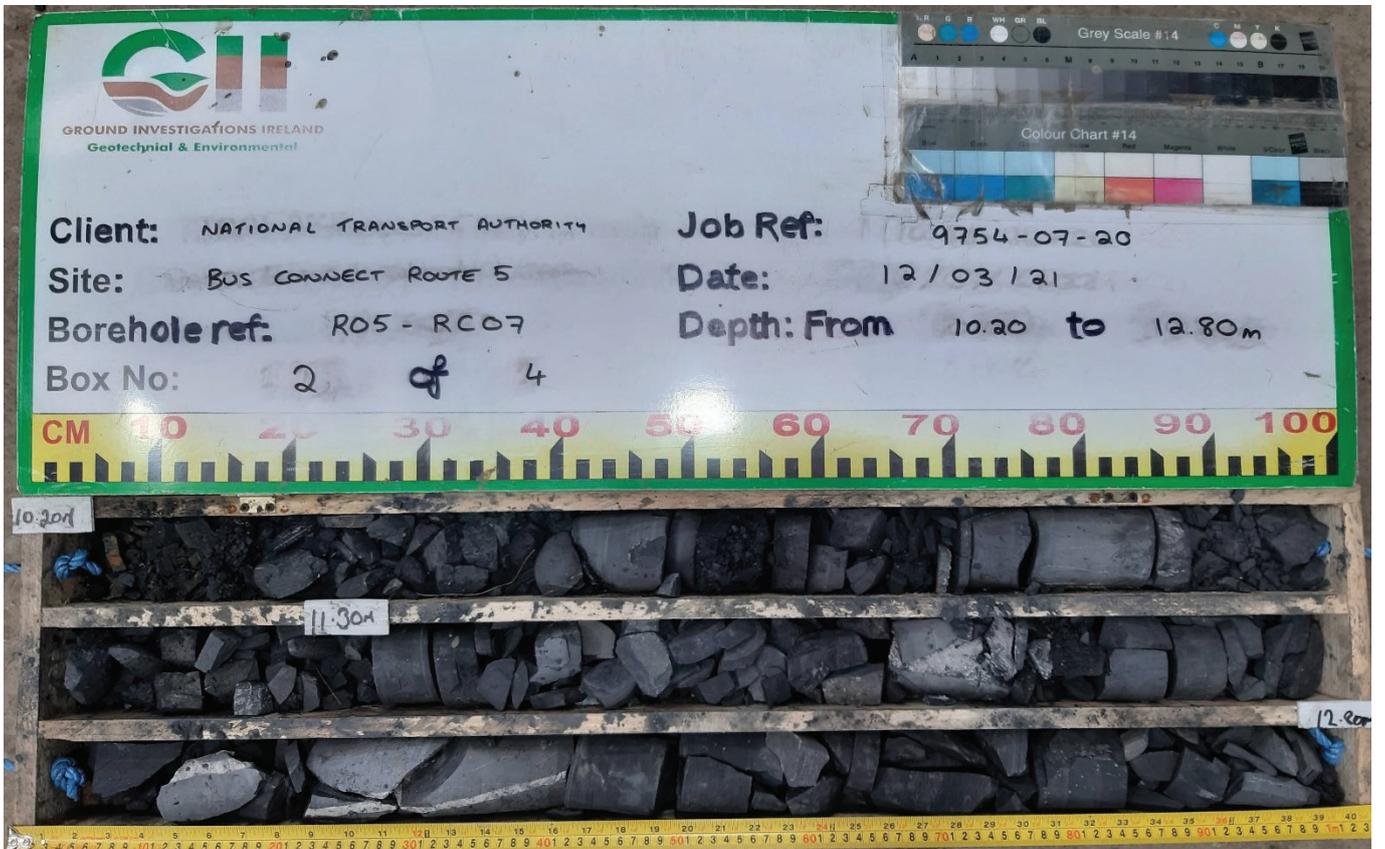
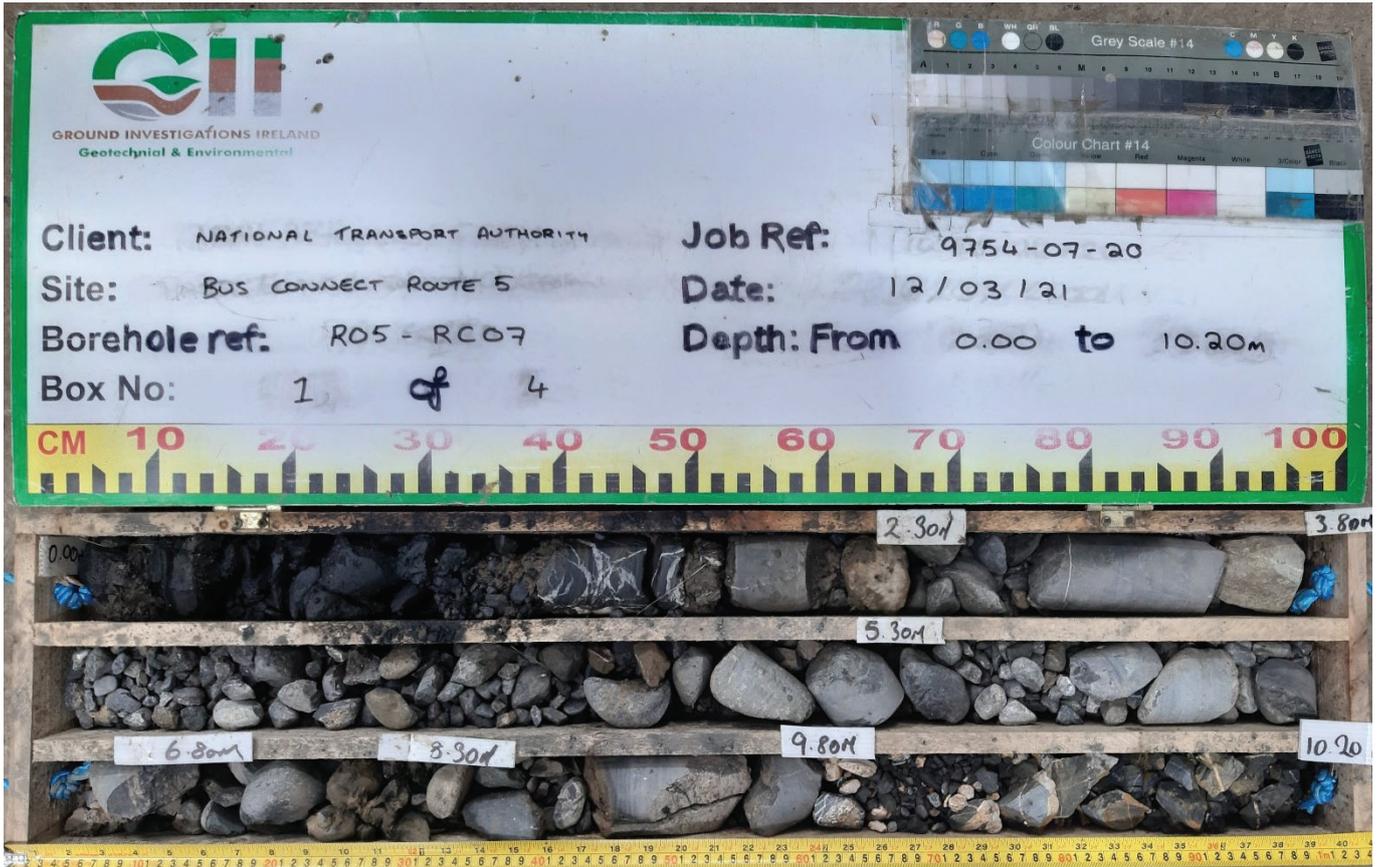
Bus Connects Route 5 – Rotary Core Photographs

R05-RC06



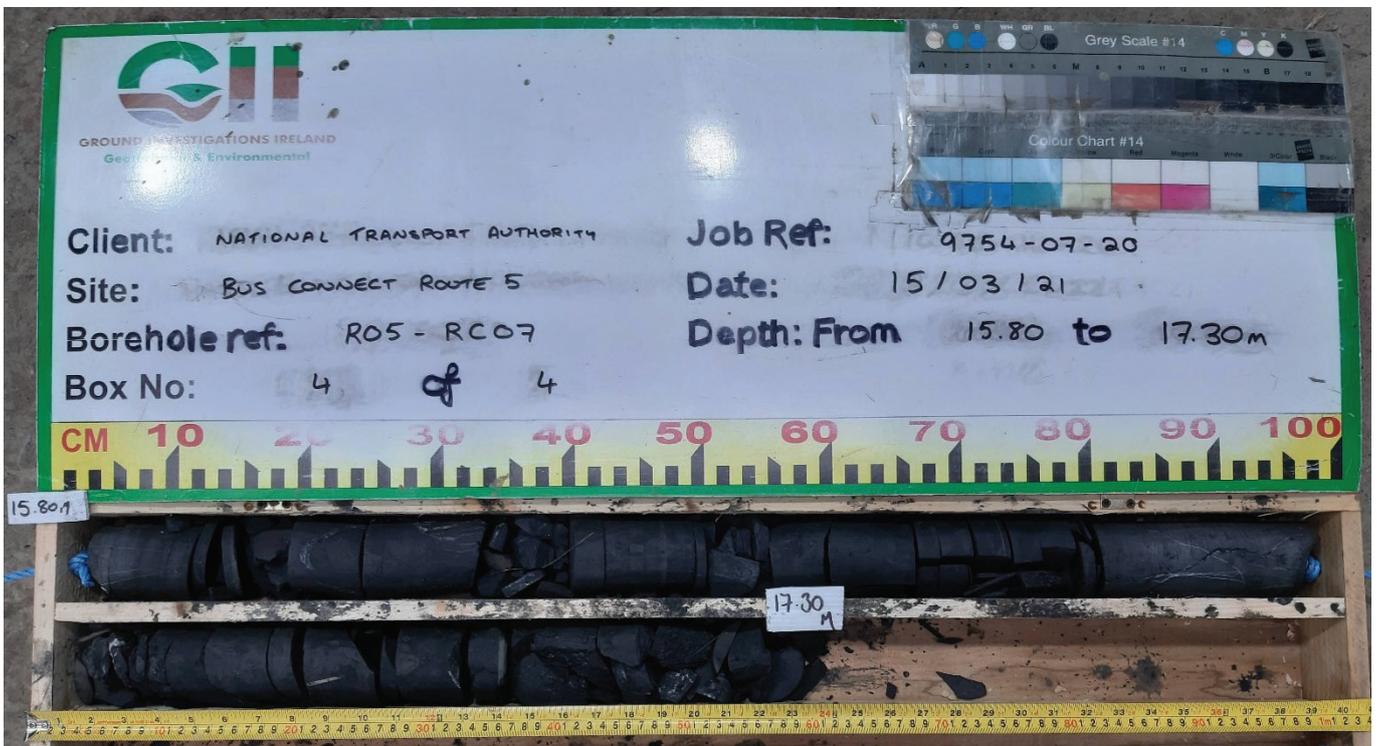
Bus Connects Route 5 – Rotary Core Photographs

R05-RC07



Bus Connects Route 5 – Rotary Core Photographs

R05-RC07





Machine : GEOTECH 10 Method : Drive-in Windowless Sampler	Dimensions 98mm to 4.00m	Ground Level (mOD) 65.83	Client National Transport Authority	Job Number 9754-07-20
	Location 706607.8 E 739366.6 N	Dates 28/05/2021	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.20-1.20	B			65.63	0.20	Brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets		
0.50	EN				(1.00)	MADE GROUND: Greyish brown slightly sandy slightly gravelly Clay with occasional rootlets		
1.20-2.00	B			64.63	1.20	MADE GROUND: Grey slightly sandy slightly gravelly Clay with occasional fragments of organic matter and wood and a rare fragment of glass		
1.50	EN							
2.00-3.00	B							
2.50	EN				(2.80)			
3.00-4.00	B							
3.50	EN							
				61.83	4.00	Refusal at 4.00m BGL Complete at 4.00m		

Remarks 0.00m-1.00m BGL 95% recovery 1.00m-2.00m BGL 95% recovery 2.00m-3.00m BGL 95% recovery 3.00m-4.00m BGL 95% recovery Refusal at 4.00m BGL	Scale (approx) 1:25	Logged By PC
	Figure No. 9754-07-20.R5-CP01A	



Machine : GEOTEC 10 Method : Drive-in Windowless Sampler	Dimensions 98mm to 2.00m	Ground Level (mOD) 55.65	Client National Transport Authority	Job Number 9754-07-20
	Location 710056.5 E 737504.1 N	Dates 28/05/2021	Project Contractor Ground Investigations Ireland	Sheet 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
0.10-1.00	B			55.55	(0.10) 0.10	Brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets		
0.50	EN					MADE GROUND: Dark grey/brown slightly sandy gravelly Clay with occasional subangular cobbles and occasional fragments of concrete and red brick		
1.00 1.00-2.00	EN B				(1.90)			
1.80	EN			53.65	2.00	Refusal at 2.00m BGL Complete at 2.00m		

Remarks 0.00m-1.00m BGL 90% recovery 1.00m-2.00m BGL 80% recovery Refusal at 2.00m BGL	Scale (approx) 1:25	Logged By PC
	Figure No. 9754-07-20.R5-CP03A	

Bus Connects Route 5 – Window Sample Photographs

R5-CP01A



Bus Connects Route 5 – Window Sample Photographs

R5-CP03A



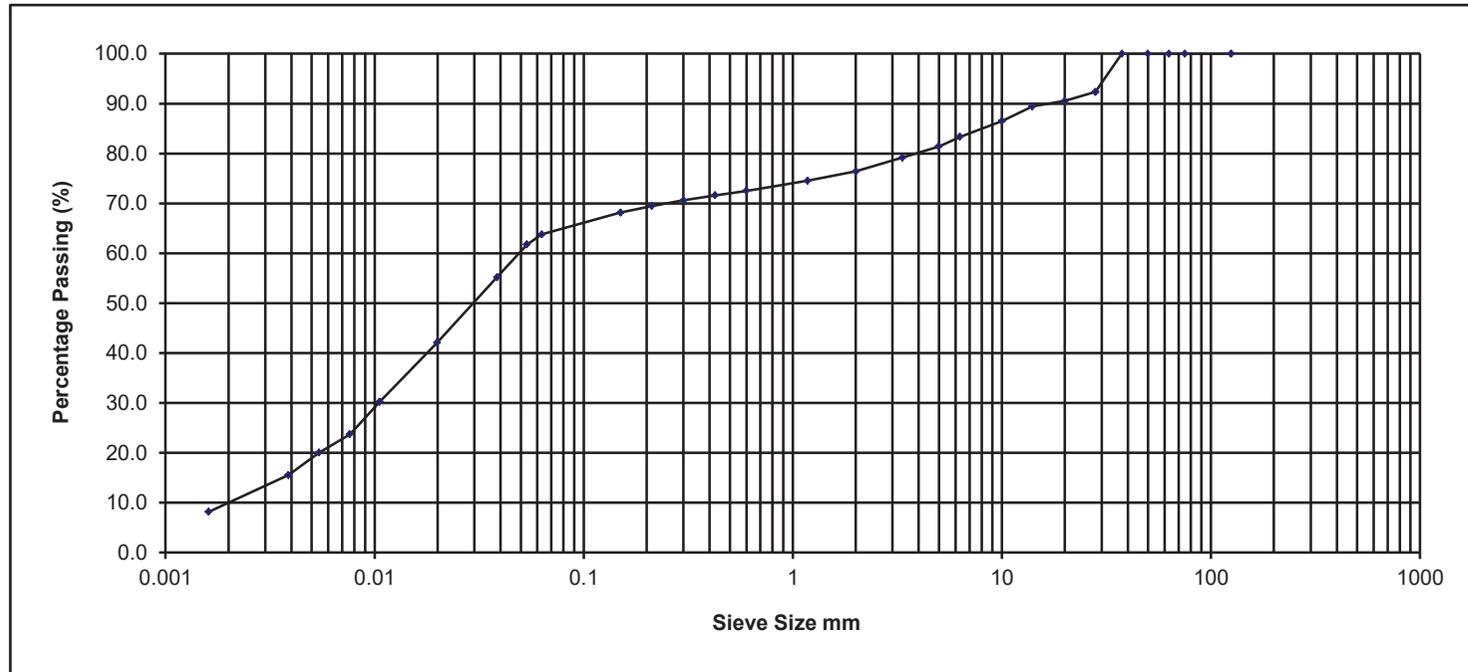
APPENDIX 4 – Laboratory Testing



NMTL Ltd

Sieve Size mm	% Passing
125.000	100.0
75.000	100.0
63.000	100.0
50.000	100.0
37.500	100.0
28.000	92.3
20.000	90.5
14.000	89.4
10.000	86.5
6.300	83.4
5.000	81.4
3.350	79.2
2.000	76.4
1.180	74.5
0.600	72.5
0.425	71.6
0.300	70.6
0.212	69.5
0.150	68.2
0.063	63.8
0.054	61.7
0.039	55.2
0.020	42.1
0.011	30.3
0.008	23.7
0.005	20.0
0.004	15.5
0.002	8.2

Determination of Particle Size Distribution BS 1377 : 1990 : Part 2 : Clauses 9.2 & 9.5



Percentage Particle Size

Clay	Fine			Medium			Coarse			Cobbles	Boulder
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse		
8.2	Silt			Sand			Gravel			0.0	0.0
	8.2	55.6		12.6			23.6				

Sample Description Dark brown slightly sandy slightly gravelly clayey SILT.

Project No. NMTL 3326

BH/TP No. R05-CP01

Project Bus connect Route 5

GII Project ID-9754-07-20

Sample No. B

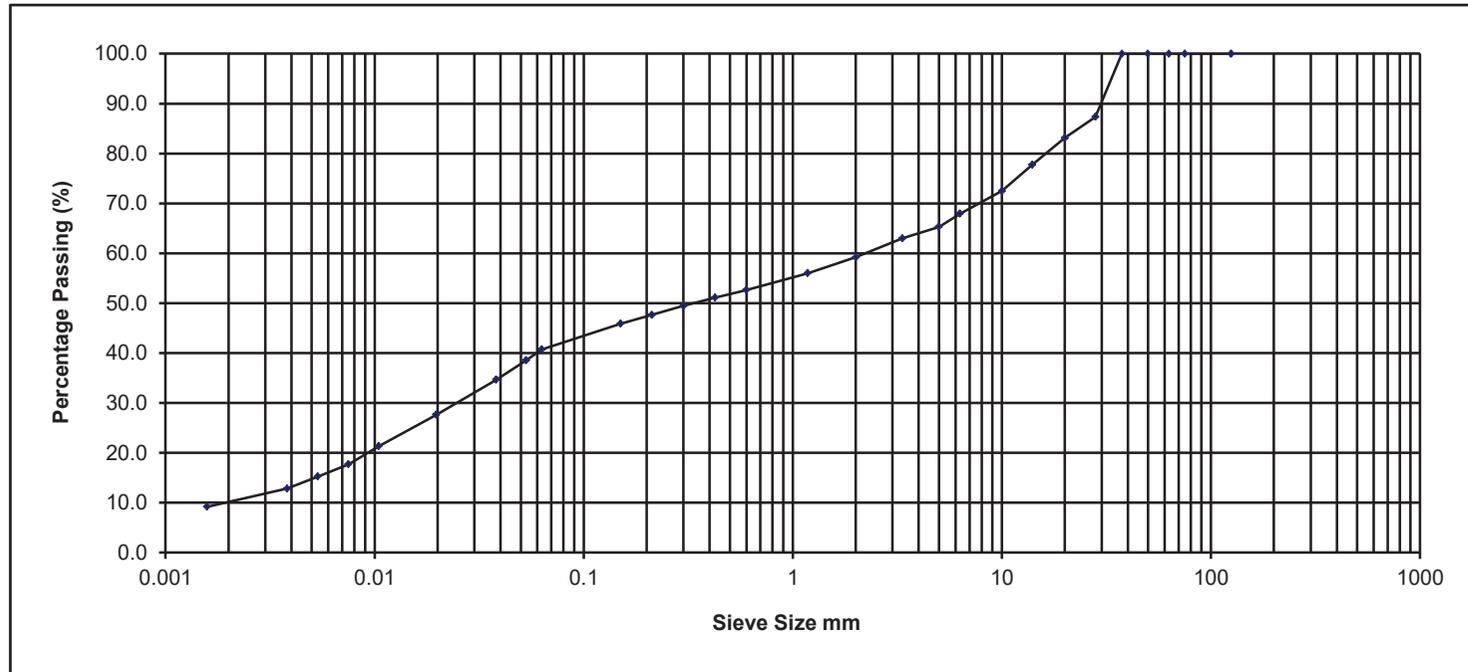
NM
TL
Ltd

Operator	Tzr	Checked	Nc	Approved	Bc	Date sample tested	14/12/2020	Depth	4.0m
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NMTL Ltd

Sieve	%
Size mm	Passing
125.000	100.0
75.000	100.0
63.000	100.0
50.000	100.0
37.500	100.0
28.000	87.3
20.000	83.1
14.000	77.8
10.000	72.5
6.300	67.9
5.000	65.3
3.350	63.0
2.000	59.2
1.180	56.0
0.600	52.7
0.425	51.1
0.300	49.5
0.212	47.7
0.150	45.9
0.063	40.7
0.053	38.5
0.038	34.7
0.020	27.6
0.010	21.3
0.007	17.7
0.005	15.3
0.004	12.8
0.002	9.2

Determination of Particle Size Distribution BS 1377 : 1990 : Part 2 : Clauses 9.2 & 9.5



Percentage Particle Size

Clay	Fine			Medium			Coarse			Cobbles	Boulder
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse		
9.2	Silt			Sand			Gravel			0.0	0.0
	31.5			18.5			40.8				

Sample Description Dark brown slightly sandy slightly gravelly clayey SILT.

Project No. NMTL 3326

BH/TP No. R05-CP01

Project Bus connect Route 5

GII Project ID-9754-07-20

Sample No. B

NM
TL
Ltd

Operator	Tzr	Checked	Nc	Approved	Bc	Date sample tested	14/12/2020	Depth	5.0m
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LABORATORY REPORT



4043

Contract Number: PSL21/1700

Report Date: 25 March 2021
Client's Reference: 2868817
Client Name: Ground Investigations Ireland Ltd
Catherinestown House
Hazelhatch Road
Newcastle
Co Dublin
D22 YD52

For the attention of: Patrick Cochran/John Duggan

Contract Title: Bus Connect Route 5
Date Received: 26/2/2021
Date Commenced: 26/2/2021
Date Completed: 25/3/2021

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins
(Director)

L Knight
(Senior Technician)

R Berriman
(Quality Manager)

S Eyre
(Senior Technician)

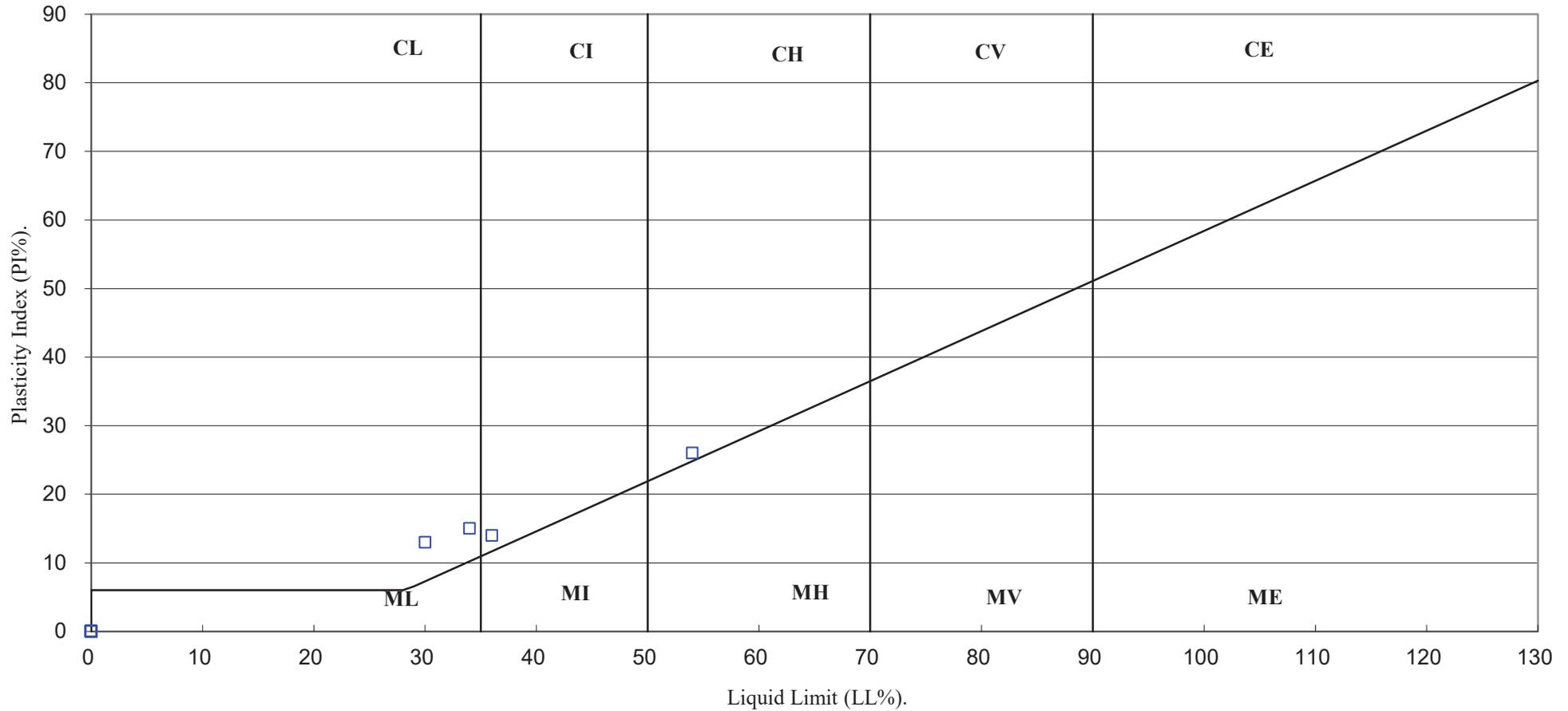
S Royle
(Laboratory Manager)

T Watkins
(Senior Technician)

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Doncaster DN4 0AR
tel: +44 (0)844 815 6641
fax: +44 (0)844 815 6642
e-mail: rberriman@prosoils.co.uk
awatkins@prosoils.co.uk

Page 1 of

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



4043

PSL
Professional Soils Laboratory

Bus Connects Route 5

Contract No:

PSL21/1700

Client Ref:

2868817

PARTICLE SIZE DISTRIBUTION TEST

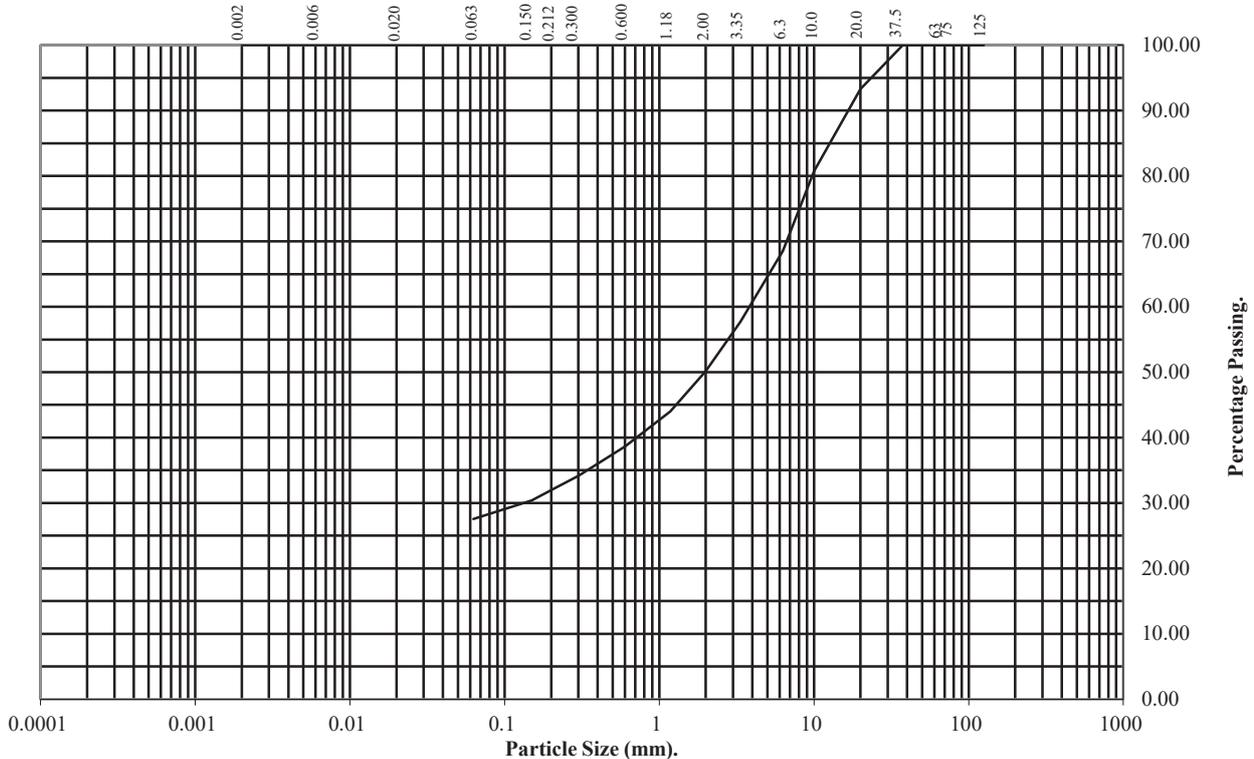
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: R5-TP01 **Top Depth (m):** 1.00

Sample Number: **Base Depth(m):**

Sample Type: B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	100
20	93
10	81
6.3	69
3.35	58
2	50
1.18	44
0.6	39
0.3	34
0.212	32
0.15	30
0.063	28

Soil Fraction	Total Percentage
Cobbles	0
Gravel	50
Sand	22
Silt/Clay	28

Remarks:
See Summary of Soil Descriptions



Bus Connects Route 5

Contract No:
PSL21/1700
Client Ref:
2868817

PARTICLE SIZE DISTRIBUTION TEST

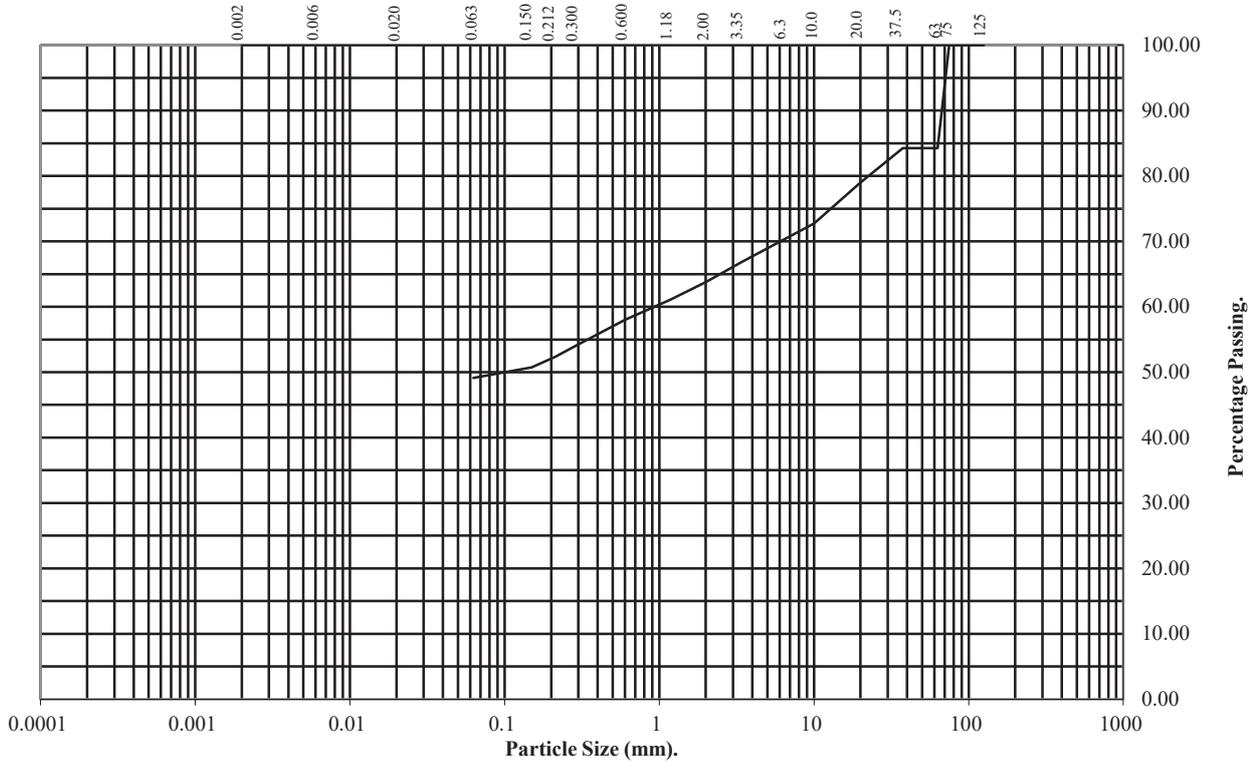
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **R5-TP05** Top Depth (m): **1.00**

Sample Number: Base Depth(m):

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	84
37.5	84
20	79
10	73
6.3	70
3.35	67
2	64
1.18	61
0.6	58
0.3	54
0.212	52
0.15	51
0.063	49

Soil Fraction	Total Percentage
Cobbles	16
Gravel	20
Sand	15
Silt/Clay	49

Remarks:
See Summary of Soil Descriptions



Bus Connects Route 5

Contract No:
PSL21/1700
Client Ref:
2868817

PARTICLE SIZE DISTRIBUTION TEST

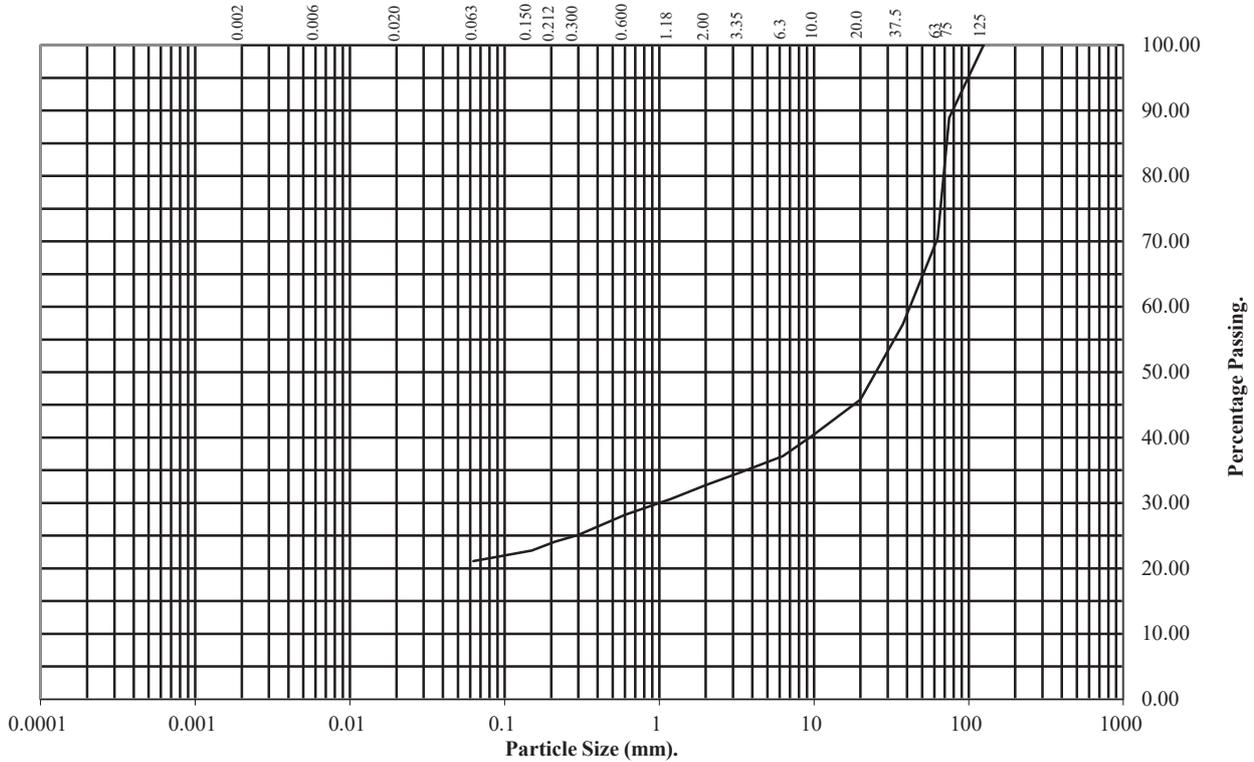
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **R5-TP06** Top Depth (m): **1.00**

Sample Number: Base Depth(m):

Sample Type: **T**



BS Test Sieve (mm)	Percentage Passing
125	100
75	89
63	70
37.5	57
20	46
10	41
6.3	37
3.35	35
2	33
1.18	31
0.6	28
0.3	25
0.212	24
0.15	23
0.063	21

Soil Fraction	Total Percentage
Cobbles	30
Gravel	37
Sand	12
Silt/Clay	21

Remarks:
See Summary of Soil Descriptions



Bus Connects Route 5

Contract No:
PSL21/1700
Client Ref:
2868817

PARTICLE SIZE DISTRIBUTION TEST

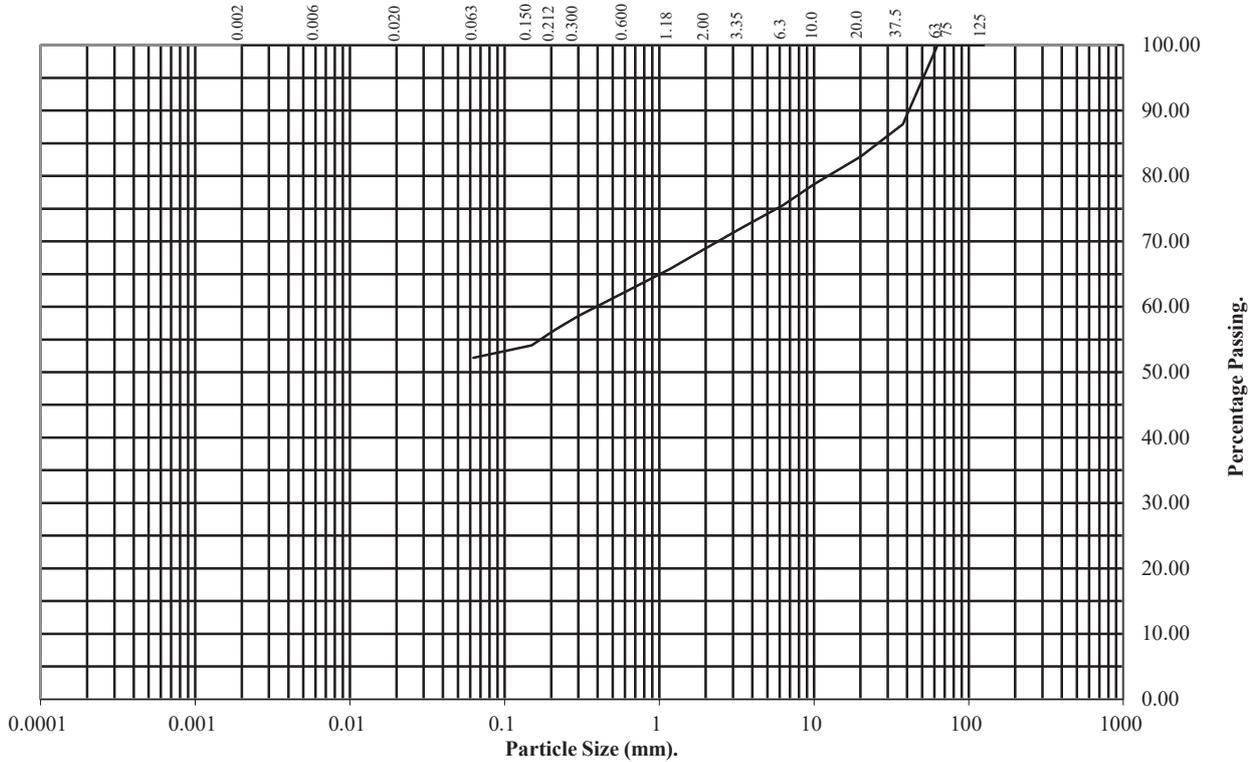
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: R5-TP07B **Top Depth (m):** 1.00

Sample Number: **Base Depth(m):**

Sample Type: B



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	88
20	83
10	79
6.3	76
3.35	72
2	69
1.18	66
0.6	62
0.3	59
0.212	56
0.15	54
0.063	52

Soil Fraction	Total Percentage
Cobbles	0
Gravel	31
Sand	17
Silt/Clay	52

Remarks:
See Summary of Soil Descriptions



Bus Connects Route 5

Contract No:
PSL21/1700
Client Ref:
2868817



LABORATORY REPORT



4043

Contract Number: PSL21/1802

Report Date: 29 March 2021
Client's Reference: 9754-07-20
Client Name: Ground Investigations Ireland Ltd
Catherinestown House
Hazelhatch Road
Newcastle
Co Dublin
D22 YD52

For the attention of: Patrick Cochran/John Duggan

Contract Title: Bus Connect Route 5
Date Received: 1/3/2021
Date Commenced: 1/3/2021
Date Completed: 29/3/2021

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins
(Director)

R Berriman
(Quality Manager)


S Royle
(Laboratory Manager)

L Knight
(Senior Technician)

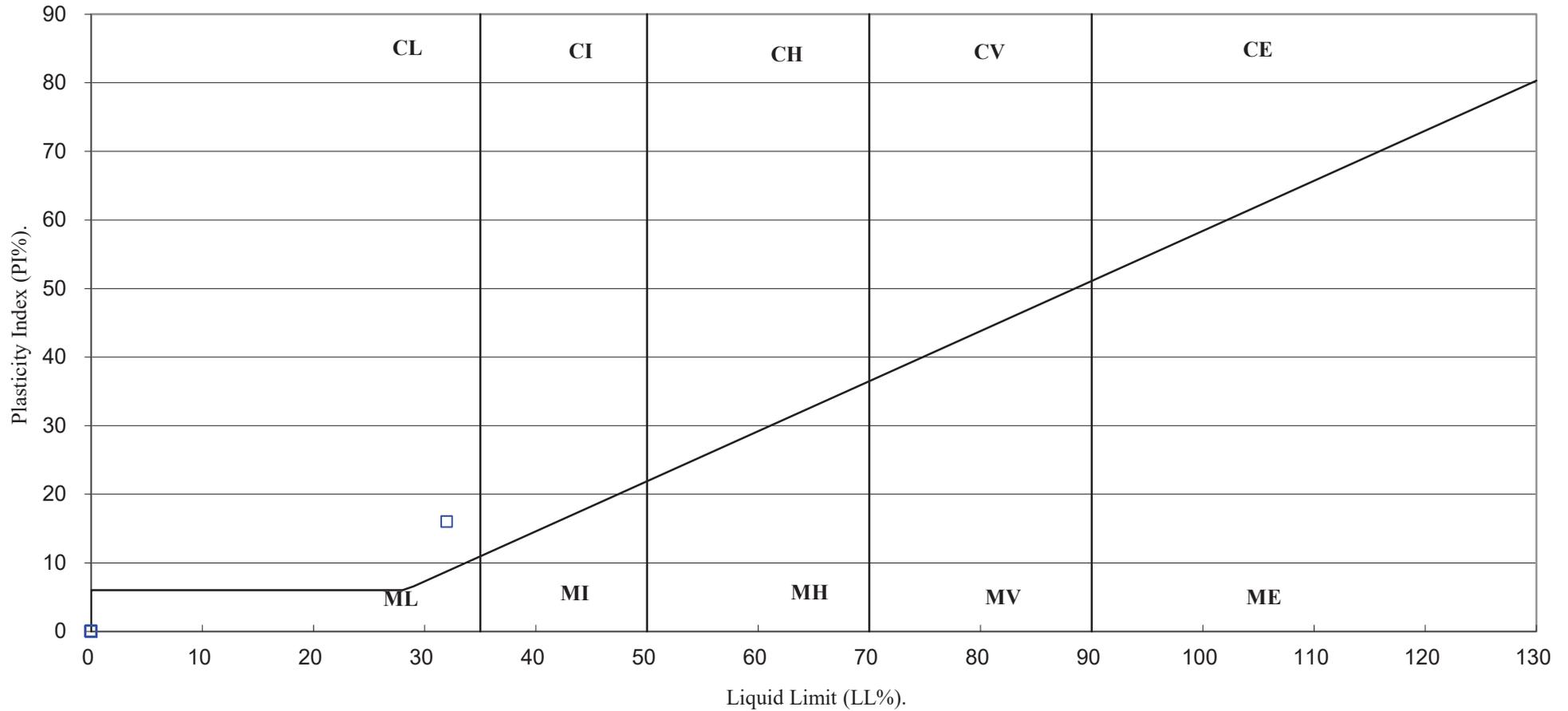
S Eyre
(Senior Technician)

T Watkins
(Senior Technician)

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Doncaster DN4 0AR
tel: +44 (0)844 815 6641
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Page 1 of

PLASTICITY CHART FOR CASAGRANDE CLASSIFICATION.



4043

PSL
Professional Soils Laboratory

Bus Connect Route 5

Contract No:

PSL21/1802

Client Ref:

2868817

PARTICLE SIZE DISTRIBUTION TEST

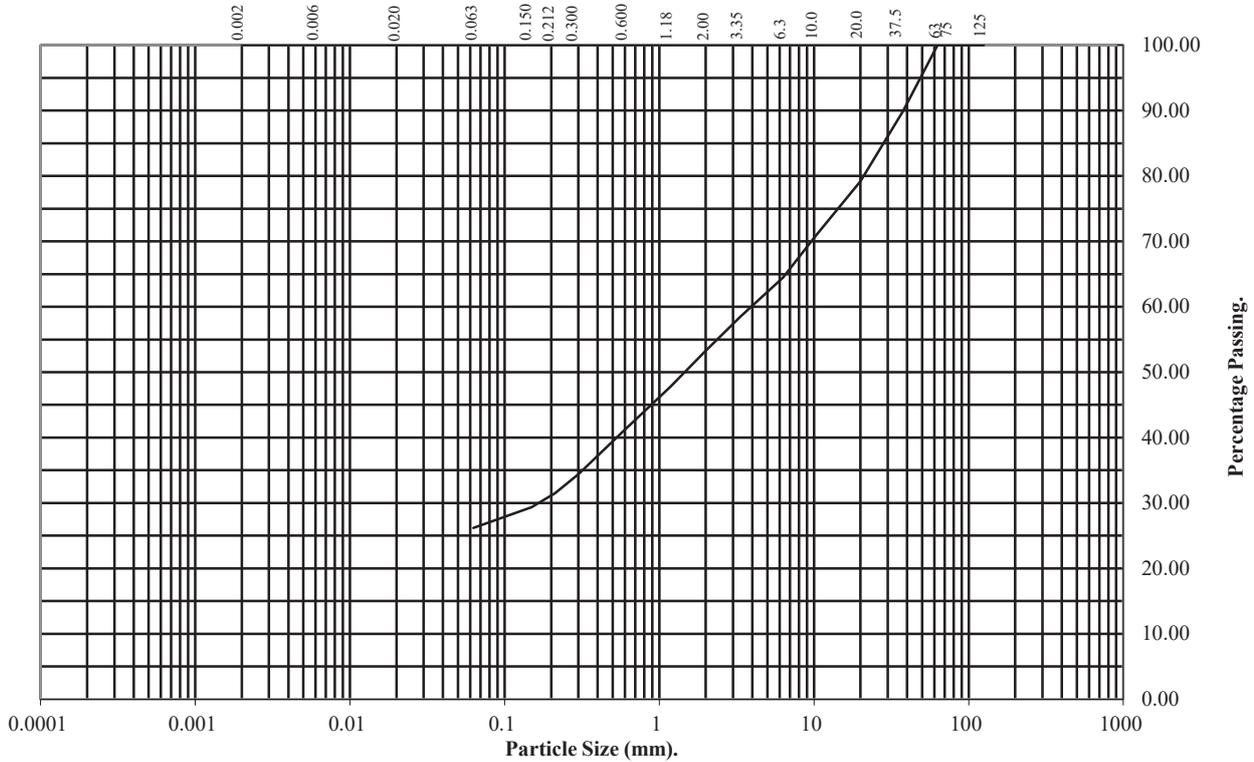
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **R05-TP08A** Top Depth (m): **1.50**

Sample Number: Base Depth(m):

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	90
20	79
10	71
6.3	64
3.35	58
2	53
1.18	48
0.6	41
0.3	34
0.212	31
0.15	29
0.063	26

Soil Fraction	Total Percentage
Cobbles	0
Gravel	47
Sand	27
Silt/Clay	26

Remarks:
See Summary of Soil Descriptions



Bus Connect Route 5

Contract No:
PSL21/1802
Client Ref:
2868817

PARTICLE SIZE DISTRIBUTION TEST

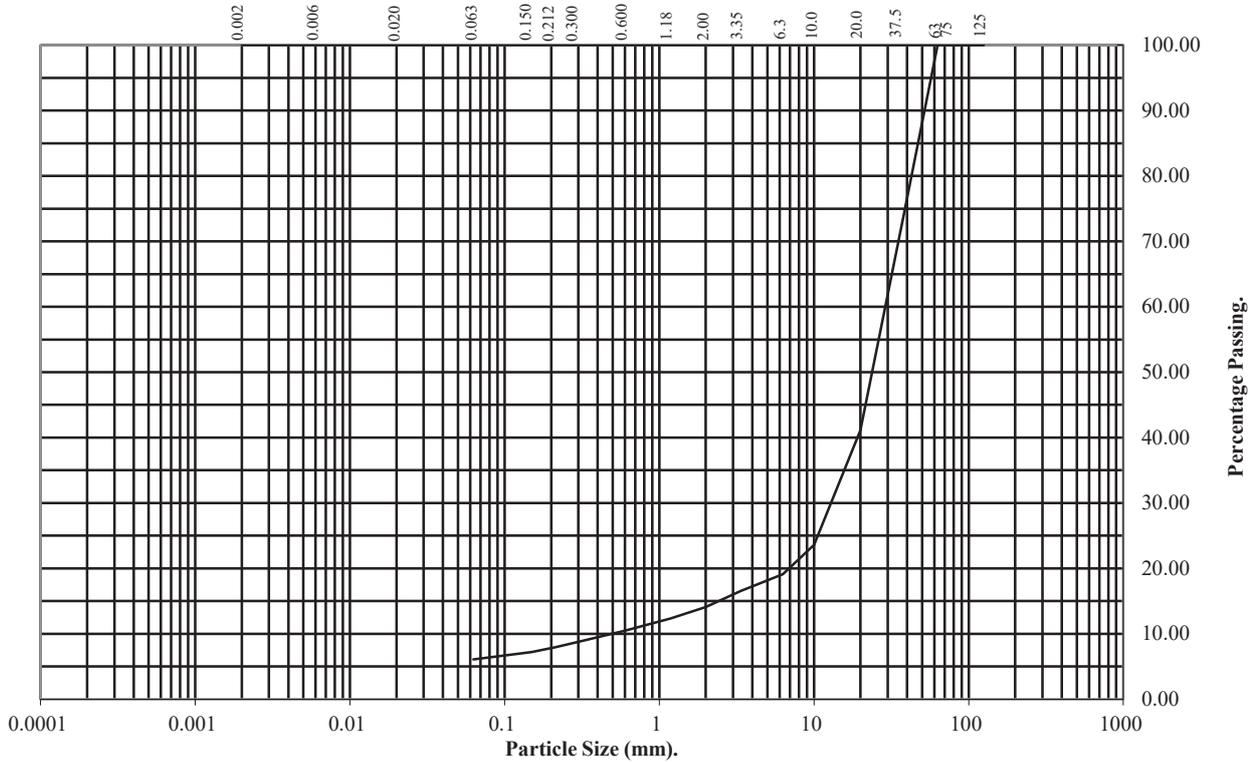
BS1377 : Part 2 : 1990

Wet Sieve, Clause 9.2

Hole Number: **R05-TP09** Top Depth (m): **0.50**

Sample Number: Base Depth(m):

Sample Type: **B**



BS Test Sieve (mm)	Percentage Passing
125	100
75	100
63	100
37.5	73
20	41
10	24
6.3	19
3.35	17
2	14
1.18	12
0.6	10
0.3	9
0.212	8
0.15	7
0.063	6

Soil Fraction	Total Percentage
Cobbles	0
Gravel	86
Sand	8
Silt/Clay	6

Remarks:
See Summary of Soil Descriptions



Bus Connect Route 5

Contract No:
PSL21/1802
Client Ref:
2868817



2531

ANALYTICAL TEST REPORT

Contract no: 94161
Contract name: Bus Connect Route 5
Client reference: PSL21/1802
Clients name: Professional Soils Laboratory
Clients address: 5/7 Hexthorpe Road
Doncaster
DN4 0AR

Samples received: 08 March 2021

Analysis started: 08 March 2021

Analysis completed: 10 March 2021

Report issued: 11 March 2021

Notes: Opinions and interpretations expressed herein are outside the UKAS accreditation scope.
Unless otherwise stated, Chemtech Environmental Ltd was not responsible for sampling.
All testing carried out at Unit 6 Parkhead, Stanley, DH9 7YB, except for subcontracted testing.
Methods, procedures and performance data are available on request.
Results reported herein relate only to the material supplied to the laboratory.
This report shall not be reproduced except in full, without prior written approval.
Samples will be disposed of 6 weeks from initial receipt unless otherwise instructed.

Key: U UKAS accredited test
M MCERTS & UKAS accredited test
\$ Test carried out by an approved subcontractor
I/S Insufficient sample to carry out test
N/S Sample not suitable for testing

Approved by: 
Rachael Burton
Customer Support Squad Leader

Chemtech Environmental Limited

SOILS

Lab number			94161-1	94161-2	94161-3
Sample id			R05-TP08A	R05-TP08A	R05-TP09
Depth (m)			0.50	1.50	0.50
Date sampled			25/02/2021	25/02/2021	25/02/2021
Test	Method	Units			
Total Organic Carbon (TOC)	CE197	% w/w C	1.1	1.0	0.5
Estimate of OMC (calculated from TOC)	CE197	% w/w	1.8	1.8	0.8

Chemtech Environmental Limited

METHOD DETAILS

METHOD	SOILS	METHOD SUMMARY	SAMPLE	STATUS	LOD	UNITS
CE197	Total Organic Carbon (TOC)	Carbon Analyser	Dry		0.1	% w/w C
CE197	Estimate of OMC (calculated from TOC)	Calculation from Total Organic Carbon	Dry		0.1	% w/w

Chemtech Environmental Limited

DEVIATING SAMPLE INFORMATION

Comments

Sample deviation is determined in accordance with the UKAS note "Guidance on Deviating Samples" and based on reference standards and laboratory trials.

For samples identified as deviating, test result(s) may be compromised and may not be representative of the sample at the time of sampling.

Chemtech Environmental Ltd cannot be held responsible for the integrity of sample(s) received if Chemtech Environmental Ltd did not undertake the sampling. Such samples may be deviating.

Key

N	No (not deviating sample)
Y	Yes (deviating sample)
NSD	Sampling date not provided
NST	Sampling time not provided (waters only)
EHT	Sample exceeded holding time(s)
IC	Sample not received in appropriate containers
HP	Headspace present in sample container
NCF	Sample not chemically fixed (where appropriate)
OR	Other (specify)

Lab ref	Sample id	Depth (m)	Deviating	Tests (Reason for deviation)
94161-1	R05-TP08A	0.50	N	
94161-2	R05-TP08A	1.50	N	
94161-3	R05-TP09	0.50	N	

Ground Investigations Ireland

Catherinestown House □

Hazelhatch Road □

Newcastle □

Co. Dublin □

Ireland □



Attention : John Duggan

Date : 8th December, 2020

Your reference : 9754-07-20

Our reference : Test Report 20/16588 Batch 1

Location : BusConnects Route 5

Date samples received : 26th November, 2020

Status : Final report

Issue : 1

Two samples were received for analysis on 26th November, 2020 of which two were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied. □

All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:



Bruce Leslie

Project Manager

Please include all sections of this report if it is reproduced

Client Name: Ground Investigations Ireland
Reference: 20/07/9754
Location: BusConnects Route 5
Contact: John Duggan

Note:

Asbestos Screen analysis is carried out in accordance with our documented in-house methods PM042 and TM065 and HSG 248 by Stereo and Polarised Light Microscopy using Dispersion Staining Techniques and is covered by our UKAS accreditation. Detailed Gravimetric Quantification and PCOM Fibre Analysis is carried out in accordance with our documented in-house methods PM042 and TM131 and HSG 248 using Stereo and Polarised Light Microscopy and Phase Contrast Optical Microscopy (PCOM). Samples are retained for not less than 6 months from the date of analysis unless specifically requested.

Opinions, including ACM type and Asbestos level less than 0.1%, lie outside the scope of our UKAS accreditation.

Where the sample is not taken by a Element Materials Technology consultant, Element Materials Technology cannot be responsible for inaccurate or unrepresentative sampling.

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Date Of Analysis	Analysis	Result
20/16588	1	R5 TP02	0.50	2	03/12/2020	General Description (Bulk Analysis)	Soil/Stones
					03/12/2020	Asbestos Fibres	NAD
					03/12/2020	Asbestos ACM	NAD
					03/12/2020	Asbestos Type	NAD
					03/12/2020	Asbestos Level Screen	NAD
20/16588	1	R5 TP02	1.10	5	03/12/2020	General Description (Bulk Analysis)	Soil/Stones
					03/12/2020	Asbestos Fibres	NAD
					03/12/2020	Asbestos ACM	NAD
					03/12/2020	Asbestos Type	NAD
					03/12/2020	Asbestos Level Screen	NAD

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 20/16588

SOILS

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overestimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.

Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

Please include all sections of this report if it is reproduced

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher, this result is not accredited.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

EMT Job No: 20/16588

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.	PM0	No preparation is required.			AR	
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.			AR	Yes
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM8/PM16	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required/Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.			AR	Yes
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM8/PM16	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required/Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.	Yes		AR	Yes
TM5/TM36	please refer to TM5 and TM36 for method details	PM8/PM12/PM16	please refer to PM8/PM16 and PM12 for method details			AR	Yes
TM17	Modified US EPA method 8270D v5:2014. Determination of specific Polychlorinated Biphenyl congeners by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM20	Modified BS 1377-3:1990/USEPA 160.1/3 (TDS/TS: 1971) Gravimetric determination of Total Dissolved Solids/Total Solids	PM0	No preparation is required.	Yes		AR	Yes
TM21	Modified BS 7755-3:1995, ISO10694:1995 Determination of Total Organic Carbon or Total Carbon by combustion in an Eltra TOC furnace/analyser in the presence of oxygen. The CO2 generated is quantified using infra-red detection. Organic Matter (SOM) calculated as per EA MCERTS Chemical Testing of Soil, March 2012 v4.	PM24	Dried and ground solid samples are washed with hydrochloric acid, then rinsed with deionised water to remove the mineral carbon before TOC analysis.	Yes		AD	Yes
TM22	Modified BS1377-3:1990 Gravimetric determination of Loss on Ignition by temperature controlled Muffle Furnace (35C-440C). On request modified ASTM D2974-00 LOI (105C-440C)	PM0	No preparation is required.	Yes		AD	Yes

EMT Job No: 20/16588

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM26	Determination of phenols by Reversed Phased High Performance Liquid Chromatography and Electro-Chemical Detection.	PM0	No preparation is required.			AR	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.			AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.	Yes		AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.	Yes		AR	Yes
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GC/FID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.			AR	Yes
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GC/FID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993 (comparabl	PM0	No preparation is required.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993 (comparabl	PM20	Extraction of dried and ground or as received samples with deionised water in a 2:1 water to solid ratio using a reciprocal shaker for all analytes except hexavalent chromium. Extraction of as received sample using 10:1 ratio of 0.2M sodium hydroxide to soil for hexavalent chromium using a reciprocal shaker.	Yes		AR	Yes
TM60	TC/TOC analysis of Waters by High Temperature Combustion followed by NDIR detection. Based on the following modified standard methods: USEPA 9060A (2002), APHA SMEWW 5310B:1999 22nd Edition, ASTM D 7573, and USEPA 415.1.	PM0	No preparation is required.			AR	Yes
TM61	Determination of Mercury by Cold Vapour Atomic Fluorescence - WATERS: Modified USEPA Method 245.7, Rev 2, Feb 2005. SOILS: Modified USEPA Method 7471B, Rev.2, Feb 2007	PM0	No preparation is required.	Yes		AR	Yes

EMT Job No: 20/16588

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM65	Asbestos Bulk Identification method based on HSG 248 First edition (2006)	PM42	Modified SCA Blue Book V.12 draft 2017 and WM3 1st Edition v1.1:2018. Solid samples undergo a thorough visual inspection for asbestos fibres prior to asbestos identification using TM065.	Yes		AR	
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.	Yes		AR	No
TM89	Modified USEPA method OIA-1667 (1999). Determination of cyanide by Flow Injection Analyser. Where WAD cyanides are required a Ligand displacement step is carried out before analysis.	PM45	As received solid samples are extracted with 1M NaOH by orbital shaker for Cyanide, Sulphide and Thiocyanate analysis.	Yes		AR	Yes
TM173	Analysis of fluoride by ISE (Ion Selective Electrode) using modified ISE method 9214 - 340.2 (EPA 1998)	PM0	No preparation is required.			AR	Yes
NONE	No Method Code	NONE	No Method Code			AD	Yes
NONE	No Method Code	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.				
NONE	No Method Code	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.			AR	
NONE	No Method Code	PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.			AR	

Ground Investigations Ireland

Catherinestown House □

Hazelhatch Road □

Newcastle □

Co. Dublin □

Ireland □



Attention : John Duggan

Date : 16th December, 2020

Your reference : 9754-07-20

Our reference : Test Report 20/17312 Batch 1

Location : BusConnects Route 5

Date samples received : 8th December, 2020

Status : Final report

Issue : 1

One sample was received for analysis on 8th December, 2020 of which one was scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied. □

All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:



Bruce Leslie

Project Manager

Please include all sections of this report if it is reproduced

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 20/17312

SOILS

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overestimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.

Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

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REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher, this result is not accredited.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

HWOL ACRONYMS AND OPERATORS USED

HS	Headspace Analysis.
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent.
CU	Clean-up - e.g. by florisil, silica gel.
1D	GC - Single coil gas chromatography.
Total	Aliphatics & Aromatics.
AL	Aliphatics only.
AR	Aromatics only.
2D	GC-GC - Double coil gas chromatography.
#1	EH_Total but with humics extracted.
#2	EU_Total but with fatty acids extracted.
_	Operator - underscore to separate acronyms (exception for +).
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry.

EMT Job No: 20/17312

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.	PM0	No preparation is required.			AR	
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.			AR	Yes
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM8/PM16	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required/Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.			AR	Yes
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM8/PM16	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required/Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.	Yes		AR	Yes
TM5/TM36	please refer to TM5 and TM36 for method details	PM8/PM12/PM16	please refer to PM8/PM16 and PM12 for method details			AR	Yes
TM17	Modified US EPA method 8270D v5:2014. Determination of specific Polychlorinated Biphenyl congeners by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM20	Modified BS 1377-3:1990/USEPA 160.1/3 (TDS/TS: 1971) Gravimetric determination of Total Dissolved Solids/Total Solids	PM0	No preparation is required.	Yes		AR	Yes
TM21	Modified BS 7755-3:1995, ISO10694:1995 Determination of Total Organic Carbon or Total Carbon by combustion in an Eltra TOC furnace/analyser in the presence of oxygen. The CO2 generated is quantified using infra-red detection. Organic Matter (SOM) calculated as per EA MCERTS Chemical Testing of Soil, March 2012 v4.	PM24	Dried and ground solid samples are washed with hydrochloric acid, then rinsed with deionised water to remove the mineral carbon before TOC analysis.	Yes		AD	Yes
TM22	Modified BS1377-3:1990 Gravimetric determination of Loss on Ignition by temperature controlled Muffle Furnace (35C-440C). On request modified ASTM D2974-00 LOI (105C-440C)	PM0	No preparation is required.	Yes		AD	Yes

EMT Job No: 20/17312

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM26	Determination of phenols by Reversed Phased High Performance Liquid Chromatography and Electro-Chemical Detection.	PM0	No preparation is required.			AR	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.			AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.	Yes		AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.	Yes		AR	Yes
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GC/FID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.			AR	Yes
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GC/FID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993 (comparabl	PM0	No preparation is required.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993 (comparabl	PM20	Extraction of dried and ground or as received samples with deionised water in a 2:1 water to solid ratio using a reciprocal shaker for all analytes except hexavalent chromium. Extraction of as received sample using 10:1 ratio of 0.2M sodium hydroxide to soil for hexavalent chromium using a reciprocal shaker.	Yes		AR	Yes
TM60	TC/TOC analysis of Waters by High Temperature Combustion followed by NDIR detection. Based on the following modified standard methods: USEPA 9060A (2002), APHA SMEWW 5310B:1999 22nd Edition, ASTM D 7573, and USEPA 415.1.	PM0	No preparation is required.			AR	Yes
TM61	Determination of Mercury by Cold Vapour Atomic Fluorescence - WATERS: Modified USEPA Method 245.7, Rev 2, Feb 2005. SOILS: Modified USEPA Method 7471B, Rev.2, Feb 2007	PM0	No preparation is required.	Yes		AR	Yes

EMT Job No: 20/17312

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM65	Asbestos Bulk Identification method based on HSG 248 First edition (2006)	PM42	Modified SCA Blue Book V.12 draft 2017 and WM3 1st Edition v1.1:2018. Solid samples undergo a thorough visual inspection for asbestos fibres prior to asbestos identification using TM065.	Yes		AR	
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.	Yes		AR	No
TM89	Modified USEPA method OIA-1667 (1999). Determination of cyanide by Flow Injection Analyser. Where WAD cyanides are required a Ligand displacement step is carried out before analysis.	PM45	As received solid samples are extracted with 1M NaOH by orbital shaker for Cyanide, Sulphide and Thiocyanate analysis.	Yes		AR	Yes
TM173	Analysis of fluoride by ISE (Ion Selective Electrode) using modified ISE method 9214 - 340.2 (EPA 1998)	PM0	No preparation is required.			AR	Yes
NONE	No Method Code	NONE	No Method Code			AD	Yes
NONE	No Method Code	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.			AR	
NONE	No Method Code	PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.			AR	

Ground Investigations Ireland
Catherinstown House
Hazelhatch Road
Newcastle
Co. Dublin
Ireland



Attention : John Duggan
Date : 21st December, 2020
Your reference : 9754-07-20
Our reference : Test Report 20/17435 Batch 1
Location : Bus Connects Route 5
Date samples received : 9th December, 2020
Status : Final report
Issue : 1

Five samples were received for analysis on 9th December, 2020 of which five were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:



Lucas Halliwell
Project Co-ordinator

Please include all sections of this report if it is reproduced

Client Name: Ground Investigations Ireland
Reference: 20/07/9754
Location: Bus Connects Route 5
Contact: John Duggan

Note:
 Asbestos Screen analysis is carried out in accordance with our documented in-house methods PM042 and TM065 and HSG 248 by Stereo and Polarised Light Microscopy using Dispersion Staining Techniques and is covered by our UKAS accreditation. Detailed Gravimetric Quantification and PCOM Fibre Analysis is carried out in accordance with our documented in-house methods PM042 and TM131 and HSG 248 using Stereo and Polarised Light Microscopy and Phase Contrast Optical Microscopy (PCOM). Samples are retained for not less than 6 months from the date of analysis unless specifically requested.

Opinions, including ACM type and Asbestos level less than 0.1%, lie outside the scope of our UKAS accreditation.

Where the sample is not taken by a Element Materials Technology consultant, Element Materials Technology cannot be responsible for inaccurate or unrepresentative sampling.

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Date Of Analysis	Analysis	Result
20/17435	1	R5-CP05	0.50	2	15/12/2020	General Description (Bulk Analysis)	Soil/Stones
					15/12/2020	Asbestos Fibres	NAD
					15/12/2020	Asbestos ACM	NAD
					15/12/2020	Asbestos Type	NAD
					15/12/2020	Asbestos Level Screen	NAD
20/17435	1	R5-CP05	1.50	5	15/12/2020	General Description (Bulk Analysis)	Soil/Stones
					15/12/2020	Asbestos Fibres	NAD
					15/12/2020	Asbestos ACM	NAD
					15/12/2020	Asbestos Type	NAD
					15/12/2020	Asbestos Level Screen	NAD
20/17435	1	R5-CP05	2.50	8	15/12/2020	General Description (Bulk Analysis)	Soil/Stone
					15/12/2020	Asbestos Fibres	NAD
					15/12/2020	Asbestos ACM	NAD
					15/12/2020	Asbestos Type	NAD
					15/12/2020	Asbestos Level Screen	NAD
20/17435	1	R5-CP05	3.50	11	15/12/2020	General Description (Bulk Analysis)	Soil/Stone
					15/12/2020	Asbestos Fibres	NAD
					15/12/2020	Asbestos ACM	NAD
					15/12/2020	Asbestos Type	NAD
					15/12/2020	Asbestos Level Screen	NAD
20/17435	1	R5-CP05	4.50	14	15/12/2020	General Description (Bulk Analysis)	Soil/Stone
					15/12/2020	Asbestos Fibres	NAD
					15/12/2020	Asbestos ACM	NAD
					15/12/2020	Asbestos Type	NAD
					15/12/2020	Asbestos Level Screen	NAD

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 20/17435

SOILS

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It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overestimate when other sulphides such as Barite (Barium Sulphate) are present.

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Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

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A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

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Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

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REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

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AR	Aromatics only.
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#1	EH_Total but with humics extracted.
#2	EU_Total but with fatty acids extracted.
_	Operator - underscore to separate acronyms (exception for +).
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry.

EMT Job No: 20/17435

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
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TM5/TM36	please refer to TM5 and TM36 for method details	PM8/PM12/PM16	please refer to PM8/PM16 and PM12 for method details			AR	Yes
TM17	Modified US EPA method 8270D v5:2014. Determination of specific Polychlorinated Biphenyl congeners by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM20	Modified BS 1377-3:1990/USEPA 160.1/3 (TDS/TS: 1971) Gravimetric determination of Total Dissolved Solids/Total Solids	PM0	No preparation is required.	Yes		AR	Yes
TM21	Modified BS 7755-3:1995, ISO10694:1995 Determination of Total Organic Carbon or Total Carbon by combustion in an Eltra TOC furnace/analyser in the presence of oxygen. The CO2 generated is quantified using infra-red detection. Organic Matter (SOM) calculated as per EA MCERTS Chemical Testing of Soil, March 2012 v4.	PM24	Dried and ground solid samples are washed with hydrochloric acid, then rinsed with deionised water to remove the mineral carbon before TOC analysis.	Yes		AD	Yes
TM22	Modified BS1377-3:1990 Gravimetric determination of Loss on Ignition by temperature controlled Muffle Furnace (35C-440C). On request modified ASTM D2974-00 LOI (105C-440C)	PM0	No preparation is required.	Yes		AD	Yes

EMT Job No: 20/17435

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM26	Determination of phenols by Reversed Phased High Performance Liquid Chromatography and Electro-Chemical Detection.	PM0	No preparation is required.			AR	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.			AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.	Yes		AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.	Yes		AR	Yes
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GCFID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.			AR	Yes
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GCFID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993 (comparabl	PM0	No preparation is required.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993 (comparabl	PM20	Extraction of dried and ground or as received samples with deionised water in a 2:1 water to solid ratio using a reciprocal shaker for all analytes except hexavalent chromium. Extraction of as received sample using 10:1 ratio of 0.2M sodium hydroxide to soil for hexavalent chromium using a reciprocal shaker.	Yes		AR	Yes
TM60	TC/TOC analysis of Waters by High Temperature Combustion followed by NDIR detection. Based on the following modified standard methods: USEPA 9060A (2002), APHA SMEWW 5310B:1999 22nd Edition, ASTM D 7573, and USEPA 415.1.	PM0	No preparation is required.			AR	Yes
TM61	Determination of Mercury by Cold Vapour Atomic Fluorescence - WATERS: Modified USEPA Method 245.7, Rev 2, Feb 2005. SOILS: Modified USEPA Method 7471B, Rev.2, Feb 2007	PM0	No preparation is required.	Yes		AR	Yes

EMT Job No: 20/17435

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM65	Asbestos Bulk Identification method based on HSG 248 First edition (2006)	PM42	Modified SCA Blue Book V.12 draft 2017 and WM3 1st Edition v1.1:2018. Solid samples undergo a thorough visual inspection for asbestos fibres prior to asbestos identification using TM065.	Yes		AR	
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.	Yes		AR	No
TM89	Modified USEPA method OIA-1667 (1999). Determination of cyanide by Flow Injection Analyser. Where WAD cyanides are required a Ligand displacement step is carried out before analysis.	PM45	As received solid samples are extracted with 1M NaOH by orbital shaker for Cyanide, Sulphide and Thiocyanate analysis.	Yes		AR	Yes
TM173	Analysis of fluoride by ISE (Ion Selective Electrode) using modified ISE method 9214 - 340.2 (EPA 1998)	PM0	No preparation is required.			AR	Yes
NONE	No Method Code	NONE	No Method Code			AD	Yes
NONE	No Method Code	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.			AR	
NONE	No Method Code	PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.			AR	

Ground Investigations Ireland
Catherinstown House
Hazelhatch Road
Newcastle
Co. Dublin
Ireland



Attention : Mike Sutton
Date : 11th March, 2021
Your reference : 9754-07-20
Our reference : Test Report 21/2952 Batch 1
Location : Busconnects Route 5
Date samples received : 25th February, 2021
Status : Final report
Issue : 1

Five samples were received for analysis on 25th February, 2021 of which five were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:



Phil Sommerton BSc
Senior Project Manager

Please include all sections of this report if it is reproduced

Client Name: Ground Investigations Ireland
Reference: 20/07/9754
Location: Busconnects Route 5
Contact: Mike Sutton

Note:
 Asbestos Screen analysis is carried out in accordance with our documented in-house methods PM042 and TM065 and HSG 248 by Stereo and Polarised Light Microscopy using Dispersion Staining Techniques and is covered by our UKAS accreditation. Detailed Gravimetric Quantification and PCOM Fibre Analysis is carried out in accordance with our documented in-house methods PM042 and TM131 and HSG 248 using Stereo and Polarised Light Microscopy and Phase Contrast Optical Microscopy (PCOM). Samples are retained for not less than 6 months from the date of analysis unless specifically requested.

Opinions, including ACM type and Asbestos level less than 0.1%, lie outside the scope of our UKAS accreditation.

Where the sample is not taken by a Element Materials Technology consultant, Element Materials Technology cannot be responsible for inaccurate or unrepresentative sampling.

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Date Of Analysis	Analysis	Result
21/2952	1	R5 - TP09	0.50	2	04/03/2021	General Description (Bulk Analysis)	soil/stones
					04/03/2021	Asbestos Fibres	NAD
					04/03/2021	Asbestos ACM	NAD
					04/03/2021	Asbestos Type	NAD
					04/03/2021	Asbestos Level Screen	NAD
21/2952	1	R5 - TP09	1.40	5	04/03/2021	General Description (Bulk Analysis)	Soil/Stones
					04/03/2021	Asbestos Fibres	NAD
					04/03/2021	Asbestos ACM	NAD
					04/03/2021	Asbestos Type	NAD
					04/03/2021	Asbestos Level Screen	NAD
21/2952	1	R5 - TP08A	0.50	8	05/03/2021	General Description (Bulk Analysis)	Soil/Stones
					05/03/2021	Asbestos Fibres	NAD
					05/03/2021	Asbestos ACM	NAD
					05/03/2021	Asbestos Type	NAD
					05/03/2021	Asbestos Level Screen	NAD
21/2952	1	R5 - TP08A	1.50	11	04/03/2021	General Description (Bulk Analysis)	Soil/Stones
					04/03/2021	Asbestos Fibres	NAD
					04/03/2021	Asbestos ACM	NAD
					04/03/2021	Asbestos Type	NAD
					04/03/2021	Asbestos Level Screen	NAD
21/2952	1	R5 - TP08A	2.20	14	05/03/2021	General Description (Bulk Analysis)	Soil/Stones
					05/03/2021	Asbestos Fibres	NAD
					05/03/2021	Asbestos ACM	NAD
					05/03/2021	Asbestos Type	NAD
					05/03/2021	Asbestos Level Screen	NAD

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 21/2952

SOILS

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overestimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.

Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

Please include all sections of this report if it is reproduced

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher, this result is not accredited.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

HWOL ACRONYMS AND OPERATORS USED

HS	Headspace Analysis.
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent.
CU	Clean-up - e.g. by florisil, silica gel.
1D	GC - Single coil gas chromatography.
Total	Aliphatics & Aromatics.
AL	Aliphatics only.
AR	Aromatics only.
2D	GC-GC - Double coil gas chromatography.
#1	EH_Total but with humics extracted.
#2	EU_Total but with fatty acids extracted.
_	Operator - underscore to separate acronyms (exception for +).
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry.

EMT Job No: 21/2952

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.	PM0	No preparation is required.			AR	
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.			AR	Yes
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM8/PM16	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required/Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.			AR	Yes
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM8/PM16	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required/Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.	Yes		AR	Yes
TM5/TM36	please refer to TM5 and TM36 for method details	PM8/PM12/PM16	please refer to PM8/PM16 and PM12 for method details			AR	Yes
TM17	Modified US EPA method 8270D v5:2014. Determination of specific Polychlorinated Biphenyl congeners by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM20	Modified BS 1377-3:1990/USEPA 160.1/3 (TDS/TS: 1971) Gravimetric determination of Total Dissolved Solids/Total Solids	PM0	No preparation is required.	Yes		AR	Yes
TM21	Modified BS 7755-3:1995, ISO10694:1995 Determination of Total Organic Carbon or Total Carbon by combustion in an Eltra TOC furnace/analyser in the presence of oxygen. The CO2 generated is quantified using infra-red detection. Organic Matter (SOM) calculated as per EA MCERTS Chemical Testing of Soil, March 2012 v4.	PM24	Dried and ground solid samples are washed with hydrochloric acid, then rinsed with deionised water to remove the mineral carbon before TOC analysis.	Yes		AD	Yes
TM22	Modified BS1377-3:1990 Gravimetric determination of Loss on Ignition by temperature controlled Muffle Furnace (35C-440C). On request modified ASTM D2974-00 LOI (105C-440C)	PM0	No preparation is required.	Yes		AD	Yes

EMT Job No: 21/2952

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
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TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.			AD	Yes
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TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GC/FID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.			AR	Yes
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TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013I	PM0	No preparation is required.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013I	PM20	Extraction of dried and ground or as received samples with deionised water in a 2:1 water to solid ratio using a reciprocal shaker for all analytes except hexavalent chromium. Extraction of as received sample using 10:1 ratio of 0.2M sodium hydroxide to soil for hexavalent chromium using a reciprocal shaker.	Yes		AR	Yes
TM60	TC/TOC analysis of Waters by High Temperature Combustion followed by NDIR detection. Based on the following modified standard methods: USEPA 9060A (2002), APHA SMEWW 5310B:1999 22nd Edition, ASTM D 7573, and USEPA 415.1.	PM0	No preparation is required.			AR	Yes
TM61	Determination of Mercury by Cold Vapour Atomic Fluorescence - WATERS: Modified USEPA Method 245.7, Rev 2, Feb 2005. SOILS: Modified USEPA Method 7471B, Rev.2, Feb 2007	PM0	No preparation is required.	Yes		AR	Yes

EMT Job No: 21/2952

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
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TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.	Yes		AR	No
TM89	Modified USEPA method OIA-1667 (1999). Determination of cyanide by Flow Injection Analyser. Where WAD cyanides are required a Ligand displacement step is carried out before analysis.	PM45	As received solid samples are extracted with 1M NaOH by orbital shaker for Cyanide, Sulphide and Thiocyanate analysis.	Yes		AR	Yes
TM173	Analysis of fluoride by ISE (Ion Selective Electrode) using modified ISE method 9214 - 340.2 (EPA 1998)	PM0	No preparation is required.			AR	Yes
NONE	No Method Code	NONE	No Method Code			AD	Yes
NONE	No Method Code	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.			AR	
NONE	No Method Code	PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.			AR	

Ground Investigations Ireland
Catherinstown House
Hazelhatch Road
Newcastle
Co. Dublin
Ireland



Attention : John Duggan
Date : 3rd December, 2020
Your reference : 9754-07-20
Our reference : Test Report 20/16404 Batch 1
Location : BusConnects Route 5
Date samples received : 23rd November, 2020
Status : Final report
Issue : 1

Nine samples were received for analysis on 23rd November, 2020 of which nine were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.

All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:



Bruce Leslie
Project Manager

Please include all sections of this report if it is reproduced

Element Materials Technology

Client Name: Ground Investigations Ireland
Reference: 9754-07-20
Location: BusConnects Route 5
Contact: John Duggan
EMT Job No: 20/16404

Report : Solid

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27				
Sample ID	R5 TP01	R5 TP01	R5 TP05	R5 TP05	R5 TP05B	R5 TP06	R5 TP06	R5 TP07B	R5 TP07B				
Depth	0.50	1.50	0.50	1.50	0.90	0.50	1.50	0.50	1.50				
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T				
Sample Date	17/11/2020	17/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020				
Sample Type	Soil												
Batch Number	1	1	1	1	1	1	1	1	1				
Date of Receipt	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020				
											LOD/LOR	Units	Method No.
Antimony	2	2	1	<1	<1	<1	1	<1	1		<1	mg/kg	TM30/PM15
Arsenic #	12.4	11.3	9.2	4.7	3.6	7.8	8.5	4.9	13.0		<0.5	mg/kg	TM30/PM15
Barium #	75	73	98	70	46	53	64	65	104		<1	mg/kg	TM30/PM15
Cadmium #	2.5	2.7	0.9	0.9	0.2	0.3	0.8	0.8	1.1		<0.1	mg/kg	TM30/PM15
Chromium #	39.8	34.0	53.4	71.4	40.8	43.4	47.0	36.4	48.0		<0.5	mg/kg	TM30/PM15
Copper #	37	31	34	15	23	24	27	15	23		<1	mg/kg	TM30/PM15
Lead #	19	16	33	14	10	20	27	47	25		<5	mg/kg	TM30/PM15
Mercury #	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1		<0.1	mg/kg	TM30/PM15
Molybdenum #	4.7	5.4	2.2	3.2	0.6	0.8	2.4	2.2	3.0		<0.1	mg/kg	TM30/PM15
Nickel #	44.7	42.1	64.6	45.5	60.7	70.2	49.2	30.6	42.4		<0.7	mg/kg	TM30/PM15
Selenium #	2	4	2	<1	<1	1	<1	<1	<1		<1	mg/kg	TM30/PM15
Zinc #	101	95	140	109	127	119	84	60	135		<5	mg/kg	TM30/PM15
PAH MS													
Naphthalene #	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04		<0.04	mg/kg	TM4/PM8
Acenaphthylene	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03		<0.03	mg/kg	TM4/PM8
Acenaphthene #	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	mg/kg	TM4/PM8
Fluorene #	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04		<0.04	mg/kg	TM4/PM8
Phenanthrene #	<0.03	<0.03	0.11	<0.03	<0.03	<0.03	0.10	<0.03	<0.03		<0.03	mg/kg	TM4/PM8
Anthracene #	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.04	<0.04	<0.04		<0.04	mg/kg	TM4/PM8
Fluoranthene #	<0.03	<0.03	0.18	<0.03	<0.03	0.08	0.36	<0.03	0.06		<0.03	mg/kg	TM4/PM8
Pyrene #	<0.03	<0.03	0.17	<0.03	<0.03	0.07	0.35	<0.03	0.04		<0.03	mg/kg	TM4/PM8
Benzo(a)anthracene #	<0.06	<0.06	0.12	<0.06	<0.06	0.07	0.27	<0.06	<0.06		<0.06	mg/kg	TM4/PM8
Chrysene #	<0.02	<0.02	0.13	<0.02	<0.02	0.06	0.30	<0.02	0.03		<0.02	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #	<0.07	<0.07	0.26	<0.07	<0.07	0.09	0.66	<0.07	<0.07		<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene #	<0.04	<0.04	0.14	<0.04	<0.04	0.04	0.37	<0.04	<0.04		<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene	<0.04	<0.04	0.10	<0.04	<0.04	<0.04	0.30	<0.04	<0.04		<0.04	mg/kg	TM4/PM8
Dibenzo(ah)anthracene #	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	<0.04	<0.04		<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene #	<0.04	<0.04	0.10	<0.04	<0.04	<0.04	0.31	<0.04	<0.04		<0.04	mg/kg	TM4/PM8
Coronene	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.07	<0.04	<0.04		<0.04	mg/kg	TM4/PM8
PAH 17 Total	<0.64	<0.64	1.31	<0.64	<0.64	<0.64	3.18	<0.64	<0.64		<0.64	mg/kg	TM4/PM8
Benzo(b)fluoranthene	<0.05	<0.05	0.19	<0.05	<0.05	0.06	0.48	<0.05	<0.05		<0.05	mg/kg	TM4/PM8
Benzo(k)fluoranthene	<0.02	<0.02	0.07	<0.02	<0.02	0.03	0.18	<0.02	<0.02		<0.02	mg/kg	TM4/PM8
PAH Surrogate % Recovery	78	88	83	74	75	85	80	75	80		<0	%	TM4/PM8
Mineral Oil (C10-C40) (EH_CU_1D_Total)	<30	<30	<30	<30	<30	<30	<30	<30	<30		<30	mg/kg	TM5/PM8/PM16

Please see attached notes for all abbreviations and acronyms

Element Materials Technology

Client Name: Ground Investigations Ireland
Reference: 9754-07-20
Location: BusConnects Route 5
Contact: John Duggan
EMT Job No: 20/16404

Report : Solid

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27			
Sample ID	R5 TP01	R5 TP01	R5 TP05	R5 TP05	R5 TP05B	R5 TP06	R5 TP06	R5 TP07B	R5 TP07B			
Depth	0.50	1.50	0.50	1.50	0.90	0.50	1.50	0.50	1.50			
COC No / misc												
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T			
Sample Date	17/11/2020	17/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020			
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil			
Batch Number	1	1	1	1	1	1	1	1	1			
Date of Receipt	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020			
										LOD/LOR	Units	Method No.
TPH CWG												
Aliphatics												
>C5-C6 (HS_1D_AL) #	<0.1 ^{SV}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1 ^{SV}	<0.1	<0.1	mg/kg	TM36/PM12
>C6-C8 (HS_1D_AL) #	<0.1 ^{SV}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1 ^{SV}	<0.1	<0.1	mg/kg	TM36/PM12
>C8-C10 (HS_1D_AL) #	<0.1 ^{SV}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1 ^{SV}	<0.1	<0.1	mg/kg	TM36/PM12
>C10-C12 (EH_1D_AL) #	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	mg/kg	TMS/IPM8/PM16
>C12-C16 (EH_1D_AL) #	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	mg/kg	TMS/IPM8/PM16
>C16-C21 (EH_1D_AL) #	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	mg/kg	TMS/IPM8/PM16
>C21-C35 (EH_1D_AL) #	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	mg/kg	TMS/IPM8/PM16
>C35-C40 (EH_1D_AL)	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	mg/kg	TMS/IPM8/PM16
Total aliphatics C5-40 (EH+HS_1D_AL)	<26	<26	<26	<26	<26	<26	<26	<26	<26	<26	mg/kg	TMS/TPM36/PM8/PM12/PM16
>C6-C10 (HS_1D_AL)	<0.1 ^{SV}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1 ^{SV}	<0.1	<0.1	mg/kg	TM36/PM12
>C10-C25 (EH_1D_AL)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	mg/kg	TMS/IPM8/PM16
>C25-C35 (EH_1D_AL)	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	mg/kg	TMS/IPM8/PM16
Aromatics												
>C5-EC7 (HS_1D_AR) #	<0.1 ^{SV}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1 ^{SV}	<0.1	<0.1	mg/kg	TM36/PM12
>EC7-EC8 (HS_1D_AR) #	<0.1 ^{SV}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1 ^{SV}	<0.1	<0.1	mg/kg	TM36/PM12
>EC8-EC10 (HS_1D_AR) #	<0.1 ^{SV}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1 ^{SV}	<0.1	<0.1	mg/kg	TM36/PM12
>EC10-EC12 (EH_1D_AR) #	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	mg/kg	TMS/IPM8/PM16
>EC12-EC16 (EH_1D_AR) #	<4	<4	<4	<4	<4	<4	<4	<4	<4	<4	mg/kg	TMS/IPM8/PM16
>EC16-EC21 (EH_1D_AR) #	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	mg/kg	TMS/IPM8/PM16
>EC21-EC35 (EH_1D_AR) #	<7	<7	79	<7	<7	<7	<7	<7	<7	<7	mg/kg	TMS/IPM8/PM16
>EC35-EC40 (EH_1D_AR)	<7	<7	<7	<7	<7	<7	<7	<7	<7	<7	mg/kg	TMS/IPM8/PM16
Total aromatics C5-40 (EH+HS_1D_AR)	<26	<26	79	<26	<26	<26	<26	<26	<26	<26	mg/kg	TMS/TPM36/PM8/PM12/PM16
Total aliphatics and aromatics(C5-40) (EH+HS_CU_1D_Total)	<52	<52	79	<52	<52	<52	<52	<52	<52	<52	mg/kg	TMS/TPM36/PM8/PM12/PM16
>EC6-EC10 (HS_1D_AR) #	<0.1 ^{SV}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1 ^{SV}	<0.1	<0.1	mg/kg	TM36/PM12
>EC10-EC25 (EH_1D_AR)	<10	<10	26	<10	<10	<10	<10	<10	<10	<10	mg/kg	TMS/IPM8/PM16
>EC25-EC35 (EH_1D_AR)	<10	<10	53	<10	<10	<10	<10	<10	<10	<10	mg/kg	TMS/IPM8/PM16
MTBE #	<5 ^{SV}	<5	<5	<5	<5	<5	<5	<5 ^{SV}	<5	<5	ug/kg	TM36/PM12
Benzene #	<5 ^{SV}	<5	<5	<5	<5	<5	<5	<5 ^{SV}	<5	<5	ug/kg	TM36/PM12
Toluene #	<5 ^{SV}	<5	<5	<5	<5	<5	<5	<5 ^{SV}	<5	<5	ug/kg	TM36/PM12
Ethylbenzene #	<5 ^{SV}	<5	<5	<5	<5	<5	<5	<5 ^{SV}	<5	<5	ug/kg	TM36/PM12
m/p-Xylene #	<5 ^{SV}	<5	<5	<5	<5	<5	<5	<5 ^{SV}	<5	<5	ug/kg	TM36/PM12
o-Xylene #	<5 ^{SV}	<5	<5	<5	<5	<5	<5	<5 ^{SV}	<5	<5	ug/kg	TM36/PM12
PCB 28 #	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	ug/kg	TM17/PM8
PCB 52 #	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	ug/kg	TM17/PM8
PCB 101 #	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	ug/kg	TM17/PM8
PCB 118 #	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	ug/kg	TM17/PM8
PCB 138 #	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	ug/kg	TM17/PM8
PCB 153 #	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	ug/kg	TM17/PM8
PCB 180 #	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	ug/kg	TM17/PM8
Total 7 PCBs #	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	ug/kg	TM17/PM8

Please see attached notes for all abbreviations and acronyms

Element Materials Technology

Client Name: Ground Investigations Ireland
Reference: 9754-07-20
Location: BusConnects Route 5
Contact: John Duggan
EMT Job No: 20/16404

Report : Solid

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27				
Sample ID	R5 TP01	R5 TP01	R5 TP05	R5 TP05	R5 TP05B	R5 TP06	R5 TP06	R5 TP07B	R5 TP07B				
Depth	0.50	1.50	0.50	1.50	0.90	0.50	1.50	0.50	1.50				
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T				
Sample Date	17/11/2020	17/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020				
Sample Type	Soil												
Batch Number	1	1	1	1	1	1	1	1	1				
Date of Receipt	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020				
											LOD/LOR	Units	Method No.
Natural Moisture Content	14.6	11.7	19.6	14.6	9.8	10.3	9.6	8.5	11.2		<0.1	%	PM4/PM0
Moisture Content (% Wet Weight)	12.7	10.5	16.4	12.8	8.9	9.4	8.8	7.9	10.1		<0.1	%	PM4/PM0
Hexavalent Chromium #	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3		<0.3	mg/kg	TM38/PM20
Chromium III	39.8	34.0	53.4	71.4	40.8	43.4	47.0	36.4	48.0		<0.5	mg/kg	NONE/NONE
Total Cyanide #	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	mg/kg	TM89/PM45
Total Organic Carbon #	0.76	0.70	1.01	0.32	0.23	0.30	0.60	0.50	0.54		<0.02	%	TM21/PM24
Loss on Ignition #	3.1	2.2	4.0	1.7	1.5	1.9	2.3	1.4	2.2		<1.0	%	TM22/PM0
pH #	8.22	8.47	8.36	8.44	8.66	8.63	8.52	8.38	8.59		<0.01	pH units	TM73/PM11
Mass of raw test portion	0.101	0.102	0.0998	0.0984	0.1012	0.1001	0.095	0.101	0.1022			kg	NONE/PM17
Mass of dried test portion	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09			kg	NONE/PM17

Please see attached notes for all abbreviations and acronyms

Element Materials Technology

Client Name: Ground Investigations Ireland
Reference: 9754-07-20
Location: BusConnects Route 5
Contact: John Duggan
EMT Job No: 20/16404

Report : CEN 10:1 1 Batch

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27				
Sample ID	R5 TP01	R5 TP01	R5 TP05	R5 TP05	R5 TP05B	R5 TP06	R5 TP06	R5 TP07B	R5 TP07B				
Depth	0.50	1.50	0.50	1.50	0.90	0.50	1.50	0.50	1.50				
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T				
Sample Date	17/11/2020	17/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020				
Sample Type	Soil												
Batch Number	1	1	1	1	1	1	1	1	1				
Date of Receipt	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020				
											LOD/LOR	Units	Method No.
Dissolved Antimony #	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002		<0.002	mg/l	TM30/PM17
Dissolved Antimony (A10) #	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	mg/kg	TM30/PM17
Dissolved Arsenic #	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025	<0.0025		<0.0025	mg/l	TM30/PM17
Dissolved Arsenic (A10) #	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025		<0.025	mg/kg	TM30/PM17
Dissolved Barium #	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003		<0.003	mg/l	TM30/PM17
Dissolved Barium (A10) #	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03		<0.03	mg/kg	TM30/PM17
Dissolved Cadmium #	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005		<0.0005	mg/l	TM30/PM17
Dissolved Cadmium (A10) #	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	mg/kg	TM30/PM17
Dissolved Chromium #	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015	<0.0015		<0.0015	mg/l	TM30/PM17
Dissolved Chromium (A10) #	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015		<0.015	mg/kg	TM30/PM17
Dissolved Copper #	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007	<0.007		<0.007	mg/l	TM30/PM17
Dissolved Copper (A10) #	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07		<0.07	mg/kg	TM30/PM17
Dissolved Lead #	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005		<0.005	mg/l	TM30/PM17
Dissolved Lead (A10) #	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	mg/kg	TM30/PM17
Dissolved Molybdenum #	0.006	0.017	<0.002	<0.002	<0.002	0.003	0.003	0.003	0.005		<0.002	mg/l	TM30/PM17
Dissolved Molybdenum (A10) #	0.06	0.17	<0.02	<0.02	<0.02	0.03	0.03	0.03	0.05		<0.02	mg/kg	TM30/PM17
Dissolved Nickel #	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002		<0.002	mg/l	TM30/PM17
Dissolved Nickel (A10) #	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02		<0.02	mg/kg	TM30/PM17
Dissolved Selenium #	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003		<0.003	mg/l	TM30/PM17
Dissolved Selenium (A10) #	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03		<0.03	mg/kg	TM30/PM17
Dissolved Zinc #	0.004	<0.003	<0.003	<0.003	<0.003	0.003	<0.003	<0.003	0.003		<0.003	mg/l	TM30/PM17
Dissolved Zinc (A10) #	0.04	<0.03	<0.03	<0.03	<0.03	0.03	<0.03	<0.03	0.03		<0.03	mg/kg	TM30/PM17
Mercury Dissolved by CVAF #	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001	<0.00001		<0.00001	mg/l	TM61/PM0
Mercury Dissolved by CVAF #	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001		<0.0001	mg/kg	TM61/PM0
Total Phenols HPLC	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		<0.05	mg/l	TM26/PM0
Total Phenols HPLC	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5		<0.5	mg/kg	TM26/PM0
Fluoride	0.3	<0.3	<0.3	<0.3	<0.3	0.3	<0.3	<0.3	0.3		<0.3	mg/l	TM173/PM0
Fluoride	<3	<3	<3	<3	<3	3	<3	<3	3		<3	mg/kg	TM173/PM0
Sulphate as SO4 #	1.3	14.5	<0.5	<0.5	<0.5	1.3	1.3	0.9	3.8		<0.5	mg/l	TM38/PM0
Sulphate as SO4 #	13	145	<5	<5	<5	13	13	9	38		<5	mg/kg	TM38/PM0
Chloride #	1.6	<0.3	<0.3	<0.3	<0.3	0.5	0.5	<0.3	<0.3		<0.3	mg/l	TM38/PM0
Chloride #	16	<3	<3	<3	<3	5	5	<3	<3		<3	mg/kg	TM38/PM0
Dissolved Organic Carbon	4	2	<2	<2	<2	<2	<2	<2	2		<2	mg/l	TM60/PM0
Dissolved Organic Carbon	40	<20	<20	<20	<20	<20	<20	<20	20		<20	mg/kg	TM60/PM0
Total Dissolved Solids #	72	48	65	49	39	56	62	42	49		<35	mg/l	TM20/PM0
Total Dissolved Solids #	720	480	650	490	390	560	620	420	490		<350	mg/kg	TM20/PM0

Please see attached notes for all abbreviations and acronyms

Element Materials Technology

Client Name: Ground Investigations Ireland
Reference: 9754-07-20
Location: BusConnects Route 5
Contact: John Duggan
EMT Job No: 20/16404

Report : EN12457_2
Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27						
Sample ID	R5 TP01	R5 TP01	R5 TP05	R5 TP05	R5 TP05B	R5 TP06	R5 TP06	R5 TP07B	R5 TP07B						
Depth	0.50	1.50	0.50	1.50	0.90	0.50	1.50	0.50	1.50						
COC No / misc															
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T	V J T						
Sample Date	17/11/2020	17/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020	16/11/2020						
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil						
Batch Number	1	1	1	1	1	1	1	1	1						
Date of Receipt	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020	23/11/2020						
										Inert	Stable Non-reactive	Hazardous	LOD LOR	Units	Method No.
Solid Waste Analysis															
Total Organic Carbon #	0.76	0.70	1.01	0.32	0.23	0.30	0.60	0.50	0.54	3	5	6	<0.02	%	TM21/PM24
Sum of BTEX	<0.025 ^{SV}	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025 ^{SV}	<0.025	6	-	-	<0.025	mg/kg	TM36/PM12
Sum of 7 PCBs #	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	1	-	-	<0.035	mg/kg	TM17/PM8
Mineral Oil	<30	<30	<30	<30	<30	<30	<30	<30	<30	500	-	-	<30	mg/kg	TM5/PM8/PM16
PAH Sum of 17	<0.64	<0.64	1.31	<0.64	<0.64	<0.64	3.18	<0.64	<0.64	100	-	-	<0.64	mg/kg	TM4/PM8
CEN 10:1 Leachate															
Arsenic #	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	0.5	2	25	<0.025	mg/kg	TM30/PM17
Barium #	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	20	100	300	<0.03	mg/kg	TM30/PM17
Cadmium #	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.04	1	5	<0.005	mg/kg	TM30/PM17
Chromium #	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.5	10	70	<0.015	mg/kg	TM30/PM17
Copper #	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	2	50	100	<0.07	mg/kg	TM30/PM17
Mercury #	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.01	0.2	2	<0.0001	mg/kg	TM61/PM0
Molybdenum #	0.06	0.17	<0.02	<0.02	<0.02	0.03	0.03	0.03	0.05	0.5	10	30	<0.02	mg/kg	TM30/PM17
Nickel #	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.4	10	40	<0.02	mg/kg	TM30/PM17
Lead #	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.5	10	50	<0.05	mg/kg	TM30/PM17
Antimony #	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.06	0.7	5	<0.02	mg/kg	TM30/PM17
Selenium #	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.1	0.5	7	<0.03	mg/kg	TM30/PM17
Zinc #	0.04	<0.03	<0.03	<0.03	<0.03	0.03	<0.03	<0.03	0.03	4	50	200	<0.03	mg/kg	TM30/PM17
Total Dissolved Solids #	720	480	650	490	390	560	620	420	490	4000	60000	100000	<350	mg/kg	TM20/PM0
Dissolved Organic Carbon	40	<20	<20	<20	<20	<20	<20	<20	20	500	800	1000	<20	mg/kg	TM60/PM0
Mass of raw test portion	0.101	0.102	0.0998	0.0984	0.1012	0.1001	0.095	0.101	0.1022	-	-	-		kg	NONE/PM17
Dry Matter Content Ratio	89.1	88.5	90.2	91.8	89.0	89.9	94.8	89.2	87.9	-	-	-	<0.1	%	NONE/PM4
Leachant Volume	0.889	0.888	0.89	0.892	0.889	0.89	0.895	0.889	0.888	-	-	-		l	NONE/PM17
Eluate Volume	0.8	0.4	0.8	0.8	0.8	0.8	0.8	0.8	0.8	-	-	-		l	NONE/PM17
pH #	8.22	8.47	8.36	8.44	8.66	8.63	8.52	8.38	8.59	-	-	-	<0.01	pH units	TM73/PM11
Fluoride	<3	<3	<3	<3	<3	3	<3	<3	3	-	-	-	<3	mg/kg	TM173/PM0
Sulphate as SO4 #	13	145	<5	<5	<5	13	13	9	38	1000	20000	50000	<5	mg/kg	TM38/PM0
Chloride #	16	<3	<3	<3	<3	5	5	<3	<3	800	15000	25000	<3	mg/kg	TM38/PM0

Please see attached notes for all abbreviations and acronyms

Client Name: Ground Investigations Ireland
Reference: 20/07/9754
Location: BusConnects Route 5
Contact: John Duggan

Note:
 Asbestos Screen analysis is carried out in accordance with our documented in-house methods PM042 and TM065 and HSG 248 by Stereo and Polarised Light Microscopy using Dispersion Staining Techniques and is covered by our UKAS accreditation. Detailed Gravimetric Quantification and PCOM Fibre Analysis is carried out in accordance with our documented in-house methods PM042 and TM131 and HSG 248 using Stereo and Polarised Light Microscopy and Phase Contrast Optical Microscopy (PCOM). Samples are retained for not less than 6 months from the date of analysis unless specifically requested.

Opinions, including ACM type and Asbestos level less than 0.1%, lie outside the scope of our UKAS accreditation.

Where the sample is not taken by a Element Materials Technology consultant, Element Materials Technology cannot be responsible for inaccurate or unrepresentative sampling.

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Date Of Analysis	Analysis	Result
20/16404	1	R5 TP01	0.50	2	30/11/2020	General Description (Bulk Analysis)	soil/stones
					30/11/2020	Asbestos Fibres	NAD
					30/11/2020	Asbestos ACM	NAD
					30/11/2020	Asbestos Type	NAD
					30/11/2020	Asbestos Level Screen	NAD
20/16404	1	R5 TP01	1.50	5	30/11/2020	General Description (Bulk Analysis)	soil/stones
					30/11/2020	Asbestos Fibres	NAD
					30/11/2020	Asbestos ACM	NAD
					30/11/2020	Asbestos Type	NAD
					30/11/2020	Asbestos Level Screen	NAD
20/16404	1	R5 TP05	0.50	8	30/11/2020	General Description (Bulk Analysis)	soil/stones
					30/11/2020	Asbestos Fibres	NAD
					30/11/2020	Asbestos ACM	NAD
					30/11/2020	Asbestos Type	NAD
					30/11/2020	Asbestos Level Screen	NAD
20/16404	1	R5 TP05	1.50	11	30/11/2020	General Description (Bulk Analysis)	Soil/Stones
					30/11/2020	Asbestos Fibres	NAD
					30/11/2020	Asbestos ACM	NAD
					30/11/2020	Asbestos Type	NAD
					30/11/2020	Asbestos Level Screen	NAD
20/16404	1	R5 TP05B	0.90	14	30/11/2020	General Description (Bulk Analysis)	Soil/Stones
					30/11/2020	Asbestos Fibres	NAD
					30/11/2020	Asbestos ACM	NAD
					30/11/2020	Asbestos Type	NAD
					30/11/2020	Asbestos Level Screen	NAD
20/16404	1	R5 TP06	0.50	17	30/11/2020	General Description (Bulk Analysis)	Soil/Stones
					30/11/2020	Asbestos Fibres	NAD
					30/11/2020	Asbestos ACM	NAD
					30/11/2020	Asbestos Type	NAD
					30/11/2020	Asbestos Level Screen	NAD
20/16404	1	R5 TP06	1.50	20	30/11/2020	General Description (Bulk Analysis)	Soil/Stones
					30/11/2020	Asbestos Fibres	NAD
					30/11/2020	Asbestos ACM	NAD

Client Name: Ground Investigations Ireland
 Reference: 20/07/9754
 Location: BusConnects Route 5
 Contact: John Duggan

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Date Of Analysis	Analysis	Result
20/16404	1	R5 TP06	1.50	20	30/11/2020	Asbestos Type	NAD
					30/11/2020	Asbestos Level Screen	NAD
20/16404	1	R5 TP07B	0.50	23	30/11/2020	General Description (Bulk Analysis)	Soil/Stones
					30/11/2020	Asbestos Fibres	NAD
					30/11/2020	Asbestos ACM	NAD
					30/11/2020	Asbestos Type	NAD
					30/11/2020	Asbestos Level Screen	NAD
20/16404	1	R5 TP07B	1.50	26	30/11/2020	General Description (Bulk Analysis)	Soil/Stones
					30/11/2020	Asbestos Fibres	NAD
					30/11/2020	Asbestos ACM	NAD
					30/11/2020	Asbestos Type	NAD
					30/11/2020	Asbestos Level Screen	NAD

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 20/16404

SOILS

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overestimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.

Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

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REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher, this result is not accredited.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

EMT Job No: 20/16404

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.	PM0	No preparation is required.			AR	
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.			AR	Yes
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM8/PM16	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required/Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.			AR	Yes
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM8/PM16	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required/Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.	Yes		AR	Yes
TM5/TM36	please refer to TM5 and TM36 for method details	PM8/PM12/PM16	please refer to PM8/PM16 and PM12 for method details			AR	Yes
TM17	Modified US EPA method 8270D v5:2014. Determination of specific Polychlorinated Biphenyl congeners by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM20	Modified BS 1377-3:1990/USEPA 160.1/3 (TDS/TS: 1971) Gravimetric determination of Total Dissolved Solids/Total Solids	PM0	No preparation is required.	Yes		AR	Yes
TM21	Modified BS 7755-3:1995, ISO10694:1995 Determination of Total Organic Carbon or Total Carbon by combustion in an Eltra TOC furnace/analyser in the presence of oxygen. The CO2 generated is quantified using infra-red detection. Organic Matter (SOM) calculated as per EA MCERTS Chemical Testing of Soil, March 2012 v4.	PM24	Dried and ground solid samples are washed with hydrochloric acid, then rinsed with deionised water to remove the mineral carbon before TOC analysis.	Yes		AD	Yes
TM22	Modified BS1377-3:1990 Gravimetric determination of Loss on Ignition by temperature controlled Muffle Furnace (35C-440C). On request modified ASTM D2974-00 LOI (105C-440C)	PM0	No preparation is required.	Yes		AD	Yes

EMT Job No: 20/16404

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM26	Determination of phenols by Reversed Phased High Performance Liquid Chromatography and Electro-Chemical Detection.	PM0	No preparation is required.			AR	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.			AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.	Yes		AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry); WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.	Yes		AR	Yes
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GC/FID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.			AR	Yes
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GC/FID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993 (comparabl	PM0	No preparation is required.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993 (comparabl	PM20	Extraction of dried and ground or as received samples with deionised water in a 2:1 water to solid ratio using a reciprocal shaker for all analytes except hexavalent chromium. Extraction of as received sample using 10:1 ratio of 0.2M sodium hydroxide to soil for hexavalent chromium using a reciprocal shaker.	Yes		AR	Yes
TM60	TC/TOC analysis of Waters by High Temperature Combustion followed by NDIR detection. Based on the following modified standard methods: USEPA 9060A (2002), APHA SMEWW 5310B:1999 22nd Edition, ASTM D 7573, and USEPA 415.1.	PM0	No preparation is required.			AR	Yes
TM61	Determination of Mercury by Cold Vapour Atomic Fluorescence - WATERS: Modified USEPA Method 245.7, Rev 2, Feb 2005. SOILS: Modified USEPA Method 7471B, Rev.2, Feb 2007	PM0	No preparation is required.	Yes		AR	Yes

EMT Job No: 20/16404

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM65	Asbestos Bulk Identification method based on HSG 248 First edition (2006)	PM42	Modified SCA Blue Book V.12 draft 2017 and WM3 1st Edition v1.1:2018. Solid samples undergo a thorough visual inspection for asbestos fibres prior to asbestos identification using TM065.	Yes		AR	
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.	Yes		AR	No
TM89	Modified USEPA method OIA-1667 (1999). Determination of cyanide by Flow Injection Analyser. Where WAD cyanides are required a Ligand displacement step is carried out before analysis.	PM45	As received solid samples are extracted with 1M NaOH by orbital shaker for Cyanide, Sulphide and Thiocyanate analysis.	Yes		AR	Yes
TM173	Analysis of fluoride by ISE (Ion Selective Electrode) using modified ISE method 9214 - 340.2 (EPA 1998)	PM0	No preparation is required.			AR	Yes
NONE	No Method Code	NONE	No Method Code			AD	Yes
NONE	No Method Code	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.				
NONE	No Method Code	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.			AR	
NONE	No Method Code	PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.			AR	

Ground Investigations Ireland
Catherinstown House
Hazelhatch Road
Newcastle
Co. Dublin
Ireland



Attention : Mike Sutton
Date : 17th June, 2021
Your reference : 9754-07-20
Our reference : Test Report 21/8443 Batch 1
Location : Bus Connections Route 5
Date samples received : 4th June, 2021
Status : Final report
Issue : 1

Seven samples were received for analysis on 4th June, 2021 of which seven were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.

All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Authorised By:



Hayley Prowse

Project Manager

Please include all sections of this report if it is reproduced

Element Materials Technology

Client Name: Ground Investigations Ireland
 Reference: 9754-07-20
 Location: Bus Connections Route 5
 Contact: Mike Sutton
 EMT Job No: 21/8443

Report : Solid
 Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21						
Sample ID	R5-CP01A	R5-CP01A	R5-CP01A	R5-CP01A	R5-CP03A	R5-CP03A	R5-CP03A						
Depth	0.50	1.50	2.50	3.50	0.50	1.00	1.80						
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T						
Sample Date	28/05/2021	28/05/2021	28/05/2021	28/05/2021	28/05/2021	28/05/2021	28/05/2021						
Sample Type	Soil												
Batch Number	1	1	1	1	1	1	1						
Date of Receipt	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021						
											LOD/LOR	Units	Method No.
Antimony	3	2	2	3	1	<1	2				<1	mg/kg	TM30/PM15
Arsenic #	16.2	17.4	14.1	22.9	12.7	4.6	14.1				<0.5	mg/kg	TM30/PM15
Barium #	131	118	131	147	125	54	84				<1	mg/kg	TM30/PM15
Cadmium #	1.1	1.5	1.2	2.5	0.2	0.7	1.3				<0.1	mg/kg	TM30/PM15
Chromium #	43.7	52.3	71.2	64.6	19.8	35.7	29.1				<0.5	mg/kg	TM30/PM15
Copper #	33	32	28	35	7	10	45				<1	mg/kg	TM30/PM15
Lead #	33	39	39	46	11	6	24				<5	mg/kg	TM30/PM15
Mercury #	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				<0.1	mg/kg	TM30/PM15
Molybdenum #	2.9	3.7	4.6	2.3	1.2	2.7	3.8				<0.1	mg/kg	TM30/PM15
Nickel #	76.7	69.9	56.9	144.4	12.0	17.2	35.9				<0.7	mg/kg	TM30/PM15
Selenium #	1	2	3	3	<1	<1	3				<1	mg/kg	TM30/PM15
Zinc #	95	128	136	114	26	35	67				<5	mg/kg	TM30/PM15
PAH MS													
Naphthalene #	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04				<0.04	mg/kg	TM4/PM8
Acenaphthylene	<0.03	<0.03	<0.03	<0.03	0.04	<0.03	<0.03				<0.03	mg/kg	TM4/PM8
Acenaphthene #	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05				<0.05	mg/kg	TM4/PM8
Fluorene #	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04				<0.04	mg/kg	TM4/PM8
Phenanthrene #	<0.03	0.04	0.09	<0.03	0.31	0.13	0.14				<0.03	mg/kg	TM4/PM8
Anthracene #	<0.04	<0.04	<0.04	<0.04	0.14	0.04	<0.04				<0.04	mg/kg	TM4/PM8
Fluoranthene #	<0.03	0.07	0.15	<0.03	1.32	0.27	0.27				<0.03	mg/kg	TM4/PM8
Pyrene #	<0.03	0.07	0.13	<0.03	1.18	0.21	0.22				<0.03	mg/kg	TM4/PM8
Benzo(a)anthracene #	<0.06	<0.06	0.12	<0.06	0.87	0.14	0.16				<0.06	mg/kg	TM4/PM8
Chrysene #	<0.02	0.04	0.09	<0.02	0.85	0.14	0.15				<0.02	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #	<0.07	<0.07	0.13	<0.07	1.88	0.26	0.25				<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene #	<0.04	<0.04	0.07	<0.04	1.04	0.14	0.12				<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene #	<0.04	<0.04	<0.04	<0.04	0.73	0.11	0.07				<0.04	mg/kg	TM4/PM8
Dibenzo(ah)anthracene #	<0.04	<0.04	<0.04	<0.04	0.13	<0.04	<0.04				<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene #	<0.04	<0.04	<0.04	<0.04	0.74	0.11	0.09				<0.04	mg/kg	TM4/PM8
Coronene	<0.04	<0.04	<0.04	<0.04	0.13	<0.04	<0.04				<0.04	mg/kg	TM4/PM8
PAH 17 Total	<0.64	<0.64	0.78	<0.64	9.36	1.55	1.47				<0.64	mg/kg	TM4/PM8
Benzo(b)fluoranthene	<0.05	<0.05	0.09	<0.05	1.35	0.19	0.18				<0.05	mg/kg	TM4/PM8
Benzo(k)fluoranthene	<0.02	<0.02	0.04	<0.02	0.53	0.07	0.07				<0.02	mg/kg	TM4/PM8
PAH Surrogate % Recovery	79	90	98	86	95	93	90				<0	%	TM4/PM8
Mineral Oil (C10-C40) (EH_CU_1D_AL)	<30	<30	<30	<30	157	<30	<30				<30	mg/kg	TM5/PM8/PM16

Please see attached notes for all abbreviations and acronyms

Element Materials Technology

Client Name: Ground Investigations Ireland
Reference: 9754-07-20
Location: Bus Connections Route 5
Contact: Mike Sutton
EMT Job No: 21/8443

Report : Solid
Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21						
Sample ID	R5-CP01A	R5-CP01A	R5-CP01A	R5-CP01A	R5-CP03A	R5-CP03A	R5-CP03A						
Depth	0.50	1.50	2.50	3.50	0.50	1.00	1.80						
COC No / misc													
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T						
Sample Date	28/05/2021	28/05/2021	28/05/2021	28/05/2021	28/05/2021	28/05/2021	28/05/2021						
Sample Type	Soil												
Batch Number	1	1	1	1	1	1	1						
Date of Receipt	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021						
											LOD/LOR	Units	Method No.
Natural Moisture Content	18.9	36.6	46.4	31.6	8.4	7.0	24.1				<0.1	%	PM4/PM0
Moisture Content (% Wet Weight)	15.9	26.8	31.7	24.0	7.7	6.5	19.4				<0.1	%	PM4/PM0
Hexavalent Chromium #	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3				<0.3	mg/kg	TM38/PM20
Chromium III	43.7	52.3	71.2	64.6	19.8	35.7	29.1				<0.5	mg/kg	NONE/NONE
Total Cyanide #	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5				<0.5	mg/kg	TM89/PM45
Total Organic Carbon #	0.37	1.30	1.99	0.33	0.32	0.23	1.01				<0.02	%	TM21/PM24
Loss on Ignition #	3.9	6.5	8.8	5.1	<1.0	<1.0	1.9				<1.0	%	TM22/PM0
pH #	8.54	7.44	7.47	7.52	9.48	10.13	8.23				<0.01	pH units	TM73/PM11
Mass of raw test portion	0.1061	0.1241	0.1307	0.1172	0.1002	0.0952	0.0974					kg	NONE/PM17
Mass of dried test portion	0.09	0.09	0.09	0.09	0.09	0.09	0.09					kg	NONE/PM17

Please see attached notes for all abbreviations and acronyms

Element Materials Technology

Client Name: Ground Investigations Ireland
 Reference: 9754-07-20
 Location: Bus Connections Route 5
 Contact: Mike Sutton
 EMT Job No: 21/8443

Report : EN12457_2
 Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

EMT Sample No.	1-3	4-6	7-9	10-12	13-15	16-18	19-21								
Sample ID	R5-CP01A	R5-CP01A	R5-CP01A	R5-CP01A	R5-CP03A	R5-CP03A	R5-CP03A								
Depth	0.50	1.50	2.50	3.50	0.50	1.00	1.80								
COC No / misc															
Containers	V J T	V J T	V J T	V J T	V J T	V J T	V J T								
Sample Date	28/05/2021	28/05/2021	28/05/2021	28/05/2021	28/05/2021	28/05/2021	28/05/2021								
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil	Soil								
Batch Number	1	1	1	1	1	1	1								
Date of Receipt	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021	04/06/2021								
								Inert	Stable Non-reactive	Hazardous	LOD LOR	Units	Method No.		
Solid Waste Analysis															
Total Organic Carbon #	0.37	1.30	1.99	0.33	0.32	0.23	1.01	3	5	6	<0.02	%	TM21/PM24		
Sum of BTEX	<0.025	<0.025	<0.025	<0.025	<0.025 ^{5V}	<0.025	<0.025 ^{5V}	6	-	-	<0.025	mg/kg	TM36/PM12		
Sum of 7 PCBs #	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	<0.035	1	-	-	<0.035	mg/kg	TM17/PM8		
Mineral Oil	<30	<30	<30	<30	157	<30	<30	500	-	-	<30	mg/kg	TM5/PM8/PM16		
PAH Sum of 17	<0.64	<0.64	0.78	<0.64	9.36	1.55	1.47	100	-	-	<0.64	mg/kg	TM4/PM8		
CEN 10:1 Leachate															
Arsenic #	<0.025	<0.025	<0.025	<0.025	0.027	<0.025	0.025	0.5	2	25	<0.025	mg/kg	TM30/PM17		
Barium #	<0.03	0.35	0.34	0.12	0.05	0.07	0.04	20	100	300	<0.03	mg/kg	TM30/PM17		
Cadmium #	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.04	1	5	<0.005	mg/kg	TM30/PM17		
Chromium #	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	0.5	10	70	<0.015	mg/kg	TM30/PM17		
Copper #	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	2	50	100	<0.07	mg/kg	TM30/PM17		
Mercury #	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.01	0.2	2	<0.0001	mg/kg	TM61/PM0		
Molybdenum #	0.03	0.11	0.03	<0.02	0.05	0.06	0.06	0.5	10	30	<0.02	mg/kg	TM30/PM17		
Nickel #	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	0.4	10	40	<0.02	mg/kg	TM30/PM17		
Lead #	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.5	10	50	<0.05	mg/kg	TM30/PM17		
Antimony #	<0.02	<0.02	<0.02	<0.02	0.05	0.04	<0.02	0.06	0.7	5	<0.02	mg/kg	TM30/PM17		
Selenium #	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.1	0.5	7	<0.03	mg/kg	TM30/PM17		
Zinc #	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	4	50	200	<0.03	mg/kg	TM30/PM17		
Total Dissolved Solids #	580	2010	1760	1201	660	420	530	4000	60000	100000	<350	mg/kg	TM20/PM0		
Dissolved Organic Carbon	<20	70	120	40	<20	<20	<20	500	800	1000	<20	mg/kg	TM60/PM0		
Dry Matter Content Ratio	85.1	72.6	69.1	76.6	89.9	94.3	91.9	-	-	-	<0.1	%	NONE/PM4		
pH #	8.54	7.44	7.47	7.52	9.48	10.13	8.23	-	-	-	<0.01	pH units	TM73/PM11		
Fluoride	4	<3	3	<3	<3	<3	<3	-	-	-	<3	mg/kg	TM173/PM0		
Sulphate as SO4 #	<5	188	<5	<5	194	120	209	1000	20000	50000	<5	mg/kg	TM38/PM0		
Chloride #	<3	7	11	10	9	4	7	800	15000	25000	<3	mg/kg	TM38/PM0		

Please see attached notes for all abbreviations and acronyms

Client Name: Ground Investigations Ireland
Reference: 20/07/9754
Location: Bus Connections Route 5
Contact: Mike Sutton

Note:
 Asbestos Screen analysis is carried out in accordance with our documented in-house methods PM042 and TM065 and HSG 248 by Stereo and Polarised Light Microscopy using Dispersion Staining Techniques and is covered by our UKAS accreditation. Detailed Gravimetric Quantification and PCOM Fibre Analysis is carried out in accordance with our documented in-house methods PM042 and TM131 and HSG 248 using Stereo and Polarised Light Microscopy and Phase Contrast Optical Microscopy (PCOM). Samples are retained for not less than 6 months from the date of analysis unless specifically requested.

Opinions, including ACM type and Asbestos level less than 0.1%, lie outside the scope of our UKAS accreditation.

Where the sample is not taken by a Element Materials Technology consultant, Element Materials Technology cannot be responsible for inaccurate or unrepresentative sampling.

EMT Job No.	Batch	Sample ID	Depth	EMT Sample No.	Date Of Analysis	Analysis	Result
21/8443	1	R5-CP01A	0.50	2	11/06/2021	General Description (Bulk Analysis)	Soil/Stone
					11/06/2021	Asbestos Fibres	NAD
					11/06/2021	Asbestos ACM	NAD
					11/06/2021	Asbestos Type	NAD
					11/06/2021	Asbestos Level Screen	NAD
21/8443	1	R5-CP01A	1.50	5	11/06/2021	General Description (Bulk Analysis)	Soil/Stone
					11/06/2021	Asbestos Fibres	NAD
					11/06/2021	Asbestos ACM	NAD
					11/06/2021	Asbestos Type	NAD
					11/06/2021	Asbestos Level Screen	NAD
21/8443	1	R5-CP01A	2.50	8	11/06/2021	General Description (Bulk Analysis)	Soil/Stone
					11/06/2021	Asbestos Fibres	NAD
					11/06/2021	Asbestos ACM	NAD
					11/06/2021	Asbestos Type	NAD
					11/06/2021	Asbestos Level Screen	NAD
21/8443	1	R5-CP01A	3.50	11	11/06/2021	General Description (Bulk Analysis)	soil
					11/06/2021	Asbestos Fibres	NAD
					11/06/2021	Asbestos ACM	NAD
					11/06/2021	Asbestos Type	NAD
					11/06/2021	Asbestos Level Screen	NAD
21/8443	1	R5-CP03A	0.50	14	11/06/2021	General Description (Bulk Analysis)	soil
					11/06/2021	Asbestos Fibres	NAD
					11/06/2021	Asbestos ACM	NAD
					11/06/2021	Asbestos Type	NAD
					11/06/2021	Asbestos Level Screen	NAD
21/8443	1	R5-CP03A	1.00	17	11/06/2021	General Description (Bulk Analysis)	soil
					11/06/2021	Asbestos Fibres	NAD
					11/06/2021	Asbestos ACM	NAD
					11/06/2021	Asbestos Type	NAD
					11/06/2021	Asbestos Level Screen	NAD
21/8443	1	R5-CP03A	1.80	20	11/06/2021	General Description (Bulk Analysis)	Soil/Stones
					11/06/2021	Asbestos Fibres	NAD
					11/06/2021	Asbestos ACM	NAD

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

EMT Job No.: 21/8443

SOILS

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Limits of detection for analyses carried out on as received samples are not moisture content corrected. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

Sufficient amount of sample must be received to carry out the testing specified. Where an insufficient amount of sample has been received the testing may not meet the requirements of our accredited methods, as such accreditation may be removed.

Negative Neutralization Potential (NP) values are obtained when the volume of NaOH (0.1N) titrated (pH 8.3) is greater than the volume of HCl (1N) to reduce the pH of the sample to 2.0 - 2.5. Any negative NP values are corrected to 0.

The calculation of Pyrite content assumes that all oxidisable sulphides present in the sample are pyrite. This may not be the case. The calculation may be an overestimate when other sulphides such as Barite (Barium Sulphate) are present.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 accreditation applies to surface water and groundwater and usually one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. The temperature of sample receipt is recorded on the confirmation schedules in order that the client can make an informed decision as to whether testing should still be undertaken.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

BLANKS

Where analytes have been found in the blank, the sample will be treated in accordance with our laboratory procedure for dealing with contaminated blanks.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.

Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

REPORTS FROM THE SOUTH AFRICA LABORATORY

Any method number not prefixed with SA has been undertaken in our UK laboratory unless reported as subcontracted.

Measurement Uncertainty

Measurement uncertainty defines the range of values that could reasonably be attributed to the measured quantity. This range of values has not been included within the reported results. Uncertainty expressed as a percentage can be provided upon request.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS Ref No. 4225) accredited - UK.
SA	ISO17025 (SANAS Ref No.T0729) accredited - South Africa
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
>>	Results above calibration range, the result should be considered the minimum value. The actual result could be significantly higher, this result is not accredited.
*	Analysis subcontracted to an Element Materials Technology approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample

OC	Outside Calibration Range
----	---------------------------

HWOL ACRONYMS AND OPERATORS USED

HS	Headspace Analysis.
EH	Extractable Hydrocarbons - i.e. everything extracted by the solvent.
CU	Clean-up - e.g. by florisil, silica gel.
1D	GC - Single coil gas chromatography.
Total	Aliphatics & Aromatics.
AL	Aliphatics only.
AR	Aromatics only.
2D	GC-GC - Double coil gas chromatography.
#1	EH_Total but with humics mathematically subtracted
#2	EU_Total but with fatty acids mathematically subtracted
_	Operator - underscore to separate acronyms (exception for +).
+	Operator to indicate cumulative e.g. EH+HS_Total or EH_CU+HS_Total
MS	Mass Spectrometry.

EMT Job No: 21/8443

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.	PM0	No preparation is required.			AR	
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.			AR	Yes
TM4	Modified USEPA 8270D v5:2014 method for the solvent extraction and determination of PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM8/PM16	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required/Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.			AR	Yes
TM5	Modified 8015B v2:1996 method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) within the range C8-C40 by GCFID. For waters the solvent extracts dissolved phase plus a sheen if present.	PM8/PM16	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required/Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.	Yes		AR	Yes
TM5/TM36	please refer to TM5 and TM36 for method details	PM8/PM12/PM16	please refer to PM8/PM16 and PM12 for method details			AR	Yes
TM17	Modified US EPA method 8270D v5:2014. Determination of specific Polychlorinated Biphenyl congeners by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM20	Modified BS 1377-3:1990/USEPA 160.1/3 (TDS/TS: 1971) Gravimetric determination of Total Dissolved Solids/Total Solids	PM0	No preparation is required.	Yes		AR	Yes
TM21	Modified BS 7755-3:1995, ISO10694:1995 Determination of Total Organic Carbon or Total Carbon by combustion in an Eltra TOC furnace/analyser in the presence of oxygen. The CO2 generated is quantified using infra-red detection. Organic Matter (SOM) calculated as per EA MCERTS Chemical Testing of Soil, March 2012 v4.	PM24	Dried and ground solid samples are washed with hydrochloric acid, then rinsed with deionised water to remove the mineral carbon before TOC analysis.	Yes		AD	Yes
TM22	Modified BS1377-3:1990 Gravimetric determination of Loss on Ignition by temperature controlled Muffle Furnace (35C-440C). On request modified ASTM D2974-00 LOI (105C-440C)	PM0	No preparation is required.	Yes		AD	Yes

EMT Job No: 21/8443

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM26	Determination of phenols by Reversed Phased High Performance Liquid Chromatography and Electro-Chemical Detection.	PM0	No preparation is required.			AR	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.			AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.	Yes		AD	Yes
TM30	Determination of Trace Metals by ICP-OES (Inductively Coupled Plasma – Optical Emission Spectrometry): WATERS by Modified USEPA Method 200.7, Rev. 4.4, 1994; Modified EPA Method 6010B, Rev.2, Dec 1996; Modified BS EN ISO 11885:2009: SOILS by Modified USEP 6010B, Rev.2, Dec.1996; Modified EPA Method 3050B, Rev.2, Dec.1996	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.	Yes		AR	Yes
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GC/FID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.			AR	Yes
TM36	Modified US EPA method 8015B v2:1996. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID. MTBE by GC/FID co-elutes with 3-methylpentane if present and therefore can give a false positive. Positive MTBE results will be re-run using GC-MS to double check, when requested.	PM12	Modified US EPA method 5021A v2:2014. Preparation of solid and liquid samples for GC headspace analysis.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013	PM0	No preparation is required.	Yes		AR	Yes
TM38	Soluble Ion analysis using Discrete Analyser. Modified US EPA methods: Chloride 325.2 (1978), Sulphate 375.4 (Rev.2 1993), o-Phosphate 365.2 (Rev.2 1993), TON 353.1 (Rev.2 1993), Nitrite 354.1 (1971), Hex Cr 7196A (1992), NH4+ 350.1 (Rev.2 1993) – All anions comparable to BS ISO 15923-1: 2013	PM20	Extraction of dried and ground or as received samples with deionised water in a 2:1 water to solid ratio using a reciprocal shaker for all analytes except hexavalent chromium. Extraction of as received sample using 10:1 ratio of 0.2M sodium hydroxide to soil for hexavalent chromium using a reciprocal shaker.	Yes		AR	Yes
TM60	TC/TOC analysis of Waters by High Temperature Combustion followed by NDIR detection. Based on the following modified standard methods: USEPA 9060A (2002), APHA SMEWW 5310B:1999 22nd Edition, ASTM D 7573, and USEPA 415.1.	PM0	No preparation is required.			AR	Yes
TM61	Determination of Mercury by Cold Vapour Atomic Fluorescence - WATERS: Modified USEPA Method 245.7, Rev 2, Feb 2005. SOILS: Modified USEPA Method 7471B, Rev.2, Feb 2007	PM0	No preparation is required.	Yes		AR	Yes

EMT Job No: 21/8443

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS/S ANAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM65	Asbestos Bulk Identification method based on HSG 248 First edition (2006)	PM42	Modified SCA Blue Book V.12 draft 2017 and WM3 1st Edition v1.1:2018. Solid samples undergo a thorough visual inspection for asbestos fibres prior to asbestos identification using TM065.	Yes		AR	
TM73	Modified US EPA methods 150.1 (1982) and 9045D Rev. 4 - 2004) and BS1377-3:1990. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.	Yes		AR	No
TM89	Modified USEPA method OIA-1667 (1999). Determination of cyanide by Flow Injection Analyser. Where WAD cyanides are required a Ligand displacement step is carried out before analysis.	PM45	As received solid samples are extracted with 1M NaOH by orbital shaker for Cyanide, Sulphide and Thiocyanate analysis.	Yes		AR	Yes
TM173	Analysis of fluoride by ISE (Ion Selective Electrode) using modified ISE method 9214 - 340.2 (EPA 1998)	PM0	No preparation is required.			AR	Yes
NONE	No Method Code	NONE	No Method Code			AD	Yes
NONE	No Method Code	PM17	Modified method BS EN12457-2:2002 As received solid samples are leached with water in a 10:1 water to soil ratio for 24 hours, the moisture content of the sample is included in the ratio.			AR	
NONE	No Method Code	PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465:1993(E) and BS1377-2:1990.			AR	



LABORATORY REPORT



4043

Contract Number: PSL21/1998

Report Date: 12 April 2021
Client's Reference: 2868817
Client Name: Ground Investigations Ireland Ltd
Catherinestown House
Hazelhatch Road
Newcastle
Co Dublin
D22 YD52

For the attention of: Patrick Cochran

Contract Title: Bus Connect Route 5
Date Received: 10/3/2021
Date Commenced: 10/3/2021
Date Completed: 12/4/2021

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

A Watkins
(Director)

R Berriman
(Quality Manager)

S Royle
(Laboratory Manager)

L Knight
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S Eyre
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Page 1 of



LABORATORY REPORT



4043

Contract Number: PSL21/2671

Report Date: 20 April 2021
Client's Reference: 2868817
Client Name: Ground Investigations Ireland Ltd
Catherinestown House
Hazelhatch Road
Newcastle
Co Dublin
D22 YD52

For the attention of: Patrick Cochran

Contract Title: Bus Connect Route 5
Date Received: 31/3/2021
Date Commenced: 31/3/2021
Date Completed: 20/4/2021

Notes: Opinions and Interpretations are outside the UKAS Accreditation

A copy of the Laboratory Schedule of accredited tests as issued by UKAS is attached to this report. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced other than in full, without the prior written approval of the laboratory.

Checked and Approved Signatories:

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(Director)

R Berriman
(Quality Manager)

S Royle
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Page 1 of

APPENDIX 5 – Groundwater Monitoring



Appendix E

Historical Ground Investigation Data

R67

INV 110 50 878

IRISH SOIL LABORATORIES LTD.				BOREHOLE No. 40			
CONTRACT BLAKESTOWN SECTION "2A"				REPORT No. S. 372/2			
Bored for DUBLIN CORPORATION				Ground Level			
Site Address BLANCHARDSTOWN, DUBLIN				Boring Commenced 7.9.80		Boring Completed 8.9.80	
Type and Dia. of Boring MECHANICAL EXCAVATOR							
Water Strikes		Water Levels Recorded During Boring					
1.	Hole Depth						
2.	Casing Depth						
3.	Water Level						
Remarks Pit stable, no seepage							
Description		Scale		Samples & S.P.T.			
		Depth	Legend	Ref. No.	Type	Depth	N
Topsoil							
Reddish brown silty CLAY		0.30					
		0.50					
Stiff greyish brown stony BOULDER CLAY with occasional angular cobbles and small boulders below 1.75m.		2.00					
Dense brownish grey sandy clayey GRAVEL		2.60					

Code : L—Undisturbed Sample D—Large Disturbed Sample J—Jar Sample

SPRENGER
 JOB NO D656
 MADE BY
 DATE MADE

RECORD OF TRIAL PIT

R210

DAILY PROGRESS	DEPTH TO WATER	SAMPLES OF TEST		DEPTH (FEET)	CORRECTION LEVEL
		FROM	TO		
1/1/86				0.0	61.24
				0.25	60.95
				0.70	60.54
				1.00	60.24
				1.45	59.79
				2.00	59.24
				2.80	58.44

~~Repeat as before.~~

Light brown firm silty clay.

Brown silty clay with sandy brown veins and peaty veins. F.M. cobbles Firm

Dark brown/grey silty clayey / clayey silt - med F.M.C. cobbles. Some yellow sandy veins.

Clayey gravel with boulders and dark grey sandy veins. Firm and near horizontal bedding appearance and some mixt mixed thro.

Clayey blue/grey sandy gravel boulders (L.S.) Firm. some undercutting from 17 to 2.

REMARKS
 Seepage 2.5 in @ 2:24 PM. Good ground
 P.T. 2.8.
 Veins East, West face > 1.30 @ 1m.
 W.L. @ 2:33 PM = 3.80 mm
 2:43 PM 4.80 mm

METHOD OF EXCAVATION

TRIAL PIT
 69

ADDRESS
 JOB NO. D 626162
 MADE BY
 DATE MADE

RECORD OF TRIAL PIT

R210

DAILY PROGRESS	DEPTH TO WATER	SAMPLES OR TESTS		LOG END	DEPTH	REDUCED LEVEL	DESCRIPTION OF STRATA
		FROM	TO				
12/1/50					0.00	159.94	GROUND LEVEL
					0.40	159.64	Topsoil and debris
					0.90	159.14	Light brown clay with fine stone
					1.10	158.94	Very firm dark brown clay with very small sandy and peaty veins. Firm angular cobbles.
					2.20	157.74	Dark brown very firm silty clay F.M.C. cobbles dark brown sand veins dipping 20° South. Exposed deep running thro' exposure all around.
					3.00	156.94	Very firm brown boulder clay

REMARKS
 3mins after completion of pit - slight undercutting west bank from 1-3 2-2 sandy veins and exposure from S.W. corner at 2 am @ 3:06 pm
 No vines possible
 No water collecting at 3:20 pm
 Firm to dig and clay.
 3m deep 2000 x 500

METHOD OF EXCAVATION

TRIAL PIT

GSI REPORT 461

Greater Dublin Drainage Scheme

LAYERS FOR BOREHOLE 58814 (Company Name: 2B)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5881401	0	6.86				Boulder Clay	Boulder Clay
5881402	6.86	8.08		Black		Boulder Clay	Boulder Clay
5881403	8.08	9.91				Bedrock	Bedrock

GSI REPORT 461

Greater Dublin Drainage Scheme

LAYERS FOR BOREHOLE 58836 (Company Name: 1J)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
5883601	0	1.22		Brown		Boulder Clay	Boulder Clay
5883602	1.22	2.9		Grey	Gravelly	Clay	Clay
5883603	2.9	4.72				Bedrock	Bedrock

GSI REPORT 717

North Eastern Gas Pipeline (NEP1)

LAYERS FOR BOREHOLE 61121 (Company Name: T7/365)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
6112101	0	.3				Top Soil	Top Soil
6112102	.3	1.3	Soft to Firm	Orangish Brown	Silty	Clay	Clay
6112103	1.3	3.3	Loose	Grey Brown	Silty Sandy Gravelly	Clay	Clay

GSI REPORT 717

North Eastern Gas Pipeline (NEP1)

LAYERS FOR BOREHOLE 61166 (Company Name: B7/368)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
6116601	0	.5				Top Soil	Top Soil
6116602	.5	1.6	Firm	Red Brown	Sandy	Clay	Clay
6116603	1.6	2	Firm	Grey	Gravelly	Clay	Clay
6116604	2	3.8		Grey	Gravelly	Clay	Clay
6116605	3.8	10				Bedrock	Bedrock

GSI REPORT 717

North Eastern Gas Pipeline (NEP1)

LAYERS FOR BOREHOLE 61167 (Company Name: B7/412)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
6116701	0	.1				Top Soil	Top Soil
6116702	.1	2	Firm to Stiff		Silty Sandy Gravelly	Clay	Clay
6116703	2	4	Medium Dense		Gravelly	Silt	Silt
6116704	4	5.15				Gravel And Cobbles	Gravel And Cobbles
6116705	0	10				Bedrock	Bedrock

SITE INVESTIGATIONS LTD.

BOREHOLE RECORD

CONTRACT Queen Street.
 Bored for J. McCullough & Partners.
 Site Address Dublin.

BOREHOLE No. 1.

Investigation

10

6.375

Boring Commenced 23 / 2 / 84

Boring Completed 27 / 2 / 84

Type of Boring Shell & Auger.

Diameter of Borehole 200 mm.

R745

Ground Level -

Water Struck (l) 5.50 m BGL.

Standing Water Level 5.50 m BGL.

Remarks All levels are related to ground level. Chiselling 5½ hours.

Depth in Meters		Thickness	Samples			Description of Strata
From	To		Ref. No.	Type	Depth	
0.00	0.15	0.15				Concrete slab. (Chiselling ¼ hour).
0.15	2.65	2.50	33191	D	1.00	Very loose fill of rubble, brick, ash, silty clay etc.
			33192	D	2.00	
2.65	2.85	0.20	33193	D	2.60	Medium dense fine to coarse silty sandy gravel.
2.85	3.25	0.40	33194	D	3.00	Medium dense fine to coarse sandy gravel.
3.25	5.50	2.25	33195	D	4.50	Dense fine to coarse gravel with cobbles and boulders. (Chiselling 3 hours).
			33196	D	5.00	
5.50	5.85	0.35	33197	D	5.50	Dense brown coarse sand.
5.85	6.50	0.65	33198	D	6.00	Dense fine to coarse gravel with cobbles and boulders. (Chiselling 2 hours).
6.50						Final Level.
						Standard Penetration Tests:
						At 1.15 3 blows to 12"
						At 2.00 2 blows to 17"
						At 3.15 112 blows to 12"
						At 4.65 62 blows to 12".
						At 6.20 620 blows to 12".

Code: U — Undisturbed Sample D — Disturbed Sample P — Piston Sample W — Water Sample.

Report No. 1452	BORING RECORD			IGSL				
Contract ELLIS QUAY DEVELOPEMENT				Borehole No. 1 Sheet 1				
Location ELLIS QUAY, DUBLIN		Type and Diameter Cable Tool 200mm						
Client LARK HOMES		Ground Level						
		Date 13.2.90 - 15.2.90						
Description	Reduced Level	Legend	Depth	Samples			Field Records And Tests	
				Ref. No.	Type	Depth		
Concrete floors			0.75				N	
FILL : Brick rubble, stones timber etc.				5731	D	1.50	(1.5) 34	
			3.20	5733	D	3.20	(3.1) 1	
V.soft dark grey organic SILT			4.00					
Firm brown grey SILT			4.70	5734	D	4.50	(4.5) 17	
Medium dense to dense fine to coarse sandy GRAVEL				5732	D	5.00		
				5735	D	6.00	(6.0) 24	
							(7.5) 27	
				5736	D	8.00		
							(9.0) 21	
Compact fine to coarse gravel with boulders			9.30	5737	D	9.50		
							(11.0) 60	
				5738	D	12.00		
							(12.5) 58	
				5739	W	Water		
				5740	D	14.00	(14.0) 69	
			16.00	5741	D	16.00	(16.0) 53	
Coarse GRAVEL with thin layers of grey brown silt			17.00	5742	D	16.50		
Water Level Observations during Boring				Remarks Breaking out concrete & boring in heavy fill = 2hrs Chiselling boulders at 12.50 = 1½hrs Sample/Test key C-Cone Penetration Test U-Tube Sample N-Blows/0.3 metres D-Disturbed Sample R-Refusal W-Water Sample V-Vane S-Standard Penetration Test				
Date	Hole Depth	Casing Depth	Depth to Water					Remarks
13.2.90	4.70	4.70	4.70					Water noted

Report No. 1452	BORING RECORD—Continuation						
Contract ELLIS QUAY DEVELOPEMENT				Borehole No. - 1 Sheet 2			
Description	Reduced Level	Legend	Depth	Samples			Field Records And Tests
				Ref. No.	Type	Depth	
Compact fine to coarse GRAVEL with boulders		0°	17.00				(17.5) 30/150
		0°		5743	D	18.00	
Hard Black silty CLAY with fragments of grey LIMESTONE		0°	19.50				(19.5) 40/75mm
		x		5744	D	20.00	
Grey black limestone fragments		A	21.50				(21.5) Refusal
Refusal at 22.00		A	22.00				
<p>* Blowing in sand and gravels from 7.00 - 9.00</p>							
Water Level Observations during Boring					Remarks Chiselling from 19.50-21.50 = 1½hrs Chiselling 21.50 - 22.00 = 2 hrs		
Date	Hole Depth	Casing Depth	Depth to Water	Remarks			
15.2.90	22.00	21.00	5.50	End of boring			
	22.00	Nil	3,00	Final level			

Report No. 1452	BORING RECORD			IGSL
Contract ELLIS QUAY DEVELOPEMENT				Borehole No. 3 Sheet
Location ELLIS QUAY, DUBLIN			Type and Diameter Cable Tool 200mm	
Client LARK HOMES			Ground Level	
			Date 14.2.90 - 19.2.90	

Description	Reduced Level	Legend	Depth	Samples			Field Records And Tests
				Ref. No.	Type	Depth	
FILL : Brick, boulders, timber, concrete, glass, gravel & clay		XXXX					N
		XXXX					(2.0) 23
		XXXX					(4.0) 2
Soft grey black organic silt with bones, glass etc.		XXXX	4.50	3848	D	3.50	(5.0) 2
Fine to medium sandy GRAVEL		XXXX	5.50	3849	D	5.00	(6.0) 10
		XXXX					(7.0) 16
Fine to coarse GRAVEL with a little sand and cobbles & boulders		XXXX	7.00	3850	D	6.50	(8.0) 32
		XXXX					(9.0) 45
** Boulder concentration from 9.00 - 10.50.		XXXX					(10.5) 61
		XXXX					(12.0) 58
		XXXX					(13.5) 32/150mm
		XXXX					(15.0) 48
Fragments of grey limestone		XXXX	16.50	3852	D	9.00	(16.5) R
		XXXX	17.00	3853	D	10.50	
		XXXX					
		XXXX					

Water Level Observations during Boring				Remarks
Date	Hole Depth	Casing Depth	Depth to Water	
14.2.90	3.50	3.50	3.50	Water noted
19.2.90	17.00	16.50	4.20	
	17.00	Nil	3.00	
				Final level

Remarks	
Chiselling in fill = 2½ hrs	
Chiselling in boulders = 4 hrs	
Chiselling in limestone = 2 hrs	
Sample/Test key	C-Cone Penetration Test
U-Tube Sample	N-Blows/0.3 metres
D-Disturbed Sample	R-Refusal
W-Water Sample	V-Vane
S-Standard Penetration Test	

Report No. 1452	BORING RECORD	IGSL
Contract ELLIS QUAY DEVELOPEMENT		Borehole No. 4 Sheet 1
Location ELLIS QUAY, DUBLIN	Type and Diameter Cable Tool 200mm	
Client LARK HOMES	Ground Level	
	Date 20.2.90 - 22.2.90	

Description	Reduced Level	Legend	Depth	Samples			Field Records And Tests
				Ref. No.	Type	Depth	
FILL : Demolition rubble, brick, boulders, wood, glass, tin, steel etc.		XXXX					N (1.5) 7
Grey black organic SILT with glass, pottery, ash etc.		x x	3.00	3858	D	3.50	(3.0) 2
		x x					(4.0) 3
Fine to medium sandy GRAVEL with some thin layers of sandy silt		x x	4.50	3859	D	4.50	(5.0) 11
Fine to coarse GRAVEL with some coarse sand and occ. cobbles & boulders ** (Some blowing from 7.00 - 9.00)		o o	6.00	3860	D	6.00	(6.0) 17
		o o					(7.0) 28
		o o					(8.0) 34
		o o					(9.0) 48
		o o					(10.5) 49
		o o					(12.0) 57
		o o					(13.5) 49
		o o					(15.0) 64
		o o	17.00	3867	D	16.50	(16.5) 58

Water Level Observations during Boring				Remarks
Date	Hole Depth	Casing Depth	Depth to Water	
20.2.90	4.00	4.00	4.00	Water noted
22.2.90	20.00	19.50	4.50	
	20.00	Nil	3.75	Final level

Remarks
 Chiselling in fill = 3 hrs
 Chiselling in boulders & gravel = 2½ hrs
 Chiselling at 19.50 = 2 hrs

Sample/Test key
 U-Tube Sample C-Cone Penetration Test
 D-Disturbed Sample N-Blows/0.3 metres
 W-Water Sample R-Refusal
 S-Standard Penetration Test V-Vane

Report No. 1452	BORING RECORD—Continuation							
Contract ELLIS QUAY , DEVELOPEMENT					Borehole No. 4 Sheet 2			
Description	Reduced Level	Legend	Depth	Samples			Field Records And Tests	
				Ref. No.	Type	Depth		
Fine to coarse GRAVEL with some sand.		60	17.00	3868	D	18.00	(18,00) 64	
Coarse gRAVEL with fragments of grey broken limestone		0	19.50	3869	D	19.50	(19.5) R	
		0	20.00	3870	W	Water		
Water Level Observations during Boring				Remarks NOTE : PVC pipe installed from G.L. to 20.00m - slotted from 0.00 - 4.00				
Date	Hole Depth	Casing Depth	Depth to Water					Remarks

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Report No. 1452	BORING RECORD			IGSL			
Contract ELLIS QUAY DEVELOPEMENT				Borehole No. 5 Sheet			
Location ELLIS QUAY, DUBLIN			Type and Diameter Cable Tool 200mm				
Client LARK HOMES			Ground Level				
			Date 21.2.90		23.2.90		
Description	Reduced Level	Legend	Depth	Samples			Field Records And Tests
				Ref. No.	Type	Depth	
FILL : Brick, clay, stones		[X-X-X-X]	2.90	5757	D	2.00	N (1.5) 22
BOULDERS Fine to coarse very sandy GRAVEL		[O-O]	3.50	5758	D	4.00	(4.0) 28
Coarse gravels with boulders and some coarse sand		[O-O]	6.10	5759	D	6.00	(6.0) 32
		[O-O]	7.00	5760	D	7.00	(7.5) 49
		[O-O]	9.00	5761	D	9.00	(9.0) 41
		[O-O]	10.50	5762	W	Water	(10.5) 45
Water Level Observations during Boring				Remarks Chiselling 8.00 - 10.00 = 1½hrs Chiselling in Fill & concrete = 3hrs			
Date	Hole Depth	Casing Depth	Depth to Water				
Sample/Test key				C-Cone Penetration Test			
U-Tube Sample				N-Blows/0.3 metres			
D-Disturbed Sample				R-Refusal			
W-Water Sample				V-Vane			
S-Standard Penetration Test							

R838

Report No. 1452	BORING RECORD			IGSL			
Contract ELLIS QUAY DEVELOPEMENT				Borehole No. 2 Sheet			
Location ELLIS QUAY, DUBLIN			Type and Diameter Cable Tool 200mm				
Client LARK HOMES			Ground Level				
			Date 16.2.90 -- 20.2.90				
Description	Reduced Level	Legend	Depth	Samples			Field Records And Tests
				Ref. No.	Type	Depth	
FILL : Heavy deposits of brick, concrete, stones & clay		XXXX	1.80	5745	D	1.60 (1.5)	N R
FILL : Brick, glass, black stony CLAY		XXXX	4.70	5746	D	3.00 (3.0)	R
Fine to coarse gravel with some sand and occasional cobbles & boulders * Some blowing from 8.00 - 12.00		OO	5.00	5748	D	4.00	
		OO	5.00	5749	D	5.00 (5.0)	35
		OO	7.00	5750	D	7.00 (6.5)	26
		OO	9.00	5751	D	9.00 (8.0)	31
		OO	12.00	5752	D	12.00 (10.0)	42
Compact coarse gravel with cobbles & boulders		OO	13.00			(12.0)	33
		OO	15.00	5753	D	15.00 (14.0)	47
Coarse sand with boulders		OO	16.00			(16.0)	29
Fragments of limestone		OO	17.00			(17.5)	R
		OO	17.50				
Water Level Observations during Boring				Remarks			
Date	Hole Depth	Casing Depth	Depth to Water	Remarks			
16.2.90	4.70	4.70	4.70	Water noted			
20.2.90	17.50	17.50	5.50	Final level			
	17.50	Nil	3.80				
				Sample/Test key C-Cone Penetration Test U-Tube Sample N-Blows/0.3 metres D-Disturbed Sample R-Refusal W-Water Sample V-Vane S-Standard Penetration Test			

Chiselling through fill = 4½ hrs
 Chiselling boulders = 2½ hrs
 Chiselling at 17.00 = 2 hrs
 Installed 100mm PVC pipe in hole

REPORT NO.		GEOTECHNICAL CORE LOG RECORD							I.G.S.L							
CONTRACT: Arran Quay Terrace							DRILLHOLE NO.:	RC1								
CLIENT: Luas Light Rail System							OPENHOLE DRILLING:	76mm / ODEX								
LOCATION: Arran Quay Terrace, Dublin							GROUND LEVEL (mOD):									
							INCLINATION:	Vertical								
							FLUSH:	Water								
							DATE STARTED:	27.7.00								
							DATE COMPLETED:	28.7.00								
							DRILLED BY:	IGSL								
							LOGGED BY:	IGSL								
DOWNHOLE DEPTH (m)	CORE RUN DEPTH (m)	T.C.R. %	S.C.R. %	R.Q.D. %	Fracture Spacing (mm)			POINT LOAD Is(50) MPa	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	GEOTECHNICAL DESCRIPTION				
					0	250	500									
10												Overburden - Returns of sands and gravel material (fragments of sub rounded and sub angular cobbles and boulder size material)				
11											SPT @ 11.00 N = 49 (7, 9, 10, 9, 11, 19)					
12											SPT @ 12.00 N = Ref (25,30)					
13											SPT @ 13.00 N = 54 for 225mm (10, 9,10, 19,25 R)					
14											SPT @ 14.00 N = 70 (5,9,11,12,24,23)	14.00	Drillhole Terminated			
15																
16																
17																
18																
19																
20																
REMARKS:										Core logged in accordance with BS 5930 except for definition of solid core which is taken as that defined by Norbury et al 1986			KEY TO SYMBOLIC LOG			
										▲ Point Load Test Sample				MADE GROUND		
														OVERBURDEN		
														LIMESTONE		

REPORT NO.		GEOTECHNICAL CORE LOG RECORD							I.G.S.I			
CONTRACT: Arran Quay Terrace							DRILLHOLE NO.: RC2	SHEET: 1 of 2				
CLIENT: Luas Light Rail System				OPENHOLE DRILLING: 76mm / ODEX		DATE STARTED: 25.7.00		DATE COMPLETED: 26.7.00				
LOCATION: Arran Quay Terrace, Dublin				GROUND LEVEL (mOD):		INCLINATION: Vertical		DRILLED BY: IGSL				
				FLUSH:		Water		LOGGED BY: IGSL				
DOWNHOLE DEPTH (m)	CORE RUN DEPTH (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing (mm)		DISCONTINUITIES	POINT LOAD Is(50) MPa	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	GEOTECHNICAL DESCRIPTION
					0	250						
0												MADE GROUND (some imported stone and tar)
-1												MADE GROUND (Brick, clay, gravel, timber)
-2												
-3												
-4											3.90	Overburden - Returns of sands and gravel material (fragments of sub rounded and sub angular cobble and boulder size material)
-5							SPT @ 4.50m N = 30 (4, 5, 5, 5, 6, 14)					
-6							SPT @ 6.00m N = 36 (4, 4, 7, 8, 11, 11)					
-7												
-8							SPT @ 6.50m N = 44 (5, 6, 5, 12, 10, 17)					
-9							SPT @ 9.00m N = 52 (8, 9, 7, 12, 20, 16)					
-10												
REMARKS: Core logged in accordance with BS 5930 except for definition of solid core which is taken as that defined by Norbury et al 1986 ◀ Point Load Test Sample										KEY TO SYMBOLIC LOG		
											MADE GROUND	
											OVERBURDEN	
											LIMESTONE	

REPORT NO.	GEOTECHNICAL BORING RECORD		I.G.S.L
CONTRACT: Proposed Liffey Bridge	BOREHOLE NO.: 4 (N) Lane		SHEET: 1 of 2
CLIENT: Dublin Corporation	BOREHOLE DIAM. (mm) 200		DATE STARTED: 26.6.99
CONS. ENG: Roughan & O'Donovan	BOREHOLE DEPTH 11.40		DATE COMPLETED: 27.6.99
LOCATION: River Liffey (Blackhall Place), Dublin	CASING DEPTH (m) 11.40		BORED BY: I.G.S.L
			LOGGED BY: I.G.S.L

DOWNHOLE DEPTH (m)	DESCRIPTION	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS
					REFERENCE NUMBER	SAMPLE TYPE	DEPTH RECOVERED	
0	Tarmacadam		9.60 9.30	0.10				Depth N
-1	MADE GROUND (Comprised of imported stone)							
-2	MADE GROUND (Comprised of red brick, silt, gravel timber, pottery, rope, glass and cobbles)		7.60	1.80	2443	D	1.50	1.50 4
-3					2444	D	3.00	3.00 9
-4					2445	D	4.50	4.50 10
-5					2446	D	6.00	6.00 7
-6								
-7								
-8	Dense fine to coarse (predominantly coarse) sandy GRAVEL with frequent cobbles and boulders		-7.00	7.40	2447	D	7.50	7.50 45
-9					2448	D	9.00	9.00 60

Remarks. Chiselling From 0 - 1.50 for 3.25hrs From 1.90 - 2.30 for 1hr From 8.40 - 8.70 for 1.5hrs	Water level observations during boring				
	DATE	HOLE DEPTH	CASING DEPTH	DEPTH TO WATER	REMARKS
	27.6	3.20	3.20	3.20	seepage
		3.20	3.20	3.00	20 mins
		7.50	7.50	7.50	strike
	7.50	7.50	3.90	20 mins	

REPORT NO.		GEOTECHNICAL BORING RECORD					I.G.S.L.	
CONTRACT: Proposed Liffey Bridge					BORE-HOLE NO.: 4 (N) Land		SHEET: 2 of 2	
CLIENT: Dublin Corporation			BOREHOLE DIAM.(mm) 200		DATE STARTED: 26.6.99		DATE COMPLETED: 27.6.99	
CONS. ENG: Roughan & O'Donovan			BOREHOLE DEPTH 11.40		BORED BY: I.G.S.L.		LOGGED BY: I.G.S.L.	
LOCATION: River Liffey (Blackhall Place), Dublin			CASING DEPTH (m) 11.40					
DOWNHOLE DEPTH (m)	DESCRIPTION	SYMBOLIC LOG	ELEVATION (MOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS
					REFERENCE NUMBER	SAMPLE TYPE	DEPTH RECOVERED	
9	Dense fine to coarse (predominantly coarse) sandy GRAVEL with frequent cobbles and boulders							Depth N
10					2449	D	10.00	10.50 60 for 225mm then ref
11			-8.00	11.40	2450	D	11.40	
12	Refusal							
13								
14								
15								
16								
17								
18								
Remarks: Chiselling From 11.00 - 11.40 for 2hrs				Water level observations during boring				
				DATE	HOLE DEPTH	CASING DEPTH	DEPTH TO WATER	REMARKS
				27.6	11.40	nil	3.20	Bh End
FIELD TEST KEY: U-U100, Db-Disturbed Sample, S-SPT, W-Water Sample, R-Refusal.								

GSI REPORT 3743

Development

LAYERS FOR BOREHOLE 116225 (Company Name: 1)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
1162250 1	0	2.7				Fill - Made Ground	Fill - Made Ground
1162250 2	2.7	3.6	Firm	Brown	Very Sandy, Very Gravelly	Silt	Silt
1162250 3	3.6	8.8		Brown	Silty Sandy	Gravel	Gravel

GSI REPORT 3743

Development

LAYERS FOR BOREHOLE 116226 (Company Name: 2)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
1162260 1	0	2.2				Fill - Made Ground	Fill - Made Ground
1162260 2	2.2	3.8	Stiff	Brown	Silty Gravelly	Clay	Clay
1162260 3	3.8	5.5	Dense	Brown	Clayey	Gravel	Gravel
1162260 4	5.5	12	Dense	Brown	Slightly silty sandy	Gravel	Gravel

GSI REPORT 3880

Law Society Premises

LAYERS FOR BOREHOLE 117742 (Company Name: 1)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
1177420 1	0	.2				Fill - Made Ground	Fill - Made Ground
1177420 2	.2	2.3				Fill - Made Ground	Fill - Made Ground
1177420 3	2.3	9.7			Fine to Coarse Sandy	Gravel	Gravel

GSI REPORT 3880

Law Society Premises

LAYERS FOR BOREHOLE 117743 (Company Name: 2)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
1177430 1	0	.2				Fill - Made Ground	Fill - Made Ground
1177430 2	.2	2.9				Fill - Made Ground	Fill - Made Ground
1177430 3	2.9	9.1			Fine to Coarse Sandy	Gravel	Gravel

GSI REPORT 3880

Law Society Premises

LAYERS FOR BOREHOLE 117744 (Company Name: 3)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
1177440 1	0	.2				Fill - Made Ground	Fill - Made Ground
1177440 2	.2	1.7				Fill - Made Ground	Fill - Made Ground
1177440 3	1.7	2.1	Dense	Brown	Sandy Clayey	Gravel	Gravel
1177440 4	2.1	8.7			Fine to Coarse	Gravel	Gravel

GSI REPORT 3880

Law Society Premises

LAYERS FOR BOREHOLE 117745 (Company Name: 4)

LAYER	TOP	BASE	STRENGTH	COLOUR	MINORLITH	MAJORLITH	INTERPRETATION
1177450 1	0	.2				Fill - Made Ground	Fill - Made Ground
1177450 2	.2	1.6				Fill - Made Ground	Fill - Made Ground
1177450 3	1.6	2	Dense	Brown Grey	Very Clayey Sandy	Gravel	Gravel
1177450 4	2	9			Fine to Coarse Sandy	Gravel	Gravel

REPORT NO.		GEOTECHNICAL BORING RECORD					I.G.S.L.	
CONTRACT: Proposed Residential Development		BOREHOLE NO.: 1			SHEET: 1 of 1			
CLIENT: Dublin Corporation		BOREHOLE DIAM.(mm) 200			DATE STARTED: 4.6.99			
CONS. ENG: Thorburn Colquhoun		BOREHOLE DEPTH 7.20			DATE COMPLETED: 4.6.99			
LOCATION: Queen Street, Dublin		CASING DEPTH (m) 7.20			BORED BY: I.G.S.L.			
					LOGGED BY: I.G.S.L.			
DOWNHOLE DEPTH (m)	DESCRIPTION	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS
					REFERENCE NUMBER	SAMPLE TYPE	DEPTH RECOVERED	
0	Tarmacadam / Imported Stone			0.30				Depth N
-1	MADE GROUND (Comprised of red brick, clay, gravel ash, clinkers and some cobbles)				1004	D	1.00	1.00 32
-2				2.00	1005	D	2.00	2.00 52
-3	Dense fine to coarse slightly silty sandy GRAVEL with frequent cobbles and boulders				1006	D	3.00	3.00 44
-4				4.10	1007	D	4.00	4.00 54
-5	Very stiff brown silty gravelly CLAY with some cobbles			4.50	1008	D	4.30	
-6	Hard black slightly silty gravelly CLAY with frequent cobbles and boulders				1009	D	5.50	5.00 72
-7					1010	D	6.50	6.00 70
-8				7.20				7.00 Ref
-9	Refusal							
Remarks.				Water level observations during boring				
Move rig on and off site each shift. Chiselling From 0.20 - 0.90 for 1.5hrs From 3.40 - 3.50 for 1hr From 4.40 - 4.60 for 0.75hrs From 7.00 - 7.20 for 2hrs				DATE	HOLE DEPTH	CASING DEPTH	DEPTH TO WATER	REMARKS
				8.6	7.20	nil	Dry	Bh End

FIELD TEST KEY: U-U100, Db-Disturbed Sample, S-SPT, W-Water Sample, R-Refusal.

118004

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REPORT NO.		GEOTECHNICAL BORING RECORD					I.G.S.L.		
CONTRACT: Proposed Residential Development		BOREHOLE NO.: 2			SHEET: 1 of 1				
CLIENT: Dublin Corporation		BOREHOLE DIAM.(mm) 200			DATE STARTED: 9.6.99				
CONS. ENG: Thorburn Colquhoun		BOREHOLE DEPTH 7.10			DATE COMPLETED: 9.6.99				
LOCATION: Queen Street, Dublin		CASING DEPTH (m) 7.10			BORED BY: I.G.S.L.				
					LOGGED BY: I.G.S.L.				
DOWNHOLE DEPTH (M)	DESCRIPTION	SYMBOLIC LOG	ELEVATION (MOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS	
					REFERENCE NUMBER	SAMPLE TYPE	DEPTH RECOVERED		
0	Tarmacadam / Imported Stone			0.20				Depth N	
-1	MADE GROUND (Comprised of red brick, clay, gravel ash, concrete, timber, steel and some cobbles)				1011	D	1.00	1.00 11	
-2	Dense fine to coarse slightly silty sandy GRAVEL with frequent cobbles and boulders			1.80	1012	D	2.00	2.00 55	
-3					1013	D	3.50	3.00 64	
-4								4.00 48	
-5					4.30	1014	D	5.00	5.00 79
-6	Hard black slightly silty gravelly CLAY with frequent cobbles and boulders				1015	D	6.50	6.00 31 for 150mm then Ref	
-7								7.00 Ref	
-8	Refusal			7.10					
Remarks. Move rig on and off site each shift.					Water level observations during boring				
					DATE	HOLE DEPTH	CASING DEPTH	DEPTH TO WATER	REMARKS
					9.6	7.10	nil	Dry	Bh End
Chiselling From 3.50 - 3.90 for 1.25rs From 6.80 - 7.10 for 2hrs									

FIELD TEST KEY: U-U100, Db-Disturbed Sample, S-SPT, W-Water Sample, R-Refusal.

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REPORT NO.:		GEOTECHNICAL BORING RECORD				I.G.S.L.		
CONTRACT: Proposed Residential Development		BOREHOLE NO.: 3		SHEET: 1 of 1		DATE STARTED: 3.6.99		
CLIENT: Dublin Corporation		BOREHOLE DIAM.(mm) 200		DATE COMPLETED: 3.6.99		BORED BY: I.G.S.L.		
CONS. ENG: Thorburn Colquhoun		BOREHOLE DEPTH 6.30		LOGGED BY: I.G.S.L.				
LOCATION: Queen Street, Dublin		CASING DEPTH (m) 6.30						
DOWNHOLE DEPTH (m)	DESCRIPTION	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS
					REFERENCE NUMBER	SAMPLE TYPE	DEPTH RECOVERED	
0	Tarmacadam / Imported Stone			0.20				Depth N
-1	MADE GROUND (Comprised of red brick, clay, gravel ash, concrete, steel and some cobbles)			1.30	1000	D	1.00	1.00 16
-2	Dense fine to coarse slightly silty sandy GRAVEL with frequent cobbles and boulders			1.30	1001	D	2.50	2.00 39
-3				4.00	1002	D	4.00	3.00 35 for 150mm then Ref
-4	Very stiff brown silty gravelly CLAY			4.40				4.00 57
-5	Hard black slightly silty gravelly CLAY with frequent cobbles and boulders			6.30	1003	D	5.00	5.00 83
-6				6.30	1006	D	6.00	6.00 53 for 150mm then Ref
-7	Refusal							
-8								
-9								
Remarks. Move rig on and off site each shift. Chiselling From 0.30 - 0.90 for 1hr From 3.40 - 3.60 for 1hr From 5.40 - 5.60 for 0.75hrs From 6.10 - 6.30 for 2hrs				Water level observations during boring				
				DATE	HOLE DEPTH	CASING DEPTH	DEPTH TO WATER	REMARKS
				3.6	6.30	nil	Dry	Bh End

FIELD TEST KEY: U-U100, Db-Disturbed Sample, S-SPT, W-Water Sample, R-Refusal.

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REPORT NO.		GEOTECHNICAL BORING RECORD					I.G.S.L.		
CONTRACT: Proposed Residential Development		BOREHOLE NO.: 4			SHEET: 1 of 1				
CLIENT: Dublin Corporation		BOREHOLE DIAM.(mm) 200			DATE STARTED: 10.6.99				
CONS. ENG: Thorburn Colquhoun		BOREHOLE DEPTH 6.20			DATE COMPLETED: 10.6.99				
LOCATION: Queen Street, Dublin		CASING DEPTH (m) 6.20			BORED BY: I.G.S.L.				
					LOGGED BY: I.G.S.L.				
DOWNHOLE DEPTH (m)	DESCRIPTION	SYMBOLIC LOG	ELEVATION (MOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS	
					REFERENCE NUMBER	SAMPLE TYPE	DEPTH RECOVERED		
0	Tarmacadam / Imported Stone			0.15				Depth N	
-1	MADE GROUND (Comprised of red brick, clay, gravel ash, concrete, timber, steel and some cobbles)				1022	D	1.00	1.00 22	
-2								2.00 Ref	
-3					1023	D	3.00	3.00 19	
-4					4.00	1024	D	4.00	4.00 28
-5	Medium dense to dense fine to coarse silty sandy GRAVEL with frequent cobbles and boulders				1025	D	5.00	5.00 64	
-6				6.20	1026	D	6.00	6.00 Ref	
-7	Refusal								
-8									
-9									
Remarks. Move rig on and off site each shift.					Water level observations during boring				
					DATE	HOLE DEPTH	CASING DEPTH	DEPTH TO WATER	REMARKS
Chiselling From 0.40 - 0.90 for 0.50hrs From 3.30 - 3.50 for 0.75hrs From 6.00 - 6.20 for 2hrs					10.6	6.20	nil	Dry	Bh End

FIELD TEST KEY: U-U100, Db-Disturbed Sample, S-SPT, W-Water Sample, R-Refusal.

R3919

REPORT NO.		GEOTECHNICAL BORING RECORD					I.G.S.L.	
CONTRACT: Proposed Residential Development		BOREHOLE NO.: 5			SHEET: 1 of 1			
CLIENT: Dublin Corporation		BOREHOLE DIAM.(mm) 200			DATE STARTED: 11.6.99			
CONS. ENG: Thorburn Colquhoun		BOREHOLE DEPTH 6.60			DATE COMPLETED: 11.6.99			
LOCATION: Queen Street, Dublin		CASING DEPTH (m) 6.60			BORED BY: I.G.S.L.			
					LOGGED BY: I.G.S.L.			
DOWNHOLE DEPTH (m)	DESCRIPTION	SYMBOLIC LOG	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS
					REFERENCE NUMBER	SAMPLE TYPE	DEPTH RECOVERED	
0	Tarmacadam / Imported Stone			0.15				Depth N
-1	MADE GROUND (Comprised of red brick, clay, gravel ash, concrete, timber, glass and some cobbles)				1016	D	1.00	1.00 24
-2								2.00 41
-3					1017	D	3.00	3.00 23
-4				3.80	1018	D	4.00	4.00 57
-5	Medium dense to dense fine to coarse silty sandy GRAVEL with frequent cobbles and boulders				1019	D	5.00	5.00 68
-6					1020	D	6.00	6.00 31 for 150mm then Ref
-7				6.60				
-8	Refusal							
-9								
Remarks. Move rig on and off site each shift. Chiselling From 2.30 - 2.50 for 1hr From 3.50 - 3.80 for 1hr From 6.30 - 6.60 for 2hrs				Water level observations during boring				
				DATE	HOLE DEPTH	CASING DEPTH	DEPTH TO WATER	REMARKS
				11.6	6.60	nil	Dry	Bh End

FIELD TEST KEY: U-U100, Db-Disturbed Sample, S-SPT, W-Water Sample, R-Refusal.

REPORT NO: 9540	GEOTECHNICAL BORING RECORD	IGSL Ltd.
CONTRACT: Tolka River Flooding		BOREHOLE NO: BH B1 Sheet 1 of 1
CLIENT: Fingal County Council ENGINEER: RPS MCOS	GROUND LEVEL (mOD): 61.65 BOREHOLE DIAMETER (mm): 200 BOREHOLE DEPTH (m): 8.00 CASING DEPTH (m): 8.00	DATE STARTED: 12/05/2004 DATE COMPLETED: 12/05/2004
CO-ORDINATES: E 307159.75 N 239888.33		BORED BY: T McCarthy

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS	STAND PIPE DETAILS
					REF. NUMBER	SAMPLE TYPE	DEPTH (m)		
0	FILL comprising of soft to firm brown slightly sandy slightly gravelly CLAY				5172	B	0.00		
1	Stiff grey brown slightly sandy gravelly CLAY (possible fill)		60.85	0.80	5173	B	1.50	N=22	
2					5174	B	2.50	N=34	
3					5175	B	3.50	N=16	
4					5176	B	4.50	N=25	
5					5177	B	5.50	N=78/ 190mm	
6					5178	B	6.50	N=26	
7					5179	B	7.50	N=18	
8	Medium dense brown slightly sandy fine to medium GRAVEL End of Borehole at 8.00 m		53.85 53.65	7.80 8.00					
9									
10									

From (m)	To (m)	Hours	Comments
2.90	3.10	0.50	
5.70	6.00	0.75	
7.10	7.30	0.50	

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
7.80			6.30	20	Medium

Date	Tip Depth	RZ Top	RZ Base	Type

Date	Hole Depth	Casing Depth	Depth to Water	Comments

Remarks: Hand dig service inspection pit

REPORT NO. 9540	TRIAL PIT / DYNAMIC PROBE RECORD	IGSL Ltd.
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CONTRACT: Tolka River Flooding	Trial Pit No.: TP17
CLIENT: Fingal County Council	Sheet: Sheet 1 of 1
ENGINEER: RPS MCOS	Excavation Method: CAT432
CO-ORDINATES: E 308159.11 N 238753.49	Date Started: 03/03/2004
	Date Completed: 03/03/2004
HAMMER MASS (kg) : 50.0 INCREMENT SIZE (mm) : 100 FALL HEIGHT (mm) : 500	Ground Level (mOD): 44.30

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water Strike (m)	Samples			Probe Type: DPH	
						Ref. No.	Type	Depth (m)	Probe Readings (blows / increment)	Graphic Probe Record (>25 blows is refusal)
0.0	MADE GROUND comprising of firm brown sandy gravelly CLAY with many cobbles some boulders and occasional pieces of plastic								0	
0.3								3		
0.6						J2961	B	0.60	2	
0.70	Soft black peaty sandy SILT/ CLAY containing roots and organic debris		0.70	43.60					1	
1.00	Stiff grey very sandy slightly gravelly SILT/CLAY		1.00	43.30					1	
1.40	Stiff orange brown sandy gravelly CLAY with some cobbles and some boulders		1.40	42.90					7	
1.80	OBSTRUCTION - possible boulder		1.80	42.50					7	
1.85	Final depth, 1.60 m		1.85	42.45					8	
									12	
									10	
									6	
									20	
									25	

Groundwater Observations: Rapid flow at 0.4m

Stability Remarks: Pit collapsing

General Remarks:

135217

REPORT NO: 9253 **GEOTECHNICAL BORING RECORD** **IGSL Ltd.**

CONTRACT : Phoenix Park Development BOREHOLE NO: BH1
 Sheet 1 of 1

CLIENT : Flynn & O'Flaherty GROUND LEVEL (mOD) - DATE STARTED: 28/11/2003
 ENGINEER : OMS Architects BOREHOLE DIAMETER (mm) 200 DATE COMPLETED: 28/11/2003

CO-ORDINATES : E - BOREHOLE DEPTH (m) 3.00 BORED BY: J.O'Hara
 N - CASING DEPTH (m) 2.60

DEPTH (m)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS	STAND PIPE DETAILS
					REF. NUMBER	SAMPLE TYPE	DEPTH (m)		
0	MADE GROUND consisting of clay, gravel and cobbles	[Cross-hatch pattern]							
0.40	Very soft to soft dark brown sandy gravelly CLAY with cobbles	[Dotted pattern]		0.40	7123	B	1.00	N=5	
1.70	Stiff brown sandy gravelly CLAY with cobbles and boulders	[Dotted pattern]		1.70	7124	B	2.00	N=32	
2.50	Very stiff to hard black/grey sandy gravelly CLAY with cobbles and boulders	[Dotted pattern]		2.50					
2.60				2.60					
3.00	Obstruction - Possible rock/boulder End of Borehole at 3.00 m	[Circular pattern]		3.00	7125	B	3.00	N=R	
4									
5									
6									
7									
8									
9									
10									

R5619

Hard Strata Boring / Chiselling

From (m)	To (m)	Hours	Comments
2.60	3.00	2.00	

Water Strike Details

Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
2.50	2.50		2.00		Moderate

Standpipe Installation Details

Date	Tip Depth	RZ Top	RZ Base	Type

Groundwater Observations

Date	Hole Depth	Casing Depth	Depth to Water	Comments
28/11/2003	3.00	3.00	1.90	BH End
28/11/2003	3.00	0.00	1.10	Casing pulled, BH end.

Remarks:

135218

REPORT NO: 9253	GEOTECHNICAL BORING RECORD	IGSL Ltd.
CONTRACT : Pheonix Park Development		BOREHOLE NO: BH2 Sheet 1 of 1
CLIENT : Flynn & O'Flaherty ENGINEER : OMS Architects	GROUND LEVEL (mOD) - BOREHOLE DIAMETER (mm) 200 BOREHOLE DEPTH (m) 2.80 CASING DEPTH (m) 2.60	DATE STARTED: 28/11/2003 DATE COMPLETED: 29/11/2003
CO-ORDINATES : E - N -		BORED BY: J.O'Hara

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS	STAND PIPE DETAILS
					REF. NUMBER	SAMPLE TYPE	DEPTH (m)		
0	TOPSOIL								
0.40	Soft brown slightly peaty sandy gravelly CLAY with cobbles and boulders				7126	B	1.00	N=6	
1.50	Stiff dark brown sandy gravelly CLAY with cobbles and boulders				7127	B	2.00	N=28	
2.50	Obstruction - Possible rock/boulder								
2.80	End of Borehole at 2.80 m				7128	B	2.80	N=R	
3									
4									
5									
6									
7									
8									
9									
10									

R5619

Hard Strata Boring / Chiselling				Water Strike Details					
From (m)	To (m)	Hours	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
2.50	2.80	2.00		2.50	2.50		2.30		Slow
Standpipe Installation Details				Groundwater Observations					
Date	Tip Depth	RZ Top	RZ Base	Type	Date	Hole Depth	Casing Depth	Depth to Water	Comments
					29/11/2003	2.80	0.00	0.80	Casing pulled, BH end.
					29/11/2003	2.80	2.80	1.50	BH End

Remarks:

135219

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REPORT NO: 9253		GEOTECHNICAL BORING RECORD		IGSL Ltd.	
CONTRACT : Phoenix Park Development			BOREHOLE NO: BH5 Sheet 1 of 1		
CLIENT : Flynn & O'Flaherty		GROUND LEVEL (mOD) -		DATE STARTED: 02/12/2003	
ENGINEER : OMS Architects		BOREHOLE DIAMETER (mm) 200		DATE COMPLETED: 02/12/2003	
CO-ORDINATES : E -		BOREHOLE DEPTH (m) 1.80		BORED BY: J.O'Hara	
N -		CASING DEPTH (m) 1.80			

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS	STAND PIPE DETAILS
					REF. NUMBER	SAMPLE TYPE	DEPTH (m)		
0	TOPSOIL			0.30					
0.30 - 1.60	Stiff brown/black sandy gravelly CLAY with cobbles and boulders				7141	B	1.00	N=38	
1.60	Obstruction - Possible rock/boulder			1.60					
1.60 - 1.80	End of Borehole at 1.80 m			1.80	7142	B	1.80	N=R	
1.80 - 10									

R5619

Hard Strata Boring / Chiselling				Water Strike Details					
From (m)	To (m)	Hours	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
1.60	1.80	2.00							Dry
				Groundwater Observations					
Date	Hole Depth	Casing Depth	Depth to Water	Comments					
02/12/2003	1.80	0.00		BH dry, end of BH					

Remarks:

135220

REPORT NO: 9253		GEOTECHNICAL BORING RECORD			IGSL Ltd.	
CONTRACT : Phoenix Park Development				BOREHOLE NO: BH6 Sheet 1 of 1		
CLIENT : Flynn & O'Flaherty		GROUND LEVEL (mOD) -		DATE STARTED: 03/12/2003		
ENGINEER : OMS Architects		BOREHOLE DIAMETER (mm) 200		DATE COMPLETED: 03/12/2003		
CO-ORDINATES : E -		BOREHOLE DEPTH (m) 1.90		BORED BY: J.O'Hara		
N -		CASING DEPTH (m) 1.90				

DEPTH (M)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS	STAND PIPE DETAILS
					REF. NUMBER	SAMPLE TYPE	DEPTH (m)		
0	TOPSOIL			0.20					
0.20	Soft to firm brown slightly sandy, peaty CLAY								
0.80	Very stiff dark brown sandy gravelly CLAY with cobbles and boulders			0.80	7143	B	1.00	N=54	
1.60	Obstruction - Possible rock/boulder			1.60					
1.90	End of Borehole at 1.90 m			1.90	7144	B	1.90	N=R	
2									
3									
4									
5									
6									
7									
8									
9									
10									

Hard Strata Boring / Chiselling				Water Strike Details					
From (m)	To (m)	Hours	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
1.80	1.90	2.00							

Standpipe Installation Details					Groundwater Observations				
Date	Tip Depth	RZ Top	RZ Base	Type	Date	Hole Depth	Casing Depth	Depth to Water	Comments
					03/12/2003	1.50	1.50	-	BH dry, end of BH

Remarks: Water added to assist drilling

R5619

135243

R5619

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REPORT NO. 9253	TRIAL PIT RECORD	IGSL Ltd.
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CONTRACT: Phoenix Park Development	Trial Pit No.: TPRC1
CLIENT:	Sheet: Sheet 1 of 1
ENGINEER:	Excavation Method: JCB
CO-ORDINATES: E - N -	Date Started: 13/11/2003
	Date Completed: 13/11/2003
	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									
	Loose brown gravelly SAND		0.20							
	Firm brown sandy gravelly CLAY with occasional cobbles and boulders		0.60							
1.0						K2763 K2764	B	1.00		
	Stiff brown sandy gravelly CLAY with cobbles, boulders and rock slabs		1.50							
2.0	Obstruction		2.00			K2765	B	2.00		
	End of Trial Pit at 2.05 m		2.05							
3.0										
4.0										

Groundwater Conditions: No groundwater encountered

Stability: Stable

Remarks:

135244

R5619

✓

REPORT NO. 9253 TRIAL PIT RECORD IGSL Ltd.

CONTRACT: Phoenix Park Development	Trial Pit No.: TPRC2
	Sheet: Sheet 1 of 1
CLIENT:	Excavation Method: JCB
ENGINEER:	Date Started: 14/11/2003
CO-ORDINATES: E - N -	Date Completed: 14/11/2003
	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									
0.60	Firm brown sandy gravelly CLAY with occasional cobbles and boulders. From 2m rock fragments present.		0.60			K2768 K2769	B	1.00		
2.00						K2770	B	2.00		
2.20	Obstruction End of Trial Pit at 2.20 m		2.20							
3.0										
4.0										

Groundwater Conditions: No groundwater encountered

Stability: Stable

Remarks:

R5709

Appendix I – Cable Tool Borehole Records

REPORT NO: 9638		GEOTECHNICAL BORING RECORD				IGSL Ltd.			
CONTRACT : Blackhall Place				BOREHOLE NO: 1		Sheet 1 of 2			
CLIENT :		GROUND LEVEL (mOD)		DATE STARTED: 06/04/2004		DATE COMPLETED: 07/04/2004			
ENGINEER : Barrett Mahony		BOREHOLE DIAMETER (mm) 200		BORED BY: J. O'Hara					
CO-ORDINATES : E -		BOREHOLE DEPTH (m) 14.30							
N -		CASING DEPTH (m) 14.30							
DEPTH (m)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS	STAND PIPE DETAILS
					REF. NUMBER	SAMPLE TYPE	DEPTH (m)		
	MADE GROUND containing reinforced concrete and hardcore			0.40					
	MADE GROUND containing loose brick rubble								
-1					3985	B	1.00	N=4	
-2					3986	B	2.00	N=5	
-3					3987	B	3.00	N=8	
-4					3988	B	4.00	N=4	
-5	Dense/very dense grey brown coarse GRAVEL			4.60					
-6					3989	B	5.00	N=6/ 225mm	
-7					3990	B	6.00	N=45	
-8					3991	B	7.00	N=40	
-9					3992	B	8.00	N=38	
-10					3993	B	9.00	N=45	
	Continued next sheet				3994	B	10.00	N=R	

Hard Strata Boring / Chiselling				Water Strike Details					
From (m)	To (m)	Hours	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
0.00	0.40	2.00		7.80	7.80		5.80		Slow/Moderate
4.60	4.80	0.50							
5.40	5.70	0.75							
10.30	10.60	0.75							
12.20	12.50	1.00							
14.10	14.30	2.00							

Standpipe Installation Details					Groundwater Observations				
Date	Tip Depth	RZ Top	RZ Base	Type	Date	Hole Depth	Casing Depth	Depth to Water	Comments
					07/04/2004	14.30	0.00	11.50	End of BH

Remarks:

R5709

135926

REPORT NO: 9638		GEOTECHNICAL BORING RECORD		IGSL Ltd.	
CONTRACT : Blackhall Place			BOREHOLE NO: 1 Sheet 2 of 2		
CLIENT : ENGINEER : Barrett Mahony		GROUND LEVEL (mOD) -		DATE STARTED: 06/04/2004	
CO-ORDINATES : E - N -		BOREHOLE DIAMETER (mm) 200		DATE COMPLETED: 07/04/2004	
		BOREHOLE DEPTH (m) 14.30		BORED BY: J. O'Hara	
		CASING DEPTH (m) 14.30			

DEPTH (m)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS	STAND PIPE DETAILS
					REF. NUMBER	SAMPLE TYPE	DEPTH (m)		
0.00	Dense/very dense grey brown coarse GRAVEL								
11.00					3995	B	11.00	N=63/ 225mm	
12.00					3996	B	12.00	N=R	
13.00					3997	B	13.00	N=65/ 225mm	
14.00					3998	B	14.00	N=50/ 150mm	
14.30	End of Borehole at 14.30 m								

Hard Strata Boring / Chiselling				Water Strike Details					
From (m)	To (m)	Hours	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
0.00	0.40	2.00		7.80	7.80		8.90		Slow/Moderate
4.60	4.80	0.50							
5.40	5.70	0.75							
10.30	10.90	0.75							
12.20	12.50	1.00							
14.10	14.30	2.00							

Standpipe Installation Details					Groundwater Observations				
Date	Tip Depth	RZ Top	RZ Base	Type	Date	Hole Depth	Casing Depth	Depth to Water	Comments
07/04/2004	14.30	0.00	11.50			14.30	0.00	11.50	End of BH

Remarks:

REPORT NO: 9638		GEOTECHNICAL BORING RECORD		IGSL Ltd.	
CONTRACT : Blackhall Place			BOREHOLE NO: 2 Sheet 1 of 2		
CLIENT : ENGINEER : Barrett Mahony		GROUND LEVEL (mOD) -		DATE STARTED: 01/04/2004	
CO-ORDINATES : E - N -		BOREHOLE DIAMETER (mm) 200		DATE COMPLETED: 02/04/2004	
		BOREHOLE DEPTH (m) 10.50		BORED BY: J. O'Hara	
		CASING DEPTH (m) 10.50			

DEPTH (m)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS	STAND PIPE DETAILS
					REF. NUMBER	SAMPLE TYPE	DEPTH (m)		
0.20	MADE GROUND (consisting of reinforced concrete)								
0.50	MADE GROUND (consisting of hard core)								
0.50	MADE GROUND (consisting of loose brick rubble)								
1.00					3968	B	1.00	N=9	
2.00					3969	B	2.00	N=7	
3.00					3970	B	3.00	N=6	
4.00					3971	B	4.00	N=20	
5.00					3972	B	5.00	N=8	
5.50	MADE GROUND (consisting of black organic silt/ clay)								
6.00					3973	B	6.00	N=9	
6.50	Very dense, grey/ brown slightly sandy GRAVEL with frequent cobbles								
7.00					3974	B	7.00	N=64/ 225mm	
8.00					3975	B	8.00	N=55	
9.00					3976	B	9.00	N=R	
10.00					3977	B	10.00	N=45/ 150mm	

Hard Strata Boring / Chiselling				Water Strike Details					
From (m)	To (m)	Hours	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
0.00	0.20	1.00	13-16m Continuous	5.50	5.50		5.50		Did not rise
0.20	0.50	1.00		8.00	8.00		6.60		Moderate
7.10	7.50	1.25							
9.20	9.40	1.50							
13.00	16.00	3.00							

Standpipe Installation Details					Groundwater Observations				
Date	Tip Depth	RZ Top	RZ Base	Type	Date	Hole Depth	Casing Depth	Depth to Water	Comments
05/04/2004	16.60	0.00	13.80			16.60	0.00	13.80	End of BH

Remarks:

135927

135927

R5709

REPORT NO: 9638		GEOTECHNICAL BORING RECORD			IGSL Ltd.	
CONTRACT : Blackhall Place				BOREHOLE NO: 2 Sheet 2 of 2		
CLIENT :		GROUND LEVEL (mOD) -		DATE STARTED: 01/04/2004		
ENGINEER : Barrett Mahony		BOREHOLE DIAMETER (mm) 200		DATE COMPLETED: 02/04/2004		
CO-ORDINATES : E -		BOREHOLE DEPTH (m) 10.50		BORED BY: J. O'Hara		
N -		CASING DEPTH (m) 10.50				

DEPTH (m)	DESCRIPTION	LEGEND	ELEVATION (mOD)	DEPTH (m)	SAMPLES			FIELD TEST RESULTS	STAND PIPE DETAILS
					REF NUMBER	SAMPLE TYPE	DEPTH (m)		
0.00	Very dense, grey/ brown slightly sandy GRAVEL with frequent cobbles				3979	B	11.00	N=59	
1.00					3980	B	12.00	N=63/ 275mm	
2.00					3981	B	13.00	N=66/ 190mm	
3.00					3982	B	14.00	N=80/ 170mm	
4.00					3983	B	15.00	N=R	
5.00					3984	B	16.00	N=R	
16.60	End of Borehole at 10.50 m <i>16.60</i>								

Hard Strata Boring / Chiselling				Water Strike Details					
From (m)	To (m)	Hours	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time	Comments
0.00	0.20	1.00	13-16m Continuous	3.50	5.50	-	5.50	-	Did not rise
0.20	0.50	1.00		8.00	8.00	-	6.60	-	Moderate
7.10	7.50	1.25							
9.20	9.40	1.50							
13.00	16.00	3.00							

Standpipe Installation Details					Groundwater Observations				
Date	Tip Depth	RZ Top	RZ Base	Type	Date	Hole Depth	Casing Depth	Water	Comments
					05/04/2004	16.60	0.00	13.80	End of BH

Remarks:

Appendix II – Laboratory Test Records



GEOTECHNICAL BORING RECORD R6617

REPORT NUMBER

11836

CONTRACT Blanchardstown S.C.		BOREHOLE NO. BH1
CO-ORDINATES(_)		SHEET Sheet 1 of 1
CLIENT McAleer & Rushe		DATE STARTED 02/06/2006
ENGINEER Ian Black Consulting Ltd.		DATE COMPLETED 06/06/2006
BOREHOLE DIAMETER (mm) 200		BORED BY IGSL
BOREHOLE DEPTH (m) 7.10		PROCESSED BY Z. Knotkova
CASING DEPTH (m) 7.10		

Depth (m)	Description	Legend	Elevation	Samples			Field Test Results	Standpipe Details
				Depth (m)	Ref. Number	Sample Type		
0	MADE GROUND (consisting of tarmac)							
0.20	MADE GROUND (consisting of compact angular gravel - sub-base)							
0.40	Firm brown CLAY/SILT with occasional fine gravel			W7852	B	0.40		
1.10	Stiff brown gravelly CLAY with cobbles			W7853	B	1.00	N = 13 (1, 2, 3, 4, 3, 3)	
2.00				W7854	B	2.00	N = 17 (1, 2, 4, 4, 4, 5)	
3.00				W7855	B	3.00	N = 19 (2, 3, 4, 4, 5, 6)	
4.00				W7856	B	4.00	N = 32 (1, 3, 5, 7, 10, 10)	
5.00	Hard grey gravelly CLAY with cobbles			W7857	B	5.00	N = 81 (2, 7, 15, 20, 22, 24)	
5.70				W7858	B	5.70		
6.00				W7859	B	6.00	N = 43 (2, 5, 7, 10, 12, 14)	
7.10	Obstruction End of Borehole at 7.10 m						N = 75/150 mm (25, 50)	

HARD STRATA BORING/CHISELLING				WATER STRIKE DETAILS					
From (m)	To (m)	Time (h)	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
3.6	3.8	0.75							BH Dry
5.5	5.7	0.5							
6.8	7.1	2							

INSTALLATION DETAILS					GROUNDWATER DETAILS				
Date	Tip Depth	RZ Top	RZ Base	Type	Date	Hole Depth	Casing Depth	Depth to Water	Comments
06/06/2006	7.00	1.00	7.00	50mm SP	02-06-06	7.10	0.00		BH Dry

REMARKS

IGSL BH LOG 11836.GPJ IGSL GDT 15/6/06



GEOTECHNICAL BORING RECORD R6617

REPORT NUMBER

11836

CONTRACT Blanchardstown S.C.

BOREHOLE NO. **BH2**
SHEET Sheet 1 of 1

CO-ORDINATES(_)

GROUND LEVEL (m)
BOREHOLE DIAMETER (mm) 200

DATE STARTED 31/05/2006
DATE COMPLETED 31/05/2006

CLIENT McAleer & Rushe
ENGINEER Ian Black Consulting Ltd.

BOREHOLE DEPTH (m) 6.90
CASING DEPTH (m) 6.90

BORED BY IGSL
PROCESSED BY Z. Knotkova

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples			Field Test Results	Standpipe Details
					Ref. Number	Sample Type	Depth (m)		
0	MADE GROUND (consisting of tarmac)			0.20					
	MADE GROUND (consisting of compact angular gravel - sub-base)			0.50	W7816	B	0.50		
	MADE GROUND (consisting of brown clay with traces of roots and fill material)			1.20	W7817	B	1.00	N = 10 (1, 1, 2, 3, 3, 2)	
1	Firm brown CLAY with fine to coarse gravel			1.80	W7818	B	1.80		
				2.00	W7819	B	2.00	N = 18 (1, 2, 4, 4, 5, 5)	
2				2.70	W7820	B	2.70		
	Stiff to very stiff dark grey gravelly CLAY with cobbles			3.00	W7821	B	3.00	N = 28 (2, 4, 7, 10, 5, 6)	
3				4.00	W7822	B	4.00	N = 35 (2, 4, 6, 9, 10, 10)	
4				5.00	W7823	B	5.00	N = 82 (2, 5, 15, 20, 22, 25)	
5				6.00	W7824	B	6.00	N = 49 (3, 6, 8, 10, 15, 16)	
6				6.70					
7	Obstruction End of Borehole at 6.90 m			6.90				N = 75/150 mm (25, 50)	
8									
9									

HARD STRATA BORING/CHISELLING

WATER STRIKE DETAILS

From (m)	To (m)	Time (h)	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
2.5	2.7	0.75							BH Dry
5.4	5.6	0.75							
6.7	6.9	2							

GROUNDWATER DETAILS

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type	Date	Hole Depth	Casing Depth	Depth to Water	Comments
					31-05-06	6.90	0.00		BH Dry

REMARKS

IGSL BH LOG 11836.GPJ IGSLGDT 15/06/06



GEOTECHNICAL BORING RECORD R6617

REPORT NUMBER

11836

CONTRACT Blanchardstown S.C.

BOREHOLE NO. **BH3**
SHEET Sheet 1 of 1

CO-ORDINATES(_)

GROUND LEVEL (m)
BOREHOLE DIAMETER (mm) 200

DATE STARTED 06/06/2006
DATE COMPLETED 06/06/2006

CLIENT McAleer & Rushe
ENGINEER Ian Black Consulting Ltd.

BOREHOLE DEPTH (m) 7.90
CASING DEPTH (m) 7.90

BORED BY IGSL
PROCESSED BY Z. Knotkova

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples			Field Test Results	Standpipe Details
					Ref. Number	Sample Type	Depth (m)		
0	MADE GROUND (consisting of tarmac)								
	MADE GROUND (consisting of compact angular gravel - sub-base)			0.20					
	Firm light brown sandy CLAY with fine to medium gravel			0.60	W7860	B	0.60	N = 18 (1, 2, 4, 4, 5, 5)	
1					W7861	B	1.00		
2					W7862	B	2.00	N = 20 (2, 3, 5, 7, 4, 4)	
3					W7863	B	3.00	N = 23 (2, 2, 4, 5, 7, 7)	
	Very stiff dark brown/grey gravelly CLAY with cobbles			3.20					
4					W7864	B	4.00	N = 38 (2, 4, 7, 9, 10, 12)	
5					W7865	B	5.00	N = 82 (3, 7, 15, 20, 22, 25)	
6					W7866	B	6.00	N = 42 (2, 4, 7, 9, 12, 14)	
7					W7867	B	7.00	N = 45 (3, 5, 8, 10, 12, 15)	
8	Obstruction End of Borehole at 7.90 m			7.70 7.90					

HARD STRATA BORING/CHISELLING

WATER STRIKE DETAILS

From (m)	To (m)	Time (h)	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
3.4	3.6	0.75							BH Dry
4.8	5	1.25							
5.5	5.7	0.75							
7.7	7.9	2							

GROUNDWATER DETAILS

INSTALLATION DETAILS

INSTALLATION DETAILS					Date	Hole Depth	Casing Depth	Depth to Water	Comments
Date	Tip Depth	RZ Top	RZ Base	Type	06-06-06	7.90	0.00		BH Dry

REMARKS

IGSL BH LOG 11836.GPJ IGSLGDT 15/06/06



GEOTECHNICAL BORING RECORD R6617

REPORT NUMBER

11836

CONTRACT Blanchardstown S.C.

BOREHOLE NO. BH4
SHEET Sheet 1 of 1

CO-ORDINATES(_)

GROUND LEVEL (m)
BOREHOLE DIAMETER (mm) 200

DATE STARTED 01/06/2006
DATE COMPLETED 01/06/2006

CLIENT McAleer & Rushe
ENGINEER Ian Black Consulting Ltd.

BOREHOLE DEPTH (m) 8.70
CASING DEPTH (m) 8.70

BORED BY IGSL
PROCESSED BY Z. Knotkova

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples			Field Test Results	Standpipe Details
					Ref. Number	Sample Type	Depth (m)		
0	MADE GROUND (consisting of tarmac)								
	MADE GROUND (consisting of compact angular gravel - sub-base)			0.20					
	Firm to stiff brown sandy gravelly CLAY			0.40	W7825	B	0.40		
1					W7826	B	1.00	N = 21 (1, 2, 4, 4, 6, 7)	
2					W7827	B	2.00	N = 22 (1, 3, 4, 5, 7, 6)	
3					W7828	B	3.00	N = 63 (2, 4, 7, 14, 20, 22)	
	Very stiff to hard grey/grey brown gravelly CLAY with cobbles			3.25	W7829	B	3.60		
4					W7830	B	4.00	N = 44 (2, 5, 8, 10, 12, 14)	
5					W7831	B	5.00	N = 51 (3, 7, 10, 11, 14, 16)	
6					W7832	B	6.00	N = 42 (2, 4, 8, 10, 12, 12)	
7					W7833	B	7.00	N = 46 (2, 3, 7, 10, 14, 15)	
8					W7834	B	8.00	N = 60 (3, 5, 9, 14, 17, 20)	
9	End of Borehole at 8.70 m			8.70					

HARD STRATA BORING/CHISELLING

WATER STRIKE DETAILS

From (m)	To (m)	Time (h)	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
3.5	3.7	0.75							BH Dry
4.7	4.9	0.75							
8.4	8.7	2							

GROUNDWATER DETAILS

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type	Date	Hole Depth	Casing Depth	Depth to Water	Comments
					01-06-06	8.70	0.00		BH Dry

REMARKS

IGSL BH LOG 11836.GPJ IGSL.GDT 15/06/06



GEOTECHNICAL BORING RECORD

R6617

 11836

REPORT NUMBER

CONTRACT Blanchardstown S.C.		BOREHOLE NO. BH5
		SHEET Sheet 1 of 1
CO-ORDINATES(_)	GROUND LEVEL (m)	DATE STARTED 01/06/2006
	BOREHOLE DIAMETER (mm) 200	DATE COMPLETED 01/06/2006
CLIENT McAleer & Rushe ENGINEER Ian Black Consulting Ltd.	BOREHOLE DEPTH (m) 8.50	BORED BY IGSL
	CASING DEPTH (m) 8.50	PROCESSED BY Z. Knotkova

Depth (m)	Description	Legend	Elevation	Samples			Field Test Results	Standpipe Details
				Depth (m)	Ref. Number	Sample Type		
0	MADE GROUND (consisting of tarmac)							
	MADE GROUND (consisting of compact angular gravel - sub-base)			0.20				
	Firm brown sandy CLAY with fine to coarse gravel			0.40	W7835	B	0.40	
1					W7836	B	1.00	N = 16 (1, 2, 5, 4, 4, 3)
2					W7837	B	2.00	N = 19 (1, 2, 4, 4, 5, 6)
3	Very stiff to hard dark brown/grey brown sandy gravelly CLAY with cobbles			2.80	W7838	B	2.80	N = 38 (2, 4, 7, 9, 10, 12)
					W7839	B	3.00	
4					W7840	B	4.00	N = 42 (2, 5, 8, 10, 12, 12)
5					W7841	B	5.00	N = 72 (2, 4, 10, 18, 20, 24)
6					W7842	B	6.00	N = 43 (1, 4, 7, 10, 12, 14)
7					W7843	B	7.00	N = 53 (2, 5, 9, 12, 15, 17)
8					W7844	B	8.00	N = 49/85 mm (2, 15, 24, 25)
	End of Borehole at 8.50 m			8.50				

HARD STRATA BORING/CHISELLING				WATER STRIKE DETAILS					
From (m)	To (m)	Time (h)	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
3.7	3.9	1							BH Dry
4.8	4.9	0.5							
5.5	5.7	0.75							
8.3	8.5	2							

GROUNDWATER DETAILS				
INSTALLATION DETAILS				
Date	Hole Depth	Casing Depth	Depth to Water	Comments
01-06-06	8.50	0.00		BH Dry

REMARKS

IGSL BH LOG 11836.GPJ IGSLGDT 15/6/06



GEOTECHNICAL BORING RECORD

REPORT NUMBER

11836

R6617

CONTRACT Blanchardstown S.C.

BOREHOLE NO. BH6
SHEET Sheet 1 of 1

CO-ORDINATES(_)

GROUND LEVEL (m)
BOREHOLE DIAMETER (mm) 200

DATE STARTED 02/06/2006
DATE COMPLETED 02/06/2006

CLIENT McAleer & Rushe
ENGINEER Ian Black Consulting Ltd.

BOREHOLE DEPTH (m) 5.80
CASING DEPTH (m) 5.80

BORED BY IGSL
PROCESSED BY Z. Knotkova

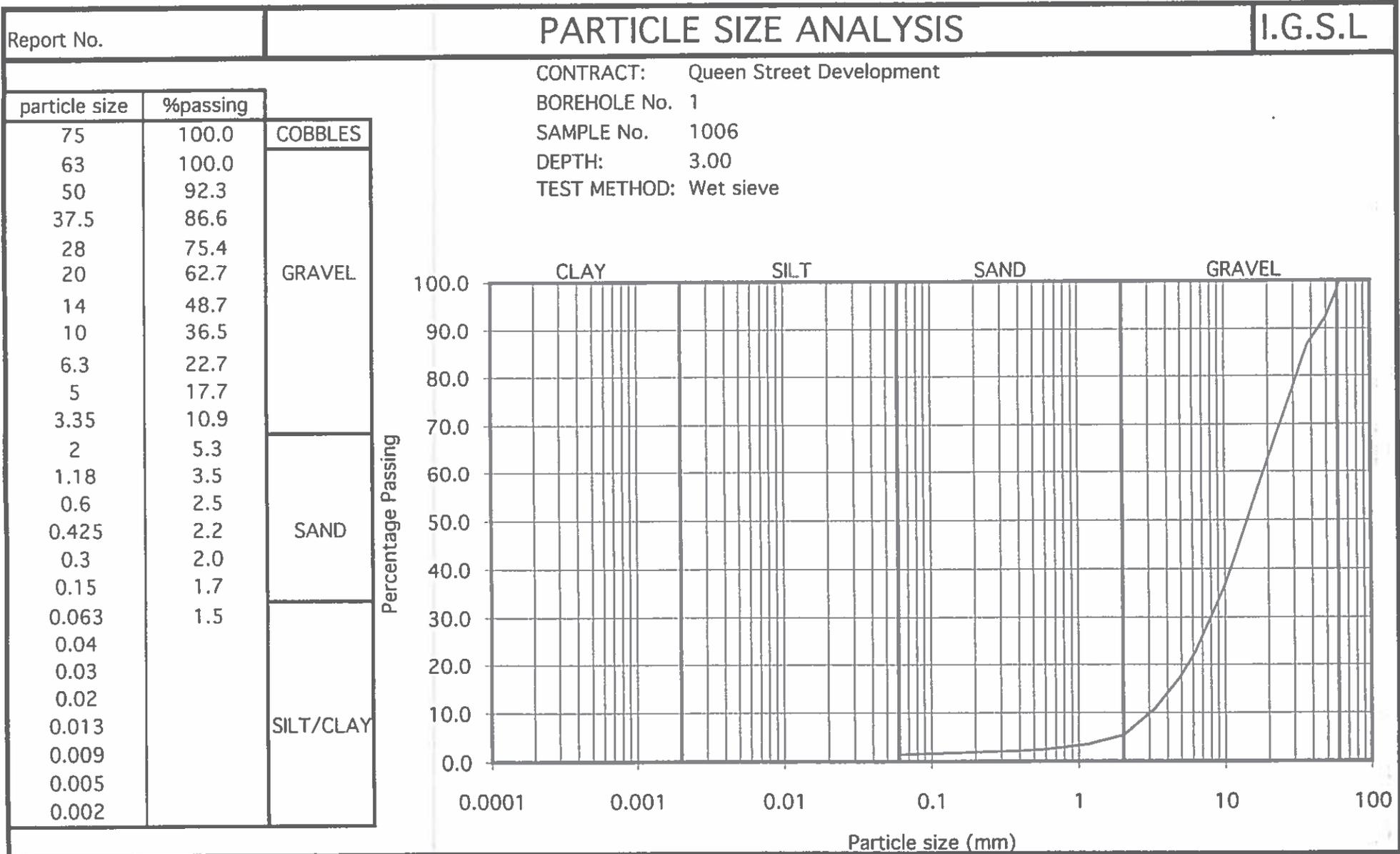
Depth (m)	Description	Legend	Elevation	Samples			Field Test Results	Standpipe Details
				Depth (m)	Ref. Number	Sample Type		
0	MADE GROUND (consisting of tarmac)							
	MADE GROUND (consisting of compact angular gravel - sub-base)			0.20				
	Firm brown sandy gravelly CLAY			0.40	W7845	B	0.40	
1					W7846	B	1.00	N = 15 (1, 2, 4, 4, 3, 4)
2					W7847	B	2.00	N = 18 (1, 3, 5, 7, 3, 3)
3					W7848	B	3.00	N = 12 (1, 1, 2, 3, 3, 4)
4					W7849	B	4.00	N = 14 (1, 1, 4, 3, 3, 4)
5	Stiff grey brown gravelly CLAY			4.50				
					W7850	B	5.00	N = 24 (1, 2, 3, 5, 7, 9)
6	End of Borehole at 5.80 m			5.80				
7								
8								
9								

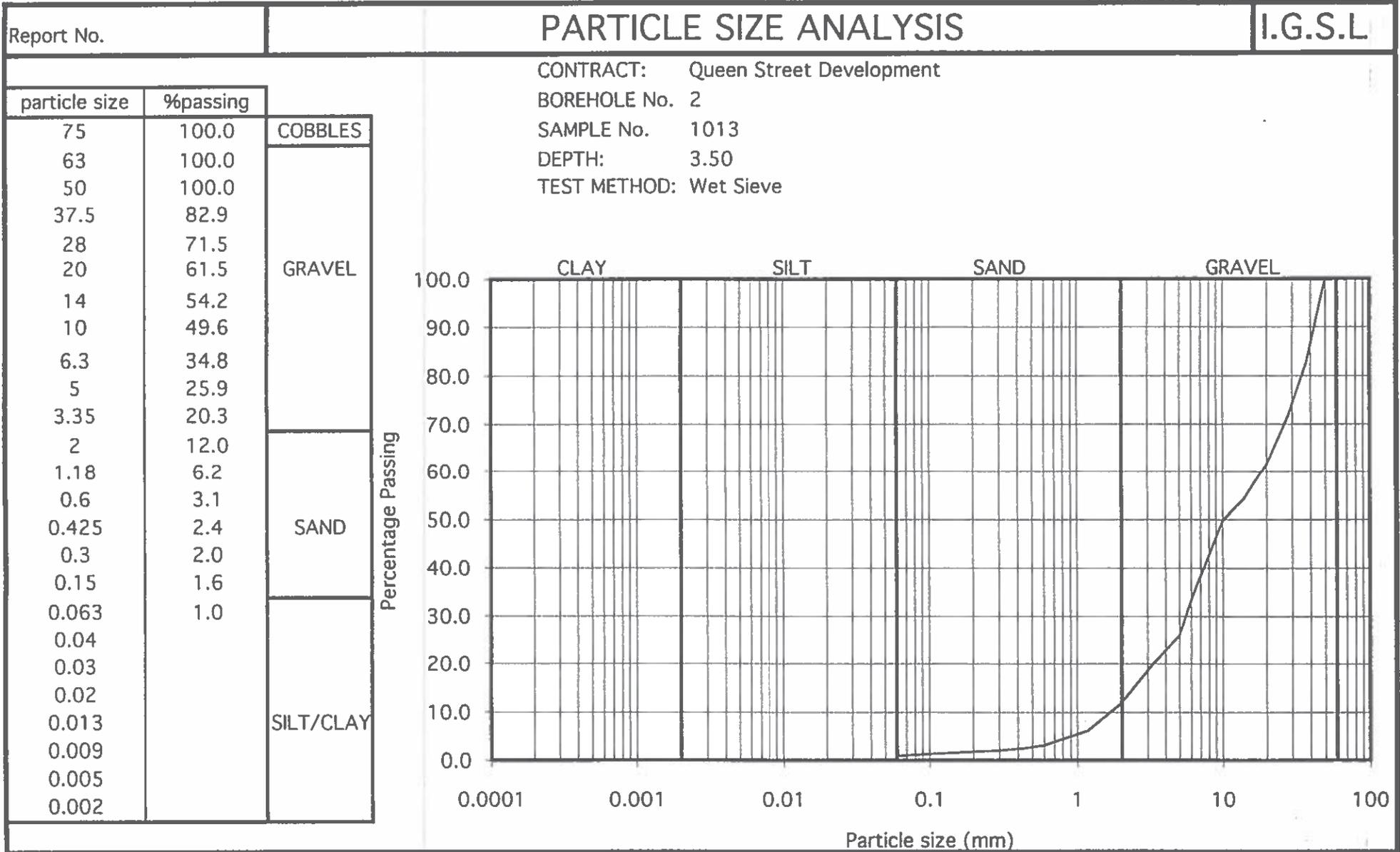
HARD STRATA BORING/CHISELLING				WATER STRIKE DETAILS					
From (m)	To (m)	Time (h)	Comments	Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
2.5	2.6	0.75							BH Dry
5.7	5.8	2							

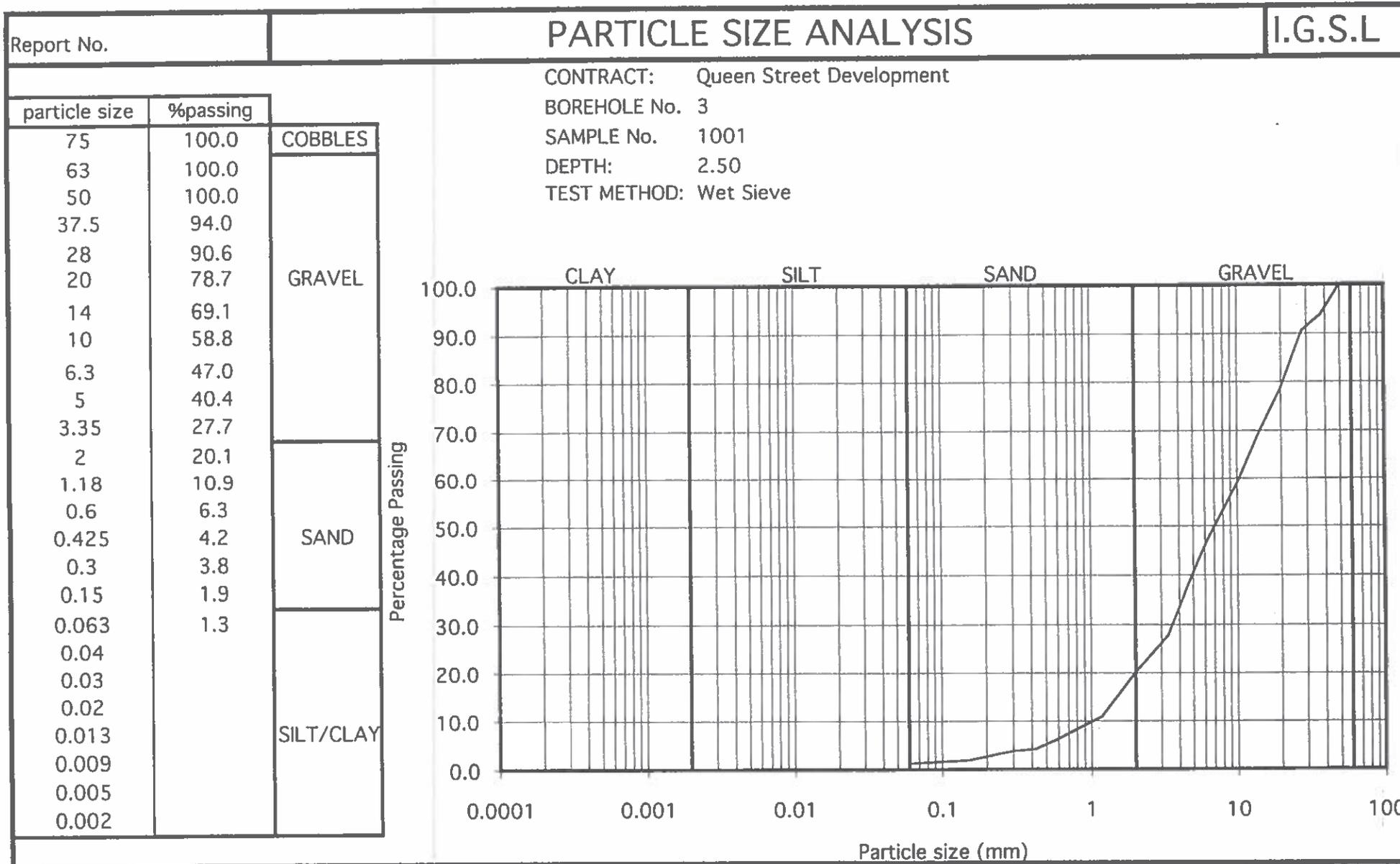
INSTALLATION DETAILS					GROUNDWATER DETAILS				
Date	Tip Depth	RZ Top	RZ Base	Type	Date	Hole Depth	Casing Depth	Depth to Water	Comments
02/06/2006	5.80	1.00	5.00	50mm SP	02-06-06	5.80	0.00		BH Dry

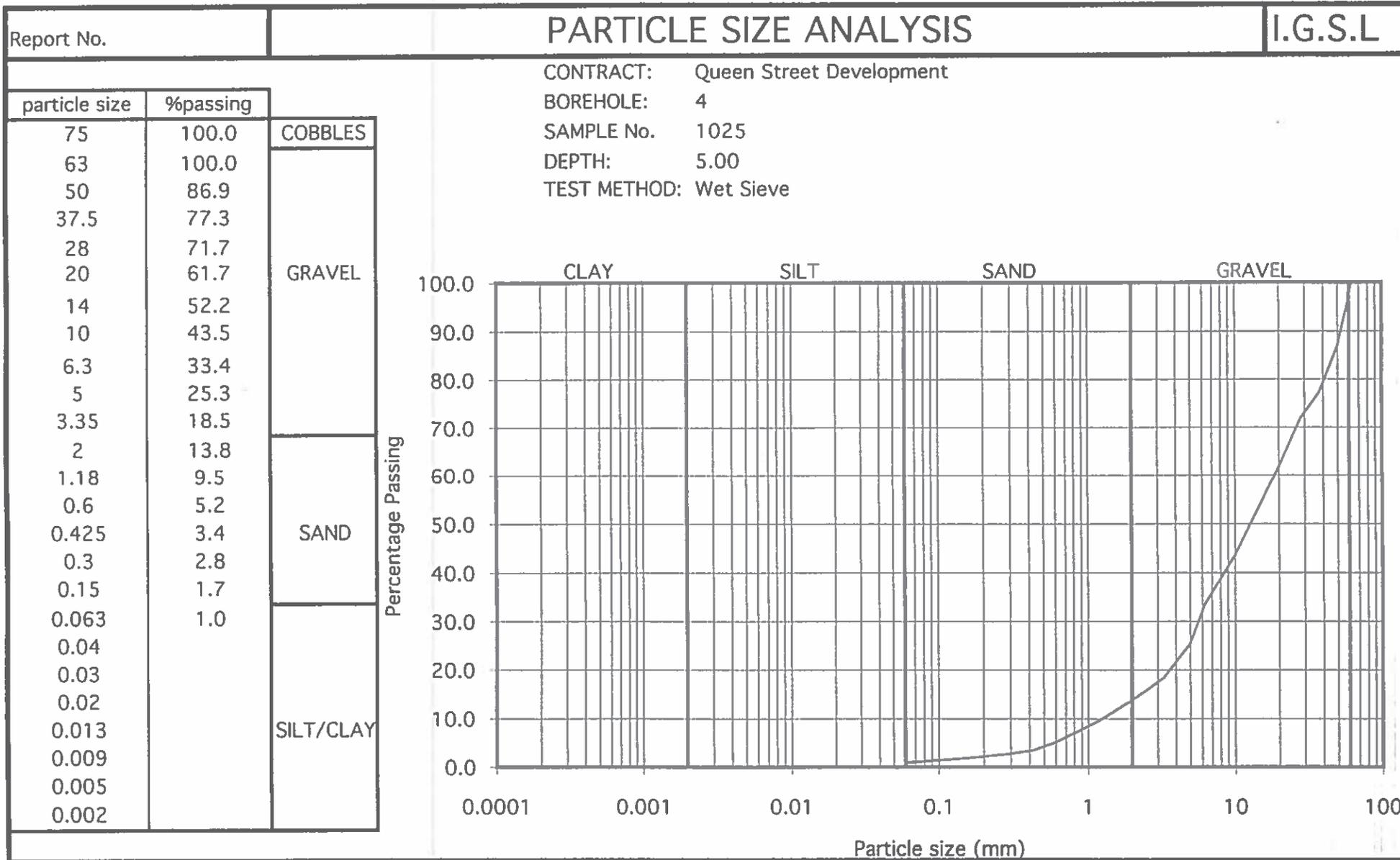
REMARKS

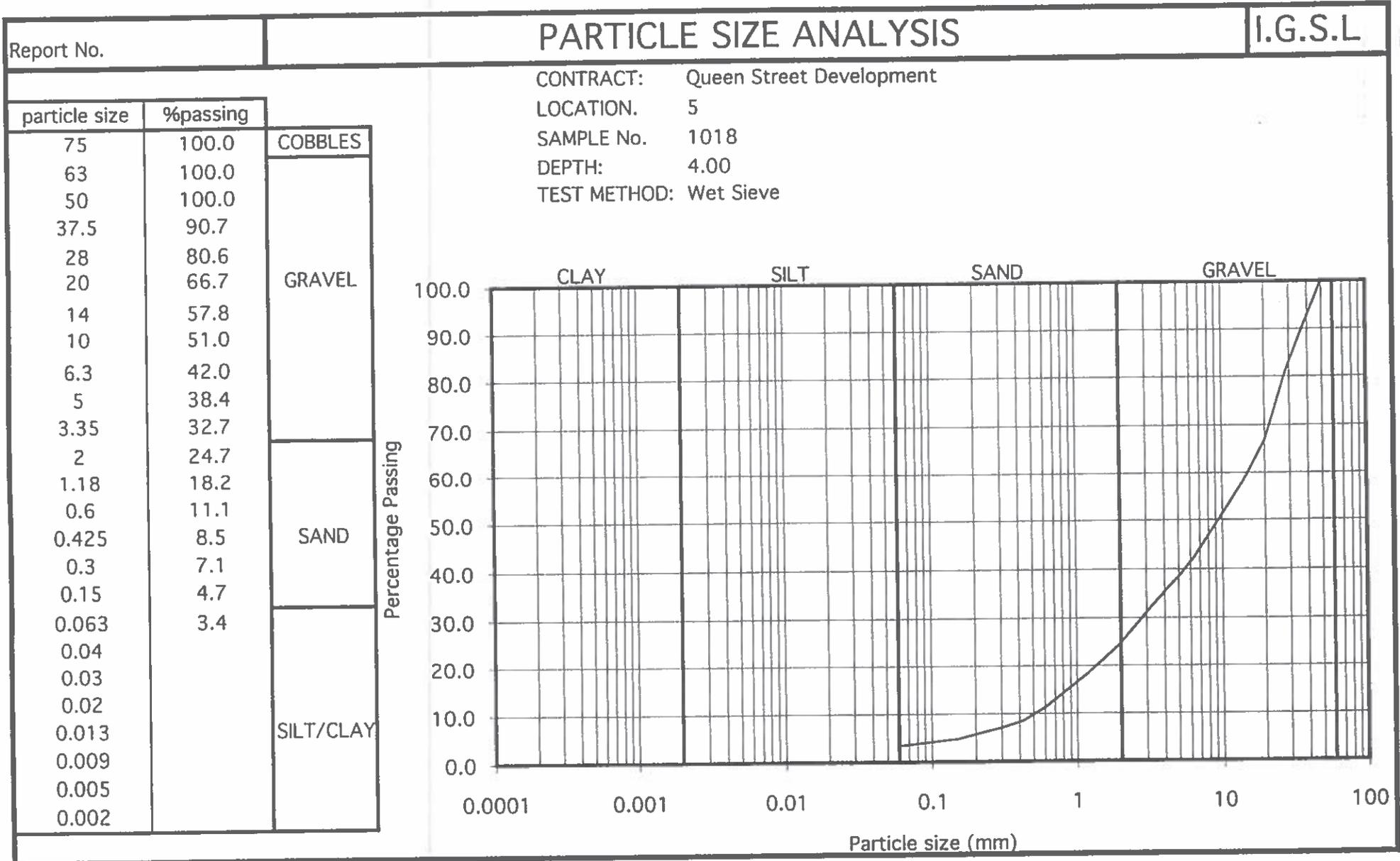
IGSL BH LOG 11836.GPJ IGSL GDT 15/6/06











R3919

Report No.		CLASSIFICATION TEST RESULTS							IGSL	
Contract:		Queen Street, Dublin								
Borehole No.	Depth (M)	Reference No.	Description	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Water Content %	pH	Sulphate Content %	
1	5.50	1009	Black slightly silty gravelly CLAY with cobbles	33	21	12	10.45			
3	5.00	1003	Black slightly silty gravelly CLAY with cobbles	23	14	9	11.89			

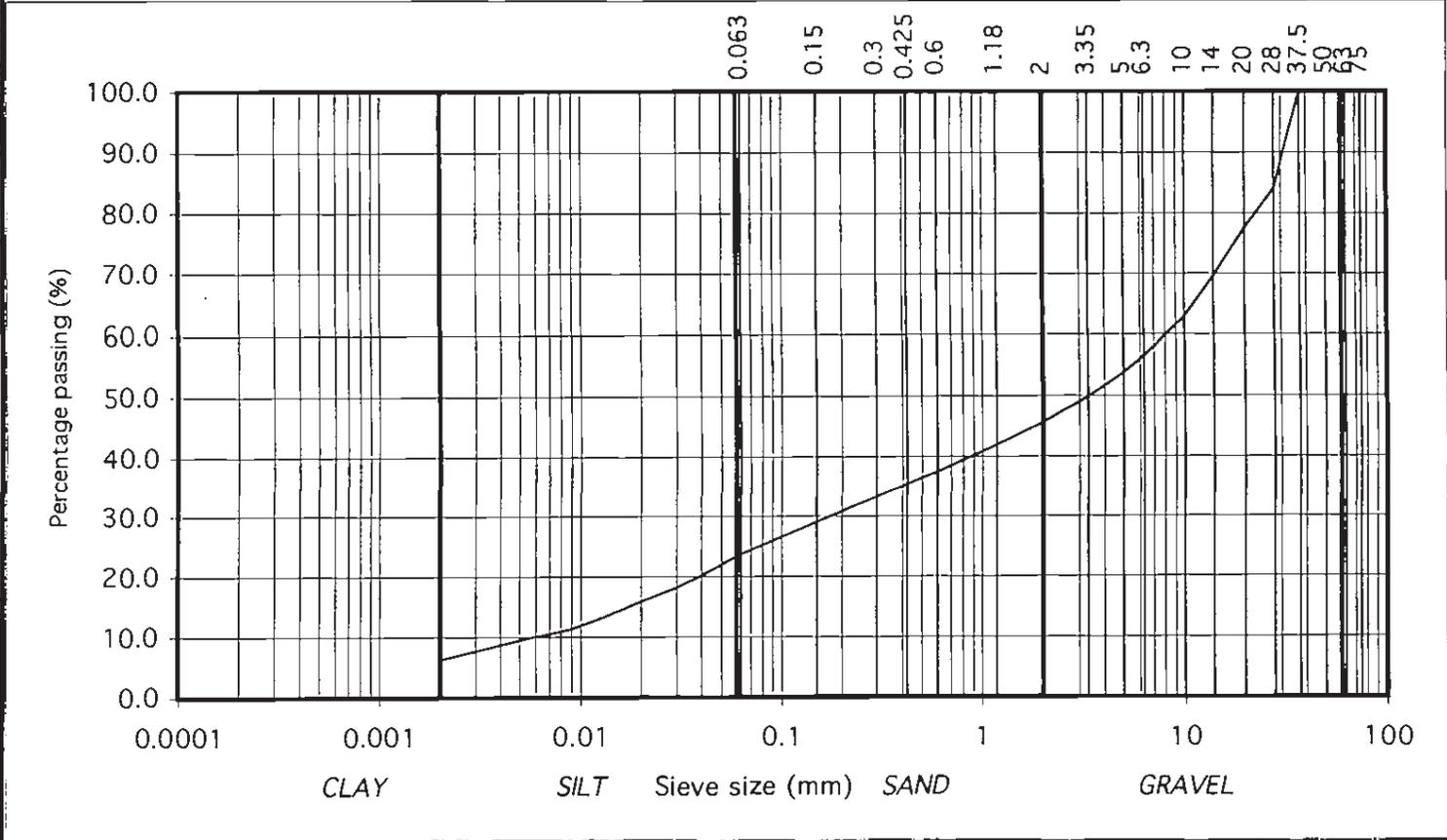
Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

R5614

Contract No: 9540
 Contract: TOLKA RIVER FLOODING
 BH/TP No: B1
 SAMPLE No.: 5173
 DEPTH (m): 1.5-1.95
 TEST METHOD: Wet sieve and hydrometer
 DESCRIPTION: Grey brown slightly sandy, gravelly, SILT/CLAY

particle size	% passing	
75	100.0	COBBLES
63	100.0	
50	100.0	
37.5	100.0	GRAVEL
28	84.0	
20	77.4	
14	69.4	
10	62.8	
6.3	56.5	
5	53.7	SAND
3.35	49.8	
2	45.6	
1.18	41.9	
0.6	37.5	
0.425	35.4	
0.3	33.2	
0.15	28.9	
0.063	23.6	
0.04	20.0	
0.03	18.1	SILT/CLAY
0.02	15.8	
0.013	13.2	
0.009	11.3	
0.005	9.4	
0.002	6.2	



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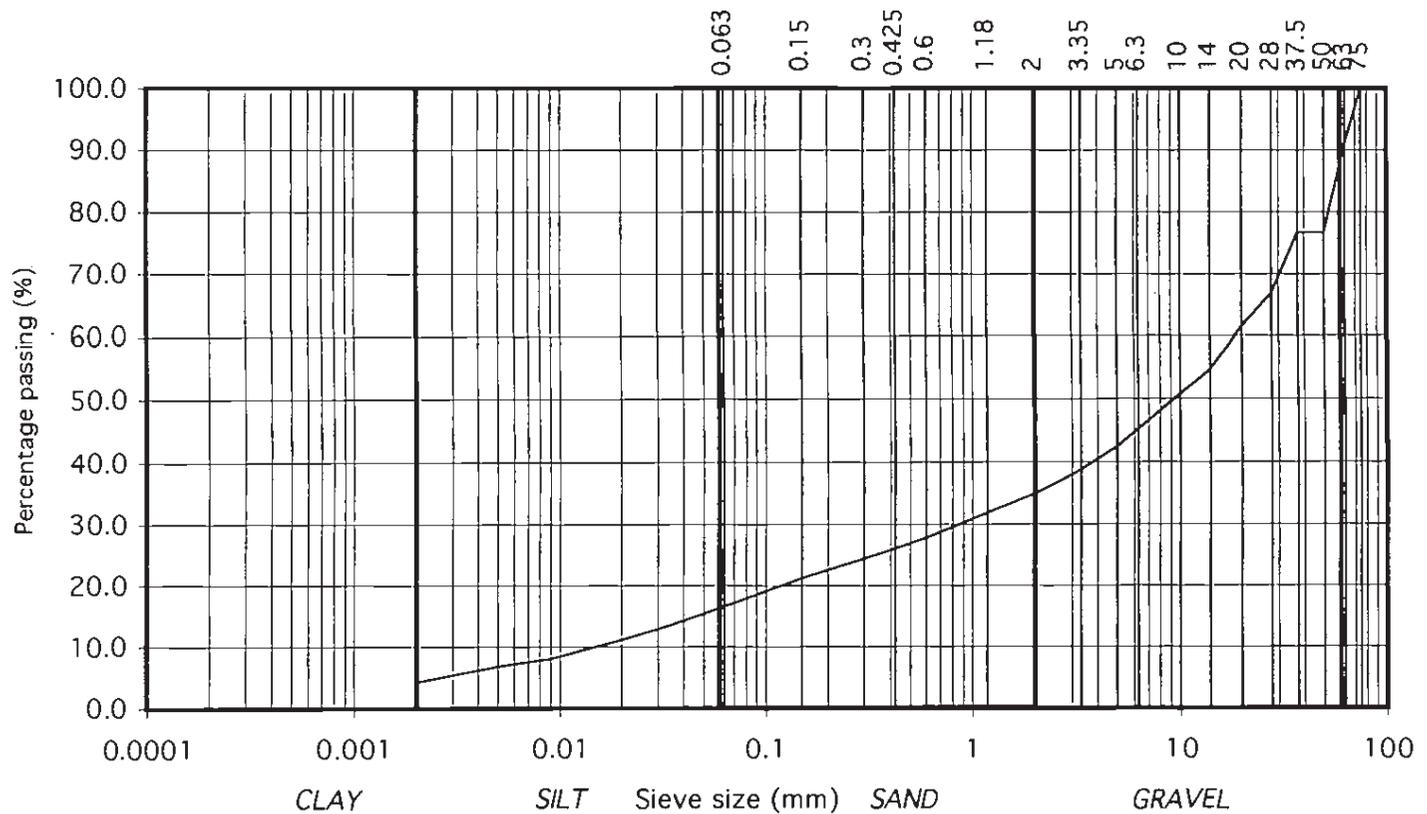
Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

R5614

Contract No: 9540
 Contract: TOLKA RIVER FLOODING
 BH/TP No: B1
 SAMPLE No.: 5179
 DEPTH (m): 7.5-7.95
 TEST METHOD: Wet sieve and hydrometer
 DESCRIPTION: Grey slightly sandy, very gravelly, SILT/CLAY with some cobbles

particle size	% passing	
75	100.0	COBBLES
63	90.7	
50	76.6	GRAVEL
37.5	76.6	
28	66.8	
20	61.4	
14	54.6	
10	50.8	
6.3	45.2	
5	42.4	
3.35	38.8	
2	34.8	
1.18	31.7	
0.6	27.8	
0.425	26.0	
0.3	24.4	
0.15	21.1	SILT/CLAY
0.063	16.5	
0.04	14.1	
0.03	12.8	
0.02	11.1	
0.013	9.3	
0.009	7.9	
0.005	6.7	
0.002	4.2	



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	D CONNOLLY	6/7/04			

9253

CLASSIFICATION TEST RESULTS

TO BS 1377:1990:PART2:CL 4 & 5

IGSL

Contract: PHOENIX PARK DEVELOPMENT

R5619

BH/TP No.	Depth (M)	Ref No.	Description	Passing 425um %	Test Code	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Classification	Water Content %
BH G2	2.00	7135	Brown sandy gravelly CLAY	54	A	24	12	12	CL	12.4
BH G3	2.00	7130	Brown sandy gravelly CLAY	51	A	22	11	11	CL	10.9
BH1	2.00	7124	Brown sandy gravelly CLAY	48	A	20	11	9	CL	10.6
BH 2	1.00	7126	Brown sandy CLAY with roots	68	A	24	15	9	CL	19.8
BH 5	1.00	7141	Grey brown sandy gravelly CLAY	42	A	21	13	8	CL	10.3
BH 6	1.00	7143	Dark brown sandy gravelly CLAY	38	A	20	10	10	CL	9.8
TP 1	2.00	2747	Brown sandy gravelly CLAY	49	A	21	11	10	CL	10.4
	3.00	2748	Black gravelly CLAY	55	A	23	12	11	CL	8.6
TP 4	1.00	2717	Brown sandy gravelly CLAY	52	A	24	13	11	CL	14.5
	3.00	2720	Black gravelly CLAY	49	A	22	13	9	CL	9.0

TEST REPORT

Determination of Particle Size Distribution & Moisture Content

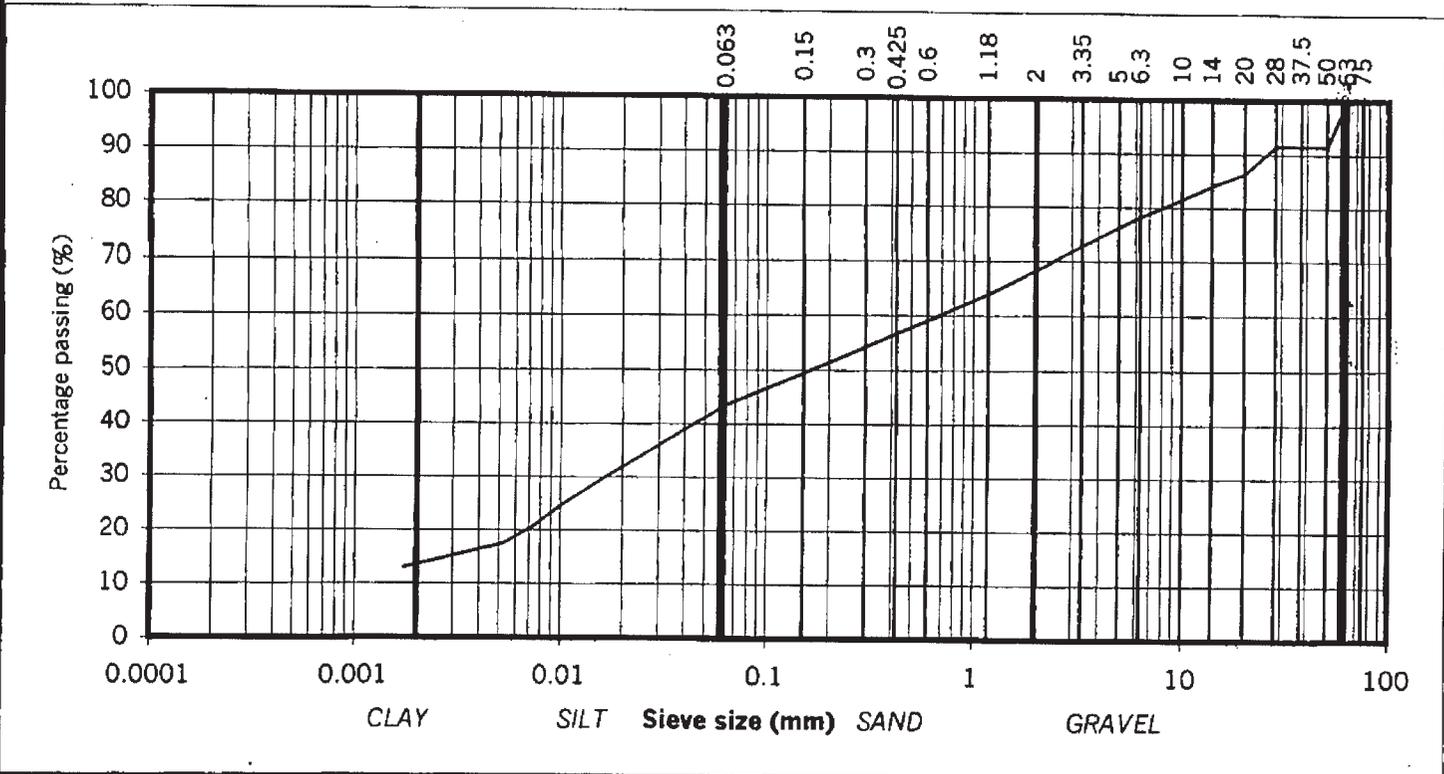
Tested in accordance with: BS1377:Part 2:1990 , clauses 3.2 & 9.2

R5619

Moisture Content: 17.7%

Contract No: 9253
 Contract: PHOENIX PARK RACECOURSE
 Lab. Sample No. 7124-E584 Location: BH.1 at 2.00m
 Date Tested 12/12/03 Engineers: O'MUIRE-SMYTH
 Test Method: Wet sieve Client: FLYNN & O'FLAHERTY
 Description: Light brown slightly sandy, slightly gravelly, SILT/CLAY

sieve size	% passing	
125	100	COBBLES
75	100	
63	100	
50	91	
37.5	91	
28	91	GRAVEL
20	86	
14	84	
10	81	
6.3	78	
5	76	
3.35	73	
2	68	SAND
1.18	64	
0.6	59	
0.425	57	
0.3	54	
0.15	49	SILT/CLAY
0.063	44	
0.027	35.0	
0.017	30.4	
0.010	24.8	
0.007	20.6	
0.005	17.5	
0.002	12.9	



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		09/01/04		09/01/04	1 of 1

Approved signatories: J Barrett (Technical Manager) S Elliot (Laboratory Manager)

TEST REPORT

Determination of Particle Size Distribution & Moisture Content

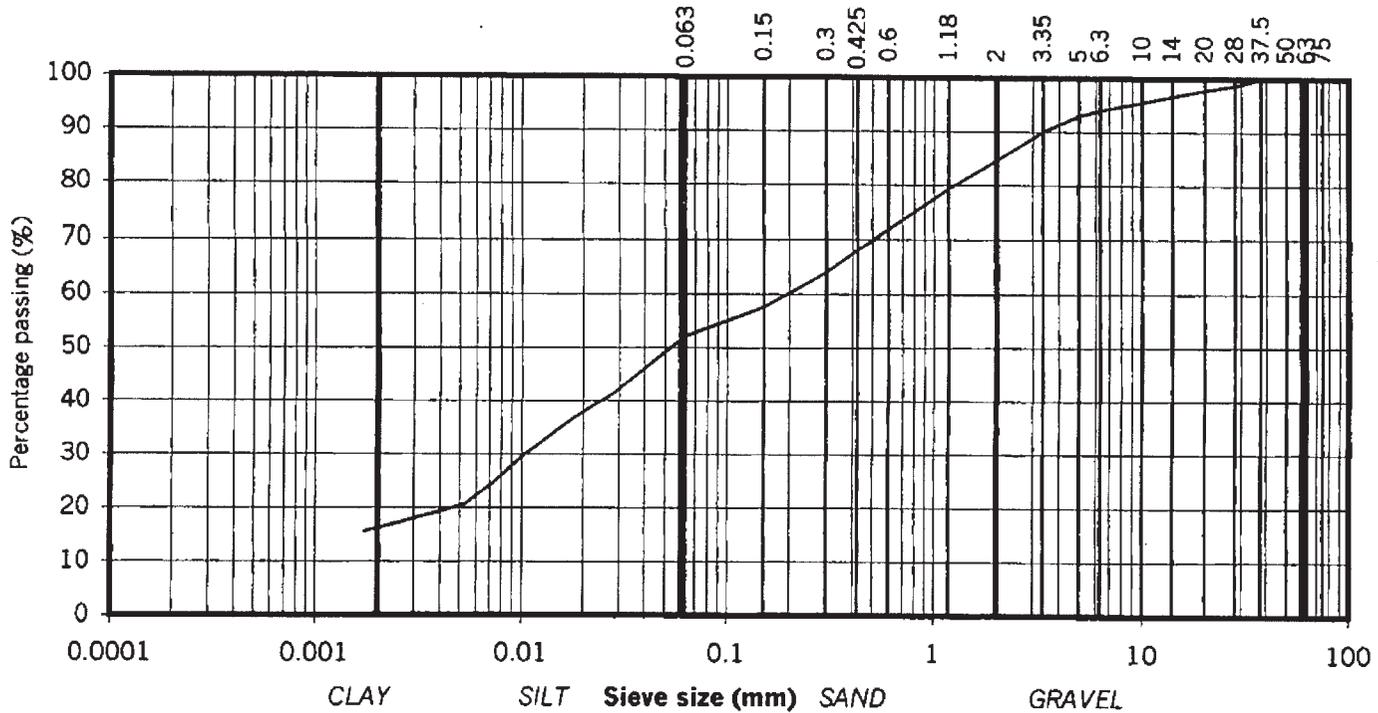
Tested in accordance with: BS1377:Part 2:1990 , clauses 3.2 & 9.2

R5619

sieve size	% passing	
125	100	COBBLES
75	100	
63	100	
50	100	
37.5	100	GRAVEL
28	99	
20	98	
14	97	
10	95	
6.3	94	
5	93	
3.35	90	SAND
2	85	
1.18	79	
0.6	72	
0.425	68	
0.3	64	SILT/CLAY
0.15	58	
0.063	52	
0.027	41.1	
0.017	36.5	
0.010	29.8	
0.007	24.7	
0.005	20.5	
0.002	15.5	

Contract No: 9253
 Contract: PHOENIX PARK RACECOURSE
 Lab. Sample No. 7141/E587 Location: BH.5 at 1.00m
 Date Tested 12/12/03 Engineers: O'MUIRE-SMYTH
 Test Method: Wet sieve Client: FLYNN & O'FLAHERTY
 Description: Brown slightly sandy, slightly gravelly, SILT/CLAY

Moisture Content: 26.1%



IGSL

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	09/01/04		09/01/04	1 of 1

Approved signatories: J Barrett (Technical Manager) S Elliot (Laboratory Manager)

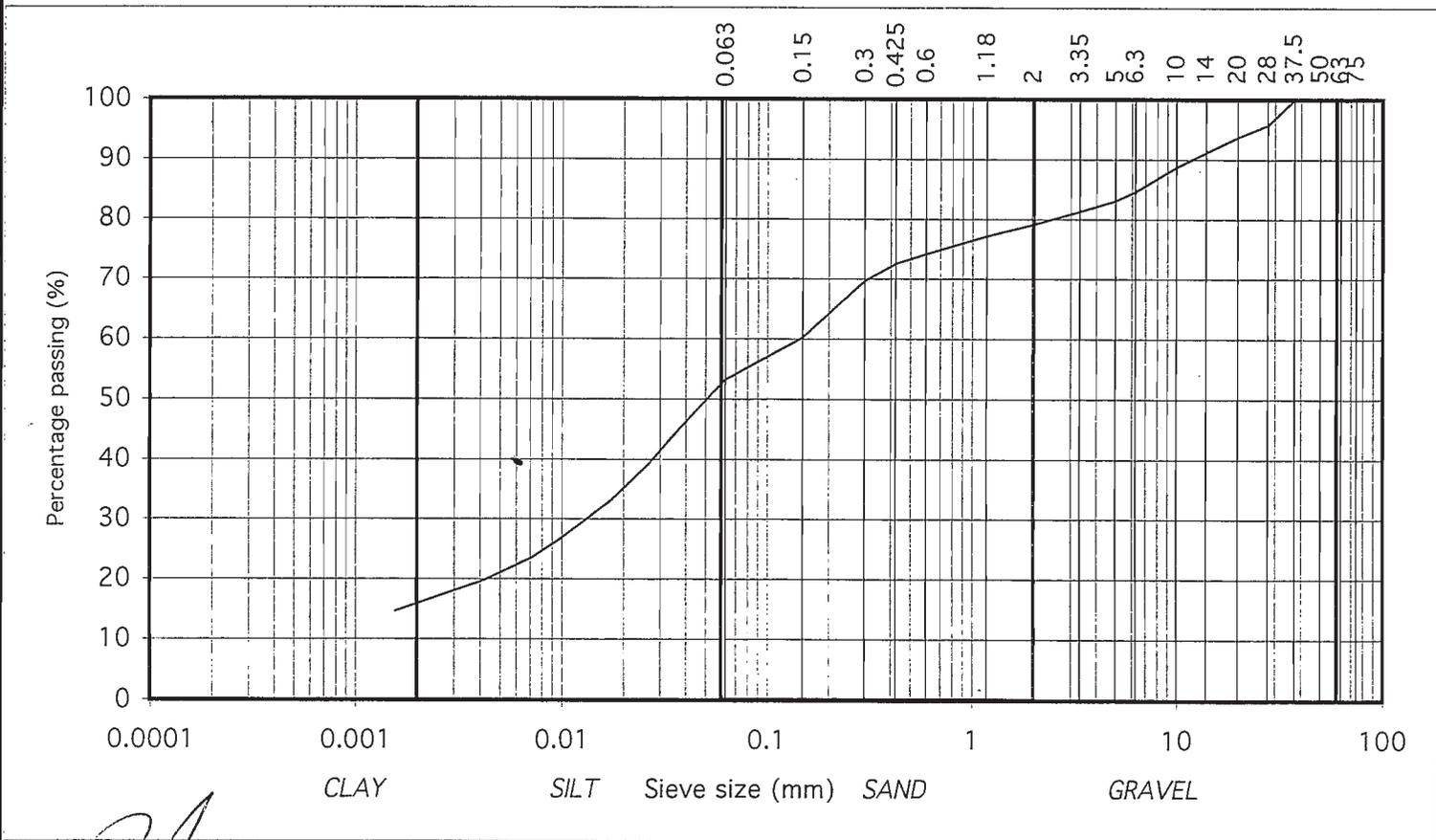
Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

R6617

particle size	% passing	
75	100	COBBLES
63	100	
50	100	
37.5	100	
28	96	
20	94	GRAVEL
14	91	
10	89	
6.3	85	
5	83	
3.35	81	SAND
2	79	
1.18	77	
0.6	74	
0.425	72	
0.3	70	SILT/CLAY
0.15	60	
0.063	53	
0.037	45	
0.027	39	
0.017	33	
0.010	27	
0.007	24	
0.004	20	
0.002	15	

Contract No: 11836
 Contract: BLANCHARDSTOWN TOWN CENTRE
 BH/TP No: BH 1
 SAMPLE No.: 7854
 DEPTH (m): 2.00
 TEST METHOD: Wet sieve and hydrometer
 DESCRIPTION: Mottled brown slightly sandy, slightly gravelly, CLAY



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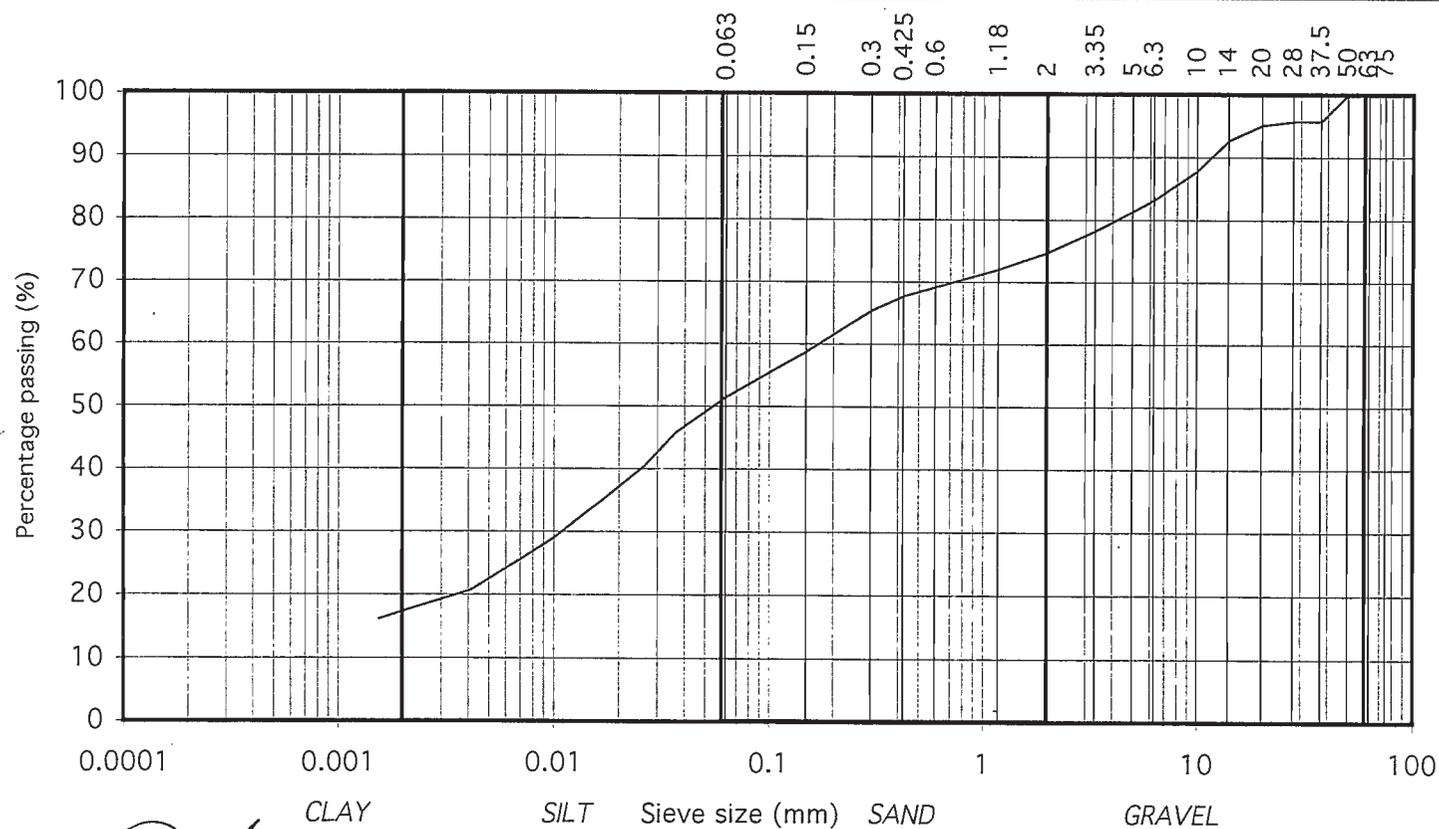
Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

R6617

particle size	% passing	
75	100	COBBLES
63	100	
50	100	
37.5	96	GRAVEL
28	96	
20	95	
14	93	
10	88	
6.3	83	
5	81	
3.35	78	
2	75	
1.18	72	
0.6	69	SAND
0.425	68	
0.3	65	
0.15	59	
0.063	51	SILT/CLAY
0.037	46	
0.027	40	
0.017	35	
0.010	29	
0.007	26	
0.004	21	
0.002	16	

Contract No: 11836
 Contract: BLANCHARDSTOWN TOWN CENTRE
 BH/TP No: BH 5
 SAMPLE No.: 7840
 DEPTH (m): 4.00
 TEST METHOD: Wet sieve and hydrometer
 DESCRIPTION: Grey slightly sandy, slightly gravelly, CLAY



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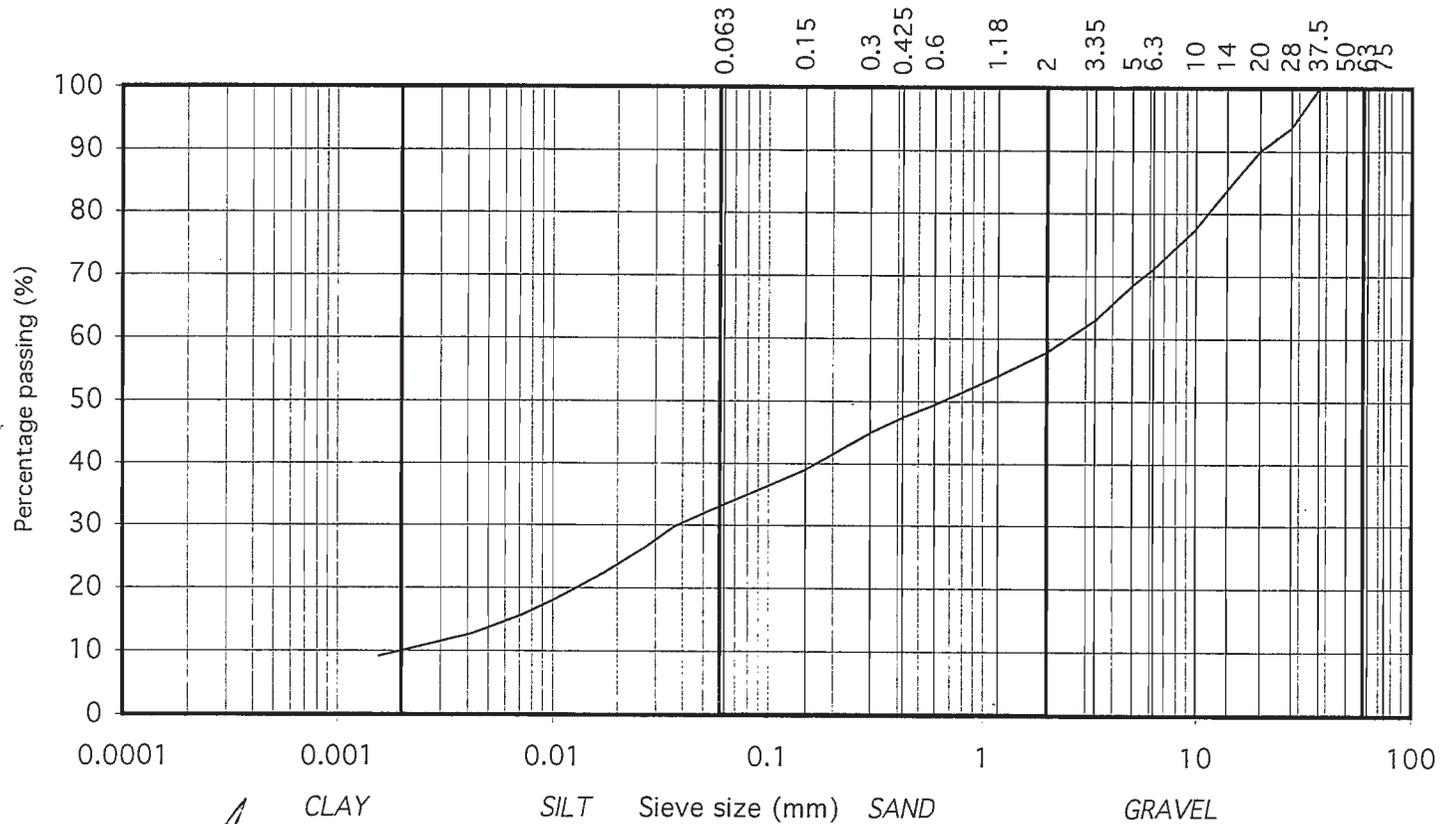
Determination of Particle Size Distribution

BS1377:Part2:1990 , clauses 9.2

R6617

particle size	% passing	
75	100	COBBLES
63	100	
50	100	
37.5	100	
28	94	
20	90	GRAVEL
14	84	
10	78	
6.3	71	
5	68	
3.35	63	SAND
2	58	
1.18	54	
0.6	49	
0.425	47	
0.3	45	SILT/CLAY
0.15	39	
0.063	33	
0.037	30	
0.027	26	
0.017	22	
0.010	18	
0.007	16	
0.004	13	
0.002	9	

Contract No: 11836
 Contract: BLANCHARDSTOWN TOWN CENTRE
 BH/TP No: BH 6
 SAMPLE No.: 7849
 DEPTH (m): 4.00
 TEST METHOD: Wet sieve and hydrometer
 DESCRIPTION: Grey brown slightly sandy, gravelly, CLAY



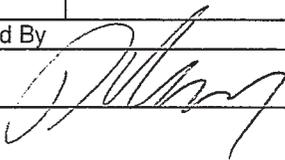
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Summary of Classification Tests

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
BH 1	7854	2.00	D	14.6	33	16	17	72.0	WS	Mottled brown slightly sandy slightly gravelly CLAY	C L
BH 2	7281	3.00	D	11.7	28	16	12	61.7	WS	Mottled grey slightly sandy slightly gravelly CLAY	C L
BH 3	7862	2.00	D	11.9	31	15	16	75.1	WS	Brown slightly sandy slightly gravelly CLAY	C L
BH 3	7866	6.00	D	12.2	31	15	16	72.5	WS	Mottled grey brown slightly sandy slightly gravelly CLAY	C L
BH 4	7826	1.00	D	10.5	32	15	17	75.3	WS	Mottled brown slightly sandy slightly gravelly CLAY	C L
BH 5	7840	4.00	D	11.1	29	14	15	68.0	WS	Grey slightly sandy slightly gravelly CLAY	C L
BH 6	7846	1.00	D	21	51	26	25	66.9	WS	Brown slightly sandy slightly gravelly CLAY	C H
BH 6	7849	4.00	D	14.7	30	16	14	47.0	WS	Grey brown slightly sandy slightly gravelly CLAY	C L

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

IGSL	Contract	BLANCHARDSTOWN TOWN CENTRE				Contract No.	11836
	Issued By		Date	6/7/06	Date	Page	
							of

Appendix F

Geotechnical Risk Register

ARUP

JOB TITLE	Blanchardstown to City Centre Core Bus Corridor
JOB NUMBER	268401-00
MADE BY	Ozgur Alper
CHECKED BY	Geoff Petelka
DATE	30/06/021
Description of spreadsheet	Geotechnical Risk Register
Member/Location	
Filename	Geotechnical Risk Register

CONTENTS OF SPREADSHEET

Sheet	Description
Cover	
Notes	
Geotechnical Risk Register	
Hide	Hidden

AUTHORISATION OF LATEST VERSION

Type and method of check		
Signatures & dates:	Made by	
	Checked	

REVISIONS	Current Revision	
	Current Status	

Rev.	Date	Made by	Checked	Description
1	08/07/021	OA	GP	JoC

(1) Purpose of spreadsheet

1. The Geotechnical Risk Register should be utilised as a live document throughout the life cycle of the design process (*i.e. from desk study stage through to construction*)
2. The RR has been designed for the user to initially identify the hazard and subsequently identify the associated risks.
3. While in the past the hazard and associated risk may have been amalgamated into a single input, this suggested method forces the users to think about the specific hazard which may exist and additional risks which could arise.

(2) Key Notes of Guidance

1. This is a risk register. As such each item should be developed around a particular risk. In some situations, a single hazard may present two or more different risks. If this is the case, each risk should be identified and itemised in the register.
2. The sub-ref should be used in situations where a risk evolves over the life-cycle of the project. *i.e.* a subsequent aspect of the risk has been identified even after the prescribed mitigation control.

(3) Risk Analysis Matrix

Risk Table	Severity			
	Likelihood	H	M	L
H	H	H	M	L
M	H	M	L	L
L	M	L	L	L

(4) Sources of data & Links to other spreadsheets

Date	File path / URL	Description

(5) Special features

(6) Diary of development, including checking

(if supplement is needed to Cover page)

Date	Who	Description

Best Practice Guide

1. Don't duplicate raw data in the spreadsheet *i.e.* use cell references where possible.
2. Use colours to distinguish between fixed data, user-variable data, calculations and results.
3. Explicitly define constants to be used in equations, using named cells where appropriate.
4. Avoid password use unless essential and documented (to avoid loss of work with loss of password).
5. Ensure extracts copied to other documents can be traced back to the spreadsheet.
6. Plot to engineering scale whenever sensible to do so, and make units obvious.
7. For charts, use colours/patterns which will be distinguishable if printed or photocopied in black & white.
8. Give sheets & workbooks descriptive names.
9. Use comments to describe the purpose of individual cells and ranges of cells.
10. Use the revision facility on the cover page and maintain the diary where further details required.

GEOTECHNICAL RISK REGISTER

Please refer to notes for more information

Rev.

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JOB TITLE: **Blanchardstown to City Centre Core Bus Corridor**
 JOB NO: **268401-00**

Particular Definitions

Hazard: Ground conditions and geotechnical related elements which have the potential to adversely impact on the project.
Risk: The consequence if a particular hazard was to occur or was left untreated.



Ref.	Sub Ref.	Created By		Phase of Works and/or Source	Hazard			Risk		Risk / Opportunity	Pre-Mitigation Risk Analysis			Risk Control Mitigation Measures			Post-Mitigation Risk Analysis			Status
		Date	Initials		Hazard	Observation / Cause	Location of Hazard	Risk Exposure	Risk Impact Category		Likelihood L/M/H	Severity L/M/H	Risk L/M/H	Mitigation Measures	Phase of Application	Required by	Likelihood L/M/H	Severity L/M/H	Risk L/M/H	
1	(i)	30/06/2016	OA	Preliminary Design	Contamination	Encountering unexpected contaminated ground during construction.	Site Extent	Material present may be contaminated. This presents a health and safety risk during the construction.	Health & Safety	R	M	M	M	Further GI to be scheduled at detailed Design	Ground Investigation	Client	L	L	L	Active
2	(i)	30/06/2016	OA	Preliminary Design	Contamination	Presence of made ground	Site Extent	Material excavated during the works may not be suitable for reuse on site and require disposal to a licenced landfill.	Commercial	R	M	M	M	Further GI to be scheduled at detailed Design	Ground Investigation	Client	M	L	L	Active
3	(iii)	30/06/2016	OA	Preliminary Design	Unforeseen ground conditions	Less favourable ground material properties.	Geology	More excavation and replacement or ground treatment required.	Design	R	M	M	M	The detailed design should assess the proposed scheme elements and local ground conditions in accordance with Eurocode 7.	Detailed Design	Client	L	L	L	Active
4	(iii)	30/06/2016	OA	Preliminary Design	Settlement	Presence of very soft to soft material at Tolka River Bridge Widening	Geology	Material present may cause settlement and bearing resistance problems.	Design	R	H	H	H	The detailed design should consider the soft material.	Detailed Design	Client	L	L	L	Active
5	(iii)	30/06/2016	OA	Preliminary Design	Settlement	Presence of very soft to soft material at old Phoenix Park Racecourse based on historical ground investigation data	Geology	Material present may cause settlement and bearing resistance problems.	Design	R	M	M	M	Further GI to be scheduled at detailed Design	Detailed Design	Client	L	L	L	Active
6	(ii)	30/06/2016	OA	Preliminary Design	Unforeseen ground conditions	Low undrained shear strength and effective parameters of Made Ground	Geology	Material present may cause settlement and bearing resistance problems.	Design	R	H	M	H	Strength and physical properties of made ground should be investigated at site before the construction	Detailed Design	Contractor	L	L	L	Active
7	(iv)	30/06/2016	OA	Preliminary Design	Chemically reactive ground	Aggressive ground conditions	Geology	Chemical attack on buried concrete due to acid and/or sulphate in the soil or ground water.	Design	R	M	M	M	Limited sulphate and pH level testing indicates that aggressive ground is not present. Concrete class shall be chosen to ensure required durability.	Detailed Design	Contractor	L	L	L	Active
8	(i)	30/06/2016	OA	Preliminary Design	Contamination	Re-useability of the material	Geology	Material excavated during the works may not be suitable for reuse on site and require disposal to a licenced landfill or require suitable material to be imported.	Design	R	M	M	M	Further GI to be scheduled at detailed Design	Ground Investigation	Client	L	L	L	Active
9	(iii)	30/06/2016	OA	Preliminary Design	Settlement	Insufficient characterisation of the ground materials.	Geology	Unexpected or poor ground materials could lead to excessive deformation of the retaining walls if it is not assessed and considered during detailed design.	Design	R	M	M	M	Further GI to be scheduled at detailed Design	Detailed Design	Client	L	L	L	Active